THE WEATHER CLASSROOM®

ATMOSPHERE

This lesson addresses the following National Standards:

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

Physical Science Standards
- Light, electricity and magnetism

Earth and Space Science
- Structure of the earth system
- Earth in the solar system

Language Arts:
- Written and oral presentations

Visual Arts:
- Color Wheel

Geography
- Latitude
- Location and travel itinerary

Preview

Atmosphere is the sea of air that allows animals and plants to live and is the stage for all Earth's weather. For centuries, we have explored the atmosphere to find out more about how it affects us and how we affect it.

Weather Fact

The Weight of the Air
At sea level, the weight of the air around you is about 14.7 pounds per square inch. As your altitude increases, the density of the air and, therefore, its weight decreases. At an altitude of 10,000 feet, air pressure is about 10 pounds per square inch, almost 1/3 less than sea level.

Weather Terms

All glossary terms can be found at http://www.weatherclassroom.com/glossary
Air
Atmosphere
Atmospheric pressure
Barometer
Barometric pressure
Chinook
Coriolis effect
Exosphere
High pressure system
Inches of mercury (Hg)
Ionosphere
Land breeze
Low pressure system
Mesosphere
National Center for Atmospheric Research (NCAR)
Prevailing wind
Santa Ana winds
Satellite
Sea breeze
Sea level pressure

Q & A

Start Talking

What is the atmosphere? How have we explored it?

Answer: The atmosphere is the sea of air in which we live and breathe. Gravity keeps this mix of gases — 78% nitrogen, 21% oxygen, 1%other gases, including 0.9% argon and 0.03% carbon dioxide — from dissipating into space. Humans have explored the atmosphere with kites, hot air balloons, airplanes, rockets, satellites and lasers.

Why is the atmosphere called the "weather machine"?

Answer: Weather occurs within the first layer of our atmosphere and is powered by the radiant energy from the Sun. Land, air and water absorb heat differently: different layers of the atmosphere trap heat, hold water vapor or lose heat. This uneven heating of earth /pressure) differences that, in turn, cause winds, the movement of air that creates and affects weather.

Going further: Challenge students to draw diagrams that illustrate the "parts" of the atmospheric weather machine, including the sun, wind, Earth features, Earth's rotation, etc.

Why is it important to understand our atmosphere?

Answers will vary, but should include: Understanding the atmosphere and how it interacts with earth's features can help us understand, forecast and prepare for weather. Since life on Earth cannot exist without air, it's important to understand how to keep the atmosphere free of pollutants.

Going further: Besides providing O2 for animals to breath and CO2 for plants to use in photosynthesis, what other important jobs does the atmosphere perform? As a class, create a list of "what if's" to illustrate the importance of Earth's atmosphere.

Answer: The atmosphere protects life on Earth from radiation from the Sun; it keeps the hear from the Sun from escaping into space and allowing Earth to freeze; it is a major part of the water cycle and keeps the climate on Earth moderate compared to that of other planets.

Teaching note: See "The Goldilocks Theory: An Internet Exploration" in Hands On.

Q & A

If you cannot smell, see, touch, or taste air, how do we know it exists?

Have students describe and explain the on-air experiment.

Answer: People have proven that air exists because it takes up space. In the First Century AD, Hero noticed that, WHEN a container is turned upside down and put straight into a tub of water, the water will not flow into the container. If, however, a hole is put in the container, water will enter it, but if the air in the container escapes, there will not be any room for the water

Going further: Have students explain ways that they know that air has mass. Perform demonstrations for the class or challenge students to set up their own demonstrations.

Answer: For example: (1) Tie the balloons to the opposite ends of a meter stick. Balance the stick. Then blow air into one balloon. Which is heavier? Or, (2) place a book on top of a deflated balloon. Inflate the balloon. Why does the book rise?

What work do scientists conduct at the National Center for Atmospheric Research (NCAR)?

Answer: NCAR scientists study anything that has to do with the atmosphere — the Sun, air in motion, storms, oceans, the chemistry of the atmosphere and its interactions. Although the facility is in Boulder, Colorado, NCAR scientists go where specific atmospheric events occur — thunderstorms in Kansas and tropical squalls in the South Pacific or the tropical Atlantic. In their work they use aircraft, supercomputers, high altitude observations, satellites and telescopes from around the world.

Why is the work of NCAR important?

