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

Prepared by

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October 7, 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)

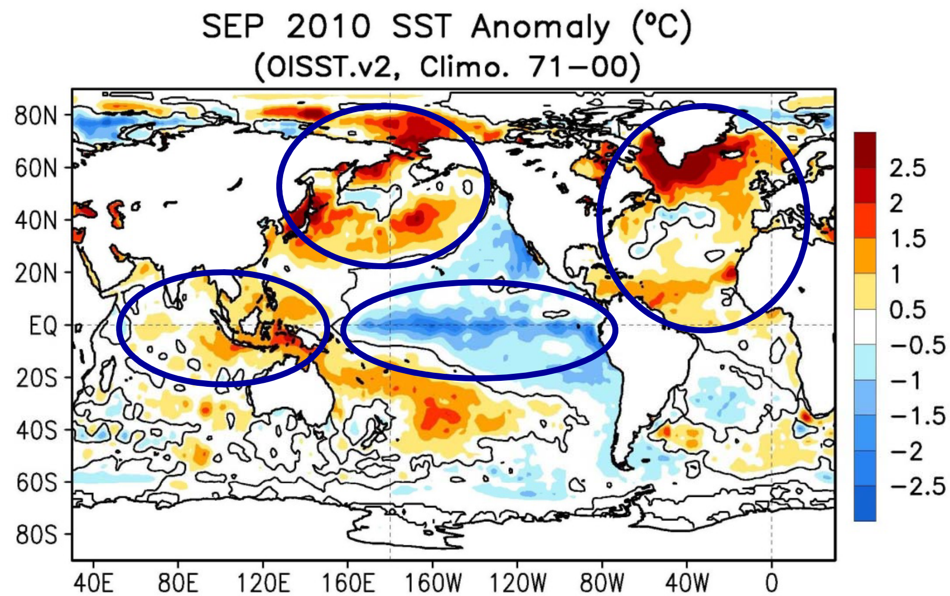
Outline

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

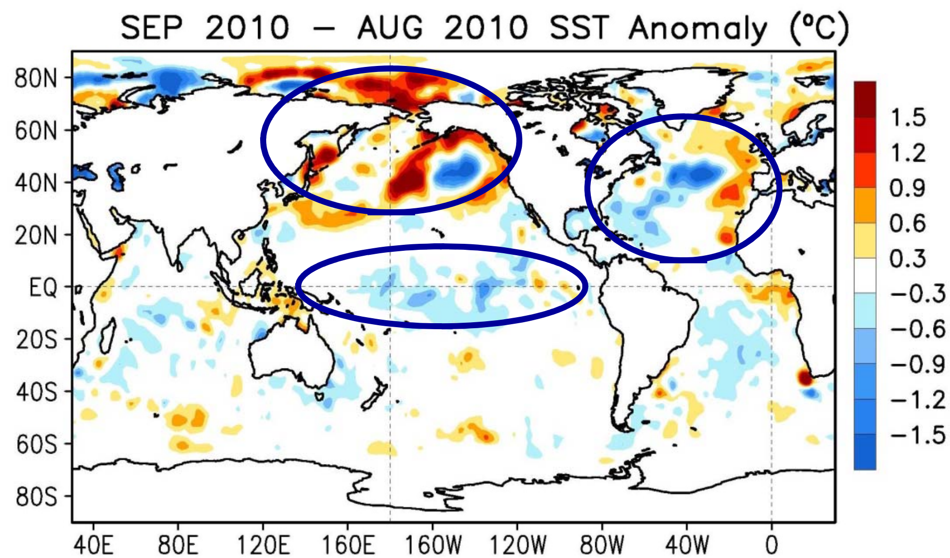
Overview

- **Pacific/Arctic Ocean**
  - **ENSO cycle: La Niña conditions intensified (NINO3.4=-1.7°C in Sep 2010).**
  - **NOAA/NCEP Climate Forecast System (CFS) predicted a strong La Niña, to last through the Northern Hemisphere spring 2011.**
  - **PDO has been below-normal since Jul 2010, strengthened to be -2 in Sep 2010.**
  - **Arctic sea ice extent increased seasonally after mid-Sep 2010, and was still well below-normal.**
- **Indian Ocean**
  - **The tropical Indian Ocean Basin warming weakened in Sep 2010.**
  - **Dipole Mode index has been below-normal since May 2010, and strengthened to be about -0.8°C in Sep 2010.**
- **Atlantic Ocean**
  - **NAO index has been persistently below-normal since Oct 2009, and it was -0.8 in Sep 2010.**
  - **Strong positive SSTA (>2.5°C) presented in the high latitudes in Sep 2010.**
  - **SST in the tropical North Atlantic (TNA) has increased steadily from Dec 2009 to May 2010, gradually weakened from Jun to Aug 2010, and persisted in Sep 2010.**
  - **Easterly wind shear anomaly and above-normal tropical cyclone heat potential in the Atlantic hurricane MDR were favourable to hurricane development.**

Global SST Anomaly (^{0}C) and Anomaly Tendency



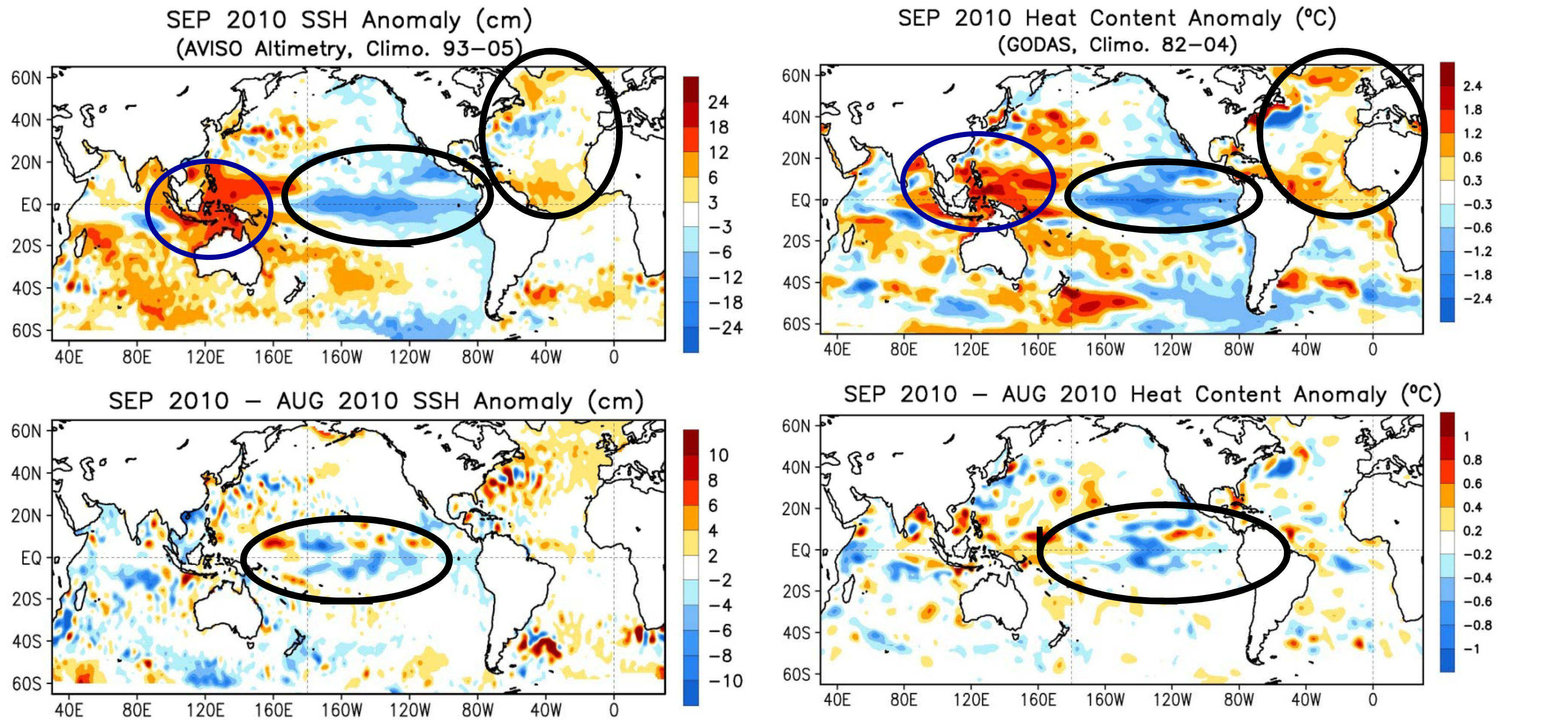
- Negative SSTA in the tropical eastern and central Pacific, indicating the La Niña conditions.
- Negative PDO SST pattern presented in N. Pacific.
- Positive SSTA existed in the tropical Indian Ocean and tropical W. Pacific.
- Strong positive SSTA in the high latitude North Atlantic, Arctic, and tropical Atlantic.



- SSTA decreased in the central tropical Pacific, suggesting strengthening of La Niña conditions.
- SST tendency was large in N. Pacific and Arctic.
- Negative SSTA tendency presented in the western and central N. 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.

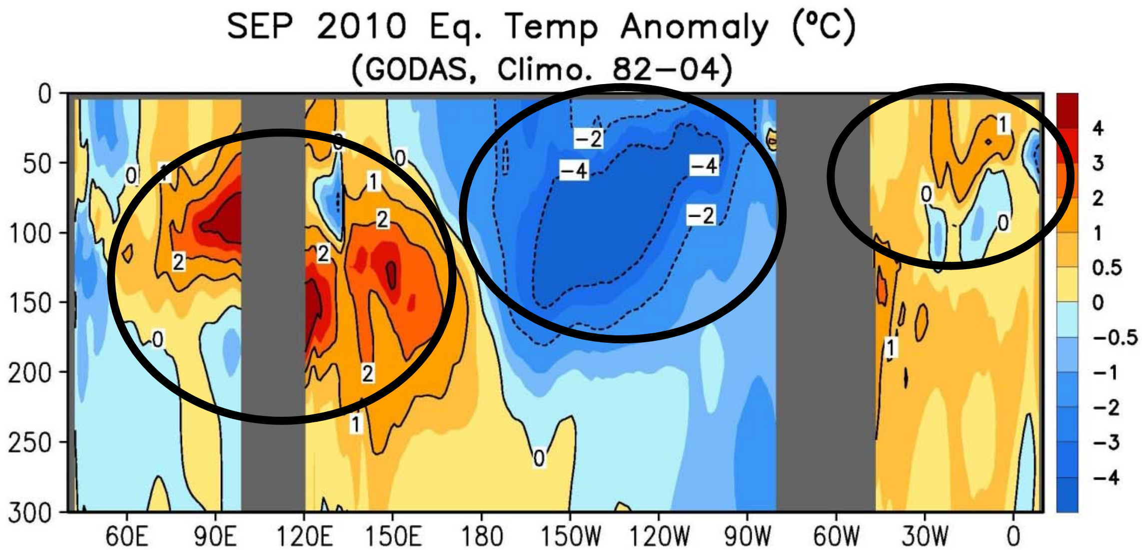
Global SSH/HC Anomaly (cm/°C) and Anomaly Tendency



- **Negative SSHA and HCA strengthened along the Equator in the central-eastern tropical Pacific, consistent with strengthening of La Nina conditions.**
- **Positive HCA and SSHA strengthened in the eastern tropical Indian Ocean and western Pacific.**
- **The tripole SSHA and HCA pattern in North Atlantic persisted.**
- **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).**

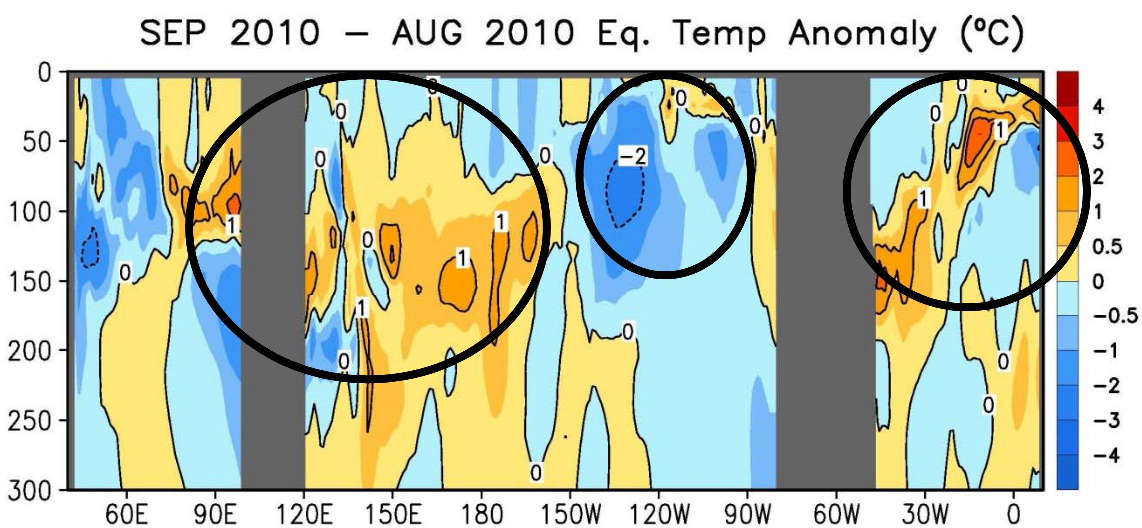
Fig. G2. Sea surface height anomalies (SSHA, top left), SSHA tendency (bottom left), top 300m heat content anomalies (HCA, top right), and HCA tendency (bottom right). SSHA are derived from http://www.aviso.oceanobs.com, and HCA from GODAS.

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 temperature anomalies dominated near the thermocline of the Indo-Pacific Ocean, and Atlantic Ocean.

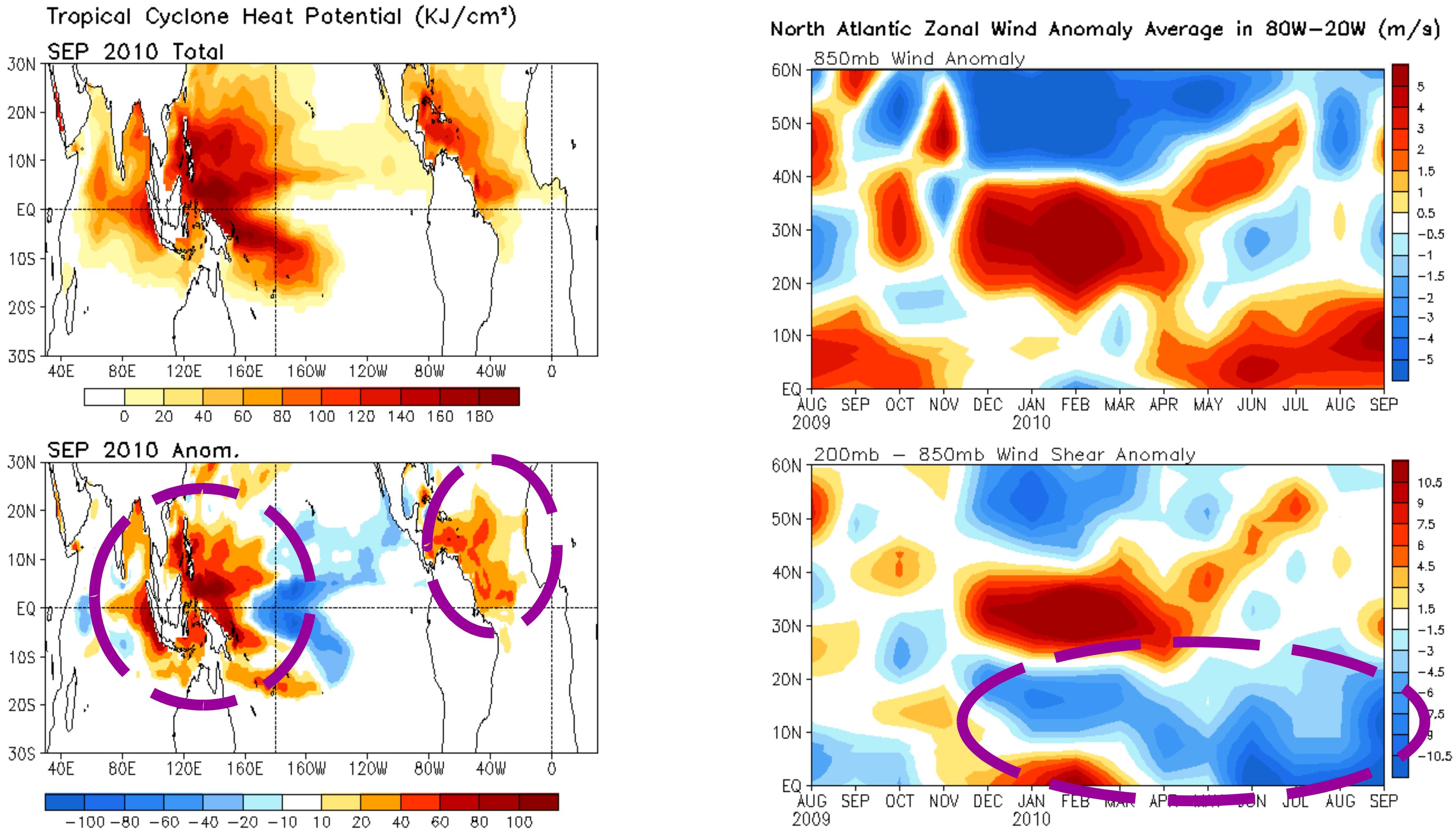


- Positive (negative) temperature tendency presented near the thermocline of the western (eastern) Pacific.

- Positive temperature tendency presented near the thermocline of the tropical eastern Indian Ocean, and 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

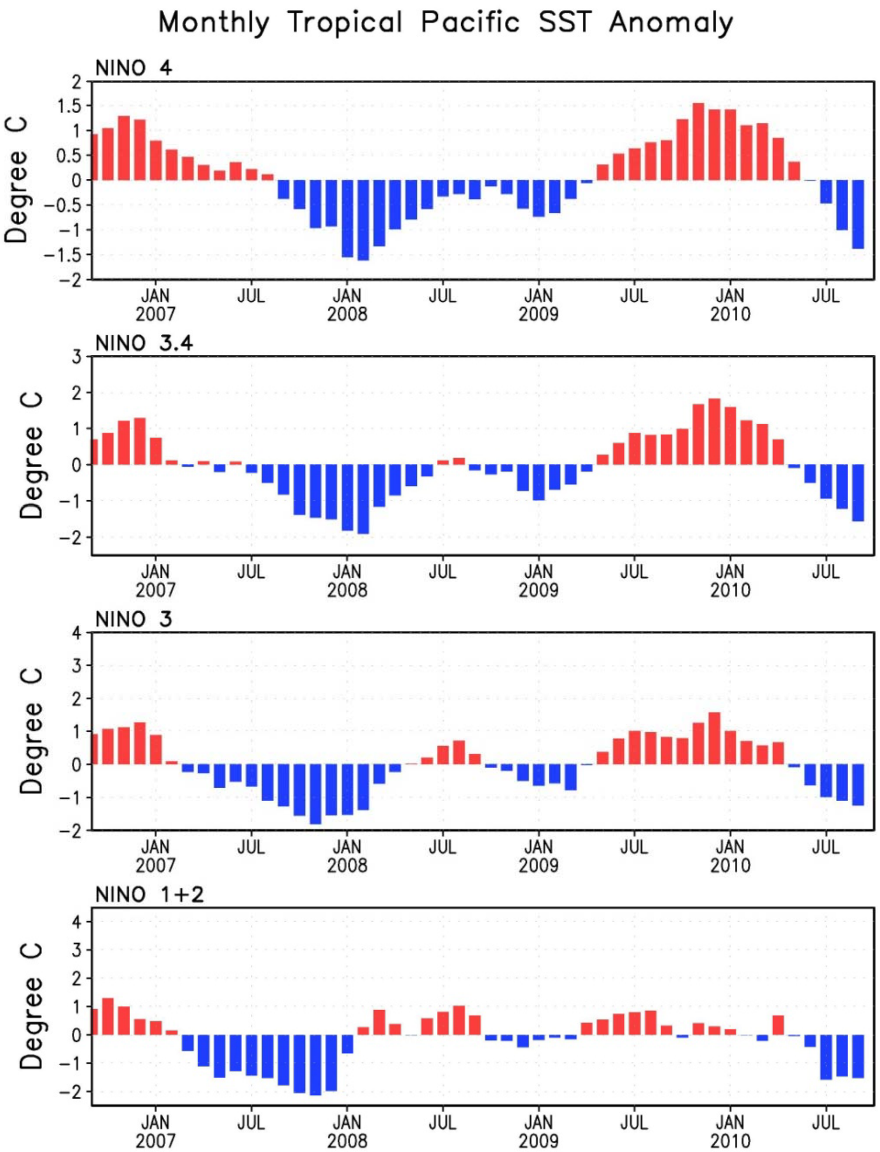


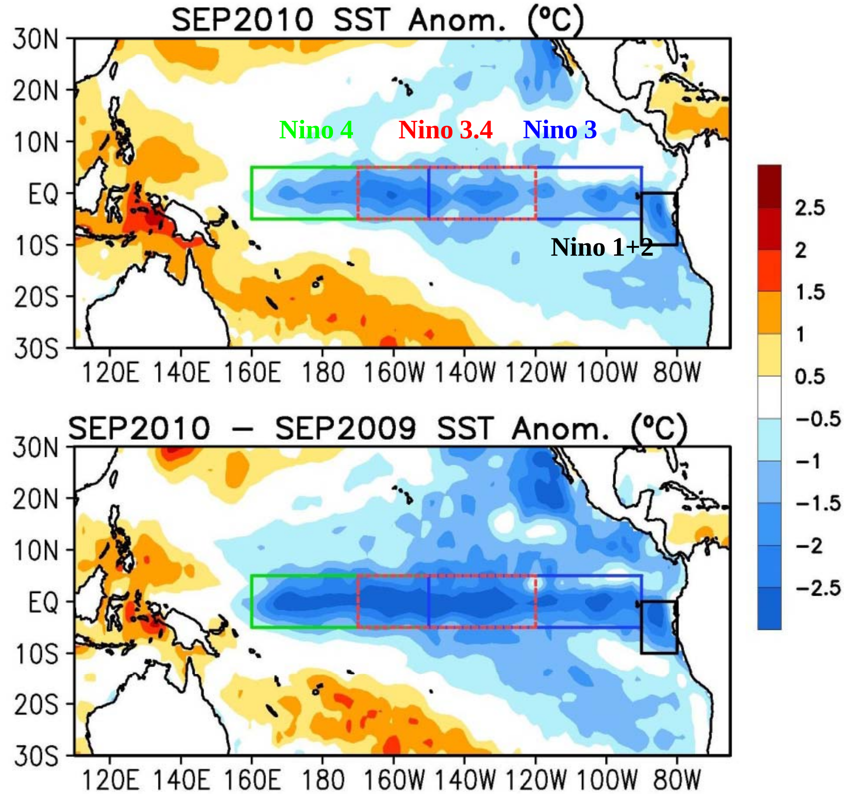
- **Large positive TCHP anomalies presented in the tropical North Atlantic, and the Indo-Pacific Warm Pool.**
- **Easterly vertical wind shear anomalies presented in the Atlantic MDR since Dec 2009.**
- **The positive TCHP anomalies and easterly vertical wind shear anomalies are favourable to the hurricane development 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

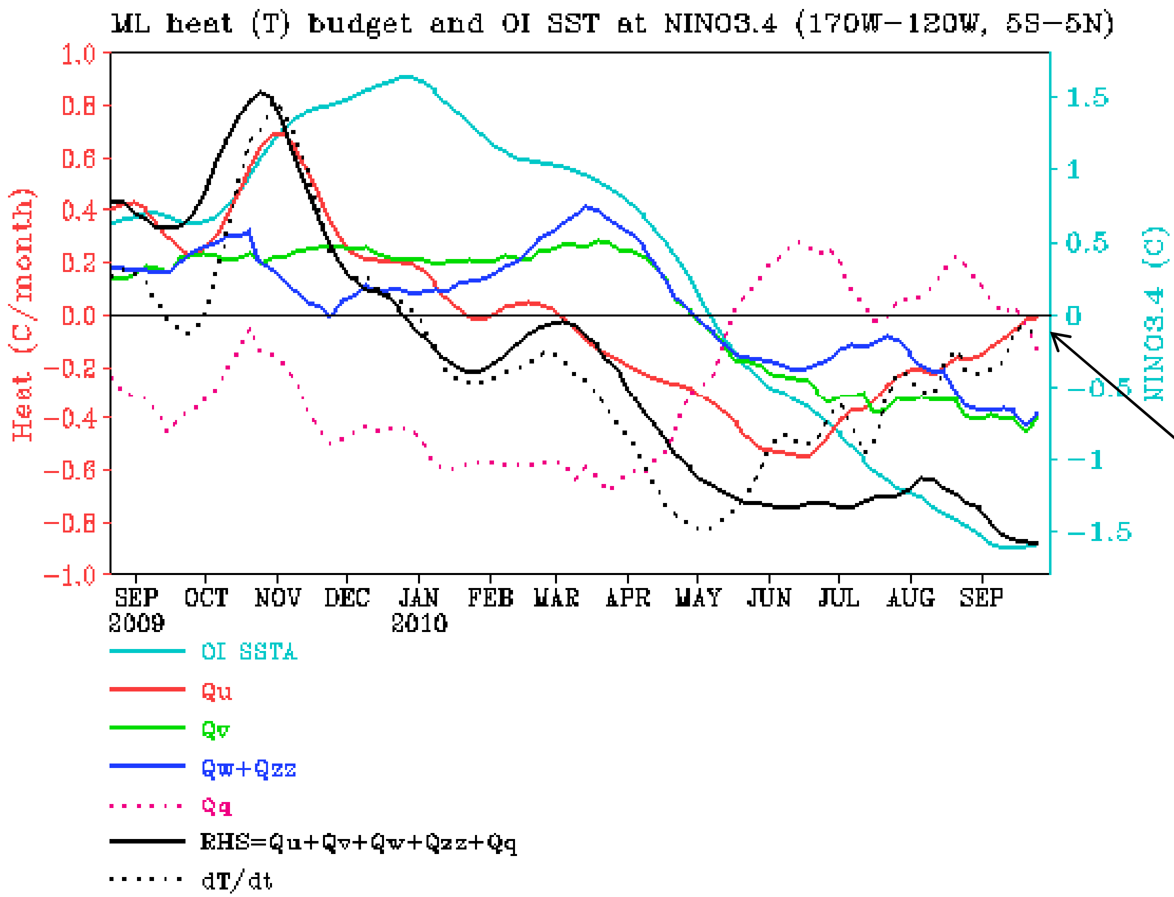




- **All Indices decreased in Sep 2010, indicating intensification of La Niña conditions.**
- **The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v3b.**

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.

NINO3.4 Heat Budget



- **Negative tendency (dT/dt) in NINO 3.4 weakened since 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) was weak in Sep 2010.**

- **The negative tendency (dT/dt) is overestimated by the total budget term (RHS) since Jun 2010. This may be due to the fact that (1) the cooling from Qu and Qv might be overestimated in the GODAS due to too strong zonal and meridional current, and (2) surface heat flux (Qq) was too weak.**

Qu: Zonal advection; Qv: Meridional advection;

Qw: Vertical entrainment; Qzz: Vertical diffusion

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

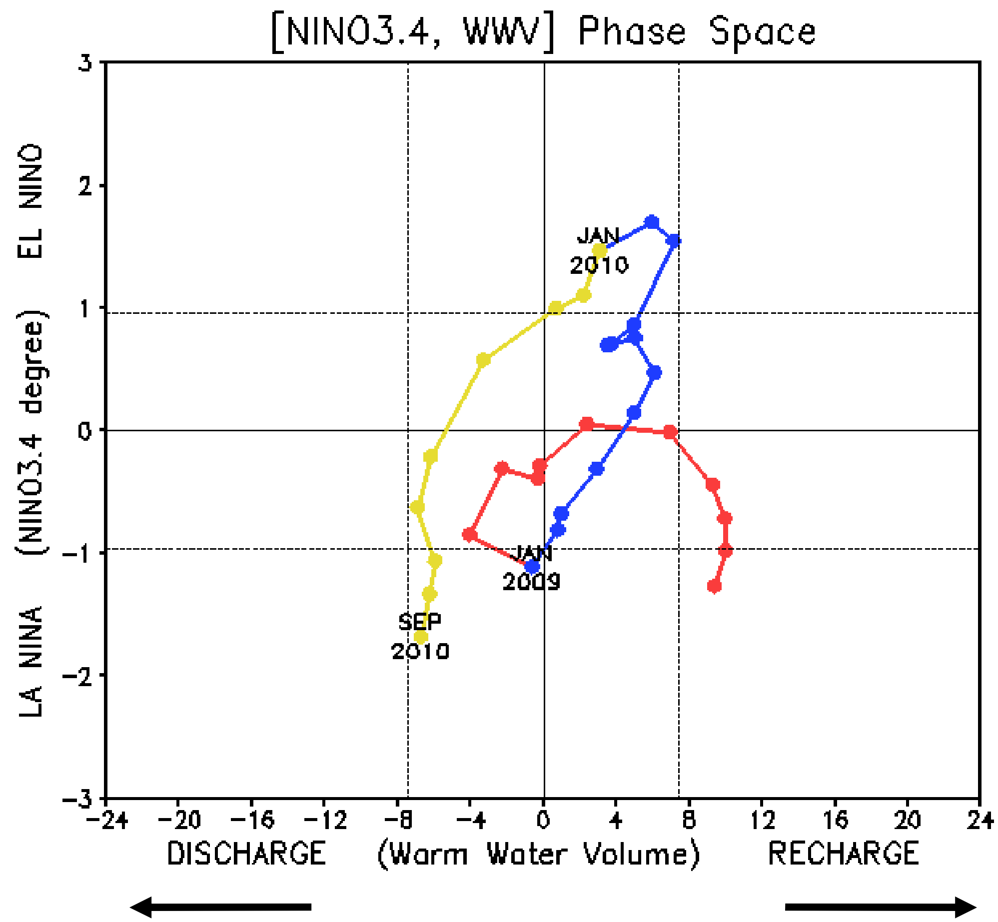
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

Warm Water Volume (WWV) and NINO3.4 Anomalies

-**WWV is defined as average of depth of 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.**

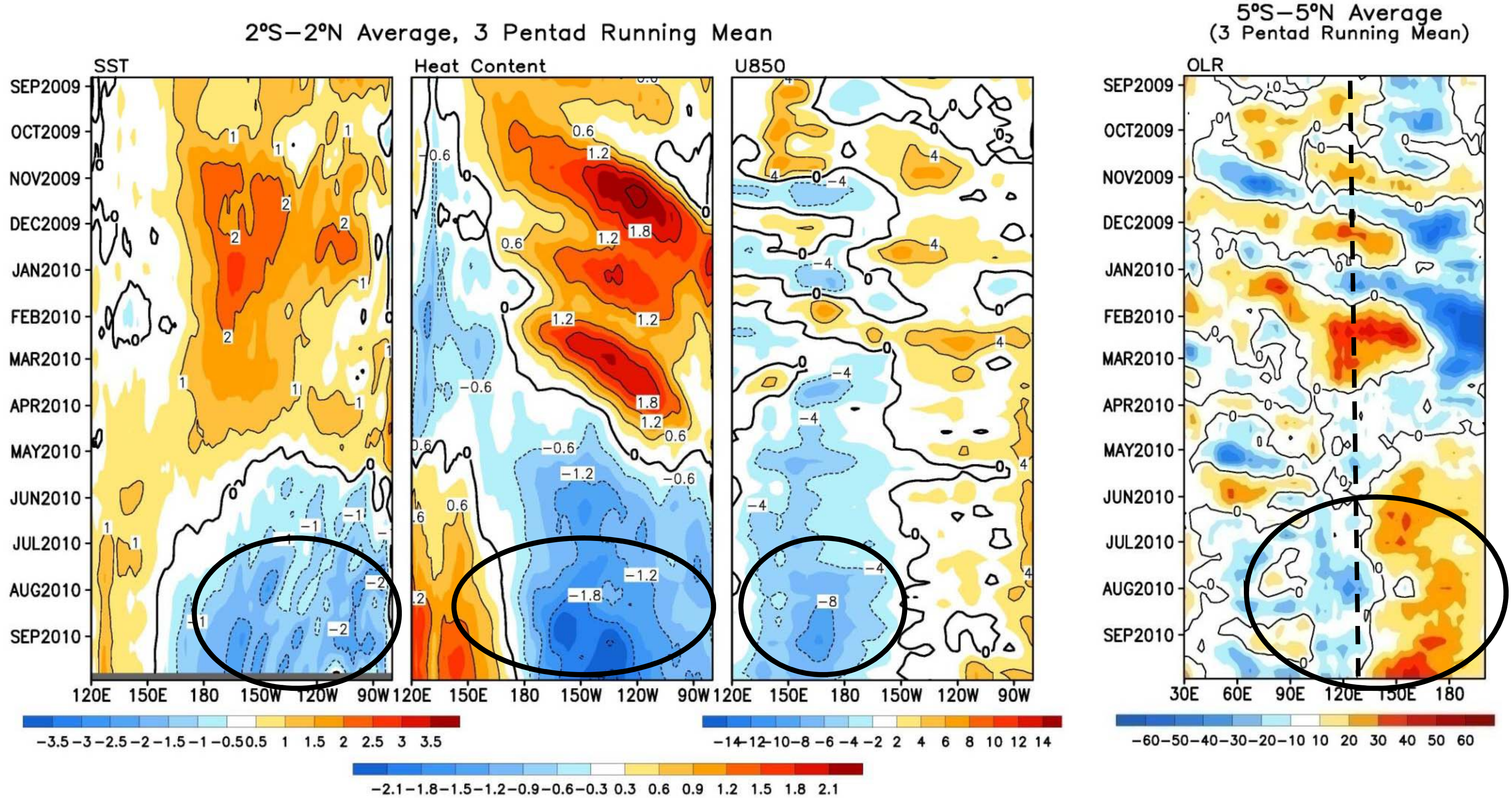


- **Nino3.4 has decreased steadily in the past few months and became less than -1C since July 2010, indicating moderate-strong La Nina conditions.**

- **WWV slightly decreased from Jul 2010 to Sep 2010.**

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.

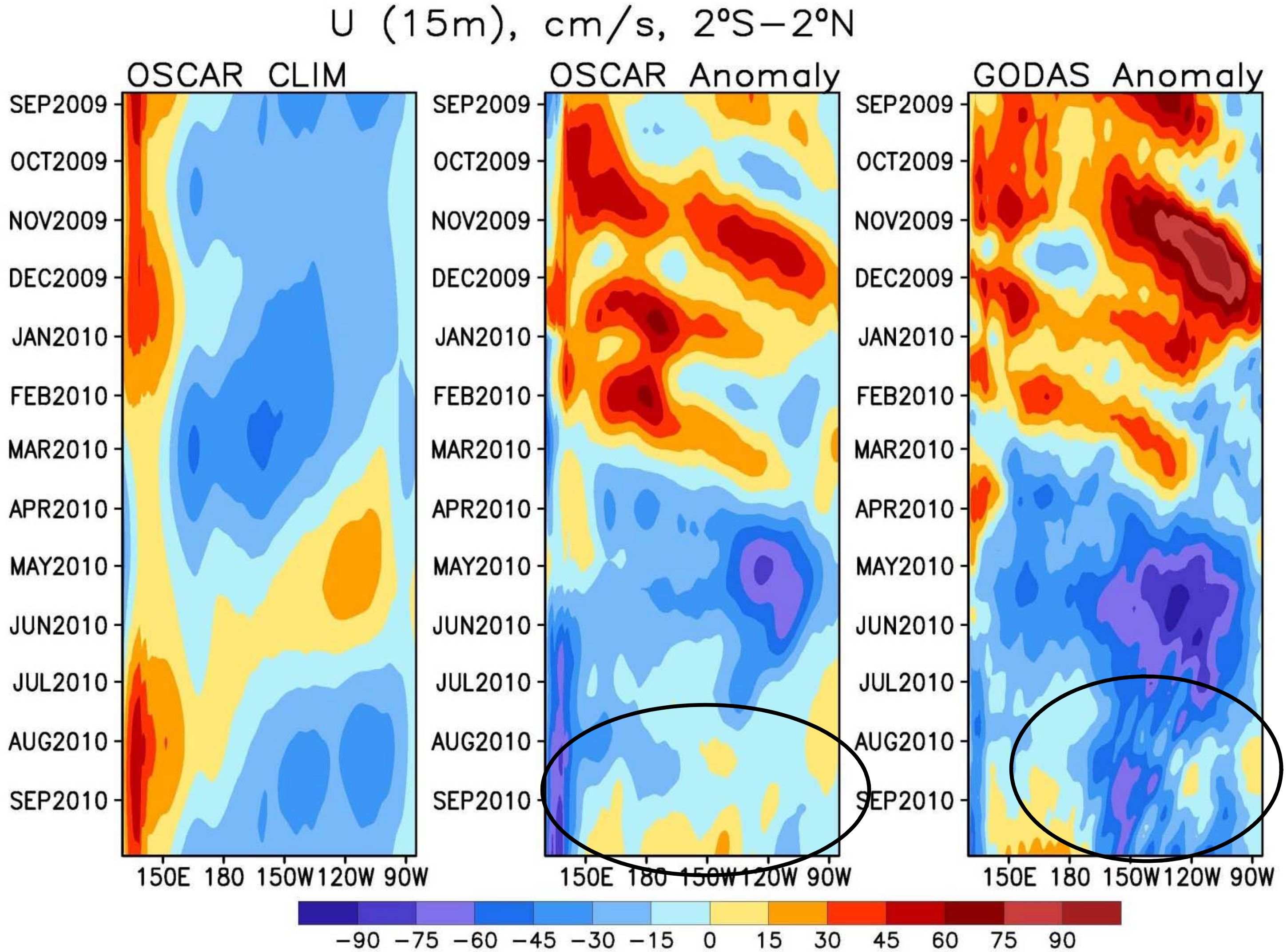
Evolution of Equatorial Pacific SST (ºC), 0-300m Heat Content (ºC), 850-mb Zonal Wind (m/s), and OLR (W/m²) Anomaly



- **Negative SSTA and HC300 further developed, consistent with the intensification of La Niña conditions.**
- **Convection was enhanced over the Maritime Continent and tropical Indian Ocean, and suppressed in the equatorial central Pacific since May 2010, consistent with the low level (850 hPa) zonal wind divergence and convergence anomaly.**

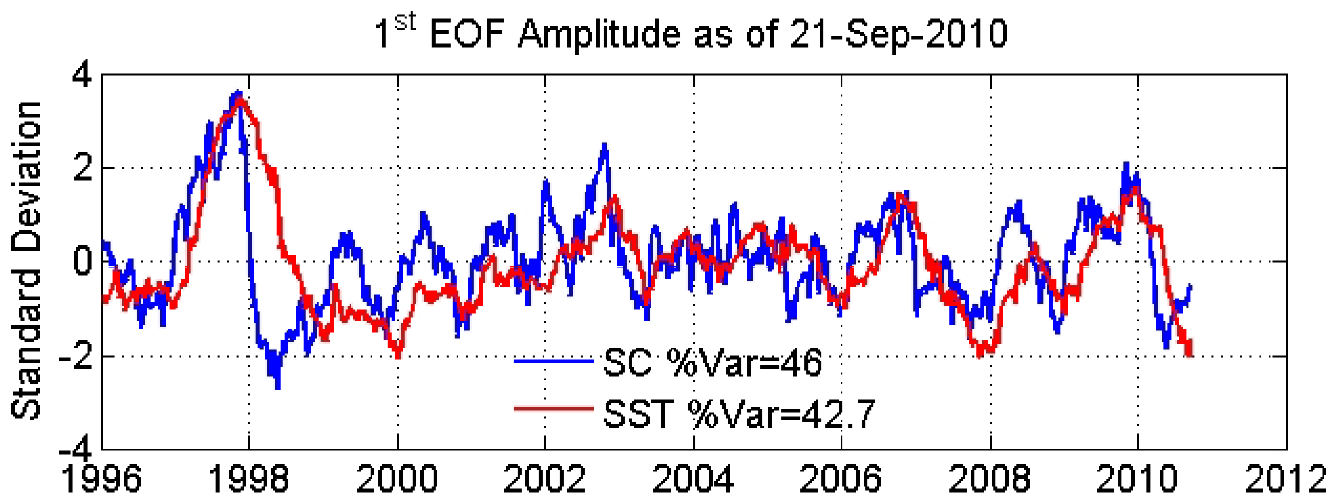
Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2ºS-2ºN and Outgoing Long-wave Radiation (OLR, right) averaged in 5ºS-5ºN. SST is derived from the NCEP OI 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 Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



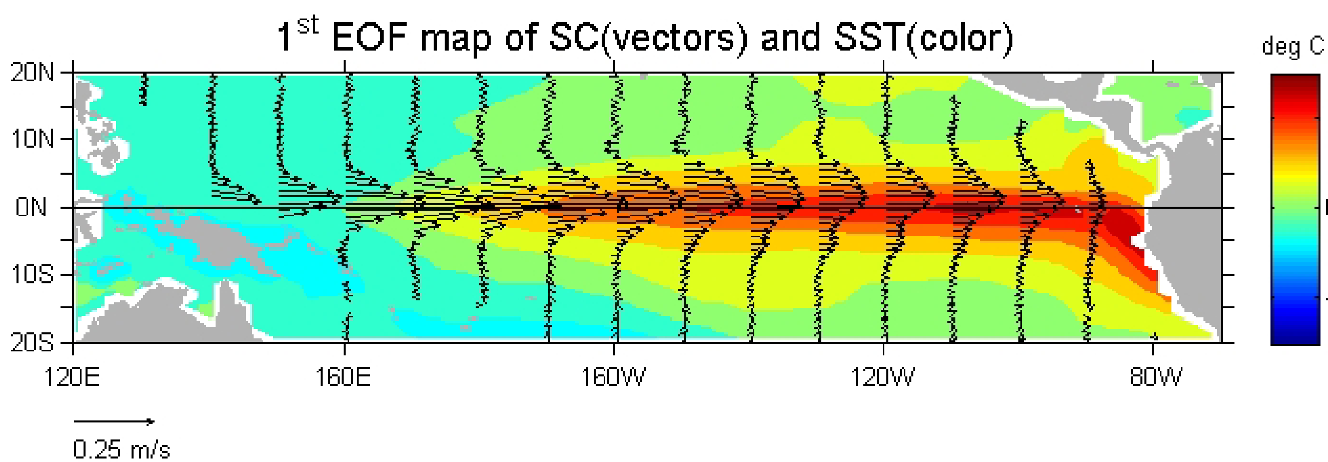
- Anomalous zonal current was weak in OSCAR since late Jul 2010, implying reduction of the zonal advection contribution to the La Niña conditions.
- However, anomalous zonal current remained strong in GODAS since Jul 2010 , which contributed to the imbalance of mixed layer heat budget.

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



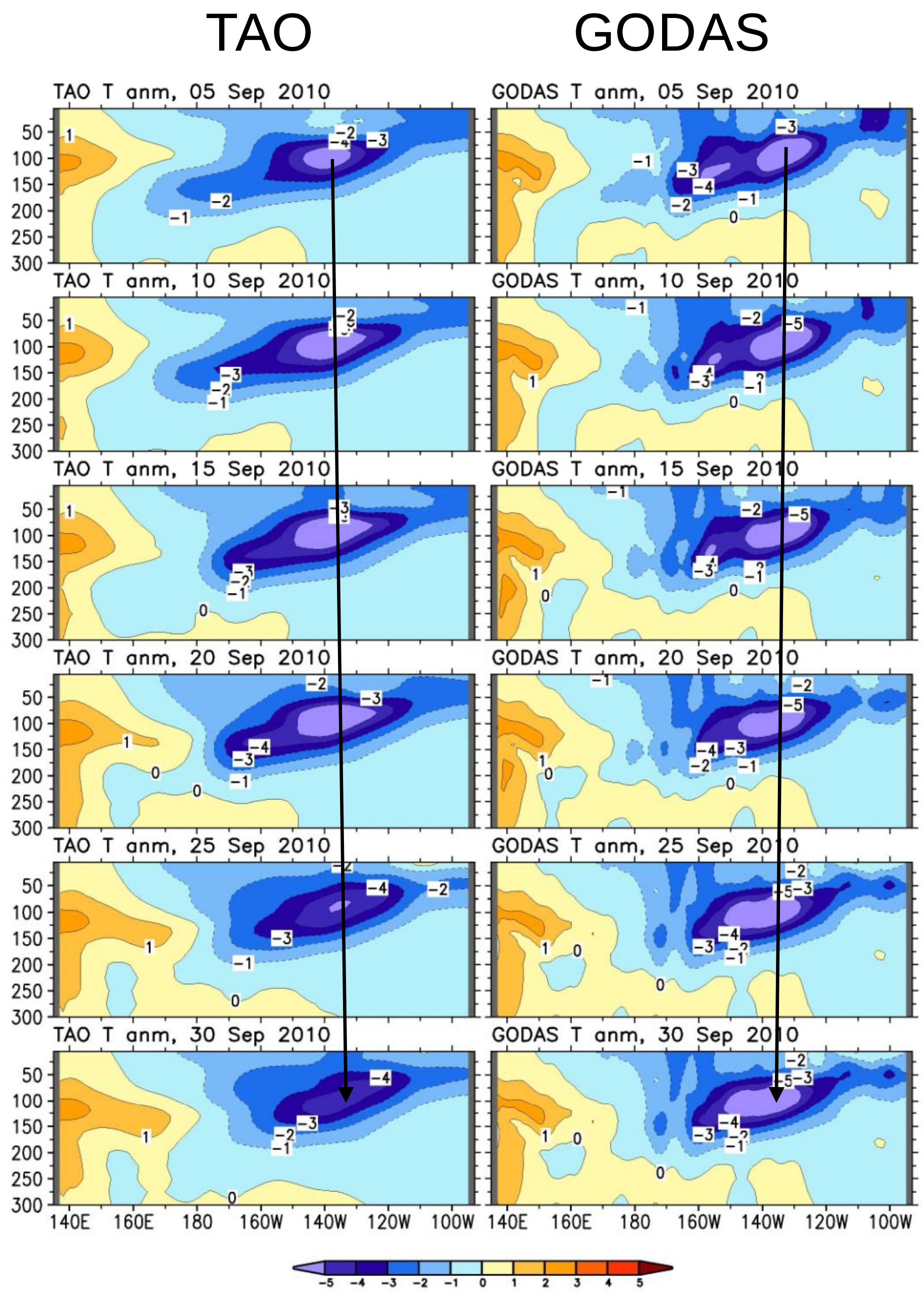
- Westward surface current anomaly weakened since Jul 2010, similar to the case in 1998 in both its amplitude and evolution.

- 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)

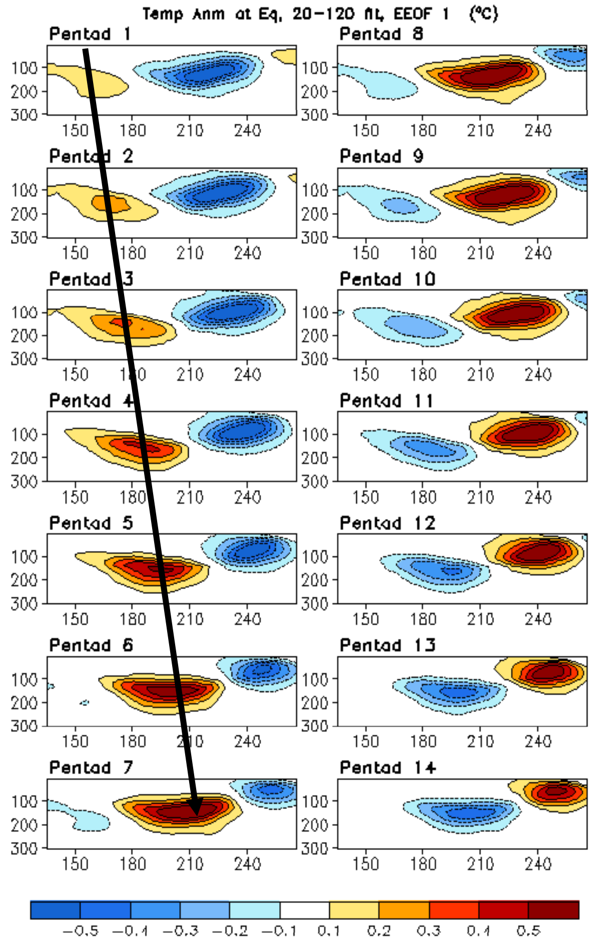
Equatorial Pacific Temperature Anomaly

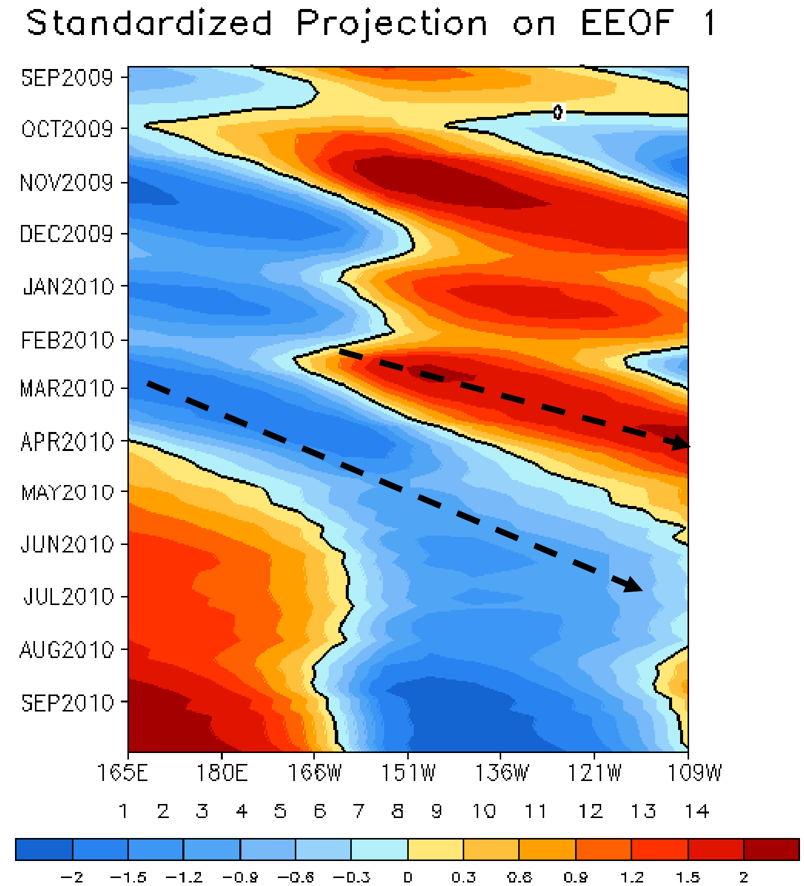


TAO climatology used

- **Negative anomaly of ocean temperature in the eastern-central equatorial Pacific persisted in Sep 2010, consistent with the La Niña conditions.**
- **Negative temperature anomaly in the central and eastern equatorial Pacific had little propagation.**
- **Temperature anomaly weakened slightly in TAO after Sep 20, but persisted in GODAS.**

Oceanic Kelvin Wave Indices

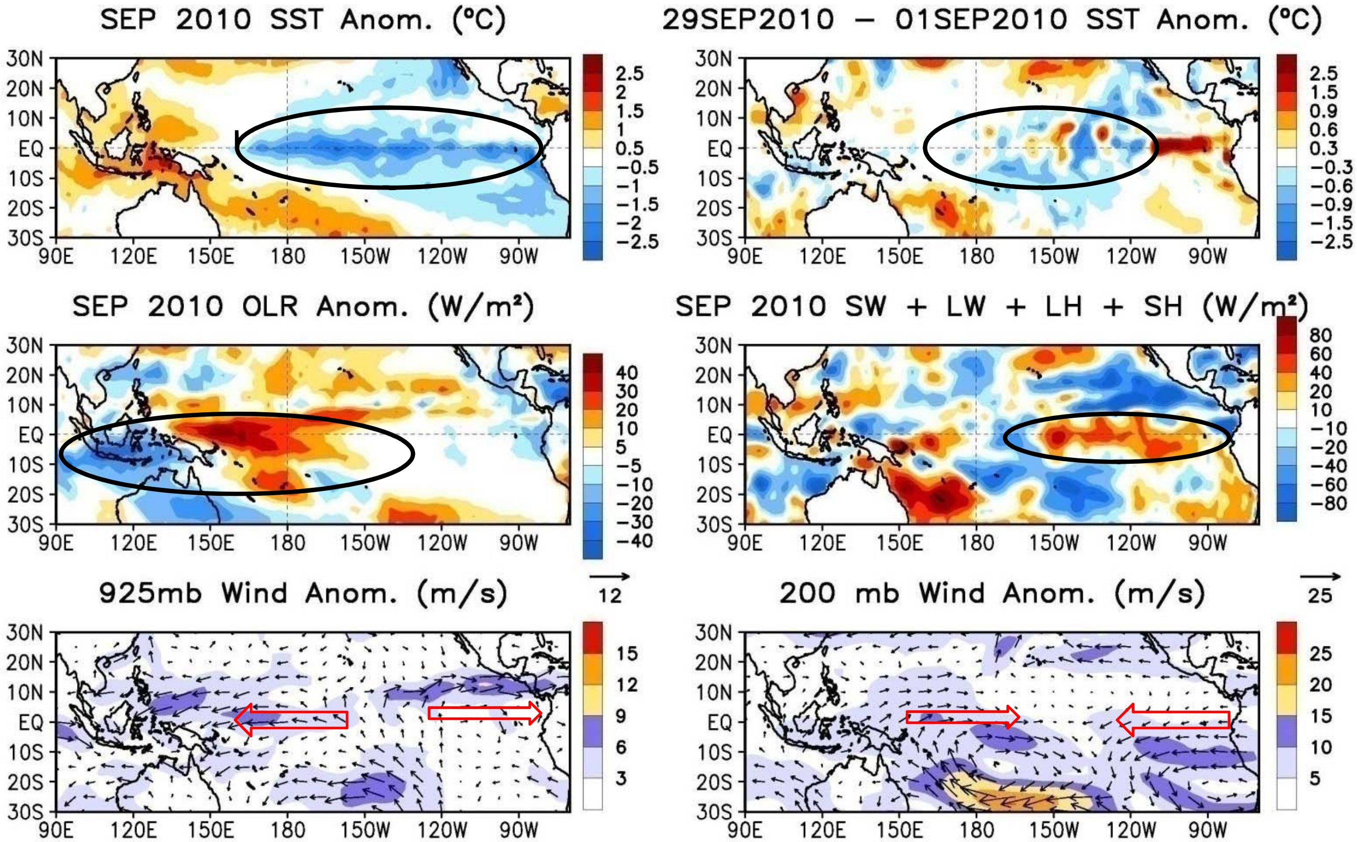




- **Upwelling Kelvin wave occurred in late Feb 2010 in the W. Pacific and propagated eastward, which may have contributed to the transition of ENSO cycle from the warm phase to the cold phase.**
- **There were no Kelvin wave propagations since Jun 2010.**

- **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

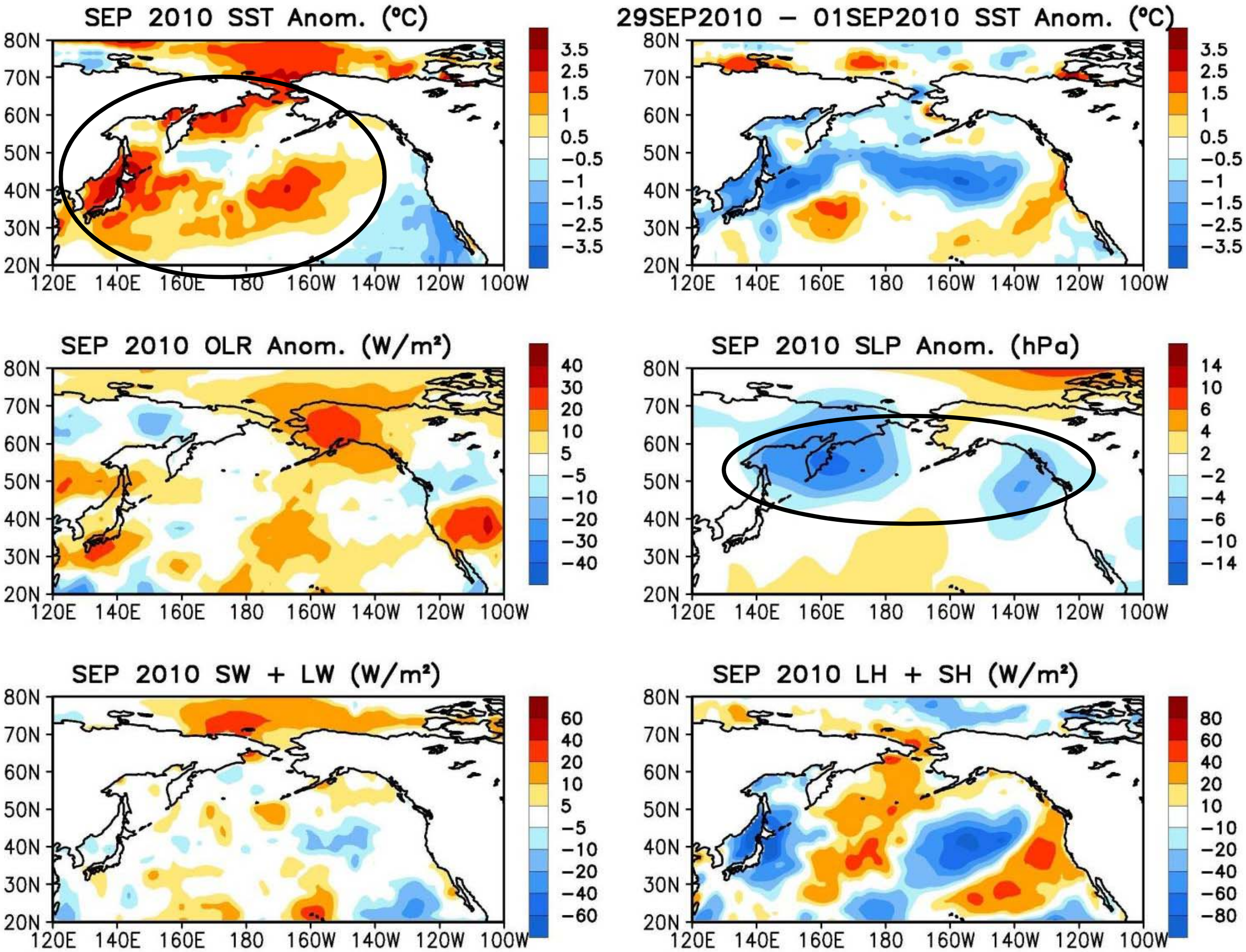


- **Negative SSTA further developed in the central-eastern equatorial Pacific in Sep 2020.**
- **Convection was enhanced (suppressed) over the Maritime Continent (in the western-central tropical Pacific).**
- **Negative (positive) SSTA tendency presented in the central tropical Pacific (eastern equatorial Pacific).**
- **Net surface heat flux anomalies damped SSTA between 160W-90W.**
- **Easterly (westerly) wind anomaly in low level (high level) presented in the western and central tropical Pacific; opposite anomalies also presented in the eastern tropical Pacific.**

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

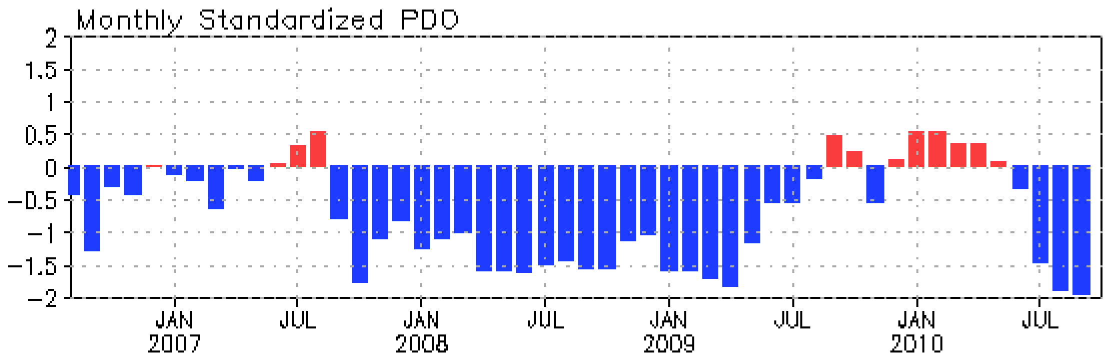
North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

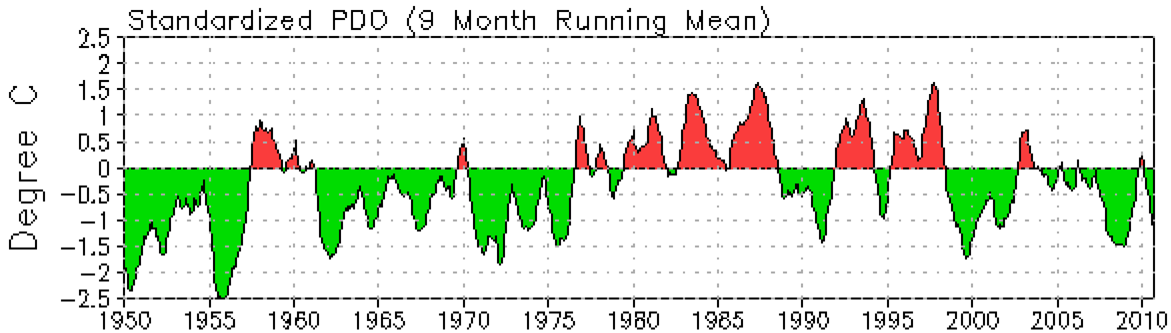


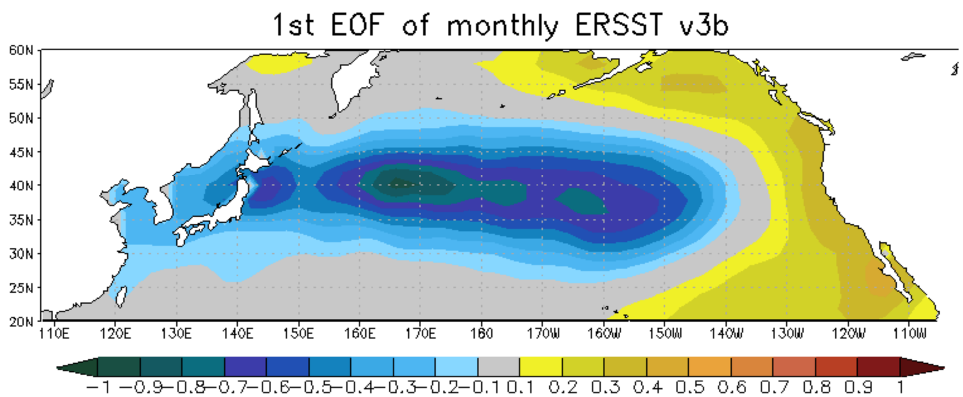
- Strong positive SSTA in western-central N. Pacific and Arctic Ocean, and negative SSTA in the south-eastern N. Pacific in Sep 2010, consistent with the negative PDO index in Sep 2010 (next slide).
- SSTA tendency showed some consistency with latent and sensible heat flux (LH+SH).
- Negative SLP anomaly presented in the Sea of Okhotsk, the Bering Sea, and the Gulf of Alaska that had impacts on the coastal upwelling.

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 near -2.0 in Sep 2010.

- The PDO index has been below normal since Jun 2010.

- Negative PDO index was coincident with the La Nina conditions.

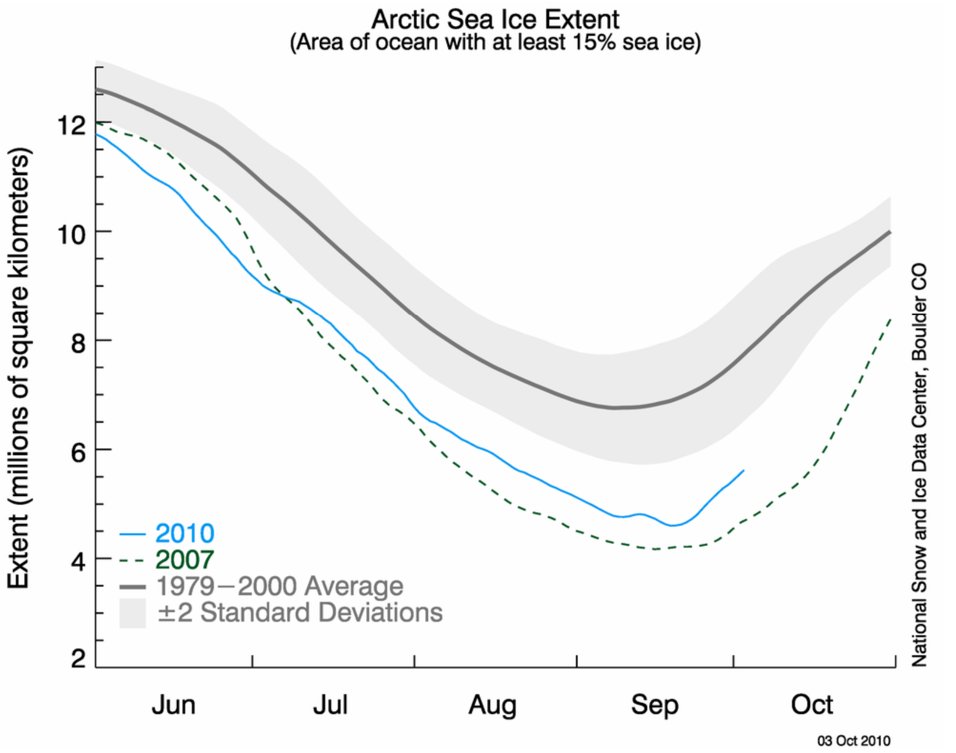
- Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.

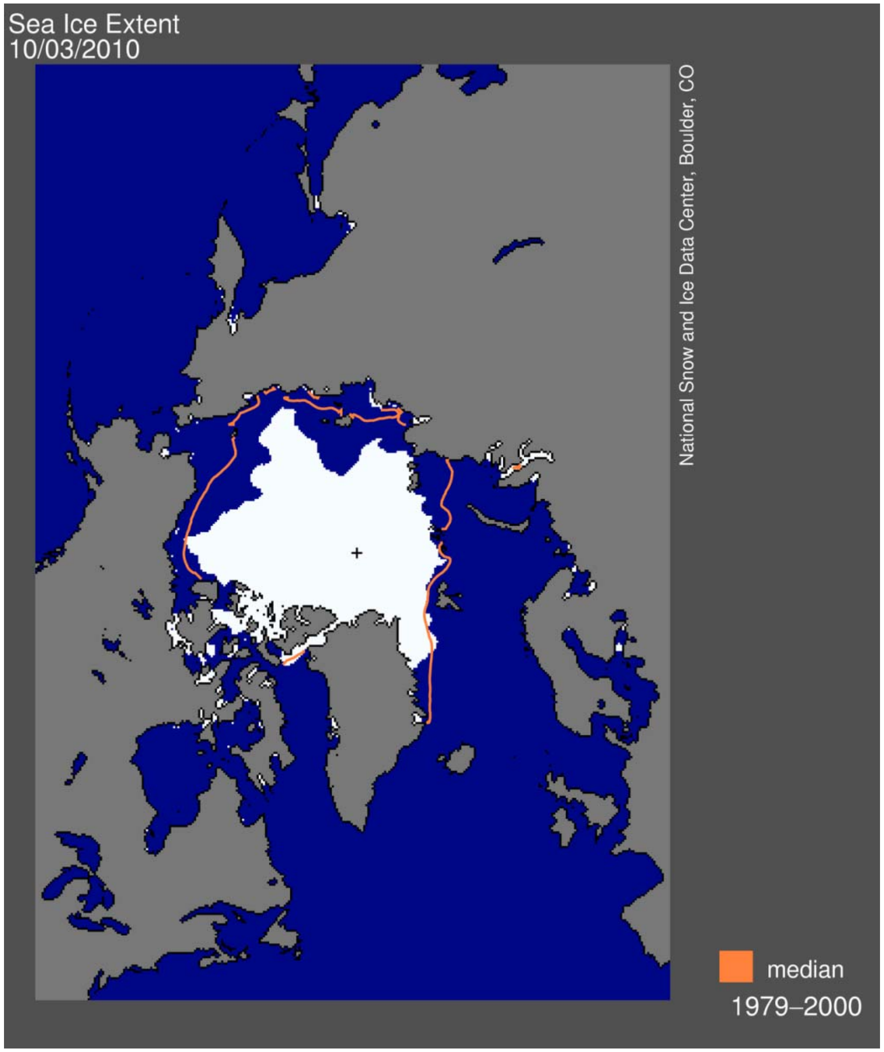
- The PDO index differs slightly from that of JISAO, which uses a blend of UKMET and OIv1 and OIv2 SST.

Arctic Sea Ice

National Snow and Ice Data Center

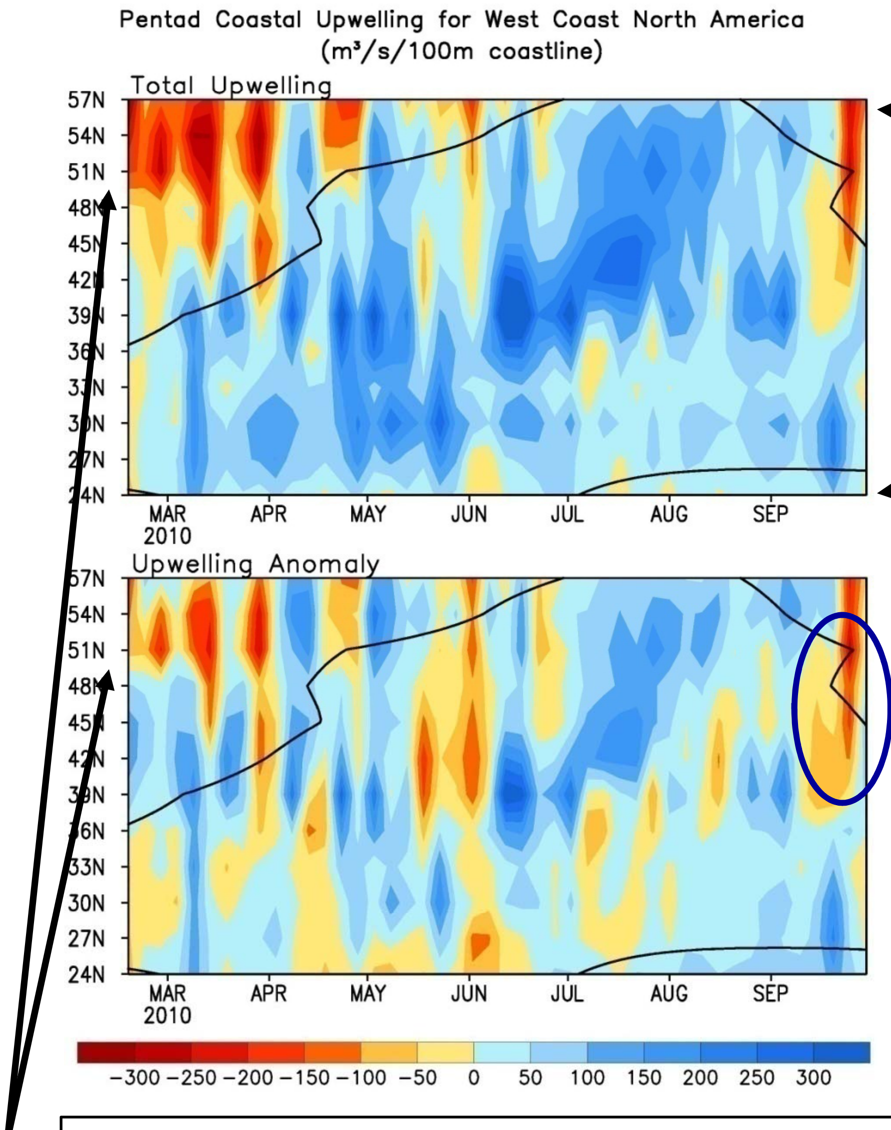
http://nsidc.org/arcticseaicenews/index.html

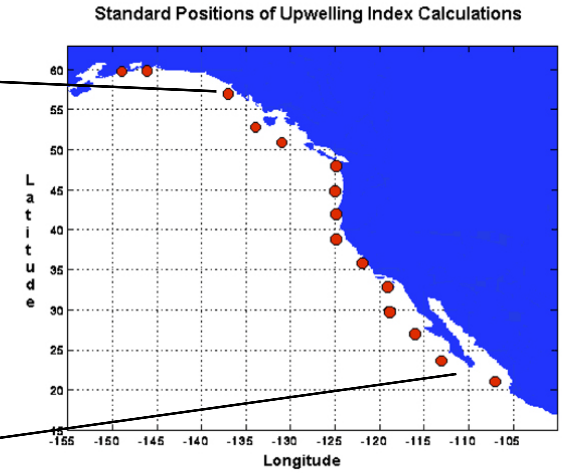




- **The Arctic sea ice extent since middle of Jun 2010 was slightly larger than that in 2007.**
- **Sea ice extent in Sep 2010 was still well below normal.**
- **Sea ice extent increased seasonally after mid-Sep 2010.**

North America Western Coastal Upwelling





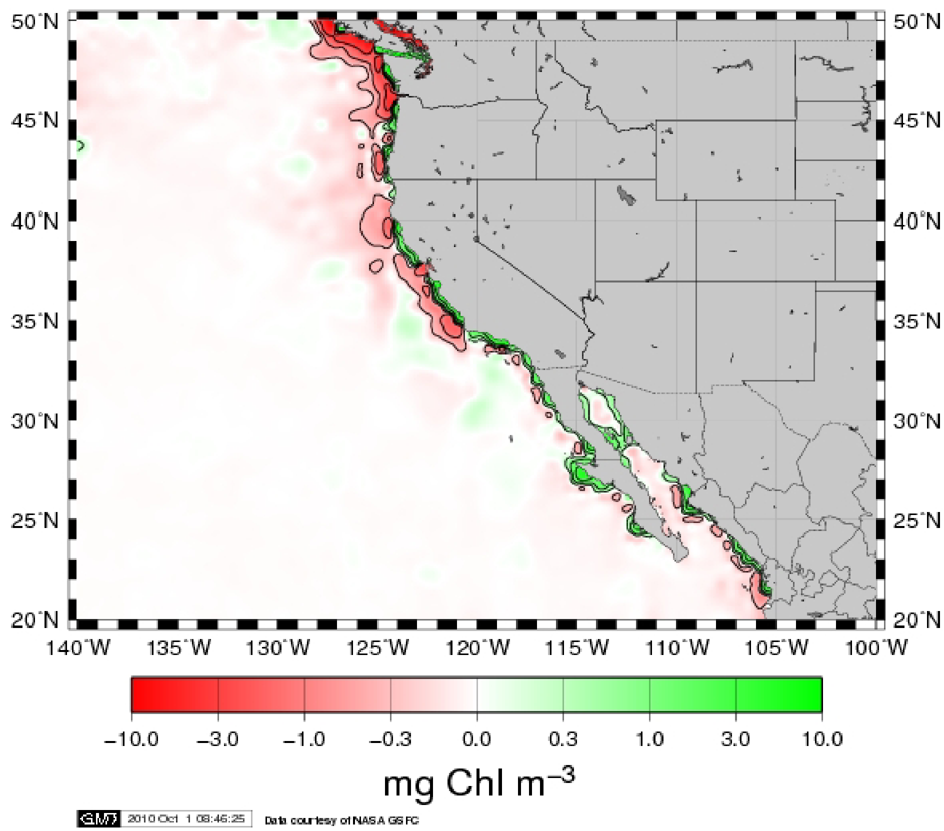
- **Upwelling weakened (strengthened) in 36-57N (24-35N) in Sep 2010.**

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 36°N to 57°N.**

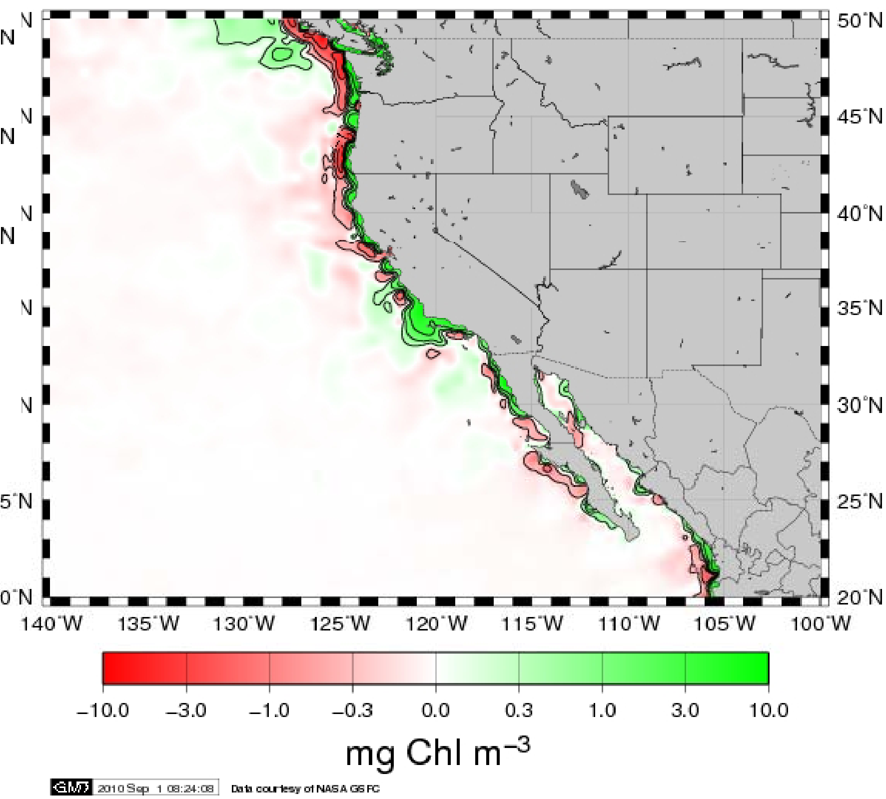
Monthly Chlorophyll Anomaly

MODIS Aqua Chlorophyll a Anomaly for September, 2010



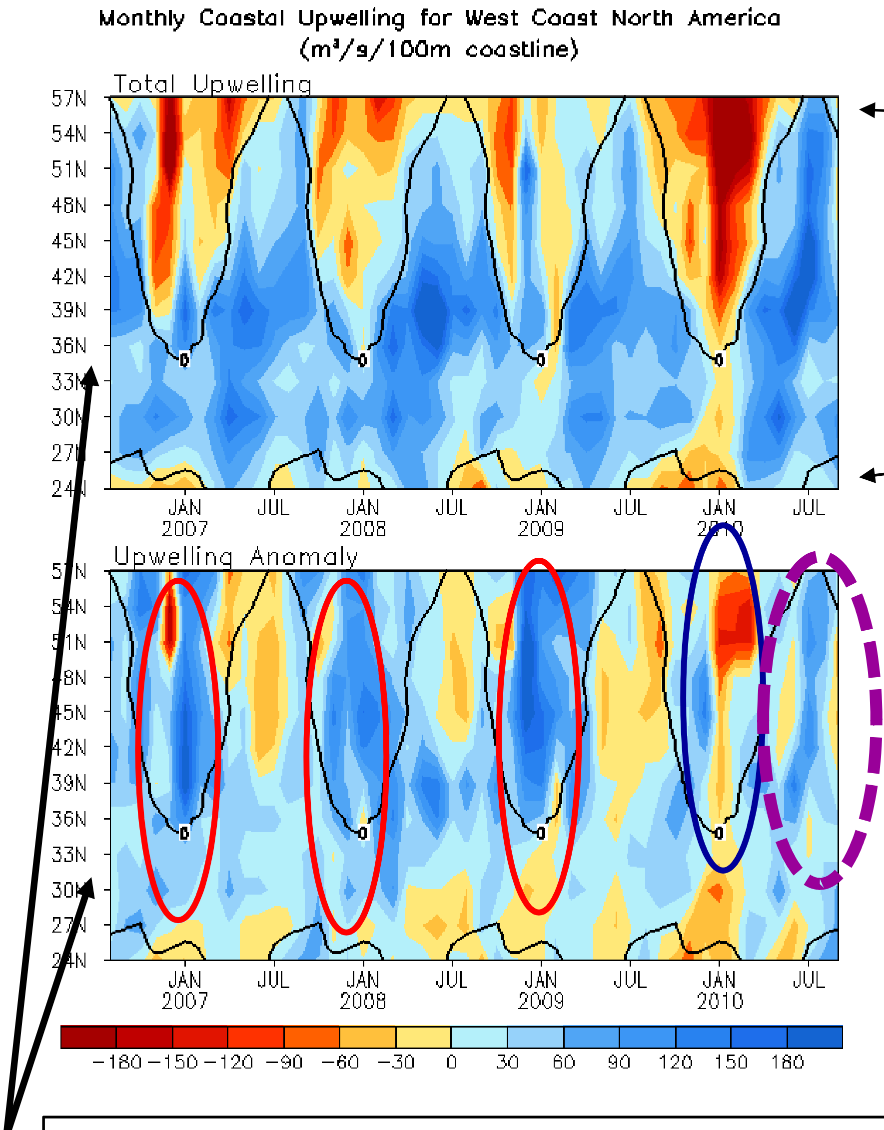
- **Negative (positive) chlorophyll anomaly presented along the coast north (south) of 33N.**
- **The chlorophyll anomalies are consistent with the upwelling anomalies in Sep 2010.**

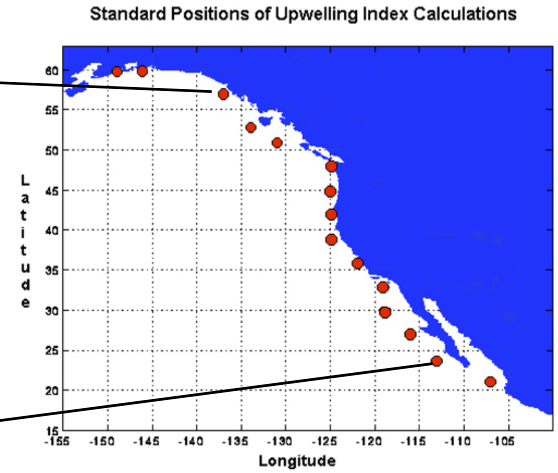
MODIS Aqua Chlorophyll a Anomaly for August, 2010



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.

- The 2010 upwelling season so far is relatively strong compared with other seasons since 2007.

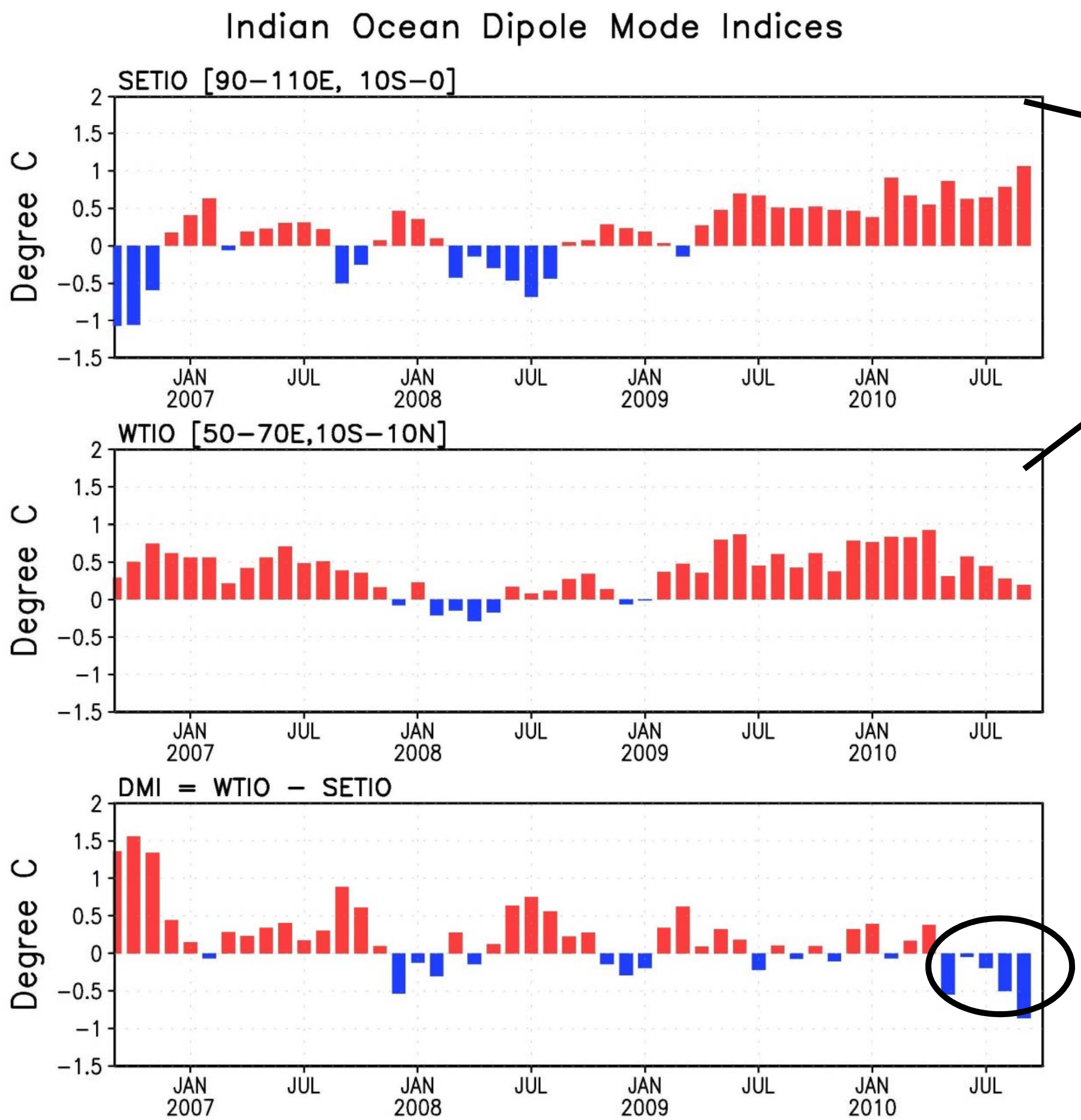
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport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

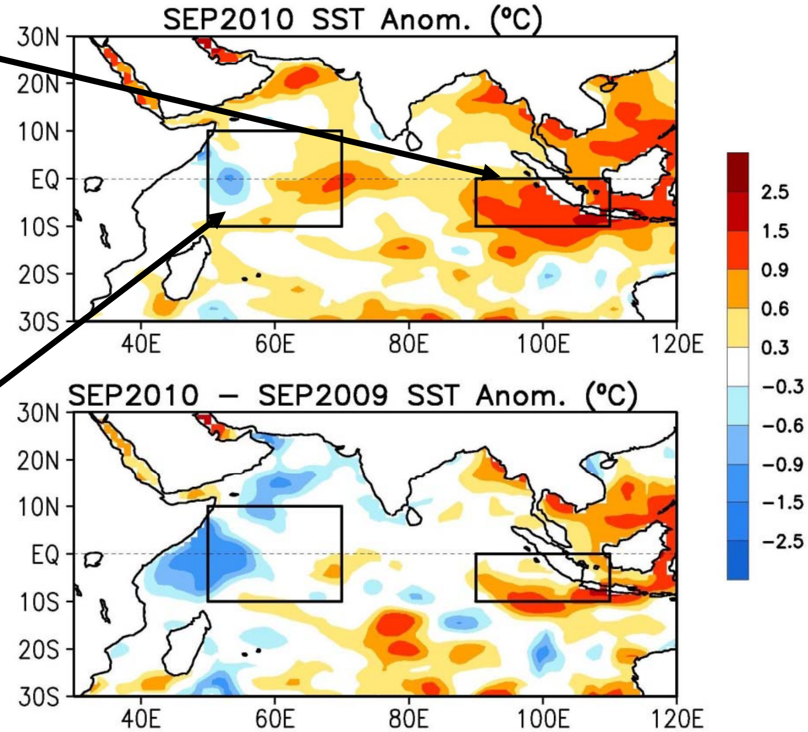
- Area below (above) black line indicates climatological upwelling (downwelling) season.

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

Tropical Indian Ocean

Evolution of Indian Ocean SST Indices

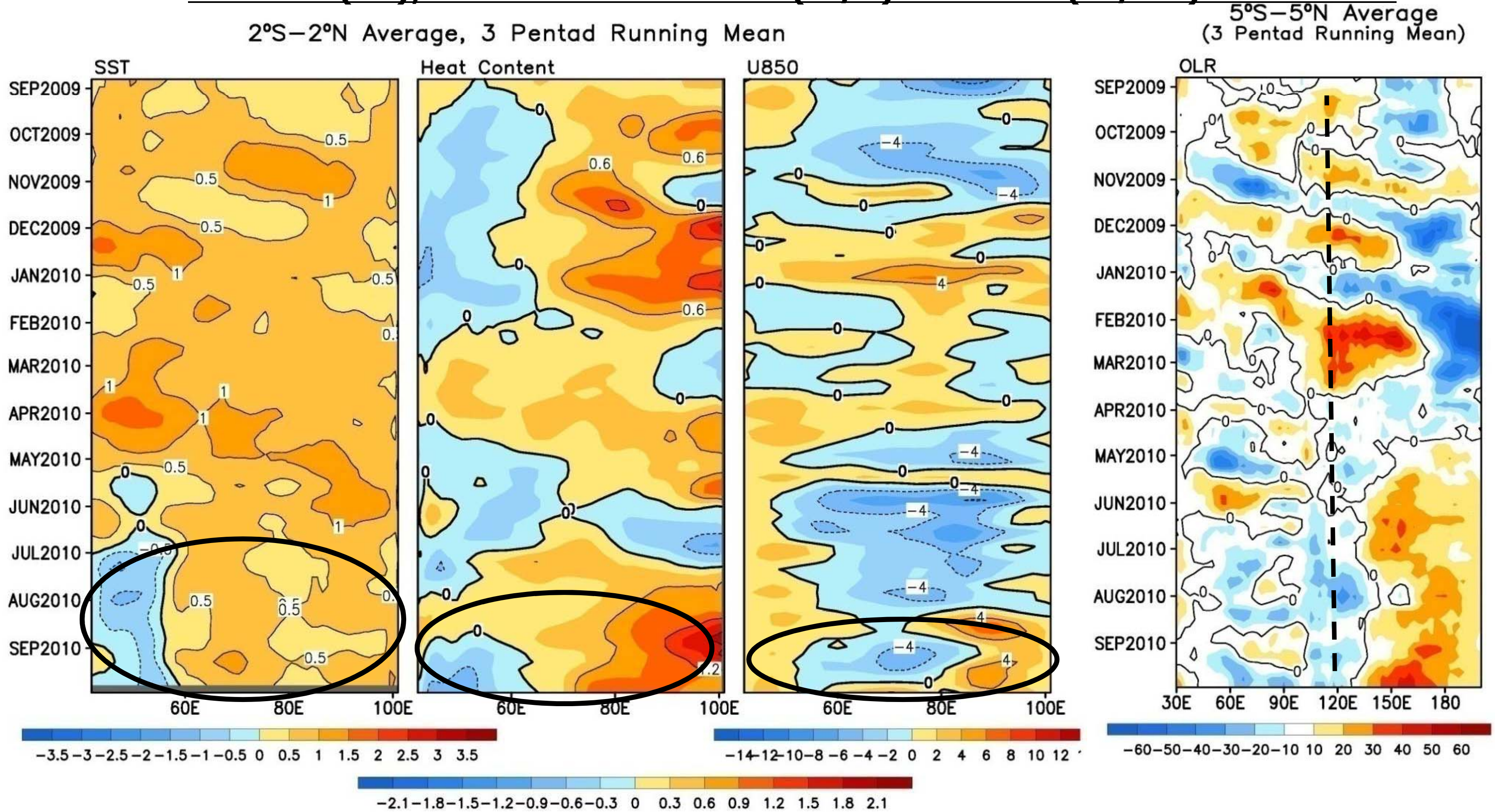




- **Eastern (SETIO) pole SSTA increased to about 1C above-normal; while western (WTIO) pole SST decreased to near-normal.**
- **DMI was below-normal since May 2010, and strengthened in Sep 2010.**

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.

