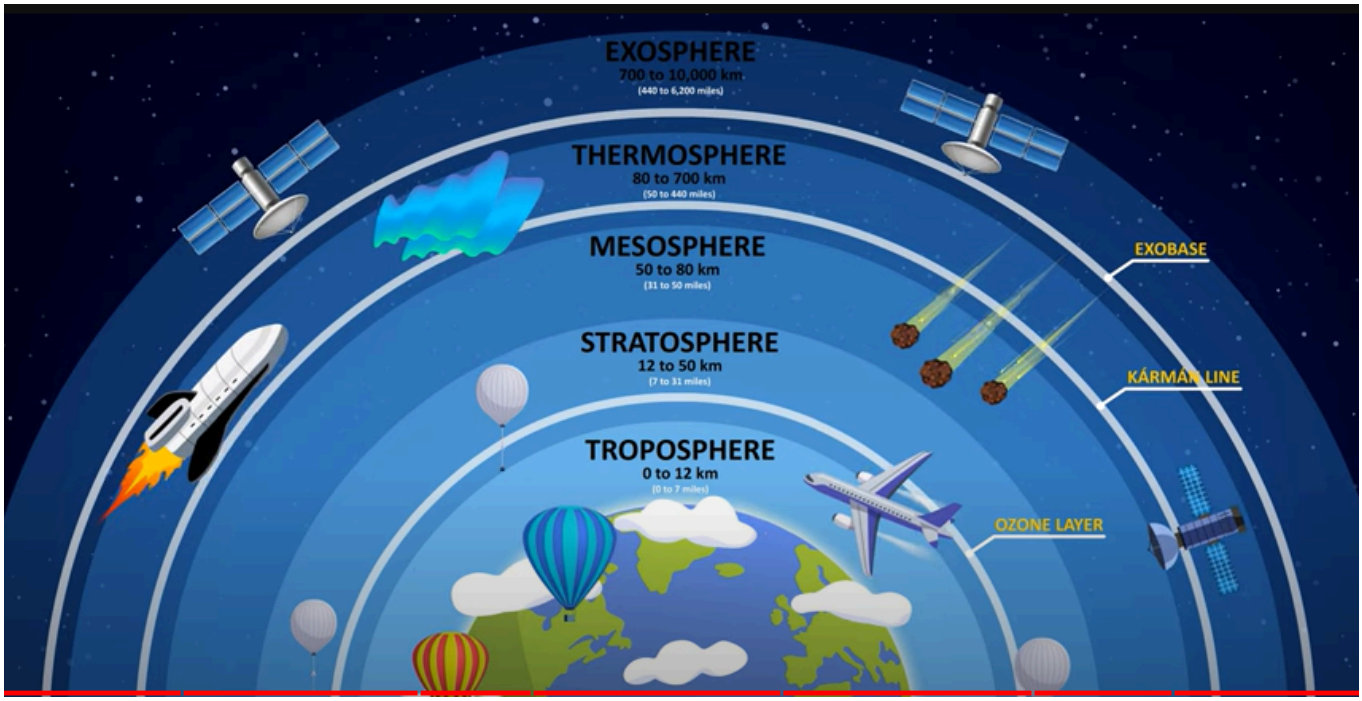
A Quick Trip up into the Atmosphere

Let's take a trip up a ways into the atmosphere. We will focus on the two bottom layers, which determine the weather and climate - the **Troposphere** (tropo = change, turning) and the **Stratosphere** (strat = layer, level). **As we've seen, almost all weather is in the Troposphere.**

But first, let's get the bigger picture for context. It's much more than we're used to thinking about. This trip goes from the surface all the way up to the lowest satellites.



