

Climate Science

Unit 3 Impact of Climate Change

Unit Overview: The impacts of climate change are wide reaching. Students will discover that climate change impacts the frequency and intensity of storms, the timing of seasonal changes, and the most basic components of the water cycle. The information in this unit bridges concepts studied in Unit 1 Earth's Energy Balance with Unit 2 Climate Change. Studying data models with the information and concepts from Earth's Energy Balance and Climate Change allow for a complete study of the impacts of climate change.

Unit Storyline: Students bring together concepts from Unit 1 Earth's Energy Balance and Unit 2 Climate Change to study how climate change is impacting the natural and physical world.. In the first lesson students analyze data, read articles, manipulate computer simulations, and perform laboratory activities to gain an understanding of how climate change and rising atmospheric temperatures have worldwide impacts on the global water cycle. As components of the water cycle speed up and worldwide evaporation rates increase this effects the amount and intensity of hurricanes and cyclones globally. Students then consider evidence from various sources including video, text, and data based in phenology (the study of periodic events in biological life cycles and how these are influenced by seasonal and interannual variations in climate) to determine if the timing of seasonal shifts has been changing in response to rising global atmospheric temperatures. Changes in seasonal shifts have significant impacts on ecosystem relationships that can affect all living organisms.

Anchor Phenomena –

Climate change has wide ranging effects on humans, the environment, and ecosystem both locally and globally.

Essential Questions/Potential Driving Questions

What is the impact of climate change on Earths water cycle?

How does the changes of water cycle components effect humans and other living things?

What affect does global climate change have on the frequency and intensity of hurricanes?

How could a shift in seasonal change disrupt relationships in an ecosystem?

What is phenology?

Do we see evidence for climate change in the timing of phenological events of plants and animals?

What effects does climate change have on our seasons?

What effects does climate change have on the life cycles of plants and animals?

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New York State Science Learning Standards (NYSSLS) by Lesson

<p>Lesson: Climate Change Impacts on the Water Cycle – Performance Expectation and Disciplinary Core ideas:</p> <ul style="list-style-type: none"> • 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 Sciences. <ul style="list-style-type: none"> • ESS2.A - Earth Materials and Systems* • ESS3.D – Global Climate Change* • ESS2.D – Weather and Climate* 	<p>Lesson: Getting to the Core: Time for a Season Change– Performance Expectation and Disciplinary Core Ideas:</p> <ul style="list-style-type: none"> • HS-ESS3-6 – Use a computational representation to illustrate the relationships among Earth systems and how those relations are being modified due to human activity. <ul style="list-style-type: none"> • ESS3.D – Global Climate Change* • ESS2.D – Weather and Climate* 	
<p>Lesson: Getting to the Core: Hurricanes and Climate – Performance Expectation and Disciplinary Core Ideas:</p> <ul style="list-style-type: none"> • 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 Sciences. <ul style="list-style-type: none"> • ESS2.A - Earth Materials and Systems* • ESS3.D – Global Climate Change* • ESS2.D – Weather and Climate* 	<p>Science and Engineering Practices* Analyzing and Interpreting Data Engaging in Argument from Evidence Developing and Using Models</p>	<p>Crosscutting Concepts* Patterns Stability and Change Systems and System Models</p>

