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

Prepared by

Climate Prediction Center, NCEP

November 8, 2007

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

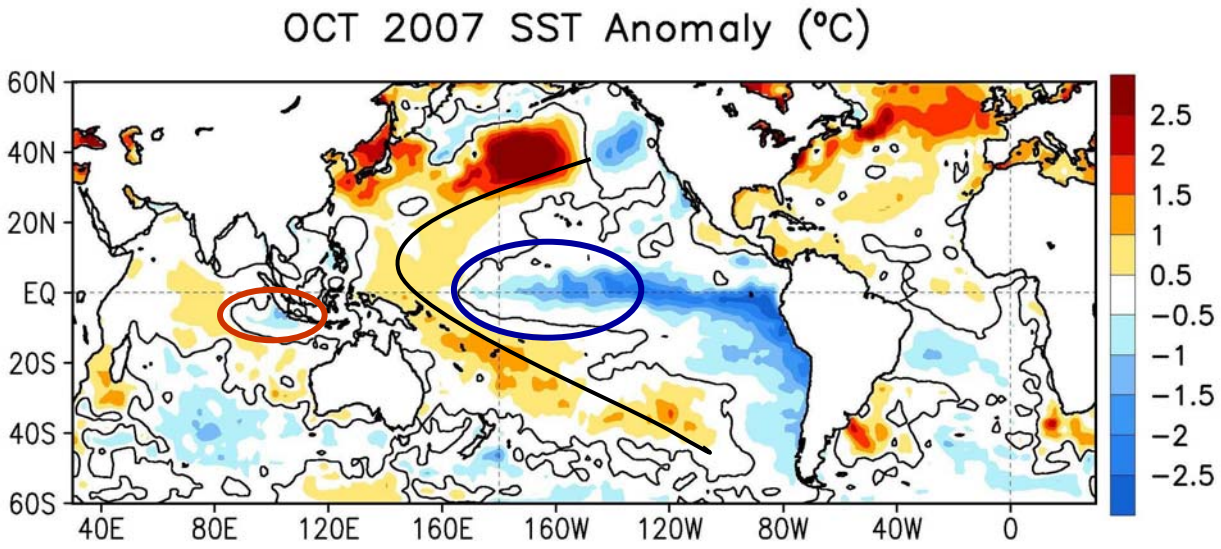
Outline

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

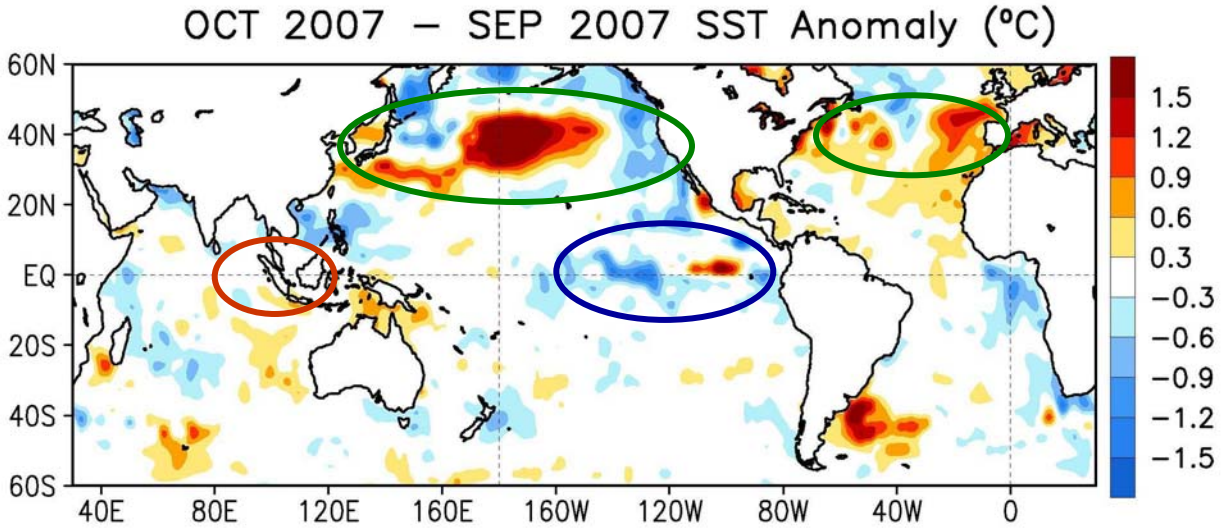
Overview

- **Pacific Ocean**
  - Negative SST anomalies east of dateline and along the coast of South America
  - Further development of negative SST anomalies in the central Pacific
  - CPC's prognostic assessment: La Niña will continue in the next several months
  - Large SST changes in the subtropical North Pacific
- **Indian Ocean**
  - Near normal SST conditions prevailed in the tropical ocean
  - IOD index became normal
  - Weak MJO development
- **Atlantic Ocean**
  - Near normal SST conditions prevailed in equatorial Atlantic.
  - SST anomalies remained much smaller than those in the last year in MDR
  - Precipitation anomalies over Gulf of Mexico and Caribbean Sea
  - Positive SST anomaly stretched southward in the extra-tropical North Atlantic

Global SST Anomaly (ºC) and Anomaly Tendency



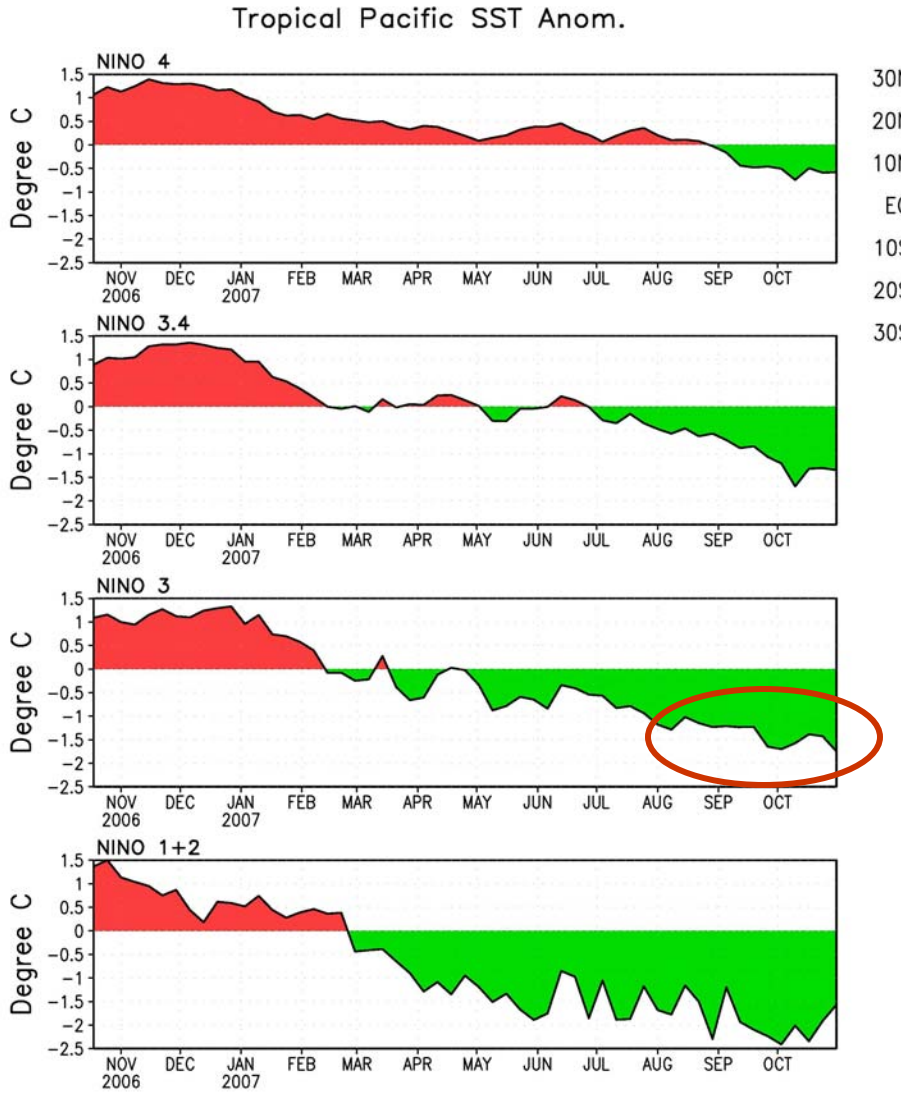
- **Cold SST anomalies east of date line… a canonical horseshoe pattern in the Pacific**
- **near normal SST anomaly in Indian Ocean**
- **Near normal SST in tropical Atlantic**

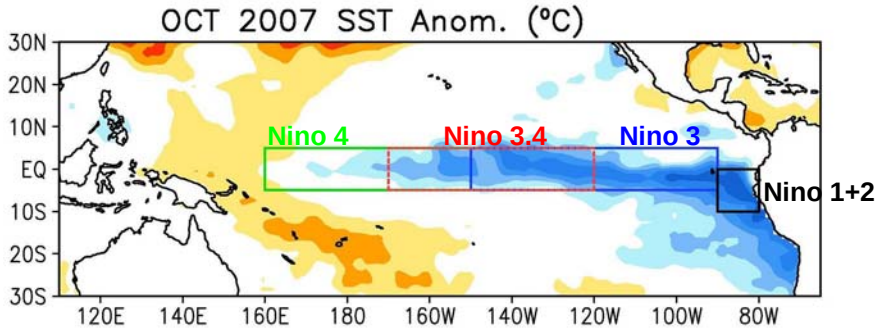


- **SSTA intensified near 140W but weakened at 100W**
- **Large changes in the NH extra-tropics**
- **Cooling near Java coast weakened**

Pacific Ocean

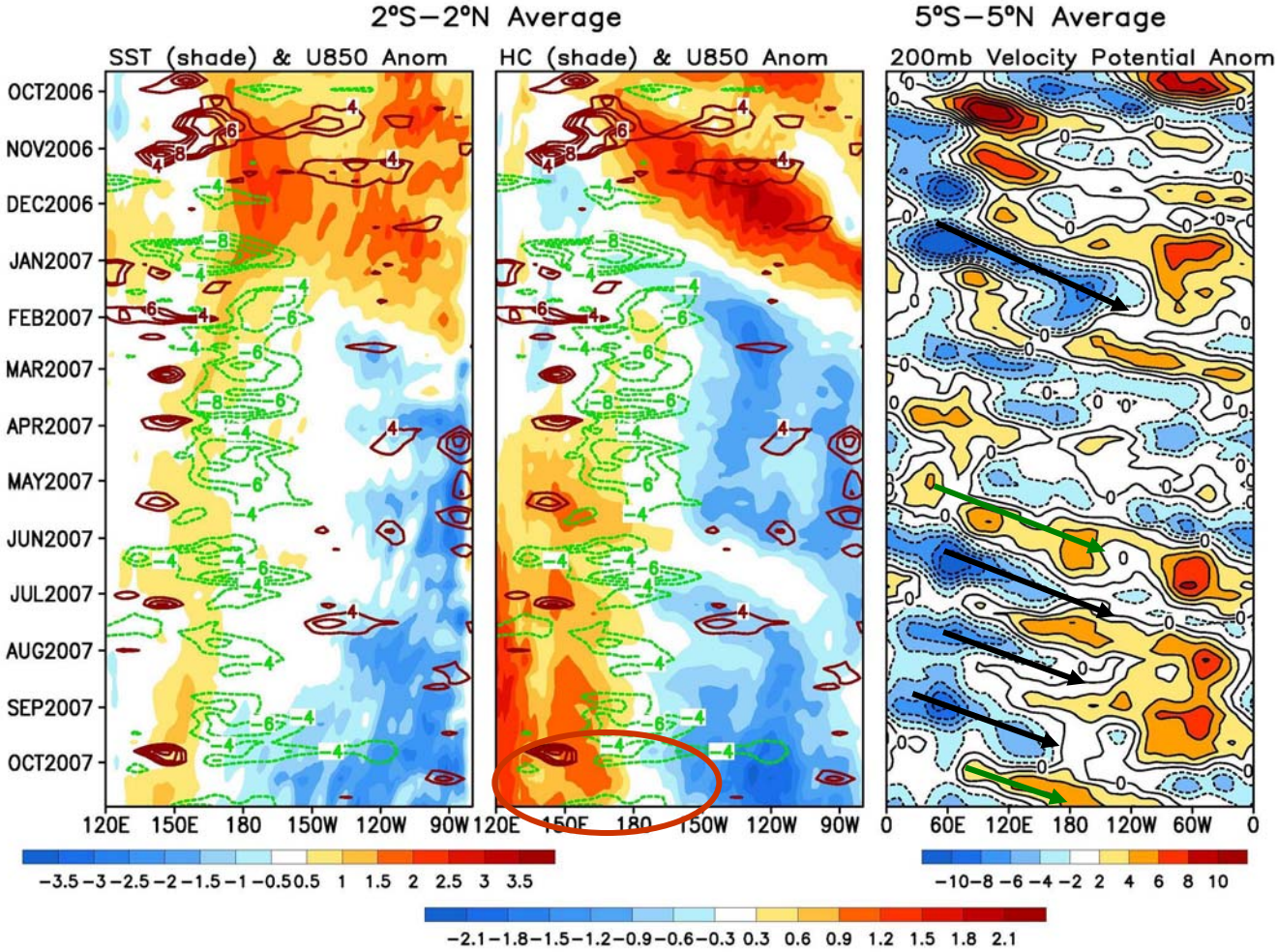
Recent Evolution of Pacific NINO SST Indices

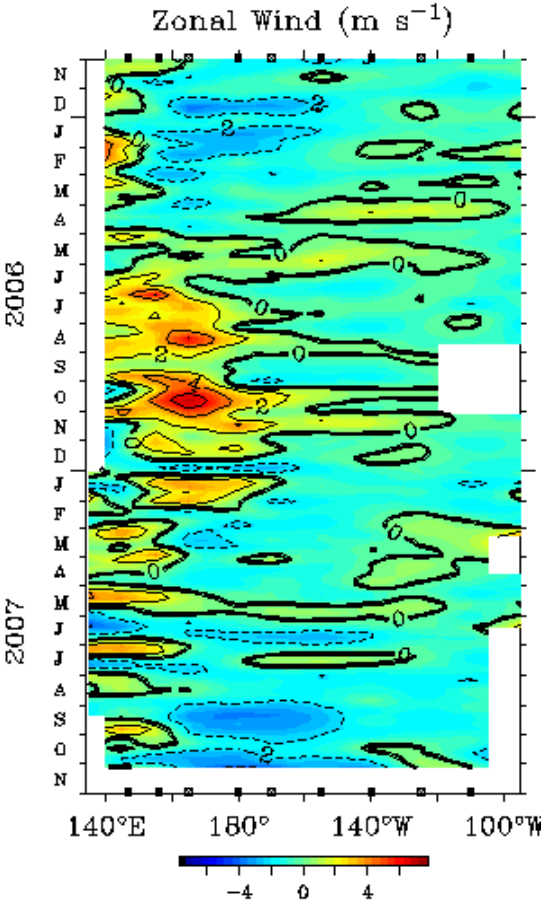




- **All Niño SST indices maintained**
- **CPC's ENSO Prognostic Statement: ASO ONI -0.8C, meeting NOAA La Nina definitions. The La Nina is to continue**

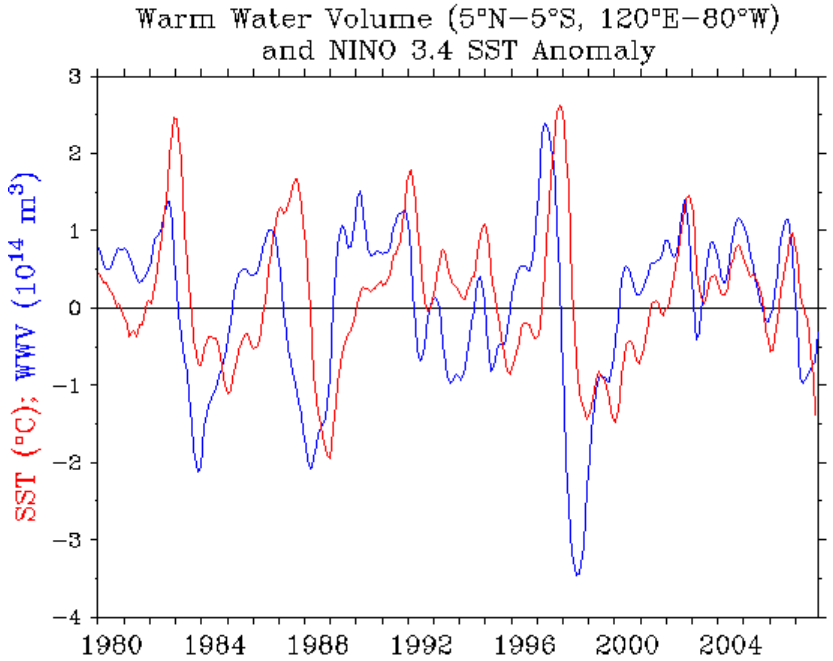
Evolution of Equatorial Pacific SST (°C), 850-mb Zonal Wind (m/s), 0-300m Heat Content (°C) and MJO Activity



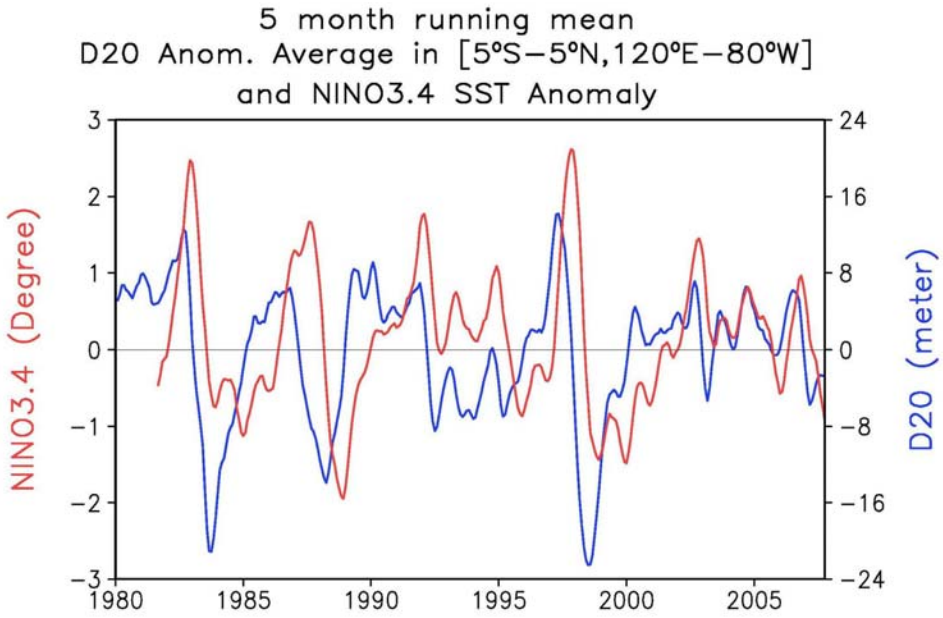


- **Strong WWB in early October**
- **Easterly anomalies diminished near the date line in mid-October, and remerged later**
- **Weakened convection in Maritime continent associated with weak MJO activity**

Pacific Warm Water Volume



PMEL

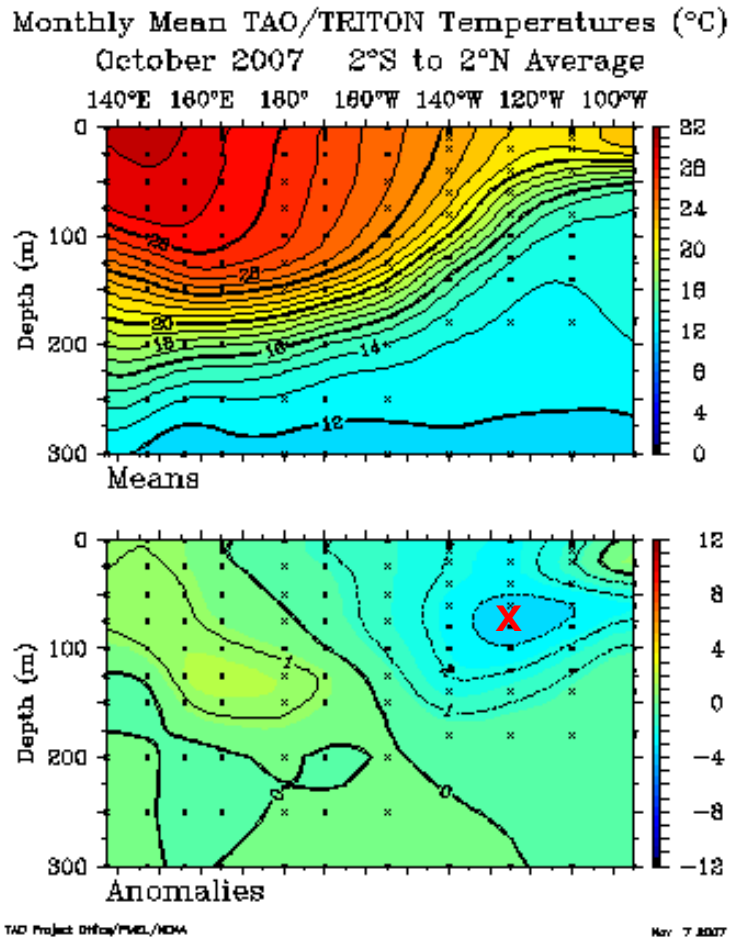


GODAS

Depth-Longitude Section of Temperature

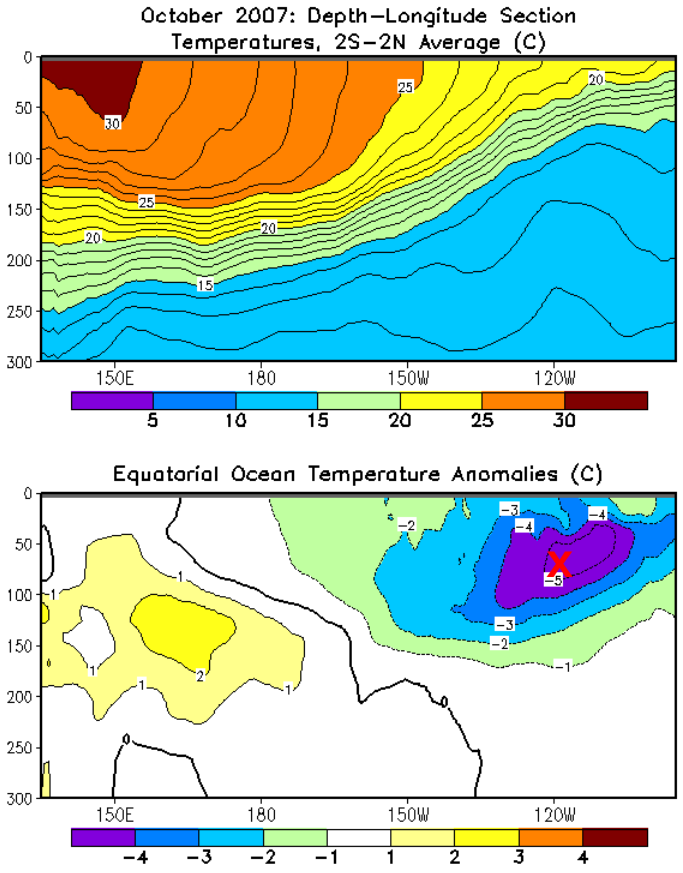
TAO

(1970-1987 Climatology)



GODAS

(1982-2004 Climatology)



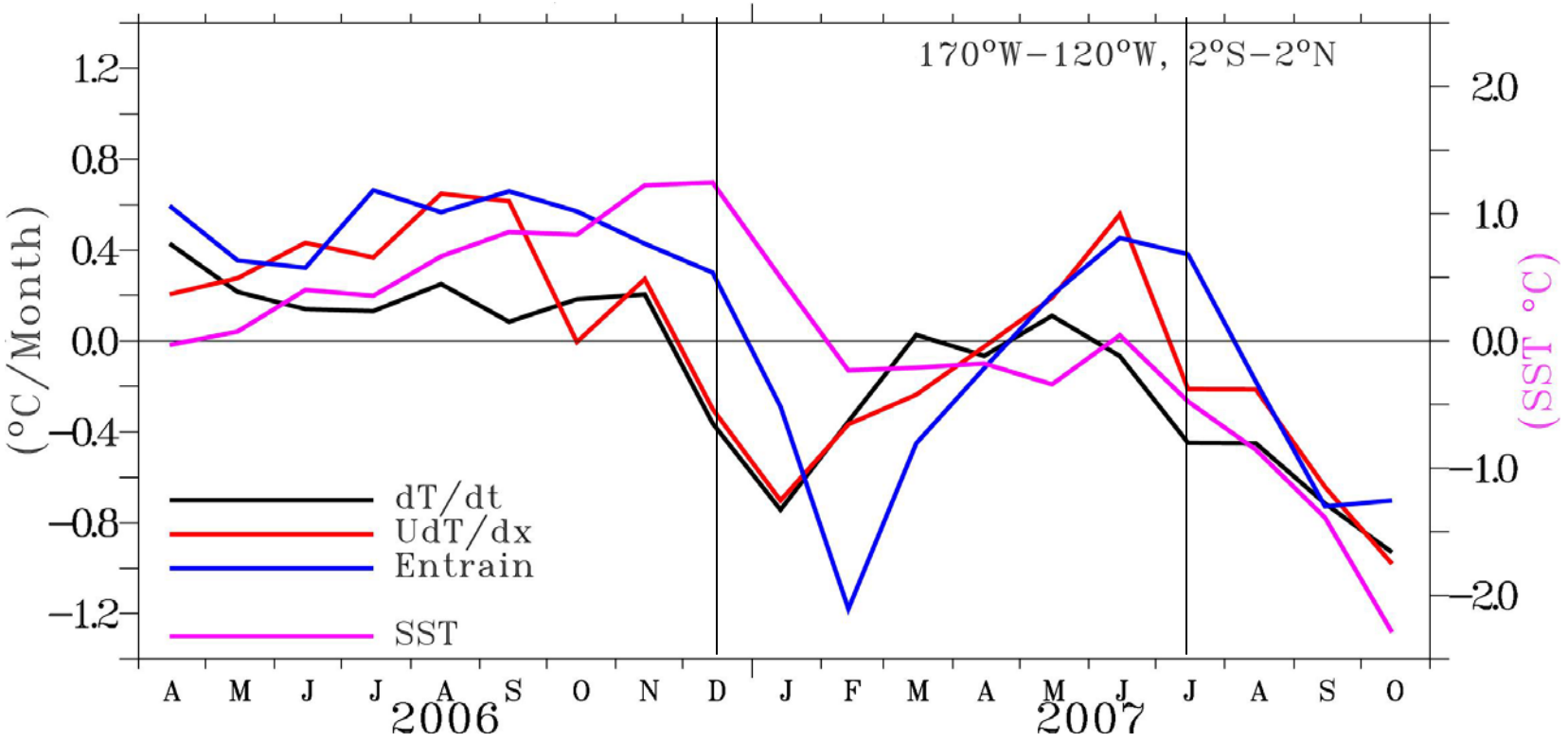
East-west dipole pattern of temperature anomalies featuring La Nina conditions

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

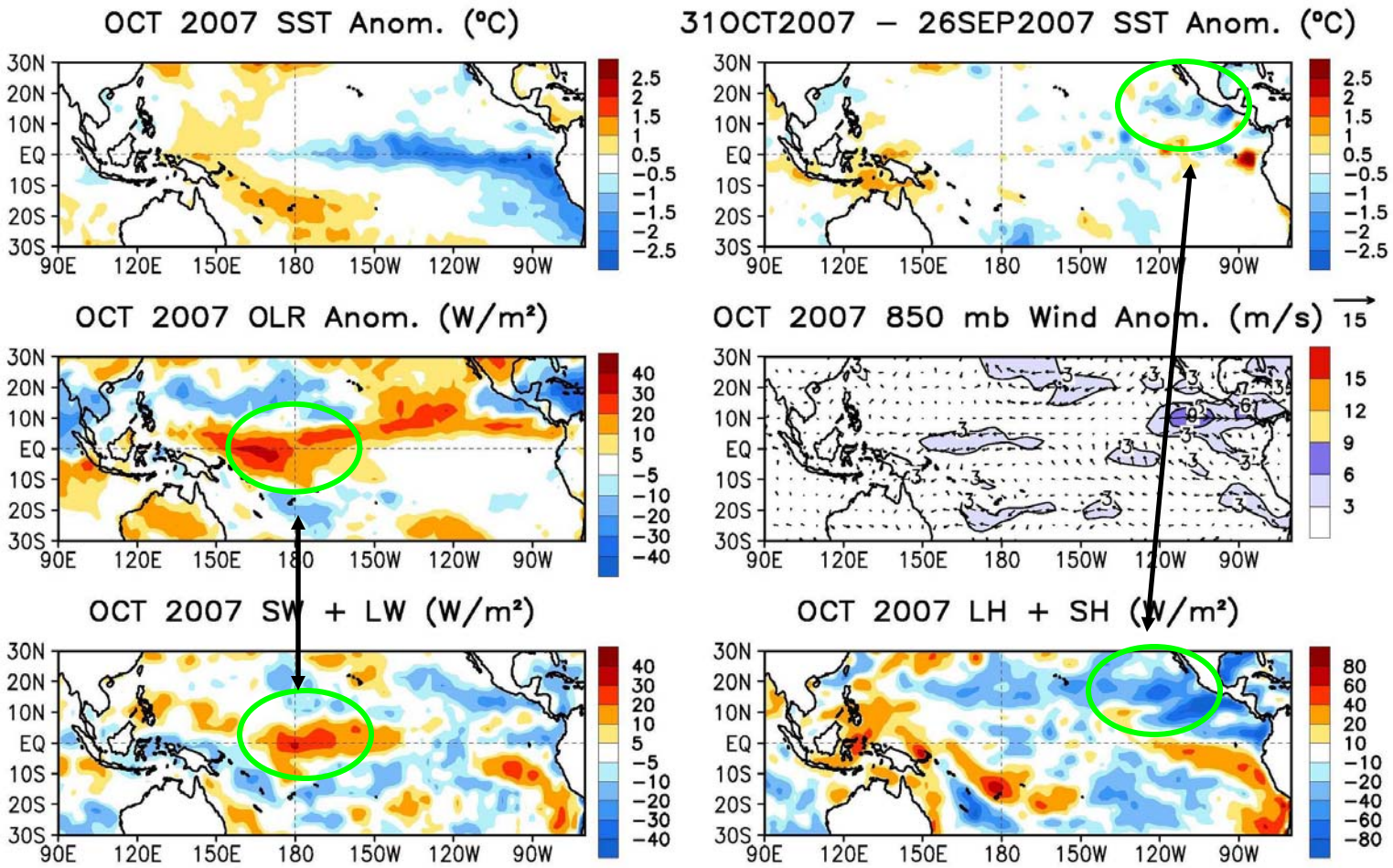
Recent Evolution of Heat Budget in NINO3.4 SST Anomaly

Courtesy of Dr. Dongxiao Zhang

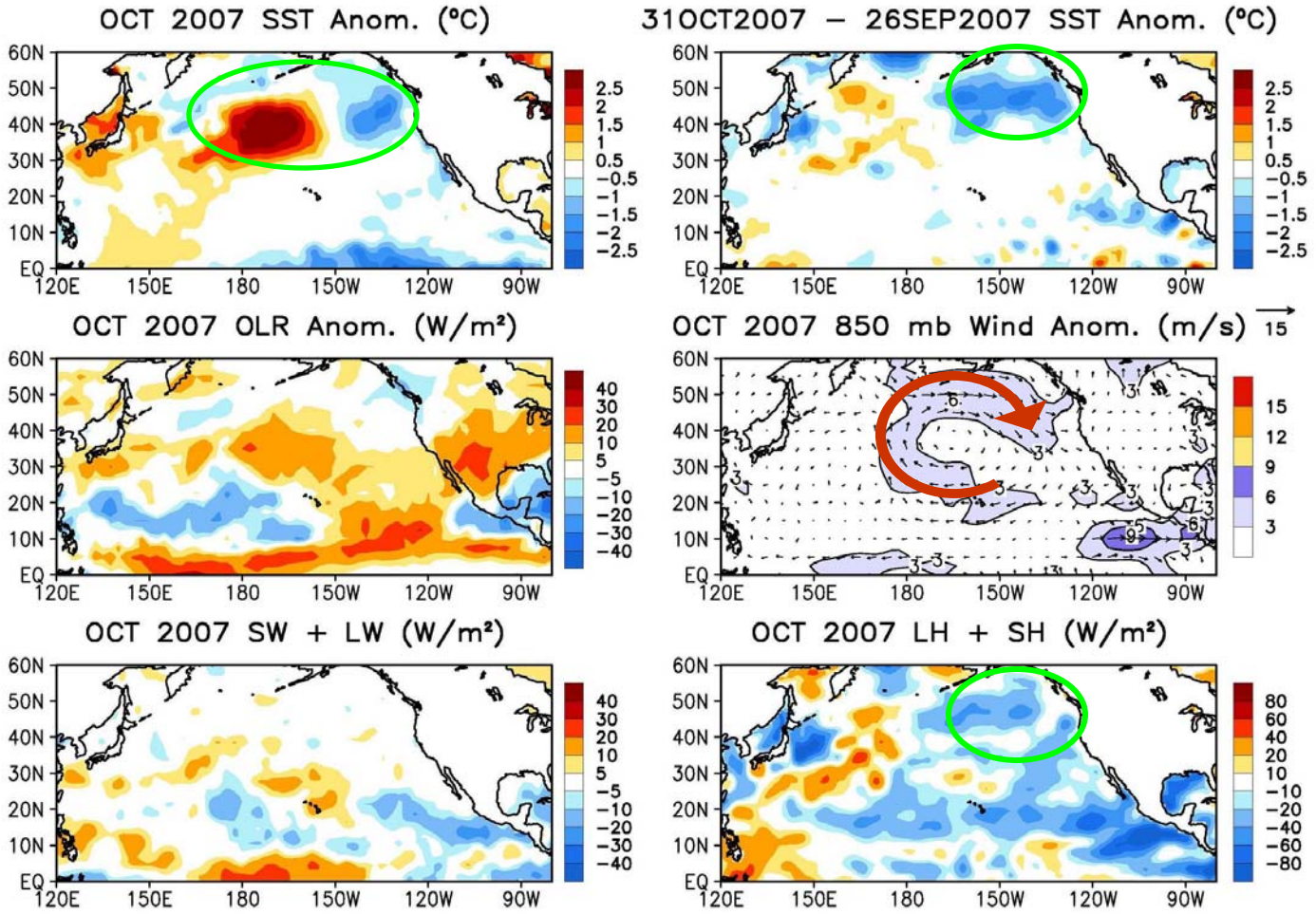


- advective cooling in Dec. 2006 (MJO) followed by entrainment cooling in Jan. 2007
- advective and entrainment warming in May-Jul 2007 (MJO) delayed La Nina development
- advective cooling in Jul. 2007 (MJO) followed by entrainment cooling in Aug-Oct 2007 led to La Nina development
- Advective cooling continued in October

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



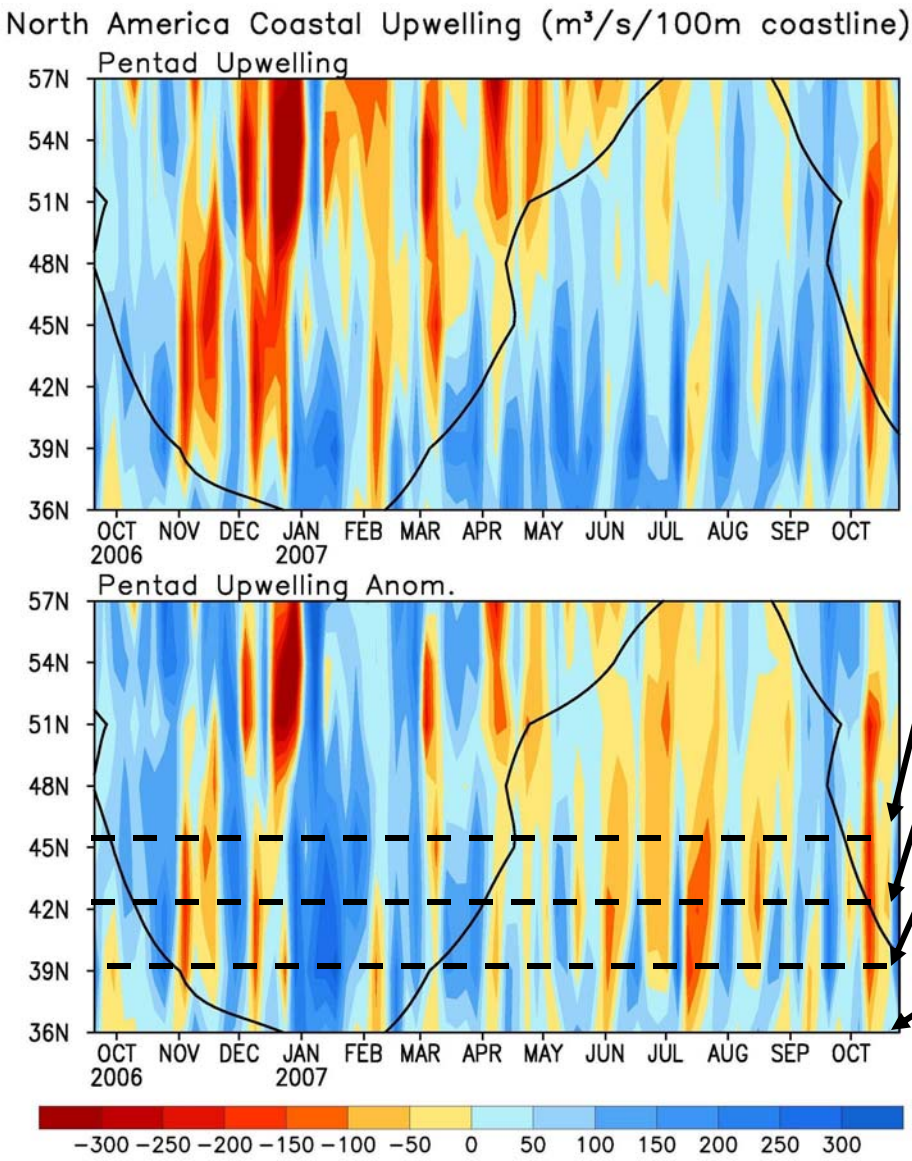
North Pacific: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx



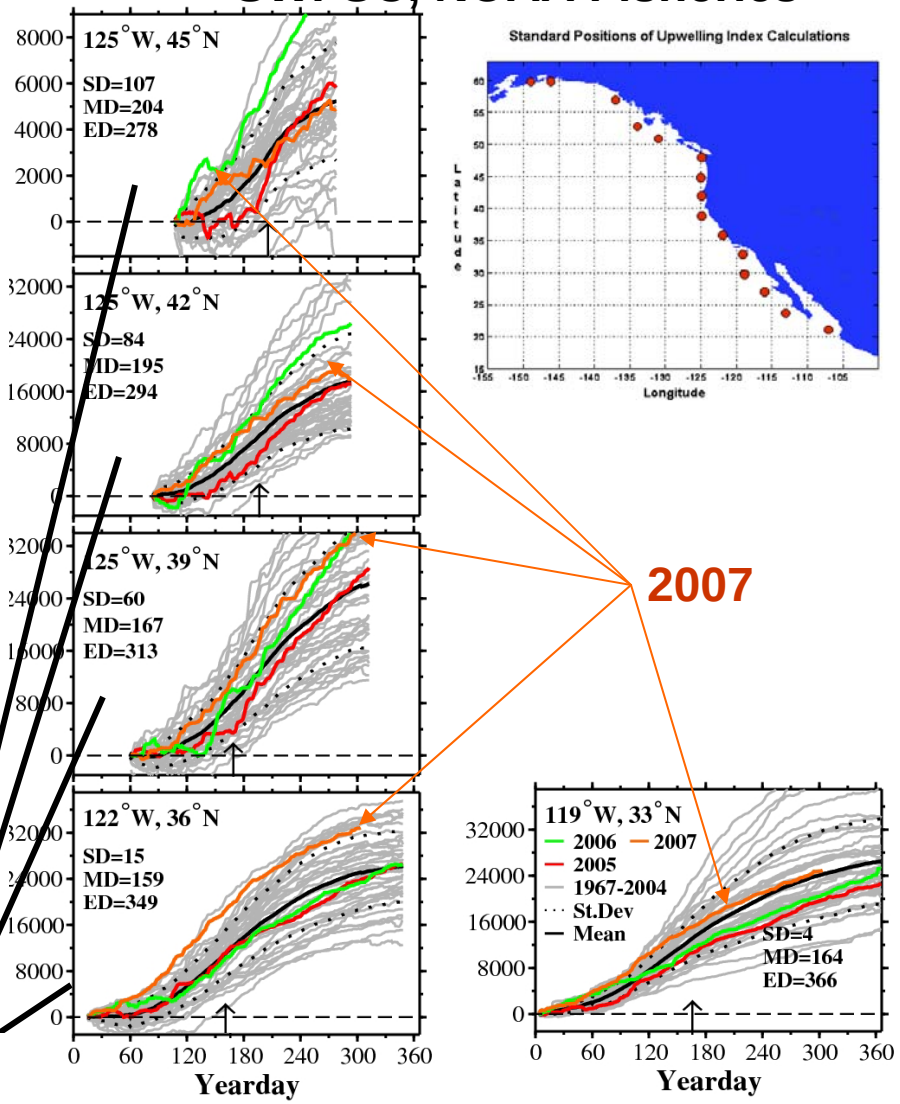
- **Western coast of North America and Gulf of Alaska cooled down … weaken Aleutian Low**
- **Ekman transport / pumping and surface heat fluxes were likely the main external forcing**

North America Western Coastal Upwelling

CPC, NCEP



SWFSC, NOAA Fisheries

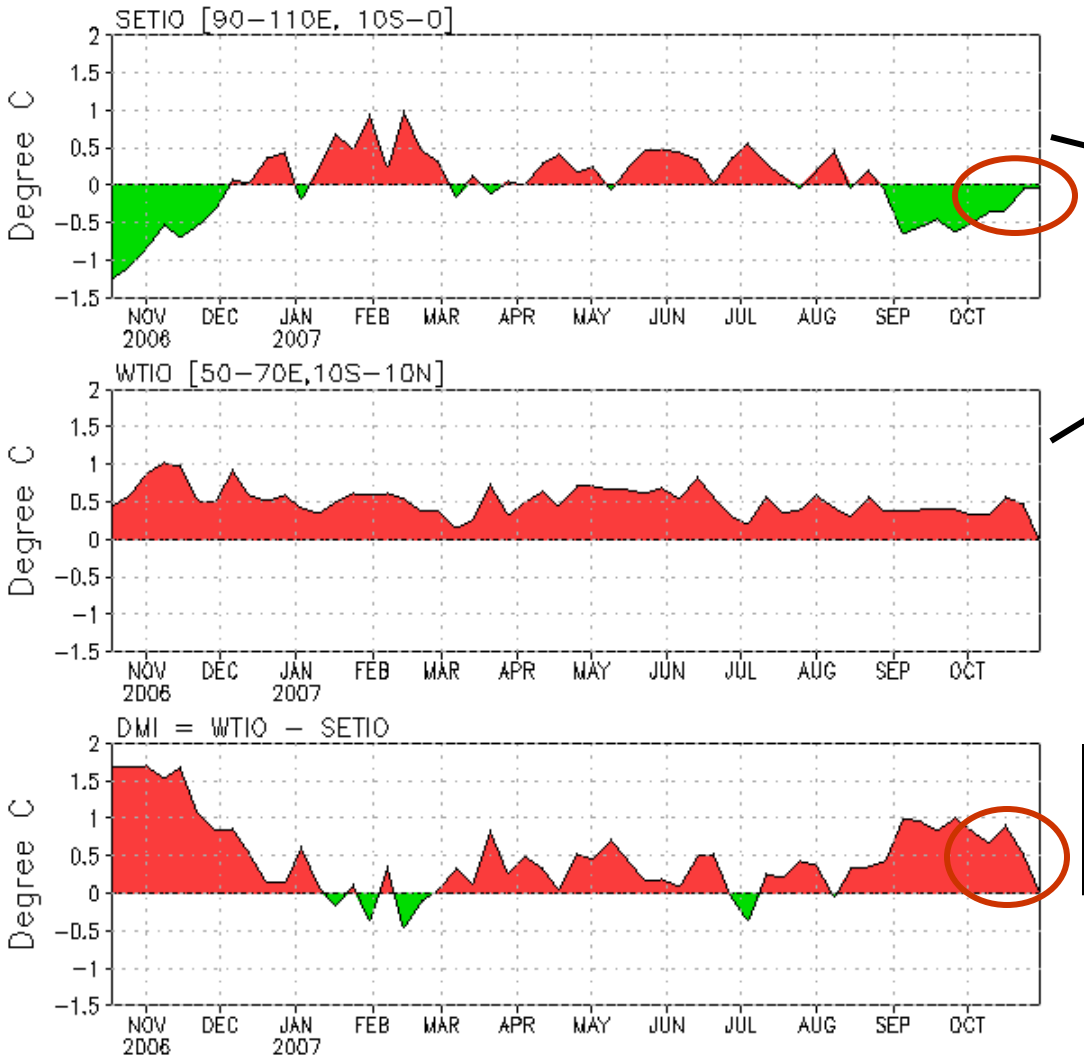


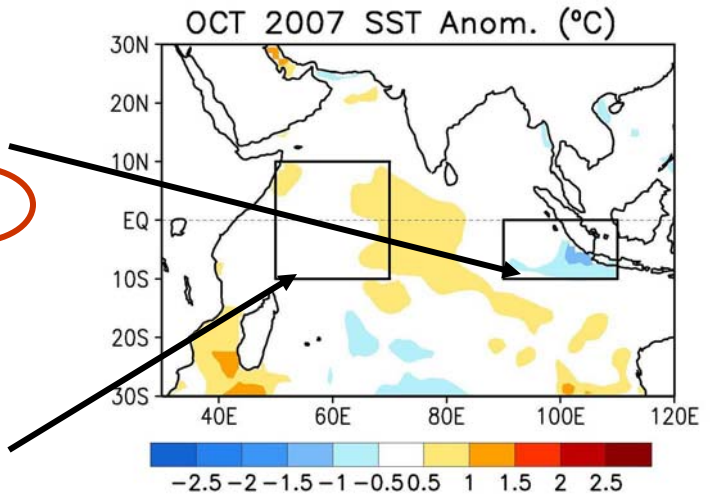
2007 has a strong upwelling season between 45ºN-36ºN

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

Indian Ocean

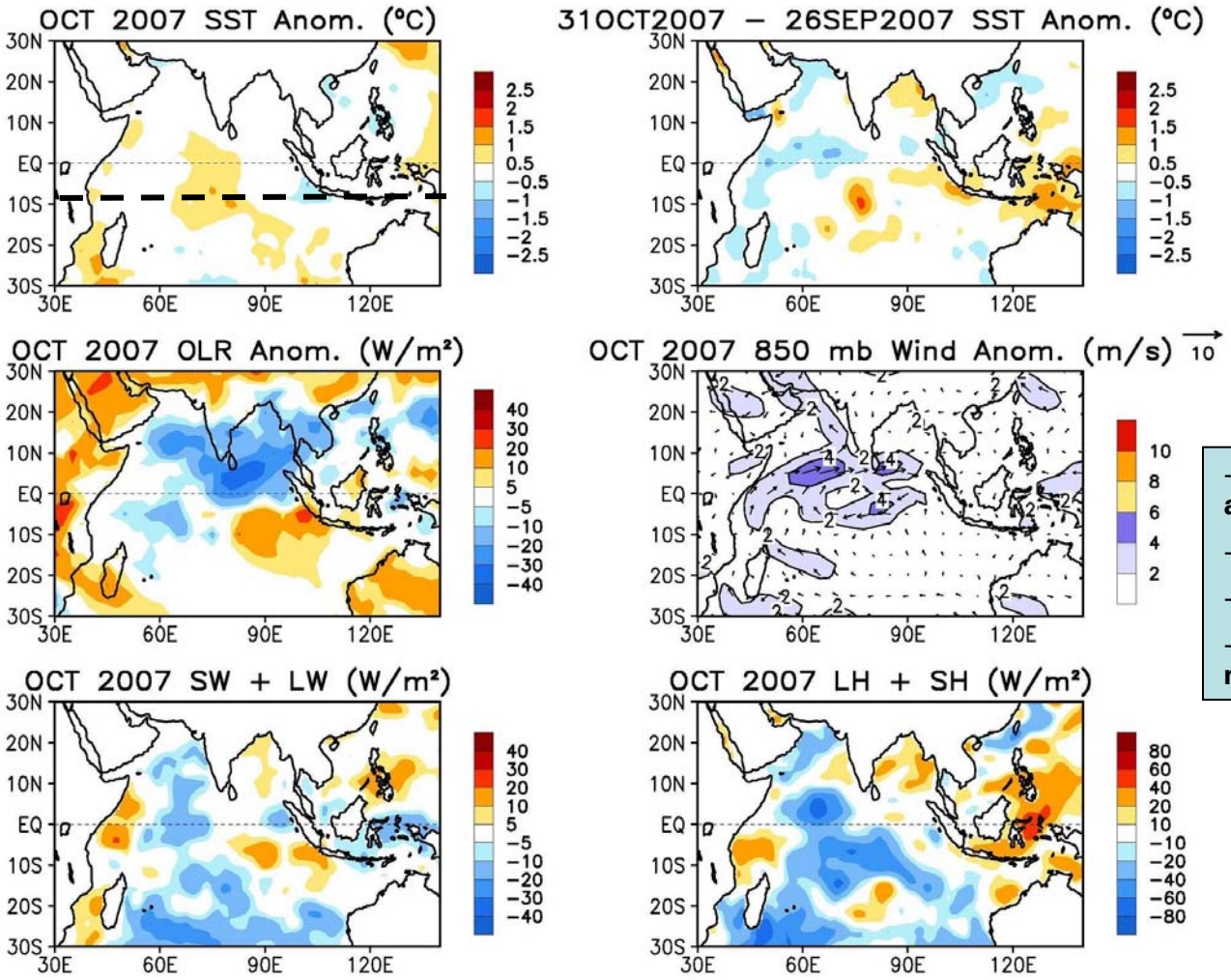
Recent Evolution of Indian Ocean SST Indices





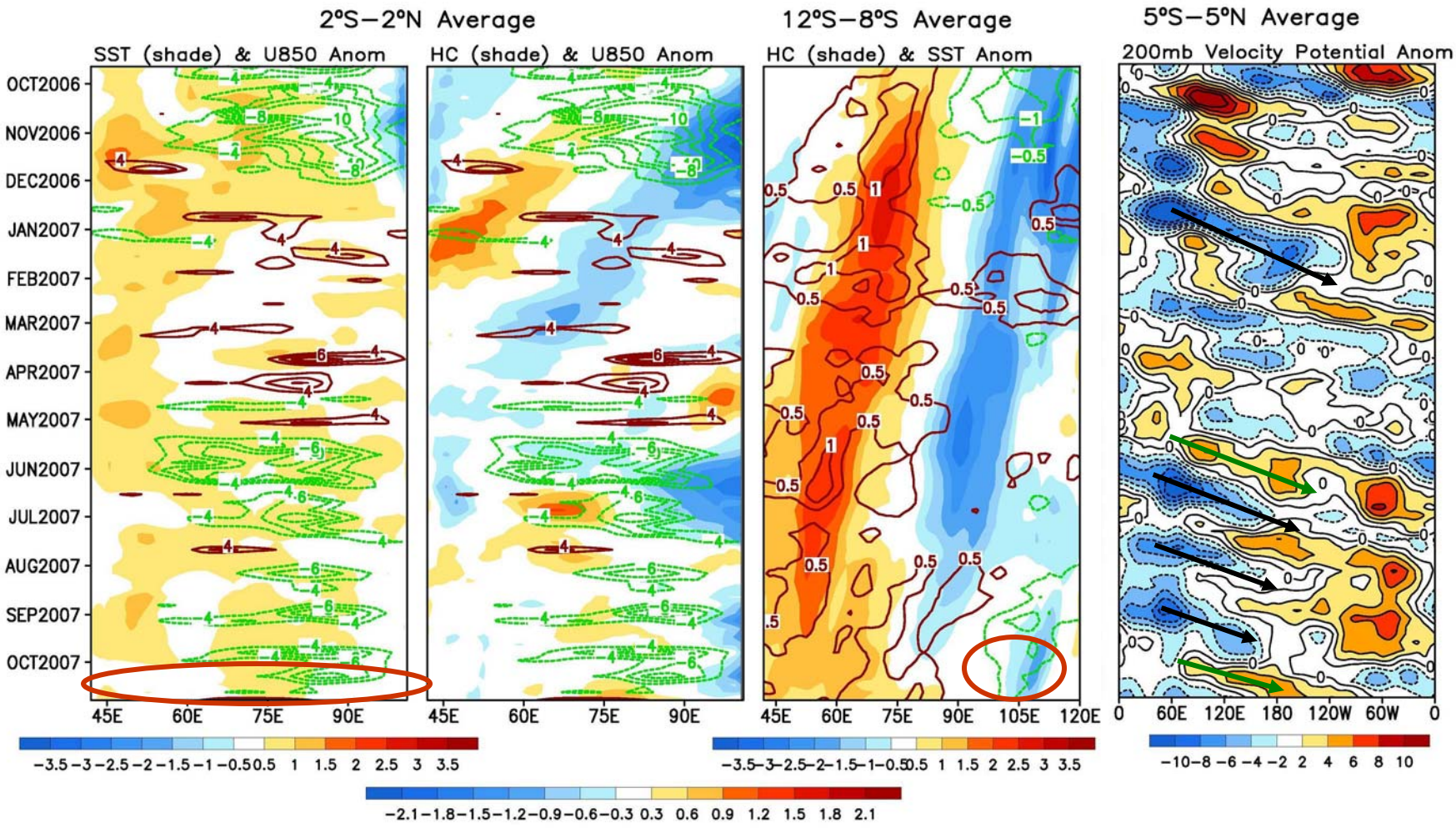
- **Cooling in the south-eastern Indian Ocean weakened**
- **IO Dipole Mode Index (DMI) became normal**

Tropical Indian Ocean: SST Anom., SST Anom. Tend., OLR, 850-mb Winds



- **Stronger x-equatorial flow related above normal monsoon rainfall**
- **Above-normal Somali jet**
- **Weakened SETIO SST anomaly**
- **Near normal along-shore wind near Sumatra**

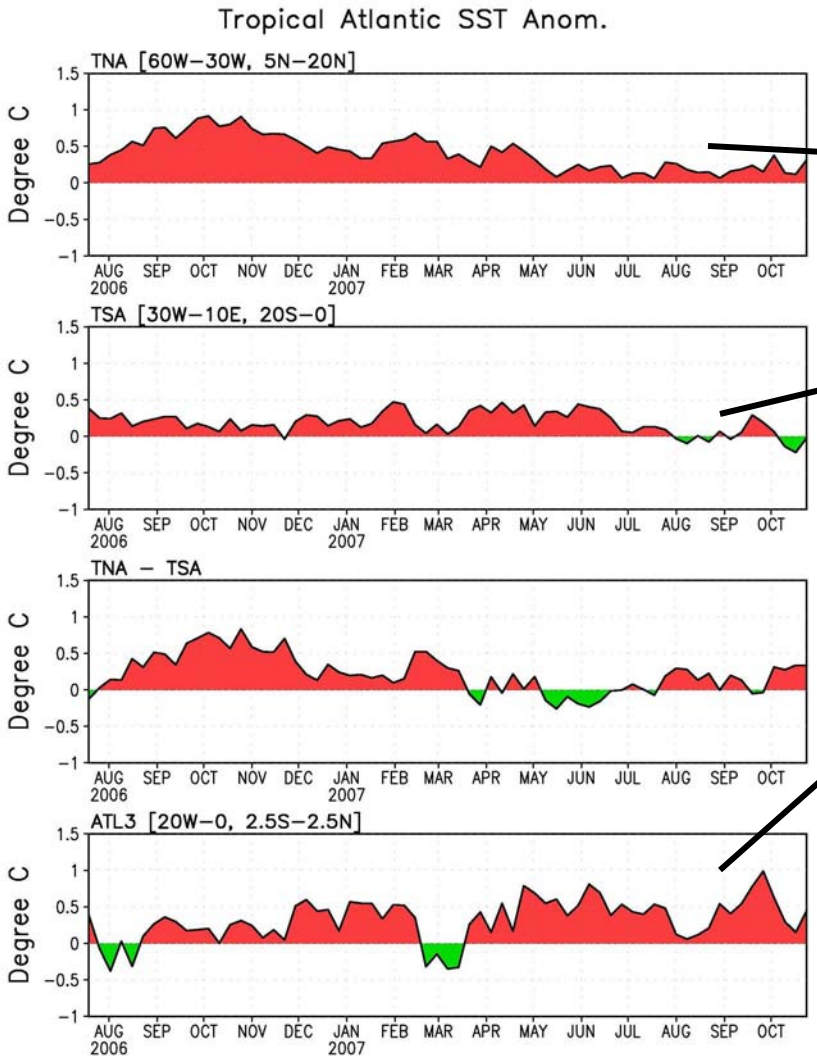
Evolution of Equatorial/10°S Indian SST (°C), 850-mb Zonal Wind (m/s), 0-300m Heat Content (°C)

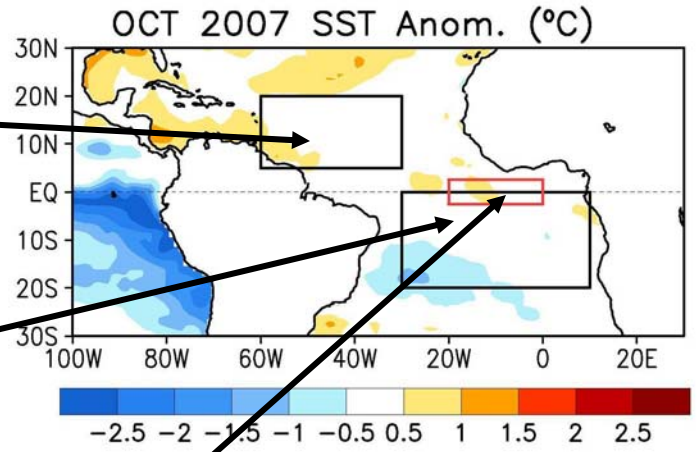


- **Cooling near the Java coast is associated with easterly wind anomalies and negative heat content**
- **Easterly wind anomalies were probably associated with above-normal monsoon circulations**
- **Both SST and wind returned to normal at the end of October**

Atlantic Ocean

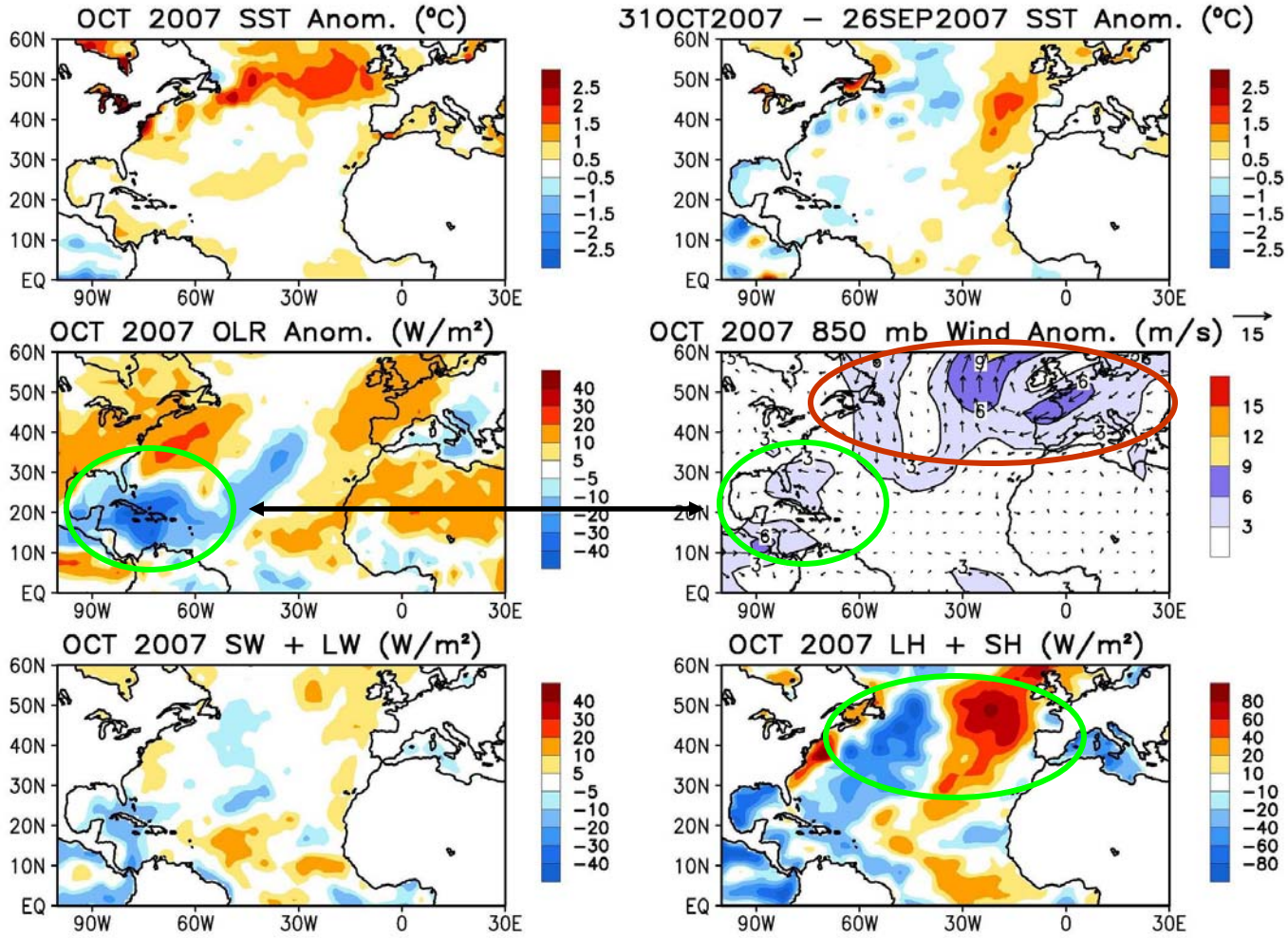
Recent Evolution of Tropical Atlantic SST Indices





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

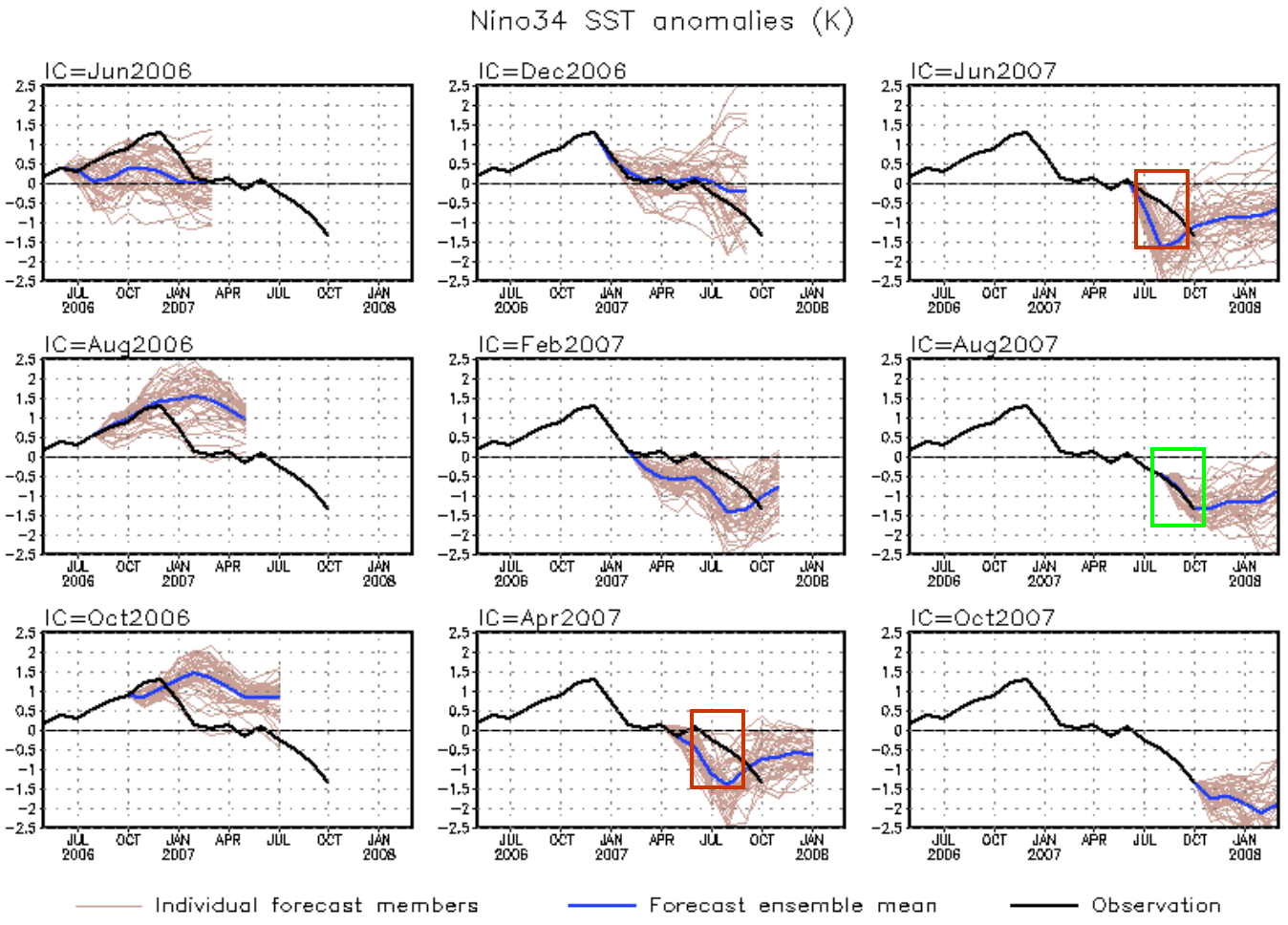
North Atlantic: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx



- Cyclonic wind and precipitation anomalies in Gulf of Mexico and Caribbean Sea
- Large wind and surface heat flux anomalies contributed to SST changes

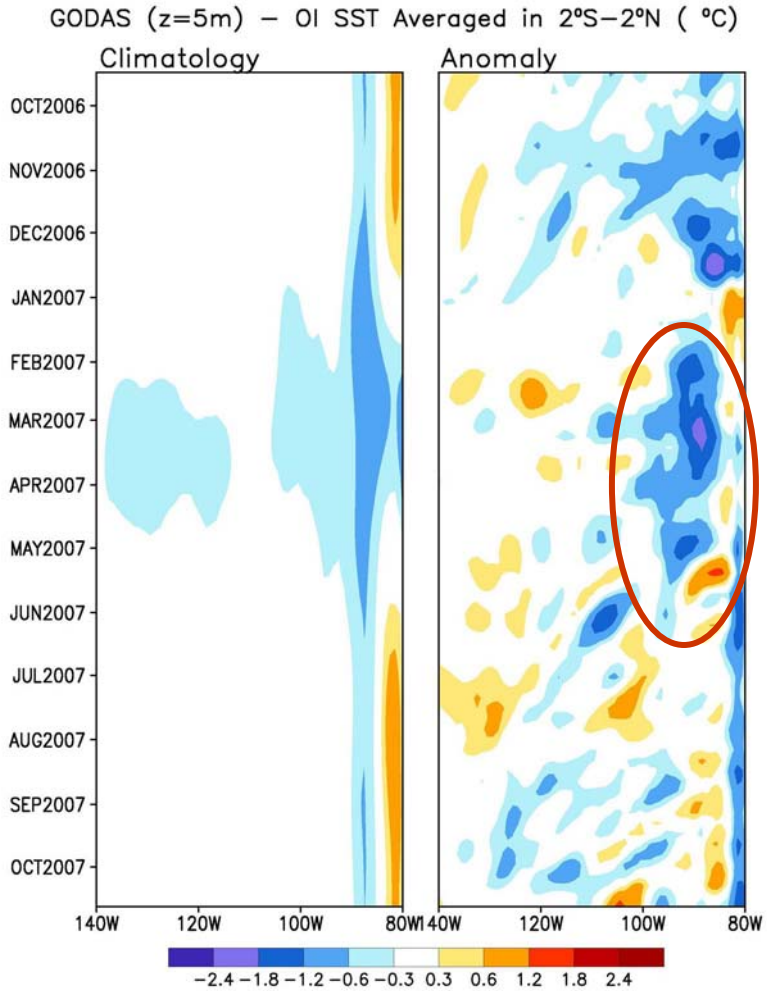
CFS SST Predictions and Ocean Initial Conditions

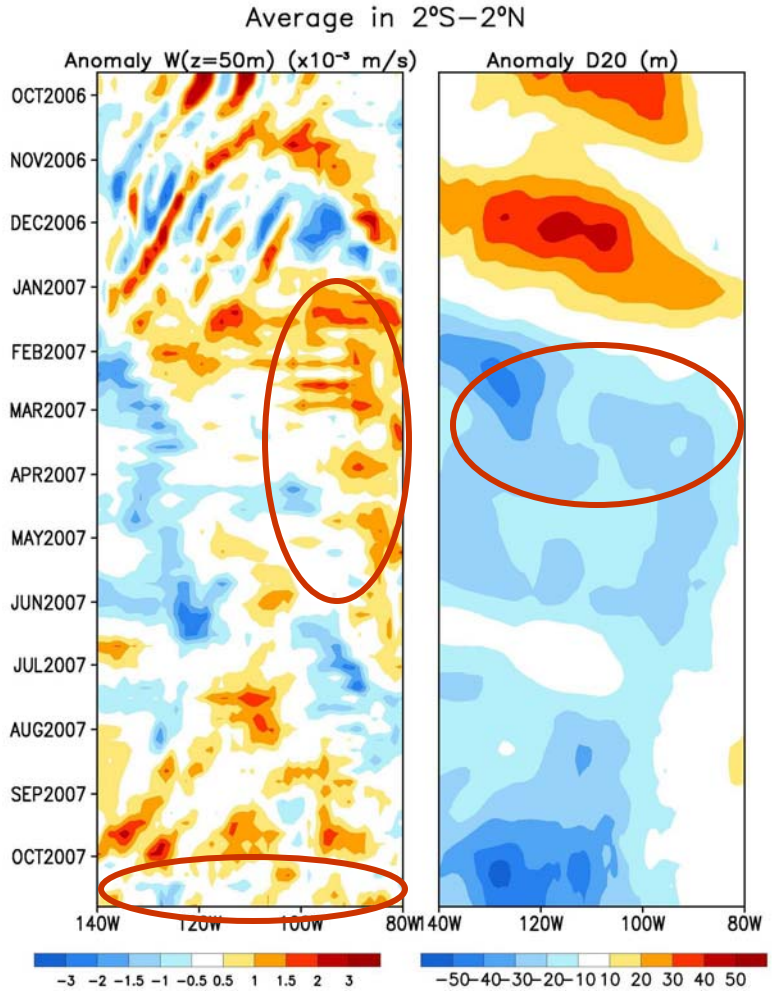
CFS Niño 3.4 SST Predictions from Different Lead Times



- **Earlier onset of cold SST anomalies in spring**
- **Reasonable SST forecast in summer**

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



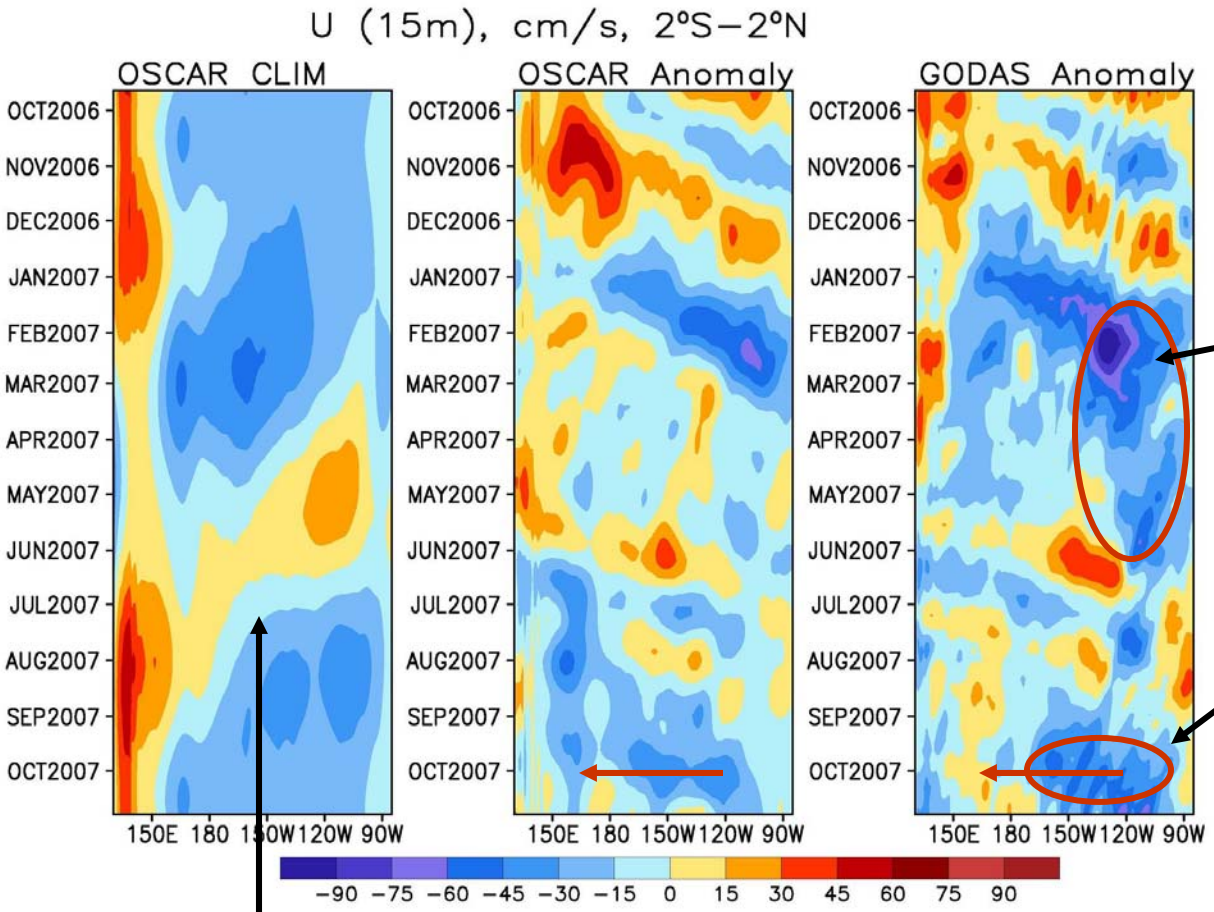


- Large negative SST biases in spring of 2007

  Related to anomalously strong upwelling at 50-meter depth, and shallow thermocline in the analysis

- Upwelling is abnormally strong in Sept. 2007 and returned to normal in Oct. due to weakened easterly anomalies

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

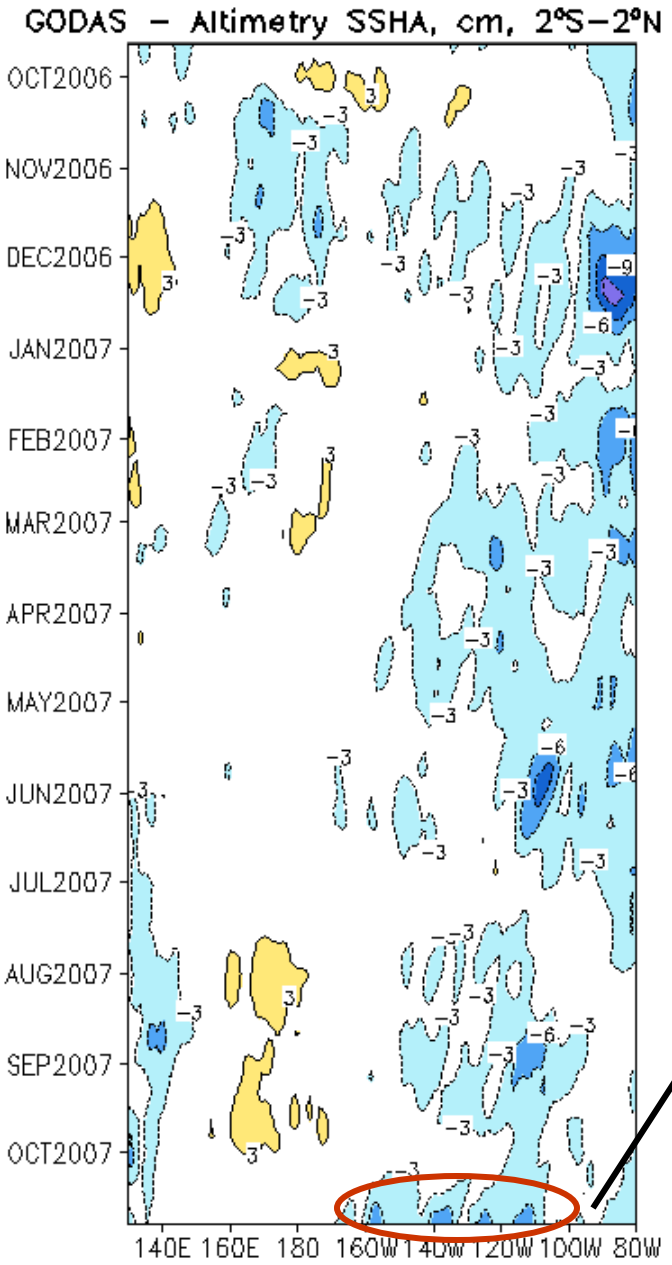


Too strong westward currents

Anomalous westward currents since Sept. 2007

Climatological surface currents are westward since July

Cold SST biases and too strong westward currents contributed to earlier onset of cold SST forecast in spring 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 (-5C) in GODAS are probably too large, consistent with the differences between TAO and GODAS shown in slide 9.**

Summary

- **Pacific Ocean**
  - Negative SST anomalies east of dateline and along the coast of South America
  - Further development of negative SST anomalies in the central Pacific
  - CPC's prognostic assessment: La Niña will continue in the next several months
  - Large SST changes in the subtropical North Pacific
- **Indian Ocean**
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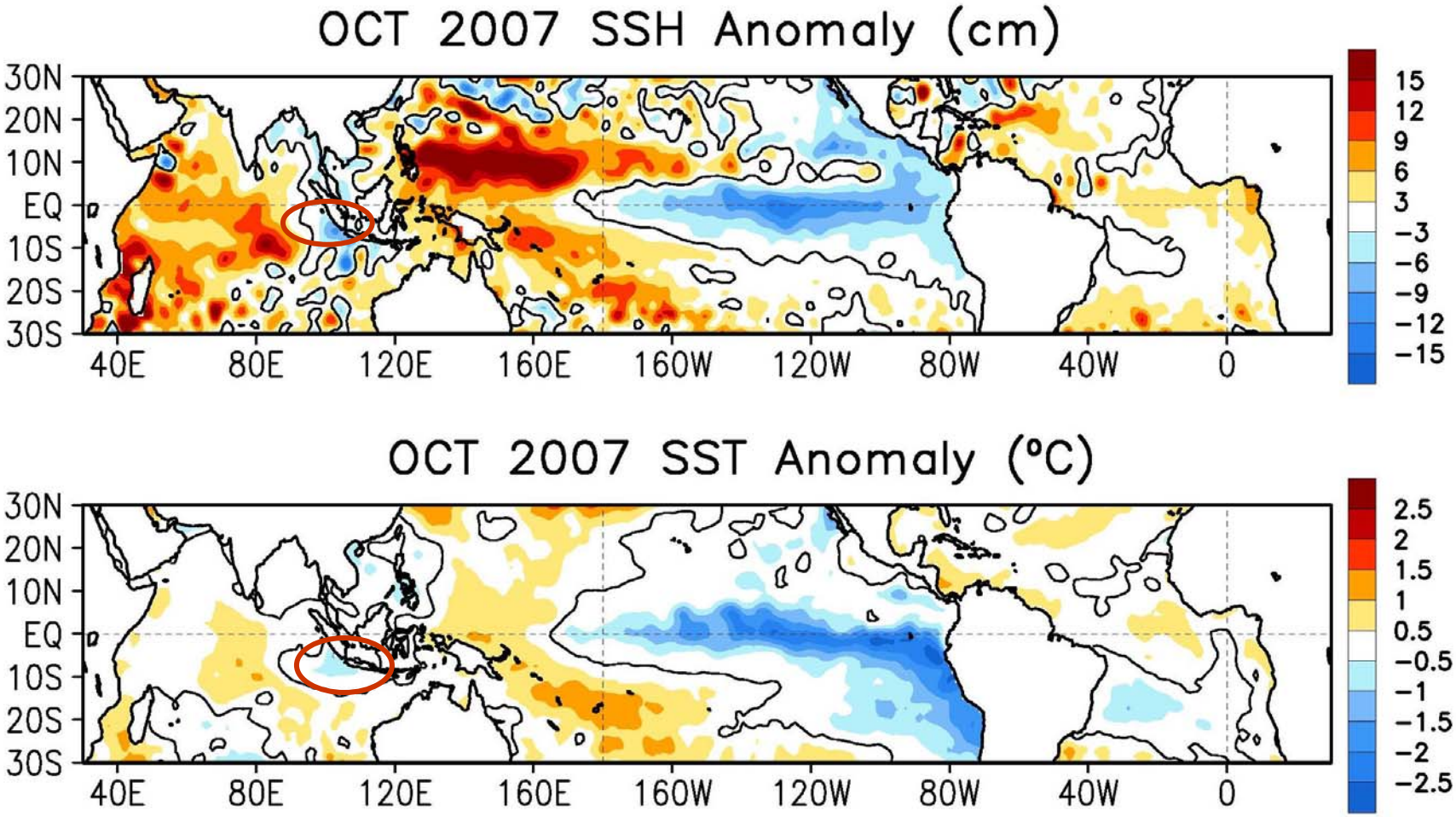
  - Cyclonic wind precipitation anomalies along Gulf of Mexico and Caribbean Sea
  - Positive SST anomaly stretched southward in the extra-tropical North Atlantic

