Teek and Tom Episode 2

The Ocean is Key to the Weather and Climate We See!

LESSON 3

A Day at the Beach

All URLs were reviewed and accurate at the time of this lesson's publication. If you should come across a non-operational link, contact NOAA Ocean Service Education at oceanserviceseducation@noaa.gov. All images are credited to NOAA unless otherwise noted.

Introduction

The ocean absorbs energy — or heat — from the sun, and this has a major influence on Earth's weather and climate. Earth's ocean is far more important than the land as a source of the heat energy that drives weather and climate. The ocean covers more than two-thirds of the Earth's surface. It absorbs more energy from sunlight and stores heat longer than land. The sun's rays penetrate and heat up the ocean to a depth of many meters. These same rays, however, only heat up the very top layer of sand, soil, or rock on land surfaces. Water is very effective at absorbing and storing heat. These two factors play a big role in how the ocean impacts our weather.

The ocean moderates the climates in coastal areas. Because water does not heat up as easily as land, the ocean helps keep coastal areas cooler during the summer when inland temperatures soar. We can see this by comparing coastal and inland cities in California. The average temperatures of San Francisco, a coastal city, fluctuate very little over the course of a year. This is due to the moderating effect that the ocean has on temperatures. In contrast, the inland city of Sacramento is much cooler in the winter months and warmer in the summer months. This is due to the heating and cooling of its surrounding land mass.

Lesson Summary

Students will conduct a simple activity to demonstrate how water absorbs energy differently than land and air. This is what causes sea breezes, which keep coastal temperatures from getting too hot or cold. Students will then compare coastal and inland city temperature data to look at real-world examples of the ocean's effect on land temperatures.

Components of this lesson were adapted from Radiative Heating of Land and Water from NOAA's Global Monitoring Laboratory (https://gml.noaa.gov/outreach/info_activities/pdfs/LA_radiative_heating_of_land_and_water.pdf).

Objectives

- Students will compare differences in heating and cooling of land and water.
- Students will identify how prevailing winds and the movement of air masses affect weather in their location.

Estimated Time

It is estimated that one or two 45-minute class periods are needed for this lesson. This does not include the time required to view Teek and Tom Episode 2: *"The Ocean is Key to the Weather and Climate We See!"*, 11:15 minutes (https://oceantoday.noaa.gov/teekandtom/episode-2.html).

Education Standards

The lessons that accompany the Teek and Tom series were designed for upper elementary and middle school students. The Standards addressed are abbreviated here with a full list in Appendix A (https://oceantoday.noaa.gov/teekandtom/educators-guide/appendix-a.pdf).

Next Generation Science Standards

- 3-ESS2-1: Earth's Systems. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
- MS-ESS2-4: Earth's Systems. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- MS-ESS2-5: Earth's Systems. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

Common Core English and Language Arts: Writing Standards Grades 4-5

Common Core Mathematics: Measurement and Data - Represent and interpret data.

College, Career, and Civic Life (C3) Framework for Social Studies: Geographic Representations

Materials

The following materials allow for the set-up of a single demonstration for a class of approximately 30 students. You will need one setup per group if you want students to do this.

Arrange the pans to receive equal heat from the lamp within the red circle. Measure the temperatures within the red circle.

- Three thermometers
- Three small shallow pans, cups, or containers (small aluminum pans work well). Many options are available, but make sure that the pans or cups are the same size and can hold the soil/sand/water to the same level. The pans should contain at least 1 inch of soil, sand, or water.
- Lamp with heat bulb. If the pans are large, you may need a heat lamp for each of the sample pans. The key is equal light/heat for each of the samples. If your school's food service has food warmers, those

would work, too. The setup pictured includes a clamp heat lamp from the local hardware store. The lamp fixture is rated for 250 watts. The bulb is a 125-watt infrared/heat bulb.

