# ATOC 1060-002
# OUR CHANGING ENVIRONMENT

## Class 18 (Chp 5, P92-96)

### Objectives of Today's Class

**[1] El Nino-Southern Oscillation (ENSO);**

**[2] ENSO climatic and society impact**

# El Nino-Southern Oscillations (ENSO) Events

## El Nino: Christ child. Occur around Christmas;

## Period: 2-7 years

## Normal Condition:EQUATORIAL atmosphere:

## Walker Circulation or Walker Cell: East-West

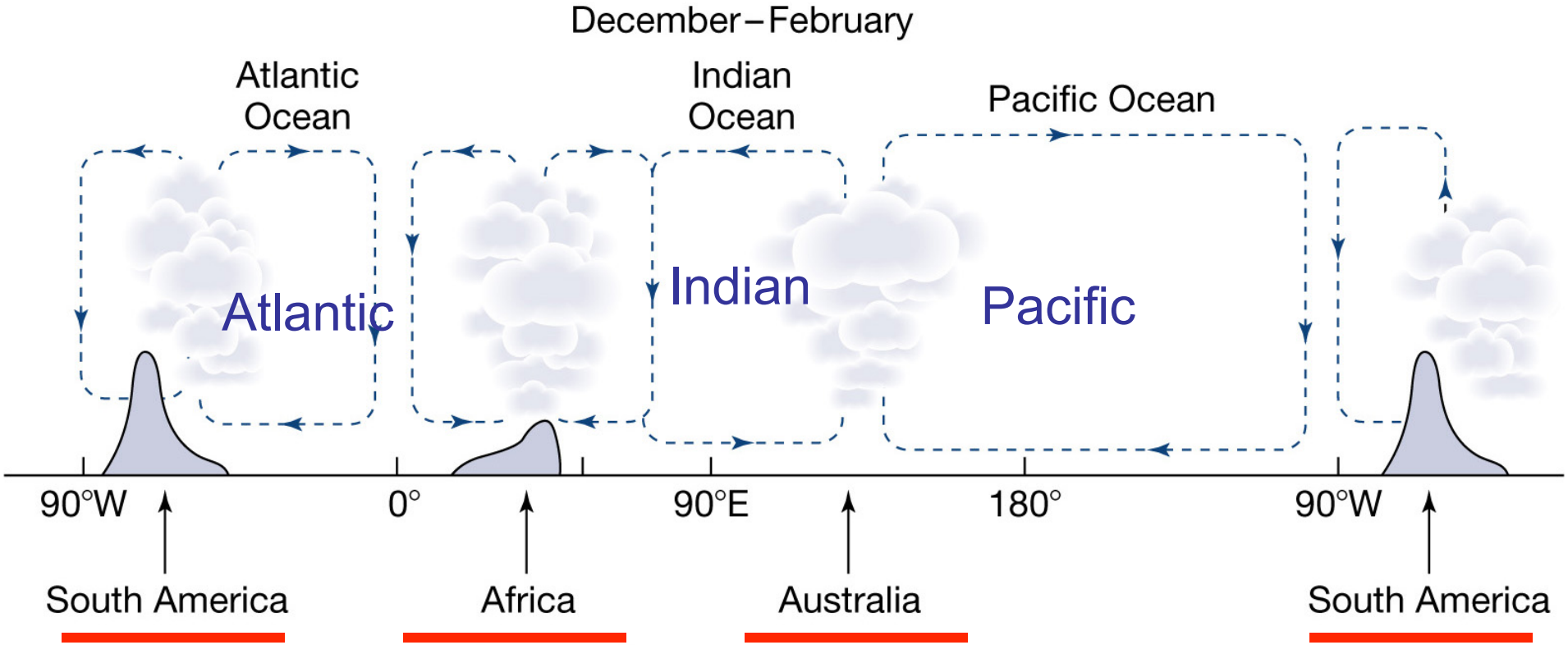





