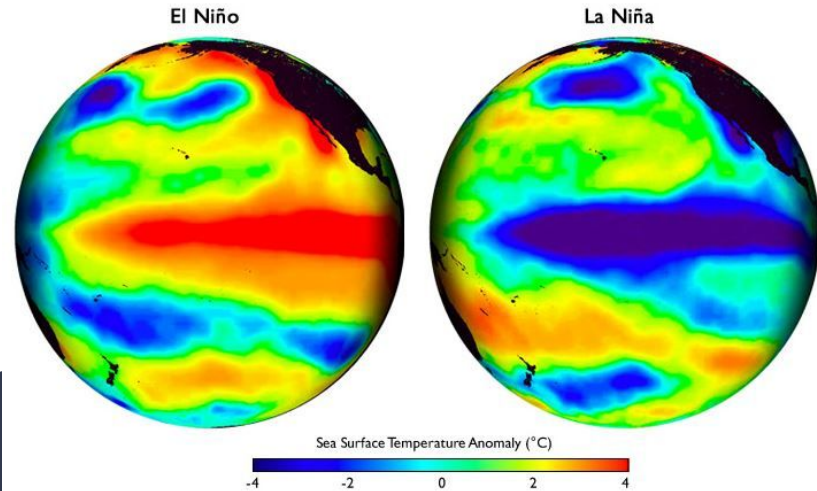




Weather 101: Global Circulations



Presented by NWS Nashville, TN

Emily Carpenter
Lead Meteorologist
NWS Columbia, SC

What is your interest in or association with weather and climate?



Select all that apply

- a) SKYWARN spotter
- b) COOP Observer
- c) CoCoRaHS
- d) Educator
- e) General weather interest

Topics

- Earth's orbit, global circulation and the seasons
- Global Climate
- Intro to Teleconnections
- El Niño and La Niña
- MJO/PDO
- Other Teleconnections



What is the difference between “weather” and “climate”?

Weather- The state of the atmosphere at any particular time and place, which is always changing.

- Temperature, pressure, humidity, clouds, precipitation, visibility and wind.

Climate- The accumulation of daily and monthly weather over a long period of time (usually 30 years) which is referred to as “normal”. Also includes extremes.

- Average yearly temperatures and precipitation amounts.

“Climate is what you expect, weather is what you get!”



What are some factors which affect Earth's seasons and global climate?

Select all that apply

- a) Earth's tilt on its axis
- b) Earth's proximity (closeness) to the sun
- c) Earth's daily rotation
- d) Amount and location of landmass and large water bodies
- e) Differences in incoming solar radiation

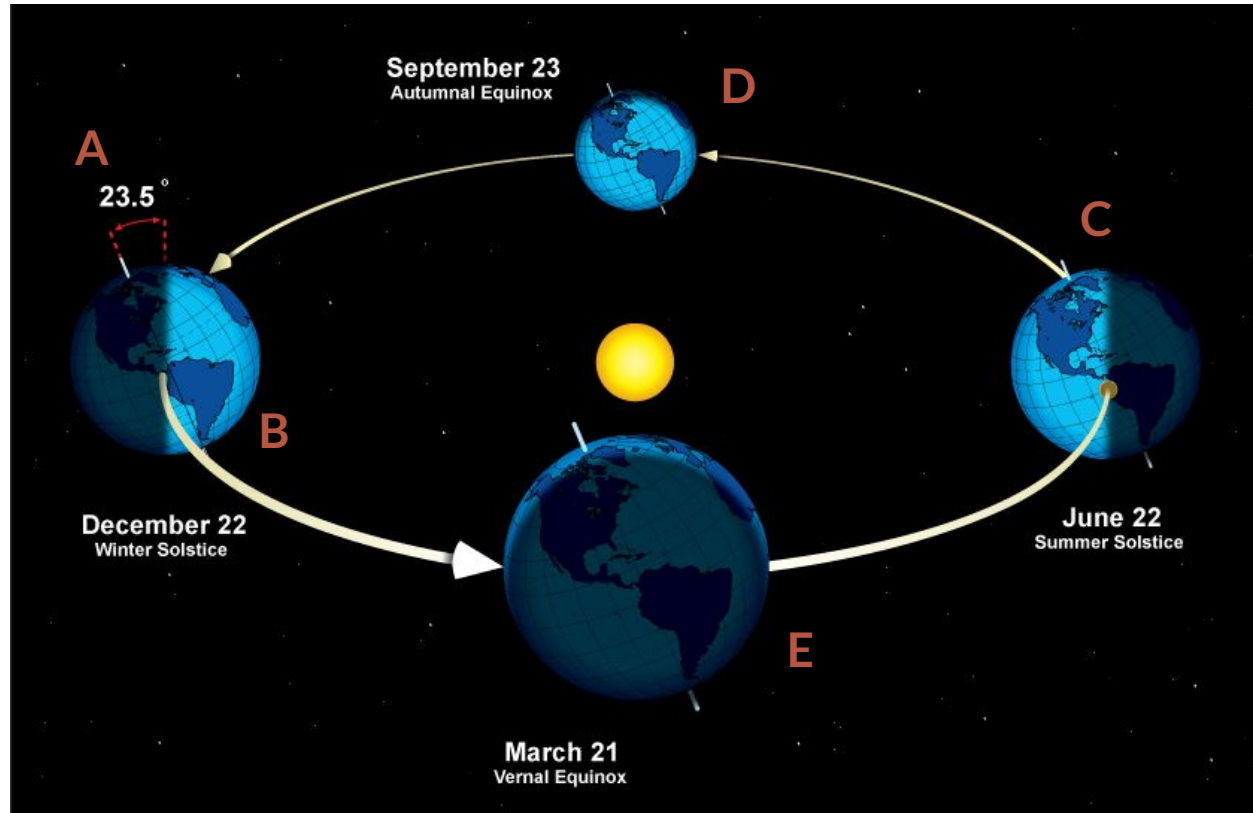
Earth's Orbit and The Seasons

A: Earth's tilt

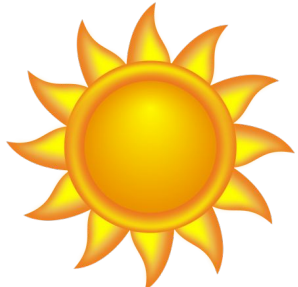
B: Incoming radiation
greatest in S Hemisphere

C: Incoming radiation
greatest in N Hemisphere

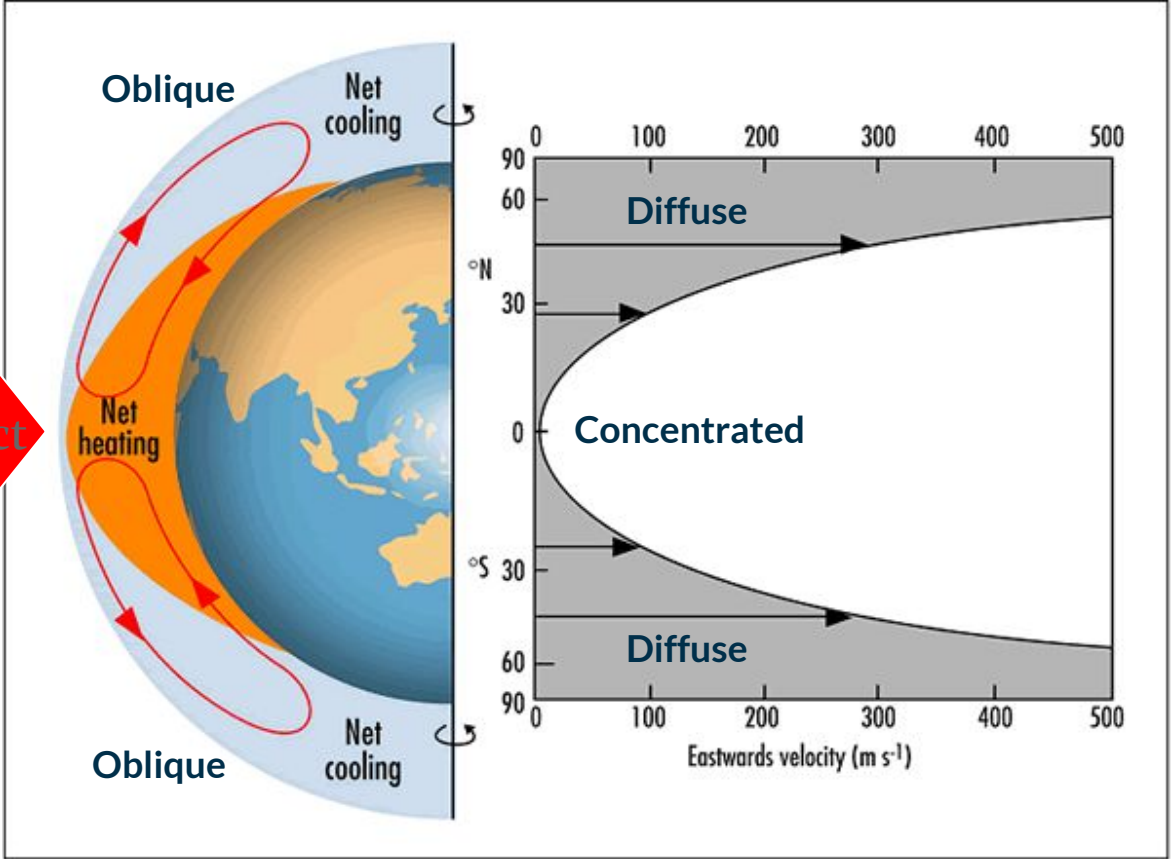
D/E: Incoming radiation
equal in both
Hemispheres during the
Equinoxes



Global Energy Balance



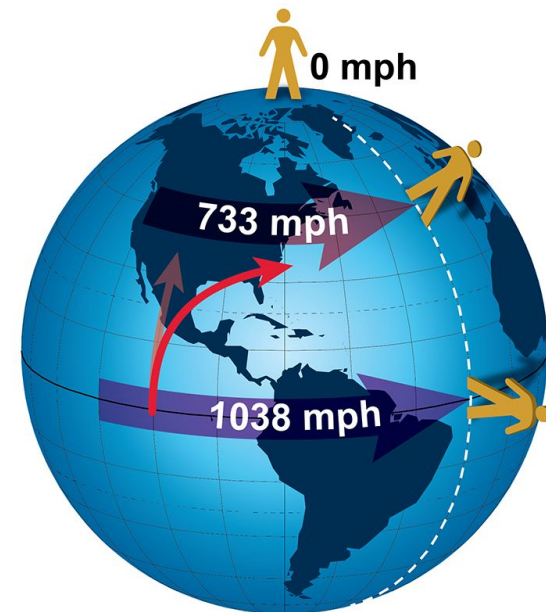
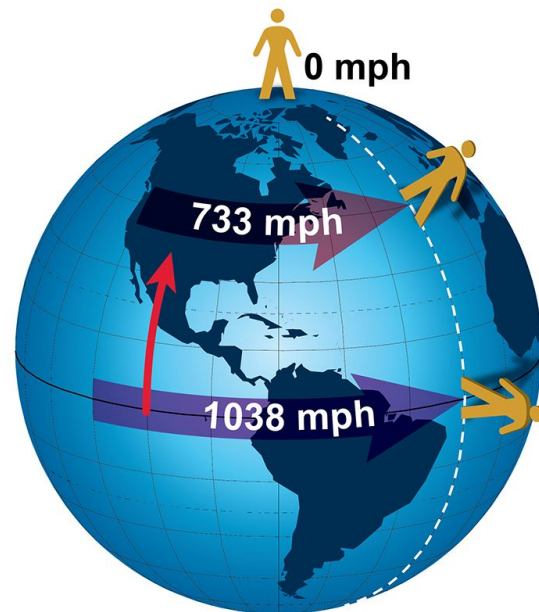
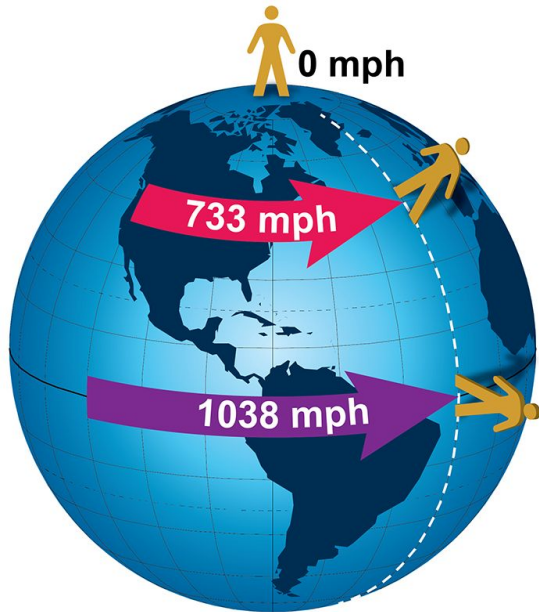
Direct



