

THE PERFECT STORM



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THE PERFECT STORM

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6 Wild Issues
about Extreme
Weather



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THE PERFECT STORM

6 Wild Issues on Extreme Weather

Welcome to the ultimate exploration of the weather—the [Perfect Storm](#). For the first time, the six magazines from Cobblestone Publishing explore the same theme at the same time. It's a look at a single topic, but from six different angles: the world of weather and how it affects us all. From extreme weather to strategies for coping with global warming to weather refugees, the Perfect Storm presents a wide look at an issue that is on everyone's mind these days.

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A KING WHO
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ENCOUNTER
With Mother Nature

How Trees
Tell of
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Holland's Constant
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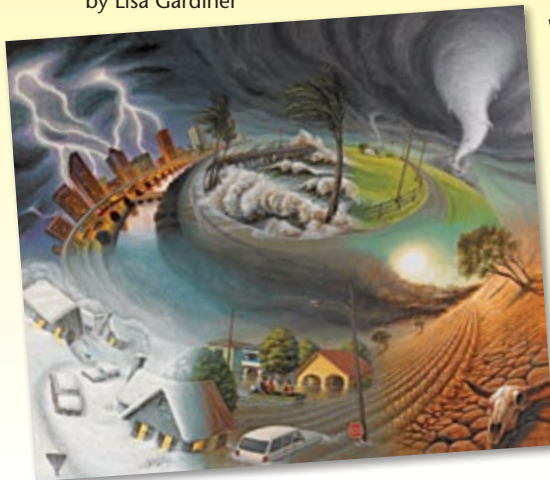
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Weather—It can help and it can hurt! Find out how in CALLIOPE and her five sister magazines. Their March covers are all taken from this "weather poster"!

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WICKED WEATHER FACTS



1 The largest hailstone thus far recorded in the United States fell in Vivian, South Dakota, on July 23, 2010, and measured eight inches in diameter.

2 The largest recorded snowflake fell on January 28, 1887, in Montana. It measured 15 inches across and 8 inches thick.

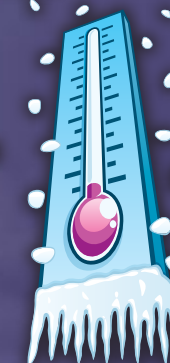


3 The heaviest recorded rainfall dates to July 18, 1995, when almost 72 inches fell in a 24-hour period in Foc-Foc, Reunion, an island in the Indian Ocean.



4 The hottest temperature ever recorded on earth was in Al Aziziyah, Libya, in northern Africa, when it reached 139.9 degrees Fahrenheit on September 13, 1922.

5 The coldest temperature ever recorded on earth was in Vostok II, Antarctica, when it reached -128.5 degrees Fahrenheit on July 21, 1983.



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ABOUT THE COVER: For the full weather report, after you read this issue of **CALLIOPE**, check our her sister magazines—**APPLESEEDS**, **COBBLESTONE**, **DIG**, **FACES**, and **ODYSSEY**.

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CALLIOPE is pronounced **kub LIE o pee**. In ancient Greek and Roman mythology, Calliope was the Muse of epic poetry and eloquence. The ancients honored the Muses as the goddesses of the arts and sciences.

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Sunshine is delicious, rain is refreshing, wind braces us up, snow is exhilarating; there is really no such thing as bad weather, only different kinds of good weather.

—John Ruskin (1819–1900),
leading English author and art critic

WHY LAND BRIDGES?

by Patricia d. Lock

Millions of years ago, most of the landmasses in today's southern hemisphere were joined together in a supercontinent called Gondwana. When the supercontinent split up, the landmasses moved apart and were separated by seas. Living species, detached from the rest of their kind, continued their evolution and development along divergent lines.

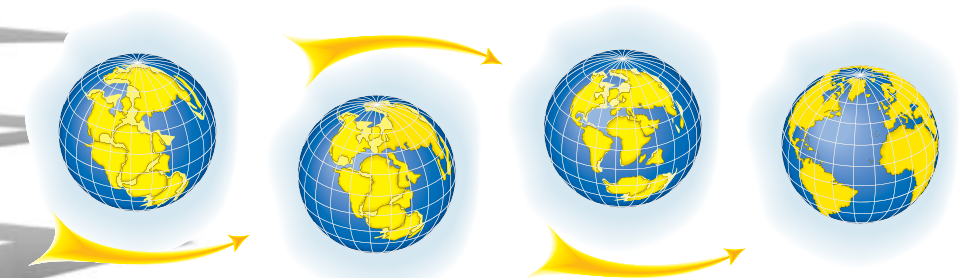
A 'Neat' Overpass

What curious phenomena appear when sea levels fall and then disappear again when they rise? —Land bridges, of course! They are what humans used to move from our origins in Africa across the rest of the world.

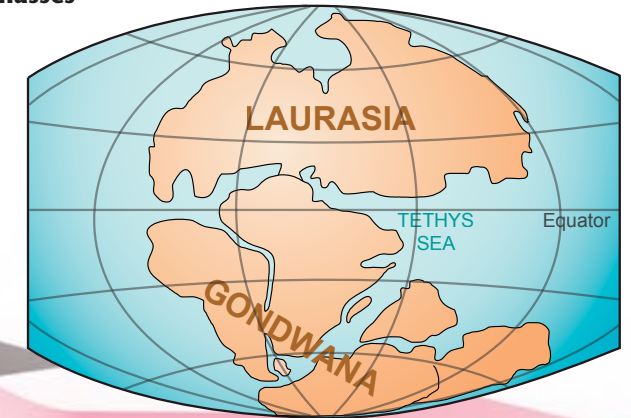
A "land bridge" is a connection between two landmasses that usually are separated by water. Due to some change, land that was water-covered becomes exposed. This creation of a "bridge" between two separate

terrains allows the exchange of plant and animal species. Large migrations can change the balance of nature in both places. When the land bridge floods, those that migrated are again isolated.

The scientist Jules Marcou first proposed the theory of land bridges in 1857 to explain why different continents had so many similarities. Geologists at that time had a great deal of evidence that connections between some landmasses had once existed. With a growing understanding of ice ages, they also understood what made sea levels fall. Land bridges became the leading explanation for the similarity of geology, fossils, and life on widely separated continents. This view held until the theory of plate tectonics



And so the landmasses moved apart



The earth's northern landmasses (Laurasia) and southern landmasses (Gondwana) some 200 million years ago

became accepted in the 1960s.

Land bridges are created in three ways. The most common is by marine regression—that is, when sea levels fall, the sea floor is exposed. Land bridges can also appear due to the effects of plate tectonics or the rise of the sea floor when weight from glaciers is removed—a phenomenon known as "rebound." Most of the land bridges we know were exposed during ice ages, when sea levels lowered because the water was locked up in glaciers.

The most recent ice age peaked about 20,000 years ago. As the ice age came to a close, the glaciers melted, and the land bridges were flooded. In a modern-day opposite of glaciation, global warming is already raising sea levels. As the waters rise, land bridges that exist today may be submerged just as the prehistoric ones were.

Meet 15 of the Earth's Largest Plates



Did you know?

The theory of plate tectonics (formerly called continental drift) was put forward by meteorologist Albert Wegener in 1915. He explained how the continents were once linked, but could not explain the mechanism that allowed them to move. It took what amounted to a 50-year argument for the theory finally to be accepted. By then, Wegener had died on an arctic weather study in Greenland.

Linking Africa and Asia

The Isthmus of Suez is the first land bridge that allowed humans to spread across the globe. It connects Africa to Asia and was formed where the rift valley separating Africa from Asia stopped growing 28 million years ago. Today, the Isthmus of Suez is also part of a much larger political "land bridge"—the crossroads of the world where Africa, Asia, and Europe meet.

The earth's lithosphere is its outer solid part. The section just below the top crust is composed of several large, thin, relatively rigid plates. Plate tectonics is the theory that says these plates at the plate boundaries can cause earthquakes.

The Asian mainland had a land bridge connecting it to Sumatra, Java, and Borneo. This land bridge arose during the last **glacial maximum** around 26,500 years ago. At the time, the receding phase of the last ice age was occurring, and it was a period of strong climate variation, which would have caused changes in local vegetation. This situation, along with exposure of the land bridges, may have spurred people living there to explore farther east toward Australia.

Australia had two land bridges, one reaching from the mainland to New Guinea, and a smaller one connecting Australia to

Glacial maximum refers to a period in the earth's climate history when ice sheets are at their maximum extent.

Tasmania. These land bridges were also exposed during the last glacial maximum, when sea levels in the area dropped as much as 400 feet. Their formation was crucial to human expansion there since without the land bridges, sea distances were too great for migration.

The Best-Known Link

The best-known land bridge is the Bering Strait land bridge, which linked eastern Asia to the North American continent near present-day Alaska. Scientists believe that this bridge was the route humans took to North America around 20,000 years ago. At that time, the area was broad, flat grassland that attracted herds of animals and the hunters who followed them. At the end of the ice age, the glaciers retreated and sea levels rose, cutting the hunters off from their origins. The land bridge was submerged and by 6,000 years ago, the coastline looked much as it does today.

As humans spread across the North American continent, they moved south until they reached another land bridge—the Isthmus of Panama. This 48-mile-wide strip of land connects North and South America. It was created when the collision of the Pacific Plate and the Caribbean Plate pushed up the sea floor. Its appearance about 3 million years ago allowed "the Great American Interchange"—an exchange and intermixing of plants, animals, and, later, humans who traveled north and south

Did you know?

There is no evidence for a land bridge ever linking New Zealand to Australia. New Zealand's origins appear to have been as a block that separated from the supercontinent Gondwana about 80 million years ago, either near what became Australia or possibly from what became South America. There are geological and plant similarities among the three areas to this day.

Calliope Says

Check out this image of the Gulf of Suez. You can see that the two sides were once joined but have moved apart and along each other as the rift was formed:
http://en.wikipedia.org/wiki/File:GOS_WWsat.PNG



across the bridge. The Isthmus of Panama will likely be affected by future sea level rise because the Panama Canal's highest point is only 85 feet above sea level.

Linking England to the Mainland

There were two land bridges linked to Great Britain. The smaller one connected it to Ireland and was most likely caused by rebound as the 2000-foot-thick ice sheets retreated at the end of the last ice age. Because of its different origin, the Ireland land bridge flooded around 12,000 years ago, well before many of the other land bridges. This meant that humans and other European species did not arrive there until much later.

Great Britain's other land bridge, sometimes called Doggerland, connected it to mainland Europe. At that time, most of the North Sea and the English Channel were exposed grassy tundra. Humans and other mainland species lived on the tundra and crossed to settle in what would become Great Britain. Doggerland was flooded by the sea about 8,500 years ago. Today, fishing trawlers occasionally drag up mammoth fossils as well as human tools and weapons from the sea bed.

Land bridges show us how people came to be spread across the globe, even to seemingly impossible places. They also give us a sense of how our world can change over a relatively short period of time. Will some future fisherman net an artifact from our time that was lost when the seas rose? 🐟



In ancient times, nature was Egypt's best protection. The lands the Egyptians called home bordered the great, life-giving Nile River. To the north lay the Mediterranean Sea; to the east and west were vast deserts; and to the south were the cataracts. The traditional southernmost boundary was at Aswan, where the natural border that kept the country safe in this direction was the first cataract, a rocky area that slowed river traffic. The word derives from the Greek term *katarraktes*, which means "something that comes rushing or smashing down." Along the Nile, this meant waterfalls or river rapids.

The Mighty Six

There are six cataracts between Aswan and modern Khartoum, the capital of Sudan. At each, the Nile is rocky or had a significant change in elevation. The cataract at Aswan was an area filled with small islands and rocky outcroppings.

The second was southwest of present-day Lake Nasser. Today, it is underwater, as the construction of the High Dam at Aswan caused the waters upstream to rise substantially. The third lies downstream from the modern town of Dongola in Sudan. Upstream of the third cataract, the Nile first turns north and then south again, forming a horizontal S-shape. The fourth and fifth cataracts are on either side of this great bend. The sixth cataract is about halfway between the fifth cataract and Khartoum, where the two major branches of the Nile, the White and the Blue, join together.

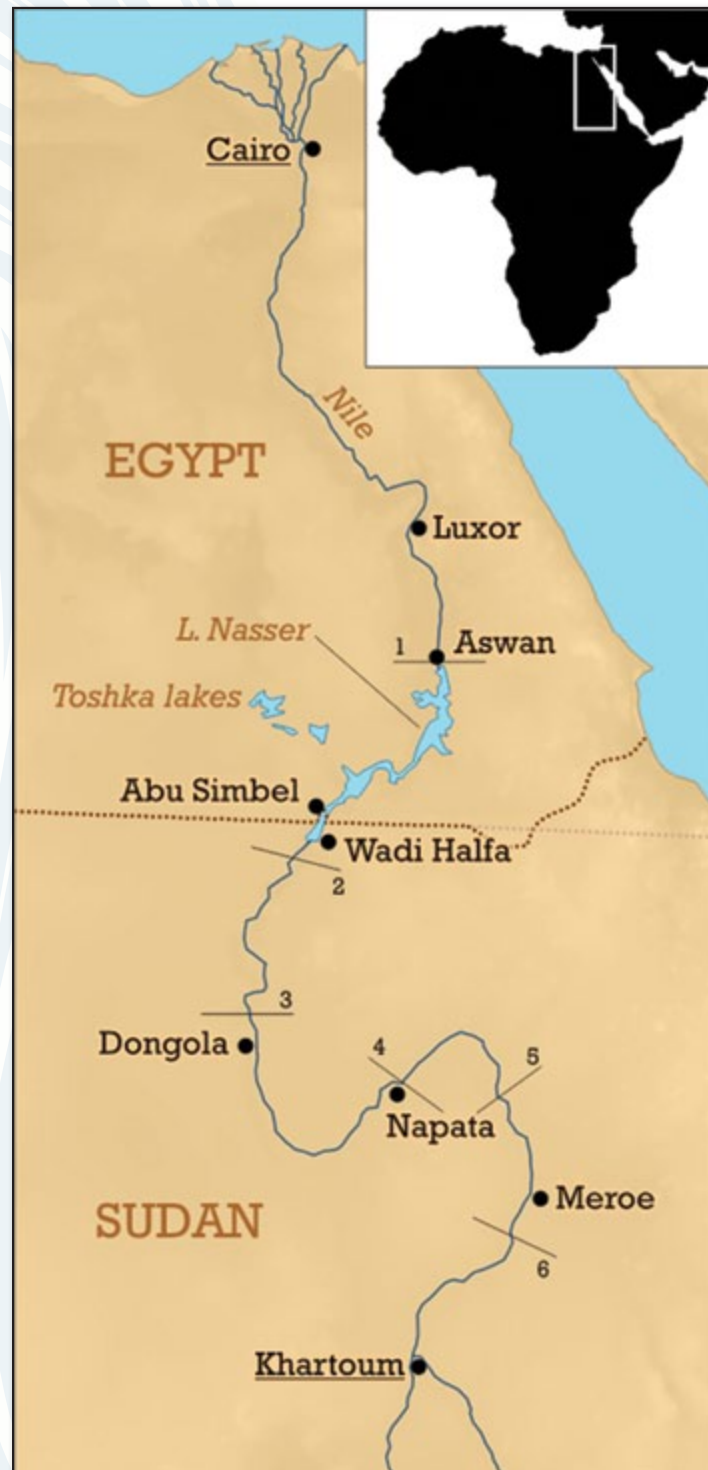
To the ancient Egyptians, the area of the first cataract was considered the source of the Nile flood and the origin point of the river. They knew that the Nile continued south, but it was the first cataract that formed their definite boundary line. They saw their land, lying between Aswan and the Mediterranean, as an area where justice and order ruled. What lay beyond what nature provided as

CATARACTS AS BOUNDARIES

by Angela Murock Hussein

The sun sets on the Nile, winding its way through some rough terrain in Northern Sudan.

THE NILE'S CATARACTS



This map, with the Nile's six cataracts marked, shows the present-day boundary between Egypt and Sudan (ancient Nubia).

natural boundaries, such as the deserts or foreign lands, they considered dangerous and chaotic.

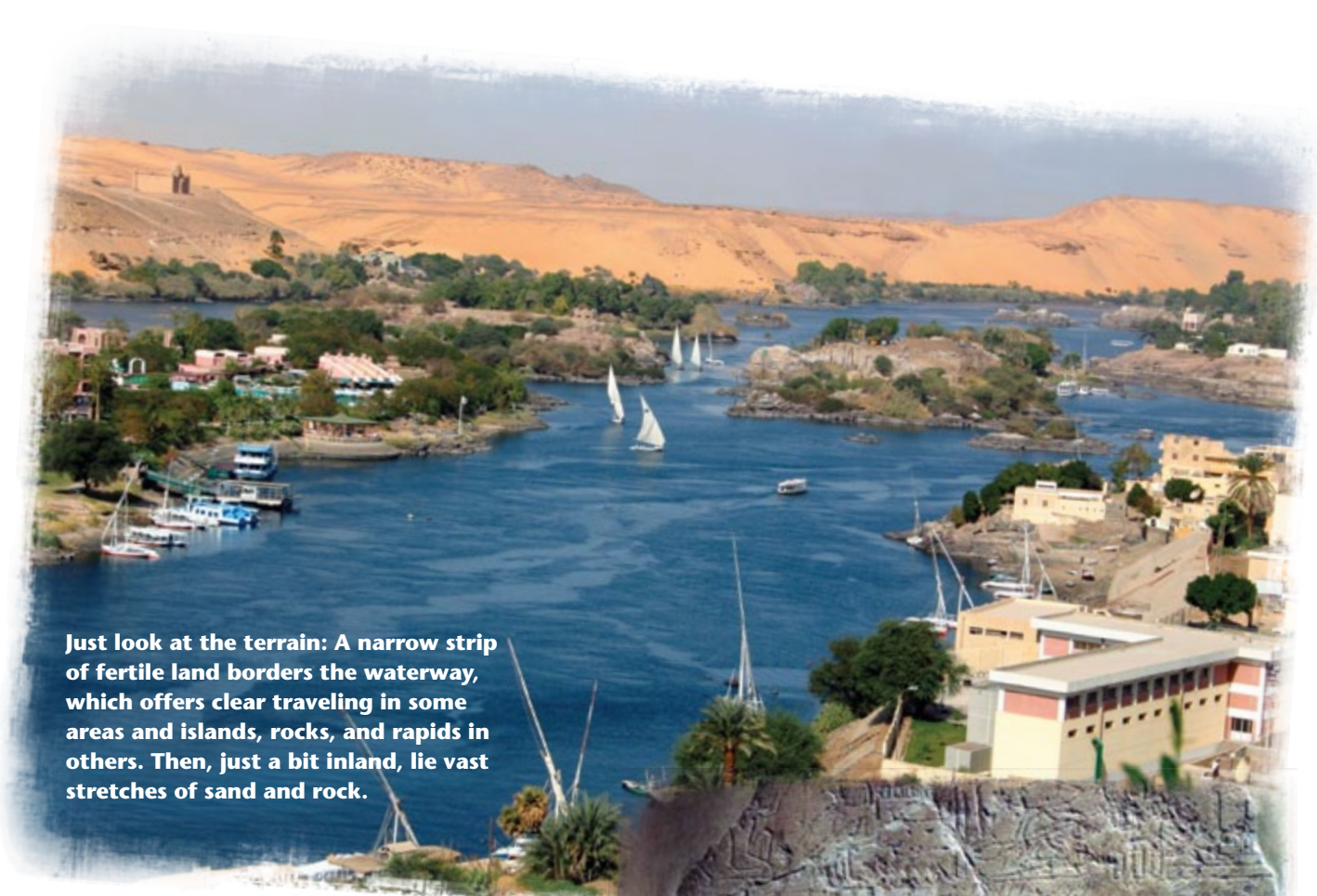
Navigating the Nile

Since boats were the most common mode of travel in the Nile Valley in ancient times, the Nile was the country's superhighway. All types of traffic used the Nile, including commercial and military. The cataracts were natural stopping places on that highway. The absence of cataracts from Aswan to the Mediterranean helped keep Egypt unified and connected for much of its history, especially since even the largest boats could travel the distance smoothly and swiftly. At the same time, the cataracts south of the border protected Egypt against would-be invaders. To navigate cataracts, boats had to slow down. In addition, large boats or fleets of boats, such as those that would be required to transport troops and supplies, would have had to go through in single file, making them vulnerable to attack. Because the same was true of merchant vessels, Egypt grew rich by controlling the trade that passed through.

From the time when Upper and Lower Egypt were unified into one kingdom, the natural southern border of the country had been in Aswan. Here were the quarries of red granite that was used in building the royal tombs. To the south lay the land of Nubia, which had a long history of interacting with its northern neighbor and which, like Egypt, grew wealthy from its control of the trade route. Egypt traded with Nubia for such products as gold, ivory, animal skins, and ostrich eggshells, which were used for drinking vessels.

In Control—North and South

The Nubians were fierce warriors and well-known for their skill as archers (see opposite). In fact, Nubian archers sometimes fought as mercenaries in the Egyptian army.



Just look at the terrain: A narrow strip of fertile land borders the waterway, which offers clear traveling in some areas and islands, rocks, and rapids in others. Then, just a bit inland, lie vast stretches of sand and rock.

At different times in antiquity, Egypt invaded Nubia to claim more direct control over its lands and wealth. As a result, through the centuries, the southern border of Egypt shifted sometimes farther south and sometimes to the north. The cataracts, however, always functioned as stations where river traffic could be controlled by the kingdoms of both Egypt and Nubia.

In Aswan, there was an island called Elephantine, so named because ivory was traded there. At the second cataract was the extensive walled town of Buhen, which was founded as a military installation in the Middle Kingdom and grew larger during the course of its 200-year life. Near the third and fourth cataracts were Kerma and Napata, which were, at different times, the capitals of the Nubian kingdom of Kush. The sixth cataract was close to Meroe, which also served as a Kushite capital. So it was that the most important cities of Nubia, as well as the command posts of its central



Hatshepsut, an 18th Dynasty Egyptian ruler, had reliefs of Nubian archers adorn a wall in her temple at Deir el Bahri.

authority, were centered near the cataracts nature had positioned along the Nile. 🏛️

Angela Murock Hussein is an archaeological consultant and a cataloger for the Mochlos Excavations in East Crete.

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monsoons – a trading partner

by Annamma Spudich

Today, black pepper is the most commonly used spice in the world. But, this was not always true. For several hundred years, it was the most sought-after commodity in international trade.

Like other rare spices, pepper is the

Peppercorns, anyone?

natural product of just the southwest corner of India known as the Malabar Coast (present-day state of Kerala). Archaeological evidence shows that pepper was being used at least as early as 2000 B.C., and excavations in India's Indus Valley offer evidence of the use of pepper and other herbs and spices by 1000 B.C. The ancient Chinese valued it as a treatment for such illnesses as malaria, cholera, and dysentery.

A Costly 'Treat'

As pepper consumption increased, so, too, did the cost of the spice. During the first century A.D., Greek and Roman merchants came to India to buy the spice. Caches of gold and silver Roman coins discovered at excavation sites in south India and references in writings bear witness to the vast sums of money Europeans spent for pepper. According to the first-century A.D. Roman author Pliny, pepper sold in Rome for 100 times its original cost. In fact, transporting pepper from India to Europe was an important part of the east-west spice trade.

Archaeological and literary evidence shows that the spice traveled west across the

seas on sailing ships and overland by horse and camel caravans. A major change in the east-west trade routes came in the first century A.D. Ancient sources credit a Greek mariner named Hippalus as the first westerner to learn how ships could use the southwest and northeast monsoon winds to their advantage.

For thousands of years, Easterners had been using these winds to help them navigate the Indian Ocean. Arab traders also knew the monsoon wind patterns and used them to aid their travel on the waters between the Malabar Coast and the Arabian Peninsula. When the southwest winds blew from April through October, they filled the sails of ships traveling from west to east. When the northeast monsoon blew between October and April, travel from east to west, from India to the Arabian Peninsula, was easier. By riding the monsoons, traders shortened the length of sea travel considerably.

The Secret's Out!

For centuries, Arab merchants had kept the use of the winds a secret. Tradition says that after Hippalus realized that the monsoon

winds reversed direction twice a year and recognized which winds blew when, Roman sailors quickly took advantage of his discovery and broke the Arab monopoly of the spice trade with India. By riding the monsoon winds, a roundtrip journey from Europe to India, which previously had taken two years by land, now took less than a year by sea. So it was that pepper literally began riding the monsoon winds from Malabar to Arabia, and then was transported on to Europe. Today, pepper is cultivated in many parts of the world, and no country is the exclusive source of the "rare spice." 🌶️

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Annamma Spudich, a scientist and native of Kerala, India, is researching the spice trade and the knowledge exchange between India and Europe.

Who knows? Perhaps some of these Greek coins once paid Arab merchants for some spices!

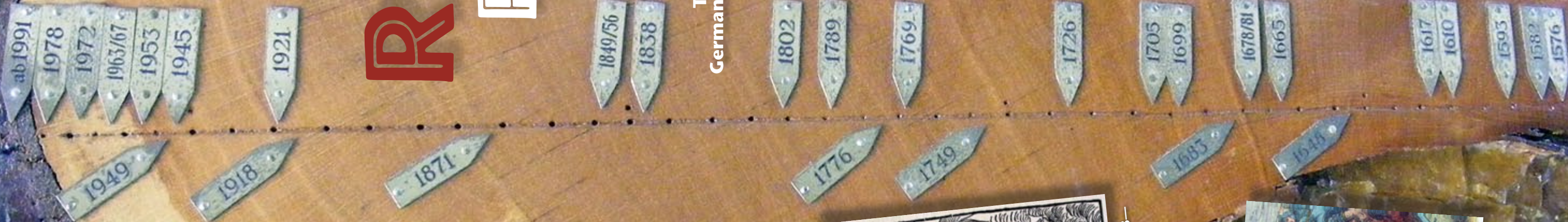
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TREES TELL OF ROME'S RISE AND FALL

by Marina DeBattista

The date tags on this cross-section of a German tree felled in 1991 mark the rings for many of the years from 1545 to 1991.



The Dance of Death—this version dates to 1493—was a common topic in the Middle Ages, especially following the deadly plagues that devastated Europe in the 1300s.



The Huns fight the Visigoths in the late A.D. 300s.

What do historical events such as the decline of the Roman Empire, the plague known as Black Death, and the 17th-century migration to America have in common? The answer—extreme weather conditions.

Today, we are all familiar with weather bulletins that provide forecasts. Their accuracy is simply the result of technological progress that has made it possible for the climate to be monitored closely and systematically. But this was not the case in the past, when only the most extreme weather phenomena were chronicled. Scientists, in their attempt to reconstruct climate history, must look beyond the often unreliable information left to us by our ancestors. Two good sources are tree rings and lake sediment cores, both of which can offer some clues. This is especially true in Europe, where wood was the preferred material for buildings and objects. The study of annual tree rings has been especially rewarding, as demonstrated by a recent article published in the journal *Science*.

'Reading' Wood

For 30 years, a team of scientists collected pieces of wood uncovered in ruins, archaeological sites, and artifacts found in France, Germany, and Italy. Even wood preserved in rivers and bogs was considered for this study. The result was, in the words of one author of the report, a "super-big data set." The 9,000 wood samples that were gathered have sealed within them the structure and pattern of tree rings covering



A researcher bores into a tree to obtain a core. Using dendrochronology, she will then use the rings to date the tree.

2,500 hundred years and offer clues to climate change during that time.

To unlock the information “stored” in these samples, the scientists used a technique known as dendrochronology. This method relies on the fact that annual tree rings are affected by weather conditions. The patterns found in tree-ring samples taken from living trees over the past 200 years were then compared with existing weather records for that same interval of time. The two were compared to establish how temperature and moisture affect the ring growth. For this particular study, oak samples from France and Germany were used to investigate the effect of moisture on ring growth. The effects of temperature were studied separately, based on stone pine and larch samples gathered from high altitudes in Austria.

Abundance Leads to Success

Armed with this information, the researchers then proceeded to analyze the samples collected. For the first time, a continuous and accurate weather history for France and Germany during the last 2,500 years was mapped, all based on the ring growth information. The scientists are confident that their results are accurate, because the data set available was so massive. As one researcher said, “You just need a lot of material and a lot of rings.”

The climate chronology established by this study revealed without any ambiguity that the warm temperatures favorable to agriculture did prevail between 300 B.C. and A.D. 200, a 500-year period that coincided with the rise of the Roman Empire. The fall of Rome occurred during a time of extended droughts that, in turn, led to foreign invasions. Favorable climate conditions returned around the early 800s, when new kingdoms, formed in the aftermath of the fall of the Roman Empire, started to consolidate. These lasted for about 500 years, corresponding to the peak years of medieval Europe. They, in turn, were followed by a cold snap and rainy summers that allowed both famine and great plagues to spread throughout Europe.

The same cold snap affected Greenland and caused its Viking population to move farther south in search of warmer temperatures. Research based on a different study of lake sediment cores in west Greenland that date back more than 5,000 years also indicate that temperature drops affected the area’s pre-historic inhabitants. Both studies reveal that there is a pattern of climate flip-flopping that interferes with and definitely impacts human activity.

Weather Not the Sole Cause

While these studies indicate that weather plays an important role in human history, weather, by itself, certainly does not cause historic events. The fall of Rome was not brought about by bad weather, but was the result of a number of complex social, political, and natural events. Pre-industrialized civilizations were greatly influenced by climate swings, while today’s globalized civilization is able to do more to affect the climate. 🏛️

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Marina Debattista is the production editor with Taylor and Francis in Abington, England, which publishes academic scientific journals.



BEWARE THE KAMIKAZE

by Gloria W. Lannom

J apan’s annual typhoon season begins in late summer and continues through the fall. Like the hurricanes that strike the east coast of the United States, these violent rain and wind storms are extremely destructive. The word “typhoon” describes its strength, as it derives from the Chinese words for “great wind.”

In the last part of the 13th century, typhoons contributed to the outcome of two major events in Japanese history. The Mongol hordes had earlier thundered across Central Asia to take China. Now, Kublai Khan, the grandson of the great Mongol conqueror Genghis Khan, sat on the Chinese

throne as the founder and first emperor of the Yuan Dynasty (1279–1368). After destroying the last resistance from the preceding Song Dynasty, he had invaded and subdued Korea. The first non-Chinese to conquer all China, he ruled a territory stretching from the Pacific Ocean to the Ural Mountains and from Siberia to Afghanistan. But he hungered for more land and saw Japan as his next conquest.

Kublai sent emissaries to conduct negotiations and then fumed when he was informed that the Japanese had rejected his demands to submit to Chinese rule and had even dared to behead his envoys.

Swoosh—and the typhoon sweeps up the Mongol fleet as it attempts to invade Japan.



This painting of Kublai Khan was done in 1294, shortly after his death that same year.

And the Invasion Begins

Still, the Japanese greatly feared invasion by the Mongol emperor's mighty military forces. The panicked members of the Japanese court in Kyoto, which, at the time, was the country's capital, began praying to their gods for deliverance. Meanwhile, the samurai, or military lords, made defensive preparations.

Kublai Khan's plan was to invade by sea. His commanders chose the shortest crossing point between Korea and Japan, a distance of about 100 miles over treacherously rough

waters. The first expedition arrived from Korea in mid-November 1274. Composed mainly of Korean ships manned by Korean sailors, the invaders staged a violent takeover of two small islands. They then advanced to the port of Hakata on the large island of Kyushu, where fierce fighting began. Japan's fall to the Mongol invaders seemed imminent.

Imminent, that is, until a warning came that a typhoon was about to strike the area. The weather-wise Korean sailors persuaded the commanders to send their men back to the ships before the storm struck land. For some, however, the advice came too late as tempestuous gales drove their vessels out to sea, destroying many of them. An estimated 13,500 men perished before the remaining ships made it back to Korea.

Just seven years later, in 1281, Kublai Khan tried again. That diplomatic effort also failed and, as in the past, his emissaries were beheaded. This time Mongols, Koreans, and Chinese sailors made up the attack force. But the Japanese were better prepared this time. With their difficult-to-scale stone defensive walls and improved strategy, they offered enormous resistance. And, helping them once again was a massive typhoon. Thus, it seemed fitting to the Japanese to name these winds *kamikaze*, or "divine winds," for who but the gods would send such help to their earthly followers.

The ferocious, gale-force southwest winds of mid-August blew continuously for more than two days, mercilessly pounding the shores, uprooting huge trees, and wreaking havoc on manmade structures. For the Mongols, the result was a catastrophe. They lost at least half their fleet and had to retreat.

A God-Given Victory

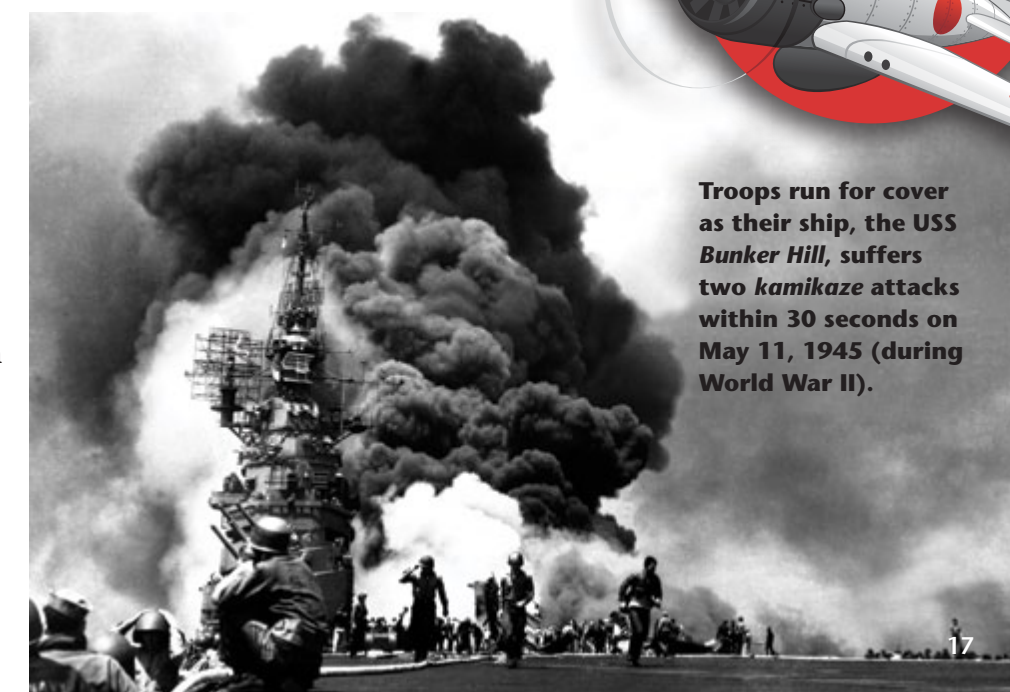
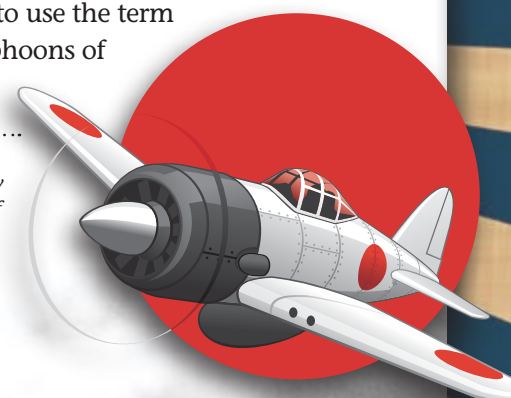
In the years that followed, the Japanese victory over Kublai Khan greatly affected how the Japanese thought of themselves. They became convinced that their islands were divine and that the gods had sent divine winds to

protect them from outsiders. It was not difficult for the Japanese to believe in the intervention of the gods because they traced their ancestry back to the mythical sun goddess Amaterasu. Many historians, however, think that the Japanese had more to thank than the storms for their victories. They see among the other contributing factors unseaworthy ships and the reluctance of the Chinese and the Koreans to fight.

Understandably, Kublai Khan found it difficult to gain support for a third invasion attempt. He died in 1294, never having accomplished his goal of taking control of Japan.

The term *kamikaze* surfaced again in the 1940s, as World War II raged in the Pacific. Some of the Allied forces began to use this Japanese word to describe suicide attacks on their shipping by Japanese airmen, soldiers, and boat crews. Not so with the Japanese, however, who continued to use the term to describe the violent typhoons of the 13th century.

On a visit to Kyushu Island, **Gloria W. Lannom** saw many painted clay Hakata dolls, one of the island's best-known products.



Troops run for cover as their ship, the USS Bunker Hill, suffers two kamikaze attacks within 30 seconds on May 11, 1945 (during World War II).

DID YOU KNOW?

There is a word in the English language that describes the ailment of a person with an extreme fear of wind and rain. It's *anemophobia*, a derivative of two Greek words: *anemos*, meaning "wind," and *phobos*, meaning "fear."



DROUGHT

REARRANGES KINGDOMS

by Susan Kegel



A swarm of locusts

"Voracious locusts. Soaring millet prices. An ever-increasing number of corpses lining the streets." Such was the news in China in 1640, when the country was in the middle of a seven-year drought. But, actually, the area had been unusually dry for the preceding 100 years.

Desperation Sets In

Historical records tell of three major droughts during this period, as well as a severe cold spell in 1629 that lasted for 14 years. A famine began in 1632, followed three years later by swarms of locusts. The dry weather turned to full-scale drought in 1637. By 1640, people were so desperate that they were eating tree bark and even corpses.

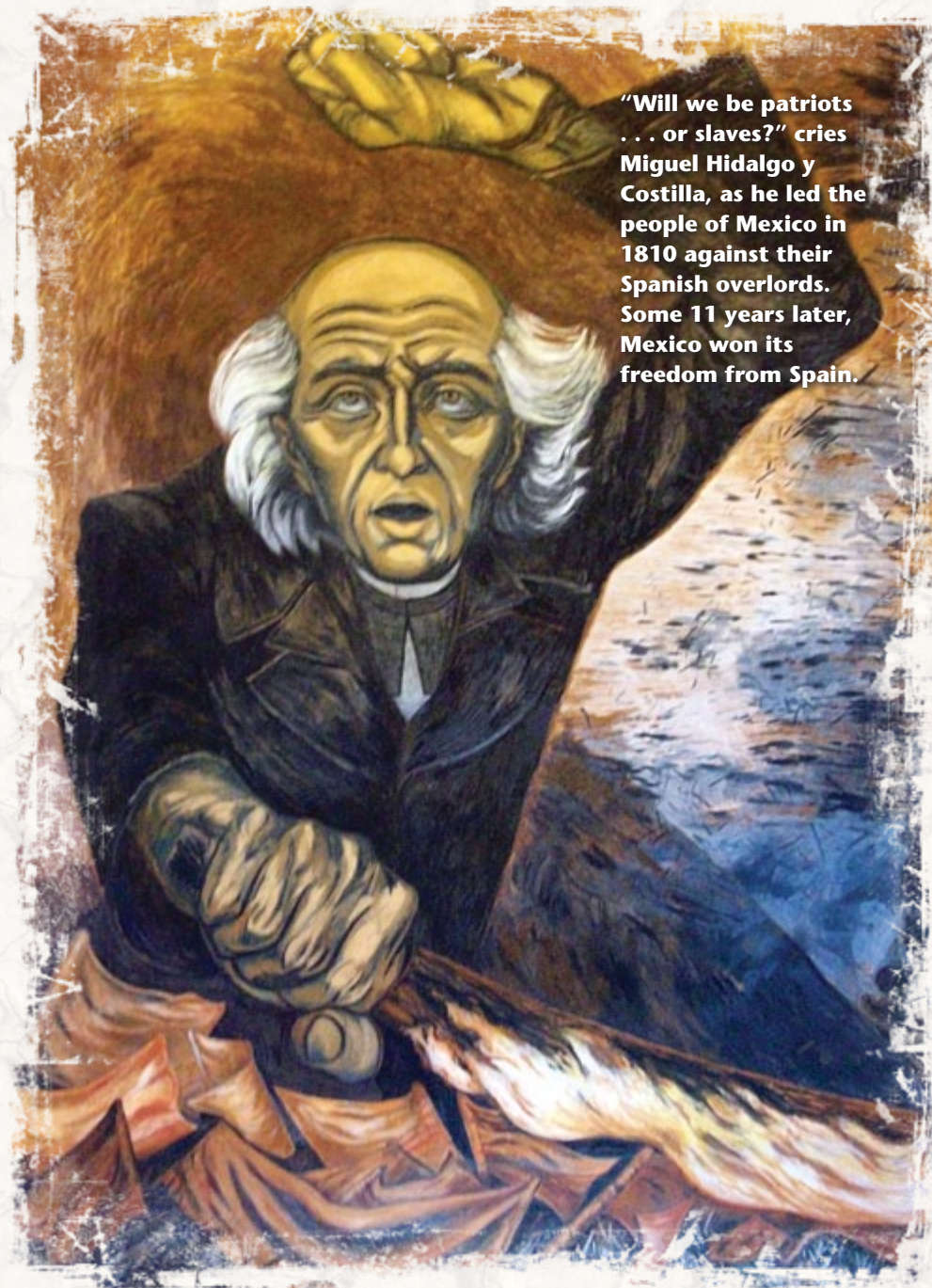


Manchuria, to the north, also suffered from the cold and drought and even stopped paying its annual tribute to China. Angered, the emperor of China sent in his army, which led to a long and costly war. But the Chinese were experiencing other difficulties as well. Because of the drought, the people had no money to pay their taxes, so the emperor could not pay the military. Some soldiers fled to find food elsewhere, some turned to crime, and others rebelled. With the country in chaos, the weakened government was no match for the Manchurians, who overthrew the Ming dynasty in 1644 and founded the Qing dynasty.

The Ming dynasty disaster is typical of severe droughts around the world. Crops wither and die, causing food shortages for people and livestock, which, in turn, lead to escalating prices for what food remains. As the economy grinds to a



Lush, flowering, foxtail millet



“Will we be patriots . . . or slaves?” cries Miguel Hidalgo y Costilla, as he led the people of Mexico in 1810 against their Spanish overlords. Some 11 years later, Mexico won its freedom from Spain.



Chinese people displaced by floods in August 1931

halt, people can no longer pay their taxes, leading the government, in many cases, to stop functioning. The land dries out so severely that the soil turns to dust and blows away. Forest fires, epidemics, and plagues of locusts are common. Unlike tornados, hurricanes, and other bad weather, droughts affect everyone for hundreds of miles, and the effects can last for years. In addition, people have few options. They can move away or they can rebel against their government in the hope that new leadership will fix the problem.

‘Year of Hunger’

In Mexico, for example, the people chose rebellion. In 1786, Mexico had not yet gained its independence from Spain, and there was such a severe

drought that people called it “the year of hunger.” Just three years later, another drought occurred. This time, an entire lake dried up to the extent that new land was exposed and neighboring villages quarreled among themselves over what belonged to whom. When the summer rains did not come in 1808, and then again in 1809, the people knew what to expect. Many starved or died from disease, while many others scoured the countryside for edible weeds or turned to

crime. Meanwhile, the Spanish government, weakened because of the constant wars in Europe, fell to the French ruler Napoleon. However, when Napoleon put his brother on the Spanish throne in 1810, the starving Mexican peasants saw an opportunity to rebel. After joining together to fight the foreign king, they finally won independence from Spain in 1821.

Scientists suspect that the droughts in China and Mexico had a similar cause. Unusually warm temperatures in the Pacific Ocean, a climate pattern known as El Nino, have caused drought not just in those two countries, but also in southern Peru, Bolivia, Brazil, Australia, Indonesia, parts of Africa, and India.

Welcome, Monsoons!

In India, in a normal year, temperatures start rising in February and the land dries out. By April, it can be as hot as 110 degrees every day. Dust covers everything in a grey tone, even obscuring the sky. People long for the monsoon rains that bring relief from the months of sweltering heat. Then, around June, clouds start to appear each morning. Finally, one day, the clouds grow larger and darker, and suddenly it pours. The change is instantaneous. The streets and trees are washed clean. People greet the rain with great joy. Children rush outside to play and dance for hours in the rain with their friends.

The monsoon season, which runs from June to September, brings 80 percent of India’s annual rainfall. When the rains do not come, the result is catastrophic for the farmers. Nine drought-induced famines in India between 1685 and 1899 killed more than 70 million people, including 600,000 deaths during Mexico’s “year of hunger.”

New Not Always Best

When new types of seeds and fertilizers were developed and became available in the 1960s, Indians hoped to prevent such famines. Using this Green Revolution

Let the monsoon rains come! These women in Darjeeling, India, have their boots and umbrellas to protect them as they pick tea leaves.



technology, the Punjab region in northern India tripled its food production.

But there are side effects. The new seeds require lots of water and fertilizers. So, when farmers began planting a month earlier to get the seeds growing before the rains came, the amount of water needed to irrigate the lands nearly doubled. Too much water, however, brings poisonous mineral salts up from lower soils, and the nitrogen in the fertilizers filters down and contaminates the water. In the process, the soil loses its natural fertility, and so the plants need even more fertilizer. As a result, after using these practices for 30 years, 100 times the amount of fertilizer produced only five times as much food.

Today, some Indian farmers are turning to the ancient practice of rainwater harvesting. They use small, semi-circular dams to collect water from rain-fed streams. The water forms a pond and soaks into the ground instead of running off. This method not only prevents the soil from drying out, but it also replenishes the wells. So, even if a village receives less than three inches of rain, it has enough water to grow crops. Throughout India, there are about 140,000 such reservoirs that can be cleaned regularly and put back into use, giving hope that future famines can be prevented with such environmentally friendly practices. 🏡

Susan Kegel is a freelance writer living in Redmond, Washington, where El Nino can bring dry winters and below-normal snowpack in the mountains, causing summer drought.

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FUN WITH WORDS

WORD ORIGINS

Cyclone By definition, the word “cyclone” refers to a storm that consists of a swirl of counterclockwise winds circulating around a low-pressure center. The word was coined in 1848 by British meteorologist Henry Piddington, who had studied storms in the Indian Ocean. To name such weather, he suggested using a variation of the Greek word *kyklon*, which means “revolving.” But Piddington apparently confused *kyklon* with another Greek word—*kykloma*, which means “a wheel” or “movement in a circle resembling the coil of a snake.” By 1856, the term was also being used to describe tornadoes in the United States, such as the cyclone in the story *The Wizard of Oz*. Today, the word “cyclone” once again is used to refer to tropical storms in the southwestern Pacific and Indian oceans.

Weather This word traces its origin to *we*, which means “blow,” and formed part of what is known as the Indo-European family group of languages. Two nouns were created from *we*: *wedhrom*, which the Russian language adapted to *vedro*, meaning “good weather”; and *wetrom*, from which the Lithuanian word *vetra*, meaning “storm,” derives. One of these words then became the base for the early German word *wethram*, which, in time, became the German word *wetter* and the English word “weather.” From *we*, we also get the English words “ventilate” and “wind.”

WORD STORIES

Hurricane When Christopher Columbus and his men landed in Hispaniola, they met the Taino people. Columbus’ crew soon adopted and adapted some words from Arawak, the language of the Taino. One word was *hurican*, which the Taino are believed to have borrowed from the neighboring Carib tribes. Interestingly, *Hurican* was the Carib God of Evil and derived from a Mayan god named Hurakan. Hurakan was a creator god, who was said to have blown his breath across the ocean waters to create land. Later, he sent a great storm and flood that destroyed humans after they angered the gods. As a result, when the Spanish arrived in the area, they called huge tropical storms accompanied by rain and heavy winds *huricans*, which came into English as “hurricane.”

Thursday In the ancient Roman world, the day now known as Thursday was called *dies Iovis*, or “Jupiter’s Day.” Jupiter was the king of the gods and also the god of thunder and lightning. The ancient Germans, as well as the Norse, followed much the same practice of naming days in honor of gods. So, for Thursday, they used their equivalent of Jupiter—Thor, their god of thunder. In the ancient Germanic language, the day became *thonaras daga*, which Old English adapted to *thunresdaeg*. In time, this was adapted to our English name for the fourth day of the week—Thursday.

EXPRESSIONS

“Red sky at night” Ever hear the rhyme “red sky at night/sailor’s delight/ red sky at morning/sailors take warning”? It dates to medieval England. At the time, there was no accurate way to predict the weather, and people used their observations of the world around them and their experiences to create probable weather situations. The rhyme is quite accurate, since a red sky in the morning indicates that the rising sun is reflecting the dust particles of a system that has just passed from the west—a sign that a storm system may be moving to the east. A morning sky that is a deep, fiery red tells of a high water content in the atmosphere, which most likely means rain. A red sky at night means that the setting sun is sending its light through a high concentration of dust particles. Usually, this situation indicates high pressure and stable air coming in from the west—the variables needed for good weather.

“Feeling under the weather” If you feel “under the weather,” chances are that you are sick or unwell. The phrase has nautical origins. On board a ship, if a sailor felt sick, he was sent below deck to recover, away from (or under) the weather. Originally, this expression meant to be feeling the effects of seasickness or bad weather. Gradually, however, it came to refer to any kind of illness. An expanded version of the phrase is “under the weather bow,” referring to the side of the ship facing the bad weather.



illustrated by Tom Lopes



The Armada, in crescent formation, sails up the English Channel in 1588.



For two years, the Spanish fleet had been gathering in Lisbon, Portugal, the best-defended port in the Spanish empire. Then, on May 28, 1588, the Armada, as the 130 vessels and nearly 30,000 men under the command of Medina Sidonia were known, set sail. The goal was the long-dreamed-of mission of Spain's King Philip II: the conquest of England.

A Good Plan

The plan had the Armada sailing up the English Channel to the Netherlands, fighting with the enemy only if attacked. The fleet would then anchor near the port of Dunkirk, where the Duke of Parma's huge army was stationed. There, the Armada would undertake its most important task: keeping the English navy away from Parma's troops as they crossed the Channel to England in small landing-craft. Once in England, Parma's men were to launch an assault on London with assistance from the reserve troops that had sailed from Lisbon with the Armada.

But, unfavorable winds had plagued the Armada from the start. After three weeks at sea, the fleet had only reached northern Spain.

DEFEAT OF THE ARMADA

by Louise Chipley Slavicek and Duane Damon

Their provisions were running low, and a storm had damaged several of the ships. Discouraged, Medina Sidonia wrote to King Philip, imploring him to postpone the expedition. "I have dedicated this enterprise to God," Philip replied. "Get on, then," he commanded his admiral, "and do your part!"

Finally, the English and Spanish fleets did face each other. The English were awestruck at the sight of the Armada sweeping up the Channel in a crescent formation several miles long. "We never thought," said one, "that they could ever have found, gathered, and joined so great a force."

By August 6, the Armada, with the English trailing behind, reached the French port of Calais. But, Medina Sidonia had yet to hear back from the Duke of Parma regarding the precise timing of their rendezvous.

When he did, the news was devastating. Parma wrote that he needed at least six days to assemble his army, but Medina Sidonia could hardly wait 24 hours. The swifter English fleet was anchored half a mile away, watching his every move.



And the battle rages . . .

Fireships

Lord Admiral Howard, the English commander, was determined not to allow the Spanish fleet to escape north to hook up with the Duke of Parma's army in Flanders. He ordered his officers to rig up fireships and to sail them into the heart of the Armada. His intention was to scatter their formation. Toward midnight, when the tide and winds were favorable, volunteer English seamen sailed the fireships as close as they could to the Armada and then escaped by boat.

A seasoned commander, Medina Sidonia had anticipated this kind of attack. He positioned numerous small craft windward of his Armada to divert the fireships, but six of the eight blazing ships made it through and threatened to set the Spanish fleet aflame. Medina Sidonia signaled to his ships to haul up or cut their anchors, and then to regroup nearby. The bulky Spanish galleons, galleasses, merchant

ships, and others immediately set forth, as many crews had cut their anchors in a panic. Even though none of the Spanish ships caught fire, the English stratagem worked.

When dawn broke on Monday, the flagship, the *San Martin*, and four other galleons found themselves alone to confront the entire English fleet. After Medina Sidonia managed to rejoin his harried fleet,

he rallied them back into the crescent formation again.

Blazing Cannon

A fierce battle raged for nine hours. Both fleets discharged their broadsides within shouting distance. Each side's cannon blazed away, shattering the other's woodwork and rigging. The unwieldy Spanish ships found it more difficult to maneuver and could not keep up with their English counterparts. By the end of the battle, the sea was littered with damaged ships, their decks bloody and shattered by cannonballs.

Around 4 P.M., when the Spanish were on the brink of total defeat, the English ran out of shot (ammunition). The two sides separated and fended for themselves in the wind-tossed seas. The Spanish headed northeast to salvage the remnants of their fleet. The English dropped back and purposely allowed the Spanish to flee. According to Fray Geronimo de la Torre, who was on board the *San Martin*, there was "scarcely a man who could sleep that night; we were all wondering when we would run aground." Miraculously, the wind shifted and carried them out to the open sea—shattered, dispirited, but still afloat.

By morning, the hapless Spanish fleet was being blown about, not safely out of the English Channel, but toward the sandbanks of the western Netherlands. Aboard the *San Martin*, Medina Sidonia and his officers could only watch helplessly as the shoreline—and certain doom—drew ever nearer. Once aground, the stranded vessels would be pounded to splinters by the weather and the English guns. A last-minute change in wind direction, however, delivered the Armada from another disaster.

Little Choice

Now, the only reasonable option was to return to Spain. With English sail commanding the Channel, and the weather against them, only

one route was left open to the Armada: northwestward, then south, for a risky, 1,500-mile loop around the entire British Isles.

While the English commanders doubted the Spanish would return for another full-scale battle, they did think the Spanish might land somewhere on the coast of England, or perhaps Scotland or Ireland. England's queen, Elizabeth I, agreed and hastily assembled a makeshift army to fend off a possible land invasion. Then, once again, nature intervened.

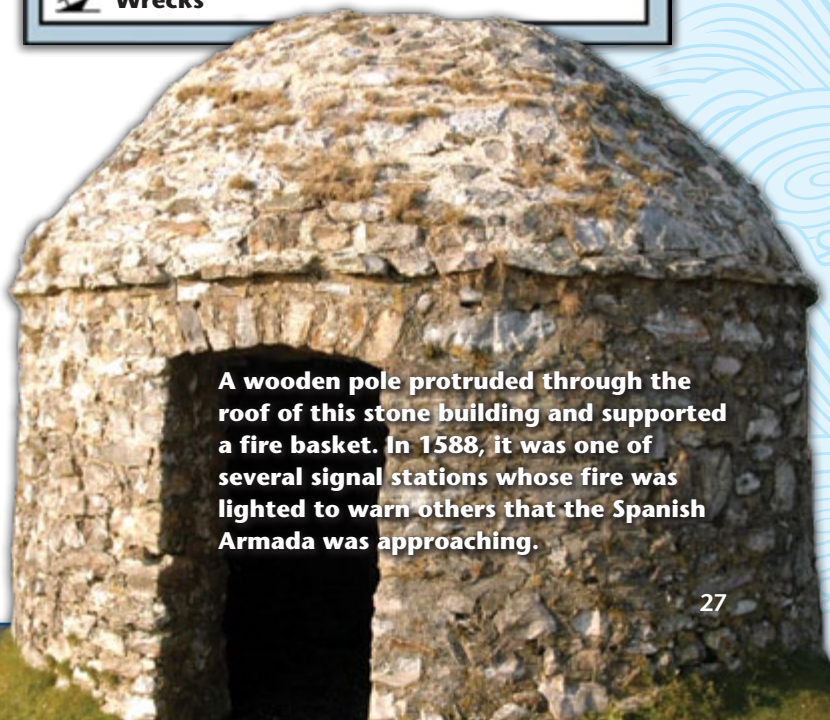
On August 22, a powerful gale north of Scotland slammed into the 112 remaining Spanish ships. The Armada was left fatally weakened, disorganized, and vulnerable. A jubilant Elizabeth ordered a medallion struck to honor the victory she believed God had provided. Its inscription read, "He breathed, and they were scattered."

A Disastrous Ending

One Spanish ship ran aground on Fair Isle in Scotland, a neutral country. Others suffered a worse fate. Some 24 came to grief on the wild and rocky coast of Ireland. Many ships broke up in the pounding surf, drowning hundreds of sailors and soldiers. Survivors struggled to reach shore, where many were beaten and stripped. Others, however, were given help. A few managed to repair their vessels and continue their journey.

In late September, the Armada's remnants began limping into Spanish ports. A hardhearted King Philip said publicly, "I sent my fleet against men, not against the wind and the waves." Privately, however, Philip agonized over the terrible loss of life. In all, between 15,000 and 20,000 Spaniards had died during or soon after the campaign. 🏰

Louise Chipley Slavicek has written numerous articles and books on world and American history for young people. **Duane Damon**, author of six nonfiction books for young readers, writes regularly for CALLIOPE and COBBLESTONE magazines.



A wooden pole protruded through the roof of this stone building and supported a fire basket. In 1588, it was one of several signal stations whose fire was lighted to warn others that the Spanish Armada was approaching.

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by Colin Martin

What the Wrecks Say



During the Armada's terrible voyage back to Spain, many ships were lost off the wild Atlantic coasts of Scotland and Ireland.

We do not know exactly how many, since some may have vanished without a trace in the open sea, while others perhaps foundered on shorelines so remote that no one saw them go down. But at least 26—a fifth of the entire fleet—are known to have been wrecked in these waters.

For centuries, hopeful adventurers have tried to find the treasure that was rumored to have gone down with the ships, but none has ever been recovered.

An Invaluable Find!

In modern times, archaeologists rather than treasure hunters have searched for Armada wrecks. The most important find so far is the wreck of *La Trinidad Valencera*—a huge merchant ship from Venice, Italy, that had been hijacked by King Philip's officers in Sicily to take part in the invasion of England. Although not technically a fighting ship, it was very well armed. The ship carried a large contingent of soldiers together with their equipment, including three giant siege guns, which would have been used to support the Duke of Parma's attack on London. When the wreck was found off Donegal in 1971, all three guns were recovered, each stamped with a weight mark exactly matching the figure recorded in the ship's documents.

Parts of gun carriages were also found. These were of two types—one designed to transport the cannon on land, and the

Trail refers to the part of a gun carriage that rests on the ground when the piece is ready for action.

other for use at sea. The shipboard version was heavy and cumbersome, with two solid wheels and a long **trail**, quite unlike the compact four-

wheeled carriages used by the English. Tests of the two types showed that the Spanish cannon took twice as long as the English cannon to load and fire—yet another factor that explains the Spaniards' poor showing as gunners.

Even more revealing was a set of wooden gauges for matching the **bore** of cannon to the various sizes of shot available. These were so inaccurate and misleading as to be worthless.

Bore refers to the interior cavity of a gun.

Soldiers—Not Sailors

But the Armada was an invasion task force rather than a fighting fleet, and *La Trinidad Valencera* finds show how well that force was equipped. Its soldiers were armed with arquebuses and muskets (light and heavy firearms), 18-foot pikes, and a wide range of close-quarter weapons, including grenades and flame-throwers. They had everything they needed for a successful land campaign—provisions, ammunition, medical supplies, and a vast range of materials and tools with which to throw up siegeworks and gun emplacements (positions). It was Spain's misfortune, and probably England's salvation, that these tough and well-equipped soldiers never came ashore. 🏰

Underwater archaeologist **Colin Martin** is a reader in maritime archaeology at the University of St. Andrews in Scotland.

An archaeologist works among the timbers of a wrecked ship. Modern underwater archaeology is conducted with the same skill and rigor as are applied on land sites.

Left: This muzzle-end of a broken gun recovered from the wreck *El Gran Grifón* off Fair Isle has been bored well off-center. Not only would this have made it inaccurate, but it probably would have blown up if fired with a full charge.

Below: This modern crew of British sailors was able to load and fire a replica of the compact four-wheel truck carriage used by the English in the Armada battles twice as quickly as they could operate the same gun mounted on a Spanish-type carriage.



Here's Why!

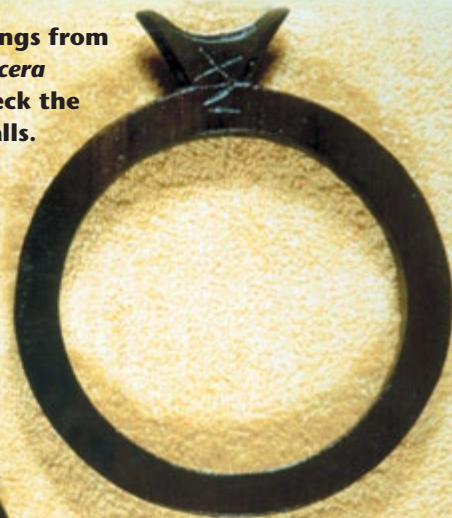
by Colin Martin

It is especially difficult to match the sizes of two different objects that must fit together if you do not have a reliable way of measuring each. The difficulty is compounded if they are made in two different places. Archaeological evidence (see pages 28–29) is proving that such was the case with the Armada.

In the 1500s, there were no uniform standards or measurements for such things as guns and shot, and examples found on Armada wrecks show that the scales used were inaccurate and confusing. The Armada's ships came not only from Spain, but also from Portugal, the Italian states, and northern Europe. All these places used their own measuring systems, which were often very different. Some individual towns even had their own systems.

In addition, the guns themselves and, in particular, the diameter of their bores, were not made to any agreed-upon standard, but according to the whim of each gunmaker.

These wooden rings from *La Trinidad Valencera* were used to check the size of cannonballs. Like the wooden scale, they were very inaccurate.



As a result, the Armada's ships often had guns and ammunition that did not match.

Try this experiment with a friend.

Directions

1 Without watching what your friend is doing, roll a piece of plasticine into a ball that you estimate to be one inch in diameter. At the same time, have your friend make a paper tube that is also one inch in diameter, again judged by the eye. Do not use any measuring device.

2 Bring the plasticine "cannonball" and the paper "gun bore" together and see how closely they match.

3 Have several pairs of friends or students try this experiment. Then try fitting together all possible combinations of the "cannonballs" and "gun bores." You'll probably end up as confused as the poor Spanish gunners seem to have been in 1588.

Think about how different our world is from the world of the 1500s. Almost everything we use, from radios and watches to automobiles and space rockets, depends on many parts that must fit together exactly. Such exactness requires accurate measurements and standards that have been agreed upon by many nations. Yet, we still don't always get it right. The Space probe that crashed on Mars in 1999 failed because someone mixed up inches and centimeters.

This wooden scale from *La Trinidad Valencera* was used to measure the bore of a gun to determine the weight of iron shot that would fit it. Modern calculations show that it was extremely inaccurate.

You Need:

- roll of plasticine
- piece of heavy paper

THE PERFECT PARTY

illustrated by
Chuck Whelon

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CELEBRATION OF
ODYSSEY'S 20TH
ANNIVERSARY!

A PARTY?
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BOLTS FROM
THE SKY?

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DISPLEASED
WITH MY PARTY
OUTFIT?

I'D
BETTER SEEK
SHELTER!

IN ANCIENT
GREECE, MANY PEOPLE
WOULD HAVE INTERPRETED
A DRAMATIC STORM LIKE THAT AS A
SIGN THAT THE GODS WERE ANGRY
WITH THEM.

THANK
GOODNESS THAT
LIGHTNING STORM
PASSED. IT
ALMOST SEEMED
UNNATURAL.

OH, NO! WHAT
NOW? IS THAT A
TORNADO?

MEANWHILE, BACK AT DR. CY BORG'S LAB . . .

THE ELECTRICAL POWER
IN THESE NANOBOTS SHOULD
LIGHT THINGS UP!

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INVADERS BEWARE!

by Jennifer P. Baker

Have you ever left the house with an umbrella but quickly realized you needed sunscreen? Packed for a day at the beach, stepped out of your door and realized it was about to rain? The 18th-century Scottish poet Robert Burns once wrote, “The best laid schemes of Mice and Men oft go awry, And leave us nothing but grief and pain, For promised joy!” No matter how long you take to plan something, there is almost always an unexpected twist. This could not be

more true than in the story of a French emperor named Napoleon Bonaparte, who met his match when he went up against Mother Nature!

Making a Sure-Proof Plan!

In his attempt to create a global empire, Napoleon realized that world domination would be impossible unless he had control of Russia. In June of 1812, Napoleon invaded Russia with an army of about 600,000 men and 50,000 horses. He planned an attack that he thought would annihilate Russian forces and conquer the great city of Moscow.

Napoleon leads his officers and troops, all tired and exhausted, through mud and snow in 1814.

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To achieve his goal, Napoleon would rely on his time-tested approach of quickly concentrating his troops in one location. This approach had worked throughout Europe but required the speedy movement of Napoleon's vast army. The French soldiers under Napoleon's command could march 15 to 20 miles a day, but were followed by a supply wagon that could only go about 10 to 12 miles a day. To avoid being slowed down by the latter, Napoleon insisted that his troops live off the land, finding food as they marched. While this tactic had worked in Central Europe, the French army soon found that the harsh climate and the Russian practice of destroying all that they could as they retreated meant that living off the land during this campaign was nearly impossible. After only one month of fighting, more than 10,000 horses had died!

Not So Sure-Proof!

Indeed, Mother Nature seemed to be against Napoleon's imperial ambitions. As the troops marched into Russia, it was too hot—making it a very dry, dusty march to Moscow. In September, Napoleon reached

the capital city. By that time, however, it had been abandoned and all supplies removed. The city was set on fire, causing such extensive damage that it was unfit to serve as winter quarters. Unable to face defeat, Napoleon waited until October to order a retreat back to France. By that time, the air had turned to a bone-chilling, well-below-zero cold.

The extreme Russian winter took its toll on both troops and horses. But the French army would face another dilemma when a warm spell started to thaw the frozen roads. The heavy usage by both armies had left the roads very rutted, and walking through the mud slowed down the troops. Streams that had thawed now became obstacles, and rivers that could have been crossed without bridges now needed bridges. All of which took precious time and energy away from an already depleted army. Over the course of his invasion of Russia, thousands of Napoleon's troops died in their sleep, overcome by exhaustion and exposure. By the time the army crossed into Poland in early December, less than 100,000 tired, tattered soldiers remained of the 600,000 proud soldiers who had invaded Russia five months earlier.

Watch Out for Mother Nature!

By 1812, Napoleon had conquered most of Europe and was well on his way to creating a global empire, but he had yet to face the one enemy who would prove to be his downfall—Mother Nature. This episode of history proves yet again that even some of the best laid plans “leave us nothing but grief and pain.” 🏠

.....
A social studies teacher at Winchester High School, **Jennifer P. Baker** has her masters in history from Teachers College, Columbia University.

A Battle of Wills

Napoleon's battle with Mother Nature seemed a bit one-sided (see pages 32–34), but what about trying to bridge Mother Nature and then punishing her when you feel she does not cooperate? Well, the Persian leader Xerxes did just that.

In 480 B.C., Xerxes decided to invade Greece. He knew that his father, Darius I, had done the same 10 years earlier, but had met defeat. Xerxes was determined to finish his father's work. All that stood between him and his enemies, so Xerxes reasoned, was the Hellespont, a narrow body of water in present-day Turkey that is now known as the Dardanelles.

A long narrow strait, the Hellespont connects the Aegean Sea to the Sea of Marmara. In 480 B.C., it presented a significant barrier to the Persian offensive. Xerxes decided that instead of attempting to cross the strait by ship, he would construct a bridge over it. But, before he could move his troops across the bridge, an incredible storm destroyed it. Not only did Xerxes punish the engineers—they lost their heads—but he also ordered the waters whipped 300 times and chains dropped into them as a mark of enslavement (right).

