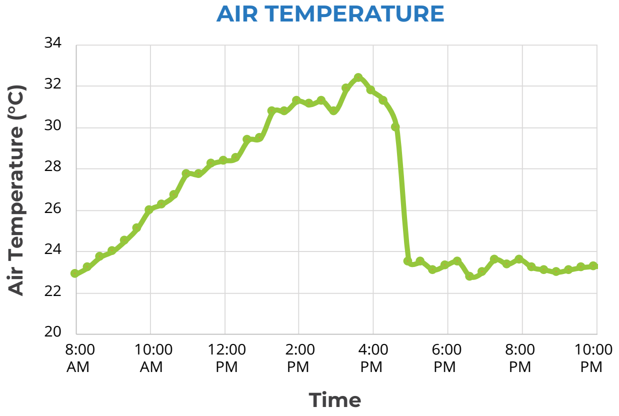
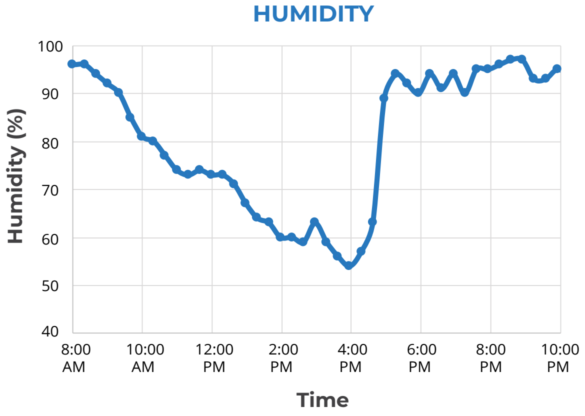
Learning Sequence 1 Assessment: From Cloud to Storm

An isolated storm happened in Rockwall, Texas, on August 26, 2017. The graphs below show how humidity and air temperature changed during the day. Use the data in the graphs below to answer the following questions.


AIR TEMPERATURE


HUMIDITY

1. What time do you think the storm occurred? Explain your reasoning using the temperature and humidity data.

Performance Outcome: *Analyze and interpret data to support reasoning about the relationship between changes in temperature and humidity and storms.*

Indicators of progress

- *Students identify that the storm happened between 4:00 p.m. and 5:00 p.m. Students explain that at this time air temperature decreased and humidity increased, which indicate the storm.*

Incomplete or inaccurate ideas

- *Students identify any other time period for the storm.*
- *Students do not identify high humidity as a key factor.*
- *Students may focus more on temperature than humidity.*

Suggestions*: Revisit the sunny day and stormy day graphs from Lesson 4. Ask students why low humidity would not be a good condition for a rainstorm. Ask students what happens to surface water (lakes, ocean, rivers, soil moisture) when temperatures warm up during the day (evaporation).*

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2. Sunrise in Rockwall, Texas, was at 6:57 a.m. on August 26. Explain why the air temperature changed the way it did from between 8:00 a.m. and 12:00 p.m.

Performance Outcome: *Analyze and interpret data to support reasoning about the relationship between changes in energy from sunlight during a day and changes in air temperature during a day.*

Indicators of progress

- *Students identify that when the Sun rises, it warms the Earth's surface (the ground). The longer the Sun is overhead, the more the ground and the air above the ground warms up. That is why there is a slow increase in temperature during the morning.*

Incomplete or inaccurate ideas

- *Students focus on Sun warming air molecules directly from above.*
- *Students focus on air temperature being affected mostly by cloud cover and not linking to the warming of the surface.*

Suggestions*: Revisit the Longmont temperature measurements in Lesson 3. Talk about what happens when energy from the Sun reaches Earth.*

3. The air temperature was measured about one meter above the ground. Draw a line on the air temperature graph to show how you think the temperature of the ground changed over the day. Then, explain why you think the surface temperature would change like this.

Performance Outcome: *Draw a graph to show how surface temperature data would be different from temperature data higher above the ground.*

Indicators of progress

- *Students correctly draw the surface temperature data mirroring (at least mostly) the air temperature data, with surface temperature warmer than air temperature.*
- *Students explain that the ground is warmed by the Sun, which then warms the air above it.*

Incomplete or inaccurate ideas

- *Students draw the surface temperature cooler than the air temperature.*
- *Students develop an explanation that indicates the air is heated from the Sun above, and not from the ground below.*

Suggestions: *Same as question 2.*

4. The air temperature near the surface is different from the air temperature higher in the atmosphere. Explain how they are different and why this difference is necessary for a storm to form.

Performance Outcome: *Explain how air temperature at the surface and high in the atmosphere create conditions/cause the formation of storms.*

Indicators of progress

- *Students mention air temperature conditions related to evaporation and condensation, identifying warmer temperatures near the surface as related to evaporation and cooler temperatures near the clouds as related to condensation, forming clouds and storms.*
- *If used after the Explore/before the Explain lessons, it's OK if students do not mention that warm air can evaporate more moisture. If this item is used after the Explain lesson, students may mention it here.*

Incomplete or inaccurate ideas

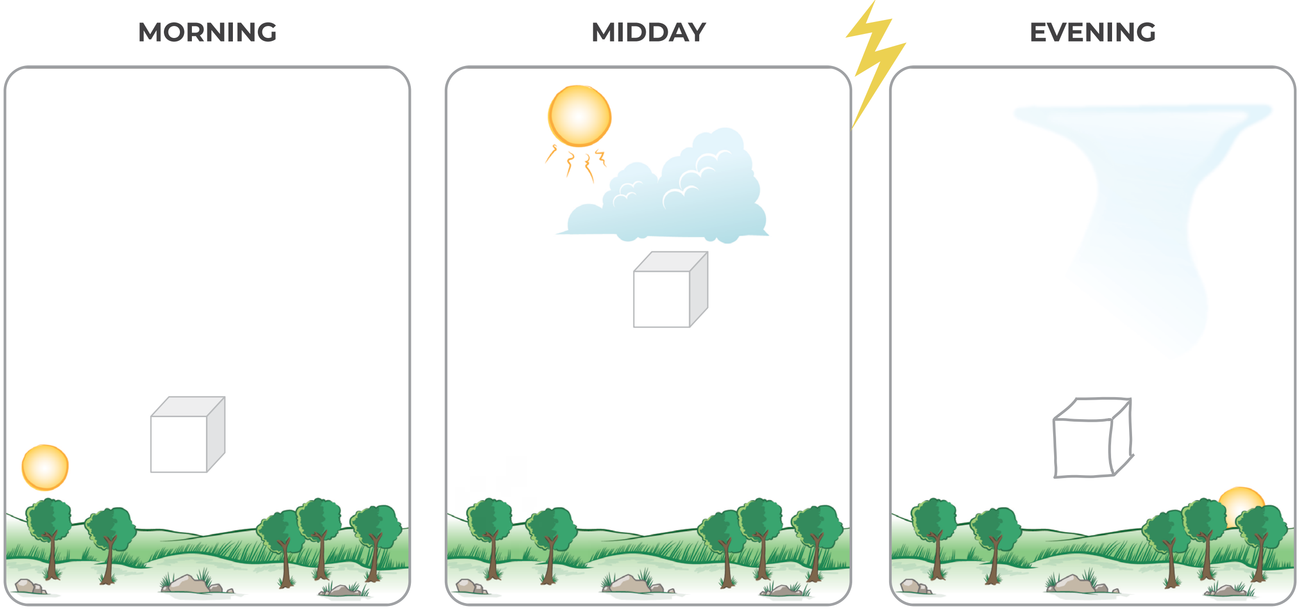
- *Students do not connect temperature changes to evaporation or condensation.*
- *Students do not identify an accurate temperature gradient from the ground to the clouds.*

Suggestions

- *Revisit Lesson 3 data that students collected from the Virtual Ballooning interactive. Talk about what would be happening to water at the surface when it is warmed and what happens to water in cooler temperatures.*
- *Flip the temperature gradient and ask students to explain changes if the alternative gradient were the case: If it was warm in clouds, what would happen to water? If it was cold at the surface, what would happen to water?*

The pictures below show one location at three different times during one day: morning, midday, and evening. The day was sunny in the morning and then a thunderstorm formed around 3:00 p.m., which lasted an hour.

The boxes in the pictures represent a "pocket" of air that moves over time. In the morning, the air is near the ground. At midday (12:00 p.m.), the pocket of air has moved higher in the atmosphere. Answer the questions below to complete the model and to explain what it shows about the thunderstorm.



5. Draw a box to show where you think the pocket of air might be on the "Evening" diagram.

Performance Outcome: *Develop a model to show how air rises and falls during a day.*
Indicators of progress

- *Box is drawn near the surface or lower than the middle box.*

Incomplete or inaccurate ideas

- *Box is drawn higher than or at the same level as the middle box.*

Suggestions*: Revisit the Mylar balloon demonstration (Lesson 5). Ask students to discuss what happened to warmed air when it reached cooler temperature higher in the atmosphere.*

6. Explain why you put the box where you did.

Performance Outcome: *Develop a model to show how air rises and falls during a day.*
Indicators of progress

- *Explanation includes ideas about cooling and/or sinking air. Students may also mention that vapor condensed from the air when the storm developed and/or talk about air particles getting closer together as it cools, causing it to sink back to the surface.*

Incomplete or inaccurate ideas

- *Students believe the air continues to rise after the storm.*
- *Students believe the air cools but stays at the same altitude.*
- *Students believe there is warm air above the cloud, and the cool air stays below the cloud (indicating the air is heated by the Sun directly and not heated from the ground below).*

Suggestions*: Revisit Mylar balloon demonstration and/or Air on the Move reading (Lesson 5).*

7. Do you think the temperature and humidity of the air in the box is increasing, decreasing, or staying the same during the morning and midday (just before storm)? Circle your answers for each time in the table to the right.

