Global Ocean Monitoring: Recent Evolution, Current Status, and Predictions

Prepared by

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http://www.cpc.ncep.noaa.gov/products/GODAS/

Outline

- Overview
- Recent highlights
  - Pacific Ocean
  - Indian Ocean
  - Atlantic Ocean
- GODAS and CFS SST Predictions

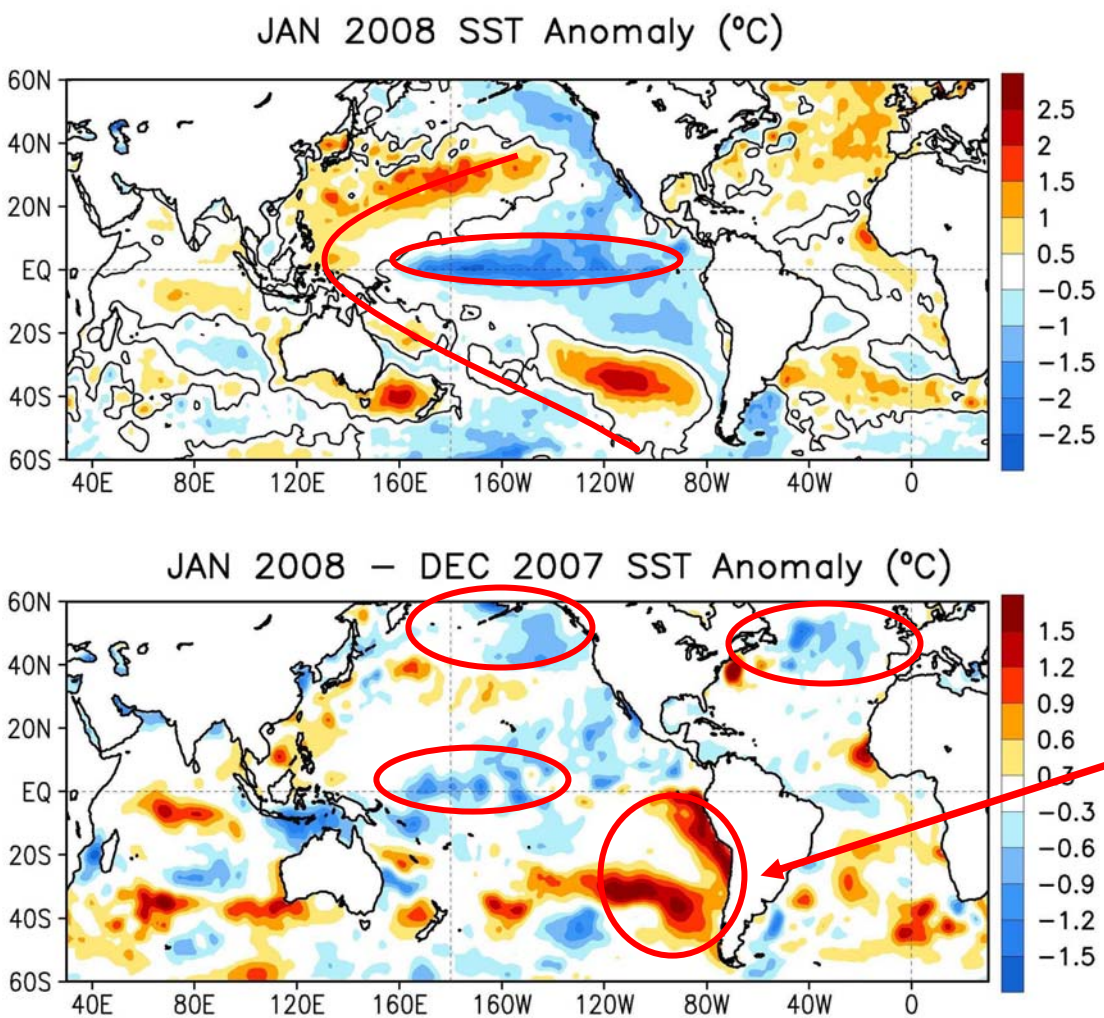
Overview

- **Pacific Ocean**
  - Moderate-strength La Niña (ONI SST < -1C) persisted from SON to NDJ for three consecutive seasons
  - CPC's prognostic assessment: La Niña will continue into the Spring of 2008
  - Easterly wind anomaly weakened in the western Pacific due to MJO activities
  - Strong anti-cyclone wind anomalies near the western coast of North America favored coastal upwelling and reduced SST
  - Coastal upwelling has been abnormally strong since September with large intraseasonal variability

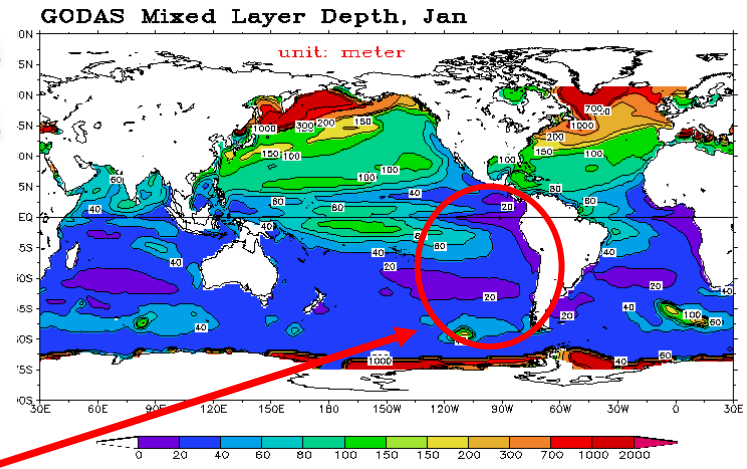
- **Indian Ocean**
  - Near normal SST presented in the tropical Indian Ocean
  - Below-normal convection related to MJO activities

- **Atlantic Ocean**
  - Near normal SST presented in the tropical Atlantic Ocean
  - Negative SST anomalies in south-western Atlantic weakened – forced by La Nina?
  - Positive SST anomalies in the extra-tropical North Atlantic weakened
  - NAO index has been persistently positive since September

Global SST Anomaly (ºC) and Anomaly Tendency



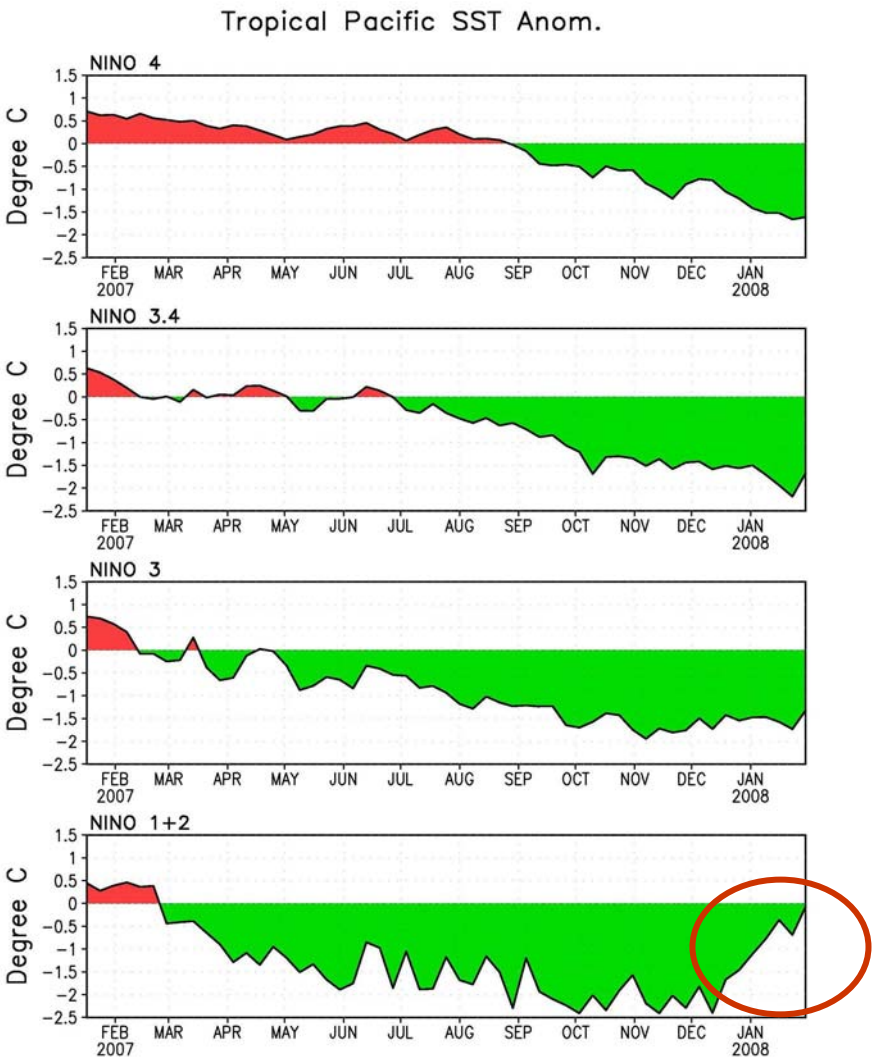
- Negative SSTA east of 160E-- a canonical horseshoe pattern in the Pacific
- Near normal SST in Indian Ocean
- Near Normal SST in tropical Atlantic

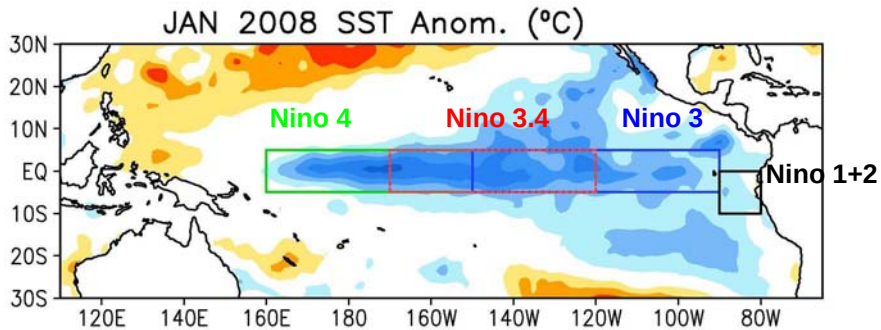


- Negative SSTA in central Pacific strengthened, while those in far eastern Pacific weakened
- SSTA in NH extra-tropics enhanced in Pacific and weakened in Atlantic
- Positive SSTA north of Australia disappeared

