MIDDLE SCHOOL EARTH SCIENCE: WEATHER

Standards Bundle

Standards are listed within the bundle. Bundles are created with potential instructional use in mind, based upon potential for related phenomena that can be used throughout a unit.

MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. (SEP: 2; DCI: ESS2.C; CCC: Energy/Matter) [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [*Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.*]

MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. (SEP: 3; DCI: ESS2.C, ESS2.D; CCC: Cause/Effect) [Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [*Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.*]

MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. (SEP: 4; DCI: ESS3.B; CCC: Patterns, Technology) [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

Content Overview

This section provides a generic overview of the content or disciplinary core ideas as an entry point to the standards.

Almost all energy that drives the cycling of matter comes from the sun. The sun drives all weather patterns on Earth. Water influences weather and weather patterns through oceanic, atmospheric and land circulation. Weather can change in a short amount of time and factors such as air pressure, temperature, humidity, precipitation, and wind can cause those changes. Weather can be predicted, but weather forecasting has not been perfected. Data from weather maps, diagrams, and other visualizations can be used to detect and predict weather patterns. Ocean currents can redistribute energy from the sun, which can affect regional climates. Location on the planet (i.e. Latitude and longitude) will determine the weather and climate experienced. Large bodies of water can also affect the weather patterns in a given area. Natural hazards can impact resource availability and development. By mapping the natural events in an area and understanding the geological forces involved, future events can be predicted.

Phenomena

Phenomena can be used at varying levels of instruction. One could be used to anchor an entire unit, while another might be more supplemental for anchoring just a unit. Please remember that phenomena should allow students to engage in the SEP and use the CCC/DCI to understand and explain the phenomenon.

- Tornadoes occur more often in Tornado Alley than other areas of the United States.
- London, England is further north than South Dakota but has a milder climate.
- Hurricanes affect the east coast more than the west coast of the United States.
- Hurricanes moved east to west but weather patterns move west to east.
- Meteorologists use improved technology (ie Doppler et al.) and yet weather predictions are still not perfected.

Storyline

This section aims to decode not only the DCI connections, but also the SEP and CCC in a detailed account of how they possibly fit together in a progression for student learning, including both rationale and context for the bundle.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models ● Develop a model to describe unobservable mechanisms. **Planning and Carrying Out Investigations** ● Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.	**ESS2.C: The Roles of Water in Earth's Surface Processes** ● Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. ● Global movements of water and its changes in form are propelled by sunlight and gravity ● The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.	**Energy and Matter** ● Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. **Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in

Analyzing and Interpreting Data ● Analyze and interpret data to determine similarities and differences in findings.	**ESS2.D: Weather and Climate** ● Because these patterns are so complex, weather can only be predicted probabilistically. **ESS3.B: Natural Hazards** ● Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	natural or designed systems. **Patterns** ● Graphs, charts, and images can be used to identify patterns in data.

Through the water cycle, water is cycled and recycled through both the living and nonliving components of Earth's ecosystems. The global movement of water, driven by energy from the sun and the forces of gravity, continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, crystallization, and precipitation, as well as downhill flows on land through runoff and groundwater.

When teaching the disciplinary core ideas such as weather, climate, and differential heating of the Earth, students need to understand the difference between the phenomena and possible causes. Some cause and effect relationships, like the heating of the Earth and the redistribution of that energy, influence much of the weather on the planet. Students can use models to represent complex weather systems and their interactions. An example of this would be the transfer of energy through convection.

Weather consists of short term atmospheric conditions, which can vary from day to day. Weather is the condition of the atmosphere at any given time. Students can analyze data such as weather maps, diagrams, and visualizations and interpret weather patterns to help them understand the atmospheric changes that can occur daily in weather. Air masses always flow from a high pressure area to a low pressure area (which is created by differences in temperatures due to unequal heating of Earth's surface). This air movement creates weather that changes over time, depending on location.

Students can develop models for air masses through planning and conducting investigations to collect data about convection and convection currents. Fluids with a lower density can be used to model a low pressure area and fluids with a greater density can be used to model a high pressure area. Weather conditions can result from different types of air masses colliding thereby creating storms.

