EarthComm Alignment
to the Next Generation Science Standards
Earth and Space Science

The page numbers listed represent each section in which students are being prepared to meet the *Next Generation Science Standards*.

Activate Learning
Engaged Students. Passionate Teachers.

Earth's Place in The Universe

Performance Expectation	DCI	SEP	CC	*EarthComm* Location
HS-ESS1-1 Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.	The Universe and Its Stars Energy in Chemical Processes and Everyday Life	Asking Questions and Defining Problems (8-7, 8-8, 8-9) **Developing and Using Models** Planning and Carrying Out Investigations (8-7, 8-9) Analyzing and Interpreting Data (8-7, 8-8, 8-9) Obtaining, Evaluating, and Communicating Information (8-7, 8-8, 8-9)	**Scale, Proportion, and Quantity** Energy and Matter (8-7, 8-8, 8-9)	**Chapter 8, Section 7** (p. 977-988) *Students carry out an investigation that uses a spectrometer to see the different color components of visible light. They analyze and interpret data to describe the range of frequencies of energy within electromagnetic radiation. After this, they obtain information about a space mission and look at how astronomers are using electromagnetic radiation to understand the evolution of the Earth system. They relate their experiences to how electromagnetic radiation reveals the temperature and chemical makeup of objects such as stars.* **Chapter 8, Section 8** (p. 989-1000) *Students analyze and interpret sunspot and solar flare data by plotting the number of sunspots in a given year and correlating strong solar flare activity with larger numbers of sunspots. They examine the structure of the Sun and the flow of solar energy in terms of reflection, absorption, and scattering. Finally, students look at the cycles and effects of sunspots, solar flares, and the solar wind on the Earth system.* **Chapter 8, Section 9** (p. 1001-1011) *Students plan and carry out an investigation in which they measure and graph the apparent differences in brightness of three light bulbs at different distances. They then analyze data using a Hertzsprung-Russell (HR) diagram to classify stars according to their spectral characteristics. They relate their experiences to the relationship between the brightness of an object (its luminosity) and its magnitude. They examine stellar structure and the stellar evolution (the life histories of stars) as well as the chances of another star affecting Earth in some way.*
HS-ESS1-2 Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.	The Universe and Its Stars Electromagnetic Radiation	Asking Questions and Defining Problems (8-1, 8-3) Developing and Using Models (8-1, 8-3) Analyzing and Interpreting Data (8-3) Using Mathematics and Computational Thinking (8-1) **Constructing Explanations and Designing Solutions** (8-3)	Scale, Proportion, and Quantity (8-1) **Energy and Matter** (8-3)	**Chapter 8, Section 1** (p. 904-912) *Students develop and use a scale model of the solar system and identify some the strengths and limitations of scale models. They then use mathematics to compare the distances between the Sun and the planets to the distances to other objects in the universe, including stars and galaxies. They consider the position of Earth within the solar system and the solar system's location within the Milky Way Galaxy. They also look at the different types of galaxies in the universe and some of the distances between them.* **Chapter 8, Section 3** (p. 921-935) *Students consider the evidence that is used to explain the big bang theory for how the universe formed. They use a model that illustrates the relationship between the motion of stars and galaxies and the energy they emit. They then use a model of an expanding universe. After this, they analyze data and identify patterns in the emission of microwave energy coming from the sky. Finally, they use a model that illustrates the formation of the solar system from a large cloud of gas and dust.*
HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.	The Universe and Its Stars Energy in Chemical Processes and Everyday Life	Asking Questions and Defining Problems (8-9) Planning and Carrying Out Investigations (8-9) Analyzing and Interpreting Data (8-9) **Obtaining, Evaluating, and Communicating Information** (8-9)	**Energy and Matter** (8-9)	**Chapter 8, Section 9** (p. 1001-1011) *Students plan and carry out an investigation in which they measure and graph the apparent differences in brightness of three light bulbs at different distances. They then analyze data using a Hertzsprung-Russell (HR) diagram to classify stars according to their spectral characteristics. They relate their experiences to the relationship between the brightness of an object (its luminosity) and its magnitude. They examine stellar structure and the stellar evolution (the life histories of stars) as well as the chances of another star affecting Earth in some way.*

HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system	Earth and The Solar System	Asking Questions and Defining Problems (8-1, 8-2, 8-4, 8-5, 8-6) Developing and Using Models (8-1, 8-2, 8-5) Planning and Carrying Out Investigations (8-5) Analyzing and Interpreting Data (8-4, 8-5) **Using Mathematics and Computational Thinking** (8-1, 8-4, 8-5, 8-6) Obtaining, Evaluating, and Communicating Information (8-4, 8-5, 8-6)	Patterns (8-2) Cause and Effect (8-5) **Scale, Proportions and Quantity** (8-1, 8-4, 8-6)	**Chapter 8, Section 1** (p. 904-912) *Students develop and use a scale model of the solar system and identify some the strengths and limitations of scale models. They then use mathematics to compare the distances between the Sun and the planets to the distances to other objects in the universe, including stars and galaxies. They consider the position of Earth within the solar system and the solar system's location within the Milky Way Galaxy. They also look at the different types of galaxies in the universe and some of the distances between them.* **Chapter 8, Section 2** (p. 913-920) *Students analyze the celestial coordinate system for mapping positions on the celestial sphere. First, they develop a system for identifying specific locations on Earth. They then extend their ideas to the celestial coordinate system, a mathematical model for locating objects in the sky.* **Chapter 8, Section 4** (p. 936-945) *Students explore the shapes of the orbits of the planets by using mathematics to develop models of planetary movement. They measure the major axis and distance between the foci of an ellipse. This helps them to understand the relationship between the distance between the foci and eccentricity of an ellipse. They then examine the eccentricity of Earth's orbit of the Sun over time. They also consider the orbits of comets and asteroids in relation to Earth and the Sun.* **Chapter 8, Section 5** (p. 946-961) *Students use a model that demonstrates lunar phases. They then carry out an investigation in which they observe the Moon over time, noting changes in its apparent shape. After this, they analyze data to examine the relationship between tides and phases of the Moon. Following this, they complete calculations to determine how the Moon has influenced the length of a year on Earth. Finally, they obtain information about the Moon's likely origin.* **Chapter 8, Section 6** (p. 964-976) *Students use mathematics to calculate the energy released by five asteroids of different sizes hitting Earth's surface. They then compare the energy released by these impact events to known natural and human-made energy releasing events, including the six strongest earthquakes in the world between 1950 and 2016.*
HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.	The History of Planet Earth Plate Tectonics and Large-Scale System Interactions Nuclear Processes	Asking Questions and Defining Problems (1-1, 1-2, 1-6, 2-1 - 2-7, 7-1) Developing and Using Models (1-6, 2-3 - 2-6) Planning and Carrying Out Investigations (2-1, 2-2, 2-3, 2-4) Analyzing and Interpreting Data (1-1, 1-2, 1-6, 2-2 - 2-7, 7-1) Constructing Explanations and Designing Solutions (1-1, 1-2, 2-7) **Engaging in Argument from Evidence** (1-6) Obtaining, Evaluating, and Communicating Information (2-1 - 2-5, 7-1)	**Patterns** (1-1, 1-2, 2-1, 2-5, 2-6, 2-7, 7-1) Cause and Effect (2-5, 2-7) Scale, Proportion, and Quantity (2-1, 2-2, 2-3, 2-4) Stability and Change (1-6)	**Chapter 1, Section 1** (p. 10-23) *Students analyze data on maps to describe the distribution of volcanoes and earthquakes at global, regional, and local scales. They plot the latitude and longitude of the volcanoes and earthquakes closest to their community and make inferences about possible locations of future volcanic activity. They then examine the basic structure of Earth's interior and how volcanoes and earthquakes are features of Earth's crust.* **Chapter 1, Section 2** (p. 24-31) *Students analyze and interpret data from Global Positioning System (GPS) satellites to determine the direction and rate of motion of the North American Plate. They determine that the average direction of movement of the North American Place is to the west. They then consider the structure of Earth's crust and the underlying mantle.* **Chapter 1, Section 6** (p. 63-75) *Students examine some of the evidence that supports the idea that the continents of Earth have moved during geologic time. First, they analyze data on minerals, rock formations, and fossils and determine their distribution across the continents. They then use a series of maps as a model to explain how the position of the continents has changed over time and also how they may appear 250 million years into the future.* **Chapter 2, Section 1** (p.158-169) *Students plan and carry out investigations in which they examine a series of mineral samples to develop a list of properties that can be used to identify minerals. They then use a set of observations and tests to identify the minerals they examined.* **Chapter 2, Section 2** (p. 170-180) *Students carry out an investigation in which they determine a method for classifying igneous rocks. They then carry out an investigation in which they identify igneous rocks using a traditional igneous classification scheme and then compare this classification system to their own. They relate their experiences to how igneous rocks form and how the rates of magma cooling determine grain size in igneous rocks. Students then analyze a geologic map of their area to determine if any igneous rocks are present.*

