

**Lesson by Lesson Guide  
Investigating Weather Systems  
Kendall Hunt (BSCS)**

and

**Alignment Lessons**

## Table of Contents

NC Essential Standards and Clarifying Objectives .....	3
Essential Question for the Unit .....	3
Pre-Unit Assessment .....	3
Unit Information .....	3
Lesson 1 - Vacation Destination .....	5
Lesson 2 - Where in the World? .....	8
Lesson 3 - The Reason for Seasons .....	11
Lesson 4 - American Weather.....	14
Lesson 5 - Climb to Cold.....	17
Lesson 6 - What Drives the Weather? .....	20
Lesson 7 - Oh! The Pressure!.....	25
Lesson 8 - Understanding the Weather Systems.....	30
Heat Transfer ( <i>Alignment Lesson</i> ) .....	33
Lesson 9 - Weather Wise .....	38

## **NC Essential Standards and Clarifying Objectives**

### **5.E.1 Understand weather patterns and phenomena, making connections to the weather in a particular place and time.**

5.E.1.1 Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

5.E.1.2 Predict upcoming weather events from weather data collected through observations and measurement.

5.E.1.3 Explain how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation.

### **5.P.2 Understand interactions of matter and energy and the changes that occur.**

5.P.2.1 Explain how the sun's energy impacts the processes of the water cycle (including evaporation, transpiration, condensation, precipitation, and run-off).

### **5.P.3 Explain how the properties of some materials change as a result of heating and cooling.**

5.P.3.1 Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures (conduction, convection, or radiation).

5.P.3.2 Explain how heating and cooling affect some materials and how this relates to their purpose and practical applications.

## **Essential Question for the Unit**

**How can technology be used to build an understanding of weather and climate?**

## **Pre-Unit Assessment**

Two formative assessment probes are correlated to the *Investigating Weather Systems* unit of study. The first is called “Rainfall” and can be found on page 171 of *Uncovering Student Ideas in Science Volume 3* (Orange Cover), by Page Keeley et al. This probe elicits students’ ideas about precipitation. The other formative assessment is called “Camping Trip” and can be found on page 137 of *Uncovering Student Ideas in Science Volume 4* (Green Cover) by Page Keeley et al. This probe elicits students’ ideas about the effect of solar radiation on Earth’s temperature. You might choose to administer one probe or both probes.

## **Unit Information**

The Tracks *Investigating Weather Systems* unit is a literacy-based approach to science instruction. In addition to hands-on investigations, you will find reading selections to support student learning as well as opportunities for students to express their learning through presentation, letter writing, and the creation of a travel brochure.

As you begin the unit, begin collecting new or used pizza boxes so students can create a solar oven in their study of heat transfer (convection, conduction, and radiation). This alignment lesson, called Heat Transfer, appears under days 67-68 in CMAPP. You might solicit the help of adult volunteers to cut the pizza boxes using the box cutters available in the *Ecosystems* science kit. Be aware of food allergies in your classroom. The lesson is written to make s'mores in the solar oven, but an alternative might be to melt bits and pieces of crayons in a baking cup. Solicit the help of adult volunteers to assist you in removing items from the solar ovens, as they can become very hot. Oven mitts, pot holders, and spatulas should be available.

Rather than using the smoke box made out of cardboard, as presented in Lesson 6, you can purchase a metal and glass convection chamber (smoke box) from Carolina Biological for \$41.35 plus tax and shipping. (1-800-334-5551 Item # 753449) You will also find a link on CMAPP to a video demonstration of the smoke box.

Finally, important teacher content information about weather can be found in the "Information for the Teacher" section at the end of each lesson in the *Investigating Weather Systems* Teacher Guide.



Clarifying Objective 5.E.1.3 highlights the effects of global patterns, such as the jet stream and the Gulf Stream, on **local** weather. Throughout this Lesson by Lesson Guide, you will find information regarding the impact of global weather patterns on North Carolina weather.

## **Lesson 1 - Vacation Destination (*Lesson 1 in Investigating Weather Systems*)**

*Students will explore weather at home and around the world. Students will be introduced to instruments that provide weather data. Students will begin collecting local weather data.*

\*This lesson can cover 2-3 days with an additional 15 minutes each day for weather data collection.

### **Clarifying Objectives**

**5.E.1.1** Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

**5.E.1.2** Predict upcoming weather events from weather data collected through observation and measurements.

### **Focus Question(s)**

**What instruments can be used to obtain data about the weather?**

**How can weather data be used to predict patterns of weather?**

**How are aspects of weather related and influenced by one another?**

**How do components of weather interact to form weather systems?**

<b>Activity</b>	<b>Guiding Questions</b>
<ul style="list-style-type: none"><li>• Begin by asking the students where they have gone when they have taken a vacation. Solicit answers from many students, commenting only that the places have been in different parts of the state, country, and world. Acknowledge that vacations, wherever they are, are fun to take. Together with students, read the introduction to the lesson in the student guide. Ask for some ideas of places where students would like to go on a dream vacation. Accept all answers and build excitement for the idea of thinking about a dream vacation destination.</li><li>• Students choose a dream vacation destination and predict that day's high temperature at that location.</li><li>• Students check the accuracy of their prediction and share their results.</li><li>• Students are also introduced to the weather station/newscast/website (whatever is easier for your classroom).</li><li>• They will create a data table and review procedures for collecting weather data.</li><li>• Have groups share findings in a whole class discussion. This discussion helps</li></ul>	<ol style="list-style-type: none"><li>1) What instruments can be used to obtain data about the weather? (There are instruments that provide data about weather. These include: thermometer, barometer, anemometer, wind vane, and rain gauge).</li><li>2) How can weather data be used to predict patterns of weather? (Weather data can be used to predict patterns of weather).</li><li>3) How are factors of weather related and influence one another? (Factors of weather, such as temperature, air pressure, wind speed, and precipitation are related and influence one another).</li><li>4) How do components of weather interact to form weather systems? (Components of weather interact to form weather systems).</li></ol>

<p>to clarify concepts taught in the lesson and identify any misunderstandings. Any additional content for the lesson can be brought into the discussion at this time.</p> <ul style="list-style-type: none"> <li>• Ask students what questions they have now.</li> </ul>	
---	--

### **Science Content Words**

*Use these terms when teaching the lesson:*

<b>weather</b>	state of the atmosphere at a given time and place with respect to wind, temperature, cloudiness, moisture, and pressure; daily or hourly conditions
<b>meteorologist</b>	scientist who studies weather
<b>Sun</b>	the driving force of weather
<b>temperature</b>	degrees warm or cold; influenced by cloud cover
<b>wind speed</b>	changes as air pressure changes
<b>wind direction</b>	reported by the direction from which wind originates; prevailing westerly winds blow from the west to the east
<b>precipitation</b>	form of water that falls from the clouds to the Earth
<b>barometric (air) pressure</b>	weight of the air above the surface of the Earth, applies pressure on objects
<b>cloud cover</b>	fraction of the sky covered by clouds; cloudy, partly cloudy, partly Sunny
<b>thermometer</b>	instrument used to measure temperature (in degrees Fahrenheit or Celsius)
<b>anemometer</b>	instrument used to measure wind speed (in miles per hour or mph)
<b>wind vane</b>	instrument used to measure wind direction
<b>rain gauge</b>	instrument used to measure amount of rain over a specific period of time
<b>barometer</b>	instrument used to measure air pressure

### **Integration Hints**

- Students can use websites, such as Weatherbug ([link available on CMAPP Days 50-52](#)) to collect local and global weather data.
- Students generate a list of weather-related words and will add to the list throughout the unit.
- You might consider incorporating weather data collection into centers so data collection is occurring at the same time each day.

### **Science Notebook Helper**

- Students can draw a weather collection table in their science notebooks or attach a teacher-provided data table ([available on CMAPP Days 50-52](#)) to their notebooks.
- Students can respond to questions on the Lesson 1 Question outline ([available on CMAPP Days 50-52](#)) and paste it in their science notebooks as an artifact of learning.

### **Assessment Opportunities**

- As the *Investigating Weather Systems* unit is just beginning, the formative assessment probe can serve as an assessment opportunity.
- You might notice the weather words students generate at the beginning of the unit and how students' definitions of the weather words become more sophisticated as the unit progresses.



