Unit 6.3 Weather, Climate & Water Cycling

Content Area: **Science**
Course(s): **Science 6**
Time Period: **Marking Period 3**
Length: **MP3**
Status: **Published**

Essential Questions

Why does a lot of hail, rain, or snow fall at some times and not others?

Lesson 1 What causes this kind of precipitation event to occur?

Lesson 2 What are the conditions like on days when it hails?

Lesson 3 How does the air higher up compare to the air near the ground?

Lesson 4 Why is the air near the ground warmer than the air higher up?

Lesson 5 What happens to the air near the ground when it is warmed up?

Lesson 6 How can we explain the movement of air in a hail cloud?

Lesson 7 Where did all that water in the air come from, and how did it get into the air?

Lesson 8 What happens to water vapor in the air if we cool the air down, and why?

Lesson 9 Why don't we see clouds everywhere in the air, and what is a cloud made of?

Lesson 10 Why do clouds or storms form at some times but not others?

Lesson 11 Why don't water droplets or ice crystals fall from the clouds all the time?

Lesson 12 What causes more lift in one cloud versus another?

Lesson 13 Why do some storms produce (really big) hail and others don't?

Big Ideas

Unit Summary and Storyline

This 6th grade science unit on weather, climate, and water cycling is broken into four separate lesson sets. In the first two lesson sets, students explain small-scale storms. In the third and fourth lesson sets, students explain mesoscale weather systems and climate-level patterns of precipitation. Each of these two parts of the unit is grounded in a different anchoring phenomenon.

The unit starts out with anchoring students in the exploration of a series of videos of hailstorms from different locations across the country at different times of the year. The videos show that pieces of ice of different sizes (some very large) are falling out of the sky, sometimes accompanied by rain and wind gusts, all on days when the temperature of the air outside remained above freezing for the entire day. These cases spark questions and ideas for investigations, such as investigating how ice can be falling from the sky on a warm day, how clouds form, why some clouds produce storms with large amounts of precipitation and others don't, and how all that water gets into the air in the first place.

The second half of the 6th grade science weather and climate unit is anchored in the exploration of a weather report of a winter storm that affected large portions of the midwestern United States. The maps, transcripts, and video that students analyze show them that the storm was forecasted to produce large amounts of snow and ice accumulation in large portions of the northeastern part of the country within the next day. This case sparks questions and ideas for investigations around trying to figure out what could be causing such a large-scale storm and why it would end up affecting a different part of the country a day later.

Anchoring Phenomenon

This unit uses two anchors, one to drive student questions and investigations in the first half of the unit, and one to drive student questions and investigations in the second half of the unit. The unit begins with students watching, in three short video clips of relatively short precipitation events, hail falling at different locations in North America at different times of year. Students develop initial models to explain what causes this kind of precipitation event to occur, considering (1) the changes that happen over time where the hail falls, (2) the changes that occur to matter in the air at a particle level, and (3) the energy that transfers into, through, and out of the system. They expand the range of phenomena by considering other times when they've seen or heard of a lot of precipitation fall in one place in either a relatively short time (minutes) or continuously over a much longer time (hours or days). Students then develop a Driving Question Board (DQB) to guide future investigations.

The second half of the unit re-anchors in the context of a larger-scale weather event in Lesson 14. It begins with students watching a winter weather report and forecast clip from the Today show (from 8:00 a.m. (EST) on Saturday, Jan. 19, 2019) and analyzing maps for most of the United States,. Students evaluate their previously developed model ideas for explaining the causes of a hailstorm to determine whether the same causes also help explain how what happened in the air over the country at the time of the forecast was connected to what was predicted to happen by the end of the weekend (40 hours later), which includes some areas that went on to receive over a foot of snow accumulation and other areas that received over half an inch of ice accumulation. Students then add new questions to their Driving Question Board (DQB) to guide future investigations. The second half of the video from the same forecast is then introduced in Lesson 18, to support a transition to climate-related questions and investigations in the last few lessons of the unit.

Each OpenScied unit's anchoring phenomenon is chosen from a group of possible phenomena after analyzing student interest survey results and consulting with external advisory panels. We also chose hail as the first anchoring phenomenon for this unit for these reasons:

- Severe weather events provided a compelling context for explaining weather-related phenomena. Hailstorms fell into this category, and explanations for them did not require model ideas that were beyond the target DCIs for the middle school level, which something like tornadoes would require.
- The relatively sudden and brief window of a hailstorm event (up to about 15 min in length) and relatively small impact area (a few miles) provided a more tractable scale system to begin investigating how changes in the matter flow and energy transfer into the air can drive the formation of storms, before moving on to larger-scale weather system (mesoscale) and climate-related patterns (hemisphere scale) in the later half of the unit.
- A pre-field test release of this anchor produced Driving Question Boards that had over 85% of the students' questions on them as well as ideas for investigations to answer those questions. These investigations were anticipated by the unit development team, and were specifically targeted in the field test version of the storyline.

