The Evolution of the T2L Science Curriculum

Over the last four years, the Teach to Learn program created 20 NGSS-aligned science units in grades K-5 during our summer sessions. True to our plan, we piloted the units in North Adams Public Schools, and asked and received feedback from our science fellows and our participating teachers. This feedback served as a starting point for our revisions of the units. During year 2 (Summer of 2015), we revised units from year 1 (Summer/Fall 2014) and created new units to pilot. In year 3, we revised units from years 1 and 2 and created new units of curricula, using the same model for year 4. Our understanding of how to create rich and robust science curriculum grew, so by the summer of 2018, our final summer of curriculum development, we had created five exemplar units and established an exemplar unit template which is available in the T2L Toolkit.

We made a concerted effort to upgrade all the existing units with exemplar components. We were able to do much, but not all. So, as you explore different units, you will notice that some contain all elements of our exemplar units, while others contain only some. The fully realized exemplar units are noted on the cover page. We did revise all 20 units and brought them to a baseline of "exemplar" by including the Lessons-At-A-Glance and Science Talk elements.

Grade 3

Weather and Climate

A T2L Exemplar Unit

MCLA
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Williams

Teach To Learn

A collaboration between MCLA, Williams College, and North Adams Public Schools

Funded by NSF DUE-IUSE Award #1432591

T2L Curriculum Unit

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Weather and Climate

Earth and Space Science/Grade 3

In this unit, students will learn about the importance of our sun, how the earth moves in relationship to the sun, why different places on the earth are impacted differently by the sun, the concept of energy as it relates to heat and light, and the importance of energy exchange between the Earth and the sun. Students will further develop their graphing skills to communicate information visually and make predictions about weather data.

Authors, Summer 2017

Julia Choi, Psychology major, Music major, Neuroscience minor, Williams College
Joy DeMayo, Second Grade Teacher, Colegrove Park Elementary School, North Adams Public Schools
Jessica Lesure, Elementary Education major, Psychology major, Massachusetts College of Liberal Arts
Lisa Marceau, Fifth Grade Teacher, Colegrove Park Elementary School, North Adams Public Schools
Sofia Phay, Psychology major, Williams College
Sophia Robert, Philosophy major, Biology major, Cognitive Science minor, Neuroscience minor, Williams College
Jade Schnauber, Early Childhood Education major, Sociology major, Massachusetts College of Liberal Arts
Natalie Torrey, Education major, Interdisciplinary Studies major, Massachusetts College of Liberal Arts

Revisions, Summer 2018

Tiffinie Alvarez, Secondary Education major, English major, Massachusetts College of Liberal Arts
Priscilla Mercado, Computer Science major, English major, Williams College

Project Management

Leslie Rule, Teach to Learn, Massachusetts College of Liberal Arts

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Table of Contents

Unit Plan

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Stage 1 Desired Results

Meaning

Grade Level Standards

3-ESS2-1. Use graphs and tables of local weather data to describe and predict typical weather during a particular season in an area.
Clarification Statements: Examples of weather data could include temperature, amount and type of precipitation (e.g., rain, snow), wind direction and wind speed. Graphical displays should focus on pictographs and bar graphs.

3-ESS2-2. Obtain and summarize information about the climate of different regions of the world to illustrate that typical weather conditions over a year vary by region.
Clarification Statements: Examples of information can include climate data (average temperature, average precipitation, average wind speed) or comparative descriptions of seasonal weather for different regions.

3-ESS3-1. Evaluate the merit of a design solutions that reduces the damage caused by weather.*

UNDERSTANDINGS
Students will understand that…

- There are different types of weather that occur around the world and that weather can vary from year to year depending on the region.
- The sun is the driving force for climate conditions.
- Seasons drive weather and it is possible to predict weather patterns based on previous data.
- Humans interact and impact the climate by what they do.

ESSENTIAL QUESTIONS

1. **Why do different places on Earth have varying seasonal changes?**
2. **How do humans respond to and interact with the Earth's Climate?**

Student Learning Targets

"I can" statements

1. I can obtain local and global weather data.
2. I can explain that the sun plays an important role on day vs. night, weather, and seasons.
3. I can describe how the earth moves in relationship to the sun.
4. I can use different models to show why different places on the earth are impacted differently by the sun.
5. I can describe the concept of energy, as it relates to heat and light.
6. I can explain the importance of energy exchange between the Earth and the Sun.
7. I can explain graphs are tools to communicate information visually
8. I can use graphs to make predictions and assumptions about weather data in a given area

Clarification Statement: Examples of design solutions to reduce weather-related damage could include a barrier to prevent flooding, a wind-resistant roof, and a lightning rod. **ESS2.D: Weather and Climate** Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next (3-ESS2-1) Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years (3-ESS2-2) **ESS3.B: Natural Hazards** A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards, but can take steps to reduce their impact	9. I can research and record weather data about a particular area of interest 10. I can define climate and differentiate it from weather. 11. I can investigate ways that plants and animals adapt to the climate conditions in their environments. 12. I can explain how global and local climate conditions create and sustain ecosystems. 13. I can explain how weather and climate in different regions shape the lifestyles and cultures of the people that live there. 14. I can collect data to support a claim 15. I can explain different perspectives and experiences across the globe in relation to the climate's impact. 16. I can identify and describe natural disasters, and the processes by which they occur and why they occur in specific locations. 17. I can explain and compare impact (magnitude). 18. I can describe and assess how regions respond to and prepare for disasters. 19. I can explain and describe how humans affect the climate. 20. I can describe ways to better the environment and climate. 21. I can explain the core details of the lessons and can construct thoughtful questions about the topics. 22. I can elaborate and generate answers to questions about how humans respond to and interact with Earth's climate.

Stage 2 – Evidence

Evaluative Criteria	Assessment Evidence
Science journal Class discussions Group presentations Individual projects/ activities	Unit Assessment OTHER EVIDENCE: * • Independent science journal entries • Class discussions • Presentations (both group and individual)

	• Individual/ group activities such as, weather graphs, trioramas, World Marketplace, and the website scavenger hunt.

Stage 3 – Learning Plan

Lesson 1: Students will explore local weather data and make weather predictions. They will then explore global weather data and predictions over long periods of time. Students will then make predictions about why temperature acts the way it does and why certain places are warmer than others. Lastly, the students will be introduced to the sun's relationship to the Earth via the use of a globe and light.

Lesson 2: In this lesson, students will explore different models of the sun and earth. Through experimenting with a globe and a flashlight, and with their own bodies and space, students will seek to understand spatial and movement features of the sun and earth. This exploration will be contextualized by reinforcing the importance that the sun - and its spatial relationship to the earth over time - dictates different weather and climate for different regions on earth.

Lesson 3: In this lesson, students will learn the definition of energy and how it may differ from their idea of energy. This will help their understanding of how the sun affects the weather and climate on Earth. Students will learn through classroom experiments, hands on activities and short discussions.

Lesson 4: Students will be exploring data collection tools concerning weather information to guide understanding that weather differs in different locations. Students will be exposed to graphs as a means of "seeing" data and being able to make predictions about regional weather patterns. Students will research particular areas of interest and collect data to describe conditions of that area.

Lesson 5: Part 1: The first activity will help students differentiate weather from climate . The students will explore various ecosystems using Google Cardboard to get a sense of various climate conditions in well known ecosystems around the world. They will then model some of the ecosystems and consider the various plants and animals that could be sustained in such conditions.

Lesson 5: Part 2: In the Google Earth Photo activity, students will observe four locations, each in a different climate zone, and consider the climate conditions necessary to sustain that ecosystem. Using this information, the students will find the same locations on their Climate Zone worksheets and determine which climate zones are located in which latitudes of the Earth. Lastly, the students will be encouraged to use their knowledge from Lessons 2 and 3 to explain how the Sun and the Earth's position might contribute to the creation of these broad climate zones.

Lesson 6: This lesson will serve as a transition to thinking about the second essential question. Students will be exposed to different regions (familiar and unfamiliar) and the lifestyles that revolve around the according climates. Students will explore sociocultural aspects of specific regions and their impact on the climate. Sociocultural aspects include food, clothing, agriculture, jobs, and any other categories that are critical to human life and shaped by the forces of the region's climate. After gathering data about a particular region, students will have the opportunity to present their research in the form of a world marketplace game.

Lesson 7: In this lesson, students will be exploring natural disasters through the use of critical thinking, models and role playing. They will be asked to think deeply about how humans prepare for natural disasters. They will be constructing and observing their own models of certain disasters and they will be playing a game to give them a better understanding of the effects of these disasters.

Lesson 8: This lesson will start with a brief discussion on the fate of our trash, which will connect to the idea of human behavior impacting climate. Students will explore examples of human actions through the online scavenger hunt activity. Then, students will become Earth doctors and work to find solutions to improve the environment and climate.

Lesson 9: In this lesson, students will be referring back to information from previous lessons. They will be reviewing these concepts through physical models and explanation. They will be given time to interview and learn from local businesses before creating their own town.

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Lessons at a Glance

Key

Independent online student research	Tech Integration	YouTube Video (or other video site)	Kinesthetic Learning	Outdoor education

Resource and Modalities Chart

Lesson	Core Activities	Extensions	Tools and Modalities
1. Weather Around the World	• Using a Thermometer • Weather Across America • Fortune Tellers		
2. The Earth and the Sun -- An Essential Friendship	• Globe and Flashlight Demo • Kinesthetic Model • Northern/Southern Hemispheres		
3. Energy -- Teamwork Makes the Dreamwork	• Land Versus Water • Sun S'mores • Energy Exchange Skit	• Cloud role-play	
4. Understanding Collection of Weather Data	• Observing Weather Graphs		
5.1 Ecosystems and Climate	• Exploring Ecosystems • Trioramas		

5.2 Ecosystems and Climate	• Google Earth Photos • Climate Zones		
6. Understanding Other Regions	• World Marketplace	• Interview with Buddy School from different location, or local person who has lived in different climates	 
7. A Recipe for (Natural) Disaster	• Tornado in a Bottle • Survival Game		
8. Earth Doctors	• Website Scavenger Hunt • Earth Doctor Collage	• Field trip to local greenhouse • Field trip to Hopkins Forest (Carbon footprint)	 
9. 1 Think Global, Act Local	• Brainstorming • The Great Pacific Garbage Patch • Interview Local Businesses		
9.2 Think Global, Act Local	• Create your own town		

Lesson Feature Key

Lessons in this unit include several features to help instructors. This key is a quick guide to help identify and understand the most important features.

Icons

Talk science icon: Look for this icon to let you know when to use some of the talk science strategies (found in the unit resources of this unit)

Anchor phenomenon icon: Indicates a time when an anchoring scientific phenomenon is introduced or when an activity connects back to this important idea**.**

Text Formatting:

[SP#: ….] Any time you see a set of brackets like this, it indicates that students should be engaged in a specific science or engineering practice.

<u>Underlined text in the lesson</u>:

This formatting indicates important connections back to the central scientific concepts and is useful to note these connections as an instructor, as well as for students.

Callouts

Teaching Tip

In these call-out boxes, you'll find tips for teaching strategies or background information on the topic.

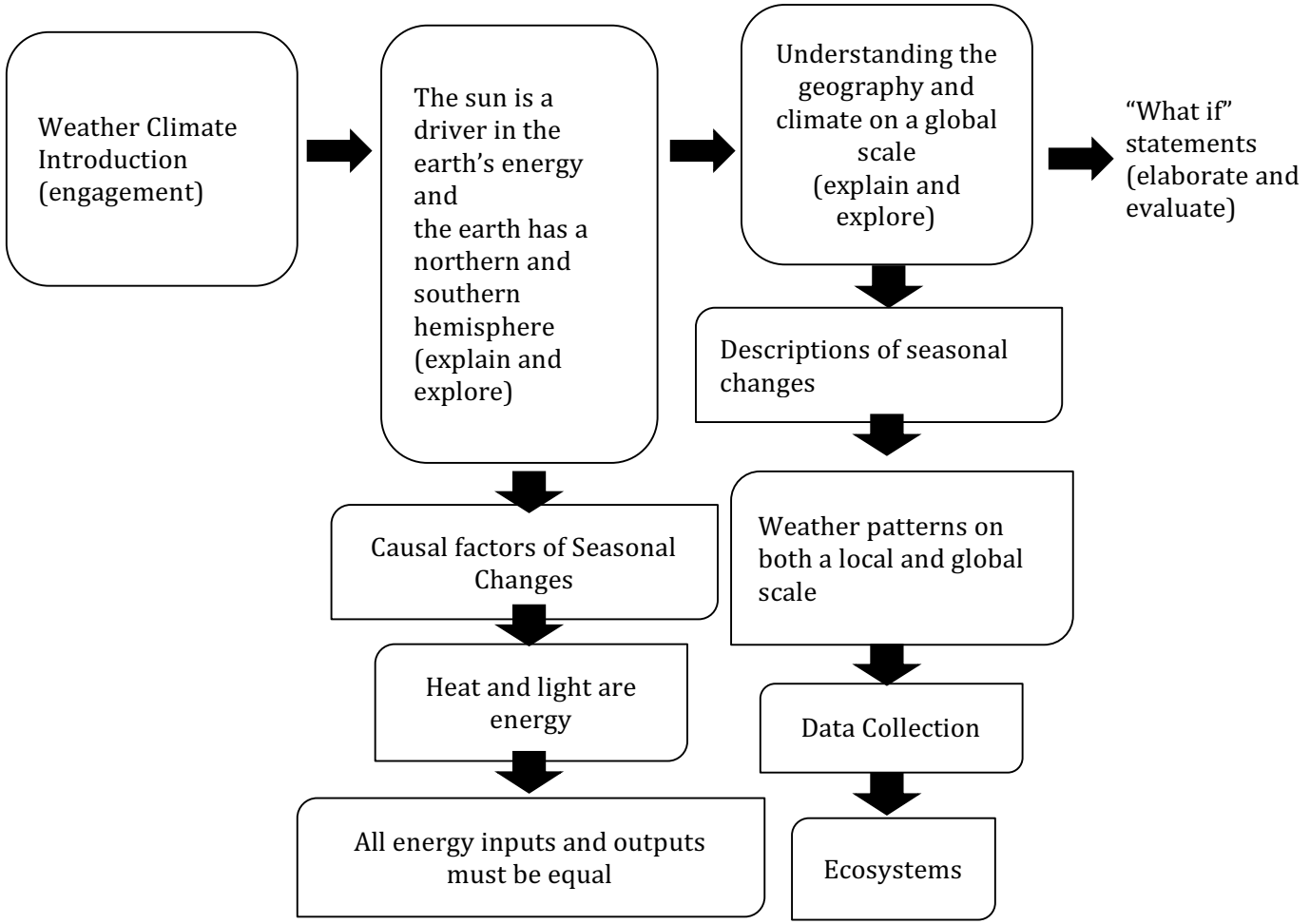
Student Thinking Alert

Look out for common student answers, ways in which students may think about a phenomenon, or typical misconceptions.

