THE WEATHER CLASSROOM®

WEATHER & GEOGRAPHY

This lesson addresses the following National Standards:

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science Standards
- Motions and forces

Earth & Space Science Standards
- Structure of the Earth's system
- Earth's history
- Origin and evolution of the Earth's system

Language Arts
- Write stories
- Make written and oral presentations

Visual Arts
- Illustrate
- Color Wheel

Geography
- Places and regions
- Physical systems
- Environment and society
- The uses of geography

Preview

The physical features of our planet have a tremendous impact on weather patterns. The presence or absence of mountains, the proximity to an ocean, and the eruption of volcanoes and the movement of Earth's crust can drastically change the climate of an area.

Weather Fact

The Tibetan Plateau:
The highest geographical region on Earth began rising about 8 million years ago as a result of the Indian Continental Plate moving north and under the Asian Continental Plate. This created (and is still creating) the Himalayan Mountains along with the plateau. The result has been an extreme change in global climate patterns – such as wetter, stormier Asian monsoons and colder Siberian and Canadian winters.

Weather Terms

All glossary terms can be found at http://www.weatherclassroom.com/glossary/

arctic jet
biosphere
Chinook
climate
continental shelf
erosion
Gulf Stream
Haboob
jet stream
low level jet
mountain breeze
mountain wave
orographic lifting
polar jet
poles/polar
rain forest
rain shadow
subtropical
subtropical jet
thermal low
tropics/tropical
valley breeze
weathering

Q & A

Start Talking

What is the biosphere?

Answer: The biosphere is that part of the Earth capable of sustaining life. Living organisms have been found existing near the top of Mt. Everest, netted while flying of floating at 30,000+ feet in the atmosphere, in the ocean from the surface to depts. Of nearly 7 miles, within and beneath the 3-mile thick Antarctica ice sheet, in the deepest cave systems and nearly 1,000 feet down in the Earth's crust.

Going Further: What does this wide variation in life-sustaining biomes say about life on Earth? What does it say about the possibility of life on other planets?

Teaching Note: Check "biome" in Weather and Geography Resources to find out more about Earth's biosphere.

What are the major parts of the biosphere?

Answer:

Atmosphere – the gaseous layer surrounding our planet composed of 8% nitrogen, 21% oxygen and 1% other gases, including CO2 and H20.

Lithosphere – the hard part of the planet consisting of rocks, minerals, soils of the crust, and the materials brought to the surface by volcanism.

Hydrosphere – the water parts of Earth, involving surface water systems (lakes, oceans, streams, etc.), ground water systems (aquifer, capillary water, etc.) and ice (glaciers, ice caps, etc.)

What is a climate?

Answer: A climate is a long-term weather pattern within a given geographical area. This is a measure of temperatures, precipitation, seasons and wind patterns.

What are some different types of climates?

Answer: There are both macroclimates and microclimates. Macroclimates involve large expanses and are generally divided into 'zones.' These zones are in turn defined by latitude. From the Equator, these are described as: Tropical, Subtropical, Temperate, Sub-Polar and Polar (moving either north or south). Within each of these macroclimates are smaller areas defined by their microclimate. Some examples of these are: humid tropical, Mediterranean, warm desert, cold desert, southern temperate, northern temperate, alpine.

Q & A

What is a biome?

Answer: A biome is a large geographical area described by the dominant flora, fauna and climate. Terrestrial biomes include: tropical rain forest, temperate rain forest, taiga, grasslands, deserts and temperate deciduous forests.

Going Further: Is a biome the same as an ecosystem? No, but a biome consists of several types of ecosystems. Investigate your local area to first determine the biome in which you live, and then discover the different types of ecosystems that exist. (For example: You may live in an area described as a deciduous forest biome. But your area may be dominated specifically by an oak-hickory forest ecosystem, and within this forest you can also have streams, lakes, swamps, meadows, and pine or mixed forests.)

Teaching Note: Check "biome" in Weather and Geography Resources to find out more about Earth's biosphere. Go to Hands On: Biomes and Ecosystems for step-by-step activity directions in examining local/regional ecosystems/biomes.

Does everyplace within a climate zone or biome have the same weather, life and physical features?

