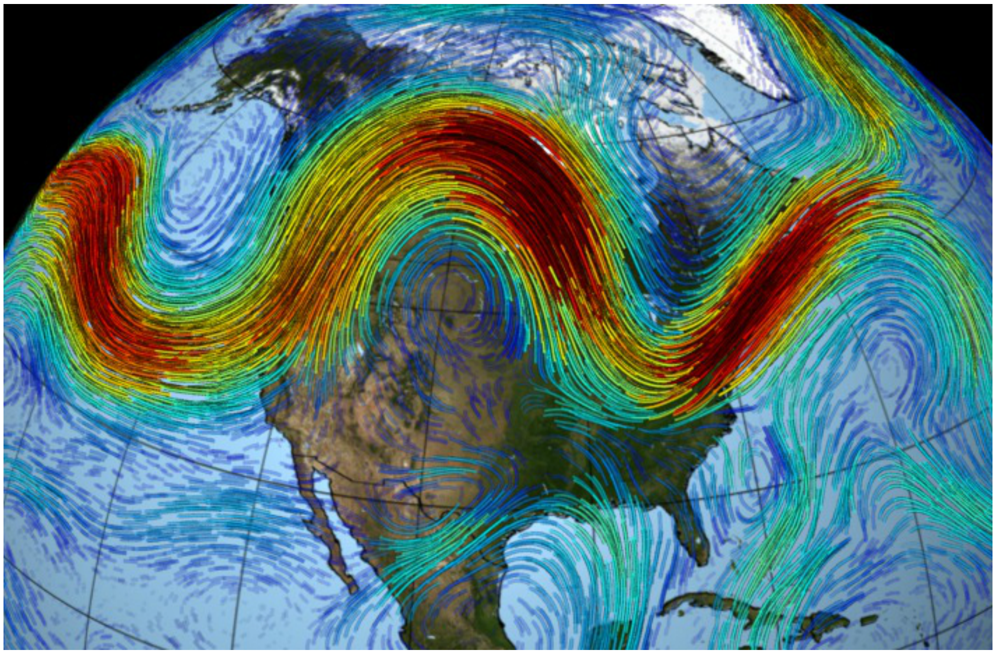
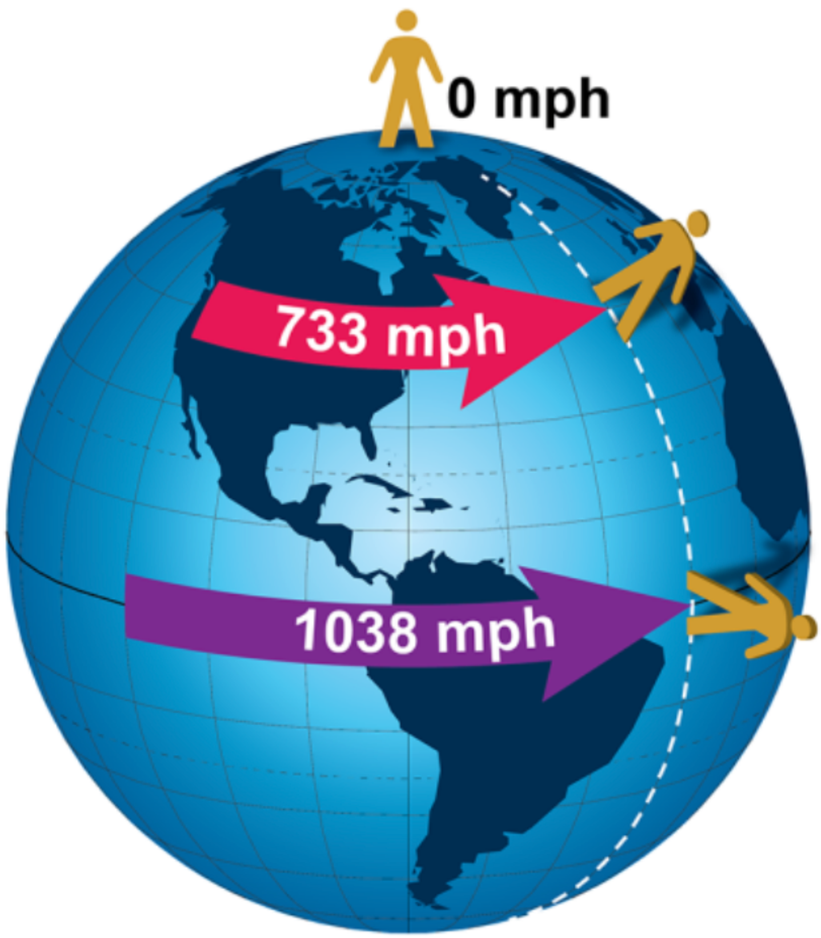
The Differences Between The Polar & Subtropical Jet Stream



The jet stream can be thought of as a "river" of air moving at a certain speed from west to east. This ribbon of fast air resides several miles away from the surface of the Earth, equating to approximately 30,000 feet. The jet stream carries "energy", which tele-connects to all parts of the globe that is responsible for delivering various types of weather.

