Land and Sea Breezes

Throughout the guide teaching tips are in red.

Activity Description and Estimated Class Time

This 1-day activity explores differences in the rates that sand and water heat and cool. When two nearby locations on the ground heat and cool differently, the temperature of the air above them is also different. Temperature differences in the air drive convection, which causes air to move vertically and horizontally. We experience horizontally moving air as wind. Conducting this activity as soon as possible after the convection activity will help students understand one cause of wind.

Objectives

Students will develop an understanding of the following ideas and content:

- Sand and water heat and cool at different rates.
- Different characteristics of land and water produce different temperatures in nearby locations.
- Different temperatures at neighboring locations cause wind.

Students demonstrate understanding of these ideas by:

- Predicting and measuring heating and cooling of sand and water under identical conditions.
- Using observations of differential heating to explain causes of convection in nature and connecting these to convection seen in the previous activity.

Correlations to NC Science Standards

7.E.1.5 Explain the influence of convection, global winds and the jet stream on weather and climatic conditions.

Brief Science Background

Often, the temperatures of two different materials receiving the same amount of heat rise and fall at different rates. For its temperature to climb, a pound of water needs to absorb much more heat than, for example, a pound of dirt. Said another way, if the same amount of water and dirt receive the same amount of heat, the dirt warms up faster. The fact that different materials under the same conditions heat and cool at different rates is a factor in our weather. When the sun shines on different materials that are near each other, it produces different temperatures. The temperature of the ground influences the temperature of the air above it. These differences in air temperature cause wind. A good example of this is land and sea breeze.

Materials

Materials for the whole class or the teacher

- 8 clamp lights with 100 watt bulbs
- 16 squat 3.5 oz plastic cups
- 16 thermometers
- a small bag of clean sand
- 2 32-oz plastic containers of tap water
- 10 rulers

- colored pencils
- copies of SD-1, sand and water temperature graph, 1 per student
- copies of SD-2, day and night breezes at the beach, 1 per student
- *a sink
- *places to plug in the clamp lights near student work stations
- *a clock with a second hand visible to the whole class, or some other way to time events to the nearest second

* provided by the teacher

Materials for groups of 4 students

- one 3.5 oz plastic cup containing tap water
- one 3.5 oz plastic cup containing sand
- two standard thermometers
- one clamp light with a 100 watt bulb
- access to a clock with a second hand
- one ruler
- 4 copies of SD-1, sand and water temperature graph
- 2 different colors of colored pencils
- *science notebook

* provided by the teacher

Preparation

1. On the day of the activity, pour 8 3.5-oz plastic cups half full of tap water. Also half fill 8 3.5-oz plastic cups with sand. **These cups will be reused for all classes.**
2. Have clamp lights available with a way to clip them 8 inches over the cups (e.g. ring stands*), shining straight down equally into 2 cups side-by-side.
3. Be sure a sink or dishpan is available to dispose of water.
4. Copy one SD-1 (temperature v. time) per student.
5. Place materials for groups of 4, listed above, at each station.

Procedure

1. Ask the class to recall a trip to the beach.
   - On a sunny day, how did the sand feel on their feet?
   - At mid-day, how did the water feel when they stepped into it?
   - Ask if anyone has been out on the beach at night? If so, how did the sand feel on their feet at that time?
   - Ask how the water felt by comparison to the sand at night?

2. Ask students what they think might cause these changes between day and night. Try to get as many ideas as possible.

3. Explain that we are going to try to find out how sand and water warm in the sun and cool at night. To do this, we will expose a cup of sand and a cup of water to the same amount of heat, and see what happens to their temperatures. Ask the class to predict, in their notebooks, what they think will happen to the sand and the water.

4. Form teams of 4 and ask each team to go to a station set out around the room. Teams are responsible to read and record the temperatures of both cups once a minute for 10 minutes.

5. Once teams are at the stations, ask them to place thermometers in both cups, with the bulb of the thermometer in the sand half an inch deep. Place both cups with thermometers side-by-side.

6. Ask teams to plug in the clamp light with the light off and clip the light 8 inches above the surface of the sand and water pointing straight down.

7. Teams will record temperatures in both cups once a minute for 10 minutes. Instruct students to make a data table in their notebook that records temperatures in both cups each minute. Ask them to take the beginning temperatures of the water and sand and record these in their table.

8. Start the process by telling teams to note the time and turn the lights on. They will record the temperatures again 1 minute from when they turned the light on, and every minute after until the 5 minute mark.

