Middle School Earth and Space Sciences

Students in middle school continue to develop their understanding of the three disciplinary core ideas in the Earth and Space Sciences. The middle school performance expectations in Earth Space Science build on the elementary school ideas and skills and allow middle school students to explain more in-depth phenomena central not only to the earth and space sciences, but to life and physical sciences as well. These performance expectations blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge to explain ideas across the science disciplines. While the performance expectations shown in middle school earth and space science couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.

The performance expectations in **ESS1: Earth’s Place in the Universe**, help students formulate an answer to questions such as: “What is Earth’s place in the Universe, What makes up our solar system and how can the motion of Earth explain seasons and eclipses, and How do people figure out that the Earth and life on Earth have changed through time?” The ESS1 Disciplinary Core Idea from the NRC Framework is broken down into three sub-ideas: the universe and its stars, Earth and the solar system and the history of planet Earth. Students examine the Earth’s place in relation to the solar system, Milky Way galaxy, and universe. There is a strong emphasis on a systems approach, using models of the solar system to explain astronomical and other observations of the cyclic patterns of eclipses, tides, and seasons. There is also a strong connection to engineering through the instruments and technologies that have allowed us to explore the objects in our solar system and obtain the data that support the theories that explain the formation and evolution of the universe. Students examine geoscience data in order to understand the processes and events in Earth’s history. The crosscutting concepts of patterns, scale, proportion, and quantity, and systems and systems modeling are called out as organizing concepts for these disciplinary core ideas. In the ESS1 performance expectations, students are expected to demonstrate proficiency in developing and using models, analyzing data, and constructing explanations and designing solutions; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **ESS2: Earth’s Systems**, help students formulate an answer to questions such as: “How do the materials in and on Earth’s crust change over time, How does the movement of tectonic plates impact the surface of Earth, How does water influence weather, circulate in the oceans, and shape Earth’s surface, What factors interact and influence weather, and How have living organisms changed the Earth and how have Earth’s changing conditions impacted living organisms?” The ESS2 Disciplinary Core Idea from the NRC Framework is broken down into five sub-ideas: Earth materials and systems, plate tectonics and large-scale system interactions, the roles of water in Earth’s surface processes, weather and climate, and biogeology. Students understand how Earth’s geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students investigate the controlling properties of important materials and construct explanations based on the analysis of real geoscience data. Of special importance in both topics are the ways that geoscience processes provide resources needed by society but also cause natural hazards that present risks to society; both involve technological challenges, for the identification and development of resources. Students develop understanding of the factors that control weather. A systems approach is also important here, examining the feedbacks between systems as
energy from the sun is transferred between systems and circulates though the ocean and atmosphere. The crosscutting concepts of patterns, cause and effect, scale proportion and quantity, systems and system models, energy and matter, and stability and change are called out as organizing concepts for these disciplinary core ideas. In the ESS2 performance expectations, students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, and constructing explanations; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **ESS3: Earth and Human Activity** help students formulate an answer to questions such as: “How is the availability of needed natural resources related to naturally occurring processes, How can natural hazards be predicted, How do human activities affect Earth systems, How do we know our global climate is changing?” The ESS3 Disciplinary Core Idea from the *NRC Framework* is broken down into four sub-ideas: natural resources, natural hazards, human impact on Earth systems, and global climate change. Students understand the ways that human activities impacts Earth’s other systems. Students use many different practices to understand the significant and complex issues surrounding human uses of land, energy, mineral, and water resources and the resulting impacts of their development. The crosscutting concepts of patterns, cause and effect, and stability and change are called out as organizing concepts for these disciplinary core ideas. In the ESS3 performance expectations, students are expected to demonstrate proficiency in asking questions, developing and using models, analyzing and interpreting data, constructing explanations and designing solutions and engaging in argument; and to use these practices to demonstrate understanding of the core ideas.
MS-Ess1 Earth's Place in the Universe

Students who demonstrate understanding can:

**MS-Ess1-1. Develop and use a model of the Earth–sun–moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]

**MS-Ess1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.** [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students’ school or state).] [Assessment Boundary: Assessment does not include Kepler’s Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]

**MS-Ess1-3. Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object’s layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]

**MS-Ess1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s 4.6-billion-year-old history.** [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth’s history. Examples of Earth’s major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

### Science and Engineering Practices

**Developing and Using Models**
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena. (MS-Ess1-1),(MS-Ess1-2)

**Analyzing and Interpreting Data**
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Analyze and interpret data to determine similarities and differences in findings. (MS-Ess1-3)

**Constructing Explanations and Designing Solutions**
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-Ess1-4)

### Disciplinary Core Ideas

**ESS1A: The Universe and Its Stars**
- Patterns of the apparent motion of the sun, moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-Ess1-1)
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-Ess1-2)

**ESS1B: Earth and the Solar System**
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-Ess1-2),(MS-Ess1-3)
- This model of the solar system can explain eclipses of the sun and moon. Earth’s spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-Ess1-1)
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-Ess1-2)

**ESS1C: The History of Planet Earth**
- The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-Ess1-4)

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The performance expectations above were developed using the following elements from the NRC document: A Framework for K–12 Science Education.

**Connecting to Engineering, Technology, and Applications of Science**

**Interdependence of Science, Engineering, and Technology**
- Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-Ess1-3)

**Connections to Nature of Science**

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-Ess1-1),(MS-Ess1-2)

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Connections to other DCIs in this grade band:
- **MS-PS2.A** (MS-Ess1-1),(MS-Ess1-2), (MS-Ess1-4), (MS-LS4.A) (MS-Ess1-4); **MS-Ess1.3** (MS-Ess1-3)
- **Articulation of DCIs across grade bands:** **3.PS2.A** (MS-Ess1-1),(MS-Ess1-2), **3.LS4.A** (MS-Ess1-4), **4.PS2.B** (MS-Ess1-1),(MS-Ess1-2), **5.ESS1A** (MS-Ess1-2), **5.ESS1B** (MS-Ess1-1),(MS-Ess1-2), **5.ESS1C** (MS-Ess1-1),(MS-Ess1-2), **HS.LS4.A** (MS-Ess1-4); **ESS1.1** (MS-Ess1-1); **ESS1.2** (MS-Ess1-1),(MS-Ess1-2), **ESS1.3**; **HS.PS1.A** (MS-Ess1-1), **HS.PS1.B** (MS-Ess1-1),(MS-Ess1-2), **HS.PS1.C** (MS-Ess1-1),(MS-Ess1-2), **HS.PS2.A** (MS-Ess1-1),(MS-Ess1-2), **HS.PS2.B** (MS-Ess1-1),(MS-Ess1-2)

**Common Core State Standards Connections:**

- **ELA/Literacy —**
  - **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-Ess1-3), (MS-Ess1-4)
  - **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-Ess1-3)

- **WHST.6-8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-Ess1-4)

- **SL.8.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-Ess1-1),(MS-Ess1-2)

- **Mathematics —**
  - **MP.2** Reason abstractly and quantitatively. (MS-Ess1-3)
  - **MP.4** Model with mathematics. (MS-Ess1-1),(MS-Ess1-2)
  - **6.RP.A.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-Ess1-1),(MS-Ess1-2)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K–12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.
| 7.RP.A.2 | Recognize and represent proportional relationships between quantities. (MS-ESS1-1),(MS-ESS1-2),(MS-ESS1-3) |
| 6.EE.B.6 | Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2),(MS-ESS1-4) |
| 7.EE.B.4 | Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-2),(MS-ESS1-4) |
**MS-ESS2 Earth’s Systems**

**MS-ESS2.1.** Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth’s materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]

**MS-ESS2.2.** Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at varying time and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth’s surface at time and spatial scales that can be large (continental plates or tectonic plates, or the upwelling or downwelling of large bodies of water), medium (erosion, mountain building, or volcanic eruptions), or small (such as local weather events or changes in landscape features).] [Assessment Boundary: Assessment does not include the naming or the specific description of large scale (continental plate) or the specific processes (volcanic eruptions or plate tectonics) that are not assessed.]

