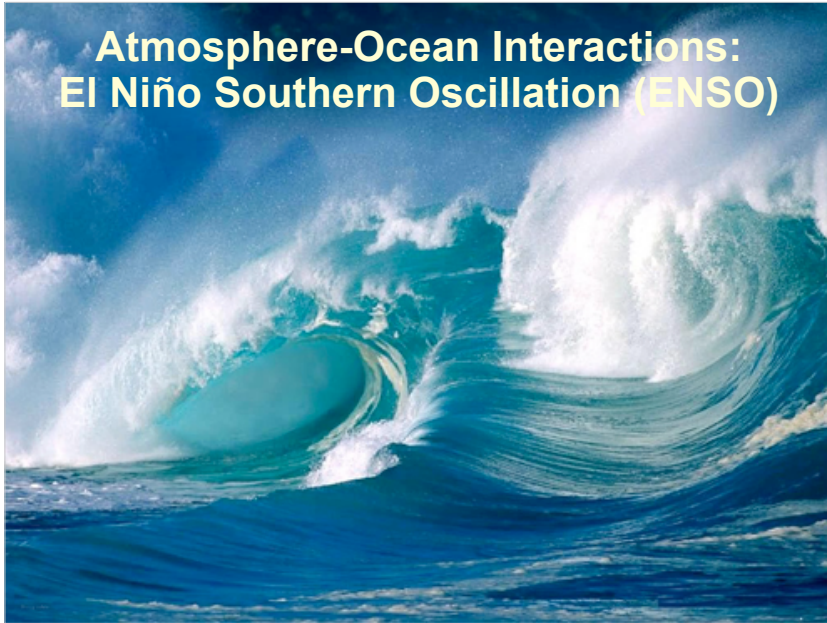
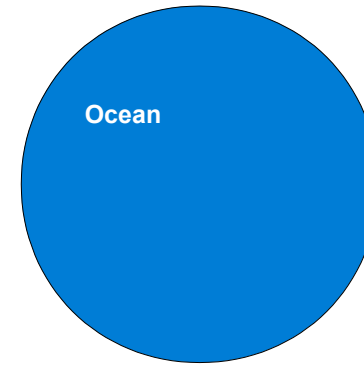


Atmosphere-Ocean Interactions: El Niño Southern Oscillation (ENSO)



Energy Reservoirs



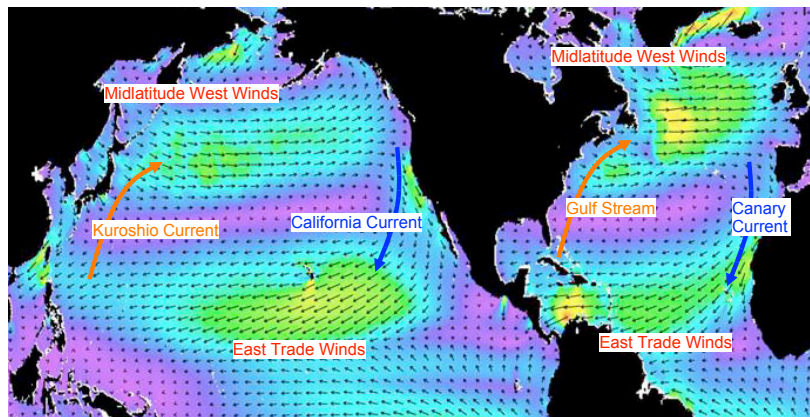
Atmosphere

- The oceans are about 4000 m deep on average
- The top 10 m equal the mass of the atmosphere
- The top 3 m equal the heat capacity of the atmosphere!!

The state of the oceans determines the climate on time scales of thousands to millions of years!

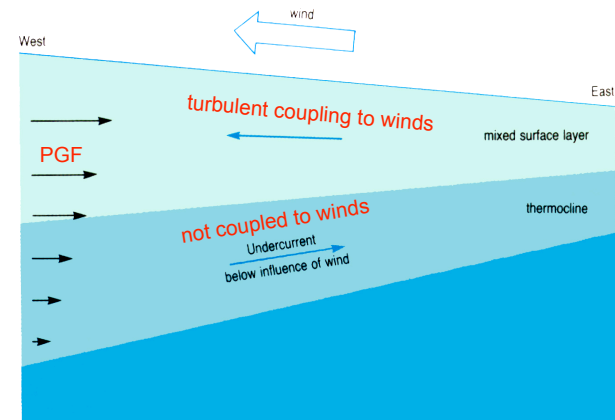
2

Low-Level Winds Drive the Ocean



Annual-Average Surface Winds

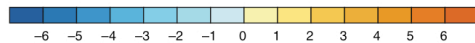
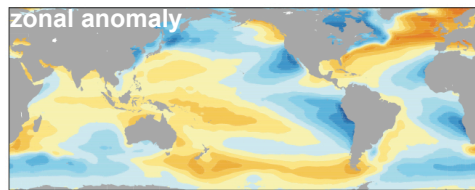
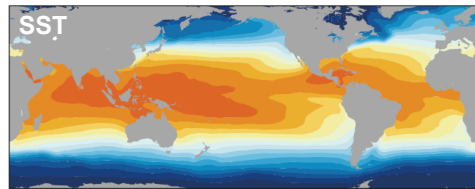
Equatorial Cross Section



- No Coriolis → east wind pushes water west
- Warm water piles up in the west, upwelling and cooler ocean water in the east

4

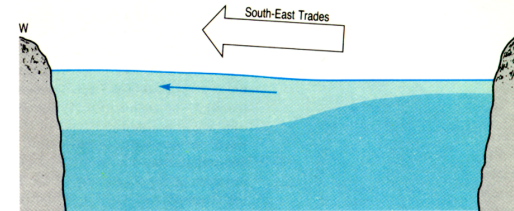
Sea Surface Temperatures



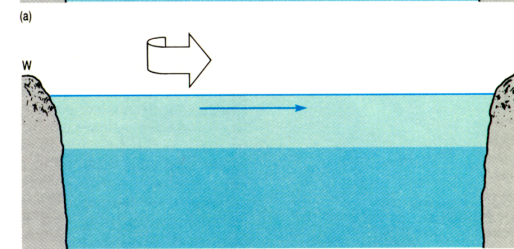
- West Pacific “warm pool”
- Effects of western vs eastern boundary currents!
- Upwelling regions

5

El Niño

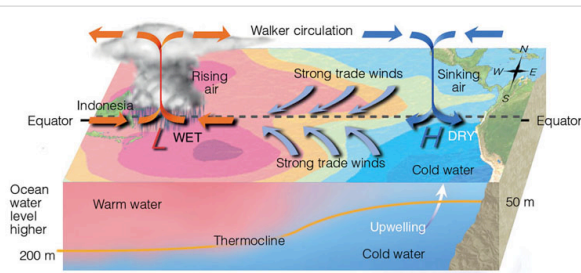


- Normal conditions: huge accumulation of deep warm water in West Pacific



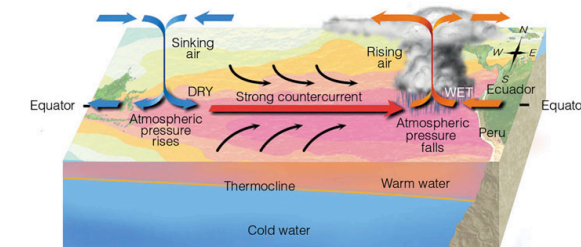
- El Niño: relaxation of trade wind forcing allows warm water to flow eastward

6



(a) Non-El Niño conditions

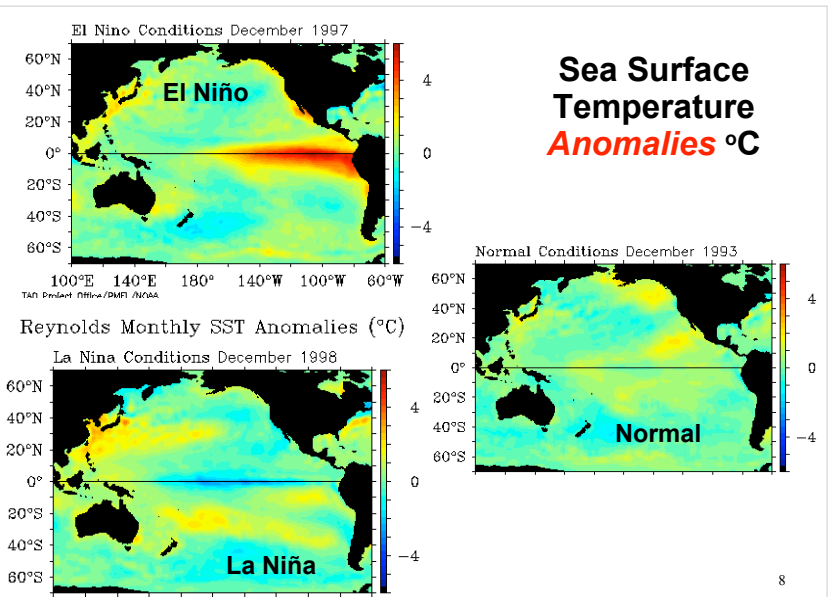
El Niño vs La Niña



(b) El Niño Conditions

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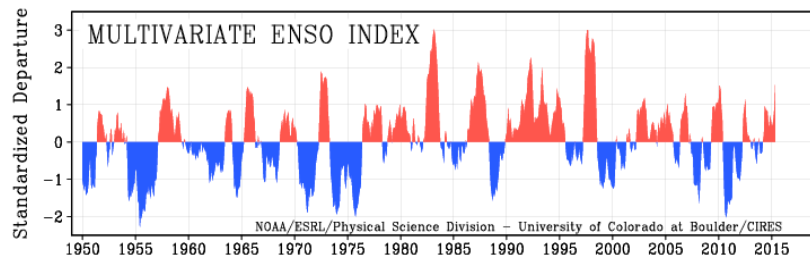
7



Sea Surface Temperature Anomalies °C

8

El Niño Southern Oscillation (ENSO) updated until present

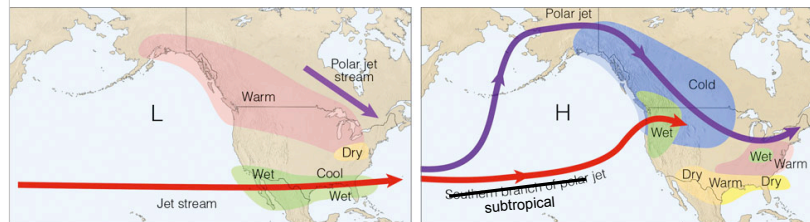


Related to sea surface temperature variations of the tropical pacific

We are currently in an El Niño phase.

9

Typical ENSO Winter Weather Patterns across North America



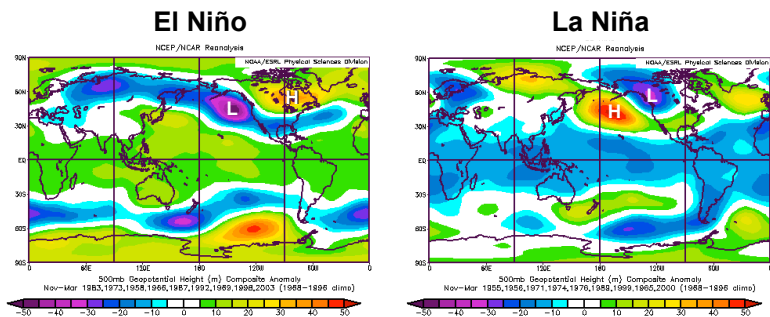
(a) El Niño winter conditions

(b) La Niña winter conditions

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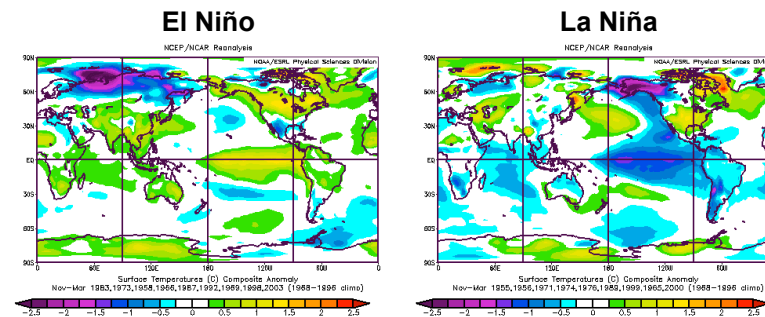
- El Niño:
 - Warm tropical East Pacific SSTs
 - Advection of warm, moist air onto Pacific coast
- La Niña:
 - Cold tropical East Pacific SSTs
 - High pressure splits & deflects jet; western drought

El Niño vs. La Niña Observed 500 hPa Heights



11

El Niño vs. La Niña Observed Surface Temperatures



12