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

Prepared by

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August 6, 2010

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)

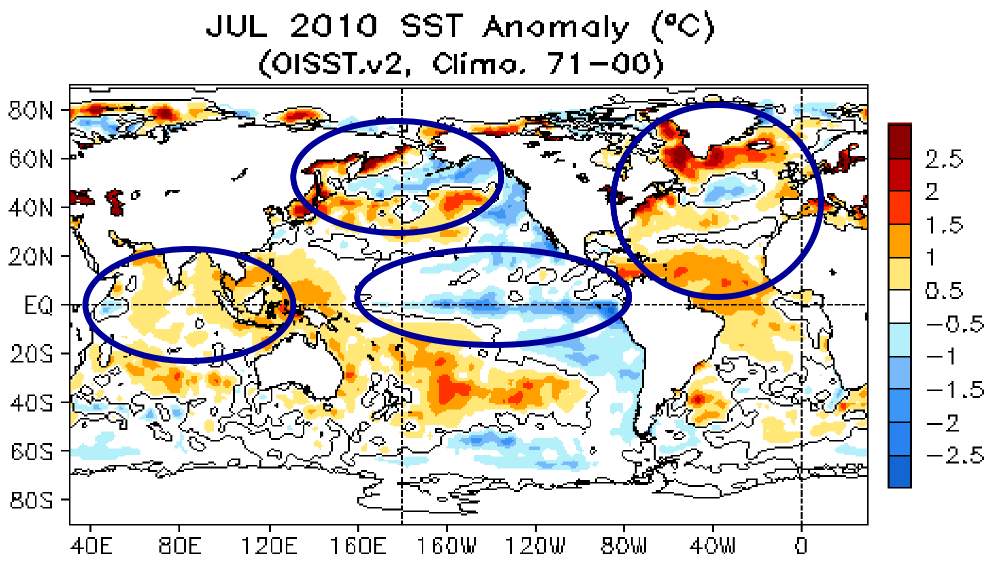
Outline

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

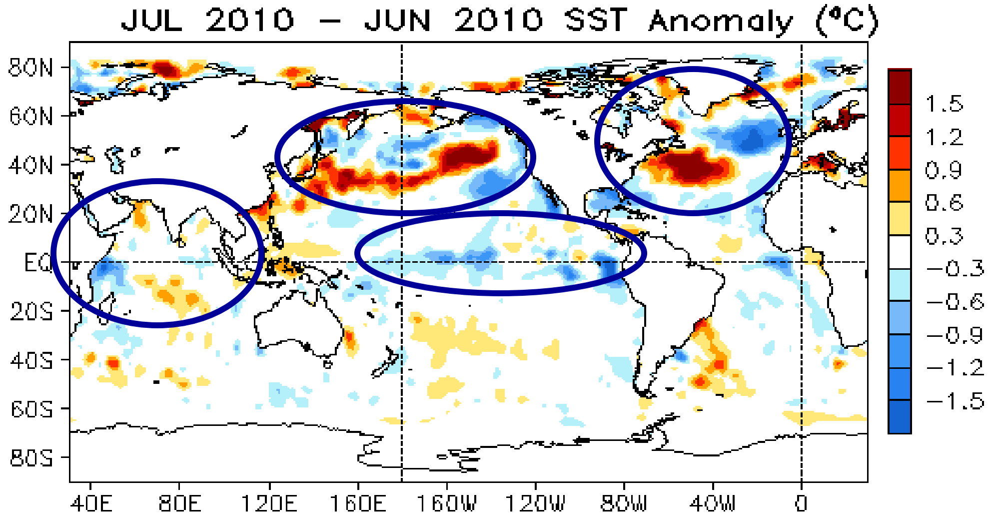
Overview

- **Pacific/Arctic Ocean**
  - ENSO cycle: La Niña conditions developed in Jul 2010
  - NOAA/NCEP Climate Forecast System (CFS) has predicted a moderate-to-strong La Niña from Apr-Jul I.C., and the La Nina is forecast to last through the Northern Hemisphere winter 2010/2011 and spring 2011.
  - PDO index has been near-normal from Sep 2009 to Jun 2010, and it suddenly dropped to -1.5 in Jul 2010.
  - Arctic sea ice extent was well below-normal in Jul 2010, comparable to the historical low in 2007.
- **Indian Ocean**
  - Positive SSTA weakened (strengthened) in the Arabian Sea and along the coast of Somali (in the central-south Indian Ocean).
  - Dipole Mode index was weakly below-normal during May-Jul 2010.
- **Atlantic Ocean**
  - NAO index has been persistently below-normal since Oct 2009, and it is -0.42 in Jul 2010.
  - Tripole SSTA pattern persisted in Jul 2010.
  - SST in the tropical North Atlantic (TNA) has increased steadily from Dec 2009 to May 2010, and gradually weakened afterwards.
  - Easterly wind shear anomaly and above-normal tropical cyclone heat potential were observed in the Atlantic hurricane MDR in the past few months, which are favourable for hurricane development.

Global SST Anomaly (⁰C) and Anomaly Tendency



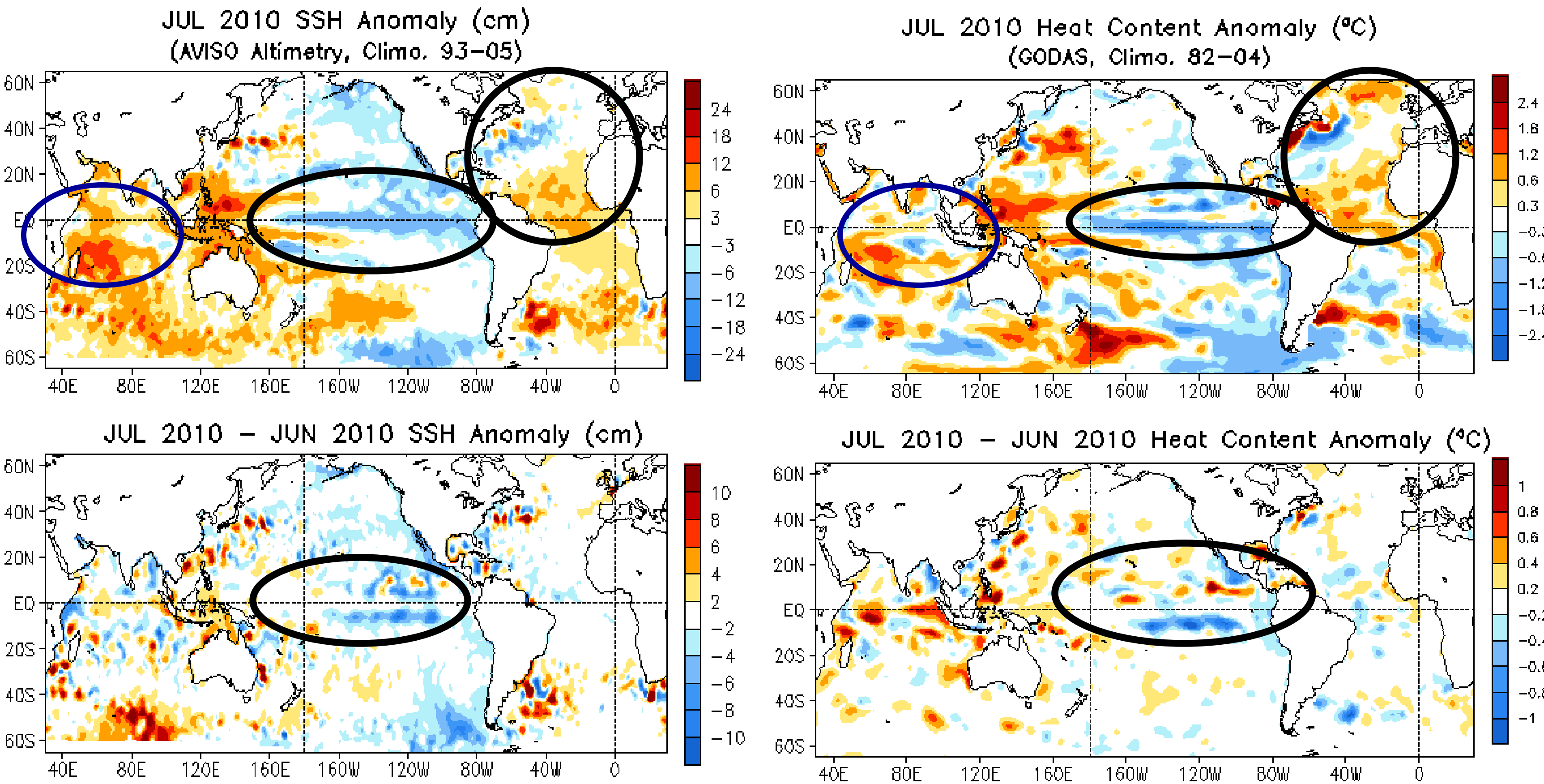
- Negative SSTA presented in the tropical eastern and central Pacific, consistent with La Niña conditions.
- Negative PDO SST pattern presented in N. Pacific.
- Positive SSTA presented in the tropical Indian Ocean and tropical W. Pacific.
- Tripole SST anomaly pattern persisted in North Atlantic, and positive SSTA in the tropical North Atlantic has been near historical high during Mar-Jul 2010.



- SSTA continuously decreased in the central and eastern tropical Pacific, suggesting strengthening of La Niña conditions.
- SST tendency was large in N. Pacific.
- Both positive and negative SST tendency existed in the tropical Indian Ocean.
- Tripole SSTA tendency pattern suggested the persistency and slightly northward shift of the tripole SSTA pattern in North Atlantic.

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.

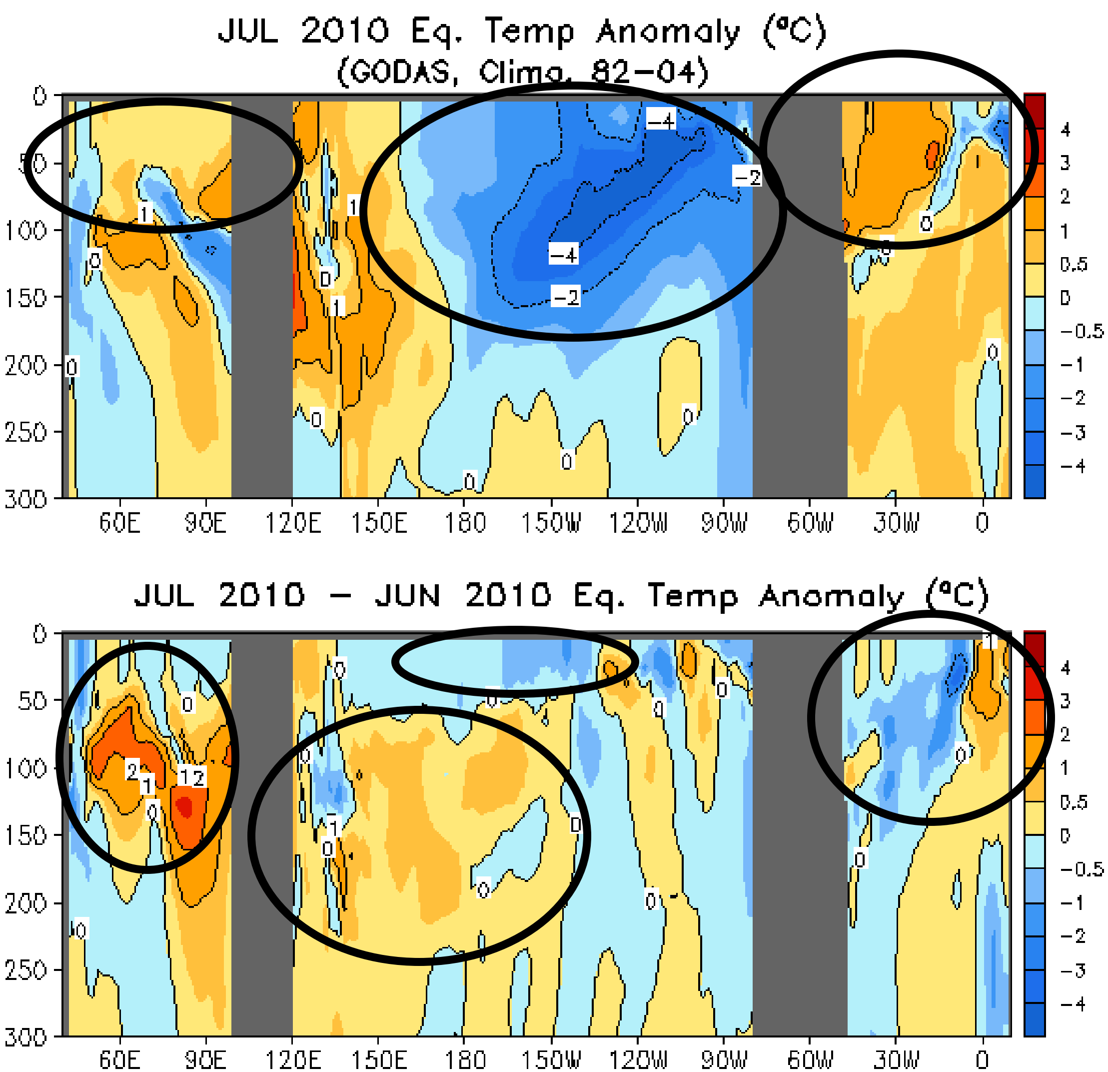
Global SSH/HC Anomaly (cm/°C) and Anomaly Tendency



- **Negative SSHA and HCA strengthened off the Equator in the central-eastern tropical Pacific, consistent with strengthening of La Nina conditions.**
- **Positive HCA and SSHA presented in the tropical Indian Ocean and western Pacific.**
- **The tripole SSHA and HCA pattern in North Atlantic were consistent with the tripole SSTA pattern there.**
- **SSHA and HCA 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^{O}S-2^{O}N



- Negative subsurface ocean temperature anomalies dominated in the equatorial central and eastern Pacific, consistent with the La Niña conditions.

- Positive ocean temperature anomalies dominated in the equatorial Indian and Atlantic Ocean.

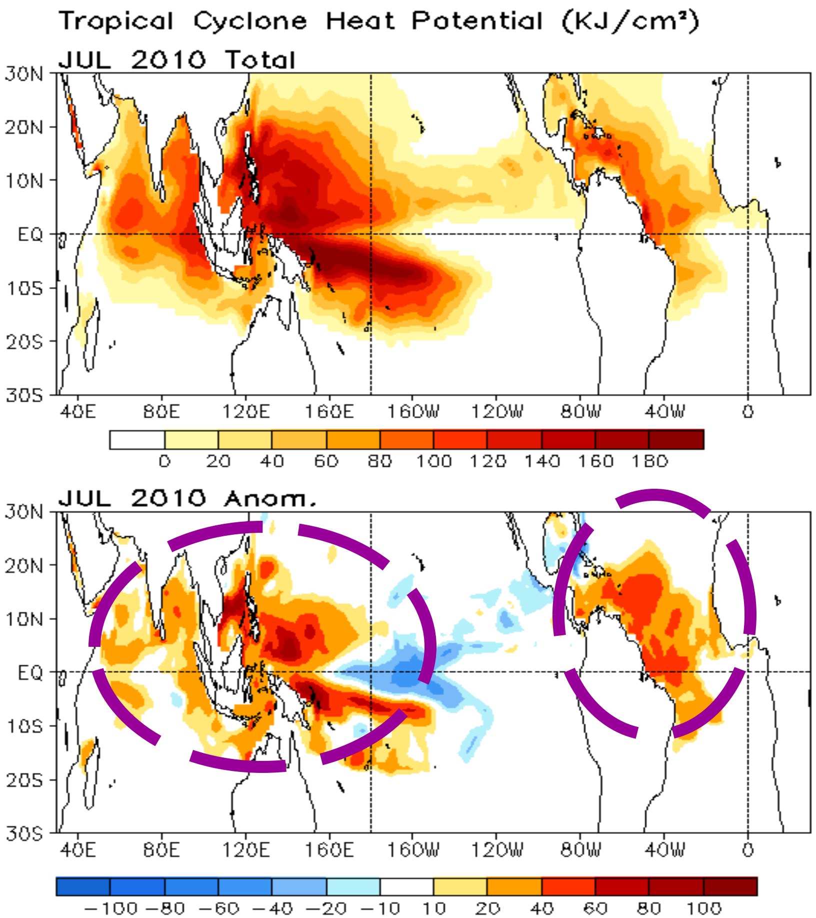
- Positive (negative) temperature tendency presented in the western and central Pacific near thermocline (near the surface).

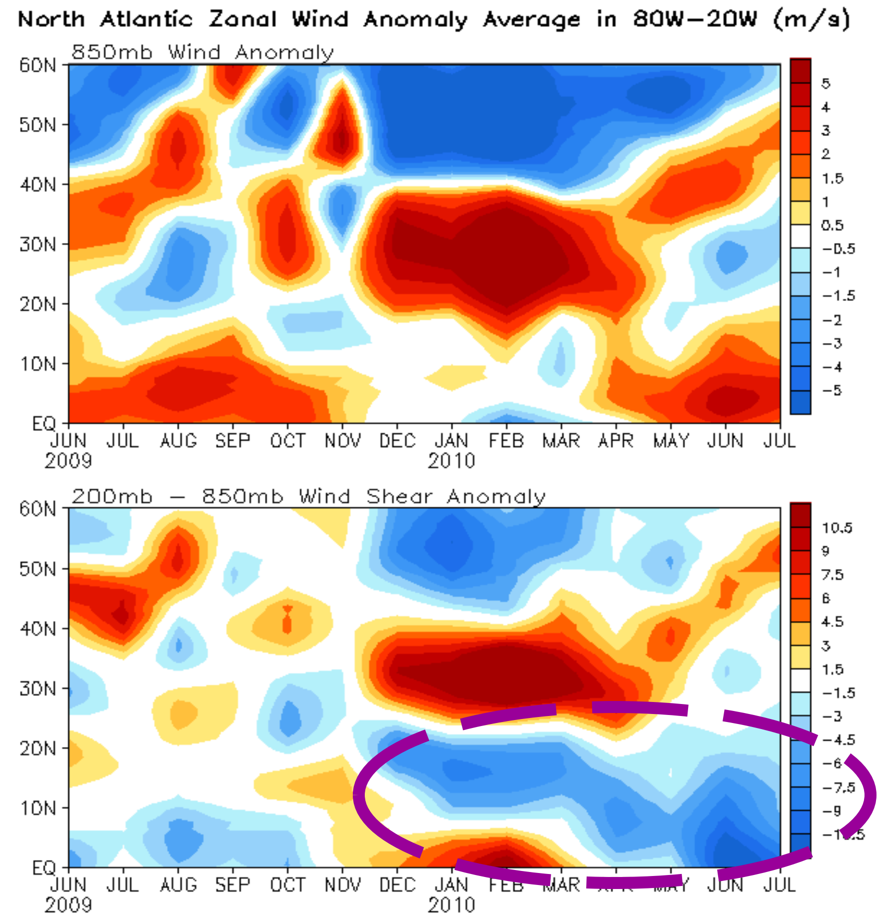
- Positive temperature tendency presented in the tropical Indian Ocean near thermocline.

- Both positive and negative tendencies suggested slight weakening of the negative and positive anomaly of the ocean temperature in the tropical Atlantic 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.

Tropical Cyclone Heat Potential, Wind Shear Anomaly





- **Large positive TCHP anomalies presented in the tropical North Atlantic, and NW and SW Pacific Ocean, parts of the tropical Indian Ocean in Jul 2010.**

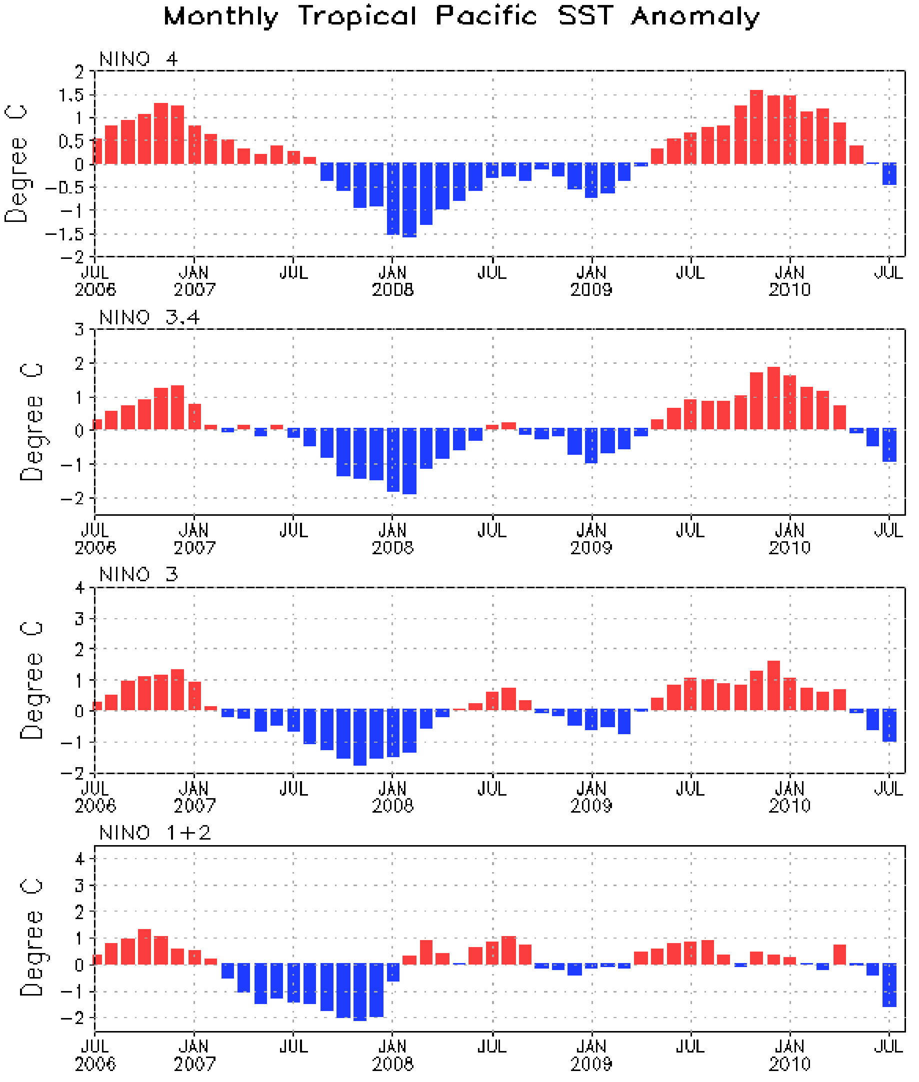
- **Easterly vertical wind shear anomalies presented in the Atlantic MDR since Dec 2009.**

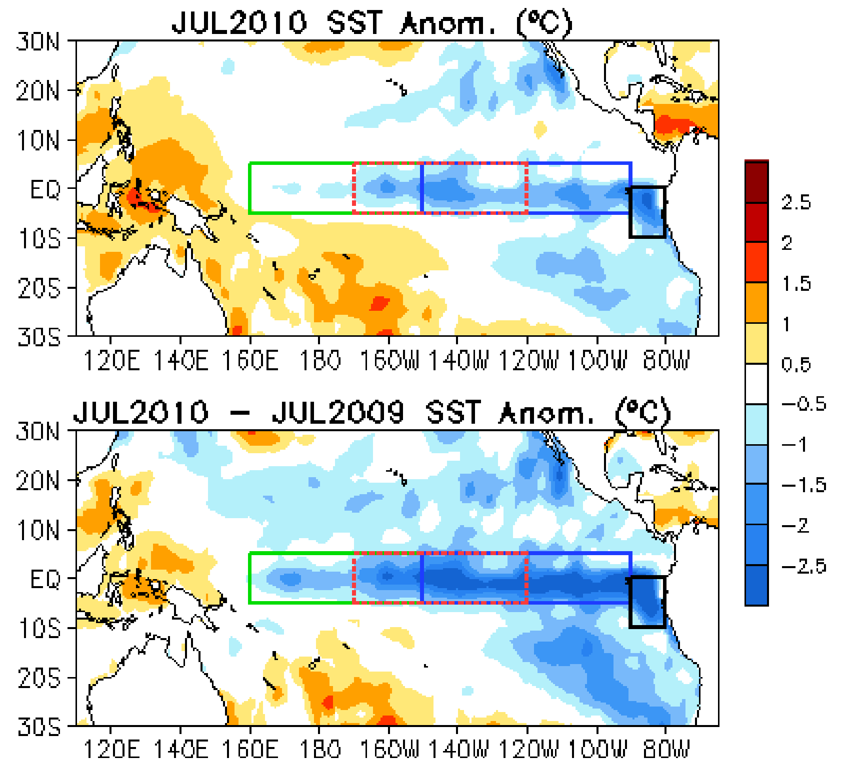
- **The positive TCHP anomalies and easterly vertical wind shear anomaly might affect the hurricane activity in the coming months in the Atlantic basin.**

The tropical cyclone heat potential (hereafter TCHP), is defined as a measure of the integrated vertical temperature from the sea surface to the depth of the 26°C isotherm.

Tropical Pacific Ocean

Evolution of Pacific NINO SST Indices



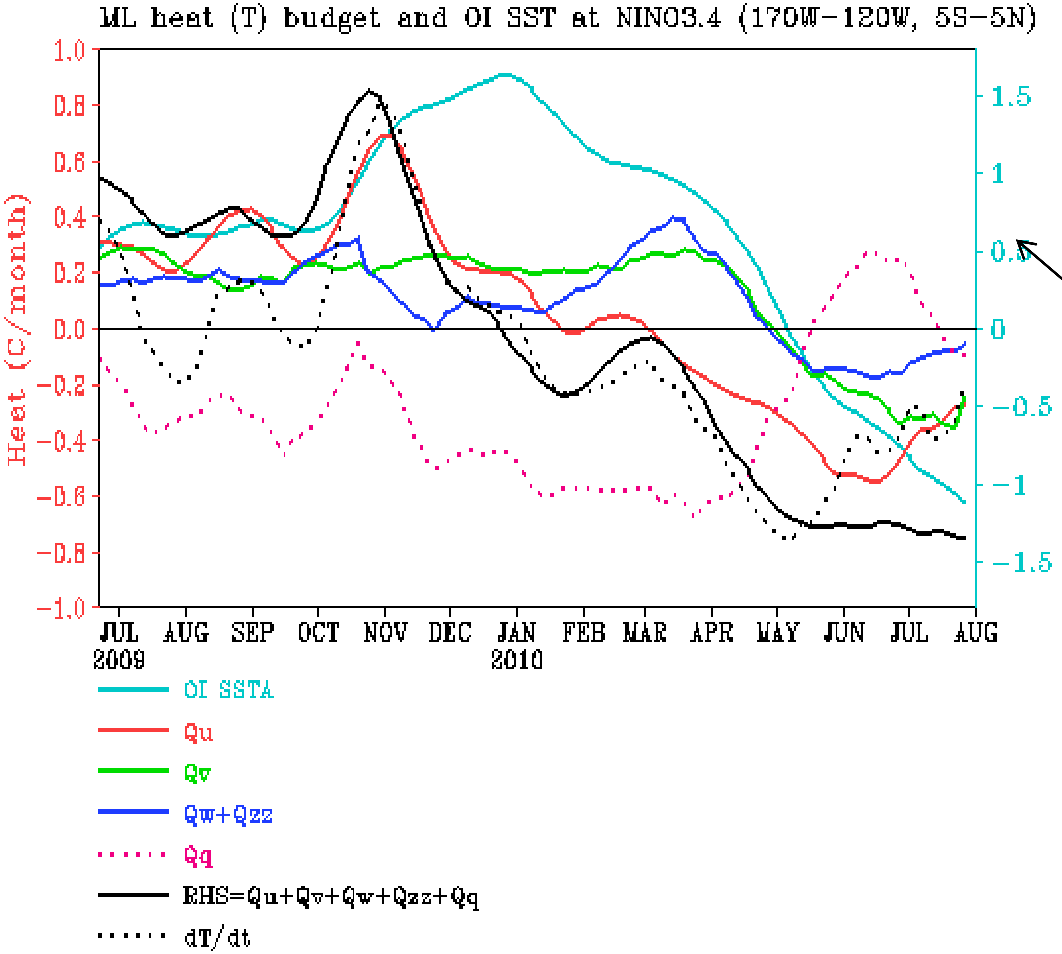


- **All indices decreased and became negative in Jul 2010, indicating the development of La Niña.**

- **The indices were calculated based on OISST. They 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 (ºC) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1971-2000 base period means.

NINO3.4 Heat Budget



- **Negative tendency (dT/dt) in NINO 3.4 slightly weakened in Jul 2010, probably due to the reduction of the cooling from Qu.**

- **All dynamical terms (Qu, Qv, Qw+Qzz) contributed to the negative tendency.**

- **The thermodynamic processes (Qq) transitioned from positive (damping) to negative (enhancing) in Jul 2010.**

- **The negative tendency (dT/dt) is overestimated by the total budget term (RHS) since Jun 2010. The cooling from Qu and Qv might be overestimated in the GODAS due to too strong zonal and meridional divergence of the ocean current.**

Qu: Zonal advection; Qv: Meridional advection;

Qw: Vertical entrainment; Qzz: Vertical diffusion

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

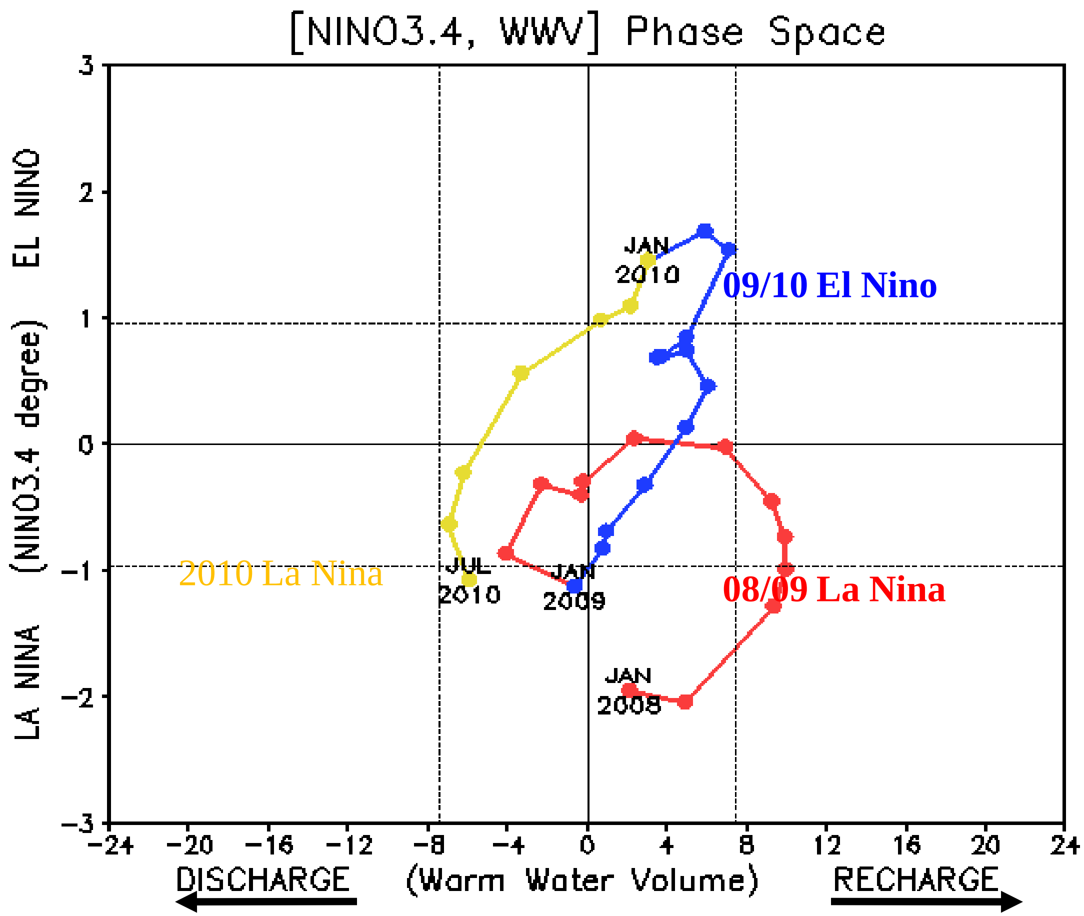
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

Warm Water Volume (WWV) and NINO3.4 Anomalies

-WWV is defined as average of depth of 20°C in [120°E-80°W, 5°S-5°N] (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.

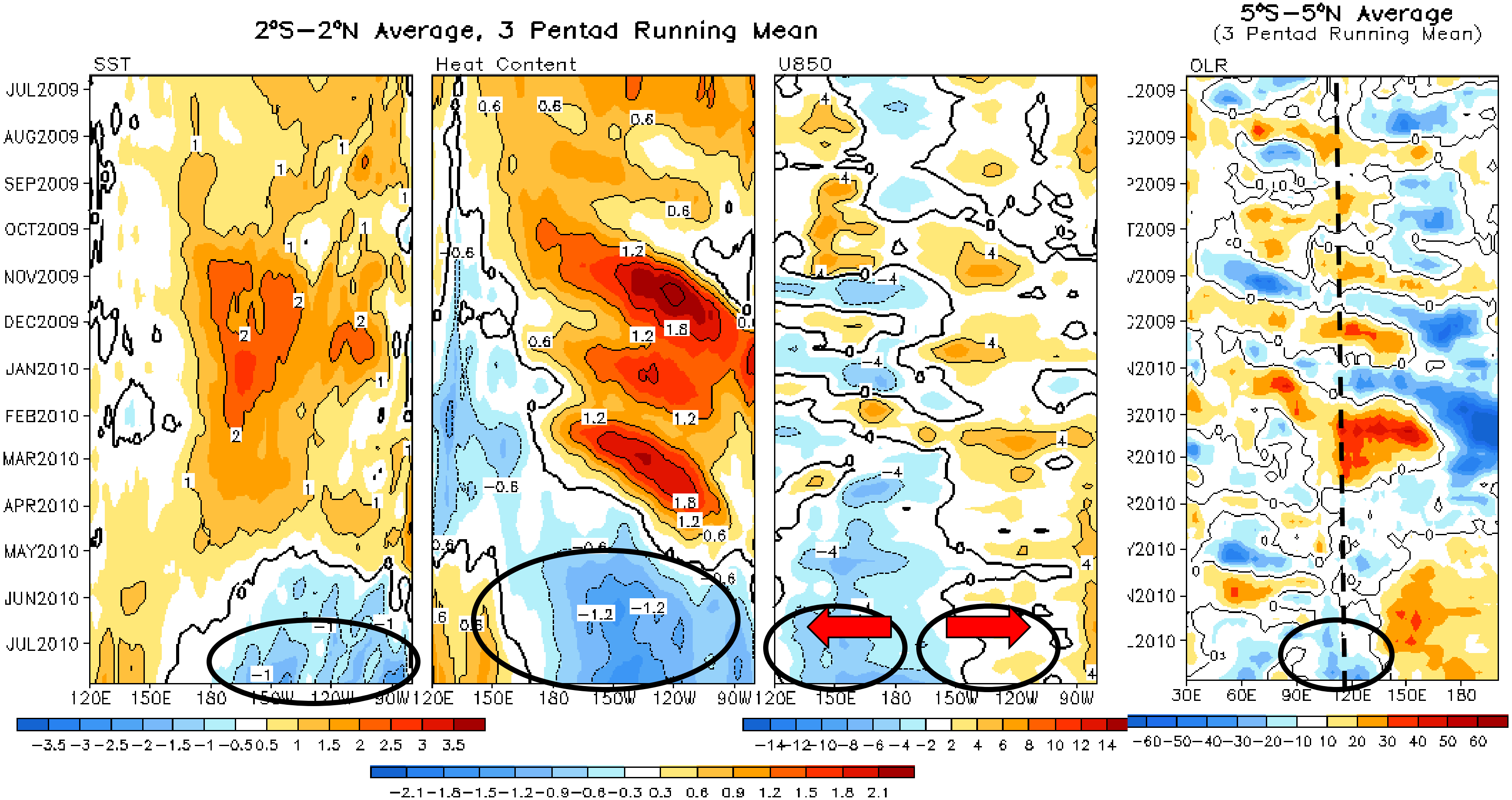


-Nino3.4 has decreased steadily in the past few months and became less than -1C in July 2010, indicating the transition of the ENSO cycle from neutral to La Nina conditions.