Differences in pressure at different areas can cause different types of weather. Students can analyze weather data for a period of time and interpret how differences in temperature and air pressure can result in changes in weather. Sunlight unevenly heats the Earth's surface, both land and oceans, which releases it over time and redistributes it through ocean currents, which in turn heats the atmosphere (i.e. differential heating). The resulting temperature patterns, together with the Earth's rotation (e.g. Coriolis effect) and location of continents and oceans, create large-scale patterns of atmospheric circulation.

Our Earth has an atmosphere, it creates a blanket of gases that regulates the average surface temperature of our planet. Students can conduct investigations and analyze the resulting data from different Earth materials that are submitted to thermal energy via sunlight or heat lamp to determine how thermal radiation affects these materials. They can analyze data to see the patterns.

Bodies of water influence weather and climate for areas near to them. Water absorbs energy much slower than other Earth materials. It takes five times more heat energy to raise an amount of water one degree than it takes to raise the temperature of an equal amount of dry soil or sand. Because of this, it creates low and high pressure areas, which in turn influences the weather (sea and ocean breezes). Wind is caused from these pressure differences. Areas near the equator have very low pressure areas, so this creates the Coriolis effect (wind created because of Earth's rotation). Students can use models to explain how differential heating of Earth's materials causes different areas of pressure.

Understanding these cycles and related geological forces can help predict the likelihood of future events. Many natural hazards are preceded with certain phenomena that allow for reliable predictions, such as volcanic eruptions and severe weather. Other hazards, such as earthquakes, cannot be so easily predicted. This can be accomplished through a thorough analysis and understanding of geological forces, such as tectonic plate motion, and by mapping natural hazards in a region, such as weather. Using patterns occurring in this data and the resulting predictions, technologies can be developed to mitigate the effects of these catastrophic nature events. This data includes locations, magnitudes, and frequencies of the hazards, and other information from satellite systems and other technologies that can record data inside or outside of the Earth.

Formative Assessment

Formative assessment is crucial because all learners benefit from timely and focused feedback from others. It promotes self-reflection, self-explanation, and social learning. It can also make learning more relevant. Each of the questions below might be used throughout the formative assessment process. Specific prompts may focus on individual practices, core ideas, or crosscutting concepts, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given bundle, standard or lesson-level performance expectation.

SEP Developing and Using Models

- Create a model to show how water cycles through the Earth's system.

SEP Planning and Carrying Out Investigations

- Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

SEP Analyzing and Interpreting Data

- Analyze and interpret data on natural hazards to predict the probability of a future event.

CCC Energy and Matter

- How does the uneven heating of the Earth affect weather patterns?
- How does the redistribution of energy influence weather?

CCC Cause and Effect

- How do ocean currents affect climate?
- How does the sun affect weather patterns?

CCC Patterns

- How do land features, such as mountains, affect weather patterns?

Performance Outcomes

These are statements of how students use knowledge and are similar to the standards in how they blend DCI, SEP, and CCC, but at a smaller grain-size. These are potential outcomes for instruction as it plays out in lessons and activities in the classroom. It is important to also think of these as smaller outcomes that build toward the larger goal of mastering the standards.

- **Engage in argument from evidence** to describe how global movements of water and its changes in form *are propelled* by sunlight and gravity and water cycles among land, ocean, and atmosphere .
- **Obtain, evaluate, and communicate** how weather and climate *are influenced* by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.
- **Analyze and interpret data** to show that interactions vary with latitude, altitude, and local and regional geography, all of which can *affect* oceanic and atmospheric flow *patterns*.
- **Use graphical displays** (e.g., maps, charts, graphs, and/or tables) to map *patterns* of natural hazards in a region such as volcanic eruptions, earthquakes, and severe weather.
- **Distinguish between** *causal and correlational relationships* among geological forces and natural hazards such as volcanic eruptions, earthquakes, and severe weather.
- **Analyze data** and its accuracy in forecasting the locations and likelihoods of future hazardous events and **observe** how the accuracy of data, with better technological tools and methods, *causes* improvements.
- **Construct, analyze, and/or interpret graphical displays** of data to *predict* possible future hazardous events.