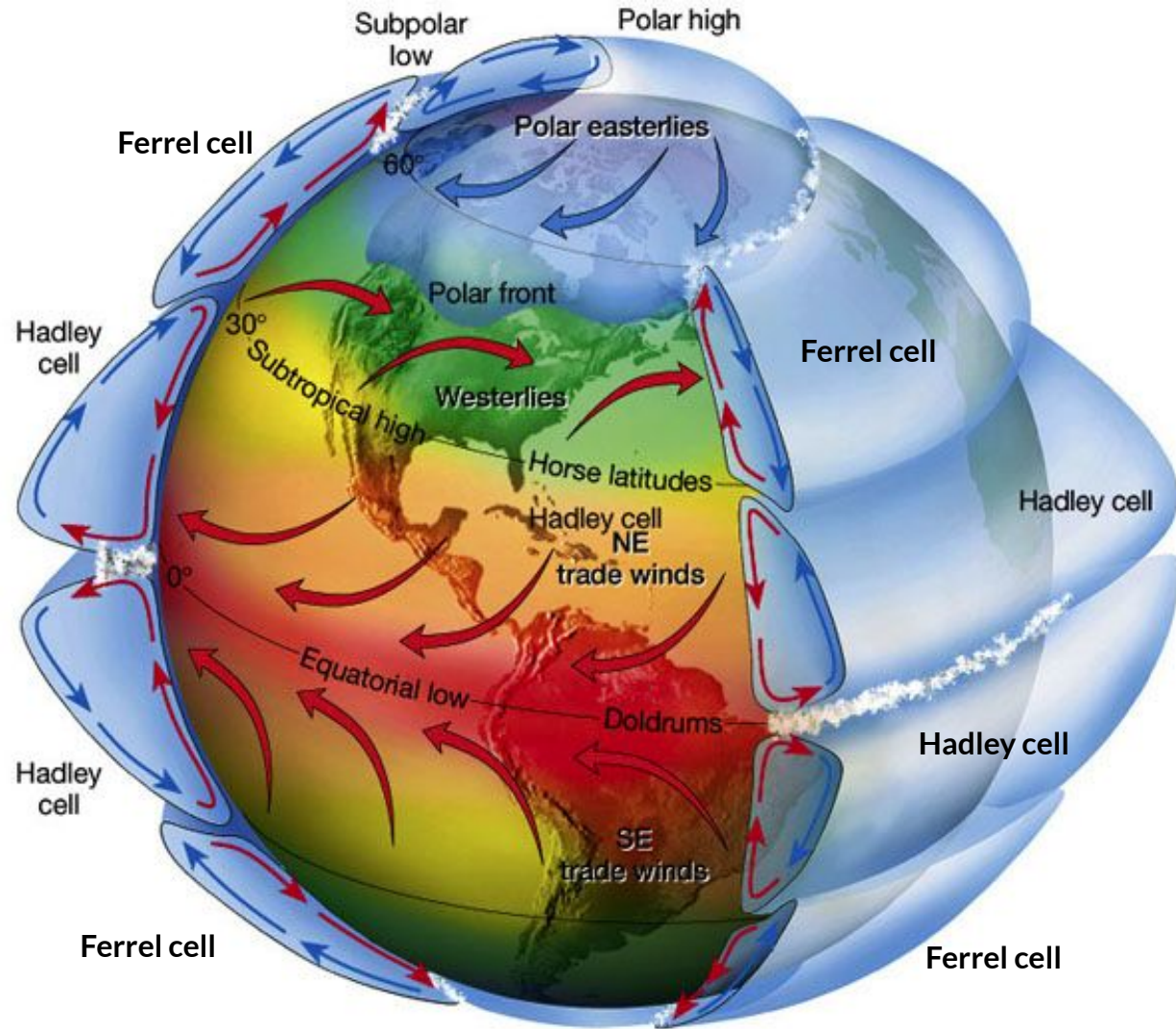


The Coriolis Force

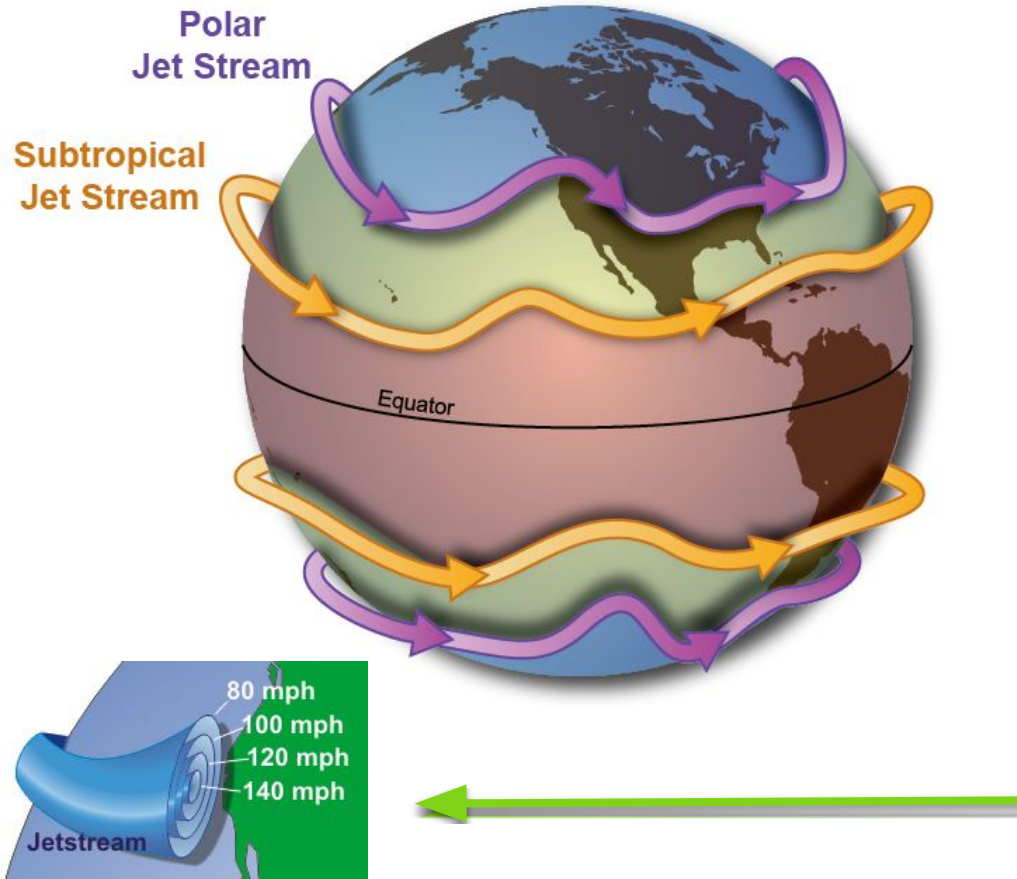
A phenomenon that causes fluids (like water and air) to curve as they travel across or above Earth's surface. It is a small force which is only noticeable for motions over longer periods of time or distances (weather disturbances like hurricanes).



Effects of the Global Circulation



Jet Stream



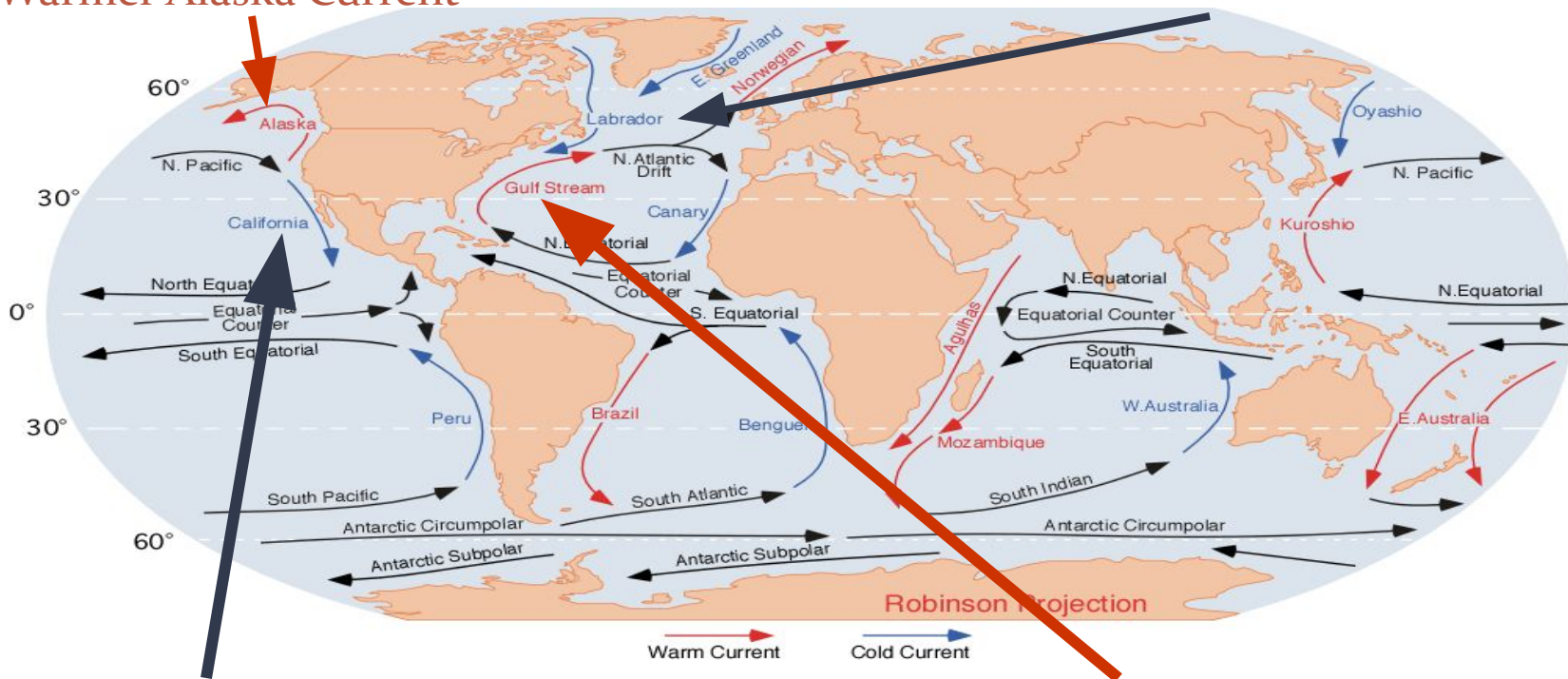
- Jet Streams meander around the globe, dipping and rising in altitude/latitude, splitting at times, forming eddies, and even disappearing altogether to appear somewhere else.
- The location of the jet stream has implications for seasonal weather.
 - The **polar jet** is located around 50°-60° N/S.
 - The **subtropical jet** is located around 30°N/S.
- Jet streams "follow the sun", moving toward the poles during the summer months, and back toward the equator during the winter.
- Jet streams vary in height of four to eight miles above sea level and can reach speeds of more than 275 mph.

