

4-H

Natural Resource

Club



Weather & Climate Science

WEATHER & CLIMATE SCIENCE

The Level 1 4-H Weather and Climate Science manual introduces basic weather words and ideas. Activities focus on understanding the signs of weather. Youth will also begin to learn the difference between weather and climate. The Level 2 manual will introduce youth to more complex weather topics including: air pressure, winds, humidity, and fronts. Level 3 delves even deeper into weather and introduces climate science concepts to help prepare youth to fully understand weather and/or study these topics at a college or university.

Indiana 4-H Weather & Climate

Science manuals

(Order from Purdue's *The Education Store*, www.edustore.purdue.edu)

- Level 1, Grades 3-5, 4-H-1023
- Level 2, Grades 6-8, 4-H-1023a
- Level 3, Grades 9-12, 4-H-1024
- Level 1, Facilitator's Guide, 4-H-1024b
- Level 2, Facilitator's Guide, 4-H-1025
- Level 3, Facilitator's Guide, 4-H-1025b

Invited Speaker Suggestions

- CoCoRaHS member (volunteer weather observers and data collectors), see www.cocorahs.org, click on "states" under the title; Indiana; and "Find Your Local Coordinator"
- Local weather watcher
- Local TV meteorologist

Resources

- Indiana 4-H Weather webpage: www.ydae.purdue.edu/natural_resources/
- NOAA Weather forecast, (enter your zipcode): www.noaa.gov/wx.html
- National Weather Service: www.nws.noaa.gov
- Community Collaborative Rain, Hail, & Snow (CoCoRaHS) Network, www.cocorahs.org/
- Window to the Universe website, www.windows2universe.org/
- Purdue
 - Earth, Atmospheric, and Planetary Sciences, www.eaps.purdue.edu
 - Longer periods of tornado activity are most likely to spawn the worst events, but they may also be more predictable
- Smithsonian National Museum of Natural History, Climate and Human Evolution, <http://humanorigins.si.edu/research/climate%20research>

Activities

The following activities are from the Indiana 4-H Weather and Climate Science manual.

Page	Activity Suggestions	Materials Needed	Time (min.)
<i>Comparing Climates</i>			
3-5	Youth learn about temperate, desert, tropical, and tundra climates.	Pencil and dictionary or other resource, copies of pg 4	30
<i>Country of Colors</i>			
6-7	Youth learn about the USDA Hardiness Zone map and the zone where they live.	Copies of pg 7, colored pencils. Internet (optional).	30
<i>Earth's Surfaces</i>			
10-11	Youth study the effect of color on sun's heating power and consider how this phenomenon might affect weather.	Thermometer, desk lamp, clock, construction paper, copies of pg 11	30
<i>Invisible Air</i>			
14-16	Youth learn about the properties of air.	Glass jar, plastic straw, hot glue, food coloring, ice, towel	30
<i>'Tis the Season</i>			
19-21	Youth use their own knowledge to explore the changing seasons.	Copies of pp 19-21 and crayons	30
<i>Weather Alerts</i>			
27-29	Youth complete a word search to learn important weather terminology.	Copies of pg 28, pencil	30
<i>Weather or Climate?</i>			
30-31	Youth learn the difference between weather and climate and determine if a particular statement is about weather or climate.	Copies of pp 30 & 31, pencil	30

COMPARING CLIMATES



How are four U.S. climate areas — temperate, desert, tropical, and tundra — the same, and how are they different?



Weather is the current condition of the **atmosphere**, including temperature, wind, cloudiness, **precipitation**, and **relative humidity**. Climate is the average weather over time. The local climate affects the clothes you wear, when we plant flowers and vegetables, and the crops that farmers grow. There are four climates in the United States: temperate, desert, tropical, and tundra.

A *temperate* climate has seasons with hot and cold weather, but not as hot or cold as in other climates. Indiana has a temperate climate. We also have rain and snow but, generally, not as much as in some other climates. The *desert* climate has very little rainfall and hot temperatures. *Tropical* climates have warm or hot conditions year-round. The *tundra* climate has extremely cold conditions most of the year. All of these climates have seasons, but the seasons are not always as noticeably different as the seasons we experience in Indiana. You will compare data from states in the four U.S. climate areas — temperate, desert, tropical, and tundra — and look for what is similar and what is different.

