Middle School Earth and Space Sciences

Students in middle school develop understanding of a wide range of topics in Earth and space science (ESS) that build upon science concepts from elementary school through more advanced content, practice, and crosscutting themes. There are six ESS standard topics in middle school: *Space Systems*, *History of Earth*, *Earth's Interior Systems*, *Earth's Surface Systems*, *Weather and Climate*, and *Human Impacts*. The content of the performance expectations are based on current community-based geoscience literacy efforts such as the Earth Science Literacy Principles (Wysession et al., 2012), and is presented with a greater emphasis on an Earth Systems Science approach. The performance expectations strongly reflect the many societally relevant aspects of ESS (resources, hazards, environmental impacts) as well as related connections to engineering and technology. While the performance expectations shown in middle school ESS 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 **MS.Space Systems** help students formulate answers to the questions: "What is Earth's place in the Universe?" and "What makes up our solar system and how can the motion of Earth explain seasons and eclipses?" Two sub-ideas from the NRC *Framework* are addressed in these performance expectations: ESS1.A and ESS1.B. Middle school students can 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. The crosscutting concepts of patterns; scale, proportion, and quantity; systems and system models; and interdependence of science, engineering, and technology are called out as organizing concepts for these disciplinary core ideas. In the MS.Space Systems performance expectations, students are expected to demonstrate proficiency in developing and using models and analyzing and interpreting data; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **MS.History of Earth** help students formulate answers to the questions: "How do people figure out that the Earth and life on Earth have changed over time?" and "How does the movement of tectonic plates impact the surface of Earth?" Four sub-ideas from the NRC *Framework* are addressed in these performance expectations: ESS1.C, ESS2.A, ESS2.B, and ESS2.C. Students can examine geoscience data in order to understand the processes and events in Earth's history. Important concepts in this topic are "Scale, Proportion, and Quantity" and "Stability and Change," in relation to the different ways geologic processes operate over the long expanse of geologic time. An important aspect of the history of Earth is that geologic events and conditions have affected the evolution of life, but different life forms have also played important roles in altering Earth's systems. In the MS.History of Earth performance expectations, students are expected to demonstrate proficiency in analyzing and

interpreting data, and constructing explanations; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **MS.Earth's Systems** help students formulate answers to the questions: "How do the materials in and on Earth's crust change over time?" and "How does water influence weather, circulate in the oceans, and shape Earth's surface?" Three sub-ideas from the NRC *Framework* are addressed in these performance expectations: ESS2.A, ESS2.C, and ESS3.A. Students understand how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students can 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 and for the mitigation of hazards. The crosscutting concepts of cause and effect, energy and matter, and stability and change are called out as organizing concepts for these disciplinary core ideas. In the MS.Earth's Systems performance expectations, students are expected to demonstrate proficiency in developing and using models and constructing explanations; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **MS.Weather and Climate** help students formulate an answer to the question: "What factors interact and influence weather and climate?" Three sub-ideas from the NRC *Framework* are addressed in these performance expectations: ESS2.C, ESS2.D, and ESS3.D. Students can construct and use models to develop understanding of the factors that control weather and climate. 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 cause and effect, systems and system models, and stability and change are called out as organizing concepts for these disciplinary core ideas. In the MS.Weather and Climate performance expectations, students are expected to demonstrate proficiency in asking questions, developing and using models, and planning and carrying out investigations; and to use these practices to demonstrate understanding of the core ideas.

The performance expectations in **MS.Human Impacts** help students formulate answers to the questions: "How can natural hazards be predicted?" and "How do human activities affect Earth systems?" Two sub-ideas from the NRC *Framework* are addressed in these performance expectations: ESS3.B and ESS3.C. Students understand the ways that human activities impacts Earth's other systems. Students can 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 interdependence of science, engineering, and technology are called out as organizing concepts for these disciplinary core ideas.