Activity 2.4 Twister in a Bottle

Teacher Background

Tornadoes are the most intensely violent of all Earth's storms. They can uproot trees and fling them hundreds of yards in the air. Buildings can literally explode. Automobiles, buses and houses can be lifted in their entirety and transported many feet. Yet people (*very* lucky people, it turns out!) have also been lifted off the ground and then gently lowered back to earth unharmed.

While tornadoes are extremely powerful they are usually small. The average width of a tornado is half a kilometer, 300 to 400 yards, but some can be as broad as a mile, about 1.5 kms. Most tornadoes last only a few minutes and only stay on the ground for a path of a few miles. But on May 26, 1917, a family of 4-8 individual tornadoes traveling on a similar path touched down and traveled 293 miles, taking 7 hours and 20 minutes! (This is sometimes improperly identified as one single, very long-lived tornado, since the concept of families of tornadoes was only developed later.) The record tornado track seems to be the Tri-State Tornado of March 18, 1925, which traveled 219 miles.

A tornado is a violently rotating column of air. The devastating force of the tornado depends on the speed with which the air turns. Scientists still don't know if a tornado grows from the clouds down or from the ground up, but as the spinning air extends between clouds and ground, low pressure causes water vapor to condense, allowing us to observe the funnel shape of the tornado. When it touches the ground and begins to take up dirt, rocks and other debris, the tornado often turns black. This hands-on Activity uses different physics to create a distinctive vortex shape, but we think capturing a "twister in a bottle" may well fascinate some students enough that they'll return to the website or the videos to explore the realities of tornadoes with educated eyes and more curious minds.

Although scientists aren't sure exactly what triggers this violent rotation, they do know what general conditions can spawn tornadoes. Many follow the path of severe thunderstorms. (Hurricanes can also spawn tornadoes, especially when they make landfall. NOAA researchers believe they encountered an intense vortex—a tornado—as they penetrated the eye of Hurricane Hugo: see the link from Frank Mark's BIOgraphy in the WHO section of the LIVE FROM THE STORM website for a gripping account of that flight.) When cool, dry air meets warm, moist air, conditions are ripe for thunderstorms. With just the right combination of masses of air passing over or across each other, a "mesocyclone" can begin to generate the intense updrafts and downdrafts that result in tornadoes. (See the Interactive Animation in the WHY section of the website.) However researchers are still not able to predict exactly what conditions will definitively result in tornadoes. They worry that without this scientific breakthrough, false alarms may make some residents of "Tornado Alley" prone to ignoring warnings that turn out to be correct.

The US experiences more tornadoes than any other country in the world—though Bangladesh and India could certainly be contenders if there were better records of their violent weather. Every American state has experienced the devastating force of tornadoes, but the majority occur on the Great Plains from Texas north through Kansas (as in "The Wizard of Oz") and Oklahoma (as in the more recent movie "Twister") where cooler air from across the Rockies is in frequent

battle with warmer tropical air pushing up from the Gulf. (See WHERE and WHEN for more on the geography and seasonality of tornadoes.)

Objectives
Students will observe the shape and motion of a tornado by simulating a funnel cloud in a bottle.
Students will review current safety precautions in the presence of tornado watches and warnings.
Students will observe the devastating potential of tornadoes. (Video and website)

Vocabulary
mesocyclone
vortex

Materials
two 2-liter plastic bottles with caps (with a 1/2 inch matching hole) or a tornado tube purchased from a science supply store
small pieces of paper, sand or soil, glitter, drop of dish soap or other small objects
water
towels to wipe up
Activity 2.4 Student Worksheet
WEATHERlogs

LFSTORM Standards Correlation sheet (for teacher reference)

Engage
Begin by showing video of a tornado, such as that found in the Teacher Resource Video (as part of Tim McCollum's Doppler radar demonstration) or one of the LIVE FROM THE STORM programs. Discuss what students saw here or in the many "weather disaster" shows appearing on TV. Ask students if anyone has ever experienced a tornado. Have them describe their experiences. Discuss the safety procedures that should be followed when they are under a tornado watch or warning. Before or after the Activity, go online and read some of the eyewitness accounts and BIOgraphies from members of the NOAA "Vortex" study, headed by Erik Rasmussen, the most serious, long-term up-close study of tornadoes to date—but with the explicit warning that they, the students, should NEVER go outside to observe or chase a tornado.

Important note: please inform students that based on the most recent experiences in the May 3, 1999 Oklahoma City tornadoes, NOAA researchers are counseling people NOT to take shelter under highway overpasses when tornadoes approach. Two people died in this way on May 3. They may have seen a TV program about an earlier storm in which some lucky people happened to survive because in that case a much weaker tornado came close but did not directly hit them. The official advice now is: "Use the highway to keep going and get away: do not take shelter under an overpass!"

Explain/Explore
Procedure
Distribute Worksheet and review procedure with students. Specify if they will be using tornado tubes or the "hole in bottle cap" method. Have students implement the Activity, circulating among the groups to ensure safety procedures are being followed, answering questions and generally encouraging them as the fabled "guide on the side." Be sure that seals are tight and that students realize that repeated accidents in which bottles fly apart spraying other students are not "accidents"! More importantly make sure students are recording observations in WEATHERlogs.

As you circulate (sic), ensure they understand the different physics involved in this model tornado (water, gravity and air bubbles) and in real tornadoes (low pressure, air in rapid rotation, etc.) In a real life tornado, air is spinning up and into the storm with the largest debris being lifted 100-150 feet (30-45 meters) off the ground. That's why people call them "giant vacuum cleaners." Have each team place a different substance in their bottle (sand, paper punches, glitter etc.) and then have each group show the class what happens. (Note that in the video they will also be able to see debris—simulated here by the small pieces of material—in motion. Tornado researchers actually use video of objects being whirled around in a tornado to measure wind speed. Sorry, despite what students might have seen in "Twister," flying cows are *unlikely* and if they ever did fly, they would not be mooing. According to NSSL experts, the pressure would make it hard to vocalize!

Encourage students to create their tornadoes over and over again. They will continue to observe new things about funnel clouds, vortices, and the differential effects of mass (in the "glitter debris, etc.) each time.

Expand/Adapt/Connect
Show the videos again. Have students compare what they see in the video to what they just created. They can use their model to help explain their comparisons. Have them brainstorm and discuss the differences between real life tornadoes and these twisters in bottles.

Bring in an eyewitness account of a tornado either from a newspaper or read one of the professional storm chaser accounts you can find online at the LIVE FROM THE STORM site.

Go online and research tornadoes. (Start with our website and the URLs below.) Where is "Tornado Alley" located? (WHERE) What time of the year are tornadoes most likely to develop? What time of year are tornadoes most likely to occur in *your* area? (WHEN)

Prepare a tornado safety plan for your family.

Use this Activity and the Emergency Preparedness information covered in it as possible content for "The Great Emergency Preparedness PSA Contest." You can find full information online at the LIVE FROM THE STORM site in the CLASSROOM CONNECTION section of the EDUCATORS section.

Suggested URLs

http://www.nssl.noaa.gov/edu/tornado/
Authoritative Q&A about tornadoes from the National Severe Storms Lab, featured in LFSTORM program 2.

http://www.fema.gov/library/tornadof.htm
FEMA Tornado Fact Sheet: what to have on hand and what to do in the case of a tornado.

http://www.learner.org/exhibits/weather/act_tornado/
Interactive online activity where students look at pictures of the sky to determine whether a tornado is possible.