CEREAL CITY SCIENCE by BCAMSC

Teacher Guide and Student Journal
Sample Activity and Planning Pages

Weather, Climate, & Human Impact MSENG2

A Middle School Unit supporting Next Generation Science Standards and Michigan Science Standards

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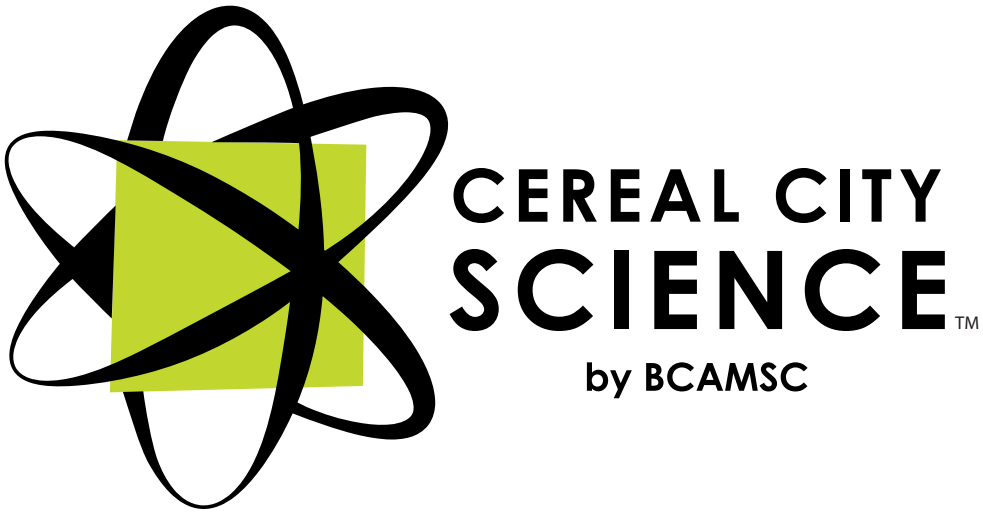
A Middle School Unit supporting Next Generation Science Standards and the Michigan Science Standards

Developed and written by
Battle Creek Area Mathematics + Science Center
for



Weather, Climate, and Human Impact

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NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas/Performance Assessments	Activity
ESS2.C: The Roles of Water in Earth's Surface Processes • The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. • Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.	1,5,6,7
MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	3,4,5,6,7
MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climate.	3,4,5,6
ESS2.D: Weather and Climate • Weather and climate are influenced by interaction 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-ESS2-6) • Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) • The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)	1,2,3,4,5,6,7,8
MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	3,4,5
MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climate.	3,4,5,6
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)	1,7,8
MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	1,7,8

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

NEXT GENERATION SCIENCE STANDARDS

ESS3.C: Human Impacts on Earth's 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) • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3, MS-ESS3-4)	2,7,8
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	7,8
MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.	7,8
This unit develops a storyline using the effect of climate change on animal behavior (migration), changing populations of plants and animals, and the needs for all organisms to survive. The following Middle School Life Science Disciplinary Core Ideas are integrated within the Earth Science Disciplinary Core Ideas:	
Disciplinary Core Ideas/Performance Assessments	**Activity**
LS2.A: Interdependent Relationships in Ecosystems • Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) • Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)	3,7,8
MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	
LS2.C: Ecosystem Dynamics, Functioning, and Resilience • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)	3,7,8
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	3,7,8
LS1.D: Information Processing • Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical) transmitting them as signals are processed in the brain, resulting in immediate behaviors or memories.	3,7,8

NEXT GENERATION SCIENCE STANDARDS

Science and Engineering Practices/Performance Assessments	Activity
Asking Questions and Defining Problems Asking questions and defining problems in 6-8 builds on K-5 experiences and progresses to specify relationships between variables, clarify arguments and models. • Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5)	1,4
MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	1,7,8
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomenon. (MS-ESS2-6)	1,2,3,4,5,6,8
MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climate.	3,4,5,6
Planning and Carrying Out Investigations Planning and carrying out investigations in 6–8 builds on K–5 and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions. • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)	2,3,4,5,7,8
MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	3,4,5
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings. (MS-ESS2-5)	2,3,4,6,7,8
MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	2,3,4

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

NEXT GENERATION SCIENCE STANDARDS

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 knowledge, principles, and theories. • Apply scientific ideas or principles to design an object, tool, process, or system. (MS-ESS3-3)	2,3,4,5,6,7,8
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	1,7,8
Connections to Nature of Science	
Engaging in Argument from Evidence • Engaging in argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds. • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or model for a phenomenon or a solution to a problem. (MS-ESS3-4)	7,8
MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.	7,8

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

NEXT GENERATION SCIENCE STANDARDS

Crosscutting Concepts/Performance Assessments	Activity
Cause and Effect • Cause and effect relationships may be used to predict phenomena in natural and designed systems. (MS-ESS2-5, MS-ESS3-4) • Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (S-ESS3-3)	1,2,3,4,5,6,7,8
MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	3,4,5
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	7,8
MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.	7,8
Systems and System Models • Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. (MS-ESS2-6)	2,3,4,5,6,7,8
MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climate.	3,4,5,7
Stability and Change • Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)	2,4,5,6,7
MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	7,8
Patterns • Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)	2,3,4
MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	3,4
MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.	7,8

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

UNIT AT A GLANCE

Activity	Time to Complete	Lesson Level Learning Goals	Phenomena	Summary: Students will...
1 Severe Weather	Preparation: 20 minutes Activity: 3 classes Lesson 1A : 55-60 min. 2 classes Lesson 1B: 55-60 min.	Raise questions about the cause of tornadoes and other severe weather events. Develop an initial model that explains their ideas of the cause of the outbreak of tornadoes in 2014.	**2014 Tornado Outbreak - observe videos of tornado and the weather report leading up to and during the storm**	• Develop initial models based on ideas and wonderings about the tornado and severe storm. • Raise questions about the causes of tornadoes and severe weather events. • Share ideas about the use of different weather instruments. • Use weather monitoring instruments to collect local weather data over a period of time.
2 Aware of the Air	Preparation: 20 minutes Activity: 5 classes Lesson 2A: 55-60 min. Lesson 2B: 55-60 min., 2 classes Lesson 2C: 55-60 min., 2 classes	Obtain information to provide evidence of the make-up of the air. Plan and carry out an investigation to find out the effect of the angle of sunlight on air temperature. Plan and carry out an investigation to find out how elevation and air pressure affect temperature.	**Daily weather video**	• Obtain information about the gases that make up the air. • Use an interactive to explore what would happen if the amount of O_2 in the atmosphere changes. • Share ideas about the amount of CO_2 in the atmosphere. • Investigate the effect of the angle of the sun on temperature. • Investigate the effect of atmospheric pressure on temperature.
3 The Heat is On - What Makes the Wind?	Preparation: 20 minutes Activity: 4 classes Lesson 3A: 55-60 min., 2 classes Lesson 3B: 55-60 min. Lesson 3C: 55-60 min. Lesson 3D: 55-60 min.	Develop a model that explains how winds are formed. Plan and carryout an investigation to find out the effect of temperature on air particles.	**Video of a very windy day.**	• Share initial ideas about the wind and collaborate to generate a model. • Conduct an investigation into the movement of air during temperature change . • Observe the movement of air in a convection model. • Obtain information about what makes the tornado rotate. • Read about an accidental discovery of how migrating birds changed their pattern to avoid the tornadoes.

