Weather Starts With the Sun

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Introduction

How many times have you used the phrase "what a beautiful sunset/sunrise?" These expressions create an illustration in our head of the Sun moving up and down while Earth remains a stationary object. This image contradicts the reality that Earth rotates on its axis, causing the Sun to leave our view. Teaching weather centers on the conditions we experience on Earth. Naturally students question what drives weather patterns. To properly address their curiosity teachers must understand in depth the interconnections of our weather patterns. We must broaden the scope of weather to its source, the Sun.

Objectives

The students I teach are high performing, with over 90 percent on or above grade level. The parents support their children in any way possible and most hold college degrees. This unit is designed to supplement a unit on weather, and includes ideas to deepen understanding of weather concepts. Through this unit students will gain a deeper understanding of the Earth-Sun relationship, the heliocentric model, and how weather as we know it depends on the Sun. In focusing on the Sun's role in weather the unit will also explore weather conditions on other planets in comparison to Earth.

The focus throughout the unit centers on Earth's place in the Solar System. When learning science, students need exposure to big ideas so they can begin to connect smaller ideas together. With the big idea exposed to the students it sets them up to ask why, leading to opportunities within the classroom for student led inquiry. Exploring how Earth's place in the Solar System directly affects our weather conditions will build a deeper understanding of the weather concepts.

This unit contains several goals for the students. First the unit will build a knowledge foundation of the Sun. Most 5th grade students understand that the Earth revolves around the Sun, but have not explored the power of the Sun on Earth. Through this unit, the students will make connections between the Sun's activities and weather conditions here on Earth. To effectively facilitate this connection with the students it is critical for them to see the Sun as more than a “yellow disk” in the sky. Through recognizing the Sun’s characteristics and activity the students will evaluate the complexity of the Sun.

Secondly, the unit will deepen the students’ understanding of Earth’s atmosphere. As you go higher in altitude the temperature drops, but many students ask “Why? If you are getting closer to the Sun?” Our atmosphere acts as a shield between Earth and space, which impacts the relationship between the Sun and Earth. To gain a full understanding of weather the students must explore how the atmosphere affects weather. Students can easily relate to ideas they experience. Their experience on Earth tells them we are protected from the Sun, however they have never experienced space, where there is no protection from the Sun. Discussing the dynamics of our atmosphere becomes difficult because we have not experienced anything different, as well as the abstract nature of air. We cannot see the air which makes it difficult to understand how our atmosphere’s air pressure changes from sea level to near space. Classroom experiences that investigate our atmosphere will deepen understanding of the Sun’s relationship with Earth. One way to foster this understanding is by making comparisons with Earth’s atmosphere and other planet’s atmospheres, as well as how the Sun affects them because of the differing atmospheric characteristics. The goal of this unit is make these comparisons with the Moon, Venus, and Mars. Specifically, the students will connect the composition of the atmosphere (or lack of) with the characteristics of the weather on the celestial body. This connection will deepen the students’ understanding of an atmosphere’s role in the Sun-celestial body relationship. The students will reach the generalization that each celestial body’s unique atmospheric characteristics contribute to the temperature differences found on each celestial body.

Thirdly, this unit will explore the connection between the angle the Sun’s rays hit Earth and the temperatures on Earth. Interestingly, even if the Earth is closer to the Sun it is not necessarily warmer because it is the angle at which the Sun’s rays hit Earth that determine temperature. Earth’s tilt of 23º contributes to the differences in the directness of the Sun’s rays around the globe throughout the year. Fifth grade students learned in past grades about seasons and Earth’s rotation and revolution around the Sun. However, they have not analyzed the relationship between Earth’s tilt and the angle of the Sun’s rays in relation to temperature. Through this unit my students will identify the effect of insolation on temperature during the course of a day, as well as over the course of a year at different locations around the globe. To lead the students to the generalization that the tilt of the planet determines the seasons and temperatures they must learn how insolation affects other planets. Specifically the students will compare the tilt of Mars, Uranus, and Jupiter to Earth's.

The fourth goal of this unit connects with the angle of insolation. When teaching science I have found one of the hardest concepts for students to connect with is wind. They have experienced wind firsthand but really have no idea how or why it happens. The uneven heating of the Earth due to insolation explains the prevailing winds found on Earth. The goal of this unit is for students to make the generalization that uneven heating causes wind. To deepen the students understanding of this concept this unit will compare the wind on Earth with Jupiter's wind.

In the end, I want to find ways to make an abstract idea concrete. I want to create experiences for my students to explore the Sun's relationship with Earth, as well as other planets. Through these comparisons the students will realize that all weather characteristics of Earth are not unique. The unit will show Earth as part of a bigger picture, and not the only "important" place in the universe.

Background Information

Sun Facts

The Sun is the closest star to Earth at 93 million miles away, and can hold one million Earths inside of it. If traveling by airplane it would take 20 years to reach the Sun, and 8 months for an airplane to circle around it.

With no solid surface, the Sun is made mostly of the gases hydrogen and helium. The energy of the Sun comes from the fusion of hydrogen atoms into helium. These reactions take place about half a million miles within the Sun in the region called the core. The energy released through the fusion can take as long as 100,000 years to reach the surface of the Sun. From the surface of the Sun it takes 8 minutes for the light to reach Earth. Several layers make up the Sun, but we see the photosphere with the naked eye. "Photos" is Greek for light. The gases in the outer layers of the Sun move around by convection. Convection is the bulk movement of matter, hot material rises while cooler material sinks moving energy with it. Radiation, which is energy in the form of light, is how the Sun's energy reaches Earth. This energy is converted to other forms of energy here on Earth. The light from the Sun is absorbed by the ground, oceans, etc. which causes these objects to warm up. The light from the Sun is being converted to thermal energy. Plants also absorb the Sun's light and convert the Sun's energy into sugars.