Answer: No. Geographical features, such as mountains and valleys, and the proximity to the oceans and general wind patterns all serve to vary conditions widely in relatively small areas. For example, the SubTropical Climatic Zone extends from the Tropic of Cancer to the northern Palm Line (roughly 350 N) and the Tropic of Capricorn to the southern Palm Line (roughly 350 S). Within this zone lie the driest deserts on Earth, especially the Atacama in Chile, South America, the Namib in Namina, Africa, and the Sahara across northern Africa. Yet, also within this zone lie the southern plains and humid southeastern regions in North America, and the southern Amazonian rain forest and the pantanel in South America.

Do island climates vary as much as continents?

Answer: In most cases islands are too small or have terrains that don't affect the overall climate. However, in some cases there are drastic changes within just a few kilometers. Large islands, such as Madagascar, and those with dramatic elevation changes, such as Hawaii, exhibit contrasting climate extremes. Hawaii lies in the Tropical Climatic Zone and is covered mostly with tropical rainforests. Tropical rainforests such as that of Mt. Waialeale on Kauai can receive over 400cm of precipitation annually. However, the summits of Mauna Kea at 4205m and Mauna Loa are 4170m are high enough to have a sub-polar climate, supporting a tundra ecosystem, and receive a scant 20cm of precipitation each year.

The Weather Classroom: Break

Q & A

In general, what controls the climatic patterns in North America?

Answer: There are five major forces:

Daily and seasonal heating and cooling. Daily heating and cooling is affected by insulation (the amount of solar energy reaching Earth's surface), cloud cover and the type of surface. Water absorbs and releases heat energy more slowly than land and tents to moderate temperatures and humidity. Seasonal heating and cooling is affected by Earth's 22.50 tilt from the orbital plane around the sun and the distance from the sun.

Jet Stream. This 'river of moving air' encircles the globe, generally in the northern temperate zone. Sometimes it will split and form a second stream in the southern temperate and subtropical zone. This phenomenon is often associated with stormy weather, which meteorologists refer to as a 'storm track.'

Gulf Stream. This 'oceanic river' moves up the east coast of the U.S. bringing warm tropical water from the equator. This warm water provides much of the humidity and energy that triggers hurricane development, as well as moistens the southeastern and eastern U.S.

Cool Pacific currents. These waters, powered by the warm Kuroshio Current and cooled by the cold Oyashio Current, bring cool water from Alaska and western Canada past the west coast of the United States.

Winds in the Great Plains. Exhibiting a relatively flat terrain, this great area of former grasslands allows unimpeded movement of large masses of air to move quickly down the center of the continent.

Going Further: Meteorologists refer to the Jet Stream as the "Storm Track." They use current and past data, following the tracks of major storm systems across North America. Map the jet stream patterns concurrently with the storms. Is the term 'storm track' appropriate? Explain.

Teaching Note: Use The Weather Channel's "Maps" at http://www.weather.com/ to follow storm fronts and map the jet stream.

What are the overall effects of these major weather forces?

Answer: These forces result in the cold, dry climate of the north-central region; the warm, humid climate of the southeast; the warm, dry climate of the western regions; and, the tremendous thunderstorms, tornadoes and blizzards of the central plains.

Q & A

Some of the Pacific Northwest is covered in temperate rainforests, yet there are deserts in central Idaho and Nevada. How does this happen?

Answer: There are two major influences at work in this area. First is the relatively cool California Current, which is fed by the warm Kuroshio and North Pacific Currents. (The convergence of the North Pacific and old Oyashio Currents creates the cool California Current.) This current also brings humid air to the Pacific Northwest. Second is the presence of mountain ranges – the Coast Ranges, the Cascade Range, and the Sierra Nevadas. These mountains block the flow of air coming in from the Pacific Ocean causing it to rise up the seaward slopes. This air movement is known as the "orographic lift." As the air rises it cools and allows water vapor to condense, forming clouds. Once the air temperature lowers to the dew point, the water droplets in the clouds fall as precipitation. So marked is this effect in the Pacific Northwest that over 200cm of rain per year may fall in some areas. This precipitation and the mild temperatures influenced by moderately cool ocean currents establish the environmental conditions necessary to the growth of a temperate rain forest ecosystem.

Going Further: Are temperate and tropical rainforests similar? Consider: annual precipitation, temperature ranges, flora, fauna, general biodiversity. Investigate to discover the similarities and differences between these two ecosystems.

Teaching Note: Check "biomes" in Weather and Geography Resources to find out more.

Why can arid conditions exist just a few kilometers east of a temperate rain forest across a mountain range?

Answer: If the orographic lifting mechanism is strong enough and the mountains are high enough, the moisture in the air is 'squeezed out' as precipitation on the windward side of the mountains. Therefore, the air that does cross the mountain ranges has lost most of its water vapor and is too dry to allow for cloud formation and precipitation. This is known as the "rainshadow effect." This phenomenon has resulted in many arid ecosystems around the planet.

Q & A

How are the mountains and mountain ranges that influence weather patterns formed?

Answer: There are two main ways in which mountains form – volcanism and plate tectonics. Vulcanism causes the accumulation of molten material to ooze out of Earth's upper mantle. This material, usually erupting in the form of lava, cools into basalt and many other rocks and minerals. Repeated and/or continuous eruption activity can produce a mountain many thousands of meters high. Hawaii's islands formed in this way, with Mauna Kea accumulating volcanic material to an elevation of over 17,050m above the sea floor. Plate tectonics (the movement of crustal plates over the liquid mantle, aka continental drift) create mountains when plates collide or one slides under another (subduction). The Appalachian Mountains were formed by the collision of the North American and African Plates (about 200 mybp), while the Coastal ranges, Cascades and Sierra Nevadas are forming by the subduction of the Pacific and Juan de Fuca Plates under the North American Plate. (Mt. Everest in the Himalayas, forming the subduction of the Indian Plate under the Asia Plate, has an elevation of over 8800m).

Going Further: Islands are constantly forming and eroding. Even now a new island is forming just off the coast of Hawaii. Choose an island, island chain or archipelago and investigate its formation history and probably future. Some possible choices are: Hawaii, the Galapagos, Krakatoa and Anak Karkatoa, Indonesia, the Philippines, Santorini, and Montserrat.

What are the Earth's crust and mantle?

Answer: These are layers of the Earth. If out planet were sliced in half, we would see many layers each with a slightly different make-up and character. Although geologists are not 100% certain of our planet's interior, modern theory defines five layers.

The innermost – **the Inner Core** – is probably made of solid iron and other heavy metals.

The Outer Core has a similar make-up, but is considered to be semi-solid in nature.

The Upper and Lower Mantles consist of molten rock and minerals, and it is the material of the Upper Mantle observed erupting from volcanoes.

The aesthenosphere is the layer of the Upper Mantle in which convection currents – known as cells – cause the movement of the crustal plates known as continental drift.

The Crust (aka lithosphere) is the thin (only about 5-1000km thick) layer of crystalline rock that forms Earth's surface.

Q & A

Do volcanoes affect climate in ways other than mountain building?

Answer: Most definitely! While quiet eruptions are responsible for building mountains, explosive eruptions can obliterate mountains and even entire islands! These explosive eruptions also release tons of gases, rocks and ash high into the atmosphere. The dust blocks some of the sun's radiant energy from reaching Earth's surface and cools down the climate. The dust particles also act as nuclei for water vapor forming clouds that can increase precipitation many thousands of kilometers from the eruption.

Going Further: Have relatively recent volcanic eruptions affected climates? Investigate some of the larger eruptions over the past two centuries, such as Krakatoa, Mt. St. Helens, Mt. Pinatumbo and others. Discover what effects, if any, their explosive eruptions on climates in their local area globally.

Teaching Note: Check out "volcanism" in Weather and Geography Resources to find out more.

Is mountain building the only way continental drive affects climate?

Answer: No. Another effect this phenomenon has is that as the crustal plates move, coastlines are changed and ocean currents shift course. When the temperatures and directions of these currents are altered, the effects on the land masses will also change. For example, if the Gulf Stream were to turn east from North America at a lower latitude, cold water from the Artic would move further south. This would result in a much colder climate in Europe, possible triggering another Ice Age. In North America, cold air masses would be able to penetrate further south also cooling and drying the temperate climate. Other effects would be seen worldwide, a cascade effect where the change in one climate effects change in a neighboring climate.

The Weather Classroom: Break

Q & A

With all that mountain building occurring over Earth's history, why aren't there higher mountains?

Answer: Simply because gravity and weather work to break down and crumble the mountains as quickly as they are formed. You can see how this works by comparing young and old mountains. The Appalachian Mountains are considered old mountains. They are relatively low, rounded and covered with vegetation and soil. The Rocky Mountains are much younger and are sharp and jagged with little vegetation or soil.

