ESSENTIAL QUESTION

How do we know human activity is influencing climate, and what can we do about it?

Introduction to Culminating Project and Individual Project Organizer

Lift-Off Task: Optional Addendum: Weather and Climate

Formative Assessment—Graph Analysis of Weather and Climate

Lift-Off Task: What Is Climate Change, and Why Do We Care about It?

Formative Assessment—Individual Project Organizer Lift-Off Task

Task 1: The Effects of Carbon Dioxide on Climate

Formative Assessment—Individual Project Organizer Task 1

Task 2: What Is Causing Climate Change, and How Do We Know?

Formative Assessment—Individual Project Organizer Task 2

Task 3: The Effects of Climate Change on Humans and the Environment

Formative Assessment—Individual Project Organizer Task 3

Task 4: What Can We Do?

Formative Assessment—Individual Project Organizer Task 4

Culminating Project: School Board Presentation

Group and Individual Assessment

Climate Change Unit Storyline

The topic of climate change can make some people feel discouraged and doomed. It is one of the most complex scientific and social challenges we face today. It is also one of the most complex topics to teach. Hopefully, by the end of this unit students will feel empowered and inspired to make an informed difference in the fight against climate change.

In the last unit, students talked about weather. In the Lift-Off Task of this unit, they shift to discussing climate—the weather conditions in an area over a much longer period of time. Scientists have discovered that in the last decade, the world's climate is changing at a dangerous rate. In this task, students will be introduced to what climate change is through popular media, thus creating within them an imperative to help. By the end of the task, students generate a list of questions about things they still need to know in order to help in the fight against climate change—questions that will continue to frame the unit as they go through the tasks.

Before students begin to think about climate change, they first have to explore the mechanisms behind Earth's global climate as it has been. In Task 1, they learn that for thousands of years, Earth has been lucky enough to have a global climate that is generally not too hot and not too cold. As Goldilocks would say in the story of the three bears, the temperature was "just right"—at least for survival of the plants and animals on earth. However, students saw in the Lift-Off Task that global temperatures have been rising over the past century. In this task, they begin to ask why. In Task 1, they conduct an investigation that will lead them to the conclusion that it is greenhouse gases such as carbon dioxide that are causing the increase in temperature.

Students then take this information about greenhouse gases and temperature and ask the question that many climate change deniers ask: Are humans really responsible for the rise in temperature, or is the Earth just in a natural warm period? To answer this question, students need to compare the time when humans put little CO_2 in the atmosphere to today's times in which they are putting more in the atmosphere. In Task 2, students practice graph analysis skills to look at an abundance of evidence that supports one of two claims: human activities have led to the increase in global temperature, or Earth is just in another natural warm period. In looking at the evidence, students are able to make a concrete connection between human activity, burning of fossil fuels, increased carbon dioxide, and increased temperature.

Now that students have considered what is causing climate change and the evidence for it, the question becomes: Why do we care? In Task 3, students examine a variety of resources (article, videos, and graphs) to identify ways climate change is affecting plants, animals, humans, and the Earth. By the end of this task, students are able to create one long cause and effect chain about the topic of climate change—enabling them to see the complex mechanism as a whole.

At this point in the unit, students know that climate change is happening. They have seen evidence of its reality, explanations of its causes, and examples of its many impacts. However, it is important that students do not despair. While the consequences are great and mounting, there are ways to mitigate them. In Task 4, students do an audit of their classroom's carbon footprint, using the data to develop actions to reduce carbon emissions in their classroom. This activity provides the core of their Culminating Project, which is to develop a proposal for a school board to reduce production of greenhouse gases by their school. In the end, students should leave this unit believing that if they take action now to reduce the greenhouse gas emissions that warm our planet, they can reduce the risks that future generations will otherwise face.

Connect the Sixth Grade Climate Change Unit with Prior Knowledge

This summary is based on information found in the NGSS Framework.

Disciplinary Core Idea ESS3: Earth and Human Activity

This unit falls within the Disciplinary Core Idea ESS3: Earth and Human Activity.

In the Climate Change unit, students focus on two aspects from ESS3.C, Human Impacts on Earth Systems, and ESS3.D, Global Climate Change, by formulating answers to the questions "How do we know our global climate is changing?" and "How do human activities affect Earth systems?" (In the NRC Framework, the concept of climate change can also be broken down into two sub-ideas: global climate change and human impact on Earth systems.) In the context of this Disciplinary Core Idea, students will achieve the following goals by the end of this unit:

- Ask questions to clarify evidence of greenhouse gases in the atmosphere that have caused the rise in global temperatures over the past century.
- Gain knowledge of the causes and effects of climate change and use that knowledge to develop methods to monitor and minimize human impact on greenhouse gas production.