*Denotes hyperlink for additional information

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Time Frame	Climate Change Impacts on the Water Cycle	5 E Model	Teacher Resources and Materials	In Class Student Activities Lab Resources	Online Resources
	<p>Phenomena Glaciers and sea ice are melting along with an increase of sea level.</p> <p>Vocabulary ablation sublimation evaporation albedo thermal expansion</p>	<p>Engage Students will be introduced to the unit phenomena by watching a short video of a flash flood in a desert setting. Students will use this phenomena to create a model of the water cycle with what students believe are the impacts of climate change in their initial water cycle model.</p>	<p>Climate Change Impacts on the Water Cycle Lesson Plan</p> <p>Climate Change Impacts on the Water Cycle PowerPoint</p>	<p>Climate Change Impacts on the Water Cycle Student Resource</p>	<p>PhET Simulation - Glaciers Students will investigate how environmental conditions (temperature and precipitation) impact glacial mass.</p> <p>PhET Simulation -States of Matter Students will investigate water behavior as thermal energy (heat) is added to liquid water.</p>
		<p>Explore Students will interpret graphs of data that convey impacts of climate change over the past century. Following this teachers will facilitate a jigsaw reading activity based on two articles related to climate change and the water cycle.</p>	<p>Climate Impacts Graph Matching Cards</p> <p>Jigsaw Activity</p>	<p>Student text selections for jigsaw:</p> <p>Section 1 – Introduction - The Water Cycle and Climate Change</p> <p>Section 2 – Changing Climate Means Changing Weather</p> <p>Section 3 – Evaporation, Precipitation, and Climate Change</p> <p>Section 4 – Changing Climate Effects on World’s Oceans and Seas</p>	<p>Rising Sea Levels (Nearpod Video) This video offers an overview of what is contributing to sea level rise. Questions are embedded in the video for student responses.</p> <p>Coping with Climate Change: Texas Towns Struggle with Water (Nearpod Video) The plight of two Texas towns in their struggle for water due to drought and record temperatures are reported on.</p>
		<p>Explain Students will learn what is happening to water when thermal energy (heat) is added to water by participating in a thermal expansion laboratory and a PhET computer simulation.</p>	<p>Thermal Expansion of Water – TR</p> <p>PhET Simulation – States of Matter – TR</p>	<p>Thermal Expansion of Water – SR</p>	<p>NASA’s Earth Minute: Greenland Ice (Nearpod Video) NASA is monitoring Greenland’s ice sheet from space to the ocean floor to provide scientific data concerning the global impact of all its melting ice.</p>
		<p>Elaborate Students will study climate change impacts on Arctic glaciers, sea level, rainfall, and sea ice.</p>	<p>Glaciers Then and Now Image Pairs</p> <p>PhET Glaciers – TR</p> <p>Graphing Sea Level Trends TR</p> <p>Teacher Protocol – Driving Question Board</p>	<p>Graphing Sea Level Trends – SR</p> <p>U.S Drought Monitor Map</p> <p>Projection Maps Related to Soil Moisture and Dry Days in the U.S.</p> <p>Farms in the U.S.</p>	

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			All About Sea Ice All About Arctic Climatology and Meteorology Dwindling Sea Ice Lab Activity – TR	Arctic Sea Ice Animation (2016-2018) Maps of Arctic Sea Ice Extent 2016-2018	Our Climate and Our Future – Coastal Permafrost Erosion in Alaska** - Nelson, an Indigenous person from Alaska show how climate change is melting permafrost and causing coastal erosion in his hometown.
		Evaluate Students return to their original water cycle model with climate change impacts and make modifications based on experiences and evidence gathered from this lesson. Modification includes a written impact statement about how their model changed including an explanation of how the water cycle is impacted due to climate change.	Scoring Rubric for Final Model		
	Lesson Connection to Storyline: Students create and modify a model of how climate change impacts the water cycle. Evidence gathered by students is varied and includes text, data, graphic, video, and analyzation of computer models and simulations. Students determine that increased evaporation of water from rising atmospheric temperatures is the primary driver of the water cycle changes which then impacts Arctic glacier and sea ice melt, sea rise, and extremes in rainfall.				