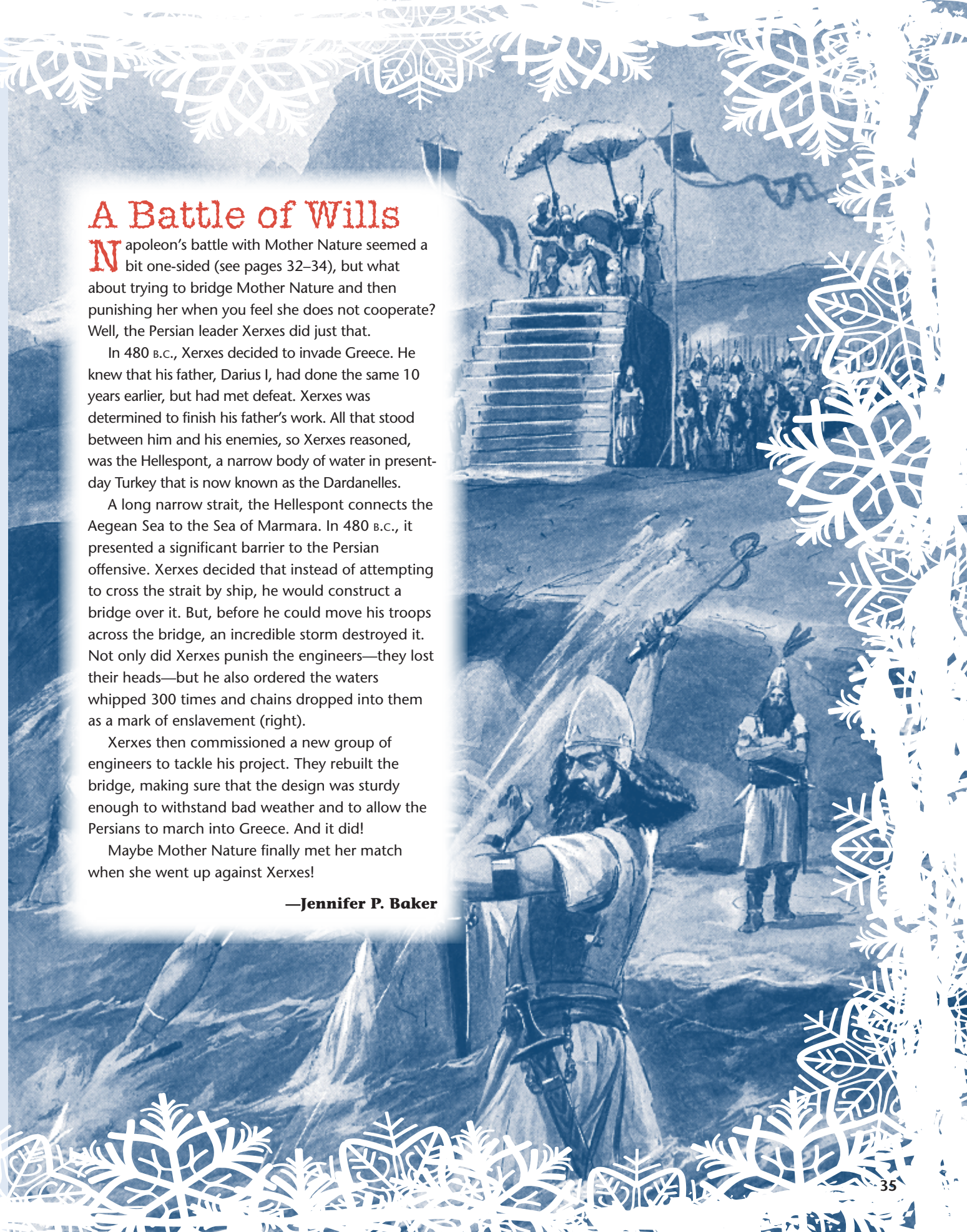
Xerxes then commissioned a new group of engineers to tackle his project. They rebuilt the bridge, making sure that the design was sturdy enough to withstand bad weather and to allow the Persians to march into Greece. And it did!

Maybe Mother Nature finally met her match when she went up against Xerxes!

—Jennifer P. Baker



“Burn Moscow!”
shouts Napoleon.





Panic spreads as a volcano erupts, triggering earthquakes that tear apart the land and the buildings on it.



THE YEAR

WITHOUT A SUMMER

by Lisa Gardiner

The summer of 1816 was no summer at all in Western Europe and eastern North America. Rather, snow blanketed much of New England, and cold rain fell across Europe in the middle of what should have been the hot season. The skies were dark and gloomy, making it difficult to see the sun, even in the middle of the day. For this reason, 1816 soon became known as “The Year Without a Summer.”

And the Cause Was...

At the time, no one knew that it was a volcano on the other side of the world causing the strangely cold summer. That volcano was Mount Tambora on Sumbawa Island in Indonesia. It had started erupting on April 5, 1815, and did not calm down until four months later. In fact, it spewed so much ash, gases, and rock into the air that, by the time it stopped erupting, it had shrunk by 4,200 feet. To date, Mount Tambora has sent more particles into the atmosphere than any other volcano in recorded history.

During the eruption, the air in the vicinity of the volcano was dark with the ash. When the larger particles that had spewed upward rained back down, they covered houses with

so much ash that roofs caved in. These particles also covered fields, causing crops to fail. Boats in the area had to force their way through the two feet of ash floating on top of the ocean. Overall, the eruption and the earthquakes that it triggered killed 90,000 people in Southeast Asia.

Some of the tiny particles of ash, dust, and **sulfate aerosols** that the volcano spewed out did not fall back down immediately. These entered the stratosphere, the level in the sky above where weather events such as thunderstorms develop. The stratosphere trapped the particles for several years and sent them traveling around the world. Because they traveled everywhere, their effect on climate was global, as they blocked sunlight and shaded the earth. For several years, they cooled the earth more than five degrees Fahrenheit. The greatest impact of the cooling was felt in eastern North America and Western Europe.

Sulfate aerosols refer to particulate matter consisting of sulfur compounds formed by the interaction of sulfur dioxide and sulfur trioxide with other compounds in the atmosphere. Particulate matter refers to any matter in the atmosphere except water, including dust particles, pollen, or particles produced by internal combustion engines.



Mount Tambora today

Snow in July

On the morning of July 9, 1816, Professor Parker Cleveland, who recorded the temperature every morning at his home in Brunswick, Maine, found his thermometer reading near freezing. In fact, people throughout New England awoke to find frost on the ground several times during July and August of that year. Weeks earlier, in June, a storm brought freezing temperatures, wind, and up to six inches of snow in Vermont, New Hampshire, and Maine. Much more snow fell in Canada.

The cold weather destroyed most of the crops and caused leaves to freeze on trees and turn black. Frustrated by the weather, some New England farmers found themselves unable to grow crops. They were running out of food. Many decided to move to the Midwest in hopes of finding a warmer climate. Records tell of 42,000 people emigrating from New England to Ohio in 1816.

Creativity to the Fore

In Europe, no one remembered ever having seen such a cold summer or such a bad harvest. As the cold weather killed almost all the crops in Western Europe, there were food shortages and famine. In France, the people were so upset that they rioted in the streets. Those farmers who had managed to

grow crops feared that robbers would steal their food.

The crop failures had other consequences as well. At the time, horse-pulled carriages and carts were used to transport whatever and whoever needed moving from place to place. When crops failed, the oats that horses ate became scarce, and their cost rose significantly. This, in turn, made travel by horse very expensive. Determined to find a solution to the problem, a German named Karl Drais invented a mode of transportation that did not require a horse—the bicycle. The year was 1816, and his bicycle, the first two-wheeler, had no gears or brakes.

The dreary, cold weather also inspired artists and writers. When the English poet Lord Byron invited friends to spend the summer at his home in Switzerland on the shore of Lake Geneva, he did not know that dark clouds would cover the sky most of the time. To avoid the weather, Lord Byron and his guests stayed indoors and entertained themselves by writing scary stories. One of his house guests was Mary Shelley, and her scary story became a book called *Frankenstein*.

What Goes Up Must Come Down

It took a couple of years for the particles Mount Tambora spewed into the stratosphere to fall to the ground, but once they did, the world's climate returned to what it had been. Thus, the volcano's effect on climate may have been temporary, but creative inventions such as the bicycle and scary stories such as *Frankenstein* continue to be popular. 🏠

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Lisa Gardiner writes and creates illustrations to help explain how the earth works. She holds a B.A. and Ph.D. in geology and has worked as an earth science educator for more than a decade.



FOG AND COLD Wreak Their Damage

by Carolyn J. Gard

While most people have had weather spoil a picnic or a baseball game, few people ever think about it affecting a battle's outcome. But, that has happened—three times, in fact, during World War II.

It was 1942, and Germany's leader Adolph Hitler wanted to crush the Soviet

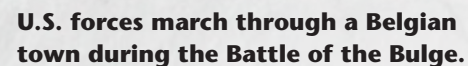
Union. For the campaign to be a success, he needed to take the city of Stalingrad. Despite having fewer forces, the Soviet troops encircled Stalingrad after the German troops had entered, trapping them there without provisions. Hitler's officers insisted that their air force, the Luftwaffe, could fly in supplies. They had done so before, but now it was December, and the beginning of the harsh Soviet winter. Because bad conditions grounded many of the flights, hundreds of Germans starved to death. On February 2, 1943, Hitler's field marshal surrendered. Hitler had been defeated at Stalingrad—not by superior force, but by weather.

Cold Takes Its Bite

Weather was key to another important Allied victory in Europe. In 1944, Hitler planned to force the Allies out of Europe by

In bitter cold, Russians lead their German prisoners in 1943.





“building” an offensive wall. His meteorologist chose December 16 for the attack, a day that he predicted would have awful weather conditions—thick fog, cold, snow, black ice, and rain. At first, the fog helped the Germans by hindering the Allied air attack, but the weather cleared, which worked in the Allies’ favor. On December 23, a day of “unlimited visibility,” the Allies took to the air, dropping supplies to the embattled troops and renewing their attack on the Luftwaffe.

The battle continued for another month, even as the temperature often dropped to zero degrees Fahrenheit. By mid-January, the starving Germans had retreated. The

With the fog lifting, U.S. airplanes attack.

confrontation became known as the Battle of the Bulge, because Hitler had only succeeded in putting a bulge in the Allied front lines.

A Shifting Weather Front

Weather also helped the U.S. effort in the Pacific. In 1942, military intelligence estimated that a surprise attack by the Japanese could be expected on Hawaii, Alaska, or even the west coast of the United States. To block the Japanese from heading east, the U.S. stationed its naval forces between Midway Island, where they had an outpost, and the Aleutian Islands off Alaska.

Aware that weather systems in the north Pacific are predictable, the Japanese used this information to select June 4, 1942, as the day to begin their assault on Midway. A storm that was moving northeastward pushed rain and clouds ahead of it, creating low visibility and providing cover for their fleet. Studying the weather pattern for this area also helped the U.S. predict the time of the attack and prepare for it. They knew that the enemy fleet was hiding behind the weather front, so they made ready to attack when the weather cleared and the fleet appeared.

As the weather cleared and the Japanese lost the protection of the poor visibility, the superior U.S. air power soon sent the Japanese fleet into retreat (left). The ships headed to the northwest where they were again able to hide under low clouds. This escape route allowed them not only to avoid more bombing, but also to save the fleet from annihilation.

Thus, history proved that success in battle involves good planning, superior forces, and a healthy respect for the weather. 🏰

Freelance writer **Carolyn J. Gard** in Boulder, Colorado, with her husband and two dogs. A volunteer naturalist for the city, she takes school children on hikes in the mountains where she teaches them about nature.



LET THE WINDS BLOW

by Charles F. Baker

And they sure did—scattering the letters of 12 words found to the right and on pages 15–17. Can you put them back together again? The six unused letters will spell what emperor Kublai was.

Note: One word is found twice.

Asia
China
Hakata
Japan
kamikaze
Khan

**Korea
rain
sea (2)
ship
wind
Yuan**

WATER MIX-UP

by Francis Brooks

The author wrote the article on pages 6–9, but the rough cataract waters scrambled the letters. Can you help her fill in the blanks in the sentences below? The answers are all in the turned-up waves.

1. There are _____cataracts between Aswan and Khartoum.
2. Cataracts derives from the Greek word _____.
3. Egyptians used _____
_____for drinking vessels.
4. Nubians were especially known for their skill as _____.
5. Two major branches of the Nile are the _____and the _____.
6. The capital of Sudan is _____.





? ASK CALLIOPE

illustrated by Susan Rice

? **George Washington's teeth look so old and gross in the July/August 2011 issue of CALLIOPE. Where are they now?**

—Pettee
Raymond, Maine

! Well, they have experienced a lot of "handling" over the centuries. Presently, the lower half of a set of Washington's teeth—a set carved from hippopotamus ivory—and the first president's last remaining tooth belong to The New York Academy of Medicine. Engraved on the denture are the words: *Under jaw. This is Great Washington's teeth by J. Greenwood. First one made by J. Greenwood, Year 1789.*



? **Have you ever heard of a Roman hero named Regulus?**

—Pete, Web post

! Sure have! He was one of early Rome's most respected military leaders. When the Carthaginians (from present-day Tunisia in northern Africa) lost to the Romans in 256 B.C., they chose not to surrender. Rather, they regrouped, met the Romans on the battlefield again the following year—and, this time, won! They then sent a Roman named Regulus, whom they had taken prisoner, back to Rome to negotiate a treaty. Regulus was to return once the agreement was negotiated. Despite the protests of his fellow Romans, Regulus remained true to his word and returned to Carthage, where he was subsequently tortured and killed.

? **Someone told me that my name, Jane, traces its origins to ancient Rome. Is that true?**

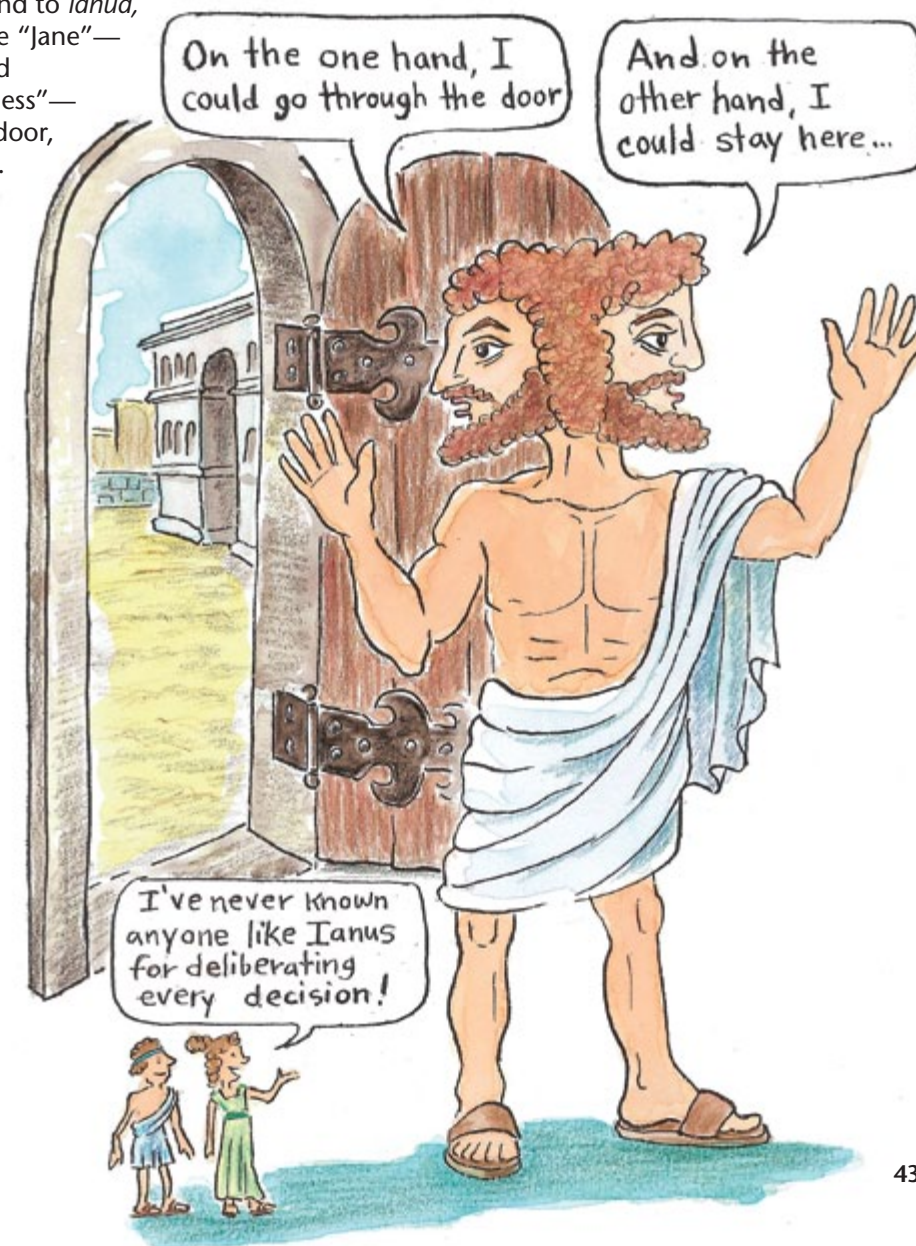
—Jane, Web post

! Yes! Latin, the language spoken by the Romans, had no letter "j." Instead, the letter "i" was used. When "i" preceded a vowel, the Romans pronounced the "i" like "y" (a letter that also did not exist in Latin). As the centuries passed and Latin became the common language throughout Europe, various changes occurred. One of these was that the "i" before a vowel became a "j." Now, back to your name! It traces its roots to *ian*, which, in turn, traces its roots to *Ianus*, the Roman god of beginnings and transitions, and to *ianua*, Latin for "door." Thus, the name "Jane"—as well as the names "Janet" and "Janice"—mean "openmindedness"—that is, they, like *Ianus* or like a door, look at both sides of every issue.

? **Was Rome ever ruled by kings?**

—Nora, Web post

! Legend says there were seven kings before the Roman Republic, with elected officials, started in 509 B.C. According to the ancient Romans, they were: Romulus (the twin brother of Remus and credited as the founder of Rome), Numa Pompilius, Tullus Hostilius, Ancus Marcus, Tarquinius Priscus, Servius Tullius, and Tarquinius Priscus. Note that the last three were said to be Etruscans, a people who lived to the north of Rome and from whom the ancient Romans borrowed many customs, including the toga—the distinctive garment worn by Roman male citizens.



FROM OUR READERS

Dear **CALLIOPE**,

You guys have an amazing magazine. I get super-excited when I get the magazine. I'm in love with history. This whole summer I have been writing history essays for fun. When I grow up, I want to live in Washington, D.C., and work in some museum or work for the president or be in the Navy. I mostly want to do something that allows me to get buried in Arlington National Cemetery like my cousin. I have had a tough year. My grandma, uncle, and three cousins all died in one year. And your magazine really helped. I mostly wanted to point out that you guys should keep up the good work. But, I do have one question. Where do you guys get all your information?

LAURYN
WEST MELBOURNE, FLORIDA

Thanks, Lauryn!
We do lots of research to find the material you read each month in **CALLIOPE**. Here's to enjoying many more issues!

Mrs. Kelly's fifth grade history class at The Country School in Madison, Connecticut, sent **CALLIOPE** their poems on "Who Built Egypt?" We've included one here and will highlight others in future issues.

Who Built Egypt?

BY MICHAEL LUCHINI

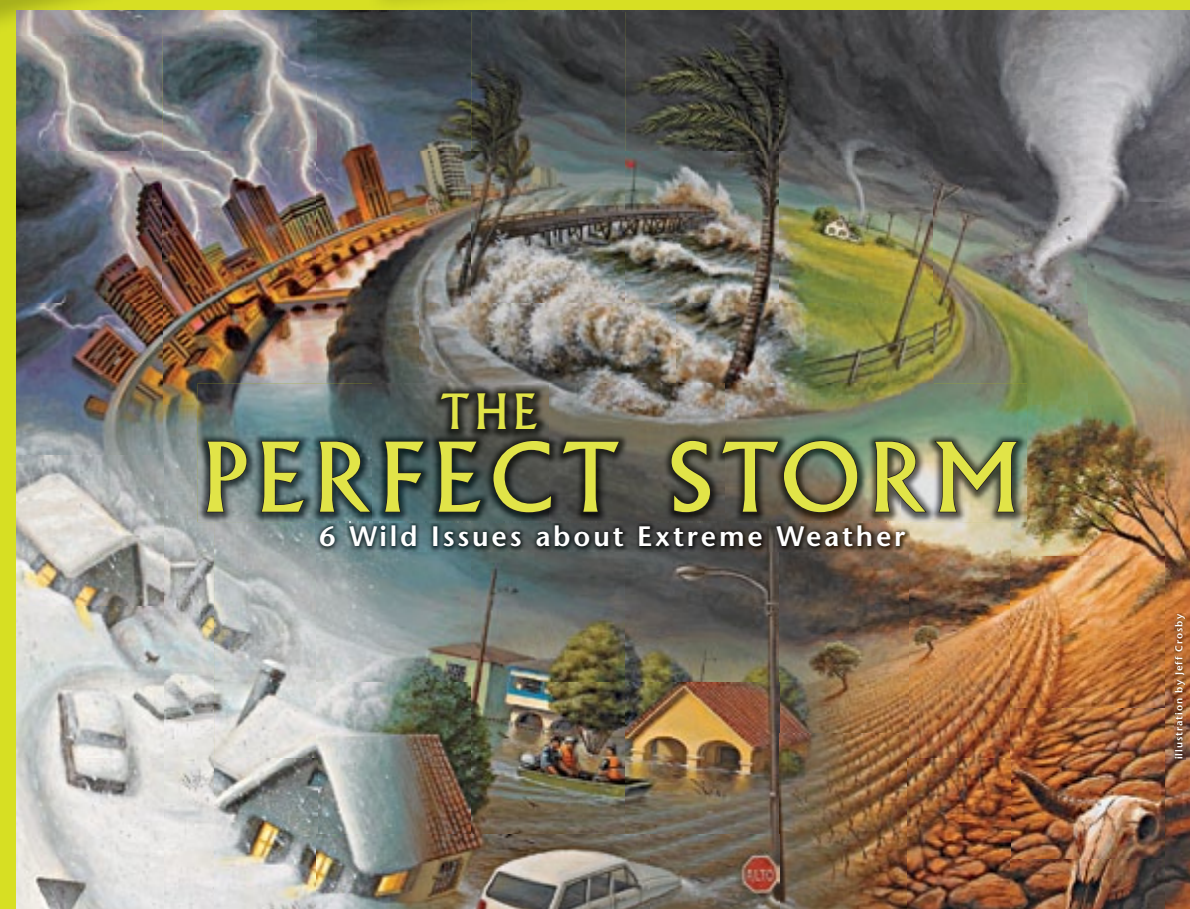
I did, proclaimed Ay
I keep my livestock under control
Day and night,
And provide food for
The people of Egypt.
No matter how big the job
It is my duty to herd my livestock
Up and down the Nile,
I don't know what I would do
Without my crook for herding.
In the hot summer months,
I herd my livestock to the delta,
Where they work in the marshes,
When winter comes,
My goats, sheep, and cows
Wander the Nile Valley
Under my watchful eye.
My troublesome livestock
Always getting me in a quarrel,
Whether it's eating someone else's
crops,
Or running off, but they are my
children.
I name them, live with them,
And even talk to them to keep them
moving along.
I am at the base of the social
pyramid.
But this is the occupation for me.
I watch over my livestock
While they work.
Without my livestock and myself
Egypt wouldn't exist,
For I am the herdsman.

Here's to all who helped
feed the people of Egypt.

6 magazines, 1 extreme topic



The March issues of **COBBLESTONE**, **CALLIOPE**, **DIG**, **FACES**, **APPLESEEDS**, and **ODYSSEY** share the same theme: **The Perfect Storm**. Take an exciting look at extreme weather's impact on cities, culture, and history. Put all six covers together for a mosaic poster of nature's ability to dish out punishing weather.



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BOOKS

How the Weather Works: A hands-on guide to our changing climate by The Templar Company Limited

(Candlewick, 2011, www.candlewick.com) is sure to answer all your questions about weather. Its illustrations, pop-ups, pull-tabs, diagrams, and maps will have you taking a much closer look at the world around you—on a day-to-day basis. Highly recommended.



Weather and Climate Change by Laura Howell (Usborne, 2007, www.usbornebooksandmore.com) uses maps, great photos, diagrams, detailed captions, engaging illustrations, and a great selection of Internet links to detail and explain hurricanes, droughts, global warming, the greenhouse effect—and much, much more. Really interesting!

Explore Weather and Climate by Kathleen M. Reilly (Nomad, 2012, www.nomadpress.net) is the perfect complement to this issue with its 25 relevant, engaging, hands-on projects, including creating a storm in a bottle, eating an edible climate map, making a rain gauge, and constructing a sun catcher. Complementing the text are informational sidebars, did-you-know boxes, and word explanations. You'll enjoy!



@

For a history of the National Weather service in the United States, click on:

www.weather.gov/pa/history/index.php

Here's a site that defines itself as: National Weather Association—Connecting Operational Meteorologists in Pursuit of Excellence in Weather Forecasting, Communication and Service:

www.nwaa.org/links/history.php

Want to know the weather—anywhere in the world—right now? Then, check out this U.S. government site sponsored by the National Oceanic and Atmospheric Administration (NASA):

www.weather.gov

COBBLESTONE RESOURCES

Other materials that complement this issue's theme, "Perfect Storm," and are available from Cobblestone Publishing include:

the March 2011 issue of *APPLESEEDS*, *COBBLESTONE*, *DIG*, *FACES*, and *ODYSSEY*



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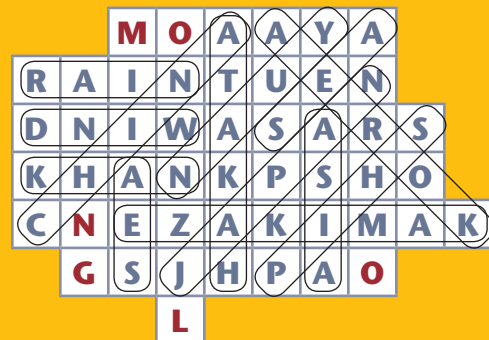
WRITE TO US!

Ask **CALLIOPE**, 30 Grove St., Peterborough, NH 03458 or askcalliope@caruspub.com

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Check out our online teacher's guides at **WWW.COBBLESTONEPUB.COM**

Answers to Let the Winds Blow page 41:
Unused letters spell Mongol



Answers to Water Mix-Up page 41:

1. six, 2. *katarraktes*, 3. ostrich eggshells, 4. archers, 5. White, Blue, 6. Khartoum.

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WATER

FRIEND AND FOE



Present-day waterworks against floods in the Netherlands

by Patricia d. Lock

The name "Netherlands" means "lowlands" and describes its country perfectly. One quarter of the land is below sea level, and half is less than 39 inches above it. To make matters worse, the Netherlands is sinking, in relation to sea level, by eight inches per century. Without a constant fight against the sea and the rivers flowing to it, fully half of the Netherlands would be flooded. The first dikes—that is, earth and rock mounds designed to hold back the sea—were built in the Middle Ages. With global warming causing sea levels to rise, the Netherlands is in a perpetual struggle for its very existence.

A New Land Is Born

The Netherlands area emerged from the sea near the end of the last ice age, at the same time as the flooding of the North Sea. It consisted of marshland with the Rhine, Meuse, Scheldt, and other large rivers flowing through it on their way to the sea. Over time, the marshland became peat bogs with many lakes.

When humans first came to the Netherlands, they came for the plentiful hunting and fishing. As they settled in, they found that water was changing the land constantly. Some settled on **moraines** left behind by retreating glaciers, others built embankments

Moraines are accumulations of rocks and earth carried along and deposited by a glacier. Moraines usually form at the edges of glaciers as they retreat, melting and dropping their cargo of debris.

Did you know?

Many people call the Netherlands "Holland," but Holland is just one of the country's provinces.



Four of the 1,000 windmills still working in the Dutch countryside.

Below: One of the pumping stations (now a museum) used to drain Haarlem Lake in the Netherlands in the 1850s.



Did you know?

During the 1953 flood, the quick-witted mayor of Rotterdam ordered the captain of a ship to wedge his vessel into a breach in the main dike there, saving that area from the disaster that Zeeland experienced.

to live on during years with high spring tides.

The Netherlands has a moderate, maritime climate, with cool summers

and warm winters. It averages around 30 inches of rain a year and has consistent winds of 13-18 miles per hour, perfect for wind power. Its location at the mouth of many large rivers means that storms can cause huge floods, even if there is no rain. Its nearness to the North Sea makes it vulnerable to fierce storms that can cause tides up to 17 feet above normal. Some storms are so strong that they breach dikes, wreaking havoc and flooding the land with salt water. In the 12th and 13th centuries, an especially relentless series of storms caused the North Sea to break through dikes and natural barriers along the north coast, drowning entire towns and creating two new inland seas, the Waddensee and the Zuiderzee.

Water Lends a Helping Hand

The creation of the inland seas, while a disaster for some, was a boon to Amsterdam. The little town now had a direct route to the North Sea, and trade thrived. In time, Amsterdam became the business and cultural center for a trading empire that circled the globe. A system of canals was built to support trade and the growing population. The people of Amsterdam also found dikes and

canals to be useful defenses against overland attacks. For example, in 1672, Prince William of Orange flooded the area around Amsterdam. French and British soldiers attacking the city decided to wait until the water froze before they crossed. But, when they did begin crossing, the winds changed from the usual cold winds out of the north to warm winds from the south, and the ice quickly melted. Many soldiers were lost in the struggle to return to land, and eventually the attack on Amsterdam was abandoned.

Polders and Windmills

In the Middle Ages, as diking techniques spread, enterprising people began using them to reclaim flooded land. They built dikes in shallow areas and then pumped out the water trapped behind them. These reclaimed areas are called polders.

Pumping was first done by hand, but in 1414, the introduction of the drainage windmill changed everything. As the use of windmills spread, the land became more secure, and more and more polders could be created for farms and pastures. By 1850, there were 10,000 windmills in operation across the Dutch landscape. Eventually,

steam power replaced wind power for most of the pumping, but there are still about 1,000 working windmills today.

Devastating Floods

The Zuiderzee, one of the inland seas created by 12th-century storms, overflowed frequently. About twice a century, storm surges were so fierce that they caused massive flooding and devastation, killing hundreds of thousands of people. In 1886, Cornelis Lely, a civil engineer and statesman, worked to close off and drain the Zuiderzee. His plan included putting a 20-mile-long dike across its mouth to separate the inland sea from the North Sea. This would protect the area from floods and allow the land behind the dike to be poldered and farmed. The first dike was completed in 1933. Poldering began soon after. The last one, completed in 1975, brought the total new land to 640 square miles. The province of Flevoland was created, and its capital was named Lelystad after Cornelius Lely.

In early 1953, flood control priorities changed. On the night of February 1, a huge storm surge broke the dikes in the province of Zeeland, killing 2,000 people and flooding 800 square miles of land. The dikes were destroyed in 67 places and breached in more than 400. Most people were asleep when the sea overtook them. Determined to reclaim the flooded land and to prevent such disasters in the future, the people of the Netherlands embarked on an ambitious new project.

Let's Build Barriers

The Delta Works plan centered on improving safety by strengthening the coastal defenses. One of the key goals was to shorten the amount of coastline that needed to be protected by 430 miles. Storm surge barriers would be built in locations that could not be dammed or diked. Most of the

Calliope Says

- For a video of the 1953 flood, go to:
http://wn.com/North_Sea_flood_of_1953
www.youtube.com/watch?v=zUEfU0P92Ws
www.youtube.com/watch?v=eh012V-sY-4
- For a CBC radio news report from 1945 about the retreating Germans blowing up the Zuiderzee dike, flooding the interior of the Netherlands, click on:
<http://rc-archives.cbc.ca/programs/1068-11425/page/1/>
- For a Web site on the Delta Works, check out:
www.deltawerken.com/English/10.html?setlanguage=en
- For information about a storm surge barrier that protects Europort near Rotterdam, see:
<http://gcaptain.com/maeslant-barrier?2584>

time, the barriers would be open, allowing free flow of water and sea life.

The plan was a challenge to the hydraulic technology of the time. New methods, tools, and even ships had to be designed. As the plan progressed, environmental impact became a factor, and changes were made to better preserve natural areas. The first storm surge barrier was completed in 1958, the last in October 1986. An additional barrier across the Rotterdam shipping channel was completed in 1997.

Tomorrow!

The Dutch live with water every day, as both a friend and a foe. While the largest projects are now complete, innovations for the future are always in development. There are test houses that are tethered to the ground that can float up to 16 feet higher than the usual water level. A floating apartment complex and floating roads have been built, and there are even plans to try out floating gardens. While the future is uncertain, whatever it holds, the Dutch will deal with it with courage and ingenuity. 🏠

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Patricia d. Lock, a system engineer at NASA's Jet Propulsion Laboratory, is currently working on the GRAIL mission to map the gravity of our moon. Launched in September 2011, the GRAIL mission includes two cameras to be controlled by students from middle schools around the U.S. To learn more or to get your school involved, visit <http://moonkam.ucsd.edu>



THEN: *In the first century B.C., when the wind blew, the figure of Triton (the son of the Greek god of the sea, Poseidon) atop the Tower of Winds in Athens pointed to one of the eight wind deities representing the direction.*

THEN AND NOW

WHAT'S CHANGED? The technology used to monitor and record wind velocity and speed. The belief that deities controlled the various winds.

WHAT'S THE SAME? Both are powered by wind, which makes each point at the direction from which the wind is coming. Both are high enough and large enough to be readily visible from the ground and from a distance away.

NOW: *The Douglas DC-3 weathervane at Whitehorse International Airport in Yukon, Canada (needs only a 5-knot wind to make it rotate)*



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MARCH 2012 VOLUME 22 NUMBER 6

Weather Workers Wanted

AppleSeeds

A Cobblestone Publication

THE PERFECT STORM

Hey, I
thought you said
you had a broken
feather, that's why
you insisted I
carry you...

I'M NOT
TRYING TO
FLY!

Stormy
Weather
Inside!

Welcome! Hurricanes and tornadoes and tsunamis—Oh my! Extreme weather has been in the news a lot lately. This month, *AppleSeeds* and its five sister magazines—*Calliope*, *Cobblestone*, *Dig*, *Faces*, and *Odyssey*—are taking a look at the weather in our March issues. We asked Illustrator Jeff Crosby to create the covers for these special issues. You can see all six covers at WWW.COBBLESTONEPUB.COM/KIDS_STORM.HTML.



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Your Perfect Weather Job



Say Hello to: The *AppleSeeds* Kids
written and illustrated by Annette Cate

Welcome to the AppleCorps for Mel Hess's students at PS 321 in Brooklyn, NY. *AppleSeeds* asked them this question:

What would you do or create that would make money for you in extreme weather conditions?

Read their answers in this issue.



Consulting Editor

Robert Landis first became interested in meteorology in elementary school, when he made a rain gauge for a science project. After studying meteorology in college and graduate school, he developed a specialty: the effect of weather on oceans. As part of his research he lived on an iceberg at the North Pole and also in the Caribbean. Later, as the Director of the United Nations' World Weather Watch, he visited and worked in 109 different countries. He also was a director in the National Weather Service, responsible for all day to day operations. Today he is a consultant in meteorology, living in the Washington, DC area.

“On some days the weather can make what you do the most fun. On the other hand, the weather can cause the scariest of times, when there is a tornado or hurricane bearing down. Each day is different, and I decided I needed to find out why. Since I studied meteorology and learned to forecast the weather, I have had a chance to travel the world. Because the weather is always changing and everyone is interested in what lies ahead, there are many interesting careers that involve helping planes to fly and ships to sail, or just deciding what to wear on the school bus today!”

— Robert Landis

APPLECORPS

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My Father, AL ROKER

by Leila Roker

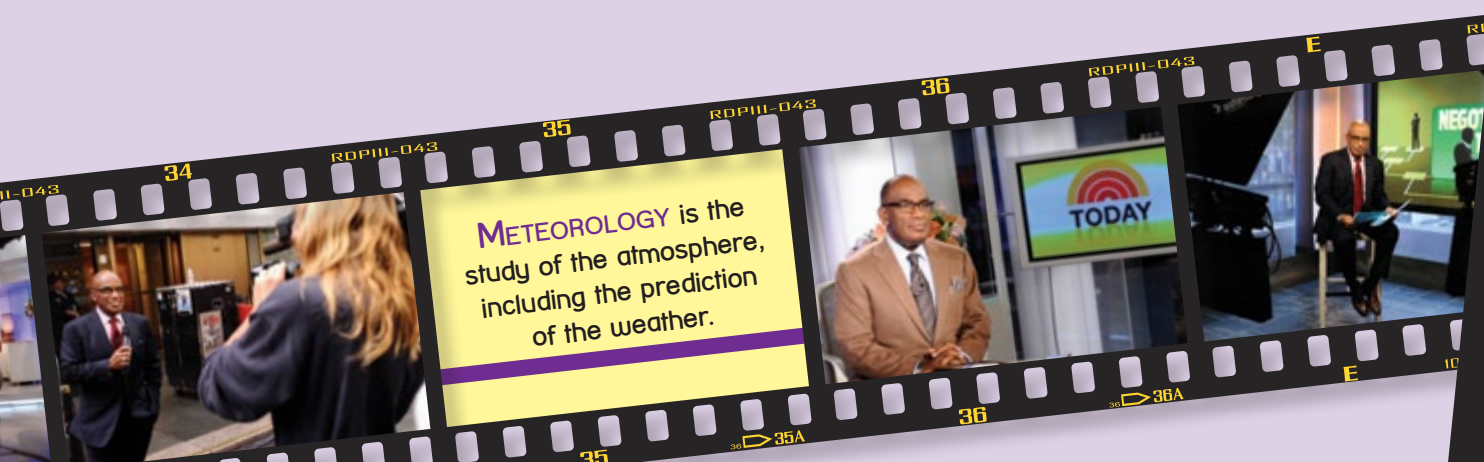
My dad, Al Roker, is a weatherman. I think it's a really cool job, although sometimes it can be a little hard because he travels a lot. He gets to go to a lot of really cool places, see cool things, and meet some really incredible people. In this interview, I can show you a lot of what he does. I hope you enjoy it.

LR: How did you get into the weather business?

AR: When I was a freshman in college, I took a meteorology class, but I never thought I would actually use it. At the end of my sophomore year, I got a job doing weekend weather at the CBS station in Syracuse, New York. At the end of my junior year, I became the weekday weatherman. After I graduated, I spent seven years in Washington, D.C., and Columbus, Ohio. Then, in 1983, I got the



LEILA ROKER is in the 7th grade in New York City.



METEOROLOGY is the study of the atmosphere, including the prediction of the weather.





opportunity to come back home and be the weekend weatherman at WNBC in New York. In 1984, I started filling in for Willard Scott on the *Today Show*. In 1996, with Willard Scott's blessing, I became the regular weatherman for the *Today Show*.

LR: You have to travel a lot for your job. What were your scariest trips?

AR: We were among the first journalists to land in Haiti after the earthquake. It was really scary, because a lot of people were frightened and had no idea what their future was going to be.

Another frightening moment was covering the 2010 wildfires in southern California. There was a sudden wind shift, and before we knew it, my crew and I were surrounded by flames. We escaped thanks to the firefighters accompanying us! I had to slide down a hill on my butt.

In 2005, while covering Hurricane Wilma, a 100+ mph wind gust knocked me off my feet during a live broadcast on the *Today Show*.

LR: What do you like the most or find the most fascinating in meteorology?

AR: What I like about doing the weather is that no two days are alike. It is a constantly changing atmosphere and environment. I get to go to fascinating places and meet amazing people. That's the best part of the job. The worst part of the job is that the travel that takes me to those people and places also takes me away from my family. And that's very hard.

LR: To you, what are the most important parts of weather broadcasts?

AR: Trying to be as accurate as possible, being honest with your audience that you don't always know the answer, and admitting when you missed a forecast.

LR: What is your favorite part of your job?

AR: My favorite part of my job is that I get to work with some really amazing people both in front of the camera and behind the scenes. Our *Today Show* is definitely like a second family to me.

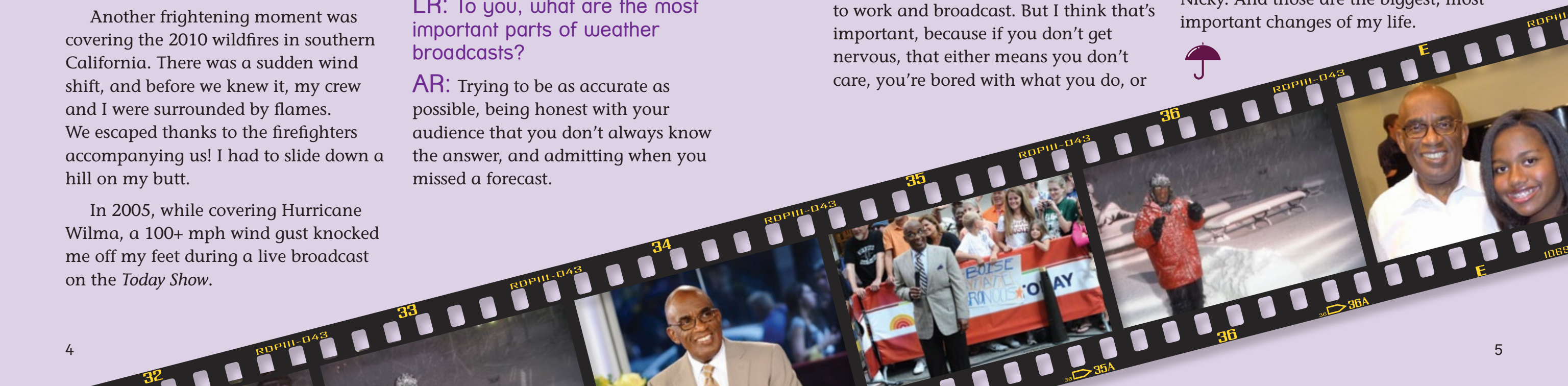
LR: Do you get really nervous before you broadcast the weather in front of a lot of people?

AR: I get nervous every day before I go to work and broadcast. But I think that's important, because if you don't get nervous, that either means you don't care, you're bored with what you do, or

you've stopped doing your best. Having a few butterflies in your stomach isn't a bad thing.

LR: How has meteorology and the *Today Show* affected your life?

AR: It's had many effects on my life: It brought me to NBC in New York, which is where I met my then-future wife, Deborah Roberts, who also was working at NBC. After we got married, we had two very special children—the author of this article, Leila, and her little brother, Nicky. And those are the biggest, most important changes of my life.



BLOW BY BLOW

by Rebecca Loescher

MALCOLM

I would use batteries to make a heated snow shovel so that after a snowstorm people could shovel faster and easier and also melt the ice underneath.



WILEY

When there's a lot of ice on the ground, I would sell a plate of steel cleats that attaches to your shoes so people wouldn't slip on ice. To get them off, you press a button and air pushes through the shoes, which forces the cleats off.



"Perfect storm? Let's show them!" said the wind to the rain. "Let's go! You gather storm clouds, fill them up, and I'll begin to blow! We'll soak the earth, twist trees, and flip umbrellas inside out, flood streams, back yards, and playgrounds, till rain gutters start to spout. It wouldn't be complete without our dazzling lightning show. I'll mix cold air and hot together . . . ZAP! . . . the heavens glow! And then, let's throw loud thunder in for a big, booming celebration. Ridiculous, how people think a downpour ruins a vacation! I'll set large fields of wheat to dancing, tossed in rippling waves; you send the cougar kits skit-skittering to their caves. I'll whip the ocean's wildest waves to shore in restless form; you burst from heavy, darkened clouds . . . *oh, what a perfect storm!* Then, when I'm finally out of breath, and you've not one drop more, our storm is done—it's over—just like many times before. Dogs race around, shake back and forth . . . wet fur and droplets fly; unhappy bees wait under leaves for flowers to drip-dry. Birds flap in splashy-splashy baths in puddles on the street, and happy children pull on boots to cover eager feet. While grown-ups gather mops and brooms and hope to see the sun, we've given kids our best performance, followed up with fun!"



IS THERE A STORM IN YOUR FUTURE?

by Laura Helweg



Does your heart beat faster during a thunderstorm? Do you study photos of tornado destruction? Do you wonder what happens inside a hurricane? If you're crazy about storms, there's a weather career for you.

HUNTING HURRICANES

Pilots called "hurricane hunters" fly airplanes through hurricanes and tropical storms. They brave the roller-coaster winds and waterfall rains to gather information for scientists and forecasters at the National Hurricane Center. The crew includes a pilot, a co-pilot, a research meteorologist, a navigator, and a safety officer.

They drop sensors that measure wind speed, wind direction, air pressure, humidity, and temperature inside the hurricane. This data helps scientists understand the structure and energy within hurricanes and how they form and grow. The data also helps engineers to design buildings that will survive storms.

I read more about the Hurricane Center on pages 28-30!



ANA

For extremely hot weather I would make a light-colored shirt with holes in it to let in cool air.





TRACKING TORNADOES

Scientists also want to know more about tornadoes. Why do they happen? What makes them strong?

Each spring, researchers travel to the Midwest to an area called "tornado alley," to observe and measure the structure of tornadoes. These "tornado chasers" use satellites, radar, and weather reports to guide them

to thunderstorms likely to form tornadoes. Then they get into specially equipped vans topped with radar dishes, radio antennae, and cameras. They try to race ahead of the storms to leave storm stations with instruments to take measurements when a tornado blows by. If they're lucky, they're able to collect information that helps forecasters give better warnings.



MAREVE

For beach houses where tsunamis could come, I would make big hard plastic domes. When a tsunami hits, the dome would come down and cover the house.

MAKING MODELS

Meteorological programmers design computer models that use science to understand how future storms will behave. The programmer enters data from scientists' measurements of past thunderstorms, hurricanes, and blizzards into math equations. The computer solves the equations and creates a model that shows the growth and movement of the storms. The programmer then

puts each new storm's "real time" data into the equations to make predictions.

These models created by computer programmers help meteorologists predict dangerous weather so you know when to take cover.

WATCHING SPACE WEATHER

Did you know that the sun has weather too? Space weather forecasters watch solar weather with satellites and radio telescopes.

Solar wind, solar flares, and other "space weather" can interfere with much of the technology we use every day. Their magnetic energy interferes with or harms satellites that carry TV broadcasts, cell phone signals, and power grids that light your house. They also interfere with satellite radio signals that are used by ships and airplanes.

Space weather forecasters tell people five to seven days ahead when to expect solar storms. Then satellites can be turned off, power stations can switch to alternate sources, and ship captains and pilots can use other tools to land safely.

SNAPPING STORMS

Weather photographers travel around the country taking pictures and videos of clouds, tornadoes, lightning, hurricanes, and blizzards. Finding storms is the easy part. But it takes practice to photograph a lightning flash or a black funnel cloud in a dark sky!

Weather photographers sell their images to magazines, Web site owners, and filmmakers, so that everyone can enjoy the beauty of storms.



DUNCAN

When there is extreme heat, I would make a hat that is shaped like a bucket with three fans attached to it, and all you have to do is put ice in the top and the fans will turn on and cool you off.





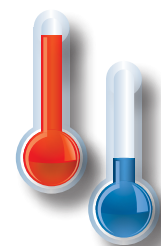
MAYA

I would make hard plastic umbrellas so people won't get head injuries during hailstorms.

Why

I Am a Meteorologist

by Steve Prinzivalli



WEATHER MATTERS

The weather makes a big impact on everyone. That's why forecasting the weather and knowing the current conditions outside is so important.

JUST THINK:

Teachers and coaches need to know if students can go outside for recess or sports.

Farmers and gardeners rely on the weather to know when to plant and water their crops and plants.

Managers at sports stadiums use the forecast to decide if the big game should be played or postponed.

A METEOROLOGIST'S JOB

You probably see meteorologists on TV and hear them on the radio. Many other meteorologists do important work behind the camera and in other jobs. Some of them are computer experts and track storms using special software. Others are storm chasers who go out and try to follow the path of a tornado. Meteorologists are also teachers, scientists, and researchers who study the atmosphere, including the weather. Meteorologists around the world share their observations and information with one another every day.

In my job, I research information on lightning strikes. I'm like a detective. My work helps improve our ability to detect where lightning may strike next. I look at in-cloud lightning that stays in the sky, as well as the very dangerous cloud-to-ground lightning that can injure or even kill people. And lightning can strike the same place more than once! So it is important that we know as much as possible about how lightning behaves.

Meteorologists can work long days, especially if a snowstorm, hurricane, or other major weather event is happening. And like many adults, some meteorologists may have to move when they get a new job. But learning about weather, and helping to inform people and keep them safe from severe weather, makes the job of a meteorologist exciting and rewarding.



BRIDGET

For very hot days I would put little holes into hoses and lay them next to each other and charge people to walk through the cool mist coming from them.

STEVE PRINZIVALLI
is a professional
meteorologist at
WeatherBug by Earth
Networks.

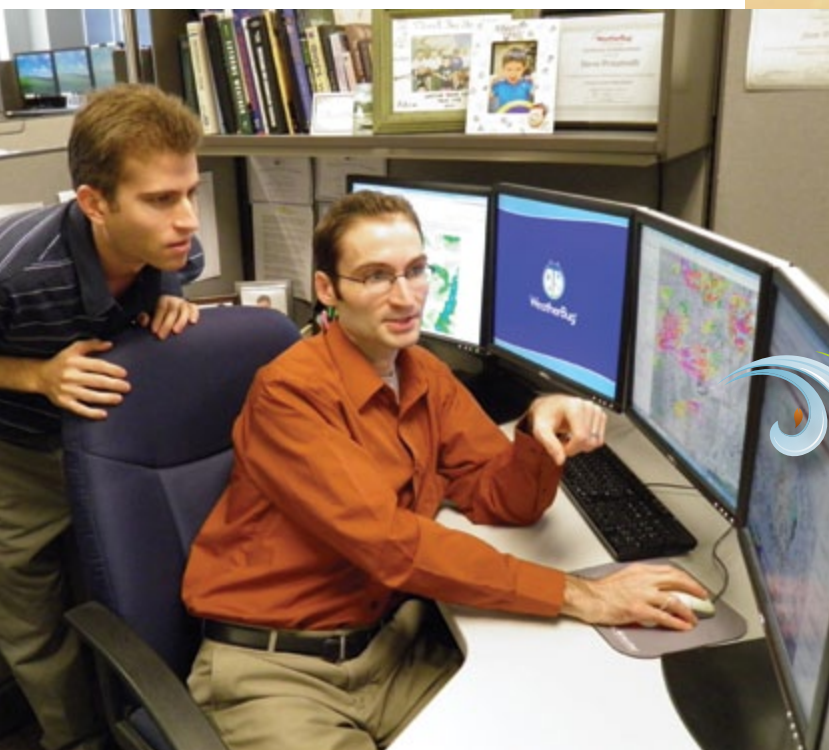


BECOME A METEOROLOGIST!

When I was a kid, I loved snow days! I liked guessing how much snow would fall and if school would be delayed or cancelled due to heavy snow. I also liked reading about weather facts. Did you know that no two snowflakes are alike? Or that a bolt of lightning is as skinny as a pencil and five times hotter than the sun?

Meteorologists must take lots of math and science courses in school, all the way through college. Even though much of what we do uses computers, you still need to be able to understand why the atmosphere works the way it does and to calculate the movement of a storm using your math skills.

So, if you ever have a snow day away from school, always remember that it inspired at least one meteorologist, and maybe it will inspire you, too!



• Steve in 5th grade



WANT TO FIND OUT MORE ABOUT LIGHTNING?

Steve Prinzevali recommends these sites:
www.lightningsafety.noaa.gov
www.fema.gov/kids/sabrina.htm
www.lightningsafety.noaa.gov/multimedia/Lightning_Game.swf

YOU CAN BE A METEOROLOGIST!

by Carollyne Hutter



tested by James, Logan, Clara, Katie, and Alex

• MAKE A TORNADO IN A JAR •

WHAT YOU WILL NEED

- A clear jam jar or similar see-through container with a screw on lid
- Dish soap
- Food coloring

WHAT TO DO

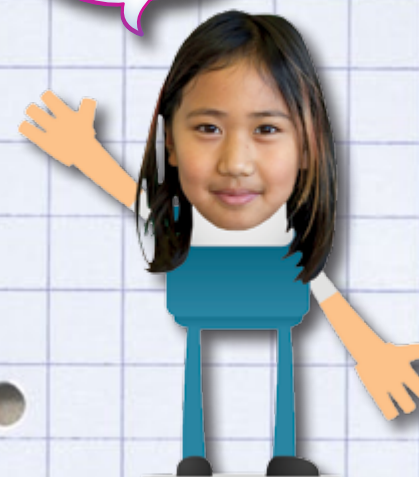
1. Fill up the container with water. Leave some room at the top, and add a few drops of the dish soap and a few drops of the food coloring. Tightly screw on the lid.
2. Swirl the container around in a circle lots of times, and then stop.
3. Watch inside the jar at what looks like a tornado. It will slowly disappear as it reaches the top of the container.

EXPLANATION

A tornado is air that is spinning very fast. In the real world, tornadoes are made in a similar way when cold and warm air combine and spin.

TENZIN

When it's very cold, I would sell heaters to put below car seats to warm the seat so you won't freeze.



BRANT

When it is extremely cold, I would make a jacket with thin plastic in the lining for boiling water to keep you warm on short walks.



• MAKE LIGHTNING IN YOUR MOUTH •

WHAT YOU WILL NEED

- Mint hard candies
- A dark room
- A mirror (if you do it alone). You can do this with a partner and take turns.

WHAT TO DO

1. Go to a really dark room. If you are doing this alone, stand in front of the mirror.
2. Wait a few moments until your eyes get used to the darkness.
3. Pop a mint candy into your mouth.
4. While keeping your mouth open, break the candy up with your teeth. Really crunch on it and look for sparks. If you are looking into the mirror, you should see bluish flashes of light. If you are doing it with a partner, he or she will see the flashes.

EXPLANATION

When you break the candy apart, you're breaking apart sugars inside the candy. The sugars release little electrical charges into the air. These charges attract the oppositely charged nitrogen in the air. When the two meet, they react by producing a tiny spark that you can see.



• MAKE A RAINBOW •

WHAT YOU WILL NEED

- An outside area
- A garden hose attached to a water spigot
- A sunny day

WHAT TO DO

1. Turn on the water so the garden hose produces a light flow of mist.
2. Stand with your back to the sun.
3. Look for a rainbow in the mist of the water.

EXPLANATION

Light is made up of a lot of colors: red, orange, yellow, green, blue, indigo, and violet. When light passes through the water, it is broken up into the colors seen in a rainbow.

• MAKE YOUR OWN RAIN GAUGE •

WHAT YOU WILL NEED

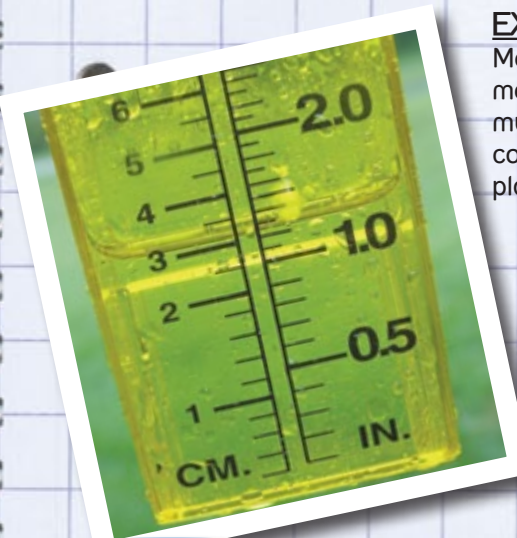
- A plastic ruler
- A wide-mouthed jar or glass with a flat bottom
- Tape (clear packaging tape works best)
- An outside area
- A notebook

WHAT TO DO

1. Set the ruler into your jar or glass. Tape it to the side.
2. Find a place outside to put your rain gauge. It must be open and away from trees.
3. Check the rain gauge, measure the amount of rain collected, empty the bottle, and place it back where it was. Do this every day at the same time.
4. Keep a weather diary and write down the amount of rain collected each day.

EXPLANATION

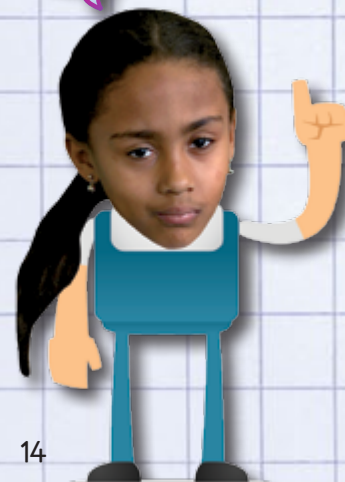
Measuring rainfall is important to meteorologists. They keep track of how much rain an area is getting. Then they compare the amount to other days and other places.



ERMON
For extreme cold I would make a coat out of electric blanket material. It would have a thermostat that would adjust the heat.



SARAH
When there is a flood, I would make giant skateboards with huge wheels so people get on and ride above the water.



ISABELLA
In a sandstorm, I would have a horse pull a sand-proof tent, and people would hear my bell and come inside so that they wouldn't get sand in their eyes.



HENRY
For hurricanes I would make a battery-powered bicycle with hollow plastic wheels and big tires so if you get swept up by a hurricane you could press a button and wheels would flip sideways so you would be raised up and hover above all the blowing trash.



• READ THE CLOUDS •

WHAT YOU WILL NEED

- Clouds
- A cloud chart (Download a cloud chart at www.weatherwizkids.com/weather-clouds.htm).

WHAT TO DO

1. Go outside or just look out the window at the clouds.
2. Notice two important things: the shape of the clouds and how high in the sky they are.
3. Compare the clouds in the sky with your cloud chart.

EXPLANATION

Knowing which clouds are in the sky can help you forecast the weather. Clouds are grouped into different categories. The Greeks first tried to classify clouds more than 2,000 years ago. But it wasn't until 1803 that the Englishman Luke Howard came up with a system for classifying clouds that works. It is still used today around the world.



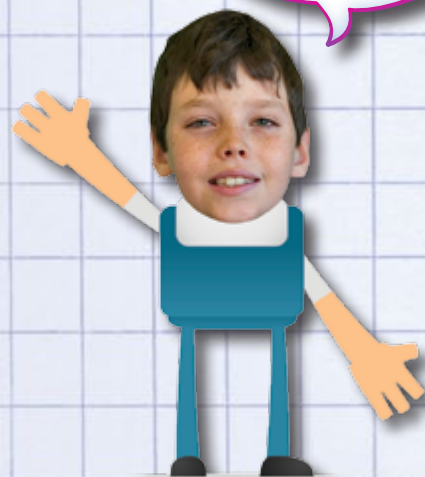
LOGAN

When it is extremely foggy, I would make a battery-operated fan stitched to the brim of a baseball hat to blow away the fog in front of me.

CHRIS

For floods, I will make a tricycle with three huge tires that have lots of little paddles glued on the tires so you can pedal through the water.

Those are great ideas! I HATE flying in fog! And the tricycle idea is fabulous, as long as I get to ride on the handlebars.



OPEN THE REFRIGERATOR

AND CHECK THE WEATHER

by Dan Risch

"Hickory nuts are pretty neat. I found an aquatic hickory I've never seen in an archaeological site in South Carolina. The hickory nut is misshapen and squished looking. It's 50,000 years old." Dr. Dorothy Peteet, Columbia University



• This seed is 12,000 years old! One of Dr. Peteet's favorites, it's the seed of a kind of birch tree.

Small seeds can tell a big story about Earth's ancient weather.

"When you find seeds in sediment at the bottom of a lake, it means a tree grew there long ago," says Dr. Dorothy Peteet, a researcher at Columbia University in New York. (Sediment is solid material, like mud, that has settled at the bottom of the water.) "It's like having seeds in a refrigerator, forever," she says. "They are perfectly preserved."

Dorothy is one of the world's few "seed people." She collects seeds dropped by trees that lived thousands of years ago. Some of those seeds are now buried deep underground. Dorothy has dug up seeds that are over 100,000 years old!

ERICA

When there is a lot of snow, I would invent a normal car that can hover when you push a button. Then it can hover above the snow and with its boiling hot hover-fire can melt the snow and ice below.



Lake bottoms are good spots to hunt for ancient seeds. “Lakes have soft sediment,” says Dorothy. “You know, your toes squish in the bottom of a lake.”

But Dorothy would never go barefoot when seed collecting. “The best time to core a lake bottom is in the winter,” she says. Lake ice makes a steady work platform.

Dorothy and her team trudge onto the ice and drill holes. Through the holes, they sink a “corer” into the sediment far below. The corer works like a drink straw: When you place a straw into soda, cover the top end of it, and pull it up, the soda stays in. The corer works in a similar way, but instead of a sweet drink, the corer pulls up a “long sausage” of old sediment.

Back in her warm lab, Dorothy sifts through her “sausages” of muck and mud. “I guess, for me, the discovery of taking a little bit of dirt, screening it, and seeing what we’ll find is my favorite part,” she says.

“One of the most exciting things we discovered was a very abrupt climate change,” explains Dorothy. “We identified a cold period in the Northeast United States. It was marked by spruce trees increasing in the forests while oaks died back.”

“There were birch trees too. Many birches grow only in warmer climates. But because we could identify the specific type of seed, we

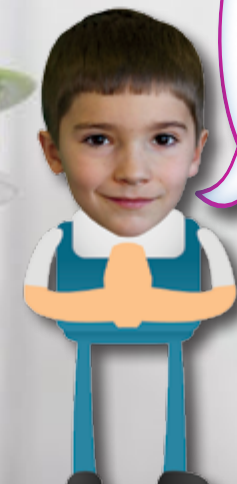
INDIA
When there’s a lot of snow, I would make a grocery sled with a box attached to the top of it with very high sides. Then your groceries will stay in the box and you can pull your grocery sled home.



• These lucky students are helping Dr. Peteet collect seeds. They use corers to check the sediment for seeds.



JASPER
In extremely cold weather I would make a pot of boiling water close to the ground on a rolling, low cart. People would pay for it to melt the ice and then it would vacuum up the water so it couldn’t freeze again.



found out it was a paper birch that grows in cold climates.”

Dorothy and her colleagues discovered that New York’s warmth-loving oak forests disappeared for about 1,500 years and were replaced by paper birches and lots of snow. For the first time, climate researchers could be sure that about 12,800 to 11,600 years ago, the New York area went through a mini-Ice Age. That knowledge helps climatologists better understand global warming.

“It’s just so exciting to say when that cold period occurred and to say exactly what the trees looked like,” says Dorothy. All because of little seeds shelved away in Earth’s refrigerator.



SONIA
For when there is a hurricane and the electricity goes out, I would make glow-in-the-dark wallpaper so that people can see in the dark.



VINCENT AND THE SUPERCOOLED CLOUD

by Susan M. Zikoyanis  illustrated by Giovanni Da Re

Many countries, including our own, have seen drought—caused by lack of rainfall. But what if there was a way to get water in the sky to fall to Earth's surface?



The year was 1943. In a New York laboratory, a man had a vision: Vincent J. Schaefer, an American scientist, was experimenting with ways to make rain. Schaefer did a series of tests. In the tests, he changed the chemical structure of a cloud to produce rain. This process is called weather modification, or cloud seeding.

First, Schaefer had to create an environment in which to produce a cloud. He got a deep-freezer box, lined it with a black material, installed a light, and set the temperature below the freezing point of 32 degrees Fahrenheit. He leaned into the box and exhaled his breath several times, saturating the box with moisture from his lungs. The box filled with fog, what is called a supercooled cloud.

The next challenge was to turn that fog into snow. For weeks, he tried many things, but nothing happened. Schaefer felt that Nature was not giving up her secrets. Then it came to him. What would happen if something really, really cold was introduced into the fog? Knowing that dry ice is a cooling agent to lower temperatures, he took a few chunks of and threw it into the fog. Instantly, the box filled with ice crystals that sparkled in the light. These tiny crystals quickly formed into snowflakes, producing more flakes from the rest of the moisture in the box. Vincent Schaefer had made snow!

He repeated this experiment several

times, using only a pinch of dry ice and another chemical called silver iodide. The silver iodide proved much quicker and spread further in the cloud than the dry ice did. It was the perfect recipe!

On November 13, 1946, Schaefer tried his experiment with a real cloud. Flying over a mountain in Massachusetts, he sprinkled several pounds of dry ice mixed with silver iodide into the cloud. Within five minutes, snow flurries streamed down from the cloud. Vincent knew that by the time the frozen precipitation reached the ground, it would turn into rain. From that day forward, Vincent J. Schaefer became known as the “rainmaker”!

By using the building blocks of Vincent's discovery, scientists today have improved ways to control the atmosphere through cloud seeding. But it's a practice that is still being studied. Any time that we tamper with Nature, there are risks. In fact, cloud seeding can produce either too much precipitation or the drought it is meant to stop. But one thing is certain, thanks to Vincent: It's now possible to do more than just talk about the weather! 



YOU CAN HELP

by **Kassandra Radomski**

Severe tornadoes, floods, drought, wildfires, hurricanes, and tropical storms are becoming more common. Temperatures over the last several years have been the warmest ever recorded.

Why is this happening? Many scientists think that extreme weather and higher temperatures are due to Earth's climate getting warmer. Earth's temperature has been slowly increasing for hundreds of years, but there are things people are doing to make temperatures rise even faster.

Think of all the ways you and your family use energy. Heating and cooling your home, watching TV, doing laundry, driving, and using the computer might be a few that come to mind. To create that energy, we burn fossil fuels, such as coal, oil, and natural gas. This has resulted in too many "greenhouse gases." The greenhouse gases make it difficult for heat to escape from our atmosphere into space, which contributes to rising Earth temperatures.

The good news is, we can all work together to slow down global warming by using less energy.

Unplug TVs, DVD players, video games, and appliances when you aren't using them. Or plug these items into power strips that you can just turn off.

Put your computer into "sleep" mode when you're done using it, and turn it off at night.

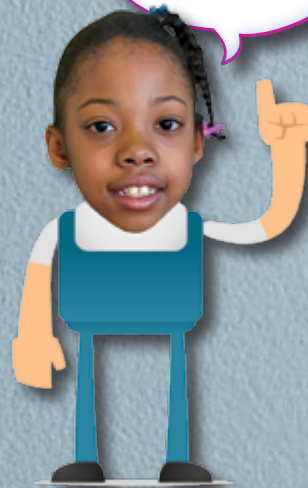
Look for the Energy Star label when your family buys new computers and appliances.

Turn off the water when brushing your teeth, take shorter showers, and use less water in the bath. (Running water takes energy, especially hot water.)

Walk or ride your bike when you can. If you don't walk to school, take the bus. Talk to your family about

KAYLEE

I would make battery-heated shoe soles that melt snow so you can walk in a clear path.



ERIC

For extreme cold I'd make a cream that would warm your skin so that you can play in the cold without putting on gloves, earmuffs, or ski masks. The more cream you put on, the warmer you get.



carpooling with friends to and from after-school activities.

Close the shades on hot days, so you don't have to turn on the air-conditioner.

On cold days, wear a warm sweatshirt or sweater, rather than turning up the heat.

Recycle cans, paper, plastic, and glass. (Recycling uses less energy, too!)

These are just a few changes you can make. See if you can come up with some other ideas. Get your family and friends to make changes, too. Together, we can all make a difference!



WANT TO LEARN MORE?
Try these great books:

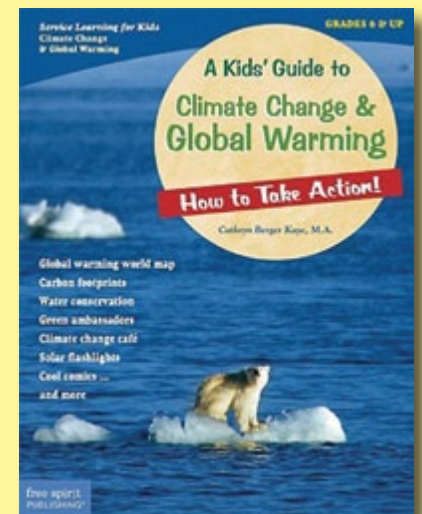
True Green Kids: 100 Things You Can Do to Save the Planet

by **Kim McKay and Jenny Bonnin**



A Kids' Guide to Climate Change & Global Warming: How to Take Action!

by **Cathryn Berger Kaye**



WEATHER WORKERS

by Donna Henes
illustrated by Craig Spearing

Today some people can predict the weather pretty accurately. And people also know how to *make* certain kinds of weather. Scientists have figured out how to make snow for skiing and rain for thirsty crops. Some people say there are also many kinds of nonhuman weather workers.

