



Data Puzzles

Weather vs. Climate: Extreme Cold in a Warming World?

No matter where you live in the United States, you're likely to experience temperatures each year that are surprisingly warm and shockingly cold! The **weather** on any given day can change and lead to extremely cold days, extremely warm days, but more likely just kind of normal days. Scientists keep track of temperatures throughout the year, over lots of years, to figure out what the **climate** (normal temperature) of a given place is like. These days, we hear a lot about how the climate is changing and global temperatures are rising, but when temperatures are below zero on a freezing cold winter day, it's hard to imagine the Earth is actually warming! This paradox, of feeling cold but being told that our Earth is warming is what led Dr. Jen Kay to study cold weather events and winter climate patterns in the United States.



Picture (above) from [NBC](#)

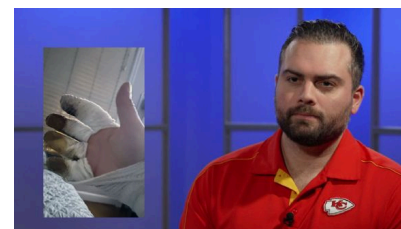
For example, on Jan 13, 2024, the Kansas City Chiefs and the Miami Dolphins squared off in what would be one of the coldest NFL games ever played. At kickoff, temperatures dipped to -4°F . However, the windchill temperature, which describes how cold it feels to human skin due to wind, was -27°F . Players huddled by heaters when on the sideline and on the field, condensed water vapor poured off their heads. At one point during the game, Kansas City quarterback Patrick Mahomes took a hit that actually cracked his helmet ([watch here](#)), something that likely happened because of the extreme cold that made the outer shell brittle. Superstar fan Taylor Swift stayed warm in her parka. However, thirteen other fans had to be hospitalized for frostbite with several requiring amputations.



Chiefs quarterback, Patrick Mahomes, has his helmet shatter. Picture from [People](#)



A bundled-up Taylor Swift high-fives Chief fans. Picture from [People](#)

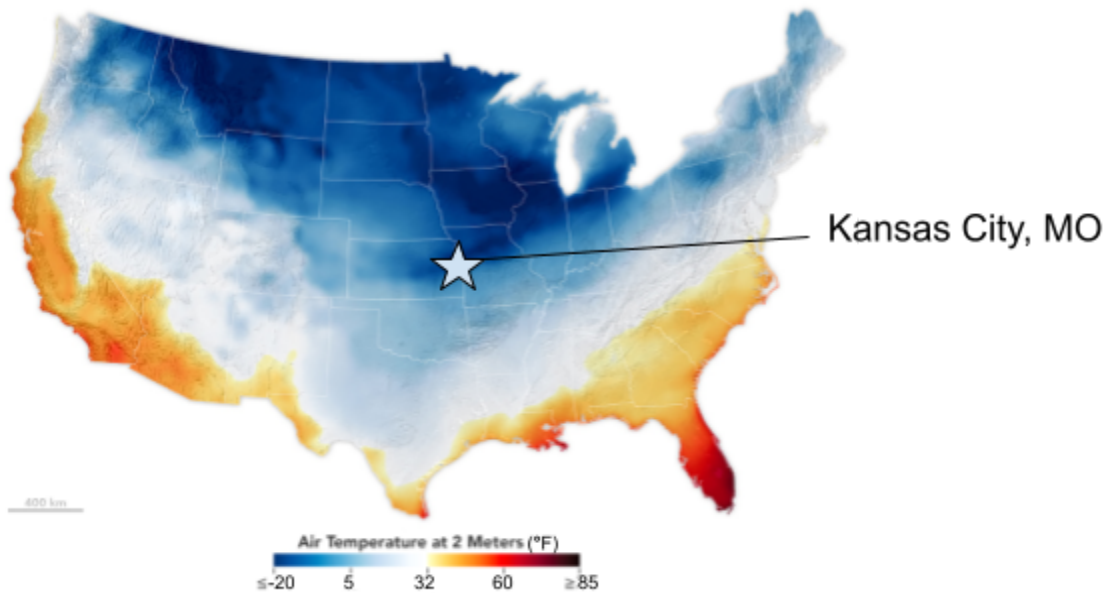


Chiefs fan spent three days in the hospital after suffering frostbite at the game. Picture from [ESPN](#).



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It turns out these cold temperatures weren't just impacting Kansas City. From January 13th, the night of the football game, through Jan 16th, much of the United States experienced subzero temperatures. Below is a map of air temperatures across the United States two days after the game, on January 15th. Events like this are examples of weather—short-term conditions that can change quickly.



The map above shows air temperatures at 2 meters (6.5 feet) above the ground at 7 a.m. Eastern Standard Time on January 15th, 2024. Image from [NASA](#). The temperatures on the scale have been converted into Fahrenheit and are approximate.

Stop and think: What was the air temperature in your community on January 15th, 2024?