- Stopwatch or timer
- Sand
- Soil (potting soil will work)
- Tap water
- Colored pencils or markers
- Large map of the U.S. You can use the map that is provided in the slide set or display a large paper map. One example of a good map for projection is the U.S. Map from the United States Geological Survey (https://www.usgs.gov/media/images/general-reference-printable-map).
- Students will need printouts of student record sheets, graphs, and/or maps to carry out the activities. Student record sheets are located at the end of this lesson.
- If you would like to provide the maps/graphics on a projection system, students will only need the student record sheets. Depending on the configuration of your classroom, we recommend one set per student or group.
- All maps/graphics presented in the activity are available as a slide set to project or present while teaching these activities. (https://oceantoday.noaa.gov/teekandtom/educators-guide/slide-set-3.zip)

Preparation

1. The teacher notes below include information about finding local maps/data.
2. Teacher notes/extensions, etc., below also include ways to explore the topic or activity further.

InvesTeekation Pathway

ENGAGE

Part 1. Engage

1. Ask the students if they have ever visited a beach. Then, have them imagine walking barefoot on that beach on a hot day. If you have students who have not visited a beach, ask them about walking barefoot on a sidewalk or street on a hot day.
2. If you walked on the beach or the sidewalk after sunset, what did the temperature feel like compared to the day under full sunlight? *Students would be expected to say that the cooler air temperatures cause the sidewalk or beach to cool down quickly.*

EXPLORE

Part 2. Explore

1. Show students the experimental setup with containers of soil, sand, and water under a heat lamp. NOTE: Caution students that heat lamps can get very hot. If you are doing this as a class demonstration, ask student helpers to record the time so that temperatures are taken every minute for 10 minutes of heating and every minute for 10 minutes of cooling. Place a thermometer in each container just below the surface. Place the containers 8 inches below the lamp bulb, but leave the lamp off for now. Ask students to predict:
   a. Which substance (soil, sand, or water) do you think will have the greatest rise in temperature after 10 minutes? Why do you think that?

b. Which substance (soil, sand, or water) do you think will cool off the fastest after 10 minutes? Why do you think that?

2. Ask students to record the starting temperature of each material in their data table at "0 minutes." Turn on the lamp and record the temperature of each material every minute until 10 minutes have passed. Turn off the light and move it away from the containers. Continue recording the temperature of the containers every minute for another 10 minutes.

3. Students should plot the data for the three materials on a line graph. Label the x-axis as "Time (minutes)" and the y-axis as "Temperature (°F)." Connect the points for the three datasets using different color lines for each of the three materials. Label the lines appropriately with "water," "sand," and "soil."

Discussion questions

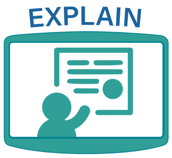
1. Which material heated up the fastest? Support your answer with evidence from the lab.

2. Which material cooled the fastest once the light was turned off? Support your answer with evidence from the lab.

3. How do these results compare to your predictions?

4. Which material was better at storing heat? *This material would be the one that cooled off slowly.*

Typical graphs for the experiment show that the soil and sand heat up faster than the water and cool down faster after the heat is turned off. The soil and sand reach higher temperatures than water during the 10 minutes of heating time. Students should find that water heats up slowly and cools off slowly. Water is very effective at absorbing and storing heat. These two factors play a big role in how the ocean impacts our weather.



Part 3. Explain

1. Ask students to draw an area where land and ocean meet. Have them consider which surface on their drawing will heat up the fastest. Then, ask them to draw arrows to show where they think air will rise fastest when warmed by the sun during the daytime.

2. Show the students simple images illustrating the differences between land and sea breezes. Ask them to identify and label the land breeze and sea breeze.

3. Sea breezes occur during hot summer days because of the unequal heating rates of land and water. During the day, the land's surface heats up faster than the water's surface. As the air above the land is warmer than the air over the water, the air over the land rises. As the warm air over the land rises, cooler air over the ocean flows in over the


Credit: Shutterstock

land's surface to replace the rising warm air. This is what causes the sea breeze. The land breeze image illustrates what occurs at night. In this case, the land's surface cools quicker than the water's surface. The air over the ocean is warmer and still rising. The denser cool air over the land flows offshore to replenish the rising warm air over the ocean. Similar effects can be observed over very, very large lakes.

SEA BREEZE	LAND BREEZE
Air over land is hotter than air over water during the day.	Air cools faster over land at night compared to air over the ocean.
Air rises over the land.	Air rises over the water.
As warm air rises, cooler air is drawn in underneath it from the ocean to take its place over the land.	As warm air rises, cooler air is drawn in underneath it from the land to take its place over the ocean.

ELABORATE

Part 4. Elaborate

In this part of the lesson, we ask students to make predictions about temperature ranges in a coastal and an inland city before we show them actual data. First, have the students locate San Francisco and Sacramento, California, on a projected U.S. map. Ask students to predict:

1. If the sun shines equally on both cities, which location would get hotter during the day?
2. Have them explain why they arrived at that prediction.
3. Based on the results of the experiment, which city would probably experience a greater difference between its daytime and nighttime temperatures?
4. Have them explain their answers based on the results of the experiment.

EVALUATE

Part 5. Evaluate

Ask the students to look at the daily temperature graphs for Sacramento and San Francisco over a 48-hour time period.

1. Ask them to use what they have learned about the moderating effect of being a coastal city to explain the range of temperature differences between the two cities (San Francisco and Sacramento) on the same day.

   As an inland city, Sacramento has a wider range of temperatures than San Francisco, and the daytime temperatures are much higher.

2. Ask the students which city they would rather live in. Ask them to share their reasoning with another student. In a large group, discuss their preferences for weather.
3. How do the daily weather patterns of these cities compare to where you live now?


Credit: Shutterstock

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Extension

If you live near a beach, this might be a good time to emphasize good beach safety. This video might be helpful: Ocean Today Beach and Bay Safe - Checklist (https://oceantoday.noaa.gov/fullmoon-wavesafe-checklist/welcome.html).

These NOAA websites will be helpful for student understanding during discussions about their ideas:

- NOAA JetStream website: The Sea Breeze (https://www.noaa.gov/jetstream/ocean/sea-breeze)
- NOAA National Data Buoy Center (https://www.ndbc.noaa.gov/education/seabreeze.shtml)

Student Record Sheets

PART 1.

1. In this episode, Teek and Tom enjoy a day at the beach and smores. Have you ever walked barefoot on a beach or sidewalk on a sunny day in the summer? What did the temperature feel like?

2. If you walked on the beach or the sidewalk after sunset, what was the temperature like compared to during the day?

Earth Curiosities

Rope Cloud

On January 25, 2023, NOAA satellites captured an unusually long and long-lived rope cloud produced by a cold front over the Gulf of Mexico near Florida. A rope cloud is a very long, narrow, rope-like band of cumulus cloud formations. Rope clouds tend to form at the dividing line between cooler and warmer air. You can find animations of the rope clouds on the National Environmental Satellite, Data, and Information Service website (https://www.nesdis.noaa.gov/news/earth-orbit-rope-clouds).

PART 2.

We will investigate how different substances change temperatures under a heat lamp. The heat lamp will take the place of the sun in this experiment. We will compare how soil, sand, and water heat up and cool down over time. You will record temperature data on the charts below.

1. Which substance (soil, sand, or water) do you think will have the greatest rise in temperature after 10 minutes? Why do you think that?

2. Which substance (soil, sand, or water) do you think will cool off the fastest after 10 minutes? Why do you think that?

Heating It Up Data

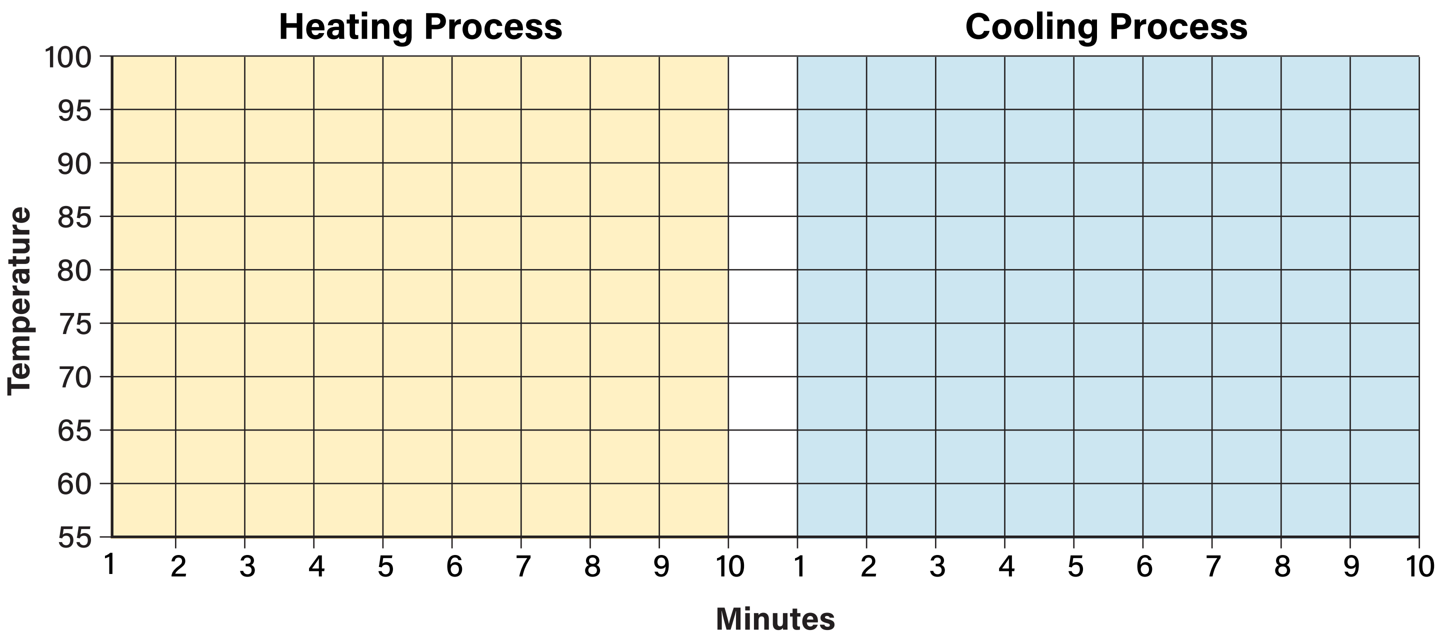
Time (min)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Sand (°F)										
Soil (°F)										
Water (°F)										

Cooling It Down Data

Time (min)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Sand (°F)										
Soil (°F)										
Water (°F)										

Graph it! The graph below will help you visualize the data differently. Plot the heating and cooling process for each of the substances. Use a different line color for each substance and indicate them on the legend below.

Sand line color	
Soil line color	
Water line color	



Your Conclusions

1. Which material heated up the fastest? Support your answer with evidence from the lab.

2. Which material cooled the fastest once the light was turned off? Support your answer with evidence from the lab.

3. How do these results compare to your predictions?

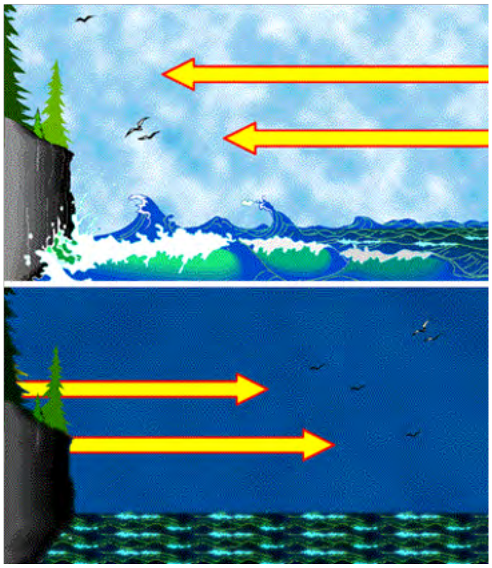
4. Which material was better at storing heat?

PART 3.

Let's compare the results of your experiment to a real-life scale.