THOR, the red-haired Norse god, sent sparks flying when he sent his magic lightning hammer toward Earth. He was associated with war and battles and caused thunder, lightning, rain, and storms.

SHANGO was a god of thunder, storms, and war for the Yoruba people of Nigeria. He carried a double-headed axe very much like the Nordic Thor.

The Roman god **JOVE** was the master of lightning. He sent down thunderbolts to punish the wicked and warn the empire of sinful behavior.

OYA was the Yoruba goddess of weather, tornadoes, lightning, destructive rainstorms, the winds, and tempests. She accompanied her storm god husband during his thunderstorms, destroying buildings, ripping up trees, and blowing everything down. She destroyed things in order to make room for new growth.

THE NAMEDER OF CLOUDS

by Damian Fagan

In London in the 1700s, young Luke Howard liked to watch clouds. He was inspired by a poem titled "The Cloud" by Percy Bysshe Shelley. But his father considered watching the sky a waste of time. At school, Luke spent hours indoors reciting Latin words like *nube* ("by a cloud"), *nubes* ("a cloud"), and *nubis* ("of a cloud"). His schoolmaster was strict about learning quickly, and fortunately Luke was a fast learner.

Because of this, he was allowed to spend some school time outdoors studying nature and the things he liked.

After finishing school at age 16, Luke became apprenticed to a chemist for the next six years. When Luke moved to the countryside to manage a chemical factory, he finally had time to study the sky. He recorded daily weather conditions and sketched clouds. He understood that certain clouds were associated with particular weather.

In those days, though, people didn't agree on the names for clouds. Different people used different names for the same cloud shapes. In 1802, Luke proposed a way to classify, or organize, the different types of clouds. He used Latin names to identify three main types of clouds: *cirrus* ("curl of hair"), *cumulus* ("heap"), and *stratus* ("layer"). With these names, he could further define more-complex cloud types such as *cirrostratus*, *cumulostratus*, and *cirrocumulus*. Another cloud description, *nimbus*, means "rain." Finally, there was a language for naming clouds!

Though changes have been made, Luke's system and several of his cloud names were adopted by meteorologists around the world.

Luke Howard died in 1864. Outside his home in Tottenham, England, hangs a simple sign that reads "Namer of Clouds."



CIRRUS

CUMULUS

STRATUS

LILY
When there is a very rainy day, I would make an umbrella hat so you don't have to worry about holding it. You could also use it as a sun hat on very hot days.

SACHA
I would make a rubber suit with a waterproof zipper and boots attached so people could go through floods and help others.

ELLA
For places that have lots of hurricanes, I will sell really strong iron bolts that will keep everything in your house from falling, especially bookcases.

Cirrostratus

Cirrocumulus

Altostratus

Alto cumulus

Stratocumulus

Cumulonimbus

Nimbostratus

Fog

Cumulus

In the Eye of the National Hurricane Center

by Carollyne Hutter



THEO

When there are sandstorms, I would make a helmet with battery-powered fans that would blow the sand away from people's faces.



Along the coast of Africa, heavy thunderstorms are concentrating into tropical clusters. Across the ocean in Miami, Florida, meteorologists at the National Hurricane Center are using satellites to watch these storms develop and organize. These storm clusters, often called easterly waves, could be the beginning of a hurricane that will strike the United States.

The National Hurricane Center puts together prediction information on these deadly storms to help protect lives and property. It tracks weather in the Atlantic Ocean, Caribbean Sea, and Eastern Pacific Ocean. It provides advisories and alerts — called tropical storm and hurricane watches — for the United States and the Caribbean countries.

Uh oh. . . The disturbance has moved across the ocean and into the Caribbean. It has grown into a tropical storm that is headed to the coast of Florida. Once the storm reaches tropical storm status (winds of 40 miles per hour or more), the National Hurricane Center names the storm “Tropical Storm Ted.” Names for tropical storms and hurricanes are names commonly used in North and South America. They alternate between male and female names.

HURRICANE HUNTERS

To get a closer look at Ted, the center sends airplanes into the storm. The pilots and scientists onboard are called “Hurricane Hunters.” They can determine the location, strength,

and movement of the storm. They report their findings by satellite to the National Hurricane Center. The planes carry dropsondes, which are cylindrical tubes with parachutes attached that carry instruments and radio equipment. A dropsonde measures air pressure, temperature, humidity, and wind speed.

The National Hurricane Center also gets information about the storm from weather stations, ships, and buoys. When storms are about 100 miles off shore, coastal weather radars provide important data.

The information and data from all these sources are fed into a computer to create models. These models predict the path and the strength of storms.

DANGER ALERTS!

The winds of Tropical Storm Ted are whipping around faster, and the National Hurricane Center has issued storm watches. It recommends that several coastal forecast offices be prepared to issue local warnings. Radio stations, television, and the Internet all broadcast these warnings. The National Weather Service also broadcasts the warnings on its own NOAA radio, as well as on Facebook and Twitter.

The winds are now 75 mph, and Ted is officially a hurricane. Once a storm is within 36 to 48 hours of landfall, the National Hurricane Center goes into high gear to communicate its forecasts and

HURRICANES

Hurricanes start as tropical thunderstorms. The warm ocean water and the warm air above feeds the tropical storm through the process called convection. The counterclockwise winds suck large amounts of moist air toward the center of the storm. This creates an “eye wall.” The eye wall is where the air is then rapidly forced up into the atmosphere.

Because the atmosphere gets colder higher up, the air condenses from water vapor into cloud droplets. Those droplets either become rain droplets or go straight to ice crystals through a process called sublimation.

This whole process gives off energy that speeds up the winds and further develops the storm. The storm grows bigger as it gets caught in the spinning air. Dark clouds are pulled into the storm, causing the storm to whirl faster. Because the clouds are so high and thick, along with carrying tons of water, they block the sun and look dark for those of us on the ground.

Hurricanes can last for up to a week and range in width from 100 miles to 300 miles. What is strange about hurricanes is that in the center of them, called “the eye,” is calm. As the eye passes overhead, it can fool people into thinking the hurricane is over.

Scientists use a scale of 1 to 5 to describe the strength of a hurricane. Category 1 is the weakest hurricane, with winds between 74 mph and 95 mph. This type of hurricane causes some damage to small buildings and trees. At the other end of the scale is a Category 5 hurricane. The wind speed is over 155 mph. This type of hurricane can destroy cities and towns.

warnings to the public.

Because Hurricane Ted is heading toward land, towns along the coast are asking the people who live there to evacuate. Before they go, the people board up their houses to protect them from wind and flying objects.

OFF-SEASON

Hurricane season is from June 1 to November 30. It’s an intense, exciting job for the meteorologists at the National Hurricane Center during this period. Tropical storms and hurricanes have to be watched 24 hours a day, so the meteorologists are always working.

All year-round, scientists at the National Hurricane Center research hurricanes. They study data from all sources. These scientists want to understand hurricanes better, so they can improve their forecasts. Better forecasts can help save lives and properties. ☂



BREE
When there is ice on the ground I would have a sleigh that has a little heater on the bottom to melt the ice and snow so that people could walk on a clean sidewalk.



RYAN
I would build sleds that have a sail and rudder so that on snowy land they could be sailed over the snow.

THE APPLESEEDS KIDS ATTEND



THERE ARE 6 PERFECT PARTY CARTOONS. TO SEE THEM ALL, VISIT WWW.COBBLESTONEPUB.COM/KIDS_STORM.HTML

Answers to Cross-Frame Puzzle, back cover:

ACROSS: 1. MONITOR 2. IODIDE 3. HURRICANE 4. DROPSONDE 5. TROPICAL

DOWN: 1. METEOROLOGY 2. SEDIMENT 3. SEED 4. LIGHTNING 5. HUMIDITY 6. SATELLITES 7. FOSSIL

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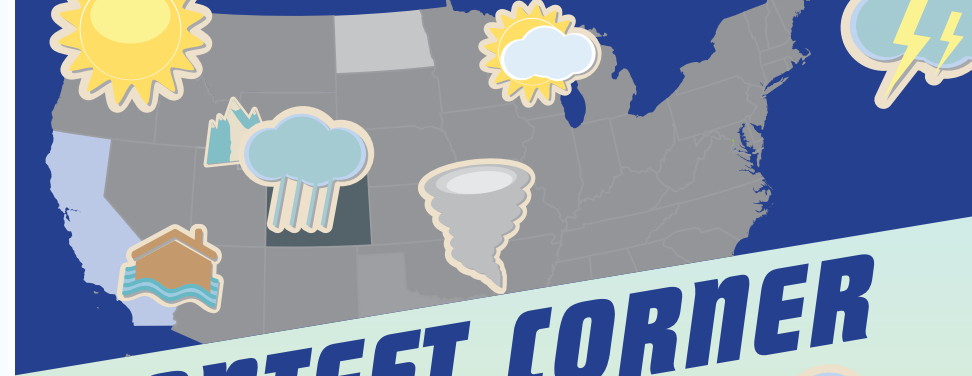
Earth Networks—WeatherBug: 10-12 all photos; Dorothy Peteet: 17-19 all photos; Photos.com:13-16 sticky notes and background paper, 15 rain gauge, 17-19 refrigerator backdrops, 22-23 electrical backdrop; NBC News TODAY: 2-5 all photos, 14; NOAA: 7-9 all, 27 clouds poster, 28-30 all; Shutterstock: cover umbrella, contents background, weather bodies throughout, 2-5 clap boards and film frames, 6 background, 10-12 clip art, 13 bottle, 14 mouth with lightning, weather stickers, 17-19 magnet letters, 26 clouds, 32 weather map icons, back cover background.

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CONTEST CORNER

In this issue of *AppleSeeds*, you've learned about some jobs related to the weather. Now we want to know, if you could have any job related to the weather, what would it be? Tell us what weather job you'd most like to have, and draw a picture showing you doing that job. Use plain white paper and lots of color.

Send your entry to:

**AppleSeeds
Weather Jobs Contest**
30 Grove Street
Peterborough, NH 03458

DEADLINE:
April 15, 2012

The winner will receive a
copy of the *Old Farmer's
Almanac for Kids*, Volume 4.



6 magazines, 1 extreme topic



The March issues of *COBBLESTONE*, *CALLIOPE*, *DIG*, *FACES*, *APPLESEEDS*, and *ODYSSEY* share the same theme: **The Perfect Storm**. Take an exciting look at extreme weather's impact on cities, culture, and history. Put all six covers together for a mosaic poster of nature's ability to dish out punishing weather.



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issues together in a **FREE** digital
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PREDICTING THE WEATHER WITHOUT A WEATHERMAN

People have always found ways to predict weather using signs from nature. Try some of this old-fashioned wisdom for yourself!



The bushier a squirrel's tail is, the colder and snowier the winter will be.



If a woolly bear caterpillar has a narrow band around its middle, it will be a harsh winter.



The longer the leaves stay on the trees, the colder the winter will be.



Sea gulls sitting on the sand is a sign of rain.



Cows tend to lie down before it rains.



Large anthills in the summer mean a cold and snowy winter.



If you cut the inner part of a persimmon seed in half, and it looks like a spoon, then it will be a snowy winter.



Flies bite more before it rains.



Cats groom themselves more during fair weather.



A dog or cat will bark or meow less before a storm.



Count the number of chirps a cricket makes in 14 seconds and add 40 to that. This will give you the temperature in Fahrenheit where the cricket is. (Crickets chirp faster when warm and slower when cold.)

WWW.COBBLESTONEPUB.COM

March 2012 • Volume 14 • Number 6

CROSS-FRAME PUZZLE

ACROSS:

1. Meteorologists _____ tropical storms to see if they will become hurricanes.
4. A small tube with a parachute that carries instruments and radio equipment into a storm.
5. Tropical storms often become _____.

DOWN:

1. The science of predicting weather.
2. Solid material that has settled at the bottom of water.
3. If you _____ a cloud, you may produce rain.
4. This can be as thin as a pencil and hotter than the sun.
5. This word describes how much moisture is in the air.
6. Solid material that has settled at the bottom of water.
7. _____ fuels like coal and oil contribute to greenhouse gases.

funny business



Q: How do hurricanes see?

A: With one eye!

Q: Whatever happened to the cow that was lifted into the air by the tornado?

A: Udder disaster!

"Extreme" Is the Forecast! p. 6

www.odysseymagazine.com

ODYSSEY

ADVENTURES IN SCIENCE

A Cobblestone Publication • March 2012

Celebrate!
Join the Party!

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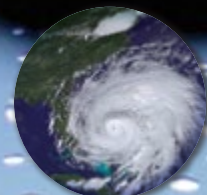
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by Karen Romano Young



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44 THE PERFECT
PARTY

Have you noticed how extreme weather is stealing headlines and making the news these days? This month, ODYSSEY and its five sister magazines—APPLESEEDS, CALLIOPE, COBBLESTONE, FACES, and DIG—are devoting their March issues to a look at the power and unpredictability of weather. We asked illustrator Jeff Crosby to create unique covers for these special issues. Check out page 47 for more information about the other magazines and see on the left how the covers for all six magazines create one impressive “perfect” storm!

CONSULTING EDITOR

Dr. Hugh Willoughby teaches meteorology at Florida International University. He studies observations made from airplanes and tries to understand how hurricanes work and how they affect people. Before he was a professor, he was in the Navy and worked at NOAA's Hurricane Research Division. Dr. Willoughby has flown into the eyes of typhoons or hurricanes more than 400 times.

Visit our online index at www.cobblestonepub.com/2011index_odyssey.html

www.odysseymagazine.com 1

Last October 29–30, as we worked on this issue, Mother Nature decided to punctuate the meaning of a “perfect storm” for us. The right conditions came together and 30+ inches of snow fell overnight in New Hampshire. Flowerbeds were buried and maple trees’ leafy limbs sagged under the white stuff’s weight. In New England, we’re used to the powerful punch of a classic nor’easter—but not for Halloween! Was the freak storm a result of climate change?

We look at that question carefully in the following pages. You’ll read about the tornadoes, hurricanes, droughts, and even a “black blizzard” that slammed the country last year. And discover that a report released by the Intergovernmental Panel on Climate Change (IPCC) last November warned that it is “very likely” that we will experience more such extremes, as a result of human-caused influences contributing to climate change. Fortunately, meteorologists are working to predict these severe weather events farther into the future to save lives and property. And climate scientists are attempting to accurately model what climate change will mean long range for the planet.

There is some really good news to celebrate in this issue too. It’s ODYSSEY’s 20th Anniversary! Please join the party on page 44. The weather sort of cooperated.

Erik Lindstrom

SCIENCE SCOOPS by Kathryn Hulick

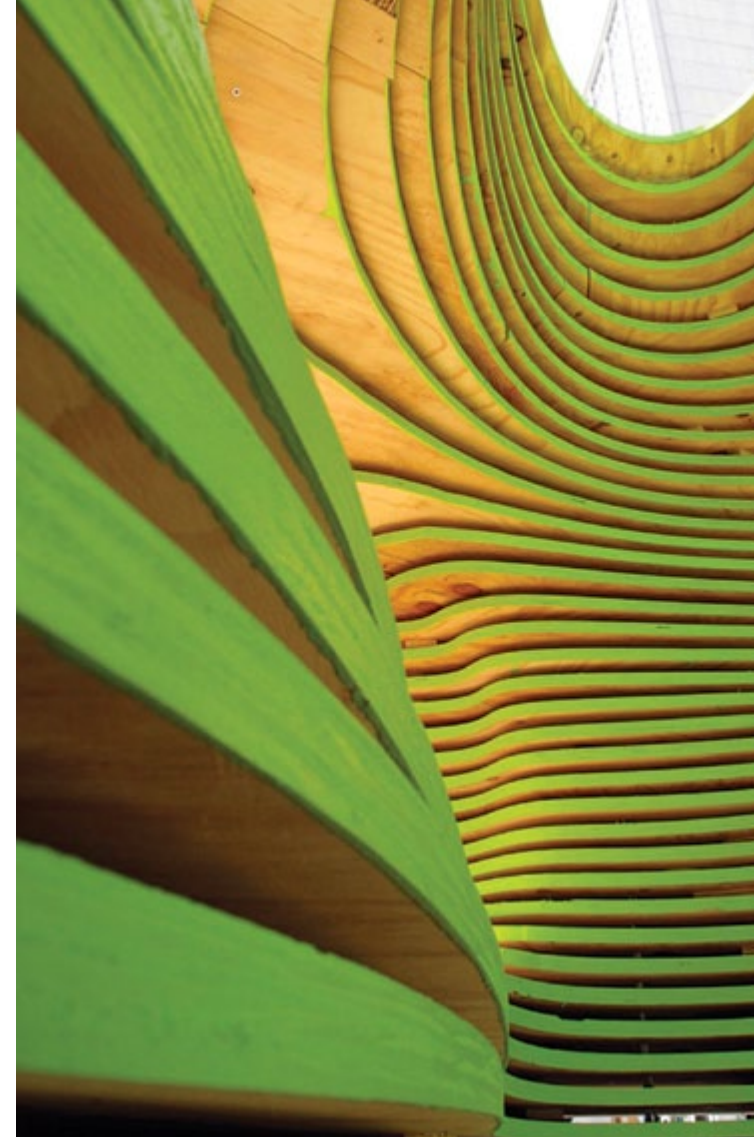
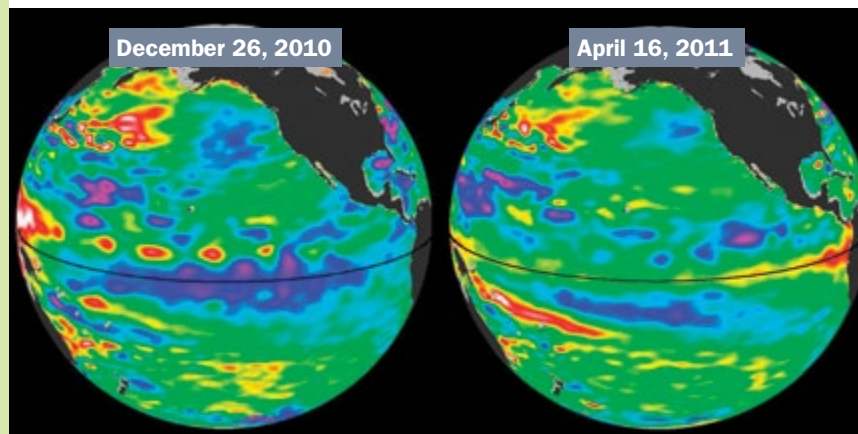
Why So Much Wild Weather? Blame “Nothing”

Now and ice fell unrelentingly through the winter, while floods and tornadoes wreaked havoc in the spring of 2011. Some scientists say it was the worst weather Americans have experienced since 1927. But why? Where did all these storms come from?

El Niño is the name for a regularly occurring weather event in which the surface temperature of parts of the Pacific Ocean rises to over 80 degrees F. *La Niña*, on the other hand, means that sea surface temperatures have dropped below the normal range of 60–70 degrees F. Both changes in temperature affect the weather pattern—sometimes for the better, and sometimes for the worse. But this time, something else was going on. Bill Patzert of NASA calls it . . . La Nada!

“La Niña was strong in December [2010],” he said. “But back in January [2011] it pulled a disappearing act and left us with nothing—La Nada—to constrain the jet stream.” If La Niña hadn’t fizzled out, it would have pushed the cold arctic air of the jet stream up and away from the United States. Instead, as Patzert put it, “Like an unruly teenager, the jet stream took advantage of the newfound freedom—and the results were disastrous.” That cold jet stream of air coming from the west ran into strong, warm winds from the south. When cold and warm air stacks on top of each other, the result is wild, wacky weather! (See also “Extreme Weather: A Glimpse of Things to Come,” p. 6 and “Know Your Streams,” p. 20.)

LEFT: The blue and purple band in this satellite image of the Pacific Ocean shows the cool waters of La Niña. The right image shows La Niña’s rapid exit from the equator near the U.S. coast four months later.



SHELTER FROM THE STORM

Taking emergency shelter in the Origami Cave during a natural disaster would be its own adventure.

When disaster strikes, where do you go? Emergency shelters spring up in schools, hospitals, or any building left standing. Sometimes, tents are erected to care for victims and shelter survivors.

The Emergency Shelter Exhibition in Sydney, Australia in September 2011 showcased architects’ and artists’ ideas for shelters that do more than protect people from rain—they also look beautiful and comforting. One shelter designed by the Laboratory for Visionary Architecture (LAVA), called the Origami Cave, looks like a giant paper lantern and even glows with battery- or solar-operated LED lights. The design team explained that they based the shape on a water molecule, and that the shelter can be flattened for easy shipment to a disaster area. Plywood, cardboard, or even newspapers can be used to form the interior.

The Exhibition raised money for the victims of Japan’s Great Tohoku Earthquake in March 2011.

Germ Hitching a Ride in Hailstones

Have you ever been caught in a hailstorm? Talk about weird weather—chunks of solid ice ranging in size from pebbles to golf balls fall from the sky. And hail gets even weirder when you dissect it and look inside. Montana State University graduate student Alex Michaud usually studies ice in Antarctica, but after a particularly bad hailstorm rained ice on his doorstep in Gallatin County, he decided to pick some up and study it in the lab.

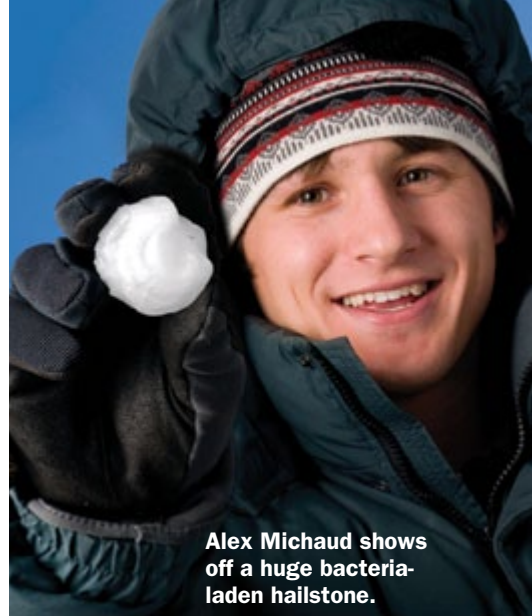
What did Michaud see inside the ice? Living bacteria! The really cool

part is the large number of bacteria found living inside the embryo, or center of a hailstone. When hail forms (or rain or snow, for that matter), it needs something to form around, called a “nucleating particle.” A bit of dust floating in the air does the trick, and so do airborne bacteria. This means that germs can actually *cause* a hailstorm!

“Well, they need a way to get back down to the surface,” Michaud told National Public Radio.

“It’s a pretty harsh environment up there in the clouds, lots of UV,

cold, dry, not the best place for a living thing to be, and so it’s good to be brought back down to where you have protection in the soil or on a plant surface, much more suitable habitats.”



Alex Michaud shows off a huge bacteria-laden hailstone.

Hurricanes, Heat Waves, and Quakes, Oh My! Is global warming to blame?

It’s easy to blame global warming, also known as “climate change,” for weather disasters. But it’s not so easy to prove it. Scientists working on the problem of linking changes in global climate to particular storms are part of a growing field known as “climate science.”

Climate scientists have two goals. One is *attribution*, or finding a link between a specific weather event and a change in climate. Goal number two is *prediction*—or figuring out when and where future natural disasters may take place, based on what we know now about climate change.

The Intergovernmental Panel on Climate Change (IPCC) released a special report on extreme weather and climate change in November 2011, making it clear that we should watch out for even wilder weather in

the near future. The report’s authors wrote, “There is evidence that some extremes have changed as a result of anthropogenic [human-caused] influences, including increases in atmospheric concentrations of greenhouse gases.” They noted that more frequent heat waves are “very likely” over most land areas. It is also “likely” that heavy precipitation events will become more frequent or

form a larger share of total rainfall in many areas. The authors discuss other extreme events too.

But you can’t blame every terrible or strange weather event on global warming. Remember the Halloween snowstorm that hit the Northeast in October 2011? It likely wasn’t caused by climate change. Maybe we should blame ghosts and ghouls for that one!



Snow from a classic nor’easter rather than the typical fall frost coated this jack-o-lantern in New Jersey last October.

NEUTRINOS FASTER THAN THE SPEED OF LIGHT?

According to Einstein and the laws of physics, nothing can travel faster than the speed of light. But in September 2011, a pair of researchers showed that neutrinos seemed to zip by slightly faster than the universal speed limit.

This could be a groundbreaking discovery in physics that will change our view of how the world works. However, the scientific community isn’t ready to rewrite the laws. Instead, they’ve been looking for what went wrong in the measurement.

The supposedly law-breaking neutrinos were created and sent on their way at CERN, the vast underground particle accelerator in Switzerland. Then, they were measured at an underground detector 450 miles away in Italy. According to the measurements, the neutrinos made the trip 60 nanoseconds faster than a beam of light. This is a teeny tiny difference—there are a billion nanoseconds in one second—but it is still a difference.

Antonio Ereditato, of the University of Bern in Switzerland, explained his team’s finding to the *New York Times*: “We measure the distance and we measure the time, and we take the ratio to get the velocity, just as you learned to do in high school.”

Clearly, if the distance measurement is off by just a



A view of the neutrino detector at Italy’s Gran Sasso Laboratory

few inches, or if the exact time the particles were created or detected is off by the tiniest fraction of a second, then the measurement is wrong. Physicists Andrew Cohen and Sheldon Glashow of Boston University chimed in with a paper showing that the speedy neutrinos should have lost energy on the trip, and this energy should have been detected. But it wasn’t.

Then, two months later, the original group repeated the experiment. Only this time, they fixed one problem with the first

test—the time it took to create the burst of neutrinos at CERN was larger than the 60-nanosecond speed discrepancy, meaning that the times of departure and arrival were perhaps not accurate enough. Surprise—those pesky neutrinos still seemed to be traveling about 60 nanoseconds faster than light.

No one is saying the result is impossible, Nobel Prize-winner Glashow told *Science News*. “But if it turns out to be true, I would say to Nature, ‘You win.’ Then I’d give up, and I’d retire.”



What do you think? Could faster-than-light travel ever be possible? Contact us at odysseymagazine@caruspub.com or: LIGHT SPEED, ODYSSEY, 30 Grove Street, Suite C, Peterborough, NH 03458.

Welcome To The ANDOVER SKATE PARK

ALL PARTICIPANTS MUST

- PURCHASE A DAY or SEASON PASS.
- HAVE A CURRENT & VALID ANDOVER SKATE PARK WAIVER ON FILE.
- WEAR AN AGGRESSIVE SKATE HELMET WHILE SKATING.
- BE RESPECTFUL TO THE PARK, OTHER SKATERS & STAFF.

CLOSED

Temperatures topped the 100-degree mark in Andover, Massachusetts, last July, closing this skate park.

C L O S E D

T O D A Y

T O O H O T

EXTREME WEATHER

A GLIMPSE OF THINGS TO COME?

by Kathiann M. Kowalski

When Hurricane Irene hammered the East Coast last August, it toppled trees, knocked out power, and flooded large areas. A few months earlier, flooding along the Mississippi caused massive damage. And this spring, the deadliest tornado in 60 years swept through Joplin, Missouri, killing 116 people and destroying everything in its path.

Meanwhile, Texas suffered from severe drought. While previous droughts generally had about two-thirds of normal rainfall, only 40 to 45 percent fell for most of 2011. “This is like a double drought,” says John Nielsen-Gammon, Texas State Climatologist and professor at Texas A&M University.

Get ready for more battering by bad weather. Although it’s impossible to blame global warming for specific events in 2011, convincing predictions say that both floods and droughts will become more common, and perhaps more extreme, on a weather globe.

Greenhouse Gases and Climate Warming

Hurricanes, heat waves, floods, droughts, and tornadoes have all happened before. And over millions of years, Earth’s climate has naturally gone from warm periods to ice ages and back again. When scientists talk about global warming or global climate change, however, they’re focusing on possible human impacts since the *Industrial Revolution*.

Every day, factories, power plants, motor vehicles, and other sources emit tons of carbon dioxide and other “greenhouse gases.” Basically, greenhouse gases trap extra heat in Earth’s atmosphere, warming it slightly above what it would have been otherwise.

Since 1988, the Intergovernmental Panel on Climate Control (IPCC) has been studying greenhouse gases’ potential impacts. In 2007, the group’s Fourth Assessment Report said it was “very likely” that greenhouse gas emissions from human activities caused most of Earth’s average

Industrial Revolution — The period from 1760 to 1850, when manufacturing went through a major shift from manual labor to machines

FOR THE RECORD . . .

Here's a look back at some of the United States' record-breaking bad weather in 2011:

- Ten weather disasters racked up more than \$1 billion each in damages from January through August 2011—more than any other year from 1980 through 2010.
- Texas had its driest March on record in 2011. Texas also set a 2011 record for least rainfall from February through April.
- Rapid snow melts made water crest to record and near-record levels at many locations along the Ohio, Red, and Mississippi rivers.
- Wildfires burned 1.79 million acres in April 2011, setting a new national record for that month.
- Oklahoma, Texas, and Delaware had their hottest July ever in 2011.
- Several cities recorded their highest high temperatures ever in July 2011, including Newark, New Jersey (108 degrees F) and Fairbanks, Alaska (97 degrees F). Houston hovered above 100 degrees F for a record 24 days in a row in August 2011.
- The national Storm Prediction Center recorded 1,371 preliminary tornado reports from January through May 2011, setting a new record for those months. Eight hundred seventy-five of those reports came in during April.
- Locations in Montana and North Dakota recorded record snowfalls for the 2010–2011 cold season.
- Burlington, Vermont, had its largest snowstorm on record in March 2011.
- More than 1,300 daily precipitation records were broken in April 2011, including 197 new records set in Kentucky.

Last September, firefighters in Texas battled one of the most destructive wildfires in the state's recent history.

continued from p. 7

temperature increase for the preceding 60 years. By 2100, the IPCC estimates, average global temperatures will climb between 2 degrees and 11.5 degrees F (1.1 degrees to 6.4 degrees C).

Normally, we won't feel differences of just a couple of degrees. The real problem is the possibility for more very hot days and other extreme events. "In climate models what you see is that when you add more greenhouse gases to the atmosphere, the extremes change more than the averages do," says Jay Gullede at the Pew Center on Global Climate Change. "It's the extreme weather events that cause damage, not the average."

Was Climate Change the Culprit?

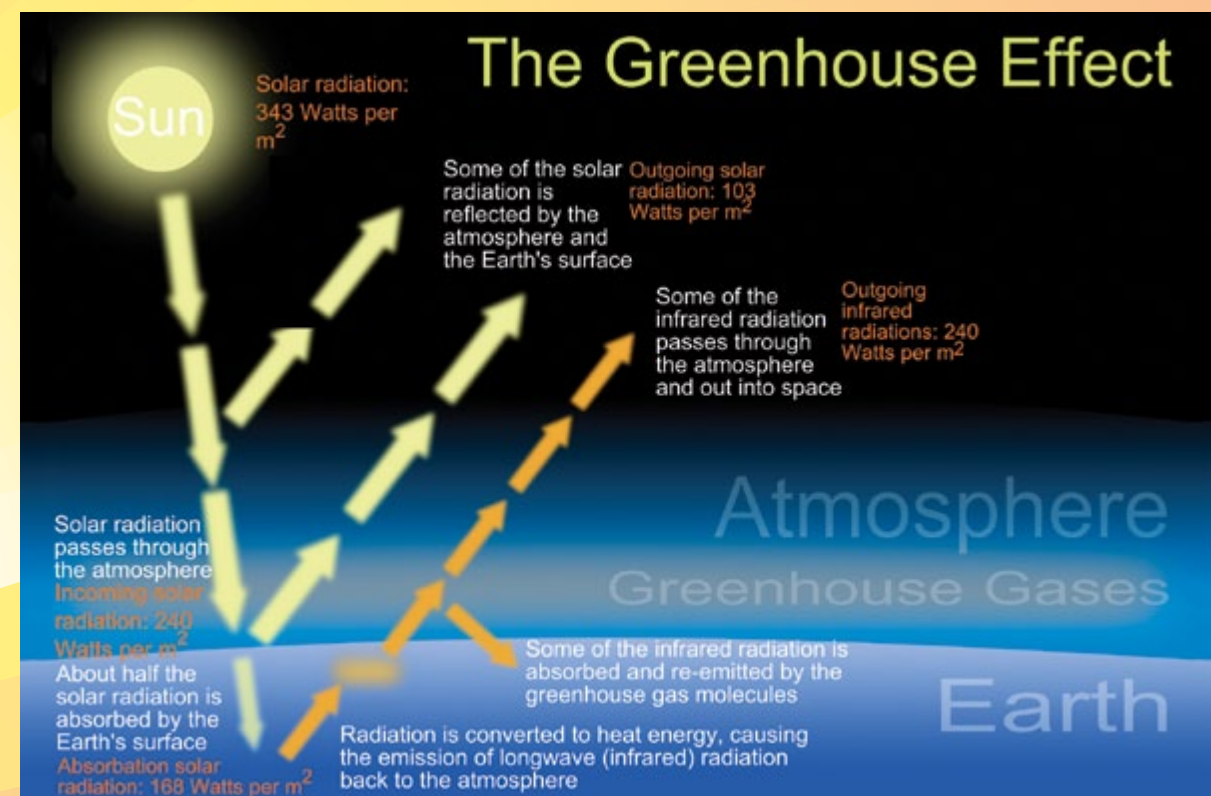
Which of 2011's bad weather events came about because of climate change? Scientists can't really say. "You cannot attribute any single day's event to global warming," says Tom Peterson at the National Climatic Data Center in North Carolina.

"The atmosphere is what scientists call a chaotic system," explains Gullede. "It follows the laws of physics, of course. But with very, very small disturbances of the atmosphere, many, many, many different things can possibly happen." Thus, you can't work backwards from one specific result to one particular cause.

Beyond this, natural forces play major roles in causing weather. Texas's hot, dry summer of 2011 was driven largely by *La Niña*, a weather pattern linked to cooler waters in the Pacific Ocean. A warming and cooling cycle in the Atlantic, called the Atlantic Multidecadal Oscillation, also played a part. Drier ground made temperatures even hotter.

"We probably would have broken the record [for high temperatures] even without the global temperature increase," notes Nielsen-Gammon. Moreover, it's hard to tell whether global warming will increase or decrease Texas rainfall in the long run, he says. If global warming will decrease the state's rainfall, then Nielsen-Gammon estimates that maybe 1 degree F of the 2011 heat wave came from climate change. Natural forces would have

La Niña — Climate events that result from cooler-than-usual waters in the tropical Pacific Ocean



As solar energy warms the Earth, the warmth spreads into the atmosphere. But as the warmth reaches pollutants, the chemicals absorb some of the heat and some of the heat radiates back to the ground. Less and less of the heat escapes into space. More and more heat is trapped. Eventually global temperatures rise.

caused the other 4 degrees.

One extra degree can make a drought more widespread and severe. More importantly, the climate is still adjusting to greenhouse gas emissions, which keep going up. "The relative importance of climate change is just going to keep increasing over time," says Nielsen-Gammon.

So far, several studies have used forecasting models to try to link climate change to specific events. In one study of conditions like those before Great Britain's floods in 2000, two-thirds of the model runs had greater flood risks with greenhouse gas emissions than without them. Another study concluded that greenhouse gas emissions doubled the chances of Europe's 2003 heat wave from about 1,000 to one to 500 to one. Both cases gave odds that global warming had an impact—not a definitive yes or no.

Rather than focusing on individual weather events, suggests Gullede, ask how likely they are to happen in the future. "If they used to happen once every ten years, and they now happen once every four years, that change is statistical," he says. "And that we can attribute to warming."

Gullede and Jeff Masters at Weather

Underground both use the concept of dice to think about risks of extreme weather from climate change. Suppose that instead of rolling a number from 2 to 12, one of the dice has seven faces, so you can now roll from 2 to 13. Suppose also that the dice are loaded, so larger numbers come up more often.

In a similar way, climate change may expand the range of what extreme weather events can happen. It will also make extreme events more likely.

What Can We Expect?

"Increases in extremes in heat are one area where we will first see the effects of global warming," says Masters. Very hot days are likely to become more common, and new records might be set.

Heavy precipitation is also likely to increase in many areas. A warmer atmosphere causes more evaporation. "If you have more water vapor in the air," says Masters, "that means more of it can come down as rain in heavy rainfall events."

In *arid* areas, however, higher extreme temperatures increase chances for drought and wildfires. Warmer air evaporates more water, drying the ground. "The temperatures get hotter as the ground gets drier," adds Nielsen-

Arid — Dry

IS GLOBAL WARMING REAL?

While some skeptics argue to the contrary, most climate scientists agree that human activities are indeed causing climate change. A 2010 study published by the National Academies of Science found that 97 percent of climate scientists agree with the IPCC that the evidence is sufficient to show that human activities have caused most of Earth's increased average temperatures over the last 60 years.

Gammon. "The additional extreme temperatures make wildfires much more likely, and those fires that do form become larger and affect more land."

On the flip side, climate change will probably mean fewer bitterly cold days. But fewer record cold days could also mean more snowstorms. "The heaviest snowfalls always occur right around freezing," explains Masters. "That's when the atmosphere is still cold enough to snow, but you have the maximum amount of water vapor in the air."

Will hurricanes become more common? That question is still "up in the air," says Gullede. "The indications at this point are that on a global basis, total hurricanes are likely to become less frequent, but the strongest ones [will become] more frequent." Research is ongoing.

Likewise, it's tough to tell whether climate change will bring more or fewer tornadoes. "Major tornado outbreaks require a whole bunch of things to come together," notes Peterson. Those factors include **wind shear**, thunderstorm

Wind shear —
A high-altitude shift
in wind speed
or direction

Hurricane Irene
hammered the
Northeast last
August, causing
destructive flooding
along its path.

clouds, and other conditions. Plus, major tornado outbreaks are very rare. "You can't really say that that's going to be more common in the future or not, based upon the information," says Peterson.

Looking Ahead

Climate models and weather forecasts both look toward the future, but they're two different things. "Climate is what you expect. Weather is what you get," says Masters, quoting from Mark Twain.

Because the atmosphere is chaotic, weather forecasting works up to about one week. In contrast, climate models calculate average conditions several decades or a hundred years in the future.

"The biggest unmet need is that people want five- to ten-year forecasts," says Peterson. Providing that information is tough, though, because science can't yet pinpoint when events like **El Niño** and La Niña will happen. Nonetheless, communities need to make decisions. Cities and towns might expand systems for handling storm water if increased flood risks justified the cost. Or, if science could say when droughts were likely, farmers could adjust crops and herd sizes and invest in better water conservation.

Some efforts seek to build regional weather forecasting into part of a longer-term climate model. Other researchers are refining the data used in climate models. For example, some now start with current ocean conditions instead of historical averages.

Meanwhile, as we cope with what's happening now, today's extreme weather can also help us prepare for tomorrow's risks. "That identifies places where we need to take adaptation measures," says Gullede. "It also helps put a dollar value and a human cost value on the consequences of climate change."

Kathiann M. Kowalski has written 22 books for young people, including *Global Warming: Open for Debate* (Marshall Cavendish, 2004). She writes often for *ODYSSEY* and other Cobblestone publications.

El Niño —
Climate events
that result from
warmer-than-usual
waters in the tropical
Pacific Ocean

SHOULD WE PUT THE CAT IN HER CARRIER?

by Nick D'Alto • illustrated by Chris Hsu



"Mom, will we need to evacuate Fluffy, too?"

The Miranda family has been glued to the Internet and TV all day, keeping an eye on the threatening weather. Hurricane William is headed for the Atlantic coast, where they live. Will the storm make landfall near their town? How powerful will the wind, rain, and storm surge be? Will they need to evacuate?

Answering these questions will call on an amazing array of technology in the air, sea, and space, connected to some of the most powerful computers on Earth. The prediction will draw on weather data taken second by second, as well as

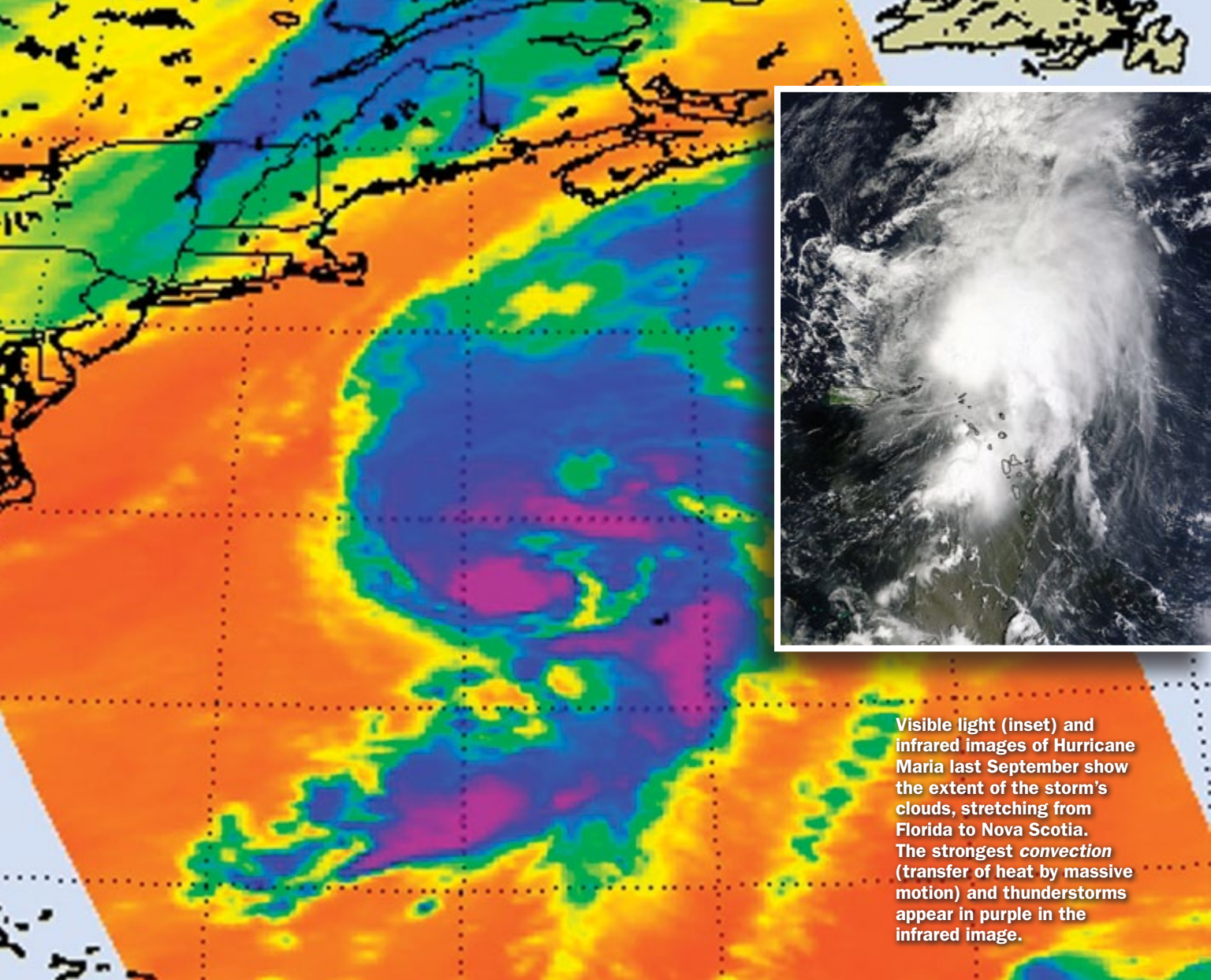
on weather reports compiled a century ago.

As the Miranda family watches the latest weather reports, here's how science tracks the storm.

An Eye in the Sky

TV weather forecaster: "Satellite imagery shows hurricane William approaching the coast and gaining strength."

Storm tracking begins out in the reaches of space. Weather satellites offer unique advantages by observing storms from high above the clouds,



especially over oceans, where ground and radar stations can't reach. They can survey enormous areas and watch constantly, often spotting weather triggers that start storms before they're noticeable on Earth. And they can track a storm's progress across the globe.

To do all this, the GOES (Geostationary Operational Environmental Satellites) orbit 22,300 miles above the equator, a magic distance that lets them "hang" motionless over the same spots on Earth, rotating as the planet does. GOES (pronounced like the word "goes") East watches the Atlantic, while GOES West scans the Pacific. Together, they spy two thirds of the Earth constantly. Other weather satellites in lower orbit whirl around Earth's poles, providing additional data.

These space platforms provide the satellite imagery that you see on TV. But the images you see aren't really photographs, because weather satellites don't use cameras. Instead, they use *radiometers*—electronic sensors that turn light into electrical signals. Aboard each of the GOES, a mirror swings in front of a powerful telescope to reflect light into its radiometer, letting the satellite "see" land, water, and clouds. The process is very rapid; GOES can scan an area 2,000 miles across (about half the size of the United States) every 41 seconds. Clipping these still images together shows the weather in motion; the composite images are the storm animations you see on TV.

GOES radiometers see the way you do—by detecting visible light reflected back into space. This enables meteorologists to view how the clouds and sea appear from space, which helps them determine the size, shape, and path of a hurricane. But GOES has another way to see—by using infrared radiation, which is like regular light but with wavelengths longer than we can see. Infrared shows how much heat the sea and clouds are giving off, which helps meteorologists determine the power of a storm. Since low clouds are usually warmer and higher clouds colder, infrared images also show how different parts of a storm rise into the atmosphere. Visible light and infrared radiation are a perfect team; visible light works only in daylight and infrared works both day and night.

The satellites beam all their data to powerful ground computers, which organize it into a form that humans can understand. The results are beamed back up to the satellites, so the information can be transmitted to weather stations across the globe.

On the nightly news, visible images show white and gray clouds, their shading indicating where the clouds are thickest. Since we can't see infrared radiation, these images are turned into color-coded pictures. Blue shows the warmest parts of the storm; yellow and white, the coldest.

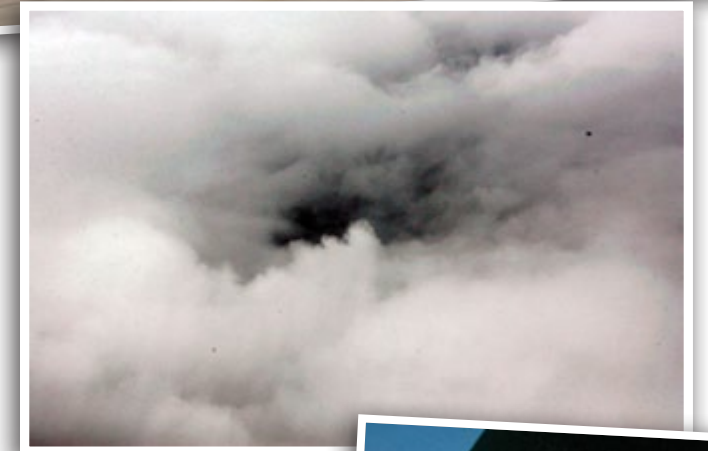
To see GOES images in action, visit <http://www.ghcc.msfc.nasa.gov/GOES/goeswestpacusir.html>.

Call in the Air Force

Internet News Report: "Hurricane William's wind speeds have picked up dramatically, while its barometric pressure continues to fall."

How do meteorologists know this? While satellites can see over a hurricane, they can't see as well inside it. So while most airplanes avoid rough weather, a special breed of aircraft deliberately flies into the fury of a storm.

The crew of the Air Force's 53d Weather Reconnaissance Squadron, nicknamed the "Hurricane Hunters," operate special sturdy,



TOP to BOTTOM: Loaded with meteorological data-gathering instruments, an Air Force WC-130 readies for flight into a hurricane. Inside the storm, it launches a *dropsonde*, a cardboard tube about the size of a person's forearm stuffed with weather sensors. Weather officer Brian Schroeder watches a computer screen as information from the dropsonde comes in.



REFLECTING ON THE WEATHER

Radar can spot a plane approaching an airport. It can track a coming storm the same way. Radar works because microwave radiation—which is invisible at wavelengths even longer than the infrared—bounces off objects (much the way a ball bounces off a wall). For weather, the “objects” are water droplets in clouds and rain. Timing the bounce lets weather radar identify how far away a storm lies. By detecting how the returning waves are “squeezed” as they bounce back, Doppler radar can also tell what direction and how quickly the storm is moving. Weather radar provides valuable data at land-based stations and on the coasts.

stable aircraft, called WC-130s. These four-engine turboprops are equipped to observe and fly through dangerous storms in the Atlantic and Caribbean. Outfitted with extensive weather equipment, they carry a crew that includes two dedicated weather personnel.

After verifying the position of a storm in low-level flights, a WC-130 enters the hurricane at 10,000 feet, passing through the storm’s *eyewall* (the region around its center where winds are most treacherous, and rain most intense). There, the aircraft deploys *dropsondes*, which are like the instruments under weather balloons, but these fall downward on a parachute. These instrument-packed metal cylinders collect data on wind speed, atmospheric pressure, and other key weather factors, relaying it back to aircraft wirelessly as they plunge through the storm and splash down in the ocean.

WC-130s may remain aloft for up to 18 hours, covering over 3,500 miles. By combining cutting-edge weather science with the crew’s consummate flying skills, these missions help better identify the width of a storm, its potential landfall, and its severity, improving storm forecasting dramatically.

To visit the Hurricane Hunters, see <http://www.hurricanehunters.com>.

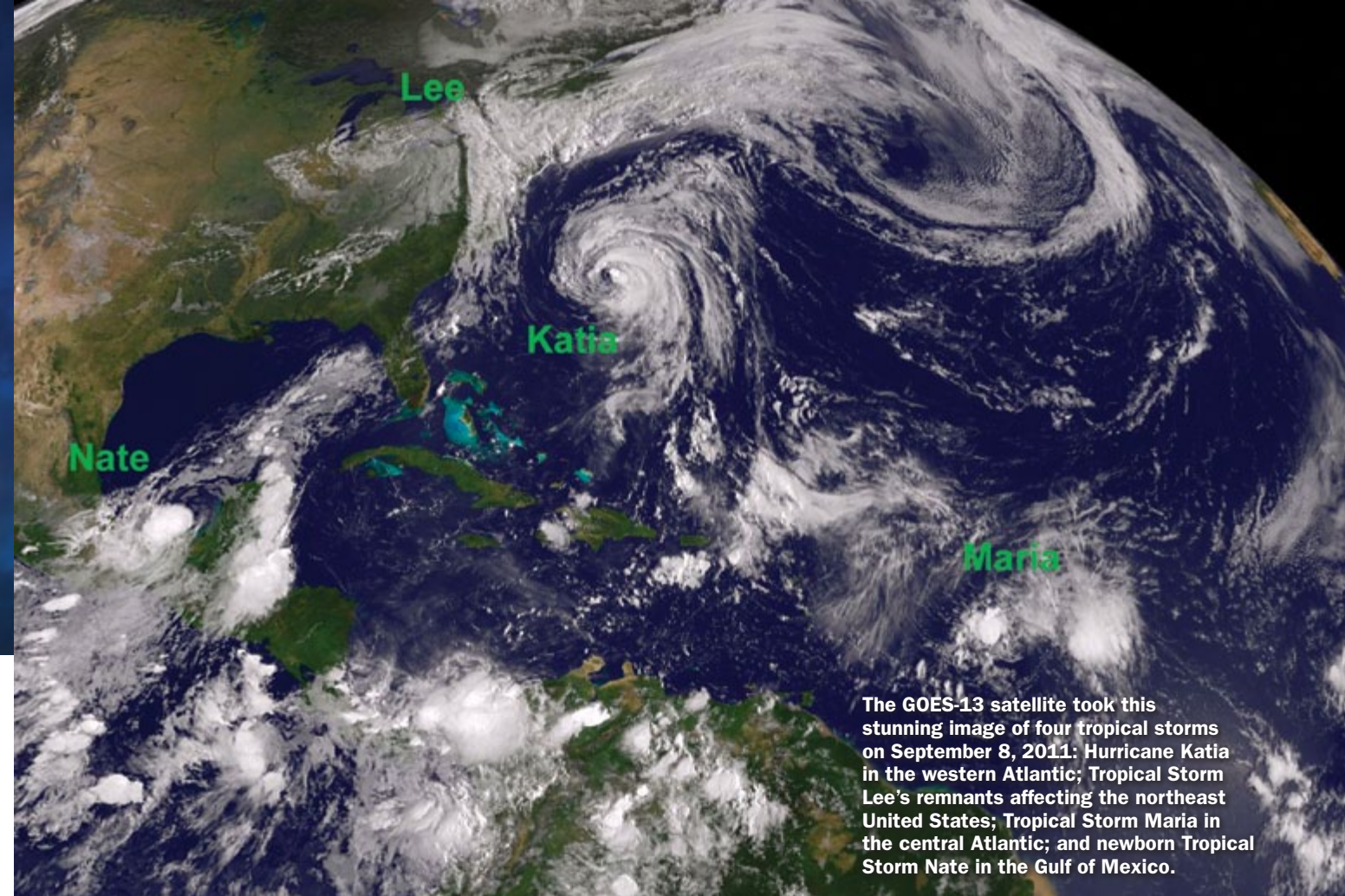
Go Figure

Nightly Newscaster: “Our latest computer models show Hurricane William following one of four possible tracks, two of which would result in landfalls . . .”

Satellites, aircraft, and other sources can collect immense amounts of data about a storm. So much, that no human could analyze it. That’s why the storm-tracking forecasts you see on TV (sometimes called “spaghetti maps” for their various wavy lines) are the result of *numerical weather prediction*, where the weather forecaster is a computer.

The storm itself is placed in the computer as tens of thousands of equations and data points. The process of numerical meteorology begins with *initialization*, using all available data to describe weather conditions right now. Next comes numerical *modeling*, using equations to describe the behavior of the ocean, atmosphere, and surrounding terrain. For example, how will air move around a particular mountain? How will wind or pressure change as weather meets a particular coast? Answering such questions may draw on data from many years of weather records.

Solving all the equations can predict how weather conditions will change over time. The answers are revolutionizing how we predict what a storm will do next.



The GOES-13 satellite took this stunning image of four tropical storms on September 8, 2011: Hurricane Katia in the western Atlantic; Tropical Storm Lee’s remnants affecting the northeast United States; Tropical Storm Maria in the central Atlantic; and newborn Tropical Storm Nate in the Gulf of Mexico.

The process, however, presents many challenges. First, the equations needed are incredibly complex, in some cases so involved that even a computer can’t solve them completely. Second, weather itself is what scientists call “chaotic.” The slightest change in conditions in one place can produce huge changes somewhere else. As a result, the farther into the future (one hour, one day) we predict, the less certain even the best forecast can be.

To try to solve this problem, scientists are calling on ever more computing power. Faster, more powerful computers solve each equation more frequently. They also work with more data, allowing programmers to model weather and terrain in greater detail. This increased information helps improve weather forecasts.

Breaking News: “Hurricane William will go out to sea without making landfall. Residents are advised to remain in their homes

and continue to monitor the storm for the next 24 hours.”

And so our storm warning has a happy ending: The Miranda family won’t need to evacuate. Thanks to some of the most powerful technologies on (and above) Earth, they know that they can put their pet’s carrier away for now. By the way, where is that cat hiding, anyway? 🐱



TERRIBLE TWISTER!

by Kathryn Hulick

Winds shrieking and swirling at over 210 miles per hour, a giant tornado bore down on the city of Joplin, Missouri. Directly in its path, 12-year-old Caleb, his parents, and his two little sisters sat at the local Stained Glass Theater watching a play. “The air got this funny feel and my mom started telling me that we’d better get down to the basement,” Caleb said. He was one of only five people who made it inside the storage room, the closest thing to a storm room in the theater. Almost everyone else huddled in the basement, the stairwell, or on the auditorium floor by the stage.

The spinning monster from the sky hit around 5:40 p.m. on May 22, 2011.

Inside the Cyclone

“It was terrible. I plugged my ears and started yelling,” said Caleb.

Convective Available Potential Energy (CAPE) — A measurement of how much energy is waiting to be released in the atmosphere

Convective INhibition (CIN) — A measurement of how much energy is preventing air masses from rising upwards

Wind shear — Winds that change speed or direction as you go higher in the atmosphere.

LEFT: A view of St. John’s Hospital, near the Stained Glass Theater in Joplin, Missouri, the day the tornado hit. RIGHT: An image taken several days later shows the hospital, which was too badly damaged to treat those injured in the tornado.

Moving at 20–25 miles per hour, slow for a tornado, it took the storm about a minute to tear through the theater, ripping off the roof and walls, snapping the plank of wood securing the back door, and smashing cars against the foundation.

“It felt like an eternity,” Caleb said. “I was pretty sure someone in my family was going to die.”

Miraculously, his family all survived with minor bumps, cuts, and bruises. A friend of Caleb’s who was also at the theater had to be air-lifted to a hospital in Kansas City because of injuries. The hospital next door to the theater, St. John’s, was too badly damaged to treat anyone. The friend recovered, and Caleb’s house, just a 15-minute drive from the theater, was untouched.

What makes a storm like the Joplin tornado possible? How in the world does an atmosphere that most of the time provides us with sunshine, a few rain showers, and pleasant breezes, wrap a car around a telephone pole?

Recipe for Disaster

To make a tornado, first you need an unstable atmosphere, with a lot of **Convective Available Potential Energy**, or CAPE. The three key ingredients for CAPE are:

- #1 **Moisture**—Extra water suspended in the air, especially near the ground
- #2 **Temperature Difference**—Warm, moist air below cold, dry air
- #3 **Lift**—A force that makes an air mass rise, such as low pressure

Mix these three together, and the mass of warm, moist air near the ground rises in updrafts that can become very strong. At the same time, cool air from above moves downwards. Another thing that

increases CAPE is **Convective INhibition**, which is like a cap or lid on the updrafts. Once the cap breaks, things can get really wild.

Then, you’ll also need a fourth ingredient: #4 **Wind shear** — Winds that get faster and change direction as you go higher in the atmosphere.

Shear can tilt the rising updrafts so that the rain and hail fall out of them, and don’t slow things down with their weight. All this energy can feed a *supercell*, or a gigantic rotating thunderstorm. The spinning wind inside the supercell is called a *mesocyclone*. Once you’ve got a mesocyclone, you’ll likely see lightning, thunder, rain, and maybe even hail. As the winds in the mesocyclone high above the ground spin faster and faster, it’s likely to form a tornado.

Often, the first sign of a tornado is a whirlwind of dust on the ground. Then, a funnel reaches down from the supercell above. When the two connect, a tornado is born.

This Army Corp of Engineers map shows the impact of the massive, slow-moving Joplin tornado.

Structure Damage

Catastrophic Damage
Moderate Damage

FAST FACTS: NUMBERS

199 TORNADOES

Hit on April 27, 2011—the most ever recorded on a single day

8,000 BUILDINGS

Destroyed in Joplin, Missouri

24 MINUTES

To get to safety after the first tornado warning was issued in Joplin

19 STATES

Affected by the April 27 tornado outbreak

162 DEATHS

Caused by the devastating Joplin tornado



TWISTER ALERT!

Tornado safety starts with knowing that a tornado is on its way.

And you don't have to live in Tornado Alley to experience a tornado. In 1953, two of the deadliest twisters in United States history occurred in Worcester, Massachusetts, and Flint, Michigan. So wherever you live, stay informed and have a plan.

If a twister is coming and you're in a building:

- **Find the Safest Place!** If there is no basement, choose a closet, bathroom, or windowless room on the lowest floor, close to the center of the structure.

- **Take Cover!** If you can, get under something sturdy. Make sure nothing heavy can fall directly on you. Crouch facedown, and cover the back of your neck and head with blankets, pillows, or if nothing else is available, your hands to protect yourself from flying objects—glass, metal, 2 x 4s, etc.

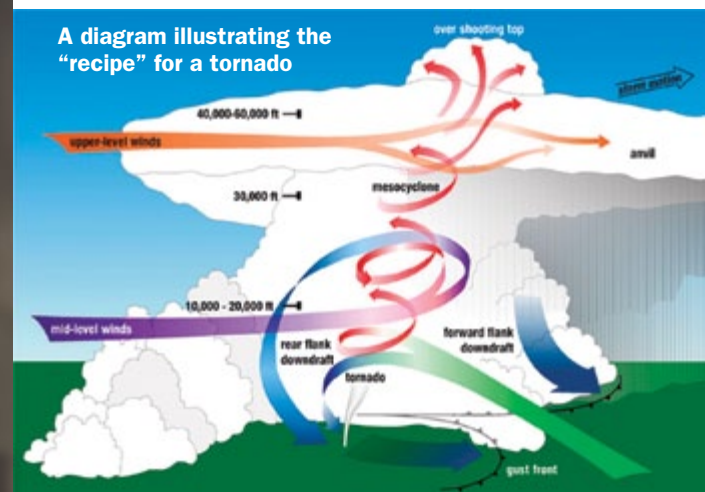
- **Keep Them Closed!** Opening doors and windows does not prevent damage and exposes you to more flying debris.

If you're in a car and can't drive away:

- **Get Out!** Tornadoes can throw vehicles around like toys. Park off the road so that you don't block the way for emergency vehicles.

- **Get Low!** Lie facedown in a ditch or low spot. Wind Speed is lower at ground level. (If heavy rain is present, watch for flash flooding in your ditch!)

- **Cover Up!** Protect your head and neck from flying debris.



Tornadoes come in many varieties, measured on the *Enhanced Fujita Scale* (see sidebar). The tornado that hit Joplin came in at EF-5, the strongest storm on the scale. What made it so deadly? “Just like any recipe, when you modify the ingredients somewhat, you end up with either a really great dish or a disaster,” explains Greg Carbin of the National Weather Service Storm Prediction Center in Oklahoma. It was clear on May 22 that all the ingredients for wild weather were in place. But the atmosphere is a complex system, and it's very difficult to determine exactly how those four ingredients will interact or how bad a particular storm will actually be until it hits.

Gazing into a Crystal Ball

Meteorologists, or scientists who study the weather, rely on many tools to predict, track, and warn us about storms. Doppler radar can tell meteorologists how fast winds are moving and in what direction. Satellites give a big-picture view of the atmosphere from above, and most airports and airplanes take regular measurements of wind speed, direction, and pressure. All of these data feed into computer models of the atmosphere that run simulations to help us understand how the weather will change over the next few days. “They're like our crystal ball,” says Carbin.

These visions of the future granted by some of the fastest computers in the world still aren't perfect. The simulations can't possibly handle data from every single point in the atmosphere, so they average the numbers across large areas.

Tornadoes are especially tricky to predict simply because of their small size. “Tornadoes are terrible and tiny,” says Carbin, “and hurricanes are horrible and huge.” That's why we get a hurricane warning several days in advance, but a tornado warning often comes only 20–30 minutes before the storm.

In the next few years, computer modeling could reach small scales of five to ten miles, and eventually, it could become possible to model and predict individual thunderstorms. “You really need the best and brightest programmers and the fastest computers to do that type of work,” says Carbin.

A Year That Broke Records

The Joplin tornado was the deadliest tornado to hit the United States since 1947, but that wasn't the only tornado record set in 2011. A staggering number of tornadoes swept through midwestern and southern states during the last two weeks of April, resulting in a record-breaking 753 total tornadoes that month. “It was the worst [storm season] I have ever seen,” said Howard Bluestein, a storm chaser and professor at the University of Oklahoma.

April and May are normally busy months for severe weather in an area of the United States nicknamed “Tornado Alley.” With the Rocky Mountains to the west, the Gulf of Mexico to the south, and the Great Plains in the middle, geography helps create the ingredients for violent weather. As the cold, dry air of the jet stream flows west across the United States, it hits the Rocky Mountains, and low pressure forms at their base. This low pressure pulls up warm, moist air from the Gulf of Mexico, which is carried unhindered across the open plains, where it slams into the jet stream (see “Know Your Streams,” p. 20). The result: wild weather!

Life Will Never Feel Normal Again

Caleb's family returned home after the storm, but many in Joplin weren't so lucky. Friends who'd lost their house moved in with Caleb's family for three months, and the outpouring of help for victims was incredible. “Our church set up a supply tent

JOPLIN TORNADO IT'S A 5!

How are tornadoes measured? Meteorologists use the Enhanced Fujita Scale. Since it is currently impossible to measure wind speed in the **vortex** of a tornado, the F-scale is based on damage done by the twister.

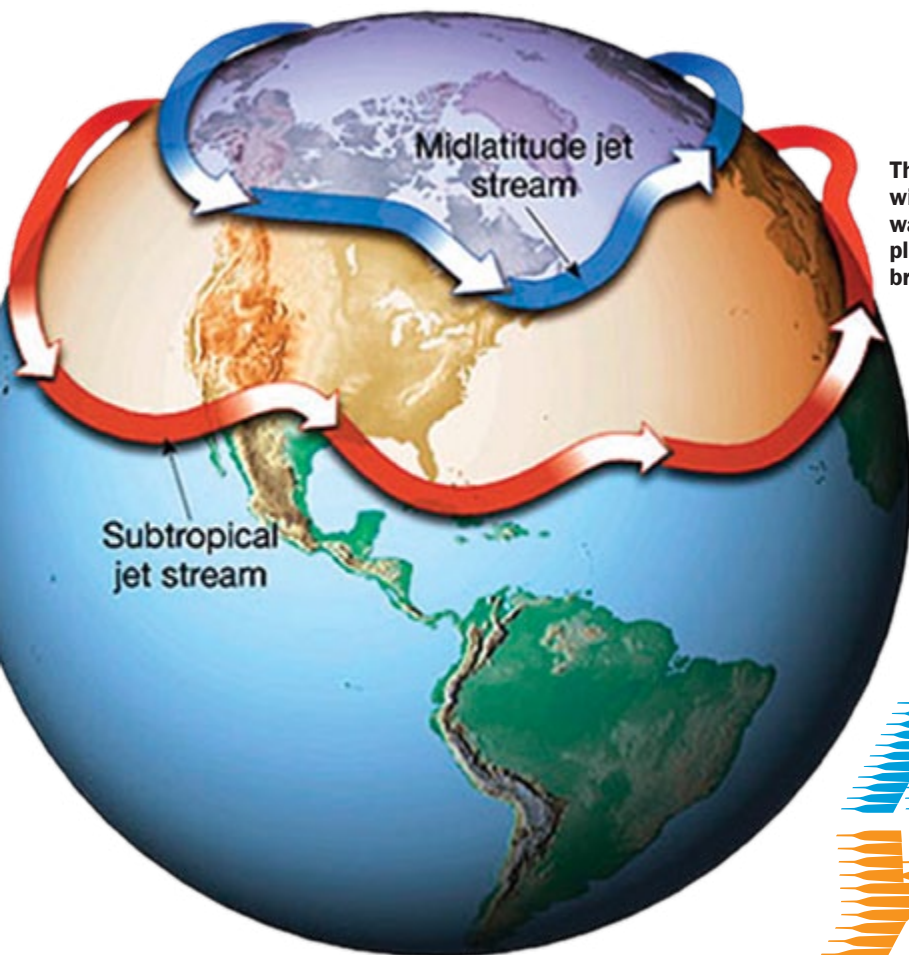
SCALE	WIND ESTIMATE (MPH)	TYPICAL DAMAGE
F0	74	LIGHT
F1	74–112	MODERATE
F2	113–157	CONSIDERABLE
F3	158–206	SEVERE
F4	207–260	DEVASTATING
F5	>261–319	INCREDIBLE

Vortex — A spiral mass of air (or water) that sucks everything toward its center



where tornado victims could come in any time for free stuff,” said Caleb. Still, things will never feel normal again. “Now, whenever there's a storm, I start to panic,” he says. Hopefully, he'll never have to endure another tornado, but if one comes, he'll be ready. His family has a safe room in their house, and now they know how serious a tornado warning can be! 📢

Kathryn Hulick lives in Massachusetts, a safe distance from Tornado Alley, where she likes to hike, paint, and write Science Scoops for *ODYSSEY*.



The *jet stream* is a “westerly” wind that often stretches all the way around the Earth. In many places it splits into two distinct branches as shown here.

by Gabriel Susca-Lopata and Peg Lopata

KNOW YOUR STREAMS

The atmosphere is a busy place. It’s an ocean of air that is always moving. Within this atmospheric sea there are “rivers of air,” called *currents*. When currents move at high speed over long distances they are called *jets*. Jets play an important role in the weird weather we have down here on Earth.

