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

Prepared by
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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)

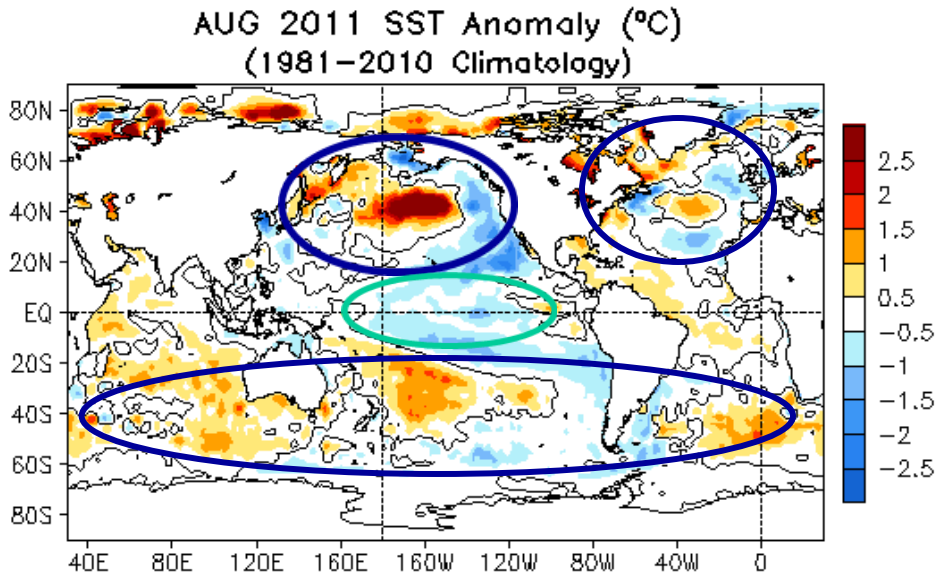
Outline

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

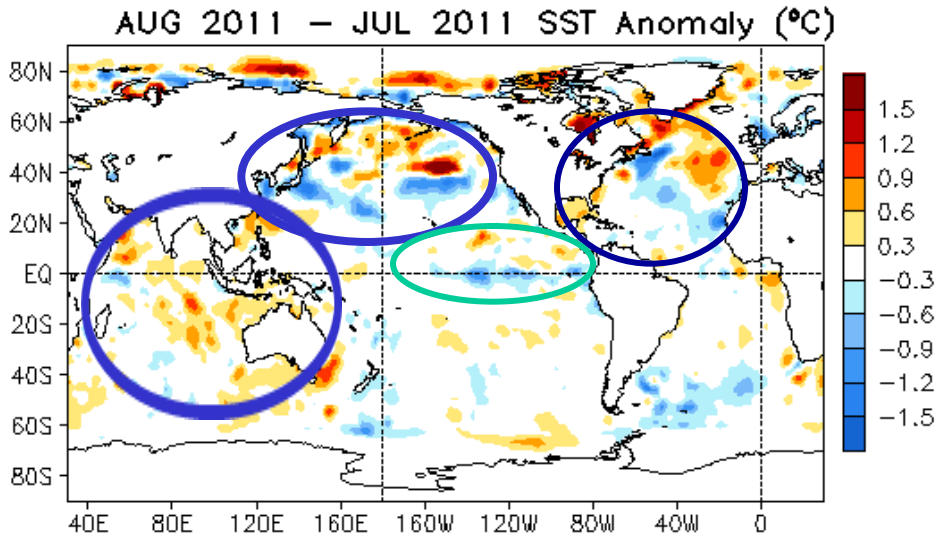
Overview

- **Pacific and Arctic Oceans**
  - La Nina conditions rebounded with OISST NINO3.4=-0.6°C in Aug 2011.
  - Some models, including CFSv1 and CFSv2 predict a moderate La Nina event in coming boreal fall and winter.
  - Negative PDO persisted, with PDOI=-2.3 in Aug 2011.
  - Artic sea ice extent continued to decline in Aug 2011.
- **Indian Ocean**
  - Positive SSTA developed along the African equatorial coast.
- **Atlantic Ocean**
  - Negative phase NAO presented since May 2011 and intensified in Jun and Jul 2011, and persisted in Aug 2011 with NAOI=-1.4.
  - Positive SSTA continued and small wind shear observed in the Atlantic Hurricane Main Development Region.

Global SST Anomaly (°C) and Anomaly Tendency



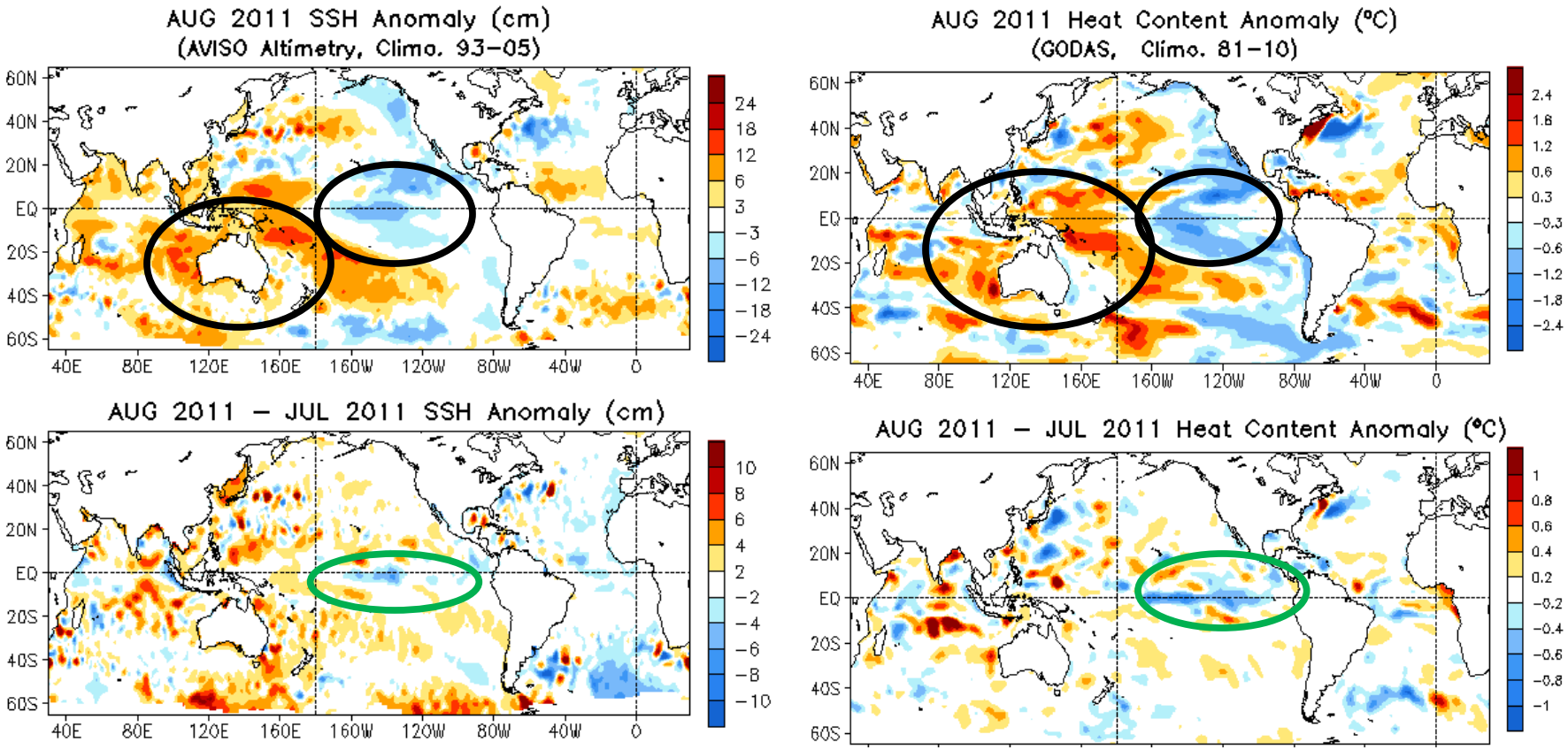
- **Negative SSTA presented over the equatorial central-eastern Pacific.**
- **A horseshoe pattern in the North Pacific persisted.**
- **Horseshoe SSTA pattern prevailed over the extratropical North Atlantic and SST in the tropical Atlantic was above normal.**
- **Positive SSTA was observed in mid-latitude southern oceans.**



- **Cooling tendencies presented in the central and eastern tropical Pacific.**
- **Positive (negative) tendencies observed in high (middle) latitudes of North Pacific and North Atlantic.**
- **Warming tendencies seen in the central-eastern tropical Indian 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 1981-2010 base period means.