Remember that jet streams are 3D, and are regions where wind speed increases toward a central core

Ocean Currents

Warmer Alaska Current

Cooler Labrador Current

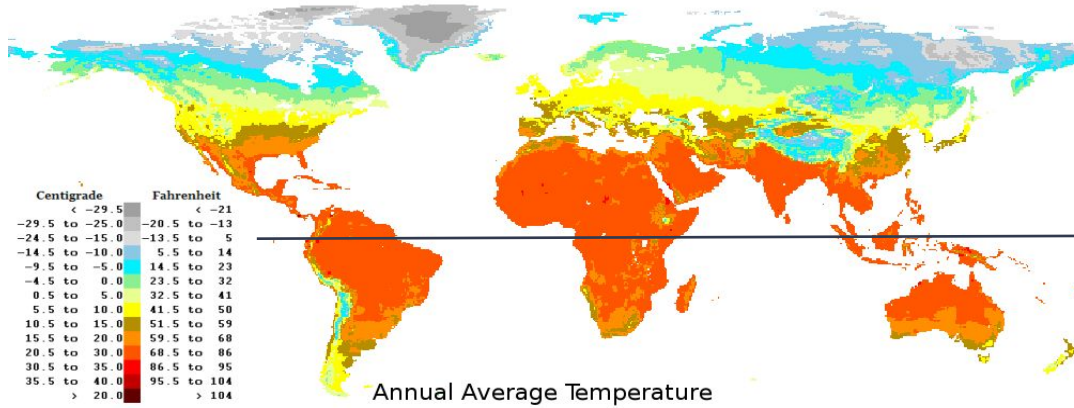


Cooler California Current
Flowing South from High Latitudes

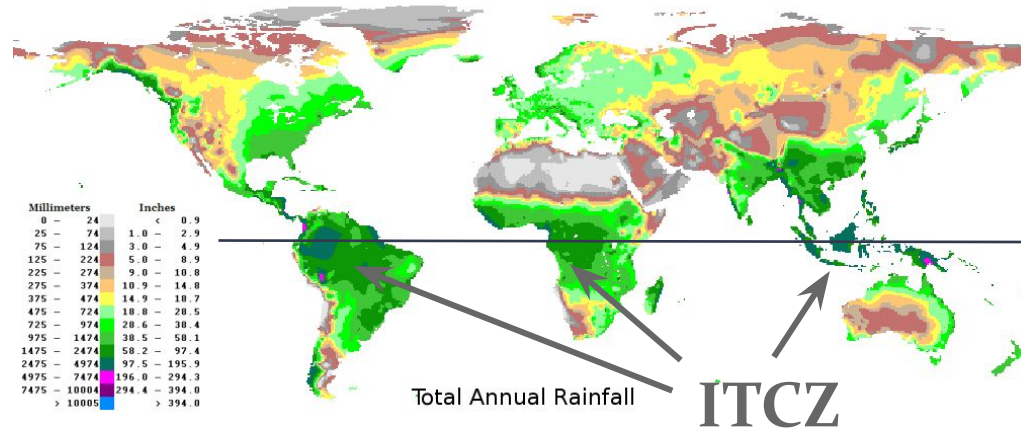
Warmer Gulf Stream Flowing
Northward from the Equator

Proximity to the Equator

Average Temperature



Total Rainfall



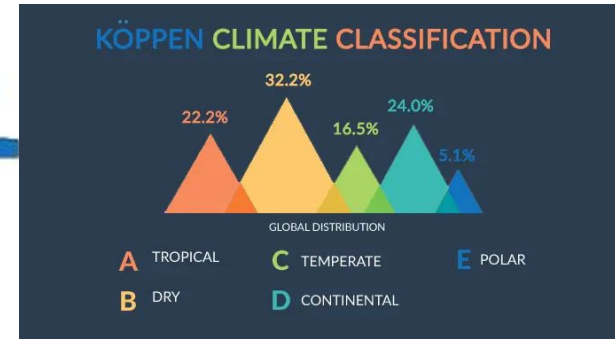
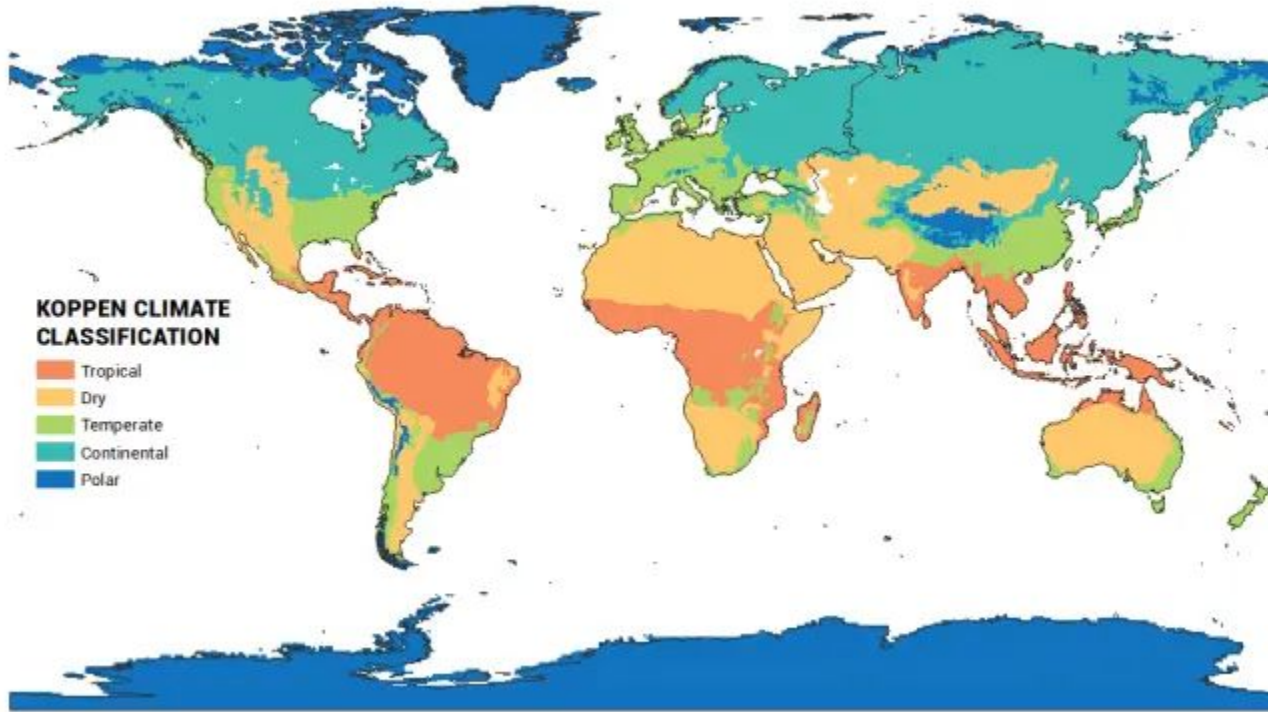


How many different types of climate are there?

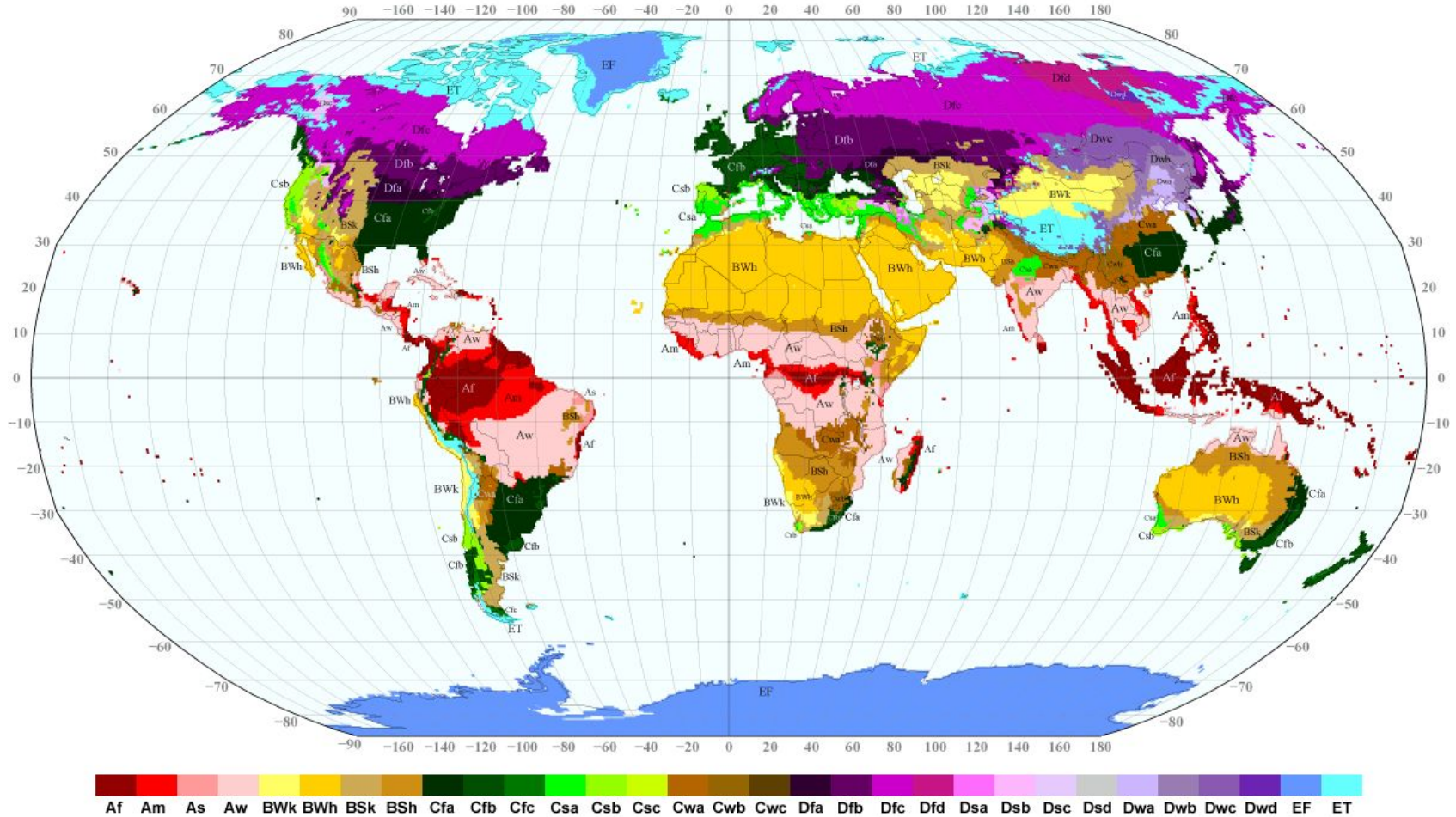
Select the best answer.

- a) Less than 5 types
- b) 5-10 types
- c) 10-15 types
- d) More than 15 types

Köppen Climate Classification



Köppen-Geiger Climate Subdivisions



What are Teleconnections?

- Large-scale atmospheric variability patterns which reflect large-scale changes in the atmosphere.
- Many teleconnection patterns span entire ocean basins and continents.
- Changing conditions in one part of the world can affect areas far from the source.
 - Abnormal weather occurring simultaneously on opposite sides of the globe.
- Have low-frequency (long time scale) variability, typically on the order of months to years.
- They help provide some level of predictability of the climate system.

El Niño/Southern Oscillation (ENSO)



El Niño, La Niña, Oceanic Niño Index (ONI)

