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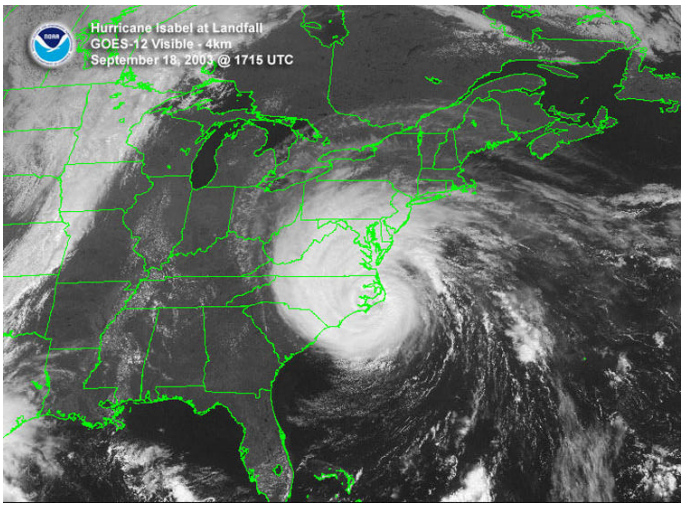
TEAM UP ON THE WEATHER

On a gray breezy day last September, thousands of people got in their cars and reluctantly left home. U.S. east coast highways were thick with traffic. Schools were closed. Businesses shut down. When powerful Hurricane Isabel arrived some 38 hours later, nearly everyone in the storm's path had fled to safety.

Days later Vice Admiral Lautenbacher, in a briefing to President Bush, praised the National Oceanic and Atmospheric Administration (NOAA): "Without NOAA's excellent track forecasts, hurricane Isabel's toll on lives and property would have been even more devastating. This is NOAA's first year of providing 5-day forecasts—and the 5-day forecast for Isabel was as good as our 2-day forecasts have been over the last decade."

Many people in NOAA played a role. A team of pilots, for instance, flew Gulfstream-IV High Altitude Surveillance jets right up to the approaching hurricane, logging 25,000 miles in the days before landfall. Their jets deployed devices called dropsondes—little weather stations that fall toward the sea, measuring pressure, humidity, temperature and wind velocity as they plummet. The data were radioed back to the aircraft and transmitted to forecasters on shore.

While two Gulfstream-IV crews flew night and day around the storm, a NOAA satellite named GOES-EAST monitored Isabel from above. (GOES is short for Geostationary Operational Environmental Satellite.)



GOES-East satellite image of hurricane Isabel as it makes landfall on September 18, 2003 at 1715 UTC.

From an orbit 22,300 miles above the Atlantic Ocean, GOES-EAST had a unique view. "It could see the entire hurricane at once," says Ron Gird of NOAA. "Scientists used infrared spectrometers onboard the satellite to estimate the height of the storm clouds, their temperature and water content. GOES can also measure the temperature of the ocean surface—the source of power for hurricanes."

Constant streams of data from GOES and the Gulfstream aircraft were fed to supercomputers at NOAA's Environmental Modeling Center in Maryland where sophisticated programs, developed over the years by meteorologists and programmers, calculated the storm's most likely path.

Supercomputers. Satellites. Jet airplanes. Scientists. Programmers. Pilots. It took a big team using a lot of tools to predict where Isabel would go—accurately and with time to spare.

Says Vice Admiral Lautenbacher: "I hope everyone at NOAA shares the pride of being part of a team effort that so effectively warned the public of impending danger and enabled citizens to take action to protect themselves and their loved ones."

PLAY THE WEATHER CHALLENGE GAME

See how well you can team up to play this weather trivia game.

Photocopy the pages of this article with the weather trivia questions. Then cut the questions apart on the lines. Notice that the questions fall into four categories: Weather Effects, Weather Science, Weather Technology, and Weather Statistics.

You will need to divide the class into teams of three, four, or five people, depending on the size of the class. You don't want too many teams, or the game will go too slowly. One way to choose teams and mix people up a bit is to write the team numbers on little pieces of paper, fold, and have each student draw a number to see to which team he or she will be assigned. For example, if there are 30 members of the class, write six each of numbers 1-5 on the pieces of paper. Then, get all the teammates together in different parts of the room.

The teacher, or an appointed class member, will read the questions aloud. Decide which team will go first, second, third, etc.

The reader reads the question (starting with the category) to the team whose turn it is. (The correct answer is in italics and underlined. The number in the upper right-hand corner identifies the question for purposes of matching it to the information pages that may be downloaded from The Space Place Website, referenced below.) The team has 30 seconds to collaborate, agree, and give only one answer. If the answer is correct, they get 5 points. If incorrect, they get 0 points. If they are not sure of the answer, before the 30 seconds is up, they can ask for a hint. (But they cannot ask for the hint if they have already given a wrong answer.) If they get the correct answer within 15 seconds after hearing the hint, they get 3 points. The reader keeps time, and writes the scores on the board for all the teams.