				Chapter 2, Section 3 (p. 170-180) *Students use models that demonstrate how sedimentary rocks form. They then carry out an investigation in which they observe common sedimentary rocks and write descriptions of the rock samples. Students then use their written descriptions to determine whether each rock sample is clastic, organic, or chemical in nature. After this, they analyze a geologic map of their community to determine which kinds of sedimentary rocks are found near them.* **Chapter 2, Section 4** (p. 193-201) *Students carry out an investigation in which they examine the properties used to classify metamorphic rocks and then use a metamorphic rock chart to identify metamorphic rock samples or photographs. They then use a model that demonstrates deformation during metamorphism. Finally, students search for evidence of metamorphic rocks in their community by analyzing a local geologic map.* **Chapter 2, Section 5** (p. 204-213) *Students use a model that illustrates how a real fold looks in map view and in cross-section view. They then use a model to examine faults and determine the direction of forces needed to cause normal faults, reverse faults, and strike-slip faults. Finally, they interpret a simple map and cross section that contains folds and faults.* **Chapter 2, Section 6** (p. 214-225) *Students use models and interpret a series of simplified cross sections to explain the major geologic principles geologists use to determine the relative ages of rock units. They then use these principles to interpret the geologic history of an area using a simplified geologic cross section.* **Chapter 2, Section 7** (p. 226-235) *Students analyze and interpret a geologic map of the United States and produce their own, simplified version of the map. They determine where the oldest and youngest rocks in the United States can be found and what types of rocks they are. Students describe the major physiographic regions of the United States by comparing the United States geologic map with a map outlining the major physiographic provinces* **Chapter 7, Section 1** (p. 774-790) *Students will analyze data on a map of Earth's geologic provinces. They look for patterns in the data to explain the development of Earth's continents and look for clues about the history of the crust. They then analyze data on a map that shows the geology of the rocks that underlie the North American continent to understand its geologic development.*
HS-ESS1-6 Apply scientific reasoning and evidence form ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.	The History of Planet Earth Nuclear Processes	Asking Questions and Defining Problems (7-1, 8-3, 8-5) Developing and Using Models (8-3, 8-5) Planning and Carrying Out Investigations (8-5) Analyzing and Interpreting Data (7-1, 8-3, 8-5) Using Mathematics and Computational Thinking (8-5) **Constructing Explanations and Designing Solutions** (8-3) Obtaining, Evaluating, and Communicating Information (7-1, 8-5)	Patterns (7-1) Cause and Effect (8-5) Energy and Matter (8-3) **Stability and Change**	**Chapter 7, Section 1** (p. 774-790) *Students will analyze data on a map of Earth's geologic provinces. They look for patterns in the data to explain the development of Earth's continents and look for clues about the history of the crust. They then analyze data on a map that shows the geology of the rocks that underlie the North American continent to understand its geologic development.* **Chapter 8, Section 3** (p. 921-935) *Students consider the evidence that is used to explain the big bang theory for how the universe formed. They use a model that illustrates the relationship between the motion of stars and galaxies and the energy they emit. They then use a model of an expanding universe. After this, they analyze data and identify patterns in the emission of microwave energy coming from the sky. Finally, they use a model that illustrates the formation of the solar system from a large cloud of gas and dust.* **Chapter 8, Section 5** (p. 946-961) *Students use a model that demonstrates lunar phases. They then carry out an investigation in which they observe the Moon over time, noting changes in its apparent shape. After this, they analyze data to examine the relationship between tides and phases of the Moon. Following this, they complete calculations to determine how the Moon has influenced the length of a year on Earth. Finally, they obtain information about the Moon's likely origin.*

Earth's Systems

Performance Expectation	DCI	SEP	CC	*EarthComm* Location
HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	Earth Materials and Systems Plate Tectonics and Large-Scale System Interactions	Asking Questions and Defining Problems (1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 2-1, 2-2, 2-3, 2-4, 2-5, 2-6, 2-7, 3-4, 3-5, 3-6, 3-7, 3-8, 3-9, 3-10) **Developing and Using Models** (1-3, 1-4, 1-5, 1-6, 1-7, 2-3, 2-4, 2-5, 2-6, 3-4, 3-5, 3-6, 3-8, 3-9, 3-10) Planning and Carrying Out Investigations (1-3, 2-1, 2-2, 2-3, 2-4, 3-6, 3-7, 3-9) Analyzing and Interpreting Data (1-1, 1-2, 1-4, 1-5, 1-6, 2-2, 2-3, 2-4, 2-5, 2-6, 2-7, 3-4, 3-5, 3-9) Constructing Explanations and Designing Solutions (1-1, 1-2, 1-3, 1-4, 2-7) Engaging in Argument from Evidence (1-6) Obtaining, Evaluating, and Communicating Information (2-1, 2-2, 2-3, 2-4, 2-5, 3-5, 3-7, 3-9)	Patterns (1-1, 1-2, 2-1, 2-5, 2-6, 2-7, 3-5) Cause and Effect (1-3, 1-7, 2-5, 2-7, 3-5, 3-9, 3-10) Scale, Proportion, and Quantity (2-1, 2-2, 2-3, 2-4, 3-4, 3-6, 3-9) System and System Models (1-4, 1-5, 3-4, 3-8) Energy and Matter (3-6) Structure and Function (3-7) **Stability and Change** (1-6, 3-7, 3-8, 3-10)	**Chapter 1, Section 1** (p. 10-23) *Students analyze data on maps to describe the distribution of volcanoes and earthquakes at global, regional, and local scales. They plot the latitude and longitude of the volcanoes and earthquakes closest to their community and make inferences about possible locations of future volcanic activity. They then examine the basic structure of Earth's interior and how volcanoes and earthquakes are features of Earth's crust.* **Chapter 1, Section 2** (p. 24-31) *Students analyze and interpret data from Global Positioning System (GPS) satellites to determine the direction and rate of motion of the North American Plate. They determine that the average direction of movement of the North American Place is to the west. They then consider the structure of Earth's crust and the underlying mantle.* **Chapter 1, Section 3** (p. 32-40) *Students plan and carry out an investigation in which they use a variety of liquids to investigate the effects of density on how a material moves. They develop a method to determine the density of a variety of rocks. After this, they use a model to explain the densities of Earth's materials and the role of heat in causing Earth's lithospheric plates to move. Students relate their experiences to thermal convection and the forces that drive the movement of Earth's lithospheric plates.* **Chapter 1, Section 4** (p. 41-50) *Students use a model to determine the forces that cause the subduction of lithospheric plates. They then build a model that simulates seafloor spreading. They use the model to explain how crust is created and destroyed at divergent plate boundaries. After this, they analyze data on a world plate tectonic map to explore the different types of plate boundaries. Finally, they analyze and interpret data on maps to describe the plate tectonic setting of their own community.* **Chapter 1, Section 5** (p. 51-62) *Students use a model that illustrates plate tectonic processes and the major landforms they produce. They identify the surface features connected with different types of plate boundaries. They also relate differences in mantle material to certain features of Earth's crust. They then analyze data on a world map to determine patterns in hot-spot formation.* **Chapter 1, Section 6** (p. 63-75) *Students examine some of the evidence that supports the idea that the continents of Earth have moved during geologic time. First, they analyze data on minerals, rock formations, and fossils and determine their distribution across the continents. They then use a series of maps as a model to explain how the position of the continents has changed over time and also how they may appear 250 million years into the future.* **Chapter 1, Section 7** (p. 78-85) *Students develop models of volcanoes and construct contour maps of the models to learn how topographic maps depict elevations and features. They then connect representations of the land surface to the relationship between magma composition and types of volcanic landform.* **Chapter 2, Section 1** (p. 158-169) *Students plan and carry out investigations in which they examine a series of mineral samples to develop a list of properties that can be used to identify minerals. They then use a set of observations and tests to identify the minerals they examined.* **Chapter 2, Section 2** (p. 170-180) *Students carry out an investigation in which they determine a method for classifying igneous rocks. They then carry out an investigation in which they identify igneous rocks using a traditional igneous classification scheme and then compare this classification system to their own. They relate their experiences to how igneous rocks form and how the rates of magma cooling determine grain size in igneous rocks. Students then analyze a geologic map of their area to determine if any igneous rocks are present.*

				Chapter 2, Section 3 (p. 181-192) *Students use models that demonstrate how sedimentary rocks form. They then carry out an investigation in which they observe common sedimentary rocks and write descriptions of the rock samples. Students then use their written descriptions to determine whether each rock sample is clastic, organic, or chemical in nature. After this, they analyze a geologic map of their community to determine which kinds of sedimentary rocks are found near them.* **Chapter 2, Section 4** (p. 193-201) *Students carry out an investigation in which they examine the properties used to classify metamorphic rocks and then use a metamorphic rock chart to identify metamorphic rock samples or photographs. They then use a model that demonstrates deformation during metamorphism. Finally, students search for evidence of metamorphic rocks in their community by analyzing a local geologic map.* **Chapter 2, Section 5** (p. 204-213) *Students use a model that illustrates how a real fold looks in map view and in cross-section view. They then use a model to examine faults and determine the direction of forces needed to cause normal faults, reverse faults, and strike-slip faults. Finally, they interpret a simple map and cross section that contains folds and faults.* **Chapter 2, Section 6** (p. 214-225) *Students use models and interpret a series of simplified cross sections to explain the major geologic principles geologists use to determine the relative ages of rock units. They then use these principles to interpret the geologic history of an area using a simplified geologic cross section.* **Chapter 2, Section 7** (p. 226-235) *Students analyze and interpret a geologic map of the United States and produce their own, simplified version of the map. They determine where the oldest and youngest rocks in the United States can be found and what types of rocks they are. Students describe the major physiographic regions of the United States by comparing the United States geologic map with a map outlining the major physiographic provinces* **Chapter 3, Section 3** (p. 282-291) *Students carry out investigations in which they examine the effects that different materials, as well as the angle of repose, have on slopes. They then analyze contour data on a map to identify slopes in their community and determine their characteristics. Students relate their experiences to the importance of slopes in land use plans and land development.* **Chapter 3, Section 4** (p. 292-303) *Students observe the effects of high-gradient streams by constructing a model in a stream table. They then calculate a stream gradient using a topographic map. They consider the connections between stream gradient, elevation, and discharge by analyzing data from river systems in their community and from the Mississippi River system.* **Chapter 3, Section 5** (p. 304-313) *Students explore the characteristics of low-gradient streams by constructing a model in a stream table. They then collect and analyze data for a low-gradient stream or river in their community and explain its channel, floodplain, and streamflow characteristics.* **Chapter 3, Section 6** (p. 316-326) *Students use a model to explain the relationship between stream velocity and the characteristics of transported particles. They then carry out an investigation of sediment particles form a local river to explain how both erosional and depositional systems are related to materials transported by local streams and the effects these materials have on the community. Finally, they use a stream table as a model to explain the effect of flow velocity on the characteristics of stream-channel materials.* **Chapter 3, Section 7** (p. 327-334) *Students consider the structure of soil and how different types of soil are suited for various uses. They plan and conduct an investigation in which they develop a classification system for identifying different types of soil. They then plan and conduct an investigation in which they measure a specific property of soil that makes it possible to use the soil for a certain purpose*

