Understanding Weather and Climate

Content Area: **Science**
Course(s): **Science 6**
Time Period: **Trimester 3**
Length: **13 Lessons**
Status: **Published**

Unit Overview

This unit is based on the underlying principle that the earth is a complex system with interrelated components of earth, air, water, and organisms that affect the whole. Atmospheric events and oceanic processes have a dramatic impact on the earth's surfaces and inhabitants. In this unit, students experiment with factors that determine daily weather and influence that produce different climate zones climate changes. Students explore the concepts of daily and catastrophic weather, the role of the ocean in the world's weather, and climate and it's changes; a research project, and a final assessment.

This unit is mostly laboratory and project based. However, there are many important reading selections from both the STC and Pearson publications. The Pearson Interactive Science series listed in the bibliography is used mainly as a reinforcement for the lab activities and as an additional source of readings, vocabulary, and diagrams. In addition, many other sources of reading materials, videos, and other media are used to enhance the lesson, such as *National Geographic, Smithsonian Magazine, Science Scope* (NSTA), *BrainPop, YouTube, Science Illustrated,* and other relevant books and current events.

Essential Questions

What factors interact and influence weather and climate?

How can natural hazards be predicted?

How do human activities affect Earth systems?

Content

Weather and Climate

Weather and Climate: Complex interactions determine local weather patterns and influence climate, including the role of the ocean.

Natural Resources: Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.

Natural Hazards: Mapping the history of natural hazards in a region and understanding related geological forces.

Human Impacts:

Human impacts on Earth systems: Human activities have altered the biosphere, sometimes damaging it, although changes to environments can have different impacts for different living things. Activities and technologies can be engineered to reduce people's impacts on Earth.

Global climate change: Human activities affect global warming. Decisions to reduce the impact of global warming depend on

understanding climate science, engineering capabilities, and social dynamics.

Skills

- Noticing things in nature and asking questions about them.
- Making accurate observations and measurements of scientific phenomena, including weather.
- Learning to work cooperatively with lab partners and classmates.
- Learning to follow a sequence of instructions over a period of time to answer an inquiry.
- Designing and conducting controlled experiments.
- Learning to use scientific instruments and techniques to collect data.
- Recognizing patterns in lab-group and class data.
- Making careful measurements of temperature.
- Analyzing relationships between variables in data sets.
- Thinking about the meaning of data.
- Making use of models and simulations to analyze system to identify flaws that might occur or to test possible solutions to a new problem.
- Communicating experimental and research results in writings, graphs, tables, and oral presentations.
- Recognizing the need for precise definitions and careful thought about the data required to answer a given question.
- Writing complete, coherent accounts of inquiries conducted in class with evidence-based conclusions.
- Reflecting upon experiences during "Understanding Weather and Climate" in writing and oral discussion.
- Continuing to seek more information on unit topics in reading and online research.
- Developing the ability to assess one's own learning.

Assessments

The majority of this unit is an inquiry-based hands-on approach to learning. It consists of laboratory activities which vary in their intensity, approach, skill, and evaluative measurements. For example, some of the lab activities are "walk-through" labs, where the student is guided through a procedure and a process, and is asked to make connections among the main concepts presented in the activity and associated readings. Other lab activities consist of a problem that is presented to the student, which he or she must solve by designing an experiment (which is then peer and teacher evaluated before proceeding with the lab activity) and collecting data. Regardless of the lab activity, students are evaluated based on the quality and presentation of the collected data in graphic organizers; the efficacy and accuracy of the experimental design; the connections made between the experimental design, the data collected, and the conclusion of the laboratory report- i.e. "tying it all together to see the big picture"; and lab etiquette and adherence to safety rules.

Other evidence for learning includes several short 5-10 question quizzes, and end-of-unit lab practical (hands-on) test, end-of-unit paper test based on the labs, and several creative projects, which may include posters, skits, songs, poems, and presentations.

Lessons/Learning Scenarios

Lesson 1: "Our Ideads about Weather and Climate"

Objectives:

- Independently record ideas and questions about earth's weather and climate
- Collaboratively record ideas and questions about earth's weather and climate
- Compare the features of a globe with those of a map
- Students record where they think weather and climate events occur on earth

Learning Activities:

- Assess students' pre-existing ideas and questions about weather and climate
- Students create group concept maps to show their understanding of weather and climate
- Students indicate their understanding of the geographic locations of atmospheric and oceanic with weather events.