OBJECTIVE: Compare the four climates found in the United States.

Weather Tote

- Pencil
- Dictionary



- 1 Read the data in the chart below for each of the four climates.
- 2 Answer the questions about the four climates on the next page.
- 3 Answer the follow-up questions.

TEMPERATE CLIMATE

Central Indiana

average temperature
average precipitation



January (winter)	July (summer)	yearly average
25.5°F	75.4°F	52.3°F
2.3"	4.5"	39.9"

DESERT CLIMATE

Central Arizona

average temperature
average precipitation



TROPICAL CLIMATE

Southern Florida

average temperature
average precipitation



TUNDRA CLIMATE

Central Alaska

average temperature
average precipitation



WHICH CLIMATE HAS:

- temperate?
- desert?
- tropical?
- tundra?

The highest average temperature? _____ What is it? _____

The lowest average temperature _____ What is it? _____

The highest July temperature? _____ What is it? _____

The lowest July temperature? _____ What is it? _____

The highest January temperature? _____ What is it? _____

The lowest January temperature? _____ What is it? _____

The highest average precipitation? _____ What is it? _____

The lowest average precipitation? _____ What is it? _____

The highest July precipitation? _____ What is it? _____

The lowest July precipitation? _____ What is it? _____

The highest January precipitation? _____ What is it? _____

The lowest January precipitation? _____ What is it? _____

Look up the word *temperate* in the dictionary, and write the definition below:

The first question in the chart above asked you about climate extremes — highest and lowest of the averages. How many times did the temperate climate have the extreme data for one of the climates?



SHARE WHAT HAPPENED:

- Were you surprised by the differences in the climates?
- What data surprised you?

APPLY:

- What do you think it would be like to live in each of the other climates?
- Which climate do you think that you would be happiest living in year-round? Why?
- How are flowers, plants, and agricultural crops affected by climate?

COUNTRY OF COLORS



What is a hardiness zone?



Buds, new leaves on trees, tulips, and daffodils tell us that spring is coming because the weather is warming up. These plants can survive our cold winter temperatures. But many flowers we enjoy need to be planted in the spring after the danger of frost has passed. In this activity, you will learn about **hardiness zones** and how they are determined.

The U.S. Department of Agriculture (USDA) publishes the Hardiness Zone Map to help gardeners and farmers plan what and when to plant. The map shows zones based on the **average annual extreme minimum temperatures** for a 30-year period in the United States. This is important information because many plants are very sensitive to cold temperatures and cannot survive freezing.

AVERAGE ANNUAL EXTREME MINIMUM TEMPERATURES

Average *the sum of all values divided by the number of years*

Annual *over a year*

Extreme *the lowest*

To find the average annual extreme minimum temperature, add the lowest temperature of each year for 30 years and divide the sum by 30. Areas with similar extreme minimum temperatures (within 10°F) are grouped together in zones. Areas with colder winter weather have lower zone numbers. Areas with warmer winters have higher zone numbers.

OBJECTIVE: Know Indiana's hardiness zones.

Question: Why do some flowers bloom year after year, while others need to be planted each year?

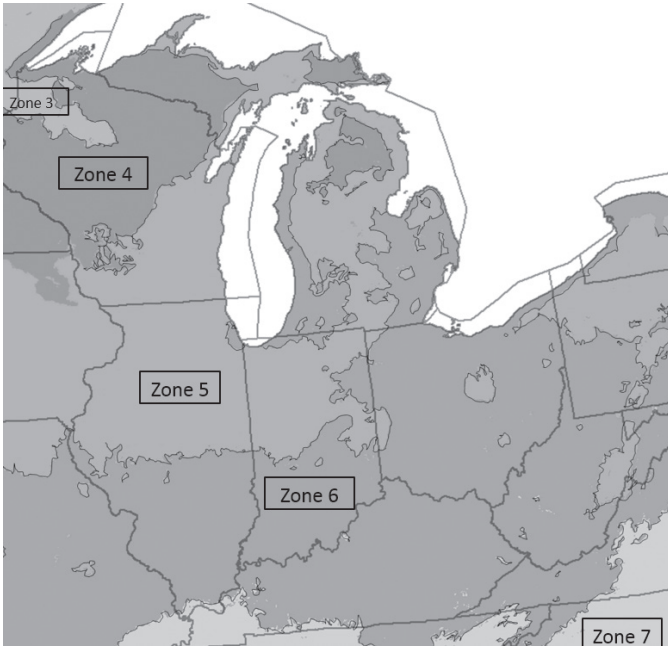
Weather Tote

- Pencil
- Colored pencils, markers, or crayons
- Hardiness Zone Map (on next page)