How does weather wear down mountains?

Answer: Two forces are at work – erosion and weathering. Erosion is the gradual wearing away of land by the actions of gravity, wind, water or ice (esp. glaciers). Weathering is the gradual breakdown of rock my mainly precipitation and temperature changes. Although they sound similar, there are different physical effects that always work together to bring down mountains and carve valleys and canyons.

Wind Erosion – This is usually more apparent in arid climates. The wind picks up tiny grains of soil and sand and transports this material, sometimes for many hundreds of miles. As the grains hit solid objects, they act like a sand-blasting machine and gradually wear away those objects – one tiny part at a time.

Water Erosion – Water erodes in two ways, first by chemically breaking down and dissolving materials, and second by transporting silts and sands that break down materials in a manner similar to wind.

Ice Erosion – Ice, especially in glaciers, can literally 'gouge' out huge areas of rock and soil by moving slowly downhill due to the force of gravity on the large mass.

Water Weathering – This action is mainly chemical. The water will dissolve various minerals and gases, often forming weak acidic compounds (carbonic acid, sulfuric acid, etc.). These acids slowly dissolve away rock mineral allowing small pieces of undissolved rock and mineral to be transported away, and often forming cracks and rocks.

Temperature Weathering – Rock absorbs the sun's heat readily, which causes the rock to expand ever so slightly. At night, the rock quickly loses that heat and shrinks. This daily expansion and contraction creates joints and cracks into which water can then flow. When water freezes, it expands widening the cracks even more.

Q & A

Do erosion and weathering have the same effects everywhere?

Answer: Yes and no. Yes, in that these forces do break down rock and change landscapes all over the Earth. No, in that these forces have different effects on different materials. For example, hard rock, such as basalt and granite, will erode and weather at a very slow rate. Sometimes, especially on granite, this weathering will produce large, thin slab of rock that are sloughed off the parent rock, known as 'exfoliation'. Soft rock, such as sandstone and limestone will weather at a quicker rate. Water will quickly create cracks in the rocks and seep down and throughout the formation. Sometimes, large underground areas erode away quicker than the surface forming caves and caverns. As the roof of the cave continues to erode, and soils accumulate above the ground, the rock will give way and form a sinkhole.

Does the climate affect weathering?

Answer: Absolutely! In arid climates, most weathering is done by the wind. Rocks and mountains are constantly blasted by sand-bearing winds. This erosion has resulted in some fascinating landscapes throughout our world. In wetter climates, water is the main force. Precipitation collects as surface water, forming streams. These streams with their silt and sand loads scour the soils and rocks of the land. In areas of soft rock and unconsolidated soils, these streams can gouge deep troughs in the land, eventually forming canyons.

Teaching Note: Check "weathering" in Weather and Geography Resources to find out more.

Going Further: Hoodoos? Haboos? Balancing rocks? Natural arches? Tepuis? Monadnocks? Research these and other types of unusual geologic formations. Discover what forces created these natural wonders. Create a weathered landscapes bulletin board with photographs, drawings or diagrams illustrating each of these unusual landforms.

Teaching Note: Check "landforms" in Weather and Geography Resources to find out more.

Did water erosion form the Grand Canyon?

Answer: In part, yes. The Colorado River with its tremendous load of slits and sands had gouged out a series of canyons, including the largest on Earth, the Grand Canyon. The layers of different types of rock eroded at different rates and the river meandered and changed course helping to create the fantastic geological formations seen there. But, geologic uplift also helped increase the erosion. As the Pacific Plate subducted under the North American Plate, the latter rose, resulting in the Rocky Mountains and the elevation of much of what is now northern Arizona, known as the Kaibab Plateau. This rise in elevation and slope increased the velocity of the river, thus increasing its erosive powers.

Q & A

How does elevation and slope affect weathering and erosion?

Answer: Gravity is the force at work here. Everything on the surface of the Earth is held tight by gravity. This force is constantly pulling everything inward toward the core. As a result, if volcanoes quit erupting and the crustal plates quit moving, everything would eventually be pulled until the continually at work changing the topography of the landscape. As land is pushed or built up, gravity pulls it back down. In other words, as mountains erode valleys fill. This occurs more quickly on steep slopes because there is less material to produce enough frictional force to slow or stop the gravitational pull. Sometimes huge masses of eroding rock and soils will succumb to gravity all at once and result in a landslide. This form of rapid erosion, common in areas with steep slopes and soft rocks, is knows as mass wasting.

