Activity 2: The Climate Team

What You Will Do: Make a Solar Cooker

Big Idea

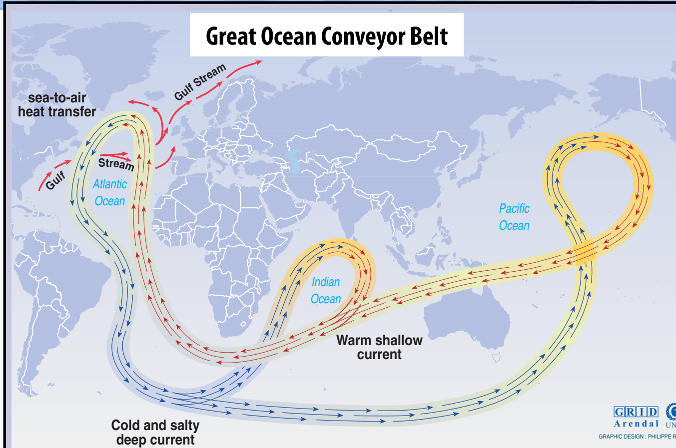
Climate is regulated by complex interactions among components of the Earth system. (Climate Science Principle 2)

What You Will Need

- Adult partner
- 1 – Cardboard about 22 in x 10 in
- 1 – Cardboard about 57 in x 45 in (from a large appliance carton or mirror box)
- Aluminum foil, about 18 square feet
- White glue
- Foam paint brush, about 2 inches wide
- Measuring cup, at least 2 oz capacity
- Paper or plastic cup, about 8 oz capacity
- Duct tape
- Black pot, 1 or 2 quart capacity (buy an inexpensive aluminum pot from a local thrift store and paint the outside with flat black paint)
- Metal ruler or straightedge
- Knife for cutting cardboard (safety box cutters and safety utility knives have a built-in shield to protect fingers)
- Gloves for protection while using the knife (hardware stores and home centers have cut-resistant gloves)
- Sunglasses and oven mitts for protection while using your Solar Cooker
- Rice

We can think of Earth's ocean, atmosphere, clouds, ice, land, plants and animals as the Climate Team, because they all affect climate. The climate at a particular place on Earth depends upon how members of the Climate Team work together.

The ocean is one of the Climate Team's power players. One reason is that the ocean is very large and covers 70% of Earth's surface. Another reason is that water has a high heat capacity, which means it takes a lot of heat to change the temperature of water. Raising the temperature of one kilogram of water by one degree requires more than three times as much heat energy as raising the temperature of one kilogram of air by one degree. The ocean absorbs large amounts of heat energy from the Sun, and ocean currents move this energy from one place on Earth to another. The ocean's major current systems are sometimes called the "global conveyor belt," and the heat that they carry has a large impact on climate.



The Global Conveyor Belt is caused mainly when seawater in the Norwegian Sea is cooled and sinks into the deep ocean. The sinking process can slow down or even stop if large amounts of freshwater enter the Norwegian Sea from unusual rainfall, snow, runoff, or melting ice. Changes in the Global Conveyor Belt can cause climate changes in Europe and other areas of Earth's Ocean (United Nations Environment Programme and World Meteorological Organization, 1996; *http://maps.grida.no/library/files/storage/31new.pdf*).

The atmosphere is another one of the Climate Team's power players, and it exchanges heat with the ocean. Water from the ocean enters the atmosphere when it evaporates, and returns to the ocean as rain or snow. When water evaporates it absorbs heat, and when it precipitates as rain or snow it releases heat. Movement of water vapor in the atmosphere is another way that heat can be transferred from one place to another. The atmosphere also absorbs and reflects energy from the Sun. The amount of solar energy that is absorbed or reflected depends on the gases that make up the atmosphere. The ways that different gases affect Earth's climate is discussed more in Activity 6, *I Didn't Do It, Did I?*.

