GOES Weather Quiz

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Explanations of the Answers

Effects

(1) The human body works well only within a narrow range of temperatures (98.6º F, give or take a degree or two), and has good ways to keep its temperature stable in both cold and hot environments. When we are too hot, we perspire as a way to cool off. Bodies that are not used to the heat may not respond well enough and their temperature may climb to 105º F or more. A person in this kind of trouble may be very tired and confused, and may lose consciousness. These are symptoms of heatstroke. Cool this person off and get medical help immediately!

(2) The human body works well only within a narrow range of temperatures (98.6º F, give or take a degree or two), and has good ways to keep its temperature stable in both cold and hot environments. When we are too cold, we shiver, which helps generate body heat. Also, the blood vessels near the skin get smaller, so less heat escapes. Our hands and feet have more surface area exposed compared to the volume of blood to keep them warm, so they get cold first and may actually freeze in extreme cold. If the body loses too much heat in spite of all its defenses, core body temperature will drop dangerously below normal. This condition is called hypothermia and can be fatal.

(3) The wings of an airplane are shaped so that as air rushes over them, the air pushes harder on the bottom of the wing than on the top. This higher air pressure on the bottom of the wing is what lifts the airplane off the runway and keeps it aloft. The faster the wing moves through the air, the more lift the air provides. That is why an airplane has to go a certain speed on the runway before it can lift off. Hot air is thinner (less dense) than cold air, so to get the same amount of lift in hot air, the airplane has to go faster. Of course, this also means the plane will need more of the runway to accelerate to the necessary speed.

(4) The light we can see isn't the only kind of light the Sun puts out. Ultraviolet (UV) light from the Sun, although invisible to humans, carries more energy than visible light and, over time, can damage living cells. Fortunately, Earth's atmosphere absorbs the worst of it, but some does get through. The ozone layer (10-20 miles up) in Earth's atmosphere helps protect us from UV. Unfortunately, some of the pollutants that humans have been releasing into the atmosphere are acting to destroy some of that ozone, thus letting through more of the harmful UV. It is more important than ever for us fur-less and feather-less creatures to protect our skin with clothing and sunscreen.

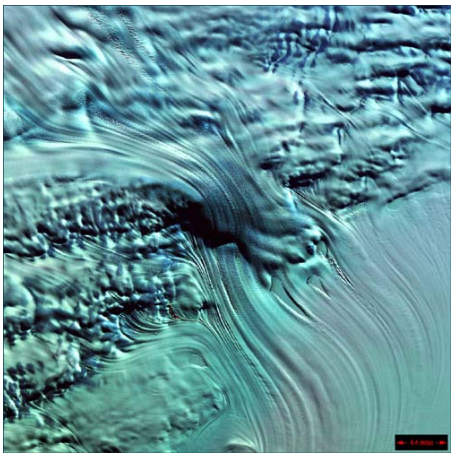
(5) Jet streams are the world's fastest winds (except for occasional severe storms, like hurricanes and tornados), blowing 128 to 304 kilometers (80 to 190 miles) per hour. Temperature differences cause them to form in the upper atmosphere, above 9,000 meters (30,000 feet). The Coriolis effect (caused by Earth's rotation) causes these winds to curve. If airplane pilots can catch a ride on a jet stream as they fly east, they can save lots of time and fuel. Obviously, on the trip back west, they try to avoid the jet stream!

(6) A tornado looks like a funnel-shaped cloud, extending down from thick storm clouds toward the ground. Winds up to 480 kilometers per hour (300 miles per hour) have occurred inside these powerful whirlwind storms. When they touch the ground, they make a mess of everything that gets in their path. The United States gets more tornadoes than any other country, most often in the central plain states where cold, dry air flowing south from Canada meets warm, moist air flowing north from the Gulf of Mexico. The thunderstorms that develop where they meet are great birthing places for tornadoes. The GOES environmental satellites can "watch" for these severe weather conditions so that weather forecasters can warn people to prepare for possible tornados.

(7) Lightning occurs when electricity travels between areas of opposite electrical charge within a cloud, between clouds, or from a cloud to the ground. Lightning bolts between cloud and ground start with electrons (negatively charged particles) zig-zagging downward from the cloud, drawing a streamer of positively charged ions up from the ground. The lightning "seeks" the shortest path between the cloud and ground, so will strike whatever trees or tall structures are handy. You don't want the tallest thing to be you or anywhere near you! A car's rubber tires do not conduct electricity very well, so can insulate you from the ground. Tall buildings usually have lightning rods to conduct the electricity harmlessly into the ground. If you are caught outside, crouch on the ground to stay low while balancing on the balls of your feet so you have as little contact with the ground as possible.

(8) When too much rain falls too fast, the ground may not be able to absorb it or drain it by the usual channels of streams and rivers. Especially in mountainous areas, a severe downpour can dump huge quantities of water onto slopes and hillsides. The water flows rapidly into canyons, gushing downward in a terrifying, watery wall that drowns everything in its path. In towns and cities, especially near rivers, the ground may not be able to soak up or drain away the water fast enough, so the lower areas of the town get flooded. Or the river may breach its banks.

(9) By burning huge amounts of fossil fuels (oil and coal) and destroying forests, humans are causing carbon dioxide levels in the atmosphere to increase. Carbon dioxide is a "greenhouse gas." Too much of it in the atmosphere acts as a heavy blanket, causing Earth's average temperature to rise. As Earth warms, some of the ice in glaciers and polar regions will melt, raising sea level. Scientists have shown a direct connection between levels of carbon dioxide in the atmosphere and sea level. In the 20th century, sea levels rose 10 to 25 centimeters (4 to 10 inches). If carbon dioxide levels were to rise to double what they were before the industrial revolution, sea level could rise more than 1 meter (40 inches), which would endanger 118 million people living in coastal cities around the world. (Source: Woods Hole Research Center, http://www.whrc.org/globalwarming/warmingearth.htm)



The Lambert Glacier in Antarctica is the world's largest glacier. Image by Landsat 7.

SCIENCE

(1) A tornado looks like a funnel-shaped cloud, extending down from thick storm clouds toward the ground. Winds up to 480 kilometers (300 miles) per hour have occurred inside these powerful whirlwind storms. Meteorologists are not yet sure where these storms get their powerful spin. The United States gets more tornadoes than any other country. The GOES environmental satellites can "watch" for these severe weather conditions so that weather forecasters can warn people to prepare for possible tornados.

(2) The Sun is the engine that drives our weather. Each day and throughout the seasons, it heats some parts of Earth more than others. Cold air is more dense and exerts more pressure than warm air. So cold air tends to push its way into areas of lower pressure, causing wind. Heat from the Sun drives evaporation from the oceans, rivers, and lakes, making water vapor. Water vapor rises, condenses onto dust particles in the air and forms clouds, which can develop into storms. Earth's rotation also contributes to weather, but it is the Sun's energy that starts it all and keeps it going.

(3) Seasons occur because Earth spins on a lopsided axis. When the North Pole is tilted away from the Sun as Earth spins on its axis, it is winter north of the equator and summer south of the equator. Six months later, when the North Pole is tilted toward the Sun, it's summer in the north and winter in the south. In North America, summer officially begins about June 21. In Australia, far south of the equator, December 21 is the official beginning of summer. Latitude (a location's distance north or south of the equator) has a big effect on how warm or mild summer is, but other things are important too.

(4) When the North Pole is tilted toward the sun as Earth spins on its axis, it is summer north of the equator and winter south of the equator. In the Northern Hemisphere, summer solstice (about June 21) is the longest day of the year. This is the day the North Pole is pointed most directly toward the Sun, so the Sun is highest in the sky, rising earliest and setting latest as Earth rotates.

(5) Earth's orbit around the Sun is not a perfect circle. Surprisingly to those living in the Northern Hemisphere, Earth is closest to the Sun around January 4—about 5 million kilometers (3.1 million miles) closer than in July. Even stranger, Earth's average temperature is higher in July when Earth is farthest from the Sun! It is during this part of Earth's orbit when it is summer in the Northern Hemisphere, since this is when the North Pole is tilted most toward the Sun. Most of Earth's land masses are in the Northern Hemisphere. Land heats up faster than ocean, so the average temperature over the whole planet is warmer. However, of much more influence to the weather in particular locations on Earth are the tilt of Earth's axis, the oceans' ability to hold and move heat around, and the effects of mountains and other land forms on wind currents.

(6) The wind is caused by a complex collection of forces. Warming and cooling of the air causes changes in density, or pressure. Air tends to move from areas of high pressure to

areas of low pressure. Even very small differences in pressure from one area to another can cause very strong winds. Friction from obstacles like trees, mountains, and buildings affect winds, slowing it down, or creating updrafts, downdrafts, funneling effects, and so on.

(7) Hurricanes (also called cyclones or typhoons) usually start over warm, tropical oceans. Thunderstorms rise high into the air, causing the atmospheric pressure to drop. As trade winds in the area begin spiraling, warm moist winds in the center are drawn upward by low pressure. If the spiraling wind reaches 118 kilometers (74 miles) per hour, the storm is called a hurricane. The World Meteorological Organization has six separate name lists for hurricanes. Each list is reused every six years, with the exception of the names of storms that have resulted in major damage or death. Those names are not used again.

Hurricane Andrew, hitting Florida and Louisiana in 1992, killed 60 people, caused over $20 billion in damage, and caused 2 million people to be evacuated from their homes.

(8) Sound travels about 1.6 kilometer (1 mile) in 5 seconds. When you see a flash of lightning, start counting. If you hear thunder in 5 seconds, the lightning struck about 1.6 kilometer away. If you hear thunder in 10 seconds, it was about 3.2 kilometers (2 miles) away. If you see the lightning and hear the thunder at the same time, check to make sure you still have your shoes and socks on (check your pulse while you're at it)!

(9) A tornado looks like a funnel-shaped cloud, extending down from thick storm clouds toward the ground. Winds up to 480 kilometers (300 miles) per hour have occurred inside these powerful whirlwind storms. When they touch the ground, they make a mess of everything in their path. The United States gets more tornadoes than any other country, most often in the central plains states where cold, dry air flowing south from Canada meets warm, moist air flowing north from the Gulf of Mexico. The thunderstorms that develop where they meet are great birthing places for tornadoes. The GOES environmental satellites can "watch" for these severe weather conditions so that weather forecasters can warn people to prepare for possible tornados.

TECHNOLOGY

(1) All the air above you in the atmosphere is being held near Earth's surface by gravity. For every square centimeter of Earth's surface, the atmosphere above it, all the way up to space, weighs about 1 kilogram. This means that at normal sea level, air exerts about 1 kilogram of pressure on every square centimeter (or 14.7 pounds per square inch) of your body! Atmospheric pressure is measured with an instrument called a barometer. Barometric pressure readings are taken at many locations by NOAA's National Weather Service and combined to produce maps showing high and low pressure areas. Because air tends to move from high pressure areas to low pressure areas, knowing the pressure differences in different locations helps weather forecasters predict what the weather will do over large regions in the immediate future.

(2) The GOES orbit at 35,800 kilometers (22,300 miles) above Earth's in the plane of the equator. At that altitude, one orbit takes precisely 24 hours (one Earth rotation), so each satellite

seems to hover over the same spot on Earth all the time. They are so high, they have a view of the full disk of Earth and can get the big picture of any storms developing and which way they are headed. Thanks in part to real-time (meaning right this second) information from the GOES satellites, meteorologists (scientists who study the weather) have gotten very good at predicting what is going to happen in the next 12 to 24 hours.

(3) The GOES orbit at 35,800 kilometers (22,300 miles) above Earth's surface in the plane of the equator. At that altitude, one orbit takes precisely 24 hours (one Earth rotation). Therefore, they are "parked" in what is called a geostationary orbit. They orbit exactly over Earth's equator and make one orbit per day. Thus, since Earth rotates once on its axis per day, the GOES seems to hover over the same spot on Earth all the time.

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(5) The GOES are so high, they have a view of the full disk of Earth and can get the big picture of any storms developing and which way they are headed. They provide real-time (meaning right this second) pictures, movies, and other information that helps meteorologists (scientists who study the weather) predict what the weather is going to do in the next 12 to 24 hours.

(6) The GOES orbit at 35,800 kilometers (22,300 miles) above Earth's surface. They are so high, they have a view of the full disk of Earth and have a complete view of any developing storms, including hurricanes. GOES images and movies show the storms, which way they are headed, and how fast. This information helps meteorologists (scientists who study the weather) predict what the storm is going to do in the next 12 to 24 hours and warn people living in its possible path.

(7) Geo- means earth or ground; stationary means not moving. The GOES orbit at 35,800 kilometers (22,300 miles) above Earth's surface. At that altitude, one orbit takes precisely 24 hours (one Earth rotation). Therefore, they are "parked" in what is called a geostationary orbit. They orbit exactly over Earth's equator and make one orbit per day. Thus, since Earth rotates once on its axis per day, the GOES seems to hover over the same spot on Earth all the time.

(8) NOAA's National Weather Service (NWS) is the United States government's official voice for issuing warnings during life-threatening weather situations. Much of the imagery and other data used by the NWS comes from the GOES. The Department of Agriculture uses weather data to keep farmers informed about current and predicted weather conditions important to their crops. The Department of Transportation includes the Federal Aviation Administration (FAA), which provides weather data to airport operators all over the U.S. to help them evaluate current weather situations, as well as forecast about 30 minutes into the future. The National Endowment for the Arts, however, has no need for weather data to perform its function.

(9) The first TIROS (for Television Infrared Observation Satellite) was launched April 1, 1960. It was basically a black-and-white TV with a camera attached. It orbited Earth 725 kilometers (450 miles) overhead. It could take pictures only in the daylight, since it could detect only visible light, and not infrared (which depends on heat energy, not visible light). TIROS 1 made way for many generations of weather satellites, including GOES, which can do everything from monitor crops to provide detailed information on developing atmospheric conditions allowing meteorologists to predict weather events many days in advance.

