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

Prepared by
Climate Prediction Center, NCEP

June 8, 2011

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

This project to deliver real-time ocean monitoring products is implemented by CPC in cooperation with NOAA's Office of Climate Observation (OCO)

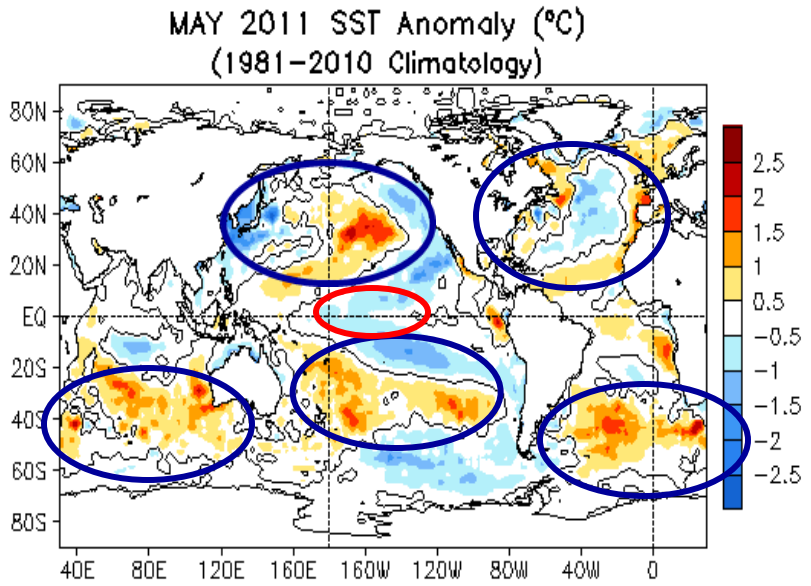
Outline

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

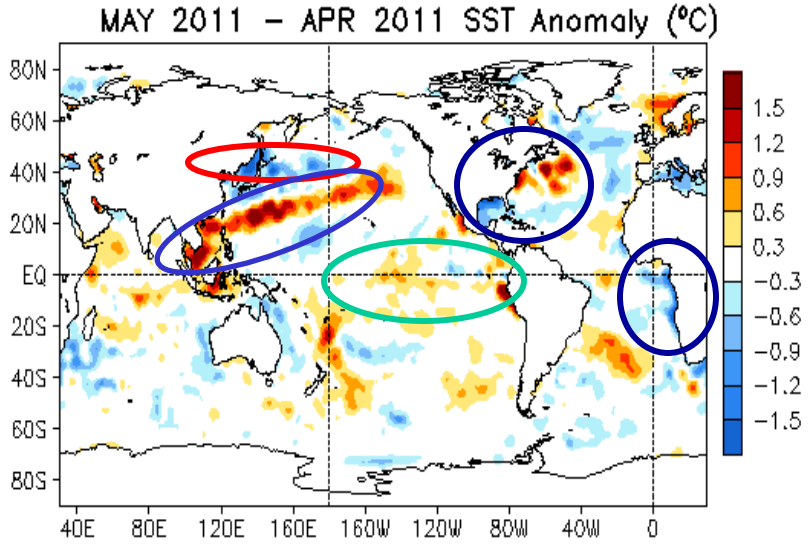
Overview

- **Pacific and Arctic Oceans**
  - **ENSO cycle: La Niña conditions dissipated to neutral conditions with OISST NINO3.4=-0.43°C in May 2011.**
  - **NOAA/NCEP Climate Forecast System (CFS) suggests that the ENSO-neutral conditions are expected at least through the boreal summer.**
  - **PDO has been negative since Jun 2010, and weakened steadily since Jan 2011, coinciding with the decaying La Nina.**
  - **Artic sea ice extent continued to decline in May 2011 and reached the third lowest in the satellite records.**
- **Indian Ocean**
  - **Neutral SSTA conditions dominated in the deep tropical Indian Ocean.**
- **Atlantic Ocean**
  - **NAO was near-normal in May 2011.**
  - **Tripole SSTA pattern has weakened since Feb 2011.**
  - **Positive SSTA continued in the Atlantic Hurricane Main Development Region.**

Global SST Anomaly (°C) and Anomaly Tendency



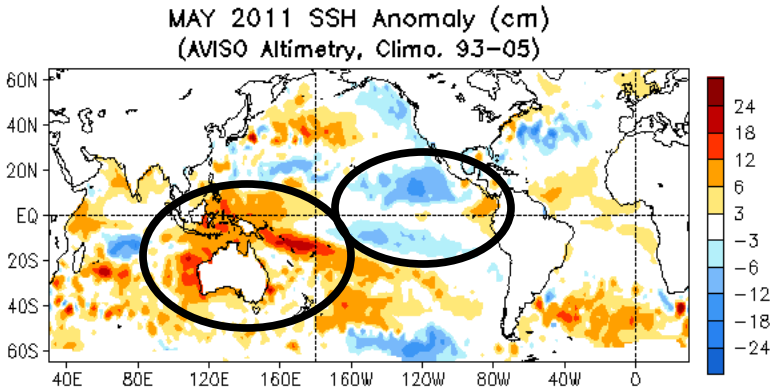
- **Neutral SSTA dominated the equatorial Pacific ocean.**
- **SST anomaly pattern in the extra-tropical Pacific resembles SST composites of La Nina, suggesting the lingering effects of La Nina.**
- **A weak tripole SSTA pattern presented in North Atlantic.**
- **Positive SSTA was observed in the mid- and high- latitude southern Indian and Atlantic oceans.**

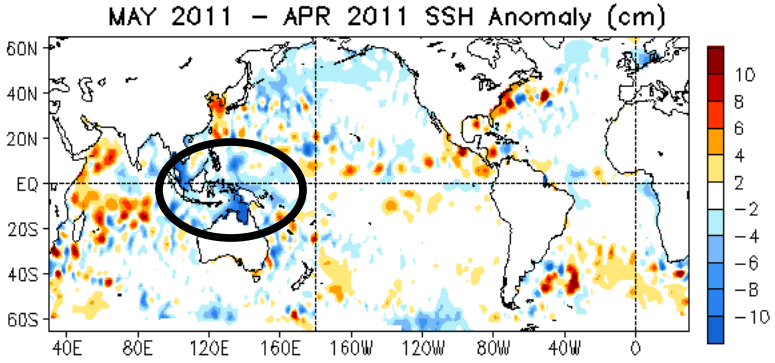


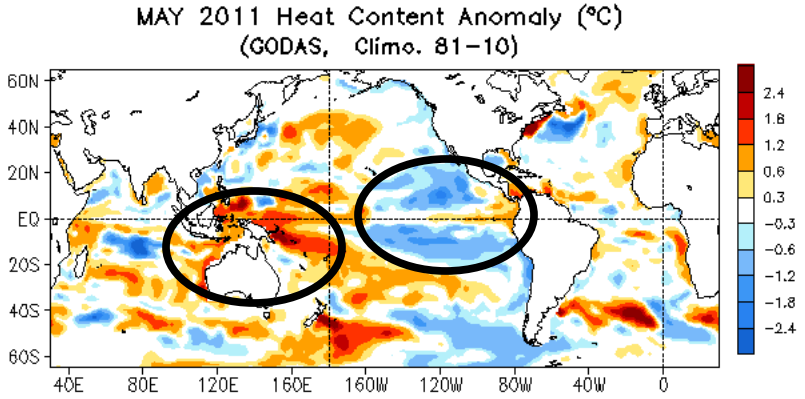
- **A weak warming continued in the central and eastern tropical Pacific.**
- **A strong warming was observed in South China Sea, extending from Philippine Sea to the central North Pacific.**
- **A strong cooling was observed near Japan.**
- **A strong cooling (warming) was present in the Gulf of Mexico(near the east coast of U.S.).**
- **A moderate cooling was observed in the southeast Atlantic Ocean.**

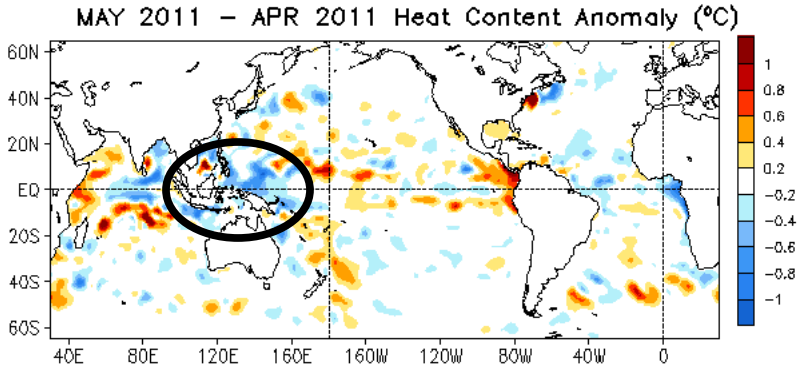
Fig. G1. Sea surface temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1971-2000 base period means.

Global SSH/HC Anomaly (cm/ºC) and Anomaly Tendency









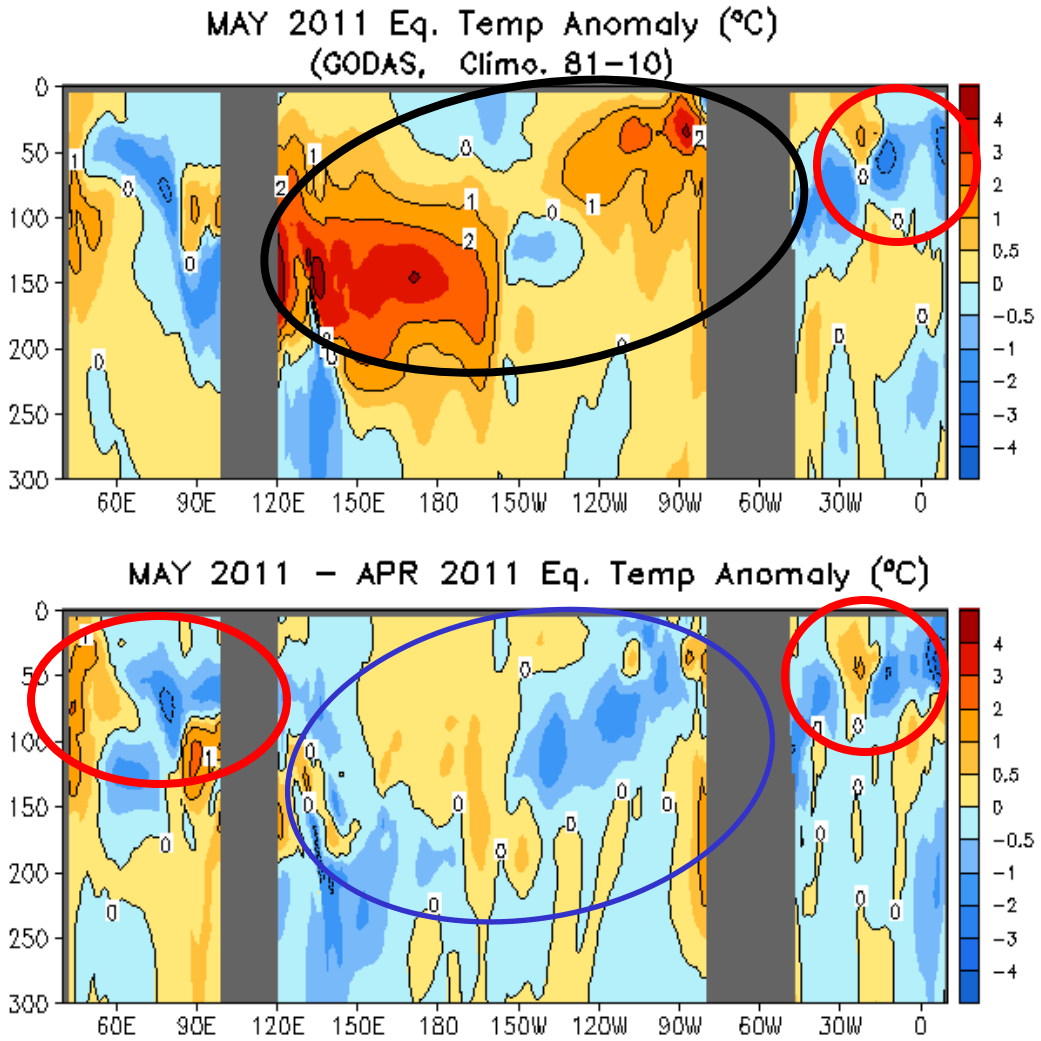
- **Positive SSH and Heat content (HC) anomalies were observed in the western and southwestern tropical Pacific and near the west coast of Australia, which weakened substantially from previous month.**

- **Negative SSH and HC anomalies were observed off the equator in the east-central tropical Pacific, indicating the lingering effects of La Nina.**

- **SSH and HC anomalies as well as their tendencies were largely consistent, except in the Southern Ocean where biases in GODAS climatology are large (not shown).**

Fig. G2. Sea surface height anomalies (SSHA, top left), SSHA tendency (bottom left), top 300m heat content anomalies (HCA, top right), and HCA tendency (bottom right). SSHA are derived from http://www.aviso.oceanobs.com, and HCA from GODAS.

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



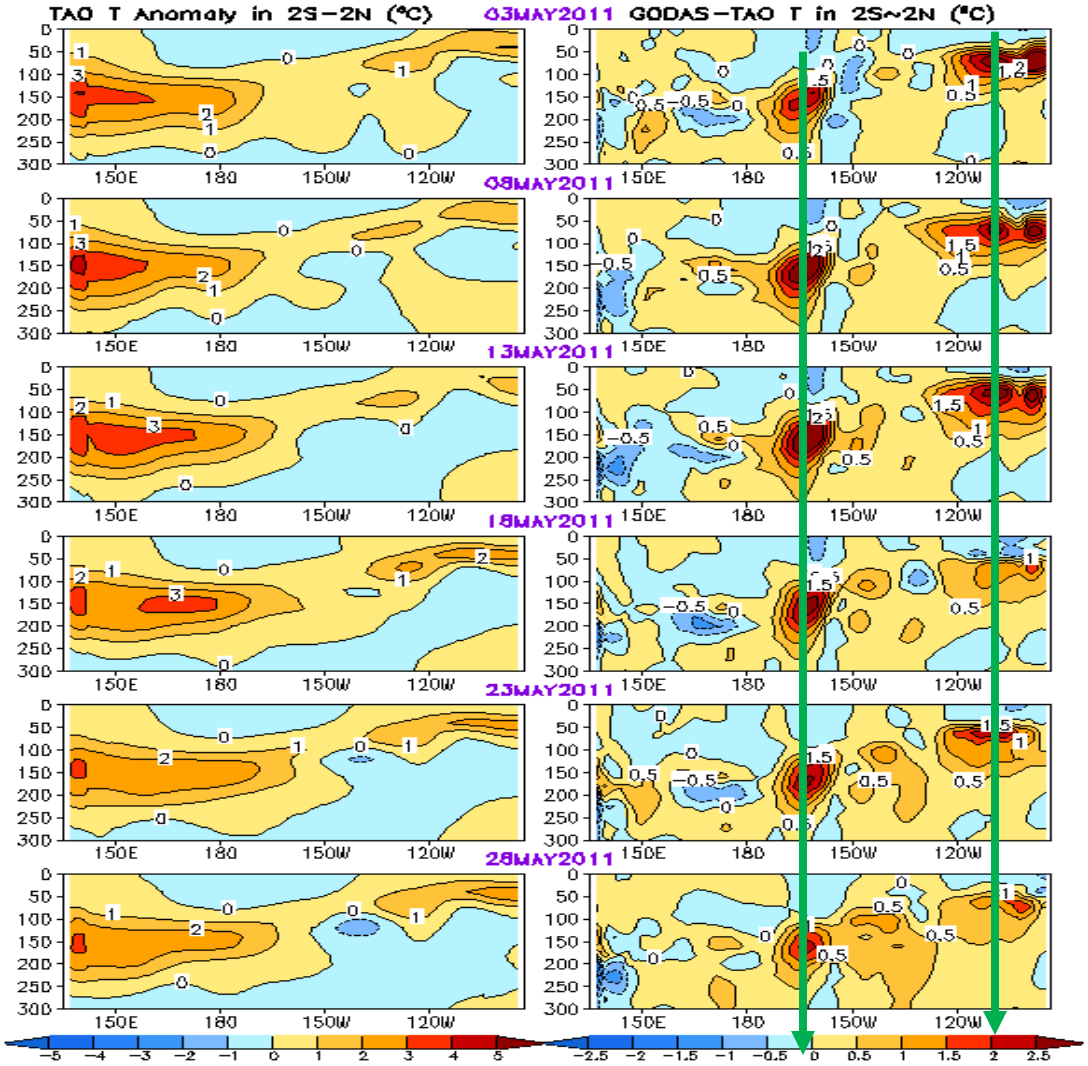
- **Positive ocean temperature anomalies along the equatorial Pacific thermocline continued in May.**
- **Negative temperature anomalies prevailed near the equatorial Atlantic thermocline.**

- **Compared with April, positive subsurface temperature anomalies weakened in most of the equatorial Pacific.**
- **Negative temperature anomaly tendency dominated in the equatorial Atlantic Ocean.**
- **Both positive and negative temperature anomaly tendencies existed in the equatorial Indian Ocean.**

Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1982-2004 base period means.

