

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

Prepared by
Climate Prediction Center, NCEP
July 8, 2008

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

Outline

- **Overview**
- **Recent highlights**
 - **Pacific Ocean**
 - **Indian Ocean**
 - **Atlantic Ocean**
- **CFS SST Predictions**

Overview

- **Sub-surface Observations**

- GODAS disagrees with NODC sub-surface temperature analysis in Southern Oceans due to lack of observations.

- **Global Ocean**

- Global mean SST cooling since last year has halted.
- No corresponding changes in global sea-surface height.

- **Pacific Ocean**

- La Nina has transitioned to ENSO-neutral conditions: NINO3.4 in June is -0.4C.
- CPC's prognostic assessment: ENSO-neutral conditions will continue into fall.
- Easterly wind anomalies and suppressed convection in C. Pacific weakened.
- E. Pacific positive SST anomalies persisted.
- Negative PDO pattern in N. Pacific persisted.

- **Indian Ocean**

- Easterly wind anomalies in tropical Indian persisted.
- Positive IODM patterns in SST, winds, OLR, and heat content: DMI in June is 0.7C.

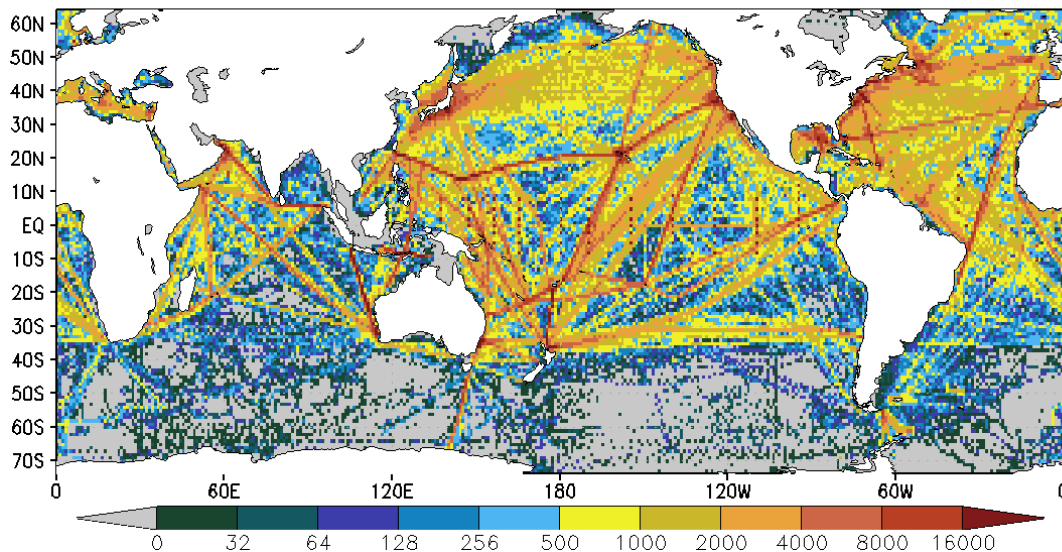
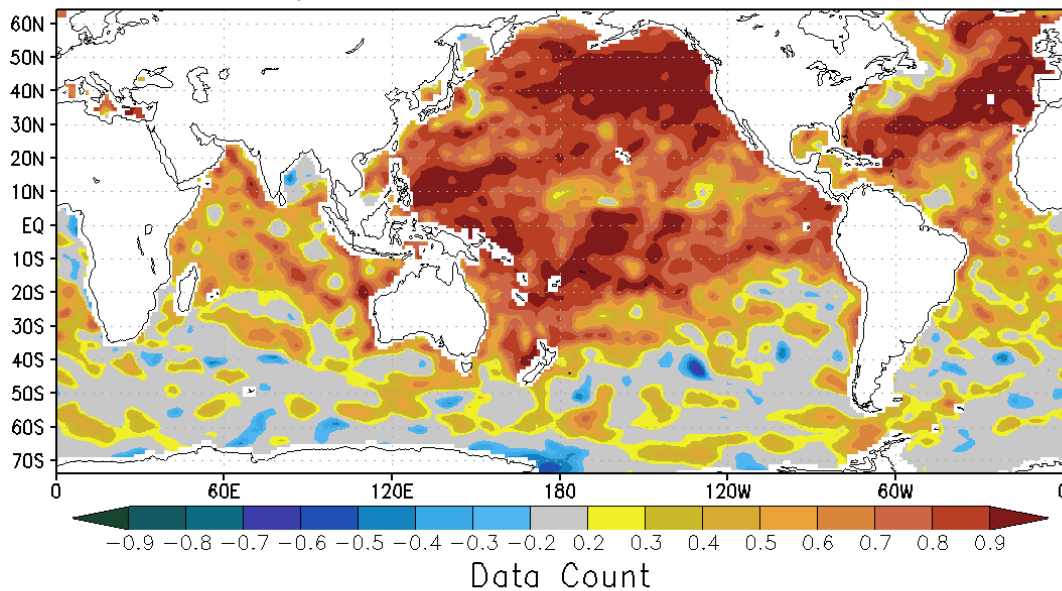
- **Atlantic Ocean**

- Northern Atlantic has warmed in the past few months.

Comparison of GODAS with NODC analysis:

300 m Heat Content (1979-2003)

HC300 Temporal Correlation: Annual Mean GODAS,NODC

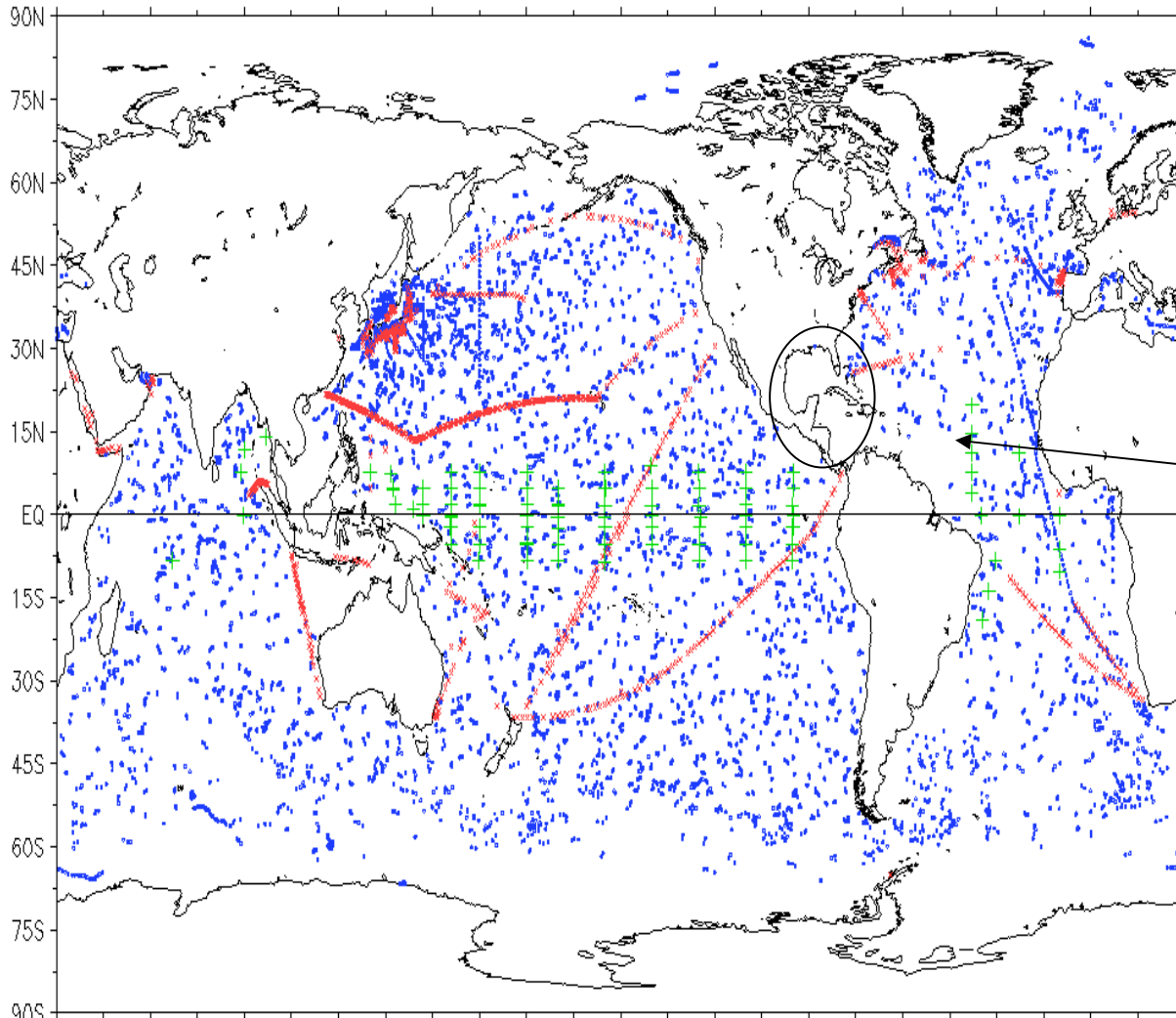


-Good correspondence between temporal correlation and data count.

- Little observations south of 40S in 1979–2003 when the coverage of Argo floats is limited.

Input data Distribution: June 2008

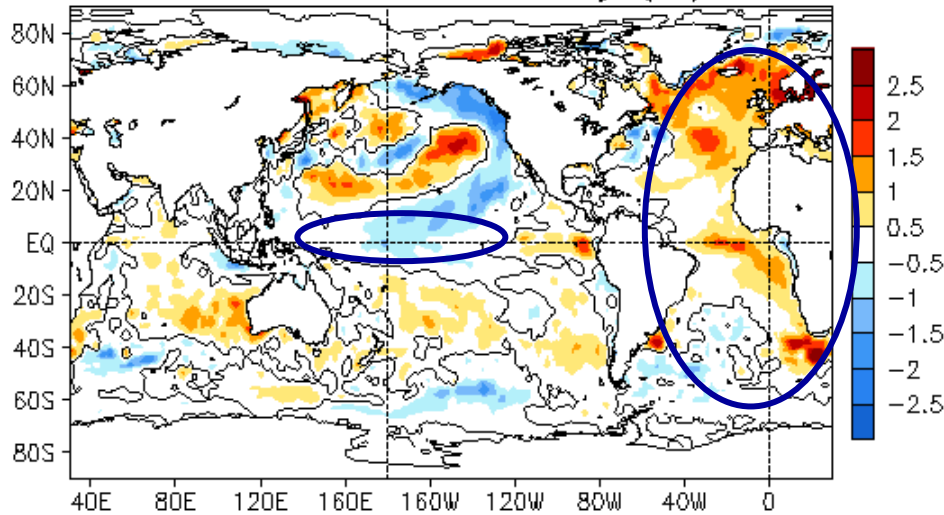
Temperature profiles (0–250m), 2008 June



-No observations in Gulf of Mexico, and only 1 in Caribbean Sea.

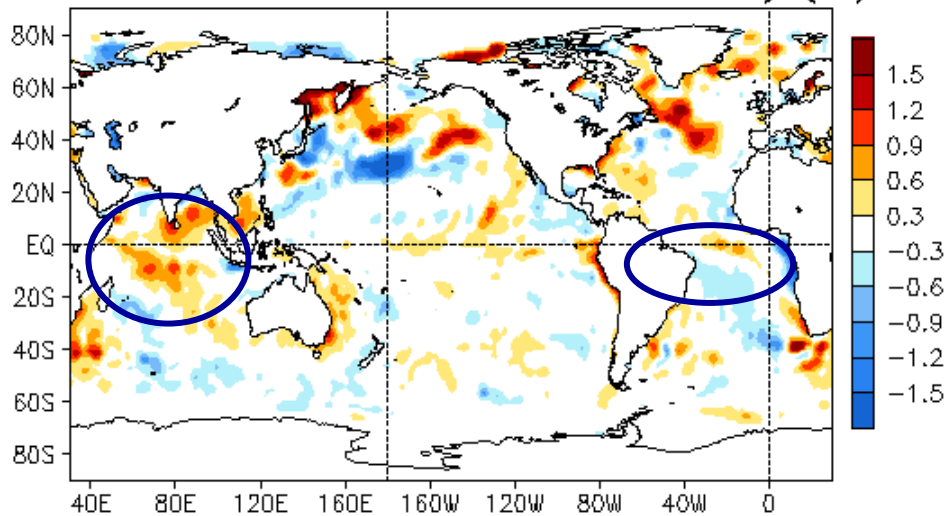
Global SST Anomaly ($^{\circ}\text{C}$) and Anomaly Tendency

JUN 2008 SST Anomaly ($^{\circ}\text{C}$)



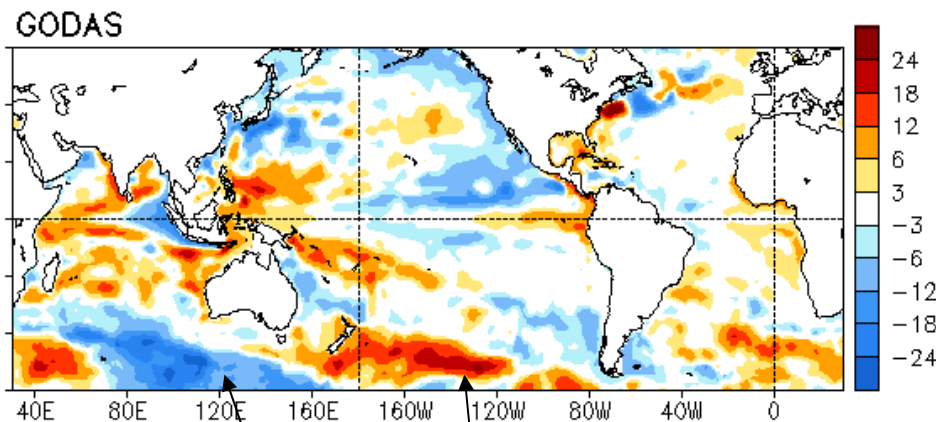
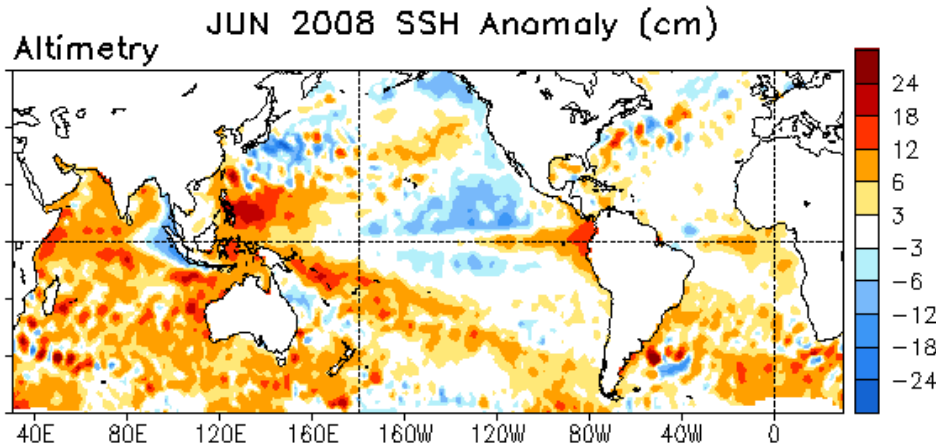
- Negative PDO pattern in North Pacific
- Above-normal SST in large portions of Atlantic.
- Negative temperature anomalies confined to near the Dateline in the equatorial pacific.