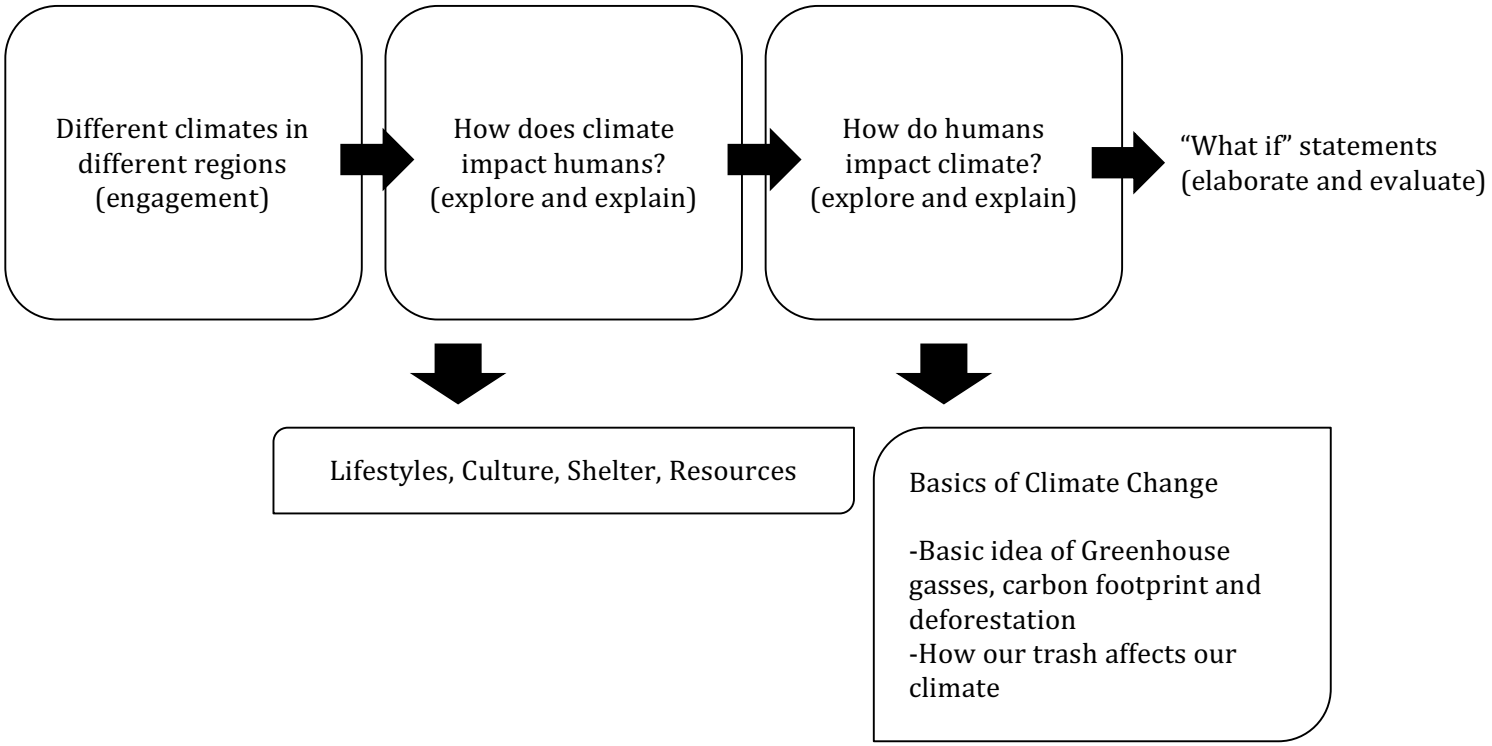
This unit was developed with National Science Foundation funding (Grant #1432591). It is a DRAFT document that will be revised as the unit is piloted and feedback received.

Essential Question Concept Maps

Essential Question 1:
Why do different places on Earth have varying seasonal changes?



Essential Question 2:
How do humans respond to and interact with the Earth's Climate?



Tiered Vocabulary List

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Tier 1	Tier 2	Tier 3
Thermometer	Temperature	Equator
Energy	Fahrenheit	Circumference
Data	Rotation	Orbit
Graphs	Tilt	Axis
Recycle	Ecosystem	Hemisphere
	Absorb	Air pressure
	Exchange	Agricultural
	Balanced	Greenhouse gasses
	Precipitation	Carbon footprint
	Climate	Deforestation
	Tropical	
	Thrive	
	System	
	Cultural	
	Lifestyle	
	Natural disaster	
	Hurricanes	
	Tornadoes	
	Landslides	
	Floods	
	Flash floods	
	Climate change	
	Solar energy	

Science Content Background

Please read through the explanation provided in the next few pages and jot down questions or uncertainties. Consult internet resources to answer your questions, ask colleagues, and work together as a team to grow your own understanding of the science content and the central phenomena in this unit. This knowledge primes you to better listen and respond to student ideas in productive ways. Please feel free to revisit this explanation throughout the unit to revise and improve your own understanding of the science content.

Essential Questions:

1. Why do different places on Earth have varying seasonal changes?
   Different parts of the Earth receive smaller or larger amounts of the Sun's energy (at specific times and over longer periods of time), depending on their location and the time of year. Therefore, the differences result in variations in temperature, amount of precipitation, and other aspects of seasonal change, which then create different ecosystems.

1. How do humans respond to and interact with the Earth's climate?
   Humans interact with Earth's climate by constructing ways to survive and thrive in response to factors in their environment, and by overcoming the barriers posed by their environment. Human activity also contributes to changes in global conditions (such as temperature) over long periods of time, which in turn leads to changes in global climate.

Rationale for the Order of Content

In a more challenging approach, we put students in the hot seat right away. Starting at the grandest scale, learning about the Sun may entail many student misconceptions, which we would like to correct to lay the foundation for future student learning. Knowing the concrete, causal mechanisms of the Sun's contribution to Earth's energy systems creates a scaffold for students to apply this concrete knowledge to future lessons, for example to explain descriptions of seasonal changes and how these changes differ by climate over the geographic landscape. Students explore not only the mechanisms of climate, but also the interactions between Earth's climate and humans.

Anchoring Phenomena

In this unit we use a long-term mystery to create a common thread between all lessons. Throughout the unit, students are given hints about mystery locations (such as Mt. Greylock and the Great Barrier Reef) in order to connect how weather and climate affect different places on Earth.

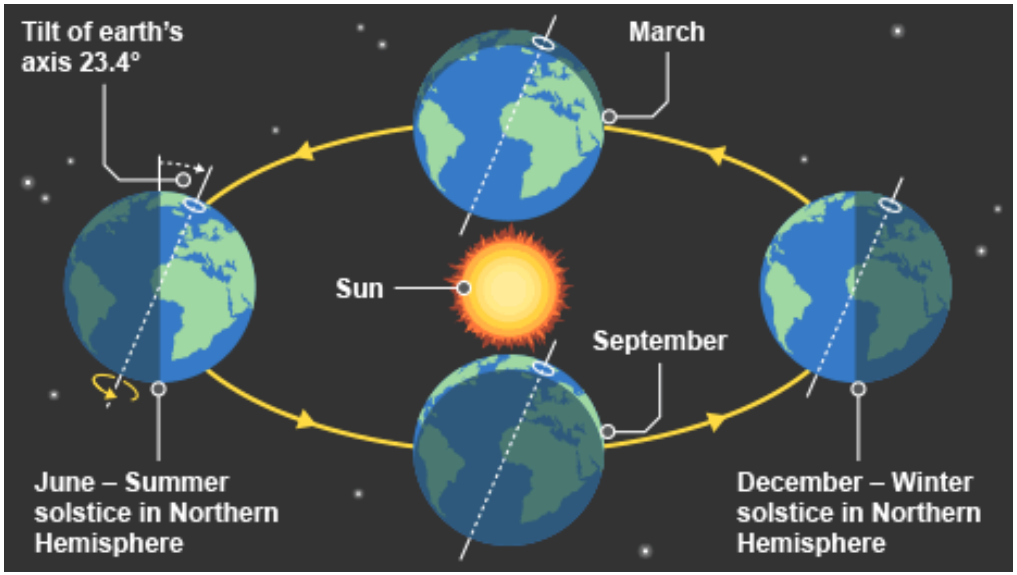
Key Science Ideas

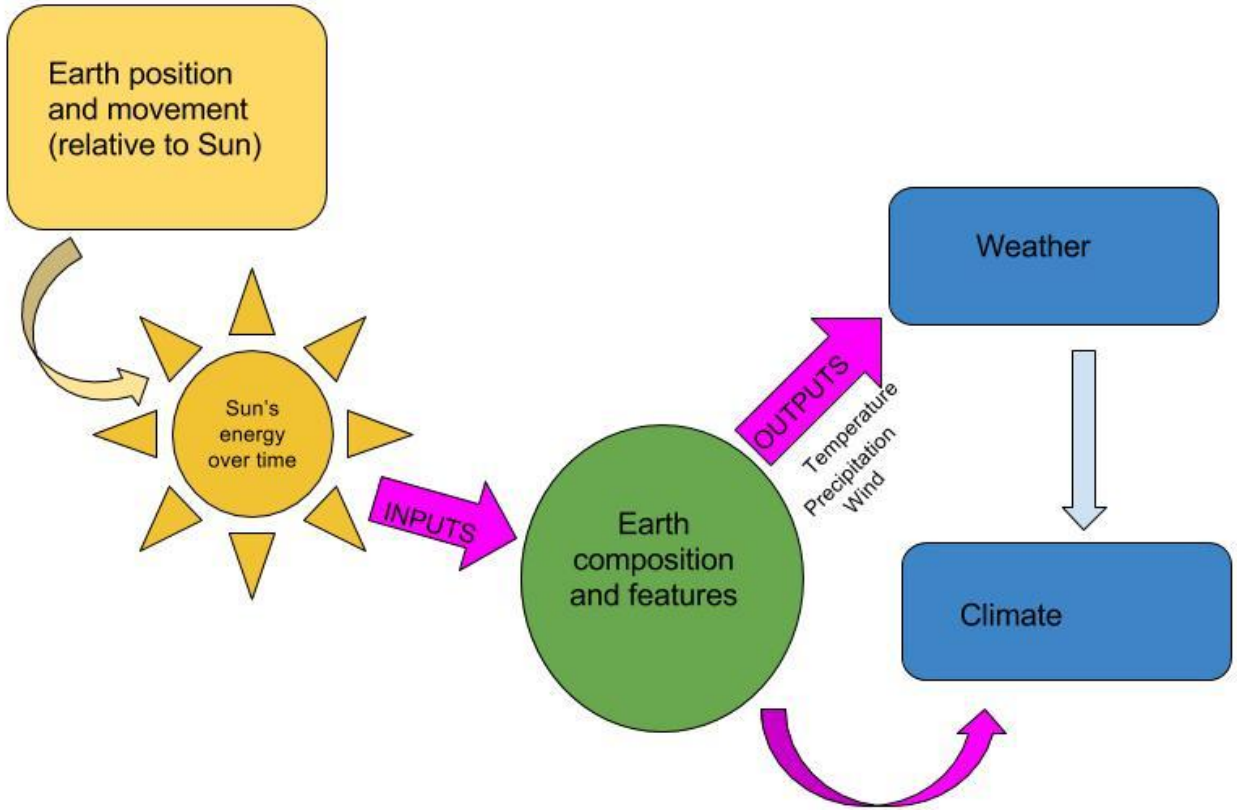
1) The Sun is a driving force in weather and climate
   a) The Earth orbits the Sun, and rotates on a tilted axis → different exposure to sunlight, based on angle and position, impacts the *intensity* with which sunlight hits Earth
      i) This directly affects the weather and climate of a location.
   b) Energy, in the form of sunlight, is exchanged with Earth
   c) It requires less energy to heat up land than to heat up water
   d) The Earth's energy input and output must be balanced
   e) Northern and Southern hemispheres
      i) Opposite seasons
      ii) Land vs. water difference (ratio of land to water is higher in the Northern hemisphere)
2) Weather
   a) Short term experiences that affect day to day life
   b) Seasonal changes in weather patterns
   c) Natural disasters and their effect short term and long term
3) Climate
   a) Long term experiences that affect cultures and lifestyles
   b) Created by weather patterns such as average temperature, rainfall, air pressure and winds
   c) Different climates create different ecosystems
      i) Ex. Tundra (cold), Rainforest (tropical), Deserts (dry), Woodland Forest (temperate)
   d) Humans' impact on climate
      i) Basic ideas behind climate change involving deforestation, our carbon footprint, our trash, and greenhouse gasses

Explanation

The Sun is a major driving force of weather and the climates that exist on Earth. The Earth revolves around the Sun every year on a tilted axis. This provides different degrees of sun exposure to different locations based on the angle and position in in the orbit. The fact that different locations on Earth receive varying intensity of sunlight and length of sunlight over the course of a year gives Earth its many different climates.

The ocean also exerts a major influence on weather and climate because it is easier to heat up land than water. The ocean absorbs and stores large amounts of energy from the Sun and releases it very slowly; in that way, the ocean moderates and stabilizes global climates. The energy balance of Earth (incoming energy from sunlight is equal to the outgoing energy lost to space) is very important because if the energy balance on Earth is not stable, the planet will begin either heating up or cooling down and neither are good for sustaining life on earth.





The Northern and Southern hemispheres also play a role in the movement and balance of Earth's energy, due to the uneven ratio of land to water in both hemispheres. Water absorbs the Sun's energy more slowly than land because, generally, water is lighter colored than the land and because of water's physical properties (especially its specific heat). Lighter colored objects reflect more light than darker colored ones, so therefore darker colored objects absorb more light and also more energy.
The "greenhouse effect" keeps Earth's surface warmer than it would be otherwise. To maintain any average temperature over time, energy inputs from the Sun and from radioactive decay in Earth's interior must be balanced by energy loss due to

radiation from the upper atmosphere. However, greenhouse gases accumulate in the atmosphere and prevent some of the energy from radiating back out into space. This causes a gradual warming of the atmosphere because more energy is being put into the system than is released.

Weather, which varies from day to day and seasonally throughout the year, is the condition of the atmosphere at a given place and time. Climate is longer term and location sensitive; it is the range of a region's weather over one or more years, and, because it depends on latitude and geography, it varies from place to place. Sunlight hits the Earth most directly around the equator. Due to temperature differences caused by differences in the amount of sunlight absorbed, recurring climatic conditions develop, which are characterized by the average temperature and precipitation. In some areas, climate zones can be interrupted by great altitude differences such as a mountain range or oceans. There are four major climate zones: the **tropical** zone, the **subtropics** or **warm** zone, the **temperate** zone, and the **polar** or cold zone. Each zone is characterized by unique amounts of precipitation and temperature range. These conditions, in turn, determine the types of vegetation and wildlife that each climate zone can sustain. Thus, ecosystems are dependent upon climate patterns and zones, because different plants and animals respond better to different climate conditions.

Natural processes can cause sudden or gradual changes to Earth's systems, some of which may adversely affect humans. Through observations and knowledge of historical events, people know where some of these hazards—such as earthquakes, tsunamis, volcanic eruptions, severe weather, floods, and coastal erosion—are likely to occur. Understanding these kinds of hazards helps us prepare for and respond to them.

While humans cannot eliminate natural hazards, they can take steps to reduce their impacts. For example, loss of life and economic costs have been greatly reduced by improving construction, developing warning systems, identifying and avoiding high-risk locations, and increasing community preparedness and response capability.

Humans do have to prepare for their survival on this planet but sometimes that loses sight of making sure the planet survives as well. Humans are a big contributor to the global warming that is happening on Earth right now. Climate change is highly affected by humans. Some examples would be: the effects of greenhouse gases that are mentioned above as well as deforestation, our carbon footprint, and our trash.

Lesson 1: Weather Around the World

Lesson Background

This lesson emphasizes the crucial role that the Sun plays in dictating Earth's weather systems and climate. The amount of sunlight a region receives creates weather and climate characteristics - over short and long-time scales. As the Engagement phase of the 5E model, this lesson raises questions and sparks intrigue for exploring why different places experience different seasons. This lesson is built around dispelling the egocentric misconception for 3rd graders that weather is the same everywhere. **It is important that prior to each lesson the instructors review all internet resources. **

Science Content Background (for instructors)

In this lesson the Earth's relationship to the Sun is explained through the amount of direct and indirect sunlight certain locations on earth are receiving and how this affects them. The Sun shines directly at the equator creating hotter climates and the farther away the location is from the equator determines the variation of their seasons. Day and night are also directly affected by where the Sun is shining. Our time zones approximately follow the Earth's rotation so that each time zone has the Sun shining directly above at noon.

Overview of the Lesson

Students explore current local and global weather data and predict patterns over long periods of time. Students construct preliminary explanations for why different temperature patterns emerge in different regions. Lastly, students initially explore the Sun's relationship to the Earth via the use of a globe and light.

Focus and Spiral Standard

3-ESS2-1. Use graphs and tables of local weather data to describe and predict typical weather during a particular season in an area. {**Clarification statements:** Examples of weather data could include temperature, amount and type of precipitation (e.g., rain, snow), wind direction, and wind speed. Graphical displays should focus on pictographs and bar graphs.}

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
- Asking questions and defining problems - Analyzing and interpreting data - Obtaining, evaluating, and communicating information	**ESS2.D: Weather and Climate** Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next (3-ESS2-1) Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years (3-ESS2-2)	**Patterns:** Patterns of change can be used to make predictions (3-ESS2-1), (3-ESS2-2)

Learning Targets

1. I can identify ways to obtain local and global weather data.
2. I can explain that the sun plays an important role on day vs. night, weather, and seasons.

Assessment

Students will be tested on their ability to make predictions about the amount of Sun exposure in different places, from the information they receive during the globe activity.

Targeted Academic Language

Tier 1: Thermometer
Tier 2: Temperature, Fahrenheit
Tier 3: Equator, Circumference

RESOURCES AND MATERIALS

Quantity	Item	Source
1 per student	Science Journal	Classroom teacher
6 per class	**Thermometers (for outside use)**	**Bin**
	http://www.earthcam.com/network/ https://www.timeanddate.com/worldclock/personal.html	CMC Website
5 per class	**Tilted Globes (or as many as possible so each student can have hands on time with the globe)**	**Bin**
5 per class	**Flashlights (or the same amount as globes)**	**Bin**
1 per student	The Long-Term Location Mystery Booklet of Clues (13 pages total)	Binder
1 per class	Globe	Classroom Teacher

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening / Activator

Lead a discussion about the weather today: Is it hot? Is it cloudy? What do we think the temperature is today? Would you rather wear a bathing suit or a winter coat right now? Introduce the topic that this lesson will be about and pass out science journals.

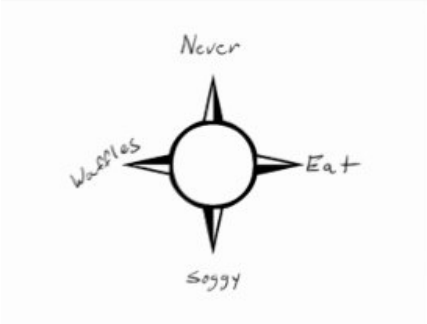
During the Lesson

1. Using a Thermometer

A. Before going outside, demonstrate how students should safely use and read a thermometer. These are tools, not toys. Have students watch the thermometer song video to review how thermometers work.
https://www.youtube.com/watch?v=Vk6rP_4wpvk
B. Once outside, pass out the thermometers in small groups and ask students to measure and record the temperature in their science journals.
C. Gather the class to share temperature results and discuss why it is this temperature. What month is it? What season is it? Does it look like this everywhere in the world, and why? Have students record all ideas in journals. (Depending on current weather conditions, conduct discussion outside or back inside classroom).

2. Learn the Continents

A. Students can use dry erase markers on the Globe and label the Equator and the cardinal directions: North, South, East and West.

i. 

ii.

B. Students get in small groups and play "I spy" a country in the North or another direction to have the kids get a sense of the countries.

3. **What Is It Like Across America?**
   A. Ask the class, "What do you think it looks like in California right now?" Visit http://www.earthcam.com/network/ and project live stream of the location (**visit the site before class to make sure the cameras are operational**).
   B. Allow students to make observations based on real-time footage and ask: What season does it look like? Why does it look different or similar to what we see outside our window? Why is the temperature different?

Teaching Tip

Think-Pair-Share is a common strategy where you first give students time to think on their own, before talking with a partner/peer about their ideas. You then have the pairs share out to the class.

4. **Tell the future**
   A. After conveying that different people experience weather differently, transition to predictions and ask: What will the weather be like here, in North Adams, in 4 months? What will the weather be like in California in 4 months?
   B. Have students draw predictions in science journals. Think-Pair-Share with a partner and then discuss with the class. Correct any misconceptions on the board.

5. **How The Sun Hits Earth**
   A. Bring out globes and flashlights and split up into same groups as before.
   B. Pick three different locations, preferably ones that are on opposite sides of the globe, to best display day and night (ex. North Adams and Hong Kong) and one close and far from the equator (ex. North Adams and Puerto Rico) to spark discussion about sun exposure and its effect on average temperature. To emphasize that different locations receive different sun exposure (and the impact that has), project a world clock that shows different time zones (https://www.timeanddate.com/worldclock/personal.html)

Student Thinking Alert

Common student misconception: We have the same seasons and weather as everywhere else. Instruct the students to use clues and critical thinking from the previous activity to correct those misconceptions.

C. First, have students predict how they think the Sun shines on Earth (from above, below, the side) and ask them to explain why they think they are right. Explain that there is a great size difference between the Earth and the Sun. They are welcome to explore these ideas with their materials. 
(Science Talk: Try using sentence starters to explain predictions in full sentences)

Teaching Tip
Important details to note here are the concentration of direct versus indirect light from "the Sun" on different areas of the globe

D. Lead students toward the right answer that the sun shines directly on the equator (ask the students if they know what and where the equator is, and if they are unsure, point out and explain how it runs around the circumference). Have students shine their flashlight directly at the equator.
E. Have the students locate on the globe all three of your chosen locations (maybe put stickers or some marker on the locations so that it's easier for kids to find)
F. Start a discussion about day and night between your first two locations. Have the students explore what day and night looks like from each location and record in science journal.
G. Start a discussion about Sun exposure on different parts of the planet. Have students again explore why the first and third locations have different average temperatures, by using their flashlight and globe. Record any thoughts and ideas in science journals.

Assessment

Revisit the website http://www.earthcam.com/network/ and bring up all three locations used in globe activity, or as close as you can get, and ask the students to list them in order of what they thinks gets the most sunlight year round to which gets the least using the concepts we explored today in their science journals and encourage them to change their answers later on if they discover or learn something that changes their thoughts.

Lesson Closing

Write on the board "Long-Term Location Mystery" -- explain that throughout this unit the class will receive a clue after each lesson about two mystery locations. Hand out the Booklet of Clues and explain that each new clue will be recorded. By the end of the unit, we'll solve the mystery! (Location A: Mt. Greylock and Location B: Great Barrier Reef). Then give them the temperature at that time of both locations as their first hint.

Teaching Tip

In the answer to this assessment, it's not important that students get the answer completely right. It is important that they know Puerto Rico receives the most sunlight (the distances from the equator to Hong Kong and North Adams are not sufficiently different to be accurately compared). They should be encouraged to check back and see if their new knowledge can help them better complete this activity or revise their previous answers (hint: latitude coordinates would be helpful).

Lesson 2: The Earth and the Sun ~ An Essential Friendship

Lesson Background

This lesson focuses on the relationship between the Earth and the Sun, highlighting the spatial and physical movement of each body in relation to each other. Core activities include demonstrating relationships with a globe and flood light, and having students construct a model of the movement with their bodies.

Science Content Background (for instructors)

Since the Sun is the driving force in producing different weather and climates on earth (which will be covered over the course of the unit), it is important to initially understand how the Earth and Sun move in relation to each other in order to then understand *why* different parts of the Earth experience different seasonal changes. The main content covered in this lesson explains that the Earth simultaneously orbits around the Sun and rotates around a tilted axis. Content is further developed by introducing the different hemispheres. The Northern and Southern hemisphere experience "opposite" seasons because of their orientation in relation to the Sun (i.e. when the Northern hemisphere receives most direct sun exposure, the Southern hemisphere experiences relatively indirect exposure). Exposure to the Sun determined by these components dictates different weather and climates.

Overview of the Lesson

In this lesson, students will explore different models of the Sun and Earth. Students seek to understand spatial and movement features of the Sun and Earth through experimenting with a globe and a flashlight, and with their own bodies in space. Exploration is contextualized by reinforcing the importance of the Sun - and its spatial relationship to the Earth over time – in creating different weather and climate for different regions on Earth.

Focus and Spiral Standard

5-ESS1-2. Use a model to communicate Earth's relationship to the Sun, Moon, and other stars that explain (a) why people on Earth experience day and night, (b) patterns in daily changes in length and direction of shadows over a day, and (c) changes in the apparent position of the Sun, Moon, and stars at different times during a day, over a month, and over a year.

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
- Asking questions and defining problems - Developing and using models - Obtaining, evaluating, and communicating information	**ESS1.B: Earth and the Solar System** The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	**Cause and Effect:** Cause and effect relationships are routinely identified, tested, and used to explain change (3-ESS3-1)

Learning Targets

1. I can describe how the **earth moves in relationship to the sun.**
2. I can use different models to show why **different places on the earth are impacted differently by the sun.**

Assessment

Engagement in constructing models with teams, participating in group and class discussions, exit ticket and science journal responses.

Targeted Academic Language

Tier 1:

Tier 2: Rotation, Tilt

Tier 3: Orbit, Axis, Equator, Hemisphere

RESOURCES AND MATERIALS

Quantity	Item	Source
1 per student	Science Journal	Classroom teacher
	https://www.youtube.com/watch?v=4rMYrP8feJY	CMC Website
5 per class	**Globe**	**Classroom Teacher/Bin**
5 per class	**Flashlight**	**Bin**
1 per student	**Sunglasses**	**Bin**
1 per student	Exit Worksheet	Binder
5 per class	Play Dough	Bin

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

1. Project the time lapse video of Alaska where the sun never fully sets during the summer (https://www.youtube.com/watch?v=4rMYrP8feJY).
2. Ask the students what they see, where they think this is, and what time of day they think it is. Once some observations and inferences have been shared, tell students that the time lapse was taken in Alaska throughout a 24-hr period! This should spark new questions and some confusion, but let students hold onto that intrigue (don't have to give clear explanations yet). Why hasn't the sun set by midnight?

3. Emphasize that the time lapse depicts a phenomenon that is very different from how our sky looks over the course of a day.

Distribute sunglasses (one per student) and have them wear (if they want) while starting a discussion. Ask, "Why do we wear sunglasses? Do people all across the globe wear sunglasses?" If not directly stated by students, emphasize the points that people everywhere in the world see the Sun, but see it differently, and relate back to picture of Alaska. [SP1: Asking Questions and Defining Problems]

During the Lesson

1. **Globe/flashlight demonstration** [SP2: Developing and Using Models]
   A. Break students up into groups of 3-4 and give each group a globe and a flashlight. Have groups experiment with the tools to demonstrate how they think the Sun might shine on the Earth. Prompt with questions such as, "How far away do you think the sun is from the Earth? What is the sun's position in relation to the Earth?"

Teaching Tip
If possible, acquire at least 5 tilted globes (borrow from other classrooms just for this lesson!) so each small group of students can have hands-on time with a model.

   B. Transition into discussion as the students start to construct a model of how the Sun and Earth *move* in relation to each other. Find California on the globe (or mark it with a sticker) and ask students to recall their 4-month predictions for that location from the previous lesson. Ask, "How do you think the Earth's position in relation to the Sun changes in those 4 months?" to reflect their predictions in changing weather. Call the class' attention back together and have one group demonstrate the movement model they constructed and provide an explanation for *why* they think the Sun and Earth move such in such a manner.

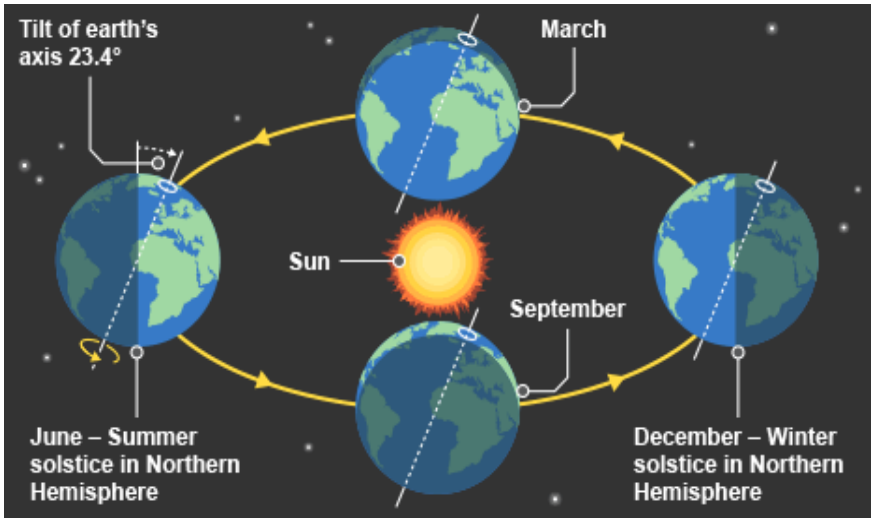
C. After validating (but not correcting) students' models, demonstrate the accurate model for the whole class (can still use two students to act as Sun and Earth). Emphasize that the Earth orbits around the Sun, as well as rotates on a tilted axis (depicted by globe). Explain that a geocentric understanding (Earth-centered solar system) is a historical misconception, but we now understand that the solar system is heliocentric (Sun-centered). Explain that Earth's axis of rotation (line from pole to pole) is tilted at a 23° angle. Transition into semi-kinesthetic model by having one student fixed in the center of a circle holding the flashlight as the Sun, and a circle of students surrounding the sun passing the globe around to represent the orbit. *Make sure the tilt stays oriented at a fixed point in the room.

Student Thinking Alert
A common misconception can manifest during this model: students might think the Sun moves around the Earth. Let students construct (potentially) inaccurate models at first.

Student Thinking Alert
Address a common misconception - that a place is warmer when it gets closer to the Sun. The Sun's impact is not dictated by Earth's distance, but instead by intensity or density of exposure to sunlight (either more or less direct). Furthermore, the tilt of the axis does not change the total amount of sunlight that the Earth receives. Instead, the tilt of the axis changes when and where sunlight hits.

2. **Kinesthetic model** [SP2: Developing and using models]
   A. Have students return to their groups and designate one student as the Sun (depending on class needs, teachers can assign roles or have students self-designate), and another as the Earth. Students can take turns acting out different roles.

B. Ask the Earth student to move according to the model that was just demonstrated with the globe. Classroom Teacher or Science Fellows can walk around and prompt students to include important elements if they forget at first - orbit, rotation, and tilt. [SP2: Developing and Using Models]



Include a quick debrief of the models - can either facilitate as a discussion, think-pair share, or written reflection in science journals. Ask students to think about what these models demonstrate or show. What did they leave out?

Science fellows should show the following video before moving on to the next activity: https://www.youtube.com/watch?v=l64YwNl1wr0 (stop at 2:28)

3. Northern/Southern hemispheres:

A. As students investigate movement with their own bodies, introduce the concept of the two hemispheres. Ask students to recall what they learned about the equator from the previous lesson and have someone point it out on a globe.

B. Make the connection between the equator line on the globe and their belly buttons as the middle line on their bodies in their kinesthetic model.

C. Ask them to discuss in their groups what is different about regions above and below the equator - prompt them to make observations from the globe (how much land or water on either side), and the model they have just constructed (how does each side differ in sun exposure?)

D. Ask for some groups to share observations and write them on the board, and transition to a brief class discussion. Introduce the vocabulary of *Northern* and *Southern hemispheres,* and reinforce the observations written on the board. If observations are not made by students, explicitly include:

- There is a larger amount of land in the Northern hemisphere, and a larger amount of water in the Southern hemisphere
- When the Northern hemisphere receives *direct* exposure to sunlight, the Southern receives *indirect* exposure.

Extension Activity: Students use playdough to model the position of the sun and earth(northern hemisphere) during the Spring, Summer, Winter, and Fall solstice.

Exit Exercise [SP6: Constructing Explanations and designing solutions]

Project two images or live streams of locations of roughly the same longitude in the Northern and Southern hemispheres: North Adams and Santiago, Chile. Ask students to share preliminary observations of the images, hinting at why seasons can be seemingly "opposite" between the hemispheres? Hand out the worksheet and ask them to fill out the information. Depending on the level of the class, the worksheet can be completed individually, in pairs, or larger groups.

Lesson Closing:

Long-term mystery:

Give the next clue: Location A is experiencing season [x] right now. Location B is experiencing season [y] right now.

- September-November: Location A is experiencing fall right now. Location B is experiencing spring right now.
- December-February: Location A is experiencing winter right now. Location B is experiencing summer right now.
- March-June: Location A is experiencing spring right now. Location B is experiencing fall right now.

Assessment

Engagement in constructing models with teams, participating in group and class discussions, exit ticket and science journal responses.

Teaching Tip

Teachers and Science Fellows should prep for the next lesson by making the solar ovens (2-3 large boxes will be needed depending on the size of the class). Refer to this website for directions: https://climatekids.nasa.gov/smores/

Lesson 3: Energy ~ Teamwork Makes the Dream Work

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

Lesson Background

In the previous lesson, students learned about the Sun and Earth's positional relationship. In this lesson, we explore how the mechanisms and processes of energy exchange shape weather and climate.

Science Content Background (for instructors)

The core ideas include Sun's energy as a source of light and heat, heat absorption in land vs. water, and balanced energy exchange between the Earth and space. The Earth is at a life sustaining temperature because there is an approximately equal input of energy as there is an output. If the input of energy were greater than the output, the Earth would become hotter. Likewise, if the output were greater, the Earth would become cooler. The input of energy is in the form of sunlight absorbed by the Earth. The output is the energy the Earth reflects or emits into space.