Geologic forces definitely have effects on climates and how they can change. Are there other forces that affect climate?

Answer: Yes. How out planet orbits the Sun has a dramatic effect on climate. Our orbit is slightly elliptical and results in distance changes from the Sun. These changes alter the amount of solar radiation (insolation) we receive – more when we're closer, less when we're further away. Also, the tilt of the Earth (23.50) to the plane of the solar system effects seasonal changes. Astronomers theorize that the Earth 'wobbles' occasionally, shifting the tilt in the opposite direction – possibly as often as every 10,000 years or so. This would cause sudden and drastic global changes in climate and seasonality. Humans also have an impact on climate. Humans, like other organisms, alter our environment to produce a more comfortable, healthy life. Unfortunately, some of our means to a 'better life' have changed our climate – and it will get worse before it gets better. Emissions from the burning of fossil fuels, industrial chemical emissions and deforestation have released gases into the atmosphere that are beginning to severely affect ecosystems and global climate. Sulfur and nitrogen compounds combine with water vapor to form acids. The resulting acid precipitation destroys ecosystems by rapid physical deterioration and the leaching of nutrients from soils. The loss of vegetation, especially forests, decreases the amount of water vapor in the air and results in a drier climate. Also, the release of carbon dioxide and methane has enhanced the Greenhouse Effect (which is essential to life) so much that global warming is occurring and causing climate changes. Although the long-term effects are not certain, sea levels rise, ice melting and the alteration of ocean and atmospheric currents could certainly have dramatic effects on climate change.

Going Further: Global warming has been a controversial subject for several decades. Is it real or just a short, perfectly natural climatic phenomenon? What are the apparent causes of this phenomenon? What are some of the possible ramifications to global climate? How might the world's economic situation change? Will some sort of ecological collapse occur? What legislation – local, national and global – has been proposed and/or enacted to address the issue? What citizen actions can be and/or have been taken? Have student teams pick a question within the issue of global warming for research. Have them report to the class on scientific, political and/or grass root reactions to this important theory.

Hands On – Kind of a Drag

Teaching Note: Below are several demonstrations and research activities. You may assign different activities or research projects to small groups of students, select one or two activities and use them as whole group demonstrations, or have students select one or two questions to pursue for individual or small group research.

Discuss glaciers: What are they? Where are the found? What effects do they have on climates and geography?

Probable responses: Glaciers are large, moving sheets of ice. They are found in cold climates, particularly high mountains and polar regions. They can cool the climate by reflecting most of the sun's heat energy and, as atmospheric heat transfers to the ice, the air cools. Glaciers that form on slopes will gradually move toward sea level. As the slope increases, the glacier moves faster along the ground, scraping away the material forming valleys, cliffs, lakes and other features, especially drumlins and terminal moraines.

Distribute Student Handout: Kind of a Drag and have students work together to create the demonstration. After students make their observations, have them answer the following questions:

What were some of the effects of the activity?

Answer: Possible effects, depending upon the landscape construction and the size of weight of the box: scraping off of soil and sand/gravel layer; skid marks on the clay layer; large gouges where larger rocks had been; piled material in front of the box; cliffs and "hanging valleys."

Does this activity accurately demonstrate glacial action?

Answer: Compare the class landscape with photos, illustrations and charts of actual glacial activity. Have students draw conclusions based on the results.

Extensions: Repeat this activity using blocks of ice instead of a wooden box. (Students should note that the ice will 'pick up' some of the material.) Alter the landscape to stimulate an Alpine region with multiple glaciers. Change the slope of the landscape from flat to steep. Each time, have students observe the effects and compare and contrast the geological effects.

Going Further: Do glaciers affect climate, or does climate affect glaciers?

Answer: Glaciers and climate can and do work together. As snow accumulates, the atmosphere becomes colder. The colder the air, the less snow melts and more can accumulate, eventually forming ice fields. These will allow subsequent snowfalls to remain longer and accumulate deeper-forming glaciers. The longer they persist, the colder the air and the cooler the climate. If the climate warms, due to various forces (wind pattern changes, plate tectonics, global warming, etc.), glaciers will melt and recede. This leaves behind geologic features that affect the wind and precipitation patterns of the area, thus creating microclimates.