Why Does The Jet Form?

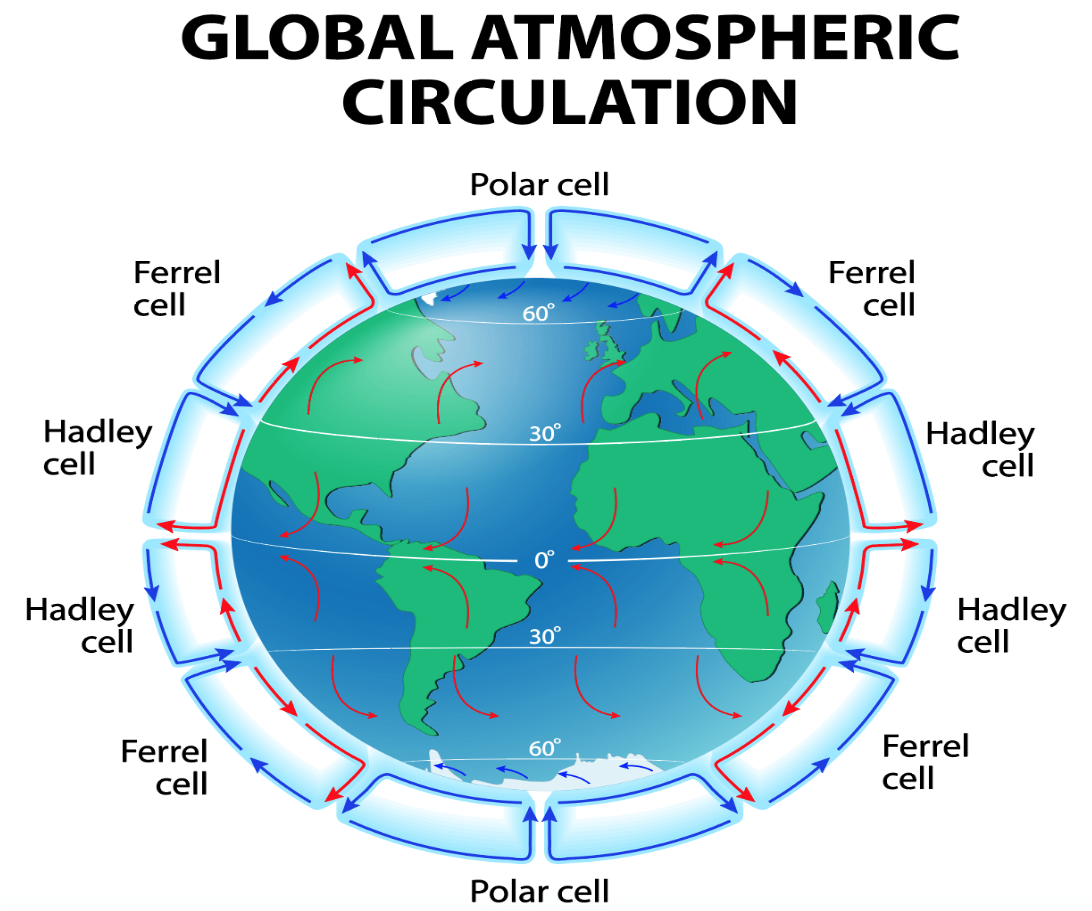
It exists due to the combination of the Earth's rotation and the Coriolis effect. The tropics are dominated by the amount of heat that exists in the oceans with the poles being the opposite. Warm air from the tropics rise and wants to shift toward the poles. However, since the Earth now spins, the rising warm air is deflected to the right in the Northern Hemisphere (Coriolis Effect). Imagine standing at the equator and then at the North Pole. Since Earth is widest at the equator, you must travel at very fast speed as the Earth spins since velocity is zero at the pole. In fact, there is a greater than 1,000 mph difference in speed between the very tip of the North Pole and at the widest point of the equator as shown below from [NOAA](). Momentum of air is always conserved, so those parcels zipping around at the equator will move poleward, though as the diameter of the Earth decreases as you gain latitude, the faster the air will move (since those parcels of air are coming from a region of very fast momentum).



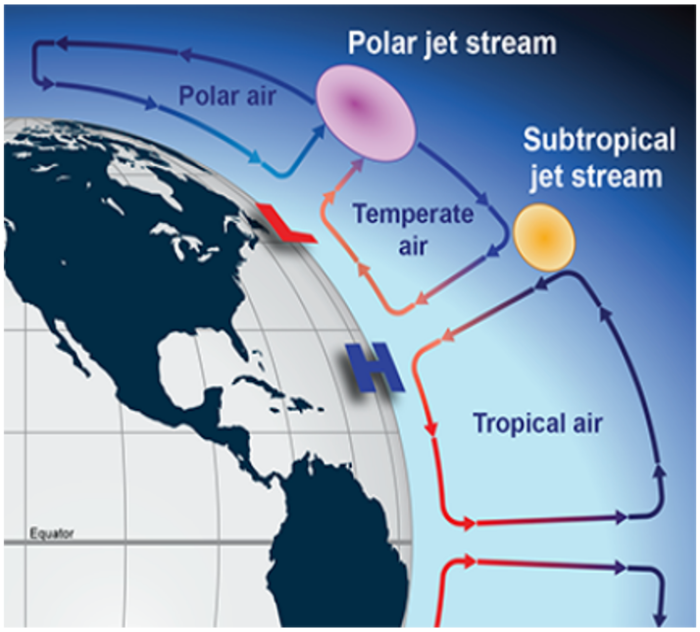
The Polar & Subtropical Jet Streams

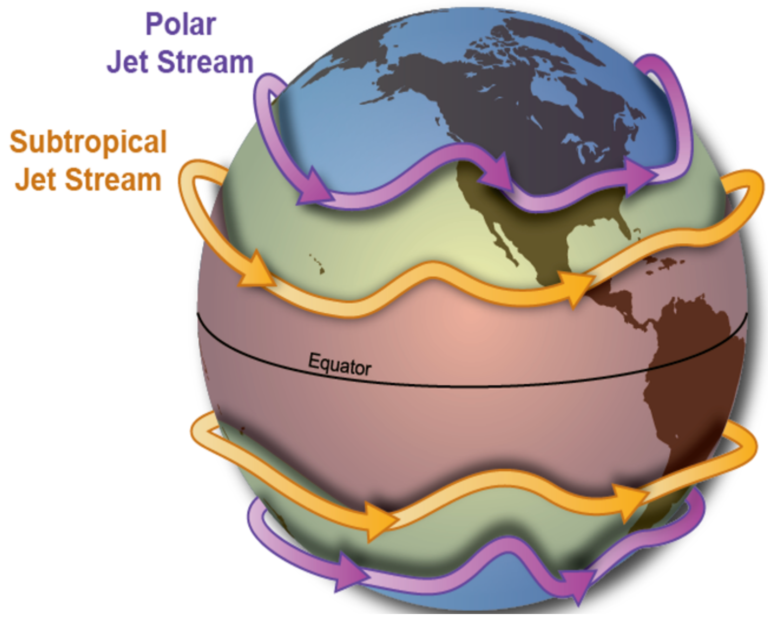
Now that we established why it exists, we can analyze the main "branches" of the jet. As aforementioned, warm air rises at the tropics and the colder, dense air sinks at the poles. The Earth's circulation contains three main "cells" that prevail across both hemispheres, which are broken into the Hadley cell, Ferrel cell, and Polar cell. Due to the variations between temperature between the equator and poles, it forms these circulations. Air rises as we stated at the tropics and sinks around 30*N/S forming the subtropical high (i.e., latitudes where the deserts are located).

That air is then transported poleward where it meets the denser, colder air in the mid-latitudes, while air sinks at the poles. It's where air from the Hadley cell meets air from the Ferrel cell (below) forms the subtropical jet stream. Air between the Polar cell and Ferrel cell (50-60*N/S) forms the polar jet. We see this illustration presented nicely below.



Taking that graphic above, compare it to the one below from NOAA. It's essentially the same content explained above between the cells of Earth, thus forming the various jet streams. It's the clashes between temperature that truly manifest these fast ribbons of air, other than the momentum and energy conserved within all those air parcels. Jet streams simply divide temperature boundaries. Below, this visually demarcates the division between density of air where south of the subtropical jet is warmer (less dense), while northward the air is cooler (more dense). Further toward the pole, this is where the coldest air resides.

