Up in the Air

Purpose

- To introduce students to aerosols and help students understand that there are small particulates in the atmosphere.
- To engage students in collecting, analyzing, interpreting data, and making predictions.
- To introduce students to the concept of random sampling.

Overview

Students will work in groups to make an aerosol sampler, a simple adhesive tool that allows students to collect data and estimate the extent of aerosols present at their school. By participating in this activity, students will obtain a quantitative measurement of the aerosols present at the school and, as an optional activity, can compare results geographically, across their community, or by time, collecting measurements day to day.

Student Outcomes

Students will collect data, analyze, and interpret data as they explore the amount of aerosols present in the air around their school. They will gather information regarding the weather conditions around their school to determine how this affects the amount of aerosols present.

Estimated Time

- Part 1: Approximately 30 minutes
- Part 2: Approximately 30 minutes (after the Aerosol Sampler has been exposed for at least 2 hours)

Level

Primary (most appropriate for grades K-8)

Materials

Per Group

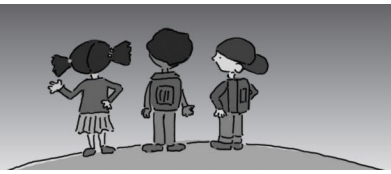
- 1 copy *Up in the Air Student Activity Sheet*

Part 1:

- 1 piece clear contact paper
- 1 piece cardboard or 1/4-inch plywood (30 cm square)
- Clear tape

Part 2:

- 1 magnifying glass
- 1 six-sided die
- *Up in the Air Aerosol Sampler Grid*



Preparation:

- Locate the specific location(s) for laying out samplers, preferably, a flat, elevated, open area. The surface does not have to be horizontal. Students need to have easy access to this area.
- Collect materials for each student group.
- Prepare *Aerosol Data Worksheets and Aerosol Sample Grids* for each student group.

Teacher's Notes

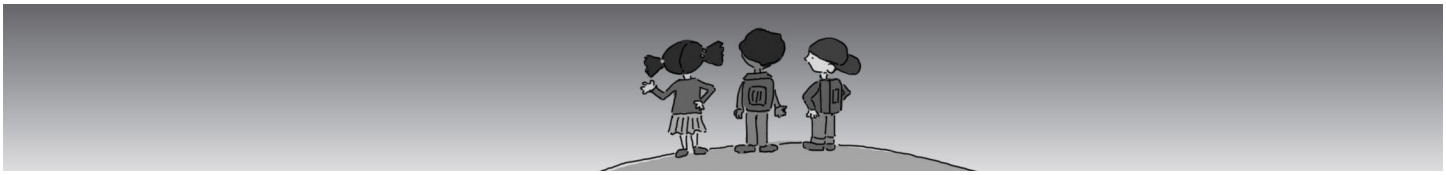
Dust storms, forest fires, volcanic eruptions, and various other natural events emit enormous quantities of small particles into the atmosphere. Human activities such as biomass burning, vehicular emissions, and industrial processes generate huge amounts of fine particles that are released into the atmosphere. When these particles, which may be solid or liquid droplets, are suspended in the atmosphere, they are generally referred to as aerosols. Aerosol particles range in size from very small sub-visible up to raindrop sizes. Aerosols at high altitudes are often transported over very long distances and are sometimes spread globally by winds and circulation patterns. Typically, they remain in the atmosphere for relatively long periods, often a year or more. Aerosols closer to the ground have much shorter residence times in the atmosphere as they are usually removed by sedimentation and weather processes. Certain types of aerosols pollute the air, and in some cases pose potential health problems. Aerosols with certain chemical and physical properties are potentially capable of influencing chemical changes in the atmosphere. They may also impact global climate by altering the Earth's radiation balance. For these reasons, aerosols are a subject of great interest and are widely studied by environmental and atmospheric scientists.

The extent to which aerosols may affect the environment or the radiation balance depends largely on the amount of aerosols present in the atmosphere. The number of aerosol particles in a given volume of air (particles per cubic centimeter) is one convenient way to quantify aerosols. There is a variety of ingenious methods used by researchers to measure aerosol number concentrations over various particle size ranges. Some methods require the use of sophisticated instruments such as lasers or research-grade particle counters. There are, however, much simpler techniques that may be used for dust particles and other aerosol particles in the visible size range. This activity is based on a very simple method, which involves collecting and counting aerosol particles.

What To Do and How To Do It

Part 1: Set Up the Experiment

1. Divide the class into multiple research groups.
2. Ask the students to describe what they see in the sky. Ask students if they have ever noticed small particles in the sky. Some aerosols are too small for our eyes to see, but other aerosols are larger such as dust or ash.
3. Tell your students that today they are going to collect data on the amount of aerosols around their school.
4. Assign each research group an area on the school grounds to place its aerosol sampler. Depending on the grade level of your students, pass out materials to each group and discuss the procedure.
5. Have each group tape 1 piece of contact paper in the center of the cardboard with the sticky side up. Keep the protective backing on the contact paper.
6. If students will be collecting data over multiple times or days, have groups repeat above procedures as necessary until enough aerosol samplers are created.
7. Have each group complete the weather questions on the *Up in the Air Student Activity Sheet.* You may need to read the local paper, watch the local weather, or retrieve weather data online before filling in statistics.



