Unit 7 Atmosphere, Air Pollution & Global Change

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Enduring Understandings

ERT-4 Earth's systems interact, resulting in a state of balance over time

ENG-2 Most of the Earth’s atmospheric processes are driven by input of energy from the sun.

STB-2 Human activities have physical, chemical, and biological consequences for the atmosphere.

STB-4 Local and regional human activities can have impacts at the global level.

Essential Questions

Where does air pollution go once its airborne?

How can local human activities have a global impact?

Lesson Objectives

Atmosphere Objectives:

ERT-4.D Describe the structure and composition of the Earth’s atmosphere.

ERT-4.E Explain how environmental factors can result in atmospheric circulation.

ENG-2.A Explain how the sun’s energy affects the Earth’s surface.

ENG-2.B Describe how the Earth’s geography affects weather and climate.

ENG-2.C Describe the environmental changes and effects that result from El Niño or La Niña events (El Niño–Southern Oscillation).

Air Pollution Objectives:

STB-2.A Identify the sources and effects of air pollutants.

STB-2.B Explain the causes and effects of photochemical smog and methods to reduce it.

STB-2.C Describe thermal inversion and its relationship with pollution.

STB-2.D Describe natural sources of CO2 and particulates.

STB-2.E Identify indoor air pollutants.

STB-2.F Describe the effects of indoor air pollutants.

STB-2.G Explain how air pollutants can be reduced at the source.

STB-2.H Describe acid deposition.

STB-2.I Describe the effects of acid deposition on the environment.

STB-2.J Describe human activities that result in noise pollution and its effects.

Global Change Objectives:

STB-4.A Explain the importance of stratospheric ozone to life on Earth.

STB-4.B Describe chemicals used to substitute for chlorofluorocarbons (CFCs).

STB-4.C Identify the greenhouse gases.

STB-4.D Identify the sources and potency of the greenhouse gases.

STB-4.E Identify the threats to human health and the environment posed by an increase in greenhouse gases.

STB-4.F Explain how changes in climate, both short- and longterm, impact ecosystems.

STB-4.G Explain the causes and effects of ocean warming.

STB-4.H Explain the causes and effects of ocean acidification.

Standards

Atmosphere Standards:

ERT-4.D.1 The atmosphere is made up of major gases, each with its own relative abundance.

ERT-4.D.2 The layers of the atmosphere are based on temperature gradients and include the troposphere, stratosphere, mesosphere, thermosphere, and exosphere.

ERT-4.E.1 Global wind patterns primarily result from the most intense solar radiation arriving at the equator, resulting in density differences and the Coriolis effect.

ENG-2.A.1 Incoming solar radiation (insolation) is the Earth’s main source of energy and is dependent on

season and latitude.

ENG-2.A.2 The angle of the sun's rays determines the intensity of the solar radiation. Due to the shape of the Earth, the latitude that is directly horizontal to the solar radiation receives the most intensity.

ENG-2.A.3 The highest solar radiation per unit area is received at the equator and decreases toward the poles.

ENG-2.A.4 The solar radiation received at a location on the Earth's surface varies seasonally, with the most radiation received during the location's longest summer day and the least on the shortest winter day.

ENG-2.A.5 The tilt of Earth's axis of rotation causes the Earth's seasons and the number of hours of daylight in a particular location on the Earth's surface.

ENG-2.B.1 Weather and climate are affected not only by the sun's energy but by geologic and geographic factors, such as mountains and ocean temperature.

ENG-2.B.2 A rain shadow is a region of land that has become drier because a higher elevation area blocks precipitation from reaching the land.

ENG-2.C.1 El Niño and La Niña are phenomena associated with changing ocean surface temperatures in the Pacific Ocean. These phenomena can cause global changes to rainfall, wind, and ocean circulation patterns.

ENG-2.C.2 El Niño and La Niña are influenced by geological and geographic factors and can affect different locations in different ways.

Air Pollution Standards:

STB-2.A.1 Coal combustion releases air pollutants including carbon dioxide, sulfur dioxide, toxic metals, and particulates.

STB-2.A.2 The combustion of fossil fuels releases nitrogen oxides into the atmosphere. They lead to the production of ozone, formation of photochemical smog, and convert to nitric acid in the atmosphere, causing acid rain. Other pollutants produced by fossil fuel combustion include carbon monoxide, hydrocarbons, and particulate matter.

STB-2.A.3 Air quality can be affected through the release of sulfur dioxide during the burning of fossil fuels, mainly diesel fuels.

STB-2.A.4 Through the Clean Air Act, the Environmental Protection Agency (EPA) regulated the use of lead, particularly in fuels, which dramatically decreased the amount of lead in the atmosphere.

STB-2.A.5 Air pollutants can be primary or secondary pollutants.

STB-2.B.1 Photochemical smog is formed when nitrogen oxides and volatile organic hydrocarbons react with heat and sunlight to produce a variety of pollutants.

STB-2.B.2 Many environmental factors affect the formation of photochemical smog.

STB-2.B.3 Nitrogen oxide is produced early in the day. Ozone concentrations peak in the afternoon and are higher in the summer because ozone is produced by chemical reactions between oxygen and sunlight.

STB-2.B.4 Volatile Organic Compounds (VOCs), such as formaldehyde and gasoline, evaporate or sublimate

at room temperature. Trees are a natural source of VOCs.

STB-2.B.5 Photochemical smog often forms in urban areas because of the large number of motor vehicles there.

STB-2.B.6 Photochemical smog can be reduced through the reduction of nitrogen oxide and VOCs.

STB-2.B.7 Photochemical smog can harm human health in several ways, including causing respiratory problems and eye irritation.

STB-2.C.1 During a thermal inversion, the normal temperature gradient in the atmosphere is altered as the air temperature at the Earth's surface is cooler than the air at higher altitudes.

STB-2.C.2 Thermal inversion traps pollution close to the ground, especially smog and particulates.

STB-2.D.1 CO2 appears naturally in the atmosphere from sources such as respiration, decomposition, and volcanic eruptions.

STB-2.D.2 There are a variety of natural sources of particulate matter.

STB-2.E.1 Carbon monoxide is an indoor air pollutant that is classified as an asphyxiant.

STB-2.E.2 Indoor air pollutants that are classified as particulates include asbestos, dust, and smoke. STB-2.E.3 Indoor air pollutants can come from natural sources, human-made sources, and combustion.

STB-2.E.4 Common natural source indoor air pollutants include radon, mold, and dust.

STB-2.E.5 Common human-made indoor air pollutants include insulation, Volatile Organic Compounds (VOCs) from furniture, paneling and carpets; formaldehyde from building materials, furniture, upholstery, and carpeting; and lead from paints.

STB-2.E.6 Common combustion air pollutants include carbon monoxide, nitrogen oxides, sulfur dioxide, particulates, and tobacco smoke.

STB-2.E.7 Radon-222 is a naturally occurring radioactive gas that is produced by the decay of uranium found in some rocks and soils.

STB-2.F.1 Radon gas can infiltrate homes as it moves up through the soil and enters homes via the basement or cracks in the walls or foundation. It is also dissolved in groundwater that enters homes through a well.

STB-2.F.2 Exposure to radon gas can lead to radoninduced lung cancer, which is the second leading cause of lung cancer in America.

STB-2.G.1 Methods to reduce air pollutants include regulatory practices, conservation practices, and alternative fuels.

STB-2.G.2 A vapor recovery nozzle is an air pollution control device on a gasoline pump that prevents fumes from escaping into the atmosphere when fueling a motor vehicle.

STB-2.G.3 A catalytic converter is an air pollution control device for internal combustion engines that converts pollutants (CO, NOx, and hydrocarbons) in exhaust into less harmful molecules (CO2, N2, O2, and H2O).

STB-2.G.4 Wet and dry scrubbers are air pollution control devices that remove particulates and/or gases from

industrial exhaust streams.

STB-2.G.5 Methods to reduce air pollution from coalburning power plants include scrubbers and electrostatic precipitators.

STB-2.H.1 Acid rain and deposition is due to nitrogen oxides and sulfur oxides from anthropogenic and natural sources in the atmosphere.

STB-2.H.2 Nitric oxides that cause acid deposition come from motor vehicles and coal-burning power plants. Sulfur dioxides that cause acid deposition come from coal-burning power plants.

STB-2.I.1 Acid deposition mainly affects communities that are downwind from coal-burning power plants.

STB-2.I.2 Acid rain and deposition can lead to the acidification of soils and bodies of water and corrosion of human-made structures.

STB-2.I.3 Regional differences in soils and bedrock affect the impact that acid deposition has on the region—such as limestone bedrock's ability to neutralize the effect of acid rain on lakes and ponds.

STB-2.J.1 Noise pollution is sound at levels high enough to cause physiological stress and hearing loss.

STB-2.J.2 Sources of noise pollution in urban areas include transportation, construction, and domestic and industrial activity.

STB-2.J.3 Some effects of noise pollution on animals in ecological systems include stress, the masking of sounds used to communicate or hunt, damaged hearing, and causing changes to migratory routes.

Global Change Standards:

STB-4.A.1 The stratospheric ozone layer is important to the evolution of life on Earth and the continued health and survival of life on Earth.

STB-4.A.2 Stratospheric ozone depletion is caused by anthropogenic factors, such as chlorofluorocarbons (CFCs), and natural factors, such as the melting of ice crystals in the atmosphere at the beginning of the Antarctic spring.

STB-4.A.3 A decrease in stratospheric ozone increases the UV rays that reach the Earth's surface. Exposure to UV rays can lead to skin cancer and cataracts in humans

STB-4.B.1 Ozone depletion can be mitigated by replacing ozone-depleting chemicals with substitutes that do not deplete the ozone layer. Hydrofluorocarbons (HFCs) are one such replacement, but some are strong greenhouse gases.

STB-4.C.1 The principal greenhouse gases are carbon dioxide, methane, water vapor, nitrous oxide, and chlorofluorocarbons (CFCs).

STB-4.C.2 While water vapor is a greenhouse gas, it doesn't contribute significantly to global climate change because it has a short residence time in the atmosphere.

STB-4.C.3 The greenhouse effect results in the surface temperature necessary for life on Earth to exist.

STB-4.D.1 Carbon dioxide, which has a global warming potential (GWP) of 1, is used as a reference point for

the comparison of different greenhouse gases and their impacts on global climate change. Chlorofluorocarbons (CFCs) have the highest GWP, followed by nitrous oxide, then methane.

STB-4.E.1 Global climate change, caused by excess greenhouse gases in the atmosphere, can lead to a variety of environmental problems including rising sea levels resulting from melting ice sheets and ocean water expansion, and disease vectors spreading from the tropics toward the poles. These problems can lead to changes in population dynamics and population movements in response.

STB-4.F.1 The Earth has undergone climate change throughout geologic time, with major shifts in global temperatures causing periods of warming and cooling as recorded with CO2 data and ice cores.

STB-4.F.2 Effects of climate change include rising temperatures, melting permafrost and sea ice, rising sea levels, and displacement of coastal populations.

STB-4.F.3 Marine ecosystems are affected by changes in sea level, some positively, such as in newly created habitats on now-flooded continental shelves, and some negatively, such as deeper communities that may no longer be in the photic zone of seawater.

STB-4.F.4 Winds generated by atmospheric circulation help transport heat throughout the Earth. Climate change may change circulation patterns, as temperature changes may impact Hadley cells and the jet stream.

STB-4.F.5 Oceanic currents, or the ocean conveyor belt, carry heat throughout the world. When these currents change, it can have a big impact on global climate, especially in coastal regions.

STB-4.F.6 Climate change can affect soil through changes in temperature and rainfall, which can impact soil's viability and potentially increase erosion.

STB-4.F.7 Earth's polar regions are showing faster response times to global climate change because ice and snow in these regions reflect the most energy back out to space, leading to a positive feedback loop.

STB-4.F.8 As the Earth warms, this ice and snow melts, meaning less solar energy is radiated back into space and instead is absorbed by the Earth's surface. This in turn causes more warming of the polar regions.

STB-4.F.9 Global climate change response time in the Arctic is due to positive feedback loops involving melting sea ice and thawing tundra, and the subsequent release of greenhouse gases like methane.

STB-4.F.10 One consequence of the loss of ice and snow in polar regions is the effect on species that depend on the ice for habitat and food.

STB-4.G.1 Ocean warming is caused by the increase in greenhouse gases in the atmosphere.

STB-4.G.2 Ocean warming can affect marine species in a variety of ways, including loss of habitat, and metabolic and reproductive changes.

STB-4.G.3 Ocean warming is causing coral bleaching, which occurs when the loss of algae within corals cause the corals to bleach white. Some corals recover and some die.

STB-4.H.1 Ocean acidification is the decrease in pH of the oceans, primarily due to increased CO2 concentrations in the atmosphere, and can be expressed as chemical equations.

STB-4.H.2 As more CO2 is released into the atmosphere, the oceans, which absorb a large part of that CO2, become more acidic.

STB-4.H.3 Anthropogenic activities that contribute to ocean acidification are those that lead to increased CO2

concentrations in the atmosphere: burning of fossil fuels, vehicle emissions, and deforestation.

STB-4.H.4 Ocean acidification damages coral because acidification makes it difficult for them to form shells, due to the loss of calcium carbonate.

Content

Vocabulary:
Layers of the Atmosphere

Weather vs. Climate

Cold vs. Warm Front

Temperature Inversion & its causes

Indoor Pollutant

Outdoor Pollutants

Primary & Secondary Pollutants

Six Major Pollutants- Causes & Effects of Each

Smog (industrial & photochemical)

Coriolis effect

Greenhouse Effect

Climate Change

Greenhouse Gas

Ozone

Ocean Acidification

Coral Bleaching

Response to Climate Change

Resources

College Board AP Central : https://apcentral.collegeboard.org/courses/ap-environmental-science/course

College Board AP Environmental Science Course & Exam Description
Manual https://apstudents.collegeboard.org/sites/default/files/2019-05/ap-environmental-science-course-and-

exam-description.pdf

College Board AP Environmental Science "AP Classroom" https://apcentral.collegeboard.org/about-ap/news-changes/ap-2019?course=ap-environmental-science

AP Environmental Science Classroom Resources https://apcentral.collegeboard.org/courses/ap-environmental-science/classroom-resources

Khan Academy (Please look in AP Biology & Chemistry/Physics for all APES topics) https://www.khanacademy.org/science

Bozeman Science AP Environmental Science videos http://www.bozemanscience.com/ap-environmental-science