9. At 5 minutes, ask everyone to turn off the light and continue recording temperatures once a minute until the 10 minute mark.

10. Give out SD-1, sand and water temperature graph, and ask students to graph their data. They should use two different colored pencils to draw the lines, one for the sand and one for the water. Ask them to label the sand and water lines.

11. When everyone is finished, hold a class discussion about results. What do the teams notice about the results? **The sand heated and cooled faster than the water.**

Wrap-Up

1. Remind students that the currents we saw in water in the previous activity also happen in air. In the activity we just did, after 10 minutes under the light, the sand heated more than the water. Ask the class to compare the sand and water cup to the hot H cup and cold C cup in the previous convection activity as follows:
   - After 10 minutes under the light, which cup (H or C) was the sand most like?
   - After 10 minutes under the light, which cup (H or C) was the water most like? **As the sand heated more than the water in this activity, the sand became like the H cup in the convection activity. The water was more like the C cup.**

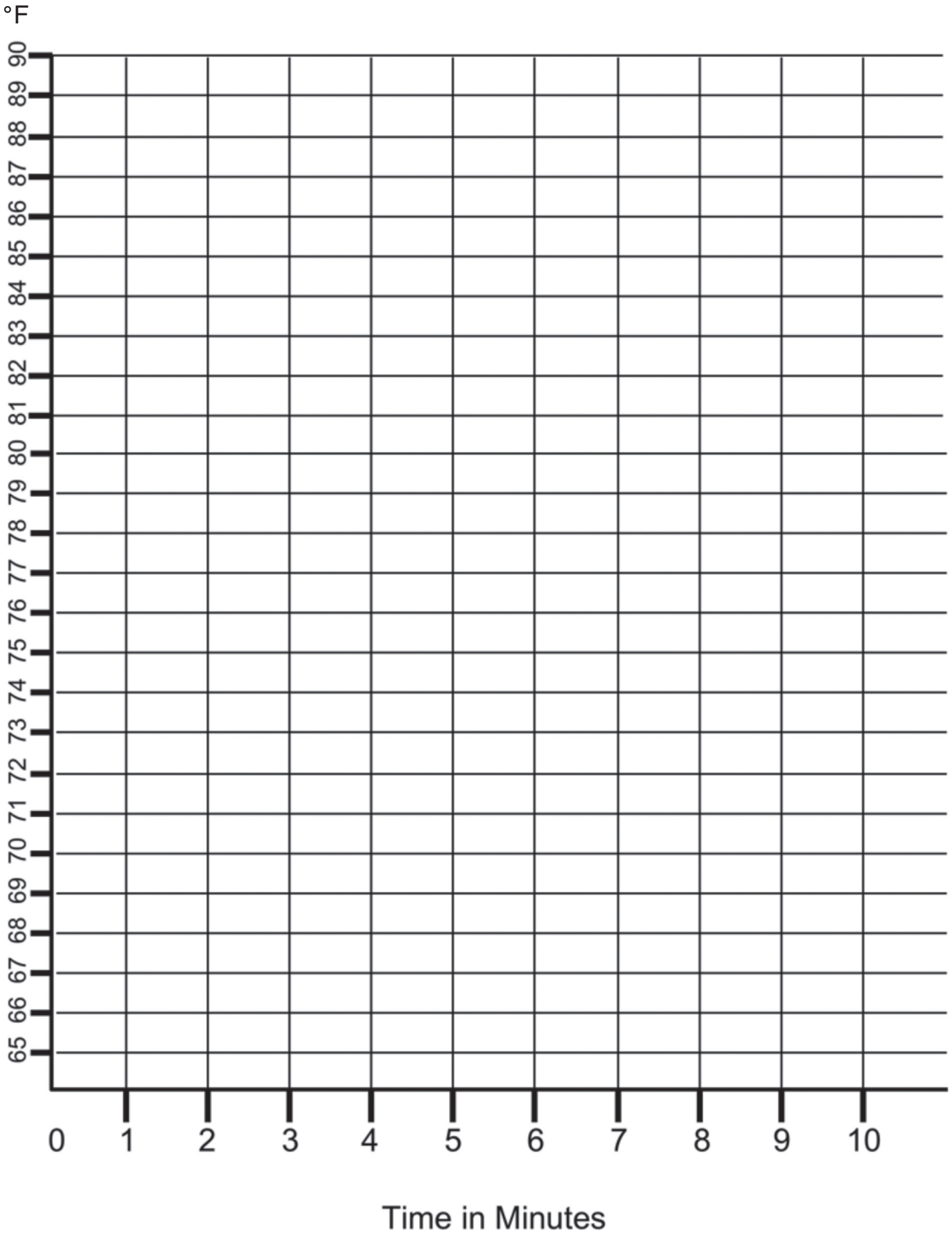
2. Give out copies of SD-2, Day and Night Breezes, and ask students to use what they have learned to fill in the wind patterns on both diagrams using arrows and labels. Ask them to label the warm and cool air and show their directions and sketch a flag on the beach to show the wind. Compare this with the convection activity and point out that convection moves air and water in the same way.