DEMONSTRATION 1

Materials:

- Onion paper, rice paper or translucent paper
- Map of your area
- Writing utensil
- Tape

Biomes and Ecosystems

As a class, determine in which biome your community exists. Then, have students brainstorm different ecosystems that exist in your area.

Possible response: Biomes in North America include: tundra, taiga, temperate rain forest, mountains, temperate grasslands, savanna, chaparral, deserts, deciduous forests, southern pine forest and sub-tropical woodlands. Some ecosystems include marine, estuarine, lentic (still freshwater), lotic (moving freshwater), short grass prairie, tall grass prairie, spruce-fir forest, oak-hickory forest, maritime forest, alpine tundra, arctic tundra, poplar-hemlock forest, peat bog, warm deserts, cold deserts, and others.

Direct teams of students to investigate the different types of ecosystems in your area. Using photos, field trips, maps and other means, locate as many ecologically different areas as possible.

Use available resources (Internet, USGS, media center, county offices) to have students create a map of your area (county, parish, state). Include elevation changes, hills, valleys, streams, lakes and other geologic features (topography).

Instruct students to illustrate the locations and extent of the different ecosystems they identified on this map.

Direct another student team to research the weather patterns for your area and identify precipitation and temperature differences, general wind patterns, major storms' locations, floods and other data.

Have the weather team use onionskin paper, rice paper, other transparent tracing paper or plastic film to illustrate their findings. (The weather map must be the same dimensions as the first map.) They should first outline the general area of the first map, and then show the weather information. Overlay the weather information onto the first map. Discuss any correlations among weather patterns, geology and existing (and former) ecosystems between the maps.

Do some areas seen to receive more rain that others? Are some areas cooler or warmer than others? What is the prevailing wind and storm direction?

Answer: Answers will vary.

Does the geology of your area create microclimates and therefore allow for different ecosystems?

Answer: Answers will vary.

Extension: Challenge students to research and discover what landforms, ecosystems and microclimates existed in the study area prior to human settlement. Have them determine what changes in local weather and microclimates might have been caused by human activities.

Going Further: Does your area differ from those nearby in terms of weather and climate patterns, geologic features and/or ecosystems? Increase the scope of the study to include adjacent counties, parishes or states. Contact other schools in those areas to assist with the project.

DEMONSTRATION 2

Materials:
- Student Handout "Times, They Are A'Changin'"
- Writing utensil

Times, They Are A'Changin'

Discuss the climatic change with students. Have Earth's climates always been as they are today? If not, what are some changes that have occurred? Do we know why they changed? (Possible Responses: Earth's climates have not always been the way they are. Just 10,000 years ago, much of the northern hemisphere was in the grip of an Ice Age. Judging by paleontological and geological information, Antarctica used to have temperate to sub-tropical climates, northern Canada was once tropical, the Sahara Desert used to be lush, temperate forests with rivers, lakes, and all other places on this planet have had climatic changes. The changes have occurred for many reasons, but primarily, as the result of continental drift which alters topography, wind movement and ocean currents.) Have students talk about how the climate may change in the future, and what may cause these alterations.

Distribute Student Handout: Times, They Are A'Changin' to teams of students. Inform teams that they will be given geologic, atmospheric and/or oceanic changes in and around North America.

Assign teams changes in one or more of these features and phenomena. Remind students of how climates in North America are affected by the Gulf Stream, Jet Stream, Pacific Currents, Rocky Mountains and other mountain ranges (Coastal Ranges, Sierra Nevada, Ozarks, Appalachians, etc.) and vegetation cover. Challenge them to predict possible local, continental and global climatic changes. Teams will then share their predictions with the class.

Analysis: Would changes in any of one of the factors influencing the climate in North America result in marked differences?

Answers: Answers may vary for each of the factors. Wind patterns, temperature ranges, precipitation and subsequent vegetation changes will all have major impacts.

Which change would affect your area most? How and why?

Answer: Answers will vary.

Extension: Have students write fictional essays or short stories on how the possible climatic changes will affect life and living in North America.

STUDENT HANDOUT
Materials:
- Silty clay, sand, gravel, pebbles, rocks, topsoil
- Wooden box, no wider than one-third the width of the landscape rope
- Heavy material (sand, rocks or ice blocks, etc.)

Kind of a Drag

Directions: Work with your fellow geologists to follow the steps below.

Purpose:
To demonstrate the effects of glacial movement on the landscape.

Procedure:
Create a model landscape, either outdoors, or within a large container in the classroom. Begin with a layer of silty clay, compacted as much as possible, then add mixed layers of sand, fine gravel, some larger pebbles and a few larger rocks. Cover the layers with a topsoil mixture. Illustrate the layers of your landscape:

- Within the landscape, build mountains, hills, valleys, ridges, etc. Illustrate the topography of your landscape.
- Attach a rope to one end of the wooden box and place it at one end of the landscape. Fill the box with heavy material. Carefully and slowly, pull the box across the landscape. Record and illustrate your observations:

Analysis:
What are the effects of the dragging activity on the landscape?

Does this activity accurately demonstrate glacial action? Compare your landscape with photos, illustrations and charts of actual glacial activity. What are your conclusions?

Going Further: Repeat this activity using blocks of ice instead of a wooden box. Note that the ice will 'pick up' some of the material. Alter the landscape to simulate an Alpine region with multiple glaciers. Change the slope of the landscape from flat to steep. For each change, observe the effects and compare and contrast the geologic effects.

STUDENT HANDOUT

Times, They Are A'Changin'

Directions: Work with your team to predict what changes the following may have on local, continental and/or global climates.

Purpose: To postulate on the effects of geologic, oceanic, atmospheric and/or floral changes would have on climate.

Procedure:

Choose from one of the scenarios listed below. Investigate to discover how present conditions influence weather and climate. Research the history of the area to discover what weather and climates were present in the past, why they existed, and how and why they changed. From your research and knowledge of how physical features/phenomena affect weather and climate, predict what changes could result if they were altered. Using appropriate AV materials, present your findings to the class for discussion.

What if this happened…

• Costal Ranges	Rise higher with peaks over 8,000m
• Bering Straight	Land raises joining Asia and N. America
• Jet Stream	Recedes to Arctic Circle
• Cascade Volcanoes	Simultaneous eruptions of all volcanoes
• Gulf Stream	Turns east at 300 latitude
• Rocky Mountains	Erode to elevations less that 1,000m
• Earth's Tilt	Decreases from 23.50 to 00
• Earth's Rotation	Reverses direction, like Venus
• Global Warming	Global temperatures raise 50C

Analysis:

Which scenarios produced the most drastic changes? Why?

Which scenario is most likely to occur? Explain.

Would the rate of change at which these scenarios occurred affect the outcomes? Explain.

Internet Resources

World Climates

World Book: Around the World Climates (Maps)
http://www.worldbook.com/fun/atw/climates/index.htm

Climate Classification
http://fridge.arch.uwa.edu.au/topics/thermal/climate/classification.html

Mountain Climates
http://www.colorado.edu/epob/epob3020bowman/003.html

National Climate Data Center
http://www.ncdc.noaa/gov/ol/ncdc.html

Biomes

Blue Planet Biomes
http://www.blueplanetbiomes.org/table_of_contents.htm

Biome Basics
http://www.richmond.edu/~ed344/webunits/biomes/biomes.html

Winds

Whirling Winds of the World
http://freespace.virgin.net/mike.ryding/

Names of Winds
http://ggweather.com/winds.html

Seismic Changes

Global Volcanism Program
http://www.volcano.si.edu/gvp/

National Earthquake Information Center
http://www.neic.cr.usgs.gov

Landforms
http://www.athena.ivv.nawa.gov/curric/land/landform/landform.html

Desert Landforms
http://www.sunysuffolk.edu/~keahj20/landforms.html

Weathering

Weathering Slide Show
http://www.geo.duke.edu/geo41/wea.html

Earth Science: Weathering and Erosion
http://pages.prodigy.net/pmedina/erosion.htm

Weathering
http://www.dc.peachnet.edu/~pgore/geology/geo101/weather.htm

Weathering Vocabulary
http://bellnet.tamu.edu/res_grid/cuedwe17.htm

Global Climate Change

Bush Announces Climate Initiative
http://www.weather.com/newscenter/topstories010611climatebush.html

President Bush's Remarks on Global Climate Change
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