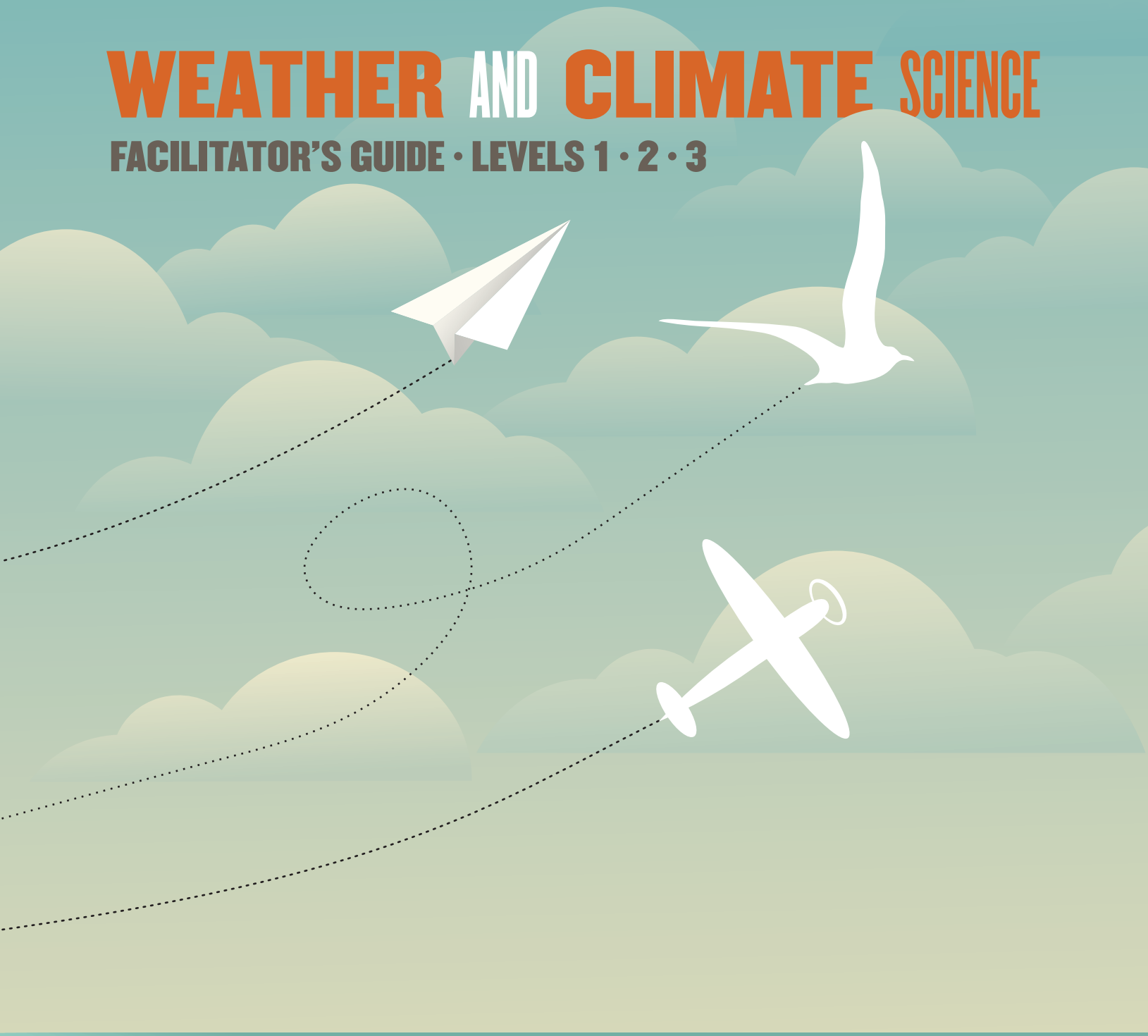
PURDUE EXTENSION

National PEER REVIEWED

WEATHER AND CLIMATE SCIENCE

FACILITATOR'S GUIDE · LEVELS 1 · 2 · 3



4-H-1052-Levels 1·2·3

WEATHER AND CLIMATE SCIENCE

FACILITATOR'S GUIDE • LEVELS 1 • 2 • 3

NOTE

THANK YOU for taking the time to help a young person learn more about weather and climate science. Weather watching is useful on a daily basis and can even be a lifelong hobby. Learning about the earth's climate and climate change is important to understanding and responding to our changing weather.

The 4-H Weather and Climate Science curriculum is for youth who enjoy learning about science, especially weather and climate. Level 1 introduces basic terms and concepts for youth in grades 3–5. Activities focus on understanding the signs of weather. Level 2 activities introduce youth in grades 6–8 to more complex weather topics, understanding climate, and making and using weather instruments. Level 3 activities are divided into two major sections: weather and climate. Level 3 delves deeper into weather and climate science concepts to prepare youth to be well informed and to study these topics at a college or university. Youth are encouraged to supplement their learning by consulting knowledgeable people and current written materials in Level 3 with references from governmental and/or university sources (online extensions *.gov and *.edu).

This Facilitator's Guide answers questions in the youth manual and suggest ways to enhance the activities. It also offers additional information about working with youth.

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SCIENCE STANDARDS

NGSS indicates the Next Generation Science Standards for each activity. See www.nextgenscience.org/next-generation-science-standards for more information.

See Purdue Extension's Education Store, www.edustore.purdue.edu, for additional resources on many of the topics covered in the 4-H manuals.

NOTE TO THE PROJECT FACILITATOR

Thank you for helping a 4-H member learn about weather and climate science as a project facilitator. This facilitator's guide answers the questions in the youth guides and suggests ways to facilitate the activities. It also gives additional information about working with youth, for those who wish to learn more.

You can help youth get the most out of this project by being enthusiastic and asking thoughtful questions. Team up with youth to help them select goals, identify resources, gain confidence, and evaluate their own progress. The activities are designed so youth have an opportunity to learn by doing with your help and guidance.

Your main role is to provide a safe, supportive environment for youth to practice important life skills as they explore the world of weather and climate science through many exciting activities.

RECOMMENDATIONS

- Gather materials. Youth should collect the materials listed in the tool kit before doing the activity. All the supplies used in these activities can be found around the home or purchased at minimal cost.
- Read and understand the activity. Each activity is self-contained.
- Encourage youth to try different activities and to enjoy learning.
- Show the relevance of each activity. Explore with youth the interconnectedness of each activity to the real world.
- Emphasize relying on others. Expand the learning activity and get additional supporting information from your Extension office. The Internet can provide a wealth of information to enrich learning. Take care to use sites that are supported by educational organizations (*.edu), government agencies (*.gov), professional societies, national organizations, and not-for-profit groups associated with the study of weather and climate.
- Keep safety in mind at all times. Some activities are done outdoors where wasps, bees, and other potentially harmful insects might be. Keep a watchful eye on the surroundings, and look out for weather changes.
- Visit Purdue University's Department of Earth, Atmospheric, and Planetary Sciences Teacher Resource website, http://www.eaps.purdue.edu/outreach/teacher_resources.html, for new and supporting educational materials.

LEARNING GOALS

Weather and Climate Science, Level 1

- Begin to learn about weather and climate science.
- Learn basic terms and concepts.

Weather and Climate Science, Level 2

- Understand drivers of weather systems and climate change.
- Develop further understanding of, and an appreciation for, weather and climate science.

Weather and Climate Science, Level 3

- Understand why learning about weather and climate science is important.
- Educate others about weather and climate science.
- Become a lifelong learner; continue to read and learn about weather and climate science.

KEY SCIENCE CONCEPTS

Weather is the state of the atmosphere at a particular place and time. An area's climate and many local factors — temperature, wind, cloudiness, precipitation, and relative humidity — influence the weather.

Climate is the usual, long-term weather conditions for an area, the average weather over time.

Climate system: How earth's water and gases flow or change state because of the sun's energy.

Climate change

"The surface temperature of our earth depends on a process called the heat budget. This budget, like any other type of budget, remains balanced if the amount of energy coming in equals the amount going out. If the energy balance is disrupted, then the result would be a change in temperature. Ice ages occur when the energy going out exceeds incoming solar energy; global warming occurs when the incoming solar energy is greater than the energy going out. Clouds play a major role in the heat budget. Clouds act as both a block to

solar energy coming in as well as an insulator trapping heat below.

An indication of climate change would be a gradual shift in the earth's average surface temperature. Locally, annual temperatures might fluctuate due to differences in weather systems from one year to the next. On a global scale, however, those local fluctuations are canceled out and the earth's average temperature should remain the same. But global average temperature, currently 57°F (14°C), has risen almost 1 degree over the last century. Some scientists predict that temperatures will rise another 2 to 6 degrees over the next century!"

Reference: Atmospheric Radiation Measurement Program (ARM), http://education.arm.gov/teacherslounge/lessons/climate_change.pdf, downloaded June 2014

4-H LIFE SKILLS

4-H programs help youth develop knowledge and skills that help them become caring, competent adults. In "Targeting Life Skills in 4-H" (University of Florida IFAS Extension, 4-H FS 101.9) Norman and Jordan define life skills as competencies that assist people in functioning well in the environments in which they live. 4-H uses the Targeting Life Skills Model (Hendricks, 1998) to identify important assets that youth can learn through 4-H programming. The model uses the 4-H Pledge to categorize various life skills under four general competency areas: Head, Heart, Hands, and Health.

Head: knowledge, reasoning, and creative competencies

- Thinking – using one's mind to form ideas and make decisions; to imagine; to examine carefully in the mind; to consider

  Managing – using resources to accomplish a purpose

Heart: personal and social competencies

- Relating – establishing a mutual or reciprocal connection between two people that is wholesome and meaningful to both
- Caring – showing understanding, kindness, concern, and affection for others

Hands: vocational and citizenship competencies

- Giving – providing, supplying, or causing to happen; social responsibility
- Working – accomplishing something or earning pay to support oneself through physical or mental effort

Health: health and physical competencies

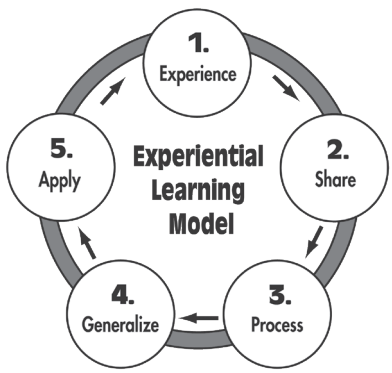
- Living – acting or behaving; the manner or style of daily life
- Being – living one's life; pursuing one's basic nature; involved in personal development

Targeted life skills are listed for each activity in this curriculum to remind youth that they are learning more than subject matter knowledge. Facilitators should review the life skills to understand the overarching goals of the activity with respect to youth development.

THE EXPERIENTIAL MODEL

The 4-H National Headquarters Fact Sheet explains, "Experiential learning takes place when a youth is involved in an activity, looks back at it critically, determines what was useful or important to remember, and uses this information to perform another activity. 4-H uses this hands-on learning approach to teach new topics and life skills." Experiential Learning Principles, www.4-h.org/resource-library/curriculum/development/, July 2014.

The experiential learning model is a way of teaching to help youth make the most of any activity. It distinguishes 4-H activities from many other educational methods. Experiential learning is a process that allows youth to first learn by doing, before being told or shown how, and then to process the experience. Activities are designed so youth experience a learning activity; share what they did; process what they did through discussion, analysis, and reflection; generalize what they learned to test their comprehension and appreciation of the activity; and think about how they can apply what they learned to other situations.



Pfeiffer, J.W., & Jones, J.E., "Reference Guide to Handbooks and Annuals"
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Using the experiential learning process in group settings offers these advantages:

- The adult can quickly assess the youth's knowledge of the subject.
- The youth builds on past experience or knowledge.
- The adult acts as coach rather than as teacher.
- The youth relate the experience to their own lives and experiences.
- Mentors may use a variety of methods to involve the youth in the experience.
- Youth with different learning styles can be successful.
- Discussions can move from the concrete to the abstract and analytical, which particularly benefits youth in middle school and high school.
- Youth are stimulated to learn through discovery and to draw meaning from the experience.
- Youth can work together, share information, provide explanations, and evaluate themselves and others.
- Youth take responsibility for their own learning.

Evaluating youth learning using a simple rubric such as the one shown can help 4-H volunteer leaders assess the effectiveness of their teaching methodology and youth interest. Evaluate each step of the experiential model by indicating what you think the 4-H members learned in a particular activity (your best guess). Work on improving any low scores.

Step	Excellent	Average	Minimal
Experience			
Share			
Process			
Generalize			
Apply			

YOUTH DEVELOPMENT STAGES

Understanding the physical, mental, social, and emotional development of youth will help you when working with the 4-H members in your club. No two youth develop at the same rate, and transitions are often gradual. Your teaching and involvement helps 4-H club members grow and mature, and makes 4-H a rewarding and fulfilling experience.

Activities at 4-H club meetings are not always as successful as you, the volunteer leader, hope and plan for. Sometimes youth talk among themselves rather than listening to you; no one comes to a scheduled field trip; or no one speaks up to answer your questions when you are trying to involve the youth in a discussion. If you are working with a broad age range, the activity might be too simple for the older youth and too difficult for the younger ones. This is challenging for the 4-H leader. Giving the older 4-H members leadership opportunities can be effective.

Youth of the same age can vary greatly in physical, mental, social, and emotional growth and interests. These differences are even more marked between age groups. Research provides some generalities that can help you understand how to plan activities for different age groups.

EARLY ELEMENTARY (MINI 4-H)

This is an active age, so keep these children busy. They are concrete thinkers and need to understand what you want them to do and how to do it. They are generally more interested in making something than in completing a project — process is more interesting than product. Youth in this age group tend to seek adult approval and depend on adults, although their peers' opinions are beginning to be important. They do best in small groups with set rules and rituals. Competition is inappropriate for this age group.

UPPER ELEMENTARY

This is also a physically active age, so hands-on activities work best. Youth in the upper elementary grades are still fairly concrete thinkers — things are black and white, right or wrong — but are beginning to think logically and symbolically. Because this age group has a strong need to feel accepted, an adult should evaluate each product, rather than encouraging competition among peers with only one winner. This age prefers to know how much they have improved against past efforts and how to improve in the future.

These youth are beginning to identify with peers but continue to value adult guidance. They are also beginning to discover the benefits of making other people happy, but more for the benefits to themselves rather than the benefit to others. They begin to take responsibility for their actions and to develop increased

independence of thought, which might allow them to try new things. Letting this age group help in the decisions of the club helps them start learning about leadership.

MIDDLE SCHOOL

Middle school youth are beginning to move to more abstract thinking. Justice and equality are important to this age. Therefore, project judging may now be viewed in terms of what's fair as well as a reflection of self-worth. They prefer to find their own solutions, rather than adults giving them. Try to provide supervision without interference. Independent thinking and actions begins to emerge. Avoid comparing middle school youth with each other; compare performance with past accomplishments.

Junior volunteer organizations often are popular with teens toward the upper end of this age group, particularly with opportunities for developing leadership.

HIGH SCHOOL

Most high school-aged teens know their abilities, interests, and talents. They tend to be concerned with themselves and their peer group. While they can understand the feelings of others, they lean toward self-absorption, particularly in the earlier years of high school. Relationship skills are usually fairly well developed. Getting a driver's license increases both independence and dating, and acceptance by members of the opposite sex is important.

High school-aged youth begin to think about the future and make realistic plans. They enjoy career exploration and preparation. Their vocational goals influence the activities they select.

Projects requiring research and creativity give teens an opportunity to demonstrate how much they have learned and what they can accomplish. Teens set goals based on their personal needs and priorities and generally reject goals that others set for them.

As teens master abstract thinking, they might try new ideas in ways that confuse adults. Teens can generally initiate and complete tasks without supervision. A leader can help by arranging new experiences in areas of interest to teens but must be sure to allow them plenty of input. Assume the role of advisor/coach for independent workers, rather than teacher/lecturer. Club meetings, rituals, and uniforms do not generally appeal to this group. However, many teens enjoy looking back on their achievements in 4-H and appreciate special recognition for leadership activities. By the time they graduate from high school and begin college or a career, youth feel they have reached full maturity and expect to be treated as such.

POSITIVE IMPACT

These guidelines give only a brief overview of child and youth development as a resource to help you plan your activities as a volunteer leader. The publication Ages and Stages of Child and Youth Development* has more in-depth information and is available from your county Purdue Extension office.

You, as the club volunteer, are a valuable asset to your community and to your club's members. The guidelines for the stages of child and youth development, in combination with your special skills and interest in youth, will help you plan and carry out a successful 4-H program and make a positive impact on the lives of young people.

*Ages and Stages of Child and Youth Development, A Guide for 4-H Leaders, NCR-292, available at Purdue Extension's Education Store, www.edustore.purdue.edu; search NCR-292.

ACTIVITY FACILITATION AND ANSWERS: LEVEL 1

COMPARING CLIMATES

Big Picture: People often think of the different seasons as being different climates. An area's climate includes the seasons there. Different seasons are therefore part of our climate. Climates are classified in different ways. This activity highlights the temperate, tropical, desert, and tundra climates because these can be illustrated using regions in the United States. In this scheme, rainfall and temperature are the major components of climate. Other systems involve biomes or geologic features. Indiana is in the temperate climate. The word "temperate" means moderate, and the youth will discover that Indiana does not have the extreme differences in rainfall or temperature of other climates. Indiana's climate, even though it has great variation of weather, is moderate when considering extremes in temperature and rainfall.

FACILITATING THE ACTIVITY

Youth might be able to complete this activity without adult assistance. You should check that they are interpreting the data correctly.

Climate Answers:

Question: Look up the word "temperate" in the dictionary and write the definition.

ANSWER:
The definition probably includes the word "moderate" or something about not having extremes.

Question: The questions you answered from the data were extremes (highest and lowest of the averages). How many times did the temperate climate have extreme data in a category?

ANSWER:
Only 1

SHARE AND APPLY QUESTIONS

ANSWER:
Interpretive – no right or wrong answers

The highest average temperature?	Tropical	What is it?	75.9°F
The lowest average temperature	Tundra	What is it?	26.9°F
The highest July temperature?	Desert	What is it?	93.5°F
The lowest July temperature?	Tundra	What is it?	26.9°F
The highest January temperature?	Tropical	What is it?	67.2°F
The lowest January temperature?	Tundra	What is it?	-10.1°F
The highest average precipitation?	Tropical	What is it?	55.9 in.
The lowest average precipitation?	Desert	What is it?	7.7 in.
The highest July precipitation?	Tropical	What is it?	5.7 in.
The lowest July precipitation?	Desert	What is it?	0.8 in.
The highest January precipitation?	Temperate	What is it?	2.3 in.
The lowest January precipitation?	Tundra	What is it?	0.5 in.

GENERALIZE TO YOUR LIFE

Question: Why doesn't Indiana have many extremes in temperature and rainfall?

ANSWER:
Indiana has a temperate climate in which rainfall and temperatures are moderate.

Question: Temperature and rainfall are the major factors in a climate. What might some other differences be?

ANSWER:
Ideas could include vegetation, humidity, elevation, and others.

CONNECTIONS

There are many climates around the world. Encourage youth to investigate them and compare them to our climate.

There are different terminology systems. Some are based on temperature and precipitation, some on biomes (flora and fauna), and some on geologic components.

FLY HIGHER

Calculate the difference in average temperature and rainfall between January and July for each climate. What climate has the greatest extremes for temperature and rainfall?

LIFE SKILLS

- Weather Skills: Understanding that climates are different in other areas, and that Indiana has a temperate climate that does not have extremes in rainfall or temperature.
- Indiana Science Standards: 2.2.4
- NGSS: ESS2.D, 3ESS2-1, 3-ESS2-2
- Success Indicator: Youth understand that Indiana is in a temperate climate that includes changing seasons with moderate temperature and rainfall.

SOURCES

- Climate: www.climate-zone.com/climate/united-states
- Temperate image: www.nhptv.org/natureworks/nwep8c.htm
- Desert image: www.city-data.com/picfilesv/picv27841.php
- Tropical image: www.nps.gov/ever/parknews/upload/greategret.jpg
- Tundra image: www.animalcorner.co.uk/biomes/tundra.html

Climate/State	Indicator	January	July	Difference
Temperate/Central Indiana	Average Temperature	25.5°F	75.4°F	49.9°F
	Average Precipitation	2.3"	4.5 in.	2.2 in.
Desert/Central Arizona	Average Temperature	53.6°F	93.5°F	39.9°F
	Average Precipitation	0.7 in.	0.8 in.	0.1 in.
Tropical/South Florida	Average Temperature	67.2°F	82.6°F	15.4°F
	Average Precipitation	2.0 in.	5.7 in.	3.7 in.
Tundra/Central Alaska	Average Temperature	-10.1°F	62.5°F	72.6°F
	Average Precipitation	0.5 in.	1.9 in.	1.4 in.

Note that the tundra climate has the largest average temperature difference, and the tropical climate has the largest average precipitation difference. The tropical climate has the smallest temperature difference, and the desert climate has the smallest precipitation difference (and the least precipitation overall).

NEXT GENERATION SCIENCE STANDARDS

The 4-H Weather & Climate Science activities primarily address the Next Generation Science Standard (NGSS) educational disciplines: Earth and Space Science and the Core Ideas:

ESS1 Earth's Place in the Universe

ESS2 Earth's Systems

ESS3 Earth and Human Activity

The discipline of Physical Science (PS) and the Core Ideas below are touched on in a few activities.

PS1 Matter and Its Interactions

PS3 Energy

The table below lists Sub Ideas that each activity touches upon and performance expectation codes, when addressed. See NGSS Text for a description of the performance expectations.

ACTIVITY	SUB IDEA	PERFORMANCE EXPECTATION CODE
LEVEL 1		
Comparing Climates	ESS2.D	3-ESS2-1 3-ESS2-2
Country of Colors	ESS2.D	MS-ESS3-5
Defining Weather Words	ESS2.D	
Earth's Surfaces	ESS2.D	5-ESS2-1 MS-ESS2-6
H2O	ESS2.D	MS-ESS2-5
Invisible Air	ESS2.D PS1.A PS3.A	5-PS1-1 MS-ESS2-5 MS-PS3-4
Reading About Wild Weather	ESS2.D	
'Tis the Season	ESS2.D	3-ESS2-1
Watching the Wind	ESS2.D	3-ESS2-1
Weather Affects Plans	ESS2.D	5-ESS3-1
Weather Alerts	ESS2.D	5-ESS3-1
Weather or Climate?	ESS2.D	3-ESS2-1
Where Is the Heat?	ESS1.B	5-ESS1-2

ACTIVITY	SUB IDEA	PERFORMANCE EXPECTATION CODE
LEVEL 2		
Air Pressure	ESS2.D	5-PS1-1
Carbon Footprints	ESS2.D ESS3.D	MS-ESS2-5 MS-ESS3-5
Cloud Formation	ESS2.D	5-ESS2-1 5-PS1-1
Cloud Types	ESS2.D	MS-ESS2-5
Cold Fronts	ESS2.D	MS-ESS2-5
Earth's Rotation	ESS2.D	
Global Winds	ESS2.D	MS-ESS2-6
The Greenhouse Effect	ESS2.D ESS3.D	MS-ESS2-5 MS-ESS3-5
Humidity	ESS2.C ESS2.D PS1.A	MS-ESS2-5 MS-PS3-4
Hurricanes	ESS2.D	MS-ESS2-5 MS-ESS2-6
Making Weather Instruments	ESS2.D	3-ESS2-1 MS-ESS2-5
Mini-Tornado	PS1.A	MS-PS3-4
Out of the Dust	ESS2.D	MS-ESS2-5
Seasons	ESS1.B	5-ESS1-2 MS-ESS2-5 MS-ESS2-6
Using Weather Instruments to Collect Data	ESS2.D 3-ESS2-1	MS-ESS2-5

ACTIVITY	SUB IDEA	PERFORMANCE EXPECTATION CODE
LEVEL 3		
WEATHER		
Air Masses and Front	ESS2.D	5-ESS2-1 MS-ESS2-5
Isaac's Storm	ESS2.D ESS3.B	
Monitoring Weather	EES2.D	5-ESS1-2 MS-ESS2-5
Pressure Systems	ESS2.D	MS-ESS2-5
Weather Station Models	ESS2.D	MS-ESS2-5
Weather in the Troposphere	ESS2.D	HS-ESS2-4
Windchill and Heat Index	ESS2.D	MS-ESS2-5
CLIMATE		
Climate and Climographs	ESS2.D ESS3.D	3-ESS2-2
Drought Monitoring	ESS2.D	MS-ESS2-5 MS-ESS2-6
Energy in the Atmosphere	ESS2.D ESS3.D	MS-ESS2-6
Energy Balance	ESS2.D ESS3.D	HS-ESS2-4 HS-ESS3-6
Impacts of Climate Change	HS-PS3.B ESS3.D	HS-ESS2-2 HS-ESS3-5
Investigating Climate Change	ESS2.A ESS3.D	HS-ESS2-2 HS-ESS3-5 HS-ESS2-7
The Sun–Earth Relationship	ESS1.B ESS2.D ESS3.D	HS-ESS3-6
Sunspot Cycle	ESS2.D ESS3.D	HS-ESS3-6
Volcanoes	ESS3.C ESS2.D ESS3.D	HS-ESS2-2 HS-ESS2-4

Reference: Next Generation Science Standards for States, By States, Volume 1, The Standards (ISBN 13: 978-0-309-27227-8; ISBN 10: 0-309-27227-0; Library of Congress Control Number: 2013939525)

SCIENCE STANDARDS

PERFORMANCE STANDARDS, LISTED BY DISCIPLINE, CORE IDEA

Earth's Place in the Universe, Core Idea: ESS1

Sub Idea: ESS1.B Earth and the Solar System

Performance Expectation code 5-ESS1-2

Represent data in graphical displays to reveal patterns of daily changes in the length and direction of shadows day and night and seasonal appearance of some stars in the night sky. (The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its north and south poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different tines of the day, month, and year.)

- Level 1, Where Is the Heat?
- Level 2, Seasons
- Level 3, Monitoring Weather

Earth's Systems, Core Idea: ESS2

Sub Idea: ESS2.C – The Roles of Water in Earth's Surface Processes

Sub Idea: ESS2.D – Weather and Climate

Performance Expectation code: 3-ESS2-1

Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. (Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.)

- Level 1, Comparing Climates
- Level 1, 'Tis the Season
- Level 1, Watching the Wind
- Level 1, Weather or Climate?
- Level 2, Making Weather Instruments
- Level 2, Using Weather Instruments to Collect Data

Performance Expectation code: 3-ESS2-2

Obtain and combine information to describe climates in different regions of the world. (Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.)

- Level 1, Comparing Climates
- Level 3, Climate and Climographs

Performance Expectation code: 5-ESS2-1

Develop a model using an example to describe ways in which the geosphere, biosphere, hydrosphere, and/or atmosphere interact. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.)

- Level 1, Earth's Surfaces
- Level 2, Cloud Formation
- Level 3, Air Masses and Fronts

Performance Expectation code: MS-ESS2-5

Collect data to provide evidence of how motions and complex interactions of air masses result in changes in weather conditions. [Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather at a fixed location to change over time and how sudden changes in weather can result when different air masses collide. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation). Assessment does not include recalling the names of cloud types or weather symbols.]

- Level 1, H2O
- Level 1, Invisible Air
- Level 2, Carbon Footprints
- Level 2, Cloud Types
- Level 2, Cold Fronts
- Level 2, The Greenhouse Effect
- Level 2, Humidity
- Level 2, Hurricanes

- Level 2, Making Weather Instruments
- Level 2, Out of the Dust
- Level 2, Seasons
- Level 2, Using Weather Instruments to Collect Data
- Level 3, Air Masses and Fronts
- Level 3, Monitoring Weather
- Level 3, Pressure Systems
- Level 3, Weather Station Models
- Level 3, Windchill and Heat Index
- Level 3, Drought Monitoring

Performance Expectation code: MS-ESS2-6

Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. (Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.)]

- Level 1, Earth's Surfaces
- Level 2, Global Winds
- Level 2, Hurricanes
- Level 2, Seasons
- Level 3, Drought Monitoring
- Level 3, Energy in the Atmosphere

Performance Expectation code: HS-EES2-2

Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

- Level 3, Impacts of Climate Change
- Level 3, Investigating Climate Change
- Level 3, Volcanoes

Performance Expectation code: HS-EES2-4

Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. (Examples of the causes of climate change differ by timescale, changes in human activity, ocean circulation, solar output, changes to Earth's orbit and the orientation of its axis.)

- Level 3, Weather in the Troposphere
- Level 3, Energy Balance
- Level 3, Volcanoes

Performance Expectation code: HS-ESS2-7

Construct an argument based on evidence about the simultaneous co-evolution of Earth's systems and life on Earth. (Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems.)

- Level 3, Investigating Climate Change

Earth and Human Activity, Core Idea: ESS3

Sub Idea: ESS3.C Human Impacts on Earth Systems

Sub Idea: ESS3.D Global Climate Change

Performance Expectation code: 5-ESS3-1

Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. (Individuals and communities are doing things to help protect Earth's resources and environments.)

- Level 1, Weather Affects Plans
- Level 1, Weather Alerts

Performance Expectation code: MS-ESS3-5

Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and

the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

- Level 1, Country of Colors
- Level 2, Carbon Footprints
- Level 2, The Greenhouse Effect

Performance Expectation code: HS-ESS3-5

Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems. [Examples of evidence are for climate changes (such as precipitation and temperature) and their associated impacts.]

- Level 3, Impacts of Climate Change
- Level 3, Investigating Climate Change

Performance Expectation code: HS-EES3-6

Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. (An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification with resulting impacts on sea organism health and marine populations. Assessment does not include running computational representations, but is limited to using the published results of scientific computational models.)

- Level 3, Energy Balance
- Level 3, The Sun-Earth Relationship
- Level 3, Sunspot Cycle

DISCIPLINE: PHYSICAL SCIENCES (PS)

PS1 Matter and Its Interactions, Core Idea: PS1

Sub Idea: PS1.A Structure and Properties of Matter

Performance Expectation code: 5-PS1-1

Develop a model to describe that matter is made of particles too small to be seen. (Examples of evidence could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water. Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model that shows gasses are made from matter particles that are too small to see an that are moving freely around in space can explain many observations.)

- Level 1, Invisible Air
- Level 1, Air Pressure
- Level 2, Cloud Formation

Energy, Core Idea: PS3

Sub Idea: PS1.A Structure and Properties of Matter

Performance Expectation code: MS-PS3-4

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. (Examples of experiments could include comparing final water temperatures after different masses of ice have melted in the same volume of water with the same initial temperature.)

- Level 1, Invisible Air
- Level 2, Humidity
- Level 2, Mini-Tornado