7th Grade, Lesson 1: What is Climate Change?

MDE_MCCRSS: E.7.9B Students will demonstrate an understanding of the relationship between natural phenomena, human activity, and global climate change.

E.7.9B.1 Read and evaluate scientific or technical information assessing the evidence and bias of each source to explain the causes and effects of climate change

E.7.9B.2 Interpret data about the relationship between the release of carbon dioxide from burning fossil fuels into the atmosphere and the presence of greenhouse gasses

E.7.9B.3 Engage in scientific argument based on current evidence to determine whether climate change happens naturally or is being accelerated through the influence of man.

Learning Outcomes: After completing Lesson 1, students will be able to explain what global climate is, why and how it varies locally, and what affects its change (including two out of three factors: the earth's movement and the sun's energy; the third element, the greenhouse effect is extensively discussed in lesson 2).

Learning Objectives	Introduced & Practices Skills	Activities
⇒ Explain what climate is and how it relates to weather. ⇒ Identify the main climate variables (precipitation, high and low average temperatures). ⇒ Compare local climates based on data reported using these variables. ⇒ Distinguish between local and global climate. ⇒ Analyze how factors, such as proximity to the equator, proximity to water, ocean currents, elevation, and prevailing winds impact local climates. ⇒ Show that global climate on earth is an average of regional climates. ⇒ Demonstrate how global climate is affected by changes in earth's movement (Milankovitch Cycles) and variation in the amount of energy produced by the sun.	⇒ Represent data as histograms and line graphs ⇒ Interpret data from histograms and line graphs ⇒ Read and interpret graphs with more than one plotted variable ⇒ Locate latitude on a geo-physical map	**Activity 1:** Interpreting clima-graphs: weather and climate in Jackson, MS **Activity 2:** Comparing and contrasting clima-graphs: what impacts climates **Activity 3:** Watch a video demonstration and discuss impacts of earth's movement's on global climate change

7th Grade, Lesson 2: Greenhouse Gas Effect?

MDE_MCCRSS: E.7.9B Students will demonstrate an understanding of the relationship between natural phenomena, human activity, and global climate change.

E.7.9B.1   Read and evaluate scientific or technical information assessing the evidence and bias of each source to explain the causes and effects of climate change

E.7.9B.2   Interpret data about the relationship between the release of carbon dioxide from burning fossil fuels into the atmosphere and the presence of greenhouse gasses

Learning Outcomes: After completing Lesson 2, students will be able to examine the impact of greenhouse gases on earth's climate and its changes.

Learning Objectives	Introduced & Practiced Skills	Activities
⇒ <u>Describe</u> what happens to solar energy directed towards the earth. ⇒ <u>Explain</u> what the natural greenhouse effect is and how it creates habitable conditions on Earth. ⇒ <u>Identify</u> major greenhouse gases and their sources, and <u>distinguish</u> between natural and manmade sources. ⇒ <u>Examine</u> the effects recent increases in anthropogenic (manmade) emissions have made on earth's energy budget.	⇒ <u>Perform</u> an experiment to collect data on temperature changes in varying atmospheric conditions ⇒ <u>Create</u> a simple data set from experimental measurements and plotting them ⇒ <u>Critique</u> experimental design and <u>design</u> modifications ⇒ <u>Formulate</u> a hypothesis and <u>test</u> it using experimental data ⇒ <u>Summarize</u> data in a pie chart ⇒ <u>Formulate</u> scientific predictions based on processes illustrated by a complex diagram	**Activity 1:** Recreate Earth's Energy Diagram **Activity 2:** Play a matching game: major greenhouse gases and their sources: **Activity 3:** Create and analyzing a pie chart of anthropogenic (manmade) greenhouse gases emissions **Activity 4:** Conduct a classroom experiment: observe and measure greenhouse gas effects

7th Grade, Lesson 3: Carbon Cycle and Human Impact

MDE_MCCRSS: E.7.9B Students will demonstrate an understanding of the relationship between natural phenomena, human activity, and global climate change.

E.7.9B.2 Interpret data about the relationship between the release of carbon dioxide from burning fossil fuels into the atmosphere and the presence of greenhouse gasses

Learning Outcomes: After completing Lesson 3, students will be able to show how carbon atoms cycle across different terrestrial and aquatic pools; and explain how the cycle is affected by burning fossil fuels. Students will be able to prove that recent increases in atmospheric carbon concentration is caused by burning fossil fuels and justify that the recent changes in global temperatures are associated with the increased carbon dioxide concentrations.

Learning Objectives	Introduced & Practiced Skills	Activities
⇒ Explain how carbon flows between carbon pools (oceans, fossil fuels, terrestrial ecosystems and the atmosphere) through natural processes (photosynthesis, respiration, and decomposition) and human activities (burning fossil fuels, agricultural practices and deforestation) ⇒ Investigate human contributions to recent increases in atmospheric carbon dioxide concentrations. ⇒ Explain how scientists know that recent increases in CO_2 concentrations are from burning fossil fuels, and not from natural processes.	⇒ Recognize long term trends in historic data ⇒ Formulate predictions about future behavior of a variable based on its past trends. ⇒ Create models of isotopes ⇒ Prove a scientific statement by reporting evidence that justifies it	**Activity 1:** Play the carbon cycle game. **Activity 2:** Show human fingerprints on carbon emissions by making carbon isotopes models and recreate radioactive decay with chickpeas and lentils **Activity 3:** Recreate the Keeling Curve

⇒ <u>Evaluate</u> the relationship between recent increases in atmospheric carbon dioxide concentrations and rising global average temperatures. ⇒ <u>Cite evidence</u> and <u>explain how</u> climate scientists show that humans cause recent global warming and local climate change		

7th Grade, Lesson 4: From Global Warming to Local Climate Change

MDE_MCCRSS: E.7.9B Students will demonstrate an understanding of the relationship between natural phenomena, human activity, and global climate change.

E.7.9B.1   Read and evaluate scientific or technical information assessing the evidence and bias of each source to explain the causes and effects of climate change

Learning Outcomes: After completing Lesson 4, students will be able to explain how ocean currents move water masses across the globe and describe the mechanism (differences in water density) that powers the global conveyor belt (GCB). They will be able to formulate scenarios about how recent warming of ocean waters may affect the GCB and hypothesize how under these different scenarios local climates will change.

Learning Objectives	Introduced & Practices Skills	Activities
⇒ Explain how oceans absorb and store heat and contrast this with how air does it ⇒ List factors that affects water density ⇒ Explain how heat is transported through the GCB across the globe using a world map ⇒ Examine recent trends in ocean temperatures ⇒ Judge the effect rising water temperatures may have on the GCB ⇒ Hypothesize what local climate changes may be observed as ocean warming impacts GCB	⇒ Develop cause-effect hypotheses ⇒ Interpret and use geographical directions (NESW) to navigate the world map ⇒ Interpret data expressed as deviation from a mean	**Activity 1:** Conduct an experiment on water density **Activity 2:** Analyze data on ocean warming **Activity 3:** Recreate a schematic of ocean currents

7th Grade, Lesson 5: Sea Level Rise and Ocean Acidification

MDE_MCCRSS: E.7.9B Students will demonstrate an understanding of the relationship between natural phenomena, human activity, and global climate change.

 E.7.9B.1   Read and evaluate scientific or technical information assessing the evidence and bias of each source to explain the causes and effects of climate change.

Learning Outcomes: After completing Lesson 5, students will be able to explain how increasing global ocean temperatures lead to sea level rise (SLR) and describe a variety of SLR effects on coastal areas. Students will also be able to describe how increased emissions of carbon dioxide and temperature increases affect marine life. They will be able to describe the mechanism leading to ocean acidification and its impact on calcium carbonate shells and skeletons, as well as to report how increased water temperatures further accelerate the process. Students will also be able to describe the elements and process of coral bleaching.

Learning Objectives	Introduced & Practices Skills	Activities
⇒ <u>Describe</u> mechanisms causing sea level rise: thermal expansion and glacial ice melting. ⇒ <u>Observe</u> the effects of sea level rise on the Coast of MS and other coastal locations under several likely sea level rise scenarios. ⇒ <u>Explain how</u> coral is affected by rising temperatures. ⇒ <u>Assess</u> impacts and <u>synthesize</u> mechanisms behind impacts for ocean acidification and acidification combined with warmer temperatures on marine life.	⇒ <u>Create</u> a data set from experimental measurements, <u>interpret</u> the data and <u>formulate</u> conclusions ⇒ <u>Use</u> an interactive software "Surging Seas" available on the web ⇒ <u>Extrapolate</u> experimental results to formulate general conclusions	**Activity 1:** Conduct an experiment on thermal expansion **Activity 2:** Conduct an experiment on ice melting impact on sea level rising **Activity 3:** Observe local impacts of sea level rise using "Surging Seas" interactive webpage **Activity 4:** Conduct an experiment on ocean acidification and global warming's impact on marine life **Activity 5:** Recreate coral bleaching using schematics

8th Grade, Lesson 1: What is Paleoclimatology?

E.8.7   Students will demonstrate an understanding of geological evidence to analyze patterns in Earth's major events, processes, and evolution in history.

E.8.7.4 Use research and evidence to document how evolution has been shaped both gradually and through mass extinction by Earth's varying geological conditions (e.g., climate change, meteor impacts, and volcanic eruptions).

Learning Outcomes: After completing Lesson 1, students will be able to explain how information about past climates can be inferred from climate archives and illustrate it by conducting tree ring analysis.

Learning Objectives	Introduces & Practices Skills	Activities
⇒ <u>Explain</u> how information about past climatic conditions is stored in climate archives and how we can use climate proxies when direct measurements are not available ⇒ <u>Describe</u> what we can learn from tree rings	⇒ <u>Infer</u> past climatic conditions from tree rings ⇒ <u>Create</u> a time series data set from individual samples of tree rings	**Activity 1:** Analyzing and interpreting tree rings.

8ᵗʰ Grade, Lesson 2: Ice Core Analysis

E.8.7   Students will demonstrate an understanding of geological evidence to analyze patterns in Earth's major events, processes, and evolution in history.

E.8.7.4 Use research and evidence to document how evolution has been shaped both gradually and through mass extinction by Earth's varying geological conditions (e.g., climate change, meteor impacts, and volcanic eruptions).

Learning Outcomes: After completing Lesson 2, students will be able to explain what climatic proxies are contained in ice cores, and how they can be uncovered. Students will report how climate data from ice cores is created.

Learning Objectives	Introduced & Practiced Skills	Activities
⇒ <u>Describe</u> what climate proxies can be obtained from ice cores. ⇒ <u>Explain</u> how climate proxies from ice cores can be used to recreate past climatic conditions.	⇒ <u>Perform</u> a simplified ice core analysis ⇒ <u>Appraise</u> strength and weaknesses of different climate archives	**Activity 1:** Home-made ice core analysis

8th Grade, Lesson 3: From the Past to the Future of Earth's Climate

8.7 **Students will demonstrate an understanding of geological evidence to analyze patterns in Earth's major events, processes, and evolution in history.**

E.8.7.4 Use research and evidence to document how evolution has been shaped both gradually and through mass extinction by Earth's varying geological conditions (e.g., climate change, meteor impacts, and volcanic eruptions).

Learning Outcomes: After completing Lesson 3, students will be able to synthesize past climate patterns fluctuating between glacial and interglacial periods and connect these trends with fluctuation of CO_2 concentrations. They will describe geological relationships between climate change and carbon dioxide and predict trends for the earth's future climate based on recent changes in CO_2 concentration patterns.

Learning Objectives	Introduced & Practices Skills	Activities
⇒ <u>Assess</u> patterns in past temperature and carbon dioxide concentrations over the last 800,000 years ⇒ <u>Explain how</u> climatic changes on a geological scale inform us about what we observe today ⇒ <u>Appraise</u> what geological patterns can tell us about the future of earth's climate	⇒ <u>Develop</u> cause-effect hypotheses ⇒ <u>Interpret</u> and <u>use</u> geographical directions (NESW) to navigate the world map ⇒ <u>Interpret</u> data expressed as deviation from a mean	**Activity 1:** Reconstructing and analyzing temperatures and carbon dioxide concentrations over the past 400,000 years from Vostok data.