



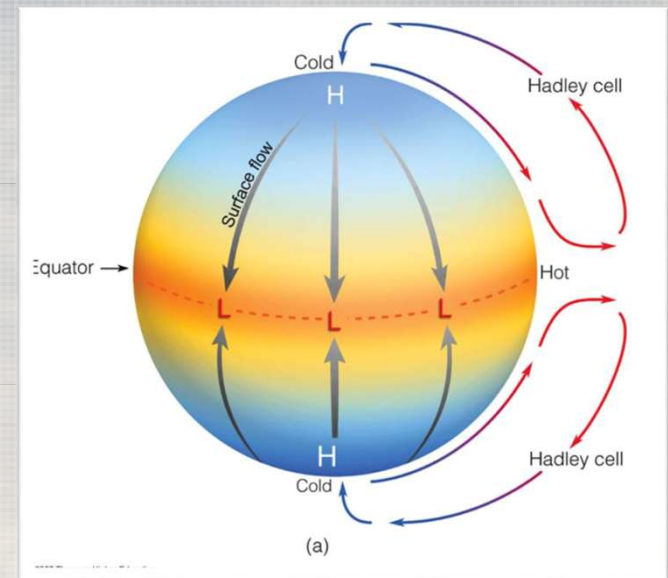
ATMO 102 Pacific Climates and Cultures

Lecture 9: Global Wind

Global Circulation Patterns

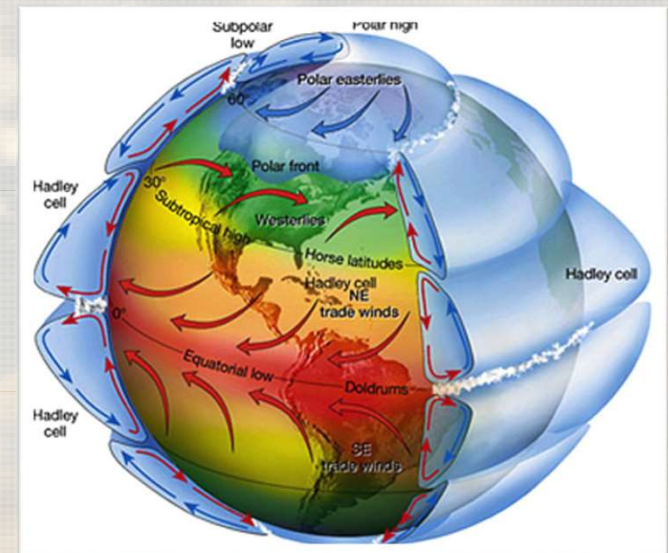
- **Single-Cell Model**

- First idea
- Solar energy drives the winds
- Doesn't account for rotation



- **Three-Cell Model**

- Proposed in 1920s
 - Equator and 30° N (S)
 - 30° N (S) and 60° N (S)
 - 60° N (S) and 90° N (S)

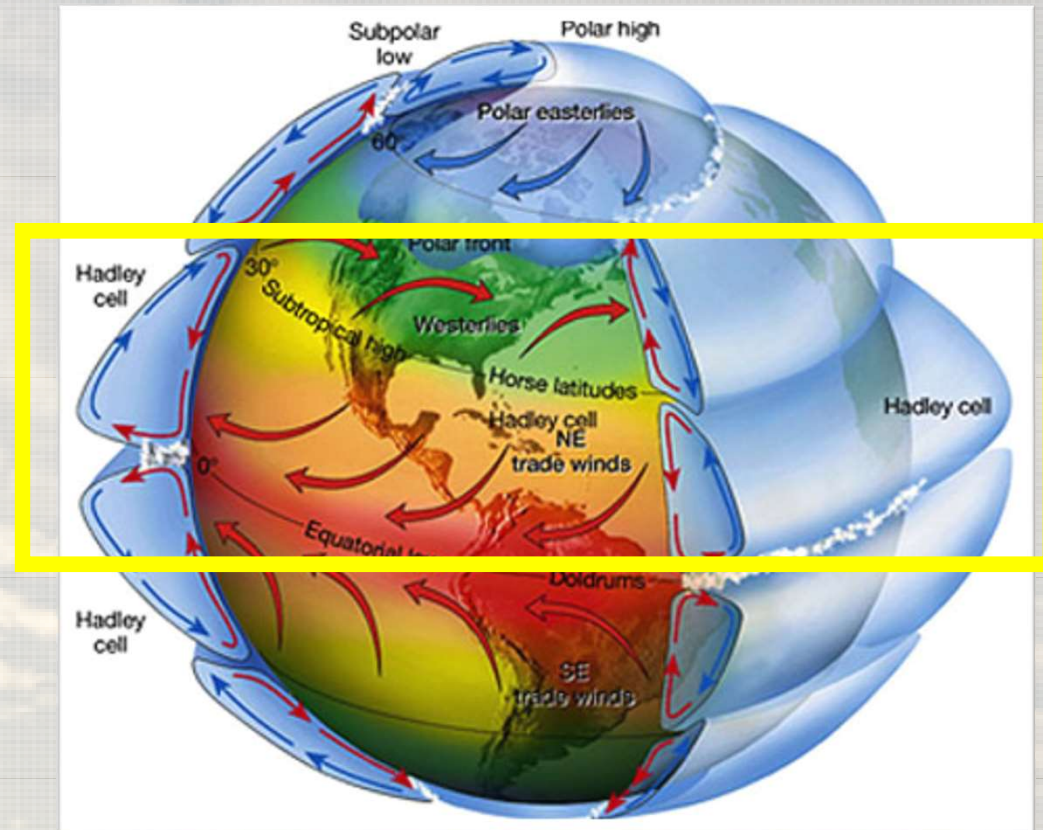


Three Cell Model – Hadley Cell

• 0-30 N (S)

- Air rises at the equator, travels north and subsides between 25-30 N (S) (**Horse Latitudes**)
- From the center of the Horse Latitudes the surface flow splits
 - **Trade Winds:** equator-ward due to Coriolis
 - **Westerlies:** Go towards the poles