Note that the crosscutting concept of cause and effect is of paramount importance in this unit.

In this sixth grade Climate Change unit, students ask questions about climate change that will guide their explorations throughout the unit. In line with these questions, they will investigate how greenhouse gases in the atmosphere affect global temperature, which they will combine with other analyzed evidence to construct an explanation for the causes of climate change. Through research, they will identify the impacts of climate change on humans and the environment, creating an imperative for action. By the end of this unit, they will be able to develop their own informed action plans to reduce greenhouse gas production in their own classroom. Moving into sixth grade curriculum, it is important to know that while students may have heard of climate change in popular media, they will not yet have defined much of the basic vocabulary associated with the topic, such as climate, global warming, greenhouse gases, mitigation, etc. Students may have a basic understanding that our climate is changing, but do not have knowledge of the cause and effect processes as well as evidence-based thinking in this context.

The following are the sixth grade Climate Change performance expectations.

MS-ESS3-3 **Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*** [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

MS-ESS3-5 **Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.** [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Prior Knowledge from Prior Grades

In kindergarten, students begin to think about where animals live and why they live there. This includes humans, who have impacted the environment around them more so than any other animal. At this stage, students begin to think about different human impacts on land, water, air, and other living things, such as cutting down trees to make paper. This thinking allows students to connect their own impact with potential solutions they may already be familiar with, such as reusing paper or recycling bottles. The connection between human impact on the environment and human action solutions sets the foundation for later discussions in the sixth grade

unit about the human impact on climate change and the corresponding solutions humans can provide. Students will return to this exploration of the crosscutting concept of cause and effect in the sixth grade unit. While this performance expectation does not focus explicitly on climate change, it begins setting the stage for students to delve into human impact on the environment and designing solutions—two core themes in the sixth grade Climate Change unit.

The following is the kindergarten performance expectations.

K-ESS3-3 **Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.*** [Clarification Statement: Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]

In fifth grade, students continue to think about ways that humans can protect the environment. At this point, students delve into impacts with more specificity than experiential knowledge, understanding that human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. Students obtain specific information about ways humans use science ideas to protect Earth's resources and environment. One of the examples that may arise is using technology to help monitor greenhouse gas emissions and mitigate climate change. The focus on protecting Earth's resources and environment sets the stage for further exploration of this topic in the sixth grade Climate Change unit. This performance expectation also gives students practice at researching and combining evidence within the context of climate change—a cognitive skill they will use throughout the sixth grade Climate Change unit and then extend to actual data analysis and construction of explanations.

The following is the fifth grade performance expectations.

5-ESS3-1 **Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.**

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Connect Core Ideas, Scientific Practices, and Crosscutting Concepts from K–6

	Kindergarten	Fifth Grade	Sixth Grade
Core Idea ESS3.C **Human Impacts on Earth Systems**	• Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (K-ESS3-3)	• Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)	• Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)
Core Idea ESS3.D **Global Climate Change**	• None	• None	• Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3–5)
Science and Engineering Practices	• Obtaining, Evaluating, and Communicating Information	• Obtaining, Evaluating, and Communicating Information	• Asking Questions and Defining Problems • Analyzing and Interpreting Data • Constructing Explanations
Crosscutting Concepts	• Cause and Effect	• Systems and System Models	• Cause and Effect

Standards and Objectives

Climate Change Standards

NGSS Performance Expectations

MS-ESS3-3 **Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*** [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

MS-ESS3-5 **Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.** [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Disciplinary Core Ideas

ESS3.D: Global Climate Change

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3–5)

ESS3.C: Human Impacts on Earth Systems

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- Ask questions to identify and clarify evidence of an argument. (MS-ESS3–5)

Analyzing and Interpreting Data

- Analyze and interpret data to provide evidence for phenomena.

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3)

Crosscutting Concepts

Cause and Effect

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-3).

