Environmental Science
Grades 11 - 12
Unit 4: Climate Change

New Jersey Student Learning Standards - Science

Established 2016-2017
Revised 2018-2019
Revised 2019-2020
Revised 2020-2021
Revised 2021-2022
Revised 2022-2023

Marking Period	Unit Title	Recommended Instructional Days
3	**Climate Change**	**30 Days**

NJSLS - Science: ***TItle***	**NJSLS - Science:** ***Performance Expectations***	
HS-ESS2 Earth's Systems HS-ESS3 Earth and Human Activity	HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that causes changes to other Earth systems. HS-ESS2-4 Construct scientific arguments using data to support claims that spatial and temporal patterns in weather and climate found around the Earth are created by complex global, regional, and local interactions involving sunlight, and all of the Earth's spheres 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. HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere as it relates to our climate system. 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.	**Recommended Activities, Investigations, Interdisciplinary Connections, and/or Student Experiences to Explore NJSLS-S within Unit**

FOUNDATION Disciplinary: ***Core Idea***	**FOUNDATION Disciplinary:** ***Statement***	
ESS1.B: Earth and the Solar System ESS2.A: Earth Materials and Systems	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. Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. 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.	**Essential Question/s:** How are climates formed? How does the ozone shield protect the planet from harmful radiation and how do we protect it? What are some of the effects of global climate change that are being observed already and what is predicted for the future? **Lab Demonstrations**: **Activity Description**: "Latitude and Climate" Using a globe or world map, indicate three continental locations and relate information about their climates. Then have the students choose 3 areas and relate information about their climates. **Activity Description**: "Convection Currents" Design a Model – clear casserole dish, very cold water, an immersion heater, and food coloring dropper bottle. Tell students you will demonstrate how different temperatures create air and water currents. **Activity Description**: "Air Currents and the spinning Earth" Design a Model - Lightly dust a globe with flour. Have a student fill an eyedropper with water and hold it over the north pole. Ask a student to spin the globe counterclockwise while the student with the dropper drips water onto the globe. Let the globe come to a rest and then ask the students to describe the tracks made by water. **Lab Activities:** **Activity Description**: "Precipitation Extremes on Earth"

ESS2.C: The Roles of Water in Earth's Surface Processes ESS2.D: Weather and Climate	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. 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. 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 re-radiation into space. Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.	Students are given precipitation data sheets of multiple countries and find the difference in millimeters between the annual average. Modify lessons by allowing calculators and minimizing data sheets. **Activity Description**: "Rain Shadows in Satellite Imagery" Students study a satellite image of the Pacific Northwest. Have students identify the Cascade Mountains. Point out green areas to the west and brown areas to the east of the range. Have students write what might cause this difference. Modify the lesson by removing the written portion. **Activity Description**: "Modeling Ozone Reactions" Have students construct models of O2 molecules with plastic-foam balls and straws. Proceed to have students demonstrate 03 formation and degradation. Have students sketch and explain what is happening, as the molecules are separating and rejoining. Modify the lesson by removing the sketch portion. **Activity Description**: "Decreasing Land Surface" Find a topographic map of a low-lying coastal region of the United States, such as Florida. Locate the 150ft contour line. Explain that if the polar ice caps melt entirely, everything below 150ft will be underwater. Group students and hand each group a different map of a low-lying area. Tell the students to repeat the task of finding the 150ft contour line. Have students sketch a picture of what the "new" state will look like if the seas rise. Have students write a report about profound effects of such an event on human and other organisms. Modify lessons by removing reports. **Projects:** **Activity Description**: "Case Study: Ice Cores – Reconstructing Past Climates" Students read a case study about the information ice cores can tell us about the past climates of Earth. Students answer critical thinking questions pertaining to the article. Modify lessons by limiting the amount of critical thinking questions or using the questions as a class discussion.

ESS3.C: Human Impacts on Earth Systems ESS3.D: Global Climate Change ETS1.B: Developing Possible Solutions	Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. 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. 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. 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. (	**<u>Activity Description</u>**: "Testing a climate model" Have students use a computer simulation program to manipulate the levels of atmospheric gasses, such as oxygen and carbon dioxide, and observe the simulation response. Ask them to suggest other variables to manipulate, and have them make predictions about the resulting effects. Modify the lesson by limiting the amount of manipulations. **<u>Activity Description</u>**: "How Much Does a Car Really Cost?" Ask students to select a vehicle and research what it would cost them over a period of one year. Provide them with the research materials, as well as the annual mileage and fuel price. Have them list the make, model, engine size, retail cost, fuel efficiency, annual maintenance and insurance costs, annual maintenance fees, and other annual fees such as parking. Provide formulas for students to plug in the data to see their results. Have students' type a formal report about their vehicle and present it to the class. Modify the lesson by removing the formal report and have students present their findings. **<u>Activity Description</u>**: "Making a Difference: Ozone Shield" Students read an article interview with a leading Ozone scientist Susan Solomon, and her strides in ozone health. **<u>Activity Description</u>**: "Math/Graphing Lab: Methyl Bromide: The Ozone's Enemy" Students analyze historical data that include estimated consumptions of methyl bromide and concentrations of stratospheric ozone over Antarctica. Graph data and analyze patterns. Decide whether a plot represents a cause-and-effect relationship among variables. Extension: Have students use internet resources to research the total column of ozone in your area. Modify the lesson by removing the extension.
FOUNDATION **Science and Engineering Practices:** ***Core Idea***	**FOUNDATION** **Science and Engineering Practices:** ***Statement***	**<u>Long-Term Project:</u>** **<u>Activity Description</u>**: "Forming a Hypothesis about Pollution Damage" Students will form a hypothesis about ground level ozone in your area and relate its presence or absence to the alteration of rubber and nylon. Predict