3. If needed, show SD-3, Answer Key, and explain how what we see at the beach is like what we saw in the tray on the hot and cold water cups.

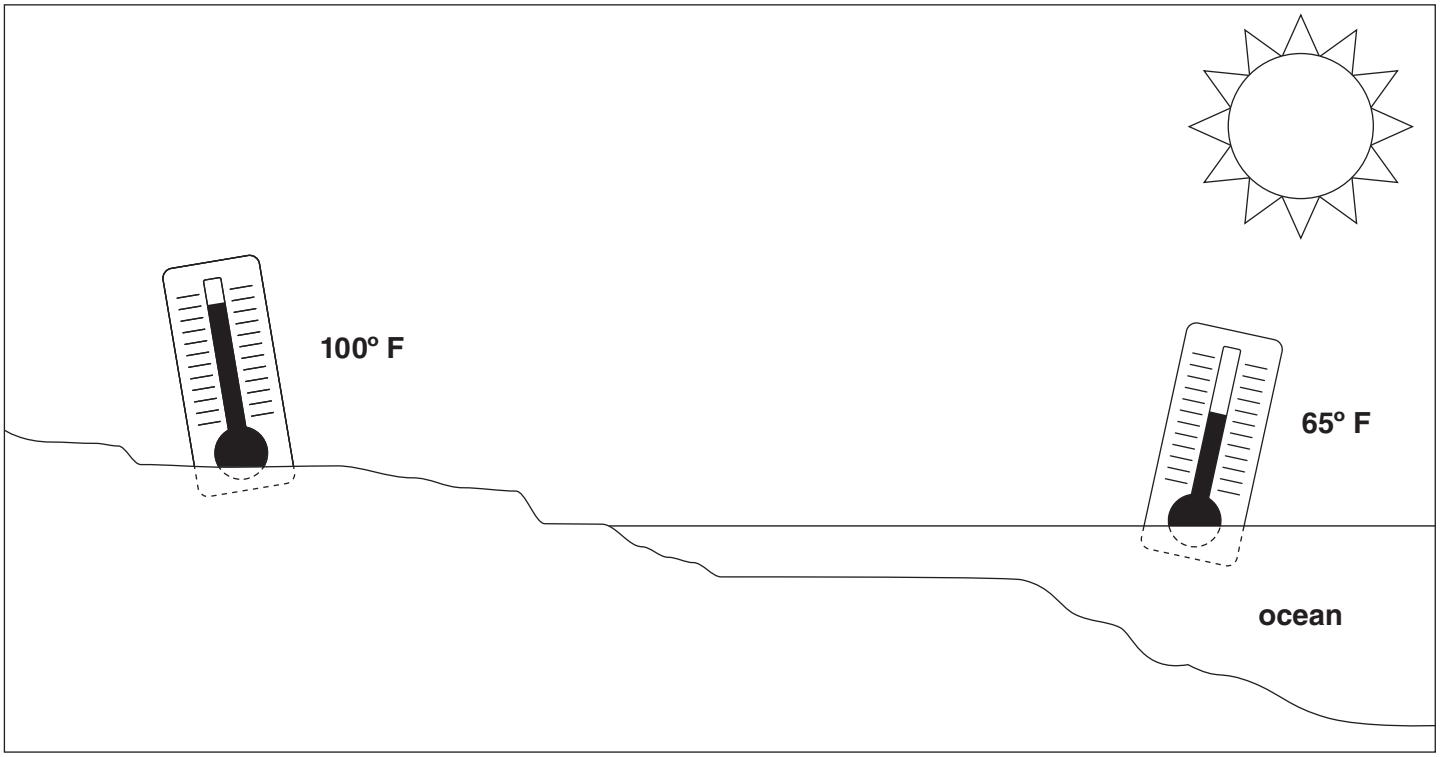
   - On a sunny day, the sun heats the sand enough to make it relatively warmer than the ocean. At this time, the sand acts like the cup of hot water. It warms the air above it and causes it to rise. The water remains cool relative to the land because water takes much longer to heat up. At that time, the water is like the cup of ice. The air above it cools and sinks. Air sinking above the relatively cool water moves inland to take the place of air rising off of the relatively warm sand. As a result, wind blows from the water toward the land. This is a sea breeze.
   - In the evening as the sun is goes down, the sand cools quickly and becomes cooler than the water. The air above the sand cools and sinks. The water remains at more or less the same temperature, becoming relatively warmer than the sand. Air over the relatively warmer ocean begins to rise. At that time, the sand is like the cup of cold water and the ocean is like the cup of hot water. As air above the water rises up, air above the sand rushes out to sea to replace it. As a result, wind blows from the land toward the water. This is a land breeze.

