

Unit 5: Earth Systems

Instructional Days: 20

Unit Summary***How do individual communities use science ideas to protect Earth's resources and environment?***

In this unit of study, students are able to describe ways in which the geosphere, biosphere, hydrosphere, and atmosphere interact. The crosscutting concept of *systems and system models* is called out as an organizing concept for this disciplinary core idea. Students are expected to demonstrate grade-appropriate proficiency in *developing and using models, obtaining, evaluating, and communicating information*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 5-ESS2-1 and 5-ESS3-1.

Student Learning Objectives

Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. *[Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]* ([5-ESS2-1](#))

Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. ([5-ESS3-1](#))

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5-ESS2-2	Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
5-ESS3-1	Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment
ESS2.A	Earth’s major systems are the geosphere, the hydrosphere, the atmosphere, and the biosphere
ESS2.C	Nearly all of Earth’s available water is in the ocean
ESS3.C	Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space

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Enduring Understandings
<ul style="list-style-type: none"> • Earthquakes, other natural disasters, and tectonics are responsible for the patterns and changes of Earth’s rock formations • The locations of fossils show the order in which rock layers were formed. • Climate and weather shape the land and determine which living things are found in a region.
Essential Questions
<ul style="list-style-type: none"> • Why does our planet look the way it does? • How and why do the Earth’s features constantly change? • How does the Earth’s constant change affect our future?

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Unit Sequence	
<i>Part A: In what ways do the geosphere, biosphere, hydrosphere, and/or atmosphere interact?</i>	
Concepts	Formative Assessment
<ul style="list-style-type: none"> • A system can be described in terms of its components and their interactions. • Earth’s major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). • The Earth’s major systems interact in multiple ways to affect Earth’s surface materials and processes. • The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. • Winds and clouds in the atmosphere interact with landforms to determine patterns of weather. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> • Describe a system in terms of its components and interactions. • Develop a model using an example to describe a scientific principle. • Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. <i>(The geosphere, hydrosphere, atmosphere, and biosphere are each a system. Assessment is limited to the interactions of two systems at a time.)</i> • Examples could include: <ul style="list-style-type: none"> ✓ The influence of oceans on ecosystems, landform shape, and climate. ✓ The influence of the atmosphere on landforms and ecosystems through weather and climate. ✓ The influence of mountain ranges on the wind and clouds in the atmosphere.

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Unit Sequence	
<i>Part B: How do individual communities use science ideas to protect Earth's resources and environment?</i>	
Concepts	Formative Assessment
<ul style="list-style-type: none"> • A system can be described in terms of its components and their interactions. • Science findings are limited to questions that can be answered with empirical evidence. • Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. • Individuals and communities are doing things to help protect Earth's resources and environments. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> • Describe a system in terms of its components and interactions. • Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. • Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

What It Looks Like in the Classroom
<p>In this unit of study, students develop models to describe the interactions that occur within and between major Earth systems and conduct research to learn how humans protect the Earth's resources.</p> <p>Foundational to this unit of study is the understanding of a system, its components, and the interactions that occur within the system. Initially, students may need opportunities to review familiar examples of systems, such as plants and animals, listing external and internal structures and processes and describing the interactions that occur within the system. Students can then begin to think about Earth's major systems, identifying the components and describing the interactions that occur within each. For example:</p> <ul style="list-style-type: none"> ✓ The geosphere is composed of solid and molten rock, soil, and sediments. Some processes that occur between the components of the geosphere include erosion, weathering, deposition, sedimentation, compaction heating, cooling, and flow. These processes cause continual change to rock, soil, and sediments. ✓ The hydrosphere is composed of water in all its forms. Water, unlike the vast majority of earth materials, occurs

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naturally on the Earth as a solid, liquid, or gas, and it can be found on, above, and below the surface of the Earth. Some processes that occur in the hydrosphere include evaporation, condensation, precipitation, run-off, percolation, freezing, thawing, and flow. These processes cause water to change from one form to another in a continuous cycle.

- ✓ The atmosphere is a critical system made up of the gases that surround the Earth. The atmosphere helps to regulate Earth's climate and distribute heat around the globe, and it is composed of layers with specific properties and functions. This system, composed mainly of nitrogen, oxygen, argon, and carbon dioxide, also contains small amounts of other gases, including water vapor, which is found in the lowest level of the atmosphere where weather-related processes occur. In addition to weather processes, radiation, conduction, convection, carbon cycling, and the natural greenhouse effect are processes that occur in the atmosphere.
- ✓ The biosphere comprises living things, including humans. Living organisms can be found in each of the major systems of the Earth (the atmosphere, hydrosphere, and geosphere). Some processes that occur within the biosphere include transpiration, respiration, reproduction, photosynthesis, metabolism, growth, and decomposition.

As students become more comfortable with describing each system in terms of its components and interactions, they should begin to think about and discuss the interactions that occur between systems. This should be a natural progression in their learning, since students will discover that any interactions that occur within a system affect components of other systems. Students should develop models that describe ways in which any two Earth systems interact and how these interactions affect the living and nonliving components of the Earth. Some examples include:

- ✓ The influence of oceans on ecosystems, landform shape, or climate.
- ✓ The impact of the atmosphere on landforms or ecosystems through weather and climate.
- ✓ The influence of mountain ranges on wind and clouds in the atmosphere.
- ✓ The role of living organisms (both plants and animals) in the creation of soils.

As a class, students can brainstorm additional examples. They can use any type of model, such as diagrams or physical replicas, to describe the interactions that occur between any two systems, and they can choose to enhance the model with multimedia components or visual displays.

Once students have an understanding of the components and interactions that occur within and between Earth's major systems, they should gather information about the ways in which individual communities use science ideas to protect Earth's resources and environment. Students can work individually, in pairs, or in small groups to conduct research using books and

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other reliable media resources. They should paraphrase and summarize information as they take notes, then use their information to support their finished work. Students' research should help them determine:

- ✓ How human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space
- ✓ What individuals and communities are doing to help protect Earth's resources and the environment.

Students can share their work in a variety of ways and should provide a list of sources for the information in their finished work.

Although engineering design is not explicitly called out in this unit, students could incorporate engineering design in a number of ways as they explore human impact on the environment.

- ✓ Students may design a way to promote local, sustainable agriculture, making healthy food available to more people in their communities while having minimizing the impact on the local environment.
- ✓ Students can design ways to capture and use rainwater throughout their community to lessen the impact on local freshwater reserves.
- ✓ Students can design and implement a variety of recycling projects that have a positive impact on the environment by increasing the reuse of materials that normally end up in landfills and decreasing our reliance on earth resources.
- ✓ Students can research and design ways to increase the use of environmentally friendly fertilizers and pesticides that do not harm the local environment. Students can create pamphlets, presentations, or even commercials that inform the local community of the impact that chemical fertilizers and pesticides have when used in and around homes and businesses and offer information on safer alternatives that are just as effective.

Students will need time to conduct research, determine criteria for success, consider constraints on available resources, and design solutions based on the information they gather. Students will need access to reliable sources of information that will help them as they work through the design process.

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Connecting with English Language Arts/Literacy and Mathematics*English Language Arts*

In this unit, students can use information from print and digital sources to build their understanding of Earth's major systems and the interactions that occur within and between them. As students read and gather information from multiple print or digital sources, they should use the information to make inferences, answer questions, participate in discussions, solve problems, and support their thinking about the interactions that occur among Earth's systems and the impact that humans have on Earth's resources and environments. As students build models to explain the interactions between the systems and research ways in which individual communities use science ideas to protect the Earth's resources and environments, they can enhance their work with multimedia components, such as graphics and sound and visual displays.

Mathematics

In this unit, students should:

- ✓ Reason abstractly and quantitatively when analyzing data used as evidence to explain how Earth's major systems interact and how human activities affect Earth's resources.
- ✓ Model with mathematics by using tables, charts, or graphs to organize data and information they collect to support explanations about the interactions that occur within and between Earth's systems.
- ✓ Represent real-world and mathematical relationships through graphing. For example, students can graph data to show the relationship between the amount of rainfall that occurs and changes in air temperature or pressure or the relationship between the types or number of organisms living at various altitudes.

Modifications

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: [All Standards, All Students/Case Studies](#) for vignettes and explanations of the modifications.)

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-

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- auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
 - Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
 - Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
 - Use project-based science learning to connect science with observable phenomena.
 - Structure the learning around explaining or solving a social or community-based issue.
 - Provide ELL students with multiple literacy strategies.
 - Collaborate with after-school programs or clubs to extend learning opportunities.
 - Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Research on Student Learning
N/A

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Prior Learning**Grade 2 Unit 4: The Earth's Land and Water**

- Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.
- Wind and water can change the shape of the land.

Grade 3 Unit 1: Weather and Climate

- Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.
- Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.

Grade 4 Unit 1: Weathering and Erosion

- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

Future Learning**Grade 6 Unit 7: Weather and Climate**

- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.
- 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.
- Global movements of water and its changes in form are propelled by sunlight and gravity.
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.
- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.

Grade 8 Unit 3: Stability and Change on Earth

- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and

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biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

Grade 7 Unit 8: Earth Systems

- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.
- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.
- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.

Grade 6 Unit 7: Weather and Climate

- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.
- 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.
- Global movements of water and its changes in form are propelled by sunlight and gravity.
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.
- Because these patterns are so complex, weather can only be predicted probabilistically.
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

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Connections to Other Units

In **unit 4**, students are able to describe and graph data to provide evidence about the distribution of water on Earth.

Sample of Open Education Resources

[NOAA What-a-Cycle](#): Through role-playing as a particle of water, students gain an understanding of the complexity of the movement of water through earth's systems. Stations are set-up for nine different water reservoirs associated with the water cycle. On each turn, students roll the dice at each station and either stay in place or move to a different location. Students track their unique journey through the water cycle to later share and discuss the strengths and limitations of the game as a model for the movement of water through Earth's systems.

[Shower Curtain Watershed](#): What is a watershed? How do our actions affect the health of a watershed? Students explore these questions by analyzing pictures and identifying watershed features. Students then make a watershed model using a plastic shower curtain, a spray bottle of water and themselves or classroom objects. The objectives of the lesson are to: a) Identify nonliving and living features found in a watershed. b) Understand how human activities can affect watersheds.

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Teacher Professional Learning Resources**Assessment for the Next Generation Science Standards**

The presenters were Joan Herman, Co-Director Emeritus of the National Center for Research on Evaluation, Standards, and Student Testing (CRESST) at UCLA; and Nancy Butler Songer, Professor of Science Education and Learning Technologies, University of Michigan.

Dr. Herman began the presentation by summarizing a report by the National Research Council on assessment for the Next Generation Science Standards (NGSS). She talked about the development of the report and shared key findings. Next, Dr. Songer discussed challenges for classroom implementation and provided examples of tasks that can be used with students to assess their proficiency on the NGSS performance expectations. Participants had the opportunity to submit questions and share their feedback in the chat.

View the [resource collection](#).

Continue discussing this topic in the [community forums](#).

NGSS Crosscutting Concepts: Patterns

The presenter was Kristin Gunckel from the University of Arizona. Dr. Gunckel began the presentation by discussing how patterns fit in with experiences and explanations to make up scientific inquiry. Then she talked about the role of patterns in NGSS and showed how the crosscutting concept of patterns progresses across grade bands. After participants shared their ideas about using patterns in their own classrooms, Dr. Gunckel shared instructional examples from the elementary, middle school, and high school levels.

NGSS Crosscutting Concepts: Structure and Function

The presenters were Cindy Hmelo-Silver and Rebecca Jordan from Rutgers University. Dr. Hmelo-Silver and Dr. Jordan began the presentation by discussing the role of the crosscutting concept of structure and function within NGSS. They then asked participants to think about the example of a sponge and discuss in the chat how a sponge's structure relates to its function. The presenters introduced the Structure-Behavior-Function (SBF) theory and talked about the importance of examining the relationships between mechanisms and structures. They also discussed the use of models to explore these concepts. Participants drew their own models for one example and shared their thoughts about using this strategy in the

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classroom.

NGSS Core Ideas: Earth and Human Activity

The presenters were Susan Buhr Sullivan, Director of the CIRES Education and Outreach Group at University of Colorado; and Aida Awad, Science Department Chair at Maine East High School in Park Ridge, IL and president of the National Association of Geoscience Teachers (NAGT). The program featured strategies for teaching about Earth science concepts that answer questions such as "How do humans depend on Earth's resources?" and "How do humans change the planet?"

Dr. Buhr Sullivan began the presentation by describing the interconnections between this disciplinary core idea and other components of *NGSS*. She then talked about building a foundation for key concepts related to Earth and Human Activity at the elementary level. Ms. Awad continued the discussion by sharing the progression of this core idea through the middle school level and on to high school. The presenters provided a list of resources and activities that teachers can use to begin implementing *NGSS* in the classroom.

Visit the [resource collection](#).

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Appendix A: NGSS and Foundations for the Unit		
<p>Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. <i>[Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.] (5-ESS2-1)</i></p>		
<p>Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment. (5-ESS3-1)</p>		
<p>The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:</p>		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Developing and Using Models</p> <ul style="list-style-type: none"> Develop a model using an example to describe a scientific principle. (5-ESS2-1) <p>Obtaining, Evaluating, and Communicating Information</p> <ul style="list-style-type: none"> Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1) 	<p>ESS2.A: Earth Materials and Systems</p> <ul style="list-style-type: none"> Earth’s major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth’s surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of 	<p>Systems and System Models</p> <ul style="list-style-type: none"> A system can be described in terms of its components and their interactions. (5-ESS2-1),(5-ESS3-1) <p>-----</p> <p style="text-align: center;">-----</p> <p style="text-align: center;">Connections to Nature of Science</p> <p>Science Addresses Questions About the Natural and Material World.</p> <ul style="list-style-type: none"> Science findings are limited to questions that can be answered with

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	<p>weather. (5-ESS2-1)</p> <p>ESS3.C: Human Impacts on Earth Systems</p> <ul style="list-style-type: none"> Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth’s resources and environments. (5-ESS3-1) 	<p>empirical evidence. (5-ESS3-1)</p>
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English Language Arts	Mathematics
<p>Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-ESS3-1) RI.5.1</p> <p>Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS2-1),(5-ESS3-1) RI.5.7</p> <p>Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-ESS3-1) W.5.8</p> <p>Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ESS3-1) RI.5.9</p> <p>Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-ESS3-1) W.5.9</p> <p>Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-ESS2-2),(5-ESS2-1) SL.5.5</p>	<p>Reason abstractly and quantitatively. (5-ESS2-1),(5-ESS3-1) MP.2</p> <p>Model with mathematics. (5-ESS2-1),(5-ESS3-1) MP.4</p> <p>Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. (5-ESS2-1) 5.G.A.2</p>

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Common Vocabulary	
Atmosphere	Rock breakage
Cycle	Rock composition
Earth's surface	Soil color
Force	Soil texture
Forms of water	Weathering
Fresh water glacial movement	Wedge
Moisture	Global
Properties of soil	Chemical
Properties of water	