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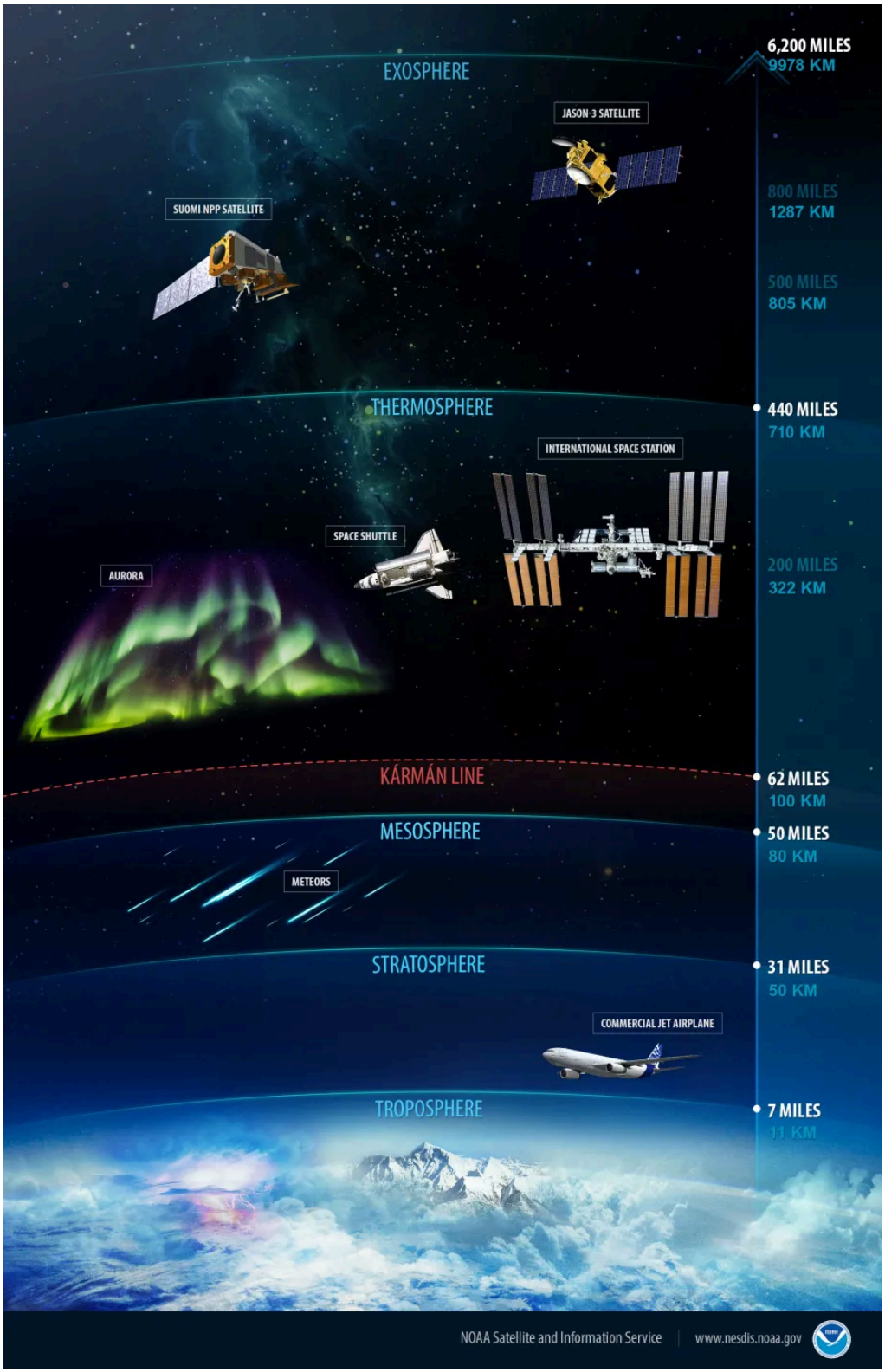
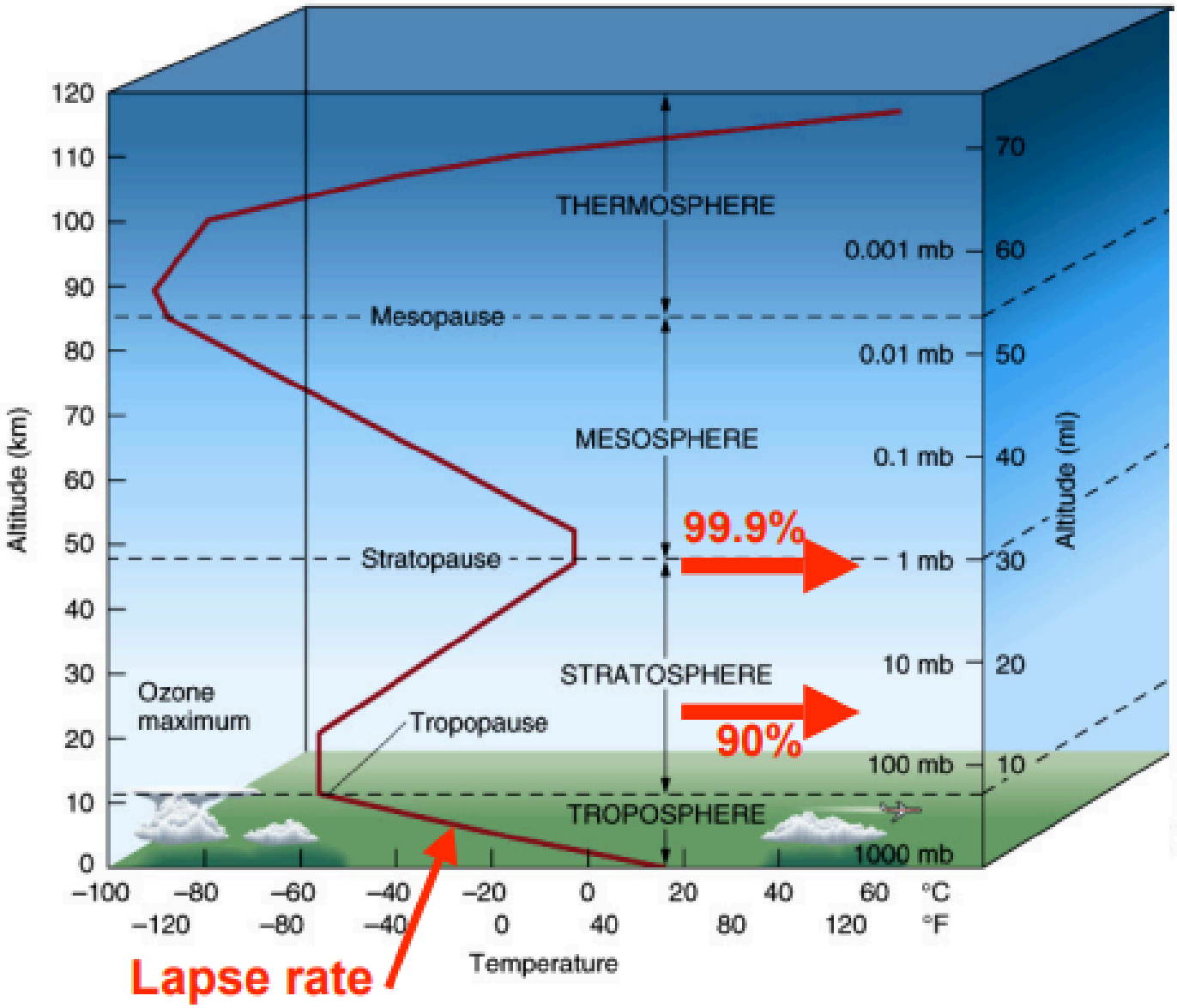


Note that this is NOT TO SCALE! The Troposphere is 1/100 of the total height!

Given that context (and looking at the bottom 4 layers more to scale), notice that:

- Air pressure decreases as you go up, as you'd expect. See the column with "mb" as the scale. 1000 millibars (mb) = 1000x 1/1000 bar = 1 bar (as in barometric pressure) = 1 atmospheric pressure. So, **1000 mb is the average pressure at SEA LEVEL**. Around 80% of the atmospheric gasses are down in the Troposphere, and virtually all of the rest of the atmospheric mass is in the Stratosphere. (Not a lot of gas higher up).

- Temperature does crazy things as you go up. First it gets colder as you go up from the surface. Then, in the Stratosphere, it heats, etc.



The Earth and Its Atmosphere: 1. Vertical structure 2. Weather and climate

Some Patterns of Temperature in the lower layers of the atmosphere

Troposphere

- Gets colder as you go up, because its heat comes mainly from the sun-warmed ground. This results in warmer air at the surface rising up until it cools off. If the warm surface air is moist, the water condenses as it gets colder, and we get rain.
- If a warm cloud makes it high enough, it will spread out into an “anvil” shape, because any higher is so cold that all the moisture condenses and falls.
- This rising and falling action (convection like in a pot of heated water) is the “mixing” action which gives the Troposphere its name. This is almost all of our Weather.

Tropopause

- At some point, the tropospheric gasses have cooled so much that convection (rising heat) ceases. Higher up, the little air that is left will be getting hotter, so it will stay above the colder, upper-reaches of the Troposphere.

Stratosphere

- Now any increase in temperature is coming directly from the sun. Ozone in this rarefied atmosphere stops much of the highest energy ultraviolet light from the sun, and this heats it. Warmth is from above so it gets warmer going up. [By the way, it is this ozone layer that formed long ago which allowed life to move from the ocean, where UV was blocked,

Stratopause

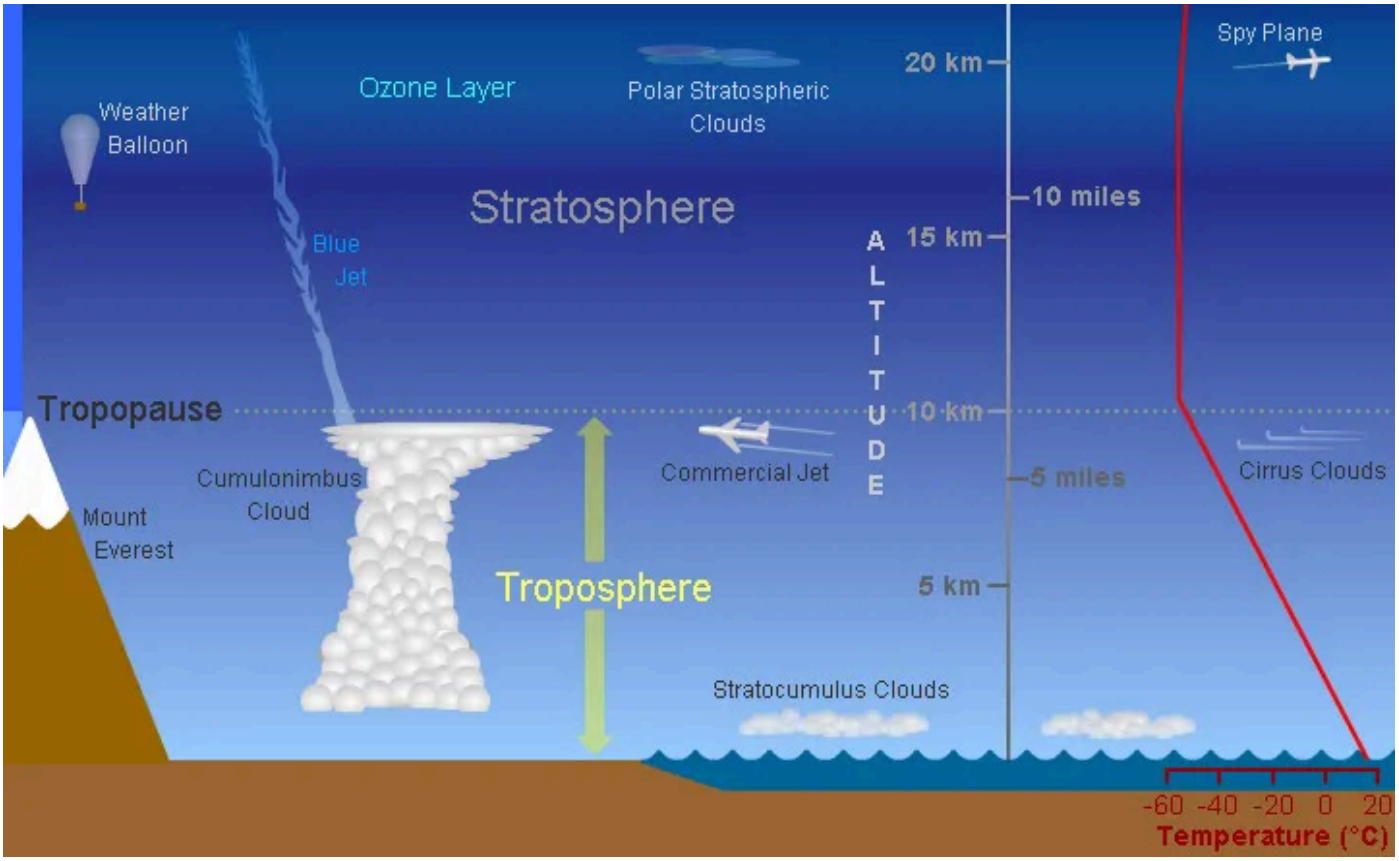
- At some point, the atmosphere is so thin that little UV is being absorbed and CO2 is radiating our heat, so the warming trend ends.

Mesosphere

- Cooling increases with height

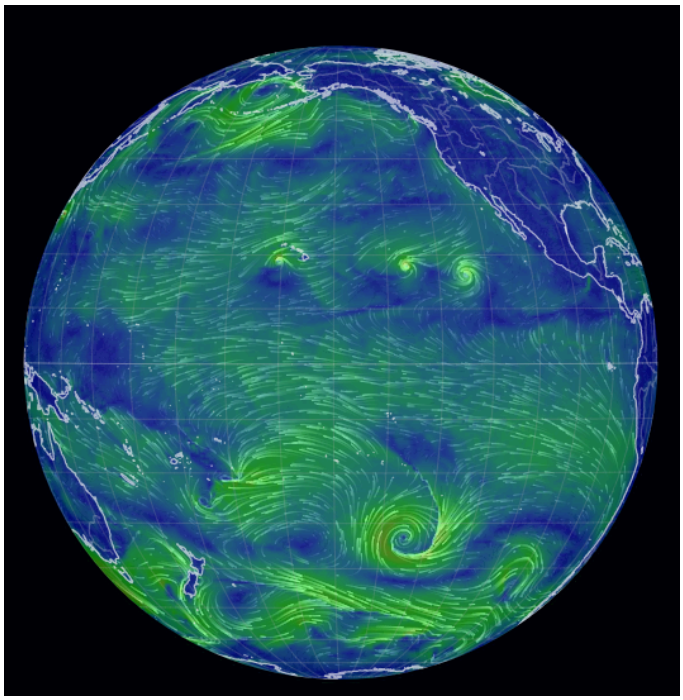
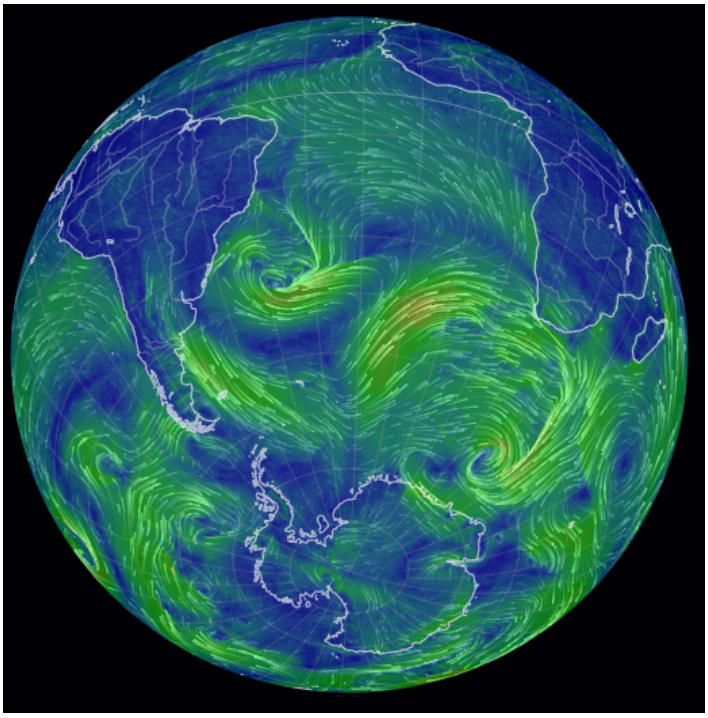
Very helpful material can be found at https://en.wikipedia.org/wiki/Atmosphere_of_Earth and the resources it references.

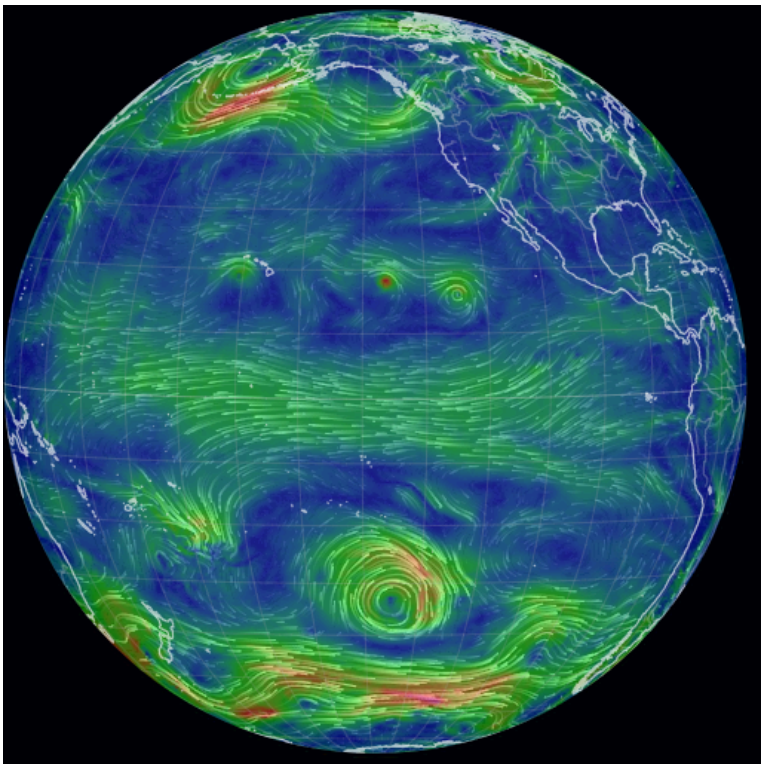
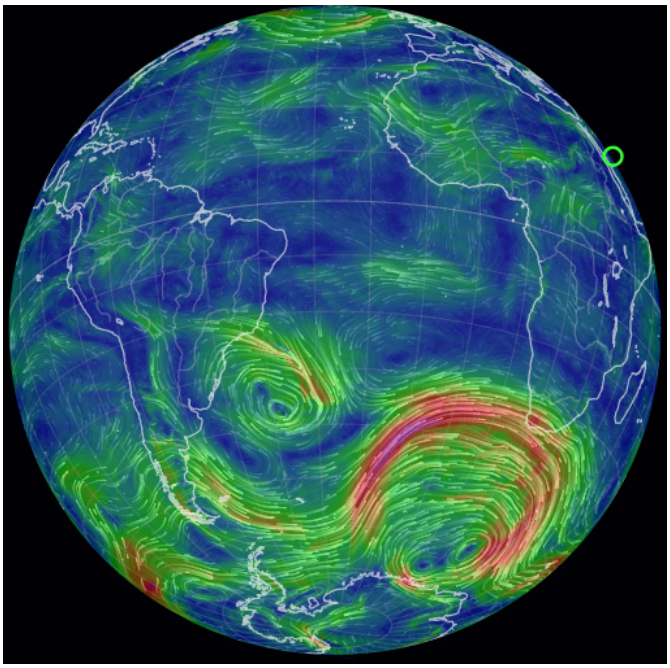
What I'd like to focus more on today is the lower layers, the Troposphere and Stratosphere.

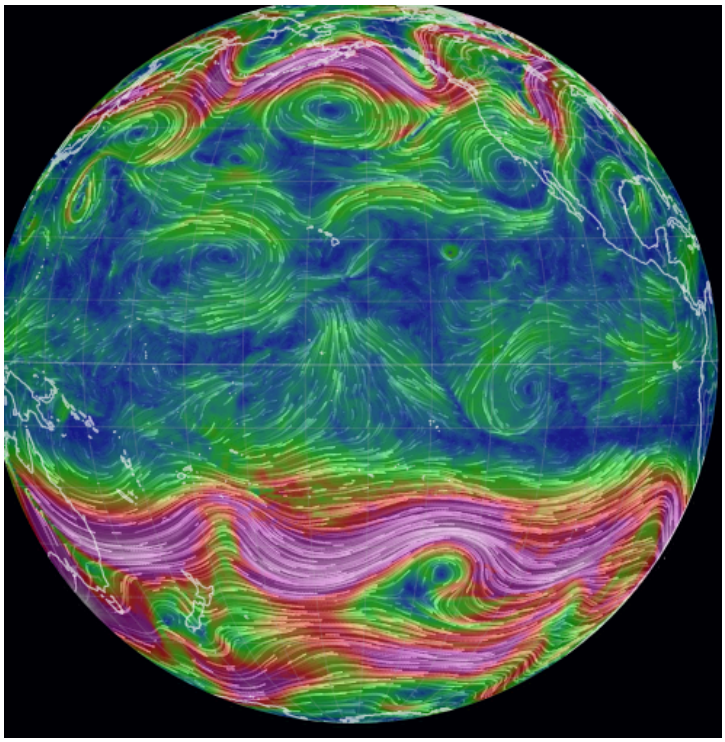
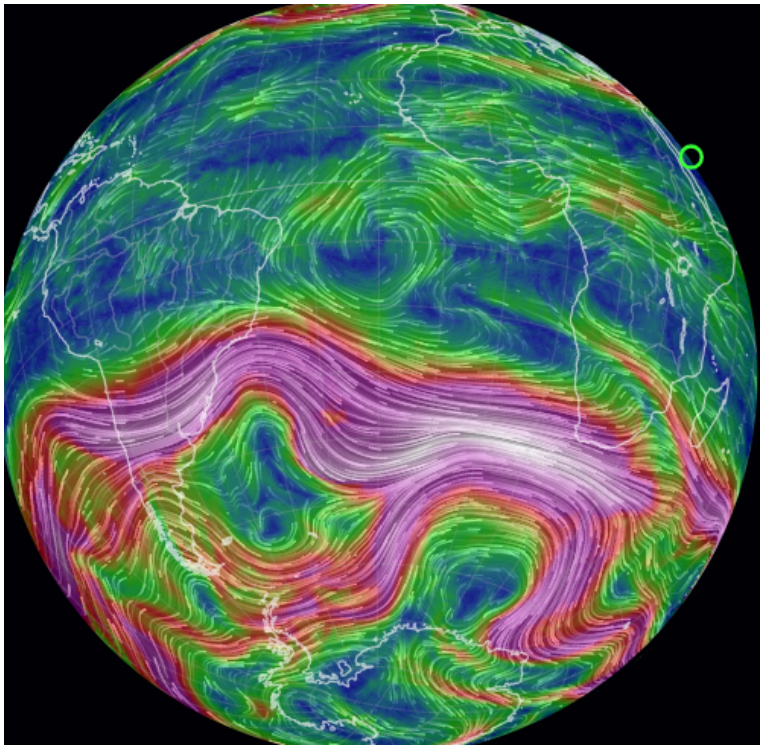


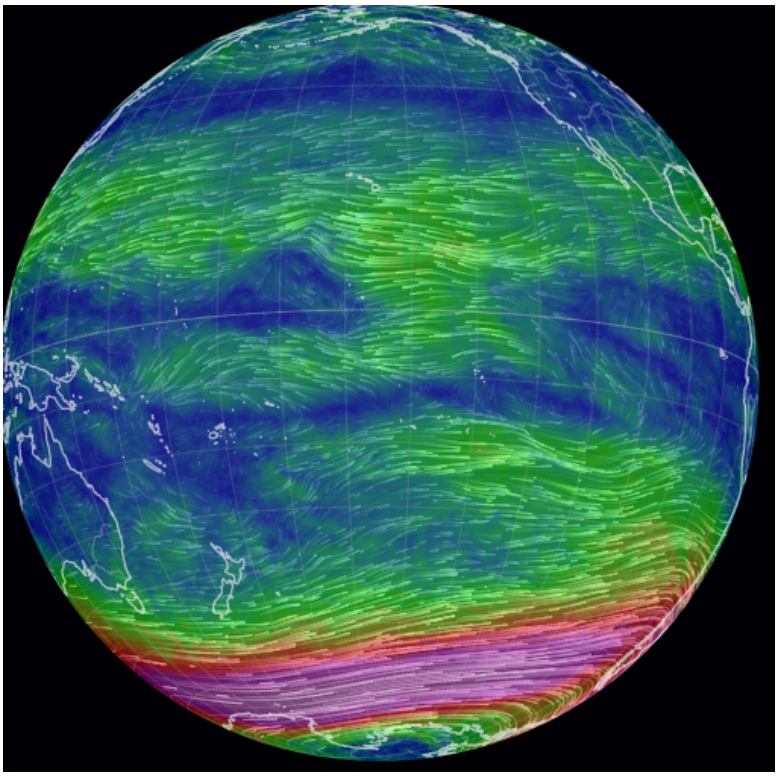
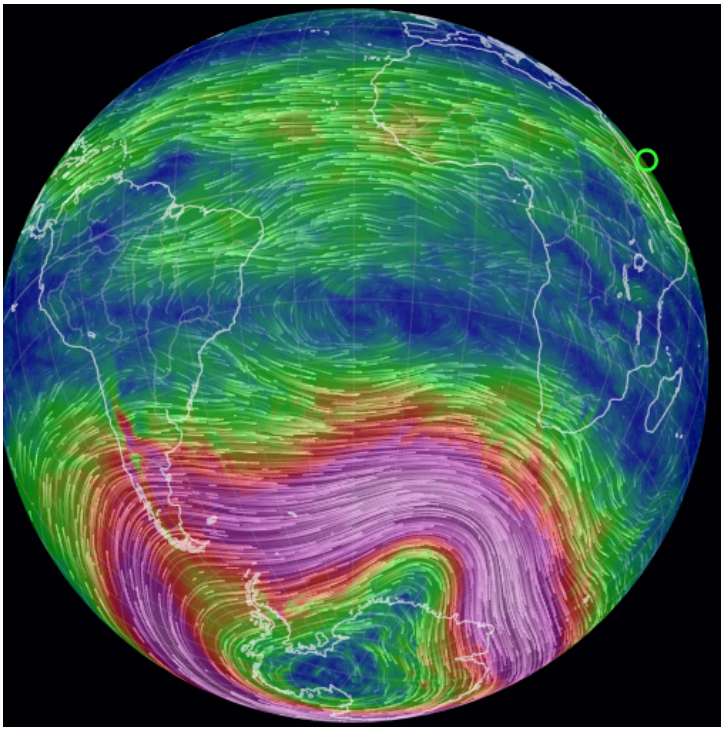
https://scied.ucar.edu/learning-zone/atmosphere/troposphere