1. Draw a small picture of a coastal area where the ocean meets land or beach.
2. Label the ocean and land.
3. Remember the results of the experiment that you just observed. Which surface on your drawing do you think will heat up the fastest? Draw arrows to show where you think air will rise the fastest when warmed by the sun during the daytime.

Take a look at the images. Label which one shows a land breeze and which shows a sea breeze.



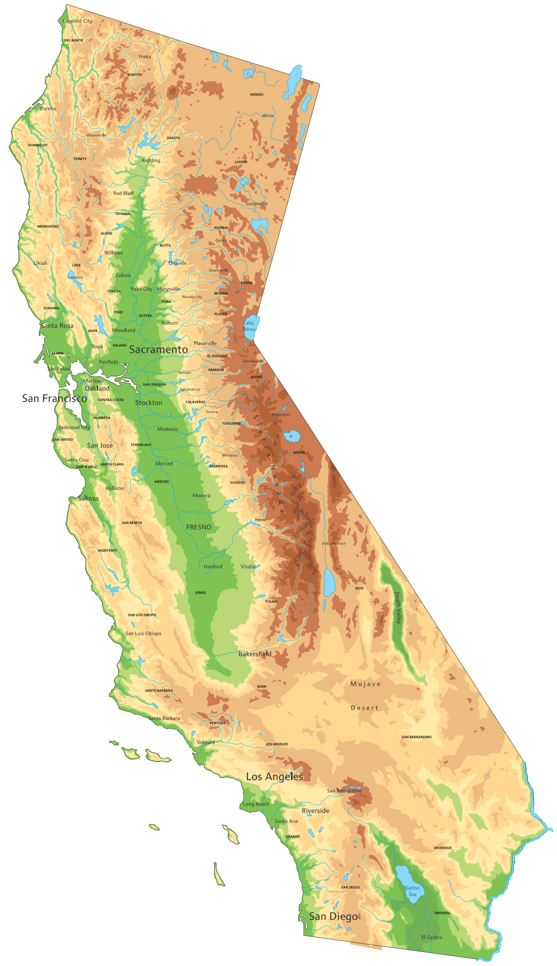
Credit: NOAA NCDC

PART 4.

1. On a map, locate San Francisco and Sacramento, California.
2. If the sun shines equally on both cities, predict which location would get hotter during the day.
3. Explain why you made that prediction.
4. Based on the results of the experiment, which city would probably experience a greater difference between its daytime and nighttime temperatures? Explain your reasoning.

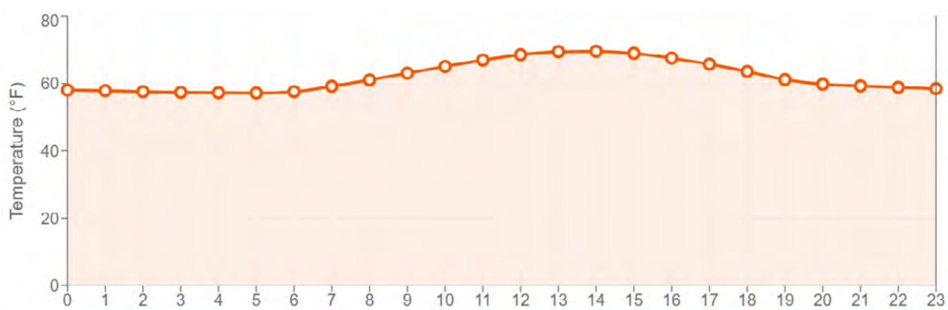
PART 5.

Locate San Francisco and Sacramento on the California map. The graphs below show temperature ranges for night and day over 24 hours. Notice that the temperature ranges on the graphs are different.



Credit: Shutterstock

San Francisco, California



Sacramento, California

1. Use what you have learned about the moderating effect of being a coastal city to explain the difference in the range of temperatures between the two cities on the same day.

2. Which city would you rather live in? Explain why.

3. How do the daily weather patterns of these cities compare to where you live now?


Credit: Shutterstock