Equatorial Pacific Temperature Anomaly

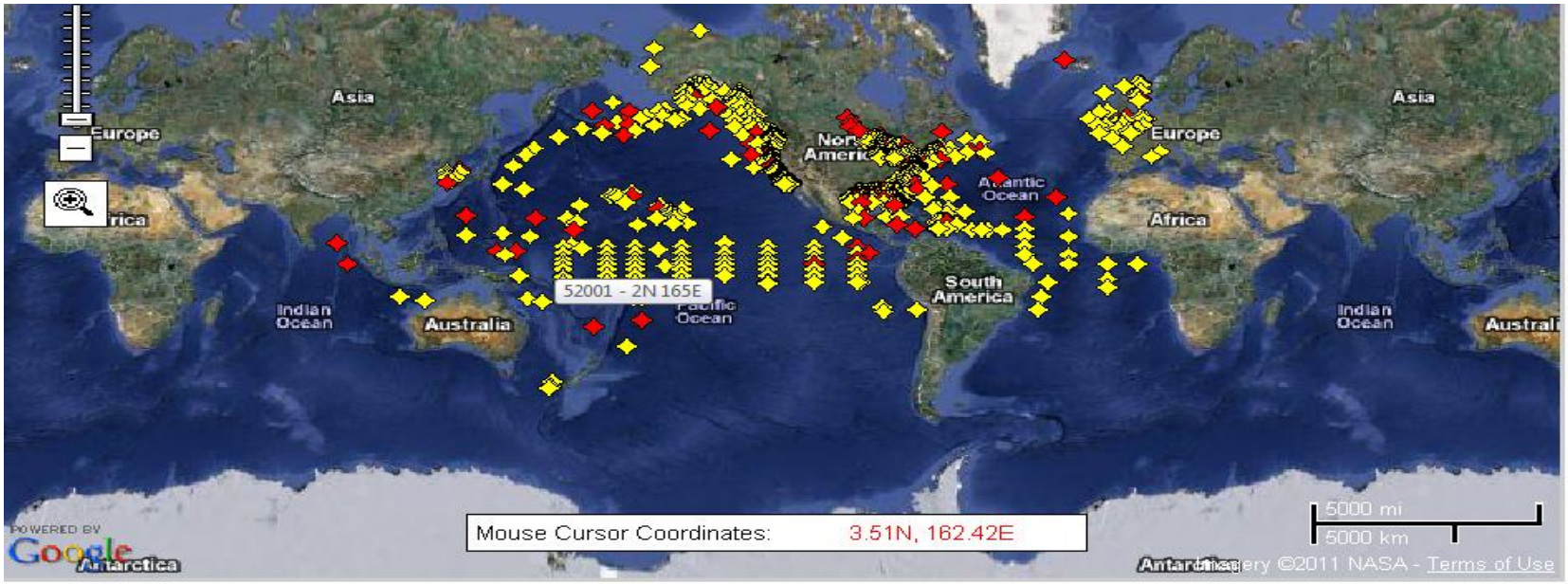
TAO GODAS-TAO



- **Compared with TAO, GODAS is about 2°C too warm near the thermocline at 170W-160W and 120W-90W.**

- **Some TAO moorings have failed to delivery data in 2010-2011, which might have contributed to the large discrepancies between TAO and GODAS.**

Some TAO moorings have failed to delivery data in 2010 and 2011



- Stations with recent data
- Stations with historical data only
- Stations with no data in last 8 hours (24 hours for tsunami stations)
- Tsunami station in event mode (within previous 24 hours)

1060 stations deployed
894 have reported in the past 8 hours

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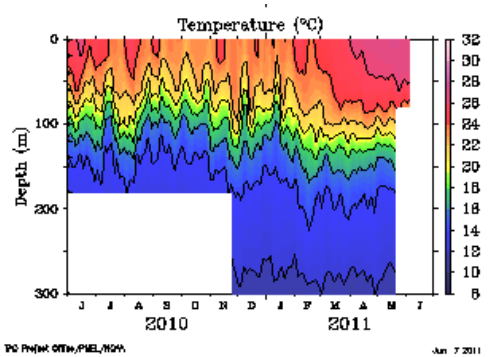
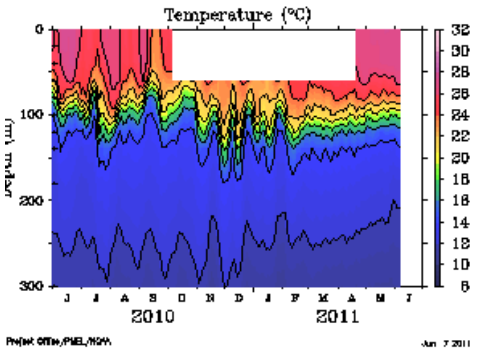
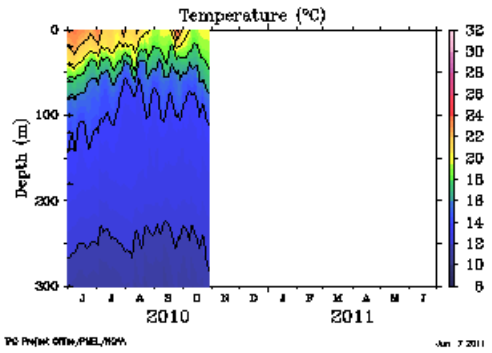
Get Observations by Owner as KML



(0°N, 140°W)



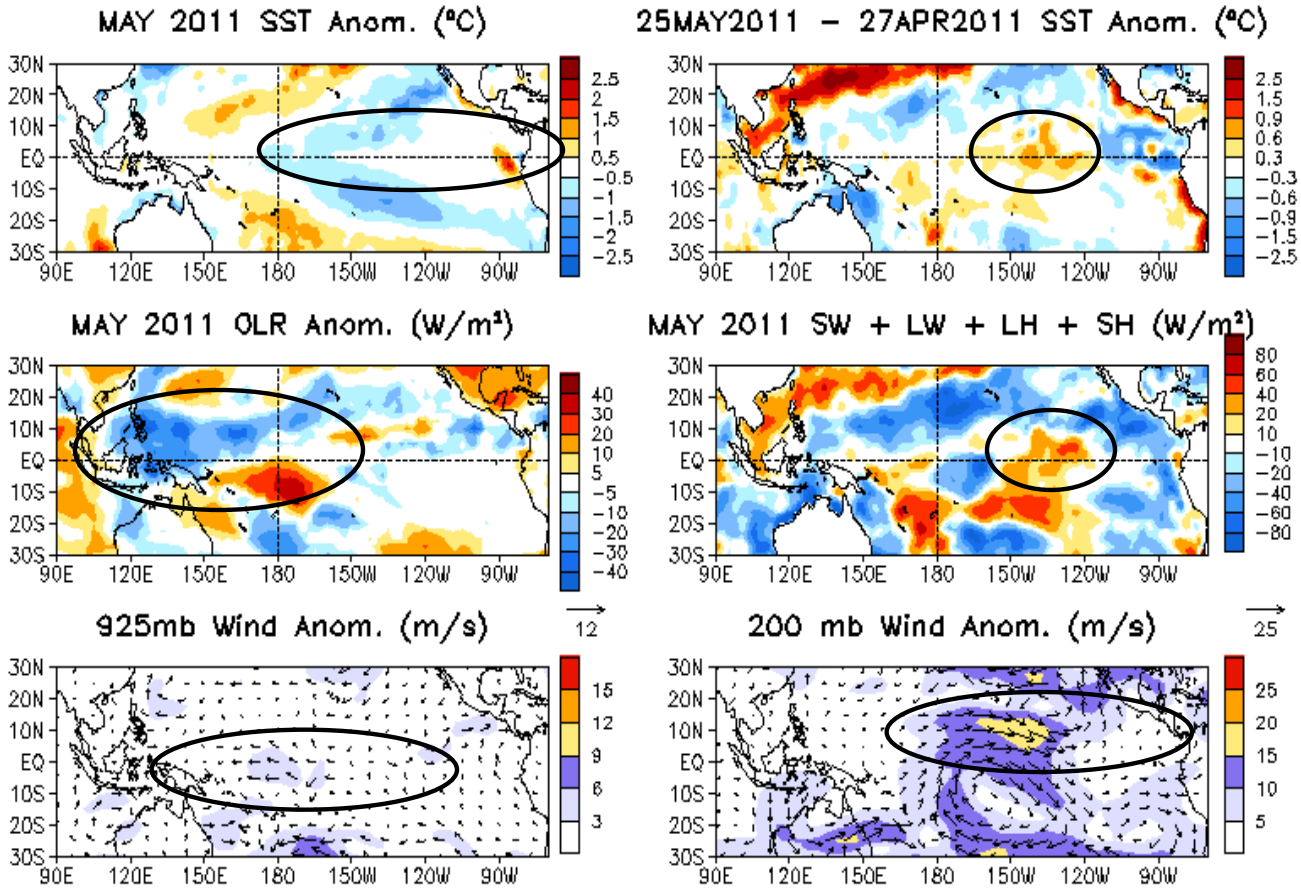
(2°N, 140°W)



0°N, 110°W)

Tropical Pacific Ocean

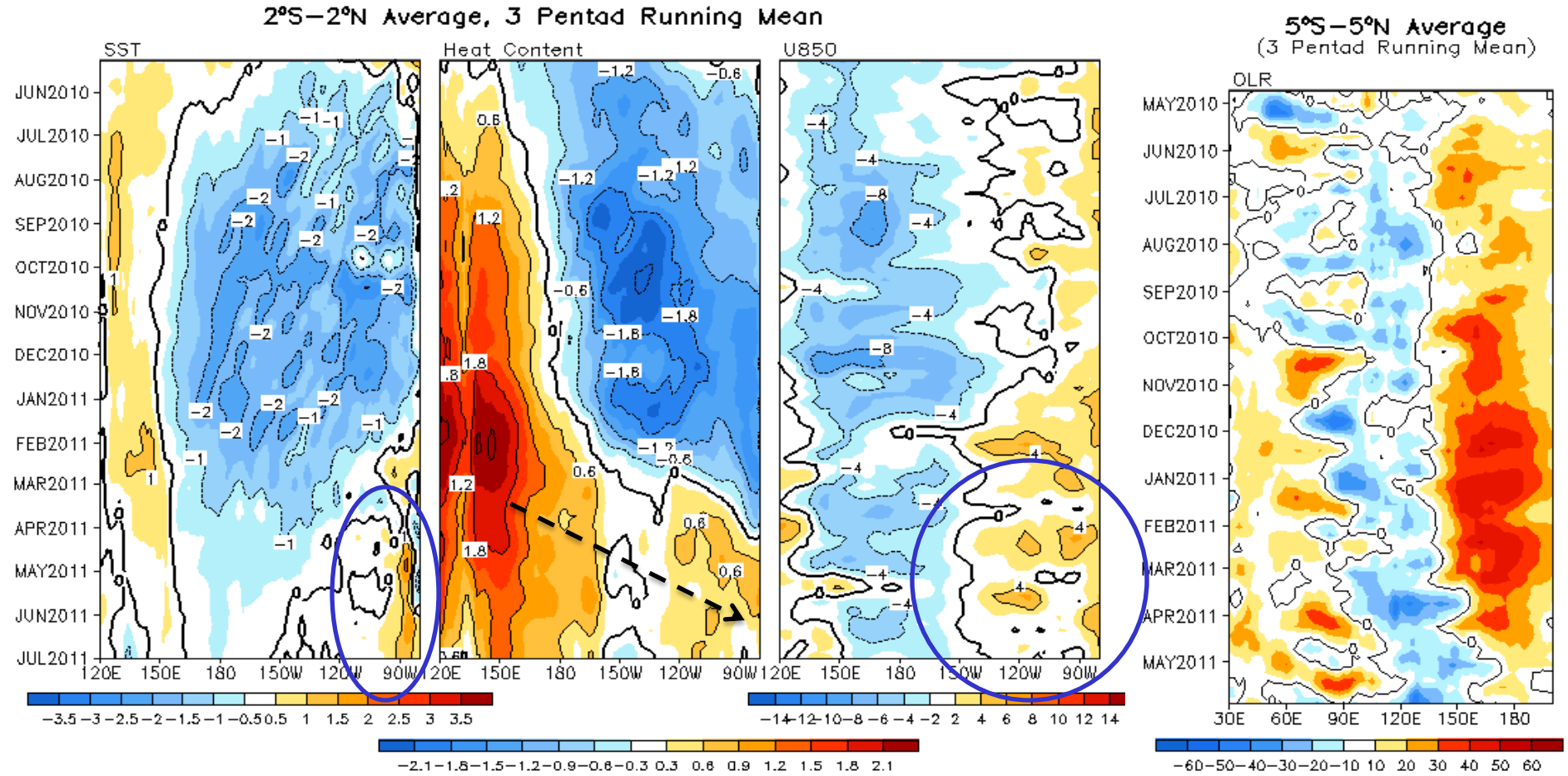
Tropical Pacific: SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Winds



- **Near-normal SST prevailed over much of the equatorial Pacific.**
- **Convection was enhanced (suppressed) near the Philippine Sea (south of the equator near the dateline).**
- **Net surface heat flux anomalies contributed to SST warming near 150ºW-120ºW.**
- **Easterly (westerly) wind anomalies in low (high) level weakened but persisted over the central Pacific, indicating lingering effects of La Nina.**

Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1979-1995 base period means except SST anomalies are computed with respect to the 1971-2000 base period means.

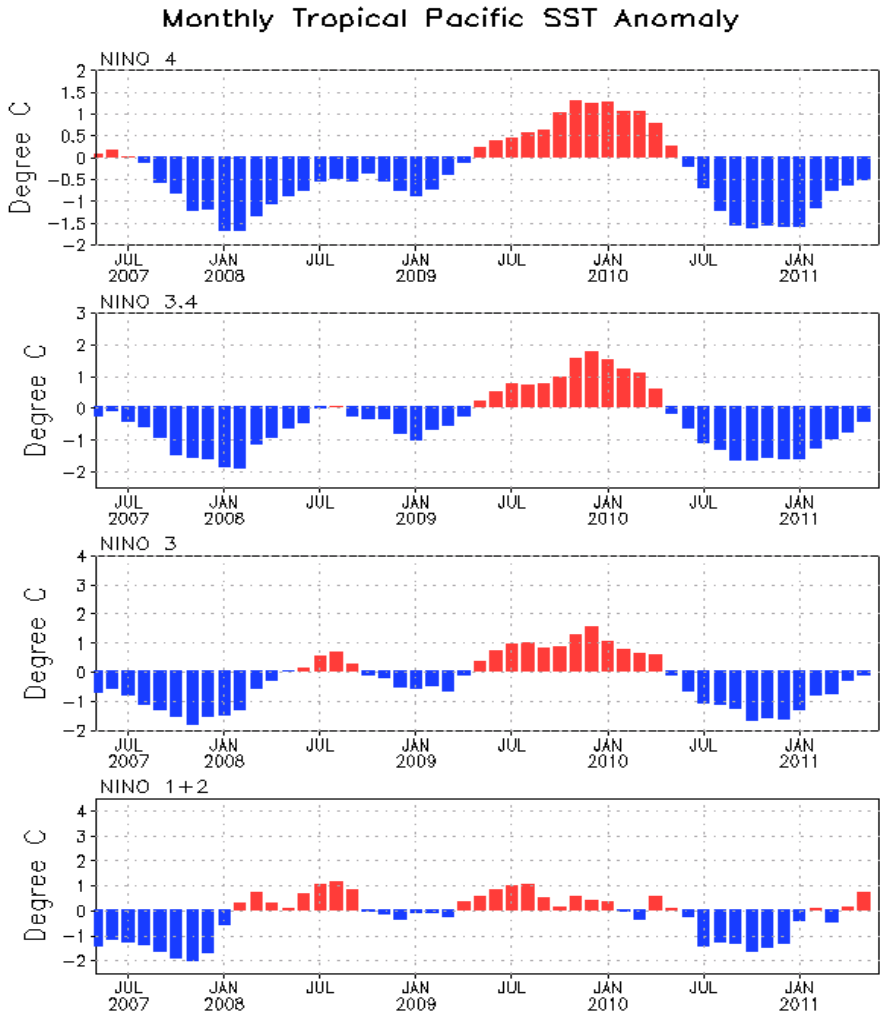
Evolution of Equatorial Pacific SST (ºC), 0-300m Heat Content (ºC), 850-mb Zonal Wind (m/s), and OLR (W/m²) Anomaly

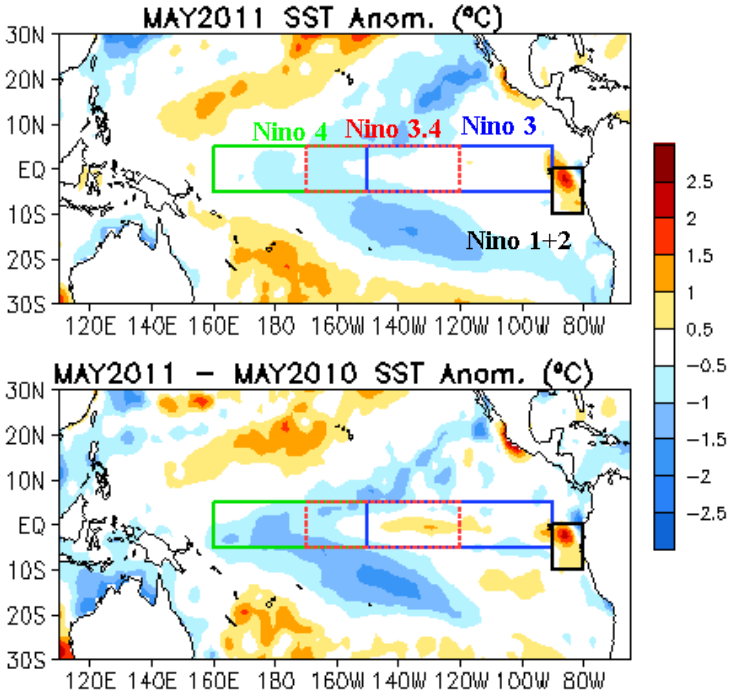


- **Positive heat content anomalies appeared in the central and eastern equatorial pacific since Feb 2011.**
- **The SST in the eastern equatorial Pacific was generally above-normal since Feb 2011, which might be attributed to the eastward propagation of down-welling kelvin waves and local air-sea interactions.**

Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2ºS-2ºN and Outgoing Long-wave Radiation (OLR, right) averaged in 5ºS-5ºN. SST is derived from the NCEP OI SST, heat content from the NCEP's global ocean data assimilation system, U850 from the NCEP CDAS. Anomalies for SST, heat content and U850/OLR are departures from the 1971-2000, 1982-2004, 1979-1995 base period pentad means respectively.

Evolution of Pacific NINO SST Indices





- Except Nino1+2 ,other NINO indices weakened continuously since Jan 2011 or Dec 2010, and NINO3.4=-0.43 in May 2011.

-Observations indicated the 2010/11 La Nino event had ended, and ENSO-neutral conditions prevailed in May 2011.

- The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v3b.