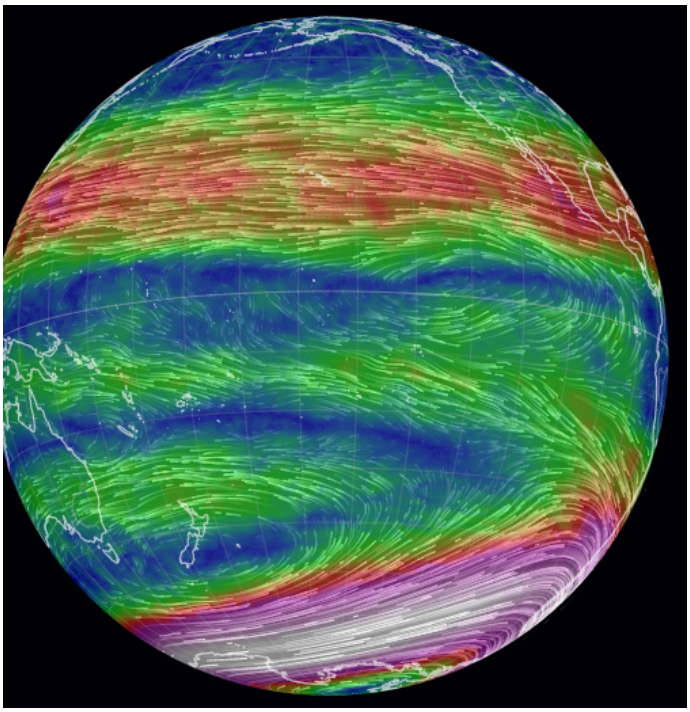
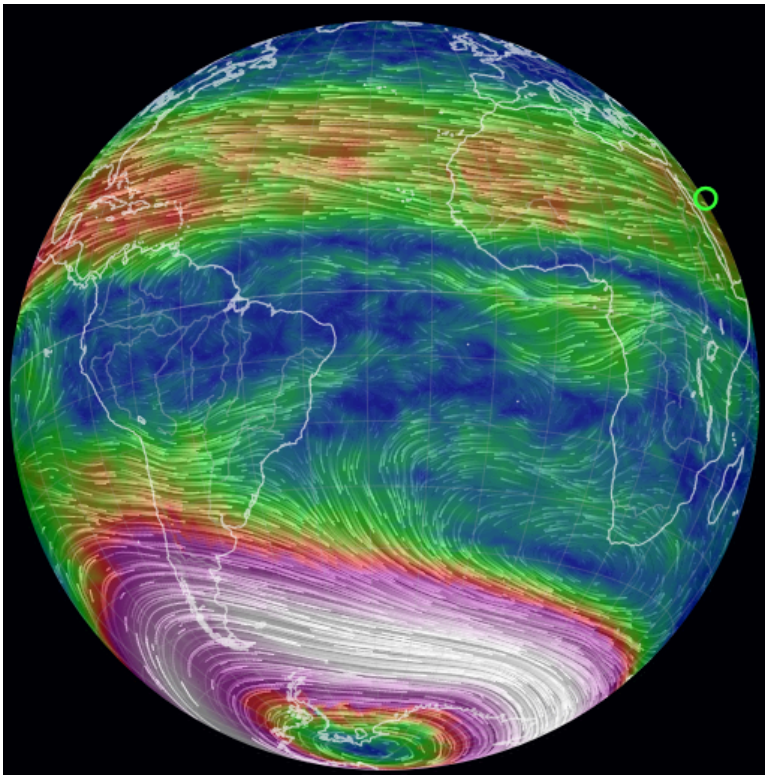
Now, let's have fun with earth.nullschool: [Earth Nullschool] All on Monday, August 26, 2024.
Looking at the winds at various pressure levels (altitudes).

Sea Level - 1000mb	Hurricanes Hone, Hectare, and Gilma heading for Hawaii. Big cyclone in south Pacific	
	Lots of action in the South Atlantic and Southern Ocean	

700 mb - a couple of miles up	Winds are more intense. Can still see the surface storms.	
		

250 mb - near top of Tropopause, around 8 miles up.	Not much of the surface effects remain. Jet streams are now showing	
		

70 mb about 13 miles up	Well into the tropopause. Things are getting linear and smooth	
		

10 mb about 20 miles up	We are now high in the Stratosphere - above the jet streams. The intensely fast winds (around 260 mph) are above the South Pole, since it is winter down there, and these are missing at the North Pole. This is the Southern POLAR VORTEX	 

Punchline

Within the distance we travel (horizontally) without thinking much about it, 10-20 miles, the atmosphere is amazingly complex. Do play around with Earth Nullschool ! It's an amazing resource and we've barely scratched the "surface"!

Approximate "Cheat Sheet":

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

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washingtonpost.com

Our Natural World - This is Us

Seagull on sea turtle; Finalist, Fine Art category, Menorca, Spain

ENRIC GENER - OCEAN PHOTOGRAPHER OF THE YEAR 2024