A few days after its January 13th arrival, the cold air moved back into the Arctic and temperatures in Kansas City returned to “normal”, or what we might expect based on decades of weather observations. We refer to these “normal” temperatures for a particular region as its climate. Scientists are interested not just in single cold outbreaks, but in how the overall climate of the United States has changed over many decades. For example, Kansas City’s average winter temperature has been about 31°F since 1975—but scientists want to know: Is that typical of most U.S. cities? Are winters across the country warming, cooling, or becoming more variable?

Scientists like Dr. Jen Kay study weather events, like those causing cold Arctic air to move south, as well as long-term temperature patterns of a region (climate) to better understand how winters in the United States are changing. By comparing decades of winter temperature data from many states, Dr. Kay investigates an important question: **How have average winter temperatures across the United States changed over time, and how do these trends relate to extreme weather events?**



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Identifying Important Science Ideas

1. Draw and Describe

Imagine you are going to a Chiefs game in January in Kansas City...	
a) What would you pack in your suitcase for Kansas City in January? Write or draw your answer below.	b) What would you actually wear to the game if it was -15° F like it was in the Puzzle Plot? Write or draw your answer below.
c) Write 2-3 sentences to describe the difference between weather and climate. <hr/> <hr/> <hr/>	

2. **Investigative question:** What question is Dr. Kay investigating?

3. **Make a prediction about the investigative question** (see question 2):

a. Do you think average winter temperatures in Kansas City, MO have (circle one):

- Increased over time (winters are getting warmer)
- Decrease over time (winters are getting colder)
- Stayed the same

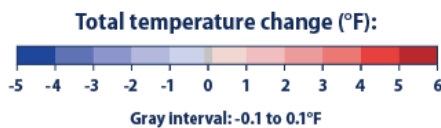
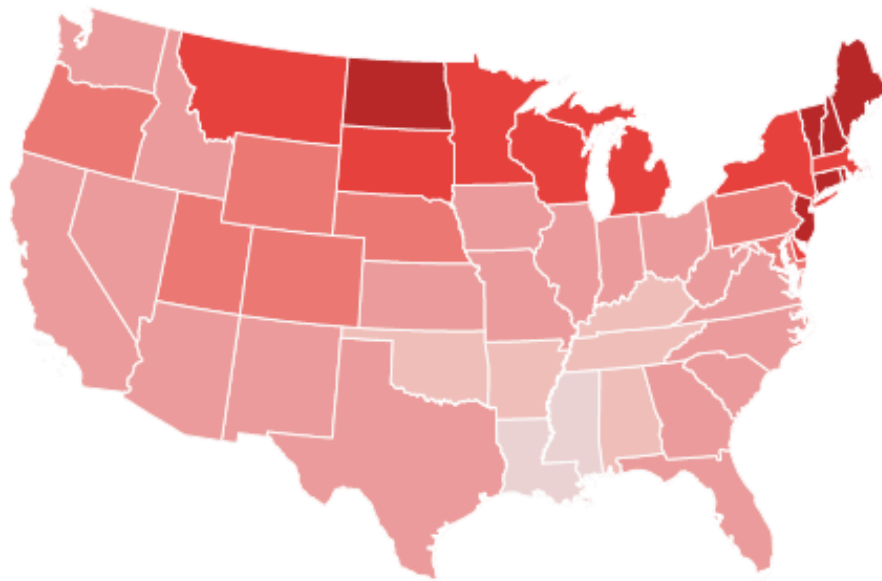
b. Defend your answer. Why do you think this?



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Supporting Ongoing Changes in Thinking

Instructions: Refer to the “Change in winter temperature by state, 1896-2023” map below and the “Air Temperature” from the Puzzle Plot to answer questions #4 & 5. Map from NOAA.



4. Which states on each map show the greatest increases in winter temperature and the lowest air temperatures on January 15th, 2024?

States with the greatest increases in winter temperature:	States with the lowest air temperatures on January 15th, 2024:
1. North Dakota	1.
2.	2.
3.	3.



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5. Revisit your prediction: Based on the trends you identified, would you expect average winter temperatures to be *higher, lower, or the same* in the year 2050? Explain.

6. Constructing Evidence-Based Explanations

Imagine that you are part of scientist Dr. Jen Kay's research team and a science journal asked you to write an article about how winters can be BOTH extremely cold (weather) and also getting warmer (climate).

Imagine that you are part of scientist Dr. Jen Kay's research team and a science journal asked you to write an article about how winters can be **BOTH** extremely cold (weather) and also getting warmer (climate).

a) What are key science ideas that you think should be included in this article?

b) What key evidence from the lesson supports your claim? Use data from both maps to support your explanation - even better if the data comes from where you live!

c) Come up with a catchy headline for your article!

Headline: _____



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7. **Digging Deeper:** Winter isn't the only season with changing temperatures! Use [this interactive site to figure](#) out which seasons are warming fastest where you live.

<p>Season with most warming</p> <p>1.</p> <p>2.</p> <p>3.</p> <p>4.</p> <p>Season with least warming</p>	<p>What impact does seasonal warming have on your community?</p>
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