The Super Jet

The jet stream is one of the biggest and fastest of the jets. It’s like a ribbon of eastward-moving air (or “westerly” wind) that often stretches all the way around the Earth. The jet stream is a few miles thick vertically and a few hundred miles wide horizontally. Jet stream winds occur in the middle latitudes—areas between 30 and

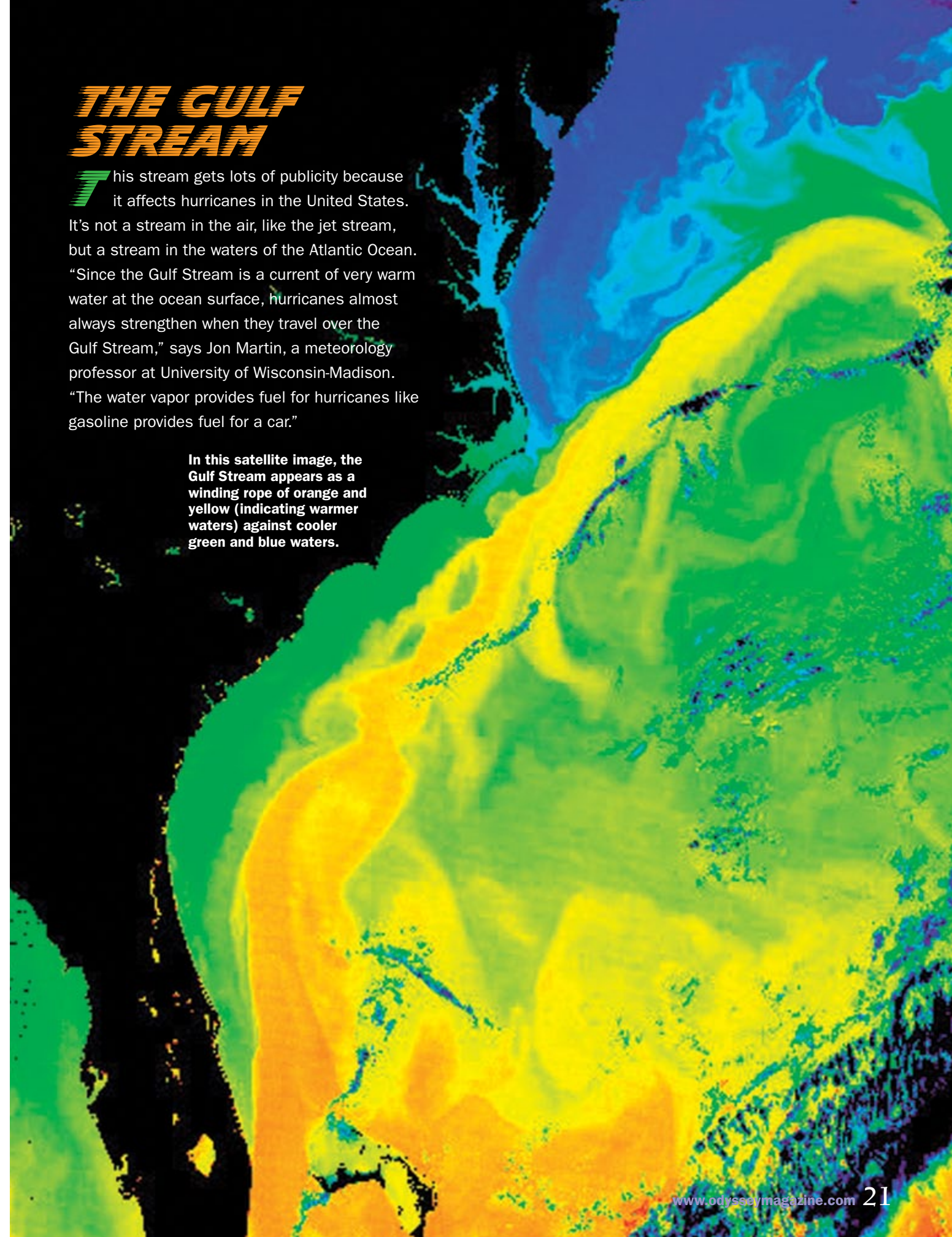
60 degrees north or south. The jet stream can meander northward and southward, and in many places it splits into two distinct branches—a Subtropical Jet nearer to the equator and a Midlatitude Jet closer to the poles (illustrated above). The strongest winds in the jet stream often exceed 200 miles per hour (mph), but once in a while, in some places, the winds approach nearly 300 mph. In comparison, hurricane winds’ maximum speed is around 200 mph.

Fortunately for us, strong jet stream winds occur several miles above the surface of the Earth. But they still affect us down here, bringing all kinds of catastrophic weather. For example, there was a major windstorm in Madison, Wisconsin, on October 26, 2010. Gusts of over 70 mph wreaked

THE GULF STREAM

This stream gets lots of publicity because it affects hurricanes in the United States. It’s not a stream in the air, like the jet stream, but a stream in the waters of the Atlantic Ocean. “Since the Gulf Stream is a current of very warm water at the ocean surface, hurricanes almost always strengthen when they travel over the Gulf Stream,” says Jon Martin, a meteorology professor at University of Wisconsin-Madison. “The water vapor provides fuel for hurricanes like gasoline provides fuel for a car.”

In this satellite image, the Gulf Stream appears as a winding rope of orange and yellow (indicating warmer waters) against cooler green and blue waters.



CLIMATE CHANGE AND THE STREAMS

Some scientists say global warming is already affecting the major atmospheric and water streams, while others think it is too soon to tell.

Dr. Joseph Kidston at the Climate Change Research Centre at the University of New South Wales says, “Global warming has caused the atmospheric jet streams to move away from the equator and towards the poles slightly, especially in the Southern Hemisphere.” But Tom Woollings, a meteorologist at the University of Reading, disagrees. “Global warming has probably not yet affected the jet or Gulf streams,” he says. “The atmospheric jets vary so much from year to year that it’s too early to see if [global warming] is causing this [movement] or if it is just natural variability.”

Forecasts indicating what will happen to the streams with continued warming are not certain either.

According to Jian Lu, a research scientist at the Center for Land-Ocean-Atmosphere Studies at George Mason University, “The jet stream will rise up both vertically and pole-ward due to global warming.” Joseph Kidston agrees, but he thinks the magnitude of the future shift is uncertain, because scientists don’t really understand why the shift is occurring. “However, if it continues as it’s been going over the last few decades,” he says, “it has the potential to cause widespread changes in rainfall, particularly in the mid-latitudes where the majority of the world’s population lives.”

Lu thinks the shifting of the jets will also be accompanied by other changes in the atmosphere, which will “lead to an expansion of subtropical dry areas and impact the availability of water in the southwestern United States, Southern Europe, and Mediterranean Africa.” The atmospheric changes will also lead to warmer, wetter weather in northern countries.

Woollings says the Gulf Stream is very stable and unlikely to be much affected by climate change. However, he says the Gulf Stream affects a large circulation of water in the Atlantic that keeps Europe relatively mild, considering how far north it is. “This circulation, which is way too large to be called a jet, is expected to weaken under climate change, but there is strong agreement between climate models that it will not stop completely,” he says. “This weakening might partly offset the warming expected over Europe, but not enough to reverse the trend and make Europe become cooler instead of warmer.”

havoc. “This storm was tied to an incredibly strong jet stream—the strongest we’ve seen in years—that came racing across the Pacific Ocean a week before the storm,” says Dr. Jon Martín, Chair of the Department of Atmospheric and Oceanic Sciences at the University of Wisconsin-Madison. “The jet stream was made so incredibly strong (wind speeds near 200 mph at six miles above the ground!) by its interaction with super typhoon Megi in the west Pacific Ocean. Megi was slammed up against the jet stream, and several days later that jet stream spawned this big windstorm.”

The Lowly Jet

Air currents near the surface, up to a couple of thousand feet above the surface, also play an important role in weather. One of these currents, called a low-level jet, is often involved in dramatic weather in the central United States and is partly responsible for the tornadoes in *Tornado Alley*, a popular term for the area in the United States where the most tornadoes occur. During the early spring, a low-level air stream can develop and bring warm, moist air from the Gulf of Mexico northward into the Great Plains states, such as Kansas and Oklahoma. The moisture and warm air from this low-level jet are like fuel for some of the severe thunderstorms that break out in the Plains during the spring. Some of these severe storms then go on to produce tornadoes.

Other low-level air currents can also move large amounts of moisture thousands of miles. Called “atmospheric rivers,” they are similar to low-level jets. One, known as the Pineapple Express, carries moisture from near Hawaii all the way to the United States West Coast. The Express doesn’t always run, though. Like many low-level jets, it only happens during certain conditions. Water from the Pineapple Express brought record rainfall and severe floods to the Pacific Northwest states in November 2006. 🌧️

Gabriel Susca-Lopata is a meteorologist and graduate research assistant studying hurricanes at the University of Utah. His campus is located near mountains that get 500 inches of snow during winter. **Peg Lopata**, associate editor of *FACES* magazine, loves most kinds of weather, but especially winter.

ACTIVITY TO DISCOVER

Will My State Be Hit

Did a major storm strike your neighborhood this year? Have you ever wondered if one could?

All 50 states in the United States can be affected by severe weather, but some are hit by more extreme events than others. Flip the page to view the United States map, which explains some of the factors that influence weather, and also highlights some of the places hit hardest in 2011, a powerful storm year. Then test your knowledge of national weather trends by answering the questions below.

Check your answers on page 26. Give yourself one point for each correct answer. If you score at least seven points, you’re an ODYSSEY Extreme Weather Expert.

by Cindy Argentine
illustrated by
Scott Raymond

- 1** Which state has the most tornadoes?
- (a) Texas
 - (b) Florida
 - (c) Oklahoma
 - (d) All of the above (depending on how you define “most tornadoes”)
 - (e) None of the above

- 2** “Tornado Alley” is a nickname for an area in the central United States where tornadoes are common. Experts sometimes disagree about how large Tornado Alley is, but they agree that certain core states should be considered part of it. Which states do they agree on?
- (a) Oklahoma, Kansas, and Nebraska
 - (b) Missouri, Illinois, and Wisconsin
 - (c) Kentucky, Indiana, and Ohio

- 3** Which state has never had a tornado?
- (a) North Carolina
 - (b) Washington
 - (c) Maine
 - (d) Mississippi
 - (e) None. Every state has had a tornado.

- 4** Which states are struck most often by hurricanes?
- (a) Florida, Texas, Louisiana, North Carolina, and South Carolina
 - (b) Maine, Massachusetts, Connecticut, New York, and New Jersey
 - (c) Delaware, Maryland, and Virginia
 - (d) Washington, Oregon, and California

- 5** How many states have been hit by the strongest

- hurricanes—classified as Category 5, which cause incredible damage.
- (a) 10
- (b) 7
- (c) 3
- (d) None

- 6** Where are blizzards most common?
- (a) New York, New Jersey, and New Hampshire
 - (b) North Dakota, South Dakota, and Minnesota
 - (c) Idaho, Utah, and Nevada

- 7** Is it always snowing during a blizzard?
- (a) Yes
 - (b) No

- 8** Which state has thunderstorms most often?
- (a) Florida, the Sunshine State
 - (b) Tennessee, the Volunteer State
 - (c) California, the Golden State
 - (d) Arkansas, the Natural State

Weather means the specific conditions going on outside around us at any one place and moment. "Climate" refers to the general weather conditions that are typical for an area over time. The climate of a place sets the stage for understanding what its weather will be like much of the time. The topography of the land (mountain or plain), and its nearness to bodies of water and distance from the equator, all play a role in shaping climate. The map depicted here shows eleven different types of climate found in the United States.

WEATHER EXTREMES

While climate determines the type of weather a region is likely to have, 2011 broke numerous records in weather extremes. We've noted a few significant events.

Wettest March–May 2011 on record in Pacific Northwest

WASHINGTON

An imaginary shifting line running vertically through the middle of the United States is known by some meteorologists as "the dryline," because it divides typically dry air to the west from humid air to the east.

Minnesota experienced its 4th snowiest winter on record in 2011. The Minnesota–St. Paul Airport recorded 86.6 inches for the season.

Burlington, Vermont, had its largest snowstorm on record in March 2011.

A rare, unprecedented early-season snowstorm struck the Northeast on October 29–30. The Halloween trickster dropped 32 inches of snow in Peru, Massachusetts.

Ohio recorded 38 tornadoes in 2011, more than double its annual average.

Delaware had its hottest July ever in 2011.

Wildfires burned 1.79 million acres in April 2011, setting a new national record for the month.

Texas had its driest March on record in 2011.

Fairbanks, Alaska, recorded its highest high temperature ever in July 2011.

Climate Legend

- Tropical wet**—warm and wet all year (rainforest)
- Tropical wet and dry**—warm all year; rainfall varies by season (savanna)
- Arid**—hot and dry
- Semiarid**—temperature varies by season; mostly dry
- Mediterranean**—warm, dry summers and cool, wet winters
- Humid subtropical**—hot, humid summers and cool winters
- Marine**—warm summers, cool winters, and precipitation year-round
- Humid continental**—hot summers, cold winters, and precipitation year-round
- Subarctic**—cool to cold all year
- Tundra**—cold all year
- Mountain**—cold winters; warm summers; snow frequent

BLIZZARDS

are winter storms that have winds greater than 35 miles per hour and visibility of one-quarter mile (or less) for at least three hours.

Why they are common in the North:

Generally, the farther north you go in the United States the colder it gets. This portion of the country is closer to the frozen North Pole and farther away from Earth's steamy equator. Freezing temps make snowfall common in the winters in the northern United States. Add in strong winds whipping across open plains, and blizzards can result.

HURRICANES

are actually a collection of thunderstorms covering a huge area—sometimes hundreds of miles—swirling over open water. They bring damaging wind, torrential rain, and flooding when they pass from sea to land.

Why they are common on the East Coast:

All the states that border the Gulf of Mexico and the Atlantic Ocean have the potential to be hit by hurricanes. However, hurricanes are not a significant concern for the Pacific coast of the United States. This is because the warm trade winds (those between the equator and latitude 30 degrees N) blow from east to west. Tropical storms and hurricanes follow that course. For the United States, these storms originate over the Atlantic Ocean and travel west toward the eastern portion of the country.

TORNADOES

begin from thunderstorms. When a thunderstorm has winds high in the sky going faster and in an opposite direction from winds closer to the ground, a tornado can form. (See "Terrible Twister," p. 16, for more information on how tornadoes form.)

Why they are common in the Central United States:

Several geographic features contribute to making the Great Plains a great place for spawning tornadoes: First, the prevailing wind direction across the United States is from west to east (as with the jet stream—see "Know Your Streams," p. 20). Second, the location of the Rocky Mountains in the western United States. Third, the temperature and humidity differences of three air masses that often meet in the central states. Warm, dry air from the southwest moves east. Warm, moist air from the Gulf of Mexico heads north. When these air masses meet, they don't just mix—they collide as they travel with different speeds at different levels, which can lead to rotations. Severe thunderstorms and tornadoes often result.

Answer Key

1 (d). It really does matter how you define “most tornadoes.”

Texas averages the most tornadoes each year in any one state. However, if you factor in the difference in size between states, and you include all types of tornadoes (even the weak ones), then **Florida** wins. It has the most annual tornadoes per 10,000 square miles, though Florida’s tornadoes tend to be weaker than ones in the Central Plains. If you consider state size and limit your definition to “strong to violent” tornadoes, then **Oklahoma** wins. It has the highest average annual number of strong-to-violent tornadoes per 10,000 square miles.

2 (a). Most maps show Tornado Alley as a corridor extending from Texas northward through Oklahoma, Kansas, and Nebraska. Some storm chasers and experts recommend extending it into neighboring states to the east.

3 (e). According to the National Oceanic and Atmospheric Administration (NOAA), all 50 states have recorded at least one tornado.

The United States leads the world in number of tornadoes each year, with an average of more than 1,000 per year.

4 (a). The five states with the most hurricane strikes—meaning those where a hurricane made landfall or produced hurricane-force winds over land—are Florida, Texas, Louisiana, North Carolina, and South Carolina. Alabama, Georgia, Mississippi, Virginia, and New York complete the top ten.

5 (c). Three states—Florida, Louisiana, and Mississippi—have been hit by Category 5 hurricanes. Both Hurricane Andrew of 1992 and the Labor Day Hurricane of 1935 hit Florida. Hurricane Camille of 1969 hit Louisiana and Mississippi.

6 (b). North Dakota, South Dakota, and Minnesota have the most blizzards in the continental United States. They averaged more than one per year over a recent 41-year period (at least 41 blizzards in 41 years). Counties in Iowa, Nebraska, Kansas, Colorado, Wyoming, and Idaho are next, with 21–40 blizzards during the time period studied. Alaska also has lots of blizzards.

New York and some other New England states get lots of snow and occasional blizzards, but they don’t get super-strong winds as often as the northern Midwest and Great Plains states.

7 (b). It doesn’t have to be snowing during a blizzard. Sometimes the wind will pick up snow that has already fallen and cause a severe winter weather event, called a “ground blizzard”!

8 (a). The sunshine state—Florida—has the most thunderstorms each year. They are often brief, late-afternoon storms with lots of sunshine before and after.

Give yourself 1 point for each correct answer from the list above.

SCORING:

7–8 points—Extreme Weather

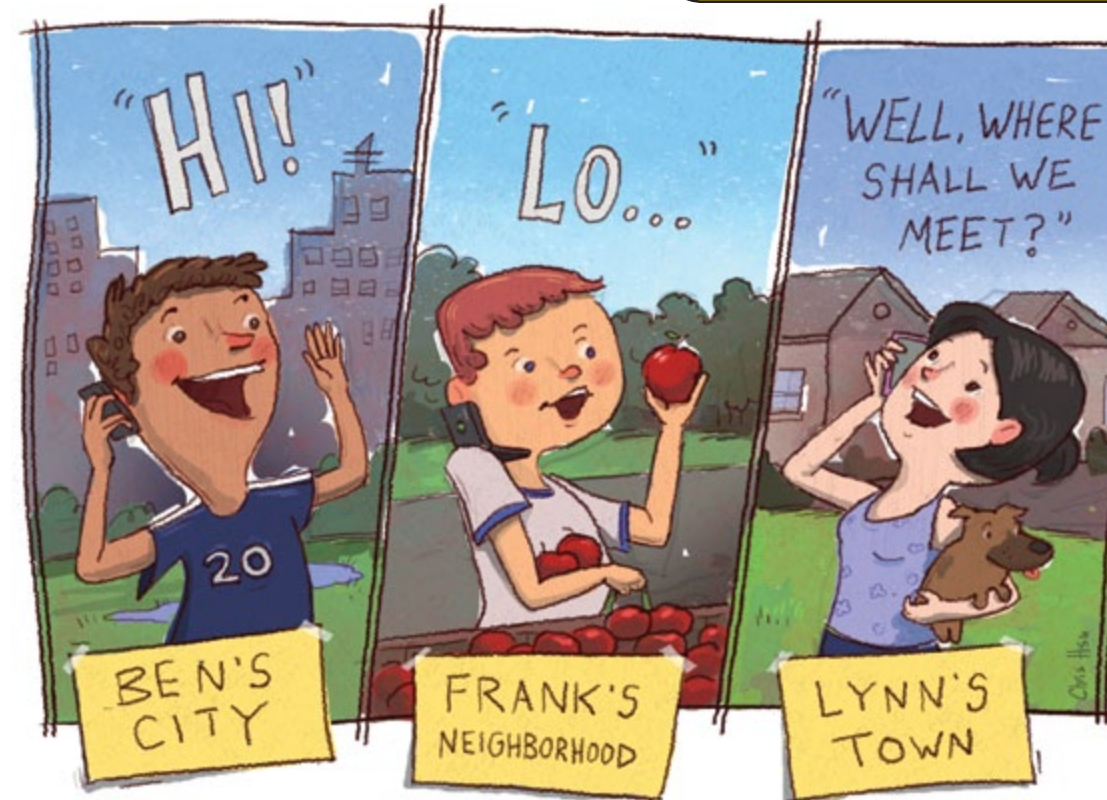
Expert. You really know your weather and your geography. Congratulations!

5–6 points—Master. You’ve got a great foundation for understanding where storms strike and why.

3–4 points—Apprentice. You made several good guesses. You’re on your way to understanding more about extreme weather.

1–2 points—Novice. You’ve got a little storm knowledge. Keep reading to learn more.

0 points—Don’t give up. You’ll be an expert after reading through this issue! 🗣️



Great Day For a Picnic!

ATMOSPHERIC PRESSURE SYSTEMS DETERMINE WHETHER WE HAVE GOOD OR BAD WEATHER.

by Nick D'Alto • illustrated by Chris Hsu

Ben, Frank, and Lynn are planning a picnic and they don’t want their fun to get rained on (or even worse, rained out). Each lives in a different town, so they are trying to figure out which area is the best location for the picnic. They have a map that shows some weather information for the planned date, but it’s kind of . . . incomplete. Can you complete the map and help the friends decide the perfect place for their get-together?

Five science facts to help you:

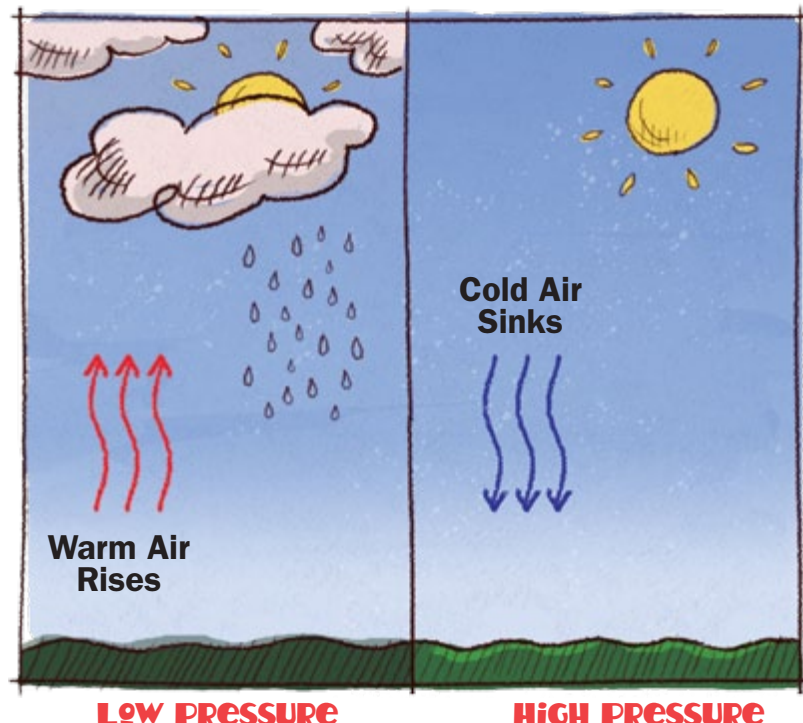
1 The numbers on the map on page 29 indicate different atmospheric pressures. While we may not notice it in everyday life,

air does have weight. Atmospheric pressure is a way of measuring the weight of the air pressing down on us (see sidebar, p. 29).

2 As you can see, air’s weight can vary. Cooler air is

usually heavier, while warmer air is usually lighter. (That’s mostly because in cooler air, the molecules are closer together, while in warmer air, they’re farther apart.)

3 Air’s different weights can make it rise or fall. You already know this: A hot-air balloon rises because the air inside it is warmer. Colder, heavier air sinks, while warmer, lighter air rises.



THIS WEATHER STORY IS HIS-STORY

As you may have already guessed, the names of our three characters, Ben-Frank-Lynn (kind of) spell the name of a famous founding father—who was also America’s first great weather forecaster. A self-trained meteorologist, Benjamin Franklin was the first to discover how lightning, hurricanes, and many other weather phenomena work.

Franklin also had a real-life weather adventure much like our story. It all began when he was trying to observe an eclipse near his home in Philadelphia, when a terrible storm drove him indoors. Disappointed, Franklin wrote to his brother in Boston, and discovered he had experienced the same storm, several hours later. Intrigued, Franklin wrote letters to different friends all over the colonies, asking each about the weather that night. Amazingly, he discovered that the same storm had traveled north and east, up the Atlantic coast. This happened even though the wind in the storm blew towards the south and west! Franklin already knew that weather happens when air moves. Now, he understood that the weather moves, too.

Today, Franklin’s discovery is remembered as the basis of *synoptic* weather forecasting—predicting future weather by taking weather readings at different places over time. Only one ingredient was missing from his predictions. Franklin regretted that his letters (written by hand, and carried by stagecoach) couldn’t arrive fast enough to tell his friends about the weather that was coming to their locale! —N. D’Alto

4 “Up” eventually means “cold.” When air rises in the atmosphere, it eventually gets colder. (That’s because it expands in the lower pressure higher up.)

5 “Cold” means clouds may form. Air always contains some water *vapor* (water as a gas). When air cools, the vapor it holds starts turning back to liquid.

This “weighty” science causes weather!

Let’s watch it happen:

- When warm air rises, it gets colder. So its water vapor turns back to a liquid. Tiny suspended droplets of this water produce clouds. When these drops combine or freeze, they may fall as rain or snow.
- But when air falls, it gets warmer. So the water vapor inside it tends to remain a gas. This produces cloud-free skies, which often mean fair weather.

To help remember these air pressure facts, try this phrase: When air goes up, rain may come down—but when air goes down, good weather comes up! Of course, real weather is much more complicated. But if we can figure out which way the air is moving, we can make very simple weather predictions. Let’s try a forecast for our friends’ big picnic:

1 Make a copy of the “map” below to write on.

2 Using a pencil, connect the points that show the same pressure readings. Pressure is indicated on the map in four-digit units malled millibars (mb). Draw your connections as smooth, curving lines; one for each pressure. Join the ends of each line to form a closed curve.

You’ve drawn what meteorologists call *isobars*—lines of equal pressure (iso-bar: Greek for “same weight”). Now we know how heavy the air is in different places.

3 Next, locate the highs and lows. Meteorologists study isobars because they often produce patterns of rings—like

THE WEATHER YOU’RE “WEIGHTING” FOR

Pressure readings that appear on weather maps are determined by barometers. *Barometers* are instruments—a kind of scale—that meteorologists use to weigh the air. At sea level, a column of air one inch across and up to the top of Earth’s atmosphere weighs about 14.7 lbs. This makes standard atmospheric pressure 14.7 lbs per square inch.

In barometers used for weather forecasting, air pressure is often measured using a different unit of pressure, called the millibar (mb). In that unit (and on our map), standard atmospheric pressure is 1013.25 mb.

bull’s-eyes. These bull’s-eyes mark centers of atmospheric pressure:

- At a low (L), air pressure is getting lower towards the center. This means air is rising.
- At a high (H), air pressure is getting higher towards the center. This means air is

falling.

Can you find a low-pressure center on the map? If you can, mark the center of the bull’s-eye with a capital “L.” Can you find a high? If so, mark it with an “H.”

4 Now make your weather prediction. According to the weather science we’ve learned:

- At a low, air is rising, which could mean rain.
- At a high, air is falling, so weather stays rain-free.

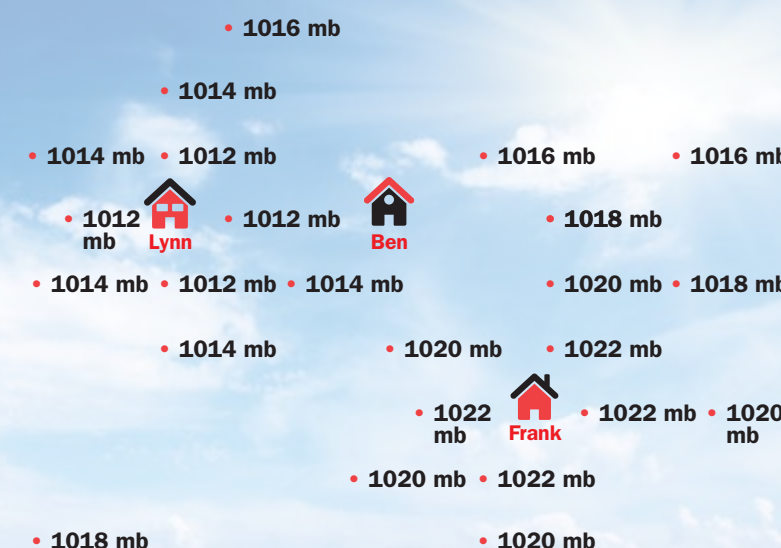
Based on the highs and lows you’ve found on the map, which of our three friends should host the picnic?

Extra credit: What are your weather forecasts for the other two towns?

See answers on page 47.

Of course, our story assumes that our three friends could all meet before the weather changed. Because sometimes, weather can change “like the weather.” (See sidebar, opposite page.) ☔

WHERE TO PICNIC?



The MAGIC in Weather

by Dan Risch with an assist from O and Aarti • illustrated by Derrick Cantrell



Gabe Susca-Lopata stands beside a Doppler radar "on wheels," an important tool in the prediction of severe weather.

Weather is changeable, often dramatic, and sometimes bewitching. It's always there just beyond the window and it grabbed Gabe Susca-Lopata's imagination early, when he was 10 years old.

Today Gabe studies weather science at the University of Utah. I talked with Gabe as he began his first semester as a graduate student in meteorology.

What got you interested in weather?

I think everyone is taken with watching weather at some point. It's magical.

I've been focused on studying weather since I was 10. Whenever we got a decent snowstorm I'd go outside. In the winter of 2000, when we didn't get many snowstorms, I started following the snowstorm forecasts. Then I got into other kinds of weather like severe thunderstorms. I started watching hurricanes. You can't actually watch hurricanes from where I was in New Hampshire, so I followed forecasts, looking at satellite and radar images.

Why did you decide on a career in weather forecasting?

Because I still like to watch the weather. I also feel that, through my interest in weather, I do something useful for people through forecasting.

Hi Gabe! When you graduate, will we see you forecasting weather on TV?

The TV thing never interested me.

You don't like TV!? What will you do?

My first choice would be severe weather forecasting: big hail, wind, tornadoes. That's why I'd want to get a job with the National Weather Service. They have a Storm Prediction Center where they forecast the likelihood of severe weather. [Check out the Storm Prediction Center at <http://www.spc.noaa.gov/>.]

But there's quite a few other things I could do with forecasting—like aviation forecasting. Knowing the weather is important in flying airplanes. And there's fire-weather forecasting. You go to fire camps in the West [where firefighters prepare to fight wildfires]. You brief firefighters on weather conditions. But forecasting tornadoes and general severe weather is my first choice.

Gabe, many readers turn away from fascinating science careers, like meteorology, because they fear math. You have tutored students in math. Tell us how to defeat the Math Monster.

When I was a college freshman, people would say, "You're good at math!" It made me laugh because a year and a half before that I was bad at math. I worked on math skills very hard my senior year in high school. It was pre-calculus. Fortunately the class included a lot of review. So I took the time to really learn the stuff. I spent about three hours a day doing the work for that class.

One of the things about math for me is that I didn't necessarily get things wrong. But at first, to do something correctly, like algebra, I had to work on it very slowly. If you are interested in a [scientific] field that requires math, don't say, "Oh, I hope I won't really have to do math." I tell people, "Get into it!"

Kids sometimes have little patience at first with something they are not good at. But work on it anyway. The point is not how fast you solve equations. It's being able to do what you need to do for your work.

Learn the Lingo:

Meteorology — Scientific words sometimes sprout from the same root word. "Meteor" and "meteorology" both stem from an ancient Greek word that means "a thing in the air." *Meteors* are bright trails that appear in the sky when meteoroids are heated to incandescence by friction with the atmosphere. So they are certainly up in the air. *Meteorology* means the science of dealing with the atmosphere and what goes on there, including weather and climate.

BACKGROUND: A rainbow appears after a storm in Utah, near Gabe's campus.

Write this down, O!

Definitely!

Besides strengthening your math skills to help your weather studies, you also volunteered at the Albany, New York, National Weather Service (NWS) office. How was that?

It was fun. I was a volunteer intern. I took down the daily temperature and precipitation data that go into a climate record used for research. I also helped launch the weather balloons. They launch every 12 hours. In severe weather, they go up at six-hour intervals.

That seems low-tech. Are balloons a major tool in weather forecasting?

Yes. In fact, a forecaster gets quite a bit of data from a balloon. It captures temperature, humidity, and wind at different heights. The data are sent to computers. Forecasters look at the data [to predict what the weather might do] and they go into computer models that also predict what might happen.

I also did a severe weather exercise. I looked at a weather event from the past and forecast what would happen. I did okay. I put a tornado warning in the right place.

Gabe, you told O and Aarti that you would like to forecast severe weather. Why?

It's exciting. I go to a window to watch a thunderstorm approach. I count the seconds between lightning strikes to guess how far away it is. It's incredibly exciting to watch the start of a thunderstorm and the downdraft of wind that comes through and cools everything off.

At the other end of dramatic weather is the dramatic impact on people. A severe weather forecast gives people information that you hope leads them to act safely.

Another Look Outside

Like Gabe, Raymond O'Keefe also likes to look out the window. O'Keefe is the Meteorologist in Charge at the NWS office where Gabe interned. When O'Keefe glanced out the window on September 4, 2011, what he saw underscores the excitement of severe weather forecasting that Gabe talks about.

It was late afternoon, a Sunday. Just the week before, Albany, New York, had been lashed by Hurricane Irene. The forecasters were preparing for wind and rain pushing northward from Tropical Storm

Ike. Around 5 o'clock, O'Keefe turned away from the radar screens, computers, and other forecasters in the office.

"It was very breezy outside," says O'Keefe. "I knew, based on the way the trees were leaning, that the wind was coming out of the south. The anemometer on our roof showed the wind was 16 miles per hour with gusts around 25 miles per hour. That was a pretty healthy wind for September." But something else about the swaying trees alarmed the veteran forecaster. He turned to his team and said, "We have pretty good helicity here!"

Strong winds at the surface were gaining strength as they climbed higher. And, as the winds rose, they began to spin, putting a twist in the air, which is known as *helicity*. "Spin in the atmosphere is an essential ingredient for tornadoes," says O'Keefe.

Not long after his glance outside, the office radar proved O'Keefe right. In bright red and green, the radar indicated a tornado 20 miles from the Albany office.

The next day, Labor Day, O'Keefe dispatched a team to verify where the tornado had touched down. They found it near the New York State Thruway, a highway bisecting the state. The trail of downed trees and damaged homes meandered for seven miles.

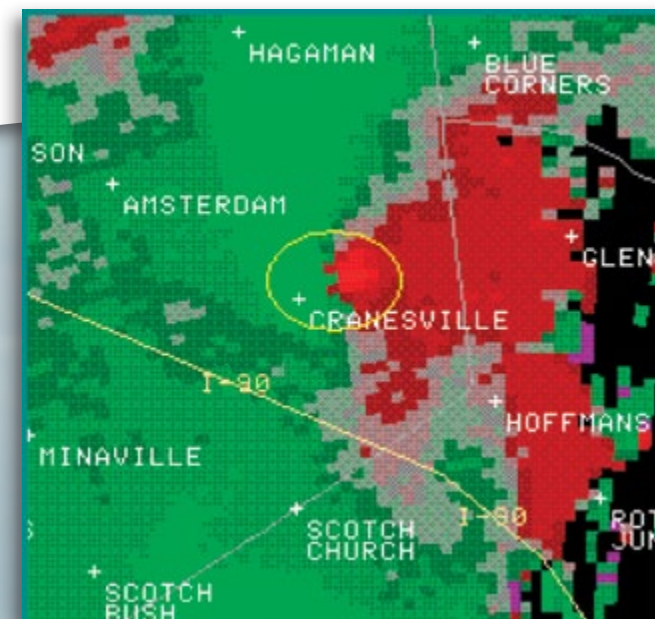
"Our mission is to protect life and property," says O'Keefe. "We want to get warnings out to people of potentially damaging weather. For student interns and meteorologists it's exhilarating, a time when you get charged up watching severe weather develop. That's when you really understand why you got into meteorology—to protect people and property."

The warnings by O'Keefe and his forecasters got the job done. No one along the path of the September 4 tornado was hurt, thanks to a few computers, radar, and a glance out the window. ☹️

Video of the September 4, 2011 Tornado

Lindsay Phillips interned with Raymond O'Keefe's National Weather Service office a few years before Gabe. She experienced the excitement of the September 4, 2011 tornado a bit differently than O'Keefe. Watch what happened after Lindsay pulled into a rest stop along the New York State Thruway that Sunday afternoon. Be patient.

Go to: http://wn.com/Tornado_crosses_NYS_Thruway



Radar is the main tool used by severe weather forecasters. It analyzes high-frequency radio waves to determine position, velocity, and other characteristics of storms. This radar image captures the "helicity" of the September 4, 2011 tornado. The circle pinpoints where the air is spinning. It's the very bright green pixel next to the very bright red pixel. When meteorologists spot this red/green couplet they know the air is spinning so fast that it's moving both toward the radar and away from the radar in that small area. That means trouble if the spinning air touches the ground!

BEWARE

by Mary Beth Cox

Phoenix, Arizona, on the evening of July 5, 2011

THE BLACK BLIZZARD!

A blizzard struck the city of Phoenix, Arizona, on July 5, 2011. But it wasn't a frozen, white, swirling kind of blizzard. This storm was gritty, dark, and stifling. Known as a "black blizzard," an American nickname for a dense cloud of dry particles that blankets an extended area, such an event is commonly called a dust storm. The Phoenix blizzard towered 5,000 feet into the air, stretched 100 miles across, and plowed a 150-mile path before it finally subsided. During the storm, visibility was nearly zero.

It's common to encounter a swipe of dust, dirt, or sand stirred up by a gust of wind. A black blizzard is the same experience mega-amplified. Such storms are powered by high winds, often the outflow from a nearby thunderstorm. Like water flowing in a river, rapid air currents pick up and transport loose, dry soil. Lighter particles

are suspended aloft and carried for miles (see Figure 1). Heavier particles are pushed forward by saltation. *Saltation* is sort of a chain reaction. Blowing particles knock into stationary particles on the ground, setting them in motion, too. Soon scads of particles bounce along by a series of skips and jumps. Saltated particles can work together to nudge pebbles and other objects. The nudging action is called *creep*. Suspension, saltation, and creep combine to move massive amounts of material. In September 2009, an epic dust storm propelled *five million tons* of red outback soil through Sydney, Australia!

Watch Out . . .

Dust storms can dramatically impact whatever or whomever gets in their way. In rural areas, the abrasive force of blowing grit damages crops

and livestock. In urban areas, buildings and vehicles suffer the grinding blast. Dust storms cripple water pumps, air conditioners, power transformers, and other exposed equipment. Transportation is disrupted for hours, if not days. Dust storms can have adverse effects on human health too. They make chronic respiratory conditions like asthma and emphysema much worse. In extreme cases, they can suffocate those caught in them. Dust storms mobilize disease-causing soil microbes—bacteria, molds, and fungi. "Valley fever" is an

infection that often follows in the wake of dust storms in Phoenix. It's caused by the soil fungus *Coccidioides immitis*.

. . . For a Dust Storm Near You

The threat of dust storms is greatest in Earth's arid regions, or *drylands*. Most susceptible is "The Dust Belt," a band of arid land that stretches from northern Africa to China. Drylands also span the western United States and most of the continent of Australia. These regions are not uninhabited wastelands; they support one-third of the world's

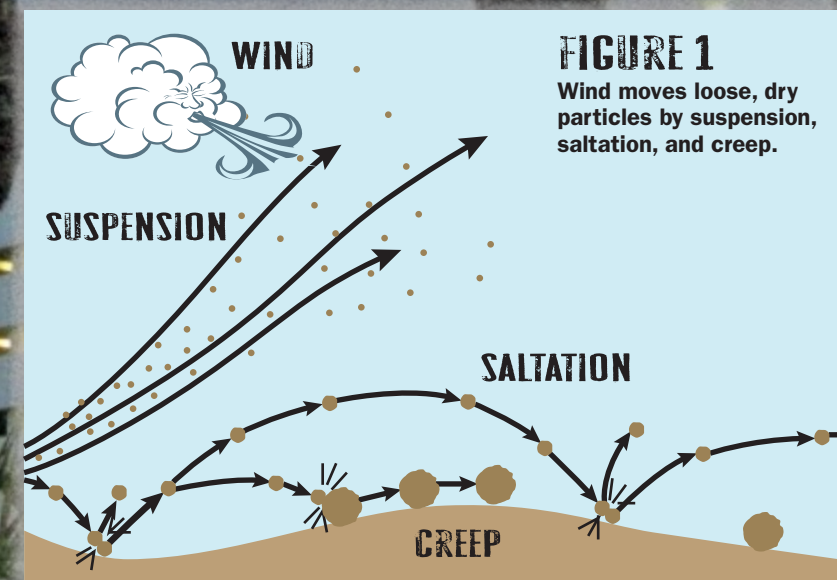


FIGURE 1

Wind moves loose, dry particles by suspension, saltation, and creep.

human population and half of its farmland and livestock (see Figure 2). Damaging dust storms are a real concern in these places, especially when drylands are made drier by drought. A *drought* is a period of reduced, irregular rainfall.

Droughts occur periodically for many reasons, including increases in planetary volcanic activity and natural wobbles in the Earth's orbit. Droughts lead to a decrease in soil moisture and an increase in dust and dirt particles suspended in the air. Cloud droplets form around these particles, called Cloud Condensation Nuclei (CCNs). However, these droplets are much too small to fall as rain. So although dusty air forms more drops than clean air, the drops don't coalesce

DUST STORM PRECAUTIONS

What can you do about the relentless advance of a wall of dirt? Nothing really, so it's best to seek shelter.

- Remain inside with all your windows and doors shut.
- Run the air conditioner to help filter particles from your air.

If you cannot reach shelter safely:

- Cover your mouth and nose.
- Head for high ground where the dust cloud will be less dense. High ground will also protect you from a flash flood, if it's an isolated thunderstorm that's kicking up the dust. Be advised that lightning may be nearby.

If you are in a vehicle:

- You may be able to safely outdistance a slow-moving dust storm. But please note: *High speed and low visibility are an extremely dangerous combination.*
- Never drive while inside a dust storm. Instead, move to the roadside out of traffic. Roll up the windows and shut the external vents. Follow these instructions and then wait patiently. Even the biggest of black blizzards eventually blow by.

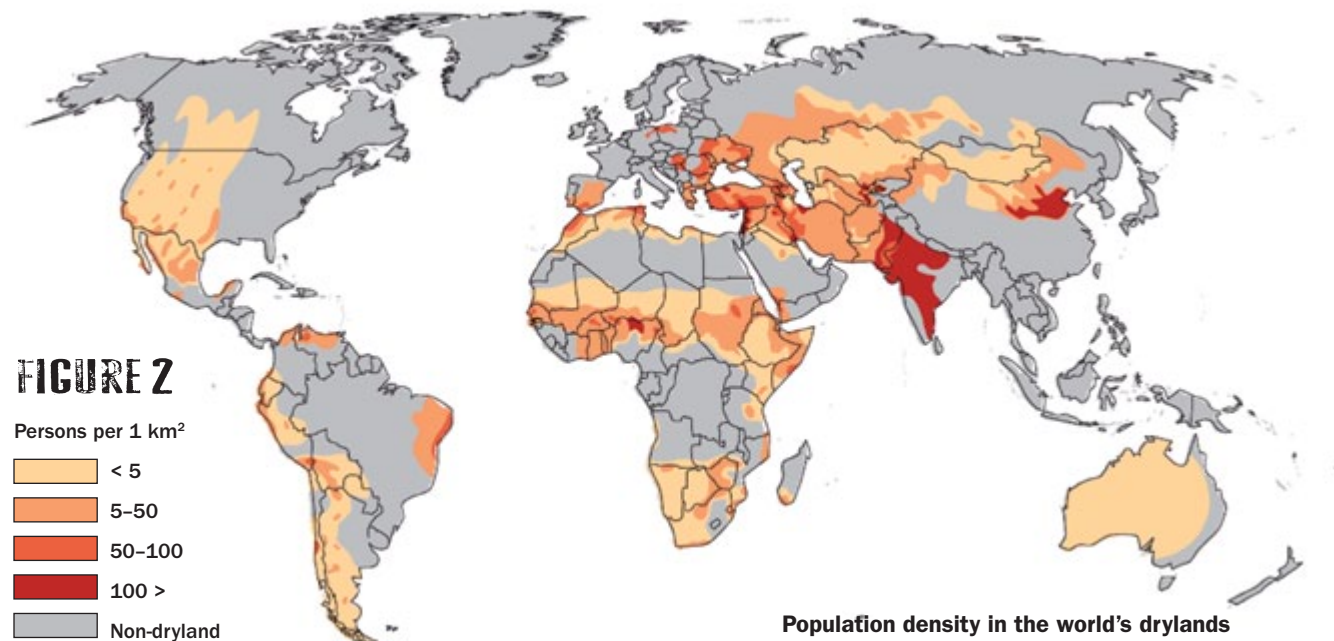


FIGURE 2

Persons per 1 km²

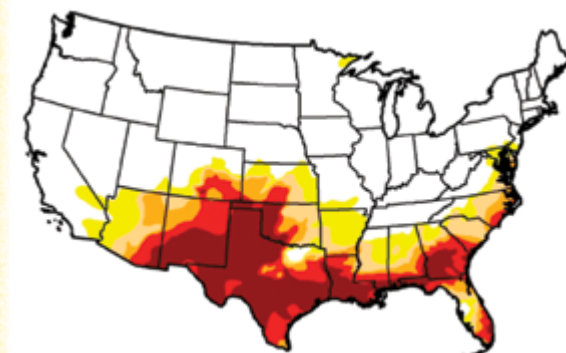
- < 5
- 5-50
- 50-100
- 100 >
- Non-dryland

(come together), inhibiting rainfall. At the time of the 2011 Phoenix black blizzard, southeastern Arizona suffered from extreme drought conditions (see Figure 3).

Droughts also contribute to the serious long-term problem of desertification. *Desertification* is the transformation of fertile drylands into less productive deserts. It is becoming a serious worry worldwide. Prolonged droughts coupled with the recent steady rise in global temperatures are diminishing the quality of Earth's drylands. Unwise human activities are accelerating the degradation. The overgrazing of livestock and the

FIGURE 3

D0 Abnormally Dry D3 Drought — Extreme
D1 Drought — Moderate D4 Drought — Exceptional
D2 Drought — Severe



U.S. drought conditions for July 5, 2011 (U.S. Department of Agriculture)

Population density in the world's drylands (United Nations Environment Programme)

excessive clearing of land for cultivation expose dry soil to wind erosion. So does the expansion of urban areas. Growing human settlements stress the land and its limited water resources. Unchecked desertification will produce an increased incidence of major dust storms. That's a lesson history has already taught. The worst dust storm ever to hit the United States was caused by drought paired with land mismanagement. April 14, 1935 became known as "Black Sunday." A monstrous 1,000-mile-wide cloud of choking dust ripped across Oklahoma and Texas on a 1,500-mile charge to the Gulf of Mexico.

Predicting Dust Storms

Dust storms are not limited to arid regions. They can build wherever there's plenty of exposed dry soil. Wind energy can drive them hundreds of miles, far from their points of origin. They are especially dangerous when they pop up unexpectedly. In April 2011, a freak dust storm engulfed a highway in northern Germany. The resulting 80-vehicle pile-up left eight dead and dozens injured. Since dust storms are rare in Germany, motorists were taken by surprise. But even where such storms are more common, they catch people off guard.

Dust storms are difficult to predict. Standard weather radar cannot "see" the storms because



The Rock Racetrack, Death Valley National Park

THE MYSTERY OF THE RACING ROCKS

Something strange is going on in Death Valley National Park. Rocks weighing as much as 700 pounds are mysteriously on the move. The rocks scoot slowly across the dry bed of an ancient lake. They leave tracks hundreds of yards long, though no one has ever seen them budge an inch. Saltation and creep cannot push such heavy objects. So scientists have offered other hypotheses to explain the phenomenon. Maybe the lakebed surface is super slippery when wet. Maybe "rafts" of ice form under the rocks in cold weather. Maybe a thin film of bacteria helps the rocks slide along. Nobody knows for sure.

dust particles are generally too small and too non-reflective, as well as below the radar's beam. The World Meteorological Organization of the United Nations is working to improve global dust and sand storm forecasts. Forty nations are cooperating to establish a network of satellite- and ground-based monitoring stations. Station data fed into advanced computer models of the atmosphere will hopefully provide more accurate dust storm predictions. As with other extreme weather events, better forecasting will enable people to take the right precautions.

You can watch for developing dust storms on the horizon. The U.S. Geological Survey operates Regional Research Web Cameras in California, Utah, and Colorado. Check them out at: http://esp.cr.usgs.gov/info/regional_cams/index.html.

by Ruth Tenzer Feldman

Weather or Not?

Feeling “under the weather”? There’s a science for that. It’s called “biometeorology” and it’s all about interactions between living organisms and the weather systems that swirl around our planet. The International Society of Biometeorology (<http://biometeorology.org>) is closely associated with the United Nations.

According to folk culture, too much moonlight makes us crazy (“lunatic” comes from the Latin meaning “moonstruck”), and windless days put us in the doldrums. But a scientifically based answer to how weather affects health can be as clear as fog.

Humans are not the most reliable experimental subjects. We are suggestible. We tend to link conditions that have no direct cause-and-effect relationship. Plus, we’re not all alike. According to Pat Thomas, author of *Under the Weather: How the Weather and Climate Affect Your Health*, about one-third of us seem to be particularly sensitive to weather. And some of us are afraid of certain weather

patterns (thunder and lightning are the most common), which will cause our bodies to react.

However, scientists do agree that when it comes to temperature, humans are consistent. Our bodies try to regulate internal temperature to within the narrow range of 95 to 104 degrees F (35 to 40 degrees C). Any change in the weather that threatens this stability results in stresses to our bodies that affect health.

The Human Barometer

Biometeorologists have studied the roles a wide range of climatic or atmospheric conditions play on our health—with mixed results. But it does seem that at least some of us act like human barometers, forecasting the weather based on the force of the atmosphere against our bodies.

Low-pressure areas have less atmospheric mass than high-pressure areas, and they seem to have negative effects on our bodies. Given the same

temperature, humid air is also lighter than dry air (since water vapor is lighter than surrounding molecules that make up “air”) and is associated with low-pressure systems. Thomas notes that higher humidity and lower air pressure result in what he says the Germans call “wetterschmerz”—weather pain. Our joints might become stiffer, along with subtle changes in the shape of our muscles, tendons, and bones.

Some other negative effects of an approaching or passing low-pressure system might include an increase in:

- ♦ the strength or number of headaches and migraines;
- ♦ disturbed sleep;
- ♦ the “blahs”;
- ♦ fluctuations in blood pressure and blood sugar;
- ♦ heart attacks or strokes;

Light therapy is effective in the treatment of depression due to Seasonal Affective Disorder or SAD.



- ♦ depression; and
- ♦ the strength or number of asthma attacks or bronchitis.

Let the Sunshine In

For most people, sunny weather is a plus. Exposure to the Sun’s rays increases our production of vitamin D, boosts our immune system, reduces the symptoms of asthma, and helps to heal skin

disorders such as psoriasis. Sunlight often elevates our mood.

Lack of exposure to sunlight (usually during long winter nights) is linked to a type of depression called seasonal affective disorder (SAD). Sufferers have an unusually high level of *melatonin*, the hormone that regulates our sleep-wake cycle. Sitting in front of especially designed bright lights helps with SAD in most cases. Scientists are now exploring a less common incidence of SAD during the summer months as well.

Hot, Cold, and Windy

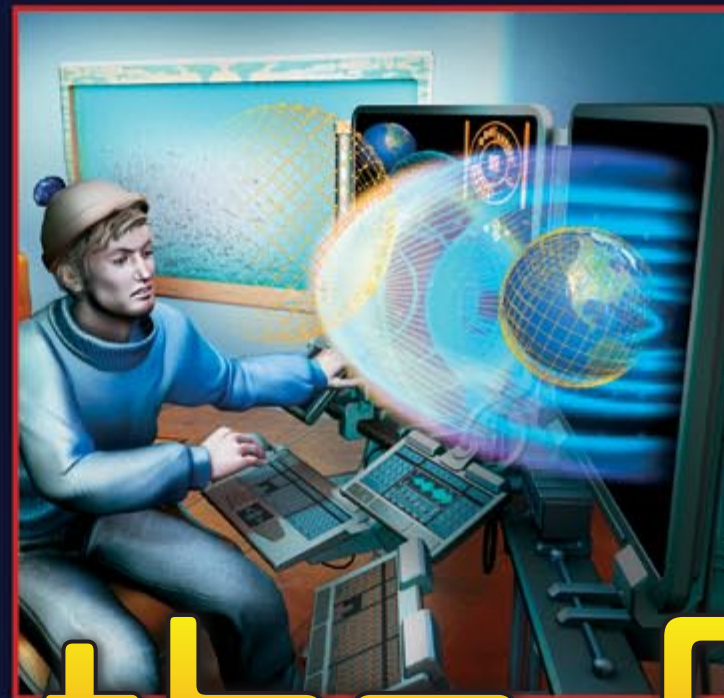
Too much Sun is dangerous (think skin cancer), especially if it’s a scorcher of a day. Sustained high heat can cause swelling in our fingers and ankles, as well as painful cramps in our abdomen, arms, and legs. We might feel chilled, dizzy, or faint, more aggressive or short-tempered, or suffer a headache and, in extreme cases, heatstroke. Feeling “hot under the collar” is serious business.

Exposure to severe cold can lead to *hypothermia* (severe loss of body heat) and frostbite. Even a mild drop in temperature between summer and winter weather might increase heart disease, as the heart works harder to keep body temperatures within that narrow comfort zone. The clotting agent fibrinogen “thickens” blood in the winter, and blood cholesterol levels tend to rise.

When we are out in winds above about 20 mph, our skin begins to signal danger. We tend to become irritable or anxious. Our adrenal glands secrete stress hormones, and high levels of serotonin may cause headaches, coughing, intestinal spasms, depression, and a host of other symptoms.

So, when you’re feeling up or down, healthy or ill, how do you know whether it’s weather? Thomas sums it up this way: “The upshot of all this challenging data may best be summed up with a gentle warning: The human barometer is a sensitive instrument; handle with care.” ☔

Ruth Tenzer Feldman tries to stay healthy in Portland, Oregon, and welcomes visitors to www.ruthtenzerfeldman.com.



Day of the Sun

fiction by Hyunsoo Kim • illustrated by Ryan Durney

"This is the Inquisitive exploration probe's AI hazardous. Europa is

Pandora. I have an emergency report, potentially canceled. Systems failing . . ."

"WHAT?!!!" screamed Dr. Khan, head of NASA's technology department. "A solar storm bigger than the Earth headed straight for us?"

"Yes, according to the *Inquisitive*, before it went down from a minor solar flare," said directing officer Simon Brown, using his finger to slide away a presentation image on the interactive hologram. "The actual solar storm is just beginning to grow."

"It will fully develop and reach us within days, however, and we assume that it will be extremely powerful as well," Dr. Liang of NASA's Astrophysics Department explained.

"Powerful enough to penetrate the Earth's

magnetosphere. No one can estimate the impacts of major power cuts or radiation when it arrives," added Brown, enlarging an explanatory diagram with his fingers.

"What's NASA going to do, then?" Dr. Khan screamed, even louder this time. "Will we just sit here without a proper solution while the world burns to death?!!"

"Then we shall demand a solution, Dr. Khan. But there's no need to grumble at this point in time," said Liang, attempting to calm down the riled NASA chief.

Khan grabbed his water and gulped it down.

"Thank you, Dr. Liang, for being quite calm on the matter," said Brown, shrinking back the



frightening diagram. “Would all executives please get in touch with anyone in their acquaintance who can be of assistance. We’ll need everything we’ve got to both solve this problem and keep our jobs. Not that it will matter, if the human race comes to an end.”

With that eerie scenario, Brown closed the presentation.



At Heathrow airport, Professor Jeremy Knight had just boarded his flight for Geneva. He carried a book titled *The Incomplete Quest for the Theory of Everything* as he sat down next to a woman.

“Excuse me, madam,” he said.

“It’s all right, *monsieur*,” she answered.

As Jeremy sat down, he noticed the woman’s white gown and ID card marked “Mallorie DuBois” and watermarked “WHO.”

“Pardon me, Ms. DuBois,” he said. “But are you taking this flight to go to work?”

“*Oui, monsieur*. I was in England for a holiday.”

“I see. Oh, dare I ask, do you know anything of a solar storm coming soon?”

“Ah, don’t mention it, *monsieur*,” said Dr. DuBois anxiously. “The only thing I’ll be doing in Geneva will be attending seminars and researching health casualties caused by radiation. They say the solar particles are harmful to the human body. I will be practicing organ cloning, organ stem cell growth production, and experimenting with cellular mutation rehabilitation. I’ll also attend a seminar on

researching the genome map to find a cure for leukemia as well. All because of this solar storm!”

“That’s interesting, madam, for my flight is for a similar purpose. You see, I’m . . .”

He abruptly stopped as Dr. DuBois’s phone rang. She scrolled out her rolled-up PA (Personal AMOLED) screen and answered the call. Neither she nor Knight noticed that the New Concorde aircraft (sometimes called “Mach plane”) was already speeding up the runway. Dr. DuBois turned the PA off and grasped her seat. Knight did the same, exclaiming, “It’s amazing how this thing can fly maximum Mach 8, but when it comes to takeoff I liked the old Boeing planes better!”

The doctor nodded in agreement.



The IMRAB (International Meteorology Research Antarctica Base) Deputy Chief Viktor Zhukovsky stepped into the base communications center, dripping snow all over the floor. The communications manager, Christian Scott, was viewing the state of the magnetosphere through a 3D monitor.

“Not good,” Zhukovsky stated emphatically.

“I know,” Scott replied. “I think we need to tell NASA about this.”

“Yeah. Send them the image through email, Wi-Fi 3G.”

“2G’s easier to connect. It’s also three times faster than the original.”

“3G’s seven times faster. Oh, Chris, the solar-

power heating’s down. Could you fix it up, please?”

“Yes, boss!”



The situation at CERN LHC Mark II lab in Geneva wasn’t much better than in the other labs around the globe.

“Preposterous! Just because we’re one of the leading scientific organizations of the century, that doesn’t mean we can manipulate the subatomic world like that!” Professor Knight warned the CERN group members.

“Oh, come on, Jeremy. It’s not like 30 years ago anymore. We’ve been able to sustain complete antiparticles for two hours straight!” said antimatter specialist Jose Rodriguez.

“There’s a chance of success!”

“It’s very inefficient though, Jose,” colleague Margaret Hoffman interjected. “Antimatter is a very unstable entity. We have to be realistic about this.”

“Thank you, Margaret,” Knight said, glad that she was in agreement with him. “Instead of such an antimatter missile of some sort, let’s try something else.”

“I suggest,” said Hoffman, “that we produce a large, wide shield made of magnetic material to attract the charged particles.”

“How big do you expect!” exclaimed Rodriguez. “We can’t cover the entire planet in metal!”

“Instead, let’s use titanium alloy and send up a targeted probe,” Knight offered.

“TA’s still hitting 700 million euros for 100 kg, my friend,” bellowed a voice from behind them. It was LHC Mark II Director Dominic Sladan.

“It’s worth it to save nine billion lives, sir,” Hoffman said without hesitation.

“True, and listening to each of your ideas, I think we have a reasonable answer here: a matter-antimatter annihilation-powered TA-composed probe capable of electromagnetic pulse (EMP) emission that will repel the particles or

attract and store them safely. It would resolve speed, sustainability, and solar-flare problems.”

The three scientists were quite convinced by the idea.

“Now, if that’s agreed, I’ll head up to the executive office,” the director said. “Could this team think up a way to extend the antiparticle life span immediately?”

“Yes, sir!” they cried in unison.



The probe components were constructed overnight and gathered together at NASA, which then sent them to the International Space Station for assembly through space-transference shuttles.

“This is astronaut Linda Choi onboard the ISS, fourth of August, 2032. Strangely, it’s very sunny worldwide today!” said Choi. “She’s all prepared to launch, Houston!”

“Solar storm approaching Mercury’s orbit!”

“This is Houston. You are authorized to launch.”

“Fire away!”

“This is Flare Disaster Prevention Probe AI Prometheus. Solar storm located. Commencing EMP emission now, with much hope for Earth.” 🙏

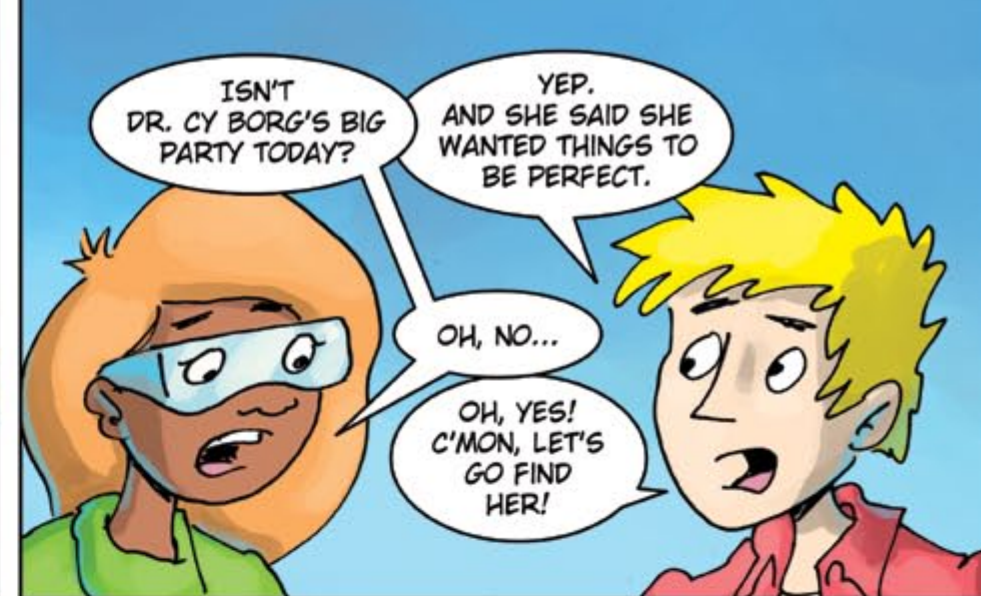
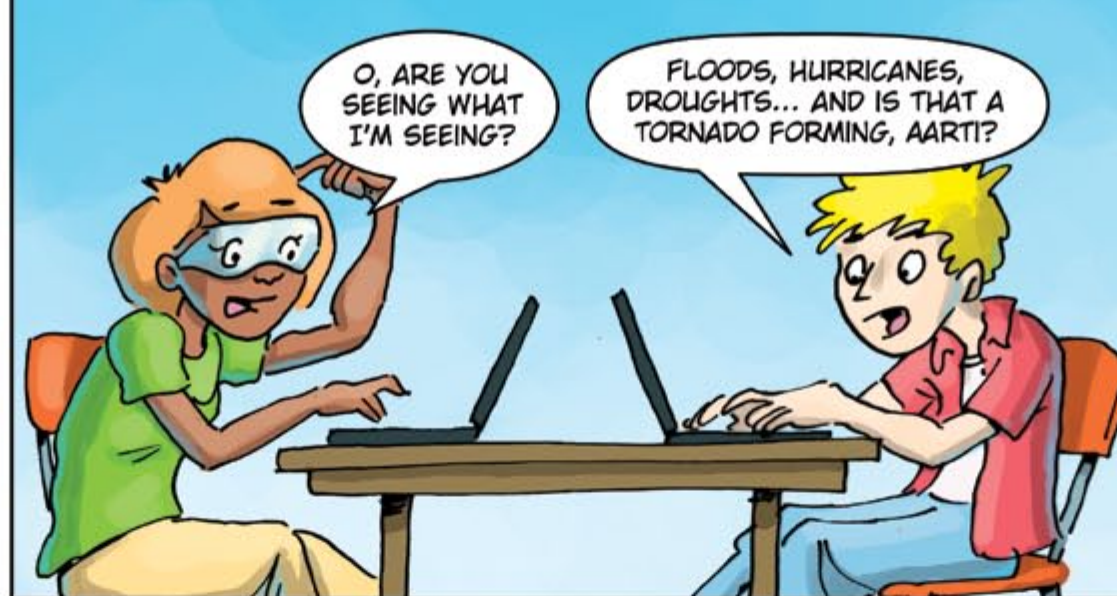


ODYSSEY was a sponsor of the National Sci-Fi Story Writing Contest in South Korea. Eighth-grade student Hyunsoo Kim won the gold award for “Day of the Sun.” Congratulations to Hyunsoo and all who participated in the contest.

THE PERFECT PARTY

illustrated by Chuck Whelon

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YOUR QUESTION...



Dear Dr. B,

I was just wondering if when you are looking out your window in heavy rain and you see it coming down diagonally—how does this happen?

Calvin I. Theis, 8, Brooklyn Park, MN

Send YOUR Question

Send it to: Dr. Cy Borg, ODYSSEY,
30 Grove Street, Suite C,
Peterborough, NH 03458.
Or send an email to:
odysseymagazine@caruspub.com.
**PLEASE INCLUDE YOUR FULL
NAME, ADDRESS, AND AGE.**

MY ANSWER:

Dear Calvin,

Gravity makes rain fall more or less vertically. However, wind often accompanies a big rainstorm. The wind can blow the raindrops off course, making them come down diagonally. To give you some more specifics, the biggest raindrops fall at about 14 miles per hour. When the wind is blowing, the sideways motion of the drops is usually close to wind speed. If the wind is blowing the raindrops sideways at 14 mph and gravity is pulling the raindrops down at 14 mph, then the drops will end up falling approximately at a 45-degree angle. This means that the rain will come down diagonally.

Vertically or diagonally, rain falls in very different amounts in

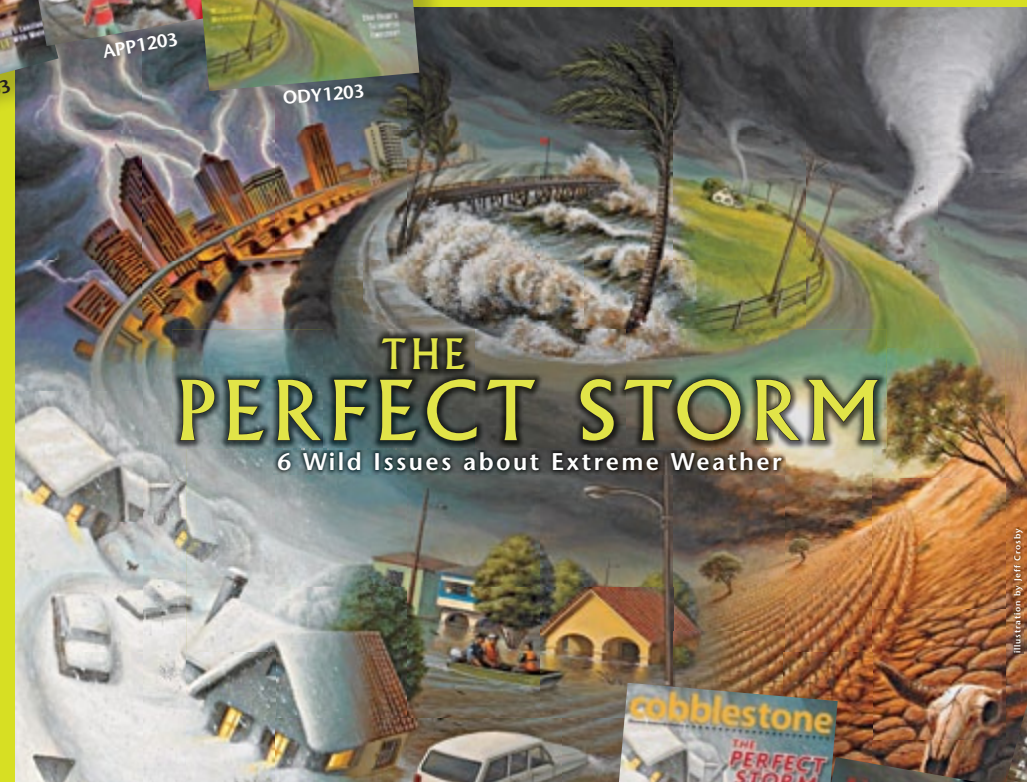
different places. Overall, the world's rainiest place is Mt. Waialeale in Hawaii (slogan: Bring Your Umbrella!), where it averages 450 inches of rain per year. However, Cherrapunji, India (slogan: Just Stay Inside!), had 905 inches of rain in 1861—almost two and a half inches of rain per day. On the other end

of the spectrum is Arica, Chile (slogan: Give Your Umbrella to Someone Who Lives on Mt. Waialeale!). No rain fell in Arica for a whole year. In fact, no rain fell in Arica for well over 5,000 days. Let's do the math . . . yes, that's zero inches per day, zero inches per month, and zero inches per year for around 14 years! ☔



6 magazines, 1 extreme topic

The March issues of COBBLESTONE, CALLIOPE, DIG, FACES, APPLESEEDS, and ODYSSEY share the same theme: **The Perfect Storm**. Take an exciting look at extreme weather's impact on cities, culture, and history. Put all six covers together for a mosaic poster of nature's ability to dish out punishing weather.