Astronomers measure solar rotation by the timing of sunspots and surface features of the Sun. Since the Sun is not a solid mass it rotates faster at the equator and more slowly at the poles, which is referred to as differential rotation. Due to this, it takes about 25 days to rotate at the equator and 36 days at the poles. Sunspots are cooler regions of photospheric gas which are seen as dark because they appear against a brighter, hotter background. They are associated with magnetic fields brought to the surface of the Sun from the interior. Sunspots follow an 11 year cycle and can last from 1 to 100 days. Sunspots usually do not have violent activity but the area around the sunspot may become an active region. Flares are an example of violent activity on the Sun. They are the result of magnetic instability on the Sun and can reach temperatures of 100 million º K (179,999,540º F). When a flare erupts it blasts particles from the Sun into space. A coronal mass ejection is another example of activity on the Sun. It occurs when gas separates from the Sun’s atmosphere and escapes into space. They occur about once a week during times of minimum sunspots, and up to 2 or 3 times a day at times of maximum sunspots. If the particles connect with the Earth’s magnetic field they can potentially cause widespread communication and power disruptions. They also cause the Northern and Southern lights, also referred to as auroras.

Sun vs Earth
Radius
Diameter
Surface Temp.

Sun
432,474 miles
864,948 miles
9,944 F
Earth
3,976 miles
7,953 miles
62 F

The Sun: Angle of Insolation

From our point of view on Earth, the center of our solar system, the Sun, appears as a large “yellow disk”. The Sun controls aspects of the Earth, as well as other planets. Earth revolves around the Sun, and simultaneously rotates on its own axis. A misconception

many students have is the closer Earth is to the Sun the higher the temperature. However, the angle of Earth's axis (which determines the incoming angle of sunlight) is the main cause for the temperatures on Earth. The tilt of Earth's axis is 23.45º. During the summer months (for the Northern Hemisphere), Earth's distance from the Sun is further than in winter, however the Sun's rays hit the Earth's surface at a more direct angle than in winter and the days are longer than the nights. The tilt also causes for the Northern and Southern hemisphere to experience opposite seasons, when it is winter in the Northern hemisphere it is summer in the Southern and vice versa. During the two solstices the Sun reaches its furthest northern and southern declinations; the winter solstice is December 21st (the shortest day in the Northern Hemisphere) and the summer solstice is June 21st (the longest day in the Northern Hemisphere). During the two equinoxes (the day and night are equal in length) the Sun crosses the celestial equator; vernal equinox-late March, autumnal equinox-late September. The following links provide animation of the Earth-Sun relationship.
http://projects.astro.illinois.edu/data/Seasons/seasons.html
http://esminfo.prenhall.com/science/geoanimations/animations/01_EarthSun_E2.html

All planets in our solar system have seasons based on the tilt of their axis. Comparing the planets' seasons with their tilts helps to build an understanding of how the Sun's angle of insolation affects Earth and other planets in our solar system. Mars has a tilt of 25.10º and has seasons similar to Earth. However, the thin atmosphere does not allow the planet to hold much heat. During the seasons the temperatures range from -125º to 23º F. Uranus rotates on its side, it looks like a ball rolling around the Sun instead of a spinning top. The tilt of Uranus is 99º causing 42 years of darkness followed by 42 years of light at the poles. This causes extreme seasons as the Sun's rays reach only a portion of the planet over an extended period of time. With a tilt of 3.13º Jupiter's constantly receives the same amount of sunlight. The consistency of how the Sun's rays hit Jupiter causes a constant wind due to the convection cells caused by the extreme difference in heat at the poles and equator.

Prevailing Winds

The pattern of winds experienced on Earth directly relates to the angle of insolation. The equator experiences direct sunlight heating up the air in this region. As the warm air rises it spreads out toward the poles and cools off. Some of the cooled air then sinks creating large convection cells. This process repeats as the Sun continues to unevenly heat the Earth, creating areas of high and low pressure. Between 30º S and 30º N are the trade winds which blow from the east to the west. Above the trade winds are the westerlies which blow from west to east. The poles have easterlies which blow from the east to the west.

Jupiter's winds are an interesting comparison to the convection caused by the Sun on Earth. Pictures of Jupiter show a pattern of alternating bands of white and dark. These stripes show the prevailing winds found on Jupiter. The white stripes (zones) are where warms gas rises, while the dark stripes (belts) are where cool gas sinks. As the cool gas sinks toward the surface it warms back up due to Jupiter's warmer core and rises back to the surface. Jupiter's rapid rotation of about 9 Earth hours causes the patterns of white and dark to stretch out around the entire planet.

Earth's Atmosphere

If you live or lived in a two story house you come to realize during the summer months that the second floor feels warmer. This leads you to the conclusion that heat rises. When you look in the sky at the Sun and think about how much heat it contains, you conclude that the closer you get to the Sun the hotter it may feel. Then you climb a mountain and discover that the air is colder than at the foot of the mountain, and your theories start to crumble. The relationship between the Sun's rays and Earth's atmosphere turns out to be more complicated.

Heat does rise, but as it rises it expands and cools resulting in a lower pressure due to less density. Connecting to insolation, the Sun mostly heats the ground, not the air. The air also cools due to radiation (light moving energy) to space. The four layers of Earth's atmosphere protect our planet and hold in the heat produced by the Sun. Out of the 100 miles of atmosphere, more than half of air is found in the first ten miles. The first layer of Earth's atmosphere is the Troposphere; all life and weather happen in this layer. The second layer is the Stratosphere; commercial jets fly in the lower area of this layer, weather balloons are also found in this layer, and the ozone layer begins here. The third layer is the Mesosphere; meteors burn in this layer causing "shooting stars" and meteor showers. The fourth layer is the Thermosphere; Earth orbiting space craft fly in this layer, and aural displays occur here.

As you go higher in altitude, air pressure and temperature decrease, but this does not stay consistent throughout all four layers of the atmosphere. The first time the temperature increases instead of decreases is the ozone layer. Ozone is made up of compounds of 3 oxygen atoms. Ozone absorbs UV light adding energy to this layer of the atmosphere causing the temperature increase. After about 20 miles, at the end of the Ozone Layer, the temperature begins to drop once again. The second time the temperature rises is near the top of the atmosphere due to the absorption of solar extreme ultraviolet and x-ray radiation. The x-rays break molecules apart into atoms contributing to the increase in temperature.

Without Earth's atmosphere we would not have liquid oceans or life as we know it. The atmosphere traps some of the Sun's heat close to the surface of Earth, allowing the ground and air to warm. It also prevents all of the heat from escaping, creating a natural greenhouse. The water vapor and carbon dioxide found in the air absorbs the heat of the Sun, keeping it near the surface of the Earth in the Troposphere.

The planets and moons in our solar system have varying types of atmospheres. Comparing the atmospheres and conditions caused by their characteristics helps to understand how Earth's atmosphere works.

On Earth's Moon there is no atmosphere. Due to the lack of atmosphere it leads to large differences in temperature through the course of a Moon day. The noon temperature on the Moon reaches 260º F while at night (lasts 14 Earth days) or in the shade temperatures are -279º F. With no atmospheric gases to hold in the Sun's heat, the heat escapes with the absence of the Sun's rays. The absence of an atmosphere also causes a difference in erosion on the Moon. On Earth air, water, wind, and other geological activity cause erosion to the Earth's surface. The Moon has no erosion except meteoritic impact. The average rates of new craters are as follows: 1 new 10 km diameter lunar crater every 10 million years, 1 new meter diameter crater once a month, 1 new cm diameter crater every few minutes. The surface of the moon also receives a constant rain of micrometeoroids which eat away at the surface. Even with the meteoritic impacts, the Moon still has 10,000 times less erosion than Earth. The numerous impacts have also left an accumulation of dust which averages at a depth of 20m, with the thinnest layer at 10m and the thickest layer at 100m. The lack of erosion causes many of the Moon's surface features to date back to its formation. The astronaut's footprints from the 1969 Moon landing are only a few cm deep, but will survive on the surface of the Moon for more than a million years.

On the planet Venus, the atmosphere appears as a thick blanket covering the planet. The atmosphere extends to a much greater height above the surface of the planet creating a surface pressure 90 times the pressure at sea level on Earth. This is equivalent to one kilometer underwater on Earth (a human cannot dive below 100 meters unprotected). The chart below tells the atmospheric gases present. The high concentration of carbon dioxide combined with a thick atmosphere leads to an extreme green house effect. The gases present on the planet absorb 99% of the infrared radiation given off by the planet. The absorption contributes to the surface temperature of 854º F.

On the planet Mars, the atmosphere is much thinner compared to Earth, with the surface pressure only 0.7% the pressure at sea level on Earth. The atmospheric gases present in Mars' atmosphere may lead one to believe it will also have high surface temperatures. However the maximum temperature reaches 98º F and the minimum temperature reaches -189º F. Mars' atmosphere is thin canceling out the amount of carbon dioxide in the atmosphere as it is spread so thinly around the planet. Mars started with a thicker atmosphere of carbon dioxide but over time the gas has absorbed into the surface (rocks) with no way to recycle itself. The planet's inability to recycle the carbon dioxide back into the atmosphere has caused the thinning of the atmosphere. On Earth carbon dioxide is recycled through volcanoes and tectonic plate movement. Mars does have the largest volcanoes in the solar system but they are not associated with plate movement but sit on top of old hot spots in the Martian mantle. The volcanoes formed as the lava flowed and spread out on the surface of Mars. These shield volcanoes have been dormant for 150 million years.

Planet	Atmospheric Gases
Earth	78% Nitrogen, 21% Oxygen, 0.9% Argon, 0.03% Carbon Dioxide
Venus	96.5% Carbon Dioxide, 3.5% Nitrogen
Mars	95.3% Carbon Dioxide, 2.7% Nitrogen, 1.6% Argon

Weather on Other Planets

We often think of the phenomenon of weather as unique to Earth. However, all planets in the Solar System experience conditions of weather similar to Earth such as clouds, wind, and precipitation (not water).

Observations of Jupiter have revealed a storm that has been in existence for at least 300 years. Scientists refer to the storm as The Great Red Spot. It averages in length at 25,000 kilometers with similarities to a hurricane. The source of the storm stems from the atmospheric areas of low and high pressure. The storm's location between a zone and a belt power the storm. The storm rotates around Jupiter with counterclockwise winds of 250 mph with the center peaceful just as in the eye of a hurricane.

Observations of Saturn have revealed a circulating cloud system near the equator. It is believed that these storms move at speeds of 1100 mph and produce conditions similar to Earth's thunderstorms. These storms reach the size of Earth and produce lightning millions of times stronger than on Earth. The lightning is believed to be powered by convection and precipitation (water and ammonia rain) just as on Earth.