- 1 Draw a line between Indiana's hardiness zones.
- 2 Color each zone a different color.
- 3 Make a key that shows the color for each zone.
- 4 Place an "x" where you live.
- 5 List five garden plants (flowers or vegetables) that cannot overwinter — not survive a winter and need to be planted each year.

PLANT HARDINESS ZONES



Adapted from the USDA Hardiness Zone map, planthardiness.ars.usda.gov

INDIANA HARDINESS ZONES



Garden plants that cannot overwinter

- 1 _____
- 2 _____
- 3 _____
- 4 _____
- 5 _____



SHARE WHAT HAPPENED:

How many zones did you find in Indiana?

APPLY:

- What is the average annual extreme minimum temperature range where you live?
- What do you think would happen if you planted a hardy perennial flower, a plant that lives more than one year, in Hardiness Zone 9, which includes the warmest parts of the United States.

GENERALIZE TO YOUR LIFE: How do the hardiness zones affect what farmers grow?



Fly Higher

- Visit the USDA Plant Hardiness Zone Map online (and in color) at <http://planthardiness.ars.usda.gov/PHZMWeb/Maps.aspx>, or look at the map to the left. Then answer the following questions.

Where are the warmest zones? What is their average minimum temperature?

Where are the coldest zones? What is their average minimum temperature?

- Find a flower or vegetable seed catalog. Your parent or Extension Educator can help you.

How are the hardiness zones listed for different flowers or vegetables?

What flowers or vegetables did you find that are not recommended for where you live?

EARTH'S SURFACES



How will the energy from sunlight heat up different-colored surfaces?



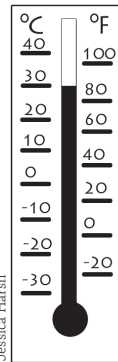
Sunlight warms the surfaces of earth. Look around you. Do all of earth's surfaces look the same? Earth has many natural surfaces, including grass, trees, sand, water, mountains, and ice. Humans create many surfaces, including roofs, sidewalks, and roads of concrete or asphalt.

When surfaces are warmed by sunlight, they warm the air above them. Different surfaces may warm the air at different rates or to a higher or lower degree. Surface warming can affect our weather.

OBJECTIVE: Study how the color of a surface influences how fast an object warms up.

Weather Tote

- Indoor thermometer, with a bulb that can safely touch the paper
- Desk lamp with a 40-watt or 60-watt bulb
- Clock or watch with a second hand
- One sheet each of white, black, brown, green, and blue construction paper



Jessica Harsh

- 1 Record the room's temperature on the thermometer as the beginning temperature in the chart on the next page.
- 2 Place the white sheet of paper on top of the thermometer.
- 3 Put the desk lamp 6 inches above the paper at the bulb end of the thermometer.
- 4 Turn on the light, and wait 5 minutes.
- 5 Record the temperature on the thermometer as the ending temperature on the chart.
- 6 Calculate the change in temperature by subtracting the first temperature from the second one. Record it on the chart.
- 7 Allow the thermometer to cool for 5 minutes.
- 8 Repeat the steps for the other colors of paper, and fill in your results in the chart.



SHARE WHAT HAPPENED:

- Which color did you think would heat the most?
- Which color did heat the most?
- Which color heated the least?
- What surfaces on earth would match the colors used in your experiment?
- Which surfaces would heat the air above them the most? The least?

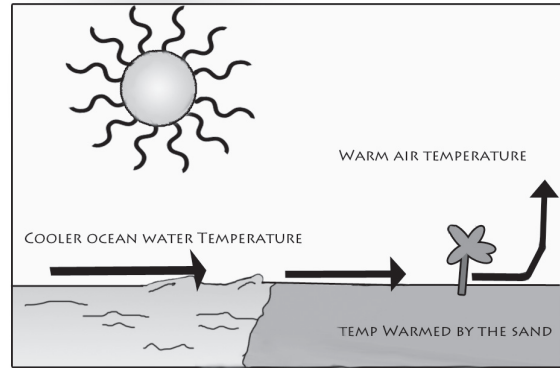
APPLY: Why does the sun’s uneven heating of oceans and land surfaces cause breezes?

