

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

Prepared by  
Climate Prediction Center, NCEP  
**August 9, 2008**

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

# Outline

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

# Overview

- **Global Ocean**

- Global mean SST anomalies went to below-zero during the past winter due to the 07/08 La Nina cooling, and have been steadily increasing since then.

- **Pacific Ocean**

- ENSO-neutral conditions: NINO3.4 for last week was +0.2C.
- CPC's prognostic assessment: ENSO-neutral conditions will continue through fall.
- Equatorial tropical Pacific heat content has recharged from Feb to May during the decay phase of the 07/08 La Nina, but discharged from May to July.
- Easterly wind anomalies and suppressed convection in C. Pacific persisted.
- Positive SST anomalies in the equatorial eastern Pacific continues to expand westward.

- **Indian Ocean**

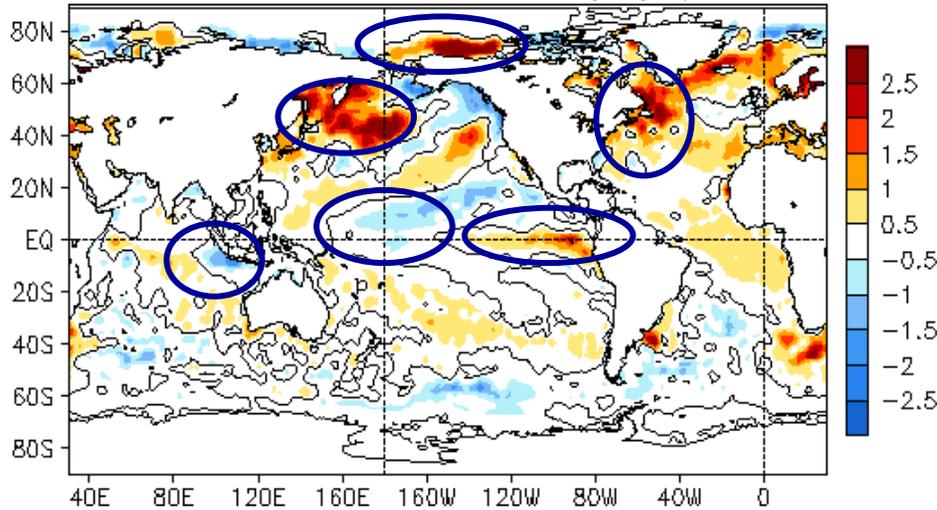
- Dipole Mode Index was above 0.5°C during June-July.
- Easterly wind anomalies in the tropical Indian Ocean persisted during May-June switched to westerly wind anomalies in mid-July, probably due to the eastward progression of the MJO (see CPC MJO Diagnostic Assessment).

- **Atlantic Ocean**

- In the hurricane Main Development Region, SST and Tropical Cyclone Heat Potential were above-average, vertical wind shears were below-average due to westerly (easterly) wind anomalies at 850 mb (200 mb) in July → favourable for hurricane development.

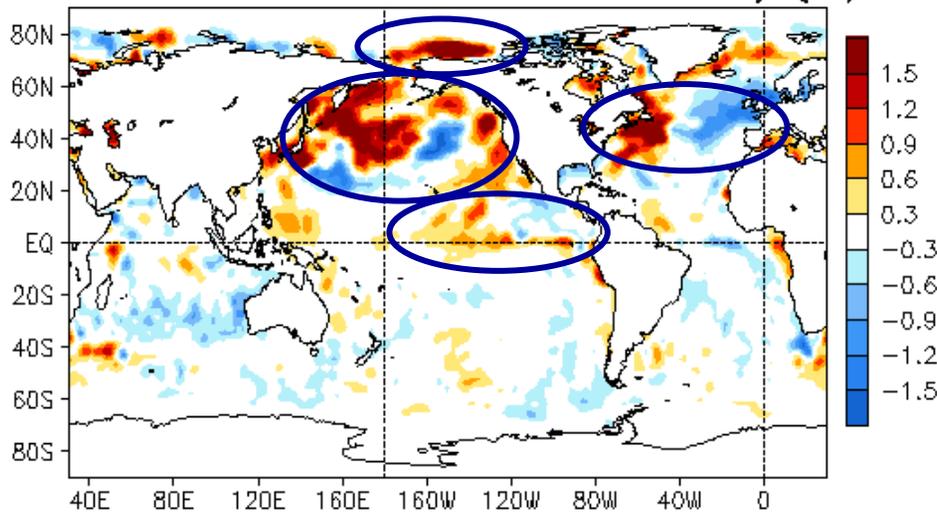
# Global SST Anomaly ( $^{\circ}\text{C}$ ) and Anomaly Tendency

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



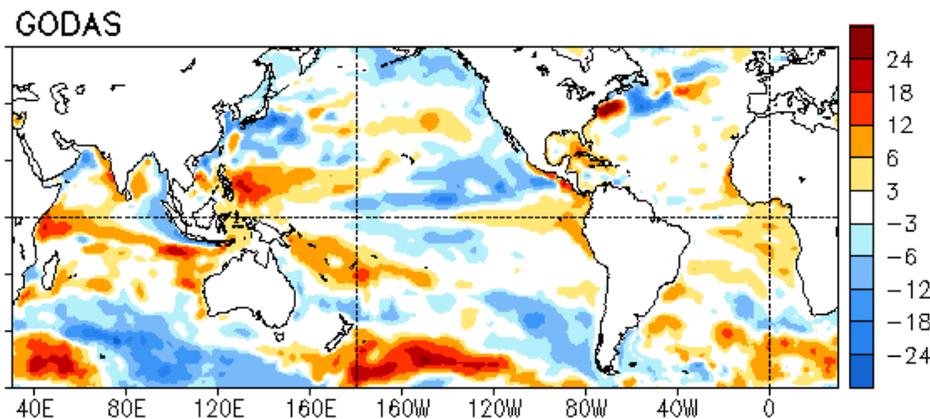
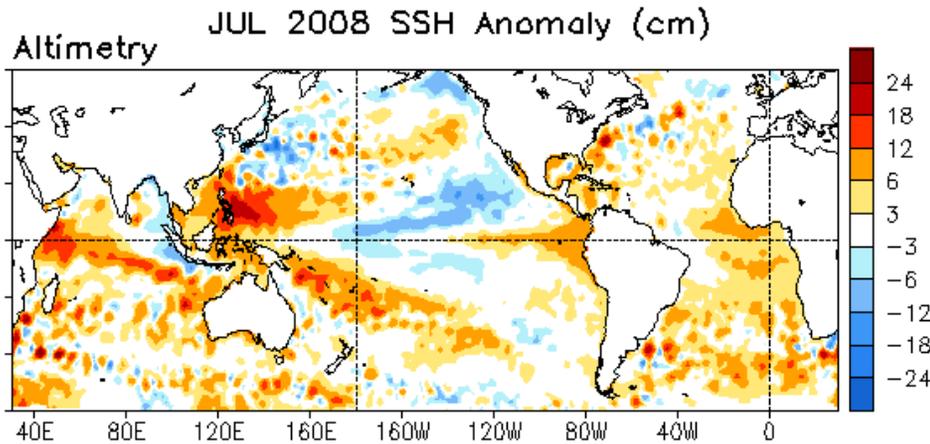
- Large positive SST anomalies presented in the western North Pacific and North Atlantic.
- Large positive SST anomalies presented in the Arctic Ocean.
- Weak negative (positive) SST anomalies presented in the central (eastern) equatorial Pacific.
- Weak-to-moderate negative SST anomalies presented in the south-eastern Indian Ocean.

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



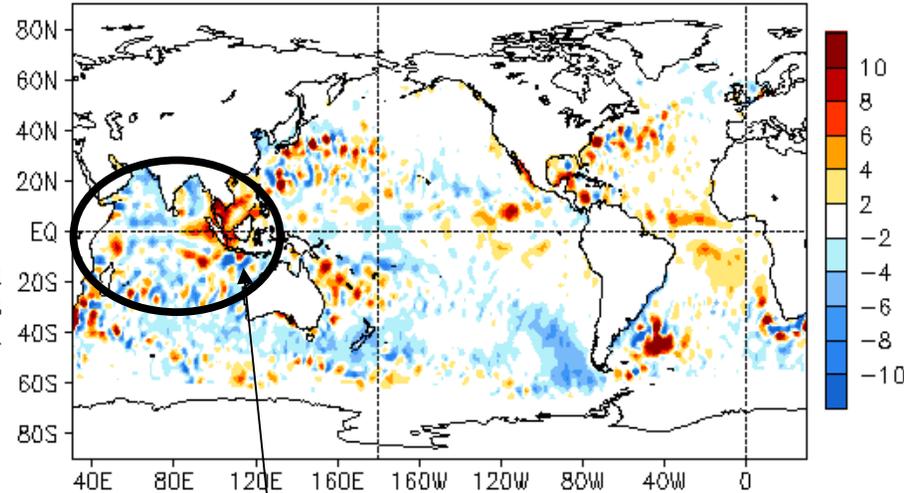
- Weak warming in all nino-regions.
- Strong warming in the North Pacific.
- Strong warming (cooling) in the western (eastern) North Atlantic.
- Strong warming in the Arctic Ocean.

# Sea Surface Height Anomaly (cm)



- GODAS SSH agrees with Altimetry SSH well except in the Southern Oceans.

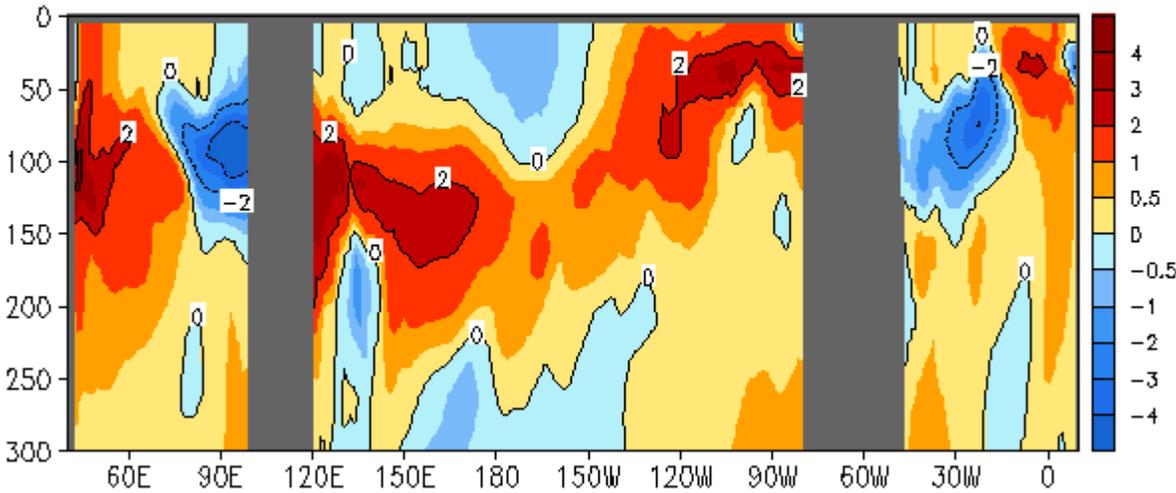
JUL 2008 - JUN 2008 SSH Anomaly (cm)



- Sea level anomalies increased (decreased) in the eastern (central) Indian Ocean.

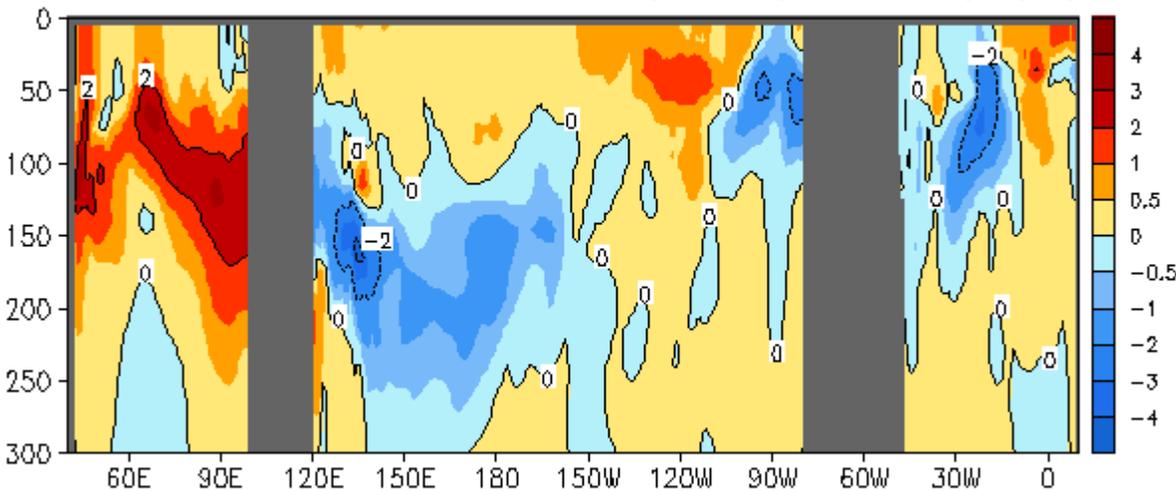
# Longitude-Depth Temperature Anomaly in 2°S-2°N

JUL 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.

JUL 2008 - JUN 2008 Eq. Temp Anomaly (°C)



- Temperature increased at 50-150 m depth in the equatorial Indian Ocean.
- Temperature decreased near the thermocline in the western and far eastern tropical Pacific.

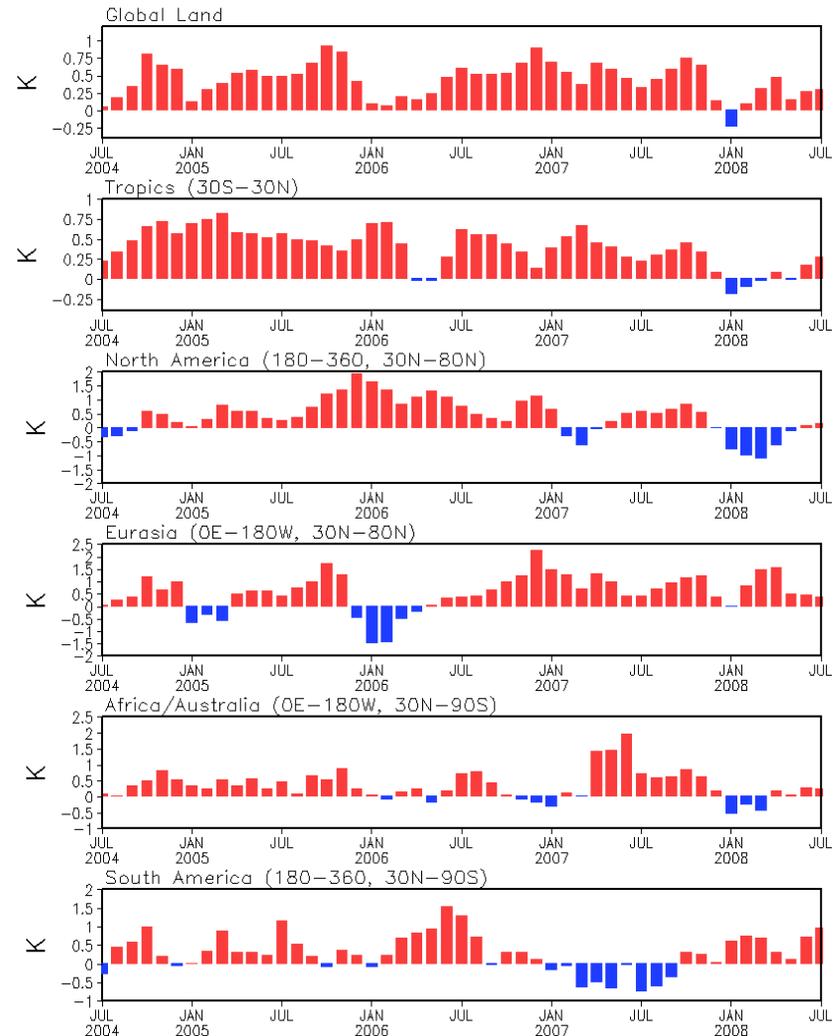
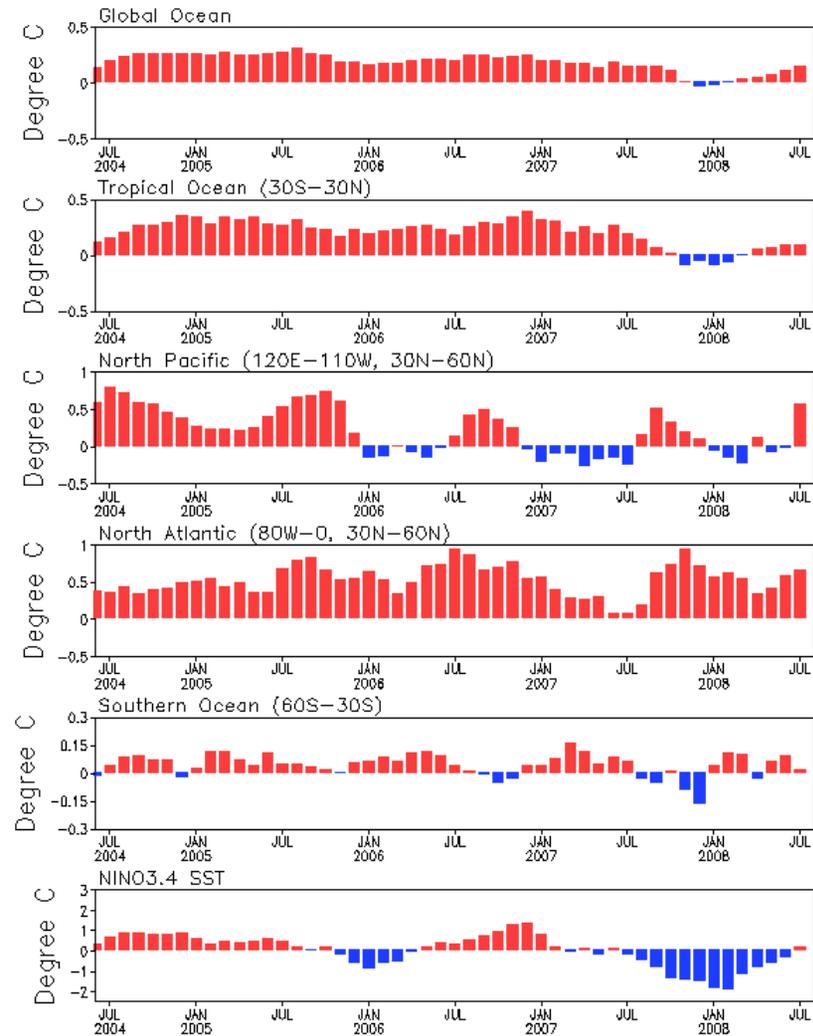
# Monthly Time Series

## Sea Surface Temperature

## CAMS Land Temperature

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

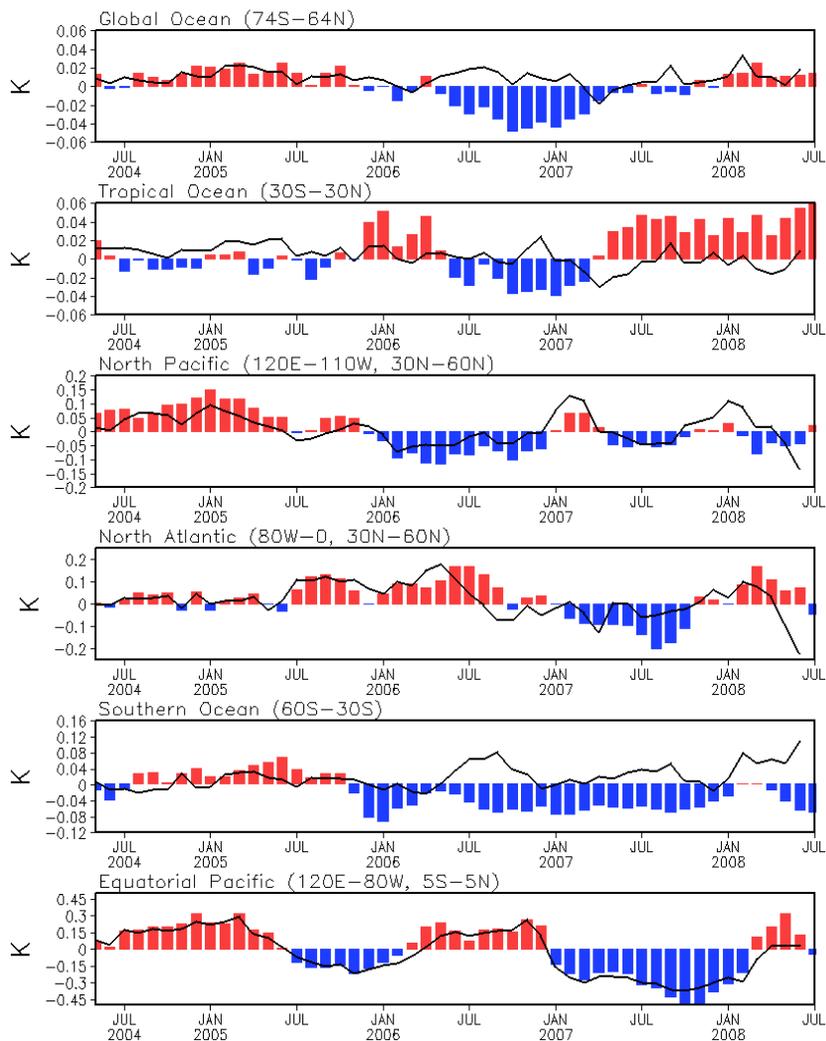
3–Month running mean Temperature (Climo. 1982–2004)



- Tropical land temperature tracks the tropical ocean temperature well.
- Land temperature variability is larger than SST variability.

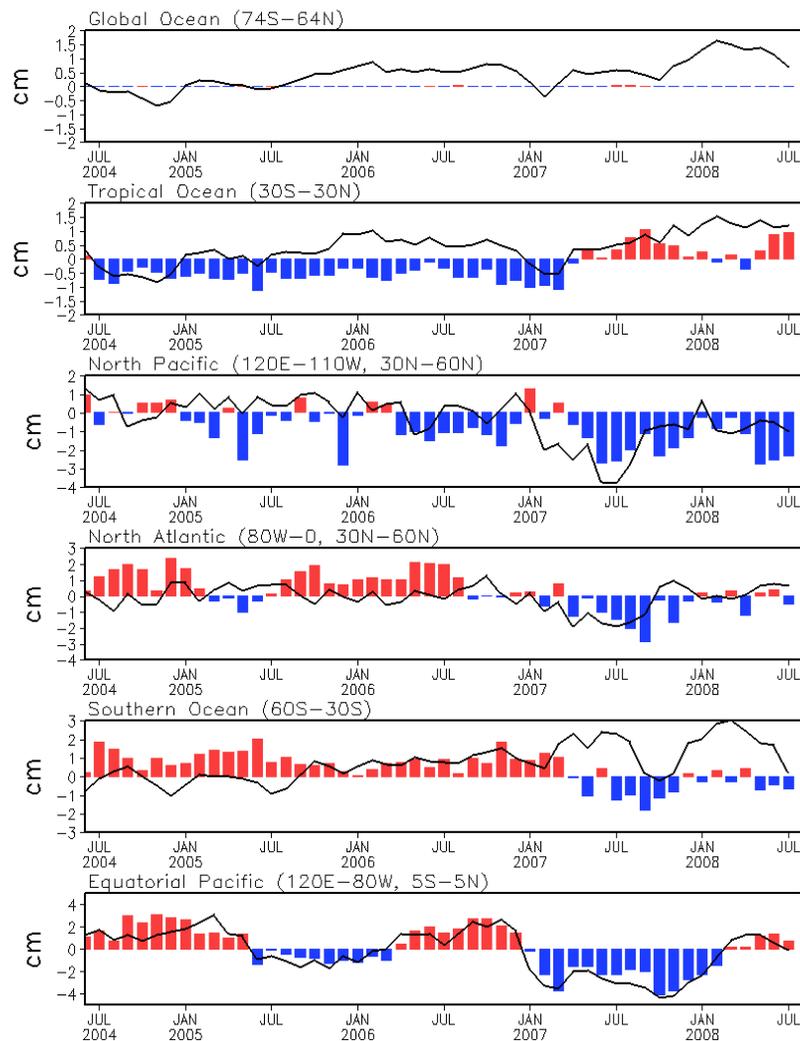
# 300 m Heat Content

Monthly HC300 Time Series (Climo. 2002–2007)



# Sea Surface Height

Monthly Sea Level Time Series (Climo. 2002–2007)



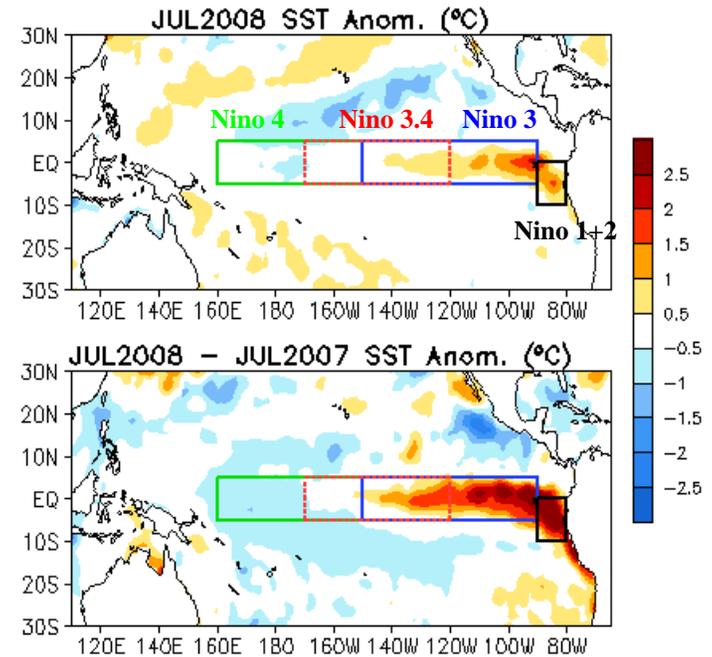
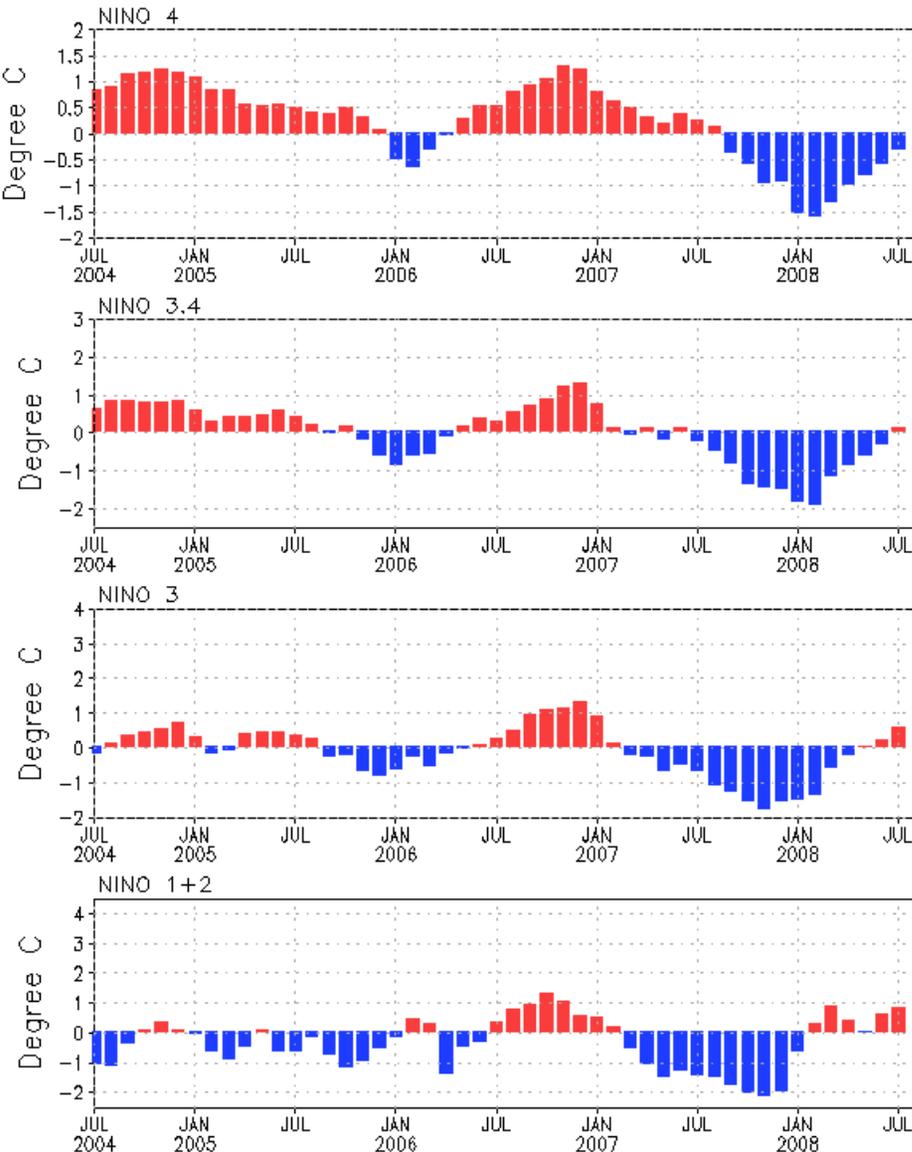
- GODAS heat content agrees poorly with that of the Coriolis ocean analysis based on the Argo data except in the tropical Pacific.

