5th Grade Earth Science: Weather Unit

NORTHSIDE
Outdoor Wonder & Learning

Cover photo credit: Lauren Greene

Developed for Chapel Hill Carrboro City Schools
Northside Elementary School Outdoor Wonder & Learning (OWL) Initiative

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5th Grade Weather
Table of Contents

5th Grade Weather Unit

Overarching Unit Question

What is weather and how does it affect us?

Essential Questions

Arc 1: What is weather and what factors influence the weather?
Arc 2: How does the ocean affect our weather?
Arc 3: How does weather affect our lives?

Transfer Goals

- Use scientific thinking to understand the relationships and complexities of the world around them.
- Identify real-world dilemmas and opportunities and apply scientific thinking to develop solutions for them.

Enduring Understandings (Science)

- Weather impacts our lives and living conditions.
- Forecasting weather allows us to make decisions that influence the quality of our lives.

Target Science Essential Standards

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 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 runoff).

Secondary Target Standards (ELA, Math, Social Studies)

ELA

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.

RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

W.5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

W.5.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.

Math

NC.5.MD.2 Represent and interpret data.

- Collect data by asking a question that yields data that changes over time.
- Make and interpret a representation of data using a line graph.
- Determine whether a survey question will yield categorical or numerical data or data that changes over time.

Unit Overview

This unit is divided into 3 Arcs. Arc 1 answers the essential question, "What is weather and what factors influence the weather?" The learning activities included in this arc guide students to use observation skills in order to describe, explain, and predict weather patterns. Students will learn that the sun's energy is the driving force of our weather. They will complete activities to learn about wind, clouds, precipitation, temperature, and the role the water cycle plays in our weather.

In Arc 2, students examine the essential question, "How does the ocean affect our weather?" Students will complete activities to help them describe and explain the gulf stream, El Nino, La Nina, Sea and Land Breezes as well as hurricanes.

Arc 3 allows students to investigate the essential question, "How does weather affect our lives?" Students will complete activities to help them explain why our choices are based on the weather, as well as the impact that climate change as on ecosystems. During the culminating activity in Arc 3, students research how to prepare for extreme weather. Students have several opportunities to use their observations skills while working on their nature journals.

Duration

14-19 days of 45 minute learning activities

Vocabulary*

atmosphere, air mass, air pressure, condensation, evaporation, high pressure system, humidity low pressure system, precipitation, prevailing winds, troposphere, water vapor, wind, weather, season, seasonal, cloud, cirrus, cumulus, nimbus, cumulonimbus, stratus, fog, anemometer, barometer, cold front, fronts, warm front, occluded front, stationary front, rain gauge, thermometer, wind vane, El Nino, Gulf Stream, Jet Stream, land breeze, La Nina, meteorologist, meteorology, sea breezes, climate, climate change**,** convection, radiation, conduction

** Definitions of vocabulary words can be found on the arc overview pages. Relevant vocabulary is listed on each learning activity page.*

Go Outdoors! Tips & Tools

Taking your class outside for science or any lessons can be rewarding and challenging. Along with behavior and materials management tips with each lesson, this section is intended to help you have the tools you need to successfully take your class outside.

Before You Go Outside

- Create **ground rules** with students for all outdoor lessons. Post the rules for students to be able to easily see.
- Ask for **parent volunteers**. Extra help can make an outdoor learning experience much more manageable.
- Teach students proper use, including safety, of the science tools they will be using.
- Set expectations before go. Give instructions both inside and repeat once outside.
- Have a clear **objective** for going outdoors. This will help focus students' attention.
- Be flexible. Structure lessons to take advantage of **opportunities and challenges**.
- Establish a meeting spot and emergency plan. Have a signal for emergency situations.
- Take students outside for short exercises to practice rules before longer outdoor lessons.
- Use **same door** to always go outside for learning. Emphasize this is different than going outside for recess.

While You Are Outside

- **Model** the activities and outdoor skills for students. Show them what you expect them to be doing.
- **Participate in the activity**. Get down on your students' level. Get your hands dirty.
- Model **respect for nature** with your students.
- The outdoors is full of **teachable moments**. Use "I wonder" statements to engage students in questioning the experience. Have students write down questions to be researched back in the classroom.
- Allow students to be **leaders** in the activity. Ask students to volunteer as teacher assistant or materials manager.
- Acknowledge that students want to explore and can do so once the assigned task is complete.

Safety First!

- Scout outdoor areas ahead of time if possible, to note **potential hazards** such as poison ivy.
- Students should **never be alone**. If a student needs to go back to the building, send 2 students.
- Take a **first aid kit and phone/walkie-talkie**. Consider bringing along staff trained in first aid/CPR.
- Let office staff know where you and your class are going if headed out on a walking field trip.
- **Stay on the trail/path**, unless otherwise directed. On the greenway, stay on the right side of path.
- **Do not eat wild plants**, unless harvesting in the garden with a teacher.
- Set **boundaries** for the students to stay within. You have to be able to see me and I have to be able to see you!

A Note on Nature Journaling

Nature journals that you use with your class should be small composition books or other blank books that students use to make outdoor observations, including writing, drawing, and painting. Students can use colored pencils, watercolor pencils, or other materials to remember details of plants, animals, and habitats they are investigating around the schoolyard. This is different from a science notebook. However, some teachers may choose to have students paste blank pages into their science notebook to use for nature journaling pages.

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Arc 1
What is weather & what factors influence the weather?

Essential Questions

What is weather and what factors influence the weather?

NC Science Essential Standards – Unpacked Content

5.E.1.1 Students know that weather can change from day to day and that many factors are measured to describe and predict weather conditions. (e.g., wind speed and direction, precipitation, temperature, and air pressure). Students know that in different latitudes and hemispheres there are different (and sometimes opposite) seasonal weather patterns.

5.E.1.2 Students know that one can collect and compare weather data in order to predict the likelihood of a particular weather condition occurring. Students know how to read basic weather instruments: thermometer, barometer, anemometer, wind vane, and rain gauge. Students also can identify atmospheric conditions (presence and type of clouds [stratus, cirrus, cumulus], fronts) that are associated with predictable weather patterns. Students can make basic weather predictions using these skills.

5.E.1.3 Students know that local weather conditions are influenced by global factors such as air and water currents. The jet stream is an air current in the upper atmosphere, located over North America that has a powerful influence on the weather conditions there. The jet stream flows from the west to the east and changes location depending on global conditions. The Gulf stream is a warm water surface current in the Atlantic Ocean that moves from south of Florida up the eastern seaboard and then across the Atlantic. The Gulf stream moderates weather along the eastern seaboard, warming the air and land there during the cooler months. In the Pacific, there is an oscillation of water temperatures known as El Nino/La Nina. This oscillation impacts the climate of North and South America for long periods of time. Hurricanes are major storms that form over warm ocean water and are caused by global weather patterns

5.P.2.1 Students know that the sun provides the energy that is a driving force for most biotic and abiotic cycles on the surface of the earth. Students know that the sun's energy fuels the water cycle and impacts different aspects of the water cycle (evaporation, transpiration, condensation, precipitation).

Lessons in this Arc

- Engaging Activity: Local Weather Data
- Learning Activity 1: The Earth's Atmospheric Layers
- Learning Activity 2: Weather & the Seasons
- Learning Activity 3: What Causes Wind
- Learning Activity 4: When Air Masses Meet
- Learning Activity 5: What Moves Air Masses
- Learning Activity 6: Clouds & Their Formation
- Learning Activity 7: Clouds & Weather
- Learning Activity 8: The Water Cycle & Weather

Go Outdoors!

- ✓ Engaging Activity: Local Weather Data
- ✓ Learning Activity 6: Clouds & Their Formation
- ✓ Learning Activity 7: Clouds & Weather

Nature Journal Connection

- Engaging Activity: Local Weather Data
- Learning Activity 6: Clouds & Their Formation
- Learning Activity 7: Clouds & Weather

Duration

6-8 days of 45 minute learning activities

Background Information

Weather is the state of the atmosphere at any given time and place with respect to wind, temperature, cloudiness, moisture, pressure, and other factors. Most of Earth's weather occurs in the **troposphere**, the lowest layer of the atmosphere. Earth's **atmosphere** is made of a series of layers that surround the earth. It absorbs energy that radiates from the earth's surface. Without the atmosphere to insulate the earth, it would be uninhabitable. **Air pressure**, the force exerted on a surface by the weight of air, decreases as you move up in the troposphere. Differences in air pressure cause the movement of air, otherwise known as **wind**. **Prevailing winds** are global winds that constantly blow in the same direction over a certain area of the earth. The **jet stream** is a series of fast flowing air currents that can push air masses to other areas and influence weather patterns. The jet streams are more active in the winter when there are wider ranges of temperature differences between arctic and tropical air masses. Air moves from areas of higher pressure to areas of lower pressure, resulting in various wind speeds. **High pressure systems** are associated with clear skies while **low pressure systems** are associated with dark clouds and precipitation. Weather is different from climate. **Climate** is dependent on the range of weather over a period of time. **Climate change** occurs when changes in Earth's climate system result in new weather patterns, lasting for at least a few decades.

An **air mass** is a body of air which has the same temperature and/or humidity throughout. **Humidity** is the amount of water vapor present in the air. A **front** is where two air masses of different densities meet. This can result in a **cold front**, cold air replacing the warm air, or a **warm front**, warm air replacing the cold air. A cold front results in cool, dry air, while a warm front results in warmer, wetter air. A **stationary front** is where two fronts meet but neither are strong enough to take over the other. There is also an **occluded front**, where a warm air mass is caught between two cooler air masses, pushing the warmer air upwards.

Different patterns of weather and daylight throughout the year are used to distinguish between the four seasons—fall, winter, spring, and summer. **Seasons** are caused when different parts of the earth receive different amounts of daylight as the earth rotates around the sun on its tilted axis. Season**s** are different, and sometimes opposite, depending on latitude and/or hemisphere. The **equator** is an imaginary line dividing the northern and southern hemisphere.

When water is heated, it **evaporates** into a gas. When it cools, it **condenses** from a gas back into a liquid. **Clouds** form when there is too much water vapor in the air. The **water vapor** condenses into tiny droplets that form clouds. Eventually, the water droplets become too heavy and fall to the ground in the form of **precipitation**. This is mainly in the form of rain, snow, sleet, or hail. **Cirrus** clouds are high altitude, feathery, thin clouds made of tiny ice crystals. **Cumulus** clouds are low altitude, fluffy clouds that are often seen with hot weather. **Nimbus** clouds are dark and produce precipitation. **Cumulonimbus** clouds are tall, dark clouds that bring thunderstorms. **Stratus** clouds are low, thin clouds that can bring light drizzles**. Fog** is a cloud of small air droplets suspended over the earth's surface.

Basic weather instruments can be used to predict the weather. Some of which include, a rain gauge, thermometer, anemometer, barometer, and wind vane. A **rain gauge** measures the amount of liquid precipitation over a set period of time. A **thermometer** is used to measure temperature. An **anemometer** is used to measure the speed of wind. A **barometer** measures air pressure. A **wind vane** is used to detect the direction wind is blowing. A **meteorologist** uses these devices in order to forecast the weather. **Meteorology** is the branch of science concerned with forecasting and understanding weather.

Vocabulary

- An **air mass** is a body of air that has the same temperature and/or humidity throughout.
- **Air pressure** is the force exerted onto a surface by the weight of air.
- The **atmosphere** is the layer of air that surrounds the earth.
- **Condensation** is the changing of gas back to a liquid.
- The **equator** is the imaginary line drawn around the middle of the earth.
- **Evaporation** is when a liquid changes back into a gas (water to water vapor).
- The **jet stream** is a narrow band of air that flows from west to east around the earth at relatively high speeds.
- A **high-pressure system** is a whirling mass of cool, dry air that generally brings fair weather and light winds.
- **Humidity** is a measure of the amount of water vapor in the air.
- A **low-pressure system** is a whirling mass of warm, moist air that generally brings stormy weather with strong winds.
- **Precipitation** is any liquid or solid form of water that falls from the atmosphere: rain, snow, hail, or sleet.
- **Prevailing winds** are global winds that blow constantly from the same direction.
- **Seasons** are periods of time during the year marked by specific weather patterns and daylight hours, resulting from the earth's changing position with regard to the sun.
- The **troposphere** is the lower layer of the atmosphere. All weather occurs in the troposphere.
- **Water vapor** is created when liquid water turns into a gas form due to heat.
- **Weather** is the state of the atmosphere at a given time and place with respect to wind, temperature, cloudiness, moisture, pressure, and other factors.
- **Wind** is the movement of air caused by earth's uneven heating of the land surfaces. Wind moves from high pressure to low pressure.

Literature Connections

Online

ReadWorks.org:

- Introduction to Clouds
- The Four Core Types of Clouds
- How Clouds Form
- Ten Basic Clouds
- Dust of Snow-Robert Frost
- Let It Snow
- Winter Worries & Hazards
- What Happens When It Rains?
- Water, Water, Everywhere

Wonderopolis.org:

- Why does water take so long to warm up?

Engaging Activity: Local Weather

Lesson Prep

- ✓ Make a *Weekly Weather Chart* using chart paper (template at end of lesson)
- ✓ Find an area outside where students can make observations without being disturbed by other students.

Vocabulary

Weather

Procedure

Independent Work

- Take students outside with their Nature Journals and tell them they will be using their observation skills.
- Use the questions below as guiding questions:
  - What do you see?
    - Is the ground wet from rain or snow?
    - Is there frost on the ground or other objects?
    - Is there any snow or ice on the ground or on other objects?
    - Is it cloudy?
    - Is it windy?
    - Is it raining?
    - Is it snowing?
  - What do you feel?
    - Is the wind blowing? How hard is it blowing against your skin?
    - Is the air hot or cold? Does the air feel dry or damp?
    - Do you feel sunshine on your skin?
- **Nature Journaling** prompt:
  - Record your observations about the weather and be sure to note the condition of the sky. Based on your observations, predict what the weather might be like in a few hours.

Mini-Lesson

- Ask students to share their observations from their nature journals.
- Explain to students that they were making observations about the weather.
- Ask students to define weather by using their observations.
- Show students the *Weekly Weather Chart*.
- Ask students why knowing what the weather conditions will be is important.

Learning Objectives:
Students will be able to understand the factors that make up weather.

Nutshell/Skills:
Students can make observations about the weather.

Science Essential Standards:
5.E.1.1, 5.E.1.2

Time:
45 minutes

Teacher Materials:
- Access to local weather data (*WRAL*)
- *Weekly Weather Chart*
- Chart paper

Student Materials:
- Nature Journals

Guided Practice

- Hang the *Weekly Weather Chart* on the wall.
- **Every day during the weather unit, s**fill in the weather chart using local weather data from the *Weather Channel* or other reliable source for local weather data (including the weather stations at Northside).
- This chart will be used to build observation skills and serve as a source of talking points throughout the unit.
- After looking at today's forecast, ask students how their predictions in their Nature Journals compared.

Independent Work

- Have students answer the following questions in their notebooks:
  - How does weather affect your daily activities at home? At school?

Assessment

- **Exit ticket:** What is weather?

Behavior Management Tips

- Discuss with students the importance of respecting nature both biotic and abiotic things. Examples include things such as:
  - leave worms and other animals alone
  - leave rocks, soil, and grass where you found them
- Define the boundary for where the students can sit and work on their nature journaling prompt.

Weekly
Weather Chart

Date & Time	Current Temperature	Precipitation Amount	Clouds (Yes or No)	Wind Speed (Anemometer)	Wind Direction	Humidity	Air Pressure (Barometer)

Learning Activity 1
The Earth's Atmospheric Layers

Lesson Prep

- ✓ Preview the *Layers of the Earth's Atmosphere Diagram.*
- ✓ Preview the U.S. National Weather Service *Weather Launch Video.*
- ✓ Preview the Interactive *Virtual Ballooning to Explore the Atmosphere .*

Vocabulary

Atmosphere, troposphere, weather

Procedure

Mini-Lesson

- Show students the *Layers of the Earth's Atmosphere Diagram.*
  - Ask students to write down everything they notice about this diagram.
  - Then ask for some volunteers to share their observations. Write these on the board. Explain to students that this is a diagram that represents the atmospheric layers of the earth.
  - Ask them which layer has clouds. Then explain that all of our weather happens in the troposphere.
- Show the U.S. National Weather Service *Weather Launch Video*.
- Show the students the Interactive *Virtual Ballooning to Explore the Atmosphere.*
  - Discuss what the numbers on the graph mean, in particular that the negative number mean cold temperatures.
  - Ask students, "What do you notice about the temperatures as the weather balloon changes in altitude?"

Independent Work

- Ask students to read the *troposphere overview* on the UCAR Center for Science Education site.
- In their science notebooks, ask students to write a 3-5 sentence summary about the troposphere and draw a diagram of the Earth's atmospheric layers.

Assessment

- The completed diagram and summary can serve as an assessment.

Learning Objectives:
To identify the atmospheric layer where our weather occurs.

Nutshell/Skills:
Students can identify the atmospheric layer where our weather occurs.

Science Essential Standards:
5.E.1.1, 5.E.1.2

ELA Essential Standards:
RI.5.1

Time:
45 minutes

Teacher Materials:
- *Layers of the Earth's Atmosphere Diagram*
- U.S. National Weather Service *Weather Launch Video*
- Interactive *Virtual Ballooning to Explore the Atmosphere*

Student Materials:
- Chromebooks or iPads
- *Troposphere overview*
- Science notebooks
- Pencils

Opportunities for Extended Learning

1. Students could compare (and graph) temperature in Boone, NC with nearby Grandfather Mountain over the course of a few days to a week to see how temperatures compare at the different elevations.

Learning Activity 2
Weather and Seasons

Lesson Prep

- ✓ Make copies of the reading passage, "What Causes the Seasons?" and the questions unless students are reading this online.
- ✓ Get chart paper.

Vocabulary

Seasons, seasonal, weather

Procedure

Mini-Lesson:

- Give students 5 minutes to list everything they know about seasons.
- Ask them to turn and talk with a partner and share their lists.
- Then ask students to answer the following question in their notebooks. "What causes seasons?"
- Tell students you will discuss the answer to the question before class is over.
- Divide the class into 6 groups.
- Tell students they will watch a short video. Each group is responsible for taking notes on one specific word. Assign one of the following words to a group:
    - Rotation
    - Axis
    - Tilt
    - Orbit
    - Hemispheres
    - Seasons
- Explain to the students that each of these words relates to the Earth.
- Show students Scholastic's StudyJams: *"A Day on the Earth"* (3:50)
- Give each group 5 minutes to discuss the notes they took about each word.
- Draw two circles on chart paper. Label one Earth and the other the Sun.
- Have each group come to the front and explain how their word relates to the Earth. Then have them draw and label how the word relates to the Earth. For example, draw a line through the Earth for axis and label it. (You could draw the lines and then students could label them.)

Learning Objectives:
Students will be able to explain why different hemispheres have different weather patterns (seasons).

Nutshell/Skills:
Students can explain why different hemispheres have different weather patterns (seasons).

Science Essential Standards:
5.E.1.1

ELA Essential Standards:
RI.5.1, RI. 5.4

Time:
45 minutes

Teacher Materials:
- Chart paper

Student Materials:
- Science Notebooks
- "What Causes the Seasons" reading passage and questions -OR- students can read the passage online
- Chromebook

- Ask students:
  - In which hemisphere is North America located?
  - If North America is experiencing winter, what season is South America experiencing?
  - How do you know South America is experiencing summer?
  - "What causes seasons?
- Ask students to look at the answer they wrote in their notebooks for the question: "What causes seasons?"
- Ask them if their answer is correct. If not, then write the correct answer.

Independent Work:

- Have students read *"What Causes the Seasons?"* and answer the questions for the passage. This is a passage from Readworks.org.

Assessment:

- Exit ticket: "What causes seasons?" and "What season is the Southern hemisphere experiencing now?"

Opportunities for Extended Learning

1. Show the students the interactive *"Why Do We Have Seasons?"*. Demonstrate how the interactive works.
2. Have students answer questions for "Why do We Have Seasons?". Answer key for questions for "Why Do We Have Seasons?".

Name: _____ Date: _____

Why Do We Have Seasons?

Go to the *"Why Do We Have Seasons?"* interactive, ***(http://bit.ly/2Uh65IT)***
Once you click on launch, you will see tabs on the left side. Click on each tab to answer the following questions:

About Seasons:

1. *What causes day and night?* _____

_____

2. *What causes the seasons?* _____

_____

3. *What are seasons?* _____

_____

4. *What are the four seasons?* _____

Earth's Orbit:

1. *Does Earth's orbit cause seasons?* _____

Sun's Path in the Sky:

1. *Why does the sun appear to move across the sky from east to west?*

_____

2. *When does sunlight strike the Earth's surface at a vertical angle?* _____

_____

3. *When does more solar energy reach the Earth's surface?* _____

_____

4. *Does this make it warmer or colder?* _____

5. *When does the Earth's surface receive less energy from the sun?* _____

_____

Sun's Angle:

1. *Why does the Earth receive a small amount of energy?* _____

_____

2. *When is the sunlight more intense?* _____

_____

3. *When is the sunlight less intense?* _____

_____

ANSWER KEY

Why Do We Have Seasons?

Go to the *"Why Do We Have Seasons?" interactive*, ***(http://bit.ly/2Uh65IT)***
Once you click on launch, you will see tabs on the left side. Click on each one of the tabs to answer the following questions:

About Seasons:

1. ***What causes day and night?*** Every day, Earth makes one rotation on its axis. This causes day and night
2. ***What causes seasons?*** Its axis always tilts in the same direction, so the parts of Earth that receive more direct sunlight and have more daylight hours change throughout the year.
3. ***What are seasons?*** times of the year with particular patterns of weather and daylight,
4. **What are the four seasons?** spring, summer, autumn, and winter.

Earth's Orbit:

1. ***Does Earth's orbit cause seasons?*** No

Sun's Path in the Sky:

1. ***Why does the sun appear to move across the sky from east to west?*** because of Earth's rotation
2. ***When does sunlight strike the Earth's surface at a vertical angle?*** When the Sun's position is higher in the sky at noon, there are more hours of daylight
3. ***When does more solar energy reach the Earth's surface?*** The higher the Sun appears in the sky, the more solar energy reaches the surface.
4. ***Does this make it warmer or colder?*** In general, this makes it warmer.
5. ***When does the Earth's surface receive less energy from the sun?***
6. Sun appears lower at noon, there are fewer hours of daylight and, since sunlight strikes less directly.

Sun's Angle:

1. ***Why does the Earth receive a small amount of energy?*** Earth is small and far away,
2. ***When is the sunlight more intense?*** When sunlight strikes Earth's surface more directly,
3. ***When is the sunlight less intense?*** When sunlight strikes at a shallower angle and it spreads over a larger area.

Learning Activity 3
What Causes Wind?

Lesson Prep

- ✓ Gather enough materials for each student to have a small, clear plastic cup, a straw, and a pom pom.
- ✓ If possible, get an anemometer and wind vane. If not, then have a picture of anemometer and wind vane.
- ✓ Gather class set of blank US maps.
- ✓ Preview *High Pressure Animation* (NASA), *Low Pressure Animation* (NASA), *Why is high pressure associated with fair, clear skies while low pressure is associated with dark clouds and precipitation?* (3:33), and *Earth: A Global Map of Wind .*

Vocabulary

Air pressure, high-pressure system, low-pressure system, wind, anemometer, wind vane

Procedure

Mini-Lesson: Air Pressure Activity

- Write the following questions on the board:
  - "What is wind?"
  - "What causes wind?"
  - Write their responses on the board.
  - Tell students that these questions and answers will be revisited throughout the lesson.
- Each student should be given a small clear plastic cup, a straw, and a small pom pom.
- Have students place a pom pom in a plastic cup. Put the straw in the cup but not touching the bottom. Blow into the straw.
- Ask students, "What happened to the pom pom?
- Explain to the students that the pressure from the air blown into the cup is called air pressure, the force exerted onto a surface by the weight of air.
- Ask students:
  - "What is the movement of air called?" (wind)
  - "What causes the air to move?" (air pressure)
  - Ask students if the answers to the questions on the board need to be revised. If yes, ask them what the new answers should be.
- Have the students make a T-Chart in their science notebook. Tell them not to label the columns yet.
- Show students the *High Pressure Animation* (NASA).
  - Tell the students that the objects that look like balls are representing the molecules in the air.

Learning Objectives:
Students will be able to explain how the differences in air pressure help to create wind.

Nutshell/Skills:
Students can explain how the differences in air pressure help to create wind.

Science Essential Standards:
5.E.1.1, 5.E.1.2

Time:
45 minutes

Teacher Materials:
- Anemometer or picture
- Wind vane or picture
- *High Pressure Animation* (NASA)
- *Low Pressure Animation* (NASA)
- *Why is high pressure associated with fair, clear skies while low pressure is associated with dark clouds and precipitation?* (3:33)
- *Earth: A Global Map of Wind*

Student Materials:
- Clear plastic cups
- Straws
- Pom poms
- Blank US maps
- Chromebooks
- Science notebooks

    - Ask students what they notice about the molecules. Give them 2 minutes to write their observations on the left side of the T-Chart.
    - Then have students share their observations with the class. Students should note that the molecules are rising and spreading out in a clockwise motion.
    - After the discussion have them title the left side of the chart as High Pressure.
    - Make sure students recognize that the blue H on the picture represents high pressure and have them write that in the column as well.
    - Explain that high-pressure systems have heavy, cool, dry air which means the students will be "happy". Have the students write this information in under the high-pressure column of the chart.
- Then show the *Low Pressure Animation* (NASA).
    - Give students 2 minutes to write their observations on the right side of the T-Chart. Then have them share their observations with the class.
    - The students should note that the molecules were spread out on the bottom and as they rise in a counterclockwise rotation the molecules come together.
    - Make sure students recognize that the red L on the picture represents low pressure and have them write that in the column as well.
    - After the discussion have them title the right side of the chart as Low Pressure.
    - Explain to the students that low-pressure systems have moisture in the air and are associated with "lousy" weather. Have the students write this information in under the low-pressure column of the chart.
- Show students the video clip: *Why is high pressure associated with fair, clear skies while low pressure is associated with dark clouds and precipitation?* (3:33)
- Explain to students that high-pressure systems move towards low-pressure systems. Show students the *Earth: A Global Map of Wind* animation.
    - Tell the students the lines represent the winds (called isobars) and the closer they are together the faster the wind is blowing.
    - Show students a picture of an anemometer. Ask them if they know what this tool is used to measure. An anemometer measures wind speed. Ask them if they know the name of the tool used to determine wind direction. Show them a picture of a wind vane.
    - Ask them if they can find any winds that may show high or low-pressure systems.
- Ask students if the answers to the questions on the board need to be revised.

Independent Work

- Have students use their Chromebooks to access a current surface map from The Weather Channel.
    - Ask them to use a blank US map to draw and label the high and low-pressure systems.
    - They should draw arrows to represent the air moving from a high-pressure system to a low-pressure system.
    - Then they should write on the map next to each system what type of weather that area is experiencing.

Assessment

- **Exit ticket:**
    - What is wind?
    - What causes wind?

Opportunities for Extended Learning

1. Show the live *Wind Map* (good animation to show wind speed) of the US. Ask students to describe their observations and note where the wind appears to be blowing the fastest and slowest across the country. What might explain their observations (e.g., a storm? mountains?). They could compare the Wind Map to this *jet stream visualization*.

Learning Activity 4
When Air Masses Meet

Lesson Prep

- ✓ Review the *What Do You Notice?* Slideshow.
- ✓ Preview the videos *Creating a weather front* and *Meteorologist Ryan Davidson Explains Weather Maps.*
- ✓ Review and become familiar with the *Weather Fronts Simulator.*
- ✓ Make copies of the *Air Masses and Fronts* graphic organizer.

Vocabulary

Air mass, front, warm front, cold front, stationary front, occluded front, high pressure system, low pressure system

Procedure

Mini-Lesson

Students will compare a temperature map to a snow cover map using the *What Do You Notice?* slideshow.

- Show students the maps with the temperature and snow cover and ask what they notice about the maps.
- Write their observations on the board. Students should notice that areas with cold temperatures are also covered with snow. If they haven't made that connection, ask them some guided questions.
- Explain to students that air with a similar temperature and moisture is called an air mass.
- Draw a line to show where the cold air mass ends and the warm air mass begins.
- Label the cold air mass. Then ask students what they think the name for the other air mass is. Label the warm air mass.
- Show students the next two slides to demonstrate cold and warm air masses.

Ask students what they think happen when different air masses meet.

- Then show the video clip, *Creating a weather front* (1:58). The meteorologist will demonstrate an activity showing how to create a front.
- Give students 5 minutes to list everything you have learned so far about cold air masses, warm air masses, and fronts. Tell students to turn and talk with their partner to share their lists.
- Take a couple of minutes to review cold air masses, warm air masses, and fronts.

Learning Objectives:
Students will be able to explain how fronts are created and describe the type of weather associated with them.

Nutshell/Skills:
Students can explain how fronts are created and the type of weather associated with them.

Science Essential Standards:
5.E.1.1, 5.E.1.2

Time:
45 minutes

Teacher Materials:
- *What Do You Notice?* slideshow

Student Materials:
- Chromebooks
- Science notebooks
- Colored pencils
- *Air Masses and Fronts* graphic organizer

- Draw the symbols for warm front, cold front, high pressure, and low pressure on the board. Have students use colored pencils to draw the symbols in their notebooks.
- Tell them to write the words that describe the symbols as they are watching the video *Meteorologist Ryan Davidson Explains Weather Maps* (great visualizations and explanations of fronts and high and low pressure). Give students a few minutes to make sure they have the words written next to the symbols.

Independent Work

- Show students the *Weather Fronts Simulator* and demonstrate how to use it.
- Ask students to use a Chromebook to access the Weather Fronts Simulator and complete the *Air Masses and Fronts* graphic organizer to learn more about the what happens when two weather fronts collide**.**

Assessment

- **Exit ticket**:
  - 3 things you have learned
  - 2 things you found interesting
  - 1 question you still have

Opportunities for Extended Learning

- Display a surface map and have students identify the type of air pressure and front that North Carolina is experiencing or will be experiencing in the next few days.

Name: _____ Date: _____

Air Masses and their Interactions

Adapted from New Visions for Public Schools

You will use a simulator to observe and identify patterns when a relatively cold dry air mass interacts with a relatively warm moist air mass.

1. Open the *Weather Fronts simulator* (*http://www.phschool.com/atschool/phsciexp/active_art/weather_fronts/*). Play the simulator for each of the four types of fronts and record your observations in the table below. Go to *Weather WizKids Weather Fronts* (*https://www.weatherwizkids.com/?page_id=80*) to learn about the weather symbols.

Front Type	Observation of warm air mass	Observation of cool air mass	Observation of resulting weather	Weather Symbols
Cold Front				
Warm Front				
Stationary Front				
Occluded Front				

Learning Activity 5
What Moves Air Masses?

Lesson Prep

- ✓ Make copies of the Wonderopolis article, "*What is a Jet Stream?*" or let the students use their Chrome Books to read it online.
- ✓ Make copies of the "What is a Jet Stream" questions, the Cause and Effect graphic organizers, and blank US maps, 1 per student of each.

Vocabulary

Jet stream, wind, air mass, cold air mass, warm air mass, meteorologist

Procedure

Mini-Lesson

- Show students the *Animation of Jet Stream* (point out the wind speed legend at the bottom).
- Ask students:
  - What do you notice?
  - What direction is the air moving?
  - Where is wind speed greatest?
- Show students the video "*How Does the Jet Stream Work?*" This is an Edpuzzle video with talking points included.

Independent Work

- Have students read the *"What is a Jet Stream?"* article from Wonderopolis and complete the *Cause and Effect* graphic organizer developed by the Florida Research Center.
- Students should also complete the questions to accompany the "*What is a Jet Stream?*" article found at the end of this lesson.
- After completing the reading and questions, ask students to draw a jet stream on a blank US map and label the type of air masses found in the ridges and troughs.

Assessment

- Exit ticket: Explain in writing, what is the jet stream and how does it affect our weather?

Learning Objectives:
Students will describe the jet stream and explain its role in our weather.

Nutshell/Skills:
Students can describe the jet stream and explain its role in our weather.

Science Essential Standards:
5.E.1.1, 5.E.1.2, 5.E1.3

ELA Essential Standards:
RI.5.1

Time:
45 minutes

Teacher Materials:
- *Cause and Effect* Answer Key
- *What is a Jet Stream?* Answer Key

Student Materials:
- *What is a Jet Stream*? article
- *Cause and Effect* graphic organizer
- *What is a Jet Stream?* questions
- US map

Opportunities for Extended Learning

1. Observe *model animation of winds aloft, including jet stream* (predictions for the next two weeks) and describe your observations, predict temperature for your area over the next two weeks based on location of cold and warm air masses. Compare your predictions to the actual weather!

Name: _____ Date: _____

What is a Jet Stream?

1. What is a jet stream? _____

_____

2. Where are jet streams located? _____

_____

3. How does the rotation of the Earth affect the jet stream? _____

_____

4. How do jet streams affect the weather? _____

_____

5. What is the relationship between temperature and the jet stream? _____

_____

6. How fast does the wind move in a jet stream? _____

_____

7. Where are the two strongest jet streams located? _____

_____

8. Why do meteorologists track jet streams? _____

_____

9. Why are jet streams stronger in the winter?_____

_____

10. Why do pilots pay attention to jet streams? _____

_____

What is a Jet Stream?
Answer Key

1. What is a jet stream?
   A jet stream is a thin current of air that's several thousand miles wide and several thousand miles long.

2. Where are jet streams located? They're found almost seven miles up in the atmosphere where the troposphere meets the stratosphere at a point called the tropopause.

3. How does the rotation of the Earth affect the jet stream? These winds begin to move from west to east, creating a jet stream.

4. How do jet streams affect the weather? Jet streams affect worldwide weather patterns, because the strong winds can rapidly push weather systems from one area to another.

5. What is the relationship between temperature and the jet stream? Temperature differences determine the strength of the jet stream.

6. How fast does the wind move in a jet stream? Most of the time, a jet stream moves along at over 100 miles per hour. At times, they reach peak speeds of over 200 miles per hour!

7. Where are the two strongest jet streams located? The two strongest jet streams are both in the Northern Hemisphere.

8. Why do meteorologists track jet streams? Meteorologists track the position of jet streams to help predict the weather.

9. Why are jet streams stronger in the winter? Because the temperature difference between the Arctic and tropical air masses is greatest at that time.

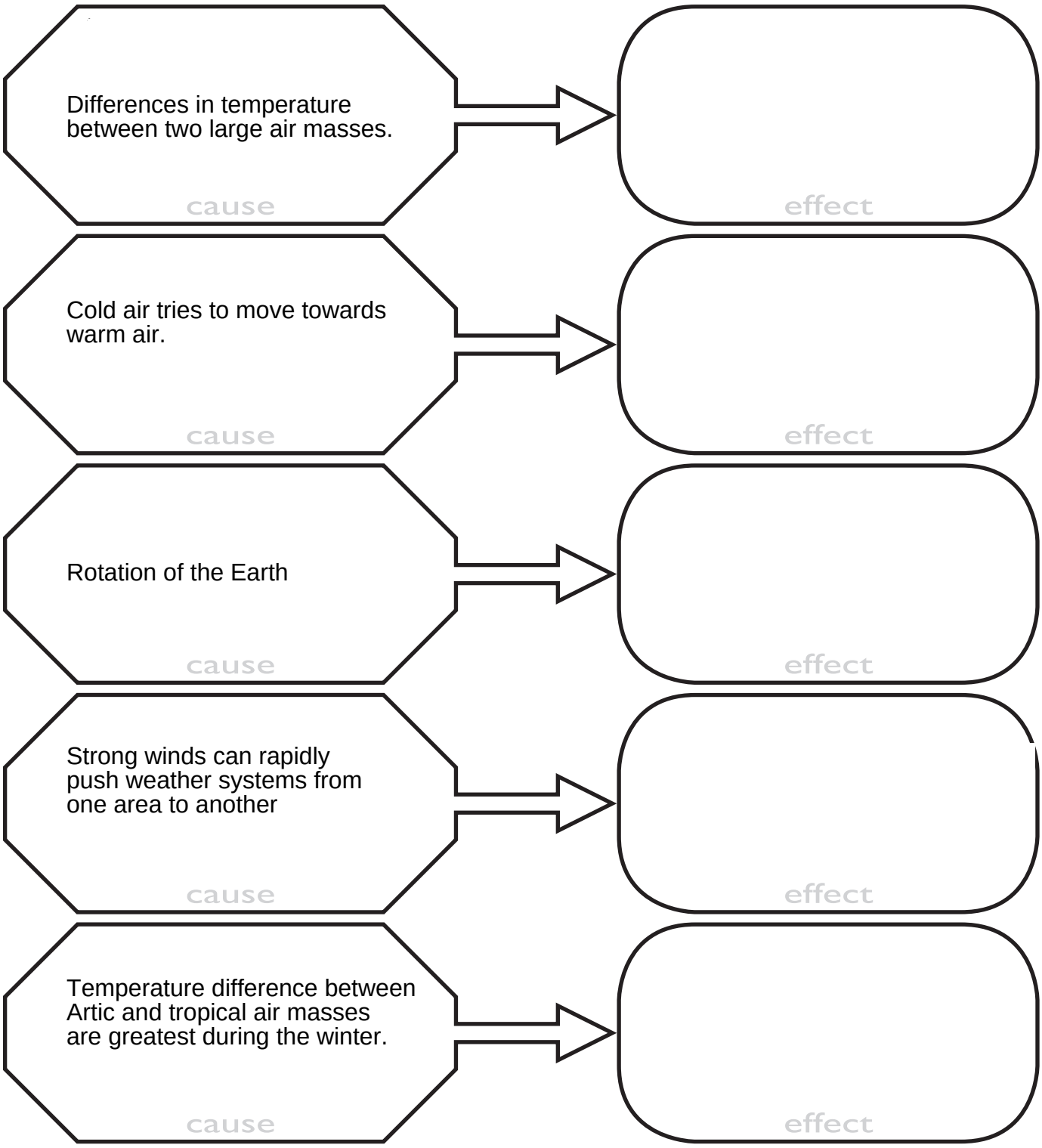
10. Why do pilots pay attention to jet streams? Pilots will fly above or below a jet stream to save time and fuel.

Name _____

Text Structure Reflection C.023.SS1a

Title: What is a Jet Stream? _____

Cause and Effect

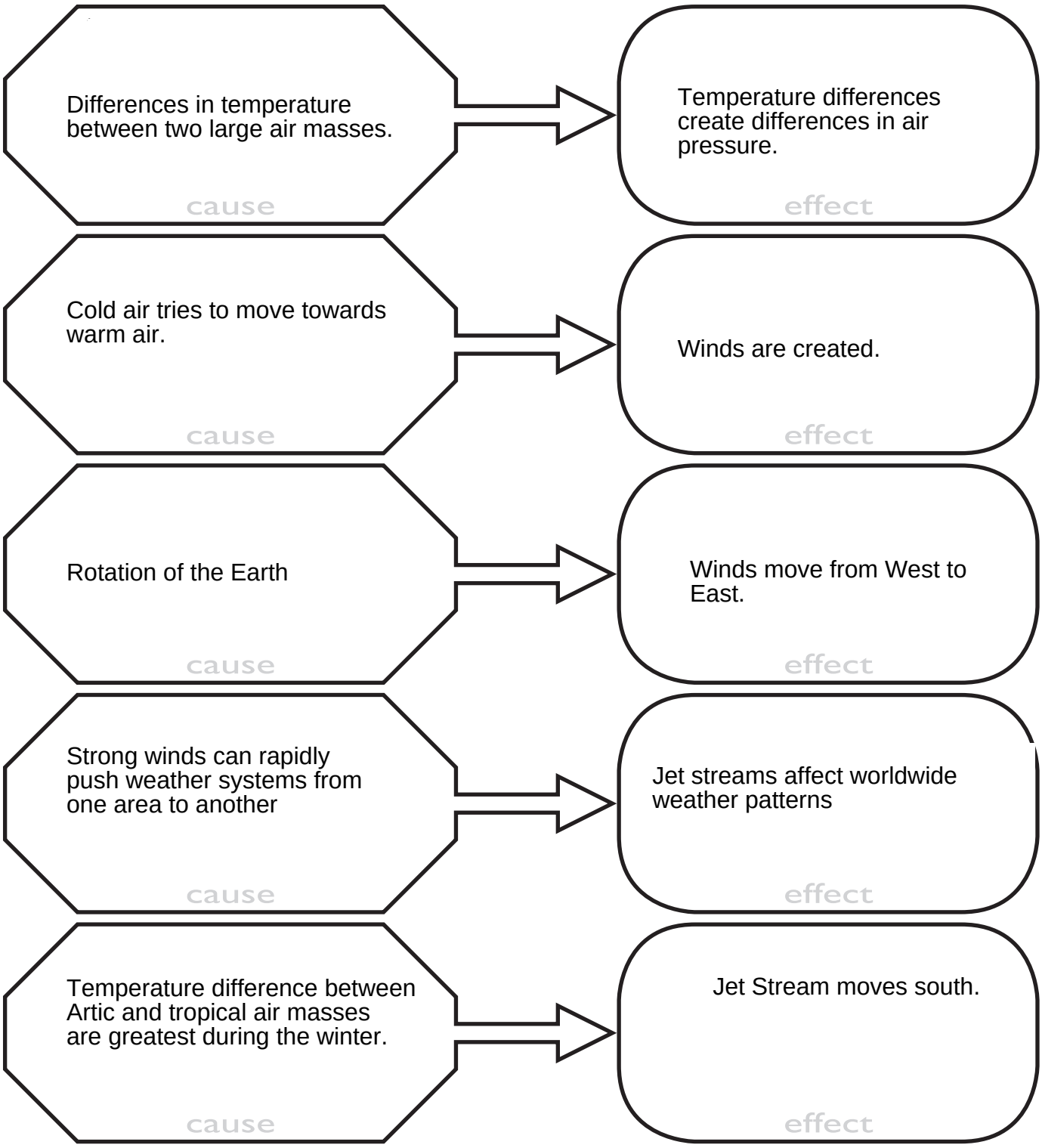


Name

Text Structure Reflection C.023.SS1a

Title: What is a Jet Stream?
Teacher Answer Key

Cause and Effect



Learning Activity 6
Clouds & Their Formation

Lesson Prep

- ✓ Locate an area outside where students will have an unobstructed view of the sky so they can make observations about clouds.
- ✓ Preview and make copies of *Cloud Spotter*.
- ✓ Preview and make copies of the *Cloud Observation Form*.
- ✓ Preview and make copies of the *Cloud ID Chart*.

Vocabulary

Cloud, cirrus, cumulus, nimbus, cumulonimbus, stratus, fog

Procedure

Mini-Lesson

- Students will go outside to do a **Natural Journaling** activity.
  - Ask students to make observations about the clouds and write them in their journals.
  - Try to do this on a day with clouds, but if there are no clouds that day, then give the students 5 minutes to list what they know about clouds in their nature journals.
  - Ask students to share their observations. Write their observations on the board. The students will use their observations to determine a definition for clouds.
- Show the video: *The Making of A Cloud* (3:10).
- **Note:** the Weather Whizkids website has instructions for a short demonstration activity to make a *Cloud in a Bottle*. If time permits, this demonstration will allow students to see how a cloud is formed.
- Take the students back outside and demonstrate how to use the *Cloud Spotter*, *Cloud ID Chart*, and *Cloud Observation Form*.
- Ideally, students will use the cloud spotter and the cloud observation form to collect data for a week to observe clouds and begin to note their relationship to weather patterns, which is the focus of Learning Activity 7.

Independent Work

- Have students read about the different types of clouds on the UCAR Center for Science Education website**:** *Common Types of Clouds*
  - Students should draw and label the cloud diagram.
  - Students can click on the names of the different clouds and should write the descriptions of each cloud in their science notebooks.

Learning Objectives:
Students will be able to explain how clouds are formed and describe the different types of clouds.

Nutshell/Skills:
Students can explain how clouds are formed and describe the different types of clouds.

Science Essential Standards:
5.L.1.2

ELA Essential Standards:
RI.5.1

Time:
45 minutes

Teacher Materials:
- *Cloud Spotter*
- *Cloud Observation Form*
- *Cloud ID Chart*

Student Materials:
- Nature Journals
- Cloud Observation Form
- Cloud ID Chart

Assessment

- Students can answer the following questions in their science notebooks:
  - 1. What is the most important thing you learned today about clouds?
  - 2. What did you learn today that you didn't know before about clouds and precipitation?

Opportunities for Extended Learning

1. For a citizen science connection, students can use the *GLOBE Observer App* on an iPad to send in cloud observations that help NASA researchers understand the data being collected by satellites observing our atmosphere, and, in particular clouds.
2. The GLOBE program has also produced a story book about clouds called *Do You Know that Clouds Have Names* available online, with photos and illustrations of different cloud types and a teacher guide embedded within the book.

Learning Activity 7
Clouds and Weather

Lesson Prep

- ✓ Copies of the *Clouds Outside My Window* graphic organizer, 1 per student
- ✓ Gather materials for cloud diagram: enough blue construction paper for each student, cotton balls , glue, black magic markers

Vocabulary

Clouds, cumulus, nimbus, cumulonimbus, stratus, fog, cirrus, precipitation

Procedure

Mini-Lesson

- Ask students to answer the question, "Why are clouds important?" in their science notebooks.
- On a cloudy day or partly cloudy day, have students go outside with their nature journals and observe the clouds.
  - Give students 10 minutes to draw the clouds and write a description of them. If you are unable to go outside, have students look out the windows to make their observations of the clouds.

- Use the *Clouds Outside My Window* * book to review the different types of clouds: cumulus, nimbus, cumulonimbus, stratus, fog, cirrus. Students should complete the *Clouds Outside My Window* Graphic Organizer as the teacher discusses the book.
- Ask students to use their graphic organizers to determine what type of clouds they observed outside.
- Ask students, "Why are clouds important?" Students answers will be because we get rain, snow, sleet, or hail from them. Ask what these things are called. If they don't know, then tell them precipitation.
- Show students the video: "*AWESOME 3D Explanation on How Different Precipitation Types Form* (" 2:49).
- Show students the *Precipitation Maps* from The Weather Channel. Explain that the colors represent different types of precipitation.

Learning Objectives:
To identify clouds and describe the type of weather associated with them.

Nutshell/Skills:
I can identify the types of clouds and describe the weather associated with them.

Science Essential Standards:
5.E.1.2

ELA Essential Standards:
RI.5.1

Time:
45 minutes

Teacher Materials:
- *Clouds Outside My Window* book
- *Clouds Outside My Window* Graphic Organizer Key

Student Materials:
- Nature Journals
- Copy of *Clouds Outside My Window* graphic organizer
- Blue construction paper
- Cotton balls
- Glue
- Black markers

**Clouds Outside My Window* book. (Free resource written by John "Dr. Lightning" Jensenius, retired NWS Meteorologist)

Independent Work

- Students can construct a cloud diagram demonstrating each of the different types of clouds using the following materials: blue construction paper, cotton balls, glue, and black markers.
- The names of the clouds, altitudes, and the type of weather associated with them should be included on the chart. NOAA's SciJinks website has great information on the types of clouds and possible weather predictions associated with them: https://scijinks.gov/clouds/.

Assessment

- **Exit ticket:** "Why are clouds important?"
- Completed Cloud Diagrams can serve as an assessment.

Opportunities for Extended Learning

- Students should have enough data from their weather charts (Engaging Activity) to graph precipitation amounts and/or temperature. As students continue gathering weather data, make sure they are noting the types of clouds they are seeing each day. Can they see patterns in the types of clouds they see and the weather on that day or later in the week?

Learning Activity 8
The Water Cycle & Weather

This activity includes part of Activity 44 *Water Wonders* from the *Project Learning Tree K-8 Environmental Education Activity Guide*, used with permission from Sustainable Forestry International, Inc.

Lesson Prep

- ✓ Read through *Part A: Go to the Head of the Cloud* in the *Water Wonders* activity from *PLT*. A full copy of the *Project Learning Tree K-8 Guide* is available in the Northside Elementary Media Center professional collection.
- ✓ Print out the station cards
  - Station 1-Cloud
  - Station 2-Glacier
  - Station 3- Ocean
  - Station 4-Stream
  - Station 5-Groundwater
  - Station 6-Animal
  - Station 7-Plant
- ✓ Get 7 number cubes (dice) = 1 per station.
- ✓ Spread the stations throughout the classroom or in a large open area outside, with a number cube at each station.
- ✓ Make copies of the *Water Cycle Scorecard* at the end of the *Water Wonders* Activity, 1 per student.
- ✓ Make copies of the *Water Cycle Agree & Disagree Statements*, 1 per student.

Vocabulary

Water cycle, evaporation, condensation, precipitation, clouds, runoff, transpiration

Procedure

Mini-Lesson

- Have students complete a 2-minute Quick Write to list everything they know about the water cycle. Then have them share their lists with a partner and add to their lists if necessary. Students will then share the lists with the class.
- Have students view the *Water Cycle Animation* (2:59).
- Ask students the following questions:
  - What did the heat from the sun do to the water? (evaporate)
  - What happens to water after it evaporates? (transported through the air, loses its heat and condenses)
  - How do clouds form? (When water vapor condenses and becomes water droplets. The droplets condense onto dust particles thus making a cloud.)

Learning Objectives:
Students will be able to describe the role the water cycle plays in our weather.

Nutshell/Skills:
Students can describe the role the water cycle plays in our weather.

Science Essential Standards:
5.E.1.2, 5.P.2.1

ELA Essential Standards:
W.5.3

Math Essential Standards:
NC.5.MD.2 (extension activities)

Time:
45 minutes

Teacher Materials:
- Activity44 *Water Wonders* from the *Project Learning Tree K-8 Environmental Education Activity Guide* (p.188-193)
- Water cycle stations
- 7 number cubes (dice)
- *Go to the Head of the Cloud* Directions
- Water Cycle Agree/Disagree Answer Key

Student Materials:
- *Water Cycle Scorecard* from PLT *Water Wonders* Activity
- *Water Cycle Agree & Disagree Statements*

- How does water return to the earth's surface? (rain, sleet, snow, hail- precipitation)
- Where was the precipitation before it fell to the earth? (clouds)
- What happens when water reaches the surface? (accumulates by going into the lakes, rivers, oceans, groundwater, and/or is used by plants-transpiration and/or evaporates.)
- How does the sun and the water cycle help distribute water around the earth?
- What role does the water cycle play in our weather?

Independent Work

Note: follow the instructions for *Go to the Head of the Class* from *Activity 44 Water Wonders* using the below adaptations and recommendations.

- Tell the students they are going to become a water droplet going through the stages of the water cycle by completing a Project Learning Tree activity called *Go to the Head of the Cloud*.
  - Position students at the 7 different stations.
  - Tell them they are to roll the number cube.
  - The number they roll corresponds with the number on the card. They are to follow the directions for that number and fill out the *Water Cycle Score Card*.
    - For example: A student is at station 1-Clouds and rolls the number 3. The sentence on the card tells the student to go to the stream station. Before leaving the station, they must fill out the *Water Cycle Score Card*. This student would start at cloud, fall as rain, and go to the stream.
- Students should use the *Water Cycle Score Card* to help them keep track of all the stages of the water cycle as they move through them.
- After the students have completed the *Water Cycle Score Card*, have them write a story describing their journey from the perspective of a water droplet going through the water cycle.

Assessment:

- Students can complete the *Water Cycle: Agree and Disagree Statements* as an assessment.

Opportunities for Extended Learning

1. Students can explore the U.S. Geological Survey *Water Cycle Interactive* or the USEPA *Water Cycle Interactive*
2. The following math extensions can be found on the Tools4TNCeachers. (*http://tools4ncteachers.com/*)
   - *Around the World*
   - *Room Temperature*
3. Reinforce water cycle and cloud concepts by viewing the *BrainPOP: Water Cycle* Video Clip and *BrainPOP: Clouds* Video Clip.

Name:_____ Date: _____

The Water Cycle Agree/Disagree Statements

Directions: Place a checkmark next to agree, disagree, or it depends beside each statement. Then explain your decision.

Statement	My Thoughts	Statement	My Thoughts
1. In the water cycle, water changes from one state of matter to another. ____ agree _____ disagree _____ it depends		5. The water cycle has nothing to do with the weather. _____ agree _____ disagree _____ it depends	
2. Cooler temperatures cause condensation. _____ agree _____ disagree _____ it depends		6. Evaporation occurs when plants release water from their leaves. _____ agree _____ disagree _____ it depends	
3. The statement, "*Energy from the Sun heats up water on Earth's surface, and the water goes into the air as water vapor.*" describes condensation. _____ agree _____ disagree _____ it depends		7. Most of the water in the water cycle can be found in clouds. _____ agree _____ disagree _____ it depends	
4. Sleet is a type of frozen precipitation. _____ agree _____ disagree _____ it depends		8. If it is warm and sunny, most likely, evaporation is not occurring. _____ agree _____ disagree _____ it depends	

Name:_____ Date: _____

The Water Cycle Agree/Disagree Statements
Answer Key

Directions: Place a checkmark next to agree, disagree, or it depends beside each statement. Then explain your decision.

Statement	My Thoughts	Statement	My Thoughts
1. In the water cycle, water changes from one state of matter to another. __X___ agree _____ disagree _____ it depends	Water changes from liquid to gas when evaporating, gas to liquid during precipitation, and liquid to a solid when frozen due to cold temp.	**5. The water cycle has nothing to do with the weather.** ___X__ agree _____ disagree _____ it depends	Without the sun's energy and water, we would not have weather. Clouds are formed through the condensation of water vapor which rises by evaporation. Precipitation falls from the clouds.
2. Cooler temperatures cause condensation. __X___ agree _____ disagree _____ it depends	When temperatures get colder water vapor turns into liquid form.	**6. Evaporation occurs when plants release water from their leaves.** _____ agree ___X__ disagree _____ it depends	Transpiration occurs when plants release water from their leaves.
3. The statement, *"Energy from the Sun heats up water on Earth's surface, and the water goes into the air as water vapor."* **describes condensation.** _____ agree ___X__ disagree _____ it depends	The sun's energy heats up the water which then turns to water vapor and rises through the air. This is called evaporation.	**7. Most of the water in the water cycle can be found in clouds.** _____ agree ___X__ disagree _____ it depends	Most of the water found on earth is in the oceans.
4. Sleet is a type of frozen precipitation. ____X_ agree _____ disagree _____ it depends	The types of precipitation are rain, snow, **sleet**, and hail.	**8. If it is warm and sunny, most likely, evaporation is not occurring.** _____ agree ____X_ disagree _____ it depends	Evaporation is caused when the sun heats up the water.

Arc 2 - How does the ocean affect our weather?

Essential Question:

How does the ocean affect our weather?

NC Science Essential Standards- Unpacked Content

5.E.1.1 Students know that weather can change from day to day and that many factors are measured to describe and predict weather conditions. (e.g., wind speed and direction, precipitation, temperature, and air pressure). Students know that in different latitudes and hemispheres there are different (and sometimes opposite) seasonal weather patterns.

5.E.1.2 Students know that one can collect and compare weather data in order to predict the likelihood of a particular weather condition occurring. Students know how to read basic weather instruments: thermometer, barometer, anemometer, wind vane, and rain gauge. Students also can identify atmospheric conditions (presence and type of clouds [stratus, cirrus, cumulus], fronts) that are associated with predictable weather patterns. Students can make basic weather predictions using these skills.

5.E.1.3 Students know that local weather conditions are influenced by global factors such as air and water currents. The jet stream is an air current in the upper atmosphere, located over North America that has a powerful influence on the weather conditions there. The jet stream flows from the west to the east and changes location depending on global conditions. The Gulf stream is a warm water surface current in the Atlantic Ocean that moves from south of Florida up the eastern seaboard and then across the Atlantic. The Gulf stream moderates weather along the eastern seaboard, warming the air and land there during the cooler months. In the Pacific, there is an oscillation of water temperatures known as El Nino/La Nina. This oscillation impacts the climate of North and South America for long periods of time. Hurricanes are major storms that form over warm ocean water and are caused by global weather patterns

5.P.3.1 Students know that when warmer things are put with cooler things, the warmer things lose heat and the cool things gain it until they are all at the same temperature. Students know that a warmer object can warm a cooler object by contact or at a distance. Conduction is the transfer of thermal energy between things that are touching. Conduction can happen within one object. (For example, thermal energy can be conducted through the handle of a metal pot.) Convection is the movement of thermal energy by the movement of liquids or gases. Convection in the oceans and atmosphere helps to move thermal energy around Earth, and is an important factor influencing weather and climate. Radiation is the transfer of energy by electromagnetic waves. Electromagnetic waves can carry energy through places with or without any matter. The Sun is the main source of electromagnetic energy on Earth. Part of this energy, light, is used by producers to make food. Radiation can also happen in other circumstances (i.e. sitting in front of a fireplace).

Lessons in this Arc

- Learning Activity 9: NASA: The Ocean: A Driving Force for Weather and Climate
- Learning Activity 10: What is the Gulf Stream?

- ❖ Learning Activity 11: What are sea breezes and land breezes?
- ❖ Learning Activity 12: El Nino & La Nina
- ❖ Learning Activity 13: Extreme Weather-Hurricanes & Flooding

Duration

5-7 days of 45 minute learning activities

Background Information

The ocean is the single largest reservoir of heat at Earth's surface. The stored heat in the ocean drives much of Earth's weather and causes climate near the ocean to be milder than climate in the interior of continents. Many of the cycles that circulate materials between the atmosphere, lithosphere and hydrosphere originate in the ocean. Ocean currents are a source of large-scale distribution of energy and resources on the Earth.

The ocean can hold and circulate more water, heat and carbon dioxide than the atmosphere although the components of the Earth's climate are constantly exchanged. Because the ocean can store so much heat, seasons occur later than they would and air above the ocean is warmed. Heat energy stored in the ocean in one season will affect the climate almost an entire season later. The ocean and the atmosphere work together to form complex weather phenomena like the North Atlantic Oscillation and **El Niño**. The many chemical cycles occurring between the ocean and the atmosphere also influence the climate by controlling the amount of radiation released into ecosystems and our environment. Air temperatures all over the world are regulated by the circulation of heat by the oceans. The ocean stores heat in the upper two meters of the photic zone. This is because seawater has a very high density and specific heat and as a result can store vast quantities of energy in the form of heat. The ocean can then buffer changes in temperature by storing heat and releasing heat. **Evaporation** cools ocean water which cools the atmosphere. It is most noticeable near the equator and the effect decreases closer to the poles.

The ocean exerts a major influence on weather and climate. It absorbs and stores large amounts of energy from the sun and releases it very slowly; in that way, the ocean moderates and stabilizes global climates. Energy is redistributed globally through ocean currents (e.g., the Gulf Stream) and through atmospheric circulation (**winds**). Sunlight heats Earth's surface, which in turn heats the atmosphere. The resulting temperature patterns, together with Earth's rotation and the configuration of continents and oceans, control the large-scale patterns of atmospheric circulation. Winds gain energy and **water vapor** content as they cross hot ocean regions, which can lead to tropical storms.

Heating is another process for transferring energy. Heat transfer occurs when two objects or systems are at different temperatures. Energy moves out of higher temperature objects and into lower temperature ones, cooling the former and heating the latter. This transfer happens in three different ways—by **conduction** within solids, by the flow of liquid or gas (**convection**), and by **radiation**, which can travel across space.

A **sea breeze** is any wind that blows from a large body of water toward or onto a landmass. A **land breeze** is any wind blowing toward the sea from the land, especially at night. **Prevailing winds** are global winds that constantly blow in the same direction over a certain area of the earth. The **jet stream** is a series of fast flowing air currents that can push air masses to other areas and influence weather patterns. The Jet Streams are more active in the winter when there are wider ranges of temperature differences between Arctic and Tropical air masses. The **Gulf Stream** is a warm water surface current that warms the air and land along the eastern seaboard during the cooler months. In the Pacific Ocean, **El Nino/La Nina** is caused by oscillating water temperatures. El Nino/La Nina impacts the climate of North and South American typically for 9-12 months and is difficult to predict.

Vocabulary

- **Conduction** is the direct transfer of heat between two things touching.
- **Convection** is the transfer of heat through fluids (liquid or gas).
- **El Niño** is the unusual *warming* of the surface waters of the eastern tropical Pacific Ocean, which causes changes in wind patterns and has a major effect on weather around the world.
- The **Gulf Stream** is a warm ocean current that flows from the Gulf of Mexico northward through the Atlantic Ocean.
- **La Niña** is the widespread cooling of the surface waters of the eastern tropical Pacific Ocean. It is the opposite of El Nino.
- A **land breeze** is a breeze blowing from the land toward the sea, especially at night, owing to the relative warmth of the sea.
- **Radiation** is transfer of heat through electromagnetic waves.
- A **sea breeze** is a breeze blowing from the sea toward the land, especially during the day owing to the relative warmth of the land.
- **Weather** is the state of the atmosphere at a given time and place with respect to wind, temperature, cloudiness, moisture, pressure, and other factors.

Literature Connections

Books

- *I Survived Hurricane Katrina*, 2005 by Lauren Tarshis (FIC TAR)*

Online

- Wonderopolis article: *What is El Nino?*
- NASA Space Place article: *What is La Nina Anyway?*

*currently available in Northside Elementary's media center

Learning Activity 9
The Ocean, Weather, & Climate

Lesson Prep

- ✓ Make copies of NASA | The Ocean: A Driving Force for Weather and Climate transcript (following the lesson), 1 per student.
- ✓ Make copies of the question sheet that accompanies the transcript.

Vocabulary

Weather, climate, Gulf Stream, El Nino, La Nina

Procedure

Mini-Lesson

- Have students answer the following question in their science notebooks: *What role does the ocean play in our weather?*
- Review the difference between weather and climate.
- Ask students to draw a KWL chart in their science notebooks. Give students 5-10 minutes to write down everything they know and wonder about the ocean as it relates to weather.
- Have students turn and talk with a partner to share what they wrote. Then ask for volunteers to share with the rest of the class.
- Show students the NASA video *"The Ocean: A Driving Force for Weather and Climate."* (6:00 min)
- Discuss with students the answer to the question: "What role does the ocean play in our weather?"
- After watching the video and the class discussion, ask students to revise the answers in their notebooks to include what they have learned about the ocean's role in our weather.

Independent Work

- Have students read the transcript from the video and answer the questions.
- When they have completed the reading assignment, have them fill in what they have learned about the ocean on their KWL charts.

Assessment

- The completed KWL chart can serve as an assessment.

Learning Objective:
Students will be able to describe how the ocean influences weather.

Nutshell/Skills:
Students can describe how the ocean influences weather.

Science Essential Standards:
5.E.1.3

ELA Essential Standards:
RI.5.1

Time:
45 minutes

Teacher Materials:
- NASA video *The Ocean: A Driving Force for Weather and Climate*

Student Materials:
- Science notebooks
- Copies of *The Ocean: A Driving Force for Weather and Climate* Transcript and Questions

Opportunities for Extended Learning

1. You may wish to show students a variety of videos in the *Ocean Currents and Climate Lesson Plan* from CPALMS, that demonstrate how ocean currents can affect weather. Students will also summarize a text about ocean currents, winds and ice. http://www.cpalms.org/Public/PreviewResourceLesson/Preview/46068

NASA | The Ocean: A Driving Force for Weather and Climate Transcript

Earth is the water planet although 40% of Earth's population lives within or near coastal regions. The ocean impacts people everywhere. Most of Earth's water is stored in the ocean, a driving force for weather and climate.

The earth's surface is warmed unevenly by the sun. Heat is a form of energy that helps drive ocean and atmospheric circulation. The ocean absorbs more heat than the atmosphere. Both the atmosphere and ocean move heat. The atmosphere does it quickly. The ocean slowly.

At the ocean's surface winds drive the currents. Multiple forces keep the global ocean conveyor belt or Thermohaline Circulation, in perpetual motion. Below the surface deeper currents are driven by difference in density.

Mixing and upwelling in the ocean transport nutrient rich water to the ocean's surface. Nutrients sustain biological productivity in the ocean.

Extreme variation in sea surface height and sea surface temperature affect ocean and atmospheric circulation. El Nino and La Nina occur when changing wind patterns displace warm and cool water in the equatorial Pacific Ocean. Both have global impacts. During either of those events the displacement of cold water by warm water leads to air temperature swings and changes in humidity. This alters weather patterns by steering storms and rainfall to new locations. Shifts in rainfall affect plant growth in areas impacted by drought.

When heat is exchanged between the ocean's surface to the atmosphere, it influences climate. For example, heat and moisture carried by the Gulf Stream northward brings warmer temperatures and a moderate climate to Europe. An eddy is a circular moving body of water that spins off a main current. Eddies play a major role transporting heat and nutrients.

Thunderstorms are a frequent occurrence in the tropics. Some of these may become large rotating systems with strong winds growing into tropical storms or hurricanes. Tropical ocean basins like the Caribbean and the Gulf of Mexico retain substantial heat making these regions favorable for rapid storm intensification. By extracting large amounts of heat from the ocean, storms can become massive and destructive like hurricanes.

A driving force for weather and climate, the ocean is essential for life on Earth. It is the primary store house for Earth's water. Without the ocean, our planet would be uninhabitable. NASA satellites and their unique view from space are helping to unveil the vast and largely unexplored ocean.

Name: _____ Date: _____

NASA | The Ocean: A Driving Force for Weather and Climate Transcript

Directions: Read the transcript from the NASA video: *The Ocean: A Driving Force for Weather and Climate* and answer the following questions.

1. What does the atmosphere and ocean move? _____

   _____

2. Which holds more heat, the atmosphere or the ocean? _____

   _____

3. What drives the surface currents in the ocean? _____

   _____

4. How are nutrients transported in the ocean? _____

   _____

5. Why are the nutrients important? _____

   _____

6. When do El Nino and La Nina occur? _____

   _____

7. During an El Nino or La Nina a displacement of cold water by warm water occurs. What affect does this have on the weather? _____

   _____

8. Explain what an eddy is and why it's important. _____

   _____

9. What role do ocean basins have in the development of tropical storms? _____

   _____

10. What role does the ocean play in our weather? _____

    _____

Name: _____ Date: _____

NASA: The Ocean: A Driving Force for Weather and Climate
Transcript
Answer Key

Directions: Read the transcript from the NASA video: The Ocean: A Driving Force for Weather and Climate

1. What does the atmosphere and ocean move? heat
2. Which holds more heat, the atmosphere or the ocean? ocean
3. What drives the surface currents in the ocean? winds
4. How are nutrients transported in the ocean? Mixing and upwelling of the oceans waters

   Why are the nutrients important? Nutrients sustain biological productivity in the ocean
5. What happens to cause an El Nino and La Nina to occur? changing wind patterns displace warm and cool water in the equatorial Pacific Ocean
6. During an El Nino or La Nina a displacement of cold water by warm water occurs. What affect does this have on the weather? air temperatures swings and changes in humidity. This alters weather patterns by steering storms and rainfall to new locations. Shifts in rainfall affect plant growth in areas impacted by drought
7. Explain what an eddy is and why it's important. An eddy is a circular moving body of water that spins off a main current. They play a major role transporting heat and nutrients.
8. What role do ocean basins have in the development of tropical storms? Tropical ocean basins retain substantial heat making these regions favorable for rapid storm intensification.
9. What role does the ocean play in our weather? The ocean absorbs and releases heat. The currents transport heat and nutrients

Learning Activity 10
The Gulf Stream

Lesson Prep

- ✓ Make copies of a world map students can write on.
- ✓ Make copies of "What is a Gulf Stream?" questions.

Vocabulary

Gulf Stream, weather

Procedure

Mini-Lesson

- Show students the video clip, *Perpetual Ocean* (3:00 mins), from NASA. Ask students, "What did you notice?"
- This will start a discussion about ocean and currents. Then show students, *What Causes the Gulf Stream?* (1:51 mins). Ask the following questions:
  - Why is Earth heated unevenly? What effect does this have on the atmosphere?
  - What is the principal cause of surface currents in the ocean?
  - Where is the Gulf Stream located?
  - Where does the warm water come from?
  - What effect does the warm water have on North Carolina?
  - If someone asked what the Gulf Stream is, what would you tell them?

Guided Practice:

- Give students a blank copy of a world map.
- Ask students to label the continents, oceans, North Carolina, and Florida.
- Ask them to draw and label the equator.
- Show students the *Gulf Stream Animation* webpage.
- Ask students, "Where is the gulf stream located? What do you notice about the colors of the gulf stream?"
- Ask students to draw and label the Gulf Stream on a world map.

Independent Work

- Students will read the short article found on SciJinks webpage called: *What is the Gulf Stream?* *https://scijinks.gov/gulf-stream/*
- Students should complete the *What is the Gulf Stream?* questions as they read.

Learning Objectives:
Students will be able to describe how the Gulf Stream helps distribute heat to North America.

Nutshell/Skills:
Students can describe how the Gulf Stream helps distribute heat to North America.

Science Essential Standards:
5.E.1.3

ELA Essential Standards:
RI.5.1

Time:
45 minutes

Teacher Materials:
- *What is the Gulf Stream*? Answer Key

Student Materials:
- World map
- Chromebook
- Science notebooks
- *What is the Gulf Stream?* Questions

Assessment

- **Exit Ticket:** Explain the effect the Gulf Stream has on the eastern United States.

Opportunities for Extended Learning

- Read the article *Ocean Currents* on Softschools.com.
- In this National Geographic activity, students can complete readings and virtual activities to learn how the Gulf Stream and ocean currents affected *The Mayflower's Atlantic Crossing*.

Name: _____ Date: _____

What is the Gulf Stream?

Directions: Read the article on the SciJinks webpage, https://scijinks.gov/gulf-stream/, and answer the following questions.

1. What is the Gulf Stream? _____

_____

_____

2. How does the Gulf Stream impact weather and climate? _____

_____

_____

3. What causes the Gulf Stream?

_____

_____

_____

4. How long have we known about the Gulf Stream? _____

_____

_____

5. How do we study the Gulf Stream today? _____

_____

_____

What is the Gulf Stream?
Answer Key

Directions: Read the article on the SciJinks webpage, https://scijinks.gov/gulf-stream/, and answer the following questions.

1. What is the Gulf Stream? The **Gulf Stream** is a strong ocean current that brings warm water from the Gulf of Mexico into the Atlantic Ocean. It extends all the way up the eastern coast of the United States and Canada.

2. How does the Gulf Stream impact weather and climate? The Gulf Stream keeps temperatures warmer in the winter and cooler in the summer for the southeastern United States and England.

3. What causes the Gulf Stream? The Gulf Stream is caused by a large system of circular currents and powerful winds, called an oceanic **gyre**.

4. How long have we known about the Gulf Stream? We've known about the Gulf Stream for more than 500 years!

5. How do we study the Gulf Stream today? Today, scientists can study the Gulf Stream from above, using satellites.

Learning Activity 11
Land Breezes & Sea Breezes

Lesson Prep

- ✓ Make copies of the Sea Breeze and Land Breeze Data Table.
- ✓ Make copies of the Sea Breeze and Land Breeze Questions.

Vocabulary

Sea breeze, land breeze, air pressure, high-pressure system, low-pressure system, convection, radiation, conduction

Procedure

Mini-Lesson:

- Ask students to make a T-Chart in their science notebooks and label one side Day and the other Night.
- Show the Land and Sea Breeze Diagram and give students 5 minutes to write observations about the diagram on their T-Charts. Ask them to share their observations and record them on the class T-Chart.
- Ask guided questions while the students are sharing their observations:
  - What does the red H mean? High pressure
  - What does the blue L mean? Low pressure
  - Why are the arrows pointing towards the blue Ls and away from the red Hs? Air pressure moves from high to low
  - What is different about the arrows in the day diagram and the night diagram? During the day the wind blows from the sea towards land (sea breeze). At night the wind blows from the land towards the sea. (land breeze)
  - What types of heat transfer do we see in the diagram? Radiation, convection, conduction
  - Explain how heat is being transferred. Radiation from the sun, convection because the air is moving from high pressure to low pressure, conduction because air molecules are vibrating and bouncing against each other.
- Ask students which part of the diagram should be labeled sea breeze and which should be labeled land breeze. Ask them to label their T-Charts accordingly.
- Demonstrate how the Land and Sea Breeze animation works and explain how they will fill out the Sea and Land Breeze Data Table.

Learning Objectives:
Students will be able to explain the differences between sea breezes and land breezes .

Nutshell/Skills:
Students can explain the differences between sea breezes and land breezes.

Science Essential Standards:
5.E.1.3, 5.P.3.1

Math Essential Standards:
NC.5.MD.2

Time:
45 minutes

Teacher Materials:
- Chart paper for class T-chart

Student Materials:
- Science Notebooks
- Chromebooks
- Land and Sea Breeze Diagram
- Land and Sea Breeze Data Table
- Land and Sea Breeze Questions

Independent Work

- Ask students to fill out the Land and Sea Breeze Data Table while watching *Land and Sea Breeze Animation*.
- Have students make a double line graph using the temperatures from the data tables.
- Have students answer the Sea Breeze and Land Breeze Questions using the data tables.

Assessment

- **Exit ticket:** Draw a Venn Diagram to compare and contrast Land and Sea Breeze.

Opportunities for Extended Learning

1. Students may also want to view the video *Sea and Land Breezes Explained* (1:46).

Land and Sea Breeze Diagram

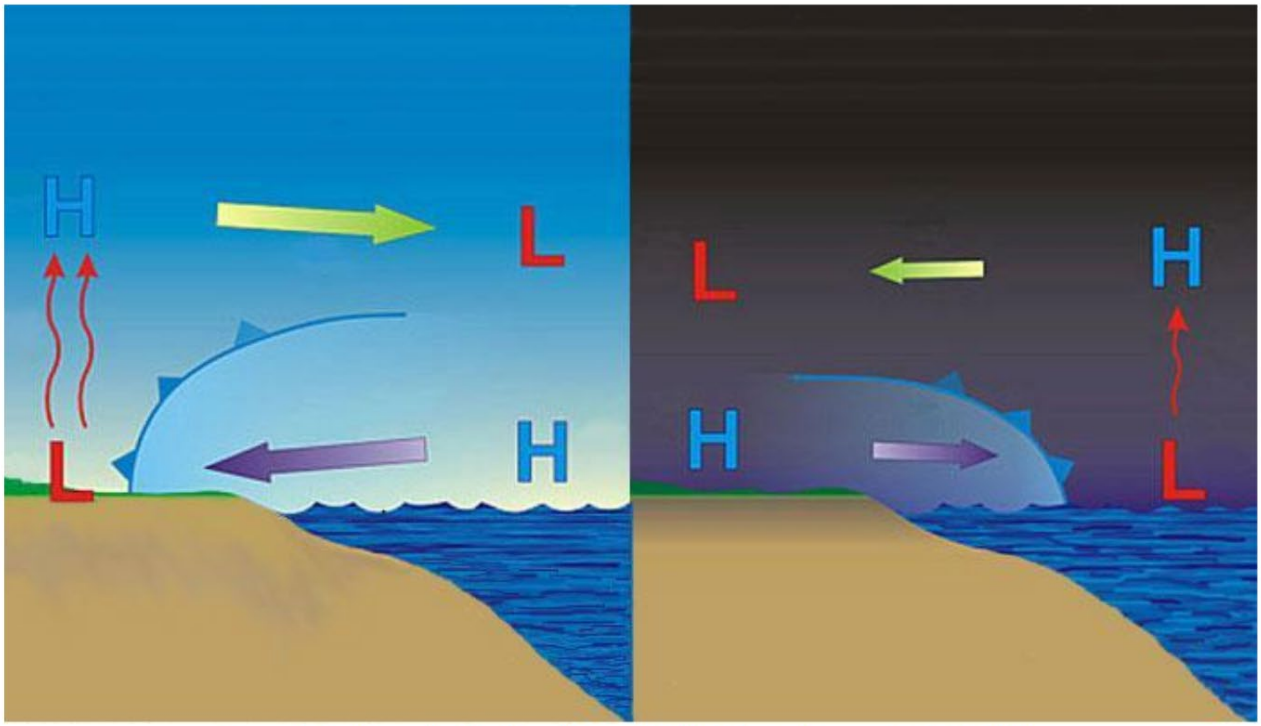


Figure A. Sea Breeze (Left) and Land Breeze (Right). (Adapted from graphic by NOAA).

North Carolina Climate office

Name: _____ Date: _____

Land and Sea Breeze Data Table

Complete the data table while watching the Sean and Land Breeze Animation.

Time	Land Temperature **(ºF)**	Ocean Temperature **(ºF)**	Direction of Blue Arrows (toward the land or away from the land)	Direction of Red Arrows (toward the land or away from the land)
12:00 pm				
1:00 pm				
2:00 pm				
3:00 pm				
4:00 pm				
5:00 pm				
6:00 pm				
7:00 pm				
8:00 pm				
9:00 pm				
10:00 pm				
11:00 pm				
12:00 am				
1:00 am				
2:00 am				
3:00 am				
4:00 am				
5:00 am				
6:00 am				
7:00 am				
8:00 am				
9:00 am				
10:00 am				
11:00 am				
12:00 pm				

Land and Sea Breeze Data Table Answer Key

Time	Land Temperature **(ºF)**	Ocean Temperature **(ºF)**	Direction of Blue Arrows (toward the land or away from the land)	Direction of Red Arrows (toward the land or away from the land)
12:00 pm	85	65	toward	away
1:00 pm	85	65	toward	away
2:00 pm	85	65	toward	away
3:00 pm	82	65	toward	away
4:00 pm	77	65	toward	away
5:00 pm	71	65	toward	away
6:00 pm	65	65		
7:00 pm (Land Breeze)	62	65	away	toward
8:00 pm	60	65	away	toward
9:00 pm	58	65	away	toward
10:00 pm	55	65	away	toward
11:00 pm	54	65	away	toward
12:00 am	53	65	away	toward
1:00 am	52	65	away	toward
2:00 am	51	65	away	toward
3:00 am	50	65	away	toward
4:00 am	50	65	away	toward
5:00 am	51	65	away	toward
6:00 am	54	65	away	toward
7:00 am	58	65	away	toward
8:00 am	65	65		
9:00 am (Sea Breeze)	72	65	toward	away
10:00 am	79	65	toward	away
11:00 am	82	65	toward	away
12:00 pm	85	65	toward	away

Name: _____ Date: _____

Land and Sea Breeze Questions

Directions: Use your data table to answer the questions.

1. What do you notice about the data? _____

   _____

2. What happens to the blue arrows as the land temperatures decrease? _____

   _____

3. What happens to the red arrows as the land temperatures decrease? _____

   _____

4. What happens to the blue arrows as the land temperatures increase? _____

   _____

5. What happens to the red arrows as the land temperatures increase? _____

   _____

6. Why is the wind changing directions? _____

   _____

7. Explain how heat is being transferred._____

   _____

Learning Activity 12
El Niño & La Niña

Lesson Prep

- Preview the video *El Niño and La Niña Explained.*
- Draw a Venn Diagram on chart paper.
- Make copies of a Venn Diagram, 1 for each group of students.

Vocabulary

El Niño, La Niña, trade winds

Procedure Part 1

Mini-Lesson

- Explain to students that they will be watching a short video called, *El Niño and La Niña Explained*. Students will work with a partner and use a Venn diagram to make observations about El Niño and La Niña.
- Before watching the video, ask students where the Pacific Ocean, Asia, and South America are on a world map. Review the cardinal directions.
- Draw a Venn diagram on chart paper. Label one circle El Niño and the other La Niña.
- Ask students to draw a copy of the Venn Diagram in their science notebooks Students should label one circle on the Venn Diagram El Niño and the other La Niña.
- Show the video. **Stop the video right after the impact of El Niño on the US** (at 53 seconds).
- Have students turn and talk to their partners to discuss what they saw and heard on the video about El Niño. Students should write down their observations in the El Niño circle of Venn diagram. Then have students share their observations with the class.
- Write their observations on the class chart.
- Follow the same procedure for the La Niña side.
- Ask the students what El Niño and La Niña both have in common. The teacher may need to play the video more than once.
- Use the information from the Venn diagram to create definitions for El Niño and La Niña. Ask students to write the definitions in their science notebooks.

Learning Objectives:
Students will be able to learn the difference between El Niño and La Niña and the type of weather conditions they bring.

Nutshell/Skills:
Students can compare and contrast El Niño and La Niña and describe their effects on weather in the United States.

Science Essential Standards:
5.E.1.3

ELA Essential Standards:
RI.5.1

Time:
Part 1 45 minutes
Part 2 45 minutes

Teacher Materials:
- Chart paper

Student Materials:
- Science notebooks
- Chromebooks

Procedure Part 2

Independent Work

- Ask students to read the Wonderopolis article, *What is El Niño?* And then answer the following question in their science notebook: *What impact does El Nina have on the North American continent?*
- Tell them to take the short quiz and play the wonder word challenge on the Wonderopolis website.
- Ask students to read the NASA Space Place article age, *What is La Niña Anyway?* and answer the following question in their notebooks: *What impact does La Niña have on the United States?*

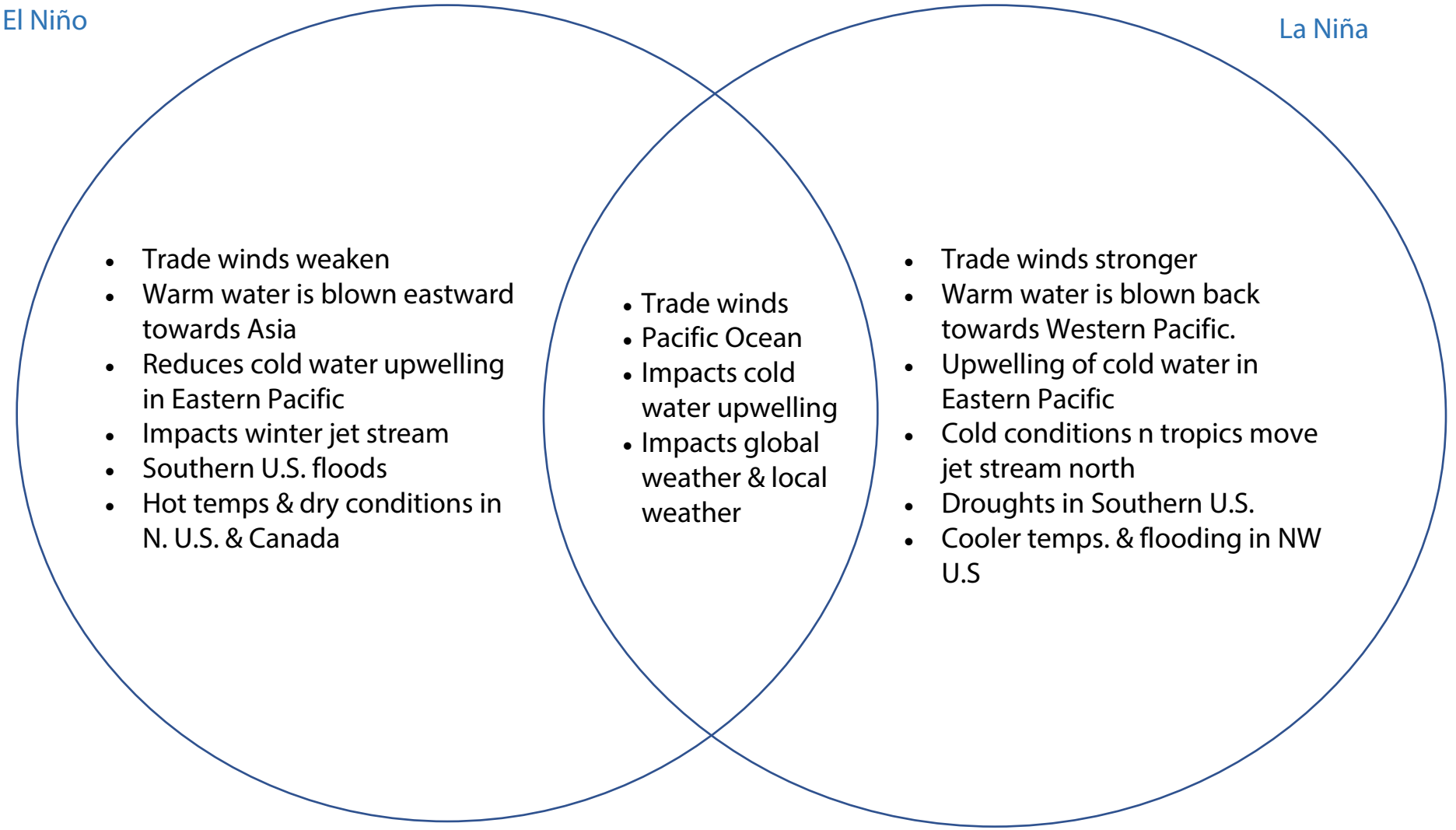
Assessment

- **Exit ticket:** what is the difference between El Niño and La Niña?

Opportunities for Extended Learning

- Students can review the *El Niño Infographic* from Weather Underground for more information.
- Ask students to read *An El Niño Fish Tale* from the UCAR Center for Science Education. *https://scied.ucar.edu/docs/el-niño-fish-tale*
    - As they are reading the story, have them fill out the *An El Niño Fish Tale Graphic Organizer*. Tell students they are to note the main ideas, what you learn, and what you wonder for each part of the story
- Students can also play the *El Niño/La Niña Sorting Game* from the UCAR Center for Science Education

El Niño and La Niña Answer Key



Learning Activity 13
Hurricanes & Flooding

Lesson Prep

- ✓ Create a class KWL chart.
- ✓ Gather materials needed for Hurricane Towers.
- ✓ Review Teacher and Student copies of the *Building for Hurricanes* activity, by NASA's Global Precipitation Measurement Mission.
  - *Building for Hurricanes-Student copy*
  - *Building for Hurricanes-Teacher copy*

Vocabulary

Hurricanes, wind, precipitation

Procedure Part 1

Mini-Lesson

- Ask students to make a KWL chart in their science notebooks and list everything they know and what they want to know about hurricanes.
- Ask students to turn and talk to their partners and discuss what they wrote on their chart about hurricanes.
- Ask for volunteers to share some information from their lists and add it to the class KWL chart.
- Then show students the National Geographic video, *Hurricanes 101* (2:42 mins).
- Give students a few minutes to add to their charts. Tell them they can add to the what they want to learn and/or what they learned columns.
- Ask students what information can be added to the class KWL chart.
- Ask students to describe what was happening the video
  - What damage did the wind cause?
  - What damage did the water cause?
- Show students the *Hurricane Formation Infographic* from Weather Underground to help explain the formation of hurricanes, the categories, and wind speeds.
- Give students a few minutes to add to their KWL charts.
- Ask if there is any more information that can be added to the class KWL chart.
- Ask students why people need to know that a hurricane is approaching.

Learning Objectives:
Students will be able to explain how hurricanes are formed and how they impact people.

Nutshell/Skills:
Students can explain how hurricanes are formed.

Science Essential Standards:
5.E.1.3

Time:
Part 1: 45 minutes
Part 2: 45 minutes

Teacher Materials:
- *Building for Hurricanes* Teacher Copy
- Scissors
- Ruler
- Tennis ball
- Fan

Student Materials:
- *Building for Hurricanes* Student Copy
- Index cards (4-8 per group)
- Straws (10 per group)
- Craft sticks (4-8 per group)
- String (~3 feet per group)
- Pipe cleaners (4-8 per group)
- Tape

- Show this video clip from the Weather Channel to help students understand the damage storm surges can cause. *Weather Channel Hurricane Florence-Augmented Reality* (1:32).
- Show students *How much damage can hurricane force winds cause?* video from WRAL (1:28) to help students understand the damage hurricane force winds can cause.

Procedure Part 2

Independent Group Work

- Tell students they will be working in groups to design a tower that can resist the intensity of hurricane force winds, based on the activity *Building for Hurricanes* by NASA's Global Precipitation Measurement Mission.
  - Students will be given the materials to build the tower and then test the tower by using a fan.

Assessment

- **Exit Ticket:** Have students complete one of the following sentence stems.
  - Something I didn't know about …….
  - I didn't know …….
- Completed KWL Charts can serve as an assessment.
- Completed hurricane structures can serve as an assessment.

Opportunities for Extended Learning

- Students can use the SciJinks *Hurricane Simulation* to demonstrate what Hurricane Florence was like on *Sept. 12*, *Sept. 14*, and *Sept 15*.
- Students can complete the Northside Rain Math Worksheet developed by UNC Institute for the Environment to examine impacts of hurricanes at Northside using rainfall data from Hurricane Matthew.

Name: _____

Precipitation at Northside Elementary: Where does the water go?

In this math activity you will find these conversions helpful:

- 1 inch = 0.025 meters
- 1 m^3 = 264.2 gallon

Part I: How much water falls onto Northside Elementary's property annually?

1. View the satellite image of Northside with the perimeter labeled in yellow. The area of this plot is approximately **22,000m^2.**
2. The average annual rainfall for Chapel Hill, NC is **47.4 inches**.
3. Using the inch to meters conversion above, convert this annual rainfall amount into meters.

47.4 inches x 0.0254 meters = _____meters

4. Calculate the volume of rain that falls on Northside each year by multiplying the average rainfall (in meters) by area (m^2) of plot. Volume should be recorded in cubic meters (m^3).

Total area (m^2)	
Annual rainfall (m)	**x**
Total volume of annual rain (m^3)	

Part II: Let's compare the total volume of water from two rainfall events, a 1" rain and a 3.77" rain (which is how much rain Chapel Hill got from Hurricane Matthew in the fall of 2018).

1. Using the unit conversions above and the total area (m^2) of Northside, calculate the total volume of rainwater (in cubic meters and gallons) from a 1" and a 3.77" rainfall event.

Total area (m^2)		
	1" Rain	**3.77" Rain**
Volume of rain (m^3)		
Volume of rain (gallons)		

2. Where does the rain go after it falls on school property?

_____

3. What happens to the water when it rains more?

_____

Part III: How much stormwater is generated by a 1" rain event at Northside Elementary School?

1. View the satellite image of Northside; use a marker to outline all surfaces that would be classified as **impermeable surfaces** (surfaces that water cannot penetrate such as a roof or pavement). Water that hits these surfaces will become **stormwater.**
2. Locate Northside Elementary School on Google Earth and use the ruler tool to calculate the area (m^2) of all impermeable surfaces.
3. Next, calculate the volume of rain that falls on these impermeable surfaces during a 1" rain fall event (Remember, convert inches to meters first!).

Area of impermeable surfaces (m^2) from Google Earth	
1" rain (m)	
Volume of stormwater (m^3)	

4. Compare your answer to Part I above. **What fraction of total annual rainfall becomes stormwater at Northside?**

5. Where do you think all of this stormwater goes?

_____

Part IV: How much stormwater is captured by Northside's cisterns?

1. Northside has three, 20,000-gallon cisterns under the driveway and a 1,500-gallon above ground cistern in the garden. **How many total gallons of water can be stored in these cisterns?**

Total volume of cisterns (gallons)	
Volume of rain (gallons)	*Answer from Part III above*

2. Using your answer from Part III above**, how many cisterns would it take to store all of the stormwater from a 1" rain event?**

Part V: How much rainfall is captured by Northside's green roof and other permeable surfaces?

1. View the satellite image of Northside; use a marker to outline all surfaces that would be classified as porous or **permeable surfaces** (surfaces that water <u>can</u> penetrate such as the garden, the grass field, porous pavement, etc). **Select one of these surfaces (e.g. green roof).**
2. Locate Northside Elementary School on Google Earth and use the ruler tool to calculate the area (m^2) of the surface you selected.
3. Next, calculate the volume of rain that falls on this surface during a 1" rain fall event (Remember, convert inches to meters first!).

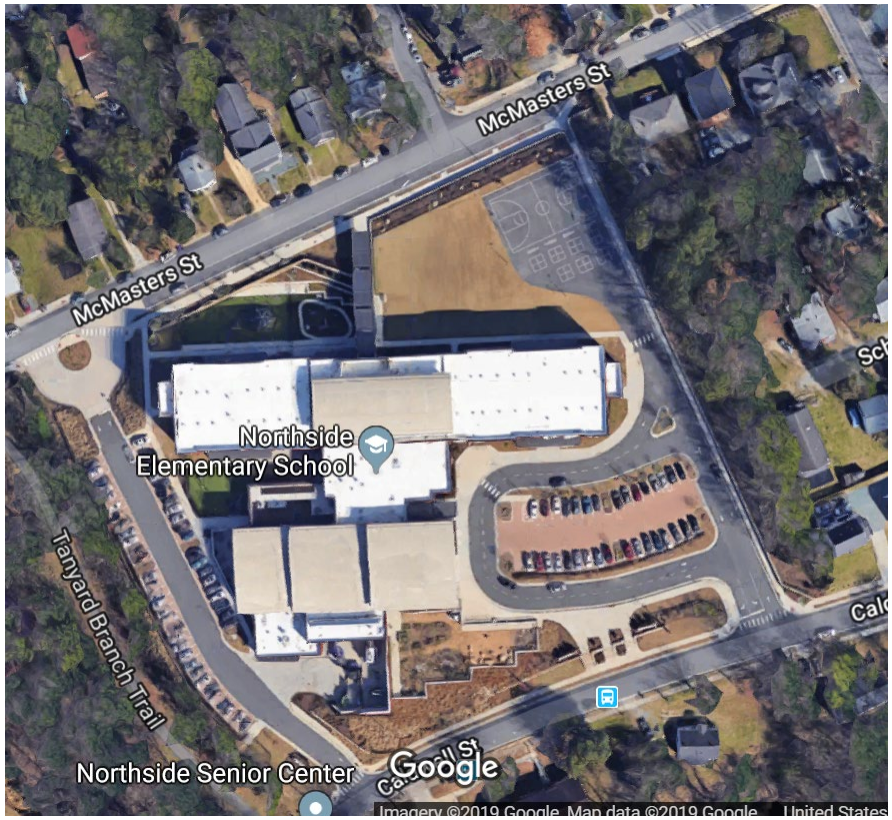
Surface	*e.g. green roof*
Area of permeable surface (m^2) from Google Earth	
1" rain (m)	
Volume of rainfall absorbed by surface (m^3)	

4. Compare your answer to part II above. What <u>fraction</u> of a 1" rainfall event is absorbed by this surface at Northside? [Optional] Add up answers from other groups to get total for all permeable surfaces at Northside.

5. Where do you think this rainwater goes once it enters the ground?

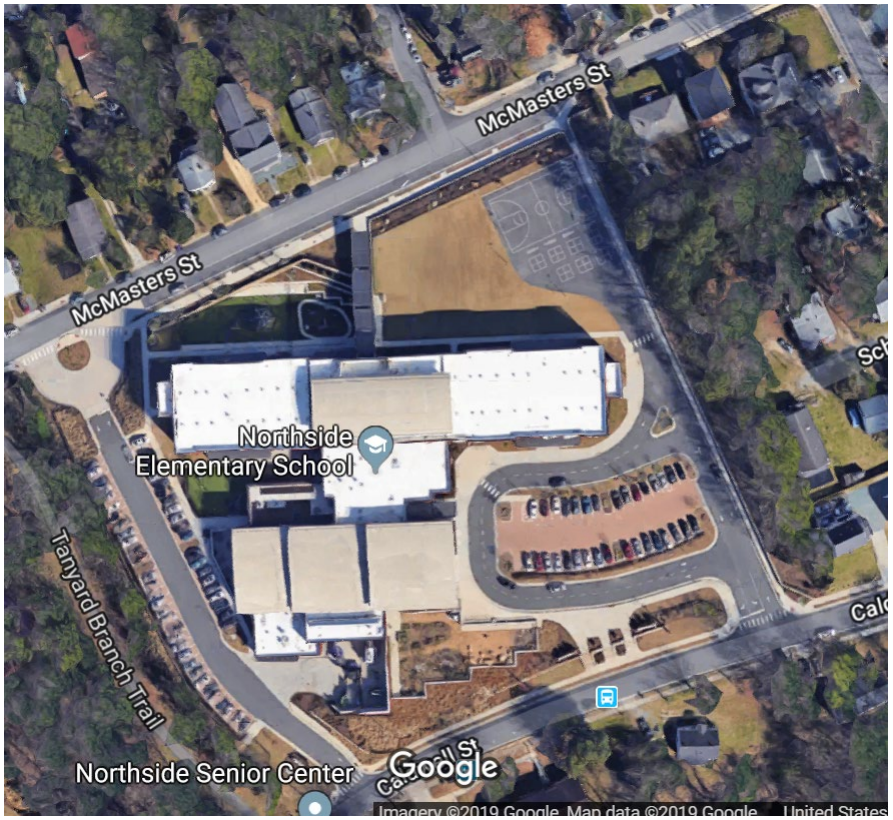
Impermeable Surfaces

Use a marker to outline all surfaces that would be classified as **impermeable surfaces** (surfaces that water cannot penetrate such as a roof or pavement). Water that hits these surfaces will become **stormwater.**



Permeable Surfaces

Use a marker to outline all surfaces that would be classified as porous or **permeable surfaces** (surfaces that water <u>can</u> penetrate such as the garden, the grass field, porous pavement, etc). **Select one of these surfaces (e.g. green roof).**



Arc 3 – How Does Weather Affect Our Lives?

Essential Questions

How does weather affect our lives?

NC Science Essential Standards- Unpacked Content

5.E.1.1 Students know that weather can change from day to day and that many factors are measured to describe and predict weather conditions. (e.g., wind speed and direction, precipitation, temperature, and air pressure). Students know that in different latitudes and hemispheres there are different (and sometimes opposite) seasonal weather patterns.

5.E.1.2 Students know that one can collect and compare weather data in order to predict the likelihood of a particular weather condition occurring. Students know how to read basic weather instruments: thermometer, barometer, anemometer, wind vane, and rain gauge. Students also can identify atmospheric conditions (presence and type of clouds [stratus, cirrus, cumulus], fronts) that are associated with predictable weather patterns. Students can make basic weather predictions using these skills.

5.E.1.3 Students know that local weather conditions are influenced by global factors such as air and water currents. The jet stream is an air current in the upper atmosphere, located over North America that has a powerful influence on the weather conditions there. The jet stream flows from the west to the east and changes location depending on global conditions. The Gulf stream is a warm water surface current in the Atlantic Ocean that moves from south of Florida up the eastern seaboard and then across the Atlantic. The Gulf stream moderates weather along the eastern seaboard, warming the air and land there during the cooler months. In the Pacific, there is an oscillation of water temperatures known as El Nino/La Nina. This oscillation impacts the climate of North and South America for long periods of time. Hurricanes are major storms that form over warm ocean water and are caused by global weather patterns

Lessons in this Arc

- ❖ Learning Activity 14: Weather and Our Choices
- ❖ Learning Activity 15: Impacts of Climate Change on Ecosystems
- ❖ Learning Activity 16: Extreme Weather

Go Outdoors!

- ▪ Learning Activity #15: Impacts of Climate Change on Ecosystems

Nature Journal Connection

- ✓ Learning Activity # 15: Impacts of Climate Change on Ecosystems

Duration

3-4 days of 45 minute learning activities

Background Information

Weather, which varies from day to day and seasonally throughout the year, is the condition of the atmosphere at a given place and time. **Climate** is longer term and location sensitive; it is the range of a region's weather over one year or many years, and, because it depends on latitude and geography, it varies from place to place. Weather and climate are shaped by complex interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions can drive changes that occur over multiple time scales—from days, weeks, and months for weather to years, decades, centuries, and beyond for climate.

Climate change, which is defined as significant and persistent changes in an area's average or extreme weather conditions, can occur if any of Earth's systems change (e.g., composition of the atmosphere, reflectivity of Earth's surface). The earth has a variety of climatic patterns, which consist of different conditions of temperature, precipitation, humidity, wind, air pressure, and other atmospheric phenomena. These patterns result from an interplay of many factors.

Ecosystems are dynamic in nature; their characteristics fluctuate over time, depending on changes in the environment and in the populations of various species. Disruptions in the physical and biological components of in ecosystems— which can lead to shifts in the types and numbers of the ecosystem's organisms, to the maintenance or the extinction of species, to the migration of species into or out of the region, or to the formation of new species (speciation)—occur for a variety of natural reasons. Changes may derive from the fall of canopy trees in a forest, for example, or from cataclysmic events, such as volcanic eruptions. But many changes are induced by human activity, such as resource extraction, adverse land use patterns, pollution, introduction of nonnative species, and global **climate change**.

Vocabulary

- **Climate** is the pattern of weather that happens over a long period of time.
- **Climate change** is a regional change in temperature and weather patterns. Current science indicates a link between climate change over the last century and human activity, specifically the burning of fossil fuels.
- An **ecosystem** includes all the living things (plants, animals and organisms) in a given area, interacting with each other, and also with their non-living environments (weather, earth, sun, soil, climate, atmosphere).

Literature Connections

Books

I Survived the Children's Blizzard of 1888 by Lauren Tarshis
I Survived: Tornado Terror by Lauren Tarshis
I Survived the Joplin Tornado 2011 by Lauren Tarshis (FIC TAR)*
I Survived: 5 Epic Natural Disasters by Lauren Tarshis
I Survived the Japanese Tsunami 2011 by Lauren Tarshis (FIC TAR)*
Night of Twisters by Ivy Ruckman (FIC RUC)*

*currently available in Northside Elementary's media center

Learning Activity 14
Weather & Our Choices

Lesson Prep

- ✓ Review the student worksheet.
- ✓ Make copies of Exploring Northside's Utility Bills Analysis Sheet, 1 per pair or for each small group.

Procedure

Mini-Lesson

- Ask students to consider the various ways Northside uses energy and guess where this energy comes from.
- Record responses on the board.
- Review the how to read bar graphs

Independent Group Work

- Students will work with a partner to complete the Exploring Northside's Utility Bills Analysis Sheet.

Assessment

- Students turn in completed worksheets.
- **Exit ticket:** How does weather impact heating or electricity use at Northside?

Opportunities for Extended Learning

1. Students examine energy use data (electricity and/or natural gas) from their household and present their findings to the class. For students who don't have access to these data online; representative data (e.g. an anonymous electric bill) can be provided by the teacher.
2. Invite Dan Schnitzer to come speak with students about the energy conservation features at Northside.
3. Invite students to make recommendations for additional energy conservation measures that can be adopted at Northside.

Learning Objectives:
Students will be able to describe how weather impacts energy use by analyzing local weather data and actual energy costs at Northside Elementary School

Nutshell/Skills:
Students can analyze and describe the effects of weather on energy costs.

Science Essential Standards:
5.L.1

Math Essential Standards:
NC.5.MD.2

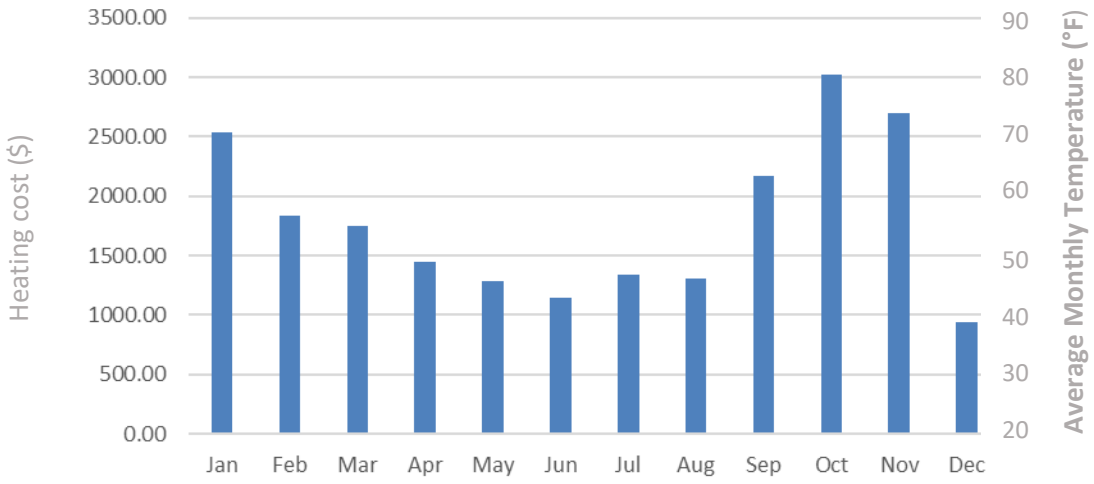
Time:
45 minutes

Student Materials:
- Exploring Northsides Utility Bills Analysis Sheet

Exploring Northside's Utility Bills | Heating

1. **Predict:** Make a prediction about the relationship between the school's heating costs (for hot water and heat) and the average monthly temperature. **What month(s) do you predict will have the highest heating costs?** Explain your reasoning below:

2. **Compare:** The bar graph below shows the amount of money ($) spent on heating at Northside Elementary School from Jan-Dec 2018. **How do your predictions from above compare to the graph below?**



The table below shows the average monthly temperature (°F) for Chapel Hill, NC from Jan-Dec 2018.

2018 Monthly Average Temperature (°F)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
35.2	49.7	45.6	56.6	72.8	77.7	78.9	77.8	76.4	61.9	47.3	43.8

3. **Graph:** Using the vertical axis on the **right** side of the graph above, **create a line graph on top of the bar graph** in order to examine the relationship between temperature and heating costs.

4. **Compare:** Once you have finished making your line graph, take a look and compare the line and the bar graph; **describe your observations below:**

5. **Analyze:** Answer the following questions about your graph:

a. Which month was the **coldest month**? _____

b. In which month was the **most money** spent on heating? _____

c. Are your answers as expected? Why or why not? What might explain your observations?

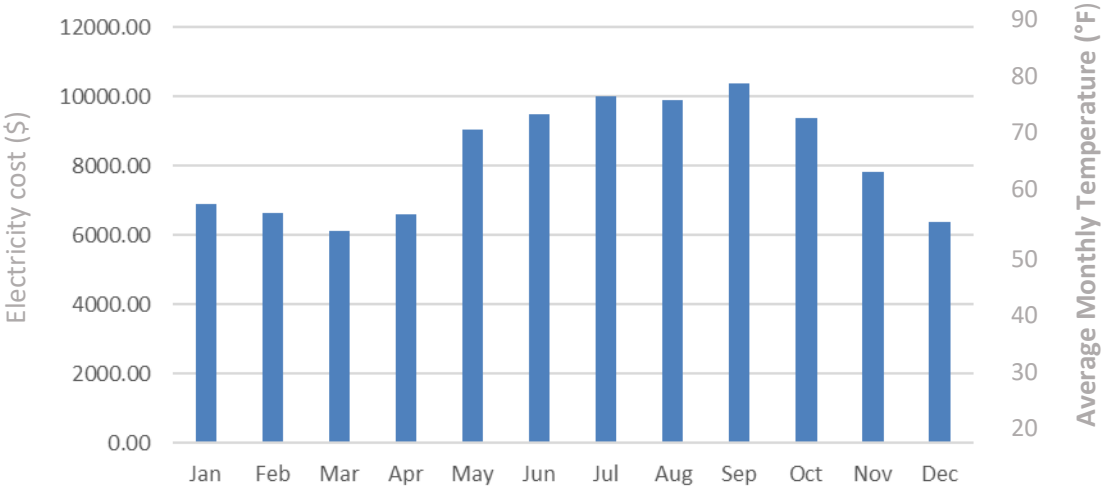
6. **Think:** The average temperature in December was 43.8˚F but the heating bill was only $937.67. **Why do you think the heating costs were lower in the month of December?** Use evidence from the graph to help explain your answer.

Exploring Northside's Utility Bills | Electricity

1. **Think:** List all the items that you can think of that use electricity in your school. Circle the item that you think uses the most electricity.

2. **Predict:** Make a prediction about the relationship between the school's electricity costs and the average monthly temperature. **What month(s) do you predict will have the highest electricity costs?** Explain your reasoning below:

2. **Compare:** The bar graph below shows the amount of money ($) (think lights and air conditioning!) spent on electricity at Northside Elementary School from Jan-Dec 2018. **How do your predictions from above compare to the graph below?**



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3. **Graph:** Using the vertical axis on the **right** side of the graph above, **create a line graph on top of the bar graph** in order to examine the relationship between temperature and electricity costs.

4. **Compare:** Once you have finished making your line graph, take a look and compare the line and the bar graph; **describe your observations below:**

5. **Analyze:** Answer the following questions:

a. Which month was the **hottest month**? _____

b. In which month was the **most money** spent on electricity? _____

c. Are your answers as expected? Why or why not? What might explain your observations?

6. **Think:** Northside has many features to help it conserve electricity. List the features that you know about:

Learning Activity 15
Climate Change & Ecosystems

Lesson Prep

- ✓ Identify areas in the schoolyard where students can make observations.
- ✓ Register for a *Project BudBurst Educator Account*. Click on "My Account" at the top right of the screen to create a Log In.

Vocabulary

Weather, climate, ecosystems, climate change

Procedure

Mini-Lesson

- Draw a T-Chart on the board. Label one side *weather* and the other side *climate*.
- Ask students to draw and label a T-Chart in their notebook.
- Ask students to list everything they know about the weather on the weather side.
- Tell students they are going to watch a video clip from NASA called, *What's the difference between weather and climate?* (2:01).
- After the video is over, give students 2-3 minutes to write down what they learned about climate on their T-chart and to make additions to the weather side if necessary.
- Ask students to turn and talk with a partner to share what they wrote. Ask for volunteers to share their notes with the class.
- Write student responses on the board. Guide students to describe that weather is what is happening right now, while climate is the pattern of weather that happens over time.
- Ask students to answer the question, "*What is the difference between weather and climate?*" in their science notebooks.
- Ask students what they know about climate change. Briefly explain that climate change is the shifting of Earth's climate and that Earth is getting warmer. As a result we are seeing shifts not only in temperature but precipitation, and other climate variables (e.g., extreme weather events).
- Ask students to compare a map of world biomes, such as https://www.internetgeography.net/topics/what-is-a-biome/, with a map of world climate zones, such as https://content.meteoblue.com/nl/meteoscool/general-climate-zones.
  - Ask: "What do you notice?"

Learning Objectives:
To explain how changes in climate may affect organisms and their food sources, and populations are affected

Nutshell/Skills:
Students can explain how changes in climate affect organisms and their food source and populations are affected.

Science Essential Standards:
5.E.1, 5.L.1

Time:
45 minutes

Teacher Materials:
- Project Budburst Educator Account

Student Materials:
- Nature journals
- Science notebooks
- Chromebooks

- Prompt students to identify a connection between climate zones and biomes/ecosystems.
- Ask students to write the question, "*What effect does climate change have on ecosystems?*" in their notebooks.
- Ask students to turn and talk with a partner about the effect climate change may have on ecosystems.
- Tell students to record their responses in their notebooks.
- Tell students they will watch a Crash Course Kids video about *Climate Change* (how climate change can affect an ecosystem) (3:40).
- Once the video is over, give students a few minutes to add to their notes.
- Then have students share their responses.

Independent Work 

- Tell students they are going outside to make observations of their schoolyard by participating in a Citizen Science project called Project Budburst, *https://budburst.org/.* Students will collect and submit data about the plants growing near school. Scientists will use data collected by students to improve the understanding of how different species are reacting to changes in climate. You can choose to collect data on one occasion or begin collecting life cycle data of plant species, such as the American beeches growing along the greenway. You can use *this PowerPoint* to help teach about Budburst. Additional information about using Budburst in your classroom can be found *here*, including forms for collecting data.
- **Nature Journaling** prompt: 
  - Sketch and describe your plant. Include information about the plant's habitat and the current weather as well as any plant life cycle observations.

Assessment

- **Exit ticket:** What effect does climate change have on ecosystems?

Opportunities for Extended Learning

1. Have students visit the *Climate Change Expedition* webpage by EPA. Tell them to click on the links to discover how climate change is affecting ecosystems.
2. Reading about Billy Barr, a man who collected weather data in Colorado Rockies for 40 years and scientists have been able to use his data to document climate change impacts. *National Geographic interview*, *Denver Post article*
3. Students can watch the video *Liz Hadly Tracks the Impact of Climate Change in Yellowstone* to see how ecosystems may be impacted due to climate change.
4. Students can use *The Climate Time Machine* from NASA's Climate Kids website to visualize changes that are occurring or may occur on Earth due to a changing climate.

Behavior Management Tips

- Discuss with students the importance of respecting nature both biotic and abiotic things. Examples include things such as:
  - leave worms and other animals alone
  - leave rocks, soil, and grass where you found them
- Define the boundary for where the students can sit and work on their nature journaling prompt.

Learning Activity 16
Extreme Weather

Lesson Prep

- ✓ Make copies of the safety checklists or students can view them online.
- ✓ Make copies of the rubrics.
- ✓ Gather materials to make posters.

Vocabulary

Hurricane, tornado

Procedure Part 1

Mini-Lesson

- Ask students to make a T-Chart in the notebooks. Label one side Before *Hurricane Michael* and the other side After Hurricane Michael.
- Show students the before pictures of Hurricane Michael's landfall. *(You will need to scroll down the page to see the pictures. The pictures have a slider bar to help compare the destruction after the hurricane.)* Ask students to write down everything they notice in the picture.
- Then show students the after pictures of Hurricane Michael's landfall. Ask them to write down what they notice about the pictures.
- Discuss what students wrote down in each column.
- Have students make another T-Chart and label one side before the Alabama tornado and after the Alabama tornado.
- Show students the short video of the Alabama tornadoes that touched down March 7, 2019. *CNN Before and after aerial photos show the devastation of the deadly Alabama tornadoes.*
- Then scroll down the page to see the before and after pictures. The pictures have a slider bar to help compare the destruction after the tornado.
- Show students the before pictures and ask them to write down everything they notice in the pictures.
- Show students the after pictures of the tornadoes. Ask students to write down everything they notice in the pictures.
- Discuss what students wrote down in each column.
- Ask students what other types of severe weather we experience in NC.
- Record their answers on the board.
- Tell the students they are going to learn how to prepare for these extreme weather events.

Learning Objectives:
Students will be able to describe how to prepare for an extreme weather event.

Nutshell/Skills:
Students can describe how to prepare for an extreme weather event.

Science Essential Standards:
5.E.1

ELA Essential Standards:
RI.5.1

Time:
Part 1: 45 minutes
Part 2: 45 minutes

Teacher Materials:
- Rubrics

Student Materials:
- Materials to make posters
- Safety Checklists

Procedure Part 2

Independent Group Work

- Students will work in groups to research one of type of extreme weather event and create a poster to show how to prepare, what to do during, and what to do after the event. Share the rubric for the extreme weather posters with the students.
- *Hurricane Safety Checklist*, *Tornado Safety Checklist*, *Winter Storm Safety Checklist*, *Flooding Safety Checklist*, *Heatwave Safety Checklist*, *Thunderstorm Safety Checklist*
- After students have completed their posters, consider posting them around the school, or otherwise sharing them with other students.

Assessment

- Completion of posters using the Rubric for Extreme Weather Event Posters.

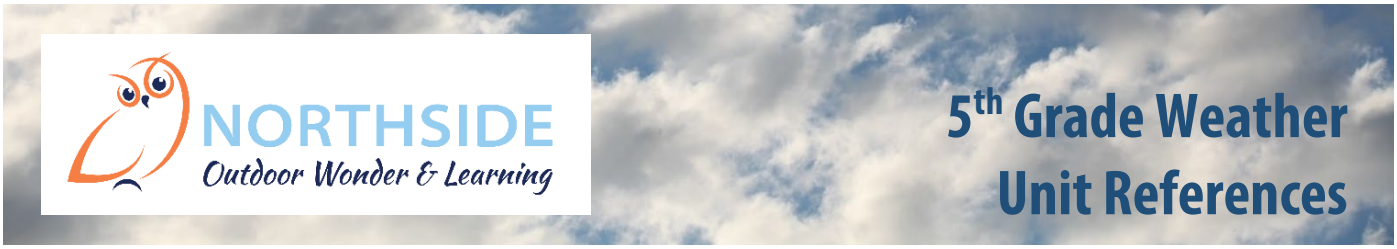
Opportunities for Extended Learning

1. Give students scenario cards about different types of weather events. Have students use their knowledge to explain what weather events are happening and how to prepare for them.

Name _____ Date_____

Extreme Weather Events
Poster Rubric

Categories	4	3	2	1
Definition	The event is explained.	The event is partially explained.	The event has very little explanation.	No explanation is provided.
Know the difference between watches and warnings	Both are, explained and a drawing showing the difference is included	Both are explained, and a drawing showing the difference is included	Both are explained but no drawing is included **OR** drawings are included but no explanation	Only one is explained with a drawing
How can I be prepared?	4 ways to prepare are listed	3 ways to prepare are listed	2 ways to prepare are listed	1 way to prepare are listed
What supplies do I need?	4 supplies are listed	3 supplies are listed	2 supplies are listed	1 supply is listed
What do I do after the weather event?	4 things to do after the event are listed	3 things to do after the event are listed	2 things to do after the event are listed	1 thing to do after the event is listed



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Engaging Activity: Local Weather

National and Local Weather Radar, Daily Forecast, Hurricane and information from The Weather Channel and weather.com. (2019). Retrieved from https://weather.com/

WRAL. (2019). Weather Forecasts in Raleigh, Durham, Fayetteville from WRAL. Retrieved from https://www.wral.com/weather/

Learning Activity 1: The Earth's Atmospheric Layers

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UCAR. (2011). The Troposphere - overview. Retrieved from https://scied.ucar.edu/shortcontent/troposphere-overview

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UCAR. (2014). Weather Balloon Launch Video. Retrieved from https://scied.ucar.edu/weather-balloon-launch-video

Learning Activity 2: Weather and Seasons

NASA. (2019, June 28). What Causes the Seasons? Retrieved from https://spaceplace.nasa.gov/seasons/en/

PBS. (2018, September 12). Why Do We Have Seasons? Retrieved from https://unctv.pbslearningmedia.org/resource/npls13.sci.ess.seasons/why-seasons/#.Wx664Egvzcs

Scholastic Inc. (2019). A Day on Earth: StudyJams! Science. Retrieved from http://studyjams.scholastic.com/studyjams/jams/science/solar-system/day-on-earth.htm

Learning Activity 3: What Causes Wind?

Beccario, C. (n.d.). A global map of wind, weather, and ocean conditions. Retrieved from https://earth.nullschool.net/#current/wind/surface/level

Fox 9 Now. (2013, March 18). Why is high pressure associated with fair, clear skies while low pressure is associated with dark clouds and precipitation? Retrieved from https://www.youtube.com/watch?v=aiYyCurh_SU

Cowan, L. (2019). GFS Model. Retrieved from https://www.tropicaltidbits.com/analysis/models/?model=gfs®ion=us&pkg=z500a&runtime

NASA's Visible Earth. (2009, August 11). High Pressure System Animation. Retrieved from https://visibleearth.nasa.gov/view.php?id=54422

NASA's Visible Earth. Low Pressure System Animation. (2009, August 11). Retrieved from https://visibleearth.nasa.gov/view.php?id=54425

Wind Map. (n.d.). Retrieved from http://hint.fm/wind/

Learning Activity 4: When Air Masses Meet

Pearson. (n.d.). Weather Fronts. Retrieved from http://www.phschool.com/atschool/phsciexp/active_art/weather_fronts/
The Weather Channel. (2013, February 20). Creating a weather front. Retrieved from https://www.youtube.com/watch?v=9U0W3-pruuY
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Weather Wiz Kids. (n.d.). Weather Forecasting. Retrieved from https://www.weatherwizkids.com/?page_id=80

Learning Activity 5: What Moves Air Masses?

Stadelman, T. (2019). How Does The Jet Stream Work? Retrieved from https://edpuzzle.com/media/5c64b312bd86bb40ae7809bc
Cowan, L. (2019). GFS Model. Retrieved from https://www.tropicaltidbits.com/analysis/models/?model=gfs®ion=us&pkg=z500a&runtime
Weather Underground. (n.d.). Maps Catalog. Retrieved from https://www.wunderground.com/maps/wind/jet-stream
Wonderopolis. (n.d.). What Is a Jet Stream? Retrieved from https://www.wonderopolis.org/wonder/what-is-a-jet-stream

Learning Activity 6: Clouds & Their Formation

NASA. (n.d.). GLOBE Observer. Retrieved from https://observer.globe.gov/
UCAR. (2012). Cloud Types. Retrieved from https://scied.ucar.edu/webweather/clouds/cloud-types
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National Weather Service. (n.d.). Cloud Spotter. Retrieved from https://www.weather.gov/media/jetstream/clouds/cloudspotter.pdf
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Weather Wiz Kids. (n.d.). Cloud In A Bottle. Retrieved from https://www.weatherwizkids.com/?page_id=1727

Learning Activity 7: Clouds & Weather

Jensenius, J. S. (2017). *The clouds outside my window*. Retrieved from https://www.weather.gov/media/owlie/CloudsOutMyWindow.pdf
SciJinks. (2019). Types of Clouds. Retrieved from https://scijinks.gov/clouds/
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The Weather Channel. (2019, July 01). US Precipitation Forecast. Retrieved from https://weather.com/maps/usprecipitationforecast

Learning Activity 8: The Water Cycle & Weather

Project Learning Tree. (2015). Water Wonders. In *Project Learning Tree Pre K-8 Environmental Education Activity Guide* (pp. 188-193). Washington, D.C: American Forest Foundation.
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BrainPOP. (n.d.). Water Cycle. Retrieved from https://www.brainpop.com/science/earthsystem/watercycle/
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USGS. (n.d.). The Water Cycle for Schools: Beginner Ages. Retrieved from https://water.usgs.gov/edu/watercycle-kids-beg.html

Learning Activity 9: The Weather, Ocean, & Climate

Florida State University. (n.d.). Ocean Currents and Weather. Retrieved from http://www.cpalms.org/Public/PreviewResourceLesson/Preview/46068

NASA Goddard. (2012, August 03). NASA | The Ocean: A Driving Force for Weather and Climate. Retrieved from https://www.youtube.com/watch?v=6vgvTeuoDWY

Learning Activity 10: The Gulf Stream

Beccario, C. (n.d.). A global map of wind, weather, and ocean conditions. Retrieved from https://earth.nullschool.net/#current/ocean/surface/currents/orthographic=-79.07,35.92,690/loc=-79.068,35.916

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SciJinks. (n.d.). What Is the Gulf Stream? Retrieved from https://scijinks.gov/gulf-stream/

Learning Activity 11: Sea Breezes & Land Breezes

McDougal Littell. (n.d.). Observe an animation of land and sea breezes. Retrieved from http://www.classzone.com/books/earth_science/terc/content/visualizations/es1903/es1903page01.cfm?chapter_no=visualization

Py, T. (2010, January 13). Land And Sea Breeze Explained. Retrieved from https://www.youtube.com/watch?v=gM0d3fGew-0

Learning Activity 12: El Nino & La Nina

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Learning Activity 15: Climate Change & Ecosystems

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Learning Activity 16: Extreme Weather

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