	TEMPERATURE	HUMIDITY
MORNING	[✓ Increasing] Decreasing Staying the same	Increasing [✓ Decreasing] Staying the same
MIDDAY	[✓ Increasing] Decreasing Staying the same	[✓ Increasing] Decreasing Staying the same

Explain why you think the temperature and humidity would change like this during the morning and then midday, just before the isolated storm occurred.

Performance Outcome: *Modify a model to describe the relationships between air temperature, humidity, time of day, and altitude.*

Indicators of progress

- *The answers to questions 3 and 4 are not completely clear cut, so look at student explanations here to determine whether they are on the right track.*
- *Morning—the stormy day pattern typically shows an increase in temperature and a decrease in humidity. Students may circle "increasing" humidity and explain that as soon as the Sun rises, the energy from the Sun warms the surface and evaporates water. This explanation would make increasing humidity a logical response. If students know more about how relative humidity is calculated in relation to temperature, they will understand why humidity decreases even if the amount of water increases.*
- *Midday—the stormy day pattern typically shows a quick increase in humidity and a slight drop in temperature during an isolated storm. Students should know that both variables need to rise to create conditions for storms, but students may also circle "decreasing" for temperature and provide a logical explanation for why this happens just before a storm.*

Incomplete or inaccurate ideas

- *Explanations that are counter to the stormy day pattern, for example, using the sunny pattern of increasing temperatures and decreasing humidity at midday leading up to the storm, show incomplete or inaccurate ideas.*

Suggestions*: Revisit the sunny day and stormy day graphs from Lesson 4. Have students reread their graph descriptions (steps 1-2), discuss their ideas, and write a caption to summarize the stormy day pattern graphs for morning, midday, and evening.*

8. One student claims that the box would get larger between morning and midday, assuming that the molecules can't escape from the box.Do you agree or disagree? Explain your reasoning.

Performance Outcome: *Students critique a model to describe the relationship between air temperature, particle arrangement, and time of day.*

Indicators of progress

- *Agree. As heat transfers to air particles, they move more and become spaced farther apart, which would make the box expand.*
- *If students have learned about particle motion, they may mention that thermal energy transfer causes the particles to gain kinetic energy.*

Incomplete or inaccurate ideas

- *Disagree. This explanation states that the only way for the box to expand is if there are more air molecules in it.*

Suggestions*: Revisit Mylar balloon demonstration and/or Air on the Move reading (Lesson 5).*

9. Another student claims that if there was another box of air high in the atmosphere at midday, it would be colder than the air below so it would sink toward the ground. Do you agree or disagree? Explain your reasoning.

Performance Outcome: *Students critique a model to describe how air moves due to temperature.*
Indicators of progress

- *Agree. Cooler air sinks while warm air rises during convection.*

Incomplete or inaccurate ideas

- *Disagree. Air higher in the atmosphere is always cooler so it doesn't sink. As students have learned that air is heated near the surface and is cooler higher in the troposphere, they may assume that cold air needs to be at higher altitude.*

Suggestions*: Revisit Mylar balloon demonstration and/or Air on the Move reading (Lesson 5).*

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10. Use what you learned about temperature and humidity patterns on a stormy day to explain why the storm happened in the afternoon instead of the morning.

Performance Outcome: *Construct an explanation for the relationship between changes in air temperature and humidity over a day and the formation of storm clouds with altitude.*
Indicators of progress

- *Mention that there needs to be time for the air to warm and water to evaporate. There also needs to be time for moisture to move from the surface to higher in the atmosphere.*

Incomplete or inaccurate ideas

- *Responses focus only on temperature or only on humidity and do not mention that it is the combination of both that creates conditions for storm.*
- *Responses do not mention anything about the time, energy from the Sun, or indicate that they understand how energy from the Sun is causing processes like evaporation and convection.*

Suggestions

- *Ask students to think about why many days begin clear and by afternoon clouds form. Ask students to write step by step what needs to happen for clouds to form on a clear day.*
- *Revisit the Consensus Model and Model Idea Tracker. See which Model Ideas would help students answer this question.*

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11. Describe how energy from the Sun helps to cause the storm.

Performance Outcome: *Construct an explanation for why isolated storms depend on changes in sunlight.*
Indicators of progress

- *Students mention the role of sunlight or energy from the Sun in warming the surface and evaporating water at the surface. They may also mention that warmer air at the surface rises, bringing moisture or water vapor higher in the atmosphere.*

Incomplete or inaccurate ideas

- *Responses focus only on warm temperatures or only on evaporation and not the combination of both.*
- *Responses focus on sunlight warming the air directly.*

Suggestions*: Revisit students' Heating of Earth models and/or the Model Idea Tracker. Have students trace energy from the Sun to air molecule movement and convection.*
