Midlatitude Cyclones and Climate Change

Key Concepts:

- Blizzard
- Cyclone
- Fujita Scale
- Midlatitudes
- Tornado

WHAT YOU WILL LEARN

1. You will learn the different types of midlatitude storms.
2. You will analyze data concerning the frequency and intensity of tornadoes and blizzards in the midlatitudes.
3. You will examine the possible link between global climate change and midlatitude storms.

Engage Your Thinking

All extreme weather events or storms are known as cyclones. The location in which these cyclones occur determines the type of storm—for example, cyclones that occur in the tropics are known as hurricanes and cyclones that occur in the **midlatitudes** (between 30 and 60 degrees of latitude) are known as tornadoes and blizzards. Hurricanes are considered tropical cyclones because they originate near equatorial, or tropical, regions. Other cyclones, such as blizzards and tornadoes, originate in midlatitude regions. Since most of the United States is located in the midlatitude area much of the U.S., and especially the Midwestern states, is impacted by tornadoes and blizzards. The frequency and severity of tornadoes and blizzards may be influenced by climate change. In this activity you will learn about tornadoes and blizzards and how climate change might be influencing the frequency and severity of these storms or cyclones. Before starting this activity answer the following questions based on what you currently know and think.

1. Which types of weather conditions are necessary for a snowstorm to be considered a blizzard?

2. What is the Fujita Scale?

3. Why has an apparent increase in tornadoes occurred since 1950?

4. How has global climate change possibly altered the frequency and intensity of midlatitude cyclones?

Explore and Explain

In general, a **cyclone** is an area of low atmospheric pressure, characterized by inward spiraling winds. This spiral rotates clockwise in the southern hemisphere and counter-clockwise in the northern hemisphere. Midlatitude cyclones of the northern hemisphere are located between 30 degrees and 60 degrees latitude. These cyclones impact the weather in the continental United States and are the source of most of the stormy weather in the U.S.

A cyclone in the midlatitude United States is usually accompanied by a north-pushing warm front (warm moist air) and a south-pulling cold front (colder, drier air) wrapped around the center of low pressure (Figure 1).

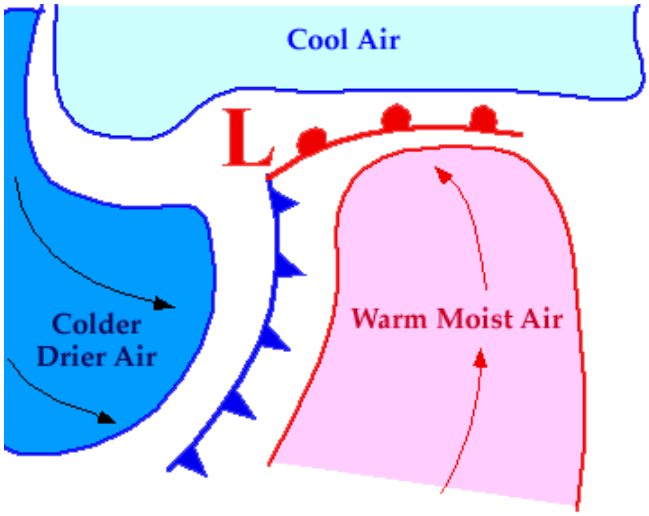

Figure 1. The Formation of a Cyclone. Source: NOAA

A key factor in determining whether or not the cyclone will develop into a severe storm is the degree of difference in temperature and humidity between the air masses present at that point in time. The greater the difference, the more intense or severe the resulting storm will be. The two major types of severe midlatitude cyclones are tornadoes and blizzards. These two severe storms are attributed to the difference between summer and winter associated with midlatitude climates.

5. Where are the “midlatitudes” on a globe or map of the Earth?

Tornadoes are often referred to as “nature’s most violent storms”. They luckily are relatively short-lived storms. In that short time, however, they can cause almost total destruction. Tornadoes are classified by wind speed on the **Fujita Scale** (Table 1).

