Course Title:	Content Area:	Grade Level:	Credit (if applicable)
Meteorology	Science	10-12	0.5

Course Description:
Students in this course learn meteorology by developing an understanding of the multiple factors that lead to weather patterns, weather formation and climate. The major topics of study include: Solar radiation, atmospheric moisture and stability, precipitation, air pressure and circulation, air masses and fronts, and changing climates. This course embeds multiple hands-on and virtual lab experiences to enhance students' knowledge and class experience. Students will be expected to maintain a detailed and scientific weather journal, as well as research weather and climate events and share their findings through projects, models, written and/or oral reports and presentations.

Aligned Core Resources:	Connection to the ***BPS Vision of the Graduate***
Grade 6 Science-Destructive Weather Physical Science-The Year without Summer	Critical Thinking and Problem Solving
Additional Course Information: ***Knowledge/Skill Dependent courses/prerequisites***	**Link to *Completed Equity Audit***

Standard Matrix

District Learning Expectations and Standards	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales ~~to form continental and ocean-floor features.~~						X		
HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.	X							X
HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	X	X		X	X		X	X
HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.		X		X	X		X	
HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere								X

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.	X							
HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.								X
HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	X						X	X
HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.								X
HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.		X						
HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.		X						
HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).			X	X				
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*			X	X				
HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.			X					
HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.						X		

Unit Links

Unit 1: Introduction to Meteorology and Atmospheric Science
Unit 2: Solar Radiation

Unit Title:
Unit 1: Introduction to Meteorology and Atmospheric Science

Relevant Standards: Bold indicates priority
• • HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems. • HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. • HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Essential Question(s):	Enduring Understanding(s):
• What is the study of meteorology? • How has the study of meteorology progressed over time? • What makes meteorology a branch of atmospheric science? • How does the modern atmosphere compare to the primeval atmosphere? • What is the structure of the modern atmosphere?	• Learning Sequence 1: Meteorology is the study of the atmosphere, atmospheric phenomena, and atmospheric effects on our weather. The atmosphere is the gaseous layer of the physical environment that surrounds a planet. Forecasters use atmospheric data to scientifically assess the current state of the atmosphere and make predictions of its future state. • Learning Sequence 2: The art of weather forecasting began with early civilizations using recurring astronomical and meteorological events to help them monitor seasonal changes in the weather. Early meteorological instruments were refined during the seventeenth through nineteenth centuries, other related observational, theoretical, and technological developments also contributed to our knowledge of the atmosphere; and individuals at scattered locations began to make and record atmospheric measurements. • Learning Sequence 3: Earth's original atmosphere was probably just hydrogen and helium, because these were the main gasses in the dusty, gassy disk around the Sun from which the planets formed. The Earth and its atmosphere were very hot. Molecules of hydrogen and helium move really fast, especially when warm. Actually, they moved so fast they eventually all escaped Earth's gravity and drifted off into space. Earth's "second atmosphere" came from Earth itself. There were lots of volcanoes, many more than today, because Earth's crust was still forming. The volcanoes released: (1) steam, (2) carbon dioxide, and (3) ammonia. • Learning Sequence 4: Earth's Modern (3rd Atmosphere): Much of the CO_2 dissolved into the oceans. Eventually, a simple form of bacteria developed that could live on energy from the Sun and

	carbon dioxide in the water, producing oxygen as a waste product. Thus, oxygen began to build up in the atmosphere, while the carbon dioxide levels continued to drop. Meanwhile, the ammonia molecules in the atmosphere were broken apart by sunlight, leaving nitrogen and hydrogen. The hydrogen, being the lightest element, rose to the top of the atmosphere and much of it eventually drifted off into space.
Demonstration of Learning:	**Pacing for Unit**
End of Unit Assessment Laboratories Scientific Models	5 blocks
Family Overview (link below)	**Integration of Technology:**
	Intentionally aligned use of digital tools and resources to support acquisition of content, researching, organizing and communicating learning
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Meteorology, Feedback, Climate, Weather, Patterns, Absorption, Redistribution, Positive feedback, Feedback, Mechanism, Dynamic, System interactions, EMR, Photosynthesis, Respiration, Carbon dioxide, Oxygen, Regional climate, Global climate, Temperature, Green-house gas, Carbon cycle, Carbon reserve, Biosphere, Reflection, Atmosphere (layers), Exosphere, Ionosphere, Aurora, Thermosphere, Molecules, Density, High/Low Pressure, Temperature, Mesosphere, Stratosphere, Ozone Layer, Troposphere, Composition (elements, compounds), Major ocean currents, Seasons, Axis/Axial tilt, Radiation, Conduction, Convection, Circulation, Meteorologist, Station model, Radar, Barometer, Anemometer, Air Mass, Front, Storm, Latitude, Longitude, Maritime, Continental, Cycles, Climate change, Satellite	• Meteorology Labs • Better Lesson Resources • Weather Analysis Lab • Station Model Lab • Meteorology Resources • Weather Resources • NASA Weather Teacher resource • Satellite Meteorology 7-12 Teacher Resources • NSTA Standards Page with Classroom resources (at the bottom right of page)
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
	AAAS Misconceptions: Atmosphere
Connections to Prior Units:	**Connections to Future Units:**
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Highlight patterns, critical features, big ideas, and relationships	• Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer

	routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems

Supporting Multilingual/English Learners

Related *CELP standards:*	**Learning Targets:**
An EL can make accurate use of standard English to communicate in grade appropriate speech and writing.	All learning targets listed in this unit.