- Because GODAS SSH is a diagnostic variable, its global mean stays near 0, thus we cannot use GODAS to assess trends in sea level height.

# Pacific Ocean

# Evolution of Pacific NINO SST Indices

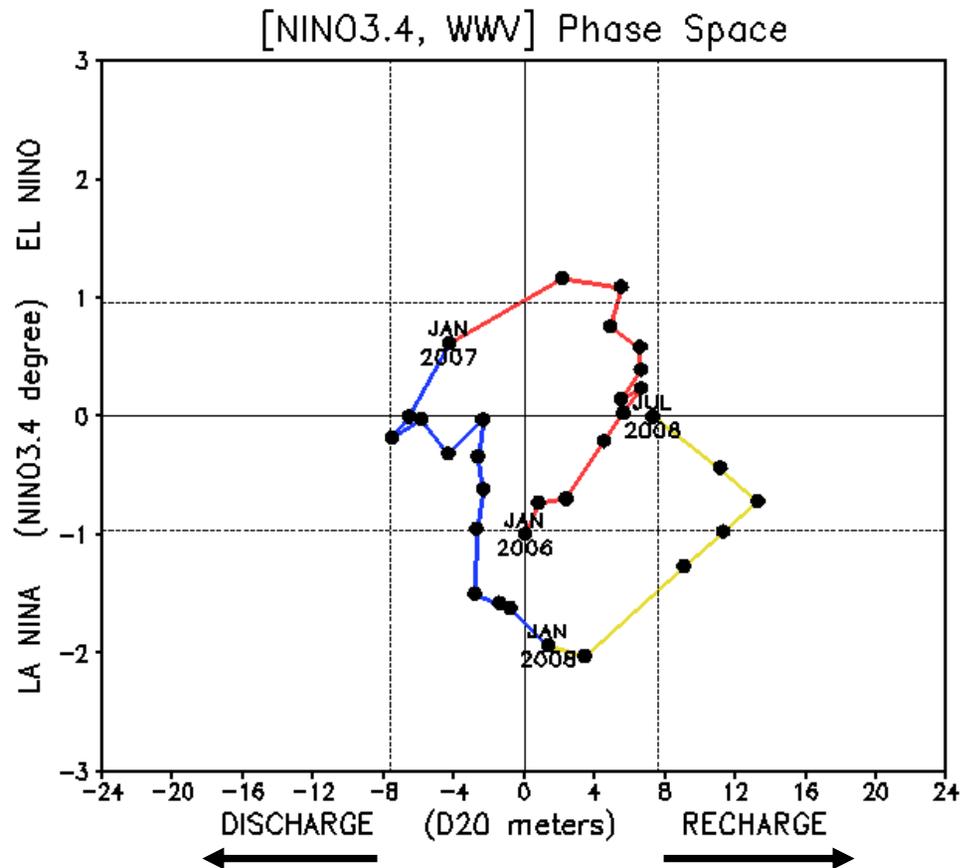
Monthly Tropical Pacific SST Anomaly



- ENSO-neutral conditions presented in July.
- NINO3 is slightly positive.
- Positive anomalies in Nino1+2 has persisted from February to July.

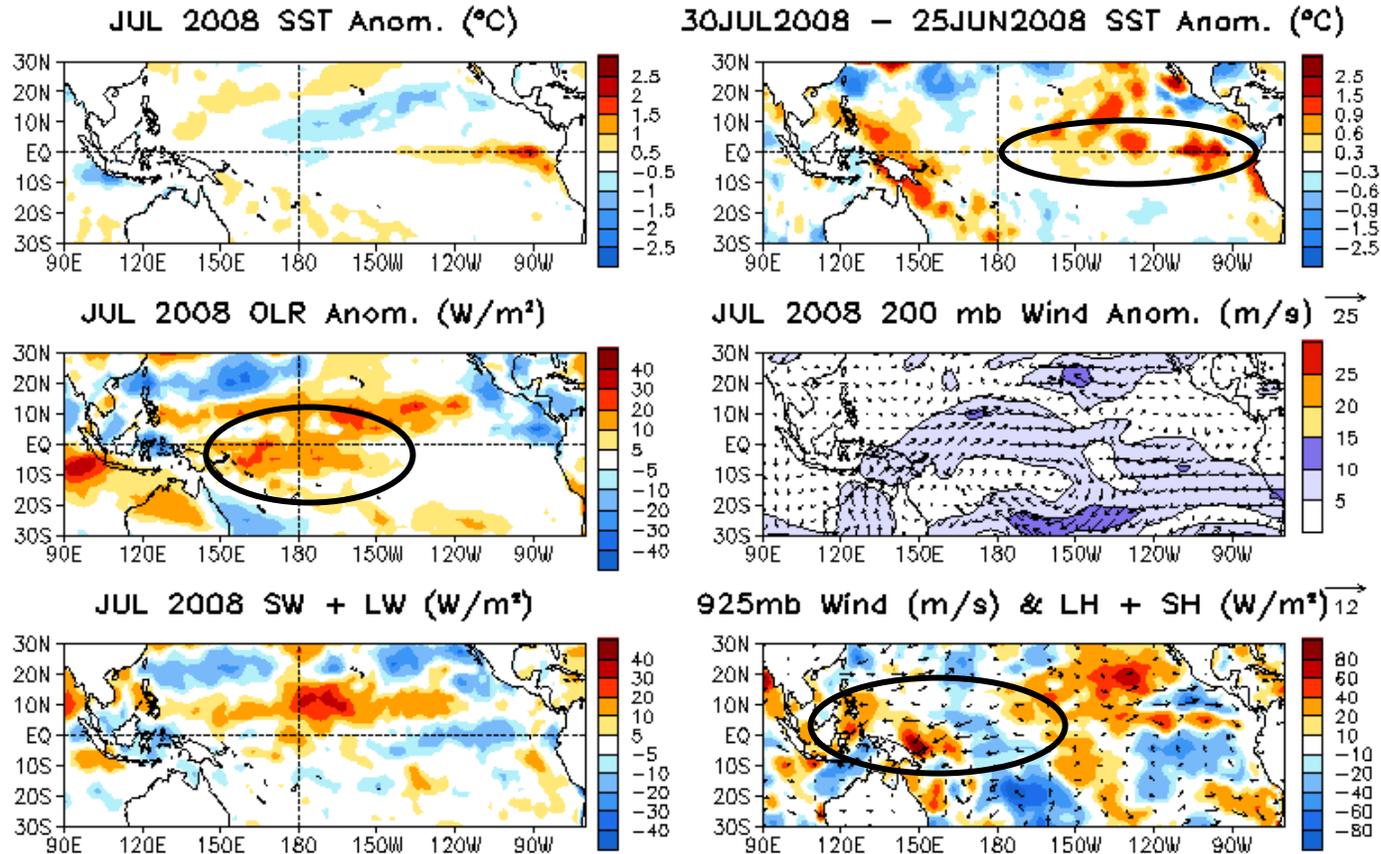
# Warm Water Volume and NINO3.4 Anomalies

Warm Water Volume(WWV) is defined as average of depth of 20°C in [120°E-80°W, 5°S-5°N] ([http://www.pmel.noaa.gov/tao/el\\_nino/wwv/](http://www.pmel.noaa.gov/tao/el_nino/wwv/)) and calculated with GODAS data.



- Warm Water Volume(WWV) has increased rapidly from February to May, but has decreased since then.

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

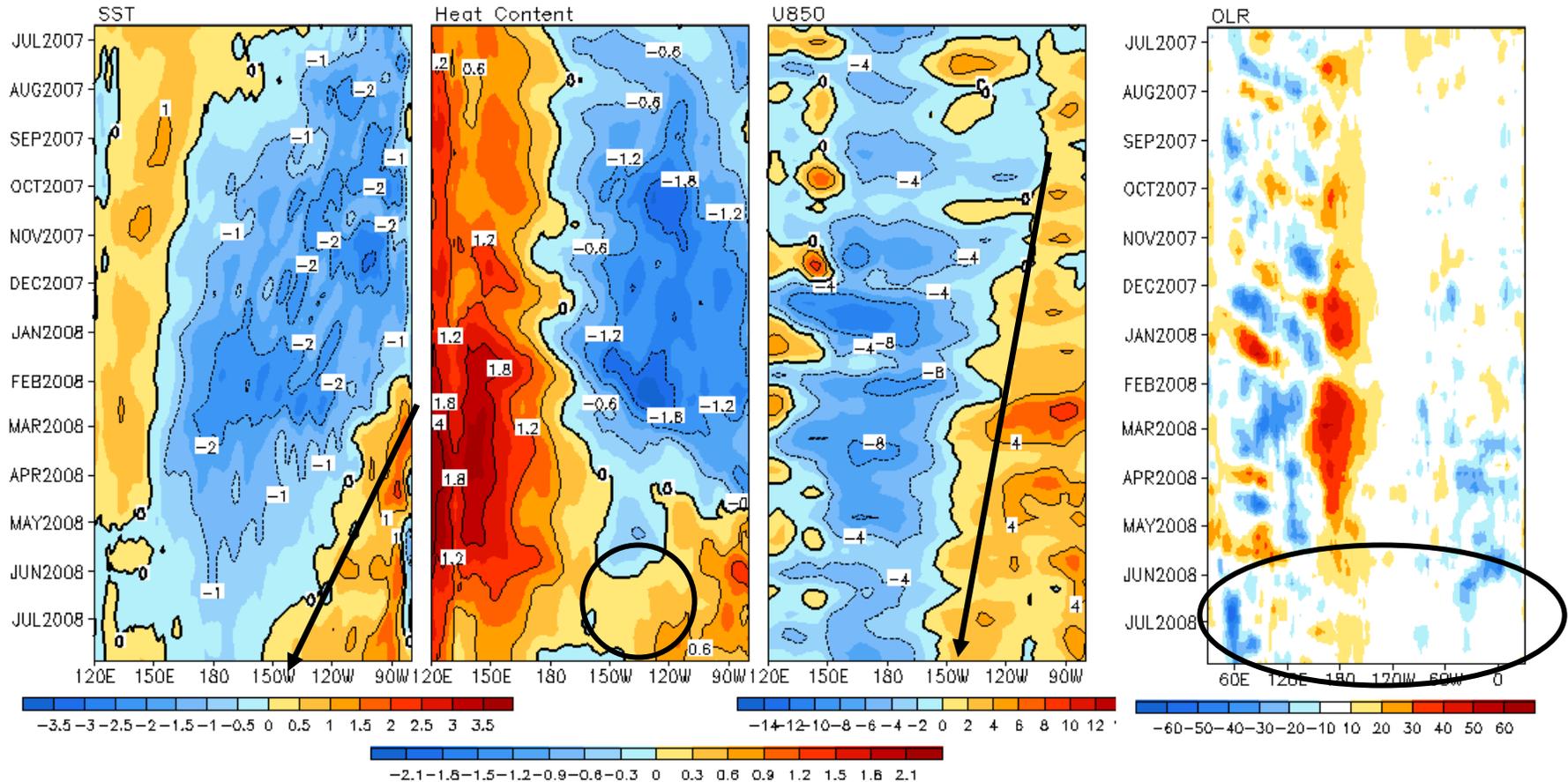


- SST increased east of the Dateline and in the far western Pacific.
- Suppressed convection and easterly (westerly) wind anomalies at 925mb (200 mb) presented in the western-central Pacific.

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

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

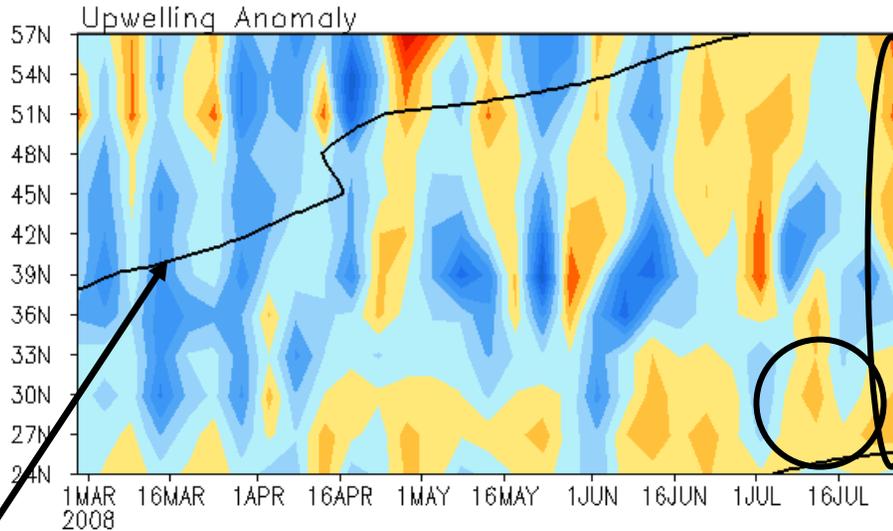
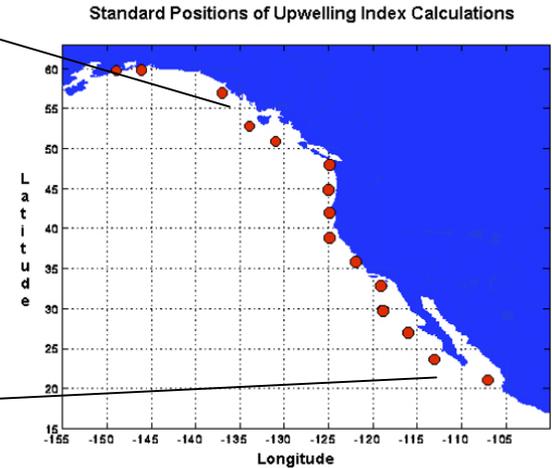
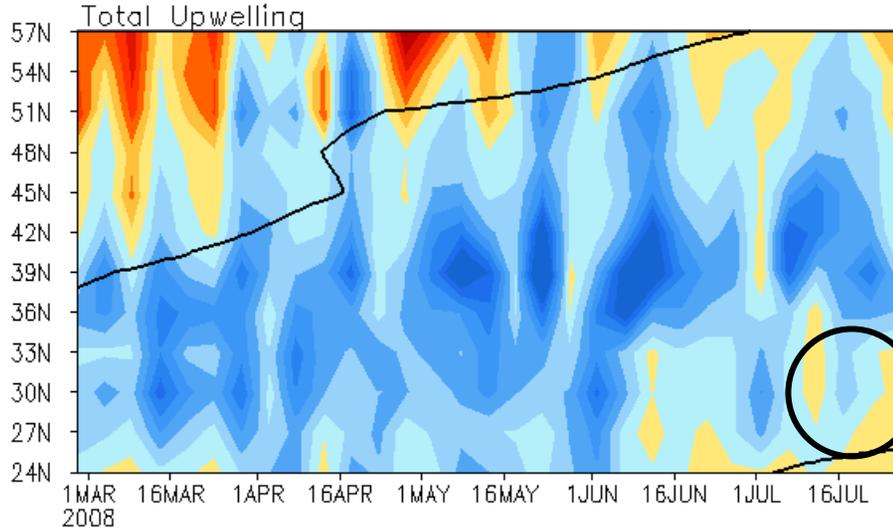
2 $^{\circ}\text{S}$ –2 $^{\circ}\text{N}$  Average, 3 Pentad Running Mean



- Positive SST and westerly wind anomalies in the eastern Pacific continue to expand westward.
- Positive heat content anomalies in the central Pacific have switched to negative anomalies.
- Suppressed convection near the Dateline and enhanced convection in the western Indian Ocean persisted, but enhanced convection in the tropical Atlantic diminished.