**MS-ESS2.3.** Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean features (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Assessment does not include the naming of the specific processes (continental drift or paleomagnetic techniques) that are not assessed.]

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

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

**MS-ESS2.6.** Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sun-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]

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The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

### Disciplinary Core Ideas

**ESS1.C: The History of Planet Earth**
- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (HS.ESS1.C GBE) (secondary to MS-ESS2-3)

**ESS2.A: Earth’s Materials and 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. (MS-ESS2-1)
- 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. (MS-ESS2-2)

**ESS2.B: Plate Tectonics and Large-Scale System Interactions**
- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances, completely apart. (MS-ESS2-3)

**ESS2.C: The Roles of Water in Earth’s Surface Processes**
- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and cryoturbation, and precipitation, as well as through processes of the land. (MS-ESS2-4)
- 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. (MS-ESS2-5)
- Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)
- Water’s movements—both on the land and underground—cause weathering and erosion, which change the land’s surface features and create underground formations. (MS-ESS2-2)

**ESS2.D: Weather and Climate**
- 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. (MS-ESS2-6)
- Because these patterns are so complex, weather can only be predicted probabilistically.
- The ocean exerts a major influence on weather and climate by...
### MS-ESS2 Earth’s Systems

- Science findings are frequently revised and/or reinterpreted based on new evidence. (MS-ESS2-3)
- Absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)

#### Connections to other DCIs in this grade-band:
- MS.PS1.A (MS-ESS2-1), (MS-ESS2-4), (MS-ESS2-5); MS.PS1.B (MS-ESS2-1), (MS-ESS2-2); MS.PS2.A (MS-ESS2-5), (MS-ESS2-6); MS.PS2.B (MS-ESS2-4); MS.PS3.A (MS-ESS2-4), (MS-ESS2-5); MS.PS3.B (MS-ESS2-1), (MS-ESS2-5), (MS-ESS2-6); MS.PS3.D (MS-ESS2-4); MS.PS4.B (MS-ESS2-6); MS.LS2.B (MS-ESS2-1), (MS-ESS2-2); MS.LS2.C (MS-ESS2-1); MS.LS4.A (MS-ESS2-3); MS.ESS1.B (MS-ESS2-1); MS.ESS3.C (MS-ESS2-1)

#### Articulation of DCIs across grade-bands:
- 3.PS2.A (MS-ESS2-4), (MS-ESS2-6); 3.LS4.A (MS-ESS2-3); 3.ESS2.D (MS-ESS2-5), (MS-ESS2-6); 3.ESS3.B (MS-ESS2-3); 4.PS3.B (MS-ESS2-1), (MS-ESS2-5); 4.ESS1.C (MS-ESS2-2), (MS-ESS2-3); 4.ESS2.A (MS-ESS2-1), (MS-ESS2-2); 4.ESS2.B (MS-ESS2-3); 4.ESS2.E (MS-ESS2-2); 4.ESS3.B (MS-ESS2-3); 5.PS2.B (MS-ESS2-4); 5.ESS2.A (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-5), (MS-ESS2-6); 5.ESS2.C (MS-ESS2-4); HS.PS1.B (MS-ESS2-1); HS.PS2.B (MS-ESS2-4), (MS-ESS2-6); HS.PS3.B (MS-ESS2-1), (MS-ESS2-5), (MS-ESS2-6); HS.PS3.D (MS-ESS2-2), (MS-ESS2-6); HS.PS4.B (MS-ESS2-4); HS.LS1.C (MS-ESS2-1); HS.LS2.B (MS-ESS2-1), (MS-ESS2-2); HS.LS4.A (MS-ESS2-3); HS.LS4.C (MS-ESS2-3); HS.ESS1.B (MS-ESS2-6); HS.ESS1.C (MS-ESS2-2), (MS-ESS2-3); HS.ESS2.A (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-3), (MS-ESS2-4), (MS-ESS2-6); HS.ESS2.B (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-3); HS.ESS2.C (MS-ESS2-1), (MS-ESS2-4), (MS-ESS2-5), (MS-ESS2-6); HS.ESS2.D (MS-ESS2-3), (MS-ESS2-4), (MS-ESS2-5), (MS-ESS2-6); HS.ESS2.E (MS-ESS2-1), (MS-ESS2-2); HS.ESS3.D (MS-ESS2-2)