Developing and Using Models	Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Use a model to provide mechanistic accounts of phenomena. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	locations that contain detectable ozone. Identify the presence or absence of ozone in your selected locations. Observe and describe the condition of rubber and nylon exposed at locations you select. Relate the condition of rubber and nylon to the presence or absence of ozone. Design an instrument to combat ozone in your area. Students write a formal proposal of an instrument. **Interdisciplinary Connections:** Content: ELA NJSLS#: RST.11-12.1/12.2/12.7/12.8 / WHST.9-12.2/12.7 / SL.11-12.5 Content: Math NJSLS#: MP.2/MP.4/ HSN-Q.A.1/HSN-Q.A.2/HSN-Q.A.3
Analyzing and Interpreting Data	Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	
Scientific Investigations Use a Variety of Methods	Science investigations use diverse methods and do not always use the same set of procedures to obtain data. New technologies advance scientific knowledge.	
Scientific Knowledge is Based on Empirical Evidence	Science knowledge is based on empirical evidence. Science disciplines share common rules of evidence used to evaluate explanations about natural systems. Science includes the process of coordinating patterns of evidence with current theory.	

	Science arguments are strengthened by multiple lines of evidence supporting a single explanation.	
FOUNDATION Crosscutting Concepts: ***Core Idea***	**FOUNDATION Crosscutting Concepts:** ***Statement***	
Cause and Effect	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	
Stability and Change	Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system.	
Interdependence of Science, Engineering, and Technology	Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	
Influence of Engineering, Technology, and Science on Society and the Natural World	Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3) Engineers continuously modify these technological systems by applying scientific knowledge and	

	engineering design practices to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	
Social and Emotional Learning: ***Competencies***	**Social and Emotional Learning:** ***Sub-Competencies***	
Self-awareness	Recognize one's feelings and thoughts and how they impact one's own behavior.	
Self-Management	Identify and apply ways to persevere. Recognize and identify the thoughts, feelings, and perspectives of others.	
Social Awareness	Demonstrate an awareness of the differences among individuals, groups, and others' cultural backgrounds. Demonstrate an understanding of the need for mutual respect when viewpoints differ.	
Responsible Decision Making	Demonstrate an awareness of the expectations for social interactions in a variety of settings. Develop, implement, and model effective problem-solving and critical thinking skills. Identify the consequences associated with one's actions in order to make constructive choices.	

	Evaluate personal, ethical, safety, and civic impact of decisions.	

Assessments (Formative) ***To show evidence of meeting the standard/s, students will successfully engage within:***	**Assessments (Summative)** ***To show evidence of meeting the standard/s, students will successfully complete:***
Formative Assessments: ● Do Now questions ● Exit Polls ● Kahoot ● Current Event Essays	**Benchmarks:** ● District generated diagnostic test and four district assessments. **Summative Assessments:** ● Exams based on multiple choice, true/false, short answer responses ● Summative essays based on performance tasks ● Summative presentations

Differentiated Student Access to Content:
Teaching and Learning *Resources/Materials*

Core Resources	**Alternate Core Resources** ***IEP/504/At-Risk/ESL***	**ELL Core Resources**	**Gifted & Talented Core Resources**
● Holt Environmental Science ● Basic Lab Equipment ● Chromebooks ● Newsela ● Smartboard ● biointeractive.org ● nasa.gov ● Crash Course video series ● Kahoot	● modified tests ● supplemental study guides	● modified tests ● supplemental study guides ● multilingual assignments ● multilingual dictionary	● modified assignments ● supplemental assignments

Supplemental Resources

Technology:
- Chromebooks
- Smartboard

Other:
- NA
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Differentiated Student Access to Content: **Recommended *Strategies & Techniques***			
Core Resources	**Alternate Core Resources** ***IEP/504/At-Risk/ESL***	**ELL Core Resources**	**Gifted & Talented Core**
• Holt Environmental Science • Basic Lab Equipment • Chromebooks • Smartboard • biointeractive.org • nasa.gov • Crash Course video series	• Utilize a multi-sensory (VAKT) approach during instruction, provide alternate presentations of skills by varying the method (repetition, simple explanations, additional examples, modeling, etc.), modify test content and/or format, allow students to retake tests for additional credit, provide additional times and preferential seating as needed, review, restate and repeat directions, provide study guides, and/or break assignments into segments of shorter tasks	• Extend time requirements, preferred seating, positive reinforcement, check often for understanding/review, oral/visual directions/prompts when necessary, supplemental materials including use of an online bilingual dictionary, and modified assessment and/or rubric.	• Create an enhanced set of introductory activities, integrate active teaching/learning opportunities, incorporate authentic components, propose interest-based extension activities, and connect students to related talent development opportunities.

New Jersey Legislative Statutes and Administrative Code (place an "X" before each law/statute if/when present within the curriculum map)									
	Amistad Law: *N.J.S.A. 18A 52:16A-88*		Holocaust Law: *N.J.S.A. 18A:35-28*		LGBT and Disabilities Law: *N.J.S.A. 18A:35-4.35*	x	Standards in Action: *Climate Change*	x	Diversity and Inclusion *N.J.S.A. 18A:35-4.36a*