# North America Western Coastal Upwelling

Pentad Coastal Upwelling for West Coast North America  
( $m^3/s/100m$  coastline)



- Total Upwelling was weak south of 33N in July due to negative upwelling anomalies there  
- Upwelling was suppressed along most of the coast near the end of July.

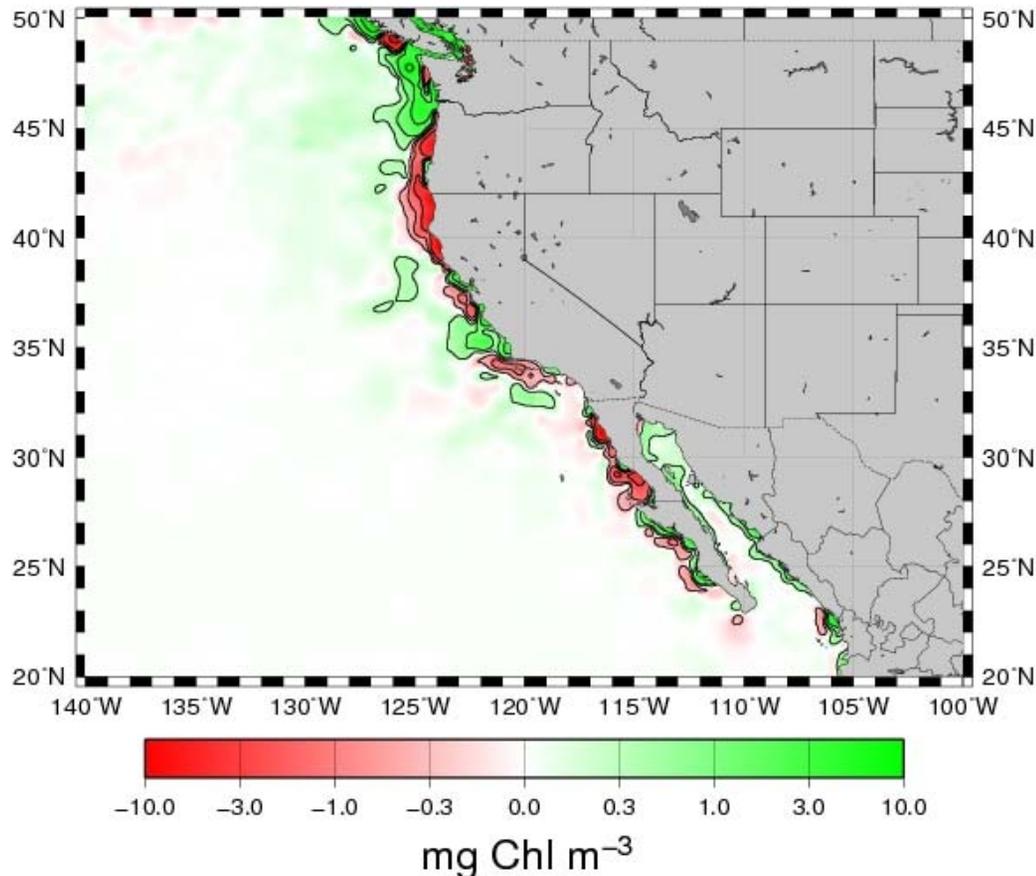


- Area below (above) black line indicates climatological upwelling (downwelling) season.
- Climatologically upwelling season progresses from March to July along the west coast of North America from 36°N to 57°N.

# Monthly Chlorophyll Anomaly

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

MODIS Aqua Chlorophyll a Anomaly for July, 2008



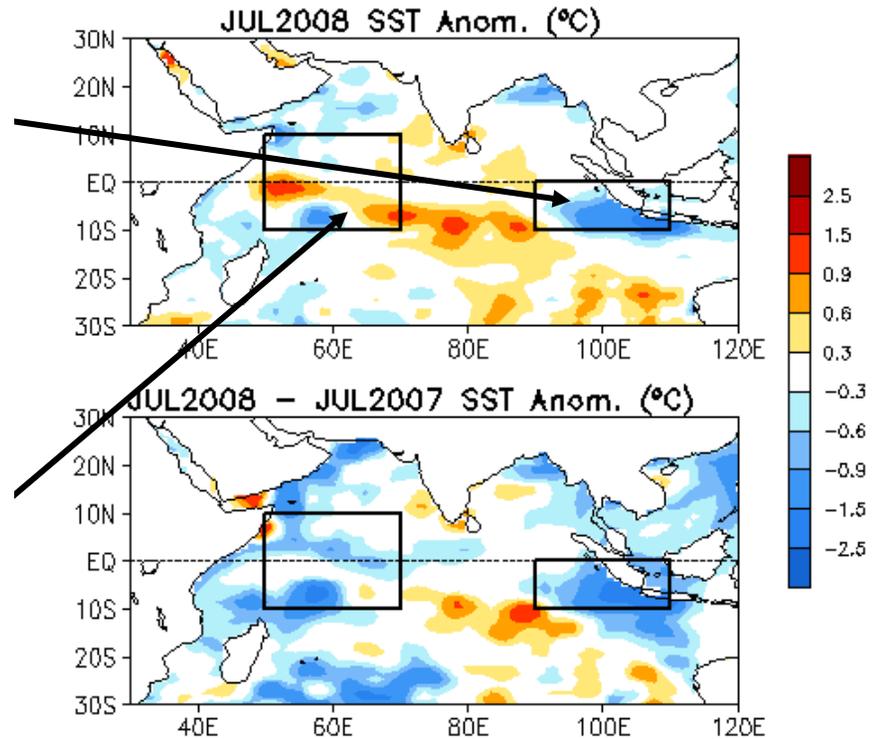
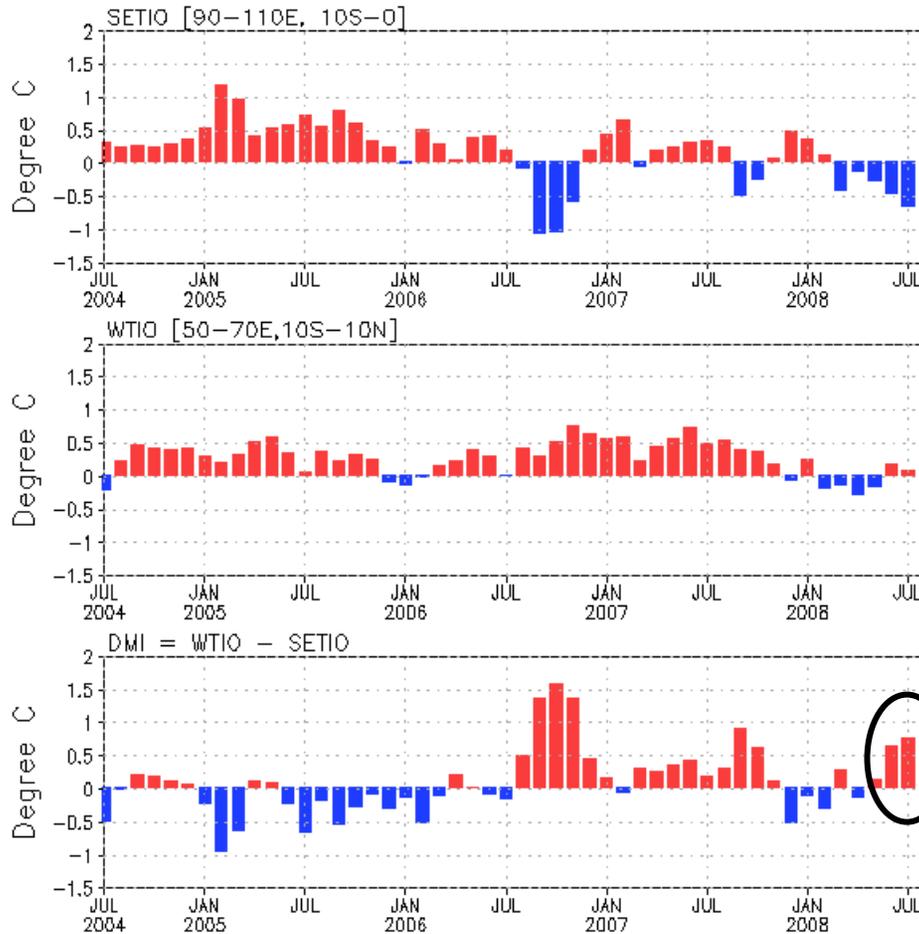
Negative Chlorophyll anomalies south of 43°N were largely consistent with suppressed upwelling there.

GLW 2008 Aug 6 22:10:40 Data courtesy of NASA GSFC

# Indian Ocean

# Recent Evolution of Indian Ocean SST Indices

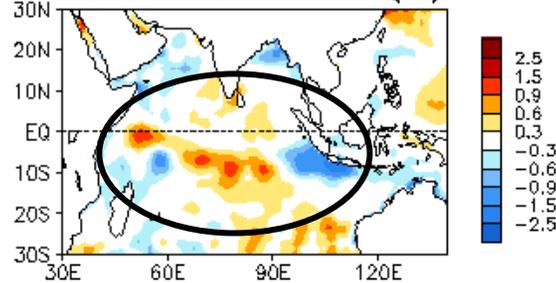
Indian Ocean Dipole Mode Indices



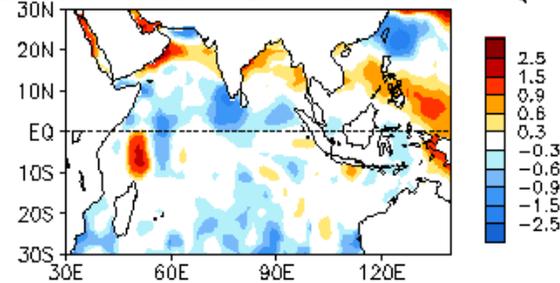
- Tropical Indian Ocean SST is cooler than that last year.
- Dipole Mode Index (DMI) was above 0.5°C in June-July.

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

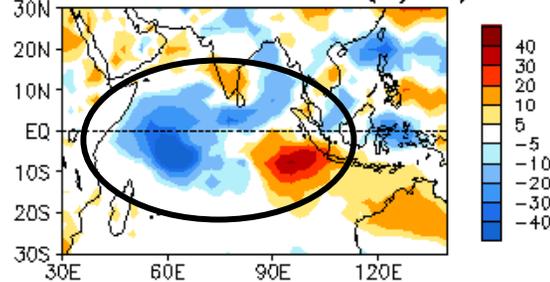
JUL 2008 SST Anom. ( $^{\circ}\text{C}$ )



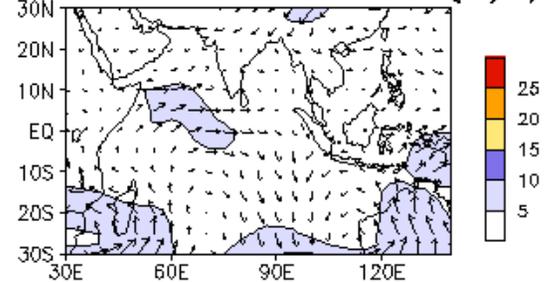
30JUL2008 - 25JUN2008 SST Anom. ( $^{\circ}\text{C}$ )



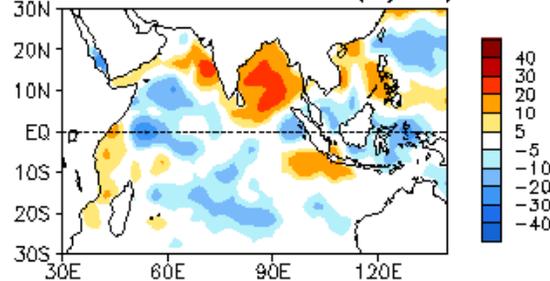
JUL 2008 OLR Anom. ( $\text{W}/\text{m}^2$ )



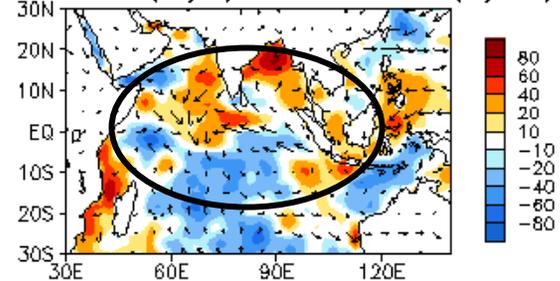
JUL 2008 200 mb Wind Anom. ( $\text{m}/\text{s}$ )  $\overrightarrow{15}$



JUL 2008 SW + LW ( $\text{W}/\text{m}^2$ )



