

Shifting Winds - Teacher Guide



A wind turbine at the National Wind Technology Center south of Boulder, Colorado. Credit: CIRES

Setting the Stage

At the foot of the Rocky Mountains, strong windstorms are a common weather event. Scientists have been tracking windstorms and are trying to answer the question “Are wind patterns changing as the climate warms?” The answer may lead to better communication to the public about changing conditions and hazardous wind storm events.

Lesson Overview

Lesson 1 – (60 minutes) Why does wind matter?

Access students’ prior knowledge of strong winds and examine local wind hazards. Students then analyze seasonal wind data and apply their knowledge to explain the seasonality.

Lesson 2 – (60 minutes) Is it getting windier?

Students look at how wind patterns are changing over time, then create a public-facing infographic for weather warnings based on changing local wind conditions.

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Instructional Overview	
Grade Level	Middle School
Instructional Time	120 minutes (<i>total time needed</i>)
Unit Driving Question	How are wind patterns changing over time?
Anchoring Phenomenon	Damaging windstorms at the foot of the Rocky Mountains in Boulder, CO and surrounding areas.
Building Toward	NGSS ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates CDE: Earth and Space Science: 7. Complex interactions determine local weather patterns and influence climate.
Three Dimensions	Science and Engineering Practices: - Analyzing and Interpreting Data Disciplinary Core Ideas: - Weather and Climate are influenced by interactions involving sunlight, the atmosphere, landforms. Crosscutting Concepts: - Cause and effect - Systems and system models
What Students Will Do	- Look for patterns in local wind speeds to explain what causes wind - Apply their knowledge of what causes wind to explain yearly, local wind storms - Create an infographic to explain how wind patterns are changing
Materials	☐ Lesson Slides ☐ Student Handouts ☐ Lesson 1 ☐ Lesson 2 ☐ Infographic Assignment & Example Infographics
Material Preparation	- Print student handouts or provide digital copies - Review presenter notes in slide deck
Vocabulary	<u>Wind</u>: Movement of air from areas of high pressure to areas of low pressure <u>Chinook winds</u>: Warm, dry winds that blow down the eastern slopes of the Rocky Mountains



Lesson 1 - Why does wind matter? (60 minutes)

Refer to slides 1-14 in the [slide deck](#). See presenter notes for additional information.

1. Trauma Informed Practice (10 minutes)
 - a. Provide a brief warning to students that you will be mentioning damaging winds and wildfires in this unit as a way to understand why wind conditions are important. Explain that talking about natural disasters can bring up a lot of emotions and that all emotions are okay.
 - b. Review the strategies students can use in class if they start to feel unsettled, anxious, or sad. Ask if there are any others they can think of to add to the slide. Students should choose one strategy to use today from the options and write it on a sticky note or piece of paper with their name on it. Collect the notes and read them quickly so you can anticipate which students may want to check in with you.
2. Wind Storms (15 minutes)
 - a. Warm-up: Facilitate a think-pair-share for the warm-up prompt, “Think back to a time you experienced a strong wind storm.” Be prepared to press students for additional details about what happened, the location, and the season. You should share details of your own experience with damaging winds. Look for patterns that emerge in student stories such as season, location, and how they know the wind was especially strong.
 - b. Explain that we are going to look at why and how scientists study wind. Today, we are going to talk about why wind matters to people and communities. Boulder, Colorado and the broader Front Range area have some of the highest peak wind speeds of any city in the US. NOAA, the National Oceanic and Atmospheric Association, has [records](#) of strong wind storms in Boulder, CO that go back about 45 years.
 - c. Students will examine several years from the wind records and record information on their student worksheet. Model for students how to do this using the year 1977.
3. Why is it so windy here? (30 minutes)
 - a. Facilitate a think-pair-share about where students think the windiest place in Colorado is. As students share their answers, highlight the commonalities in answers such as mountaintops or near mountains.
 - b. Explain to students that mountains are so windy because of downslope winds, which locally and throughout North America, west are called Chinook winds.
 - c. Ask students **when** the Chinook winds occur. Use their answers to prompt a display of the graph showing the number of wind storms per month in south Boulder, Colorado. Talk through the minimum, maximum, and patterns. Explain that windstorms are defined as winds that can create light damage such as tree branches breaking. Students should answer questions 1 through 5 in their student worksheet.