Overview of the Lesson

In this lesson, students define energy, which scaffolds their understanding of how the Sun affects the weather and climate on Earth. Students will learn important ideas and concepts through classroom experiments, hands on activities and short discussions. **It is recommended that the instructors watch the YouTube videos prior to the lesson.**

Focus and Spiral Standard

4-PS3-1. Make observations to show that energy can be transferred from place to place by sound, light, heat and electric currents. {Clarification Statements: Evidence of energy being transferred can include vibrations felt a small distance from a source, a solar-powered toy that moves when placed in direct light, warming a metal object on one end and observing the other end getting warm, and a wire carrying electric energy from a battery to light a bulb.}

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
- Asking questions and defining problems - Developing and using models - Obtaining, evaluating, and communicating information - Analyzing and interpreting data	**PS3.A: Definitions of Energy** Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2), (4-PS3-3)	**Cause and Effect:** Cause and effect relationships are routinely identified, tested, and used to explain change (3-ESS3-1)

Learning Targets

1. I can describe the concept of energy, as it relates to heat and light.
2. I can explain the importance of energy exchange between the Earth and the Sun.

Assessment

Check on the Sun s'mores and hand them out to students to eat at the end of class. Review the students' science journals and check to make sure they were writing down the facts and making their observations and predictions about the experiments.

Targeted Academic Language

Tier 1: energy
Tier 2: absorb, exchange, balanced

RESOURCES AND MATERIALS

Quantity	Item	Source
2	**Floodlight**	**Bin**
1	**Stick Thermometer**	**Bin**
2 per group	Plastic Cups (any size)	Bin
1	Bag of potting soil	Bin

	Land and Water Crash Course https://www.youtube.com/watch?v=7vTfyAMu6G4	CMC Website
	Here Comes The Sun Crash Course https://www.youtube.com/watch?v=6FB0rDsR_rc&t=121s	CMC Website
2-3	Large Cardboard box	Bin
1	Roll of Aluminum Foil	Bin
1	Bag of Medium Sized Marshmallows	Bin
1	Box of Graham Cracker	Bin
20 Bars	Hershey's Chocolate	Bin
1 per student	**Sunglasses**	**Bin**
1 box	Black Permanent Markers	Classroom Teacher
1 per student	Science Journals	Classroom Teacher

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening / Activator

Ask the students what differences they notice between night and day. If their answers consist of "it's darker at night" and "at night I go to bed," give them a directing question such as, "What do you notice about the temperature?" Explain that the Sun is our source of heat. As our location on Earth rotates away from the Sun, there is less direct sunlight available at our location on Earth, causing colder temperatures. Hand out (paper) sunglasses. Plug in the floodlights and explain that the lamp is like our Sun. It releases energy in the form of light and heat. Discuss common misconceptions of what energy is (i.e. energy is when kids feel energetic or the energy that comes from an outlet). Quickly play this video to help show the difference (https://www.youtube.com/watch?v=6FB0rDsR_rc&t=121s). Ask a couple of students to volunteer to come up to the floodlights and place their hand in front of the light (but not too close, as the bulb gets hot). Ask them if they can feel energy in the form of heat radiating from the light.

During the Lesson

1. Sunsmores

A. Introduce the experiment as a way we can harness the Sun's energy to make s'mores without a fire! **The solar cooker should be made prior to the lesson. Follow the directions from this link (https://climatekids.nasa.gov/smores/)**

2. Land Vs. Water Activity

A. Ask students what they think absorbs more energy in the form of heat, land or water. (A very common example of heat absorption is when black car seats get really hot in direct sunlight).
B. Tell them they will be doing an experiment to show which absorbs more heat and that they should write down their predictions in their science journals. If time allows, ask if any students would like to share their predictions. Alternative: If it is raining or there is no window with direct sunlight, use the floodlights instead. [SP4: Analyzing and interpreting data]
C. In groups of 3-4, distribute two plastic cups for each group. One cup should be filled half way with water and the other one with soil, which either the Classroom Teacher or Science Fellow(s) will be walking around with to fill the group's cup.
D. Remind students that they should mark their cups with their initials or a symbol, such as a star, so they know which cups theirs are.
E. Have the students take the initial temperature of the soil and the water in their science journals. If the students do not know how to use a thermometer, give a quick explanation of how the measurements work.
F. Once the cups are filled and marked, have each group place them on the windowsill where they will get the greatest amount of sunlight.
G. Have the students come back to measure the temperature of the soil and water every 20 minutes or so. Ask them to record the temperature each time in their science journals.

3. YouTube Video

A. Once the cups have been placed on the windowsill, play this youtube video to give them some context: https://www.youtube.com/watch?v=7vTfyAMu6G4&t=73s

4. **Energy Exchange Skit** [SP2: Developing and Using Models]
   <u>The students will represent the Earth, energy emitted by Earth to space, the Sun, and the Sun's energy absorbed by Earth.</u>
   A. Split the class in half and assign one half to Sun and the other half to the Earth. Give the students identification cards to help.
   B. Request that 3 students from the Sun group move to the other and that 3 students from the Earth group move to a new, neutral, third group (representing space). Ask the students what is represented when these students move from their location to the other (transfer of energy). Repeat this action as many times as needed for comprehension. Students can dictate the activity if they understand.
   C. Explain that this action <u>represents the equal energy exchange of the Earth</u>**.** A certain amount of energy reaches us from the Sun, and the Earth releases an equal amount of energy into space. Equal exchange allows our Earth to stay at a stable temperature.
   D. (Talk science: try using sentence starters and modeling science talk; have students answer in full sentences.) Ask the students "what if?" questions. What if the energy exchange wasn't equal? What if we were absorbing more energy from the Sun than the Earth was emitting into space?

Teaching Tip

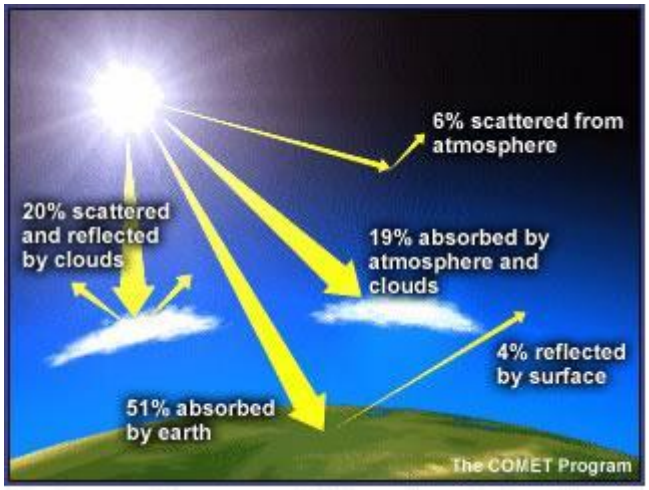
Useful metaphor: unequal energy exchange is similar to an oven. To heat up an oven, the energy input must be larger than the energy output, so that the net energy or heat within the oven is higher than the outside. Therefore, if the Earth were to absorb more energy than it released, it would heat up, just like an oven.

Extension

If the class is more advanced in their understanding of energy, add in clouds as a factor. Have the kids bounce back if they bump into the desks when they move from the Sun group as if the desks were the clouds. Also have some of the kids from the Earth group sit down to show they have been absorbed by the ground. Refer to the image for more options and additional information.

Lesson Closing

Review results of the soil and water experiment to check if initial predictions were correct. Recall from the previous lesson that the Northern hemisphere has more water than the Southern hemisphere, thus is warmer on average because land/soil is "easier" to heat up (requires less energy). Project an air temperature loop (http://climvis.org/anim/maps/global/tmp2m.html) and ask for observations. Do certain areas stay hot throughout most of the year? If so, what part of the world (use terms like Northern and Southern hemisphere)?



Give the next clue about the two long term mystery locations. Ask the students, "With this knowledge about Location A and B, which do you think is warmer?"

Location A (Mt. Greylock): Is 1.875 sq. miles of land
Location B (Great Barrier Reef): Is 132,974 sq. miles of water
If any student wants to make a guess to any of the locations, ask them to come up to you privately.

Assessment

Check on the sun s'mores and hand them out to the students to eat at the end of class. Review the students' science journals and check to make sure they were writing down important ideas, and making observations and predictions about the experiments.

Lesson 4: Understanding Collection of Weather Data

Lesson Background

This lesson focuses on the collection of weather data by the use of graphs, maps, and other tools so students can effectively use such tools for future activities.

Science Content Background (for instructors)

Through the record of weather patterns across long time periods of time we are able to create predictions and monitor our climate. Graphs are one way to collect and record these patterns in a visual display. Line graphs like the one used in this lesson are good at showing patterns over time and they are easy to read because you gather the information the same way you would read a book: from left to right. Maps are also a useful tool for gathering weather data. The maps used in this lesson are all color coded to represent different weather patterns such as temperature, wind, and precipitation. All of these tools help us better understand weather prediction and climate in different locations.

Overview of the Lesson

Students explore weather data collection tools and techniques to provide further evidence that weather differs over varying locations. Students will be exposed to graphs as a means of "seeing" data and draw conclusions about regional weather patterns. Students research individual areas of interest and collect data from online sources to describe conditions of that area.

Focus and Spiral Standard

3-ESS2-1. Use graphs and tables of local weather data to describe and predict typical weather during a particular season in an area. [**Clarification Statements**: Examples of weather data could include temperature, amount and type of precipitation (e.g., rain, snow), wind direction, and wind speed. Graphical displays should focus on pictographs and bar graphs.

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
- Planning and carrying out investigations - Analyzing and interpreting data - Obtaining, evaluating, and communicating information	**ESS2.D: Weather and Climate** Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next (3-ESS2-1) Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years (3-ESS2-2)	**Patterns:** Patterns of change can be used to make predictions (3-ESS2-1), (3-ESS2-2)

Learning Targets

1. I can explain that graphs are tools to communicate information visually.
2. I can use graphs to make predictions and assumptions about weather data in a given area.
3. I can research and record weather data about a particular area of interest.

Targeted Academic Language

Tier 1: data, graphs
Tier 2: temperature, precipitation

RESOURCES AND MATERIALS

Quantity	Item	Source
	Climate Kids "What do all these graphs mean?" webpage [https://climatekids.nasa.gov/graphs/]	CMC Website
As needed per classroom	Chart paper	Classroom Teacher

As needed per classroom	Markers	Classroom Teacher
	Graphical map images	CMC Website
1 per group	**Laminated United States Map**	**Bin**
1 per student	Computer or iPad	Classroom Teacher
1 per student	"Weather Observers" Worksheet	Binder
1 per student	Science Journals	Classroom Teacher
1 per classroom	Mini Cactus	Contact Sue Beauchamp

**** Items in bold should be returned for use next year ****

LESSON DETAILS

Lesson Opening / Activator

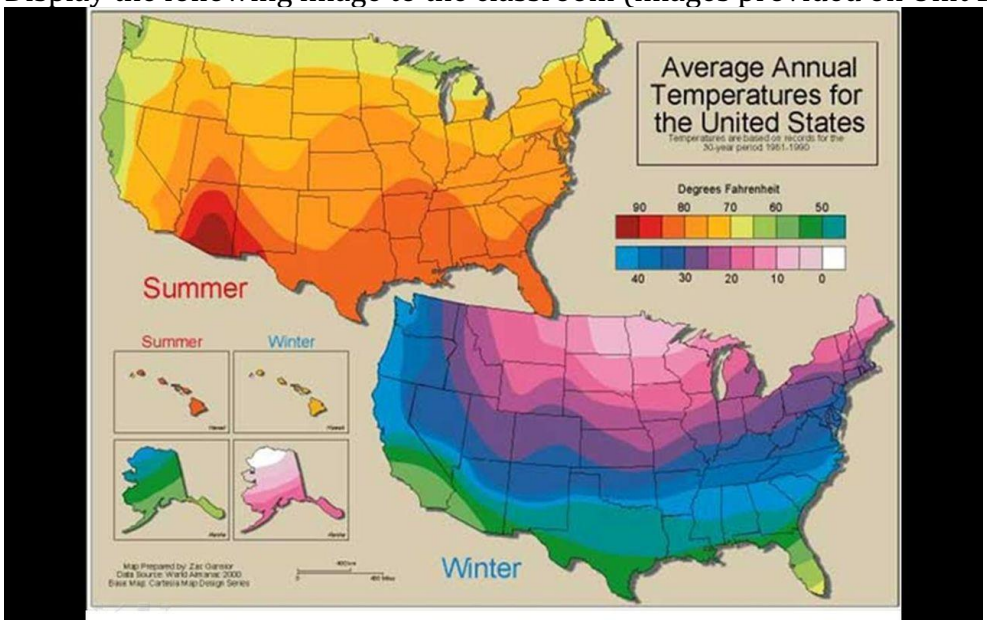
Engage students' prior knowledge about graphs -- what have they seen before, what do they know about graphs? Explore ClimateKid's "What do all these graphs mean?" webpage [https://climatekids.nasa.gov/graphs/]. Explain that graphs are one way of describing weather data. How do you think this weather data was collected? While graphs are a way of visually representing data, we need other tools to gather data, that allow us to understand data and predict typical weather patterns.

Thinking about aspects of *weather*, brainstorm a list of what might be important to measure to make conclusions and predictions about the weather of a region (Examples should include *temperature, precipitation, wind direction and speed*). Record answers on the board or chart paper.

During the Lesson

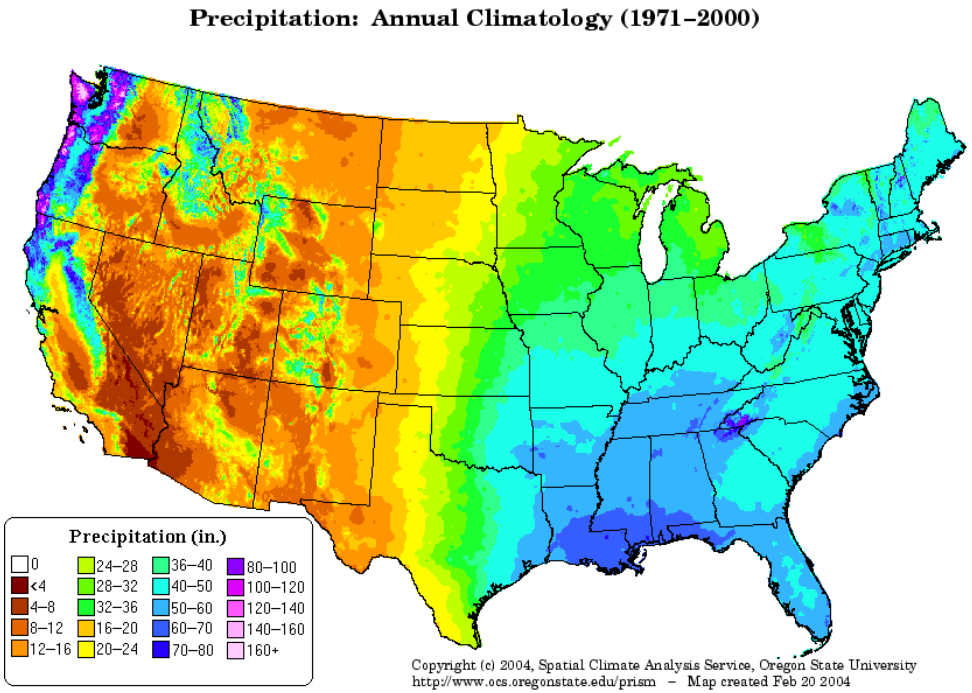
1. **Observing Weather Graphs** [SP4: Analyzing and interpreting data]
   One of the most important types of weather data is temperature.

A. Refresh students on the use of thermometers to measure temperature, which they have explored in previous lessons. Temperature change happens over the course of the day, the month, and the year.
B. Display the following image to the classroom (images provided on Unit Drive):



C. Discuss major aspects of the graph, including title and legend to make sense of the image. Ask the students why the states of Alaska and Hawaii are represented in boxes to the side.
D. Ask about patterns that students notice in the graph, including how the temperature shows a gradient from North to South. What causes this? What does that mean for different regions on the map? Show the class the GIF of temperature changes (located on the Unit CMC Website) over the globe. What other observations can we make now?

Display the following image to the classroom (images provided on Unit CMC Website):

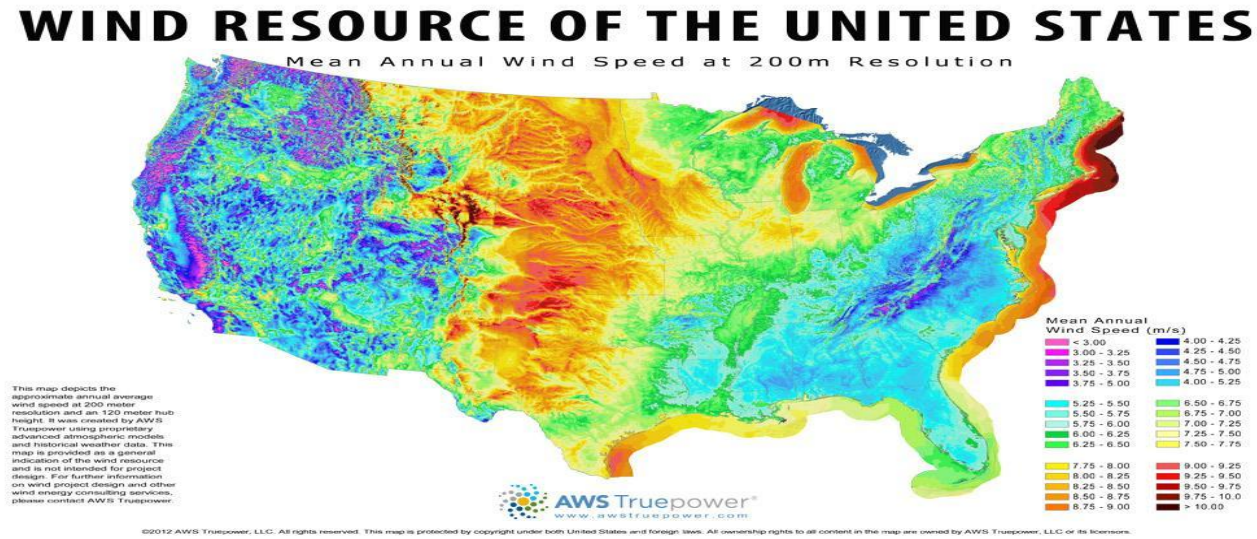


E. Discuss the major aspects of this graph, including title and the legend to make sense of the image.

F. (Talk Science: whole class discussion of questions). Ask students what they notice about the graph, including similarities and differences from the previous image. What is the map lacking? Ask what the students know about the areas that get the highest amount of precipitation versus the lowest amounts. What are other observations that students can make? Show the class the GIF of precipitation levels (located on the Unit CMC Website) over the globe. What other observations can we make now?

Wind direction and wind speeds are also important to describe weather patterns. What do students know about wind? What are the potential damaging effects. How do we use wind power? Students may be able to speak about the wind turbines located in the North Adams area. Display the following image to the classroom (images provided on Unit CMC Website):

G. Lead a similar conversation as the last two images. What are points of interest, what do students notice, what are student questions? Notice that the wind speed is recorded not only over land but over the water as well. What is the impact of this?



2. Becoming Weather

Observers [SP3: Planning and carrying out investigations]

A. Sort students into 5 different groups; each group will be assigned to one city (Houston, TX; Chicago, IL; San Francisco, CA; Orlando, FL; New York, NY).
B. Students will predict weather conditions in each area, then research the weather conditions for summer and winter in each area.
C. Have students record the data they find on the worksheet provided, and save this in their science journal. At teacher's discretion, assign each student a particular type of weather data to research, to ensure student participation and accountability.
D. The Science Fellows or Classroom Teacher can provide a demonstration of how to research a particular city, using North Adams, MA as the example location. A great website to use for this research is http://www.wunderground.com -- use the "History" tab after searching your city to discover weather conditions for a specific date. For the purpose of this lesson, use June 21 of previous year for summer dates and December 21 of previous year for winter dates.
E. Share-out the information for each location.

3. **Why?**
   A. Lead a short discussion on why weather data collection matters. Why do we care? What does it do for us?
   B. Tell students that exploring weather patterns allows scientists to predict future weather. Why might it be important to know about future weather? We use future predictions to plan vacations and other outdoor activities, and to prepare for large storms - a concept to be explored in more detail later in the unit.

Furthermore, collection of weather data is important for understanding climate conditions, as climate is defined by weather patterns that exist in an area over prolonged periods of time.

Lesson Closing

Open discussion about the mystery locations -- what do they already know about Mystery Locations A and B? Provide weather statistics during summer and winter dates about the mystery locations.

Mystery Location A (Mt. Greylock):
Average Temperature for June 21, 2016: 67°F
Average Temperature for December 21, 2016: 24°F
Precipitation Level for June 21, 2016: 0.27 in
Precipitation Level for December 21, 2016: 0.00 in
Wind Speed for June 21, 2016: 5 MPH
Wind Speed for December 21, 2016: 3 MPH

Mystery Location B (Great Barrier Reef):
Average Temperature for June 21, 2016: 61°F
Average Temperature for December 21, 2016: 78°F
Precipitation Level for June 21, 2016: 0.00 in
Precipitation Level for December 21, 2016: 0.00 in
Wind Speed for June 21, 2016: 6 MPH
Wind Speed for December 21, 2016: 6 MPH

Discuss any important observations made, any predictions that are refuted or confirmed by this data, or any other student questions.

Teaching Tip
Set up mini cactus for Lesson 5 after lesson 4 is complete. Students should be monitoring these plants and watering as they see fit, but no formal explanation is required at this point.

Assessment

Review students' science journals and "Weather Observers" worksheet.

Lesson 5: Ecosystems and Climates

Lesson Background

Lesson 5 will be split into two class periods due to time constraints. The first part introduces the concept of climate by extending the knowledge from the previous lesson about weather and data collection to how we define climates: by collecting data about weather patterns in specific areas over long periods of time. The second part has students investigating ways that different plants and animals respond to specific climate conditions, after which students will understand how global and local climate conditions create and sustain certain ecosystems.

Science Content Background (for instructors)

Climate is defined by patterns of weather in specific areas over long periods of time. Weather is the momentary state of conditions at a specific time and place. Sunlight hits the Earth most directly around the equator. Due to temperature differences caused by differences in the amount of sunlight absorbed, recurring climatic conditions develop, which are characterized by the average temperature and precipitation. In some areas, climate zones can be interrupted by great altitude differences such as a mountain range or oceans. There are four major climate zones: the tropical zone, the subtropics or warm zone, the temperate zone, and the polar or cold zone. Each zone is characterized by unique amounts of precipitation and temperature range. These conditions, in turn, determine the types of vegetation and wildlife that each climate zone can sustain. Thus, ecosystems are dependent upon climate conditions, because different plants and animals respond better to different climate conditions. More details can be found here: https://content.meteoblue.com/en/meteoscool/general-climate-zones .

Overview of the Lesson

Part 1: The first activity differentiates weather from climate through a video and taking notes with a worksheet. Next, students explore various ecosystems through Google Cardboard to get a sense of various climate conditions in well known global ecosystems. They then model ecosystems and consider the various plants and animals that could be sustained in such conditions.

Part 2: In the Google Earth Photo activity, students observe four locations, each in a different climate zone, and consider the climate conditions necessary to sustain that ecosystem. Using this information, students find the same locations on their Climate Zone worksheets and determine which climate zones are located in which latitudes of the Earth. Lastly, students are encouraged to use their knowledge from Lessons 2 and 3 to explain how the Sun and the Earth's position might contribute to the creation of different climate zones.

Focus and Spiral Standard

3-ESS2-2. Obtain and summarize information about the climate of different regions of the world to illustrate that typical weather conditions over a year vary by region. {Clarification statement**:** Examples of information can include climate data (average temperature, average precipitation, average wind speed) or comparative descriptions of seasonal weather for different regions.}

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
-Asking questions and defining problems -Developing and using models -Analyzing and interpreting data -Constructing explanations -Obtaining, evaluating, and communicating information	**ESS2.D: Weather and Climate** Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next (3-ESS2-1) Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years (3-ESS2-2)	**Patterns:** Patterns of change can be used to make predictions (3-ESS2-1), (3-ESS2-2). **Cause and Effect:** Cause and effect relationships are routinely identified, tested, and used to explain change (3-ESS3-1)

Learning Targets

1. I can define climate and differentiate it from weather.
2. I can investigate ways that plants and animals adapt to the climate conditions in their environments.
3. I can explain how global and local climate conditions create and sustain ecosystems.

Assessment

Assess students' science journals, models, worksheets.

Targeted Academic Language

Tier 1: ecosystem
Tier 2: climate, tropical, thrive
Tier 3: temperature, air pressure

RESOURCES AND MATERIALS

Quantity	Item	Source
	Climate and Weather video https://www.youtube.com/watch?v=XirAUvS_29I	CMC Website
1 per student	Climate and Weather Worksheets (3 pages total)	Binder
1 per student	Science Journal	Classroom Teacher
1 per student	Climate Zone Worksheet	Binder
	Instructions for Triorama Model	Binder
1 per student	White paper/Cardstock paper	Bin
For class	Colored pencils, glue, scissors	Classroom Teacher

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening / Activator

The classroom has been taking care of two different plants over the past week. Tell students the plants' names and have them guess which ecosystem each plant likely belongs in (e.g. desert, forest) and describe that environment (e.g. dry, sunny, lots of shade). Talk about the care involved in the two plants that the teacher brought to the classroom (e.g. sunlight, watering). Ask them to write in their science journals why each plant thrives in those ecosystems (how much water do they need, what type of protections do they have)? They can also write down animals that might live in the same environment as each plant. Recall

that last week we looked at weather changes over short periods of time. Over the next two lessons, we will examine how *long* term weather patterns (over years and decades) create conditions that allow ecosystems (such as deserts and forests) to thrive. Why does a rainforest stay a rainforest across seasonal changes?

During the Lesson (Part I)

1. **Climate and Weather Activity**
    A. Have students fill out worksheets as the video plays.
    B. Pause the video at appropriate points to allow students enough time to write down answers. It may be helpful to have students read the questions before the video. https://www.youtube.com/watch?v=XirAUvS_29I

2. **Exploring Ecosystems (Tech integration: Google Cardboard)**
    A. Pose the question, "What is the biggest desert on Earth?" Explain that the answer is actually Antarctica, and the second largest is the Arctic desert. Deserts are defined by the level of precipitation, not the temperature. The third largest desert is the Sahara, which is very hot. We will explore these places with Google Cardboard.
    B. Explore various ecosystems on Google Earth or Google Cardboard. For Google Earth, type in the following locations as they are written in the brackets (): (Antarctica), (Sahara desert) look for photosphere as there is no street view, the Amazon rainforest (Novo Airao), and the African savannah (The Savannah Africa).

3. **Triorama activity** [SP2: Developing and Using Models]
    For Science Fellows: Below is a link to a YouTube tutorial that explains how to create a triorama: https://www.youtube.com/watch?v=vlDrGFBR8yw
    A. Split the class into groups of 4 and tell them that we are making models of different ecosystems.
    B. Each student in the group will model one of four ecosystems: a hot desert (like the Sahara), a tropical rainforest (like the Amazon), a temperate forest (like Hopkins Forest), and tundra (like the Arctic).
    C. Prompt students to think about the plants and animals that would be present in those ecosystems to give them ideas for what to draw.

D. Once student's complete individual ecosystems and fold them into triangular prisms, have them glue together all group member's ecosystems. Instructions for triorama models can be found in the binder.

Lesson Closing (Part I)

Tell students to open up their long-term mystery booklets. Display the images of red spruce and algae included on the CMC Website so that they can sketch it on their sheets. The others can be sketched from prior knowledge, but if not feel free to look them up. Encourage students to find out more about these animals and plants. They can ask or research at home. Location A has red spruce trees and hawks. Location B has algae and turtles.

-- End of Class Period 1 --

During the Lesson (Part II)

1. Google Earth Photos activity
    A. Pick four ecosystems, one in each of the four major climate zones (as shown on the worksheet).
    B. For each ecosystem, start zoomed out on the map, and then click on the photos that are attached to the name of the location. For each ecosystem, have the students write down the location (country and continent) as the title in their science journals and what *climate* conditions (not weather) would help sustain that ecosystem (e.g. it should be warm in general, there should be lots of precipitation).
    C. The following suggestions should be typed into google maps/earth as quoted:
        i. "Greenland, Denmark" (snowy mountains) = arctic climate zone

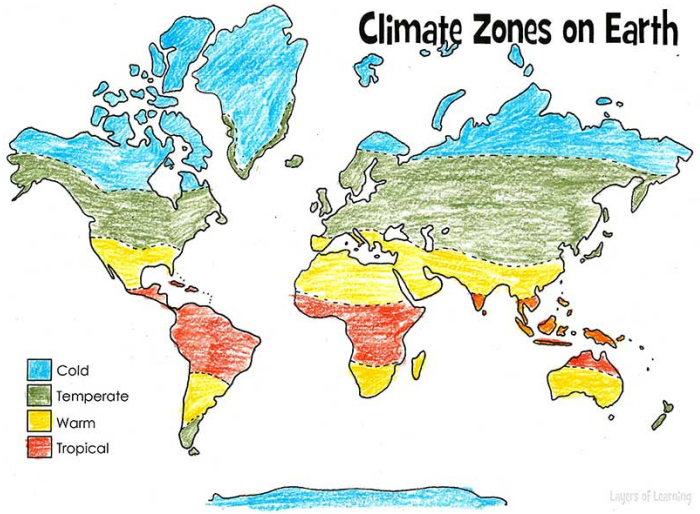
ii. "New England, USA" (pine forest) = temperate climate zone
iii. "Amazon Rainforest, Codajás - State of Amazonas, Brazil" (tropical rainforest) = tropical climate zone
iv. "Sahara desert" (desert) = subtropical climate zone

2. Climate Zone activity
   A. Hand out the Climate Zones worksheet. Project an image of Google Earth (a 3-dimensional representation), and have students identify the equator and draw it in the appropriate location on the worksheet (a 2-dimensional representation).
   B. Then locate the ecosystems we explored on Google Earth (very zoomed out view) on the Climate Zones worksheet map and mark their approximate locations. Students should determine the location of each ecosystem as a class, and mark the answer on their own worksheet. A Science Fellow should walk around and ensure that the ecosystems are within the boundaries of the correct climate zone.

Teaching Tip
Only click on photos that show natural phenomena related to the intended ecosystem, to not confuse students.

   C. Explain that areas around the world with similar long term climate conditions form climate zones. Dotted lines on the sheet mark four major climate zones on Earth. Explain that we will use the information we just gathered to figure out which climate zone is in which region.
   D. First, we need to understand the legend, which indicates four climate zones that we will label. Ask the students to think about New England's climate (North Adams' climate): How many seasons do we have? What are our seasons like? Explain that New England has temperate weather: define "temperate" on the board and have students copy in their science journals or on the back on climate zone worksheet.
      i. Temperate: without extreme climate conditions (temperature and precipitation), generally has four seasons (winter, spring, summer, fall).
   E. Next, ask students to think about the Amazon rainforest: is it ever cold there? The Amazon rainforest is a tropical rainforest, categorized by a tropical climate zone.
      i. Tropical: extreme climate conditions (all twelve months have an average temperature of 64 °F), generally has two seasons (dry and wet).

F. Apply new and prior knowledge about the four ecosystems to color in the four major climate zones.
   i. If students do not understand the distinction between subtropical (warm) and tropical, elaborate that while the tropics are warm and wet, the 'warm' climate zone is characterized by warmth and dryness.



3. Conceptual Extension

A. In groups, discuss the relationship between the Sun and the Earth's position that might cause climate zones.
B. Discussion can be facilitated with questions about the location of the equator, its prolonged exposure to most of the Sun's intensity, etc. For example: a tropical climate zone is defined by warm temperatures all year around, and seasons are only dictated by precipitation (dry and wet). What is it about the location of the tropical climate zone that causes this (focus mainly on the warm temperatures year round)?

Lesson Closing (Part II)

(Talk Science: sentence starters and arguing from evidence)

Before presenting the clue for this week, have students (in groups of 4-5) refer to the clues from previous lessons and predict the climate zones of the mystery locations (clues from Lesson 4 and Part I of Lesson 5 should be helpful). Encourage students to write notes about previous clues in the space provided that might help them figure it out. Once a group has chosen the climate zone for each location, have them write down a rationale as to why they think "Location ___ is in Climate Zone _____." Once the groups have finished, provide them with the accurate climate zones:

Location A is in the *temperate* climate zone, *Location B* is in the *tropical* climate zone.

Student Thinking Alert

Students should connect the information that they learned in Lessons 2 and 3 to what they learned today - locations near the equator receive the most consistent and direct sunlight.

Assessment

In Part I, students will be assessed by their answers to the climate and weather worksheet, the results of the matching game in their science journals, and an evaluation of their triorama models. In Part II, they will be assessed on the Climate Zone worksheet and their participation in discussion.

Lesson 6: Understanding Other Regions

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

Lesson Background

This lesson transitions the unit to Essential Question 2 by synthesizing information from previous lessons. Using their knowledge of climate zones from previous lessons, students now explore the sociocultural implications of different ecosystems and climates. Because students have learned about the scientific processes that drive and connect to Earth's climate, they are pushed to consider how climate ultimately impacts human life, thus encouraging them to think about the bidirectional relationship between humans and the Earth's climate.

Science Content Background (for instructors)

Since this is a transition lesson, all the science content from preceding lessons applies. In addition, Students should understand that humans interact with Earth's climate by constructing ways to survive and thrive in response to factors in their environment and by overcoming the barriers posed by their environment. People of different regions need a variety of tools and clothing to protect themselves from the weather and climate conditions they experience. This also impacts the produce, natural resources, jobs, and industries that the people of a region have available to them.

Overview of the Lesson

In this lesson students refer back to, and integrate information from, previous lessons. They review these concepts through research and role-playing activities and are accountable for the knowledge acquired throughout the unit. Students explore different regions (familiar and unfamiliar) and the lifestyles that revolve around these climates. In small groups, students research different regions, exploring the sociocultural aspects of that specific region as a product of climate. Sociocultural aspects include food, clothing, agriculture, jobs, and any other categories that are critical to human life.
After gathering data about their particular region, students will have the opportunity to present and apply their research in the form of a world marketplace game.

Focus and Spiral Standard

3-ESS2-2. Obtain and summarize information about the climate of different regions of the world to illustrate that typical weather conditions over a year vary by region. {Clarification statement: Examples of information can include climate data (average temperature, average precipitation, average wind speed) or comparative descriptions of seasonal weather for different regions. {{State assessment boundary: An understanding of climate change is not expected in state assessment.}

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
-Asking questions and defining problems -Engaging in an argument from evidence -Constructing explanations -Planning and carrying out investigations -Analyzing and interpreting data -Obtaining, evaluating, and communicating information	**ESS2.D: Weather and Climate** Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next (3-ESS2-1) Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years (3-ESS2-2)	**Cause and Effect:** Cause and effect relationships are routinely identified, tested, and used to explain change (3-ESS3-1) **Influence of Engineering, Technology, and Science on Society and the Natural World:** Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands (3-ESS3-1)

Learning Targets

1. I can explain how weather and climate in different regions shape the lifestyles and cultures of the people that live there.
2. I can collect data to support a claim.
3. I can describe different perspectives and experiences across the globe in relation to the climate's impact.

Assessment

Science Journal worksheets

Targeted Academic Language

Tier 2: culture, lifestyle, ecosystems

Tier 3: agriculture

RESOURCES AND MATERIALS

Quantity	Item	Source
	http://www.earthcam.com/network/	CMC Website
1 per class	Computer projector	Classroom Teacher
10 per group	**Counting chips**	**Bin**
1 per student	Science Journals	Classroom Teacher
1 per student	World Market Merchant Worksheet (2 pages total)	Binder
1 per student	World Market Shopper Worksheet (2 pages total)	Binder

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

(Talk Science: whole class discussion strategies.)

Probing questions:

What if you lived in a different region?

What would you see or not see there?

What kinds of things would you feel, hear, smell, and taste?

Explain that since different regions have different weather and climate, people have different everyday experiences. Ask students if anyone has been outside our climate region and what kind of differences they observed and felt? Note if anyone has been drastically out of the current climate region (for example, from New England states to South America).

During the Lesson

1. Ecosystems Review
    A. If needed, play a short video for each of the ecosystems before the actual lesson with a 4 senses reflection.
    B. After a small discussion about experiences in different regions, project a list of different ecosystems with corresponding images.
    C. This is a short review/refresher of what was previously learned. http://www.earthcam.com/network/
2. World Marketplace Game [SP8: Obtaining, evaluating, and communicating information]
    A. Divide the class into small groups of three or four, and have them pick a location from a list. The list should include the following ecosystems (the specific locations are up to the teacher's preference. These are just potential examples):
        i. Tundra: Alaska
        ii. Desert: Arizona or Egypt
        iii. Tropical Rainforest: Brazil
        iv. Boreal Forest: Canada
        v. Deciduous Forest: Korea, Japan, or China
        vi. Grassland: Zimbabwe
    B. Students will use books and the internet to research relevant plants and animals (ones that are raised, grown, or consumed), types of clothing people wear (accessible materials), and any specific tools/objects for activities or to prepare for a weather condition.
    Links for research:
        1. Tundra: Alaska-
        https://sciencing.com/plants-animals-alaska-6122269.html
        https://weather.com/weather/tenday/l/Anchorage+AK+USAK0012:1:US
        2. Desert: Egypt
        https://weather.com/weather/tenday/l/Cairo+Egypt+EGXX0004:1:EG
        https://www.britannica.com/place/Egypt/Plant-and-animal-life

3. Tropical Rainforest: Brazil
   http://lntreasures.com/brazil.html

   https://weather.com/weather/tenday/l/Rio+de+Janeiro+Brazil+BRXX0201:1:BR
4. Boreal Forest: Canada
   https://sciencing.com/plants-animals-canada-6755090.html
   https://weather.com/weather/tenday/l/Toronto+Canada+CAXX0504:1:CA
5. Deciduous Forest: Japan
   https://weather.com/weather/tenday/l/Tokyo+Japan+JAXX0085:1:JA
   http://lntreasures.com/japan.html
6. Grassland: Zimbabwe
   https://weather.com/weather/tenday/l/Harare+Zimbabwe+ZIXX0004:1:ZI
   http://lntreasures.com/zimbabwe.html

C. Record information in the "Merchant Worksheet" (information is revisited later in the game). Prompt groups to consider, "What does this information inform us about your region's climate? What materials are accessible during certain seasons? For example, would we need to buy and sell snow boots in tropical rainforests?"
D. After students gather enough information, set up a station for each group around the classroom. Each station represents a market stand from the group's region. Students set up market stands with drawn and labeled pictures of items that they previously researched (fruits, vegetables, livestock, tools, clothing, etc.). Each group receives 10 counting chips (for simplicity, every color will have the same value). Groups should list prices for each item, ranging from 1 chip to 5 chips.
E. Assign half the groups as merchants in the first round, and the other half as shoppers. Merchants will provide information about their products to their customers, using the research from their"Merchant Worksheet." Sell your items by explaining why customers need certain items if they were to visit your region. Each shopper/pair of shoppers buys goods from every market stand, so be sure to warn them to be economical with their chips. If there are leftover chips, revisit a favorite market. Shoppers also fill out a worksheet as they shop and merchants teach them about their goods.

F. After the first group of shoppers has visited every stand (about 10-15 minutes), move to the second round and switch roles.
G. In the same groups, students can share what kinds of items they bought from each market and why it was important to buy them. Ask questions such as: Why do you think the market sold such items? Could an item from Market Stand A be sold from Market Stand B?

Extension:

1. Student-based Interview: If possible, connect with a school from a significantly different region and arrange a Skype call (or similar) with the class. Let students prepare questions to ask to the other students. Examples include: What is the weather like there today? What are your seasons like? Also have them note any differences they might observe. What are they wearing?
    a. Alternative: If difficult to connect with a school or arrange a Skype call, find a local person (from a nearby college, a school staff, community worker, etc.) who has lived in a different ecosystem for some part of his or her life and lead a student-based interview with that person.

Lesson Closing

Long-Term Mystery Hint:
Mystery Location A (Mt. Greylock): You'll need snow boots to go here in the winter!
Mystery Location B (The Great Barrier Reef): You'll need swimming suits to go here!

Assessment

Students' knowledge will be assessed by examining what they wrote in the worksheets in their Science Journals.

Lesson 7: A Recipe for (Natural) Disaster

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

Lesson Background

This will be a two-part lesson. Classroom Teachers and Science Fellows may decide how to teach the lesson, but we have included a suggested breaking place.) This lesson allows students to explore different types of natural disasters, their impacts, and how communities respond to and prepare for severe weather and natural disasters.

Science Background Content (for instructors)

The main natural disasters featured in this lesson are hurricanes, tornadoes, landslides, and flooding. The second part of this lesson allows students to think critically about ways people and communities respond to and prevent natural disaster damage. Hurricane: start as tropical storms that form over warm ocean waters, become storms with high winds and heavy rain. Tornado: fast spinning column of air stretching from thunderstorm cloud down to Earth's surface, characterized by extreme winds. Landslide: occur when a slope becomes unstable, and mass (can be rocks, debris, etc.) moves down the slope under the force of gravity. Flood: aftermath when too much rain forces rivers, streams, and lakes to overflow, sending water where it doesn't belong. Not included in our lesson are earthquakes, which are not covered because they are related more to (and caused by) tectonic movements rather than climatic and weather conditions.

Overview of the Lesson

In this lesson, students explore the causes and effects of natural disasters through critical thinking, models, and role playing. They construct and observe their own models of certain disasters and role play a natural disaster scenario to give them a better understanding of the effects of these disasters.

Focus and Spiral Standard(s)

3-ESS3-1. Evaluate the merit of design solution that reduces the damage caused by weather. {Clarification statement**:** Examples of design solutions to reduce weather-related damage could include a barrier to prevent flooding, a wind-resistant roof, and a lightning rod.}
4-ESS3-2. Evaluate different solutions to reduce the impacts of a natural event such as an earthquake, blizzard or flood on

humans* {Clarification statement**:** Examples and solutions could include an earthquake-resistant building or a constructed wetland to mediate flooding.}

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Funded by NSF DUE-IUSE Award #1432591

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
-Asking questions and defining problems -Planning and carrying out investigations -Analyzing and interpreting data -Constructing explanations and designing solutions -Obtaining, evaluating, and communicating information	**ESS3.B: Natural Hazards** A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards, but can take steps to reduce their impacts (3-ESS3-1)	**Cause and Effect:** Cause and effect relationships are routinely identified, tested, and used to explain change (3-ESS3-1) **Influence of Engineering, Technology, and Science on Society and the Natural World:** Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands (3-ESS3-1)

Learning Targets

1. I can identify and describe natural disasters, the processes by which they occur, and why they occur in specific locations.
2. I can explain and compare impact (magnitude).
3. I can describe and assess how regions respond to and prepare for disasters.

Assessment(s)

Participation in role playing activity and review of science journals

Targeted Academic Language

Tier 2: natural disaster, hurricane, tornado, landslide, flood (flash flood)

RESOURCES AND MATERIALS

Quantity	Item	Source
1 per student	Science Journal	Classroom Teacher
	Natural disaster picture + clip https://www.youtube.com/watch?v=-dfi0b6w0JY	CMC Website
	Severe Weather Crash Course https://www.youtube.com/watch?v=QVZExLO0MWA	CMC Website
As Needed	Various arts supplies (construction paper, pipe cleaners, pom poms, glue, markers)	Bin and Classroom Teacher

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

Anchor image: Project the "Natural Disaster Picture" and ask students what they see and what they think is going on? How did this happen? Confusion and questions are good! Try to spark intrigue, but explanations/answers are not necessary yet. Next, show the natural disaster clip (https://www.youtube.com/watch?v=-dfi0b6w0JY) and prompt discussion about what students observe and how it relates to the picture before. Watch the video a second time and ask the students to match what they see with all applicable words from the word bank that the Classroom Teacher or Science Fellow writes on the board (**Hurricanes**, Tornadoes, Landslide, **Floods (flash floods)**, **Rain**, Snow, **Wind;** bold words are the correct match answers). Based on the definition of each natural disaster create a visual representation. Discuss answers and provide facts to battle any misconceptions. Then prompt a discussion on how they could prevent or reduce the damage of the disaster shown.

During the Lesson

1. **Tornado in a Bottle:**
   This activity allows students to construct their own model of a tornado, and extrapolate important features/characteristics of this natural disaster. Activity adapted from http://www.sciencekids.co.nz/experiments/makeatornado.html. Preparation requires filling each group's bottle with water (unless students are able to fill their own bottles, at teacher's discretion)
   A. Divide the class into groups of 3-4. Distribute a plastic bottle (with the top on) about ¾ full with water to each group, along with a small cup of dish soap, and a small cup of glitter.
   B. Instruct each group to uncap the bottle and put a few drops of dish soap in, and sprinkle a few pinches of glitter in. Put the cap back on tightly.
   C. Each group can then have one student (and take turns so each student has the opportunity) turn the bottle upside down and hold it by the neck. Quickly spin the bottle in a circular motion for a few seconds, then pause and watch to see if you can observe a mini tornado forming.
   D.  After each student has the opportunity to try activating the tornado, ask them to think-pair-share in their groups about these questions: What do we see in the bottle? Encourage specific observations (not just "I see a tornado," or "I see glitter"), and prompt with questions "Why do you think it's a tornado? What is the glitter doing/how is it moving? What does the glitter represent?" (*Targeted vocabulary should attempt to include funnel or vortex shaped.*)

2. **Crash Course**
   A. Watch the crash course on severe weather (https://www.youtube.com/watch?v=QVZExLO0MWA) and encourage students to take notes.
   B. Draw a quad Venn diagram (example below) on the board and ask students to follow along in science journals.
   C. Label each circle with one natural disaster (Hurricanes, Tornadoes, Landslide, Floods) and ask students for shared and different characteristics of each disaster.
   D. Focus on students' input, but Science Fellows and Classroom Teacher might guide further thinking. The example to the right conveys knowledge that students should be able to explain from prior activities.

Extension: Create a foldable with the natural disasters and the criteria given from the video. The students work in groups to discuss and place the information to the natural disaster. End the session by letting the students work in a "community" where there is an alert for a particular disaster. The students will be the leaders and create a plan for their community to stay safe.

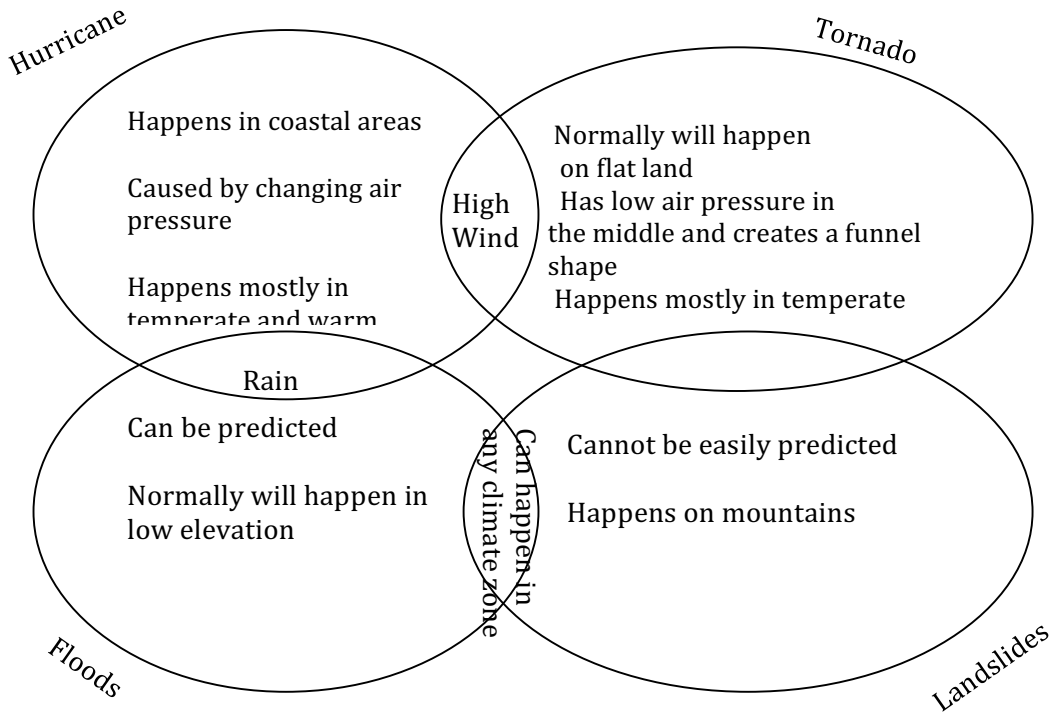
Long Term Mystery:

Have students take out their Long Term Mystery booklets and get ready to receive Lesson 8's clue:
Location A was affected by a landslide in the year 1990.
Location B is most likely to be affected by a hurricane due to its location.

(This is the suggested breaking point in the lesson.)

Response and Preparation

Facilitate introductory conversation about how human societies have learned to respond to and prepare for natural disasters given what was just learned about the features and impacts of natural disasters. Post four pieces of chart paper with each natural disaster at the top (1 per paper) around the room; students walk around and write down answers for how people might respond to or prepare for the different natural disasters. Teachers and Science fellows can stand near paper and prompt students with questions.



Survival Game

Students have the opportunity to act out and think critically about how they would respond to natural disasters. This 3-day response scenario is broken down: how we prepare (day 1), how we react and respond (day 2) and how we move forward and prevent (day 3).

1. Divide students into 5 teams and assign them a location and natural disaster
   -Oklahoma, tornadoes
   -Florida, hurricanes
   -Virginia, flooding
   -California, landslides
   -North Adams, to be used as a comparison, or "control," weather location

2. Students role play events for 3 days concerning their location and natural disaster.

Day 1: Deliver weather prediction to each group (impending natural disaster and extreme weather) and ask students in their teams to decide how to prepare individually and as a community. Brainstorm a list (one student can scribe) in their groups and choose one item of preparation from the list to further develop. Construct/represent a creative model of chosen item (act it out, build out of materials). Classroom Teachers and Science Fellows circulate and guide brainstorming process. Ideas to include: how do we prepare houses, food, decision to leave or stay, etc. Have students connect each option they come up with to the feature of their specific natural disaster (i.e. hurricanes have strong winds, so I'm going to board up the windows on my house). Next, have groups share or present the creative model and explain rationale for preparation. Classroom Teacher or Science Fellow can write answers on the board to collect all in one place for reference.

Day 2: (Science Talk: use small group discussion strategies.) The predicted weather is now happening! Ask groups to discuss what is happening to them individually and what is happening to their physical community. Then have groups share and have the teacher or science fellow write answers on the board to collect them all in one place for all groups to reference.

Day 3: Extreme weather has ended, ask groups to discuss what happened and how they plan on fixing damage on individual and community levels. How is our community going to deal with the aftermath, and how would we prepare for this natural disaster in the future? Again, have students choose one option from their list to represent creatively (either build or act out, etc.) in front of the class. Have the Classroom Teacher or Science Fellow write answers on the board to collect for reference.

Lesson Closing: (Talk Science: use guiding questions in whole class discussion to connect ideas.)
Lead students in a closing discussion about what they found interesting or challenging about the role playing activity. Tie this back to topics covered in Lesson 4 concerning why it is important to make predictions about weather. How long do you think is an adequate time to prepare? What if you did not have that much time to prepare?

Assessment

Participation in role playing activity and review of science journals

Lesson 8: Earth Doctors

Teach To Learn
A collaboration between MCLA, Williams College, and North Adams Public Schools
Funded by NSF DUE-IUSE Award #1432591

Lesson Background

In previous lessons, students learned how climate shapes human life and how humans survive, thrive, and protect themselves against climate. In this lesson, students will shift the perspective and learn how humans impact climate. This lesson develops awareness of how our actions impact the climate and instill responsibility to protect our environment and climate.

Science Content Background (for instructors)

This lesson focuses on the greenhouse effect and ways that students can work to make their carbon footprint smaller. The greenhouse effect is similar to how a garden greenhouse works. A greenhouse holds in the heat from the Sun to help plants grow all year round. It works by letting in sunlight but trapping heat (in the form of infrared radiation). Similarly, gasses in our atmosphere trap heat but let in sunlight, causing the Earth's average temperature to be much higher than it would be otherwise. One of the primary heat-trapping gasses is Carbon Dioxide. Our carbon footprint is the amount of carbon emissions (especially Carbon Dioxide) produced from our consumption needs (including all of the energy needed to produce our food and products, and the energy we directly consume to power our cars, houses, etc.). Examples of ways to reduce our carbon footprint or energy consumption include: remembering to turn off all electronics and lights when not in use, using public instead of private transportation, eating locally produced food and less meat and dairy, wasting less water, reusing and recycling products, and insulating our homes.

Overview of the Lesson

This lesson starts with a brief discussion on the fate of our trash, which later connects to the idea of human behavior impacting climate. Students explore examples of human actions through an online scavenger hunt activity and corresponding worksheets. Then, students will become Earth Doctors to find solutions to protect the environment/climate.

Focus and Spiral Standard

5-ESS3-1. Obtain and combine information about ways communities reduce human impact on the Earth's resources and environment by changing an agricultural, industrial, or community practice or process.

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
-Asking questions and defining problems -Planning and carrying out investigations -Constructing explanations and designing solutions -Engaging in an argument from evidence -Obtaining, evaluating, and communicating information	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (3-LS4-4)	**Cause and Effect:** Cause and effect relationships are routinely identified, tested, and used to explain change (3-ESS3-1) **Influence of Engineering, Technology, and Science on Society and the Natural World:** Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands (3-ESS3-1)

Learning Targets

1. I can explain and describe how humans affect the climate.
2. I can describe ways to better the environment and climate.

Assessment

Review worksheets

Targeted Academic Language

Tier 1: Recycle
Tier 2: Climate Change, Solar Energy
Tier 3: Greenhouse Gasses, Carbon Footprint, Deforestation

RESOURCES AND MATERIALS

Quantity	Item	Source
1 per class	Computer projector	Classroom Teacher
	Toy Story Clip https://www.youtube.com/watch?v=QtQPmDjuA5s	CMC Website
1 per student	Classroom Laptops	Classroom Teacher
1 per group	Printer Paper	Classroom Teacher
1 set per group	Colored pencils/markers	Classroom Teacher
1 per student	Scavenger Hunt Worksheet (3 pages total)	Binder

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening/ Activator

Ask, "Where does our trash go?" If students answer "trash can," prompt to think further by asking, "Where does it go after we throw it away in the trash can?" Next, as a visual and relatable example, show the YouTube clip from the movie Toy Story 3 (https://www.youtube.com/watch?v=QtQPmDjuA5s). Briefly discuss what happened in the clip: where did the scene take place? What did you notice about the location? Important points: "The toys were in the furnace" and "The trash was being burned." Explain that a lot of our trash is taken to an incinerator/furnace and burned. Ask them the following questions:

- Is burning everyone's trash good or bad? Why?
- Where else does our trash end up? (answers include the river, lake, ocean, landfill, underground, etc.)

During the Lesson

1. **Trash Talk**
    A. Have a short discussion with the students about the impact of our trash on the environment. We often handle trash irresponsibly, which makes the Earth sick!

B. Ask, "How do we tell if someone is sick?" We might check if that person has a fever. Similarly, we can tell that the Earth is sick by looking at the global temperature.
C. Introduce the concept of climate change: Not only does the climate affect our everyday lives, we, as humans, also have a great impact on the climate by the things we do. The global temperature is rising because of human activity.

2. **Scavenger Hunt**

A. Students pair up to engage in an online scavenger hunt on laptops, visiting Climate Kids website (climatekids.nasa.gov).
B. Distribute the scavenger hunt worksheets and allow students to explore the website about the climate and climate change.
C. After students finish, review worksheet as a class. Discuss ways that students can help with global warming.
D. When giving answers about how humans are the main cause of global warming, discuss in greater detail the ideas of our carbon footprint and deforestation (may require preparation by the Classroom Teacher and/or Science Fellows).

Teaching Tip
Games featured on this website might distract students from task.

3. **Earth Doctor Collage** [SP6: Constructing explanations and designing solutions]

A. We are now Earth Doctors and will brainstorm ways to make the Earth feel better (Optional: hand out toy doctor equipment for students to wear, and the Classroom Teacher and Science Fellows can be the patient--Earth).
B. As a class, have students come up with several ideas and record on the board. Examples: ride a bike instead of a car, recycle, use solar/wind/water energy, turn off electricity when not in use, use reusable water bottles, etc.
C. Divide the class into groups of 3-4, and instruct each group to pick a solution from the board and draw a picture with a caption. The finished drawings should be hung on a classroom wall labeled "As Earth Doctors, We Can…"

Teaching Tip
Captions for the pictures should be full sentences that feature the problem, the solution(s), and the WHY or HOW

Optional: Create a chart listing the solutions that the students came up with, and throughout the year every time someone announces that he or she has done something on the solution chart, put a sticker on the chart.

Extension

Will need to be planned in advance

1. Field trip to a local greenhouse where students can explore and ask the workers questions they may have about how greenhouses work, and how this relates to the Earth.
2. Field trip to Hopkins Forest to explore the impacts of deforestation.

Lesson Closing

Give students another hint about their long term mystery location to record in their booklets.
The hints are:
Location A (Mt. Greylock) has been changed over the course of many years due to weathering and erosion. Natural disasters have caused a face to appear on it.
Location B (The Great Barrier Reef) has been changed due to coal pollution, which is bleaching and killing the surrounding wildlife.

Assessment

Review worksheets.

Lesson 9: Think Global, Act Local

Lesson Background

This will be a two-part lesson. Classroom Teachers and Science Fellows may decide how to split the lesson, but we have included a suggested breaking point.

Synthesizing information from previous lessons, Lesson 10 seeks to assess students' understanding and elaborate on the material by interviewing local businesses and constructing models of a town that can prepare for and respond to climate conditions. Students construct causal explanations that draw on conceptual frameworks from previous lessons. Students should be able to cohesively answer Essential Questions 1 and 2 (but this lesson focuses on EQ2). Humans interact with Earth's climate by constructing ways to survive and thrive in response to factors in their environment and by overcoming the barriers posed by their environment. Human activity also contributes to changes in global conditions (such as temperature) over long periods of time, which in turn leads to changes in global climate.

Science Content Background (for instructors)

Since this is a evaluate lesson all the science content from every preceding lesson applies.

Overview of the Lesson

This lesson requires students to interview local businesses or individuals. Contact should be made prior to the teaching of Part 1 of this lesson to prepare instructors, students, and interviewees for their assignments. In this lesson, students will be referring to information from previous lessons to show their mastery of the concepts. They will be reviewing these concepts through physical models and explanations. They will be given time to interview and learn from local businesses before creating their own town.

Focus Standard(s)

3-ESS2-2. Obtain and summarize information about the climate of different regions of the world to illustrate that typical weather conditions over a year vary by region. {Clarification statement: Examples of information can include climate data (average temperature, average precipitation, average wind speed) or comparative descriptions of seasonal weather for different regions.}{State assessment boundary: An understanding of climate change is not expected in state assessment.}

3-ESS3-1. Evaluate the merit of design solution that reduces the damage caused by weather. {Clarification statement: Examples of design solutions to reduce weather-related damage could include a barrier to prevent flooding, a wind-resistant roof, and a lightning rod.}

NGSS Alignment

Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
-Asking questions and defining problems -Constructing explanations and designing solutions -Engaging in an argument from evidence -Obtaining, evaluating, and communicating information	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (3-LS4-4)	**Influence of Engineering, Technology, and Science on Society and the Natural World:** Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands (3-ESS3-1)

Learning Targets

1. I can explain the core details of the lessons and can construct thoughtful questions about the topics.
2. I can elaborate and generate answers to questions about how humans respond to and interact with Earth's climate.

RESOURCES AND MATERIALS

Quantity	Item	Source
	Markers	Classroom Teacher
	Colored pencils	Classroom Teacher
1 per student	White printer paper	Classroom Teacher
1 per student	My Town Worksheet (3 pages total)	Binder
1 pack	Construction paper	Bin
1 12 pack	Glue sticks	Classroom Teacher
2 per group	Scissors	Classroom Teacher

****Items in bold should be returned for use next year****

LESSON DETAILS

Lesson Opening / Activator

Engage students' prior knowledge by creating a mind map of the big ideas that were talked about in previous lessons. Students are encouraged to find the connections between all the main ideas and concepts (regions, natural disasters, and our effects on climate) that they learned previously as they draw out their maps. Supply the students with markers and or colored pencils so they can color coordinate connecting ideas, if they wish. This should take around 10 minutes.

Teaching Tip

Mind maps (sometimes called concept maps) are a good way for students to visualize their ideas, and the connections between those ideas. To connect ideas, they can use arrows to indicate direction, as well as text to indicate the relationship (e.g., " leads to" or "results from").

During the Lesson

Part 1:

1. **Read Great Garbage Patch**
    a. Discuss the main idea and supporting details to enhance background knowledge.
    b. Consider asking the following discussion questions:
        i. **Look closely at the pictures printed on page 21.**
            1. Describe the contents of the jar Miriam is holding.
            2. Explain why the mussels, crabs, and sea anemones are living on a piece of discarded rope.
        ii. **Look closely at the picture printed on page 37.**
            1. Observe the tiny fish and plastic pieces captured together in the clear dish.
            2. Tell how this picture makes you feel.
            3. Do you think the tiny fish have been affected by the plastic? Explain how.
        iii. **Look closely at the picture printed on page 40.**
            1. Compare the picture of the littered beach with the one featured on the left. In what ways are the two the same? Contrast the pictures.
    c. Time permitting, watch the following video: https://www.youtube.com/watch?v=VT4GUhWMjog (7:38 min)
        i. **Video Overview:** Inside the Plastic Vortex: A groundbreaking Scripps voyage led by students helps define a rising environmental threat.
2. **Brainstorm!**
    A. Explain that we will interview local businesses to collect data for the final project. Convey details of the final project, so students understand the expectations (*directions for final project found in Part 2*).
    B. Facilitate a discussion about effective interviewing and questions related to content from previous lessons. Work together to brainstorm a list of interview questions that focus on important factors of climate.

Questions may include:

- What does your business do?
- How does your business change or respond to the changing seasons and weather? Do you have to do anything differently from winter to summer?
- Would your business survive/thrive in a different climate zone?
- What natural resources does your business use? How do you get them?
- Do you take part in any measures to "go green" or reduce your effect on the Earth's climate? If so, what are they?

1. **Interview Local Businesses** [SP8: Obtaining, evaluating, and communicating information]

Allow the students to interview local people around the community on how their business affects the environment in both good and bad ways and on some ways their business is reducing their negative impact. (Interviewee examples: Local museum, Schools, Colleges, Local businesses)

- **Classroom Teacher & Science Fellows**: Please record and/or take notes on the interview answers.

Lesson Closing

Tell students that this will be their last clue for their long term mysteries. For Location A, the clue will be **Park Rangers** and for Location B, the clue is **Snorkeling business**. Have students consider the impacts on the local environments that these types of businesses might have. It may be helpful to tell them what each business/organization does, e.g. park rangers patrol the grounds and make sure that campers, hikers, and other visitors are following the rules - including fire safety regulations; and snorkeling and diving businesses allow tourists to come and get close to lots of fish and other sea creatures. With this information, the students can think about how these jobs may impact the local environment, positively or negatively.

Lesson Part 2:

1. **Final Project: Create your own town** [SP2: Developing and using models]

This project provides students the opportunity to apply knowledge about environmental impacts on a town and considerations a town must take into account to reduce impact on climate change.

a. Encourage students to consider the ideas presented by the local business interviews and evaluate what they thought were the most effective plans. They should also feel free to come up with modifications or generate ideas of their own.
b. Provide students with the art supplies needed/desired for the construction of their town. Items such as construction paper, printer paper, markers/colored pencils, scissors and glues sticks should be distributed to each group. Allow up to 20 minutes for the students to create a visual of the town.
c. Pass out the Town Worksheet that the students can fill out. This worksheet will have space for the students to take down the important factors of how their town runs. Things such as how they combat climate change, what products they sell, and how weather and climate affects them should be written down.
d.  (Science Talk: oral presentations should be structured so students can practice presentation skills and their peers can practice active listening.) Once everyone is done with the projects, allow for students to present their towns either from their desks or in front of the class. The class is encouraged to ask the presenters any questions

they might have. If the students who are presenting are having trouble answering any questions, the Classroom Teacher and Science Fellows are welcome to jump in and help them.

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Lesson Closing

(**Final page in their Mystery booklets.**) Have students take a couple guesses as to what they think the mystery locations are; ask students why they guessed what they did. If a student guesses correctly and hasn't told any of their peers, reward them with candy or small toy/trinket. If no one guesses correctly, reveal to the class (with drumroll) that the mystery locations were **Mount Greylock** (location A) and **the Great Barrier Reef** (location B).

Assessment

Review students' mind maps and final projects - both their participation in the creation of the project and the quality of the finished product.

Unit Activity Planner

Activity	Learning Targets	Science Connection to Phenomena	MA Standards
Lesson 1 **Activity 1**: Using a Thermometer	I obtain local and global weather data. I can explain that the sun plays an important role in day and night, weather, and seasons.	The Sun has a direct relationship to the Earth's weather systems and climate. Specifically, the average temperature is dependent on the amount of sunlight an area receives.	**3-ESS2-1**. Use graphs and tables of local weather data to describe and predict typical weather during a particular season in an area. [**Clarification Statements**: Examples of weather data could include temperature, amount and type of precipitation (e.g., rain, snow), wind direction and wind speed. Graphical displays should focus on pictographs and bar graphs.]
Lesson 1 **Activity 2**: Weather Across America			
Lesson 1 **Activity 3**: Fortune Tellers			
Lesson 1 **Activity 4**: How the Sun Hits the Earth			

Lesson 2 **Activity 5**: Globe and Flashlight Demonstration	I can describe how the Earth moves in relationship to the sun. I can use different models to show why different places on the Earth are impacted differently by the sun.	The Sun shines directly on the equator. The Northern and Southern hemispheres experience opposite seasons, because the Earth simultaneously orbits the Sun and rotates on its tilted axis.	**5-ESS1-2**. Use a model to communicate Earth's relationship to the Sun, Moon, and other stars that explain (a) why people on Earth experience day and night, (b) patterns in daily changes in length and direction of shadows over a day, and (c) changes in the apparent position of the Sun, Moon, and stars at different times during a day, over a month, and over a year.
Lesson 2 **Activity 6**: Kinesthetic Models of the Earth and Sun			
Lesson 2 **Activity 7**: Discussing Northern and Southern Hemispheres			

Lesson 3 **Activity 8**: Land Versus Water **Lesson 3** **Activity 9**: Energy Exchange Skit	I can describe the concept of energy, as it relates to heat and light. I can explain the importance of energy exchange between the Earth and the Sun.	Land and water absorb and retain heat from the Sun at different rates. The Northern hemisphere has a greater proportion of land, while the Southern hemisphere has a greater proportion of water, thus leading to differences in climate. The energy exchange between the Earth and the Sun is **balanced**. Any imbalances in energy distribution would lead to drastic climate problems.	**4-PS3-1**. Make observations to show that energy can be transferred from place to place by sound, light, heat and electric currents. [**Clarification Statements**: Evidence of energy being transferred can include vibrations felt a small distance from a source, a solar-powered toy that moves when placed in direct light, warming a metal object on one end and observing the other end getting warm, and a wire carrying electric energy from a battery to light a bulb.]
Lesson 4 **Activity 10**: Observing Weather Graphs	I can explain graphs are tools to communicate information visually. I can use graphs to make predictions and assumptions about weather data in a given	Collection of weather data is necessary to record patterns across different times and areas in order to make predictions about future weather.	**3-ESS2-1**. Use graphs and tables of local weather data to describe and predict typical weather during a particular season in an area.

Lesson 4 **Activity 11**: Becoming Weather Observers	area. I can research and record weather data about a particular area of interest.	To understand climate, weather patterns are observed over prolonged periods of time.	[**Clarification Statements**: Examples of weather data could include temperature, amount and type of precipitation (e.g., rain, snow), wind direction and wind speed. Graphical displays should focus on pictographs and bar graphs.]
Lesson 4 **Activity 12**: Why Do We Predict?			

Lesson 5 **Activity 13**: Climate and Weather **Activity 14**: Exploring Ecosystems **Activity 15**: Trioramas **Activity 16**: Google Earth Photos **Activity 17**: Climate Zones	I can define climate and differentiate climate from weather. I can investigate ways that plants and animals adapt to the climate conditions in their environments.	Climate and weather are different concepts. Climate is defined by collecting data about weather patterns in specific areas over long periods of time. Ecosystems are dependent upon climate patterns and zones, because different plants and animals respond better to different climate conditions.	**3-ESS2-2**. Obtain and summarize information about the climate of different regions of the world to illustrate that typical weather conditions over a year vary by region. [**Clarification Statements**: Examples of information can include climate data (average temperature, average precipitation, average wind speed) or comparative descriptions of seasonal weather for different regions.]

Lesson 6 **Activity 20**: World Marketplace Game	I can explain how weather and climate in different regions shape the lifestyle and cultures of the people that live there. I can collect data that supports a claim. I can explain different perspectives and experiences across the globe in relation to the climate's impact.	Climate conditions dictate sociocultural aspects of humans' lives. Differences in climate can cause differences in how people live their day to day lives - from lifestyle choices to career options, from available resources to the state of the economy. Humans interact with Earth's climate by constructing ways to survive and thrive in response to factors in their environment and by overcoming the barriers posed by their environment.	**3-ESS2-2**. Obtain and summarize information about the climate of different regions of the world to illustrate that typical weather conditions over a year vary by region. [**Clarification Statements**: Examples of information can include climate data (average temperature, average precipitation, average wind speed) or comparative descriptions of seasonal weather for different regions.]
Lesson 7 **Activity 21**: Tornado in a Bottle	I can identify and describe natural disasters, the process by which they occur, and why they occur in specific locations. I can explain	Natural disasters are an important aspect of weather and climate that can play a large role in shaping the bidirectional	**3-ESS3-1**. Evaluate the merit of a design solutions that reduces the damage caused by weather.*

Lesson 7 **Activity 22**: Crash Course on Natural Disasters	and compare impact (magnitude). I can describe and assess how regions respond to and prepare for disasters.	relationship between humans and their environment. Local communities construct ways of responding to and preparing for natural disasters.	[**Clarification Statement**: Examples of design solutions to reduce weather-related damage could include a barrier to prevent flooding, a wind-resistant roof, and a lightning rod.] **4-ESS3-2**. Evaluate different solutions to reduce the impacts of a natural event such as an earthquake, blizzard or flood on humans.* [**Clarification Statement:** Examples and solutions could include a earthquake-resistant building or a constructed wetland to mediate flooding.]
Lesson 7 **Activity 23**: Response and Preparation			
Lesson 7 **Activity 24**: Survival Game			
Lesson 8 **Activity 25**: Trash Talk	I can explain and describe how humans affect the climate. I can describe ways to better the environment and climate.	Humans' impact on the climate can be measured through our carbon footprint, which considers processes like deforestation and energy consumption. There are ways of reducing humans' negative effects on the environment by	**5-ESS3-1**. Obtain and combine information about ways communities reduce human impact on the Earth's resources and environment by changing an agricultural, industrial, or community practice or process.
Lesson 8 **Activity 26**: Climate Kid's Scavenger Hunt			

Lesson 8 **Activity 27**: Earth Doctor Collage		reducing their consumption and waste output, and by recycling, riding a bike instead of driving in a car, and using clean sources of energy.	
Lesson 9 **Activity 28**: Brainstorm for Interviews	I can explain the core details of the lessons and can construct thoughtful questions about the topics. I can elaborate and generate answers to questions about how humans respond to and interact with Earth's climate.	Humans interact with Earth's climate by constructing ways to survive and thrive in response to factors in their environment and by overcoming barriers posed by their environment. Human activity contributes to changes in global conditions, such as temperature, over long periods of time, which in turn leads to changes in global climate.	**3-ESS2-2**. Obtain and summarize information about the climate of different regions of the world to illustrate that typical weather conditions over a year vary by region. [**Clarification Statements**: Examples of information can include climate data (average temperature, average precipitation, average wind speed) or comparative descriptions of seasonal weather for different regions.]
Lesson 9 **Activity 29**: Interviewing Local Business			**3-ESS3-1**. Evaluate the merit of a design solutions that reduces the damage caused by weather. *

Lesson 9 **Activity 30**: Create Your Own Town			**[Clarification Statement**: Examples of design solutions to reduce weather-related damage could include a barrier to prevent flooding, a wind-resistant roof, and a lightning rod.]

Next Generation Science Standards (NGSS) Alignment

Performance Standard	Science/Engineering Practice (SP)	Disciplinary Core Idea (DCI)	Cross Cutting Concepts (CCC)
3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. **3-ESS2-2.** Obtain and combine information to describe climates in different regions of the world. **3-ESS3-1.** Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. **W.3.7** Conduct short research projects that build knowledge about a topic	**Analyzing and Interpreting Data:** Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships (3-ESS2-1) **Engaging in Argument from Evidence:** Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem (3-ESS3-1) **Obtaining, Evaluation, and Communicating Information:** Obtain and combine information from books and other reliable media to explain phenomena (3-ESS2-2)	**ESS2.D: Weather and Climate** Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next (3-ESS2-1) Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years (3-ESS2-2) **ESS3.B: Natural Hazards** A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards, but can take steps to reduce their impacts (3-ESS3-1)	**Patterns:** Patterns of change can be used to make predictions (3-ESS2-1), (3-ESS2-2). **Cause and Effect:** Cause and effect relationships are routinely identified, tested, and used to explain change (3-ESS3-1) **Influence of Engineering, Technology, and Science on Society and the Natural World:** Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands (3-ESS3-1) **Science is a Human Endeavor:** Science affects everyday life (3-ESS3-1)

5E Instructional Model Background

This instructional model exists as a set of phases for science instruction that starts with students' prior knowledge in order to reconstruct a new knowledge with deeper understanding. The *Engagement* phase is first, in which teachers and students begin to mull over questions, prior knowledge and understanding, and potential frustrations they might have with a topic. This phase is meant to be informal – this is the start of the lesson. The second step involves *Exploring* phenomena, which acts as an introduction to the larger concepts that engages students in a hands-on approach. After exploration, *Explanation* of scientific concepts begins. To further student understanding, *Elaboration* is next, in which students are presented with even more challenging activities and problems. Following the learning process comes *Evaluation*, as deemed necessary by learning goals and defined achievements. The model is based on scientific research about how children learn and is meant to be followed chronologically, although some steps may be repeated.

Science Talk and Oracy in T2L Units

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Science talk is much more than talking about science. In line with the science and engineering practices, students are expected to make a claim that can be supported by scientific evidence. The MA STE Standards (and the NGSS) value the importance of engaging in an argument from evidence. NGSS defines how this practice takes form in the real world: *"In science, reasoning and argument are essential for identifying the strengths and weaknesses of a line of reasoning and for finding the best explanation for a natural phenomenon. Scientists must defend their explanations, formulate evidence based on a solid foundation of data, examine their own understanding in light of the evidence and comments offered by others, and collaborate with peers in searching for the best explanation for the phenomenon being investigated."*

Students are asked to participate in articulate and sensible conversations in which they are able to communicate their ideas effectively, listen to others to understand, clarify and elaborate ideas, and reflect upon their understanding. These forms of talk can be developed using scaffolds such as the A/B Talk protocol (below) and strategies for class discussions (from the Talk Science Primer, link below). Oracy is developed in the physical, linguistic, cognitive, and social-emotional realms; each of these realms can be expanded upon over time in order to develop a thoughtful speaker. Being able to display appropriate body language, use proper tone and grammar, be thoughtful and considerate thinkers, and allow space for others thoughts and opinions are all important facets of oracy to work on and through with students. Incorporating the appropriate scaffolding is an important aspect of fostering these skills. Techniques for teaching effective science talk often include modeling, discussion guidelines, sentence-starters, and generating roles, while gradually putting more responsibility on students to own their thinking and learning.

Part of creating a safe school environment for students is allowing them a space that is comfortable enough for them to express ideas and ask questions, while being validated for their thoughts and questions; students should be feel comfortable and confident when speaking and listening for understanding. Effective talk is an important part of being an active, intelligent member of a community and society. Successful development in oracy is important for future employability and general well-being of adults.

The following resources should be helpful examples of how to employ effective use of progressive oracy and science talk in your classrooms.

- Oracy in the Classroom: https://www.edutopia.org/practice/oracy-classroom-strategies-effective-talk
- Science Talk Primer: https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

A/B Talk Protocol

Adapted from https://ambitiousscienceteaching.org/ab-partner-talk-protocol/

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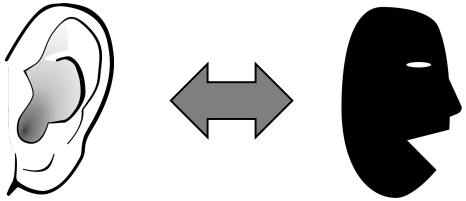
1. Share your ideas  **Partner A** • I think _____ happened because… • Evidence that supports my idea is… • The activity we did with _____ helps me know more about _____ because… • One thing I'm wondering about is…	2. Listen to Understand  **Partner B** • I heard you say _____. What makes you think that? • I heard you say _____. What if _____? • Can you explain the part about _____ again? • What do you mean when you say _____?
3. Clarify and elaborate  **Partner A** Answer partner's questions or ask for clarification in order to understand a question.	4. Repeat steps 2 & 3 until all questions are answered  
5. Switch roles and repeat steps 1-4 	6. Reflect on your understanding in writing • My idea about _____ changed when my partner said _____. • I will add _____ to my idea about _____ because… • I still have questions about… • I may be able to answer my question(s) if I could investigate _____.

List of Unit Resources

Lesson 1

Quantity	Item	Source
1 per student	Science Journal	Classroom teacher
6 per class	**Thermometers (for outside use)**	**Bin**
	http://www.earthcam.com/network/ https://www.timeanddate.com/worldclock/personal.html	CMC Website
5 per class	**Tilted Globes (or as many as possible so each student can have hands on time with the globe)**	**Bin**
5 per class	**Flashlights (or the same amount as globes)**	**Bin**
1 per student	The Long-Term Location Mystery Booklet of Clues (13 pages total)	Binder

Lesson 2

Quantity	Item	Source
1 per student	Science Journal	Classroom teacher
	https://www.youtube.com/watch?v=4rMYrP8feJY	CMC Website
5 per class	**Globe**	**Classroom Teacher/Bin**
5 per class	**Flashlight**	**Bin**
1 per student	**Sunglasses**	**Bin**
1 per student	Exit Worksheet	Binder

Lesson 3

Quantity	Item	Source
2	**Floodlight**	**Bin**
1	**Stick Thermometer**	**Bin**
2 per group	Plastic Cups (any size)	Bin
1	Bag of potting soil	Bin
	Land and Water Crash Course https://www.youtube.com/watch?v=7vTfyAMu6G4	CMC Website
	Here Comes The Sun Crash Course https://www.youtube.com/watch?v=6FB0rDsR_rc&t=121s	CMC Website
2-3	Large Cardboard box	Bin
1	Roll of Aluminum Foil	Bin
1	Bag of Medium Sized Marshmallows	Bin
1	Box of Graham Cracker	Bin
20 Bars	Hershey's Chocolate	Bin
1 per student	**Sunglasses**	**Bin**
1 box	Black Permanent Markers	Classroom Teacher
1 per student	Science Journals	Classroom Teacher

Lesson 4

Quantity	Item	Source
	Climate Kids "What do all these graphs mean?" webpage [https://climatekids.nasa.gov/graphs/]	CMC Website
As needed per classroom	Chart paper	Classroom Teacher
As needed per classroom	Markers	Classroom Teacher

	Graphical map images	CMC Website
1 per group	**Laminated United States Map**	**Bin**
1 per student	Computer or iPad	Classroom Teacher
1 per student	"Weather Observers" Worksheet	Binder
1 per student	Science Journals	Classroom Teacher
1 per classroom	Mini Cactus	Contact Sue Beauchamp

Lesson 5

Quantity	Item	Source
	Climate and Weather video https://www.youtube.com/watch?v=XirAUvS_29I	CMC Website
1 per student	Climate and Weather Worksheets (3 pages total)	Binder
1 per student	Science Journal	Classroom Teacher
1 per student	Climate Zone Worksheet	Binder
	Instructions for Triorama Model	Binder
1 per student	White paper/Cardstock paper	Bin
For class	Colored pencils, glue, scissors	Classroom Teacher

Lesson 6

Quantity	Item	Source
5 pieces per classroom	Large Poster paper	Bin
1 per Student	Markers	Classroom Teacher

1 per classroom	Answering the Big Questions: Teacher Resources and Worksheet (5 pages total)	Binder
1 packet per student	All Systems Go Worksheet Packet (9 pages total)	Binder

Lesson 7

Quantity	Item	Source
	http://www.earthcam.com/network/	CMC Website
1 per class	Computer projector	Classroom Teacher
10 per group	**Counting chips**	**Bin**
1 per student	Science Journals	Classroom Teacher
1 per student	World Market Merchant Worksheet (2 pages total)	Binder
1 per student	World Market Shopper Worksheet (2 pages total)	Binder

Lesson 8

Quantity	Item	Source
1 per student	Science Journal	Classroom Teacher
	Natural disaster picture + clip https://www.youtube.com/watch?v=-dfi0b6w0JY	CMC Website
	Severe Weather Crash Course https://www.youtube.com/watch?v=QVZExLO0MWA	CMC Website
As Needed	Various arts supplies (construction paper, pipe cleaners, pom poms, glue, markers)	Bin and Classroom Teacher

Lesson 9

Quantity	Item	Source
1 per class	Computer projector	Classroom Teacher
	Toy Story Clip https://www.youtube.com/watch?v=QtQPmDjuA5s	CMC Website
1 per student	Classroom Laptops	Classroom Teacher
1 per group	Printer Paper	Classroom Teacher
1 set per group	Colored pencils/markers	Classroom Teacher
1 per student	Scavenger Hunt Worksheet (3 pages total)	Binder