- A subsequent piloting of this anchor confirmed that this type of weather event was intriguing for students who had varying levels of firsthand experience with hail. This included those who experienced hail relatively frequently (classrooms in the midwest), as well as for those who encountered it far less frequently (classrooms on the west coast) and those who had neither encountered nor heard of it before (some international students).

We also chose a video of a winter storm weather report and forecast from Jan., 19, 2019 as the phenomenon to re-anchor the second half of this unit for these reasons:

- The video clip included weather reporting and forecasts for the western, central, and eastern United States. This broad area of impact provides regional connections to most students in the country.
- Related predictions, regarding a potential loss of energy due to the effect of freezing rain on downed power lines and the forced closing of schools in the northeast, provide a severe winter storm context that has an impact on the related activities that students engage in.
- The four extratropical cyclones covered in the forecast are examples of mesoscale (synoptic) low pressure weather systems. These systems commonly occur in the middle latitudes of the Earth (e.g., the United States) across multiple seasons of the year. These, in combination with anticyclones of high-pressure air, drive much of the weather changes that students experience – capable of producing a myriad of weather events, including cloudiness and mild showers to heavy gales, thunderstorms ,and blizzards.
- The differences in the predicted precipitation across different regions from all of these storm systems reveal some new patterns related to coastal proximity, elevation, and prevailing winds. These patterns provide a context to start exploring climate-oriented questions, which are also part of the target DCIs for this unit.

Enduring Understandings

Next Generation Standards

This unit builds toward the following NGSS Performance Expectations (PEs) as described in the OpenSciEd Scope & Sequence:

- MS-ESS2-4
- MS-ESS2-5
- MS-ESS2-6
- MS-PS1-4*

Disciplinary Core Ideas

The 6th grade science weather and climate unit expands students' understanding of weather and climate, and the role of water in Earth's surface processes which include these grades 6-8 elements of the Disciplinary Core Ideas (DCIs). It addresses all but the crossed-out sections of the ones shown below.

ESS2.C: The Roles of Water in Earth's Surface Processes

- Global movements of water and its changes in form are propelled by sunlight and gravity.
- The complex patterns of the changes and the movement of water in the atmosphere, determined by

winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.

- Variations in density due to variations in temperature ~~and salinity~~ drive a global pattern of interconnected ocean currents.
- Water continually cycles among land, ocean, and atmosphere via ~~transpiration~~, evaporation, condensation and crystallization, and precipitation~~, as well as downhill flows on land.~~

ESS2.D: Weather and Climate

- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms~~, and living things.~~ These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.
- Because these patterns are so complex, weather can only be predicted ~~probabilistically~~.
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

This unit builds on DCI elements that students should have developed in the prior OpenSciEd unit 6.2. These ideas are elicited and are used in new contexts (primarily different because of time and temporal scale). In many cases, the unit helps students extend these DCIs. The plain text beneath each of the DCI elements below describes how the ideas are used and where they are extended.

- PS1.A: Structure and Properties of Matter: Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
  - This particle model is reused and extended in Lessons 3-11, 13-14, and 17-18. It is used to model (1) how energy is transferred from the ground to the air (through conduction), (2) why air changes its density (due to changes in the speed of air particles), (3) why density would affect the amount of air pressure detected by a barometer (due to differences in the amount of force applied to the barometer from changes in the weight of a column of air particles overhead), and (4) how the cooling of water vapor in the air can cause the molecules in it to slow down enough that they stick to, rather than bounce off of, neighboring particles in collisions, thereby causing the particles to condense or solidify out of the air.
- PS3.A: Definitions of Thermal Energy: The temperature of a system is proportional to the average internal kinetic energy and potential energy per molecule (whichever is the appropriate building block for the system's material). When the kinetic energy of an object changes, there is inevitably some other change in energy at the same time.
  - The idea that thermal energy transfer can occur through conduction is used to explain how the air above the ground is heated by it, and how warm rising air cools off as it moves higher up, This idea is reused in Lessons 5-8, 10, 12, 13, 14, 17, 18, 20, and 22.
- PS4.B: Electromagnetic Radiation When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.
  - The idea that light is absorbed by the ground and converted to thermal energy is an idea that is reused in Lessons 3, 6-8, 10, 14, 17, 18, 20, and 22 in this unit.

Disciplinary Core Ideas are reproduced verbatim from A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. DOI: https://doi.org/10.17226/13165. National Research Council; Division of Behavioral and Social Sciences and Education; Board on Science Education; Committee on a Conceptual Framework for New K-12 Science Education Standards. National Academies Press, Washington, DC.

