FACILITATOR GUIDE

Investigating Clouds

Learning objectives

This activity explores three ideas:

- Clouds influence Earth's weather and climate.
- Clouds form when individual water molecules combine into droplets.
- NASA researchers study clouds in order to better understand and predict how Earth's climate is changing.
- Particular to the information sheet, worksheet, and Globe postcard: Citizen science programs collect and share the data with researchers that collaborate with NASA.

Materials

- 2 2-liter clear plastic "soda" bottles
- 2 Fizz Keeper™ bottle air pumps
- Isopropyl alcohol
- Red laser pointer
- *Investigate the Sky Today* worksheet
- GLOBE postcards
- Pencils
- *Observing Clouds* information sheet
- Activity and facilitator guides

The Explore Science toolkit comes complete with all necessary materials for this activity. Materials are also readily available to create or restock activity kits. Graphic files can be downloaded from www.nisenet.org. A common laser pointer may not be powerful enough to create a visible beam, but a 5mW laser directly connected to two CR2032 batteries will work.

Safety

Be especially careful of open flames around this activity. Use a well-ventilated space. The alcohol cloud is extremely flammable. Always point the laser down. Remind visitors not to point the laser at people, especially their eyes.

Advanced preparation

Place a couple drops of isopropyl alcohol (no more than 1 teaspoon) into each bottle at least 10 minutes beforehand (this step can be completed up to several hours before the activity).

Notes to the presenter

As you're pumping air into the bottle, you may want to talk to younger visitors about what they know about clouds. What do they think clouds are made of? How do they think clouds form? This will help kids connect the activity to their experiences, and you can adjust your presentation based on visitors' knowledge of the subject.

You can have kids help pump up the bottle, although the pump may be difficult for smaller children to use. If you plan to do this activity with younger children, you can try to swap the 2L bottle for a smaller plastic bottle, which will require fewer pumps.

Releasing the pressure in the bottle as fast as possible will create the most visible cloud. But before releasing the air from the bottle, let visitors know that there will be a sudden noise, and that the alcohol may be stinky. Doing a countdown with kids before releasing the valve can help them prepare for the surprise. You can leave the end of the bottle open or shut once you release the pressure—experiment with this to get the most consistent cloud.

When you shine the laser into the bottle, have visitors pay particular attention to the way the laser beam becomes visible as it passes through the cloud, and whether the visible beam becomes longer or shorter as you move the laser back and forth across the bottle.

The longer you wait between making each new cloud, the better the cloud will be—wait at least 5 minutes, if possible. Shaking the bottle or warming it with your hands can help speed the time between making clouds.

In your toolkit is a takeaway postcard for NASA's GLOBE Observer citizen science project. Go to observer.globe.gov to download the app and join a global community contributing to NASA science. At that site you'll also find interactives, tutorials, and other resources to take cloud investigations to the next level. And stay tuned for additional GLOBE Observer citizen science campaigns coming in spring 2017 and beyond.

Background information

Clouds form when individual molecules in a gas or vapor stick together to form tiny droplets. An enormous number of molecules—more than 1,000,000,000,000,000,000 of them—must come together to form a single droplet. Huge groups of these droplets floating together form clouds. Clouds form more quickly and more commonly on a particulate in the air, such as dust or soot.

The clouds in our atmosphere are made of water, but in this activity participants will be making clouds out of isopropyl alcohol. We use alcohol in the cloud bottles because alcohol evaporates more quickly than water and forms a thicker vapor (and therefore a denser cloud).

When participants first shine a laser through the bottle it will appear to be empty, since the alcohol vapor is invisible. Once pressure in the bottle is increased and then dropped (causing the temperature inside to rise and then fall again) the molecules in the alcohol vapor will collide and stick together to form floating droplets—a visible cloud.

List of terms

Evaporate: To change from a liquid to a gas, or *vapor*. Kids may be familiar with evaporation through boiling, but it can happen even when a liquid isn't hot enough to boil.

Condense: To change from a gas, or vapor, to a liquid.

LiDAR: Short for "Light Detection And Ranging." LIDAR uses lasers to create images of a wide range of materials, including non-metallic objects, rocks, rain, chemical compounds, aerosols, clouds, and even single molecules.

Laser: An acronym of "Light Amplification by Stimulated Emission of Radiation." A laser differs from other sources of light in that it emits light coherently. This means the light has the same frequency (in our case, the wavelength of red) and a constant phase difference (the waves of light are the same distance from each other).

Simplified Combined Gas Law (pV=nRT): As you pump air into the 2-liter bottle, the pressure goes up and the volume stays the same (2 liters). When this happens, the temperature goes up. When releasing the pressure, the opposite happens: temperature goes down.

Difficult concepts

Participants may already be familiar with clouds here on Earth and may think that clouds can only be made of water. If participants bring up things they've experienced or have heard of, you might say something like, "Yes, while rain and clouds here on Earth are made of water (H_20), not all clouds in our solar system are! For example, on Titan (one of Saturn's moons) clouds are made of methane (CH_4)." You can use the demonstration to illustrate that many different liquids can form gaseous vapors and condense into clouds—just like the cloud in a bottle! In this activity we're making clouds using rubbing alcohol, or isopropyl alcohol (C_3H_8O).

Some participants might dispute climate change. You can respectfully respond, "Yes, not everyone is in complete agreement about climate change. The great majority of scientists agree it is occurring, and we have a lot of supporting evidence. We are presenting the scientific perspective on the importance of studying clouds in this activity."

Staff training resources

Refer to the *Tips for Leading Hands-on Activities* sheet in your activity materials.

- An activity training video is available at vimeo.com/191168947.
- A content training video is available at vimeo.com/191171524.

The NISE Network has a curated list of programs, media, and professional development resources in the NASA Wavelength Digital Library that directly relate to the toolkit. These resources can be viewed and downloaded from nasawavelength.org/users/nisenet.

Credits and rights

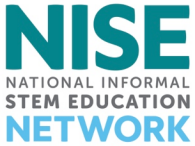
This is a classic activity and was inspired by multiple *Cloud in a Bottle* activities available on howtosmile.org.

Photograph of Cirrus clouds from below used under a Creative Commons 2.0 license: Dimitry B: https://www.flickr.com/photos/ru_boff/8690313402/in/photostream/

Photograph of swirling clouds from the ISS courtesy NASA.

Illustration of ISS and CATS over the Great Lakes courtesy NASA Goddard Space Flight Center.

Computer simulation of Aqua and photograph of cirrus clouds from above courtesy NASA.



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