



Winter Storms in the US

For Prelims: Winter Storms in the US, Hypothermia, Snowstorms, Blizzards, [Polar Vortex](#), [Arctic](#).

For Mains: Winter Storms in the US, Atmosphere structure and composition, temperature, wind systems, clouds, and rainfall types.

[Source: TH](#)

Why in News?

Winter storms in the U.S. have led to a range of challenges, affecting various states with sub-freezing temperatures, snow, and ice.

- The situation has resulted in at least 72 deaths nationwide in January 2024, primarily due to **Hypothermia or Road Accidents**.

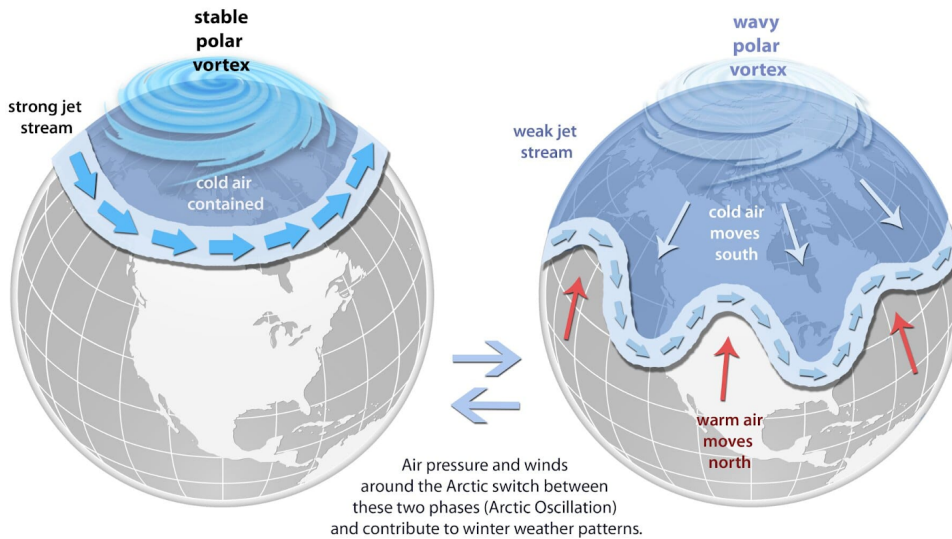
What are the Factors Causing Severe Winter Storms in the US?

- **Polar Vortex:**
 - The [Polar Vortex](#) is a large area of low pressure and cold air surrounding both of the Earth's poles.
 - The term "**vortex**" refers to the counterclockwise flow of air that helps keep the colder air near the Poles. It always exists near the poles but **weakens in summer and strengthens in winter**.
 - Occasionally, **disruptions in the polar vortex can lead to outbreaks of cold air moving southward into the United States**, bringing frigid temperatures.
 - **Climate change**, in the Arctic, leads to a phenomenon called **Arctic amplification**. This is the faster warming of the Arctic compared to the rest of the globe. The amplified warming in the **Arctic weakens the polar vortex, making it more susceptible to disruptions**.
 - The weakening can result in the polar vortex stretching or splitting, allowing **cold Arctic air to spill southward**.

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The Science Behind the Polar Vortex

The polar vortex is a large area of low pressure and cold air surrounding the Earth's North and South poles. The term vortex refers to the counterclockwise flow of air that helps keep the colder air close to the poles (left globe). Often during winter in the Northern Hemisphere, the polar vortex will become less stable and expand, sending cold Arctic air southward over the United States with the jet stream (right globe). The polar vortex is nothing new — in fact, it's thought that the term first appeared in an 1853 issue of E. Littell's *Living Age*.



▪ Arctic Air Masses:

- The intrusion of **Arctic air masses** into the US can cause a rapid drop in temperatures. These air masses originate in the **Arctic region and can extend southward**, bringing bitterly cold conditions to areas that are not accustomed to such extremes.

▪ Jet Stream Patterns:

- The jet stream, a fast-flowing ribbon of air high in the atmosphere, plays a role in steering weather systems.
- Changes in the **jet stream pattern can allow cold air from the Arctic** to plunge southward, affecting large portions of the country.

What are Winter Storms?

