Norfolk Public Schools
Science Learning in Place Plan: Earth science Lessons

Week 7: April 27 – May 1, 2020 (Historical Geology)

Monday	Tuesday	Wednesday	Thursday	Friday
Reading & Text Annotation: • Read Section 12.2 "**Fossils: Evidence of Past Life.**" • Use Critical Reading Strategies to make note of the key points in the passage	Concept Analysis: • Review Section 12.2, "**Fossils: Evidence of Past Life.**" • Answer questions 1-6. Attempt to use vocabulary and examples from the article to justify your answers.	Reading & Text Annotation: • Read "**Drilling Deep for Knowledge about fossil fuels-power and pollution.**" • Use Critical Reading Strategies to make note of the key points in the passage.	Concept Analysis: • Read & Review the background in "**U.S. Energy Usage Graphing Activity.**" • Use the graph in part II and the background information to answer the questions 1-5 in part II.	Data Analysis: • Review the data table in part III of "**U.S. Energy Usage Graphing Activity.**" • Create a graph according to the instructions in part III then answer questions 1-3 in part III.

Week 8: May 4 – 8, 2020 (Astronomy)

Monday	Tuesday	Wednesday	Thursday	Friday
Reading & Text Annotation: • Read "**Star Life Cycles.**" • Use *Critical Reading Strategies* to make note of the key points in the passage.	Concept Analysis: • Review "**Star Life Cycles.**" • Answer questions 1-3. Use vocabulary and examples from the article to justify your answers.	Concept Analysis: • Review background information and the graph on "**H-R Diagram Worksheet.**" • Answer Questions 1-12 using information provided in the background and on the graph.	Data Analysis: • Review the data table for #13 on the "H-R Diagram Worksheet" • Use the graph to fill in the data table with the correct color and type of star.	Reading & Text Synthesis: • Read "**Out in space: Meteors and Meteorites.**" • Write a short paragraph explaining the central idea of the article. Use two pieces of evidence from the article

Week 9: May 11 – 15, 2020 (Atmosphere)

Monday	Tuesday	Wednesday	Thursday	Friday
Concept Analysis • Examine the GLOBAL WINDS diagram • Answer the questions based on the diagram.	Reading & Text Annotation: • Read **"How to read a weather map?"** • Use *Critical Reading Strategies* to make note of the key points in the passage.	Data Analysis: • Examine the isobar weather and fronts maps • Answer the questions based on the maps	Concept Analysis: • Read **"Is climate warming affecting hurricanes?"** • Answer the questions 1 and 2 about the number of hurricanes and strong hurricanes	Interpreting Data: • Make bar graphs **of the data from Are Hurricanes getting Stronger** • Answer the concluding question based on your graphs

CRITICAL READING *strategies*

Marking the Text

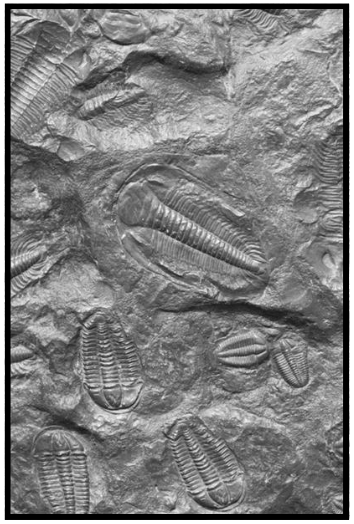
- # Number the paragraphs
- Circle key terms
- Underline essential info (...based on the reading purpose)
- Box new vocab words (...and define them in the margins)

Additional Ways to Mark the Text

- [Bracket] information (when underlining has been used for another purpose)
- Write labels in the margins (double underline labels to stand out from other marks)

Fossils

Fossils of plant or animal life from long ago are found in many rocks. For fossils to happen, the plant or animal would have died long ago and got washed away by one of the weathering processes. It eventually got covered with mud and rock particles. The soft part of the body of the plant or animal decayed and all that remained was the hard part of the skeleton. Over thousands and thousands of years, layers of mud and rocks and dead plants piled up. Then they compacted together and cemented to form rock. The hard parts of plants and the skeletons of animals left the imprint in the rock. Earth is always moving and as the earth's crust shifted, the fossils surfaced. The fossils that have been found, tell us about life on earth long ago. Geologists know how old the fossils are due to how low in the sedimentary rock the fossil was discovered. The lower in the layer means, the older the rock is, the higher in the layer means the fossil is more recent. Most fossils are small shellfish, snails, trilobites, clams and plant life. However, large imprints of dinosaurs and foot-prints have also been discovered. If you are lucky enough to stumble on something like this, you should call the museum as the professionals will carefully uncover the large fossil.



QUESTIONS:

1. **Describe the fossils in the picture and decide if they might have been plant or animal life from long ago. Explain your answer.**
2. **Where would earth's oldest fossils be found?**
3. **Define what a fossil is using your own words.**
4. **How do fossils form?**
5. **What can we learn from fossils?**
6. **What should you do if you come across a really interesting and large fossil? Why?**

newsela

Drilling deep for knowledge about fossil fuels - power and pollution

By Encyclopaedia Britannica, adapted by Newsela staff on 07.06.17
Word Count **942**
Level **1030L**

Big Bend Power Station is a major coal-fired power plant near Apollo Beach, Florida.

A fossil fuel is a natural substance like oil or coal, formed from the buried remains of organisms. Fossil fuels are used as a source of energy.

It took millions of years for fossil fuels to form. Heat and pressure from layers of sediment changed the decayed organic remains into materials such as coal and petroleum.

The energy in fossil fuels is the energy from sunlight stored in the tissues of the buried organisms as a result of photosynthesis. Photosynthesis is the process that plants use to make their own food.

Fossil fuel usage has steadily increased since the Industrial Revolution, which started in the mid-1700s. This is when new manufacturing processes came about. Fossil fuels also enabled people to generate electricity on a large scale to light homes, offices and city streets. They powered new and faster types of transportation like steam boats and locomotives, and later automobiles and jet planes.

At the start of the 21st century, fossil fuels made up nearly 90 percent of the world's energy supplies. However, fossil fuels are nonrenewable resources, which means once we use them, they are gone forever.

Because it takes millions of years for fossil fuels to form, they cannot be replaced.

