**Unit Essential Question:** *How do people use technology to survive in regions with different climates?*

**Introduction**

In the Lift-Off task, students saw photos of people living in extreme climates and began to generate questions about these extreme climates and how people are able to survive there. In the next two tasks, students will explore what causes such extreme climates. To begin this exploration, students must start with the Sun because it is the key energy source behind all mechanisms that determine regional climates. In this task, students use physical and computer simulation models to visualize the Sun-Earth system. Through these models, they will notice that the Sun does not heat the Earth equally because of the tilt of the Earth as it orbits around the Sun. This unequal heating causes patterns of atmospheric and oceanic circulation that students will delve into in the next task. By the end of this task, students will be able to dispute a common misconception about seasons and explain why the region they chose for their culminating project has such extreme temperatures.

**Alignment Table**

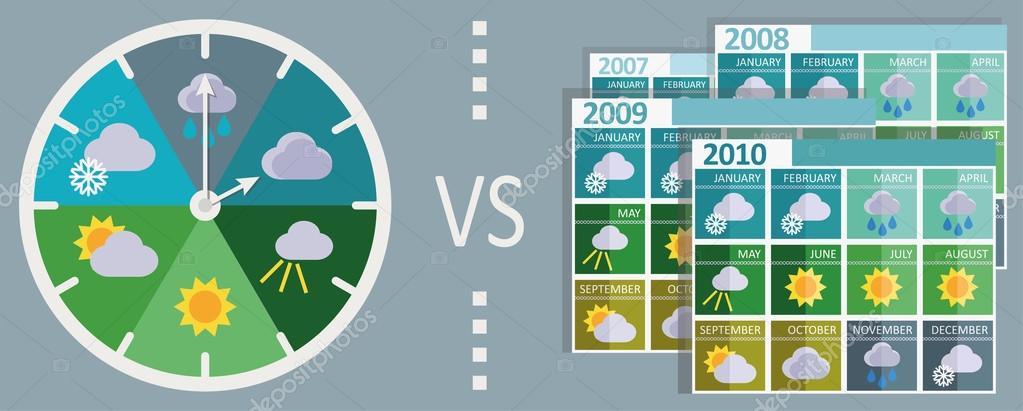
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| **Performance Expectations** | **Science and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |
| **MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.** [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.] | **Developing and Using Models**   * Develop and use a model to describe phenomena. | **ESS2.D: Weather and Climate**   * Weather and climate are influenced by interactions involving sunlight. These interactions vary with latitude.   \*The other elements of the DCIs associated with this PE will be addressed in Task 2. | **Systems and System Models**   * Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. |
| **Supplementary Crosscutting Concepts**   * Patterns   + Patterns can be used to identify cause and effect relationships. * Scale, Proportion, and Quantity   + Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. | | | |
| **Equity and Groupwork**   * Participate in group roles to use physical and computer simulation models. * Discuss and compare observations with partners and group members. * Use the *Stronger Clearer* method to give and receive feedback. | | | |
| **Language**   * Compare and contrast weather and climate. * Describe observations of a model. * Describe a phenomenon using a written explanation and a model. * Use the *Stronger Clearer* method to improve language. | | | |

**Learning Goals**

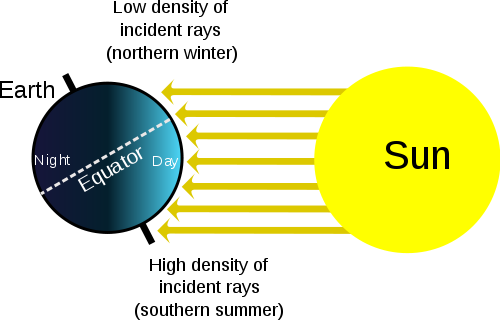
This learning task asks students to develop and use models to describe how unequal heating and rotation of the Earth help determine regional climates. More specifically, the purpose is to:

* Engage prior knowledge to differentiate weather and climate.
* Explore the Sun-Earth system using physical and computer simulation models.
* Explain why it is not wise to take a ski trip in New Zealand in December.
* Use the *Stronger Clearer* method to improve an explanation and model.
* Apply knowledge of the Sun-Earth system to explain typical temperatures in their chosen region.

**Content Background for Teachers**

 In this task, students begin to explore the mechanisms that determine regional climates. First, students need to activate prior knowledge about the difference between weather and climate. Weather is what we actually see day-to-day: sunny, rainy, snowy, or foggy days. It describes conditions on a specific day in a specific area. Climate, however, is the average conditions in a general region. We will be focusing mainly on climate in this unit, but we will also focus on weather events in later units.

In this task, students first focus on the Sun-Earth system because the Sun ultimately determines all climates on Earth. The Sun warms the planet, drives the water cycle, and causes all patterns of atmospheric and oceanic circulation—these are all factors in determining a region’s climate. Because climate science is so complex, we have split this Performance Expectation into two tasks. This task focuses on that first step of the Sun warming Earth.

**** Through models, students learn that the Earth is always tilted slightly (23 degrees) in the same direction. This means that at different times of year, as Earth orbits around the sun, sunlight will be angled more directly on certain parts of the Earth. For example, in North America in November, the northern hemisphere is angled away from the sun, which causes less direct sunlight and colder temperatures. In June, when the Earth is on the opposite end of its orbit, the northern hemisphere is angled more towards the sun, causing more direct sunlight and warmer temperatures. Thus, these changes in sunlight intensity as the Earth orbits the sun throughout a year are what cause seasons. This becomes the basis of the scenario in the *Explain*, as students consider why regions in different hemispheres experience different seasons at the same time of year. In general, students will also notice that because of the angle of the sun, the Poles receive less sunlight and are colder, whereas the equator receives lots of direct sunlight and is warmer.

These concepts around unequal heating of Earth are an essential foundation for students to understand before thinking about patterns of atmospheric and oceanic circulation in the next task.

**Academic Vocabulary**

* Weather
* Climate
* Equator
* Poles
* Hemisphere
* Season
* Temperature
* Latitude

**Time Needed (Based on 45-Minute Periods)**

4.5 Days

* Engage: 0.5 period
* Explore: 1.5 periods
* Explain: 0.5 period
* Elaborate: 1 period
* Evaluate and Reflection: 1 period

**Materials**

* Unit 2, Task 1 Student Version

Engage

* Large poster that says “Weather”
* Large poster that says “Climate”

Explore (Per group)

* Flashlight, Penlight, or Other Light Source
* Styrofoam Ball (at least 4 inches in diameter)
* 2 Toothpicks or Skewers
* Rubber Band
* Computer

Evaluate

* Project Organizer Handout
* Computers or Tablets (for research)

**Instructions**

**Engage**

1. Introduce Task 1: In the Lift-Off task, you saw examples of people living in extreme climates. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
   * Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.
2. Transition to Task 1: What causes these environments to have such extreme climates? What made some regions so hot and others so cold? In this task, we will investigate one of the major reasons behind a region’s climate.
   * Now pass out their Task 1 student guide.
3. Before students delve into the causes of climate, we need them to understand what climate is and how it is different from weather. They have learned about the difference between climate and weather in prior grades, so this activity serves to activate that prior knowledge.
4. To set up this activity, place a poster that says “Weather” in one corner and another poster that says “Climate” in the opposite corner. Have all students stand in the center of the room.
   * First have students turn to a partner and discuss what they think the difference is between weather and climate.
   * Then read each of the statements on their Student Guide aloud. After you read each statement, give students time to move to the “Weather” or “Climate” corner, depending on which they think the statement is describing. For each statement, call on at least one student to share their reasoning.
     + We encourage using equity sticks as a fair and equitable way to call on students (See “How To Use This Curriculum” for more details).
   * An answer key is provided below:

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| --- | --- |
| **C = Climate**  **W = Weather** | **Statements found in Student Version** |
| W | It rained on May 8 |
| C | Germany is a cold country. |
| C | Summer is hot. |
| W | It is supposed to rain this weekend |
| C | Florida is hotter than Alaska |
| W | That was an amazing lightning storm last night |
| C | Cities near the ocean tend to be wet. |
| W | It might snow in Tahoe tomorrow |
| W | Today it was colder than usual. |
| C | 1992 was one of the coldest summers on record. |
| W | There is a hurricane predicted to hit tomorrow. |
| W | The highest recorded temperature of all time was 136 degrees Fahrenheit in Libya. |
| C | It rains every October |

1. Once the activity is complete, have students return to their seats for a class discussion to define the difference between weather and climate. Come to a consensus on two definitions and have students record this in their Student Guides.

* Again, we encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).

**Explore**

1. Now that students understand what we mean when we say “climate”, they are ready to explore one major reason for why climates around the world can be so different—the Sun-Earth system. In this activity, they use two models to answer the question: Does every part of Earth get the same amount of energy from the Sun all the time?

* This activity gives students practice with the SEP of **Developing and Using Models** as they use physical and computer simulation models to describe how the Sun unequally heats Earth.
* Students also emphasize the crosscutting concepts of **Systems and System Models** and **Scale, Proportion, and Quantity** as they use two models to visualize the Sun-Earth system, which is too large to be seen. These models show interactions between parts and the flow of energy within the Sun-Earth system.

1. Students will work with two models—a physical model and a computer simulation model. You can run this activity in a few ways. Student groups can run through both simulations at their own pace, or you can have them do one at a time, pausing after each to debrief what they observed.

* Regardless of the process you choose, we highly recommend modeling the set-up for both the models so students have an idea of how to build the ball-toothpick model and how to use the computer simulation.
* Should you find that your students have misconceptions that all the Sun’s rays shine in only one direction and towards the Earth, you may choose to utilize a light source that shines in all directions (ie. a lamp), instead of a flashlight.

1. Distribute the materials outlined in the Materials List above and assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Recorder.
   * Ask the Facilitator to read the directions and to make sure everyone understands the task.
   * Ask the Materials Manager to gather the materials needed to complete the task.
   * Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
   * Ask the Recorder to make sure the group is recording their analysis in their Student Guide.
2. Sample Student Responses:

Physical Model:

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| **Discussion Questions** | **Your Responses** |
| In general, what locations on the Earth get more sunlight and what locations get less? | *Earth gets more direct sunlight at the Equator and less direct sunlight at the Poles.* |
| How do you think the different amounts of sunlight affect temperature in these areas? | *I think this makes it much warmer at the Equator than at the Poles.* |
| Why do you think the amount of sunlight that hits Earth varies by region? | *Earth is round so it hits more directly at the equator and spreads out more at the Poles. Also, the tilt of the Earth means that one half of Earth gets more direct sunlight than the other half at any given time.* |

Computer Model:

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| --- | --- | --- | --- |
| **Time of Year** | **Location** | **Observations of the Sun’s Rays** | **How do you think this affects the temperature in the region at this time of year?** |
| November | Northern Hemisphere | *Very Angled* | *It is colder during this time of year.* |
| June | Northern Hemisphere | *Direct* | *It is warmer during this time of year.* |
| June | Southern Hemisphere | *Very Angled* | *It is colder during this time of year.* |
| November | Southern Hemisphere | *Direct* | *It is warmer during this time of year.* |
| November | Equator | *Direct* | *It is warm during this time of year.* |
| June | Equator | *Direct* | *It is warm during this time of year.* |

Discussion Questions:

* These discussion questions emphasize the supplementary CCC of **Patterns**, as students use patterns in their observations to identify cause and effect relationships between the Sun-Earth system and climates on Earth.
* a: What part of the world gets the most direct sunlight throughout the year? Why? *The equator because the Earth is a sphere, and the center of the sphere will be exposed towards the Sun more often, so it gets the most direct sunlight. The equator get perfectly direct sunlight twice per year (fall and spring), while the northern and southern hemispheres get direct sunlight only once per year.*
  + - The least amount of sunlight? Why? *The Poles because the Earth is round and light spreads out as it hits at more of an angle.*
* b: How does the amount of sunlight hitting Earth vary throughout the year in a region? *As the Earth goes around the Sun, the angle that Sunlight hits Earth will be more or less direct. For example, if it hits the northern hemisphere directly during June and is hot, at the opposite time of year in November, it will hit indirectly and be cold.*
  + - Why do you think this happens? *The Earth is tilted so one hemisphere is always angled more directly toward the sun than the other.*
    - How do you think this affects the climate of that region during different times of year? *It will be colder in half the year with less direct sun and warmer in half the year with more direct sun.*

1. Once all groups have completed the modeling activities and discussion questions in their groups, we recommend debriefing some of their findings as a class. In general, students should understand that because the Earth is round and tilted, the Sun hits regions at different angles and this varies throughout the year, creating both different climates and seasons.

* Use a ball-toothpick model or the computer simulation to help you ask students questions as you facilitate the discussion.
* We encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).

**Explain**

1. Now that students have used models to explore the Sun-Earth system, they are ready to tackle a common misconception and develop their own model.

* This activity emphasizes the SEP of **Developing and Using Models**, as students develop their own models to describe a phenomenon that showcases the Sun’s unequal heating of Earth.

1. Introduce the following scenario to students: Your friend wants to plan a ski trip to New Zealand during their winter break in December. Individually, explain to your friend whether it is a good idea and draw a model to illustrate your explanation.

* If students don’t know where they are and where New Zealand is, show the class on a map, or preferably on a globe.
* We recommend students do this task individually since they will be sharing their explanations with partners in the *Elaborate* activity.

1. Optional Sentence Stems to Provide:

* I think you should…
* When it is winter here…
* Because \_\_\_, this means…
* This means that…

1. Possible Student Sample:

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| Written Explanation  Dear Friend,  While it sounds wonderful to go skiing over winter break, I think you should pick a different location. Even though it is winter here in December, which means cold weather and skiing, it does not mean it is winter everywhere on Earth! Because the Earth is tilted, this means that one hemisphere is always getting more direct sunlight than the other. When it is winter here in the northern hemisphere, we are getting less direct sunlight because we are angled away from the Sun. This means that the southern hemisphere, where New Zealand is, is angled more towards the Sun, getting more direct sunlight. This means it is actually summer in New Zealand and the weather is warm! Hope this helps.  Sincerely,  Your Friend | Model  Macintosh HD:Users:laurenstoll:Downloads:Untitled drawing.jpg |

**Elaborate**

1. Students will now participate in a language routine known as *Stronger Clearer*. This activity gives students the opportunity to share their ideas, gather feedback, and revise their explanations and models. This protocol is especially useful at this stage since the practice of modeling is still difficult for many students and these are particularly complex concepts.
2. Students will share with three different partners, allowing them to discuss feedback and record any notes each time. Once complete, students should be given time to individually revise their explanations and models based on their discussions. A protocol is provided in their student guide.
3. The revised explanations and models are a good option for formative assessment. Collect student work to identify trends in students’ ability to use models to describe how the tilt of the Earth causes unequal heating of the hemispheres. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.
4. Optional: Debrief the scenario as a class, coming to consensus on why skiing in New Zealand in December is not a great idea. Co-construct a model on the board based on the discussion.

* Again, we encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).

1. Return to the whole-class concept map from the Lift-Off Task.
   * In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
     + Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
     + Draw circles around each question and boxes around each concept.
     + Write connector words to describe connections between the concept boxes.
     + For this task, students may begin to connect some of their previous question circles to concept boxes about the following: a key cause of climate - unequal heating of Earth by the Sun.
   * Have students analyze the additions to the class concept map for as many examples of this task’s crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
     + **Systems and Systems Models**: These could be phrases such as, “is a part of” “connects to,” “interacts with,” “is made up of,” “works together with,” etc.

* Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

**Evaluate: Connecting to the Culminating Project**

1. Students independently complete the Task 1 section of the Unit 2 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
2. Students have been asked to design a product that makes it more comfortable for people to live in a region with an extreme climate. Their prompt is as follows: Research the region you selected.

* Where is it located on Earth?
* How can its location on Earth explain the typical temperature in the region?
* Draw a Sun-Earth model to show and explain a major cause of your region’s climate.

**Reflection**

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:

* At the beginning of this task, you were given a list of statements to identify as relating to weather or climate. Would the modeling you did in the rest of this task relate to weather or climate? Why?
* In this task, we focused on the crosscutting concept of **Systems and System Models**:Models can be used to represent systems and their interactions. Where did you see examples of **System and System Models** in this task?
* Now that you have learned more about a major cause of climates, what questions do you still have?

1. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

**Assessment**

1. You may collect students’ Project Organizer and assess using:

* *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
* This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

1. You may also give students time to make revisions with one of the two options:

* Students may make changes to their Project Organizer according to your comments OR
* Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.