Mountain Weather: Mtn. Barriers

Focus Question(s):

How do the Rocky Mountains affect Colorado's weather?

You Will Need:

- Clear plastic container filled with room temperature water
- Bucket of rocks
- 1 cup hot water
- 1 cup cold water
- Thermos or coffee mug (optional)
- blue and red food coloring
- Mountain barriers worksheet
- Pen/ pencil

Learning Objectives:

Students will be able to:

- Explain how cold and warm air (or fronts) moves relative to one another.
- Understand the general movement of warm and cold fronts across the United States
- Understand how mountains act as a barrier to weather systems (wind and precipitation) and thus recognize why most of CO's precipitation stays on the western slope.

This fun experiment showcases how the Rocky Mountains effect the weather in Colorado, and begins to bring students an awareness of the larger weather patterns that effect the U.S. In this experiment, students will build their own "map of Colorado" using a rectangular bucket as the state and placing rocks inside to form the mountains. Once the material for the experiment are ready, students can begin watching the Mountain Barriers Experiment Video, which will teach them how to do the experiment. Alternatively, if you do not have access to all of the needed experiment materials, students can follow along with the experiment video, making their own hypothesis and observations as they watch the experiment unfold. Answers to the mountain barriers worksheet can be found at the end of this document.

Before Beginning Experiment:

- Print out a copy of the mountain barriers worksheet (or have it ready to fill out electronically)
- Boil a cup of hot water, add a few drops of red food coloring to it, and keep warm in a thermos or mug
- Fill a cup with cold water and a few drops of blue food coloring, and keep cold in the freezer
- Fill the clear plastic bucket about ½ full with room temperature water and place on a cleared off surface that you don't mind getting a little wet
- Set bucket of rocks, worksheet, and writing utensil next to bucket of water

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Further Information:

Notes: This can be a messy experiment, so be prepared to get a little wet. Depending on age/maturity of students, worksheets might not be a good idea. Instead of a worksheet, have kids focus on observations and, if available, write hypotheses/ observations/ conclusions on a whiteboard to see and discuss.

Helpful Background Information: This activity visually demonstrates how warm and cold air moves, cold air sinks—warm air rises. Furthermore, it demonstrates how warm and cold air (or fronts) responds to CO's mountains.

Cold air (or fronts) is dense. The air molecules stay closer together because of their low temperature (and thus low energy). Since cold air is dense it is heavy and tends to sink. It more easily gets trapped by CO's mountains, but air pushing into the area behind it can still force it up and over the mountains.

Warm air (or fronts) is less dense. The air molecules have greater temperature/more energy. Thus the individual air molecules are farther apart. Since warm air is less dense and thus less heavy, the air molecules tend to rise.

When air masses (cold or warm) run into large obstacles, such as a mountain, they are forced upward (ALSO KNOWN AS OROGRAPHIC UPLIFT). This lifting produces cooling (because of the lower pressure as you move up in altitude). Since warmer air can hold more water vapor than colder air, this cooling often causes water vapor in the air to condense into liquid water, creating clouds. If enough moisture exists, precipitation will drop on the windward side of the mountain range. This process creates a rain shadow on the leeward side of the mountains—warmer temperatures and less moisture. Since our prevailing winds of from the west, the western slope of the Rockies often get lots of snow and leave the greater Denver area in a rain shadow with little snow. However, when we receive wind from the south/east, the opposite can happen. This is common in the spring when the foothills/Golden is sometimes buried in wet storms.

For more information, check out these articles/ videos:

https://scijinks.gov/weather-map/

https://www.youtube.com/watch?v=iMu4dShS74w

Key Vocabulary:

- **Weather:** The state of the atmosphere at a place and time as regards heat, dryness, sunshine, wind, rain, etc
- **Rain Shadow:** A region having little rainfall because it is sheltered from prevailing rain-bearing winds by a range of hills or mountains.
- **Rocky Mountains:** The large mountain range running north to south across Colorado.
- **Warm Front:** The movement of a mass of warm air across a space, a high pressure system because the warm air floats higher above the ground.

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- **Cold Front:** The movement of a mass of cold air across a space, a low pressure system because the cold air remain close to the ground.
- **Precipitation:** Any form of water particles—liquid or solid—that falls from the atmosphere and reaches the ground.
- **Orographic Lift**: Horizontally moving air that is forced up along topographic barriers (the Rockies). Lifting produces cooling and eventually clouds if humidity exists.

Mountain Barriers Worksheet Answer Key

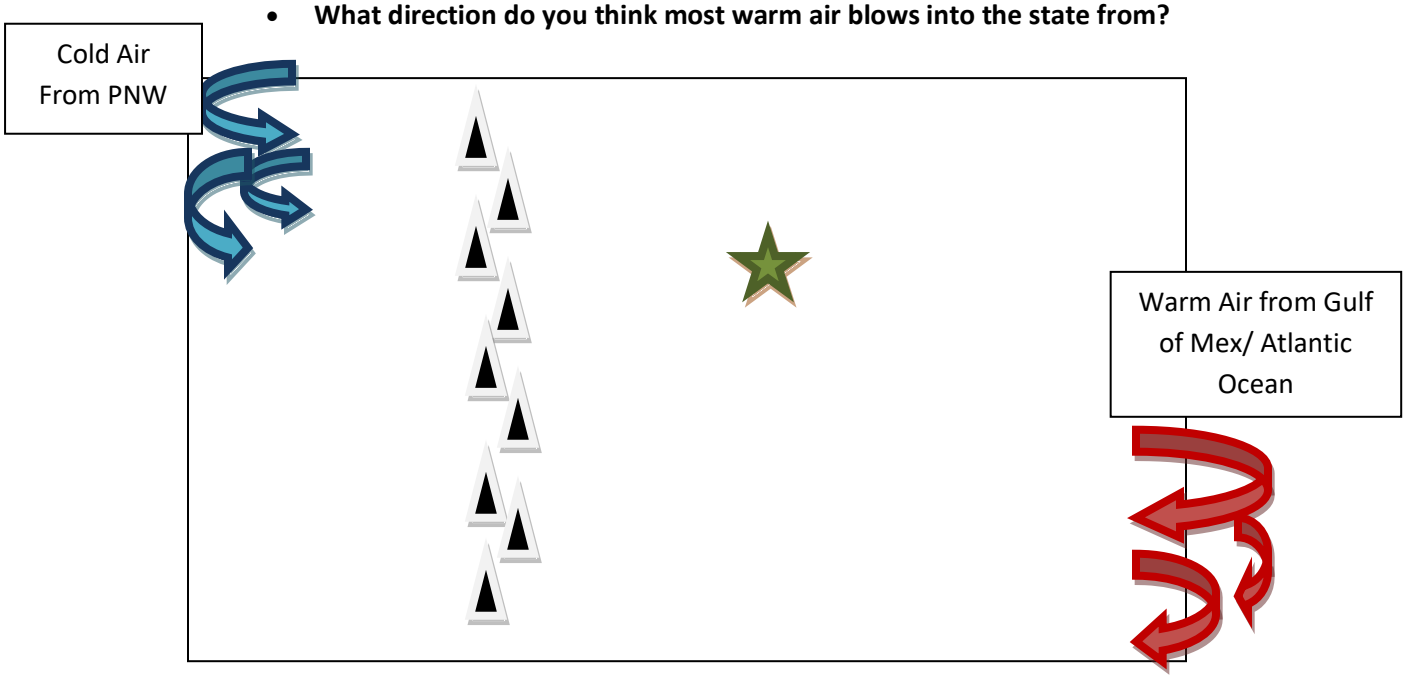
1. **What is weather?**

Snow, sun, rain. Daily changes in the atmosphere.

2. **What do you think influences our weather here in Denver?**

The Rocky Mountains!

3. **Label the state of Colorado with the following:**
   - **The Rocky Mountains**
   - **Denver**
   - **What direction do you think most cold air blows into the state from?**
   - **What direction do you think most warm air blows into the state from?**



4. **Make some hypotheses (your best guess):**
   - **What will happen when you add cold water to your model?**
     It will stay in a clump, low to the ground and get stuck behind the mountains, i.e. won't make it to Denver.
   - **What will happen when you add warm water to your model?**
     It will float higher in the model and diffuse out from where it's poured.

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5. **What actually happened to the cold and warm water?**
   The cold water floated in a clump from where it was poured and then was stopped by the mountains. The warm air floated at the surface and diffused out from where it was poured. Some moved over the mountains and pushed the cold air up and over the mountains, where it mixed together and turned purple.

6. **Based on the results of your experiment, can you add to your answer to question number 2? What influences the weather in Denver?**
The Rocky Mountains! They are a barrier that stops cold air, forces it to move up in elevation, drop its moisture, and then warm as it drops down in elevation and moves into Denver (leaving Denver in a rain shadow).