Whirling Weather

Compelling Question	**What causes weather to spin, and how does spinning weather affect people?**
Academic Standards	**SOCIAL STUDIES 4.2.4 Describe how physical processes of the Earth's surface impact humans and their environment.** A. Identify and describe the different climates in the United States using maps, globes, and graphs. B. Explain how climate and natural processes including floods, wind, and storms impact how we live **SCIENCE 5.ESS2.1 Develop a model to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.** Disciplinary Core Ideas: • Earth's major systems are the geosphere, hydrosphere, atmosphere, and biosphere. • These systems interact in multiple ways to affect Earth's surface materials and processes. • The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. • Winds and clouds in the atmosphere interact with landforms to determine patterns of weather.
Staging the Question	Tornadoes, hurricanes, and cyclones can develop into the Earth's most violent storms. All of these phenomena form in the air (atmosphere), spin across land (geosphere) or water (hydrosphere), and affect living things (biosphere).

Supporting Question 1

What does the Earth's spin suggest about the spin of severe storms?

Formative Performance Task 1

Supplies needed: Clay, pencil/stick, Handouts 1 & 2, and colored pencils/pens.

Students will create their own model of Earth and observe the Coriolis force from different perspectives.

Featured Sources 1

OU CIWRO Science Class: Putting a spin on things - Whirling Weather, mark 0:00-6:20: www.youtube.com/watch?v=ThlcNspdD-s&t=6s

Supporting Question 2

What causes air to move in the first place? What is meant by the term "an ocean of air?"

Formative Performance Task 2

Supplies needed: Handouts 3 & 4, colored pencils/pens, short cardboard tube (toilet paper core).

Students will investigate “pressure gradient force” in the atmosphere by observing a disturbance to a pan of milk. Students will draw a map of air circulation around a low pressure system (cyclone).

Featured Sources 2

OU CIWRO Science Class: Putting a spin on things - Whirling Weather, mark 6:21-22:15: www.youtube.com/watch?v=ThlcNspdD-s&t=6s

Supporting Question 3

How do scientists assess the damage of a tornado?

Formative Performance Task 3

Supplies needed: Sink and drain stopper, and parsley flakes/similar.

Students will discern damage to houses as rated on the Enhanced Fujita (EF) Scale. Students will model conservation of angular momentum.

Featured Sources 3

Students will discuss implications of loss of life and damage to property due to storms.

OU CIWRO Science Class: Putting a spin on things - Whirling Weather, mark 22:16-35:29: www.youtube.com/

Summative Performance Task

Argument

Supplies needed: Poster paper, markers

Students will work in pairs to create a poster detailing a major storm (Moore tornado, Hurricane Katrina, etc.). They will answer: How did the spinning weather form? What was the impact on life and property?

Interactive internet resources for maps, graphs, statistics:
https://www.ncei.noaa.gov/access/monitoring/tornadoes/

NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2022). https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73

Extension (Optional)

Students will demonstrate the Coriolis force on a playground. Ask the students to spin the merry-go-round from left to right (counterclockwise viewed from above) to mimic what we experience of the Earth's rotation in the Northern Hemisphere. Two students will sit on opposite sides of a spinning merry-go-round and attempt to throw the ball at one another. Students will explain why the ball (wind) follows a curved path while on a rotating structure (Earth).

Students who are on the merry-go-round will see the ball curve, while the students who aren't on the merry-go-round will see the ball going straight. Likewise, if we weren't on a spinning globe, the wind would go straight. Because we are on a spinning globe, the wind curves.

Taking Informed Action (Optional)

Students will contact their local emergency management agency, Red Cross, United Way or Salvation Army to find out more how to help people displaced by severe storms in their area.

Teacher Background Sheet

According to the National Oceanic and Atmospheric Administration (NOAA), about 1,200 tornadoes are recorded across the United States each year.[1] Many of those are in Oklahoma. In 2022 (as of July 11), there have been nine weather/climate disaster events with losses exceeding $1 billion each to affect the United States. In addition to drought and severe storms, these events included two major tornado events. The impact of storms to humans is significant. In 2017, the economic impact of tropical cyclones alone was $315 billion in the United States.[2]

Spinning weather makes up some of the most destructive climatic events, but where does spinning weather come from? Weather systems, which can take up to weeks to form, are impacted by the Coriolis force – an effect whereby a mass moving in a rotating system experiences a force acting perpendicular to the direction of motion and to the axis of rotation. On Earth, the effect tends to deflect moving objects to the right in the Northern Hemisphere and to the left in the Southern Hemisphere, and it is important in the formation of cyclonic weather systems.