Lesson Sequence	**Learning Target**	**Success Criteria/ Assessment**	**Resources**
1 What is the study of meteorology?	• I can describe the tenets of the study of meteorology (CR). • I can describe some of the modern tools used to make meteorological predictions (CR).	• I can define the various factors/tenets (ocean currents, geology, seasons, amount of solar radiation) that affect the weather in a region. • I can define the data provided by modern meteorological tools (radiosonde, weather stations, satellite data, supercomputer for forecasting)	NASA Meteorology Guide
2 How has the study of meteorology progressed over time?	• I can describe the historic meteorological instruments and explain their function (CR). • I can compare ancient tools to modern tools for studying meteorology (CR), (P). • I can compare and contrast types of meteorology data in the 19th century to today (CR), (P).	• I can explain how early man used knowledge of the weather to make agricultural decisions. • I can explain the use and data collected from early meteorological instruments (barometer, anemometer, rain gauge, vanes) • I can compare and contrast the type and quality of data collected from ancient tools to modern tools.	NASA Meteorology Guide
3 What makes meteorology a branch of atmospheric	• I can describe how the study of meteorology is an atmospheric science (CR). • I can model the primeval atmosphere	• I can compare and contrast the 3 atmospheric stages of earth.	• Absorb/Emit Lab • Atmosphere structure and composition • Temperature and

science? How does the modern atmosphere compare to the primeval atmosphere?	and make (general) comparisons to the modern atmosphere (P).	• I can model the changes in atmosphere over time with both pictures and written explanations.	pressure lab
4 What is the structure of the modern atmosphere?	• I can describe the current model or vertical structure of the atmosphere . • I can analyze data to define the components of the differing layers of the modern atmosphere .	• I can graph the vertical structure of the atmosphere. • I can analyze my graph to make sense of the unique layers within the modern atmosphere. • I can explain why the vertical structure of the atmosphere graph changes due to location (latitude).	• Atmosphere structure and composition activities • Layers of the atmosphere lab

Unit Title:	
Unit 2: Solar Radiation	
Relevant Standards: Bold indicates priority	
• HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. • HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. • HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.	
Essential Question(s):	**Enduring Understanding(s):**
• What are the Earth-Sun Relationships? • What is the nature of radiation? • How does solar radiation heat the Earth? • How does solar radiation interact with the atmosphere and Earth? • What optical phenomena are associated with solar radiations and its interactions with the atmosphere and Earth? • How do meteorologists measure and record solar radiation? • How do meteorologists use solar radiation information?	• Learning Sequence 1: It is the earth's relationship to the sun, and the amount of light it receives, that is responsible for the seasons and biodiversity. The amount of sun a region receives depends on the tilt of the earth's axis and not its distance from the sun.Every location on Earth receives sunlight at least part of the year. • Learning Sequence 2: Solar radiation, often called the solar resource, is a general term for the electromagnetic radiation emitted by the sun. • Learning Sequence 3: Energy from the sun is transferred through space and through the earth's atmosphere to the earth's surface. Since this energy warms the earth's surface and atmosphere, some of it is or becomes heat energy. There are three ways heat is transferred into and through the atmosphere: radiation, conduction, convection. • Learning Sequence 4: About 29 percent of the solar energy that arrives at the top of the atmosphere is reflected back to space by clouds, atmospheric particles, or bright ground surfaces like sea ice and snow. This energy plays no role in Earth's climate system. About 23 percent of incoming solar energy is absorbed in the atmosphere by water vapor, dust, and ozone, and 48 percent passes through the atmosphere and is absorbed by the surface. Thus, about 71 percent of the total incoming solar energy is absorbed by the Earth system. • Learning Sequence 5: Solar radiation is often defined as the energy reaching the earth from the sun. A large part of this is visible sunlight, but the solar spectrum extends into the UV as well as the near infra-red. It reaches us in different ways: directly from the sun (direct solar radiation), through scattering through the atmosphere (diffuse solar radiation) or via reflections. These quantities can be measured separately as (1) total radiation on the surface or (2)

	the global horizontal irradiance.
Demonstration of Learning:	**Pacing for Unit**
End of Unit Assessment Laboratories Scientific Models	6 Blocks
Family Overview (link below)	**Integration of Technology:**
	Intentionally aligned use of digital tools and resources to support acquisition of content, researching, organizing and communicating learning
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Temperature, Solar radiation, Solar energy, Thermometer, Fahrenheit, Celsius, Tilt-Seasons, Albedo, Unequal heating, Storage, Ultraviolet light, Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere, Water Cycle, Evaporation, Condensation, Precipitation, Surface runoff, Water cycle, Dew point, Saturation, Cloud cover, Wind direction, Visibility, Humidity (relative, etc), EMR, Spectra, Radiation, Solar energy, Hydrogen, Helium, 1st atmosphere, 2nd atmosphere, 3rd atmosphere, Energy, Energy transfer, Radiation, Conduction, Convection, Solar radiation, Solar energy	• Meteorology Labs • Better Lesson Resources • Weather Analysis Lab • Station Model Lab • Meteorology Resources • NASA Meteorology Guide
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
	AAAS Misconceptions: Solar Radiations/Seasons
Connections to Prior Units:	**Connections to Future Units:**
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Highlight patterns, critical features, big ideas, and relationships	• Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems
Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**