   NOTE: As the cups cooled, the sand did not get cooler than the water. If it had, it would have illustrated what happens at the beach, where sand does get cooler than the water. In that case, the sand acts like the cold cup in the convection activity. Sand in this demonstration cannot get cooler than the water because both it and the water can only cool to about the same temperature, room temperature. Beach sand gets cooler than the water because the ocean near the beach in the summer remains much warmer through the night and sand at the beach cools more because it is connected to the cool mass of the earth.

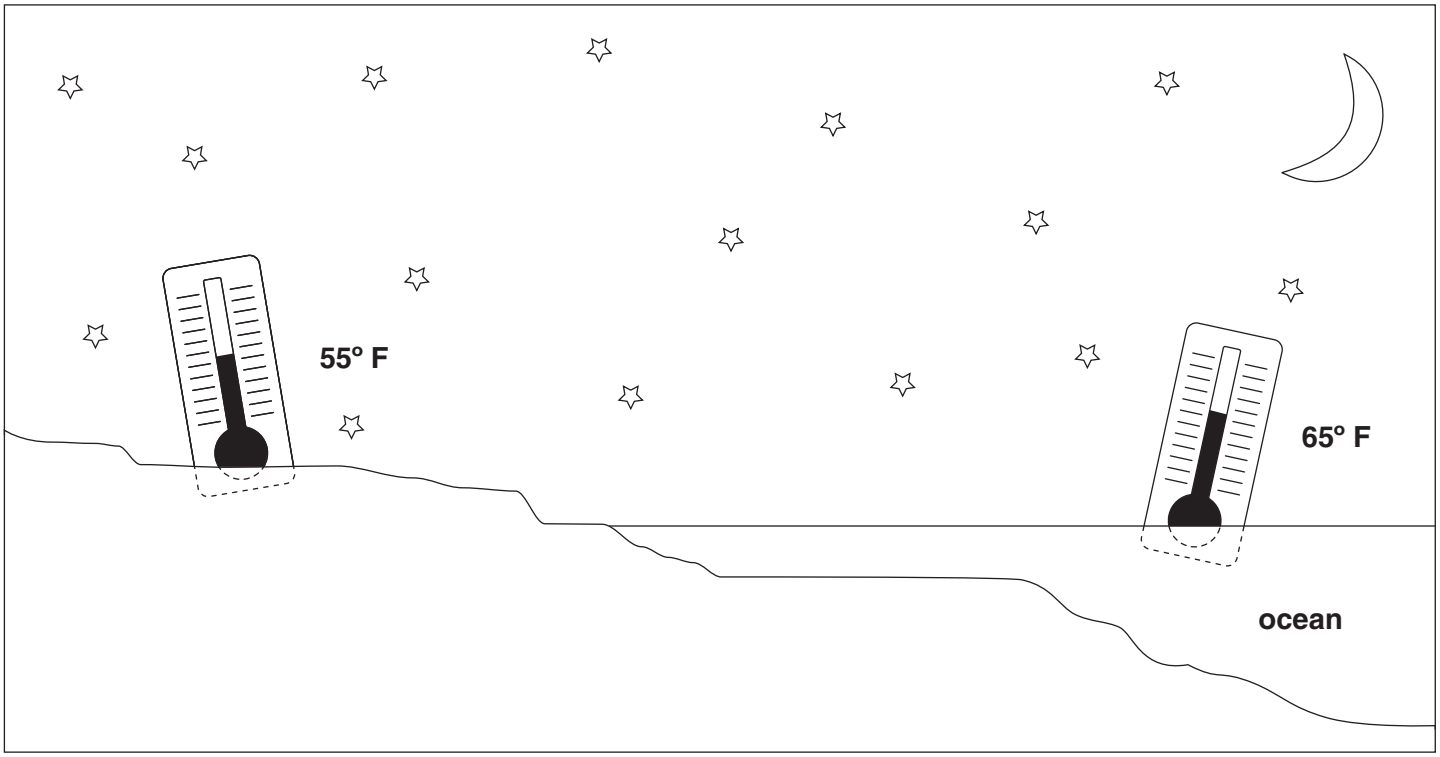
Support Document - 1 Sand and Water Temperature Graph



