TEACHER LESSON PLANS

An Earth System Science Teacher Professional Development Toolkit for Climate Science

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Introduction

The *Teacher Lesson Plans* packet provides a description of and link to classroom lessons that align with the climate system content of the workshop and PowerPoint program. It is designed to assist teachers in the classroom implementation of the climate system content covered in the workshop. Many of the lessons identified engage students in analyzing and interpreting climate data and visualizations. Pedagogically the activities promote active learning and collaboration. The lesson plans are organized by program topic:

- Climate system
- Greenhouse gases, greenhouse effect, and the carbon cycle
- The Earth's energy budget
- Global warming, climate variability, and climate change
- Changes in the climate system
- Adaptations and mitigation
- Actions and impacts

Additional resource links are also provided. The manual, *An Earth System Science Teacher Professional Development Toolkit for Climate Science*, provides an overview of the toolkit, guidelines for conducting effective workshops, and a listing of available resources and background readings.

Lesson Plan Outline

Climate System

- The Ocean and Weather: El Nino and La Nina
- Climographs: Temperature, Precipitation, and the Human Condition
- Polar Regions: Arctic Adaptations and Global Impacts
- Environmental Issues in the Polar Regions
- Ocean Impacts of an El Nino Event
- Comparing the Effects of El Nino and La Nina
- Tropical Atlantic Aerosols
- Investigating Factors that Influence Climate
- Weather and Climate
- El Nino
- El Nino and Global Warming

Greenhouse Gases, Greenhouse Effect, and the Carbon Cycle
- A Case Study of Local Trends in the Carbon Cycle
- Carbon Dioxide and Global Warming: What is the Evidence?
- Energy, Fossil Fuels and the Carbon Cycle
- Fossil Fuel Use and Carbon Dioxide Emissions

The Earth's Energy Budget
- Harnessing Solar Energy
- Star Power! Discovering the Power of Sunlight
- How Does the Earth's Energy Budget Relate to Polar Ice?
- The Milankovitch Cycles and Their Affect on Climate Change

Global Warming, Climate Variability, and Climate Change
- Abrupt Climate Change
- Climate and CO2: Analyzing Their Relationship
- Evidence of Climate Change
- Is Grandpa Right, Were Winters Colder When He Was a Boy?
- Evidence of Change Near the Arctic Circle
- Studying Snow and Ice Changes
- Climate Change: The Debate, A Structured Controversy
- Climate Change or Climate Variability: Making Sense of U.S. Temperature and Precipitation Data
- Hurricanes and Global Climate Change
- Mid-Latitude Cyclones and Climate Change
- Volcanoes and Global Warming
- Sunspot Activity and Its Effect on Climate Change

Changes in the Climate System
- Grasslands and Climate Change
- Simulating Climate Change Research in Grasslands
- Mountain Pine Beetles
- Coral Bleaching in the Caribbean
- Analyzing Tree Rings to Determine Climate Change
- March of the Polar Bears: Global Change, Sea Ice, and Wildlife Migration
- Ocean Currents and Sea Surface Temperature
- Climate Change and Arctic Ecosystems Case Study
- Climate Change and Arctic Ecosystems
- Climate Change and Biomes
- Bird Migration and Climate Change

Adaptations and Mitigation
- Renewable Energy Sources
- Green Roof Design

- Is Global Warming a Crisis Requiring Immediate Action?
- Photosynthesis, Trees, and the Greenhouse Effect
- Zoo Poo
- Your Family's Carbon Footprint

Actions and Impacts
- Inspiring change – at home and at school
- Write On!
- Your Family's Carbon Footprint

Annotated Lesson Plans

Climate System

The Ocean and Weather: El Niño and La Nina

Purpose: To have students learn about the inter-annual weather phenomena El Niño and La Niña. Additionally, students will learn important concepts regarding ocean and weather interconnectedness, where these weather changes occur, as well as an overview of their effects.

Grade Level: 6 - 8

Estimated Time for Completing Activity: Two to three hours

http://www.nationalgeographic.com/xpeditions/lessons/15/g68/seasnino.html

Climographs: Temperature, Precipitation, and the Human Condition

Purpose: To calculate average temperature and precipitation can be displayed graphically through Climographs. Climographs are excellent tools for studying climate, and can elucidate connections between human conditions and climate. Students will learn how to use, read, and construct climographs, as well as learn how to match them to appropriate locations within the U.S. and Africa.

Grade Level: 9 - 12

Estimated Time for Completing Activity: Four to six hours

http://www.nationalgeographic.com/xpeditions/lessons/15/g912/

Polar Regions: Arctic Adaptations and Global Impacts

Purpose: To enhance students understanding of the interconnectedness between the ocean and humans, as well as the great capacity for oceans to support life. The adaptive capabilities of animals

and people in Arctic environments will be touched upon, especially within the context of the change taking place in the Arctic due to climate change. Lastly, students will learn about the International Polar Year.

Grade Level: 6 - 8

Estimated Time for Completing Activity: Two to three hours

http://www.nationalgeographic.com/xpeditions/lessons/08/g68/seatoshiningsea2.html

Environmental Issues in the Polar Regions

Purpose: To highlight the importance of polar regions will be highlighted in this lesson, with a specific focus on environmental issues related to human impacts such as depletion of the ozone layer as a result of pollution. Students will learn about the implications of anthropogenic warming in polar regions and how the rest of the world will be affected. In this lesson, students will educate the public through a magazine that they will create, and ultimately provide a convincing argument that more attention should be paid to this pressing issue.

Grade Level: 9 - 12

Estimated Time for Completing Activity: Three to four hours

http://www.nationalgeographic.com/xpeditions/lessons/05/g912/polarregions.html

Ocean Impacts of an El Nino Event

Purpose: To examine the factors that characterize the El Nino phenomenon, including sea surface height, sea surface temperatures, and wind vectors. Students should be able to define El Nino, correlate the factors, and analyze images that pertain to ocean and wind change.

Grade Level: 9 - 12

Estimated Time for Completing Activity: Two 50 minute periods

https://mynasadata.larc.nasa.gov/preview_lesson.php?passid=68

Comparing the Effects of El Nino and La Nina

Purpose: To have students collect actual sea surface temperature and precipitation satellite data, and graphically display their findings. Following data collection, students should select two different longitudinal locations and compare the effects from El Nino/La Nina along with satellite data.

Grade Level: 7 - 8

Estimated Time for Completing Activity: Two 50 minute class periods

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=99

Tropical Atlantic Aerosols

Purpose: To learn how to use satellite data pertaining to annual aerosol concentrations in the tropical Atlantic and their origin. This lesson focuses on aerosol transport and the effects of the radiation

budget on aerosols. Lastly, students will identify relationships between aerosol concentrations and hurricane strength in the Atlantic Ocean.

Grade Level: 8

Estimated Time for Completing Activity: 50 minutes

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=56

Investigating Factors that Influence Climate

Purpose: To examine how climate factors such as average temperature, temperature range, and precipitation vary spatially with regard to latitude and longitude through inquiry methods. Students should be introduced to Live Access Server prior to the lesson.

Grade Level: 9 - 12

Estimated Time for Completing Activity: 6-10 days based on a 50 minute period

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=76

Weather and Climate

Purpose: To have students collect and interpret weather data. Students will then analyze temperature and precipitation data for possible indications of climate change. Lastly, students should understand the differences between weather and climate in terms of temporal and spatial scale.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
　　　Click: Extreme Weather Tab at left under teacher/learning modules

El Nino

Purpose: To understand the interconnectedness between changes in atmospheric and ocean content with regard to El Nino. Students should understand that El Nino is essentially the shifting of warm water in relation from changes in trade winds.

Grade Level: 6 - 8

Estimated Time for Completing Activity: Variable

http://sciencenetlinks.com/lessons/el-nino/

El Nino and Global Warming

Purpose: To investigate the cause and effect of El Niño events and how an El Niño event might change climatic events around the world. The goal is for students to learn about current thinking on the relationship between global warming and El Niño events.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

Greenhouse Gases, Greenhouse Effect, and the Carbon Cycle

A Case Study of Local Trends in the Carbon Cycle

Purpose: To investigate the interconnectedness between carbon dioxide levels and chlorophyll-A measurements and compare the two datasets. Students should be able to make the connection between global climate change and local effects.

Grade Level: 10 - 12

Estimated Time for Completing Activity: 50 minutes

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=9311

Carbon Dioxide Case Study: What is the Evidence?

Purpose: To go through a case study where students read and interpret data about the link between atmospheric carbon dioxide levels and global warming. In addition to answering focus questions, students should conduct an issues analysis. Finally, one should emphasize the methods and locations where CO2 data is collected and subsequent interpretation.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
Click: Greenhouse Gases Tab at left under teacher/learning modules

Energy, Fossil Fuels and the Carbon Cycle

Purpose: To interpret and visualize data and information about energy, energy use, fossil fuels, and the carbon cycle. Students should be able to represent the data in graphical form and draw their own conclusions, followed by discussion.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
Click: Greenhouse Gases Tab at left under teacher/learning modules

Fossil Fuel Use and Carbon Dioxide Emissions

Purpose: To interpret and visualize data records of U.S. fossil fuel use and the amount of carbon dioxide released from the burning of fossil fuels. Additionally, students should also analyze data

regarding how the various energy-use sectors emit different amounts of carbon dioxide into the atmosphere. The Kyoto protocol is also introduced.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
> Click: Greenhouse Gases Tab at left under teacher/learning modules

The Earth's Energy Budget

Harnessing Solar Energy

Purpose: To experiment with cookers, calculators, and collectors to discover the properties of light. Students should learn about the use of these common materials to create a solar calculator. Finally, students should become familiar with concepts regarding the differences between energy transfer in different environments.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://sciencenetlinks.com/lessons/harnessing-solar-energy/

Star Power! Discovering the Power of Sunlight

Purpose: To discover that the electromagnetic spectrum and sunlight are the main tools that scientists use to study the solar system. Students will calculate (approximately) the power of sunlight that reaches the earth from the sun. In order for this lesson to be successful, students must have some prior knowledge of the basic concepts of heat and energy transfer.

Grade Level: 9 - 12

Estimated Time for Completing Activity: Variable

http://www.sciencenetlinks.net/lessons.php?BenchmarkID=4&DocID=419

How Does the Earth's Energy Budget Relate to Polar Ice?

Purpose: To use satellite data to identify trends in real satellite data in the form of maps. Students should begin to understand how the amount of ice in the Northern Hemisphere is related to the overall energy flux in the global radiation budget. Students should also be able to discover a relationship through correlation of two data factors.

Grade Level: 5 - 7

Estimated Time for Completing Activity: 50 minutes

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=101

The Milankovitch Cycles and Their Affect on Climate Change

Purpose: To go over a case study in which students learn about natural cycles that cause a change in the amount of solar radiation received by the Earth. Students are asked to analyze how these natural cycles might be contributing to global warming and climate change. Energy-use sectors emit different amounts of carbon dioxide into the atmosphere.   Prior knowledge of basic orbital concepts is important.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
> Click: Natural Processes Tab at left under teacher/learning modules

Global Warming, Climate Variability, and Climate Change

Abrupt Climate Change

Purpose: To understand that the climate knowledge base changes rapidly with abrupt climate change. This lesson focuses on the discipline of science itself, and how knowledge is developed and improved. The instructor should place emphasis on methodology and observations as a means to refine knowledge in climate science.

Grade Level: 9 - 12

Estimated Time for Completing Activity: Variable

http://sciencenetlinks.com/lessons/abrupt-climate-change/

Are the World's Weather and Climate Changing?

Purpose: To use prior knowledge to discuss past knowledge of weather-related topics. Students will learn to connect the notion of weather pattern change with climate change. Finally, students will create a presentation based on information from selected articles as to why weather patterns and climate are changing.

Grade Level: 6 - 12

Estimated Time for Completing Activity: Variable

http://www.curriki.org/xwiki/bin/view/Coll_eberrymab/LESSONPLANARETHEWORLDSWEATHERANDCLIMATECHANGING?bc

Climate and CO_2: Analyzing Their Relationship

Purpose: To have students examine several scenarios of future world climate scenarios, and make the connection between increases in the greenhouse effect with regard to climate change. This will reinforce knowledge of the relationship between CO_2 and the greenhouse effect. Students will also

learn about patterns associated with CO_2 production and the main producers of anthropogenic CO_2.

Grade Level: 9 - 12

Estimated Time for Completing Activity: Ten to twelve hours

http://www.nationalgeographic.com/xpeditions/lessons/07/g912/co2.html

Evidence of Climate Change

Purpose: To see how Colorado's climate is changing as a result of anthropogenic CO_2 increase in the atmosphere. Students should identify ways in which climate change in Colorado will affect the people who live there, and to discuss media coverage of climate change. Students should provide their own opinions on the subject to generate discussion.

Grade Level: 6 - 8

Estimated Time for Completing Activity: Four hours

http://learnmoreaboutclimate.colorado.edu/model-lessons/evidence-of-climate-change

Is Grandpa Right, Were Winters Colder When He Was a Boy?

Purpose: To collect and analyze NOAA and NASA climate data. Students will examine and use current weather data with historic weather data to determine whether there has been a significant change in temperature. Finally, students should make the connection between local and global changes in climate.

Grade Level: 6 - 8

Estimated Time for Completing Activity: 50 minutes

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=97

Evidence of Change Near the Arctic Circle

Purpose: To graphically represent climate data from polar regions. Students will then analyze the graphs and draw conclusions about climate change in polar regions. Lastly, students should discover the relationships between the various factors.

Grade Level: 8 - 12

Estimated Time for Completing Activity: Two 50 minute class periods

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=98

Studying Snow and Ice Changes

Purpose: To learn how to implement mathematical operations, such as addition and subtraction, on data expressed in map form. Students should then understand how changes in ice and snow cover have changed between 1994 and 2004. Data analysis tools are available at My NASA Data.

Grade Level: 9 to 12

Estimated Time for Completing Activity: 1 - 2 periods

Climate Change Debate: The Debate, A Structured Controversy

Purpose: To use resources about greenhouse gases, global warming, and climate change to develop and defend a position statement on climate change. Students should then debate the different positions and construct a consensus position statement. Lastly, students should understand the different facets in the climate science controversy.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
> Click: Greenhouse Gases Tab at left under teacher/learning modules

Climate Change or Climate Variability: Making Sense of U.S. Temperature and Precipitation Data

Purpose: To analyze U.S. temperature and precipitation data from NOAA to determine if the U.S. climate is changing. Students interpret the temperature and precipitation data in the contexts of the hydrologic cycle and agricultural impact on the environment.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
> Click: Extreme Weather Tab at left under teacher/learning modules

Hurricanes and Global Climate Change

Purpose: To present a summary of basic hurricane facts, followed by examination of several potential influences on hurricane frequency and intensity, including El Niño and increased levels of CO_2 in the atmosphere. Students should interpret data about the relationship between global climate change and hurricanes. Details such as changes in intensity and frequency should be touched upon.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
> Click: Extreme Weather Tab at left under teacher/learning modules

Mid-Latitude Cyclones and Climate Change

Purpose: To examine background data about mid-latitude storms (blizzards and tornadoes). Students will then analyze historical data concerning the frequency and intensity of these events. Lastly, students should use this background and historical data, then look at the IPCC projections for the 21st century.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

Click: Extreme Weather Tab at left under teacher/learning modules

Volcanoes and Global Warming

Purpose: To investigate the type and amount of materials ejected by a volcanic eruption and how these materials might affect the atmosphere. An overview of the various greenhouse gases should be provided for review. Based on the data, students decide the role volcanic activity plays in respect to global temperature as compared to the affect human activity may have on global temperature.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

Click: Natural Processes Tab at left under teacher/learning modules

Sunspot Activity and Its Effect on Climate Change

Purpose: To go through a case study in which students learn about solar cycles that cause a change in the amount of solar radiation received by the Earth. Students are asked to analyze how these solar cycles might be contributing to global warming and climate change.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

Click: Natural Processes Tab at left under teacher/learning modules

Changes in the Climate System

Grasslands and Climate Change

Purpose: To understand and distinguish the long-term and short-term responses of grasslands to climate change, and examine their ecological properties. Students will also see how scientists can predict changes in grassland reproductive mechanisms and community structure. This lesson offers students an opportunity to study climate change in further depth with regard to a particular ecosystem.

Grade Level: 9 - 12

Estimated Time for Completing Activity: Variable

Simulating Climate Change Research in Grasslands

Purpose: To focus on a specific application of plant competition (in the grassland ecosystem) in

context with a changing climate. Also, in this lesson it is important to highlight that differences in climate change predictions can significantly affect this ecosystem.

Grade Level: 9 - 12

Estimated Time for Completing Activity: Variable

http://sciencenetlinks.com/lessons/simulating-climate-change-research-in-grasslands/

Mountain Pine Beetles

Purpose: To look at the growing issue of the pine beetle infestation in the forests of Colorado. Students should begin by discussing the driving questions, followed by a pre-assessment classroom dialog to determine what students already know about Colorado's changing forests. Students then work in groups or individually (depending on the size of the class) to develop power point presentations based on their research findings.

Grade Level: 9 - 12

Estimated Time for Completing Activity: Variable

The driving question for the mountain pine beetle model lesson is, "What is changing our forests?" The http://learnmoreaboutclimate.colorado.edu/model-lessons/mountain-pine-beetles

Coral Bleaching in the Caribbean

Purpose: To use real satellite data to study coral bleaching. Students will use graphs, maps, and images to determine the sea surface temperature threshold that causes the onset of coral bleaching. Finally, students should become familiar with the sensitivities of oceanic organisms in context with rapid climate change.

Grade Level: 5 - 12

Estimated Time for Completing Activity: 50 minutes

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=51

Analyzing Tree Rings to Determine Climate Change

Purpose: To study drought and abnormal precipitation patterns using tree ring analysis as a proxy. Students will use monthly average precipitation data draw conclusions about such abnormal precipitation patterns from tree ring studies. This lesson will provide students with the skills to find and use datasets to study a specific physical phenomenon.

Grade Level: 6 - 8

Estimated Time for Completing Activity: 50 minutes

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=95

March of the Polar Bears: Global Change, Sea Ice, and Wildlife Migration

Purpose: To utilize snow-ice coverage data in Alaska in relation to temperature change to study polar

bear migration.   Students should draw their own conclusions regarding migration patterns in the region. Students will use maps and time series data to study the impact of environmental changes on wildlife as a consequence of climate change.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Two 50-minute class periods

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=90

Ocean Currents and Sea Surface Temperature

Purpose: To enhance understanding of the mechanisms of how the atmosphere and oceans distribute heat via their respective circulation patterns. Students will use satellite data to make predictions about global climate change with regard to differential heating patterns. The fundamental understanding of the interconnectedness of our oceans and atmosphere is important.

Grade Level: 8-12

Estimated Time for Completing Activity: 50 minutes

https://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=9

Arctic Ecosystems Case Study

Purpose: To read and interpret data about climate change and arctic ecosystems. In this case study, students will carefully examine a case study of climate change in an arctic ecosystem, and draw their own conclusions following the analysis.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
		Click: Ecological Impacts Tab at left under teacher/learning modules

Climate Change and Arctic Ecosystems

Purpose: To learn how to analyze and interpret graphs and images involving climate change and the Arctic ecosystem. Students will create a brochure explaining Arctic climate changes. Lastly, students should demonstrate how they can make positive impacts on arctic ecosystems in light of rapid environmental change.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
		Click: Ecological Impacts Tab at left under teacher/learning modules