Hint: Have you ever been to a sandy beach on a hot, sunny day? What happens if you go barefoot on the sand? How does it feel when you sink your feet in the water? Both surfaces — sand and water — receive the same amount of sunlight, but each heats up much differently.

Look at the arrows in the diagram in column 2 that show a sea breeze. Then answer the questions.

- Why is the air over the land rising?
- What is causing the sea breeze?
- How does the surface affect breezes?

SUN’S HEAT AND SEA BREEZES



Adapted from <http://blogs.kxan.com/2013/06/12/what-is-a-sea-breeze/>

GENERALIZE TO YOUR LIFE: Think of places that have two different surfaces, like a plowed field next to a forest or a large parking lot next to a city park.

- How might the different surfaces affect the wind in each place?
- How might humans change the earth’s surfaces and affect the local weather?



Fly Higher

Take an outdoor thermometer outside on a sunny, calm day. Put the thermometer on several different surfaces to see how the sunlight is causing these surfaces to warm. Use something to shade the thermometer (like an umbrella) so that the sunlight does not affect the thermometer.

TESTING COLORED SURFACES [TABLE 1]

Surface Color	Beginning Temperature	Ending Temperature	Temperature Change
White			
Black			
Brown			
Green			
Blue			

INVISIBLE AIR



How do we know air is there?



Air is one of many things we know exists, but that we cannot see. Earth is covered with a layer of air called the **atmosphere**.

Weather occurs in the atmosphere. When the air interacts with the sun's energy and earth's surface, it creates weather. So you need to understand the properties of air to understand weather.

OBJECTIVE: Understand that warm air rises and cool air sinks.

PART 1

Question: Does air take up space?

Weather Tote

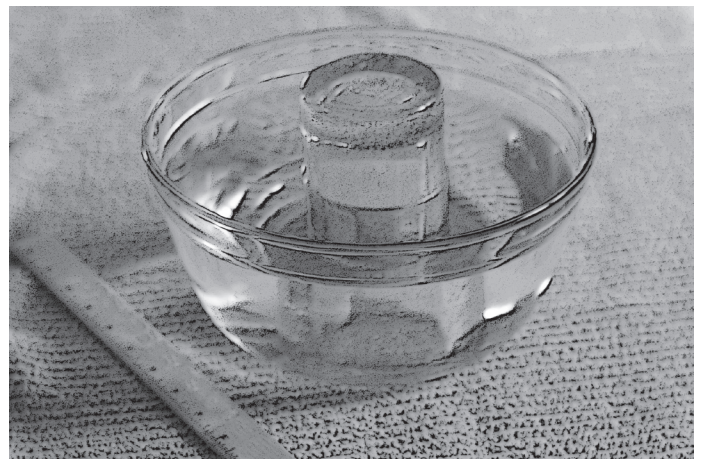
- Glass
- Clear bowl
- Water
- Towel
- Ruler



- 1 Place the clear bowl on the towel.
- 2 Add water so the bowl is about $\frac{3}{4}$ full.
- 3 Measure the height of the water:

- 4 Turn the glass upside down, and push it straight down into the water.
- 5 Measure the height of the water again:

- 6 Record the difference in the height of the water before (3) and after (5):



SHARE WHAT HAPPENED:

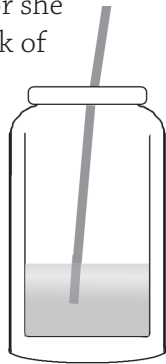
- What happened to the water in the bowl when you inserted the upside-down glass?
- What kept the water from entering the glass?

PART 2

Question: How does temperature change the amount of space that air occupies?

Weather Tote

- Glass jar (not plastic) with a metal screw-on lid (pint or similar size will work)
- Clear skinny plastic straw, like some restaurants use
- Hot glue gun and glue stick or Play-Doh
- Food coloring
- Ice cubes or freezer cold packs
- Towel
- Also Needed:** Ask an adult to drill a hole in the center of the metal lid. Using a drill bit the same size as the diameter of the straw, he or she should place the metal lid on the block of wood, hold the lid and drill a hole in the center.



What do you think will happen when air is cooled?

To help you answer this question, construct a testing jar using the following steps:

- 1 Place the lid on the jar, and put the straw through the hole so that the bottom of the straw is about $\frac{1}{2}$ " from the bottom of the jar.
- 2 Seal the straw to the top of the lid, using hot glue or Play-Doh.
- 3 Remove the lid from the jar, and seal the straw to the bottom of the lid for an airtight seal.

- 4 Place about 1" of water in the jar, and add one drop of food coloring.
- 5 Place the lid with the straw firmly on the jar.
- 6 Put the jar on the towel to avoid a mess from spilling water.
- 7 Rub two ice cubes or freezer cold packs against the outside of the jar to cool the air inside the jar.
- 8 Observe what happens in the straw as the air inside the jar cools.
- 9 Now warm the air in the jar by wrapping your hands around the jar.
- 10 Observe what happens in the straw as the air inside the jar warms up.



SHARE WHAT HAPPENED

- What did you observe when you cooled the air in the jar with the straw?
- What did you observe when you warmed the air in the jar with the straw?

PART 3

Questions:

- 1 Which is heavier (denser) — warm or cold air?
Circle your guess:

WARM COLD
- 2 If the air in a balloon is cooled, how will the balloon's weight (**density**) change?
Circle your guess.

BECOMES HEAVIER (denser)

BECOMES LIGHTER (less **dense**)

NO CHANGE

Weather Tote

- Yardstick or similar board
- Two rubber bands
- Two balloons
- Ice cubes or freezer cold packs
- Masking tape
- Towel



- 1 Blow up the balloons, and attach them to each end of the yardstick with the rubber bands.
- 2 Balance the yardstick on the back of a chair. Tape the balancing point of the yardstick to the chair back.
- 3 Rub ice cubes on one of the balloons, or put one of the balloons in the freezer or a bowl of ice water for five minutes. Put it back in the same place on the yardstick. If you use ice, avoid a mess by keeping the towel under the melting ice.
- 4 Observe how the balance changes.



SHARE WHAT HAPPENED: Did the balloons on the yardstick stay balanced when you cooled one of the balloons?

APPLY: Why does cooled air sink? Why does warmed air rise?

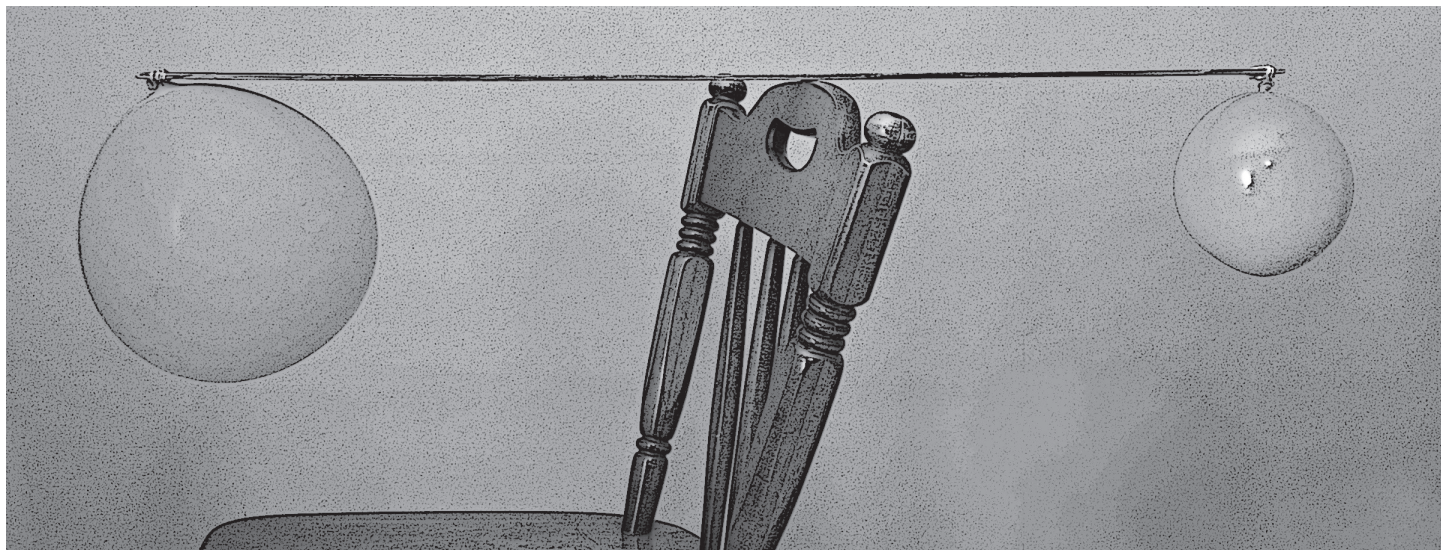
GENERALIZE TO YOUR LIFE:

- Is there a breeze outside today? How might changes in the air temperature have caused that breeze?
- Have you ever seen a hot air balloon? How do you think a hot air balloon works?



Fly Higher

- Using an indoor thermometer, compare the temperature of the air in a room near the floor and near the ceiling. If your house has two or more floors, compare the floor and ceiling temperatures in an upstairs room.
- If you have a garage or barn, compare the two temperatures in that building on a warm day.
- How can you explain any differences?



'TIS THE SEASON



How do the changing seasons affect the way we live?



The weather in Indiana changes with the four seasons. These changes cause people to wear different clothes and do different outdoor activities. The seasons also affect the plants and animals that live outside.

OBJECTIVE: Identify the effects of changing seasons.



Show how seasons are different by drawing in the boxes what you or others like to see, hear, or do during each season. You might show the clothes people wear outside or the outdoor sports and activities they play, the view outside your window, or how plants change.

SPRING

SUMMER

FALL

WINTER



SHARE WHAT HAPPENED:

- Was it hard to decide how to draw the seasons?
- Was one season more difficult to show than others?

APPLY: What is your favorite season? Why?

GENERALIZE TO YOUR LIFE:

- How does the season affect what you wear?
- How does the season affect what you do outside?
- How does the season affect plants?



Fly Higher

Take photographs, make a video, or find pictures in magazines or on the Internet that show the different seasons. Use your pictures or photos to teach younger children about the seasons.

WEATHER ALERTS



What are NWS alerts?



The *National Weather Service* (NWS) watches the weather for us. When bad weather is approaching, the NWS sends alerts to radio, TV, and Internet sources so that we can prepare to protect ourselves and our property. The three kinds of NWS alerts are an *advisory*, a *watch*, and a *warning*. It is important to understand what these words mean. A storm advisory means that a storm is anticipated. A storm watch means that a storm is expected. A storm warning means that a storm is in your area and you must take cover. You will learn the definitions for hazardous weather terms that may be involved in an NWS alert.

OBJECTIVE: Learn the definitions for common weather words.

Weather Tote

Pencil



- 1 Find each word in the Word Bank in the word-search puzzle on the next page.
- 2 Match each word to the definition in the Weather Alerts Data Sheet as best as you can.
- 3 Discuss your answers with your 4-H facilitator.

DEFINITIONS: *From the National Weather Service*

STORM ADVISORY An advisory is issued when a hazardous weather event is occurring, imminent, or likely. Advisories are for less serious conditions than warnings. Advisory conditions may cause significant inconvenience, and if caution is not exercised, could lead to situations that may threaten life or property.

STORM WATCH A watch is used when the risk of a hazardous weather event has increased significantly, but its occurrence, location, or timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so. A watch means that hazardous weather is possible. People should have a plan of action in case a storm threatens, and they should listen for later information and possible warnings, especially when planning travel or outdoor activities.

STORM WARNING A warning is issued when a hazardous weather event is occurring, imminent, or likely. A warning means weather conditions pose a threat to life or property. People in the path of the storm need to take protective action.

**WORD
SEARCH
PUZZLE**

q u i t j h u h f r l p
 a f u h k g y i e t o z
 z o i u b l i z z a r d
 w g k n l f c o v g t x
 s n l d p d e p w b i c
 x b o e o s t a c i k v
 c g p r i a r z d n n b
 f l a s h f l o o d m d
 d t j t u q w x e h j n
 e r v o t o r n a d o m
 r f w r y s e s w y u l
 f v e m z w i n t e r k

WORD BANK

blizzard
 flash flood
 fog
 heat
 ice
 thunderstorm
 tornado
 wind
 winter

WEATHER ALERTS DATA SHEET

Weather Alert	Kind of Weather from Word Bank list
Winds of 58 mph or higher with hail of 1" in diameter or more with dangerous lightning	
Winds of 40 mph or higher or wind gusts of 58 mph or higher for one hour or more	
Imminent danger of rapid flooding in low-lying areas	
Blowing snow reducing visibility to a quarter mile or less for 3 hours or longer and sustained winds of 35 mph or greater or frequent gusts to 35 mph or greater	
A tornado is imminent	
¼ inch or more of ice accumulation	
The heat index value is expected to reach or exceed 110 degrees within the next 12–24 hours	
Reduced visibility to a quarter mile or less over a large area for an extended period (2 or more hours)	
A significant combination of hazardous winter weather is occurring or imminent	

WEATHER OR CLIMATE?



What is the difference between weather and climate?



People often say climate and weather as if they mean the same thing. They do not. The temperature today is considered part of today's *weather*, but the average temperature over the last 30 years is considered part of our climate. Weather is the day-to-day changes in the **atmosphere** and describes a single occurrence, such as the current temperature. An example of weather is a temperature reading of 85 degrees Fahrenheit on the 4th of July. An example of climate would be the average high temperature for your city or town on the 4th of July.

OBJECTIVE: Describe the difference between weather and climate.

Weather Tote

- Pencil
- Tables 1 and 2
- Optional:* A resource on weather and climate, such as the Internet, a book, or a person



- 1 Imagine that you will spend the day outside today. Look or listen to today's weather report, and choose the clothes you will wear from the list of clothes given in Table 1, Dressing for Weather. Put an X next to the clothes that you choose to wear outside today.
- 2 You might hear any of the statements in Table 2 on your radio or TV. Read each statement in the first column of Table 2.
 - Indicate if the statement is an example of weather or climate by placing an X in one of the Example columns (2 or 3).
 - Explain your reason for your answer by placing an X in one of the Reason columns (4 or 5).

DRESSING FOR THE WEATHER

[TABLE 1]

T-shirt		Shorts		Gym shoes	
Tank top		Jeans or long pants		Snow boots	
Long-sleeve shirt		Heavy socks		Light jacket	
Sweatshirt		Light socks		Raincoat	
Hoodie		Sandals		Winter coat	
Swimsuit		Flip-flops		Hat and gloves	

WEATHER OR CLIMATE? [TABLE 2]

Announcer's Statement	Example		Reason	
	Weather	Climate	Single Occurrence	An Average
Yesterday the high was 55°F and the low was 43°F.				
Today we are expecting a high of 61°F.				
That is 10 degrees above the normal high of 51°F for this date.				
We will have clear skies today with no rain forecasted for the next three days.				
We usually would have four inches of rain this month.				
Hurricane season is beginning in the tropics.				
A tropical storm is developing in the Atlantic Ocean.				
To the north, a massive snowstorm is on its way.				
We do not normally see a snowstorm like this at this time of year.				
Tornado season is upon us, and we must be prepared.				
We usually expect four or five tornado outbreaks to occur this month.				
This morning a tornado damaged a building on High Street downtown.				



SHARE WHAT HAPPENED:

- Did you find it difficult to decide which of the statements in Table 2 were about weather and which were about climate?
- Are the clothes you wear today determined by the weather? Or the climate?
- Are the clothes you keep in your closet and dresser determined by the weather? Or the climate?
- Do you have clothes you don't wear very much? If so, why?

APPLY: Pick another time of year. What clothes from Table 1 would you wear outside at that time of year?

GENERALIZE TO YOUR LIFE:

- Would you keep all the same clothes if you lived in Hawaii? What would be different?
- Would you keep all the same clothes if you lived in Alaska? What would be different?



Fly Higher

Do you have a friend or relative who lives in another climate area — for example, Florida or Georgia; Arizona or California; Washington or Idaho; Maine or Vermont? Contact them, and compare the kind and number of types of clothes they keep and wear.