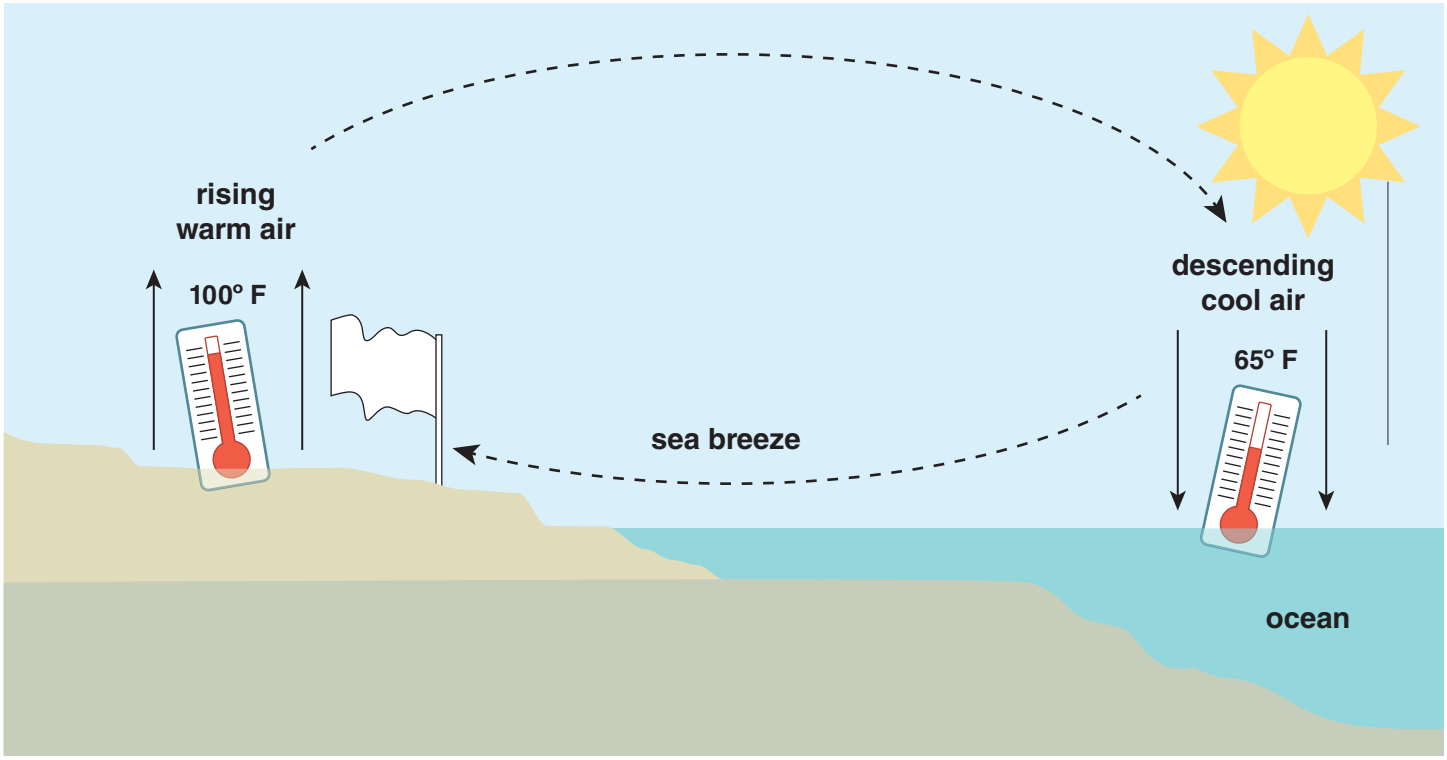
Day Breeze at the Beach



Night Breeze at the Beach



Sea Breeze



Land Breeze