▪ About:

- Winter storms are **weather events characterized by extreme cold temperatures**, precipitation in the form of snow, sleet, or freezing rain, and often accompanied by **strong winds**.
- These storms can disrupt normal daily activities, impact transportation, and pose various hazards to communities.

▪ Winter Storm Formation:

- **Moist Air Rising:** Winter storms **begin with moist air rising** into the atmosphere. This can occur at a cold front where warm air is lifted above cold air or as air moves up a large hill or mountain.
- **Source of Moisture:** A source of moisture is necessary for cloud formation and precipitation. This can be provided by **air blowing across large bodies of water**, such as lakes or oceans, picking up water vapour.
- **Cold Air:** The key factor that differentiates winter storms is the presence of cold air. When temperatures **both near the ground and throughout the atmospheric layers** are below freezing, precipitation occurs in the form of snow or ice.

▪ Types of Winter Storms:

- **Snowstorms:** These are **storms where precipitation falls mainly as snow**. Snowflakes form as water vapor condenses into water droplets and freezes. The air temperature determines whether the precipitation falls as snow, rain, or freezing rain.
- **Blizzards:** Defined by strong winds rather than the amount of snow, blizzards have wind **speeds at or above 35 MPH (Miles Per Hour)**. Blizzards create blowing snow

- conditions, reducing visibility and **causing the accumulation of snowdrifts.**
- **Lake Effect Storms:** These storms form **due to the abundance of moisture from the Great Lakes (USA).** Cold, dry air passing over the lakes picks up water vapour, leading to heavy snowstorms in areas south and east of the lakes.
 - **Ice Storms:** Winter storms with an accumulation of at least 0.25 inches of ice on outdoor surfaces. Ice storms create **slick layers on the ground, making travel and walking hazardous.** They can also lead to the **snapping of branches and powerlines.**

What is Hypothermia?

▪ About:

- Hypothermia is a medical emergency that occurs when the body loses heat faster than it can produce it, resulting in a **dangerously low body temperature.**
- The normal body temperature is around 98.6 degrees Fahrenheit (37 degrees Celsius), and **hypothermia typically sets in when the body temperature drops below 95 degrees Fahrenheit** (35 degrees Celsius).
- Cold exposure can lead to hypothermia through a **combination of factors that disrupt the body's ability** to maintain its core temperature.
- The Body's natural response to cold conditions is to generate heat and conserve warmth, **primarily regulated by the hypothalamus in the brain.**

▪ Symptoms:

- Shivering, which may stop as hypothermia progresses. (Shivering is actually a good sign that your heat regulation systems are still active.)
- Slow, shallow breathing
- Confusion and memory loss
- Drowsiness or exhaustion.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims:

Q. The formation of ozone hole in the Antarctic region has been a cause of concern. What could be the reason for the formation of this hole? (2011)

- (a) Presence of prominent tropospheric turbulence; and inflow of chlorofluorocarbons
- (b) Presence of prominent polar front and stratospheric clouds; and inflow of chlorofluorocarbons
- (c) Absence of polar front and stratospheric clouds; and inflow of methane and chlorofluorocarbons
- (d) Increased temperature at polar region due to global warming

Ans: (b)

- The severe depletion of stratospheric ozone in the Antarctic in late winter and early spring is known as the 'ozone hole'.
- The air temperature in the Antarctic regions is extremely low in the lower stratosphere in the winter season. Polar stratospheric clouds (PSCs) are formed in the polar ozone layer when in winter, minimum temperatures fall below about -78°C . This occurs on average for around 5 to 6 months over Antarctica.
- Besides, the nitric acid in PSCs reacts with CFCs to form chlorine, which catalyzes the photochemical destruction of ozone.
- Halogen gases enter the stratosphere primarily from the tropical upper troposphere and these are transported towards the poles through the stratospheric air motions.
- Besides, stratospheric air in the Antarctic region is relatively isolated for long periods in the winter

months as the strong winds encircle the Antarctic, forming a polar vortex which prevents substantial motion of air into or out of the polar stratosphere.

- Therefore, option (b) is the correct answer.

Mains:

Q.1 How does the cryosphere affect global climate? **(2017)**

Q.2 How do the melting of the Arctic ice and glaciers of the Antarctic differently affect the weather patterns and human activities on the Earth? Explain. **(2021)**

Q.3 Why is India taking keen interest in resources of Arctic region? **(2018)**

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