- WWV decreased from Dec 2009 to Jun 2010, then slightly increased in Jul 2010.

Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20°C in [120°E-80°W, 5°S-5°N] 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.

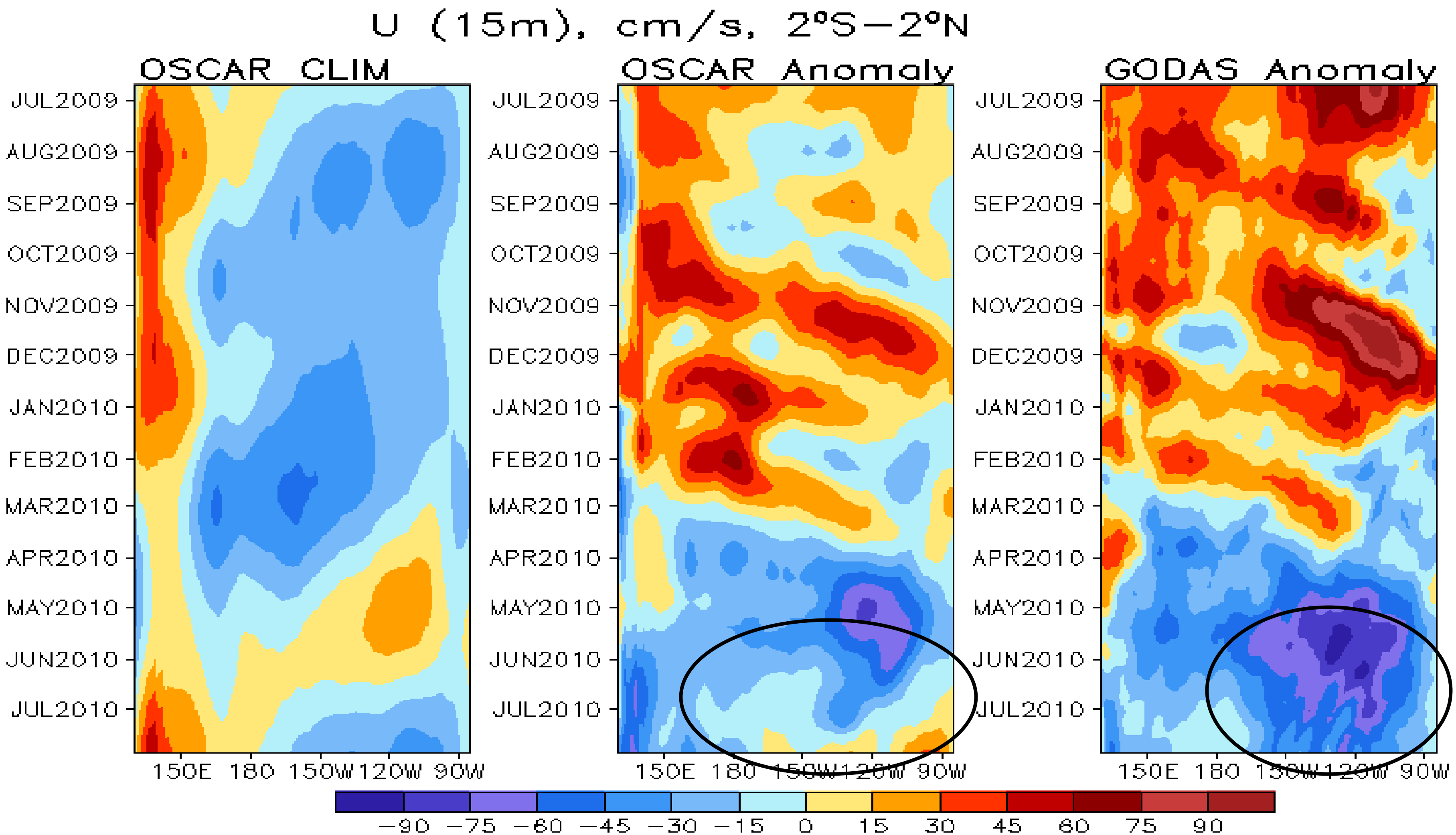
Evolution of Equatorial Pacific SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s), and OLR (W/m²) Anomaly



- **Negative SSTA and HC300 further developed, consistent with the development of La Niña conditions.**
- **Convection intensified over the Maritime Continent and suppressed in the central equatorial Pacific in Jul 2010, consistent with the low level (850 mb) zonal wind divergence and convergence anomaly.**

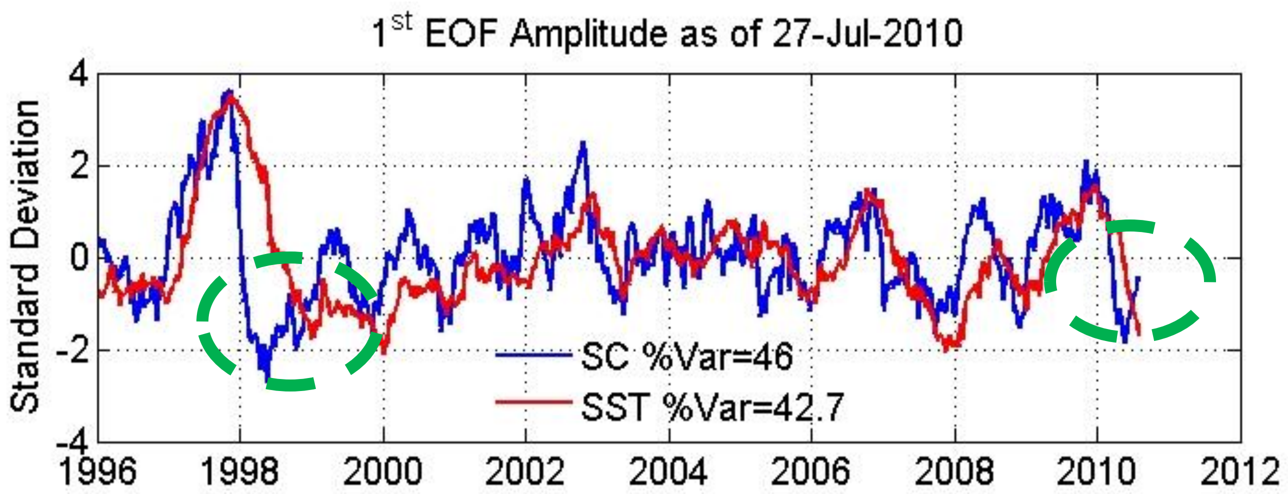
Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2°S-2°N and Outgoing Long-wave Radiation (OLR, right) averaged in 5°S-5°N. SST is derived from the NCEP OI 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.

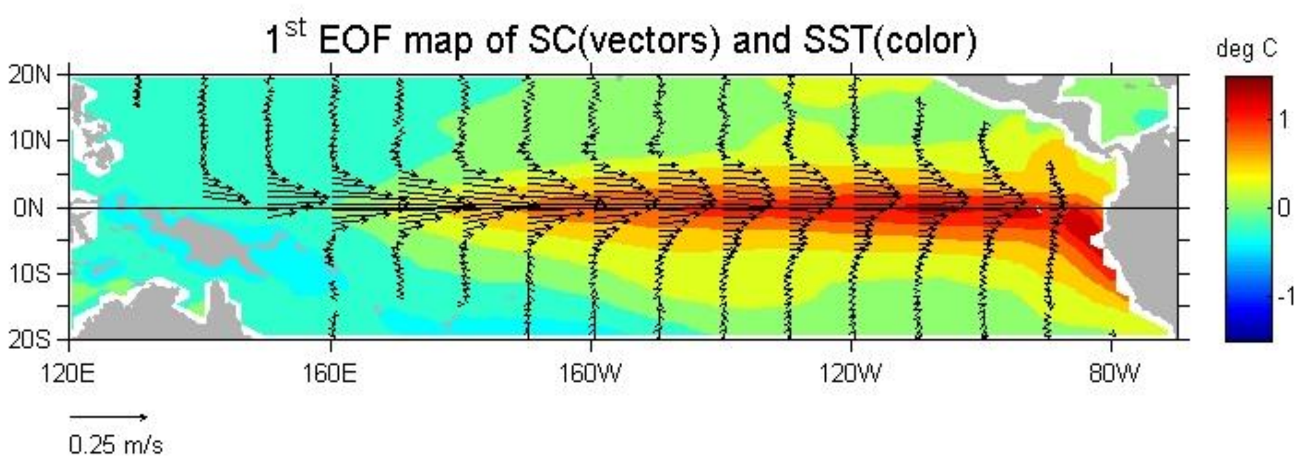
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- **Westward anomaly of surface zonal current transitioned into eastward anomaly in OSCAR since late Jul2010, implying reduction of the contribution of zonal advection to the development of La Niña conditions, consistent with the heat budget analysis in slide 10 and the EOF analysis of surface current in next slide .**
- **On average, surface zonal current anomalies simulated by GODAS were stronger than those of OSCAR in the equatorial Pacific.**

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





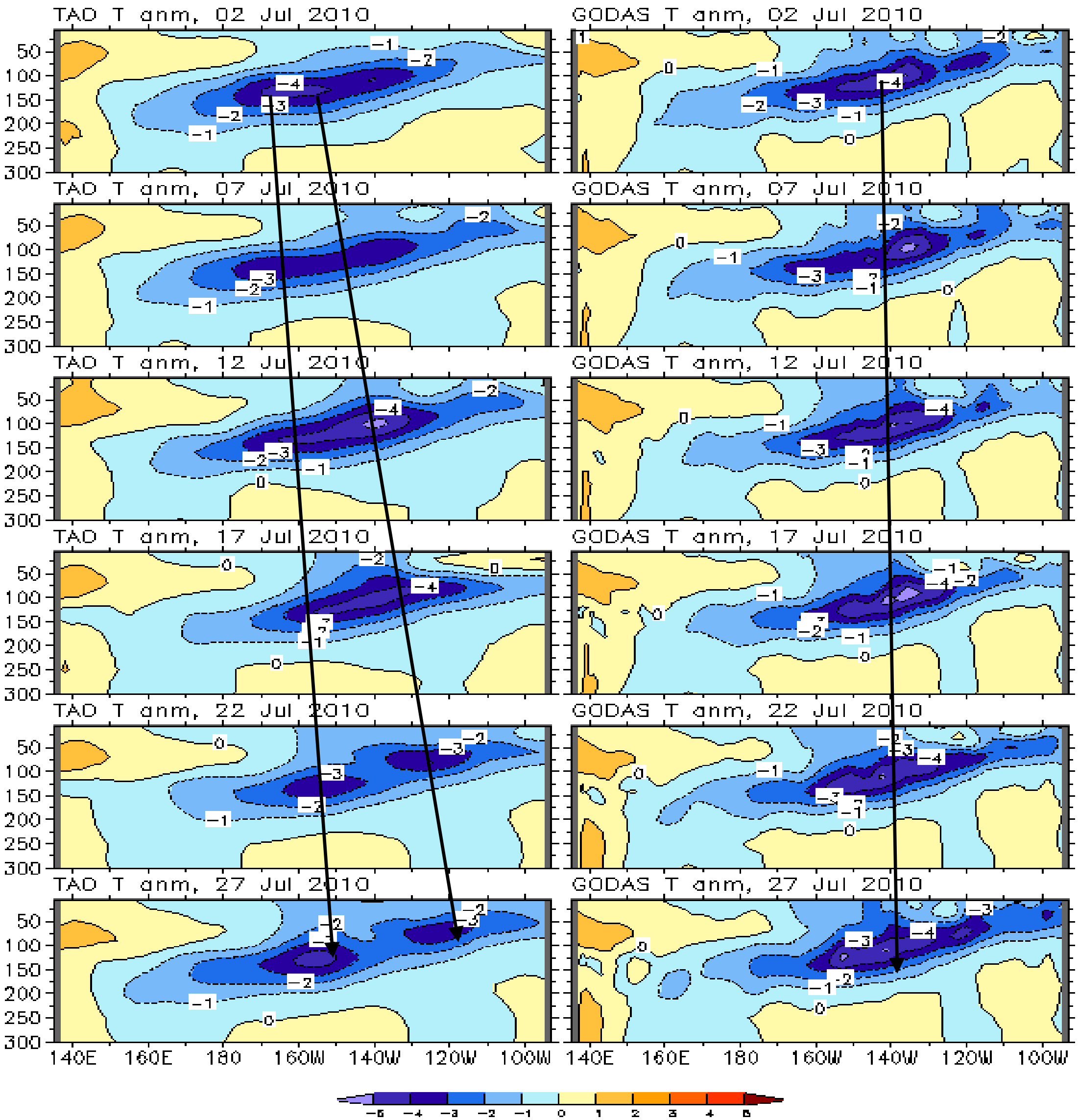
- Westward surface current anomaly weakened in Jul 2010, similar to the case in 1998 in both its amplitude and evolution.

- 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 Dr. Kathleen Dohan and see "http://www.esr.org/enso_index.html" for details)

Equatorial Pacific Temperature Anomaly

TAO GODAS

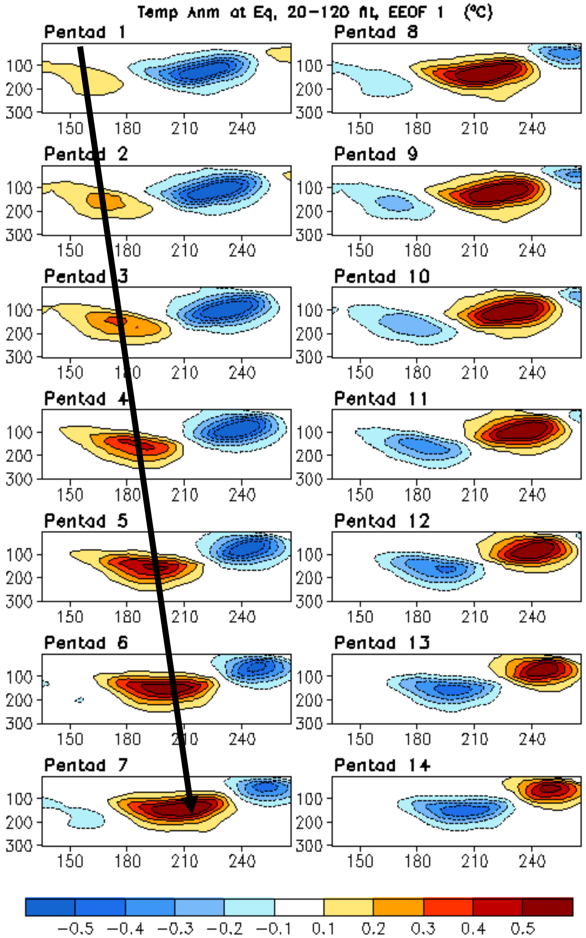


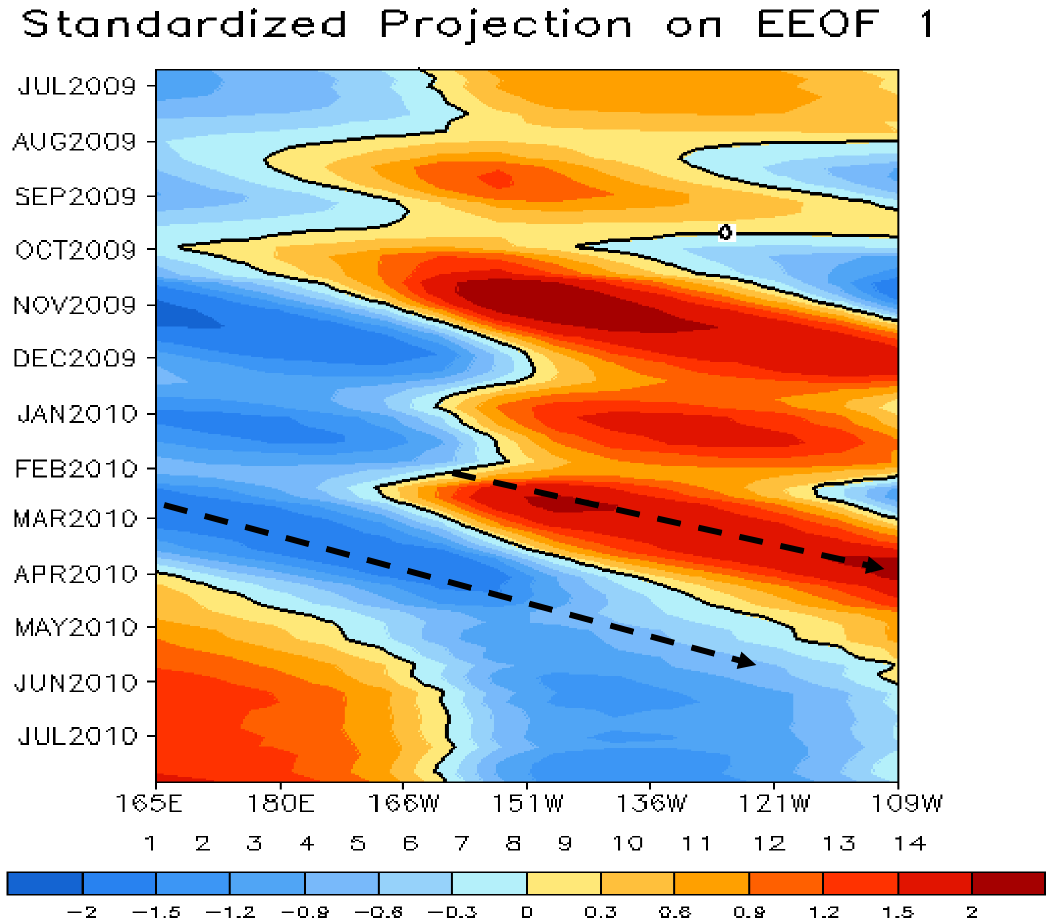
TAO climatology used

- **Negative anomaly of ocean temperature in the eastern-central equatorial Pacific persisted in Jul 2010, consisting with the development of La Niña conditions.**

- **Negative temperature anomaly in the central and eastern equatorial Pacific had almost no propagation since Jun 2010, particularly in GODAS.**

Oceanic Kelvin Wave Indices

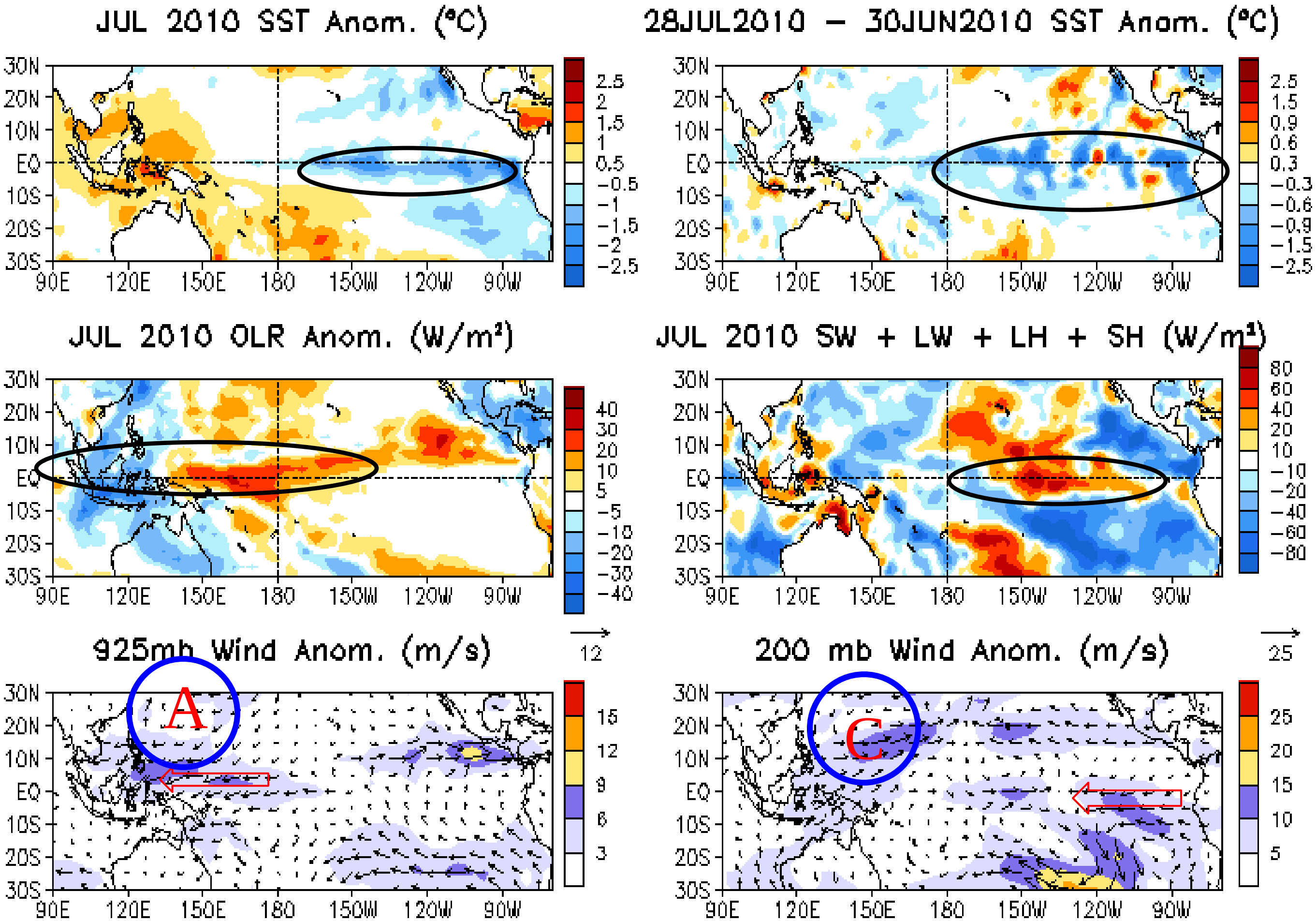




-Upwelling Kelvin wave occurred in late Feb 2010 in the W. Pacific and propagated eastward, which may have contribution to the transition of ENSO cycle from the warm phase to the neutral phase.
- There are no Kelvin wave propagations in the past two months, consistent with the development of low frequency variability associated with La Nina conditions.

- **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.**

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

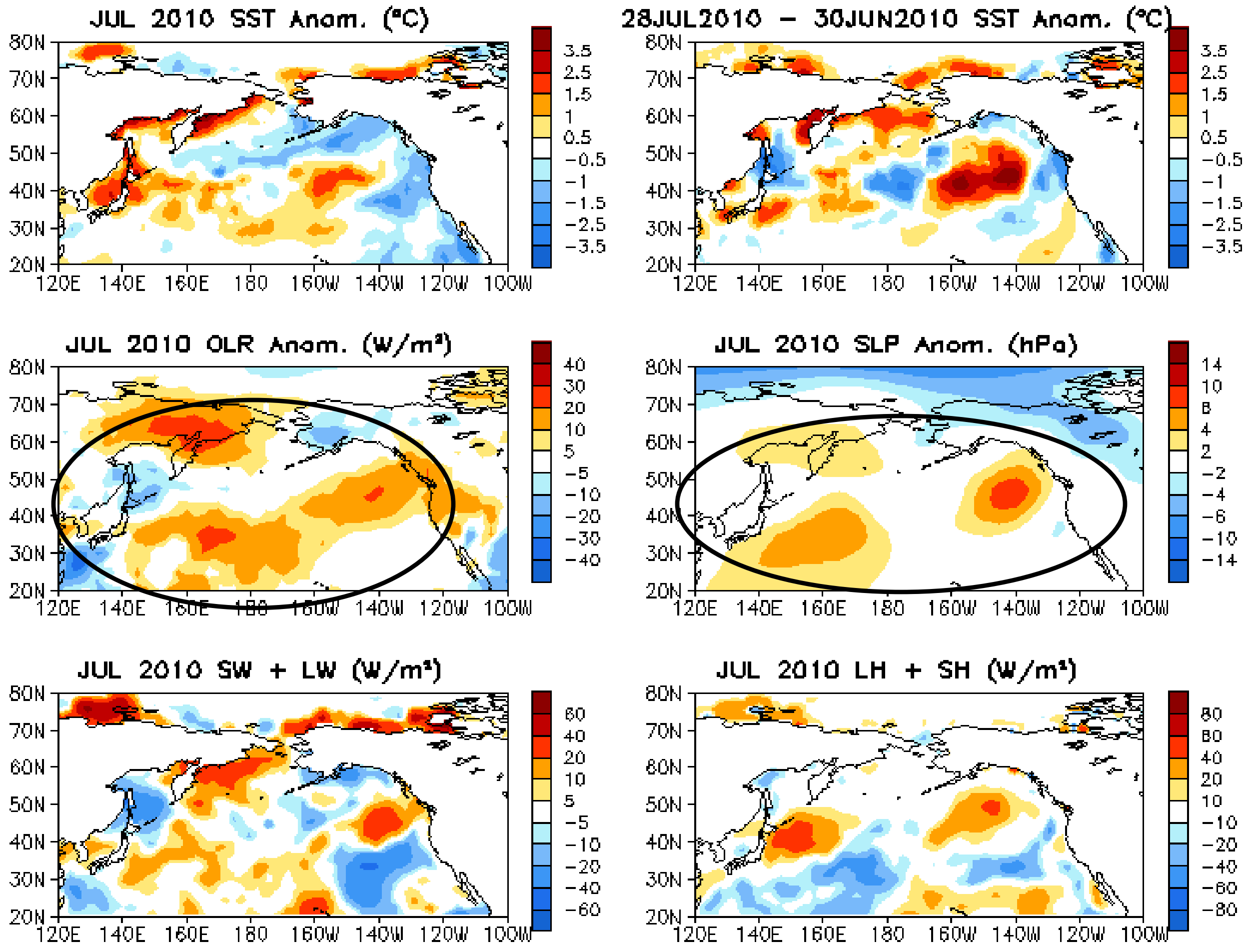


- Negative SSTA further developed in the eastern-central equatorial Pacific in Jul 2020.
- Convection was enhanced (suppressed) over the Maritime Continent (equatorial central Pacific).
- Negative SSTA tendency dominated along the equatorial Pacific, and net surface heat flux damping existed around 150W-110W, suggesting the importance of the ocean dynamics in the ENSO phase transition.
- Easterly wind anomaly presented in the W. tropical Pacific in low level and in the E. Tropical Pacific in high level.
- Anomaly anticyclone (cyclone) presented east of the Philippines at 925mb (200mb), which may be connected with the warming in the Indian Ocean (Xie et al. 2009).

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.

North Pacific & Arctic Ocean

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



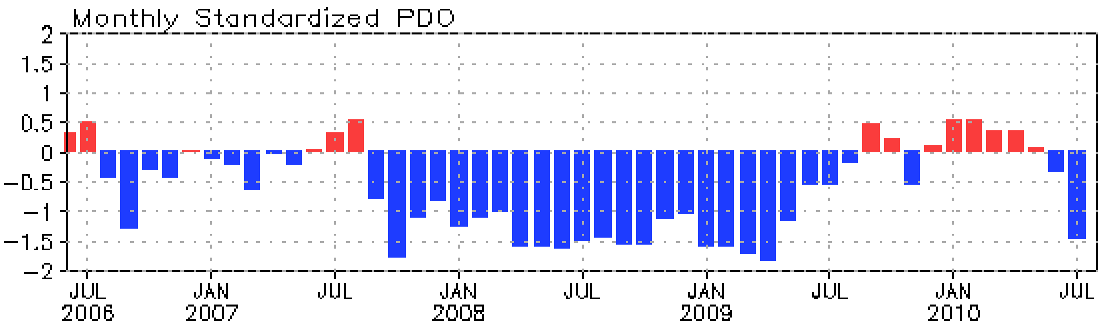
- Strong negative (positive) SSTA presented in Gulf of Alaska and near the coast of N. America (in the central N. Pacific) in Jul 2010, consistent with the negative PDO index in Jul 2010 (next slide).

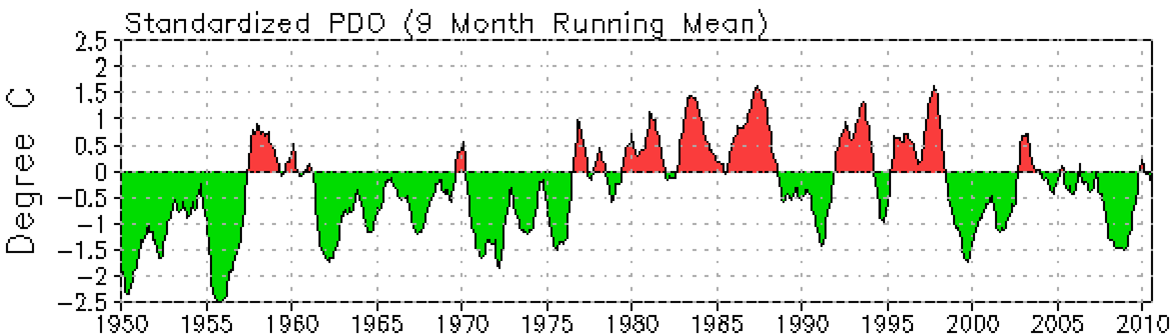
- Negative (positive) SLP anomaly presented in the Arctic and Alaska (North Pacific). A strong blocking presented near the coast of N. America, favourable for coastal upwelling. The above-normal SLP in the NW Pacific is associated with the anomaly anticyclone east of the Philippines.

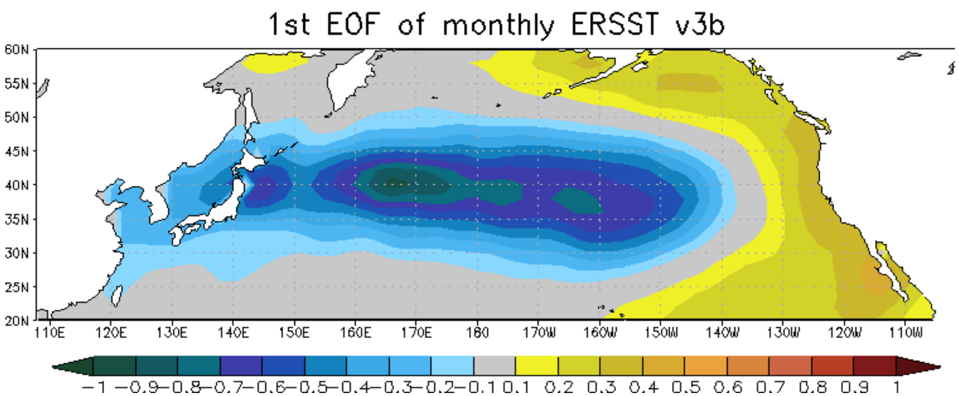
- OLR and SLP anomaly share a similar pattern: positive SLP anomaly is collocated with positive (negative) OLR anomaly.

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







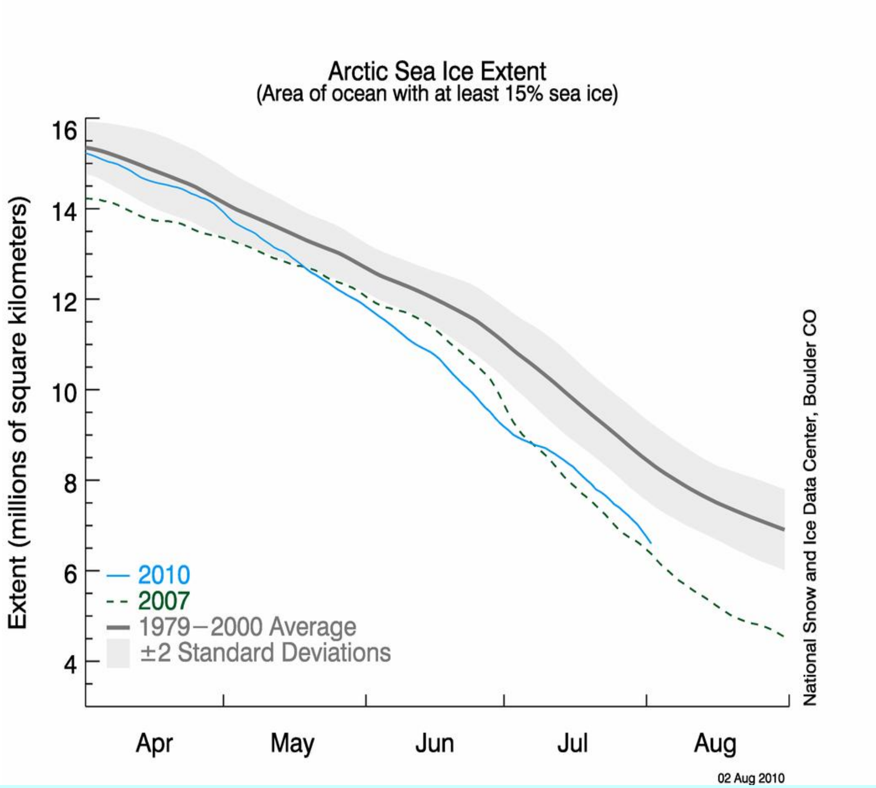
- **The PDO index was -1.5 in Jul 2010.**
- **The PDO index has been near-normal from Aug 2009 to Jun 2010.**

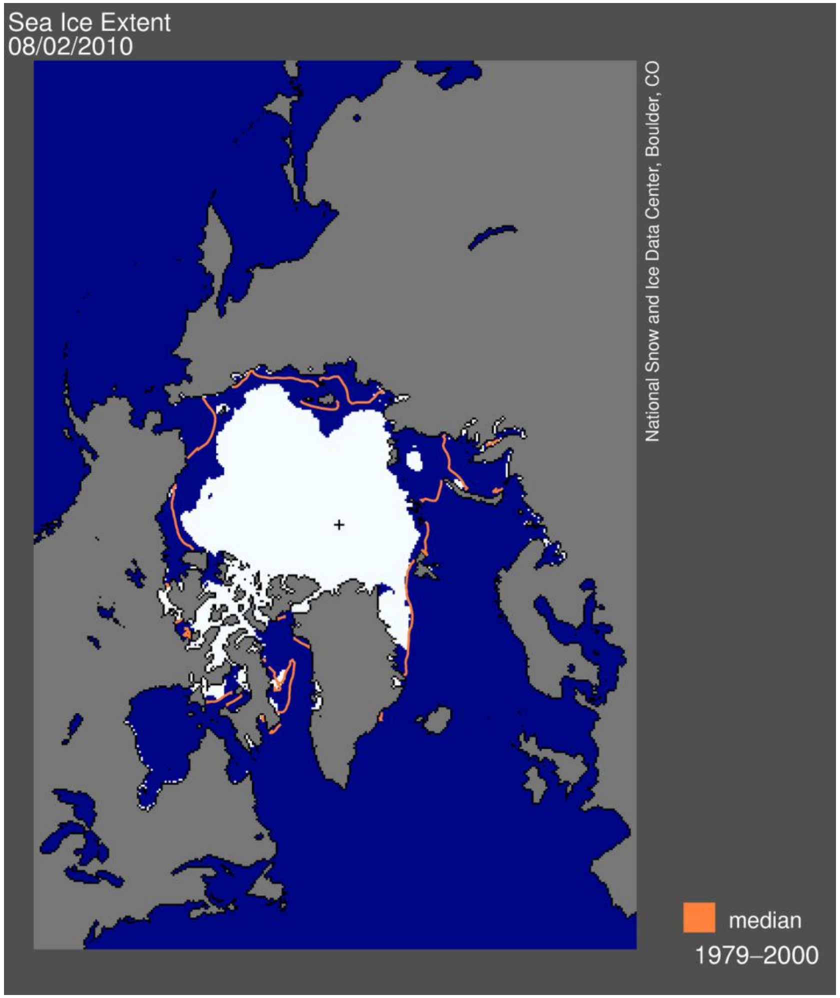
- **Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.**
- **The PDO index differs slightly from that of JISAO, which uses a blend of UKMET and OIv1 and OIv2 SST.**