Mars has winds due to the angle of insolation the same as Earth. Mars also has major dust storms, which create dust devils, storms that resemble tornadoes. The storm begins as wind lifts dust into the atmosphere. As the dust absorbs sunlight, it warms the air causing more wind, and more dust to rise. The storm strengthens as more dust rises and warms. These storms range from 200 miles to a few thousand miles in diameter. In rare cases a dust storm can cover the entire surface of Mars and last for months.

Titan, a moon of Saturn, has a thick atmosphere of 95% nitrogen and 5% methane. Titan has a cycle of methane much like the water cycle on Earth. Liquid lakes of methane have been discovered on Titan, as well as clouds. In order for the methane to cycle through evaporation, condensation, and precipitation it must be colder than -296.5º F.

Strategies

Notebook

For the following strategies a science notebook/journal is needed for each student in the class. These should be treated valuably and the students should be referred to as scientists during class. Referring to the students as scientists will build a classroom climate that anyone can conduct their own scientific experiments. It is important for the students to realize every time we ask "why" we create an opportunity to experiment.

Vocabulary

In science many new vocabulary words are introduced. These words are often not used in everyday language, which makes it extremely important for the students to be exposed to the words and to use it in writing/speech. In the past I have found that my students can study for a vocabulary quiz, memorize the definitions, ace the quiz but not have an understanding of the concept. One way to foster a deeper understanding of the vocabulary words is to have the students write definitions in their own words, and to include an illustration to help remember the definition. I have my students split their notebook paper into four boxes on each side, and assign the vocabulary words and page number for each box. The students work in groups to read through the lesson associated with the weather concept. As they read a section which covers a vocabulary word they stop to discuss what it actually means and why. They then record the definition in their own words, and draw a picture which will help them remember what the word means. After all the students have completed this process, I assign each group a word and have them create a short skit to show the meaning of the word. When discussing weather concepts in class it is imperative to use the correct vocabulary as a teacher, as well as to encourage the students to during class conversations.

Recording Experiments

With every weather concept providing students with the opportunity to experiment creates a valuable lesson. Only reading and discussing science concepts will not foster the inquiry based learning experience necessary for a depth of understanding. When providing the students with an experience to experiment they should also record the process in their science notebook. The students should first write a hypothesis (an educated guess) of what they believe will happen. Next they should write out a step by step procedure, as well as a method for recording observations/data (chart). The students should then reflect on their hypothesis and their observations and write a conclusion. The conclusion also provides an opportunity for you to provide guiding questions that will help the students discover the purpose of the experiment. Finally, the students should write down any other questions they have that may have been created from this experiment or unanswered by it. For the first several experiments, the students will have to be walked through this lab report. However, after modeling it several times your class will be able to set up their notebook and carry out the steps of the experiment on their own. The questions the students write down at the end of their report can serve as a tool in assessing what the students still do not understand, as well as a starting point for the students creating their own experiment to answer the question.

Another strategy using the science lab report is to provide the students with a goal for the experiment, provide a list of materials for the students to use, and then allow the students to design their own experiment to prove the goal. Allowing the students to design the experiment will foster discussion of “why” between the group members as they decide on the process of the experiment. It will also help to guide the students toward creating their own experiments from their own questions without any materials or direction from the teacher.

Observation

Treating your students as scientists requires that everyone master the skill of observation. On a science pretest, I had a student ask me if he could go look out the window to help him answer a question about clouds because he never looks at the sky. It seems that life gets so busy we keep looking forward but do not take the time to look around us or up! When it comes to the concept of weather there are many things your students can observe and record in their notebooks. Each day you could go outside and have the students record the weather conditions (cloud cover, precipitation, wind, temperature) and then compare it to the weather report. Students may also observe the Sun’s location in the sky at the same time each day. The students can then draw a picture with landmarks (trees, buildings) around it. Overtime the students will notice the change in the Sun’s location in the sky as we change seasons.

Background Knowledge

Each time you begin teaching a new concept it is worth the time to create a list as a whole class to record what the students know. This list can then serve as a tool in future lessons. The list created can be referred back to in several ways. Ideas the students knew could be reinforced as you teach why those things are happening. Ideas the students knew that were not necessarily correct can be reviewed with the newly learned information to re-teach misunderstandings. The list should be posted in the classroom over the course of the unit.

Models

In every science book there tend to be the same pictures that are supposed to make a complex idea visual. I have realized that I can understand these pictures as a teacher because I already understand the concept. However for a 5th grader learning the concept the picture looks like a foreign language. Instead of using these pictures, provide models which you can hold and manipulate to create a more concrete visualization. A styrofoam ball with pieces of pipe cleaner on each end can create a model of Earth and its axis. This model can be used when teaching about the revolution and rotation of Earth and its relationship to the Sun.

Classroom Activities

Activity One: Introduction to the Sun

Objective

Students will identify key characteristics about the Sun compared to Earth.

Procedure
This activity should be completed before you begin your unit on weather. In Class: First create a list of everything the students know as a class about the Sun. Then for homework assign the students to bring in new information about the Sun. Share this information in class the next day and add it to the list. As the students share their information, add to it with interesting facts about the Sun. Preparation: Gather facts about the Earth to compare with the facts students share about the Sun. Use the planet comparison tool (see resources) to give your students a visual of how small the Earth is compared to the Sun. Gather pictures of the Sun from the Hubble Telescope site to continue conversation and inquiry about the Sun, and how we know these facts.

Activity 2: Angle of Insolation

Objective

Students will analyze the location of the Sun in the sky and connect its location with the temperature over the course of a day.

Procedure

Choose a time of a day when you can take your class outside to observe the Sun each day in the same location. It is extremely important you make it clear to your students not to look directly at the Sun. Provide each student with a large piece of white paper and have them divide it into 30 equal boxes. When going outside have the students draw a picture of the Sun in the sky drawing trees, buildings and other landmarks to show the general location of the Sun. Repeat this for 30 days and then hold a discussion of the observations and connect it with the science concept of insolation. Make sure to relate insolation over the course of a day with the temperature changes throughout the day.

Activity 3: Angle of Insolation

Objective

Students will evaluate the temperature differences caused by the directness of the Sun's rays.

Procedure

For this activity have the students placed in groups of about 4 and use the strategy Recording Experiments found above. Each group will have two thermometers and two pieces of black construction paper. Tape each thermometer to a piece of construction paper. Find a place outside which is receiving direct sunlight. Before bringing the supplies outside record the temperature of each thermometer. Then outside place one thermometer standing straight up, and one laying down. Have the students record the temperature every 5 minutes for a total of 30 minutes. To lead the students through the conclusion of the experiment pose these questions to the students: What were the differences in the thermometer readings? Why do you think there was a difference? Based on the data explain the temperature differences between the equator and poles.

Activity 4: Angle of Insolation

Objective

Students will connect the tilt of a planet with its seasons.

Procedure

This activity also requires students to work in groups of about 4 using the strategy for Recording Experiments found above. In this activity students will explore the angle of insolation on the planets of Earth, Mars, Uranus and Jupiter. The students will first make a clay ball to represent each planet making each one somewhat in proportion to its actual size. The students may use the planet comparison module found in the resources below to determine how big to make each clay ball. Each group will use a book standing straight up from the desk to create a 90º angle as a reference for the next step in the activity. Provide students with the degrees of the tilt of the axis for each planet (Earth 23º, Mars 25º, Uranus 99º, Jupiter 3º). The students will first place a toothpick through the top of the clay ball. Using the 90º reference from the book and a protractor the students will tilt the planet ball to its appropriate degree and then place 3 toothpicks at the bottom of the planet to create a stand for it to stand on. For each planet the students will use the following directions and record their observations in a chart format.

1. Plug in Lamp
2. Place a string in an elliptical path around the lamp
3. Simulate each planet's revolution around the Sun
4. Stop at the solstices and equinoxes and record which hemispheres of the planet are in direct sunlight

After completing the activity for each planet allow the students to predict what the seasons are like for each planet. Guide them to use their observations on Earth as a guideline since they have firsthand experience with Earth's seasons. Make sure to point out the importance of the relationship between the Sun and the tilt of the planet's axis to the seasons of the planet.

Activity 5: Prevailing Winds

Objective

Students will observe how cold and hot material interact.

Procedure

This activity has students working in groups of 4 and intends for the students to follow the steps for Recording Experiments as described above. Each group will need a large clear tub filled with room temperature water. They will also need a cup of boiling hot water colored red, and a cup of ice cold water colored blue. The group will then pour the hot and cold water into the tub from opposite sides at the same exact time and pace. The students should observe the cold water sinking and the hot water rising, which demonstrates convection. After discussing this activity connect it with the activities on the angle of insolation. Guide the students to make connections with convection due to the angle of insolation.

Activity 6: Atmosphere

Objective

Students will analyze how characteristics of an atmosphere (thickness, gases) affect temperature.

Procedure

This activity will also have students working in groups of about 4 and will require the students to follow for Recording Experiments as in the strategies above. Each group will need 4 digital thermometers (the nature of the experiment would not allow regular thermometers to be read accurately) and different sized zipper bags. Before starting record the starting temperatures of the thermometers. Also locate a place outside in direct sunlight to place the materials. One thermometer will not be placed in a bag (represents the Moon), one will be placed in a snack sized bag filled with air (represents Mars), one will be placed in a sandwich bag with air and inside of a gallon sized bag filled with air (represents Earth), the last will be placed in a snack bag filled with air, inside of a sandwich bag filled with air, inside of a gallon sized bag filled with air (represents Venus). The students will use their own breath to blow air into the bag, providing carbon dioxide to the "atmosphere". Place all thermometers outside and record the temperature every 5 minutes for 30 minutes. Then bring the thermometers inside and place in a dark place (possibly inside of a closet or drawer) and record the temperatures after 30 minutes. During the conclusion discussion take the opportunity to discuss greenhouse gases and the greenhouse effect comparing Earth with the other planets. Make sure to point out the importance of the relationship between the Sun and the planet's atmosphere.

Activity 7: Weather on Other Planets

Objective

Students will compare and contrast weather on Earth and other planets.

Procedure

Toward the end of your unit on weather would be an excellent time to introduce this activity. The students will need an understanding of Earth weather to effectively complete the assignment. This activity could be completed individually, or as partners. The students can choose between Jupiter, Saturn, Mars, and Titan (moon of Saturn) as a topic of study. Provide the students with resources to guide them (refer to websites and books below). Assign the students with the task of researching the evidence of weather on the assigned topic. They should then compare and contrast the weather phenomenon with Earth's weather. The information should be compiled in an essay form following this format. Paragraph one: Hypothesis of weather on the assigned topic with reasoning (provide the students with a chart of basic information on the planet/moon), Paragraph two: description of weather on assigned topic, Paragraph three: similarities and differences with Earth's weather, and Paragraph four: Revisit hypothesis confirming or correcting original idea.

Classroom Materials

Chart Paper
Internet Connection with Projector/Interactive Board
Large White Construction Paper (One piece per student)
Black Construction Paper (2 pieces per group)
Modeling Clay
Toothpicks (16 per group)
Lamp (one per group)
String
Thermometers (4 per group)
Snack Sized Plastic Zipper Bags (2 per group)
Sandwich Sized Plastic Zipper Bags (2 per group)
Gallon Sized Plastic Zipper Bags (2 per group)
Large Clear Tub (1 per group)
Water (Room Temperature, Boiling Hot, Ice Cold)
Protractor (1 per group)

Bibliography

Teacher Resources

Chaisson, Eric. *Astronomy: A Beginner's Guide to the Universe*. 6th Revised edition ed. New York: Addison-wesley Professional, 2009.
A great resource for background information on the universe. This book includes pictures
and illustrations of the concepts. This book is an excellent go to book for gaining an
understanding of the intricacies of the Solar System.

Eddy, John A.. *The Sun, the Earth, and Near-Earth Space: A Guide to the Sun-Earth System*. Washington D.C.: National Aeronautics And Space Administration, 2009.
This book focuses on the Earth-Sun relationship. It covers topics solely about the Sun and
the Earth and then explains the impact the Sun has on the Earth from the top of Earth's
atmosphere to its effect on human technology.

Hughes, Karel, and Julian Mayes. *Understanding Weather: A Visual Approach*. London: A Hodder Arnold Publication, 2004.
With a focus on Earth's atmosphere this book explores weather conditions and their
causes. It also connects prevailing winds with the different climates around the world.

Lang, Kenneth R.. *Sun, Earth and Sky*. 2nd ed. ed. New York: Springer, 2006.
A detailed look at the Sun and its activity in the solar system. The book also investigates
the interaction between Earth's atmosphere and space.

Moldwin, Mark. *An Introduction to Space Weather*. New York: Cambridge University Press, 2008.
A depth of knowledge of the Sun's activity and how it interacts with Earth. It also
explains obstacles in space travel and living due to space weather.

Vita-Finzi, Claudio. *The Sun: A User's Manual*. 1 ed. New York: Springer, 2008.
This book explores the Sun's connection with climate, life, and health. It also describes the Sun's characteristics inside and out.

Student Resources

Bailey, Jacqui. *Sun Up, Sun Down: The Story of Day and Night (Science Works)*. Minneapolis: Picture Window Books, 2004.
Written as a narrative this book explains the Sun and Earth's interaction through one day.

It includes illustrations and explanations of Earth’s rotation and includes many facts about the Sun and Earth. A great read aloud that would lead to discussions of the Sun’s connection with Earth’s weather conditions. Book Level: 4.2 Lexile: 800

Bonnet, Robert L., and Dan Keen. *Science Fair Projects: Flight, Space & Astronomy (Science Fair Projects)*. New Ed ed. New York: Sterling Pub Co Inc, 1998.
A book of various simple experiments. This book would be a great one to have the students bring home with the assignment of completing one of the projects to supplement the concepts taught. The “projects” that would connect with this curriculum unit are Project 3 Going Up? Hot air rising, Project 18 Over & Under Air movement and air pressure, Project 22 Stellar Performance The night sky as the Earth turns, Project 23 Sun Day News The changing length of day and night, Project 26 Sun Trek Tracking the Sun’s movement, Project 27 I Am a Sundial Telling time from the Sun, Project 28 Sunny Spot light The art of spreading light, Project 30 Just Add Air Making environmental changes, Project 32 No Strings Balancing with pressures, Project 34 Tilt Our solar system’s leaning planets, Project 37 South of the Border Different skies for North and South, Project 40 Color Me Warm The effect of sunlight on colored objects, and Project 49 Mirror, Mirror Comparing heat from direct and reflected sunlight.

Brandt, Keith. *SUN*. chicago: Troll Assoc.,,1985, First Edition, 1985.
This book would be useful as an independent reader or for a small group. It covers the overall importance of the Sun and goes into detail about the Sun’s rays and their interactions with the Earth.

Bright, Michael. *Greenhouse Effect (World About Us)*. A. Sutton: Gloucester Pr, 1991.
A supplement to launching discussion about our atmosphere. This book includes short
descriptions with pictures of the causes (natural and human) of the greenhouse effect,
effects of the greenhouse effect, evidence of rising temperatures and what to do now.

Brotak, Edward. Wild About Weather: 50 Wet, Windy & Wonderful Activities. New Ed ed. New York: Lark Books, 2005.
A mini textbook that covers the weather conditions on Earth. It includes many
illustrations and 50 activities for students to complete at home or school. It would be an
excellent source for students who need to read the concept from another author, as well as
a supplement to classroom activities. Lexile: 910

Capogna, Vera Vullo. *Did You Ever Wonder About Things You See in the Sky? (Did You Ever Wonder?)*. New York: Benchmark Books (Ny), 1999.
A great read aloud to get students looking up into the sky. This book explains many of
the phenomena we experience such as the color of the sky, rainbows, the Sun, clouds,
lightning, hail, thunderstorms, stars, and the Moon. Before reading have your students
observe the sky day and night and record what they see, then you can compare with the
topics in the book.

Jackson, Tom. *Destination Earth (Destination Solar System)*. New York: Powerkids Press, 2009.
A good reference book to have available for students to read. This book gives an over
view of many concepts about Earth. The sections on Earth's place in the Solar System,

the view from above Earth, and Earth's atmosphere are most appropriate for this curriculum unit. Book Level: 6.0

Karas, G. Brian. *On Earth (Ala Notable Children's Books. Younger Readers (Awards))*. New York: Putnam Juvenile, 2005.
This book would serve as a great read aloud which would act as a launching point in
discussion about Earth. It has useful illustrations and a few words per page. It covers the
concepts of Earth's rotation and revolution around the Sun. Book Level: 3.0

Miller, Ron. *Sun, The*. Brookfield: 21st Century, 2002.
A mini textbook on the Sun and its relationship with Earth. It includes pictures that would
be useful in class lessons. The book could also challenge advanced students who are
ready to dive deeper into the intricacies of the Sun.

Ph.D., Art Sussman. *Dr. Art's Guide to Planet Earth : For Earthlings Ages 12 to 120*. San Francisco: West Ed, 2000.
A mini textbook which explores many aspects of Earth. The topics that would be most
appropriate for this curriculum unit are Earth's cycles, energy from the Sun, the Ozone
Layer, and climate change. This book includes many illustrations with the text. The book
could be used to help students understand concepts from the district textbook, by reading
about the same concepts from a different author.

Singer, Marilyn. *On the Same Day in March: A Tour of the World's Weather*. New York: HarperTrophy, 2002.
An excellent read aloud for exploring the topic of insolation. The book gives a brief
description of the weather in 17 different places around the globe on the same day in
March.

The following six books are all from the same series. Each one examines the planet's
place in the Solar System, the conditions of the planet, a brief history of explorations to
the planet, and habitability level. These books would serve as great
reference books for the students and could be used as part of an independent or group
study of each planet. Book Levels: 5.8-6.1

Sparrow, Giles. *Destination Saturn (Destination Solar System)*. New York: Powerkids Press, 2009.

Sparrow, Giles. *Destination Uranus, Neptune, and Pluto (Destination Solar System)*. New York: Powerkids Press, 2009.

Sparrow, Giles. *Destination Jupiter (Destination Solar System)*. 1 ed. New York: Powerkids Press, 2009.

Sparrow, Giles. *Destination Mars (Destination Solar System)*. New York: Powerkids Press, 2009.

Sparrow, Giles. *Destination Venus (Destination Solar System)*. 1 ed. New York: Powerkids Press, 2009.

Sparrow, Giles. *Destination Mercury (Destination Solar System)*. 1 ed. New York: Powerkids Press, 2009.

Sparrow, Giles. *Destination the Sun (Destination Solar System)*. New York: Powerkids Press, 2009.

This book describes the Sun from Earth, in orbit, and its physical characteristics. Other
concepts covered are sunspots and storms, how the sun shines, how it was formed, and
how it will end. It also gives a brief history of human study of the Sun. Parts of this book
could be read aloud as you explore the Sun's affect on weather. Book Level: 6.4

Sparrow, Giles. *Destination the Moon (Destination Solar System)*. 1 ed. New York: Powerkids Press, 2009.
This book describes the phases of the Moon, features of the Moon's surface, how the
Moon formed, its relationship with Earth, the conditions of the Moon over the course of a
day and a brief history of space exploration on the Moon. In the classroom this book can
serve as a reference/supplement for students as you compare Earth with other objects in
space. Book Level: 6.1

Websites for Teachers

"Does Mars Have Seasons? | Universe Today." Universe Today. http://www.universetoday.com/14719/does-mars-have-seasons/ (accessed August 9, 2010).
Detailed information on Mars and its seasons, includes graphics and links to topics
related to Mars.

"Earth-Sun Relations." Prentice Hall Engineering, Science, and Mathematics. http://esminfo.prenhall.com/science/geoanimations/animations/01_EarthSun_E2.html (accessed August 9, 2010).
Animated movie which shows Earth's rotation and revolution around the Sun.

"Greenhouse Effect - animated diagram." Earthguide: Educational Resources in Earth, Marine, Environmental and Planetary Sciences. http://earthguide.ucsd.edu/earthguide/diagrams/greenhouse/ (accessed October 24, 2010).
Animated movie which explains Earth's greenhouse effect with explanations and pictures.

"HubbleSite - Out of the ordinary...out of this world.." HubbleSite - Out of the ordinary...out of this world.. http://hubblesite.org/ (accessed October 24, 2010).
A great site to access pictures from space.

"Lunar and Planetary Science at the NSSDC." Welcome to the NSSDC!. http://nssdc.gsfc.nasa.gov/planetary/ (accessed October 24, 2010).
Includes detailed information on each planet as well as the Moon, including missions.

"Mars Exploration Program: Missions." Mars Exploration Program. http://mars.jpl.nasa.gov/programmissions/missions/ (accessed October 24, 2010).
Detailed information on missions to Mars including international, past, present, and
future.

"MESSENGER Web Site." MESSENGER Web Site. http://messenger.jhuapl.edu/ (accessed October 24, 2010).
Contains information on the NASA mission to orbit Mercury.

"Missions to Venus - Explore the Cosmos | The Planetary Society." The Planetary Society. http://www.planetary.org/explore/topics/venus/missions.html (accessed October 24, 2010).
Detailed information on the missions made to Venus.

"NASA - Planetary Seasons ." NASA - Home . http://www.nasa.gov/audience/foreducators/postsecondary/features/F_Planet_Seasons.html (accessed August 9, 2010).
Descriptions of the seasons on the planets in our solar system.

"NASA Science." NASA Science. http://science.nasa.gov/ (accessed October 24, 2010).
Great source for information on Earth and Heliophysics.

"NASA's Solar System Exploration: The Planets: Orbits and Physical Characteristics." Solar System Exploration. http://solarsystem.nasa.gov/planets/charchart.cfm (accessed August 9, 2010).
A chart which compares the planets' characteristics.

"Seasons on Uranus | Universe Today." Universe Today. http://www.universetoday.com/19305/seasons-on-uranus/ (accessed August 9, 2010).

Deatiled article explaining the seasons on Uranus. Also includes links to other sites about
Uranus and its seasons.

"Solar System Exploration: Home Page." Solar System Exploration. http://solarsystem.nasa.gov/index.cfm (accessed October 24, 2010).
Includes a great education section with lessons and activity ideas involving space and
Earth.

"SpaceWeather.com -- News and information about meteor showers, solar flares, auroras, and near-Earth asteroids." SpaceWeather.com -- News and information about meteor showers, solar flares, auroras, and near-Earth asteroids. http://www.spaceweather.com/ (accessed November 28, 2010).
This site reports current conditions on the Sun including sunspots and coronal holes.

"Student Observation Network | Tracking a Solar Storm." NASA - Student Observation Network - We have Moved. http://son.nasa.gov/tass/index.htm (accessed October 24, 2010).
Background information on the Sun and its activity. Includes resources for tracking solar storms.

"Tilt of Jupiter | Universe Today." Universe Today. http://www.universetoday.com/15131/tilt-of-jupiter/ (accessed August 9, 2010).
Detailed article explaining the effects of Jupiter's tilt. Includes links to similar information.

Websites for Students

"Astronomy Our Place in Space." American Museum of Natural History: Ology The Museum's Science Website for Kids. www.amnh.org/ology/astronomy (accessed October 24, 2010).
Includes games, activities, and information in a kid friendly format on topics dealing with
astronomy.

"EARTH'S Seasons - Zoom Astronomy." ENCHANTED LEARNING HOME PAGE.

http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Seasons.shtml (accessed August 9, 2010).
A kid friendly article on the Earth’s seasons.

"KidsAstronomy." Kids Know it Network. www.kidsastronomy.com/ (accessed October 24, 2010).
A great site for kids to use for researching the planets, Sun, and moons of our solar
system.

NASA. "Life in a greenhouse? How ghastly!." NASA Space Place. http://spaceplace.nasa.gov/en/kids/tes/gases/index.shtml# (accessed October 24, 2010).
Kid friendly article including pictures that describes the greenhouse effect and Ozone.

"NASA Sun Earth Media Viewer: Live Solar Images." NASA | Sun-Earth Connection Education Forum. http://ds9.ssl.berkeley.edu/viewer/flash/flash.html (accessed October 24, 2010).
Includes images of the Sun as seen from Earth. It also includes illustrations, visualizations, and interviews with scientists.

"Planet Size Comparison." Education and Public Outreach. http://www.messenger-education.org/Interactives/ANIMATIONS/Planet_Size_Comparison/planet_size_comparison_full.htm (accessed October 24, 2010).
A great site which provides a visual comparison between any two planets, as well as the
Sun and Moon.

"SCOSTEP." SCOSTEP. http://www.scostep.ucar.edu/comics/booklets.html (accessed July 16, 2010).
Comic books dealing with topics about the Sun-Earth relationship and the atmosphere.

"The Space Place :: Planet X-treme Weather." The Space Place :: Home. http://spaceplace.nasa.gov/en/kids/goes/planets/ (accessed October 3, 2010).
Kid friendly article exploring weather on different planets.

"Welcome to the Planets." Welcome to the Planetary Data System.
http://pds.jpl.nasa.gov/planets/ (accessed October 24, 2010).
Detailed information on all the planets including many graphics. It also includes the
option to have the text read to you.

The Sun is the star at the center of the Solar System. It is a nearly perfect sphere of hot plasma, heated to incandescence by nuclear fusion reactions in its core, radiating the energy mainly as visible light and infrared radiation. It is by far the most important source of energy for life on Earth. Its diameter is about 1.39 million kilometres (864,000 miles), or 109 times that of Earth. Its mass is about 330,000 times that of Earth, and accounts for about 99.86% of the total mass of the Solar Calculate local times for sunrises, sunsets, meridian passing, Sun distance, altitude and twilight, dusk and dawn times.Â Local Weather. Hour-by-Hour. 2-Week Forecast. Past Week. Climate. Sun & Moon. Sun & Moon Home.Â Start free trial. More Information. What is Solar Noon? Tips on Photographing Sunsets and Sunrises. Related Links. Moon Calculator â€“ Find times for moonrise, moonset and more. Moon Phase Calendar â€“ Calculate moon phases for any year. Day and Night World Map â€“ See which parts of the Earth are currently illuminated by the Sun. Space Weather + Ham Radio Resources. Science Website. The Universe. Interest. ExploreAstro at Caltech/IPAC.Â NASA SDO: The Sun in Multiple Wavelengths of Light Over 5 Years. 1.2K. 113. Nasa filmed the Sun for ten years - check out the video! The Sun has started a new solar cycle, meaning a period of space weather that can have serious consequences for technology on Earth and astronauts. The Sun goes through a regular cycle of calm and stormy activity, which lasts for around 11 years. Nasa has now announced the beginning of a new one. The new solar cycle, called 'Solar Cycle 25', could result in an increase in the Sun's activity over the next few years.Â However, the Sun's activity isn't always catastrophic with the energy it releases creating beautiful auroras, bright lights seen in the night sky on Earth. More space stories Some years ago, on the night before an impending big snowstorm, the phone started to ring incessantly at the News 12 Weather Center in Westchester, NY, where I work. But the inquiries being posed that night were not viewers asking about the impending big snow, but rather about something that was up in the sky at that hour.Â And a person who watches the sky carefully enough may sometimes notice a connection between the sun, moon and impending weather. Here are a few examples, each accompanied by a little folklore. Let's start with halos. "The bigger the ring, the nearer the wet." Halos are produced when light from the sun or the moon strikes ice crystals suspended high in the atmosphere at altitudes above 25,000 feet (7,600 meters).