Pacific Ocean

Recent Evolution of Pacific NINO SST Indices

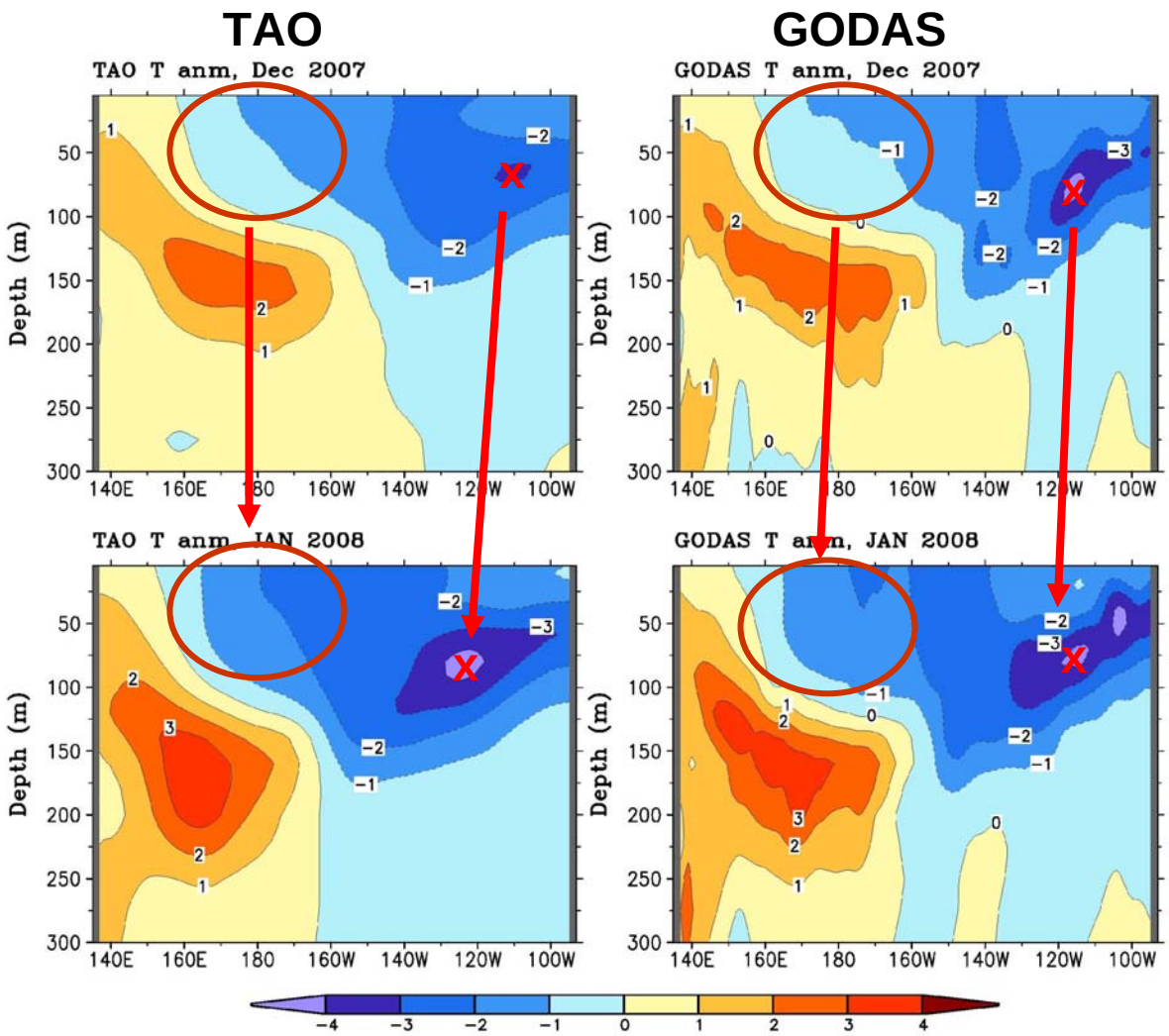




- **NINO 4 strengthened, NINO 3.4 and NINO 3 persisted, NINON 1+2 weakened substantially.**

- **CPC's ENSO Prognostic Statement: NDJ ONI -1.4C, a moderate-strength La Nina persisted. The La Nina will continue into the spring of 2008.**

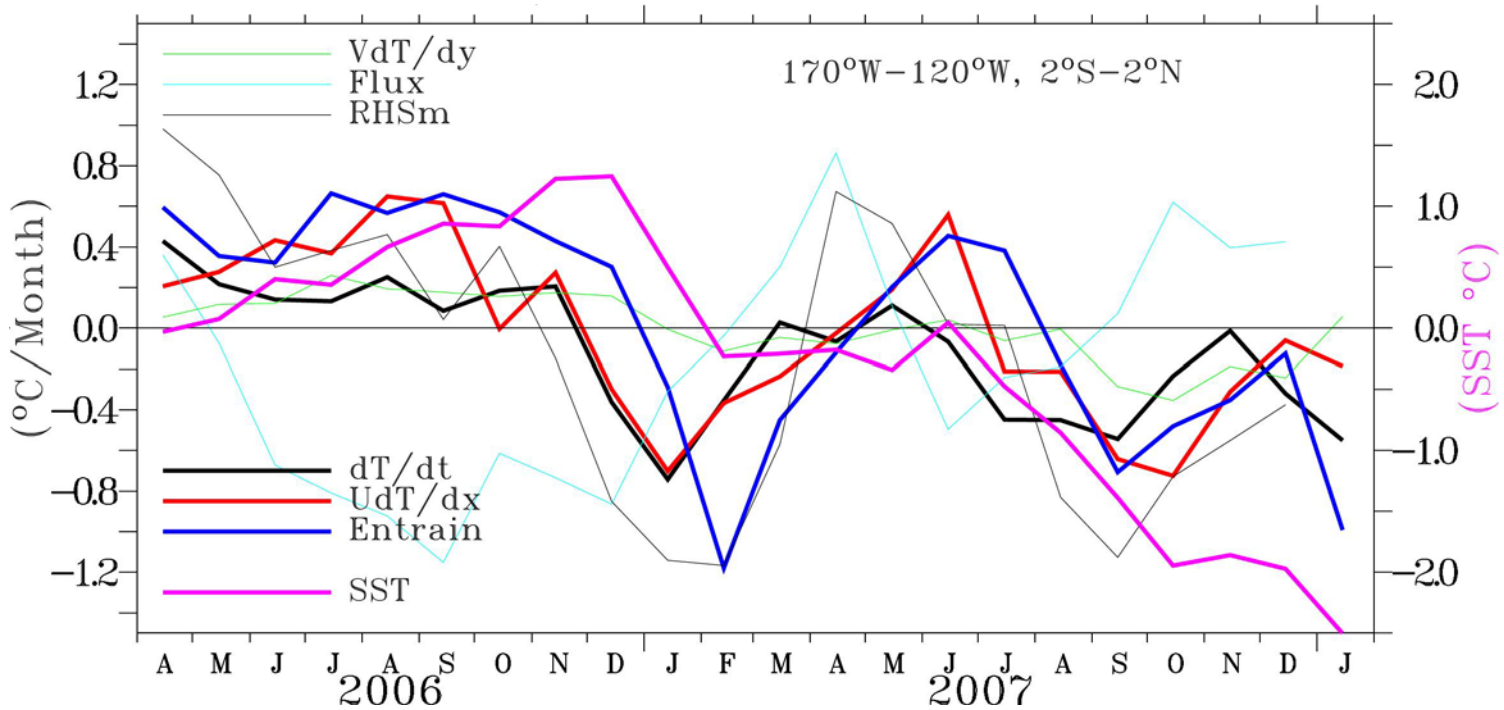
Depth-Longitude Section of Temperature Anomaly in 2ºS-2ºN



- East-west dipole pattern of temperature anomalies featuring La Nina conditions
- Temperature anomalies of GODAS are consistent with those of TAO when the same climatology (TAO climatology) was used
- Negative subsurface temperature anomalies in western-central Pacific enhanced

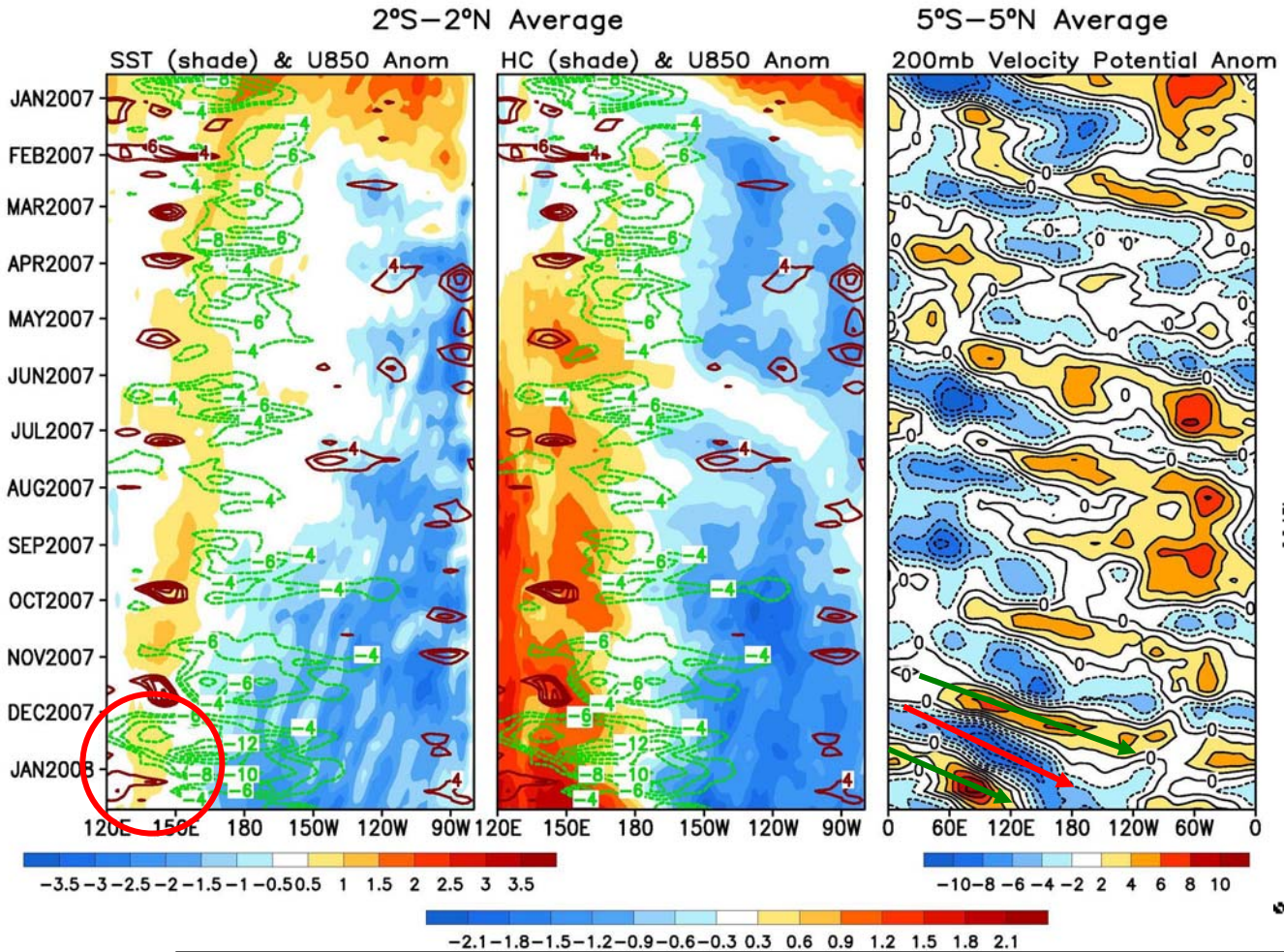
Recent Evolution of Heat Budget in NINO3.4 SST Anomaly

Courtesy of Dr. Dongxiao Zhang

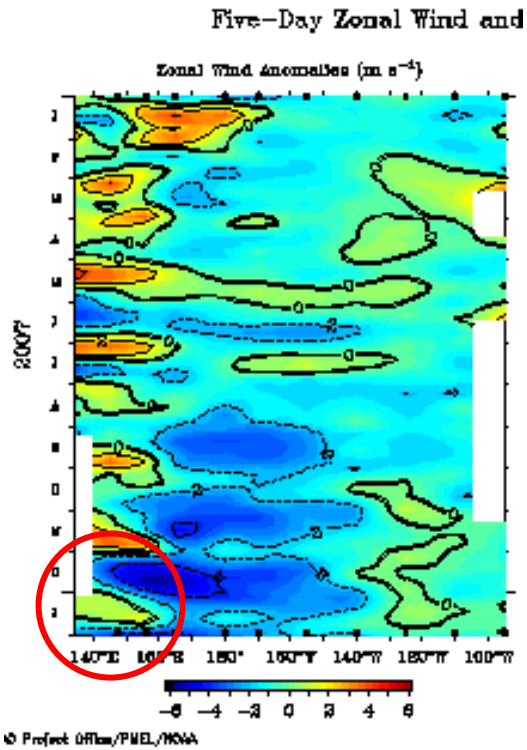


- **Advective cooling in Dec. 2006 (MJO) followed by entrainment cooling in Jan. 2007**
- **Advective and entrainment warming in May-Jul 2007 (MJO) delayed La Nina development**
- **Advective cooling in Jul 2007 (MJO) followed by entrainment cooling in Aug-Oct 2007 led to La Nina development**
- **Entrainment cooling strengthened and became much stronger than advective cooling in January 2008**

Evolution of Equatorial Pacific SST (°C), 850-mb Zonal Wind (m/s), 0-300m Heat Content (°C) and MJO Activity

