Topics	Instructions for Each Section	Objectives	Multimedia Components	Practice Exercises	Short-Essay Questions	List of Key Terms	Summaries	Alignment with Standards	Rubrics/Keys	Time Required for this Activity
Introduction to Global Warming	Instruct students to watch the introductory movie. The text below is a transcript of the movie narration. Then click at upper right to move forward and begin the lesson.	The introductory movie sets the stage for what scientists know, and don't know, about global warming. Students then get the message that, via this on-line lesson, they will participate in an exploration of the subject.	The introduction contains a QuickTime movie. Please be sure the proper free plug-in is installed before beginning this lesson.	None.	None.	-Earth science -global warming -climate change -environ-mental change -carbon dioxide -atmosphere -natural hazards -Kyoto	Scientists report that increasing levels of man-made greenhouse gases are driving up Earth's average temperature.	Physical Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	None.	3 minutes
Radiation from the Sun and Earth	Instruct students to watch these movies. They may take notes, or refer to the movie transcripts. Based upon what they learn, they should be able to complete the interactive Practice Exercises that follow (click the link below	Students will be able to describe the relative wavelength of radiation emitted by the sun and earth. Students will be able to describe the relative amount of energy carried by radiation from the Sun and Earth.	QuickTime Movie: Radiation from the Sun and Earth. Shockwave practice exercise. Be sure to install the proper free Shockwave plug-in before beginning.	Students get feedback as they complete each exercise. Any incorrect response should prompt them to review & try again.	The three differences in radiation from the Sun and Earth are: 1. Short vs long wave-length. 2. High vs low energy. 3. Solar vs Terrestrial. --- Because Earth emits as much energy in the form of longwave radiation, it	-Sun -Earth -electro-magnetic radiation -solar -energy -wavelength -longwave -shortwave -temperature -infrared -ultraviolet -terrestrial	Both Sun and Earth emit radiant energy based on their temperatures. The hot sun emits high-energy, short-wavelength radiation, while the cooler Earth emits lower-energy, long-wavelength radiation.	Physical Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	Under the Sun: "shortwave," "high energy," & "solar." Under Earth: "longwave," "low energy," & "terrestrial." Question 1 is "True" and #2 is "False." --- Equilibrium means longwave radiation emitted is "equal to" absorbed solar radiation.	9 minutes (for both movies and both Practice Exercises)

Earth's Energy Balance		Students will be able to describe how both longwave and shortwave radiation influence the surface temperature of Earth. Students will be able to describe how the Earth prevents itself from continuously heating up.	QuickTime movie: Earth's Energy Balance. Shockwave Practice Exercises. Be sure proper plug-ins are installed. Be sure proper plug-ins are installed.	Students get feedback as they complete each exercise. Any incorrect response should prompt them to review & try again.	heat up indefinitely	-energy balance -radiative equilibrium -absorption -emission -shortwave radiation -longwave radiation	temperature depends on the proportion of incoming solar radiation to outgoing longwave radiation. The release of longwave radiation keeps the Earth from continuously warming and establishes Earth's temperature equilibrium.	Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	The righthand situation would require Earth to emit more longwave radiation.	
Greenhouse Effect	Ask students to watch the movie and complete the Practice Exercise. Any incorrect responses should prompt a review and re-try.	Students will be able to describe how carbon dioxide and water vapor interact with longwave radiation to create Earth's greenhouse effect. Students will be able to describe how the greenhouse effect enhances the surface temperature of Earth.	QuickTime movie: Greenhouse Effect; and Shockwave Practice Exercise. Be sure proper plug-ins are installed.	Students get feedback as they complete each Practice Exercise. Any incorrect response should prompt them to review & try again.	CO_2 and water vapor absorb longwave radiation. --- If CO_2 and water vapor were removed, Earth's temperature would drop as all its longwave energy escaped to space. --- If more CO_2 is added, Earth's surface will grow warmer as more heat energy is	-greenhouse effect -greenhouse gases -water vapor -carbon dioxide	Water vapor and carbon dioxide in the atmosphere trap much of the Earth's outgoing longwave radiation and re-radiate it toward Earth. This exchange of longwave radiation between Earth's surface and the atmosphere is known as the greenhouse effect.	Physical Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	Question 1 is "False" & #2 is "True." Longwave radiation is re-emitted "in all directions." The righthand diagram of Earth is correct.	5 minutes

Human Activities and Carbon Dioxide	students to watch these movies. They may take notes, or refer to the movie transcripts. Based upon what they learn, they should be able to complete the interactive Practice Exercises that follow (click the link below each movie).	Students will be able to explain how human and societal activities release stored carbon into the atmosphere.	Movie: Human Activities and Carbon Dioxide; and Shockwave Practice Exercise.	Students get feedback as they complete each Practice Exercise. Any incorrect response should prompt them to review & try again.	Since the late 1800s, CO_2 has increased mainly due to human burning of forests and fossil fuels. ---------- Average global temperature has risen about 1.0°C in the last century.	-carbon -Industrial Revolution -Fossil fuels -photo-synthesis	contain high concentrations of carbon that have been stored in the solid earth for hundreds of millions of years. Burning these fuels releases carbon dioxide into the atmosphere.	Physical Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	the lefthand image shows more carbon being released. In #2, the right image shows more carbon released; and in #3 the righthand image is correct.	9 minutes (for all three movies and Practice Exercises)
Modern Atmospheric Concentration of Carbon Dioxide		Students will be able to describe how the concentration of carbon dioxide in the atmosphere has changed over the last 100 years.	Movie: Modern Atmospheric Concent-ration of Carbon Dioxide; and Shockwave Practice Exercise.	Students get feedback as they complete each Practice Exercise. Any incorrect response should prompt them to review & try again.		-concentra-tions -parts per million by volume	Since the Industrial Revolution, consumption of fossil fuels has increased. Over the last 100 years, the concentration of carbon dioxide in the atmosphere increased from 280 parts per million (ppm) to 360 ppm today.	Physical Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	For #1, the upper righthand graph shows the correct CO2 increase.; and for #2 the lefthand graph shows the correct predict. Most increase in global temperature came "after 1960." The global rise in temperature since 1880 is "approximately 1.0°C."	

Modern Global Temperature		Students will be able to describe how the global average temperature has changed over the past century.	Movie: Modern Global Temperature; and Shockwave Practice Exercise.	Students get feedback as they complete each Practice Exercise. Any incorrect response should prompt them to review & try again.		-global average temperature -global annual temperature -	average annual temperature has increased from 13.6° to 14.6° Celsius since the 1880s. Most of this 1° C increase (0.7° C) occurred in the last 40 years.	Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G		
Regional Climates and Habitats	Have students select a climate region of interest by clicking the relevant square on the map.	For each region chosen, students will learn about the prevailing environment and climate conditions. This information gathering is text and picture based.	Text and Graphics: Current Climate and Habitats	None.	Questions are given unique to each region available for study. You can either have students test from memory, or refer back to help them answer.	-global -regional	Global warming will affect the whole planet, but students can gain more appreciation for its possible impacts by focusing on one of four specific regions.	Physical Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	Each region has unique habitats that predominate. These are described in detail in each section.	6 minutes
Formulating a Hypothesis	Simple hypotheses are given for each region. But you may prefer to have students either expand upon the hypothesis given, or to form their own.	Students should be able to gather information about the environmental and climatic conditions for regions on Earth and then, given some change, form their own hypothesis about how that change will impact the region.	None.	None.	Encourage students to write their hypotheses in their own words using complete sentences.	-hypothesis	Like scientists, students can develop hypotheses about how global warming will (or will not) impact different regions on Earth based on what they know about past and current conditions	Physical Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	In general, a simple hypothesis is given for each region: as carbon dioxide levels increase in the atmosphere, the climate and the environment will change over the next century.	3 minutes

Computer Climate Models	Ask students to watch the movie and complete the Practice Exercises. Any incorrect responses should prompt a review and a re-try.	Students will be able to describe how computer climate models help scientists understand how climate will change in the future.	QuickTime movie: Computer Climate Models; and Shockwave Practice Exercise.	Students get feedback as they complete each Practice Exercise. Any incorrect response should prompt them to review & try again.	math formulas to describe the complex interactions in Earth's climate system, models help scientists estimate future conditions. --- No, models only give estimates. There are still too many unknowns about Earth's climate to make exact predictions about the future.	-climate system -computer models -climate models	Scientists can describe many of the components of Earth's climate system with mathematical equations. Using super-fast computers, scientists combine numerous equations into complex computer programs known as climate models.	Physical Science, Grades 5-8 - Content Standard G	The words "Measure-ments" and "Observations" fill in the first two blanks. Scientists use these to create "Equations" (3rd blank). Enter "CO_2" in the first blank and the other two terms in the last two. Climate models provide "estimates" about the future.	4 minutes
Using a Climate Model for Data Interpretation	Click to select study region. Users can display temp. & habitat maps. Then hit "Run Model." Use the slider to display results for a given year.	Using a simple climate model, students can visualize how a region on Earth will change over the next century given a rise in carbon dioxide.	Shockwave Climate Model: Using a Model for Data Interpretation Be sure the proper plug-in is installed.	Have students play with model to become familiar with all its functions.	Based upon the results of their model run, students are presented with several questions to answer.	-climate model -Celsius -Fahrenheit	Like scientists, students can test their hypotheses about regional impacts of global warming by using computer climate models.	Physical Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	There will be obvious temperature changes in the model run. Answers will vary based on which regions students pick and what their hypotheses are.	5 minutes

Possible Consequences of Temperature Increase	A graph shows the rise in CO_2 from 1959 – 2002. Have students review the text & images and think about the implications of change for their study region.	Students learn that there are consequences — both positive & negative — in future global warming scenarios.	Text and Graphics: Possible Consequences of Temperature Increase	None.	Based upon the info presented, students are asked to respond to several questions pertaining to their study region.	(See above)	warming will change regional climates and environments in different ways. Changes in precipitation, length of growing season, fire susceptibility, and type of plants and animals are possible with increasing temperature.	Physical Science, Grades 5-8 - Content Standard B - Content Standard D - Content Standard F - Content Standard G	Correct responses to questions will vary according to the region each student selects. Answers can be found by reviewing the "Possible Consequences" pages. Some answers are subject to students' own opinions.	4 minutes

The total estimated time required to complete this on-line lesson is about 50 minutes. But times will vary, of course, depending upon class size, access to computers, whether students are working in teams or as individuals, etc.