UNIT AT A GLANCE

Students Figure Out How To:	Practice/Crosscutting Concepts	PE at Lesson Level and Assessment
• Investigate what causes changes in weather and severe weather events. • Develop models that explain their thinking. • Recognize patterns in weather data that can be used to predict future weather events.	**Asking Questions and Defining Problems** **Developing and Using Models** **Cause and Effect**	**PE at Lesson Level** Raise questions about the cause of tornadoes and other severe weather events. Develop an initial model that explains their ideas of the cause of the outbreak of tornadoes in 2014. Collect data to determine the cause of different components of weather. **Formative Assessment** Initial Models Questions Science Talk Journal Entry
• Plan and carry out an investigation to find out the effect of the angle of the sun on air temperature. • Obtain and analyze information about the balance of gases in the atmosphere and the effect of an increase in CO_2. • Analyze data from investigations to draw a conclusion about the effect of the angle of the sun on temperature in a region. • Describe the affects of altitude on pressure and temperature.	**Obtaining, Evaluating, and Communicating Information** **Developing and Using Models** **Planning and Carrying Out Investigations** **Analyzing and Interpreting Data** **Constructing Explanations and Designing Solutions** **Cause and Effect** **Systems and System Models** **Patterns** **Stability and Change**	**PE at Lesson Level** Obtain information to provide evidence of the make-up of the air. Plan and carry out an investigation to find out the effect of the angle of sunlight on air temperature. Plan and carry out an investigation to find out how elevation and air pressure affect temperature. **Formative Assessment** Science Talk Journal Entry Activity Page **Summative Assessment** Final models Activity Pages Journal Entry Class Discussion
• Develop a model to explain what makes the wind. • Collect and analyze data about the movement of air during a temperature change. • Analyze observations of a convection model and apply to what happens in the atmosphere with temperature change. • Develop a model to explain convection currents. • Apply the sun's warming of the land and oceans to the different temperatures around the world. • Obtain information to share and compare about how birds avoided the storm.	**Developing and Using Models** **Planning and Carrying Out Investigations** **Analyzing and Interpreting Data** **Constructing Explanations and Designing Solutions** **Obtaining, Evaluating, and Communicating Information** **Cause and Effect** **Systems and System Models** **Patterns**	**PE at Lesson Level** Develop a model that explains how winds are formed. Plan and carry out an investigation to find out the effect of temperature on particles of matter (air particles). **Formative Assessment** Activity Pages **Summative Assessment** Final models Journal Entry

UNIT AT A GLANCE

Activity	Time to Complete	Lesson Level Learinging Goals	Phenomena	Summary: Students will...
4 What Makes the Clouds and Rain?	Preparation: 20 minutes Activity: 4 classes Lesson 4A: 55-60 min. 2 classes Lesson 4B: 55-60 min. 2 classes	Develop a model to explain what happens when warm and cold air masses meet.	**Weather report predicts change from warm and sunny to cooler and cloudy with a chance of rain.**	• Carry out an investigation to find out what happens when a cold air mass moves into an area with a warm air mass. • Record and interpret their observations. • Share their findings • Compare their findings with a demonstration. • Use a model demonstration to explain what makes the clouds.
5 Water Vapor in the Atmosphere and Precipitation	Preparation: 20 minutes Activity: 3 classes Lesson 5A: 55-60 min. 2 classes Lesson 5B: 55-60 min.	Develop a model that explains the different conditions in the atmosphere that create different types of precipitation.	**Video of clouds forming.**	• Make observations of clouds forming in the sky. • Plan and carry out an investigation that provides evidence of water vapor in the atmosphere. • Share data and observations. • Revise models based on new information. • Obtain information from text and illustrations that explain how different forms of precipitation are created.
6 Water on Earth	Preparation: 20 minutes Activity: 5 classes Lesson 6A: 55-60 min. 2 classes Lesson 6B: 55-60 min. Lesson 6C: 55-60 min.	Demonstrate, using a model the relationship between the warming by the sun of the Earth and the water cycle as it applies to the atmosphere.	**"The glass of water you drink today might contain molecules of water that a dinosaur drank millions of years ago." from *Water* by Seymour Simon**	• Role play a water droplet. • Obtain information about water on Earth from text. • Brainstorm ideas of how to make a model that demonstrates the water cycle. • Make observations of the changes in the model over time. • Read about tennis shoes washing up on the shore after a cargo spill in the ocean. • Use a model to demonstrate how the wind moves the ocean waters. • Use an animated video to explain ocean currents and how they affect climates • Obtain information from text that explains the movement of the oceans.