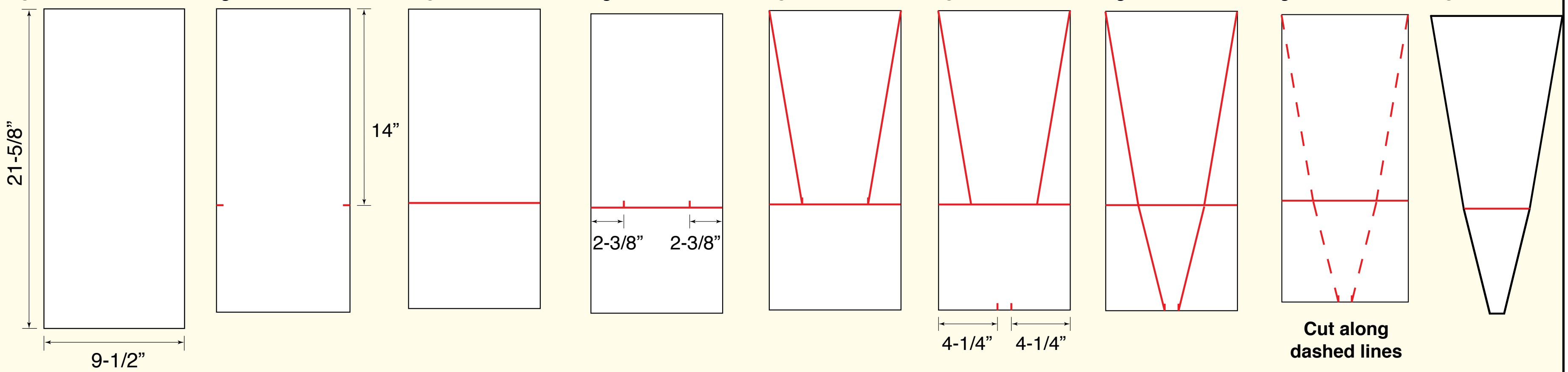
How It Works

Solar cooking is an easy, safe, and convenient way to cook food without using fuel. These benefits are particularly important for people who live in places where fuel is scarce or expensive. Besides cooking food, solar energy can be used to purify drinking water by boiling it, and avoid waterborne diseases that kill many people every year.

The basic principle of solar cookers is when sunlight strikes a dark-colored object, the object absorbs some of the energy in the sunlight and converts it to heat. This causes the object to become hot. Solar cookers use shiny surfaces to reflect sunlight onto a dark pot to increase the amount of heat energy that the pot receives. These reflectors may be flat panels, boxes, or curved surfaces (see Want to Do More for sources of different solar cooker designs). Dark, shallow, thin metal pots with dark, tight-fitting lids are the best containers for solar cooking. Some solar cookers use a clear plastic bag around the pot to trap heat and still allow sunlight to strike the pot.

Figures 1 - 9: Steps to make a pattern for the solar cooker.

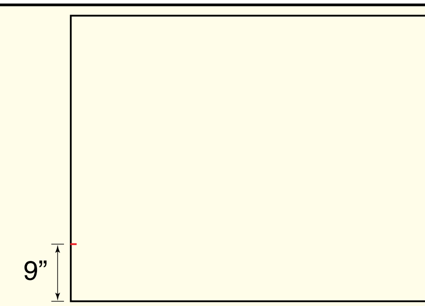
Figure 1. **Figure 2.** **Figure 3.** **Figure 4.** **Figure 5.** **Figure 6.** **Figure 7.** **Figure 8.** **Figure 9.**



CAUTION:

- **Be sure to wear sunglasses whenever you work with aluminum foil outside in the sun.**
- **Wear oven mitts when removing pots and pans from your solar cooker! When the sun is shining they can become too hot to touch in one or two minutes!**
- **Tips for Safe Cutting: Sharp is safe, because a dull knife can slip off the cardboard rather than cut into it easily. Always use a cutting board to protect the blade of the knife and help keep it sharp. Keep your fingers away from the path of the blade as you cut. Begin with a light scoring cut to guide the blade for additional cuts. Several light cuts make it easier to control the blade. Never force the blade through materials being cut, because it increases the chances of an uncontrolled slip.**

Figure 10.



How to Do It

1. Cut a pattern for your solar cooker from the 22 in x 10 in piece of cardboard.
   a. Place the cardboard on a flat surface and cut it to measure 21-5/8 in by 9-1/2 (Figure 1).
   b. Make a mark 14 inches from the top of the cardboard along each side (Figure 2). Draw a line between these marks (Figure 3).
   c. Make a mark 2-3/8 inches from the sides of the cardboard on the line drawn in Step 1b (Figure 4).
   d. Draw a line from the top corners of the card-board to the marks made in Step 1c (Figure 5).
   e. Make a mark 4-1/4 inches from the sides of the cardboard along the bottom (Figure 6).
   f. Draw a line from the marks made in Step 1c to the marks made in Step 1e (Figure 7).
   g. Put the cardboard on a cutting board or several layers of scrap cardboard. Cut along the lines drawn in Steps 1d and 1f (Figure 8). Use a metal ruler or straightedge to keep the cuts straight. **(Be careful and wear gloves!)**
   h. Your pattern should look like Figure 9.

