

# Polar Vortex

## [UPSC Notes]

### What is a Polar Vortex?

A polar vortex is a vast region with low-strain and freezing air covering both the planet's poles. The literal meaning of the term vortex is the anti-clockwise movement of air that retains the cold air nearby the poles. It is observed that throughout the winters in Northern Hemisphere, the polar Vortex becomes comparatively less stable and often expands, sending cold Arctic air toward the south over the US with the jet stream. The term polar Vortex is not new; instead, it is believed to be recognized in the 1853 issue of "Littell's Living Age".

It is primarily present in the upper troposphere that sometimes extends to the lower stratosphere, especially at the poles. It is a constant low-pressure area that rotates at the upper level of the north pole in an anti-clockwise direction, and at the South Pole, it rotates in a clockwise direction.

The polar Vortex has been in the bulletins afterward the northern hemisphere faced its coldest age or phase during the winter season of 2013-2014.

Furthermore, this same freezing air force came back in 2020. This time countries like the USA, Canada, and Russia suffered undergone one of their coldest winter seasons ever recorded.

### Polar Vortex and Global Warming

Many a time, the polar Vortex is associated with global warming. It is believed that many global warming issues are caused due to polar Vortex.

- The worldwide temperature has increased by approx.  $0.8^{\circ}\text{C}$  since the 1880s.
- The Arctic has heated and melted at more than double the rate due to the polar Vortex.
- The North Pole, North America, and other similar regions have very little temperature difference from the Arctic region.
- The jet stream's energy moves upward, disturbing the Polar Vortex and initiating it to split.

## Some More Details on Polar Vortex

A polar vortex can be understood as a whirling cone of low-pressure air above the North and South poles, which establishes itself in a more resilient form because of a rise in temperature in consequence of the contrast in temperature between North America's polar regions and Europe.

Specific patterns or conditions in weather arise during the swirls over the stratosphere (Earth's atmospheric layer is present 10-48 km from the ground level). When the polar Vortex is most compelling, its accumulated cold air inclines toward the polar zones of North America and the European Continents.

However, sometimes, the polar Vortex faces some disturbance leading to warming of the stratosphere in only a few days.

## The Potency of Polar Vortices

The polar vortices have the following strengths:

- The Polar vortices are most potent and effective during the winters and move to their lowest strength and effectiveness during the summer.
- A polar vortex can become more potent in the course of a volcanic eruption and remain with the same strength for nearly two years after the preliminary eruption event.
- When the Arctic Vortex is extended or stretched out on top form with two cyclone centers, it will make a single polar vortex.
- The Arctic variant of the Polar Vortex is much less continual or permanent compared to the Antarctic variant polar vortex.
- Weather phenomena associated with the "La Nina" can considerably reinforce or intensify a polar vortex.
- Extratropical whirlwinds or storms that migrate to the higher altitudes when the polar Vortex is brittle can disturb the single Vortex making minor vortices within the polar air reservoir. These small vortices can individually remain for more than one month.

## Duration of the Polar Vortices

The Arctic polar vortex discontinues or starts to break up from the middle of March to the middle of May every year.

- The event of breaking of the Arctic polar vortex signs the end of the winter season and the commencing of the beautiful spring season.
- This polar vortex event or the transition significantly affects farming activities, environments, and many other climate rotations. Additionally, it affects ocean ice, the ozone layer, cloud formation, and atmospheric temperature.
- If a polar vortex breaks up earlier than the scheduled time, it causes a warming phase from February end to the middle of March. While on the other side, if a polar vortex breaks up late breakup period causes two warming phases, first in January and second in March.
- Sometimes, polar vortices break off or discontinue before the final warming phase ends. This Polar Vortex can shift to the North-eastern, Southern, Central, and Midwestern United States & Canada.

## Impacts of Polar Vortex on Earth's atmosphere

A polar vortex and its related events can have the following impacts on the Earth's environment.

- The Polar Vortex's breakups in the higher atmosphere can have significant sudden or delayed impacts on the environment, such as decreasing atmospheric temperature and extremely harsh cold in the winter in the Eastern United States, Western regions & Northern Europe.
- Abrupt stratospheric warming due to the polar Vortex can lead to the warm Arctic region in the stratosphere as well as the troposphere.
- The warm Arctic region works in favor of cold air and causes more harsh winter weather in the Northern Hemisphere and mid-latitudes comprising the Eastern United States.

## Features of Polar Vortex

A polar vortex swirls over the stratosphere, 10-48 Km above the ground level.

- A stronger or potent polar vortex act as a protective barrier for the mid-latitudes protecting them from cold Arctic air.
- Typically, it happens when the polar Vortex is most potent and cold air is less prone to fall deep into the mid-latitudes, including Northern US and Europe.

- However, the polar Vortex sometimes gets disrupted or weakens because of the wave energy rising skyward from the Earth's lower atmosphere.
- Such happenings or events with polar Vortex abruptly warm the stratosphere in just a few days, and this event is known as sudden stratospheric warming far above the Earth's surface.
- As a consequence of this stratospheric warming, the polar Vortex tends to shift its location a little toward the south of the north pole. Sometimes this shift splits the polar Vortex into 'sister vortices'.

## Slipping or Shifting of the Polar Vortex

A Polar vortex goes across somewhere above 65° North and South latitudes.

- The polar Vortex becomes very powerful when the temperature contrast between the polar Vortex and temperate regions is highest. At this stage, its meandering is insignificant or nearly null.
- However, the polar vortex meander known as Rossby waves when this temperature contrast is slight.
- The slight temperature contrast does not mean the summertime.
- The meandering polar Vortex generates irregular or flashing low-pressure & high-pressure chambers.
- High-pressure chambers are formed underneath the ridges, and low-pressure chambers are formed underneath the troughs.
- It happens because of the upper air circulations shaped by the polar Vortex.
- Due to the severe meandering of the Polar Vortex, the high-pressure chambers force over to the north and shift the polar Vortex from its standard position.
- It means the polar Vortex moves far from the pole and glides into the temperate regions having extremely low pressure.
- As soon as the polar Vortex holds back its strength, the high-pressure chambers become ineffectual and move back to their original latitudinal positions.
- The polar vortex shifts or slips back to its original position or poles with the shift in high-pressure chambers.

What is Polar Vortex's location?

A polar vortex is a region of low-pressure Arctic air typically centered around the north pole.

It is usually held in place by the jet stream, a stream of wind far above the surface level, and separates cold air from warm air, bending around high-and, low-pressure weather systems.

### How did a polar vortex shift to the south?

A high-pressure system from the west pushed the jet stream, and a portion of the polar Vortex shifted farther south than the normal position.

That brought a portion of the Polar Vortex well into North America and caused the temperature in the Midwest and the eastern US to dive to zero.

### Polar Vortex and Ozone layer Depletion

Even though polar vortex and ozone layer depletion are two entirely diverse topics, however related phenomena of the Earth's atmosphere.

There is a constant decline in the total amount of the ozone layer, approx.—4% in the Earth's stratosphere. Additionally, a considerable reduction in the stratospheric ozone layer is observed in the vicinity of the Earth's polar regions.

### Polar Vortex UPSC Essential Points to Notice

These are some of the polar vortex facts and points essential for UPSC exams:

- A polar vortex is not featured at the Earth's surface; instead, it is far above the Earth (approx. 10-48 Km), typically in the centre and upper stratosphere.
- The Arctic polar vortex comprises two primary centres. The first is above Baffin Island, and the second is above North-eastern Siberia.
- Stratospheric forewarnings cause the Polar vortex and weather effects.
- The Polar Vortex is a massive region of low-pressure cold air encompassing the Earth's poles, especially the North pole. The polar Vortex was also recognized by the name of Polar Pig.
- The term "vortex" in polar Vortex indicates the anti-clockwise movement of air that keeps the cold air close to the Poles. A polar vortex always endures adjacent to the poles but diminishes during summers and reinforces during winter.

- Moreover, the polar Vortex expands during winters in the northern hemisphere and sends cold air toward the south. This event occurs recurrently during the winter season and is much related to large outbursts of Arctic air in the US and some regions of Europe and Asia.
- The only threat of the Polar Vortex to humans is the degree of cold temperatures could get low when the polar Vortex spreads out and send Arctic air toward the south into the regions that are not cold usually.