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Climate Change Unit Objectives

Task	Content	Science and Engineering Practices	Equity and Groupwork	Language
Optional Lift-Off Weather and Climate	• Describe the difference between weather and climate.	• Analyze data about weather and climate.	• Rephrase and build on others' ideas during group discussion.	• Discuss data and come to a consensus.
Lift-Off What Is Climate Change, and Why Do We Care about It?	• Describe climate change, its causes, and its effects.	• Ask questions about climate change.	• Rephrase and build on others' ideas during group discussion.	• Identify and connect vocabulary concepts. • Build on what others say to help strengthen students' understanding of cause and effect relationships.
Task 1 The Effects of Carbon Dioxide on Climate	• Explain how the amount of greenhouse gases in the atmosphere affects global temperature.	• Plan and carry out an investigation to determine the effect of CO_2 levels on temperature. • Construct an explanation about CO_2 and temperature using experimental evidence.	• Discuss findings as a group.	• Write a clear and logical explanation using evidence.
Task 2 What Is Causing Climate Change, and How Do We Know?	• Compare levels of carbon dioxide and temperature in the past to those of today.	• Analyze data to identify evidence to support a claim or counterclaim. • Construct an argument about the cause of climate change.	• Build on other group members' ideas.	• Construct an argument based on evidence.
Task 3 The Effects of Climate Change on Humans and the Environment	• Identify and explain ways that climate change affects plants, animals, and humans.	• Analyze data about the effects of climate change on the world around us. • Construct an explanation linking the cause and effects of climate change.	• Make contributions to group discussions.	• Discuss with a partner the impacts of climate change on animals and the environment.
Task 4 What Can We Do?	• Identify ways their class can reduce greenhouse gas emissions.	• Analyze data and apply the data to develop actions for reducing greenhouse gas in their classroom.	• Listen to others' ideas.	• Draw and label a diagram to show their plan for reducing greenhouse gas emissions.

Task	Disciplinary Core Ideas	Science and Engineering Practices	Equity and Groupwork	Language
Culminating Project • Group: School Board Proposal • Individual: Newsletter Article	• Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. • Human activities have altered the biosphere, sometimes damaging it, although changes to environments can have different impacts for different living things. • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). • Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and applying that knowledge wisely in decisions and activities.	• Asking Questions and Defining Problems • Analyzing and Interpreting Data • Constructing Explanations	• Write a school board proposal together and present as a group.	• Write a newsletter article. • Present school board proposal.
Performance Expectations	• MS-ESS3-3: **Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*** [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).] • MS-ESS3-5: **Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.** [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]			

Misconceptions

Knowing what is wrong is as important as knowing what is right.

Lift-Off Task: What Is Climate Change, and Why Do We Care about It?

Misconception	Accurate Concept
Global warming and climate change are the same thing.	Global warming refers to the average temperature increase across the globe. Climate change is a larger category that also includes extreme weather events that may occur as a result of the increase in global temperature.
Burning fossil fuels is the only cause of climate change.	Deforestation also adds to the problem of climate change by removing a source of carbon storage and cycling.
The Earth's global temperature has only warmed about 1°C, which is not that big of a deal. Our weather changes that much all the time!	Even 1 degree of global warming leads to disastrous results, like hurricanes, droughts, extreme wildfires, sea level rise, etc. Under these conditions, many plant and animal species cannot adapt quickly enough to survive.
The Sun causes global warming.	The output of energy from the Sun has been monitored by satellites for 30 years and has not increased during this period of rapid global warming.

Task 1: The Effects of Carbon Dioxide on Climate

Misconception	Accurate Concept
Greenhouse gases are like a blanket or a pane of glass. They provide a physical barrier that traps the heat.	It is inaccurate to refer to greenhouse gases as a physical barrier. Rather than block heat from leaving Earth, greenhouse gases absorb heat and re-radiate it, which keeps Earth's surface warm.
We would be better off with no greenhouse gases in the atmosphere.	Without any greenhouse gases, the Earth would be freezing and humans could not live on Earth. We need a perfect balance of greenhouse gases. This is known as the "Goldilocks" principle.
Carbon dioxide is the only greenhouse gas.	The primary greenhouse gases in Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. We talk most about carbon dioxide because it has caused most of the warming effect.
All of the energy from the Sun that hits Earth stays on Earth's surface.	Earth absorbs only 51% of the Sun's rays. The rest are either reflected back into space or absorbed by the atmosphere.
The atmosphere only contains greenhouse gases.	The atmosphere is mostly made up of nitrogen and oxygen, which are not greenhouse gases because they do not absorb energy.
Alka-Seltzer® tablets are solid carbon dioxide.	Alka-Seltzer® tablets, when combined with water, create a chemical reaction that releases carbon dioxide gas.

Task 2: What Is Causing Climate Change, and How Do We Know?

Misconception	Accurate Concept
The Earth's climate has changed many times before. We are just in another period of natural climate change.	Previous natural periods of warming have not had the same high levels of carbon dioxide in the atmosphere that we do now, due to human activity. Also, this warming period does not follow the same patterns as previous natural warming periods.
Greenhouse gases only come from human activities.	There are also natural causes of greenhouse gas production: methane from cows, volcanic eruptions, natural cycles of carbon dioxide between the ocean and air and between land and air.
Burning fossil fuels and the release of carbon dioxide is the only cause of climate change.	The livestock industry and excess trash production lead to excess methane in the atmosphere.
The world has been cooling for the past decade. I have seen in the news that there has been a lot of rain and snow recently.	Incidental snowstorms or periods of rain give the false impression that the Earth is no longer warming. Climate is defined by long-term averages (30 years), and data for the last century has shown a clear increase in global average temperature.

Task 3: The Effects of Climate Change on Humans and the Environment

Misconception	Accurate Concept
Climate change is the increase of global temperature, so the result is always drier climates.	Sometimes, the hot air actually makes bigger storms, resulting in more precipitation at times. Climate change has been associated with extreme weather events such as increased precipitation during normally drier summer months and more consecutive dry days during winter.
All the effects of climate change can be viewed as separate effects.	Many effects of climate change are connected. For example, melting glaciers lead to rising sea levels.
Increased temperature is the only thing that affects humans and the environment.	Increased levels of carbon dioxide can also have an effect. For example, increased carbon dioxide makes eucalyptus toxic to Koala bears. The ocean can also absorb carbon dioxide, causing ocean acidification that damages coral reefs.
All species are harmed by climate change.	The bark beetle population is flourishing at higher temperatures, infecting millions of forest acres in the United States and killing hundreds of thousands of trees. While this doesn't harm the bark beetle, it does end up worsening climate change, because trees are essential for carbon storage and cycling.

Task 4: What Can We Do?

Misconception	Accurate Concept
Using electricity for heat is better than using gas or coal because it doesn't burn fossil fuels.	Electricity is generated in a power plant, often by burning fossil fuels, which releases greenhouse gases into the atmosphere.
Driving cars is the main source of greenhouse gas emissions.	Electricity is the largest source of greenhouse gas emissions.
The climate has already warmed and there are drastic consequences, so there is nothing we can do to fix it.	While we can't go backward, we can reduce current greenhouse gas emissions to mitigate future global warming for future generations. We can also work to mitigate the effects of climate change to make the impact on human communities less severe.
Helping reduce greenhouse gas emissions mostly involves walking or biking to school instead of driving cars.	There is a wide variety of different practices students can take to minimize their carbon footprint, including but not limited to buying products with minimal packaging, recycling, reusing products, adjusting thermostats to use less heating and air conditioning, replacing light bulbs with compact fluorescent lighting, walking/biking/carpooling, buying energy-efficient products, using less hot water, unplugging devices, using the off switch, planting more trees, using renewable energy sources (e.g., installing solar panels), eating less meat, etc.

Culminating Projects

Unit Essential Question: How do we know human activity is influencing climate, and what can we do about it?

Introduction

The topic of climate change can make some of us feel discouraged and doomed. In this Culminating Project, we want students to think local and understand that there are things they can do to be part of a solution. The project focuses on the carbon footprint of the classroom rather than students' home environment because many schools and districts have students who have no permanent home. In addition, the calculations and solutions are more feasible at the classroom level than the town or city level.

Objectives

- Apply scientific principles to design a method for monitoring and minimizing a particular human impact on the environment.
- Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Time Needed (based on 45-minute periods)

Total: 5–8 days

- I: Outline presentation and write scripts (1–2 class periods)
- II: Practice presentations (1 class period)
- III: Present proposed solutions (1–2 class periods)
- IV: Individual newsletter article (2–3 class periods)

Materials

- Paper and colored pencils/pens
- Results from classroom audit (Task 4)
- Optional: Computers and software to create digital slide presentation

Instructions

1. In the Lift-Off Task, students were introduced to the Culminating Project to lay the foundation of the unit and get students thinking about why they need to learn about climate change.

2. When returning to the Culminating Project at the end of the unit, review the Culminating Project in the Student Edition.

    - You might want to describe what happens in a school board meeting and/or show a short clip of a council meeting (example: https://www.youtube.com/watch?v=3nLyOxPsS94—many more are available on YouTube).
    - Optional: Replay the video clip about a group of students implementing solutions to help reduce climate change (from the Lift-Off Task): http://youngvoicesonclimatechange.com/movie_dreaming.php (6:22)

3. Review the Culminating Projects in the Student Edition. Have students go over expectations of the rubrics they will be assessed on.

4. Follow these steps for the Group Culminating Project.

    a. I: Groups outline presentations and write scripts.

    b. II: Groups practice presentations.

    c. III: Groups present their proposed solutions.

        - Students will need to know that during the school board meeting, they will be responsible for their presentation as well as playing the role of the audience when others are presenting. Encourage students to ask the groups questions.

5. IV: For the Individual Culminating Project, review page 3 of the student instructions, emphasizing expectations from the rubrics already provided.

    - Emphasize to students in the Individual Culminating Project, students will summarize everything they have learned from the unit.
    - Encourage them to go back to their Student Edition as their Individual Project Organizer to help them write their article.

    Follow these steps for the Individual Culminating Project:

    1. Outline newsletter article.
    2. Get peer feedback.
    3. Write draft of newsletter article, incorporating suggestions.
    4. Get another peer's feedback.
    5. Write final draft of newsletter article, incorporating feedback.

Assessment

Student work will be evaluated using:

- Science and Engineering Practices Rubric
- Science Content Rubric
- Oral Presentation Rubric (select one or two aspects from the Oral Presentation Rubric to focus on)

Science Content Rubric

Assess Using Individual Culminating Project Script

SCIENCE CONTENT RUBRIC				
THE STUDENT DEMONSTRATES THEIR SCIENTIFIC KNOWLEDGE OF THE FOLLOWING CONTENT STANDARD	EMERGING	DEVELOPING	PROFICIENT	ADVANCED
Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS3-5)	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **incompletely, inappropriately, and/or incorrectly**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **correctly but incompletely**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **correctly and completely**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **completely and correctly** AND synthesizes or makes connections across multiple contexts.
Human activities have altered the biosphere, sometimes damaging it, although changes to environments can have different impact for different living things. Activities and technologies can be engineered to reduce people's impacts on the Earth. (MS-ESS3-3)	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **incompletely, inappropriately, and/or incorrectly**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **correctly but incompletely**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **correctly and completely**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **completely and correctly** AND synthesizes or makes connections across multiple contexts.
Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). (MS-ESS3-5)	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **incompletely, inappropriately, and/or incorrectly**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **correctly but incompletely**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **correctly and completely**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **completely and correctly** AND synthesizes or makes connections across multiple contexts.
Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **incompletely, inappropriately, and/or incorrectly**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **correctly but incompletely**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **correctly and completely**.	The concept is modeled, used, explained, interpreted, argued OR otherwise applied **completely and correctly** AND synthesizes or makes connections across multiple contexts.

Science and Engineering Practices Rubric

The Climate Change unit will be assessed using the highlighted rows.