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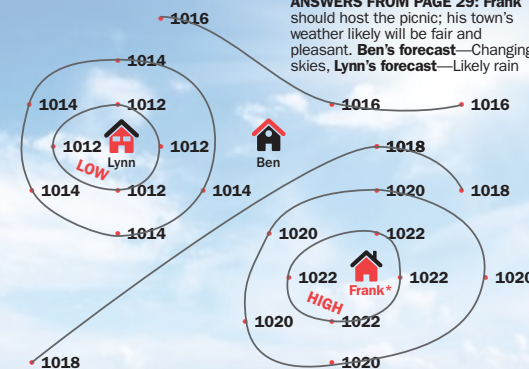
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WHERE TO PICNIC? = SOLUTIONS

ANSWERS FROM PAGE 29: Frank should host the picnic; his town's weather likely will be fair and pleasant. Ben's forecast—Changing skies, Lynn's forecast—Likely rain



*Best picnic spot

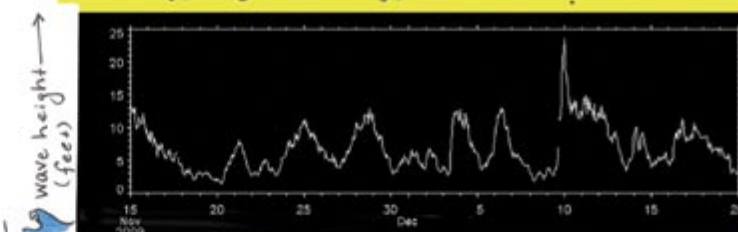
How do scientists in the stormy Gulf of Maine study the feeding habits of North Atlantic right whales even when the ~~sea is~~ and waves go sky-high?

Mark Baumgartner is a biologist at Woods Hole Oceanographic Institution who wants to answer questions about whales and their eating habits.



At left, Baumgartner attaches a tag to the back of a right whale. The tag records data about the whale's dives and movements, then pops off so the scientist can retrieve it and get the data. Notice how calm the sea is. And consider how rough this research would be in high seas!

This graph shows wave height in the Gulf of Maine from November to January, when right whales frequent the area. What's a seasick scientist to do?

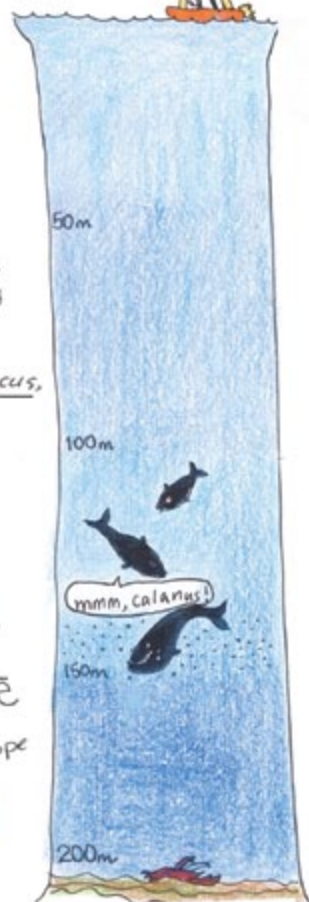


RIGHT Whale doodle

"Here's the method we used.

Every time a tagged whale surfaced from a long dive, we would mark the resurfacing location, bring over an oceanographic vessel, and drop instruments over the side that measured the vertical distribution of the prey, *Calanus finmarchicus*, and vertical profiles of temperature and salinity in that exact location."

They were studying the water column, a section of the sea looked at from surface to sea floor in hope of finding out why whales dive where they dive.



The profiling instrument package samples water from any depth the scientist wants by counting *Calanus*-sized particles and taking digital pictures of the plankton. A ship is needed to deploy this tool.



2 mm
Calanus finmarchicus

That's what's in this jar on Baumgartner's desk.

He says there are between 20,000 and 30,000 in the jar.

Right whales eat 1 to 2 billion of these every day.

Baumgartner says, "In weight, that's the equivalent of a Volkswagen Beetle."

In calories, it's 3,000 Big Macs."



x 3,000

Calanus are zooplankton (tiny floating animals). They move up and down in the water column—down during the day and up at night. To observe how whales handle this change in the food supply, scientists have to stay out at sea for long periods of time, because one cycle takes a whole day. And the Gulf of Maine is too stormy for that!

YOU MIGHT STAY OUT FOR A DAY OR TWO OR THREE, BUT THEN THE WEATHER SUDDENLY GOES CRAZY. YOU HAVE TO GO HOME.

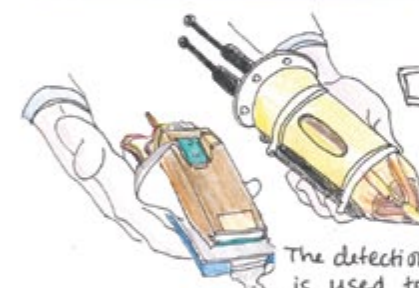
A HUMANIMAL DOODLE BY KAREN ROMANO YOUNG



Technology to the rescue! Even as the ship deck starts to ~~vib~~, scientists can "deploy" (set out) these profiling floats that can float on the current, gathering data and using acoustic recorders to listen. When the float "hears" a whale, the scientists send one of these:

I'm a glider.

Glider can use GPS to go where scientists send them.



The detection instrument and the casing that is used to install it in a glider

This instrument lets us do real-time whale detection. In our pilot study, we put the gliders in the water and a nor'easter was coming up the coast—a 5-day storm with gale-force winds and very steep seas. We sent a robot to do the work when we couldn't physically be there ourselves.

A buoyancy pump lets the glider go up and down and the stubby wings give it lift so it can be directed laterally (side to side).

"I don't think storms mean much to whales and their prey."



Glider let whales be observed in places scientists can't access, at times they can't get to sea.



What a perfect
rainbow after
The Perfect
Storm!

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CONSULTING EDITOR

Jeff Masters, *Director of Meteorology, Weather Underground*, received his Ph.D. degree in air pollution meteorology from the University of Michigan in 1997 and cofounded the Internet's first on-line weather company, Weather Underground, in 1995. Masters currently serves on the Board of Directors for the company, which can be found at www.wunderground.com. His daily weather blog is often the most widely read weather blog on the Internet. His previous job includes flying with the Hurricane Hunters from 1986 to 1990 as a flight meteorologist for NOAA's Aircraft Operations Center in Miami.

ABOUT THE COVER

Have you noticed how extreme weather is stealing headlines and making the news these days? This month, *COBBLESTONE* and its five sister magazines—*APPLESEEDS*, *CALLIOPE*, *FACES*, *DIG*, and *ODYSSEY*—are devoting their March issues to a look at the power and unpredictability of weather. We asked illustrator Jeff Crosby to create unique covers for these special issues. Check out page 47 for more information about the other magazines and see how the covers for all six issues create one impressive "perfect" storm! (illustrated by Jeff Crosby)

EDITOR'S NOTE

I live and work in New England. This part of the country enjoys short springs, warm summers, beautiful falls—and long, snowy winters. New Englanders have learned to embrace the blizzard-like conditions that are part of our longest season. But it was kind of a shock when, late last summer, we witnessed a tornado, an earthquake, and a hurricane. These were extreme weather conditions that we rarely, if ever, see, and they all occurred within the span of about a week. Meanwhile, elsewhere in the country, Texas and other parts of the Southwest endured one of the worst droughts on record, while massive flooding and deadly tornadoes struck communities in the Midwest. With extreme weather dominating the news, we thought we'd take a look at some of the famous weather events in U.S. history and see what we've learned from them. One thing's for sure: While modern forecasting helps us understand patterns and make predictions, in the end weather remains a powerful force beyond human control. Maybe that explains our fascination with it.

Meg Chorlian
Editor

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BLIZZARD!

by Jeanie Mebane
illustrated by Matthew Gauvin

No one on the prairie was prepared for the violent blizzard that blew in on January 12, 1888. The morning had dawned 30 to 40 degrees warmer than the day before. After weeks of below zero temperatures, the day seemed almost balmy. Many residents thought a January thaw had arrived.

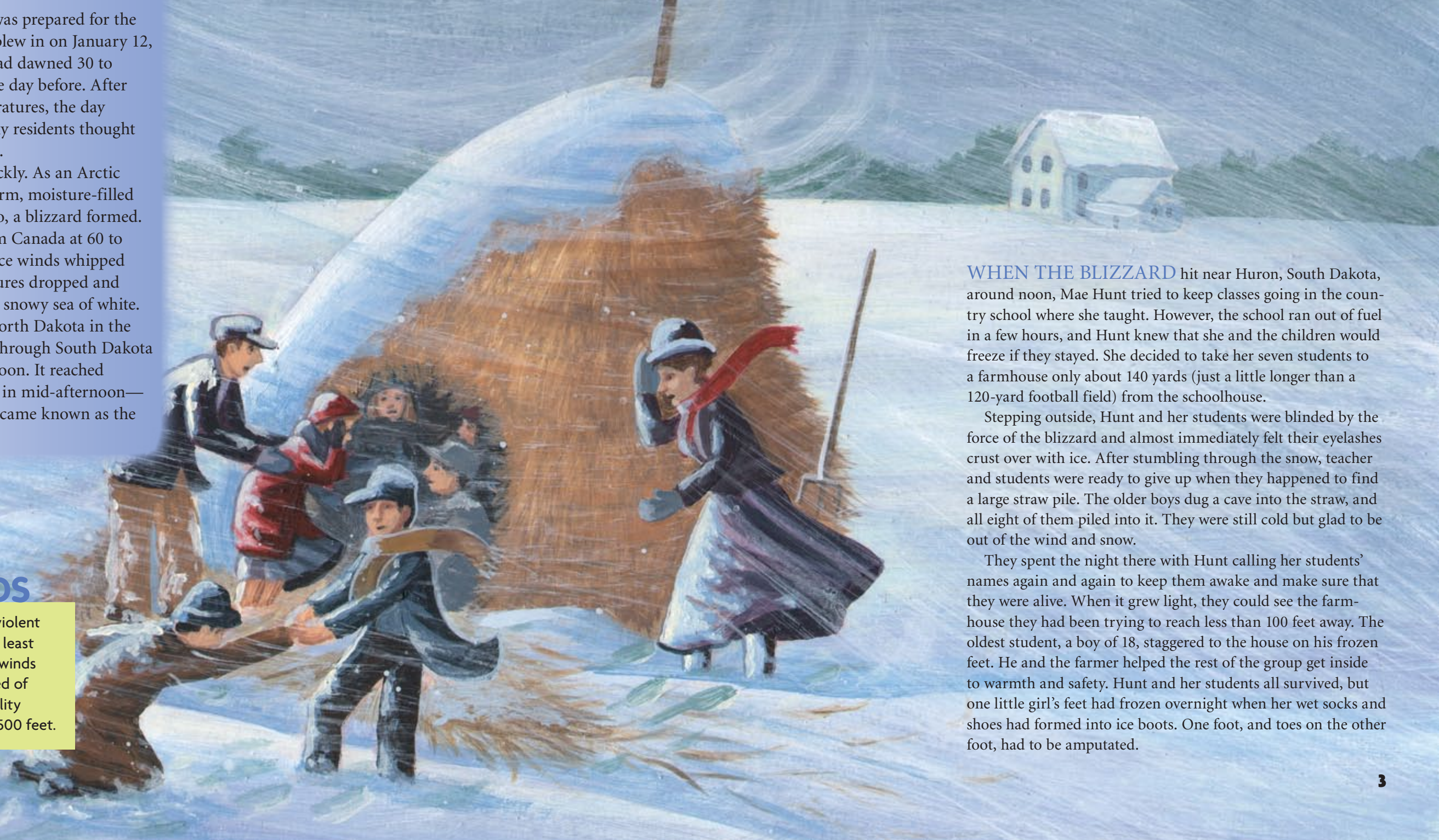
But the day changed quickly. As an Arctic cold front collided with warm, moisture-filled air from the Gulf of Mexico, a blizzard formed. It raced southeastward from Canada at 60 to 70 miles per hour. Gale-force winds whipped the falling snow. Temperatures dropped and objects became hidden in a snowy sea of white.

The storm hit western North Dakota in the morning and then moved through South Dakota and western Nebraska by noon. It reached eastern Nebraska and Iowa in mid-afternoon—school dismissal time. It became known as the Schoolchildren's Blizzard.

BLIZZARDS

ABOUT

Blizzards are defined as violent snowstorms that last at least three hours and consist of winds blowing at a minimum speed of 35 miles per hour and visibility reduced to not more than 500 feet.



WHEN THE BLIZZARD hit near Huron, South Dakota, around noon, Mae Hunt tried to keep classes going in the country school where she taught. However, the school ran out of fuel in a few hours, and Hunt knew that she and the children would freeze if they stayed. She decided to take her seven students to a farmhouse only about 140 yards (just a little longer than a 120-yard football field) from the schoolhouse.

Stepping outside, Hunt and her students were blinded by the force of the blizzard and almost immediately felt their eyelashes crust over with ice. After stumbling through the snow, teacher and students were ready to give up when they happened to find a large straw pile. The older boys dug a cave into the straw, and all eight of them piled into it. They were still cold but glad to be out of the wind and snow.

They spent the night there with Hunt calling her students' names again and again to keep them awake and make sure that they were alive. When it grew light, they could see the farmhouse they had been trying to reach less than 100 feet away. The oldest student, a boy of 18, staggered to the house on his frozen feet. He and the farmer helped the rest of the group get inside to warmth and safety. Hunt and her students all survived, but one little girl's feet had frozen overnight when her wet socks and shoes had formed into ice boots. One foot, and toes on the other foot, had to be amputated.

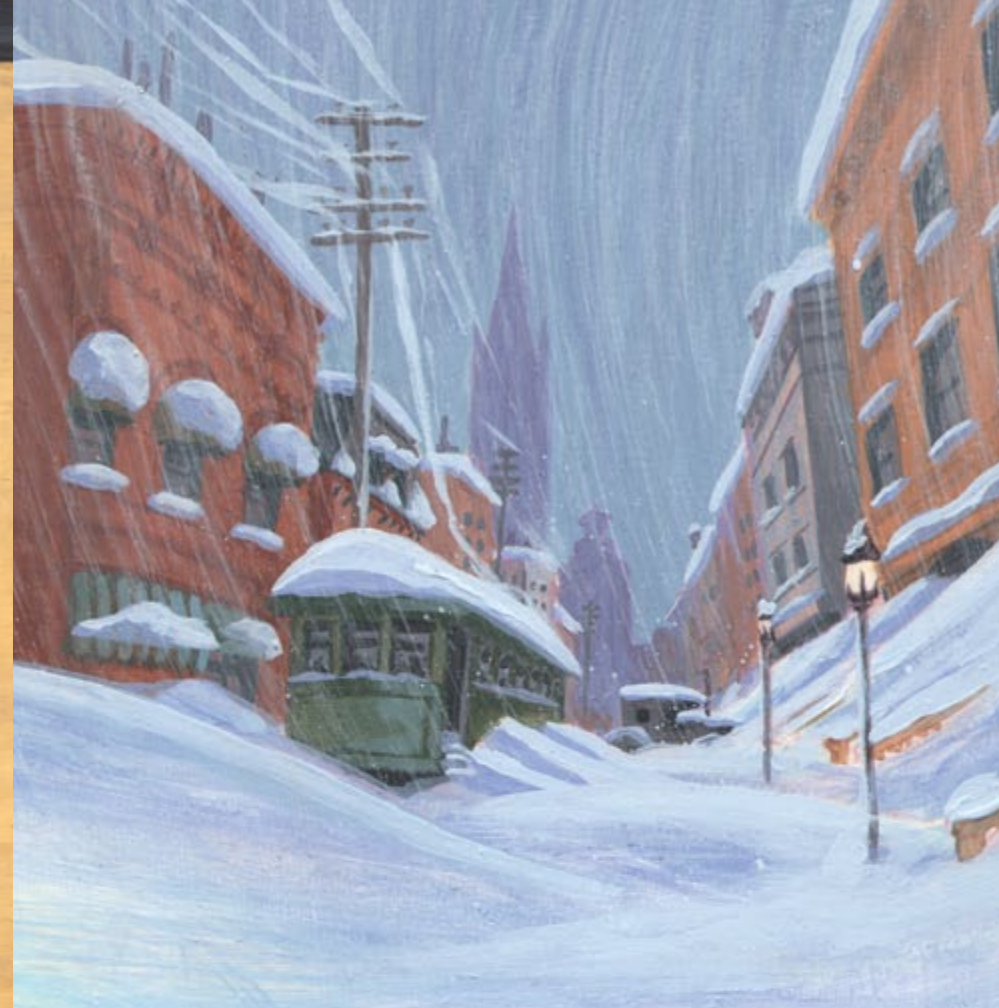


IN EASTERN NEBRASKA, Barney and Anna Barry feared for the lives of their three older children who had walked the mile to school that morning. The Barrys decided it would be safest for their children and their schoolmates to stay at school. While Barney prepared to take supplies to the school, Anna put the stew she was cooking into a covered kettle for Barney to carry. After dressing warmly, Barney tied a bag of blankets onto his back.

Unable to see in the storm, Barney knew that he could get lost if he tried to walk along the road to the school. He decided to follow fence lines through the fields between his home and the school. As he made his way, Barney couldn't see anything in the blowing snow—not even his left hand guiding him along the fence wire. He trudged through the deep snow as fast as he could to reach the school before dismissal time. If he did not get there in time, the children would start home—and get lost in the storm.

Near the school, Barney had to leave the fence and blindly cross the long schoolyard before he safely reached the schoolhouse. Inside, the teacher and students were huddled around a heating stove. Leaving the stew and blankets, Barney told the teacher to keep the students there for the night. Then, concerned about his wife and young children left at home, Barney made the return trip, again following the fences.

Barney, his family, and all the children in their school survived the storm. Two hundred thirty-five other Nebraska schoolchildren did not. About 500 people died in the blizzard. Their bodies were scattered across fields, clinging to fences within a few feet of shelters, and even inside freezing homes. Some bodies weren't discovered until the snow melted in spring. Others survived but were crippled or suffered amputations. Some, weakened by exposure during the storm, succumbed to illnesses in the weeks that followed.



THE SCHOOLCHILDREN'S BLIZZARD continued eastward and southward across the country. At the same time, part of the frigid air mass slipped westward. Within days, the entire country experienced record-breaking low temperatures. Snow fell in areas usually too warm for snow.

Two months later, from March 11 to 14, a second devastating blizzard struck in 1888. This time, the East Coast from Maryland to Maine was covered with up to 50 inches of snow in some places. Wind gusts of up to 70 miles per hour were recorded. Daily life along the heavily populated East Coast ground to a halt in what became known as the Great White Hurricane of 1888. Roads were blocked and railroads were stopped, trapping travelers in trains. The weight of the snow took down telegraph lines. Snowdrifts reached the top of some homes. Buried under huge amounts of snow for days, cities became isolated and about 400 people died. After the snow stopped falling, the melting snow caused flooding.

But the future would be different: One outcome of the blizzard was that cities more quickly embraced the idea of building underground transportation systems, which are the backbones of major urban centers today. And communication lines were moved underground, too. ☂

Jeanie Mebane started writing as a child in eastern Nebraska. She especially enjoys writing about natural sciences and history.

STORM OF THE CENTURY

For three days, the Storm of the Century pounded 26 eastern states from Alabama to Maine. The massive storm shut down every East Coast airport and impacted about half of the nation's population. In some places unaccustomed to any snowfall, the March 1993 storm dumped 2 to 3 feet of snow. It also brought tornadoes, storm surges, and flooding. But it became a milestone in weather history for a different reason: the way it was forecasted. Using computer models, National Weather Service forecasters were able to accurately predict the severity of the storm days in advance and release storm warnings and alerts.



This map captures the intensity of the 1993 storm that paralyzed the East Coast.

A Famous Flood

by Marcia Amidon Lusted

Located in a valley, Johnstown, Pennsylvania, became flooded when a dam holding back a rain-swollen lake gave way.

You can't fight the power of all that water.



Residents of Johnstown, Pennsylvania, were accustomed to moving their belongings onto the second floor of their homes to keep them dry. Johnstown was built in a valley where two rivers—the Little Conemaugh and the Stonycreek—ran along the edges of town and then joined at its western end to form the Conemaugh River. These rivers drained snowmelt from the mountains and frequently flooded, which made the sight of water in the streets of Johnstown a common occurrence.

But a different set of circumstances unfolded as water seeped into Johnstown's streets early in

the morning of May 31, 1889. After a heavier-than-usual rainstorm swelled the rivers into flood stage, rains had also overfilled Lake Conemaugh, 14 miles up from the city. Lake Conemaugh had been artificially created for the South Fork Hunting and Fishing Club, a summer resort for rich and elite members. The South Fork Dam held back the waters to form the two-mile-long lake.

The water was 60 feet deep at the dam, and as the rain fell throughout the morning on May 31, the water level by the dam rose until those at the club feared that the dam would collapse. People worked frantically to keep it from failing, adding dirt

to the top, digging a second spillway, and taking out the screens that kept the expensive stocked fish from escaping from the lake. But their efforts weren't enough. Just before 3:00 P.M., everyone at the lake watched in horror as the dam "just moved away."

It took only an hour for the water from the lake to sweep down the 14 miles to Johnstown. By the time it arrived, it was believed to have had as much force as Niagara Falls. It also was carrying a load of debris from the places it had swept through upstream, including houses, barns, animals, and people—both dead and alive.

Trains were swept off their tracks. Houses and buildings were destroyed or picked up and carried toward a huge stone bridge owned by the Pennsylvania Railroad Company, where they became wedged in the bridge's stone arches. People were swept up in this same wave of debris. Many of those who survived the rushing water eventually became trapped against the stone bridge and died when the debris caught fire. Others drowned or were swept farther downstream and severely injured by the crush of objects in the water around them.

Gertrude Quinn Slattery was only six years old when she was swept away by the floodwaters while clinging to a muddy mattress. She described her rescue by a man who plunged into the fast-moving water and risked his own life to save her: "At last he reached me, drew himself up and over the side of the mattress and lifted me up. I put both arms around his neck and held on to him like grim death. Together we went downstream. . . ." When they

Once the dam broke, only a trickle of water was left in the lakebed.

The rush of the water swept up everything in its path, causing a crush of debris to get caught at a stone railroad bridge.

A pontoon bridge was constructed to allow for travel through the flooded city.



Four square miles of Johnstown were destroyed. Parts of the city looked like they had been flattened by a steamroller.

Morgues are places where unidentified bodies are kept until ready for burial.

reached a place where several men were leaning out the window of a house trying to pull people to safety, the man tossed Gertrude through the air to them.

It didn't take long for news of the devastating flood to reach the world, and relief efforts began immediately. Clothing, food, lumber, medical supplies, and money were sent to Johnstown. Clara Barton and the American Red Cross came and built warehouses for donated supplies and hotels for the homeless. Makeshift *morgues* were created in the few buildings left standing. The flood killed one out of every 10 people in Johnstown—more than 2,200 total.

With the destruction of the South Fork Dam, Johnstown residents may have felt that they were at less risk for future floods, but this was not the case. In March 1936, three days of rain combined with heavy runoff from melting snow sent 14 feet of floodwaters into

Johnstown again. Twenty-four people died, and 3,000 buildings were damaged or destroyed. This time, the federal government sent help in the form of 7,000 men from the Works Progress Administration (WPA) to help clean up the town. President Franklin D. Roosevelt also authorized the U.S. Army Corps of Engineers to dig channels for the rivers that flowed around Johnstown, increasing their capacity and

hopefully preventing future floods.

In July 1977, however, a line of severe thunderstorms stalled over the area and dropped as much as a foot of rain. Several dams in the area failed, and once again floodwaters engulfed Johnstown, rising higher than the protective river channels. Although engineers thought that the floodwaters would have been even higher and more destructive without the channels, 85 people died, and property damage was estimated at more than \$300 million. This time, Johnstown, with an already fragile economy, did not recover as well and many flood-damaged businesses never reopened. The city's population dropped by 20 percent over the next 10 years. Weather and flooding had changed the course of Johnstown's history. ☂

Marcia Amidon Lusted has written many nonfiction books for children. As a New Englander, she's used to many different kinds of weather but is happy not to have experienced any floods.

Flash floods are America's deadliest weather hazard, says the National Weather Service (see page 17). They occur in all 50 states and kill an average of 100 people each year.

In the past, when *floodplains* were used mostly for farming and *wetlands* were left undeveloped, floods caused only occasional trouble. But as cities have grown, many houses and roads have been built in floodplains. This leaves fewer wetlands and other natural areas for water to soak into, which means greater forces of water collecting and needing a place to go.

Flash floods happen when prolonged heavy rain can't drain quickly enough—typically, within six hours of a rainstorm. Without warning, sudden surges of water weaken or wash away bridges, dams, and roads. They uproot trees and destroy homes and other buildings. The average annual damage in the United States from flash floods is more than two billion dollars.

What can you do to protect yourself? Before any heavy rains fall, know your area's risk for flooding. Stay inside during prolonged intense rainstorms. Listen to weather warnings on the TV or the radio. In case of a warning, get to higher ground as soon as possible.

Never play around rising floodwaters. Never try to wade through a flash flood, even if it only reaches your ankles. If you slip and fall, even a small current can be dangerous. Six inches of surging water can sweep a person off his or her feet. Two feet of floodwater can carry away most automobiles. If you're in a car, don't drive into areas covered by floodwaters. Instead, follow the advice of the National Weather Service: "Turn Around and Don't Drown!"

Kathiann M. Kowalski is a resident of Ohio, which experiences weather that ranges from blizzards to floods and tornadoes. Katherine Swarts contributed to this article.

Floodplains are areas of land that flood often. Wetlands are low-lying areas that are saturated with moisture.



Floodwaters can pack a powerful punch, as the missing chunks of this paved road prove.

FAST-MOVING
WATER

by Kathiann M. Kowalski

Swallowed

by the Sea

by Julie Lake

Galveston was enjoying a golden era of prosperity in the late 1800s. Located on Galveston Island off the Texas coast on the Gulf of Mexico, the city had developed into a major commercial center and an important port. Today, however, the city is famous for the hurricane that nearly destroyed it. The Galveston Hurricane was the deadliest storm to strike the United States: Historians estimate that at least 8,000 people—and possibly as many as 12,000—lost their lives as a result of it.

Why did so many perish that day?

The reasons are many. At the time of the hurricane, weather prediction was still in its infancy. It would be another 60 years before scientists began using radar and eventually satellites to accurately track storms. Instead, at the turn of the 20th century, the nation relied on a network of scattered weather stations sharing eyewitness accounts and employing basic tools such as barometers and anemometers, which measure air pressure and wind velocity (see page 15).

When ship captains encountered bad weather at sea, they would relay information about a storm's location when they docked. These details would then make their way in a hopscotch pattern, via telegraph and telephone lines, to the main weather office in Washington, D.C., which attempted to advise coastal and inland cities of any impending dangerous conditions. Official predictions, however, were often vague, and measuring storm severity was difficult.

The deadly 1900 storm was first detected in the tropical Atlantic Ocean on August 27. It reached Cuba as a tropical storm on September 3 and then moved into the southeastern Gulf of Mexico. Although Isaac M. Cline, Galveston's U.S. Weather Bureau forecaster, received some information about the approaching storm and hoisted a hurricane warning flag over the Weather Bureau building the day before it hit, no one on the island fully understood the severity of the storm.

By late morning on September 8, many adults and children gathered at the beach to watch the huge crashing waves. Cline patrolled the beach and warned people to get to higher ground. Old-timers in Galveston were used to storms—the relatively flat island with a height of less than nine feet above sea level often flooded without much damage to property. Many residents believed that the gentle slope of the underwater coast offered special protection to Galveston that other coastal areas did not possess.

The truth of the matter was that Galveston merely had been lucky. The major hurricanes that hit the Texas coast in 1875 and 1886 came inland far from Galveston, where winds did not exceed 60 miles per hour.

The 1900 hurricane was another story. It made landfall early in the evening on September 8 to the east of the island. This made for the worst possible trajectory—one that ensured maximum flooding due to the counterclockwise rotation of Atlantic hurricanes. As the storm neared Galveston, the strong winds ripped a steamship from its moorings in the harbor. The massive vessel destroyed

That is one massive-looking hurricane!



HURRICANES

Hurricanes are strong tropical cyclones that form over the Atlantic or eastern North Pacific Ocean. They occur when heavy precipitation and strong winds spiral around an area of low barometric pressure—the eye—at the storm's center. *Typhoon* is used to describe such storms when they form in the western North Pacific.

ABOUT



Galveston's bridges to the mainland, cutting off the islanders' only evacuation routes.

At the height of the storm, the winds blew in excess of 130 miles per hour. The ocean swallowed the island, reaching a depth of more than 15 feet in many parts of town. People climbed to upper floors and then to rooftops as houses flooded and then broke apart.

By the time the storm moved onto the mainland early Sunday morning, it had killed one fifth of Galveston's population and destroyed 3,600 homes and buildings. Help was slow in arriving because telephone and telegraph lines were down and railroad tracks linking Galveston to the mainland were damaged. Radio and television did not yet exist. A group of men from Galveston guided a boat through the bay, which was filled with debris and dead bodies, and then hiked overland until they were able to

flag down help.

Once word spread of Galveston's destruction, help poured in from all over the world. Among the heroes was Clara Barton, who at age 78 directed

The track of the 1900 hurricane indicates the height of its force as it hit Galveston, Texas.

Today a seawall protects Galveston from storms, but in 1900, this structure did not exist and the surge from the 1900 hurricane simply swept over the city.

I never knew water could be so destructive.

the American Red Cross relief effort, the last mission of her career. In her report on the disaster, Barton described the sight that awaited her when she arrived in Galveston:

"It was one of those monstrosities of nature which defied exaggeration. . . . The churches, the great business houses, the elegant residences of the cultured and opulent, the modest little homes of laborers of a city of nearly forty thousand people; the center of foreign shipping and railroad traffic lay in splinters and debris piled twenty feet above the surface, and the crushed bodies, dead and dying, of nearly ten thousand of its citizens lay under them."

The civic leaders of Galveston quickly mobilized, organizing efforts to find and identify bodies. Although burial was the custom of the time, the huge number of casualties made it necessary to burn most of the dead in massive funeral pyres to prevent the spread of disease.



Debris filled Galveston's streets.

THE SAFFIR-SIMPSON HURRICANE WIND SCALE

The Saffir-Simpson Hurricane Wind Scale rating is based on a hurricane's wind intensity at the time of measurement.

Category One: Winds 74–95 miles per hour. Some minor damage will occur.

Category Two: Winds 96–110 miles per hour. Some extensive damage will occur.

Category Three: Winds 111–130 miles per hour. Devastating damage will occur.

Category Four: Winds 131–155 miles per hour. Catastrophic damage will occur.

Category Five: Winds greater than 155 miles per hour. Catastrophic damage will occur.



Many survivors eventually left Galveston, never to return, but the bustling seaport was too valuable an asset to leave in ruins.

A massive rebuilding effort took place, which included the construction of a 17-foot seawall by the U.S. Army Corps of Engineers. The town then pumped in dirt behind the seawall to raise the elevation of the entire city.

The seawall has been tested many times over the years, most recently in 2008 when Hurricane Ike caused significant damage to the island. The seawall held, and an extensive evacuation effort helped prevent widespread loss of life. By the time Ike dissipated, there were 26 direct deaths in the United States and 28 indirect deaths. ☂

The dead were so numerous that bodies had to be burned instead of buried to avoid the spread of disease.

Julie Lake is the author of *Galveston's Summer of the Storm*. She lives in Austin, Texas, where she works in a high school library. Visit her Web site at www.julielake.com.

KATRINA STRIKES

As Hurricane Katrina bore down on New Orleans, Louisiana, in August 2005, many people could not help thinking about Galveston a century earlier.

Like Galveston, New Orleans is a large city with a busy harbor. New Orleans also has a very low elevation, with many parishes, or communities, below sea level.

Similar to the 1900 Texas storm, Katrina also made landfall on the eastern side of the city—the worst possible location in terms of flooding. Katrina unleashed a 10- to 20-foot **storm surge** in portions of southeastern Louisiana and triggered even more severe flooding in Mississippi and Alabama.

In terms of wind speed, Hurricane Katrina reached 120 miles per hour at landfall on August 29 in Louisiana, earning a high Category Three classification. Hurricane Katrina could easily have surpassed Galveston's death toll had it

not been for the massive evacuation that took place on the Gulf coast. The evacuation, which saved so many lives, was made possible by modern weather forecasting and constant alerts to the public. Meteorologists were able to track Katrina as it formed in the Bahamas, cut a path through Florida, and then zeroed in on Louisiana.

As it was, Katrina caused at least 1,800 deaths, making it the third-deadliest U.S. hurricane. It is the most destructive storm in U.S. history in terms of economic loss. Through enormous effort and a global outpouring of donations and help, however, New Orleans, like Galveston, is making a comeback. —J.L.



A **storm surge** is a rise of water above tide level associated with a storm and caused by the combined effect of low pressure and strong winds.

When New Orleans' extensive levee system failed, seawater rushed in and got trapped in the city.



Father of All Forecasters

by Charlene Brusso

Did you know that the National Weather Service gathers data from across the country to help create local weather reports every day? In fact, its on-line national map (www.weather.gov/view/largemap.php) refreshes itself every five minutes to offer updated watches, warnings, and advisories. Cleveland Abbe would be so proud!

Abbe was born in New York City on December 3, 1838. In the summers, he worked on his grandfather's farm outside Windham, Connecticut. Fascinated by nature, he learned how important the weather could be on the farm. Heavy rains might delay planting or drown plants before they could be harvested. Storms could knock crops flat.

After studying science and mathematics, Abbe became a teacher. While teaching at the University of Michigan in Ann Arbor, he also studied astronomy. In 1868, he was hired as director of Ohio's Cincinnati Observatory. Abbe knew that atmospheric conditions such as clouds, haze, fog, and rain could affect astronomical observations. He became fascinated with the idea of studying weather in other places to predict what the local weather would be like.

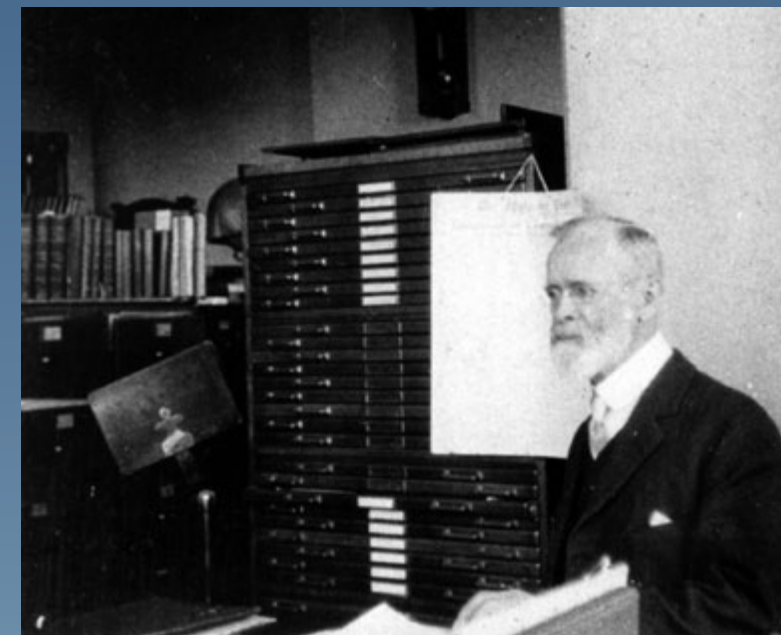
But how would he get the data he needed? Abbe proposed setting up a network of weather observers around Cincinnati. The observers would record eight different things, from local **barometric pressure** and temperature to details about atmospheric conditions, such as the wind, clouds, and rain or snowfall amounts. They would send their data by telegraph to Abbe at a central office, where he would coordinate the information to predict the weather for the next few days. His predictions could then be sent back by telegraph to each weather station, so they could all share the results.

Abbe convinced the Cincinnati Chamber of Commerce to give him money to set up a network of 20 observers and to help get his weather bulletin printed in the city's daily papers. The first official public forecast—predicting the weather for the Ohio River valley over the next two days—appeared on September 22, 1869.

Barometric pressure, or air pressure, is created by the weight of the atmosphere pressing on a surface.



Abbe's ideas about gathering information about the weather became the foundation for today's National Weather Service.



Early weather scientists charted and prepared weather forecasts by hand.

That Doppler radar looks like a big soccer ball!



Today the National Weather Service uses advanced technologies such as Doppler radar domes to help monitor the weather.



The success of Abbe's local weather reports, or "probabilities," helped him gain the attention of larger groups, including the U.S. government. Early in 1870, President Ulysses S. Grant signed a bill establishing the Weather Bureau, and Abbe became its chief meteorologist. Originally part of the U.S. Army Signal Corps, the bureau used observers in distant military stations around the country to gather data. Abbe's first official national weather report was delivered on February 19, 1871.

For the first six months, Abbe was the only one who knew enough about meteorology to create forecasts. His skill earned him the nickname "Old Probabilites." Abbe worked hard to make each forecast consistent and precise. Every report included information on temperature, wind direction, barometric pressure, and current weather conditions.

But Abbe couldn't do it all himself, so he taught others to measure and predict the weather. By 1872, the Weather Bureau was sending out more than 500 daily weather bulletins for locations across the country. Abbe also wrote articles, did research, and organized state weather services across the country. He even thought of dividing the country into four standard time zones to help coordinate weather observations.

Abbe wanted his observers to have the best equipment for carrying out their work. The bureau's instrument division tested thousands of barometers, *anemometers*, and *hygrometers*. Bureau scientists also designed and built many of their own instruments.

Despite failing health, Abbe was part of the U.S. Weather Bureau until his death on October 28, 1916, at the age of 78. His hard work established today's National Weather Service (renamed from the U.S. Weather Bureau in 1967) and built the foundations of modern meteorology. ☂

Charlene Brusso is a freelance science writer based near Syracuse, New York.

Anemometers are instruments used for measuring wind speed and force.

Hygrometers are instruments used for measuring humidity in the atmosphere.

AT YOUR FINGERTIPS

Isn't modern technology great?



by Ruth Tenzer Feldman

You can find all kinds of weather information, from today's clouds over Topeka to next year's predicted rainfall on the West Coast, by going to the National Weather Service (NWS) at www.weather.gov.

The NWS is the federal agency that provides weather, hydrologic (water-related), and climate forecasts and warnings for the nation, including U.S. territories and ocean areas. The agency, an arm of the National Oceanic and Atmospheric Administration (NOAA), has about 4,800 employees in 131 weather forecast offices, 19 river forecast centers, and 6 national centers. The NWS has teams of scientists studying satellite, buoy, radar, and computer information to forecast when and where any given condition will likely occur.

The NWS Storm Prediction Center forecasts severe weather up to three days in advance and updates information as severe weather approaches. A weather alert system now warns people about 11 minutes before a tornado strikes—which is about 11 minutes longer than people had 20 years ago!

The Climate Prediction Center studies weather patterns lasting months or years. These depend on the El Nino-Southern Oscillation (ENSO), which is a measure of the surface temperature of the tropical Pacific Ocean. Every month, the center publishes the ENSO Diagnostic Discussion forecasting climate conditions in the nation.

NWS information is used for adjusting airline flight routes, protecting property from floods or hurricanes, managing crop harvests, and even stocking up on toilet paper.

Each year, Americans get more than 1,584,000 NWS forecasts as well as up to 50,000 potentially life-saving severe weather warnings. So the next time the NWS accurately predicts a clap of thunder—or anything else—be sure to give the agency some appreciative claps of your own.

Ruth Tenzer Feldman spent her childhood on the New Jersey seashore, where she weathered many a hurricane.



Accurate weather information is at our fingertips with devices such as digital weather stations for homes.





Sun

Clouds

Wind

Fog

Freezing rain

Snow

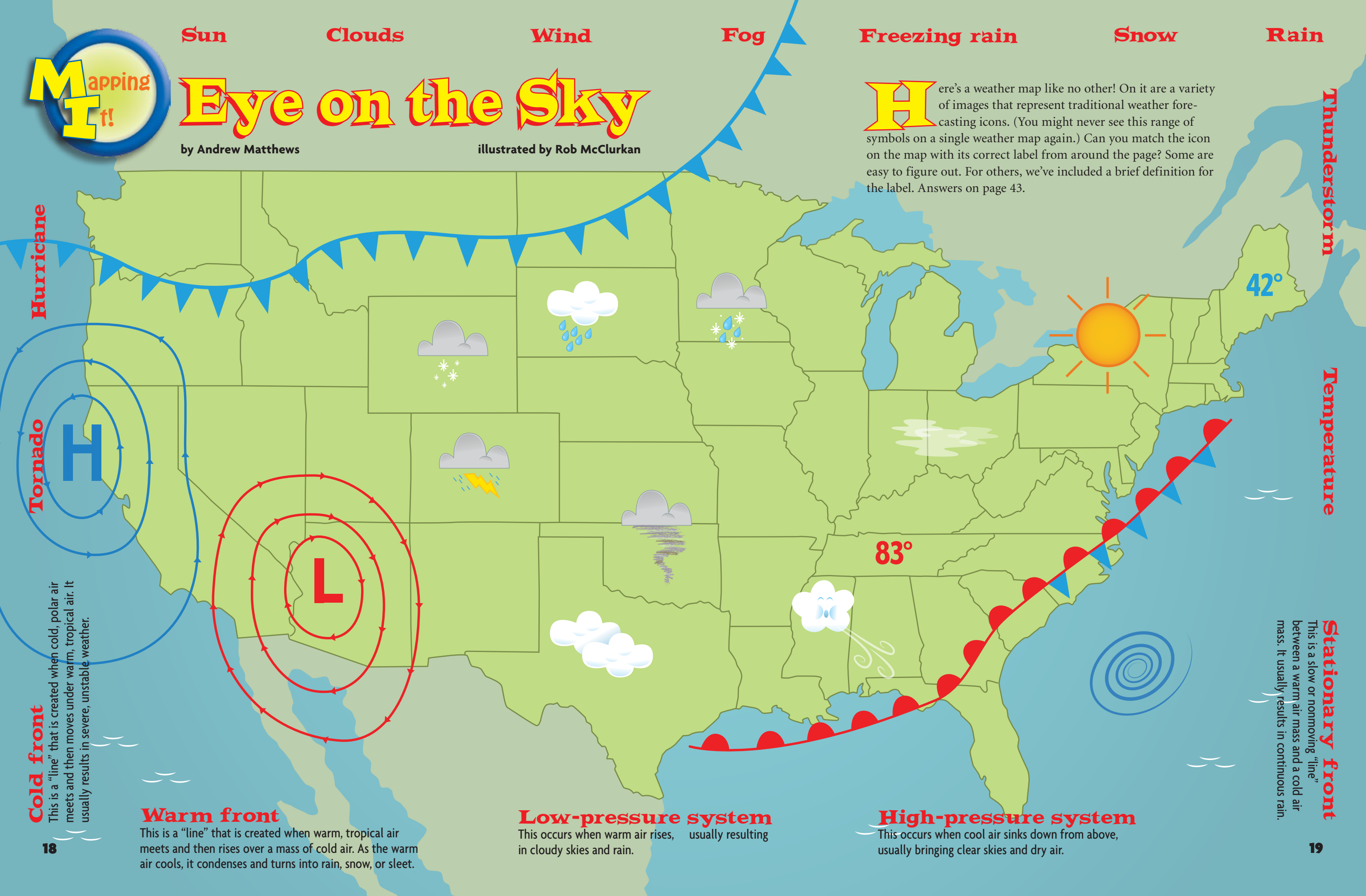
Rain

Eye on the Sky

by Andrew Matthews

illustrated by Rob McClurkan

Here's a weather map like no other! On it are a variety of images that represent traditional weather forecasting icons. (You might never see this range of symbols on a single weather map again.) Can you match the icon on the map with its correct label from around the page? Some are easy to figure out. For others, we've included a brief definition for the label. Answers on page 43.



Hurricane

Tornado

Cold front

Thunderstorm

Temperature

Stationary front

Warm front

This is a "line" that is created when warm, tropical air meets and then rises over a mass of cold air. As the warm air cools, it condenses and turns into rain, snow, or sleet.

Low-pressure system

This occurs when warm air rises, usually resulting in cloudy skies and rain.

High-pressure system

This occurs when cool air sinks down from above, usually bringing clear skies and dry air.



by Ruth Spencer Johnson

Monster Tornado

The people of southeastern Missouri had no idea that the deadliest tornado in U.S. history was heading their way. But over the course of 3½ hours, the monster storm would carve a 219-mile path of destruction through three states. When it finally dissipated, the Tri-State Tornado killed nearly 700 people, injured more than 2,000, and destroyed 15,000 homes in 19 communities.

The forecast for March 18, 1925—“rains and strong shifting winds”—did not sound too threatening, but severe afternoon thunderstorms generated a tornado that touched down at about 1:00 P.M. near Ellington, Missouri. Moving about 60 miles per hour, twice as fast as an average tornado, the twister traveled northeast and destroyed most of the town of Annapolis.

The storm was nearly a mile wide and looked like a huge black cloud filled with tumbling debris. Because it did not resemble a typical tornado with a whirling funnel cloud, many people did not realize what was happening until it was too late to take cover. By the time the superstorm raced across the Mississippi River into southern Illinois, it had traveled about 80 miles in 83 minutes, leaving 13 people dead.

The tornado saved its greatest fury for southern Illinois. It roared into the tiny village of Gorham at about 2:30 P.M. “Then the air was filled with 10,000 things. Boards, poles, cans, garments, stoves, whole sides of the little frame houses, in some cases the houses themselves, were picked up and smashed to



earth,” reported a newspaper. The tornado destroyed all the buildings in town and killed 37 people.

At a record speed of 73 miles per hour, the tornado barreled on to Murphysboro, a railroad town of 12,000 people. Schools and homes collapsed, and a railroad repair yard was demolished. Two hundred thirty-four people died that day,

TORNADOES

A tornado is a column of violently spinning air hanging down from a cloud to Earth. The air is invisible, but water droplets often condense around the revolving air column to create a funnel cloud. Scientists don’t fully understand how tornadoes form, but they do know that layers of air with differing temperatures, wind directions, and amounts of moisture and density can develop into tornadoes.

ABOUT

making the Murphysboro death toll the highest ever in a single U.S. city hit by a tornado.

But the tornado was just getting started. With its wind speeds reaching 300 miles per hour, it flattened the village of De Soto, killing 33 people in the school. It then blasted into the large mining town of West Frankfort. Eight hundred men were working 500 feet down in the West Frankfort mine when the storm knocked out the electricity. Without power for the elevator, the miners had to climb narrow escape ladders to exit the mineshaft. Reaching the surface, they found many of their family members among the 148 dead. All told, about 600 people died in Illinois.

Speeding across the Wabash River, the tornado plowed into the southwestern corner of Indiana at

4:00 P.M. It wiped out the village of Griffin, and then veered slightly northward, bringing destruction to more towns and farms. About 70 people died in Indiana before the tornado finally ended its terrible rampage at 4:30 P.M. It still holds the record for ground speed, length of track, and death toll from a single U.S. tornado.

What made the Tri-State Tornado so deadly? Besides its speed, size, and strength, the storm's unusual appearance fooled people into thinking it was just a thunderstorm. Many buildings were poorly constructed and could not provide adequate protection to those who sought shelter.

Above all, the U.S. Weather Bureau had no real ability in 1925 to predict or track severe storms. Without *Doppler radar*, weather

TORNADO ALLEY

The tornado spotter carefully watches the sky. A severe storm unleashes thunder and lightning. Soon hail the size of golf balls begins to fall. Suddenly, the spotter sees a whirling funnel drop from a billowing, dark cloud. A tornado has formed!

An area of the central United States, nicknamed Tornado Alley, has become famous for having the right ingredients for tornado formation. In that region, warm, moist air from the Gulf of Mexico collides with hot, dry air from the Southwest and cold, dry air from Canada and the Rocky Mountains to spawn more tornadoes than anywhere else in the world. Tornado Alley has no official boundaries, but its width is generally considered to extend eastward from central Kansas and Nebraska to western Ohio. Its length reaches from northern Iowa to central Texas. But tornadoes have happened in every state and on every continent except Antarctica. So keep your eye on the sky! —R.S.J.

Highway signs in Oklahoma alert travelers to the danger of tornadoes in the area.

This image captures both the strength and random nature of tornadoes. While everything else in the house is gone, part of a chimney and a bookcase—with books still on it—remain seemingly untouched.



satellites, or computer models of weather movements that meteorologists use today, forecasters could not tell where or when a tornado would occur. Not until 1948 did the bureau issue the first official tornado warning.

Even if forecasters could have predicted the twister's path, there was no way to quickly communicate the danger to the public. Many homes did not have telephones or radios, and television and warning sirens did not exist.

The 1925 tragedy made people more aware of the destructive power of a tornado. As a result, communities formed networks of storm spotters to watch the sky and inform residents of approaching tornadoes. Scientists worked to develop better methods of forecasting storms.

Today, the National Weather Service constantly monitors thunderstorms, and its Storm Prediction Center issues a tornado watch if conditions are right for a tornado to occur. If one is seen, a tornado warning is announced. Then communities activate tornado sirens, while television and radio stations inform people about the danger and advise them to take cover.

All but one of the 25 deadliest tornadoes in the United States happened before 1956. Tornadoes are no less severe today, but better construction practices and modern forecasting and warning systems give people a much better chance to find shelter in time to ride out dangerous storms in safety. ☂

Ruth Spencer Johnson grew up in Indiana, where she learned to keep an eye out for tornadoes.

Doppler radar is a type of weather radar that measures the speed and direction of a moving object, such as rain or wind.

How did that bookcase remain standing?



Weather played an important role in these famous historic moments.



12th century

Historians believe that a series of severe droughts between the 11th and 13th centuries caused Native American populations to decline and eventually resulted in the Anasazi Indians abandoning their homes in the American Southwest.



1903

Predictions of good weather conditions convinced Wilbur and Orville Wright to test their theories about flight on the beach at Kill Devil Hills, near Kitty Hawk, North Carolina. The site's steady, unobstructed winds helped the Wright Brothers glide into history.

1777-78

During the Revolutionary War, bitter winter conditions took their toll on the Continental Army at Valley Forge, Pennsylvania—about 2,000 soldiers died. But the army emerged from the winter better trained and more disciplined.



1925

Blizzard conditions isolated Nome, Alaska, during a diphtheria epidemic. When airplanes from Anchorage were unable to reach Nome, dogsled relay teams carried the life-saving serum through the harsh winter weather—and saved the day.



1846

The Donner-Reed Party, a group of pioneers attempting to reach California, took a "shortcut" that resulted in the party getting trapped by blizzards in the Sierra Nevadas. Nearly half of the 87 members died in what turned out to be one of the worst winters in that mountain range's history.



1944

Heavy winds and high seas forced the Allies to reconsider their plan to cross the English Channel and land in Normandy, France, during World War II. D-Day, which began a massive offensive against Germany, was postponed from June 5 to June 6.

Covered in Dust

by Peter Roop



Where did all that dust come from?



The morning of Sunday, April 14, 1935, dawned clear and dry across the southern Great Plains. Families went to church, planning to enjoy picnics and visits with friends afterward.

Then, in mid-afternoon, the air suddenly turned cooler. Birds began fluttering nervously. All at once, a rolling black cloud of dust darkened the northern horizon. Everyone hurried home, trying desperately to beat the overwhelming “black blizzard” before it struck.

Black blizzards were nothing new to the residents of the southern Plains. They had been experiencing these destructive dust storms for several years. Yet the wall of flying soil that struck on April 14 was particularly awesome in its size and intensity. The day became known as Black Sunday.

From 1932 through 1940, powerful storms of dust ravaged the farming and grazing lands throughout the area of the Great Plains known as the *dust bowl* (see page 28). Attics collapsed under the weight of tons of dust, tractors were buried beneath six-foot drifts of dirt, and travelers became stranded in their cars. In many locales, a day rarely passed without dust clouds rolling over. People lost their way in the black blizzards and perished.

Before the “dirty 30s,” as people called that time, the dust bowl region had experienced seasons of bumper crops. The years 1926, 1929, and 1931 produced particularly fine fields of wheat. Encouraged by the bounty,

farmers began to use more efficient machinery to carve out even greater fields. In so doing, the farmers uprooted the grasses that had held together the rich prairie soil for ages.

Then the weather changed. Less rain fell throughout the Plains. The ground dried up, crumbling into small pieces. Crops withered and died. At the same time, the ever-present prairie winds increased in strength and duration. The winds first shifted the *topsoil*, then lifted it and transported it for miles. Drought and wind storms were not new to the Great Plains, but the lack of prairie grass to hold down and protect the soil was.

During the height of the storms, a farmer in Texas commented, “If the wind blew one way, here came the dark dust from Oklahoma. Another way and it was the gray dust from Kansas. Still another way, the brown dust from Colorado and New Mexico.”

Many families abandoned their farms. For those who remained, life was a challenge. People battled constantly to keep the dust out of their homes. Windows were taped and wet sheets hung to catch the dust. At dinner tables, cups, glasses, and plates were kept overturned until the meal was served. Dentists and surgeons struggled to keep their instruments sterile. The dust caused “dust pneumonia” which sometimes killed the very young and the very old.

Yet people kept a sense of humor. When the drought was especially bad, farmers told the tale of how a man hit on the head by a single raindrop had to be revived by throwing two buckets of sand in his face. Hunters were said to have shot prairie dogs overhead as they tunneled through the dusty air. One farmer mused, “I hope it’ll rain before the kids grow up. They ain’t never seen none.”

Finally, by 1938, the worst of the drought was over. The situation was reversed largely due to government actions. A special branch of the U.S. Department of Agriculture—the Soil Conservation Service (SCS)—was created in 1935 and went to work. The SCS used carefully planned conservation methods and wiser farming techniques to restore prairie grasses, develop crop-rotation practices, and enable farmers to live off the land without ruining it. As the new soil conservation measures



FAST FACT

DUST FROM THE PLAINS BLACKENED THE SKY IN WASHINGTON, D.C., BEFORE BLOWING HUNDREDS OF MILES OUT OVER THE ATLANTIC OCEAN.

Topsoil is the upper part of the soil.

Without a lot of warning, dust storms turned a sunny day into night.



DROUGHT

Drought occurs over an extended period of time and takes place when an area’s water supply and precipitation levels fall off dramatically. Strong winds and erosion also impact the severity of a drought.



Farm families found life during the Dust Bowl very difficult.

took hold, crops started to return. The ravaging winds slackened and dust storms came less frequently. And the rains returned.

Drought struck the Great Plains again in the 1950s, but thanks to the federal government's improved conservation measures, the soil suffered much less damage. For example, the practice of conservation tillage left as much as possible of the plant residue on top of the soil. The remains functioned like mulch—as a protective covering to hold in moisture and prevent erosion.

In addition, some of the areas of land most prone to erosion on the Great Plains were returned to natural grasslands. Grass has a long root system that is better able to withstand drought conditions and wind. These areas should never

have been converted to farmlands in the 1930s.

Sometimes, however, even improved understanding is not enough. In 2011, southwestern states experienced a severe drought. Texas was the most severely hit by a combination of extraordinarily low rainfall and high heat. This time, the issues associated with drought were even more serious because larger numbers of people have chosen to live in parts of the country that are naturally dry. The higher demand for water for cattle, farmland, and residential use made the 2011 drought particularly devastating. ☔

DID YOU KNOW?

Dust Bowl is a term used to describe both a place and a time. The dust bowl region of the United States refers to the southern portion of the Great Plains, including parts of Texas, Oklahoma, New Mexico, Colorado, and Kansas. But "Dust Bowl" refers to the period in the 1930s when drought, prairie winds, and poor land-use practices combined to make living and farming in the region nearly impossible. Millions of acres of land became useless as the topsoil simply blew away.

FAST FACT

IN 1994, THE SOIL CONSERVATION SERVICE WAS RENAMED THE NATURAL RESOURCES CONSERVATION SERVICE.





FEMA staff works in a Mobile Emergency Response Support vehicle set up in Joplin, Missouri, after a tornado devastated that community in May 2011.



ABOVE: An Army National Guard Chinook helicopter lifts bales full of sand to aid in the effort to protect against flooding along the Missouri River in June 2011. BELOW: Members of Connecticut's National Guard organize and load supplies, including MREs (Meals Ready to Eat), for communities that were hit by Hurricane Irene in 2011.



HELP IS ON THE WAY

by Marcia Amidon Lusted

When disaster strikes, the following organizations are among the first to spring into action.

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

When a state finds its resources overwhelmed by a disaster and declares a state of emergency, FEMA prepares to step in. FEMA is a U.S. government agency whose purpose is to help coordinate a plan of action when a disaster strikes. These scenarios can include natural disasters as well as terrorism. When an event such as a hurricane or a tornado occurs, FEMA personnel work with state and local officials and organizations to provide immediate help with food and shelter. Later, they coordinate long-term housing, insurance claims, and financial assistance for victims. FEMA also focuses on disaster preparedness, such as how to create emergency supply kits and how to protect property from potential damage.

NATIONAL GUARD

The U.S. Army National Guard not only serves as a military force during wartime, but it also functions as a first responder during times of crisis on the home front. Its motto is "Always ready, always there." For example, 50,000 National Guard members were sent to the Gulf states to aid in the recovery after Hurricane Katrina in 2005. National Guard troops help with evacuations and search-and-rescue missions as well as fill law enforcement and security positions, including enforcing curfews and preventing looting. They also supply heavy equipment for repairs and rebuilding and

helicopters for aerial surveys of disaster areas.

AMERICAN RED CROSS

The American Red Cross has been the biggest emergency response organization in the United States since it was founded in 1881. Today, however, the Red Cross does more than just help people after disasters. It also sponsors community services to help the needy, offers support for members of the military and their families, sponsors educational programs about health and safety, and collects and processes blood donations. The local chapters are usually first on the scene after a natural disaster, and there is a large network of volunteers who travel to disaster areas to supply and distribute food, clean-up kits, and financial help and to find shelter. The Red Cross also provides counseling and guidance for emotional issues after a disaster.

MISSION GROUPS

Church mission groups are one of the major sources of volunteer assistance after disasters, both in the United States and around the world. Many religious groups sponsor members to travel to places where there has been a natural disaster to help with recovery. These volunteers often stay temporarily at local churches and schools and spend their time helping affected homeowners with repairs, ranging from reconstruction to painting and landscaping. They also assemble disaster emergency kits and raise donations of money and emergency supplies. Church mission groups often are a way for young people to volunteer and do community service. ☂



A volunteer in this American Red Cross truck provides a hot meal to a North Dakota resident after his neighborhood was flooded in July 2011.



ABOVE: Southern Baptist Convention Disaster Recovery volunteers pull debris from a damaged home. BELOW: This Missouri Boy Scout troop represents just a handful of the nearly 1,000 scouts who volunteered to help clean up around Joplin, Missouri's, schools after a tornado leveled the city in May 2011.





HOW'S THE WEATHER UP THERE?

An Interview with Meteorologist Brian Clark

by Marcia Amidon Lusted



Located 6,288 feet above sea level, New Hampshire's Mount Washington is said to be the home of the worst weather in the world. It lies in the path of three different storm tracks—where weather blows in from the Ohio River valley, the St. Lawrence Seaway, and the East Coast. In fact, in April 1934, a wind gust of 231 miles per hour was measured on Mount Washington, which was a world record for a surface station until 2010. That might explain why the buildings there are all chained to the ground!

It seemed only right that *COBBLESTONE*'s issue on historic U.S. weather events should include a chat with someone at the Mount Washington Observatory. The observatory has continuously staffed the mountain since 1932 (although earlier attempts at taking weather observations on the mountain date to the late 1800s).

To learn more about the observatory and all the services it offers, check out its Web site, www.mountwashington.org/about.

Brian Clark completed an internship at the Mount Washington Observatory during the winter of 2006. It was a once-in-a-lifetime experience and led to his current full-time job there as a meteorologist and education specialist.

IS THE MOUNT WASHINGTON OBSERVATORY REALLY HOME TO THE WORST WEATHER IN THE WORLD?

After calling this mountain home for five years, I do truly believe that it has some of the worst weather you will find anywhere in the world. You'll be hard-pressed to find another location on our planet that sees the combination of extreme cold, super hurricane-force winds, snow, blowing snow, and freezing fog all at the same time on such a frequent basis.

WHAT SPECIFICALLY DOES THE OBSERVATORY DO? WHY IS IT STILL IMPORTANT IN THIS AGE OF SATELLITE WEATHER AND OTHER INNOVATIONS?

Our mission as a nonprofit organization has three major parts to it: science, education, and research. The scientific part of this mission is our 80 years of weather observations, climate data collection, and mountain weather forecasting that we've done.

On the education side of things, we try to teach people not just about Mount Washington and the incredible place that it is, but also about meteorology and science in general. We do this through overnight educational trips to the summit, day trips, distance learning programs like Internet videoconferencing, tours of the summit weather station, outreach programs in classrooms, our interactive science and weather museum at the Weather Discovery Center in North Conway, and more.

This is one extreme place to live and work.



This may look like the North Pole, but it's really Mount Washington Observatory's observation deck—on a sunny day.



For research, we work with colleges, universities, and other companies on research projects and new instrument testing. We complete a weather observation every hour, every day, year-round. This means that someone physically goes outside to observe certain aspects of the weather every hour. We send these hourly observations, a kind of weather snapshot, to the National Weather Service (NWS). The NWS uses our data for keeping track of climate data, forecasting, and use in weather-forecasting models that meteorologists across the United States rely on to more accurately predict the weather. Our observations



FAST FACT

IN 2010, A PANEL OF EXPERTS CERTIFIED THAT TROPICAL CYCLONE OLIVIA HAD A WIND GUST OF 253 MILES PER HOUR IN AUSTRALIA.



Clark adjusts the three-cup anemometer, which is used to measure low wind speeds.

are particularly important for these weather models because we are providing elevated data. In other words, we are sort of like a weather balloon sitting at 6,288 feet 24 hours per day, 365 days per year.

In addition to hourly observations, we are also continuously tracking and recording numerous weather variables like wind, temperature, and pressure. This collection of data at the surface is still important. Satellites cannot detect some of the small-scale weather phenomena that we see here. Satellites also cannot keep track of things like snowfall, icing rate, and horizontal visibility.

HAS THE TECHNOLOGY USED AT THE OBSERVATORY CHANGED OVER THE YEARS?

The technology has changed drastically. Even as few as 10 years ago, we were unable to digitally log any significant portion of the data from our instrumentation and were still relying heavily upon paper charts. Although we continue to record on paper charts for consistency, everything that we observe and record these days is logged into digital databases, allowing future researchers to more easily access our data and work with it. This has probably been the most dramatic technological change at the observatory.

WHAT TYPES OF JOBS ARE DONE AT THE OBSERVATORY?

One day, I might be giving tours and talking to a classroom in California through our distance learning program, and then the next day, I am shoveling six-foot snowdrifts from in front of our emergency exits. We also have to forecast the weather, fix instrumentation, make repairs to other aspects of our facility, paint, and do woodworking—the list could go on.



Clark braves the elements to read the sling psychrometer, which measures the amount of water vapor, or humidity, in the air.

WHAT'S THE HARDEST PART ABOUT LIVING AT THE OBSERVATORY FOR LONG STRETCHES OF TIME?

Our workweek runs from Wednesday to Wednesday (eight work days) and then we have off from Thursday to Tuesday (six days). This rotation continues year-round. While on shift, I am working for about 12 hours, from 5:30 A.M. to 5:30 P.M.

Clark explains some of the roles the observatory fills to hikers.



The hardest part is that it sometimes feels like we are living two different lives—one on the mountain and one in the valley. Being away for eight days at a time can also be hard on relationships, both with friends and family. It also affects some things you would never think of, like joining a sports league or becoming a member of an organization that meets on a weekly basis.

Although we are certainly isolated and live in fairly small quarters, we have all the comforts of home. Indoors, we have access to the Internet, cable TV, books, games, movies, and musical instruments. We also often take advantage of nice weather outside when we get it. Some of us enjoy going for hikes, and in the winter, we often go backcountry skiing or snowboarding.

WHAT ARE SOME OF THE DANGERS OF WORKING AT THE OBSERVATORY DURING EXTREME WEATHER CONDITIONS?

We have to be conscious of safety year-round, but it becomes even more important in the winter. Transportation is difficult during the winter months and involves a snow tractor traveling on the Mount Washington Auto Road. It can take 1 to 1½ hours going just one way on a nice day. Some one-way trips can take as long as six hours in bad weather conditions, and then there are some days that a trip is simply not possible because the weather is too extreme. If I were to get hurt or sick, it could be anywhere from several hours to a day or two before I could get to a hospital.

WHAT ADVICE DO YOU HAVE FOR OUR READERS INTERESTED IN LEARNING ABOUT WEATHER FORECASTING?

My biggest piece of advice is to study hard in school, especially when it comes to math and science. Meteorology in college involves a lot of math and physics. Beyond the schoolwork, you can also follow the weather by going to sites like AccuWeather.com and the National Weather Service Web site (www.weather.gov) where you can look at weather forecasts, read blogs, read weather discussions, look at satellite images, and basically familiarize yourself with weather information. ☂



The observatory's snow cat is necessary to reach Mount Washington's summit from mid-October through mid-May.



Clark heads outside to take an observation amidst heavy winds and thick overhead fog.

MEET MARTY

Marty the cat is the only full-time resident of the Mount Washington Observatory. Marty is the most recent in a long line of observatory cats dating back to the station's beginnings in 1932. Just like you might have a pet at your house, the meteorologists at the observatory enjoy a pet at theirs!





Who doesn't love a clear, sunny day? The truth is, though, bad weather is unavoidable. But you don't have to let threatening skies completely ruin your day. Here are some easy tips to help you "weather" the next big storm that hits your neighborhood.

First, be aware of the weather in your part of the country. For example, if you live in the South, you should know when hurricane season runs. Life in the Midwest means watching out for tornadoes. Freezing temperatures and blizzards in the North can create dangerous situations in the winter. Keep informed by watching the news or checking an app for weather alerts.

Second, make sure you have the necessary emergency supplies on hand. You don't want to be left in the dark if a storm knocks out power to your house. Stock up on items that provide light, such as candles or flashlights. Don't forget to check that you have matches and batteries! While you're at it, double-check your other



electronic devices. Fresh batteries for a portable radio, a DVD player, or a handheld gaming system can help keep you informed or pass the time while you wait for the power to be restored.

Sometimes, harmful power surges occur when the power is turned back on, which can blow out computers and other large appliances. Remind your parents or other adults to unplug computers, microwaves and other ovens, washers and dryers, and other expensive major appliances.

Even if you don't lose power, certain weather situations are just plain hazardous to drive in. Plan ahead by keeping a supply of nonperishable food and bottled water on hand. Canned and dried foods that can be prepared without the use of water or electricity are good to keep in your home. Be prepared to ration your food and water to last as long as you and your family need.

Remember to create a family plan. Set up a phone tree that allows your family to stay in touch in case anyone is caught in bad weather away from home.