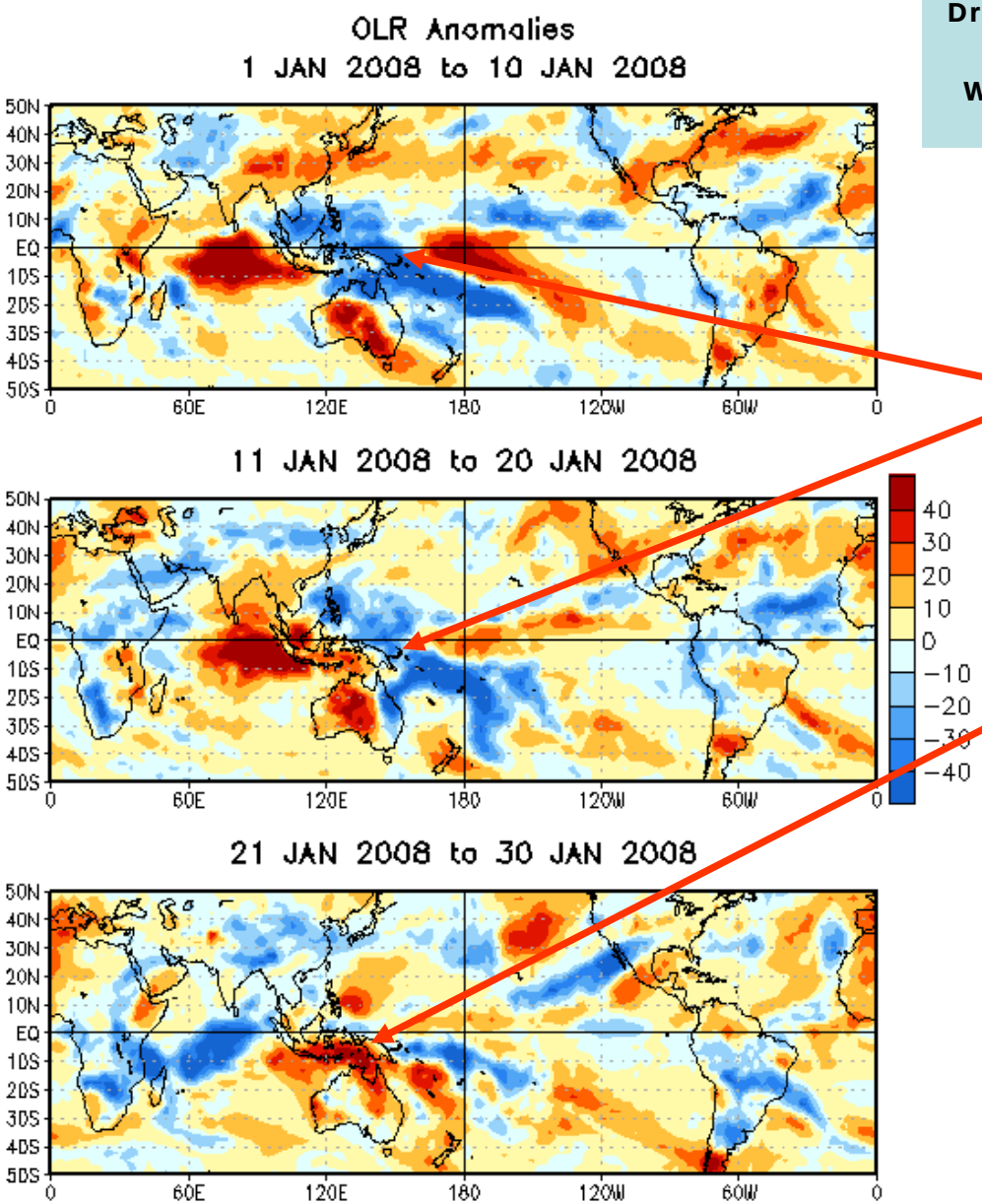


TAO winds



- **CPC's MJO prognostic statement: Moderate-to-strong MJO activity presented since mid-November**
- **In January, convective active phase of MJO progressed to Maritime Continent and western Pacific**
- **Associated with the progression of MJO, easterly wind anomalies weakened in the far western Pacific**

OLR Anomalies: Last 30 days



Drier-than-normal conditions, positive OLR anomalies (/red shading)

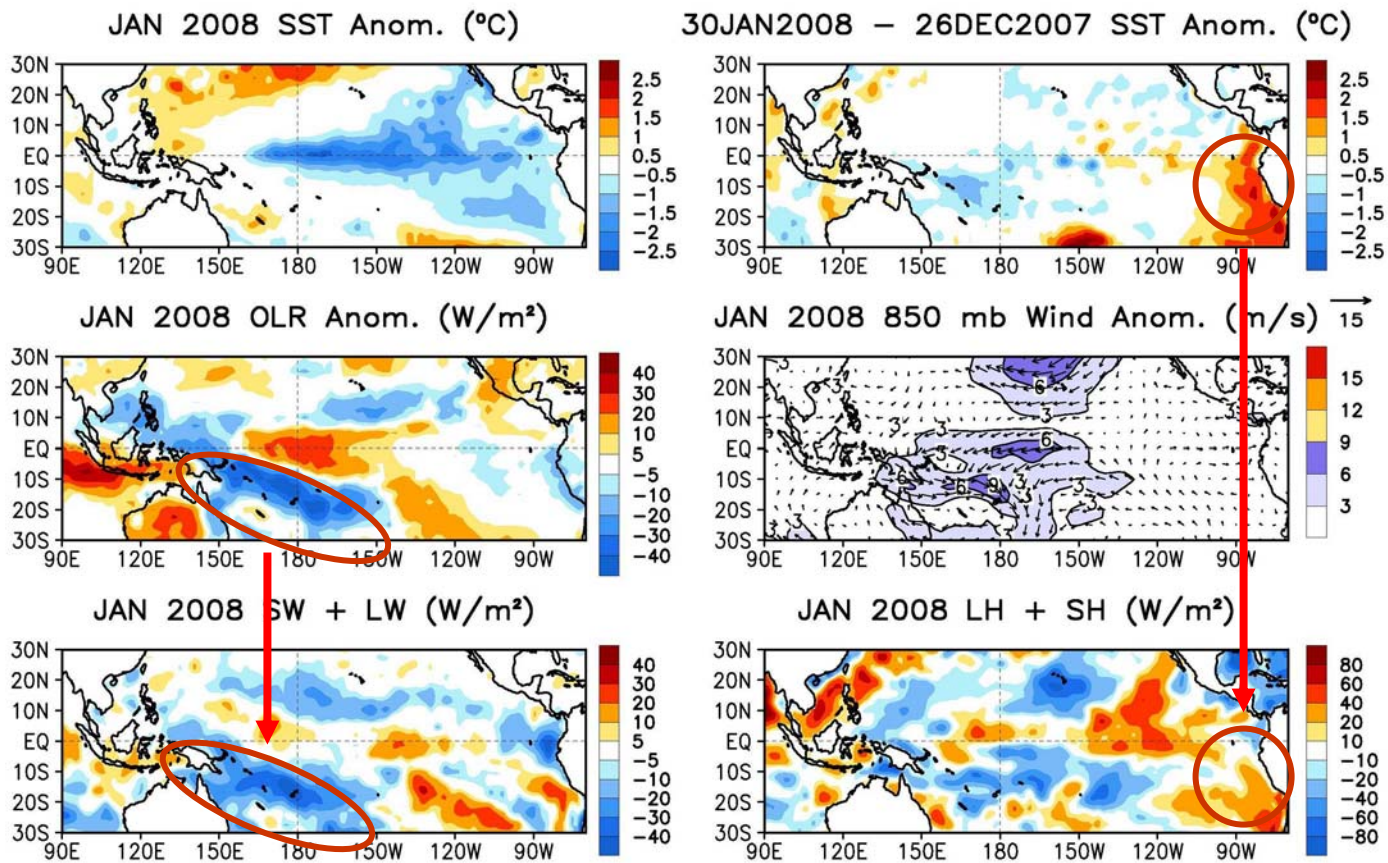
Wetter-than-normal conditions, negative OLR anomalies (blue shading)

Wet conditions were observed across the Maritime continent and western Pacific during early to mid January.

The suppressed phase of the MJO has resulted in dry conditions shifting from the Indian Ocean to Indonesia and northern Australia by late January.

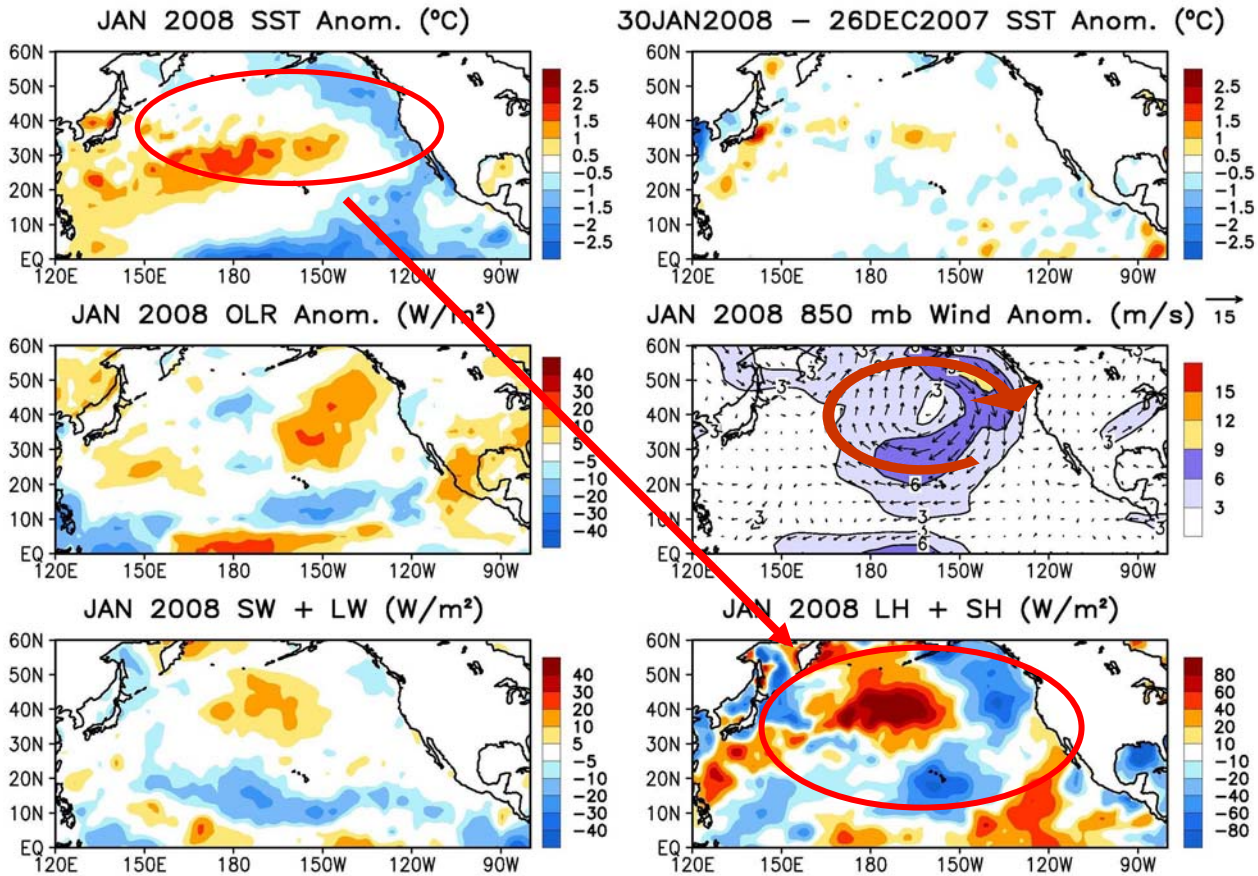
Enhanced convection has redeveloped in the Indian Ocean during late January.