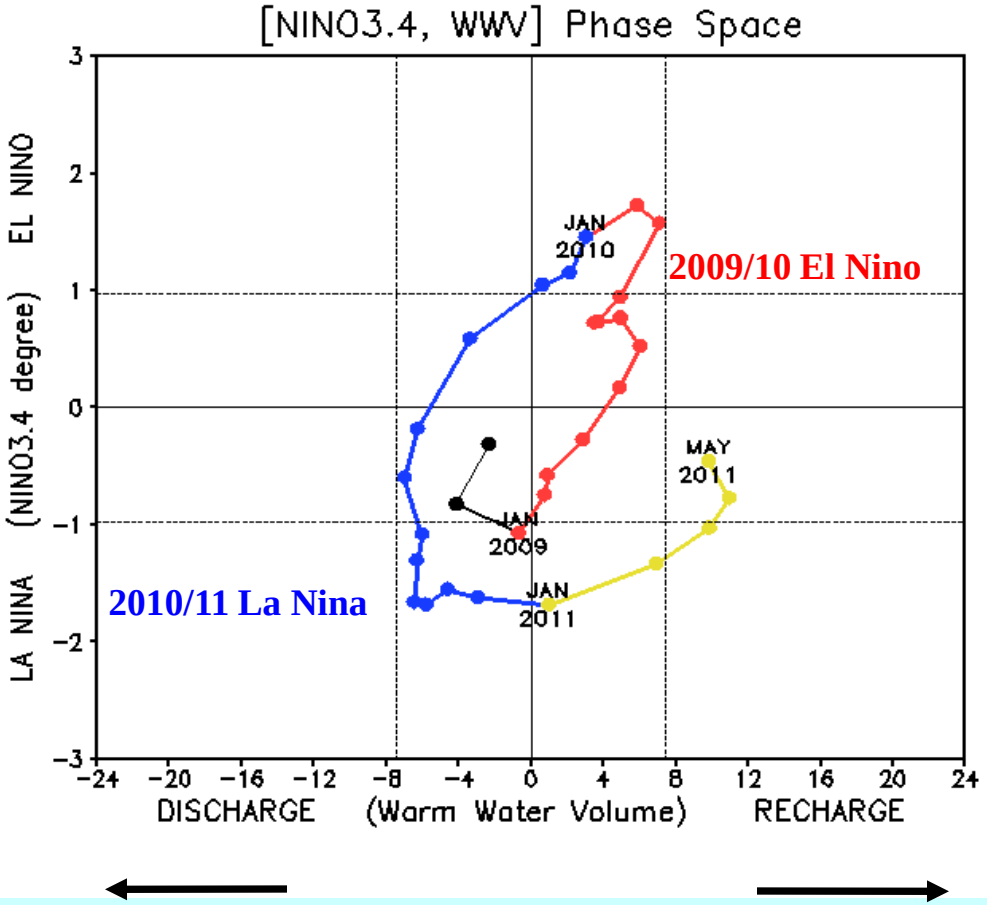
Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1971-2000 base period means.

Warm Water Volume (WWV) and NINO3.4 Anomalies

-**WWV is defined as average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] (Meinen and McPhaden, 2000).**

-**Since WWV is intimately linked to ENSO variability (Wyrtki 1985; Jin 1997), it is useful to monitor ENSO in a phase space of WWV and NINO3.4 (Kessler 2002).**

- **Increase (decrease) of WWV indicates recharge (discharge) of the equatorial oceanic heat content.**



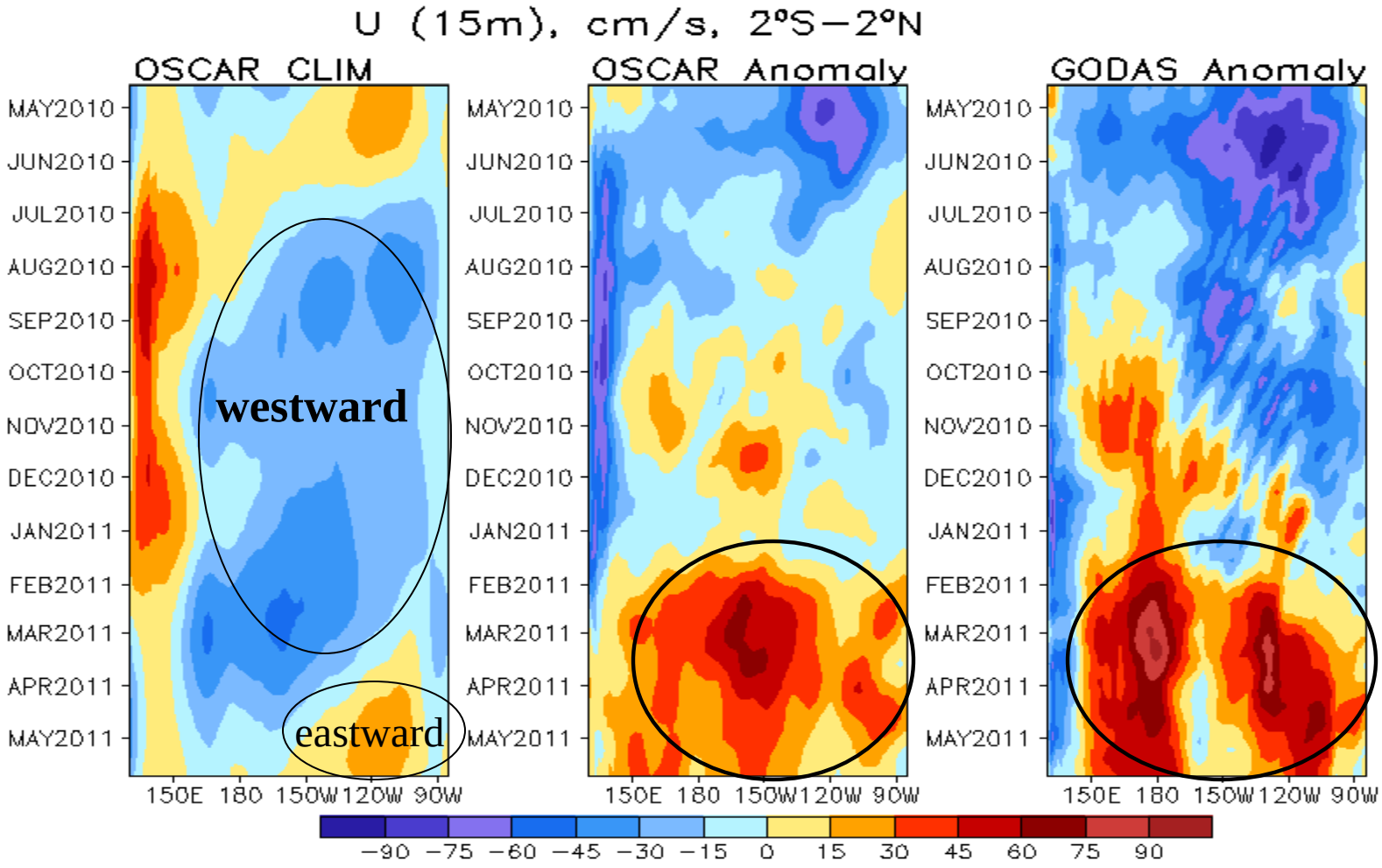
- **WWV recharge enhanced significantly since Jan 2011 due to the recent downwelling Kelvin wave episodes and air-sea coupling that links the strengthening WWV with increasing NINO3.4.**

- **WWV recharge started to decrease in May.**

- **La Nina conditions had transited to ENSO-neutral conditions in May 2011.**

Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] calculated with the NCEP's global ocean data assimilation system. Anomalies for WWV (NINO 3.4) are departures from the 1982-2004 (1971-2000) base period means.

Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)

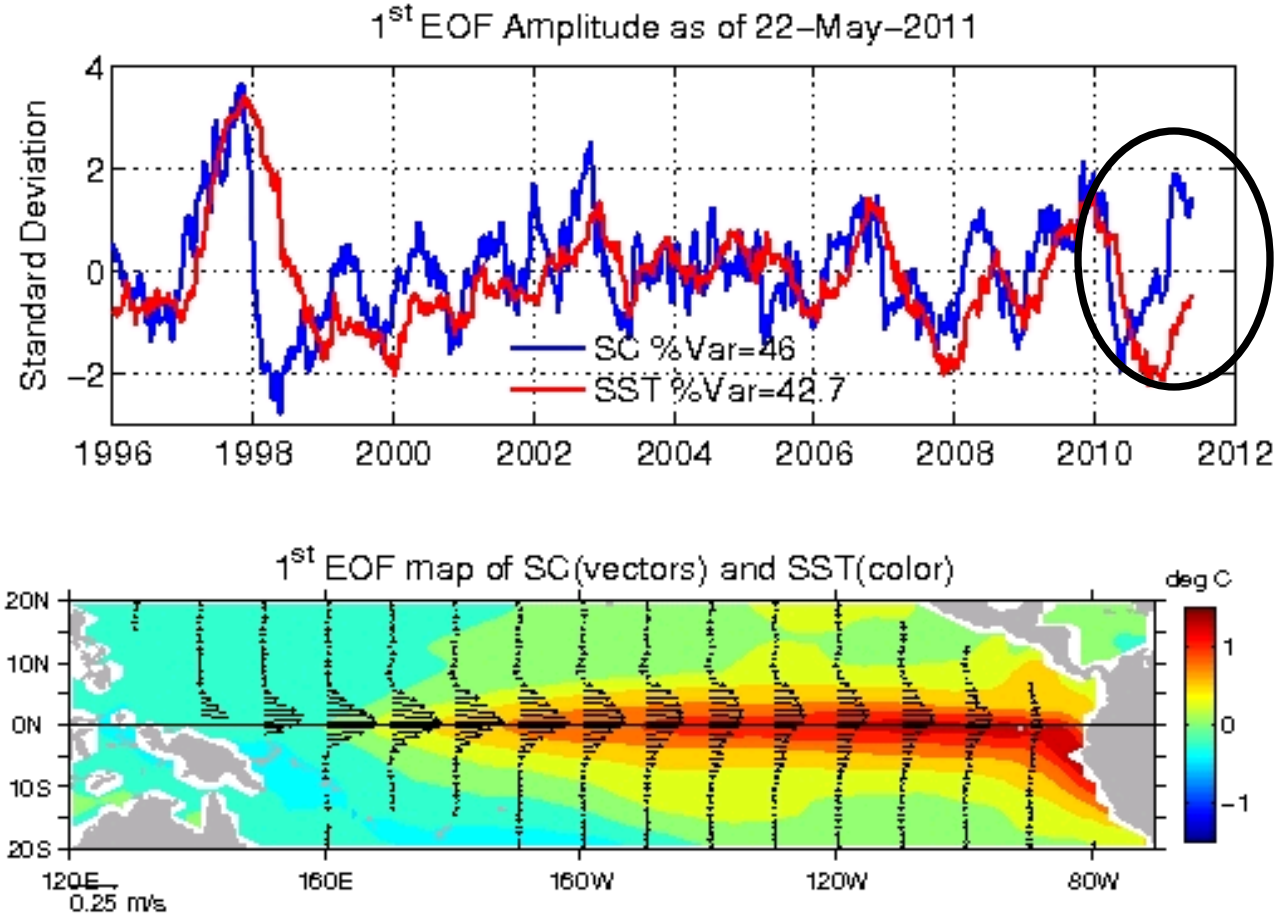


- **Eastward anomalous current in the central and eastern equatorial Pacific presented since late Jan 2011 and peaked in Mar 2011, implying that anomalous zonal current advection contributes to the positive SST tendency in the eastern Pacific.**

- **Anomalous zonal current had one maximum center between 180°-150°W in OSCAR, and two maximum centers around 180° and 130°W, respectively, in the GODAS, during Feb-May 2011.**

-**The estimate eastward current anomalies in GODAS were larger than in OSCAR since Feb,2011.**

ENSO cycle as indicated by 1st EOF of surface current and SST anomalies

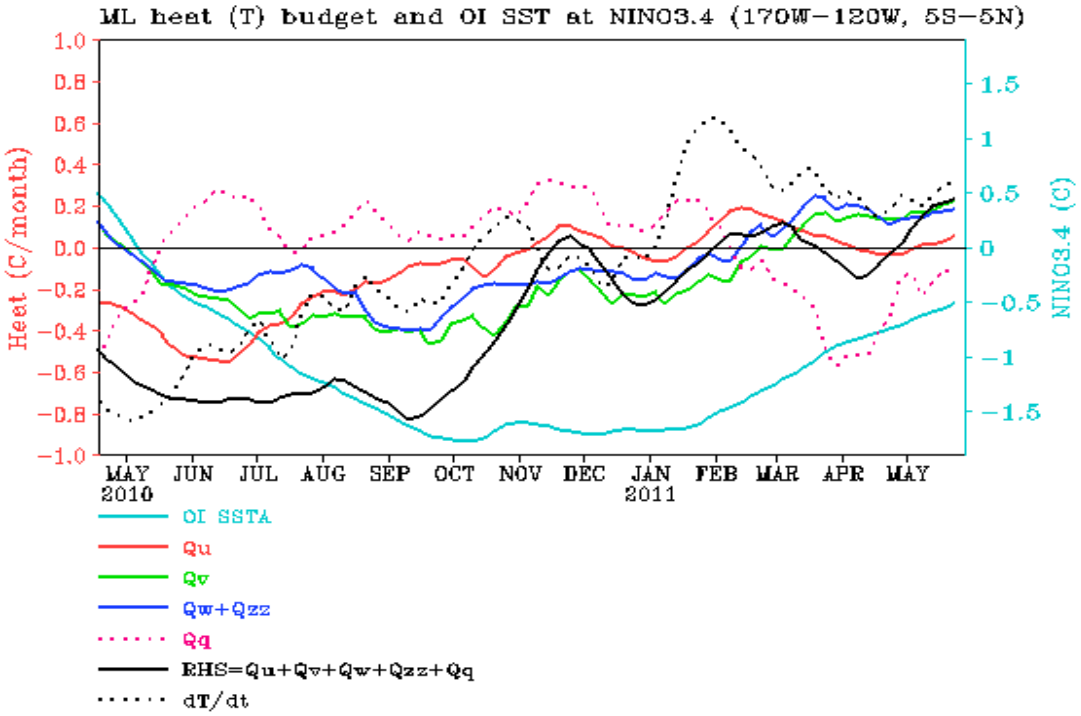


- **Zonal current anomaly has become eastward since Dec 2010.**

- **On average, ocean surface zonal current anomaly leads the SSTA by a few months.**

First EOF mode of ocean surface current (SC) and SST anomalies for the past decade extending through the latest 10-day period. The amplitude time series (top panel) are computed by fitting the data sets to 10-year base period eigenvectors (1993-2002). The amplitudes are then normalized by their respective standard deviations. The bottom panel shows the corresponding EOF maps, scaled accordingly. The El Niño signal can be seen as periods of positive excursions (> 1 Std. Dev.) of the amplitude time series. T the near real-time SC are the output from a diagnostic model.
(supplied by **Earth& Space Research**: **Dr. Kathleen Dohan** and see "http://www.esr.org/enso_index.html" for details)

NINO3.4 Heat Budget



- **Positive Tendency (dT/dt) in NINO 3.4 (dotted line) continued in May, indicating the transitioning from ENSO to ENSO-neutral conditions.**
- **Dynamical terms (Qv, Qw+Qzz,Qu) were generally positive since Feb 2011.**

- **The thermodynamic term (Qq) was negative since Feb 2011, peaked in late Mar 2011.**

- **The total heat budget term (RHS) has cold biases compared with dT/dt.**

Huang, B., Y. Xue, X. Zhang, A. Kumar, and M. J. McPhaden, 2010 : The NCEP GODAS ocean analysis of the tropical Pacific mixed layer heat budget on seasonal to interannual time scales, J. Climate., 23, 4901-4925.

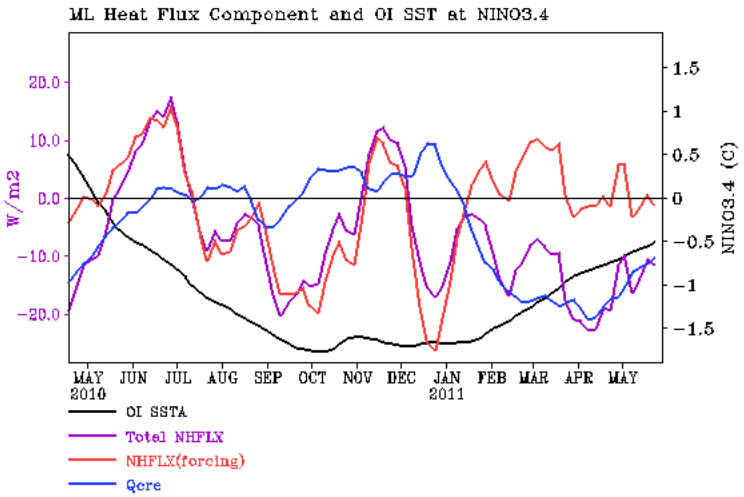
Qu: Zonal advection; Qv: Meridional advection;

Qw: Vertical entrainment; Qzz: Vertical diffusion

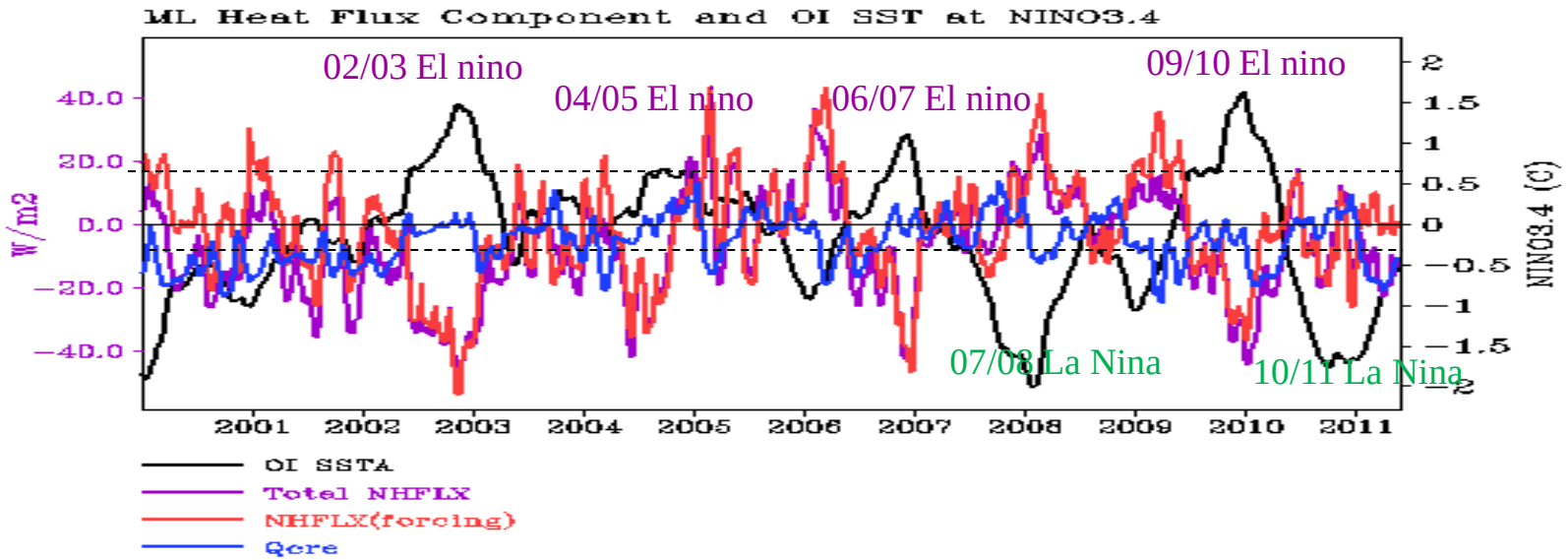
Qq: (Qnet - Qpen + Qcorr)/ρcph; Qnet = SW + LW + LH +SH;

Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

Components of Net Heat Fluxes in GODAS

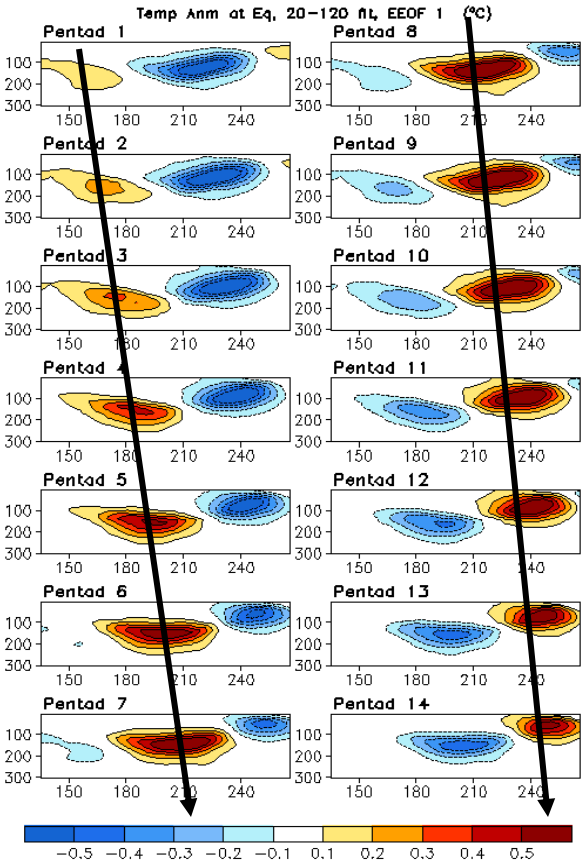


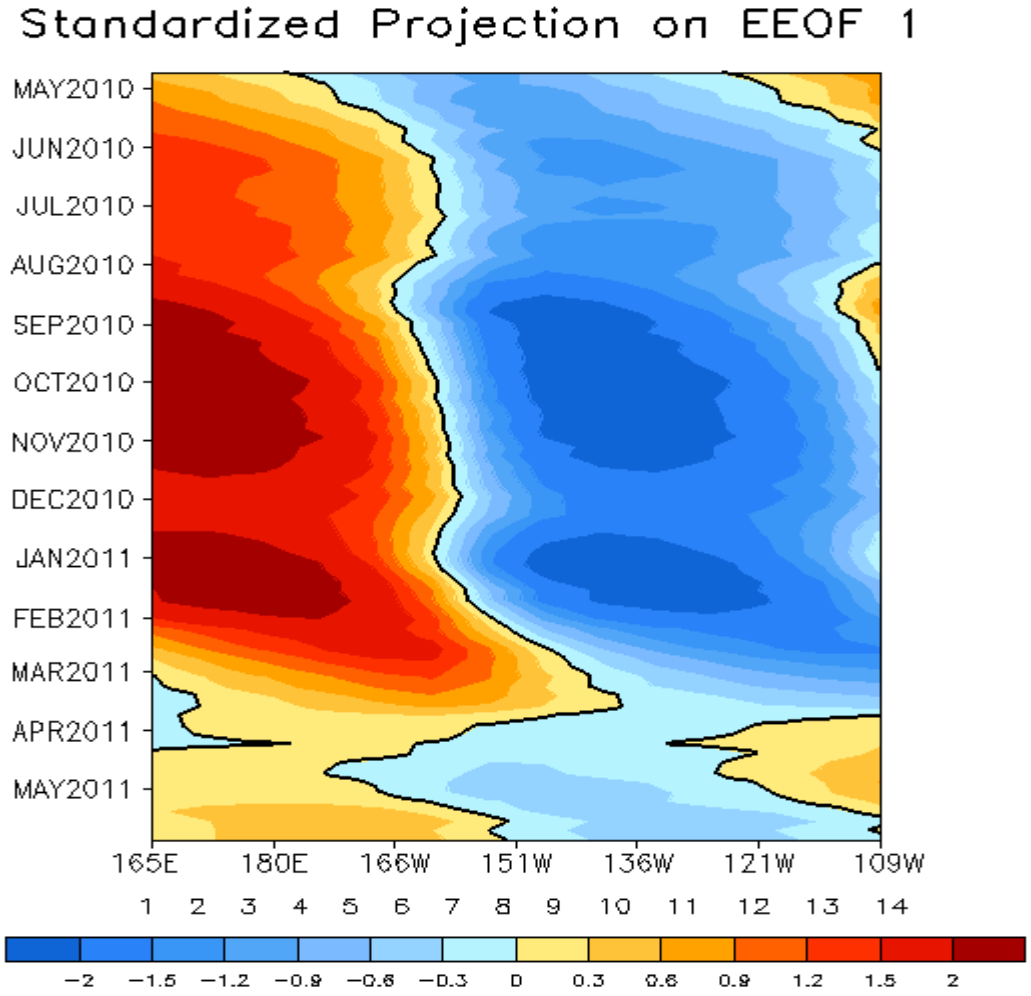
- **In GODAS, the total net heat flux (Total NHFLX) includes the net heat flux (SW+LW+LH+SH) from R2 (NHFLX) and flux correction (Qcre) due to SST relaxation to observed SST.**
- **The strong cooling in Total NHFLX since Jan 2011 was largely attributed to the strong cooling in Qcre, which indicates that the model SST was too warm compared to observations during the period.**



- **NHFLX tends to have opposite sign to NINO3.4 during the major El Nino and La Nina events, i.e. atmospheric fluxes damp ENSO.**
- **However, the outphase relationship between NHFLX and Nino 3.4 was noticeably absent during the 2010/11 La Nina event.**

Oceanic Kelvin





- Downwelling Kelvin wave initiated in late Jan 2011 in the W. Pacific arrived at the eastern coast in April.

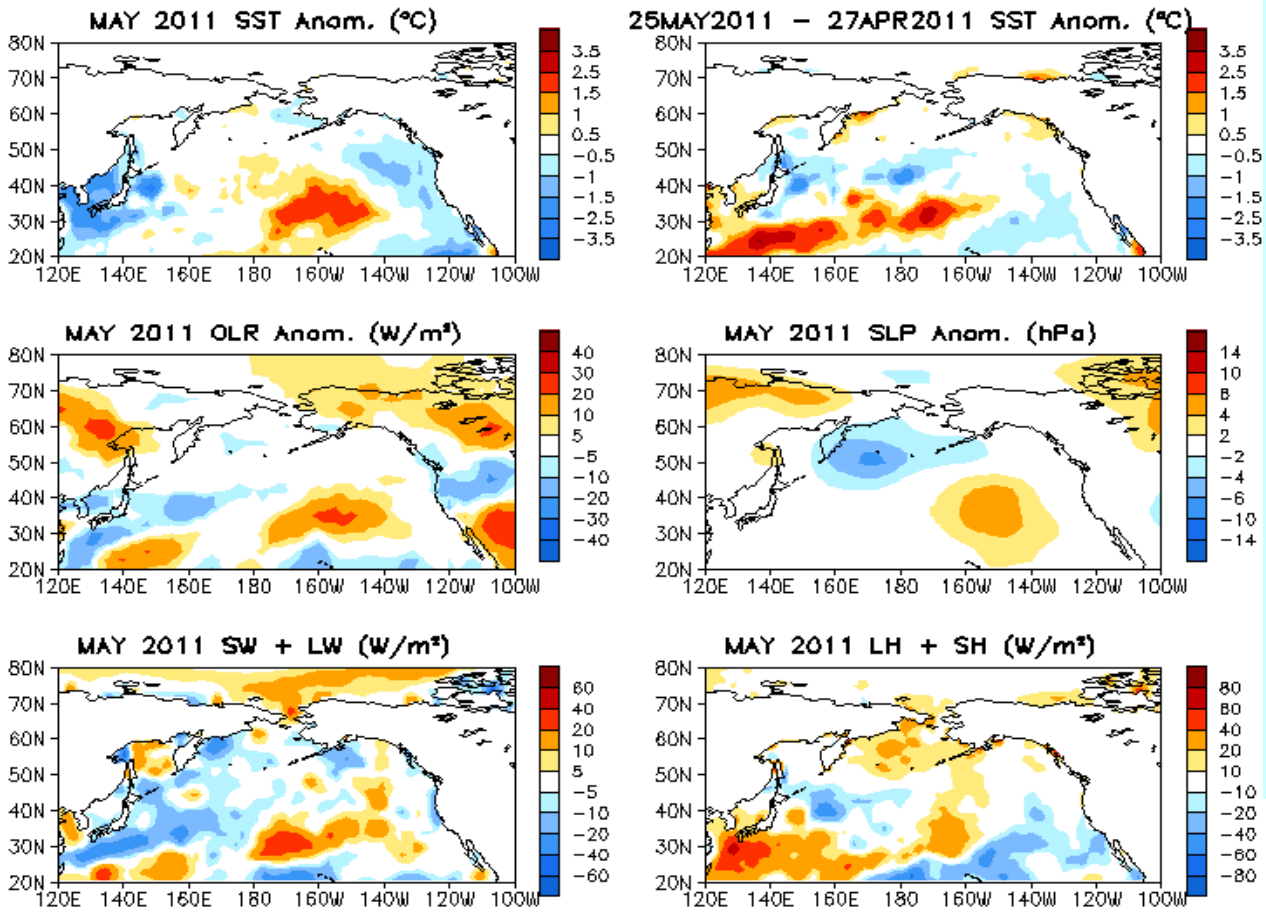
- Extended EOF (EEOF) analysis is applied to 20-120 day filtered equatorial temperature anomaly in the top 300m using 14 lagged pentads (similar to that in Seo and Xue, GRL, 2005).

- EEOF 1 describes eastward propagation of oceanic Kelvin wave cross the equatorial Pacific in about 70 days.

- Oceanic Kelvin wave indices are defined as standardized projections of total anomalies onto the 14 patterns of EEOF 1.

North Pacific & Arctic Ocean

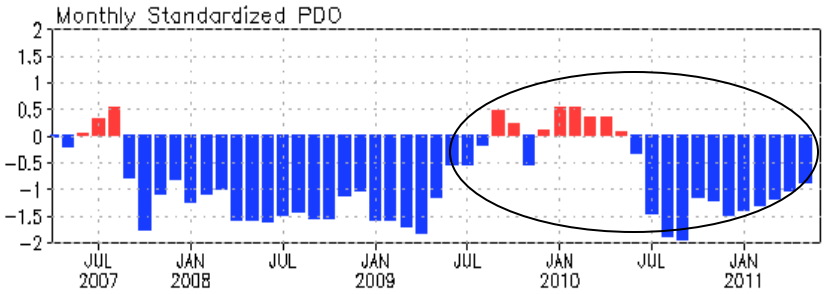
North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

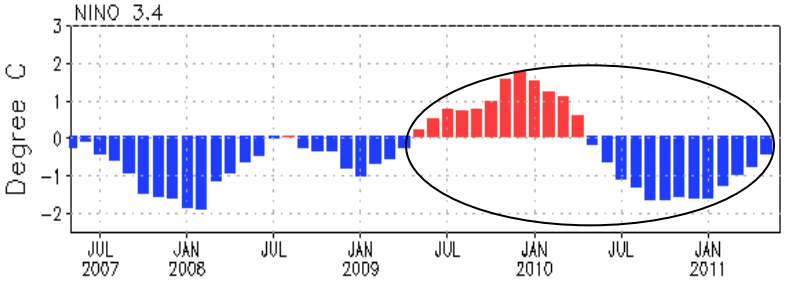


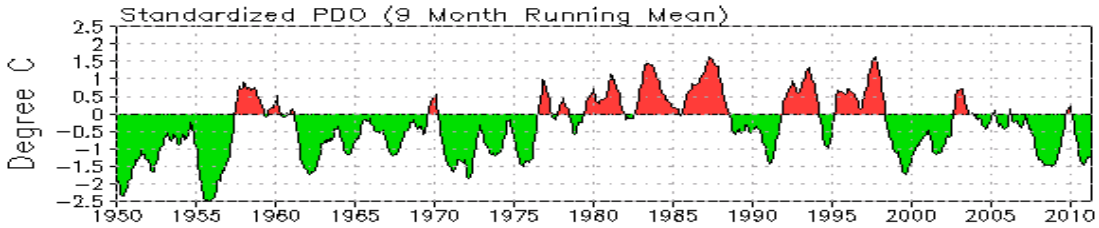
- **Positive (negative) SSTA was observed in the central North Pacific (along the west coast of N. A. and near Japan) in May 2011, consistent with the negative PDO index (next slide).**
- **Negative (positive) SSTA tendency presented north (south) of 35°N, indicating a southward shift of the Kuroshio-Oyashio Extension .**
- **The North Pacific High (centered at 35N,150W) enhanced.**
- **The mean Aleutian low shifted westward.**

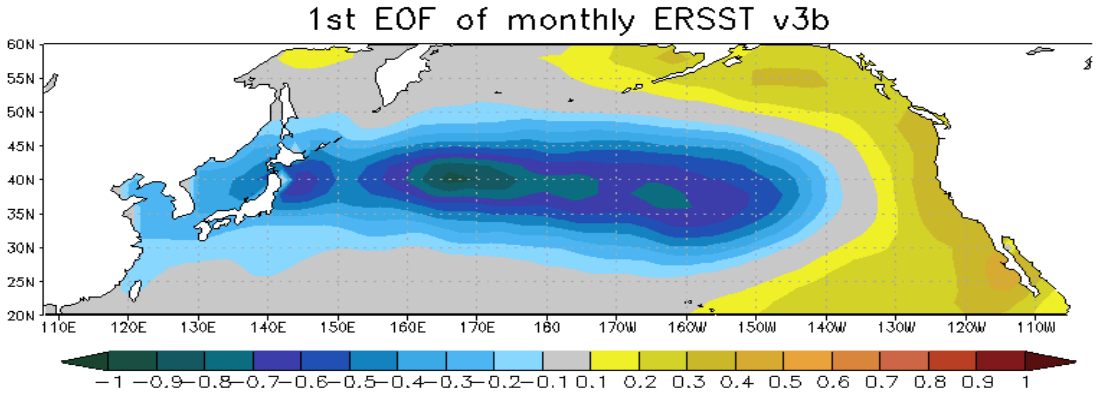
Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible heat flux anomalies (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, sea surface pressure and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1979-1995 base period means except SST anomalies are computed with respect to the 1971-2000 base period means.

PDO index









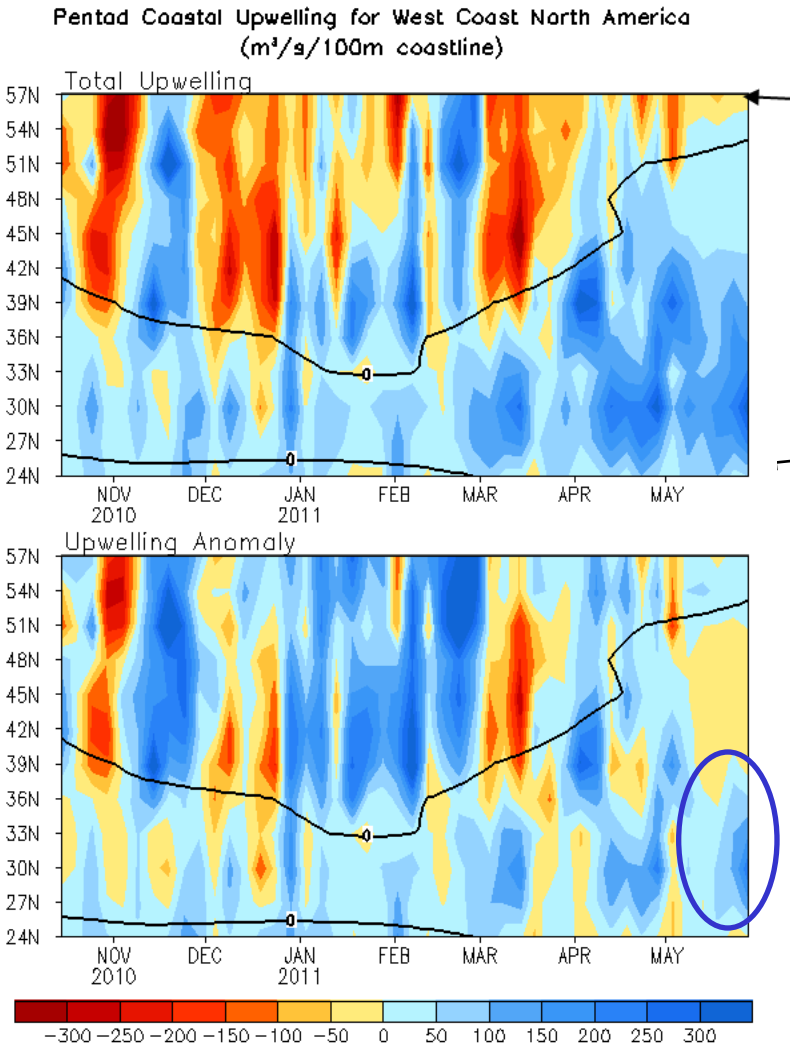
- The negative PDO index weakened since Dec 2010, which was coincident with the decaying La Nina conditions.

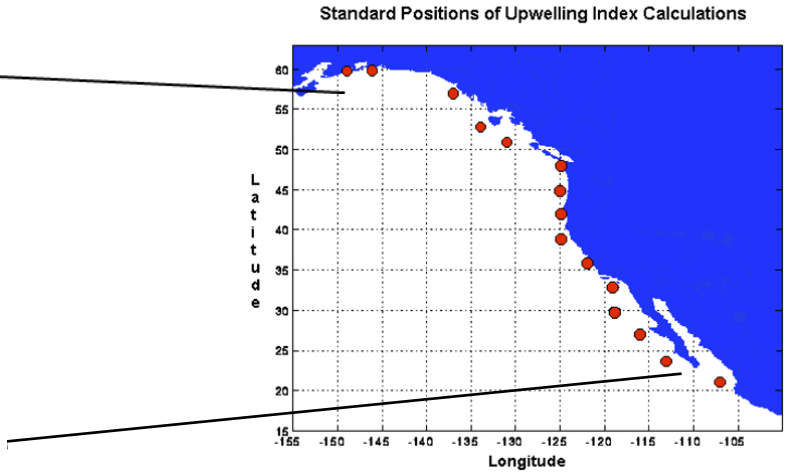
- The apparent positive correlation between NINO3.4 and PDO index suggests strong influences of the La Nina on the North Pacific SST variability through atmospheric bridge.

- Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.

- The PDO index differs slightly from that of JISAO, which uses a blend of UKMET and OIv1 and OIv2 SST.

North America Western Coastal Upwelling





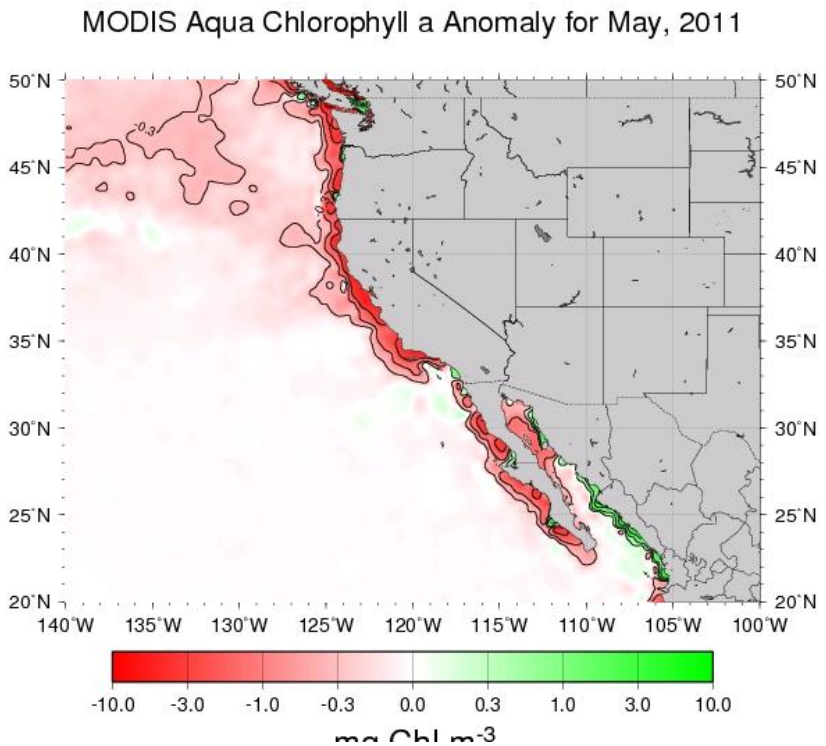
- Upwelling was enhanced at 24°N-39°N in May 2011, consistent with the SLP anomaly pattern.

Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point ($m^3/s/100m$ coastline). Anomalies are departures from the 1982-2004 base period pentad means.

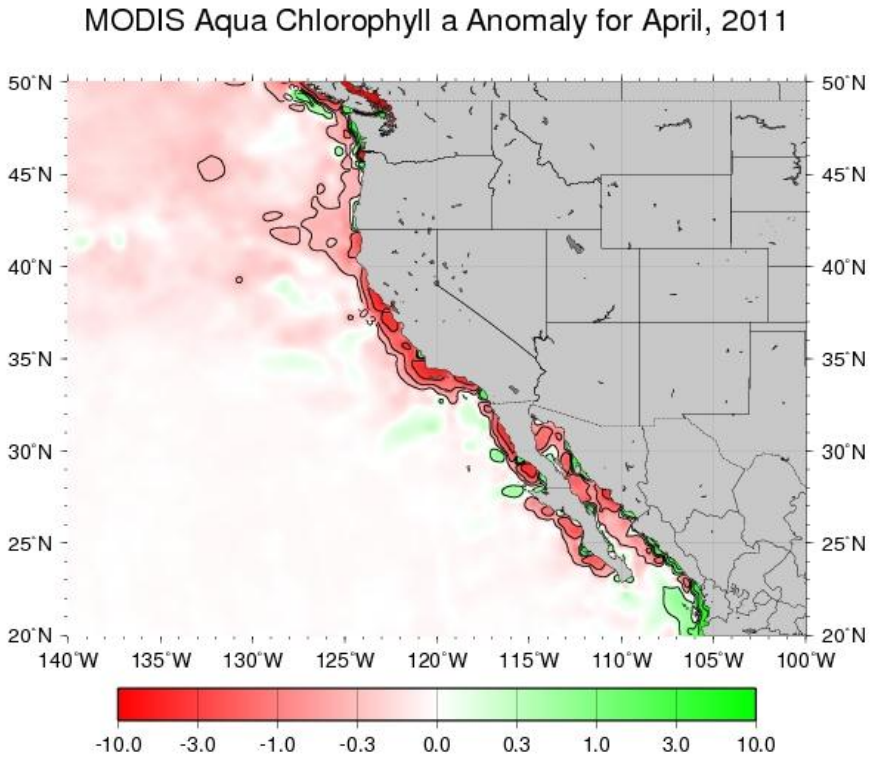
- Area below (above) black line indicates climatological upwelling (downwelling) season.

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

Monthly Chlorophyll Anomaly



- **Negative chlorophyll anomalies dominated at 23°N-50°N in May 2011.**
- **The anti-correlation between upwelling and Chlorophyll (23N-40N) suggested that upwelling may not be the dominant factor determining the chlorophyll anomalies in this month.**

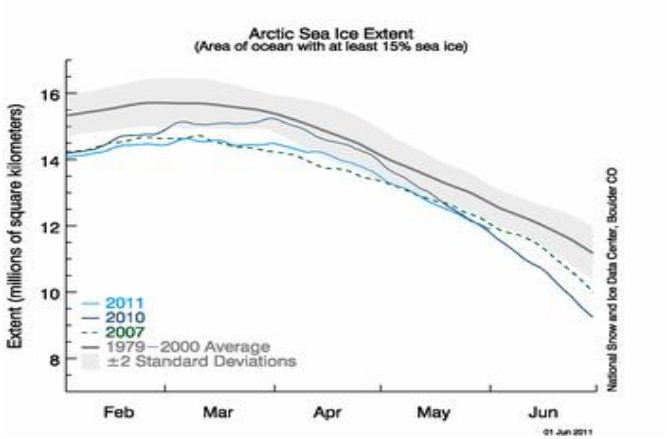


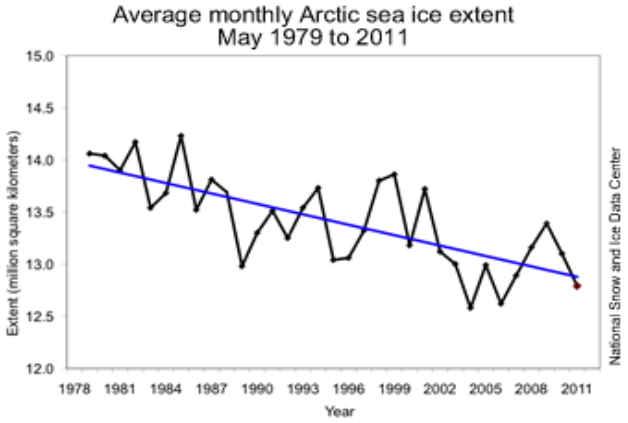
http://coastwatch.pfel.noaa.gov/FAST

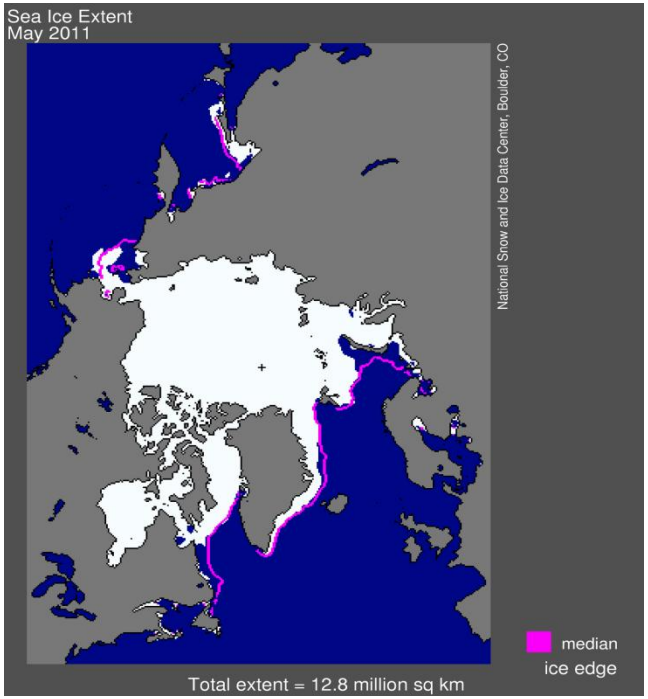
Arctic Sea Ice

National Snow and Ice Data Center

http://nsidc.org/arcticseaicenews/index.html





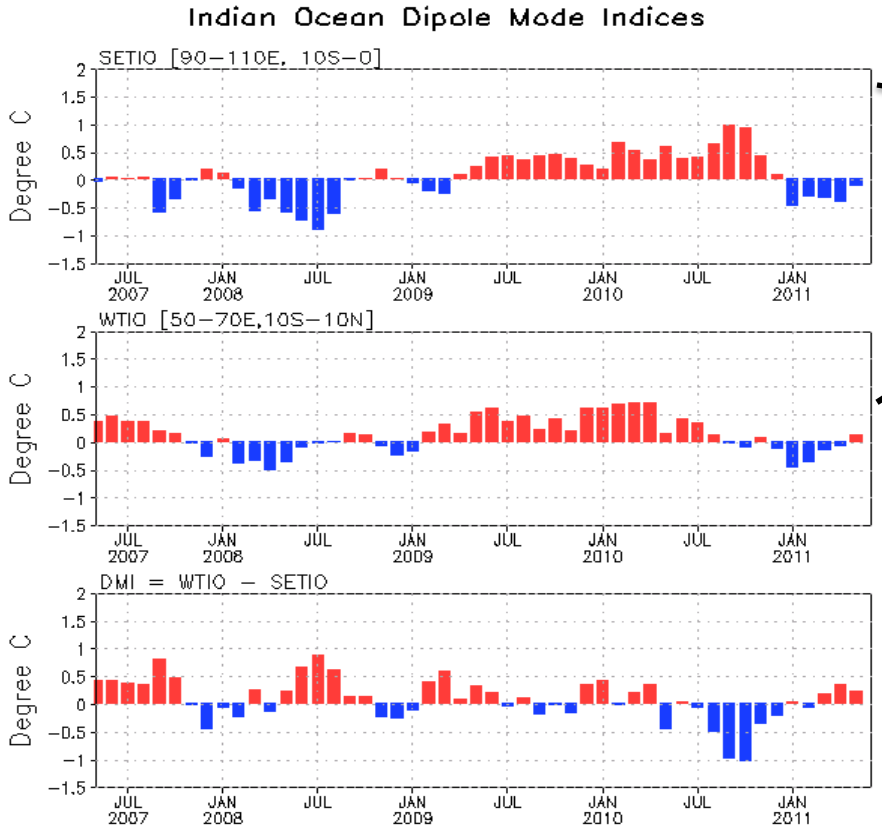


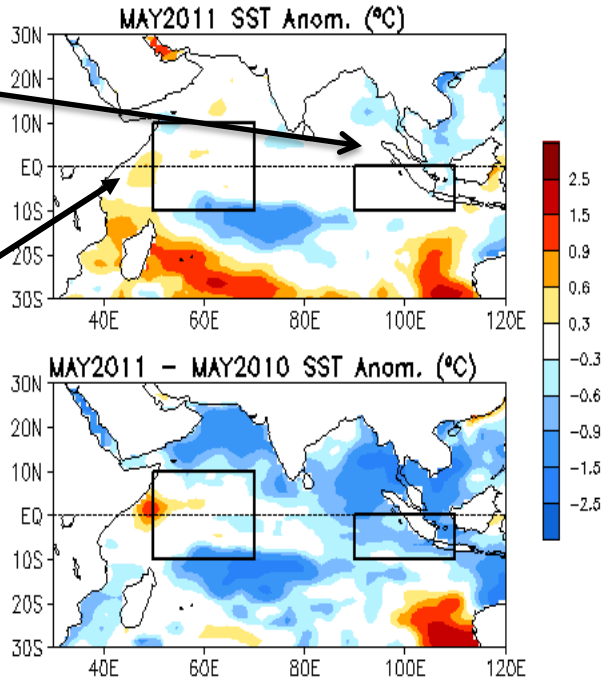
- **The Arctic sea ice extent continued to decline in May 2011, which was the third lowest in the satellite records.**

-**The sea ice deficit mainly occurred in the subpolar Atlantic.**

Tropical Indian Ocean

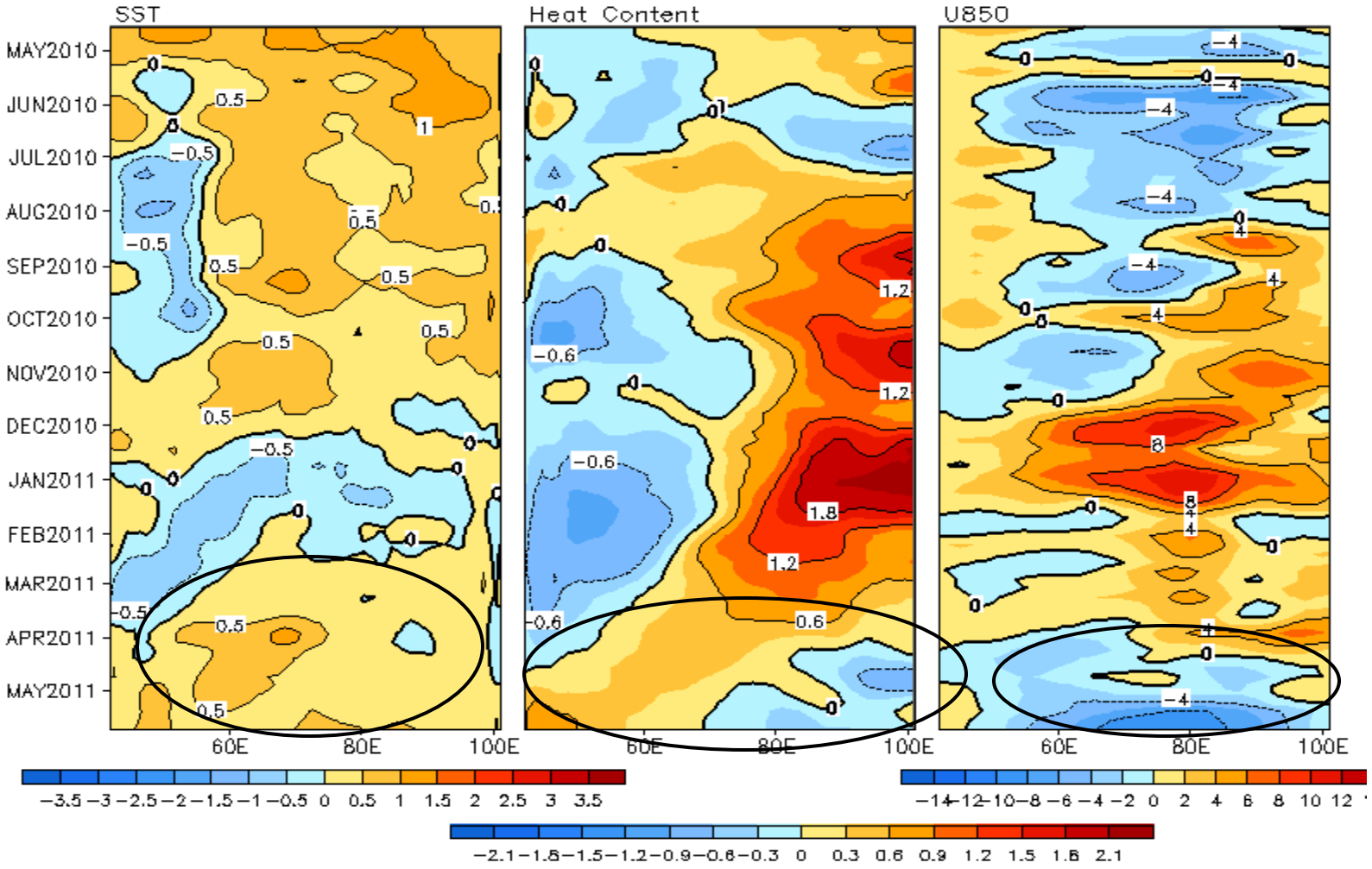
Evolution of Indian Ocean SST Indices





- **Eastern (SETIO) and western(WTIO) pole SSTA were near-normal in May.**
- **DMI has been near-normal since Nov 2010.**

Fig. I1a. Indian Ocean Dipole region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the SETIO [90°E-110°E, 10°S-0] and WTIO [50°E-70°E, 10°S-10°N] regions, and Dipole Mode Index, defined as differences between WTIO and SETIO. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1971-2000 base period means.