STORM CHECKLIST

Batteries
First-Aid Kit
Band-Aids/Bandages
Neosporin
Personal Medications
Nonperishable Food
Bottled Water
Charged Cell Phone
Cell Phone Charger
Battery-Operated
or Solar-Powered Radio
Flashlight, Candles, and Matches
Extra Blankets, Sleeping Bags, and Pillows

If a storm hits at night, designate a specific place to meet in your house so that you can check that everyone is safe.

Then, make sure you have a plan of action to remain safe. If, for example, a hurricane or tornado is approaching, stay indoors and keep away from doors and windows. A basement or other low-to-the-ground spot may be the safest place to be during very severe windstorms. Do not go out until the storm is over. Bad weather is part of nature, but you can lessen its impact if you are prepared to get through it safely. For more ideas on how to create a plan and keep informed, check out the Federal Emergency Management Agency's (FEMA) helpful site at www.ready.gov.

Felicia Truman was an editorial intern at Cobblestone Publishing.

Do we have everything we need?



WILD WEATHER

Crossword Puzzle

by Andrew Matthews

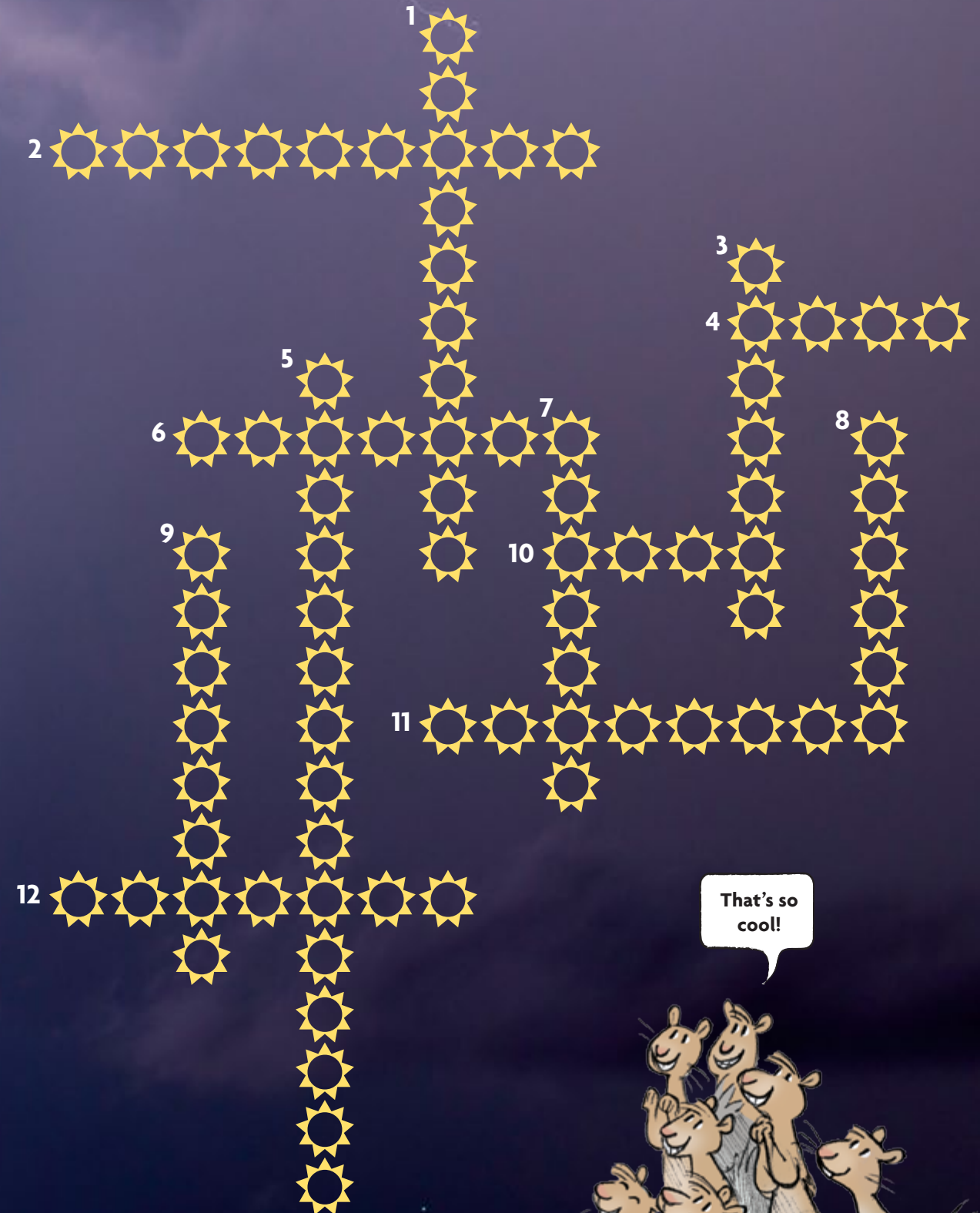
 eather” or not you keep your eye on the sky, we predict that you’ll have no trouble solving this crossword puzzle. Answers on page 42.

Across

2. Galveston, Texas, remains famous today for the devastating _____ that struck in 1900.
4. Cleveland _____ was the first American to gather data from a surrounding area in order to forecast the weather.
6. Severe lack of rain combined with high heat results in _____.
10. Too much of this type of weather can lead to flooding.
11. The American _____ is an organization that offers help to those impacted by disasters.
12. Today’s National Weather _____ first began as the U.S. Weather Bureau in 1870.

Down

1. If a storm is coming, remember to keep fresh batteries and a _____ handy in case the power goes out.
3. In 2005, this hurricane devastated New Orleans, Louisiana.
5. The _____ Observatory claims to have the worst weather in the world.
7. If you see a funnel cloud that indicates this type of storm, head for shelter.
8. Involving dangerous, fast-moving water, flash _____ are America’s deadliest weather hazard.
9. This type of storm involves heavy snow, blowing winds, and poor visibility.



That’s so cool!



Weather Can Change History

At times, the best-laid plans of leaders and governments were ruined by an uncontrollable force: the weather.

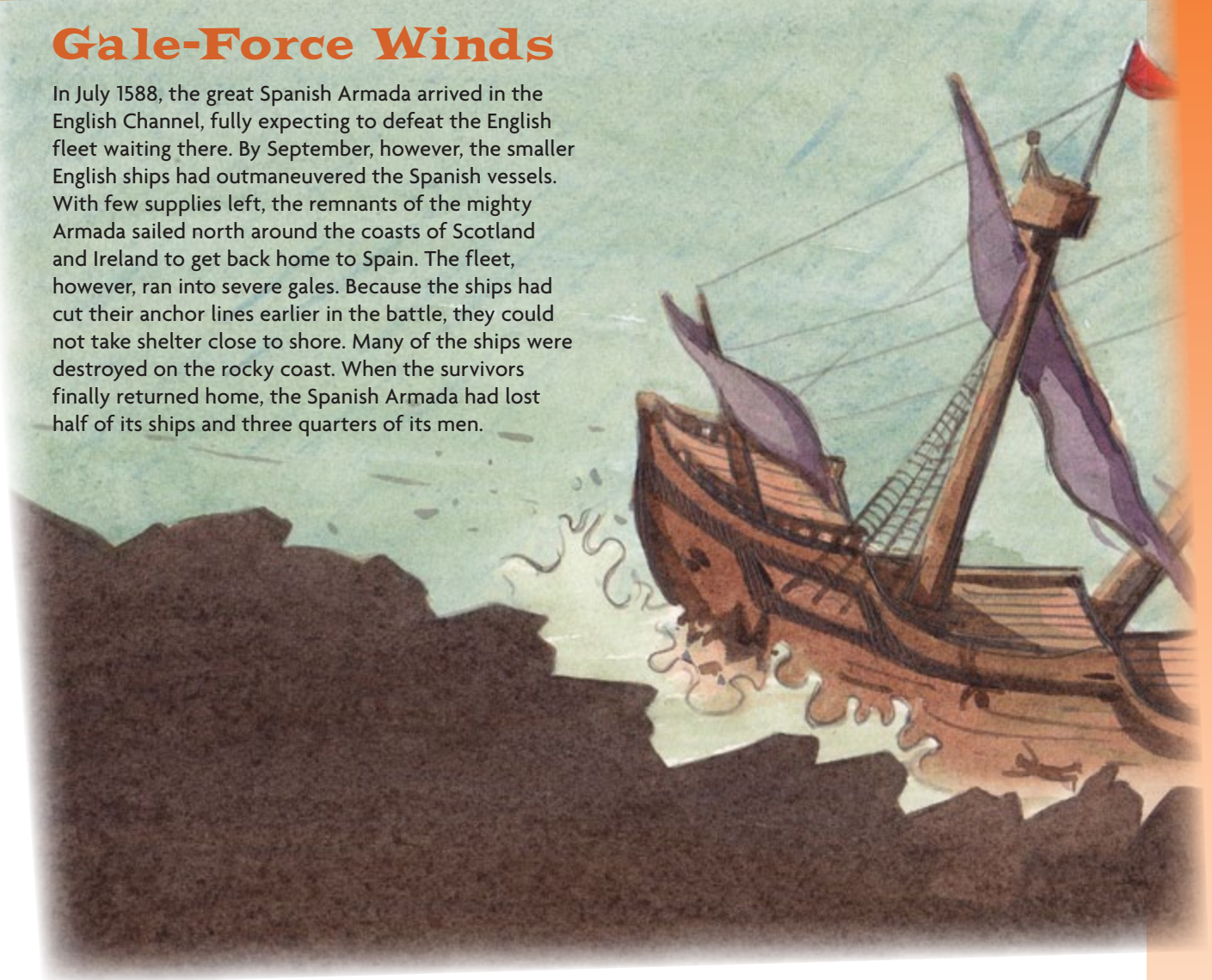
Typhoon Trouble . . . Twice

Mongolian emperor Kublai Khan was determined to conquer Japan. His first effort, in 1274, involved 40,000 men in hundreds of ships. After the Mongols reached Japan's Hakata Bay, however, a typhoon struck and about 13,000 men drowned as one third of the Mongol ships sank. Undeterred, Kublai tried again to conquer Japan in 1281 with an even larger force, but another typhoon struck. At least half of the Mongol warriors drowned, and only a few hundred ships remained. It was the most disastrous naval invasion attempt in history, and Kublai was forced to abandon his imperial plans. The Japanese word *kamikaze*, which means "divine wind," was first used to describe these typhoons that twice saved Japan from enemy invaders.



Gale-Force Winds

In July 1588, the great Spanish Armada arrived in the English Channel, fully expecting to defeat the English fleet waiting there. By September, however, the smaller English ships had outmaneuvered the Spanish vessels. With few supplies left, the remnants of the mighty Armada sailed north around the coasts of Scotland and Ireland to get back home to Spain. The fleet, however, ran into severe gales. Because the ships had cut their anchor lines earlier in the battle, they could not take shelter close to shore. Many of the ships were destroyed on the rocky coast. When the survivors finally returned home, the Spanish Armada had lost half of its ships and three quarters of its men.



A Harsh Winter

In 1812, French leader Napoleon set out with 600,000 men to invade Russia. He ordered that his men and horses survive off the land rather than rely on slow-moving supply wagons. The outnumbered Russian troops, however, retreated ahead of the French and burned fields and destroyed gardens, leaving the enemy with nothing to forage from the surrounding countryside. The French army pursued the Russians all the way to Moscow, which the Russian government abandoned and ordered burned. Unable to pin the Russian army down and decisively defeat it, Napoleon decided to retreat before winter made the return march impossible. But winter came early that year. Already weak from lack of food and supplies, the French soldiers were unprepared for the snow and the bitterly cold weather they faced. Men died in their sleep from exhaustion and exposure. Only 100,000 soldiers of the once-mighty French army survived.

Tornado

A raging torrent of power
that makes brave people scream and cower.
A funnel of wind flying at dangerous speed,
sweeping up objects—it's a storm of greed.
Duck your head and cover it well
'til you hear the clang of the all-clear bell.

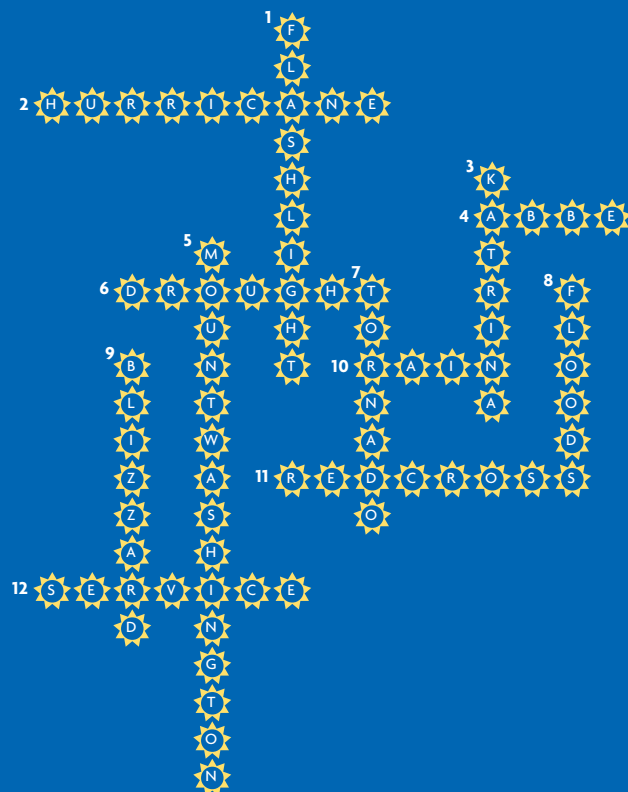
Emily Ellenbecker, age 11
Cascade, Wisconsin

Elements of Life and Color

Ocean clear,
fire blazing,
tears drop,
no idea why.
Clouds roll by in the fading sky.
Clouds part ways,
revealing heaven's lights.
In the dark, shocked night,
showing no need for fright or sorrow
I lull myself to sleep until the morrow.
Earth as damp,
wind as colorful,
sun bursting,
flooding the air.
With a spring in my step,
and a newly found desire,
nothing can stop me.
Like a mesmerizing dream,
working like a team,
reassuring family and friends,
happiness having no end,
when you know you'll be laughing soon again.

Talia Yavorek, age 10
Cheshire, Connecticut

Answers to Wild Weather Crossword Puzzle from page 38:



Thomas Jefferson
The War of 1812
1862: A Year in the Civil War

Write to us! Draw a picture or write a poem or short essay that connects to one of the above COBBLESTONE themes on which we currently are working. All contributions must be your own, original work. Include your name and address, and a note from a parent, guardian, or teacher acknowledging the originality of your work. We will include as many as we can in the upcoming issue to which your work relates.





Send your idea for a funny caption for this photo to: Just for Fun, COBBLESTONE, 30 Grove Street, Peterborough, NH 03458. Please include a letter from a parent or guardian that confirms the caption is your original work and that we have permission to publish it. And don't forget to send your name and address. If your caption appears in a future issue of COBBLESTONE, we'll send you a complimentary copy of that issue.



C'mon, just one bite of your nose!
Matthew Berube
Columbus, Ohio

Waiter! Waiter! I wanted an apple.
Joshua Schueller
Bemidji, Minnesota



Would you mind if I ate your nose?
Zachary Schueller
Bemidji, Minnesota

Whose nose is bigger?
Clara Weybright
Manheim, Pennsylvania

November/December
Winners!



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GIVING BACK

by Dennis Denenberg

This month's mystery hero was named "Hero of the Year" in 2008 by Cable News Network (CNN) and was awarded \$100,000 to support her work in a small community just outside of New Orleans, Louisiana. How did she get CNN's attention? Read on about this real hero!

In August 2005, one of the most catastrophic storms in modern U.S. history hit Louisiana: Hurricane Katrina. People fled their homes and returned to find devastated areas. Most wondered how they could restart their lives. This month's mystery hero thought of a way.

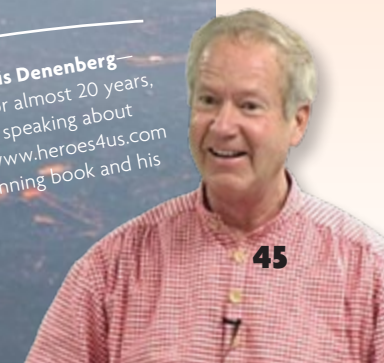
The third of four children, our hero grew up in Washington, D.C., and attended Catholic schools. Her teachers instilled in her a desire to help others, and she often participated in "service" days. After graduating from Boston College in Massachusetts, our hero volunteered in the Peace Corps. She lived in a small rural village in Lesotho, Africa, where there was no running water or electricity. This eye-opening experience helped our hero learn how people can face difficult situations without losing hope.

She decided to apply what she learned in Lesotho to help people devastated by Katrina. She wanted to give people hope. With her boyfriend, Zack Rosenberg, she organized the St. Bernard Project to enlist volunteers to donate their time and energy. Since 2006, more than 400 homes have been reconstructed. And most important, people are returning and rebuilding their lives—just as our mystery hero envisioned.

Visit the St. Bernard Project's Web site (www.stbernardproject.org) and think about how you can become part of this effort. Or become a local hero by getting involved and helping others in your community. This month's mystery hero's name is revealed on page 48.



"Dr. D"—also known as Dr. Dennis Denenberg—loves history and real heroes. For almost 20 years, he's been writing, teaching, and speaking about heroes all over America. Visit www.heroes4us.com to learn all about his award-winning book and his Hero-Virtue trading cards.



More Media

The **Weather Channel** offers some interesting programs about both today's weather and when weather made history. Check local cable listings.

On the Web

At the National Oceanic and Atmospheric Administration's National Weather Service Web site, **www.weather.gov**, you can find a wealth of information, both historic and up-to-date. There are specific areas for hurricanes, radar, severe weather, marine weather, space weather, and aviation weather.

Weather Decision Technologies, **www.wdtinc.com**, is a company that provides high-technology information regarding weather detection and forecasting.



Ethan Rates It...

★★★★★ Have you ever found yourself mesmerized by nature's fury during a major storm? From floods to hurricanes, blizzards to tornadoes, the U.S. Weather Service has tracked storms, informed communities, and served the country in important ways. Developed by the National Oceanic and Atmospheric Administration (NOAA), **www.history.noaa.gov/nws_stories.html**, is a Web site devoted to the history of the Weather Service. With in-depth articles and compelling, personal accounts of weather-related disasters, the importance of this small government agency and how it has helped keep Americans safer from storms comes into focus. The most fascinating aspect of this on-line resource is the biographies of the meteorologists who have dedicated their lives to fulfilling the service's mission. In their pursuit of studying the weather, these men and women became scientists, pioneers, and adventurers. Grade 5 and up.



At **support.wdtinc.com/mobile.html**, check out information about an iMapWeather Radio iPhone app. There's a fee for downloading the app from Weather Decision Technologies.

www.wunderground.com is the Web site for Weather Underground, a real-time, free weather service.

From the Archives

Explore some of these Cobblestone Publishing weather-related back issues:

Weather Alert! (APP0712)
Chilly Science: Ice and Snow (ODY0212)

Natural Disasters (COB8604)

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Disasters: Science to the Rescue (ODY9503)

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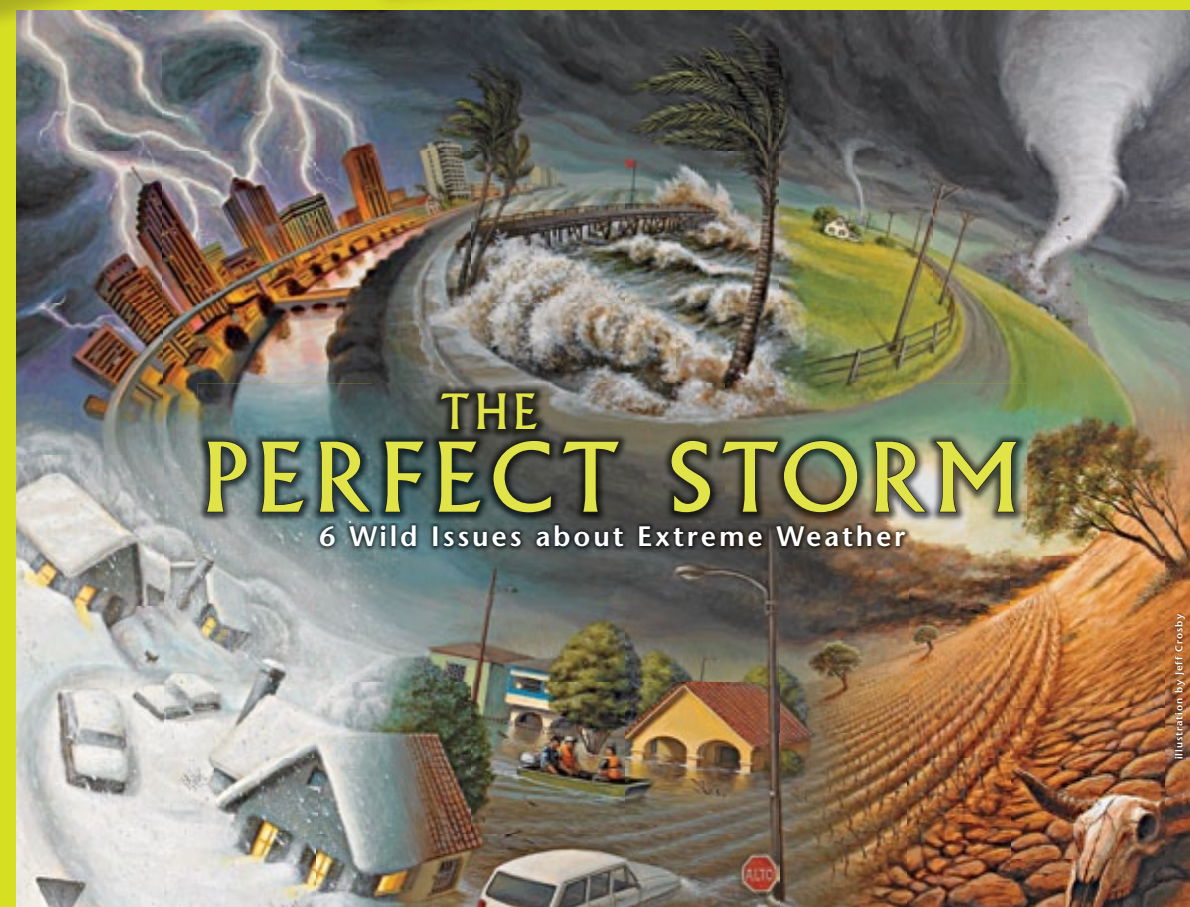


Interested in any of these issues? Want to know more? Please call customer service at **800-821-0115** or visit our Web site at **www.cobblestonepub.com**.

6 magazines, 1 extreme topic



The March issues of *COBBLESTONE*, *CALLIOPE*, *DIG*, *FACES*, *APPLESEEDS*, and *ODYSSEY* share the same theme: **The Perfect Storm**. Take an exciting look at extreme weather's impact on cities, culture, and history. Put all six covers together for a mosaic poster of nature's ability to dish out punishing weather.



FREE!

Print issues available for \$6.95 each (plus S&H)

For a limited time, get all six issues together in a **FREE** digital edition! Join our email list at **www.cobblestonepub.com/storm.html** and we'll send you the link for your exclusive digital edition.



Brain Ticklers

Give your brain a little tickle to see how well you read and understood this issue on historic weather events. If you believe the answer is false, give yourself the ultimate test and see whether you can explain why it is false. Answers are below.

- Cleveland Abbe was the first person to set up a system of data-gathering weather observers in order to predict weather.**
☐ TRUE ☐ FALSE
- The Johnstown Flood resulted after the Mississippi River overflowed its banks.**
☐ TRUE ☐ FALSE
- The Galveston Hurricane is the deadliest hurricane in U.S. history.**
☐ TRUE ☐ FALSE
- The increased number of prairie dogs burrowing tunnels made the 1930s Dust Bowl particularly devastating.**
☐ TRUE ☐ FALSE
- The American Red Cross is among the first relief organizations to get to the scene of a disaster.**
☐ TRUE ☐ FALSE

Answer to Dr. D's Mystery Hero from page 45: Liz McCartney

Answers to Brain Ticklers from above: 1. True, 2. False, 3. True, 4. False, 5. True. The Johnstown Flood occurred after a dam failed to hold back a rain-swelled lake. The uprooting of the protective prairie grasses to create larger fields was one of the things that made the Dust Bowl particularly devastating.

Picture Credits: courtesy NOAA: 5, 12 (top inset), 14 (top), 15 (bottom), 16 (top), 17 (bottom); North Wind Picture Archives: 6; Library of Congress: 7 (all), 8, 12–13 (middle), 13 (top and right insets), 15 (top), 27, 28; Shutterstock.com: 9, 10, 10–13 (background), 11 (inset), 14 (bottom), 16 (bottom), 17 (top), 20–23 (all), 28 (bottom background), 36 (all), 37 (top right, candles, phone, matches), 38–39, 44 (both), 45 (background), 48 (right, both), back cover; National Archives and Records Administration: 26, courtesy FEMA: 30 (top) (photo by Bradley Carroll), 30 (middle) (photo by Jeannie Mooney), 30 (bottom) (photo by Jocelyn Augustino), 31 (top) (photo by Patsy Lynch), 31 (middle) (photo by David Valdez), 31 (bottom) (photo by Rossyeth Rey-Berrios); courtesy Mount Washington Observatory: 32–35 (all); Clipart.com: 37 (blankets, pillows); courtesy Liz McCartney: 45 (inset middle); courtesy Dennis Denenberg: 45 (inset bottom); courtesy Ethan LaFrance: 46; Photos.com: 48 (left). Cobblestone Publishing has made every effort to trace the copyrights of these images.

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Say What?

exploring the origins of words and sayings

by Molly Troy

Raining Cats and Dogs

There is no clear origin for this expression, but it most likely derives from 17th-century England. Due to an inadequate city sewage system, heavy rain often resulted in small animals—such as cats and dogs—drowning during a storm. Although they did not fall from the sky, the sight of their carcasses floating through the city streets during and after a storm made it seem as though it had been raining cats and dogs. Ugh!

Molly Troy was an intern at Cobblestone Publishing.

Cartoon Connection

with EBENEZER & The COLONEL

by KE Lewis





March 2012 • Volume 33 • Number 3

FAMOUS FORECASTER

by Felicia Truman

A Few Facts:

- Found throughout North America, groundhogs are also known as woodchucks and land-beavers. They are the largest members of the ground squirrel family.
- Groundhogs live six to eight years, have an average weight of seven pounds, and reach an average height of two and a half feet.
- They are excellent diggers, swimmers, and tree climbers.
- They are not too accurate at predicting the weather: Phil gets the forecast correct less than half the time.

The crowd is quiet as Phil appears on Gobbler's Knob, located just east of Punxsutawney, Pennsylvania. The people wait for the moment when Phil gives his famous annual forecast. Phil is a groundhog with unique weather-prediction powers. If he sees his shadow, it is a

sign that there will be six more weeks of winter. No shadow sighted by Phil means that there will be an early spring. The tradition of celebrating Groundhog Day on February 2 is a long one: It dates back to the late 1800s, when German immigrants to Pennsylvania first put their faith in a groundhog's ability to predict the length of winter.



FACES

People, Places, and Cultures

pg. 36



THE PERFECT STORM

Weather & Us

Can We Control
the Weather?

pg. 26

Do You Believe
in Miracles?

pg. 22



MYSTERY PHOTO?

Hmmm...
what is this?

The answer is on page 48.

ABOUT THE COVER

Have you noticed how extreme weather is stealing the headlines and making the news these days? This month, **FACES**, and its five sister magazines — **APPLESEEDS**, **CALLIOPE**, **COBBLESTONE**, **DIG**, and **ODYSSEY** — are devoting their March issues to a look at the power and unpredictability of weather. We asked illustrator Jeff Crosby to create unique covers for these special issues. Check out how the covers for all six magazines create one impressive “perfect” storm!



MARCH 2012 FACES People, Places, and Cultures

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CONSULTING EDITORS

Randy Cerveny is a president's professor at Arizona State University who specializes in weather and climate in the School of Geographical Sciences. He is the author of two books, *Weather's Greatest Mysteries Solved!* and *Freaks of the Storms: The World's Strangest Weather Stories*. His research, including more than 100 science articles, has ranged from looking at the weather associated with prison escapes to computing the weather of the next 10,000 years. He is currently working with the World Meteorological Organization to catalog the world's weather extremes.

Nancy Selover received her PhD from Arizona State University in geography with an emphasis in climatology. She was the Assistant State Climatologist from 1999 until she was appointed the State Climatologist in 2007. Her research interests include field study, instrumentation, urban climatology, micro-climates, and evaporation. As State Climatologist, Dr. Selover provides climate data and analysis to researchers, state agencies, and the general public. She also does presentations to school and community groups on urban climate, climate change, monsoons, drought, and severe weather.

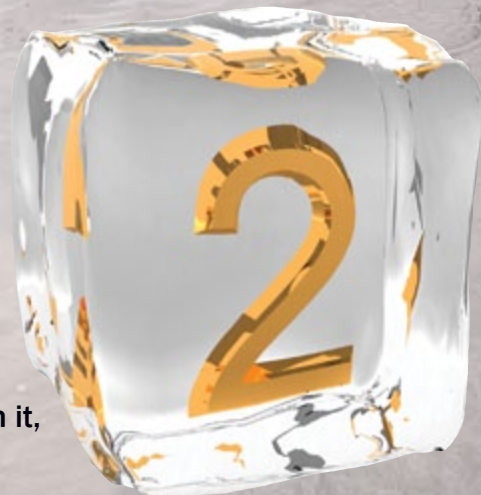
High 5

by Marcia Amidon-Lusted

THE WEATHER... it's a part of our daily lives, but it also has a big effect on how we live, where we live, and what we do. And lately it's been on everyone's minds more than ever before. Here are five facts about the weather, both good and bad!



What do you do when you live in a small, flat country prone to flooding? You harness the power of the wind, of course! The Netherlands has been making use of its windy weather for hundreds of years and still does today.



All around the world, people live in harsh climates, from scorching deserts to freezing steppes. Explore how people have adapted their homes to both utilize their environment and protect them from it, no matter what it is.



More and more people are choosing to leave rural, agricultural areas for the opportunities in large cities. And while they may not worry so much about natural weather conditions there, they have to deal with an entirely new manmade climate hazard: smog.



Everyone, at some time, wishes they lived in a different climate. But what if the climate of your hometown *forced* you to leave it in order to survive? The problem of climate refugees, the name for those people who have to leave their homes because of environmental disasters, is only going to get bigger.



Is it possible for a place to receive no rain at all? It is if you're in the Atacama Desert in Chile, one of the driest places in the world. And yet people have made their homes here for more than 10,000 years, and there are also plenty of plants and animals. How do they survive?



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• Monsoon rains caused devastating flooding in Thailand in 2011 killing hundreds of people.

At a Glance



YANG YANG JI, 9, Ontario, Canada
When my mom and I came back from swimming one afternoon, there was a tornado and a thunderstorm. My mother was driving. Then suddenly we couldn't see anything it was raining so hard. I was so scared. Mother drove so slowly and turned on the hazard lights. We were lucky. The tornado passed by and we were safe.



JANINA MORGAN, 19, Leeuwarden, The Netherlands
2011 was the coldest summer we've had in Holland in ages! We had probably only three weeks of sun. All the other days felt like it was autumn already.



ALEC SILVER, 16, Brattleboro, Vermont
There was so much flooding during Hurricane Irene in the summer of 2011 that water was right outside our door. The street had turned into a violent river that came up to our knees.



JOHNNE GUTKNECHT, 12, Madison, Wisconsin
The weirdest weather I have ever experienced was probably one summer night at about 11. The sky was bright green. There was a tornado warning that day, but the sky only turned weird colors in my neighborhood.

SOPHIA KNACK, 9, O'Fallon, Illinois
When we had friends over one Labor Day, there was a bad storm. It felt like our windows were going to break. The power went out and that made it even scarier. It damaged a couple fences and roofs.



ELLIE NAMITINIA, Israel
It was a sunny bright day in New Delhi, India, in the summer of 2008. Then all of a sudden the sky darkened and crazy hail was falling from the sky; the hail was as big as a golf balls and so heavy that it went through our umbrella.



ELENA GRIGEVICH, 15, North Scituate, Rhode Island
When Hurricane Irene hit our neighborhood in the summer of 2011, everybody's power went out. Ours came back on quickly and we invited our neighbors over to take showers and cook their food. I loved the wind and the rain during the hurricane. I even volunteered to run out in the storm to get the mail out of the mailbox!

MAXIM TUELL, 9, Broomfield, Colorado
Once last fall, we were coming home from a store in weather that was what I imagine a hurricane would be like. The wind was blowing so hard it felt like the car would topple over. Even after we closed the garage door, the wind kept pushing rain under it and flooded our garage.



MEG E. ALBANESE, 11, Chiba, Japan
I was ready for school but then I heard that school was cancelled because of a typhoon. I was bored and looked outside. Then the wind came and soon all the trees and stuff in the garden fell. My dad and mom were sad.



DAIKI SHINOMIYA, Japan
I remember rain pouring from a pitch-black void in the sky, muscular winds toppling meter-thick trees. God's rage at its peak.



BEN RUSSO, 12, North Scituate, Rhode Island
Thunderstorms are my favorite wild weather. My family and I love to smell the electricity in the air, see the flashes off in the distance, and watch the thunderstorms roll in.

What
Wild Weather
Have You Experienced?



Animals in the

Hot, cold, wet, or dry, animals are masters at adaptation. They have coats and skin to shelter them from all kinds of weather and body shapes to keep them alive through every kind of storm. But some animals are particularly adept at enduring the toughest conditions.



• Emperor penguins live in the coldest climate on Earth. Perfect weather for a swim! Not to worry, they've got lots of body oil that helps keep them dry in the water.

UNDERWATER FLIERS

Inhabiting the world's oceans, leatherback turtles are well adapted to their wet world. With its smooth, flexible shell, this turtle can dive nearly a mile! Its shell is actually a layer of thin, tough, rubbery skin with thousands of coin-sized bone plates. Blood flowing to and from the flipper surfaces shuts down from time to time, keeping heat in the core of its body. Cold blood in the flippers is warmed by outgoing blood before it reaches the body core. It also has a thick jacket of fat within its teardrop-shaped body.

FOR THE BIRDS

On the south polar continent of Antarctica, penguins are cold weather specialists. During the Antarctic winter the temperatures can drop to -31 degrees Fahrenheit. Emperor penguins huddle together and sleep to conserve heat. Did you know that penguins can recapture 80 percent of the heat that escapes in their breath through a heat exchange system in their nasal passages?

Emperor penguins and other penguin species have special feathers that trap air, creating a thick layer of insulation. The dark plumage on their backs absorbs heat from the sun. King and emperor penguins tip their feet up and rest all their weight on their heels and tail to reduce contact on the icy surfaces.



• What's one of this animal's favorite meals? Look for the answer on page 48.

EXTREME

by Peg Lopata

A DESERT EXPERT

An inhabitant of the deserts of southwest North America, the sidewinder rattlesnake gets its name from the clever way it gets around in the desert — sideways! It slithers on its chin and a loop section of its body so only two points touch the ground at the same time. This protects it from the hot terrain while it crawls; it also allows it to move quickly over the shifting sands. "Watching sidewinders move over a dune is magical!" says Dr. Andrew T. Holycross of Arizona State University.

The sidewinder's most important adaptation for life in a dry environment is mostly its ability to excrete waste in solid form, not liquid, according to Holycross. "If you've ever looked closely at snake, bird, or lizard poo, you've probably noticed the thick white stuff on it. That is uric acid, which builds up gradually in their vent and gets pushed out when they finally poop."

To avoid the heat, the nocturnal sidewinder spends much of its life underground. Holycross

explains that the upturned, horn-like scales over their eyes "may serve to keep sand out of the eyes when they burrow into the sand, or may help camouflage them."

Although the desert may not get rain for two years, sidewinders can survive getting all the liquid they need from a diet of small desert animals.



Peg Lopata is associate editor of FACES.

• ...Ssssooo, how do you get from A to B?

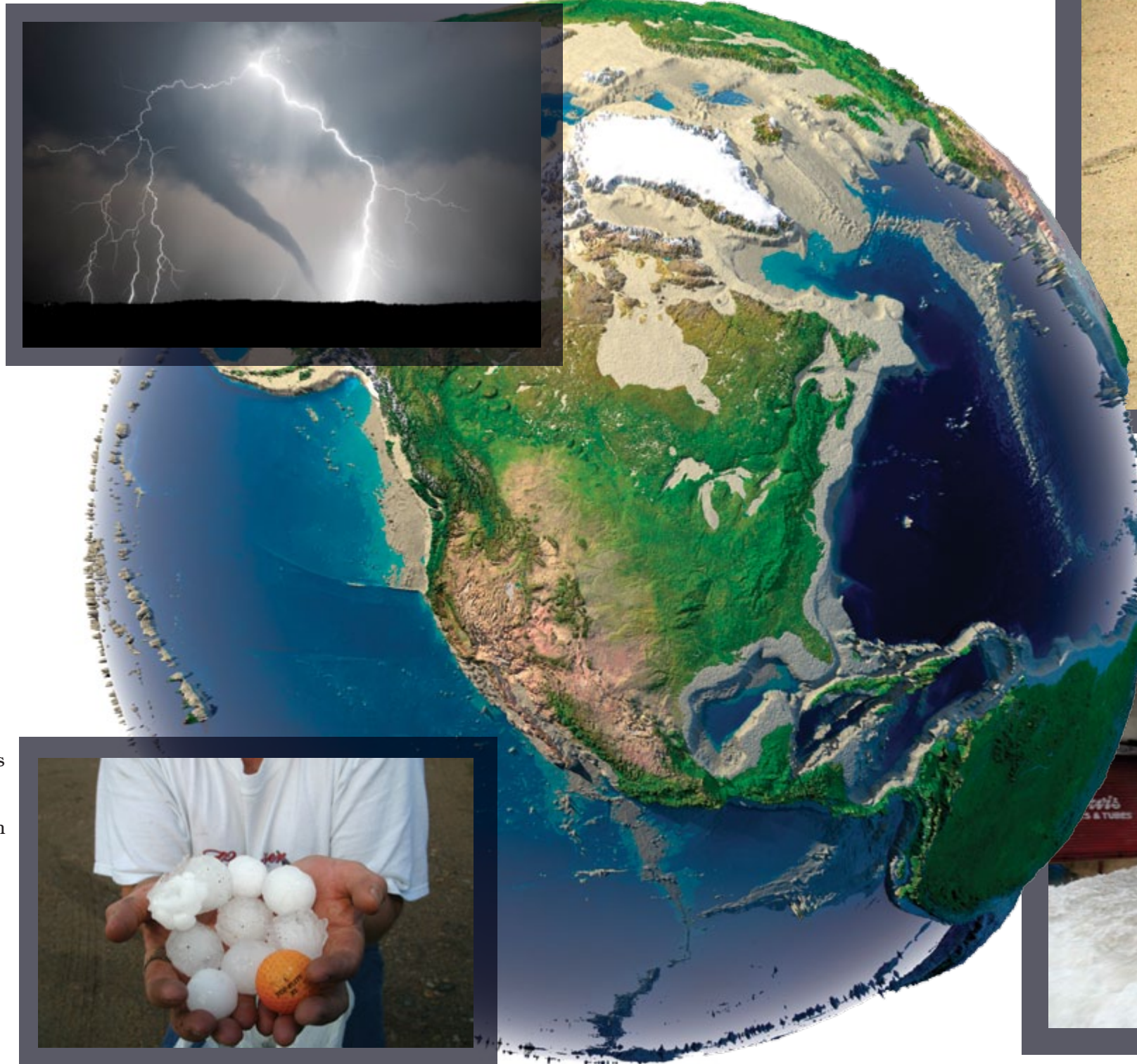


A Planet of

PEOPLE LIVE AND EXPLORE ACROSS THE ENTIRE PLANET. As they travel over mountains, across oceans, through deserts and over icy glaciers, they experience and record the most extreme weather that our planet can create. People have measured blistering temperatures of more than 120 degrees Fahrenheit and bone-chilling temperatures of -80 degrees F. They've recorded blasting winds of more than 120 miles per hour and torrential rains measured in feet per day. They have even experienced horrific tropical storms and tornadoes. One of the most critical duties of today's meteorologists and climatologists is to record those extremes and determine if such weather is becoming more frequent.

Some of the hottest temperatures happen in the world's deserts. Deserts tend to have many sunny days in a row allowing intense heat to build up over time. The two hottest temperatures ever measured occurred on different sides of the world. The current hottest temperature in the world was in the northern Sahara Desert in the country of Libya. There, in 1922, meteorologists recorded a blistering temperature just over 136 degrees F! A few years earlier, in Death Valley, California, the second-highest temperature of 134 degrees F was recorded during a severe 1913 dust storm.

On the other hand, the coldest temperatures have been measured in the bitterly cold regions near the North and South Poles. These areas also tend to be deserts — very little precipitation falls, but what precipitation does fall, stays as snow. Consequently, polar regions such as northern Siberia and Antarctica have many clear sky days but, because the sun is so low on the horizon or even below it, the clear skies allow for the heat of the earth to escape upwards, leaving cold surfaces. The absolute coldest recorded surface temperature occurred in a remote Antarctica field station back in 1983 when the temperature plummeted to a bone-chilling cold of -128.5 degrees F.



• Hail, tornadoes, drought, and heavy rains — they are all part of the wild weather we experience on Earth.





- *Weather impacts our daily lives in many ways.*



The south polar continent of Antarctica is also home to some of the fastest winds measured on the planet, but the two world record wind gusts have been measured at places near Australia and in the United States. For a long time, the fastest winds ever recorded on the surface of Earth were the tremendous winds of 231 miles per hour measured at the Mount Washington Observatory in New Hampshire, back in 1932. However, recently, world meteorologists determined that the surface winds of a 1996 Australian tropical cyclone — what is commonly called a hurricane when it occurs in the northern Atlantic Ocean — had measured winds of 253 miles per hour.

Tropical cyclones also help to create some of the wettest places in the world. A small, mountainous island in the Indian Ocean, called La Reunion, has recorded some of the heaviest rains ever measured as a result of tropical cyclones. The record for 24-hour rainfall occurred on that island back in 1966 when an astonishing 71.8 inches of rain fell — that's nearly six feet of water falling in a single day!

There are also places that almost never receive any precipitation. These desert areas can be found in places such as northern Africa or even in the cold polar regions of Antarctica. But one of the absolute driest places is found in the arid Atacama Desert of Peru and Chile in South America — as you'll see in this very issue. Rainless periods can actually last decades.

Storms also produce some of the extremes found around our planet. Strong tropical cyclones and typhoons in the western Pacific Ocean are considered to be the most deadly storms on Earth. For example, in 1970, a horrible tropical cyclone struck the tiny, low-lying country of Bangladesh, and the resulting flood and disease killed an estimated quarter of a million people.

A much smaller, but also deadly storm feature — the tornado — is primarily just a North American event. Surprisingly to many people, 80 to 90 percent of all the world's tornadoes happen in North America with only a few occurring elsewhere in places such as Great Britain, Western Europe, China, and Australia. While most severe storms normally drop at most only one or two tornadoes at a time, occasionally a powerful, severe storm can produce a multitude of these swirling vortices. One of the greatest outbreaks of tornadoes occurred recently in the spring of 2011 in the southeastern United States when more than 250 tornadoes formed within a single 24-hour day.

As meteorologists and climatologists continue to study and measure the fascinating weather across our planet, we are slowly beginning to understand how our weather works. While the subjects of meteorology and climatology are relatively new sciences, we have already begun to improve our short-term weather forecasts and are now beginning to even figure out how our planet's weather and climate will be changing into the far future. Such important scientific work will eventually help us all appreciate — and survive — the wide variety of weather on our planet of extremes.



Randy Cervený is a professor of geographical sciences at Arizona State University.



THEY’VE BEEN CALLED ENVIROGEEES, ENVIRONMENTAL MIGRANTS, AND CLIMATE REFUGEES. They sound like fancy terms, but for the people they describe, it comes down to one thing: These people are forced to leave their homes and look for new ones, all because of the changes in weather.

“Refugee” usually describes someone who is forced to flee from his or her own country and seek safety somewhere else because of political issues such as war or genocide, religion, or race. But a climate refugee is someone who is forced to leave home because of sudden or long-term changes to their environment created by climate change. These changes include droughts, flooding from excessive rain, rising sea levels, desertification, and changes in the normal weather patterns, such as more frequent extreme weather events like hurricanes and monsoons. These changes can drastically affect a family’s ability to grow food, access clean water, and make a sustainable living, forcing them to flee to areas where they might have a better chance of survival.

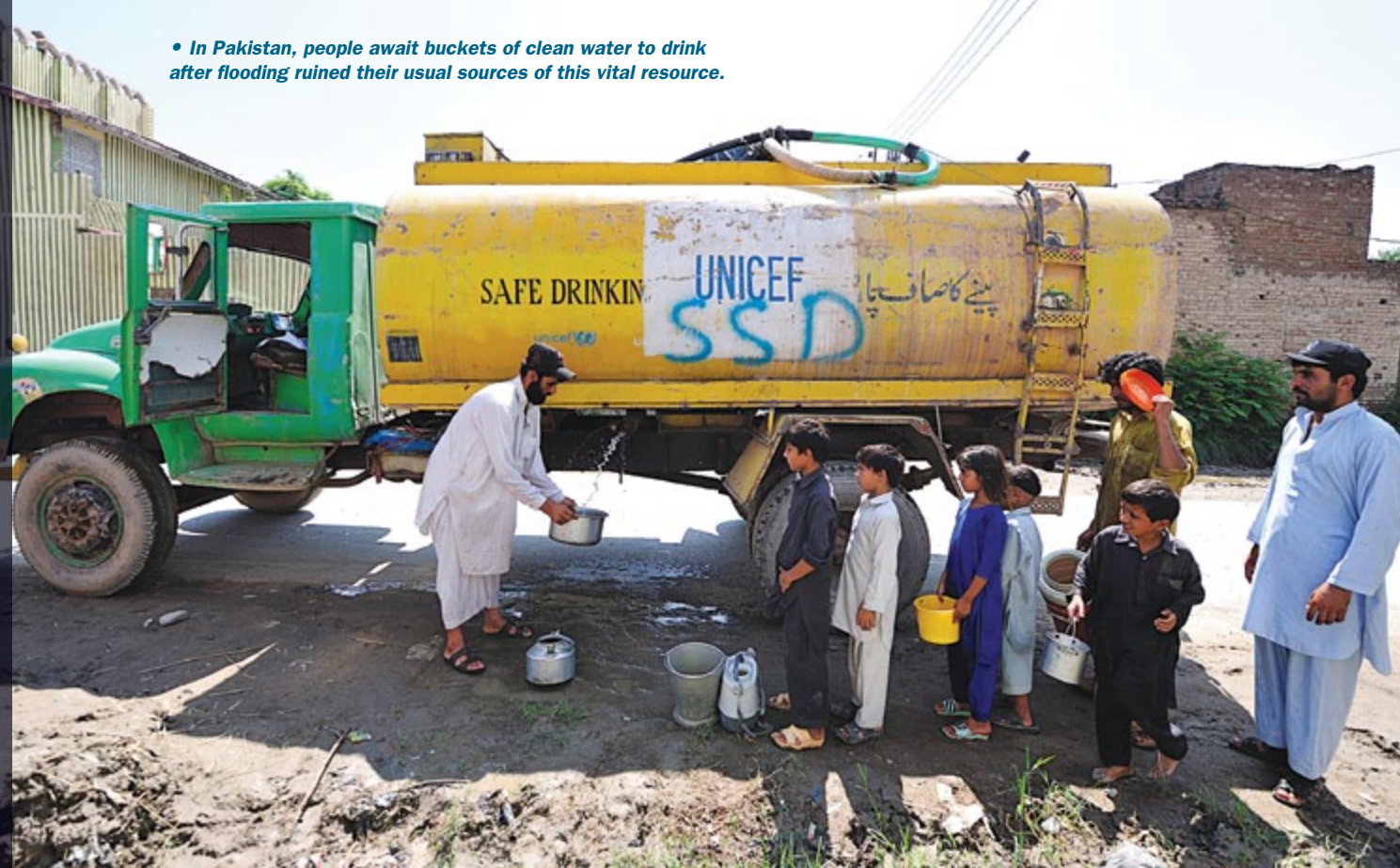
Many climate scientists are predicting a rise in global temperatures and higher sea levels that will continue over the next 100 years. If that is true, the problem of climate refugees will only become bigger. According to the International Red Cross and Red Crescent health organizations, more people are now forced to leave their homes because of environmental disasters than because of war. And more than half of the world’s refugees could actually be classified as environmental refugees. By 2050, there could be as

FLEEING FROM THE WEATHER

HAITIAN HEROICS
Rescuers help the victims of Hurricane Ike, which struck Haiti in September 2008.

by Marcia Amidon Lusted

• In Pakistan, people await buckets of clean water to drink after flooding ruined their usual sources of this vital resource.



many as 150 million environmental refugees.

Many places in the world have already seen changes that are forcing people to leave their countries and become refugees. Many people who live on islands in the Pacific have seen their crops and gardens washed away or the soil contaminated by the salt of rising seawater levels. In addition, they are no longer catching as many fish as they used to because rising ocean temperatures are bleaching coral reefs and depleting the fish population. These islands also experience water shortages during droughts or sudden torrents of rain during tropical storms due to changing rainfall patterns.

In other parts of the world there is not enough water due to changing weather patterns. Because of the years of drought affecting millions of people in Africa, the group Save the Children estimates that every day, 800 children cross the border into Kenya from Somalia. Children and adults in Somalia are suffering from malnutrition because crops have failed and livestock are dying. The United Nations has even called the current Somali drought the worst humanitarian disaster in the world. And yet Kenya cannot handle the number of climate refugees streaming in from Somalia. Refugee camps are overflowing and

there is a desperate need for food and other supplies.

EVEN IN THE UNITED STATES, the devastation caused by Hurricane Katrina in New Orleans in 2005 resulted in many people losing their homes, their businesses, and their jobs. As a result, many people were evacuated to other parts of the country, and many of them settled in those places permanently. With no jobs or homes available to them in their own city, they became climate refugees within their own country because of the storm.

Climate refugees are not only leaving a desperate situation, but they also are creating problems in the places where they go. Other countries often can't handle the numbers of refugees who arrive there. For example, 1,500 Somali refugees a day arrive in Kenya, overwhelming the camps. Other countries, such as Australia and New Zealand, have had to put a limit on the number of climate refugees from the Pacific Islands that they can accept. As more and more parts of the world begin to suffer from environmental catastrophes, a bigger gulf between the parts of the world that are unaffected and the areas where people can no longer survive grows. And refugees will still arrive illegally in many places, hiding in trucks,

trains, boats, and aircraft, trying to find a place where they can get food and water.

WHAT CAN WE DO ABOUT CLIMATE REFUGEES? For those who have been forced to flee because of climate change, it might be impossible for them to ever go home. There is widespread agreement that the lag time for response to any reduction in the emissions from burning gas and oil is 100 years or more, so current refugees won't be going home, but perhaps their future generations may. However, science is working on methods that may allow crops to grow despite our changing

environment. Countries that are less affected by climate and weather disasters could provide more aid (both money and supplies) to countries where there are people suffering from environmental catastrophes. Unfortunately, it's a problem that's only going to grow in the years to come, and now is the best time for people — and especially young people — to start thinking about the world as a global community, where everyone depends on and helps everyone else. If we think of ourselves as a world without borders, then climate refugees will no longer be refugees. They'll just be neighbors in need.



• From the American Southwest to Somalia (below), droughts are devastating.



The Land That Wind Built

by Marcia Amidon Lusted



• Old or new, windmills have been part of the landscape of the Netherlands for many years.

SOME COUNTRIES HAVE WATERPOWER.

Others have vast reserves of coal or oil to use for energy. But what do you use for energy if you live in a low, flat land with constant wind? Why, wind power, of course!

The Netherlands, a small country with 12 provinces, borders the North Sea and is north of Belgium and west of Germany. Twenty-five percent of its land is below sea level. Another 50 percent is only a little more than three feet above sea level. As a low, flat country located on the ocean, the Netherlands' prevailing winds make it ideal for the use of wind power. Windmills have operated in the Netherlands since the 1400s, and at one time there were 10,000 of them. There were also some water mills, but because so much of the Netherlands is flat, water didn't flow fast enough to power them successfully, and they were only used in a few areas.

The Netherlands originally had two types

of windmills. One type, industrial windmills, used wind to power things such as saws and grindstones. Windmill power allowed the Netherlands to process and export cocoa, tobacco, and grain, and were also used to process spices, chalk, lime, and dyes. But the second type, drainage mills, were especially important. Because of its low, flat landscape, the people of the Netherlands constantly battled the sea and built levees and dikes to keep water from flooding the land. Drainage mills used the constant wind to turn huge sails, and the power they produced pumped water out of low-lying areas. Windmills could also be used to pump out water in order to create more useable reclaimed land. In such a small country, making dry land from former ocean regions was extremely important for expanding farming and providing more room for homes and businesses.

Windmills could also be used to send

messages. By changing the position of the windmill's sails and tilting them one way or another, the miller could send signals, such as "celebration," "mourning," "brief resting," or "longer time resting." That way people in the area would know what was happening there, and if it was a good time to visit the mill. During World War II, windmill sails were also used to warn people who were in hiding, or to send coded messages.

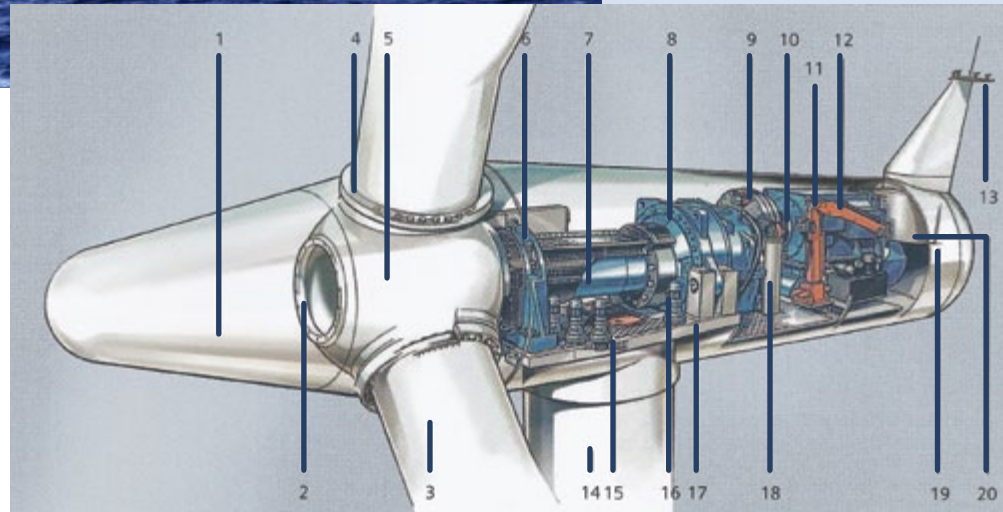
Although fewer than a thousand classic windmills remain in the Netherlands, and many of these are nonfunctioning tourist attractions, wind power is still an important aspect of life. But today's wind power comes from modern wind turbines and wind farms. Modern windmills are tall and thin, with a central pole made from steel or aluminum. They usually have three blades made of fiberglass, although some wind turbines can produce energy with just two spinning



• *Small country? No problem! Building windmills in the coastal waters off the Netherlands has allowed this country to be the world's leader in producing wind power for its citizens.*

A WIND TURBINE UP-CLOSE

- | | |
|--------------------|----------------------------|
| 1. Spinner | 11. Generator |
| 2. Spinner bracket | 12. Service crane |
| 3. Blade | 13. Meteorological sensors |
| 4. Pitch bearing | 14. Tower |
| 5. Rotor hub | 15. Yaw ring |
| 6. Main bearing | 16. Yaw gear |
| 7. Main shaft | 17. Nacelle bedplate |
| 8. Gearbox | 18. Oil filter |
| 9. Brake disc | 19. Canopy |
| 10. Coupling | 20. Generator fan |



blades. They can be as tall as 300 feet, although smaller wind turbines are made for residential use. Wind farms with as many as 20 modern wind turbines are located around the country, for a total of almost 2,000 windmills. However, because the Netherlands is a small country with limited dry land, offshore wind farms set in the ocean waters have also been constructed. The turbines are constructed right in the water. They are less noisy and not as intrusive as wind turbines on land, and because water is smoother (allowing the wind to flow more easily over it) than land, the average wind speed is usually faster over open water and produces more energy. The government has identified more than 60 possible sites for future offshore wind farms.

Wind power has become even more important now that Europe and the rest of the world are attempting to limit the emissions from burning gas and oil, and with those fossil fuels becoming more expensive, more and more countries are focusing on renewable energy resources. Wind is one of the cheapest forms of renewable energy, and the Netherlands is already accustomed to using windmills, even if modern wind turbines don't have the whoosh of turning fabric sails and the creak of wooden gears. New windmills don't have the charm of the old-fashioned ones we associate

with the Netherlands, but in the end, they produce power the same way that they have for hundreds of years...by harnessing the awesome power of the wind!

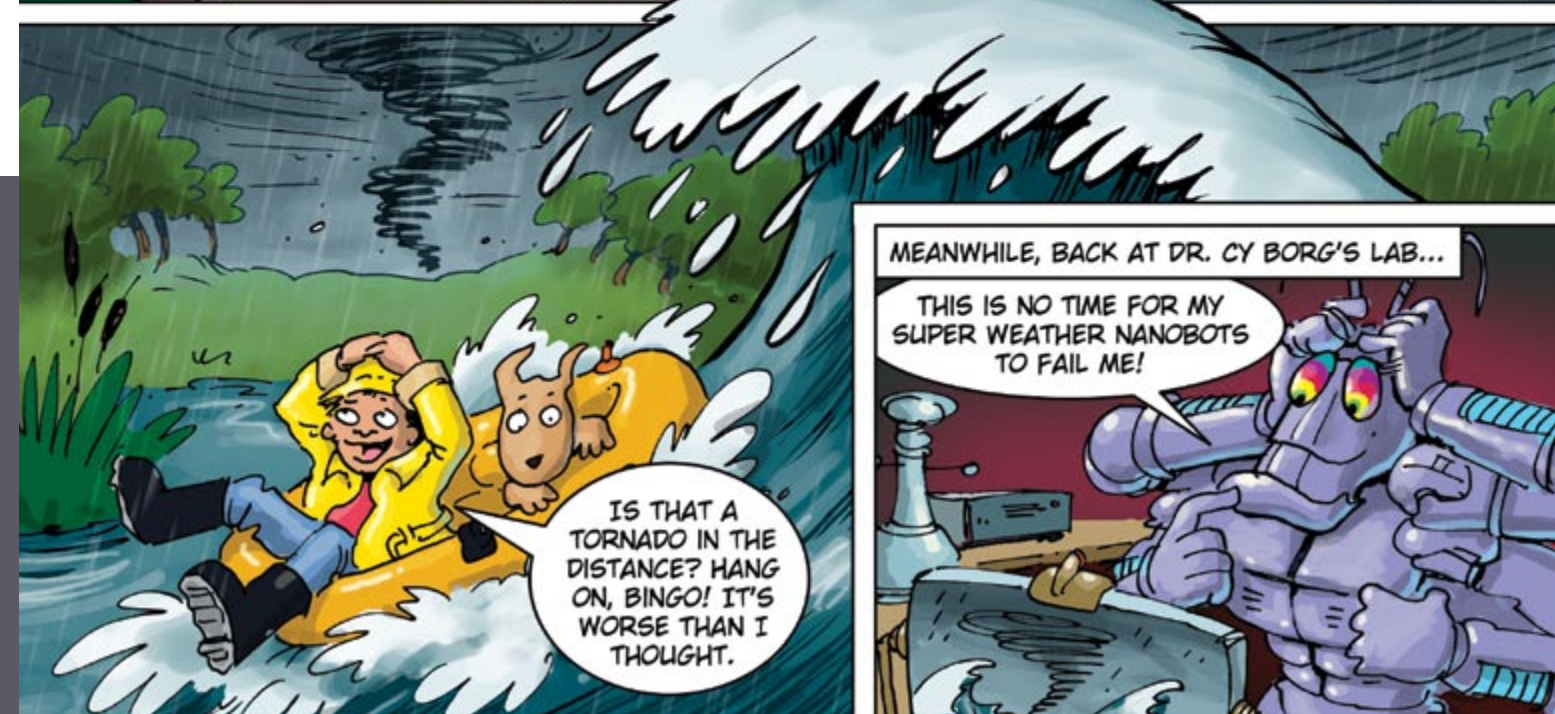


WIND POWER AROUND THE WORLD

The use of wind power is growing every year, all over the world. The United States, China, and Germany generate more wind power than any other countries. Spain and India are also leading users of wind power, followed by France, the United Kingdom, Portugal, and Denmark. The worldwide capacity of wind power at the end of 2010 was 200 gigawatts...that's enough to power about 60 million California homes or about 300 million Chinese homes. As more and more countries enact legislation to limit the emissions from burning gas and oil and expand sources of renewable energy, windmills will continue to be built in record numbers.



illustrated by Chuck Whelon



MEANWHILE, BACK AT DR. CY BORG'S LAB...

THIS IS NO TIME FOR MY SUPER WEATHER NANOBOTS TO FAIL ME!

THERE ARE 6 PERFECT PARTY CARTOONS. TO SEE THEM ALL, VISIT WWW.COBBLESTONEPUB.COM/KIDS_STORM.HTML

Is it really possible for a place to receive no rain? Yes! Inland from the coastal mountains of Chile lies the Atacama Desert — the driest in the world. In some places there, it has never been known to rain! In others, it rains perhaps four times in a hundred years. Despite the dryness, however, the Atacama’s average temperatures are almost cool compared with those of other deserts, thanks to the chilly Humboldt Current off the coast.

Starting near the Peruvian border, the Atacama Desert extends south for more than 600 miles to the Aconcagua River, just above the center of Chile. The land is composed mostly of salars (salt pans), located at the foot of the coastal mountains in the west, and soil beds called alluvial fans, found near the Andean foothills in the east. Because it seldom rains, farming is possible in only a few small fertile places. For people living in most other parts of the Atacama, water has to be trucked or piped in from faraway rivers and springs.

You can see some strange sights in this desert. For example, during the night, the *camanchaca*, a thick fog, forms — but no rain falls, and the mist burns off fast in the heat of the morning sun. In recent years, however, scientists have created “cloud trappers,” large square nets specially designed to capture some of that precious moisture. The water drips from the nets into tubing and flows into a holding tank.

There is one notable exception to the overall dryness here. Every few years — usually during a period of El Niño, when the central Pacific Ocean dramatically warms — heavy amounts of rain and snow fall on La Silla (SEE-ya, “chair” or “saddle”) Mountain. This is followed by a remarkable natural event called *desierto florido* (flowering desert), as rainwater soaks the seeds lying dormant in the ground. They grow into plants and blossom abundantly from September to the end of November (spring in South America). This spectacular scenery can be viewed from the European Southern Observatory on top of La Silla.

Mummies, rock paintings (called petroglyphs), pottery, and textile fragments show that people have lived in the Atacama Desert for more than 10,000 years. One of the most interesting pre-Hispanic sites is San Pedro de Atacama, a village that was formerly the center of civilization in this area. In the museum there, thousands of objects reveal some of the secrets of those long-ago days. For example, mummies’ skulls show that



•Parched! Don't travel here without lots of water or all that might be left of you. . .



• . . .is your hand in this desert land.

The Driest Place on Earth:

these ancient people practiced *trepanning*, an operation to remove a portion of the bone, probably to relieve pain. The skulls show later bone regrowth, indicating that, amazingly, some individuals survived this delicate but primitive brain surgery.

The desert may look empty at first, but if you watch closely, you'll see that a surprising range of wildlife has found a habitat here. Llamas, vicuñas, alpacas, and guanacos, plus colorful flamingos, ducks, and numerous other birds, all make their home amid the wondrous landscapes of the Atacama Desert.



Gloria W. Lannom is a freelance writer from California and a frequent contributor to FACES.

The Atacama Desert

by Gloria W. Lannom

In Search of MIRACLES

by Todd Tuell

“MEGACITY” SOUNDS LIKE A MADE-UP WORD FROM SOME FUTURISTIC COMIC BOOK. Because of the rapid growth of so many cities around the world, “megacity” is in fact a new word created by urban researchers to categorize any city or metropolitan area with a population greater than 10 million people. In 1975 there were only three megacities in the world. Now, there are 26 of these enormous urban centers.

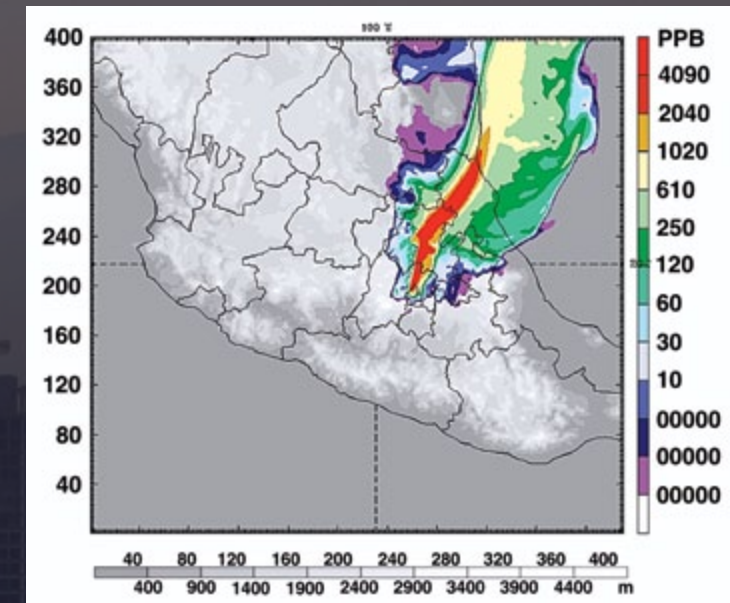
Ana Cristina Luna Noriega is a 15-year-old girl growing up in one of these megacities,

Mexico City. She is one of about 20 million people living in this metropolitan area. Just as its category as a megacity indicates, Mexico City is a sprawling, industrialized city facing the issues of congestion, noise, traffic, and water and air pollution. It has long had a reputation as one of the most polluted cities in the world.

Mexico City was not always like this. When Ana Cristina’s grandparents moved to Mexico City in 1964 from a village in the state of Oaxaca, the population of Mexico City was just 1.5 million. With suburbs and the villages

in the district, there were a total of about six million inhabitants. Like so many others, her grandparents came for work and educational opportunities that they couldn’t get in rural Mexico. The flood of people migrating to Mexico City caused its population to double in just one generation. By the early 1980s, the metropolitan area had grown to more than 14 million people.

More people meant more workers were available. Factories began to spring up everywhere. Steady income gave more people the ability to buy cars. In just a few short years,



• In this image, the colored area shows a plume of pollutants drifting from Mexico City toward the coastal Mexico—Texas border. Some of the pollutants are from factories, some are from burning biomass, or plants.



• Ana Cristina Luna Noriega is one of the 20 million who live in Mexico City.

• The haze over Mexico City is a sign of polluted air.



• In 2008, for the first time more people lived in cities than in rural areas.

the city became covered in a blanket of smog — a noxious mixture of smoke and pollution — as bad as any ever seen around the world. Mexico City had never seen such a development. There was nothing in place to deal with air quality, road construction, or the demand for fresh water and expanded sanitation systems.

It wasn't just the people of Mexico City who were suffering. What researchers began to see was that pollution becomes airborne and is carried in large plumes downwind. Heavy concentrations such as those produced in Mexico City could affect visibility, human health, and even the ecosystems of communities hundreds of miles away. As Mexico City grew to a size larger than any the world had ever seen, small villages to the northeast saw changes in weather patterns. The livelihood of these farming communities was drastically affected by changes to the growing seasons and by the pollutants falling as acid rain — the toxic mixture of pollution and rain — destroying their crops.