Table 1. The Fujita Scale. Source: The Tornado Project

Fujita-Scale Rating	Intensity Phrase	Wind Speed
F0	Gale tornado	40-72 mph
F1	Moderate tornado	73-112 mph
F2	Significant tornado	113-157 mph
F3	Severe tornado	158-206 mph
F4	Devastating tornado	207-260 mph
F5	Incredible tornado	261-318 mph
F6	Inconceivable tornado	319-379 mph

6. A tornado moves through the area uprooting large trees and destroying smaller, weaker structures such as garages and sheds, and the wind speed reached 130 mph. What is the Fujita Scale rating for this tornado (see Table 1)?

In 2007, scientists developed an Enhanced Fujita Scale; this scale has been modified to take in consideration both wind gusts and sustained winds. It is shown below (Table 2).

Table 2. Enhanced Fujita Scale. Source: NOAA

FUJITA SCALE			**DERIVED EF SCALE**		**OPERATIONAL EF SCALE**	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85	**0**	**65-85**
1	73-112	79-117	1	86-109	**1**	**86-110**
2	113-157	118-161	2	110-137	**2**	**111-135**
3	158-207	162-209	3	138-167	**3**	**136-165**
4	208-260	210-261	4	168-199	**4**	**166-200**
5	261-318	262-317	5	200-234	**5**	**Over 200**

Although tornados are among the most violent storms or weather events, they often do not result in death. Today, because of improved forecasting and early warning systems there has been a significant drop in the number of deaths from tornadoes. The top 10 deadliest tornadoes in U.S. history are displayed in Table 3.

Table 3. Top 10 Killer Tornadoes in the US. Source: The Tornado Project

Rank	State(s)	Date	Dead	Injured	F-Scale	Town(s)
1	MO-IL-IN	March 18, 1925	695	2027	F5	Murphysboro, Gorham, DeSoto
2	LA-MS	May 7, 1840	317	109	F?	Natchez
3	MO-IL	May 27, 1896	255	1000	F4	St. Louis, East St. Louis
4	MS	April 5, 1936	216	700	F5	Tupelo
5	GA	April 6, 1936	203	1600	F4	Gainesville
6	TX-OK-KS	April 9, 1947	181	970	F5	Glazier, Higgins, Woodward
7	LA-MS	April 24, 1908	143	770	F4	Amite, Pine, Purvis
8	WI	June 12, 1899	117	200	F5	New Richmond
9	MI	June 8, 1953	115	844	F5	Flint
10	TX	May 11, 1953	114	597	F5	Waco

7. How many of the Top-10 killer tornadoes have occurred since 1960?

Blizzard conditions occur during a snowstorm, when winds exceed 35 mph and visibility is reduced to near zero. A **blizzard** is the most dangerous winter storm. During the Great Blizzard of 1978, the lowest atmospheric pressure of any non-tropical storm in U.S. history was recorded.

8. If you have experienced a blizzard or a tornado, describe it in your own words. If you have not had that experience, try to describe how you might feel as it occurs.

Extend Your Thinking

Climate not only refers to the average temperature and precipitation for a region, but also the type, frequency, and intensity of weather events, including severe storms. For example, the Midwestern U.S. experiences summer thunderstorms and tornadoes and winter snowstorms and blizzards. Climate change may alter or change the frequency and severity of these weather events or storms, perhaps causing more severe tornadoes and blizzards. Predicting how or if climate change will impact these weather events is difficult. The Intergovernmental Panel on Climate Change (IPCC), however, predicts that: some weather events will increase in frequency and/or severity during the 21st century due to changes in climate. Although predicting the impact of climate change on severe weather events is difficult, weather records for the Midwest show that the Midwest climate has changed since 1895. Annual temperature and precipitation have increased by about 1° F and 3 inches respectfully, with variability among the states and seasons (Figure 2).