Tropical Pacific: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx



- **Enhanced convection in far western Pacific and SPCZ, suppressed convection in central Pacific**
- **Easterly wind anomalies weakened in the western Pacific,**
- **Westerly wind anomalies east of 140W**

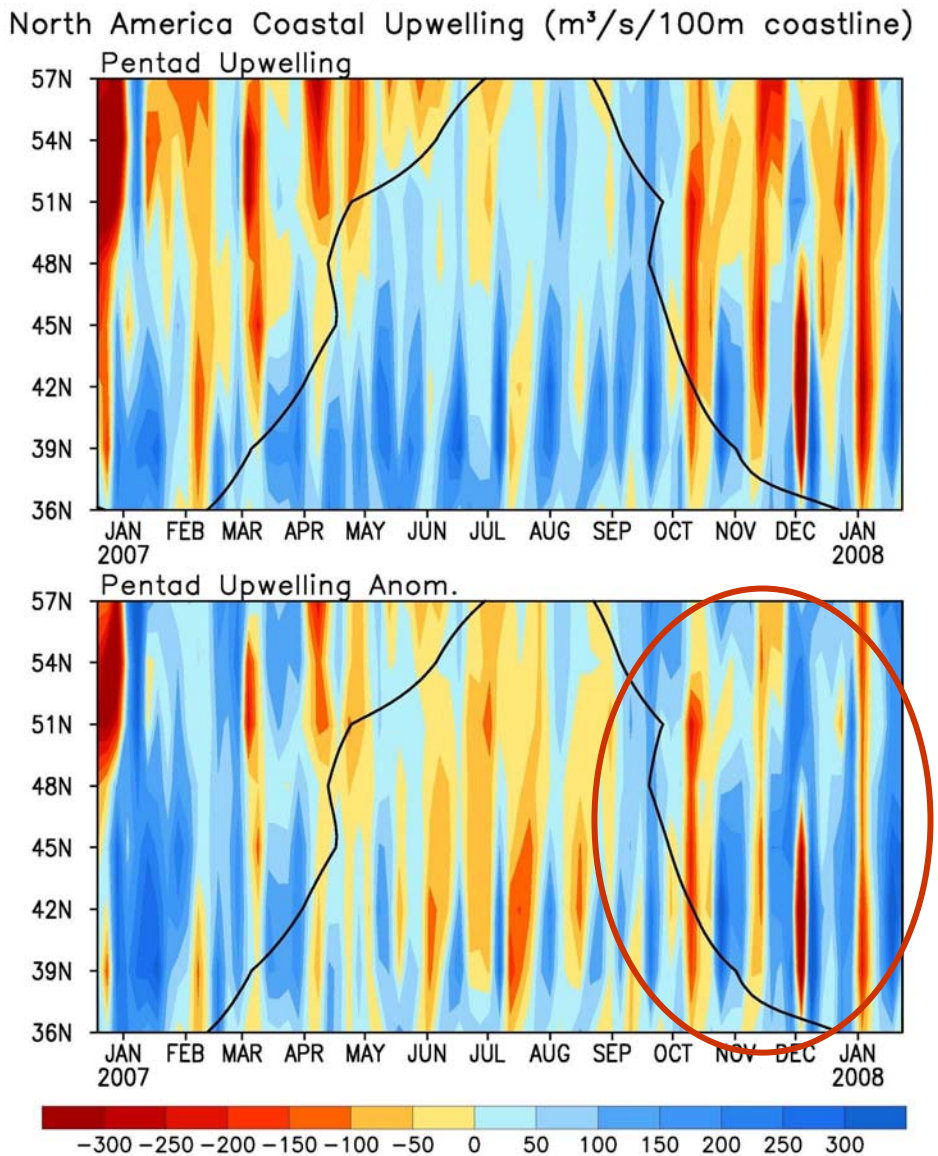
North Pacific: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx

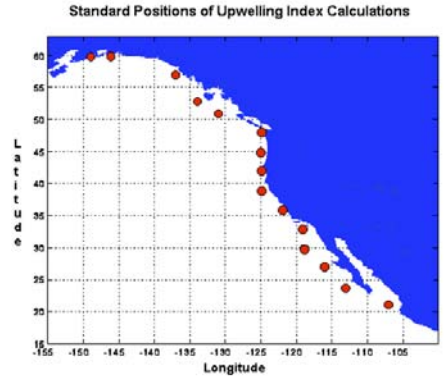


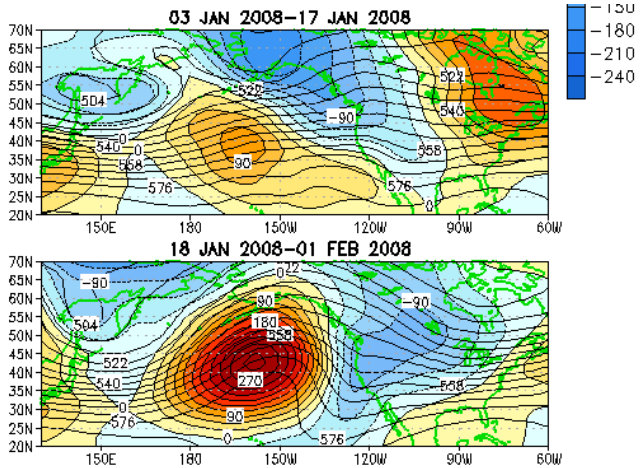
- Cooling near western coast of North America and warming in central North Pacific stronger than those in December.
- Ekman transport / pumping and surface heat fluxes were likely the main external forcing

North America Western Coastal Upwelling

CPC, NCEP





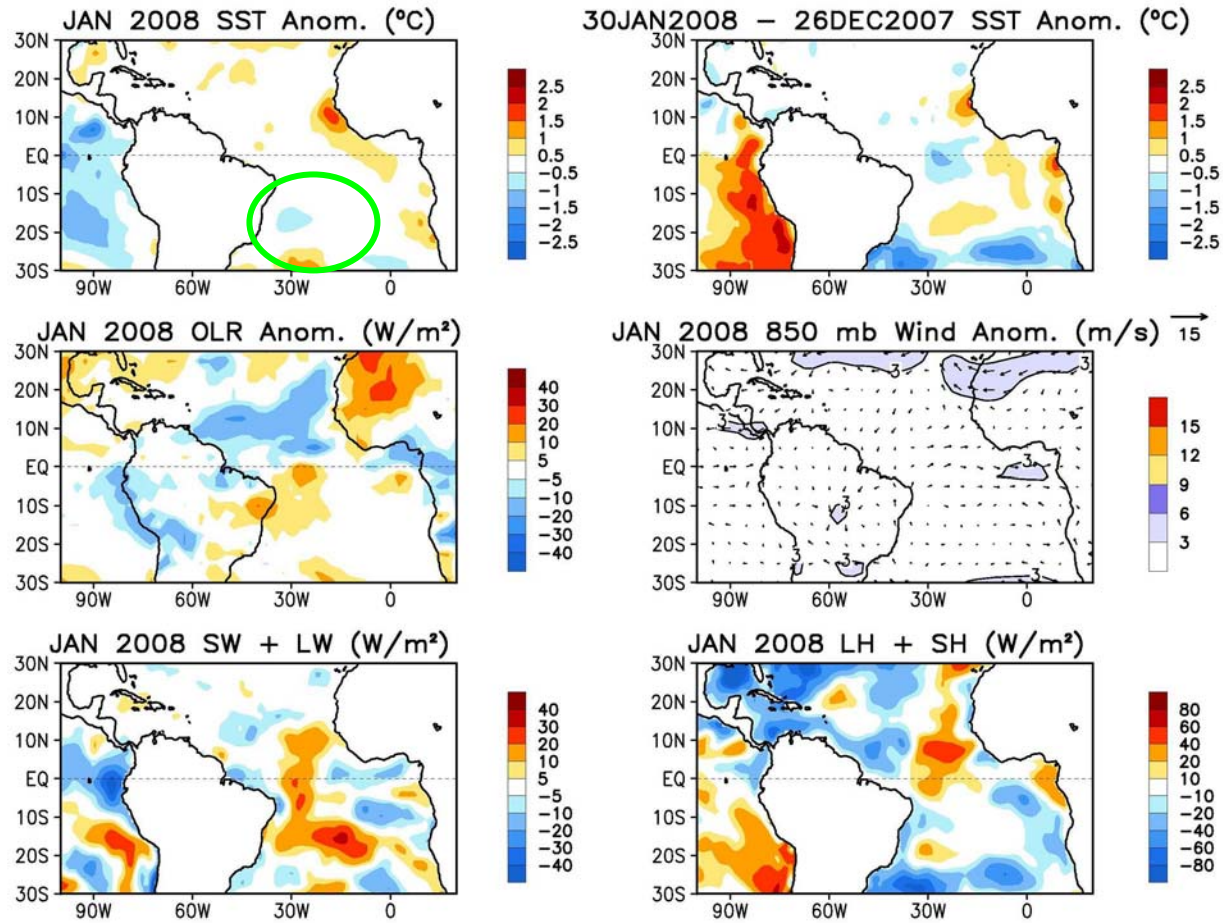


- **Downwelling prevails climatologically since October, but they are interrupted by frequent upwelling events**
- **Upwelling is abnormally strong since September with large intraseasonal variability**
- **Strong blocking in second half of Jan. 2008 lead to above-normal upwelling**

•Climatologically upwelling season progresses from March to July along the west coast of North America from 36°N to 57°N.

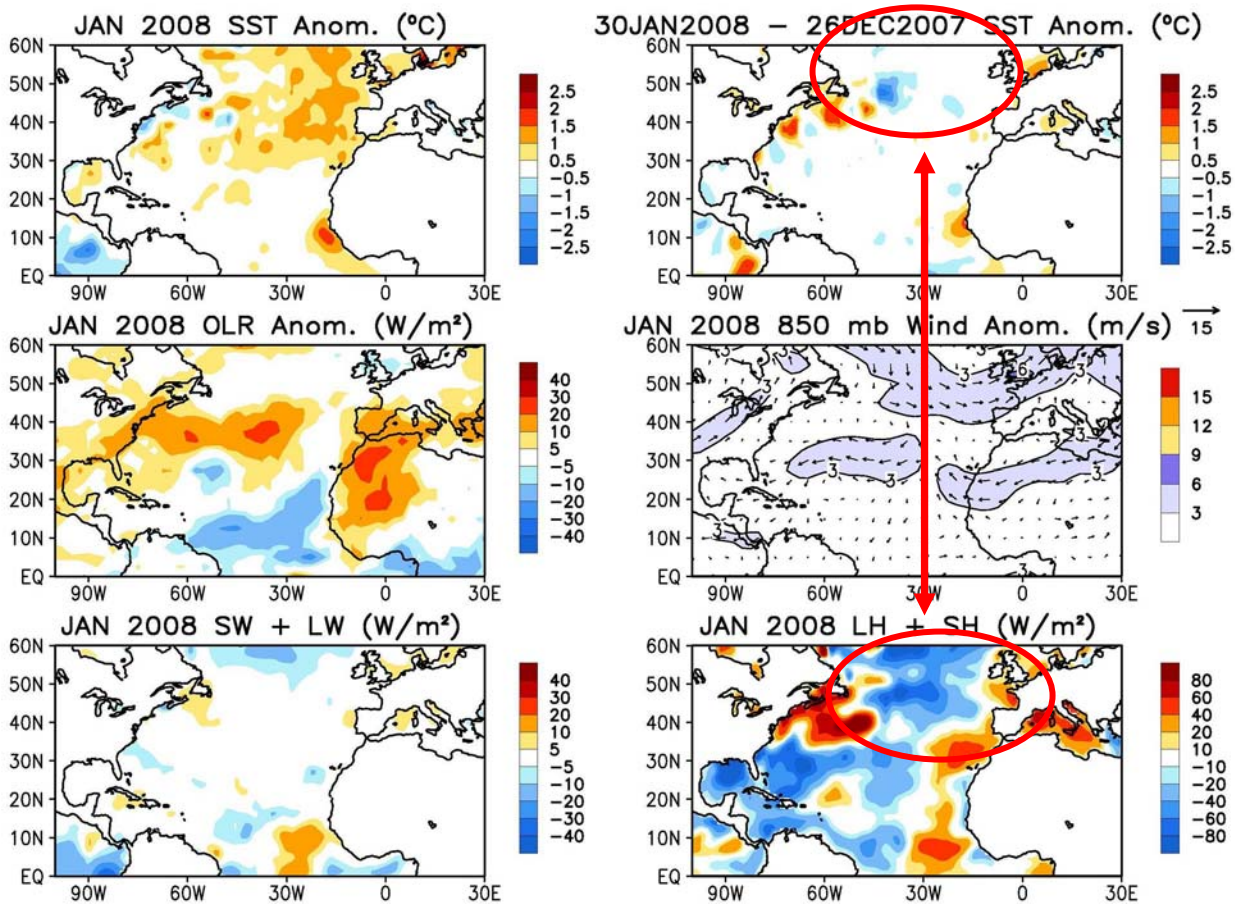
Atlantic Ocean

Tropical Atlantic: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx



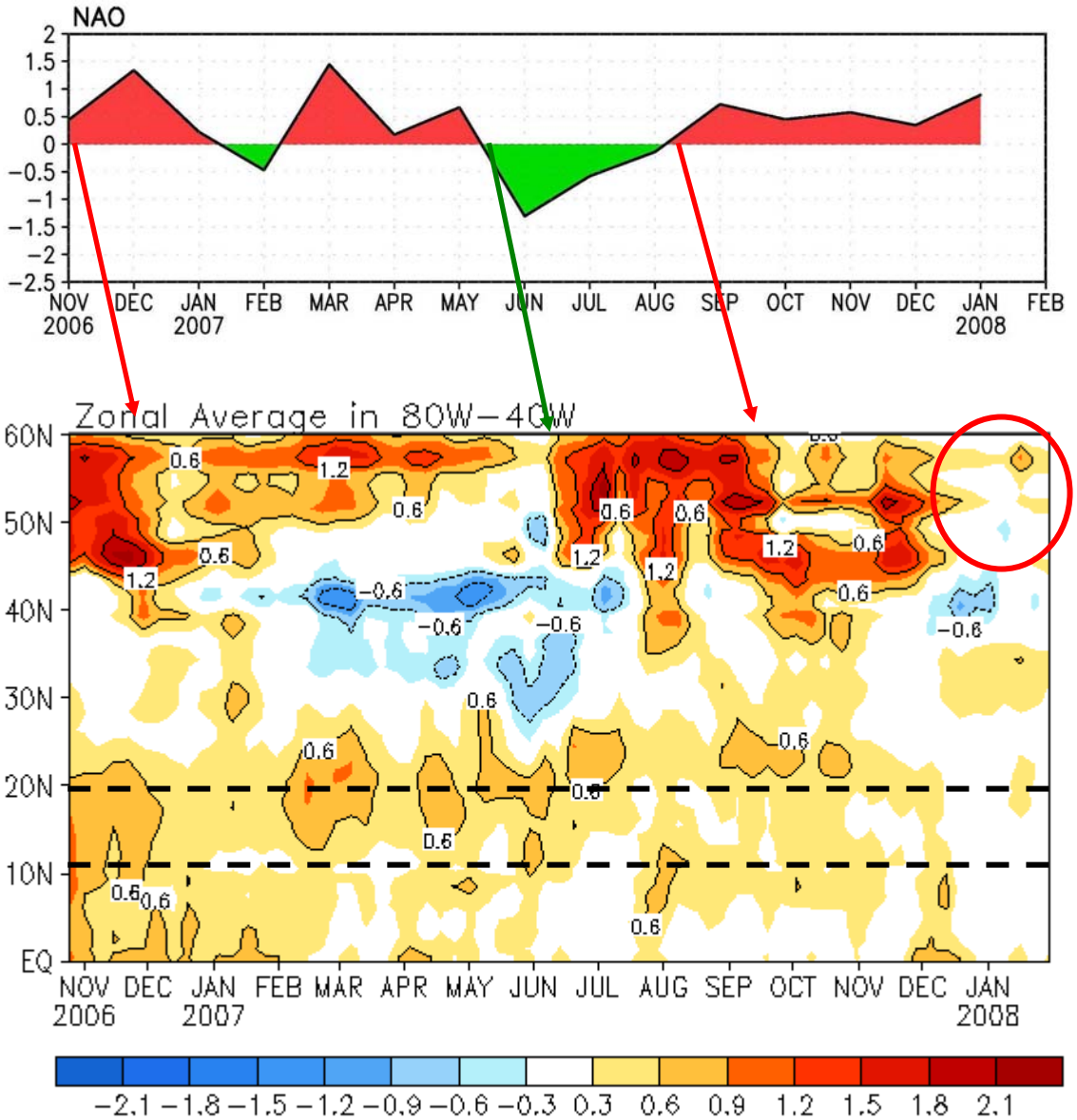
- SST near normal in tropical Atlantic
- Negative SSTA between 10S and 20S weakened, La Nina forced?

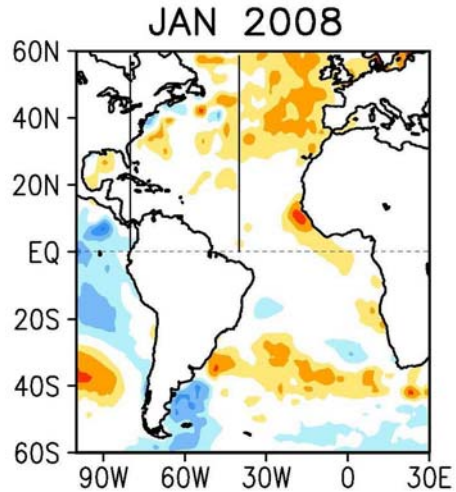
North Atlantic: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx



- **Large positive SST anomalies between 30N and 60N**
- **Negative surface heat flux anomalies contributed to SST cooling**

Attribution of SST Anomaly in Northwest Atlantic

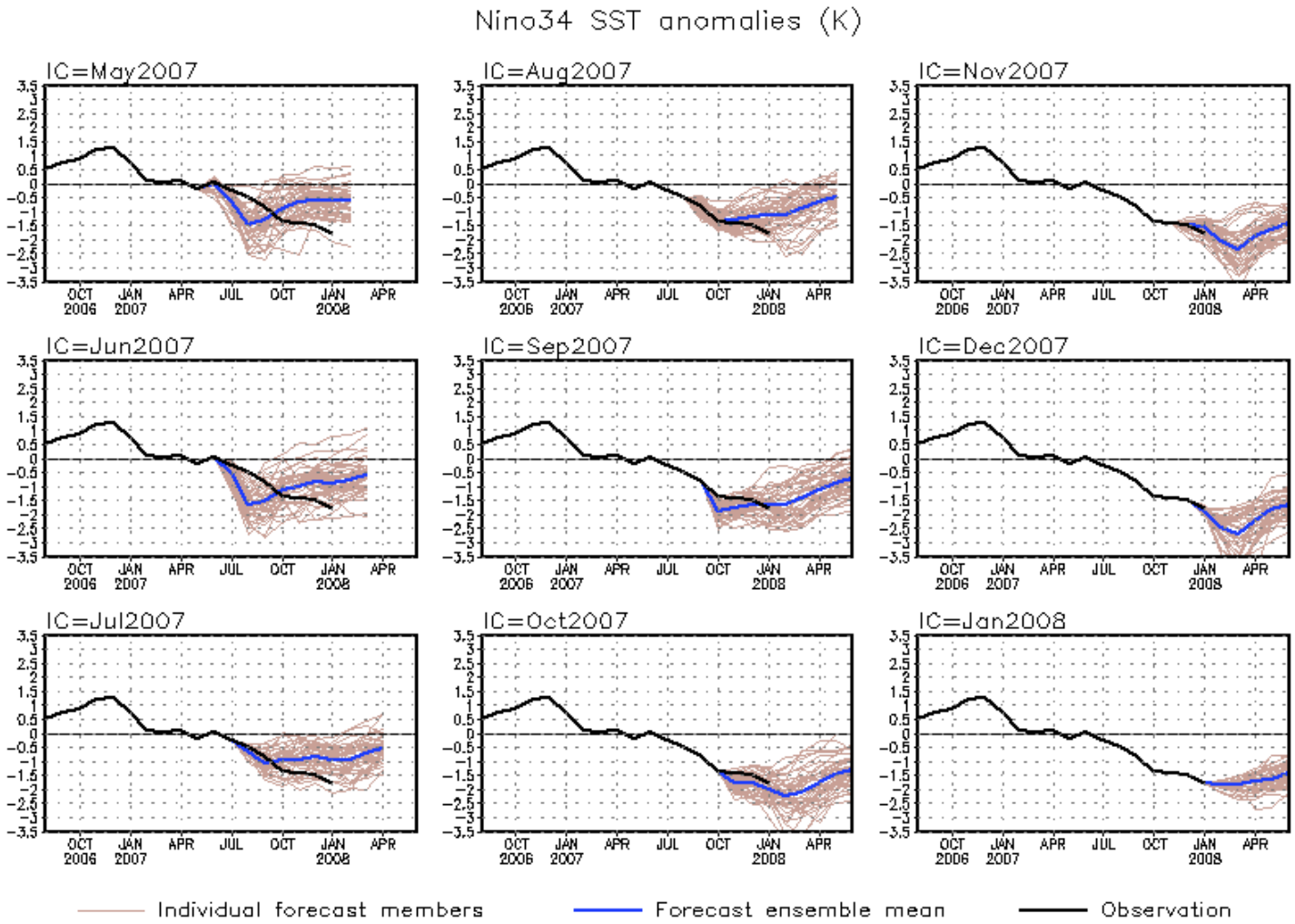




- **NAO index has been positive since September**
- **North Atlantic SST decreased**

CFS SST Predictions and Ocean Initial Conditions

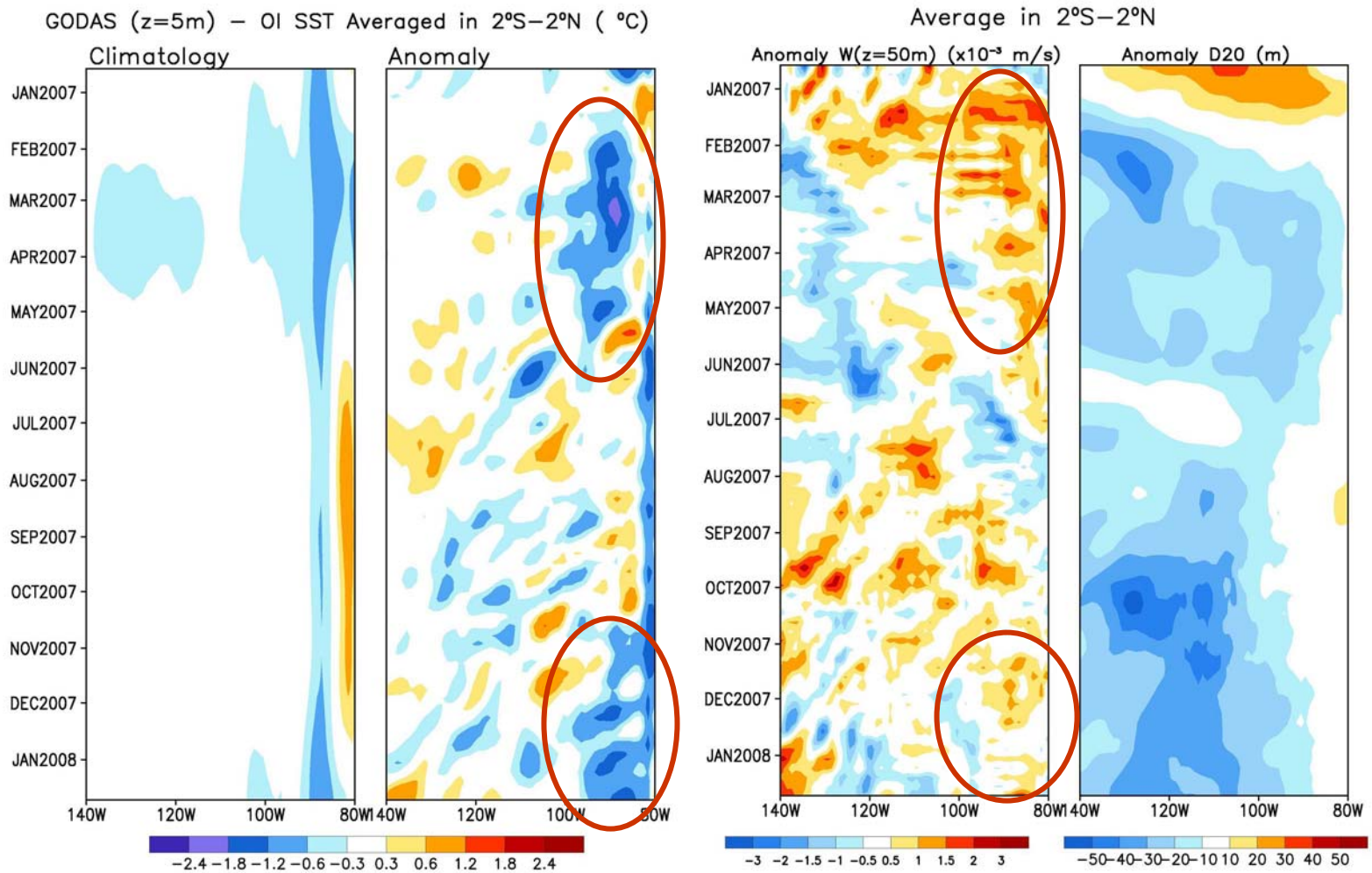
CFS Niño 3.4 SST Predictions from



CFS update to 1-day lag on Jan. 23 2008

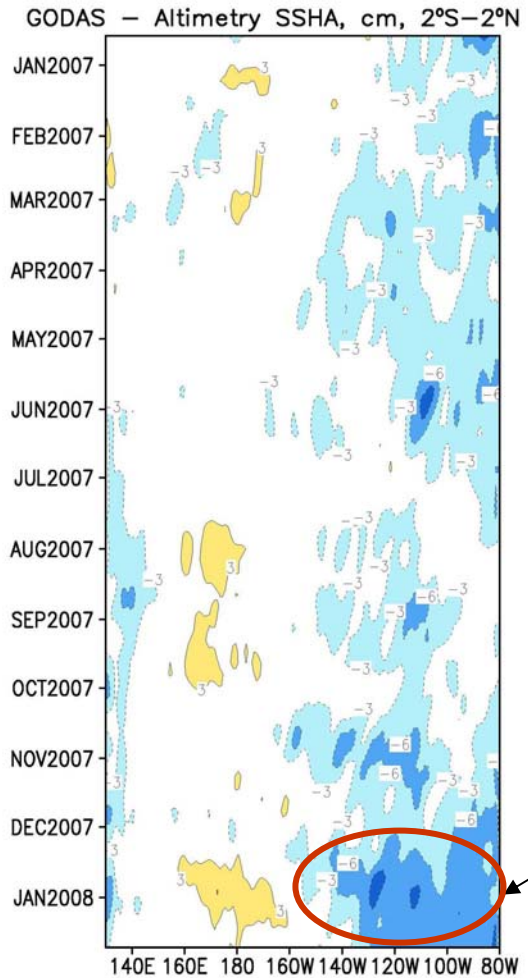
- **Earlier onset of cold SST anomalies in spring**
- **Reasonable SST forecast in July-August**
- **SST forecast biased towards cold in September-October**

Recent Evolution of Equatorial Far Eastern Pacific SST Biases, Vertical Velocity and D20 Anomaly



- **Large negative SST biases east of 100W in spring of 2007, and since November 2007**
- **Might be related to anomalously strong upwelling at 50-meter depth**

Recent Evolution of GODAS Biases: Sea Surface Height



- GODAS SSH anomalies have been consistently too low in the eastern Pacific since December 2006
- GODAS SSH anomalies are about 6cm lower than those Altimetry SSH since December 2007 east of 140W
- What caused the cold biases?

Summary

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  - CPC's prognostic assessment: La Niña will continue into the Spring of 2008
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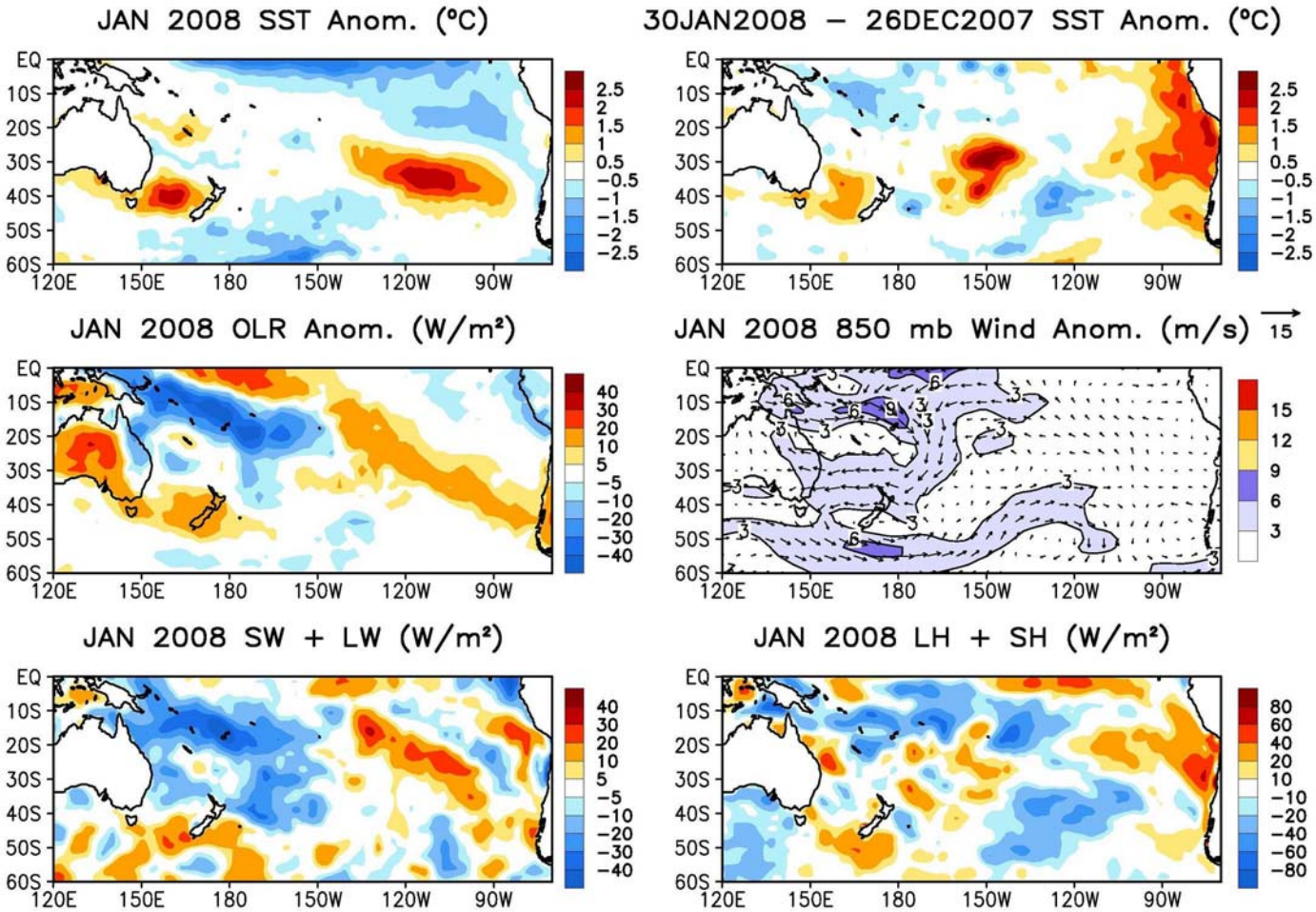
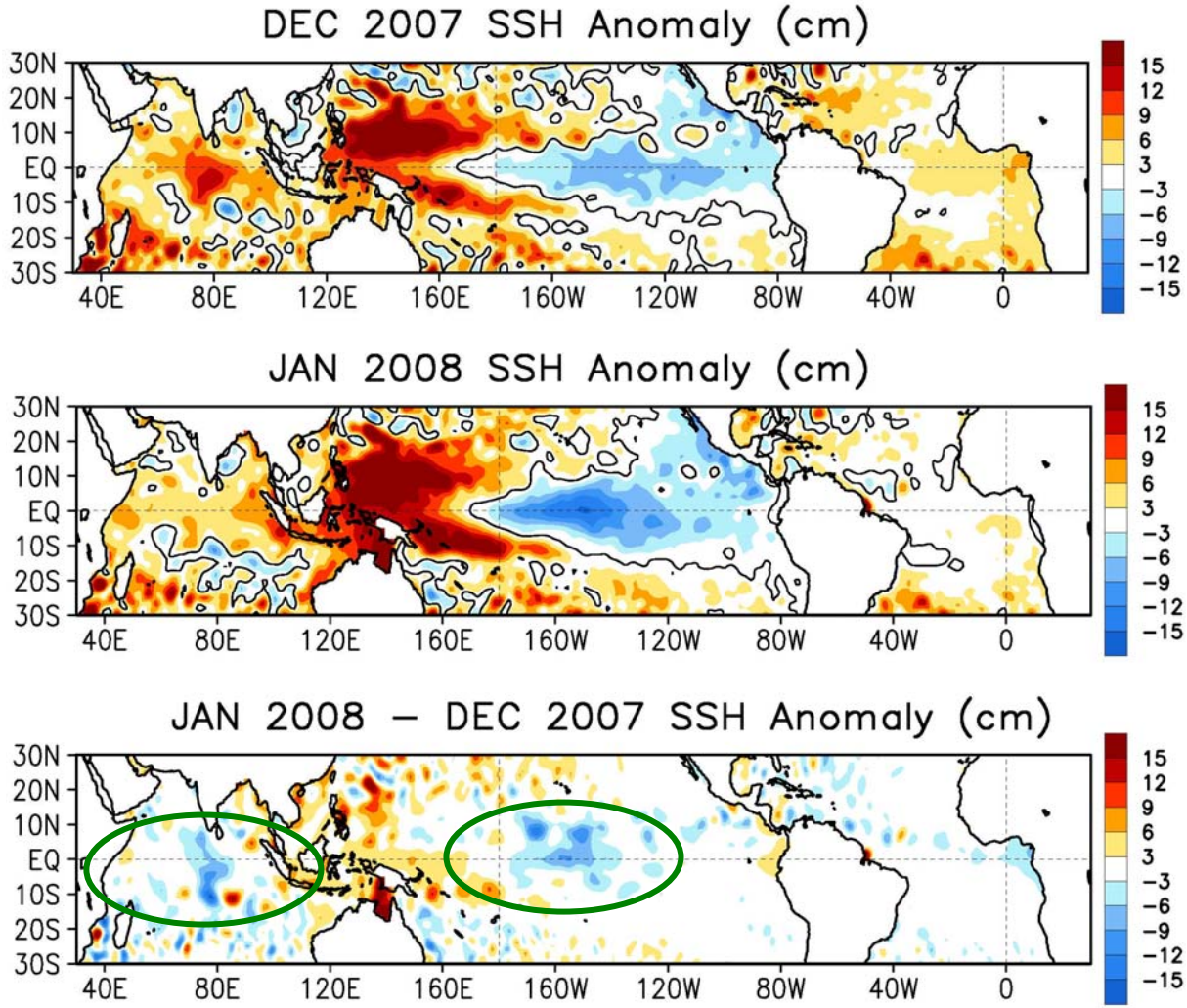
Backup Slides

South Pacific: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx

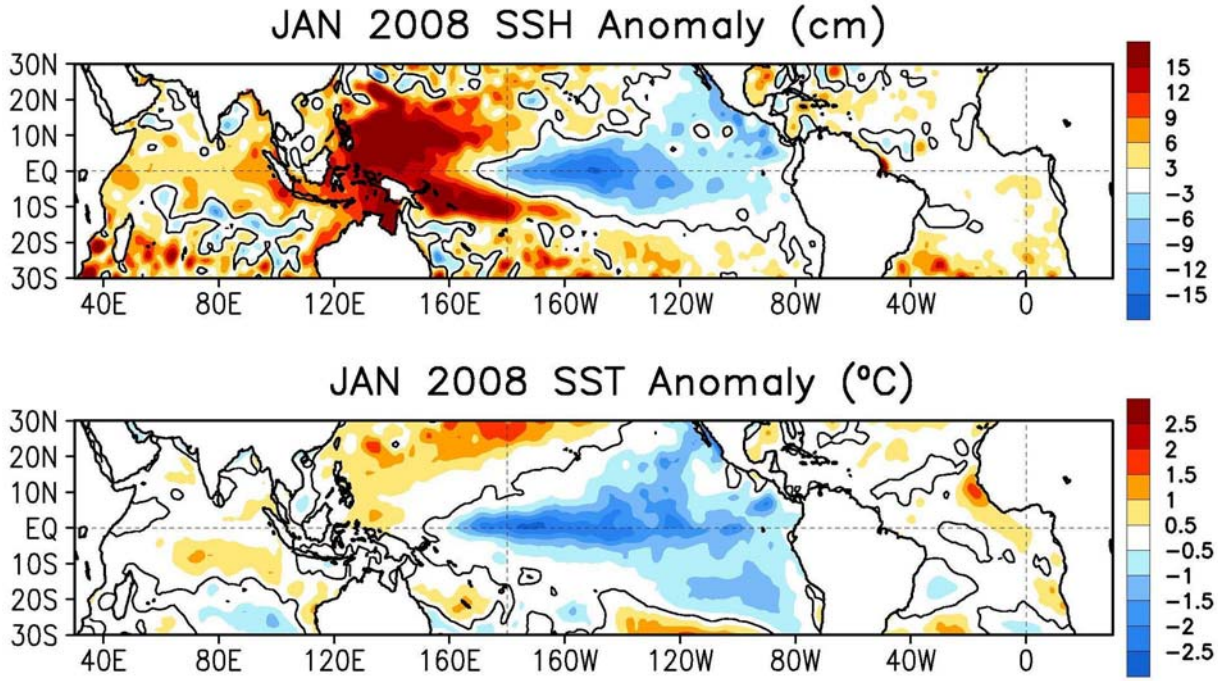


Global SSH Anomaly and Anomaly Tendency



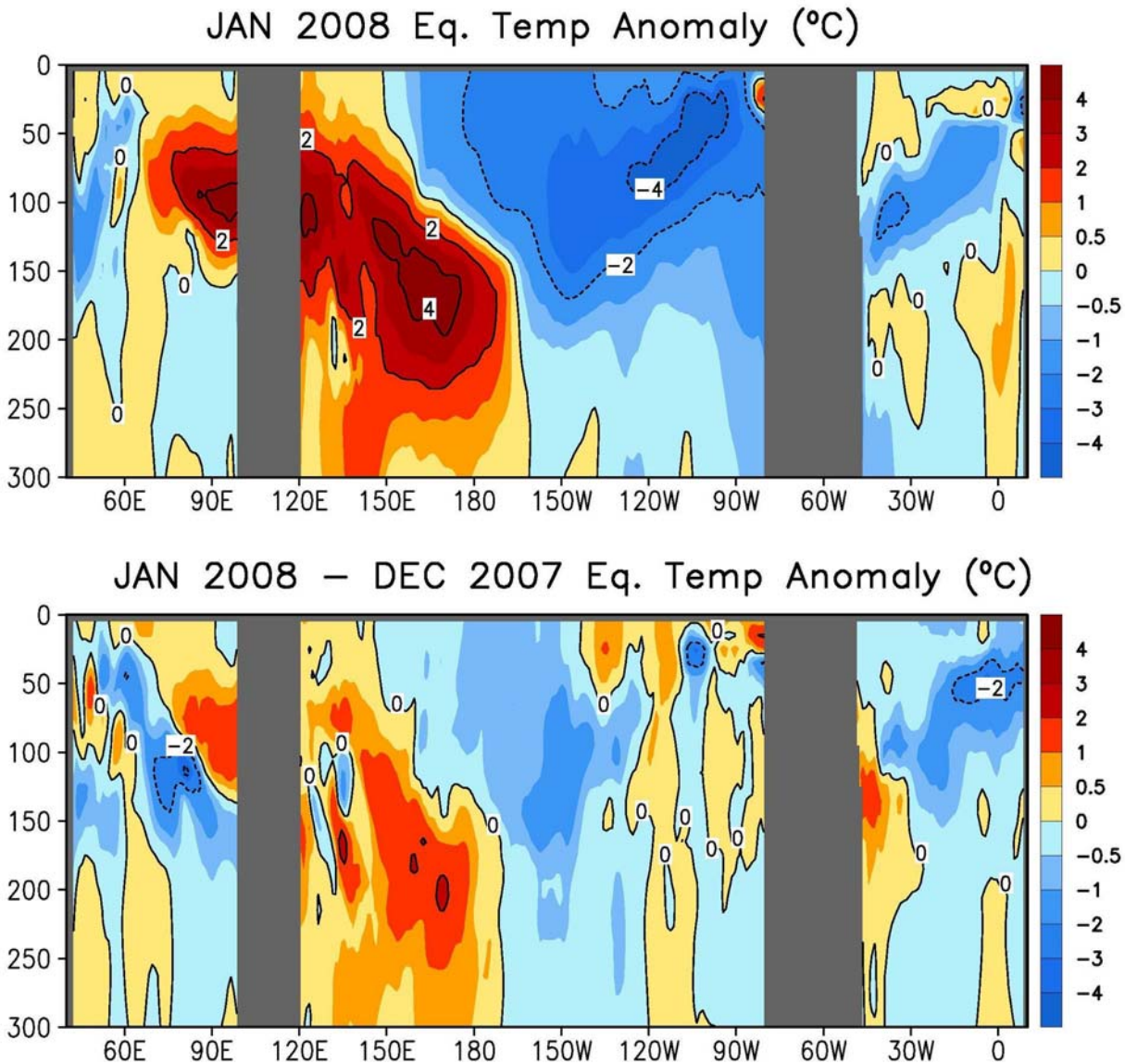
- **SSHA weakened in the far eastern tropical Indian Ocean**

SSH Anomaly (cm) v.s. SST Anomaly (^{0}C)

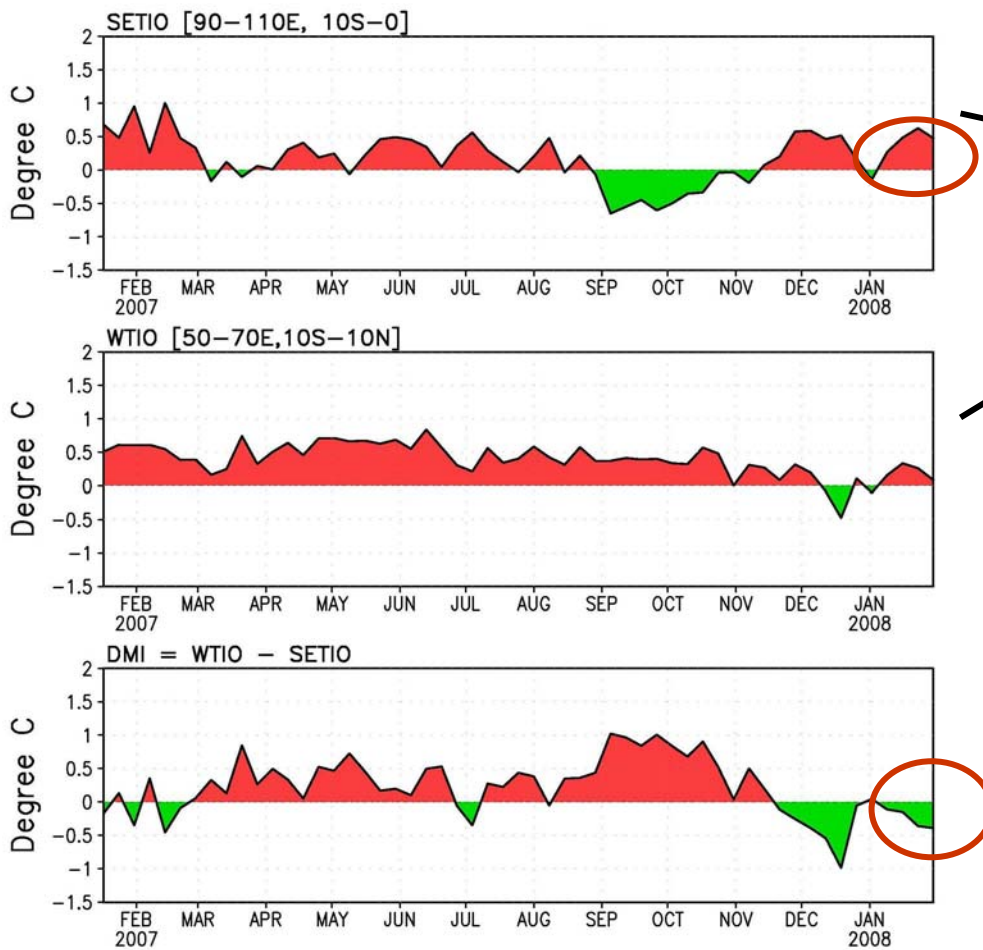


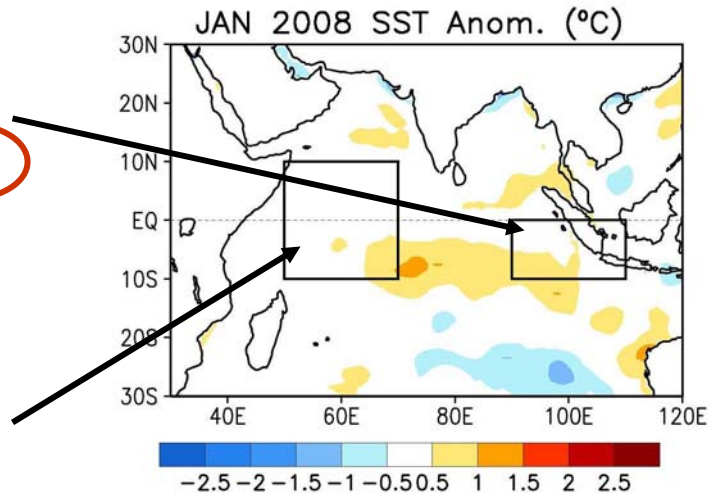
- **Good consistency between SSH and SST in the equatorial latitudes**

GODAS Equatorial X-Z Temperature



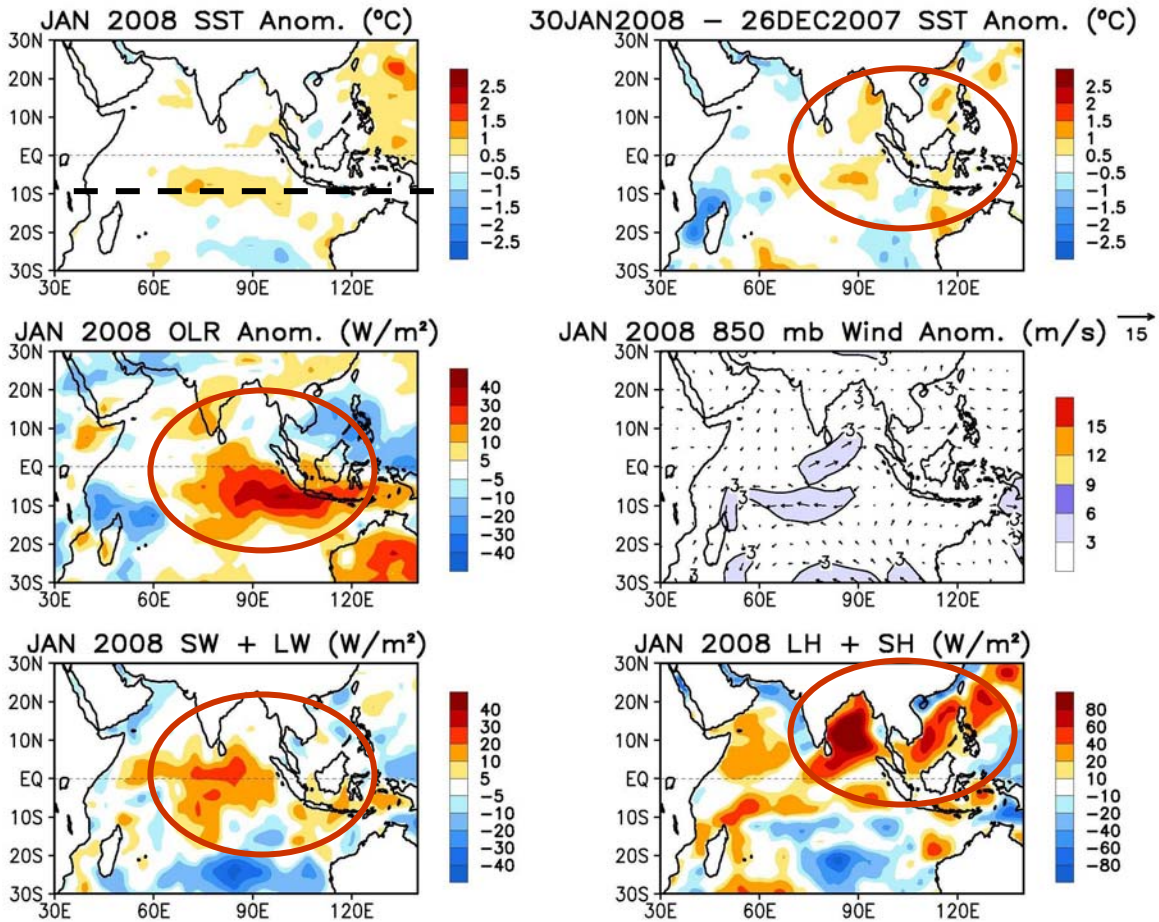
Recent Evolution of Indian Ocean SST Indices





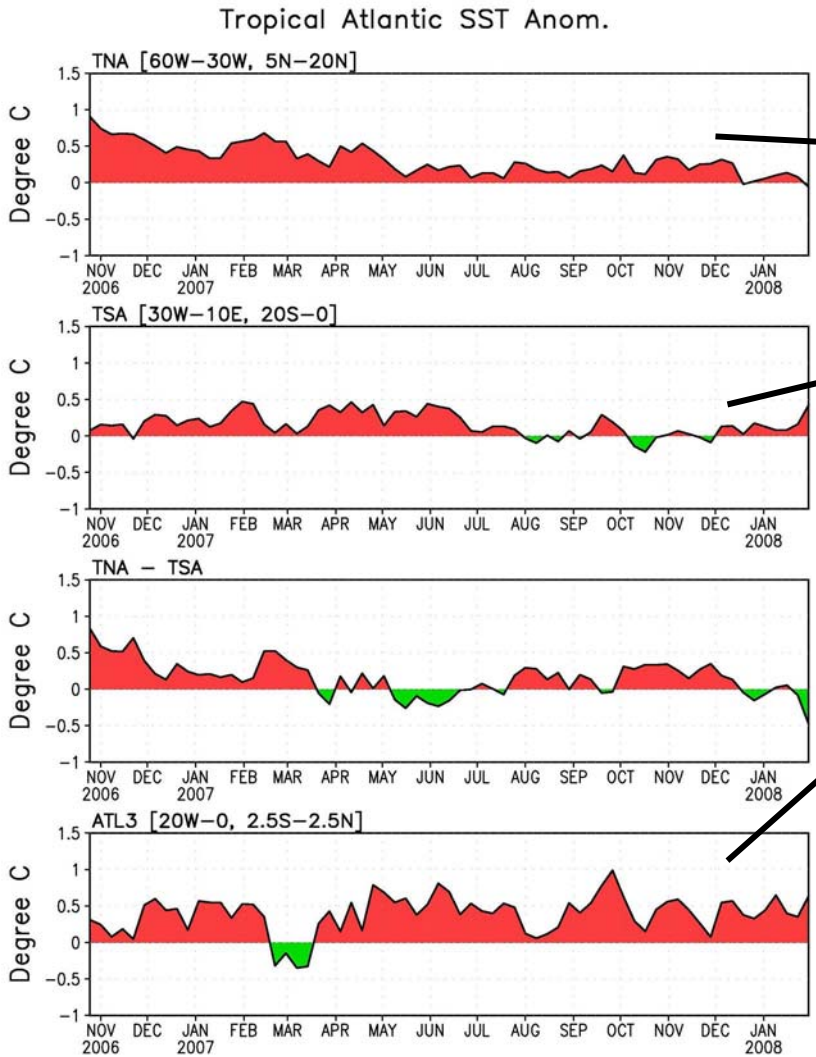
- SST are near normal in Indian Ocean
- IO Dipole Mode Index (DMI) is near normal

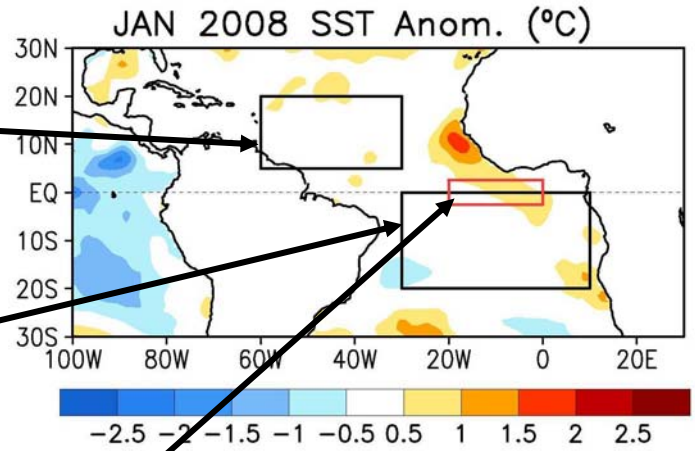
Tropical Indian: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx



- **Below normal rainfall over most of Indian ocean due to influences of MJO**
- **Above normal surface heat flux, warming up the SST**

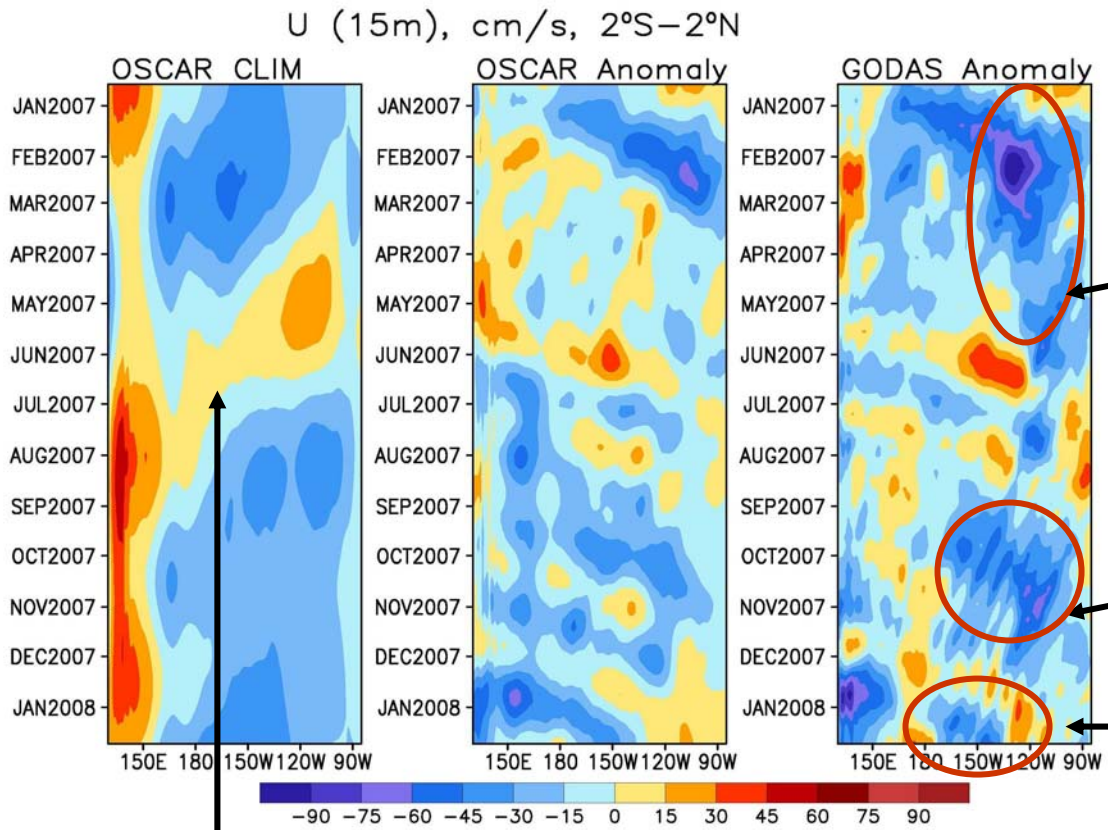
Recent Evolution of Tropical Atlantic SST Indices





All indices are near normal in January 2008

Recent Evolution of GODAS Biases: Equatorial Surface (15 m) Zonal Current



Too strong westward currents

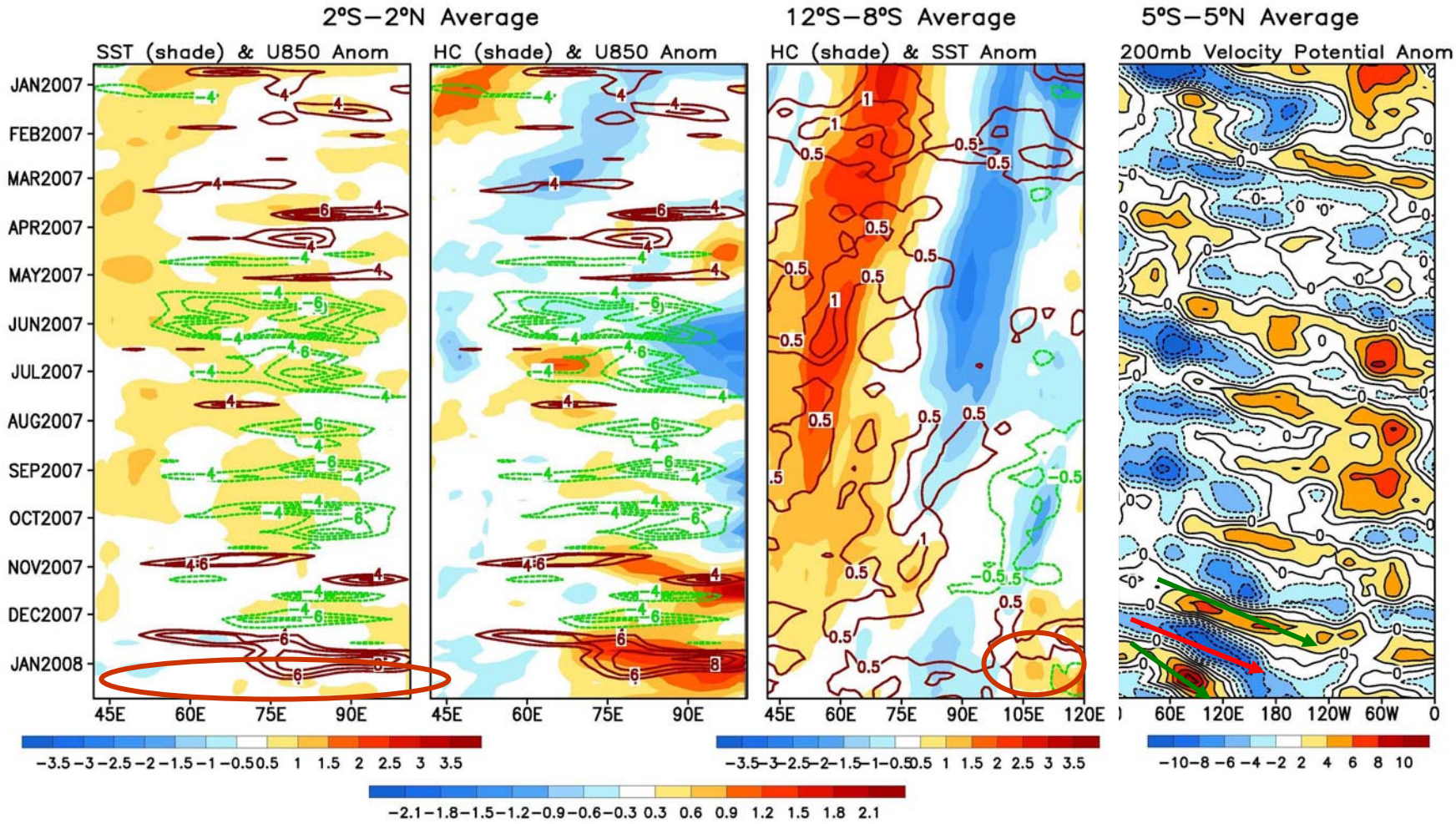
Too strong westward currents

Westward currents

Climatological surface currents are westward since July

Indian Ocean

Evolution of Equatorial/10°S Indian SST (°C), 850-mb Zonal Wind (m/s), 0-300m Heat Content (°C)



- **Moderate MJO activities**
- **Strong westerly wind anomaly in December dissipated in early January**
- **Forced positive HC anomalies in the eastern equatorial Indian Ocean**