Figure 15-12

# Normal condition:

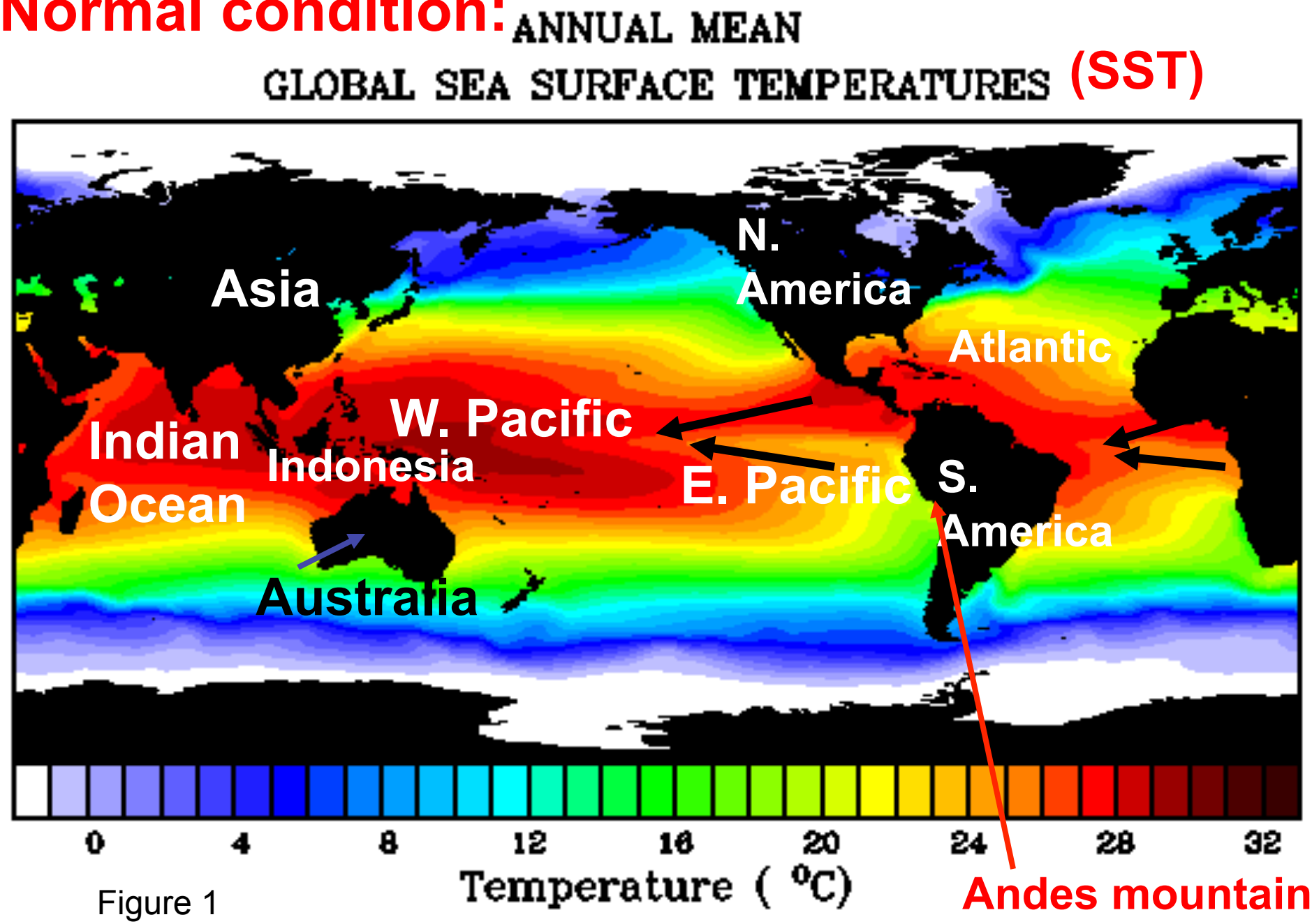



Figure 1

**Normal condition: Enhanced normal - La Nina**

**1.Atmospheric circulation &sea level pressure (SLP);**

**2. Oceanic circulation, SST, nutrients, fishery;**

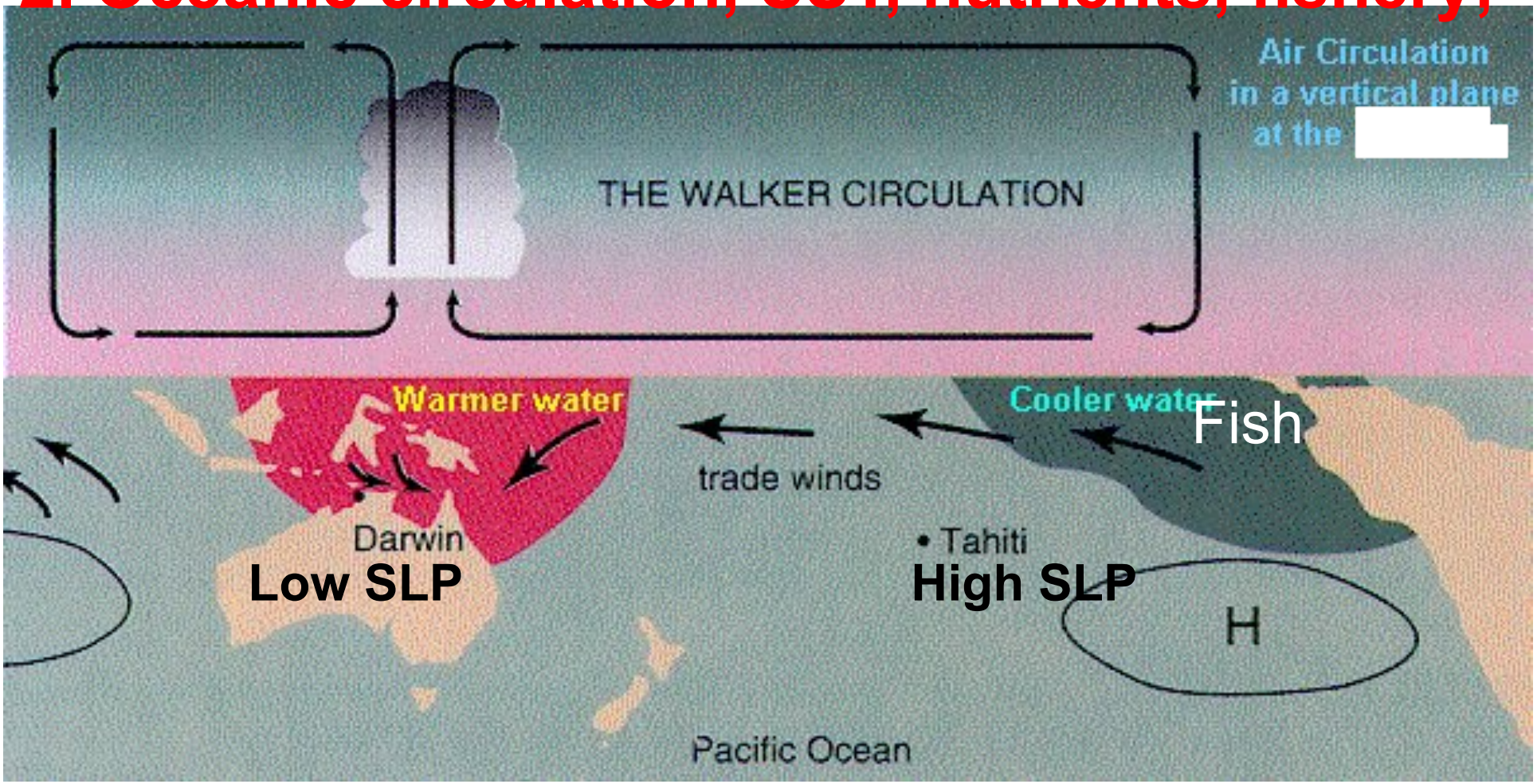
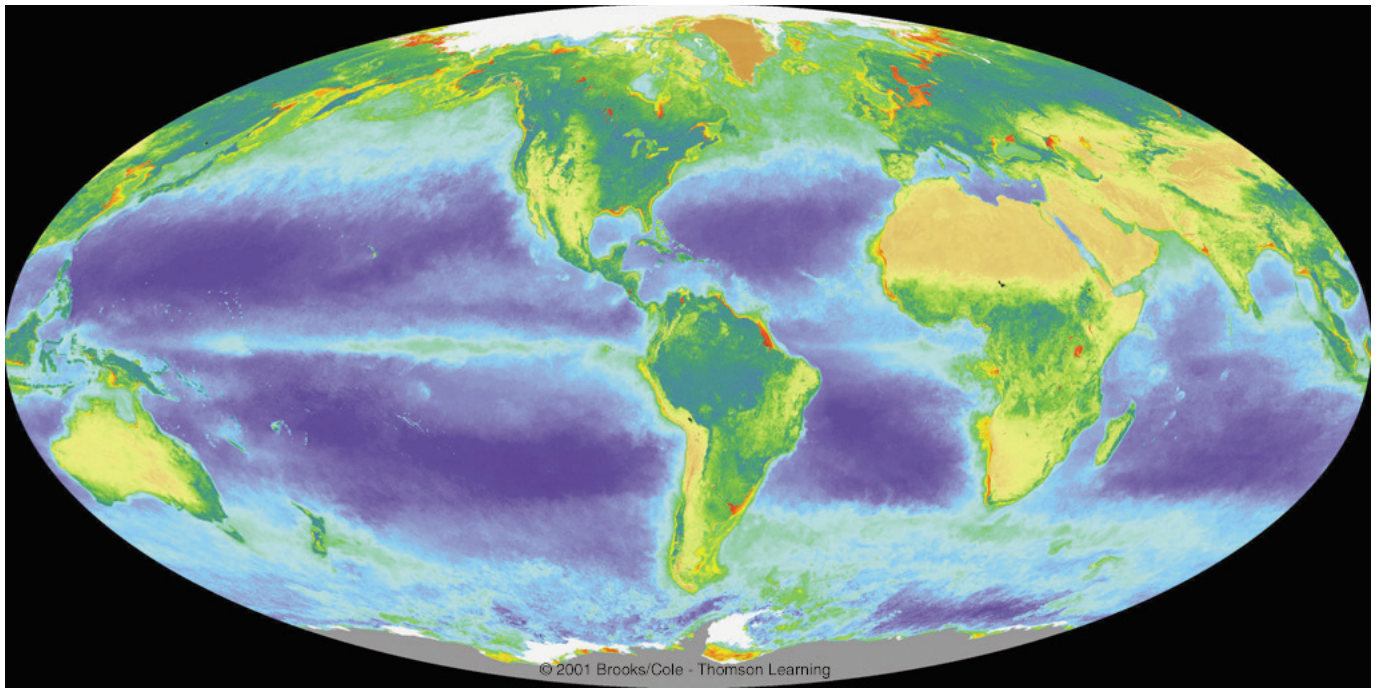
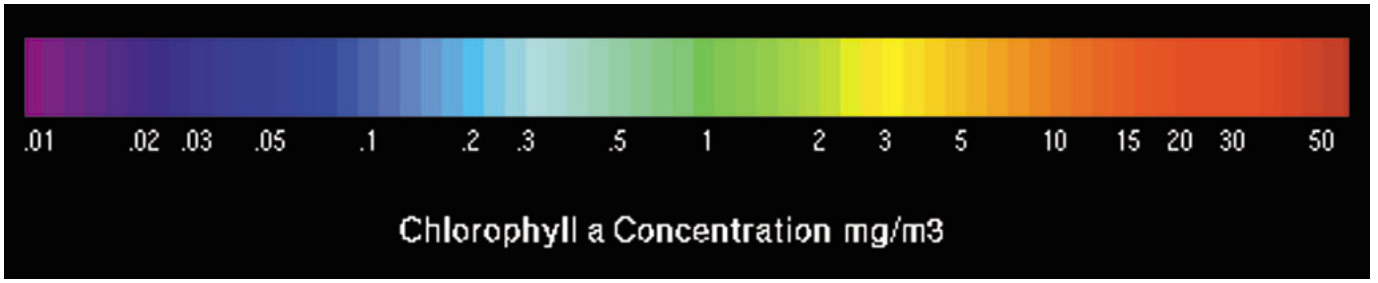



Figure 2

# Upwelling and Ocean Chlorophyll concentration



# The El Nino condition: Warm phase of SO;

## 1.Atmospheric circulation &sea level pressure (SLP);

## 2. Oceanic circulation, SST, nutrients, fishery;

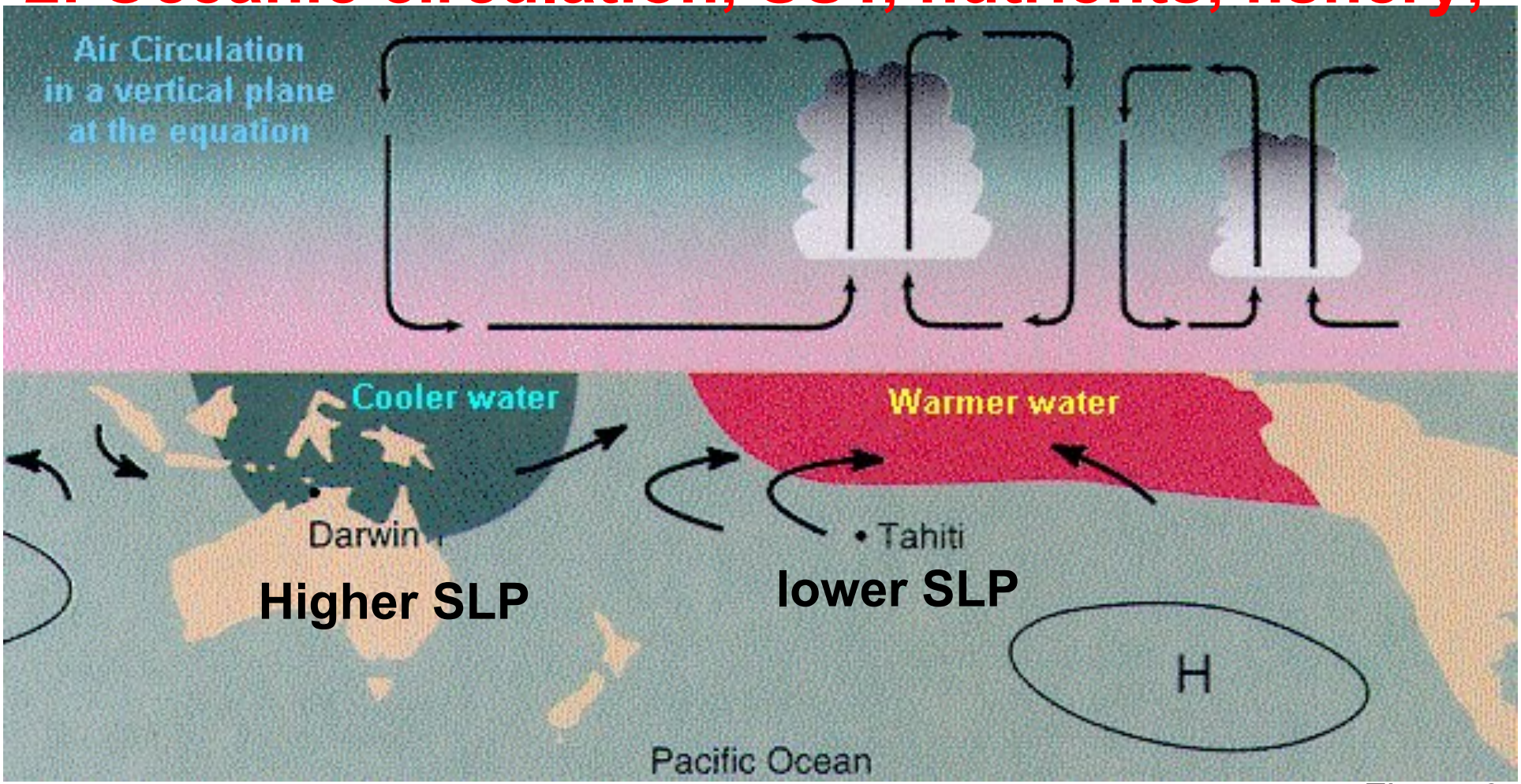



Figure 3

# SST anomaly, 1997/98 El Nino

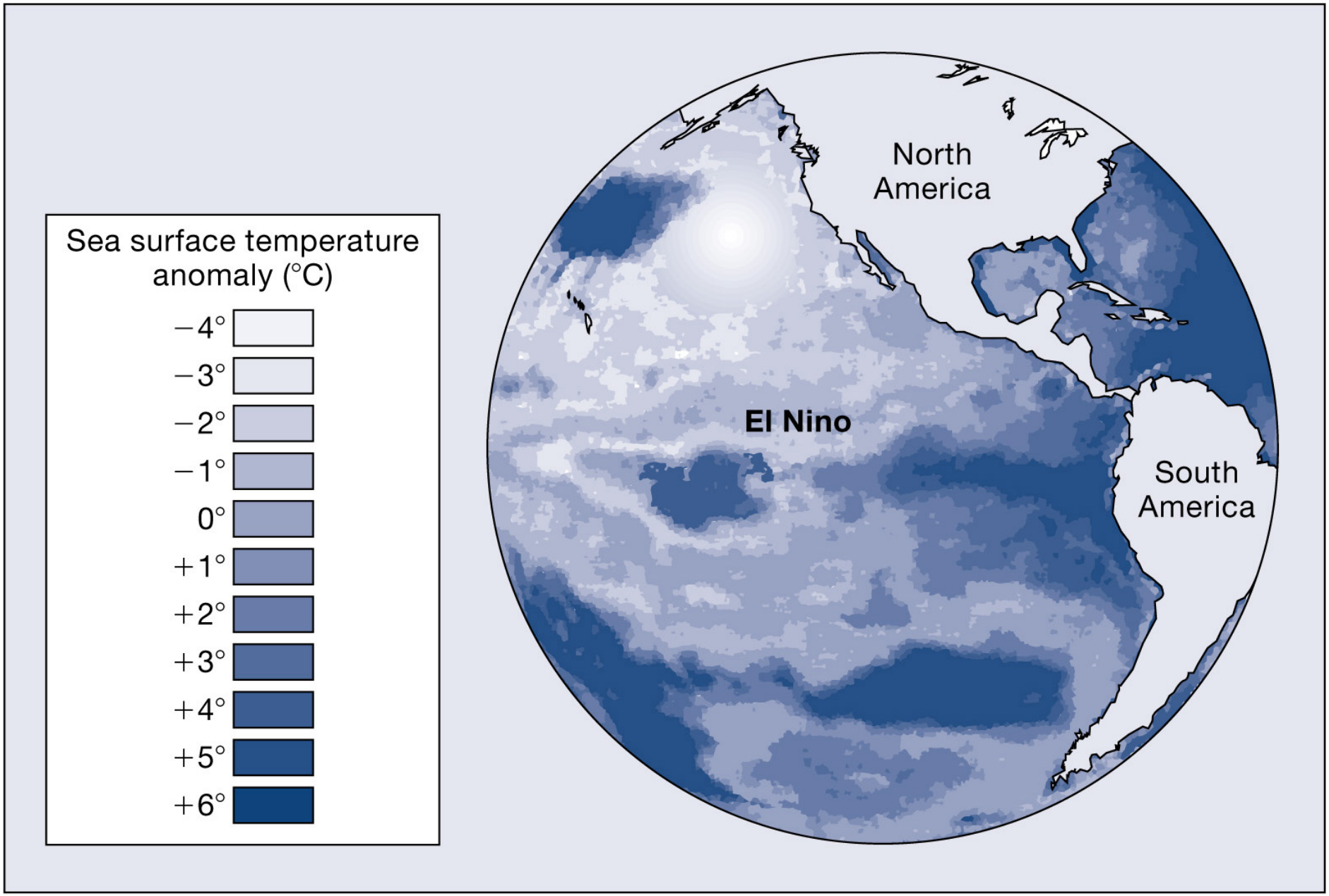
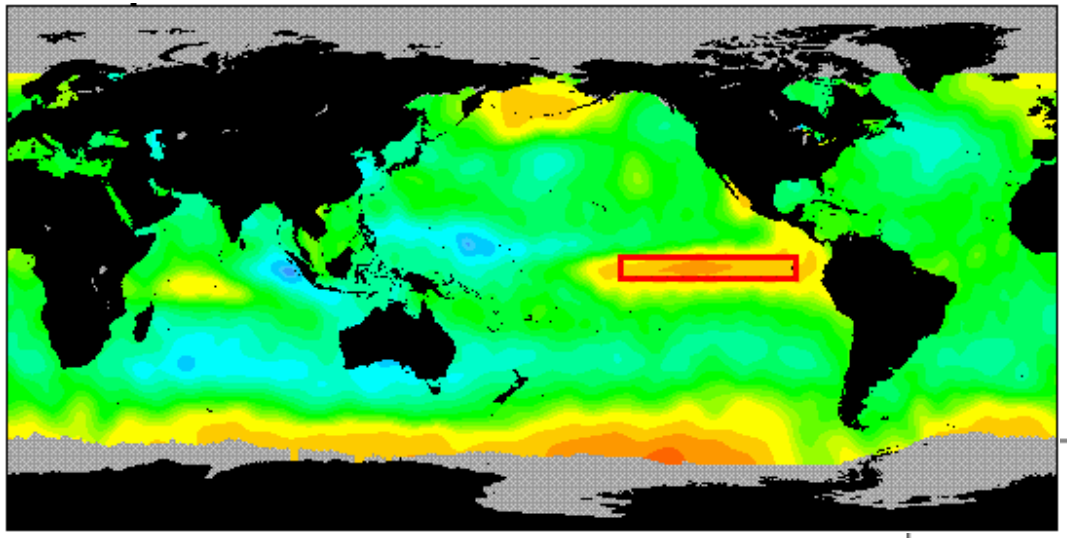




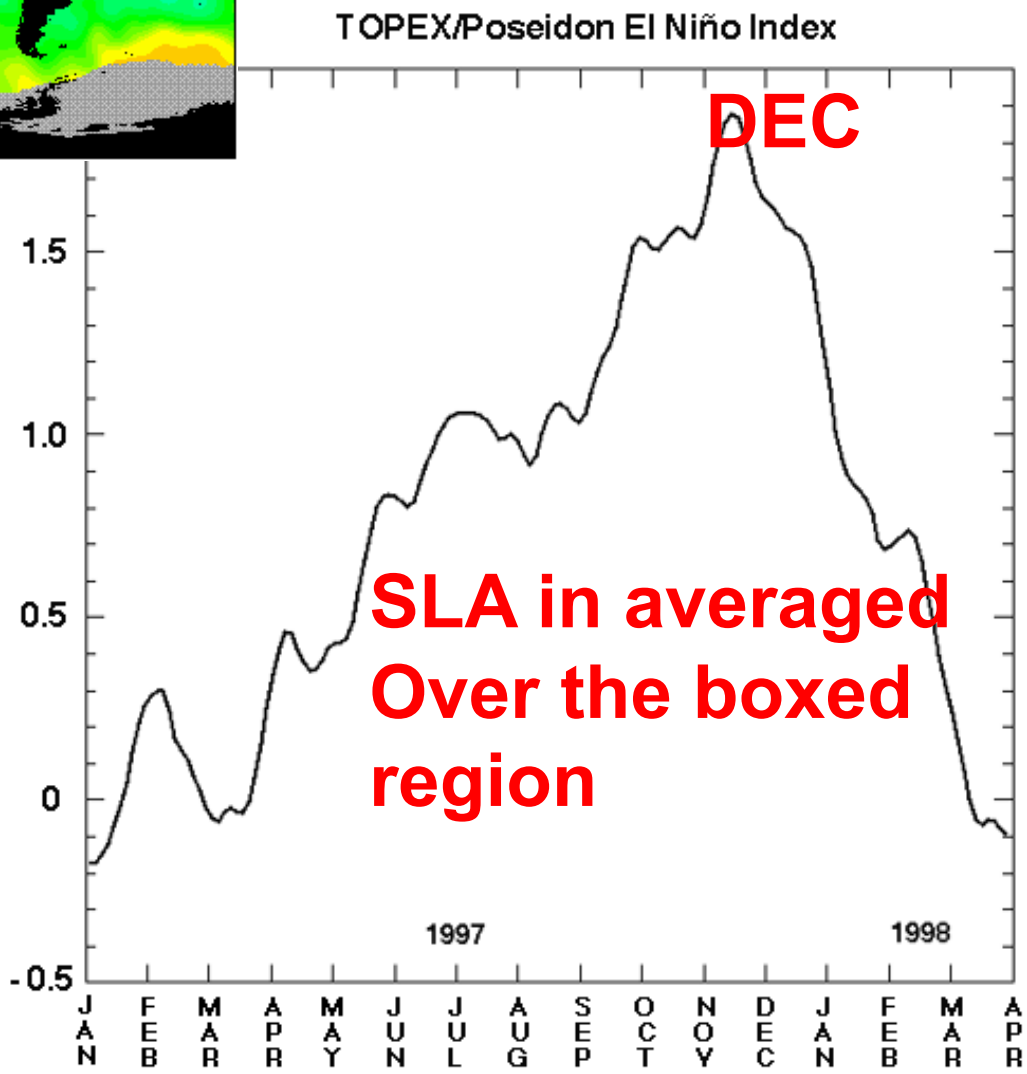

Figure 15-15



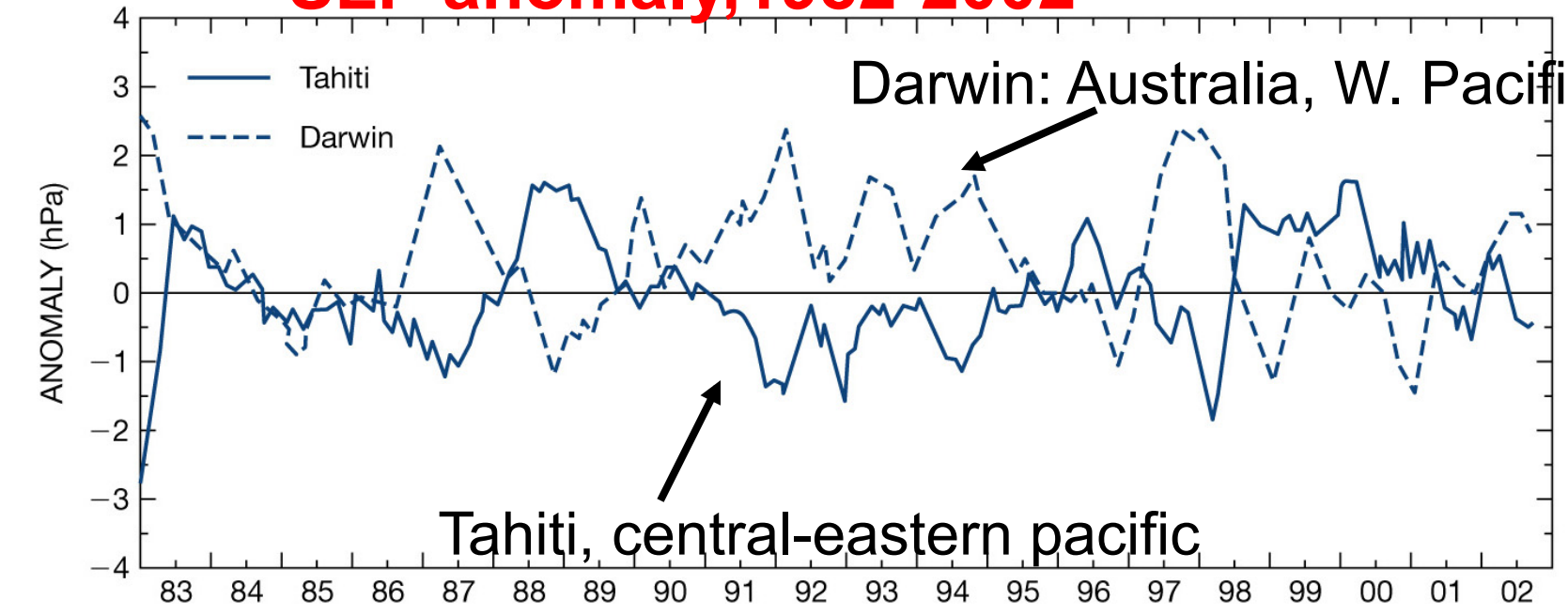
# 1997/98 El Nino: High SLA in E. Pacific

**Satellite TOPEX/Poseidon Sea Level Anomaly (SLA):**

**Red: high SLA;**
**Blue: low SLA**

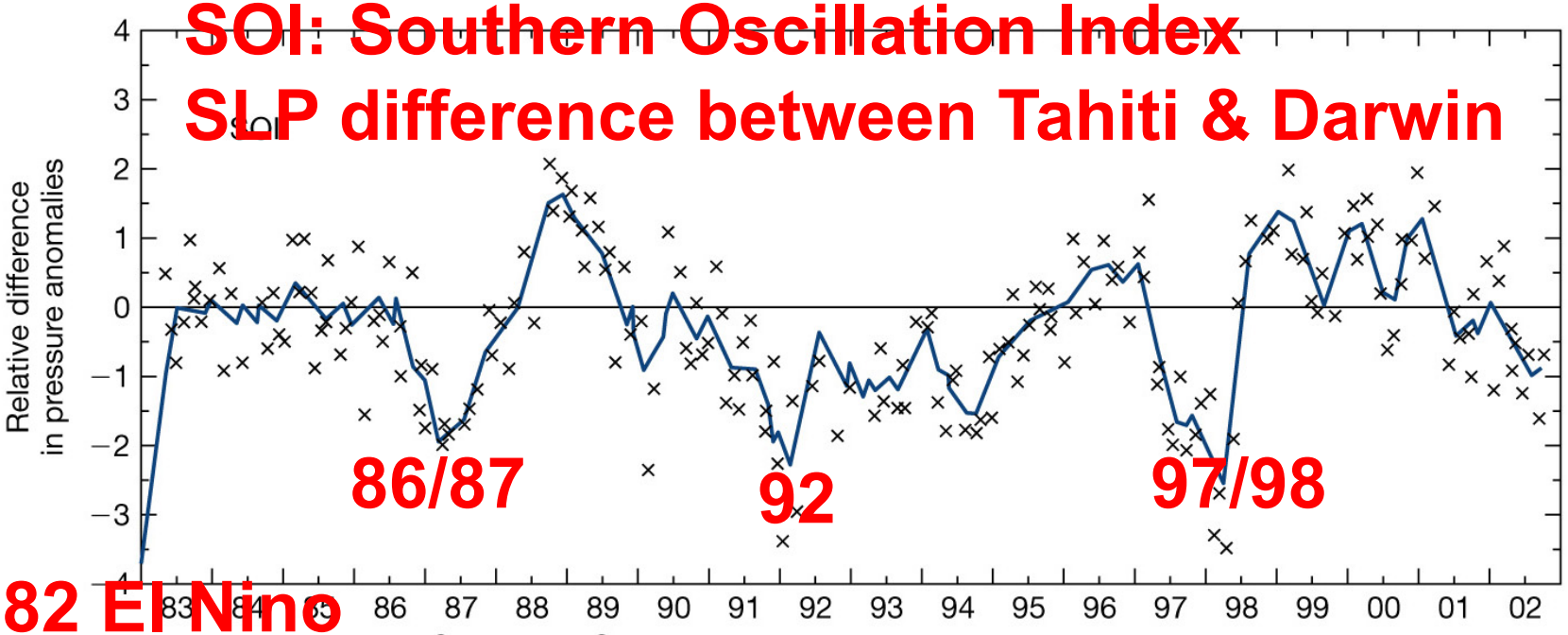


# SLP anomaly,1982-2002




## SOI: Southern Oscillation Index

## SLP difference between Tahiti & Darwin

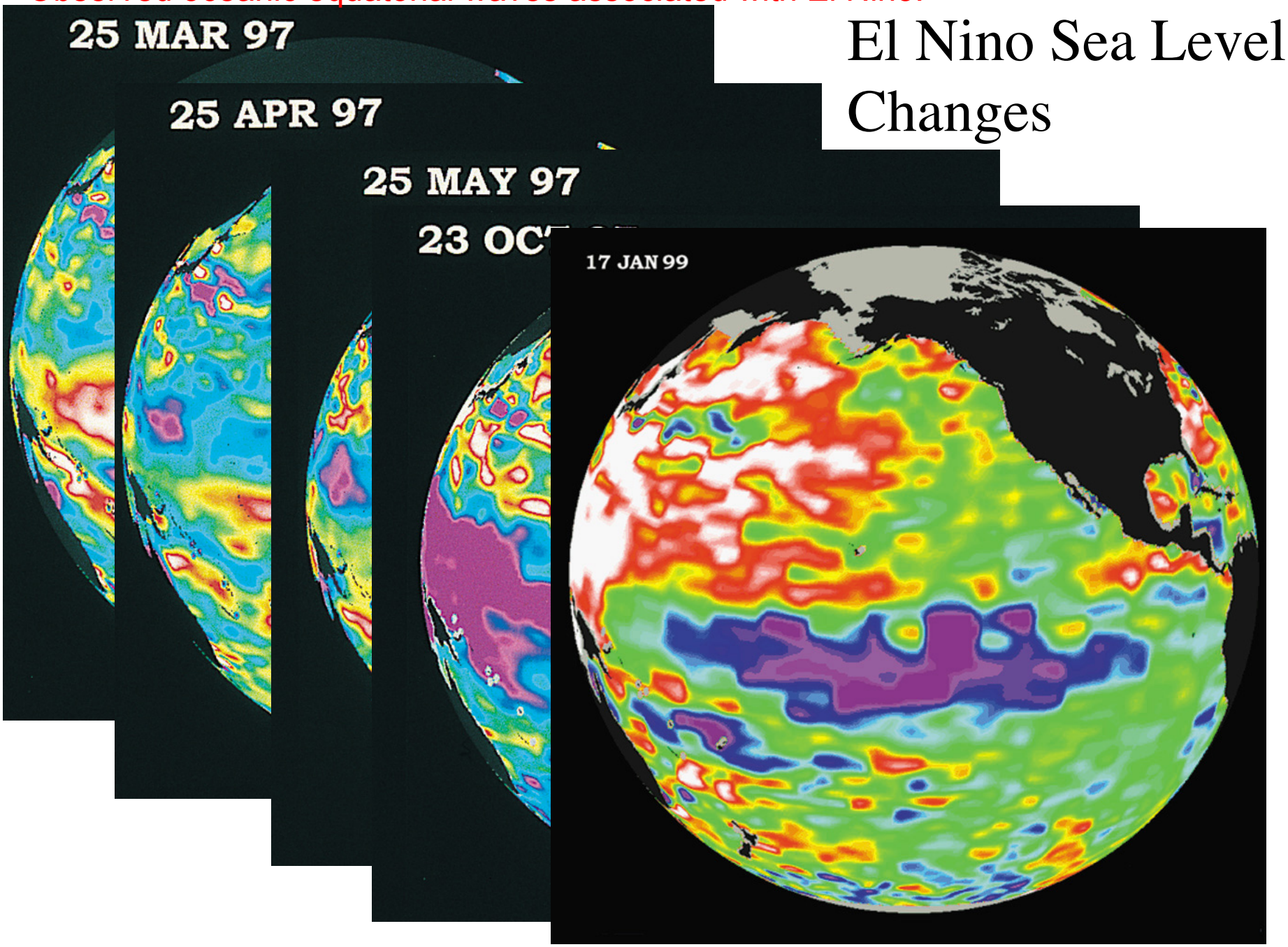


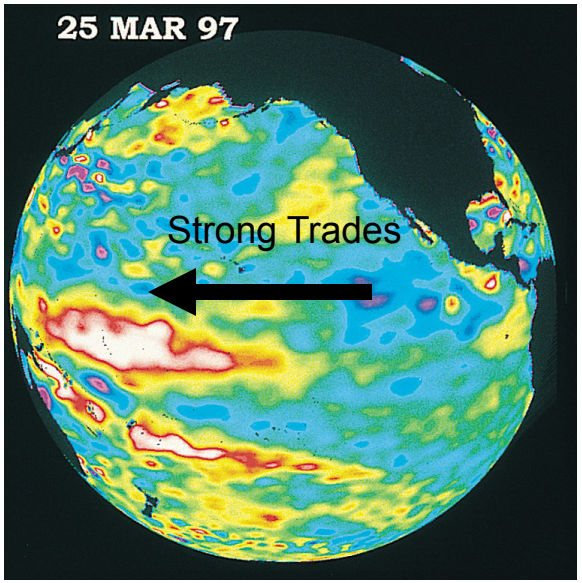
# El Nino dynamics

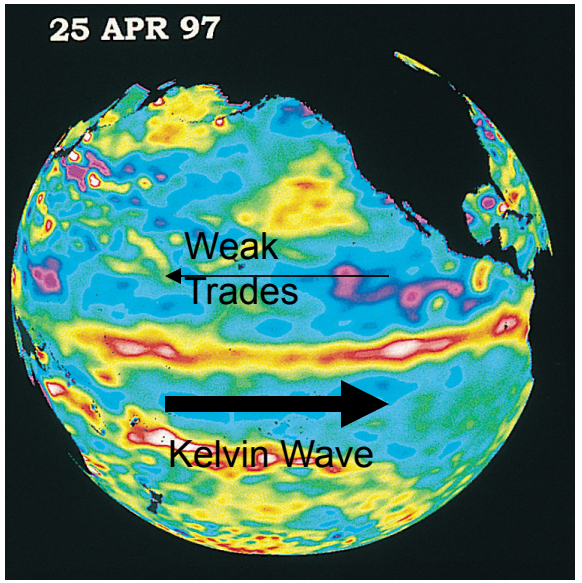
**[1] Coupled Oscillator:**
**Strong easterly trades: enhance off-equatorial**
**Wind stress curl =>**
**Ekman convergence => downwelling =>**
**westward propagating Rossby waves =>**
**western boundary, coastal Kelvin waves to**
**the equator =>**
**Downwelling east ward propagating Kelvin waves =>**
**push thermocline down =>**
**reduce upwelling in Eastern Pacific => El Nino.**

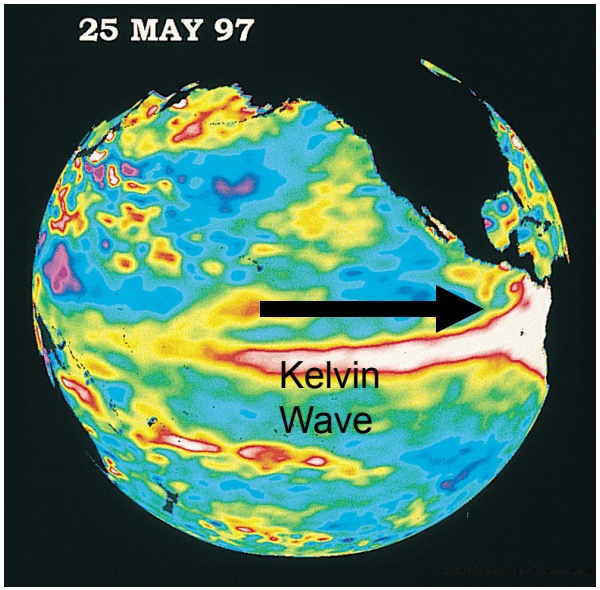
Observed oceanic equatorial waves associated with El Nino:

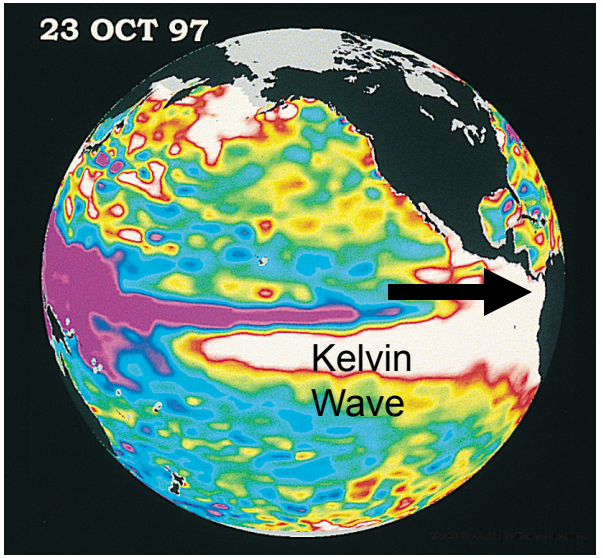
# El Nino Sea Level Changes




25 MAR 97
Strong Trades

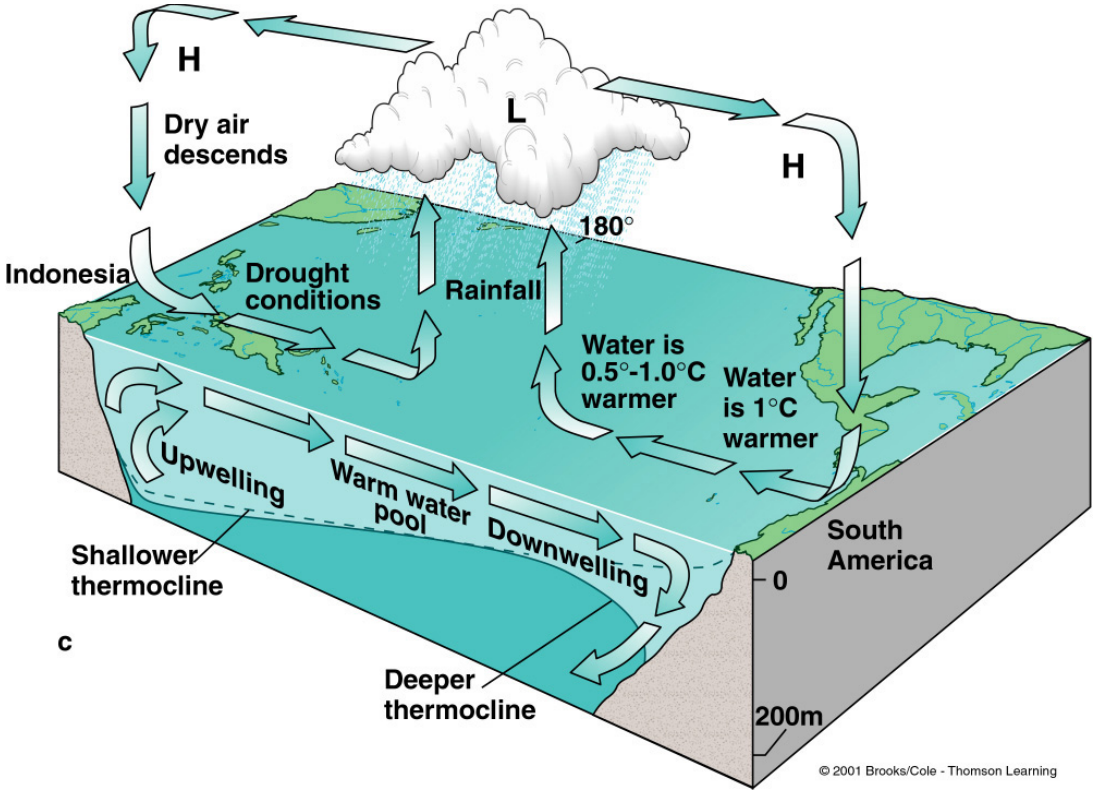

25 APR 97
Weak
Trades
Kelvin Wave


25 MAY 97
Kelvin
Wave


23 OCT 97
Kelvin
Wave

# El Nino dynamics

## [2] Positive ocean-atmosphere coupling




## [3] Also can be triggered by atmospheric Intraseasonal oscillations – stochastic forcing, cause ENSO irregularity.

# ENSO: Coupled ocean-atmosphere phenomenon

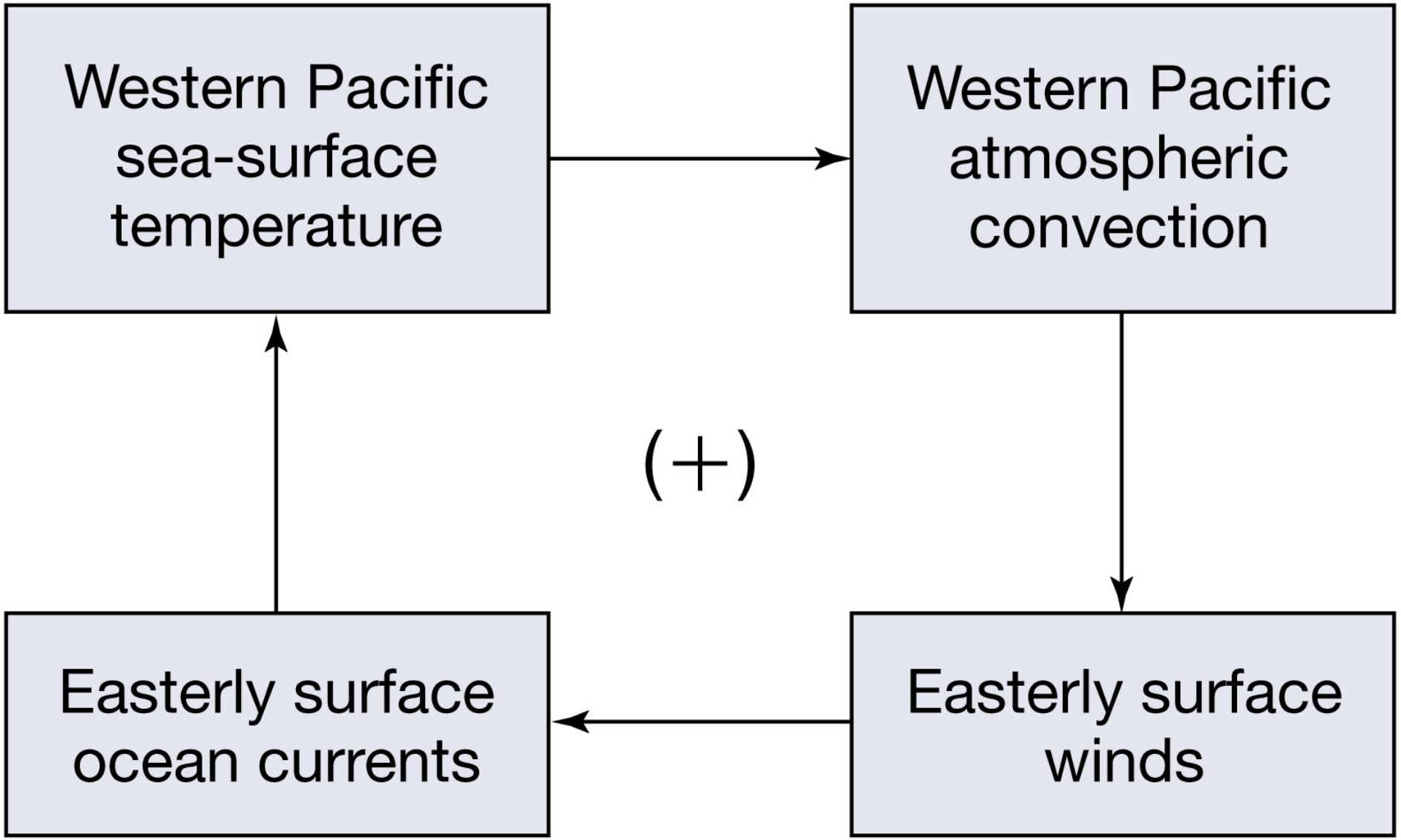
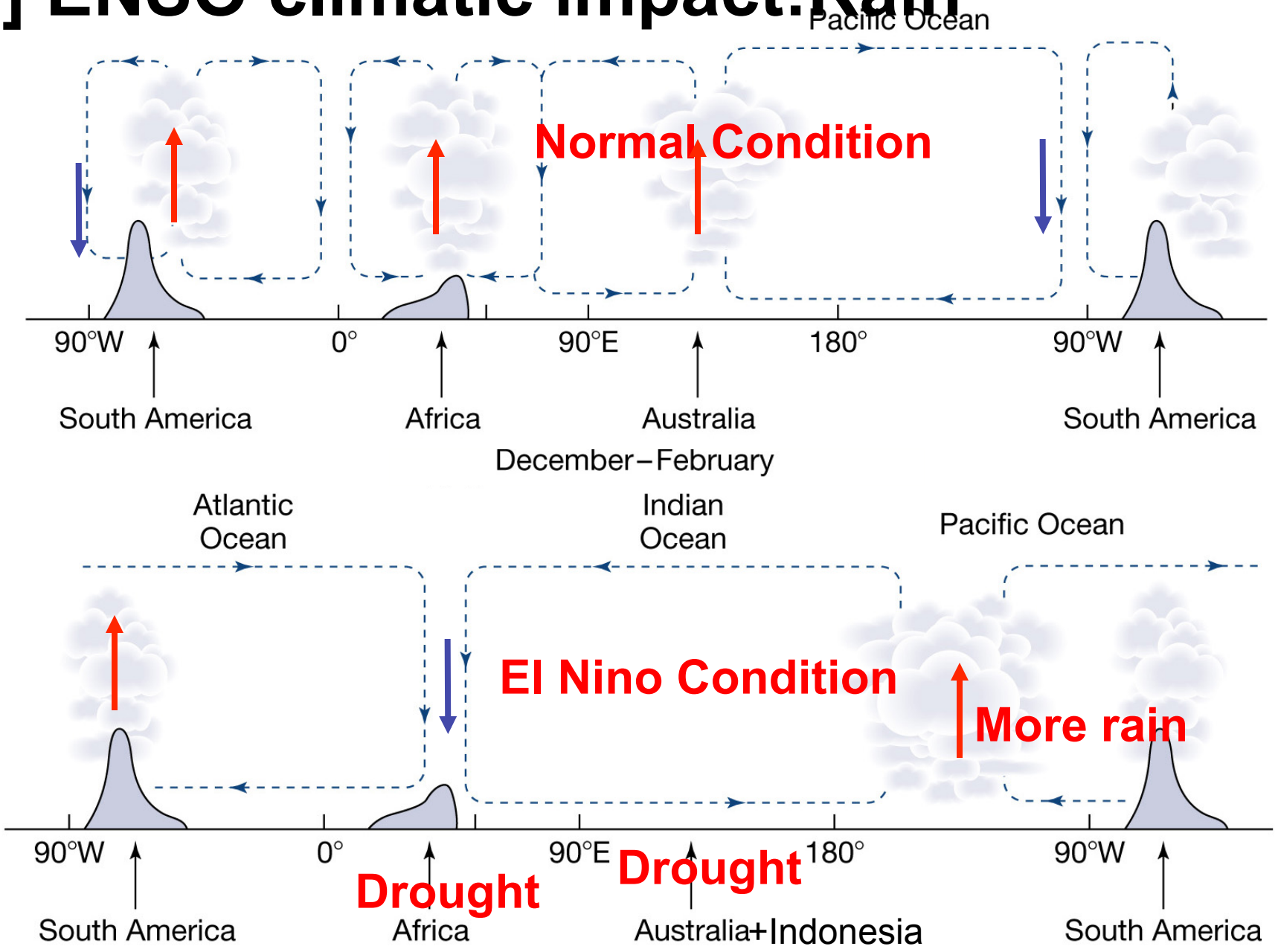



Fig 15-14

# [2] ENSO climatic impact:Rain



# El Nino impact on tropical and mid-latitude rainfall & temperature

## Northern winter December–February

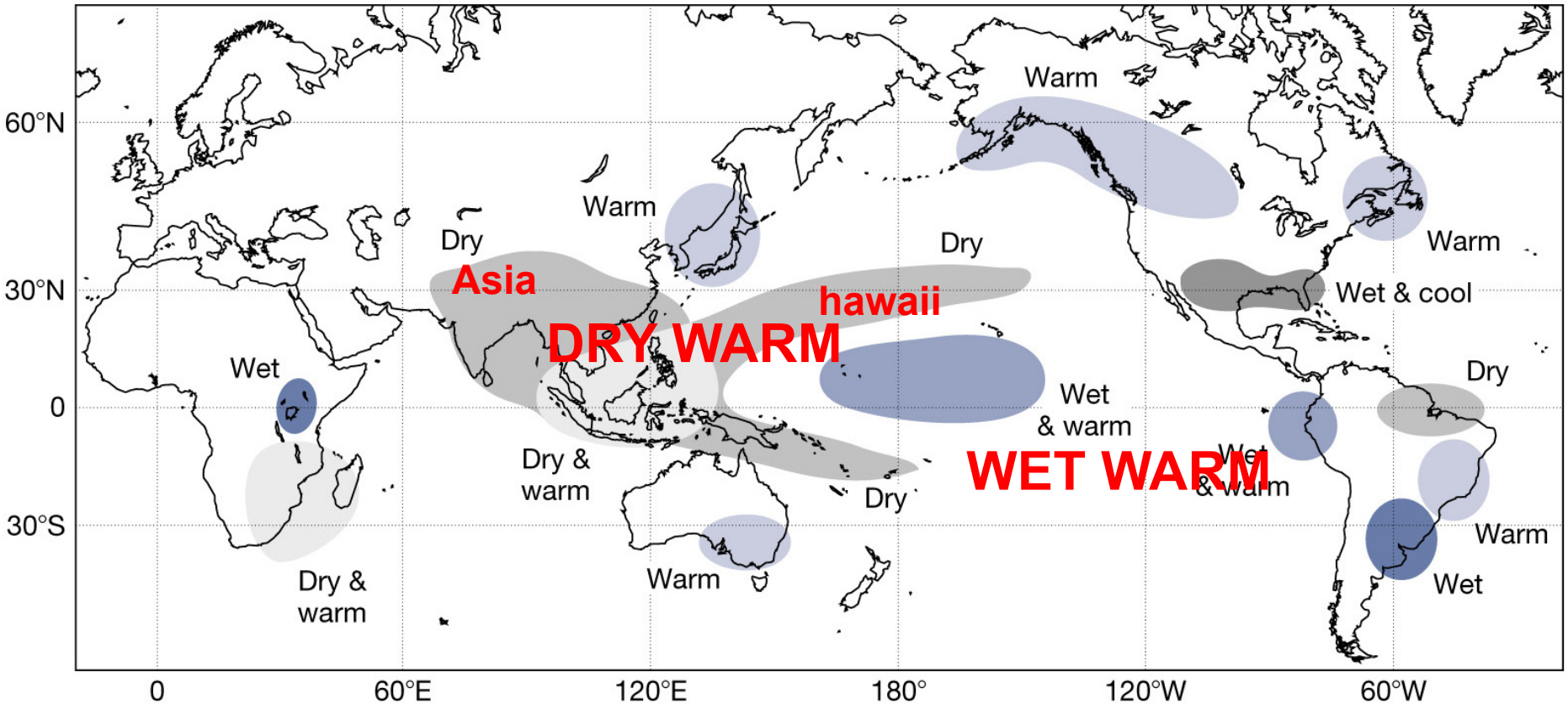




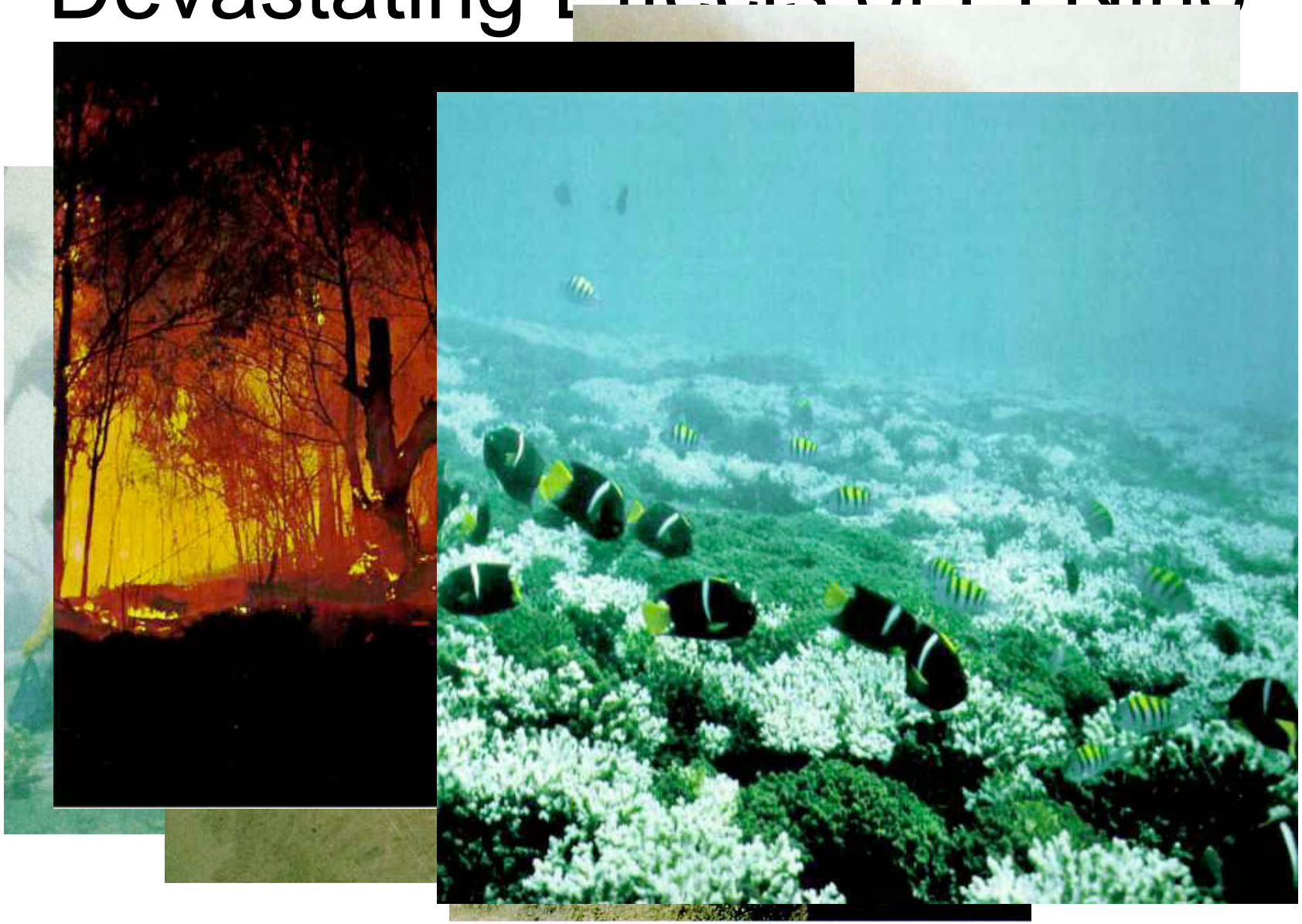

Fig 15-18

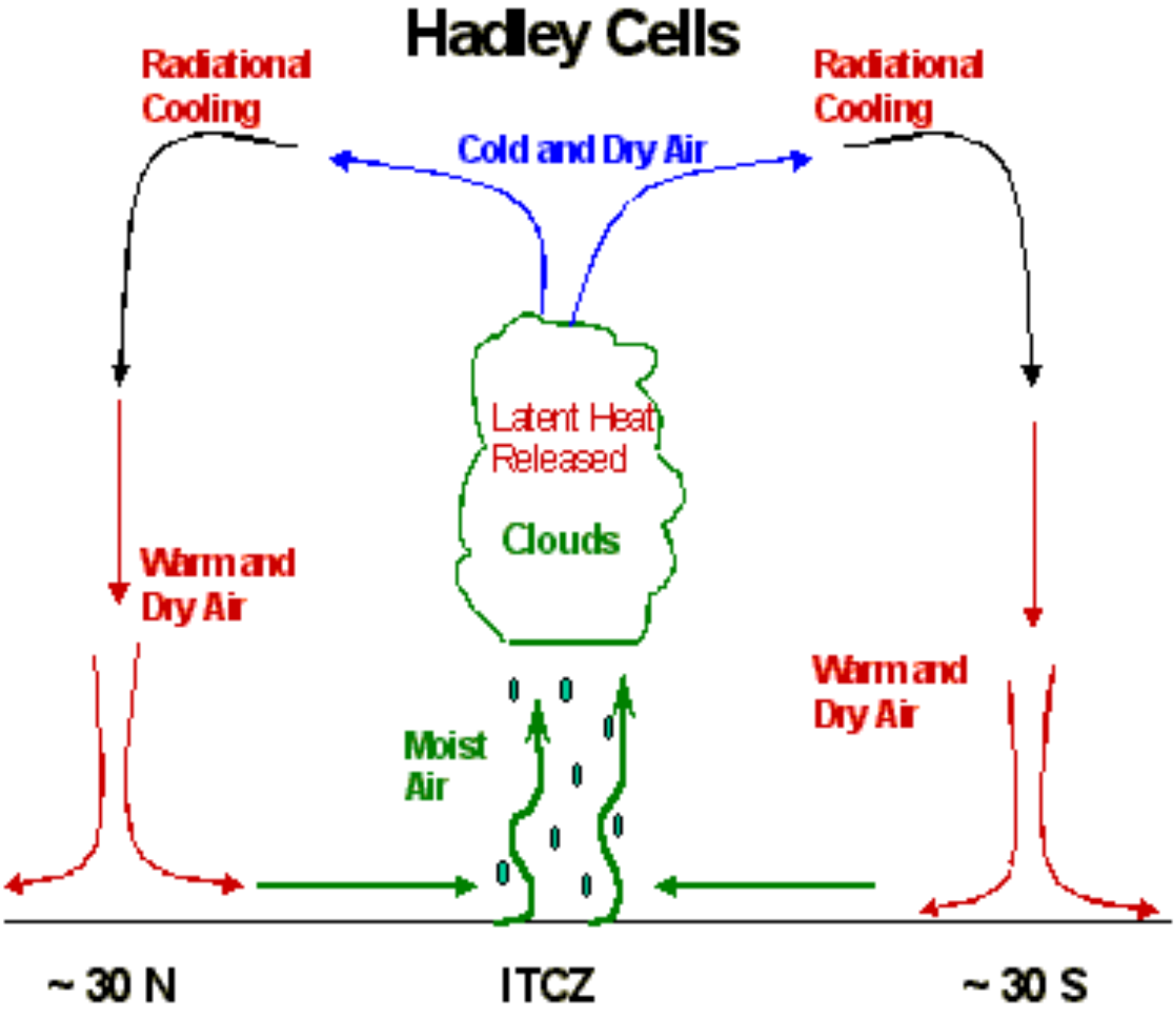
# El Nino impact on tropical rainfall by changing the Walker Cell: east-west atmospheric circulation

**Drought: Australia, Indonesia, Central America, Brazil, and southeast Africa;**

**High rainfall: central Pacific, western slopes of the Andes in Ecuador and Peru (floods, landslides, high soil erosion);**

# Devastating Effects of El Nino




Hadley Cells
Radiational Cooling
Radiational Cooling
Cold and Dry Air
Latent Heat Released
Clouds
Warm and Dry Air
Warm and Dry Air
Moist Air
~ 30 N
ITCZ
~ 30 S

# El Nino impact on tropical and mid-latitude rainfall & temperature

## Northern winter December–February

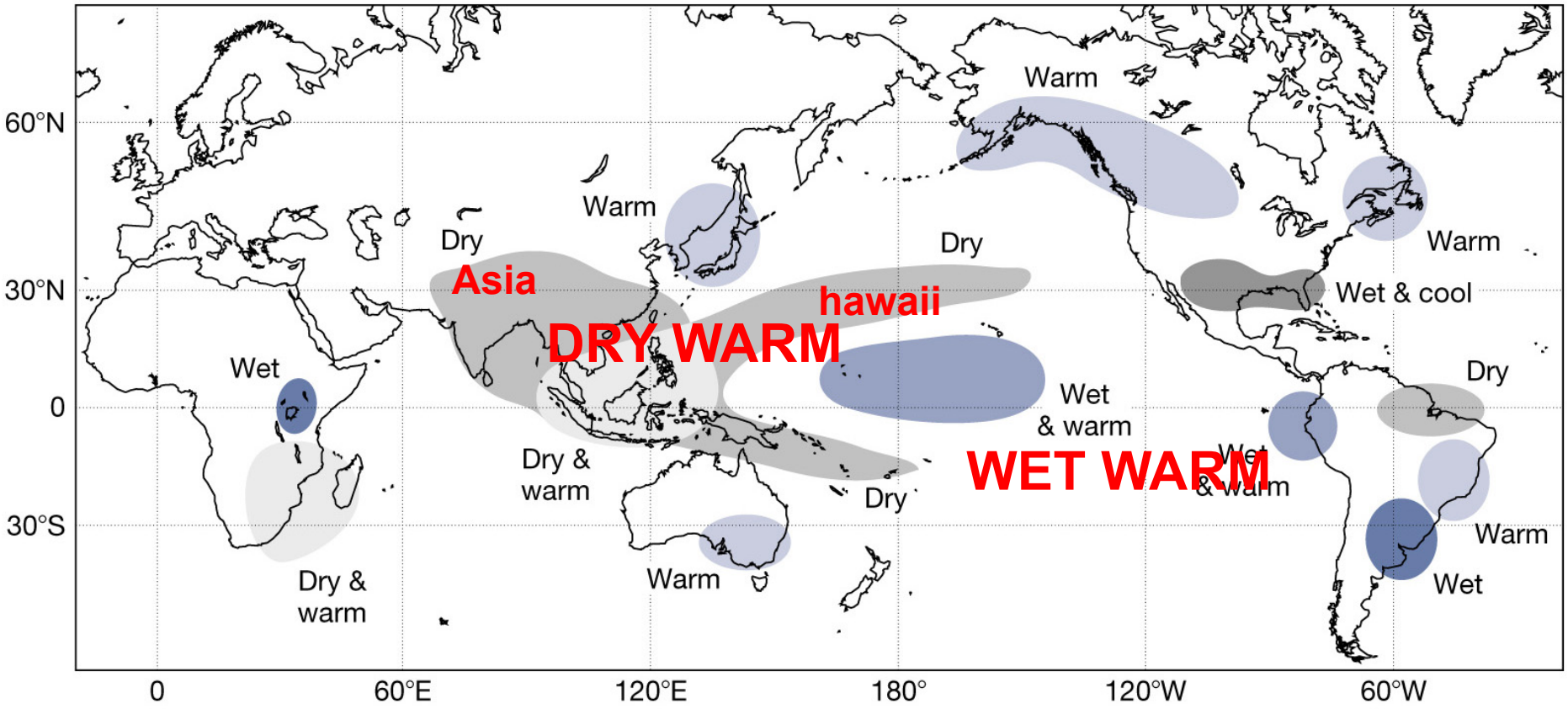





Fig 15-18

# El Nino impact on subtropics by affecting Hadley cell

**El Nino: Asia, Hawaii dry and warm; Southeastern US: wet and cool; weaker monsoon;**

**La Nina: stronger monsoon; 2006 La Nina, persistent rainfall in Hawaii due to La Nina, reduced Hadley cell sinking branch there.**

**NOTE: Asia, Hawaii: >20N; Hadley cell sinking branch**