Warmer temperatures tend to increase evaporation causing more precipitation. The following precipitation trends have been observed for the midlatitudes:

- Precipitation has increased over land from 1900.
- It has become significantly wetter in eastern parts of North America.
- There has been an increase in the number of heavy precipitation events (storms) over many areas during the past century.

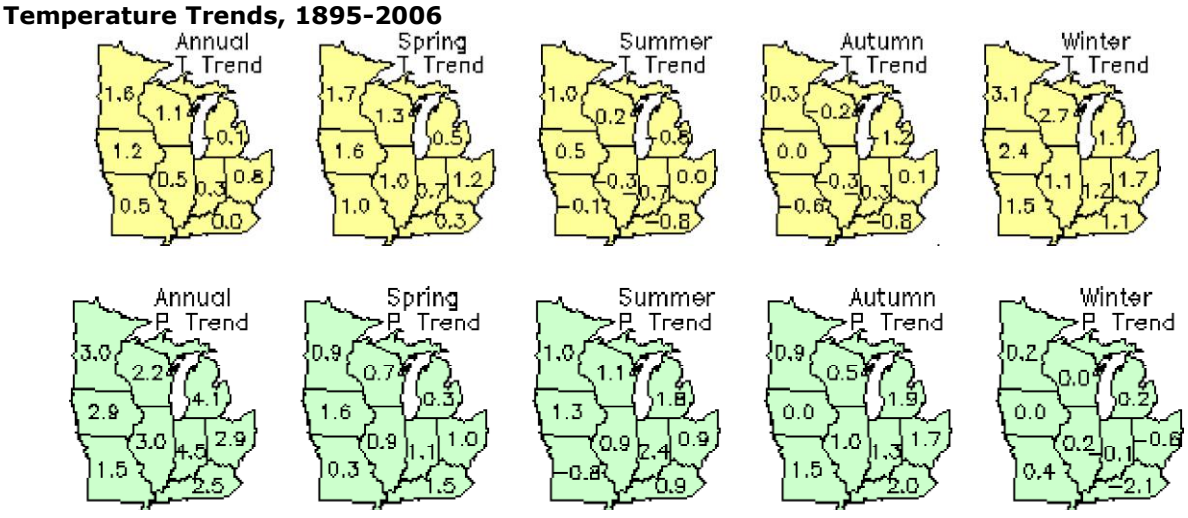

Figure 2. Climate Change in the Midwest. Source: Midwest Regional Climate Center

9 Based on Figure 2, which Midwestern state has the largest increase in annual summer temperature and which state has the largest increase in annual spring precipitation?

Although there is evidence that annual precipitation and temperature trends for the midlatitudes have changed, there is less certainty about the effect of climate change on severe weather events. This uncertainty is due to the natural variation in the intensity and frequency of midlatitude storms, combined with the inconsistent data and observation methods used in the past. These factors make it difficult to determine if climate change is causing the intensity and frequency of severe storm events to increase.

The total number of tornadoes by year for the U.S. is shown in Figure 3 and the total number of severe (F3 to F5) tornadoes for the U.S. is shown in Figure 4. The number of severe winter storms is shown in Figure 5.

10. Based on the data in Figures 3 and 4, how might climate change be impacting the number and severity of tornadoes?

11. Offer two possible explanations why such a dramatic increase in the total number of tornadoes has occurred from 1955 to the present?

