Project-Based Inquiry Science: Weather Watch
Storyline

Targeted Performance Expectations:
· MS-ESS2-4 · MS-ESS2-5 · MS-ESS2-6 · MS-ESS3-2 · MS-ETS1-4

Weather Watch: What's the Big Challenge?
Develop a Plan to Respond to a Severe Weather Event

Storyline	Science and Engineering Practices	Crosscutting Concepts
In the *Introduction* to *Weather Watch*, students are introduced to the *Big Challenge: Develop a plan for responding to a severe weather event*. Students briefly read about severe weather and then watch a video that shows several types of severe weather. Through a set of discussion questions, students begin to consider the severe weather they saw in the video and the types of severe weather that might happen where they live. They share these ideas and create the *Project Board* to make their prior knowledge public.	**Developing and Using Models** (physical model of a vehicle is used to describe, predict, and explain motion and friction) **Planning and Carrying Out Investigations** (building on the videos students begin to consider what they need to investigate) **Obtaining, Evaluating, and Communicating Information** (videos of weather events are watched and evaluated) **Asking Questions and Defining Problems** (students create the *Project Board* and add what they think they know and questions they would like to investigate)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Weather Watch: Learning Set 1
What Is Weather, and How Is It Measured and Described?

Storyline (with Disciplinary Core Ideas and Science Content)	Science and Engineering Practices	Crosscutting Concepts
Introduction to *Learning Set 1* and *Section 1.1*: In the introduction to *Learning Set 1*, students begin to consider the effects of a severe weather event and that they must consider, *What is Weather?* and *How is it Measured and Described?* As students move into *Section 1.1*, they begin by working in small groups and becoming experts at one location in the U.S. by making observations and looking for patterns in a series of weather maps. They focus on the critical features of weather, including precipitation and the movement of fronts. Through analysis of detailed maps and tables of weather information, students begin to pinpoint patterns in weather across the U.S. Because each group has become an expert on one location and the other groups have not analyzed the information at that location, all groups share to help the class see the patterns and trends at each location. To help students synthesize the information from the maps and tables, they engage in a reading about air pressure and wind as well as the work of meteorologists and climatologists. Following the reading, students update the *Project Board* to help all students better understand the variety of terms that have been introduced.	**Developing and using Models** (maps are models for the types of weather and the movement of weather patterns across the U.S. students use the maps to make predictions and explanations **Planning and Carrying Out Investigations** (investigations of maps support the development of general ideas about weather patterns) **Analyzing and Interpreting Data** (data provided on weather maps and is analyzed for trends and patterns)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Section 1.1 (continued) **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)	*Section 1.1 (continued)* **Obtaining, Evaluating and Communicating Information** (air pressure and changes in air pressure support making explanation about weather patterns) **Constructing Explanations and Designing Solutions** (initial explanations about weather patterns are created)	*Section 1.1 (continued)*
Section 1.2: Now, students collect their own weather data using five different weather instruments. Each group builds one instrument, identifies where it should be placed to collect accurate data, and shares their plan with the rest of the class. The class then places the instruments outside and collects data for five days, recording the data daily and keeping careful records. **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)	**Planning and Carrying Out Investigations** (using the weather instruments they design and place to collect weather data over five days) **Analyzing and Interpreting Data** (collected weather data is analyzed) **Asking Questions and Defining Problems** (challenges around the design, build and positioning of weather instruments are solved)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 1.3: Students are introduced to the climate regions in the U.S. and notice that each of their expert areas are in one climate region. Using these expert areas, students build on their understanding by analyzing data tables and maps to focus on trends in temperature and precipitation over 12 months. These analysis experiences also help students begin to define weather compared to climate. **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)	**Analyzing and Interpreting Data** (multiple maps and data charts provide information about regional weather) **Obtaining, Evaluating, and Communicating Information** (reading maps and descriptions) **Asking Questions and Defining Problems** (ask questions about the causes and movement of weather patterns)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 1.4: After collecting weather data for five days, students begin to analyze the data and explore maps and additional weather data to better understand the trends and patterns in the data they have collected. To support their developing understanding of weather patterns, students now read about fronts and air masses and track these weather components on additional maps. These ideas lay the foundation for weather prediction in the following lessons. Students add this understanding to the *Project Board*. **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)	**Analyzing and Interpreting Data** (data from weather instruments is analyzed and compared to maps) **Obtaining, Evaluating, and Communicating Information** (reading about fronts and air masses) **Constructing Explanations and Designing Solutions** (initial explanations about weather causes and prediction are added to *Project Board*)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Back to the Big Challenge: As they return to the unit's *Big Challenge*, students now have access to a great deal more information about weather and weather patterns. In this section they begin to identify factors that indicate potential of severe weather. They also have begun to differentiate between weather and climate. They share their ideas in a short discussion and then add their current knowledge to the *Project Board*. **Disciplinary Core Ideas:** **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Engaging in Argument from Evidence** (begin to design their severe weather plan for their region and support their solution verbally) **Analyzing and Interpreting Data** (use data to support their initial explanations) **Constructing Explanations and Designing Solutions** (using local weather information, students begin to better understand the challenges of weather prediction and the motion of weather patterns)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Weather Watch: Learning Set 2 ***Why Are There Differences in Temperature?***		