Fossil fuels may be solids, liquids or gases. All fossil fuels are hydrocarbons, a class of chemicals composed only of carbon and hydrogen atoms. Coal, petroleum and natural gas are the most commonly known fossil fuels.

Coal

Coal is the most widely used of the solid fossil fuels. Most coal formed from plants that grew in or near swamps in warm, humid regions of the Earth. This happened during the Carboniferous Period, which was about 359 to 299 million years ago.

Dead plant matter fell into the swamps and settled at the swamp bottom. Over millions of years, sediment covered and compressed the decaying plant matter, forming peat. The pressure and heat of more sediment layers changed the peat into lignite, which is soft coal. Continued heat and pressure on the lignite changed it into harder forms of coal.

Anthracite is the hardest coal and was the last to form. Hard coals are considered the best energy sources among the coals because they burn the hottest and do not release as many pollutants into the air as other types of coal.

Oil And Natural Gas

Petroleum, or oil, is the most common liquid fossil fuel and natural gas is the most gaseous fossil fuel. Petroleum is often called crude oil, or just oil.

Oil and natural gas formed through a similar process, often in the same swampy location. They were made from the buried remains of tiny water organisms. As these organisms died and sank to the muddy bottom, their buried remains changed into a substance called kerogen.

Over millions of years, increasing heat and pressure from more sediment layers changed the kerogen into petroleum. Depth and temperature determined whether the petroleum was liquid or gaseous. Natural gas formed at deeper, hotter locations.

The main liquid fossil fuels used today are made from oil. These include gasoline, fuel oils such as diesel and jet fuel, and oils for home heating.

Kerosene was used a long time ago to provide light, and is still used in many places for cooking. It also is the main fuel for modern jet engines.

Natural gas is used for heating and cooking in the home and for industrial heating. It is also used to generate electricity.

Other Fossil Fuels

Peat and coke are solid fossil fuels that are commonly used today. Peat is used as a heating fuel in areas where other fuels are not available. But, it burns slowly and produces a lot of smoke and very little heat. Coke is a residue that remains after gases and tar are extracted from some types of coal. Coke is to make iron and in other processes.

As fossil fuel reserves are used, the search for other fuel sources has increased. Two such resources are oil shale and tar sands, which contain fuel sources. Extracting useful substances from them is difficult and costly. Until recent years, these resources were not good fuel options.

Where Fossil Fuels Are Found

Fossil fuels are not found equally around the world. For example, the United States, Russia, and China have the largest coal deposits. Australia, India and South Africa also have large amounts.

More than half of the world's known oil and natural gas reserves are located in the Middle East. This means that the Middle East contains more oil than the rest of the world combined.

Limited Supply, Pollution Problems

Two main disadvantages of fossil fuels are their limited supply and the environmental harm they cause. Burning petroleum and coal releases harmful gases into the air. These gases pollute the air and react with moisture in the atmosphere to create acid rain.

Burning fossil fuels also releases carbon dioxide into the atmosphere. Over many years, the percentage of carbon dioxide in the atmosphere has increased. Scientific evidence shows this buildup increases temperatures. This warming of Earth's atmosphere is called the greenhouse effect. It contributes to climate change, which is a serious environmental concern.

These problems have led scientists and engineers to develop new ways to generate power without using fossil fuels.

For example, some cars are now powered by electricity instead of gasoline. Homes can be heated using solar or geothermal energy. Some electric power plants run on nuclear energy, water power or wind power.

These alternative energy sources are forms of renewable resources because—unlike fossil fuels—they cannot be depleted. Also, renewable energy does not emit carbon dioxide. This can help limit climate change.

Activity 4ef: US Energy Usage Graph Unit E: Energy and Natural Resources
Learning Targets:

e) Gather, analyze and interpret data to evaluate the use of both nonrenewable and renewable energy resources in the United States. (DOK1-2)
(consumption, exploration, and development, extraction, production)
f) Access multiple sources to evaluate the sustainability of both nonrenewable and renewable energy resources in the United States. (DOK 2-3)
(consider resource development, consumption and reserves)

U.S. Energy Usage Graphing Activity

Background:

Energy in America is consumed by three major sectors of our economy: the household, commercial sectors, and the transportation sector. Homes and industries across America utilize coal, natural gas, oil, and uranium (nuclear power plants) for heating and electricity. To no ones surprise, however, the transportation sector relies almost entirely on oil (gasoline). Each of these commodities is a nonrenewable resource.

In the beginning of civilization people relied on renewable sources of energy. We lived on solar energy stored in food, burned wood from fallen trees, learned to use the wind to transport ships, and utilized flowing water to drive machines. For much of human history we were a solar-powered society.

Even though the energy stored in fossil fuels was discovered early in human history, the fossil fuel age really began with the Industrial revolution. During that period, coal was used extensively for heating buildings. As mines went deeper seeking that coal, problems with flooding arose. Spurred by the demand for power to pump water out of the mines, the steam engine was invented. As a result, a whole host of industrial applications of the perfected steam engine were discovered.

A dependence on fossil fuels came more slowly in the U.S. than Europe. Europeans were already well into the Industrial revolution at the end of the 19^{th} century. On the other hand, the U.S. was still operating with renewable energy resources… wind, wood, and water.

Wood alone accounted for about 90 percent of U.S. energy consumption in 1850 and was used for heating homes, and powering steamboats and trains. The conversion to coal began to take place at the end of the 19^{th} century. Virgin forests were cut down and it became necessary to transport energy to its point of consumption. Wood, when burned produces about half the energy as the same amount of coal. Therefore, coal has about twice the energy density as wood. If you are going to transport energy, you want to carry as much per pound as possible. Thus, coal replaced wood, and later oil replaced coal.

The use of oil began to grow at the turn of the century with the invention and broad use of the automobile. Natural gas, a byproduct of oil was beginning to be used for heating buildings. Petroleum (the name for oil and natural gas) was cleaner and more efficient than coal and wood, and at the end of World War II the petroleum age had arrived. It now appears that the dominance of the petroleum products may also be drawing to a close. In 1974 they made up 77 % of the total energy use. In 1982, the share of oil and natural gas fell to 69 %.