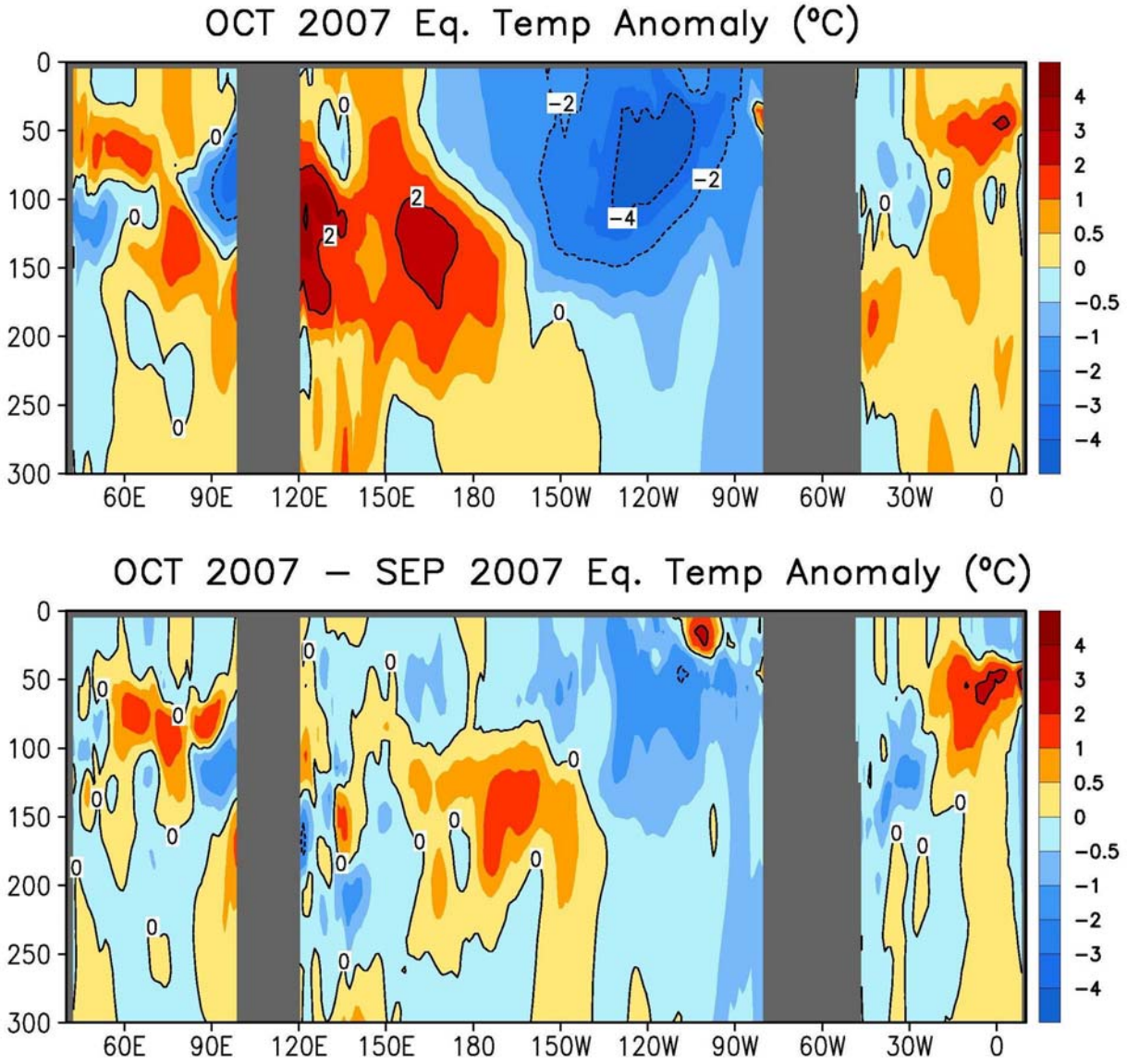
Backup Slides

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

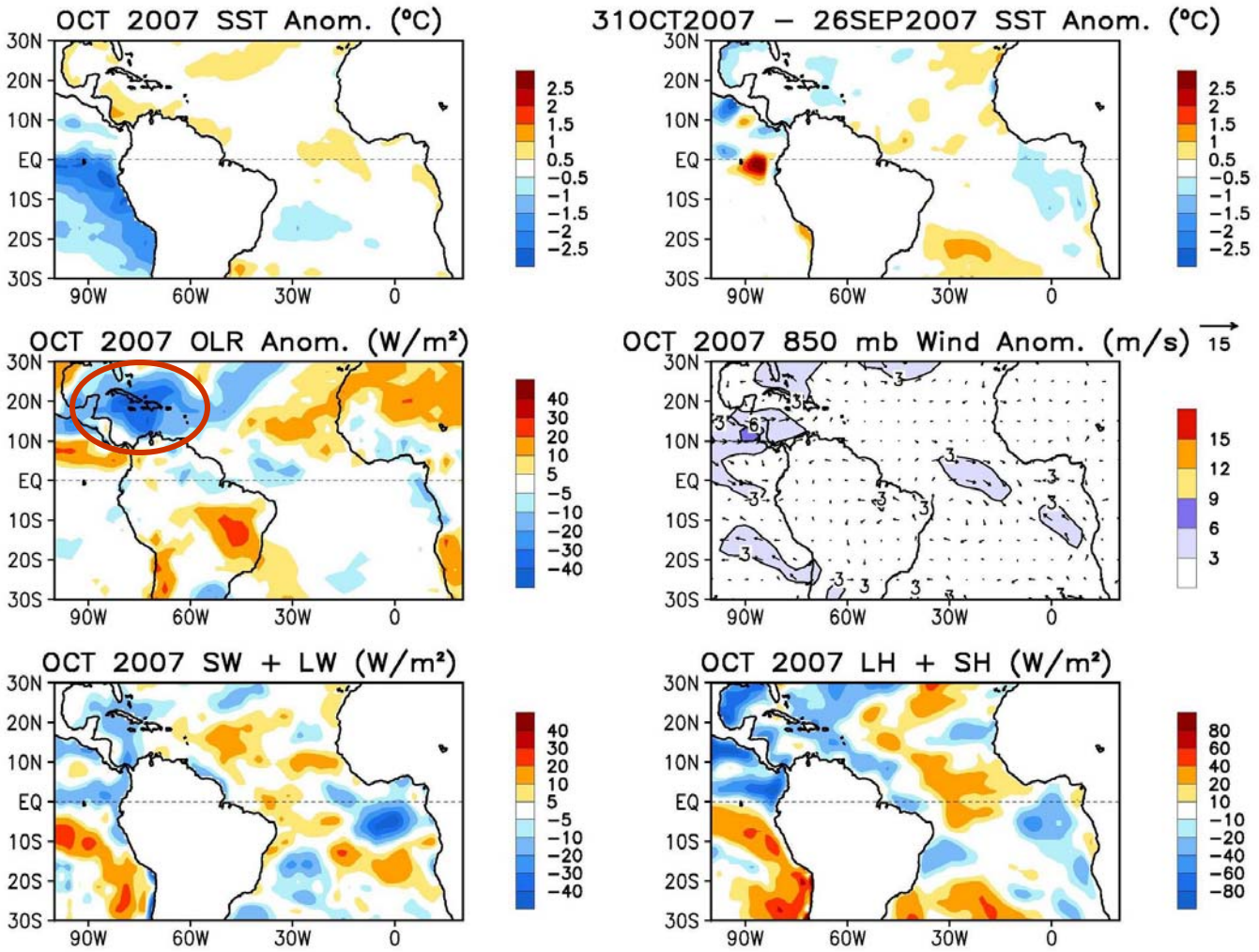


- **Good consistency between SSH and SST in the equatorial latitudes**
- **Changes in the SH extratropical latitudes in the SSH may reflect warming trends in the deeper oceans**

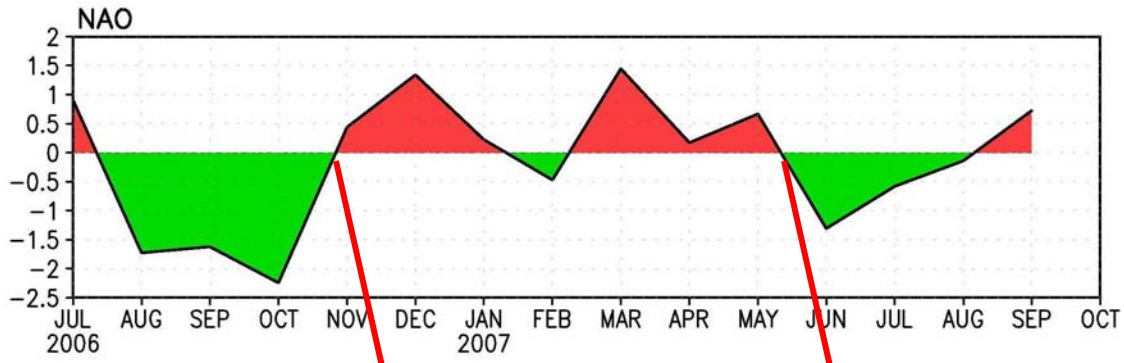
GODAS Equatorial X-Z Temperature

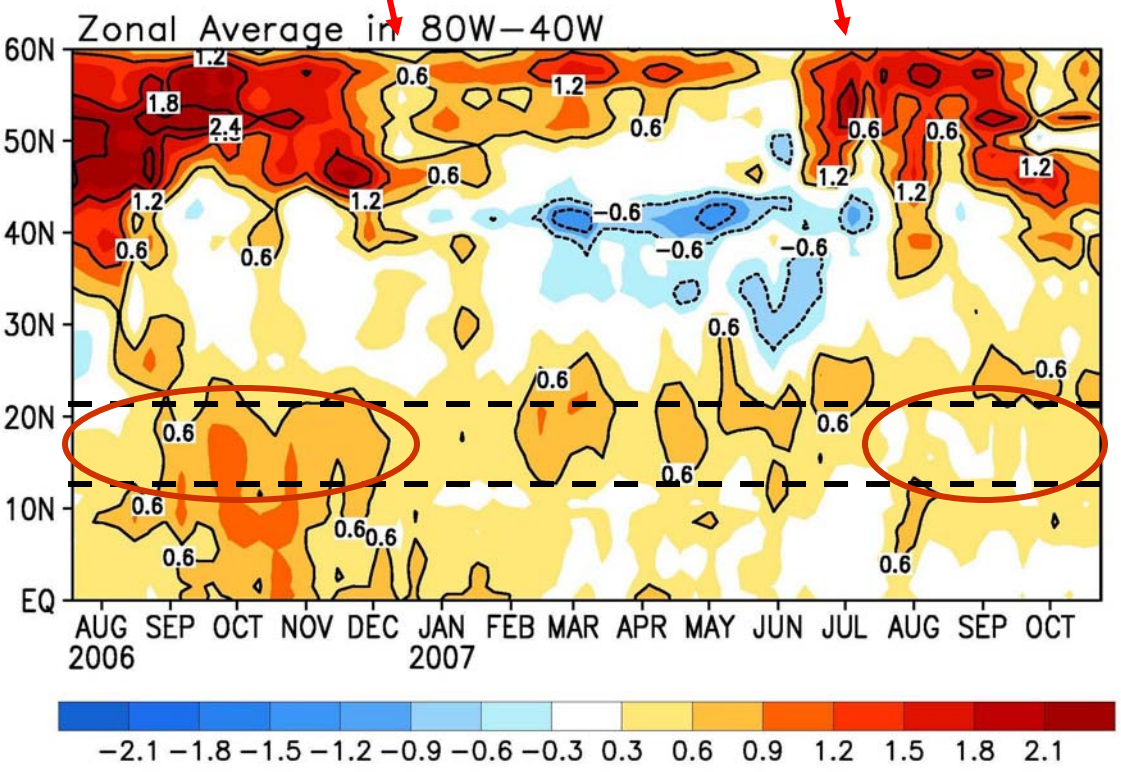


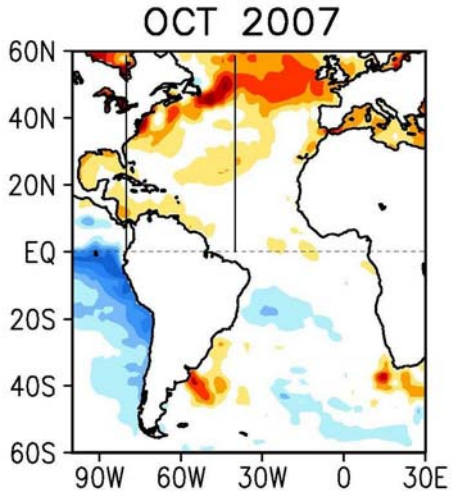
Tropical Atlantic: SST Anom., SST Anom. Tend, OLR, 850-mb Winds, Sfc Rad, Sfc Flx



Attribution of SST Anomaly in Northwest Atlantic

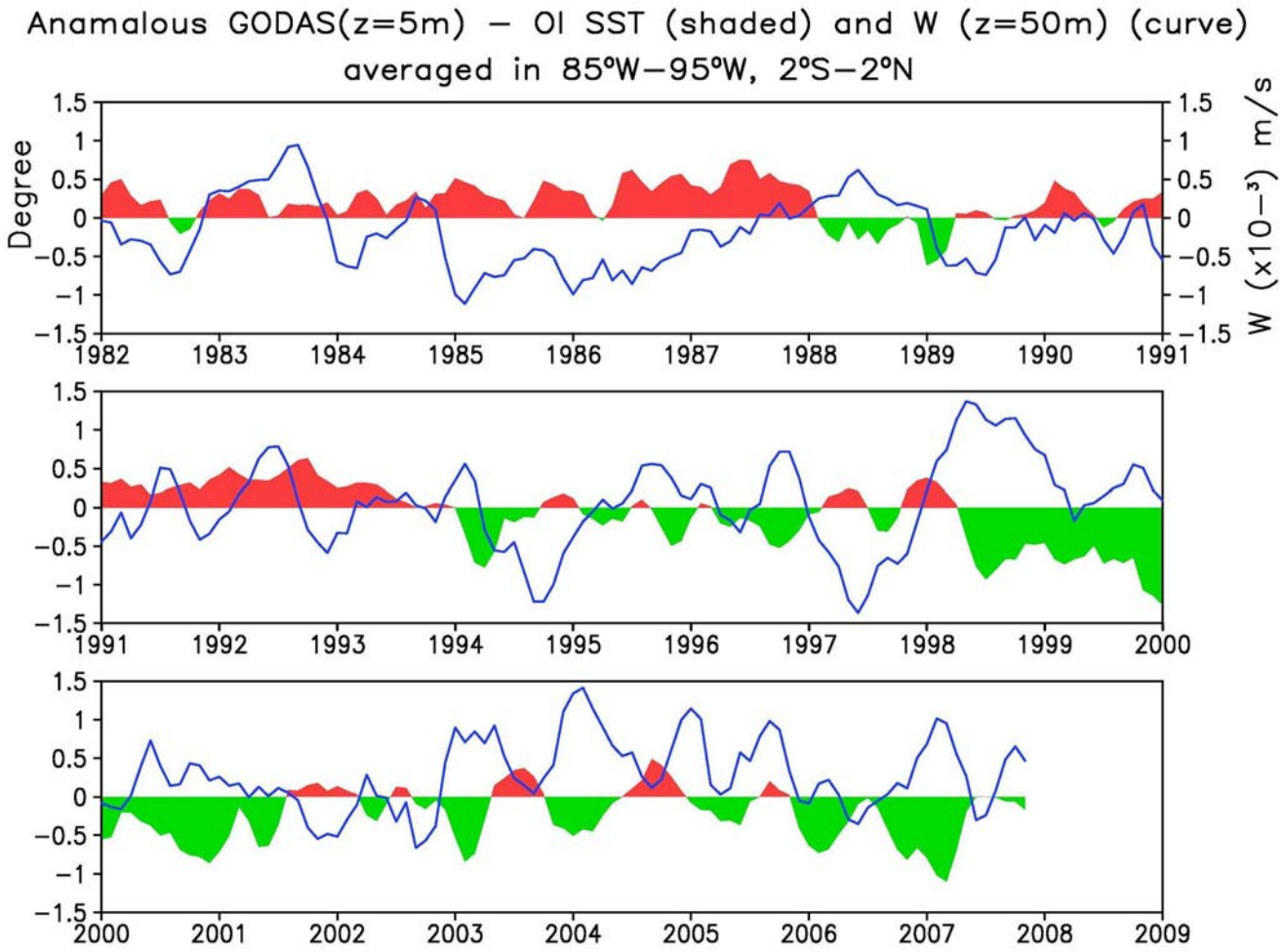






Hurricane season warm SST anomalies weaker than they were last year in MDR

Historical Evolution of Equatorial Far Eastern Pacific SST Biases and Vertical Velocity

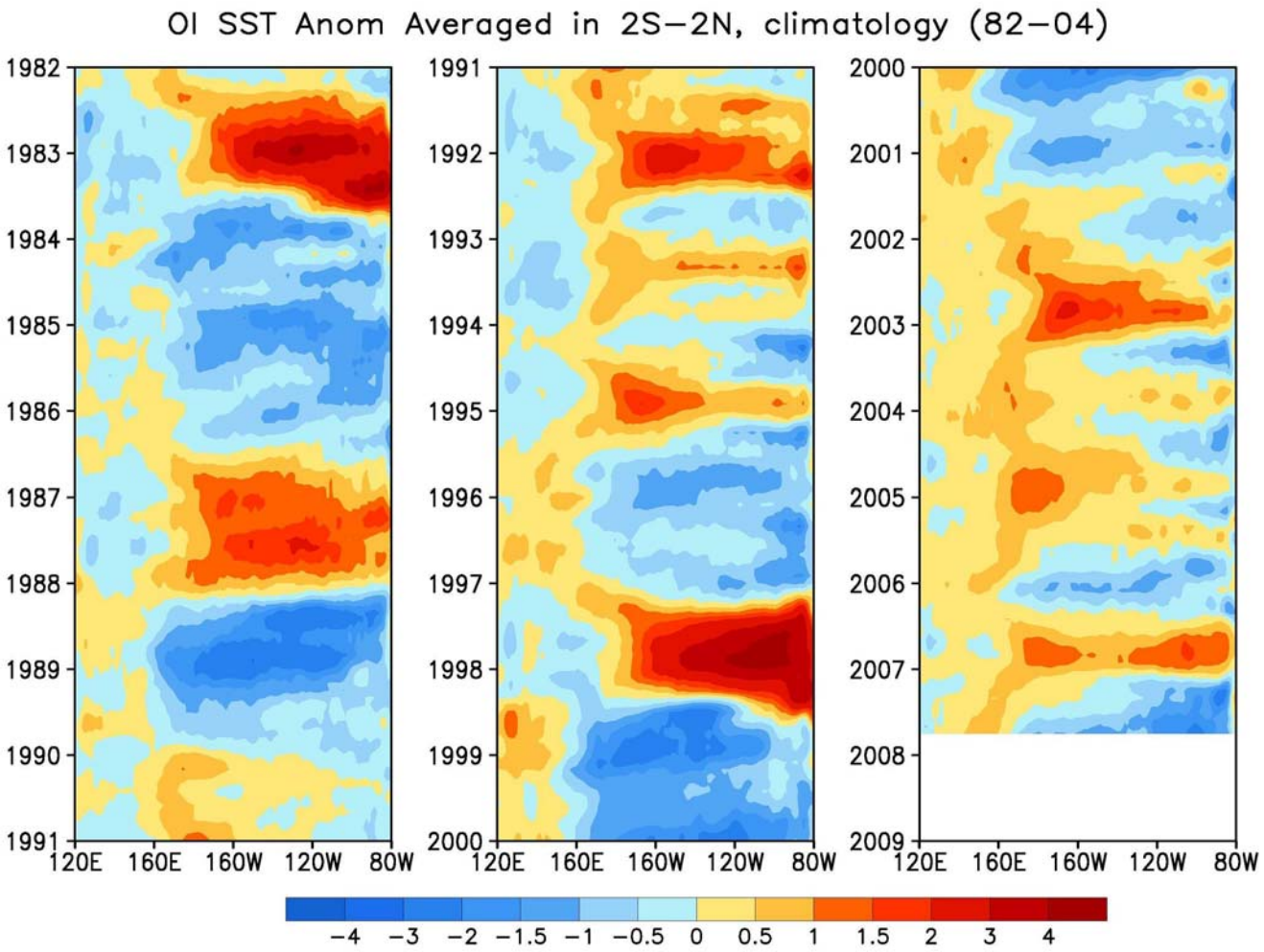


Negative anomalous SST biases since 1998

Related to anomalously strong upwelling

Anomalous upwelling - annual cycle – early spring surge since 2003

Decadal Variability of Equatorial Pacific SST

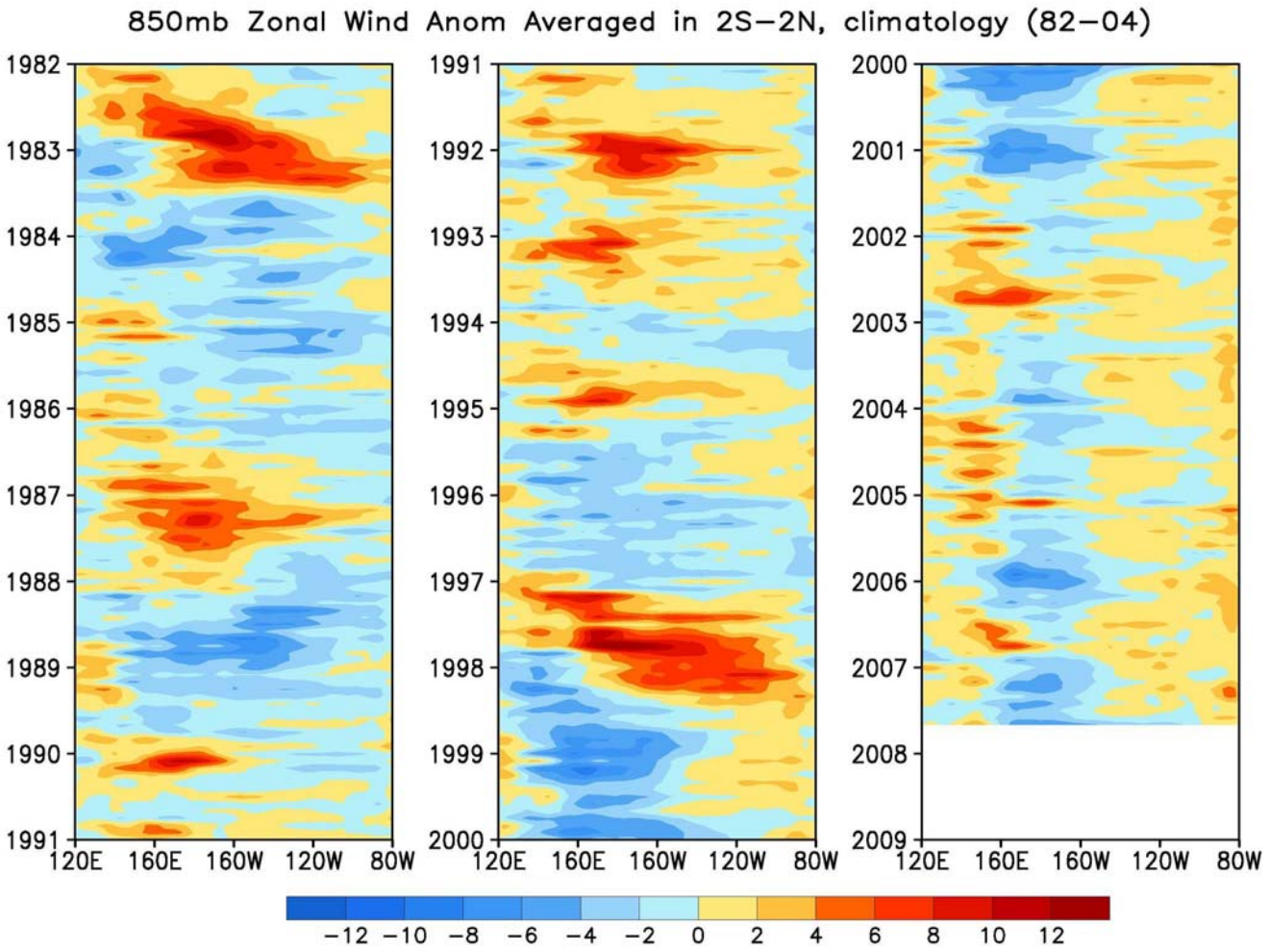


Persistent western Pacific warming since 2001

Weak SST variability since 2001

High frequency (annual) eastern Pacific SST variability – annual cooling in spring

Decadal Variability of Equatorial Pacific Zonal Winds



Easterly anomalies persistent near the dateline since 2001

Westerly wind events abundant west of 160E since 2001

Westerly anomalies persistent in the far eastern Pacific since 2001