JUN 2008 - MAY 2008 SST Anomaly ($^{\circ}\text{C}$)



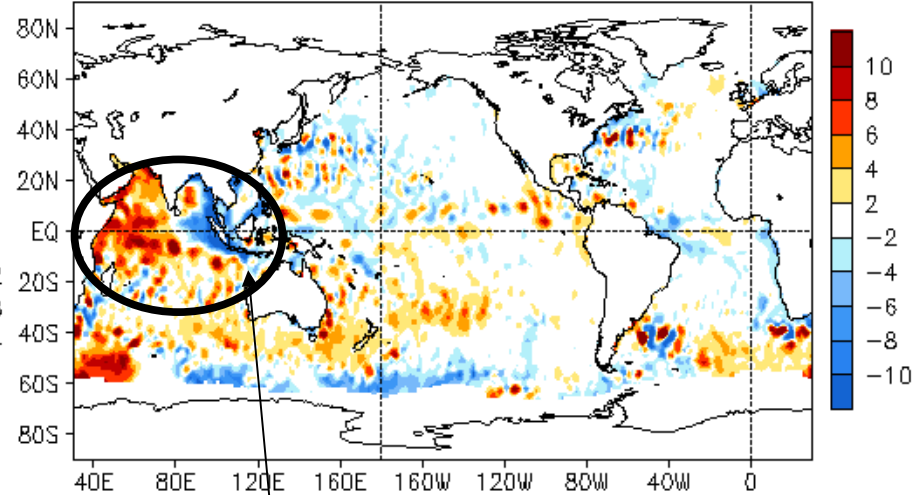
- Weak warming in all nino-regions
- Central Indian Ocean warmed up
- Largest changes presented in North Pacific and Atlantic.

Sea Surface Height



-Large discrepancies in Southern Oceans, likely due to poor climatology.

JUN 2008 - MAY 2008 SSH Anomaly (cm)

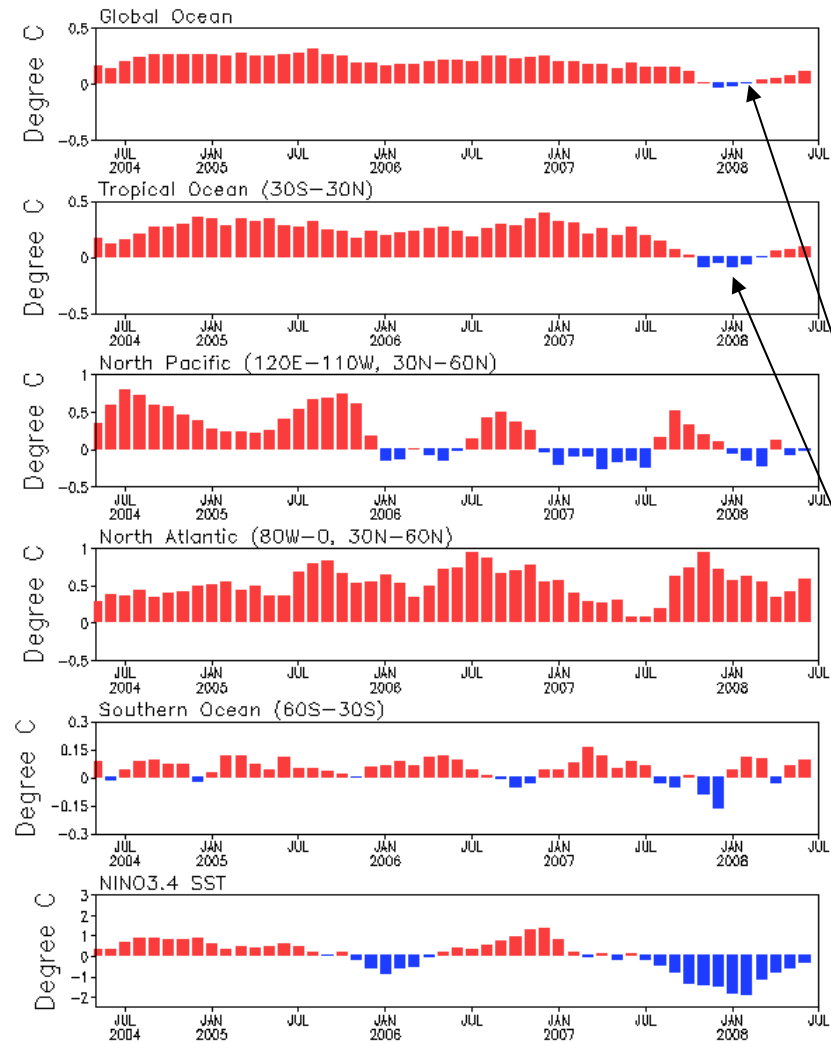


- Significant decrease in SSH in the eastern Indian Ocean and increase in western Indian Ocean.

Monthly Time Series

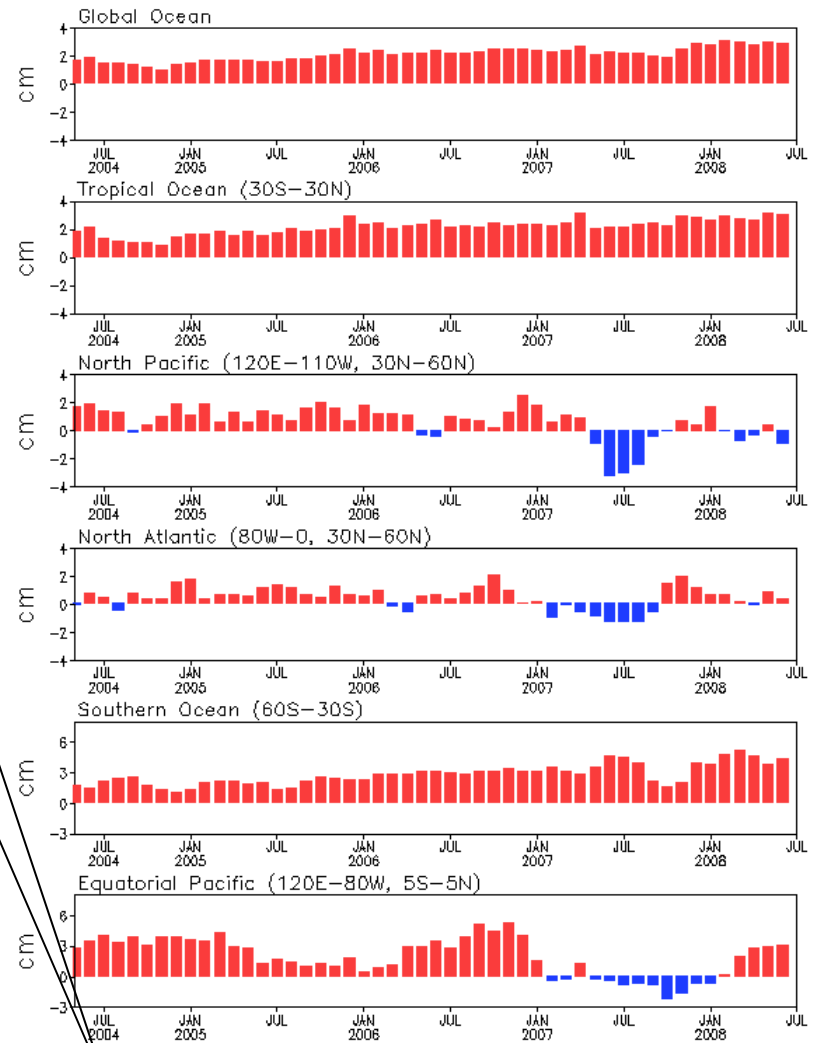
Sea Surface Temperature

Monthly SST Time Series (OISST.v2, Climo. 1971–2000)



Altimetry

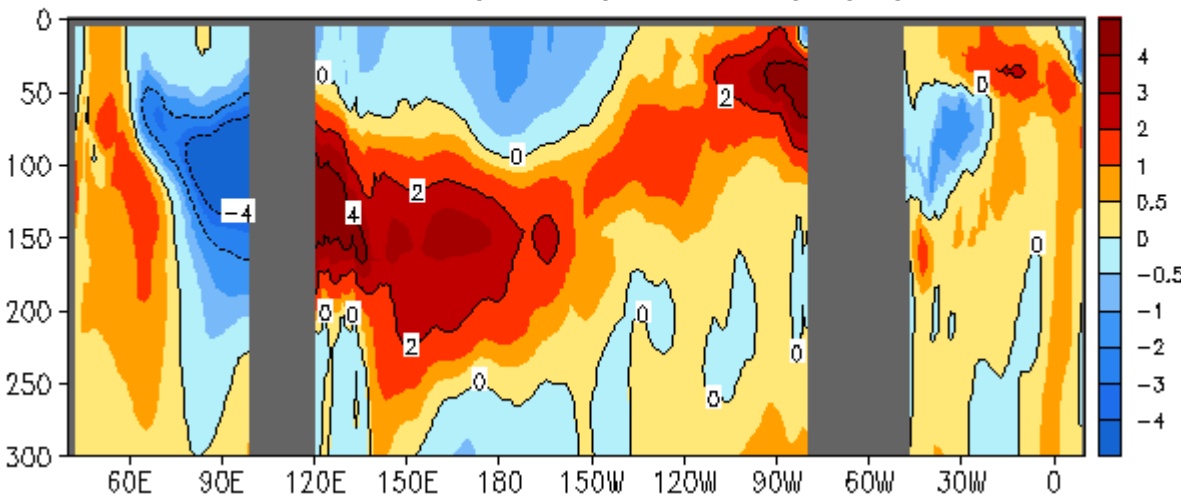
Monthly SSH Time Series (Aviso Altimetry, Climo. 1993–2005)



- Cooling of global SST since mid-2007 is not reflected in altimetry. Suggesting that the cooling is only at the surface.
- Now that the La Nina is over, the global SSTs are warming again.
- North Atlantic SST has been persistently above-normal since 1995.

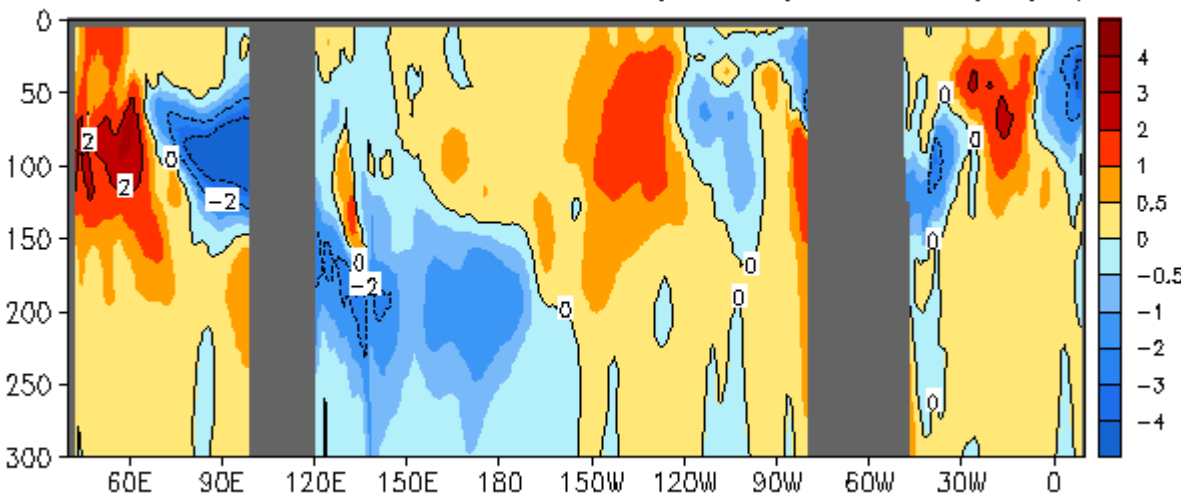
Longitude-Depth Temperature Anomaly in 2°S-2°N

JUN 2008 Eq. Temp Anomaly (°C)



- Positive temperature anomalies now extended across the entire equatorial Pacific near the thermocline.
- negative anomalies were confined to the upper 75 meters in the central and western Pacific.
- Indian ocean is showing signs of another dipole event.

JUN 2008 – MAY 2008 Eq. Temp Anomaly (°C)

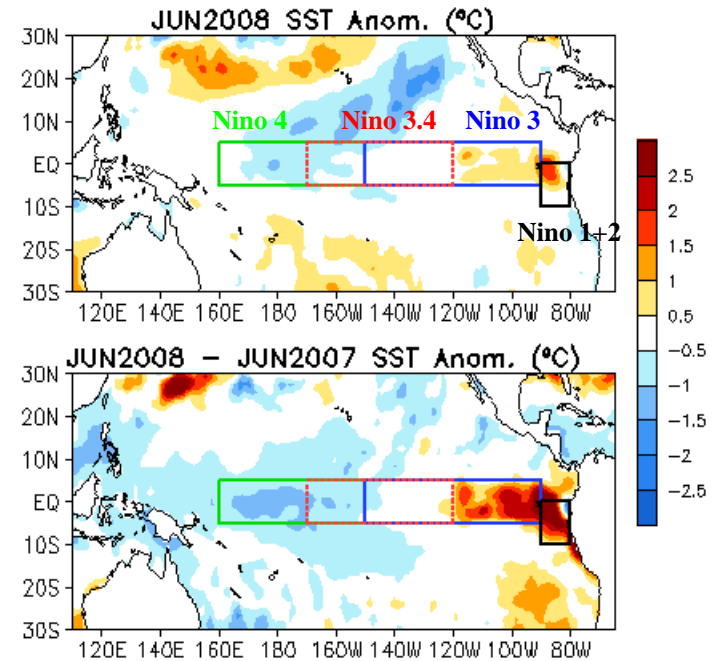
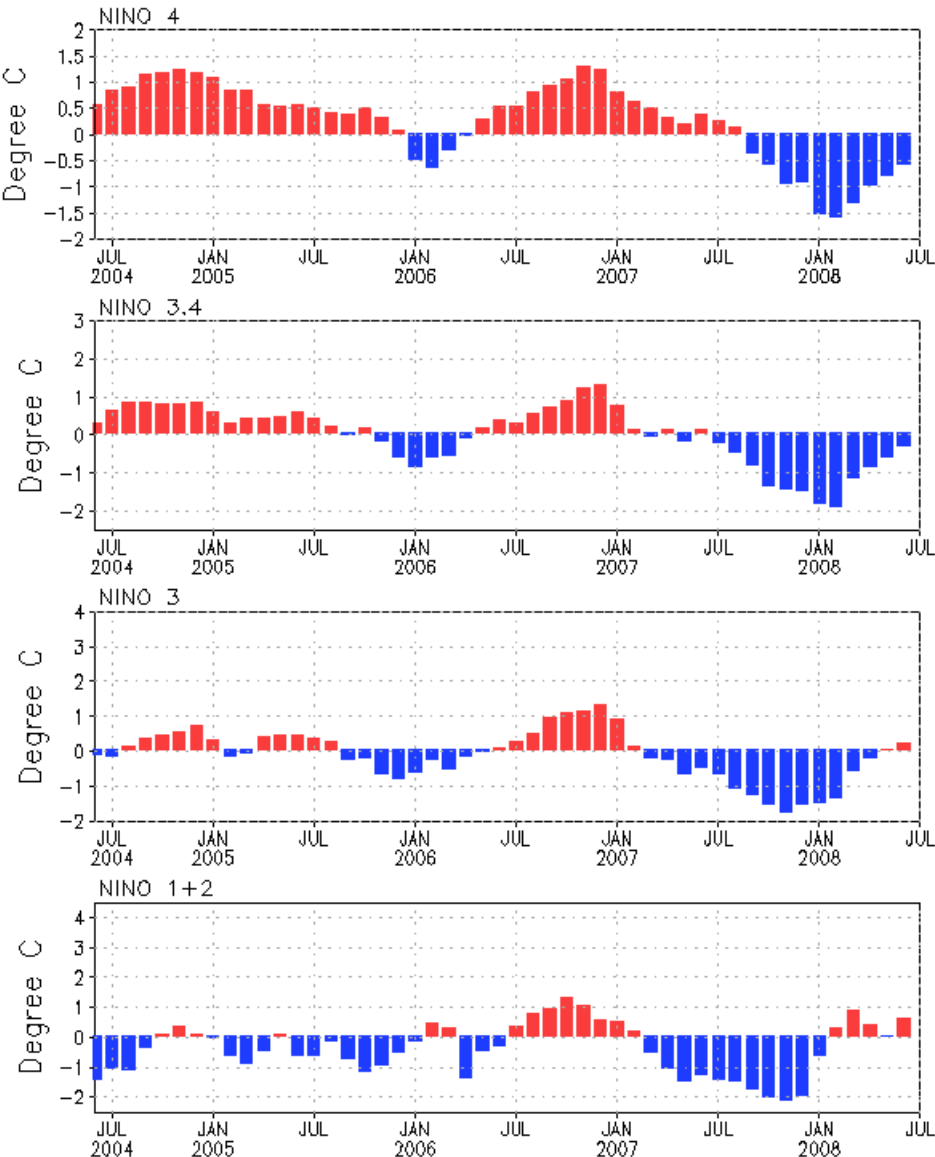


- Anomalies in Indian ocean continue to grow.
- Western Pacific anomalies have shifted eastward, but did not reach the surface.
- Central Atlantic warmed, accompanied by cooling near the western coast of Africa.

Pacific Ocean

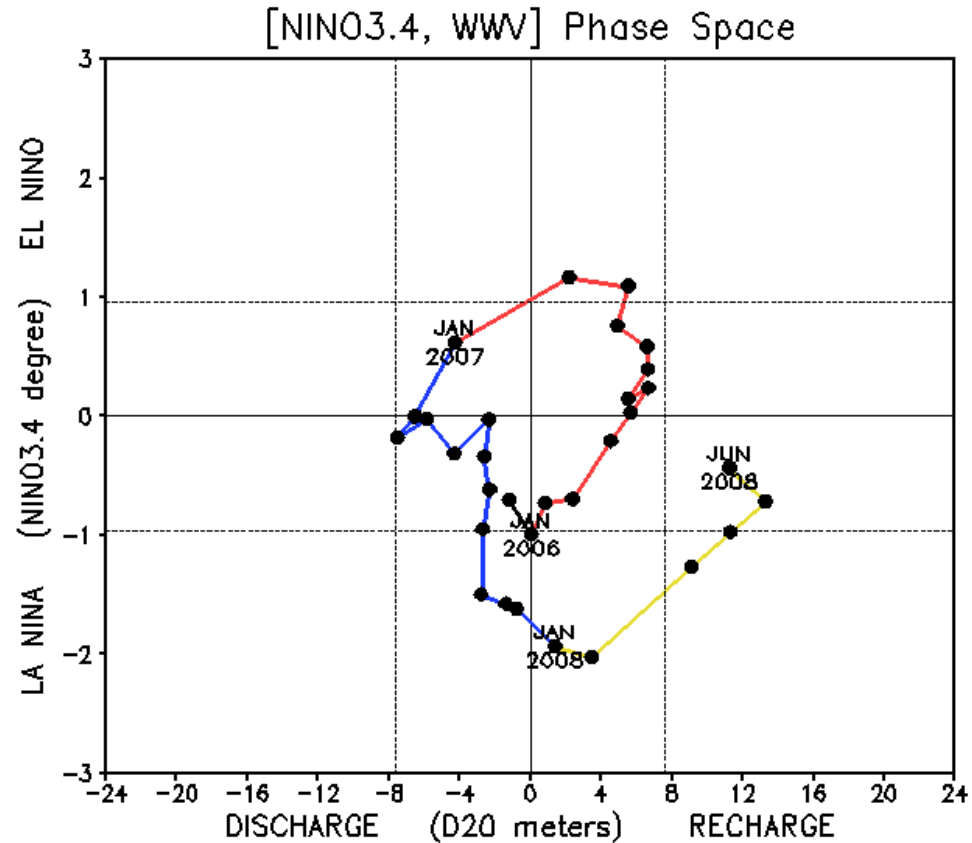
Evolution of Pacific NINO SST Indices

Monthly Tropical Pacific SST Anomaly



- ENSO-neutral conditions presented in June.
- Positive anomalies in Nino1+2 has persisted from February to June.

Warm Water Volume and NINO3.4

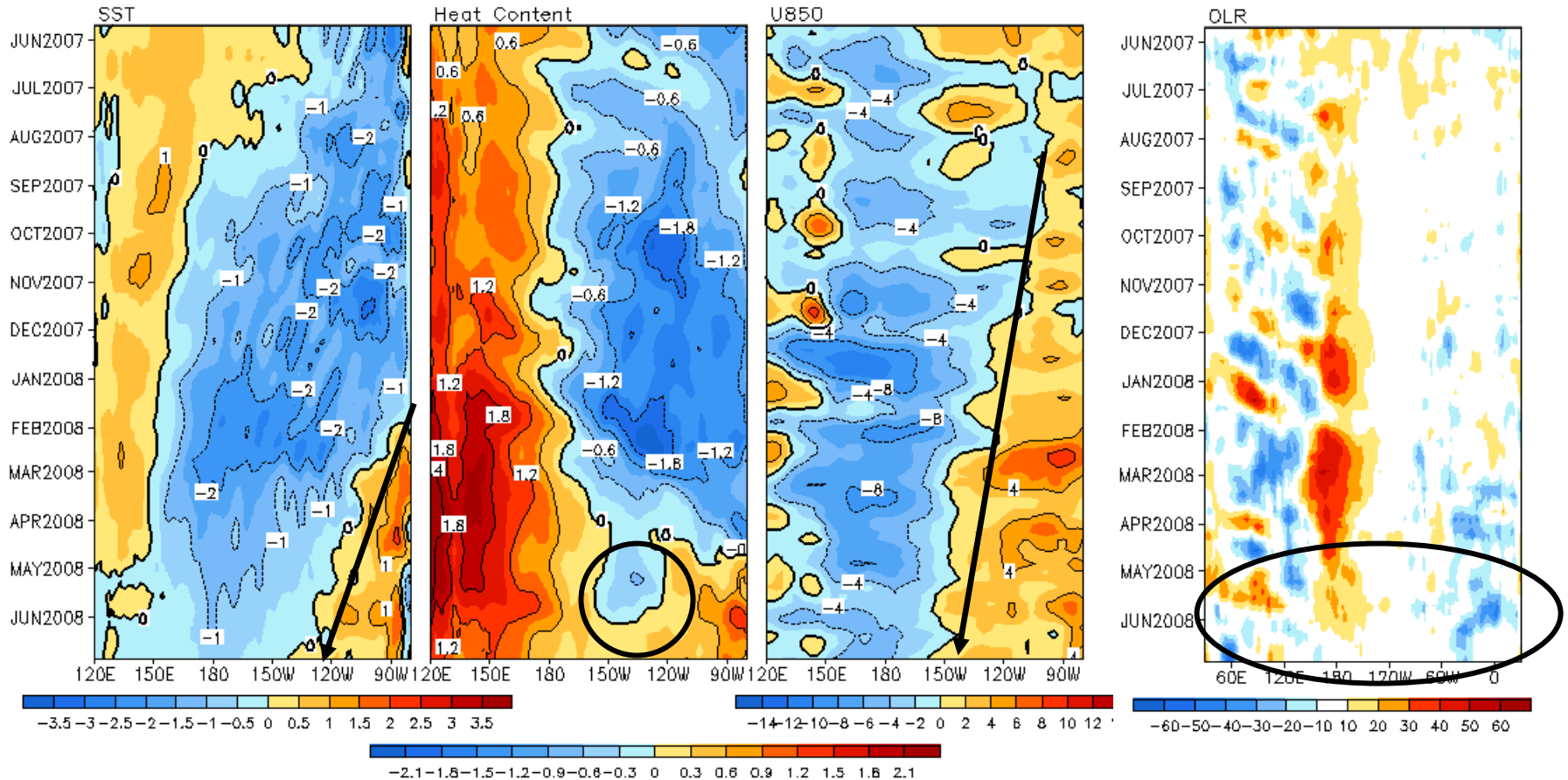


- Warm Water Volume(WWV) has increased rapidly from February to May, but decreased in June.
- WWV in June 08 is the 4th largest, smaller than that in June 82, 97, and 89.

Evolution of Equatorial Pacific SST ($^{\circ}\text{C}$), 0-300m Heat Content

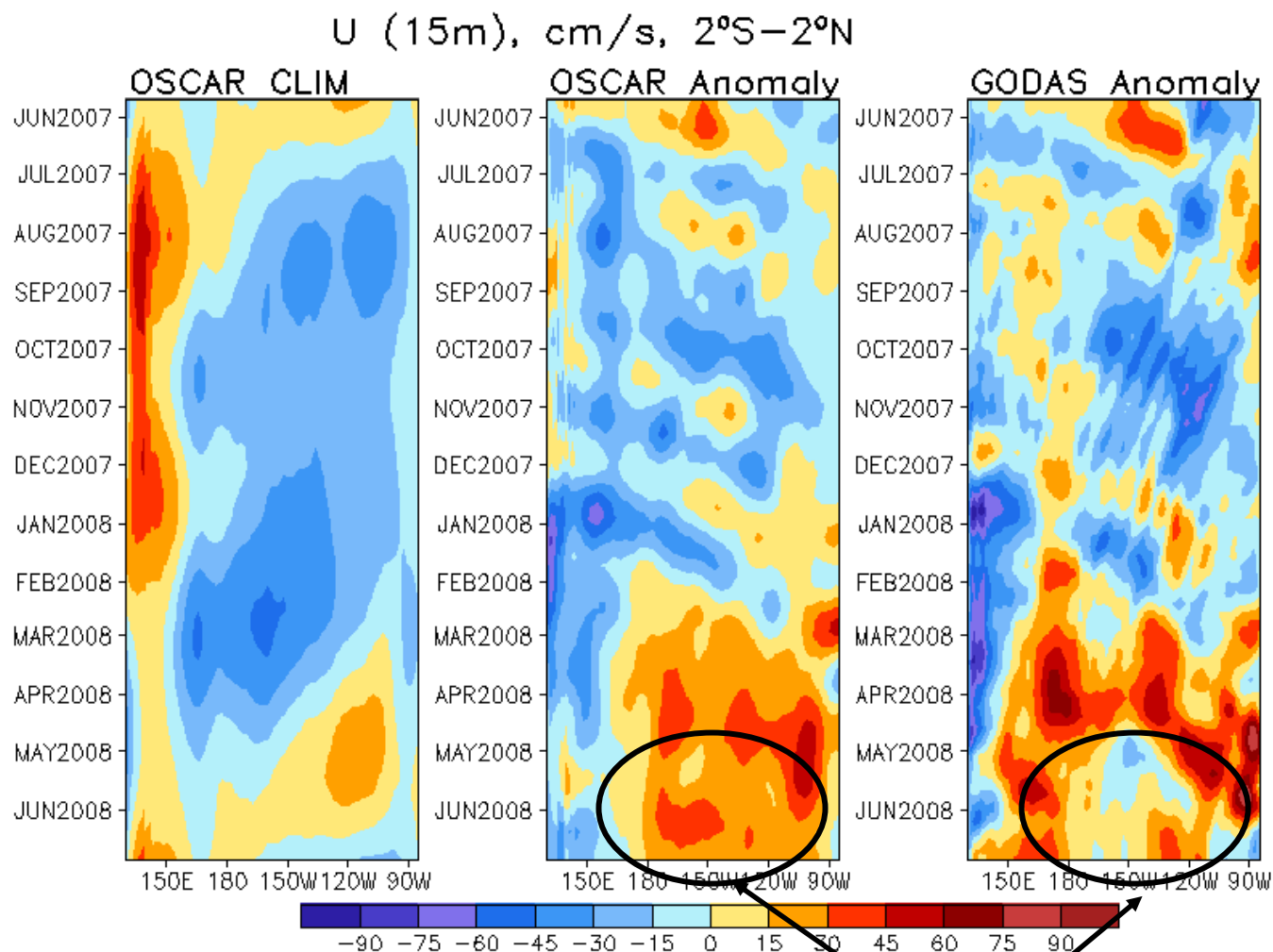
($^{\circ}\text{C}$), 850-mb Zonal Wind (m/s), and OLR (W/m^2)

2 $^{\circ}\text{S}$ –2 $^{\circ}\text{N}$ Average, 3 Pentad Running Mean



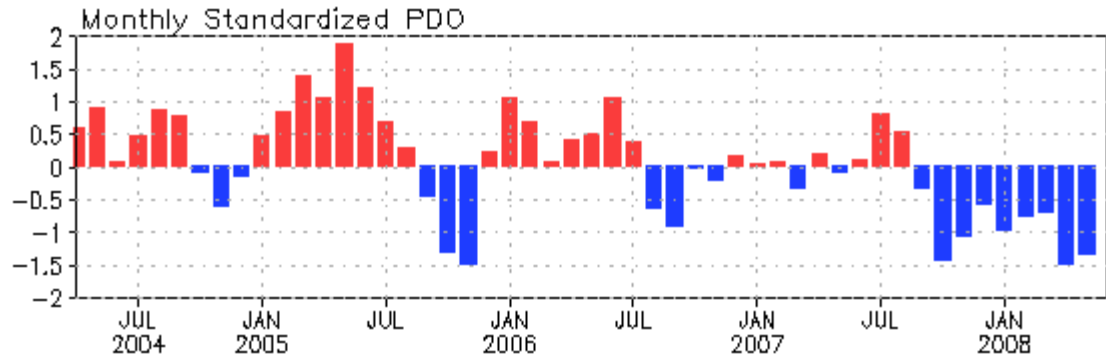
- Positive SST anomalies in the far eastern Pacific and westerly wind anomalies continue to extend westward.
- Negative heat content anomalies in the central-eastern Pacific switched to positive anomalies.
- Suppressed (enhanced) convection near the Dateline (Maritime Continent) weakened, but enhanced convection in the tropical Atlantic persisted.

Evolution of Equatorial Surface (15 m) Zonal Current



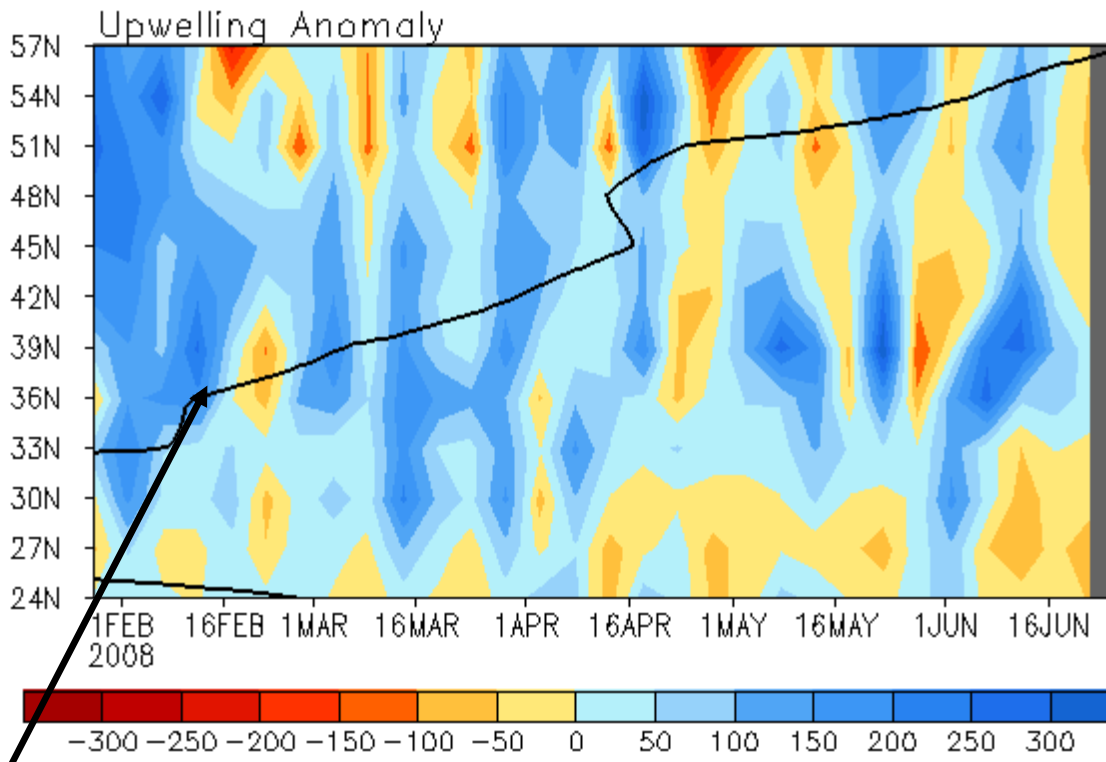
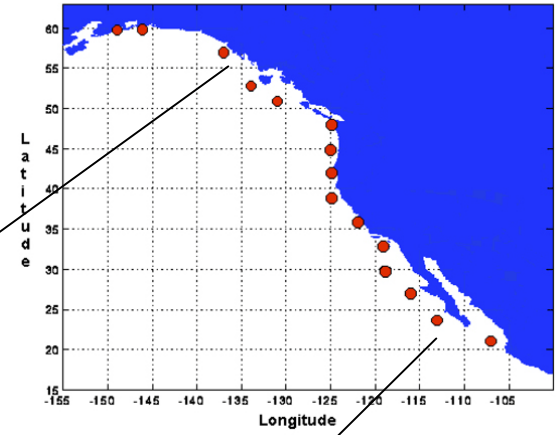
Large Difference in central Pacific.

PDO and North America Western Coastal Upwelling



[UW/NOAA JISAO PDO page](#)

Standard Positions of Upwelling Index Calculations



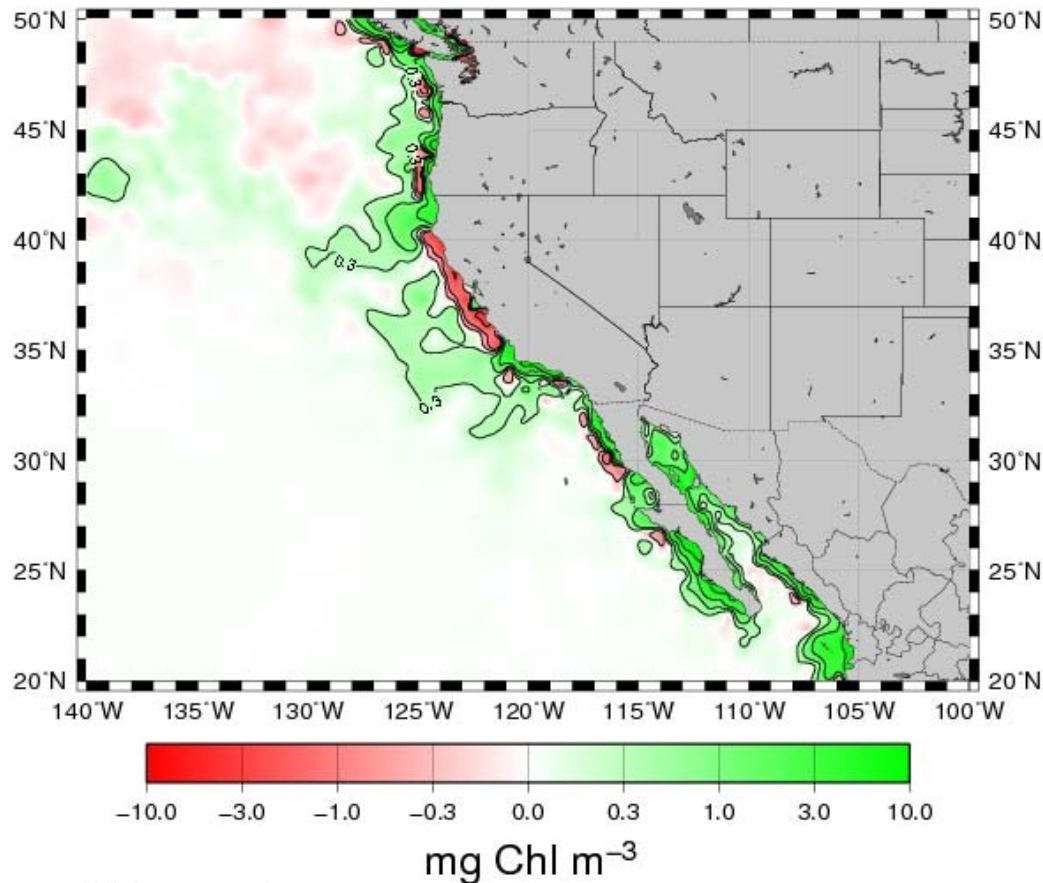
- Negative PDO persisted since October 2007.
- Large week to week variability.
- Tendency for less upwelling off of Mexico starting mid-April.

- Area below (above) black line indicates climatological upwelling (downwelling) season.
- Climatologically upwelling season progresses from March to July along the west coast of North America from 36°N to 57°N.

Monthly Chlorophyll Anomaly

<http://coastwatch.pfel.noaa.gov/FAST>

MODIS Aqua Chlorophyll a Anomaly for May, 2008



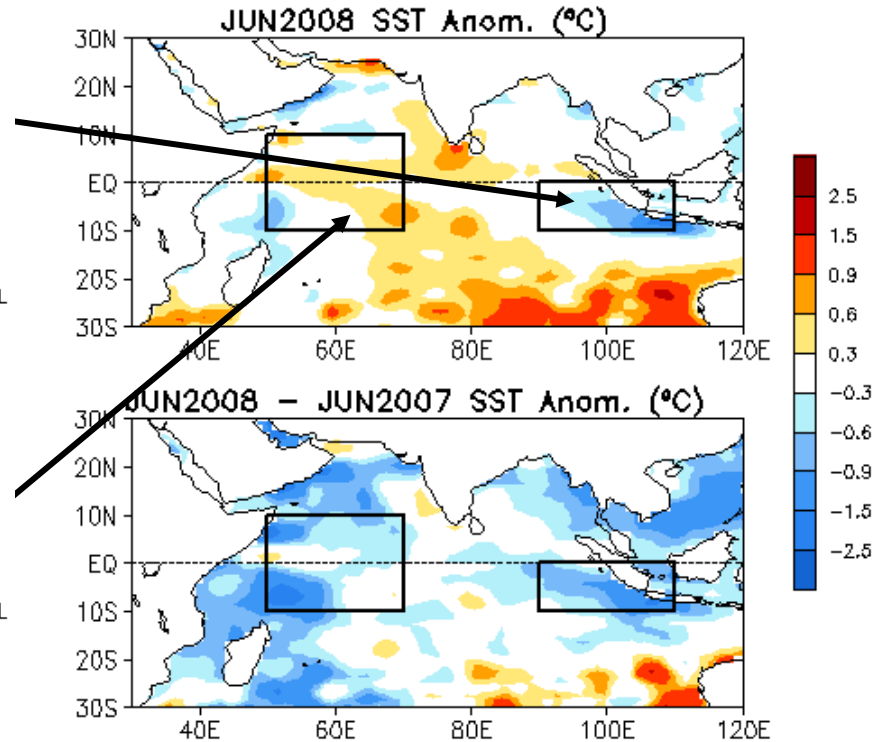
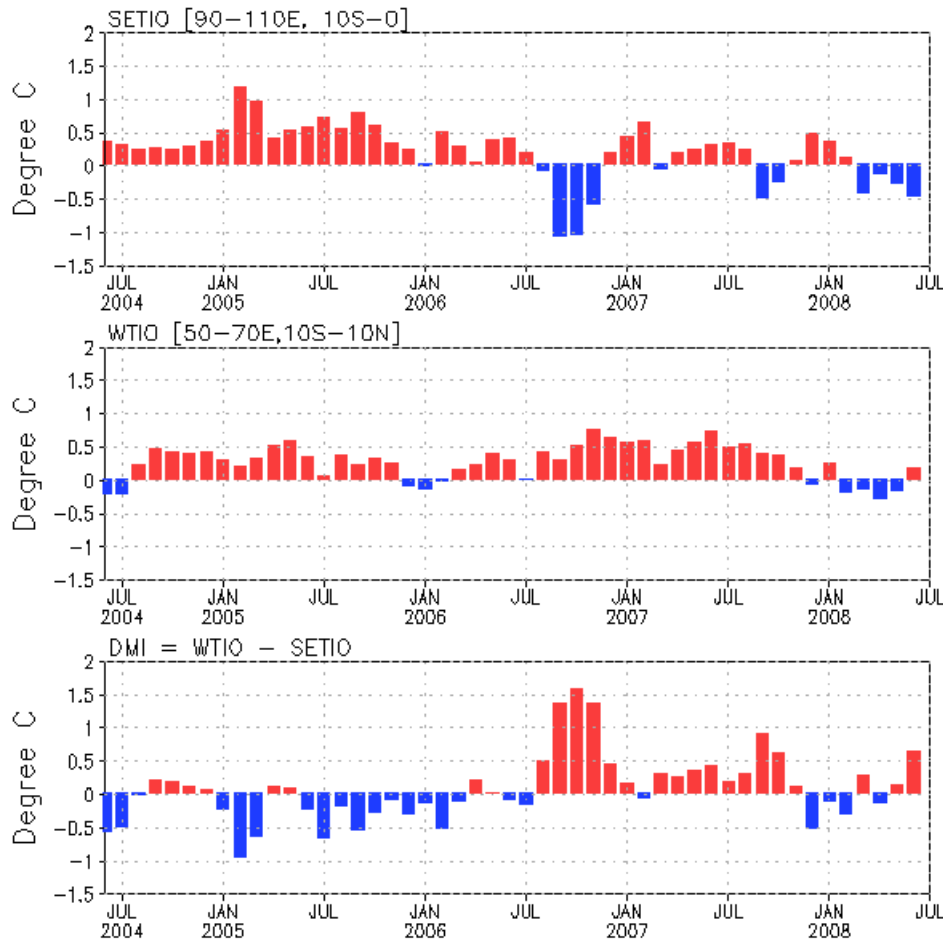
Positive Chlorophyll anomalies along most of the west coast in response to increased upwelling.

GM 2008 Jun 2 10:45:39 Data courtesy of NASA GSFC

Indian Ocean

Recent Evolution of Indian Ocean SST Indices

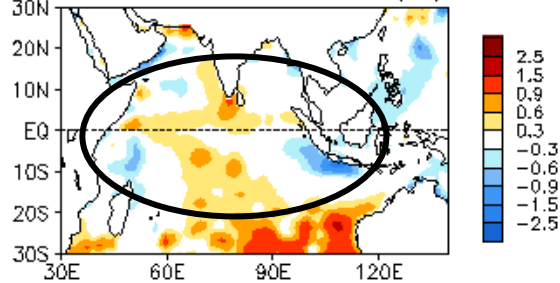
Indian Ocean Dipole Mode Indices



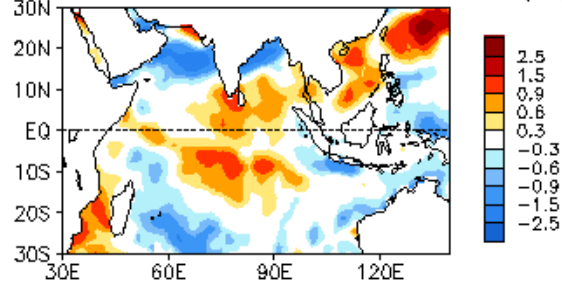
- Much of the Indian Ocean is 0.5-1 degree cooler than last year.
- IO Dipole Mode Index (DMI) is about 0.7C.

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

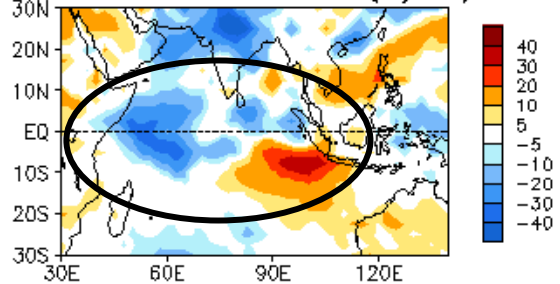
JUN 2008 SST Anom. ($^{\circ}\text{C}$)



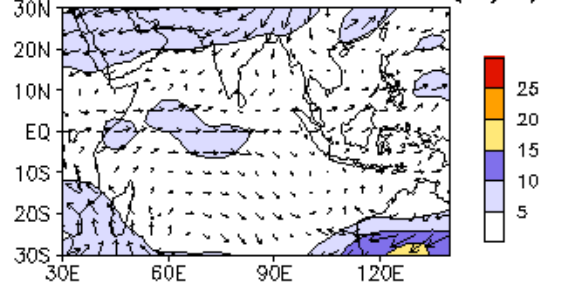
25JUN2008 - 21MAY2008 SST Anom. ($^{\circ}\text{C}$)



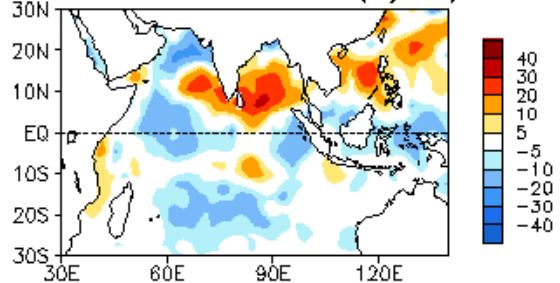
JUN 2008 OLR Anom. (W/m^2)



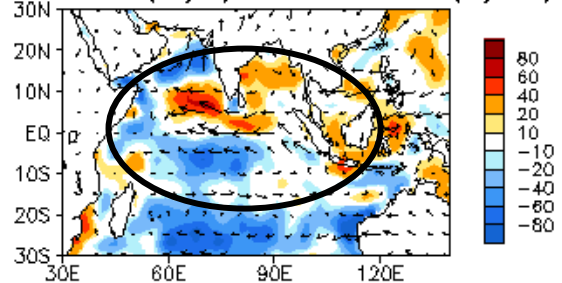
JUN 2008 200 mb Wind Anom. (m/s) $\overrightarrow{15}$



JUN 2008 SW + LW (W/m^2)



925mb Wind (m/s) & LH + SH (W/m^2) $\overrightarrow{8}$

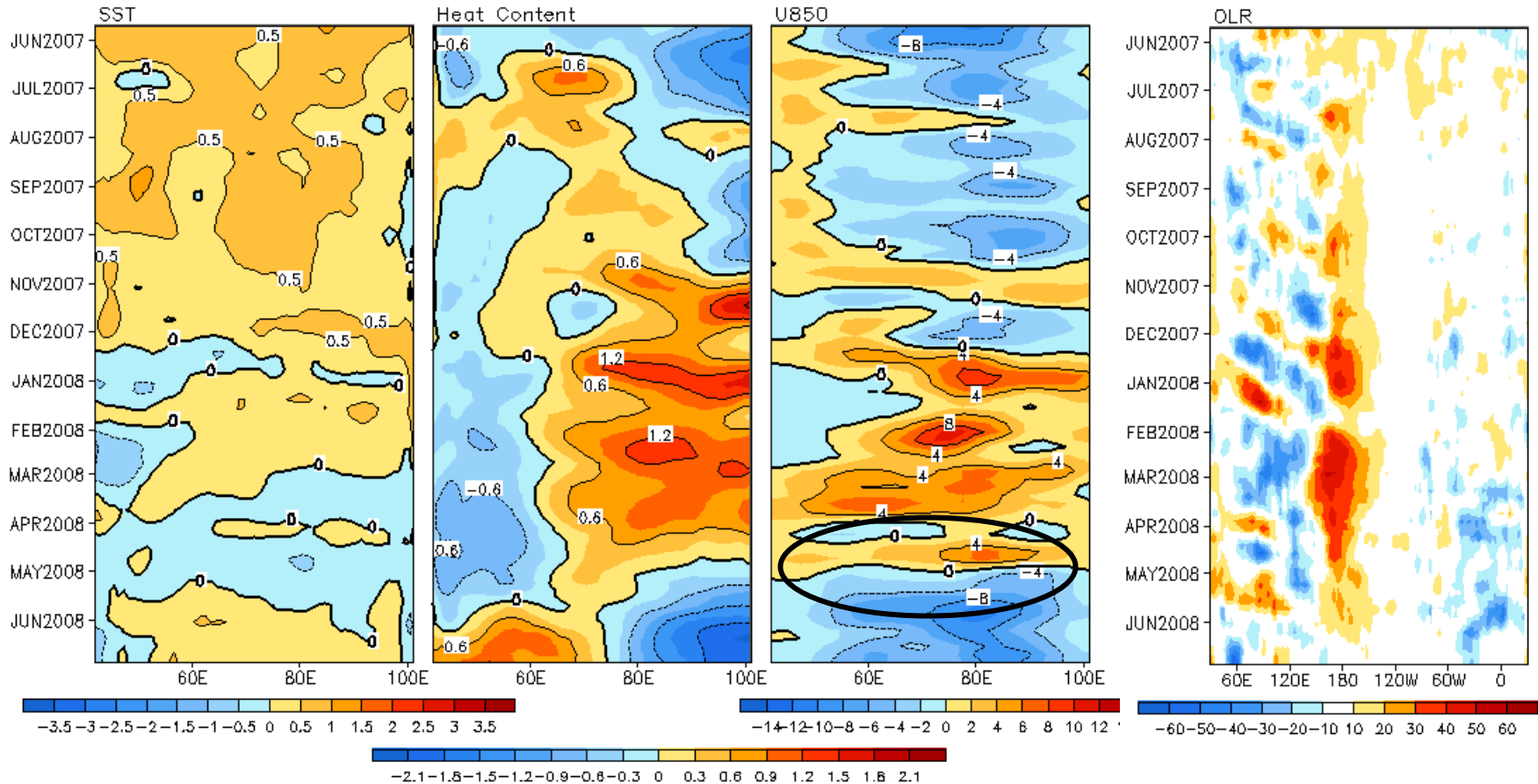


- Enhanced rainfall over western Indian Ocean and India, and suppressed rainfall in south-eastern Indian Ocean, consistent with positive (negative) SST anomalies in central (south-eastern) Indian Ocean.

- Easterly wind anomalies at 925mb forced upwelling near Java.

Recent Evolution of Equatorial Indian SST ($^{\circ}\text{C}$), 0-300m Heat Content ($^{\circ}\text{C}$), 850-mb Zonal Wind (m/s) and OLR (W/m^2)

2 $^{\circ}\text{S}$ –2 $^{\circ}\text{N}$ Average, 3 Pentad Running Mean

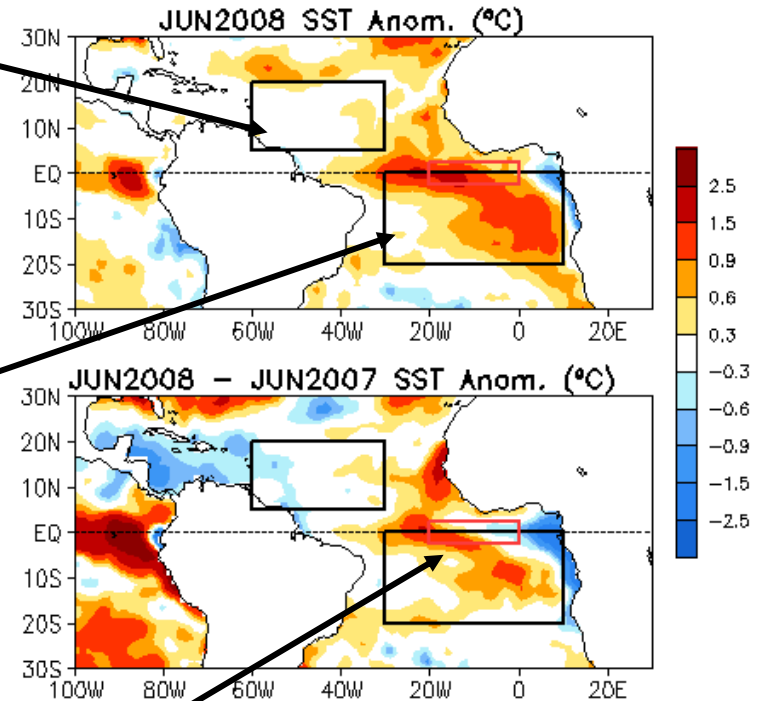
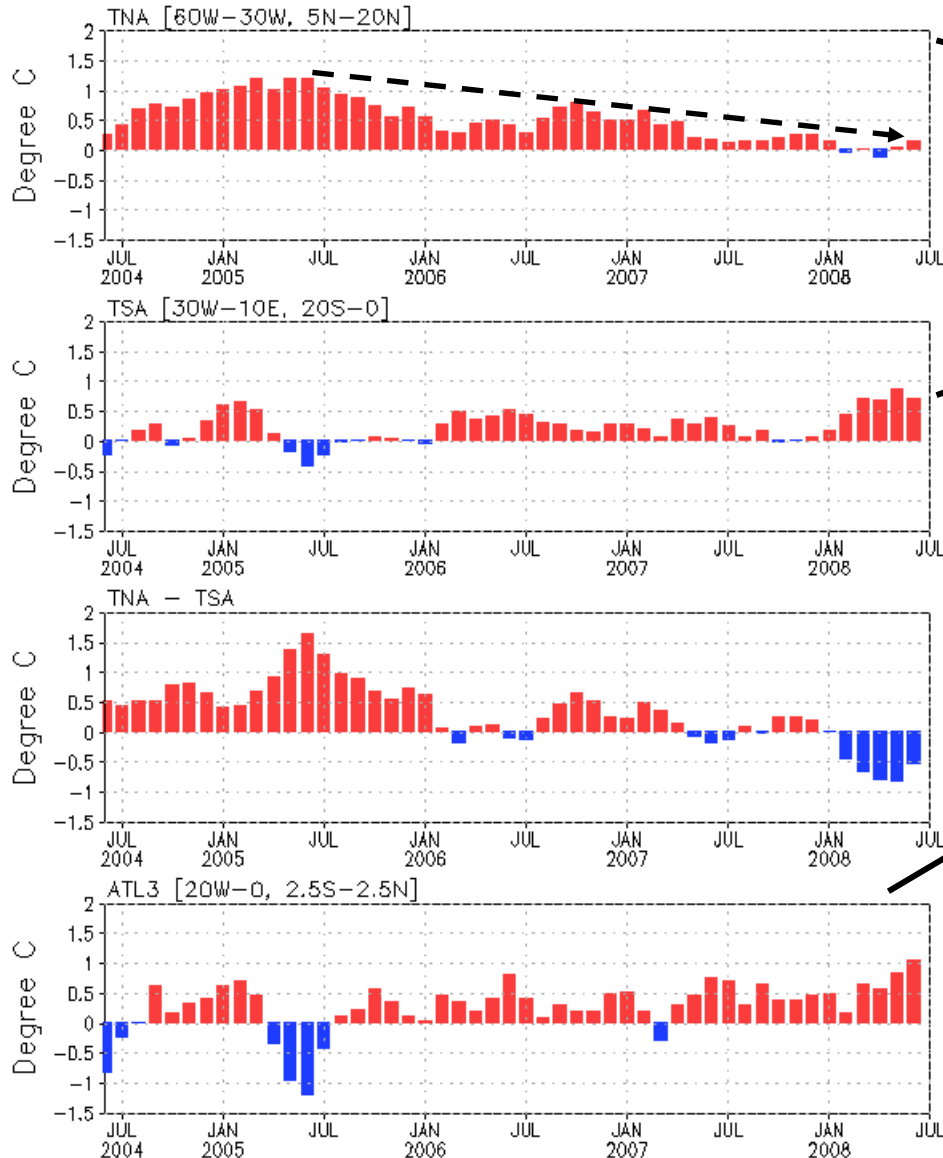


- Westerly anomalies that were persistent during the past winter switched to easterly anomalies in late April
- Reduction (build-up) of heat content in eastern (western) Indian ocean were associated with the switch in the winds.

Atlantic Ocean

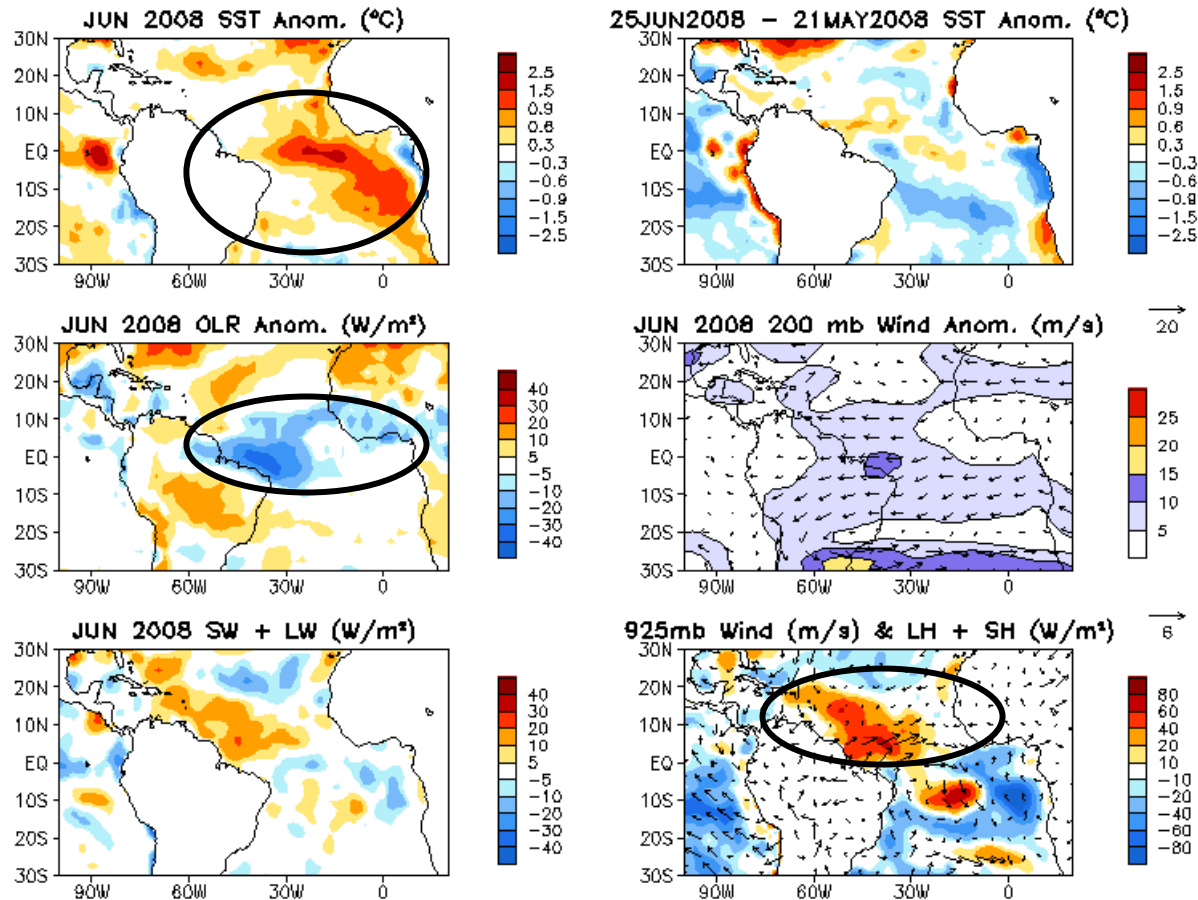
Evolution of Tropical Atlantic SST Indices

Monthly Tropical Atlantic SST Anomaly



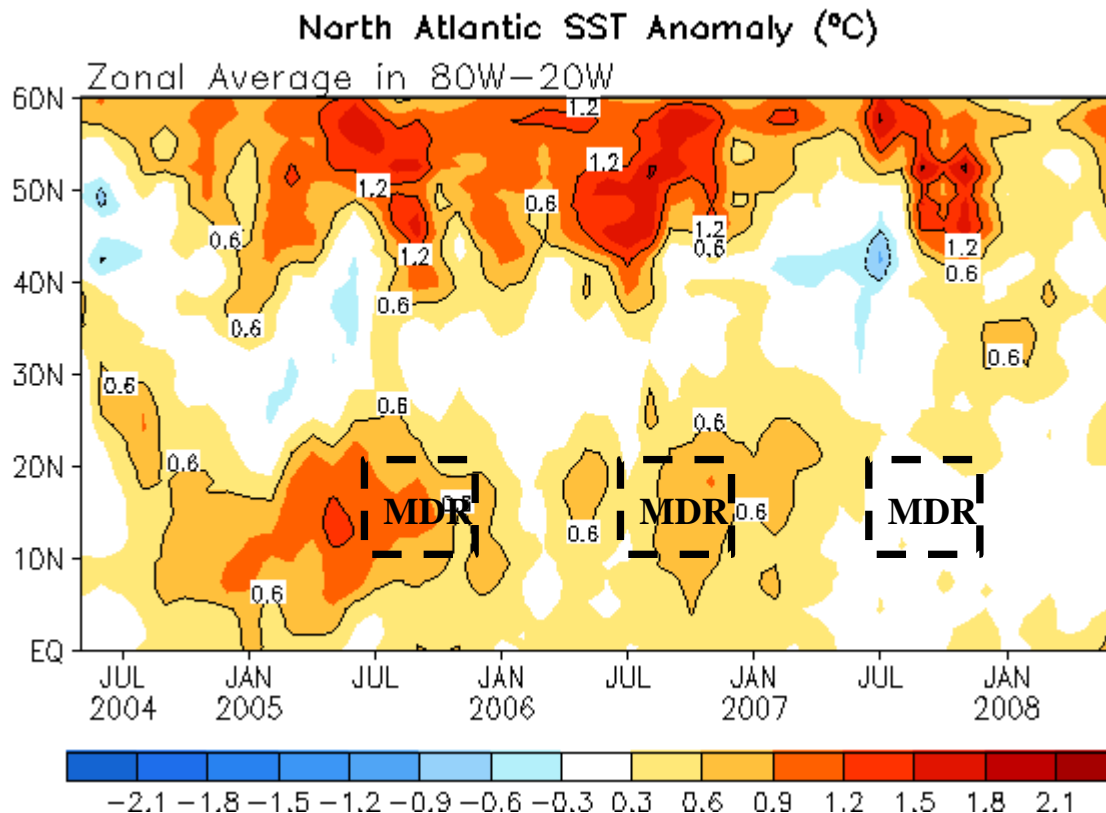
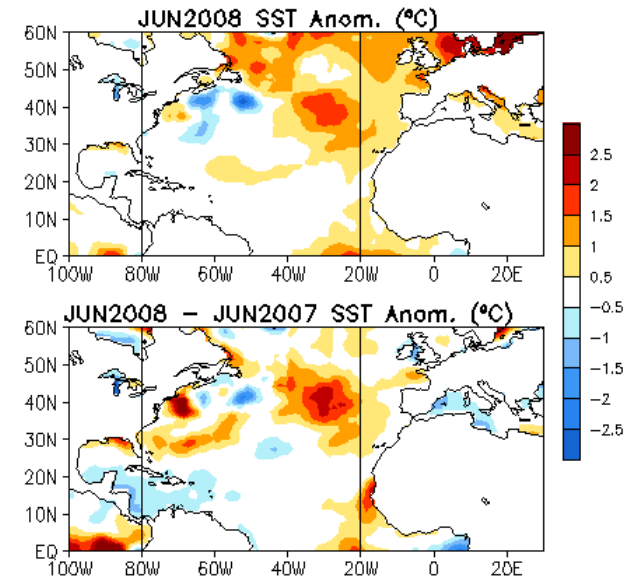
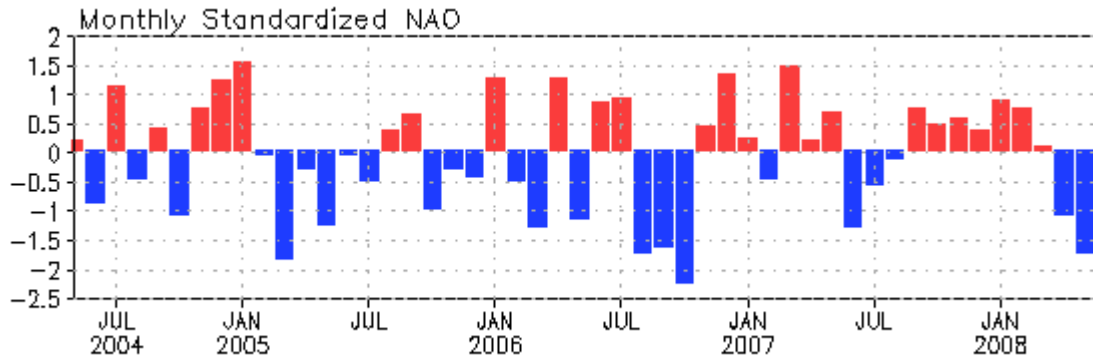
- TNA has been trending downward from about +1C above-normal in summer 2005 to slightly below-normal in April, and then increased slightly over the past 2 months
- TSA has been above-normal since February
- Meridional SST Gradient Mode (TNA-TSA) remains negative, although the anomalies decreased in magnitude..
- ATL3 increased steadily over the past 3 months, and reached 1.1C in June

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



- SST decreased along the west coast of Africa.
- Enhanced convection presented to the west of maximum positive SSTA in the equatorial Atlantic.
- Strong westerly wind anomalies at 925 mb between Brazil and Cape Verde.

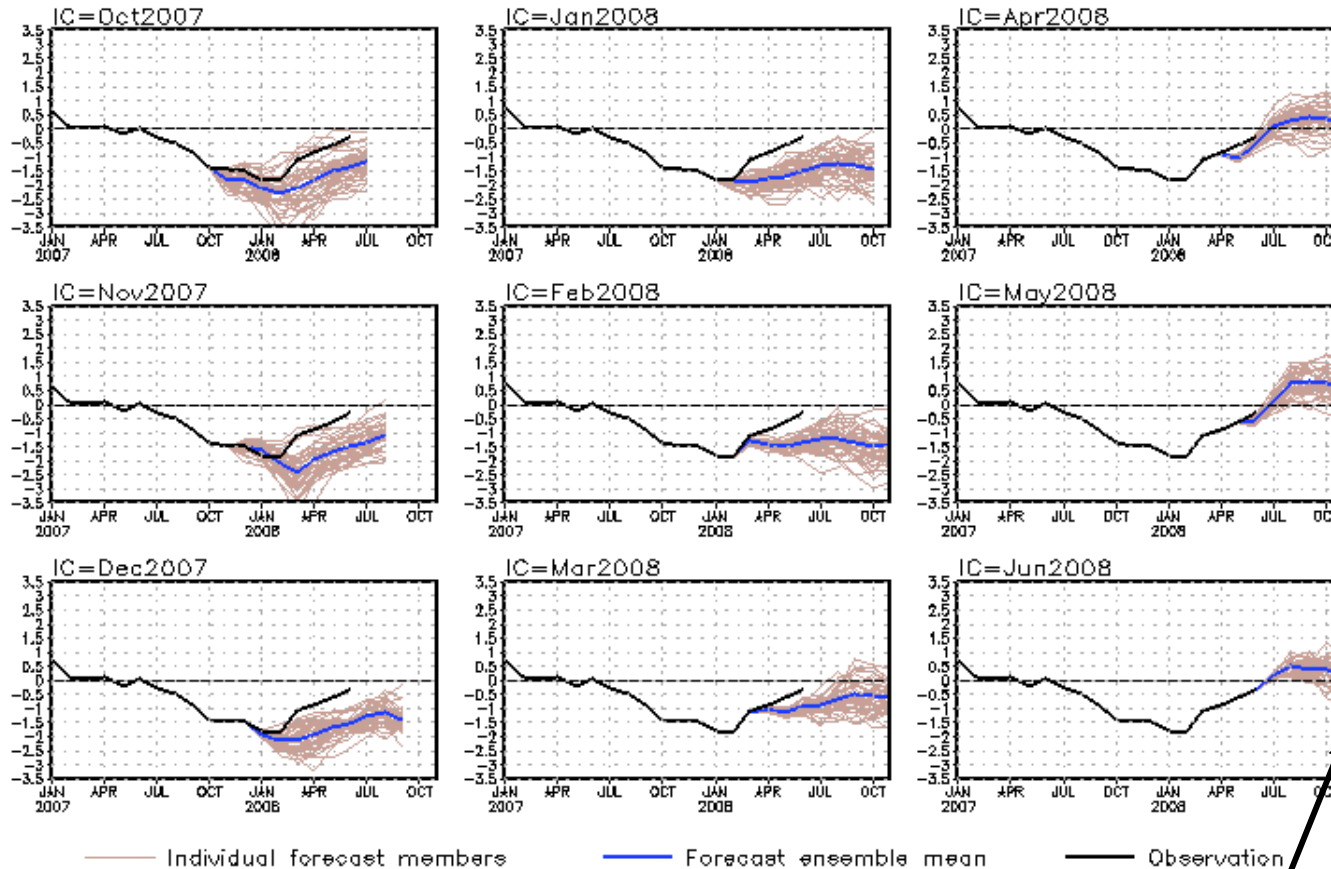
SST Anomaly in North Atlantic



- High-latitude North Atlantic SSTA are closely related to NAO index – negative NAO leads to SST warming and positive NAO leads to SST cooling.
- Negative NAO persisted over last 3 months, and has caused large warming in North Atlantic.