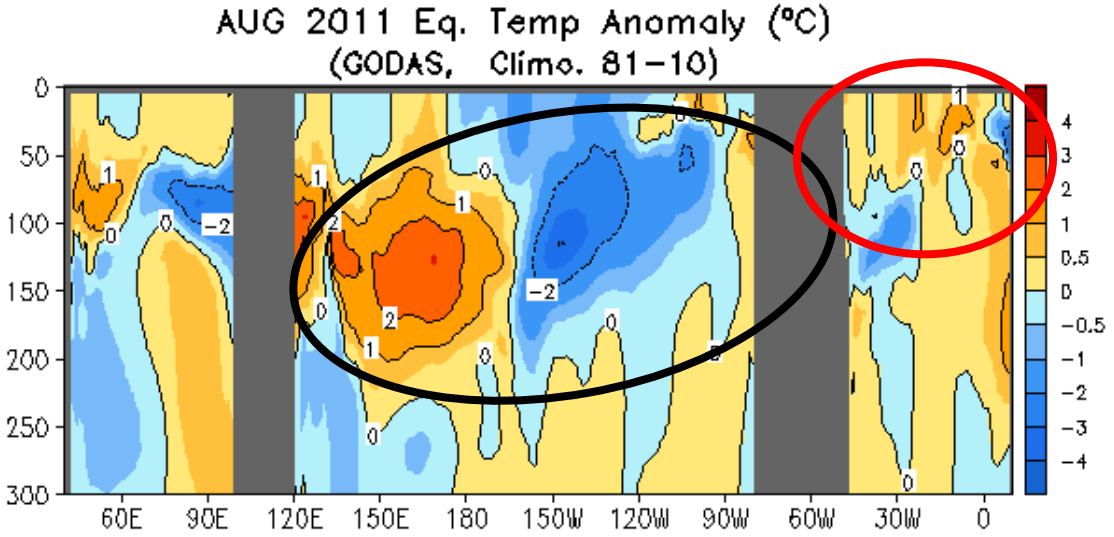
Global SSH/HC Anomaly (cm/°C) and Anomaly Tendency



- **Positive SSH and Heat Content (HC) anomalies persisted in the western tropical Pacific and tropical Indian Ocean.**
- **Negative SSH and HC anomalies were observed along the equator in the east-central tropical Pacific, consisting with the return 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.

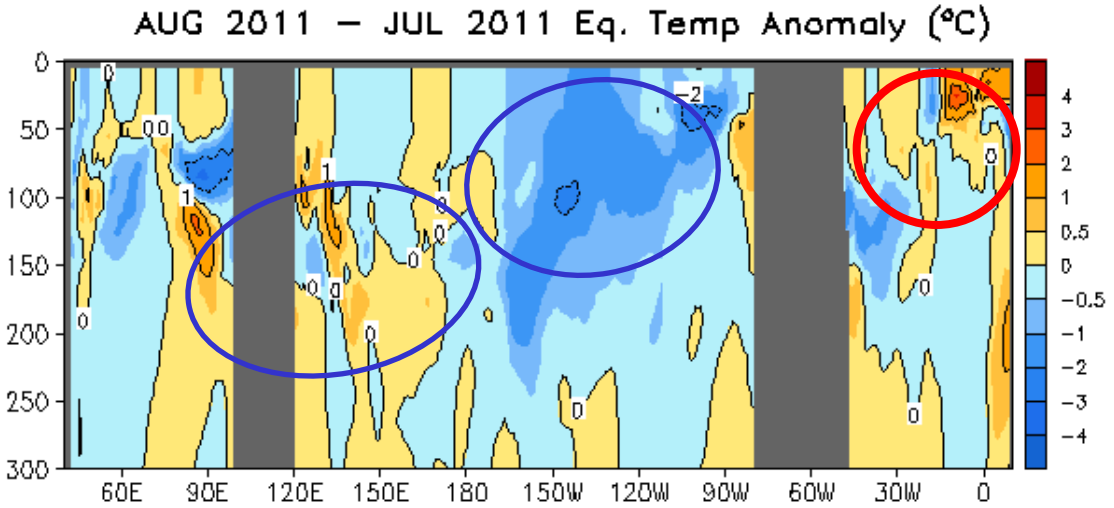
Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2°S-2°N



- **Negative temperature anomalies intensified in the equatorial central and eastern Pacific.**

- **Positive temperature anomalies prevailed near the equatorial thermocline of the western Pacific Ocean.**

- **Both negative and positive anomalies presented in the Indian and Atlantic Oceans.**



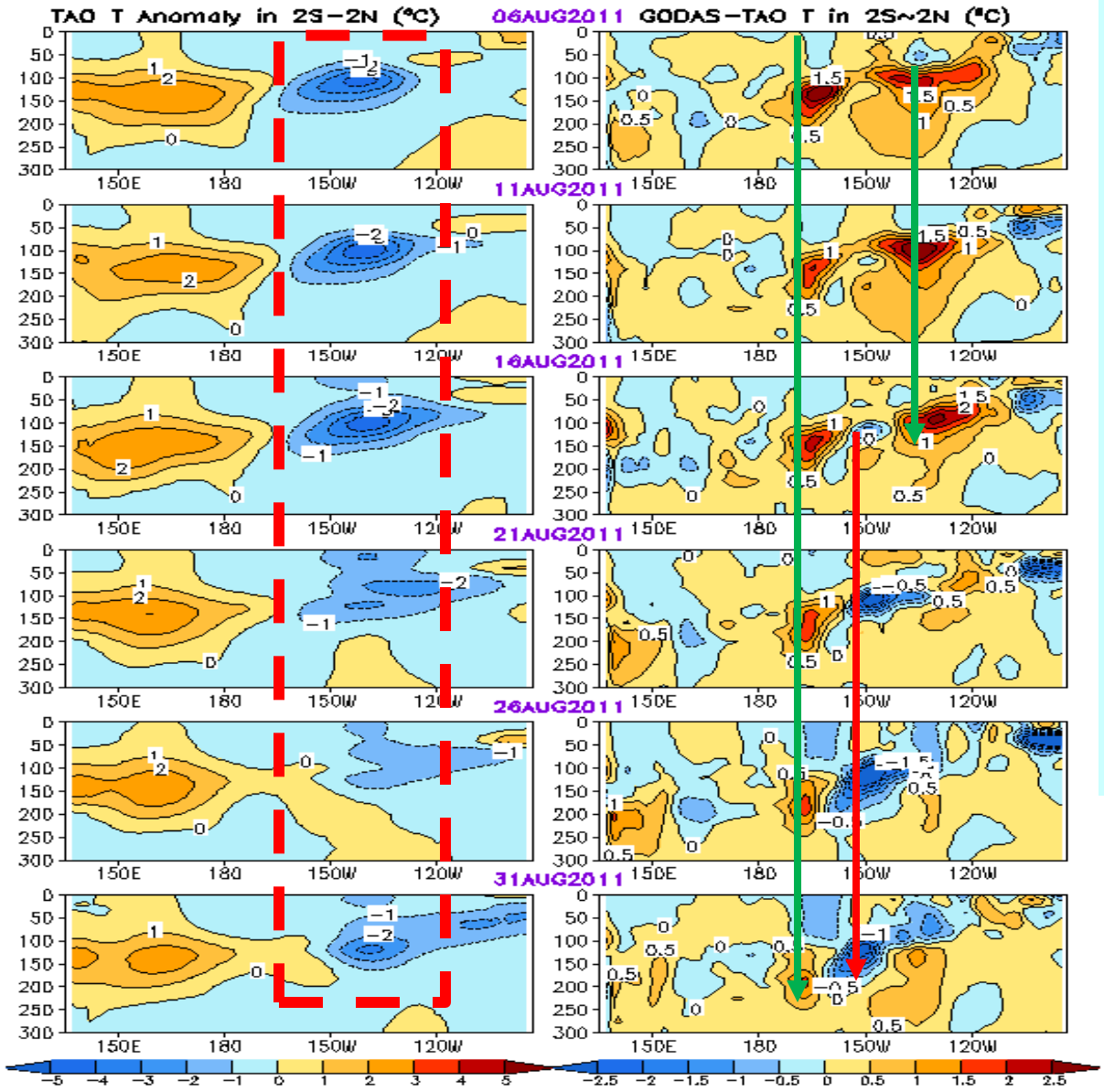
- **Compared with Jul, negative ocean temperature anomalies intensified in the east and positive ones persisted in the western Pacific along the thermocline in Aug 2011.**

- **Positive ocean temperature anomaly tendencies presented along the thermocline in the equatorial eastern 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.