UNIT AT A GLANCE

Students Figure Out How To:	Practice/Crosscutting	PE at Lesson Level and Assessment
• Develop a model that explains what happens when a cold air mass moves into an area with a warm air mass. • Apply their understanding of the effect of temperature change on the particles that make up the air. • Analyze and interpret data from their investigations and the demonstration. • Develop an explanation for what happens when a cold air mass and a warm air mass collide. • Apply their understanding of what happens when warm air and cold air meet to what makes the clouds.	**Developing and Using Models** **Asking Questions and Defining Problems** **Planning and Carrying Out Investigations** **Analyzing and Interpreting Data** **Constructing Explanations and Designing Solutions** **Obtaining, Evaluating, and Communicating Information** **Cause and Effect** **Systems and System Models** **Stability and Change** **Patterns**	**PE at Lesson Level** Develop a model that explains the behavior of air particles when a warm air mass and a cold air mass meet. **Assessment** Initial and revised models Science Talk Final model Consensus model
• Develop a model that explains how clouds form and how it rains. • Apply what they know about cold and warm air masses to cloud formation and precipitation. • Analyze and interpret data and observations from their investigations. • Use a model of how hail forms in a test tube to explain how hail forms in the atmosphere.	**Developing and Using Models** **Planning and Carrying Out Investigations** **Constructing Explanations and Defining Solutions** **Obtaining, Evaluating, and Communicating Information** **Cause and Effect** **Systems and System Models** **Stability and Change**	**PE at Lesson Level** Develop a model that explains the different conditions in the atmosphere that create different types of precipitation. **Formative Assessment** Science Talk Revised models Class consensus model **Summative Assessment** Activity Pages Journal Entry Science Talk Revised models Consensus model
• Use a role play activity to describe the movement of water through the atmosphere, hydrosphere, geosphere, and biosphere. • Analyze data that represents the percent of water in different sources on Earth. • Relate information from text to the role play activity. • Become an engineer and collaborate with peers to develop a model that demonstrates the water cycle. • Make sense of the observations and evaluate the effectiveness of the models in demonstrating the water cycle. • Relate the solar heating of the Earth to the water cycle, ocean currents and climates .	**Developing and Using Models** **Analyzing and Interpreting Data** **Constructing Explanations and Designing solutions** **Obtaining, Evaluating and Communicating Information** **Cause and Effect** **Stability and Change** **Systems and System Models** **Scale, Proportion, and Quantity**	**PE at Lesson Level** Demonstrate, using a model, the relationship between the warming of the Earth by the sun and the water cycle and ocean currents. **Summative Assessment** Activity Pages Science Talk Journal Entry Models

UNIT AT A GLANCE

Activity	Time to Complete	Lesson Level Learning Goals	Phenomena	Summary: Students will...
7 **Climate Zones and Climate Change**	Preparation: 20 minutes Activity: 7 classes Lesson 7A: 55-60 min. 2 classes Lesson 7B: 55-60 min. 2 classes Lesson 7C: 55-60 min. Lesson 7D: 55-60 min. Lesson 7E: 55-60 min.	Develop a model to explain that climate is regulated by complex interactions of components of Earth's systems. Obtain information to find out the role of CO_2 in the atmosphere and the effect of an increase. Communicate why understanding climate change matters. Develop a plan to reduce personal, school, and community carbon footprint.	**Changing bird migration due to climate change.**	• Take notes on a Weather Versus Climate video. • Review their ideas about weather and climate from Lesson 1B. • Conduct investigations into sources of CO_2 in the atmosphere. • Analyze information about scientific projects of changing bird migrations due to climate change.
8 **What is the Evidence that the Climate is Changing?**	Preparation: 20 minutes Activity: 12+ classes Lesson 8A: 55-60 min. 3-4 classes Lesson 8B: 55-60 min. 2-3 classes Lesson 8C: 55-60 min. 2 classes Lesson 8D: 55-60 min 5 classes with support to carry out plan.	Describe data scientists have collected to provide evidence about climate change. Become active participants in science and the environment and commit to a plan to take action to reduce the release of greenhouse gases. Recognize that when students organize and work together they can make a difference in the environment.	**Changing bird migration due to climate change.** **Eight climate change cards explaining evidence.**	• Brainstorm current thinking about evidence of climate change. • Take notes and obtain information from text. • Develop models to explain the greenhouse effect. • Take notes to obtain information about why birds migrate.

UNIT AT A GLANCE

Students Figure Out How To:	Practice/Crosscutting Concepts	PE at Lesson Level and Assessment
• Research the weather and climate in an assigned city or region. • Explain the components that create the different climates. • Analyze and interpret data from their CO_2 investigations.	**Obtaining, Evaluating and Communicating Information** **Planning and Carrying Out Investigations** **Analyzing and Interpreting Data** **Constructing Explanations and Designing Solutions** **Engaging in Argument from Evidence** **Systems and System Models** **Cause and Effect** **Stability and Change**	**PE at Lesson Level** Conduct research and investigations to find out the sources of CO_2 in the atmosphere. **Formative Assessment** Activity Pages Models **Summative Assessment** Science Talk Journal Entry Activity Pages
• Conduct research to gather evidence of a changing climate. • Use the model of the greenhouse effect to explain why an increase in CO_2 results in a warming of the atmosphere. • Relate the changing climate to why bird migration is changing. • Develop a plan to reduce one's own carbon footprint.	**Obtaining, Evaluating, and Communicating Information** **Developing and Using Models** **Planning and Carrying Out Investigations** **Analyzing and Interpreting Data** **Constructing Explanations and Designing Solutions** **Engaging in Argument from Evidence** **Cause and Effect** **Systems and System Models**	**PE at Lesson Level** Present findings and engage in argumentation on the effect of human activity on the climate. **Summative Assessment** Activity Pages Science Talk Student Presentations Consensus Model Final models

Severe Weather

Teacher Background Information
The beginning activities for the unit lay the foundation for student ideas regarding weather, climate, and human impact and develop a sense of what information they need to fully understand the causes of day to day weather, outbreaks of severe weather, what determines the different climates on Earth, and how and why they are changing.

The class begins the unit by brainstorming and recording ideas about severe weather by trying to figure out what caused the April 28th, 2014 tornado outbreak in Mississippi, Arkansas, Alabama, and across the Carolinas. They watch videos of the meteorologist and the weather radar that tracked the storm and listen to descriptions and experiences of people who lived through the storm.

To begin to understand climate change and the effect of human activity, more deeply, the class undertakes an in-depth study of weather, what drives the weather, and the different components of weather and how they are formed. They investigate patterns in data regarding weather and compare with historical data to find trends in changing conditions.

Students begin their exploration into how different weather events occur. The initial discussion and exploration provides the foundation for their investigations into different climates and why weather conditions differ among the climates.

Students should have considerable knowledge regarding the variation in weather from day to day and the typical weather conditions in different climates across the world from the 3rd grade unit, *Weather, Climate, and Natural Hazards*. This unit builds on the following third grade Disciplinary Core Ideas:

ESS2.D Weather and Climate

Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.

Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.

Engage the learner
The initial phase of the learning cycle is intended to introduce and activate prior knowledge about the cause of severe storms with a focus on how tornadoes form. Students develop initial models, raise questions, and determine how to investigate their ideas.

Advance Preparation
Make copies of the Pre and Post Assessment for your class. See Assessment Section for the assessment and rubric.

