



Unit Title: Global and Local Climate Change

Subject/target grade: Science, 8th grade

Unit Summary:

This unit emphasizes the importance of changing climate patterns at global and local levels and engages students' perceptions while covering the most up-to-date science regarding natural and anthropogenic causes of climate change. Building on prior knowledge of weather, climate, and the earth's atmosphere, these lessons expand on topics related to natural causes for climate change in earth's past, the effect of human activities on global climate, methods of monitoring weather and climate, regional comparisons of oral histories related to climate change, and analysis of actual weather data in classroom activities. Incorporating data from local weather stations into classroom activities gives students the opportunities to perform data analysis on actual, local data sets, while also potentially strengthening broader research or monitoring efforts in their respective regions.

Next Generation Science Standards:

MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

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-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.

Learning Objectives:

Students will be able to:

- Explain the difference between weather and climate.
- Describe evidence supporting natural global change throughout earth's history.
- Explain why the term "global climate change" is used rather than "global warming."
- Identify the phenomena and natural processes that control global climate.
- Explain how human activities can influence global climate.
- Calculate how much greenhouse gas is emitted by everyday activities; therefore, they will be able to identify four (4) ways to reduce their own greenhouse gas emitting footprint.
- Define and describe the greenhouse effect and how this phenomenon helps regulate the earth's climate.
- Identify three (3) greenhouse gases and their natural and/or anthropogenic sources.
- Identify five (5) ways in which humans contribute to greenhouse gas emissions.
- Interpret line and bar graphs showing CO² emissions data for the last 4,000 years
- Pose a clear hypothesis describing the increase in CO² emissions during the early 19th century.
- Locate publicly available and credible weather data via the internet and download this data to Excel.
- Calculate weather-related averages (temperature, precipitation).
- Process weather data to identify trends regarding temperature and precipitation over short (weeks long) and long (decades) periods.
- Describe the components and parameters measured on basic weather stations.
- Compare weather data from their own weather station to other weather stations in the region in order to ensure data quality or identify slight variations at each station.
- Compare weather data from their own weather station to another weather station at a different school in a different geographic region in order to identify similarities or differences in weather and climate patterns.
- Describe "positive" and "negative feedback" in relation to climate change.
- List consequences of global climate change on society, economies, and ecosystems.
- Describe how global climate change can increase the severity and magnitude of natural hazards.
- Recognize and describe ways in which society can alter its practices to reduce greenhouse gas emissions.
- Gather ethnographic/anthropological data from family, peers, neighbors regarding perceptions and opinions about climate change.
- Analyze how peoples' perceptions and opinions are formed based on personal experience or from media.
- Describe ways in which individuals can change their behavior to reduce greenhouse gas emissions.
- Transfer knowledge about climate change factors to a broader audience in order to change energy use behaviors and climate awareness.

Table of Lessons: Lesson Title- Brief Description	Learning Objectives	Materials
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<p>Lesson 1: What is the difference between weather and climate?</p> <ul style="list-style-type: none"> - This class will introduce the unit and differentiate the terms “weather” and “climate.” The class will also introduce climate change in terms of geologic time, and the natural and anthropogenic factors that affect climate change. <p>Lesson 2: The Greenhouse Effect—A good thing or a bad thing?</p> <ul style="list-style-type: none"> - This class presents the greenhouse effect as earth’s climate regulator and discusses its importance for maintaining life-sustaining temperatures. <p>Lesson 3: Monitoring and Measuring Climate Patterns</p> <ul style="list-style-type: none"> - This class demonstrates evidence of natural and anthropogenic climate change and introduces the tools and methods scientists use to take measurements <p>Lesson 4: Impacts of Global Climate Change</p> <ul style="list-style-type: none"> - This class explores the impacts of global climate change on society, ecosystems, and the global economy. <p>Lesson 5: Climate Change in our lifetimes? Oral History Insights for Regional Comparison</p> <ul style="list-style-type: none"> - This activity allows students to interview family, friends, and neighbors regarding their perceptions of climate change and compare them with students’ from other 	<p>Lesson 1: Weather and Climate</p> <ul style="list-style-type: none"> • Explain the difference between weather and climate. • Describe evidence supporting natural global change throughout earth’s history. • Explain why the term “global climate change” is used rather than “global warming.” • Identify the phenomena and natural processes that control global climate. • Explain how human activities can influence global climate. <p>Lesson 2: Greenhouse Effect</p> <ul style="list-style-type: none"> • Explain how human activities can influence global climate. • Define and describe the greenhouse effect and how this phenomenon helps regulate the earth’s climate. • Identify three (3) greenhouse gases and their natural and/or anthropogenic sources. • Identify five (5) ways in which humans contribute to greenhouse gas emissions. • Interpret line and bar graphs showing CO² emissions data for the last 4,000 years • Posit a clear hypothesis describing the increase in CO² emissions during the early 19th century. <p>Lesson 3: Climate Monitoring</p> <ul style="list-style-type: none"> • Locate publicly available weather data via the internet and download this data to Excel. • Calculate weather-related averages (temperature, precipitation). • Process weather data to identify trends regarding temperature and precipitation 	<p>Lesson 1: Weather and Climate</p> <ul style="list-style-type: none"> • Weather vs. Climate questionnaire • Lesson1_WeathervsClimate PowerPoint • Whiteboard/Markers <p>Lesson 2: Greenhouse Effect</p> <ul style="list-style-type: none"> • Lesson2_GreenhouseEffect PowerPoint • Handout: Bar Graph Template • Blank, white paper (1 page/student) • Markers, colored pencils. <p>Lesson 3: Climate Monitoring</p> <ul style="list-style-type: none"> • Weather Station (if possible) • Global CO² emissions handout • Computer Lab • Lesson3_ClimateMonitoring PowerPoint • MS Notepad • MS Excel • Internet Access <ul style="list-style-type: none"> - www.noaa.gov - www.wunderground.com <p>Lesson 4: Impacts of Climate Change</p> <ul style="list-style-type: none"> • Lesson4_ImpactsClimateChange PowerPoint • Notebooks • YouTube video “Chasing Ice” documentary • Whiteboard/Markers • Projector/Screen <p>Lesson 5: Oral History</p> <ul style="list-style-type: none"> • Lesson5_Handout1_OralHistory Description • Lesson5_Handout2_Student EssaySample • Lesson5_Handout3_Sample Program
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<p>classrooms in a different geographic region to see similarities and differences.</p>	<p>over short (weeks long) and long (decades) periods.</p> <ul style="list-style-type: none"> • Describe the components and parameters measured on basic weather stations. • Compare weather data from their own weather station to other weather stations in the region in order to ensure data quality or identify slight variations at each station. • Compare weather data from their own weather station to another weather station at a different school in a different geographic region in order to identify similarities or differences in weather and climate patterns. <p>Lesson 4: Impacts of Global Climate Change</p> <ul style="list-style-type: none"> • Describe “positive” and “negative feedback” in relation to climate change. • List consequences of global climate change on society, economies, and ecosystems. • Describe how global climate change can increase the severity and magnitude of natural hazards. • Recognize and describe ways in which society can alter its practices to reduce greenhouse gas emissions. <p>Lesson 5: Oral History Activity</p> <ul style="list-style-type: none"> • Analyze how peoples’ perceptions and opinions are formed based on personal experience or from media. • Describe ways in which individuals can change their behavior to reduce greenhouse gas emissions. 	<ul style="list-style-type: none"> • Notebooks/Journals • Internet/Skype Program • Whiteboard/Markers • Lesson5_OralHistory PowerPoint with information about partner school/class • Google Earth • “Conducting_Interviews” PDF
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	<ul style="list-style-type: none"> • Transfer knowledge about climate change factors to a broader audience in order to change energy use behaviors and climate awareness. • Express conclusions regarding interview data, share results, and contrast and compare their results with data from other oral history activity participants. 	
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Safety Considerations:

Evaluation Plan: Indicates the formative and summative assessment tools that will be used and the purpose of each tool.

Lesson 1:

Class discussion and teacher observations regarding whether students understand the difference between weather and climate, using examples of typical weather forecasts and posing ideas related to geologic evidence of past climates.

Lesson 2:

Students will draw a picture depicting the surface of the earth, atmosphere, and solar energy and use arrows to indicate the transfer of solar energy to the earth and its interaction with the earth’s surface and atmosphere. Students will submit their bar graphs illustrating greenhouse gases emitted by human activities and the country rankings for top greenhouse gas emitters.

Lesson 3:

Students will submit group work calculations from their Excel exercise to complete the data set for class analysis regarding weather data averages and trends. Students will participate in a class-wide debate explaining their interpretations of the trends they do or do not see in the data set.

Lesson 4:

Student participation in the formation of the “Climate Change Impacts List” alongside short presentation that defend the items included in their group’s list. Class discussion and teacher observations regarding students’ understanding of positive and negative feedback regarding changing concentrations of greenhouse gases in the atmosphere.

Lesson 5:

Students will submit an essay (at least 2 pages) summarizing their interview data and conclusions regarding the interviewees’ perceptions of climate change. During the Skype

exchange with the participating classroom, students will synthesize their written report to summarize the main conclusions in order to provide short, oral presentations to share with the other class.

Resources

Websites

National Oceanic and Atmospheric Administration: <http://www.noaa.gov/>

NOAA provides data and research from a wide variety of foci, including the surface of the sun to the depths of the ocean floor as they work to keep citizens informed of the changing environment around them. From daily weather forecasts, severe storm warnings and climate monitoring to fisheries management, coastal restoration and supporting marine commerce, NOAA's products and services support economic vitality and affect more than one-third of America's gross domestic product. NOAA's dedicated scientists use cutting-edge research and high-tech instrumentation to provide citizens, planners, emergency managers and other decision makers with reliable information they need when they need it.

NOAA: Science and information for a climate-smart nation: www.climate.gov

NOAA Climate.gov provides science and information for a climate-smart nation. Americans' health, security, and economic well-being are closely linked to climate and weather. People want and need information to help them make decisions on how to manage climate-related risks and opportunities they face. NOAA Climate.gov is a source of timely and authoritative scientific data and information about climate. Our goals are to promote public understanding of climate science and climate-related events, to make our data products and services easy to access and use, to provide climate-related support to the private sector and the Nation's economy, and to serve people making climate-related decisions with tools and resources that help them answer specific questions.

NOAA Education Resources: <http://www.education.noaa.gov>

Education resources are distributed across many websites and program offices at NOAA and on NOAA partner websites. This portal is designed to assist educators in accessing these materials from one centralized interface. The content here is a sampling of NOAA's education resources and more can be found at each linked location. Materials selected for this site are organized by Themes, topical Collections, and content type that are aligned with common teaching topics and expressed needs of educators. Linked resources are organized into Collections which provide the user with a toolkit of materials and activities suitable for integration into a variety of educational settings. Collections are not grade specific but resources are labeled for grade appropriateness where applicable. Additional NOAA resources which support educator professional development, academic scholarship, career exploration, and education grants are also available. All materials linked from this site are free for use and distribution unless expressly noted.

Weather Underground: <http://www.wunderground.com/>

Weather Underground, a commercial weather service, provides real-time weather information via the Internet. Weather Underground provides weather reports for most major cities across the world

on its website, as well as local weather reports for newspapers and websites. Most of its United States information comes from the National Weather Service (NWS), as federal law specifies that information from that agency falls within the public domain. Private weather stations are also incorporated and available via the website enabling users to access “hyper local” weather information. Also, local weather and historical records are readily available for free download to facilitate data analysis. The website is available in many languages.

The Power of Knowledge: The Story of Semilieu, Indonesia

<https://www.youtube.com/watch?v=o175nrvTQLw>

When the Indian Ocean Tsunami hit in December 2004 over 250,000 people were killed throughout Asia, but on one small island, just 40km from the epicenter of the earthquake, almost the entire population survived, thanks to the people's inherited knowledge of tsunamis, handed down from each generation to the next. The 26th December 2004 looked like just another normal day on Simeulue. Eleven-year-old Anto Suryanto and his friends were on the beach playing football when the island was hit by a major earthquake. Anto tells his story and how traditional knowledge saved his life.

“Chasing Ice” captures largest glacier calving ever filmed

<https://www.youtube.com/watch?v=hC3VTgIPoGU>

On May 28, 2008, Adam LeWinter and Director Jeff Orlowski filmed a historic breakup at the Ilulissat Glacier in Western Greenland. The calving event lasted for 75 minutes and the glacier retreated a full mile across a calving face three miles wide. The height of the ice is about 3,000 feet, 300-400 feet above water and the rest below water. Chasing Ice won the award for Excellence in Cinematography at the 2012 Sundance Film Festival and the Best Documentary from the International Press Association. It has won over 30 awards at festivals worldwide.

PowerPoints:

- Lesson 1: Lesson1_WeathervsClimate.ppt
- Lesson 2: Lesson2_GreenhouseEffect.ppt
- Lesson 3: Lesson3_ClimateMonitoring.ppt
- Lesson 4: Lesson4_EffectsClimateChange.ppt

Handouts:

- Lesson1_Handout.doc
- Lesson2_Handout_BarGraphTemplate.doc
- Lesson3_Handout_GasEmissionsandClimateMonitoring.doc
- Lesson5_Handout1_OralHistoryDescription
- Lesson5_Handout2_StudentEssaySample
- Lesson5_Handout3_SampleProgram_OralHistoryActivity

Software:

- Google Earth (GoogleMaps, satellite view)
- MS Excel

Brief description of how this unit relates to your graduate research:

This unit regarding global and regional climate change directly relates to my own doctoral research regarding extreme meteorological events, natural hazards, and their effect on populations and society. It is important to realize that human activities can have an impact on meteorological and climatological phenomena and that uncontrolled greenhouse gas emission can have long-lasting impacts on our climate. Demonstrating to students and/or the public in an academic or field-based context the ideas of positive and negative feedback can help lead to behavior change and even guide individuals to become active participants in climate and hazard monitoring.

My research in El Salvador included a participatory, educational component. Six Davis VantageVue weather stations were installed at municipal centers for authorities to monitor precipitation amounts in near-real-time. However, these stations could not capture precipitation data further up the volcano due to lack of internet and electricity. An educational effort was proposed to teach community residents from the five municipalities at higher elevations on the northern flank of San Vicente volcano to incorporate them into the scientific and data gathering process. Approximately 15 residents became local volcano observers and were trained in the use of simple rain gauges in order to record and report precipitation data to the relevant authorities at their respective municipal headquarters—especially during tropical storm emergencies. Trained, local observers are necessary to strengthen the monitoring network in areas of the volcano that are inaccessible to the authorities or where there is no electricity or internet to support a weather station.

The utility of this system proved invaluable during a tropical depression emergency in October 2011. Local observers reported rainfall data and Civil Protection authorities were able to alert residents and order evacuations of at-risk populations before flooding and small landslides affected their communities. The success of the system during the emergency was evident. It also allows scientists and students from the University of El Salvador to better monitor long-term precipitation data and climate change in the area.

In a different geographic context, weather stations and climate monitoring has proved to be a unique way to educate students about climate change. In Hermosillo, Mexico, water is very scarce and precipitation patterns seem to be changing according to local residents and institutions. In order to compare these qualitative observations with real data, a Davis VantageVue station was installed at my partner high school, Colegio Munoz. Students now have access to actual weather data from their own weather station. Data is compiled and loaded onto the free website, www.wunderground.com, where students can access archived data, which is used in Science, Ecology, and Geography classes for data analysis lessons. The incorporation of weather data in classes at Colegio Munoz has been taken one step further by allowing students from Hermosillo to interact with students from Hannahville Indian Community School in the Upper Peninsula of Michigan. Social science methods of qualitative interviews are used to allow students to capture climate change perceptions and experiences from family, friends, and neighbors. Students from both schools then interact via Skype to compare and contrast perceptions and trends from completely different geographic regions in order to note differences in climate patterns in two regionally distinct environments.

Evidence showing that human activities contribute to greenhouse gas emissions is clear. Getting students and the public involved with collecting weather and climate-related data and observations transforms them into active participants in locally relevant issues. Connecting students with other schools that gather and analyze similar data further engages them and exposes them to global changes that currently affect populations in a different geographic contexts. The participatory nature of training and relying on local “citizen scientists” in El Salvador directly relates to this lesson plan that gears students toward active data collection and analysis, and it allows them to engage in a global environmental issue that currently affects them or likely will in the near future.