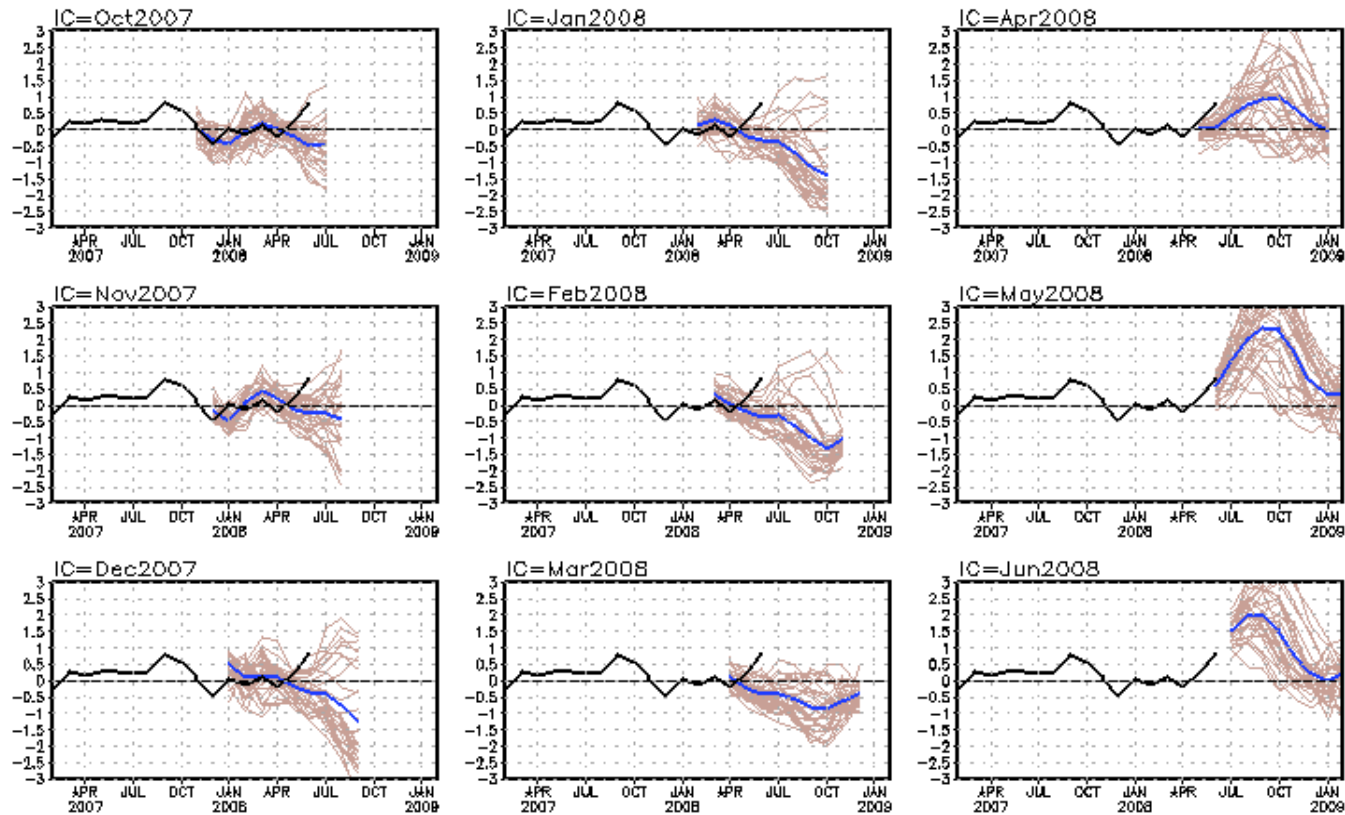
CFS SST Predictions and Ocean Initial Conditions

CFS Niño 3.4 SST Predictions from Different Initial Months



- Latest forecasts are calling for ENSO-neutral conditions.

CFS Indian Ocean Dipole SST Predictions from Different Initial Months

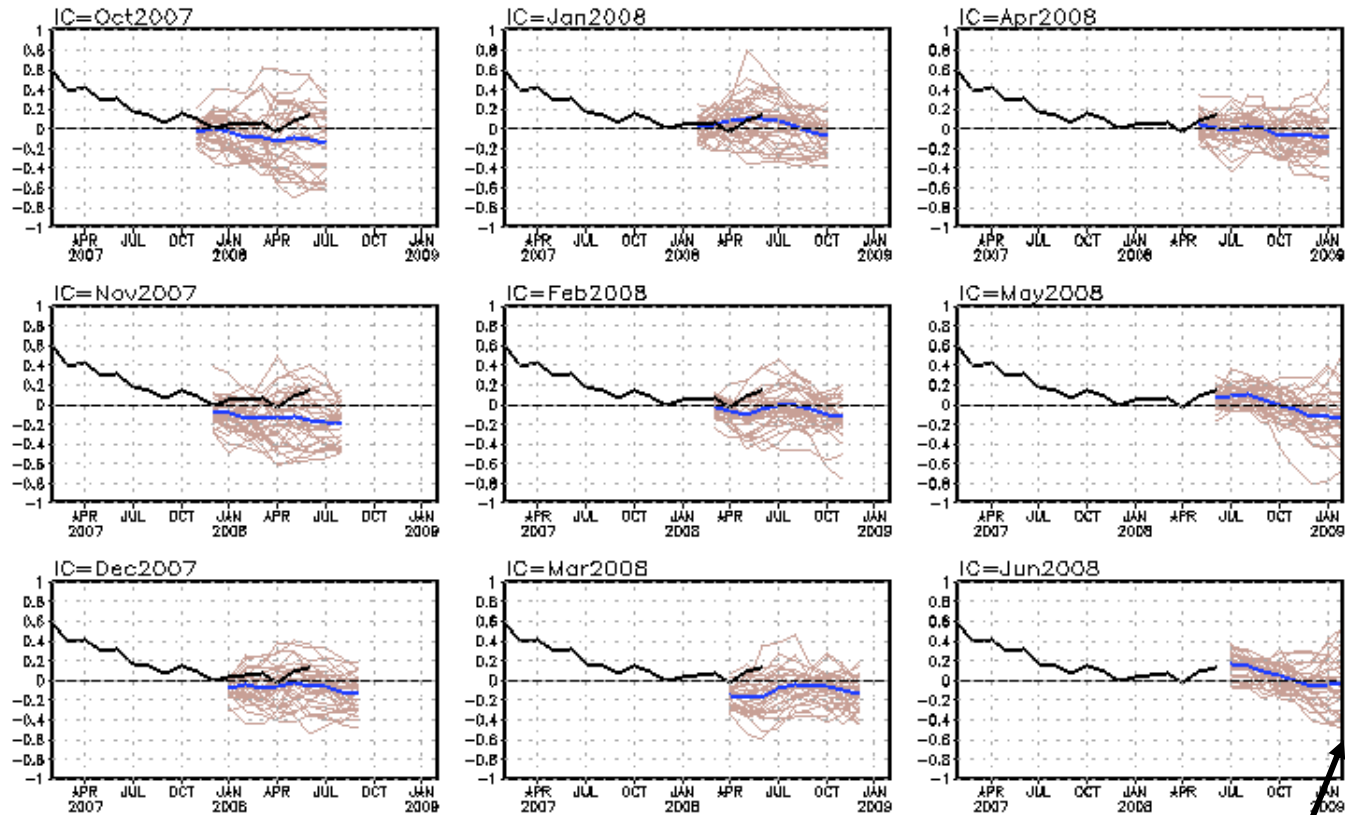


— Individual forecast members — Forecast ensemble mean — Observations

Starting in April, CFS is predicting a positive indian Ocean Dipole.
Before this time, the forecast was for a strong negative event.

CFS Atlantic Ocean SST Predictions from

Different Initial Months



— Individual forecast members — Forecast ensemble mean — Observations

- Little variability in the ensemble mean forecast.

Summary

- **Sub-surface Observations**

- GODAS disagrees with NODC sub-surface temperature analysis in Southern Oceans due to lack of observations.

- **Global Ocean**

- Global mean SST cooling since last year has halted.
- No corresponding changes in global sea-surface height.

- **Pacific Ocean**

- La Nina has transitioned to ENSO-neutral conditions: NINO3.4 in June is -0.4C.
- CPC's prognostic assessment: ENSO-neutral conditions will continue into fall.
- Easterly wind anomalies and suppressed convection in C. Pacific weakened.
- E. Pacific positive SST anomalies persisted.
- Negative PDO pattern in N. Pacific persisted.

- **Indian Ocean**

- Easterly wind anomalies in tropical Indian persisted.
- Positive IODM patterns in SST, winds, OLR, and heat content: DMI in June is 0.7C.

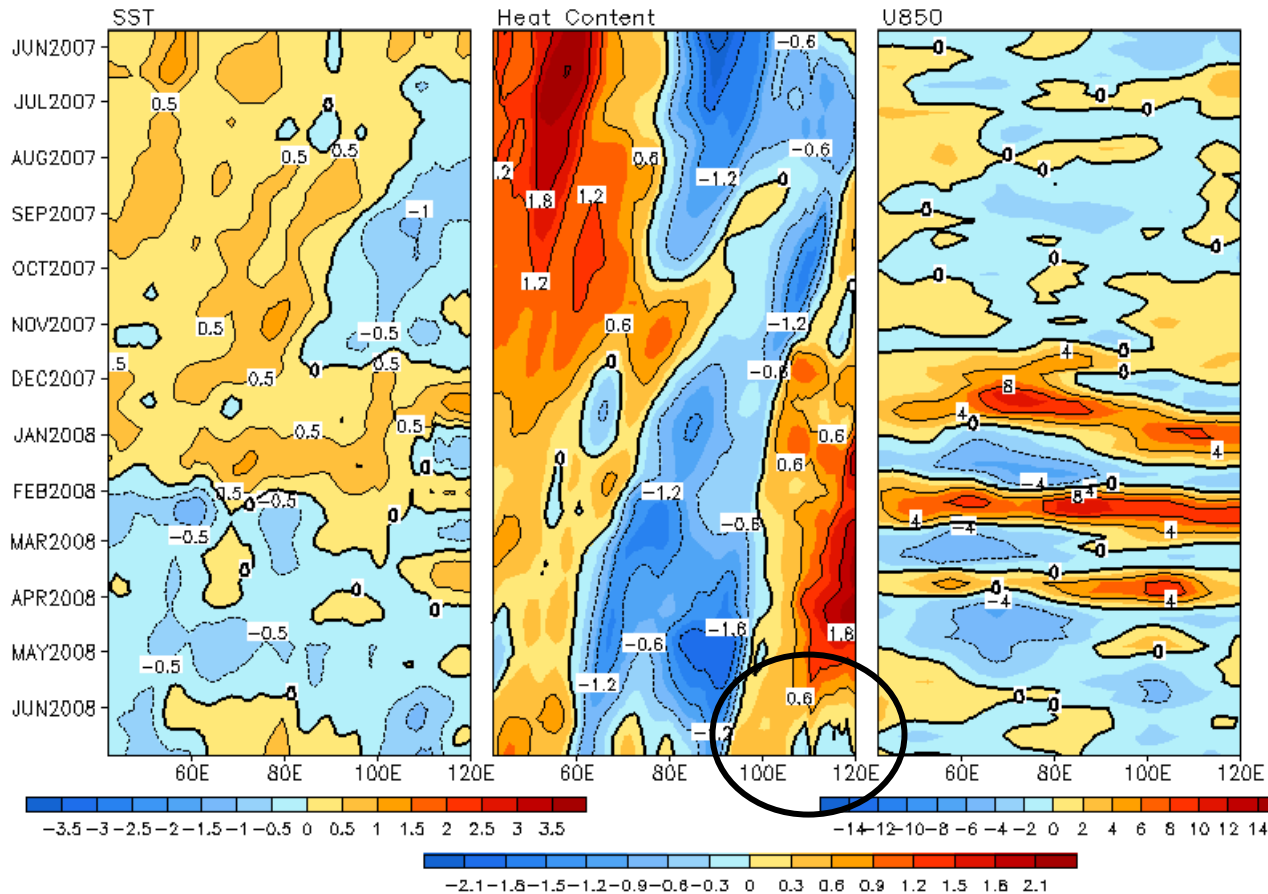
- **Atlantic Ocean**

- Northern Atlantic has warmed in the past few months.

Backup Slides

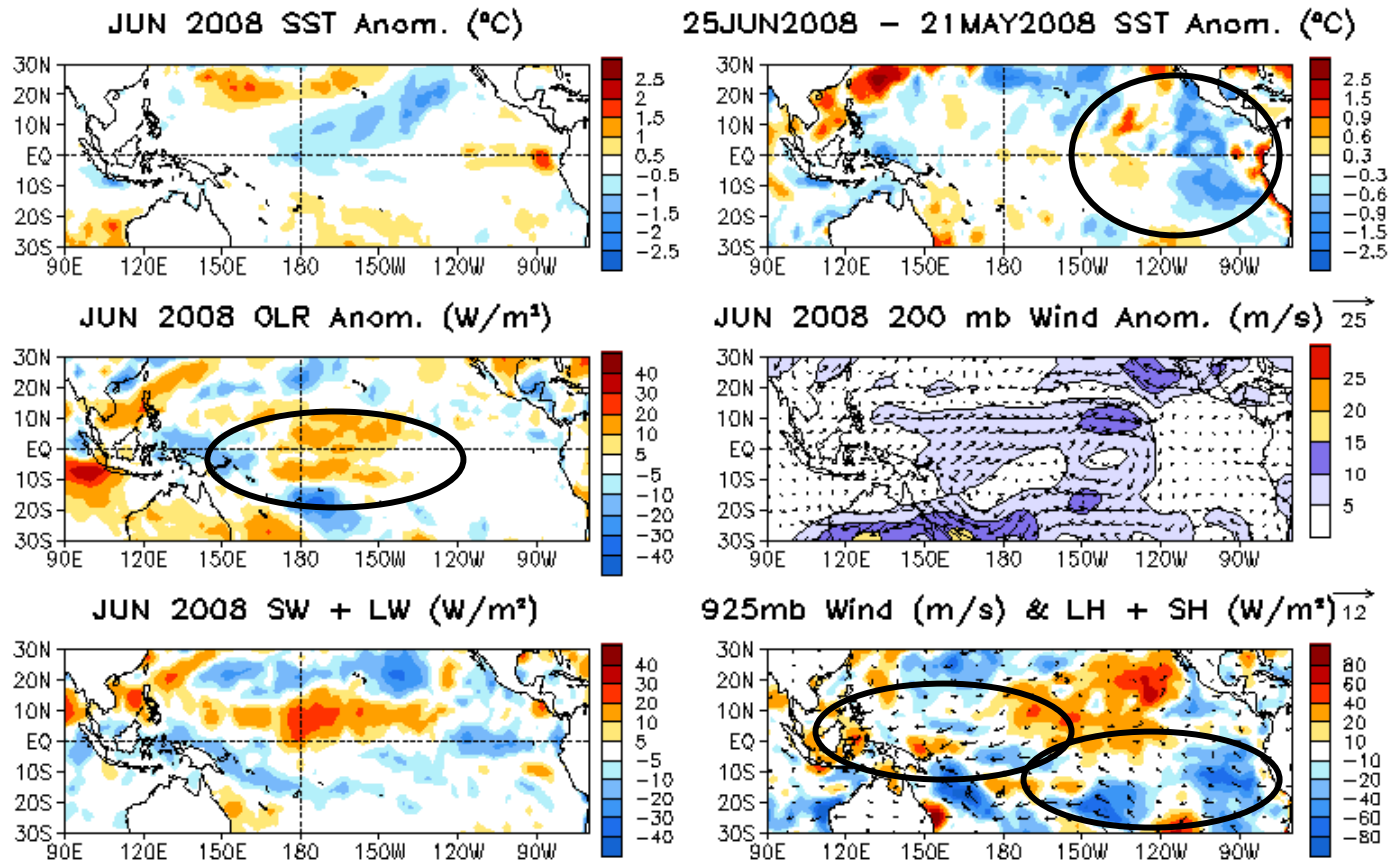
Recent Evolution of 10S Indian SST ($^{\circ}\text{C}$), 0-300m Heat Content ($^{\circ}\text{C}$), 850-mb Zonal Wind (m/s)

12 $^{\circ}\text{S}$ –8 $^{\circ}\text{S}$ Average, 3 Pentad Running Mean



Heat Content in Eastern Indian Ocean has decreased.