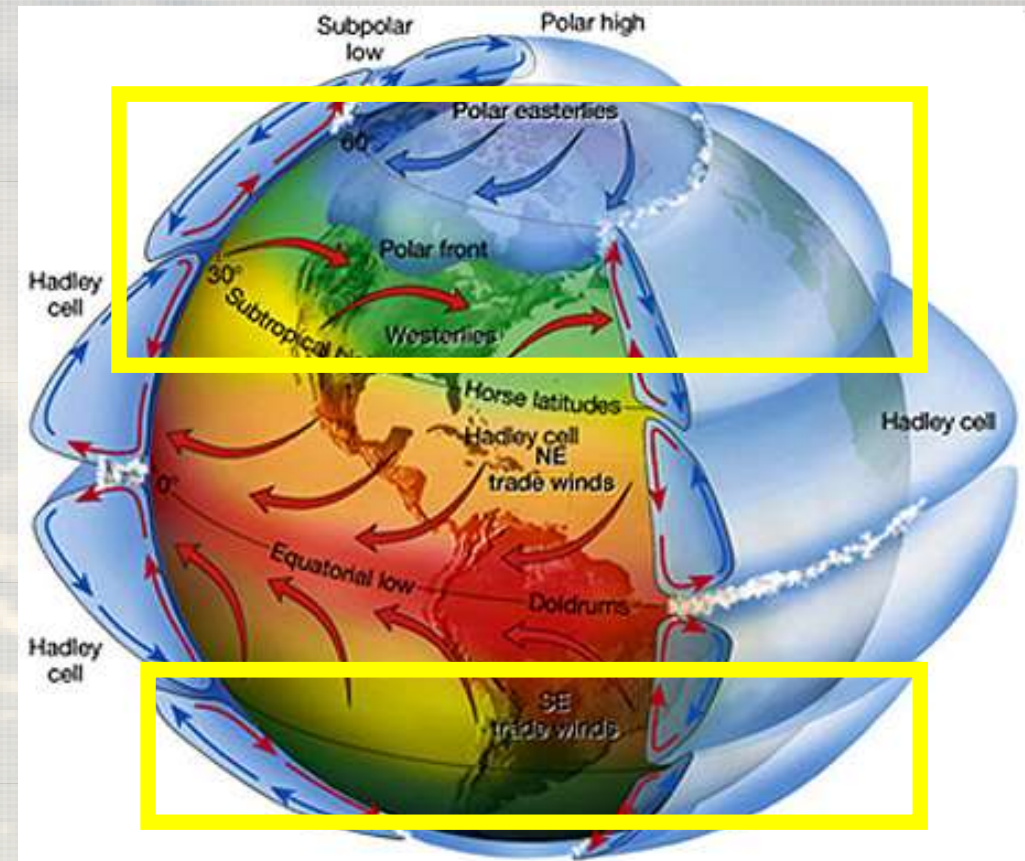
Where the trade winds (N and S) meet is called the **Doldrums**. Light winds and humid conditions.



Three Cell Model – Ferrell Cell

- 30-60 N (S)

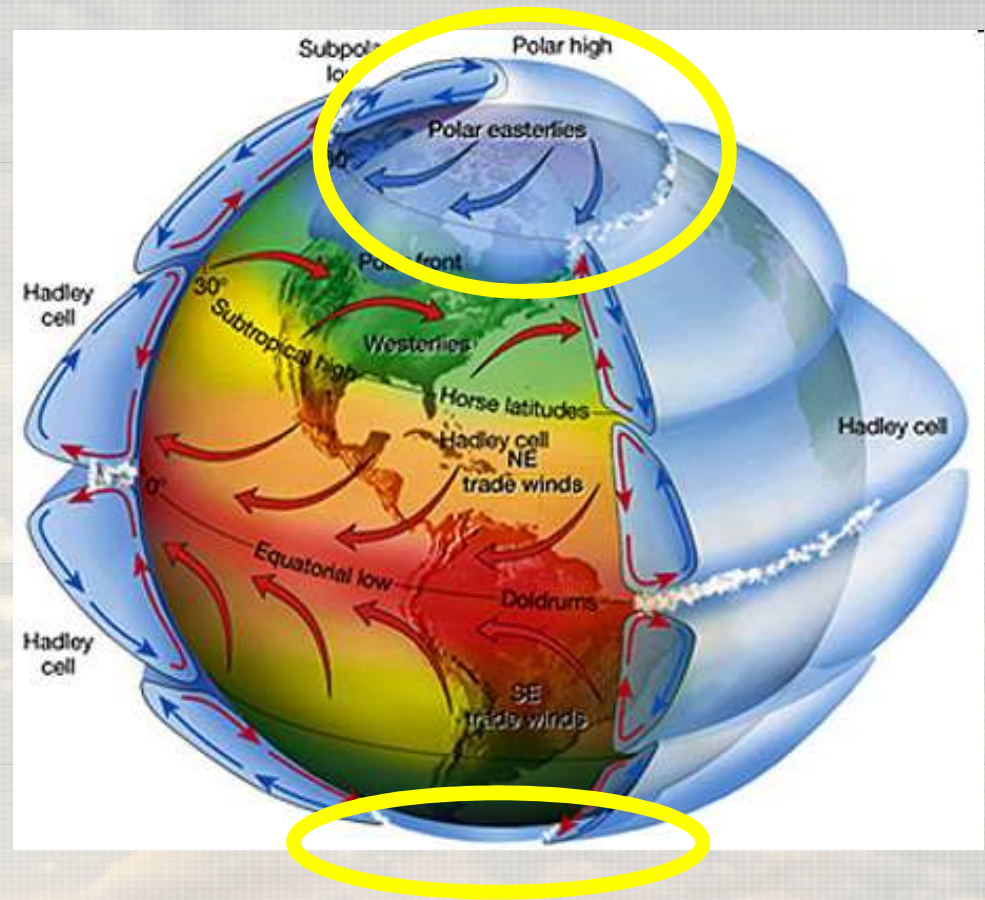
- More complicated than the Hadley cell.
 - Net surface flow is toward the poles
 - Coriolis bends them to the west....called **Westerlies!**
- More sporadic and less reliable than the trade winds
- Migration of cyclones and anti-cyclones disrupts the general westerly flow.



Three Cell Model – Polar Cell

- 60-90 N (S)

- Subsidence at the poles produces a surface flow that moves equatorward and is deflected by Coriolis into the **Polar Easterlies**.
- As cold air moves equatorward it meets with the warmer westerly flow and clashes forming the **Polar Front**.

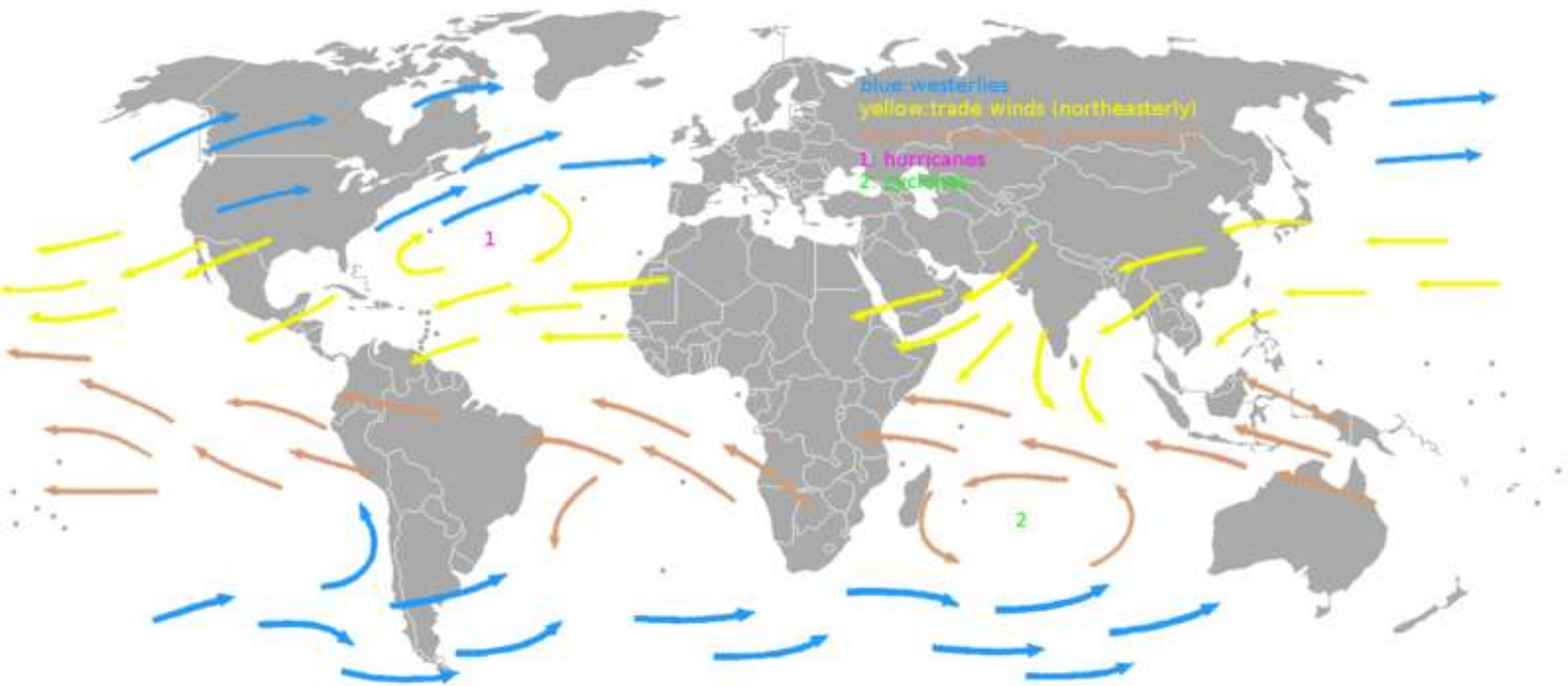


Horse Latitudes ☹️

- The Horse Latitudes are **25-30 N (S)**
- **Trade winds weaken in this region**, which would stall early Spanish ships sailing to the New World.
- When particular areas were too calm, they were **forced to toss over their frightened horses into the sea, or eat them.**
- The legend is that the horses would swim after them for miles before they drowned, and the superstitious sailors would hear **the horse screams in their haunted dreams for the rest of the voyage.**



Global Wind Patterns - General



Trade Winds in Hawai'i

- Trade winds are felt **83-95%** of the time in the summer and **42-60%** of the time in the winter.
- Warm air rises near the equator to the south of the islands and moves northward through the upper atmosphere. This airflow sinks back to the earth's surface at 30 degrees north latitude and flows back over the islands towards the equator, creating a wind moving along the ocean's surface.

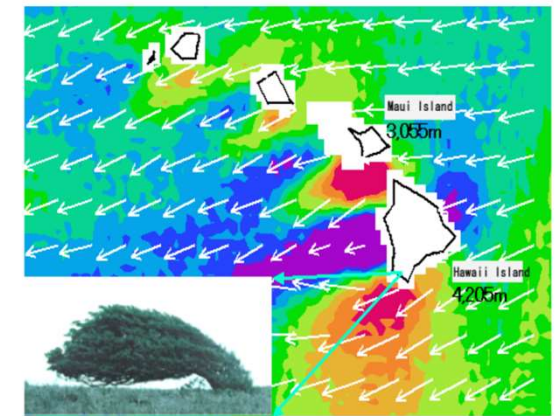
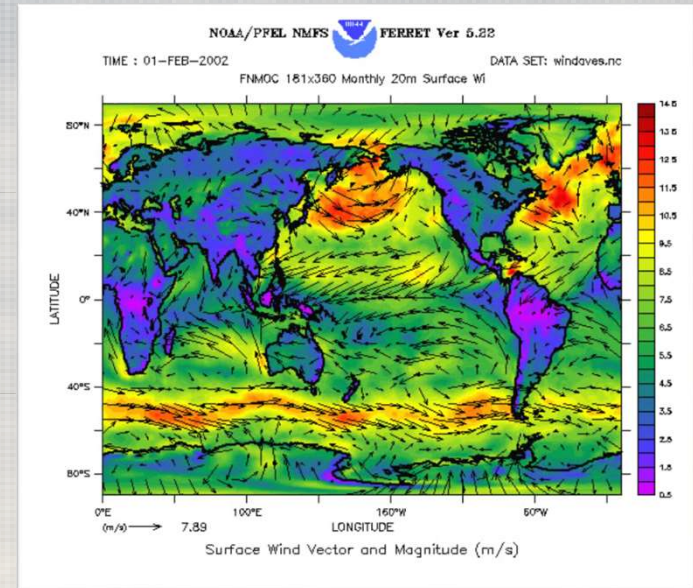


Fig. 1 Wind Velocity (Arrows) and speed (Color) around Hawaiian Islands

Easterly winds blow around the Hawaiian Islands almost all year round. These winds are weak on leeward side (blue and purple) and strong (red) on the flank of the islands. (The photograph at the bottom left was taken at the southernmost part of Hawaii Island. The bent tree reflects the long-term influence of the steady trade winds from the east.)

Westerlies

- Occur between **30-60 N (S) Latitude**.
- Blowing from the high pressure area in the **horse latitudes** towards the **poles**.
- Steer extratropical cyclones.
- Can redirect Tropical Storms
- The Westerlies are:
 - **strongest in the winter hemisphere** and times when the pressure is lower over the poles
 - **weakest in the summer hemisphere** and when pressures are higher over the poles
- The strongest westerly winds in the middle latitudes can come in the **Roaring Forties**, between 40 and 50 degrees latitude (S).