Answers will vary, but should include: The more we understand the Sun, the atmosphere and the weather they produce, the better able we'll be to predict and prepare for severe weather. We will also be better able to take care of the air we breathe.

Teaching note: Check out NCAR online, just go to Resources and click on NCAR.

The Weather Classroom: Break

Q & A

Why were animals the last type of life to evolve on Earth?

Answer: Billions of years ago, Earth was a cloud of gases where heavier materials formed solid matter and oceans; the atmosphere was mainly carbon dioxide and nitrogen. First plant life began to evolve because it used carbon dioxide for photosynthesis. The oxygen that plants gave off reacted with volcanic gases. Animal life evolved only after volcanic eruptions subsided as a result animals could breathe the oxygen that photosynthesis put into the atmosphere. The atmosphere now contains an equilibrium of gases where carbon dioxide is given off through respiration and weathering, and oxygen is given off by photosynthesis.

Going further: Based on the information about an equilibrium of gases in the atmosphere and following definitions from The Weather Channel Glossary, at http://www.weatherclassroom.com

Have students discuss the pros and cons of the "Greenhouse Effect."

Greenhouse effect

Ozone layer

Answers will vary, but the following points should be included:

- Earth's lower atmosphere is warmed primarily due to carbon dioxide and water vapor (greenhouse gases) that permit the sun's rays to heat the Earth, but restrict some heat-energy from escaping back into space.
- In the same way a greenhouse maintains warm temperatures, the "Greenhouse Effect" maintains the temperatures of the atmosphere. Without it, the surface of the Earth would have temperature extremes similar to that of Mars.
- Whereas too many greenhouse gases in the atmosphere could cause temperatures to rise out of control, as on Venus.
- Human technologies and burning fossil fuels create greenhouse gases; cutting down trees and paving green areas deplete oxygen-creating plant life the photosynthesize carbon dioxide.
- The ozone layer filters incoming ultraviolet radiation from the sun. If humans deplete the ozone layer, a greater amount of ultraviolet radiation will get through the atmosphere to Earth's surface.

Going further: Guide students to discover more about the human impact on the atmosphere, the possibility of global warming and the effects we might see. Check The Weather Channel's Special Report "Hot Planet" (http://www.weather.com/specialreports/hotplanet/index.html) and click to Resources to find more fuel for debate.

Q & A

Describe the layers of the atmosphere.

Answers: Earth's atmosphere is a mixture of gases that reaches well over 350 miles (560 kilometers) high, getting ever thinner until it blends into space. The way layers of the atmosphere are divided is based on how temperature changes from height.

Troposphere: extends from the surface of the Earth to 5 to 9 miles (8 to 14.5 km) high; contains half the molecules of the Earth's atmosphere. Weather occurs in this layer; most clouds form in this layer. Temperature decreases with altitude (to about -52° C) because Earth's surface absorbs the energy from the Sun, heats faster than the atmosphere, and then gives off heat into the atmosphere.

Stratosphere: starts above the troposphere and extends to 31 miles (50km) high. Jet planes fly into this layer because it is very stable. Temperature increases (to about -3° C) with altitude because the ozone layer, located at about 15.5 miles (25 km) from the surface of the Earth, absorbs the ultraviolet radiation from the Sun, which warms the atmosphere. About 99% of the molecules in Earth's atmosphere are within the troposphere and the stratosphere.

Mesosphere: starts above the stratosphere and extends to about 53 to 56 miles (85 to 90 km) high. Meteors burn up in this layer of the atmosphere. Temperature decreases with altitude to about -90° C.

Thermosphere: starts above the mesosphere and extends to about 372 miles (600 km) high. Temperature rises with altitude and, depending on the activity of the Sun, could reach over 1500° C. The atmosphere is so thin here that even a small increase in energy from the Sun can cause a large increase in temperature.

Exosphere: starts above the thermosphere and continues until it merges with space.

Teaching Note: The ionosphere, the region of the atmosphere filled with charged particles, is located within the thermosphere. It is not considered a layer based on temperature, but is within the thermosphere because the elevated temperatures sometimes cause molecules to become ionized.

Going Further: Click on "Windows on the Universe: Earth's Atmosphere" in Resources to find more information, photos, charts and explanations of the layers of Earth's atmosphere. Challenge a small group of students to create a scale diagram of the atmosphere, based on the facts they find. Have other groups create more detailed diagrams of specific atmospheric layers.

Going further: What's up in the atmosphere today? Have students click into monitor daily atmospheric data from NASA. Go to Resources and click into "Today From Space: The Earth's Atmosphere."

Q & A

What is air pressure? Why doesn't the pressure of all the air around us weigh us down? How can you sense a quick chance in air pressure?

Answer: Air pressure is the force or push of the air molecules downward against everything on Earth. People are not crushed by this weight because air fills all the spaces in our bodies and presses outward with equal pressure. We can sense a change in air pressure with increasing or decreasing altitude. For a moment, our ears may feel stopped up, but when our ears "pop," they are actually equalizing the pressure within our bodies and the atmosphere. In a more gradual increase in pressure, our bodies slowly equalize pressure and we may not notice any change.

Going further: Guide students to list and discuss ways humans use air pressure for their own benefit.

Answers will vary, but may include: in tires, inflated mattresses, buoyancy devices, pneumatic drills, pressurized cabins in planes.

Describe changes in air pressure with traveling from Death Valley to the top of a mountain over a mile high. Why would a plastic bottle of water and a bag of chips "puff up" during that change in altitude?

Answer: Death Valley is the lowest point in the Western Hemisphere – 282 feet below sea level. Air pressure is high at this low altitude because the atmosphere is denser. As you increase altitude, air pressure decreases because the atmosphere becomes less dense. Plastic bottles and bags are sealed to keep air out. Unlike our bodies (our ears pop) in a change in altitude, they cannot equalize pressure.

How do high and low pressure areas within the atmosphere affect the weather? Why?

Answer: Areas of high pressure usually mean sunny, fair skies; low pressure can mean cloudy, stormy weather. Air pressure is determined by the density of the air; warmer air is less dense or heavy than colder air because warm air expands, its molecules move further apart. Warm air therefore exerts less pressure on the ground, creating a low-pressure region in which air is rising, cooling and condensing into clouds that can bring rain or snow. Cooling air is denser and will sink, pulling more air behind it that will also sink, increasing pressure and temperature due to compression. In this region of high pressure, as air sinks and warms, water evaporates leaving fair skies.

Teaching Note: See "Moving Air" in Hands On.

Q & A

Why do winds blow?

Answer: Air moves from areas of high atmospheric pressure (cooler air) to areas of low pressure (warmer air), trying to equalize the density of air molecules. This movement is the wind. The greater the difference in air pressure, the greater the winds. The Earth's rotation and curve has an additional impact on winds. Winds cannot flow straight from high- to low-pressure areas because the rotation of the Earth deflects the winds to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. This is the Coriolis effect, named for French physics professor Gustave-Gaspard Coriolis, who identified the effect in 1835.

Teaching note: Review the video demonstration of the Coriolis effect with the sound off. Have students narrate the explanation.

Going further: Demonstration (this may be performed by the teacher of student groups)

Materials: rubber ball, thumbtack, aquarium or deep plastic container filled with water, food coloring

Procedure: (1) Attach one end of the string to the rubber ball with the thumbtack and suspend it in the water. (2) Start the ball spinning smoothly, then drop a little food coloring at the "pole" of the ball.

Observation: As the ball spins, the food coloring is deflected to one side.

Analysis: Currents flowing from the "pole" are deflected just above the "equator" by the Coriolis effect.

Going further: Read the following information to the class: In 1857, the Dutch meteorologist Christoph Buys Ballot showed empirically that, except near the equator where the Coriolis effect is very weak, winds in the Northern Hemisphere flow clockwise around high-pressure areas and counterclockwise around low-pressure areas. The opposite is true in the Southern Hemisphere. According to Buys Ballot's Law, if you stand with your back to the wind in the Northern Hemisphere, the lower pressure is always on your left. The opposite occurs in the Southern Hemisphere. Have students discuss ways Buy's Ballot's Law might be useful. For example: A sailor might use the information to avoid a low pressure area that could mean stormy weather.

Q & A

Name and describe some of the different kinds of winds mentioned in the video.

Answers:

Prevailing winds: winds that blow from one direction more frequently than from any other given period, such as a day, month, season or year. For example: Trade winds are two belts of prevailing winds that blow easterly toward the equator. Primarily lower level winds, they are characterized by their consistency in direction – in the Northern Hemisphere, trade winds blow from the northeast; in the Southern Hemisphere, trade winds blow from the southeast.

Sea breeze: a diurnal coastal breeze that blows onshore, from the sea to the land, caused by the temperature difference when the surface of the land is warmer than the adjacent body of water. It is predominant during the day. Land breeze: a diurnal coastal breeze that blows offshore, from the land to the sea, caused by the temperature difference when the sea surface is warmer than the adjacent land. It is predominant during the night.

Local winds: are influenced by geographic features found on the Earth's surface. For example: Chinook winds are warm, down slope winds in the Rocky Mountains that occur after an intense cold spell when the temperature could rise by 20 - 40° F in a matter of minutes.

Santa Ana winds are hot, dry winds, generally from the east, that funnel through the Santa Ana river valley in southern California and occur most often during the winter.

Going further: See "Moving Air" in Hands On for wind activities.

Going further: To find out more about other types of winds, check The Weather Channel glossary. For example:

Easterlies

Jet stream

Mountain breeze

Valley breeze

Westerlies

Why have the prevailing winds been important in the history of the world?

Answer: When wind was the only power that moved ships around the world, trade and exploration followed the paths of prevailing winds.

Going further: Have students use geography and history texts to research and map exploration and trade routes between Europe, Africa, Asia and the Americas. Challenge them to explain where and how prevailing winds had an influence. Check Resources to find out more about global winds.

Q & A

What is the National Wind Technology Center (NWTC) in Boulder, Colorado? What is its mission? Why is the study of wind technology important?

Answer: The NWTC, part of the National Renewable Energy Laboratory, manages wind turbine research for alternative energy production and application. Wind energy is becoming more popular. Wind can provide pollution-free electricity; wind is steadily available in many areas; and, wind energy costs, already competitive with conventional fossil-fueled power, continue to drop as technology improves.

Going Further: One objection to wind turbines is their possible impact on birds. Check Resources to find out more about NWTC and how it deals with avian issues.

Hands On

Moving Air

Teaching note: The following hands-on presentations can be used as classroom demonstrations or group activities, depending on your students abilities and your time frame. If possible, the activities should be divided among teams of students who will them set up and perform their assigned demonstrations for the whole class, providing scientific explanations in a Q & A period.

Distribute the Student Handout: Moving Air.

1. Provide teams with necessary material and time to form their hypotheses, set up materials and practice their demonstrations.
2. Have teams research necessary terms or explanations for their demonstrations and prepare a class presentation of the activity and the explanation.
3. Provide time for team demonstrations and a Q & A to discuss the concept of air movement.

Answers: Moving Air.

Demonstration 1: Does Hot Air Rise?

The paper with spiral swirls. When you move it away from the light source, it stops swirling. Analysis: The air above the light source is heated and rises, causing the paper spiral to swirl in the moving air. Rising warmer air (lower density) and dropping colder air (higher density) cause air movement (wind). If the atmosphere were all one temperature, there would be no air movement.

Demonstration 2: Blowing Bubbles:

Answers will vary according to the temperature and types of surfaces. However, bubbles move with the currents of air, moving up or down. The warmer the surface temperature, the higher the bubbles will rise. Over cooler surfaces bubbles will drop. Analysis: Air movement differs according to the amount of heat the surface has absorbed and how it heats the air around it. The uneven heating of the air causes winds, updrafts and downdrafts.

Going Further: Challenge students to discuss ways this demonstration illustrates the effect of cities vs. countryside on temperature and weather.

Demonstration 3: Air Masses and Weather Fronts:

The hot, red water stays above the cold water. As the waters equalize temperature, they begin to mix. Analysis: Higher density cold air masses in the atmosphere do not mix with lower density warm air masses. Where they meet, they form a front. Eventually the densities and temperatures equalize, but the movement of air masses and fronts are an important part of the weather machine.

Does Barometric Pressure Affect the Weather?

Have students discuss why the barometric pressure changed as The Weather Classroom reporter, Jason, traveled from Death Valley to the top of Dante's View, a mile-high mountain.

Answer: Air has greater density at lower altitudes; as altitude increases, air density (pressure) decreases.

Did the weather change as Jason traveled higher?

Answer: The weather was cooler at the higher altitude, but it still seemed fair and mild.

Follow the steps below to help students discover how changing barometric pressure affects the weather.

1. Distribute Student Handout, Does Barometric Pressure Affect the Weather?, to groups of students, or have a group of students turn this into a classroom wall chart.
2. Use a class barometer or have students check local forecasts on air or online at The Weather Channel (http://www.weather.com/common/home/localweather.html) to find and record the current barometric pressure. In the U.S., it is usually given as "inches of mercury." Current conditions will also show if pressure is rising, falling or steady.
3. Have students check and record air temperature, relative humidity, cloud conditions, wind speed/direction and precipitation type and amounts, using either school weather equipment or information from local forecasts.
4. Continue this process regularly over time – across seasons and types of weather. Try to take weather measurements at the same time each day.

Analysis: Over time, guide students to find patterns in their weather data and write statements that correlate barometric pressure in their area to weather conditions. Challenge students to make weather predictions based on rising or falling barometric pressure.

Answers will vary because barometric pressure and the weather you can expect during high and low pressure systems is relative to location. In general, high pressure systems bring fair skies and low pressure systems bring stormy skies.

Going further: Discover how the combination of altitude, latitude, landforms and water affect the correlation between barometric pressure and weather conditions. Have students choose, monitor and compare weather in cities across the country or around the world. Use The Weather Channel local weather sites (http://www.weather.com/common/home/localweather.html) to gather and chart data. Use maps and weather maps, texts and Internet travel sites to discover specific geographic information about each location. What impact does geography have on barometric pressure and weather?

Teaching note: Find satellite maps from around the world on The Weather Channel online at Map Index: Geography (http://www.weather.com/maps/geography.html)

Going Further: Challenge students to click into The Weather Channel's Storm Watch (http://www.weather.com/newscenter/stormwatch/) to find where storms are brewing or have had an impact. Then, go to The Weather Channel's local weather sites (http://www.weather.com/common/home/localweather.html) to check barometric pressure readings. Can students verify a pattern?

An Internet Exploration: The Goldilocks Theory

Why does life as we know it exist on Earth and apparently not on any other planets within our solar system? Well, just as Goldilocks found a porridge that was "just right," plant and animal life seem to find Earth and its atmosphere a perfect combination. Guide students to use the Internet to find, compare and share data as they find out why.

1. Divide the class into small groups and assign each a planet within our solar system to "explore." NASA has an excellent site to start an Internet exploration of planetary atmospheres. Just click on "Windows on the Universe: Our Solar System" in Resources to find information, photos, charts, animations and explanations about each planet.
2. After research is complete, have groups work together to create a wall chart to compare and contrast planetary atmospheres and determine why Goldilocks picked Earth.
3. Turn the data into a classic tale entitled "Goldilocks and the 9 Planets," complete with atmospheres that may be too hot, too cold, too dry, too poisonous, etc.

Going Further: Based on the information they have discovered and charted, have students consider and discuss: Although no other planet was just right for Goldilocks, could some of Earth's plant and animal life adapt to survive on other planets? Explain. What protections might they need? What respiratory apparatus might they develop? Have students draw the perfect plant or animal for life on _____. Challenge students to use this new life form as the basis of a science fiction tale about life or exploration on another planet.

Career Corner

Have students list the institutions and types of expertise represented by the people interview in the video. What was some of the most important information these experts conveyed?

Answer: Meteorologists at the national Center for Atmospheric Research (Peggy LeMone, Kevin Petty, Wendy Abshire) Professor of earth/space sciences at Georgia Tech (Dr. Jim St. John) Meteorologists at The Weather Channel (Colin Marquis) Wind energy specialist at the National Wind Technology Center (Sue Hock)

Next, have students consider:

- What types of jobs do these experts perform?
- What types of educational and professional background might they have?
- How do they apply their research?
- Would you like a similar job? Why or why not?

To find the answers to some of your questions, just click on the name of the expert and read a little more about their work and their background.

Going further: Guide students to find out more about the field of meteorology and preparing for related careers in The Weather Classroom online guide "Careers in Meteorology" (http). Then, check the Program Schedule (http) to set your VCR to tape the show when it airs.

DEMONSTRATION 1

Materials:
- 3-inch paper circle cut into a spiral
- 10-inch piece of thread heat source (40-watt light bulb)

Moving Air

Student Handout: Moving Air

You and your team of scientists are planning a demonstration and Q & A at a scientific symposium. Consider and complete your hypotheses, prepare your demonstrations and be ready to present your findings and scientific analyses.

Demonstration 1: Does Hot Air Rise?

Purpose: Demonstrate the movement of air of different temperatures (densitites)

Hypothesis: When air is warmed,…

Procedure:

1. Tie the thread to the center of the paper spiral
2. Hold the spiral by the thread over the heat source
3. Illustrate and describe your observation
4. Remove the spiral from the heat source
5. Illustrate and describe your observation

Analysis:

1. What causes the movement?
2. How does this illustrate the effects of uneven heating of the atmosphere?

DEMONSTRATION 2

Materials:
- Bubble Solution
- Wand Thermometer

Blowing Bubbles

Purpose:
Demonstrate the connection between temperature and air movement

Hypothesis:
Bubbles will _____ over cooler surfaces; bubbles will _____ over warmer surfaces.

Procedure: Scientist's Note: This activity should be completed outside with a variety of sun-warmed surfaces – bare ground, rocky, grassy or paved area, puddles, streams, etc. If this is not possible, you should warm different materials that have different textures by placing them in a sunny window or using a heat source.

1. Take the temperature of each surface, then blow bubbles close to and across the different surfaces.
2. Record your observations.

Surface Description	Surface Temperature	Bubble Movement

Analysis:
1. Is there a correlation between surface temperature and bubble movement? Explain.
2. How does this illustrate a part of the 'weather machine"?

DEMONSTRATION 3

Materials:

- 1 large glass jar
- 1 pitcher
- red food coloring
- very hot tap water
- ice cold water

Air Masses and Weather Fronts

Purpose: Demonstrate the movement of air of different temperatures (densities)

Hypothesis: When cold and warm water meet,…

Procedure:

1. Fill the jar half way with ice cold water.
2. Put hot tap water in the pitcher and add a drop of red food coloring.
3. Tilt the jar and slowly trickle the hot red water down the inside of the jar.
4. Illustrate and describe your observations.
5. Wait a while and illustrate and describe your observations.

Analysis:

1. Why don't the two waters mix at first?
2. Why do the two waters mid later during your observations?
3. How does this illustrate the movement of air masses in the atmosphere?

Student Handout

Does Barometric Pressure Affect The Weather?

You and your team of classroom meteorologists are charged with determining whether barometric pressure affects your weather. Do to this, you will need to measure and record weather data regularly. Use classroom weather instruments or check local forecasts on air or online at The Weather Channel (http://www.weather.com/common/home/localweather.html). Record your data in the following chart.

Date	Pressure	Rising Steady Falling	Temp.	Humidity	Cloud Cover	Wind Speed/ Direction	Precip. Type/ Amount

As you collect and record your data, formulate an hypothesis on the correlation between barometric pressure and weather conditions.

Try This

Test your hypothesis as you try to predict weather based on changing pressure.

- How accurate are your predictions?
- What type of weather or weather changes are easiest to predict?
- Does the time of year affect your predictions? Why or Why not?

Internet Resources

National Center for Atmospheric Research (NCAR)
http://www.ncar.ucar/info/cover.html

Windows to the Universe: Earth's Atmosphere
http://windows.arc.nasa.gov/cgi-bin/tour.cgi?link=/earth/Atmosphere/overview.html&sn=0&art=ok&cdp=windows3.html&cd=false&frp=windows3.html&fr=t&sw=false&tour=&edu=mid

Windows to the Universe
http://windows.arc.nasa.gov/

Today from Space: The Earth's Atmosphere
http://science.msfc.nasa.gov/newhome/essd/atmosphere_today.htm

Windows to the Universe: Our Solar System
http://windows.arc.nasa.gov/cgi-bin/tour.cgi?link=/our_solar_system/solar_system.html&sn=0&art=ok&cdp=windows3.html&cd=false&frp=windows3.html&fr=t&sw=false&tour=&edu=mid

Global Winds
http://easyweb.easynet.co.uk/~geography.net/kew/globalw.htm

Global Wind Systems
http://www.soton.ac.uk/~engenvir/environment/alternative/wind/windsys.htm

Hadley Circulation Call
http://www.meto.umd.edu/~owen/CHPI/IMAGES/circs02.html

NOAA Websites: Greenhouse Warming
http://www.websites.noaa.gov/guide/sciences/atmo/greenhouse.html

EPA: Global Warming
http://www.epa.gov/globalwarming/

Environmental Defense: Global Warming
http://www.edf.org/pubs/Brochures/GlobalWarming/

Center for the Study of Carbon Dioxide and Global Change: CO2 Science Magazine
http://www.co2science.org/

Weather Basics: Winds
http://www.usatoday.com/weather.wwind0.htm

National Wind Technology Center (NWTC)
http://www.nrel.gov/wind/