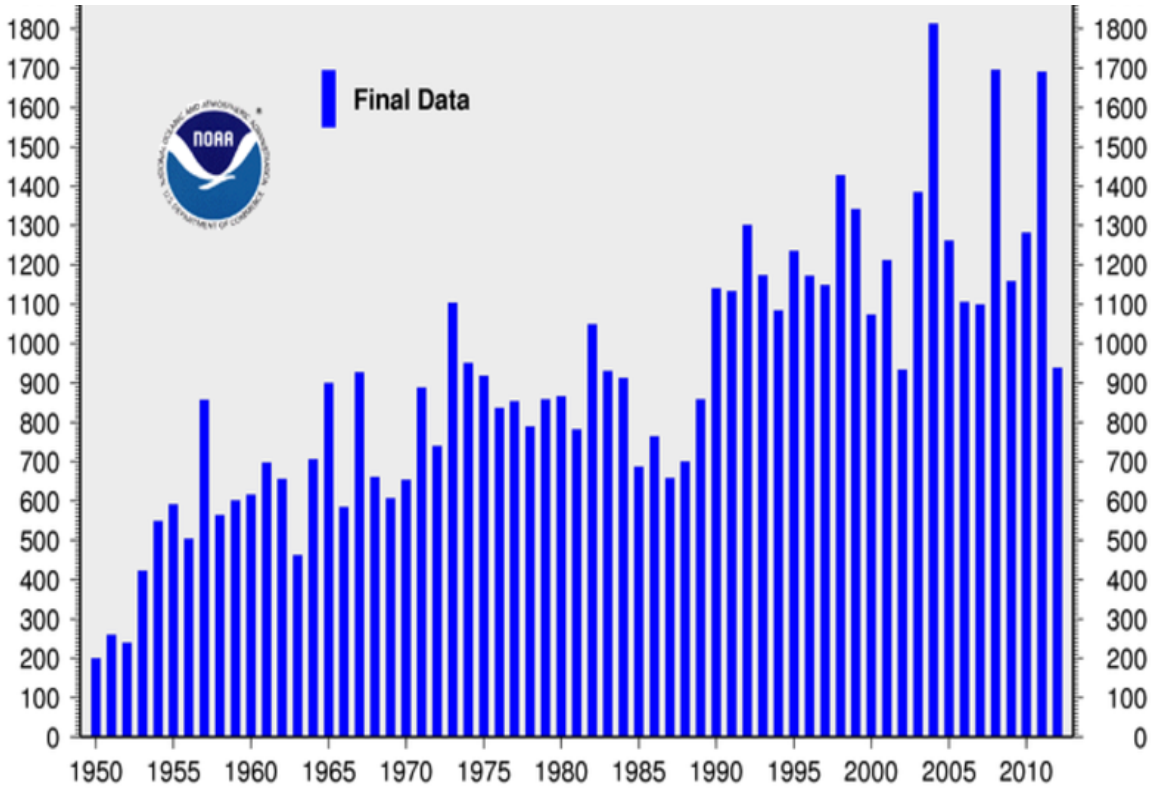

Figure 3. Number of U.S. Tornadoes. Source: NOAA

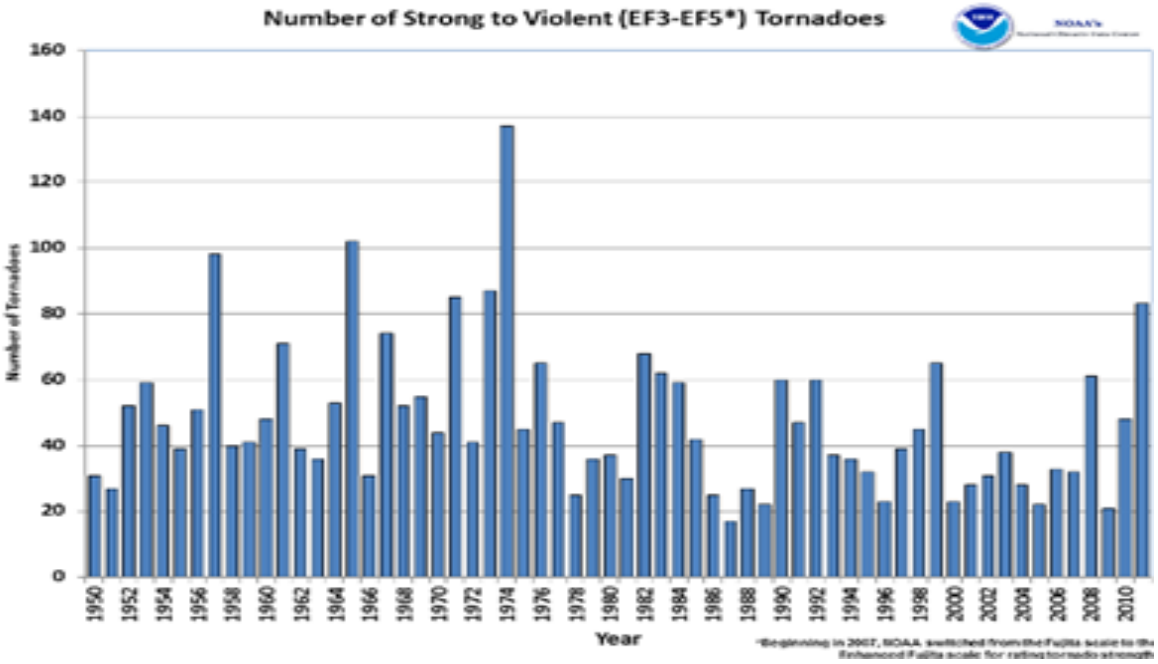

Figure 4. Number of F3-F5 Tornadoes. Source: NCDC

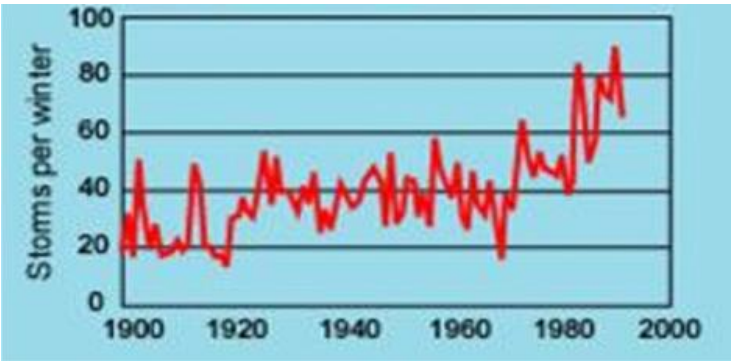

Figure 5. Number of Winter Storms. Source: Environment Canada

13. In the graph above (Figure 5), what trend is shown concerning winter storms?

13. Explain how the data shown in Figure 5 supports scientists' view that climate change may cause more severe weather events or storms.

Apply What You Have Learned

It is difficulty to directly link severe weather events or storms to human caused global warming. Global warming, however, increases the likelihood that severe weather events will increase in frequency and intensity. For example, NOAA predicts that the U.S. will experience more heat waves as a result of global warming. The IPCC has attempted to assess the likelihood of projected changes in climate for the 21st Century (Table 3). Note that there are projected changes in the midlatitudes for precipitation and temperature events.

Table 3. Projected Changes in Climate. Source: IPCC

Projected Change
Higher maximum temperatures; more hot days and heat waves over nearly all land areas
Higher minimum temperatures; fewer cold days, frost days, and cold waves over nearly all land areas
More intense precipitation events over many areas
Increased summer drying over mid-continental areas and associated risk of drought
Increase in tropical cyclone (e.g. tropical storms and hurricanes) rainfall and peak winds over some areas

14. Describe how you think the predicted changes in climate shown in Table 3 will affect severe weather, the frequency and severity of tornadoes and blizzards, in the 21st century.

Reflect on What You Have Learned

15. What weather conditions are necessary for a snowstorm to be considered a blizzard?

16. What is the Fujita Scale?

17. Why has there been an apparent increase in tornadoes since 1950?

18. How has global climate change possibly altered the frequency and intensity of midlatitude cyclones?