Introduction: The focus of this document is on one of the three dimensions of the Performance Expectations (PE); the science ideas that students should have opportunities to apply in order to explain phenomena or design solutions to real-world problems. This document should be used in conjunction with a document titled *Primer on Science Instruction*. The *Primer on Science Instruction* focusses on what teaching, learning, and assessment should look like in a three-dimensional classroom.

The Earth and space science standards blend the Disciplinary Core Ideas (DCIs) with Scientific and Engineering Practices (SEP) and Crosscutting Concepts (CCC) to support students in developing useable knowledge to explain real world phenomena. The scientific ideas are detailed on pages 173-198 of *A Framework for K-12 Science Education* (NRC, 2012). Table 1 highlights the Core and Component Ideas in Earth and space science that must be a part of the science curriculum. Beginning on page 2, each of the component ideas are described in greater detail.

Table 1: Core and Component Ideas in the Earth and Space Sciences

Core Idea ESS1: Earth's Place in the Universe ← Disciplinary Core Idea

- ESS1.A: The Universe and Its Stars
- ESS1.B: Earth and the Solar System
- ESS1.C: The History of Planet Earth

← Component Ideas

Core Idea ESS2: Earth's Systems

- ESS2.A: Earth Materials and Systems
- ESS2.B: Plate Tectonics and Large-Scale System Interactions
- ESS2.C: The Roles of Water in Earth's Surface Processes
- ESS2.D: Weather and Climate
- ESS2.E: Biogeology

Core Idea ESS3: Earth and Human Activity

- ESS3.A: Natural Resources
- ESS3.B: Natural Hazards
- ESS3.C: Human Impacts on Earth Systems
- ESS3.D: Global Climate Change

There are multiple approaches to organizing science curriculum in the middle grades. Regardless of the approach, every student needs to receive instruction in all of the Earth and space science standards. The storylines are organized by Disciplinary Core Idea (DCI). The hyperlinked title provides quick access to the complete description of the Disciplinary Core Ideas, Component Ideas, and grade appropriate elements of the DCIs.

Some districts chose to base their revised curriculum on the NJ Model Science Curriculum (MSC). Each unit of instruction includes a guiding question, a unit overview, estimated number of instructional days necessary to complete the unit, and Student Learning Objectives. Sometimes the storylines in the model curriculum units have been modified from the original narratives in this document.

ESS1: Earth's Place in the Universe (pp. 173-179 , NRC, 2012)

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?"*

Students use a systems approach, using models of the solar system to explain astronomical and other observations of the cyclic patterns of eclipses, tides, and seasons.

Students connect to engineering through the instruments and technologies 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.

Students 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.

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.**

MS-ESS1-2 **Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.**

MS-ESS1-3 **Analyze and interpret data to determine scale properties of objects in the solar system.**

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.**

ESS2: Earth's Systems (pp. 179-190 ,NRC, 2012)

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

Students make sense of 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.

Students model 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.

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.

Students who demonstrate understanding can:

MS-ESS2-1 **Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.**

MS-ESS2-2 **Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.**

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.**

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.**

MS-ESS2-5 **Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.**

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.**

ESS3: Earth and Human Activity (pp. 190-198, NRC, 2016)

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?"*

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.

Students 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.

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.**

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.**

MS-ESS3-3 **Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.***

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.**

MS-ESS3-5 **Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.**

(An asterisk indicates that the PE incorporates Engineering Practices.)

Earth and Space Science Performance Expectations Checklist

ESS1: Earth's Place in the Universe

PE	Grade and Unit
MS-ESS1-1	
MS-ESS1-2	
MS-ESS1-3	

ESS2: Earth's Systems

PE	Grade and Unit
MS-ESS2-1	
MS-ESS2-2	
MS-ESS-3	
MS-ESS2-4	
MS-ESS2-5	
MS-ESS2-6	

ESS3: Earth and Human Activity

PE	Grade and Unit
MS-ESS3-1	
MS-ESS3-2	
MS-ESS3-3	
MS-ESS3-4	
MS-ESS3-5	