Crosscutting Concepts

- Patterns
- Cause and Effect
- Systems and System Models
- Matter and Energy

Cross-Curricular Integration

Language Arts Companion Standards:

W.AW.6.1. Write arguments on discipline-specific content (e.g., social studies, science, math, technical subjects, English/Language Arts) to support claims with clear reasons and relevant evidence.

A. Introduce claim(s) about a topic or issue and organize the reasons and evidence logically.

B. Support claim(s) with logical reasoning and relevant, accurate data and evidence, that demonstrate an understanding of the topic or text, using credible sources.

C. Use words, phrases, and clauses to link and clarify the relationships among claim(s), reasons and evidence.

D. Establish and maintain a formal/academic style, approach, and form.

E. Provide a concluding statement or section that follows from the argument presented

RI.CI.6.2. Determine the central idea of an informational text and explain how it is supported by key details; provide a summary of the text distinct from personal opinions or judgments.

RL.MF.6.6. Compare and contrast information or texts to develop a coherent understanding of a theme, topic, or issue when reading a story, drama, or poem to listening to or viewing an audio, video, or live version of the text.

Activity:

Continental Drift vs. Plate Tectonics: The theory of continental drift introduced by Alfred Wegener in the early 1900's was not widely accepted until 1960. Wegener's theory was later developed into The Theory of Plate Tectonics. Compare and contrast both theories looking at the relationship between the two. Compose an argument in the form of an essay that defends Wegener's claim about continental drift based on your analysis of each theory. What parts of Wegener's theory are also parts of the Theory of Plate Tectonics? Use evidence from your analysis to defend your claim.

Diversity Integration

Objective: Students will complete a graphic organizer on a Scientist from a diverse background or protected class.

Activity:

1. Students are to make a copy of the graphic organizer that they are to complete on the scientists.
2. They will then need to complete the organizer by doing research on the person and their field of science that the scientists work in.
3. After finding information about the scientist, they will then need to write a paragraph on the person and explain to us "Why is this scientist famous? What have they done in their lifetime to help out the world?"

Lab

Lab: Weather, Climate and Water Cycling MS-ESS2-4

https://docs.google.com/document/d/10OnwZPeeUJ4LqUA7K69KLWhuhl122L_LPNKMw9R2qhw/edit?usp=drive_link

Objective:

Students will explore the water cycle, understanding evaporation, condensation, and precipitation processes.

Reflective Questions:

- What did you observe about the water levels in the cup and dish?
- How did temperature affect the rate of evaporation?
- How does this experiment demonstrate the water cycle?

Assessment:

- Students submit a short paragraph explaining the water cycle based on their observations.

- Create a diagram of the experiment, labeling evaporation, condensation, and precipitation.

Lab: Exploring Weather and Climate- MS-PS1-4

https://docs.google.com/document/d/11fF-3ka0O-6oY0mm0gZLqNDAzhIEi1xahniUQ7NHiuI/edit?usp=drive_link

Objective:

Students will investigate the difference between weather and climate by conducting a simple experiment to understand their characteristics and effects.

Reflection Questions:

1. How did the temperatures in the two cups differ, and why do you think that happened?
2. How does this experiment help you understand the difference between weather and climate?

Assessment:

- Students will write a short paragraph describing what they learned about the difference between weather and climate.
- Teacher will assess understanding based on their ability to explain temperature differences and relate them to real-world climate examples.

Science and Engineering Practices

- Developing and Using Models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data

Science and Society

Charles Darwin (February 12, 1809 - April 19, 1882)

Was an English naturalist, eminent as a collector and geologist, who proposed and provided scientific evidence that all species of life have evolved over time from common ancestors through the process he called natural selection.

James Hutton (June 3, 1726 — March 26, 1797)

Was a Scottish geologist, naturalist, chemist and experimental farmer. He is considered the father of modern geology. His theories of geology and geologic time, also called deep time, came to be included in theories which were called plutonism and uniformitarianism.

Charles Lyell (November 14, 1797 – February 22, 1875)

Was a Scottish lawyer, geologist, and populariser of uniformitarianism.

CSDT Technology Integration

8.1.8.DA.4 Transform data to remove errors and improve the accuracy of the data for analysis.

8.1.8.DA.5 Test, analyze .and refine computational models.

Activity:

SWBAT understand how the rock cycle works and what types of rocks come about after each process an interactive PowerPoint Presentation on the Rock Cycle and 2 Youtube videos on the different types of rocks.

Resources

Scientific Inquiry

MS-ESS2-1 (5.4.6.B.4) *What is Soil?* p. 42
MS-ESS2-2 (5.4.6.B.1) *Which Layer is the Oldest?* p. 104