Whether right or wrong, the next question goes to the next team. The game is over when each team has had an agreed upon number of turns. Obviously, the team with the most points wins.

Because of our limited space here, more information on each of the questions and answers can be found and easily printed at http://spaceplace.nasa.gov/en/educators/weather-quiz.pdf.

To learn more about the GOES, see http://www.oso.noaa.gov/goes . Also, visit the SciJinks Weather Laboratory at http://scijinks.nasa.gov, where you will find lots of fun activities and fascinating facts about the wild world of weather.

Effects 1

Sometimes people who exercise in very hot, humid weather and don't drink enough water may suffer

Hypothermia
Heatstroke
Anemia
Euphoria

Hint: No need for Greek.

Effects 2

Which one of the following conditions is *unlikely* to happen to someone because of very cold weather:

Frostbite
Hypothermia
Shivering
Blood clots

Hint: Hot or cold weather does not thin or thicken the blood.

Effects 3

How does hot weather affect airplanes taking off?

They have to go faster to get off the ground
The runway must be cooled with water
They must climb at a steeper angle
The pilot must turn off the air conditioning so the plane's engines don't overheat

Hint: Hotter air is thinner, so provides less lift to the wings.

Effects 4

Too much exposure to ultraviolet (UV) light from the Sun causes all of these problems to humans EXCEPT

Sunburns
Sun spots
Skin cancer
Wrinkling

Hint: These are not at all like freckles.

Effects 5

The high-altitude, high-speed jet stream that blows from west to east across the United States is used

By Canadian geese to help them navigate home
By airline pilots heading east to fly faster and save fuel
By the salmon bird heading back to the west coast to spawn
By weather forecasters to predict tornadoes

Hint: Jet streams are above 9,000 meters (30,000 feet), far above birds and tornados.

Effects 6

Tornados cause all of the following types of damage EXCEPT

Roofs torn off buildings
Collapsed walls of buildings
Flying debris
Storm surges

Hint: Tornados strike mostly in the mid-west, far from the ocean.

Effects 7

If you are caught outside in a lightning storm, the worst thing you could do is

Run into a building
Hop into a parked car
Run under an isolated tree on a hill
Crouch on the ground in a ditch

Hint: Lightning "seeks" the tallest object on the ground.

Effects 8

When a very intense thunderstorm stalls over one area for a long time, the result can be

Drought
Flash floods
Tsunamis
Mesopause

Hint: Fast wall of water where there was none before.

Effects 9

What would happen if all the glaciers and ice sheets in the world were to melt?

Temperatures around the globe would be colder.
There would be less rain.
Most coastal cities would be under water.
There would be fewer rainbows.

Hint: There's a lot of ice above sea level now.

Science 1

When cold winds blowing from the north and hot, humid winds blowing from the south meet over the plains in the middle of the U.S. (for example, Kansas, Oklahoma, and Texas), which of the following weather is likely to result:

Hurricanes
Blizzards
Drought
Tornadoes

Hint: Hot meeting cold puts a particular spin on things.

Science 2
All the energy for making storms starts out from:

The oceans
Earth's rotation
The Sun
Earth's hot core

Hint: Heats only one half at a time.

Science 3
The tilt of Earth on its axis causes

Day and night
Tides
Seasons
Aurora borealis

Hint: During summer in the northern hemisphere we bow toward the Sun, in 6 month's time, away.

Science 4
In the Northern Hemisphere, the summer solstice is

The windiest day of the year
The hottest day of the year
The longest day of the year
The shortest day of the year

Hint: The Sun is highest in the sky

Science 5
Which of these has the **least** effect on local weather:

Tilt of Earth's axis
The oceans
Varying distance of Earth's orbit from Sun
Topography of land masses (mountains, valleys, etc.)

Hint: Not perfect, but so what?

Science 6
In Earth's atmosphere, air moving from a high pressure area to a low pressure area is the cause of

Wind
Rain
Hail
Blue sky

Hint: Nature abhors a vacuum.

Science 7
The World Meteorological Organization gives men's and women's names to this type of storm:

Blizzards
Hurricanes
Tornadoes
Lightening storms

Hint: GOES sees them forming over the ocean.

Science 8
If you see lightening and 5 seconds later you hear thunder, the lightning has struck the ground

1.6 kilometers (1 mile) away
8 kilometers (5 miles) away
15 meters (about 50 feet) away
80 kilometers (50 miles) away

Hint: Speed of sound is about 346 meters per second or 1153 feet per second (there are 5,280 feet in a mile)

Science 9
In this weather event, a cloud sends a rapidly rotating column of air down to the ground.

Hurricane
Dust devil
Blizzard
Tornado

Hint: Can be very uplifting.

Technology 1
An instrument that measures atmospheric pressure is called a

Thermometer
Barometer
Odometer
Spectrometer

Hint: A "bar" is a unit of force exerted on a given area.

