

Topics in Biology - Climate Science

Unit 2 Climate Change

Unit Overview: This unit introduces students to the concept of climate change and some of the factors that contribute to climate change. The unit begins with students gathering more information about climate and climate change then using this information to create their own models of climate change. In the next lesson students obtain more facts about Earth's climate (present and past) using sample ice core data, linking temperature and carbon dioxide concentration. Students then acquire additional information related to greenhouse gases and the greenhouse effect.

Unit Storyline: Student learning and understanding now begin to focus on climate change and the factors that contribute to climate change. The first lesson students will create initial models of climate change after reading informational text on climate change and the factors that contribute to climate change. Students then analyze data with ice core samples to determine if there is a correlation between carbon dioxide concentration levels and atmospheric temperature. This allows for students to gain understanding that atmospheric gases and the greenhouse effect have a role in Earth's climate regulation. Students will determine from data analysis that the Earth is experiencing increasing carbon dioxide concentration levels and increased atmospheric temperatures. Greenhouse gases and the Greenhouse Effect's influence on the maintenance of Earth's climate in the next lesson will add to students continuing study of climate change. After students make sense of two computer based simulations focused on the relationship between greenhouse gases, infrared ray behavior, and Earth temperature at the surface and atmosphere; students will use video and text resources to further their understanding of the Greenhouse Effect. Students will then return to their initial models of climate change to make revisions with new information about greenhouse gases and the Greenhouse Effect. Finally, students will analyze data to determine if the concentration of atmospheric carbon dioxide has changed since the Industrial Revolution age. The information gained will provide additional evidence for students comprehension towards causes of climate change.

Anchor Phenomena

Climate can change over time and can vary from place to place. There are long term trends in climate such as rising average global temperatures.

Essential Questions/Potential Driving Questions

What is climate change?

What factors affect climate change?

Why is climate change important?

Is there a link between temperature and carbon dioxide (CO₂) concentration in the atmosphere?

Can past patterns of data help predict future scenarios?

What is the greenhouse effect?

What are greenhouse gases?

How do greenhouse gases trap heat and warm the planet?

Has the concentration of atmospheric carbon dioxide changed since the Industrial Revolution?

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New Your State Science Learning Standards (NYSSLS) by Lesson

<p>Lesson: Exploring Climate Change - Performance Expectation and Disciplinary Core Idea:</p> <ul style="list-style-type: none"> • 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. <ul style="list-style-type: none"> • ESS1.B – Earth and the Solar System* • ESS2.A – Earth Materials and Systems* • ESS2.D – Weather and Climate* 	<p>Lesson: Getting to the Core: The Link Between Temperature and Carbon Dioxide – Performance Expectation and Disciplinary Core Idea:</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"> • ESS3.D – Global Climate Change* 	
<p>Lesson: Greenhouse Effect – Performance Expectation and Disciplinary Core Idea:</p> <ul style="list-style-type: none"> • 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. <ul style="list-style-type: none"> • ESS1.B – Earth and the Solar System* • ESS2.A – Earth Materials and Systems* • ESS2.D – Weather and Climate* 	<p>Lesson: Climate Science Investigations: How Has Concentration of Atmospheric Carbon Dioxide Changed Since the Industrial Revolution?</p> <ul style="list-style-type: none"> • HS-ESS2-2 – Analyze geoscience data to make the claim that one change to earth’s surface can create feedbacks that cause changes to Earth’s systems. <ul style="list-style-type: none"> • ESS2.A – Earth Materials and Systems* • 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"> • ESS3.D – Global Climate Change* 	
	<p>Science and Engineering Practices*</p> <p>Developing and Using Models Analyzing and Interpreting Data</p>	<p>Crosscutting Concepts*</p> <p>Cause and Effect Stability and Change</p>

*Denotes hyperlink for additional information

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Time Frame	Exploring Climate Change	5 E Model	Teacher Resources and Materials	In Class Student Activities Lab Resources	Online Resources
	Phenomena - Climate has changed over time. Vocabulary energy conservation energy efficiency renewable energy nonrenewable energy energy consumption weather climate greenhouse effect fossil fuels hydrocarbons greenhouse gasses carbon dioxide methane emissions thermal expansion drought carbon reservoir mitigation carbon neutral sustainability	Engage - Students will be introduced to climate change through a KWL chart (K and W sections) and create a personal model of climate change.	Exploring Climate Change PowerPoint Exploring Climate Change– Teacher Lesson Plan KWL on chart paper, Post-its	KWL Chart Paper and markers	NASA time lapse video – Use this video as part of the engage when introducing the phenomena. This video shows the warming of the planet from 1880-2021. Student Informational Text (Complete document) 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
		Explore - Students will participate in a group jigsaw activity using student informational text.	Student Informational Text Resource Graphics from Informational Text	Informational Text by Group Four Column Notes	
		Explain - Students will present key findings from the informational text in 3-5 minute student generated presentations.	Graphics from Informational Text		
		Elaborate - During presentations, students will demonstrate their learning by adding information to the L section of their KWL chart.	KWL on chart paper, Post-its	KWL Chart	
		Evaluate - Students will revise their model of climate change and write a paragraph explaining why the revisions were necessary. Please keep students revised models – students will be revising their models for a second time following the lesson on the Greenhouse Effect.		Paper and markers	
	Lesson Connection to Storyline: Students will document, model and discuss what they know about climate change, explore informational text to learn more about the many factors of climate change, present what they have learned and re-visit the model to make improvements and modifications.				

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Time Frame	Getting to the Core: The Link Between Temperature and Carbon Dioxide	5 E Model	Teacher Resources and Materials	In Class Student Activities Lab Resources	Online Student Activities
	<p>Phenomena – Arctic ice holds data and information about Earth’s climate over for hundreds of thousands of years.</p> <p>Vocabulary carbon carbon cycle carbon dioxide (CO₂) fossil fuel greenhouse effect greenhouse gas ice core temperature anomaly</p>	<p>Engage - Students review the greenhouse effect, what ice cores are, and how data is collected from the ice cores samples.</p>	<p>Getting to the Core Teacher Lesson Plan Getting to the Core PowerPoint Colored Pencils</p>		<p>Learn the Basics – Today’s Climate Change (Nearpod video)</p>
		<p>Explore - Students graph temperature anomaly and CO₂ data from ice core sample.</p>		<p>Vostok Data Instructions Vostok Antarctica Ice Core Data Graph Paper – Graph 1 Graph Paper – Graph 2</p>	<p>Extension Activity resources – Climate Change – A Report from Antarctica – WAIS Divide Ice Core (Nearpod video)</p>
		<p>Explain - Students analyze ice core data (CO₂ concentration and temperature anomalies)</p>		<p>Carbon Dioxide Concentration and Temperature Anomaly</p>	<p>Extension activity – Two Column Notes</p>
		<p>Elaborate - Students determine CO₂ and temperature rate of change for two different time spans of data.</p>		<p>Carbon Dioxide Concentration and Temperature Rate of Change</p>	<p>Extension Activity – Writing Assignment</p>
		<p>Evaluate – Students respond to embedded questions involving analyzed data sets.</p>			
	<p>Lesson Connection to Storyline: Students will analyze data ice core samples to determine if there is a correlation between carbon dioxide concentration levels and atmospheric temperature. This allows for students to gain understanding that atmospheric gases and the greenhouse effect have a role in Earth’s climate regulation. Students will determine from data analysis that the Earth is experiencing increasing carbon dioxide concentration levels and increased atmospheric temperatures.</p>				

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Time Frame	Greenhouse Effect	5 E Model	Teacher Resources and Materials	In Class Student Activities Lab Resources	Online Student Activities
	<p>Phenomena –Greenhouse gases stabilize Earth’s climate and make Earth surface habitable.</p> <p>Vocabulary energy radiation solar infrared greenhouse effect greenhouse gas atmosphere carbon dioxide ozone methane water vapor</p>	<p>Engage – Students will use -2, -3, or -4 column notes to engage in a PowerPoint providing background information concerning the Greenhouse Effect</p>	<p>Greenhouse Effect Teacher Lesson Plan Greenhouse Effect Lesson PowerPoint</p>	<p>Two-Column Notetaking Guide Three-Column Notetaking Guide Four-Column Notetaking Guide</p>	<p>Concord Consortium Climate Change Simulation</p> <p>PhET Greenhouse Effect Simulation</p>
		<p>Explore – Students will work through two greenhouse gas simulations and accompanying guides to discover the relationships between greenhouse gases, Earth surface and air temperatures, and infrared ray behavior</p>	<p>Concord Consortium Climate Change Directions – PDF Concord Consortium Climate Change Directions – PPT</p> <p>PhET Greenhouse Effect Simulation Directions – PDF PhET Greenhouse Effect Simulation Directions – PPT</p>	<p>Concord Consortium Climate Change Simulation Guide</p> <p>PhET Greenhouse Effect Simulation Guide</p>	
		<p>Explain – Students will read an article, view a video, and complete graphic organizers for both concerning the Greenhouse Effect. Students will have the opportunity to collaborate with peers to add additional information to graphic organizers. Students will have a choice of articles and videos.</p>	<p>Articles</p> <ul style="list-style-type: none"> Greenhouse Effect 101 (Denchak, 2019) Greenhouse Effect (Lacis, 2020) Greenhouse Gases: Causes, Sources, and Environmental Effects (Means & Lallanilla, 2021) <p>Nearpod Videos</p> <ul style="list-style-type: none"> The Greenhouse Effect How do Greenhouse Gases Actually Work? Why Greenhouse Gases Make the Planet Warmer Explaining the Greenhouse Effect 	<p>Student Resource – Article Graphic Organizer</p> <p>Student Resource – Video Graphic Organizer</p>	
		<p>Elaborate Students will compose a four paragraph essay describing the greenhouse effect using the information and evidence from the simulations, articles, essays, and notes.</p>		<p>Greenhouse Effect Essay Writing Assignment</p>	
		<p>Evaluate – Students will return to models created in Exploring Climate Science and revise according to new information and evidence gained in this lesson. Students will write a paragraph explaining their changes and why.</p>			
<p>Lesson Connection to Storyline: Students will explore the importance of atmospheric greenhouse gases to the maintenance of Earth’s climate. After students work through two computer based simulations focused on the relationship between greenhouse gases, infrared ray behavior, and Earth temperature at the surface and atmosphere students will use video and text resources to further their background knowledge on the Greenhouse Effect. Students will return to their initial models of climate change to make revisions with new information about greenhouse gases and the Greenhouse Effect from this lesson.</p>					

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Time Frame	CSI: How Has Concentration of Atmospheric Carbon Dioxide Changed Since the Industrial Revolution	5 E Model	Teacher Resources and Materials	In Class Student Activities Lab Resources	Online Student Activities
	<p>Phenomena Atmospheric levels of carbon dioxide have changed on Earth since the Industrial Revolution.</p> <p>Vocabulary atmospheric carbon dioxide Industrial Revolution concentration</p>	<p>Engage Students will be introduced to atmospheric carbon dioxide data by watching the video (first time – just watch)– Carbon History.</p>	<p>CSI – How has Concentration of Atmospheric Carbon Dioxide Changed Since the Industrial Revolution – TR Lesson Plan</p> <p>CSI – How has Concentration of Atmospheric Carbon Dioxide Changed Since the Industrial Revolution – PPT</p>		<p>Carbon History Video – This video is in Microsoft Stream format. Students analyze the data from the animated graph embedded in the video.</p> <p>Getting the Picture: Our Changing Climate – Multimedia interactive resource uses an interdisciplinary approach infusing geography, science, and art for climate education</p> <p>Living Landscapes: Northeast Region ** Resources include videos, essays, and climate science fundamentals through a Native American lens</p>
		<p>Explore – Students (initially in pairs then pair share out to class) will discuss trends and patterns noticed in video</p>			
		<p>Explain – Students will watch the video for a second time, answering questions directly related to the video – focusing on changing CO₂ concentrations.</p>	<p>Teacher Resource – How has Concentration of Atmospheric CO₂ Changed Since the Industrial Revolution?</p>	<p>Student Resource – How has Concentration of Atmospheric CO₂ Changed Since the Industrial Revolution?</p>	
		<p>Elaborate – Students will complete data table to determine CO₂ percentages</p>			
		<p>Evaluate – Students will respond to the prompt – Has the concentration of atmospheric CO₂ changed since the Industrial Revolution?</p>	<p>CSI: How has Concentration of Atmospheric Carbon Dioxide Changed Since the Industrial Revolution – Writing Assignment</p>	<p>CSI: How has Concentration of Atmospheric Carbon Dioxide Changed Since the Industrial Revolution – Writing Assignment</p>	
	<p>Lesson Connection to Storyline: Students analyze data to determine if the concentration of atmospheric carbon dioxide has changed since the Industrial Revolution. The information gained will provide additional information towards causes of climate change.</p>				

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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
- [Climate Central](#) – Videos, data, graphics, and articles related to climate change and the impact on the public
- [The new U.S. Climate Normals are here. What do they tell us about climate change?](#) – Article from NOAA that summarizes analysis of the U.S. Climate Normals
- [NASA – Climate Change](#) - Articles, videos, data, and interactives from NASA about climate change
- [Getting the Picture: Our Changing Climate](#) – Multimedia interactive resource uses an interdisciplinary approach infusing geography, science, and art for climate education
- [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.
- [Living Landscapes: Northeast Region](#) ** Resources include videos, essays, and climate science fundamentals through a Native American lens
- [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

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	Listening <ul style="list-style-type: none"> ● Cross- Linguistic Practices: 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.) ● Build background knowledge ● Activating Prior Knowledge 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 ● Activating Prior Knowledge ● Visuals - GIFs, pictures- will assist students in understanding what they are listening to. Use visual thinking strategies to set the lens for learning. 	Speaking <ul style="list-style-type: none"> ● Sentence Frames To begin a sentence - such as <i>The water cycle is...</i> or <i>I think that water cycle is...</i> ● Academic Conversation Starters: 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. ● Choral Reading - To build fluency, self-confidence and motivation with reading/speaking ● Create movement to go with the word. Movement can be a motivating factor, as well as a 	Reading <ul style="list-style-type: none"> ● Supplementary Text to help reinforce concepts. If necessarily, use lower Lexile levels to ensure comprehension. ● Visual Aids - 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 ● 4 Square / Frayer models to help students gain a deeper understanding of vocabulary. ● Highlighting -important text to assist students in answering questions after the reading. ● Chunking-Break reading of text into chunks or paragraphs ● Performance Level Descriptors - This document 	Writing <ul style="list-style-type: none"> ● Sentence Frames - to begin a sentence- such as <i>The water cycle is...</i> or <i>I think that water cycle is....</i> ● Cloze passages with word banks ● Word banks ● Graphic Organizers to help break down the writing process and organize thoughts ● Standards-based sentence stems ● Performance Level Descriptors 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. 	Instructional Accommodations (depending on the student’s needs) <ul style="list-style-type: none"> ● Extended time for tests in class, projects and assignments ● Directions read. Broken down as necessary ● Model how to complete the activity in the lesson ● Oral simplification of directions or questions ● Translated version 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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	<ul style="list-style-type: none"> • Video to review or introduce a topic – use closed captioning to help students see the words and pronunciations while they listen to the content. • Word stretching / Vowel stretching when instructing allows student to listen closely to the pronunciation of the word • Performance Level Descriptors this document provides teachers with a description of what output they can expect from students based on earned NYSESLAT levels in the modality of listening. 	<p>kinesthetic tool for conceptualizing the rhythm and flow of fluent reading while triggering brain function for optimal learning</p> <ul style="list-style-type: none"> • Performance Level Descriptors 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. 	<p>provides teachers with a description of what output they can expect from students based on earned NYSESLAT levels in the modality of reading.</p> <p>Vocabulary Morphology- 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 be critical to expanding a student’s vocabulary.</p>		
<p>Special Education Modifications</p> <p>Special Education students must have accommodations as per Individual Educational Plan (IEP)</p>	<p>Instructional</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>Technology:</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>Other:</p> <ul style="list-style-type: none"> • Arrange seating for maximum engagement and minimum distraction 	<p>In Class Assessments</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</p>	<p>SUTW Strategies/Skills</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 				

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Science Curriculum Materials→Step Up to Writing Materials	
Culturally and Linguistically Responsive Teaching (CLRT) in the Science Classroom	<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>