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Time Frame	Hurricanes and Climate	5 E Model	Teacher Resources and Materials	In Class Student Activities Lab Resources	Online Resources
	Phenomena Hurricanes have become more extreme and damaging.	Engage Students will develop background information about what hurricanes are and how hurricanes are formed.	Hurricanes and Climate - TR – Lesson Plan Hurricanes and Climate - PowerPoint Background Reading - Hurricanes	Hurricanes and Climate Student Resource	Hurricane Interactive – This interactive allows students to visualize conditions that will strengthen or weaken a hurricane.
	Vocabulary hurricane cyclone typhoon	Explore Students determine the frequency of hurricane occurrence, the seasonal timing of hurricanes, and the strength of hurricanes in the six areas of the world where hurricanes occur.	Map of Tropical Cyclones	Map of Tropical Cyclones	Hurricane 101 – (Nearpod Video) – This video from National Geographic provides background information on what hurricanes are and how they are formed.
		Explain Students will compare maps of sea surface temperatures with maps and data of hurricane occurrence to determine why hurricanes form in certain areas of the world.	Satellite Map of Sea Surface Temperature	Satellite Map of Sea Surface Temperature	Background Reading - Hurricanes – This reading provides students with background information on hurricanes including formation, forecasting, and damage caused by hurricanes.
		Elaborate Students will analyze data of hurricane frequency and hurricane strength to consider how a warmer climate could affect hurricanes.			Our Climate Our Future – Hurricane Sandy in NYC** - Follow Annie, a Fellow with the Alliance for Climate Education as she describes how her life was and is affected by Hurricane Sandy.
		Evaluate Students will respond to analysis questions embedded in Hurricane and Climate Student Resource and write a response to the prompt - What affect does global climate change have on the frequency and intensity of hurricane?	Hurricanes and Climate Writing Assignment	Hurricanes and Climate Writing Assignment	
	Lesson Connection to Storyline:	Students make connections that with the altering of the water cycle (increased evaporation rates) from the first series of lessons and rising atmospheric temperatures the frequency and intensity of hurricanes and cyclones worldwide is changing.			

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Time Frame	Time for a Season Change	5 E Model	Teacher Resources and Materials	In Class Student Activities Lab Resources	Online Resources
	<p>Phenomena – Cherry Trees in Japan are blooming earlier in the spring.</p> <p>Vocabulary phenology abiotic biotic deciduous</p>	<p>Engage Students will watch a short video about cherry blossoms in Japan blooming early and create an initial explanation about why this could be happening. Students will complete a graphic organizer with question prompts regarding season changes and how organisms respond to temperature change.</p>	<p>Time for a Season Change – TR Lesson Plan Time for a Season Change – PowerPoint Japanese Cherry Blossom (Nearpod Video)</p>	<p>Time for a Season Change - Student Resource</p>	<p>Project Budburst – Community of researchers, educators, and community scientists to help answer important questions around the effects of climate change on plants and animals.</p> <p>Our Climate Our Future- First Foods and the Fight to Protect Indigenous Lands **– This video brings awareness to how climate change impacts Indigenous lands and First Foods.</p>
		<p>Explore Students will be prompted to make connections to seasonal change and climate; read and take notes on two articles concerning seasonal shift; and analyze cherry tree bloom data from Japan.</p>		<p>Enter winter, the fastest-warming season (2021) Patel</p> <p>Springing Forward (2009) Cutrano,</p>	<p>Enter winter, the fastest-warming season (2021) Patel,</p>
		<p>Explain Students further explore seasonal shifts and impacts on communities in an ecosystem. This includes examining phenology and phenology mismatch; graphing data of lilac bloom dates and lake ice duration; and reading an article on warming climates effects on plant and animal life cycles.</p>		<p>Spring forward; Warmer climates accelerate life cycles of plants and animals (2003), Perkins</p>	<p>Enter winter, the fastest-warming season (2021) Patel, The Washington Post. Warmer winter weather and the implications in an ecosystem are considered.</p>
		<p>Elaborate Students respond to analysis questions focused on lilac bloom data and ice duration data emphasizing the implications on humans and other organisms.</p>			<p>Springing Forward (2009) Cutrano, Science News for Students. Climate change affects the timing of flowering, migration, and other natural cycles, meaning spring is coming earlier in many parts of the world.</p>
		<p>Evaluate Students generate claims and create informational presentation with evidence and reasoning from the question: <i>Does climate change have an impact on seasons and ecosystem relationships?</i></p>		<p>Time for a Season Change – Claim-Evidence-Reasoning Project</p>	<p>Spring forward; Warmer climates accelerate life cycles of plants and animals (2003), Perkins Science News Shifts in seasons has an impact on plant and animal life cycles.</p>
<p>Lesson Connection to Storyline: Students learn that as atmospheric temperatures rise and precipitation patterns are altered living organisms are responding to this change. This is leading to possible disruptions in ecosystems. Students should gain an understanding abiotic factors (water, temperature) have a lasting impact on biotic factors that can lead to transformations in ecosystems.</p>					

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Additional Resources

[4th National Climate Assessment](#) – Assessment of the science behind climate change and variability and its impacts across the United States, now and throughout this century

[NOAA](#) – National Oceanic and Atmospheric Administration

[NASA – Climate Change](#) - Articles, videos, data, and interactives from NASA about climate change

[EPA Climate Change](#) – General information including climate change facts, how climate change is addressed, and climate connections from the United States EPA

[EPA – Seasonality and Climate Change](#) – This report from the EPA summarizes observed climate changes related to seasonality in the U.S.

[Getting the Picture: Our Changing Climate](#) – Multimedia interactive resource uses an interdisciplinary approach infusing geography, science, and art for climate education

[Living Landscapes: Northeast Region](#) ** Resources include videos, essays, and climate science fundamentals through a Native American lens

[In Hot Water: Ocean Heat and Our Warming World](#) – ArcGIS Story Map explaining the effects and consequences of warming ocean waters

[Climate Change Indicators](#) – ArcGIS Story Map focusing on climate change indicators

[Climate Change is Shifting Tiger Shark Populations Northward](#) – Information from NOAA demonstrating that tiger sharks are migrating into northern latitudes earlier and expanding north due to warming ocean temperatures.

[Our Climate Our Future](#) ** – These series of videos offer experiences for young people on the science of climate change and how to take action.

[Our Climate Our Future – Racial Justice is Climate Justice](#)** - The fight for racial justice and the fight for climate justice overlap in many ways from air pollution to hurricane evacuees

[Our Climate Our Future – Wildfires and Air Pollution in Nevada](#)** A firsthand experience regarding the impacts of wildfire smoke

[Our Climate Our Future – What is Ocean Acidification?](#) This video explains what increased carbon dioxide levels are doing to oceans

[Our Climate Our Future – Pine Beetles and Wildfires in Colorado](#)** Pine beetles along with hotter and drier environments are throwing ecosystems out of balance in Colorado

[Wet, then dry extremes contributed to devastating Marshall Fire in Colorado](#) - Resource article from NOAA about conditions contributing to a forest fire in Colorado

[Climate Central](#) – Videos, data, graphics, and articles related to climate change and the impact on the public

[Historic Harriet Tubman Sites at Risk of Rising Seas on Eastern Shore](#)** - Climate Central article focused on climate change impacts on historic landmarks

[How tidal flooding is impacting students, caretakers and education in Atlantic City](#)** - Climate Central article aimed at how flooding near coastal cities is affecting infrastructure

[Rising seas swamp Black, Spanish, and Indigenous history in Northeast Florida](#)** - Climate Central article explains how rising sea waters and frequent flooding is affecting historically Black, Spanish, and Indigenous Cultural Institutions

[Heat & Health: Expanding “urban heat island” and warming climate sends more to ER in Charlotte](#)** - Climate Central article describes how urban heat islands and a warming climate affects residents of lower income communities

[As temperatures rise, so do allergies](#)** - Climate Central details how rising temperatures contributes to high pollen counts leading to those with allergies suffering from asthma attacks affecting low-income, minority communities

[Watching Rising Seas from Space](#) (Nearpod video) This video explains the causes of sea level rise and how sea level has changed over the last two decades as observed from satellite missions

[NASA’s Earth Minute: Sea Level Rise](#) (Nearpod video) - This video explains sea level rise and implications that occur

[NASA’S Earth Minute: Gas Problem](#) (Nearpod video) – This video explains what greenhouse gases do and what happens when greenhouse gases are not balanced

[Climate Change Threatens Homes of Boston’s Most Vulnerable](#)** - Climate Central reports on how residences in Boston’s affordable housing communities are affected by severe storms and flooding

[The Karuk’s Relationship with Fire: Adapting to Climate Change on the Klamath](#)** - The report explains how climate change is affecting one Indigenous Tribes cultural use of fire

[NYS P-12 Science Learning Standards \(HS\)](#) – NYSSLS Standards for grades 9-12

[NYSED Bilingual Glossaries](#) – NYS Statewide Language Regional Bilingual Education Resource for NYSED approved bilingual glossaries

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Group Learning Routines	Group Learning Routines to Support All Learners – All Strategies	Group Learning Routines – Pairs Turn, Exchange, Sort (Elbow Exchange) Questions Starts/Questions Only Questions 2x2x2 Dialogue Lines/Dialogue Circles	Group Learning Routines – Small Groups Think-Talk-Open Exchange Read-Generate-Sort-Solve Buzzwords (Think-Talk-Exchange) – Teacher Directions Buzzwords (think-Talk-Exchange) – Template	Group Learning Routines – Whole Class Domino Share Rumors Idea Carousel Exhibition I used to think...Now I think...	
English Language Learners (ELL) Enhancements To access hyperlinked material, you must be logged into your BPS Google Drive	<u>Listening</u> <ul style="list-style-type: none"> ● <u>Cross- Linguistic Practices:</u> Gives students opportunities to make connections between what they hear and their home language (For example, allow students to listen to a passage and identify cognates.) ● <u>Build background knowledge</u> ● <u>Activating Prior Knowledge</u> Activating prior knowledge means both eliciting from students what they already know and building initial knowledge that they need in order to access upcoming content ● <u>Activating Prior Knowledge</u> ● <u>Visuals</u> - GIFs, pictures- will assist students in understanding what they are listening to. Use visual thinking strategies to set the lens for learning. ● Video to review or introduce a topic – use closed captioning to help students see the words and pronunciations while they listen to the content. ● <u>Word stretching / Vowel stretching</u> when instructing allows student to listen closely to the pronunciation of the word ● <u>Performance Level Descriptors</u> this document provides teachers with a description of what output they 	<u>Speaking</u> <ul style="list-style-type: none"> ● <u>Sentence Frames</u> To begin a sentence - such as <i>The water cycle is...</i> or <i>I think that water cycle is...</i> ● <u>Academic Conversation Starters:</u> Have a visual of a list of academic sentence starters that students can refer to in a discussion. Examples include- I expect ____ to happen. My data shows that... This helps students have a more science focused dialogue. ● <u>Choral Reading</u> - To build fluency, self-confidence and motivation with reading/speaking ● Create <u>movement</u> to go with the word. Movement can be a motivating factor, as well as a kinesthetic tool for conceptualizing the rhythm and flow of fluent reading while triggering brain function for optimal learning ● <u>Performance Level Descriptors</u> This document provides teachers with a description of what output they can expect from students based on earned NYSESLAT levels in the modality of speaking. 	<u>Reading</u> <ul style="list-style-type: none"> ● <u>Supplementary Text</u> to help reinforce concepts. If necessarily, use lower Lexile levels to ensure comprehension. ● <u>Visual Aids</u> - Pictures or models to support vocabulary words and concepts ● Video to review or introduce a topic - use closed captioning to help students read along while they listen to the content ● <u>4 Square / Frayer models</u> to help students gain a deeper understanding of vocabulary. ● <u>Highlighting</u> -important text to assist students in answering questions after the reading. ● <u>Chunking</u>-Break reading of text into chunks or paragraphs ● <u>Performance Level Descriptors</u> - This document provides teachers with a description of what output they can expect from students based on earned NYSESLAT levels in the modality of reading. ● <u>Vocabulary Morphology-</u> Morphology relates to the segmenting of words into affixes (prefixes and suffixes) and roots or base words, and the origins of words. Understanding that words connected by meaning can be connected by spelling can 	<u>Writing</u> <ul style="list-style-type: none"> ● <u>Sentence Frames</u> - to begin a sentence- such as <i>The water cycle is...</i> or <i>I think that water cycle is....</i> ● <u>Cloze passages</u> with word banks ● <u>Word banks</u> ● <u>Graphic Organizers</u> to help break down the writing process and organize thoughts ● <u>Standards-based sentence stems</u> ● <u>Performance Level Descriptors</u> This document provides teachers with a description of what output they can expect from students based on earned NYSESLAT levels in the modality of writing. 	<u>Instructional Accommodations</u> (depending on the student’s needs) <ul style="list-style-type: none"> ● <u>Extended time</u> for tests in class, projects and assignments ● <u>Directions read.</u> Broken down as necessary ● <u>Model</u> how to complete the activity in the lesson ● <u>Oral simplification</u> of directions or questions ● <u>Translated version</u> of test when available. Student may have both version English and native language version ● Use of approved bilingual glossaries from NYS in each subject

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	can expect from students based on earned NYSESLAT levels in the modality of listening.		be critical to expanding a student’s vocabulary.		
<p>Special Education Modifications</p> <p>Special Education students must have accommodations as per Individual Educational Plan (IEP)</p>	<p><u>Instructional</u></p> <ul style="list-style-type: none"> ● Pre-teach vocabulary ● Use picture vocabulary ● Scaffold Depth of Knowledge questions ● Provide copy of notes/notes in “cloze” form ● Use of Think, Pair, and Share strategy to help process information ● Scaffold written assignments with the use of graphic organizers ● Allow for multiple ways to respond (verbal, written, response board) ● Provide model of performance task ● Modify informational text to fit the needs of the students ● Provide a digital or paper interactive notebook ● Present complex tasks in multiple ways ● Provide mnemonic strategies for Environmental Science concepts. 	<p><u>Technology:</u></p> <ul style="list-style-type: none"> ● Audio reading of text ● Text to type functions ● Videos to clarify/visualize Environmental Science concepts ● Record class lecture/discussions and make accessible to student ● Nearpod- interactive presentations of notes ● Playposit - show a video clip about the topic and add your own questions for them to answer as they watch ● Allow students to type answers in chat on Teams <p><u>Other:</u></p> <ul style="list-style-type: none"> ● Arrange seating for maximum engagement and minimum distraction 	<p><u>In Class Assessments</u></p> <ul style="list-style-type: none"> ● Provide review packet or review sheet of concepts covered on the test ● Practice similar questions prior to the test ● Provide multiple options for projects ● Give a timeline of when things are due and remind them of the process often. ● Use of timer in class ● Break all complex tasks into chunks 		
<p>Step Up to Writing</p> <p>Step Up to Writing materials can be found in BPS Science K-12 Schoology Folder →9-12 Resources →Climate Science →Climate Science Curriculum Materials →Step Up to Writing Materials</p>	<p><u>SUTW Strategies/Skills</u></p> <ul style="list-style-type: none"> ● Informal Outline ● Color-Coding – Informative/Explanatory Text ● Two-column notes ● I-V-F Topic Sentence progressing to Four Step Summary Paragraph ● CUPS – Capitalization, Usage, Punctuation, Spelling ● Transitions 				
<p>Culturally and Linguistically Responsive Teaching (CLRT) in the Science Classroom</p>	<ul style="list-style-type: none"> ● Materials, resources, and/or discussions address diverse cultural backgrounds and real-world applications ● Artifacts (posters, charts, etc.) in the science classroom are representative of the cultures of the student population ● All students are given an opportunity to engage in science discourse ● Teacher demonstrates high expectations for all students <p>CLRT resources which align to Science content are denoted with a **</p>				