SCIENCE AND ENGINEERING PRACTICES RUBRIC				
SCORING DOMAIN	**EMERGING**	**DEVELOPING**	**PROFICIENT**	**ADVANCED**
ASKING QUESTIONS AND DEFINING PROBLEMS	Asks general questions that cannot be investigated.	Asks specific questions that can be investigated but do not require empirical evidence.	Asks questions that require empirical evidence to answer.	Asks questions that require empirical evidence to answer and evaluates the testability of the questions.
❑ No Evidence*	Writes a problem or design statement but it does not match the intent of the problem or the need of the client.	Writes a problem or design statement that matches the intent of the problem or the need of the client with minor errors.	Writes a problem or design statement that accurately matches the intent of the problem or the needs of the client.	Writes a problem or design statement that accurately and completely matches the intent of the problem or the need of the client.
DEVELOPING AND USING MODELS	Makes models (drawings, diagrams, or other) with major errors.	Makes models (drawings, diagrams, or other) to represent the process or system to be investigated with minor errors.	Makes accurate and labeled models (drawings, diagrams, or other) to represent the process or system to be investigated.	Makes accurate and labeled models (drawings, diagrams, or other) to represent the process or system to be investigated and explains the model.
❑ No Evidence*	Explains the limitations of the model with major errors.	Explains the limitations of the model with minor errors.	Explains the limitations of the model as a representation of the system or process.	Explains the limitations of the model as a representation of the system or process and discusses how the model might be improved.
PLANNING INVESTIGATIONS	Plans an investigation that will not produce relevant data to answer the empirical question(s).	Plans an investigation that will produce some relevant data to answer the empirical question(s).	Plans an investigation that will produce relevant data to answer the empirical question(s) and identifies the dependent and independent variables when applicable.	Plans an investigation that will completely produce relevant and adequate amounts of data to answer the empirical question(s) and identifies the dependent and independent variables when applicable.
❑ No Evidence*	Plans a design that does not match the criteria, constraints, and intent of the problem.	Plans a design and writes an explanation that partially matches the criteria, constraints, and intent of the problem.	Plans a design and writes an explanation that accurately and adequately matches the criteria, constraints, and intent of the problem.	Plans a design and writes a detailed explanation that accurately and completely matches the criteria, constraints, and intent of the problem.
CARRYING OUT INVESTIGATIONS	Writes procedures that lack detail so the procedures cannot be duplicated by another person.	Writes procedures with enough detail that another person can duplicate (replicable) but does not conduct a sufficient number of trials.	Writes detailed replicable procedures with descriptions of the measurements, tools, or instruments and conducts adequate number of trials.	Writes detailed replicable procedures with descriptions of the measurements, tools, or instruments and conducts adequate number of trials with an explanation for the proposed data collection.
❑ No Evidence*				

* If there is no student response then check the No Evidence box.

The Climate Change unit will be assessed using the highlighted rows.

SCIENCE AND ENGINEERING PRACTICES RUBRIC				
SCORING DOMAIN	**EMERGING**	**DEVELOPING**	**PROFICIENT**	**ADVANCED**
ANALYZING AND INTERPRETING DATA *"Accurately labeled" means inclusion of title, column titles, description of units, proper intervals.* ❑ No Evidence*	Makes spreadsheets, data tables, charts, or graphs that are not accurately labeled or do not display all the data. Uses inappropriate methods or makes major errors analyzing the data.	Makes accurate and labeled spreadsheets, data tables, charts, or graphs to summarize and display data but does not arrange the data to examine the relationships between variables. Uses appropriate methods but makes minor errors analyzing the data.	Makes accurate and labeled spreadsheets, data tables, charts, and/or graphs to summarize and display data and arranges the data to examine relationships between variables. Uses appropriate methods to accurately and carefully identify patterns **or** explains possible error or limitations of analyzing the data.	Makes accurate and labeled spreadsheets, data tables, charts, and/or graphs and uses more than one of these methods to summarize and display data; arranges the data to examine relationships between variables. Uses appropriate methods to accurately and carefully identify patterns **and** explains possible error or limitations of analyzing the data.
CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS ❑ No Evidence*	Constructs an explanation that includes an inappropriate claim, inaccurate evidence, and/or unclear reasoning. Uses no data to evaluate how well the design answers the problem and the redesign of the original model or prototype is inappropriate or incomplete.	Constructs or evaluates an explanation consisting of minimal claim(s), limited sources of accurate evidence, and/or minimal reasoning. Uses minimal data to evaluate how well the design answers the problem and describes an appropriate redesign of the original model or prototype with minor errors.	Constructs or evaluates an explanation that includes a claim, multiple sources of accurate evidence, and reasoning using accurate and adequate scientific ideas or principles. Uses adequate data to evaluate how well the design answers the problem and accurately explains an appropriate redesign of the original model or prototype.	Constructs, evaluates, or revises an explanation that includes a claim, multiple sources of accurate evidence, and reasoning using accurate and adequate scientific ideas or principles. Uses adequate data to evaluate how well the design answers the problem and accurately provides a detailed rationale for the appropriate redesign of the original model or prototype.
ENGAGING IN ARGUMENTS FROM EVIDENCE ❑ No Evidence*	Constructs an argument that includes an inappropriate claim, inaccurate evidence, and/or unclear reasoning.	Constructs or evaluates an argument consisting of minimal claim(s), limited sources of evidence, **or** minimal reasoning.	Constructs and/or evaluates an argument consisting of appropriate claim(s), multiple sources of evidence, and reasoning using accurate and adequate scientific ideas or principles.	Constructs, evaluates, or revises an argument consisting of appropriate claim(s), multiple sources of evidence, and reasoning using accurate and adequate scientific ideas or principles.
OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION ❑ No Evidence*	Communicates information that is inaccurate and/or inconsistent with the evidence.	Communicates accurate but minimal information consistent with the evidence but does not explain the implications **or** limitations of the investigation or design.	Communicates accurate, clear, and adequate information consistent with the evidence and explains the implications and/or limitations of the investigation or design.	Communicates accurate, clear, and complete information consistent with the evidence and provides a rationale for the implications and limitations of the investigation or design.