In the CIWRO Science Class video, "Whirling Weather," research scientist Nathan Dahl demonstrates how to create a model of the Earth to observe the rotation on the Earth's axis. Using handouts, students can experience the **Coriolis force** by drawing lines while rotating the paper. Next, Dahl explains low-pressure systems in the atmosphere and how the Coriolis force affects wind direction. **Air pressure**, **waves** and **pressure gradient force** are illustrated using diagrams and a tray of sloshing milk. Students can then draw their own low-pressure systems and cyclones on the handouts provided.

The video shows how hurricanes, cyclones and typhoons are formed and examines the differences of rotation in Hurricane Katrina (Northern Hemisphere) and Cyclone Ilsa (Southern Hemisphere). Then the video examines cyclones on land: tornadoes. The video shows examples of house damage from tornadoes ranging from EF-0 to EF-5.

Dahl demonstrates **conservation of angular momentum** in a variety of ways, including spinning in place and draining a sink of swirled water. This effect is important in understanding how wind speed in supercell storms can increase and produce tornadoes.

Suggested lesson time: Three 50-minute periods

Day 1: Compelling Question, Supporting Question 1, Supporting Question 2

Day 2: Supporting Question 3, Introduction of Project

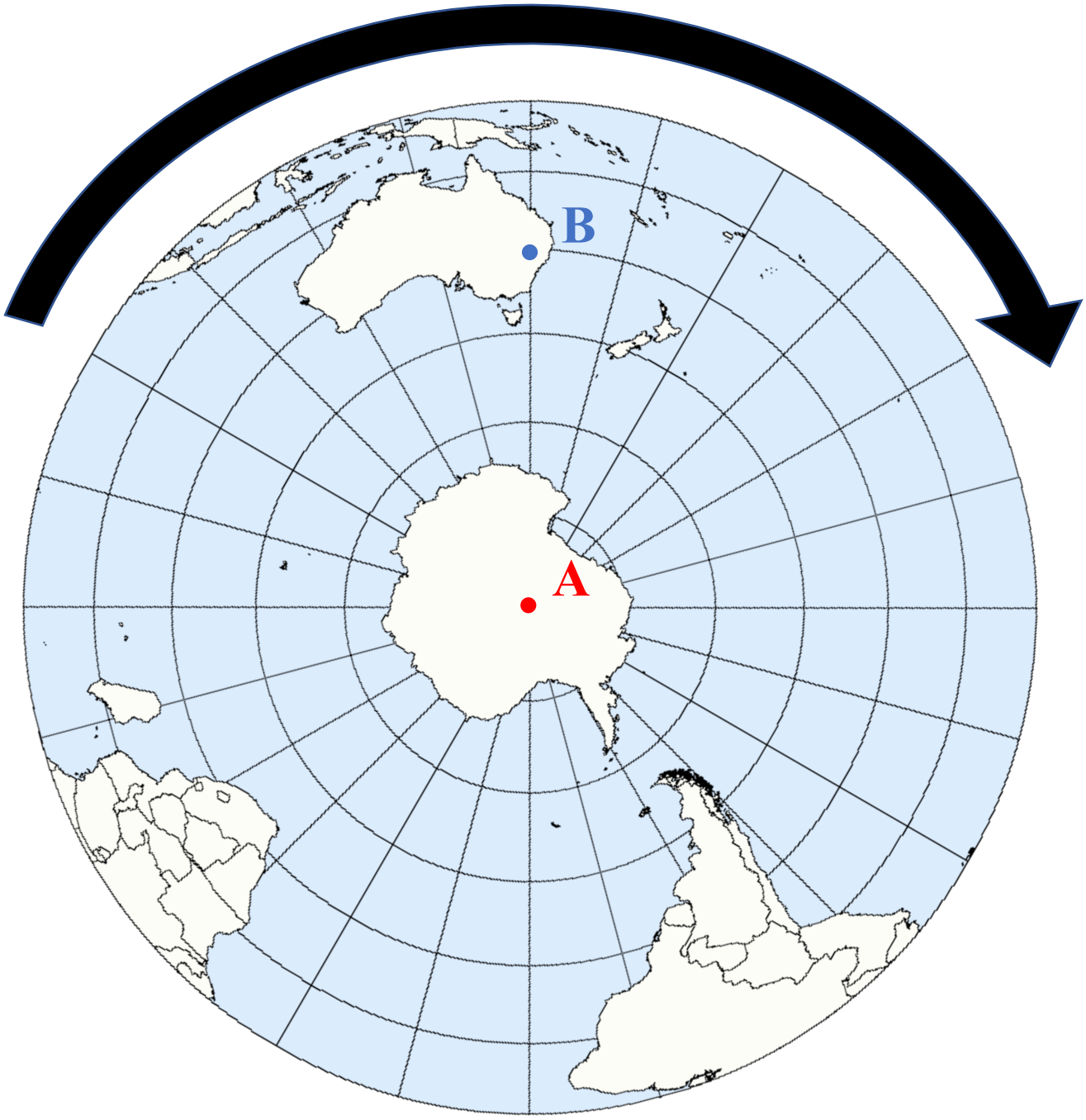
Day 3: Research Poster Project

[1] https://www.ncei.noaa.gov/access/monitoring/tornadoes/

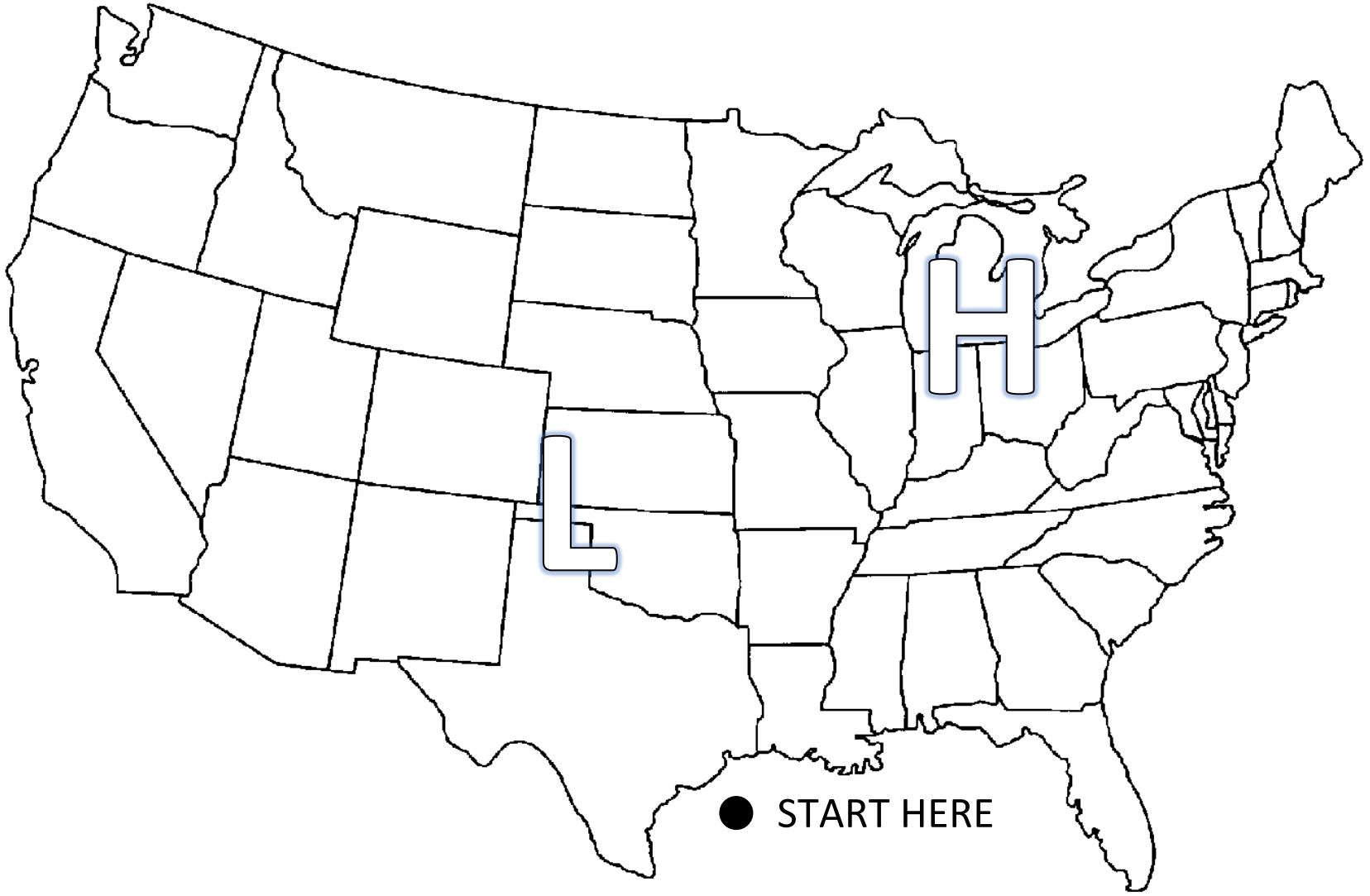
[2] NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2022). https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73

Handout 1 (NORTH)

Handout 2 (SOUTH)



Handout 3



HANDOUT 4