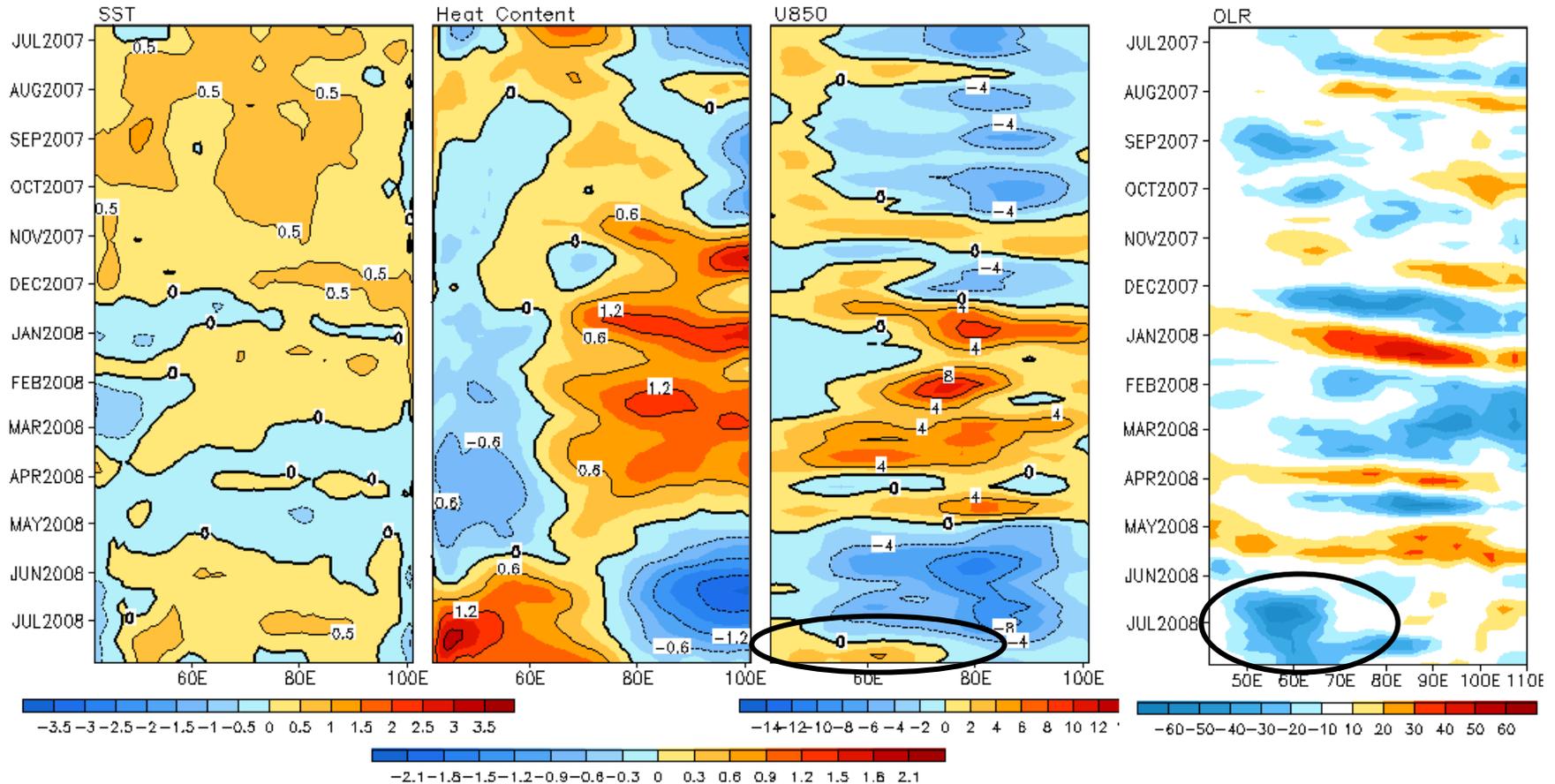
925mb Wind ( $\text{m}/\text{s}$ ) & LH + SH ( $\text{W}/\text{m}^2$ )  $\overrightarrow{8}$



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

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

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

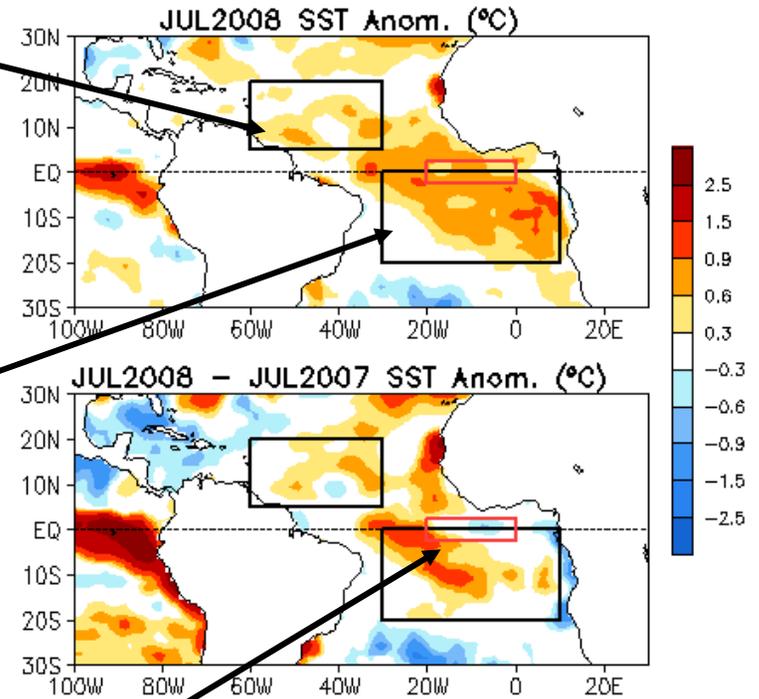
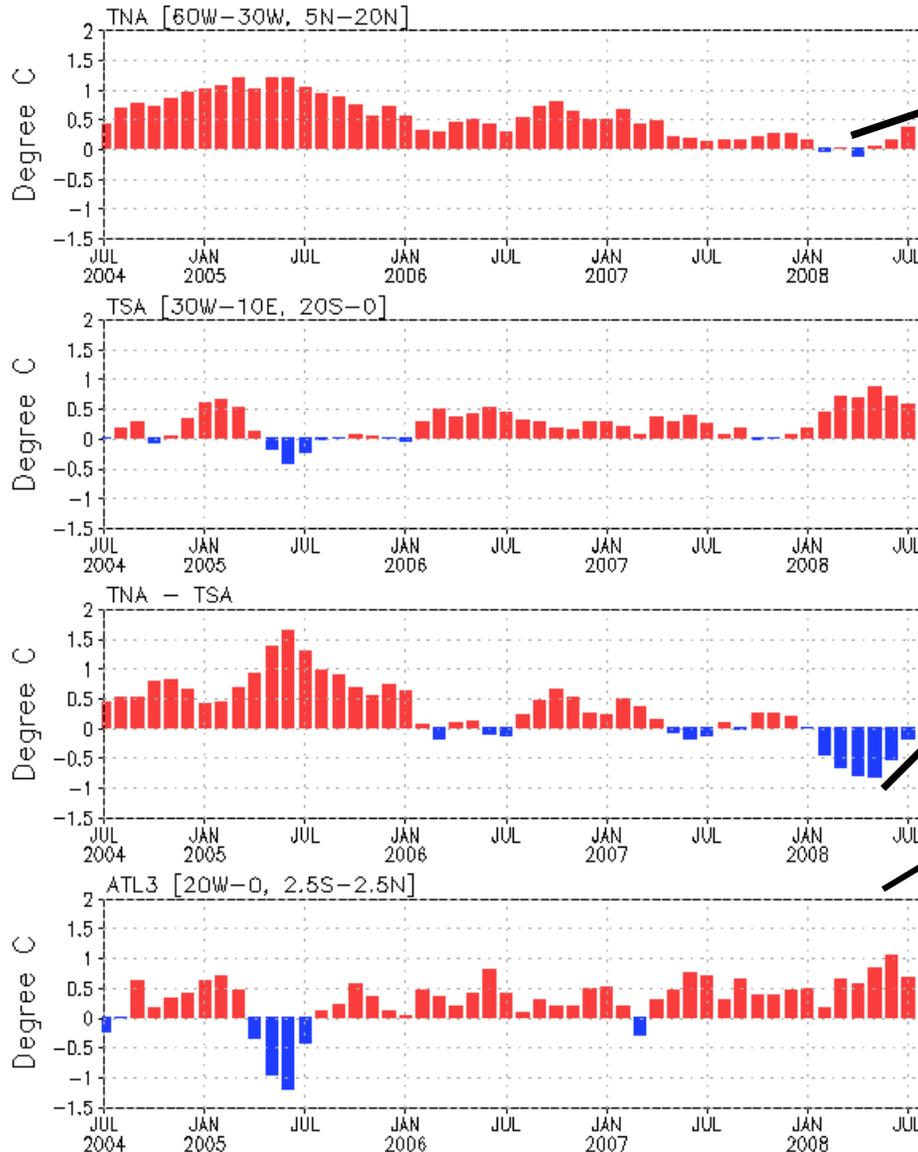


- Easterly wind anomalies persisted in May-June switched to westerly wind anomalies in mid-July in the western-central Indian Ocean, probably due to the eastward progression of the MJO (see CPC MJO Diagnostic Assessment)
- Negative heat content anomalies in the eastern Indian Ocean weakened substantially.
- Enhanced convection in the western Indian Ocean has persisted for two months, and reduced the SST in that region.

# Atlantic Ocean

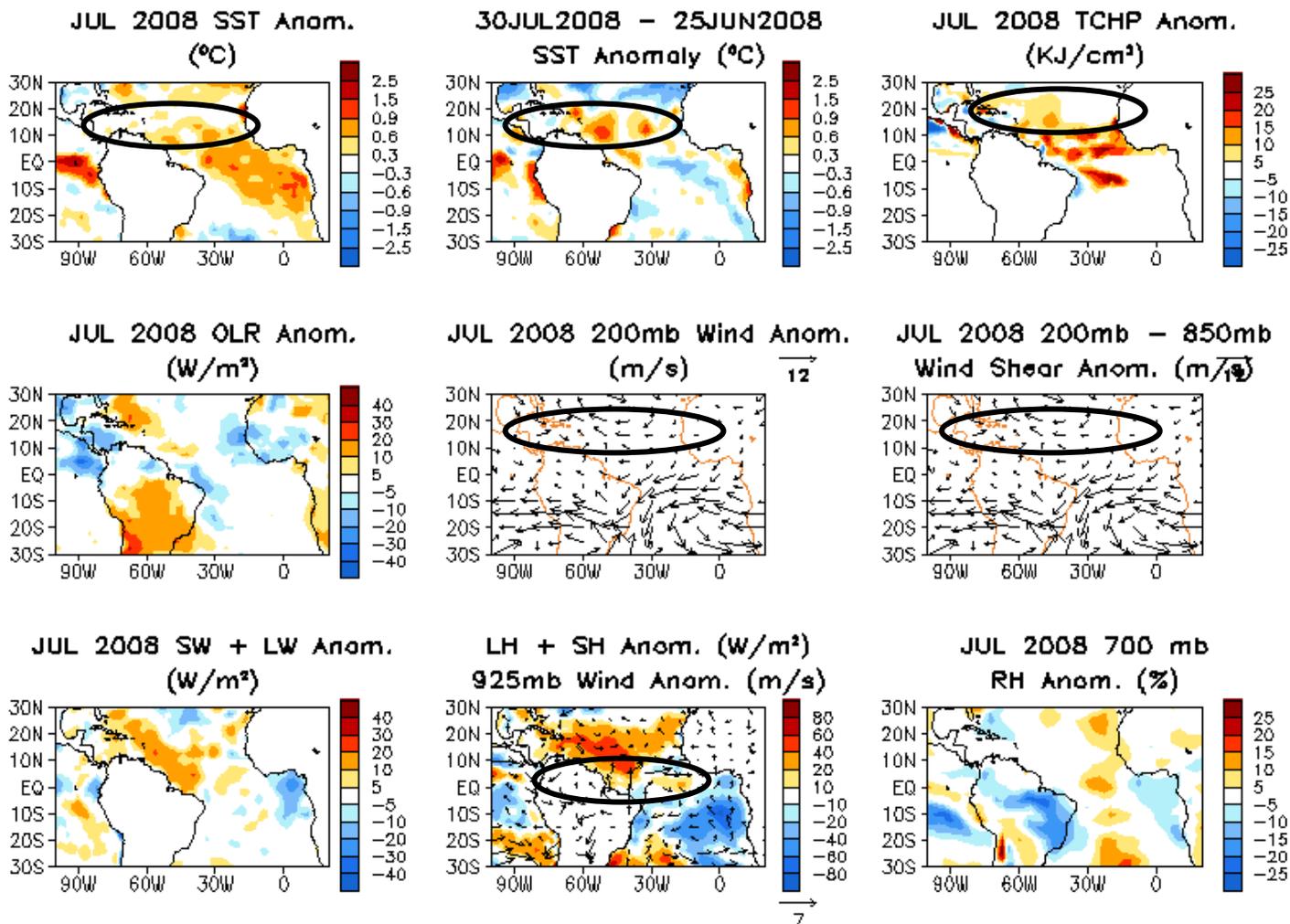
# Evolution of Tropical Atlantic SST Indices