Arctic Sea Ice

National Snow and Ice Data Center

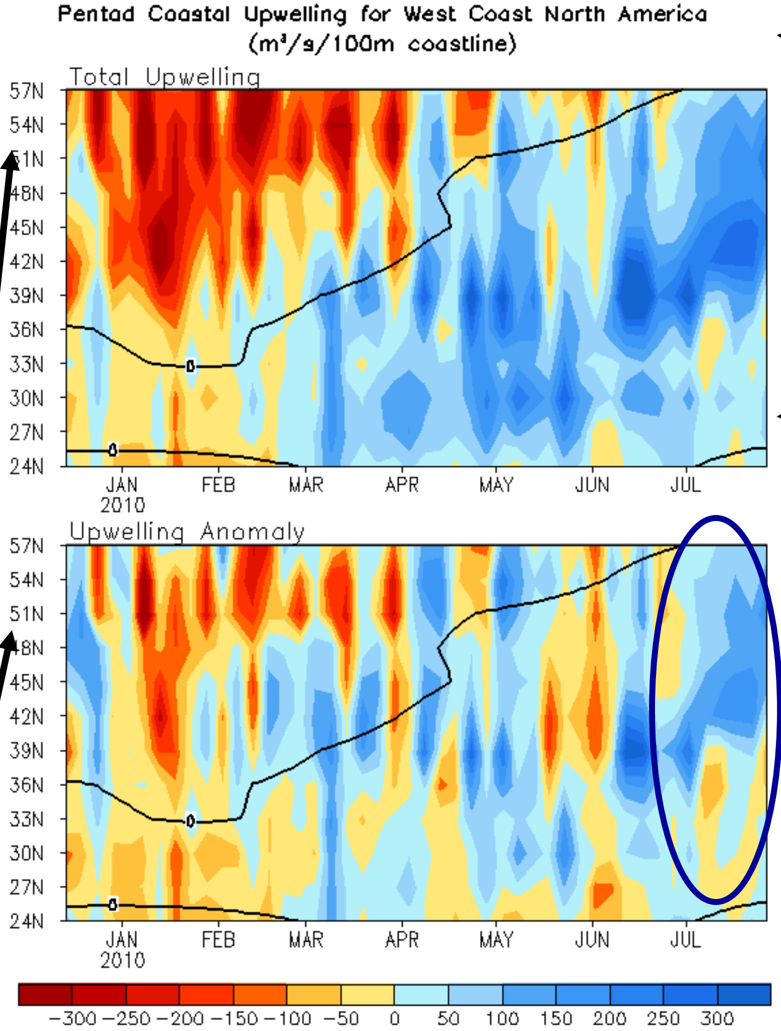
http://nsidc.org/arcticseaicenews/index.html

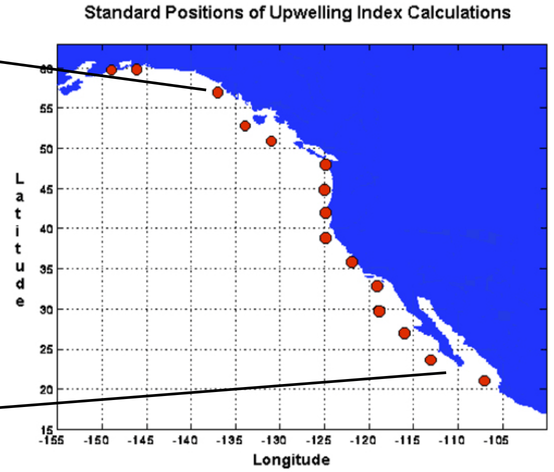




- **The Arctic sea ice extent since middle of Jun 2010 was slightly larger than that in 2007.**
- **Sea ice extent in Jul 2010 close to Jul 2007, far below normal.**
- **The decrease of the sea ice extent occurred in almost all its southern boundary.**

North America Western Coastal Upwelling



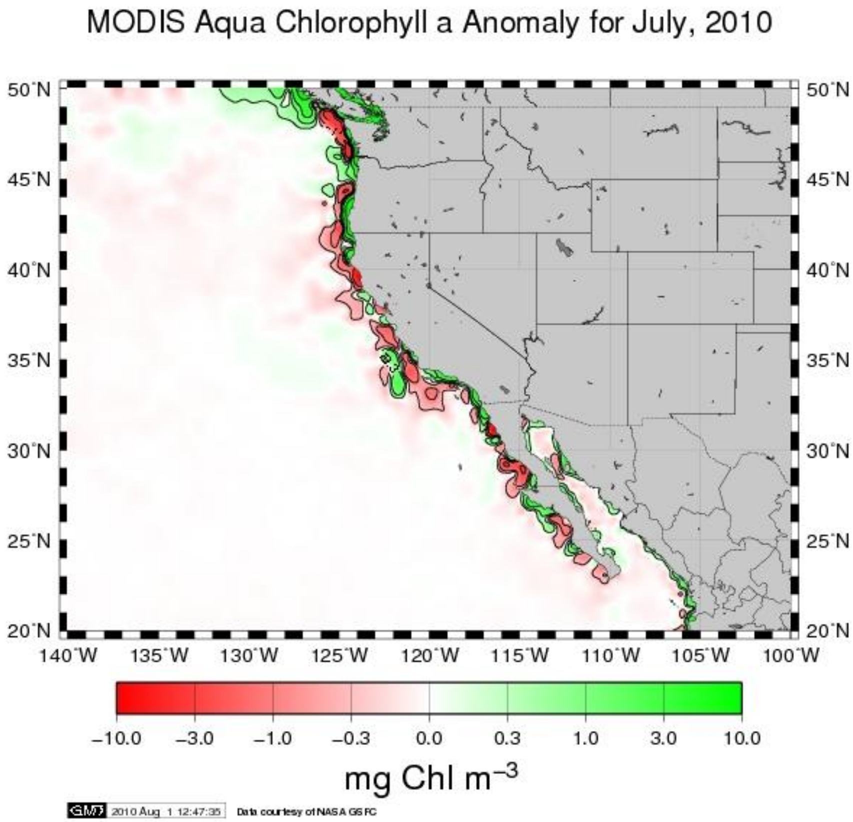


- Upwelling intensified in high-latitude and slightly weakened in low latitudes in Jul 2010.

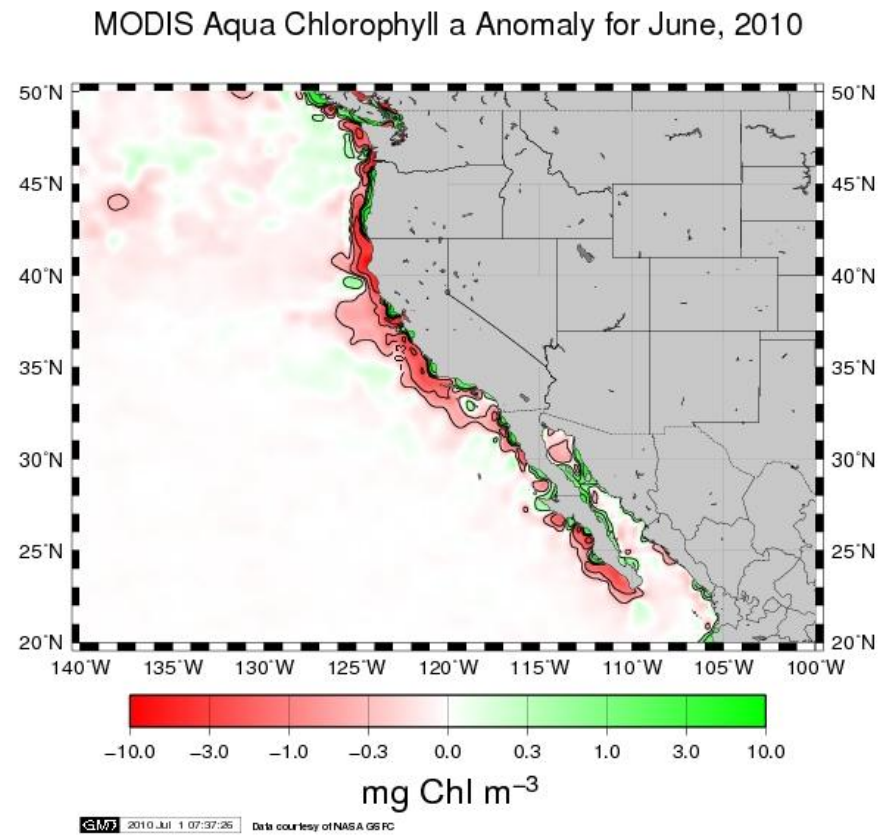
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport 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 36ºN to 57ºN.

Monthly Chlorophyll Anomaly

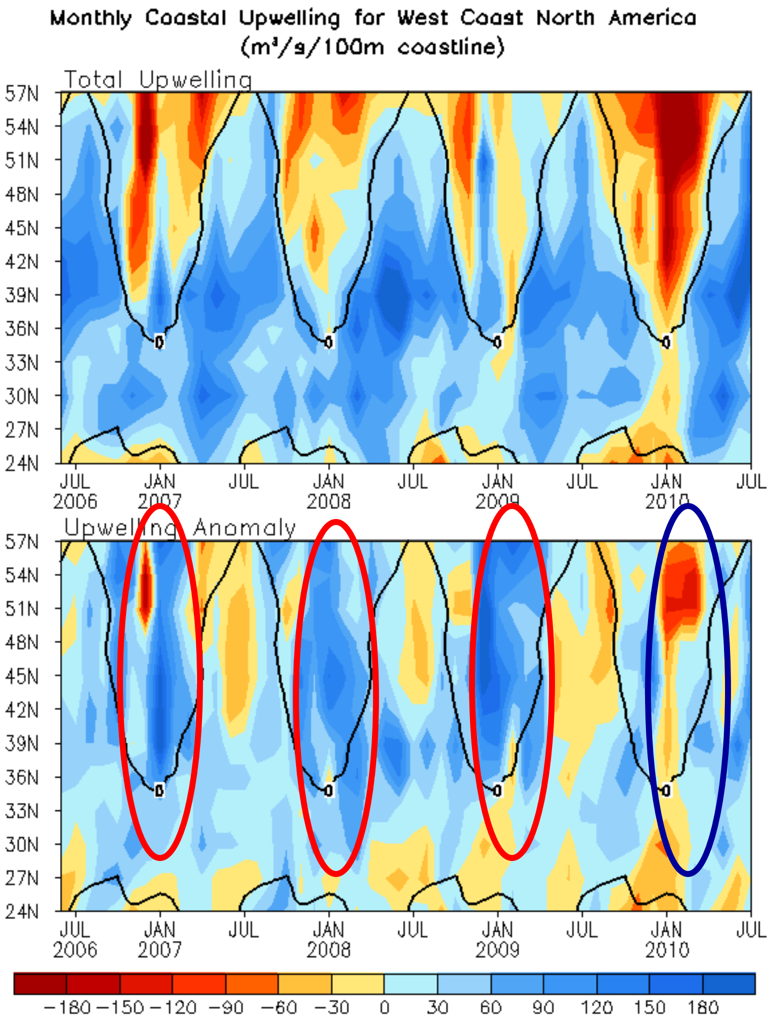


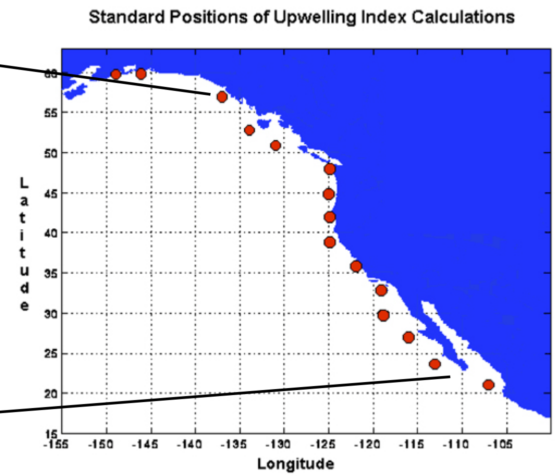
- **Weakly negative chlorophyll anomaly presented along the coast.**
- **The tendency of reduction of the negative chlorophyll anomaly is consistent with the intensified upwelling in high latitudes in Jul 2010.**



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

North America Western Coastal Upwelling





- Upwelling had been above-normal during the winter of 2006/07, 2007/08, 2008/09.

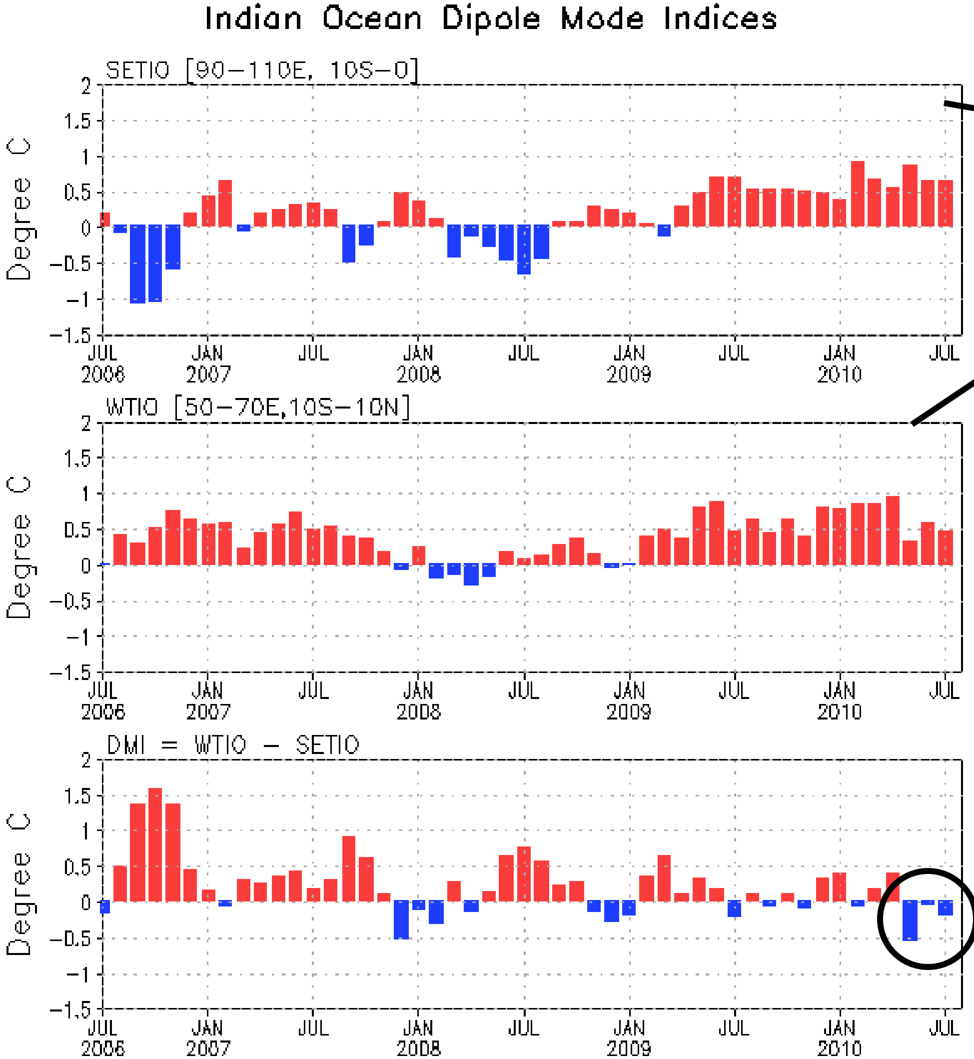
- But, upwelling was below-normal during the winter of 2009/10.

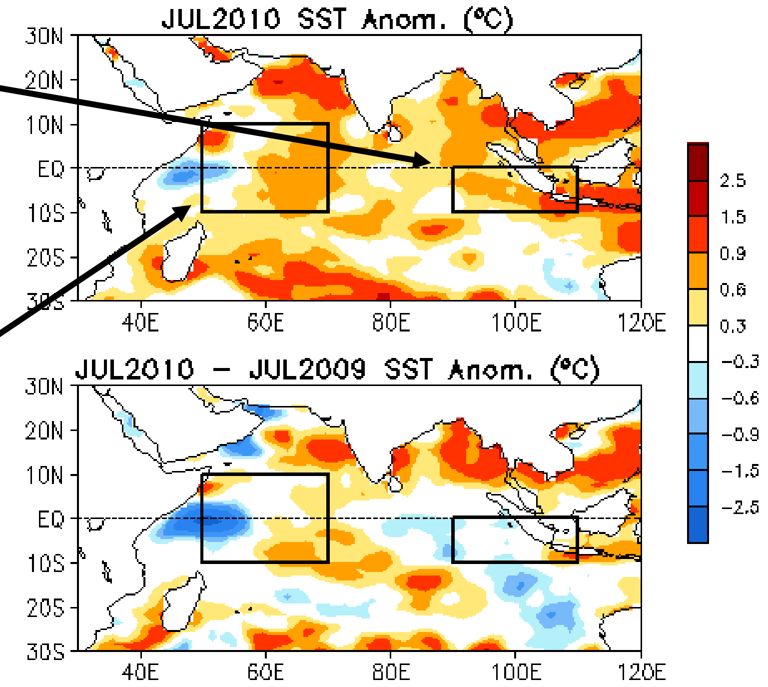
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport 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 36ºN to 57ºN.**

Tropical Indian Ocean

Evolution of Indian Ocean SST Indices



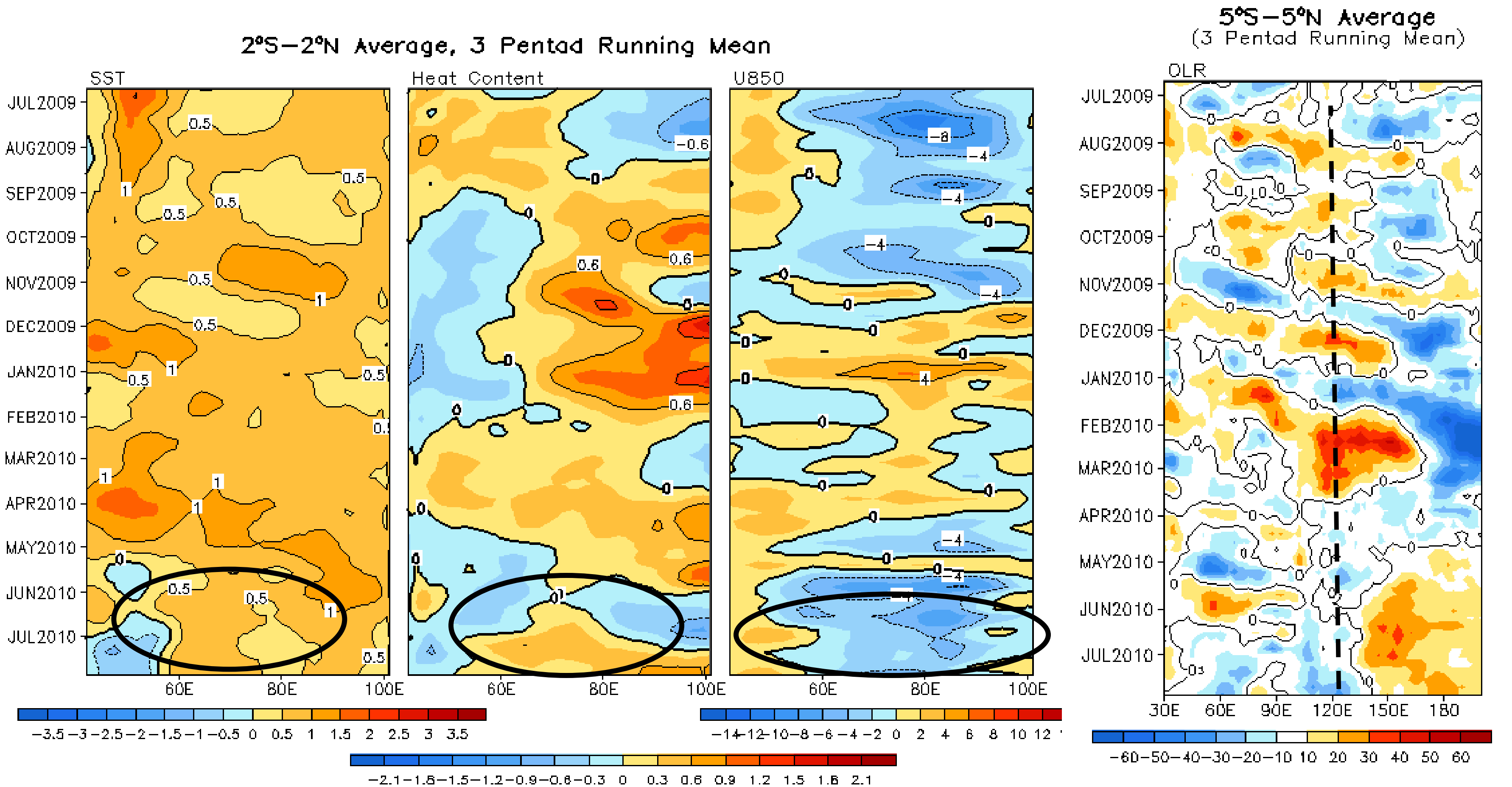


- Both eastern (SETIO) and western (WTIO) pole SSTs have been persistently above-normal since Apr 2009.

- DMI was below normal since May 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.

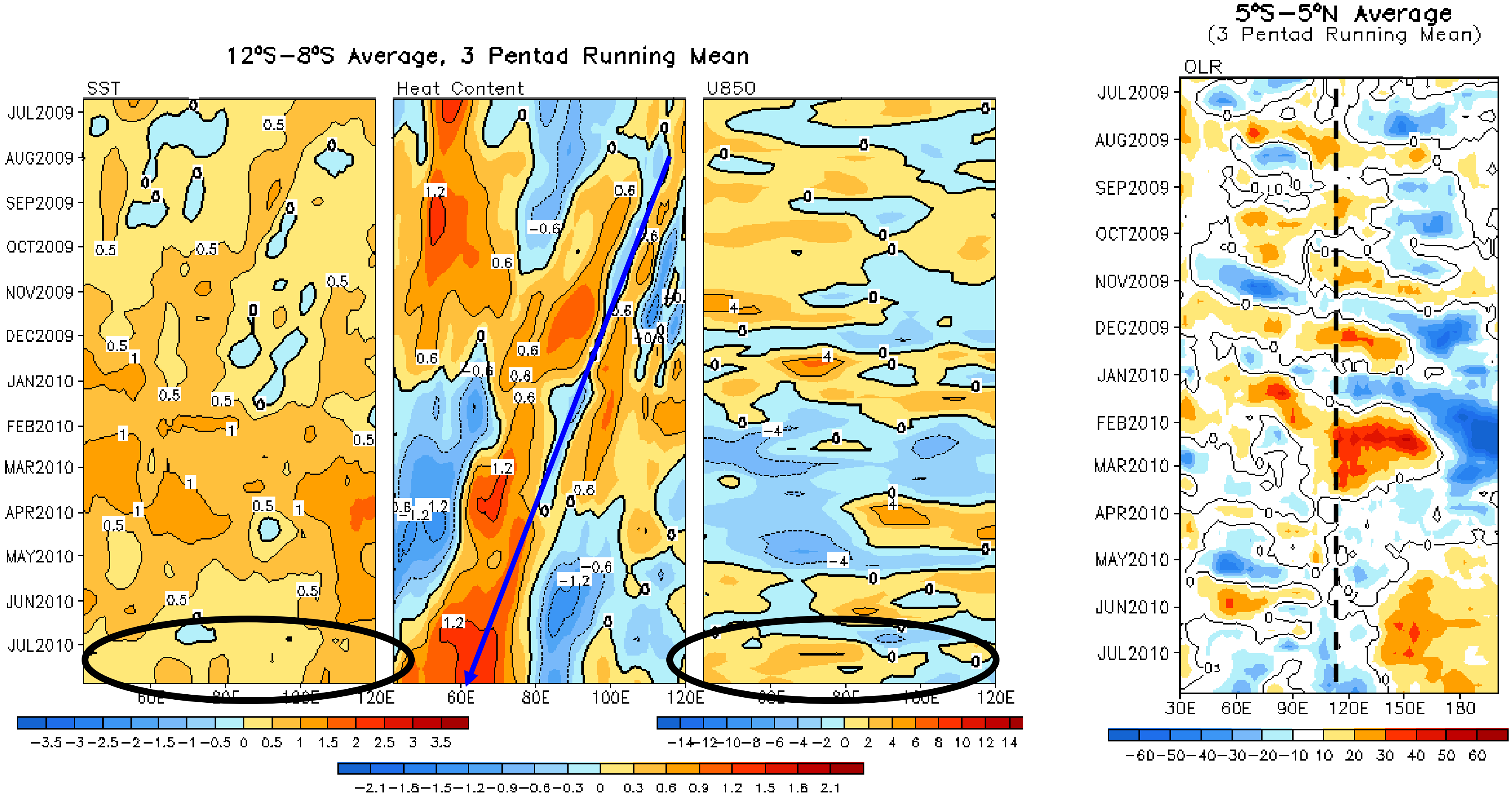
Recent Evolution of Equatorial Indian SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s) and OLR (W/m²) Anomalies



- **Weakly negative (positive) SSTA presented in the western (central-eastern) Indian Ocean in Jul 2010.**
- **Heat content anomaly transitioned from negative in Jun 2010 to positive in Jul 2010.**
- **Easterly wind anomalies dominated since May 2010.**

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)



- **Weakly positive SSTA presented in Jul 2010. SST increased between 60-90E, consistent with the arrival of positive HCA at the thermocline ridge near 8S and 60E where positive subsurface temperature anomalies can be easily brought up to near surface through mean upwelling.**
- **Positive HCA propagated westward since Jun 2009 and low-level wind anomaly was westerly in Jul 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.

- The tropical Indian Ocean Basin warming persisted in Jul 2010. The tropical Indian Ocean warming usually peaks in spring due to impacts of El Nino and declines afterward when El Nino dissipates.

- The tropical Indian Ocean warming may contribute to the persistence of the anomalous anticyclone east of the Philippines, which is linked to a north-south teleconnection (Pacific Japan: PJ) pattern in the NW Pacific and east Asia.

- The SST along the coast of Somali and in the Arabian Sea (in the central-south Indian Ocean) cooled down (warmed up), consistent with net surface heat flux anomalies.

- Anomalous convection observed over the northern part of the Indian Ocean and Maritime Continent.

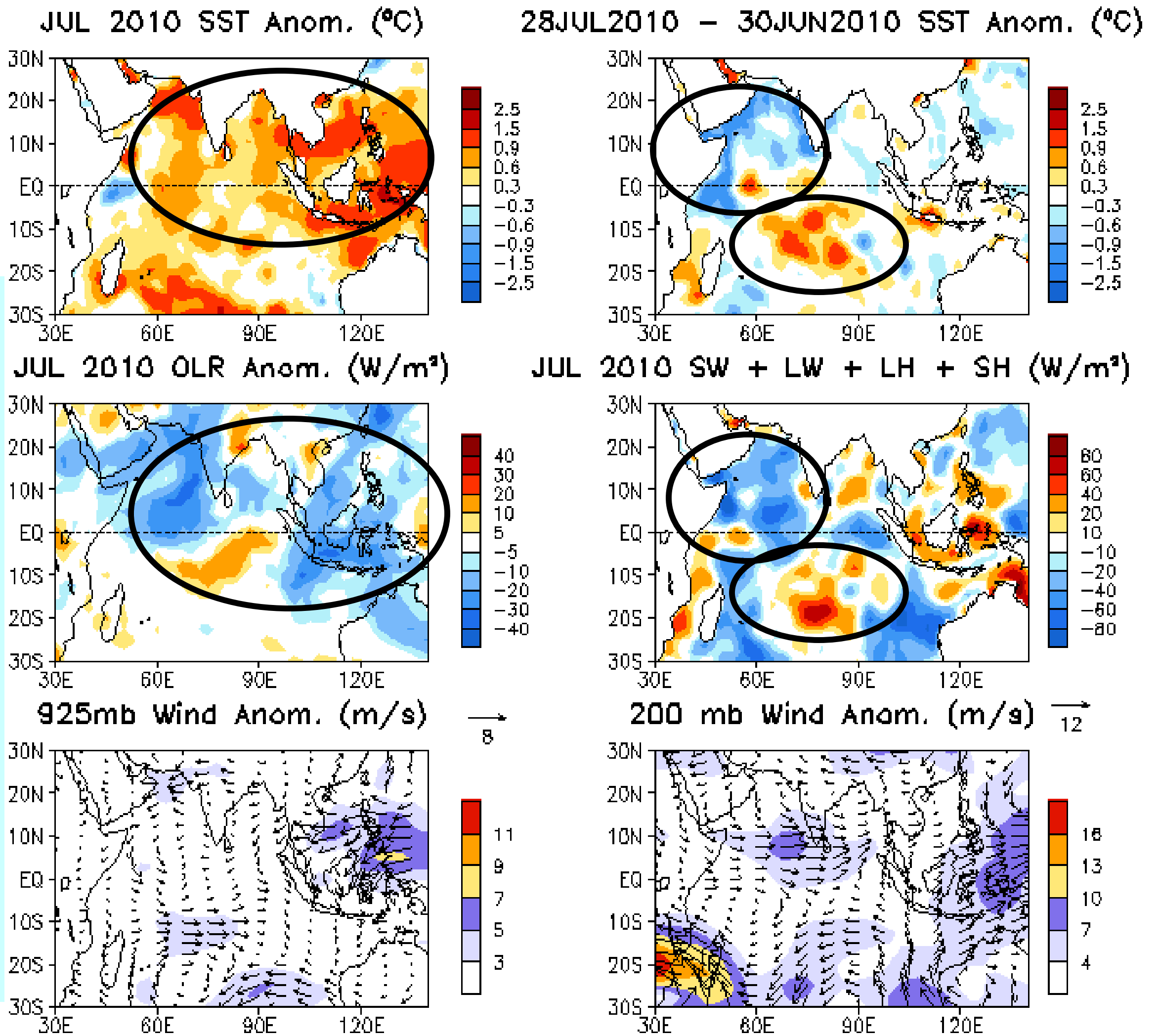
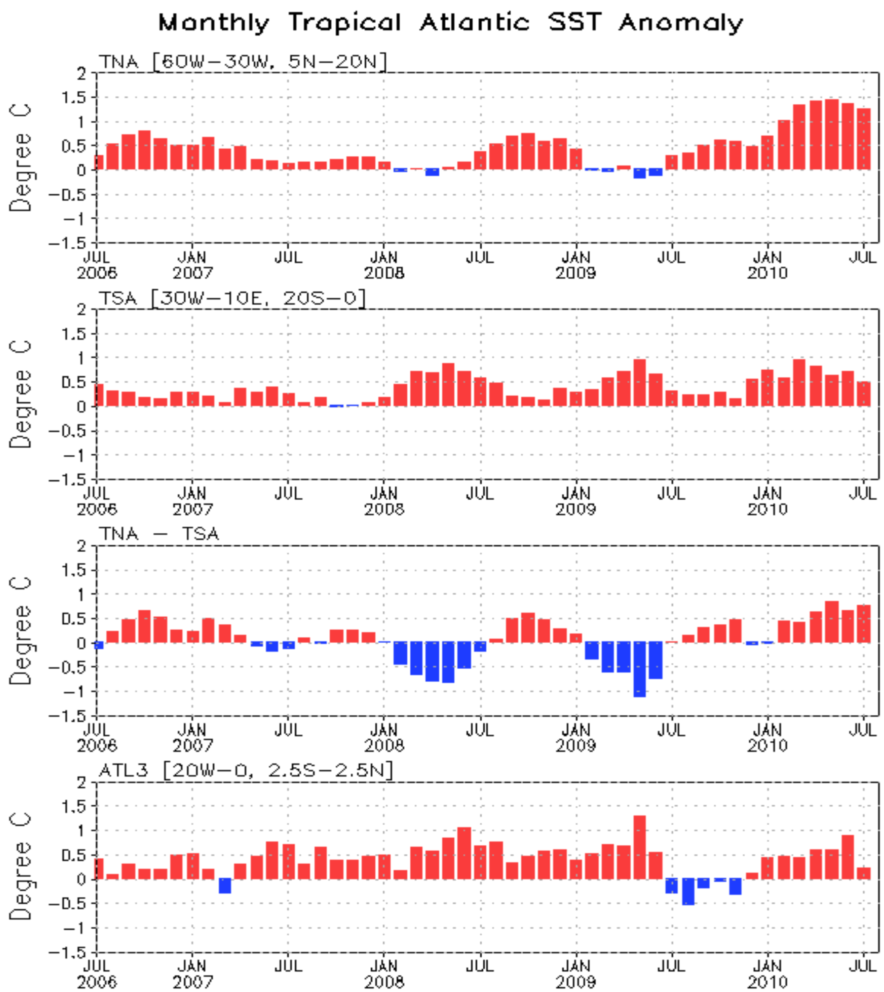
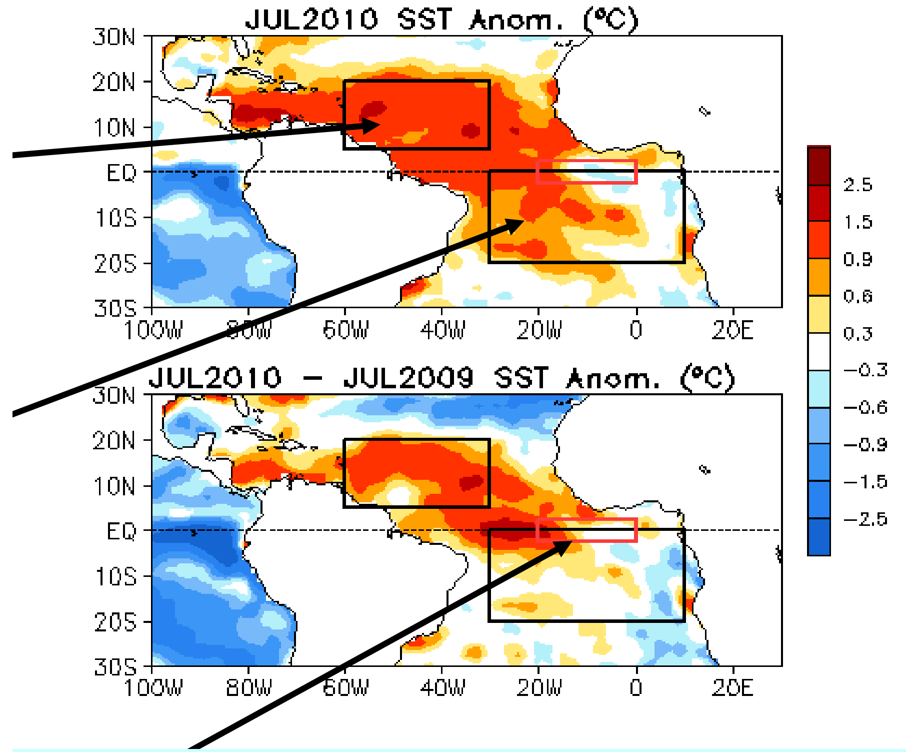


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (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