Climate Change and Biomes

Purpose: To analyze and interpret maps involving climates and biomes.   Students will create a biome map for the decade of 2050's. Lastly, students should begin to grasp how quickly our climate is

changing, and the ability of various biomes to cope with such change.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
    Click: Ecological Impacts Tab at left under teacher/learning modules

Bird Migration and Climate Change

Purpose: To understand the impacts of climate change with regard to bird migration patterns around the globe. Students should first be introduced to basic patterns of bird migrations and understand the vast distances that birds travel. Finally, students should understand the magnitude of climate change in different parts of the world, and how bird migrations may be affected both locally and regionally.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
    Click: Ecological Impacts Tab at left under teacher/learning modules

Adaptations and Mitigation

Renewable Energy Sources

Purpose: To investigate a variety of renewable energy resources that is at the forefront of current scientific research. Students should identify the benefits and drawbacks of each. Students should also become aware of the common misconceptions of both renewable and non-renewable energy sources.

Grade Level: 6 - 12

Estimated Time for Completing Activity: Variable

http://sciencenetlinks.com/lessons/renewable-energy-sources/

Green Roof Design

Purpose: To introduce students to the concept of green roof design. Students should learn about how the design of green roofs affects energy transfer between the outside environment and buildings. Students should draw their own conclusions about the benefits and economic and environmental gains from installation of green roofs.

Grade Level: 6 - 12

Estimated Time for Completing Activity: Variable

http://sciencenetlinks.com/lessons/green-roof-design/

Is Global Warming a Crisis Requiring Immediate Action?

Purpose: To introduce global warming and climate change in context of mitigation and immediate action. This topic will be introduced using a video that brings various aspects of climate change and global warming to the table. Students will break into groups that will provide arguments both for and against immediate action to curb climate change. Finally, students should write a reflective paper following the debate.

Grade Level: 6 - 12

Estimated Time for Completing Activity: Variable

http://www.curriki.org/xwiki/bin/view/Coll_MickiHR/IsClimateChangeCausedByHumans?bc

Photosynthesis, Trees, and the Greenhouse Effect

Purpose: To gain a greater understanding of the role of carbon dioxide as a greenhouse gas, and the role of anthropogenic CO_2 emissions in amplifying the greenhouse effect. Students will use their understanding of photosynthesis to identify ways in which trees can be used to mitigate the negative impacts of the greenhouse effect. Lastly, students will look at organizations that sponsor tree planting programs and come up with ways in which these programs could be an effective mitigation mechanism.

Grade Level: 6 - 8

Estimated Time for Completing Activity: Two hours

http://www.nationalgeographic.com/xpeditions/lessons/08/g68/brainpopphoto.html

Zoo Poo

Purpose: To look at the driving question for the "Zoo Poo" model, which is "Does burning zoo poo reduce the CO_2?" Beginning with trees and working their way through coal fired and biomass gasification power plants, students will explore emissions data, the impacts of industrialization (good and bad) as well as related chemistry. Students will gain a basic understanding for the carbon cycle and use common statistical measurements of mean, median and standard deviation to answer the driving question. Lastly, students will also formulate questions about what emissions data from a power plant can actually tell them.

Grade Level: 10 - 12

Estimated Time for Completing Activity: Three 50-minute class periods

http://learnmoreaboutclimate.colorado.edu/model-lessons/zoo-poo

Your Family's Carbon Footprint

Purpose: To estimate the amount of greenhouse gas students contribute to the atmosphere each year—their carbon footprint. To do this, students will use the EPA's web-based Personal Emissions Calculator. Students will collect, interpret, and visualize data about their family's carbon footprint, and compare this information to their classmates' estimated greenhouse gas emissions.

Grade Level: 7 - 12

Estimated Time for Completing Activity: Variable

http://iclimate.org/ccc/index.asp
> Click: Greenhouse Gases Tab at left under teacher/learning modules

Actions and Impacts

Inspiring Change – at home and at school

Purpose: To look at how we use and can better conserve energy in our daily lives, which is a significant action that we can take to help reduce greenhouse gas emissions. Students will be taught the causes and effects of greenhouse gases prior to the lesson. Lastly, students will come up with a plan of action to reduce emissions and energy use.

Grade Level: 1 - 7

Estimated Time for Completing Activity: Variable

http://www.climatechangenorth.ca/section-LP/LP_21_IP_S_rantinraven.html

Write On!

Purpose: To empower students by having them write a letter to the editor of a local newspaper. In this lesson, students will be provided with an opportunity to take what they have learned about climate change and come up with a way to express their views and concerns. Students should come away with a feeling that they can confidently confront the issue of climate change through this unique activity.

Grade Level: 4 - 12

Estimated Time for Completing Activity: Variable

http://www.climatechangenorth.ca/section-LP/LP_24_IH_S_writeon.html

Additional Resources

CLEAN

CLEAN stands for "Climate Literacy & Energy Awareness Network", and is an excellent educational resource for material that will enhance students' understanding of climate and energy issues. CLEAN focuses on providing access to materials that are both scientifically sound and effective as educational tools for students of a wide range of ages. Teachers can choose from a variety of subjects such as seasonal change on land and water, how climate change impacts glaciers, and the fundamentals of renewable energy.

http://www.cleanet.org/

CAMEL

CAMEL stands for "Climate, Adaptation, Mitigation, E-Learning". CAMEL is an interdisciplinary and comprehensive resource that provides a wide variety of tools in various forms. The tools available include audio/Podcasts, case studies, field exercises, simulations, datasets, PowerPoint, reports, and much more. CAMEL is also a website where teachers can not only access useful modules pertaining to climate change education, but also create their own curricular resources. This resource also has extensive educational tools that discuss the mitigation of climate change, and the common misconceptions that many students have with regard to the issue.

http://www.camelclimatechange.org/

Climate Change Videos

NSF has produced a collection of video segments featuring more than 50 leading climate researchers discussing climate change. The content is appropriate for middle and high school levels. Segments include "How do we know the Earth is warming?" and "How much has the Earth warmed recently?" Other clips explain the water cycle, Earth's heat balance, and the carbon cycle. Click on "Meet the Experts" for biographies of the scientists.

http://www.nsf.gov/news/special_reports/degree/

EPA Climate Change Kids' Website

The EPA hosts a website that provides several resources, including flash animations, online games, lesson plans for teachers, and links to other resources. This website is a public domain resource. Additionally, this website has a full course that reviews the causes and effects of climate change, as well as the actions that people can take to help slow the progress of climate change.

http://www.curriki.org/xwiki/bin/view/Coll_torquedellipse/EPAClimateChangeKidsSite?bc

http://epa.gov/climatechange/kids/index.html

eli Environmental Literacy & Inquiry

The Environmental Literacy and Inquiry Working Group at Lehigh University put together this curriculum to provide an educational tool for educators. Students will use Google Earth extensively to analyze climate patterns in different areas. This resource also provides an excellent overview of the four Earth spheres: atmosphere, hydrosphere, biosphere, and lithosphere. Information on carbon footprint analysis and other interactive activities are included. Additionally, there are several assessments available.

http://www.ei.lehigh.edu/eli/cc/overview.html

National Wildlife Federation – Climate Classroom

The National Wildlife Federation developed a "Climate Classroom" educational tool that offers a wide range of activities and tools to teach students about climate change. This resource was specifically to provide students in grades four through six with a better understanding of how climate change impacts wildlife and their habitat. The Climate Classroom includes five lesson plans, information pertaining to global change in the arctic, tips for discussing global warming with students, and much more.

http://www.climateclassroomkids.org/teacher.aspx

Global and Regional Climate Change

The site clarifies concepts, processes and graphs presented in the IPCC (2007) summary of the physical science report on climate change. The site also contains middle school and high school lesson plans for global climate system, observations of climate change, global climate change, climate modeling, and regional climate change.

http://cimss.ssec.wisc.edu/climatechange/