				Chapter 3, Section 8 (p. 335-350) *Students use a quantitative model to explain how glaciers form and the mechanics of their movement. Students then use a stream table to develop models that show how glaciers and glacial meltwater modify the landscape through specialized processes of erosion and deposition. Students use these experiences to identify the features of glacial landscapes which are a major component of Earth's surface and an important indicator of Earth's past climate.* **Chapter 3, Section 9** (p. 351-365) *Students plan and carry out investigations that examine the factors that affect the erosion of a patch of sediment by wind. They then analyze data to explain the relationship between wind speed and particle size. Next, they use a model that examines the effects of windblown particles on rock. Finally, they use a model to explain the different ways that windblown sediment is deposited.* **Chapter 3, Section 10** (p. 366-381) *Students examine how ocean waves interact with coastal systems. They do this by using a series of models that examine the factors that affect wave generation and motion. Their models also explore what happens to ocean waves as they meet various types of shorelines (shallow beach, irregular coastline, and straight coastline).*
HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.	Earth Materials and Systems Weather and Climate	Asking Questions and Defining Problems (3-3, 3-4, 3-5, 3-6, 3-8, 3-9, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, 4-7, 4-8, 4-9, 5-5, 5-7) Developing and Using Models (3-4, 3-5, 3-6, 3-8, 3-9, 3-10, 4-1, 4-4, 4-7, 5-5) Planning and Carrying Out Investigations (3-3, 3-6, 3-7, 4-2, 4-9) **Analyzing and Interpreting Data** (3-3, 3-4, 3-5, 3-9, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, 4-7, 4-8, 4-9, 5-5) Using Mathematical and Computational Thinking (5-5) Engaging in Argument from Evidence (5-7) Obtaining, Evaluating, and Communicating (3-3, 3-5, 3-7, 3-9, 4-1, 4-2, 4-4, 4-5, 4-6)	Patterns (3-5, 4-4, 4-5, 4-6) **Cause and Effect** (3-3, 3-5, 3-9, 3-10, 4-3, 4-7, 4-8) Scale, Proportion, and Quantity (3-4, 3-6, 3-9) System and System Models (3-4, 3-8, 5-7) Energy and Matter (3-6, 4-1, 4-2) Structure and Function (3-7, 4-9, 5-3) Stability and Change (3-3, 3-7, 3-8, 3-10, 5-5)	**Chapter 3, Section 3** (p. 282-291) *Students carry out investigations in which they examine the effects that different materials, as well as the angle of repose, have on slopes. They then analyze contour data on a map to identify slopes in their community and determine their characteristics. Students relate their experiences to the importance of slopes in land use plans and land development.* **Chapter 3, Section 4** (p. 292-303) *Students observe the effects of high-gradient streams by constructing a model in a stream table. They then calculate a stream gradient using a topographic map. They consider the connections between stream gradient, elevation, and discharge by analyzing data from river systems in their community and from the Mississippi River system.* **Chapter 3, Section 5** (p. 304-313) *Students explore the characteristics of low-gradient streams by constructing a model in a stream table. They then collect and analyze data for a low-gradient stream or river in their community and explain its channel, floodplain, and streamflow characteristics.* **Chapter 3, Section 6** (p. 316-326) *Students use a model to explain the relationship between stream velocity and the characteristics of transported particles. They then carry out an investigation of sediment particles form a local river to explain how both erosional and depositional systems are related to materials transported by local streams and the effects these materials have on the community. Finally, they use a stream table as a model to explain the effect of flow velocity on the characteristics of stream-channel materials.* **Chapter 3, Section 7** (p. 327-334) *Students consider the structure of soil and how different types of soil are suited for various uses. They plan and conduct an investigation in which they develop a classification system for identifying different types of soil. They then plan and conduct an investigation in which they measure a specific property of soil that makes it possible to use the soil for a certain purpose* **Chapter 3, Section 8** (p. 335-350) *Students use a quantitative model to explain how glaciers form and the mechanics of their movement. Students then use a stream table to develop models that show how glaciers and glacial meltwater modify the landscape through specialized processes of erosion and deposition. Students use these experiences to identify the features of glacial landscapes which are a major component of Earth's surface and an important indicator of Earth's past climate.* **Chapter 3, Section 9** (p. 351-365) *Students plan and carry out investigations that examine the factors that affect the erosion of a patch of sediment by wind. They then analyze data to explain the relationship between wind speed and particle size.*

Next, they use a model that examines the effects of windblown particles on rock. Finally, they use a model to explain the different ways that windblown sediment is deposited.

Chapter 3, Section 10 (p. 366-381)
Students examine how ocean waves interact with coastal systems. They do this by using a series of models that examine the factors that affect wave generation and motion. Their models also explore what happens to ocean waves as they meet various types of shorelines (shallow beach, irregular coastline, and straight coastline).

Chapter 4, Section 1 (p. 400-413)
Students analyze data on maps to identify some of the large-scale factors that influence the global movement of air. They use a model to examine the effects of regional temperature differences on air movement. They connect their experiences to global wind belts and patterns of circulation in Earth's atmosphere.

Chapter 4, Section 2 (p. 414-425)
Students examine the interactions between different types of air masses and how they result in various weather conditions. They carry out investigations that examine the effects of different temperatures on a volume of air. They then analyze temperature data on a map to identify air masses over the United States on a particular day. They relate patterns in the data to a satellite image of a large weather event that occurred around the same time. Finally, they carry out an investigation in which they use a variety of instruments to measure and collect weather data.

Chapter 4, Section 3 (p. 426-438)
Students analyze thunderstorm data to explain where in the United States the most and the least number of thunderstorms occur. They then analyze data on a topographic map to explain the relationship between topography and the incidence of flash flooding. Finally, they analyze data on a local topographic map to explain the vulnerability of their community to a flash flood.

Chapter 4, Section 4 (p. 439-448)
Students construct a map of tornado frequency throughout the United States. They compare their maps to a map illustrating thunderstorm frequency to determine the relationship between tornadoes and thunderstorms. They use the maps to determine the threat of tornadoes in their community. They then analyze data to explain how the frequency of tornadoes varies over a year. Finally, they use a model that illustrates air flow in a downburst.

Chapter 4, Section 5 (p. 449-461)
Students analyze hurricane data to determine which areas in the United State are most likely to experience hurricanes. They then analyze data to describe the frequency of hurricanes at various times of the year. Finally, they analyze data to describe the path of a hurricane and how its strength changes as it moves.

Chapter 4, Section 6 (p. 464-473)
Students analyze and interpret data on a map that shows the path of spilled shoes in the North Pacific Ocean to explain how ocean surface currents move. They then compare a map of ocean surface currents and a map of wind patterns to explain the influence of winds on surface ocean circulation. After this, they compare wind patterns during an El Niño event with winds during non-El Niño periods to make inferences about any expected changes in ocean circulation during an El Niño event.

Chapter 4, Section 7 (p. 474-488)
Students consider the factors that influence the movement of deep ocean water. They use (small-scale) ocean models to examine the influence of temperature and salinity differences between water masses on deep water circulation. They then use a model to describe how convection cells operate in the oceans. Finally, they analyze data on maps and look for patterns in global sea surface temperature and ocean salinity.

Chapter 4, Section 8 (p. 489-501)
Students consider the factors that cause an El Niño event. They analyze and interpret data relating to sea surface temperatures in El Niño and non-El Niño years to explain how sea surface temperatures vary during El Niño events. After this, they analyze and interpret remote sensing data to explain the extent and duration of an El Niño event that occurred from 1997 to 1998.

				Chapter 4, Section 9 (p. 502-515) *Students analyze data on temperature and precipitation to describe the climate of their community. They analyze a local topographic map to determine what physical features in their community might influence climate. They then compare the climate of their community to that of a different community. Finally, they plan and carry out an investigation to explain how the rates of cooling and heating of rock can affect climate.* **Chapter 5, Section 5** (p. 580-589) *Students use mathematics to analyze and interpret glacial and sea-level data. They use equal-area projections of the areas around the North and South Poles from 20,000 years ago to calculate the volume of ice during the Pleistocene and to determine how the melting or growth of these ice sheets would affect sea level. They then examine present-day equal-area projections of the areas around the North and South Poles to calculate the change in sea level that would occur if these ice sheets were to melt entirely. They use their earlier calculations of sea-level rise and fall to determine the areas of the United States that would be flooded or dry with a change in sea level. Finally, they use a model that illustrates postglacial rebound.* **Chapter 5, Section 7** (p. 602-609) *Students construct an argument for the ways that higher global temperatures could affect their community. They obtain and evaluate information about the factors that cause global warming and how they affect the different spheres of the Earth system. They then design an investigation or model that could be used to test their ideas. They also consider some of the problems in making predictions relating to climate change.*
HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.	Earth Materials and Systems Plate Tectonics and Large-Scale System Interactions Wave Properties	Asking Questions and Defining Problems (1-3, 1-4, 1-5, 1-10, 1-11, 1-12) **Developing and Using Models** (1-3, 1-4, 1-5, 1-10) Planning and Carrying Out Investigations (1-3, 1-11) Analyzing and Interpreting Data (1-4, 1-5, 1-11, 1-12) Constructing Explanations and Designing Solutions (1-3, 1-4, 1-10, 1-12)	Cause and Effect (1-3, 1-10) Scale, Proportion, and Quantity (1-12) System and System Models (1-4, 1-5) **Energy and Matter** Structure and Function (1-11)	**Chapter 1, Section 3** (p. 32-40) *Students plan and carry out an investigation in which they use a variety of liquids to investigate the effects of density on how a material moves. They develop a method to determine the density of a variety of rocks. After this, they use a model to explain the densities of Earth's materials and the role of heat in causing Earth's lithospheric plates to move. Students relate their experiences to thermal convection and the forces that drive the movement of Earth's lithospheric plates.* **Chapter 1, Section 4** (p. 41-50) *Students use a model to determine the forces that cause the subduction of lithospheric plates. They then build a model that simulates seafloor spreading. They use the model to explain how crust is created and destroyed at divergent plate boundaries. After this, they analyze data on a world plate tectonic map to explore the different types of plate boundaries. Finally, they analyze and interpret data on maps to describe the plate tectonic setting of their own community.* **Chapter 1, Section 5** (p. 51-62) *Students use a model that illustrates plate tectonic processes and the major landforms they produce. They identify the surface features connected with different types of plate boundaries. They also relate differences in mantle material to certain features of Earth's crust. They then analyze data on a world map to determine patterns in hot-spot formation*. **Chapter 1, Section 10** (p. 104-111) *Students use a model to explain how energy stored in rocks is released in the form of an earthquake. They then use coiled springs to model the movement of earthquake waves through Earth and make inferences about the effects these waves may have on Earth's surface.* **Chapter 1, Section 11** (p. 112-126) *Students carry out an investigation in which they construct a simple seismometer. They then analyze and interpret data on a seismogram to determine arrival times of the two types of seismic waves. Finally, they analyze a seismogram and determine the distance to the epicenter of an earthquake from the seismometer.* **Chapter 1, Section 12** (p. 127-139) *Students analyze and interpret reports that describe the effects of a single earthquake. They rank the reports according to intensity and plot this data on a map. They use patterns in the data to determine the earthquake's approximate origin. They then examine a tool used by scientists for collecting data relating to people's experiences of an earthquake.*

HS-ESS2-4. Analyze and interpret data to explore how variations in the flow of energy into and out of Earth's systems result in changes in atmosphere and climate.	Earth and the Solar System Earth Materials and Systems Weather and Climate	Asking Questions and Defining Problems (1-9, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, 4-7, 4-8, 4-9, 5-2, 5-3, 5-4) Developing and Using Models (1-9, 4-1, 4-4, 4-7, 5-2, 5-3, 5-4) Planning and Carrying Out Investigations (1-9, 4-2, 4-9, 5-2) **Analyzing and Interpreting Data** (1-9, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, 4-7, 4-8, 4-9, 5-3, 5-4) Using Mathematical and Computational Thinking (5-2) Obtaining, Evaluating, and Communicating (1-9, 4-1, 4-2, 4-4, 4-5, 4-6, 5-4)	Patterns (4-4, 4-5, 4-6) **Cause and Effect** (4-3, 4-7, 4-8, 5-4) Energy and Matter (4-1, 4-2, 5-2, 5-4) Structure and Function (4-9, 5-3) Stability and Change (1-9)	**Chapter 1, Section 9** (p. 95-103) *Students analyze and interpret data on maps and in data tables to develop a concept of the varying scale of volcanic eruptions and determine that volcanic ash affects a larger area than other volcanic products. Students then plan and carry out an investigation to determine the volume of gas dissolved in a carbonated beverage. They connect their experiences to the common gases dissolved in magma and released during volcanism.* **Chapter 4, Section 1** (p. 400-413) *Students analyze data on maps to identify some of the large-scale factors that influence the global movement of air. They use a model to examine the effects of regional temperature differences on air movement. They connect their experiences to global wind belts and patterns of circulation in Earth's atmosphere.* **Chapter 4, Section 2** (p. 414-425) *Students examine the interactions between different types of air masses and how they result in various weather conditions. They carry out investigations that examine the effects of different temperatures on a volume of air. They then analyze temperature data on a map to identify air masses over the United States on a particular day. They relate patterns in the data to a satellite image of a large weather event that occurred around the same time. Finally, they carry out an investigation in which they use a variety of instruments to measure and collect weather data.* **Chapter 4, Section 3** (p. 426-438) *Students analyze thunderstorm data to explain where in the United States the most and the least number of thunderstorms occur. They then analyze data on a topographic map to explain the relationship between topography and the incidence of flash flooding. Finally, they analyze data on a local topographic map to explain the vulnerability of their community to a flash flood.* **Chapter 4, Section 4** (p. 439-448) *Students construct a map of tornado frequency throughout the United States. They compare their maps to a map illustrating thunderstorm frequency to determine the relationship between tornadoes and thunderstorms. They use the maps to determine the threat of tornadoes in their community. They then analyze data to explain how the frequency of tornadoes varies over a year. Finally, they use a model that illustrates air flow in a downburst.* **Chapter 4, Section 5** (p. 449-461) *Students analyze hurricane data to determine which areas in the United State are most likely to experience hurricanes. They then analyze data to describe the frequency of hurricanes at various times of the year. Finally, they analyze data to describe the path of a hurricane and how its strength changes as it moves.* **Chapter 4, Section 6** (p. 464-473) *Students analyze and interpret data on a map that shows the path of spilled shoes in the North Pacific Ocean to explain how ocean surface currents move. They then compare a map of ocean surface currents and a map of wind patterns to explain the influence of winds on surface ocean circulation. After this, they compare wind patterns during an El Niño event with winds during non-El Niño periods to make inferences about any expected changes in ocean circulation during an El Niño event.* **Chapter 4, Section 7** (p. 474-488) *Students consider the factors that influence the movement of deep ocean water. They use (small-scale) ocean models to examine the influence of temperature and salinity differences between water masses on deep water circulation. They then use a model to describe how convection cells operate in the oceans. Finally, they analyze data on maps and look for patterns in global sea surface temperature and ocean salinity.* **Chapter 4, Section 8** (p. 489-501) *Students consider the factors that cause an El Niño event. They analyze and interpret data relating to sea surface temperatures in El Niño and non-El Niño years to explain how sea surface temperatures vary during El Niño events. After this, they analyze and interpret remote sensing data to explain the extent and duration of an El Niño event that occurred from 1997 to 1998.*

				Chapter 4, Section 9 (p. 502-515) *Students analyze data on temperature and precipitation to describe the climate of their community. They analyze a local topographic map to determine what physical features in their community might influence climate. They then compare the climate of their community to that of a different community. Finally, they plan and carry out an investigation to explain how the rates of cooling and heating of rock can affect climate.* **Chapter 5, Section 2** (p. 544-556) *Students examine the different factors that cause Earth's seasons and influence Earth's climate. They use models to explain how the tilt of Earth on its axis controls the seasons of the Northern and Southern Hemispheres. They then use a model that demonstrates how variations in Earth's orbit affect the amount of radiation Earth receives from the Sun. Students relate these experiences to orbital cycles and variations in Earth's climate.* **Chapter 5, Section 3** (p. 557-567) *Students use models to explain that over long periods of geologic time, the geography of Earth's seafloor and the arrangement of its continent's changes. They then analyze and interpret data on maps to explain how ocean basins, the different pathways through which ocean water circulates, and the resulting changes that help to redistribute heat from Earth's warmer surfaces to its cooler ones, affect global climate.* **Chapter 5, Section 4** (p. 568-577) *Students analyze and interpret data to explain changes in atmospheric carbon dioxide concentrations since 1901 and then over the last 160,000 years. They compare the data to global temperatures to find the relationship between the two. Students then develop and use a model that demonstrates the greenhouse effect.*
HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere	Weather and Climate	Asking Questions and Defining Problems (5-4, 7-2) **Developing and Using Models** (5-4, 7-2) Analyzing and Interpreting Data (5-4) Obtaining, Evaluating, and Communicating Information (5-4, 7-2)	Cause and Effect (5-4) **Energy and Matter** (5-4, 7-2)	**Chapter 5, Section 4** (p. 568-577) *Students analyze and interpret data to explain changes in atmospheric carbon dioxide concentrations since 1901 and then over the last 160,000 years. They compare the data to global temperatures to find the relationship between the two. Students then develop and use a model that demonstrates the greenhouse effect.* **Chapter 7, Section 2** (p. 791-802) *Students develop and use a model that demonstrates the release of gases dissolved in Earth's mantle into the atmosphere. They relate this experience to the process of outgassing, in which gases emanate from Earth's interior during volcanic eruptions*
HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth systems and life on Earth.	Weather and Climate Biogeology	Asking Questions and Defining Problems (7-2, 7-3, 7-4, 7-5, 7-6, 7-7, 7-8, 7-9) Developing and Using Models (7-2, 7-3, 7-5, 7-7) Planning and Carrying Out Investigations (7-3, 7-4, 7-6, 7-8, 7-9) Analyzing and Interpreting Data (7-4, 7-8) Using Mathematical and Computational Thinking (7-5) **Engaging in Argument from Evidence**	Energy and Matter (7-2) **Stability and Change** (7-3, 7-4, 7-5, 7-6, 7-7, 7-8, 7-9)	**Chapter 7, Section 2** (p. 791-802) *Students develop and use a model that demonstrates the release of gases dissolved in Earth's mantle into the atmosphere. They relate this experience to the process of outgassing, in which gases emanate from Earth's interior during volcanic eruptions.* **Chapter 7, Section 3** (p. 803-818) *Students are introduced to scientific hypotheses for the origin of the biosphere. They use a model to evaluate the chemosynthesis hypothesis for how life emerged on Earth. They then carry out an investigation in which they observe coacervates to understand how life may have formed from proto-cells. Next, they carry out an investigation in which they examine Earth's oldest evidence of life on Earth. Finally, they investigate stromatolites, special layered rocks formed by ancient cyanobacteria, and make inferences about how they lived.* **Chapter 7, Section 4** (p. 819-828) *Students carry out an investigation in which they explain the simple chemical process of rusting by immersing iron in water. They then carry out an investigation in which they explore special rocks, called banded iron formations, which provide an insight into iron oxidation several billion years ago. Finally, they analyze data about the timing of the development of banded iron formations. They use this to make inferences about the volume of iron and oxygen in the global ocean and the atmosphere.*

		Obtaining, Evaluating, and Communicating Information (7-2, 7-4, 7-6, 7-8, 7-9)		**Chapter 7, Section 5** (p. 829-841) *Students begin by creating a model of the geologic time scale using major events that have occurred through geologic time. They then use mathematics to examine the geologic time scale developed by scientists and compare it to their own scales. They see how scientists break down geologic time into periods according to the appearance and disappearance of living things throughout Earth's history. Finally, students use a model that demonstrates radioactive decay to understand how scientists determine the absolute age of a rock.* **Chapter 7, Section 6** (p. 844-851) *Students use a model that illustrates fossilization using plaster and a shell. They then carry out an investigation in which they examine the different levels of the ecosystem in their community and identify which organisms are more or less likely to be preserved in the fossil record.* **Chapter 7, Section 7** (p. 852-866) *Students use a model that examines the adaptation of a population of moths in response to a change in their environment. They then use a model of fossil specimens that contain changes in their body forms to explain rates of change in the biosphere. Following that, students develop a time sequence for a group of fossils of unknown age.* **Chapter 7, Section 8** (p. 867-875) *Students use images to carry out an investigation of the major biomes of North America. They decide which biome their own community is found in, and they compare this biome to the other North American biomes. Students think about the factors that control the distribution of plants and animals. They consider how the organisms in their community might change if the physical and chemical conditions were to change.* **Chapter 7, Section 9** (p. 876-885) *Students carry out an investigation in which they collect data about the paleoclimate before and after the Mesozoic–Cenozoic boundary event. They also obtain fossil evidence to understand how climate change can cause extinctions. They then carry out an investigation in which they compare photographs of skulls of organisms from before and after the boundary event to seek clues about which species survive*