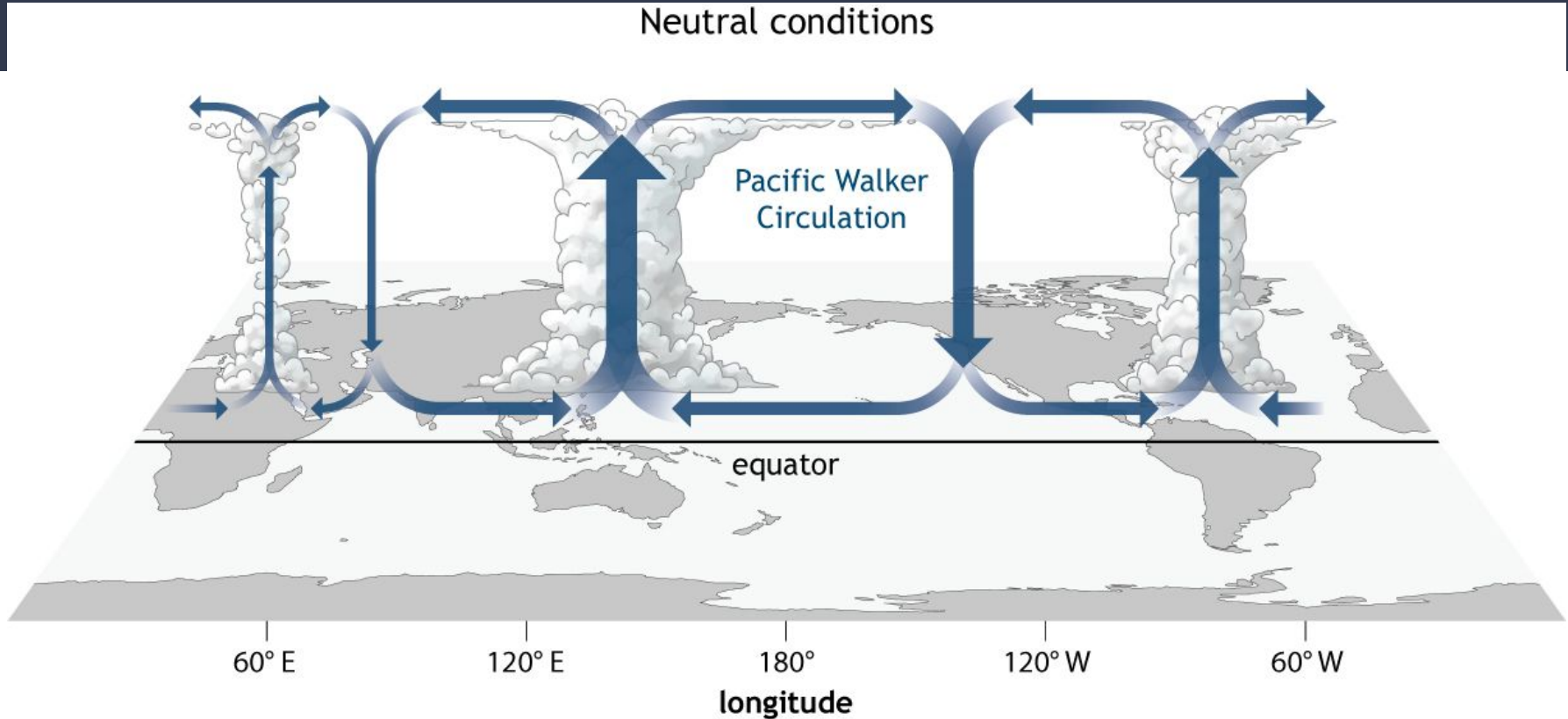


Sir Gilbert Walker



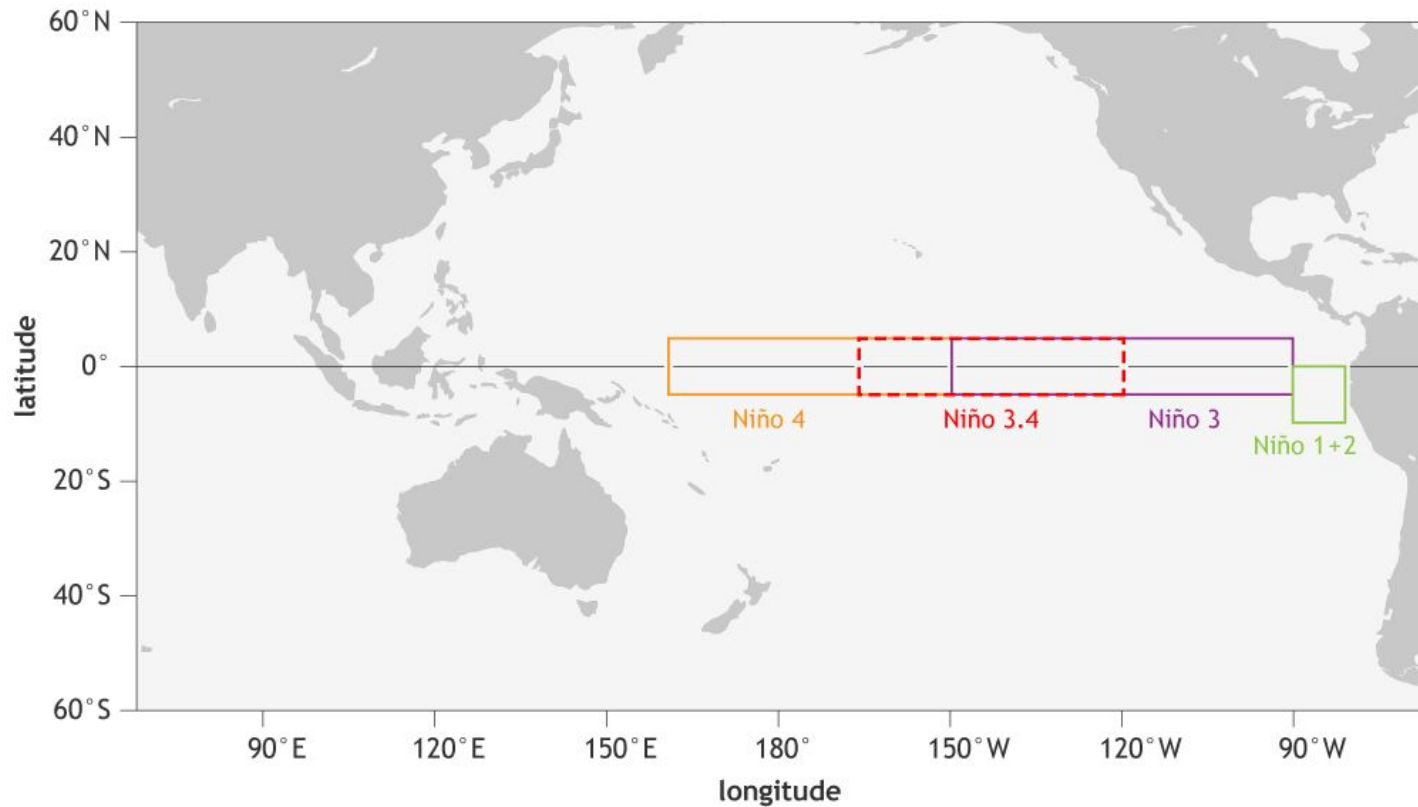
Jacob Bjercknes

ENSO Neutral

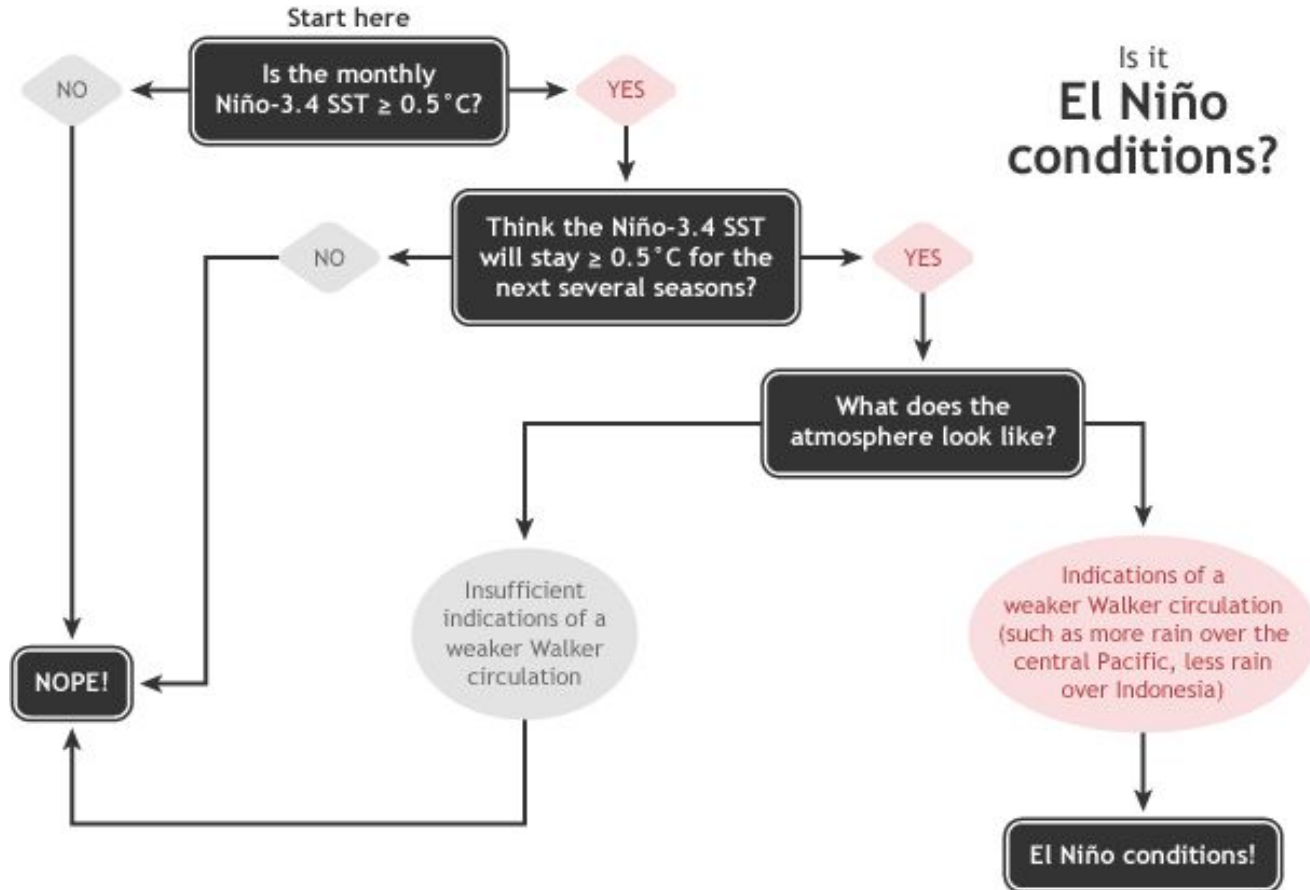


ONI - Oceanic Niño Index

Sea surface temperature

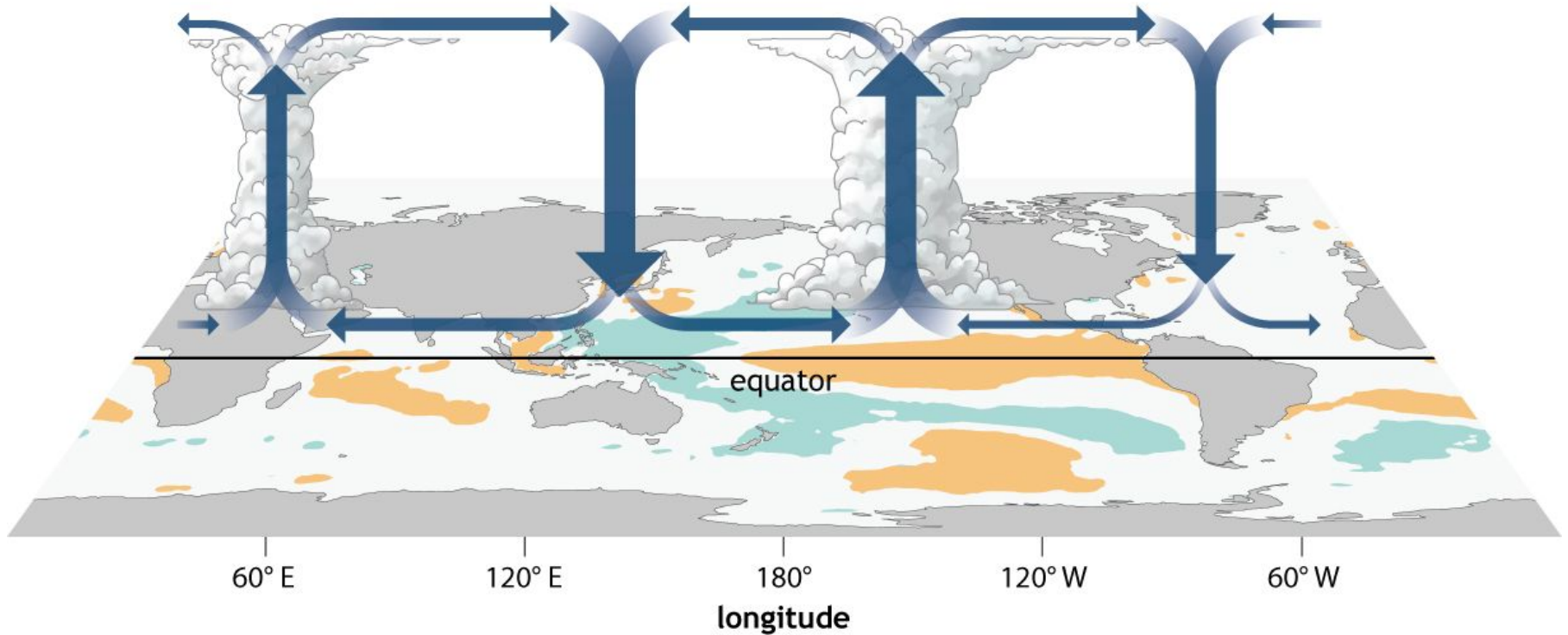


Is it El Niño?



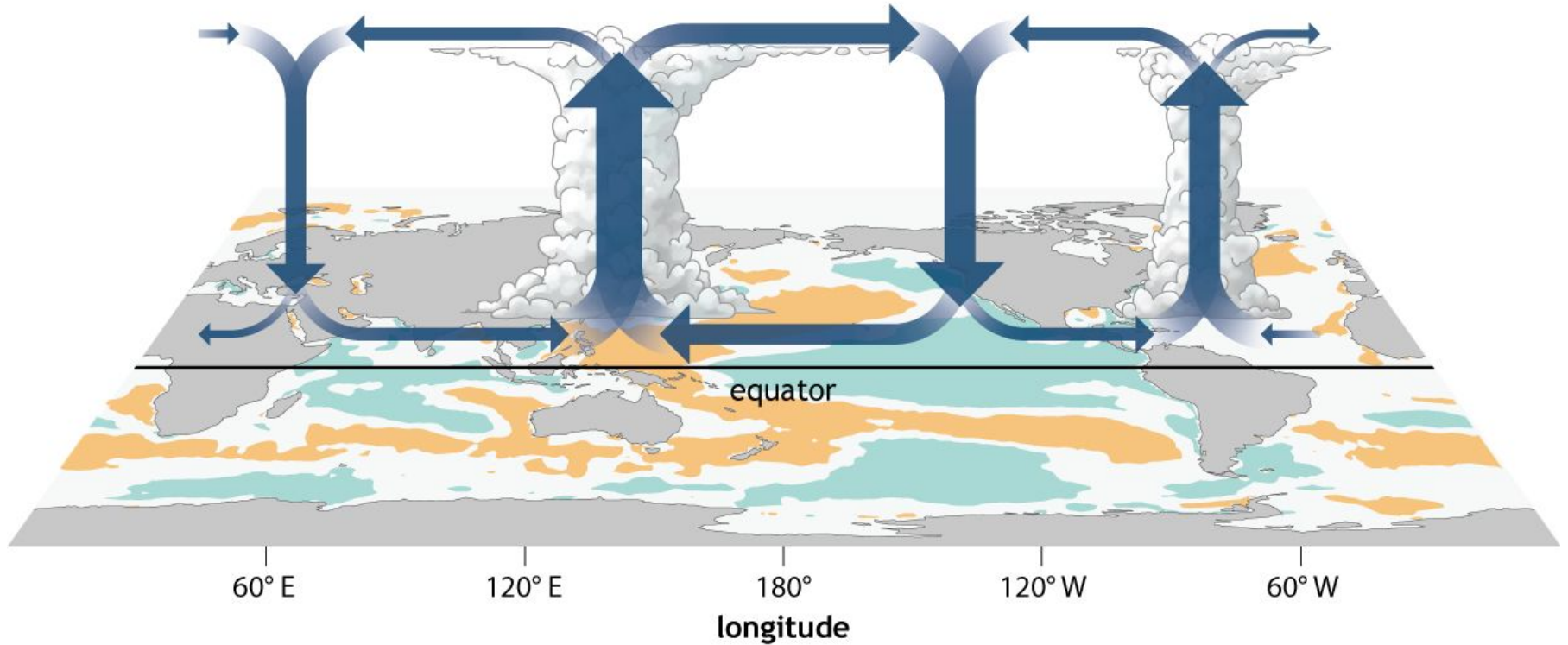
El Niño

El Niño conditions



La Niña

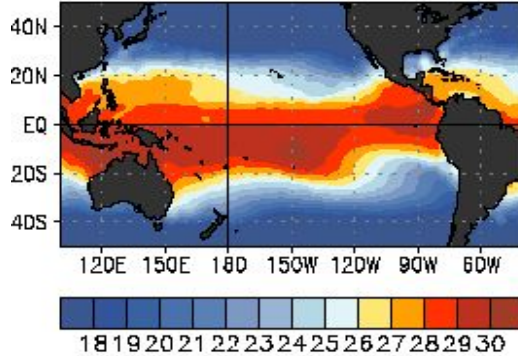
La Niña conditions



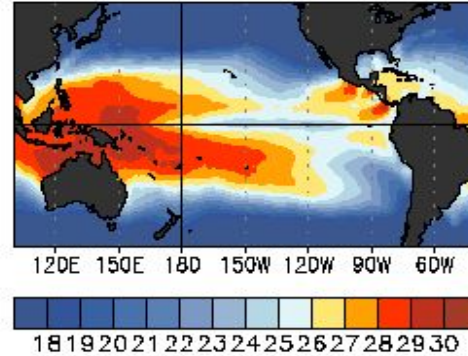
Ocean Temperatures during El Niño and La Niña

OCEAN TEMPERATURES (°C)

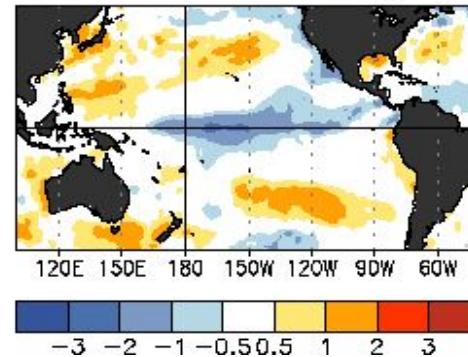
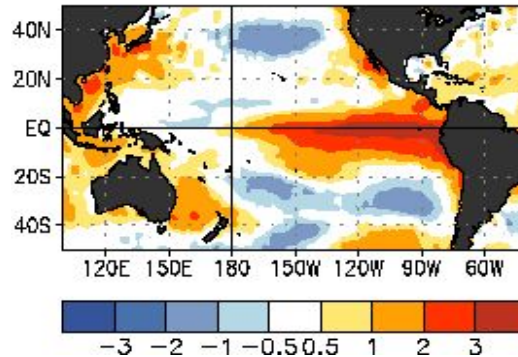
EL NIÑO
Jan-Mar 1998



LA NIÑA
Jan-Mar 1989

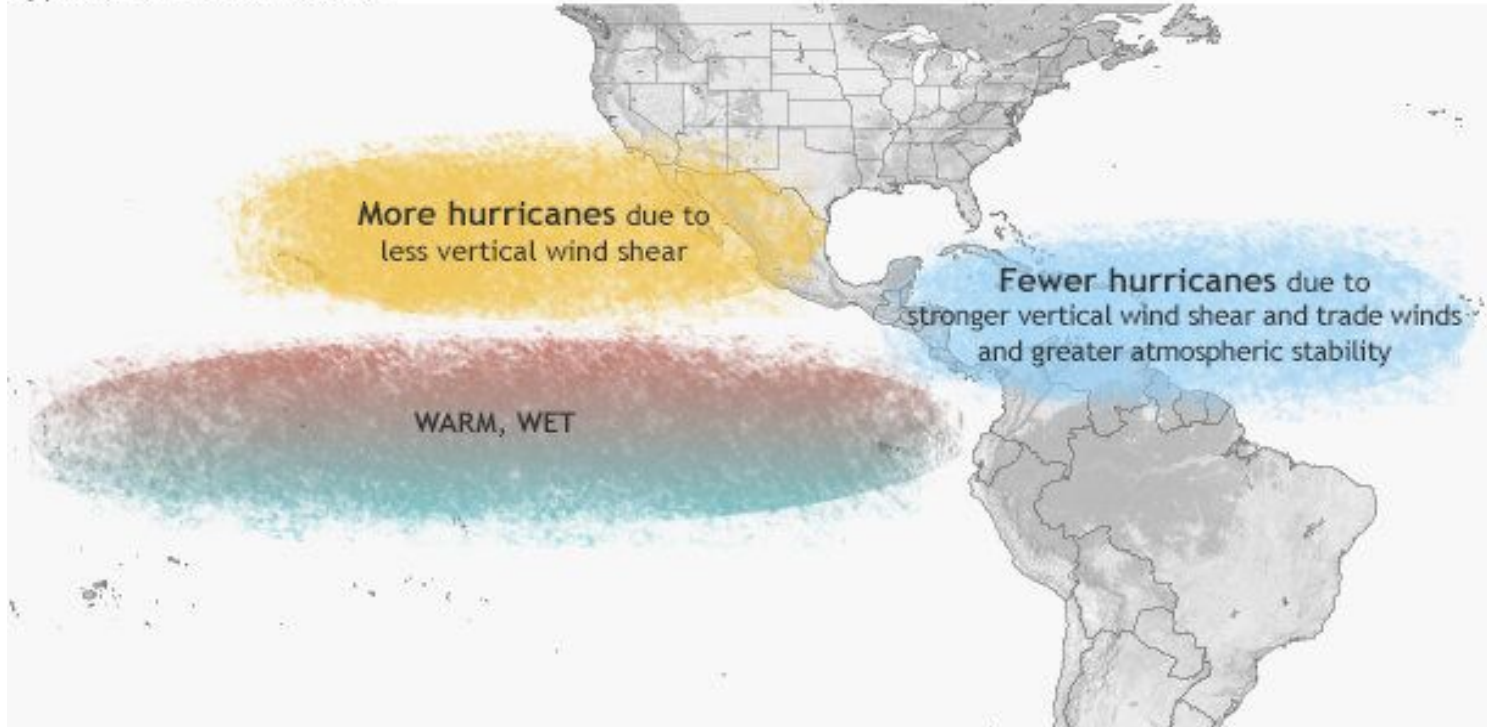


OCEAN TEMPERATURE DEPARTURES (°C)



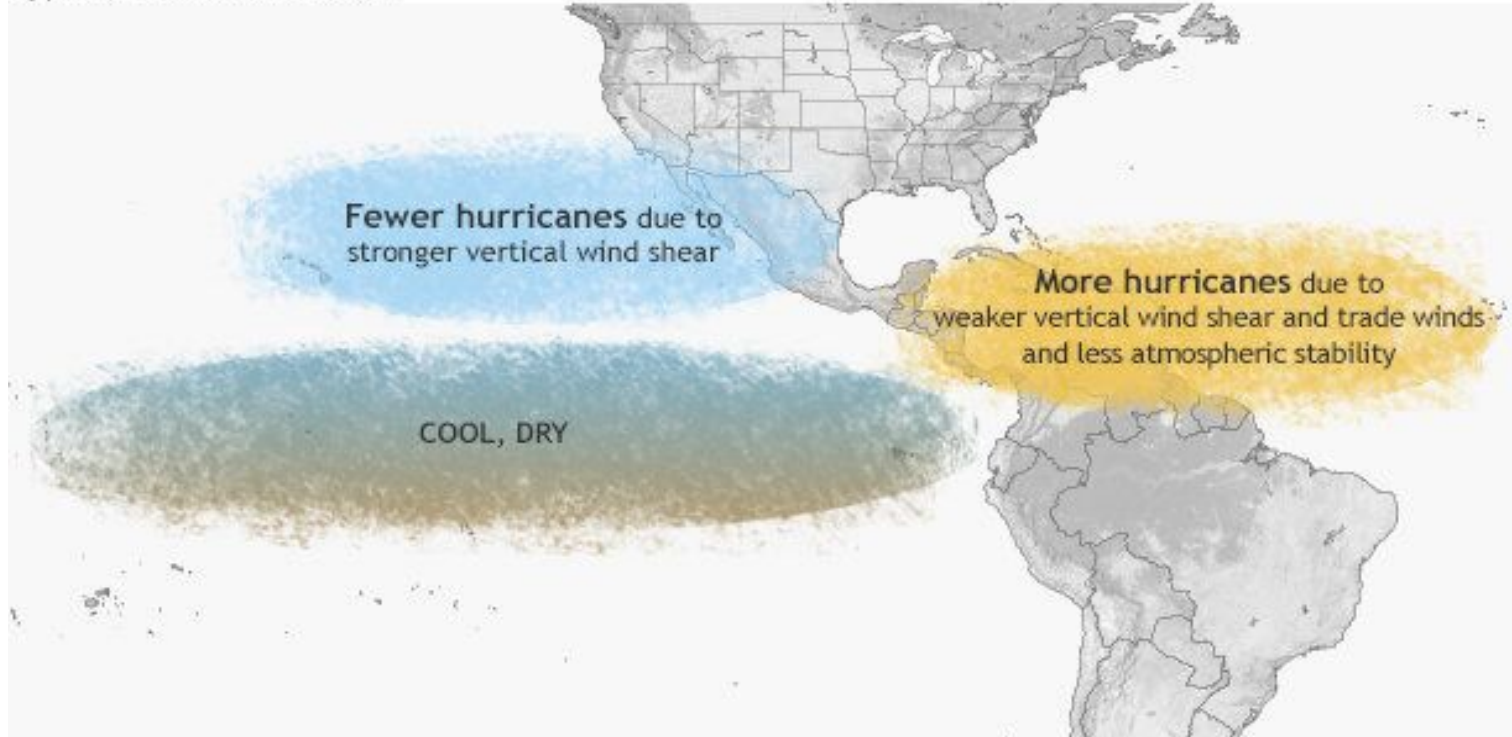
Hurricane Season Impacts

Typical El Niño influence



Hurricane Season Impacts

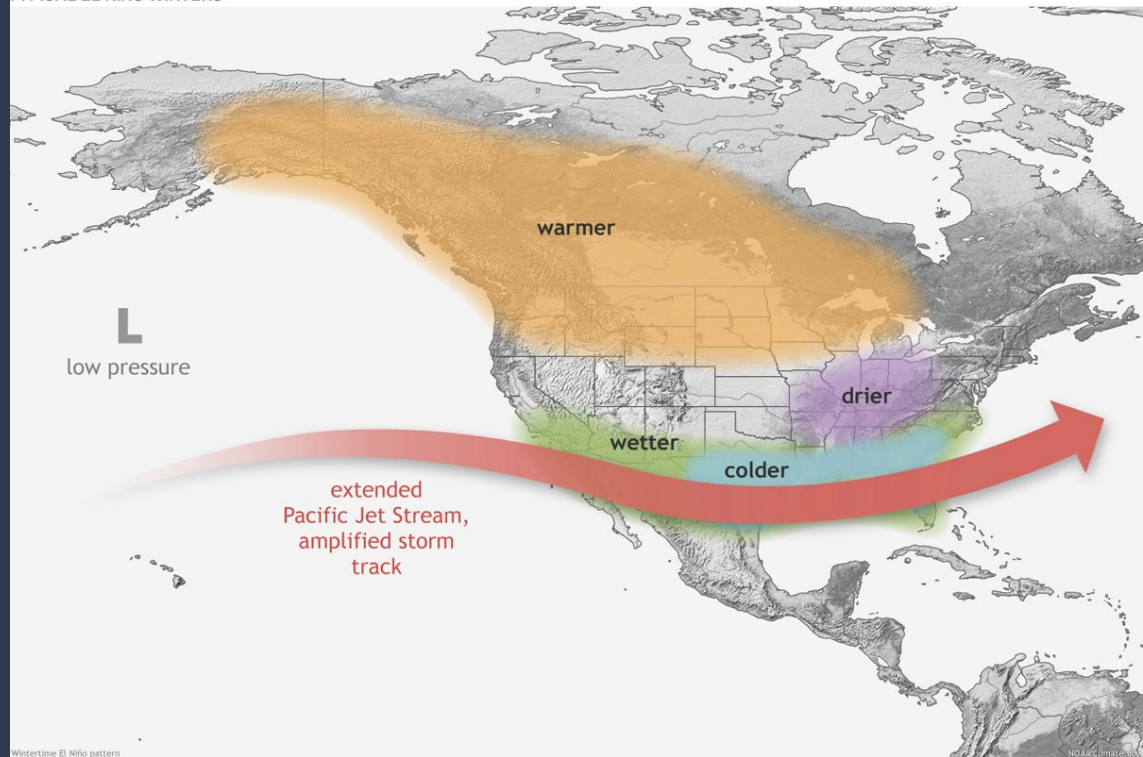
Typical La Niña influence



Winter Weather during El Niño

- Jet stream further south
- Cooler and wetter across the south
- Warmer and drier across interior and northern North America

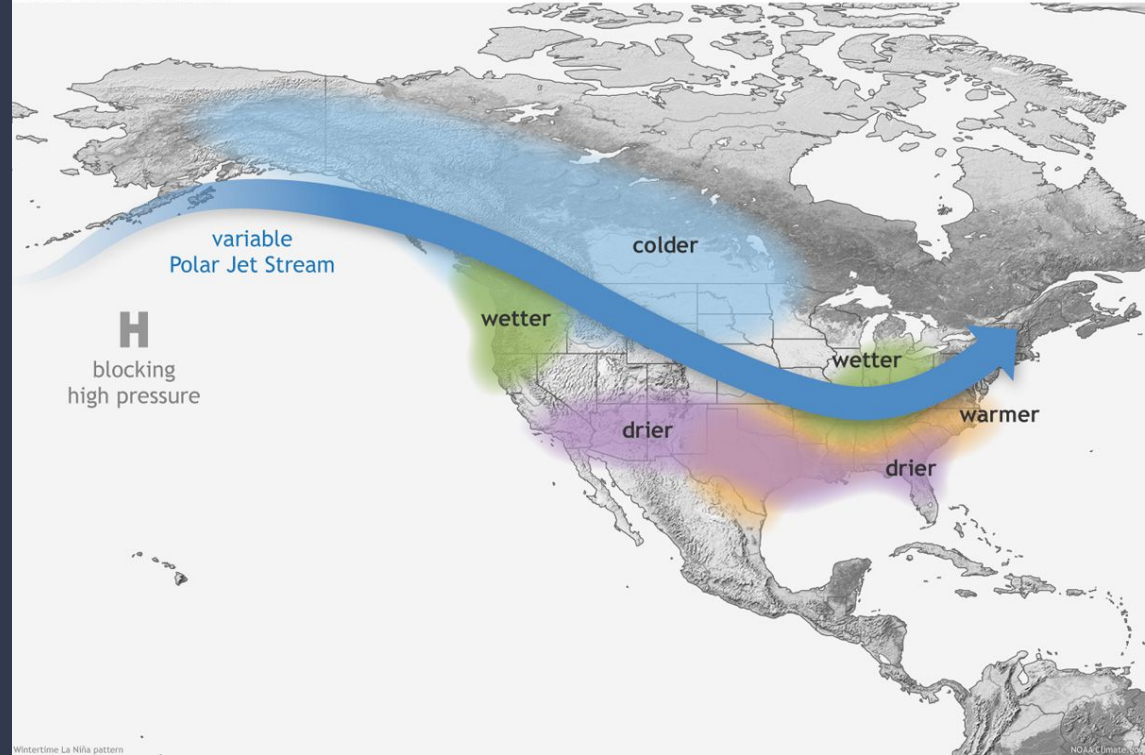
TYPICAL EL NIÑO WINTERS



Winter Weather during La Niña

- Jet stream further north with blocking high pressure in the Gulf of Alaska
- Drier and warmer across the south
- More winter storms across the interior of North America and northern tier of the US.

TYPICAL LA NIÑA WINTERS





What are some other teleconnections that you have heard of before?

Select all that apply.

- a) Madden-Julian Oscillation
- b) Pacific-Decadal Oscillation
- c) Arctic/Antarctic Oscillation
- d) North Atlantic Oscillation
- e) Pacific-North American Pattern
- f) Atlantic Multi-Decadal Oscillation

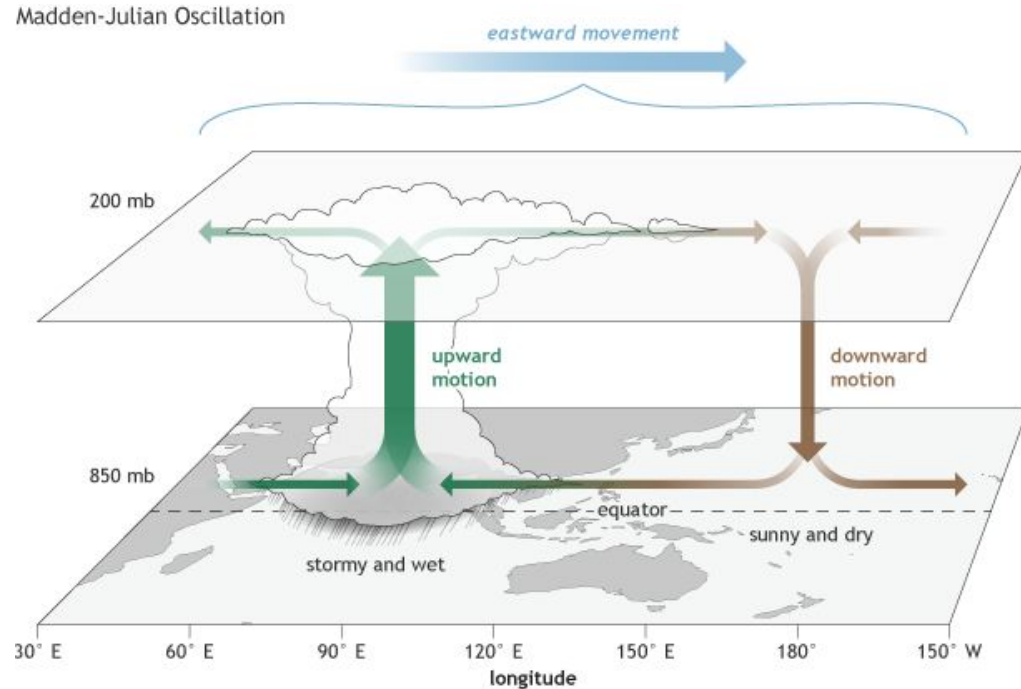
Other Oscillations and Teleconnections

MJO, PDO, AMO

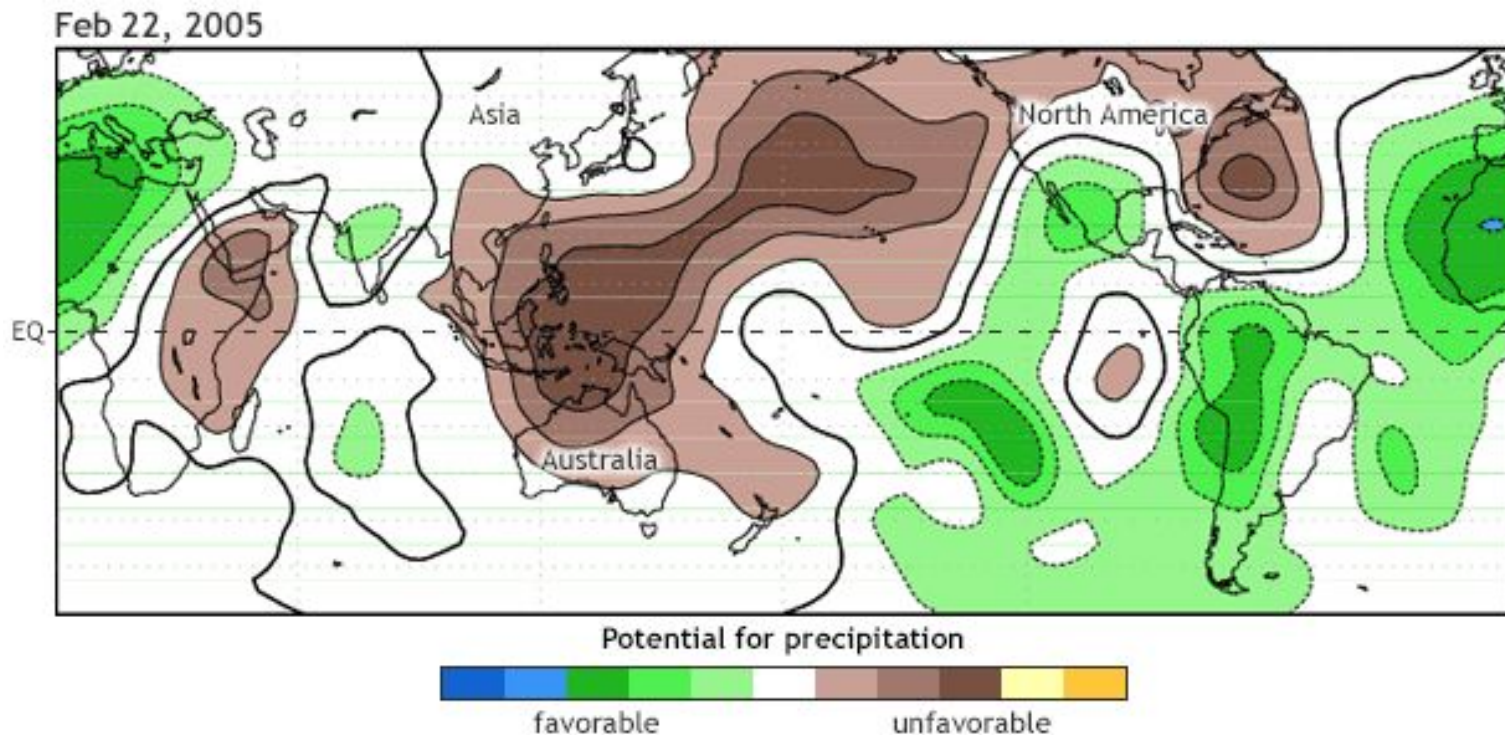
NAO, PNA

MJO – Madden Julian Oscillation

- Tropical disturbance that propagates eastward around the global tropics with a cycle on the order of 30-60 days.
- Has wide ranging impacts on the patterns of tropical and extratropical precipitation, atmospheric circulation, and surface temperature around the global tropics and subtropics.
- It can contribute to the speed of development and intensity of El Niño and La Niña episodes.

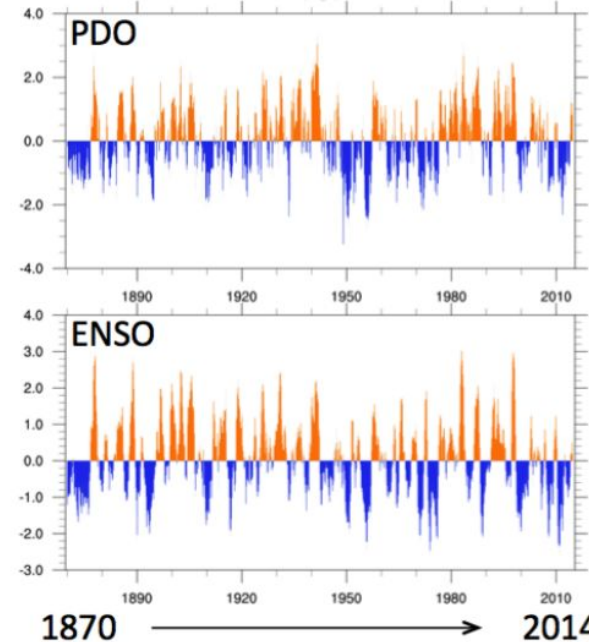
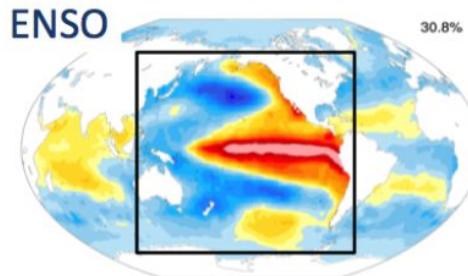
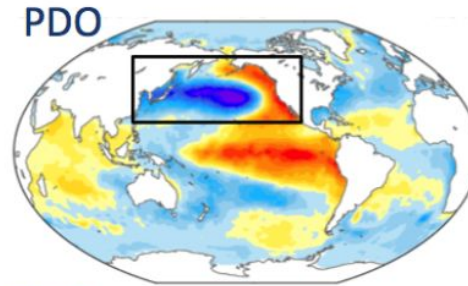


MJO – Madden Julian Oscillation

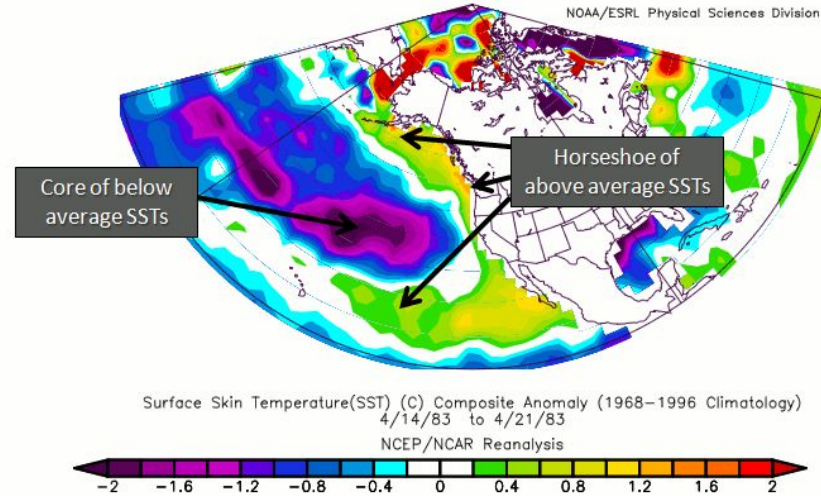


PDO – Pacific Decadal Oscillation

- A long-lived El Niño-like pattern of Pacific climate variability (Zhang et al. 1997).
- Similar to ENSO, the extreme phases of the PDO are classified as being either warm or cool.
- These phases are defined by ocean temperature anomalies in the northeast and tropical Pacific Ocean.
- PDO shifts occur on the order of 20-30 years, hence “decadal”.

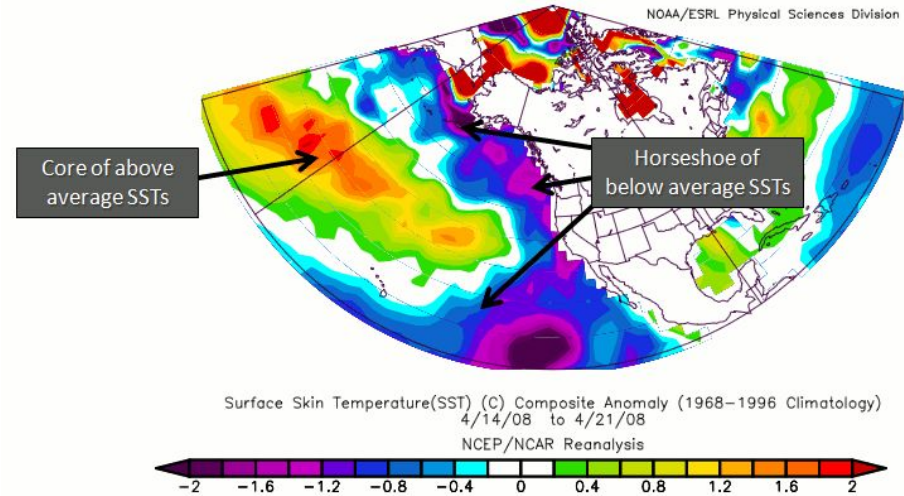


PDO – Pacific Decadal Oscillation



Positive PDO - SSTs are anomalously cool in the interior North Pacific and warm along the Pacific Coast.

Sea level pressures are below average over the North Pacific.

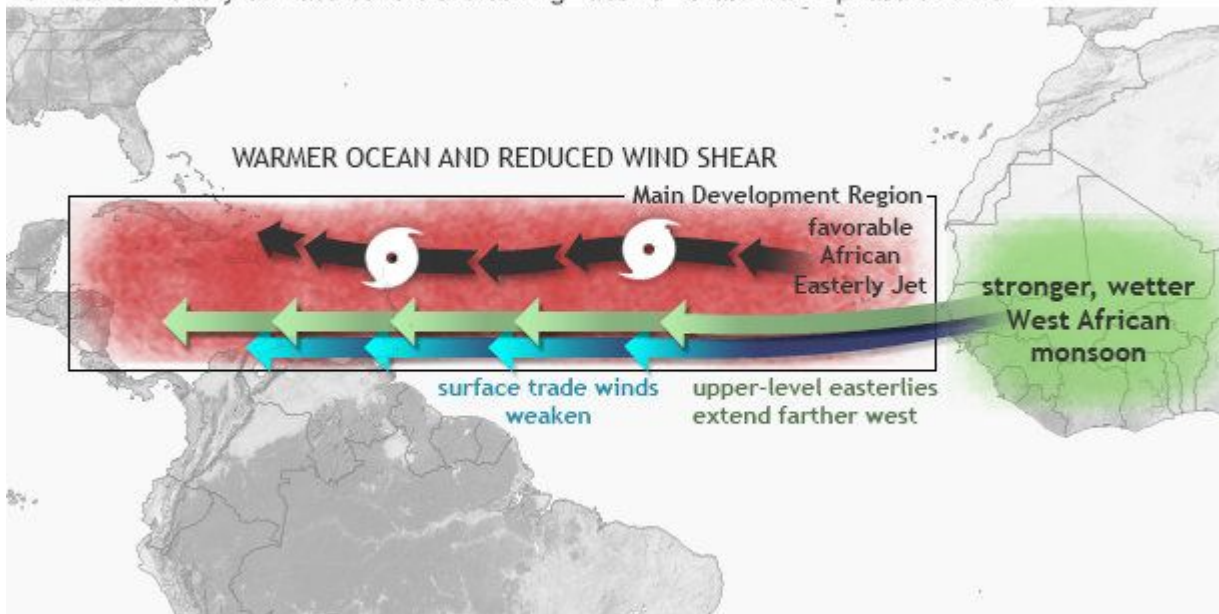


Negative PDO - Warm SST anomalies in the interior North Pacific and cool SST anomalies along the North American coast.

Above average sea level pressures over the North Pacific.

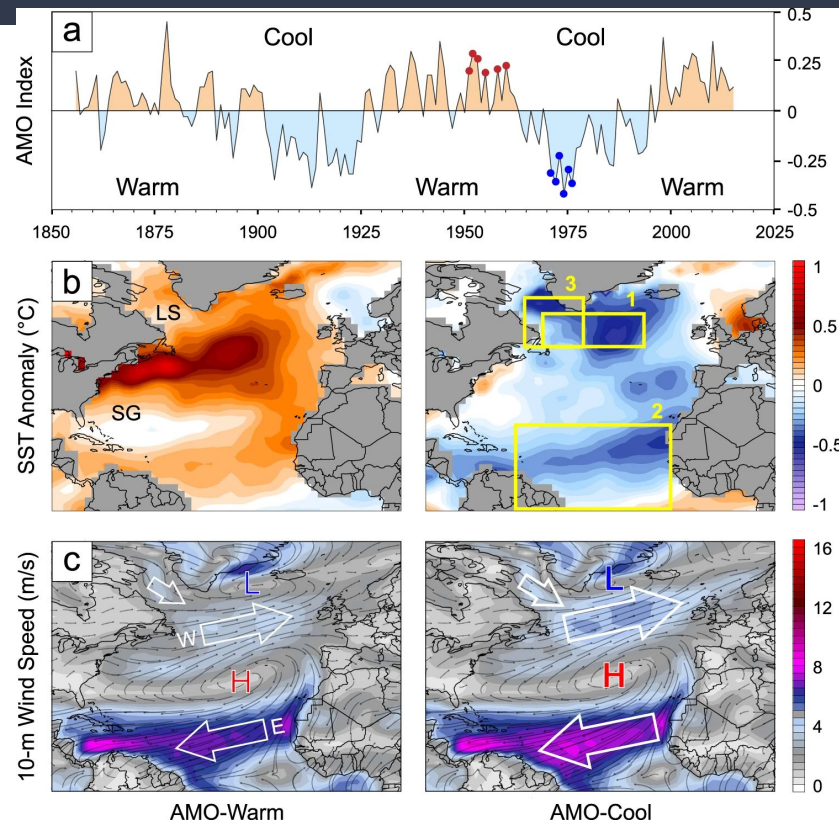
AMO – Atlantic Multi-Decadal Oscillation

Hurricane-friendly climate conditions during “active” eras: warm phase of AMO



- Another prominent climate factor to influence Atlantic hurricane activity.
- The warm phase of the AMO is associated with high-activity eras for Atlantic hurricanes, such as 1995 - present. In this phase, there are warmer SSTs across the Atlantic hurricane Main Development Region.
- Conversely, the cold phase of the AMO is associated with low-activity eras (such as the period 1971-1994).

AMO – Atlantic Multi-Decadal Oscillation



- The climate change signal is removed from the AMO index.
- Warm (positive) phase of the AMO has positive SST anomalies over most of the north Atlantic, with stronger anomalies in the subpolar region and weaker anomalies in the tropics.
- These trends are near reversed in the cool (negative) phase of the AMO.
- Impacts on the PDO and PNA have been observed (Zhang and Delworth, 2007).

North Atlantic Oscillation

The phase of the NAO reflects changes primarily in:

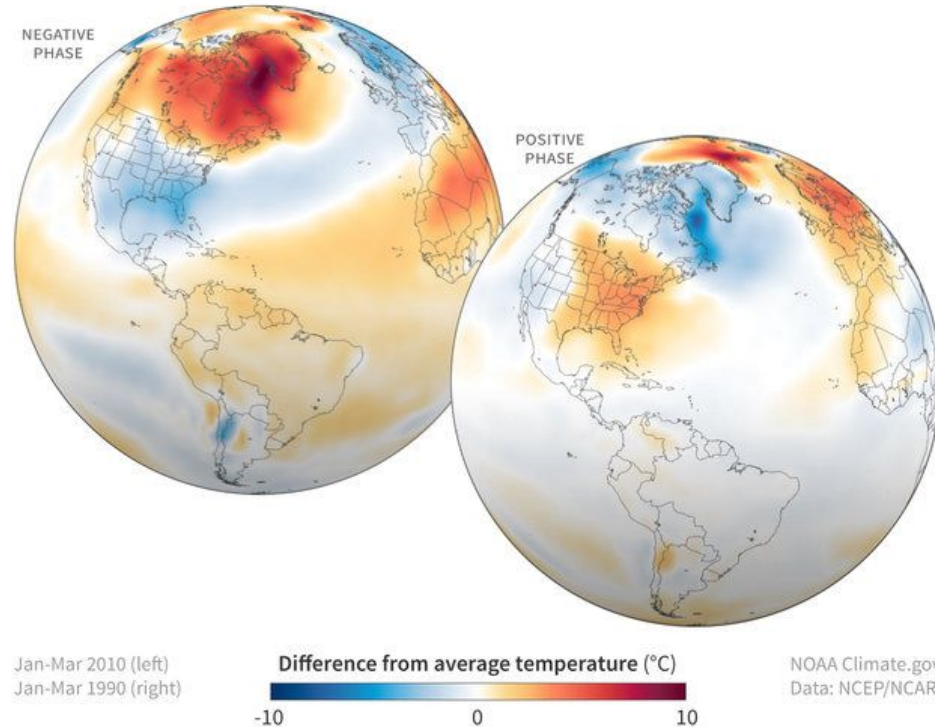
- the intensity and location of the North Atlantic jet stream and storm track.
- temperature and precipitation patterns extending from eastern North America to western and central Europe.

It is a measure of the strength difference between the Icelandic Low and Azores high.

Calculated on a daily basis, but can be averaged over time.

NAO TEMPERATURE PATTERNS

Image: climate.gov

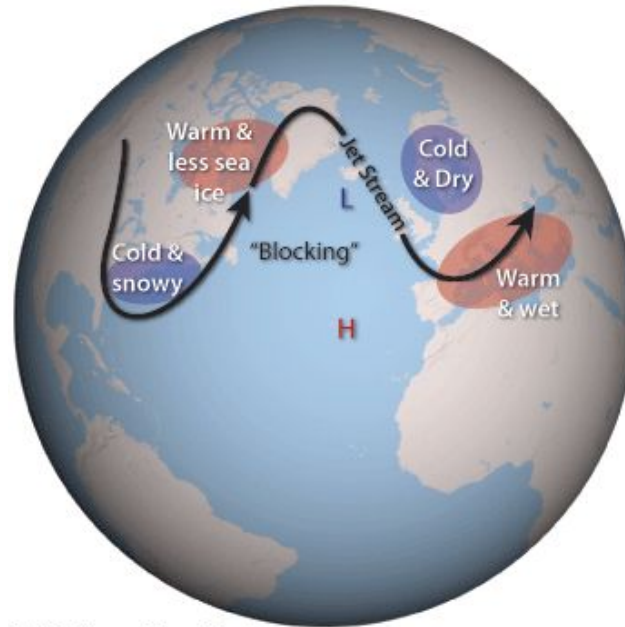


North Atlantic Oscillation

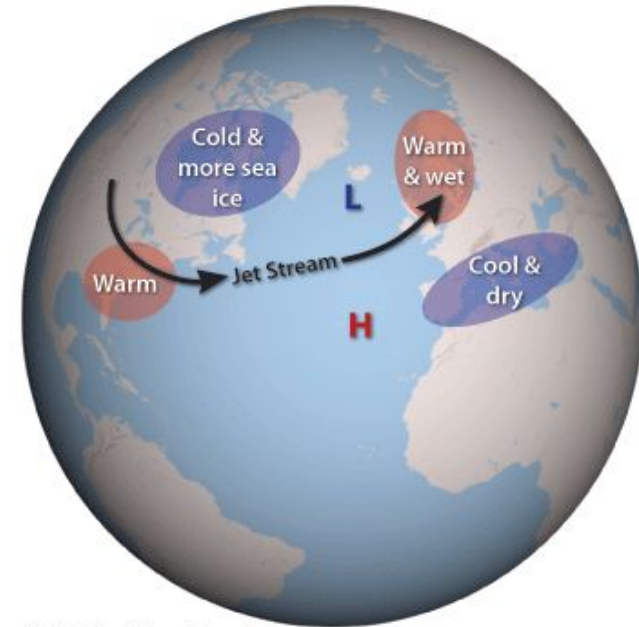
The NAO is the most prominent pattern of climate variability in the mid and high Northern latitudes.

Conditions associated with the NAO directly affect human demand for energy, quality of crop yields, and productivity of fisheries.

The NAO is not currently predictable more than a week or two in advance.

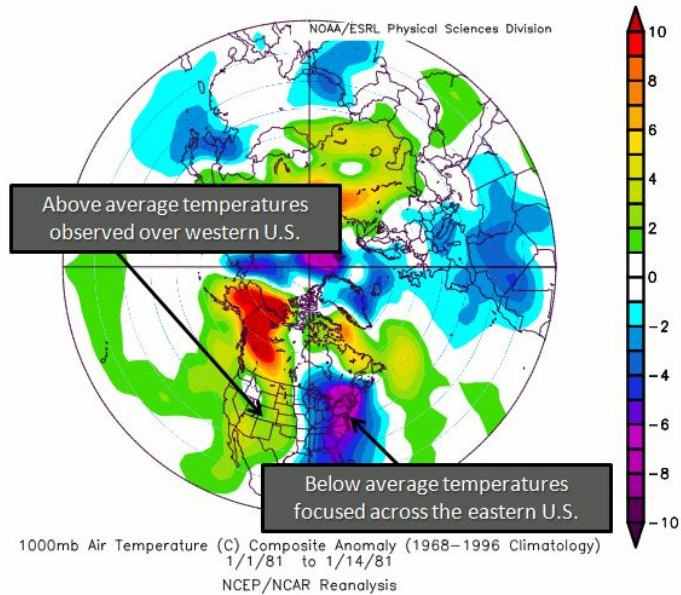
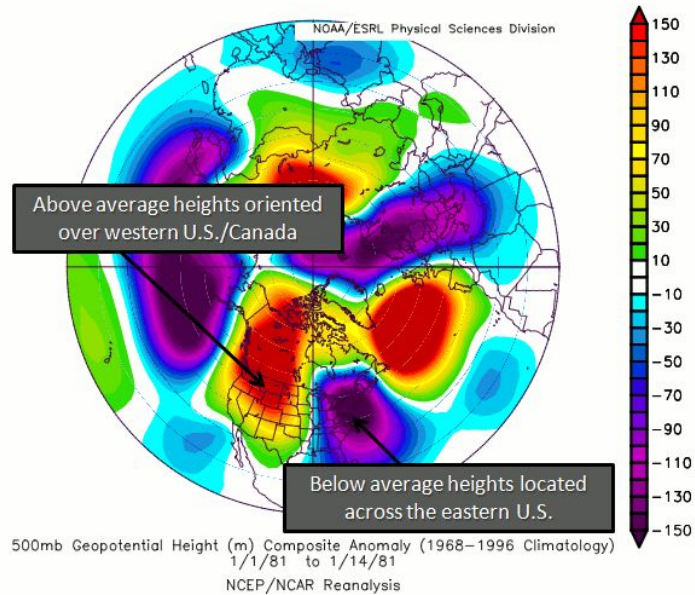


NAO Negative Mode



NAO Positive Mode

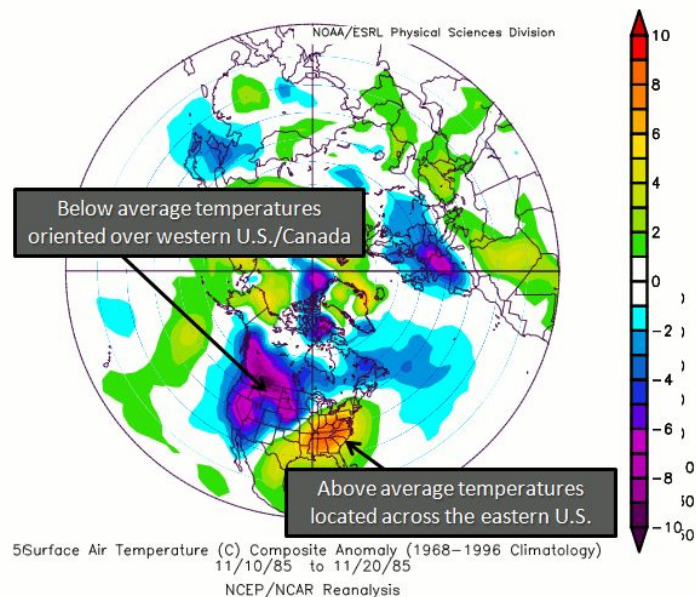
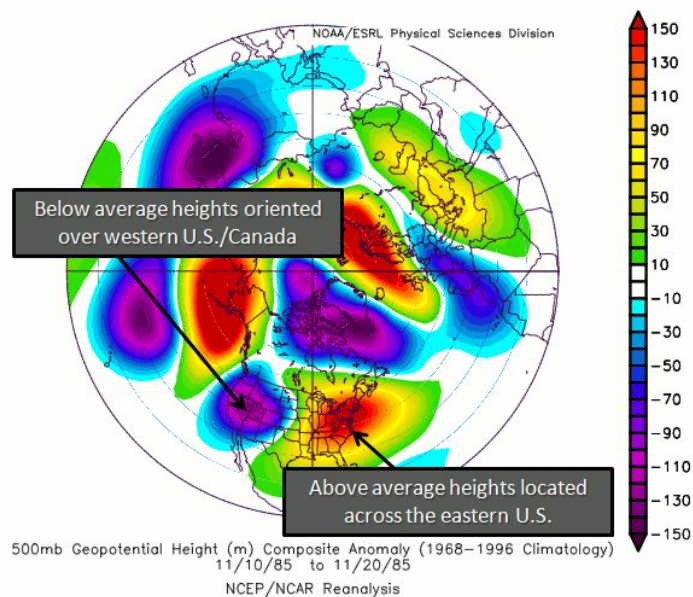
Pacific–North American Pattern



Positive

One of the most prominent modes of low-frequency variability in the Northern Hemisphere outside of the tropics. Measured by anomalies in the height fields observed over the western and eastern US. The PNA is considered a climate pattern because it is typically defined using monthly or seasonal averages.

Pacific-North American Pattern



Negative

Other Oscillations and Patterns

There remain other global-scale patterns which exist over parts of Europe and Asia which we did not discuss.

- Some patterns exist all times of the year and are in one phase or another
 - Other patterns are only found during certain season
 - Patterns like ENSO develop irregularly, though there is an average number of years between significant events
- Arctic Oscillation
 - Antarctic Oscillation
 - East Atlantic Pattern
 - East Atlantic/Western Russia Pattern
 - Scandinavia Pattern
 - Polar/Eurasia Pattern
 - West Pacific Pattern
 - East Pacific-North Pacific Pattern
 - Pacific/North American Pattern
 - Tropical/Northern Hemisphere Pattern
 - Pacific Transition Pattern
 - Et. al....



Which topic from today did you learn most about?

Select one of the following:

- a) Global energy balance
- b) Climate types
- c) ENSO
- d) Other teleconnections
- e) It was a lot - I need to review it again

Thank you for attending!

Questions?

Contact: Emily Carpenter - Emily.Carpenter@noaa.gov

Or Scott Unger – Scott.Unger@noaa.gov

Next Session: **Tue, Nov 15 @ 7pm CST - Fire Weather**



Schedule at: weather.gov/ohx/weather101

Presentation: weather.gov/ohx/weather101presentations

Resources:

<https://www.climate.gov/>

<https://www.cpc.ncep.noaa.gov/>

<https://climatedataguide.ucar.edu/>

[North Carolina Climate Office](#)