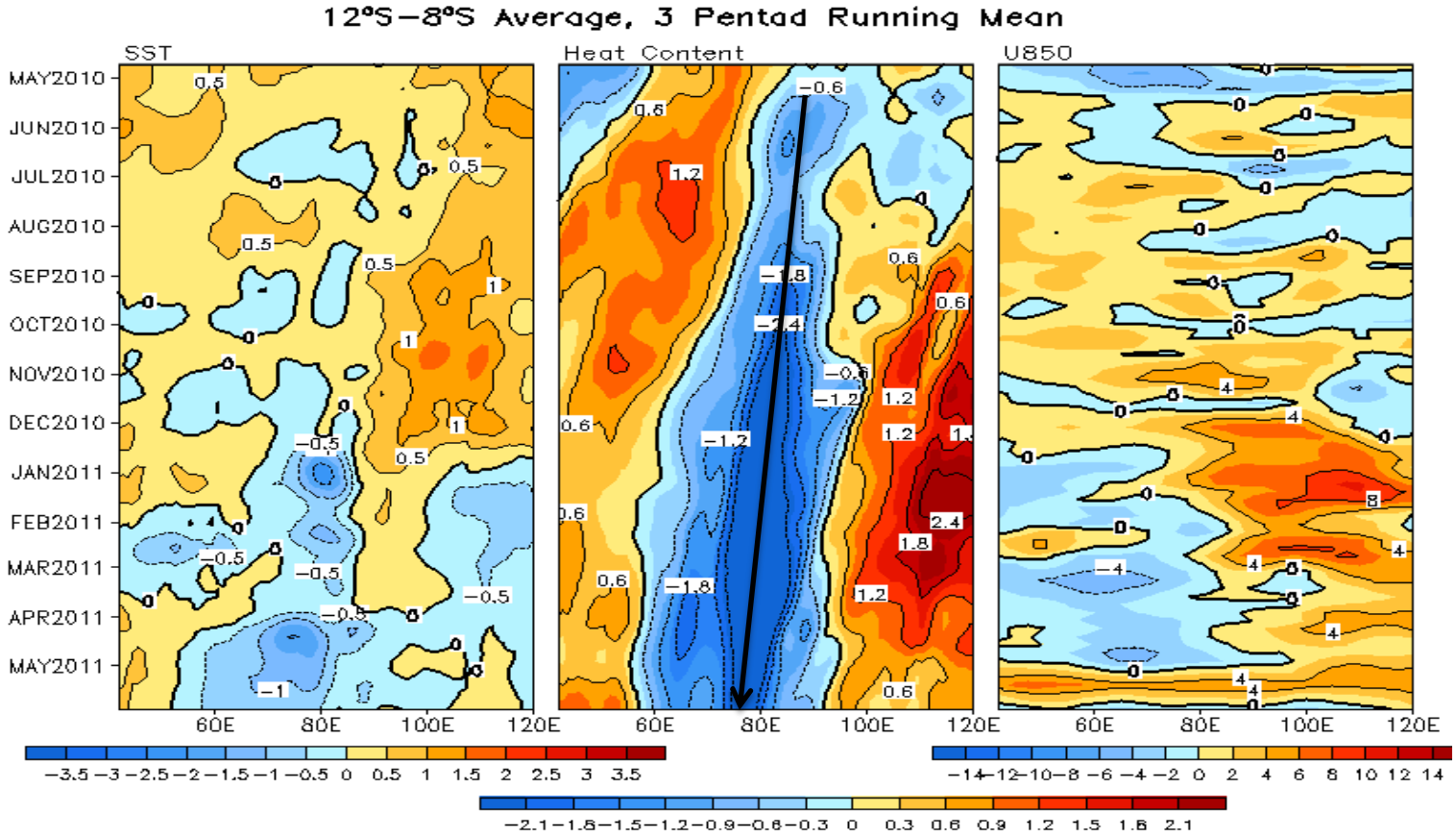
- SSTA switched to negative since mid-Dec 2010, probably due to the delayed impact of the La Nina.

But, positive SSTA imerged in the central Indian Ocean since Mar 2011.

- Positive (negative) heat content anomaly presented in the west-central (eastern) Indian Ocean in response to anomalous easterly wind forcing in the tropical Indian Ocean.

Fig. I3. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2°S-2°N and Outgoing Long-wave Radiation (OLR, right) averaged in 5°S-5°N. SST are derived from the NCEP OI SST, heat content from the NCEP's global ocean data assimilation system, and U850 from the NCEP CDAS. Anomalies for SST, heat content and U850/OLR are departures from the 1971-2000, 1982-2004, 1979-1995 base period pentad means respectively.

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



- **SST cooled down around 70E since Apr 2011, which is consistent with the strengthening of negative HC.**
- **Westerly wind anomalies prevailed over the southern tropical Indian Ocean in May.**
- **Negative HC anomaly propagated westward since May,2010.**

Fig. I4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 12°S-8°S and Outgoing Long-wave Radiation (OLR, right) averaged in 5°S-5°N. SST are derived from the NCEP OI SST, heat content from the NCEP's global ocean data assimilation system, and U850 from the NCEP CDAS. Anomalies for SST, heat content and U850/OLR are departures from the 1971-2000, 1982-2004, 1979-1995 base period pentad means respectively.

Tropical Indian: SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Wind Anom.

-**Strong negative SSTA near 70°E and 12°S persisted in May.**

- **SSTA tendency south of the equator was not very consistent with the net surface heat flux anomalies, indicating trivial influence of heat flux on SST tendency**

- **Convection was suppressed in most regions of the tropical Indian Ocean.**

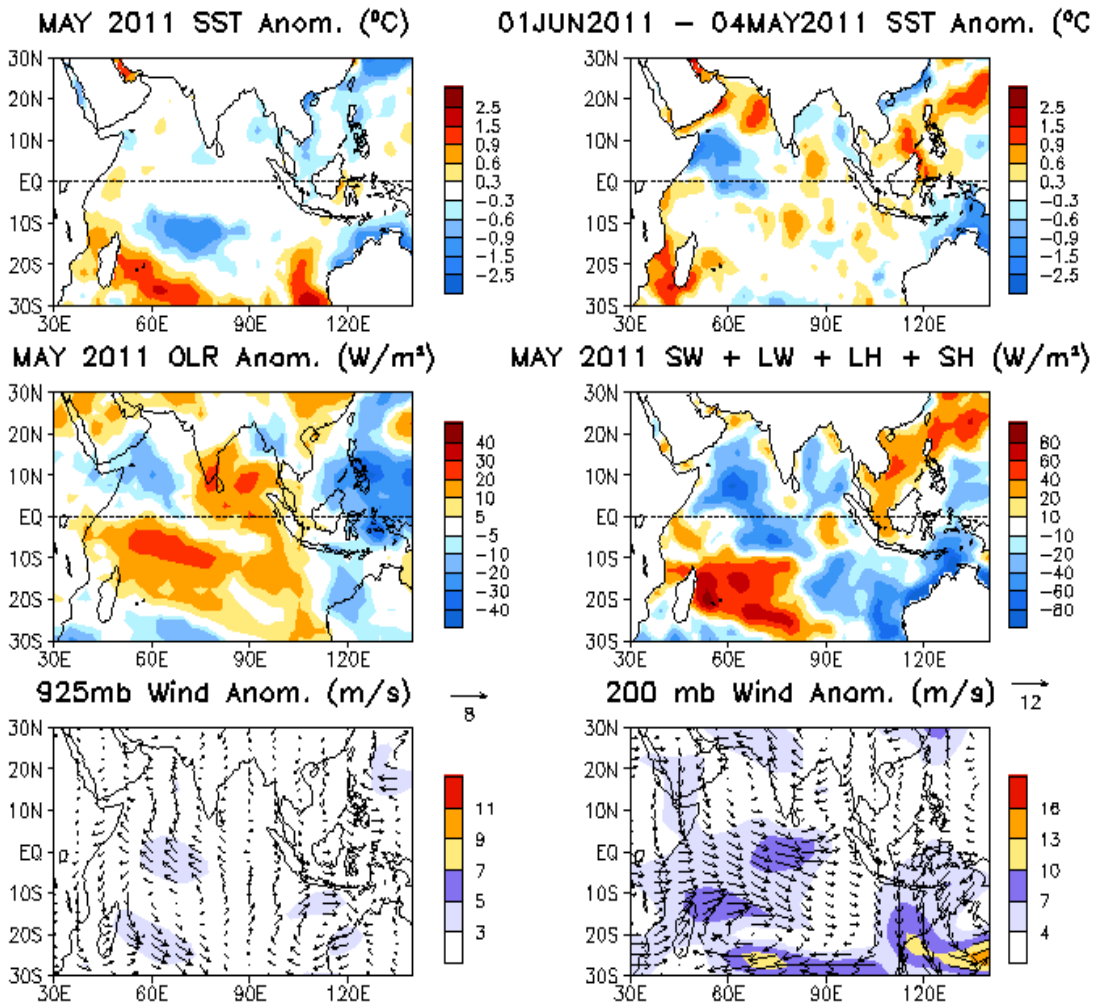
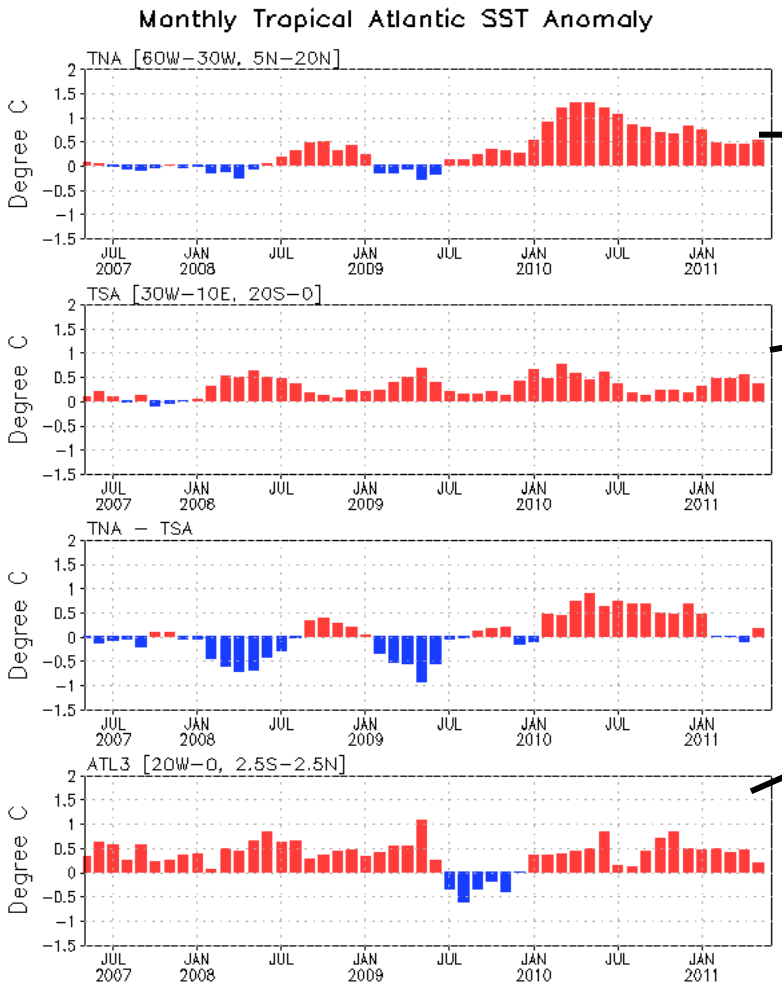
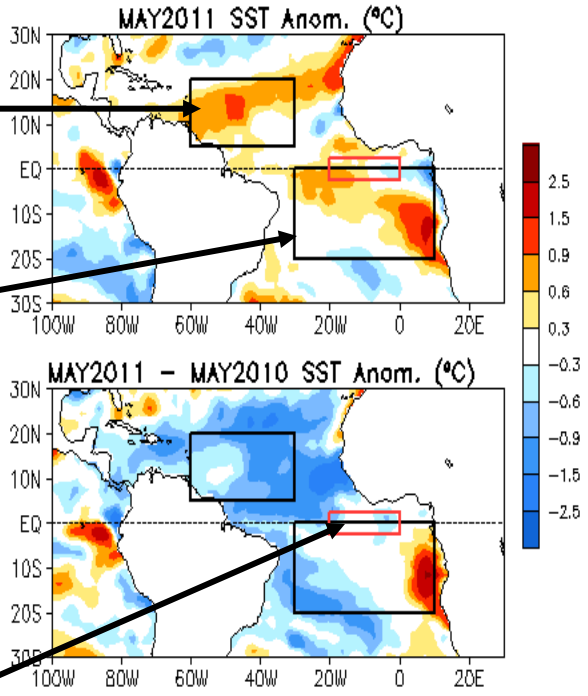


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1979-1995 base period means except SST anomalies are computed with respect to the 1971-2000 base period means.

Tropical Atlantic Ocean

Evolution of Tropical Atlantic SST Indices

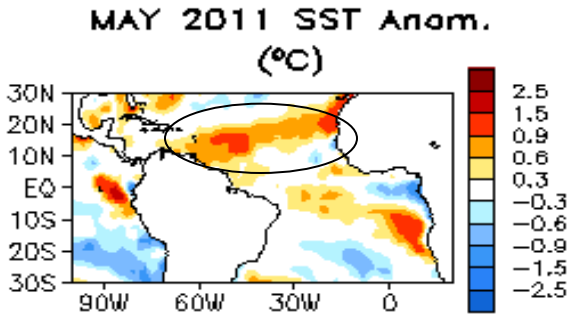


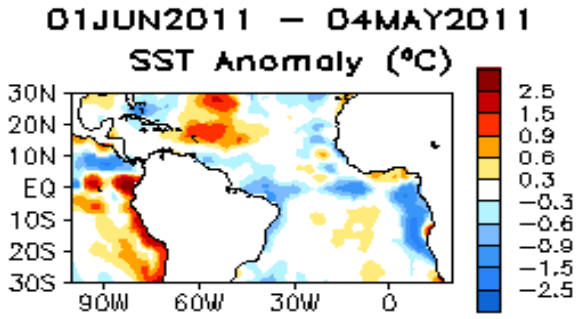


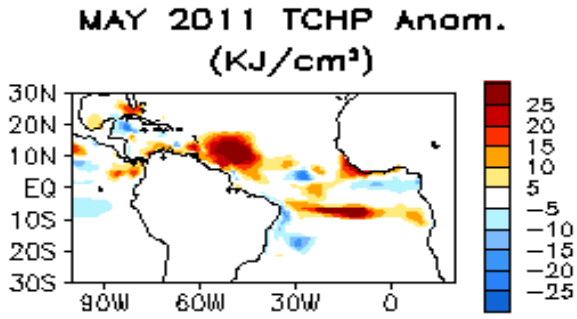
- **Positive SSTA persisted in both TNA and TSA since Feb 2011.**
- **Meridional Gradient Mode (TNA-TSA) was near-normal since Feb 2011.**
- **Positive ATL3 SST persisted since Jan 2010.**

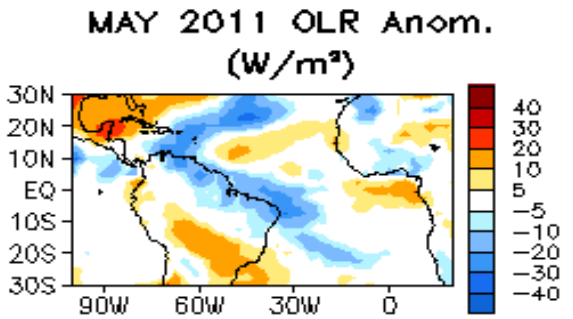
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the TNA [60°W-30°W, 5°N-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1971-2000 base period means.

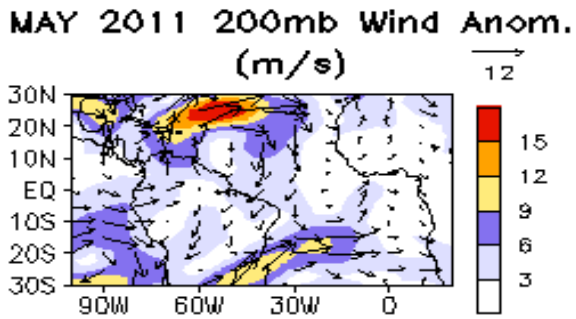
Tropical Atlantic:

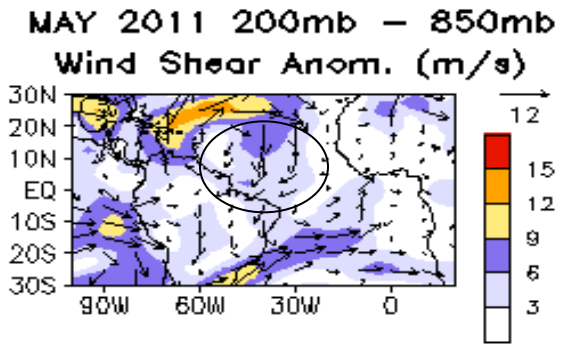


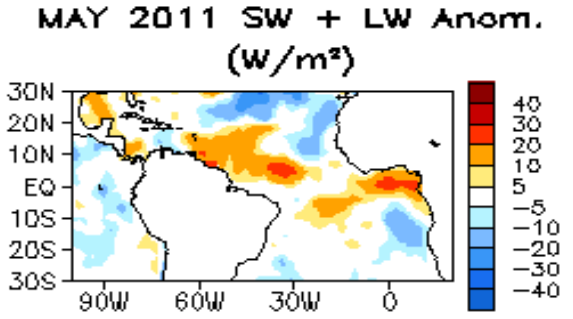


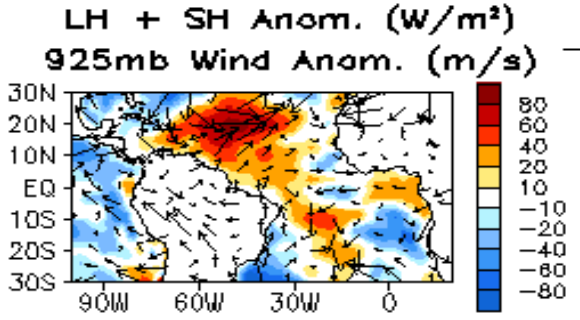


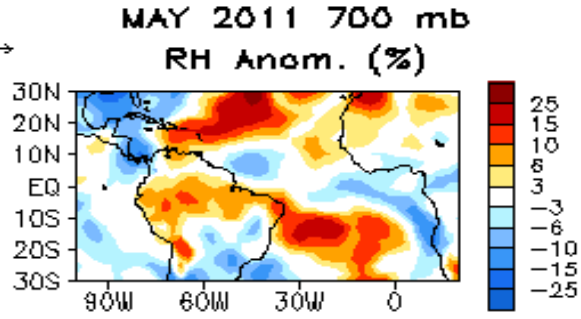












- **Positive SSTA continued in the Atlantic Hurricane Main Development Region (MDR) (tropical Atlantic ocean between 9°N-21.5°N).**

- **Above-normal TCHP and easterly wind shear anomaly in hurricane MDR are favorable for hurricane development.**

NOAA's 2011 Hurricane Season Outlooks Issued in May

NOAA's 2011 seasonal hurricane outlooks indicate the likely ranges (each with a 70% chance) of Named Storms (NS), Hurricanes (H), Major Hurricanes (MH), and percentage of the median Acccumulated Cyclone Energy (ACE).

