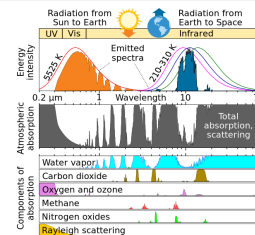


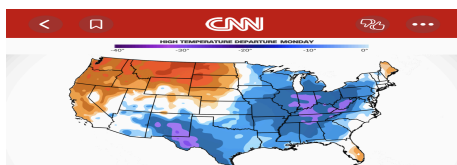
The WHAT's happening and the HOW it works of Earth's Climate Systems



Weather Whiplash

[This study was mostly lifted directly from a terrific video interview by The Climate Emergency Forum with Dr. Jennifer Francis. You can find it at: https://youtu.be/RS_0GNk_CfE?si=S0GL_k7J8U7SMBTq]

This Week's News

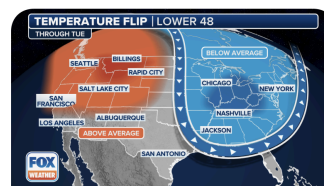


Winter returns: Major pattern shift coming this week

Allison Chinchar and Sara Tonks, CNN

Updated 8:27 AM EDT March 17, 2024

<https://apple.news/AGiNHNIKSC6JVS3aQI0Wbw>



Cold air, snow returns to U.S. with millions expected to plunge below average Monday

FOX Weather

<https://apple.news/ALsDk1sisRZ6vyDHe9hTA2w>

2020 and this January



Climate Science Study Group

Approximate "Cheat Sheet":

1 meter → 3 feet 1 degree Celsius (°C) → 2 degree Fahrenheit (°F)

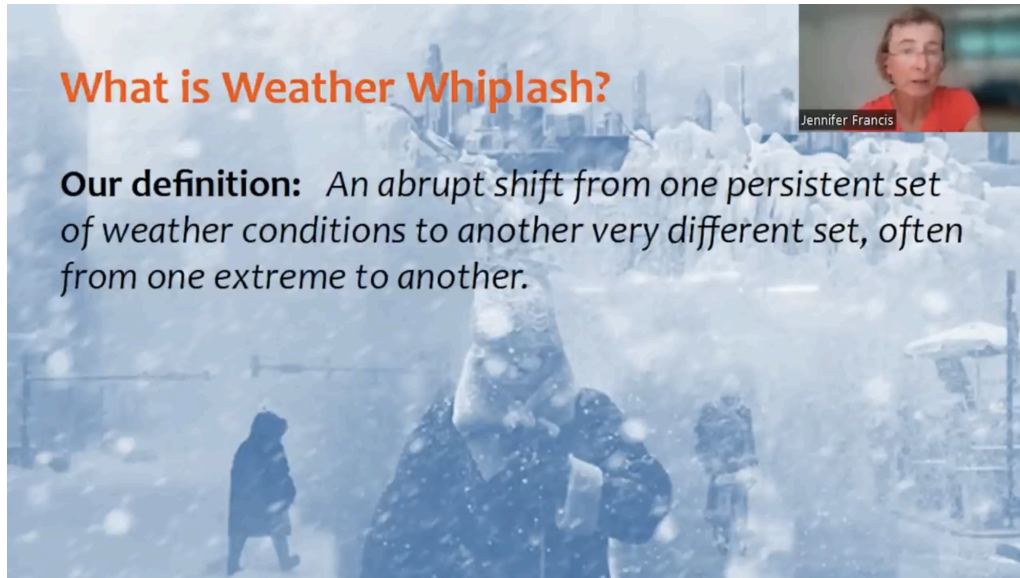
ppm = parts per million CO₂ = Carbon Dioxide

1 tonne = 1000 kilograms = 2205 pounds 1 gigatonne (1 Gt) = 1 billion tonnes

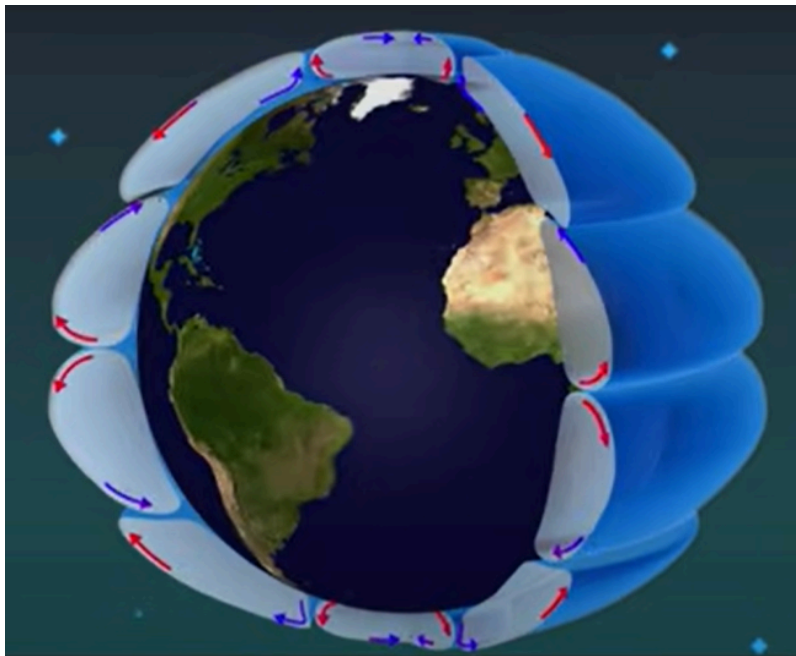
1 trillion tonnes (1Tt) = 1000 gigatons

Weather Whiplash

We've been talking about sudden changes, but it turns out they are a direct result of climate change. Below are the viewgraphs Dr. Francis used in her interview, with some perspectives added by me.



In **CSSG-2.13** on the **Big Three Global Climate Pumps** we saw the graphic below:



Note these critical aspects:

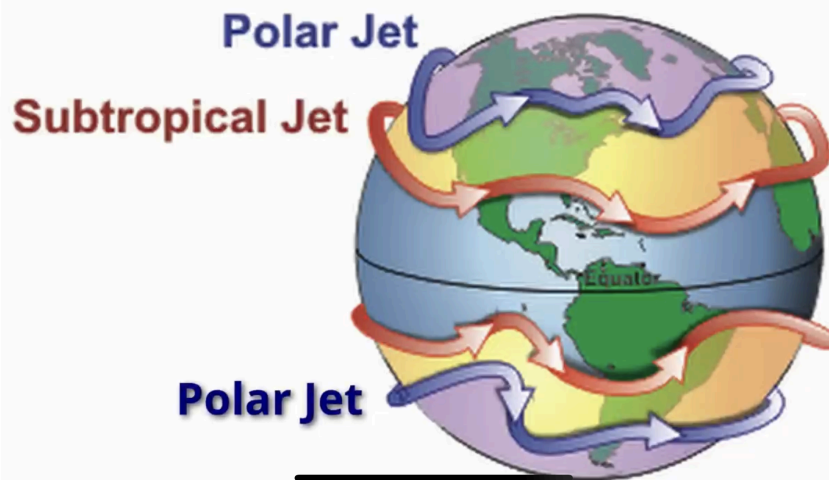
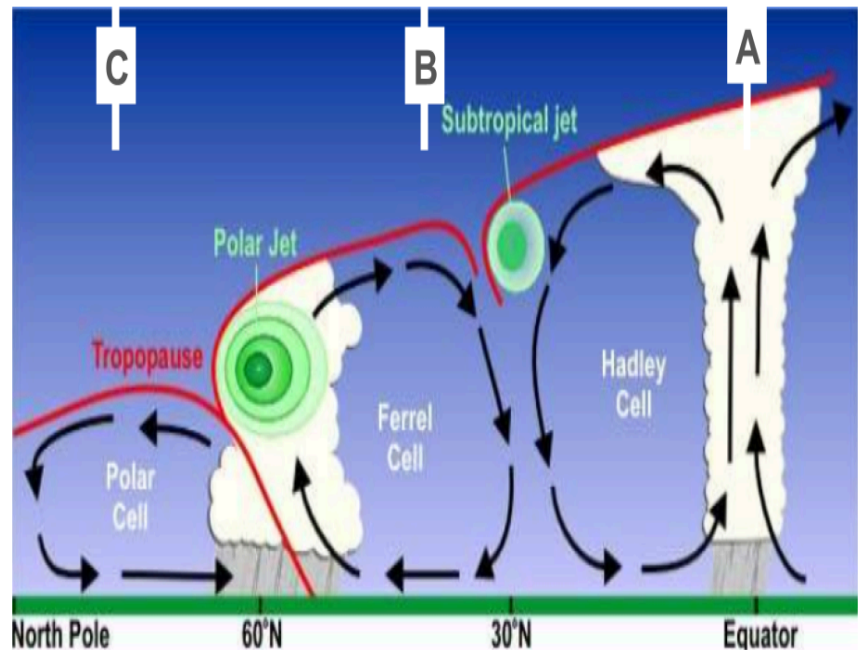
1. The Troposphere (the changing region of the surface weather - shown in blue here) is much higher in altitude at the hotter equator than at the cool poles. This drives winds towards the poles by flowing downhill.
2. In fact, the flow breaks up into cells, going both North & South, keeping the overall equator-to-pole flow.

Weather Whiplash

In **CSSG-2.14 Atmospheric Cells, Climate Change, and Arctic Blasts**, we refined this understanding by realizing that the winds flowing downhill towards the poles create Jetstreams going East - because of the Coriolis Effect (the air was moving East very fast at the equator, so, as it moves closer to the poles it gets around the earth faster, ultimately forming the jet streams).

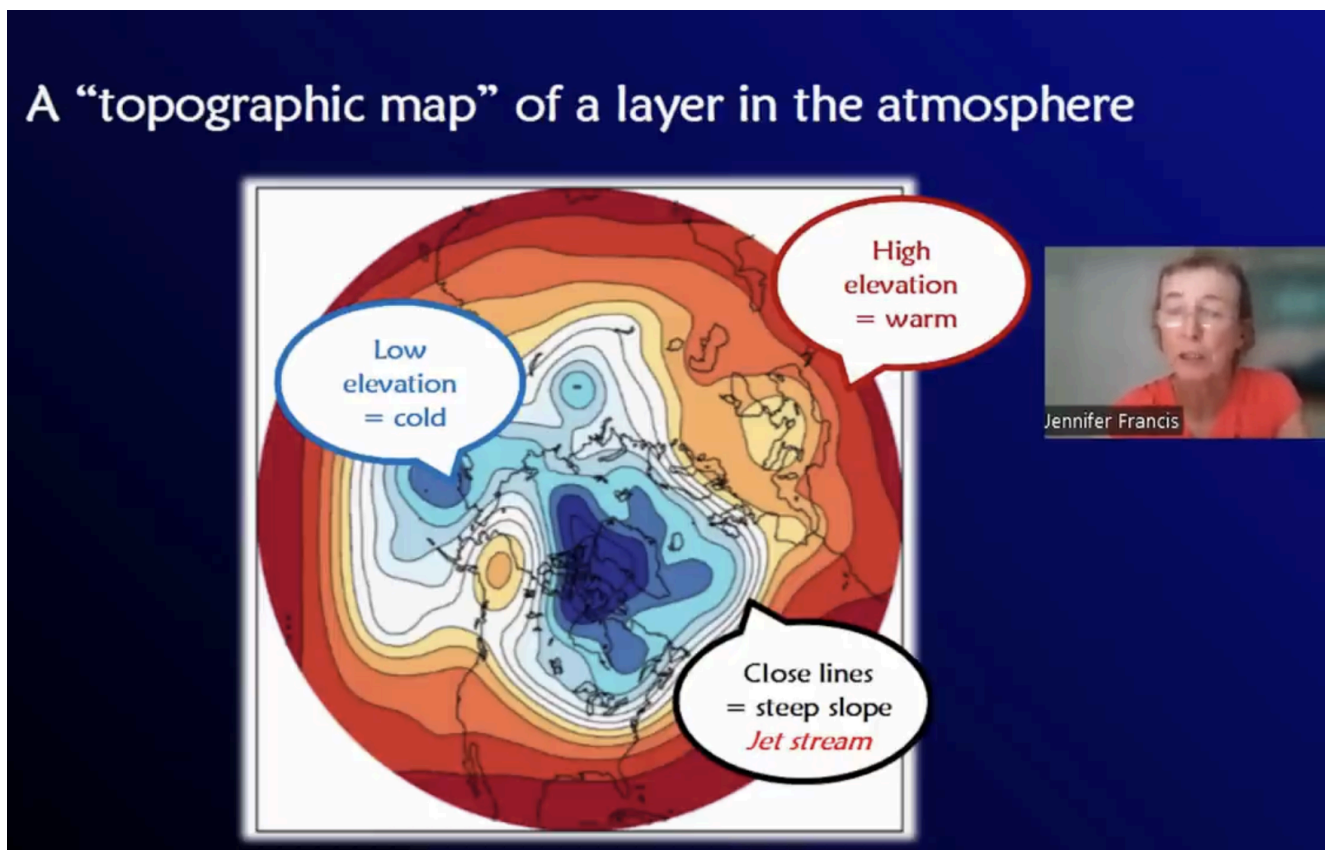
Note:+++++

1. The Subtropical Jet (at around 30° N&S) is powered by the falling flow from A→B.
2. The Polar Jet (at around 60° N&S) is powered by the falling flow from B→C.
3. The altitudes at A, B, and C are all driven by the temperatures.
4. So, if C is warmer in the winter because of global warming, C is higher in altitude, slowing Northward flow, and slowing the polar jet.
5. Slowing the polar jet allows it to be pushed into waviness by things like El Nino, etc!



Weather Whiplash

Now, let's look at Dr. Francis' materials, which pick up this concept of higher and lower altitudes, or elevations, of the troposphere:

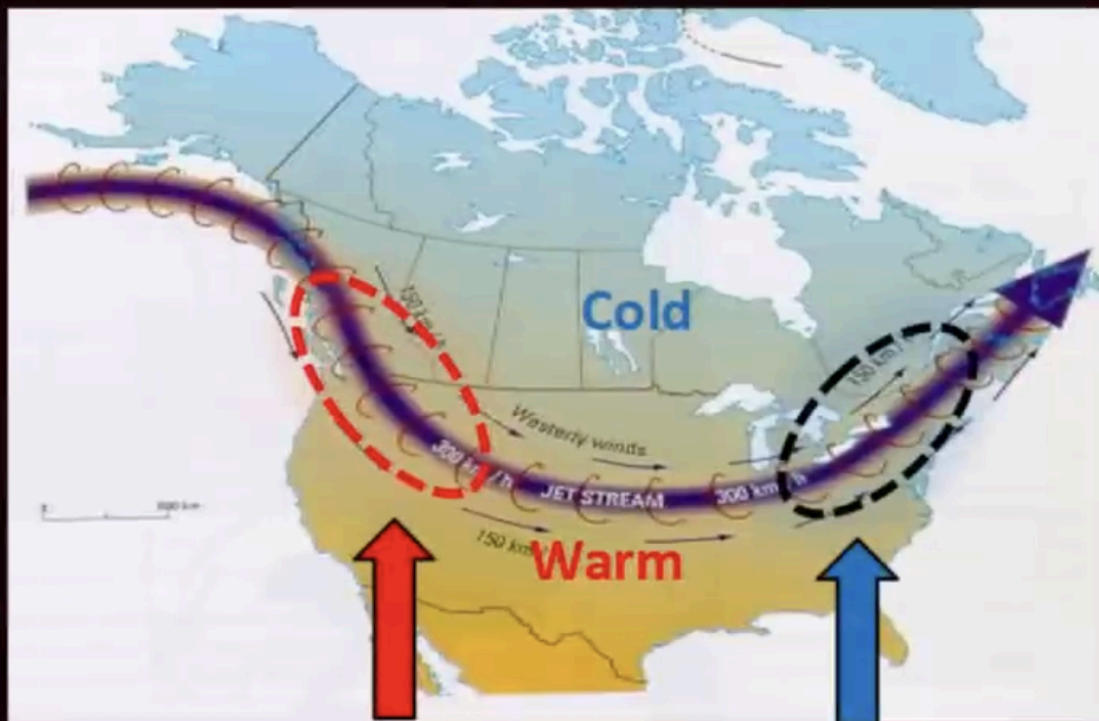


Various factors can enforce waves on the jet stream. El Nino, land surfaces heating differently from the ocean, hot spots in the ocean or land, cloudy regions, etc. They all enforce changes on what would otherwise be a circular path around the globe. And a

Weather Whiplash

weaker jet stream (a result of the temperature differences - and the resulting elevation of the troposphere) will be much more wavy.

*Why do we care about these waves?
Jet stream waves make our weather*



**Dry and
settled**

**Wet and
stormy**

But this can also bring “Whiplash” (which actually is a technical term!)

Weather Whiplash

Feb. 12, 2010
Photo Courtesy
Ryan Rosen

AVERAGE WEATHER PATTERN JANUARY 2018

ABOVE-AVERAGE TEMPERATURES

BELOW-AVERAGE TEMPERATURES

JET STREAM

JET STREAM

Jennifer Francis

Early January to mid-February 2018

Weather whiplash events are caused by major shifts in jet-stream waves

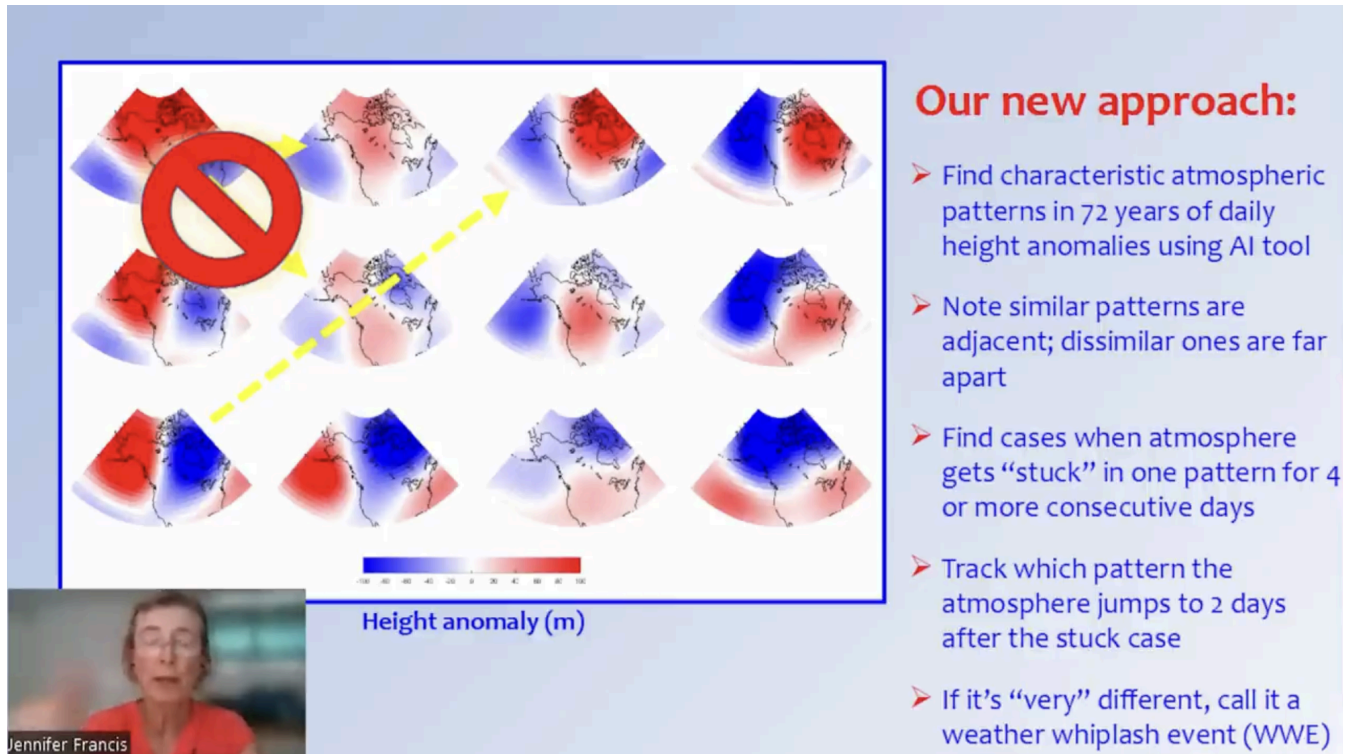
21 February 2018

NWS NCEP 2-m MAXIMUM TEMPERATURE [°F] Within 1°F Total Record Highs n=99 of 267 possible

Jennifer Francis

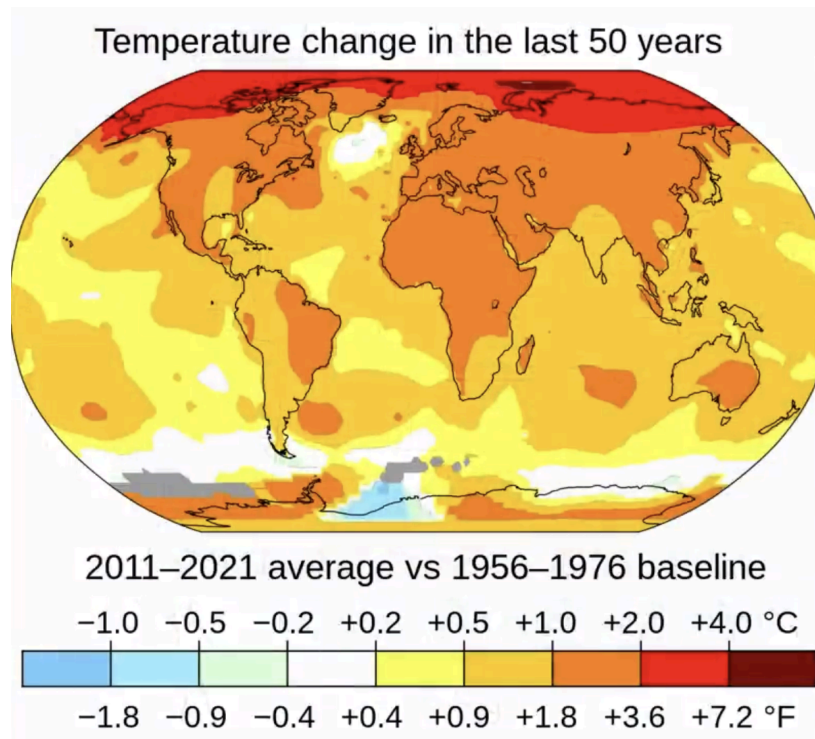
Weather Whiplash

Dr. Francis' research was to locate whiplash weather events over the past 72 years (day-by-day!) and noting if causal factors and trends could be discerned.



Weather Whiplash

This is evaluated against the real world changes over that period...



And their findings were:

1. Occurs most often when the arctic is very warm
2. Because the arctic is warming very fast, there is an increasing frequency of whiplash events
3. Based on models looking at the future, we can expect the increasing frequency to accelerate going forward.