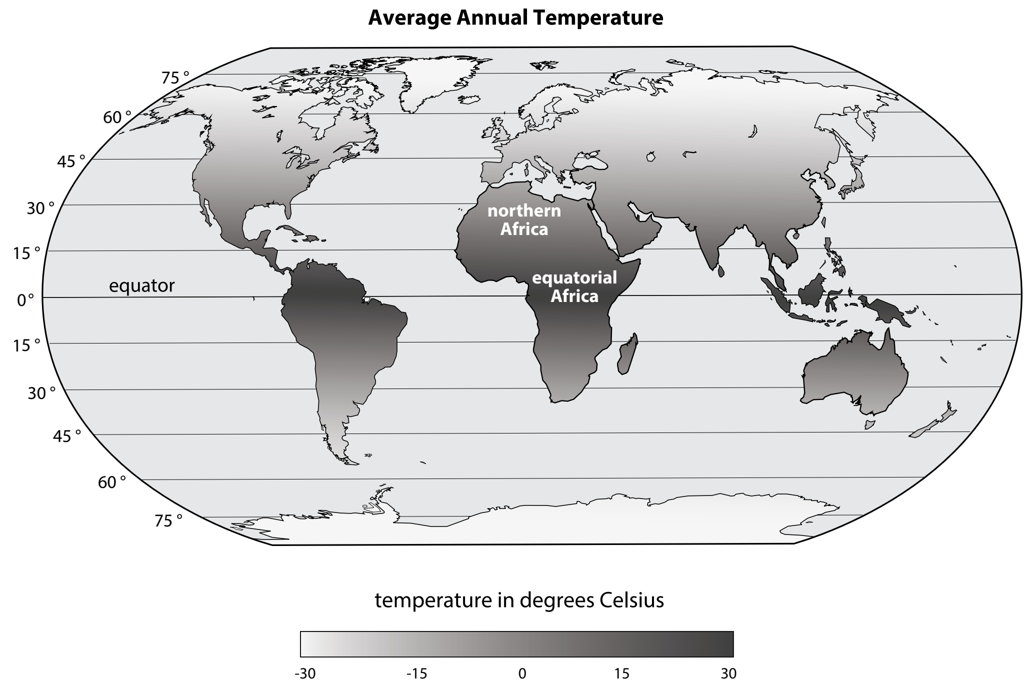
Learning Sequence 3 Assessment: Worldwide Weather

Northern Africa is very dry and receives very little rainfall throughout the year. However, equatorial Africa has many storms, meaning a lot of rainfall. Examine the map below.

MAP 1. AVERAGE ANNUAL TEMPERATURE AROUND THE GLOBE.



1. Answer the questions to explain what causes the different temperature patterns in the map above.
   a. Compare the average annual temperature in equatorial Africa to the average annual temperature in northern Africa.
   b. Explain why the average annual temperatures are different in these two regions.

Performance Outcome: *Develop an explanation for how uneven heating of Earth's surface causes different average annual temperatures in different regions of Africa.*

Indicators of progress

- *Question 1a: Students identify that annual temperatures near the equator are warmer on average than near 30°N.*
- *Question 1b: Students should indicate in their explanation that the uneven heating of Earth's surface causes temperatures to be warmer on average near the equator. This is because sunlight hits Earth near the equator straight on and is more concentrated or direct, leading to warmer temperatures. At higher latitudes, the same amount of sunlight is distributed over a larger area because of the curve of Earth, so light is more spread out and temperatures are cooler.*

Incomplete or inaccurate ideas

- *Students name "uneven heating of Earth's surface" in an explanation without a complete description of how or why that happens and how it causes cooler or warmer temperatures.*
- *Students explain that temperatures are warmer near the equator because those places are "closer to the Sun" and temperatures are cooler at higher latitudes because those places are "farther from the Sun".*

Suggestions*: Revisit Lesson 13: Step 1 if students struggle to see that temperatures are warmer around the equator and cooler at the poles. Lesson 13: Steps 2 and 3 will help students see that solar radiation is more concentrated at the equator and more spread out at higher latitudes, leading to the differences in average annual temperatures.*

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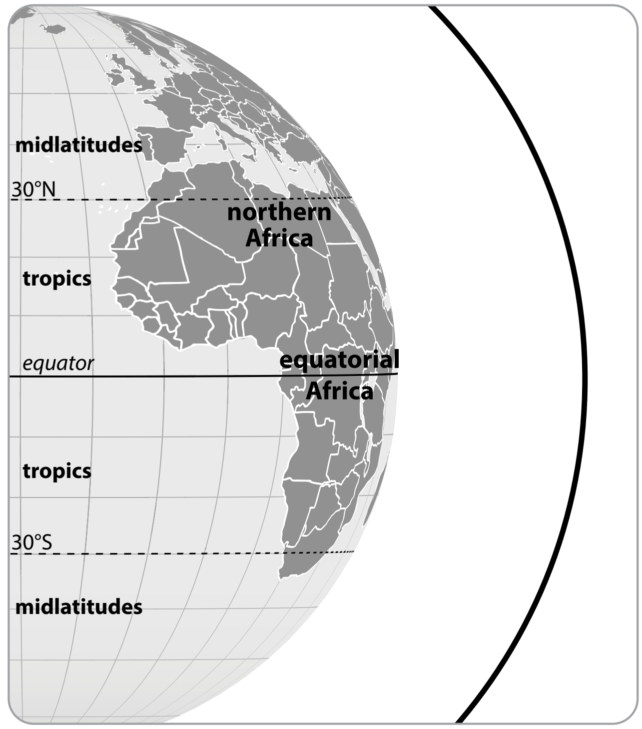
2. Draw on the cross-section below to show what is happening in the atmosphere above Africa. Focus on the tropics, which are between 30°N and 30°S latitude.

   a. Use arrows to show how air moves from the equator to the midlatitudes (from 0° to 30°N and also from 0° to 30°S).

   b. Draw clouds where you would expect to find the most cloud cover in the atmosphere above Africa.

   c. Add **H** for areas of high pressure and **L** for areas of low pressure.

AIR MOVEMENT IN THE ATMOSPHERE ABOVE AFRICA



Performance Outcome: *Develop a model to show air movement between Earth's surface and the atmosphere*

Indicators of progress

- *Question 2a: Students draw circular arrows showing air rising near the equator, sinking near 30°N, and moving toward the equator across Earth's surface.*
- *Question 2b: Students add clouds to the area in the atmosphere above the equator. This indicates that they have transferred the cloud cover pattern from Map 1.*
- *Question 2c: Students mark areas of low pressure near the equator and areas of high pressure near 30°N.*
- *Students do not need to name this as "global air circulation" or "global convection cells".*

Incomplete or inaccurate ideas

- *Students draw some but not all of the following ideas: Air rises near the equator, air sinks near 30°N, and air moves across Earth's surface toward the equator. This indicates that they have developed some of the ideas about temperature, pressure, and air movement but have not put all the pieces together.*

Suggestions: *Revisit the convection tank demonstration from Lesson 14: Steps 2 and 3 or the diagram in Lesson 14: Step 5 to help students visualize how air moves in the tropics.*

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3. Explain how different average annual temperatures in the tropics and midlatitudes help cause the different patterns in air circulation in the two regions you drew in the cross-section above.

Performance Outcome: *Use a model to explain how different average annual temperatures cause patterns of air movement across central and northern Africa.*

Indicators of progress

- *Vertical air movement: Students explain how warm air near the equator in tropical Africa means that air molecules are moving faster, are spread farther apart, and have lower pressure, causing them to rise. Cool air near 30°N means that air molecules are moving slower, are more dense, and have higher pressure, causing them to sink.*
- *Surface air movement: Students explain how the differences in areas of high and low pressure cause the air to move from high to low pressure across Earth's surface toward the equator.*

Incomplete or inaccurate ideas

- *Students name convection without a complete description of how or why this is caused by temperature differences and results in movement of air.*

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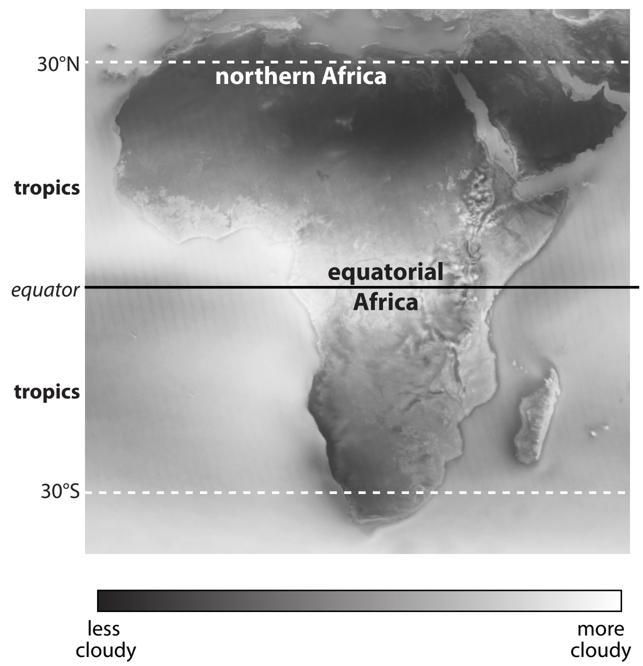
Suggestions

- *Revisit the Mylar balloon demonstration in Lesson 5: Step 1 and the reading in Lesson 5: Step 2 if students struggle with ideas about rising or sinking air, temperature, and pressure. Then help students connect these ideas on a global scale using the diagram in Lesson 13: Step 3 (temperature) and Lesson 14: Step 5 (pressure).*
- *If students struggle with why winds in the tropics move toward the equator, revisit the convection tank demonstration from Lesson 14: Steps 2 and 3.*

MAP 2. PERCENT OF AVERAGE ANNUAL CLOUD COVER OVER AFRICA FROM 2002 TO 2015.