Make copies of the Parent Letter and Activities to Do at Home to be sent home.

ESTIMATED TIME
Lesson 1A: 55-60 minutes
Lesson 1B: 55-60 minutes

LESSON LEVEL LEARNING GOALS:

Raise questions about the cause of tornadoes and other severe weather events.

Develop an initial model that explains their ideas of the cause of the outbreak of tornadoes in 2014.

MATERIALS NEEDED

For each student:
- Student pages

For each group of 4:
- chart paper/white boards
- markers
- Post-It Notes

For the class:
- Internet access

Teacher Provides:
- Chart paper/white boards
- Markers
- Post-It Notes
- Internet access

LESSON 1A

ESS2.D: Weather and Climate

- **Weather** and climate are **influenced by interaction 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-ESS2-6)
- **Because these patterns are so complex, weather can only be predicted probabilistically.** (MS-ESS2-5)
- **The ocean exerts a major influence on weather** ~~and climate by~~ **absorbing energy from the sun,** ~~releasing it over time, and globally redistributing it through ocean currents~~. (MS-ESS2-6)

TEACHING TIP

The use of the What We Think chart is an important tool for students to recognize the storyline and progression of their learning. It serves as a driving question board and activity summary board. Students have a record of the progression of their changing ideas and reference for past ideas and new ideas. The What We Did column is a record of the Science and Engineering Practices the What We Figured Out column is a record of progress toward the Disciplinary Core Ideas and Crosscutting Concepts.

Prepare for a space for Science Talk so all students are standing or sitting in a circle and have eye contact with one another. (See Science Talk and Developing Effective Questions in the Appendix.)

Prepare a space for a What We Think Chart that includes the driving question and an activity summary table. Plan to have the chart visible throughout the activities that relate to the severe weather phenomenon, climates and climate change.

Example: What We Think chart

What We Think	Questions Do We Have and How Can We Find Out?	What We Did	What We Figured Out	How Does This Help Us to Figure Out the Phenomenon?
Student initial ideas about how tornadoes and large storms form and move across the land	Student initial questions about how tornadoes and large storms occur	Description of what students did (related to the science and engineering practices).	New information as a result of the lessons	Application of new findings to phenomenon.

Preview the 2014 Tornado web sites and choose the ones appropriate for your class.

https://www.youtube.com/watch?v=DyoaahdISmc&list=PLnJCWwLNioIDgCDCeAOrcB8FL_Nonr7Vf&index=21&t=975s

https://www.youtube.com/watch?v=EEDnx4pWD0s&list=PLnJCWwLNioIDgCDCeAOrcB8FL_Nonr7Vf&index=18&t=218s

https://www.youtube.com/watch?v=WH1fImZvs_o&list=PLnJCWwLNioIDgCDCeAOrcB8FL_Nonr7Vf&index=23

https://www.youtube.com/watch?v=Dwy-mlQAOG4&list=PLnJCWwLNioIDgCDCeAOrcB8FL_Nonr7Vf&index=41

https://www.youtube.com/watch?v=1HTD3kTXP-w&list=PLnJCWwLNioIDgCDCeAOrcB8FL_Nonr7Vf&index=5

https://www.youtube.com/watch?v=ZlzJ7VbMQZQ&list=PLnJCWwLNioIDgCDCeAOrcB8FL_Nonr7Vf&index=3

https://www.youtube.com/watch?v=vhKjv9GuARQ&list=PLnJCWwLNioIDgCDCeAOrcB8FL_Nonr7Vf&index=1

https://www.youtube.com/watch?v=XT7CtF5ljxY&list=PLaS1BuqVDyKnwM6qVR3gh8a-g3vN2qwkT

Write one of the following headings each at the top of four pieces of chart paper to make classroom anchor posters.

Asking Clarifying Questions
Asking a Probing Question
Adding to an Idea
Respectfully Disagreeing with an Idea

Lesson 1A: A Stormy Day in the South

Procedure

Engage the learner

Begin the lesson by asking the students to observe a video about a severe weather event. Show the video of the 2014 tornadoes. Allow sufficient time for students to jot down thoughts, questions, and ideas in their Student Journals as the watch the video.

Record your ideas and questions about your observations of the severe weather event. Include key terms and ideas that you think are important to understanding the phenomenon.

Observations	*Questions*

Divide the class into groups of four students. Ask students to share their observations and questions from the video. Encourage students to add to their own ideas with ideas from their classmates. Facilitate the sharing of information and ideas by circulating among the groups and listening to their initial responses to the video. To help students elaborate on their explanations, ask:

- _____ I heard you use the term _____. Can you say more about that?
- Can anyone add to _____'s idea? Do the rest of you agree? Why or why not?
- What observations do you have in common? Why do you think that was important to write down? What makes you think that?
- What are some of the most interesting observations that popped up in your conversation? What questions did the observations raise?
- What is the most common question about the video within your group? What do you think is important about finding out about _____? How might we find out?

Read the prompt on the Activity Page as a class. Ask students to work individually first, and develop a model of their thinking. Discuss the use of a model to describe unobservable mechanism that work together to form severe weather. Ask students to be prepared to share their individual models and work as a group to develop one model that reflects the thinking of the group.

ESS2.C: The Roles of Water in Earth's Surface Processes

- **The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.**
- ~~Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.~~

TEACHING TIP

If some of the provided links are disabled, conduct a Google search using "April 2014 Tornado Outbreak." If your area or a nearby area has recently experienced a tornado, use the videos and weather warnings that are closer to your students' experiences. They can also be used in combination with the 2014 tornadoes.

TEACHING TIP

Listen for ideas that relate to the formation of tornadoes and severe weather events. Carry a clipboard and pen and make a note of terms students use, questions, and ideas that relate to weather conditions before the outbreak of the storm. Make note of their initial ideas regarding the radar and what the symbols and colors represent.

Some students may mention that they have heard that the number and strength of severe storms may increase with climate change. Make a note of their comments and refer to them again when raising questions.

DEVELOPING AND USING MODELS

Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.

- **Develop and use a model to describe phenomenon. (MS-ESS2-6)**
- **Develop a model to describe unobservable mechanisms.**

SYSTEMS AND SYSTEM MODELS

- Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. (MS-ESS2-6)

TEACHING TIP

If your class is new to developing and using models to explain their thinking, take time to discuss the use of models to represent ideas that explain phenomenon. Discuss how models can be used to make the unobservable components of a system (storm cell), visible. Allow time for the groups to discuss the components that they cannot see but are important in understanding their ideas. Do not lead their thinking at this time.

Work with your group and use the space provided to draw and label a model that explains the severe weather in the video. Include the unobservable mechanisms that help explain the phenomenon. Share your ideas with your group to develop a group model that includes ideas from all members.

After the groups have brainstormed their collective ideas, distribute chart paper or white boards and markers to each group. Allow sufficient time for students to collaborate and develop their models. Circulate among the groups to monitor their progress and listen to their exchange of ideas. Do not offer suggestions or information at this time. Make a note of key ideas and questions to revisit when raising questions and during Science Talk.

After the groups have had the opportunity to complete their initial models, ask the groups to display their models around the room.

In order to conduct friendly, nonthreatening critiques, as a class establish some guidelines and rules for their critiquing methods.

Ask students to create four anchor posters that will guide the class throughout the unit when sharing ideas. Display the four charts with the questioning and critiquing categories. As a class, have students suggest how they might start a question that asks a group to clarify, probe or dig deeper, disagrees, or adds to an idea. It is important for success in student-to-student interactions for the anchor charts to be developed by the students.

After the completion of the anchor questioning charts, conduct a gallery walk. Allow time for each group to make observations of the different models. Encourage students to look for common components that are in each of the models.

Sample charts:

Respectfully Disagreeing With an Idea

- I agree with… but…
- I disagree with… because…
- I agree with part of your model but disagree with this part…
- I respectfully disagree because…
- I understand where you are coming from, but I have a different idea.
- I agree with you but also think…
- I see your reasoning, but I disagree with some of the ideas because…

Asking a Clarifying Question

- What do you mean by…?
- Can you be more specific about…?
- What makes you think that?
- What evidence do you have that supports that?
- How do you know?
- Can you tell us more about…?
- What do you mean by…?
- So are you saying…?

Asking a Probing Question

- What do you mean by…?
- What makes you think that?
- If that were true, then wouldn't _____ be true?
- Where did you get this idea?
- How did you come up with…?
- What is your evidence?
- Why is _____ important in your model?
- Can you say more about…?

Adding to an Idea

- I agree with you, but also…
- I would like to add…
- I agree but also think…
- I agree with this part, but could you add…?
- Do you think adding _____ would make it more clear?
- I agree but have an idea that might add more clarity or information.
- Would it make it more clear if you added…?

Science Talk

After the groups have completed the gallery walk, ask them to bring their models and sit in a circle and share their ideas. Begin the student-to-student conversation by asking if anyone noticed a component that was included in all or most of the models of tornadoes. Ask a student to explain why his/her group found it important to include the component in the model. To help students listen carefully and think with others, ask:

- Who can repeat what _____ just said or put it into their own words?
- Can someone add to that idea?
- Do you agree? Why or why not?
- Can anyone take _____'s idea and expand on it?
- Did anyone else notice that some of the models included_____. Can someone say more about that?
- How does _____ help us to explain the outbreak of tornadoes?
- Does it always work that way?
- Who can add on to that idea?

Conclude the Science Talk by acknowledging everyone's effort in developing and critiquing models. Assure the groups that in following lessons they will be given the opportunity to make revisions and additions to their models.

Display the What We Think chart. Explain that the class has modeled and discussed their initial ideas about tornadoes and how they form and the class will be using the What We Think chart to keep a record of their initial ideas and new understandings as the lessons progress. Take this time to have students use their ideas from their notes in the Student Journals and models to make a list in the What We Think column.

TEACHING TIP

The anchor posters are developed and worded by the students. The samples listed are ideas that should be expressed in students' own words. Students may have additional ideas that are not listed in the samples. Welcome all ideas that are applicable to a friendly, nonthreatening contribution to the sharing of ideas. The anchor posters should be displayed in the classroom for the entire unit.

SCIENCE TALK

Science Talk is a conversation among the students that allows them to have the opportunity to orally express their ideas and listen to the ideas of others. Allow sufficient time for each student to express ideas and opinions. Create a classroom culture where all ideas are respected and considered.

Science Talk is not an add-on to science investigations. It addresses important science content and is a critical part of the lesson and learning. Science Talk can be whole group, small group and teams of two students. Through discussion with one another, students explore their ideas, make comparisons to the ideas of others, use evidence, and develop the skills to critique and prepare academic arguments. See Appendix, pp. 212-213 for Setting up your class for Science Talk.

TEACHING TIP

The five-column What We Think chart is an important tool in making the storyline and progression of learning visible to the class. It serves as a record of their new knowledge as well as changes to their previous thinking.

If using Google Docs or another electronic posting platform, have students in each group post their initial ideas and questions in the document you have created and shared. Be sure to monitor the student postings to avoid duplicates and/or inappropriate comments.

Continue with the Questions We Have column and explain that the class still has questions about tornadoes and how they form that need to be answered. The chart will help the class keep track of their questions and when and how they have answered their questions.

To help the students collaborate to raise questions, ask them to return to their groups and use their Activity Page and models to develop as many questions they can think of about tornadoes. Distribute Post-It Notes to each group. Ask students to use scrap paper or Student Journals and write as many questions as they can think of about tornadoes and severe weather events. Then collaborate to find 4-5 of the most pressing questions. As a class categorize the questions. Categories for questions may include:

- Cause
- Location
- Rotation
- Strength/Force
- Radar
- Predicting
- Safety/Precautions
- Damage/destruction
- Climate change

To facilitate the categorizing of questions, ask a group to read one of their questions and place it on the Questions We Have column. Ask if anyone has the same or similar questions. Ask the groups to read their similar questions and decide on a category for the questions and invite all similar questions to be posted on the column in proximity to one another. Write the category on the chart. Continue until all questions are acknowledged and categorized. (see Example on page 49)

Your students may have similar and different questions from the example chart. Raising and categorizing questions as a class is an important process for students to undertake to give them the sense that they are investigating what is real and relevant to them. The chart is merely a sample. Your students' questions may include many more questions and questions that relate to your location.

Listen for students that mention that they have heard that number of severe storms, such as tornadoes and hurricanes will increase with climate change. Encourage discussion and questions about climate change and assure students that they will take a deeper look into what they have heard and what scientists are investigating to figure out the challenge of climate change. Inform the class that at the end of the unit they will have gathered sufficient information to hold a climate change conference to carry out a plan of action to reduce the threat of climate change.

Example:

ASKING QUESTIONS AND DEFINING PROBLEMS

Asking questions and defining problems in 6-8 builds on K-5 experiences and progresses to specify relationships between variables, clarify arguments and models.

- **Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and or seek additional information.**
- Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5)

CAUSE AND EFFECT

- Cause and effect relationships may be used to predict phenomena in natural and designed systems. (MS-ESS2-5), (MS-ESS3-4)
- ~~Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (S-ESS3-3)~~

TEACHING TIP

As the unit progresses and questions are answered, move them from the Questions We Have Column to the What We Figured Out Column. Students have the opportunity to see the progress toward answering student generated questions.

LESSON 1A

FORMATIVE ASSESSMENT

The artifacts and components used for assessment in the beginning lessons serve as a formative assessment to guide instruction in following lessons.

For example, do initial models include the role of the solar heating by the sun, heating of the ocean and ocean currents, oceanic and atmospheric flow patterns, warm and cold air masses, and how winds develop? Missing and some existing components in their initial models are addressed in the following lessons.

TEACHING TIP

The class may need considerable coaching to develop a single question that drives the entire unit. If they reach a consensus on two questions (weather, climate and climate change) post both questions for the unit.

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)

Science Talk

Take this opportunity to engage the class in a Science Talk to discuss students' ideas and concerns about what they have heard about climate change. Ask students to come to the circle and engage in conversation about what they have heard, what they are currently doing to slow climate change, as well as, what they think needs to be done.

Review the anchor charts and guidelines for respectfully engaging in conversations. Refer to the questions about climate change on the What We Think chart to being the conversation. Example:

- _____, I think you raised the question about the relationship between more frequent and stronger storms due to climate change.
- Can you say more about what you heard?
- Can anyone add to _____ idea?
- What do you think about what _____ said?
- Would anyone like to share some ideas of actions we can take?
- How can we learn more?

After students have had the opportunity to share their ideas, ask what more they would like to know about climate change and add their ideas to the What We Think chart. Assure students that at the end of the unit they will plan to take action.

Explain that the chart is going to remain visible for the remainder of the unit and that as new questions and categories develop, they will be added to the chart. Explain that as the lessons progress, the class will periodically review their initial questions, add new questions, decide which questions have been answered, and what questions remain to be investigated.

Take this opportunity to develop with the class the over-arching Driving Question that will drive the following lessons. The Driving Question should be broad enough so that the individual questions are incorporated into the broader question. The Driving Question may include questions similar to the following:

- How do severe weather events occur?
- What causes day to day weather and severe weather events?
- What causes the different weather conditions, including the day to day weather and severe weather events?

Ask the students for their ideas of how they can find out more information about the formation of severe weather outbreaks like the tornadoes they observed in the video. Listen for ideas that relate to investigating what drives the weather in different regions and digging deeper into some of the terms and explanations that were referred to in their models and the tornado video.

Assessment: Formative

Use the initial models to assess the students' ability to develop and use a model to explain phenomena and include the unobservable components. (Developing and Using Models)

Use the initial models and Science Talk to assess the students' initial understanding of how weather and severe weather events are influenced. (ESS2.D, MS-ESS2-6)

Lesson 1B: Weather is For Today

Teacher Background Information
To gain a deeper understanding of the weather and severe weather, students begin to collect daily weather data and find trends and patterns in weather. Weather data collection includes daily air temperature, wind direction and speed, cloud cover, humidity, precipitation, and barometric pressure. With the Internet, newspaper, television, and radio, the weather data is easily accessible and updated on a regular basis. As a class, decide how the weather data is to be investigated and collected. Will the class take actual measurements in the schoolyard, create a weather station in the classroom, or rely on the local weather station to supply an approximate temperature for the area?

Students should also be aware that the weather not only changes from day to day but also throughout the day. The weather that they experienced at 7:30 a.m. may be very different than the weather at noon or 3:30 p.m. The key question in gathering data is what changes the weather throughout the day and from day to day? The local television weather broadcast provides the opportunity to become aware of some of the key terms used in defining and predicting weather. Weather broadcasts report the temperature, precipitation, barometric pressure, humidity, location of cold and warm fronts, and high and low pressure systems.

Through weather data collection over a period of time, students begin to recognize patterns and relationships between different weather phenomena. For example, students may recognize a relationship between wind direction, temperature, and humidity. When the wind is from the south the temperatures are generally warmer and humidity is high. The opposite is the pattern when the wind is from the north. The collection of data and recognition of patterns is intended to inspire students to raise questions as to why these patterns occur and what drives the wind and movement of air and air masses. The understanding of weather will provide a deeper foundation for the circulation of air and ocean currents that affect weather and climates.

Explore the concept.
During this phase of the learning, students explore the different weather conditions, how they are formed and measured. Students explore how the sun, ocean, atmosphere and landforms influence weather.

Advance Preparation

Preview a weather report from your local news station. The purpose of the video is to provide information to help students begin to think about their current ideas regarding the elements that make up the weather and continue to raise questions regarding weather phenomena.

MATERIAL NEEDED
For each student:
- student page

For the class:
- outdoor thermometer
- anemometer
- barometer
- rain gauge
- hygrometer
- weather vane
- note cards, 5x8
- handout: *Daily Weather Observation Log*

Teacher provides:
- chart paper
- markers
- graph paper

ESS2.D: Weather and Climate

- **Weather** and climate are i**nfluenced by interaction 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-ESS2-6)
- **Because these patterns are so complex, weather can only be predicted probabilistically.** (MS-ESS2-5)
- **The ocean exerts a major influence on weather** ~~and climate by~~ **absorbing energy from the sun,** ~~releasing it over time, and globally redistributing it through ocean currents~~. (MS-ESS2-6)

LESSON 1B

TEACHING TIP

If students do not suggest collecting and recording weather data over a period of time, provide prompts to get the students to ask the question and make suggestions. Example:

- What data and equipment do meteorologists use to forecast the weather?
- What are they looking at and using to give us a 7 day or even 10 day forecast?
- Can we replicate some of the information the meteorologist uses?

Check for student ideas that relate to patterns and trends in weather over a period of time.

Determine a local weather station to access online daily to assist the class in daily weather observations. Determine how you will display and store the *Daily Weather Observation Log* for each class. Make copies of the *Daily Weather Observation Log* for the class.

Remove the barometer and hygrometer from the stand. Assemble the weather vane and anemometer. Display the weather instruments on a materials table.

Procedure

Explore the concept.

