Cooking Up a Storm

Compelling Question	**What ingredients are needed to form clouds and severe storms?**
Academic Standards	**SOCIAL STUDIES 4.2.4 Describe how physical processes of the Earth's surface impact humans and their environment.** Disciplinary Core Idea: Differences in pressure caused by the uneven heating of the Earth by the Sun creates wind, which is a major reason why the Earth experiences different types of weather. **SCIENCE 5.ESS2.1 Develop a model to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.** Disciplinary Core Idea: Wind and clouds in the atmosphere interact with the Earth's surface (land and bodies of water), which impacts the weather. **SCIENCE 6.ESS2.4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.** Disciplinary Core Idea: Water continually cycles among land, water, and the atmosphere via evaporation, condensation, and precipitation (among other processes).
Staging the Question	Weather stems from forces invisible to the naked eye. These forces influence the formation of wind, clouds, and storms. How can we prove these forces exist?

Supporting Question 1

Why are some parts of the Earth warmer than others?

Formative Performance Task 1

Supplies needed: Flashlight and beach ball/basketball/globe.

Students will demonstrate how the curvature of the Earth impacts the angle the Sun's rays impact the Earth (more direct - more rays from the Sun (warmer), less direct - fewer rays from the Sun (cooler))

Featured Sources 1

OU CIWRO Science Class: Cooking Up a Storm, mark 0-3:42, www.youtube.com/watch?v=yzvN2t_-WWE

Supporting Question 2

Why is it colder at the top of a mountain than at sea level when high altitudes are closer to the sun?

Formative Performance Task 2

Supplies needed: Paper, ruler, pencil, and red crayon/marker.

Students will create a model illustrating how pressure impacts temperature

Featured Sources 2

See exercise on Answer 1: http:/scienceline.ucsb.edu/getkey.php?key=4561

Supporting Question 3

How does the movement of air impact the weather?

Formative Performance Task 3

Supplies needed: Hair dryer, ping pong ball, toilet paper tube and paper towel tube.

Students will simulate an updraft to show how the upward movement of air creates clouds, and clouds can produce different types of precipitation (for example: rain, snow, sleet, and hail)

Featured Sources 3

OU CIWRO Science Class: Cooking Up a Storm, mark 3:43-25:39, www.youtube.com/watch?v=yzvN2t_-WWE

Summative Performance Task

Argument

Supplies needed: Styrofoam/paper cup and lid, balloon, rubber bands, and mini pom pom balls or paper wads.

Students will create air cannons to demonstrate the power of air/wind and how it impacts objects

Students: Cut out the bottom of the Styrofoam cup. Blow up the balloon slightly to prep the balloon for assembly. Cut off the neck of the balloon. Stretch the balloon over the bottom of the cup and secure with a rubber band. If you don't have a opened dome lid for the cup, make your own lid (just need to create an opening at the top of the cup). The opening should be approximately half the diameter of the bottom of the cup. You can make this lid by cutting a hole in paper/cardstock and attaching it to the top of the cup with duct tape and/or a rubber band. Pull back on the balloon and release it to expel a torus vortex of air from the air cannon. Can you feel the blast of air on your skin? What effect does it have on wads of paper or fluffy pom pom balls on a table?

Argument (Continued)

OU CIWRO Science Class: Cooking Up a Storm, mark 25:39-32:58, www.youtube.com/watch?v=yzvN2t_-WWE
https://www.scienceworld.ca/resource/air-cannon/ https://www.youtube.com/watch?v=fverM_ZHOIs

Extension (Optional)

Fill the Styrofoam cup with fog from a mini fog machine and release air from the cannon.

Students will be able to physically see the movement of air (it was previously invisible without the fog)

Taking Informed Action (Optional)

The National Oceanic and Atmospheric Administration (NOAA)'s Weather-Ready Nation initiative is about building community resilience in the face of increasing vulnerability to extreme weather and water events. As part of the Weather-Ready Nation initiative, NOAA, along with partners such as the Federal Emergency Management Agency (FEMA), wants to motivate individuals and communities to take actions that will prepare them in the event of a weather disaster and to share their preparedness steps with others. These actions can save lives anywhere - at home, in schools, and in the workplace before tornadoes, hurricanes, and other extreme types of weather strike.

However, NOAA and its partners can't do it alone. A key member of the team is the public. That is why we are encouraging everyone to do their part. We ask everyone to "Be a Force of Nature."