* If there is no student response then check the No Evidence box.

Oral Presentation Rubric

ORAL PRESENTATION RUBRIC							
SCORING DOMAIN	EMERGING	E/D	DEVELOPING	D/P	PROFICIENT	P/A	ADVANCED
CLARITY *What is the evidence that the student can present a clear perspective and line of reasoning?*	Presents an unclear perspective Line of reasoning is absent, unclear, or difficult to follow	❑	Presents a general perspective Line of reasoning can be followed	❑	Presents a clear perspective Line of reasoning is clear and easy to follow Addresses alternative or opposing perspectives when appropriate	❑	Presents a clear and original perspective Line of reasoning is clear and convincing Addresses alternative or opposing perspectives in a way that sharpens one's own perspective
EVIDENCE *What is the evidence that the student can present a perspective with supportive evidence*?	Draws on facts, experience, or research in a minimal way Demonstrates limited understanding of the topic	❑	Draws on facts, experience, and/or research inconsistently Demonstrates an incomplete or uneven understanding of the topic	❑	Draws on facts, experiences, and research to support a perspective Demonstrates an understanding of the topic	❑	Synthesizes facts, experience, and research to support a perspective Demonstrate an in-depth understanding of the topic
ORGANIZATION *What is the evidence that the student can use language appropriately and fluidly to support audience understanding?*	Lack of organization makes it difficult to follow the presenter's ideas and line of reasoning	❑	Inconsistencies in organization and limited use of transitions detract from audience understanding of line of reasoning	❑	Organization is appropriate to the purpose, audience, and task and reveals the line of reasoning; transitions guide audience understanding	❑	Organization is appropriate to the purpose and audience and supports the line of reasoning; effectively hooks and sustains audience engagement, while providing a convincing conclusion
LANGUAGE USE *What is the evidence that the student can use language appropriately and fluidly to support audience understanding?*	Uses language and style that are unsuited to the purpose, audience, and task Stumbles over words, interfering with audience understanding	❑	Uses language and style that are at times unsuited to the purpose, audience, and task Speaking is fluid with minor lapses of awkward or incorrect language use that detracts from audience understanding	❑	Uses appropriate language and style that are suited to the purpose, audience, and task Speaking is fluid and easy to follow	❑	Uses sophisticated and varied language that is suited to the purpose, audience, and task Speaking is consistently fluid and easy to follow

ORAL PRESENTATION RUBRIC							
SCORING DOMAIN	EMERGING	E/D	DEVELOPING	D/P	PROFICIENT	P/A	ADVANCED
USE OF DIGITAL MEDIA / VISUAL DISPLAYS *What is the evidence that the student can use digital media/visual displays to engage and support audience understanding?*	Digital media or visual displays are confusing, extraneous, or distracting	❑	Digital media or visual displays are informative and relevant	❑	Digital media or visual displays are appealing, informative, and support audience engagement and understanding	❑	Digital media or visual displays are polished, informative, and support audience engagement and understanding
PRESENTATION SKILLS *What is the evidence that the student can control and use appropriate body language and speaking skills to support audience engagement?*	Makes minimal use of presentation skills: lacks control of body posture; does not make eye contact; voice is unclear and/or inaudible; and pace of presentation is too slow or too rushed Presenter's energy and affect are unsuitable for the audience and purpose of the presentation	❑	Demonstrates a command of some aspects of presentation skills, including control of body posture and gestures, language fluency, eye contact, clear and audible voice, and appropriate pacing Presenter's energy and/or affect are usually appropriate for the audience and purpose of the presentation, with minor lapses	❑	Demonstrates a command of presentation skills, including control of body posture and gestures, eye contact, clear and audible voice, and appropriate pacing Presenter's energy and affect are appropriate for the audience and support engagement	❑	Demonstrates consistent command of presentation skills, including control of body posture and gestures, eye contact, clear and audible voice, and appropriate pacing, in a way that keeps the audience engaged Presenter maintains a presence and a captivating energy that is appropriate to the audience and purpose of the presentation
INTERACTION WITH AUDIENCE *What is the evidence that the student can respond to audience questions effectively?*	Provides a vague response to questions; demonstrates a minimal command of the facts or understanding of the topic	❑	Provides an indirect or partial response to questions; demonstrates a partial command of the facts or understanding of the topic	❑	Provides an indirect or partial response to questions; demonstrates a partial command of the facts or understanding of the topic	❑	Provides a precise and persuasive response to questions; demonstrates an in-depth understanding of the facts and topic

