MA Draft Revised MS-HS *Earth &*

Based on *A Framework for K-12 Science Education*
Please direct comments, suggeste
The standards and strand ma
(*) denotes integration of t

Grade 6

Grade 7

1. Earth's Place in the Universe

5-ESS1-1

MS-ESS1-5 (MA). Use graphical displays to illustrate that the Earth and its solar system are part of the Milky Way galaxy, which is one of billions of galaxies in the universe. [Clarification Statement: Graphical displays can include maps, charts, graphs, or data tables.]

5-ESS1-2

MS-ESS1-1a. Develop and use a model of the Earth-sun-moon system to explain the causes of lunar phases and eclipses of the sun and moon. [Clarification Statement: Examples of models can be physical, graphical, or conceptual and should emphasize relative positions and distances.]

Space Science Strand Map (12/20/13)

(NRC, 2012) and adapted from the *Next Generation Science Standards* (2013)
ed edits, and questions to: mathsciencetech@doe.mass.edu.
ps are available at: www.doe.mass.edu/stem/review.html
echnology/engineering through a practice or core idea.

Grade 8

Earth and Space Science (Gr. 9-10)

TBD: parts of an atom

HS-PS1-8. Develop a model to illustrate the changes in the composition of the nucleus of the atom and the energy released or absorbed during the processes of fission, fusion, and radioactive decay. [Clarification Statement: Examples of models include simple qualitative models, such as pictures or diagrams.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released or absorbed. Assessment is limited to alpha, beta, and gamma radioactive decays.]

HS-ESS1-1. Explain that the life span of the sun over approximately 10 billion years is a function of nuclear fusion in its core.

MS-PS1-1 (gr. 8)

HS-ESS1-3. Communicate that stars, through nuclear fusion over their life cycle, produce elements from Helium to Iron and release energy that eventually reaches Earth in the form of radiation. [Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.]

HS-ESS1-2. Describe the astronomical evidence for the Big Bang theory, including the red shift of light from the motion of distant galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases, which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).

TBD: Math (Algebra)

HS-PS4-1

MS-PS2-4 (gr. 6)

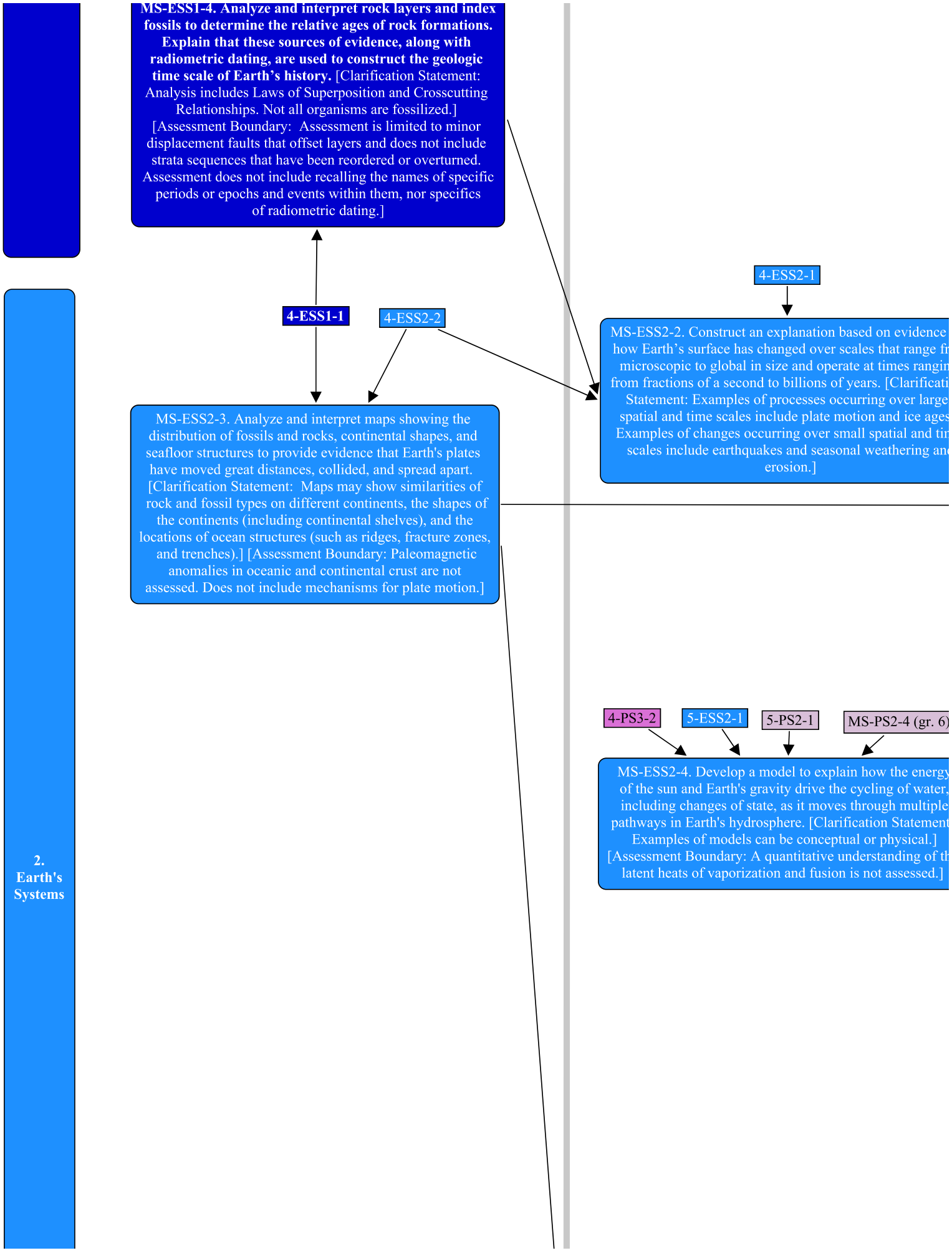
MS-PS2-2 (gr. 8)

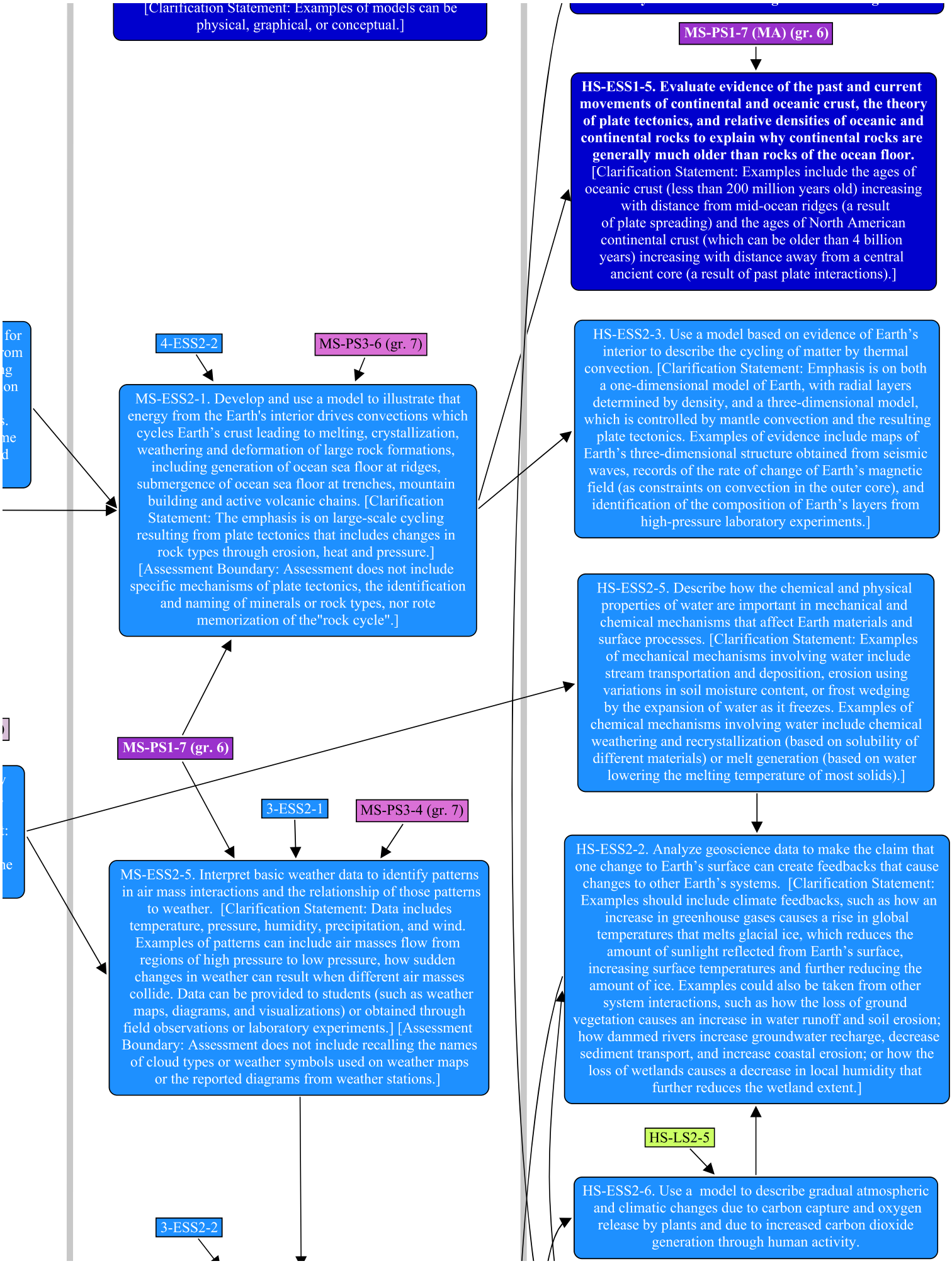
MS-ESS1-2. Explain the role of gravity in ocean tides, the orbital motions of planets, their moons, and asteriods in the solar system. [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]

HS-ESS1-4. Use Kepler's Laws to predict the motion of orbiting objects in the solar system. Describe how orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. [Clarification Statement: Kepler's Laws apply to human-made satellites as well as planets, moons, and other objects.] [Assessment Boundary: Calculations involving Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus.]

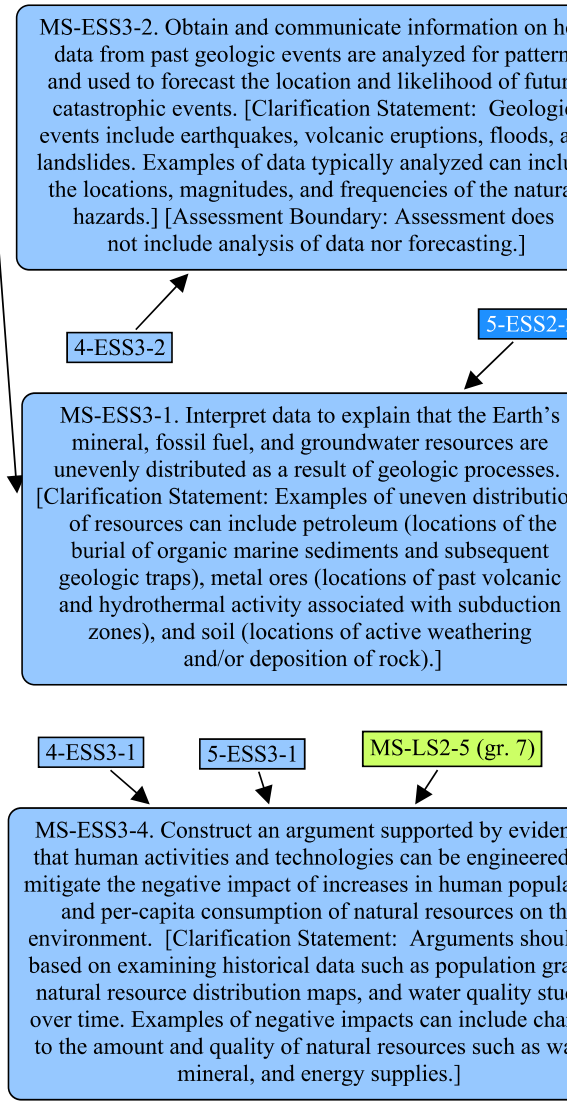
MS-ESS1-1b. Develop and use a model of the Earth-sun system to explain the cyclical pattern of seasons, which includes the Earth's tilt and differential intensity of sunlight on different areas of Earth across the year.

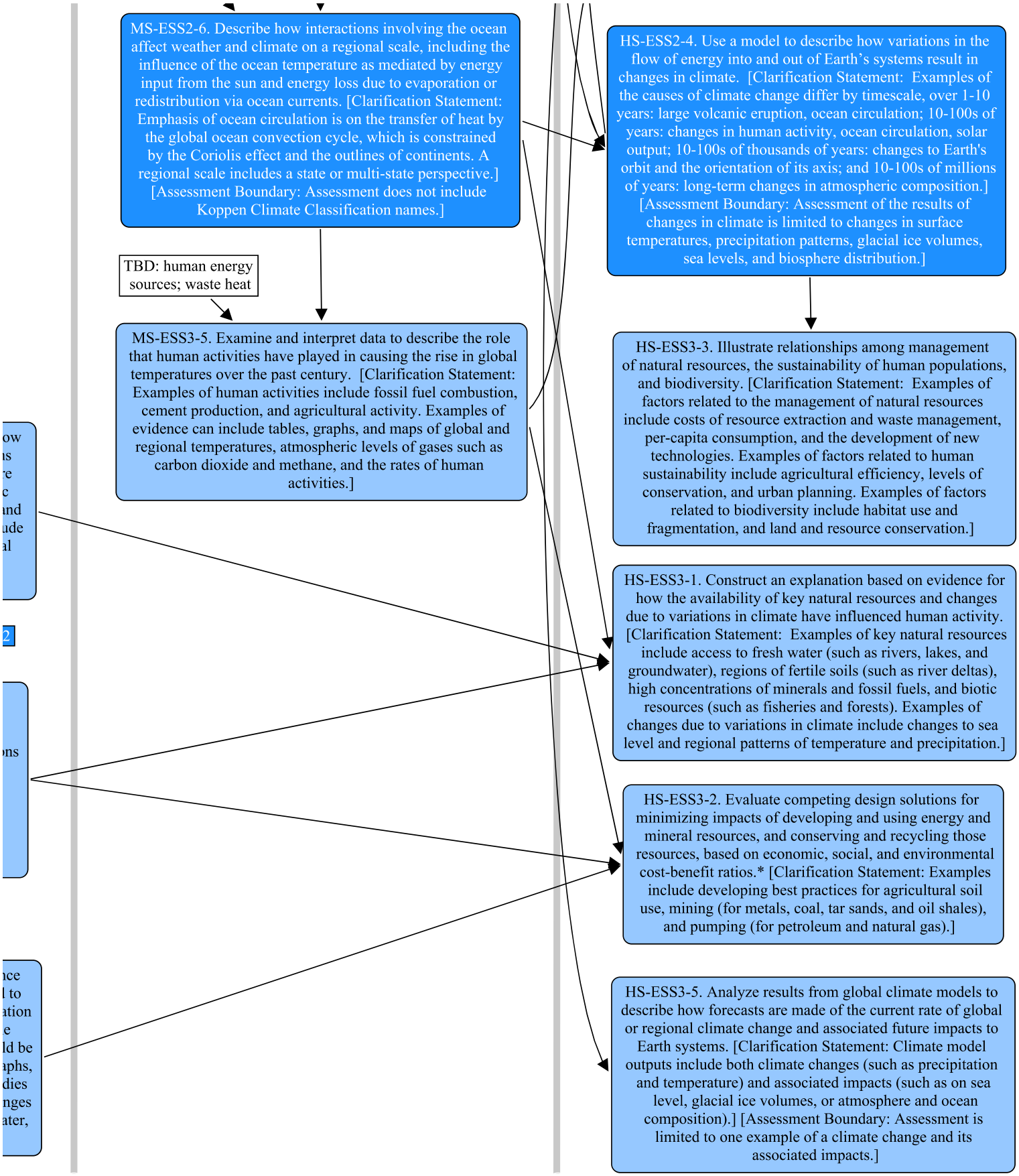
HS-ESS1-7 (MA). Analyze and interpret data to explain that long-term changes in Earth's tilt and orbit result in cycles of climate change such as Ice Ages.


2. Earth's Systems
MS-ESS1-4. Analyze and interpret rock layers and index fossils to determine the relative ages of rock formations. Explain that these sources of evidence, along with radiometric dating, are used to construct the geologic time scale of Earth's history. [Clarification Statement: Analysis includes Laws of Superposition and Crosscutting Relationships. Not all organisms are fossilized.] [Assessment Boundary: Assessment is limited to minor displacement faults that offset layers and does not include strata sequences that have been reordered or overturned. Assessment does not include recalling the names of specific periods or epochs and events within them, nor specifics of radiometric dating.]
4-ESS1-1
4-ESS2-2
4-ESS2-1
MS-ESS2-2. Construct an explanation based on evidence how Earth's surface has changed over scales that range fr microscopic to global in size and operate at times rangin from fractions of a second to billions of years. [Clarificati Statement: Examples of processes occurring over large spatial and time scales include plate motion and ice ages Examples of changes occurring over small spatial and tir scales include earthquakes and seasonal weathering an erosion.]
MS-ESS2-3. Analyze and interpret maps showing the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence that Earth's plates have moved great distances, collided, and spread apart. [Clarification Statement: Maps may show similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed. Does not include mechanisms for plate motion.]
4-PS3-2
5-ESS2-1
5-PS2-1
MS-PS2-4 (gr. 6)
MS-ESS2-4. Develop a model to explain how the energy of the sun and Earth's gravity drive the cycling of water, including changes of state, as it moves through multiple pathways in Earth's hydrosphere. [Clarification Statement Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of th latent heats of vaporization and fusion is not assessed.]


[Clarification Statement: Examples of models can be physical, graphical, or conceptual.]
MS-PS1-7 (MA) (gr. 6)
HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust, the theory of plate tectonics, and relative densities of oceanic and continental rocks to explain why continental rocks are generally much older than rocks of the ocean floor. [Clarification Statement: Examples include the ages of oceanic crust (less than 200 million years old) increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust (which can be older than 4 billion years) increasing with distance away from a central ancient core (a result of past plate interactions).]
4-ESS2-2
MS-PS3-6 (gr. 7)
MS-ESS2-1. Develop and use a model to illustrate that energy from the Earth's interior drives convections which cycles Earth's crust leading to melting, crystallization, weathering and deformation of large rock formations, including generation of ocean sea floor at ridges, submergence of ocean sea floor at trenches, mountain building and active volcanic chains. [Clarification Statement: The emphasis is on large-scale cycling resulting from plate tectonics that includes changes in rock types through erosion, heat and pressure.] [Assessment Boundary: Assessment does not include specific mechanisms of plate tectonics, the identification and naming of minerals or rock types, nor rote memorization of the"rock cycle".]
HS-ESS2-3. Use a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. [Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments.]
HS-ESS2-5. Describe how the chemical and physical properties of water are important in mechanical and chemical mechanisms that affect Earth materials and surface processes. [Clarification Statement: Examples of mechanical mechanisms involving water include stream transportation and deposition, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical mechanisms involving water include chemical weathering and recrystallization (based on solubility of different materials) or melt generation (based on water lowering the melting temperature of most solids).]
MS-PS1-7 (gr. 6)
3-ESS2-1
MS-PS3-4 (gr. 7)
MS-ESS2-5. Interpret basic weather data to identify patterns in air mass interactions and the relationship of those patterns to weather. [Clarification Statement: Data includes temperature, pressure, humidity, precipitation, and wind. Examples of patterns can include air masses flow from regions of high pressure to low pressure, how sudden changes in weather can result when different air masses collide. Data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through field observations or laboratory experiments.] [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.]
HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems. [Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]
HS-LS2-5
HS-ESS2-6. Use a model to describe gradual atmospheric and climatic changes due to carbon capture and oxygen release by plants and due to increased carbon dioxide generation through human activity.
3-ESS2-2

3. Earth & Human Activity




MS-ESS2-6. Describe how interactions involving the ocean affect weather and climate on a regional scale, including the influence of the ocean temperature as mediated by energy input from the sun and energy loss due to evaporation or redistribution via ocean currents. [Clarification Statement: 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. A regional scale includes a state or multi-state perspective.] [Assessment Boundary: Assessment does not include Koppen Climate Classification names.]
HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]
TBD: human energy sources; waste heat
MS-ESS3-5. Examine and interpret data to describe the role that human activities have played in causing the rise in global temperatures over the past century. [Clarification Statement: Examples of human activities include fossil fuel combustion, cement production, and agricultural 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.]
HS-ESS3-3. Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity. [Clarification Statement: Examples of factors related to the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors related to human sustainability include agricultural efficiency, levels of conservation, and urban planning. Examples of factors related to biodiversity include habitat use and fragmentation, and land and resource conservation.]
HS-ESS3-1. Construct an explanation based on evidence for how the availability of key natural resources and changes due to variations in climate have influenced human activity. [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils (such as river deltas), high concentrations of minerals and fossil fuels, and biotic resources (such as fisheries and forests). Examples of changes due to variations in climate include changes to sea level and regional patterns of temperature and precipitation.]
HS-ESS3-2. Evaluate competing design solutions for minimizing impacts of developing and using energy and mineral resources, and conserving and recycling those resources, based on economic, social, and environmental cost-benefit ratios.* [Clarification Statement: Examples include developing best practices for agricultural soil use, mining (for metals, coal, tar sands, and oil shales), and pumping (for petroleum and natural gas).]
HS-ESS3-5. Analyze results from global climate models to describe how forecasts are made of the current rate of global or regional climate change and associated future impacts to Earth systems. [Clarification Statement: Climate model outputs include both climate changes (such as precipitation and temperature) and associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]