COSI ON WHEELS TEACHER PACK
CURRENT CONDITIONS
PRE-VISIT CLASSROOM ACTIVITIES

Current Conditions is designed to introduce students to the science of weather. The program consists of a 45 minute interactive assembly followed by exciting hands-on activities that engage the students and encourage the development of Science Process Skills.

During the assembly the following science concepts and more will be explored:

- Atmospheric Pressure and Wind
- Cloud Types and the Water Cycle
- Weather Forecasting
- Extreme Weather and Safety

The hands-on activities are presented in several 30-45 minute sessions with each session accommodating 62 or fewer students. Hands-on activity session times are scheduled by the person at your school who coordinates the COSI on Wheels event. Students will have the opportunity to test their forecasting skills, examine the tools and instruments used by meteorologists, and explore the power of wind and air pressure. In the hands-on sessions students informally interact with the activities, spending as little or as much time as they like at each station. While many students will try all of the activities, some may choose to have a more in-depth experience with only a few.

To prepare you and your students for **Current Conditions**, we suggest familiarizing yourselves with the vocabulary list provided. We also encourage you to explore the activities detailed on the following pages.

NOTE: *Students should be reminded to never eat or drink any of their experiments, even when experimenting with food items.*

CURRENT CONDITIONS
VOCABULARY

AIR: The mixture of gases that make up the Earth's atmosphere.

ALTOCUMULUS: Medium-level clouds that appear as small, white, puffy clouds that resemble collections of cotton balls across the sky.

ALTOSTRATUS: Medium-level clouds that appear as a sheet across the sky. Clouds are often thin, allowing the sun to be seen. Rainfall from this cloud type will not reach the ground.

ANEMOMETER: An instrument that measures the speed of wind.

ATMOSPHERE: Thin layer of mixed gases that encircles the Earth.

ATMOSPHERIC PRESSURE: The amount of pressure exerted by the atmosphere at a given point. Atmospheric pressure is expressed in either millibars or inches of mercury.

BAROMETER: An instrument used to measure atmospheric pressure.

CELSIUS: Temperature scale where water at sea level has a boiling point of 100° and a freezing point of 0°

CIRROCUMULUS: High-level clouds that form in a rippled pattern that resemble the scales of a fish. These clouds are usually seen in cold and fair weather.

CIRROSTRATUS: High-level clouds that appear as a thin-layer, often causing a halo-effect around the sun.

CIRRUS: Thin, wispy clouds that appear high in the atmosphere.

CLIMATE: The long-term atmospheric conditions of an area. The prevailing weather conditions for an area during the year, averaged over a series of years.

CLOUD: A visible collection of water droplets and/or ice crystals in the air.

COLD FRONT: The leading edge of an air mass that is displacing the warmer air in its path.

CONDENSATION: The process by which water vapor turns from a gas state to a liquid state.

CUMULONIMBUS: A vertically developed cumulus cloud that is anvil shaped. This is also called a thunderstorm cloud.

CUMULUS: Low-level clouds that appear as big, white, puffy clouds.

EVAPORATION: The process by which liquid water is transformed into a gaseous state.

FAHRENHEIT TEMPERATURE SCALE: A temperature scale where water at sea level freezes at 32 degrees and boils at +212 degrees.

FRONT: The boundary between two air masses of different temperatures and humidities.

HAIL: Balls of ice that form in the updrafts of convective clouds like cumulonimbus. Once the hail reaches a certain weight it becomes too heavy and falls from the cloud.

HIGH PRESSURE SYSTEM: An area of relatively high atmospheric pressure and divergent, downward winds that rotate opposite the direction of the Earth's rotation.

ICE: The solid form of water. It can be found in the atmosphere in many forms, including ice crystals, hail, snow, and ice pellets.

LIGHTNING: A quick and visible release of electricity that occurs in response to electrical potential built up between clouds and ground or between two clouds.

LOW PRESSURE SYSTEM: An area of relatively low atmospheric pressure and convergent, upward winds that rotate in the same direction of the Earth's rotation.

METEOROLOGY: The science and study of the atmosphere and its phenomena.

NIMBOSTRATUS: Medium-level clouds that bring precipitation, often in heavy amounts.

PRECIPITATION: Any form of water, liquid or solid, that falls from the clouds and reaches the ground.

RAIN: Liquid precipitation that falls from clouds in droplets bigger than .5 mm.

SEVERE WEATHER: Any destructive weather event, but usually applies to tornadoes, blizzards, hurricanes, and thunderstorms.

SNOW: Frozen precipitation that includes ice crystals in complex hexagonal form.

STORM: An individual low pressure system that includes winds, clouds, and precipitation.

STRATOCUMULUS: Low-level clouds that can form in layers of clouds. These clouds can also form in rows with sky seen between clouds.

STRATUS: Lowest-level clouds that form in thick, gray layers of clouds. Stratus clouds often wrap around and cover the tops of tall trees and buildings, hills, and mountains.

TEMPERATURE: The measure of the degree of heat of an object.

THUNDER: The sound created by the rapid expansion and contraction of air caused by the superheating, and then quick cooling, of air around lightning.

THUNDERSTORM: Storm produced by a cumulonimbus cloud that includes heavy precipitation, lightning, thunder, and in severe cases hail and tornadoes.

TORNADO: Violently rotating column of air extending between the ground and a convective cloud.

WARM FRONT: The leading edge of an advancing warm air mass that is replacing the relatively colder air in front of it.

WATER CYCLE: The cycle that describes the transport of water in all its stages from the seas, land, and atmosphere. Stages include evaporation, condensation, precipitation, and collections.

WEATHER: The state of the atmosphere at a certain time in a given area.

WIND: The movement of air from an area of relatively high pressure to a lower pressure area.

TUMBLE WING WALKALONG GLIDER

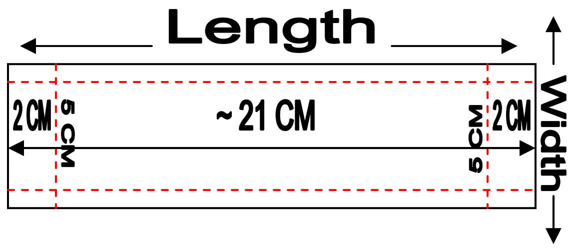
ACADEMIC STANDARDS: Earth and Space Sciences 4.1, 4.4
Physical Sciences K.1, K.5, 1.5, 1.6,
Science and Technology 1.1

OBJECTIVE:

- Students will be able to describe that air, though invisible, surrounds and affects other objects.
- Through hands-on learning and observation students will be able to identify how air affects objects.
- Students will be able to explain that air is made up of molecules that exert pressure on objects.
- Students will use directions provided to construct their own walkalong glider.

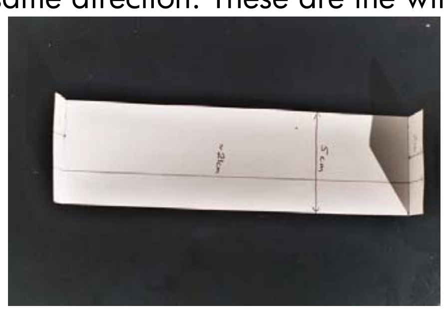
MATERIALS:

- Phone book paper (or any light weight paper) - 1 Sheet should accommodate 2-3 students.
- 3-4 pieces of large cardboard or plexiglass material. Approximately 4-6' in surface area.
- Scissors
- Rulers
- Pencils



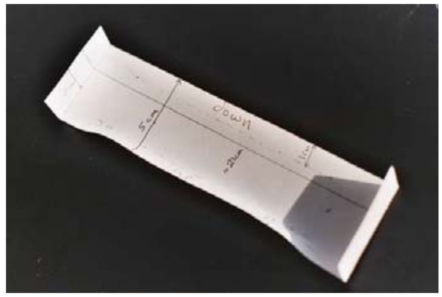
PROCEDURE:

1. Cut phone book sheet into a strip of 5 cm in width.
2. Cut strip so the overall length is approximately 21 cm.
3. Measure and draw two dotted lines across the width of the strip. These lines should each be 2 cm from the end of the strip.
4. Fold across the dotted line to form two small tabs. These folds should form two 90° angles that face the same direction. These are the wings of the glider.



