A Guide to Developing Literacy Practices in Science

Engaging in Shared-Expertise Discussions: Regional Climate

Strategy Guide

The Learning Design Group

THE LAWRENCE HALL OF SCIENCE

Earth Science

Grades 6–8

Overview

What's in this guide? This strategy guide introduces Shared-Expertise Discussions, an approach for structuring small-group discussions of science content. Students work with partners to become experts on one example of a concept. They then work in heterogeneous groups to engage in a collaborative task that requires drawing upon the knowledge that each group member brings. This guide includes a plan for introducing students to Shared-Expertise Discussions with a set of four articles that describes how regional climates are affected by various factors, including ocean currents, wind, and elevation.

Why Shared-Expertise Discussions? Students can be more motivated to learn about a concept when they are accountable for explaining it to others as well as when they can apply their learning to new situations. The approach described in this guide capitalizes on the notion of distributed expertise. Peer discussion and collaboration—when structured so students can interact productively around a meaningful task—helps students process and make sense of science concepts as well as engage in academic discourse.

How This Fits Into Your Science Curriculum

Deep learning requires that students not just learn about a topic but that they are able to apply what they have learned to another situation. Reading one of the four articles provides an opportunity for students to apply their understanding of how latitude, topography, ocean currents, and prevailing winds affect a region's climate by impacting the temperature and amount of precipitation. This strategy guide can fit well at the end of a unit on weather and climate or on air and water currents, allowing students to solidify their understanding about these ideas. It is helpful if students have some previous exposure to the water cycle and to the ways that temperature, pressure, and elevation may change characteristics of the air. Understanding the difference between climate, long-term weather patterns, day-to-day weather, and seasonal events is important in understanding the patterns presented in the articles.

Addressing Standards

NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas

ESS2.D: Weather and Climate: 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.

Crosscutting Concepts

Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information: Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).

COMMON CORE STATE STANDARDS FOR ELA/LITERACY

Reading Standards for Literacy in Science and Technical Subjects 6–12

RST.6–8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

College and Career Readiness Anchor Standards for Speaking and Listening

SL #4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

Science Background

Climates are usually classified by their average seasonal variation in **temperature** and **precipitation**. Factors that influence a climate are: **latitude**, proximity to the ocean along with temperature of **surface currents**, **prevailing winds**, amounts of **water vapor** in the air, and topography. Variation in any of these factors can explain differences in climate, and similarities in these factors are the basis for grouping climates into categories. In particular, proximity to the ocean changes climate because the ocean has a higher capacity to hold heat than land does. Therefore, places in the middle of a continent tend to have colder winters and hotter summers compared to coastal areas. Additionally, proximity to warm surface currents lead to more water vapor in the prevailing winds, which leads to more overall precipitation.

Getting Ready: Day 1

1. Make copies of each of the four articles. Account for roughly one-fourth of the class reading each article. Make sure you keep a set of the articles for yourself and have a way to project them during class.
2. Make one copy of the Regional Climate Notes copymaster for each student.
3. On chart paper, record the Guidelines for Sharing Expertise and post them where they will be easily visible to all students.
4. On the board, write "Describe the climate in our area."

Activating Background Knowledge (5 minutes)

1. **Pose question.** Direct students to the prompt that you wrote on the board: *Describe the climate in our area.* Remind students that climate refers to long-term weather patterns rather than to individual weather events.
2. **Students respond.** Have students write a brief response. Alternatively, you can have them discuss their ideas with a partner.
3. **Debrief.** Have students share their responses with the class. As it comes up in the discussion, identify key factors such as temperature, precipitation, and proximity to the ocean.
4. **Set purpose.** Explain that today, students will learn about the factors that affect the climate in different regions around the world.

Introducing the Regional Climate Articles (10 minutes)

1. **Introduce shared expertise.** Explain that you will introduce articles about four different regions with interesting climates. Let students know that they will each pick one region to read about, and then they will work with a partner to become an expert on the climate in that region.
2. **Project and introduce articles.** Briefly project each article, pointing out something unique about the climate in order to orient students to each region and offer interesting reasons for reading about it.
   - **Preview *The Australian Outback: Causes of a Desert Climate.*** Project the first page of the article and say, **"Most of Australia is very dry and hot, even though one coast is wet and rainy. Why does Australia have this climate?"**
   - **Preview *Climate in Kansas: How the Ocean Affects Faraway Places.*** Project the first page of the article and say, **"Kansas is in the very middle of the United States, yet its climate is still affected by the ocean. How can this be?"**
   - **Preview *Mediterranean Climates: What Makes California So Much Like Spain?*** Project the first page of the article and say, **"*Mediterranean* refers to countries such as Spain, in Europe, that have mostly mild climates with warm summers and cool, rainy winters. This type of climate can be found in several places on Earth, not just in Europe. How can the same climate be found in very different places?"**
   - **Preview *The Arctic vs. Antarctica: Very Different Climates.*** Project the first page of the article and say, **"Both the Arctic and Antarctica are cold and icy places, but**

Encouraging Distributed Expertise

Providing middle school students with even a small amount of choice in what they read and learn about has several benefits. In addition to increasing engagement, distributing the various examples of regional climates across the class gives students a reason to think about, share, and "teach" what they learned to others who did not read the same article. This creates an authentic purpose for student-to-student talk, which is important in helping students solidify their understanding of science ideas. This sharing of knowledge and listening to others share fosters an environment in which students are truly learning from one another. If students have trouble getting started or explaining their ideas, refer them to the questions and sentence starters on the Guidelines for Sharing Expertise poster. Or, you can create your own guidelines that you know your students will feel comfortable using. Over time, such supports help students collaborate effectively and independently.

their climates are very different. Why are they so different?" (Keep this page projected as you will need to refer to it when modeling how to read with a purpose.)

3. **Students select articles.** Have students decide which articles they would like to read and distribute them accordingly. (It is fine if the articles are not distributed evenly across the class. If possible, try to have roughly one-fourth of the class read each article.)
4. **Model reading with a purpose.** Let students know that before they start reading, you'll provide an example of how to read closely to understand climate factors. Refer to *The Arctic vs. Antarctica: Very Different Climates* article that you still have projected.
   - Read the title and first paragraph aloud.
   - Read aloud the caption for the second image, **"With its tall mountains, Antarctica is very high in elevation."**
   - Say, **"I read in the first paragraph that Antarctica gets less precipitation than the Arctic. I wonder if having very little precipitation has to do with the high elevation. I will make a note of that on my article."**
   - Next to the caption, write "Could high elevation = less precipitation?"
   - Direct students to write annotations on their articles. Explain that they can write questions, connections, and ideas that come up for them as they read. In addition, they should think about the factors that affect the regional climate and make a note of these factors when they read about them.

Reading the Regional Climate Articles (15 minutes)

1. **Students read independently.** Remind students to read actively by writing notes on the text and visual representations as they read.
2. **Plan for expert pairs.** While students are reading independently, make note of which articles students are reading so you can create pairs who have read the same article.

Discussing in Expert Pairs (15 minutes)

1. **Explain expert pairs.** When students have finished reading, regain their attention and explain that they will now meet with a partner who read the same article. Partners should work together to make sure they have a deep understanding of the climate in the region they read about. Explain that in the next session, pairs will be expected to explain the climate in their region to others who did not read about

Formative Assessment Opportunity

Students' discussions often reveal misconceptions that you may not have otherwise known they held. As students prepare to share expertise on Day 1 and share their Regional Climate Mystery matches on Day 2, listen for lingering misconceptions related to factors affecting climate. These are particularly likely to show up if students are still not thinking of climate as a long-term pattern or are having trouble understanding the connections between ocean water, water vapor, and precipitation. Make note of any ideas or questions that seem common to several students and develop a plan for discussing these at the beginning of the next session. Once all classes have finished the Regional Climate Mystery activity, you might also post a copy of a completed Regional Climate Map with the data cards taped to the correct locations. This, as well as the Factors That Affect Regional Climate poster, can serve as a resource for students as they continue to review the content of the unit.

the same region. Therefore, it is important to make sure pairs understand their regions thoroughly.

2. **Form expert pairs.** Have students sit next to another student who read the same article.
3. **Preview discussion questions.** Project the Regional Climate Notes student sheet and explain that pairs will work together to discuss and write notes about these questions. The questions will help them make sense of what they read and help them explain their regional climate to others.
4. **Model discussing climate factors.** Say, **"For example, in the article about the Arctic and Antarctica, the third paragraph on page 1 states, 'Since air gets colder as it rises, air that rises to 10,000 feet on the surface of Antarctica becomes very cold.' This explains how the high elevation makes Antarctica very cold."** On the board, write "Because air cools as it rises, the high elevation means very cold temperature." Explain that this is an example of what students could write in order to explain how elevation affects climate.
5. **Clarify importance of factors.** Explain that each article may not mention all the factors that affect regional climates—elevation, latitude, ocean currents, winds, and the rain shadow effect. Point out the table at the bottom of the student sheet where students should record the factors. Let them know that they should record only those factors that are relevant to the regional climate they read about.
6. **Set guidelines for discussion.** Point out the Guidelines for Sharing Expertise that you posted before class and have a student read aloud the three guidelines at the top. Suggest that students may also use the questions and sentence starters provided on the poster if they find them helpful.
7. **Students discuss and record information.** Distribute one copy of the Regional Climate Notes student sheet to each student and have them begin working with their partners. Prompt students to explain their thinking to their partners and to refer to the text and diagrams for evidence as needed.
8. **Preview the next session.** Tell students that in the next session, they will need to communicate what they have learned about their regional climates to others who have read about a different region. Then, everyone will need to use what they have learned from one another in order to work together to solve a challenge.

Supporting English Language Learners

Consider providing additional opportunities for oral discourse and to prepare for sharing expertise. On Day 2, students prepare to present information about the regional climates they read about. In order to maximize participation from ELLs, you can provide extra time for them to practice what they will say. Have them walk around the classroom and, at your signal, stop and form a pair with the person closest to them. Each student will then take a turn speaking about their climate example. After a few rounds, students will have had a chance to both practice what they will say as well as hear how others explain their regional climates. Then, proceed with sharing expertise in the mixed groups.

Getting Ready: Day 2

1. Assign students to groups of four. Groups should be comprised of students who have each read a different article.
2. For each group, make one copy of the set of the Regional Mystery Data Cards (1 set = 8 cards). Cut the cards apart and place each set in an envelope.
3. Make one copy of the Regional Climate Map for each group.
4. Make one copy of the Writing About a Regional Climate copymaster for each student.
5. On chart paper, record the Factors That Affect Regional Climate table. Fill in the "Factors" column and leave the "How it affects the regional climate" column blank. (You will fill in this column during the session and can use the answers provided as a reference.) Post this where it will be easily visible to all students.
6. On the board, write "Describe the climate in the region you read about. What factors affect the climate?"

Activating Background Knowledge (5 minutes)

1. **Pose question.** Direct students to the prompt you wrote on the board: *Describe the climate in the region you read about. What factors affect*

Science Note

The local surface temperature of the ocean also has a significant impact on the climate by influencing the amount of water vapor in the air. Warm water will heat the air above it, increasing air volume so the winds have room to uptake more water vapor. Both the physical blowing of wind on the ocean water and the temperature of the ocean water are important factors in the amount of water vapor that evaporates. However, whether or not the water vapor stays in the gas phase is determined by the temperature of the air. Cold air will not hold much water vapor, so any excess will turn back to liquid as rain or fog. On the other hand, warm air will hold much more. Therefore, warm currents lead to conditions in which more water vapor travels in the air over a climate's region, while cold currents lead to reduced amounts of water vapor in the air. In the articles students read, the impact of wind on the rate of evaporation and air temperature on the amount of water vapor in the air has been omitted for simplicity.

the climate? Explain that this prompt will give students a chance to think about and practice what they will say when they present to a group.

2. **Have pairs practice.** Students should talk with a partner about what their regional climate is like. (It is not necessary for partners to have read the same article.) Encourage students to refer back to their articles as well as to their Regional Climate Notes student sheets from the previous session.

Sharing Climate Expertise in Mixed Groups
(20 minutes)

1. **Arrange students in mixed groups.** If you have not already done so, have students sit in groups of four so each group is made up of students who have read a different article.
2. **Highlight the role of collaboration.** Explain that students will each have about two minutes to describe the climate in the region they read about and to explain how it is affected by some of the climate factors. Remind students that they will need to understand one another's climate examples in order to identify climate rules and solve the climate challenge. Therefore, it is important that they listen closely to all group members.
3. **Review guidelines.** Refer to the Guidelines for Sharing Expertise poster. Remind students of the guidelines they should apply to their discussions as well as to the questions and sentence starters they can use.
4. **Students present to groups.** Allow time for students to explain their regional climates to their groups. You might want to call out the time periodically in order to help focus and pace students' discussions and to ensure that all students have enough time to present. Circulate and encourage students to refer back to their articles and to use their Regional Climate Notes from the previous session if needed.
5. **Debrief.** Once all students have had an opportunity to share in their groups, direct their attention to the Factors That Affect Regional Climate poster. Explain that together, the class will think about some of the factors that affect regional climate and the generalizations they can make from what they read.
6. **Complete poster as a class.** For each factor, lead a discussion in which students share ideas about how and why the climate is affected. Prompt students to give examples from the articles they read. Have them summarize their ideas as you write them in the "How it affects the regional climate" column. (For possible student responses, refer to the completed table, which has been provided.)

Solving the Regional Climate Mystery
(20 minutes)

1. **Explain the Regional Climate Mystery.** Let students know that they will now work together in groups to figure out what the climate might be like in different cities around the world. Explain that each group will receive a set of Mystery Data Cards and a Regional Climate Map. They will need to match each card to a location on the map, using what they have learned about the factors that affect regional climates.
2. **Emphasize collaboration.** Emphasize that students will need to use their shared expertise about different regional climates in order to match the information on each card to a location on the map. They should also refer to the information that you just recorded on the Factors That Affect Regional Climate poster.
3. **Introduce card set.** Hold up one of the Regional Mystery Data Cards and point out that each card represents a mystery location and lists

the average temperature (for both winter and summer) and the average inches of rain per year.

4. **Project the Regional Climate Map.** Explain that this map shows cities that match the locations of the Regional Mystery Data Cards. Point out map features such as the equator, ocean currents, prevailing winds, and mountains ranges.

5. **Model matching data to a location.** Say, "Mystery Data Card A states that this location is very cold, with an average low temperature of 13 below zero and a high temperature of 23 degrees. This means that the location cannot be near the equator. The low temperature makes me think of *The Arctic vs. Antarctic* article that I read. I also see that this location only gets 1 inch of precipitation in one year. I think this suggests that it might be near a cold ocean current or have a dry prevailing wind from the rain shadow effect."

   - Point to the places on the map where there are cold currents moving toward the location: Luderitz, McMurdo, San Francisco. Explain that you think the mystery location could be McMurdo because of the three locations, it is the farthest from the equator and has mountains nearby for the rain shadow effect.
   - Point out that you used what you know about the factors that affect regional climate to figure out where the card was likely to go on the map.

6. **Distribute materials.** Distribute one envelope with a set of Regional Mystery Data Cards and one Regional Climate Map to each group.

7. **Groups work on the mystery.** As needed, remind students to refer to the posted Guidelines for Sharing Expertise. You may wish to note as positive examples of collaboration any ways in which students are asking questions and helping one another better understand the content.

8. **Students write about one location.** Near the end of the session, have students select one location about which they are reasonably certain is a match for the information on the card. Distribute one copy of the Writing About a Regional Climate student sheet to each student and have students write about the evidence for the location they chose. (Students can do this independently or in consultation with their group members.)

9. **Optional: debrief.** If time permits, ask a volunteer from each group to tell the class which location they think one of the Regional Mystery Data Cards goes. They can point out the location and any relevant features on the projected Regional Climate Map. Encourage the class to ask questions of the presenter, using the questions and sentence starters on the Guidelines for Sharing Expertise poster as needed. Be sure that presenters explain how their understanding of one of the factors helped them decide on the location.

Connecting to Standards

Shared-Expertise Discussions is an approach that capitalizes on the overlap between the science practices in the Next Generation Science Standards (NGSS) and the Common Core State Standards (CCSS) for English Language Arts. One way that Shared-Expertise Discussions meets these standards is that students work together to build explanatory accounts about how the world works and then apply those explanations to a new context. This provides an authentic reason for students to explain the relationships between variables that predict or describe a phenomena (NGSS Science and Engineering Practice: Constructing Explanations and Designing Solutions) while it also requires students to present information to others in a way that is logical and cohesive (CCSS Anchor Standard 4 for Speaking and Listening). In addition, Shared-Expertise Discussions capitalize on peer interactions in order to allow students to build on one another's ideas and express their own ideas more clearly (CCSS Anchor Standard 1 for Speaking and Listening).

Generalizing This Practice

Engaging students in Shared-Expertise Discussions is an approach that can be used throughout your science curriculum with a variety of activities, texts, and topics. A benefit of having students develop and share expertise about a concept is that it aids in the creation of a class community in which students see themselves as active participants in knowledge development and view one another as resources. It also helps students learn that scientists collaborate and discuss their ideas with one another in order to develop understanding. Use the following steps to use Shared-Expertise Discussions throughout your curriculum.

Preparing for Shared-Expertise Discussions

1. **Select examples that illustrate a concept.** Select a concept or phenomenon that you are teaching and find examples of that concept or phenomenon. The examples should be at a level that students can access more or less independently. Examples may be in the form of texts, visual representations (e.g., maps, diagrams, charts, tables), or multimedia. Make sure the examples are all centered around the same concept. If possible, try to give students a choice about what to learn.
2. **Identify an activity.** Create an activity that requires students to apply the ideas they will learn from the examples. For instance, students might need to pool knowledge and apply concepts to solve a mystery or figure out a problem, make and test predictions about a new example, create a visual representation or model, or demonstrate and understand cases in a simulation. It is helpful if the solution to the activity clearly draws upon the expertise that all students bring. The activity should still be feasible to complete if one example is missing or not well explained.
3. **Plan groupings.** Plan for each student to work with a partner who learned about the same example. Then, students will share their expertise with a mixed group of students who learned about different examples.
4. **Develop discussion supports.** You may wish to provide students with guidelines to help them structure their discussions. Another helpful support can be to provide sentence starters that prompt students to ask one another questions, provide evidence, and explain their thinking. You can use the guidelines and sentence starters provided with this strategy guide, or you can create your own.

Implementing Shared-Expertise Discussions

1. **Activate background knowledge.** Provide a prompt or question that helps students activate their background knowledge about the topic. Have students respond either orally or in writing.
2. **Students select their examples.** Preview each example with the class and point out interesting features or questions about each. If possible, let students choose what they will study rather than assigning the examples to them.
3. **Preview the activity.** Explain that students will participate in multiple stages of talk with their peers in order to become experts about an example, share their expertise, and then pool their knowledge for a final application activity related to a focus question. Emphasize that collaborative discussion will be essential in order for students to develop their understandings and complete their challenge application task.

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Generalizing This Practice (continued)

4. **Provide a model for students.** If students will be using a new skill or encountering a challenging task, show how you, as an expert, would complete the task. For example, if students will be reading a text, demonstrate strategies that you would use to closely read the text or use text features and diagrams to identify key ideas.
5. **Read or study examples.** Provide time and resources for students to learn about an example of the science concepts.
6. **Set expectations.** To support and focus students, provide a list of criteria and/or sentence starters that will guide their discussions. These supports should prompt students to collaborate effectively by identifying questions and confusions, seeking and building on one another's ideas, and supporting their ideas with evidence.
7. **Discuss with a fellow expert.** To solidify students' understanding of their examples, have students meet with a partner who has read or studied the same example. Provide discussion questions or a task that requires partners to discuss the example they studied and that will also prepare students to discuss their examples with peers who learned about different examples.
8. **Share expertise in mixed groups.** Arrange students into mixed groups or pairs comprised of students who learned about different examples. Direct students to briefly explain the examples they studied. Consider providing a graphic organizer or note taker that helps students identify key concepts from their examples.
9. **Groups apply learning.** Present the application activity to students. Remind them that they will need to share their expertise and collaborate with the rest of the class. Redirect students to any collaboration guidelines you created and posted.
10. **Reflect on learning.** As a class, review and debrief the task. Alternatively, have students reflect and write about what they learned from completing the task. Encourage students to include not just the examples or topics about which they are experts, but those they heard about from others as well.

Name: ____________________ Date: ____________

Regional Climate Notes

1. Regional climate that you read about: ____________________

2. What about the regional climate was interesting or surprising? ____________________

3. What is the regional climate like? (Include details about the temperature and amount of precipitation.)

4. In the table below, explain how at least one of the factors influences the regional climate.

Factor	How it affects the regional climate
elevation	
latitude	
ocean currents	
winds	
rain shadow effect	

Guidelines for Sharing Expertise

- Support your ideas with evidence.
- Ask for your partner's ideas and evidence.
- Clarify ideas and check if you understand and agree.

Questions and sentence starters:

- What do you think about . . . ?
- Could you explain your thinking?
- What is your evidence?
- You said . . . .
- Do you agree with . . . ?
- I agree with . . . because . . . .
- I disagree with . . . because . . . .

Factors That Affect Regional Climate

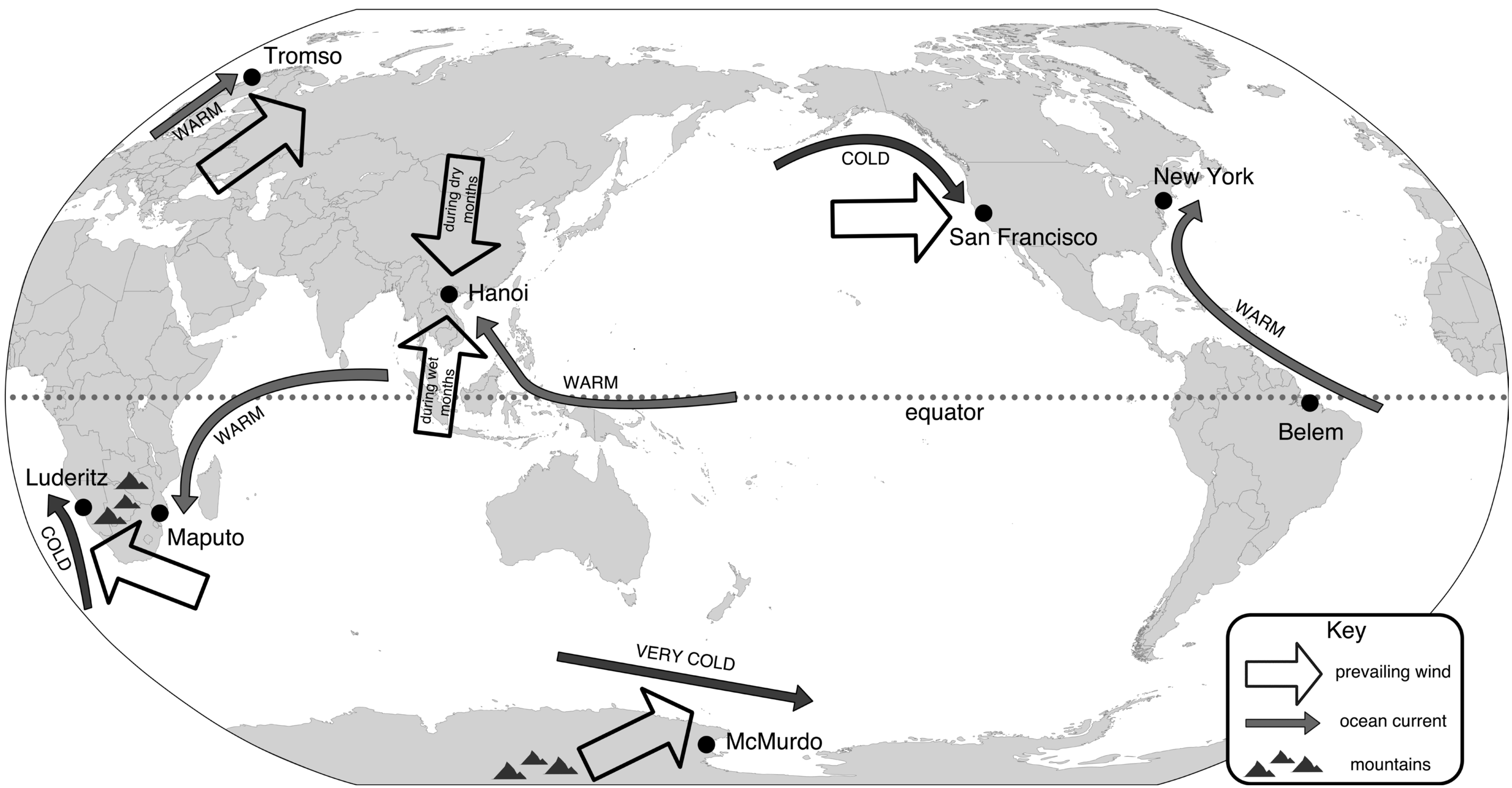
Factor	How it affects the regional climate
elevation	Higher elevations are colder. Lower elevations are warmer.
latitude	Places far from the equator are colder. Places midway between equator and pole tend to have mild temperatures. Places near the equator are warmer.
ocean currents	Warm ocean currents lead to wetter climates. Cold ocean currents lead to drier climates.
winds	Warm/wet incoming winds lead to warmer/wetter region. Cool/dry incoming winds lead to cooler/drier region.
rain shadow effect	Wind moving up mountainside results in cooling air and precipitation. Wind moving down mountainside results in warming air, less precipitation.