Equatorial Pacific Temperature Anomaly

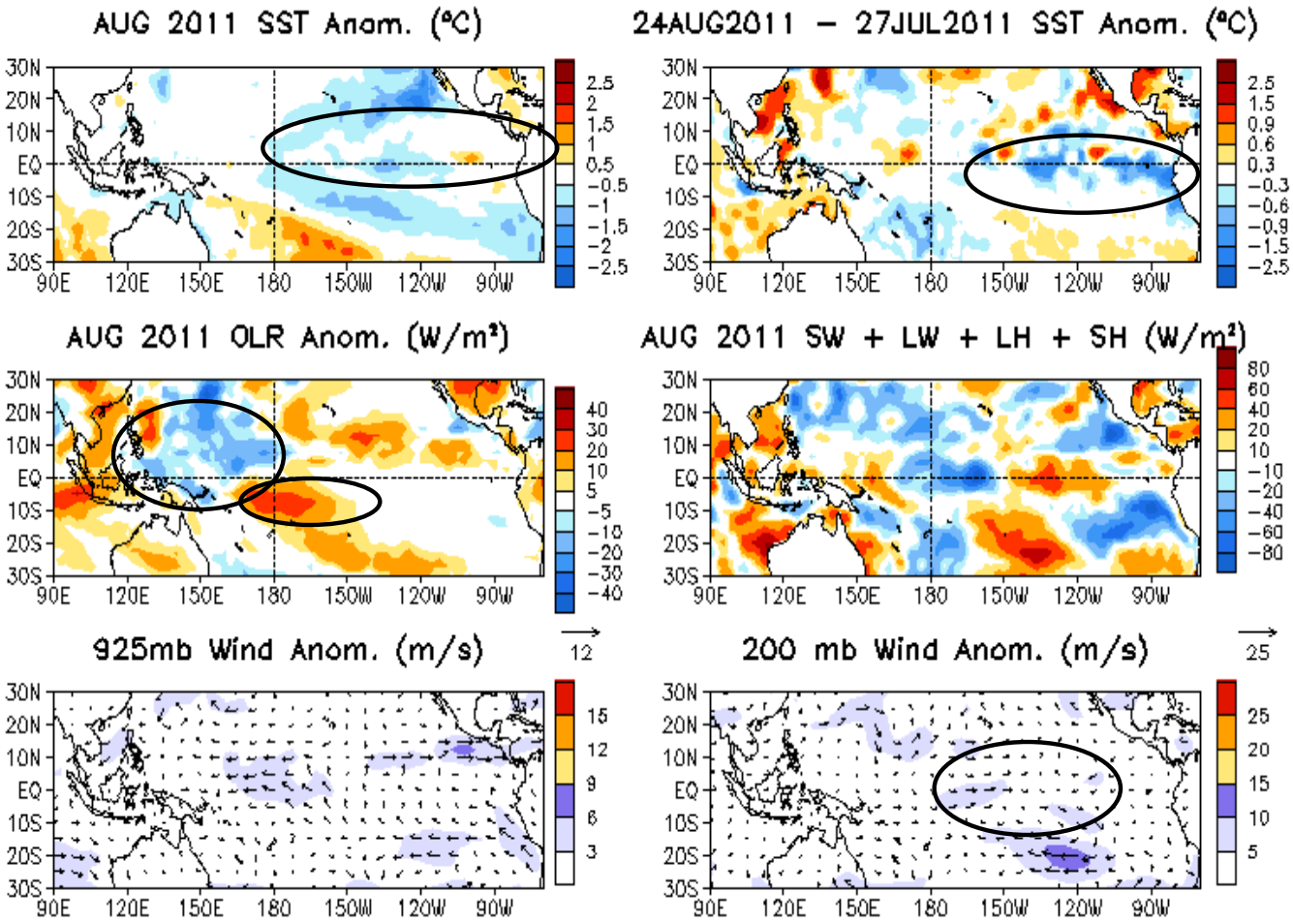
TAO GODAS-TAO



- Negative temperature anomalies in the eastern Pacific weakened since 16 Aug, then strengthened in last pentad.
- Positive ocean temperature anomalies are dominated in the western Pacific.
- Compared with TAO, GODAS was still about 1-2°C too warm near the thermocline at 170W-160W and 120W-90W before Aug 16, and too cool along 150W in recent pentads.
- Some TAO moorings have failed to delivery data in 2010-2011, which might contribute to the large discrepancies between TAO and GODAS.

Tropical Pacific Ocean

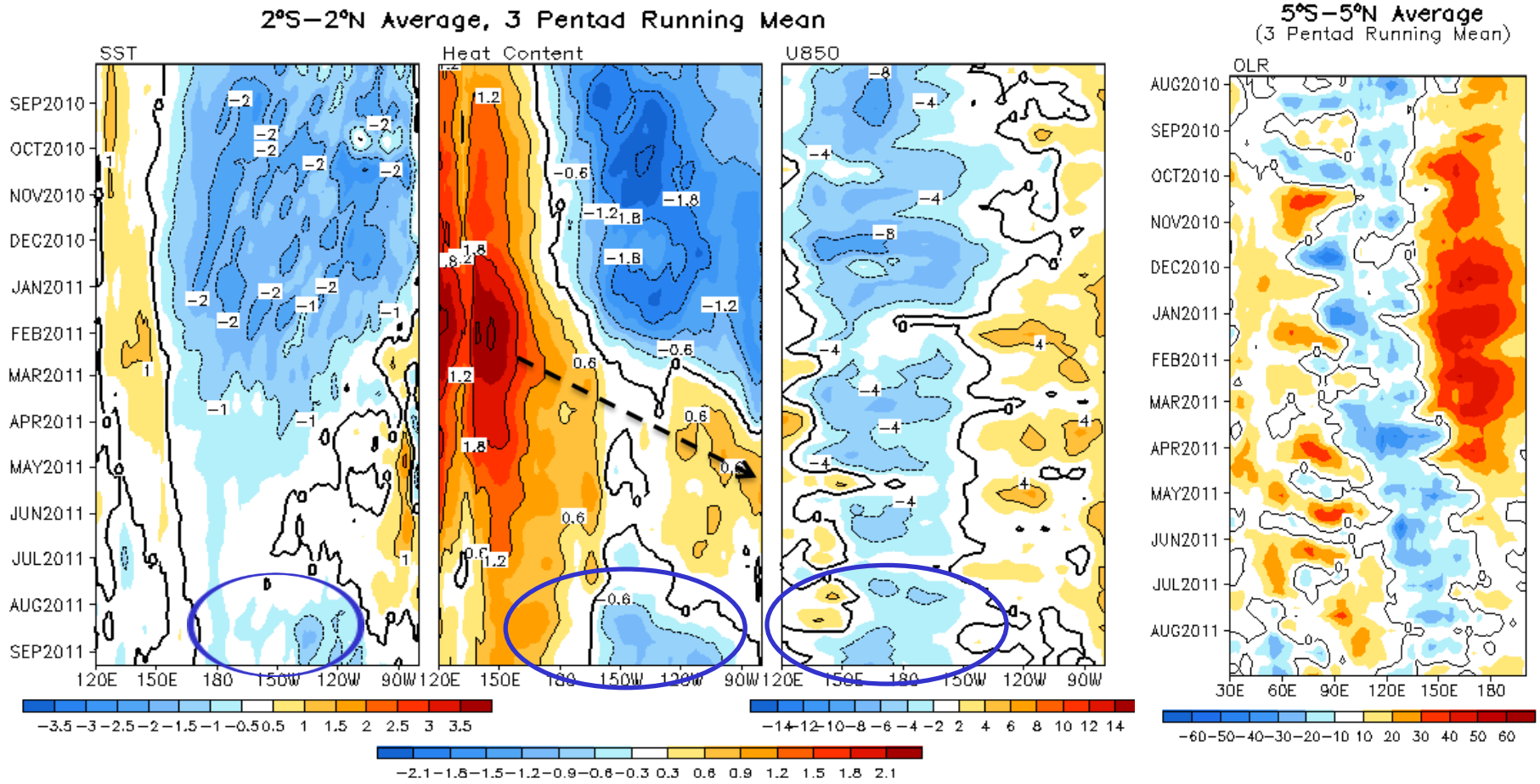
Tropical Pacific: SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Winds



- **Negative SSTA prevailed over much of the equatorial Pacific Ocean and intensified in Aug.**
- **Convection was enhanced near the Philippine Sea and suppressed south of the equator near the dateline.**
- **Westerly (easterly) wind anomalies in high (low) level presented over the central-eastern (central) Pacific, consisting with the OLR pattern.**

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 1981-2010 base period means.