2. Lay out the Reflector for your solar cooker on the 57 in x 45 in piece of cardboard.
   a. Place the cardboard on a flat surface. Make a mark 9 inches from the bottom along the left side of the cardboard (Figure 10).
   b. Place your pattern on the cardboard, and make two marks as shown in Figure 11.
   c. Draw a line around the outside of your pattern, then remove the pattern (Figure 12).
   d. Draw a line between the two marked points (Figure 13).
   e. Use your pattern to draw another outline beneath the outline drawn in Step 2c. Be sure to make the two marks (Step 2b) and draw a line between these points (Step 2d) as before. Now your layout should resemble Figure 14.

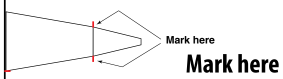


Figure 11.

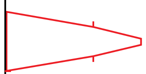


Figure 12.

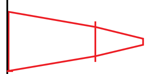


Figure 13.

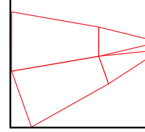


Figure 14.

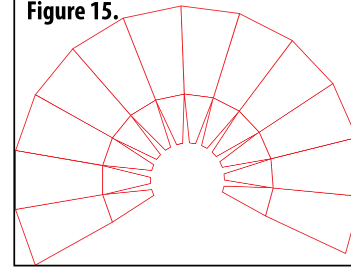


Figure 15.

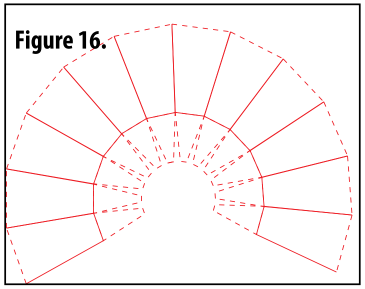


Figure 16.


Figure 17

f. Use your pattern to draw ten more outlines as shown in Figure 15. Be sure to make the two marks (Step 2b) and draw a line between them (Step 2d) on each outline.

g. Put the cardboard on a cutting board or several layers of scrap cardboard. Cut the Reflector out along the DASHED lines shown in Figure 16). Use a metal ruler or straightedge to keep the cuts straight. **(Be careful and wear gloves!)**

3. Fold the Reflector along the SOLID lines shown in Figure 16. Use a metal ruler or straightedge to keep the folds straight. You may also use the edge of a table or countertop to help make straight folds.

4. Mix 2 oz of white glue with 2 oz water in a paper or plastic cup. Use a foam paint brush to spread the glue mixture over the surface of the Reflector, then put strips of aluminum foil onto the Reflector to completely cover the surface. Allow the glue to dry.

5. Bring the small triangles together and hold them in place with duct tape on the cardboard side of the reflector (Figure 17). Do not put tape on the aluminum foil side! Bring the long edges of the Reflector together and hold them in place with more duct tape. Your reflector is finished!

6. It's time to test your Solar Cooker. A good first test is to cook some rice. Put 1/2-cup of rice into your black pot, add 1 cup of water, and place the lid on the pot. Set your Reflector on a flat surface so that it is resting on one or two of the small triangles closest to the center, and pointing toward the Sun. Put some bricks or rocks around the outside of the Reflector to keep it steady and to stop any wind from blowing it around.

Your Reflector is designed to have the approximate shape of a parabola. Parabolas are useful because their shape can focus the energy of sunlight onto a specific spot. The location of this spot depends upon the dimensions of the parabola. The focal point of your Reflector should be about six inches from the small hole at the back of the Reflector. This means that you will need some way to hold your pot in this position. A tripod (Figure 18) is a good choice, because it won't prevent reflected sun rays from reaching the sides and bottom of the pot. You can make a tripod from three sticks and a piece of heavy string. Search the Internet for "tripod lashing" (or ask a Boy or Girl Scout) to find directions for tying the sticks together to make a tripod.

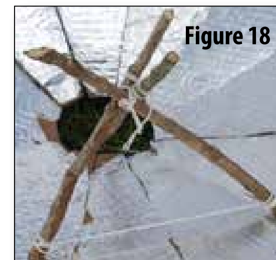


Figure 18

Put your tripod inside the Reflector, put the pot on top of the tripod, and wait (Figure 19). Rice ordinarily takes about 20 minutes to cook on top of a stove, but your Solar Cooker will probably need at least twice as much time. Check your rice after 40 minutes. If it needs more time, put the lid back on, check to be sure the Reflector is still pointed toward the Sun, and wait another 30 minutes. For long cooking times, you need to adjust the Reflector position every now and then as the position of the Sun changes in the sky.

7. Once your rice is cooked, try an experiment:

a. Put about two cups of rice in the pot without water. Cover the pot, place the lid on top, put the pot on the tripod in your Solar Cooker, and leave it in the Sun for ten minutes.

b. Check the temperature of the rice with a

Figure 19

thermometer (be careful, the pot will be hot!) and record your measurement.

c. Empty out the rice, and put two cups of water into the pot. Place the lid on top, put the pot on the tripod in your Solar Cooker, and leave it in the Sun for ten minutes.

d. Check the temperature, and record your measurement.

e. Can you explain your results? [Hint: remember the discussion of heat capacity at the beginnning of this Activity]. If land and water both receive the same amount of sunlight, which will absorb more solar energy?

8. You can cook many different types of food in your Solar Cooker! For some ideas and recipes, check out *http://www.solarovens.org/recipes/*. Remember you can also use covered black baking pans for foods such as cookies.

What About Other Members of the Climate Team?

Climate-prediction scientists know there are many other players on the Climate Team. These scientists often call the Climate Team players "climate forcings" because they can force Earth's climate to change, usually by affecting the amount of solar energy that enters and leaves Earth's atmosphere.

Some climate forcings affect solar energy entering the atmosphere as well as the energy from Earth that escapes back into space. Clouds are an example, because dense, low-lying clouds reflect sunlight back into space before it can reach Earth's surface. On the other hand, high, thin clouds have the opposite effect. These clouds allow incoming sunshine to pass through the atmosphere but trap heat that would escape back into space if the clouds were not present.

Clouds are often affected by airborne particles called aerosols. These are tiny liquid and solid particles that are injected into the atmosphere by natural processes such as ocean spray, volcanoes, and forest fires. Human activities such as burning fuels for cooking, heat, transportation, and electricity can also send aerosols into the atmosphere. Different aerosols have different effects on Earth's climate. Light-colored aerosols reflect sunlight back into space and have a cooling effect. Dark-colored aerosols absorb solar energy and make the atmosphere warmer. Sometimes, aerosols increase cloud formation, but dark aerosols like the soot from forest fires can reduce cloudiness. These kinds of opposite effects are one of the reasons that climate prediction is a complicated job!

Ice and snow can act as climate forcings because they also reflect solar energy away from Earth's surface. The ability of a surface to reflect radiation is called albedo (pronounced al-BEE-dough). When increased air temperatures cause ice and snow to melt, the surface underneath (such as soil) may be much darker. When this happens, the newly-exposed surface will absorb more energy from sunlight than was absorbed by the ice and snow. Absorption of additional energy raises the surface temperature, and causes even more melting. This is an example of positive feedback loops that can amplify the effects of a single change. The water from melting ice and snow can cause changes in major ocean currents, which in turn can lead to rapid changes in climate in regions far away from the places where the melting actually happened. The players on the climate team influence each other, which means that a significant change to one part of Earth's climate system can have effects on the entire system.

Plants and animals continuously move certain gases in and out of the atmosphere. Carbon dioxide is one of these gases that is also an important climate forcing. The effect of plants, animals, and carbon dioxide is discussed more in Activity 6.

Want to Do More?

For information about other solar cooker designs, see *http://www.solarcookers.org/index.html*. This is the Solar Cookers International website dedicated to spreading solar cooking awareness and skills worldwide, particularly in areas with plentiful sunshine and diminishing sources of cooking fuel.

Image on Page 8 is from: United Nations Environment Programme and World Meteorological Organization. 1996. Internet: *http://www.grida.no/publications/vg/climate/page/3085.aspx*; data from Climate Change 1995 – Impacts, adaptations and mitigation of climate change: Scientific-Technical Analyses. Contribution of Working Group 2 to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cartographer/Designer: Philippe Rekacewicz, UNEP/GRID-Arendal. Cambridge University Press.