What are the major wind systems of the world?

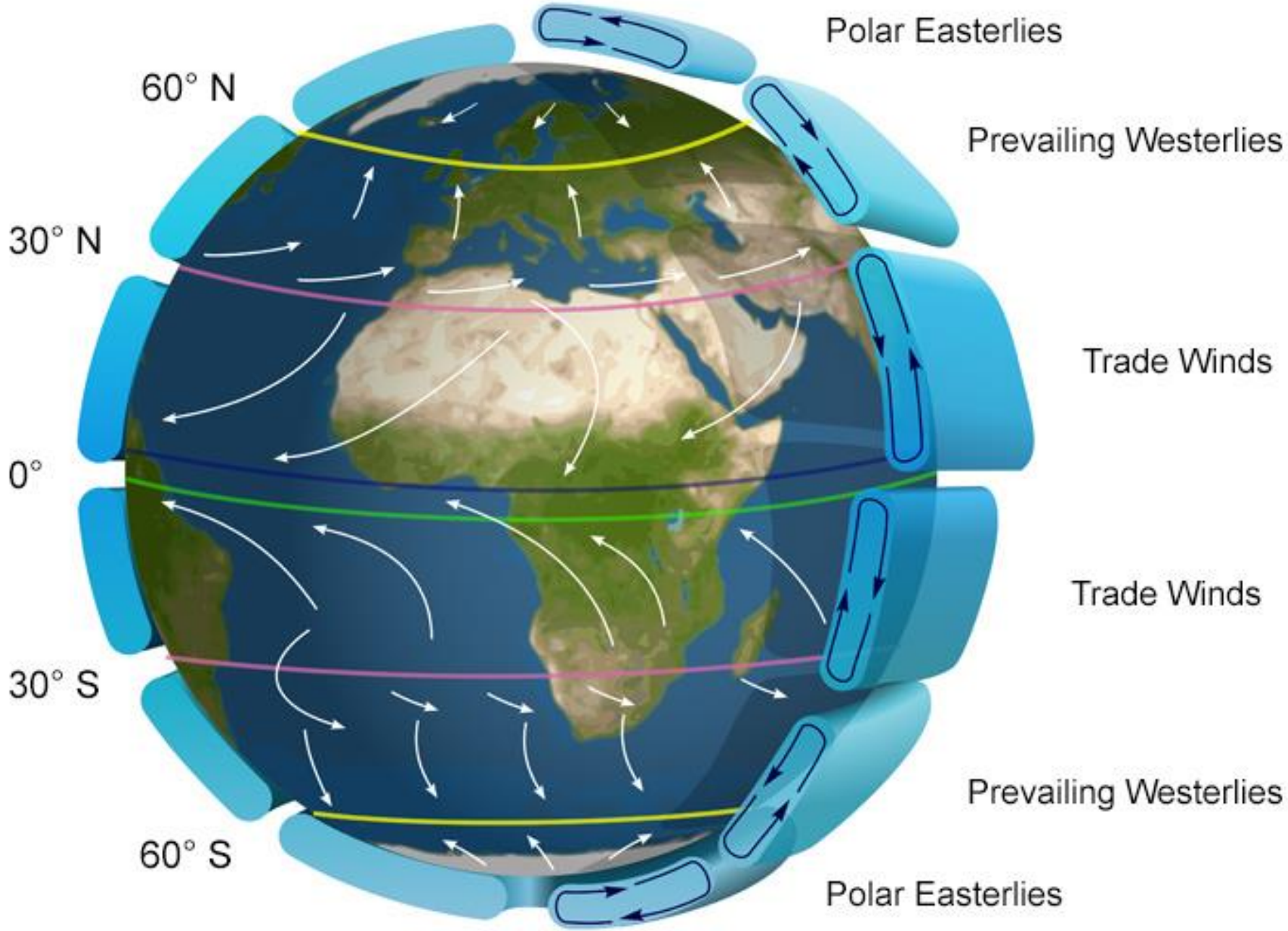
The wind is the result of an interaction between the sun's energy and the Earth. But our planet is not uniform - land and water are distributed unevenly.

The unequal heating of the surface of the planet, i.e., the temperature differences between the Equator and the Poles, combined with the Earth's rotation, is responsible for the creation and development of six major air circulation patterns, three in each hemisphere.

They are the **Polar Easterlies**, the **Prevailing Westerlies**, and the **Trade Winds**. Each one of them rules roughly 30 degrees of latitude, like wind belts around the Earth.

As Earth rotates from west to east and the **Coriolis Effect** kicks in, the winds on the Northern Hemisphere curve to the right, and the winds on the Southern Hemisphere curve to the left.

Generally, prevailing wind patterns around the world are westerly - going from west to east


Polar Easterlies
60° N
Prevailing Westerlies
30° N
Trade Winds
0°
Trade Winds
30° S
Prevailing Westerlies
60° S
Polar Easterlies

Polar Easterlies, Trade Winds and Prevailing Westerlies

- The wind typically moves from areas of high pressure to areas of low pressure.

So, the first air current moves from 90 degrees (the North Pole and the South Pole) and heats up quickly at 60 degrees (northern and southern hemispheres) - the air expands, rises, and cycles back in a counterclockwise loop.

<u>These are the so-called Polar Easterlies.</u>

- An identical process occurs between the Equator line (0 degrees) and 30 degrees (northern and southern hemispheres).

<u>These are the so-called Trade Winds</u>

- But because the air gets trapped between 30 degrees and 60 degrees, a new convection current begins to take shape, this time in clockwise mode.

<u>These are the so-called Prevailing Westerlies.</u>

The Jet Stream

We saw that the earth's rotation divided this circulation into three cells. The earth's rotation is responsible for the jet stream as well.

The wind doesn't go across the Equator very often. It's almost like a no-wind zone. Sailors call it the "doldrums."

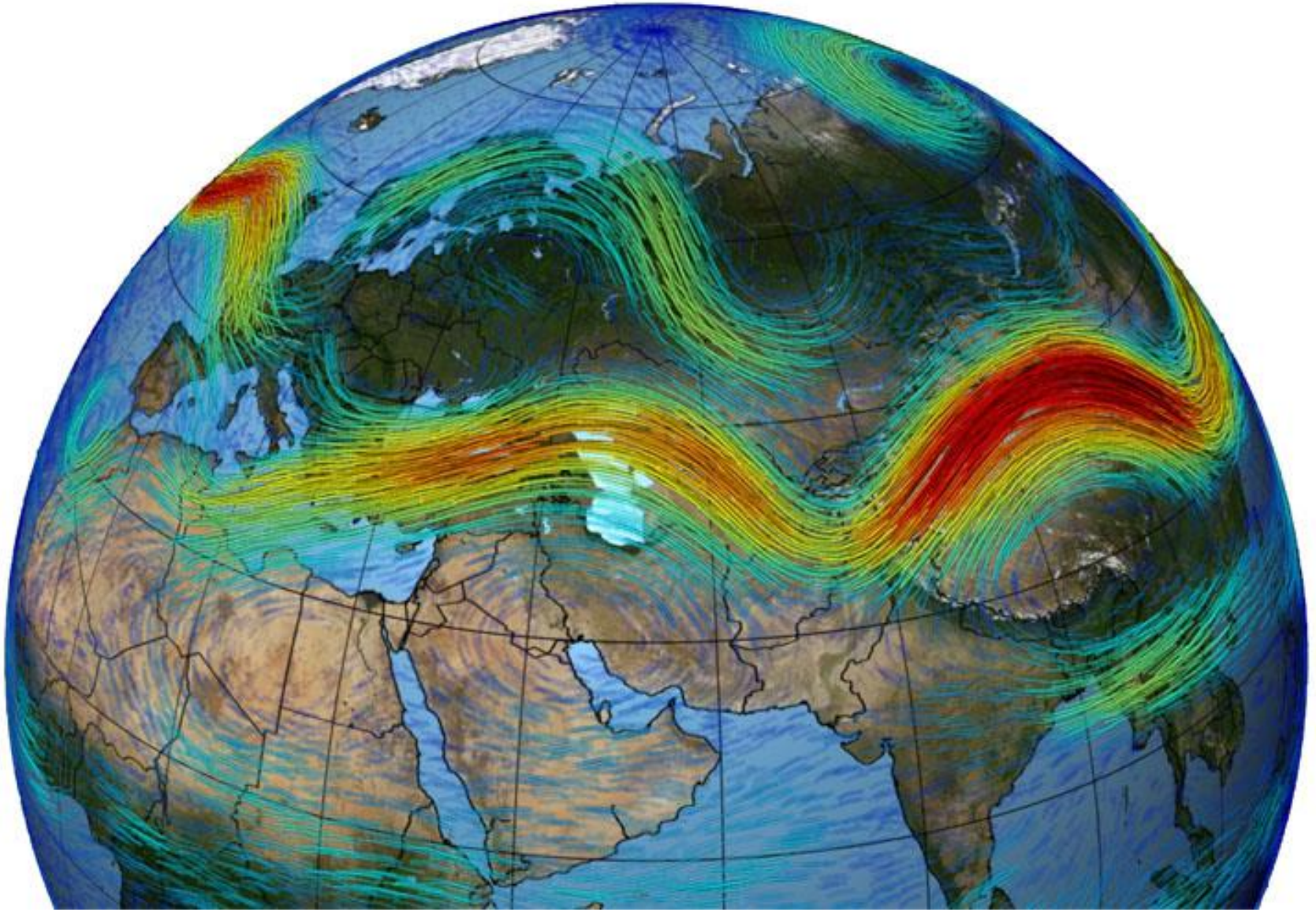
But sailing problems also take place in the area between the Prevailing Westerlies and the Trade Winds zone, about 30 degrees north.

In the past, sailors would get weight out of caravels by dumping horses overboard to travel faster.

That is why the 30th parallel north ended up being called the Horse Latitude.

- Last but not least, the collision between the Polar Easterlies (high-pressure air) and the Prevailing Westerlies (lower pressure air) forms a fast, powerful wind that moves from the west to the east - the Jet Stream.

The Jet Stream moves in a swirl pattern and changes on a daily basis. It is responsible for the transportation of weather systems.