An EL can construct grade appropriate oral and written claims and support them with reasoning and evidence.		• I can create an explanatory model to describe the reasons for the seasons and the impact on meteorological science (P). • I can describe the patterns in energy related to the different waves found on the electromagnetic spectrum (CR). • I can create a wave model to describe solar radiation (P). • I can analyze and interpret the laws of radiation (P). • I can describe the role of solar radiation on meteorology (CR). • I can explain optical events and their relationship to solar ray interactions with the atmosphere and earth (CR).	
Lesson Sequence	**Learning Target**	**Success Criteria/ Assessment**	**Resources**
1 What are the Earth-Sun Relationships?	• I can model and describe Earth's motions. • I can create an explanatory model to describe the reasons for the seasons and the impact on meteorological science (P). • I can explain the importance of Earth's orientation to the study of meteorology (CR).	• I can explain the differences between the patterns of Earths' rotation and Earth's Revolution. • I can model the impact of revolution on the seasons and meteorological science. • I can explain how tilt and latitude impact the amount of solar energy reaching earth.	
2 What is the nature of radiation?	• I can describe the patterns in energy related to the different waves found on the electromagnetic spectrum (CR). • I can create a wave model to describe solar radiation (P).	• I can identify the different parts of the electromagnetic spectrum • I can identify which electromagnetic waves become heat energy	
3 How does solar radiation heat the Earth?	• I can compare and contrast the three forms of heat transfer (CR), (P). • I can analyze and interpret the laws of radiation (P).	• I can model how Solar energy reaching Earth's surface becomes heat energy	Lab activities: • Radiation • Conduction • Convection Heat Transfer Lab
4 How does solar radiation interact with the atmosphere and Earth? What optical phenomena are associated with	• I can describe the ways in which solar radiation interacts with the atmosphere (CR). • I can describe the ways in which solar radiation interacts with the Earth (CR). • I can describe the role of solar radiation on meteorology (CR). • I can explain optical events and their relationship to solar ray interactions	• I can interpret a diagram of where solar radiation goes once it enters Earth's atmosphere. • I can model how different aspects of Earth interact with sunlight. • I can describe solar	• Absorb/Emit Lab • Temperature and pressure lab

solar radiations and its interactions with the atmosphere and Earth?	with the atmosphere and earth (CR).	events and their appearance on Earth.	
5 How do meteorologists measure and record solar radiation? How do meteorologists use solar radiation information?	• I can describe the tools and collection processes related to solar radiation and meteorology. • I can analyze and explain solar information (heat data, lumens, etc).	• I can define the **solar constant** • I can describe the difference between the two tools used to measure solar energy • I can analyze solar information to understand the differences in temperature between the layers.	Big Data, Small Devices: Solar Terminator (p209)

Unit Title:	
Unit 3: Temperature	
Relevant Standards: Bold indicates priority	
• HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects). • HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* • HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.	
Essential Question(s):	**Enduring Understanding(s):**
• How do meteorologists measure temperature? How do meteorologists use air temperature data? • How does the temperature vary in a day? How do you calculate the mean daily temperature? • What factors impact the recorded temperature of a region? • How do extreme temperatures impact human comfort?	• Learning Sequence 1:Temperature is affected by many processes at several different time and space scales. Some of these factors are well understood and very predictable (like the seasons), while others present bigger challenges. • Learning Sequence 2/3: Daily air temperatures at Earth's surface are controlled by the incoming and outgoing energy. During the day, the air temperature increases as energy gains exceed the energy lost from Earth's surface. Throughout the night, the air temperature decreases as Earth's surface loses more energy than it receives. • Learning Sequence 4: The human body always works to remain in homeostasis. One form of homeostasis is thermoregulation. Body temperature varies in every individual, but the average internal temperature is 37.0 °C (98.6 °F). Stress from extreme external temperature can cause the human body to shut down. Hypothermia can set in when the core temperature drops to 35 °C (95 °F). Hyperthermia can set in when the core body temperature rises above 37.5-38.3 °C (99.5-100.9 °F). These temperatures commonly result in mortality. Humans have adapted to living in climates where hypothermia and hyperthermia are common primarily through culture and technology, such as the use of clothing and shelter.
Demonstration of Learning:	**Pacing for Unit**
End of Unit Assessment Laboratories Scientific Models	6 Blocks
Family Overview (link below)	**Integration of Technology:**

	Intentionally aligned use of digital tools and resources to support acquisition of content, researching, organizing and communicating learning
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Electromagnetic radiation, Conduction, Convection, Radiation, Re-radiation, Rotation, Revolution, Ocean currents, Infrared, Water vapor, Chlorofluorocarbons, Greenhouse gasses, Absorption, Reflection, Positive & negative feedback loops, Types of clouds, Conservation of energy, Thermal energy, Heat, Radiant energy, Matter cycles, Energy flow, Thermal energy, Energy flow, Conduction, Convection, Radiation, Feedback, Positive feedback, Mechanism, Temperature, Homeostasis, Stabilize, Destabilize, Thermometer, Fahrenheit, Celsius, Altitude,	• Meteorology Labs • Better Lesson Resources • Weather Analysis Lab • Station Model Lab • Meteorology Resources • Weather Resources • NASA Weather Teacher resource • Satellite Meteorology 7-12 Teacher Resources
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
	AAAS: Misconceptions-Weather and Climate Basic Elements
Connections to Prior Units:	**Connections to Future Units:**
• Biology NGSS Unit: Yellowstone-Wolves Change Rivers • Physical Science NGSS Unit: The Year Without Summer • Chemistry NGSS Unit: Environmental Chemistry	
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Highlight patterns, critical features, big ideas, and relationships	• Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems
Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**
• An EL can determine the meaning of words and phrases in oral presentations and literary and informational text. • An EL can speak and write about grade-appropriate	

<table>
<tr><td colspan="2">complex literary and informational texts and topics.
• An EL can participate in grade appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.</td><td colspan="2"></td></tr>
<tr><th>Lesson Sequence</th><th>Learning Target</th><th>Success Criteria/ Assessment</th><th>Resources</th></tr>
<tr><td>1
How do meteorologists measure temperature?

How do meteorologists use air temperature data?</td><td>• I can describe the tools used to collect temperature data.
• I can describe the ways in which meteorologists protect temperature/meteorological instruments.
• I can analyze surface temperature to draw isotherms on a weather map.
• I can describe the meteorological importance of drawing and communicating isotherms.</td><td>• I can read a thermometer in both Fahrenheit and Celsius scales
• I can explain how clouds both diffuse and reflect light
• I can explain how the atmosphere is heated by Earth's surface
• I can explain how air temperature near or over bodies of water is much different from that over land due to differences in the way water and land heat and cool.</td><td>• Calculations-isotherms

• Hypothermia and Hyperthermia google slides
• BBC The Weather: Cold
• BBC The Weather: Heat</td></tr>
<tr><td>2
How does the temperature vary in a day?

How do you calculate the mean daily temperature?</td><td>• I can collect temperature data.
• I can calculate the mean daily temperature.
• I can explain the variation in temperature throughout the course of a 24 hour period.
• I can model the mean daily temperature on a weather map.</td><td>• I can draw a line on a map joining points with the same temperature.
• I can explain that during the day, the air temperature increases as energy gains exceed the energy lost from Earth's surface and during the night, the air temperature decreases as Earth's surface loses more energy than it receives.</td><td></td></tr>
<tr><td>3
What factors impact the recorded temperature of a region?</td><td>• I can develop a model to represent the temperature patterns related to land and water.
• I can construct an explanation for the temperatures in coastal communities and its relationship to ocean currents.
• I can model or explain how altitude impacts temperature.
• I can predict the average seasonal temperature based on a region's geographic position.
• I can analyze temperature data to explain the relationship between cloud</td><td>• I can explain that ocean currents act like a conveyor belt, transporting warm water and precipitation from the equator toward the poles and cold water from the poles back to the equatorial region.
• I can describe that the farther away you get from the earth, the</td><td>• Lab activities:
  ○ Radiation
  ○ Conduction
  ○ Convection
• Albedo activities/demo
• Heat Transfer Lab
• Absorb/Emit Lab</td></tr>
</table>

	cover and temperature. • I can analyze temperature data to explain the relationship between angle of solar incidence and temperature.	thinner the atmosphere gets and the total heat content of a system is directly related to the amount of matter present, so it is cooler at higher elevations. • I can identify when the sun has a lower elevation angle, the solar energy reaching Earth is less intense because it is spread out over a larger area.	
4 How do extreme temperatures impact human comfort?	• I can measure temperature and calculate wind chill. • I can measure temperatures and calculate heat index. • I can describe the ways in which meteorologists communicate information related to extreme temperatures.	• I can calculate wind chill using a wind chill chart • I can explain the difference between temperature and heat index and what factors go into its calculation. • I can provide evidence and reasoning to explain the growing need for meteorological information to be communicated to emergency managers (FEMA, Homeland Security) through the integration of weather forecasters into emergency operations and the development of weather watches, warnings, and advisories to coordinate between emergency managers and meteorologists, to benefit public safety and to improve our capability to prepare for and respond to emergencies.	• Heat Index calculations • Wind Chill calculations

Unit Title:	
Unit 4: Atmospheric Moisture and Stability	
Relevant Standards: Bold indicates priority	
• HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. • HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects). • HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*	
Essential Question(s):	**Enduring Understanding(s):**
• How does water in the atmosphere impact meteorological communications and predictions? • What are the unusual properties of water? How do these properties impact weather? • How is humidity measured? • How does humidity play a role in weather forecasting? • How does adiabatic change impact atmospheric stability?	• Learning Sequence 1: Earth's water has a significant role in weather and weather systems. Water has unique properties, such as its specific heat or heat capacity, and has the ability to change state depending on the regional temperature and pressure. Such changes in state are the result in the flow of energy that ultimately drives the water cycle and weather systems. • Learning Sequence 2: Water is the only substance on earth that naturally exists in all three physical states: solid (ice), liquid (water), gas (vapor or steam). The high specific heat of water means it takes a large amount of energy and a longer time to warm it, as well as a much longer time for that heat to be released. As the seasons change, those who live near large bodies of water--such as lakes and oceans--experience the effects of water's high specific heat on a larger scale. • Learning Sequence 3: Relative humidity is the ratio of the current absolute humidity to the highest possible absolute humidity (which depends on the current air temperature). A reading of 100 percent relative humidity means that the air is totally saturated with water vapor and cannot hold any more, creating the possibility of rain. • Learning Sequence 4: In general, as a parcel of air rises, the water vapor in it condenses and heat is released. The rising air will therefore cool more slowly as it rises; the wet adiabatic lapse rate will in general be less negative than the dry adiabatic lapse rate. The wet adiabatic lapse rate has been observed to vary between −6.5°C/km and −3.5°C/km.

Demonstration of Learning:	**Pacing for Unit**
End of Unit Assessment Laboratories Scientific Models	5 Blocks
Family Overview (link below)	**Integration of Technology:**
	Intentionally aligned use of digital tools and resources to support acquisition of content, researching, organizing and communicating learning
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere, Water Cycle, Evaporation, Condensation, Precipitation, Surface runoff, Water cycle, Dew point, Saturation, Cloud cover, Wind direction, Visibility, Humidity (relative, etc), Conservation of energy, Thermal energy, Heat, Radiant energy, Matter cycles, Energy flow, Thermal energy, Energy flow, Conduction, Convection, Radiation	• Meteorology Labs • Better Lesson Resources • Weather Analysis Lab • Station Model Lab • Meteorology Resources • Weather Resources • NASA Weather Teacher resource • Satellite Meteorology 7-12 Teacher Resources • NSTA Standards Page with Classroom resources (at the bottom right of page)
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
•	• AAAS: Misconceptions-Weather and Climate Basic Elements • AAAS Misconceptions: Cloud Formation
Connections to Prior Units:	**Connections to Future Units:**
• Physical Science Unit: The Year Without Summer • Chemistry NGSS Unit: Environmental Chemistry	
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Highlight patterns, critical features, big ideas, and relationships	• Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems
Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**

• An EL can determine the meaning of words and phrases in oral presentations and literary and informational text. • An EL can speak and write about grade-appropriate complex literary and informational texts and topics. • An EL can participate in grade appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.	