Be a Force of Nature by knowing your risk, taking action and being an example in your community.

Students will create a weather preparedness kit (https://www.ready.gov/kit) and share their preparedness plans with their classmates and families to help make everyone Weather Ready

https://www.weather.gov/wrn/force

Teacher Background Sheet

The forces that determine our weather are often invisible to the naked eye. First, we must consider the heat energy (radiation) exuded by the Sun - our “starter” in the meteorological kitchen. Much like putting a casserole in either the front and back portions of an oven, the Earth (land and water) is heated unevenly by the Sun. Near the Equator, the Sun's rays are more direct, while at the poles, the Sun's rays are less direct. This explains why the climate is warmer in equatorial regions compared to polar regions.

Have you ever noticed that the air temperature decreases as you go higher in the atmosphere (especially if you've been in an airplane or hiked up a tall mountain)? The Sun actually heats up the ground - not the atmosphere - and the ground absorbs the heat and releases/radiates the heat outward into the atmosphere. You've probably experienced how hot the ground can be if you've stood on a blacktop parking lot or on a sandy beach on a really hot, summer day! Have you stayed at the beach all day and into the night before? Ever notice that the water seems warmer at night? It takes water a long time to heat up, but it holds on to that heat for a long time! The land can heat up really quickly, but it also loses that heat just as fast.

Because the Earth (land and water) heats up and cools off unevenly, we have parts of the Earth that have lots of air molecules (high pressure) and parts that don't have as many air molecules (low pressure). The air is actually pressing down on us every day! At sea level, the weight of the air above the ground is 14.7 pounds per square inch. That means there is almost 15 pounds of invisible pressure on just one square inch of ground! High pressure (H) causes air to diverge (air molecules are racing away toward areas with less air molecules), producing clear skies and calm conditions. High pressure often brings high daytime temperatures, low nighttime temperatures, and dry weather. Low pressure (L) causes air to converge/come together (air molecules coming in from areas with high pressure (more air molecules)). Low pressure often brings cloudy skies, windy conditions, and precipitation. The Earth is constantly trying to keep things equal (in equilibrium), so the movement of air molecules from high pressure (more air molecules) to low pressure (less air molecules) creates the wind, which is the main driver for our weather. And just like your favorite sourdough bread - the starter (the Sun) made it all possible!

So we have our starter, but what other ingredients are needed to produce the rise we need to arrive at our masterpiece? When air molecules converge/come together (where we have low pressure), it forces air upward. As the air rises, it cools and condenses to form clouds. Moisture in the atmosphere and lift were necessary to create these clouds. However, if you add two other ingredients, things get a bit more interesting. Think of a hot air balloo. A hot air balloon rises when the operator pulls on the chain to release heat inside the balloon. When this happens, the air inside the balloon is warmer than its surroundings, so the balloon begins to rise. On days when we anticipate that severe weather is possible, it is typically because we notice that the atmosphere is unstable. The atmosphere is unstable when air can freely rise (it's warmer than it's surroundings) without anything stopping its upward movement. We've achieved the rise we need to form some big clouds that can produce lightning, rain, and hail.

Teacher Background Sheet (continued)

We're just missing one last ingredient, the one that really sets this recipe apart. Think of a pinwheel. When you blow air at the top of the pinwheel, it begins to spin rapidly. It spins because the wind at the top of the pinwheel is moving faster than at the bottom. When the wind changes speed and direction with height, it creates spinning in the atmosphere called wind shear. Wind shear is the ingredient that separates a regular thunderstorm from a supercell thunderstorm - which can produce tornadoes. A supercell thunderstorm has a rotating column of air (created by wind shear) called the mesocyclone, and this is the feature that can lead to tornadoes forming. Our masterpiece is complete!

The questions and activities outlined here will introduce your students to the concepts of the Sun's role in creating the weather we experience on Earth, high and low pressure, wind, and the power of air not only to create clouds, but also some of the severe weather that we can experience. A supporting activity challenges students to prepare for hazardous weather by assembling a weather preparedness kit and sharing their safety plans with their classmates and families.

Suggested lesson time: Three 50-minute periods

Day 1: Compelling Question, Supporting Question 1, Supporting Question

Day 2: Review of Previous Questions, Suppotting Question 3, Introduction of Project

Day 3: Summative Performance Task