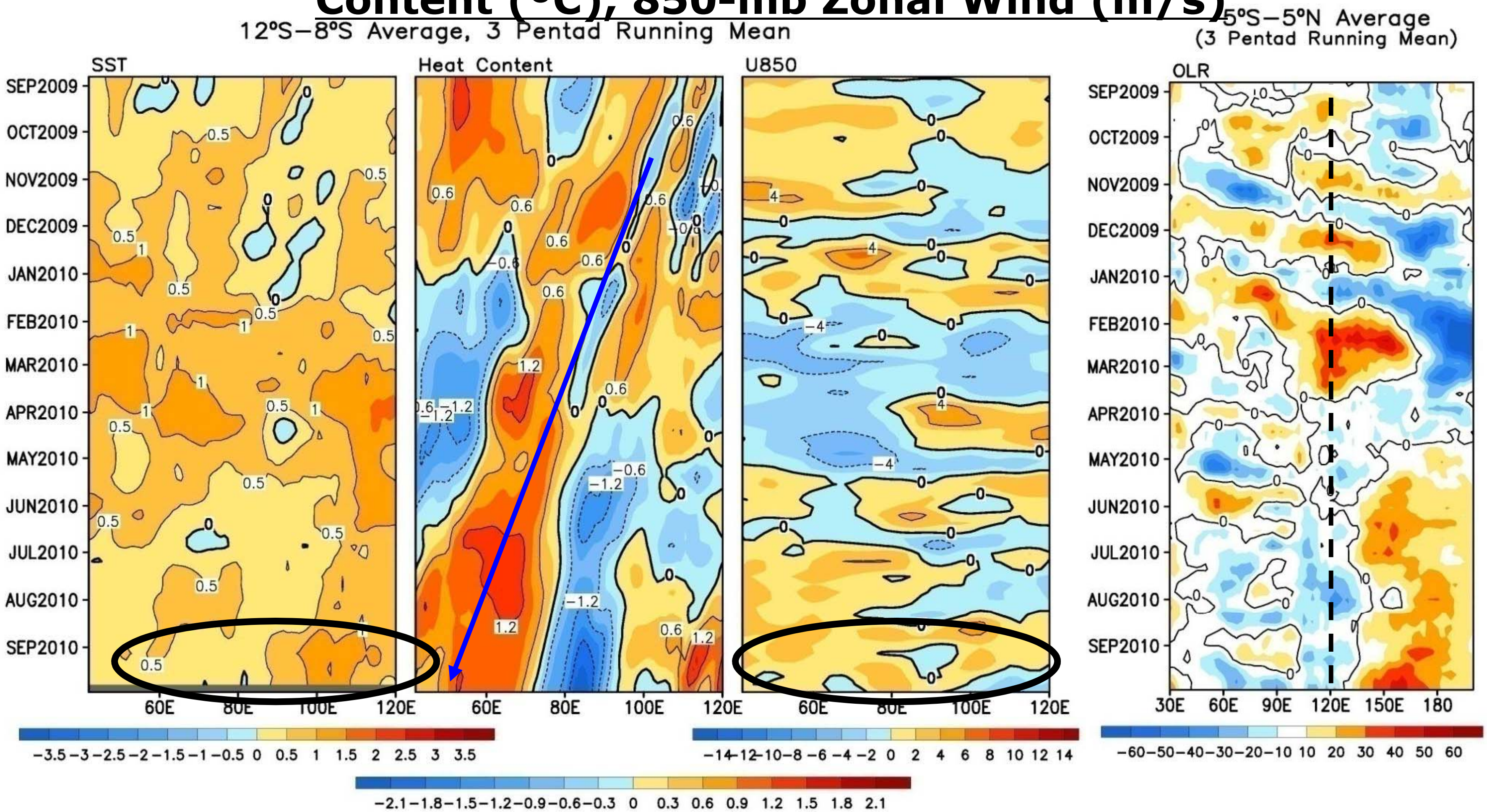
Recent Evolution of Equatorial Indian SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s) and OLR (W/m²) Anomalies



- Weakly negative (positive) SSTA presented in the western (central-eastern) Indian Ocean since Jul 2010.
- Heat content anomaly transitioned to negative west of 60E in Sep 2010, consistent with local SSTA.
- Westerly (easterly) wind anomalies presented west (east) of 80E in Sep 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.

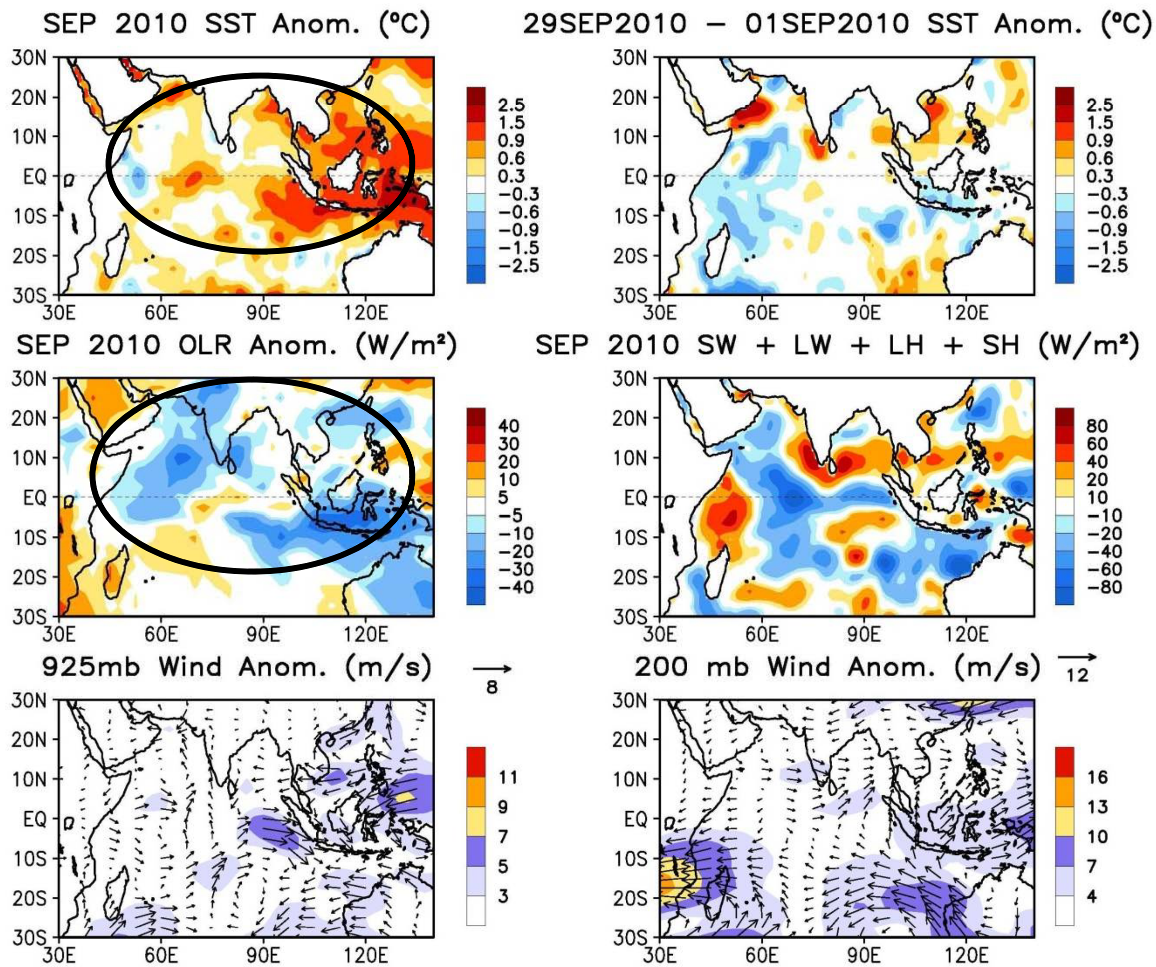
Recent Evolution of 10°S Indian SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s)



- **Positive SSTA persisted east of 90E in Sep 2010.**
- **Positive HCA propagated westward since Jun 2009, and reached the western boundary in Sep 2010.**
- **Low-level wind anomaly was mostly westerly since Aug 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.

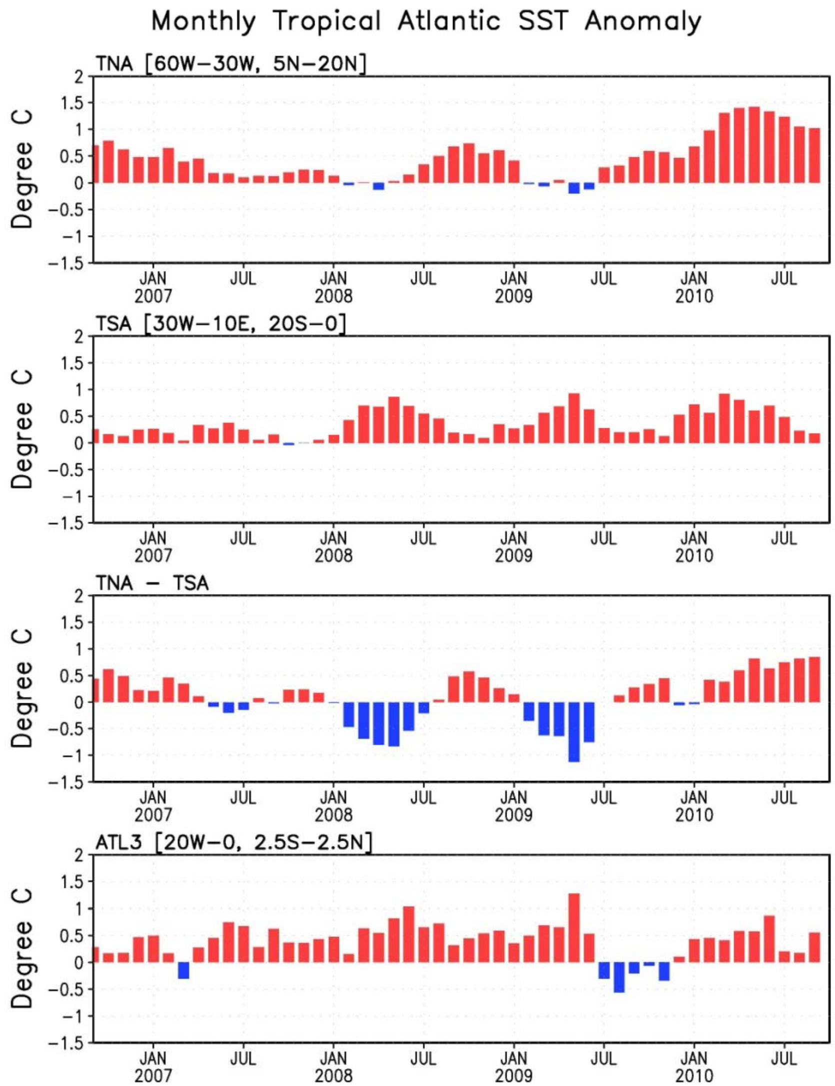


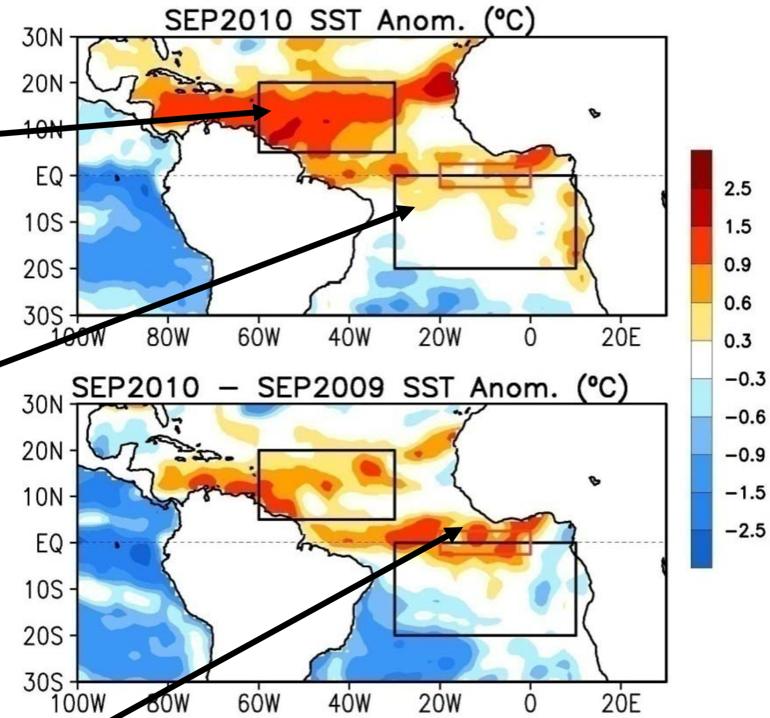
- **The tropical Indian Ocean Basin warming weakened in Sep 2010.**
- **The SST tendency is partially consistent with net surface heat flux anomalies.**
- **Convection is enhanced over the north-western tropical Indian Ocean and Maritime Continent.**

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

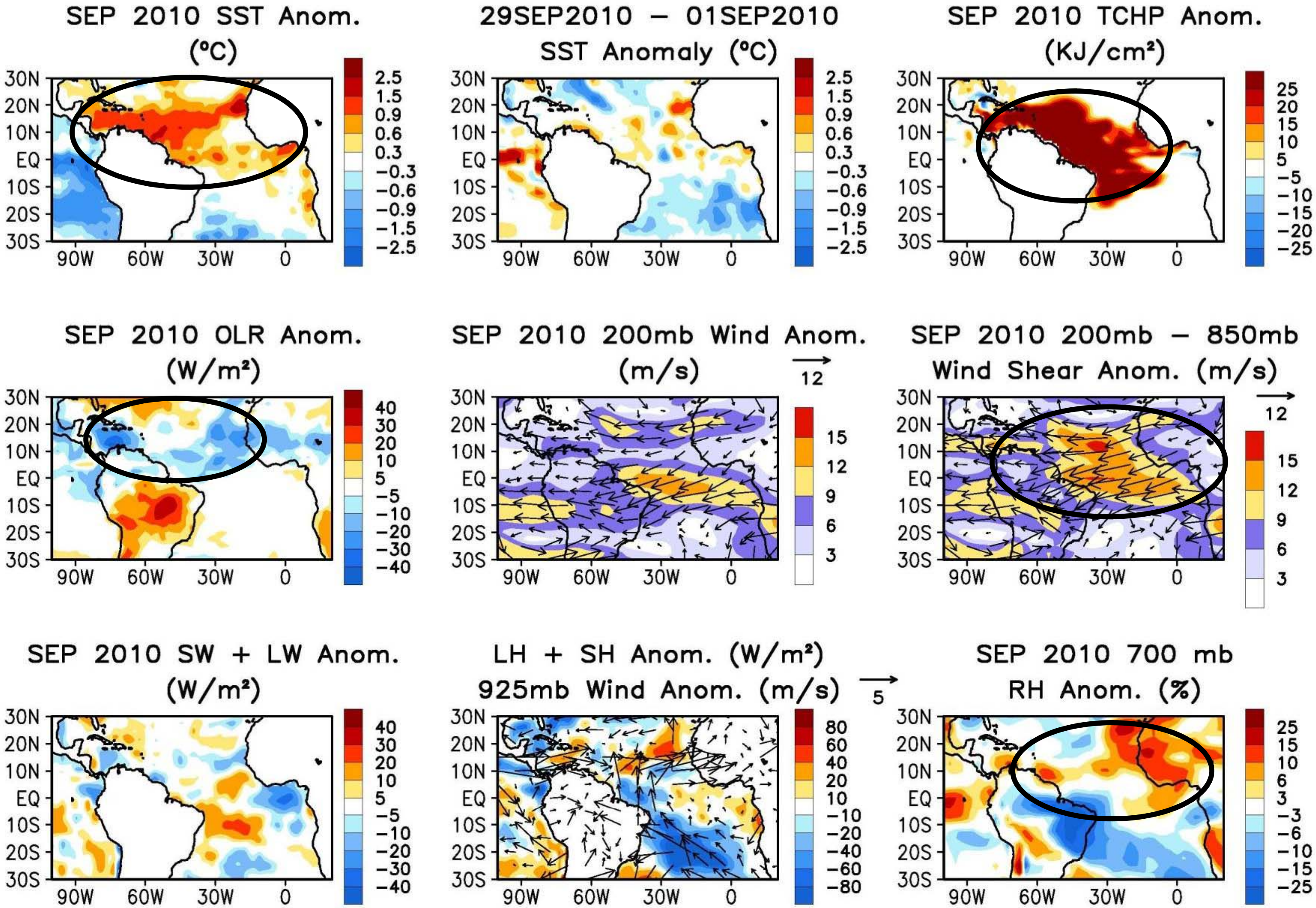




- **Positive SSTA in the tropical North and South Atlantic (TNA and TSA) persisted in Sep 2010.**
- **Meridional Gradient Mode (TNA-TSA) has been above-normal since Feb 2010.**
- **ATL3 SST has been positive since Dec 2009 and strengthened in Sep 2010.**

Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (ºC) for the TNA [60ºW-30ºW, 5ºN-20ºN], TSA [30ºW-10ºE, 20ºS-0] and ATL3 [20ºW-0, 2.5ºS-2.5ºN] 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:



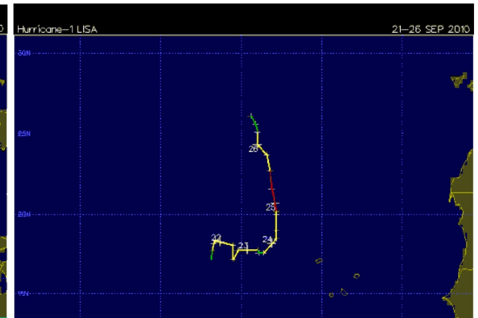
- **Positive SSTA in the tropical N. Atlantic persisted in Sep 2010.**
- **Convection was enhanced over the tropical North Atlantic.**
- **Relative humidity was mostly above-normal in the tropical N. Atlantic and W. Africa.**
- **Easterly wind shear anomaly and above-normal TCHP in the Atlantic hurricane MDR are favourable for hurricane development.**

Atlantic Hurricane Activity During Sep 1-Oct 7, 2010

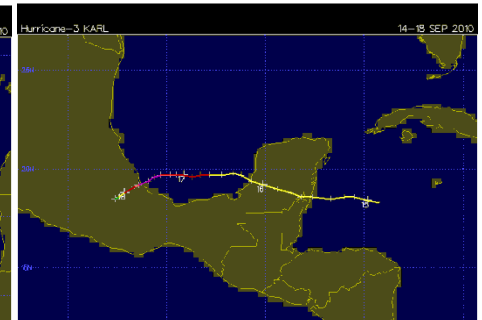
(http://weather.unisys.com/hurricane/atlantic/2010/track.gif)

Tropical Storm Nicole 9/28-29

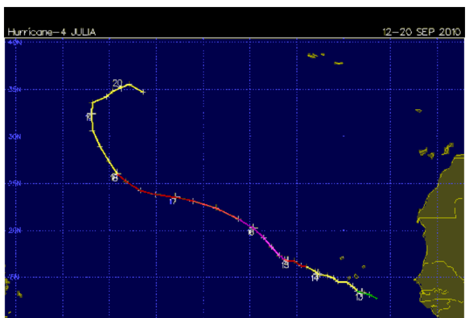
Tropical Storm Matthew 9/23-26



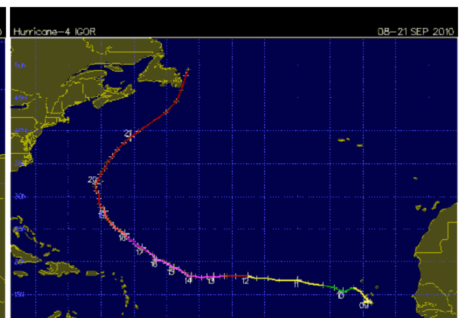
Hurricane-1 Lisa 9/21-26



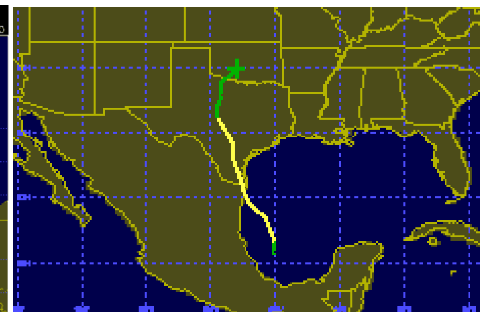
Hurricane-3 Karl 9/14-18



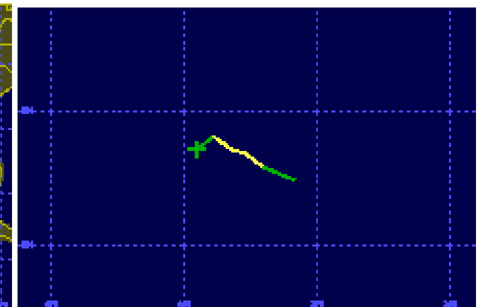
Hurricane-4 Karl 9/12-20



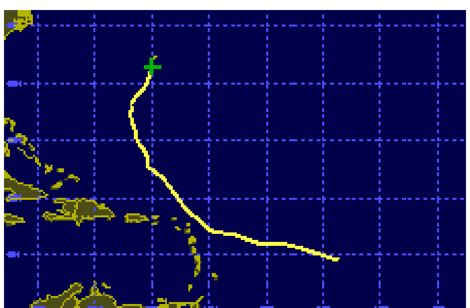
Hurricane-4 Igor 9/8-21



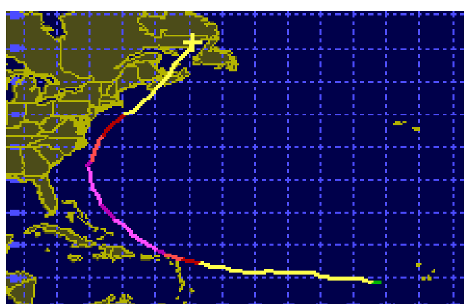
Tropical Storm Hermine 9/6-9



Tropical Storm Gaston 9/1-2



Tropical Storm Fiona 8/30-9/4



Hurricane-4 Earl 8/25-9/5

3-4 Cat-3 or greater (1.5)

4-5 hurricanes (2.5)

4-5 Tropical storms (4)

North Atlantic Ocean

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

- Negative NAO continued in Sep 2010 (next slide), consistent with SLP anomalies.
- Corresponding to the negative NAO was a tripole pattern of heat flux anomalies.
- SSTA tendency was generally consistent with surface heat flux anomalies.