For 2011 the probabilities of each season type are:

	Atlantic	Eastern Pacific	Central Pacific
Above Normal	65%	5%	5%
Near Normal	25%	25%	25%
Below Normal	10%	70%	70%

North Atlantic Ocean

North Atlantic: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

- **Tripole SST pattern weakened in May.**
- **SLP has wave-like pattern, resulted in near-normal NAO(next slide).**

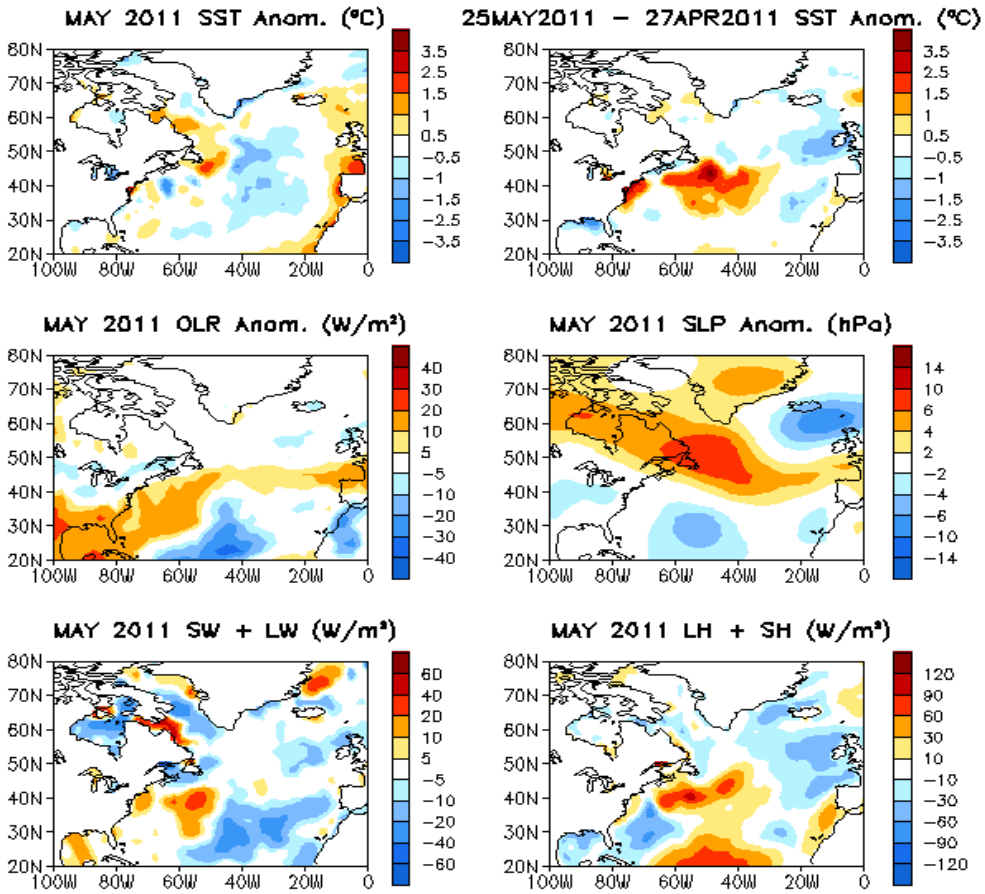
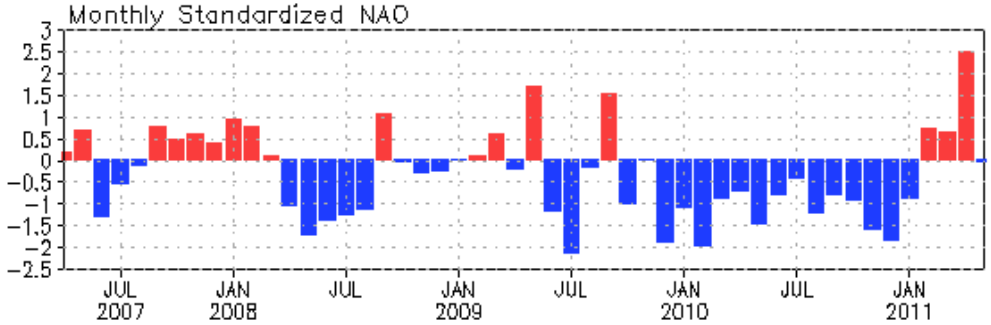
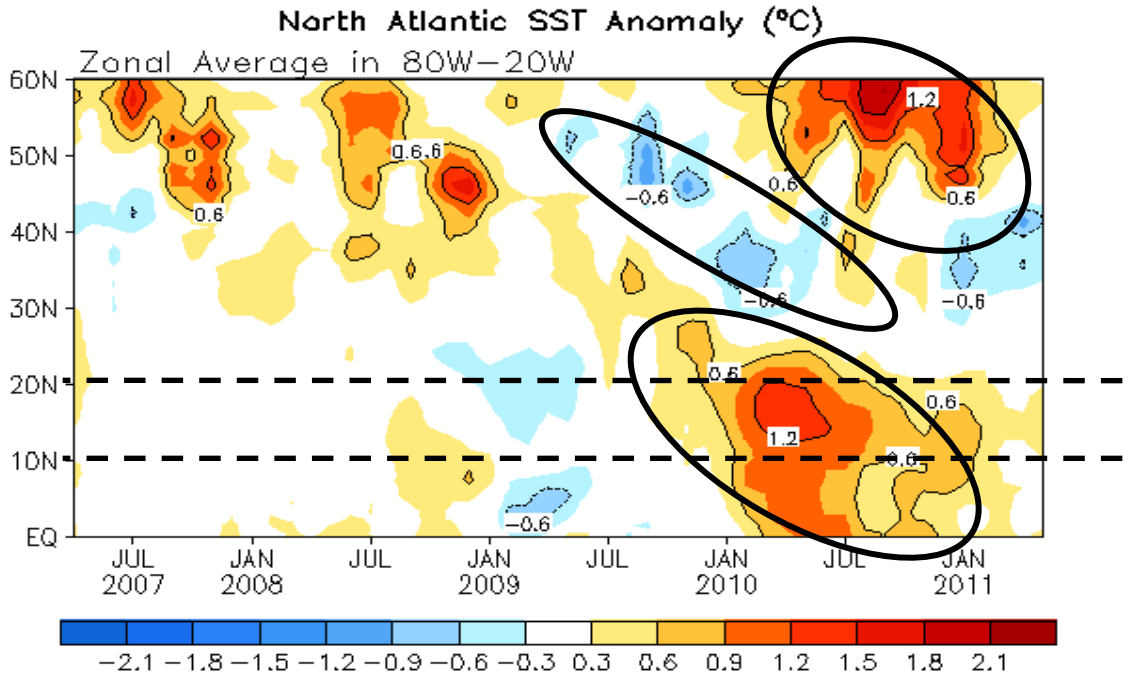
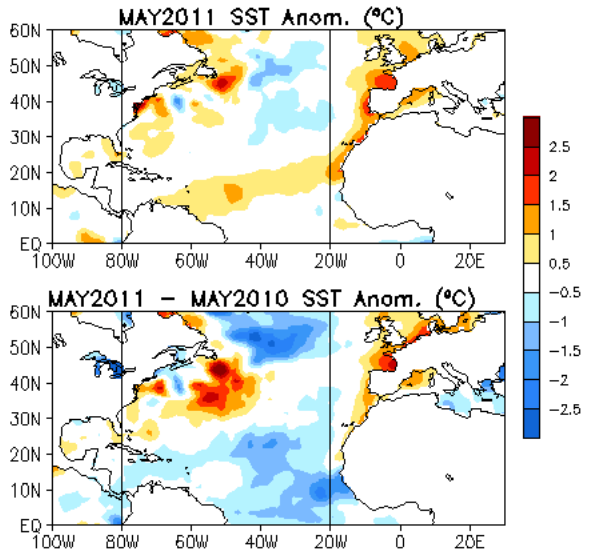


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible heat flux anomalies (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, sea surface pressure and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1979-1995 base period means except SST anomalies are computed with respect to the 1971-2000 base period means.

NAO and SST Anomaly in North Atlantic







- **NAO was near-normal in May 2011.**

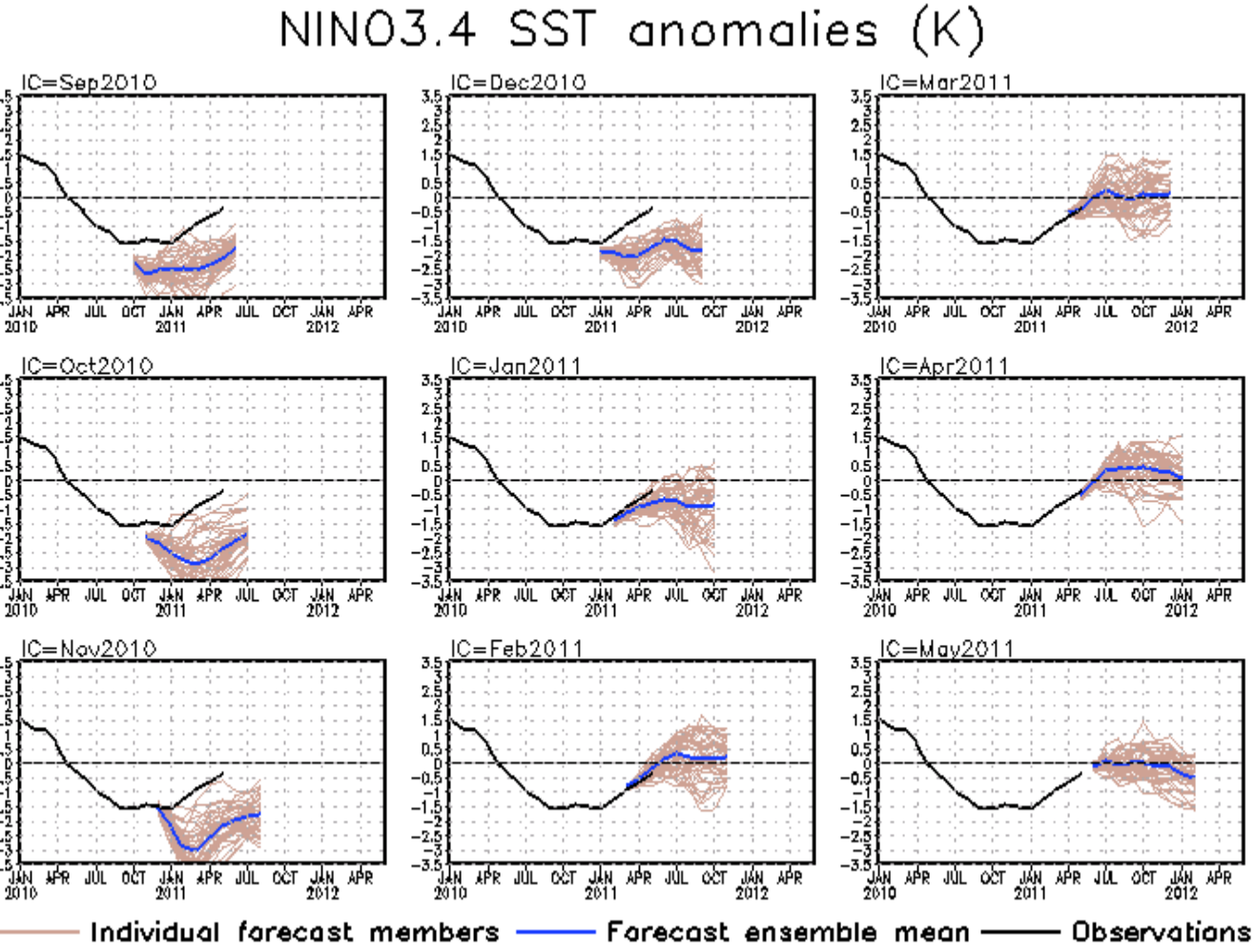
- **Consistent with the switch to positive NAO in Feb 2011, positive SSTA in the subpolar region weakened rapidly and returned to near-normal conditions around Apr 2011.**

-**The tripole or horseshoe pattern of SSTA in 2009-2011 was largely associated with the influence of NAO and ENSO cycle, as well as long-term trend and SST feedback.**

Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20°N-90°N (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80°W and 20°W (bottom). SST are derived from the NCEP OI SST analysis, and anomalies are departures from the 1971-2000 base period means.

CFS SST Predictions and Ocean Initial Conditions

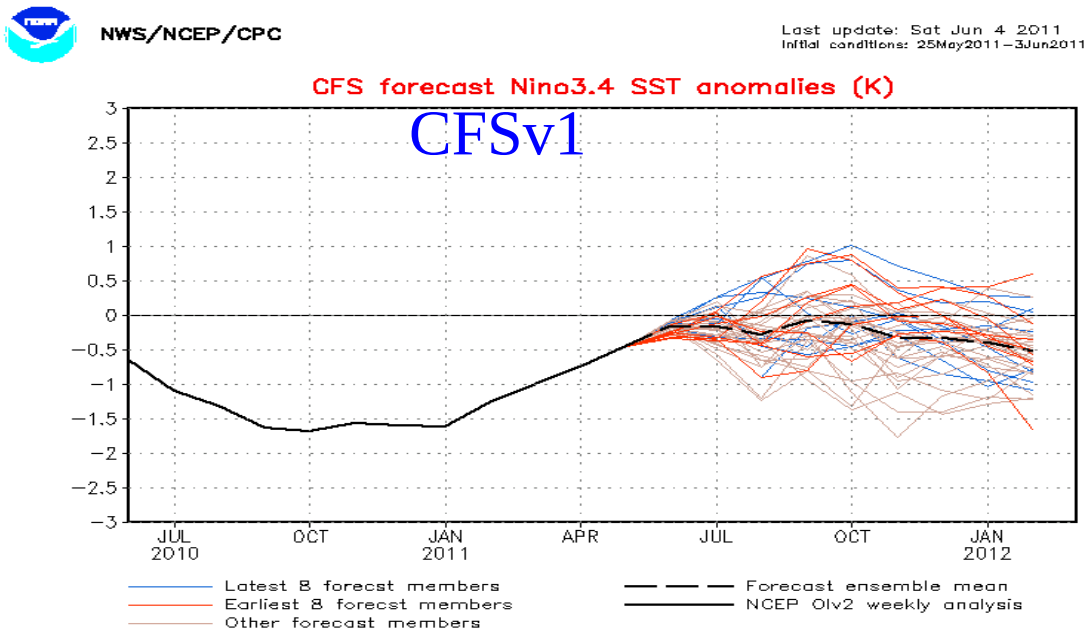
CFS Niño3.4 SST Predictions from Different Initial Months

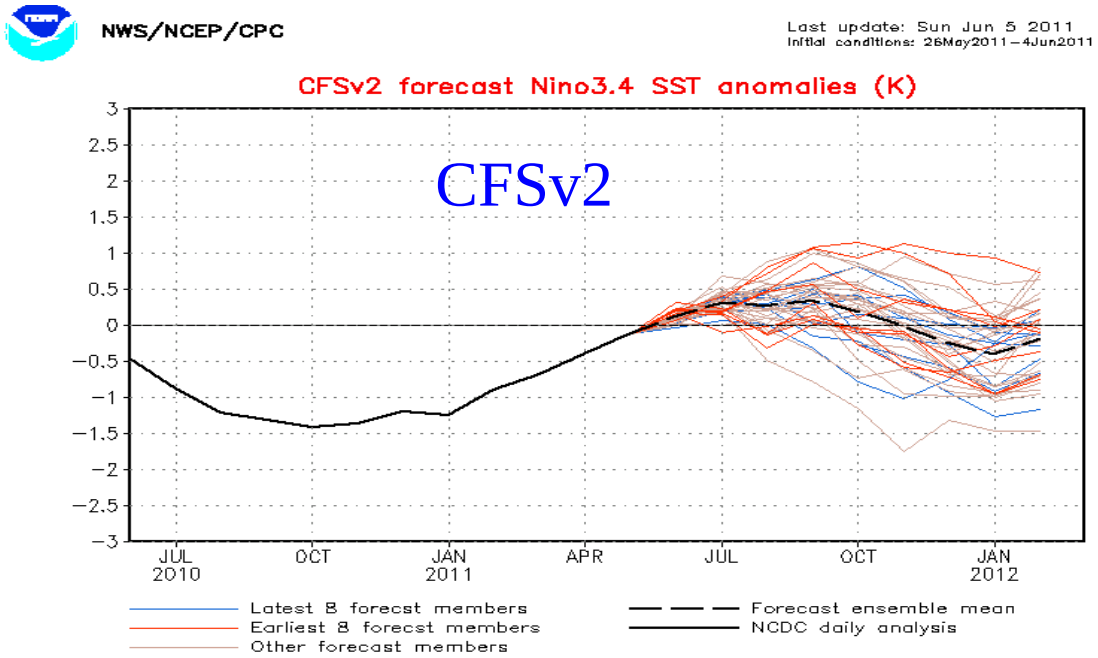


- **Forecasts from Aug 2010-Jan 2011 I.C. had cold biases. The recent cold forecast biases can be alleviated through statistical model corrections (*http://www.cpc.ncep.noaa.gov/products/people/wwang/cfs_fcst*).**

- **The latest forecasts from May 2011 I.C. suggest that ENSO-neutral conditions are expected to continue though the northern fall 2011.**

Fig. M1. CFS Nino3.4 SST prediction from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology for 1981-2006 was removed, and replaced by corresponding observation climatology for the same period. Anomalies were computed with respect to the 1971-2000 base period means.