Monthly Tropical Atlantic SST Anomaly



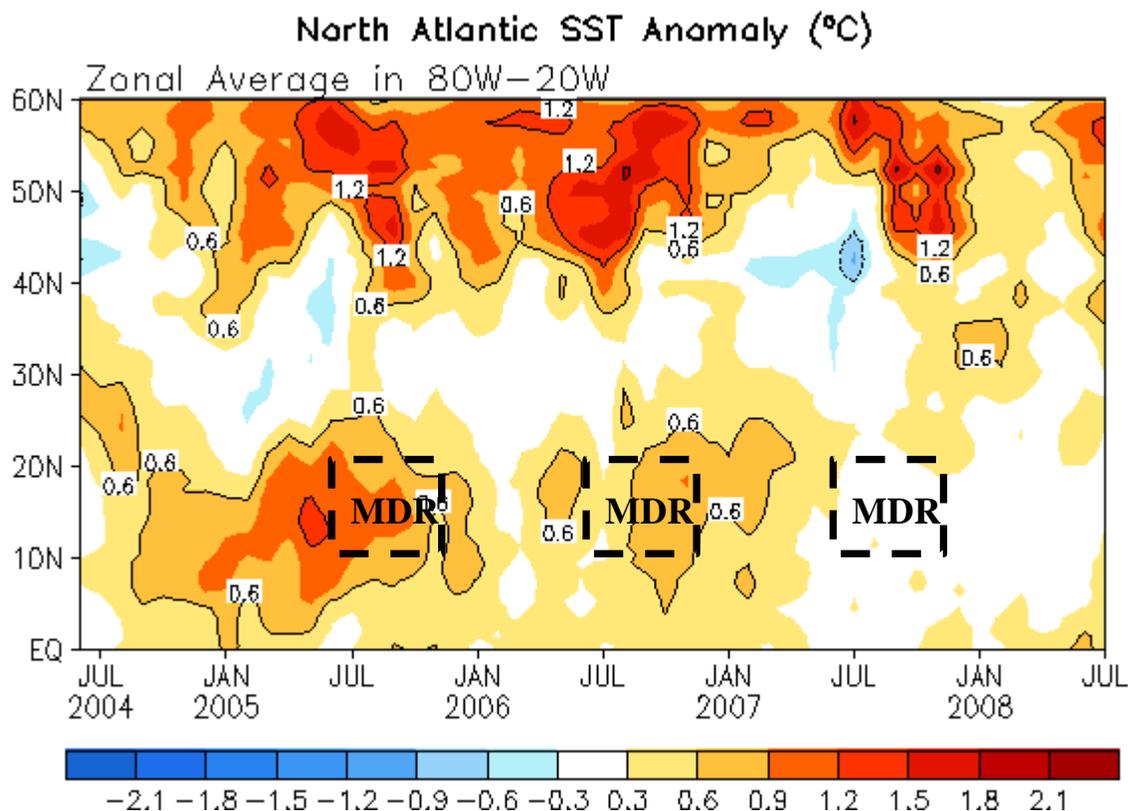
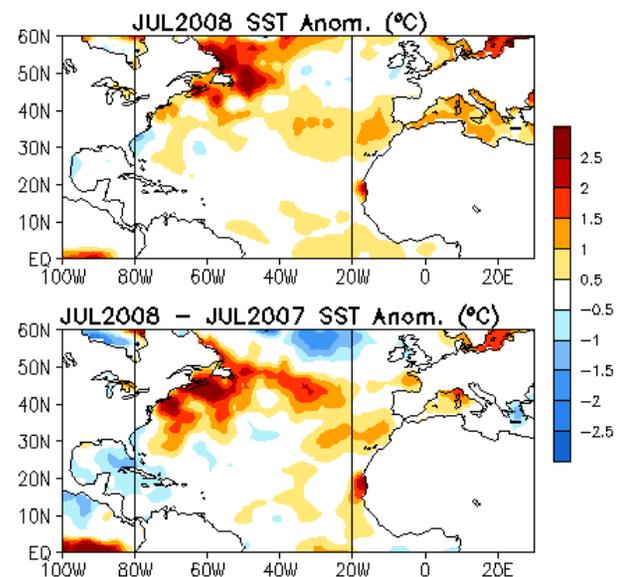
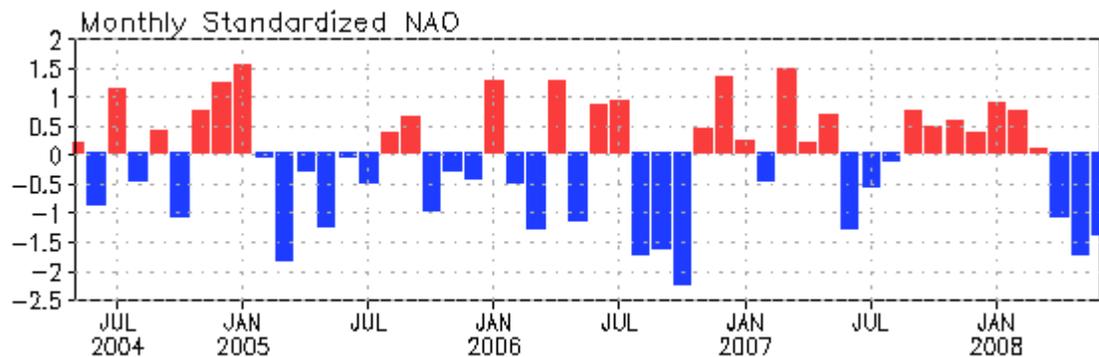
- Tropical North Atlantic SST has been steadily increasing since April.
- Meridional Gradient SST (TNA-TSA) is approaching zero in July.

# Tropical Atlantic: SST Anom., SST Anom. Tend., OLR, 850-mb Winds, Sfc Rad, Sfc Flx, TCHP, Windshear, RH Anomaly



- SSTs increased in the hurricane Main Development Region (MDR).
- Westerly (easterly) wind anomalies at 850 mb (200mb) resulted in below-average wind shear in MDR.
- Tropical Cyclone Heat Potential was above-average in MDR, favourable for hurricane development.

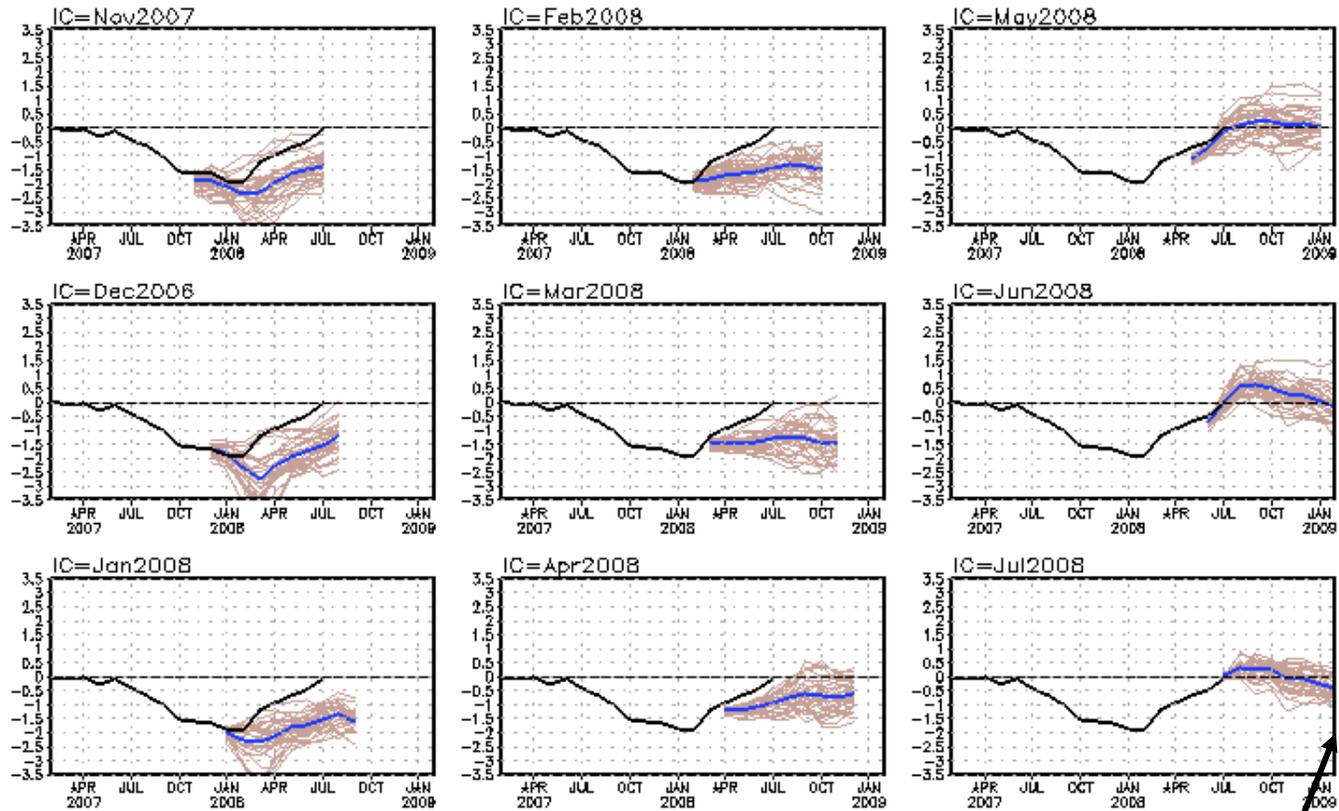
# SST Anomaly in North Atlantic



- 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 has caused large warming in the North Atlantic.

# CFS SST Predictions and Ocean Initial Conditions

# CFS Niño 3.4 SST Predictions from Different Initial Months

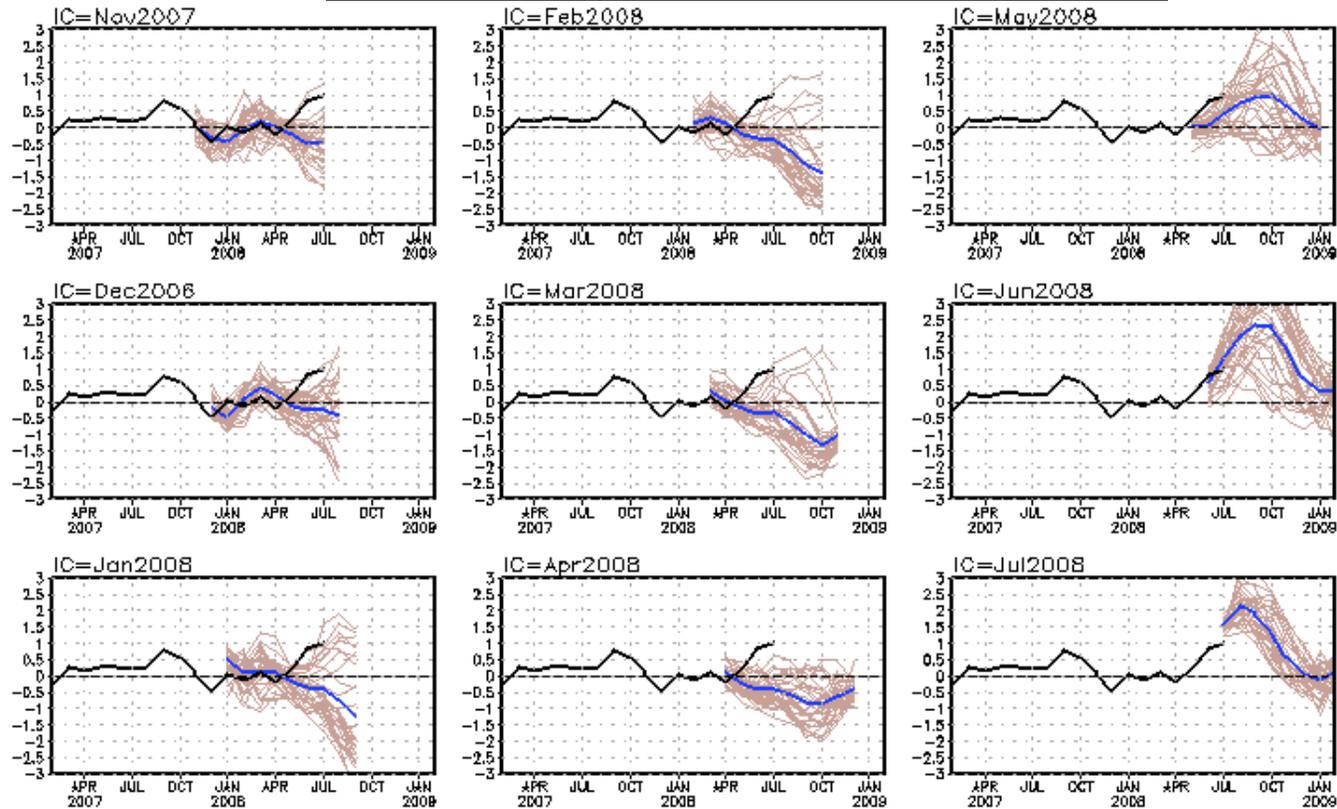


— Individual forecast members — Forecast ensemble mean — Observations

- Latest forecasts are calling for ENSO-neutral conditions.

## Predictions from

## Different Initial Months



— Individual forecast members — Forecast ensemble mean — Observations

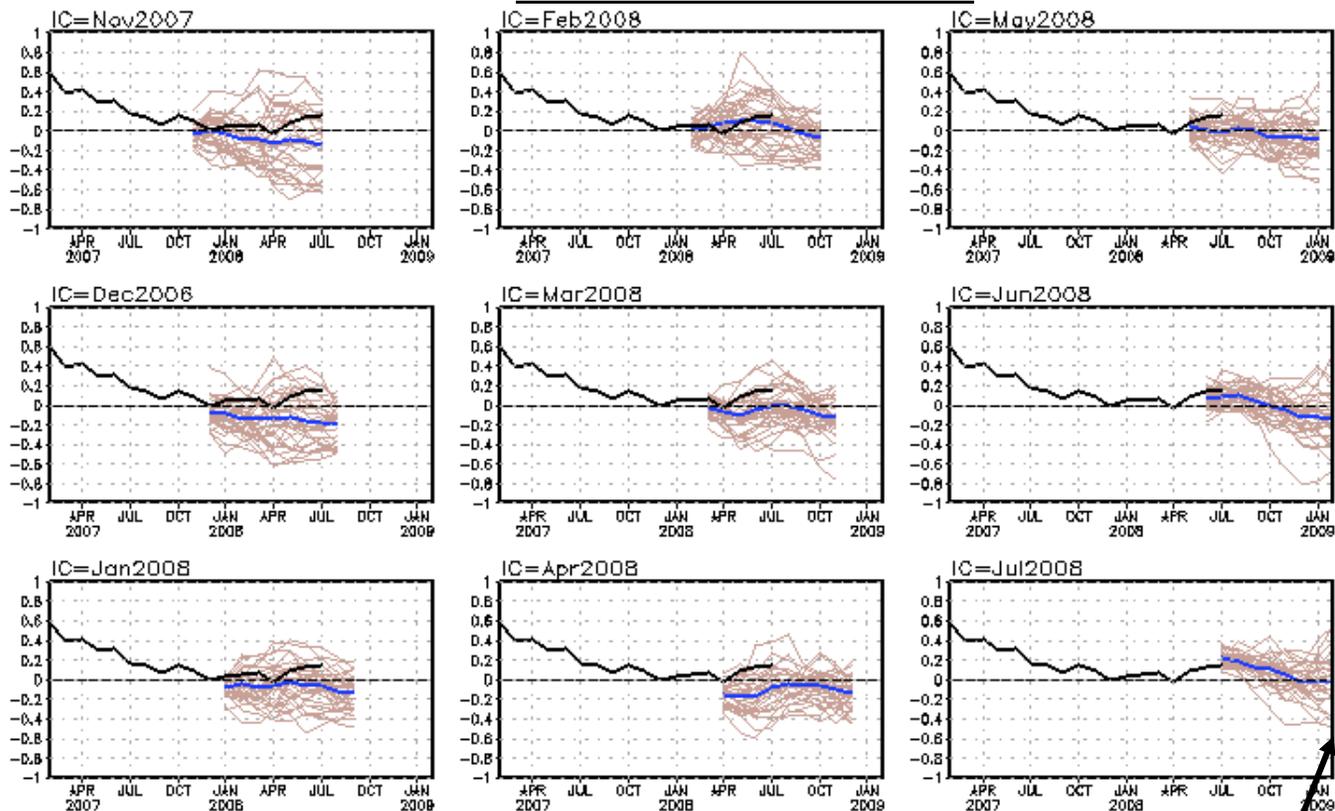
Starting from May I.C., CFS has been predicting a positive Indian Ocean Dipole.

For Jan-Apr 08 I.C., CFS called for a strong negative IOD event to be developed in fall 08.

# CFS Atlantic Main Development region (85W-

## 20W,10N-20N) SST Predictions from Different

### Initial Months



— Individual forecast members — Forecast ensemble mean — Observations

CFS forecasts missed the warming over the past 2 months. The forecast continues to damp to climatology.

# Summary

- **Global Ocean**

- Global mean SST anomalies went to below-zero during the past winter due to the 07/08 La Nina cooling, and have been steadily increasing since then.

- **Pacific Ocean**

- ENSO-neutral conditions: NINO3.4 for last week was +0.2C.
- CPC's prognostic assessment: ENSO-neutral conditions will continue through fall.
- Equatorial tropical Pacific heat content has recharged from Feb to May during the decay phase of the 07/08 La Nina, but discharged from May to July.
- Easterly wind anomalies and suppressed convection in C. Pacific persisted.
- Positive SST anomalies in the equatorial eastern Pacific continues to expand westward.

- **Indian Ocean**

- Dipole Mode Index was above 0.5°C during June-July.
- Easterly wind anomalies in the tropical Indian Ocean persisted during May-June switched to westerly wind anomalies in mid-July, probably due to the eastward progression of the MJO (see CPC MJO Diagnostic Assessment).

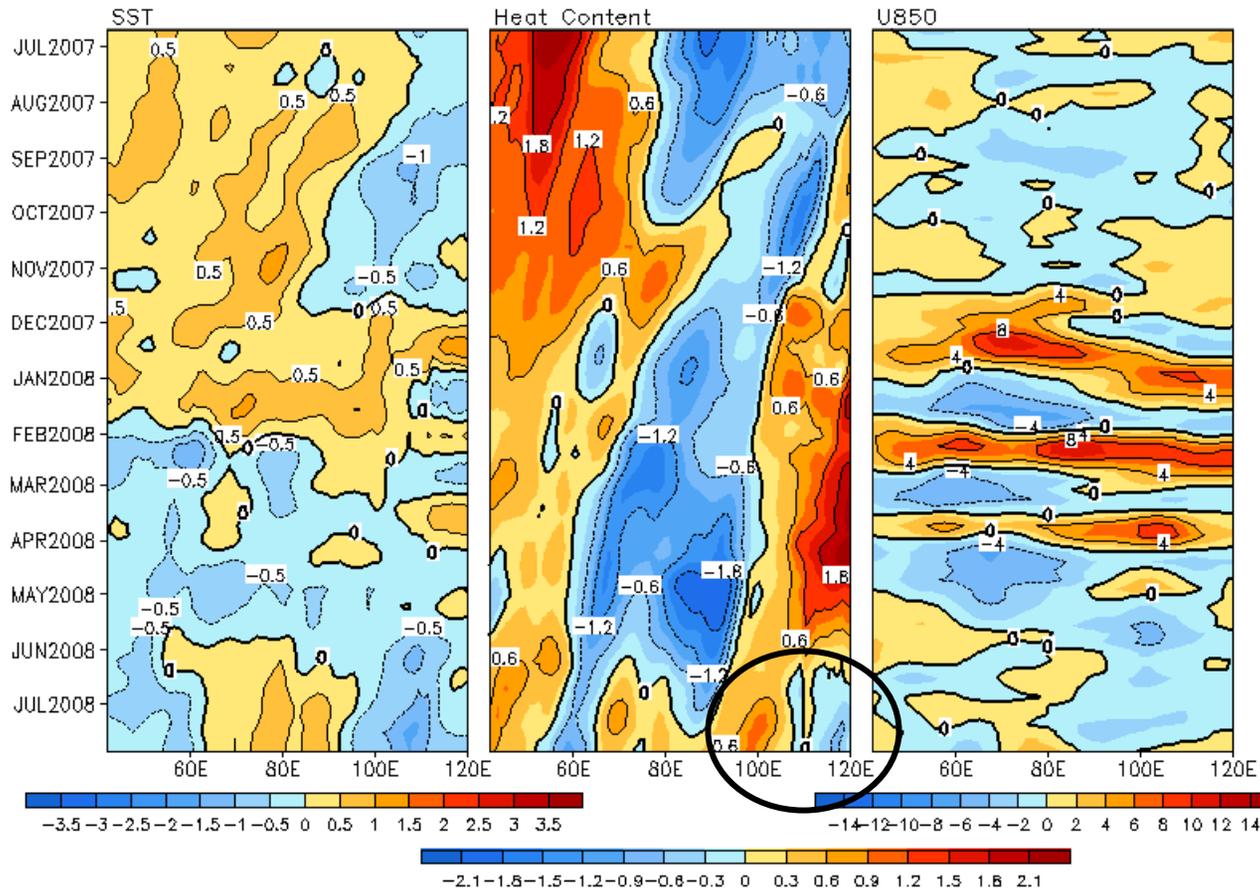
- **Atlantic Ocean**

- In the hurricane Main Development Region, SST and Tropical Cyclone Heat Potential were above-average, vertical wind shears were below-average due to westerly (easterly) wind anomalies at 850 mb (200 mb) in July → favourable for hurricane development.

# Backup Slides

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

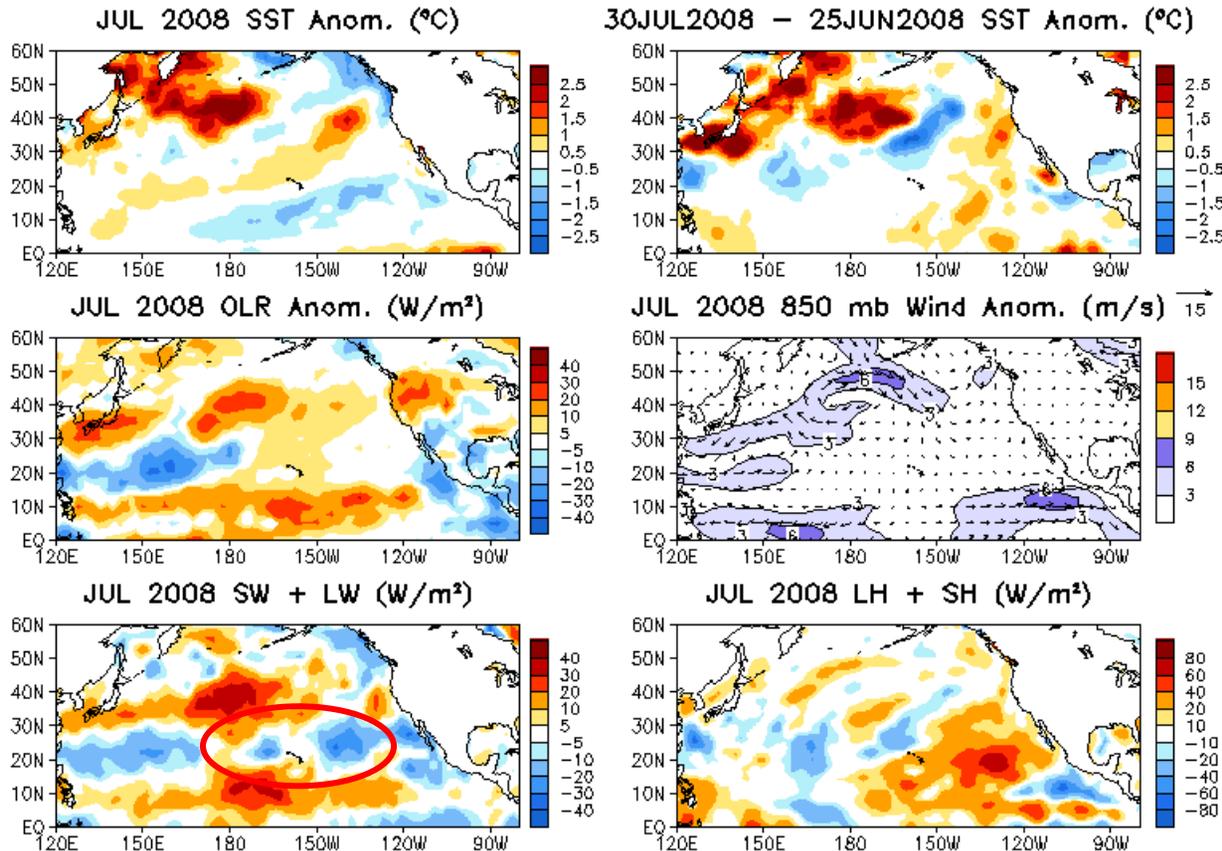
12 $^{\circ}\text{S}$ –8 $^{\circ}\text{S}$  Average, 3 Pentad Running Mean



Heat Content in Eastern Indian Ocean has decreased.

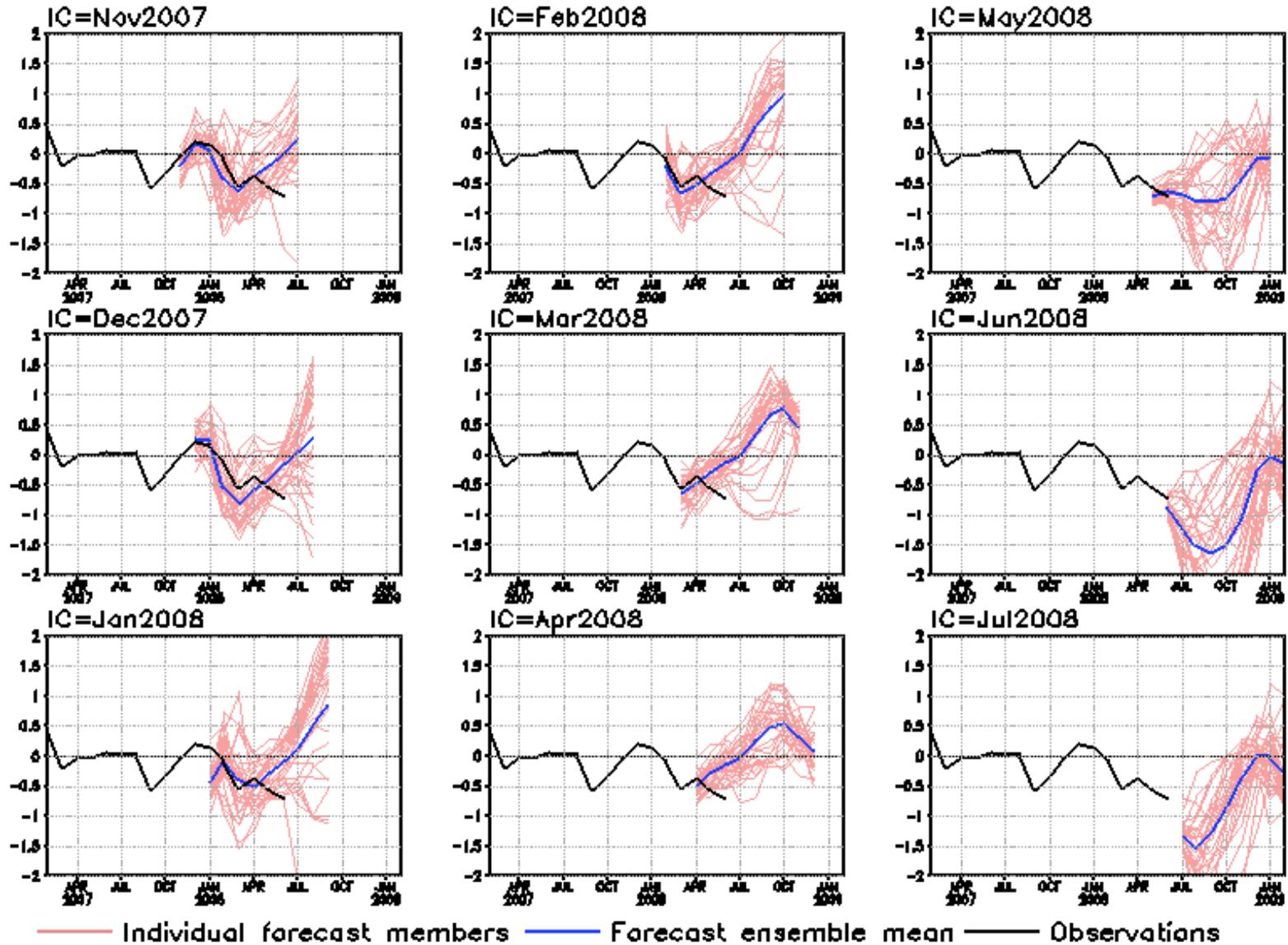
# North Pacific: SST Anom., SST Anom. Tend.,

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

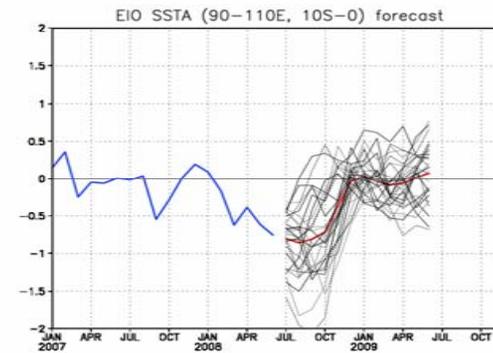
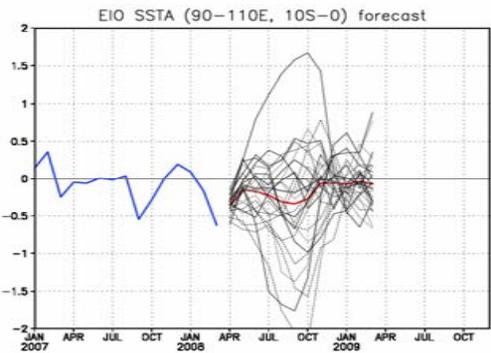
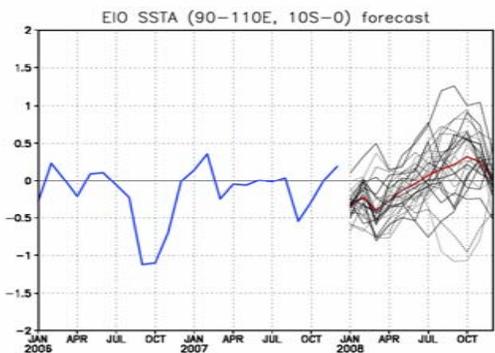
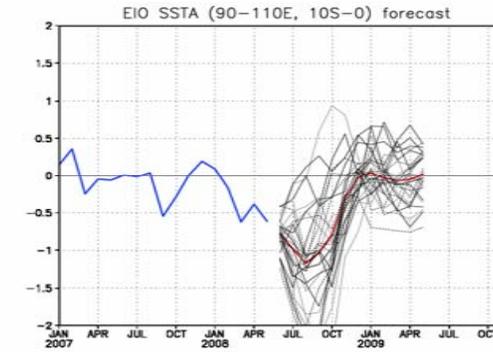
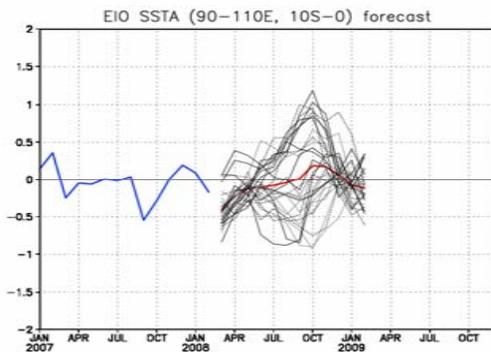
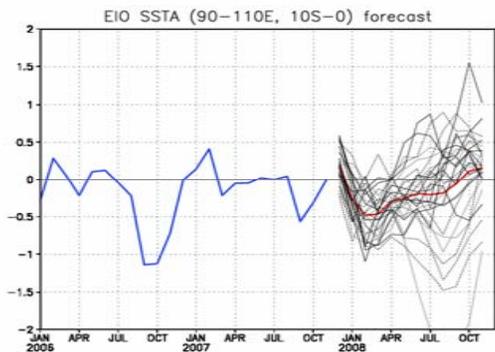
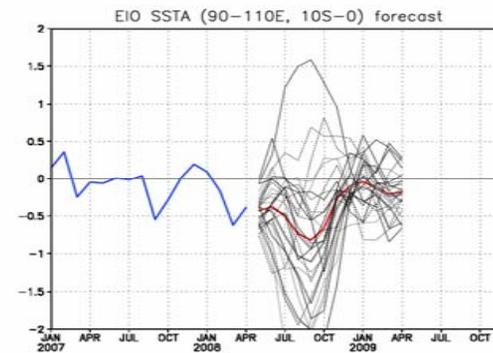
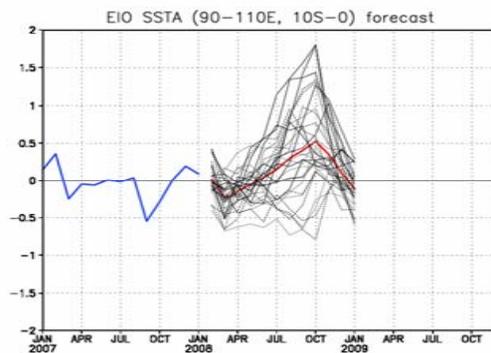
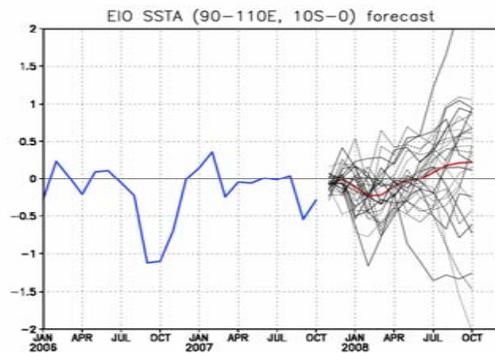


- Cooling near the west coast of North America and Gulf of Alaska persisted
- Anti-cyclonic wind anomalies near the coast of California, favorable for coastal upwelling
- Large amount of warming is radiative

# CFS EIO SST anomalies (K)



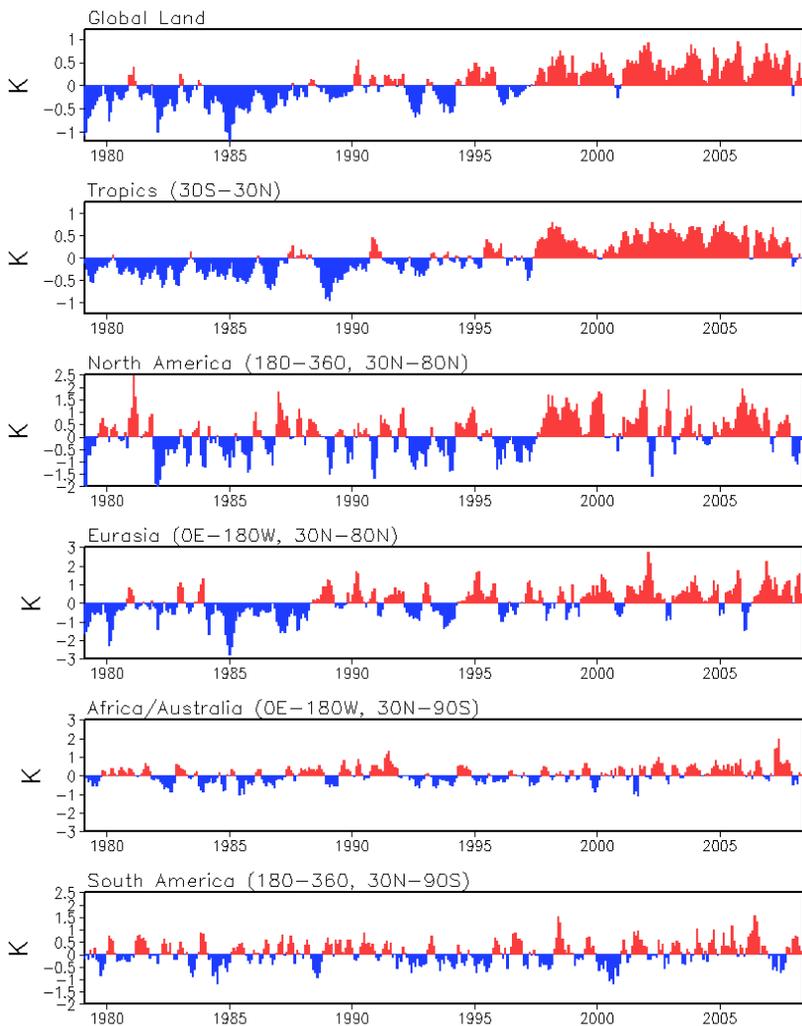
# Eastern Pole Forecasts from FRCGC....



# Monthly Time Series

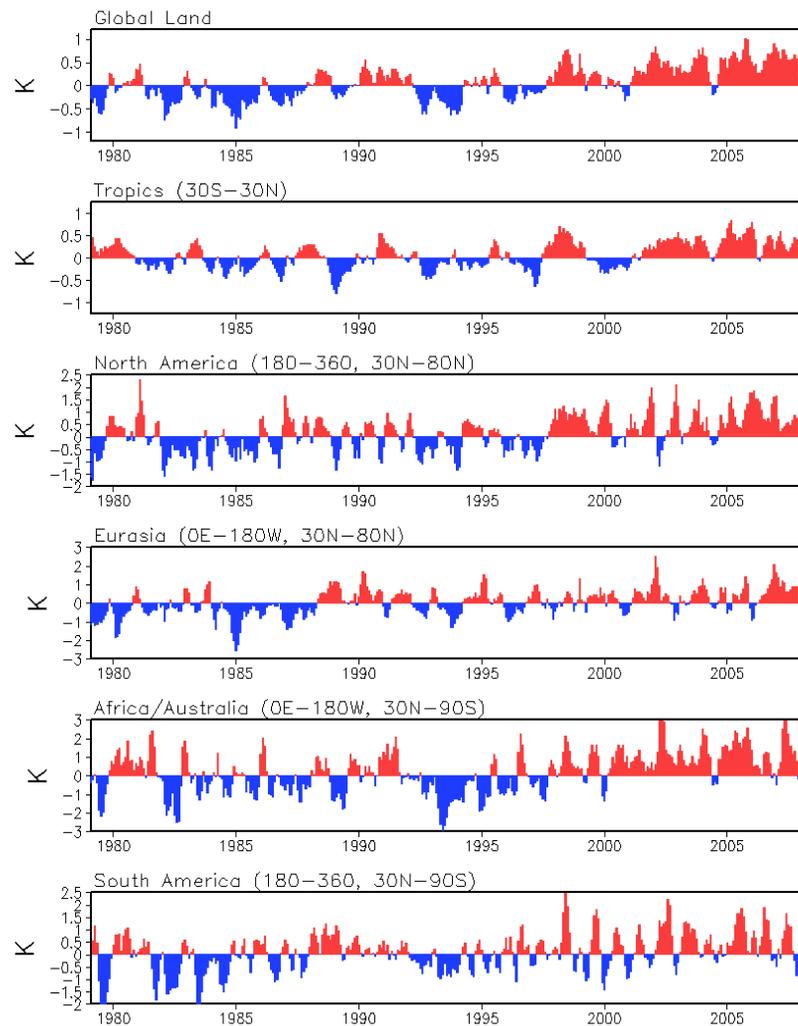
## CAMS

3-Month running mean Temperature (Climo. 1982–2004)



## CDAS

3-Month running mean Temperature (Climo. 1982–2004)



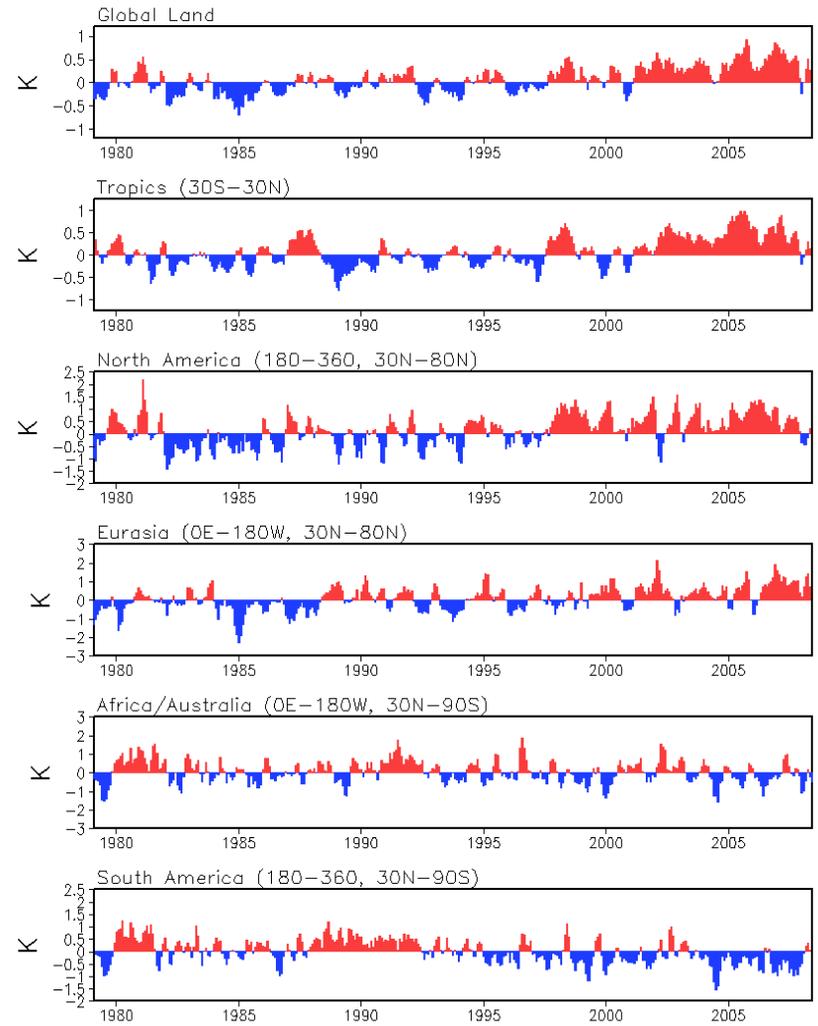
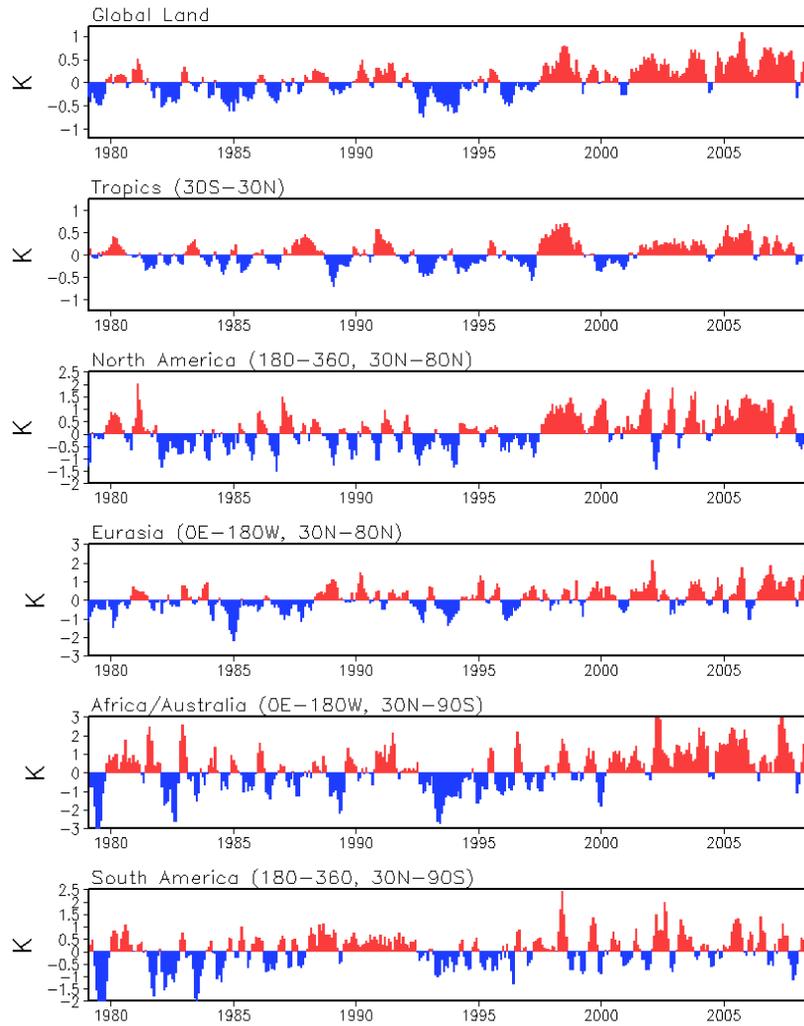
# Monthly Time Series

## CDAS-2

3-Month running mean Temperature (Climo. 1982–2004)

## JRA-25

3-Month running mean Temperature (Climo. 1982–2004)



# 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)**