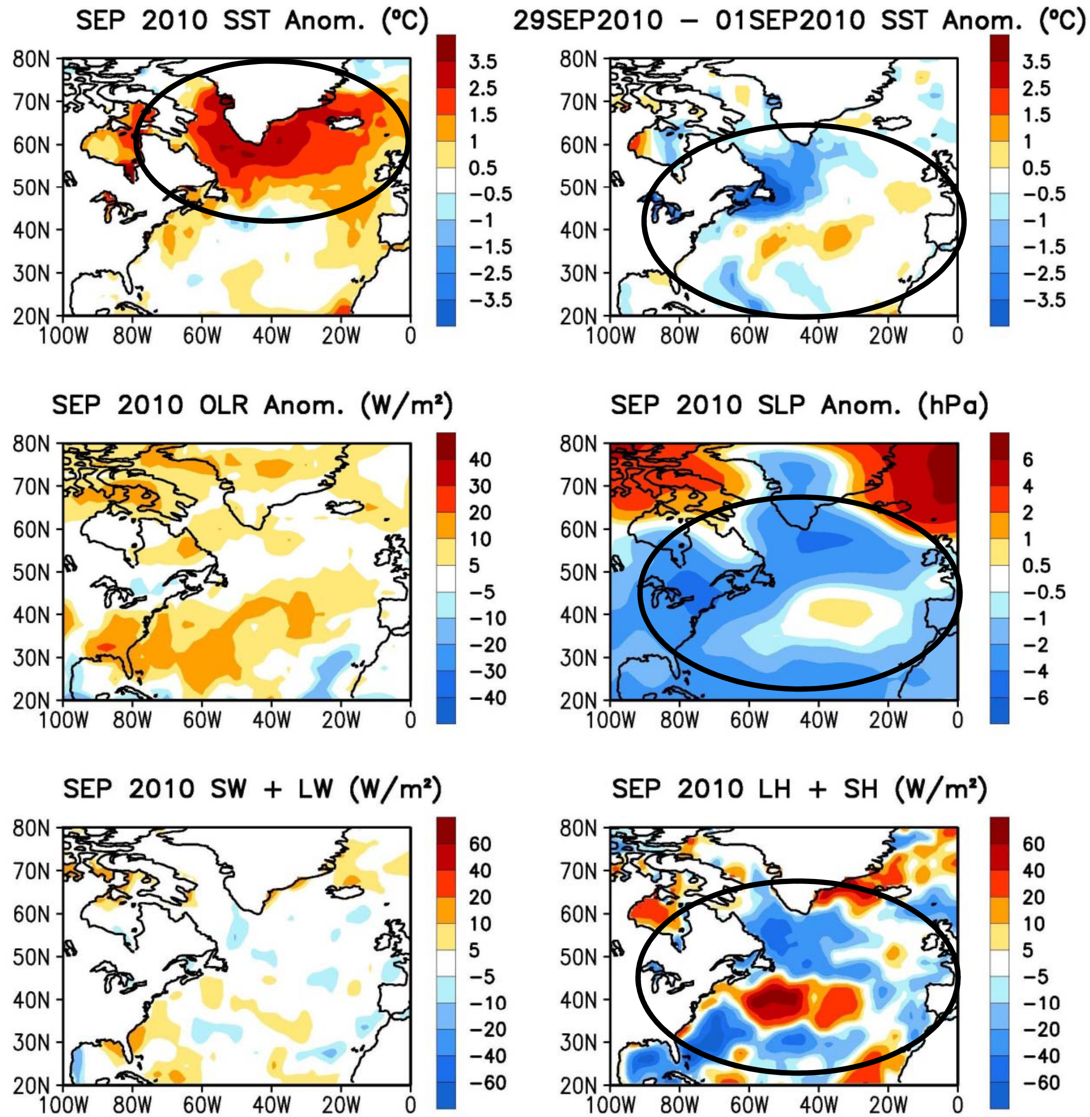
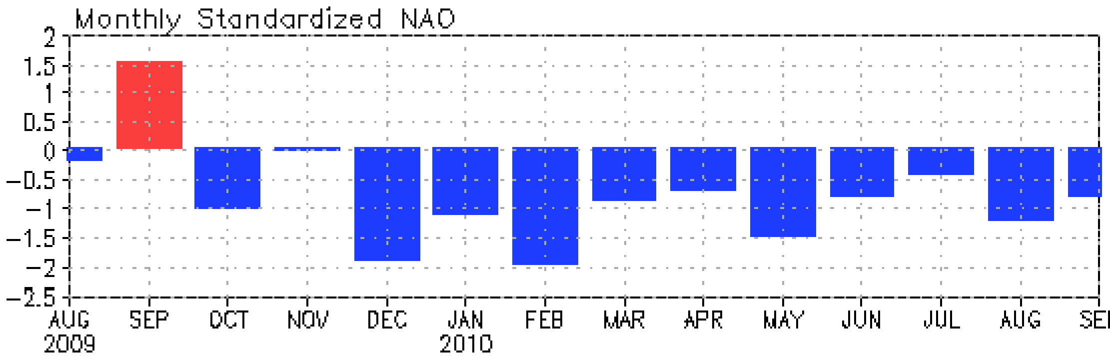
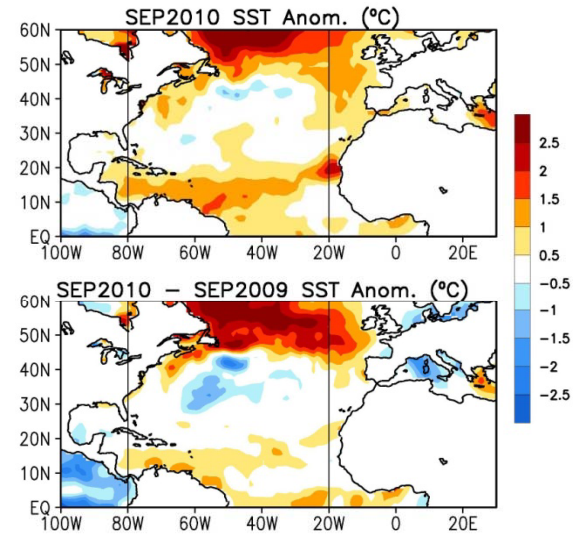
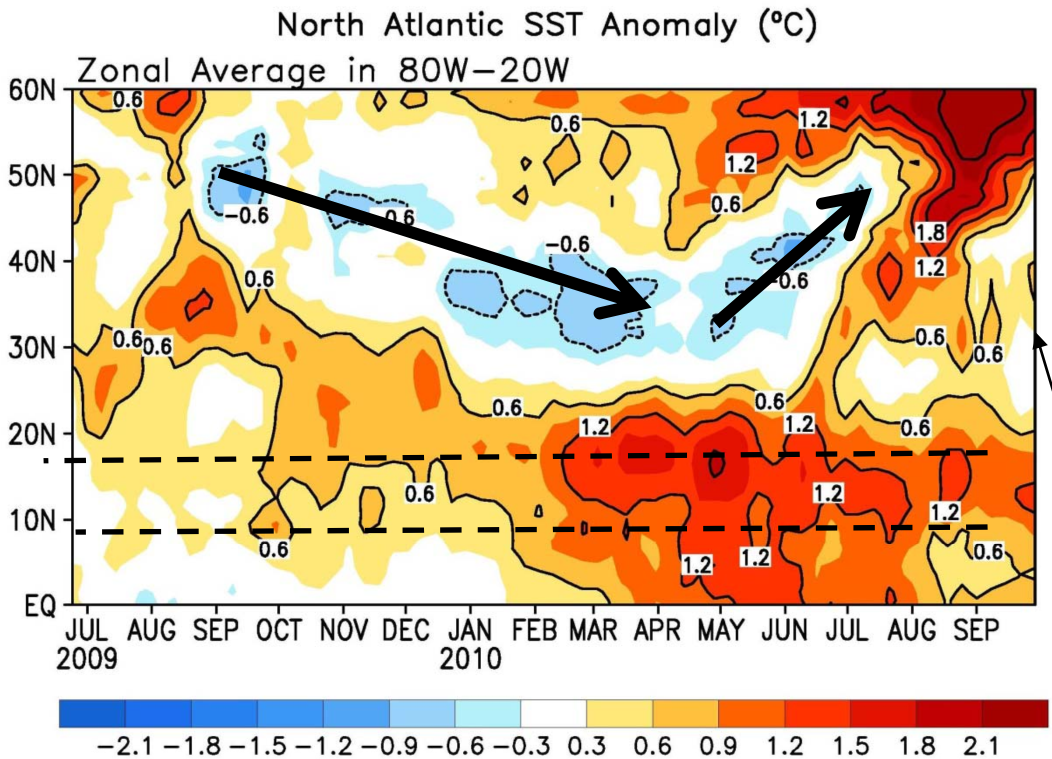


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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



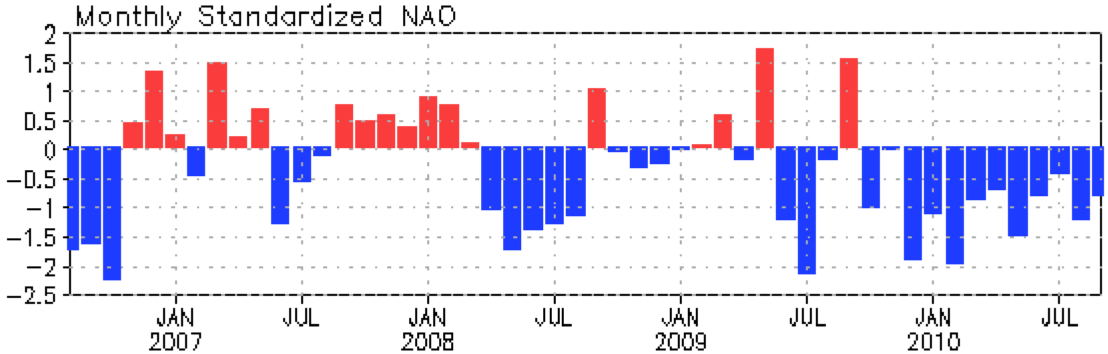


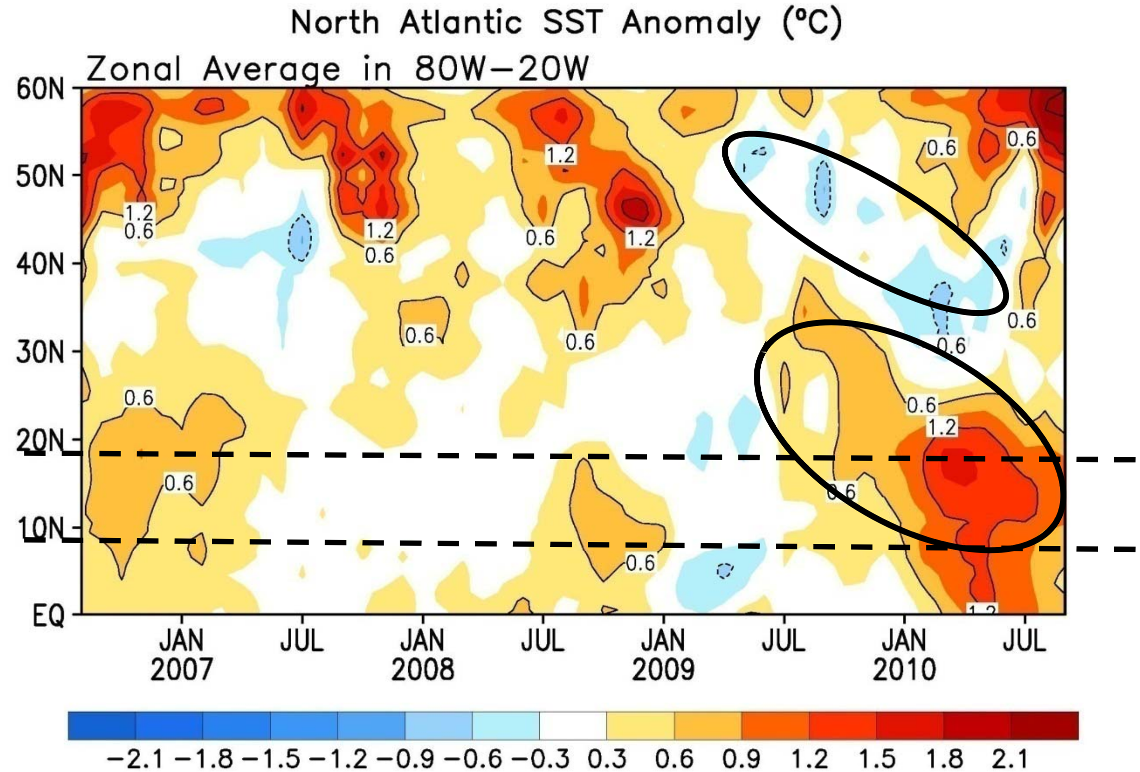


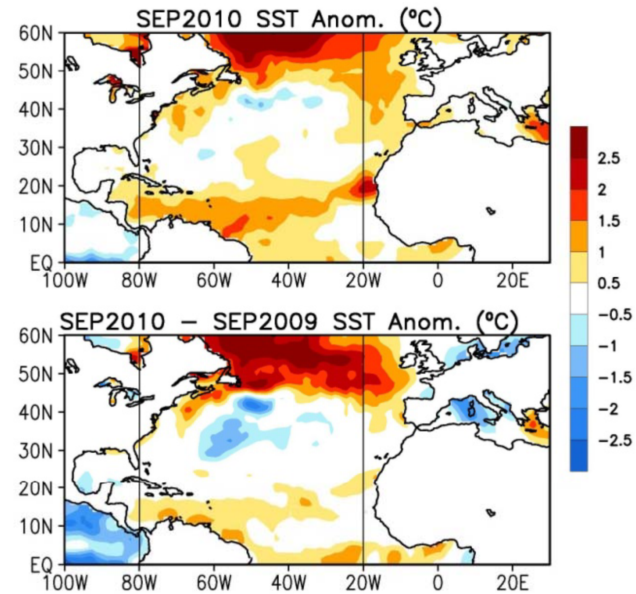
- NAO Index=-0.8.
- NAO has been persistently below-normal since Oct 2009, which contributed to the development and maintenance of negative (positive) SSTA in mid-latitude (tropical) North Atlantic.
- Strong warming presented in the high latitudes North Atlantic in Sep 2010.
- Positive SSTA in the Atlantic hurricane MDR have been above-normal since Oct 2009 and slightly weakened since Jun 2010, consistent with the delayed impacts of El Nino and seasonal cycle.
- The combination of persistent negative NAO phase and decay phase of El Nino in spring 2010 results in the strong positive SSTA in MDR, 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 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.

NAO and SST Anomaly in North Atlantic







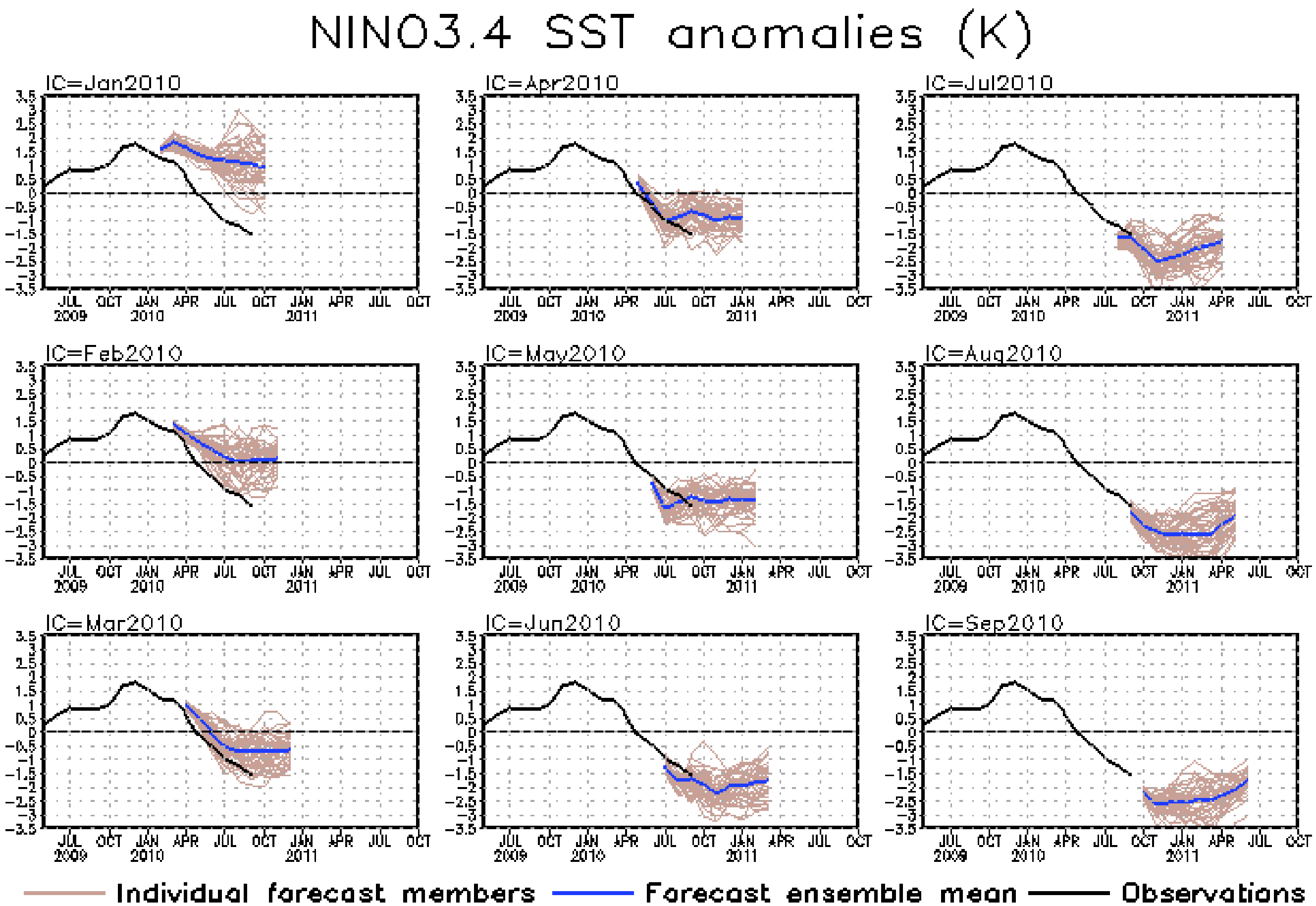
- Mid-latitude North Atlantic SST has been below-normal since May 2009 and become positive since Jul 2010.

- 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



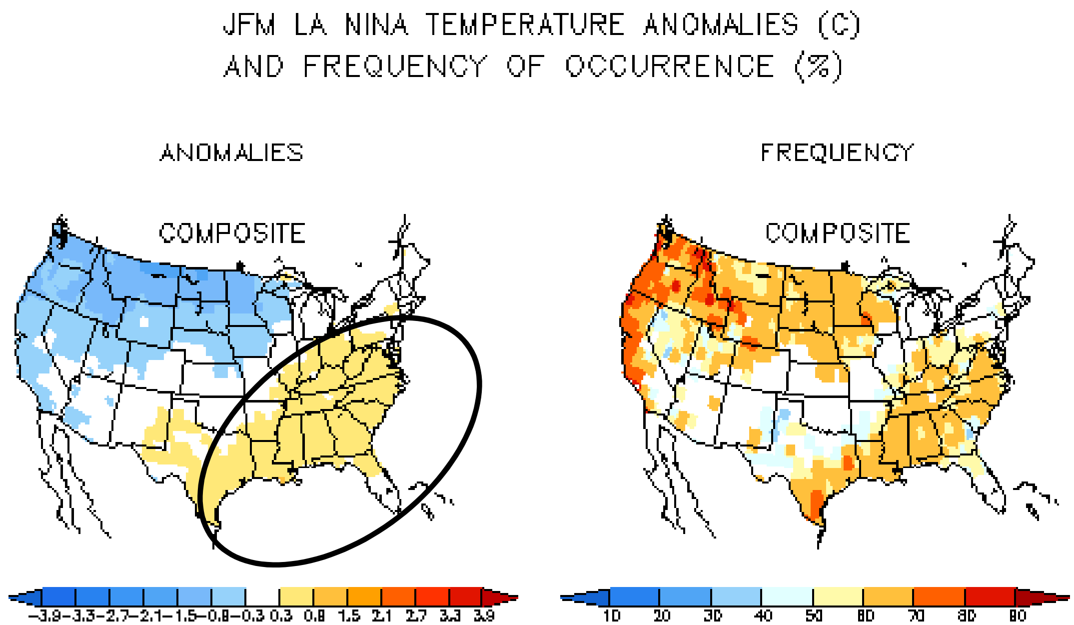
- Forecasts from Jan-Mar I.C. show warm biases, and delayed the transition from the warm phase to the cold phase of ENSO.

- The latest forecast from Sep 2010 I.C. suggests that La Niña conditions will reach its peak in winter of 2010-11, and last through the spring 2011.

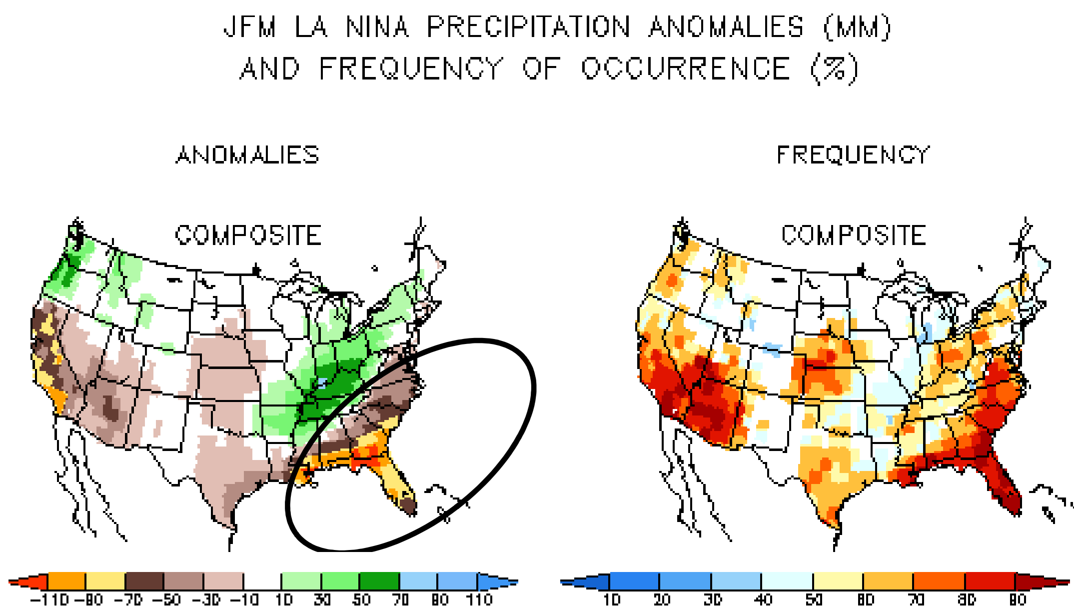
Fig. M1. CFS Nino3.4 SST prediction from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology 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.

La Nina impacts on U.S. Temperature and Precipitation

Temperature

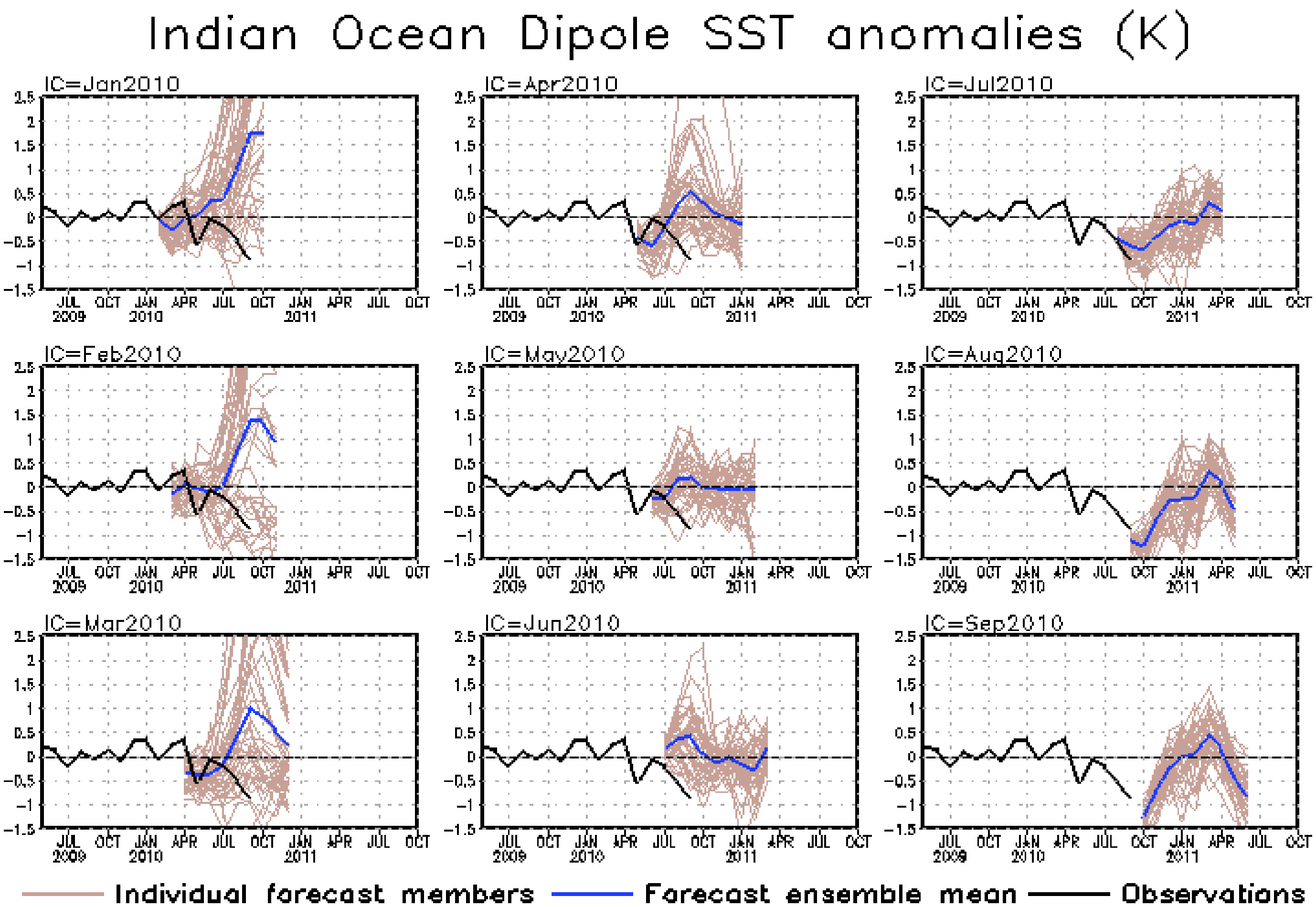


Precipitation



From CPC ENSO web page

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]

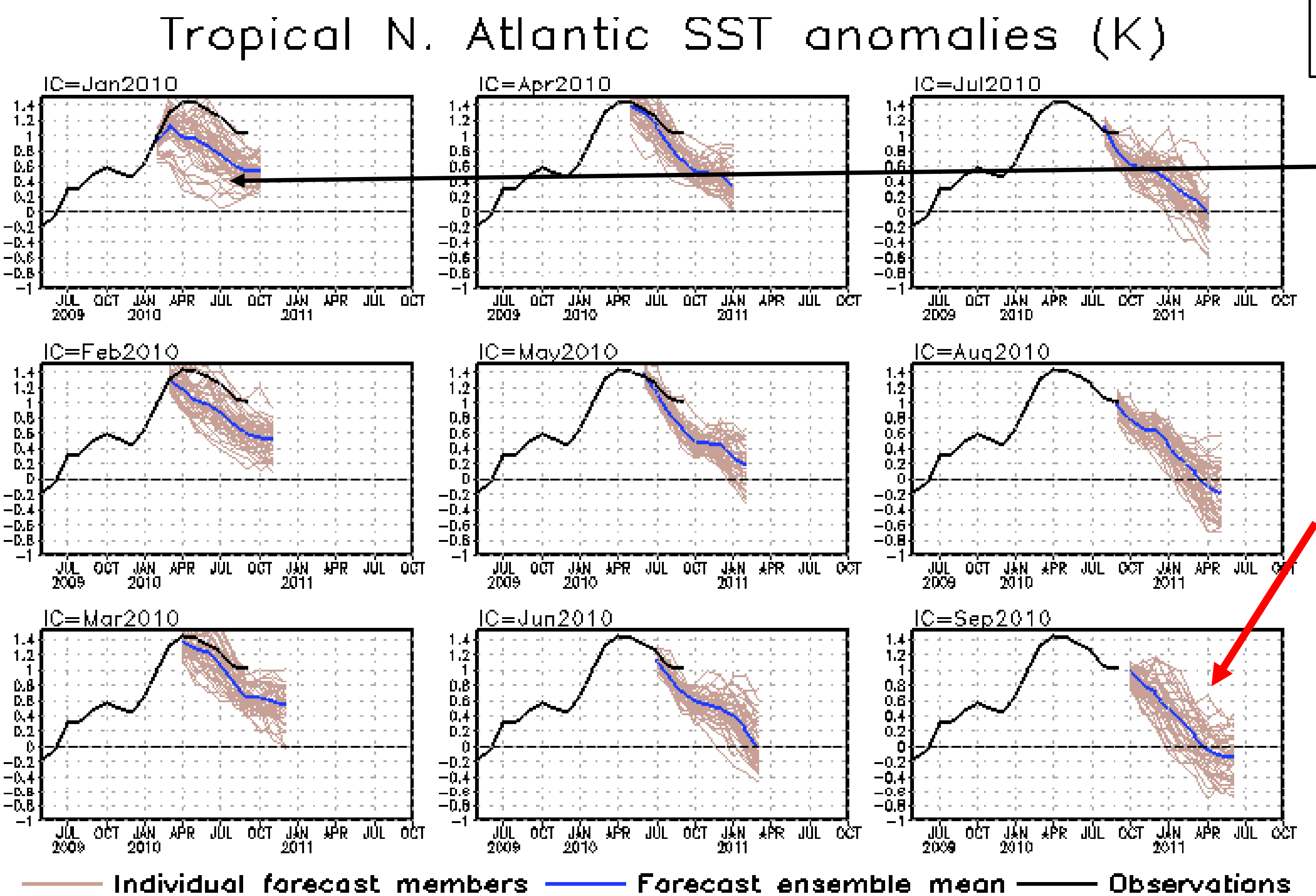
-Larger inter-ensemble member spread from Jan-Apr 2010 I.C. suggests the forecasts are less reliable. Relatively less spread in the forecasts since May 2010 I.C.

- Forecasts from Jul-Sep 2010 I.C. called for a 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].

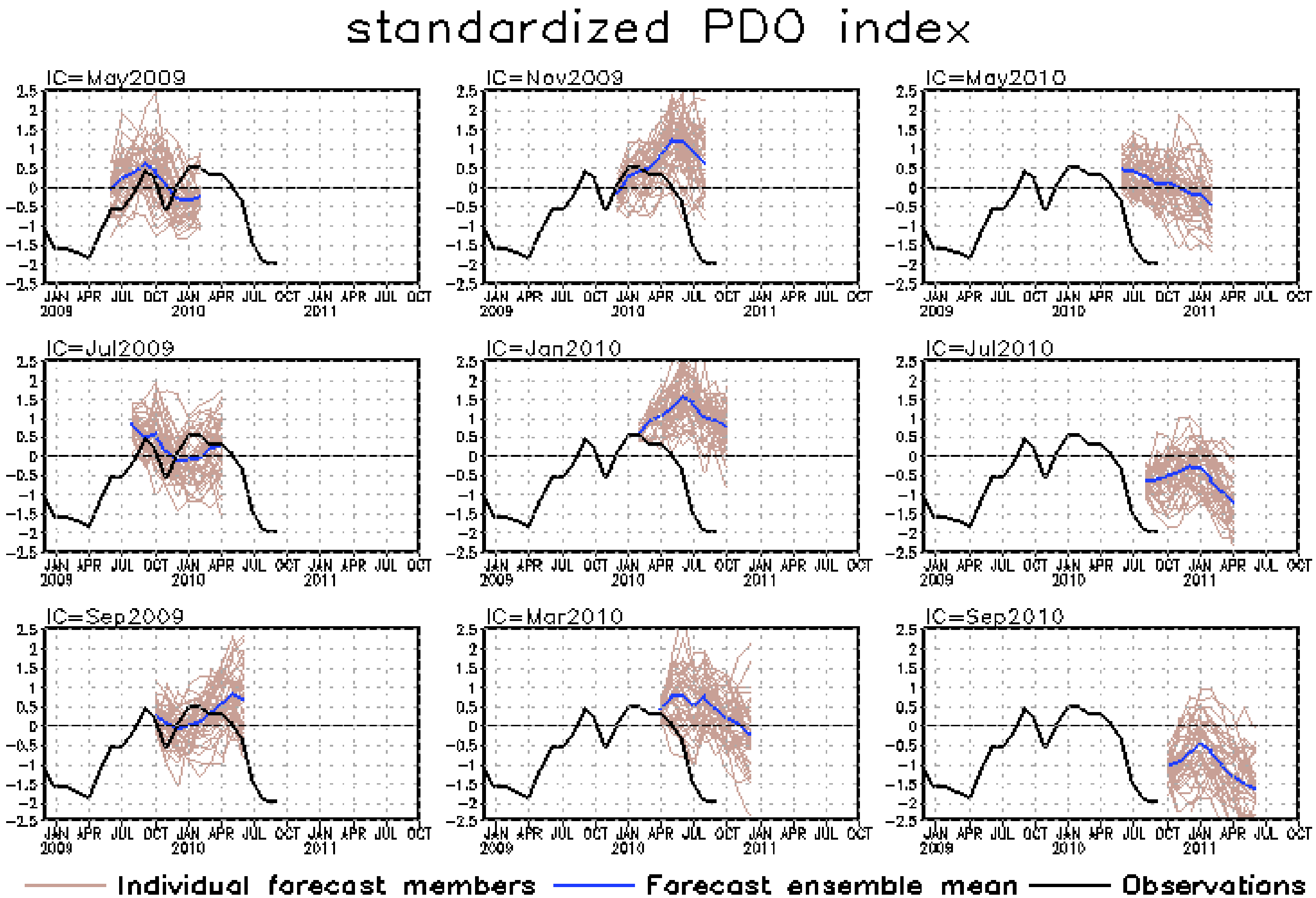


- Cold biases were large from Jan-Mar I.C.
- Less spread in the forecasts since Apr 2010 I.C.

- Latest forecasts suggested that positive SSTA in the tropical North Atlantic would decay in following months of 2010, and become near-normal in spring 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.

- Forecasts from Nov 2009-Jul 2010 I.C. show warm biases, and delayed the transition from above-normal to below-normal of the values of PDO index.

- Latest forecasts suggested that the below-normal PDO will last through the Northern Hemisphere spring 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/Arctic Ocean**
  - **ENSO cycle: La Niña conditions intensified (NINO3.4=-1.7°C in Sep 2010).**
  - **NOAA/NCEP Climate Forecast System (CFS) predicted a strong La Niña, to last through the Northern Hemisphere spring 2011.**
  - **PDO has been below-normal since Jul 2010, strengthened to be -2 in Sep 2010.**
  - **Arctic sea ice extent increased seasonally after mid-Sep 2010, and was still well below-normal.**
- **Indian Ocean**
  - **The tropical Indian Ocean Basin warming weakened in Sep 2010.**
  - **Dipole Mode index has been below-normal since May 2010, and strengthened to be about -0.8C in Sep 2010.**
- **Atlantic Ocean**
  - **NAO index has been persistently below-normal since Oct 2009, and it was -0.8 in Sep 2010.**
  - **Strong positive SSTA (>2.5C) presented in the high latitudes in Sep 2010.**
  - **SST in the tropical North Atlantic (TNA) has increased steadily from Dec 2009 to May 2010, gradually weakened from Jun to Aug 2010, and persisted in Sep 2010.**
  - **Easterly wind shear anomaly and above-normal tropical cyclone heat potential in the Atlantic hurricane MDR were 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!