4. Exit Ticket (5 minutes)

- a. Tell students you will look at their answers to the exit question, student worksheet question #7. They are creating a rule for the relationship between winds and seasons. What might cause that?

Lesson 2 - Is it getting windier? (60 minutes)

Refer to slides 15 and on in the [slide deck](#). See presenter notes for additional information.

[Example infographics](#) are found in a separate slide deck

1. Warm-up and Data (15 minutes)

- a. As a warm-up, ask students to examine the data table of number of windstorms per year for the past 20 years. They should identify the extremes on student handout 2 (question #1)
- b. Students should use the data table (previous slide) to complete the graph on their worksheet (question #2)
- c. Facilitate a think-pair-share where students discuss if they can see any change in the number of windstorms over time, whether they are increasing, decreasing, or staying the same.
- d. Explain to students what a trend line is, that it is a straight line that can reveal relationships in scatter plots. Ask students to draw a trendline on their graphs. Be prepared to demonstrate this process for students. Note: Sample data and additional descriptions of trendlines are available in [CK12](#).
- e. Students should finish answering questions #9 on their student worksheet.

2. Infographic (45 minutes)

- a. Present what a red flag warning is. Explain to students that it is a combination of conditions that makes wildfire likely through high winds, relative humidity, and the amount of dried fuels like grasses.
- b. Present a graph of red flag warnings issued by the Boulder National Weather Service over time. Facilitate a turn and talk for students to look at patterns. Ask for a few students to explain the patterns they see.
- c. Facilitate a think-pair-share for students to discuss in pairs how it's possible that overall the number of red flag warnings increases while the number of wind storms per year is going down. This should lead to a discussion of how other conditions, such as temperature, humidity, drought and amount of fuel, lead to increased wildfire risk when associated with the windy season here.
- d. Build the connection between changing climate conditions locally and how humans have trouble perceiving changes because what we refer to as climate is actually long-term averages. One example is the month of April 2022. That month was a particularly windy spring month that occurred shortly after the Marshall Fire disaster where strong winds caused rapid spread of the fire. People locally felt



- anxious and on edge about wind. When Dr. Julie Lundquist and Serena Lipari-DiLeonardo looked into the data, it was the top 4 windiest Aprils of the last 20 years. But the longer term data didn't reveal an overall increase in windiness.
- e. Explain to students that they are going to create a public communication about changing winds. We will use the infographic medium, which is a visual way to communicate information and action steps.
 - f. Present the project outline and rubric to students. Be prepared to review the example infographics as a class and to show students how to use Canva or Google Slides to create an infographic. NOTE: Creating the infographic will take longer than 30 minutes. You should assign a due date for the completed infographic or allow for additional class time.

References and Additional Resources:

Colorado Climate Cener. (2023). *Colorado's Climate at a Glance*. Colorado State University.
<https://climate.colostate.edu/co_cag/index.html>

Denver/Boulder Weather Forecast office. (2022). *High winds and Marshall Fire on December, 30th 2021*. Weather.gov. <https://www.weather.gov/bou/HighWinds12_30_2021>

Iowa Environmental Mesonet Data. (2023). Iowa State University.
<https://mesonet.agron.iastate.edu/plotting/auto/?_wait=no&q=73&opt=state&station=BOU&state=CO&ugc_state=CO&ugc=COZ216&limit=no&phenomena=FW&significance=W&r=t&dpi=100&fmt=png>

Scott, M. (2022, January 7). *Wet, then dry extremes contributed to devastating Marshall Fire in Colorado*. Climate.gov.
<<https://www.climate.gov/news-features/event-tracker/wet-then-dry-extremes-contributed-devastating-marshall-fire-colorado>>

Simpkins, K. (2022, September 26). *It's been unusually windy this spring. here's Why you should care*. CU Boulder Today.
<<https://www.colorado.edu/today/2022/05/12/its-been-unusually-windy-spring-heres-why-you-should-care>>