Roaring Forties (and Furious Fifties)

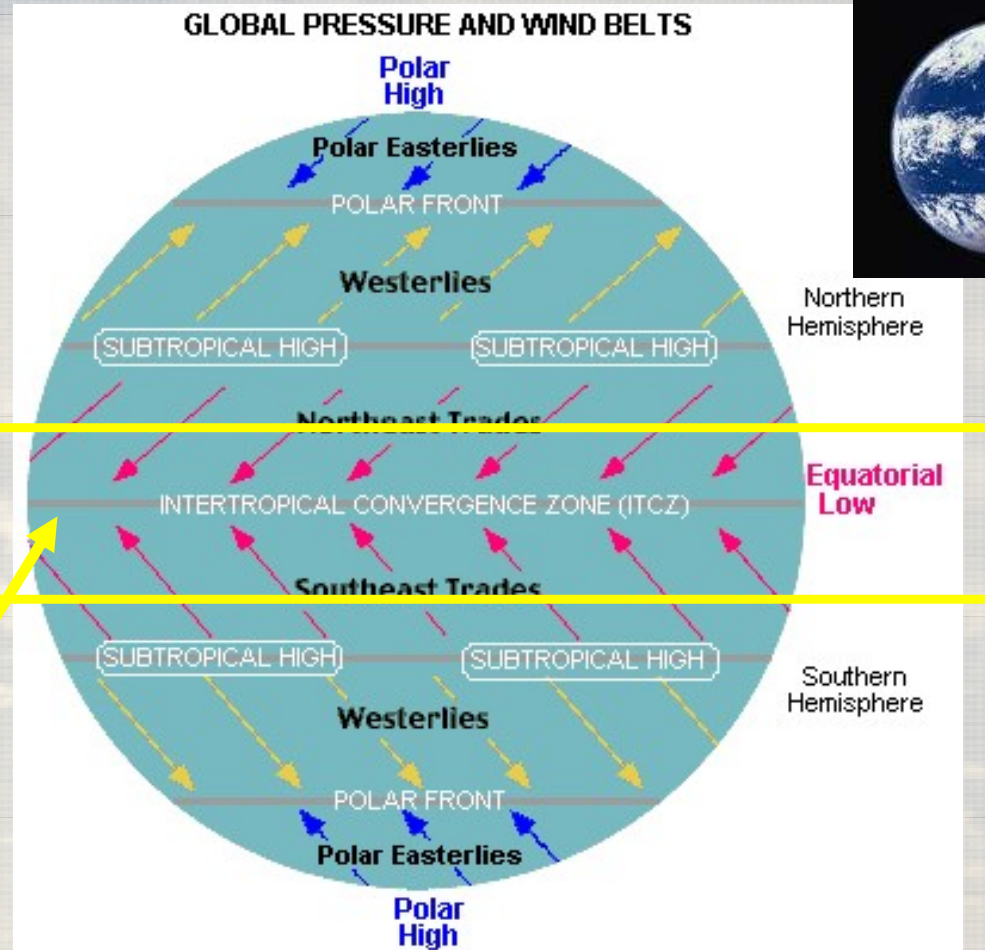
- The strong **west-to-east air currents** are caused by the combination of air being displaced from the Equator towards the South Pole and the Earth's rotation, and there are **few landmasses to serve as windbreaks**.



Observed Distribution of Pressure and Winds

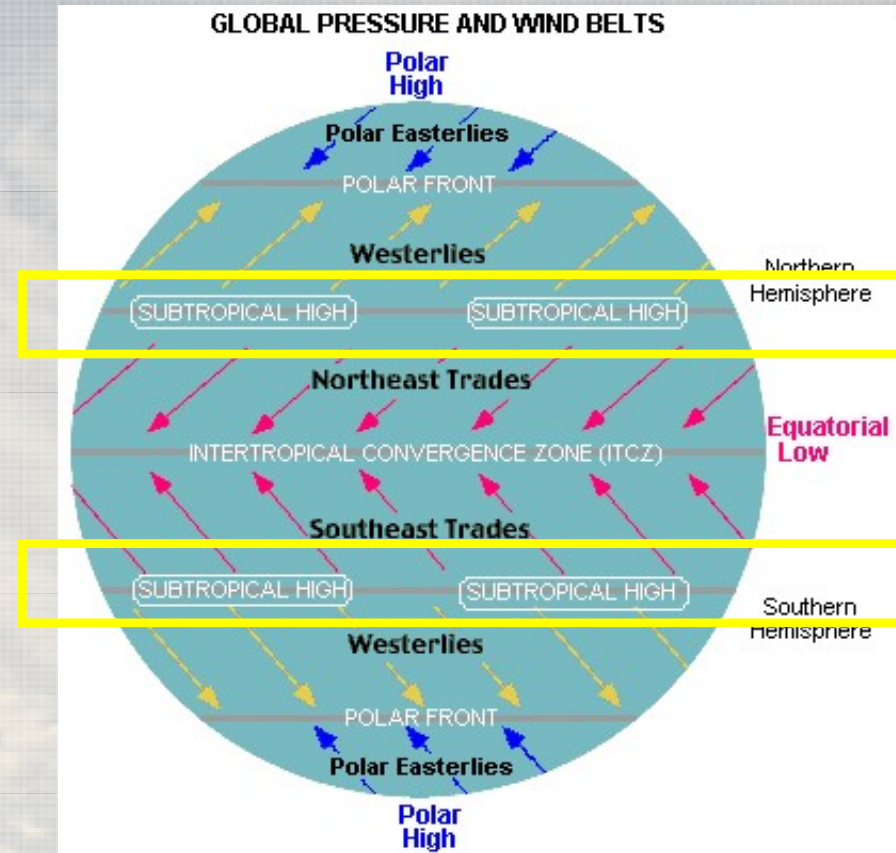
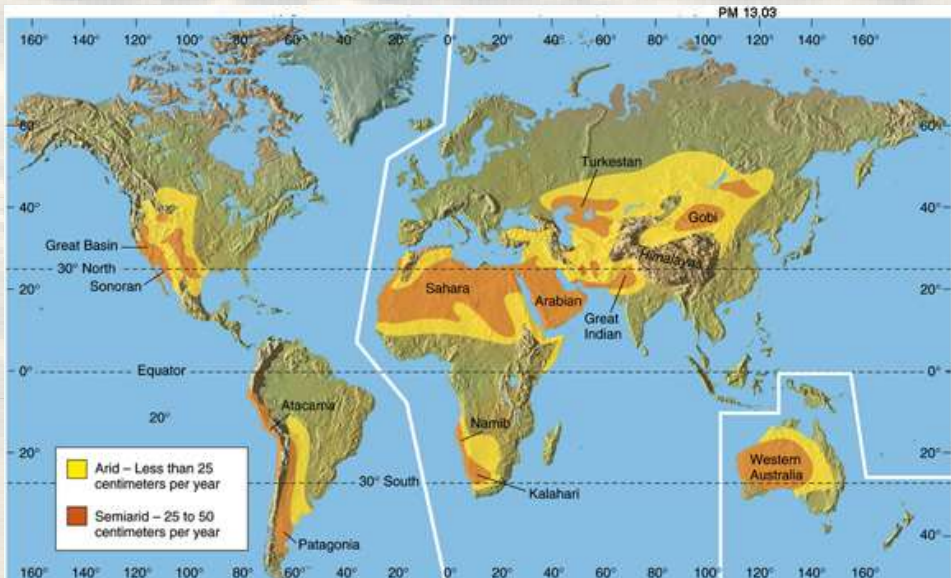
- **Equatorial Low**

- Near the equator the warm rising branch of the Hadley cells is associated with a low pressure zone.
- Ascending moist, hot air with lots of precipitation
- Also referred to as the **Intertropical Convergence Zone (ITCZ)**



Subtropical Highs

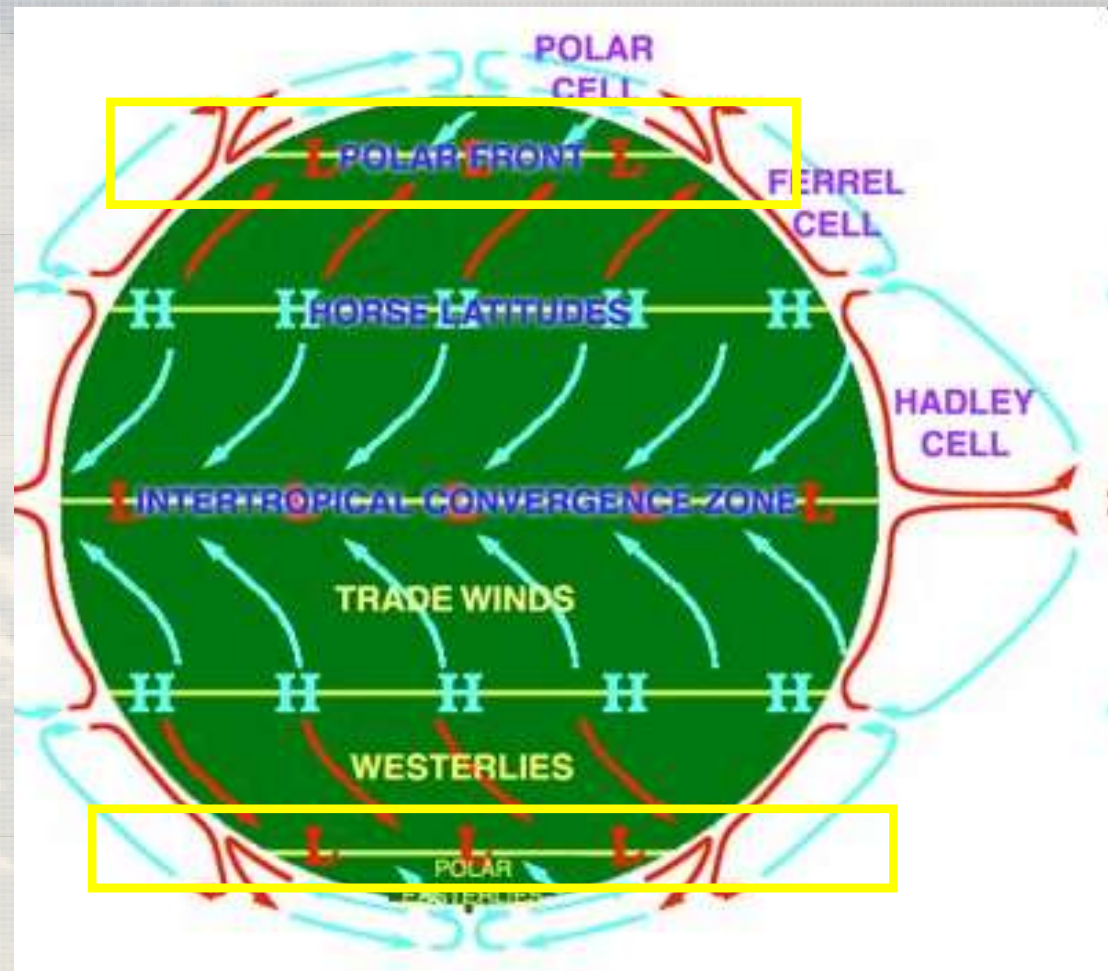
- At about **25-30 N(S)** where westerlies and trade winds originate (subsidence from aloft)
- Caused mainly by the **Coriolis deflection**



← This is where we find Deserts!

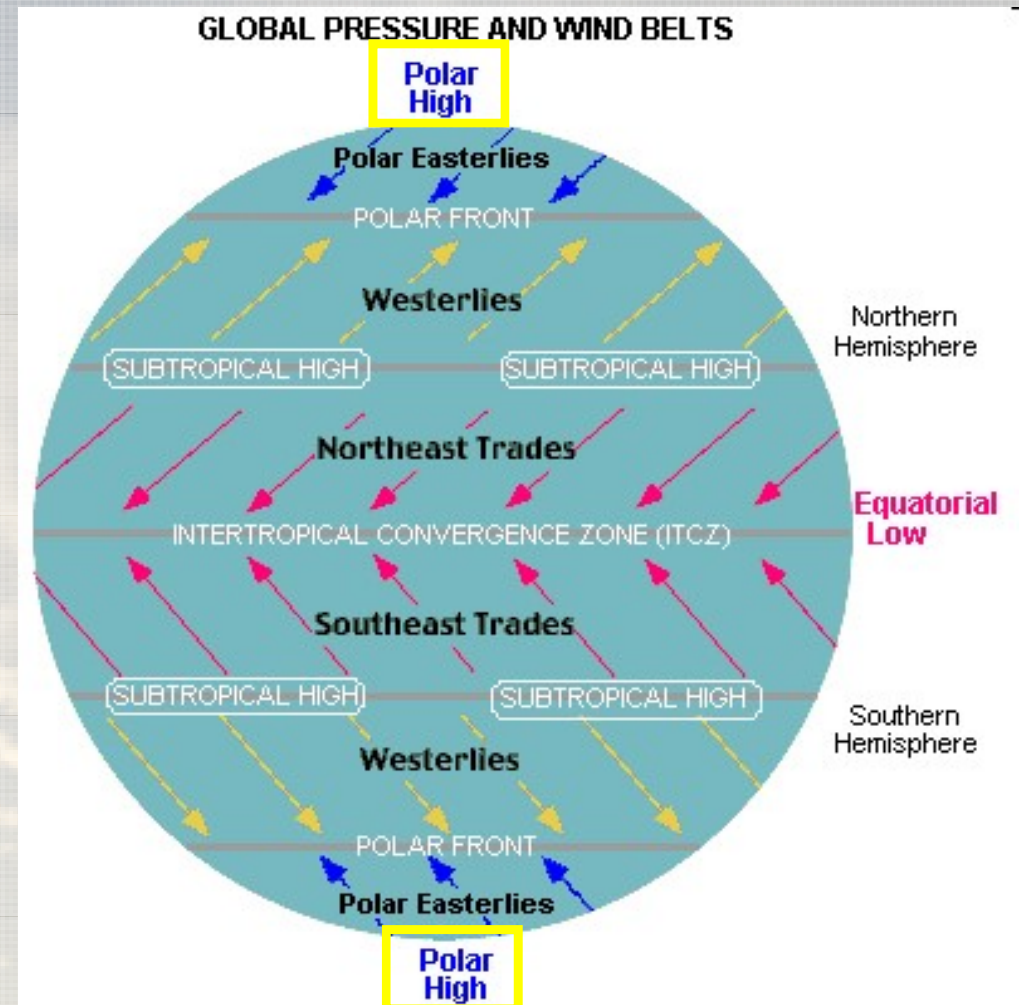
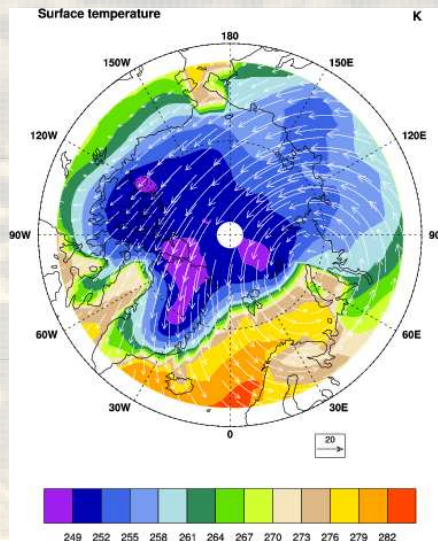
Subpolar Low

