| Earth's Place in the Universe (ESS1) | Earth's Systems (ESS2) | Earth and Human Activity (ESS3) |
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| **ESS1.A:** The Universe and Its Stars<br>**ESS1.B:** Earth and the Solar System<br>**ESS1.C:** The History of the Planet Earth | **ESS2.A:** Earth Materials and Systems<br>**ESS2.B:** Plate Tectonics and Large-Scale System Interactions<br>**ESS2.C:** The Roles of Water in the Earth's Surface Processes<br>**ESS2.D:** Weather and Climate<br>**ESS2.E:** Biogeology | **ESS3.A:** Natural Resources<br>**ESS3.B:** Natural Hazards<br>**ESS3.C:** Human Impact on Earth Systems |

## ESS1: Earth's Place in the Universe

### ESS1.A: The Universe and Its Stars

| 1st Grade | 5th Grade | 7th Grade | Earth & Space Science |
|---|---|---|---|
| Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.. | The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. | Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.<br><br>Earth and its solar system are part of the Milky Way galaxy, which is one of the many galaxies in the universe. | The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.<br><br>The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.<br><br>Other than the hydrogen and helium, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy.<br><br>Heavier elements are produced when certain massive stars achieve a supernova stage and explode. |

## ESS1: Earth's Place in the Universe

### ESS1.B: Earth and the Solar System

| 1st Grade | 5th Grade | 7th Grade | Earth & Space Science |
|---|---|---|---|
| Seasonal patterns of sunrise and sunset can be observed, described, and predicted. | The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. | The model of the solar system can explain eclipses of the sun and the moon.<br><br>Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun.<br><br>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.<br><br>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.<br><br>The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. | The solar system consists of the sun and a collection of objects of varying sizes and conditions - including planets and their moons - that are held in orbit around the sun by its gravitational pull on them.<br><br>Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.<br><br>Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the Earth. These phenomena cause a cycle of ice ages and other changes in climate. |

## ESS1: Earth's Place in the Universe

### ESS1: The History of the Planet Earth

| 2nd Grade | 4th Grade | 8th Grade | Earth & Space Science |
|---|---|---|---|
| Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe | Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes.<br><br>The presence and location of certain fossil types indicate the order in which rock layers were formed. | The geologic time scale interpreted from rock strata provides a way to organize Earth's history.<br><br>Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.<br><br>Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. | Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over years. Studying these objects can provide information about Earth's formation and early history. |

## ESS2: Earth's Systems

### ESS2.A: Earth Materials and Systems

| 2nd Grade | 4th Grade | 5th Grade | 8th Grade | Earth & Space Science and EnvironmentalScience |
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| Wind and water can change the shape of the land. | 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. | 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.<br><br>The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate.<br><br>Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. | 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.<br><br>The planet's systems interact over scales that range from microscopic to global in size. these interactions have shaped Earth's history and will determine its future. | Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.<br><br>Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface features, its magnetic field, and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust.<br><br>Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from the Earth's interior and gravitational movement of denser materials toward the interior.<br><br>The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time-scale from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. |

# ESS2: Earth's Systems

## ESS2.B: Plate Tectonics and Large-Scale System Interactions

| 2nd Grade | 4th Grade | 8th Grade | Earth & Space Science and Environmental Science |
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| Maps show where things are located.<br><br>One can map the shapes and kinds of land and water in any area. | The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns.<br><br>Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans.<br><br>Major mountain chains form inside continents or near their edges.<br><br>Maps can help locate the different land and water features areas of Earth. | 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. | Plate tectonics is the unifying theory that explains the past and current movements of rocks at the Earth's surface and provides a framework for understanding it geologic history.<br><br>Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust.<br><br>The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection.<br><br>Plate tectonics can be viewed as the surface expression or mantle convection. |

## ESS2: Earth's Systems

### ESS2.C: The Role of Water in the Earth's Surface Processes

| 2nd Grade | 5th Grade | 6th Grade | 7th Grade | 8th Grade | Earth & Space Science and Environmental Science |
|---|---|---|---|---|---|
| Water is found in the ocean, rivers, lakes, and ponds.<br><br>Water exists as solid ice and liquid form. | Nearly all of Earth's available water is in the ocean.<br><br>Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. | Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, precipitation, as well as downhill on land.<br><br>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. | The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower viscosities and melting points. |

## ESS2: Earth's Systems

### ESS2.D: Weather and Climate

| Kindergarten | 3rd Grade | 7th Grade | Earth & Space Science and Environmental Science |
|---|---|---|---|
| Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time.<br><br>People measure these conditions to describe and record the weather and to notice patterns over time. | 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.<br><br>Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. | Because these patterns are so complex, weather can only be predicted probabilistically.<br><br>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.<br><br>The ocean exerts a major influence on weather and climate by absorbing energy from the sun, and globally redistributing it through ocean currents | The foundation for Earth's: global climate system is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.<br><br>Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. |

## ESS2: Earth's Systems

### ESS2.E: Biogeology

| Kindergarten | Earth & Space Science and Environmental Science |
|---|---|
| Plants and animals can change their environment. | Organisms ranging from bacteria to human beings are a major driver of the global carbon and they influence global climate by modifying the chemical makeup of the atmosphere.<br><br>The abundance of carbon in the atmosphere is reduced through the ocean floor accumulation of marine sediments and the accumulation of plant biomass.<br><br>The many dynamic and delicate feedback mechanisms between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. |

# ESS3: Earth and Human Activity

## ESS3.A: Natural Resources

| Kindergarten | 4th Grade | 8th Grade | Earth & Space Science | Environmental Science |
|---|---|---|---|---|
| Living things need water, air, and resources from the land, and they live in places that have the things they need.<br><br>Humans use natural resources for everything they do. | Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways.<br><br>Some resources are renewable over time, and others are not. | Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources.<br><br>Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes.<br><br>These resources are distributed unevenly around the planet as a result of past geologic processes. | Resource availability has guided the development of human society.<br><br>All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.<br><br>Most elements exist in Earth's crust at concentrations too low to be extracted, but in some locations where geological processes have concentrated them, extraction is economically viable. | Resource availability has guided the development of human society.<br><br>All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. |

## ESS3: Earth and Human Activity

### ESS3.B: Natural Hazards

| Kindergarten | 3rd Grade | 4th Grade | 8th Grade | Earth & Space Science Environmental Science |
|---|---|---|---|---|
| Some kinds of severe weather are more likely than others in a given region.<br><br>Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. | A variety of natural hazards result form natural processes.<br><br>Humans cannot eliminate natural hazards but can take steps to reduce other impacts. (Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.) | A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions).<br><br>Humans cannot eliminate the hazards but can take steps to reduce their impacts. | Mapping the history of natural hazards in a region, combined with an understandin g of related geologic forces can help forecast the locations and likelihoods of future events. | Natural hazards and other geologic events have shaped the course of human history; (they) have significantly altered the sizes of human populations and have driven human migrations. |

# ESS3: Earth and Human Activity

## ESS3.C: Human Impacts on Earth Systems

| Kndgrtn | 1st Grade | 5th Grade | 6th Grade | 8th Grade | Environmental Science |
|---|---|---|---|---|---|
| Things that people do to live comfortably can affect the world around them. | Things that people do to live comfortably can affect the world around them. But, they can make choices that reduce their impacts on the land, water, air, and other living things. | 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. | Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.<br><br>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. | 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. | The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.<br><br>Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. |