FOUR DOTS, ONE IN EACH CORNER

What is a Jet Stream?

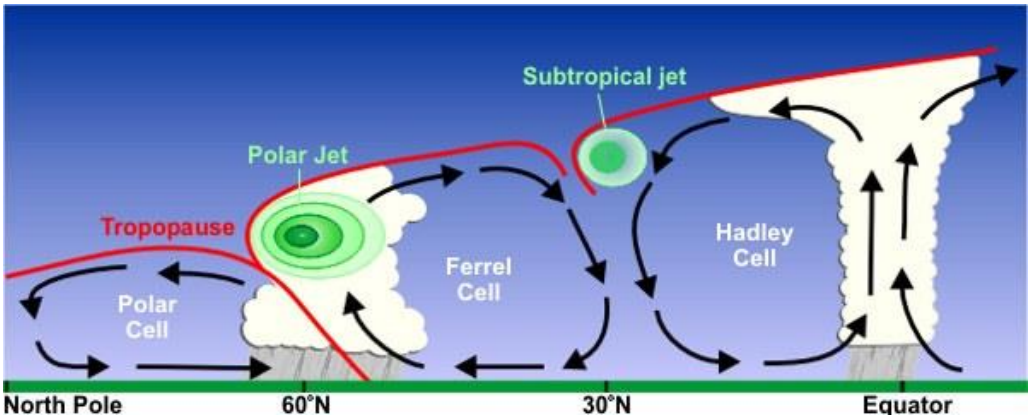
Jet streams are relatively narrow bands of strong wind in the upper levels of the atmosphere. The winds blow from west to east in jet streams but the flow often shifts to the north and south. Jet streams follow the boundaries between hot and cold air. Since these hot and cold air boundaries are most pronounced in winter, jet streams are the strongest for both the northern and southern hemisphere winters.

Since the equator gets the majority of the incoming solar radiation, a huge volume of warm air rises at the equator and spreads out toward the poles. Due to the Earth's rotation that circulation gets divided into three cells.

The motion of the air is not directly north and south but is affected by the momentum the air has as it moves away from the equator. The reason has to do with momentum and how fast a location on or above the Earth moves relative to the Earth's axis. Your speed relative to the Earth's axis depends on your location. Someone standing on the equator is moving much faster than someone standing on a 45° latitude line. Someone standing on a pole is not moving at all except that he or she would be slowly spinning.

The momentum the air has as it travels around the earth is conserved, which means as the air that's over the equator starts moving toward one of the poles, it keeps its eastward motion constant. The Earth below the air, however, moves slower as that air travels toward the poles. The result is that the air moves faster and faster in an easterly direction (relative to the Earth's surface below) the farther it moves from the equator.

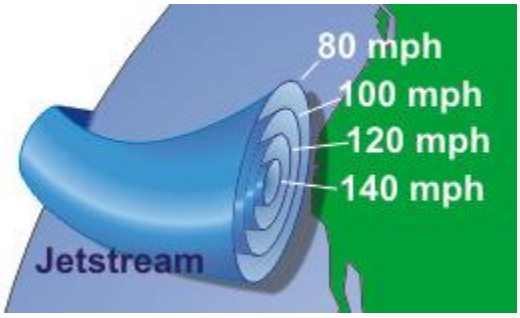
In addition, with the three-cell circulations, the regions around 30° N/S and 50°-60° N/S are areas where temperature changes are the greatest. As the difference in temperature increases between the two locations the strength of the wind increases. Therefore, the regions around 30° N/S and 50°-60° N/S are also regions where the wind, in the upper atmosphere, is the strongest.



The 50°-60° N/S region is where the **polar jet** located with the **subtropical jet** located around 30°N. Jet streams vary in height of four to eight miles and can reach speeds of more than 275 mph (239 kts / 442 km/h).

The actual appearance of jet streams result from the complex interaction between many variables - such as the location of high and low pressure systems, warm and cold air, and seasonal changes. They meander around the globe, dipping and rising in altitude/latitude, splitting at times and forming eddies, and even disappearing altogether to appear somewhere else.

Jet streams also "follow the sun" in that as the sun's elevation increases each day in the spring, the average latitude of the jet stream shifts poleward. (By Summer in the Northern Hemisphere, it is typically found near the U.S. Canadian border.) As Autumn approaches and the sun's elevation decreases, the jet stream's average latitude moves toward the equator.



Jet streams are often indicated by a line on a weather map indicating the location of the strongest wind. However, jet streams are wider and not as distinct as a single line but are actually regions where the wind speed increases toward a central core of greatest strength.

One way of visualizing this is to consider a river. The river's current is generally the strongest in the center with decreasing strength as one approaches the river's bank. Therefore, it is said that jet streams are "rivers of air".

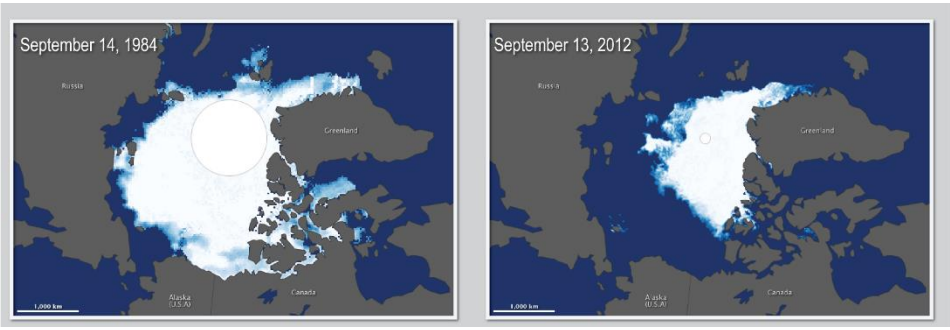
What is a Polar Vortex?

A polar vortex is simply a semi-permanent, massive low-pressure system over the poles of our planet. It always exists near the poles, but it gets weaker in summer and stronger in winter. The term "vortex" refers to the counterclockwise flow of air that helps keep the colder air near the poles. Many times during winter in the northern hemisphere, the polar vortex will expand, sending cold air southward with the jet stream (which follows the boundary between hot & cold air).

The polar vortex is created by some straightforward physics. Cold air takes up less space than warm air. As cold air above the arctic sinks, low pressure is formed and new air rushes in to fill the void. The rotation of the earth makes the air move to the right, in a counterclockwise direction. Then you've got a polar vortex. It does not stay still. Instead, it wobbles based on cold fronts and warm fronts moving below. It twists, turns and gets longer. It can even split into two.

A polar vortex event is when part of the polar vortex breaks off. This occurs when the vortex is weaker, not stronger. That might sound weird — but it actually makes sense. Normally, when the vortex is strong and healthy, it helps keep the jet stream traveling around the globe in a pretty circular path. This current keeps the cold air up north and the warm air down south. But when it isn't strong, the jet stream becomes wavy and rambling. When conditions are right, all of a sudden you have a river of cold air being pushed down south along with the rest of the polar vortex system.

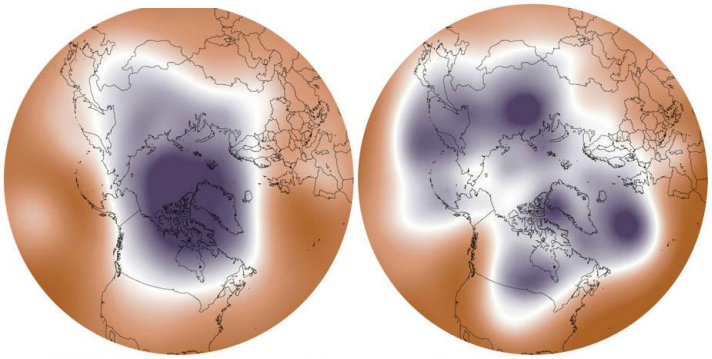
What causes the vortex to weaken?



A reduction in sea ice at the poles means less sunlight is being reflected and therefore more energy is being absorbed which leads to increased evaporation which alters the pressure and temperature gradient of the polar vortex, causing it to weaken and/or collapse.

image credit: NASA Earth Observatory 2012.

This helps to explain how on a warming planet (1.62 °F since the late 19th century) it is possible for there to be extreme cold weather events.



A strong polar vortex (left, from December 2013) is centered over the Arctic. A weakened polar vortex (right, from January 2014) allows cold air to dip farther south. Credit: NOAA

1. What is a Jet Stream?

2. In which season is the Jet Stream the strongest?

3. At which latitudes are jet streams the strongest and why?

4. What are these two jetstreams called and which one affects our weather here in North Carolina the most?

5. On the diagram of the three cell circulations, there is a giant cloud over the equator. What type of cloud is it?

6. What variables affect where the jet stream actually appears?

7. What is a polar vortex?

8. How does the intersection of the polar vortex and the jet stream affected by climate change?