Review with the class their ideas from the previous lesson of how they can gain a deeper understanding of weather, what causes different weather patterns and severe weather events. Refer to the student generated questions on the What We Think chart. Ask the students to explain what they think the term *weather* means. Ask, How would you describe the weather right now? Make a list of weather conditions described by the students. Discuss the severe weather in the video and ask students what they think the weather might have been like the day before or the day after and even consider the weather hours before and hours after. Ask the students what they need to figure out before they can completely explain the severe weather. Ask:

What could we do to figure out what causes weather to change from day to day and severe weather events?

Ask a student volunteer to describe the weather outside today and then try to recall the weather the day before and then two days before and identify a specific change in the weather. Ask students why they think that change occurred.

Show the daily weather video from your local weather channel or Weather.com. Have students make observations of the hour-by-hour forecast and 10-day forecast on Weather.com.

http://www.wwmt.com/weather (Battle Creek, Kalamazoo, MI)

http://www.woodtv.com/weather (Grand Rapids, MI)

http://www.weather.com

Ask students to record in their Student Journal different weather related terms used by the meteorologist and questions regarding the forecast.

1. *Watch the weather video with your class. Write the different weather terms the meteorologist used in the forecast.*
2. *Write questions you have about the terms and forecast.*
3. *Describe the trends in weather data in the hour-by-hour forecast.*
4. *Describe one change in the weather pattern you observed in the 10-day forecast.*

Discuss the terms that the meteorologist uses to describe the weather forecast. Example terms: system, front, low pressure, high pressure, precipitation, temperature, seasonable, clouds, wind speed, wind direction, wind chill, dew point, barometer, barometric pressure.

Ask students to share the questions they recorded in their Student Journals regarding the weather report. Example questions:

- What is a front? How do fronts form?
- What does the meteorologist mean by the term air mass? What is a weather system? How does it form?
- What caused the wide range of temperatures across the region? C
- What is a low pressure system? What is a high pressure system?
- What makes weather systems move?
- What is El Nino?
- What makes the clouds build and go away?
- What is humidity? How is it related to dew point?
- How do they measure the humidity? dew point? pressure?
- What causes the weather to change?
- What components in the atmosphere, hydrosphere, and geosphere cause different weather conditions? CC

Have students add any additional questions to the What We Think chart from Lesson 1A for reference throughout the unit. Create new categories if necessary.

Students figure out from the forecast and exploration of the local weather report that wind (speed and direction), precipitation, atmospheric or barometric pressure, temperature, cloud cover, and humidity are recorded in most daily reports. Explain that since these weather conditions are reported and recorded every day and throughout the day, they must be important in forecasting weather. Ask:

- How do they measure the important conditions?
- How can we measure the weather conditions here at our school?

Ask students how the class can plan an investigation to find out patterns in the daily changes in weather and answer some of their questions. Listen for ideas that relate to keeping track of day to day weather conditions. To help the class develop ideas for investigation, revisit the student questions and observations of changes in the weather. As students mention different weather conditions, such as barometric pressure, ask if they know how a meteorologist measures the barometric pressure and what is being measured? If students do not suggest collecting and recording data over a period of time, ask:

- Can someone describe the question we are trying to answer?
- What information do we already have?

TEACHING TIP

The teacher role in helping students develop ideas for investigation relies on drawing ideas from students using Science Talk and Developing Effective Questions (See Appendix pp. 212-213) and not introducing or suggesting investigations.

If students do not suggest collecting and recording data over a period of time, ask:

- What do you need to find out?
- What do you already know?
- What information do you need?
- What materials do you need?
- How will you collect data?

CAUSE AND EFFECT

- Cause and effect relationships may be used to predict phenomena in natural and designed systems. (MS-ESS2-5), (MS-ESS3-4)
- ~~Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (S-ESS3-3)~~

LESSON 1B

TEACHING TIP

Students may struggle with planning an investigation that answers the question of how severe weather events occur and how they are predicted. Encourage students to break down the larger question into smaller questions related to the different weather data that is collected by meteorologists over a period of time.

To help students that are stuck, ask:

- Why do you think it is important to record the temperature every day or even every hour?
- Why do most weather reports tell you the air pressure?
- The weather report tells me the wind speed and wind direction, why do you think that is important?

Check for understanding that there are important weather conditions that are monitored and can be used for forecasting future weather events.

Patterns

- Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)

- I heard _____ say that it might be helpful to collect data about the _____. How might that help us to find out how severe weather events occur and how we know severe weather is approaching?
- What do we need to carryout our investigation?
- How will we collect data?
- What tools or equipment will we need?

Students may suggest investigating changes in one particular component of the weather, such as wind or barometric pressure. Acknowledge all ideas and ask students how that information might help them answer their questions and provide a complete picture in weather data.

As students begin to develop ideas for investigation, have them share ideas and look for common investigations to develop a class investigation.

Explain the concept and define the terms.
Discuss what weather conditions were important in the weather forecast and the forecasts that we hear every day. Students figure out from the forecast that wind speed and direction, precipitation, atmospheric pressure, and temperature are included. Discuss why these conditions are important in a forecast and ask how they measure these conditions. Ask students how they could collect data and measure these conditions at the school. Listen for suggestions that they would need different weather instruments.

At this point in the planning of the investigation, display the different weather instruments and allow time for students to explore and discuss the use of the instruments and how they might be useful in their investigations.

Ask the students to form 6 groups. Distribute one weather instrument and six note cards to each group (thermometer, anemometer, barometer, rain gauge, hygrometer, weather vane). Ask the groups to discuss their initial ideas about the instrument and what it is used to measure. Give the groups sufficient time to discuss and record their ideas for the instrument on a note card. After the groups are satisfied with their recording, have them change weather instruments until all groups have discussed and recorded their ideas about all 6 instruments.

Facilitate the exploration of the weather instruments by circulating among the groups and listening to their ideas. To check student progress and encourage brainstorming related to the key question, ask:

- Can someone explain what you have discussed so far?
- How do you think the instrument is related to measuring the weather?

- How might recording the _____ over a period of time help us to explain how weather changes from day to day? CC
- How would a pattern in the data provide information about the weather? CC
- What are some other possibilities?
- What background information do you have that relates to measuring weather phenomena?
- How might this relate to changes in weather? CC

Ask the groups to share their recordings on the note cards as they relate to each weather instrument. Encourage groups that have new or different ideas to explain their reasoning. To encourage collective thinking and argumentation, ask:

- What do you think about what _____said?
- Do the rest of you agree? Why or why not?
- Does anyone have a different answer or idea?
- Does anyone have the same idea but a different way to explain it?
- Can you explain why your idea makes sense?
- What more do you need to find out?
- How might this relate to how the weather changes from day to day?

