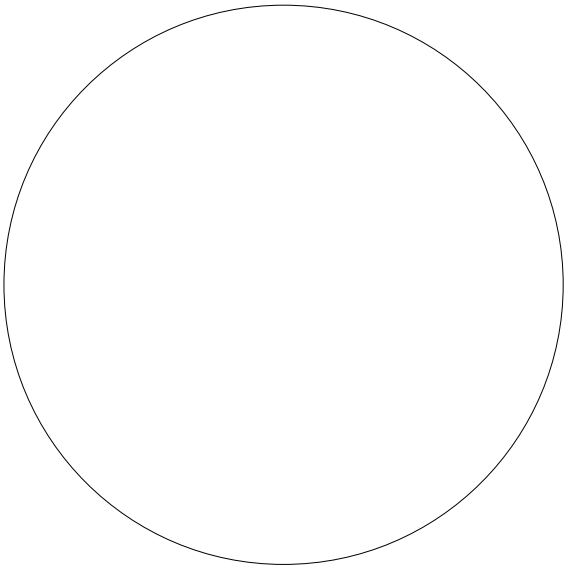
Tempest in a Teacup

Learn about convection by observing convection cells.

Materials: Teacups, teabags, medicine dispensers (cup type), cream (refrigerated), hot water, photographs of Jupiter's cloud bands (printed, projected, or online)

Procedure

1. Put 2 teaspoons of cream into a medicine cup and set it aside. The cream should be cold.
2. With the teacher's assistance, carefully pour hot water into a teacup to about 3/4ths full. The water should be near boiling temperature.
3. Place a teabag into the cup of hot water and allow it to brew for a few minutes until the water is dark. *Be careful not to spill the tea -- it is hot!*
4. Remove the teabag.
5. Pour the cream very gently into the middle of the teacup. *Do not stir!*
6. Observe carefully. Most of the cream sinks to the bottom, but watch what happens over the next few minutes. Pay close attention to what is occurring near the surface of the liquid. (After a short time, all of the cream will be completely mixed and you will see no more changes. You may want to repeat the procedure if you are unsure of what you saw in the first couple of minutes.)
7. Make a sketch of what you observed and describe what happened near the surface of the liquid.



8. Examine the pictures of Jupiter that you have been given. Describe any similarities to your observations in the teacup. _____

9. What is the surface of Jupiter made of? (Hint: it's not tea!) _____

Tempest in a Teacup

Teachers' Notes

Objectives: Students will discover the nature of convection cells by means of a simple demonstration.

Grade Level: Elementary/Middle

NSES: A1, A2, A3, A4, B1, B3, B4, B6, D1, D4, D6

NHSCF: 1a, 4b, 5b, 5c, 5g

Overview: Small convection cells are created by adding cold cream to hot tea. Within a minute the motion of the liquid in the cells becomes easily visible near the surface and remains so until natural convection has completely mixed the cream with the tea. The convection cells in the teacup bear a strong visual resemblance to the turbulence bands seen in Jupiter's atmosphere.

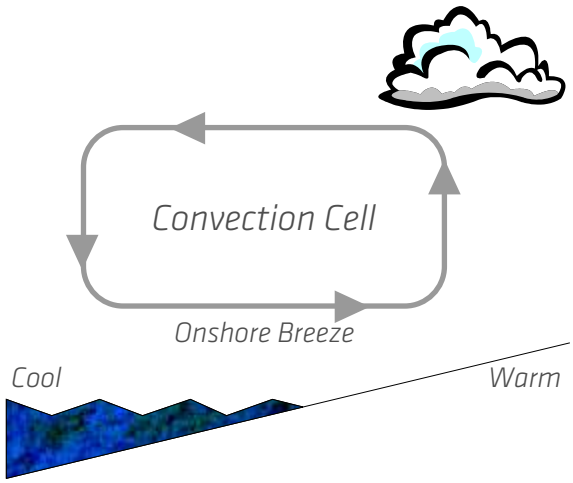
Key Concepts

Convection is the transfer of heat through a fluid (liquid or gas) caused by molecular motion. Stated differently, convection is the movement of heat energy by currents. Contrast this with heat transfer by conduction or radiation.

In meteorology, convection is the (primarily) vertical movement of heat and other atmospheric properties caused by temperature differences. Convection in the atmosphere occurs because warm air is less dense than cool air. Warm air rises and cool air descends unless obstructed. Similar processes occur in the oceans and fresh water bodies.

Convection can be found at both microscopic and massive scales – in a drop of pond water and on the surface of the sun. In all cases the "engine" that drives convection is a difference in temperatures between adjacent regions. Currents created by temperature differences are called *convection currents*.

A common example of atmospheric convection is the *onshore breeze*. Air residing over a hot sandy beach rises, to be replaced by cooler air from over the water. The rising air cools as it ascends (and may form clouds as moisture condenses out) and eventually falls back to the cooler zone above the ocean. The strength of the sea breeze depends on the magnitude of the temperature differences between land and ocean. The pattern is broken at nighttime when the beach cools off. The direction of airflow can reverse itself (creating an *offshore breeze*) if the ocean is warmer than the land.



A *convection cell* is a circulation pattern caused by convection. It implies that convection is being physically confined in some way, usually by other convection cells. Onshore breezes, turbulent air flow above an electric hotplate, patterns in the cloud bands of Jupiter, and the grainy appearance of the surface of the Sun are all explained by the presence of convection cells.

For additional information, visit this website:
http://www.solarviews.com/eng/edu/convect.htm

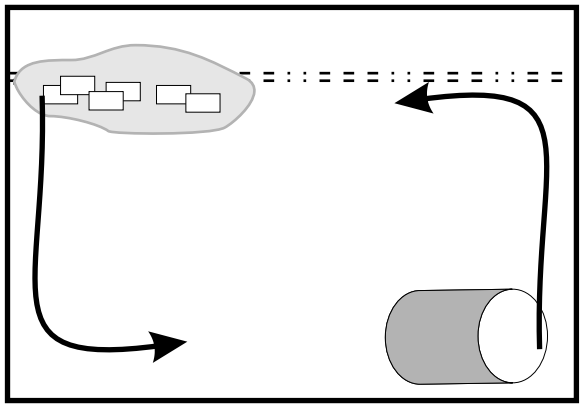
Supplemental Demonstration

This activity is effective in showing convection currents at a larger scale than the preceding activity.

Materials: Small aquarium or a very large pickle jar, 16-ounce jar (minus top), small resealable plastic bag, tape, plastic wrap, rubber band, sharp pencil, ice, blue and red food coloring

Procedure

1. Fill the aquarium to within 1 to 2 inches of the top.
2. Place cold tap water and several ice cubes into the plastic bag, mix in several drops of blue food coloring, and seal the bag.
3. Float the bag at one end of the aquarium and tape it in place so that it will not drift.
4. Fill the jar with hot water to the top, add several drops of red food coloring, and mix. Seal the opening with plastic wrap and a rubber band.
5. Set the jar on its side at the bottom of the aquarium at the end opposite the ice water.
6. Use the pencil to make a ¼-inch puncture in the bottom of the plastic bag and in the plastic wrap that seals the jar. Be careful not to disturb the water in the tank excessively.



Almost immediately, thin streams of colored water will begin to flow from the plastic bag and jar in the pattern of a convection cell with distinct convection currents.