### Common Core State Standards Connections:

#### ELA/Literacy –

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-2), (MS-ESS2-3), (MS-ESS2-5)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS2-3)
- **RST.6-8.9** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-3), (MS-ESS2-5)
- **WHST.6-8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS2-2)
- **WHST.6-8.8** Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ESS2-5)
- **SL.8.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-6)

#### Mathematics –

- **MP.2** Reason abstractly and quantitatively. (MS-ESS2-2), (MS-ESS2-3), (MS-ESS2-5)
- **6.NS.C.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)
- **6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS2-2), (MS-ESS2-3)
- **7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS2-2), (MS-ESS2-3)

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

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MS-ESS3 Earth and Human Activity

MS-ESS3 Earth and Human Activity

Students who demonstrate understanding can:

MS-ESS3.1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

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

MS-ESS3.3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

MS-ESS3.4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth’s systems as well as the rates at which they change. The consequences of increased human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

MS-ESS3.5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Science and Engineering Practices

Asking Questions and Defining Problems

MS-ESS3-2

Analyzing and Interpreting Data

MS-ESS3-2

Constructing Explanations and Designing Solutions

MS-ESS3-2

Engaging in Argument from Evidence

MS-ESS3-3

Disciplinary Core Ideas

ESS3.A. Natural Resources

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

ESS3.B. Natural Hazards

- Mapping the history of natural hazards in a region, combined with an understanding of related geologic processes, can help focus the locations and likelihoods of future events.

ESS3.C. Human Impacts on Earth Systems

- Human activities have significantly altered the biosphere; sometimes damaging or destroying natural habitats and causing the extinction of other species. If enough negative impacts accumulate, the effects of human activities on Earth can be catastrophic.

ESS3.D. Global Climate Change

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and actions.

Crosscutting Concepts

Patterns

- Graphs, charts, and images can be used to identify patterns in data.

Cause and Effect

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

Stability and Change

- Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

Science Addresses Questions About the Natural and Material World

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.


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**Common Core State Standards Connections:**

**ELA/Literacy –**

| RST.6-8.1 | Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1),(MS-ESS3-2),(MS-ESS3-4),(MS-ESS3-5) |
| RST.6-8.7 | Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS3-2) |
| WHST.6-8.1 | Write arguments focused on discipline content. (MS-ESS3-4) |
| WHST.6-8.2 | Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1) |
| WHST.6-8.7 | Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ESS3-3) |
| WHST.6-8.8 | Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ESS3-3) |
| WHST.6-8.9 | Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1),(MS-ESS3-4) |

**Mathematics –**

| MP.2 | Reason abstractly and quantitatively. (MS-ESS3-2),(MS-ESS3-5) |
| 6.RP.A.1 | Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-3),(MS-ESS3-4) |
| 7.RP.A.2 | Recognize and represent proportional relationships between quantities. (MS-ESS3-3),(MS-ESS3-4) |
| 6.EE.B.6 | Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-1),(MS-ESS3-2),(MS-ESS3-3),(MS-ESS3-4),(MS-ESS3-5) |
| 7.EE.B.4 | Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-1),(MS-ESS3-2),(MS-ESS3-3),(MS-ESS3-4),(MS-ESS3-5) |

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

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