#### **Why are Sydney, Australia, and Alert, Canada, included on the Daily Weather Chart for collecting weather data?**

*In addition to collecting local weather data, students will gather weather data for a location in the Northern Hemisphere (Alert, Canada) as well as in the Southern Hemisphere (Sydney, Australia). This data can be used to in Investigating Weather Systems Lesson 3 when students are introduced to the concept that the seasons in the Northern Hemisphere are opposite those in the Southern Hemisphere due to the Earth's tilt. While North Carolina is located in the Northern Hemisphere, its weather may not be the same as the weather in Alert, Canada, because other variables influence weather such as latitude, elevation, and proximity to a large body of water. Students will have the opportunity to further explore the effects of these variables on weather around the world and locally.*

## Lesson 2 – Why Do Different Places in the World Have Different Weather? (*Lesson 2 in Investigating Weather Systems*)

*Students will explore the idea that the angle of the Sun's rays (direct versus indirect sunlight) causes differences in temperatures around the globe.*

\*This lesson can cover 2 class sessions. Check to make sure all flashlights are in working order at least a day before beginning this lesson. Discuss how to organize the data on the graph prior to beginning the latitude and temperature graph. Use a globe to model how to label the southern hemisphere (highest degree measure to lowest degree measure), the equator at zero degrees, and then the northern hemisphere (lowest to highest degree measure).

### Clarifying Objectives

**5.E.1.1** Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

**5.E.1.2** Predict upcoming weather events from weather data collected through observation and measurements.

### Focus Question(s)

**Where does the Earth receive the most intense heat from the Sun?**

**How does uneven heating from the Sun affect temperature at different places on the Earth?**

Activity	Guiding Questions
<b>Part 1</b> <ul style="list-style-type: none"><li>Read: "Why Do Different Places in the World Have Different Weather?"</li><li>Look at the map of average temperatures in the United States. Talk about the pattern that they see on that map.</li><li>Using temperature data from cities around the world, students identify a pattern of temperatures on Earth.</li><li>Students plot the temperature data on a graph and determine the pattern of temperatures related to latitude. (if students require some scaffolding, graphs with temperature and latitude are available on CMAPP Days 53-56)</li><li>Graph just three northern hemisphere cities: Fairbanks, Istanbul, and Lagos. <b>Students must leave room on their graph paper to graph three southern hemisphere cities later.</b></li></ul> <b>Part 2</b> <ul style="list-style-type: none"><li>Using a flashlight and graph paper, teams compare the areas covered by direct and indirect light rays.</li></ul>	<b>Part 1</b> <ul style="list-style-type: none"><li>What happens to the temperature if a city's location is closer to the equator?</li><li>What happens to the temperature if a city's location is farther from the equator?</li><li>Describe the pattern you observe on your graphs.</li><li>Why do you think temperatures are higher closer to the equator?</li></ul> <b>Part 2</b> <ul style="list-style-type: none"><li>What are the differences between the direct and indirect images you observed?</li><li>Do you observe any difference in the brightness of the light?</li><li>How does the difference in these images help to understand the difference between the Sun shining directly and indirectly on the Earth?</li><li>Would temperatures on Earth be warmer at places that get direct light from the Sun or at places that get indirect light from the Sun?</li><li>Where does the Earth receive the most</li></ul>



<ul style="list-style-type: none"> <li>Students then relate their investigations to the concept of differential heating on Earth's surface.</li> <li>Have groups share findings in a whole class discussion. This discussion helps to clarify concepts taught in the lesson and identify any misunderstandings. Any additional content for the lesson can be brought into the discussion at this time.</li> <li>Ask students what questions they have now.</li> </ul>	<p>intense heat from the Sun? (<i>The Sun's energy is most intense at the equator</i>).</p> <ul style="list-style-type: none"> <li>How does uneven heating from the Sun affect temperature at different places on the Earth? (<i>The Sun's rays strike the Earth's surface at different angles due to its shape. Sun rays strike with high intensity at the Equator and surrounding Tropical Regions; medium intensity in the Mid-latitudes and Temperate Regions; and low intensity north of the Arctic Circle and south of the Antarctic Circle in the Polar Regions</i>).</li> </ul>
---	---

### **Science Content Words**

*Use these terms when teaching the lesson:*

<b>data</b>	information (plural; singular = datum)
<b>hemisphere</b>	half of a sphere; the Earth has four hemispheres: northern, southern, eastern, western; the Equator divides the Earth into the northern and southern hemispheres and the Prime Meridian divides the Earth into the Eastern and Western hemispheres.
<b>equator</b>	Imaginary, horizontal line around the middle of the Earth
<b>latitude</b>	the distance north or south of the Equator
<b>longitude</b>	the distance west or east of the Prime Meridian
<b>angle of incidence</b>	angle the sunlight hits the Earth (more intensity = warmer); sometimes called angle of insolation
<b>direct sunlight</b>	Sun rays that strike the Earth in a straight line (most direct, intense rays = Equator)
<b>indirect sunlight</b>	Sun rays that strike the Earth at an angle (most indirect, least intense rays = north and south pole)

### **Integration Hints**

- Students are organizing and displaying data on graphs. Assist students to observe patterns and trends in the data they have displayed.
- Students might further research one of the cities/countries that are included in the weather data.
- Links are available on CMAPP to reteach concepts through video and/or songs.

### **Science Notebook Helper**

- Graphs can be drawn directly in students' science notebooks or stapled into the notebook, if completed on separate sheets of paper, as an artifact of learning.

### Assessment Opportunities

- Samples of assessments (verbal or written): graphing and interpreting temperature data as related to latitude, identifying the pattern that temperatures generally are higher as one gets closer to the equator, comparing the area covered by direct and indirect light beams, relating the amount of lighted area to the intensity of the light and heat transferred to that area, and comparing the classroom model with the relationship between Earth and the Sun.
- Students can also respond to the Lesson 2 Question Outline (available on CMAPP Days 53-56) and turn them in to the teacher or place them in their science notebook.



#### **How does this investigation relate to weather in North Carolina?**

*While there are many variables which affect weather, the angle of incidence of the Sun's energy is the most important. The location of places on the surface of the Earth puts them either in a direct line with the energy from the Sun or at some angle to the energy from the Sun. While latitude and longitude are used to pinpoint locations on Earth, the focus of this lesson is latitude {the distance North or South of the Equator} and its effect on temperatures. The Equator receives the most direct sunlight while locations North and South of it receive indirect sunlight. The most indirect sunlight occurs at the North and South Poles.*

*In this investigation, St. Louis, MO (approx. 38° North Latitude) and Denver, CO (approx. 39° North Latitude) are included in the data set. (Raleigh, NC is located at approximately 36° North Latitude, which is about the same distance north of the Equator as St. Louis and Denver.) While St. Louis and Denver have similar average temperatures for January, there is a difference of 6 degrees between the average July temperatures. Denver's cooler average July temperature will be attributed to the variable of elevation in Lesson 5.*

*North Carolina's location north of the Equator means it receives indirect sunlight.*

### Lesson 3 – Seasons (*Lesson 3 in Investigating Weather Systems*)

*Students will explore the concept that seasonal variations on the Earth's surface are due to the Earth's axis.*

\*This lesson can cover 2 class sessions. You might consider having students use tennis balls or Styrofoam balls as models of the Earth for their team investigations. You could use a globe or an inflatable beach ball as a model of the Earth for demonstration purposes.

#### **Clarifying Objectives**

**5.E.1.1** Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

**5.E.1.2** Predict upcoming weather events from weather data collected through observation and measurements.

#### **Focus Question(s)**

**At any given time of the year, how are temperatures in the northern hemisphere different from temperatures in the southern hemisphere?**

**What factors cause changing seasons on Earth?**

Activity	Guiding Questions
<b>Part 1</b> <ul style="list-style-type: none"><li>• Read: "Seasons." Keep discussion brief. Record student response for comparing later.</li><li>• Model the team skill (see Teacher's Edition for question stems.)</li><li>• Read "The Long Lift Ride"</li><li>• Comparing Colorado and Australia (Venn diagram) in science notebook</li></ul> <b>Part 2</b> <ul style="list-style-type: none"><li>• The Reason for Seasons Investigation</li><li>• Refer to bar graphs from lesson 2: "Why Do Different Places in the World Have Different Temperatures?"</li><li>• <b>Graph three southern hemisphere cities: Jakarta, Rio de Janeiro, and Sydney on the same graph.</b></li><li>• Students identify a pattern of temperatures related to latitude and the intensity of the Sun's rays. Record conclusions in science notebook.</li><li>• Students identify a pattern of temperatures related to the tilt and position of the Earth (seasons) around the Sun. Record conclusions in science notebook.</li><li>• Sharing Ideas / Checking</li></ul>	<ul style="list-style-type: none"><li>• At any given time of the year, how are temperatures in the northern hemisphere different from temperatures in the southern hemisphere? <i>(In general, locations equidistant north and south from the Equator have opposite seasons, and may seem to have opposite temperatures. However, there are factors, in addition to latitude, such as proximity to water, elevation, and convection currents in air and water that also contribute to varying temperatures, and they will be explored in later lessons. Also, temperatures near the Equator may vary little throughout the year.)</i></li><li>• What factors cause changing seasons on Earth? <i>(The Earth is tilted on its axis at <math>\approx 23.5^\circ</math>. The Earth travels in an elliptical orbit. The Sun is slightly off-centered in this elliptical orbit. Although it's true that the Earth is closer to the Sun during part of this orbit, this distance change is NOT the reason for the changing seasons. In fact, the Earth is closer to the Sun during the northern hemisphere's</i></li></ul>

<p>Understanding in science notebook. Have groups share findings in a whole class discussion. This discussion helps to clarify concepts taught in the lesson and identify any misunderstandings. Any additional content for the lesson can be brought into the discussion at this time.</p> <ul style="list-style-type: none"> <li>• If time: graph the other 6 city temperatures from lesson 2. Discuss.</li> </ul>	<p>winter season at 147 million km, than it is in the northern hemisphere's summer season at 152 million km away from the Sun. This slight change in distance would be like adding a couple of blocks to a marathon run; it is insignificant. The #1 reason for the changing seasons is the tilt of the Earth).</p> <ul style="list-style-type: none"> <li>• Additional questions are listed throughout the Teacher and Student Guides.</li> </ul>
--	--

### **Science Content Words**

*In addition to terms introduced in the previous lesson, use these terms when teaching the lesson:*

<b>Earth's axis</b>	imaginary, vertical line through the middle of the Earth; Earth rotates around it
<b>tilt of the Earth</b>	Earth is tilted on its axis at $\approx 23.5^\circ$ .
<b>rotation</b>	spin; the Earth rotates counter-clockwise on its axis (1 rotation $\approx$ 23 hours, 56 minutes $\approx$ 1 day)
<b>revolution</b>	orbit; the Earth revolves counter-clockwise around the Sun in an elliptical orbit (1 revolution $\approx$ 365.25 days $\approx$ 1 year)
<b>climate</b>	weather over a long period of time (10 years, 50 years, 100 years, etc.)

### **Integration Hints**

- Students read a selection about a skier from Denver, CO, and another from Sydney, Australia.
- Students will locate Denver and Sydney on a map, or preferably on a globe, to understand their locations in different hemispheres.
- Links are available on CMAPP to reteach concepts through video and/or songs.

### **Science Notebook Helper**

- Students will use the inquiry question(s) to complete a science notebook entry. The entry includes an inquiry question, student developed prediction, planning (materials, procedure, and data collection plan), data, learnings (what the student learned from the investigation), and next steps/new questions (further questions the student has about the investigation and next steps to take in completing a further investigation).
- Part of students' data entry should be a Venn diagram comparing and contrasting Denver and Sydney based on the reading selection

### **Assessment Opportunities**

- Students write an imaginary letter to describe what causes the difference in the seasons.



### **How does this investigation relate to weather in North Carolina?**

*North Carolina is located in the Northern Hemisphere. The Northern Hemisphere receives sunlight more directly during the summer due to the curvature of the Earth. Conversely, the Northern Hemisphere receives sunlight more indirectly during the winter due to the curvature of the Earth.*

*The tilt of the Earth also creates a variance in the length of daylight in addition to the difference in direct versus indirect sunlight in summer and winter. More daylight (sunlight) and more direct solar energy combine to cause warmer weather in the summer months in the Northern Hemisphere.*

*While the reading selection in the Student Guide highlights Denver, CO, and Sydney, Australia, it's important for students to understand that Denver and North Carolina are located in the Northern Hemisphere. Students should also have the opportunity to locate Denver and/or North Carolina on a globe and compare it to the location of Sydney, Australia in the Southern Hemisphere. Manipulating a globe and noticing the difference in locations/hemispheres may lead students to a better understanding of the phenomena of opposite seasons in the Northern and Southern Hemispheres.*

## Lesson 4 - American Weather (*Lesson 4 in Investigating Weather Systems*)

*Students will explore the idea that temperatures can change due to the proximity to a large body of water.*

\*This lesson can cover 2-3 class sessions.

### Clarifying Objectives

**5.E.1.1** Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

**5.E.1.2** Predict upcoming weather events from weather data collected through observation and measurements.

**5.P.3.1** Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures (conduction, convection, radiation).

**5.P.3.2** Explain how heating and cooling affect some materials and how this relates to their purpose and practical applications.

### Focus Question(s)

**What factors affect the weather in the USA?**

**What happens to air temperature as elevation increases?**

**How do land and water absorb radiation from the Sun?**

Activity	Guiding Questions
<b>Part 1</b> <ul style="list-style-type: none"><li>Students investigate the effect of proximity to a large body of water on temperature by graphing temperature data from three cities (St. Louis, Denver, and San Francisco) that are at about the same latitude.</li><li>Students discover that the city closest to the ocean generally has warmer temperatures in winter and cooler temperatures in summer.</li></ul> <b>Part 2</b> <ul style="list-style-type: none"><li>Then, students investigate whether soil or water heats and cools faster.</li><li>After they collect temperature data, students relate the results of their investigation to the pattern of city temperatures they identified in the first activity.</li><li>Have groups share findings in a whole class discussion. This discussion helps to clarify concepts taught in the lesson and identify any misunderstandings. Any additional content for the lesson can be brought into the discussion at</li></ul>	<ul style="list-style-type: none"><li>What factors affect the weather in the USA? (<i>Sun, Earth's tilt, latitude, proximity to water, water cycle, convection</i>).</li><li>What happens to air temperature as elevation increases? (<i>Temperature decreases i.e., gets cooler. It decreases <math>\approx 3.6^{\circ} F</math> for every 1,000 feet of increased elevation</i>).</li><li>Land and water absorb radiation from the Sun. How does that affect weather? (<i>The Sun <b>radiates</b> thermal energy (heat) to the land and water on Earth. Land and water heat the air above through <b>convection</b> currents. Because land and water absorb and release (transfer) heat at different rates, the air temperature above land and water varies at all times. Therefore, geographical areas closer to bodies of water remain slightly warmer in the winter and cooler in the summer,</i></li></ul>



<p>this time.</p> <ul style="list-style-type: none"> <li>Ask students what questions they have now.</li> </ul>	<p><i>because the air above the water takes longer to cool down in the winter and heat up in the summer than the air above the land).</i></p> <ul style="list-style-type: none"> <li>Additional questions are outlined in the Teacher and Student guides.</li> </ul>
--	--

### **Science Content Words**

*Review these terms:* temperature, thermometer, latitude, longitude

*Use these terms when teaching the lesson:*

<b>potential energy</b>	stored energy; energy of position
<b>kinetic energy</b>	energy of motion; moving energy
<b>thermal energy</b>	the total potential and kinetic energy of the particles in an object; (more kinetic energy of particles = more heat, less kinetic energy of particles = less heat)
<b>radiation</b>	transfer of thermal energy <i>by electromagnetic waves</i> through places with or without matter (examples: light bulb, campfire, fireplace, microwave, Sunlight traveling through space)
<b>convection</b>	transfer of thermal energy <i>by liquids or gases</i> (examples by liquids: hotter at surface of a swimming pool, cup of soup, or boiling water on stove) (examples by gases: hot air balloon, lower floors being cooler than top floors in a building)
<b>convection current</b>	a continual cycle of heat rising, cooling, sinking, and replacing rising heat. (examples by liquids: gulf stream, El Nino/La Nina) (examples by gases: jet stream, sea breeze, land breeze)
<b>conduction</b>	transfer of thermal energy <i>between things that are touching</i> (examples of conduction: touching the handle of a hot metal pot, electrical circuit, ice in water) (examples of insulation: rubber surrounding electrical wires, insulation inside walls)

### **Integration Hints**

- Students analyze data on a line graph. Students may need assistance interpreting and analyzing line graphs that contain multiple elements such as a comparison of soil and water temperature over a period of 30 minutes.

- Students write a persuasive letter to a parent/guardian that outlines all the details of the weather in San Francisco, Denver, and St. Louis and why the chosen city is the best location for the family.

### **Science Notebook Helper**

- Graph paper can be added to a science notebook for students to create line graphs.

- Students will use the inquiry question to complete a science notebook entry. The entry includes an inquiry question, student developed prediction, planning (materials, procedure, and data collection plan), data, learnings (what the student learned from the investigation), and next steps/new questions (further questions the student has about the investigation and next steps to take in completing a further investigation).

### **Assessment Opportunities**

- A graphic organizer and related persuasive letter comparing temperature data of three cities at the same latitude (one that is near an ocean and two that are not near the ocean, such as Boone, NC, Raleigh, NC, and Kitty Hawk, NC).
- Students can complete the Checking Understanding Note Page individually or as a homework assignment.



### **How does this investigation relate to weather in North Carolina?**

*Students compare average monthly temperatures for St. Louis, Denver, and San Francisco, which are relatively located at similar latitude. (Raleigh, NC, is too!) The differences in average temperatures for cities located at similar latitude may lead students to consider other variables which influence temperature. The focus of this investigation is a city's proximity to a large body of water.*

*North Carolina has many cities in close proximity to the Atlantic Ocean. Kitty Hawk, NC, is located at approx. 36 degrees North latitude along with Raleigh, NC. Comparing the temperatures of Kitty Hawk and Raleigh might reveal some interesting differences: Summer temperatures in Kitty Hawk may be a few degrees cooler than temperatures in Raleigh while winter temperatures in Kitty Hawk may be a few degrees warmer than temperatures in Raleigh.*

*The Gulf Stream originates at the tip of the Florida peninsula and moves northward along the Eastern seaboard of the United States, influencing weather in the Southeast, including North Carolina. Cities along the coast, such as Wilmington, NC, and Kitty Hawk, NC, will generally be a few degrees warmer in winter when compared to inland cities such as Raleigh, NC, and Greensboro, NC.*



## Lesson 5 - Climb to Cold (*Lesson 5 in Investigating Weather Systems*)

*Students will explore the relationship between elevation and temperatures.*

\*This lesson will cover one class session.

### **Clarifying Objectives**

**5.E.1.1** Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

**5.E.1.2** Predict upcoming weather events from weather data collected through observation and measurements.

**5.P.3.1** Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures (conduction, convection, or radiation).

### **Focus Question(s)**

**What is the relationship between elevation and temperature?**

**How do radiation and uneven heating of the Earth's surface relate to elevation and temperature?**

**How can convection currents be used to analyze temperature at different elevations?**

Activity	Guiding Questions
<ul style="list-style-type: none"><li>• Begin by reviewing the previous lesson:<ul style="list-style-type: none"><li>- <i>The Sun radiates thermal energy (heat) to the land and water on Earth.</i></li><li>- <i>Land and water heat the air above through convection.</i></li><li>- <i>Because land and water absorb and release (transfer) heat at different rates, the air temperature above land and water varies at all times. This is referred to as "uneven heating of Earth's surface."</i></li><li>- <i>Therefore, geographical areas closer to bodies of water remain slightly warmer in the winter and cooler in the summer, because the air above the water takes longer to cool down in the winter and heat up in the summer than the air above the land.</i></li></ul></li><li>• Refer to the lesson 4 chart of temperatures. Note that each city's elevation was included.</li><li>• Ask students: "How do you think elevation may be a factor affecting</li></ul>	<ul style="list-style-type: none"><li>• What is the relationship between elevation and temperature?</li><li>• How do radiation and uneven heating of the Earth's surface relate to elevation and temperature?</li><li>• How can convection currents be used to analyze temperature at different elevations?</li></ul>

<p>temperature?"</p> <ul style="list-style-type: none"> <li>• Read the introduction of the lesson. Ask students: "Is the boy or girl correct?" Keep discussion brief.</li> <li>• Have students locate the cities of New Delhi, India; Katmandu, Nepal; and Mount Everest on a map. Note the latitude of each city.</li> <li>• Ask students: "What temperature do you predict each place may be during the month of May?"</li> <li>• Students use <i>Lesson 5 CM 5-1: Up to the Top</i> to record elevations at each "Stop" sign in the "Up to the Top" reading selection.</li> <li>• Read aloud "Up to the Top."</li> <li>• In teams, students review the story and list "clues" about temperature and other features of Mt. Everest that will help them formulate a model of the relationship between temperature and elevation.</li> <li>• Student teams use their lists to frame their own explanations for why temperatures are colder on the peak of mountains than at the base.</li> <li>• Finally, students will share their explanations.</li> <li>• Have groups share findings in a whole class discussion. This discussion helps to clarify concepts taught in the lesson and identify any misunderstandings. Any additional content for the lesson can be brought into the discussion at this time.</li> <li>• Ask students what questions they have now.</li> </ul>	
---	--

### **Science Content Words**

*Use these terms when teaching the lesson:*

<b>sea level</b>	where the ocean meets the land; zero elevation
<b>elevation</b>	the height of a place above sea level (Mount Everest has an elevation of 29,029 feet).

<b>altitude</b>	the vertical elevation of an object; the distance above sea level or above Earth's surface (The airplane was flying at an altitude of 30,000 feet).
<b>mountain</b>	a very tall, high, natural place - higher than a hill (Mount Everest is the tallest mountain on Earth).
<b>density</b>	the measure of how tightly packed the matter in an object is (hot air = less dense, cool air = more dense)

### **Integration Hints**

- Students read an expository text closely, pausing at various point to collect information provided in the text.
- Locate Mount Everest on Google Maps or share images of it. Students might research hikers/climbers who have set out to climb Mount Everest.

### **Science Notebook Helper**

- Students write explanations in their science notebooks. Encourage students to use labeled diagrams and pictures to enhance their explanations.
- Students will use the inquiry question to complete a science notebook entry. The entry includes an inquiry question, student developed prediction, planning (materials, procedure, and data collection plan), data, learnings (what the student learned from the investigation), and next steps/new questions (further questions the student has about the investigation and next steps to take in completing a further investigation).

### **Assessment Opportunities**

- Sample assessments (verbal or written): recording and accurately comparing temperatures at various elevations of Mount Everest, describing the pattern of decreasing temperatures from the bottom to the top of a mountain.
- Students complete the Checking Understanding activity independently or as a possible homework assignment.



#### **How does this investigation relate to weather in North Carolina?**

*This lesson focuses on the variable of elevation and its effect on temperature. Because of the mountains in the Western part of the state, North Carolina has several cities at higher elevations than Raleigh. Both Raleigh and Boone, NC, are at approx. 36 degrees North latitude. Comparing temperatures in Raleigh and Boone, NC, may reveal that Boone is generally cooler than Raleigh throughout the year because of its elevation. There are times throughout the winter and spring when Raleigh will have a rainy day, but Boone will experience wintry precipitation such as snow, sleet, and ice.*

## Lesson 6 - What Drives the Weather? (Lesson 6 in Investigating Weather Systems)

*Students will investigate the Sun as the source of energy for all weather phenomena on the Earth's surface.*

\*This lesson can cover 3 class sessions. It also includes investigations to be conducted at home. Rather than using the smoke box made out of cardboard, you can purchase a metal and glass convection chamber (smoke box) from Carolina Biological. (1-800-334-5551 Item # 753449) You'll also find a link (Weather & Climate Board)\* on **CMAPP Days 60-62** to a video demonstration of the convection chamber.

*\*The Weather & Climate Board is hosted by Discovery Education and will require Discovery Ed log in.*

### **Clarifying Objectives**

**5.E.1.1** Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

**5.E.1.2** Predict upcoming weather events from weather data collected through observations and measurements.

**5.E.1.3** Explain how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation.

**5.P.2.1** Explain how the Sun's energy impacts the processes of the water cycle (including evaporation, transpiration, condensation, precipitation, and run-off).

**5.P.3.1** Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures (radiation, convection, conduction).

### **Focus Question(s)**

**How does the Sun affect weather phenomena?**

**What is the role of the water cycle?**

**How do different kinds of clouds forecast weather conditions?**

**What role does convection play in weather?**

Activity	Guiding Questions
<ul style="list-style-type: none"><li>• Read the introduction: "What Drives the Weather?"</li><li>• Review weather words from lesson 1.</li><li>• Brainstorm and list all weather words learned so far that have something to do with the Sun.</li><li>• Draw a Sun beside these words. (Accept all ideas at this time. If there is disagreement, place a question mark beside the word, and remind students that this list will be reviewed later).</li><li>• Students perform simple evaporation and condensation activities at home to explore the ways water changes state from liquid to gas and vice versa. Armed with their common experiences,</li></ul>	<ul style="list-style-type: none"><li>• Can you trace the path of a single water drop through the water cycle?</li><li>• How does energy from the Sun help drive the water cycle?</li><li>• If the temperature of Earth were much colder, how would that affect the water cycle?</li><li>• If the temperature of Earth were much hotter, how would that affect the water cycle?</li><li>• What if there were no difference in temperatures from one place to another, at different elevations, or between land and water? How would the water cycle be affected?</li><li>• What is happening to the smoke in the</li></ul>

<p>students relate the Sun's energy to the formation of clouds.</p> <ul style="list-style-type: none"> <li>• Then, students use a smoke (convection) box and observe the movement of air (wind) within the box.</li> <li>• Finally, they discuss how the uneven heating of Earth's surface causes air to move. They revisit their list of weather content words and decide if other words are related to the Sun.</li> <li>• Have groups share findings in a whole class discussion. This discussion helps to clarify concepts taught in the lesson and identify any misunderstandings. Any additional content for the lesson can be brought into the discussion at this time.</li> <li>• Ask students what questions they have now.</li> </ul>	<p>box (convection chamber)?</p> <ul style="list-style-type: none"> <li>• If the smoke is moving, what else must be moving?</li> <li>• Why do you think smoke is being used in this investigation?</li> <li>• What do you think causes the air to move in the box (convection chamber)?</li> </ul>
---	--

### **Science Content Words**

*Use these terms when teaching the lesson:*

Vocabulary related to the water cycle:

<b>water cycle</b>	the continuous process by which water moves from Earth's surface to the atmosphere and back; also called the hydrologic cycle
<b>evaporation</b>	changing from liquid to water vapor; a water cycle process
<b>condensation</b>	changing from water vapor becomes liquid; a water cycle process
<b>precipitation</b>	form of water that falls from a cloud to the Earth; a water cycle process
<b>collection</b>	when precipitation accumulates in a body of water, in the ground, or as runoff to a body of water; a water cycle process
<b>ground water</b>	water stored in soil and rock beneath Earth's surface
<b>runoff</b>	excess water that the ground cannot absorb; a water cycle process
<b>water vapor</b>	water in a gas state
<b>transpiration</b>	plants give off water through stomata in leaves; water evaporating from plant leaves; a water cycle process

Vocabulary related to clouds:

<b>cloud</b>	a large collection of tiny water droplets or ice crystals in the atmosphere; classified by shape and altitude; formation depends on air mass movement; usually form at frontal boundaries and in low pressure areas
<b>stratus</b>	low level clouds (up to 6,500 feet); means "to spread out" looks like layers or blankets that cover the sky; result in overcast weather and sometimes produce

	precipitation; fog is a stratus cloud at ground level
<b>cumulus</b>	middle level clouds (6,500-18,000 feet); means "heap" or "pile;" look puffy, like cotton; grow vertically from a flat base to rounded towers; results in fair weather
<b>cumulonimbus</b>	tall cumulus clouds (grow vertically up to 50,000 feet tall); look like an anvil; results in heavy precipitation, especially thunderstorms; nimbus = rain
<b>cirrus</b>	high level clouds; (above 18,000 feet); means "curl of hair;" look thin and wispy, like feathers; composed of ice crystals (high altitude = cold temperatures)
<b>nimbus</b>	a rain cloud; may be used as a prefix or suffix for rain clouds, such as cumulonimbus, nimbostratus

#### Vocabulary related to wind:

<b>wind</b>	horizontally moving air; caused by uneven heating of the Earth's surface, which creates warm and cool air masses, resulting in differences in air pressure from place to place; moves from high pressure area to low pressure area, like when deflating a balloon;
<b>local wind</b>	moves across small distances close to Earth's surface; unpredictable; changes frequently with air pressure fluctuation (examples include: sea breeze, land breeze, Chinook, Santa Ana, etc)
<b>global wind</b>	moves great distances over the globe; predictable and stable; also called atmospheric circulations (examples include: Polar Easterlies, Prevailing Westerlies, and Trade Winds)
<b>Trade Winds</b>	winds that occur between 30° N and 30° S; blow from east to west; blow continuously toward the Equator; global winds
<b>Prevailing Westerlies</b>	winds that occur between 30° and 60° in both hemispheres; blow from west to the east; blow towards the poles; global winds
<b>Polar Easterlies</b>	winds that occur between 60° and 90° in both hemispheres; blow from east to west; blow away from the poles; global winds
<b>jet stream</b>	air current in the upper atmosphere, located above North America; has powerful influence over weather conditions; flows from west to east; changes location depending on global conditions
<b>sea breeze</b>	a convection current where air flows from sea to land during the daytime; a local wind (land heats up and cools down faster than water; see <i>convection current</i> )
<b>land breeze</b>	a convection current where air flows from land to sea during the nighttime; a local wind (land heats up and cools down faster than water; see <i>convection current</i> )
<b>windward</b>	side of the mountain facing the wind; evaporating (heated) air is pushed up by the mountain, it cools, condenses, and precipitates frequently; vegetation is dense; sometimes called wayward
<b>leeward</b>	side of the mountain not facing the wind; cooled air sinks; air is dry because it has already condensed and precipitated on the windward side; vegetation is sparse;

	deserts are found on the leeward side of mountains
<b>rain shadow effect</b>	lack of precipitation on the leeward side of the mountain

### **Integration Hints**

- Students will use the smoke box (convection chamber) to support their statements made (with verbal or written) about the movement of warm and cool air masses.

### **Science Notebook Helper**

- Students will use the inquiry question to complete a science notebook entry. The entry includes an inquiry question, student developed prediction, planning (materials, procedure, and data collection plan), data, learnings (what the student learned from the investigation), and next steps/new questions (further questions the student has about the investigation and next steps to take in completing a further investigation).

- Students can draw themselves in their diagram of the convection chamber to help them visualize the air movement they would experience.

### **Assessment Opportunities**

- Samples of assessments (verbal or written): communicating the results of three simple evaporation and condensation investigations and relating the results to the formation of clouds; describing the flow of water and energy as water changes from a liquid to a gas and back to liquid; describing the relationships between heat energy from the Sun and evaporation and the cooling of air, the formation of clouds, and precipitation; describing the horizontal movement of air inside a smoke box; relating the movement of air in the smoke box to wind on the surface of the Earth, stating that uneven heating by the Sun causes air to move; placing an image of the Sun beside most “weather words” on a class list, and thoughtfully/thoroughly responding to the questions in “Sharing Ideas” and “Checking Your Understanding” section of this lesson.



#### **How does this investigation relate to weather in North Carolina?**

*Clouds are various shapes and sizes. Observing clouds the describing their properties can help us forecast, or predict, weather. For example, observing low-level, gray stratus clouds may lead a person to predict an overcast, rainy day.*

*Students who have had the opportunity to visit North Carolina beaches may have experienced sea breezes- air moving from over the water toward the land- during the day. This wind is caused by the uneven heating of land and water by the sun and creates a convection cycle – warm, less dense air rising and cooler, dense air moving into replace the air that has risen.*

*–continued-*





*Conversely, land breezes occur at night because air is moving from over the land toward the water. This is a result of the uneven cooling of land and water, which were warmed by the sun during the day.*

*The Prevailing Westerlies, a global wind pattern which blows from the West to the East, help bring North Carolina's weather from the West to East. As residents of North Carolina, we can often look to the Midwest region of the United States and predict what our weather might be in a day or two. The Jetstream also moves weather systems from West to East. It can also impact temperatures in North Carolina – a dip to the South of North Carolina can bring cooler temperatures.*

*The Trade Winds, another global wind pattern near the Equator, blow east to West. This impacts North Carolina particularly during hurricane season (June-November) by moving tropical storms and hurricanes toward the Southeastern United States.*



## Lesson 7 - Oh! The Pressure! (Lesson 7 in Investigating Weather Systems)

*Students will explore the effects air pressure has on weather patterns, particularly winds.*

\*This lesson can cover two class sessions.

### Clarifying Objectives

**5.E.1.1** Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

**5.E.1.2** Predict upcoming weather events from weather data collected through observations and measurements.

**5.E.1.3** Explain how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation.

**5.P.3.1** Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures (radiation, convection, conduction).

### Focus Question(s)

**How can we explore the properties of air?**

**What effect does air pressure have on weather patterns, particularly winds?**

Activity	Guiding Questions
<ul style="list-style-type: none"><li>• Student teams complete four investigations and watch a classroom demonstration to explore the following properties of air: air take up more space than cold air, air has weight, and air has pressure.</li><li>• Students relate their experiences with the smoke box to the concept of air pressure. They describe the “winds” in the box (movement of air from one end of the box to the other) and relate that movement to differences in air pressure.</li><li>• Students are introduced to the effects of air pressure on other weather patterns, specifically clear and cloudy weather.</li><li>• Have groups share findings in a whole class discussion. This discussion helps to clarify concepts taught in the lesson and identify any misunderstandings. Any additional content for the lesson can be brought into the discussion at this time.</li><li>• Ask students what questions they have now.</li></ul>	<ul style="list-style-type: none"><li>• What is the exact formula, or equation for forecasting the weather? <i>(There is no exact formula, or equation, for forecasting the weather. It's so challenging at times, that meteorologists are wrong in their predictions. Weather is not completely predictable)</i></li><li>• If there's high pressure, does that always mean hot temperature like on a clear day in the summer? If there's low pressure, does that always mean a warm front is approaching, like when it rains or drizzles for hours at a time? <i>(No, there is no exact rule for how air pressure may relate to temperature in weather systems. <b>Common Misconception:</b> Do not confuse air pressure with temperature when analyzing weather systems. For example, high pressure does not always mean hot or cold temperature. Low pressure does not always mean hot or cold temperature. It is possible to experience both high pressure and low</i></li></ul>

	<p><i>pressure on any given day or season of the year. In a fixed, consistent, confined space like a two-liter bottle, when air pressure increases, temperature will increase. However, weather does not occur in a fixed, consistent, and confined space.)</i></p> <ul style="list-style-type: none"> <li>• <i>Is air pressure really that important? (When forecasting, meteorologists look for these two criteria first: 1) The moisture and temperature of air masses, and 2) The air pressure in order to see how the air masses will be moving. High pressure blows toward low pressure. Remember to think of air in columns, like the two columns on the convection box from lesson 6. The more air that is pressing down, the higher the pressure. High pressure means that cool air is pressing down in the column. High pressure means stable, fair weather, with clear skies. The less air that is pressing down, the less air there is to hold heat, the less air there is to breathe, the lower the pressure. Low pressure means that warm air is rising, and cool air is blowing in quickly to replace it. Low pressure means unstable, changing weather, with overcast skies.)</i></li> <li>• <i>What does the Sun have to do with air pressure? (Air masses are steered by the jet stream and wind. Wind blows due to different amounts of air pressure. Different amounts of air pressure are caused by the uneven heating of the Earth's surface. The uneven heating of the Earth's surface is caused by the Sun.)</i></li> </ul>
--	---

## Science Content Words

*In addition to terms introduced in previous lessons, use these terms:*

<b>atmosphere</b>	A layer of gases surrounding a planet. The Earth's atmosphere is divided into five layers: exosphere, thermosphere, mesosphere, stratosphere, and troposphere.
<b>troposphere</b>	layer of the atmosphere ~0-11 miles up; we live here; almost all of weather occurs here
<b>air mass</b>	A large region of the atmosphere where the air has similar properties throughout, such as temperature, humidity, and air pressure.
<b>High pressure system</b>	A whirling mass of cool, dry air. Because cool air is heavy and denser than warm air, it sinks. High pressure brings fair weather, sunny skies, light winds, and stable weather. High pressure systems rotate clockwise.
<b>Low pressure system</b>	A whirling mass of warm, moist air. Because warm is lighter and less dense than cool air, it rises, and then cooler air flows in underneath. Low pressure systems bring storms, strong winds, and changing, unstable weather. Low pressure systems rotate counter-clockwise.
<b>front</b>	A boundary between two air masses, resulting in stormy weather. A front is usually a line of separation between warm and cold air masses.
<b>cold front</b>	A boundary between two air masses (one cold and the other warm) moving so that the colder air replaces the warmer air.
<b>warm front</b>	A boundary between two air masses (one cold and the other warm) moving so that the warmer air replaces the colder air.
<b>stationary front</b>	A boundary between two air masses that more or less doesn't move, but some stationary fronts can wobble back and forth for several hundred miles a day.

## Integration Hints

- Students will use the smoke box (convection chamber) to support their statements made (whether verbal or written) about the movement of warm and cool air masses. Students go back to their (Lesson 6 Guided Practice) diagrams of them inside their convection box with the arrows to show the path of the convection current. Now, write "High Pressure" where there is high pressure, and label it with a blue "H." Next, students write "Low Pressure" where there is low pressure, and label it with a red "L."

## Science Notebook Helper

- Students will use the inquiry question to complete a science notebook entry. The entry includes an inquiry question, student developed prediction, planning (materials, procedure, and data collection plan), data, learnings (what the student learned from the investigation), and next steps/new questions (further questions the student has about the investigation and next steps to take in completing a further investigation).

- Have students continue to use notebooks and make drawings of the different cloud types and the types of weather associated with them.

### Assessment Opportunities

- Samples of assessments (verbal or written): describing and recording the results of four investigations, listing the properties of air in teams and as a class, explaining the crushing milk jug demonstration, describing the movement of air in the smoke box in terms of air pressure, stating that winds blow from high-pressure to low-pressure areas, and relating local wind patterns to the reported barometric (air) pressure.



#### **How does this investigation relate to weather in North Carolina?**

*The Prevailing Westerlies, a global wind pattern which blows from the West to the East, help bring North Carolina's weather from the West to East. As residents of North Carolina, we can often look to the Midwest region of the United States and predict what our weather might be in a day or two. The Jetstream also moves weather systems from West to East. It can also impact temperatures in North Carolina – a dip to the South of North Carolina can bring cooler temperatures.*

*Differences in air pressure cause winds. High pressure is associated with clear weather in North Carolina while Low pressure is associated with cloudy weather. When winds move masses of cold or warm air away from the regions where they form, air masses come into conflict. The place where air masses clash is called a front. Fronts are often the place where the most dramatic weather occurs, such as a line of strong to severe thunderstorms.*

*The movement of air as it advances and retreats creates winds that can add to a storm's energy. The greater the difference between the low and high pressure of the masses of the air involved in the storm, the higher the wind's speed. Sometimes wind shear caused by the mountains in Eastern North Carolina will weaken a storm system before moving into the central Piedmont region of the state.*

*La Niña and El Niño are oscillations of water temperatures in the Pacific Ocean. Because the Jetstream and Prevailing Westerlies move weather systems from the West Coast to the East Coast, La Niña and El Niño influence weather across North and South America. During La Niña, the eastern tropical Pacific Ocean cools, which impacts North Carolina and the Southeastern*  
*-continued-*



*United States with a warmer and drier winter season. La Niña is believed to have caused a drought in North Carolina and the Southeastern United States during 2007-2009. This led to lower freshwater supplies for drinking and cities restricted washing cars and watering lawns in an effort to conserve water.*

*During El Niño, a pool of warm western tropical Pacific water shifts toward South America. El Niño impacts North Carolina and the Southeastern United States with a cooler and wetter winter season. El Niño also tends to disrupt the development of hurricanes in the Gulf of Mexico and the Atlantic Ocean.*

## Lesson 8 - Understanding Weather Systems (*Lesson 8 in Investigating Weather Systems*)

*Students will recognize that weather patterns can be described and used to make forecasts.*

\*This lesson will cover two class sessions.

### Clarifying Objectives

**5.E.1.1** Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

**5.E.1.2** Predict upcoming weather events from weather data collected through observations and measurements.

**5.E.1.3** Explain how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation.

**5.P.2.1** Explain how the Sun's energy impacts the processes of the water cycle (including evaporation, transpiration, condensation, precipitation, and run-off).

**5.P.3.1** Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures (radiation, convection, conduction).

### Focus Question(s)

What are some possible weather patterns and trends we may identify in our local weather data?

How much weather data is needed to compile before it may be called the "climate."

What kind of weather data pattern will we find on a rainy day? Does this make a weather system?

How can we use weather patterns to make forecasts?

Activity	Guiding Questions
<ul style="list-style-type: none"><li>Students discuss the accuracy of rhymes that attempt to describe and forecast the weather. Link available on <b>CMAPP Days 65-66</b> for weather rhyme examples:</li><li>Students create their own weather rhyme that tells something they have learned about the weather.</li><li>Share student-created weather rhymes in whole group.</li><li>Read aloud student guide pages 141-142.</li><li>Review your compiled, daily weather data. If you have any missing data, and wish to check for a specific date, see the link on <b>CMAPP Days 65-66</b>.</li><li>Preview the team task on study guide p. 142.</li><li>Make <b>Weather System Teams</b> of four.</li><li>To save time (optional), use the line graph templates in "Initial Instructional Strategies."</li><li>Assign <b>Weather Data Teams</b> to graph data together (see "Teacher Tips.")</li></ul>	<ul style="list-style-type: none"><li>What are some possible weather patterns and trends we may identify in our local weather data? (<i>Example: We may observe that the sunset is occurring earlier and the sunrise is occurring later every day; when it rains, the humidity is at or near 100%; if there is 0-10% sky/cloud cover, then there is high pressure; or when the pressure was falling, the wind speed increased.</i>)</li><li>How much weather data is needed to compile before it may be called the "climate"? (<i>Climate is based on "a long time" of compiling weather data every day. Some climatologists specify that they need 10 years, 50 years, or even 100 years of data before they may officially establish a specific climate for a place or season.</i>)</li><li>What kind of weather data pattern will we find on a rainy day? Does this make a weather system? (<i>Example: When it rained, we observed high winds from</i></li></ul>

<ul style="list-style-type: none"> <li>Weather System teams analyze their graphs and identify patterns among temperature, air pressure, wind speed, and precipitation. For example, are there any dates that may represent a rainy weather system? What was the rest of the data like for that day? Were there any patterns?</li> <li>Finally, students consider the term "weather system" and analyze the parts of weather that interact to make the weather what it is.</li> <li>Teams share findings in a whole class discussion. This discussion helps to clarify concepts taught in the lesson and identify any misunderstandings. Any additional content for the lesson can be brought into the discussion at this time.</li> <li>Ask students what questions they have now.</li> </ul>	<p><i>the northwest, high humidity, falling air pressure, slightly lower temperature, and it was mostly cloudy. Yes, all of these parts of the weather may make up a weather system. We predict that this weather system may have been part of a cold front that passed through from the northwest to the southeast.)</i></p>
---	---

### **Science Content Words**

*In addition to terms introduced throughout the unit, use these terms when teaching the lesson:*

<b>weather system</b>	all the parts of weather
-----------------------	--------------------------

### **Integration Hints**

- Have students display and share their data with the class. Data should include a title, and labeled axis. Analyze the data in cooperative groups and then discuss as a class. Students can write a caption to synthesize the data presented on graphs/charts.
- Use the student graphs to determine the median, range, and mode.

### **Science Notebook Helper**

- Students will use the inquiry question to complete a science notebook entry. The entry includes an inquiry question, student developed prediction, planning (materials, procedure, and data collection plan), data, learnings (what the student learned from the investigation), and next steps/new questions (further questions the student has about the investigation and next steps to take in completing a further investigation).
- Use notebooks for graphs and explanations.

### **Assessment Opportunities**

- Samples of assessments (verbal or written): plotting and analyzing data about temperature, wind speed, air pressure, and precipitation; identifying the patterns found on line graphs; expressing how the patterns help explain the weather conditions; identifying the parts of weather systems that interact and referring to the interacting components as a system; describing the components of weather that interact.





### **How does this investigation relate to weather in North Carolina?**

*Weather changes daily. These changes are noted in weather data collected daily about temperature, air pressure, wind speed and direction, types of clouds present, and precipitation. While all of these things interact in some way to create the weather we experience day to day, there are many variables which can impact weather across North Carolina as addressed throughout this unit. Some of the variables include:*

- *proximity to a large body of water (NC cities such as Kitty Hawk and Wilmington)*
- *elevation (NC cities such as Boone, Asheville)*
- *location of the Jet Stream North or South of North Carolina*
- *Whether or not the El Niño or La Niña weather pattern is present*

*The addition of these variables adds to the complexity of weather forecasting.*



### Heat Transfer (*Alignment Lesson*)

*Students sort everyday examples of heat transfer into three categories: convection, conduction, or radiation. Students then explore heat transfer by building a pizza box solar oven.*

\*This lesson can cover two class sessions. You might solicit the assistance of adult volunteers to cut pizza boxes with box cutters prior to this investigation. Adult volunteers can assist with removing items from the solar ovens. Have oven mitts or spatulas handy for removing items.

### Clarifying Objectives

**5.P.3.1** Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures (conduction, convection, or radiation).

**5.P.3.2** Explain how heating and cooling affect some materials and how this relates to their purpose and practical applications.

### Focus Question(s)

**What are some natural examples of each type of heat transfer?**

**How can heat change the properties of a substance?**

Activity	Guiding Questions
<p><b>Part 1</b></p> <p>1. Show students a bag of marshmallows, chocolate bars, and graham crackers. Prompt students to share their experiences making s'mores. As they share their various experiences, guide students to notice that all the various ways to make s'mores involve <i>heat</i> - whether from a campfire, a microwave, or a stove top.</p> <p>Guide students to connect to the three methods of heat transfer:</p> <p><b>convection</b> - has been explored earlier in the <i>Investigating Weather Unit</i> as the cause of land and sea breezes; modeled by the convection chamber (smoke box)</p> <p><b>conduction</b> - has been explored in the <i>Magnetism &amp; Electricity Unit</i> (4th Grade); students investigated conductors, which allow the flow of energy, and insulators, which do not allow the flow of energy.</p> <p><b>radiation</b> - has been/will be (depending on the order 5th grade units are taught) introduced as the light from the Sun provides the energy for producers to undergo the process of photosynthesis. Another connection might include prompting students to remember a Kindergarten investigation where a thermometer was placed in a black</p>	<ul style="list-style-type: none"><li>• Why would (heat transfer example) be considered convection?</li><li>• Why would (heat transfer example) be considered conduction?</li><li>• Why would (heat transfer example) be considered radiation?</li><li>• Why is the aluminum foil added to the solar oven?</li><li>• Why is the black construction paper added to the solar oven?</li><li>• Why would we cover the opening of the solar oven with plastic wrap?</li><li>• Where might we place the solar ovens to receive direct sunlight?</li><li>• How might the (materials placed in the solar oven) change as a result of heating?</li><li>• How might we improve the design of the solar oven?</li><li>• How might the use of solar ovens benefit the environment?</li></ul>

construction paper pocket and another in a white construction paper pocket. Students probably discovered the thermometer in the black construction paper pocket had a higher reading than the thermometer in the white pocket due to dark colors absorbing light energy. This finding was then transferred to the idea of wearing light colored clothing on hot sunny days.

2. Explain that heat transfer is a common occurrence that happens naturally in everyday situations. Introduce the Heat Transfer sorting mat and Heat Transfer Examples (available in the Instructional Resource section below). Prompt students to cut apart the examples and sort them as an example of convection, conduction, or radiation.

3. Call time and review the Heat Transfer website ([link available on CMAPP Days 67-68](#)) with students; the website is built using Flash and may not play on Apple products such as iPad and iPod. Use the notes on the website and brief simulations to discuss the three methods of heat transfer. Each slide includes additional examples of the heat transfer method.

4. Invite students to revisit their sorting mats to confirm and/or rearrange the heat transfer examples based on the brief presentation and class discussion. Students can select an example of heat transfer and write or engage in discussion with teammates to justify the reasons why the example is convection, conduction, or radiation.

5. Call time and present the Heat Transfer Power Point for students to review the heat transfer examples. Pause for students to vote on and discuss whether the example is convection, conduction, or radiation. Prompt students to justify their thinking.

## **Part 2**

6. Share with students that they will use light from the Sun to make s'mores inside a solar oven. Introduce the materials students will use to build a solar oven. Provide students with

directions or view the video clip on how to build a pizza box solar oven. (Available on CMAPP Days 67-68)

7. Prompt students to gather the materials and begin working on their solar ovens. Circulate the class and offer troubleshooting tips such as smoothing out the aluminum foil or making sure the plastic wrap is taped securely to create a seal.

8. On a sunny day (no matter which season), identify a place on the school grounds where the solar ovens can be placed in direct sunlight and undisturbed. It will be convenient to place the solar ovens can be placed nearby so temperature can be monitored and observations can be recorded.

9. Prompt students to record observations of the materials being placed in the solar oven. For example, the chocolate is a solid and it is brown. Guide students to recall the purpose of the aluminum foil (*to reflect sunlight into the oven*), black construction paper (*to absorb sunlight*), and the plastic wrap (*to create a window for viewing and to seal the oven so less heat escapes*).

10. Observe the temperature of the solar oven and the baking process every 15-20 minutes. Students can record data and observations in their science notebooks.

11. The temperature inside the solar oven can increase quickly, especially on hot, sunny days. \*\*For safety reasons, a teacher or another adult should remove items from the solar ovens for students to observe. This is a great opportunity to discuss the need for an insulator such as an oven mitt, pot holder, or spatula, for removing items and avoid getting burned.

12. Prompt students to make an additional observation of the materials. For example, the chocolate is brown, but it is a liquid because it melted in the solar oven.

13. Students can enjoy their treats once they are cooled and assist with clean up. Provide some time for students to recall their experience in their science notebooks.

## **Science Content Words**

*Use these terms when teaching the lesson:*

<b>temperature</b>	measurement of heat; high temperature indicates more thermal energy
<b>heat</b>	energy that exists in matter
<b>convection</b>	movement of thermal energy by the movement of liquids or gases
<b>conduction</b>	transfer of thermal energy between two objects that are touching
<b>radiation</b>	transfer of energy by electromagnetic waves through places with or without matter
<b>conductor</b>	any object that allows heat (energy) to pass through easily
<b>insulator</b>	any object that is difficult for heat (energy) to pass through

## **Integration Hints**

- Students follow directions and/or video demonstration to build a solar oven from a pizza box.
- Students can write a How To explaining how to make s'mores or another recipe of their choice in the solar oven.
- Students can make a connection to the *Ecosystems* Unit by researching the environmental benefits of solar cooking. For example, solar ovens do not require the burning of fossil fuels or wood in their operation. Additionally, solar ovens can provide hot food in the absence of electricity in the days immediately following a hurricane strike.
- As an engineering extension, students can create a materials list and procedures to create a better solar oven than the pizza box solar ovens created in class. After developing a plan, students can construct their design, test it, and make adjustments as necessary.
- To review and model *conduction*, have a group of students stand in a line shoulder to shoulder (touching) and pass a ball or other object through the line.
- To review *convection*, students can toss a ball into the air (similar to juggling) to model the up and down motion of gases and liquids heating, expanding, rising (due to less density) then cooling, and falling (due to increased density).
- To review *radiation*, student pairs can toss a ball back and forth noting that the ball is traveling through the air and space between them. Just like electromagnetic waves travel from the Sun through space to the Earth.

## **Science Notebook Helper**

- Students should include detailed, labeled drawings of their solar ovens and use vocabulary correctly.

## **Assessment Opportunities**

- Students' sort mats can be used as a summative assessment. A second set of heat transfer examples can be distributed for students to sort and paste in place at the conclusion of the lesson.

- Prompt students to select an example of convection, conduction, and radiation and write a explanation to justify their stance on the type of heat transfer taking place.
- Students can generate their own list of examples of heat transfer and provide justification regarding the type of heat transfer.



**How does this investigation relate to weather in North Carolina?**

*This lesson reviews heat transfer – conduction, convection, and radiation – and emphasizes that the Sun is responsible for heating the land, water, and air in North Carolina and all over the world. Weather is a series of heat transfer through radiation (heating caused by the Sun) and convection (such as land and sea breezes). This lesson highlights some examples of heat transfer that occur in everyday scenarios.*

## **Lesson 9 - Weather Wise (Lesson 9 in Investigating Weather Systems)**

*Students will create and present travel brochures using their understanding of the variables that affect weather on earth.*

\*This lesson can cover 2-3 class sessions. Students could also conclude the unit by creating and presenting a television weathercast that shows what they know about weather systems. Have students incorporate weather content words and content information into the broadcast (creation of props optional). A written script of the broadcast is required. If students will be creating a travel brochure, you might consider providing examples of various travel brochures so students have a visual of the format and design.

### **Clarifying Objectives**

**5.E.1.1** Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

**5.E.1.2** Predict upcoming weather events from weather data collected through observation and measurements.

**5.E.1.3** Explain how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation

**5.P.2.1** Explain how the Sun's energy impacts the processes of the water cycle (including evaporation, transpiration, condensation, precipitation, and run-off).

### **Focus Questions**

**What are some variables that affect weather in various places on Earth?**

<b>Activity</b>	<b>Guiding Questions</b>
<ul style="list-style-type: none"><li>• Students demonstrate their understanding of concepts presented in this module by creating and presenting brochures.</li><li>• Each brochure describes one place on Earth and includes information about the location, relationship to the Sun, proximity to water, and other variables that affect its weather. Students must not only describe the weather but explain why this location has the weather it does.</li><li>• Students help develop a rubric that will evaluate their brochures and presentations.</li><li>• Have groups share findings in a whole class discussion. This discussion helps to clarify concepts taught in the lesson and identify any misunderstandings. Any additional content for the lesson can be brought into the discussion at</li></ul>	<ul style="list-style-type: none"><li>• Where on Earth is the place you have selected?</li><li>• In regards to elevation, is it a high place or a low place?</li><li>• How close is the place to water?</li><li>• Does the place have seasons?</li><li>• How do the Sun's rays hit this place (directly or indirectly) throughout the year?</li><li>• What are the average annual high and low temperatures?</li><li>• What is the annual rainfall amount?</li><li>• What kind of severe weather does the location experience?</li><li>• During which time of year might the location expect severe weather?</li><li>• Which variables might cause the expected weather?</li><li>• Which kinds of weather-based activities might travelers enjoy while visiting?</li><li>• How might a traveler prepare for</li></ul>

this time. • Ask students what questions they have now.	weather in this location when packing?
--	--

### **Science Content Words**

*Use terms introduced throughout the Investigating Weather Systems unit.*

### **Integration Hints**

- Students create a travel brochure or a weather newscast.
- Students present an oral presentation of their brochure or weather newscast.

### **Science Notebook Helper**

- Samples of assessments (verbal or written): discussing the general differences in weather between locations on Earth, creating a travel brochure for a specific place that describes its weather and why it has such weather, sharing the brochure with the class.
- Students will use the inquiry question to complete a science notebook entry. The entry includes an inquiry question, student developed prediction, planning (materials, procedure, and data collection plan), data, learnings (what the student learned from the investigation), and next steps/new questions (further questions the student has about the investigation and next steps to take in completing a further investigation).
- Students complete the planning and rough drafts of their brochures in their science notebooks.

### **Assessment Opportunities**

- Assess the brochures based on student led rubrics. Be sure students accurately present concepts and use vocabulary correctly in their creations.



### **How does this investigation relate to weather in North Carolina?**

*Students can compare and contrast weather in another location to weather in North Carolina. For example, comparing Kitty Hawk's weather to Miami's weather – both are located in close proximity to water and are influenced by the Gulf Stream, but Miami's latitude at 25 degrees North means it is a bit closer to the Equator (more direct sunlight) than Kitty Hawk.*

*The travel brochure project can be limited to cities within North Carolina or cities in the United States, or opened to include locations around the world.*