

Global Ocean Currents

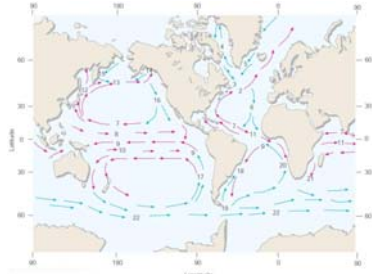
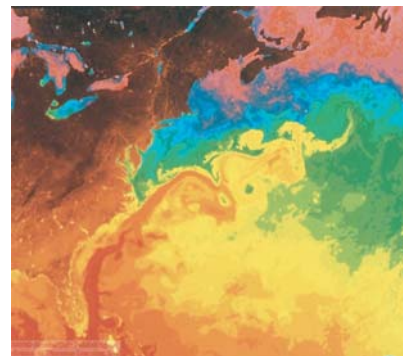


Table 1.1 Major Ocean Currents		
1. Gulf Stream	6. North Equatorial Current	13. South Equatorial Current
2. North Atlantic Drift	7. North Equatorial Countercurrent	14. Brazil Current
3. Labrador Current	8. Equatorial Countercurrent	15. California Current
4. West Greenland Drift	9. Brazil Current	16. North Pacific Drift
5. East Greenland Drift	10. Benguela Current	17. South Pacific Drift
6. Canary Current	11. North Pacific Drift	18. Antarctic Circumpolar Current
7. North Equatorial Current	12. Alaska Current	19. New Zealand Drift
8. North Equatorial Countercurrent	13. Chilean Current	

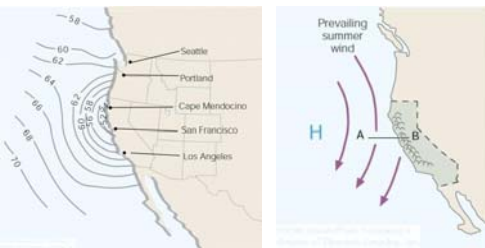
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Gulf Stream – Warm Current



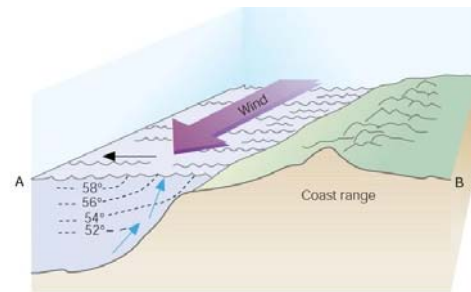
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West Coast – Cold Current



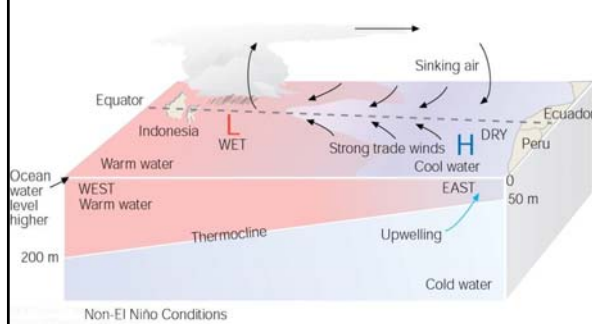
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Upwelling



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Normal Pacific Circulation

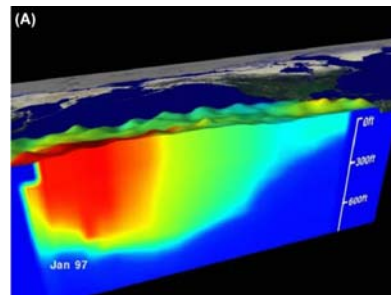


Non-El Niño Conditions

The atmospheric part of this is called the [Walker circulation](#)

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Normal Sea Temperatures



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Southern Oscillation

- Refers to changes in the Walker circulation
 - Normally wind blows from east to west in the equatorial Pacific (easterlies)
 - Low pressure in the western Pacific and high pressure in the eastern Pacific
- Change in pressure pattern across the equatorial Pacific reduces the strength of the easterlies
- **El Niño** closely linked to Southern Oscillation



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El Niño – Southern Oscillation (ENSO)

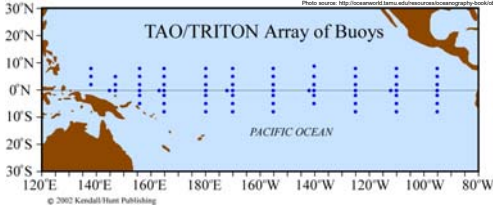
- First observed by fishermen in Peru and Ecuador
 - Warm waters → loss of nutrients → fewer fish
 - Affects weather patterns across the globe
 - “El Niño” because it occurs around Christmas
- An El Niño event is defined by warming of sea surface temperatures (SSTs) along the equator from S. America to about 5,000 miles into the Pacific
 - Weak events: +1°C; Strong events: +4°C



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Buoys

- A buoy monitoring network in the equatorial Pacific monitors conditions
- Provides surface winds, air temperature, sea surface temperatures and currents in upper several hundred feet of ocean



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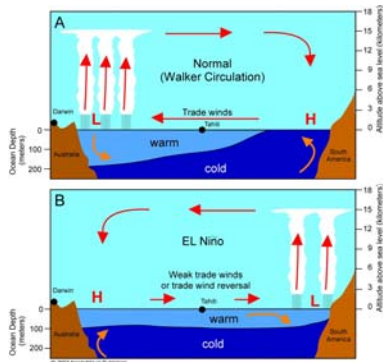
How do we get to El Niño?

1. Change in Walker circulation causes surface pressure to decrease in East Pacific and rise in West Pacific → reduces pressure gradient across the Pacific
2. Trade winds weaken or reverse, i.e., normal easterly winds weaken or become westerly
3. With weaker trade winds, warm water that “piled up” in West Pacific sloshes eastward
4. Low and high pressure areas move creating different precipitation patterns



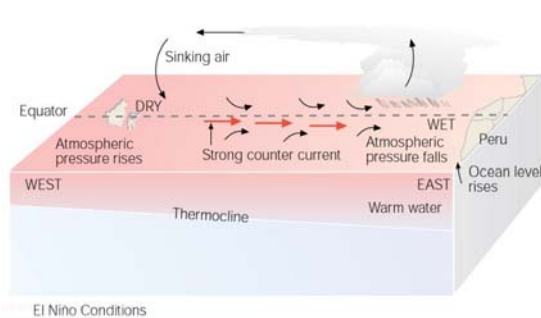
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Variations in the Walker Circulation



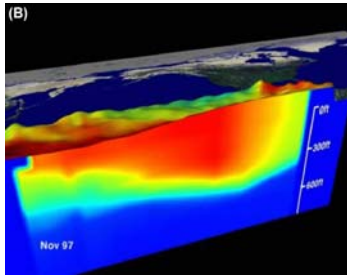
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El Niño Conditions



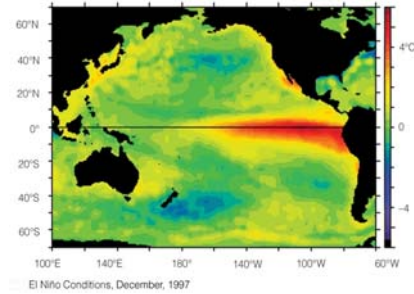
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El Niño Ocean Temperatures



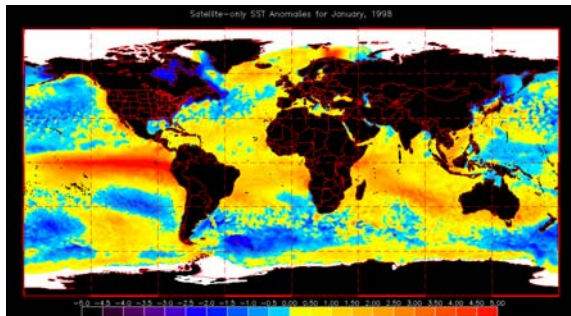
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SST Anomalies During 1997–1998 El Niño Event



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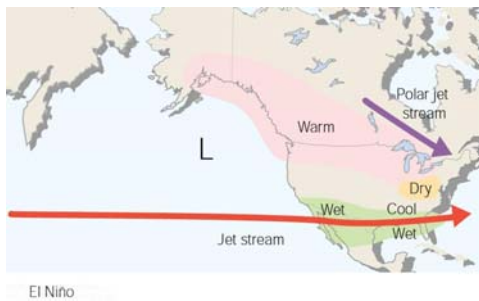
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Consequences of El Niño

- Most noticeable during winter months
- Clouds and precipitation patterns change across the globe
- In Northern Hemisphere, jet stream takes a more southerly track
- Wetter in CA, big coastal storms
- Warmer than normal in northern U.S.
- Drought in Pacific Northwest; wet along Gulf Coast
- More hurricanes in eastern and central Pacific due to higher SSTs

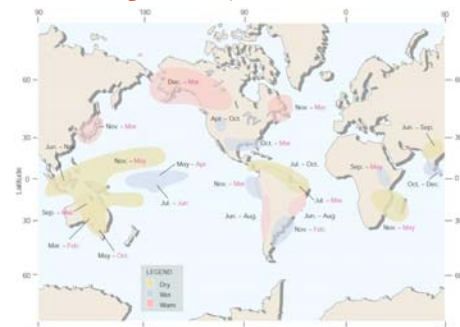
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Effects of El Niño in U.S.



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Global Perspective (El Niño conditions)



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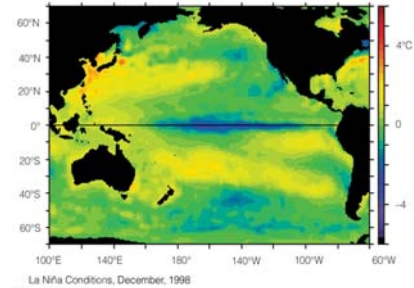
La Niña

- Typically follows El Niño as atmosphere overcorrects
- Normal Walker circulation *strengthens*
- Unusually cold water in eastern Pacific
- Opposite to El Niño in terms of SST and pressure patterns across equatorial Pacific
- Not quite opposite in changes in global patterns
- Cold air outbreaks in northwestern and northern U.S.
- May lead to drought conditions across southern/western U.S. (1988, 1998, 2006 in OK & TX)



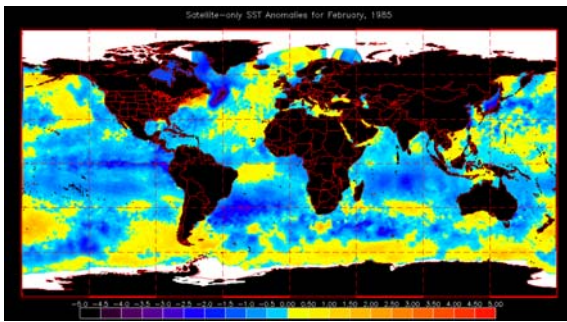
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SST Anomalies During 1998–1999 La Niña Event



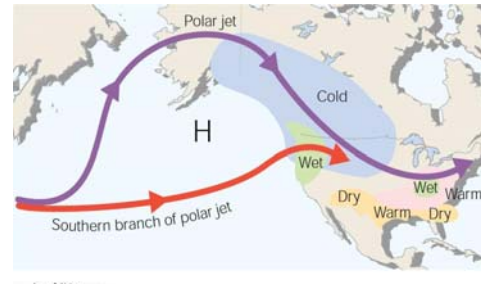
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SST Anomalies During 1985 La Niña Event



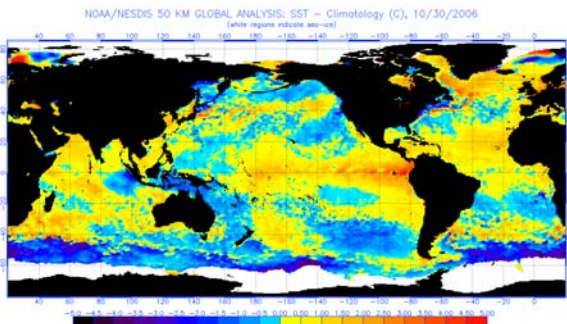
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Effects of La Niña in U.S.



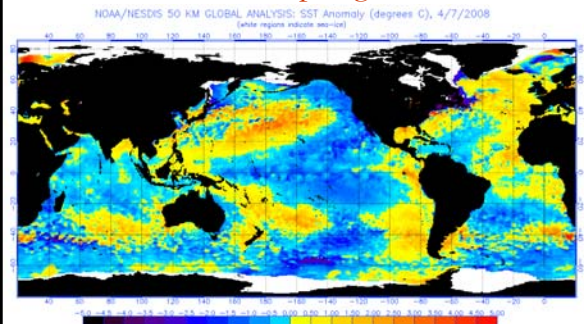
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SST Anomalies in Fall 2006

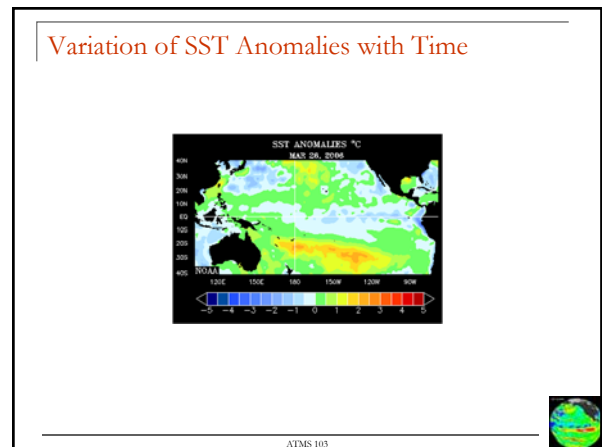
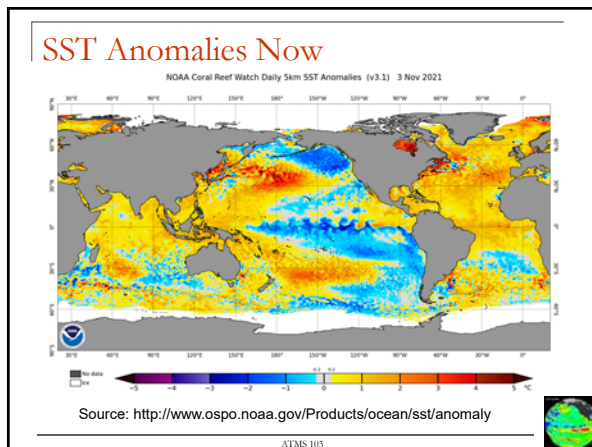
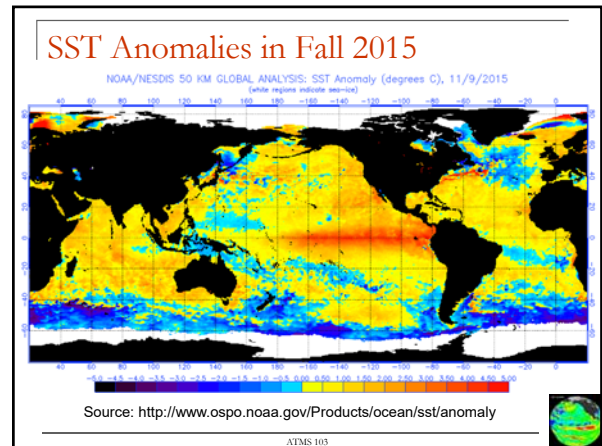
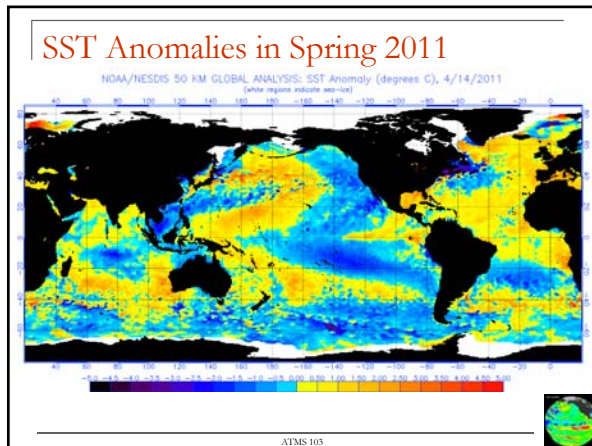


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SST Anomalies in Spring 2008



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Southern Oscillation Index

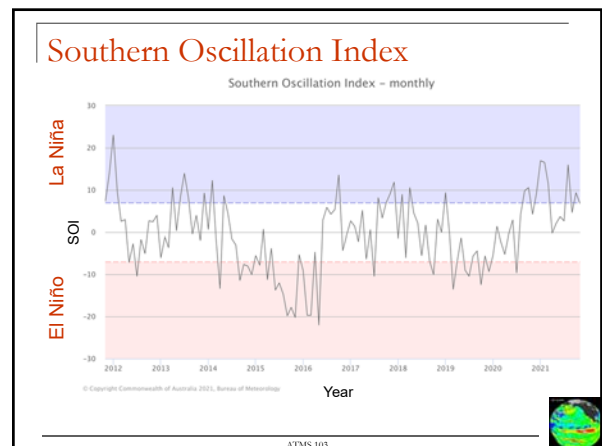
SOI = Pressure at Tahiti – Pressure at Darwin

- Pressure is expressed as departure from normal, then scaled

Negative Values → Weak Walker Circulation (El Niño)

Positive Values → Strong Walker Circulation (La Niña)

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The Connection to *Atlantic* Hurricanes

- Atlantic hurricanes are **less common** during **El Niño** and **more common** during **La Niña**
- Anomalous atmospheric heating during an **El Niño** event results in increased upper-level winds over the tropical Atlantic → increases vertical wind shear and **weakens tropical cyclones**
- 2005 (Katrina, Rita, Wilma...Zeta!) was a **La Niña** year
- 2006 (only to Isaac) was an **El Niño** year
- 2009 (only to Ida) was an **El Niño** year



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For more on El Niño/La Niña

- Visit the Climate Prediction Center at <http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml>



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