Middle School Earth and Space Science Curriculum

*(*Adapted from *Next Generation Science Standards)*

Space Systems

The Universe and Its Stars

Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.

Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.

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.

This model of the solar system can explain eclipses of the sun and the 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.

The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

Students who demonstrate understanding can:

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.
2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
3. Analyze and interpret data to determine scale properties of objects in the solar system.

History of Earth

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.

Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches.

Earth Materials and Systems

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.

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, collided, and spread apart

The Roles of Water in Earth's Surface Processes
Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.

Students who demonstrate understanding can:

1. 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. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
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.

Earth's Systems

Earth 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.

The Roles of Water in Earth's Surface Processes
Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.

Global movements of water and its changes in form are propelled by sunlight and gravity.

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.

Students who demonstrate understanding can:

1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
2. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
3. 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.

Weather and Climate

The Roles of Water in Earth's Surface Processes
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.

Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.

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.

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.

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 activities.

Students who demonstrate understanding can:

1. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
2. 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.
3. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Human Impacts

Natural Hazards
The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.

Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.

Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.

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. Changes to Earth's environments can have different impacts (negative and positive) for different living things.

Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Students who demonstrate understanding can:

1. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
2. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
3. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.