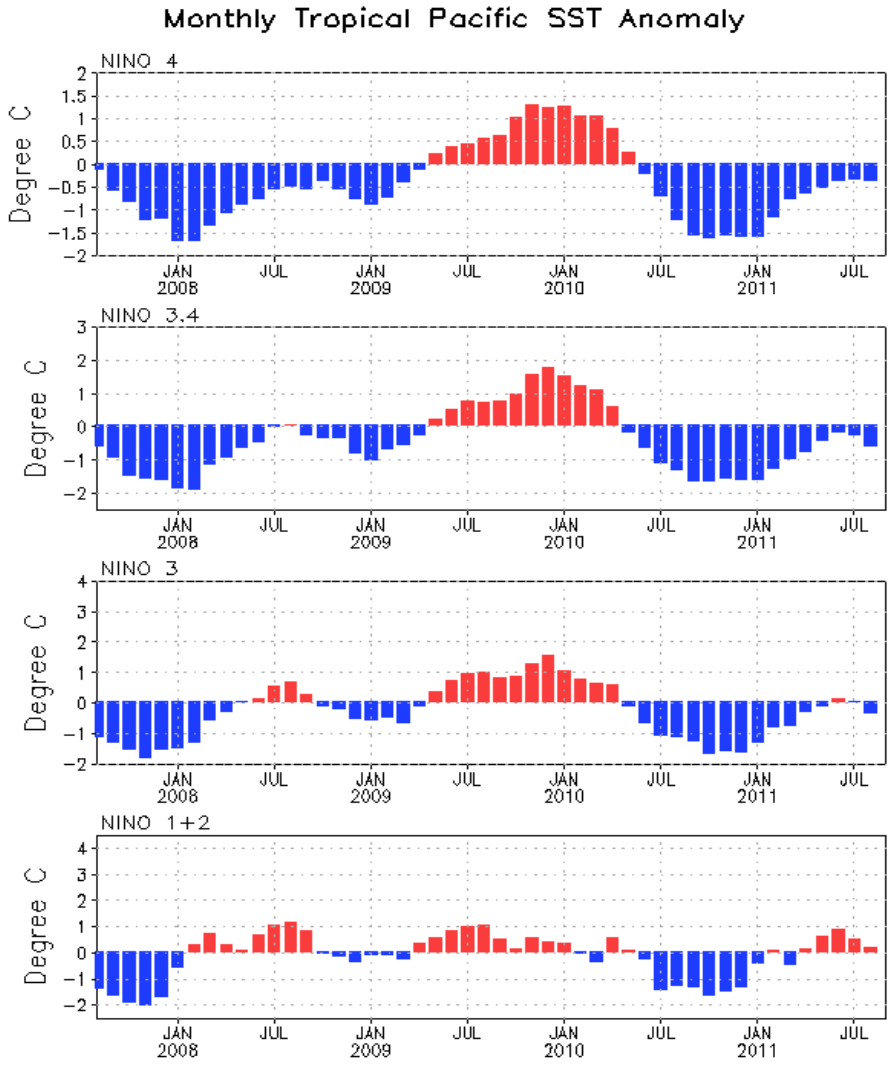
Evolution of Equatorial Pacific SST (ºC), 0-300m Heat Content (ºC), 850-mb Zonal Wind (m/s), and OLR (W/m²) Anomaly

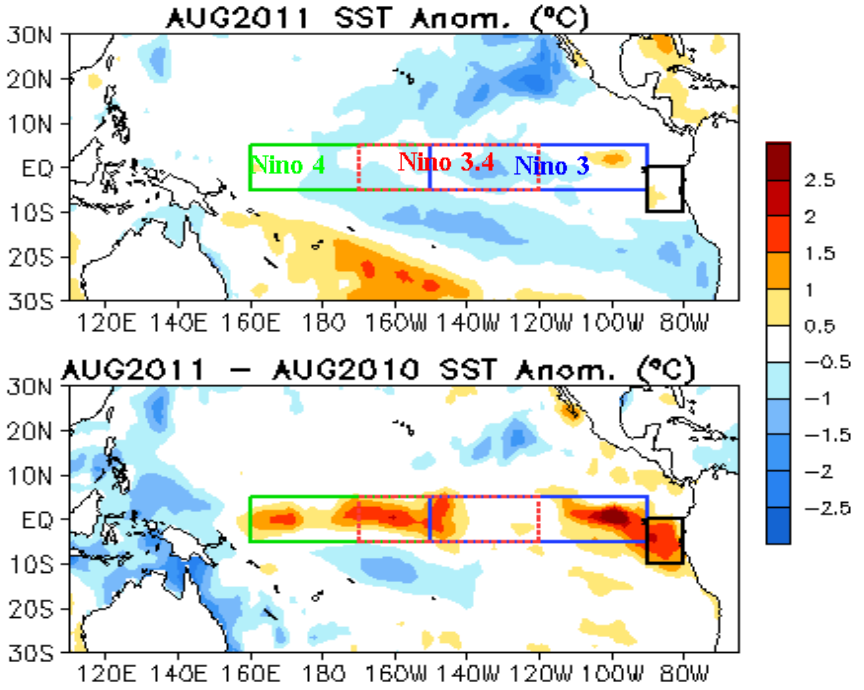


- **Negative HC and SST anomalies rebounded in the central and eastern equatorial Pacific since Jul 2011 and intensified in Aug 2011.**
- **That is consistent with intensified anomalous easterly wind in the low level in the central Pacific Ocean.**

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 1981-2010, 1982-2004, 1979-1995 base period pentad means respectively.

Evolution of Pacific NINO SST Indices





- **NINO4, NINO3, and NINO3.4 indices were negative and slightly strengthened**

- **NINO1+2 indices were still positive, but weakened.**

- **Nino3.4 =-0.6C in Aug 2011.**

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

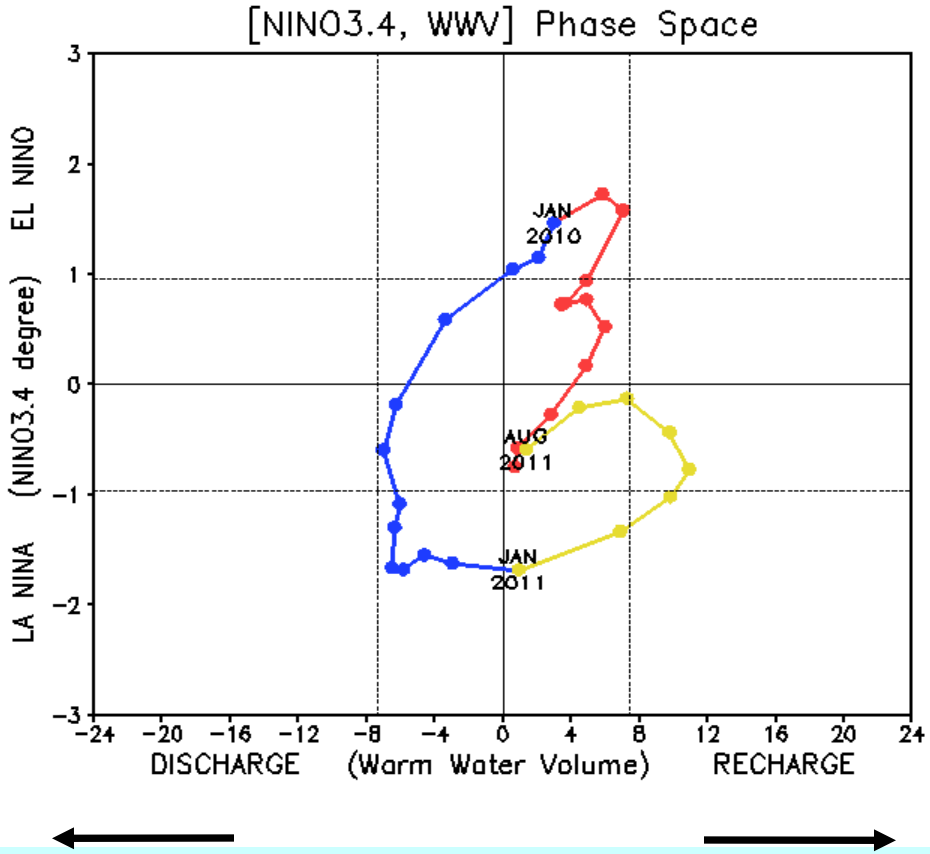
Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

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]. Statistically, peak correlation of Nino3 with WWV occurs at 7 month lag (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.