Through the 1980s and 1990s, cooperative efforts were begun between U.S. and Mexican scientists to monitor and study pollution generated by this megacity. The studies confirmed what everyone could see in the brown smog clouds above their heads. Without serious change, people's health and well-being would continue to worsen. It would take a miracle to reverse the damage. But scientists, citizens, and the government were committed to doing what it would take to clean up the pollution.

In March 2006, the recent field study called MILAGRO was begun with teams of researchers from all over the world. MILAGRO stands for Megacity Initiative: Local and Global Research Observations. *Milagro* is also the Spanish word for "miracle." The initial data from the study has been startling in many respects, according to researcher Dr. David Parrish, Program Lead for Tropospheric Chemistry at NOAA (National Oceanic and Atmospheric Administration) and a participant in the MILAGRO field campaign. "The thing that's so surprising is how rapidly the air pollution has been cleaned up in Mexico City," says Parrish. "The rate that ozone pollution has been improving in Mexico City is faster than we were able to improve the ozone levels in areas of the United States."

How were they able to make such a change? Parrish attributes this dramatic improvement to a wide range of programs. Stricter vehicle emission controls were put in place, as well as higher standards for new cars. Sulfur content in

diesel fuels sold in Mexico was reduced. Mexico City also encouraged people to use public transportation by improving its existing system.

Parrish points to a positive growth of megacities, though. How could that be possible? According to the professor, research shows that resource consumption and pollution is lower per person for 10 million people in a single city than in 10 cities of one million people each. Additionally, cleanup efforts and environmental initiatives like those implemented in Mexico City are more easily and better coordinated in one jurisdiction than across many.

Mexico City is still growing and is still battling the effects of its enormous urban congestion, but the attention now is turning to other parts of the world. Fifteen of the 26 recognized megacities are in Asia. During the industrialization of Europe and North America, millions of people migrated to the cities. Across Asia, however, **hundreds of millions** of people are now urbanizing. From Karachi to Dhaka to Manila and Jakarta, the demand for resources to sustain these cities is tremendous. There is a lack of fresh drinking water, fresh air, and adequate sanitation systems beyond even the levels experienced in Mexico City a generation ago. Unlike Mexico City, however, in many of these megacities there is very low civic demand regarding environmental issues and the improvement of the quality of life.

By 2015, there could be as many as 60 cities categorized as megacities. The growth is so astronomical that another new word has been needed to describe an associated trend. A string of megacities and other large cities urbanizing an entire region like the eastern seaboard of the United States from Boston to Washington, DC is called a **megalopolis**. Luisa Molina of the Molina Center for Energy and the Environment (MCE2) estimates that the Beijing to Tianjin megalopolis includes more than 180 million people concentrated in one geographic region and another 120 million inhabit the Pearl River Delta (Hong Kong to Guangzhou).

It will take a miracle to surmount the obstacles in these new megacities springing up across Asia. But as Mexico City and the MILAGRO studies demonstrate, when people care, miracles can happen.



Todd Tuell is co-regional advisor for the Rocky Mountain Chapter of the Society of Children's Book Writers and Illustrators.



• With great prosperity comes more cars — and more congested highways.

• Hong Kong is one of the most crowded places on Earth, with a population density of more than 16,000 people per square mile.

PACKED PLACES!
If you like crowds, you'll find more and more cities all over the world just right for you!



FAST FACTS

• The global population increases by

3 people each second. • People today live approximately 16 years longer than they did 50 years ago.

CAN WE CONTROL THE WEATHER?

by Peg Lopata

TAKE A LOOK UP THE NEXT TIME YOU'RE OUTSIDE. If you happen to see tall, white, fluffy clouds, you're looking at what meteorologists call "rainmakers." That's because this type of cloud can be tweaked to make more rain where and when it's needed. The clouds can also be tweaked to reduce the size and amount of damaging hail they might produce. More rain when you want it and less hail both reduce crop damage and make life better.

In order to make a raindrop, water needs to condense around a solid speck like dust, pollen, or even volcanic ash. Those hard but very tiny "seeds" of a raindrop can occur naturally, but we can also add them into the sky ourselves. Cloud-tweaking techniques are called cloud seeding, and there are two methods. The first uses a plane equipped with flares that shoots artificial seeds of a raindrop, in most cases something called silver iodide, into a cloud that's likely to produce rain anyway. The second method shoots the silver iodide "seeds" into the cloud from a high point on the ground where the wind carries it into the cloud. Either way, the silver iodide helps the cloud make more rain by providing more "seeds" to the raindrop formation. If the cloud is likely to produce hail instead of rain, the silver iodide reduces the size or amount of hailstones.

Silver iodide is considered relatively non-toxic. As long as reasonable care is exercised, cloud seeding with silver iodide appears to be safe for the environment.

Today, rainmaking and hail reduction is not without controversy. "It's been very difficult to show statistically that cloud seeding is actually making it rain more," says Dr. Hugh Willoughby, research professor of meteorology at Florida International University. Willoughby wonders if the promise of the technology is worth the money that must be spent to find out if it can really deliver.



• *In Thailand, officials prepare to seed clouds in an effort to bring on some rain to clear away thick smoke from forest fires and stubble burning.*

Though drought-busting is not yet possible, the science of rainmaking overall has made great strides since the 1980s. Meteorologists now know much more about cloud origin, development, and decay. Forecasting, due to better modeling and improved radar technology has also advanced so there are fewer "misses" in cloud seeding. A "miss" means seeding the wrong kind of cloud or not finding enough clouds to seed.

Today, some 26 countries have cloud-seeding projects under way. In places such as Alberta, Canada, cloud seeding is used to reduce hail, which causes millions of dollars in property damage there. In the United States, about nine states seed clouds. In Texas alone, cloud-seeding projects cover land in about 20 percent of the state.

Cloud seeding is seen as part of a water management strategy to ensure that crops will grow, reservoirs won't dry up, and power plants that run on waterpower will keep running. In Idaho, for example, the Idaho Power Company has been seeding clouds for many years. They seed the clouds of incoming snowstorms to make them produce more snow. The result is more snow pack. When the snow pack melts in the spring, more water fills the rivers that power hydroelectric generating plants. For western states, more water means reservoirs will be replenished and hydropower plants can count on producing enough electricity.

Can cloud seeding end droughts and meet all the water needs for the future in the long term? When Willoughby entered the field he thought so. "It would be absolutely wonderful to go to India when the monsoon fails . . . you go with a fleet of planes and you make it rain and the farmers get through the summer without a famine. This is a fantasy that I had when I started in this field," Willoughby says, admitting that it still remains a fantasy.

That's because during drought conditions there are usually not enough clouds around with enough water in them to seed. However, seeding clouds in drought-prone areas before droughts begin might be the answer. Taking advantage of the clouds that would probably produce rain on their own might prevent water levels from dropping to drastically low levels that cause crop failure. Wells and reservoirs might maintain enough water for people's needs.

Cloud seeding definitely holds great promise. Though not yet conclusively proven, some meteorologists are convinced that it has increased rainfall. Others have found it easier to prove that cloud seeding has reduced hailstorms and crop damage. As meteorologists' knowledge of clouds increases and forecasting tools are improved, perhaps this technology will one day move from fantasy to reality and truly become a lifesaver.



TIME FOR YOUR INJECTIONS, CLOUD!

These canisters mounted on the side of a plane contain chemicals that will be shot into rain clouds with the hope that the clouds will produce more rain.



WEAPON OF WAR NOW WEAPON OF WEATHER

An old anti-aircraft gun is used for cloud seeding in China.



• Tommy gets some news from an e-pal from Tampa, the "Lightning Capital of the USA."

e-Pals



Dear Tommy...

compiled by **Connie Colón**

FACES' New Jersey friend, Tommy, has corresponded with Robert from Tampa, Florida, for this issue. The boys talk about storms, sports, and vacations. Follow along to read parts of their actual letters.

REMEMBER ME?

Send



Dear Robert,

Did you know our moms have been friends since they were in seventh grade? My mom told me we all met years ago. I don't remember, do you? I can't wait for us all to get together in Orlando during our upcoming vacation.

I just graduated eighth grade and will be starting high school. My favorite sports are baseball and basketball. My travel team just won a summer tournament yesterday. I have Little League District All-Star games coming up. We were supposed to have practice today but it got cancelled because of thunderstorms.

So I heard Tampa is the "Lightning Capital of the USA." Do you have any good storm stories? It must cause a bunch of cancellations for stuff for you, too.

We were supposed to go to a pool party today for 4th of July but it got cancelled because of thunderstorms. We'll probably have to see fireworks tomorrow because of tonight's storm.

Write back soon,
Tommy

A SCARY STORM

Reply



Dear Tommy,

My mom told me the same thing about meeting when we were younger.

Sounds like you've been pretty busy with baseball. Sometimes it's too hot down here for sports so my brother and I do Tae Kwon Do. We are first-degree black belts and are thinking of competing next fall. I'm headed to high school, too. I'm thinking of signing up for crew. I'll be working out with the team over the next couple of weeks to see if I want to join.

Tampa is an awesome city and it is the "Lightning Capital of the USA." The storms can get pretty intense, especially during hurricane season, which is from June 1 to November 30. One day when I was home from school, there was a really bad tropical storm that came out of nowhere. I was in our media room when I heard noises like a train coming through the yard. It turned out it was a mini tornado! I looked out the window but couldn't see anything because the rain was so heavy. I waited out the storm in the bathroom where there were no windows. My mom called from her office to let me know when the bad weather passed. When I went outside I saw tree limbs from our grand oak had fallen on our fence. Limbs were all over our yard. An old oak tree was uprooted down the street and debris was everywhere.

We've had pretty bad storms and had to evacuate to get away from hurricanes in the past. It is really scary when you are leaving all your stuff behind and you don't know if you'll even have a house when you come back. We have always evacuated to Orlando because my mom says Disney hotels will withstand anything!

When you are here in July be prepared for afternoon showers. They occur almost every day. It's not unusual to see rain and sunshine at the same time.

Talk to you later!

Robert

WHOA!

Hi Robert,

I've been very busy with baseball. Some of the days are wicked hot here, too. My Little League District All-Star team just won the championship game! My coach is having everyone over for a pool party and then the league does a dinner in the fall for all the district winners.

The storm you described sounded like it was scary, especially being home alone! My mom said she had to evacuate during a hurricane when she lived in Tampa years ago. She said the same thing — it felt weird leaving all your stuff and not knowing what, if anything, would still be there later. She said the police came through in the middle of the night with bullhorns and shouted for everyone to evacuate.

Tommy

Send



• Tommy and Robert's moms have been friends since 7th grade.

TRACKING HURRICANES

Reply



Dear Tommy,

Congratulations on the championship win! I think I will sign up for crew this fall. It's a lot of work but I really like it. We start at 8:30 A.M. and go until 11:30 A.M. You can't do anything outdoors down here between noon and three because of the sun and heat. Then around 4:00 – 5:00 P.M. come the rainstorms.

I don't know if you do much hurricane tracking up there, but we have a couple storms in the gulf right now. We're already up to "D" for named storms. If you go to www.noaa.gov you can see what's brewing in the tropics. We keep a hurricane kit with emergency stuff just in case.

See you next week!

Robert



Connie Colón is a graduate of Syracuse University and a member of the Society of Children's Book Writers and Illustrators.

NEED FIREWOOD

The up side to downed trees? Firewood to keep you warm in winter.

**Always get permission from a parent or guardian before you write to a pen pal by regular mail or e-mail.*





• These caves in Tunisia are ideal for desert living as they stay cool during the heat and warm during the cold.

What is your home like? Is it one or two stories? Does it have lots of windows? Most importantly, does it keep you dry and warm?

From hot, dry deserts to windy, freezing steppes, the earth has extreme climates. People who live in these harsh climates must adapt to them. Some need shelters that keep them warm in cold temperatures. Others need homes that protect them from the heat. Many homes use the natural environment to help them feel comfortable.

UNDERGROUND CAVES

The village of Matmata, Tunisia, lies on the edge of the Sahara Desert. On a summer day, the sun bakes the land to 110 degrees Fahrenheit or more. But nighttime temperatures may be as low as 40 degrees F. Moisture in the air holds heat. Temperatures in Matmata drop because the dry desert air cannot hold heat.

The South China Sea borders Brunei on the north. Strong ocean winds fan Brunei's coast. These winds travel up the Brunei River. The cool air they deliver brings some relief from the tropical climate. The village of Kampong Ayer makes good use of these breezes. The homes in this "water village" stand on stilts several feet above the water. The sea breezes act as fans, circulating cool air through open windows and pushing out the hot air of the house.

Many families in Kampong Ayer also use ceiling fans to keep cool. The moving air causes sweat to evaporate more quickly, leaving the body cooler. Yet the river still plays a vital role in helping villagers adapt to the heat. People swim in the cool shade beneath the houses. Children in Kampong Ayer learn to swim before they learn to walk.

MOVABLE HOMES

More than 5,000 miles north of Brunei are the steppe lands of central Asia. The steppes are large, dry grasslands. These grasslands are home to nomads and their herds of sheep and



MOBILE HOME, MONGOLIAN STYLE
Come on in! A solar panel helps make life more comfortable for this little girl and her family in their portable home in Mongolia.

HOME SWEET WEATHERPROOF HOME

by Margaret Macalister Sleprow

• This home in Timor-Leste makes good use of the materials that are available to create a home.



To escape the burning sun and the nighttime chill, people in Matmata live in underground caves. Villagers dig large holes 20 feet into the ground. Ramps or staircases lead down to these holes. The holes serve as courtyards for attached underground rooms. Tunnels connect the rooms. People even carve their furniture from the rock walls.

The underground caves stay a constant temperature. The heat of the sun and the cold of the night can't penetrate the depth of these underground houses. They stay comfortably warm due to the constant internal heat of the earth keeping the temperature underground the same throughout the day and even from month to month.

A VILLAGE ON STILTS

In the Southeast Asian country of Brunei, people must adapt to a tropical climate. Located along the equator, Brunei is hot and humid. Temperatures range from 75 degrees F to 90 degrees F. It rains often, and the air is sticky.

goats. In the summer, nomads graze their herds in cool mountain pastures. In the winter, they move them to warmer valleys. Because they migrate often, nomads need homes that are easy to move. These homes must also protect them from winter temperatures of -50 degrees F.

Nomads in the steppes live in circular tents called *gers* (or *yurts*). Gers are wooden frames covered with felt made from the pelts of reindeer. Their shape helps to deflect the steppe's icy winds. The felt covering repels snow and rain. It also holds in the heat given off by stoves inside the ger. A hole in the roof allows light in and a chimney lets smoke escape.

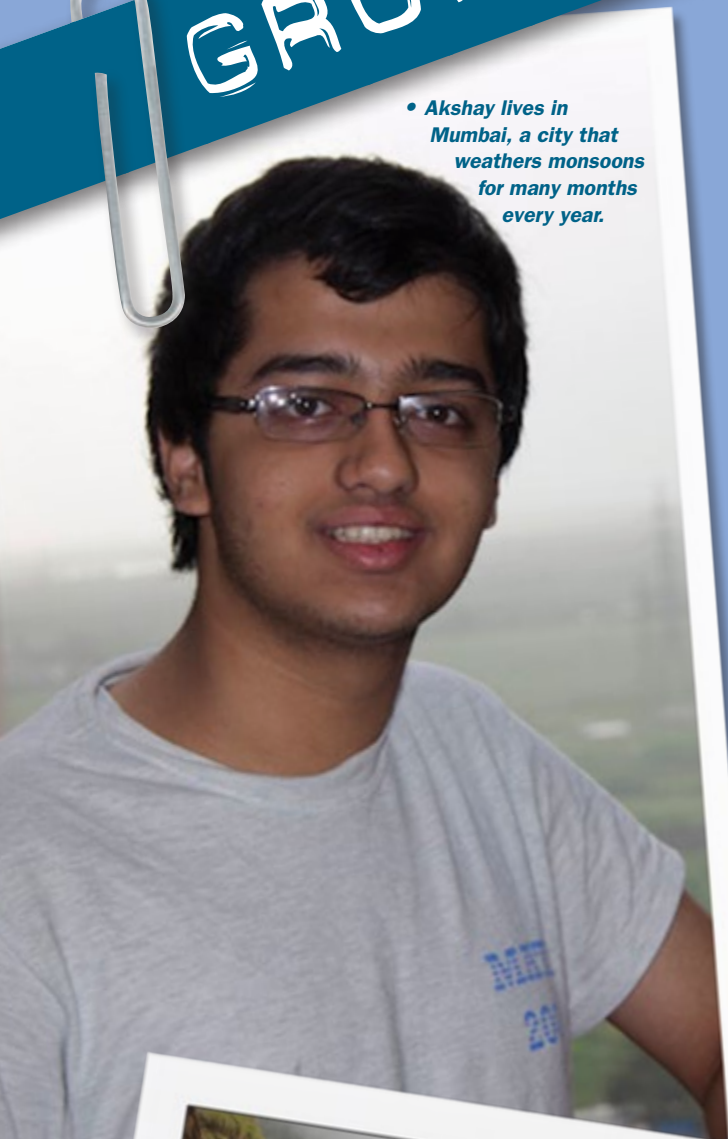
These amazing dwellings are examples of how people master the weather. Whether it's hot or cold outside, these homes are comfortable shelters from harsh climates. Which ones would you like to visit?



• In Borneo, boats are the way to get around for these people who live in a floating village in the sea.



• Akshay lives in Mumbai, a city that weathers monsoons for many months every year.



With the Monsoons!

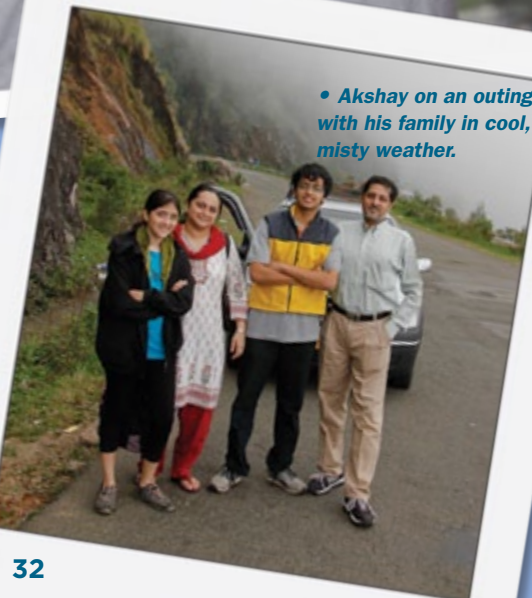
by Akshay Marathe

For as long as I can remember, my first school term always began with the onset of the monsoon in Mumbai, the city I live in. Schools in India begin by the second week of June, marking the end of the summer break that kids get in the months of April and May. At that time, brisk southwest winds, which are part of an annual shift in our winds, arrive immediately after a period of incredible heat and humidity and lead to heavy downpours of rain. Dripping in the rain instead of sweat is a welcome change for us Mumbaikars (as citizens of Mumbai city are known in the local language — Marathi)!

Personally, I love the rains. Rain occupies a special place in my heart for various reasons. One of them being that playing football in the rain is something I really enjoy and I play very often with my friends. Also, I remember playing in the ever-present, muddy, water puddles as a child, not caring, not even knowing or worrying about any kind of bacteria! The diffused sunlight owing to the dark cloud-cover, the fresh greenery of the deciduous trees, the chirping of rain birds and the constant croaking of frogs together make the monsoon climate heavenly!

For a quarter of a year, the rains have been accepted here as a part of life despite them being very problematic at times. They often disrupt traffic and the suburban train network. Once in a while, heavy rainfall results in power failures, disconnection of satellite television, bad Internet connection, etc. However, we do not have a choice but to live with these minor problems and have adapted to the monsoons. For example, we have to carry an umbrella when leaving the house. I have been caught by the rain too many times to forget carrying

Monsoon continued on page 34



• Akshay on an outing with his family in cool, misty weather.

• Julia lives in Tornado Alley, so she knows what to do to keep safe if a twister hits.



in Tornado Alley!

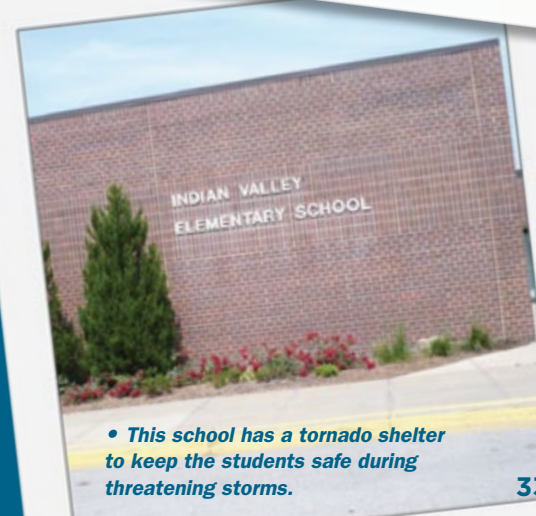
by Julia Slack

What's so different about living in Tornado Alley? To me there isn't much difference, but there are a few things. One: We have to do tornado drills in school. They are similar to fire drills except you don't go outside — you go to the school's storm shelter. Second: If there is an actual tornado most places have a tornado shelter you can use. Third (and most annoying): Tornado sirens are checked regularly to make sure that they are still in good shape. Lastly: Of course there is more chance of tornadoes if you live in Tornado Alley, but chances are still not high. I am eleven and have lived in Kansas my whole life and I've only experienced one tornado.

A REAL TORNADO

A few months ago there was a tornado that touched ground a mile away from my school. The school made an announcement that everyone needed to line up and go to the tornado shelter as quickly as possible. That part went smoothly, but actually sitting down there for an hour was not fun. Having to sit on your knees with your hands over your head for protection just made it worse. Most of the younger kids were really afraid, and many of the older kids were nervous, too. I was mostly scared that people I knew were going to get hurt. At the time, I didn't know that the tornado was so close to our school. After being down there for 30 minutes the air started getting really hot from all the people packed together. Eventually, we got to go back to class, but everyone was crazed for the rest of the day. While I was at school, my mom was grocery shopping. The employees from the grocery store started making everyone go to a safe place in the store. Luckily our house is very nearby so

Tornado continued on page 35



• This school has a tornado shelter to keep the students safe during threatening storms.

protection from June to September! This is because the tropical monsoons are famously erratic and unpredictable. One moment, there isn't a drop of rain, and the next, there might just be a heavy downpour!

In my 16 years dealing with the monsoons here, I recollect one event in which the rains scared the life out of me! Calamities like the floods of 2005 were one of the worst disasters Mumbai has faced in recent years. Even my grandfather, who grew up in Mumbai, has never been witness to something so destructive. I was just ten at the time and I didn't quite know what a flood was like. In fact, I thought the idea of streets filling with water was pretty amusing!

Mumbai receives an annual rainfall of about 250 centimeters (about eight feet). On that day though, a cloud burst during our monsoon resulted in 94.4 centimeters (about three feet) of rainfall in just 24 hours! One can imagine just how much rain that must have been! And higher tides prevented the accumulated water from draining away, bringing the city to a grinding halt. A vibrant, fast-paced metro came to a complete standstill, probably for the first time ever.

My father, Sanjay, a photographer, clicked many pictures of the dark brown mass of water inching upwards. My mother, Shilpa, had an appointment in the western suburbs that day and was not at home. She had to wade through chest-high water for more than five hours and seek refuge in her colleague's house. I was really worried, but she managed to come back home safely the next day. All of us — my sister, my grandparents, my parents and I — have these disturbing memories etched in our minds and we might never forget this face of the monsoons.

Life in the monsoons can be fun, but when it's not your day, the rains can be lethal, too!



• Ah, sun! Akshay follows the leader on a swinging bridge.



• Akshay joins an anti-corruption rally in Mumbai.

AKSHAY AT A GLANCE

Age: 16

Hometown: Mumbai, India

Name of school: Smt. Sulochanadevi Singhania School, Thane

Grade: 11

Favorite Subject: English literature

Family: father: Sanjay, a photographer; mother: Shilpa, a Web site designer; sister: Maanasi, ninth grader; grandparents: Madhusudan and Sudha Marathe

Favorite Book: *Kane and Abel* by Jeffery Archer

Favorite Actor or Singer: Aamir Khan

Favorite Food: continental (Western European) and Indian

When I am an adult I want to... take up social work in a bigger way!

she went home to our basement shelter instead, but a lot of other adults and kids had to sit at school or other places for a couple of hours until the danger of tornadoes had passed.

WHEN DO TORNADOES HAPPEN AND WHAT TO DO

Tornadoes normally (but not always) happen in the months between March and July in Kansas. Tornadoes still don't happen often during those months, but if you do happen to get caught with one moving toward you while you're driving, you want to get out and go to a low flat spot. If there happens to be a sturdy shelter nearby, go to that instead. If you are at home, go down to the basement. If you don't have a basement, go to the bathroom or a closet. You also want to keep updated on what is going on the whole time via radio, computer, or TV.

WHAT DOES A TORNADO LOOK LIKE?

Well, when a tornado is forming the sky gets all dark, with the menacing clouds of a severe thunderstorm. Then a whirling cloud starts to reach or form down to the ground. It kind of looks like a spinning funnel coming from the clouds (in proper words, a funnel cloud). Then if the cloud reaches all the way down to the ground it is called a tornado.

CAN YOU TELL IF A TORNADO IS COMING?

Yes and no. You cannot tell a tornado is coming a long time in advance like a hurricane, but there are sirens that sound if a tornado is about to or is just reaching ground. With the neat equipment that weather experts use such as radar, you should have some warning that one is coming. The television and radio stations tell you if there is a tornado watch or warning. A tornado watch is when the conditions are right for a tornado to form and usually happens earlier in the afternoon. A tornado warning is when a tornado has formed and is just about to or actually is touching the ground — that's when you have to take care! But like all weather, it is always changing.

Most of the time it is no big deal living in Tornado Alley. However, during tornado season you just need to be prepared, stay informed, and know your options.



JULIA AT A GLANCE

Age: 12

Hometown: Overland Park, Kansas

Name of school: Oxford Middle School

Grade: 6

Favorite subject: math, English, science

Family: Mom, Dad, and twin brother

Favorite book: *Percy Jackson and the Olympians* series

Favorite food: seafood

When I grow up, I want to be ... a chemist



BATTLE THE STORM

by Marcia Amidon Lusted

BEING PREPARED FOR A WEATHER DISASTER SUCH AS A HURRICANE IS NO GAME. BUT WHAT IF A GAME COULD HELP YOU TO BE BETTER PREPARED FOR A HURRICANE? THAT'S THE IDEA BEHIND A NEW GAME CALLED BATTLESTORM.



• Team Hurricane



• The Castaways, 2011 Champions



Think of a game that combines elements of games such as freeze tag, handball, and capture the flag with tips for hurricane preparedness. Toss in a little community spirit, with people coming together to solve a problem. Sound boring? Not at all! Battlestorm is played by two teams: the offensive team is called “the Town” and the defense team is called “the Storm.” The Town team tries to transport balls (“resources”) from one side of the court to the other, and the Storm team tries to stop them. In addition, the Town can earn extra powers. When people upload photographs of their hurricane preparation kits to the game Web site, the Town team earns tokens that give them advantages such as extra balls, more game time, or a bigger game court. But watch out for the Storm: they can freeze Town players, and even cause a “storm surge” that takes points away from the Town team.

And what better time to play Battlestorm than at the beginning of the hurricane season? In May 2011, the first Battlestorm event was held in Biloxi, Mississippi. Five teams from the Boys and Girls Clubs in the Biloxi area competed against the Storm (Hurricane) Team, whose members are from the local Construction Battalion of the U.S. Navy. Maurice, age 13, who participated in the game on the Castaways team, says, “Playing it was the best. I liked how it wasn’t difficult to learn, but it was complex to play.” The Castaways defeated the Storm team. They had help from their community, which posted photos of their hurricane preparedness kits online to earn the team extra powers. The Castaways team statement was, “After the storm [Hurricane Katrina in 2005], many residents of East Biloxi felt like ‘castaways,’ ... However, we persevered and are on our way back — stronger than we were before!” And they proved it by winning the first Battlestorm tournament.

Maurice pointed out that playing Battlestorm is not only fun, but a learning experience, too. “There are two sides — a playing side and a learning side,” he says. So, even if you already feel that you know about being prepared, that’s not the only reason to

play because the game is fun too. But if you need to learn more about being prepared, there’s that side, too. The two sides of the game work together because the main point is to stop the storm from scoring and so you have to tag them and stop them from scoring. This is an important lesson from the game that makes sense in real life too — in the game, if you’re on the town side and you have a shelter, then you’re safe. This is the same in real life too — if there’s a storm, you need to have shelter to be safe.”

Maurice has had firsthand experience with real hurricanes, especially Hurricane Katrina in 2005. “For Katrina, I don’t remember being scared — I remember being amazed at the power of the storm. I remember seeing a car across the street — a truck with a flat bed — the wind just picked the top of the truck, like the hood, and it flew away in the air and we never saw it again. I’ve seen how one hurricane tore up the whole coast and I think that if everyone had the information they needed, that could have been prevented. I think Battlestorm could help other kids get prepared.”

Maurice pointed out that Battlestorm is, first of all, fun to play, and that everyone on his team now wants to play again. The Boys and Girls Clubs are thinking of adapting the game to cover disaster preparedness in places that don’t experience hurricanes, but might have other kinds of natural disasters. Maurice comments, “I think that if the game were to spread more, then people would be more prepared.” Whether it’s having enough bottled water and food on hand, or having a shelter available during a storm, Battlestorm teaches its players a bigger lesson about how to be ready for the next big hurricane. And that’s no game!



• You can find out more about how Battlestorm is played, and watch a video of a game at www.battlestormgame.org

Yakutsk: Permafrost Capital of the World

by Ruth L. Spurgeon

Welcome to Yakutsk, one of the coldest cities in the world! Located in East Siberia, Russia, Yakutsk is the capital of the Russian republic of Sakha, or Yakutia. Found just below the Arctic Circle, it has a population of 250,000 people.

In January, temperatures can reach a low of -40 degrees Fahrenheit. In July, however, temperatures can reach 86 F. This makes it a city with one of the greatest seasonal differences in the world.

As Yakutsk is built on permafrost, ground that stays permanently frozen throughout the year, buildings are constructed on concrete or wooden stilts. Metal stilts cannot be used because they would conduct the heat from the buildings into the ground. Buildings are constructed by regulation at four feet above the permafrost. This prevents the buildings' heat from melting the ground beneath them.

Building on permafrost is the main concern of the Permafrost Research Institute. The institute was established in Yakutsk in 1960. The institute also seeks to develop agricultural areas, methods of mining, and environmental protection of permafrost areas.

Siberia's permafrost has allowed us a glimpse of a long-dead relative of the modern elephant, the mammoth. Yakutsk's Museum of the Mammoth was founded in 1991. It is the only institution allowed to search for mammoth remains in the Central Asian region. The permafrost of the republic acts like a giant freezer, preserving the remains of woolly mammoths. The museum allows people to come

face to face with long-dead prehistoric wildlife.

Yakutsk grew into a city when reserves of gold were found there in the 19th century. These reserves were extensively developed under Josef Stalin's rule in the mid-20th century. The rapid growth of forced labor camps in Siberia also contributed to its growth.

Today, Yakutsk is an important highway center linking the eastern and western halves of the vast country of Russia. It has tanneries, sawmills, and brickworks. There is a university and research institutes that are part of the prestigious Russian Academy of Sciences.

The Sakha Republic is one sixth of the total area of Russia. About 40 percent of its area lies above the Arctic Circle. It embraces an arctic and sub-arctic area of 1.2 million square miles that is completely covered by permafrost. Its soil contains reserves of oil, gas, coal, diamonds, gold, and silver. It is the second greatest diamond producer in the world, producing one fifth of the world's diamonds.

• Warm boots are a must in cold climates such as Siberia.



Tundra is a treeless arctic plain.

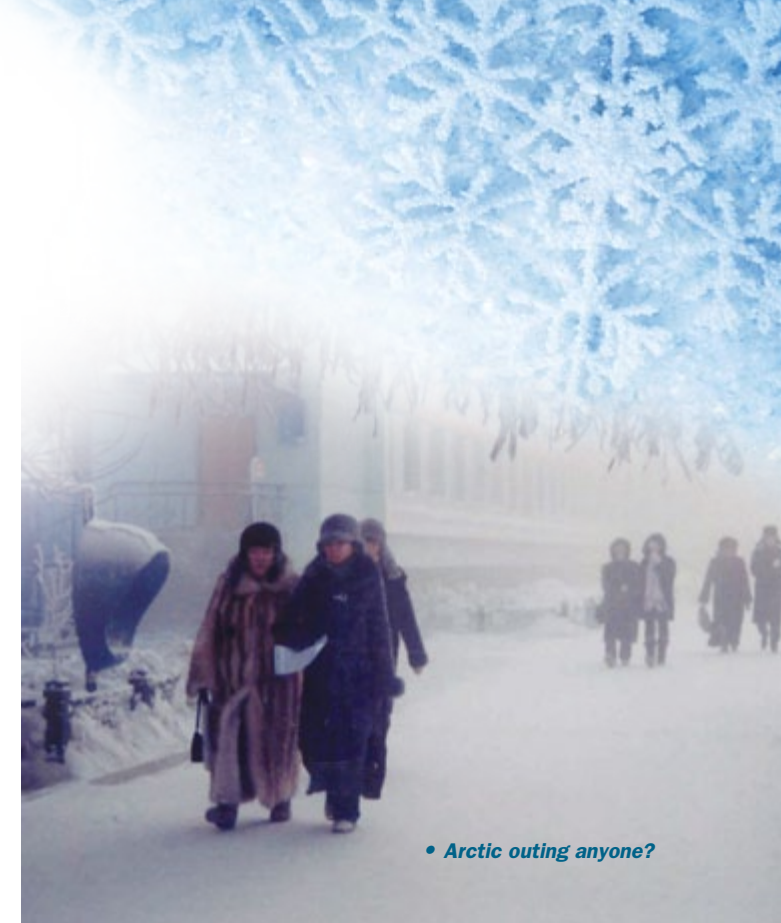


The Sakha Republic of Russia shares much in common with the state of Alaska. In fact, Yakutsk and Fairbanks, Alaska, are "sister cities" — a scaled up version of being pen pals. They foster human contact and share cultural links between each other. Like Alaska, the Sakha Republic has vast areas of undeveloped land, its economy is based on natural reserves, and it is rich in cultural diversity.

The republic is partly mountainous and partly lowland. The northern area is a **tundra** region. The climate is dry with long, severe winters. Animal life includes squirrels, Siberian ferrets, hares, blue foxes, and wild reindeer. The people of Yakutsk are well known as hunters, fishermen, and reindeer herders.



Ruth L. Spurgeon is a freelance writer from Toronto, Canada.



• Arctic outing anyone?

Do you know where this reader is enjoying his copy of **FACES**?

Here's a hint: A 2011 dust storm gave this Down Under city an orange tint.



Send us a photo of you with your copy of FACES to

facesmag@yahoo.com.

The answer is on page 48.





Got a question about people, places, and cultures?

Each month, our experts will answer several questions from readers like you. Want to know where the world's highest mountain is located? What is the largest country in the world?

Ask FACES at askfaces@yahoo.com!



Q. What is the jet stream?

— Benny, via e-mail

A. Actually there are many jet streams, and although we have only known about them for a little more than 125 years, they are an important part of life on Earth for humans. Scientists first located jet streams when tracking the volcanic smoke of the 1883 eruption of Krakatoa in Indonesia. The major jet streams are high altitude westerly winds. There are four major jet streams — each of Earth's hemispheres has one polar and one sub-tropical jet stream. They are located in the tropopause at elevations of 20,000 to 50,000 feet. The jet streams affect our weather, are used by airlines to shorten travel time, and in the future, may even be the home of airborne wind turbines.



Q. Who invented the umbrella?

— Mary, via e-mail

A. Although we may grab one today when we see storm clouds gathering, umbrellas were first used as protection when it wasn't raining. Ancient people in Egypt, China, and Greece are all known to have used them as sunshades. It wasn't until those inventive Chinese started waterproofing them that they became popular to shield users from the rain. A parasol is usually thought of as protecting from sun while an umbrella is opened when it rains. By the way, the word umbrella comes from the Latin root *umbra*, meaning, "shade." Many other terms are applied to the modern umbrella such as gamp, brolly, rainshade, and bumbershoot.



Q. Who chooses the names for hurricanes?

— Irene, via e-mail

A. Definitely not mommy and daddy hurricanes. Since 1953, the names given to cyclonic storms in the Atlantic and North East Pacific areas have been chosen from lists put together by the National Hurricane Center. Six lists of 21 names each are rotated over a six-year period. Actually all tropical storms with winds more than 34 miles per hour are named. If, for instance, Tropical Storm Isaac develops into a hurricane with sustained winds higher than 74 miles per hour, it becomes Hurricane Isaac. Check out the list at the National Hurricane Center to see if your name is on the list.

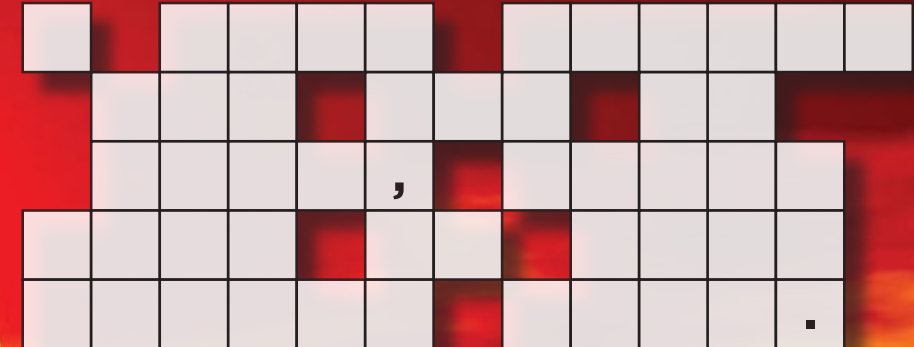
www.nhc.noaa.gov/aboutnames.shtml



Fallen Proverb

Trying to predict the weather being "weatherwise" is an old and widespread habit. It is a type of folklore. Today, with television meteorologists, radar, and satellites, dew and red skies don't seem very important. But to our ancestors, who were without modern instruments, weather signs were vital, for weather controlled their lives and fortunes. Jumbled below is a well-known weather proverb. The letters are directly below the column in which they will fit, but are mixed up within the column. It is your job to determine where each letter goes.

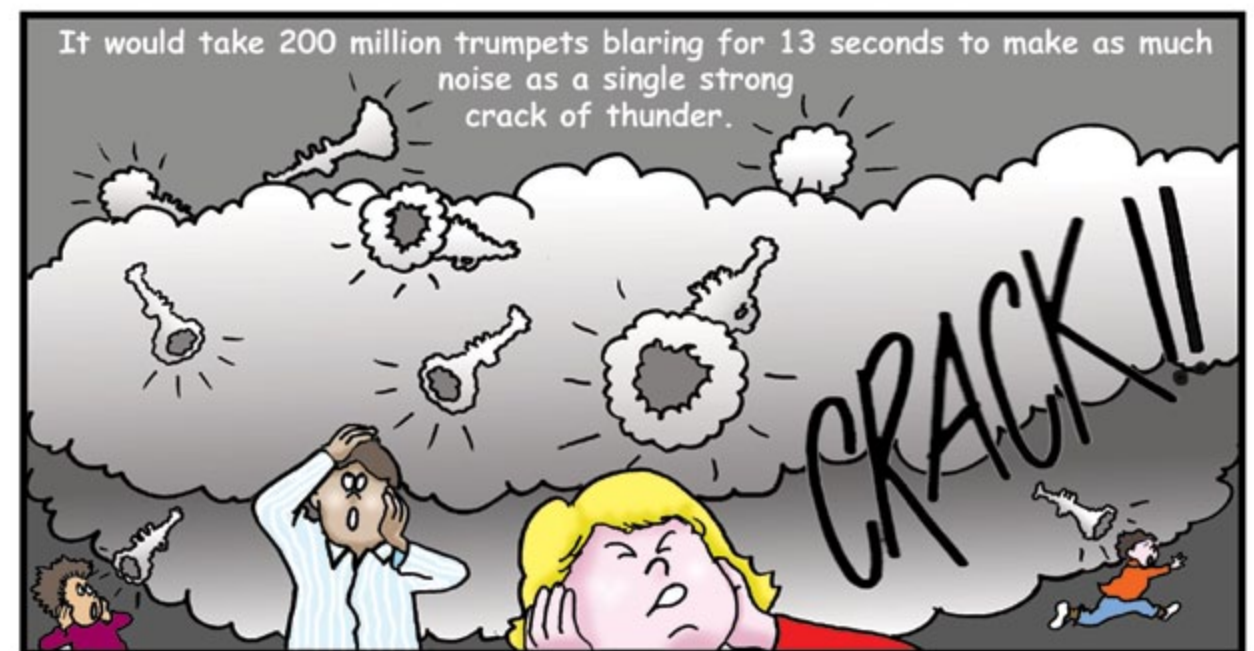
The answer is on page 48.

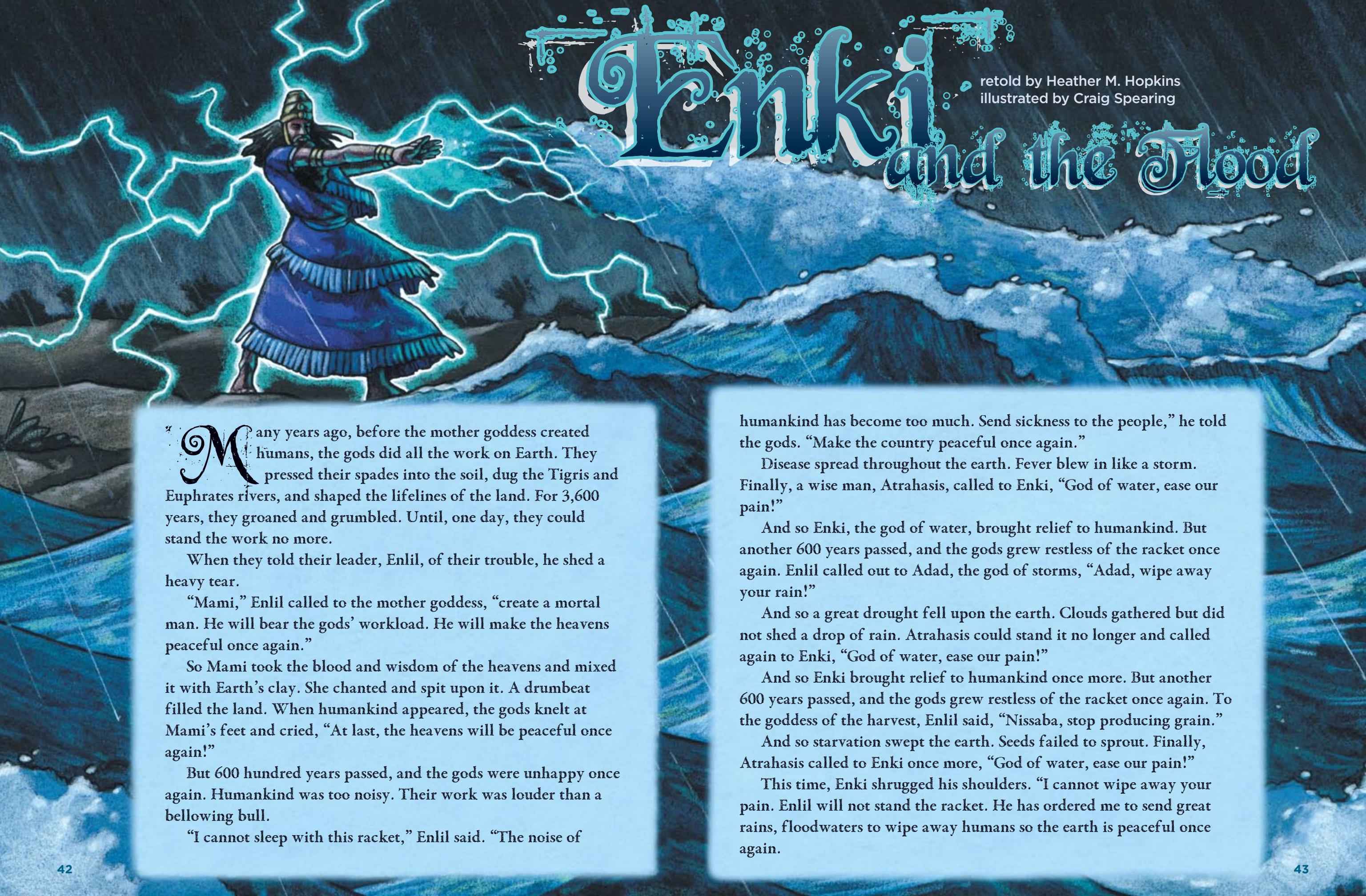


H O
M M I G M E O U
C O I N N O A S O O N
R T O I N S U S R N N W D

Face Facts

by Janise Gates





Enki and the Flood

retold by Heather M. Hopkins
illustrated by Craig Spearing

Many years ago, before the mother goddess created humans, the gods did all the work on Earth. They pressed their spades into the soil, dug the Tigris and Euphrates rivers, and shaped the lifelines of the land. For 3,600 years, they groaned and grumbled. Until, one day, they could stand the work no more.

When they told their leader, Enlil, of their trouble, he shed a heavy tear.

“Mami,” Enlil called to the mother goddess, “create a mortal man. He will bear the gods’ workload. He will make the heavens peaceful once again.”

So Mami took the blood and wisdom of the heavens and mixed it with Earth’s clay. She chanted and spit upon it. A drumbeat filled the land. When humankind appeared, the gods knelt at Mami’s feet and cried, “At last, the heavens will be peaceful once again!”

But 600 hundred years passed, and the gods were unhappy once again. Humankind was too noisy. Their work was louder than a bellowing bull.

“I cannot sleep with this racket,” Enlil said. “The noise of

humankind has become too much. Send sickness to the people,” he told the gods. “Make the country peaceful once again.”

Disease spread throughout the earth. Fever blew in like a storm. Finally, a wise man, Atrahasis, called to Enki, “God of water, ease our pain!”

And so Enki, the god of water, brought relief to humankind. But another 600 years passed, and the gods grew restless of the racket once again. Enlil called out to Adad, the god of storms, “Adad, wipe away your rain!”

And so a great drought fell upon the earth. Clouds gathered but did not shed a drop of rain. Atrahasis could stand it no longer and called again to Enki, “God of water, ease our pain!”

And so Enki brought relief to humankind once more. But another 600 years passed, and the gods grew restless of the racket once again. To the goddess of the harvest, Enlil said, “Nissaba, stop producing grain.”

And so starvation swept the earth. Seeds failed to sprout. Finally, Atrahasis called to Enki once more, “God of water, ease our pain!”

This time, Enki shrugged his shoulders. “I cannot wipe away your pain. Enlil will not stand the racket. He has ordered me to send great rains, floodwaters to wipe away humans so the earth is peaceful once again.

“But listen closely to my message,” Enki said. “Build a boat to survive the rain. After seven days and seven nights, the flood will finish flowing and you will live peacefully once again.”

Atrahasis gathered his family together. They built a sturdy boat. On board they loaded birds, fish, and animals. Then they waited for the rain.

Soon, the darkness became total. Adad bellowed from the sky. Wind screamed throughout the earth. The floodwaters stampeded over the land like a bull.

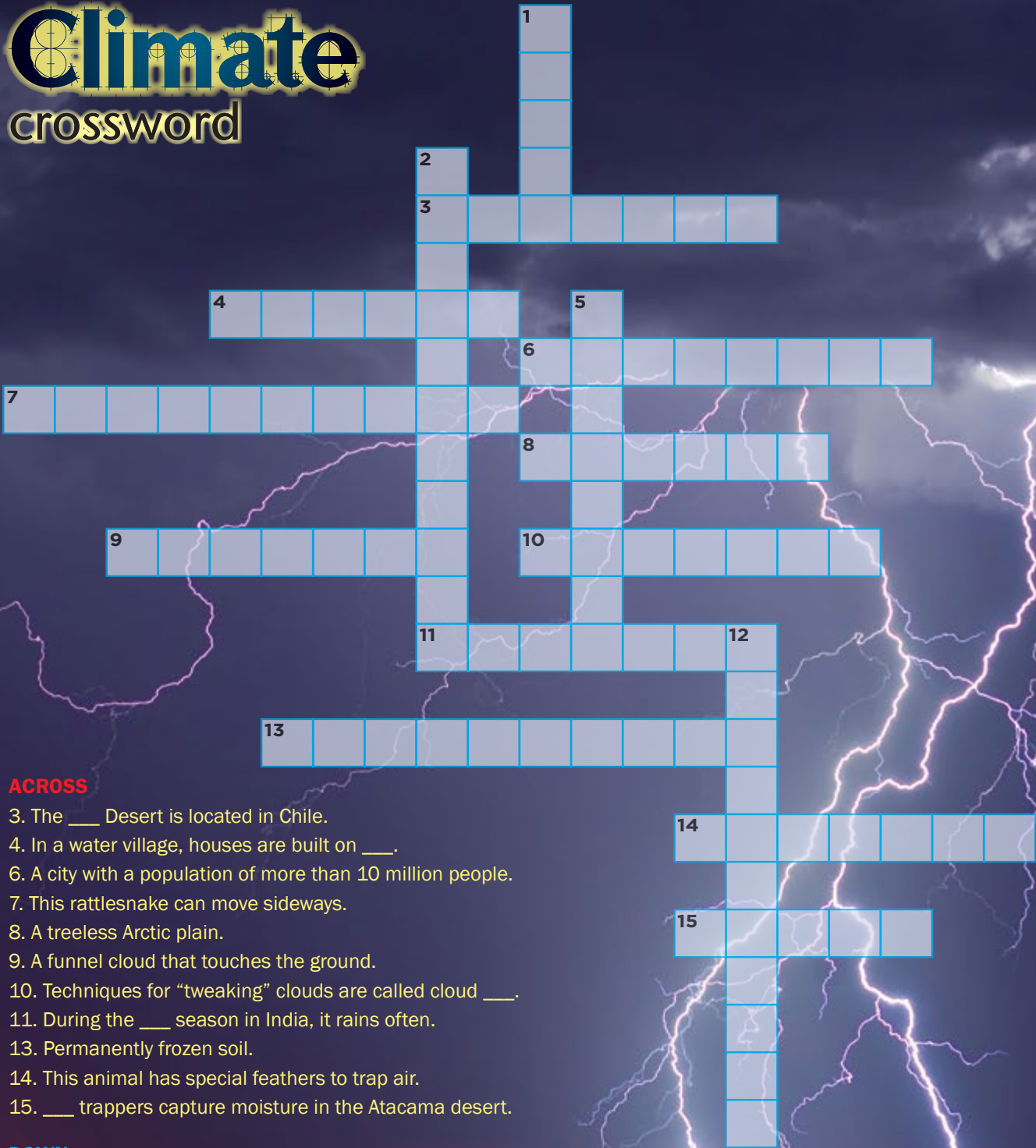
Seven days and seven nights passed. Finally, Atrahasis no longer heard the rain. When he poked his head out the door, sunlight spread over his face once again. Rejoicing, Atrahasis released his family and animals to roam about the drying land.

But Atrahasis, the wise man, would always remember the past.

“Sing of the flood to all people,” he told his children, “when humans survived the rain.” And from that day to the present, his children did the same.



Climate crossword



ACROSS

- 3. The ___ Desert is located in Chile.
- 4. In a water village, houses are built on ___.
- 6. A city with a population of more than 10 million people.
- 7. This rattlesnake can move sideways.
- 8. A treeless Arctic plain.
- 9. A funnel cloud that touches the ground.
- 10. Techniques for “tweaking” clouds are called cloud ___.
- 11. During the ___ season in India, it rains often.
- 13. Permanently frozen soil.
- 14. This animal has special feathers to trap air.
- 15. ___ trappers capture moisture in the Atacama desert.

DOWN

- 1. ___, Florida is the “Lightning Capital of the USA.”
- 2. A game that helps kids learn about storm preparedness.
- 5. Climate ___ are forced to leave home because of climate changes.
- 12. Twenty-five percent of this country’s land is below sea level.

• Nature’s fireworks light the sky during an Arizona storm.

6 magazines, 1 extreme topic



The March issues of COBBLESTONE, CALLIOPE, DIG, FACES, APPLESEEDS, and ODYSSEY share the same theme: **The Perfect Storm**. Take an exciting look at extreme weather's impact on cities, culture, and history. Put all six covers together for a mosaic poster of nature's ability to dish out punishing weather.



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Art Connection

Wild Wacky Weather Paintings with J. M. William Turner by Brenda Breuls

Fishermen at Sea, J. M. William Turner (1775 - 1851)



Artists have always been fascinated by wild weather. Legend says that J. M. William Turner, a landscape artist born in London, England, in 1775, asked to be tied to the mast of a ship during a storm at sea so that he could experience it from the most dramatic point of view. With that firsthand knowledge he hoped to paint excellent stormy scenes. You don't have to strap yourself to a sinking ship to get a good sense of the power of a storm. Just step outside during a rain storm and watch the clouds. Then capture it in your own wild wacky weather painting.

real one, there might be some crazy storms on the Internet that you could observe from the comfort of your warm, dry home!

2: MAKING A ROUGH SKETCH

Make a few sketches of the clouds, sky, and effects of the storm. Try to create a sense of tension, or something that might even be a bit scary like a tree about to crack, or a bird trying to fly home.

3: PREPARING YOUR PAPER

Tape the edges of your watercolor paper to the art board about a quarter of an inch all the way around the edge.

4: PAINTING YOUR STORM

Once you have copied your sketch onto the watercolor paper, begin by painting the lightest areas first and working towards the darkest areas last. If you create really strong contrasts between light and dark areas it will make your painting seem even more dramatic.

5: APPRECIATING YOUR WORK

When the painting is completely dry, gently remove the tape from the edges. Display it where other people can enjoy your work. You never know, they may get a feeling of a storm coming on just from looking at your painting!

MATERIALS:

- watercolor paints, paper, and brushes
- an art board slightly larger than the piece of paper you intend to paint on. (You could also use a large cutting board.)
- masking tape
- two jars of water

1: OBSERVING A STORM

Next time there is a rain storm look outside. How are the clouds moving? What colors or shapes are present? Are the trees swaying with the wind? Are birds trying to fly? If you don't want to wait for a

Contest!

Once you have completed your wild weather scene, send it to us at FACES Wild Weather, 30 Grove Street, Peterborough, NH 03458 or send us a high-resolution scan to facesmag@yahoo.com by May 1, 2012. Be sure to include your full name, age, and address.

All submissions become the property of Cobblestone Publishing and will not be returned.

Guest Review

by Bei Driese, 10, Laramie, Wyoming

Storm Runners: The Surge

by Roland Smith



Hurricanes and tornadoes can destroy houses, cars, and roads. They kill people and separate families. Their winds are so high they can blow you away. In *Storm Runners: The Surge* by Roland Smith, a boy named Chase and his father follow these storms so that Chase's father can help people who have been hit by them. *Storm Runners* is exciting and action-packed. The whole book takes place over 13.5 hours. During that time, Chase and his two friends are trying to get home from school when huge Hurricane Emily strikes Florida along the Gulf of Mexico. Although Chase is well prepared for natural disasters, he and his friends must face a giant alligator, near drowning, and exhaustion. I thought the book had a slow start but then it got exciting and was hard to put down. You need to read *Storm Runners* to find out what happens next to Chase and his friends.



Ages 9 to 12
Scholastic Press, 2001
www.scholastic.com

Answer to **Mystery Photo** on inside front cover: *This is a windmill.*

Answer to question on page 6-7 for what is a favorite meal for a leatherback turtle: *jellyfish.*

Answer to **Where in the World** on page 39: *Our reader is in Sydney, Australia.*

Answer to **Fallen Proverb** on page 41: *"A ring around the sun or moon, means rain or snow coming soon."*

Answers to **Climate Crossword** on page 45:

ACROSS: 3. Atacama, 4. stilts, 6. megacity, 7. sidewinder, 8. tundra, 9. tornado, 10. seeding, 11. monsoon, 13. permafrost, 14. penguin, 15. cloud

DOWN: 1. Tampa, 2. Battlestorm, 5. refugees, 12. Netherlands

Answer to **Meteorologist Match-up** on backcover:

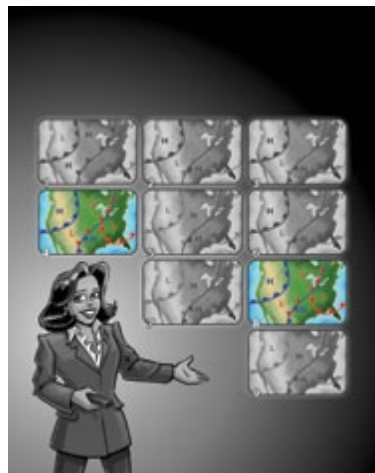


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Say what?

from October 2011 **FACES: Kids Lead the Way**



"I hereby declare today 'National Toddler Day!'"
- Isabel S.

"Let them eat birthday cake!"

- Millie M.

"I command you to put me into a diamond-studded highchair! Not this dinky throne!"

- Leyli J.

"I said a THRONE, not alone!"

- Leland C.

"No, Mom, that's not how it works here. I sit on the throne and you get the arrowroot cookies. Not the other way around."

- Max L.

"I'm the queen of this castle, and I demand applesauce!"

- Lauren G.

One Last Face

Say what?

Fill in the speech bubble for this photograph.

The best entries will be published in an upcoming issue! Send your captions to:

facesmag@yahoo.com.

Please put the title of this issue in the subject line.

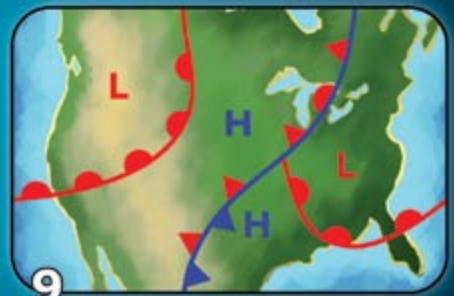


METEOROLOGIST

Match-up

Can you find the two weather maps that are identical?

The answers are on page 48.



Come to the Perfect Party!

digTM



**Reading
Climate
Clues**

Pg. 8

**A River's
Turn Makes
a City
Disappear**

Pg. 16

**Hippos in
a Desert**

Pg. 12

**THE
PERFECT
STORM**



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And they're in trees, coral, ice, and lakes.
by Lisa Gardiner

- 12 Hippos in the Desert**
Yes, and giraffes and rhinos as well!
by Paul G. Bahn

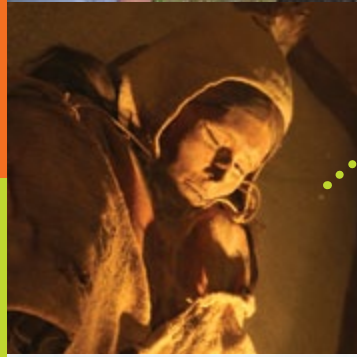
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by Lisa Kang

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And in the carbon deposits!
by Paula Neely

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You need to look at rings—really!
by Paula Neely



What's the weatherman saying? A common question, and the answer often determines what you will wear and even do. But, instead of looking ahead, we did some digging to see what weather people have experienced in the past.

DIG's five sister magazines also focused on weather. So, for a great "weather poster," get all six of the magazines and make a collage of their covers! (illustrated by Jeff Crosby)



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— the metal rod (below) attached to an exterior arch at the 16th-century Holy Monastery of St. Nicholas Anapausas in Meteora, Greece, is actually a lightning rod, whose purpose is to divert lightning harmlessly into the ground.



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... and to me, too!



An index of the articles and information in DIG's 2011 issues is online at:
www.cobblestonepub.com/2011index_dig.html

dig

Published in partnership with Archaeology magazine

QUESTIONS, WRESTLING, EGYPTIAN TRAPS, & MORE

Dear Dr. Dig,
In what ways was Roman culture derived from Greek culture?

—Bridget Mitchell, Web post

Roman culture was unique, with its own customs, laws, religion, and language. However, starting particularly in the second and first centuries B.C., the Romans developed a special appreciation for Greek culture, particularly Greek arts. Greek sculptures and paintings were collected by the wealthy, Roman temples were decorated in the Greek fashion, and Roman authors wrote Greek style poetry, drama, history, and epic. The Greeks had invented realism in sculpture—that is, they perfected the art of carving stone to make it look like flesh, clothes, and hair. Greek sculptures depicted humans in natural poses with emotional expressions on the faces. This was in contrast to earlier civilizations in the Middle East whose artists had created stiffer, repetitive-looking subjects. Roman sculpture followed this later Greek style. In architecture, although the Romans used concrete and had perfected the construction of arches and domes, they still liked to make the exteriors of buildings, especially temples, look like Greek ones. So, they included pediments and columns, even though these were not structurally necessary. In literature, Roman writers constantly referenced Greek works. For example, Livy wrote his epic poem *Aeneid* in the style of Homer's *Illiad* and *Odyssey*. This work told the story of a hero leaving the Trojan War and founding the Latin people who became the Romans, thus linking the Romans to the Greeks.

Dr. Dig is archaeologist Angela Murock Hussein, and she loves to talk to kids about her favorite subject—archaeology. Send your questions about the mysteries of Egypt, animals, early peoples, and anything else about the past to: Dr. Dig, Dig magazine, 30 Grove Street, Peterborough, NH 03458. Or, send an e-mail to askdr.dig@caruspub.com. Include your name, age, and town with your question.

Dear Dr. Dig,
What is GPS?

—Tally, Web post

GPS stands for **G**lobal **P**ositioning **S**ystem, a network of 24 satellites placed into orbit by the United States Department of Defense. Each satellite circles the earth twice a day in a very precise orbit and transmits information to each daily. A GPS receiver takes this data and determines the distance between points on the earth's surface or the relative position of these points to calculate the exact location of the person using the receiver. A GPS receiver must be locked on to the signal of at least three satellites in order to calculate a position and track movement. Once the user's position has been determined, the GPS unit can provide other information, such as speed, trip distance, sunrise/sunset times, and more.

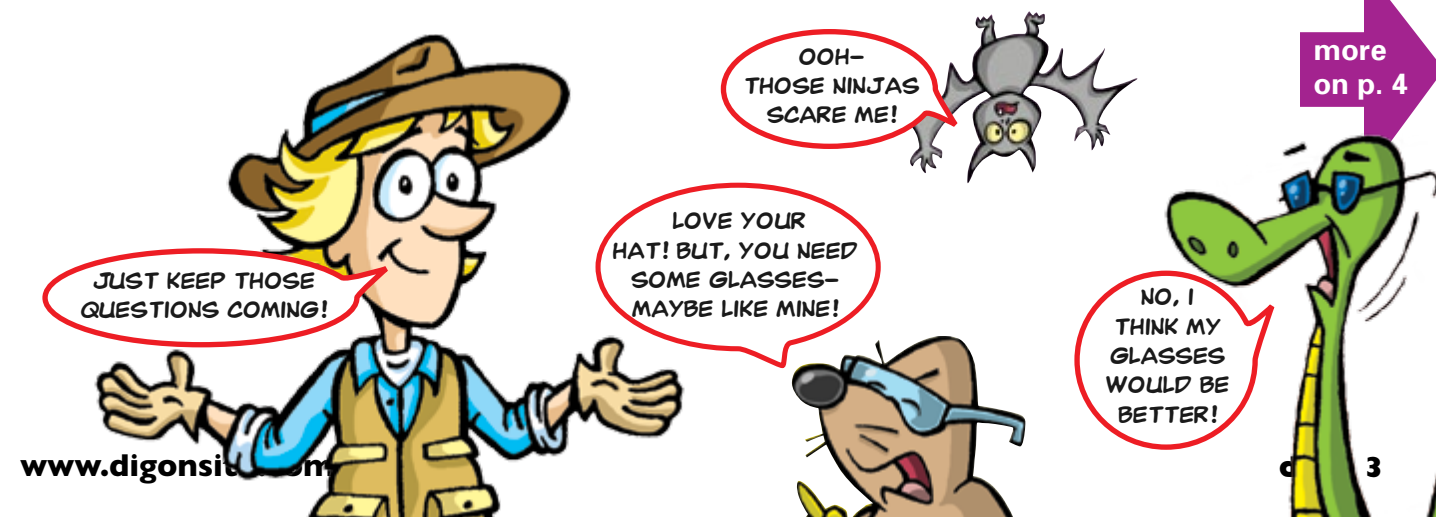
Dear Dr. Dig,
I was wondering about ninjas and samurai. Did they really crawl through air vents and secretly assassinate people?

—Andrew, Web post

Ninjas and samurai were different types of fighters who lived primarily in Japan during the medieval period. Samurai were warriors, much like knights in European cultures at the time, who served noble lords and were trained in combat and carried swords as a sign of their rank. And, just as with knights, there was a code of honor that samurai were expected to follow. Ninjas, on the other hand, were warriors who practiced less formal combat. They could be guerilla fighters, mercenaries for hire, spies, or assassins. As such, their training was more practical because they were not necessarily fighting openly on the battlefield, but were often using stealth as a weapon. The image we have of ninjas and samurai today is influenced by both Japanese folklore and modern movies, which exaggerate the details to make the action more exciting.



illustrated by John Kovalski

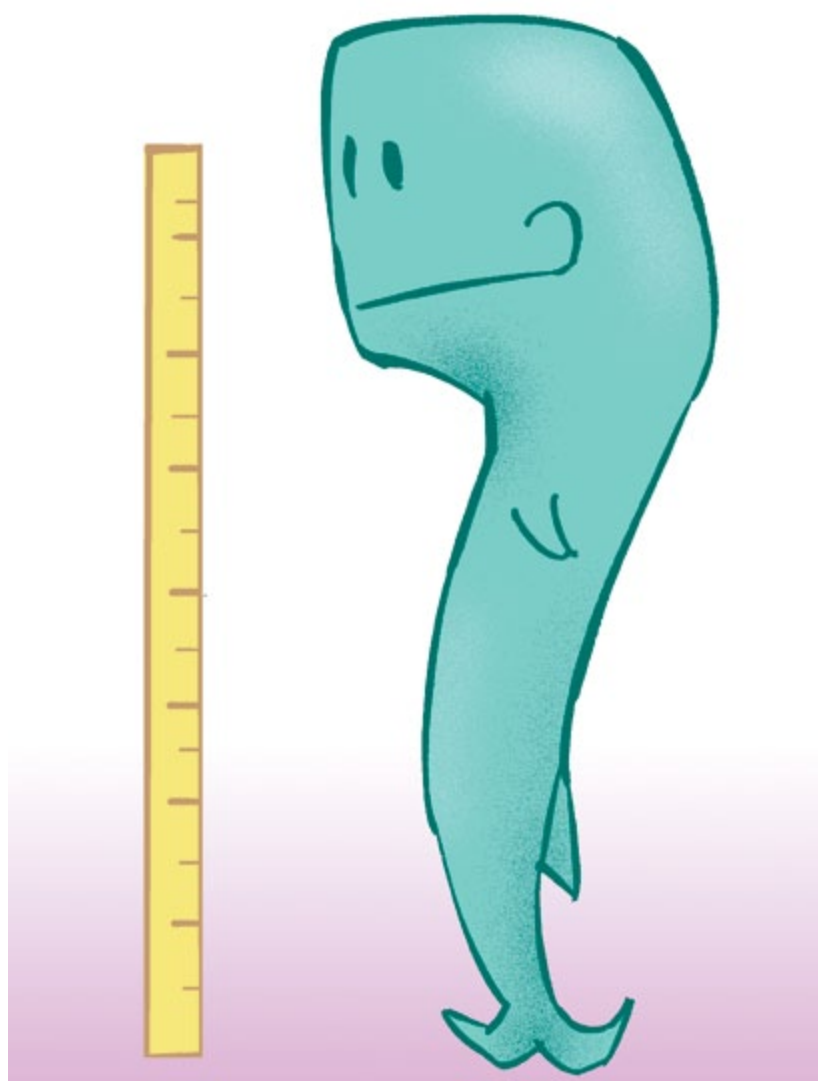


more
on p. 4

Dear Dr. Dig,
Was the skeleton of the *Leviathan melvillei* found in Peru the only one of that type found so far? Also, is it the largest-known creature and was it the earliest-known relative of the modern-day sperm whale?