Storyline (with Disciplinary Core Ideas and Science Content)	**Science and Engineering Practices**	**Crosscutting Concepts**
Section 2.1: Students continue to investigate data for their assigned areas, each section scaffolds data analysis at a new level working toward addressing the *Big Challenge*. Using data presented on colored maps, students begin to explore temperature variation at their regional site. They search for, document and analyze patterns they find in this date and record details on the *Project Board*.	**Developing and Using Models** (colered maps are used to explore temperature variations) **Analyzing and Interpreting Data** (data from colored maps is analyzed for trends in temperature)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Section 2.2: Building on the analyzed date from the previous section, students read about thermal energy and differences in motion at the molecular level caused by changes in thermal energy. They begin to draw together these resources to explore how these ideas might be related to weather. They synthesize their current understanding and then add their ideas to the *Project Board*. **Disciplinary Core Ideas:** **PS3.A: Definitions of Energy** · The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4)	**Obtaining, Evaluating and Communicating Information** (reading about friction following experiences identifying friction on the vehicle) **Planning and Carrying Out Investigations** (data collected leads to questions that can be answered through investigation) **Asking Questions and Defining Problems** (questions about sunlight and the mechanisms for weather movement are investigated with models) **Developing and Using Models** (physical model representing the sun and identifying temperature differences related to angle of Earth) **Planning and Carrying Out Investigations** (carry out investigation to determine affect of angle on the energy received from the Sun) **Engaging in Argument from Evidence** (comparing data from different groups and engaging in scientific argument about causal effect of angles of the Sun) **Analyzing and Interpreting Data** (collected data is analyzed to an-swer the question and then used in subsequent sections) **Obtaining, Evaluating and Communicating Information** (reading about angles supports explaining the collected data) **Constructing Explanations and Designing Solutions** (explanations for differences in temperature are created)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 2.3: Students now build a model that will help them explain the data they have analyzed regarding temperature differences. Using flashlights and graph paper, students investigate multiple angles at which the sun might hit the surface of the earth. They collect, record and analyze the "sunlight" data across the various angles and then share their results with the class. Through questions, discussions and reading, they use their quantitative results to develop an explanation for why some areas of earth have consistently higher temperatures than other areas, based on the directness of the Sun's energy on Earth. **Disciplinary Core Ideas:** **ESS1.A: The Universe and Its Stars** · Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1) **ESS1.B: Earth and the Solar System** · [The] model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)		Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Section 2.4: The initial ideas about angle of the sun hitting the earth now becomes part of the explanation for why temperature varies through the seasons. Using a model, students investigate how the earth moves through space and compare this to the previous exploration related to angle of the sun. In the following exploration students engage in a model that helps them make strong connections between the angle of the earth's tilt to the amount of solar energy that hits parts of Earth. Following a collaborative data analysis opportunity, students write claims that explain the causes of the seasons, support their ideas with evidence and and add their ideas to the *Project Board*. **Disciplinary Core Ideas:** **ESS1.B: Earth and the Solar System** · [The] model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)	**Developing and Using Models** (physical model of how Earth moves through space supports developing explanations about the seasons) **Engaging in Argument from Evidence** (presenting causal explanations about the seasons requires arguing from evidence) **Analyzing and Interpreting Data** (model observations are combined with data from previous activity) **Constructing Explanations and Designing Solutions** (explanation of the cause of the seasons is updated to include additional information) **Obtaining, Evaluating, and Communicating Information** (reading supports the developing scientific explanation)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 2.5: Students obtain additional information about the relationship between the earth's tilt and seasons from a scientific reading. Academic vocabulary is introduced and additional information about the seasons is provided. Students revise their previous explanations to include academic language and other aspects of seasons they think are critical for their explanation. They then update the *Project Board* information to be consistent with their current explanations. **Disciplinary Core Ideas:** **ESS1.B: Earth and the Solar System** · [The] model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)		Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 2.6: The data students have analyzed through *Section 2.5* has supported the trend that they might find warmer temperatures nearer the equator and during specific seasons. The colored maps also indicated that there are temperature differences near coasts that did not fit into the temperature bands. Through an investigation students compare the heating and cooling of land and water and share their data with the class. They use this data to develop an explanation for the differences in coastal temperature trends. After sharing their tentative explanations with the class, groups update their explanations and update the *Project Board*.	**Analyzing and Interpreting Data** (collecting data to support the phe-nomenon that air and water heat and cool at different rates) **Developing and Using Models** (using a model to collect data and create an explanation of differential heating) **Planning and Carrying Out Investigations** (carry out an investigation to collect data) **Constructing Explanations and Designing Solutions** (explaining why differential heating affects weather)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Back to the Big Challenge: Addressing the *Big Challenge* requires students to be very familiar with the region they have been assigned. Students now apply what they have learned about temperatures to identify trends within their region. They then explain these trends, share the explanation with the class and update based on feedback. Claims about the weather in each region and what causes it are added to the *Project Board*. **Disciplinary Core Ideas:** **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Constructing Explanations and Designing Solutions** (explaining how temperature affects the weather in their region)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Weather Watch: Learning Set 3 ***Why Are There Differences in Precipitation?***		
