# Why (Not) So Blue?

## Purpose

- To help students understand that aerosols in the atmosphere have an effect on sky conditions, including sky color and visibility.
- To provide students the opportunity to become more familiar with the classification categories for daytime sky color and visibility.

## Overview

Students will make a prediction about how drops of milk will affect color and visibility in cups of water representing the atmosphere. They will observe a series of 5 cups of water, each with increasing amounts of milk, representing aerosols. They will observe and record how sky color and sky visibility change depending on the increased aerosols. Students will discuss how increasing amounts of aerosols in Earth's atmosphere can affect the sky's condition and appearance.

## Student Outcomes

Students will make and record observations for sky color and sky visibility using a set of classification categories. Students will notice and be able to describe a pattern in the experimental setup: when the aerosols in the atmosphere increase, sky visibility diminishes and sky color becomes more milky and less blue.

## Time

- One 45 minute class period

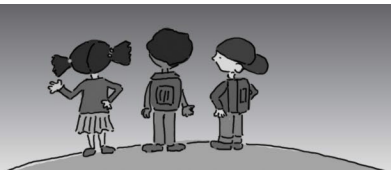
## Level

Primary (most appropriate for grades K-8)

## Materials

Per Group

- Blue paper
- 5 Clear cups per group of students (suggested 4" tall with 2" diameter base)
- Water
- Milk or liquid coffee creamer (very little is needed: only about 10 drops of each per group of students)
- 1 Eye Dropper
- 1 Stirring Utensil
- 1 Copy *Why (Not) So Blue? Student Activity Sheet*
- Elementary GLOBE storybook: *What's Up in the Atmosphere? Exploring Colors in the Sky*
- Copies of, or access to the webstory: *Become an Atmosphere Observer*
- Optional Resource: S'COOL Sky Conditions Poster



## Preparation

Students should be familiar with either the storybook, *What's Up in the Atmosphere? Exploring Colors in the Sky*, or webstory, *Become an Atmosphere Observer.*

## What to Expect

Depending on the size of the class, you may want to make 1 experimental setup, or have the students work in smaller groups. For older students, you may want to allow them to add the milk to their own cups after they make their prediction.

Each group will do the following experimental setup:

- Place five plastic cups in a straight line across the middle of the sky blue paper
- Fill each cup with 1.5 - 2" of water
- Starting with the second cup from the left, add increasing drops of milk to the cups as you move to the right of the paper. (0 in the first cup, 0.5 drops in the second cup, 1 drop in the third cup, 2 drops in the fourth cup, and 4 drops in the fifth cup)
- Using a stirring utensil, mix milk well to achieve an even consistency

Once you have set up the five plastic cups with their respective concentrations of milk, you should have an increase of milky water as you move from left to right on the sky blue paper starting with clean water in the first cup. To best observe the sky color, have students view the cups from the top. Look straight down into the cup to view the new color of the blue circle at the bottom of the cup. To best view the visibility parameter, have them view the cup from the top as well as the side. Look through the cup/liquid and compare the different cups side by side.

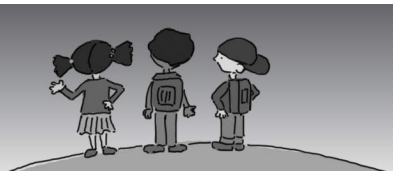
## Teacher's Notes

The amount of aerosols in our atmosphere affects our sky conditions. Most aerosols are too small to see but we can observe their impacts by observing and categorizing sky color and visibility.

When sunlight enters the atmosphere, it encounters air molecules (water vapor, oxygen, nitrogen, $CO_2$, and other trace gases) as well as other small particles, known as aerosols. Air molecules and aerosols both scatter the light; the color blue is scattered most effectively, causing the sky's blue color. In large enough concentrations, aerosols can change the appearance of the sky, affecting color and visibility. A perfectly clear sky will be deep blue in color and very clear in visibility. When many aerosols are suspended in the atmosphere, the color will look pale or milky and the visibility will become extremely hazy. Other atmospheric conditions can impact color and visibility. High relative humidity can also make the sky appear more milky. Visibility can also be impacted by fog. Some atmospheric conditions may even make the sky obscured, such as when there is a high level of ash from a forest fire.

An aerosol can be liquid or solid, mists and droplets, or tiny particles or material, such as ash. Aerosols can be anthropogenic (man-made) or naturally occurring. Man-made examples of aerosols include smoke from clearing land via burning. Naturally occurring examples of aerosols include ash from volcanic eruptions or from wildfires, pollen from plants, or dust blowing off enormous deserts like the Sahara. In this activity, drops of milk dispersed into a cup of water will be used to represent tiny particles of aerosols dispersed into the Earth's atmosphere.

