Polar Vortex

Source: IE

Why in News?

A severe **winter storm** has affected a large part of the US, impacting over 60 million people across 30 states.

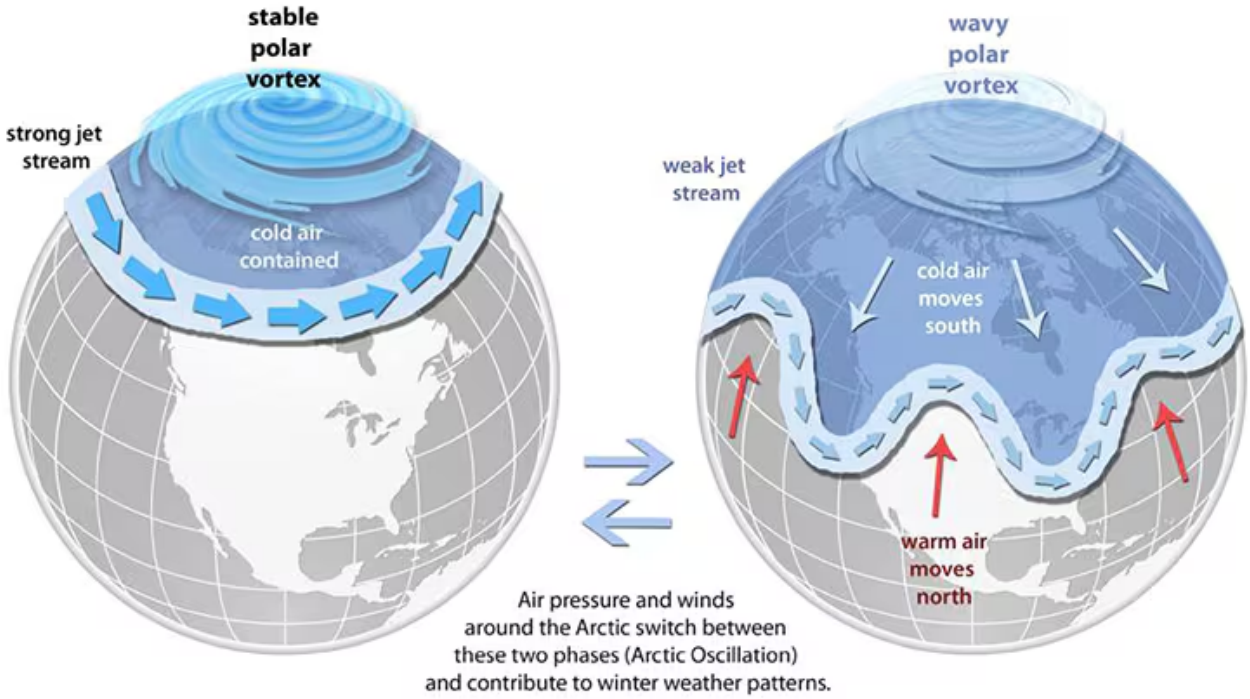
- This extreme weather is attributed to the **southward expansion of the polar vortex,** highlighting its role in causing frigid temperatures and severe storms.

Note: Winter storms are weather events characterized by **extreme cold, snow, sleet, or freezing rain,** often accompanied by strong winds.

- They form when **moist air rises, cools, and condenses into precipitation,** with cold temperatures ensuring it falls as snow or ice.

What is the Polar Vortex?

- **About:** The polar vortex is a large **area of low-pressure and cold air** that rotates around the **Earth's polar regions.**
  - The term **"vortex" describes the counter-clockwise flow of air** that confines colder air near the poles.
  - Polar Vortex exists year-round, but it weakens in summer and strengthens in winter.
- **Types:**
  - **Tropospheric Polar Vortex**: Located at the lowest layer of the atmosphere, from the **surface up to 10-15 km**, where most weather phenomena occur.
  - **Stratospheric Polar Vortex**: Occurs higher up, between **15 km to 50 km**, and is **strongest during autumn**, disappearing in the summer.
    - Its changes are influenced by **air movement and heat transfer in the polar region.** During autumn, circumpolar winds accelerate, strengthening the vortex and forming a unified, rotating mass of polar air in the **stratosphere.**
- **Mechanism of Extreme Cold:** When the **polar vortex is strong,** it keeps the jet **stream stable,** preventing cold air from moving south.
  - However, when the **vortex weakens,** a disrupted jet stream (a narrow band of strong winds), which usually moves in a straight line, becomes wavy, allowing Arctic air to flow farther south.
    - This disruption leads to **extremely low temperatures, severe storms, and extreme weather,** including snowfall and freezing rain.
- **Global Warming and Polar Vortex:** Researchers state that the Arctic is warming faster than the rest of the planet, a phenomenon known as **Arctic amplification.**
  - This reduces the **temperature gradient** (rate of change of temperature) **between the poles and the mid-latitudes**, weakening the **polar vortex.**

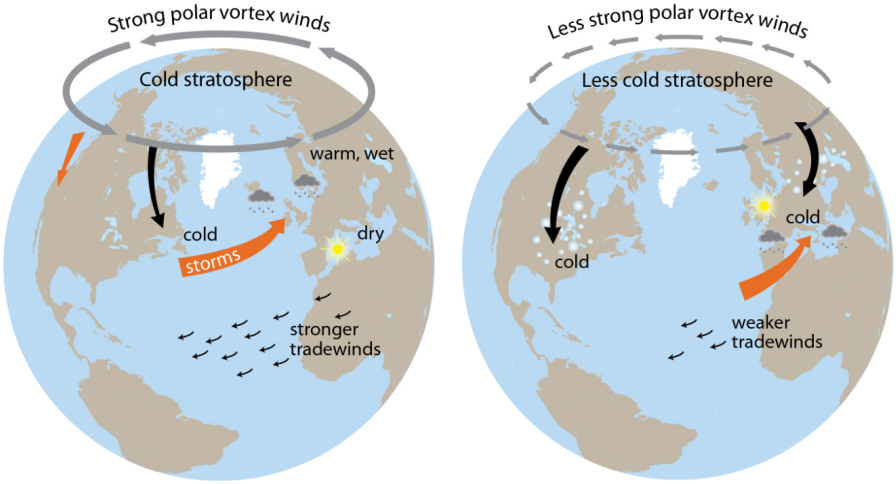


Other Geophysical Phenomenon Similar to Polar Vortex

- **Arctic Oscillation (AO):** It is a climate pattern affecting **winter weather in the Northern Hemisphere.** When the **Arctic Oscillation (AO) is positive,** a strong jet stream directs storms north, **limiting cold air outbreaks in the mid-latitudes**, while the **negative phase shifts the jet stream south, causing cold outbreaks and storms.**

Arctic Oscillation Positive Phase

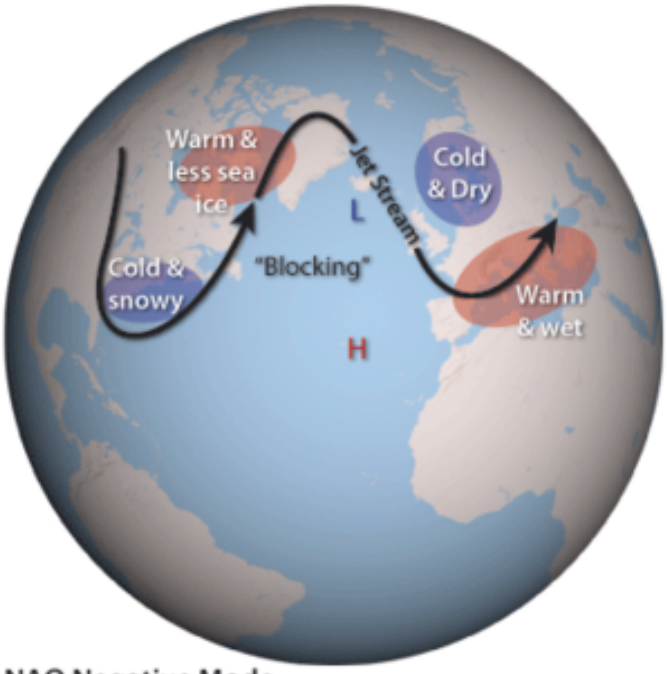
Higher-pressure air mass over North America, Europe and Asia confines extremely cold air to Arctic.



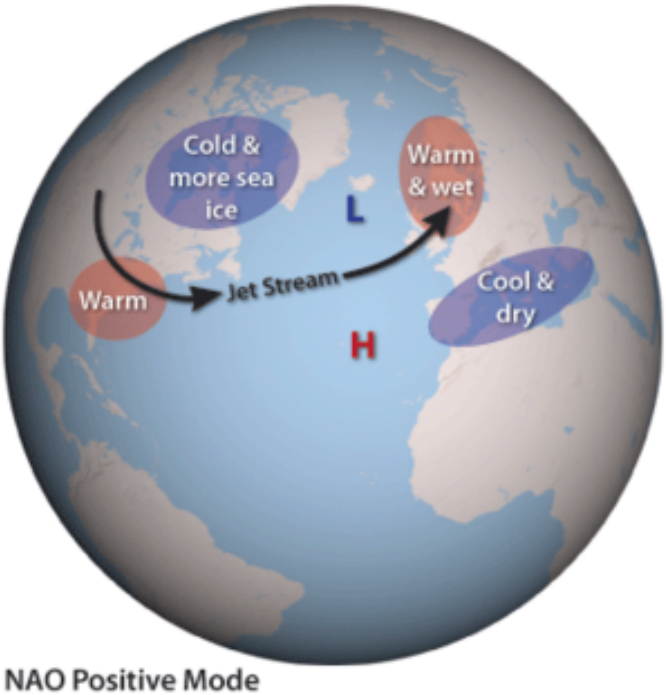
Arctic Oscillation Negative Phase

Air pressure systems weaken allowing colder air to move south and warmer air to move north.

- **North Atlantic Oscillation (NAO):** The **NAO** measures pressure differences between the **Azores High and Subpolar Low**, affecting weather patterns in North America and Europe.
  - The positive phase of NAO brings warmer, wetter conditions in the US and northern Europe, while the negative phase causes cooler, drier conditions.



NAO Negative Mode



NAO Positive Mode