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
1 How does water in the atmosphere impact meteorological communications and predictions?	• I can model the hydrologic cycle. • I can make an initial model/explanation for how water in the atmosphere drives meteorological events.	• I can identify which parts of the water cycle have the greatest impact on weather • I can explain how the heat capacity of water drives Earth's overall climate and daily weather patterns.	Content resource
2 What are the unusual properties of water? How do these properties impact weather?	• I can explain the properties of water. • I can define and model the different states of water. • I can describe the latent heat of vaporization for water. • I can connect the latent heat of water to the energy required for weather events.	• I can diagram how as water changes state it absorbs or releases energy. Example: when water vapor forms clouds energy is released back into the atmosphere • evaporative cooling helps slow down the rate of daytime heating in places where there are sources of water, such as lakes.	New York Science Teacher Files-Water Cycle Big Data, Small Devices: Tides of Change (p192) How raindrops form What do raindrops really look like? Surface Tension of water on YouTube Surface Tension of Water droplet demo/experiment Water Stations Lab
3 How is humidity measured? How does humidity play a role in weather forecasting?	• I can define and use the instruments used to determine the relative humidity. • I can calculate relative humidity. • I can use psychrometric tables to improve the communication of a weather forecast.	• I can identify three types of hygrometers and how they measure relative humidity • I can use a sling psychrometer to calculate relative humidity. • I can explain the significance of relative humidity in a temperature forecast.	Investigation:Moisture in the Atmosphere
4	• I can calculate dry and wet adiabatic	• I can explain how	Adiabatic lapse rate

How does adiabatic change impact atmospheric stability?	lapse rates. • I can describe the components of atmospheric stability and instability. • I can identify and model the connections between adiabatic change and atmospheric stability. • I can explain and model lifting mechanisms within the atmosphere.	• The adiabatic lapse rate is the rate at which the temperature of an air parcel changes in response to the compression or expansion associated with a change in elevation.	

Unit Title:	
Unit 5: Condensation and Precipitation	
Relevant Standards: Bold indicates priority	
• HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	
Essential Question(s):	**Enduring Understanding(s):**
• How do clouds form? • How are clouds classified? • How is fog different from a cloud? • How do the different types of precipitation form? How is precipitation measured? • How do meteorologists predict severe precipitative weather events? • Can weather events be manipulated?	• Learning Sequence 1: A cloud is a visible accumulation of minute droplets of water, ice crystals, or both, suspended in the air. Though they vary in shape and size, all clouds are basically formed in the same way through the vertical air above the condensation level. Clouds may also form in contact with the ground surface, too. The different types of clouds are named based on their shape and how high up they hover in the troposphere. • Learning Sequence 2: Precipitation is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. It is the primary connection in the water cycle that provides for the delivery of atmospheric water to the Earth.
Demonstration of Learning:	**Pacing for Unit**
End of Unit Assessment Laboratories Scientific Models	4 Blocks
Family Overview (link below)	**Integration of Technology:**
	Intentionally aligned use of digital tools and resources to support acquisition of content, researching, organizing and communicating learning
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere, Water Cycle, Evaporation, Condensation, Precipitation, Surface runoff, Water cycle, Dew point, Saturation, Cloud cover, Wind direction, Visibility, Humidity (relative, etc), Cloud types (cirrus, stratus, cumulus, nimbo-, alto-, etc)	• Meteorology Labs • Better Lesson Resources • Weather Analysis Lab • Station Model Lab • Meteorology Resources • Weather Resources • NASA Weather Teacher resource • Satellite Meteorology 7-12 Teacher Resources • NSTA Standards Page with Classroom resources (at the bottom right of page)

	• BBC's *The Weather* (4 DVD Series)
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
	AAAS Misconceptions: Water Cycle
Connections to Prior Units:	**Connections to Future Units:**
• Grade 6 NGSS Unit: Destructive Weather • Physical Science NGSS UNit: The Year without Summer	
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Highlight patterns, critical features, big ideas, and relationships	• Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems
Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**
• An EL can determine the meaning of words and phrases in oral presentations and literary and informational text. • An EL can speak and write about grade-appropriate complex literary and informational texts and topics. • An EL can participate in grade appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.	

Lesson Sequence	**Learning Target**	**Success Criteria/ Assessment**	**Resources**
1 How do clouds form? How are clouds classified? How is fog different from a cloud?	• I can describe the different cloud types and their formation. • I can classify clouds based on observation. • I can predict the weather based on cloud observations. • I can model the differences between fog and a cloud. • I can explain the properties and formation of the different fogs.	• Use evidence of cloud types to support my prediction. • Generate an explanatory model that describes the scientific differences between fog and clouds. • I can use key vocabulary to discuss the	New York Science Teacher Files-Types of Clouds Teacher-created slides Daily weather log identifying and recording observed clouds All the Cloud Types

	• I can model clouds and fog on a meteorological map.	environmental factors necessary to fog formation and the different types of fog.	TedEd: How did clouds get their names?
2 How do the different types of precipitation form? How is precipitation measured? How do meteorologists predict severe precipitative weather events? Can weather events be manipulated?	• I can explain how precipitation forms. • I can explain the formation of various forms of precipitation. • I can explain and use tools for measuring precipitation. • I can explain how meteorologists predict severe precipitative weather events. • I can describe the ways in which humans can manipulate weather events. • I can model precipitation on a meteorological map. • I can analyze a meteorological map to predict precipitation.	• I can distinguish between the various forms of precipitation. • I can determine key environmental conditions required for the formation of each type of precipitation. • I can understand weather map symbolism for the various types of precipitation and related weather characteristics. • I can make distinct connections between human impact on climate and the impact climate has on weather.	NWS: Types of Precipitation How Can Rain Create Conflict? Precipitation and Water Use: Crash Course Geography #11 How are weather forecasts made? BBC *The Weather*: Wet DVD

Unit Title:	
Unit 6: Air Pressure and Atmospheric Circulation	
Relevant Standards: Bold indicates priority	
• HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales • HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.	
Essential Question(s):	**Enduring Understanding(s):**

• How do we measure air pressure? How are air pressure and winds connected?
• What factors impact winds?
• What wind patterns exist on Earth?
	• Learning Sequence 1: The air around you has weight, and it presses against everything it touches. That pressure is called atmospheric pressure, or air pressure. It is the force exerted on a surface by the air above it as gravity pulls it to Earth. Atmospheric pressure is commonly measured with a barometer.
	• Learning Sequence 2: Wind is defined as the movement of air in any direction. The speed of wind varies from calm to the very high speeds of hurricanes. Wind is created when air moves from areas of high pressure toward areas where the air pressure is low. Seasonal temperature changes and the Earth's rotation also affect wind speed and direction.
	• Learning Sequence 3: Winds on Earth are either global or local. Global winds blow in the same directions all the time and are related to the unequal heating of Earth by the Sun — that is, more solar radiation strikes the equator than the polar regions – and the rotation of the Earth — that is, the Coriolis effect. Water in the surface currents is pushed in the direction of the major wind belts:
	  ○ trade winds: east to west between the equator and 30°N and 30°S
	  ○ westerlies: west to east in the middle latitudes
	  ○ polar easterlies: east to west between 50° and 60° north and south of the equator and the north and south pole

Demonstration of Learning:	**Pacing for Unit**
End of Unit Assessment Laboratories Scientific Models	4 Blocks
Family Overview (link below)	**Integration of Technology:**
	Intentionally aligned use of digital tools and resources to support acquisition of content, researching,

	organizing and communicating learning
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Feedback, Climate, Weather, Weather patterns, Atmospheric layers, Exosphere, Ionosphere, Aurora, Thermosphere, Mesosphere, Stratosphere, Troposphere, Atmospheric composition (elements), Major ocean currents, Seasons, Latitude, Direct/indirect sunlight, Annual precipitation, Humidity, Air pressure, Wind, Redistribution, Density, Diurnal cycle, Biodiversity, Climate zones, Rain forest, Grassland,Ice caps, Tundra, Boreal forest,Electromagnetic radiation, Conduction, Convection, Radiation, Re-radiation, Rotation, Revolution, Ocean currents, Infrared, Water vapor, Chlorofluorocarbons, Greenhouse gasses, Absorption, Reflection, Positive & negative feedback loops, Types of clouds, Temperature, Thermometer, Fahrenheit, Celsius, Tilt-Seasons, Albedo, Unequal heating, Storage, Ultraviolet light, Cumulus, Stratus, Cirrus, Pollutants (carbon monoxide, SOx, NOx, Ozone, CO_2 , etc.), Altitude, Ice age, Volcano, Glacier, Particle motion, States of matter, Solid, Liquid gas, Temperature, Pressure, Gas law, Atmosphere, Gravity	• Meteorology Labs • Better Lesson Resources • Weather Analysis Lab • Station Model Lab • Meteorology Resources • Weather Resources • NASA Weather Teacher resource • Satellite Meteorology 7-12 Teacher Resources • NSTA Standards Page with Classroom resources (at the bottom right of page)
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
	AAAS Misconceptions: Air Pressure and Movement
Connections to Prior Units:	**Connections to Future Units:**
• NGSS Chemistry Unit; Air Bags • Physical Science NGSS Unit: The Year Without Summer	
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Highlight patterns, critical features, big ideas, and relationships	• Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems
Supporting Multilingual/English Learners	

Related CELP standards:	Learning Targets:
• An EL can determine the meaning of words and phrases in oral presentations and literary and informational text. • An EL can speak and write about grade-appropriate complex literary and informational texts and topics. • An EL can participate in grade appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.	

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
1 How do we measure air pressure? How are air pressure and winds connected?	• I can use meteorological tools to measure air pressure. • I can analyze data collected from a barometer. • I can explain how pressure and altitude affect air pressure. • I can explain how temperature and water vapor impact air pressure.	• I can define the data collected by each of the meteorological tools. • I can measure air pressure. • I can differentiate between air pressure and altitude. • I can describe other weather characteristics that impact air pressure.	Wind Explained
2 What factors impact winds?	• I can model or explain the factors that affect wind. • I can measure wind and apply it to a meteorological weather model.	• I can describe how to determine which direction the wound will blow from looking at a weather map. • I can predict the speed of wind based on evidence of air pressure from a weather map.	• Mapping pressure belts and winds • Demonstration/activity of Coriolis effect • Coriolis Effect Video • Coriolis Effect article from Newsela Spring 2019 • Big Data, Small Devices: Wind Beneath my Wings p102
3 What wind patterns exist on Earth?	• I can describe the scale and structure of various wind patterns found on earth. • I can explain the development and behavior of local winds. • I can analyze ocean currents and use them to explain global wind patterns. • I can analyze global precipitation distribution and use global wind and ocean currents to explain the patterns in distribution. • I can communicate wind patterns on a meteorological forecast/model.	• I can explain the general reasons for the direction of wind. • I can explain why consistent wind patterns exist on Earth, relative to the ocean currents.	• Ocean currents activity and videos Video: How do Ocean Currents Work? • Mapping major ocean currents-Rubber Ducks • El niño investigation Video: El Nino Video 2: El Nino Video: Ocean driving Force • DVD: BBC's *The Weather: Wind*

Unit Title:
Unit 7: Air Masses and Fronts

Relevant Standards: Bold indicates priority
• HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Essential Question(s):	Enduring Understanding(s):
• What are air masses? • How do the 5 North American air masses determine weather in the United States? • What are fronts and how are they formed? • What is the relationship between fronts and severe weather? • How do meteorologist's communicate fronts and severe weather on a weather map?	• Learning Sequence 1: In meteorology, an air mass is a volume of air defined by its temperature and water vapor content. Air masses cover many hundreds or thousands of miles, and adapt to the characteristics of the surface below them. They are classified according to latitude and their continental or maritime source regions. • Learning Sequence 2: An air mass is a large body of air with generally uniform temperature and humidity. The area over which an air mass originates is what provides its characteristics. The longer the air mass stays over its source region, the more likely it will acquire the properties of the surface below. As such, air masses are associated with high pressure systems. There are two broad overarching divisions of air masses based upon the moisture content. Continental air masses, designated by the lowercase letter 'c', originate over continents are therefore dry air masses. Maritime air masses, designated by the letter 'm', originate over the oceans and are therefore moist air masses. • Learning Sequence 3: When a front passes over an area, it means a change in the weather. Many fronts cause weather events such as rain, thunderstorms, gusty winds, and tornadoes. At a cold front, there may be dramatic thunderstorms. At a warm front, there may be low stratus clouds. Usually, the skies clear once the front has passed. • Learning Sequence 4: Severe weather can occur with cold fronts, warm fronts, and drylines. The movement of the front will help you determine how long the precipitation will last. Slower moving fronts are more prone to produce heavy persistent rain. The upper level winds determine how fast a supercell will move once it forms. • Learning Sequence 5: A cold front is represented by a solid blue line with filled-in triangles along it, like in the map on the left. The triangles are like arrowheads pointing in the direction that the front is moving. The surface location of a warm front is represented by a

	solid red line with red, filled-in semicircles along it, like in the map on the right (B). The semicircles indicate the direction that the front is moving. They are on the side of the line where the front is moving. Etc.
Demonstration of Learning:	**Pacing for Unit**
End of Unit Assessment Laboratories Scientific Models	6 blocks
Family Overview (link below)	**Integration of Technology:**
	Intentionally aligned use of digital tools and resources to support acquisition of content, researching, organizing and communicating learning
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Air mass, Cold Front, Continental, Maritime, Warm Front, Occluded Front, Stationary Front, Polar, Tropical, Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere, Water Cycle, Evaporation, Condensation, Precipitation, Surface runoff Water cycle, Dew point, Saturation, Cloud cover, Wind direction, Visibility, Humidity (relative, etc) Regional climate, Global climate, Temperature Green-house gas, Carbon cycle, Carbon reserve Biosphere	• Meteorology Labs • Better Lesson Resources • Weather Analysis Lab • Station Model Lab • Meteorology Resources • Weather Resources • NASA Weather Teacher resource • Satellite Meteorology 7-12 Teacher Resources • NSTA Standards Page with Classroom resources (at the bottom right of page)
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
	• AAAS Misconceptions: Air Masses
Connections to Prior Units:	**Connections to Future Units:**
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Highlight patterns, critical features, big ideas, and relationships	• Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems

Supporting Multilingual/English Learners	
Related CELP standards:	**Learning Targets:**
• An EL can determine the meaning of words and phrases in oral presentations and literary and informational text. • An EL can speak and write about grade-appropriate complex literary and informational texts and topics. • An EL can participate in grade appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.	

<table>
<tr><th>Lesson Sequence</th><th>Learning Target</th><th>Success Criteria/ Assessment</th><th>Resources</th></tr>
<tr><td>1
What are air masses?</td><td>• I can model and describe air masses according to their source region.
• I can classify air masses using a three letter code.
• I can explain how air masses are modified.</td><td>• I can describe the different characteristics of air masses relative to their source location.
• I can recall the two letter abbreviations for each type of air mass.
• I can describe how air masses interact with one another. I can predict the outcome of different types of air masses interacting.
• I can explain events that may cause an air mass to change.</td><td>NY Science Teacher-Air Masses

What is an air mass?

Scholastic - Study Jams -</td></tr>
<tr><td>2
How do the 5 North American air masses determine weather in the United States?</td><td>• I can investigate the 5 North American air masses.
• I can model how the air masses impact weather conditions in the US.
• I can predict the weather in a specific region by analyzing air mass activity.</td><td rowspan="2">• I can analyze air mass activity and identify the mass as a specific type.
• I can identify fronts.
• I can differentiate between occluded, stationary, cold, and warm fronts.
• I can predict the weather associated with each type of front.
• I can explain how Mid-latitude cyclones drive most of the stormy weather in the continental United States.
• I can model the development of these cyclones by showcasing a warm front from the south meeting a cold</td><td>Investigation-Air Masses and Fronts</td></tr>
<tr><td>3
What are fronts and how are they formed?</td><td>• I can distinguish between the different types of fronts.
• I can describe the relationship between midlatitude cyclones and polar fronts.
• I can describe the lifecycle of a midlatitude cyclone.
• I can describe the conveyor belt models of air streams.</td><td>Resource: CK-12 Cyclones</td></tr>
</table>

		front from the north.	
4 What is the relationship between fronts and severe weather?	• I can model fronts and their relationship to the development of thunderstorms. • I can model fronts and their relationship to the development of lightning. • I can model fronts and their relationship to the development of tornadoes. • I can model fronts and their relationship to the development of hurricanes.	• I can generate explanatory models that show the concept of a front visually with scientific explanation. • I can describe the events that lead to the generation of thunder. • I can describe the events that lead to the generation of lightning. • I can identify the similarities and differences in hurricane and tornado formation.	NY Science Teacher-Latent Heat Student Explanatory Models Big Data, Small Devices:Extreme Weather p85, Hurricane Me p235
5 How do meteorologist's communicate fronts and severe weather on a weather map?	• I can describe the scale and structure of a frontal system. • I can explain the development and behavior of severe weather events. • I can analyze meteorological maps to describe and/or predict weather events. • I can communicate about fronts on a meteorological forecast/model. • I can communicate about severe weather on a meteorological forecast/model.	• I can describe the different types of severe weather associated with the different regions of the Earth. • I can explain why those forms of severe weather exist and the characteristics of the region that support the development of the weather event.	NY Science Teacher-Isoline Lab Big Data, Small Devices: Weather Mapper p90 Weather Mapping Fronts and Severe Weather Assessment items How To Read Symbols & Colors on a Weather Map

Unit Title:
Unit 8: Changing Climate and the World

Relevant Standards: Bold indicates priority
• HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems. • HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere • HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems. • HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. • HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Essential Question(s):	**Enduring Understanding(s):**
• How is climate change detected? What are the causes of climate change? • What are the 3 factors that affect climate change? What are climate feedback mechanisms? • What are the consequences of climate change? • What are the global climates? • How do weather observations become climate data? • Why is climate data important? How is it used?	• Learning Sequence 1: Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gasses added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. • Learning Sequence 2: Earth system science is the study of how scientific data stemming from various fields of research, such as the atmosphere, oceans, land ice and others, fit together to form the current picture of our planet as a whole, including its changing climate. Climate scientists separate factors that affect climate change into three categories: forcings, feedbacks, and tipping points. • Learning Sequence 3: Increased heat, drought and insect outbreaks, all linked to climate change, have increased wildfires. Declining water supplies, reduced agricultural yields, health impacts in cities due to heat, and flooding and erosion in coastal areas are additional concerns. • Learning Sequence 4: Climate scientists split the Earth into approximately five main types of climates. They are: A. Tropical. In this hot and humid zone, the average temperatures are greater than 64°F (18°C) year-round and there is more than 59 inches of precipitation each year. B. Dry. These climate zones are so dry because moisture is rapidly evaporated from the air and

	there is very little precipitation. C. Temperate: In this zone, there are typically warm and humid summers with thunderstorms and mild winters. D. Continental: These regions have warm to cool summers and very cold winters. In the winter, this zone can experience snowstorms, strong winds, and very cold temperatures—sometimes falling below -22°F (-30°C)! E. Polar: In the polar climate zones, it's extremely cold. Even in summer, the temperatures here never go higher than 50°F (10°C)! • Learning Sequence 5: Around the globe, millions of weather observations are recorded each day, by both human observers and automated instruments. In the United States, daily observations at stations that meet specified criteria, methodically collected by volunteer observers and automated weather stations, are used to document our weather and climate. • Learning Sequence 6: Current weather and climate data are used in many ways. People who make decisions for cities and towns rely on accurate and easy-to-understand graphs and maps to assist them in planning for energy needs, water management, and extreme weather events. Local climate data are also used to determine city budgets for maintaining roads, bridges, and other infrastructure.
Demonstration of Learning:	**Pacing for Unit**
End of Unit Assessment Laboratories Scientific Models	7 blocks
Family Overview (link below)	**Integration of Technology:**
	Intentionally aligned use of digital tools and resources to support acquisition of content, researching, organizing and communicating learning
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Climate, Greenhouse gases, El Nino, La Nina, Absorption, Redistribution, Positive feedback, Feedback Mechanism, Dynamic, System interactions, EMR, Reflection, Climate zones, Feedback, Mechanism Dynamic, System interactions, EMR, Reflection Absorption, Redistribution, Positive feedback Carbon dioxide, Global warming, Global cooling, Ice age, Climate change, Heat, Greenhouse effect, Thermohaline circulation, Feedback loops, Open vs. Closed systems, Climate model, Forecast, Global climate change, Regional climate change, Human impact, Carbon cycle	• Meteorology Labs • Better Lesson Resources • Weather Analysis Lab • Station Model Lab • Meteorology Resources • Weather Resources • NASA Weather Teacher resource • Satellite Meteorology 7-12 Teacher Resources • NSTA Standards Page with Classroom resources (at the bottom right of page)

Impact prediction, Human-induced, Biodiversity, Environmental impact, Climate change, Empirical evidence	
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Connections to Prior Units:	**Connections to Future Units:**
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Highlight patterns, critical features, big ideas, and relationships	• Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems
Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**
• An EL can determine the meaning of words and phrases in oral presentations and literary and informational text. • An EL can speak and write about grade-appropriate complex literary and informational texts and topics. • An EL can participate in grade appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.	

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
1 How is climate change detected? What are the causes of climate change?	• I can analyze climate data to find patterns that signify a change has occurred. • I can explain the natural causes of climate change. • I can explain how humans have impacted climate change	• I can explain why future regional average global temperatures will continue to rise. • I can explain how the outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gasses	Big Data, Small Devices: Climate from Pole to Pole (p81) Big Data, Small Devices: Oceans and Climate (186)

		added to the atmosphere each year. • I can explain/model the ways in which these gasses are absorbed by the ocean and biosphere.	
2 What are the 3 factors that affect climate change? What are climate feedback mechanisms?	• I can describe climate forcings (initial drivers of climate). • I can describe the climate feedback and their relationship to climate forcings.	• I can explain how scientific data from the atmosphere, oceans, land ice and others, fit together to form the current picture of our planet as a whole. • I can identify the three ways in which climate scientists characterize change: forcings, feedbacks, and tipping points.	NASA Resource
3 What are the consequences of climate change?	• I can describe climate tipping points and their relationship to feedback and forcings.	• Increased heat, drought and insect outbreaks, all linked to climate change, have increased wildfires. Declining water supplies, reduced agricultural yields, health impacts in cities due to heat, and flooding and erosion in coastal areas are additional concerns.	NASA Resource NASA Climate Time Machine
4 What are the global climates?	• I can identify and categorize a region's climate. • I can differentiate between the world's different climates (wet tropics, tropical wet and dry, dry, humid mid-latitude, humid continental, polar, highland).	• I can identify and differentiate between the different types of climate zones.	
5 How do weather observations become climate data?	• I can understand the difference between weather and climate. • I can explain the relationship between weather and climate. • I can explain the role of careful weather data collection in understanding climate. • I can read and interpret climate maps. • I can explain the similarities and differences between a weather map and a climate map.	• I know weather is a daily occurrence and that climate is representative of annual averages for a specific region or zone. • I can use a climate map to explain the climate in a specific region. • I can differentiate between a climate and a weather map.	NOAA Resource
6	• I can explain how climate data is used	•	Big Data, Small Devices:

Why is climate data important? How is it used?	in Bristol to make decisions.		Challenging the Skeptics p233