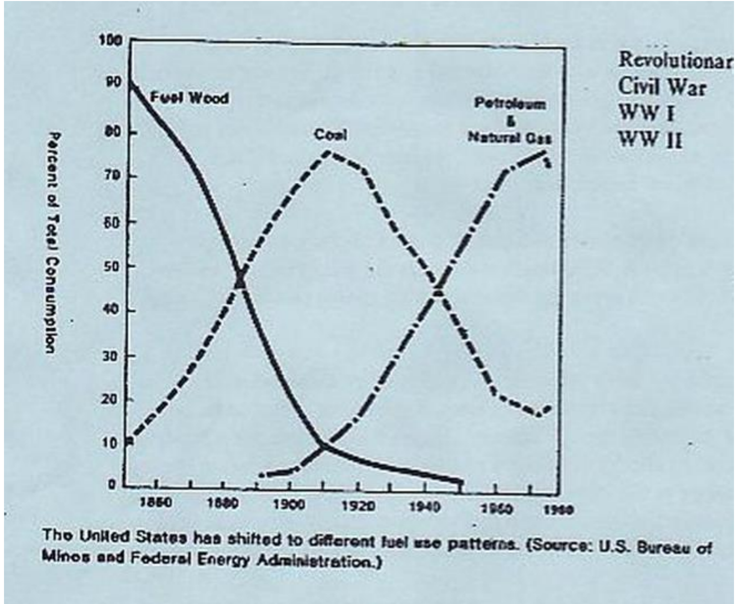
Is a transition to a new dominant source beginning? Since the early 1970's nuclear fuels have increased in use, and there has been resurgence in coal usage due to an increase in a population that is heavily reliant on enlarged electricity demands.

What happens in the future depends on fuel availability, environmental, economic, and political factors that determine our future dominant fuel sources.

Part I
On your own paper define or describe each of the following terms:

1. uranium	2. commodity	3. nonrenewable resource
4. renewable resource	5. industrial revolution	6 steam engine
7. fossil fuels	8. energy	9. energy density
10. petroleum		

Part II – Energy History of the United States Graph Interpretation



The United States has shifted to different fuel use patterns. (Source: U.S. Bureau of Mines and Federal Energy Administration.)

From the graph above, answer the following questions:

1. During what decade did the transition from wood to coal as the predominant energy source take place? Why did this happen?
2. What decade did coal usage peak in use? What is this period in U.S. history called?
3. During what decade did petroleum replace coal as a fuel source? Why did this happen?
4. Explain why coal usage might be increasing in the use as a vital energy source.
5. In general explain the trends in the graph between wood and coal, then coal and petroleum as predominant energy sources that fuel America.

Part III – U.S. Petroleum Productivity Graphing Exercise

Examine the following data. Using a piece of graph paper make a line graph of the data. Year should go on the x-axis and barrels of petroleum should go on the y-axis. Answer the questions below when you are done with your graph.

U.S. Petroleum Production (in billions of barrels)

Barrels of Petroleum (billions of barrels)	Year
0.76	1925
0.89	1930
1	1935
1.35	1940
1.71	1945
1.97	1950
2.48	1955
2.57	1960
2.84	1965
3.43	1970
2.99	1975
2.73	1978
2.55	1980
2.54	1982
1.98	1990
1.47	1995
1.25	2000
1.21	2003

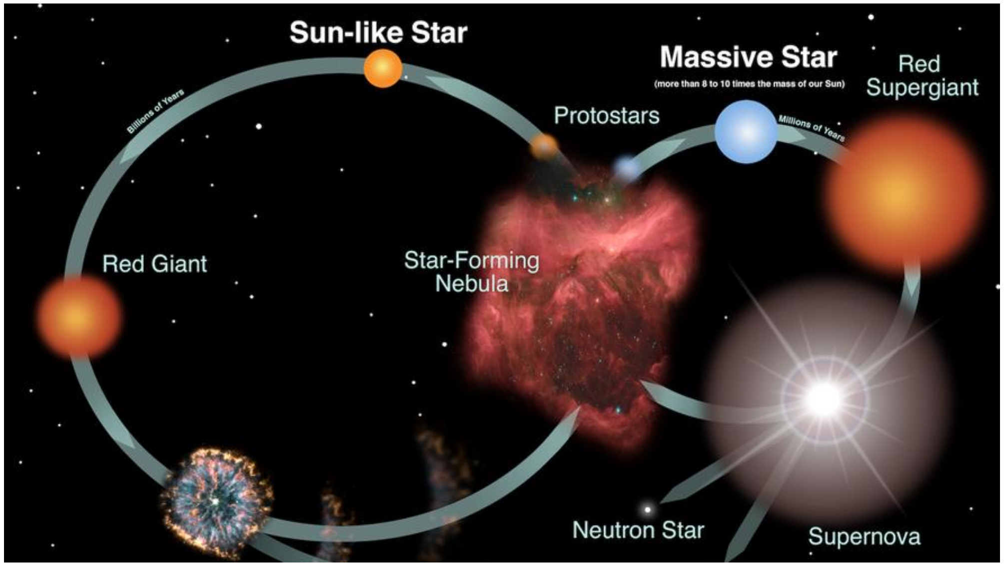
Questions

1. What is the general trend of this graph? In other words, what is happening to U.S. oil production?
2. Do you think America is using less oil over these past two decades? Where then, are we getting the oil?
3. What are some other possible reason for this drop in productivity?

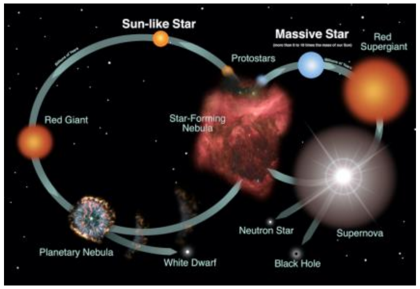
Star life cycles

By NASA, adapted by Newsela staff on 12.19.19

Word Count **105**
Level **MAX**



The illustration shows the life cycle of a low mass star (left oval) and a high mass star (right oval). If a star is about the same mass as our sun, it will turn into a white dwarf star. If it is more massive, it may undergo a supernova explosion and leave behind a neutron star. But if the collapsing core of the star is very great — at least three times the mass of the sun — nothing can stop the collapse. The star implodes to form an infinite gravitational warp in space — a black hole.



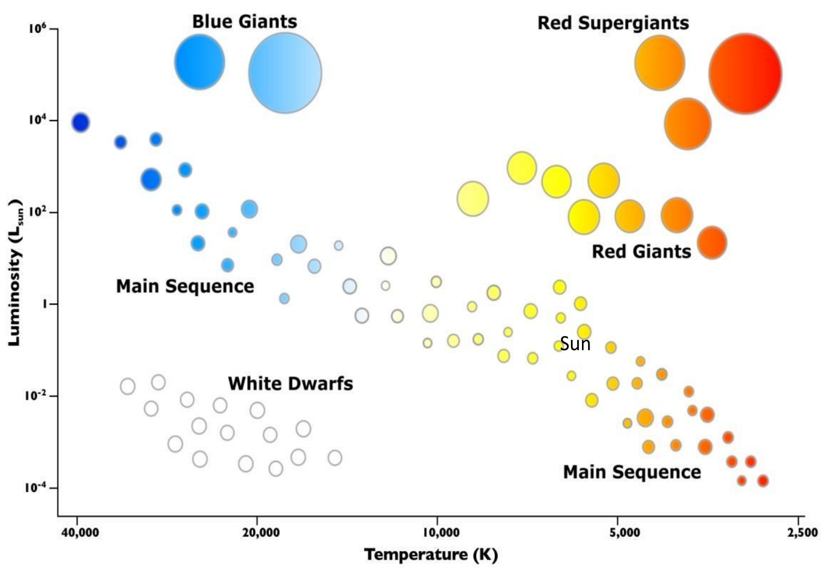
1. Based on the illustration, which characterization accurately describes both sun-like stars and massive stars?

2. How does the author distinguish between sun-like stars and massive stars?

3. Which sentence from the article BEST supports the idea that it is impossible to prevent a very massive star from imploding?

HR Diagram Worksheet

Background: The Hertzsprung-Russell diagram is actually a graph that illustrates the relationship that exists between the average surface temperature of stars and their absolute magnitude, which is how bright they would appear to be if they were all the same distance away. Rather than speak of the brightness of stars, the term "luminosity" is often used. Luminosity is a measure of how much energy leaves a star in a certain period of time.



Answer the questions using the above HR Diagram

1. What factor affects the color of a star?

2. What factor affects the luminosity of a star?

3. What is the approximate surface temperature of the sun?

4. Is the surface temperature of white dwarf stars higher or lower than red super giants?

5. What is the color of the stars with the highest surface temperature?

6. What is the color of the stars with the lowest surface temperature?

7. List the color of the stars from hottest to coldest:

8. Most of the stars on the HR Diagram are classified as which type of star?

9. What type of star has a high temperature but a low luminosity?

10. What type of star has a high temperature and a high luminosity?

11. What type of star has a low temperature but a high luminosity?

12. What type of star has a low temperature and a low luminosity?

13. Plot the stars A - E. Once plotted determine their color and type.

Letter	Temperature	Luminosity	Color	Type of Star
A	6,000 k	10^{-1}		
B	20,000 k	10^{6}		
C	20,000 k	10^{-2}		
D	2,500k	10^{6}		
E	4000 k	10^{2}		

Out in Space: Meteors and meteorites

By NASA.gov, adapted by Newsela staff on 10.21.16
Word Count **859**
Level **950L**

TOP: An outburst of Perseid meteors lights up the sky in August 2009 in this time-lapse image; NASA/JPL. MIDDLE: A large meteorite created the Barringer Crater in Alabama; U.S. Geological Survey.

Have you ever seen a shooting star? These bright flashes in the night sky are known as meteors. Meteors are pieces of space material that fall through Earth's atmosphere, the gases that surround the planet. Falling through the atmosphere causes these bits to heat up, which makes them glow for a short time.

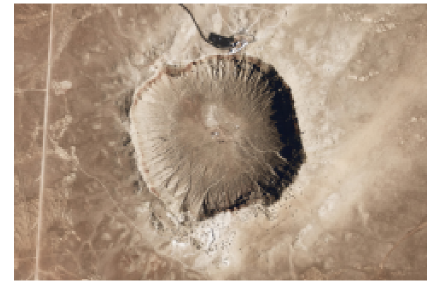
As these objects fly through space, they are called meteoroids. They become meteors for the few seconds they streak across the sky, leaving glowing trails.

Scientists estimate that about 48.4 tons (44,000 kilograms) of meteor material falls on the Earth each day. Every night, several meteors flash through the sky. Sometimes there are many more, in events called meteor showers. Some meteor showers occur at the same time each year. This is when the Earth passes through the trail of dusty material left by a comet, an icy body that orbits our sun.

Meteor Showers Normally Take Their Name From Nearby Star

Meteor showers are usually named after a star or constellation that is close to where the meteors appear in the sky. The most famous might be the Perseid meteor shower, which peaks around Aug. 12 each year. Every Perseid meteor is a tiny piece of the comet Swift-Tuttle, which passes by the Sun every 135 years.

Some pieces of rock and metal from space survive their journey through the atmosphere and fall to the ground. These are called meteorites. Most meteorites found on Earth are small. They range from the size of a pebble to the size of a fist. Some, however, are larger than a building. Early Earth was hit by many large meteorites, which caused much destruction.



When a meteorite hits the ground at high speed, it leaves an impact crater, a bowl-shaped hole in the ground. One well-known meteorite crater is the Barringer Meteorite Crater in Arizona. It is about 0.6 miles wide, and was formed by an iron-nickel meteorite that was about 164 feet across. The crater is 50,000 years old. About 170 impact craters have been found on Earth.

One Huge Meteor Killed 75 Percent Of Land, Sea Animals On Earth

One of these is the Chicxulub crater on the Yucatan Peninsula in Mexico. This crater was formed when a very large asteroid hit the Earth 65 million years ago, leaving a 180-mile wide hole in the ground. This impact is thought to have caused the extinction of about 75 percent of marine and land animals on Earth, including the dinosaurs.

Cases of people being injured or killed by meteorites are rare. The first known case happened in 1954 in the United States. A woman named Ann Hodges was badly bruised by an 8-pound stony meteorite that crashed through the roof of her home in Alabama.

Meteorites might look like Earth rocks, but they usually have a burned crust, known as a "fusion crust." The crust is formed when the meteorite passes through the atmosphere and heats up, melting as it shoots through.

There are three main types of meteorites: the "irons," the "stones" and the stony-irons. Most meteorites that fall to Earth are stony and look like Earth rocks, which makes it hard to identify them. Iron meteorites are found more often, because they look very different from Earth rocks.

Other Planets Are Hit By Meteorites, Too

Meteorites don't fall only on Earth. They land on other planets as well. In 2005, the Mars Exploration Rover Opportunity found an iron-nickel meteorite about the size of a basketball on Mars. It was the first meteorite of any type found on another planet. In 2009, the Rover found another, much larger and heavier meteorite in the same region. In total, Opportunity has discovered six meteorites during its travels on Mars.

More than 50,000 meteorites have been found on Earth. Of these, 99.8 percent came from asteroids, which are small, rocky bodies that orbit the sun. Like asteroids, most meteorites are very old — about 4.5 billion years old. The remaining 0.2 percent of meteorites come from Mars and the moon.

Asteroids and the meteorites that fall to Earth are not pieces of a planet that broke apart. They are the original materials that formed the planets.

Studying meteorites allows us to learn about the formation and early history of the solar system. They have taught scientists about organic matter, the material that forms all life and about how materials respond when they undergo huge impacts.

Meteors In History

4.55 billion years ago: Most meteorites form – they are as old as the solar system.

65 million years ago: The Chicxulub impact kills off 75 percent of the animals on Earth, including the dinosaurs.

50,000 years: Age of Barringer Meteorite Crater in Arizona.

1478 B.C.: First recorded observation of meteors.

1794: Ernst Friedrich Chladni publishes the first book on meteorites. He proposes that they come from space.

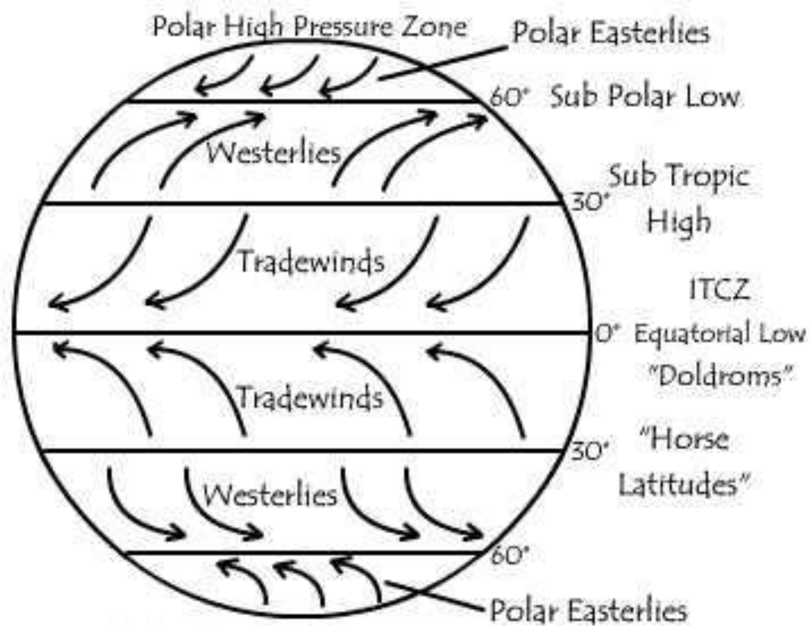
1969: The discovery of meteorites in a small area of Antarctica leads to yearly expeditions by U.S. and Japanese teams.

1982-1983: Meteorites from the moon and Mars are identified in Antarctic collections.

2005: NASA's Mars Exploration Rover Opportunity finds a basketball-size iron-nickel meteorite on Mars.

GLOBAL WINDS

Directions: Use the diagram to answer the questions below



GLOBAL WINDS QUESTIONS

1. What is the name of the winds between 30 N and 60 N?____

2. What direction do those winds come from? ____

3. At what latitudes do low pressures occur? ____

4. Does low pressure mean the air is rising (lifting) or sinking? ______________________________________

5. The doldrums mean "state or period of inactivity, stagnation, or depression". Do you think this area has a lot of wind or very little wind?
____

6. Where is the doldrums? ____

7. Looking at the diagram, what do you see that might explain why sailing ships often got stuck in the doldrums? ________________________________

8. Between what degrees are the tradewinds found? ____

9. Norfolk is at 36 N, what global wind belt affects our weather? ____

10. What direction do polar easterlies blow? ____

11. What direction do winds blow?   from ______ pressure to __________ pressure.

12. According to legend, the term “horse latitudes” comes from ships sailing to the New World that would often become stalled for days or even weeks when they encountered areas of high pressure and calm winds. Many of these ships carried horses to the Americas as part of their cargo. Unable to sail and resupply due to lack of wind, crews often ran out of drinking water. To conserve scarce water, sailors on these ships would sometimes throw the horses they were transporting overboard. Thus, the phrase 'horse latitudes' was born