Because of the amount and concentration of aerosols in the atmosphere can and does change, we observe these different sky conditions in the natural environment. In this activity, you will create an artificial test setup to demonstrate these different types of conditions. The amount of aerosols in the atmosphere affects our sky conditions. Most aerosols are too small to see but we can observe their impacts by observing and categorizing sky color and visibility. A low amount of aerosols in the atmosphere relates to unusually clear visibility and a deep blue sky color. Visibility is extremely hazy and sky color is milky when there are a lot of aerosols present in the atmosphere. Observing the parameters helps us to understand our



sky condition and make an educated guess about the amount of aerosols in our atmosphere.

**Sky Color Categories:** Deep Blue, Blue, Light Blue, Pale Blue, and Milky
**Visibility Categories:** Unusually Clear, Clear, Somewhat Hazy, Very Hazy, and Extremely Hazy

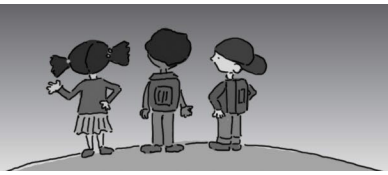
## What To Do and How To Do It

1. After reading the Elementary GLOBE book, *What's Up in the Atmosphere? Exploring Colors in the Sky*, and/or webstory, *Become an Atmosphere Observer*, talk to them about aerosols. The amount of aerosols in our atmosphere affects our sky conditions.
2. Tell the students that most aerosols are too small to see but we can observe their impacts by observing and categorizing sky color and visibility.
3. Review the sky color and visibility categories. Tell the students that they are going to do an experiment to help them become more familiar with the 5 classification categories for both daytime sky color and visibility.
4. Describe the activity to the students and tell the students that they will be placing increasing amounts of milk in each cup of water.
5. Ask the students to make a prediction. Have the students record their prediction on their activity sheet. What will happen to color and visibility as we increase the milk content? Ask them why they made this prediction.
6. If each student group is conducting the experiment, instruct them to follow the experimental setup, and place increasing amounts of milk in the cups.
7. Have each student observe color with the cups. Students should start with the first cup (clean, clear water) and work their way toward the right (most milk in the cups). They should look straight down into the cup to view the new color of the blue paper beneath the cup as the consistency changes from left to right. Have the students write down what they see.
8. Next, students should observe each cup from the side, looking through each cup of liquid and comparing the different cups side by side to assess visibility through the cup. Have the students write down what they see. If needed, place a common object behind each up such as a sticker.
9. Discuss as a class the pattern that they observe (the more aerosols that are present, the more milky the sky color becomes and visibility decreases).
10. Have a class discussion about the following ideas:

- What does the water and drops of milk represent in each cup?
- In this activity, how does the increase of milk affect the water's color and visibility?
- What do you think would happen if we added 10 drops of milk to one of the cups?
- The cup of water represents our atmosphere. What are some examples of these conditions in real life?
- What factors could cause changes in sky visibility?

## Adaptations for Younger and Older Students

With younger students, work together as a class to predict what will happen when more milk is added to the cups, and to compare the prediction and the observations. Older students can complete their activity sheets in small groups and discuss the comparison of prediction to observations among themselves. Older students could use a standardized object, like a pencil or sticker, to try to more objectively assess visibility through each cup of water.



## Further Investigations

- **Drawing Aerosol Concentrations:** Students that completed this activity should understand that drops of milk dispersed into a cup of water represent aerosols in their experiment. Students can replicate the drawings of Simon, Anita and Dennis found on page 24 of the storybook, *What's Up in the Atmosphere? Exploring Colors in the Sky*. Another example diagram can be found on the S'COOL website at: https://scool.larc.nasa.gov/lesson_plans/SkyCondActFULL2-2.pdf.
- **Look at Your Shadow:** The sky controls how your shadow appears. On a day when the sky is clear and deep blue, shadows appear dark and very sharply outlined. On a hazy day, shadows are fuzzy and not as dark. Children can see this for themselves when they go outdoors when the sun is not blocked by clouds. They can also notice the difference in how the ground under a tree looks on a clear blue day and a hazy day. On a clear day, the leaves form distinct, dark shadows on the ground. On a hazy day, the shadows are not as dark. Children can sketch their shadows on clear and hazy days to illustrate the effect of the sky.
- **Laser Measurements of Aerosols:** NASA's CALIPSO satellite lidar technology profiles our atmosphere and detect clouds and aerosols. Pulses of green light are sent from the satellite toward Earth's surface and the amount of light that is reflected back to the spacecraft is measured. Teachers can demonstrate this by using a green laser pointer, pointing down into the cups of water with "aerosols". Safety consideration: Laser pointers should never be pointed towards the eye. More CALIPSO activities can be found online, *CALIPSO Profile of the Atmosphere*: http://nasawavelength.org/resource/nw-000-000-002-234/.

# Why (Not) So Blue? Student Activity Sheet

Name: _____

When I add drops of milk to the water, this is what I think will happen:

_____

_____

_____

_____

When I add drops of milk to the water, this is what I see: