Unit 3: Earth Systems, Climate and Atmosphere

Content Area:	**Science**
Course(s):	
Time Period:	**Marking Period 1**
Length:	**3 weeks**
Status:	**Published**

Brief Summary of Unit

In this unit students will explore the biogeochemical cycles [N (Nitrogen), S (Sulfur), P (Phosphorus), Carbon, and Water], the earth's geologic and atmospheric systems and the biomes of the world. Students will learn how weather and climate affect the different parts of the world and how the earth's systems interact with each other. Students will also explore how climate change has affected earth's systems.

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CS.9-12.8.2.12.EC.1	Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made.
CS.9-12.8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
CS.9-12.8.2.12.ETW.4	Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.
LA.W.11-12.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
LA.RI.11-12.1	Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.), to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.
LA.RI.11-12.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).
LA.RI.11-12.10a	By the end of grade 11, read and comprehend literary nonfiction at grade level text-complexity or above with scaffolding as needed.
LA.RL.11-12.1	Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
LA.RL.11-12.2	Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
LA.RL.11-12.4	Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (e.g., Shakespeare as well as other authors.)

MA.S-IC.A.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
MA.S-IC.B.3	Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
MA.S-IC.B.4	Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
MA.S-IC.B.6	Evaluate reports based on data.
MA.S-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
SCI.HS.ESS2.B	Plate Tectonics and Large-Scale System Interactions
SCI.HS.ESS2.C	The Roles of Water in Earth's Surface Processes
SCI.HS.ESS2.D	Weather and Climate
SCI.HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change).
SCI.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.
SCI.HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
SCI.HS-ESS3-5	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.
SCI.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.
SCI.HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
SCI.HS-ESS1-5	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.
SCI.HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
SCI.HS-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
SCI.HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
SCI.HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.8	Evaluate media sources for point of view, bias, and motivations (e.g., NJSLSA.R6, 7.1.AL.IPRET.6).
	Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

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).

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.

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, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.

The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.

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 solid mantle and crust. 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.

Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.

Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.

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).

Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.

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.

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.

Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.

Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

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.

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 gradual climate changes.

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.

Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

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 scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.

Energy drives the cycling of matter within and between systems.

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, ocean, and land systems, and this energy’s reradiation into space.

Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

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.

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.

Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

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.

Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

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.

Essential Questions / Enduring Understandings

Essential Questions:

How do the major biogeochemical cycles support life on Earth?

How does Earth's geology and postition relative to the sun impact the way that life has evolved in different regions?

Why is the atmosphere such a vital part of Earth's structure and biodiversity?

How do the world's oceans regulate the location of different ecosystem types (biomes)?

Enduring Understandings:

The most important materials for life on Earth are transferred through the planet's living things and geology in cycles.

The complex interaction between the planet's oceans and atmophere determines the types of living things in different regions of the planet.

Objectives

Students will know how essential life elements cycle through our biosphere, atmosphere and geo-sphere.

Students will know the role that plate tectonics play in the shifting of landmasses and ecosystems

Students will know the different biomes and marine environments of the earth

Students will know how proximity to oceans and warm vs cold currents impacts the climate and weather of nearby landmasses

Students will know the major biomes on Earth and their individual characteristics.

Students will know what El Nino events are and how they impact worldwide climate patterns

Students will know the process of Eutrophication and its impact on major bodies of water such as the Gulf of Mexico and Chesapeake Bay

Students will be skilled at mapping the movement of Carbon, Nitrogen and Water

Students will be skilled at identifying major human impacts on these cycles.

Learning Plan

Intro to Climate: Class discussion of weather vs Climate. Analysis of Earth's tilt and how the angle of sunlight impact and albedo determine climate by latitute.

Climate discussion, continued: Students will brainstorm why regions near warmer ocean currents experience more rainfall than those inland or near cold water currents. Analysis of major ecosystem types in different regions of the US based on this concept.

Atmosphere: Group Jigsaw assignment, each student will learn about one of the major layers of the Earth's atmophere and its role in sustaining conditions on Earth's surface. Group challenge: come up with the best mnemonic device to remember the layers in order.

Plate Tectonics: Independent research - students will independently reasearch to identify the 3 major types of tectonic plate boundaries and specific locations on Earth where these geologic formations can be found.

El Nino vs La Nina: PPT notes and class discussion of El Nino vs La Nina events and their impact on ocean currents and global climate. Then group brainstorm and discussion: How might these events impact the spread of dieases among human populations? How might they impact food production?

Biomes Grid - Independent research and text reading: students will create a bullet point summary that includes climate characteristics, soil type, major flora and fauna, and location for each of the major biomes on Earth

BioGeoChemical Cycles Stations: over 4 class periods, students will visit a different station each day that combines text reading, worksheets and case studies to learn about the 4 major cycles: Water, Carbon/Oxygen, Nitrogen, and Phosphorous.

Assessment

Formative Assessments:

- Worksheets
- Do Nows

- Exit Tickets
- Class Discussions

Quizzes:

- Layers of the Atmosphere, Climate and Biomes Quiz
- BioGeoChemical Cycles Quiz

Bench Marks:

Midterm and Final Exam

Alternative:

- Atmosphere Jigsaw
- Plate Tectonics Research Assignment
- Atmosphere Study Guide
- El Nino / La Nina and Disease Discussion
- BioGeoChem Cycles Review
- Biomes Grid

Summative:

Unit Tests:

- Climate, Atmosphere, Ocean Currents, El Nino, Biomes, BioGeoChemical Cycles

Materials

Raven & Berg Evnironment Textbooks (ISBN: 978-1-119-39341-2)

Guided note packets (teacher developed)

Technology (student & teacher laptops, SmartBoard)

PowerPoints

Workshets/notes

Youtube/Netflix

Chesapeake Bay Case Study

Gulf Coast Hypoxia case study

Nitrogen Cycle Guided note packet

Carbon Footorint Calculator Website

Suggested Strategies for Modification

https://docs.google.com/spreadsheets/d/1P8BzKodtBsbWi4rQ0tunGWhZkCOg52IvbNO7yy-TFJI/edit?usp=sharing