- Also called the **Polar Front**
- Another low-pressure region between 50-60 corresponding to the polar front
- Responsible for much of the stormy weather in the mid-latitudes



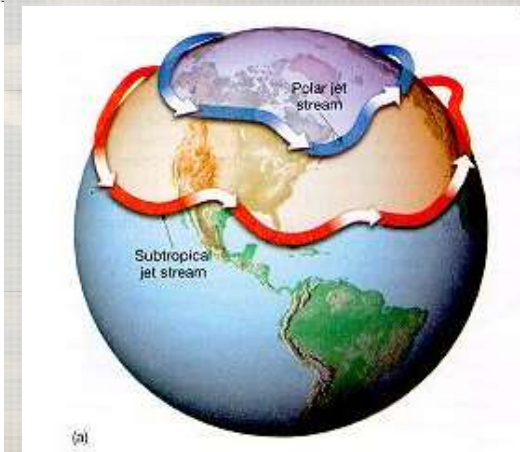
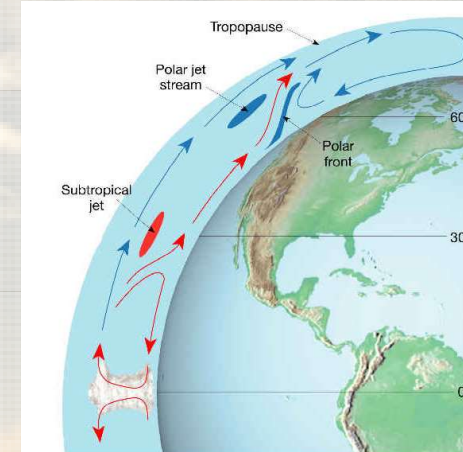
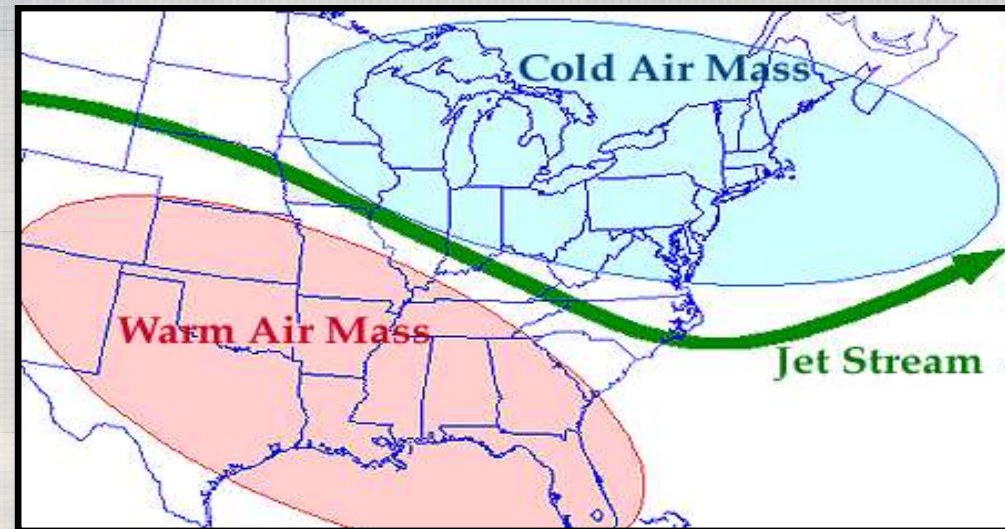
Polar Highs

- At the poles, where the polar easterlies originate
- High pressure develops over the cold polar areas due to extreme surface cooling.



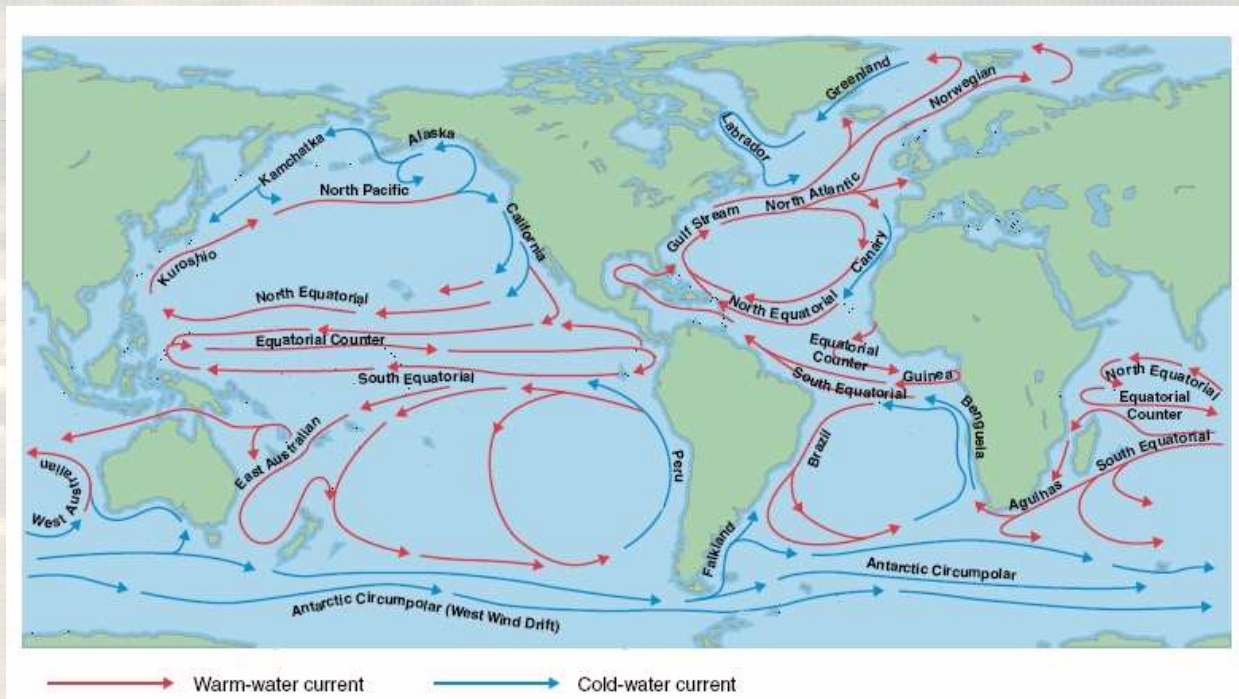
Jet Streams

- Region of the upper atmosphere where a **narrow band of air** moving **REALLY fast**
- **Location** of jet stream **influences local weather**
- **LARGE** temperature contrasts
- **Polar Jet Stream (Mid-Latitude)**
 - Where the **Polar Front** is located
 - Also called the mid-latitude jet stream
- **Subtropical Jet Stream**
 - Semi-permanent jet that exists over the subtropics



Global Winds and Ocean Currents

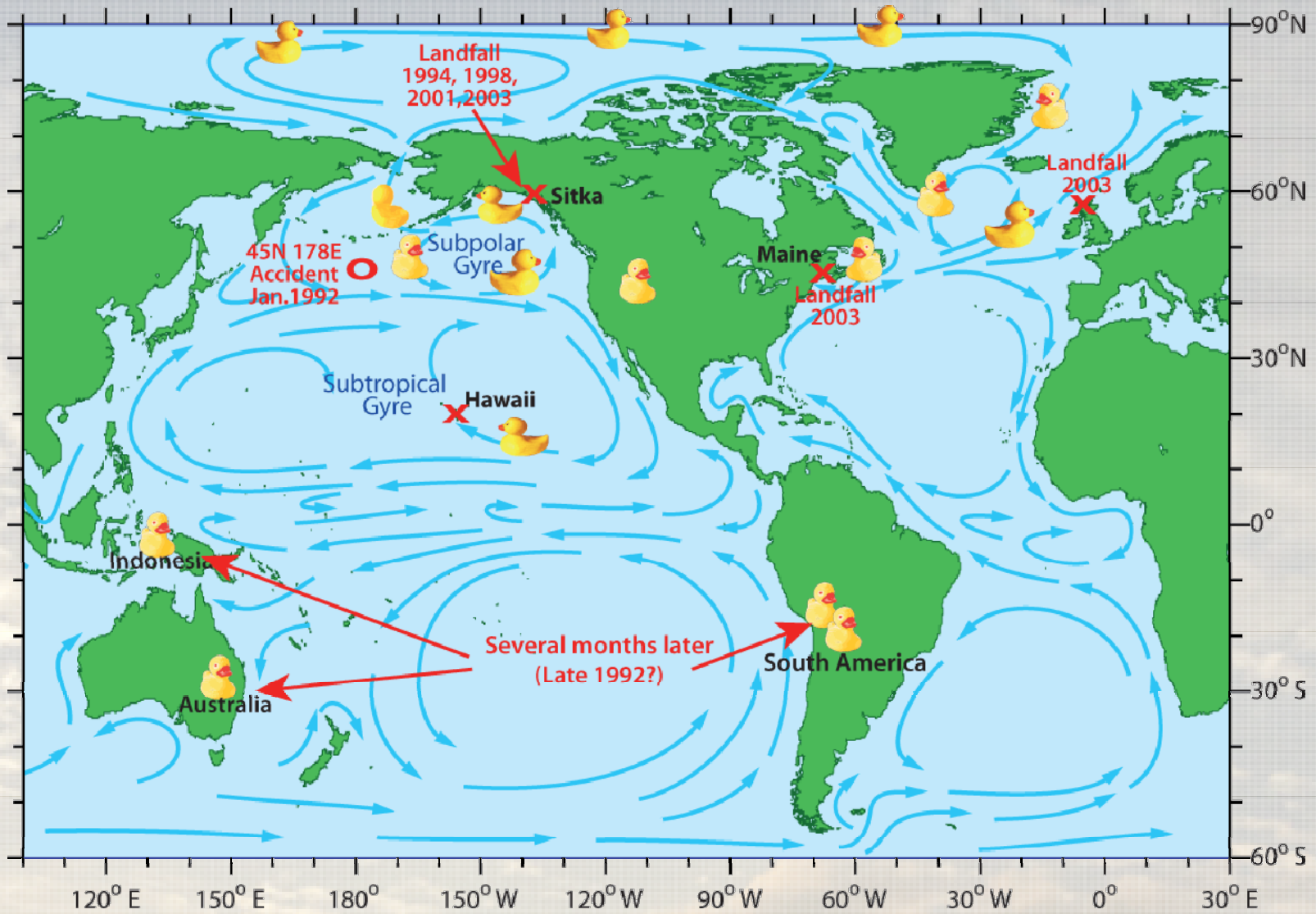
- Winds are the driving force for ocean currents.
- A relationship exists between ocean and atmosphere circulation.
- Ocean currents move more slowly than prevailing winds.



Pacific Trash Vortex

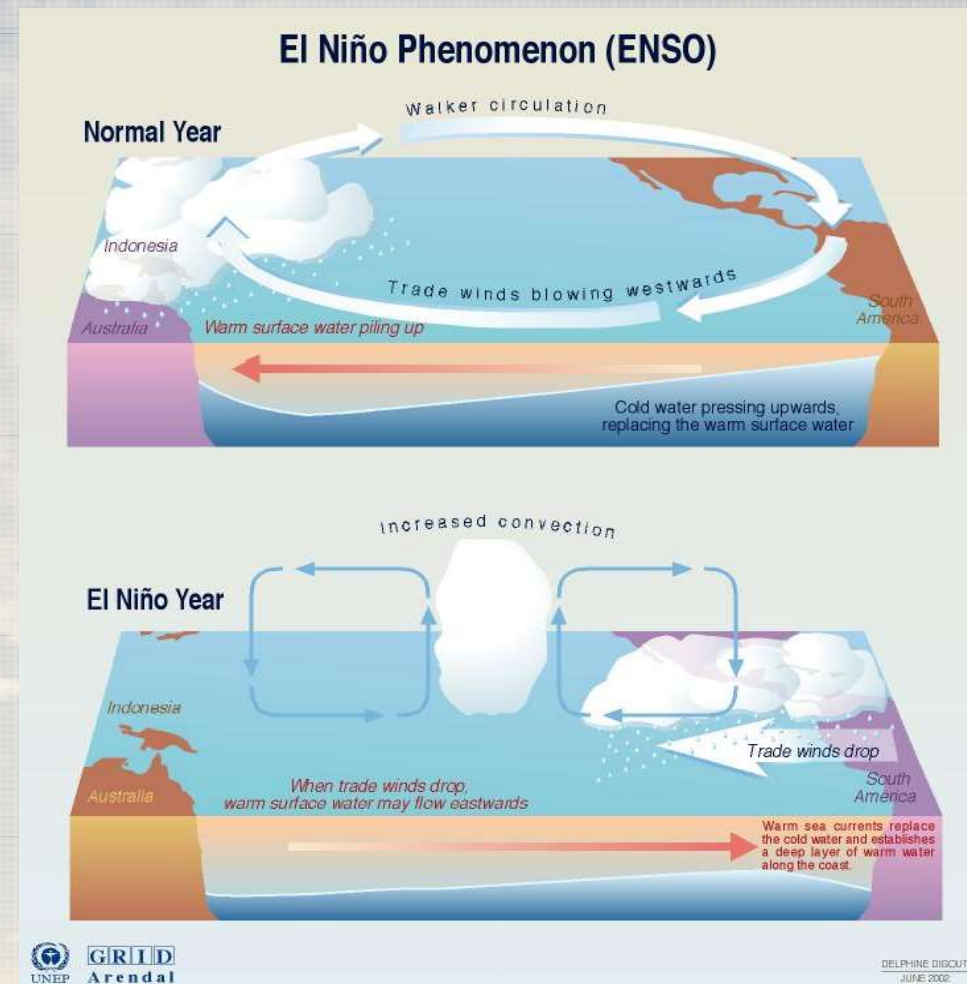
- Trash gets “**Stuck**” in the North Pacific Gyre.
- **Floating mass of trash**
- Mostly Plastic that is non-biodegradable
- 1992 – Rubber duckies got free and went all over the world following ocean currents
- <https://www.youtube.com/watch?v=ILbJZjYyXAs>





El Niño/Southern Oscillation

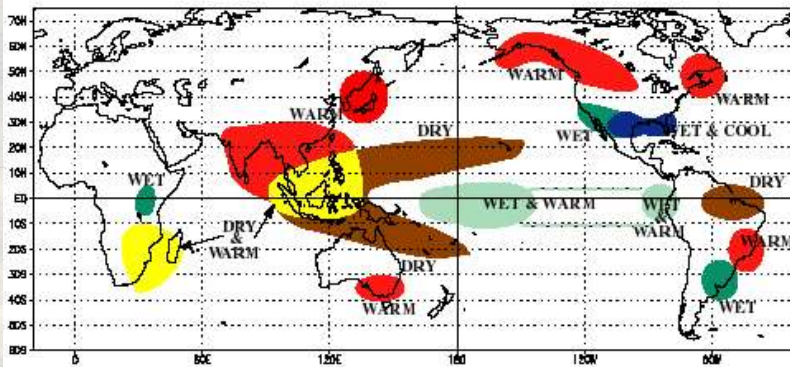
- **Ocean phenomenon** that occurs in the Equatorial Pacific
- As the southeast trade winds **decrease** in strength (weaken) the **warm water can make it farther across** the Pacific towards South American
- Named El Niño because it usually starts during Christmas.
- Usually happens every 3-7 years.
- Pressure changes and reversals in the Pacific trigger the change in winds



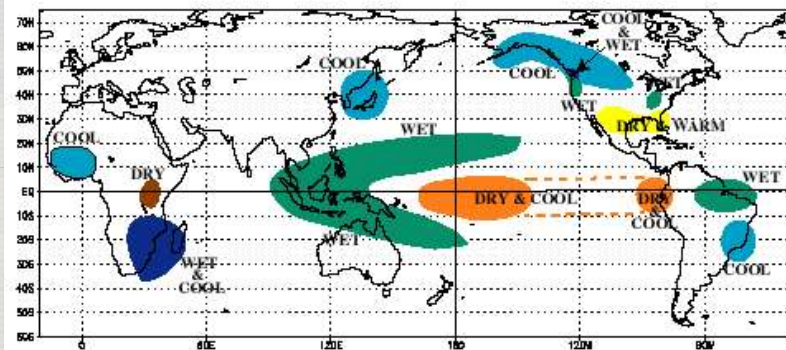
Sources: Climate Prediction Center-NCEP; NOAA.

Teleconnections – Global Ramifications

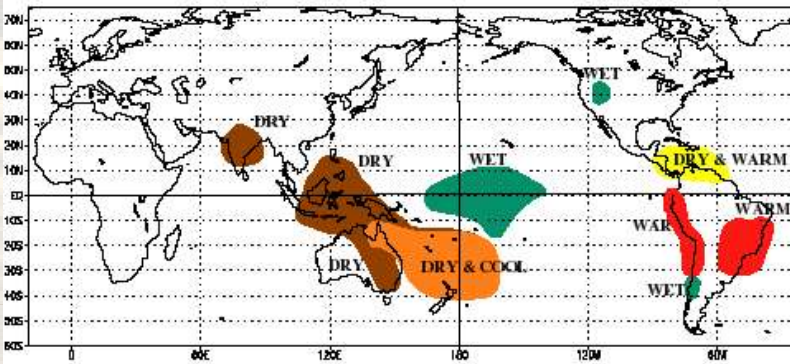
WARM EPISODE RELATIONSHIPS DECEMBER - FEBRUARY



COLD EPISODE RELATIONSHIPS DECEMBER - FEBRUARY



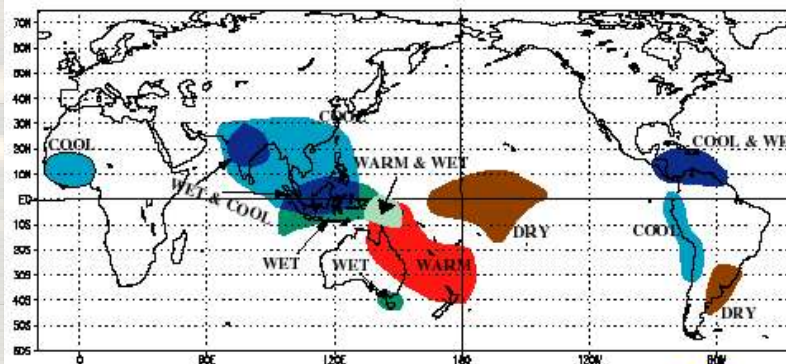
WARM EPISODE RELATIONSHIPS JUNE - AUGUST



El Niño



COLD EPISODE RELATIONSHIPS JUNE - AUGUST



La Niña



El Niño in Hawaii

- **For Hawaii:**
 - El Niño tends to bring dry winters.
 - Drought is more likely during El Niño years, during the October-March period.
 - Also, may lead to stronger hurricanes the following year (current research here at UH)