TUMBLE WING WALKALONG GLIDER (continued)

5. Fold the length edges over slightly as shown in the picture below. These folds should face in the opposite direction. The fold that goes down is the leading edge and the other fold that goes up is the trailing edge.



6. Your glider is now complete and ready to fly. To launch the glider, hold the glider so that the leading edge is facing out and the wings are facing up. Once the glider is in position you can let go and it will tumble to the ground. If the glider falls to one side or the other, the wing folds are not symmetrical and will need to be adjusted.

7. Once your glider is functioning properly it is time to guide your glider. As the glider falls hold the piece of cardboard or plexiglass directly under the glider. As your glider moves forward, continue to walk forward with the cardboard or plexiglass under the glider. The glider will stay in the air and you will be able to guide it around the room.

WHAT HAPPENED: What is keeping the glider from falling to the ground? How does the board keep the glider in the air without touching it? How does the glider's design keep it flying? Even though you can not see air, can you still feel or even see the effects of air?

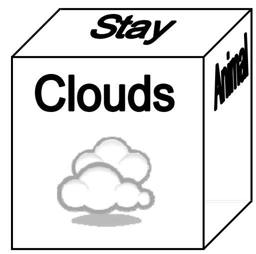
EXTENSIONS: Try different kinds of glider designs and see if they work. Also explore paper airplane designs and examine how the design of the plane interacts with the air around it.

DID YOU KNOW? A "glider" is defined as an aircraft that is not powered. The design of gliders help the aircraft use rising air to fly. Gliders can use pockets of rising air to travel long distances before finding the next source of lift. The sport of gliding became popularized in post World War I Germany. Restrictions in the Treaty of Versailles placed strict restrictions on powered aircraft. Germans turned to designing and developing more effective and efficient gliders. One of the first gliding competitions, the Wasserkuppe, was held in Germany in 1920.

THE INCREDIBLE JOURNEY

ACADEMIC STANDARDS: Earth and Space Sciences K.1, 4.2, 4.3, 4.8, 4.10
Physical Sciences 1.1, 1.2, 1.3, 1.4, 1.8, 4.1, 4.4

OBJECTIVE: Students will be able to describe the movement of water within the water cycle. Students will also be able to identify the different states of water as it moves through the water cycle.



MATERIALS:

- 9 large pieces of paper
- Pens or pencils
- Notebooks or journals
- Construction paper
- 9 boxes, about 6 inches on a side
  - These boxes will be used to make the dice for this activity. Gift boxes used for coffee mugs are the correct size. If similar boxes are not available it is still possible to create dice by taping squares of paper together in the form of a cube. There will be one cube at each of the nine stations, but more dice can be added to increase the pace of game.
- Bell, whistle, buzzer, or some sound maker to indicate turns
- Large room or playfield

PROCEDURE:

Constructing dice

1. Nine dice will need to be constructed for this game. Each die represents one of the nine stations water can move through: clouds, plants, animals, rivers, oceans, lakes, ground water, soil, and glaciers.
2. For each die, cut out six equally-sized squares from the construction paper.
3. Use the chart below to create the six sides of each die. Students may illustrate dice to match the words on the dice.

Water Cycle Table

STATION	DIE SIDE LABELS	EXPLANATION
Soil	one side *plant*	Water is absorbed by plant roots.
	one side *river*	The soil is saturated, so water runs off into a river.
	one side *ground water*	Water is pulled by gravity; it filters into the soil.
	two sides *clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	one side *stay*	Water remains on the surface (perhaps in a puddle, or adhering to a soil particle).
Plant	four sides *clouds*	Water leaves the plant through the process of transpiration.
	two sides *stay*	Water is used by the plant and stays in the cells.
River	one side *lake*	Water flows into a lake.
	one side *ground water*	Water is pulled by gravity; it filters into the soil.
	one side *ocean*	Water flows into the ocean.
	one side *animal*	An animal drinks water.
	one side *clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	one side *stay*	Water remains in the current of the river.
Clouds	one side *soil*	Water condenses and falls on soil.
	one side *glacier*	Water condenses and falls as snow onto a glacier.
	one side *lake*	Water condenses and falls into a lake.
	two sides *ocean*	Water condenses and falls into the ocean.
	one side *stay*	Water remains as a water droplet clinging to a dust particle.
Ocean	two sides *clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	four sides *stay*	Water remains in the ocean.

Lake	one side *ground water*	Water is pulled by gravity; it filters into the soil.
	one side *animal*	An animal drinks water.
	one side *river*	Water flows into a river.
	one side *clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	two sides *stay*	Water remains within the lake or estuary.
Animal	two sides *soil*	Water is excreted through feces and urine.
	three sides *clouds*	Water is respired or evaporated from the body.
	one side *stay*	Water is incorporated into the body.
Ground Water	one side *river*	Water filters into a river.
	two sides *lake*	Water filters into a lake.
	three sides *stay*	Water stays underground.
Glacier	one side *ground water*	Ice melts and water filters into the ground.
	one side *clouds*	Ice evaporates and water goes to the clouds (sublimation).
	one side *river*	Ice melts and water flows into a river.
	three sides *stay*	Ice stays frozen in the glacier.

4. After the six sides have been created, tape them together to form a cube or tape them to the sides of your box.
5. Nine signs need to be placed throughout the room or area to demonstrate the different stations (Soil, Plant, River, etc.).
6. After all nine dice and signs have been created the class is ready to begin their 'Incredible Journey' through the water cycle.

The Incredible Journey (continued)

1. Tell students that they are going to become water molecules and will be moving through the water cycle.
2. Introduce the nine stations (clouds, animals, plants, rivers, oceans, lakes, ground water, soil, and glaciers) that represent the places water can move through and identify station locations in play space.
3. Assign an even number of students to each station. The cloud station is the only station that can have an uneven number.
4. Have students at each station discuss the different places water can go from their station in the water cycle. Assist student discussions by leading a discussion on the conditions that cause water to move. For example, water movement depends on the sun's energy, the earth's electromagnetic energy, and gravity. Sometimes water will not move even when exposed to these energies. Have students make lists of the places they think the water may go.
5. After the stations have made their lists, hand each station their die so students can compare their list to where the water can actually move.
6. Have students discuss the different forms in which water moves from location to location. Most movement will take place while water is in its liquid phase.
7. Tell students that they will be mimicking the movement of water. When they move as liquid water they must move in pairs. When they move as water vapor they can move individually.
8. Students will determine their movement by rolling the die at each station. Students will line up behind the die at each station. Students will line up in pairs at every station except the cloud station where they will form a single file line. Students roll their die and move according to the face of the die. If the die reads "stay," the student will head back to the end of the line and wait for another turn to roll. In the 'Clouds' line, students will roll individually. If they are instructed to leave the 'Clouds' they must grab a partner (the person immediately behind them).
9. As they move students will be carrying a notebook or journal to can keep track of their movements.
10. Tell students the game will begin and end with the sound of the bell.

WHAT HAPPENED: What are the different forms that water can take? What causes the water to move and change form? Could you predict where you would go next as water molecules? Does the water cycle act like a normal cycle? Does it work in a continuous, unchanging circle? How can water be polluted during the cycle? How does the cycle help to cleanse polluted water?

EXTRA INFORMATION: Despite being called the water cycle most of the world's water stays put in storage. The biggest of Earth's "storehouses" of water are oceans. Of the estimated 332,500,000 cubic miles of water on earth, about 321,000,000 cubic miles of that water is located in the oceans. That means that 96.5 percent of Earth's water is located in the oceans. Other storehouses of water can include ice caps and glaciers. As a result, as temperatures around the world rise and glaciers and ice caps melt, the amount of water in the oceans increases. For example, about 125,000 years ago during a warm period in Earth's history the ocean levels were 18 feet higher than the present levels. Conversely, during colder periods more of Earth's water is stored in glaciers and ice caps. During the last ice age ocean levels were as much as 400 feet lower than the present ocean levels.

Activity created by Project WET and can also be found in the Project WET Curriculum and Activity Guide

WEATHER OR CLIMATE

ACADEMIC STANDARDS: Earth and Space Science 2.4, 2.5, 4.4, 4.5
Scientific Inquiry 3.3, 3.5

OBJECTIVE: Students will be able to interpret charts and utilize data to differentiate between weather and climate.

MATERIALS:

- Pencils
- Weather or Climate? Worksheet
- Columbus Atmospheric Data Chart
- Weather or Climate? Teacher Page- Answer Key

PROCEDURE:

1. Engage students in conversation about weather. Why is weather so important? Why do many news shows devote several segments each day to weather reports?

2. Have students list the ways that weather affects their daily lives.

3. Introduce the students to a new term: climate. Ask students if they have heard of this word and if so, what they think it means.

4. Pass out the Weather or Climate? Worksheet and Columbus Atmospheric Data charts to the students and tell the students they are about to find out if there is a difference between weather and climate.

5. After students finish the activity, review the answers together.

EXTENSION: Weather Underground, http://www.wunderground.com/ , offers up-to-date weather information and climatic data. Have students explore this website. Challenge students to look up the weather for the date and location of their birth. Was the weather on their birthday consistent with the climate or were there abnormal highs or lows?

RIDE THE WIND

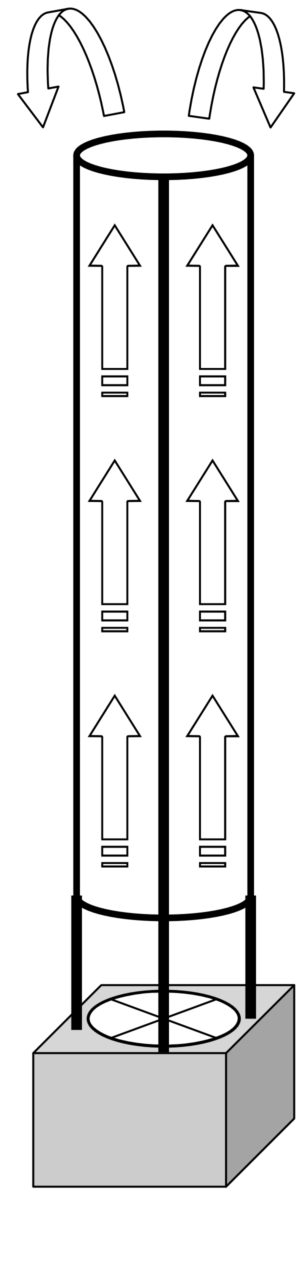
ACADEMIC STANDARDS: Earth and Space Science 4.1
Physical Sciences K.1, K.2, K.4, 1.6, 3.4
Science and Technology 1.1, 3.4, 3.5, 5.2

OBJECTIVE:

- Students will design aircraft that they will test fly on updraft winds at the Current Conditions hands-on station, *Wind Tubes*.
- Students will be able to describe the effects that updrafts of wind have on aircraft.

MATERIALS:

- Scissors
- Tape
- Glue and glue sticks
- Variety of light weight material. Common materials used in wind tubes include cardboard, paper towel rolls, paper or plastic cups, paper, straws, cotton balls, foam, ping-pong balls, and anything else you can find in your classroom. Please keep in mind that these materials will be cut, glued, taped, and otherwise manipulated.



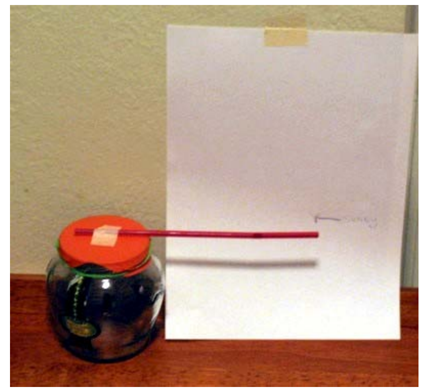
PROCEDURE:

- Engage students in discussion on air. Remind students that air takes up space and influences objects around them. Introduce students to the concepts of updrafts. Updrafts are pockets of rising warm air surrounded by cooler air. Updrafts can affect the flight of planes and cause ice crystals to accumulate into hail.
- Inform the students that during the COSI on Wheels program, *Current Conditions*, they will have an opportunity to experiment with updrafts during the hands-on station called Wind Tubes by creating their own aircraft to fly in the tubes.
- Students will create an aircraft out of the available materials. The aircraft can take on any form they want. It does not have to look like a traditional aircraft. The challenge for the students will be to design a craft that flies in the Wind Tube the longest without flying out the top of the tube or falling back to the ground at the bottom of the tube.
- Don't forget to bring your aircraft when you go to your hands-on session, and good luck on your designs.

MAKE YOUR OWN BAROMETER

ACADEMIC STANDARDS: Earth and Space Sciences 4.1, 4.5
Physical Sciences 1.5
Science and Technology 1.2, 1.7, 3.1

OBJECTIVE: Students will be able to demonstrate the changes in atmospheric pressure by constructing their own barometer.



MATERIALS: Balloon
Narrow-mouthed jar
Rubber band or piece of string
Glue
Drinking Straw
Piece of Paper

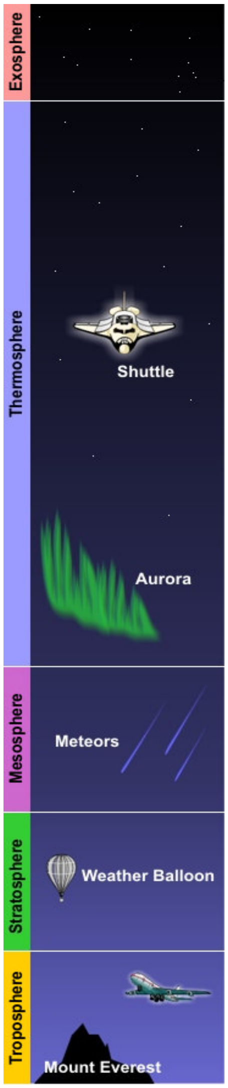
PROCEDURE:

1. Blow up the balloon carefully and then let all of the air back out. This is to stretch the balloon.
2. Cut the balloon, halfway, into two pieces. Discard the piece with the neck of the balloon.
3. Carefully stretch the other half of the balloon over the opening of the jar and then put rubber band around the rim of the jar, so the jar becomes airtight. Make sure the balloon is taut around the rim of the jar.
4. Glue or tape the straw to the top of the balloon. The straw should sit so that there is about 1 cm of space between the rim of the jar and one end of the straw.
5. Tape a piece of paper to the wall behind the straw of your new barometer.
6. As the outside air pressure becomes less than the air pressure in the jar, the balloon will expand and cause the straw to dip down. As the outside air pressure increases and becomes higher than the air pressure in the jar, the straw will rise as the balloon retracts.
7. Students should check their barometer daily and mark its reading and date on the paper. Students should be able to track if the air pressure is increasing or decreasing by using their barometers.

EXTENSION: Have the students plot the changes of air pressure on a line graph.

WHAT HAPPENED: What caused the straw to move up and down? Was the air pressure falling or rising when the straw moved downward? What kind of weather do you notice when the air pressure was falling? What weather patterns were typically observed when the air pressure was rising?

EXTRA INFORMATION: Atmospheric pressure is the weight of the air pressing down on the Earth. This air includes all the layers of the Earth's atmosphere, a thin layer of gases that surrounds the Earth. The atmosphere is composed of 78.084% Nitrogen, 20.947% Oxygen, 0.934% Argon, 0.033% Carbon Dioxide, and .002% traces of other gases. The atmosphere is divided up into many layers. The layer that is closest to the Earth's surface is called the troposphere. This layer can be anywhere from 4-12 miles high and can have temperatures ranging from 62°F to -60°F at the very top of the layer. The highest part of the atmosphere, the exosphere, can reach to 6,200 miles above the Earth!



CURRENT CONDITIONS RESOURCES SHEET

The Incredible Journey: (1995). *The Project WET Curriculum and Activity Guide.* Bozeman, MT: The Watercourse and Western Regional Environmental Education Council, pg. 161.

Make Your Own Barometer: Churchill, E.R., Loeschnig, L., and Mandell, M. (1997). *730 Easy Science Experiments.* New York: Tess Press, pg. 249.

Web Sites:

The Department of Atmospheric Sciences, University of Illinois at Urbana-Champaign http://www.atmos.uiuc.edu/index.html#

The National Weather Service: http://www.nws.noaa.gov/om/edures.shtml

The University Corporation for Atmospheric Research: http://www.ucar.edu/

The Weather Channel.com: http://www.weather.com/wxclass/education/

Books

Allaby, M., (1995). *How the Weather Works.* Montreal: Reader's Digest.

Day, J., (2006). *The Book of Clouds.* New York: Berenson Design and Books.

Dunlop, S., (2002). *The Weather Identification Handbook.* Guilford, CT: Lyons Press.

Pretor-Pinney, G., (2006). *The Cloudspotter's Guide: The Science, History, and Culture of Clouds.* New York: Perigee Books.

The Project WET Curriculum and Activity Guide. (1995). Bozeman, MT: The Watercourse and Western Regional Environmental Education Council, pg. 161.

National Audubon Society Field Guide to Weather. (1991). New York: Borzoi Books.

SCIENCE PROCESS SKILLS

On the day of the program, students will have the opportunity to participate in a variety of hands-on activities. The activities are intended to create a fun and stimulating environment which encourages the development of Science Process Skills. The skills include:

OBSERVING: Using the senses and/or appropriate tools to gather information. Observing may also include the skills of: **Measuring, Comparing,** and **Classifying.**

INFERRING: Making preliminary conclusions by assessing what is already known. Inferences are what you reason to be true, but haven't observed or tested.

QUESTIONING: Raising questions about objects, events, or phenomena. This includes recognizing and asking *investigable* questions, often beginning with phrases like 'What causes,' 'How does' or 'What makes.'

HYPOTHESIZING: Offering a possible explanation or testable statement. A hypothesis can be a good reference point for further investigation.

PREDICTING: Using ideas or evidence to foretell the outcome of a specific future event. Often involves an action and a reaction or an if/then statement.

PLANNING: Designing one's own investigation using procedures to obtain reliable data. *Planning is <u>not</u> always formal.*

INVESTIGATING: Carrying out a planned experiment based on your hypothesis. Investigation uses many of the previously stated Process Skills.

INTERPRETING: Drawing conclusions by assessing the data. Finding patterns or other meaning in the data.

COMMUNICATING: Expressing observations, ideas, conclusions, or models by talking, writing, drawing, etc.

RELATING & APPLYING: Relating makes parallels to similar concepts, and applying uses the knowledge gained to help solve a challenge.

CURRENT CONDITIONS HANDS-ON ACTIVITIES:

A Bellowing Wind: Students use bellows to explore how changes in air pressure can cause wind.

Canister Cloud: Students will examine how cloud formation can be affected by air pressure.

Cloudspotting: Look! In the sky! Students can go on a cloud hunt to search and examine multiple cloud types.

Dealing with Weather: Students discover the elements and factors needed to create various forms of extreme weather.

Extreme Weather Challenge: Students will climb the ranks of meteorology as they test their knowledge of extreme weather.

Prediction Puzzler: Students will make accurate predictions for the next day's weather using maps representing several previous days of weather data.

Solving Symbols: Students will decode complex surface weather maps.

Weather in a Vacuum: Students experience the power of air pressure as they recreate the famous Magdeburg Sphere experiment and feel, "*first-hand,*" the pressure of a vacuum.

Weather Instruments: Students use the tools of the meteorological trade to make atmospheric readings.

Wind Tubes: Students become "aerospace engineers" as they use updrafts to test fly aircraft designs while exploring how hail is created.