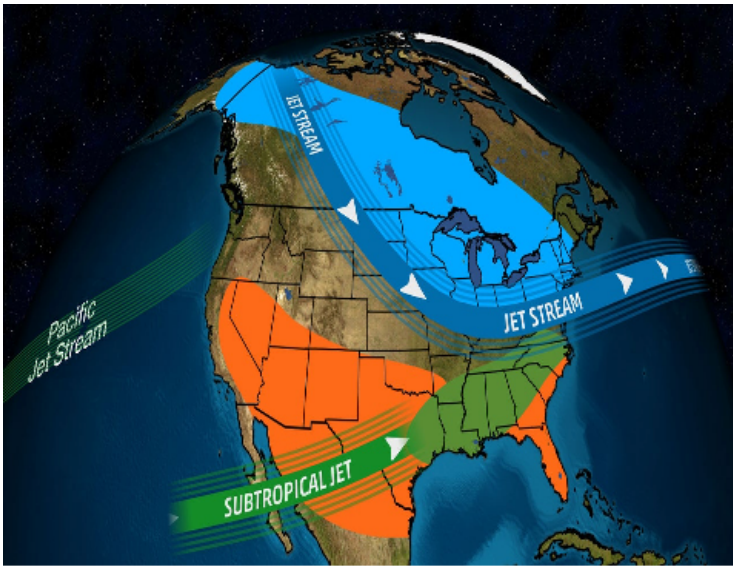


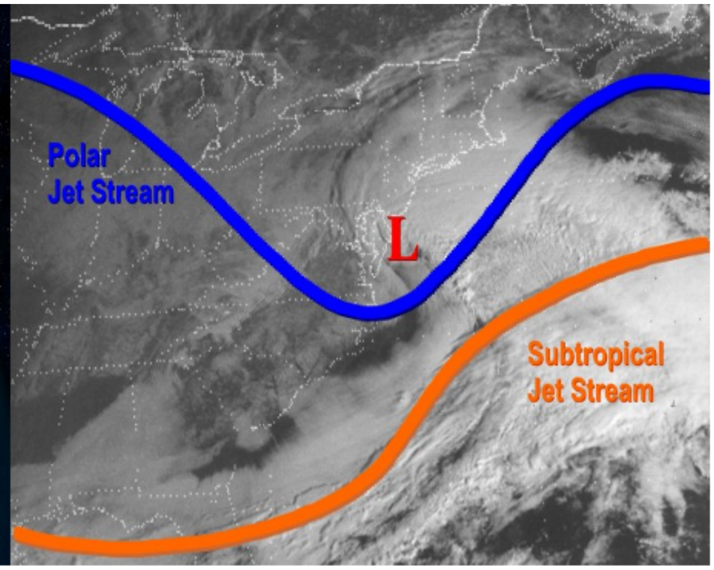


During The Winter Season

In the winter, we see the greatest temperature differences between the equator and poles. This is where both the subtropical and polar jet stream are at their greatest in terms of magnitude and intensity. The greater the difference in temperature, the greater the wind speed. This is where you can see wind speeds in jet streaks exceed 250 mph! Now imagine the clashing between the polar air and the sub-tropical air. In winter, this is where you'd see intense Nor'easters, "bomb" cyclones, and blizzards.

Below represents a nice graphic from TWC (L) of how at times, there can be both the presence of the polar and subtropical jet streams. Typically, those impactful winter cyclones like the one on the right, are a manifestation of the interaction between the two. Sometimes this is coined as "phasing". During the winter when there may be an arctic outbreak, the polar jet stream dislodges southward into the mid-latitudes. The subtropical jet stream carries the warmer, moist air since it stems from the Eastern Pacific and crosses the mild Gulf. The clashing between the cold dry air, and warm moist air creates such dynamic systems that can produce copious amounts of snow across several regions. In this case on the right, we see the result of phasing producing a large Nor’easter. It’s quite difficult to have both jet streams in “sync” and “phase” at the right time since other variables are involved that be able to time it perfectly, but this is why it makes these incredible blizzards or Nor’easters so special!





We tend to see a higher interaction between these two branches of the jet stream during El Nino’s since the subtropical jet stream is much more active than La Nina’s. If the timing is right, and an arctic outbreak occurs, there’s a much higher chance of seeing phasing. Since we’re now officially in an El Nino, we just very well may see this happen this winter!