Technology 2
The images of clouds and storms over the U.S. that are shown on TV weather reports are usually made by

Cameras on airplanes
Space Shuttle
International Space Station
Geostationary Operational Environmental Satellites (GOES)

Hint: You have to GO very high to get the really big picture.

Technology 3
How many times do each of the GOES (Geostationary Operational Environmental Satellites) weather observing satellites orbit Earth each day?

24 9
1 50

Hint: Geo- means earth or ground; stationary means not moving.

Technology 4
At what altitude above Earth's surface do the GOES (Geostationary Operational Environmental Satellites) weather observing satellites orbit?

35,800 kilometers (22,300 miles)
3,680 kilometers (2,300 miles)
8 kilometers (5 miles)
245 kilometers (153 miles)

Hint: Almost one-tenth of the way to the moon.

Technology 5
Images from the Geostationary Operational Environmental Satellites (GOES) are used primarily to

Sell cruises to the Bahamas
Advertise the latest movies
Forecast the weather
Illustrate Harry Potter books

Hint: Trouble often starts to brew at sea where no one else is looking.

Technology 6
The best views of a hurricane can be seen from

A ship in the ocean near the eye of the hurricane
A plane flying through the hurricane
The Geostationary Operational Environmental Satellites (GOES)
Clinging to a tree as the hurricane blows past

Hint: Sometimes the trees get in the way of the forest.

Technology 7
The Geostationary Operational Environmental Satellites (GOES) orbit Earth near the equator, making one orbit each day, so they seem to hover above a single point on Earth's surface all the time. This kind of orbit is called

Polar
Geostationary
Elliptical
High-inclination

Hint: This is too easy!

Technology 8
Information gathered by the Geostationary Operational Environmental Satellites (GOES) is used by all *except* the following agencies:

National Weather Service
Department of Agriculture
National Endowment for the Arts
Department of Transportation

Hint: The show must go on, regardless of the weather.

Technology 9
The first weather satellite, Tiros 1, was launched in what year?

1991
1960
1914
1843

Hint: After rockets invented, but before the moon landing.

Weather Stats 1
Which country has the wildest weather—that is, the greatest variety of extreme weather conditions—in the world?

Antarctica
United States
Cuba
England
Russia

Hint: Caught between oceans and between cold drafts and hot blasts.

Weather Stats 2
How much salt does the U.S. use each year to melt ice on roads?

45 metric tons (50 tons)
450 metric tons (500 tons)
900,000 metric tons (1 million tons)
9 million metric tons (10 million tons)

Hint: Would salt enough pretzels to feed billions.

Weather Stats 3
In 1900, before weather satellites were on duty to warn of coming storms, in what U.S. city were around 7,000 people killed by an intense hurricane?

Galveston, Texas
Omaha, Nebraska
Portland, Oregon
Phoenix, Arizona

Hint: Hurricanes form over tropical waters.

Weather Stats 4
What is the highest temperature ever recorded in Fairbanks, Alaska?

10° C (50° F)
38° C (100° F)
27° C (80° F)
18° C (65° F)

Hint: Highly unusual.

Weather Stats 5
The hottest day ever recorded in the Western Hemisphere was in Death Valley, California, on July 10, 1913, when the temperature reached

71.1° C (160° F)
56.7° C (134° F)
49.4° C (121° F)
46.1° C (115° F)

Hint: Three-fifths of the way to boiling.

Weather Stats 6
In what state of the United States are the most people killed by lightning strikes each year?

Alaska
Arizona
Florida
Hawaii

Hint: It's not because they are standing on top of a mountain.

Weather Stats 7
What was the highest wind speed (apart from inside a tornado) ever recorded on Earth's surface? (Recorded atop Mt. Washington, New Hampshire, at an elevation of 1,897 meters or 6,262 feet).

280 km (175 mi)/hr
370 km (231 mi) /hr
862 km (539 mi) /hr
198 km (124 mi) /hr

Hint: Not as fast as a jetliner, but still plenty fast.

Weather Stats 8
Which of the following U.S. cities get the most annual rainfall?

Pensacola, Florida
Astoria, Oregon
Annette, Alaska
Hilo, Hawaii

Hint: Warm water all around.

Weather Stats 9
Of the following cities, which gets the least annual rainfall?

Philadelphia, Pennsylvania
Phoenix, Arizona
Honolulu, Hawaii
Las Vegas, Nevada

Hint: Don't bet it will rain while you are there.

*This article was written by Diane Fisher and Dr. Tony Phillips. Ms. Fisher is writer and designer of The Space Place website at http://spaceplace.nasa.gov, and Dr. Phillips is an astronomer and editor of the Science@NASA Web site (**http://science.nasa.gov**). The article was provided through the courtesy of the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, under a contract with the National Aeronautics and Space Administration and support from the U.S. Department of Commerce National Oceanic and Atmospheric Administration..*