Write the name of each weather instrument on the board and with student consensus describe the function of each instrument and the units used in measurement. Relate the weather instruments to what the students think the instruments are measuring. Check for understanding that they are measuring different conditions in the atmosphere.

Example:

Thermometer/temperature: The temperature is a measurement of how fast the molecules in the air are moving. The faster the movement the greater the temperature.

Barometer: The barometer measures the air pressure.

Hygrometer: The hygrometer measures the amount of water vapor in the air.

Anemometer: The anemometer measures the wind speed.

Rain gauge: The rain gauge measures the amount of rainfall.

Weather vane: The weather vane measures the wind direction.

Elaborate on the concept.
Knowing that they have the set of weather instruments, ask the students to reach a consensus as to how they can set up a classroom weather station and collect weather data over a period of time to investigate patterns in weather conditions. Ask students to determine where the instruments are to be placed, how often during the day

TEACHING TIP
Teaching multiple classes in a day will require some collaboration among classes. All classes will need to go through the process of recognizing the important weather conditions that are consistently reported, determine that the class could collect data over a period of time, explore the different weather instruments, and decide how they can use the equipment to set up a classroom weather station.

Each class will record the different weather conditions at different times of the day, providing further data to look for patterns and trends.

Planning and Carrying Out Investigations

Planning and carrying out investigations in 6–8 builds on K–5 and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)

readings are to be recorded and the manner in which you will record and display the daily recordings. Discuss the importance of recording data at the same time every day. Provided in this unit is a blackline master of the *Daily Weather Observation Log* if your class chooses to keep a class log. (See Handouts)

As a class, determine the question they are investigating, what they think will happen, how they will set-up the investigation, materials they will use, and how they will record and collect data. Have them record the class ideas for the investigation in the Student Journal.

Class Investigation Report:

1. *Write the question you are investigating.*
2. *Write what you think you will find out.*
3. *List the materials you will use.*
4. *Draw and write how you will set up the investigation.*
5. *Make a chart to record your data. Determine how you will make observations.*

Determine student/team responsibilities for taking readings and recording them in the log. Review each weather instrument and instruct students how to take accurate readings from each. As a class, make the first entries in the log for the day.

Summary Discussion
Evaluate the students' understanding of the concept.
Return to the What We Think chart Lesson 1A. Discuss how the information from the weather instruments will help them to gain further knowledge about how tornadoes and other severe weather events occur. Discuss students' early ideas about trends in data and the relationship between the different weather phenomena they are recording.

Pre writing Strategy: Science Talk
Allow sufficient time for students to orally discuss their ideas for the response to the Journal Entry. Encourage students to discuss their points of view and listen to the ideas of their classmates.

Have the students complete the Journal Entry in the Student Journal.

Journal Entry
1. *Make a chart and record the weather data collected today in the classroom.*
2. *Write how you think daily weather data will help to determine how the weather changes from day to day and sometimes within a day.*

Assessment: Formative
Use the Science Talk and Journal Entry to assess the students' ability to describe weather data.

APPENDIX

ENGINEERING DESIGN PROCESS

The Engineering Design Process provides students with a series of steps to guide them as they solve problems and design and test products, models, and solutions. The process is cyclical, yet not necessarily in an order. Students are encouraged to evaluate as they progress through the process, revisit the mission often, and revise thinking and their plan multiple times as the process unfolds.

Engineers do not always follow the Engineering Design Process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change the design. Engineers must always keep in mind the mission or problem they are trying to solve and the limitations (cost, time, material, etc.) that are part of the solution to the problem. Two key elements in working as an engineer are teamwork and design-test-and-redesign.

Mission
- Defines the problem and what the engineers are trying to design or build.
- Describes the limitations within which the engineers must solve the problem.

Brainstorm Ideas
- Imagine, discuss, and sketch possible solutions.
- Conduct research into what has already been done.
- Discover what materials are available, time frame, and other limitations.

Plan and Design
- Draw and write a plan.
- Design your solution through drawing and manipulating materials.
- Develop a plan or steps and a schedule.

Build
- Construct your engineering device or project.
- Follow your plan.
- Adjust and test along the way.

Test and Adjust
- Test your device to see if it solves the problem within the mission and limitations.
- Make your project better based on tests: Test → Revise → Test.
- Improve based on feedback of others.

Present Your Solution
- Demonstrate how your solution solves the problem.
- Define problems and limitations.
- Describe the challenges and limitations in solving the problem.
- Describe additional revisions that could improve the device or project.

CEREAL CITY SCIENCE by BCAMSC

ENGINEERING DESIGN PROCESS

by Battle Creek Area Mathematics and Science Center
Cereal City Science
Adopted from the Carnegie Mellon Robotics Academy

CEREAL CITY SCIENCE by BCAMSC

Student Journal
MS.ES.NGSS

Weather, Climate, & Human Impact MSENG2

A Middle School Unit supporting Next Generation Science Standards and Michigan Science Standards

Name:

Name: _____

ACTIVITY **1A**
Severe Weather

Date: _____

Record you ideas and questions about your observations of the severe weather event. Include key terms and ideas that you think are important to understanding the phenomenon.

Observations	Questions

Name: _____

Date: _____

Work with your group and use the space provided to draw and label a model that explains the severe weather in the video. Include the unobservable mechanisms that help explain the phenomenon. Share your ideas with your group to develop a group model that includes ideas from all members.

Individual Model:

Name: _____

Date: _____

Ideas for group model:

1B ACTIVITY
Weather is For Today

Name: _____

Date: _____

1. Watch the weather video with your class. Write the different weather terms the meteorologist used in the forecast.

2. Write questions you have about the terms and forecast.

Name: _____

Date: _____

3. Describe the trends in weather data in the hour-by-hour forecast.

4. Describe one change in the weather pattern you observed in the 10-day forecast.

Name: _____

Date: _____

Class Investigation Report:

1. Write the question you are investigating.

2. Write what you think you will find out.

3. List the materials you will use.

Name: _____

Date: _____

4. Draw and write how you will set up the investigation.

Name: _____

Date: _____

5. Make a chart to record your data. Determine how you will make observations.

Name: _____

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Weather is For Today **1B**

Date: _____

1. Make a chart and record the weather data collected today in the classroom.

2. Write how you think daily weather data will help to determine how the weather changes from day to day and sometimes within a day.

K E Y T E R M S Name:

Date: