

Lecture 29

The El-Niño Southern Oscillation (ENSO)

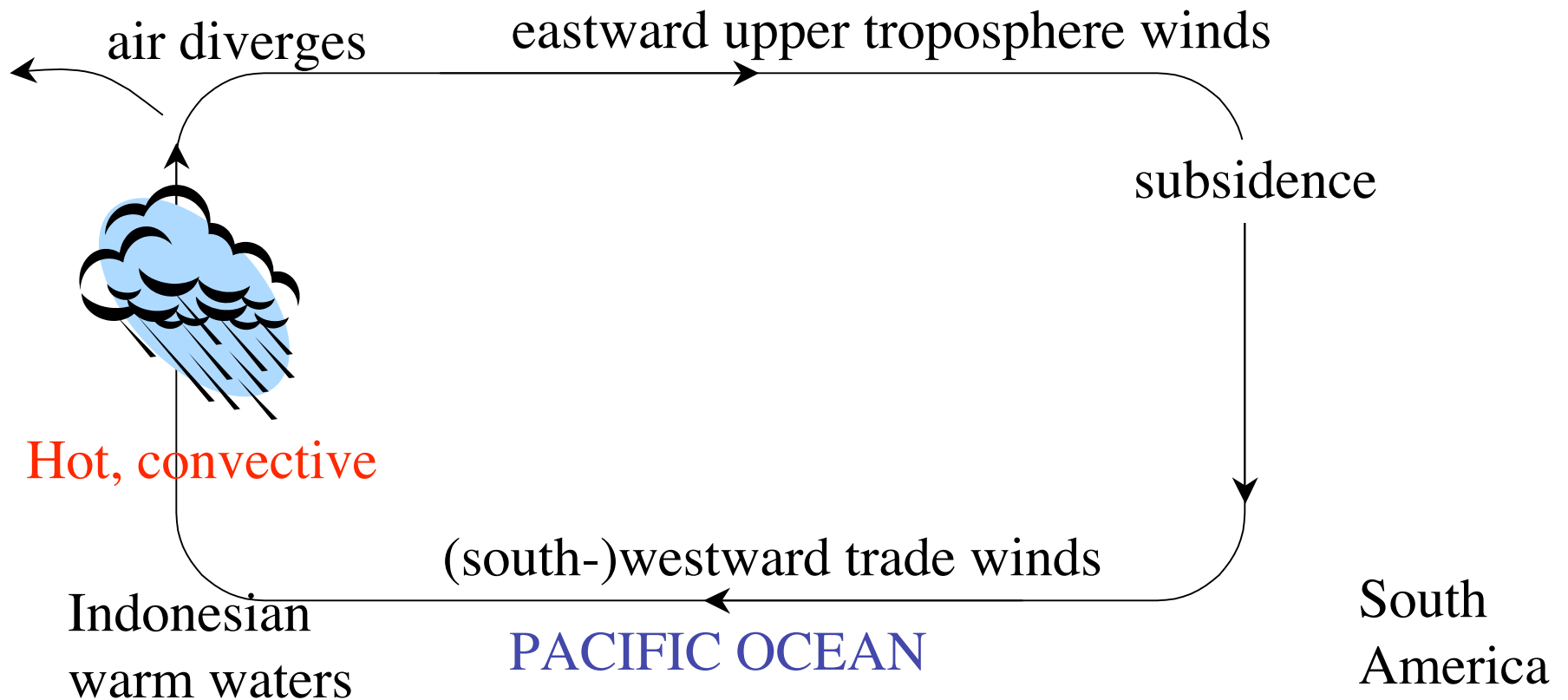
“El Niño” is Spanish for “Christ child”, the name given by fishermen to a warm ocean current off the coast of Peru/Ecuador that in some years occurs near Xmas. The warming causes a suppression of the upwelling of deep water. This causes a lack of nutrients for plankton and collapse of the fish (anchovy) population.

“La Niña” = the girl; corresponds to the opposite climate situation

El Niño is now taken to mean a major shift of the oceanic+atmospheric circulation that occurs every 2-10 years and modulates world climate

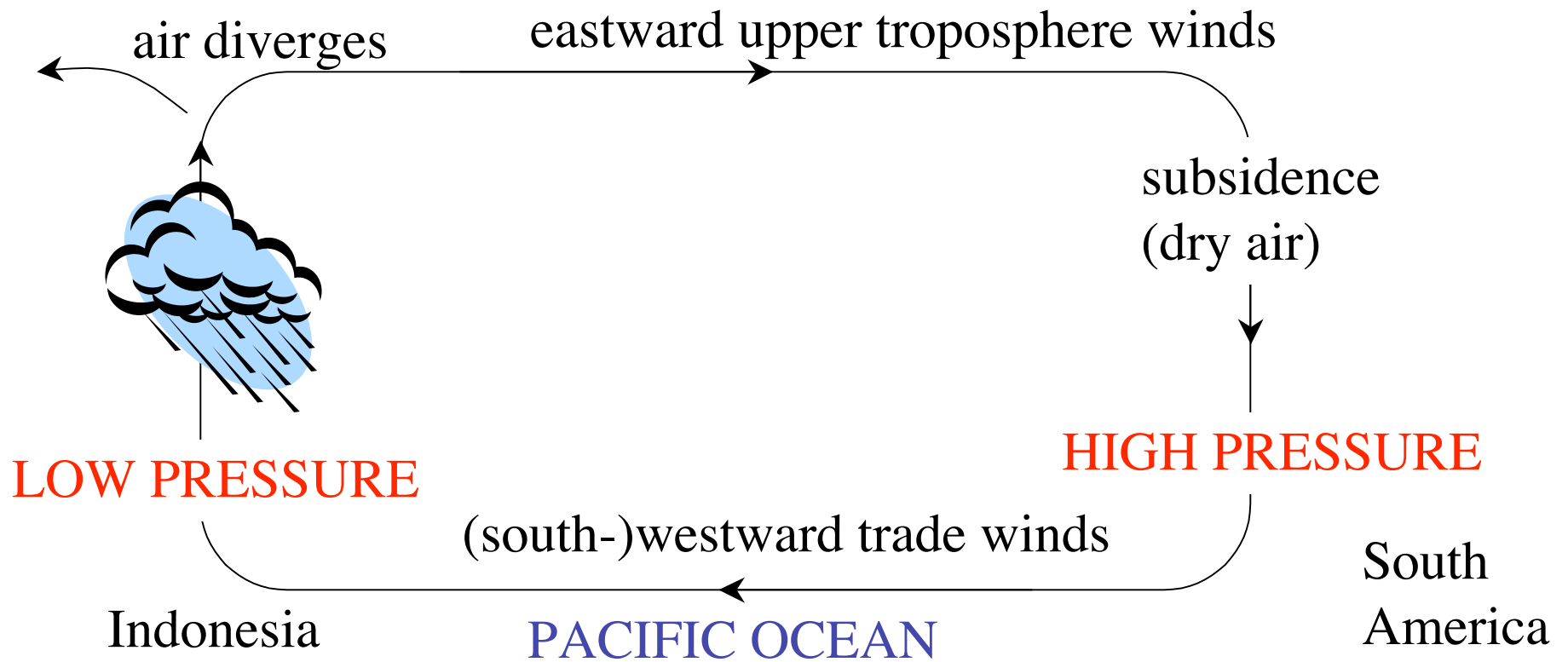
Atmosphere: The Walker circulation

Named after Sir Gilbert Walker (proposed it in 1923). Can think of this as like the Hadley circulation except occurring west-east rather than south-north

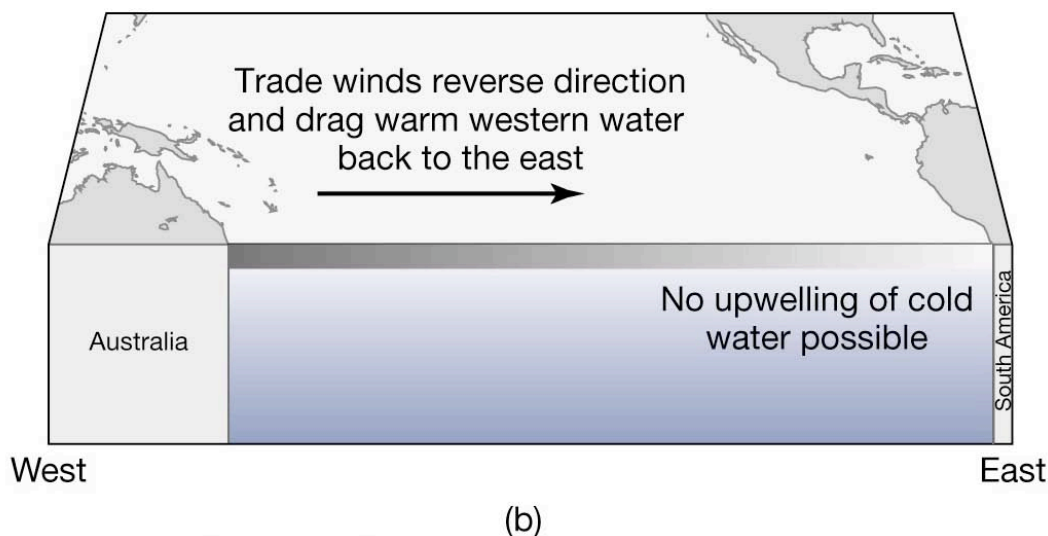
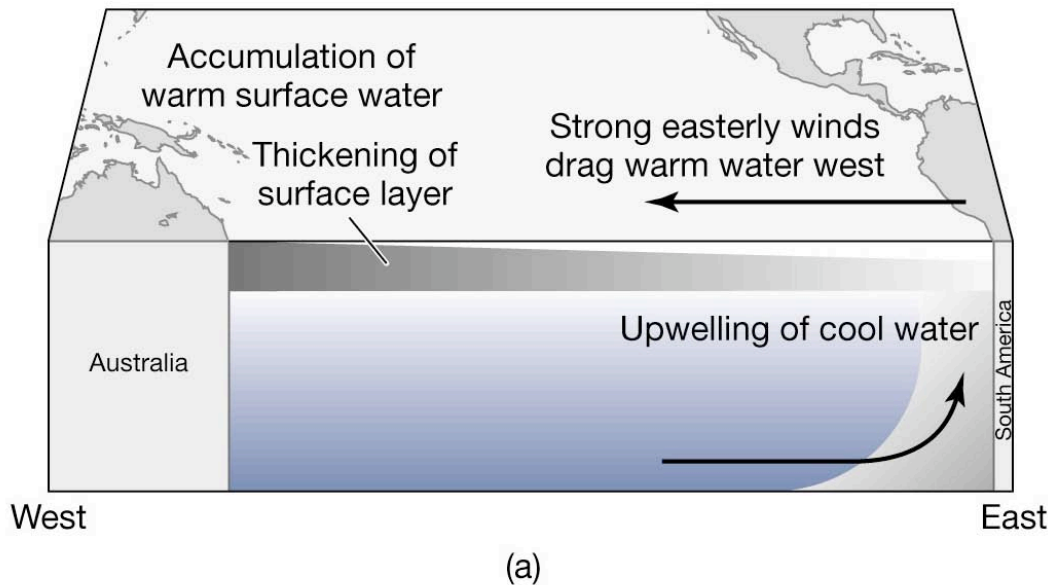


Atmosphere: Southern Oscillation

There is a difference in barometric pressure caused by the Walker circulation between the west and east Pacific. However, sometimes warmer water in the western Pacific and weakened trade winds lead to a smaller pressure difference. So there is an “oscillation” in the air pressure: the *Southern Oscillation*. Average oscillation period = 3 yrs; Ranges 2-10 yrs.



Pacific Ocean: west-to-east height difference



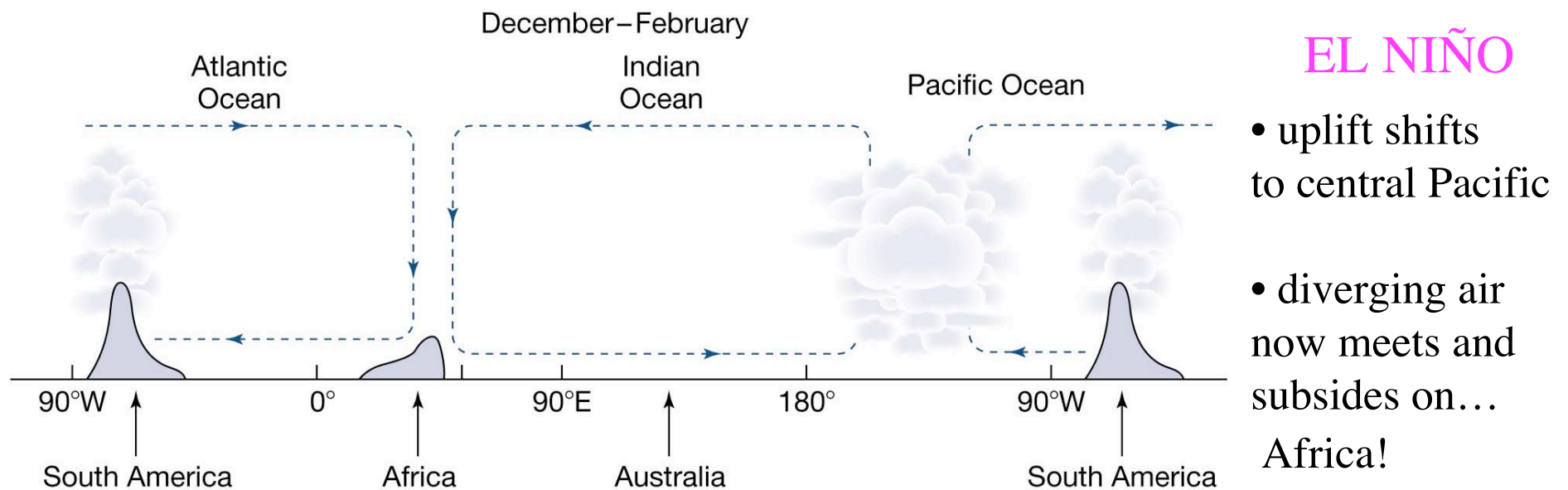
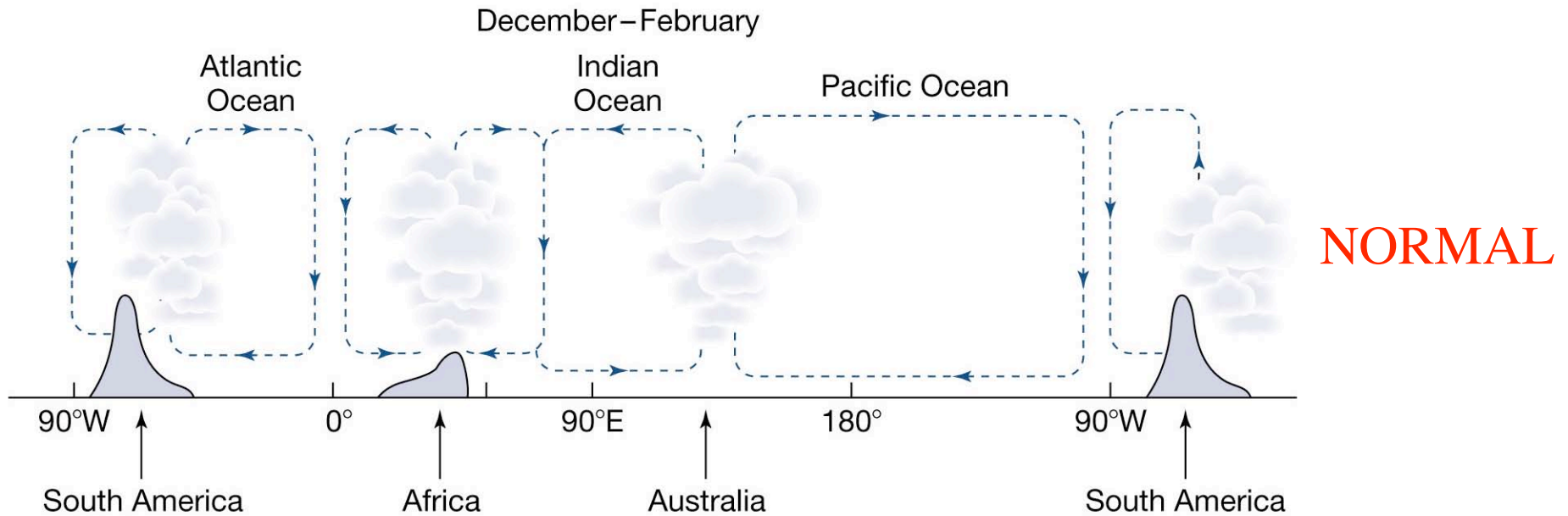
THE NORM:

- Easterly trade winds push warm surface water towards Indonesia and Australia where it “piles up” (actually, the height difference is only about 2 meters)
- Colder surface water in the east is less stratified, so allows upwelling.

EL NIÑO

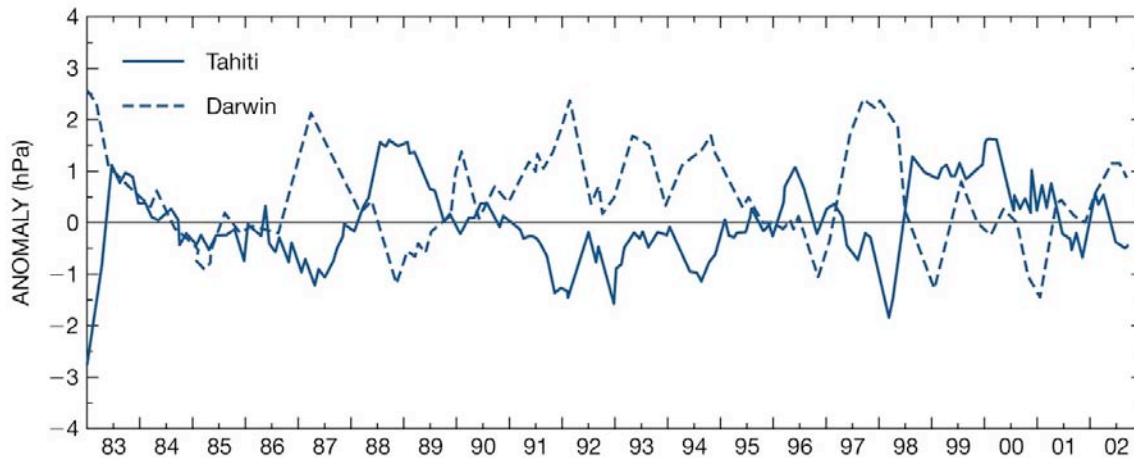
- Trade winds weaken (or even reverse).
- The western pile of warm water sloshes across to the east
- Warm surface water in the east prevents upwelling.

Atmospheric Change



Southern Oscillation

Sea-level air pressure is conventionally measured at Darwin (northern Australia) and Tahiti (south, central Pacific) for the “Southern Oscillation”.

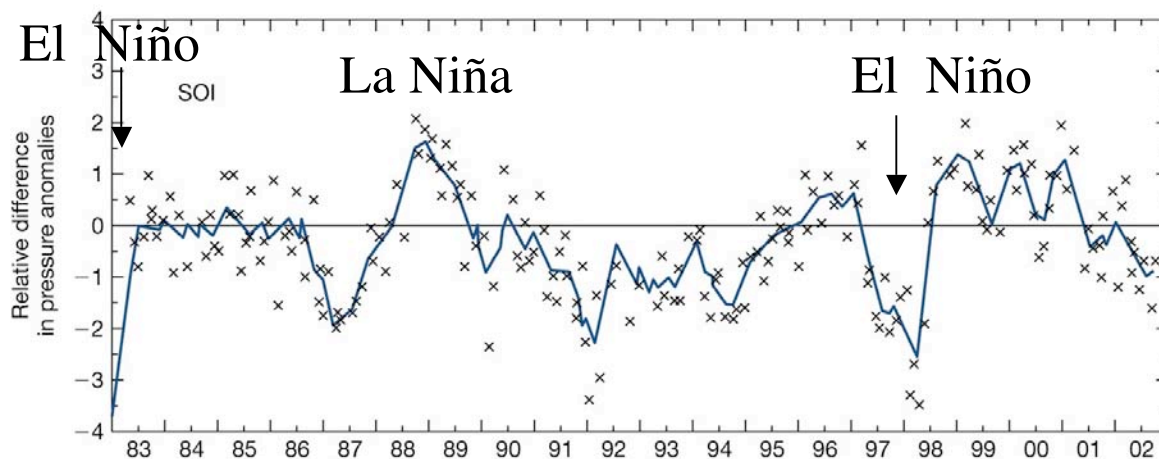


Non-ENSO:

low pressure over Australia
high pressure over Tahiti

ENSO year:

pressure increases over Australia
low pressure over Tahiti



Tahiti - Darwin difference of pressures feeds into a Southern Oscillation Index (SOI)

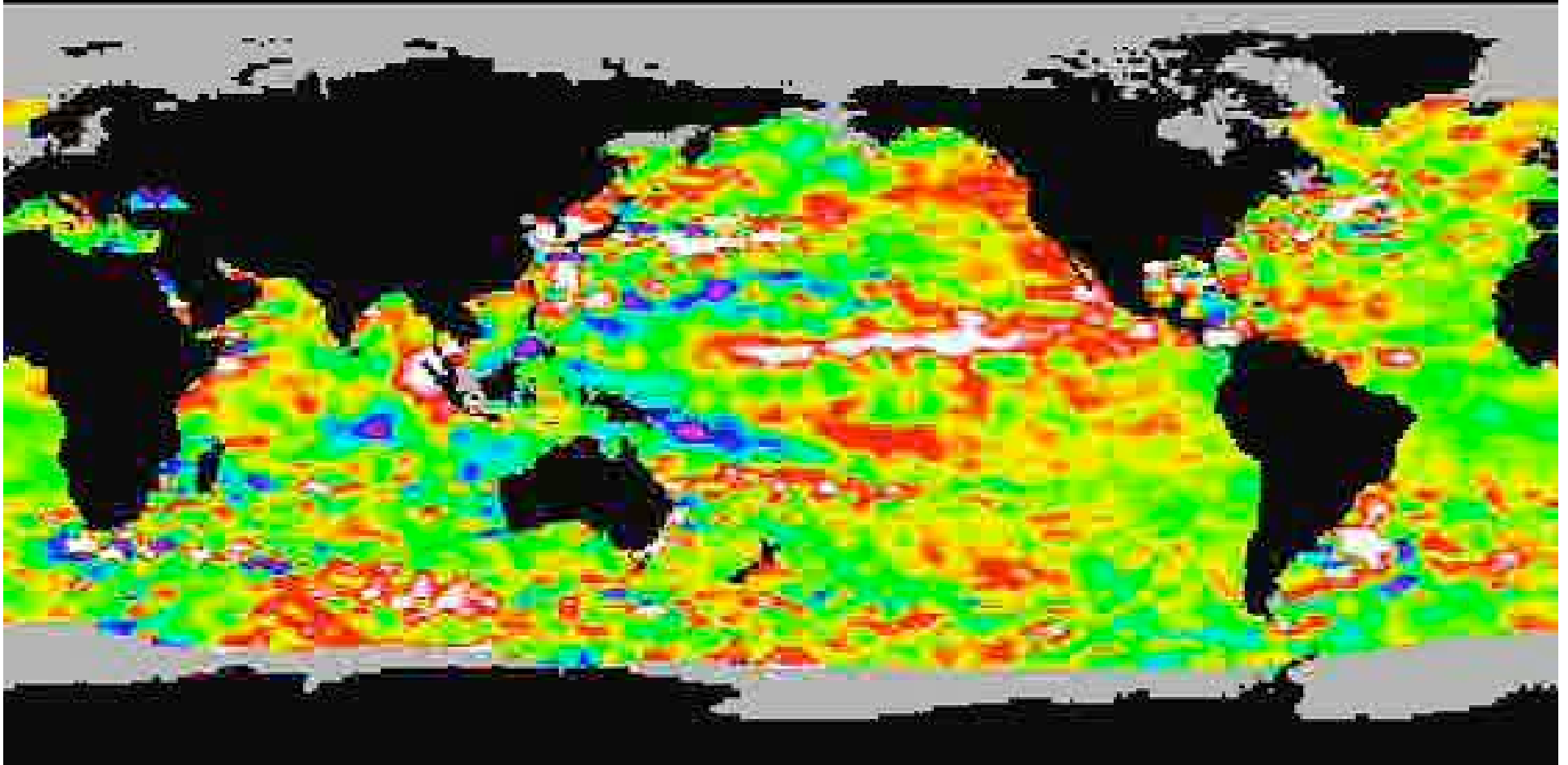
negative SOI = ENSO

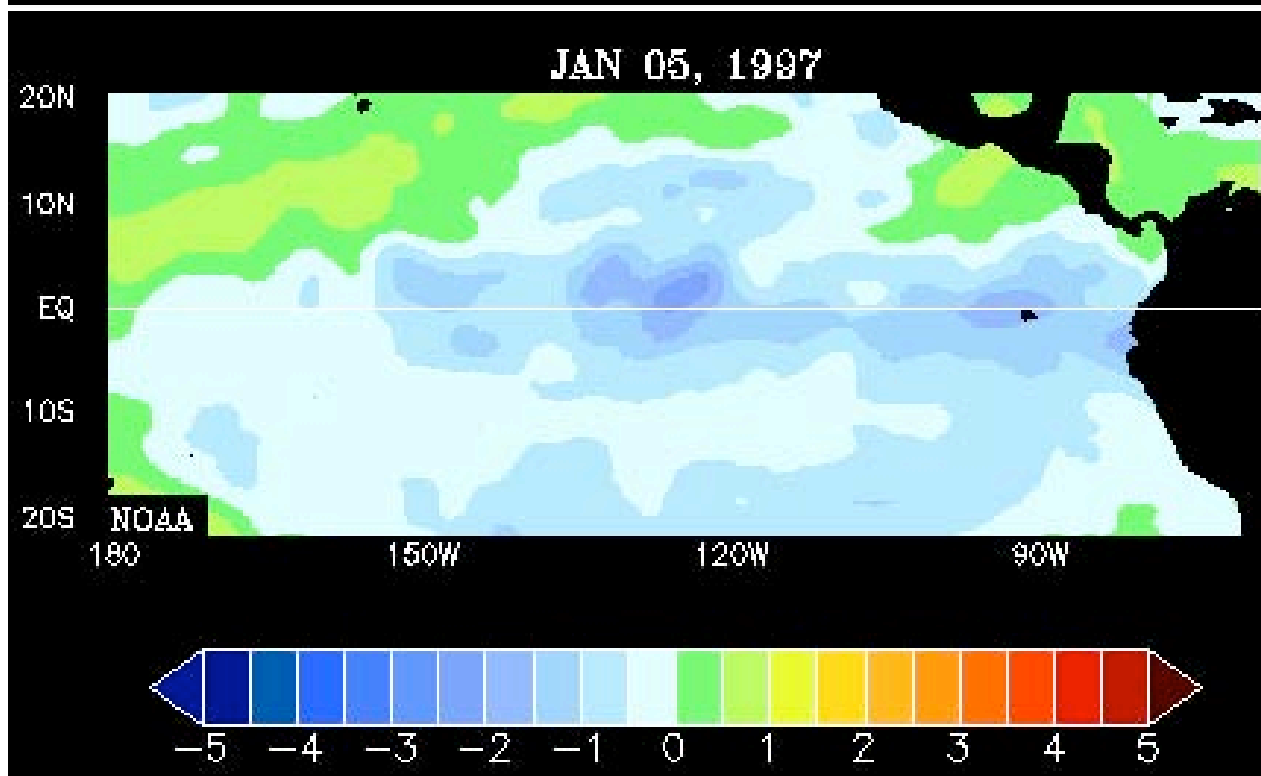
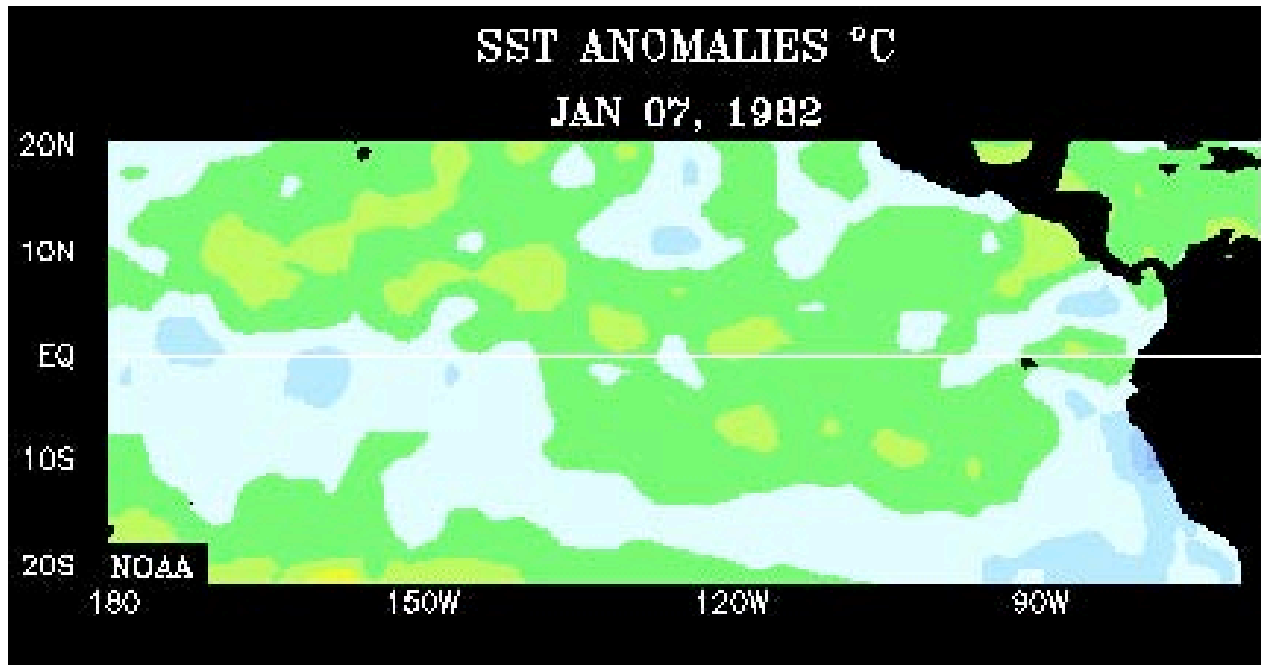
positive SOI = La Niña

Sea surface height movie

<http://topex-www.jpl.nasa.gov/>

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Sea surface temperature (SST) anomalies movie during major “ENSO events” (1983, 1997)

Usually starts with abnormally high temperature water off the coast of Ecuador and Peru.

Then the warm spreads.

Climate impacts of ENSO

Non-ENSO: summer convective rainfall over Australia/Indonesia
convective rainfall over Amazon Basin, equatorial Africa
dry, subsiding air west of Andes
convective rainfall over eastern South America

ENSO tropics: convective rainfall over central Pacific

diminished rainfall over Australia, eastern South America
dry, subsiding air over Africa

DROUGHT: Brazil, Southeast Africa, Australia, Indonesia

WET, FLOODS: west of Andes, typhoons in central Pacific

ENSO in U.S.: 1982-1983 event

flooding of Mississippi, record snowfall in Rockies

floods, landslides in California

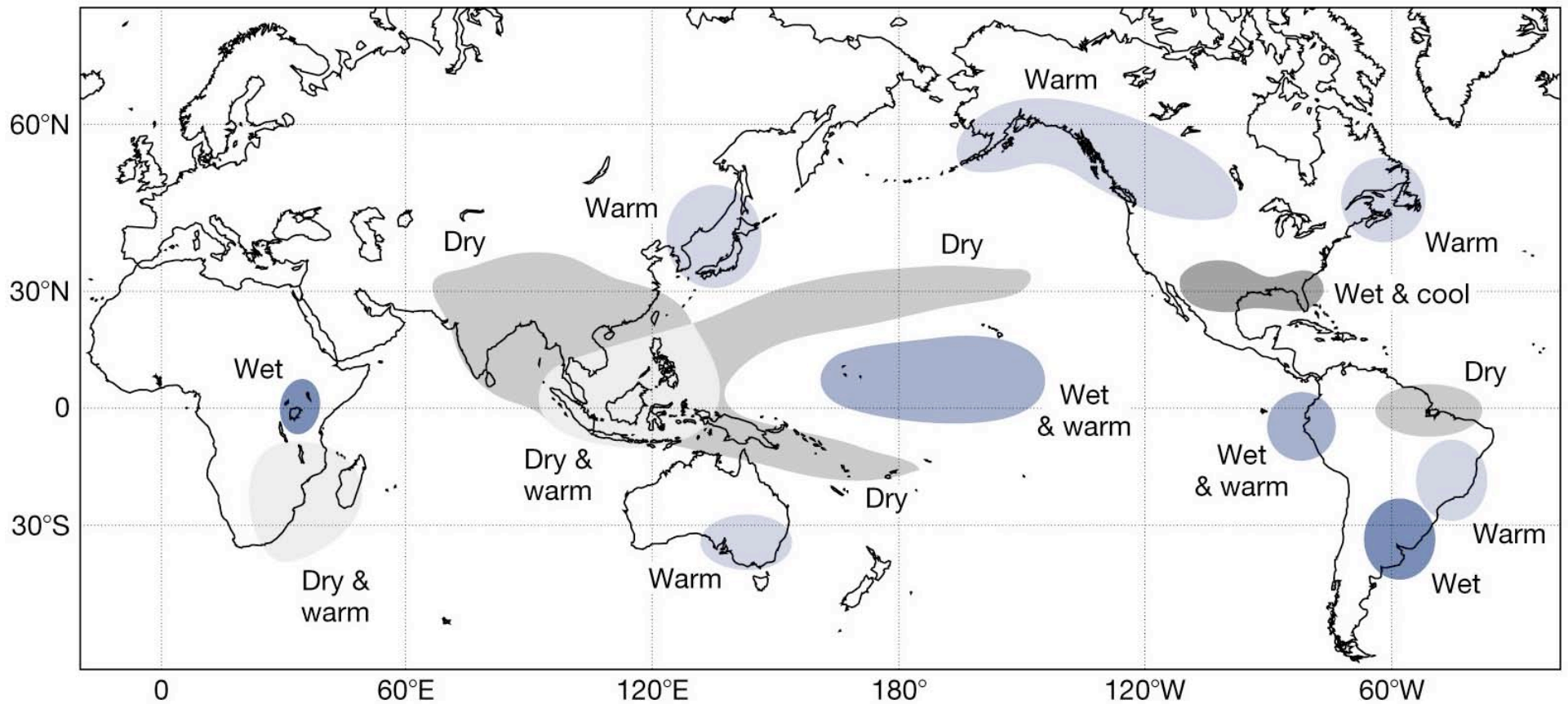
1997-1998 event

floods, mudslides along California coast

but mild winter in northeast

ENSO Climate Impacts Map

December–February



Summary

Normally, trade winds cause warm surface water to pile up in the west Pacific. If the associated Walker circulation is particularly enhanced, it is called La Niña.

When trade winds weaken, the warm western water sloshes back to the east Pacific. This sets up El Niño conditions. The circulation shifts to convergence and uplift in the central Pacific. Diverging air aloft now subsides as far away as Africa.

By shifting the location of wet zones of rising air and high pressure zones of dry subsiding air, ENSO causes major climate change around the world. The main detrimental effects of this are drought and flooding.

Midlatitude effects are harder to predict. Generally, the west and east coasts of the US get warmer. For the US, this may be bad (floods/drought) or benign (mild midwest/northeast winter).