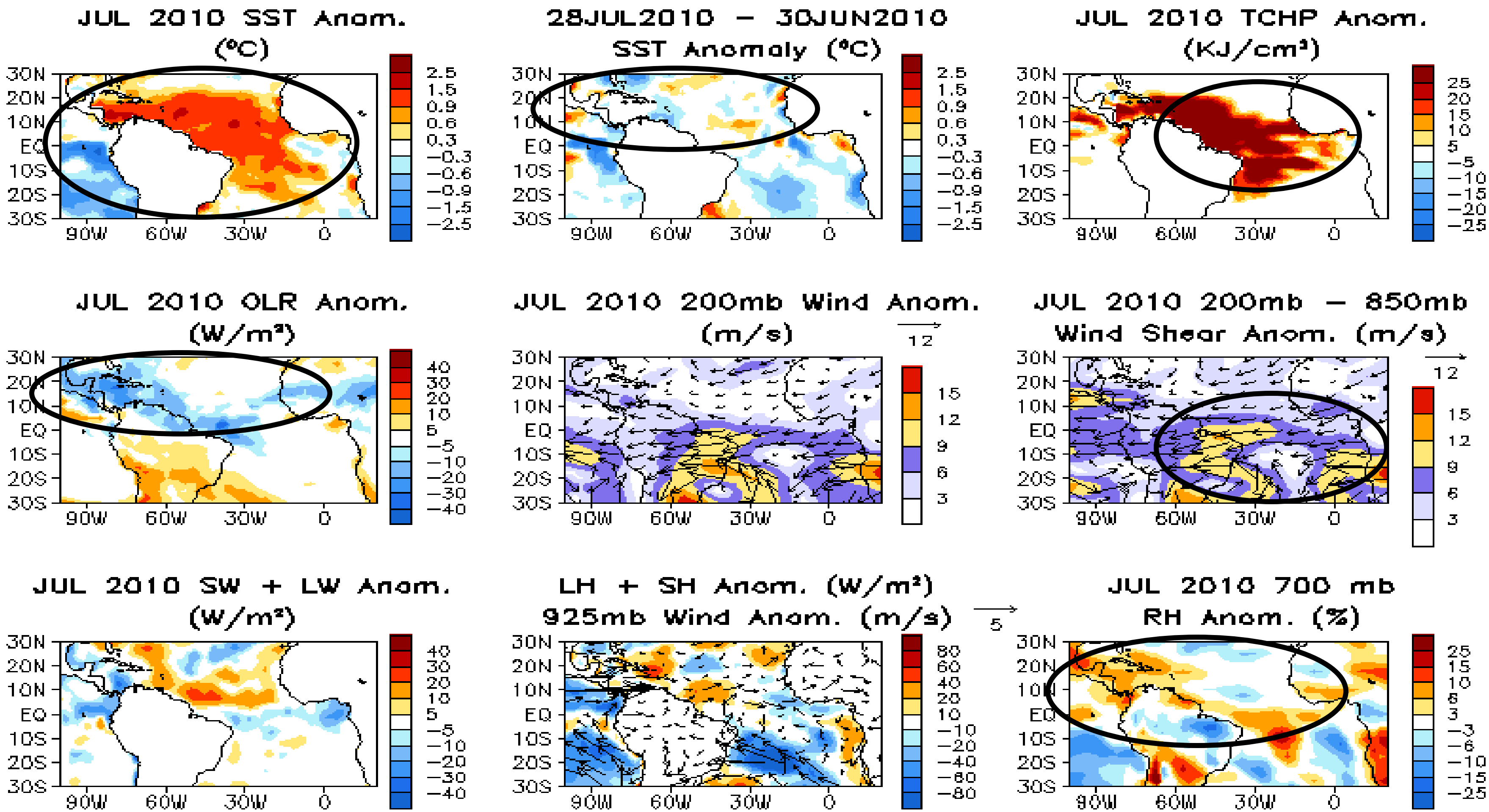




- **Positive SSTA in the tropical North and South Atlantic (TNA and SNA) slightly weakened in Jul 2010.**
- **Meridional Gradient Mode (TNA-TSA) has been above-normal since Feb 2010.**
- **ATL3 SST has been positive since Dec 2009 and weakened in Jul 2010.**

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 in the tropical N. Atlantic persisted in Jul 2010.
- Anomalous convection presented over the tropical North Atlantic and equatorial western Atlantic Ocean.
- Relative humidity was above normal in Jul 2010, particularly in the western part of the tropical ocean.
- Easterly wind shear anomaly and above-normal TCHP in the Atlantic hurricane MDR are favourable for hurricane development.

North Atlantic Ocean

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

- **Negative NAO continued in Jul 2010 (next slide), consistent with SLP anomalies.**
- **Corresponding to the negative NAO was the tripole pattern of SSTA, OLR anomalies, and LH+SH anomalies.**
- **SSTA tendency was consistent with surface heat flux anomalies.**

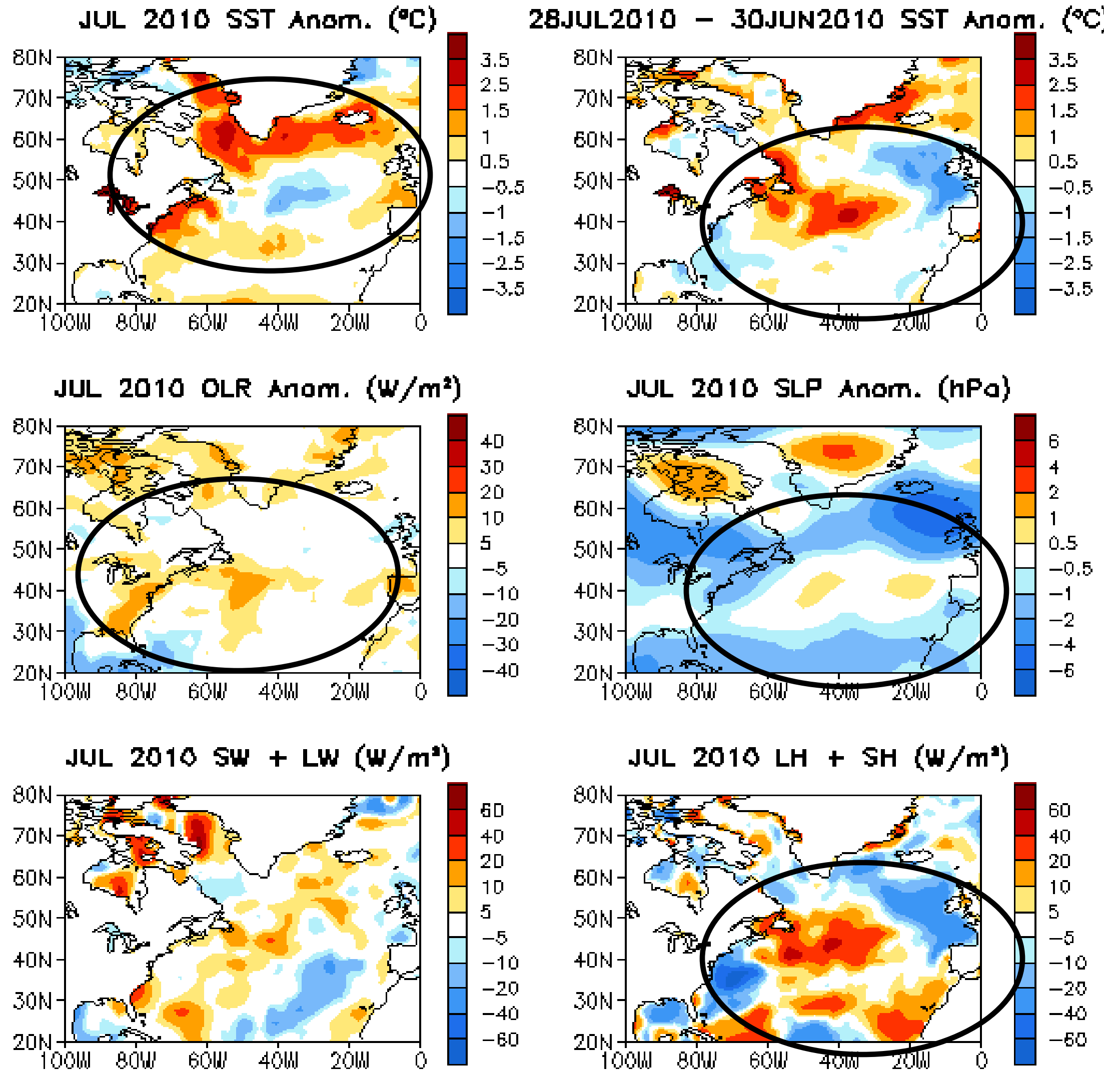
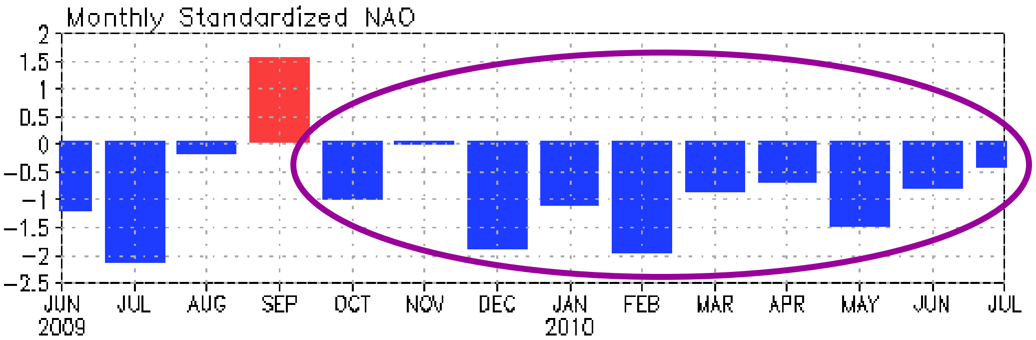
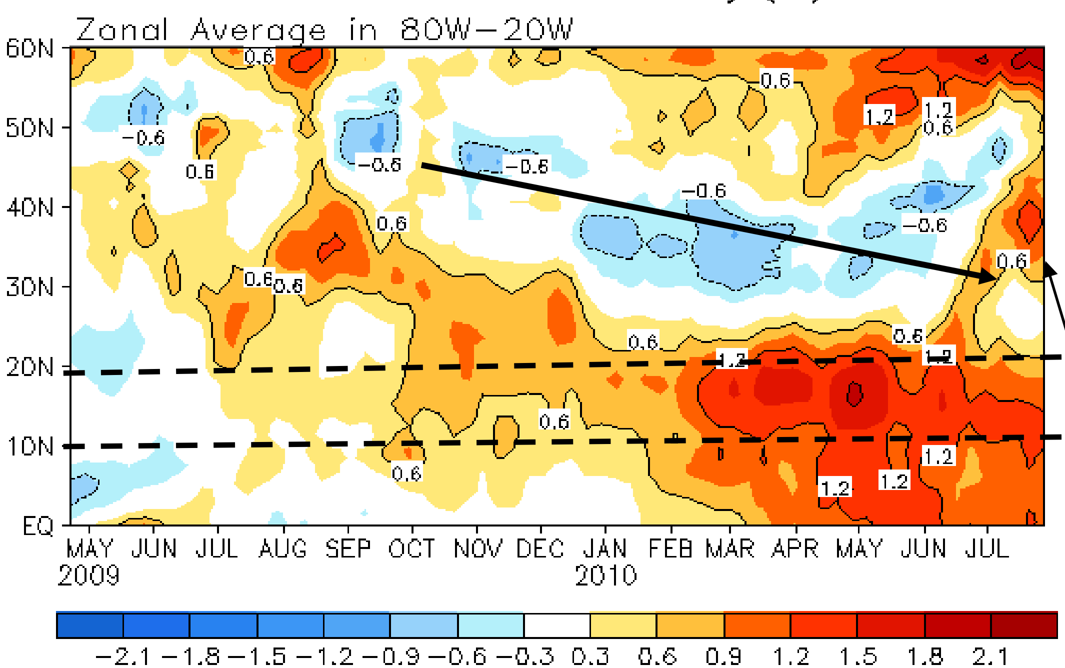
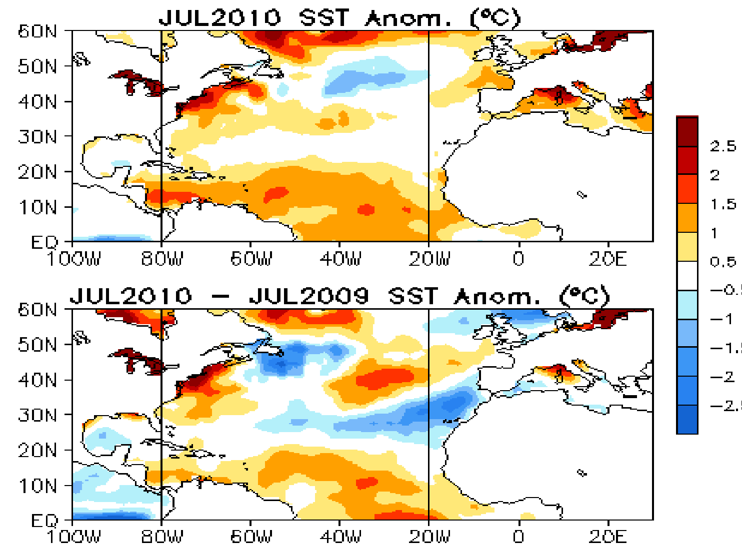


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible 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







- **NAOI=-0.42.**

-NAO has been persistently below-normal since Oct 2009, which contributed to the development and maintenance of negative (positive) SSTA in mid-latitude (tropical) North Atlantic.

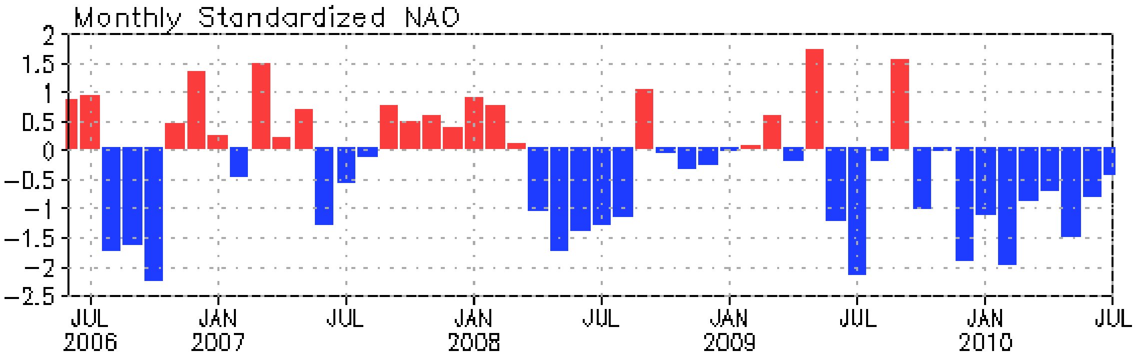
- **Mid-latitude North Atlantic SSTA are closely related to NAO index: negative (positive) NAO leads to SST cooling (warming).**

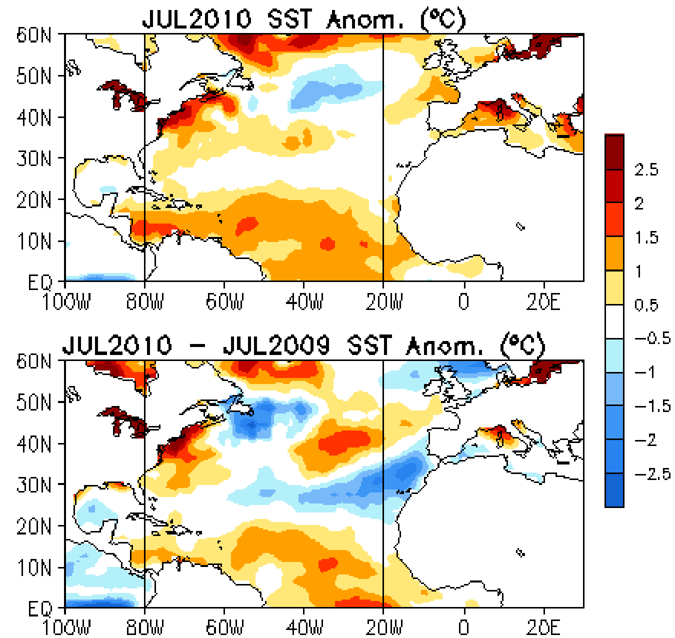
- **Positive SSTA in the Atlantic hurricane MDR have been above-normal since Oct 2009 and slightly weakened since Jun 2010, consistent with the delayed impacts of El Nino.**

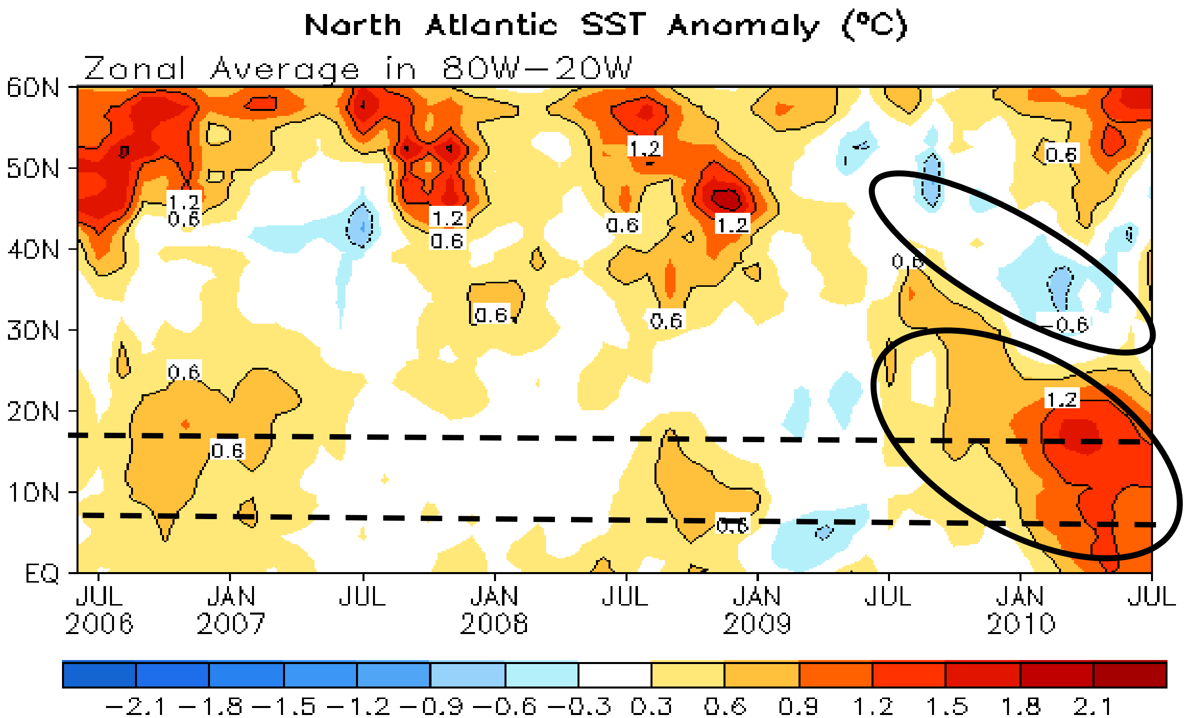
- **The combination of persistent negative NAO phase and decay phase of El Nino in this year results in the strong positive SSTA in MDR since early spring 2010, which is similar to 2005.**

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.