Earth and Human Activity

Performance Expectation	DCI	SEP	CC	*EarthComm* Location
HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resource0s, occurrence of natural hazards, and changes in climate have influenced human activity.	Natural Resources Natural Hazards	Asking Questions and Defining Problems (1-8, 1-9, 4-3, 4-4, 4-5, 5-4, 6-1, 6-2, 6-3, 6-5, 6-7, 6-8) Developing and Using Models (1-8, 1-9, 4-4, 5-4, 6-7, 6-8) Planning and Carrying Out Investigations (1-8, 1-9 6-2, 6-3, 6-5) Analyzing and Interpreting Data (1-8, 1-9, 4-3, 4-4, 4-5, 5-4, 6-1, 6-2, 6-3, 6-5, 6-7) **Constructing Explanations and Designing Solutions** Engaging in Argument from Evidence (6-7)	Patterns (4-4, 4-5, 6-2) **Cause and Effect** (1-8, 4-3, 5-4) Scale, Proportion, and Quantity (6-3) Systems and System Models (6-8) Energy and Matter (5-4, 6-1, 6-5) Stability and Change (1-9, 6-7)	**Chapter 1, Section 8** (p. 86-94) *Students use models and carry out investigations that explore factors that affect volcanic flows (viscosity, slope, magma temperature, and channelization). They examine the nature and hazards of lava flows, pyroclastic flows, and lahars.* **Chapter 1, Section 9** (p. 95-103) *Students analyze and interpret data on maps and in data tables to develop a concept of the varying scale of volcanic eruptions and determine that volcanic ash affects a larger area than other volcanic products. Students then plan and carry out an investigation to determine the volume of gas dissolved in a carbonated beverage. They connect their experiences to the common gases dissolved in magma and released during volcanism.* **Chapter 4, Section 3** (p. 426-438) *Students analyze thunderstorm data to explain where in the United States the most and the least number of thunderstorms occur. They then analyze data on a topographic map to explain the relationship between topography and the incidence of flash flooding. Finally, they analyze data on a local topographic map to explain the vulnerability of their community to a flash flood.* **Chapter 4, Section 4** (p. 439-448) *Students construct a map of tornado frequency throughout the United States. They compare their maps to a map illustrating thunderstorm frequency to determine the relationship between tornadoes and thunderstorms. They use the maps to determine the threat of tornadoes in their community. They then analyze data to explain how the frequency of tornadoes varies over a year. Finally, they use a model that illustrates air flow in a downburst.* **Chapter 4, Section 5** (p. 449-461)

		Obtaining, Evaluating, and Communicating Information (1-9, 4-4, 4-5, 5-4, 6-1, 6-2, 6-5, 6-8)		*Students analyze hurricane data to determine which areas in the United State are most likely to experience hurricanes. They then analyze data to describe the frequency of hurricanes at various times of the year. Finally, they analyze data to describe the path of a hurricane and how its strength changes as it moves.* **Chapter 5, Section 4** (p. 568-556) *Students analyze and interpret data to explain changes in atmospheric carbon dioxide concentrations since 1901 and then over the last 160,000 years. They compare the data to global temperatures to find the relationship between the two. Students then develop and use a model that demonstrates the greenhouse effect.* **Chapter 6, Section 1** (p. 628-637) *Students analyze and interpret data to determine global trends in energy sources used to generate electricity. They compare the use of energy sources for electricity generation in the United States to those used in other countries. They then identify the energy sources that are most commonly used for electricity generation in the United States and in their state.* **Chapter 6, Section 2** (p. 638-651) *Students carry out an investigation in which they examine coal samples and identify the physical properties of different types of coal. They then analyze data on a map to explain the distribution of coal resources in the United States. After this, they analyze data on trends in production and consumption of coal in the United States. They use the data to extrapolate production and consumption into the future. Finally, they obtain information about possible methods to conserve coal resources* **Chapter 6, Section 3** (p. 652-667) *Students consider how oil and gas deposits are discovered, and how oil and gas are extracted from reservoirs. They plan and carry out investigations in which they explore porosity and permeability of rock bodies and consider how these factors affect the volume and rate of production in oil and gas fields. They analyze data on oil production, imports, and consumption in the United States to recognize the dependence of today's society on oil as a resource. They then analyze data on trends in oil production and consumption to extrapolate into the future. Finally, students analyze data on a map that shows the distribution of oil and gas deposits in the United States to determine whether oil and gas are found, refined, and/or distributed near their community.* **Chapter 6, Section 5** (p. 682-693) *Students explore renewable energy sources, focusing on the potential for solar and wind energy as sources of power generation in their community. They consider the use of solar energy by carrying out an investigation in which they construct a solar water heater and determine its maximum energy output. They consider the use of wind energy by carrying out an investigation in which they construct an anemometer to measure wind speeds and calculate how much power can be generated by wind. Finally, they analyze data to explain trends in solar and wind energy consumption in the United States.* **Chapter 6, Section 7** (p. 709-717) *Students consider the ways in which mineral ores are extracted from the ground and the environmental impacts of mining minerals. They use a model that demonstrates techniques for mining ore deposits. They then analyze and interpret data to explain trends in the mining industry. Finally, they evaluate solutions for mining minerals that are based on time, cost, and environmental concerns.* **Chapter 6, Section 8** (p. 718-732) *Students identify the human and natural factors that determine the income and expenditure of water resources. They use a model to explain the flow of water between surface reservoirs. They then use a model that illustrates groundwater flow. Finally, they obtain information from their community's water-quality report to understand water-supply management in their community.*

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.	Natural Resources Designing Solutions to Engineering Problems	Asking Questions and Defining Problems (6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8) Developing and Using Models (6-6, 6-7, 6-8) Planning and Carrying Out Investigations (6-2, 6-3, 6-4, 6-5) Analyzing and Interpreting Data (6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7) **Constructing Explanations and Designing Solutions** Engaging in Argument from Evidence (6-7) Obtaining, Evaluating, and Communicating Information (6-1, 6-2, 6-4, 6-5, 6-8)	Patterns (6-2, 6-4, 6-6) Scale, Proportion, and Quantity (6-3) **Systems and System Models** (6-8) Energy and Matter (6-1, 6-5) Stability and Change (6-7)	**Chapter 6, Section 1** (p. 628-637) *Students analyze and interpret data to determine global trends in energy sources used to generate electricity. They compare the use of energy sources for electricity generation in the United States to those used in other countries. They then identify the energy sources that are most commonly used for electricity generation in the United States and in their state.* **Chapter 6, Section 2** (p. 638-651) *Students carry out an investigation in which they examine coal samples and identify the physical properties of different types of coal. They then analyze data on a map to explain the distribution of coal resources in the United States. After this, they analyze data on trends in production and consumption of coal in the United States. They use the data to extrapolate production and consumption into the future. Finally, they obtain information about possible methods to conserve coal resources* **Chapter 6, Section 3** (p. 652-667) *Students consider how oil and gas deposits are discovered, and how oil and gas are extracted from reservoirs. They plan and carry out investigations in which they explore porosity and permeability of rock bodies and consider how these factors affect the volume and rate of production in oil and gas fields. They analyze data on oil production, imports, and consumption in the United States to recognize the dependence of today's society on oil as a resource. They then analyze data on trends in oil production and consumption to extrapolate into the future. Finally, students analyze data on a map that shows the distribution of oil and gas deposits in the United States to determine whether oil and gas are found, refined, and/or distributed near their community.* **Chapter 6, Section 4** (p. 668-681) *Students analyze data on a map that shows the acidity of rain across the United States and correlate the pattern of rain pH to the distribution of coal-producing regions. They then carry out an investigation to explain how different types of rocks can neutralize the acidity of rain. They consider how this relates to environmental impacts of acid rain.* **Chapter 6, Section 5** (p. 682-693) *Students explore renewable energy sources, focusing on the potential for solar and wind energy as sources of power generation in their community. They consider the use of solar energy by carrying out an investigation in which they construct a solar water heater and determine its maximum energy output. They consider the use of wind energy by carrying out an investigation in which they construct an anemometer to measure wind speeds and calculate how much power can be generated by wind. Finally, they analyze data to explain trends in solar and wind energy consumption in the United States.* **Chapter 6, Section 6** (p. 696-708) *Students analyze mineral resource commodities data on a map to explain the distribution of mineral resources in the United States. They then use a model to demonstrate techniques for exploring and locating ore deposits. They relate their experiences to how mineral resources are found, extracted, and processed.* **Chapter 6, Section 7** (p. 709-717) *Students consider the ways in which mineral ores are extracted from the ground and the environmental impacts of mining minerals. They use a model that demonstrates techniques for mining ore deposits. They then analyze and interpret data to explain trends in the mining industry. Finally, they evaluate solutions for mining minerals that are based on time, cost, and environmental concerns.* **Chapter 6, Section 8** (p. 718-732) *Students identify the human and natural factors that determine the income and expenditure of water resources. They use a model to explain the flow of water between surface reservoirs. They then use a model that illustrates groundwater flow. Finally, they obtain information from their community's water-quality report to understand water-supply management in their community.*

HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	Human Impacts on Earth Systems	Asking Questions and Defining Problems (6-9) Planning and Carrying Out Investigations (6-9) Analyzing and Interpreting Data (6-9) **Using Mathematics and Computational Thinking** Obtaining, Evaluating, and Communicating Information (6-9)	Scale, Proportion, and Quantity (6-9) **Stability and Change**	**Chapter 6, Section 9** (p. 733-742) *Students plan and carry out an investigation to determine how much water their school uses daily. They gather data on water use in their county and a neighboring county, and they compare water use in the two areas. Then then obtain information on the quantity of water used by industry and agriculture and methods used to conserve water.*
HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.	Human Impacts on Earth Systems Designing Solutions to Engineering Problems	Asking Questions and Defining Problems (6-5, 6-10) Developing and Using Models (6-10) Planning and Carrying Out Investigations (6-5, 6-10) Analyzing and Interpreting Data (6-5) **Constructing Explanations and Designing Solutions** Obtaining, Evaluating, and Communicating Information (6-5, 6-10)	System and System Models (6-10) Energy and Matter (6-5) **Stability and Change**	**Chapter 6, Section 5** (p. 682-693) *Students explore renewable energy sources, focusing on the potential for solar and wind energy as sources of power generation in their community. They consider the use of solar energy by carrying out an investigation in which they construct a solar water heater and determine its maximum energy output. They consider the use of wind energy by carrying out an investigation in which they construct an anemometer to measure wind speeds and calculate how much power can be generated by wind. Finally, they analyze data to explain trends in solar and wind energy consumption in the United States.* **Chapter 6, Section 10** (p. 743-755) *Students examine the vulnerability of water resources to pollution by both human use and natural cycles or processes. They use a groundwater model and infer how pollutants reach the groundwater table and move with groundwater flow. They use their model to examine how extracting water from a groundwater well influences the movement of pollution in groundwater. They then carry out an investigation in which they test untreated and treated water samples from their community for nitrate. Finally, they use a model that demonstrates water treatment and then water filtration.*
HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.	Global Climate Change	Asking Questions and Defining Problems (5-1, 5-4, 5-5, 5-6, 5-7) Developing and Using Models (5-1, 5-4, 5-5, 5-6) Planning and Carrying Out Investigations (5-1) **Analyzing and Interpreting Data** (5-1, 5-4, 5-5) Using Mathematical and Computational Thinking (5-5) Engaging in Argument from Evidence (5-7) Obtaining, Evaluating, and Communicating Information (5-4, 5-7)	Patterns (5-1) Cause and Effect (5-4) Systems and System Models (5-7) Energy and Matter (5-4) **Stability and Change** (5-5, 5-6)	**Chapter 5, Section 1** (p. 534-543) *Students consider how paleoclimatologists learn about past climates by making inferences from various kinds of proxy data. They carry out an investigation in which they correlate changes in the appearance of tree rings to changes in climate that may occurred during the life of the tree. They then create a model of sediment layers to understand how fossil pollen can be used to understand climate change through time.* **Chapter 5, Section 4** (p. 568-577) *Students analyze and interpret data to explain changes in atmospheric carbon dioxide concentrations since 1901 and then over the last 160,000 years. They compare the data to global temperatures to find the relationship between the two. Students then develop and use a model that demonstrates the greenhouse effect.* **Chapter 5, Section 5** (p. 580-589) *Students use mathematics to analyze and interpret glacial and sea-level data. They use equal-area projections of the areas around the North and South Poles from 20,000 years ago to calculate the volume of ice during the Pleistocene and to determine how the melting or growth of these ice sheets would affect sea level. They then examine present-day equal-area projections of the areas around the North and South Poles to calculate the change in sea level that would occur if these ice sheets were to melt entirely. They use their earlier calculations of sea-level rise and fall to determine the areas of the United States that would be flooded or dry with a change in sea level. Finally, they use a model that illustrates postglacial rebound.*

				Chapter 5, Section 6 (p. 590-601) *Students use a stream table to develop a model that demonstrates changes in landscape associated with a moderate, steadily flowing stream. Then, they use their model to explain how a rise in sea level shapes the landscape. Finally, they use their model to explain the effect of a sea-level fall on the landscape.* **Chapter 5, Section 7** (p. 602-609) *Students construct an argument for the ways that higher global temperatures could affect their community. They obtain and evaluate information about the factors that cause global warming and how they affect the different spheres of the Earth system. They then design an investigation or model that could be used to test their ideas. They also consider some of the problems in making predictions relating to climate change.*
HS-ESS3-6 Use a computational representation to illustrate the relationship among Earth systems and how those relationships are being modified due to human activity.	Weather and Climate Global Climate Change	Asking Questions and Defining Problems (5-4, 5-7) Developing and Using Models (5-4) Analyzing and Interpreting Data (5-4) **Using Mathematical and Computational Thinking** Engaging in Argument from Evidence (5-7) Obtaining, Evaluating, and Communicating Information (5-4, 5-7)	Cause and Effect (5-4) **Systems and System Models** (5-7) Energy and Matter (5-4)	**Chapter 5, Section 4** (p. 568-577) *Students analyze and interpret data to explain changes in atmospheric carbon dioxide concentrations since 1901 and then over the last 160,000 years. They compare the data to global temperatures to find the relationship between the two. Students then develop and use a model that demonstrates the greenhouse effect.* **Chapter 5, Section 7** (p. 602-609) *Students construct an argument for the ways that higher global temperatures could affect their community. They obtain and evaluate information about the factors that cause global warming and how they affect the different spheres of the Earth system. They then design an investigation or model that could be used to test their ideas. They also consider some of the problems in making predictions relating to climate change.*