—Mason Fields
Omaha, Nebraska

The partial fossil skeleton of a whale from around 12 to 13 million years ago was unearthed in Peru in 2008. So far, it is the only one of its kind known. Named *Liviathan melvillei*, the whale had teeth, like modern orcas and sperm whales, and the skull had a bowl-shaped indentation similar to modern sperm whales, indicating that it probably had a spermaceti organ—that is, two huge oil-filled sacs. Earlier ancestors of the sperm whale with the same organ have been traced to around 25 million years ago. The largest animal that we know to ever have existed on this planet goes to another whale species, the blue whale, which still swims the oceans today.



Dear Dr. Dig,
How do we know how to pronounce ancient Egyptian names?

—Allynn Dreher, age 10
Kuna, Idaho

We can never be 100 percent sure how to pronounce any ancient language, since no one is around to speak it. However, we do know that, just as with languages today, ancient languages also had dialects and accents depending on the different regions and they changed over time. Ancient Egyptian has the added problem that the written words did not include many of the vowel sounds, something that languages such as Hebrew and Arabic still do today.

Those fluent in the language have little problem understanding, just as we can decipher the shorthand of text messaging today. But inferring how to pronounce a word when you only have the written form can be difficult for those who are not fluent speakers (which includes modern scholars reading a language that is no longer spoken). Therefore, with any word or name in ancient Egyptian, there is some room for interpretation.

Top 5 Superlative Facts

1 The “Great White Hurricane” was the nickname given to the blizzard that struck the northeastern section of the United States in 1888, bringing as much as 50 inches of snow!

2 Flooding caused by China’s Huang He (Yellow River) in 1931 left a recorded death toll of from 1 million to 3.7 million people.



3 Anyone near New Hampshire’s Mount Washington in April 1934 was near the world’s highest recorded surface wind gust—231 miles per hour!

4 A University of Oklahoma team recorded the fastest wind speed—318 mph—as part of a tornado that hit Oklahoma City on May 3, 1999.



5 The tallest wave ever recorded was part of a tsunami that struck Lituya Bay, Alaska, on July 9, 1958. It measured 1,720 feet in height.

what’s this?

from Back Cover

—a Robinson anemometer! What’s that? A wind thermometer that was first positioned on top of an observatory in England in 1846. Its purpose was to measure the force of wind. As the four cups revolve, the four open faces are exposed to the currents of air. Robinson determined that the cups rotated at a speed that was one-third of the wind’s velocity at the time. The latter was recorded on the dial below. The instrument was simple and portable, especially as the cups could be removed for traveling.

ON THE WEB

Inside a Dive

That’s the title of just one of the links on the fascinating, fact-filled site www.hamilton-scourge.hamilton.ca/ about two ships that wrecked in Lake Ontario while fighting in the War of 1812.

Catalhoyuk

DIG brought you the team’s theories and discoveries in an earlier issue. Now here’s a great interactive site (www.smm.org/catal/top.php?) that lets you explore recent developments—and much more!

NUMBERS

20

The number of gold objects—one, an earring with two beautiful pearls—that have been uncovered thus far in tombs dating to the 12th–14th centuries at Kaliakra on the Black Sea

2500

The age in years of an Egyptian mummy whose brain and vital organs were removed and replaced with rolls of linen—a practice reserved at the time for those of high status

RESOURCES

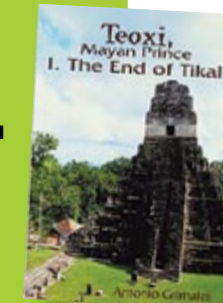
Hurricane Dancers, The First Caribbean Shipwreck

by Margarita Engle (Henry Holt, 2011, macteenbooks.com) uses a poetic format to tell of Quebrado, the son of a Taino Indian and a Spaniard who works as a sailor/translator for pirates in the Caribbean. For a different, inventive way of reading about history, this is it.



Teoxi, Mayan Prince:

1. The End of Tikal by Antonio Grimaldi (AuthorHouse, 2011, www.authorhouse.com) is an intriguing read as it lets you accompany the last absolute monarch of Tikal, who reveals to us the world in which he lived.



stones & bones

NEWS . . . DISCOVERIES . . . HISTORY . . . FACTS . . . CULTURES . . . ANIMALS . . . MYTHS . . . SCIENCE

By Charles F. Baker

TOO LONG! INCA FRONTIER WAR

Can you imagine a war lasting 17 years? Evidence has been found along the ridge of an extinct volcano in northern Ecuador that is known as Pambamarca of a long war fought between the Inca and the Cayambe of Ecuador. The evidence tells that the conflict happened before the Spanish conquistadors arrived in the Andes in the early 1500s. Thus far, 20 Inca fortresses and two Cayambe fortresses have been uncovered on the Inca frontier.

Those built by the Inca are of stone and are located on ridges about 10,000 feet above the ground. Within are platforms called *ushnus*. The Cayambe forts are fairly large and made of a tough volcanic material called cangahua. The Cayambe most likely lived both inside and outside their walls. Project director Chad Gifford, of Columbia University, says of the Cayambe structures, "There are fewer of them, but [they are] plenty big."

The Spanish told of a 17-year war between these two cultures and said that the Inca prevailed in the end and massacred the Cayambe at a lake. The discoveries provide evidence of a long struggle. Finally, after many battles, the Inca succeeded in driving the Cayambe out of their strongholds and onto the shores of a lake. In the 17th century, Spanish missionary Bernabe Cobo wrote in his book *History of the Inca Empire* that "the Inca ordered their men to cut the enemies' throats



Who knows how many battles were fought here!

without pity and to throw the bodies into the lake. As a result, the water of the lake became so darkened with blood that it was given the name that it has today—Yahuarcocha, which means 'lake of blood'."

One of the Inca fortresses, Quitoloma, has 100 structures and was filled with Inca weapons. The two Cayambe fortresses also had weapons, including sling stones and bola stones. There is evidence that the Cayambe continued to occupy the area for a long time. Cayambe pottery continued to be used in the region. Connell says, "It could be that some peoples decided after many years of resistance and warfare to simply lay down their arms or become allies with the Inca."

WOW! 1,000-YEAR-Old COINS!

Recently, more than 200 1,000-year-old coins were excavated in north China's Inner Mongolia Autonomous Region.

According to Zhang Zhenzhou, who works for the Araxan Museum, the coins, which were covered in verdigris, a green pigment, date mostly to the Northern Song Dynasty (A.D. 960–1127). Some date to the Tang Dynasty (A.D. 618–907). Zhang also mentioned that the place where the coins were found belonged to the Western Xia Kingdom. This means that the area was probably a trade route between Northern Song and Western Xia.

Chinese curator Li Daxiang adds that, "Despite the many battles between the two kingdoms, bilateral trade [trade between two countries] was booming, which led to the transfer of the Northern Song coins to Western Xia." According to Zhang, during the conflict, the people most likely tried to hide their money by burying it.

Archaeologists are studying and classifying the coins in order to discover the year they were buried. This information, they hope, will offer an insight into ancient bilateral trade. Historical records show that Song silk, porcelain (example above), iron, and various textiles were traded with cultures as far away as the Indus River and modern-day Iraq. Quite a feat for people of ancient times, don't you think?



Perhaps the coins paid for me!

JOKE

Why did the lady go outdoors with her purse open?



—Because she expected some change in the weather!

—by Chip Baker

illustrated by Tom Lopes

YIKES!

HATSHEPSUT'S UNDOING?

It's what's inside that's deadly!



Archaeologists from the University of Bonn in Germany have announced that they have discovered a carcinogenic (cancer-causing) substance in a flask said to have belonged to the 18th-Dynasty Egyptian ruler Hatshepsut. That makes the flask about 3,500 years old. After spending two years researching the dried-out contents of the flask, experts believe the queen may have poisoned herself accidentally.

The contents of the flask appear to have been a medicine used to treat skin disorders such as eczema, of which there were said to be cases in

Hatshepsut's family. The lotion included palm and nutmeg oil, along with fatty acids of the kind that can relieve such diseases, as well as benzopyrene, an aromatic and highly carcinogenic hydrocarbon.

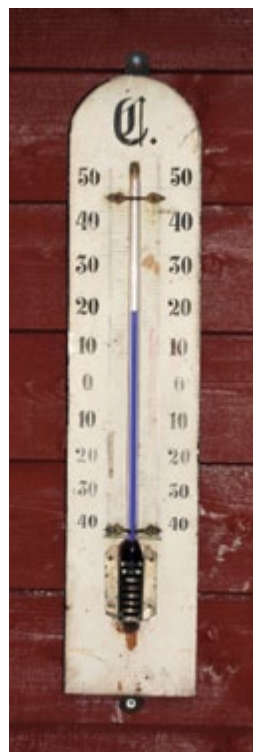
"If one imagines that the queen had a chronic skin disease and the ointment gave her short-term relief, then she may have exposed herself to a major risk over the course of a few years," says Helmut Wiedenfeld of the university's pharmaceutical institute.

What a price to pay for vanity!

CLUES to the Past

Amazing
what you
can find
out when
you know
where to
look

by Lisa Gardiner



If you want to know the exact temperature outside, just look at a thermometer.

If you want to know the average temperature in your region, you can check the recorded averages of many years in the area. But, what if you want to know what the climate was like a few hundred or even a few thousand years ago?

Since the development of the thermometer dates only to the 1600s, you will need to find another way. You will need to look for clues.

Amazing 'Time Capsules'

Clues called "proxies" provide evidence of what climate was like hundreds to thousands of years ago. They are found in many different places—from tree trunks and coral skeletons to tiny bubbles in polar ice and layers of sand and mud. Some of these clues tell us what the temperature was like in the past. Others tell us how much rain and snow fell in an area.

To understand how ancient peoples

lived in their environments, archaeologists look at proxies to understand what the climate was like at that time. For example, the Anasazi people living in the southwestern United States until about 700 years ago were affected by changes in the amount of rain. During times when water was plentiful, Anasazi communities grew. When there was drought, the communities shrank. It was by comparing clues to past climate with the findings from archaeological sites that scientists discovered this connection between the people and climate. While the story is more complicated because many factors affected the Anasazi, climate does seem to have played an important role.

How do proxies tell us about climate? Well, many proxies, including tree rings, corals, sediments, and ice, have layers that have formed over time. The thickness, color, and chemistry of the layers can be used to figure out what climate was like when the layer formed. Scientists often compare clues from many proxies, not just one, to figure out what climate was like. The examples that follow explain four different types of proxies that are used to determine what climate was like in the past.



A researcher uses a borer to extract a core from a living tree. *Inset:* Various drills used for boring.



Dendronchronology in action: The rings circling this slice from an oak tree in Godenroth, Germany, tell of the tree's growth until it was cut down in 1748. (See also page 26.)

What Trees Say

Each year, tree trunks grow a little wider—adding a layer of new wood just inside of the bark. This layer is called a tree ring. When climate is warm, the growing season is longer, and trees grow very thick rings. In some areas of the world, trees grow thick rings during years when there is lots of rain.

How do you look at a living tree's rings without cutting it down? Scientists use a tool called a borer (above and at top) to extract a small cylinder of wood called a core from the tree. The core is about as thick as a drinking straw, but is much longer if it is from an old tree.

What Corals Say

Each year, corals living in tropical seas add layers to their rocky skeletons. The thickness of the layers depends on water temperature and the depth where it is living in the ocean, and the amount of cloud cover in the sky above the ocean. The chemistry of the layers is also evidence of past climate. For instance, the types of oxygen that are in the layers depend on the temperature of the seawater where the coral lived.

Since corals can live for many thousands of years, they offer a good record of how the temperature of seawater changed through time. To get to the clues trapped in a coral's skeleton, scuba-diving scientists drill into the coral with a special underwater drill and extract a core.

A beautiful, multi-colored coral reef



What Ice Says

Ice sheets in Antarctica

You might expect that the ice sheets covering most of Greenland and Antarctica are evidence of cold climate. But the ice contains evidence of what climate was like worldwide, not just where the ice formed.

Ice sheets form in layers over time. The one at the top formed recently from snow that fell on the ice sheet. Those at the bottom formed hundreds of thousands of years ago. An analysis of the different layers offers clues as to what climate was like at specific times in the past. Scientists also look at dust and volcanic ash preserved within the ice to learn more about past climate.

Bubbles of air trapped in the ice provide a snapshot of what the atmosphere was like when the bubble formed. Bubbles of ancient air are analyzed to figure out how much greenhouse gas used to be in the air. Because greenhouse gas traps heat, the amount in air bubbles is a clue to temperature readings in the past.

Dr. Dig says



Since the barometer and thermometer were invented in the 1600s, to determine climate in earlier periods, scientists infer the climate record from physical and biological fossil data. This data includes oxygen isotope ratios detected in ice cores, tree-ring dating, archaeological discoveries, and ice floe and glacier data. Records intended for other purposes, such as weather diaries, shipping logs, tax records, crop production, and pricing records, also act as reference material.

What Lakes Say

Some scientists look for clues about past climate deep in the sand and mud at the bottom of lakes. Within those layers of sediment are grains of pollen. Plants release pollen into the air, and some of the pollen falls on lakes, sinking to the bottom where it is preserved in the sediments.

The pollen within the sediments can help scientists identify which plants used to live near the lake. Some plants prefer warm temperatures, while others prefer cold temperatures. Likewise, some plants require a large amount of water, while others need much less. By figuring out how the plants that lived near the lake changed over time, scientists can chart how climate changed near the lake.



A mountain lake

Lisa Gardiner writes and creates illustrations to help explain how the earth works. She holds a B.A. and Ph.D. in geology and has worked as an earth science educator for more than a decade.



whether this animal preferred the same kind of environment in the past as at present; and the third, of course, is the date of the images. Not one of these three, however, is always easy to tackle, especially the last one.

It is obvious that, for the most part, we have to rely on common sense if we use rock art as a source of information. If an image looks like an elephant, and everyone who sees it recognizes it as an elephant, then you can be reasonably sure—but never completely certain!—that this is what the artist intended us to see.

Since we are well aware of the type of climate and vegetation species living today need in order to thrive, we must make the basic assumption that these ancient animals had the same preferences—regardless of how many years ago that was. Certainly this seems reasonable. After all, archaeologists must constantly assume that they can predict how animals and humans acted in the past. If they did not, archaeology would be impossible!

Thanks to scientific study of sediments and pollen, we know that in the prehistory of the Sahara there seems to have been a whole series of very arid episodes. These dry periods, however, were followed by more humid periods that favored human occupation. Thus, the desert grew and



shrank at different times. Around 8,000 years ago, there was

a major humid phase, known as a “pluvial.” An extremely arid phase followed some 7,500 years ago and lasted for 1,000 years—but with different durations in the various regions. The humid “Neolithic” period followed, from about 6,500 to 4,500 years ago. But, by 2,500 years ago, the Sahara was more or less as it is now.

From Crocodiles to Camels

It was during the humid phases that the Sahara supported all the big African fauna—elephants, hippos, rhinos (see page 14), crocodiles (top), giraffes (above), and ostriches—all of which are

These finds prove “change is everywhere”!

Visit the Sahara Desert today, and you will see a bleak, but very beautiful, landscape of sand and rock that stretches across a vast area of North Africa. And yet, in some areas—especially in southern Libya—its prehistoric rock art is filled with images of giraffes, elephants (above), hippos (right), and other animals. How is this possible? Hasn't the Sahara

always been a desert? And, if so, how could these animals survive there?

A Matter of Common Sense

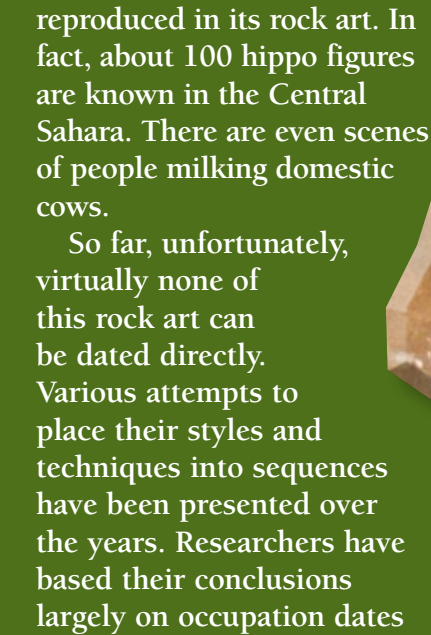
When we try to use animal images in rock art to reconstruct past environments, we must overcome three major obstacles.

The first and most basic is the identification of the animal represented; the second is the question of



Hippos in the Desert

by Paul G. Bahn



obtained from archaeological excavations. In addition, analyses of pollen have helped to reconstruct the climate and environment for each period.

The rock art is clearly linked to the different climatic phases.



The earlier phases have images of extinct buffalo and aurochs (wild cattle), while the later periods depict the present-day

animals—camels, mouflons, oryx, and gazelles, all of which are typically found in arid regions. However, as with any other rock art in the world, the artists were not providing us with a catalog of all the species that were around at the time. Their reasons for making the images were probably varied and complex. For example, some species are underrepresented, while others are totally absent. Still, they offer clear and striking evidence that the Sahara sometimes looked incredibly different from what we see today!

Paul G. Bahn is a British prehistorian. Among the many books he has authored and edited is *The Atlas of World Archaeology* (2003).

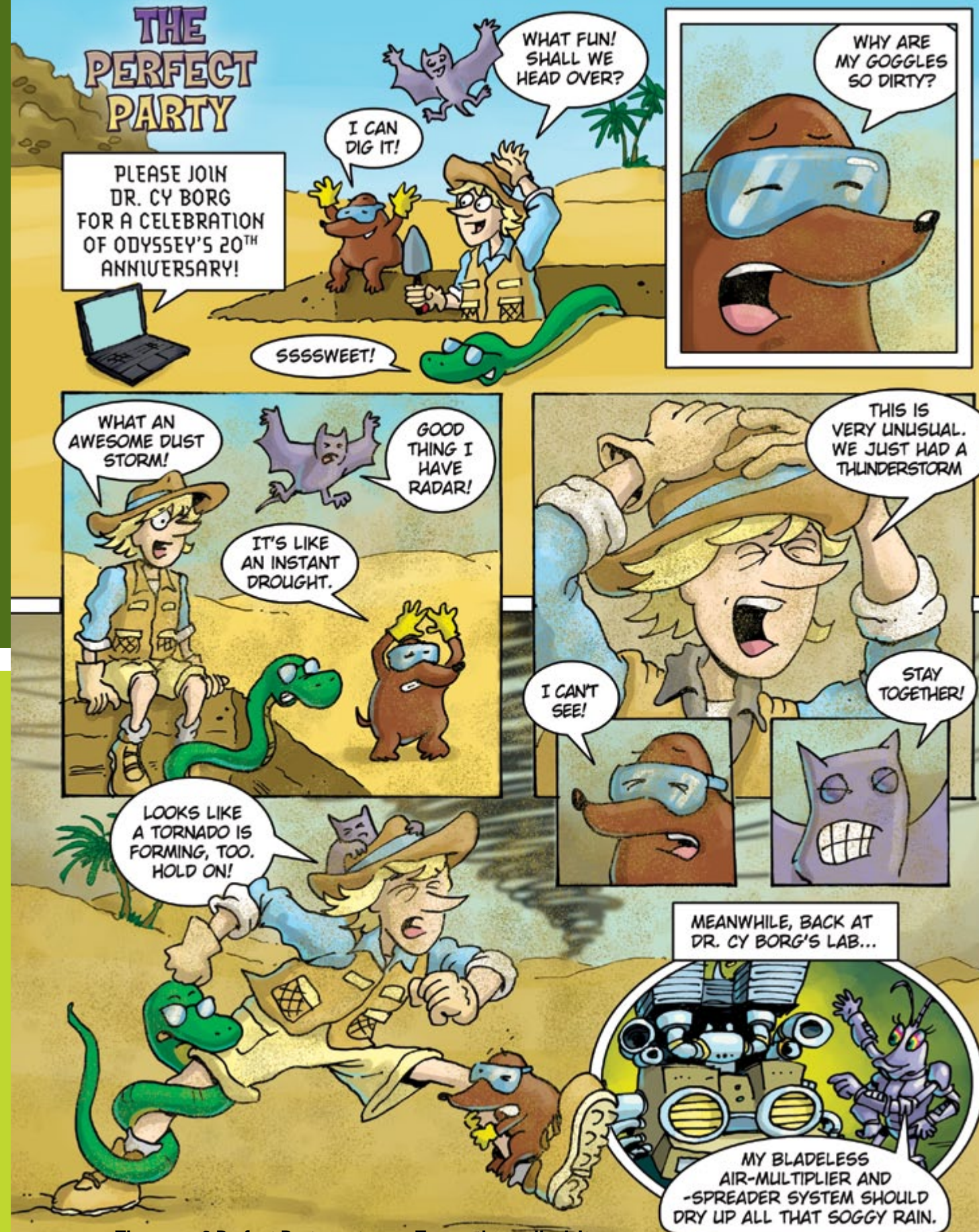
SCRAMBLE MESS

BY CHARLES F. BAKER

Use the clues below to help unscramble the answers. The circled letters will spell the name of an area in Africa that was not always dry and sandy.

- 1.** These clues offer evidence of past climate. RISEPXO _ _ _ _ _
- 2.** This tool extracts a cylinder of wood, called a _ _ _ _ _ from a tree.
OBRRE and ROCE _ _ _ _ _ and _ _ _ _ _
- 3.** In coral, clues are trapped here. TEENOKSL _ _ _ _ _
- 4.** These cover much of Antarctica. HISEETCS _ _ _ _ _
- 5.** There are layers of this at the bottom of lakes. MITNESDE _ _ _ _ _
- 6.** Thermometers tell this. PUTREMEERAT _ _ _ _ _
- 7.** Coral lives here. WESTREAA _ _ _ _ _
- 

Place in Africa that was not always dry and sandy:



There are 6 Perfect Party cartoons. To see them all, visit www.cobblestonepub.com/kids_storm.html

W

HEN A MAN IS RIDING THROUGH THIS DESERT...HE HEARS SPIRIT VOICES TALKING TO HIM AS IF THEY WERE HIS COMPANIONS, SOMETIMES EVEN CALLING HIM BY NAME...EVEN BY DAYLIGHT MEN HEAR THESE SPIRIT VOICES, AND OFTEN YOU FANCY YOU ARE LISTENING TO THE STRAINS OF MANY INSTRUMENTS, ESPECIALLY DRUMS, AND THE CLASH OF ARMS. FOR

THIS REASON BANDS OF TRAVELERS MAKE A POINT OF KEEPING VERY CLOSE TOGETHER.

Thus did the Venetian traveler and trader Marco Polo describe the Desert of Lop, a fierce stretch of barren land on the eastern Silk Road between China and Central Asia. By Polo's time (1254–1324), the area was renown as a uniquely punishing environment; travelers kept the proper course by following trails of scattered bones. And yet, in the first century B.C., a Chinese ambassador to Central Asia spoke of the same desert quite differently. He described Loulan, an oasis community of 14,100 people, thriving on the shores of Lop Nur (a salt marsh) in the Desert of Lop.

So, the questions became: What happened to the people of Loulan? How and when did this bustling community cease to exist? How did a salt marsh teeming with life become a waterless, desolate desert wasteland? To answer these questions, we must examine ancient mummies, solve the mystery of a



The Beauty of Loulan

wandering lake, and examine the effects of climate change in the region.

The 'Beauty'

Marco Polo's Desert of Lop was—and is—sandy, dry, and salty. These conditions make it perfect for the spontaneous formation of mummies through natural processes. Surprisingly, the oldest mummies that have been found in the Loulan region are approximately 4,000 years old. The best known of these is called “The Beauty of Loulan” because of her lovely features, gentle smile, and remarkable state of preservation. The Beauty's clothing is made from woven wool and fur; a goose feather tops her felt hat. Her grave goods included a comb, a small basket containing wheat, and a large winnowing tray. Not far from Beauty, archaeologists discovered additional graves with fascinating features: Each was marked with approximately 900 wooden posts arranged in

concentric circles 164 to 197 feet across.

These early burials provide interesting details about Loulan's first residents. Baskets of wheat indicate the practice of agriculture. Animal bones and wool indicate animal husbandry. Feathers, baskets, and leather clothing demonstrate that Loulan's ancient residents also hunted and fished.

So, the evidence is clear: 4,000 years ago, Loulan was a comfortable, water-rich environment. How do we know this? Well, fish require water, as do geese. Grazing animals and crops also need steady supplies of water, and so would the numerous trees used as grave markers in the area.

Moreover, it appears to have stayed that way for at least 2,000 years, because Loulan's earliest residents remained on the shores of Lop Nur, even as additional populations migrated in, bringing new technologies. For example, at nearby Yingpan, a cemetery dated from 300 B.C.–A.D. 500 was marked by tall poles.

However, the tombs contained iron goods, silk, and cotton in addition to baskets of grain.

Nature Wins

During China's Han Dynasty (206 B.C.–A.D. 220), Loulan was a critical stop on the Silk Road, but faced difficulties with water management. The Tarim River brought the essential snowmelt, but fluctuated wildly. The people of Loulan built extensive irrigation channels and attempted to dam the river. But, during spring floods, the dam proved useless. The frustrated governor of Loulan ordered prayers and sacrifices. When that did not help, he ordered his troops to attack the river with weapons!

In about A.D. 330, the people of Loulan lost their battle with the Tarim River because floods changed the river's course to the south. Loulan was stranded and disappeared beneath



A satellite image of the Desert of Lop, showing a dust storm blowing to the west. In the center is the Tarim Basin where there was once the salt marsh Lop Nur. Two lakes are visible at top in the break in the clouds over the plateau.



the desert. Lop Nur, the salt marsh, became the desolate no-man's-land of Marco Polo's tales.

A Mystery Solved

In the 19th century, stories of lost cities in the Tarim Basin tantalized European explorers, who turned to Chinese sources to locate them. Still, they could not find Loulan and Lop Nur. What they did uncover was a small lake, Qara Qoshun, more than



The Tarim River today—who would guess that it has changed course several times?

actually made it the natural, low channel that the river followed

when it again changed course. And, in 1928, the Tarim River did change course again, from Qara Qoshun back to Lop Nur—proving Hedin's theory.

WHAT DRYNESS DOES

Still, Lop Nur never returned to its former level. This is partly because the water needs of a growing population have put pressure on the Tarim River. However, a clear pattern of progressive desiccation (drying out) is emerging in Central Asia. Some scientists believe that this dryness has been happening for millennia, with a brief

100 miles to the south. Were the Chinese sources incorrect, they wondered.

Then, around 1900, a Swedish explorer named Sven Hedin found Loulan, but by accident! Later, when surveying the region, Hedin also unraveled the mystery of Lop Nur. He theorized that the Tarim River changed course periodically and that it did

so when the riverbed and terminal lake filled with silt and sand. He reasoned that, as the desert winds hollowed out the vacant watercourse, they



Just a fragment has survived, but imagine it as a piece of clothing on a person in ancient Loulan.

An uncovered burial site in the Tarim Basin



How soft this beautifully designed silk fragment must have been when the complete garment wrapped around a person living in Loulan.

interruption around 3000 B.C., following a brief reglaciation of the nearby mountains. This explains the vibrant culture in the Loulan region in 2000 B.C. As the glaciers melted, the Tarim Basin would have become unusually green and attractive.

Today, the mountain glaciers are shrinking, and snowmelt is decreasing. Many archaeological sites are now stranded in the open desert where rivers no longer reach. While this is bad news for the residents of the Tarim Basin who live in the rain shadow of the Himalayas, the extreme dryness of the Tarim Basin has given us magnificent archaeological finds, such as the Beauty of Loulan.

Freelance writer and poet Lisa Kang is an adjunct instructor at East Central College in Union, Missouri, teaching Chinese language, Asian civilization, and Islamic civilization.

Catch the Mistakes!

BY CHARLES F. BAKER



A BUDDING ARTIST TRIED TO MAKE A COPY OF OXHIDE BOOTS FOUND AT LOULAN, BUT HE MADE SIX ERRORS. CAN YOU FIND THEM?

Loulan Boots



Copy of Loulan Boots



Answers are on page 32.

DID CLIMATE CHANGE INFLUENCE THE CLIFF DWELLERS OF THE AMERICAN SOUTHWEST?

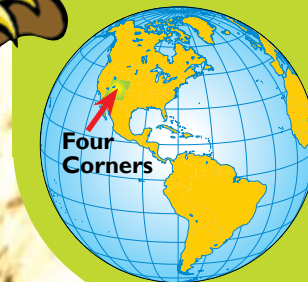
BY ALBERT GARCIA

MOVIN'

ON

UP!

Write to me!
askdr.dig@caruspub.com



Imagine stepping outside your home and finding yourself hundreds of feet high, perched dangerously on the edge of a steep cliff.

In the 13th century, this was daily life for many families in the American southwest. After living for more than 1,000 years on fertile canyon floors and mesas, people suddenly moved into homes built into the recesses of vertical canyon walls. Some of these remaining adobe structures are nearly impossible to reach even by today's most experienced rock-climbers. Within a couple of generations, however, the cliff-side homes were abandoned. For decades now, archaeologists have been scratching their heads with their trowels wondering what exactly happened.

Could a changing climate have been the culprit?

HARD TIMES AND HARD CLIMBS

As early as 1500 B.C., the Four Corners area was home to a culture known as Ancestral Puebloans. By A.D. 1100, these people successfully mastered their environment and became the largest population to live in the area until modern times.

But something changed. By the mid 1200s, the archaeological record shows an increasing presence of violence: more weaponry and warlike imagery, homes burned with the occupants inside, and unburied skeletal remains with signs of excessive trauma. Villages on the canyon floors disappeared. People either moved into fortress-like homes in protective positions along cliff-sides and steep mesas or away from the area altogether.

The dwellings usually were built within sight of other cliff dwellings, suggesting that the residents may have been preparing to help one another. Then, just as mysteriously, these homes were abandoned in less than a couple of generations. The Cliff Dwellers moved on, most likely becoming today's Zuni and Hopi tribes of northern Arizona and southern New Mexico.

SIFTING FOR CLUES

An archaeologist's job requires painstaking research using every method possible. One useful technique, dendrochronology, analyzes tree rings to see how they grow over time. The results tell us what past climates were like. (See also page 9.)

Pieces of wood from the region show that beginning around A.D. 900 and lasting 300 years,

more rain fell in the Southwest. Food production increased, the population grew, and large buildings were constructed. One such building was Pueblo Bonito (Spanish for "Pretty Village") in Chaco Canyon, New Mexico, which stood five-stories tall and consisted of more than 800 rooms.

This period of abundant resources was followed by a mini ice-age, delivering less rain, fewer resources, and stress on a finely balanced system. The climate shift is also evident in Europe's history: Crop failures in the early 1300s led to widespread famine.

The remains of the
Ancestral Puebloan
apartment complex
known today as
Montezuma's Castle

DID CLIMATE CHANGE CAUSE CULTURAL CHANGE?

While this explanation seems like a logical conclusion, the Ancient Puebloans had survived earlier droughts. There may have been a number of cultural and/or environmental factors that compelled families to leave their ancestral lands, from a change in religious beliefs to the overuse of local trees for firewood and construction.

There are still many mysteries and disagreements as to what happened to the Cliff Dwellers. What is certain, however, is that a changing environment can impact the way we live. Thus, understanding the past may help us plan not only for the present but also for our future.

Albert Garcia is a researcher and geographic information systems specialist at the South Central Coastal Information Center at California State University in Fullerton, California.

A COMPLETE WASHOUT

BY GORDON GRIMWADE



DETECTIVE TACTICS AT WORK HERE

In February 1861, storm clouds were gathering over the United States and, across the Pacific, in north Australia. In America, it was the storm clouds of civil war. In Australia, it was the wet season storms that annually deluge the tropics.

At the same time, the ill-fated Burke and Wills expedition was attempting the first crossing of continental Australia, south to north, by Europeans. Robert O'Hara Burke had left the main expedition behind and, with just three of his men—William Wills, John King, and Charles Grey—headed north. In early February 1861, they camped beside the Bynoe River at “Camp 119.”

The expedition's northernmost camp, it lay about 30 miles from the coast.

WHEN 'BLAZE' DOES NOT REFER TO FIRE

Burke and Wills then set out across the flooding lowlands to reach the north coast. Soon after they left, Billy, their horse, became bogged in “Billy Creek” (no prizes for guessing how it got that name). Fortunately, they dug him out but their goal eluded them. The storms had turned the land into a lake.

Meanwhile, at Camp 119, King and Grey

Burke and Wills blazed this tree at the Bullah Bullah Waterhole on Coopers Creek. The inset at far right shows a closeup of the blaze, which reads LXV—that is, Camp 65. *Opposite:* Burke, Wills, and King battle the elements on their way back from the Gulf of Carpentaria.

blazed several trees, which means they cut marks into them. This action actually turned out to be more important than they realized. On the return trip south, Grey, Burke, and Wills died. King was found, months later, in the care of friendly Aborigines.

In January 1862, Frederick Walker's relief expedition discovered Camp 119. The blazed trees had proved critical in showing the team the route the expedition had taken. Walker dutifully marked another prominent tree:
FW 6 Jan 1862 DIG N 6 FT

Soon after, Camp 119 slipped from memory.

FOUND!

In 1909, a remote cattle ranch owner reported some blazed trees to the Royal Geographical Society of Queensland. Dr. James Thomson, the society's





Crocodiles made research at Camp 119 more challenging. Fortunately, this one was a freshwater crocodile, and it prefers fish to archaeologists.

founder, was sent to investigate, and he later confirmed the rediscovery of Camp 119. The good doctor, however, did what others had done before him. He blazed another tree, but on high ground near Billy Creek.

Almost a century later, Camp 119, which was then listed as an important heritage site, had a rough track leading right to it. Archaeologists were sent to prepare a management plan. They found most of the trees scarred by King and Grey were still identifiable. As for Walker's tree, it was obvious, although the lettering had disappeared.

Thomson's tree, however, could not be found, and Billy Creek was a mystery as the nearest river was nearly 100 yards wide. Out in the center of it could be seen the shadowy outlines of a few fallen trees—and a few crocodiles.

Between 1909 and 2010, the Bynoe River had carved a new course. The river Burke and Wills had seen was now a developing ox-bow lake, and Billy Creek was the main riverbed. Thomson's tree site lay in the middle of the river. Over time, cyclones, also known as typhoons, had transformed the area.

Back at Camp 119 it was

noticed that the scar on Walker's tree was the right size and shape but the wrong height above ground level. In addition, several of King and Grey's scars were partially buried. Why?

AND THE ANSWER IS...

All those storms had created another change. Soil had washed from a nearby ridge and settled right where Burke and Wills had camped in 1861. In fact, the same storms that had ripped Thomson's tree away were burying Camp 119.

It was several 20th-century photographs that provided the clues. By measuring the scars in the photographs, research shows that, between 1909 and 1961, the soil rose about 1.5 inches. Since then, the rise has more than doubled, a situation made worse by bad access road planning. And, if nothing is done, the site could disappear within a few more years.

In Australia, the annual storms since 1861 have helped change the face of a continent. In America, those 1861 storm clouds transformed a nation, but in a far different manner.

Gordon Grimwade is an historical archaeologist and writer based in north Queensland, Australia.



NOW
HERE'S A
PLACE I
LOVE!

THE ANSWER'S IN THE STALAGMITE

BY PAULA NEELY

CAN'T QUESTION THIS EVIDENCE!

Surprising evidence from a 7,000-year-old stalagmite (right) in West Virginia has revealed that native peoples began affecting global climate as early as 100 B.C.

CAVE ICICLES

Stalagmites look like upside down rocky icicles on cave floors. They are formed by ground water that drips onto these floors. As the water evaporates, minerals in the water harden and build up very slowly into spiky formations. The West Virginia stalagmite was found near a cave where a Native American community lived 2,000 years ago. As it grew, it recorded changes in the environment.

When scientists analyzed chemicals in slices that they had cut from the stalagmite, they discovered that a significant amount of carbon had been released into the local eco-system beginning in 100 B.C. The carbon deposits peaked around 1400, and then began again after European colonists settled the area in the 1800s.

According to Gregory Springer, an associate professor of geological sciences at Ohio University, the evidence suggests that the Native American practice of burning trees to clear land

and control the species of trees in the forests released a significant amount of carbon into the atmosphere. For example, nut trees are fire resistant so they would have survived the fires, thrived with less competition from other trees, and produced more food for the natives.

CHARCOAL CLUE

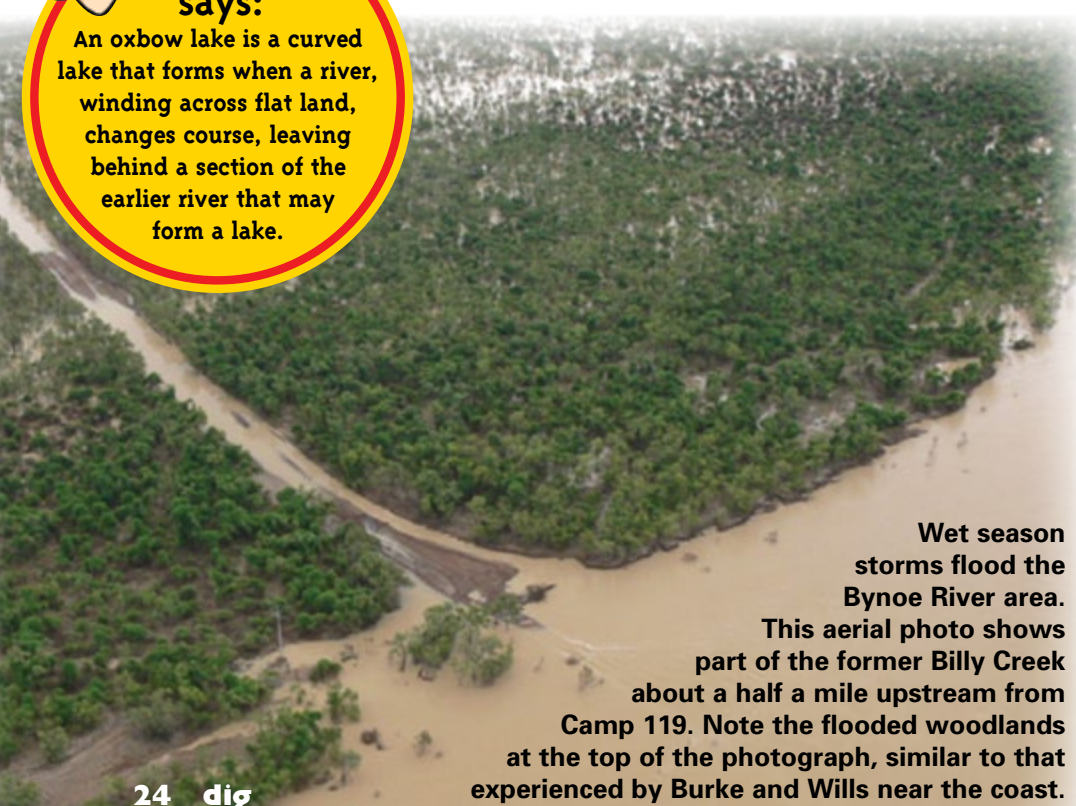
But the land clearing would also have impacted global climate. When forests are set on fire, carbon stored in trees, leaves, and soil burns and becomes carbon dioxide, a greenhouse gas that traps heat and reflects it back to earth, causing global warming. Evidence of charcoal in stream sediments and carbon isotopes in the soil above the cave corroborated the record stored in the stalagmite. Springer also says that the study shows that even though the natives were better land stewards than the European colonists, they apparently cleared more land and burned forests more frequently than previously thought.



(The coin is for size comparison.)

Dr. Dig says:

An oxbow lake is a curved lake that forms when a river, winding across flat land, changes course, leaving behind a section of the earlier river that may form a lake.



Wet season storms flood the Bynoe River area.

This aerial photo shows part of the former Billy Creek about a half a mile upstream from Camp 119. Note the flooded woodlands at the top of the photograph, similar to that experienced by Burke and Wills near the coast.

GO AWAY!

WHY
THE

WHY TREES ARE THE
ARCHAEOLOGIST'S
FRIENDS.

BY PAULA NEELY

By studying tree rings, also known as dendrochronology, scientists have identified devastating droughts and floods that occurred during the past 1,000 years and may have contributed to the fall of the ancient Angkor Empire in what is now Cambodia. These weather phenomena may also have led to the collapse of other kingdoms throughout Southeast Asia.

A TIME-CONSUMING TASK

To find trees that were old enough for the study, researchers spent 15 years trekking through mountain cloud forests, rainforests, and national parks in Southeast Asia looking for rare 1,000-year-old trees. Using a small drill, much like an apple corer, they extracted tiny cores from thousands of trees (see also page 9). The cores are about the diameter of a pencil and show the growth rings. Fortunately, the process does not hurt the trees.

By measuring the width of the rings, scientists were able to determine how much rain fell each year.

When the rainfall had been considerable, the trees grew a lot and produced a large ring. If there was a drought, they did not grow as much and produced a smaller ring.

Dr. Dig
says:

Angkor covered
about 386 square
miles—about
the size of
Los Angeles.

The tree ring evidence, combined with archaeological evidence, points to a 30-year mega-drought in Angkor from 1330 to 1360 that was previously unknown. Another shorter, but more severe, drought occurred from about 1400 to 1420.

FROM TOO LITTLE TO TOO MUCH

Between the two droughts were periods of too much rainfall and flooding that may have weakened and contributed to the fall of the wealthy empire. Angkor is thought to have collapsed in 1431 after a raid by the Siamese from what is now Thailand.

According to Brendan Buckley, the Columbia University scientist who led the Angkor study, water for drinking and agriculture would have been limited during the droughts. In addition, the floods would have damaged the empire's extensive irrigation system that was essential to growing rice, the principal crop in the area. The conditions could also have led to a rise in infectious disease.

As you can see from this aerial view, water and trees surround the temple of Angkor Wat. Below right: The calm waters reflect the majestic front side of the main complex at Angkor Wat.



catastrophic events in history, including the fall of China's Ming dynasty (1644) and the French Revolution (1789–1799). They have also led to famines that have killed millions of people.

Today, nearly 50 percent of the world's population lives in Southeast Asia and depends on the monsoon—the annual rainy season—to grow its food. During most of the year, the area is dry as winds blow across the land to the ocean. But, during the monsoon, the winds reverse and blow from the ocean to the land, usually bringing heavy rains. When the rains

Archaeologists at Angkor have found evidence of damage to the canals from severe droughts and extremely heavy rainfall. These include debris blocking the canals and sudden erosion that cut through them. There is also evidence that the canals were rerouted and rebuilt in an effort to address water shortages.

Other tree-ring studies identified a previously unknown, severe 30-year drought that occurred from 1750 to 1780. It was at this time that all the kingdoms in what are now Thailand, Vietnam, and Myanmar collapsed. Buckley first identified the drought in the rings of teak trees from Thailand and later discovered it in Vietnamese cypress trees. The drought may help explain why sweeping political changes were happening simultaneously across the region during that time.

NOT JUST ANGKOR

Drought conditions have been tied to other



do not come, crops fail, and people go hungry.

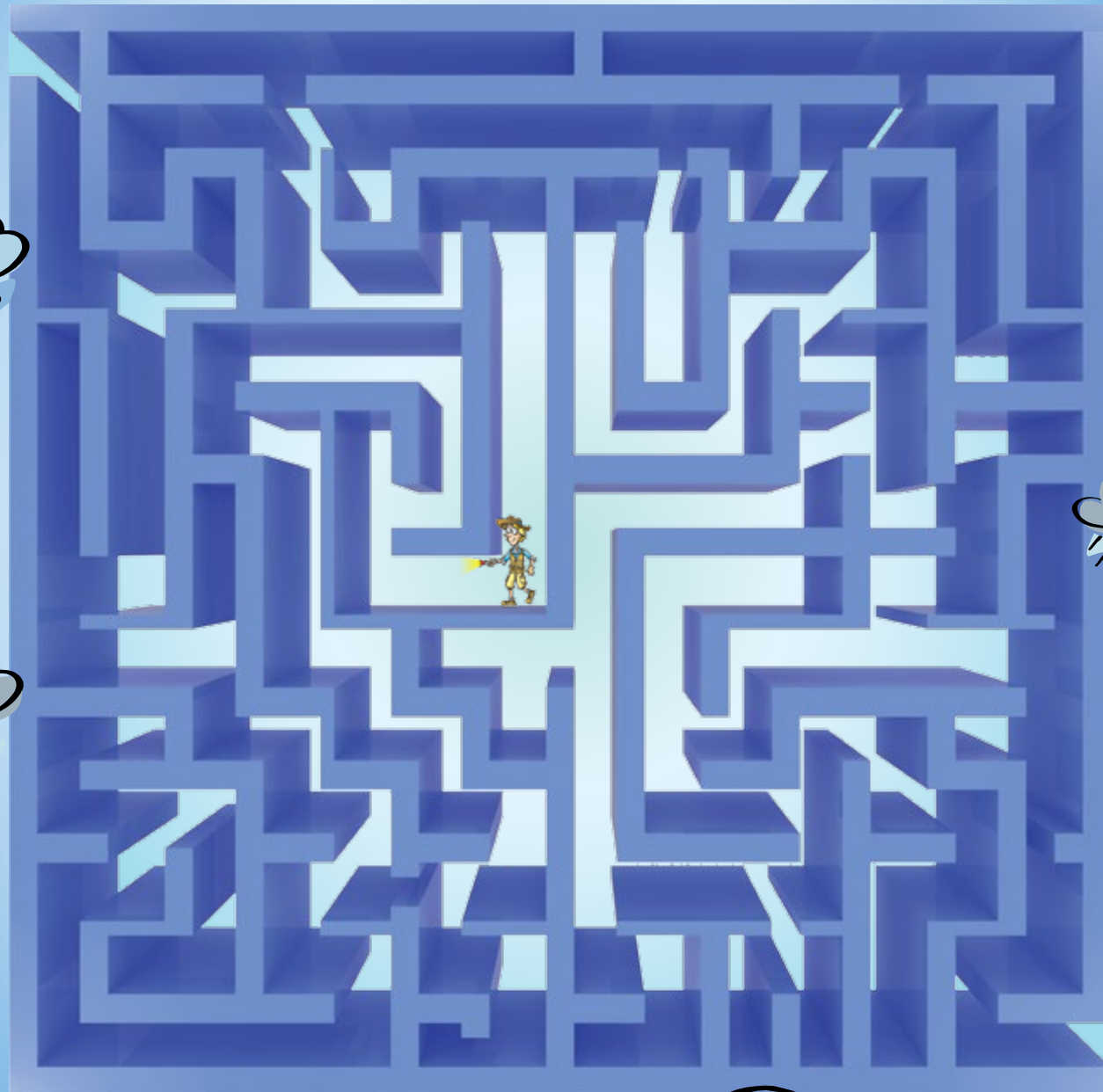
Based on Buckley's tree ring data and data from other scientists, researchers have developed a chronology of Southeast Asia monsoons during the past 1,000 years that may help scientists predict and plan for future droughts and floods. The record of annual rainfall can be compared to other climatic events, such as El Nino and sea-surface temperature changes. Further studies may also lead to a better understanding about what causes changes in the monsoons.

Paula Neely also writes for National Geographic News and American Archaeology magazines.

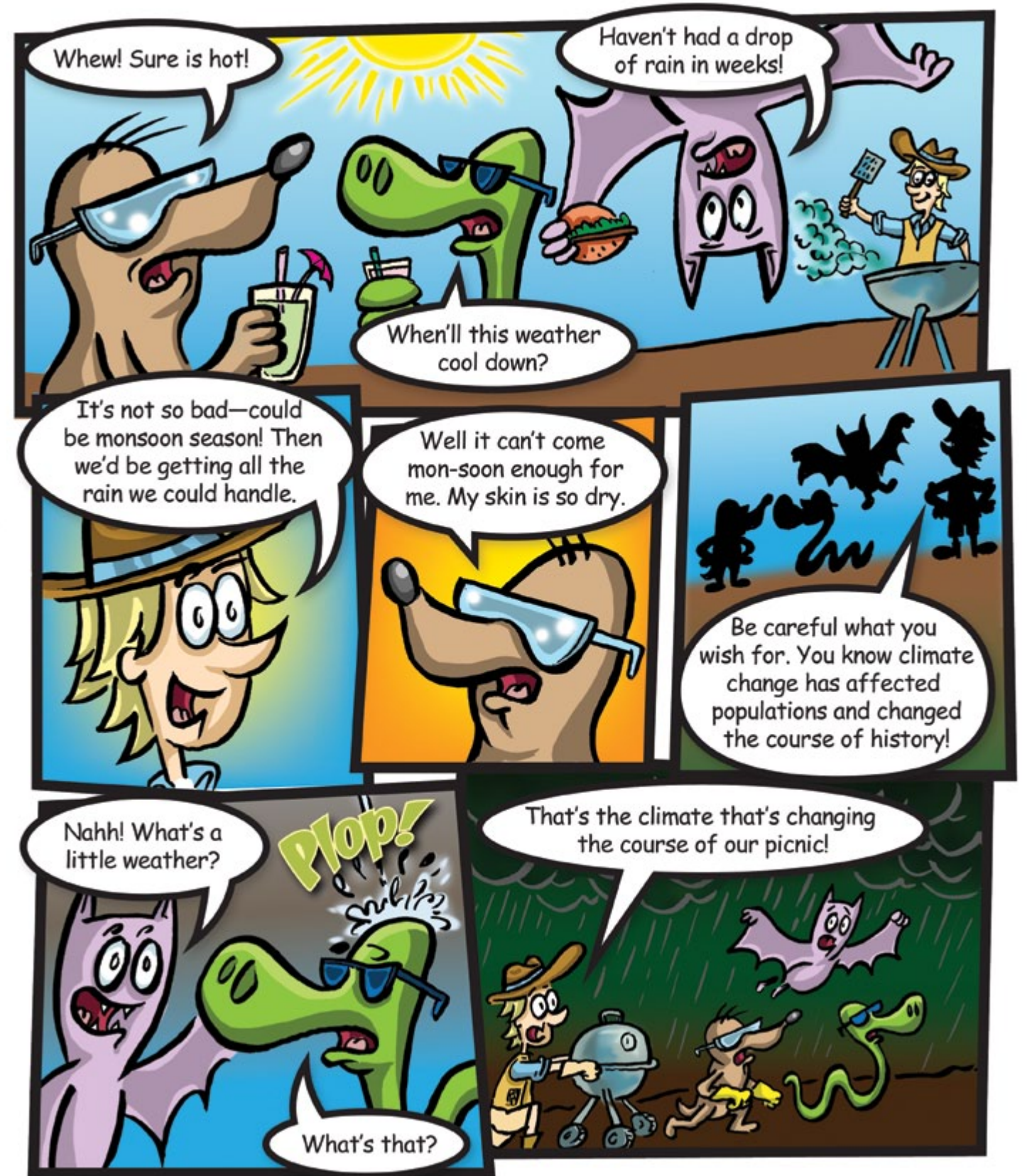
OVERWHELMED!

BY CHARLES F. BAKER

Water, ice, wind, and rain—all combine to keep Dr. Dig from exiting the excavation site—both to the north and to the south. Can you find a safe route for Dr. Dig? How about an alternate route? But, be prepared. It will be a tight squeeze through some areas!



THE ADVENTURES OF dr. dig BY DOUG BANTZ



WRITE TO ME AT
DIGSTUFF@CARUSPUB.COM
OR DIG STUFF, 30 GROVE STREET,
PETERBOROUGH, NH 03458

LORENZ BRUECHERT'S STUDENTS AT LORD KITCHENER
ELEMENTARY SCHOOL IN VANCOUVER (A CITY IN CANADA'S
BRITISH COLUMBIA PROVINCE) HAVE BEEN STUDYING ABOUT
PALEO-INDIANS AND SENT DIG SOME OF THEIR WORK:

There are many theories and evidence that help archaeologists paint a picture of how and when America was populated. Paleo-Indians are believed to have been the first people to have arrived. There are theories to suggest they came inland from the north and traveled south about 11,500 years ago when an ice-free area opened. Evidence was found in Mexico in 1932. They found Clovis points made of stone that the Paleo-Indians used for spearheads. More were found inland, and these sites became known as the Clovis sites and the "Inland Theory." It was about this time that a number of animals started to become extinct, suggesting the Paleo-Indians hunted big game following Ice Age animals like woolly mammoths, bison, elk from Asia to Alaska across Beringia. Onslaught on fearless animals was massive, and it is for this reason it is suggested that the Paleo-Indians were blamed for the extinctions of many animals. But, there are other theories, like the Coastal Theory and the Monte Verde Theory, that suggest the Paleo-Indians appeared earlier than the Clovis sites and by different routes. Even climate became a factor possibility for the extinctions of many animals. Fossil finds, carbon 14, and DNA analysis also help us get a better look at the past.

—Matteo

The Paleo Indians had a hard life. Paleo Indians lived in North America, where the climate is cold and covered in glaciers and snow. The winters were long, and the summers were short. For survival, they hunted very large animals. One of the animals was the woolly mammoth. The woolly mammoth helped the Paleo Indians because it was their food. The Paleo Indians used the tusks for shelter, and the animal hides covered the outsides. That is how the Paleo Indians had a hard way of survival.

—Madeline



THANKS,
MATTEO AND
MADELINE. THE
PALEO INDIANS
WOULD BE SO
PROUD TO READ
WHAT YOU'VE
WRITTEN.

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Jamestown 1689



Benedict Suciu, age 9
Edmonds, Washington

Dr. Dig in the caves with
his Trusty Flashlight



Praying to a Moai



Kathy, age 11
Leesburg, Virginia

Pyramids of Giza



Lexi Hanly, age 12
Aurora, Colorado

Nickolas Apher, age 9
Sturbridge, Massachusetts



Ellie Castano, age 7
Missouri City, Texas

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artwork to:
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Answers:

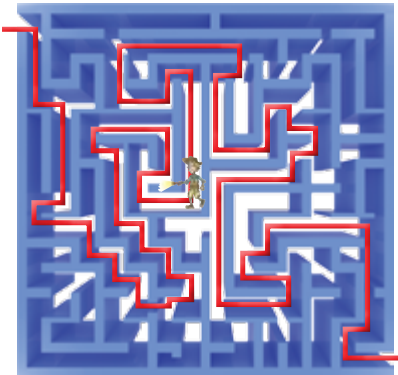
Page 14: Scramble Mess:

1. proxies; 2. borer, core; 3. skeleton;
4. ice sheets; 5. sediment; 6. temperature;
7. seawater. Place in Africa that was not
always dry and sandy: Sahara Desert.

Page 19: Catch the Mistakes!:



Page 28: Overwhelmed:



art-i-facts

MEET BA'AL

Fantastic factoids about
ancient sites, historical objects,
and amazing discoveries

The eastern coast of the Mediterranean Sea is sometimes called the Levant. There, the climate can be very hot and dry. Further, because there are not many rivers or streams and months can pass without a drop of rain, control of water is an extremely important concern for people. Where there is water, there is life and crops can grow; when there is rain, there is fertility. For this reason, in the Levant, the god of rain and storms was considered extremely powerful. He was called Ba'al Hadad. In the area, clouds often cover the summits of mountains and seem to collect there before storms.

Ba'al was said to live on a mountaintop and is sometimes depicted standing on mountains. He is usually shown striding, wearing a short kilt with one arm raised and the other held out in front of him. This pose may have been borrowed from traditional Egyptian representations of kings, which often show the king in a stance much like the one Ba'al takes here, about to smite (strike) his enemies.

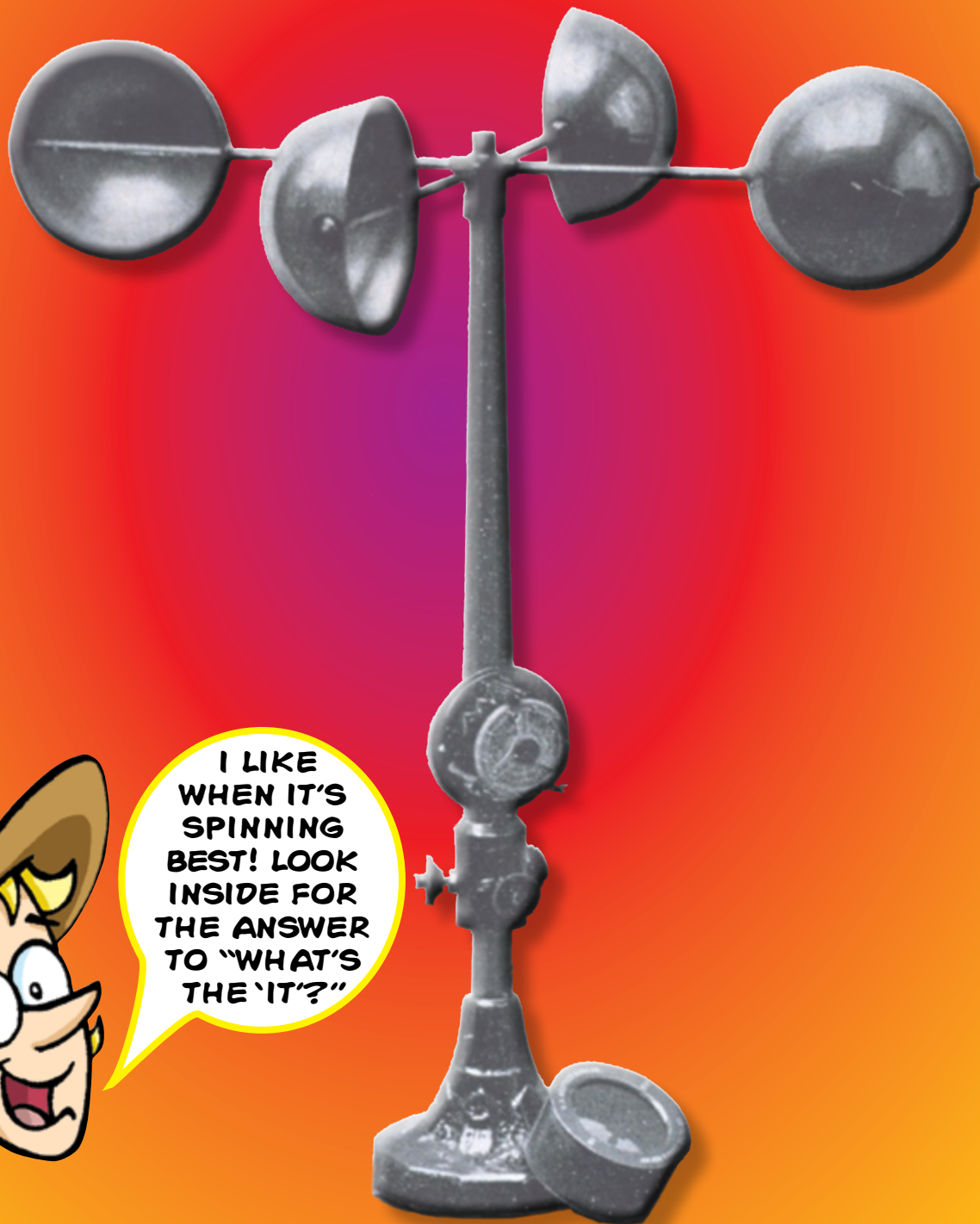
The name Ba'al means "lord," and the pose of Egyptian kings was presumably thought to be fit for a ruler. As do the Egyptian figures, so Ba'al carried, in his upraised arm, a club, which he was about to strike downward. He wore a tall headdress with a bulb at the top, like the crown of Upper Egypt. The object Ba'al carried in his other hand is missing in this 14th- to 12th-century B.C. sculpture found at Ras Shamra (ancient Ugarit) in present-day Syria. It would have been a branched staff that symbolized lightning, an attribute of storms.

—Angela Murock Hussein



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what's this?



I LIKE
WHEN IT'S
SPINNING
BEST! LOOK
INSIDE FOR
THE ANSWER
TO "WHAT'S
THE 'IT'?"

THE PERFECT PARTY

illustrated by Chuck Whelon

WHAT'S THIS?
IT LOOKS LIKE AN
INVITATION.

PLEASE JOIN
DR. CY BORG
FOR A
CELEBRATION OF
ODYSSEY'S 20TH
ANNIVERSARY!

A PARTY AT
DR. CY BORG'S.
COOL!

IT'S MORE THAN
COOL, EBENEZER,
IT'S FREEZING!

WHERE DID
ALL THIS SNOW
COME FROM?



THIS
UNEXPECTED
SNOWSTORM IS
TURNING OUT
TO BE FUN.

IT'S A
SNOWBENEZER!

HA, HA.
VERY FUNNY.

I HATE TO
MISS THE PARTY,
BUT IT'S NOT SAFE
TO TRAVEL IN THIS
BLIZZARD.

YOU NEED
FUR COATS
LIKE US!

MY
HAT!

I'LL GET IT!
WHOOPS!

CAN WE HEAD
OVER TO DR. CY
BORG'S PARTY
NOW? IT'S JUST
OVER THE NEXT
HILL.

LOOK!
THE SNOW IS
STOPPING.

FIRST A BLIZZARD,
NOW A TORNADO?
WHAT'S GOING ON?!

MEANWHILE, BACK AT DR. CY BORG'S LAB . . .

HOW DID THIS TEMPERATURE
DIAL GET TURNED DOWN?

THE APPLESEEDS KIDS ATTEND



PLEASE JOIN DR. CY BORG FOR A CELEBRATION OF ODYSSEY'S 20TH ANNIVERSARY!

HEY, GUYS! DR. CY BORG SENT US A PARTY INVITATION.

GREAT, LET'S GO.

SHE SHOULD HAVE TWEETED.

MAYBE THERE WILL BE CRAFTS!

BUT NOT ORIGAMI, I HOPE.

THIS WIND CAME UP OUT OF NOWHERE.

I THINK IT'S GETTING TOO DANGEROUS TO BE OUT.

THIS IS TOTALLY MESSING UP MY HAIR.

LET'S STOP AT MY HOUSE UNTIL THIS HURRICANE BLOWS OVER!

THIS IS CRAZY!

WHOA!

WHAT A POWERFUL STORM.

IT CERTAINLY RUFFLED MY FEATHERS.

HEY! I THINK IT'S FINALLY LETTING UP!

DO YOU THINK IT'S SAFE TO HEAD TO THE PARTY AGAIN?

THERE'S A BLUE SKY NOW. IT SURE LOOKS SAFE.

GUYS? IT LOOKS LIKE A TORNADO IS HEADED THIS WAY NOW!

LET'S HURRY AND GET TO THAT PARTY. WE'RE ALMOST THERE!

MEANWHILE, BACK AT DR. CY BORG'S LAB...

WHAT'S HAPPENING? MY WEATHER FANS ARE GOING CRAZY!

THE PERFECT PARTY

PLEASE JOIN
DR. CY BORG
FOR A
CELEBRATION OF
ODYSSEY'S 20TH
ANNIVERSARY!

A PARTY?
HOW DELIGHTFUL!
WHAT SHALL
I WEAR?

**1001
Science
Experiments**

by Dr. Bunsen Burner

I HOPE
DR. CY BORG
LIKES MY
GIFT.

LIGHTNING
BOLTS FROM
THE SKY?

IS ZEUS
DISPLEASED
WITH MY PARTY
OUTFIT?

I'D
BETTER SEEK
SHELTER!

IN ANCIENT
GREECE, MANY PEOPLE
WOULD HAVE INTERPRETED
A DRAMATIC STORM LIKE THAT AS A
SIGN THAT THE GODS WERE ANGRY
WITH THEM.

OH, NO! WHAT
NOW? IS THAT A
TORNADO?

THANK
GOODNESS THAT
LIGHTNING STORM
PASSED. IT
ALMOST SEEMED
UNNATURAL.

MEANWHILE, BACK AT DR. CY BORG'S LAB . . .

THE ELECTRICAL POWER
IN THESE NANOBOTS SHOULD
LIGHT THINGS UP!

THE PERFECT PARTY

PLEASE JOIN
DR. CY BORG
FOR A CELEBRATION
OF ODYSSEY'S 20TH
ANNIVERSARY!



SSSSWEET!

I CAN
DIG IT!

WHAT FUN!
SHALL WE
HEAD OVER?

WHY ARE
MY GOGGLES
SO DIRTY?

WHAT AN
AWESOME DUST
STORM!

GOOD
THING I
HAVE
RADAR!

IT'S LIKE
AN INSTANT
DROUGHT.

THIS IS
VERY UNUSUAL.
WE JUST HAD A
THUNDERSTORM

I CAN'T
SEE!

STAY
TOGETHER!

LOOKS LIKE
A TORNADO IS
FORMING, TOO.
HOLD ON!

MEANWHILE, BACK AT
DR. CY BORG'S LAB...

MY BLADELESS
AIR-MULTIPLIER AND
-SPREADER SYSTEM SHOULD
DRY UP ALL THAT SOGGY RAIN.

DEAR TOMMY...

PLEASE JOIN
DR. CY BORG FOR
A CELEBRATION OF
ODYSSEY'S 20TH
ANNIVERSARY!

THE PERFECT PARTY

COOL!

WILL
THERE BE
SNACKS?

WHAT SHOULD
WE BRING TO THE
PARTY?

I'M BRINGING
MY APPETITE!

WHAT A GREAT DAY
FOR A HIKE.

I HOPE
DR. CY BORG WILL
SERVE BARBECUE
MEATBALLS. THEY'RE
MY FAVORITE!

WOW! WHERE DID ALL
THIS WATER COME FROM?
IT'S TOO LATE TO TURN
AROUND. GOOD THING WE'RE
ALWAYS PREPARED.

YOU COULD'VE
PACKED A
COMPRESSOR.

HELP ME
INFLATE OUR
PORTABLE
RAFT.

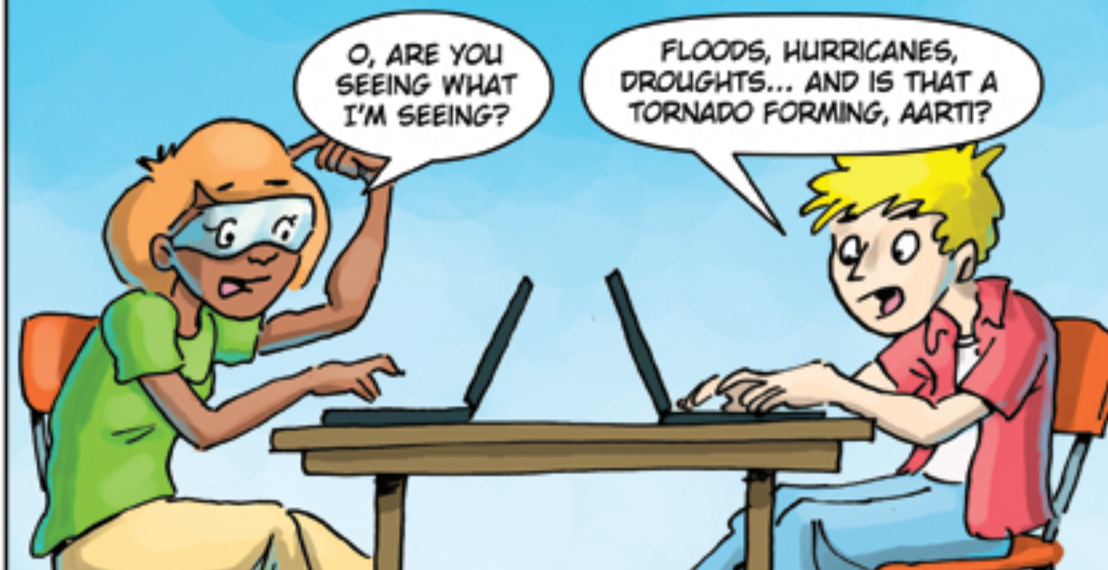
MEANWHILE, BACK AT DR. CY BORG'S LAB...

THIS IS NO TIME FOR MY
SUPER WEATHER NANOBOTS
TO FAIL ME!

IS THAT A
TORNADO IN THE
DISTANCE? HANG
ON, BINGO! IT'S
WORSE THAN I
THOUGHT.

THE PERFECT PARTY

PLEASE JOIN DR. CY BORG
FOR A CELEBRATION OF
ODYSSEY'S 20TH ANNIVERSARY!



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