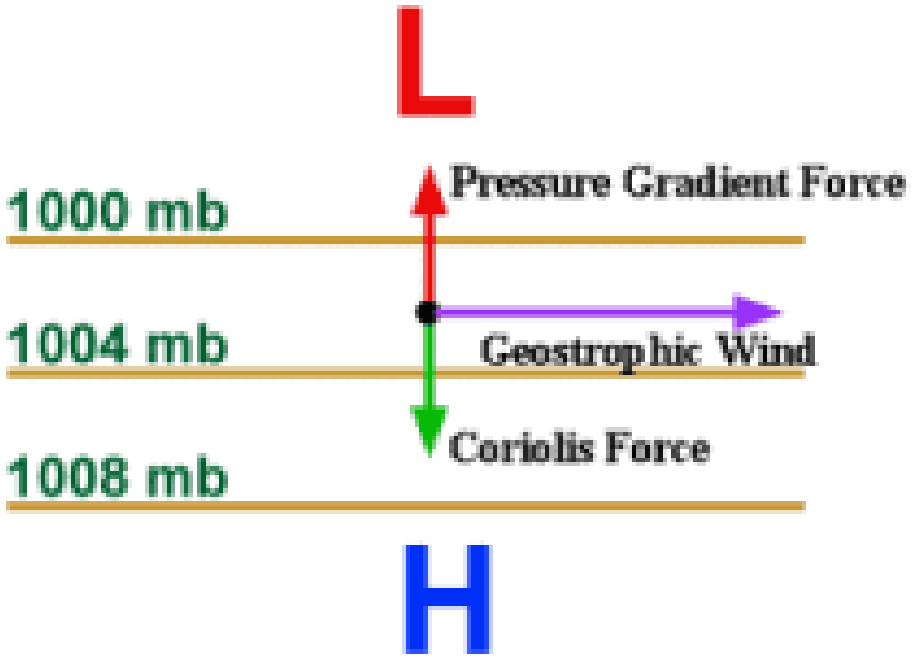
What Is the Jet Stream?

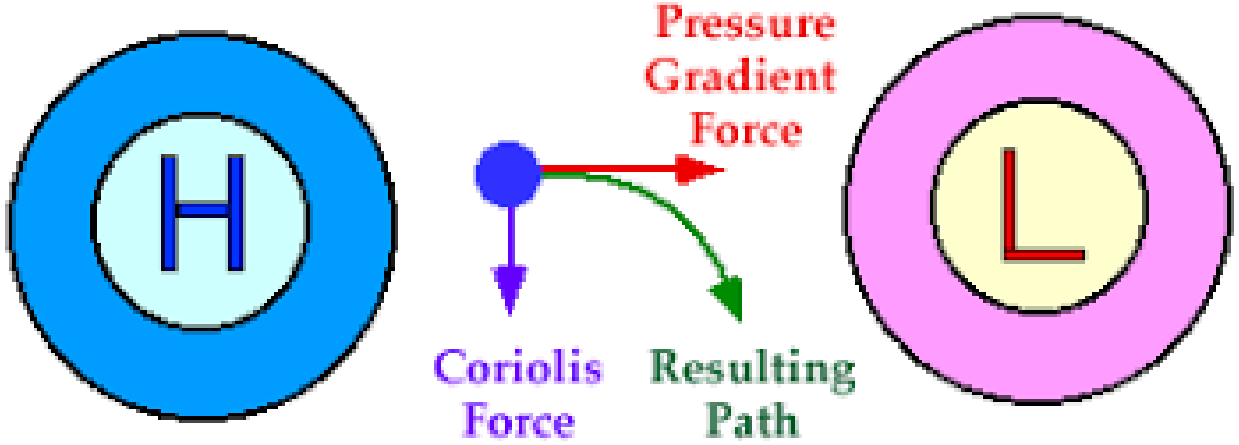
- Jet streams are narrow bands of strong wind that generally blow from west to east all across the globe. The Jet Stream is a **geostrophic wind** blowing horizontally through the upper layers of the troposphere, at an altitude of 20,000 - 50,000 feet.

Earth has four primary jet streams: two polar jet streams, near the north and south poles, and two subtropical jet streams closer to the equator.

Geostrophic wind is the wind that is caused by two important effects in the earth's atmosphere. One of these, the **pressure gradient force**, is the force that occurs when air moves from areas of high pressure to areas of low pressure. The other, the **Coriolis effect**, is the diversion of the air in the Northern Hemisphere of the earth. The movement due to pressure, in a combination with this diversion, is called the geostrophic wind. This wind is also called the geostrophic flow

Geostrophic wind





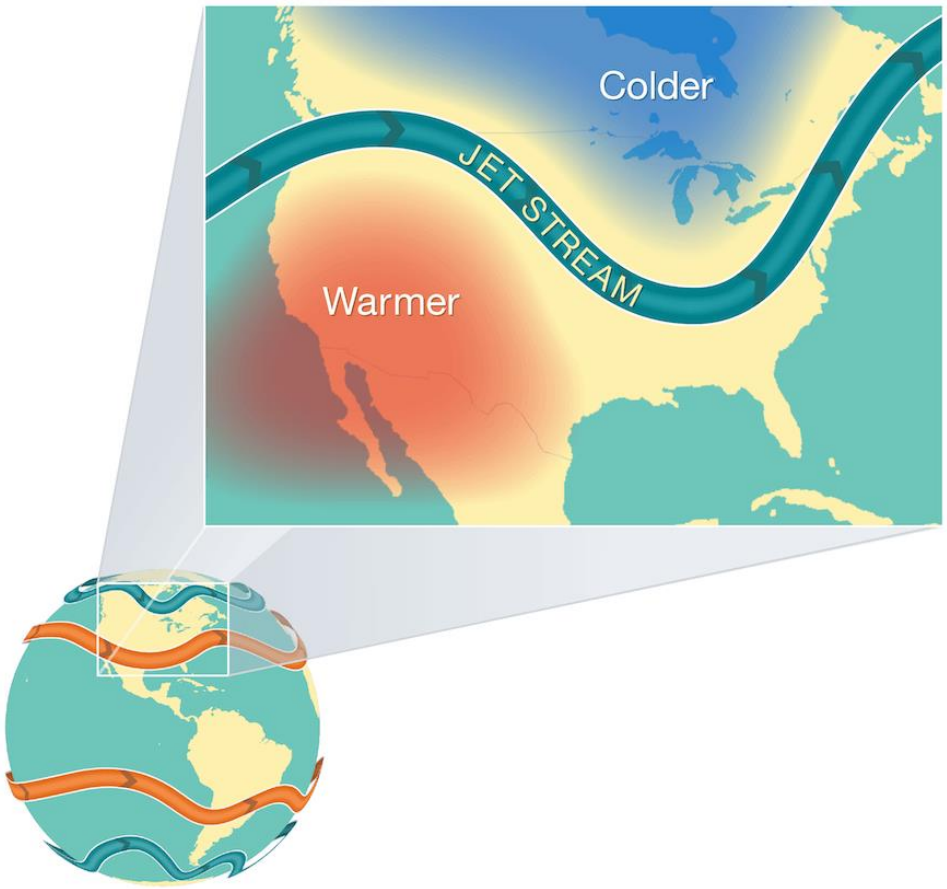
What Causes Jet Streams?

- Jet streams form when warm air masses meet cold air masses in the atmosphere.

The Sun doesn't heat the whole Earth evenly. That's why areas near the equator are hot and areas near the poles are cold.

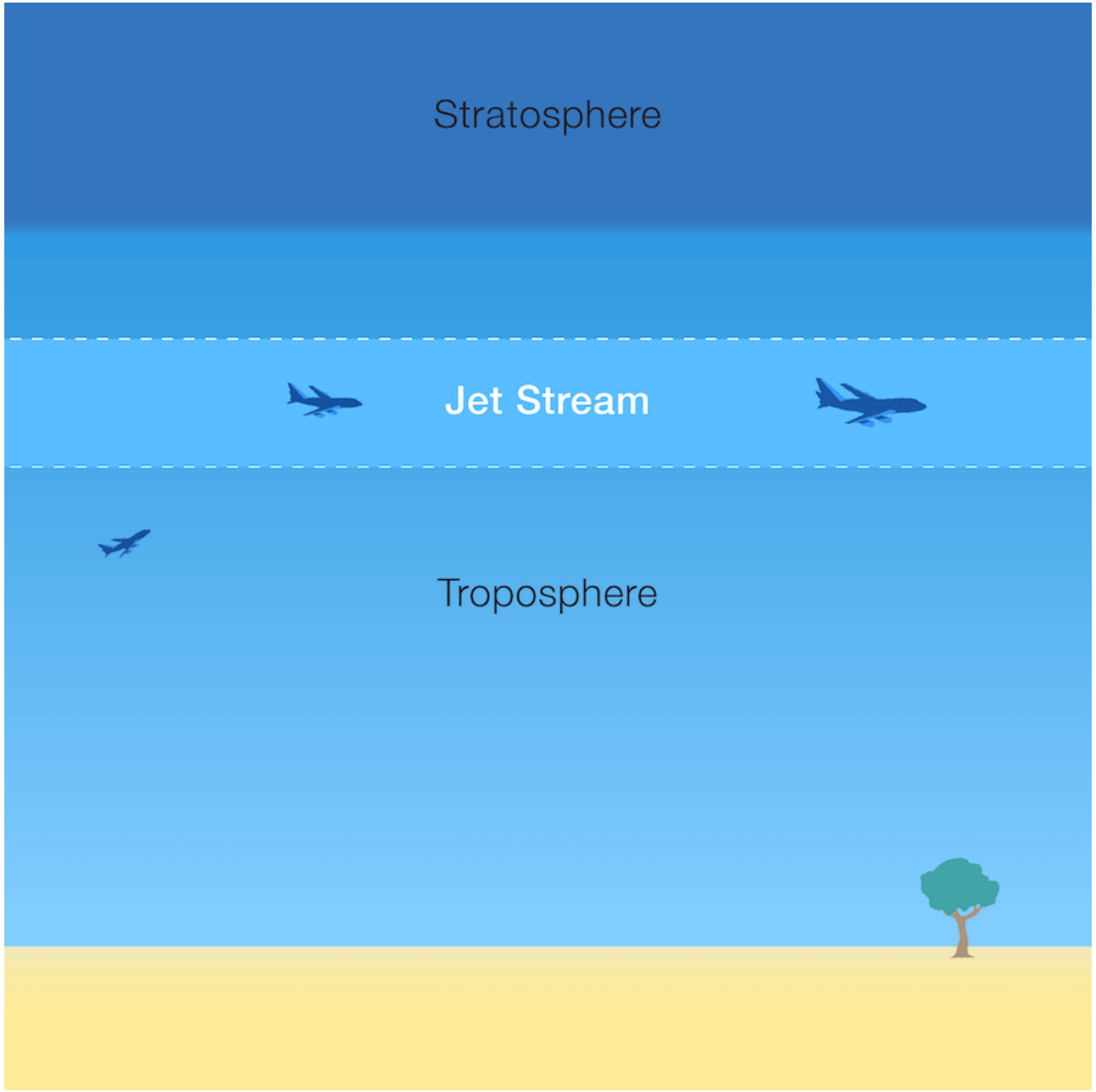
So when Earth's warmer air masses meet cooler air masses, the warmer air rises up higher in the atmosphere while cooler air sinks down to replace the warm air. This movement creates an air current, or wind. A jet stream is a type of air current that forms high in the atmosphere.

On average, jet streams move at about 110 miles per hour. But dramatic temperature differences between the warm and cool air masses can cause jet streams to move at much higher speeds — 250 miles per hour or faster. Speeds this high usually happen in polar jet streams in the winter time.



How Do Jet Streams Affect Air Travel?

- Jet streams are located about five to nine miles above Earth's surface in the mid to upper troposphere — the layer of Earth's atmosphere where we live and breathe.
- Airplanes also fly in the mid to upper troposphere. So, if an airplane flies in a powerful jet stream and they are traveling in the same direction, the airplane can get a boost. That's why an airplane flying a route from west to east can generally make the trip faster than an airplane traveling the same route east to west.



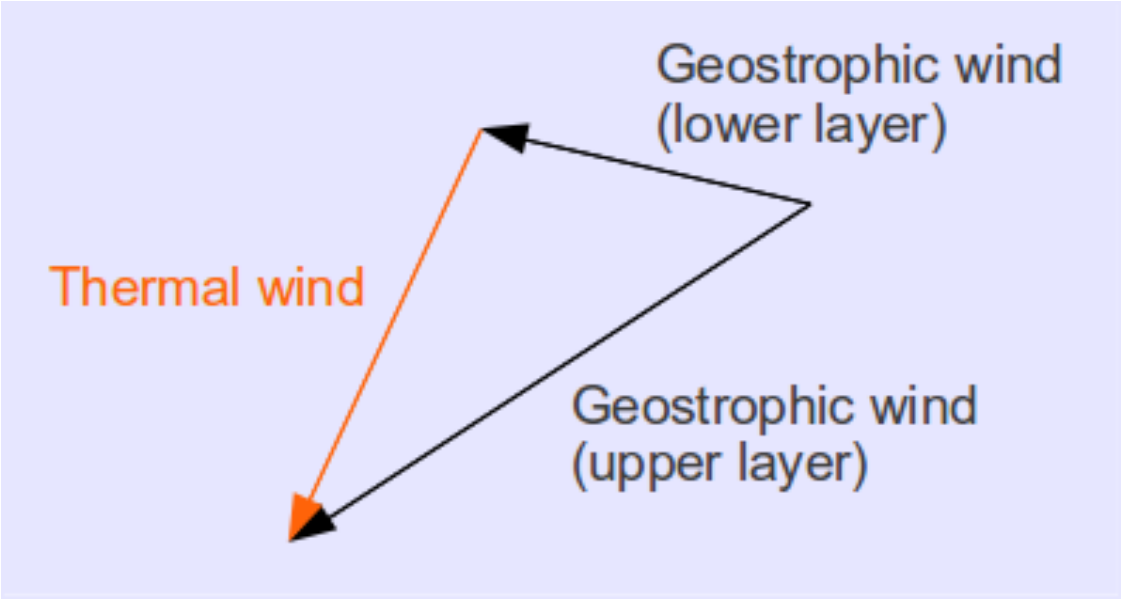
Genesis of Jet Streams

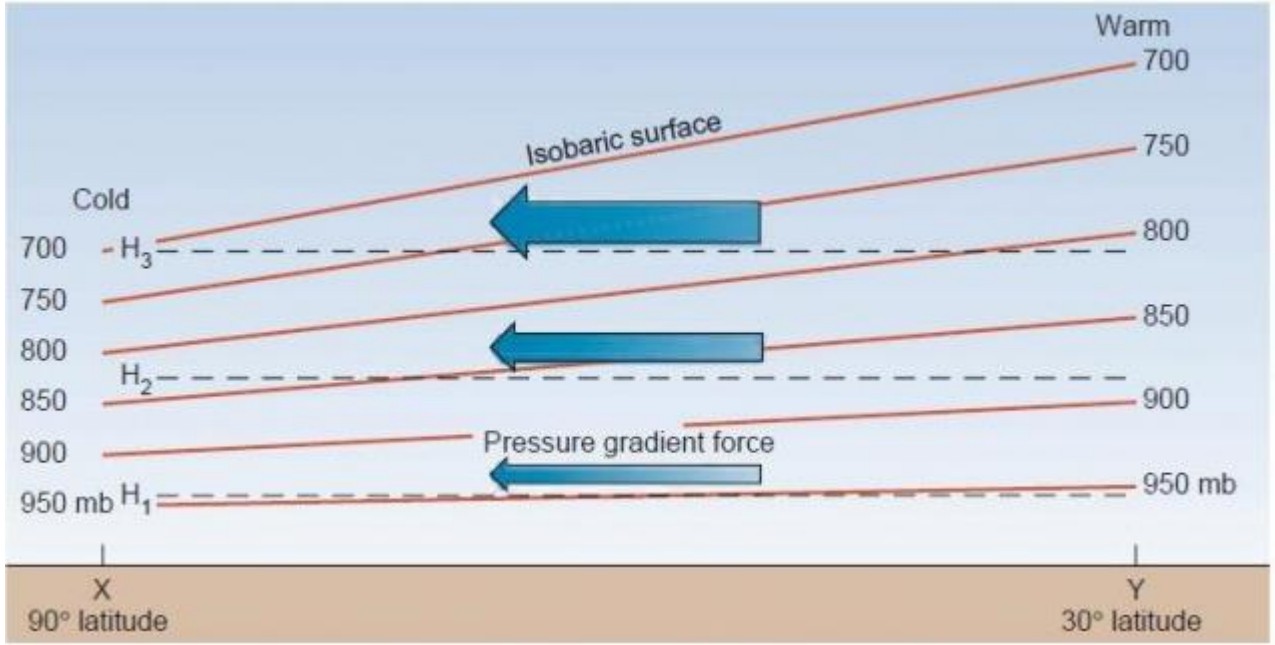
- The genesis of the Jet-streams is provided by three kinds of gradients:

✓Thermal gradient between pole and equator

✓Pressure gradient between pole and equator

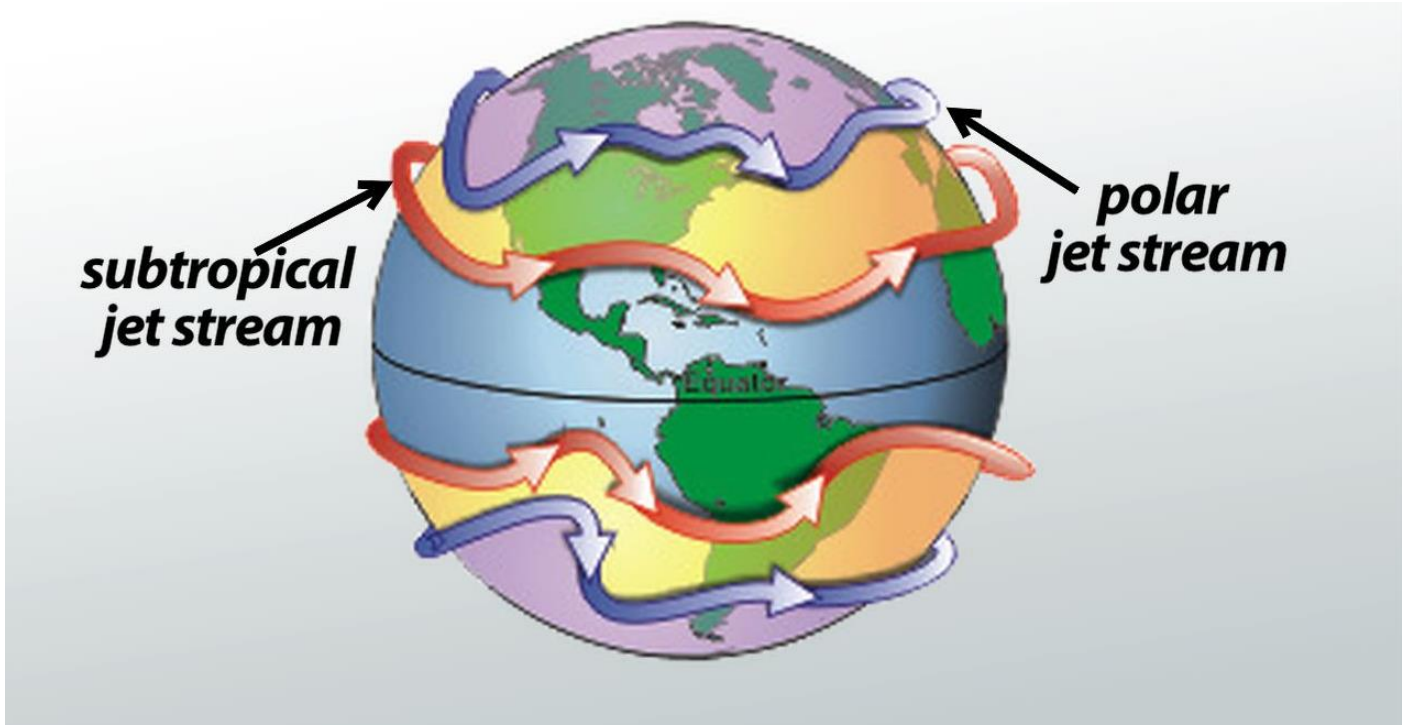
✓Pressure gradient between surface and subsurface air over the poles.

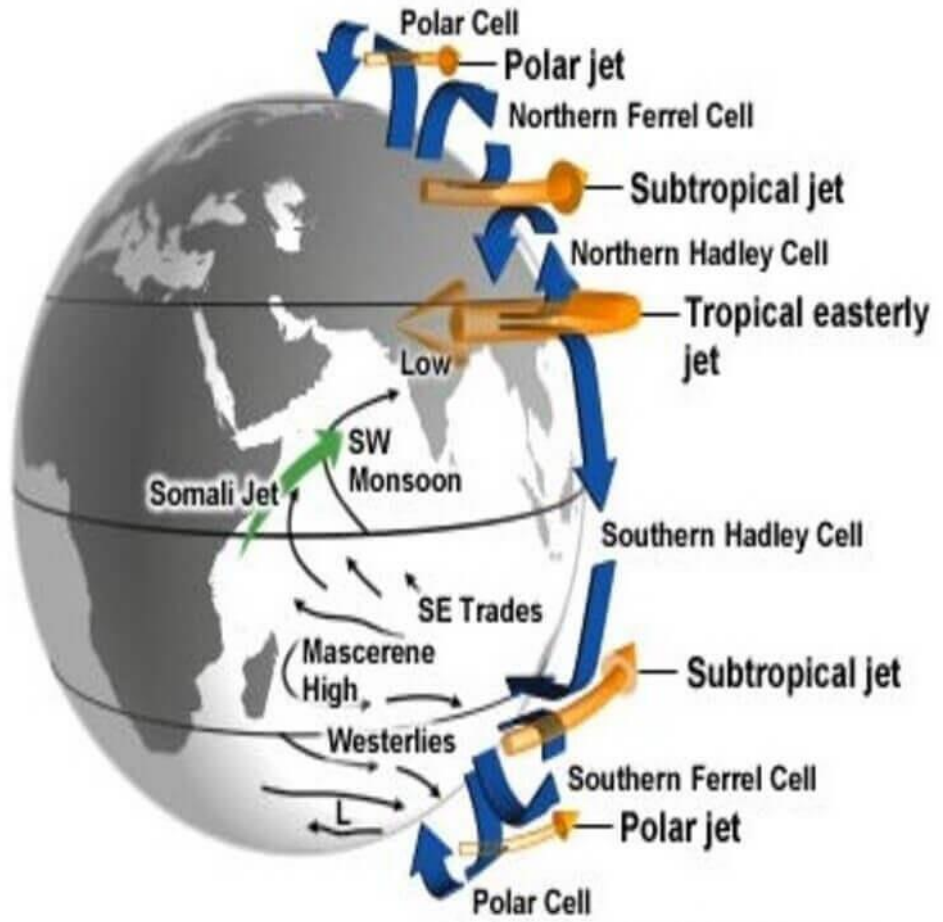




Types of Jet Streams

- **Sub Tropical Jet Streams** are best developed in winter and early spring. Their maximum speed approaches 300 knots which are associated with the merger with polar-front jets. A subsidence motion accompanies subtropical jets and gives rise to predominantly fair weather in areas they pass over. Sometimes they drift northward and merge with a polar-front jet.
- **Tropical Easterly Jet Stream** occurs near the tropopause over Southeast Asia, India, and Africa during summer. This jet implies a deep layer of warm air to the north of the jet and colder air to the south over the Indian Ocean. The difference in heating and cooling and the ensuing pressure gradient is what drives this jet.
- **Polar-Night Jet Stream** meanders through the upper stratosphere over the poles. They are present in the convergence zone above the sub polar low pressure belt.





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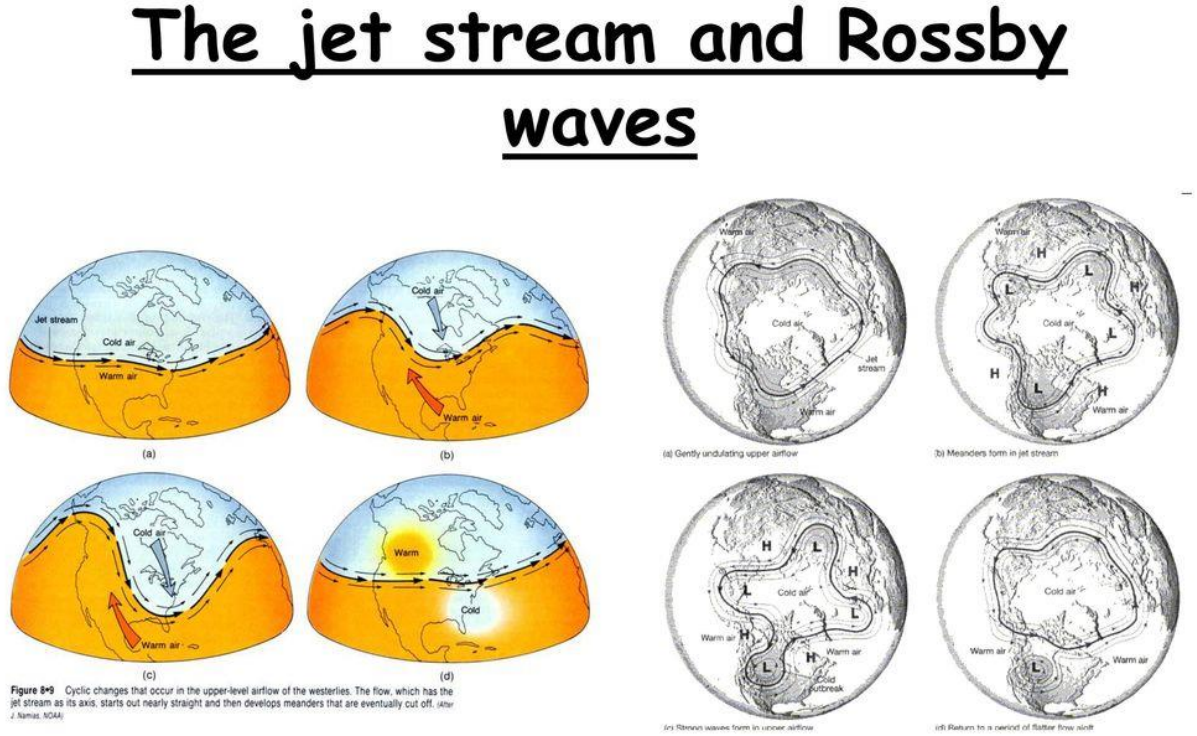
Characteristics of Jet Streams

- Its genesis is associated with the thermal contrast of air cells, for example Hadley cell, Ferrel cell.
- The meandering or the whirl movement of the Jet Stream is called **'Rossby Wave'.**
- Equatorial extension of the Jet Stream is more in winter because of the southern shift of the pressure belts.
- During winters, the thermal contrast increases and the intensity of the high pressure centre at the pole increases. It intensifies the formation of Jet Streams, its extension as well as its velocity.

A jet stream is a circulation of fast-moving air that is thousands of miles away and is not very dense. While <u>Rossby</u> is the name given to the swirling or meandering motion of the jet stream.



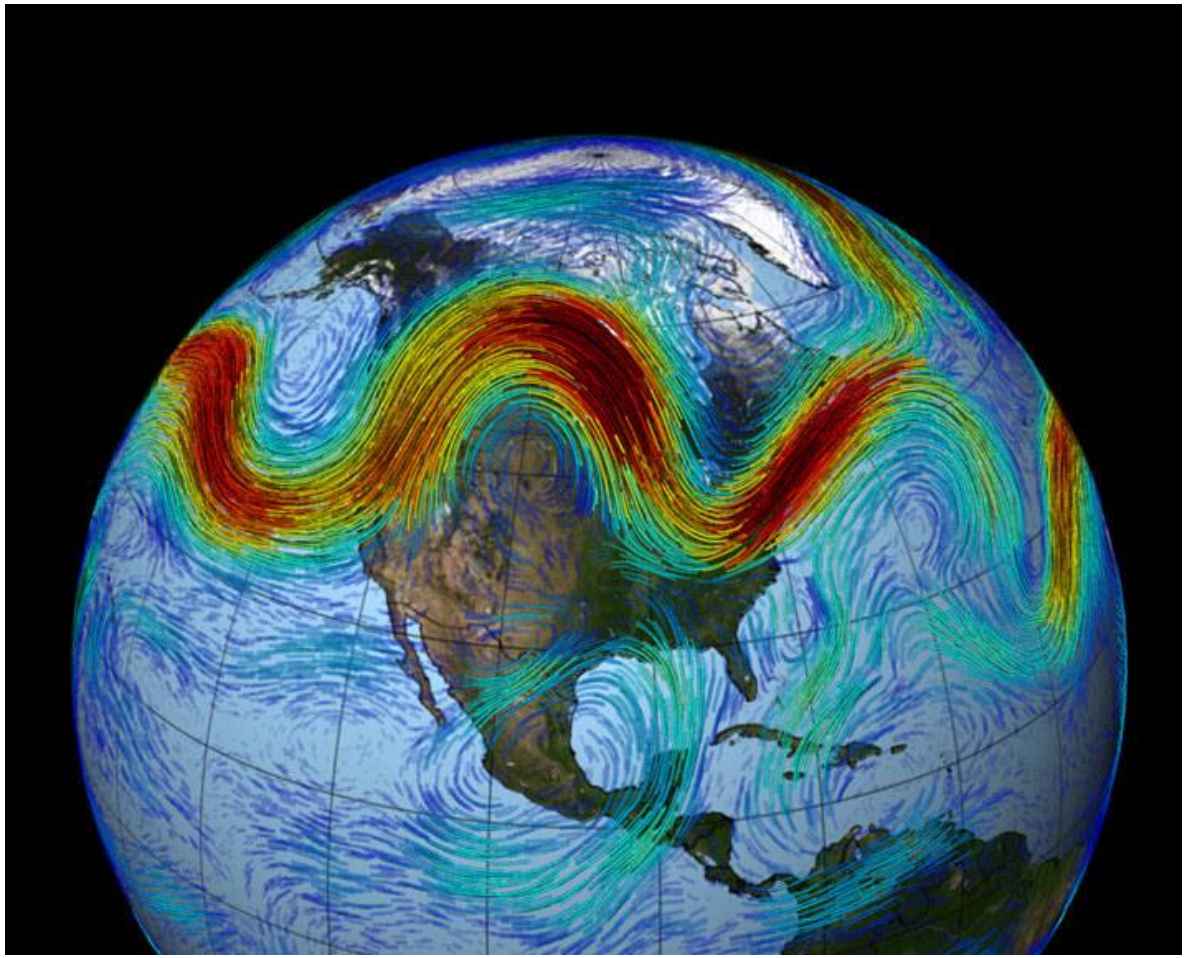
Also see the animations at
http://virga.sfsu.edu/scripts/nhemjet_archloop.html

Climatic Significance of Jet Stream

- At times, Jet Streams bring about some moisture to the stratosphere, leading to the formation of Noctilucent clouds (tenuous cloudlike phenomena in the upper atmosphere which are made of ice crystals visible in a deep twilight.)
- Plays a significant role in the onset and withdrawal of **monsoon winds.**
- Known to have brought some ozone depleting substances to stratosphere which result in **ozone layer depletion.**
- **Intensifies alternative cyclonic and anticyclonic conditions** with the crust and trough formation in its movement.
- When the air mass is moving, it undergoes alternate expansion and compression which means that it is associated with alternative high pressure and low pressure.

How Do Jet Streams Affect Weather?

- The fast-moving air currents in a jet stream can transport weather systems across the United States, affecting temperature and precipitation. However, if a weather system is far away from a jet stream, it might stay in one place, causing heat waves or floods.
- Earth's four primary jet streams only travel from west to east. Jet streams typically move storms and other weather systems from west to east. However, jet streams can move in different ways, creating bulges of winds to the north and south.



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