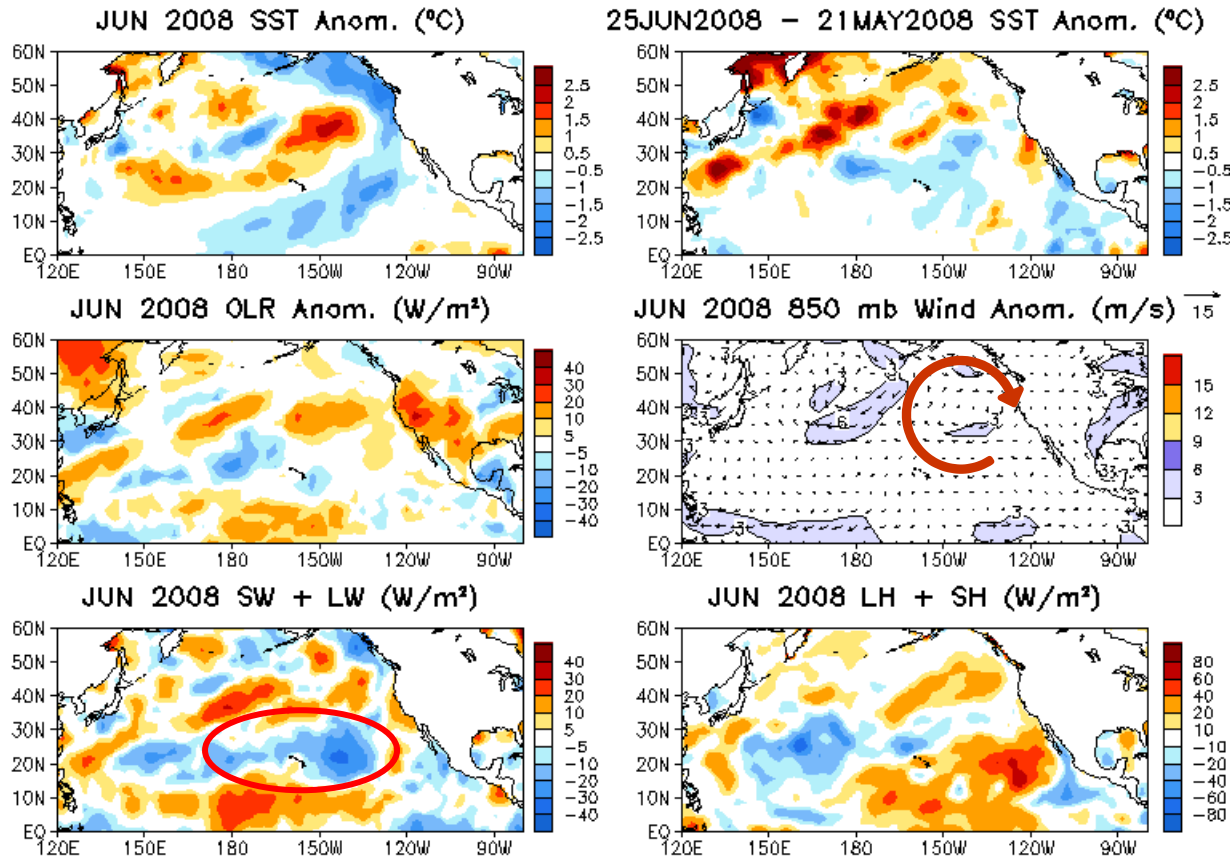
Tropical Pacific: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx



- North-east trade winds in the western Pacific are still stronger than normal
- Southeast trade winds are stronger than normal in the central and eastern Pacific.
- Suppressed convection still persists at the dateline.
- General cooling in the east

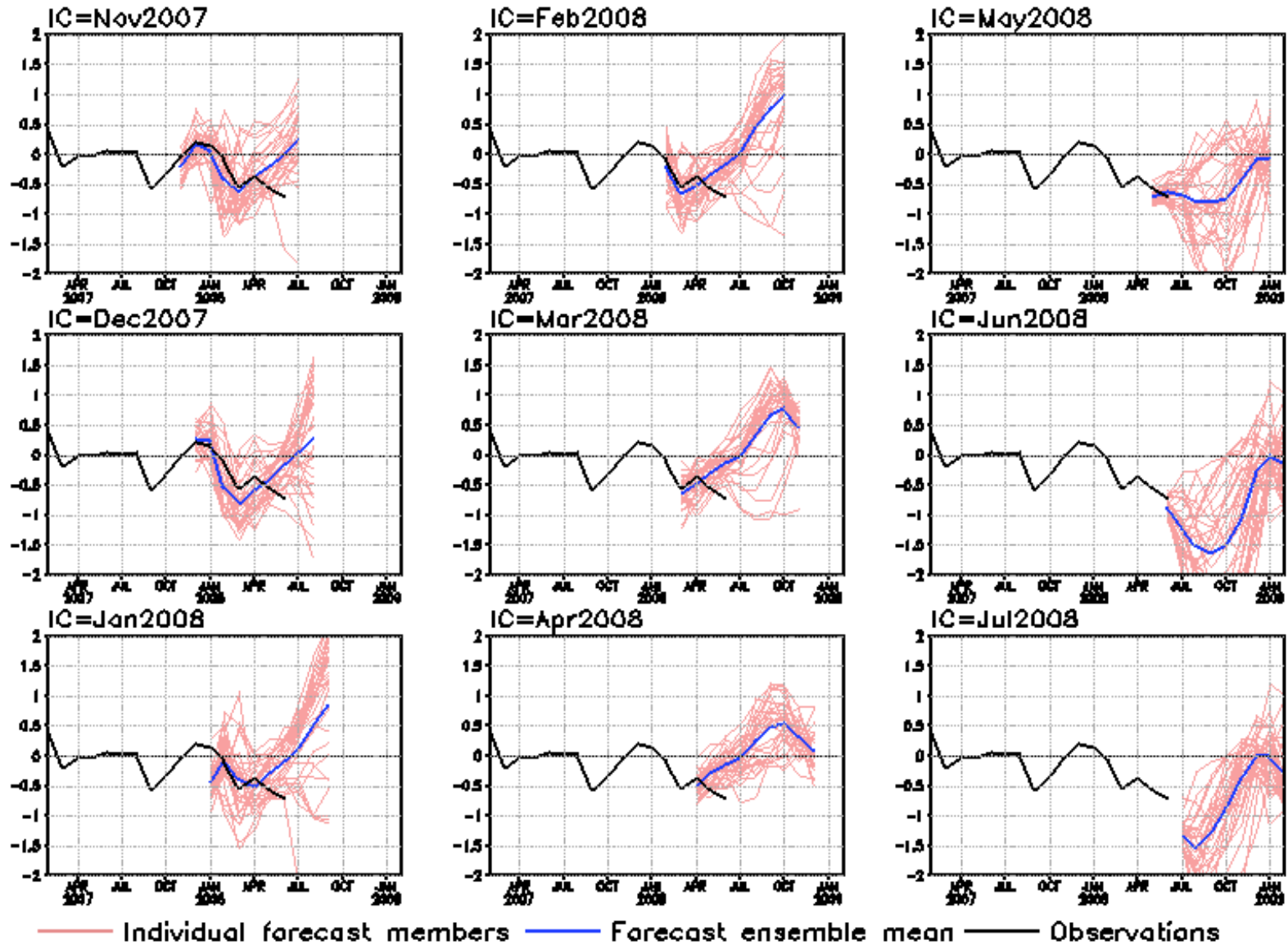
North Pacific: SST Anom., SST Anom. Tend.,

OLR, 850-mb Winds, Sfc Rad, Sfc Flx

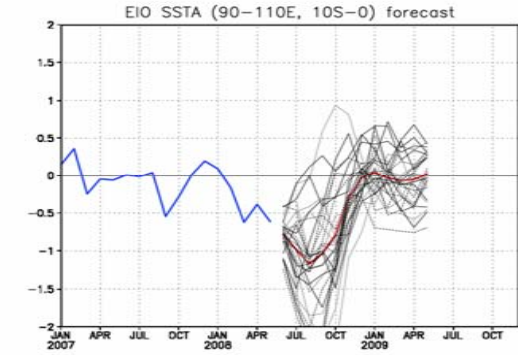
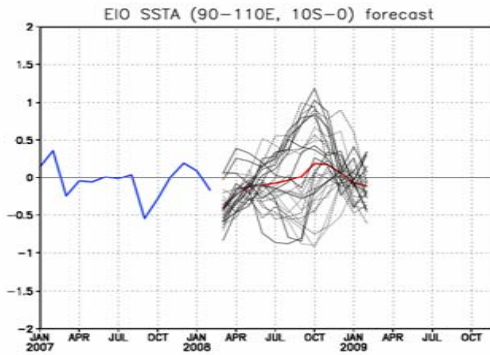
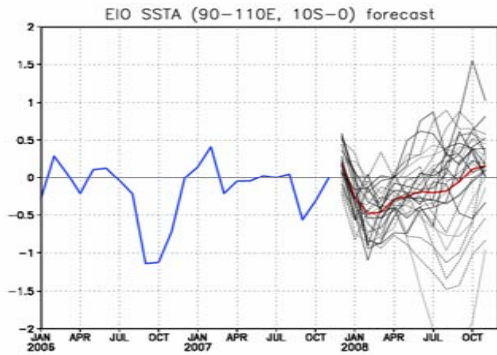
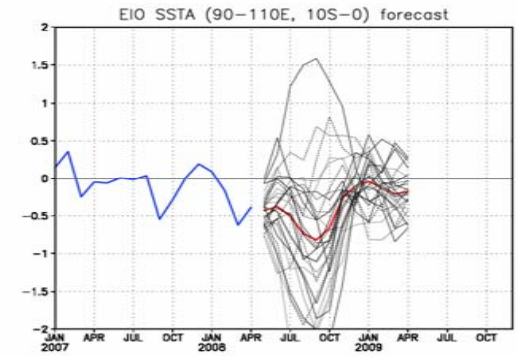
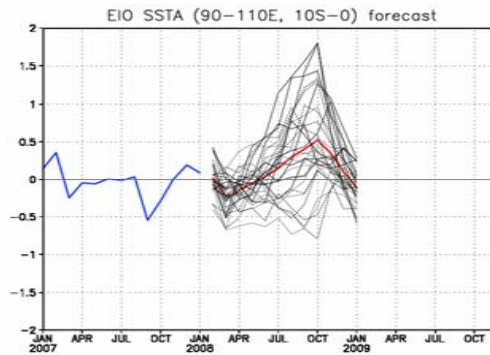
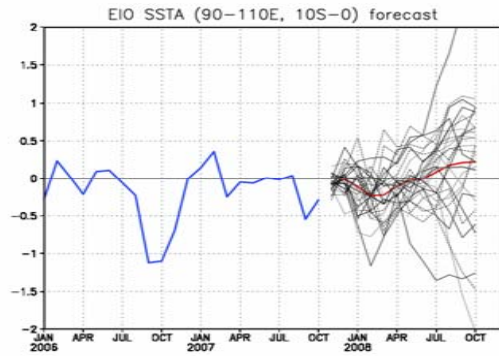
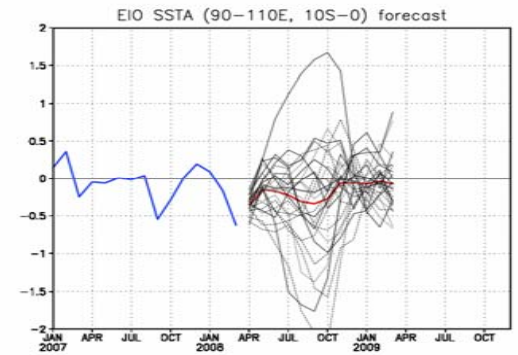
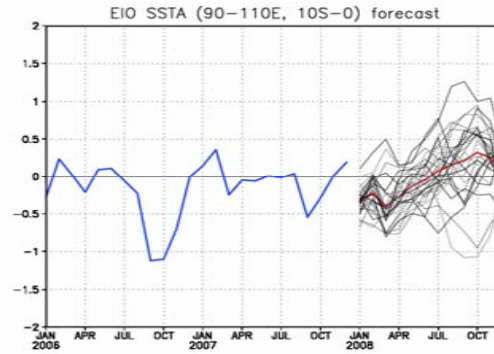
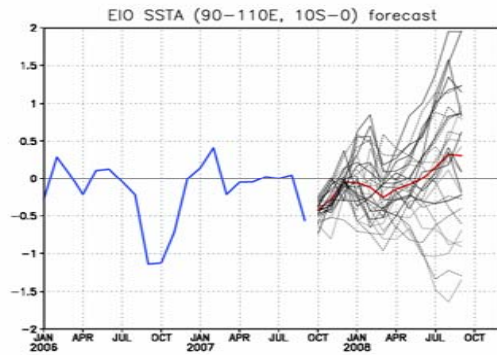


- Cooling near the west coast of North America and Gulf of Alaska persisted
- Anti-cyclonic wind anomalies near the coast of California, favorable for coastal upwelling
- Large amount of warming is radiative

CFS EIO SST anomalies (K)



Eastern Pole Forecasts from FRCGC....



Data Sources

- **Optimal Interpolation SST (OI SST) version 2**
- **Reconstructed SST (ERSST) version 3**
- **NCEP/NCAR Reanalysis-1 wind, velocity potential and heat fluxes**
- **NOAA's Outgoing Long Wave Radiation**
- **PMEL TAO equatorial temperature analysis**
- **NCEP's Global Ocean Data Assimilation System (GODAS) temperature, heat content, currents**
- **Aviso Altimetry Sea Surface Height**
- **Ocean Surface Current Analyses – Realtime (OSCAR)**