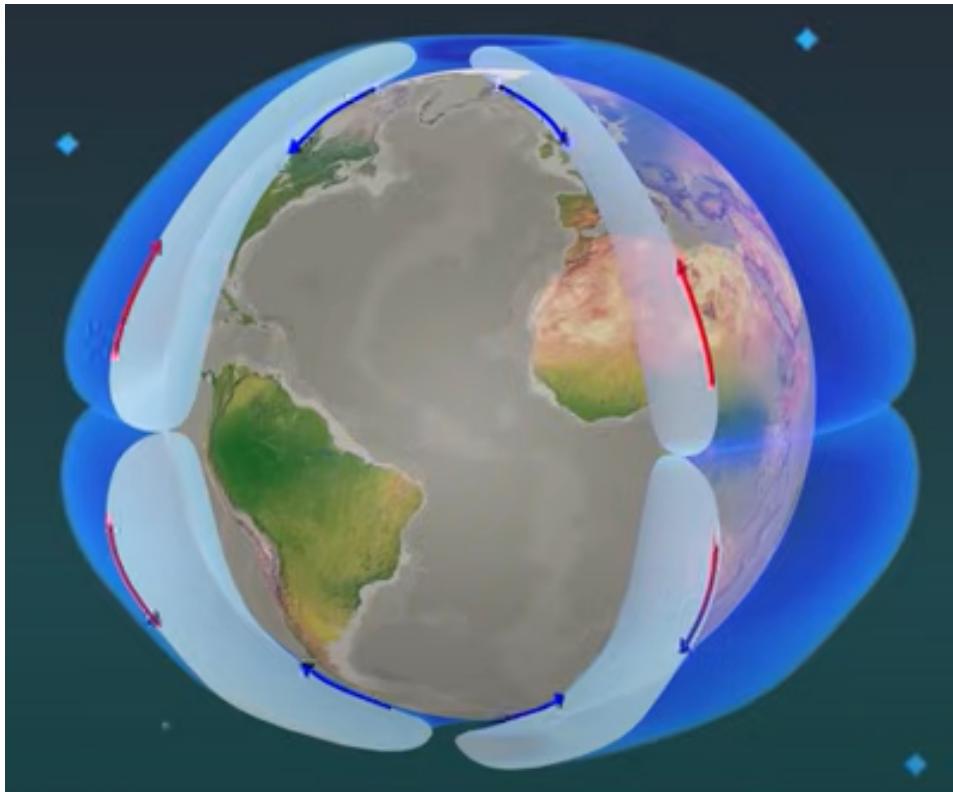


The Jet Streams

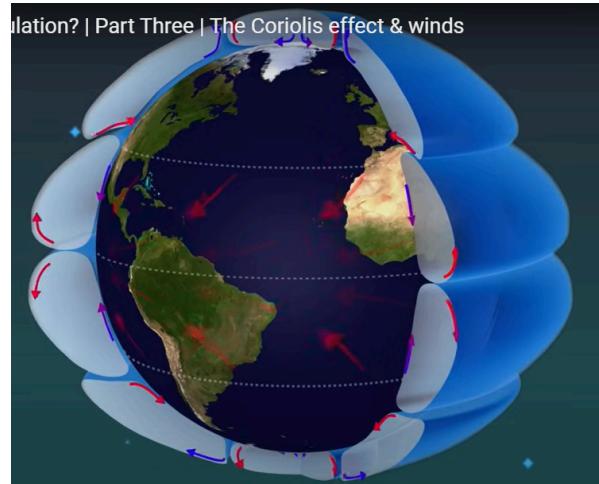
The Jet Stream conversation always has to start with their causes: the temperature difference between the equator and poles (driving air to flow downhill towards the poles) and the rotation of the earth (deflecting that flow with the coriolis effect).

The equator heats and balloons up from the surface, while the poles don't heat as much. This temperature difference between the equator and the poles causes a downhill flow towards the poles. **If the earth did not rotate (and were perfectly smooth), then a single cell moving the heat to the poles would form:**

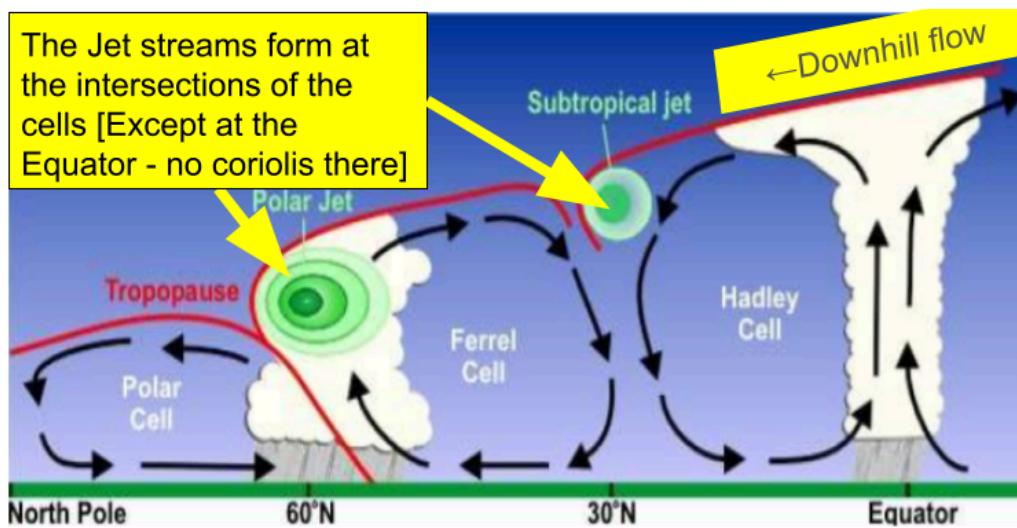
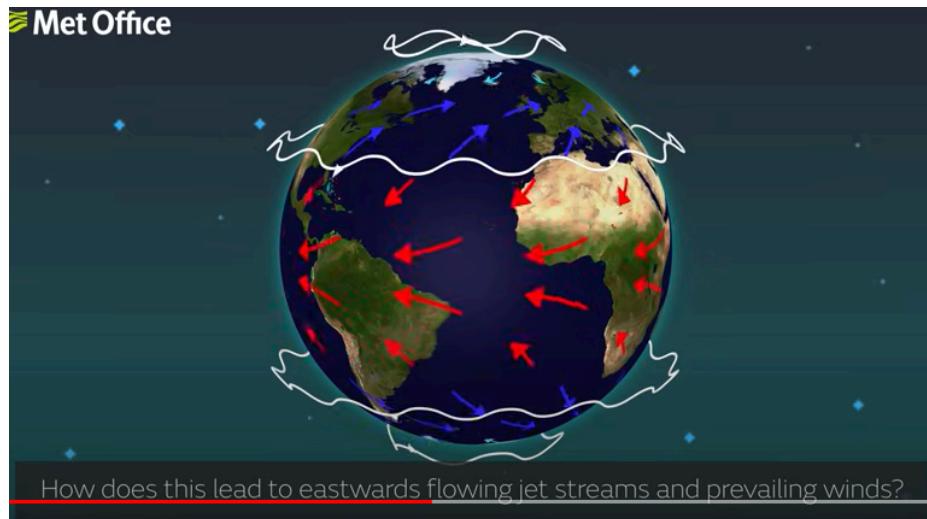


https://www.youtube.com/watch?v=xqM83_og1Fc

But, of course, the earth does rotate (and is not a uniform surface - which we will ignore in this study - we're trying to get a basic vision of how things work). The resulting form is three large cells in each hemisphere - one at the pole, one off of the equator, and one to link them at mid-latitudes (both North and South). We get the JET STREAMS from this configuration.

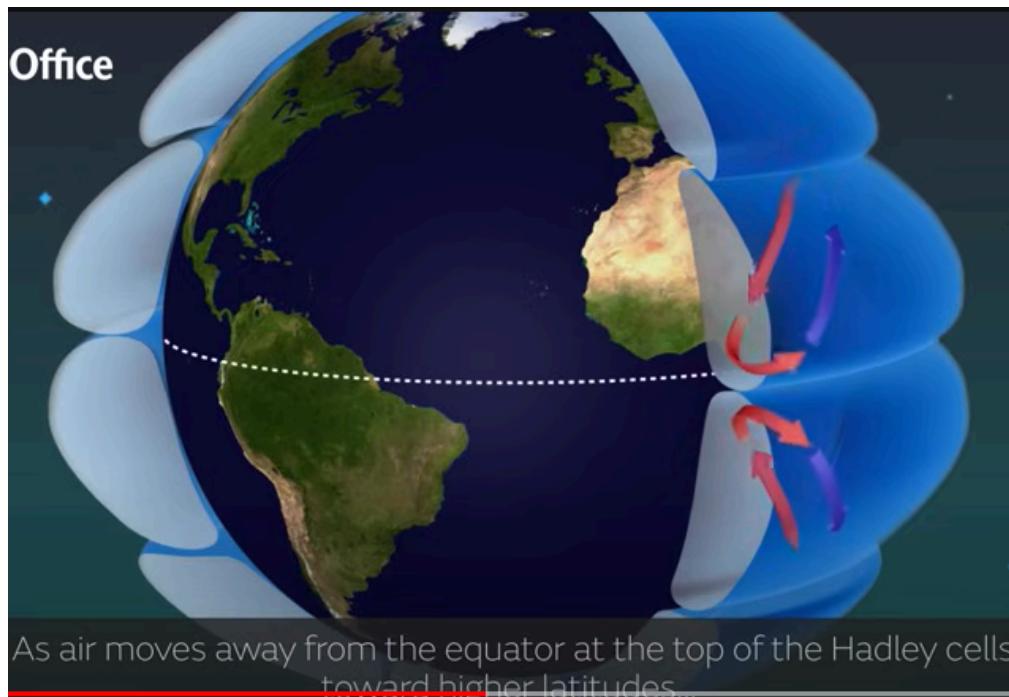
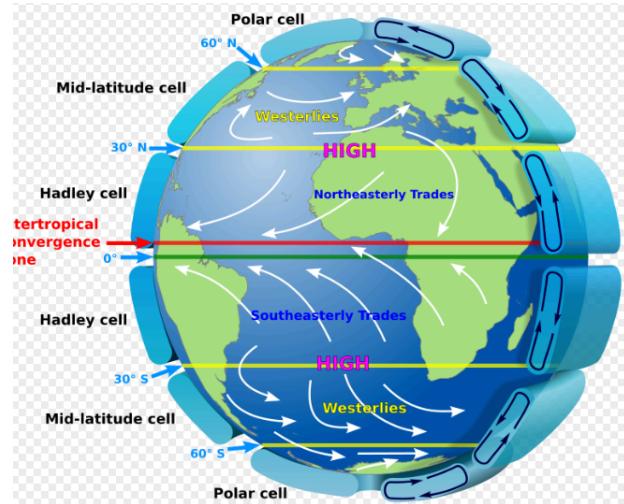


<https://www.metoffice.gov.uk/weather/learn-about/weather/atmosphere/global-circulation-patterns>

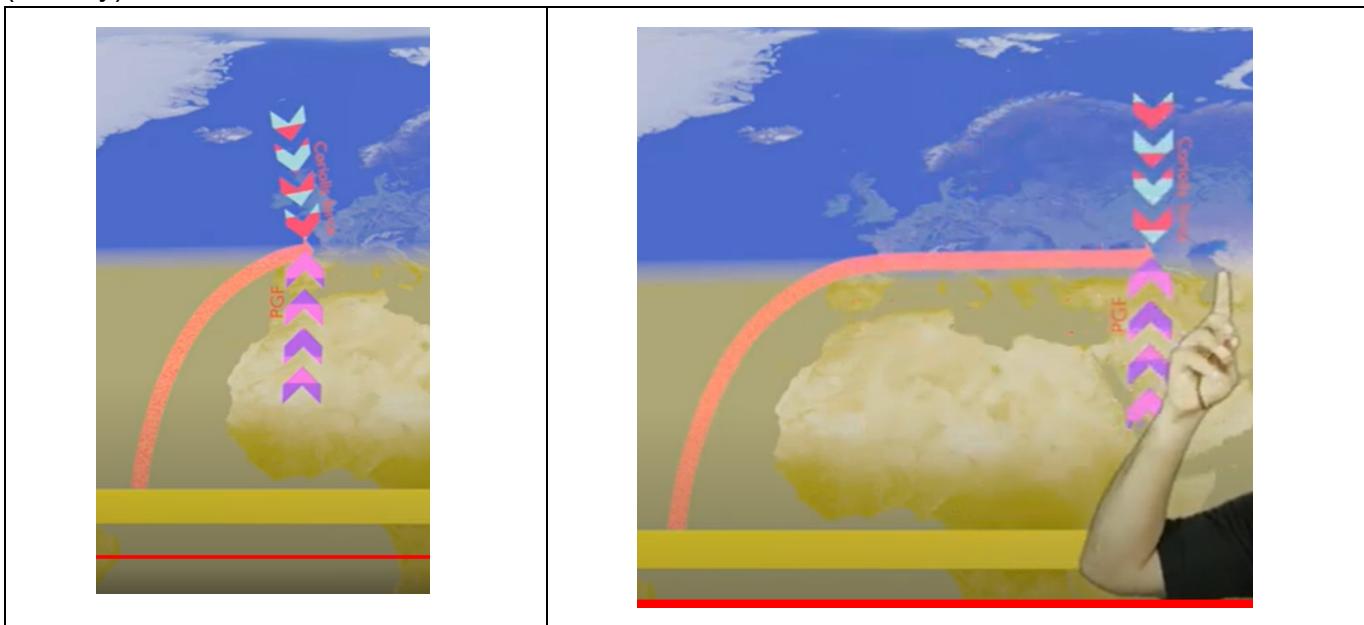


Materials Library at: <https://drive.google.com/drive/folders/100OYwNz92CbY-pC-aYEDrwJTxLj8JUZf?usp=sharing> maclankford@gmail.com

One more thing to focus on- let's look only at the first cell, the Hadley cell. The Coriolis Effect (the ice-skater effect) means that the **high-up winds** heading North from the equator (pulling the skaters arm in) will speed up and **head East**, and winds in that same cell **heading back South at the surface** will seem to slow down and **head West** (the Trade Winds near the equator).



By the time they reach around 30 deg from the equator, they are going very fast, and the coriolis force is proportional to the velocity of the flow. That means they become fully boomerang to the East. The Jet stream is formed. And it stays going East around the globe because **the downhill flow pressure pushing it to the North is offset by the demands of the coriolis force which is trying to divert it to the right**. The result is a very fast stream continuing East around the globe. This forces the north edge of the first (Hadley) cell.

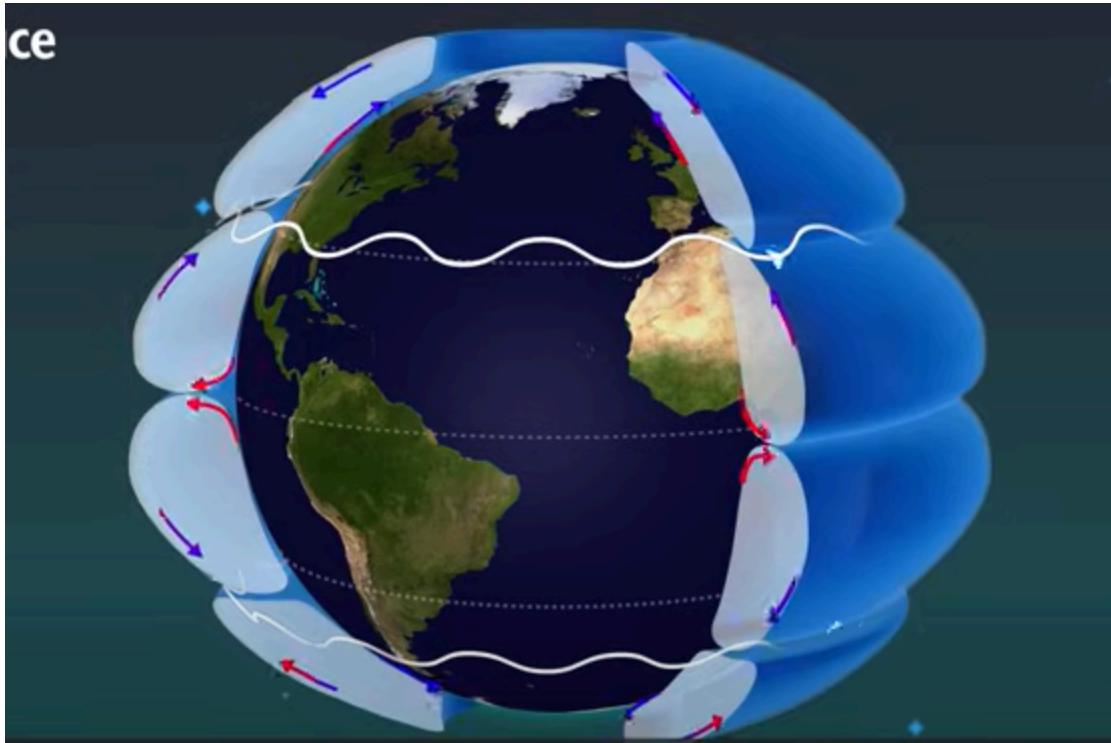


(Yes, this guy really is floating above the atmosphere, daring aliens to try to invade!)

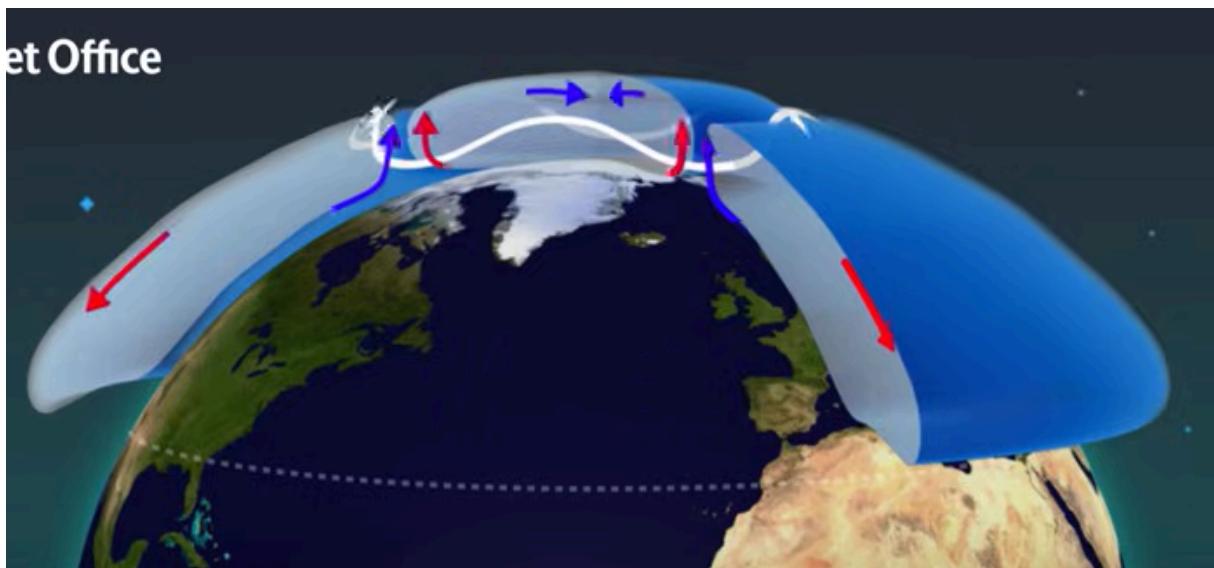
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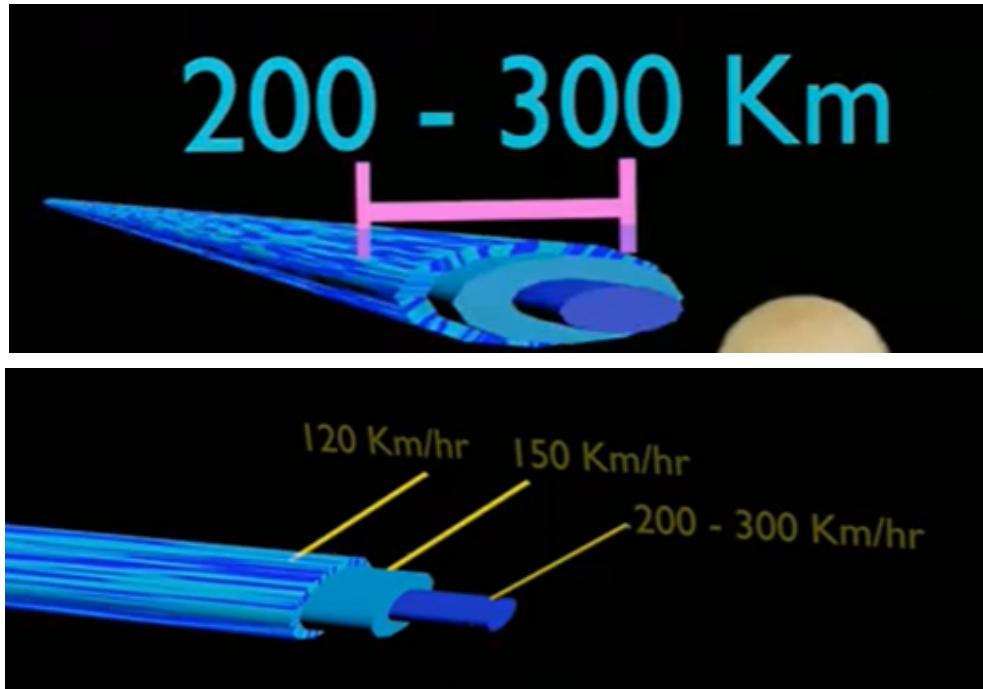
So this forms the **Subtropical jet streams** at around 30-40 deg North and South



The **Polar Jets** form a little differently - primarily because of an **intense pressure difference** right at the intersection of the Ferrel and Polar cells. This accelerates the high-up air very rapidly towards the North, causing the coriolis force to kick in towards the East. We'll not go into the details.



Here's some details on the jet stream flows



Finally, for today, the balance of forces between the coriolis force (driving flows sideways) and the downhill flow (driving flows towards the poles) get impacted by realities on the ground. Friction with the earth below, differences in heating of the land and the oceans, etc. knocks the streams about and we get wavy conditions. These are called **Rossby Waves**, after the guy who figured them out.

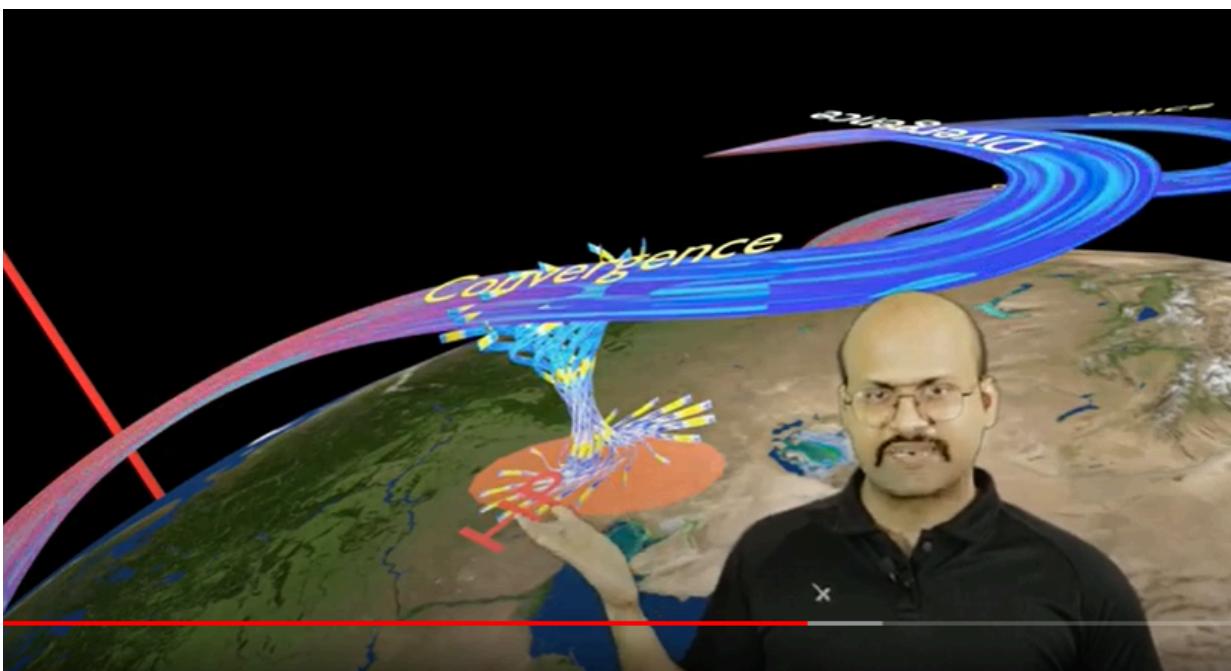
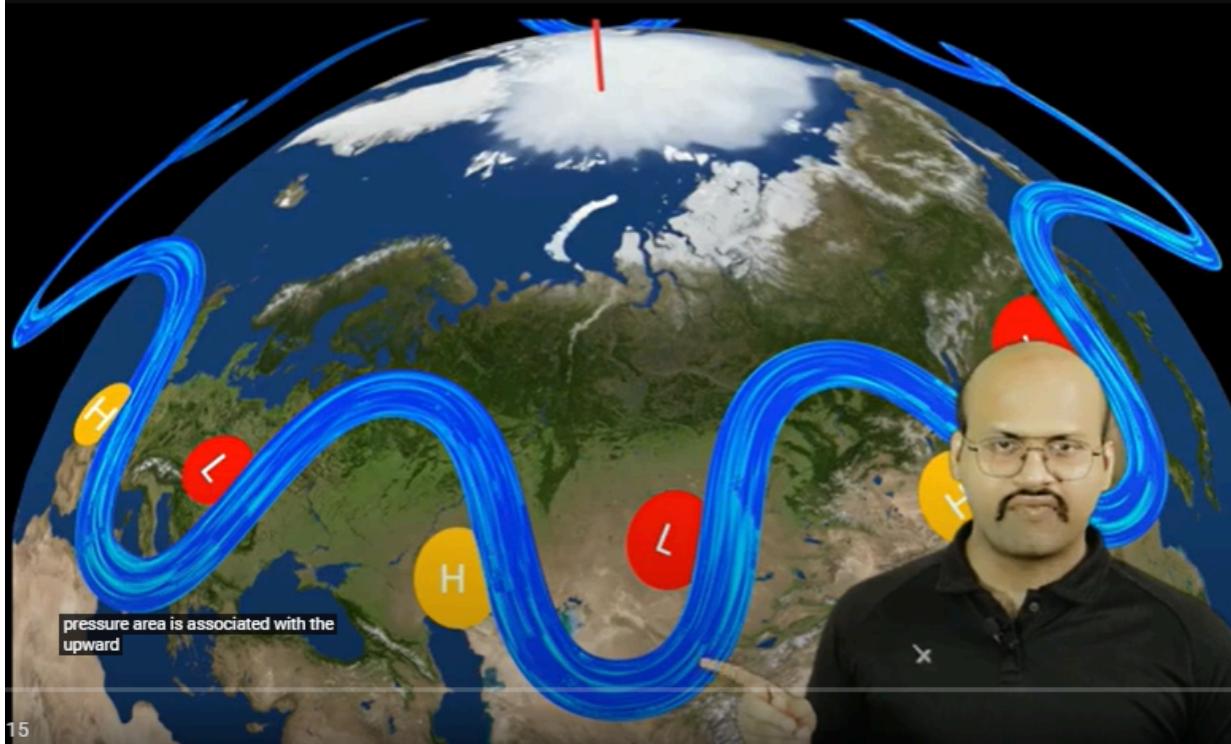


(Yes! He's still watching out for us! But what if they come from the other direction?!)

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The Rossby Waves create high and low pressure areas, and then move them around the globe.

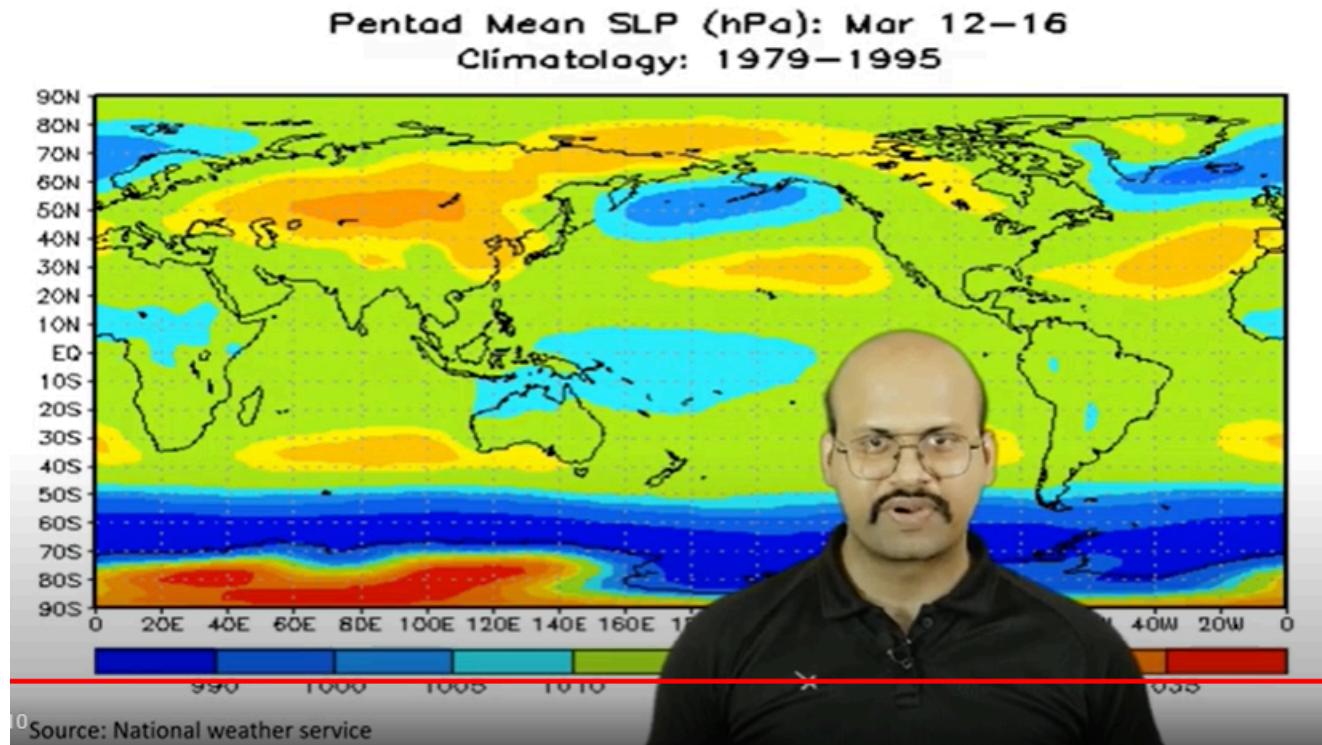


As the air flows around the kinks, it accelerates and decelerates sucking up air from the surface (low pressure) or pushing down air towards the surface (high pressure)

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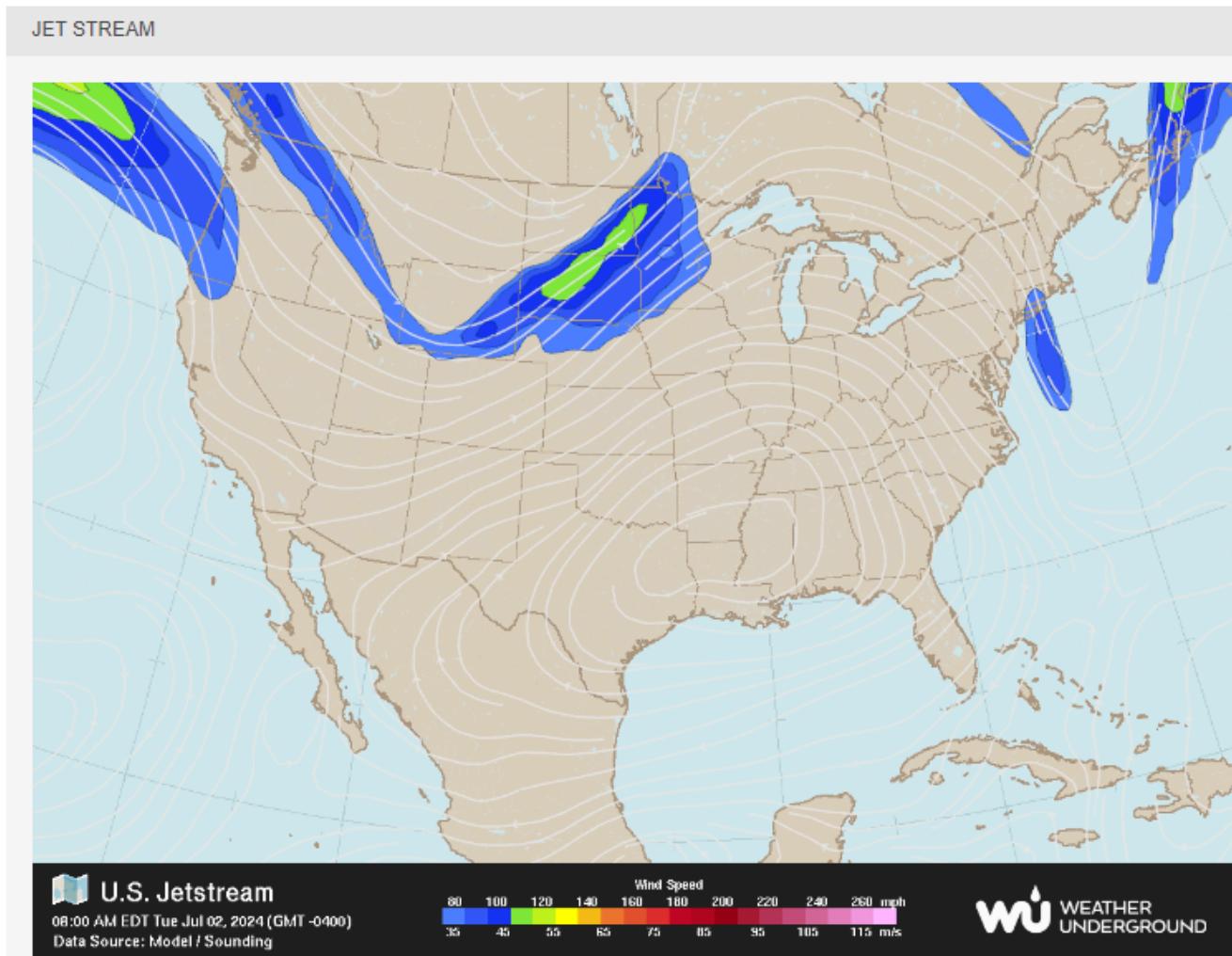
Materials Library at: <https://drive.google.com/drive/folders/100OYwNz92CbY-pC-aYEDrwJTxLj8JUZf?usp=sharing> maclankford@gmail.com

Here is a **multi-year pattern** of the air pressures caused by the jet streams - you can see regions where the pressures have persisted, impacting the **climates** across the world.



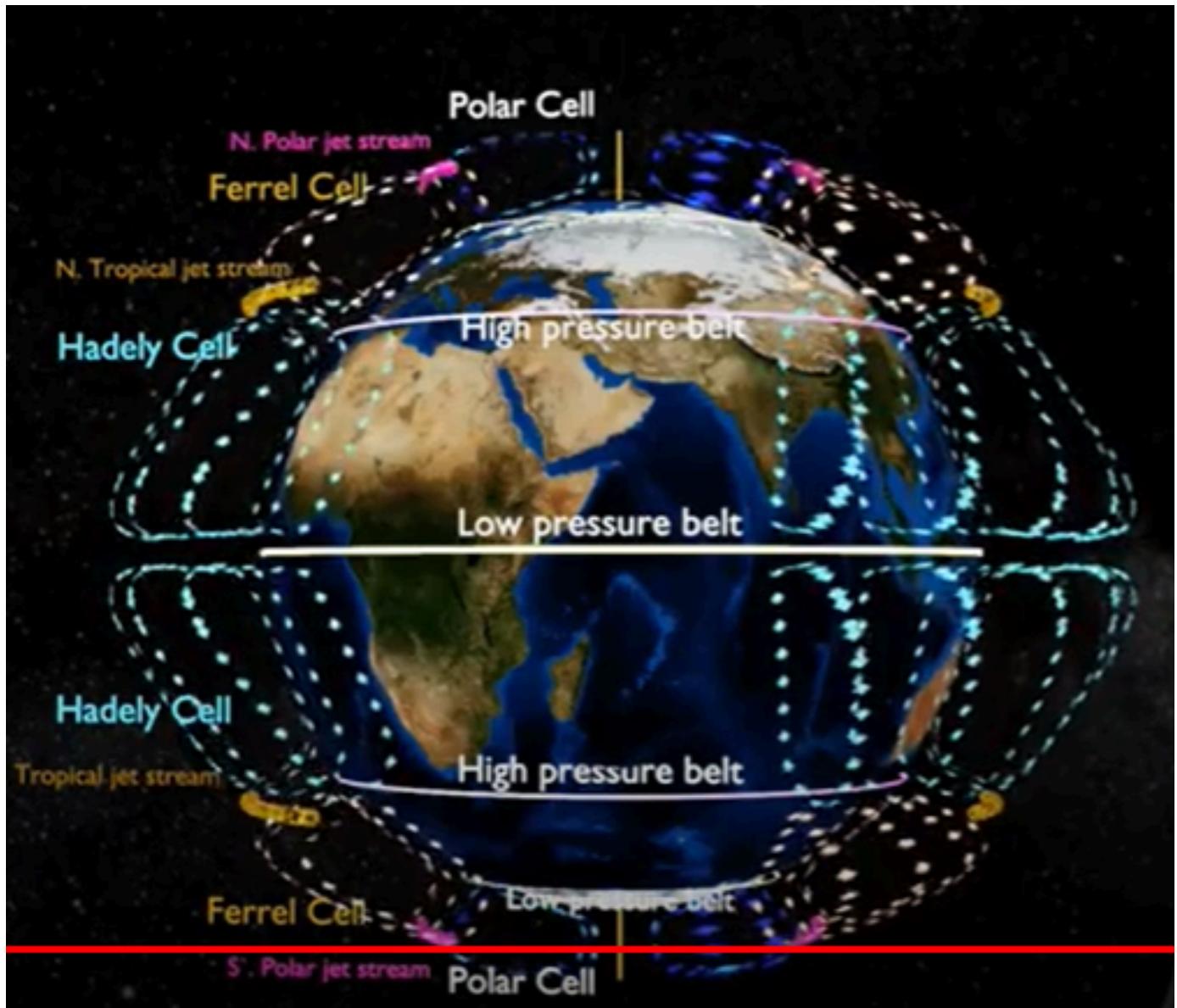
Particularly, notice the **BLUE stripe of low pressure at 60 deg South**. This is the southern polar jet stream - quite persistent and acting like the “nominal” jet stream. There is no land to interrupt it, and the sharp contrast in temperatures from the south pacific to the south pole drives flow south fast, kicking in the coriolis force, driving the flow directly East around the Pole.

So, on the weather channels, this is the kind of thing we see. Now we can look behind it to see the jet streams in action.



<https://www.wunderground.com/maps/wind/jet-stream>

Yikes!!



References:

There are some great videos from Met Lab in the UK and from Zeta in India. Both have been used extensively for this study. They are worth your time.

<https://www.youtube.com/watch?v=eDscj2bfnaY&list=PLcwy20QGwpeqH0uvIJbT4kJVr5poi1DAK&index=11>

- 10  Trade wind (Permanent winds) characteristics (3/3) | UPSC
5:11
Zeta Axis
- 11  Jet Stream formation and Geostrophic wind | UPSC
7:46
Zeta Axis
- 12  Jet Stream effects on climate | UPSC
8:45
Zeta Axis
- 13  Why Jet streams create high and low pressure areas? |...
8:16
Zeta Axis
- 14  Comparison between Polar Jetstream and Tropical...
4:16
Zeta Axis

<https://www.metoffice.gov.uk/weather/learn-about/weather/atmosphere/global-circulation-patterns>

<https://www.theweathernetwork.com/en/news/science/explainers/weather-bombs-bombogenesis-are-explosive-storms-that-create-ferocious-conditions>

<https://www.netweather.tv/charts-and-data/global-jetstream#2024/07/07/0600Z/jetstream/surface/level/overlay=jetstream/orthographic=-41.36,29.30,217>

GOOD NEWS CORNER

“

You are the sky.
Everything else—it's
just the weather.

Pema Chödrön

3:34 11:11
◀ Messages

MULTIPLIER EFFECT

The Hunt for the Most Efficient Heat Pump in the World

A new generation of engineers
has realized they can push heat
pumps to the limit, but just how
much heat you can extract
depends on your setup.

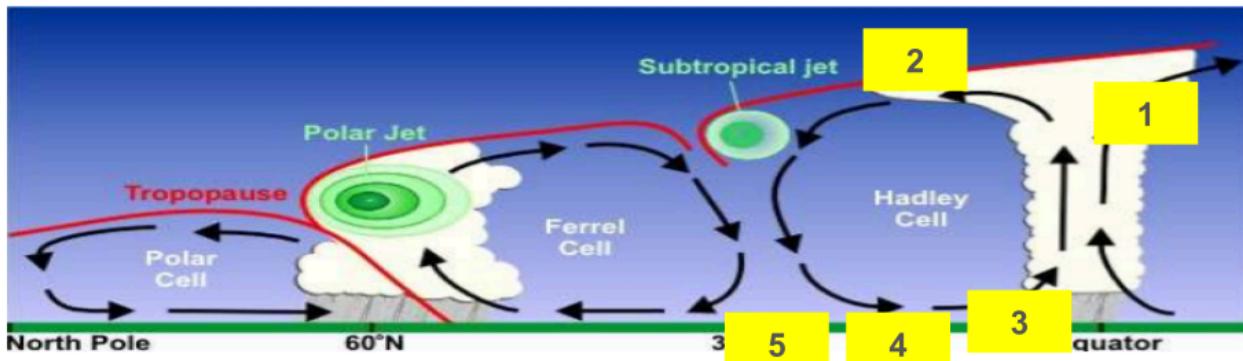
CHRIS BARANIUK
07.02.24 06:07 AM



<https://apple.news/A8Haq8CbqQHWJCmyF6TAzqg>

Approximate “Cheat Sheet”:

1 meter → 3 feet 1 degree Celsius ($^{\circ}\text{C}$) → 2 degree Fahrenheit ($^{\circ}\text{F}$)
 ppm = parts per million CO_2 = Carbon Dioxide
 1 tonne = 1000 kilograms = 2205 pounds 1 gigatonne (1 Gt) = 1 billion tonnes
 1 trillion tonnes (1Tt) = 1000 gigatons

Supplemental Material

- The sun heats the equator the moist and the wet hot air rises causing storms all along the equator (1)
- That air gets to the top, having lost its moisture and it's cold up there..(2)
- Meanwhile, the air rising at (1) causes a “vacuum” at (3). **THIS IS A VERY LOW PRESSURE AREA BECAUSE THE AIR IS RISING AWAY FROM THE SURFACE**, causing air to flow back on the surface from the North at (4).
- This forms another “vacuum” at (5), which the cold (so more dense), dry air up at (2) is more than happy to fill...
- This circulation has now formed what is called the Hadley Cell.
- Similar dynamics form other cells globally, with the jet streams being formed at their intersections (see CSSG-2.14)
- Here's the critical Point: **(5) IS A VERY HIGH PRESSURE AREA, BECAUSE THE AIR IS BACK DOWN TO THE SURFACE PUSHING**