

How does the atmosphere keep the earth warmer?

A laboratory experiment from the Little Shop of Physics at Colorado State University



Overview

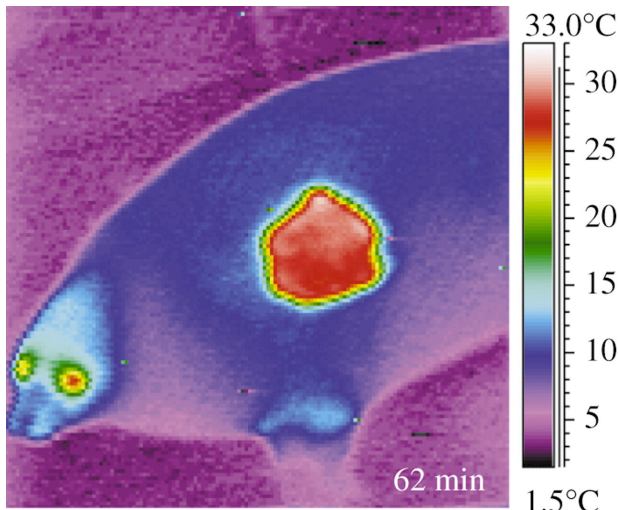
The earth cools by radiation. That's the only way that the earth can exchange energy with space. But the atmosphere is not transparent to the infrared that the earth emits, and so the earth is warmer than it would otherwise be.

Theory

We can simulate the energy exchange of the earth and the atmosphere with space by using a stack of glass plates for this simple reason: Glass is transparent to the visible light and the near infrared emitted by the sun (and the lamp!) but opaque to the far infrared, the thermal radiation, emitted by the earth. So energy gets in but can't get out—at least not so easily.

Doing the Experiment

We'll start with a simple experiment that shows how the atmosphere keeps the earth warmer:



A "thermal window" on a seal keeps it cool by emitting thermal radiation.

Necessary materials:

- Four of the same size picture frames (remove backing so just the glass and frame remain)
- Foam or wood pieces to use for spacers on the frames (hot glue one piece to each corner on the back of the frames)
- Two pieces of black felt cut to fit the size of the glass in the frames
- Infrared thermometer
- desk lamps

We purchased our frames at a dollar store, which made them quite reasonable!

- Put the black felt on two of the frames and place them under the desk lamp.
- Turn the desk lamp on and let it shine on the felt for approximately one minute.
- As soon as you turn off the desk lamp, use the infrared thermometer to take a temperature of both pieces of felt and record.
- Immediately place an extra frame over one of the black felt frames.
- Wait another minute, remove the extra frame, and then take the temperature of both felt pieces again and record.
- Quickly put the extra frame back on the black felt frame and repeat the procedure again.

There are variations of this basic procedure as well which we will discuss as we do this experiment.

Summing Up

This is a good simulation that can show how the layers of the atmosphere keep the earth warmer than it would otherwise be.

For More Information

CMMAP, the Center for Multi-Scale Modeling of Atmospheric Processes: <http://cmmmap.colostate.edu>

Little Shop of Physics: <http://littleshop.physics.colostate.edu>