Materials

Lift-Off Optional Addendum: Weather and Climate

Student Materials
per group

- Optional: computer to watch the video clips in small groups rather than as a class

Teacher Materials

- Computer to show video clips to class (or, have students watch the video clips in small groups)
- "Optional Addendum: Weather and Climate" digital slide presentation
- Video clips:
- *Climate vs. Weather* (1:59): https://youtu.be/1s8eGd7THoo
- *Weather vs. Climate* (1:21): https://youtu.be/ukIIA2D0BUU
- 2 "Weather" and 2 "Climate" signs to put up in the corners of the classroom

Lift-Off Task: What Is Climate Change, and Why Do We Care about It?

Student Materials
per group

Part I • What Is Climate Change and Why Does It Matter to Us and the World?

- Optional: computer to watch the video clips in small groups rather than as a class

Part II • What Do You Need to Know in Order to Help?

- Optional: computer to watch the video clips in small groups rather than as a class

Part III • Understand Climate Change

- Poster paper and markers
- Optional: Sticky notes for gallery walk

Teacher Materials

- "What Is Climate Change, and Why Do We Care about It?" digital slide presentation
- Video clips:
- *What Is Climate Change?* (cause and effects of climate change in Australia): https://youtu.be/ko6GNA58YOA
- *Climate Change (according to a kid)*: https://youtu.be/Sv7OHfpIRfU
- *Dreaming in Green*: http://youngvoicesonclimatechange.com/movie_dreaming.php
- Class poster for list of generated need-to-know questions
- Class poster or white-board for class concept map

Task 1: The Effects of Carbon Dioxide on Climate

Student Materials
per group

Part I • Student Lab—Plan and Conduct an Experiment to Model the Effect of Greenhouse Gases on Temperature

- 2 clear 2 L empty soda bottles with labels removed
- Aluminum foil
- 2 thermometers (these should read at room temperature; it is important they are calibrated)
- 250 mL beaker + water
- 2 Alka-Seltzer® tablets (break both in half)
- 150 W light bulb with heat lamp
- Ruler
- Stopwatch (or digital stopwatch on phone, tablet, etc.)

Part II • Greenhouse Gases and the Goldilocks Principle

- Handout: How Our Earth System Stays Not Too Hot and Not Too Cold (1 per student)

Teacher Materials

Any (or all) of the following:

- "The Effects of Carbon Dioxide on Climate" digital slide presentation
- Video: *Goldilocks and the Greenhouse: Science and Climate Change*: https://www.youtube.com/watch?v=ky0dwKjYmHE
- Images of greenhouses to display

Task 2: What Is Causing Climate Change, and How Do We Know?

Student Materials

- Handout: Evidence from Graphs
- Optional: Pencils (plain or colorful), pens, paper, scissors for ice core simulation

Teacher Materials

- "What Is Causing Climate Change, and How Do We Know?" digital slide presentation
- Video clips:
  - *CO_2 in the Ice Core Record*: http://earththeoperatorsmanual.com/segment/5
  - *Products of Burning Fuel*: https://www.youtube.com/watch?v=FfFs4q6PSaU (optional)

Task 3: The Effects of Climate Change on Humans and the Environment

Student Materials

- Handout: Resource Cards (one card for each station)
- Handout: Resource Card Questions (optional)
- Computer or tablet at stations 1 and 4

Teacher Materials

"The Effects of Climate Change on Humans and the Environment" digital slide presentation

Task 4: What Can We Do?

Student Materials

per student

- Handout: Background Information

per group

- Handout: Classroom Audit Worksheet
- Handout: Classroom Carbon Calculator

Culminating Project: School Board Presentation

Materials

- Paper and colored pencils/pens
- Results from classroom audit (Task 4)
- Optional: Computers and software to create digital slide presentation