Storyline (with Disciplinary Core Ideas and Science Content)	**Science and Engineering Practices**	**Crosscutting Concepts**
Section 3.1: Students have investigated causes for differences in temperature throughout the U.S., now they will investigate how precipitation varies and identify causes for this variation. Again, using maps that represent data by color, students identify how precipitation varies across their regions and the U.S. They analyze the data, looking for trends in precipitation as well as areas that do not seem to follow the trends. They then update the *Project Board* with this information. **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · Because [weather] patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)	**Analyzing and Interpreting Data** (colored maps are analyzing to find trends in precipitation) **Planning and Carrying Out Investigations** (carry out investigations into several precipitation maps) **Constructing Explanations and Designing Solutions** (tentative explanations are created)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 3.2: Keeping in mind these trends, students explore a precipitation model and start to identify the mechanisms that cause precipitation. They use the data collected from the model and reflect on how the model might represent the larger systems that cause precipitation. **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · Because [weather] patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)	**Developing and Using Models** (physical model of the water cycle is used to show the mechanisms that cause precipitation) **Planning and Carrying Out Investigations** (carrying out the investigation about the water cycle)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Section 3.3: Delving deeper into mechanism, students explore the changes in states of water as it moves from a puddle to the air and then again to precipitation. Students obtain information about how the Sun's energy causes rain. In doing this, they link their understanding of the changes thermal energy causes to energy of molecules and how these changes cause evaporation. Students also read about the states of what are how water changes state. They create a tentative model of the water cycle by drawing a picture of the process of evaporation. **Disciplinary Core Ideas:** **PS1.A: Structure and Properties of Matter** · Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) · In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4) **ESS2.C: The Roles of Water in Earth's Surface Processes** · Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) · 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. (MS-ESS2-5) · Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)	**Obtaining, Evaluating and Communicating Information** (reading about changes in the state of water at the molecular level) **Constructing Explanations and Designing Solutions** (initial explanation of the water cycle is created through a drawing)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 3.4: They use this picture to compare to a more common drawing of the water cycle and also make comparisons to the model they used in *Section 3.2*. After evaluating several representations of the water cycle, students create an explanation about the mechanism that causes the water cycle. The explanation is shared with the class, revised and added to the *Project Board*. **Disciplinary Core Ideas:** **ESS2.C: The Roles of Water in Earth's Surface Processes** · Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) · 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. (MS-ESS2-5) · Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)	**Obtaining, Evaluating and Communicating Information** (reading about changes in the state of water at the molecular level) **Constructing Explanations and Designing Solutions** (initial explanation of the water cycle is created through a drawing)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Section 3.5: Analyzing the trends that they saw in the first maps of the *Learning Set*, students now consider how the mechanisms of the water cycle create the patterns of precipitation shown in the data. As they find differences in precipitation that do not fit the trends, they read about the effect of geography on the mechanisms, specifically related to changes in elevation (mountains). **Disciplinary Core Ideas:** **ESS2.C: The Roles of Water in Earth's Surface Processes** · Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) · 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. (MS-ESS2-5) · Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)	**Developing and Using Models** (water cycle demonstration and diagrams provide a model students use to explain how the water cycle produces precipitation) **Analyzing and Interpreting Data** (observe and evaluate patterns of precipitation data)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Back to the Big Challenge: Again, students return to dig deeper into the map data for their region. They seek trends in precipitation data for their region, looking for differences within the trends that they might be able to explain given their developing understanding of the mechanisms and effects of geography. They explain the cause of the trends and then share these explanations with the class. After all groups have shared, all ideas are added to the *Project Board*. **Disciplinary Core Ideas:** **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Analyzing and Interpreting Data** (using map data trends are described and explained) **Engaging in Argument from Evidence** (sharing data and focusing on the criteria of developing a car that will go straight and far, creating claims about the groups' vehicle and its motion and sharing these ideas with others)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Weather Watch: Learning Set 4
What Other Factors Interact to Cause Weather Changes?