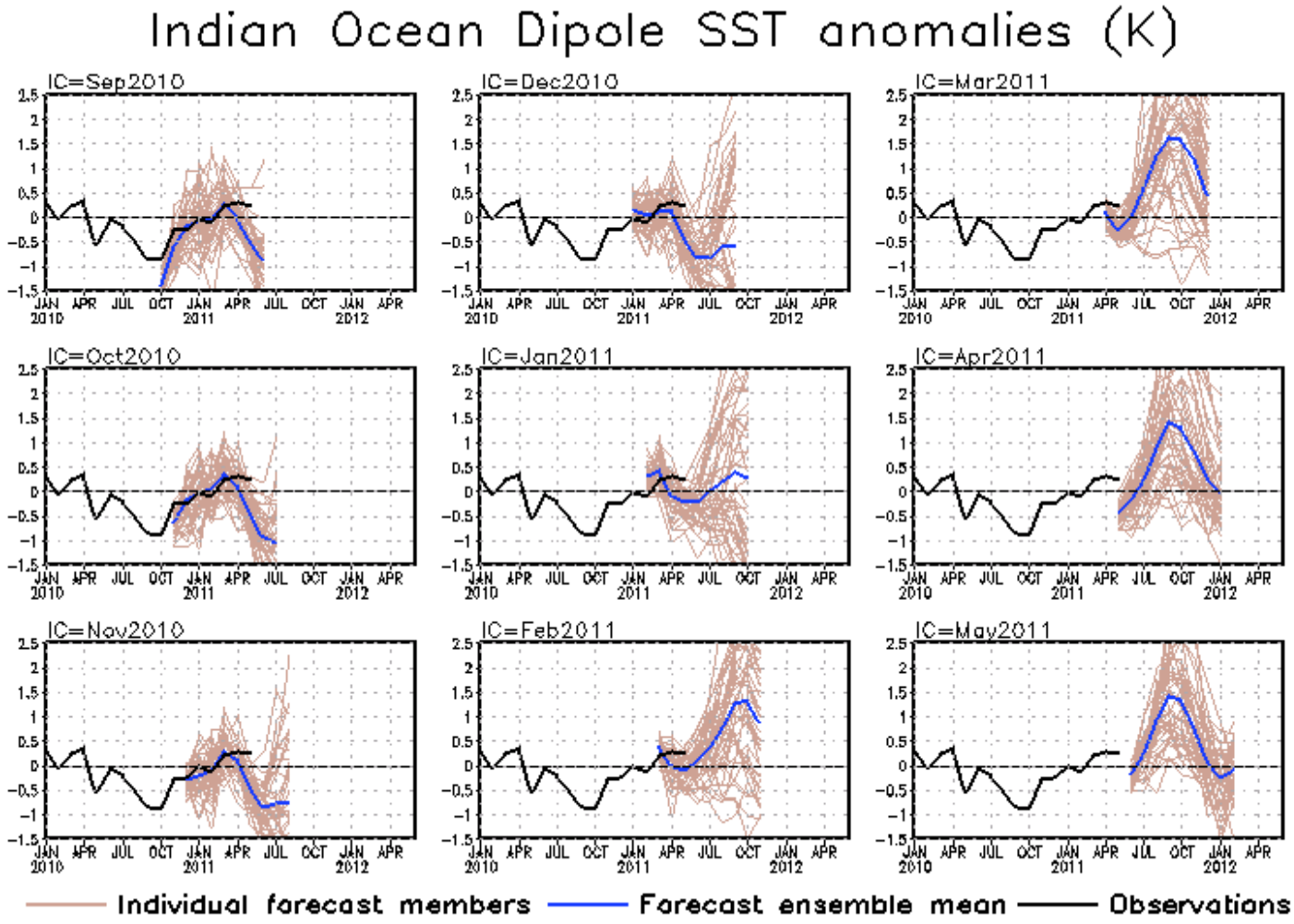




NCEP CFSv1 and v2 ENSO Forecasts:

- Both predicted ENSO-neutral condition will continue at least through Northern summer 2011.

CFS DMI SST Predictions from Different Initial Months



DMI = WTIO- SETIO

SETIO = SST anomaly in [90°E-110°E, 10°S-0]

WTIO = SST anomaly in [50°E-70°E, 10°S-10°N]

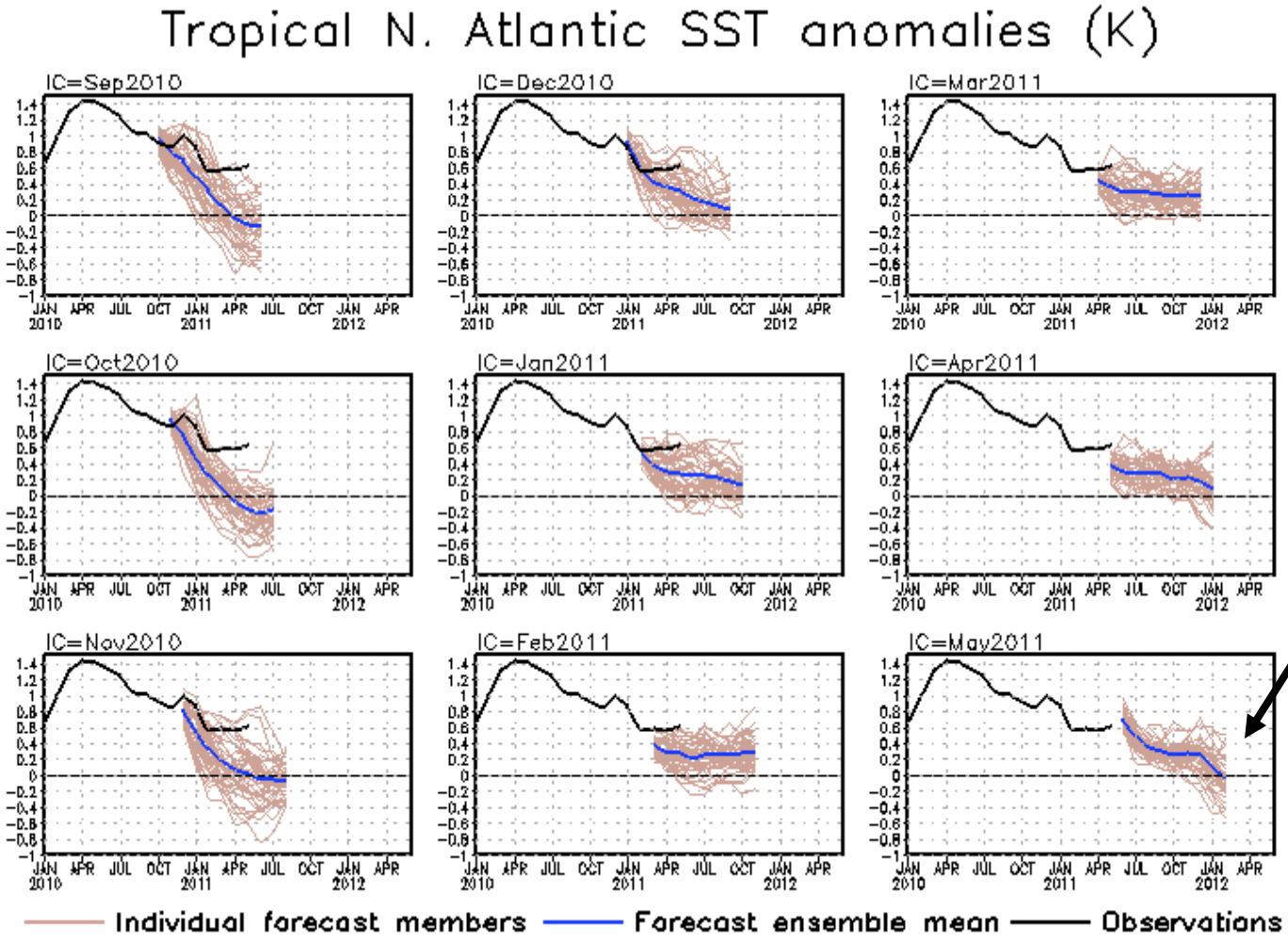
- The spread between individual members was large, implying the uncertainty of the IOD forecasts.

- Forecasts from Feb-May 2011 I.C. suggest a positive phase of IOD will develop in summer-autumn 2011.

Fig. M2. CFS Dipole Model Index (DMI) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology for 1981-2006 was removed, and replaced by corresponding observation climatology for the same period. Anomalies were computed with respect to the 1971-2000 base period means.

CFS Tropical North Atlantic (TNA) SST Predictions from Different Initial Months

TNA is the SST anomaly averaged in the region of [60°W-30°W, 5°N-20°N].

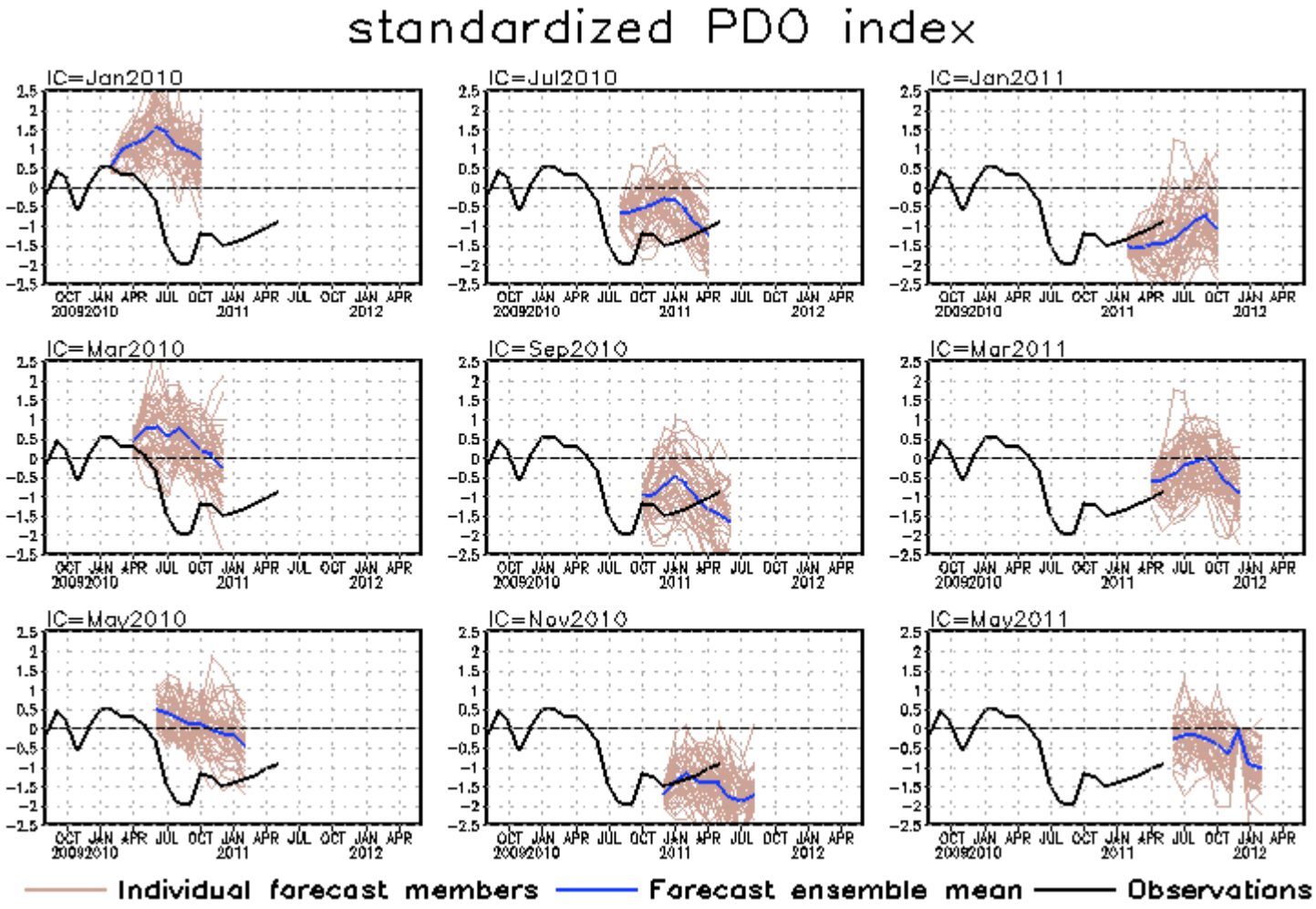


- Cold forecast biases were evident, may due to the fact that the NAO and its impact were poorly predicted.

- Latest forecasts suggest that the tropical North Atlantic SST will be near-normal in summer/fall 2011.

Fig. M3. CFS Tropical North Atlantic (TNA) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology for 1981-2006 was removed, and replaced by corresponding observation climatology for the same period. Anomalies were computed with respect to the 1971-2000 base period means.

CFS Pacific Decadal Oscillation (PDO) Index Predictions from Different Initial Months



PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

CFS PDO index is the standardized projection of CFS SST forecast anomalies onto the PDO EOF pattern.

- Latest forecasts suggest that the PDO will be near-normal condition in summer/fall 2011.

Fig. M4. CFS Pacific Decadal Oscillation (PDO) index predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology for 1981-2006 was removed, and replaced by corresponding observation climatology for the same period. Anomalies were computed with respect to the 1971-2000 base period means.

Overview

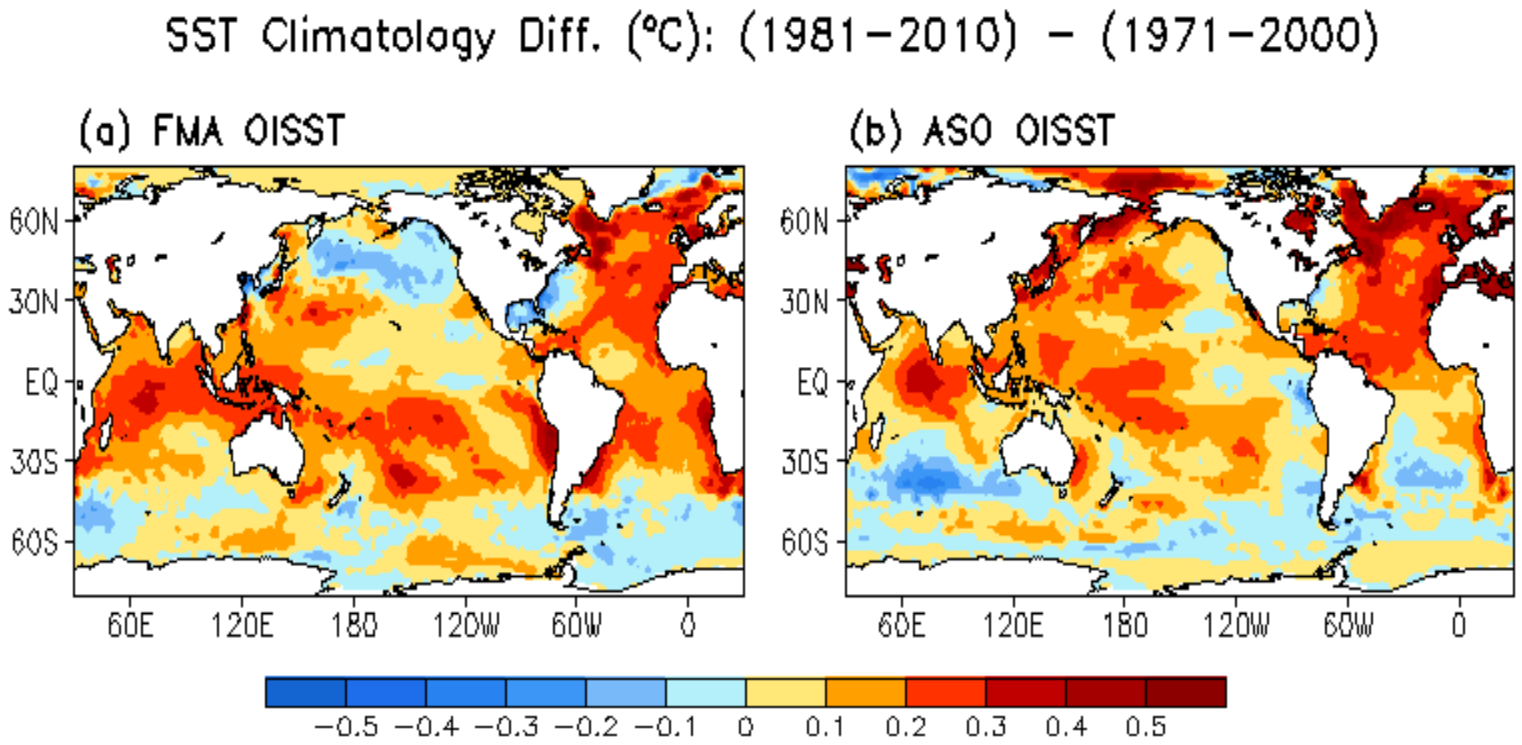
- **Pacific and Arctic Oceans**
  - **ENSO cycle: La Niña conditions dissipated to neutral conditions with OISST NINO3.4=-0.43°C in May 2011.**
  - **NOAA/NCEP Climate Forecast System (CFS) suggests that the ENSO-neutral conditions are expected at least through the boreal summer.**
  - **PDO has been negative since Jun 2010, and weakened steadily since Jan 2011, coinciding with the decaying La Nina.**
  - **Artic sea ice extent continued to decline in May 2011 and reached the third lowest in the satellite records.**
- **Indian Ocean**
  - **Neutral SSTA conditions dominated in the deep tropical Indian Ocean.**
- **Atlantic Ocean**
  - **NAO was near-normal in May 2011.**
  - **Tripole SSTA pattern has weakened since Feb 2011.**
  - **Positive SSTA continued in the Atlantic Hurricane Main Development Region.**

Backup Slides

Switch to 1981-2010 Climatology

- **SST from 1971-2000 to 1981-2010**
  - **Weekly OISST.v2, monthly ERSST.3b**
- **Atmospheric fields from 1979-1995 to 1981-2010**
  - **NCEP CDAS winds, sea level pressure, 200mb velocity potential, surface shortwave and longwave radiation, surface latent and sensible fluxes, relative humidity**
  - **Outgoing Long-wave Radiation**
- **Oceanic fields from 1982-2004 to 1981-2010**
  - **GODAS temperature, heat content, depth of 20°C, sea surface height, mixed layer depth, tropical cyclone heat potential, surface currents, upwelling**
- **Satellite data climatology 1993-2005 unchanged**
  - **Aviso Altimetry Sea Surface Height**
  - **Ocean Surface Current Analyses – Realtime (OSCAR)**

Be aware that new climatology (1981-2010) was applied since Jan 2011



1971-2000 SST Climatology (Xue et al. 2003):
http://www.cpc.ncep.noaa.gov/products/predictions/30day/SSTs/sst_clim.htm

1981-2010 SST Climatology: http://origin.cpc.ncep.noaa.gov/products/people/yxue/sstclim/

- **The seasonal mean SST in February-April (FMA) increased by more than 0.2°C over much of the Tropical Oceans and N. Atlantic, but decreased by more than 0.2°C in high-latitude N. Pacific, Gulf of Mexico and along the east coast of U.S.**

- **Compared to FMA, the seasonal mean SST in August-October (ASO) has a stronger warming in the tropical N. Atlantic, N. Pacific and Arctic Ocean, and a weaker cooling in Gulf of Mexico and along the east coast of U.S.**

Data Sources and References

- **Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)**
- **SST 1971-2000 base period means (Xue et al. 2003)**
- **NCEP CDAS winds, surface radiation and heat fluxes**
- **NESDIS Outgoing Long-wave Radiation**
- **NDBC TAO data (http://tao.noaa.gov)**
- **PMEL TAO equatorial temperature analysis**
- **NCEP's Global Ocean Data Assimilation System temperature, heat content, currents (Behringer and Xue 2004)**
- **Aviso Altimetry Sea Surface Height**
- **Ocean Surface Current Analyses – Realtime (OSCAR)**

Please send your comments and suggestions to Yan.Xue@noaa.gov. Thanks!