8. Place the aerosol sampler outside on a flat surface, preferably a meter or two above ground. (You may have to anchor the sampler if the air is windy. Make sure the contact paper is firmly taped to the cardboard.)
9. Once the sampler is anchored securely, remove the protective backing from the contact paper.
10. Expose the sampler to the outside air for at least 2 hours.

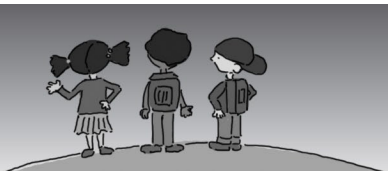
Part 2: Collect Aerosol Samples and Analyze

1. After at least 2 hours, go back outside and collect the sampler. (If the Aerosol Sampler is left outside for longer periods of time, students may want to collect weather data at the collection time as well for comparison.) Place the Aerosol Sampler Grid, grid side down, over the collecting surface and return the sampler to the classroom.
2. Remove the sampler from the cardboard and observe the aerosols from the back side of the clear contact paper (grid should be showing through).
3. Using the magnifying glass or holding the contact paper up to a light (i.e., an overhead projector), count the number of aerosols found in each of 10 randomly selected squares on the Aerosol Sampler Grid. Randomly select the squares by tossing one die twice. For example, if the numbers come up 2 and 5, the square is found in the second column, fifth row.
4. Record the number of aerosols in each sample square. Add up all the aerosols in the 10 randomly selected squares to get a total. Next, divide the total number of aerosols counted by 10 to get an average or mean number per square.
5. Compare results of each student group.
6. As a class, discuss the following:

- Did the weather conditions affect the results of this activity? If so, how? *(See data collected on local weather conditions.)*
- What types of weather conditions could cause the results to change? Why? *(Conditions like wind, rain, snow, or extreme heat could cause a change in results. These conditions affect the number of aerosols present in the air.)*
- What other factors can be identified that could affect the results of the activity? *(Time left outside, location of sampler and contaminated contact paper may affect the results of the activity.)*
- What caused the different amounts of aerosol matter found in the atmospheric samples? *(Answers vary according to population, industry, agriculture and geography. For example, combustion products from cars, fireplaces, volcanic eruptions, and a variety of other sources including dust from meteorites and comets, could contribute to the number of aerosols collected.)*
- What are other methods you might use to collect data on atmospheric particulate matter? *(Observe deposits of aerosols on objects, i.e., cars, glass, furniture.)*

Adaptations for Younger and Older Students

Younger students will need assistance in securing the particulate sampler and ensuring that a proper location is selected. In addition, they will require more parental supervision with the activity if the optional home activity is implemented. Calculating the average amount of aerosols can be done as a class. Older students should be able to conduct the activity individually or with a partner. Older students can also conduct further analysis by graphing findings or conducting a comparison of results based on day, time, or location (see *Further Investigations*).



Further Investigations

- **Further Reading:** Younger students can read the picture book, *The Air We Breathe: http://www.nasa.gov/pdf/62452main_The_Air_We_Breathe.pdf*. It is designed to introduce children to the Earth's atmosphere and its importance to life on Earth. Older students can read the NASA Earth Observatory article, *Aerosols: Tiny Particles, Big Impacts: http://earthobservatory.nasa.gov/Features/Aerosols/*.
- **Compare Samples Across Multiple Days:** Have students prepare additional aerosol samplers to take outside each day. Remind the students to record weather conditions each day the sampler is out. Students can then compare the average aerosols to the weather conditions.
- **Compare Samples Across Geographic Area:** Have students prepare their own aerosol samplers to take home. Students should expose the sampler overnight (approximately 8 hours), then place the Aerosol Sampler Grid, grid side down over the collecting surface and return the sampler to school. You can divide a map or diagram of your community or area into 4 regions: Northwest, Northeast, Southwest and Southeast. Have students place their labeled adhesive notes on the map/diagram where they live. Students can calculate aerosol averages for each region (NW, NE, SW, and SE) and make a class graph of the data.

Up in the Air Student Activity Sheet

Name: _____ Time: ___:___ AM or PM (circle one)

Date: _____

Are there clouds?
- ☐ no clouds
- ☐ some clouds
- ☐ lots of clouds
- ☐ fog

Is there precipitation?
- ☐ none
- ☐ rain
- ☐ sleet
- ☐ snow

Is there wind?
- ☐ gentle wind
- ☐ strong wind
- ☐ no wind

Visibility:
- ☐ very clear
- ☐ clear
- ☐ somewhat hazy
- ☐ very hazy
- ☐ extremely hazy

Temperature:
- ☐ cold
- ☐ chilly
- ☐ comfortable
- ☐ warm
- ☐ hot

Weather data was collected:
- ☐ when the sampler was put outside
- ☐ when the sampler was collected

Aerosol Sample Analysis (8–10 Random Squares):

	# Aerosols
Sample Square 1	
Sample Square 2	
Sample Square 3	
Sample Square 4	
Sample Square 5	
Sample Square 6	
Sample Square 7	
Sample Square 8	
Sample Square 9	
Sample Square 10	
Total (add Squares 1–10)	
Average (divide total by 10)	

Up in the Air Aerosol Sampler Grid

Date: _____ Name: _____

Time of collection: ___:___ AM or PM (circle one)

Aerosol Sampler Grid: