GRADE LEVEL: 5-8 | TIME REQUIREMENT: 2 HOURS

EARTH AND SPACE SCIENCE: WEATHER

1 READING | 1 ACTIVITY

INTRODUCTION

Weather is a core topic of upper elementary and middle school science. It also is a topic that allows you to revisit physical science concepts that underlie weather phenomena, such as the gas laws, solutions, and heat transfer.

Weather was certainly important to the military planners in World War II. For every invasion or large action in World War II, there were detailed weather forecasts made. Every flight crew went through detailed weather forecasts before taking off, and every ship had someone making or receiving forecasts of coming weather.

Weather is also something that students see and experience in their daily lives, which means that they can apply what they learn both immediately and constantly.

OBJECTIVE

The reading asks students to consider why and how we forecast weather. It introduces one of the most important weather forecasts in modern history—the forecast for D-Day in the English Channel and Normandy on June 6, 1944. The reading also asks them to apply skills of weather-map reading. Then students learn about and create simple versions of thermometers, barometers, and hygrometers. Each weather tool works in very unique ways due to the physical properties of materials.

STANDARDS

NGSS DCI PS1.A
Structure and Properties of Matter

NGSS DCI ESS2.D
Weather and Climate

NGSS SEP
Developing and Using Models

NGSS SEP
Constructing Explanations and Designing Solutions

NGSS CCC
Patterns

NGSS CCC
Energy and Matter

PERFORMANCE EXPECTATIONS

5-PS1-1
Develop a model to describe that matter is made of particles too small to be seen.

5-ESS2-1
Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

MS-PS1-4
Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-ESS2-5
Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

READINGS (1)

1. WHY WEATHER?

Description
This reading asks why weather is important and how it has made an impact on history. As students read ask: Why does weather matter? How can we predict the weather? What data do we need to predict the weather? Have students work in groups and use your preferred Kagan strategies or cooperative learning methods to organize productive student conversation.

ACTIVITIES (1)

1. WEATHER TOOLS

Description
This activity can be used in conjunction with the Why Weather reading as a way to introduce weather data collection. This lesson is a good example of how we can make measuring tools when we know the physical properties of materials. Students need to apply knowledge of what temperature, pressure, and humidity are; making the tools will help them remember.

Supplies
For all 3 tool-making activities, safety goggles or glasses are necessary

Thermometer
1 Clear small plastic bottle (too large and you'll use too much alcohol; a small 8-16 oz water bottle would work)
1 Clear plastic straw
1 Ruler
Rubbing alcohol, colored with food coloring (can be only 50 percent)
Clay
Dropper

Barometer
1 Empty plastic bottle (an empty 16-20 oz bottle will work)
1 Length of plastic tubing (you can use aquarium tubing)
Water, colored with food coloring
Clay
Ruler

Hygrometer
1 Metal can (can be a bean or coffee can)
Water
Thermometer
Ice

Instructions
Thermometer
Have the students mark the straw in half-centimeter increments with the pen and ruler. Next, they will fill the bottle one-fourth full with alcohol, put the straw in the bottle, and seal the straw in the bottle's mouth with clay. The seal needs to be tight so that air can't get in or out of the bottle. The straw also needs to be straight and in the center of the bottle's mouth. Have the students fill the straw with alcohol so that the level in the straw is just a couple of centimeters above that in the bottle. This step is possible because the air in the bottle is trapped and pushing back against the added liquid in the straw.

Have the students hold the bottle in their hands or put the bottle in a sunny spot to see if the temperature changes. Finally, to calibrate the thermometer, have the students record the marks of the alcohol level at different temperatures.

Barometer
Have the students mark the tubing in half-centimeter increments with the pen and ruler. Then have them fill the bottle halfway up with water and put the tubing in the bottle. Students will need to make sure that the tubing is not pressed against the bottom of the bottle so that it will be able to suck the water up until it is a few centimeters above the level of water in the bottle. Finally they will seal the tube with clay.

Because the air pressure outside won't change quickly, students won't see changes in the barometer quickly. Students can watch how the level changes daily and correlate it with the weather.

Hygrometer
Have students fill the can about halfway up with water and place the thermometer in the can. They should watch the thermometer until it stabilizes (just a couple of minutes) and then observe if there is any condensation on the outside of the can. If not, add a couple of ice cubes to the water and stir it, watching until the temperature stabilizes. Is there any condensation on the outside of the can? Repeat as necessary until condensation is seen. The temperature where condensation occurs is the dew point.

Generally, the humidity will be below 50 percent in a well-regulated indoor environment. If the hygrometer is taken outside into a more humid place, it may produce better results.

READING
WHY WEATHER?

WHY ARE PEOPLE ALWAYS TALKING ABOUT THE WEATHER? DOES IT REALLY MATTER?

The weather forecast for a certain day in 1944 made a big difference and may have saved thousands of lives. That day is called D-Day. The Allies had to consider many variables when they were making plans to invade France and take it back from Germany in spring of 1944.

Because the Allies were landing most of the soldiers by boat, the tide had to be low so that they could see and avoid explosive mines and deadly obstacles. The Allies also planned to use paratroopers, so the moon had to be full so that the airplanes could navigate at night and the paratroopers would be able to see when they got to the ground. There would be only one week in early June where the tide was low and the moon full. If the invasion came much later, the Germans might notice, with spies and airplane reconnaissance, the large numbers of ships and troops that had assembled in southern England. If the invasion did not take place in early June, all could be lost.

In early June, the weather on the English Channel (the narrow strip of water that separates England from France and the rest of Europe) is often very stormy. Captain James Stagg was a British officer in the Royal Air Force. Stagg was in charge of assembling weather forecasts from all the different branches of service involved in the planning of the invasion, and Stagg had the responsibility to tell General Eisenhower, the US commander in charge of the operation, when the weather conditions would be favorable. Eisenhower and his team had initially chosen June 5 for D-Day. Allied troops were to be carried in landing craft from ships offshore to the beach. These landing craft were small, and rough seas and bad weather would have made it very hard for them to reach the shore. Many of them would have sunk if the weather were too stormy.

The Allies had weather stations in Canada, Greenland, and Iceland to collect data to support forecasts of weather. Since weather generally moves from West to East in the Northern Hemisphere, the open Atlantic is a challenge for gathering weather data. In the United States, for example, we can follow weather systems from the western to the eastern states easily. Since the Germans had many stations across Europe but very few in the Atlantic, they had an even harder time predicting weather. Today, satellites give us a huge amount of data that makes weather forecasting much more accurate.

Data from their weather stations told the Allies and their meteorologists that a series of low-pressure systems and fronts, each bringing stormy weather, were lined up across the Atlantic Ocean. One of these was arriving over England on June 3 and 4. US meteorologists were recommending that the invasion go ahead on June 5. However, British meteorologists insisted that the weather would be too severe on June 5 and that the invasion should be postponed. Some suggested that the earliest possible date would be around June 16. That option seemed too late for moon-tide alignment and for keeping the date secret. A few meteorologists from England suggested that there would be a short period of calm weather between the storms, and that June 6 could be the only window of opportunity for the next two weeks.

In his report to General Eisenhower, Captain Stagg recommended setting June 6 as D-Day, the launch day of the invasion. Eisenhower accepted that recommendation. He trusted that the British meteorologists, who had more experience predicting the weather coming across England from the Atlantic than the Americans, were making a more accurate forecast.

The Germans saw the storms in the Atlantic, but didn't have enough data on their size or exact location. Because of this lack of data, they thought it would be impossible for the Allies to invade before the middle of June. Based on this forecast, they actually moved some troops away from the coast of France and thus were less prepared for the invasion.

In the end, the weather on June 5 was terrible. The seas were rough and the winds high. Conditions were still a bit rough on June 6, but the landing craft were able to get through the waves to shore, and the planes were able to insert their airborne paratroopers from the sky. The Allies built a temporary floating port starting June 7. This port allowed them to put ashore many trucks, tanks, and supplies. Two weeks later, on the date that some officers suggested for the invasion, another large storm came through, and the temporary port was destroyed. Had the Allies not had Staggs' expert advice and good weather data, the effort might have failed.

A radio weatherman from the Weather Squadron in Italy, 1944.
(Image: The National WWII Museum, 2002.337.038.)

NAME: **DATE:**

1. Look at the WWII weather maps in the reading. What symbols represent low pressure systems?

2. What symbols represent weather fronts?

3. Do we use similar maps today? What is similar and what is different about how forecasts are presented today?

4. What data do you need to be able to forecast weather?

5. What innovations since World War II have improved our ability to forecast weather?