Louisiana Believes

Crosswalk for Louisiana Student Standards for Science and NGSS: Earth Science

This document provides guidance to assist teachers, schools, and systems with determining alignment to Louisiana Student Standards for Science for resources designed for the Next Generation Science Standards. This guidance document is considered a "living" document, as we believe that teachers and other educators will find ways to improve the document as they use it. Please send feedback to STEM@la.gov so that we may use your input when updating this guide.

Updated August 24, 2021

DEPARTMENT of EDUCATION
Louisiana Believes

EARTH'S PLACE IN THE UNIVERSE	HS-ESS1-1
LSSS	**NGSS**
Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.	
Clarification Statement	
Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.	
Science and Engineering Practice:	Developing and using models
Disciplinary Core Ideas:	The universe and its stars
All stars, such as our sun, are evolving. The star called Sol, our sun, will burn out over a lifespan of approximately 10 billion years. (HS.ESS1A.a) The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS.ESS1A.c)	The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.
	Energy in chemical processes and everyday life
Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (HS.PS3D.c)	
Crosscutting Concepts:	Scale, proportion, and quantity
The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.	

Underlined sections denote **additional information or **wording differences** that appear in the Louisiana Student Standards for Science.*

EARTH'S PLACE IN THE UNIVERSE	HS-ESS1-2
LSSS	**NGSS**
Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.	
Clarification Statement	
Emphasis is on the astronomical evidence of the red shift of light from 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 intersellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by Big Bang theory.	
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	The universe and its stars
The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS.ESS1A.b) The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS.ESS1A.c) Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS.ESS1A.d)	
	Electromagnetic radiation
Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (HS.PS4B.d)	
Crosscutting Concepts:	Scale, proportion, and quantity
Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.	

EARTH'S PLACE IN THE UNIVERSE	HS-ESS1-3
LSSS	**NGSS**
Communicate scientific ideas about the way stars, over their life cycle, produce elements.	
Clarification Statement	
Emphasis is on the way nucleosynthesis, and therefore the different elements created, depends on the mass of a star and the stage of its lifetime.	
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	The universe and its stars
The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS.ESS1A.b) Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS.ESS1A.d)	
	Energy in chemical processes and everyday life
<u>Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (HS.PS3D.c)</u>	NONE PROVIDED
Crosscutting Concepts:	Energy and matter
In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	

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EARTH'S PLACE IN THE UNIVERSE	HS-ESS1-4
LSSS	**NGSS**
Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.	
Clarification Statement	
Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as <u>other celestial bodies (e.g. graphical representations of orbits)</u>.	Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as <u>planets and moons</u>.
Science and Engineering Practice:	Using mathematics and computational thinking
Disciplinary Core Ideas:	Earth and the solar system
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. (HS.ESS1B.a)	
Crosscutting Concepts:	Scale, proportion, and quantity
Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).	

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EARTH'S PLACE IN THE UNIVERSE	HS-ESS1-5
LSSS	**NGSS**
Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.	
Clarification Statement	
Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages of oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient continental <u>center</u> (a result of past plate interactions).	Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions).
Science and Engineering Practice:	Engaging in argument from evidence
Disciplinary Core Ideas:	The history of planet Earth
Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS.ESS1C.b) <u>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 billions of years. Studying these objects can provide information about Earth's formation and early history.</u> (HS.ESS1C.c)	Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS.ESS1C.b)
	Plate tectonics and large-scale system interactions
Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. (HS.ESS2B.a)	
	Nuclear processes
Spontaneous radioactive decay follows a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (HS.PS1C.b)	
Crosscutting Concepts:	Patterns
Empirical evidence is needed to identify patterns.	

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EARTH'S PLACE IN THE UNIVERSE	HS-ESS1-6
LSSS	**NGSS**
Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.	
Clarification Statement	
Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples include the absolute age of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest materials), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.	
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	The history of planet Earth
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 billions of years. Studying these objects can provide information about Earth's formation and early history. (HS.ESS1C.c)	
	Nuclear processes
Spontaneous radioactive decay follows a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (HS.PS1C.b)	
Crosscutting Concepts:	Scale, proportion, and quantity
Much of science deals with constructing explanations of how things change and how they remain stable.	

EARTH'S SYSTEMS	HS-ESS2-1
LSSS	**NGSS**
Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	
Clarification Statement	
Emphasis is on the processes by which rocks and minerals are formed and on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, erosion, and mass wasting).	Emphasis is on the processes by which rocks and minerals are formed and on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, erosion, mass wasting, <u>and coastal erosion</u>).
Science and Engineering Practice:	Developing and using materials
Disciplinary Core Ideas:	Earth materials and systems
Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS.ESS2A.a)	
	Plate tectonics and large-scale system interactions
Plate tectonics is the unifying theory that explains the past and current movements of rocks at Earth's surface and provides a framework for understanding its geologic history. (HS.ESS2B.a) Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (HS.ESS2B.b)	
Crosscutting Concepts:	Stability and change
Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	

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EARTH'S SYSTEMS	HS-ESS2-2
LSSS	**NGSS**
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 could 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 ground water 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.	
Science and Engineering Practice:	Analyzing and interpreting data
Disciplinary Core Ideas:	Earth materials and systems
Earth's systems, being dynamic and interacting, include feedback effects that can increase or decrease the original changes. (HS.ESS2A.a)	
	Weather and climate
The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere, and land systems, and this energy's re-radiation into space. (HS.ESS2D.a)	
Crosscutting Concepts:	Stability and change
Feedback (negative or positive) can stabilize or destabilize a system.	

EARTH'S SYSTEMS	HS-ESS2-3
LSSS	**NGSS**
Develop 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 the Earth's three-dimensional structure obtained from seismic wave data, 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.	
Science and Engineering Practice:	Developing and using models
Disciplinary Core Ideas:	Earth materials and systems
Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a viscous mantle and solid crust. (HS.ESS2A.b) 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 Earth's interior and gravitational movement of denser materials toward the interior. (HS.ESS2A.c)	
	Plate tectonics and large-scale system interactions
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. Plate tectonics can be viewed as the surface expression of mantle convection. (HS.ESS2B.c)	
	Wave properties
Geologists use seismic waves and their reflections at interfaces between layers to probe structures deep in the planet. (HS.PS4A.c)	
Crosscutting Concepts:	Energy and matter
Energy drives the cycling of matter within and between systems.	

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EARTH'S SYSTEMS	HS-ESS2-4
LSSS	**NGSS**
Analyze and interpret data to explore how variations in the flow of energy into and out of Earth's systems result in changes in atmosphere and climate.	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	
Changes differ by timescale, from sudden (large volcanic eruption, hydrosphere circulation) to intermediate (hydrosphere circulation, solar output, human activity) and long-term (Earth's orbit and the orientation of its axis and changes in atmospheric composition). Examples of human activities could include fossil fuel combustion, cement production, or agricultural activity and natural processes such as changes in incoming solar radiation or volcanic activity. Examples of data can include tables, graphs, maps of global and regional temperatures, and atmospheric levels of gases.	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.
Science and Engineering Practice:	
Analyzing and interpreting data	Developing and using models
Disciplinary Core Ideas:	Earth and the solar system
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 Earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (HS.ESS1B.b)	
	Earth materials and systems
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, hydrosphere circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS.ESS2A.d)	

Weather and climate	
The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere and land systems, and this energy's re-radiation into space. (HS.ESS2D.a) <u>Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b)</u> <u>Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)</u>	The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, hydrosphere and land systems, and this energy's re-radiation into space. (HS.ESS2D.a)
Crosscutting Concepts:	Cause and effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

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EARTH'S SYSTEMS	HS-ESS2-5
LSSS	**NGSS**
Plan and conduct an investigation on the properties of water and its effects on Earth materials and surface processes.	
Clarification Statement	
Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids)	
Science and Engineering Practice:	Planning and carrying out investigations
Disciplinary Core Ideas:	The role of water in Earth's surface processes
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 the viscosities and melting points of rocks (HS.ESS2C.a)	
Crosscutting Concepts:	Structure and function
The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.	

EARTH'S SYSTEMS	HS-ESS2-6
LSSS	**NGSS**
Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	
Clarification Statement	
Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.	
Science and Engineering Practice:	Developing and using models
Disciplinary Core Ideas:	Weather and climate
Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b) Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS.ESS2D.c)	
Crosscutting Concepts:	Energy and matter
The total amount of energy and matter in closed systems is conserved.	

EARTH'S SYSTEMS	HS-ESS2-7
LSSS	**NGSS**
Construct an argument based on evidence about the simultaneous coevolution of Earth systems and life on Earth.	
Clarification Statement	
Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.	
Science and Engineering Practice:	Engaging in argument from evidence
Disciplinary Core Ideas:	Weather and climate
Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS.ESS2D.b)	
	Biogeology
The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS.ESS2E.a)	
Crosscutting Concepts:	Stability and change
Much of science deals with constructing explanations of how things change and how they remain stable.	

HUMAN SUSTAINABILITY	**HS-ESS3-1**
LSSS	**NGSS**
Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	
Clarification Statement	
Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.	
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	Natural resources
Resource availability has guided the development of human society. (HS.ESS3A.a)	
	Natural hazards
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. (HS.ESS3B.a)	
Crosscutting Concepts:	Cause and effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	

HUMAN SUSTAINABILITY	HS-ESS3-2
LSSS	**NGSS**
Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.	
Clarification Statement	
Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural, soil use, forestry, and mining (coal, tar sands, and oil shales), and pumping (ground water, petroleum and natural gas). Science knowledge indicates what can happen in natural systems--not what should happen.	
Science and Engineering Practice:	
Constructing explanations and designing solutions	Engaging in argument from evidence
Disciplinary Core Ideas:	Natural resources
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. (HS.ESS3A.b)	
	Designing solutions to engineering problems
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS.ETS1B.a)	
Crosscutting Concepts:	
Systems and system models	Connections to engineering, technology, and applications of science
Systems can be designed to do specific tasks.	Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. Analysis of costs and benefits is a critical aspect of decisions about technology.

HUMAN SUSTAINABILITY	HS-ESS3-3
LSSS	**NGSS**
Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	
Clarification Statement	
Examples of factors that affect 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 that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.	
Science and Engineering Practice:	Using mathematics and computational thinking
Disciplinary Core Ideas:	Human impacts on Earth's systems
The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS.ESS3C.a)	
Crosscutting Concepts:	Stability and Change
Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	

HUMAN SUSTAINABILITY	HS-ESS3-4
LSSS	**NGSS**
Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.	
Clarification Statement	
Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).	
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	Human impacts on Earth's systems
Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS.ESS3C.b)	
	Designing solutions to engineering problems
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS.ETS1B.a)	
Crosscutting Concepts:	Stability and change
Feedback (negative or positive) can stabilize or destabilize a system.	

HUMAN SUSTAINABILITY	HS-ESS3-5
LSSS	**NGSS**
Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.	
Clarification Statement	
Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).	
Science and Engineering Practice:	Analyzing and interpreting data
Disciplinary Core Ideas:	Global climate change
Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS.ESS3D.a)	
Crosscutting Concepts:	Stability and change
Change and rates of change can be quantified and modeled over very short or long periods of time. Some system changes are irreversible.	

<table>
<tr><th>HUMAN SUSTAINABILITY</th><th>HS-ESS3-6</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td colspan="2">Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/ or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.</td></tr>
<tr><td>Science and Engineering Practice:</td><td>Using mathematics and computational thinking</td></tr>
<tr><td>Disciplinary Core Ideas:</td><td>Weather and climate</td></tr>
<tr><td colspan="2">Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (HS.ESS2D.d)</td></tr>
<tr><td></td><td>Global climate change</td></tr>
<tr><td>Important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities (e.g., through computer simulations and other discoveries <u>satellite imagery</u>). (HS.ESS3D.b)</td><td>Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.</td></tr>
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