NAO and SST Anomaly in North Atlantic





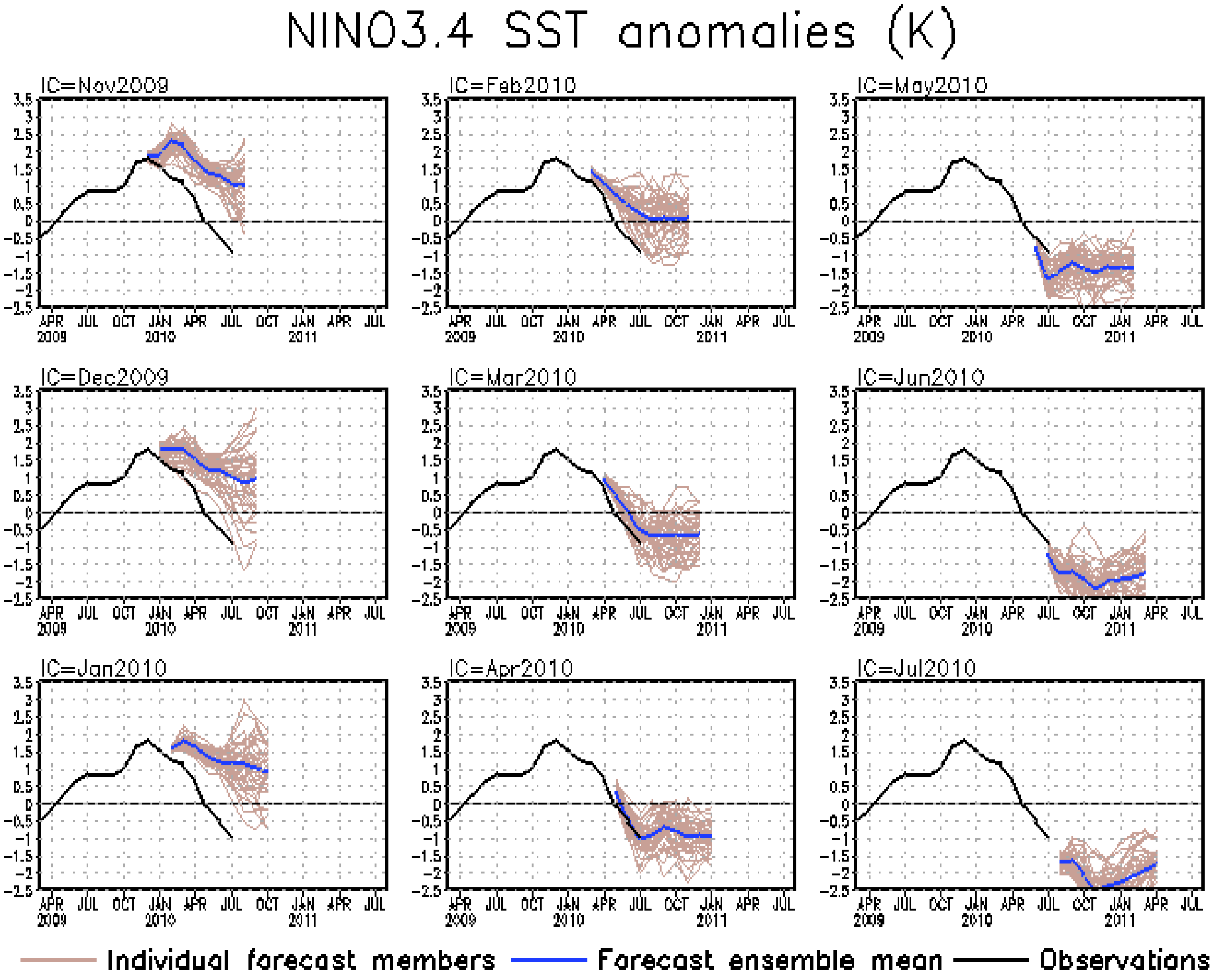


- **Mid-latitude North Atlantic SST has been below-normal since May 2009 .**
- **SST in the Atlantic hurricane MDR has been above-normal since Jul 2009, intensified significantly during Feb-May 2010, and slightly weakened since Jun 2010.**

Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20ºN-90ºN (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80ºW and 20ºW (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

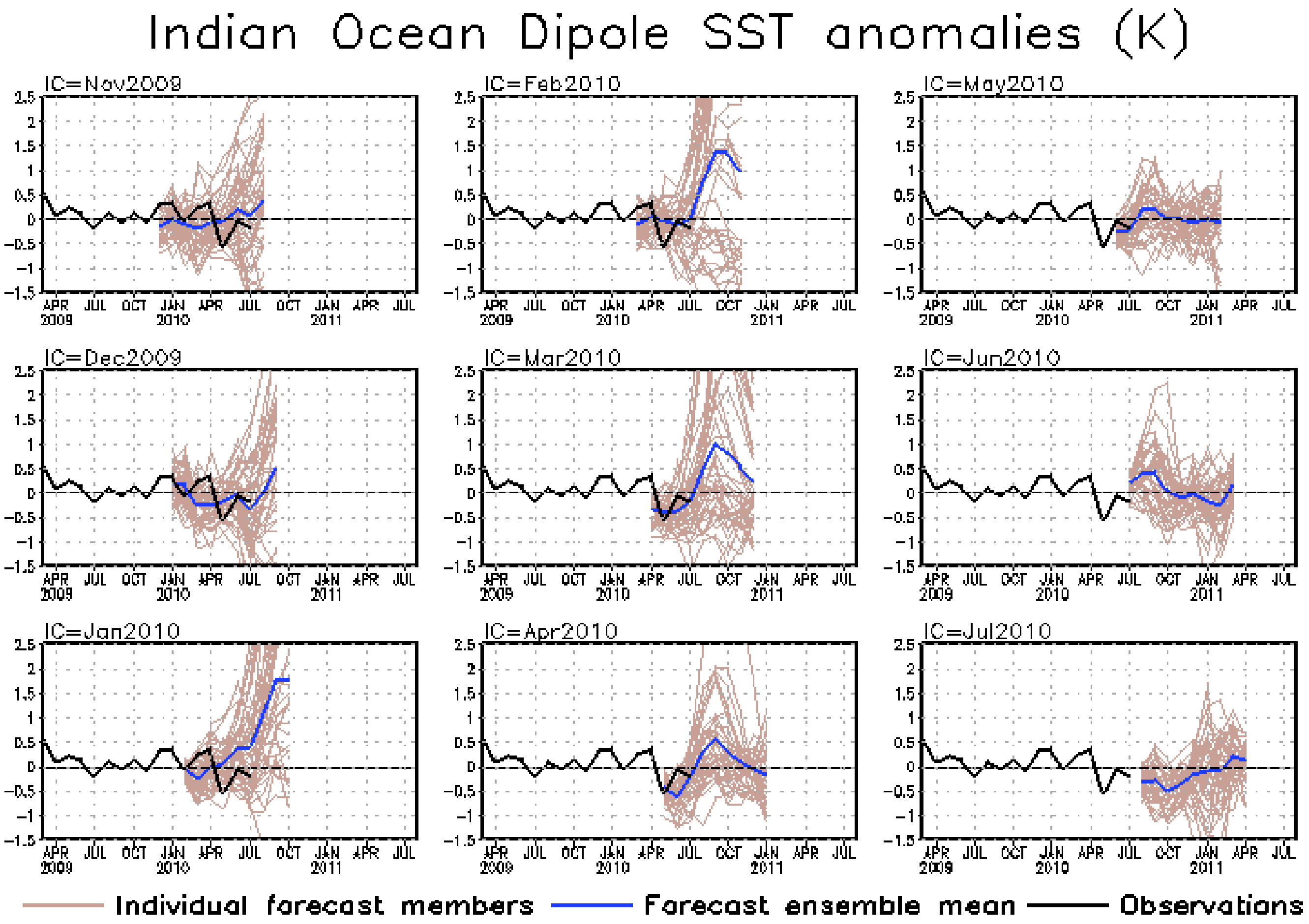


- Forecasts from Nov-Mar I.C. show warm biases, and delayed the transition from the warm phase to the cold phase of ENSO.

- The latest forecast from Jul 2010 I.C. suggests that La Niña conditions will strengthen in the fall and last through the Northern Hemisphere winter and spring 2010-11.

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.

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]

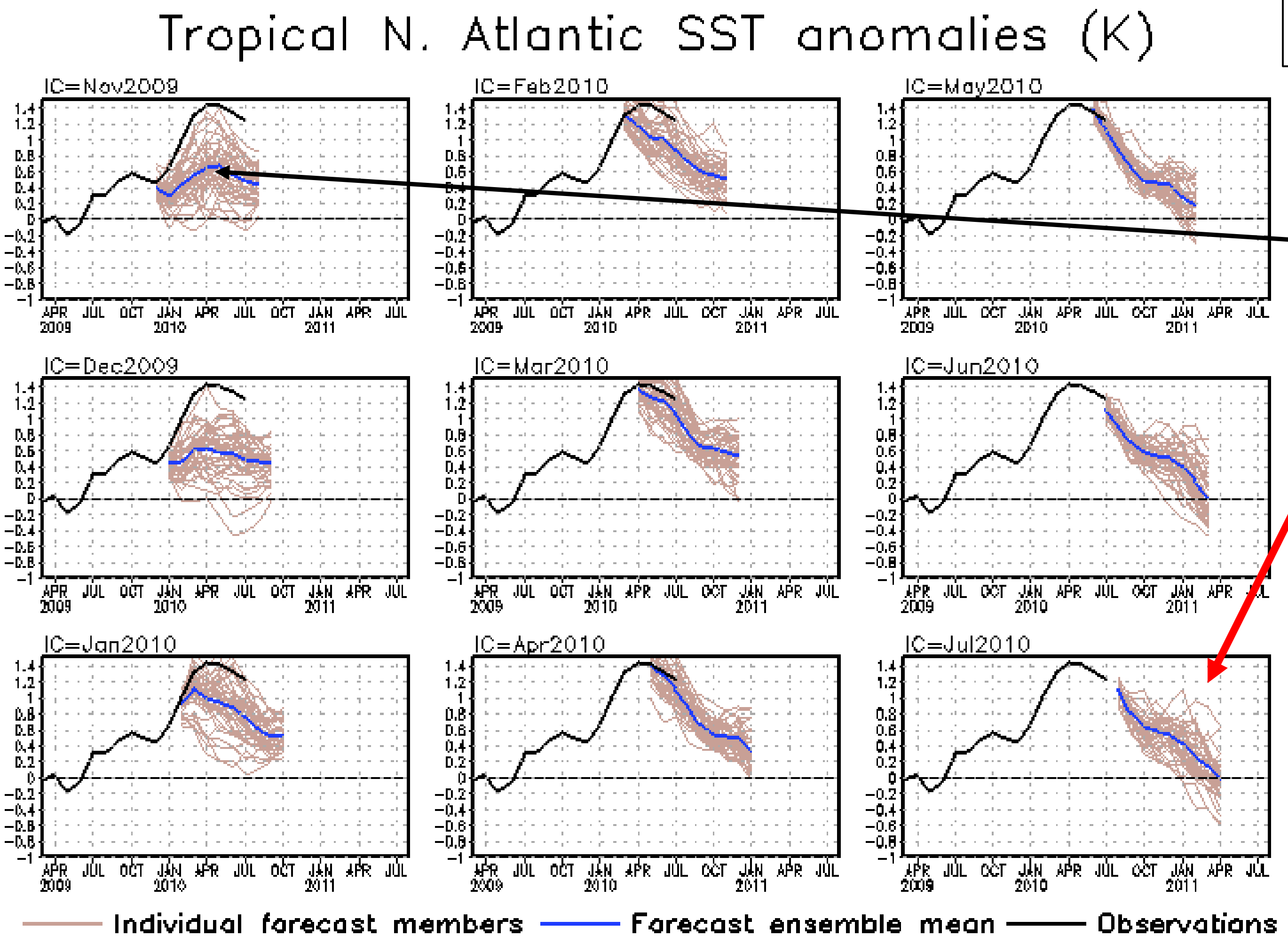
-Larger inter-ensemble member spread from Nov 2009 to April 2010 I.C. suggests the forecasts are less reliable. Less spread in the forecasts since May 2010 I.C.

- Latest forecasts from July 2010 I.C. called for a weakly negative IOD in the fall 2010.

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].

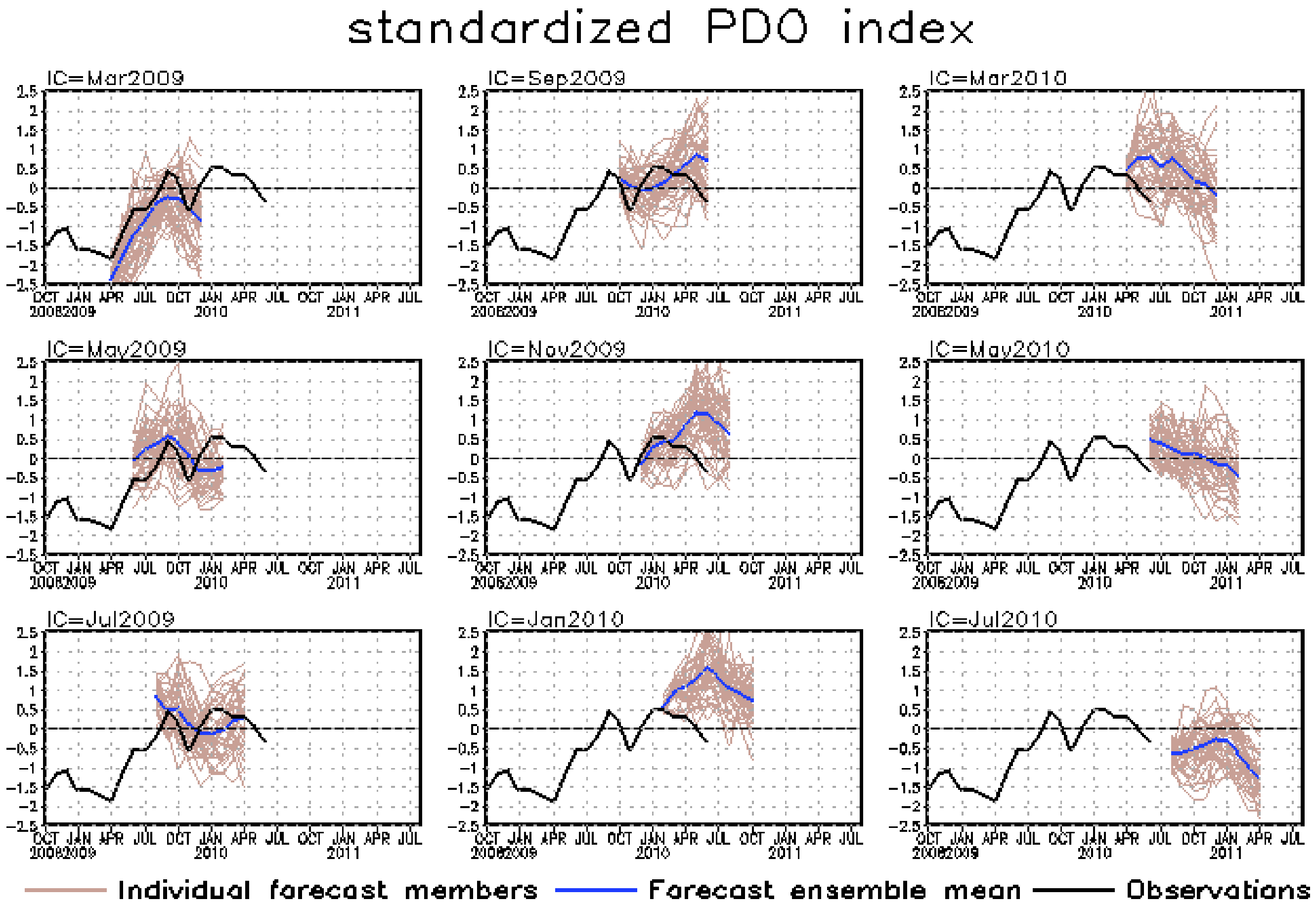


- Cold biases large from Nov-Mar I.C.
- Less spread in the forecasts since Apr 2010 I.C.

- Latest forecasts suggested that positive SSTA in the tropical North Atlantic would decay in following months of 2010, due to the weakening of the impacts of the 2009/2010 El Nino, and likely remain positive through fall 2010 and winter 2010/2011.

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 suggested that the PDO will be weakly below-normal throughout winter 2010/2011 and spring 2011.**

- **However, inter-ensemble member spread is large for PDO predictions.**

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.

Summary

- **Pacific/Arctic Ocean**
  - ENSO cycle: La Niña conditions developed in Jul 2010
  - NOAA/NCEP Climate Forecast System (CFS) has predicted a moderate-to-strong La Niña from Apr-Jul I.C., and the La Nina is forecast to last through the Northern Hemisphere winter 2010/2011 and spring 2011.
  - PDO index has been near-normal from Sep 2009 to Jun 2010, and it suddenly dropped to -1.5 in Jul 2010.
  - Arctic sea ice extent was well below-normal in Jul 2010, comparable to the historical low in 2007.
- **Indian Ocean**
  - Positive SSTA weakened (strengthened) in the Arabian Sea and along the coast of Somali (in the central-south Indian Ocean).
  - Dipole Mode index was weakly below-normal during May-Jul 2010.
- **Atlantic Ocean**
  - NAO index has been persistently below-normal since Oct 2009, and it is -0.42 in Jul 2010.
  - Tripole SSTA pattern persisted in Jul 2010.
  - SST in the tropical North Atlantic (TNA) has increased steadily from Dec 2009 to May 2010, and gradually weakened afterwards.
  - Easterly wind shear anomaly and above-normal tropical cyclone heat potential were observed in the Atlantic hurricane MDR in the past few months, which are favourable for hurricane development.

Backup Slides

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!