Why did ships get stuck in the horse latitudes? ____

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newsela

How to read a weather map

By NOAA SciJinks on 09.04.19
Word Count **973**

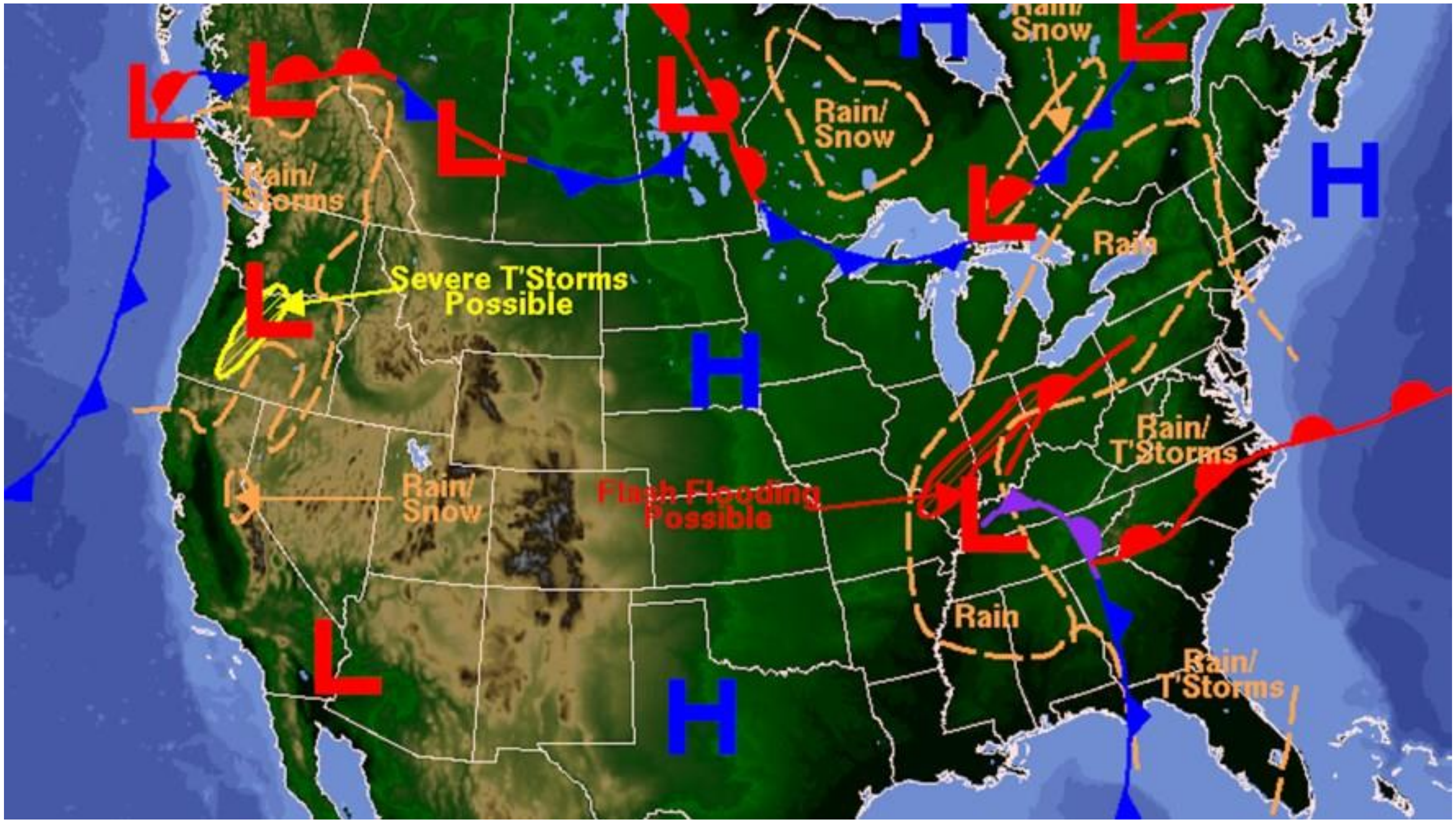


Image 1. Meteorologists use information from weather satellites and ground stations to make weather maps like this one. Photo by: NOAA

If you've looked at a weather forecast on your TV, computer or phone, you've probably seen a weather map.

Meteorologists at the National Weather Service use information from ground stations and weather satellites to make these maps. Words like "rain" and "snow" are pretty obvious. But what exactly do the symbols on a weather map tell you about the weather?

High and Low Pressure Areas

Earth's atmosphere is a jacket of gases that surrounds the planet. Although it seems like these gases could easily float away into space, gravity is constantly pulling the atmosphere toward Earth's surface. The force with which our atmosphere pushes down on a specific location on Earth is called atmospheric pressure.

Atmospheric pressure is mainly dependent on two things: the weight of the atmosphere in a specific location and the temperature of the air. If you're at a low elevation — such as in a valley — there is a lot of atmosphere above you and the weight is very heavy. That means that you experience higher atmospheric pressure at lower elevations and lower atmospheric pressure in higher elevations.

Warm air can also cause the atmospheric pressure to rise. When the air is warm, gas molecules move around quickly in the air, pushing out on the area around them. This causes high atmospheric pressure. In cold air the gas molecules slow down. This causes low atmospheric pressure.

Water vapor in the atmosphere can also change the atmospheric pressure. Very moist air that has lots of water vapor is actually lighter and less dense than dry air. This is because water molecules are lighter than molecules of nitrogen or oxygen. These are the two most abundant gases in our atmosphere. So, very moist air in the atmosphere can lead to low atmospheric pressure. Very dry air can lead to high atmospheric pressure.

Atmospheric pressure is measured with an instrument on the ground called a barometer. These measurements are collected at many locations across the U.S. by the National Weather Service. On weather maps, these readings are represented as a blue "H" for high pressure or a red "L" for low pressure.

What It Means On The Weather Map

A high-pressure system is a dense air mass that is usually cooler and drier than the surrounding air. A low-pressure system is a less dense air mass that is usually wetter and warmer than the surrounding air.

In general, areas that experience high atmospheric pressure also experience fair weather. Low pressure systems can cause the formation of clouds and storms. Air usually flows from areas of high pressure to areas of low pressure.

High And Low Pressure Systems: From Space

From high above Earth, satellites such as GOES-16 keep an eye on the weather brought by low pressure systems. The red "L" on the map above shows a low-pressure system in the Tennessee Valley region.

Cold Fronts And Warm Fronts

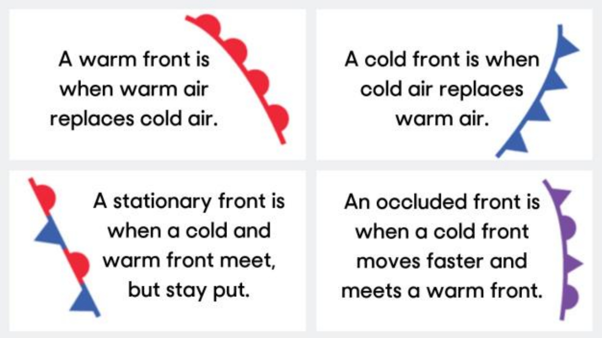
A warm front is the transition area where a mass of warm air moves to replace a mass of cold air. On a weather map, a warm front is usually drawn using a solid red line with half circles. The half circles point in the direction of the cold air that will be replaced. Warm fronts usually move from southwest to northeast. A warm front can initially bring some rain, followed by clear skies and warm temperatures.

A cold front is the transition area where a mass of cold air moves in to replace a mass of warm air. On a weather map, a cold front is usually drawn using a solid blue line with triangles. These triangles point in the direction of the warm air that will be replaced. Cold fronts typically move from northwest to southeast. A cold front can bring cold temperatures, torrential rains and high wind speeds.

A stationary front happens when a cold front and a warm front meet up, but neither moves out of the way. On a weather map, a stationary front is usually drawn using alternating cold front and warm front symbols. Stationary fronts bring long rainy periods that stay in one spot.

Cold fronts move faster than warm fronts. Sometimes, a cold front catches up to a warm front. When this happens, it's called an occluded front. Occluded fronts are drawn as a solid purple line with half circles and triangles pointing in the direction that the front is moving. An occluded front usually brings dry air.

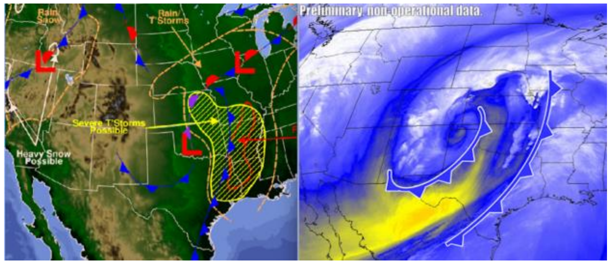
Cold Fronts And Warm Fronts: From Space



GOES-16 and other weather satellites are also on the lookout for cold fronts and warm fronts and the weather they produce. Below, you can see the comparison of a cold front on a forecast map and a cold front in a satellite image.

Weather Satellites

Information from weather satellites, such as the GOES-R series and JPSS, will help improve our understanding of Earth's weather.



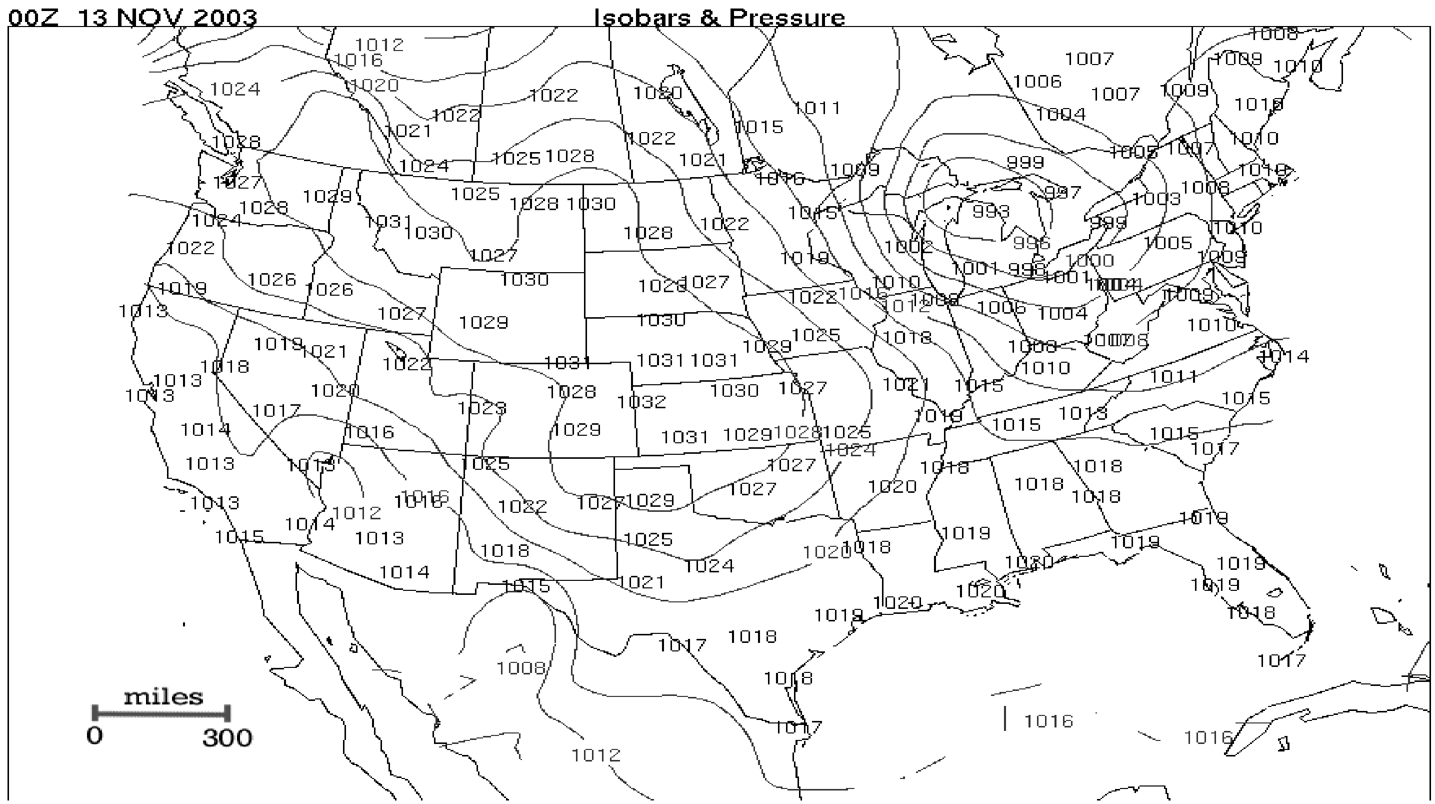
For example, the GOES-R series provides information about atmospheric water vapor and cloud height right

now. This can help meteorologists monitor and track severe weather events as they happen. Severe weather events include storms and hurricanes. JPSS satellites survey the entire planet. They continuously provide global atmospheric temperature and water vapor information. This information is needed to create reliable weather forecasts up to seven days in advance!

JPSS and the GOES-R series work together for weather applications. JPSS is critical for getting ready for severe weather events. GOES-R monitors severe weather as it unfolds for real-time warnings.

Isobars and pressure systems

On November 10, 1975, a deep and tight low pressure system moved across the Great Lakes. The wind and resulting high waves contributed to one of the worst shipping disasters in the history of the Great Lakes, the sinking of the Edmund Fitzgerald. A similar (though not as strong) storm moved across the Great Lakes on November 12, 2003, and affected the weather during the day and night until November 13, 2003.



1. On the map above, neatly **place** a large "H" and a large "L" on the map at the centers of high and low pressure or name the states where the high and low pressure areas are centered.

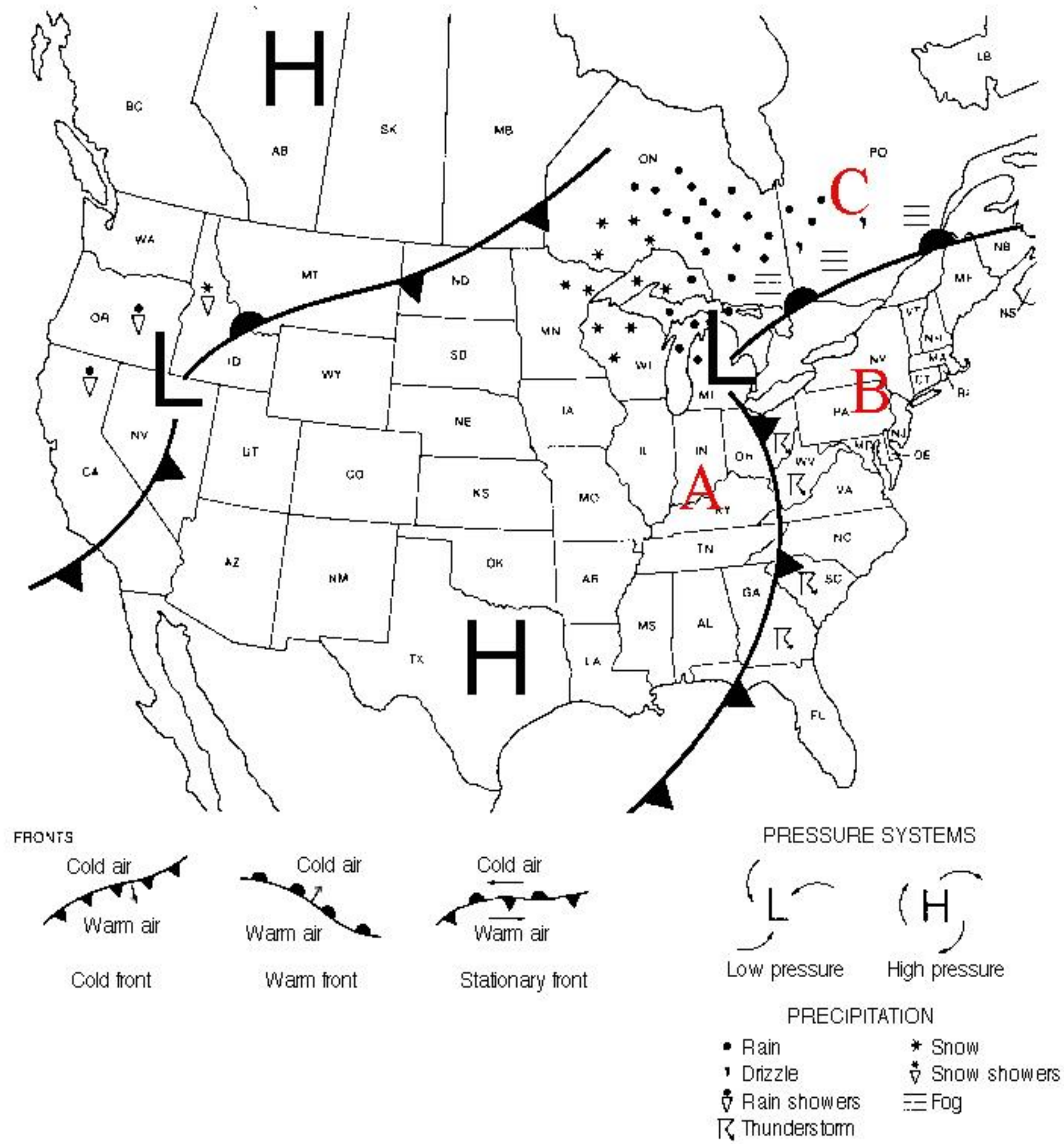
2. What type of weather is associated with low pressure?

3. What type of weather is associated with high pressure?

4. Like topographic maps, isobars can show areas of large pressure change (gradient). Wind moves from high to low pressure and where pressure changes rapidly, wind speeds are highest. Where in the country are wind speeds likely to be the highest?

5. What direction is the wind moving? From

6. What is the approximate pressure in Norfolk, VA?



Weather Map

1. What type of front is over VA and NC?

2. What direction is the front moving?

3. How will the weather change in Norfolk because of that front?

4. Does location C or B have warmer temperatures? _____ Explain your answer.

5. Does A or B have warmer temperatures? _____ Explain your answer.

Is climate warming affecting hurricanes?

We know that hurricanes form above warm ocean water. And it's thought that warmer water can lead to stronger hurricanes. The Earth warmed one degree Fahrenheit over the 20th Century. Warming is causing sea surface temperatures to climb. Has the warming climate had an impact on hurricanes? This is an area of active research. One way that scientists are trying to answer this question is by looking at the history of hurricanes.

The top table shows the total number of hurricanes that happened in each region during three time periods. The lower table shows the number of very strong hurricanes that happened over the same three time periods.

Take a look at the numbers and answer the questions below.

Total Number of Hurricanes:

Hurricane Region	1971-1985	1986-2000	2001-2016
East Pacific Ocean	148	150	143
West Pacific Ocean	137	228	228
North Atlantic	78	92	116
Southwestern Pacific	76	101	76
North Indian Ocean	0	17	17
South Indian Ocean	91	123	129

Number of Strong Hurricanes:
(Catagory 4 and 5 storms)

Hurricane Region	1971-1985	1986-2000	2001-2016
East Pacific Ocean	35	50	42
West Pacific Ocean	24	22	37
North Atlantic	13	21	31
Southwestern Pacific	7	9	23
North Indian Ocean	0	4	6
South Indian Ocean	16	22	34

Data from NOAA National Centers for Environmental Information IBTrACS v.3 retrieved by Ming Ge (NCAR)

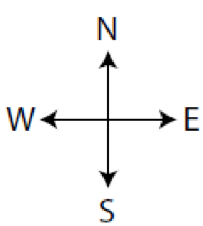
Questions:

1. Has the total number of hurricanes increased, decreased, or stayed about the same? Is the trend the same for all regions?

2. Has the number of strong (catagory 4 and 5) storms increased, decreased, or stayed about the same? Is the trend the same for all regions.

Are hurricanes getting stronger?

How many strong hurricanes were there a few decades ago? How many are there today?
Make small bar graphs on the map below using the data on the previous page to show whether there has been a change in the number of strong hurricanes in the six regions of the world where tropical cyclones occur.



What do you think?

Are there more strong hurricanes now? (Take a look at the bar graphs of strong hurricanes you made above. Do they show a trend?)

☐ YES ☐ NO