Concepts:

- Students have pre-existing ideas about weather and climate.
- Weather and climate events can be associated with certain geographical locations on a map or globe.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 2: "Introducing Storms"

Objectives:

- View satellite images of clouds and identify movement patterns within the clouds
- Model the movement of air in a tornado or hurricane
- Create a working definition for the word "vortex"
- Read to learn more about thunderstorms, tornadoes, and hurricanes

Learning Activities:

- Students observe photographs of atmospheric disturbances
- Students create a vortex in a container

Concepts:

- Clouds in atmospheric disturbances appear to swirl.
- A vortex is the movement of a liquid or a gas in a spiral around a central axis.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 3: "Heating Earth's Surface"

Objectives:

- Brainstorm ways to investigate how soil and water heat and cool
- Observe and record the rates at which equal volumes of soil and water heat and cool
- Graph and analyze the heating and cooling rates of soil and water
- Interpret to compare ocean and land temperatures
- Explain what happens to energy from the sun when it reaches the earth

Learning Activities:

- Students consider ways to test the heating and cooling of soil and water
- Students devise a controlled experiment to compare heating and cooling rates of soil and water

Concepts:

- Different surfaces on earth heat and release heat at different rates.
- Unequal heating of soil and water on the earth's surfaces produces convection currents.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 4: "Heat Transfer and the Movement of Air"

Objectives:

- Compare land and water temperatures at different times during a 24-hour period
- Investigate the effect of surface temperatures on the temperate of the air above the surface
- Investigate the effect of surface temperature on the movement of the air above the surface
- Hypothesize about the transfer of heat from the earth's surface to the air above it
- Determine the basic conditions under which water moves through the air
- Develop working definitions for the words "stable air mass" and "unstable air mass"

Learning Activities:

- Students analyze a data table of ocean and land temperatures
- Students observe an air mass over a warm and a cold surface
- Students observe the movement of an air column over warm and cold surfaces

Concepts:

- Oceans heat and cool slowly; landmasses heat and cool more quickly.
- Surfaces warmer than the air around them transfer heat and warm the air above them.
- Surfaces cooler than the air around them absorb heat and cool the air above them.
- Warm air is less dense than cool air and has a tendency to rise, creating an unstable air mass.
- Cool air is denser than warm air and has a tendency to sink, creating a stable air mass.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)

- Reading selection discussion

Lesson 5: "Convection Currents in the Air"

Objectives:

- Think about the origin and meeting of air masses with different temperature and humidity conditions
- Set up an investigation that demonstrates what happens to two airs masses when they meet
- Analyze the origin, meeting, and movement of two air masses with different temperature and humidity conditions
- Develop working definitions of the terms "convection current" and "weather front"
- Relate the movement of air within the convection model to the formation of land and sea breezes and the development of tornadoes
- Explain how winds form

Learning Activities:

- Students review the concept of air masses
- Students use convection tubes to combine different air masses

Concepts:

- Convection currents are formed by the upward movement of warm air and the downward movement of cool air.
- Air masses of different temperature and humidity meet to form convection currents.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 6: "Temperature, Pressure, and Cloud Formation"

Objectives:

- Analyze weather maps
- Model and describe how water evaporates and condenses and how these processes play a part in cloud formation
- Model and describe the air pressure conditions under which clouds form
- Collect and analyze weather data noting any patterns involving changes in barometric pressure
- Analyze weather maps, classify fronts, identify high- and low-pressure systems, and determine the weather conditions associated with each
- Complete and present a project on weather observations, and predictions
- Observe and record the rates at which equal volumes of soil and water heat and cool

Learning Activities:

- Students look at the parts of a weather map
- Students observe the condensation of cooled water vapor in a bottle
- Students observe and record variations in at least six weather variables over five days
- Students examine the data as they record it, seeking pattern emergence
- Students analyze a weather map for details on fronts and weather changes
- Students graph their data and seek patterns in the results
- Students compare data on weather, pattern-spotting, and their predictions

Concepts:

- Weather maps can indicate the presences of clouds in front and low-pressure areas.
- Water vapor changes to a liquid by condensation.
- Clouds form under low air pressure when water vapor from warm, rising air condenses (or when warm and cold air masses meet).
- Weather forecasting once depended on local observations.
- Local observations can still be used in weather forecasting.
- Data do not always contain or reveal patterns; it is not always possible to know in the first trial how much data is sufficient to reveal patterns.
- Weather maps provide information about the weather.
- Atmospheric conditions can form the basis of weather forecasting.
- Local data may be used to predict weather.
- Visual representations of data can aid in pattern-spotting.
- Failed experiments provide information that guides experimental redesign.
- Part of experimental design is determining how much and which data are necessary.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 7: "Hurricanes: Destructive Storms"

Objectives:

- Review previous knowledge of hurricanes and their locations
- Investigate and model the factors that affect the height of a storm surge
- Learn about the behavior and effects of hurricanes
- Track the formation and movement of Hurricane Katrina

Learning Activities:

- Students activate prior knowledge about hurricanes
- Students simulate conditions for a storm surge, comparing a surge's effect on two different coastal landforms
- Students plot the path of a severe hurricane

Concepts:

- Hurricanes form over tropical waters.
- A storm surge is produced by water pushed ahead of the storm by the force of hurricane winds.
- The effect of storm surge varies with coast configuration.
- Major damaging effects of hurricanes are caused by wind and water pushed to shore during the storm surge.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 8: "Earth: An Ocean Planet"

Objectives:

- Locate various zones of the ocean and the features of each

- Learn to read contour maps
- Use sets of sound marks to draw contour lines and create bathymetric maps
- Take sounding and develop a bathymetric map

Learning Activities:

- Students analyze an illustrated profile of the ocean layers
- Students construct bathymetric maps and think about how to deal with data insufficiency
- Students build seafloors for their classmates to map, then take soundings to map features of an ocean floor

Concepts:

- A vast, interconnected ocean is the dominant feature of Earth. It is the main source of water, an important source of oxygen, and support all life on the planet.
- Topographic map shows elevations above a surface by means of contour lines that fall at regular intervals.
- A bathymetric map uses contour lines to show the depth of features below a surface.
- Uncertainty is inherent in data interpretation.
- We cannot see far beneath the ocean surface. Science is required for exploration of what we cannot see.
- Thoughtful planning is essential to meaningful data collection.
- Good data interpretation requires careful thought.
- Longitude is essential to accurate seafloor mapping.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 9: "Ocean Currents"

Objectives:

- Analyze why the water temperature at the equator and poles differ
- Investigate the effect of water temperature on density and on the movement of water
- Investigate the effect of salinity on density and on the movement of water
- Understand that sea ice formation generates dense, salty water
- Verify that ice formation in salt water increases the salinity of the remaining liquid water
- Investigate the effect of wind on surface currents
- Locate some of the major ocean currents and analyze their effects on global climate

Learning Activities:

- Students measure the temperature of a heated surface as a function of the angle of incidence
- Students observe the movement of hot and cold water masses
- Students observe the movement of salty and less salty water masses, and understand that the motion is density-driven
- Using quantitative methods, students carry out an experiment to verify the teacher's assertion that freezing salt water creates freshwater ice and forces salt into the remaining liquid
- Students create a convection current by blowing on a liquid

Concepts:

- Light heats a surface more as the angle at which it strikes approaches 90 degrees.
- Temperature affects the density of water.
- Salty and less salty masses of water vary in density and create convection currents in a liquid .

- Winds blowing over a liquid's surface creates a current.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 10: "Exploration Activity"

Objectives:

- Discuss how scientists decide what data to collect and how to collect it
- Analyze a graph of data related to climate change
- Conduct research on the graph's data and subject
- Create an oral presentation to findings to deliver to the class
- Deliver an oral presentation of findings to the class

Learning Activities:

- Students take a thermometer into a large area, take multiple temperature readings, and decide how to collapse them into a single value
- Student groups are assigned a graph of climate change data to research
- Student groups research the climate phenomena their graphs describe, interpret their graphs, and prepare to explain what they show and how
- Students become aware of how they will be assessed and choose visual elements to use in their presentations
- Students follow recommendations for the presentation of their research findings

Concepts:

- Scientists must make difficult decisions about measurement, data use, and definitions when they try to describe large, varied systems like the ocean or the atmosphere.
- The ocean is tremendously large and varied.
- "Climate" refers to weather conditions over a long period of time.
- Climate changes have occurred in the past, are happening in the present, and are predicted to occur in the future.
- It is important to understand where data comes from and how it is collected so that the limits of our knowledge are clear.
- Scientific authority depends upon intelligent, clearly stated interpretation of reliable information.
- Numerous organizations – educational, governmental, and professional – have data based on climate research that can be accessed by students.
- Data may be of varying quality.
- Data are collected by specific people for specific reasons.
- Definitions are important.
- Visual elements such as graphs, maps, and videos can help convey information.
- Sharing knowledge is an important part of the scientific process.

Assessments:

- Exploration Activity Rubric
- Bibliography
- Oral Presentation and visual aid

Lesson 11: "Earth's Climate Zones"

Objectives:

- Examine natural climate zones on earth
- Examine factors that influence climate
- Study federal climate change projections for a region on the United States
- Develop climate change – related policy recommendations for the governor of your state
- Investigate the use of plant fossil data as an indicator of past climate

Learning Activities:

- Students locate their own climate zone, discuss its characteristics, and identify other similar places in the world
- Students examine and interpret regional climate projections data from the United States Global Change Research Program
- Students develop policy proposals to mitigate climate change in their own state
- Students analyze shapes of leaf fossils to determine their associated temperatures and climate in the Cenozoic Era

Concepts:

- The world is divided into five main climate zones and many more subzones.
- Climate zones are defined primarily by precipitation, temperature, and seasonal fluctuations, but they are rooted in questions about the types of life forms that can thrived in each area.
- Regions of each climate type are found around the world.
- It is possible to make climate projections given the current state of knowledge about climate and how it works.
- Climate projections are reasonable scenarios rather than forecasts.
- Current climate projections show significant, potentially dramatic climate change in U.S. regions over the next century.
- Studying climate change projections lets us consider how best to mitigate climate change and its effects.
- Climates have changed markedly in other geological times.
- Studying and envisioning past episodes of rapid climate change may help us understand how the current warming period will go.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 12: "Climate and Energy Use"

Objectives:

- Read about scientists' development and use of computer climate models
- Acquire data from an event and use it to estimate the course of a similar event
- Evaluate home energy use
- Consider ways to reduce energy use
- Review the concepts and skills developed in "Understanding Weather and Climate"

Learning Activities:

- Students read and discuss two selections on climate change
- Students participate in a teacher demonstration of the rate ice melt, graph data, and make predictions about future melting. Students then test their predictions using a second demonstration.
- Student use personal or other data to compute their energy use

Concepts:

- Scientists around the world have reached a consensus on global warming. They find compelling evidence that the earth is warming rapidly, and that much if not all of the change is anthropogenic, or caused by human activity.

- Environmental systems are complex, which makes modeling them difficult.
- The scale of environmental phenomena is extremely large, but can still be modeled.
- Energy use can be computed for individuals, groups, and countries to give a profile, or "carbon-footprint."

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 13: "Understanding Weather and Climate Assessment"

Objectives:

- Review and reinforce concepts and skills from "Understanding Weather and Climate"
- Complete a three-part assessment of the concepts and skills addressed in "Understanding Weather and Climate"
- Have students apply their own learning and skills to answer questions
- Review correct responses to Parts A and B of the assessment

Learning Activities:

- Go over Student Sheet 12: Weather and Climate Review to prepare for the assessment
- Students observe a demonstration of a convection current set up by the teacher and answer questions about it
- Students demonstrate comprehension of unit concepts by applying knowledge, principles, and skills to answer questions
- As a class, go over the assessment results, discuss answers, discuss applications of the unit to daily life, and revisit the concept map from Lesson 1

Assessments:

- "Understanding Weather and Climate" 3-part Assessment
- Class Discussion

Standards

SCI.6-8.MS-ESS2-5	Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.
SCI.6-8.MS-ESS2-6	Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
SCI.6-8.MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
SCI.6-8.MS-ESS3-2	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
SCI.6-8.MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
SCI.6-8.MS-ESS3-5	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Resources

Smithsonian Institution - National Science Resources Center: Understanding Weather and Climate. *The STC Program, 2014* .