Regional Mystery Data Cards

Average high temp. winter–summer: **13 below zero–23°F** Average precipitation in one year: **1 inch** **A**	Average high temp. winter–summer: **28°F–60°F** Average precipitation in one year: **41 inches** **B**
Average high temp. winter–summer: **66°F–73°F** Average precipitation in one year: **2 inches** **C**	Average high temp. winter–summer: **86°F–90°F** Average precipitation in one year: **96 inches** **D**
Average high temp. winter–summer: **77°F–94°F** Average precipitation in one year: **80 inches** (most during one half of the year) **E**	Average high temp. winter–summer: **38°F–84°F** Average precipitation in one year: **50 inches** **F**
Average high temp. winter–summer: **58°F–71°F** Average precipitation in one year: **22 inches** **G**	Average high temp. winter–summer: **77°F–86°F** Average precipitation in one year: **30 inches** **H**

Names of group members: ______________________________ Date: ____________

Regional Climate Map



Name: ____ **Date:** ______________________

Writing About a Regional Climate

The location ________________________ matches the climate data on Regional Mystery Card _______.

Explain how you know. What is your evidence that the climate data match this particular location?

Most of Australia is desert and dry grassland. This whole area is called the Outback.

Wikimedia/Mark Marathon

The Australian Outback: Causes of a Desert Climate

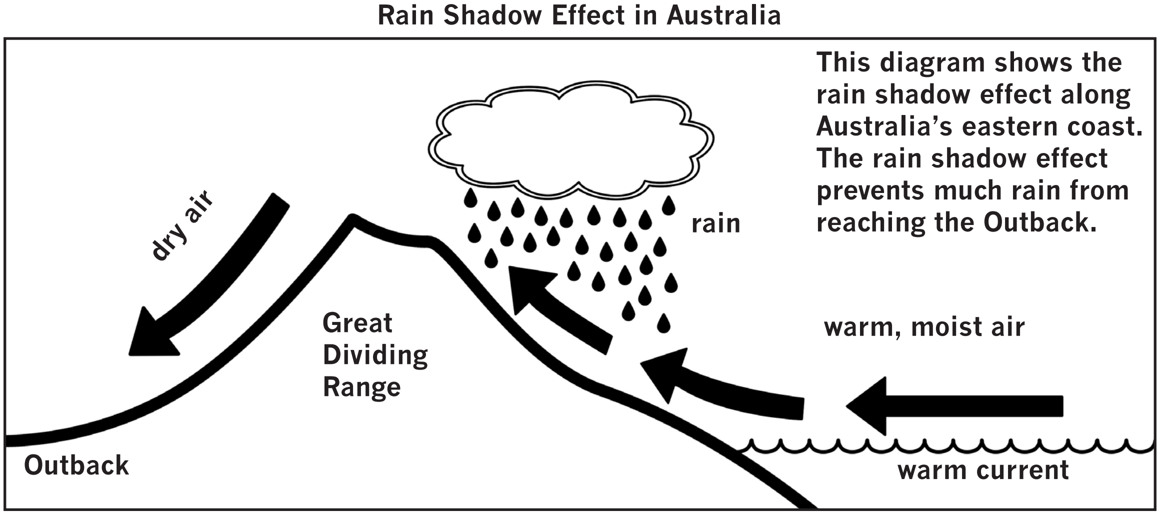
NASA

If you travel to the northern or eastern coasts of Australia, you might find yourself in a rainforest with towering trees and dripping moss. However, most of Australia is desert or dry grassland. This area is known as the Outback. Much of the Australian Outback (and about 40% of Australia) is covered in wind-blown dunes of reddish sand. More than half the country gets less than 12 inches of rain per year, and the driest places, in the central part of the country, get less than 5 inches of rain per year. What causes the climate of Australia's deserts?

Rain Shadow Near the Eastern Coast

Along the eastern coast of Australia, a warm ocean current moves southward from near the equator. This warm water evaporates easily, so a lot of water vapor is in the air along the coast. However, near the eastern coast is a large, steep mountain range called the Great Dividing Range. As wet air masses move up the slope of the mountain, they cool and the water vapor condenses and falls as precipitation. Once the air masses pass the Great Dividing Range, they no longer have much water vapor. The way these mountains block water vapor and clouds from getting to the rest of the country is called the rain shadow effect.

Rain Shadow Effect in Australia



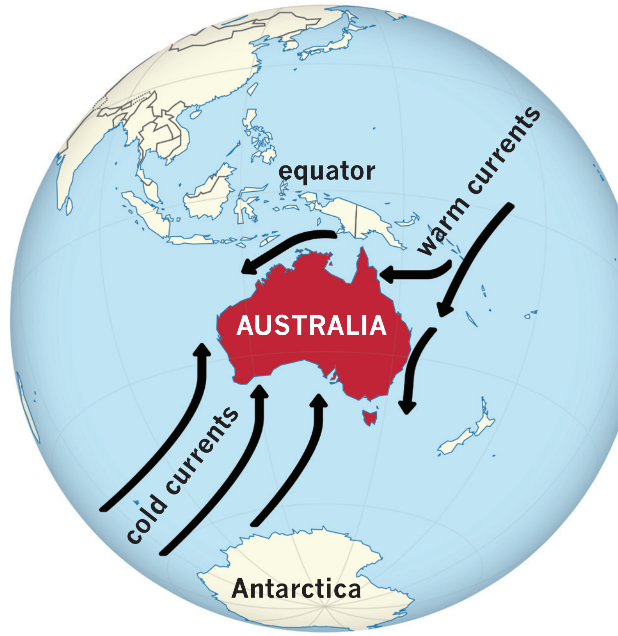
This diagram shows the rain shadow effect along Australia's eastern coast. The rain shadow effect prevents much rain from reaching the Outback.

Learning Design Group/UC Regents

Cold Currents Near the Western Coast

Unlike the ocean to the east, the ocean to the west of Australia does not provide much water vapor. Here, currents moving north from Antarctica bring cold water to the coast. Cold water usually doesn't evaporate as easily as warmer water, so there is less water vapor in the air along Australia's western coast. What water vapor there is doesn't condense to form rain clouds very often since there are few steep mountains to push the water vapor up in the air and cool it down.

Major Currents Around Australia

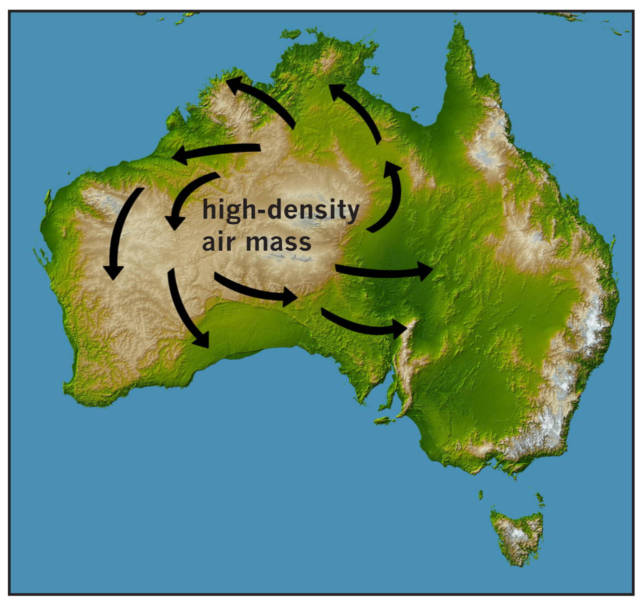


Wikimedia/TUBS (background map)

High-Density Air

Another reason for Australia's huge, dry deserts is that high-density air masses often form over the middle of the country. This high-density air pushes out along the ground toward the coasts. This means that prevailing winds often bring dry air from the center of the country rather than wetter air from over the ocean. High-density air masses are common in places around the world that have the same latitude as the center of Australia, between 20 and 30 degrees (about 2,000 to 3,000 kilometers) from the equator. Many other deserts around the world, including the Sahara, Kalahari, Arabian, and Atacama deserts, are found at similar latitudes.

Prevailing Winds in Central Australia



NASA/JPL/NIMA (background map)

When high-density air masses form in the middle of Australia, they push dry air outward.

Kansas becomes extremely cold in winter, even though it also has hot summers.

Photo by Liz Roll/FEMA

Climate in Kansas: How the Ocean Affects Faraway Places

Wikimedia Commons

Kansas is in the middle of the United States. In fact, the town of Lebanon, Kansas, is the exact center of the country! Even though all parts of Kansas are more than 750 kilometers from the nearest part of the ocean, the ocean still affects the climate in Kansas.

Extreme Temperatures

The climate of Kansas is known for temperature extremes: the weather can be very hot or very cold. In the winter, temperatures in Kansas are regularly below freezing. The coldest temperature ever recorded there was –40°F (forty degrees below zero)! In the summer, temperatures often climb above 100°F, with a record high of 121°F. Why are temperatures in Kansas so extreme? One reason is that Kansas is so far away from the ocean. Like most places on Earth, Kansas gets more sunlight in summer than in winter. If Kansas were near the ocean, the ocean water would soak up a lot of the energy from that sunlight, then release it slowly at night. Ocean water keeps the air nearby from getting as hot or as cold as it would otherwise. However, Kansas has no ocean nearby to cool the air on hot days or warm the air on cold nights. That is part of the reason why Kansas gets so hot in the summer and so cold in the winter.

Winds coming all the way from the Gulf of Mexico can cause tornadoes in Kansas, like the one in this photo.

NOAA/Jerry and Karla Westerman

Summer Storms

The ocean also affects precipitation in Kansas, even though Kansas is so far away. Places in Kansas average between 16 and 46 inches of precipitation per year, with most falling as rain during the summer. In summer, the prevailing winds come to Kansas from the south, bringing warm air from near the equator. This air comes from over the Gulf of Mexico, a part of the ocean south of the United States. Water from the Gulf evaporates, filling this air with water vapor. The land between the Gulf and Kansas is quite flat, so these warm, wet air masses move quickly to Kansas. When these quick-moving air masses meet denser air masses, the less-dense air gets pushed up above the denser air. This rising air can cause huge thunderstorms that dump summer rain on Kansas. Some of these storms also bring hail and even tornadoes.

Prevailing Winds in Summer

Wikimedia Commons

Cold Winters

In winter, the prevailing winds in Kansas come from the northwest. These winds are much drier and colder. Temperatures drop, much less precipitation falls, and storms are less common.

Prevailing Winds in Winter

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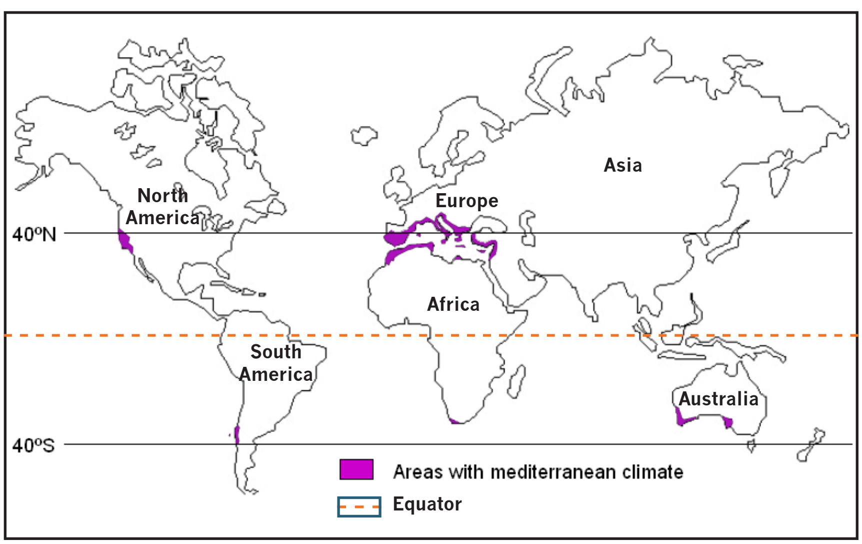
Mediterranean Climates: What Makes California So Much Like Spain?

If a person from the coast of California traveled thousands of miles to Spain or to southwestern Australia or central Chile, it might seem in some ways that she had never left home. Sure, people might be speaking a different language and there would be different animals and styles of buildings, but the weather would be very similar. If it were summer, it would be warm and almost never rain, just like home. In winter, it would be cool and rainy. She might see the same fields of grape vines or fig trees as at home. That's because these areas all have Mediterranean climates. How can places scattered so far apart all have the same type of climate?

Warm (but Not Hot) Summers

Places with Mediterranean climates are close enough to the equator that they get warm during the summer, but far enough from the equator that they don't usually get extremely hot. These places are near cool ocean surface currents, which also help keep them from getting too hot.

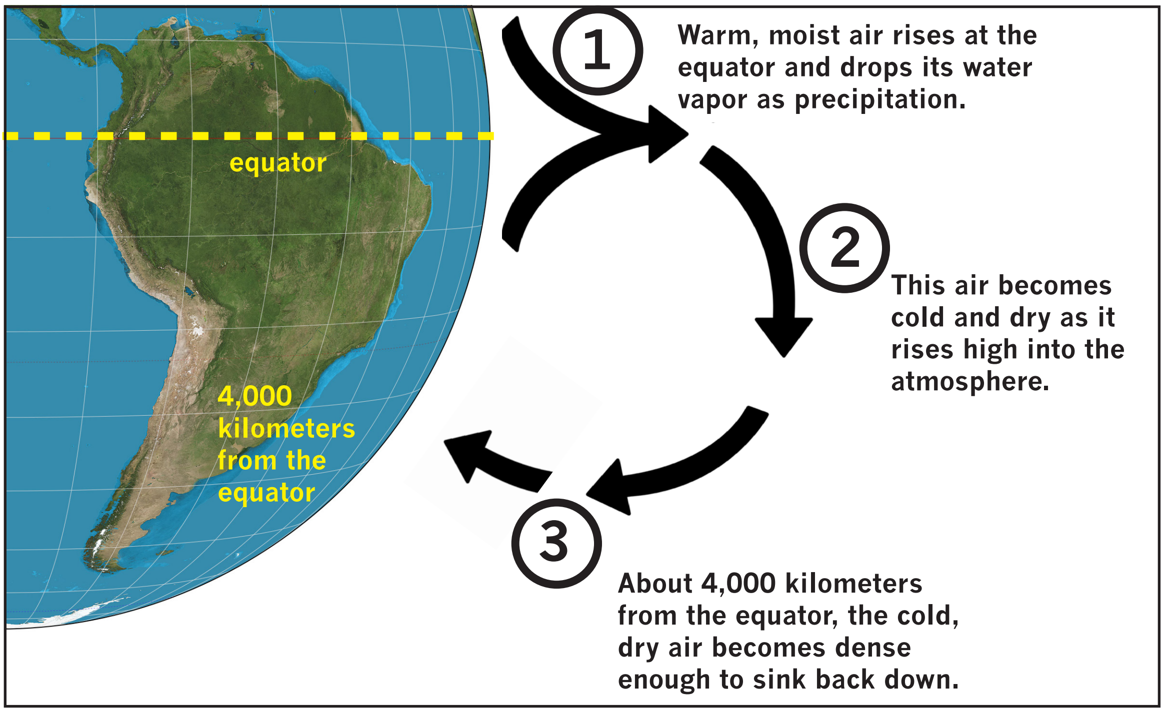


Wikimedia Commons

All the places marked in purple on this map have a Mediterranean climate. Many of these places are around the edges of the Mediterranean Sea—that's how the climate got its name. (The Mediterranean Sea is between Europe and Africa.)

Dry Summers

All places with the Mediterranean climate are about the same distance from the equator: around 4,000 kilometers. Even though the equator is thousands of kilometers away, it has a big effect on Mediterranean climates. Masses of warm air rise near the equator. These warm, rising air masses are moist, because lots of warm water evaporates near the equator. As the warm, moist air rises, it cools and drops its water vapor as precipitation. The air is now dry, and it keeps rising higher in the atmosphere, becoming colder and denser. In summer, the air masses become dense enough to sink back down at about 4,000 kilometers from the equator. This sinking, dry air keeps precipitation away from areas with Mediterranean climates during the summer.



NOAA NESDIS Environmental Visualization Laboratory (background image)

Wet, Cool (but Not Cold) Winters

In winter, sinking dense air no longer comes to places with Mediterranean climates. Instead, prevailing winds bring storms from over the ocean or from near the poles. However, these are usually rainstorms, not snowstorms. Because these areas are near the ocean and the right distance from the equator, winter temperatures are cool, but usually not cold enough for frost or snow.

The Arctic vs. Antarctica: Very Different Climates

The Arctic is at Earth's North Pole.

Wikimedia/Strebe

Antarctica is at Earth's South Pole.

You may think of the Arctic and Antarctica as being very similar. After all, these are both polar regions: Antarctica is a continent at the South Pole, and the Arctic is an area of land and water surrounding the North Pole. Antarctica and the Arctic are both cold and icy. However, did you know that the Arctic gets about 10 times more precipitation than Antarctica? Read on to find out about more ways that Antarctica and the Arctic are different—and to learn why.

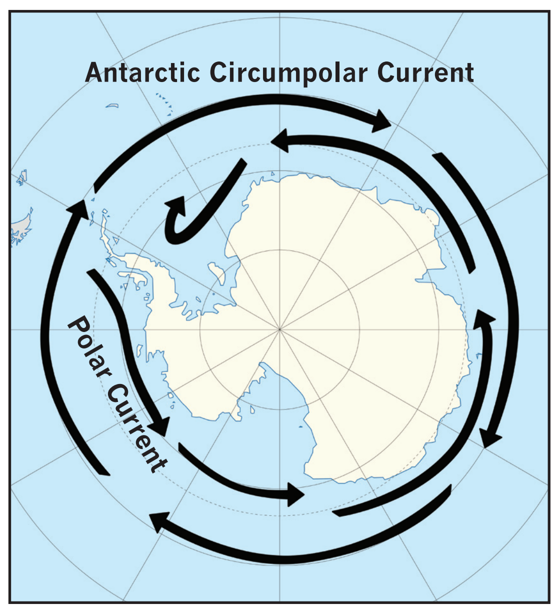
Antarctica

Antarctica is the continent at Earth's South Pole. It is the coldest place on Earth and one of the driest places, too. Average temperatures on Antarctica range from –121°F in the winter to 50°F in the summer. Each year, Antarctica gets less than 2 inches of precipitation, all in the form of snow.

Wikimedia/Andrew Mandemaker

With its tall mountains, Antarctica is very high in elevation.

Why is Antarctica so cold and dry? Cold ocean currents surround Antarctica. Since colder water usually evaporates more slowly than warm water, not much water evaporates near Antarctica. There is very little water vapor in the air, so there is not much precipitation. The cold water around Antarctica also helps keep the air cold. However, there's another reason why Antarctica is so cold: elevation (how high a place is). Most of Antarctica is about 10,000 feet above sea level, which makes it the highest continent on Earth. In comparison, the average elevation in North America is only 2,500 feet! Since air gets colder as it rises, air that rises to 10,000 feet on the surface of Antarctica becomes very cold.



Wikimedia/NuclearVacuum (background map)

The South Pole is at the center of this map. The map shows the cold currents that flow all around Antarctica.

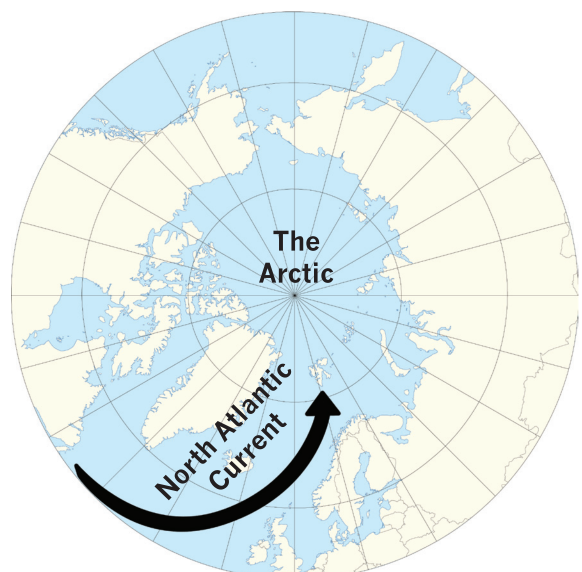
The center of the Arctic is ocean covered by an ice cap. Some of the ice at the edges melts in summer.

Wikimedia/Patrick Kelley

The Arctic

Did you know the North Pole is not on land? The Arctic is the area at Earth's North Pole, and the Arctic Ocean is at its center. The North Polar Ice Cap covers much of the Arctic Ocean. Some of this ice melts in the summer and freezes again in the winter. The Arctic region also includes the far northern parts of Canada and Russia, as well as a large island called Greenland. Average temperatures in the Arctic range from –4°F in the winter to 50°F in the summer. Most parts of the Arctic get about 20 inches of precipitation per year, but some get up to 47 inches of precipitation. This precipitation can be either rain or snow.

Why is the Arctic so much warmer and wetter than Antarctica? For one thing, the Arctic is mostly ocean—almost all of it is at sea level. The Arctic's low elevation helps keep it warmer than Antarctica. In addition, warm currents flow toward the Arctic, so the water there is warmer than the water near Antarctica. Since warmer water usually evaporates more easily than colder water, there is more water vapor in the air in the Arctic. As this water vapor rises, it cools and condenses. This is how precipitation forms. Because of this, there is more precipitation in the Arctic than there is in Antarctica. Although the Arctic is cold, it is nowhere near as cold as Antarctica—the coldest place on Earth.



Wikimedia/Tentotwo (background map)

The North Pole is at the center of this map. The map shows a warm current that flows toward the Arctic.

About Disciplinary Literacy

Literacy is an integral part of science. Practicing scientists read, write, and talk, using specialized language as they conduct research, explain findings, connect to the work of other scientists, and communicate ideas to a variety of audiences. Thus, the Next Generation Science Standards (NGSS) and the Common Core State Standards (CCSS) alike call for engaging students in these authentic practices of science. Through analyzing data, evaluating evidence, making arguments, constructing explanations, and similar work, students engage in the same communicative practices that scientists employ in their profession. Through supporting and engaging students in science-focused literacy and inquiry activities that parallel those of scientists, students master discipline-specific ways of thinking and communicating—the disciplinary literacy of science. Strategy guides are intended to help teachers integrate these disciplinary literacy strategies into the science classroom.

About Us

The Learning Design Group, led by Jacqueline Barber, is a curriculum design and research project at the Lawrence Hall of Science at the University of California, Berkeley. Our mission is to create high-quality, next-generation science curriculum with explicit emphasis on disciplinary literacy and to bring these programs to schools nationwide. Our collaborative team includes researchers, curriculum designers, and former teachers as well as science, literacy, and assessment experts.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

The Learning Design Group

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