WEATHER STATS

(1) The USA has the wildest weather in the world! With two coastlines exposed to storms that form at sea, plus frequent masses of cold, dry air coming down from the Arctic and Canada meeting up with moist, warm air from Mexico and the Gulf, plus several mountain ranges to mix things up, the USA has all the right stuff to whip up plenty of weather excitement.

(2) Depending on the concentration, salt lowers the freezing temperature of water a few degrees. So if salt is spread on an icy road in the morning, the ice will probably melt. Trouble is, when night falls, the water, which has seeped into small cracks in the road during the day, often freezes again. Water expands 10% when it turns to ice and creates tremendous force. So the ice makes the cracks in the road bigger. The next day, the same thing happens. By the end of winter, the road is full of large cracks and potholes. Salt also causes metal to rust and corrode, which is not good for cars or bridges or the underlying metal supports of concrete highways. Too much salty runoff from the roads is also bad for trees and the environment. Salt solves one problem, but causes many others.

(3) Galveston, Texas, is on a barrier island facing the Gulf of Mexico. In 1900, the highest point in Galveston was only 9 feet above sea level. Since the Gulf is shallow, hurricanes can push up large storm surges. On September 8, 1900, the 38,000 people of Galveston were warned a storm was on the way, but they had weathered many storms before and were not very concerned. By 4:00 PM, tides were one foot above the highest point on the island. In a few hours, a 1.2-meter (4-foot) wave, then a 6-meter (20-foot) wave hit the island. Winds gusted to 160 kilometers (100 miles) per hour. If satellite imagery had been available, the people of Galveston would have known this was no ordinary storm and they would have had plenty of time to evacuate to safety.

(4) On June 27, 1915, the temperature in Fairbanks reached a record 38º C (100º F). Temperatures above 32º C (in the 90s º F) are rare there. Fairbanks is in central Alaska at about 65º N latitude. Each summer, it has an average of seven days of temperatures over 27º C (80º F).

(5) Death Valley recorded the hottest temperature in the Western Hemisphere at 56.7º C (134º F) and the second hottest in the world (beat out by El Azizia, Libya, at 57.8º C (136º F). Death Valley is the lowest, hottest, driest location in North America. Nearly 550 square miles of its area are below sea level.

(6) In the U.S., around 73 people each year are killed by lightning and about 1000 are injured. In Florida, lightning kills more people than all other weather-related causes combined. Outdoors is the worst place to be during a lightning storm. If you see lightning, hear thunder, or even see dark clouds, immediately go inside a building or get inside a hard-topped vehicle

and stay there until after the lightning storm ends. If you are caught outside without shelter, the worst thing you can do is get near or under a tree! Find the lowest point possible and crouch down, but do not sit or lie down. You want to stay as low as possible and be in contact with as small an area of the ground as possible.

(7) Mt. Washington, New Hampshire, has a reputation for "the world's worst weather." The average annual temperature on the summit is only -3° C (26.5° F), with the records being -44°C (-47° F) and 22° C (72° F). On average, 6.5 meters (256 inches) of snow falls each year, with the seasonal maximum being 14.4 meters (566 inches). The annual average wind speed is 56 kilometers (35 miles) per hour and hurricane-force winds occur about every third day. It was on Mt. Washington that the world's highest ever wind speed was recorded at 370 kilometers (231 miles) per hour.

(8) Of the cities listed, Hilo, Hawaii, gets the most rain each year, with an average of 325.50 centimeters (128.15 inches). However, you may be surprised to learn that Yakutat, Alaska, gets even more, at 342.80 centimeters (134.96 inches). The amount of rain falling in a particular location depends on many factors, including topography. Deserts are often on the leeward sides of mountains because as the air is forced to rise over the mountain, it cools and the moisture in it may condense to form clouds and rain, ice, or snow. When the same air descends down the other (leeward) side of the mountain it has already given up most of its moisture, so it is dry and becomes warmer as it decreases in elevation.

(9) Of the cities listed, Las Vegas, Nevada, has the lowest average annual rainfall at 10.6 centimeters (4.19 inches). However, Yuma, Arizona, gets only 6.7 centimeters (2.65 inches). Phoenix gets an average annual rainfall of 18 centimeters (7.11 inches). Honolulu gets around 61 centimeters (24 inches) along the coast but about 89 centimeters (35 inches) at about 1.5 kilometer (1 mile) inland and about 152 to 178 centimeters (60 to 70 inches) at about 3 kilometers (2 miles) inland. Philadelphia has average annual rainfall of 102 centimeters (40.3 inches).

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