Storyline (with Disciplinary Core Ideas and Science Content)	Science and Engineering Practices	Crosscutting Concepts
Section 4.1: Students have investigated and synthesized their explanations for the effect of precipitation and temperature differences on weather. In *Learning Set 4* they investigate wind and ocean currents and how these factors help to define patterns in weather and make predictions more accurate. Using a historical narrative that describes how people have collected data to better understand wind and ocean currents over time, students realize the importance of these factors in predicting weather, shipping, and exploration. The narrative pays particular attention to the work of Benjamin Franklin in determining the ocean currents in the Atlantic.	**Obtaining, Evaluating and Communicating Information** (historical narrative provides information about the history of science related to wind and ocean currents)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Section 4.2: Having read the narrative, students add questions about wind to the Project Board and begin to explore the mechanism behind wind. Using a model and iterative poster creation, discussion, and reflection, students develop initial claims and then update them as they gather more data. Students' claims begin at the macroscopic level and then additional information is added to be able to explain wind at the particle level. **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · 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-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)	**Asking Questions and Defining Problems** (questions about wind and ocean currents are generated from historical narrative)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 4.3: Weather is also affected by what occurs in the upper atmosphere creating global wind patterns. Students have become experts at a small part of the U.S. weather but have not looked at the weather at a more global scale. Students create a model that would help them to connect global wind patterns. After seeing a demonstration and observing the differences in how cold and warm liquids flow, students make predictions about the pathways of global winds. When students' predictions do not match the previously collected and analyzed data, they use the model to add the movement of Earth. Working in small groups, students create explanations to answer two questions: *What causes Earth's global winds?* and *How do Earth's global winds cause changes in the weather?* After sharing their initial explanations, students revise them. Then they read an academic reading section about global winds and add this information to their explanation and increasing the use of academic vocabulary. They revise their explanations, share them, add additional information and add the claims and evidence to the *Project Board*. **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · 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-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)	**Developing and using Models** (development of model to predict and describe global wind patterns based on temperature data) **Constructing Explanations and Designing Solutions** (creating an explanation about the interaction between temperature and global winds) **Planning and Carrying Out Investigations** (using a model to plan and carry out investigation about global wind patterns) **Engaging in Argument from Evidence** (discussing and describing explanations relating temperature and global winds) **Analyzing and Interpreting Data** (drawing evidence from a variety of investigations and interpreting it relating temperature to global winds)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Section 4.4: Students have identified global wind patterns and the mechanisms that cause them, now they connect this idea to the mechanisms that cause weather and can help explain the trends in changing weather in the U.S. they observed in *Learning Set 1*. Students explore and model convection currents using various temperatures of water and use this as data to map on to different conditions in the atmosphere. As they read about convection currents in the atmosphere, they compare their model to the description of the mechanism on a much larger scale. Again, students revisit their explanations and layer their scientific knowledge of convection currents on to their explanation. They can then return to the maps they analyzed in *Learning Set 1* and explain why the weather patterns move from west to east. Students share their explanations to make them public and then add them to the *Project Board*. **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · 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-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)	**Constructing Explanations and Designing Solutions** (construct explanation about the interaction between convection currents and weather) **Asking Questions and Defining Problems** (about how convection currents create weather patterns) **Obtaining, Evaluating and Communicating Information** (reading about convection currents and the atmosphere connected to weather patterns)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 4.5: This *Learning Set* focuses on global winds and ocean currents. Students now tackle the motion of ocean currents and how this effects weather patterns. Students begin by analyzing what they already know about convention and temperature variations between land and water to make predictions about where heating and cooling should occur. Using colored maps of ocean temperature and additional maps representing currents and gyres as data, students evaluate their predictions against the data. They then recognize the ways their predictions and the data are not matched and search for reasons for some anomalous data. They obtain information about the effect of oceans on weather and climate through a scientific reading and evaluate their current explanations based on the reading. They create an explanation using ocean current and wind data to support the interaction between ocean current, wind patterns and climate. After sharing their explanations students update them and add their explanation to the *Project Board*. **Disciplinary Core Ideas:** **PS3.B: Conservation of Energy and Energy Transfer** The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) **ESS2.D: Weather and Climate** · 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-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)	**Developing and Using Models** (colored maps of ocean data support the creation of explanations of ocean currents effects on weather and climate) **Analyzing and Interpreting Data** (data from maps is analyzed for patterns showing the interaction between ocean currents and climate) **Constructing Explanations and Designing Solutions** (initial explanations relating ocean currents, wind patterns, and climate are created) **Engaging in Argument from Evidence** (adding explanations to the *Project Board*, arguments from evidence are created)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Section 4.6: Critical to addressing the *Big Challenge* regarding a severe weather event is the ability to predict weather. Students apply data from the previous sections to better understand how weather predictions can be made. Through a reading and set of diagrams they identify how large air masses work. They were introduced to the map symbols for fronts and observed their movement in *Learning Set 1* but now investigate the mechanism that causes them. Again, students update their explanations about global winds and ocean current effects on weather, adding what they have identified as ways to predict weather. Building on the explanation, students read about cloud formation and movement, add this information to the explanation, share it with the class and update the *Project Board*. **Disciplinary Core Ideas:** **ESS2.D: Weather and Climate** · 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-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)	**Developing and Using Models** (colored maps of ocean data support the creation of explanations of ocean currents effects on weather and climate) **Analyzing and Interpreting Data** (data from maps is analyzed for patterns showing the interaction between ocean currents and climate) **Constructing Explanations and Designing Solutions** (initial explanations relating ocean currents, wind patterns, and climate are created) **Engaging in Argument from Evidence** (adding explanations to the *Project Board*, arguments from evidence are created)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Section 4.7: Students have information about weather to apply to severe weather. Students revisit the several severe weather occurrences they observed at the beginning of the unit and read more about each. They evaluate what they have read and identify the challenges of predicting severe weather of all types. Students then create an explanation for the prediction of severe weather. **Disciplinary Core Ideas:** **ESS3.B: Natural Hazards** · Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)	**Obtaining, Evaluating and Communicating Information** (reading outlining the challenges of weather prediction requires consideration of predicting severe weather events) **Constructing Explanations and Designing Solutions** (initial explanation of how severe weather can be predicted)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**
Back to the Big Challenge: In the *Big Challenge*, students are asked to create a plan for a severe weather event. Predicting such a weather event is critical for having a plan. As they complete *Learning Set 4*, students return to their region of the U.S. and consider which type of severe weather they think would most likely occur in that region. They create an explanation based on global wind and ocean currents and share their ideas with the class. The *Project Board* is updated as students prepare to address the *Big Challenge*. **Disciplinary Core Ideas:** **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Analyzing and Interpreting Data** (data from regional maps is analyzed for patterns showing the interaction between ocean currents and climate) **Constructing Explanations and Designing Solutions** (initial explanation of how severe weather can be predicted in their region)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**

Weather Watch: Address the Big Challenge Develop a Plan to Respond to a Severe Weather Event		
Storyline (with Disciplinary Core Ideas and Science Content)	**Science and Engineering Practices**	**Crosscutting Concepts**
To prepare for their final planning, students read a play that elucidates the decision making that various people need to do to develop a community wide plan for severe weather. Taking these different viewpoints into consideration, students begin to develop a collaborative plan for addressing a severe weather event in the region they have become experts on. They gather information from a variety of sources, apply what they have learned about the weather in their region, and create a final showcase of their plan. **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) **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Engaging in Argument from Evidence** (in presenting their plans, identification of supporting evidence and arguing from evidence is required) **Constructing Explanations and Designing Solutions** (design solution of a severe weather event plan)	Unit Level: **Patterns** **Cause and Effect** **Systems and System Models**