4. Examine map 2 above, which shows cloud cover.

Use what you know about how clouds form and the patterns in air circulation in the tropics to explain why there are fewer clouds in northern Africa.

Performance Outcome: *Use knowledge of convection caused by uneven heating to explain why northern Africa has few clouds.*

Indicators of progress

- *Students connect cloud formation to warm, moist air rising in the area of low pressure at the equator and explain that these conditions are not present over northern Africa and/or students focus on relatively cooler, drier air sinking around 30°N, which does not create conditions for cloud formation.*
- *Students explain that air over tropical Africa cools as it rises, forms clouds, and releases moisture. By the time air has moved over northern Africa the moisture and the clouds are gone.*

Incomplete or inaccurate ideas

- *Students focus on cloud formation related to one variable only (e.g., it is hotter, so there are more clouds; there is more water at the equator, so there are more clouds). This shows they may understand part of the convection model but have not made connections to develop a complete model.*
- *Students may not connect sinking air at 30°N with drier air. This is an important piece of the model.*

Suggestions: *Revisit Lesson 5: Steps 2 and 3 to discuss how convection leads to cloud formation. Connect these ideas to convection at a global scale by returning to the diagram in Lesson 14: Step 5.*

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5. Storms in tropical Africa generally do not move directly north from the equator toward northern Africa. Draw on the image below to explain the movement of storms in this part of the world.

   a. At 30°N, winds spread out across Earth's surface. Draw the direction that winds would travel north and south of 30°N if the Earth was not spinning.

   b. Use a different color to draw how winds actually curve north and south of 30°N due to the Coriolis effect.

   c. Use what you know about the direction of winds to explain why storms in tropical Africa do not equitorial move directly north from the equator toward northern Africa.

Performance Outcome: *Develop an explanation for how atmospheric circulation in the tropics and midlatitudes and the Coriolis effect cause patterns of surface winds across northern and tropical Africa.*

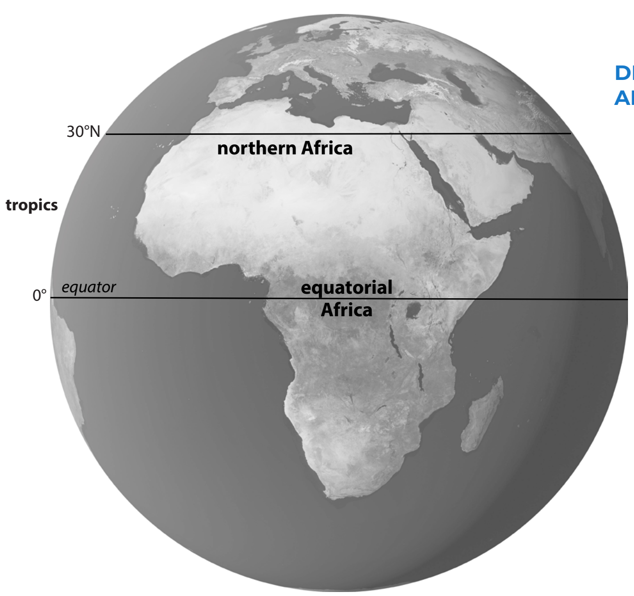
Indicators of progress

- *Question 5a: Students add arrows to the image showing winds moving south from 30°N toward the equator and north from 30°N toward the poles with no deflection.*
- *Question 5b: If students draw any curved arrows, that shows they understand that the Coriolis effect causes winds to curve. If students curve arrows to the right above 30°N and to the left below 30°N (from a bird's eye view) this shows they understand the direction winds curve due to the Coriolis effect.*
- *Question 5c: Students should indicate in their explanation that storms do not move from the equator to 30°N because (1) convection causes air to move from 30°N toward the equator and (2) the Coriolis effect resulting from Earth's rotation causes those winds to curve moving from east to west near the equator. The combination of the two is an important indicator of progress in both their explanation and drawing.*

Incomplete or inaccurate ideas

- *Students draw or explain air moving only north-south or only east-west. This indicates they are not thinking about the combination of convection and the Coriolis effect.*
- *If students don't show winds curving to the right, this indicates that they don't understand the direction winds curve due to the Coriolis effect.*
- *Students name convection or the Coriolis effect in their explanation without a complete description of how or why either results in movement of air. For the Coriolis effect, a connection to Earth's spin is sufficient. For convection, students should explain unequal heating of Earth's surface at different latitudes.*

Suggestions: *Revisit Lesson 5: Steps 2 and 3 to discuss how convection leads to cloud formation. Connect these ideas to convection at a global scale by returning to the diagram in Lesson 14: Step 5.*



DIRECTION OF WIND IN NORTHERN AND EQUATORIAL AFRICA

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