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

Prepared by

Climate Prediction Center, NCEP

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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

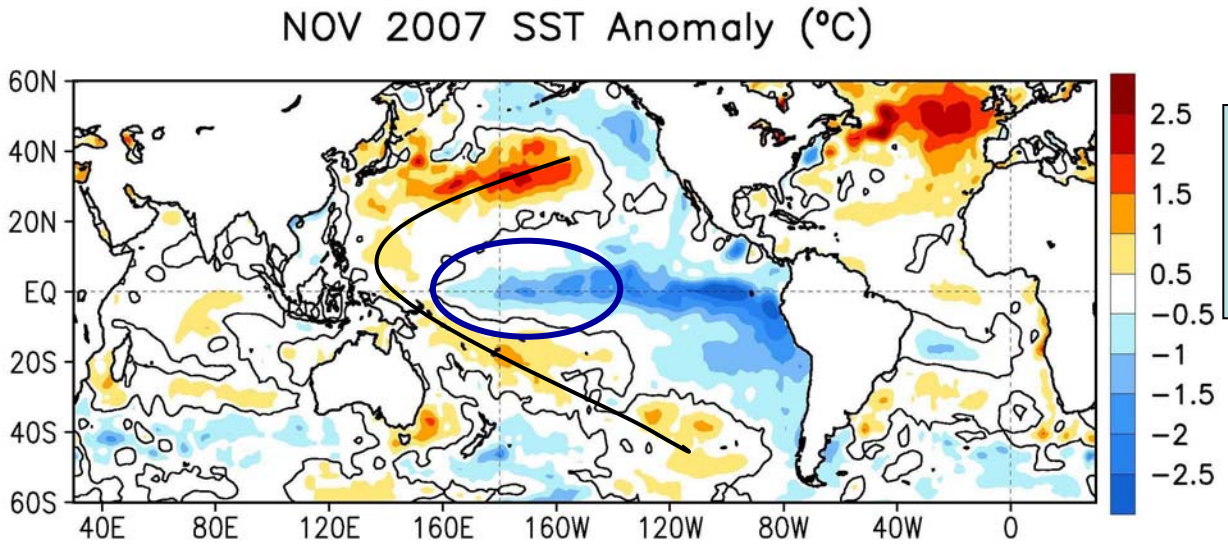
Overview

- **Pacific Ocean**
  - Negative SST anomalies intensified near 100W and extended westward to 160E.
  - CPC's prognostic assessment: La Niña reached a moderate strength (ONI < -1 degree) in SON and will continue throughout the Spring of 2008
  - Moderate MJO activity presented in the indo-Pacific region and contributed to the enhanced convection in the far western Pacific and near Philippe Sea
  - Strong MJO-related westerly wind anomalies are expected to generate downwelling Kevin waves and possibly damp the growth of La Nina SSTA
  - Large SST changes in the extra-tropical North Pacific

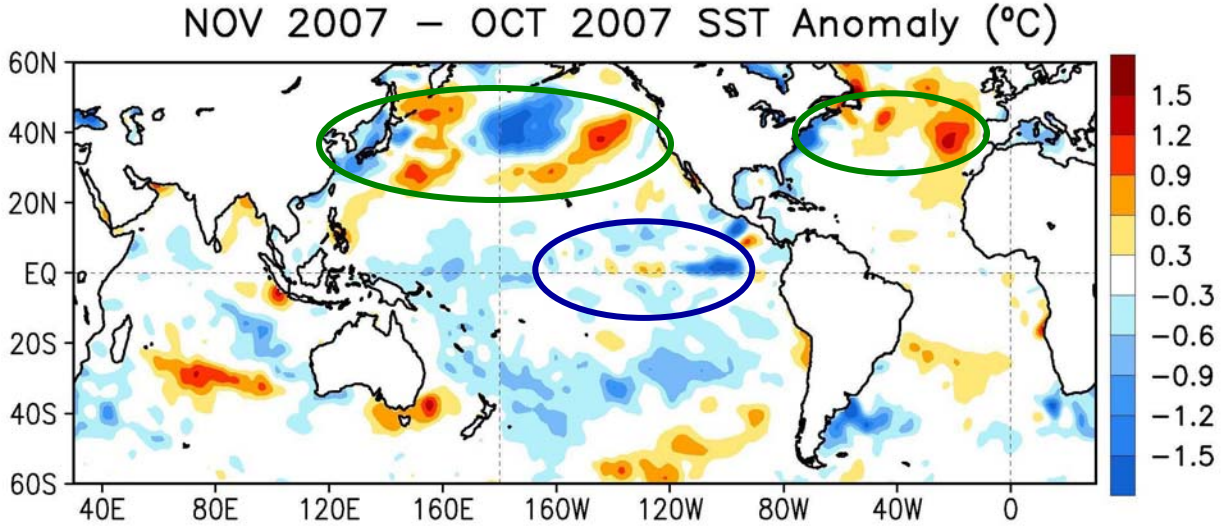
- **Indian Ocean**
  - Near normal SST conditions prevailed in the tropical Indian
  - IOD index became normal
  - MJO-related westerly wind anomalies increased SSH dramatically in the far eastern tropical Indian Ocean

- **Atlantic Ocean**
  - Near normal SST conditions prevailed in the tropical Atlantic
  - Anti-cyclonic wind and precipitation anomalies in the extra-tropical North Atlantic

Global SST Anomaly (⁰C) and Anomaly Tendency

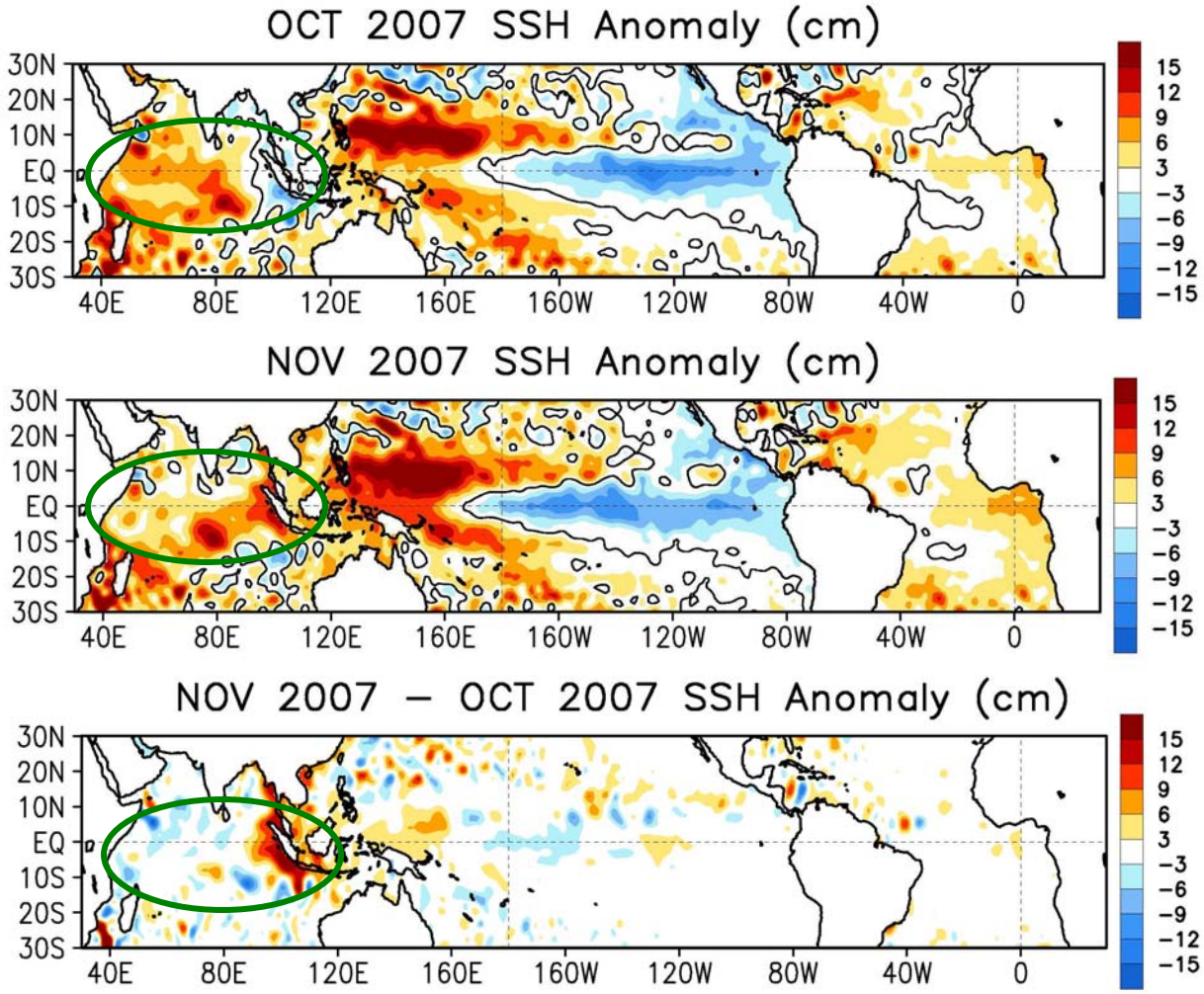


- **Negative SSTA east of date line… a canonical horseshoe pattern in the Pacific**
- **Normal SST in Indian Ocean**
- **Normal SST in tropical Atlantic**



- **Negative SSTA intensified near 100W and extended to 160E**
- **Large SST changes in the NH extra-tropics**
- **Negative SSTA near Java coast disappeared**

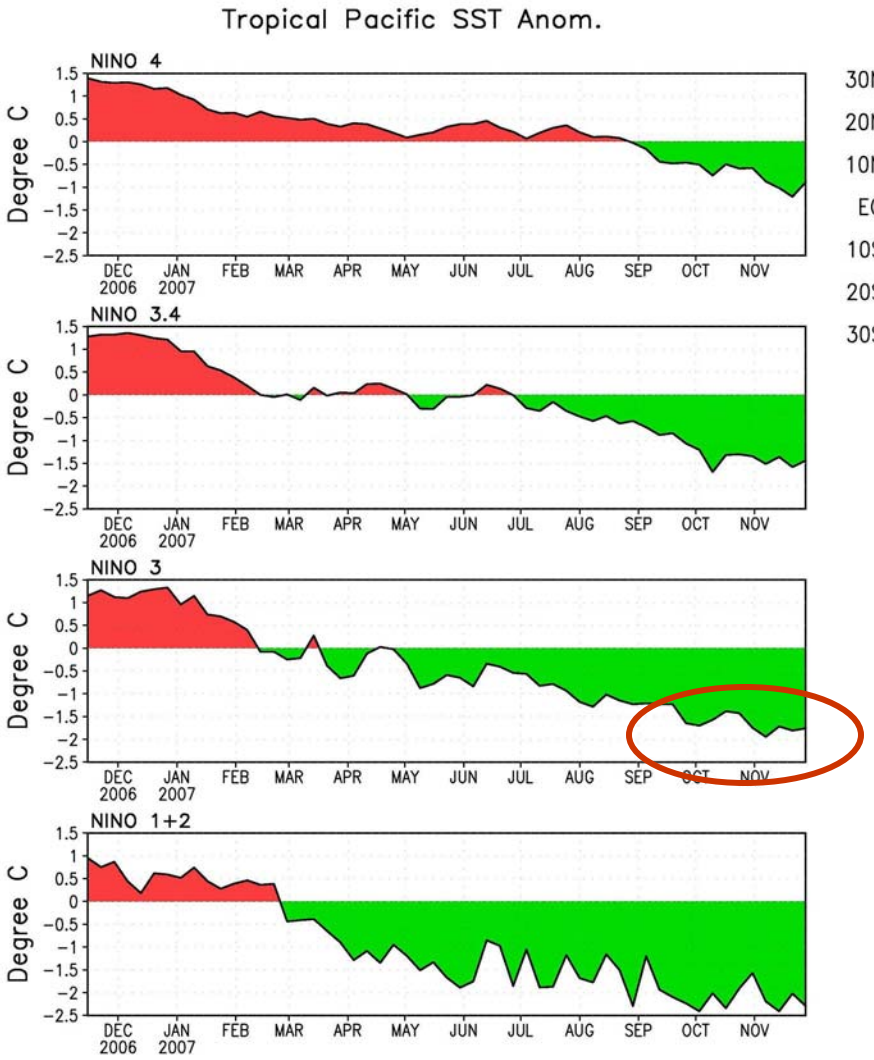
Global SSH Anomaly and Anomaly Tendency

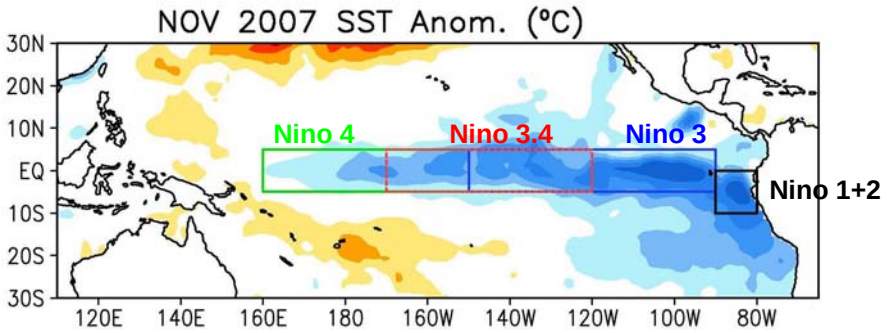


- **SSH increased dramatically in the far eastern tropical Indian Ocean in November due to MJO-related westerly wind anomalies**

Pacific Ocean

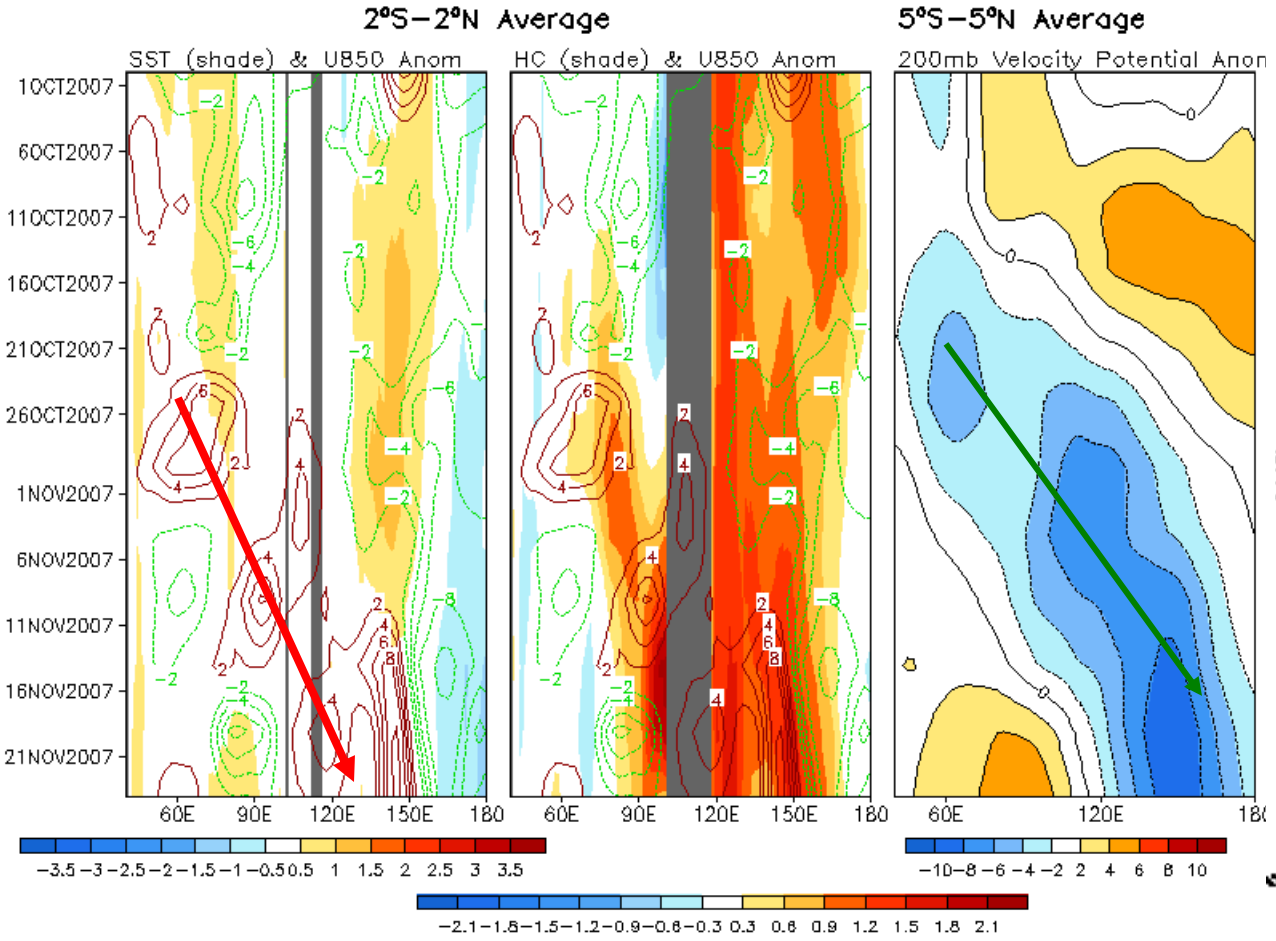
Recent Evolution of Pacific NINO SST Indices



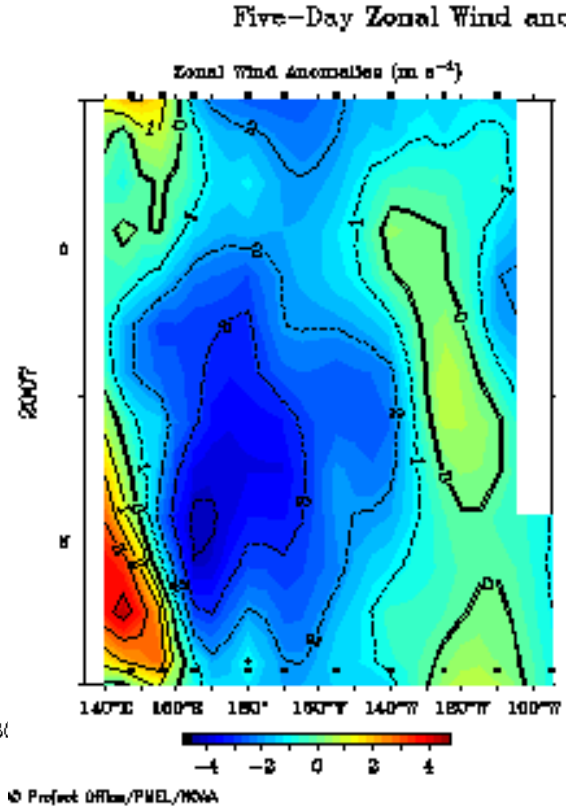


- **NINO4 SST intensified, but other NINO indices persisted**
- **CPC's ENSO Prognostic Statement: SON ONI -1.1C, meeting NOAA moderate La Nina definition. The La Nina is to continue**

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



TAO winds

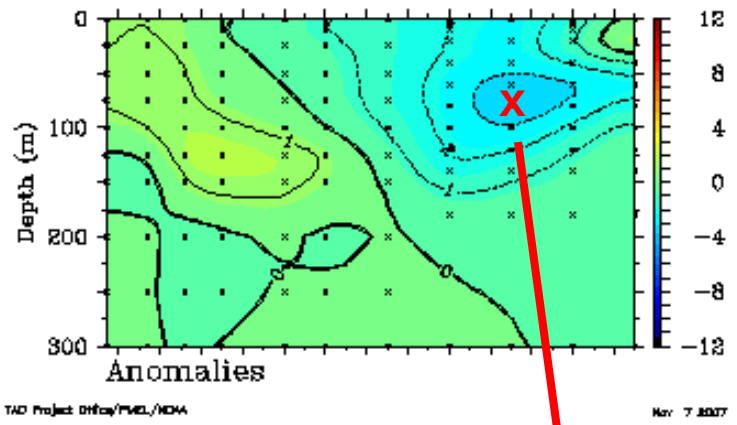


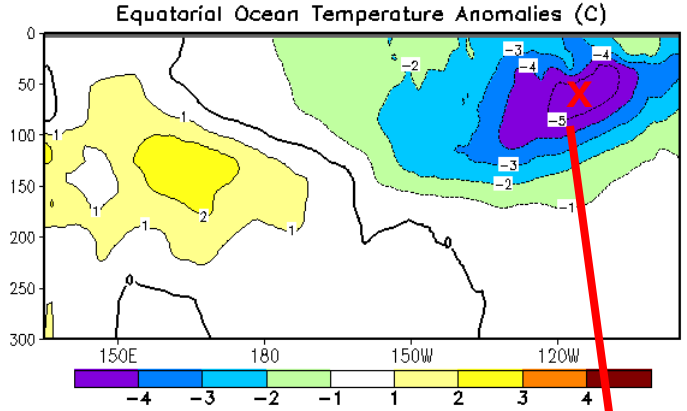
- CPC's MJO prognostic statement: Moderate MJO activity presented since late October
- MJO-related westerly wind anomalies propagated from western Indian to western Pacific Ocean, meeting easterly wind anomalies associated with La Nina near 150E
- Potential impacts of MJO on La Nina development need to be monitored closely
- How does CFS forecast response to the MJO-related westerlies in the past two weeks?

Depth-Longitude Section of Temperature Anomaly

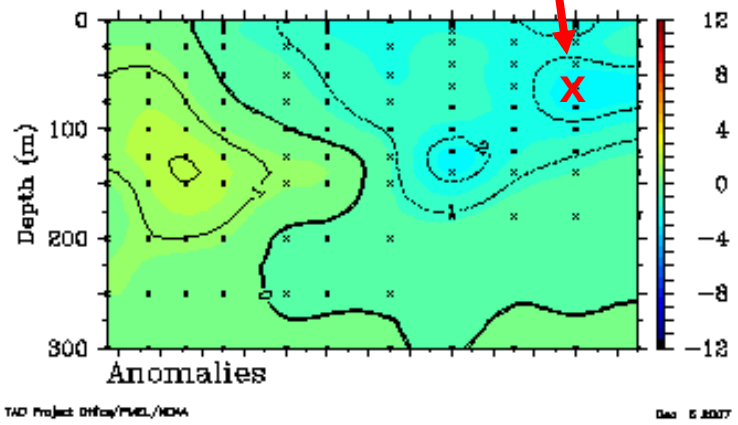
TAO | **GODAS**

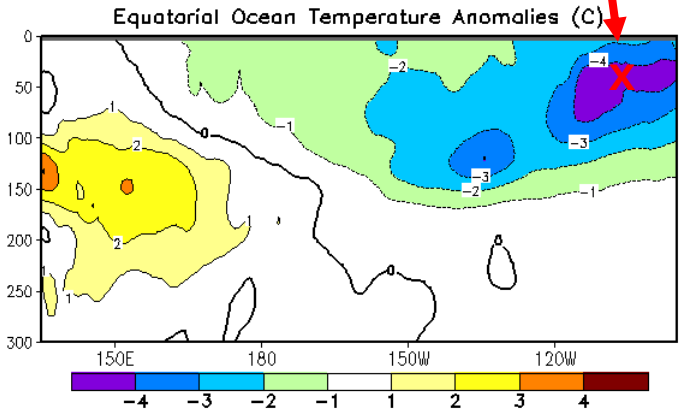
October





November

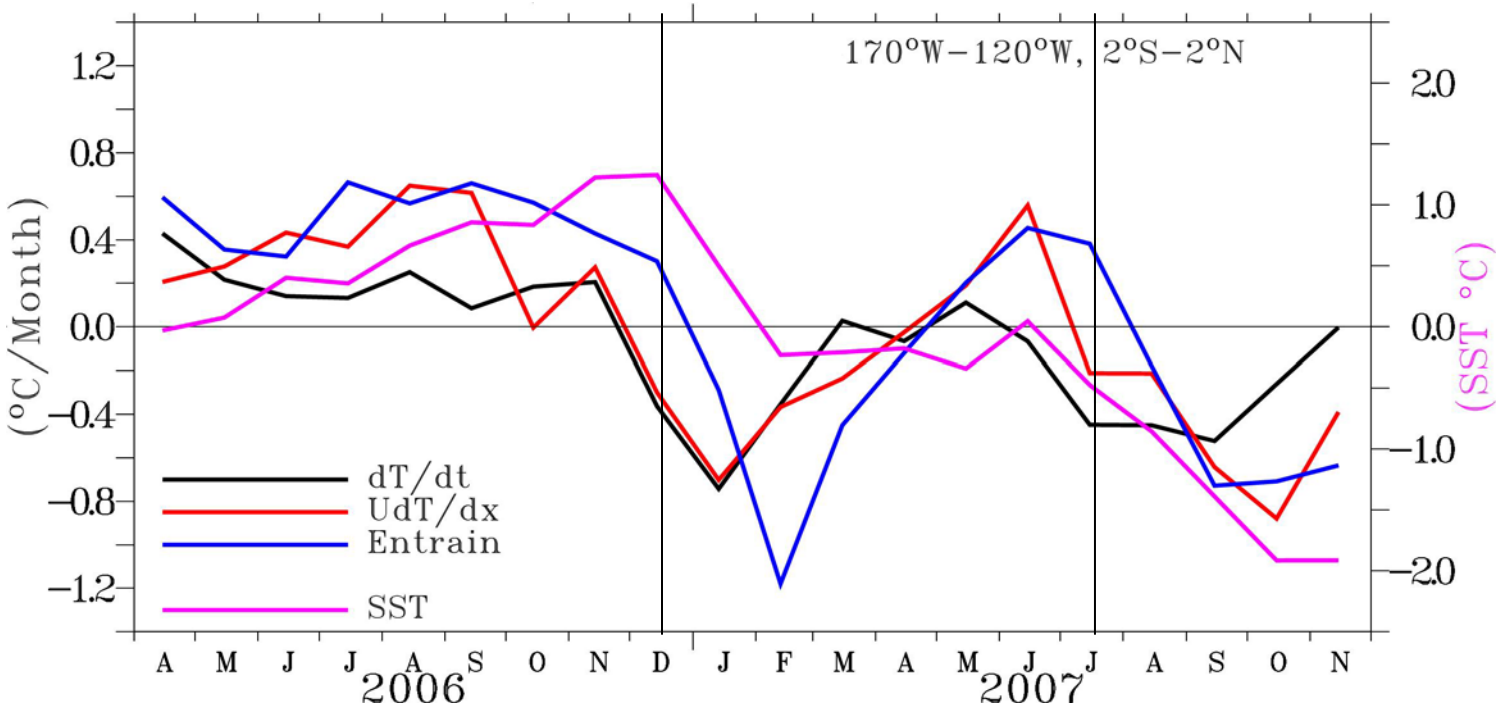




- East-west dipole pattern of temperature anomalies featuring La Nina conditions
- Temperature anomalies in GODAS are stronger than those of TAO, partially caused by diff. climatology base period
- Temperature anomaly differences are largest near thermocline in the far eastern Pacific
- Thermocline temperature anomalies moved eastward and were weaker than those in October

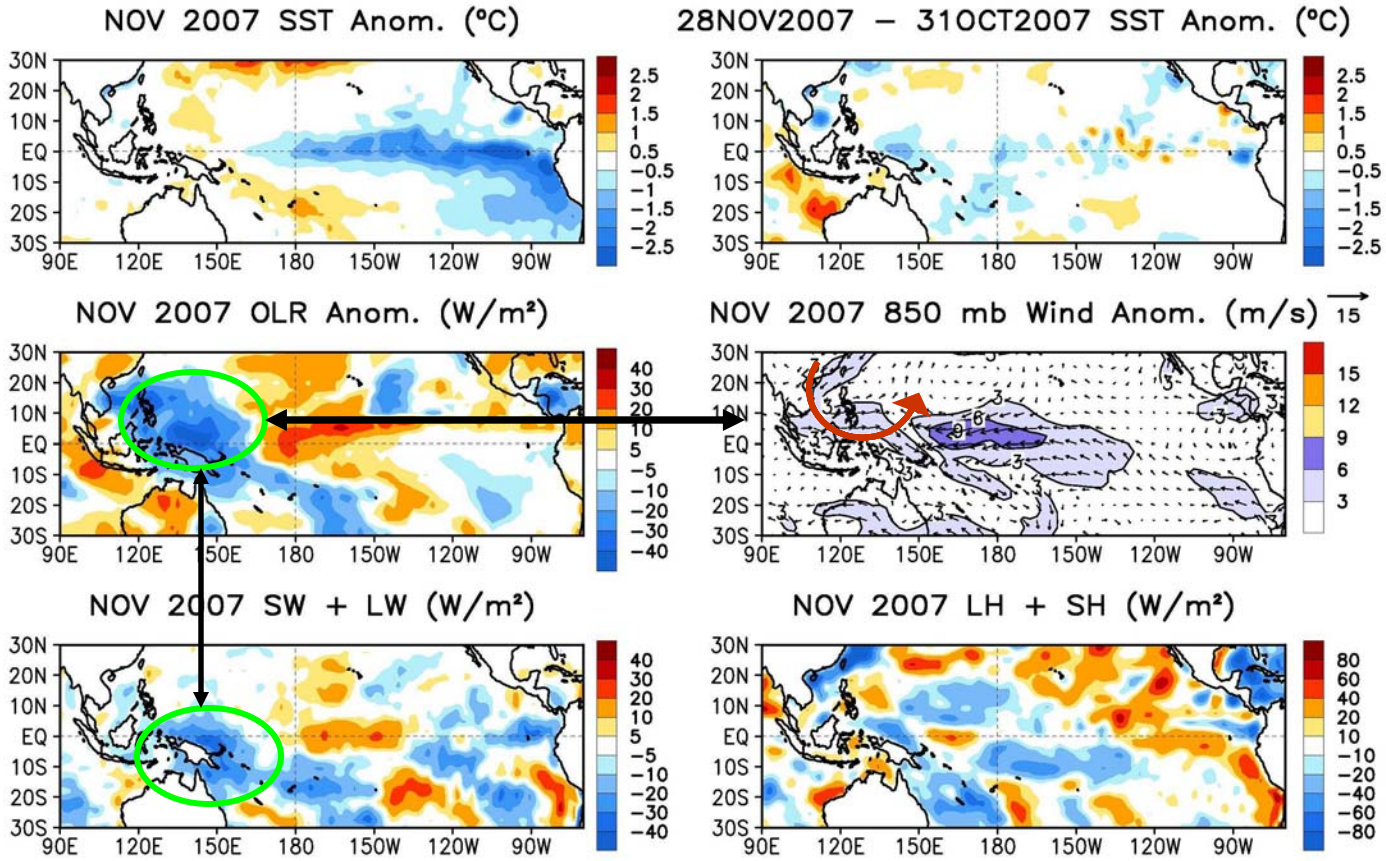
Recent Evolution of Heat Budget in NINO3.4 SST Anomaly

Courtesy of Dr. Dongxiao Zhang



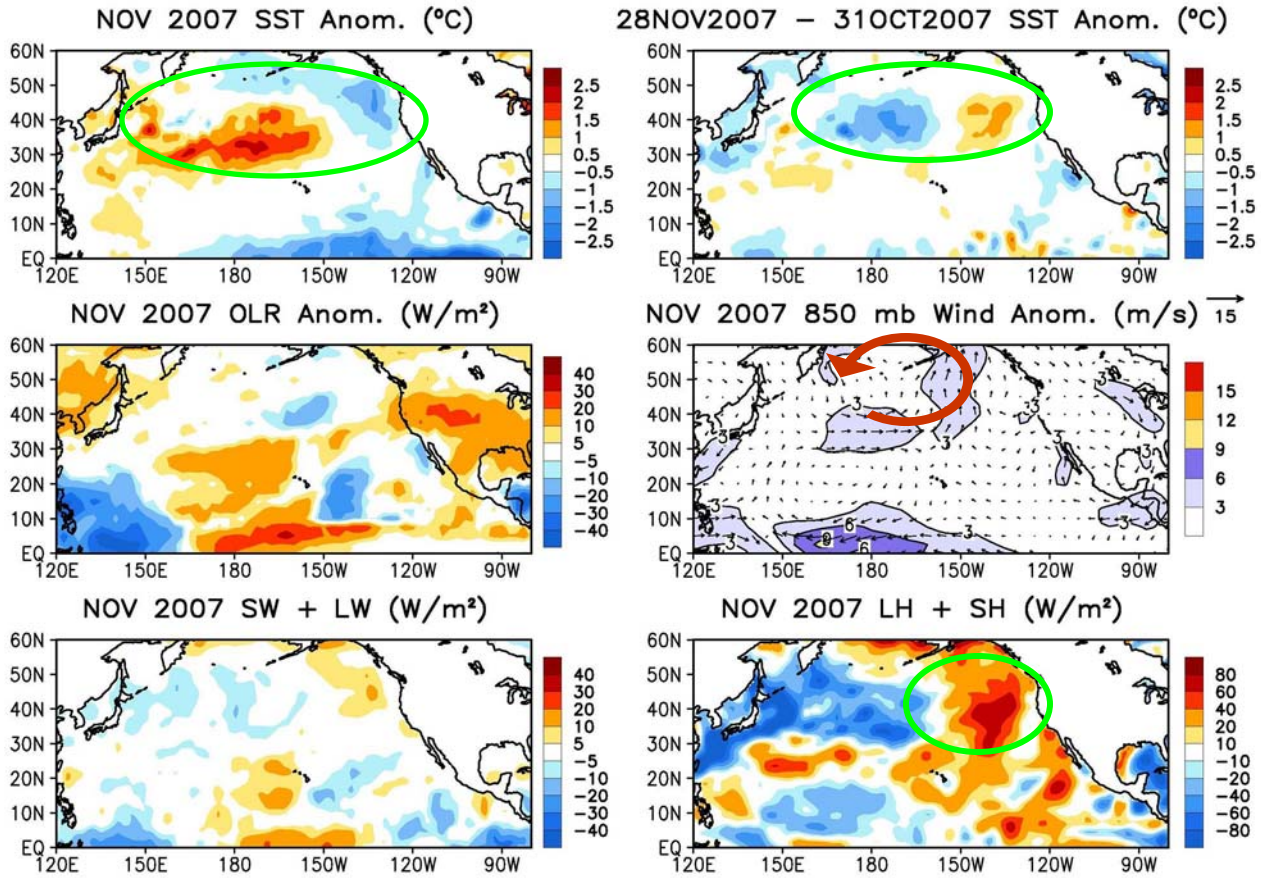
- advective cooling in Dec. 2006 (MJO) followed by entrainment cooling in Jan. 2007
- advective and entrainment warming in May-Jul 2007 (MJO) delayed La Nina development
- advective cooling in Jul. 2007 (MJO) followed by entrainment cooling in Aug-Oct 2007 led to La Nina development
- both Advective and entrainment cooling weakened in November
- SST tendency is near zero in November

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



- **Enhanced convection, reduced SW heating, and 850 hPa cyclonic flow in the far western Pacific**
- **Easterly wind anomalies near the Date Line intensified**

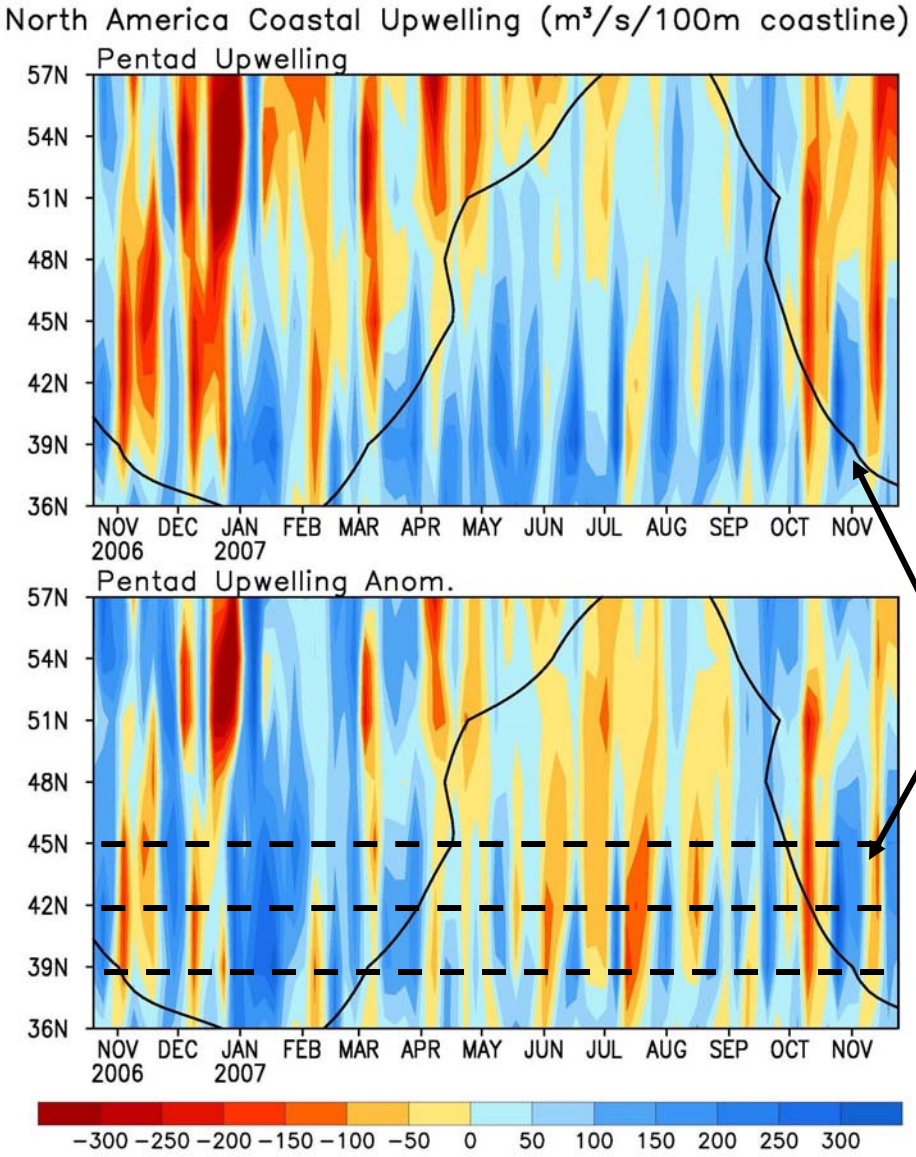
North Pacific: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx

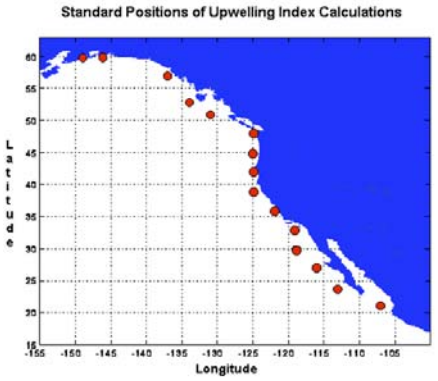


- **Cooling near western coast of North America and warming in central North Pacific weakened due to stronger Aleutian Low**
- **Ekman transport / pumping and surface heat fluxes were likely the main external forcing**

North America Western Coastal Upwelling

CPC, NCEP



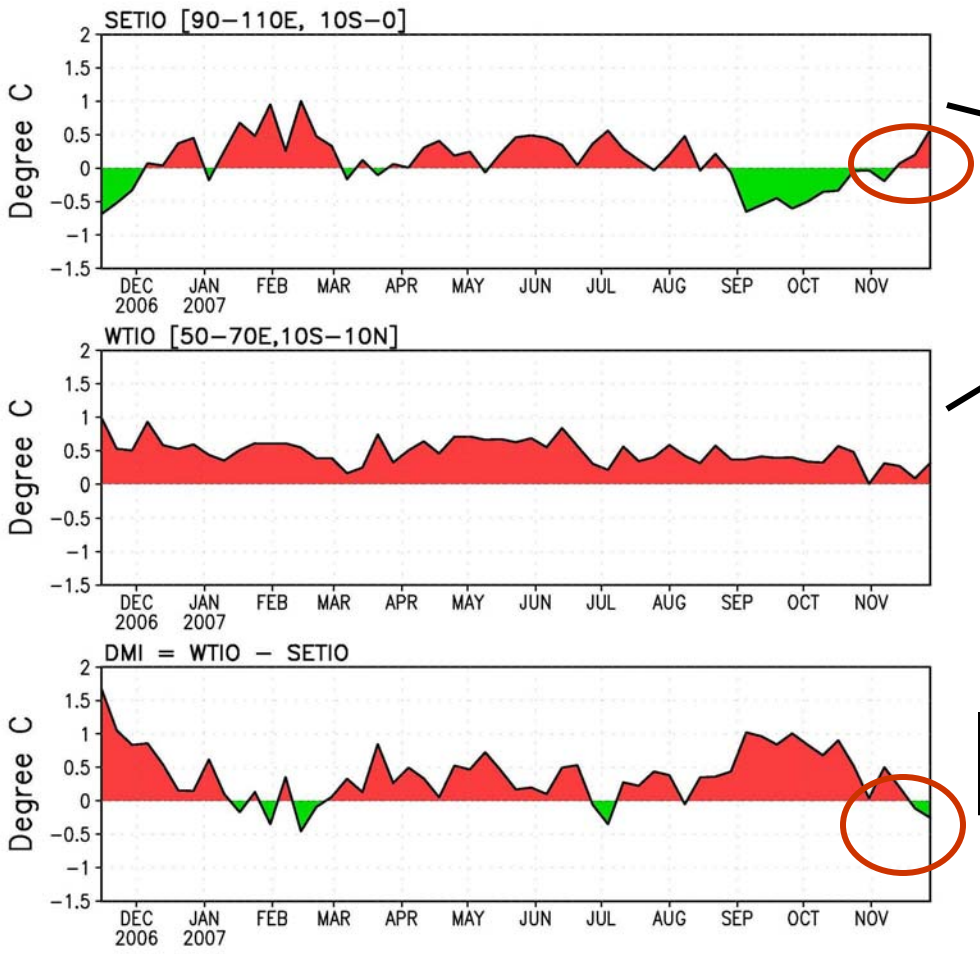


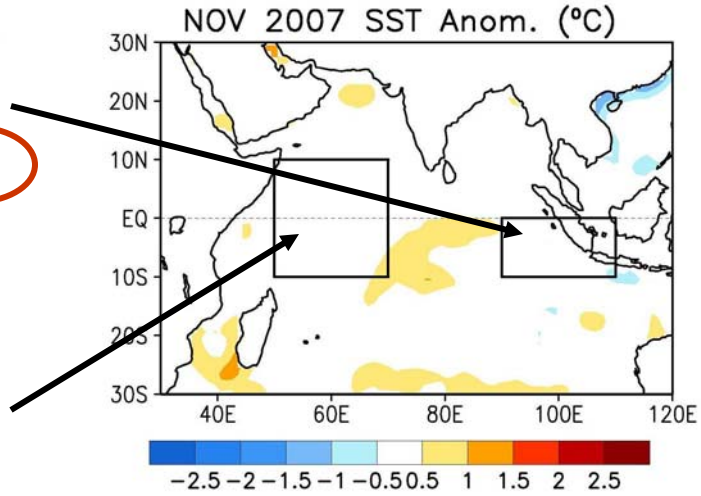
- **Climatological downwelling prevails along the coast in November**
- **Large intraseasonal variability since October**

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

Indian Ocean

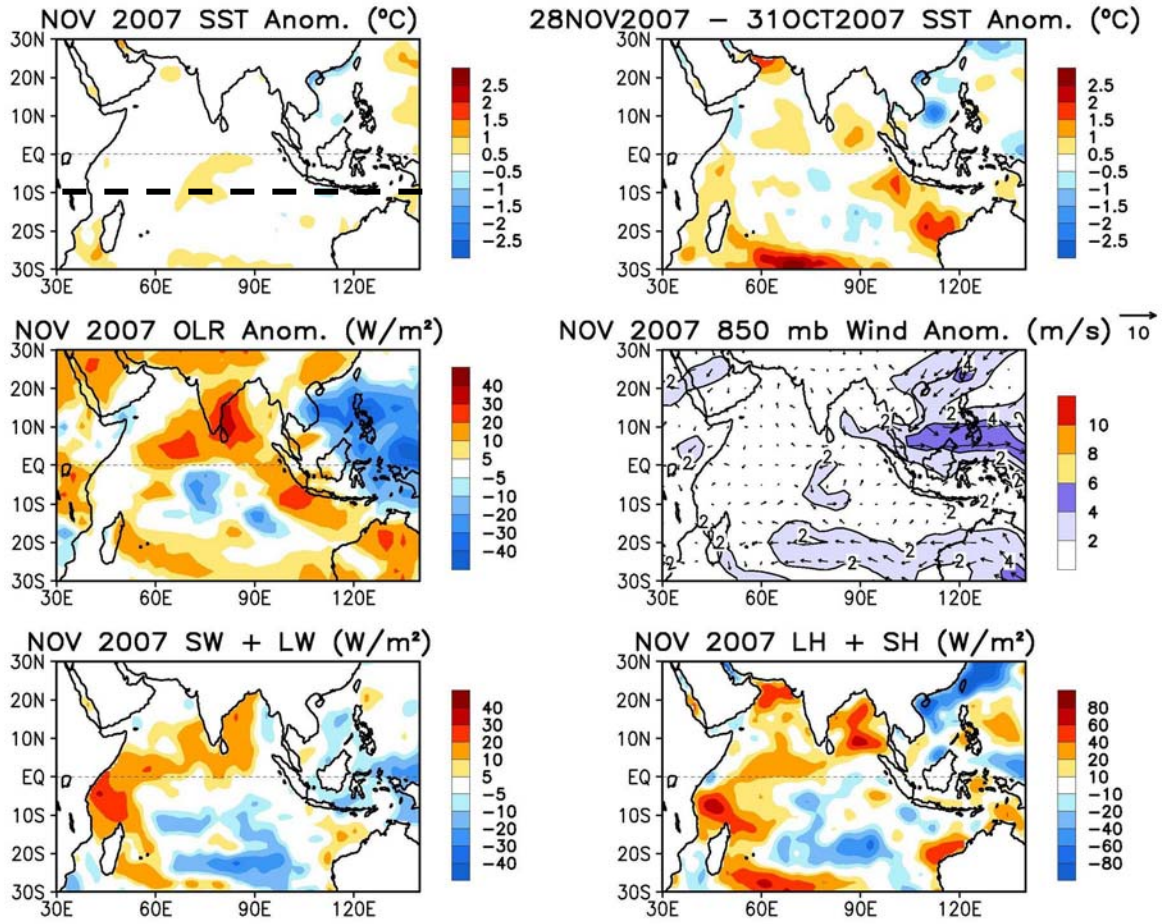
Recent Evolution of Indian Ocean SST Indices





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

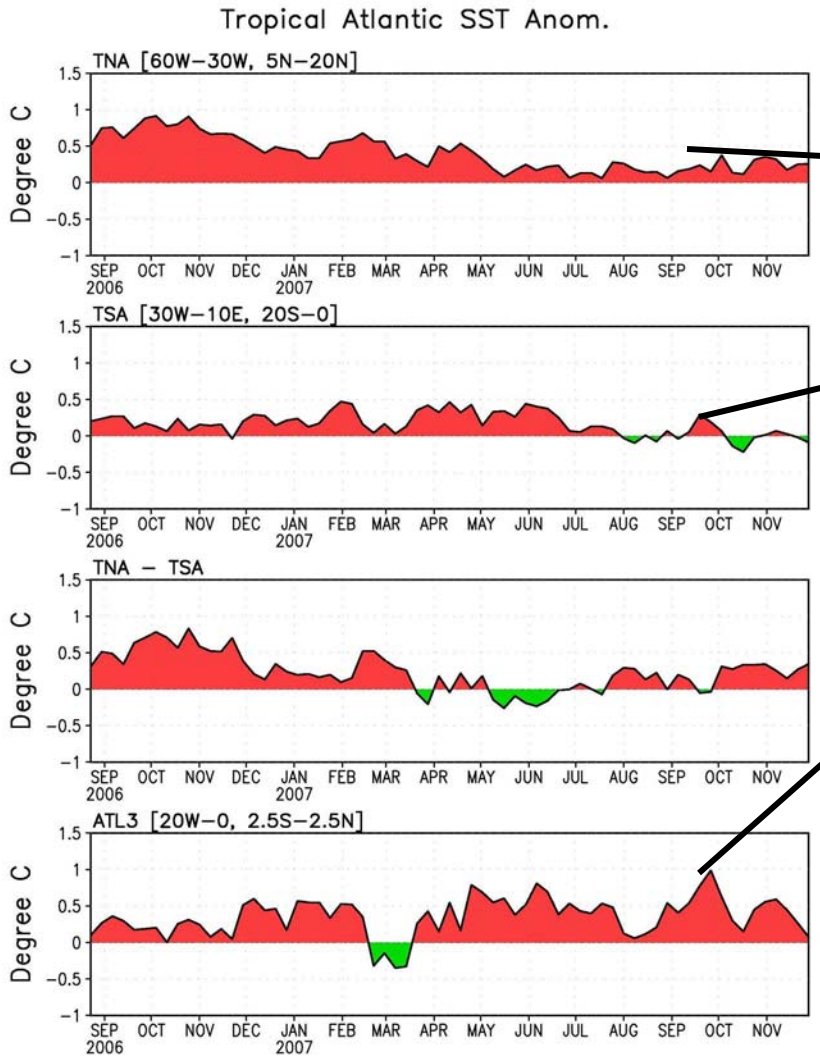
Tropical Indian: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx

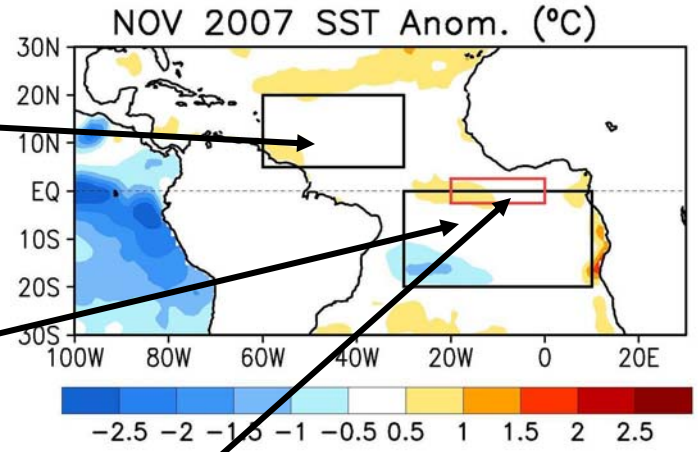


- **Below normal rainfall over most of Indian ocean**
- **Weak SST and wind anomalies**

Atlantic Ocean

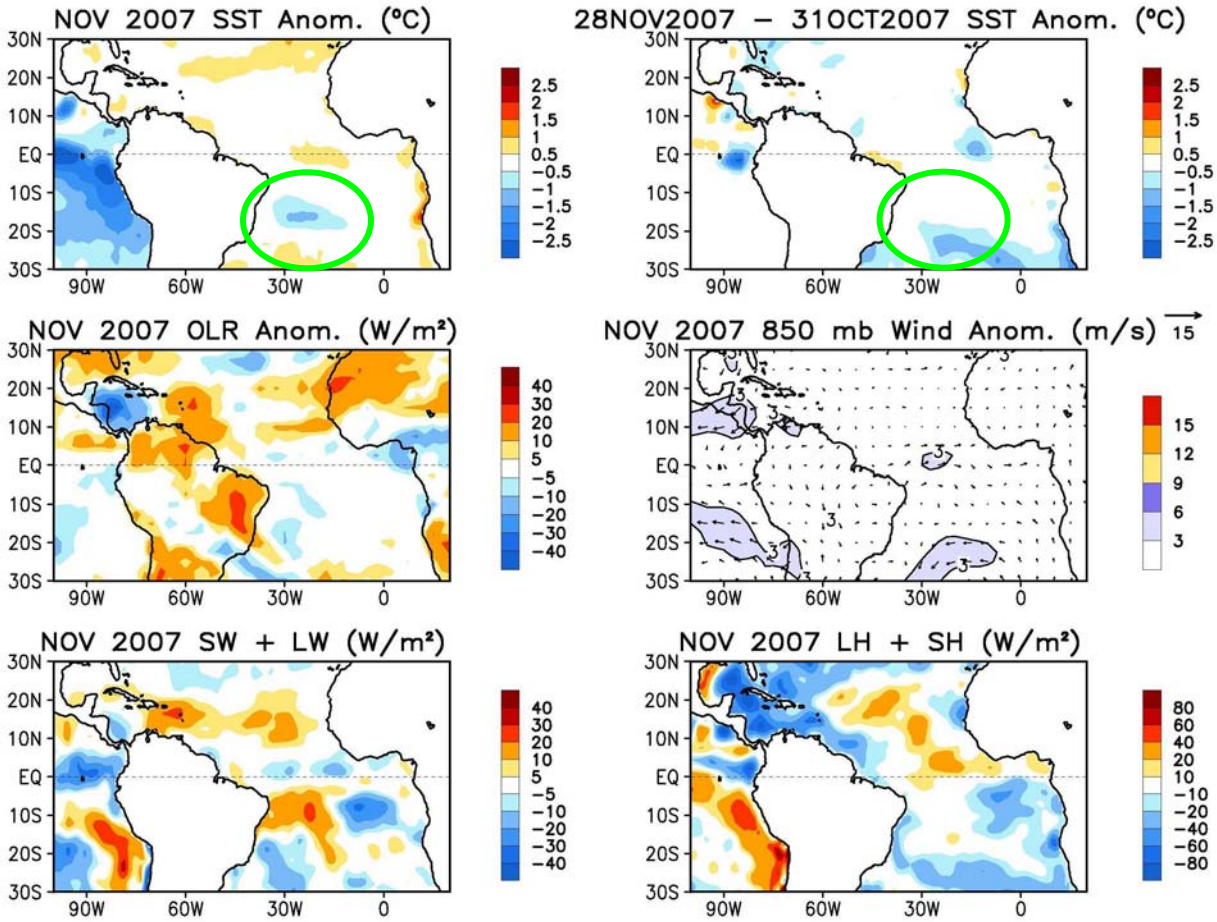
Recent Evolution of Tropical Atlantic SST Indices





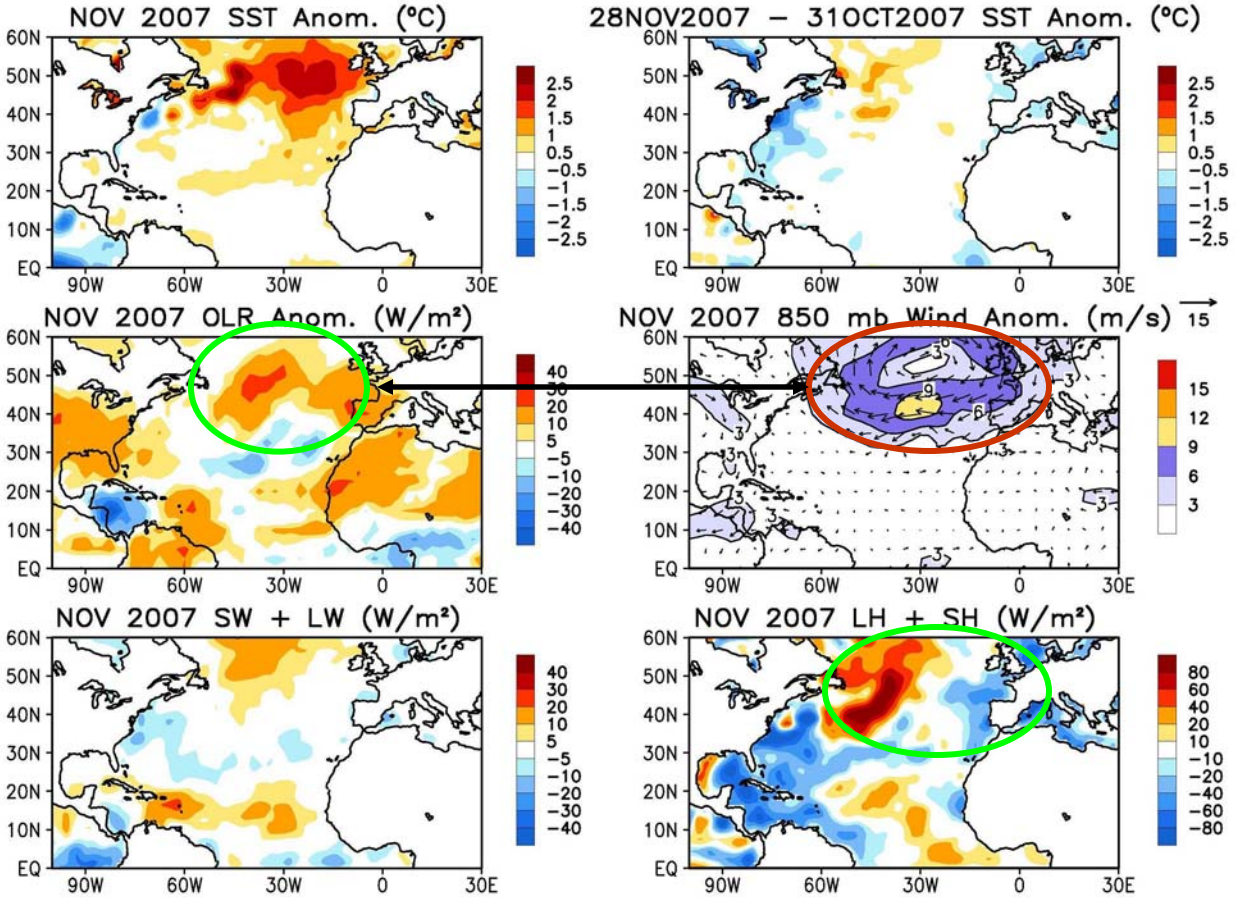
- **TNA SST anomalies weaker than those in the last year**
- **TSA SSTs are near normal**
- **ATL3 became normal**

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



- **Tropical SST near normal**
- **Negative SST between 10S and 20S maintained**
- **Cooling south of 20S**

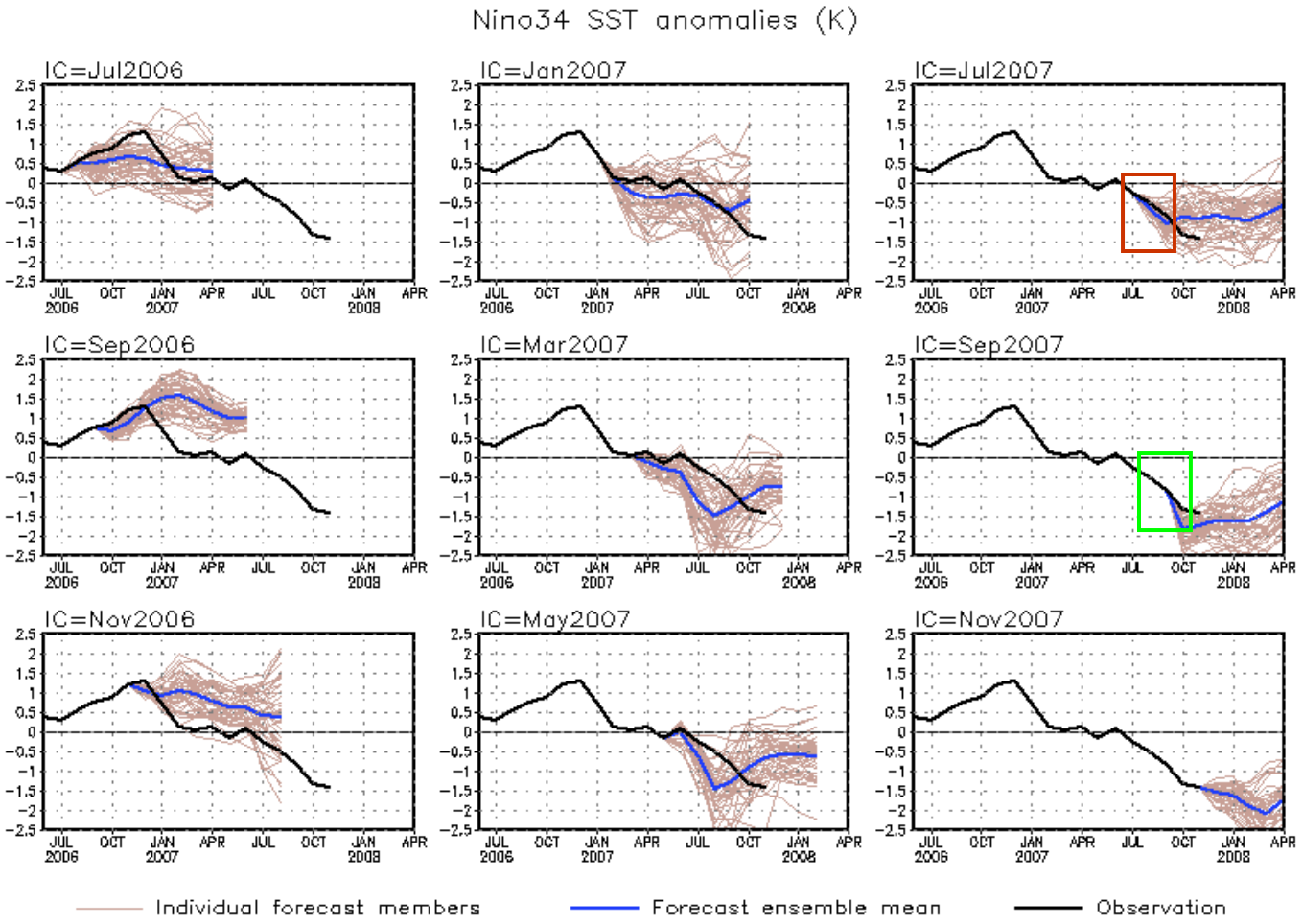
North Atlantic: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx



- **Large positive SST anomalies near 50N**
- **Anti-cyclonic wind anomalies are associated with negative precipitation anomalies**
- **Large wind and surface heat flux anomalies contributed to SST changes**

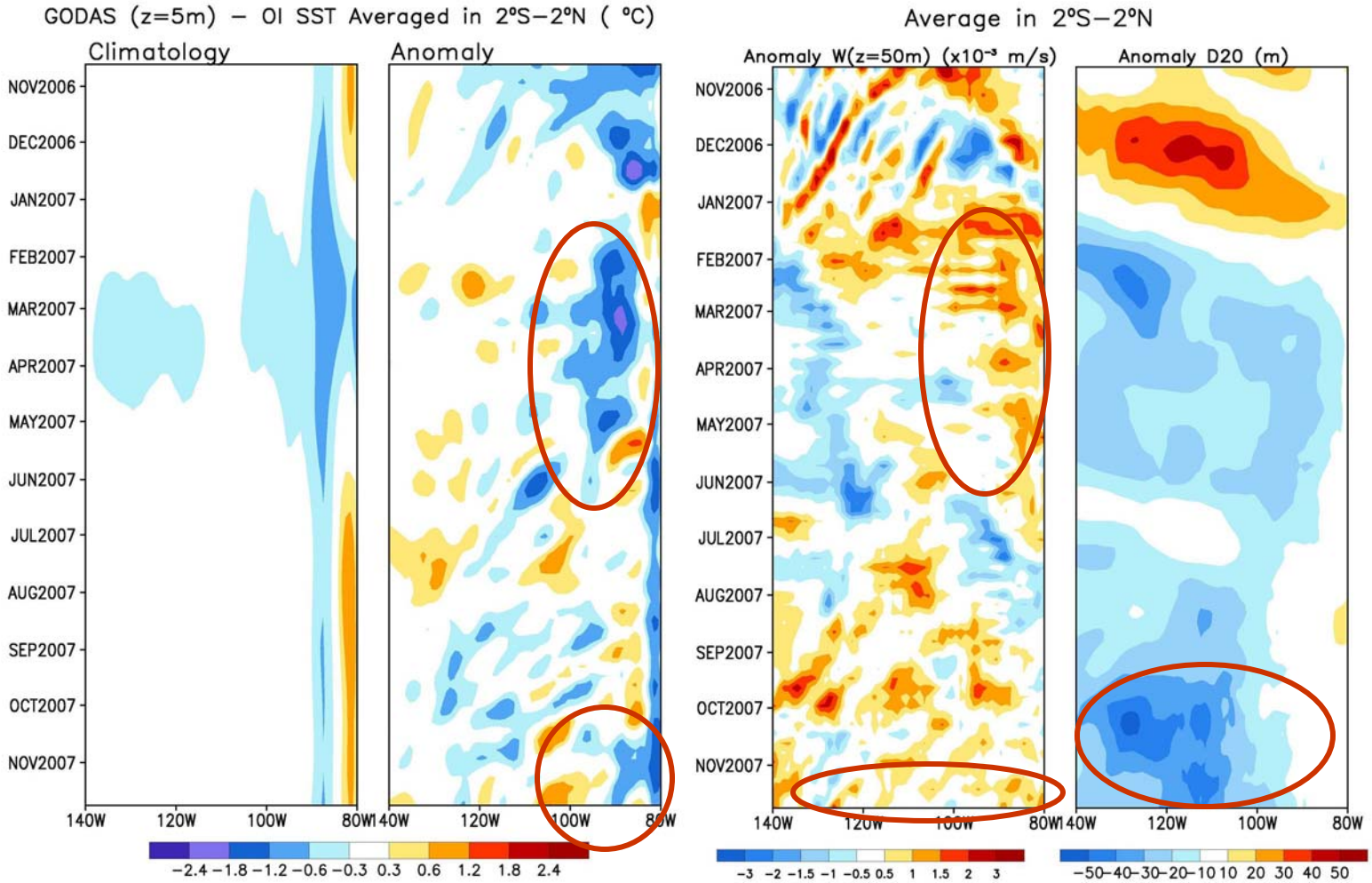
CFS SST Predictions and Ocean Initial Conditions

CFS Niño 3.4 SST Predictions from Different Lead Times



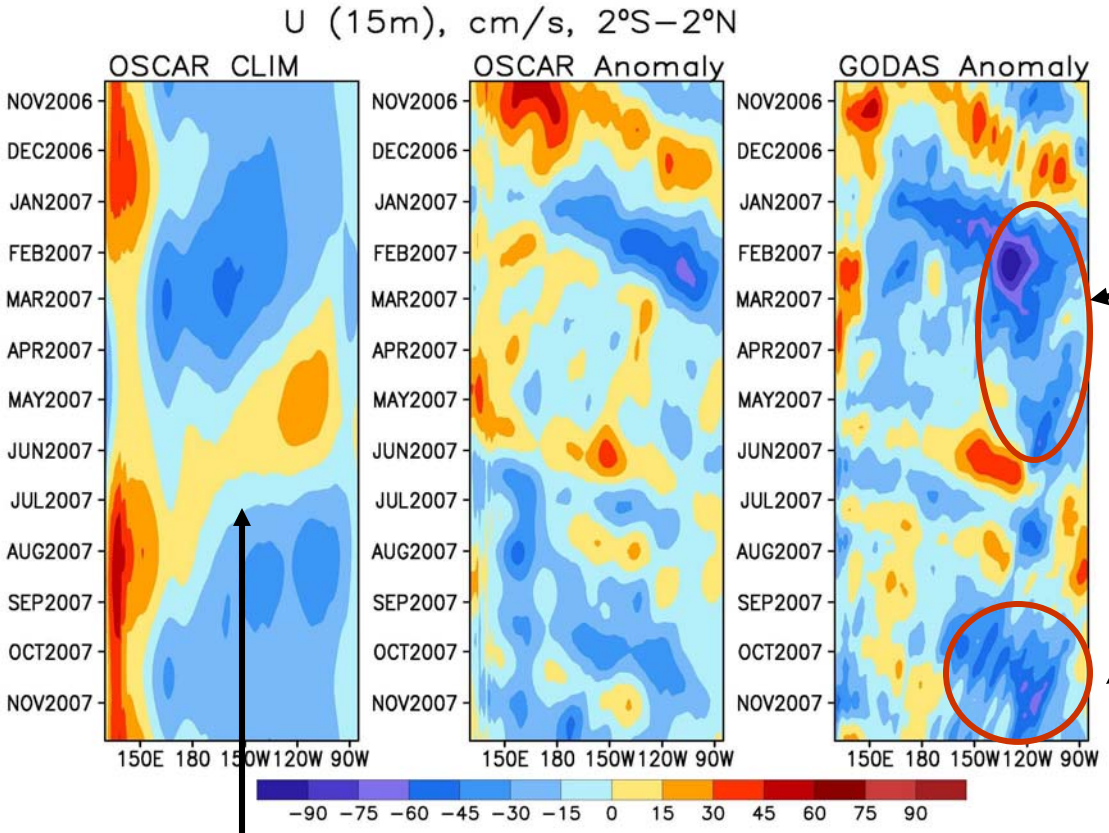
- **Earlier onset of cold SST anomalies in spring**
- **Reasonable SST forecast in July**
- **SST forecast biased towards cold since September**

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



- **Large negative SST biases in spring of 2007, and November 2007**
- **Related to anomalously strong upwelling at 50-meter depth, and shallow thermocline in the analysis**
- **Upwelling is slightly above normal in November 2007 due to strengthened easterly anomalies**

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

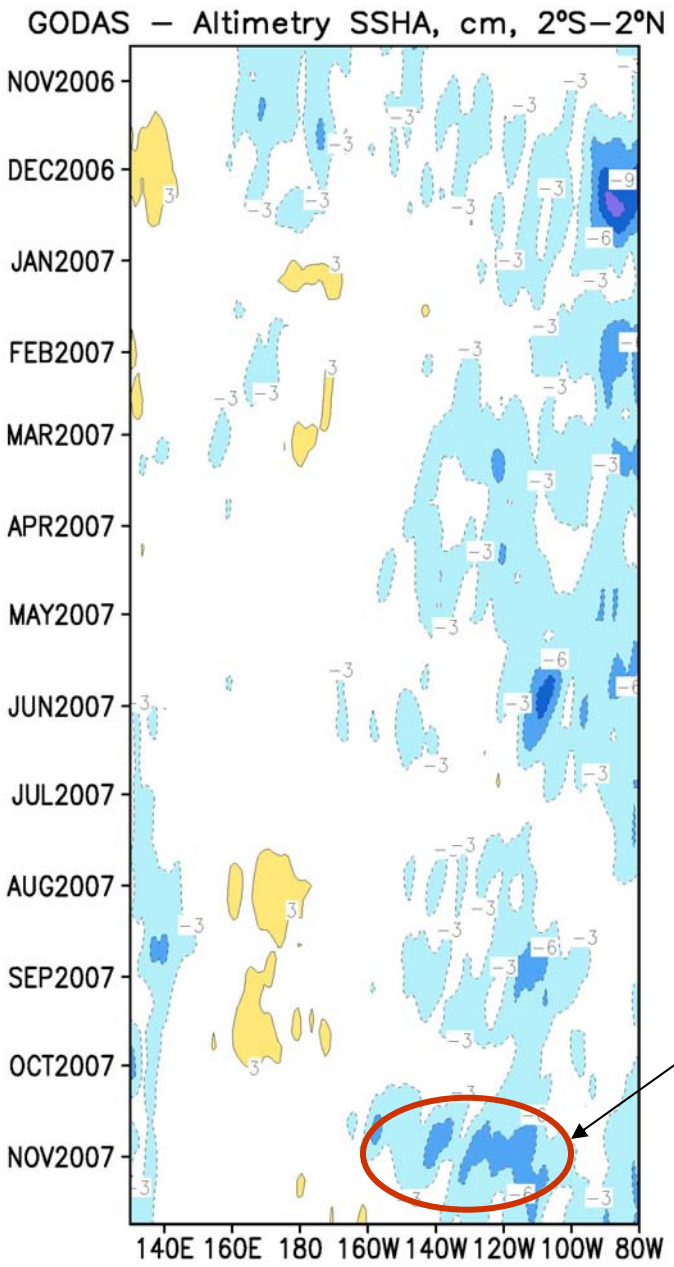


Too strong westward currents

Too strong westward currents since Sept. 2007

Climatological surface currents are westward since July

Cold SST biases and too strong westward currents contributed to cold biases in SST forecast in spring 2007 and since Sept. 2007???



- **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 in the later half of October 2007 between 160W-110W**

- **Negative subsurface temperature anomalies (-4C) in GODAS are probably too large, consistent with the differences between TAO and GODAS shown in slide 9.**

Summary

- **Pacific Ocean**
  - Negative SST anomalies intensified near 100W and extended westward to 160E.
  - CPC's prognostic assessment: La Niña reached a moderate strength (ONI < -1 degree) in SON and will continue throughout the Spring of 2008
  - Moderate MJO activity presented in the indo-Pacific region and contributed to the enhanced convection in the far western Pacific and near Philippe Sea
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  - Near normal SST conditions prevailed in the tropical Atlantic
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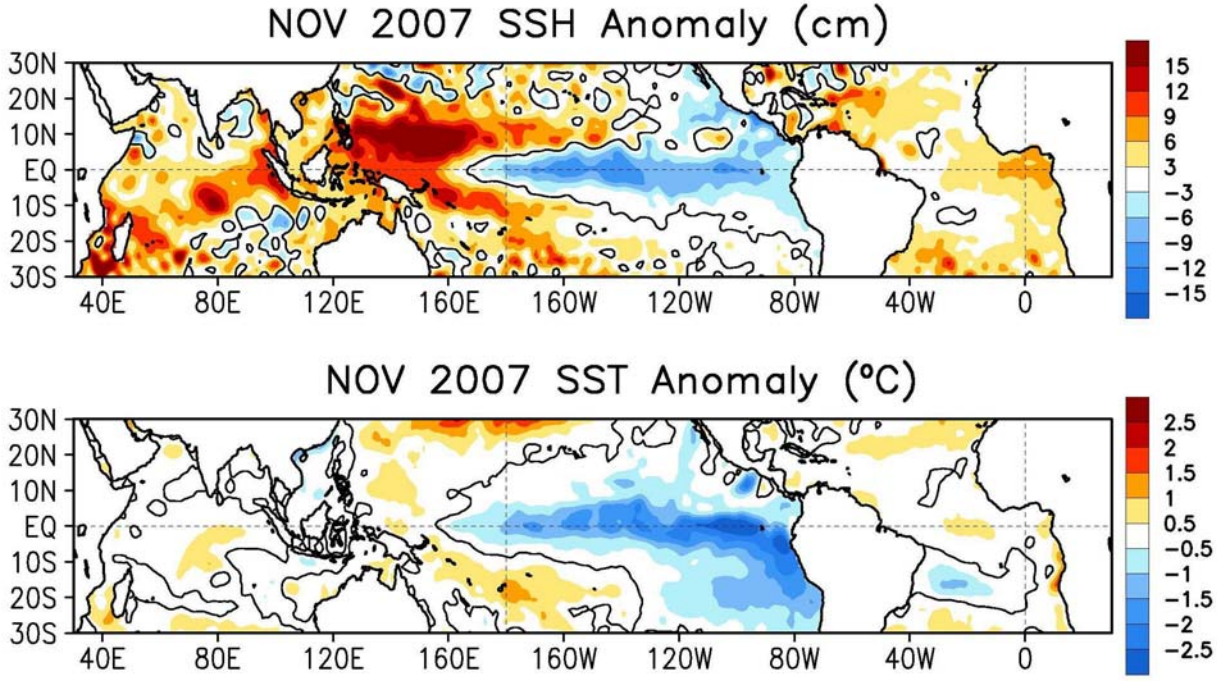
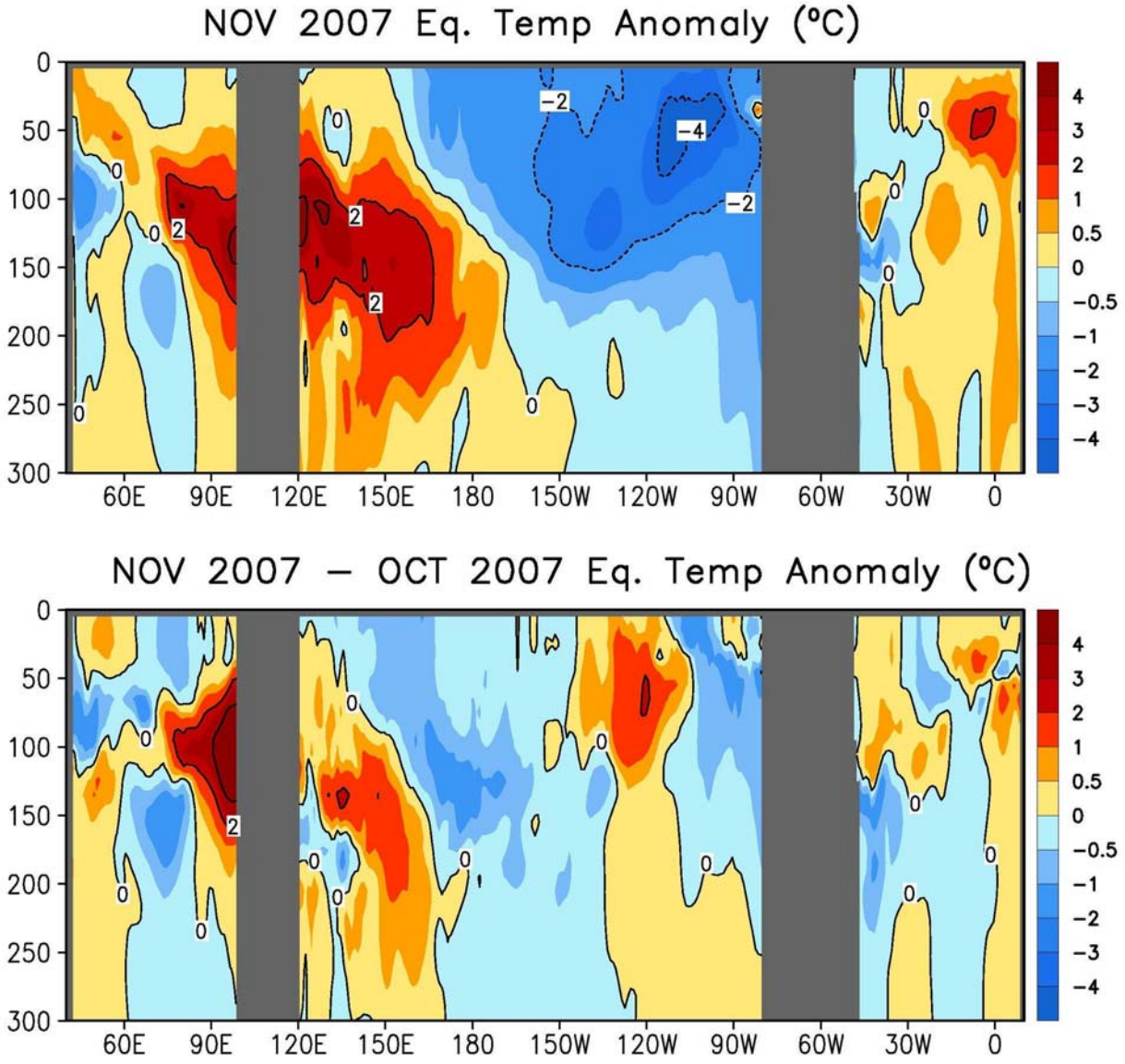
Backup Slides

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

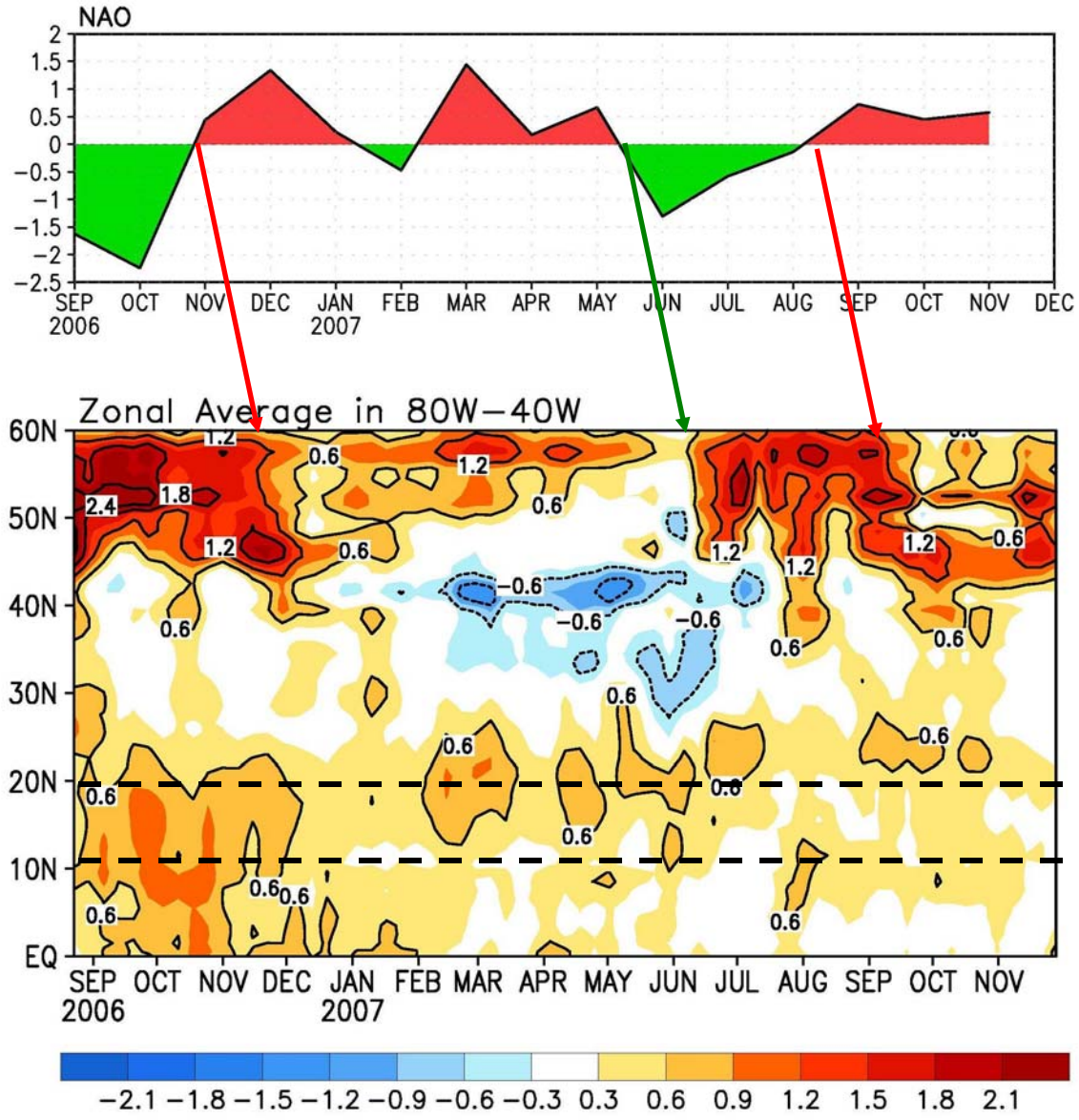


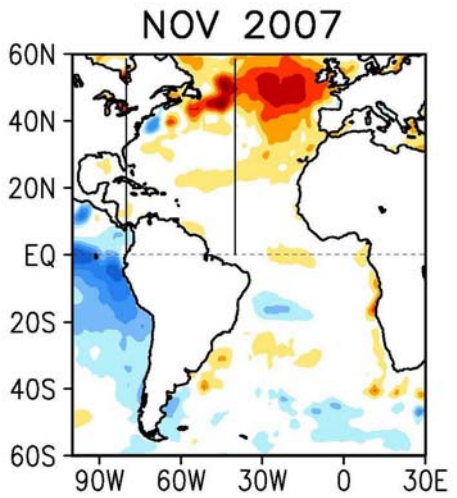
- **Good consistency between SSH and SST in the equatorial latitudes**
- **Changes in the SH extratropical latitudes in the SSH may reflect warming trends in the deeper oceans**

GODAS Equatorial X-Z Temperature



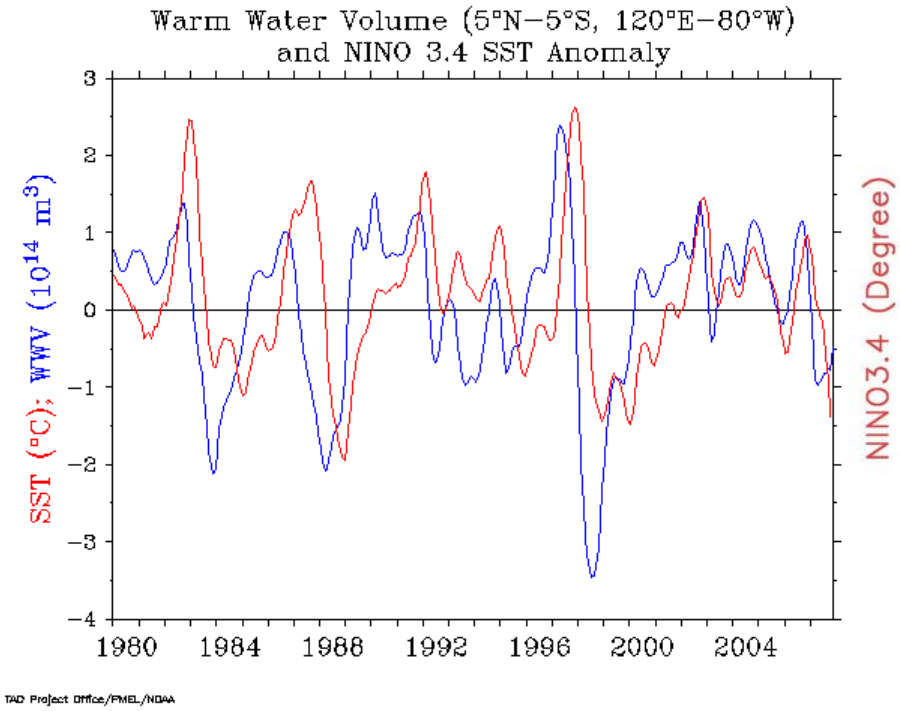
Attribution of SST Anomaly in Northwest Atlantic



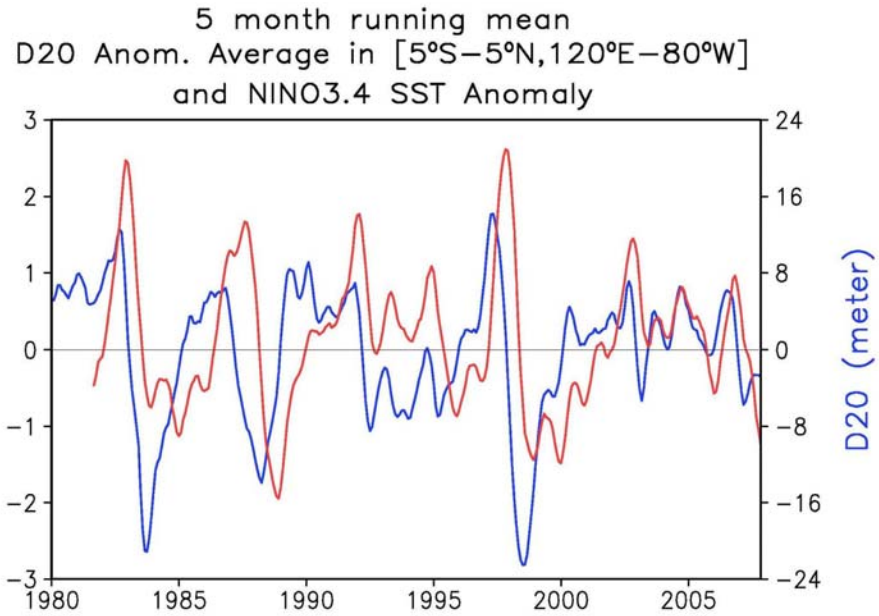


- NAO index has been positive since August
- Hurricane season warm SST anomalies weaker than they were last year in MDR

Pacific Warm Water Volume

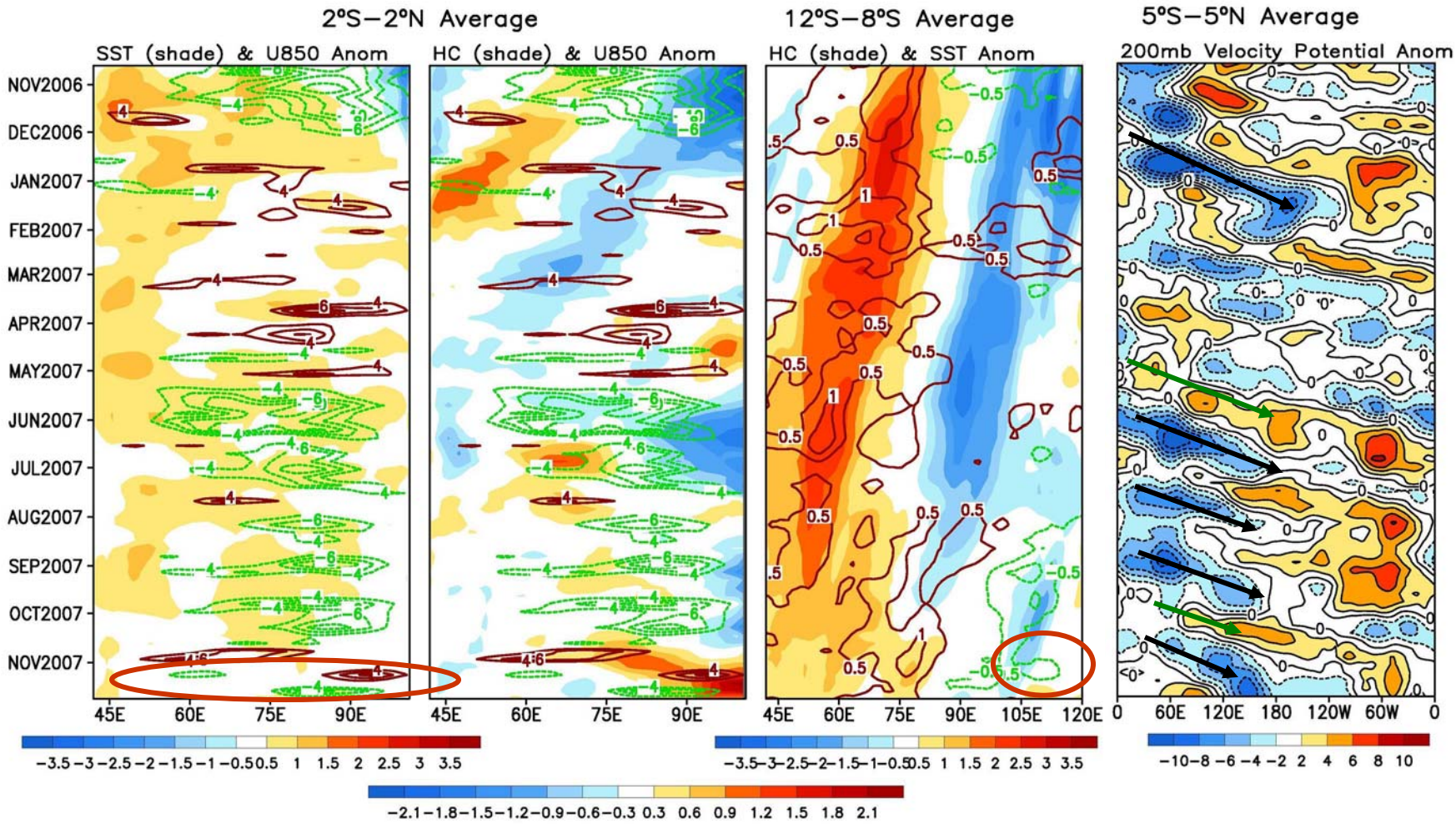


PMEL

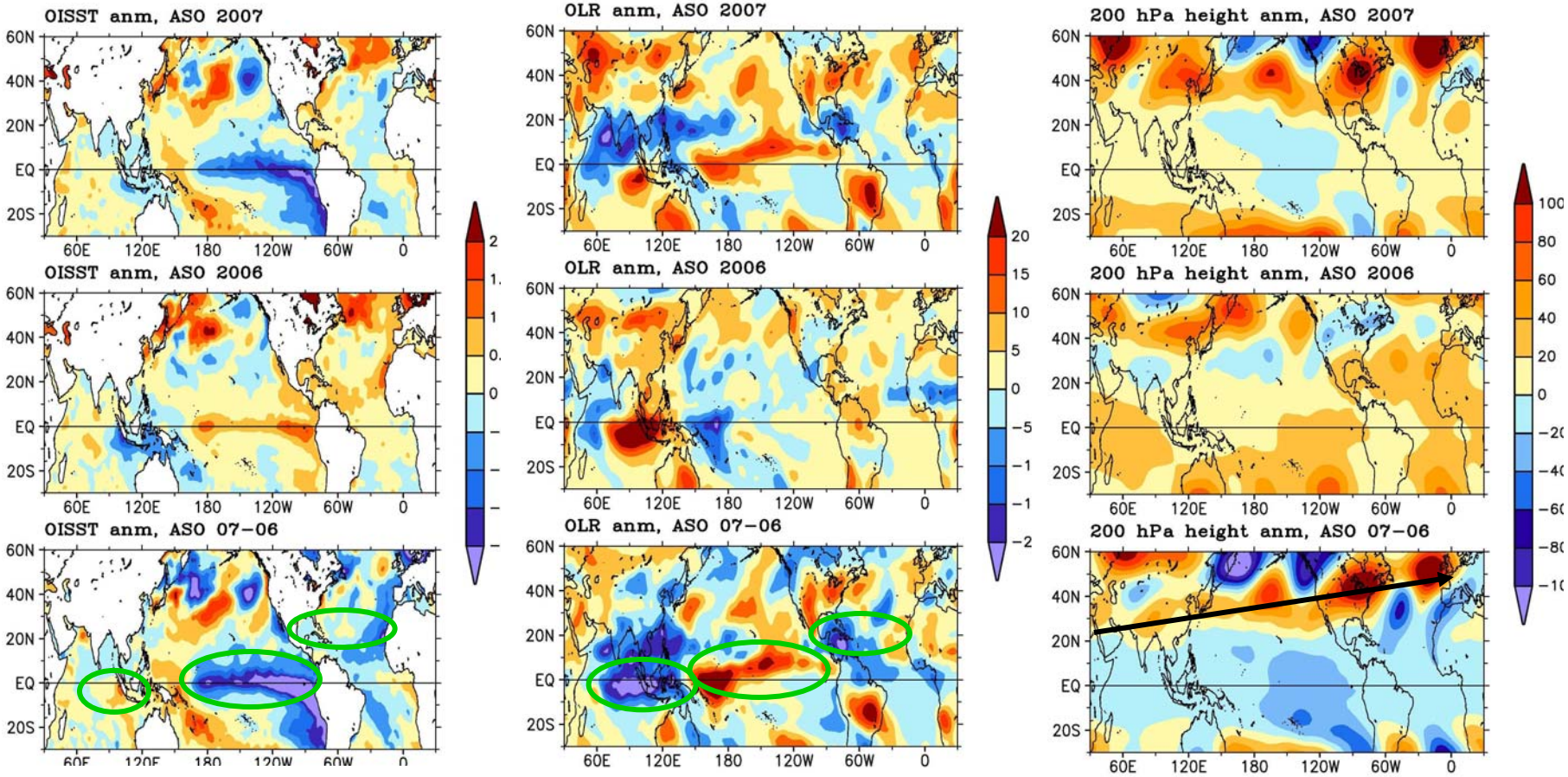


GODAS

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

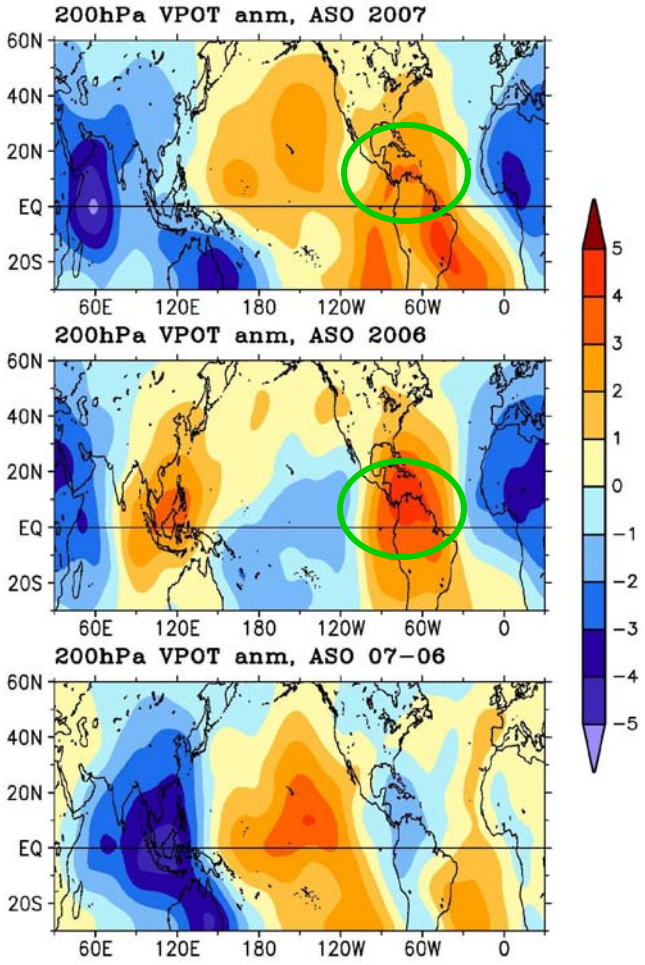


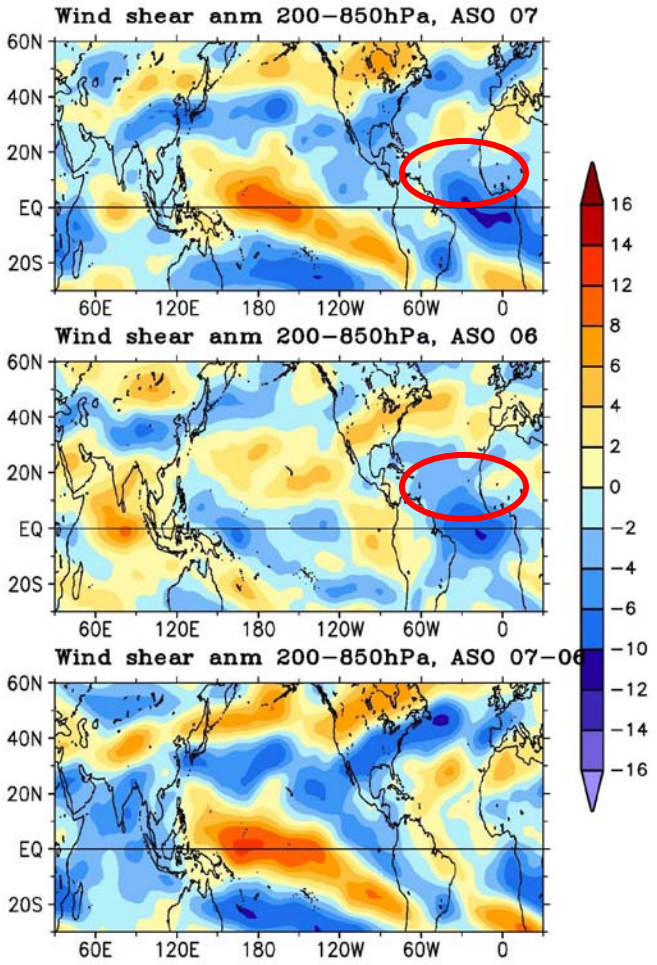
Pacific, Atlantic, and Indian Ocean connections in hurricane season of ASO 2006-2007



- Pacific: 2006 El Nino vs.2007 La Nina (should favor 2007 Hurricane season)
- Indian Ocean: weak IOD in 2007 but much stronger in 2006 (Impact in the Atlantic unknown)
- Atlantic: Warmer SSTs in 2006 (should have favor 2006 Hurricane season over 2007)

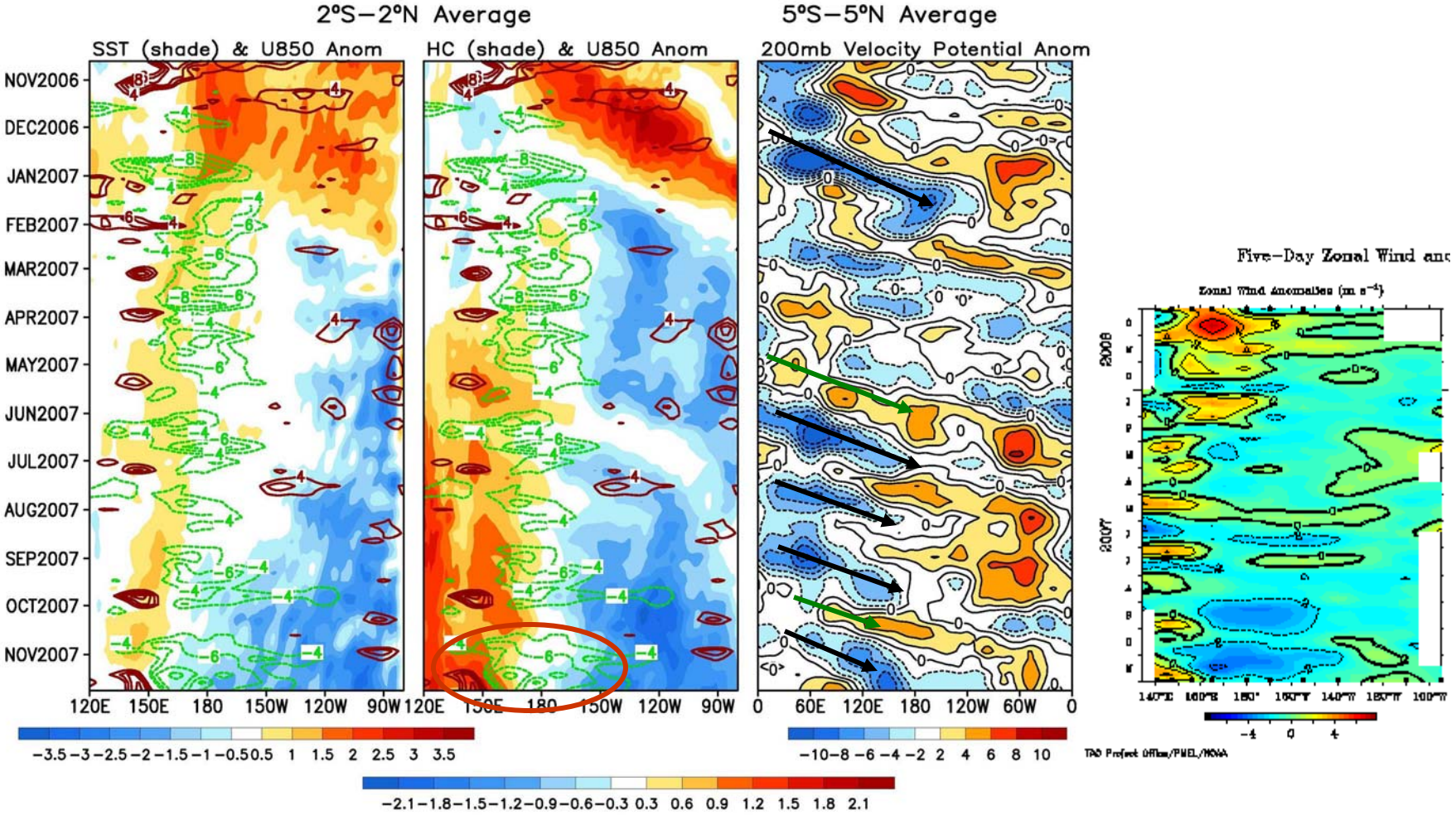
Pacific, Atlantic, and Indian Oceans in ASO 2006-2007: continued





- Positive velocity potential anomaly over Central America and western Atlantic
- structure of velocity potential in wave-1 in 2007 and wave-2 in 2006
- Negative wind shear anomalies over tropical North Atlantic

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



- **Strong WWB near 150E**
- **Easterly anomalies near the date line**
- **Convective activity propagate from Maritime continent toward east: MJO at modulate strength**