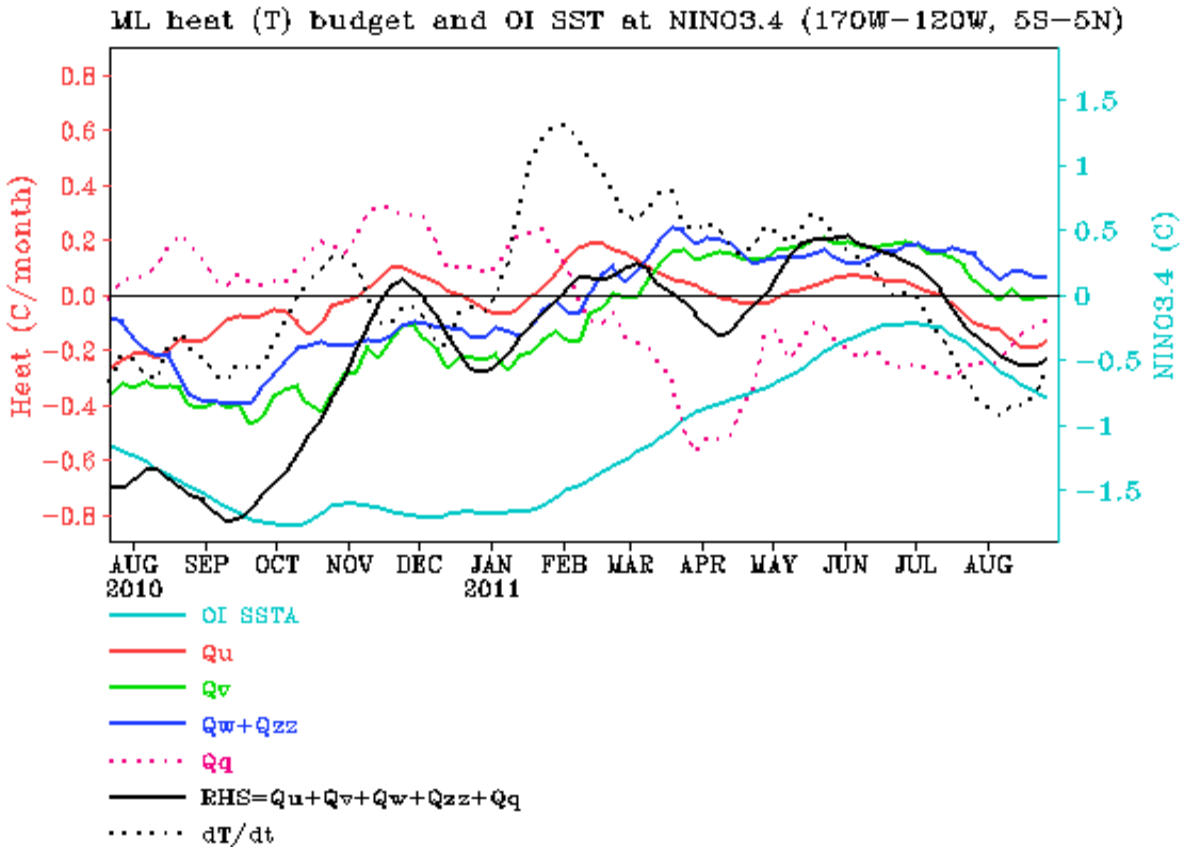
- WWV recharge enhanced significantly since Jan 2011 due to the downwelling Kelvin wave episodes and air-sea coupling that links the strengthening WWV with increasing NINO3.4.

- WWV recharge started to decrease since Apr 2011.

- Recharge was near zero and Nino3.4 was -0.6 C in Aug 2011.

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 (1981-2010) base period means.

NINO3.4 Heat Budget



- **Negative SSTA tendency (dT/dt) in NINO 3.4 (dotted line) observed since Jul and intensified in Aug, indicating the return of La Nina conditions.**

- **Dynamical terms (Qv, Qw+Qzz) was near zero, and zonal advection (Qu) was negative in Aug 2011.**

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

- **The total heat budget term (RHS) agreed with tendency (dT/dt) well since May 2011.**

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.

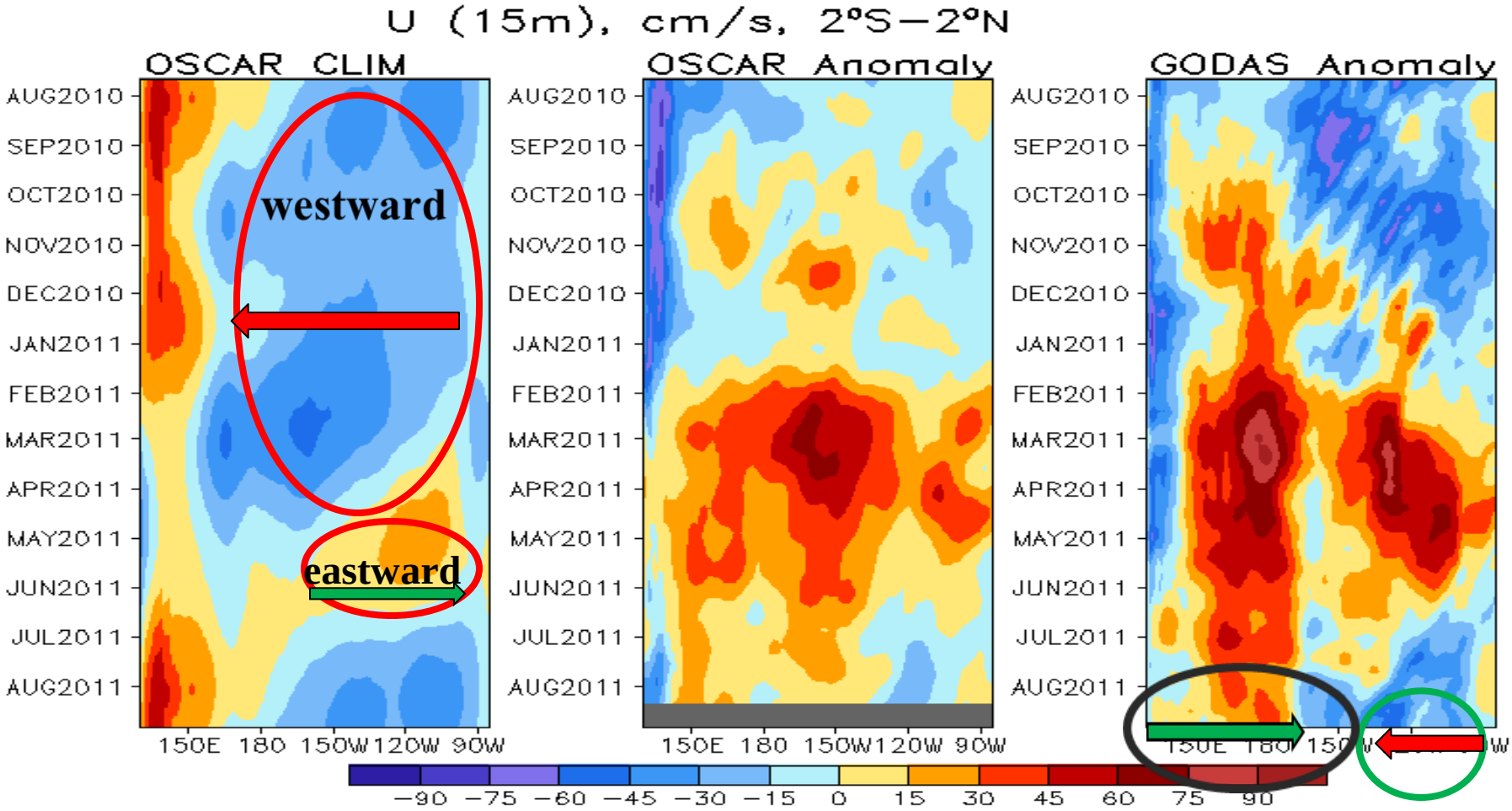
Qu: Zonal advection; Qv: Meridional advection;

Qw: Vertical entrainment; Qzz: Vertical diffusion

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

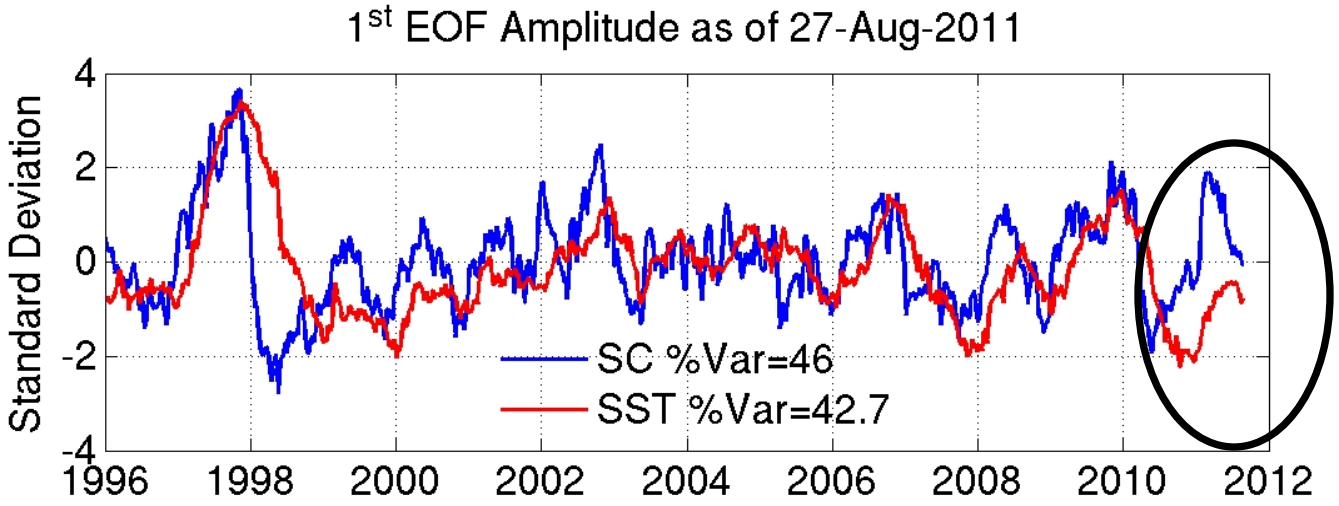
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

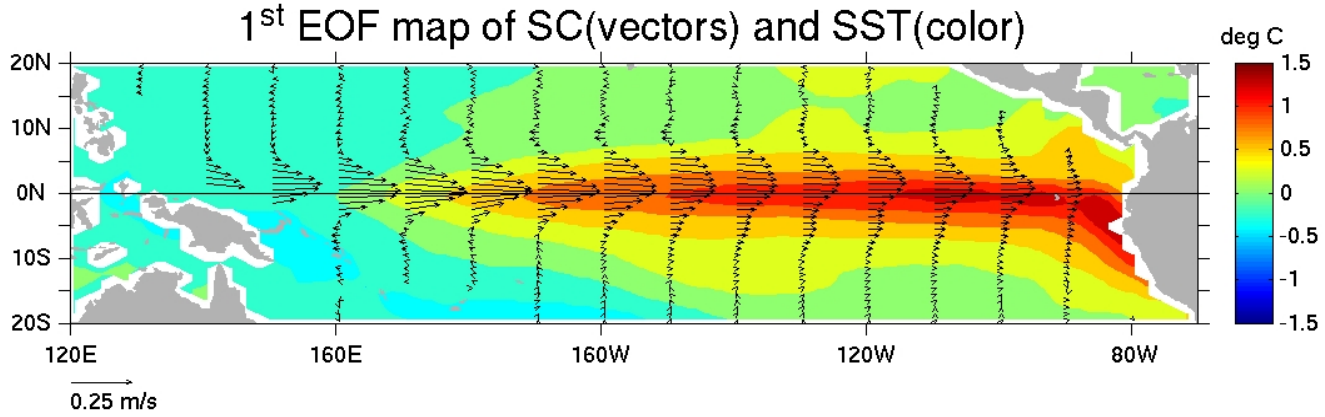
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- **Eastward zonal current anomalies across the equatorial Pacific substantially weakened since May 2011, with westward (eastward) current anomalies in the eastern (central) Pacific Ocean in Aug 2011.**
- **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 overall 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



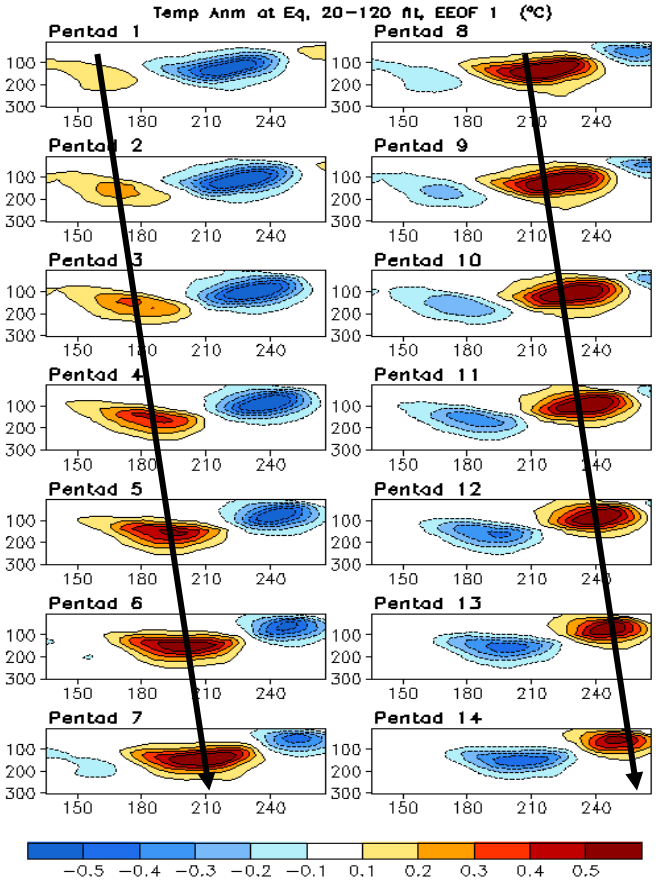


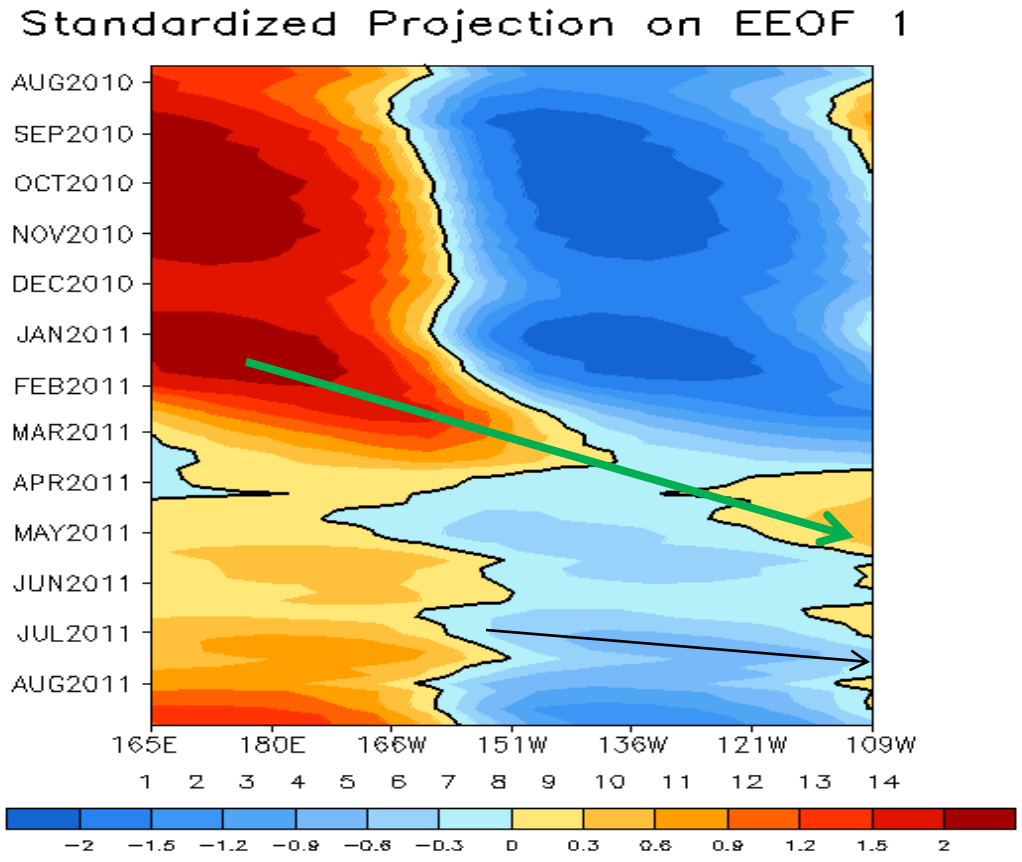
- **Zonal current anomaly has become eastward since Dec 2010, weakened in recent months, and near zero in Aug 1st 2011.**
- **On average, ocean surface zonal current anomaly leads the SSTA by a few months.**

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)

Oceanic Kelvin Wave Indices





- Downwelling Kelvin wave initiated in late Jan 2011 in the W. Pacific arrived at the eastern coast in Apr 2011.
- Since May 2011, local air-sea interaction was active and enhanced in Aug 2011.

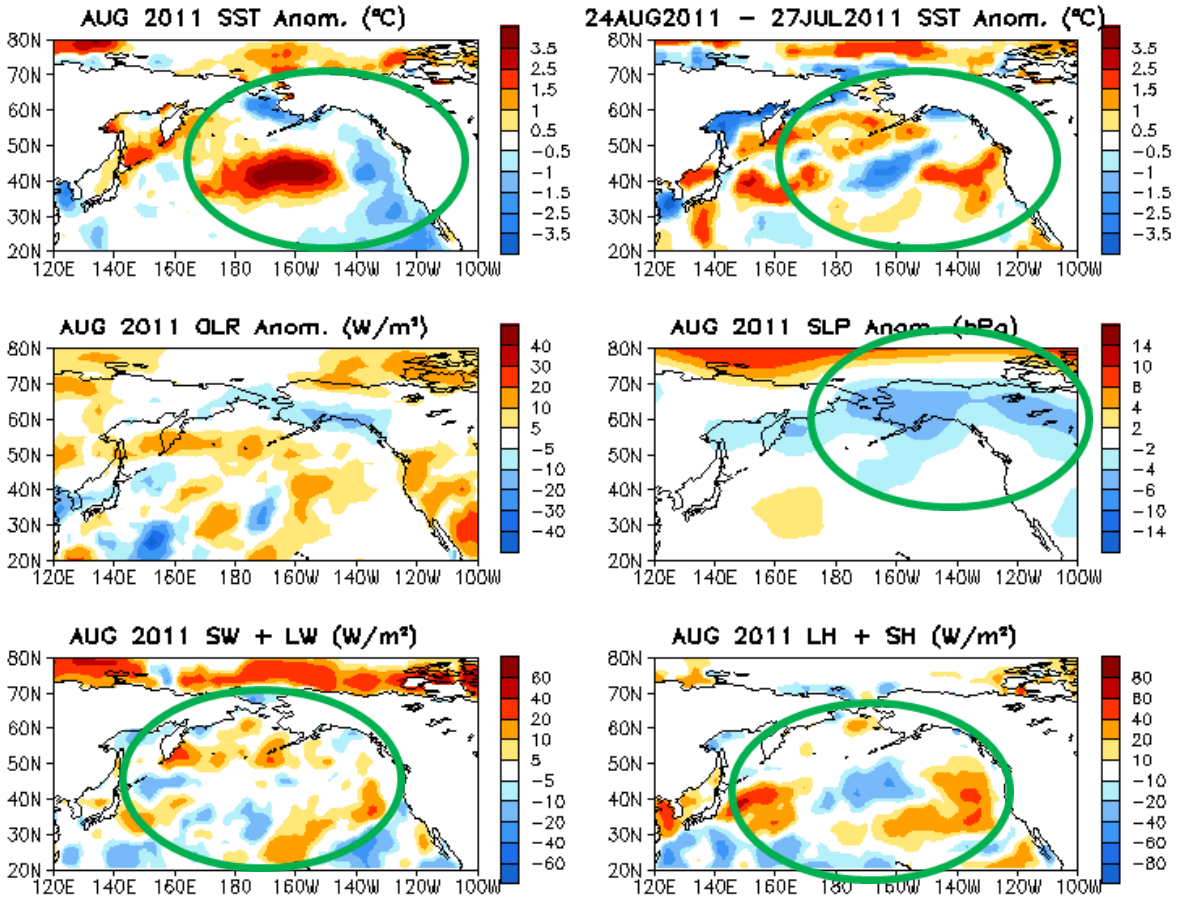
- Extended EOF (EEOF) analysis is applied to 20-120 day filtered equatorial temperature anomaly in the top 300m using 14 lagged pentads (similar to that in Seo and Xue, GRL, 2005).

- 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

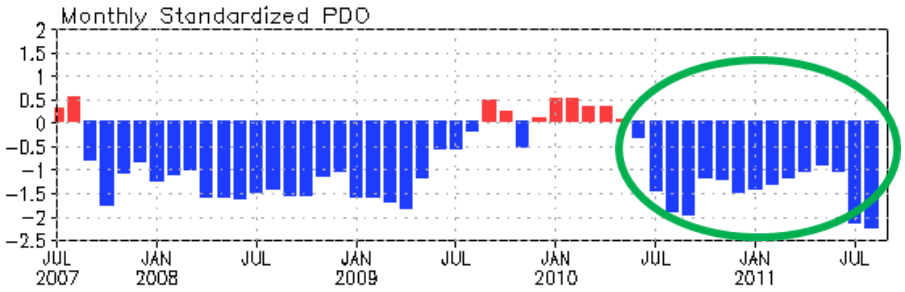
North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

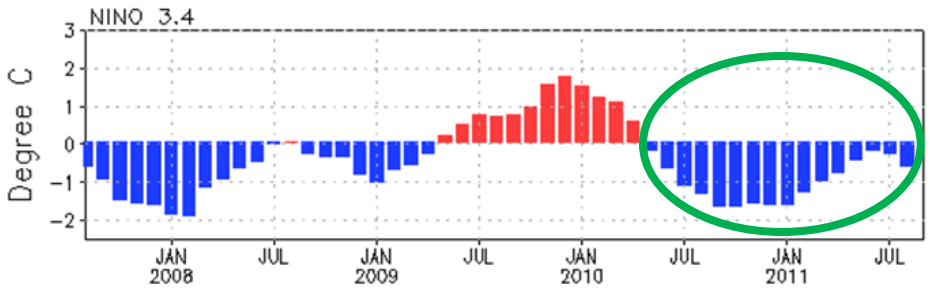


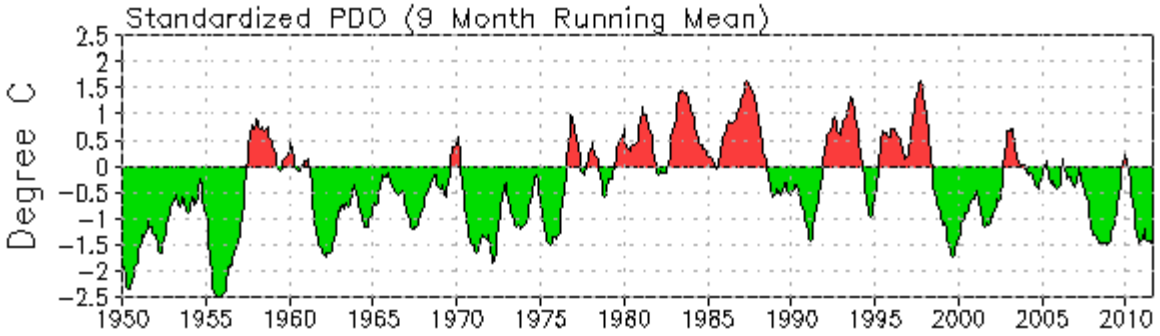
- **Positive SSTA was observed in the central North Pacific and negative SSTA along the west coast of N. America since Jul 2011, consistent with the negative PDO index (next slide).**
- **Negative SSTA tendency presented over the central North Pacific and positive ones in the surround region.**
- **Net surface heat flux anomalies contributed to the SST tendency in the North Pacific.**

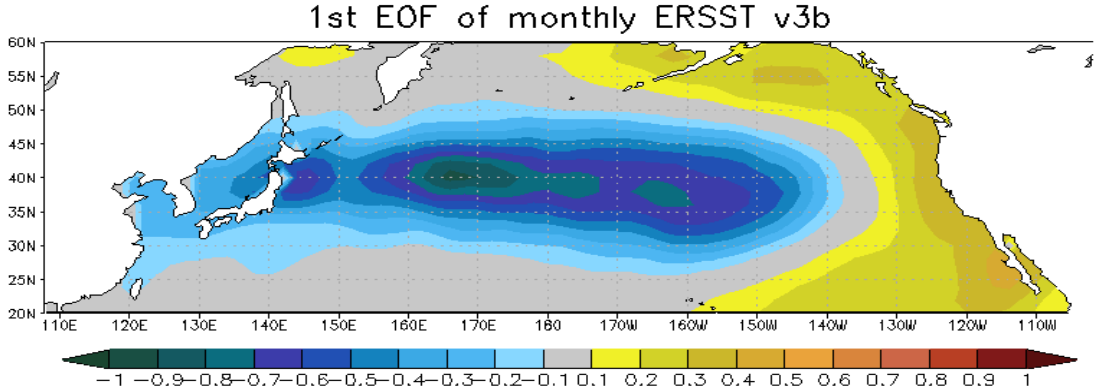
Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible 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 1981-2010 base period means.

PDO index









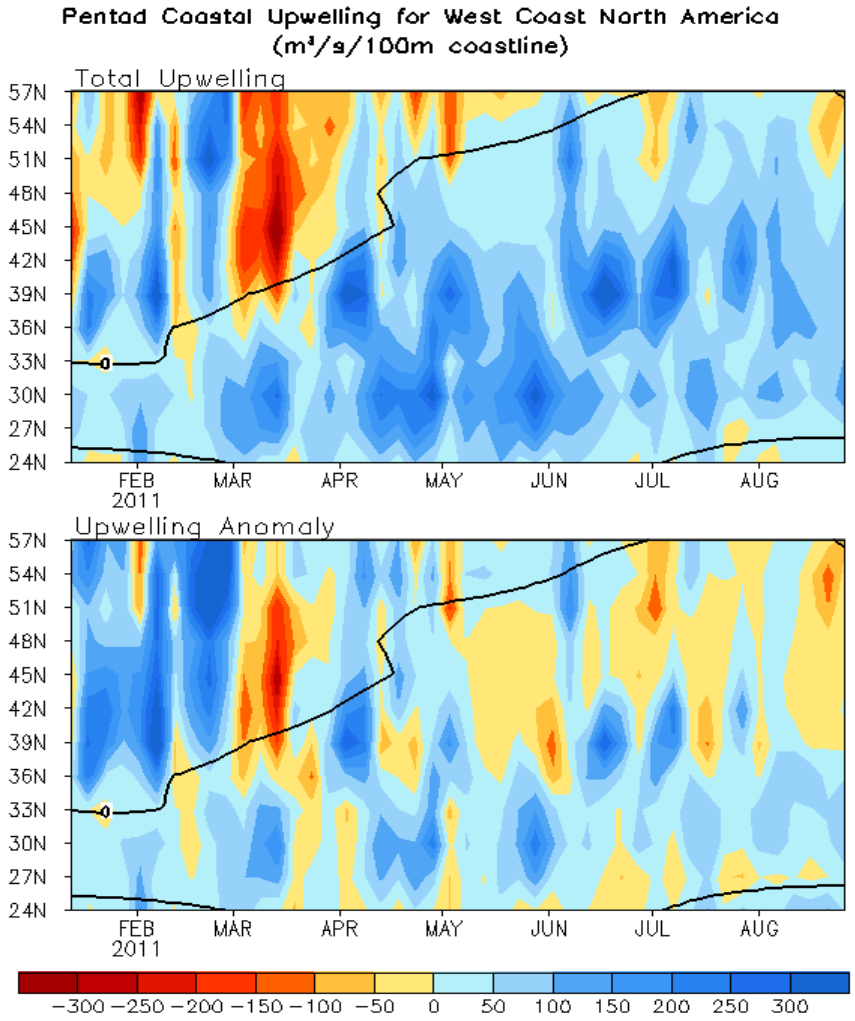
- The negative PDO intensified substantially since Jul and persisted in Aug with PDO index =-2.3.

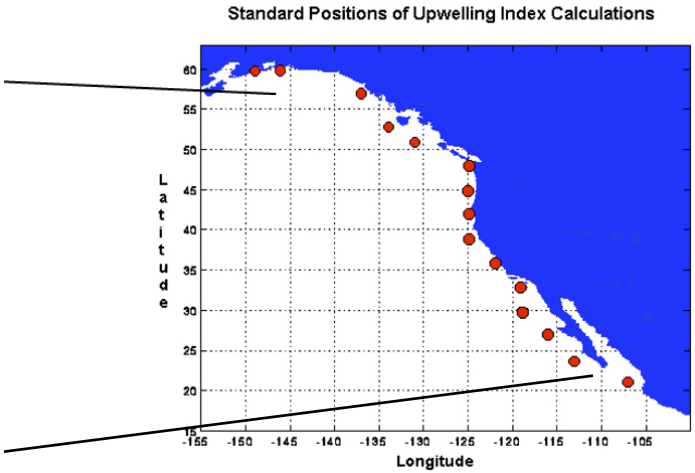
- The apparent positive correlation between NINO3.4 and PDO index suggests strong influences of the La Nina on the North Pacific SST variability through atmospheric bridge.

- 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





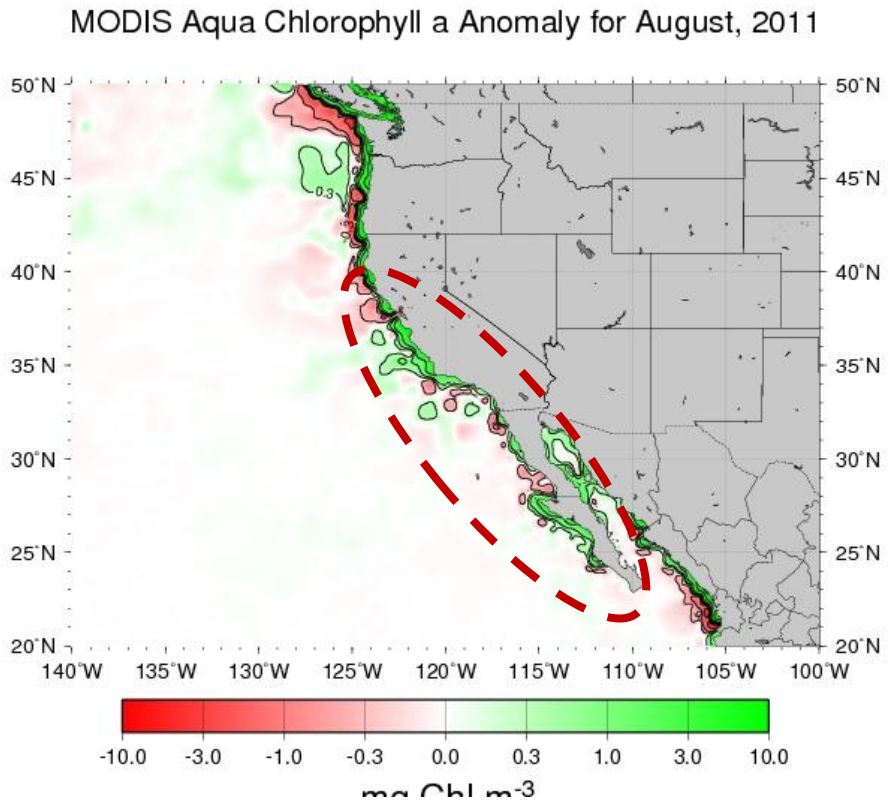
- Upwelling was enhanced at 24°N-36°N and suppressed in the north in Aug 2011.

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.

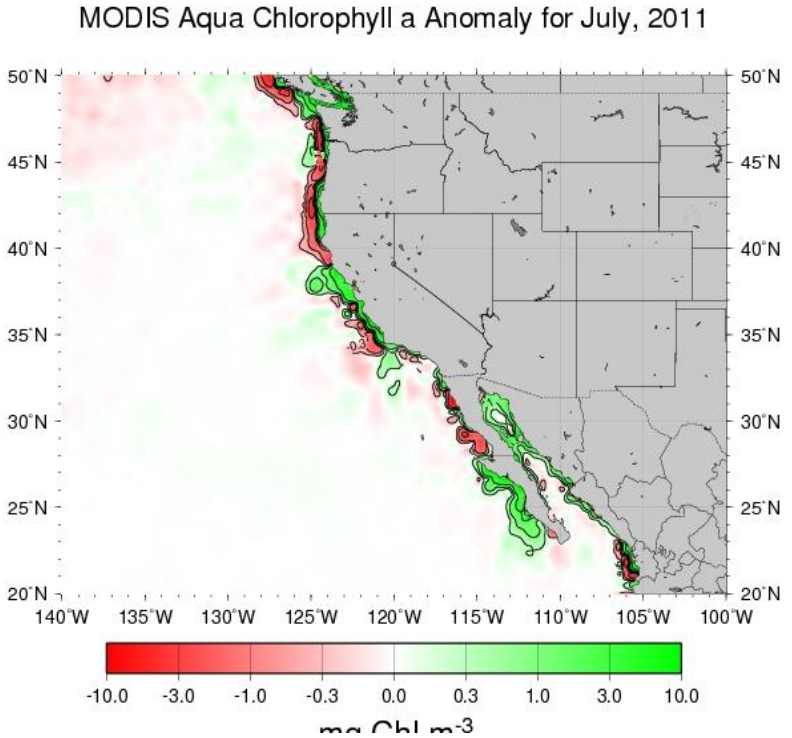
- Area below (above) black line indicates climatological upwelling (downwelling) season.

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

Monthly Chlorophyll Anomaly



- **Both positive and negative chlorophyll anomalies were small and presented along the coastal regions in Aug 2011.**
- **It seems that chlorophyll anomalies were not directly associated with the coastal upwelling anomalies in Aug 2011.**

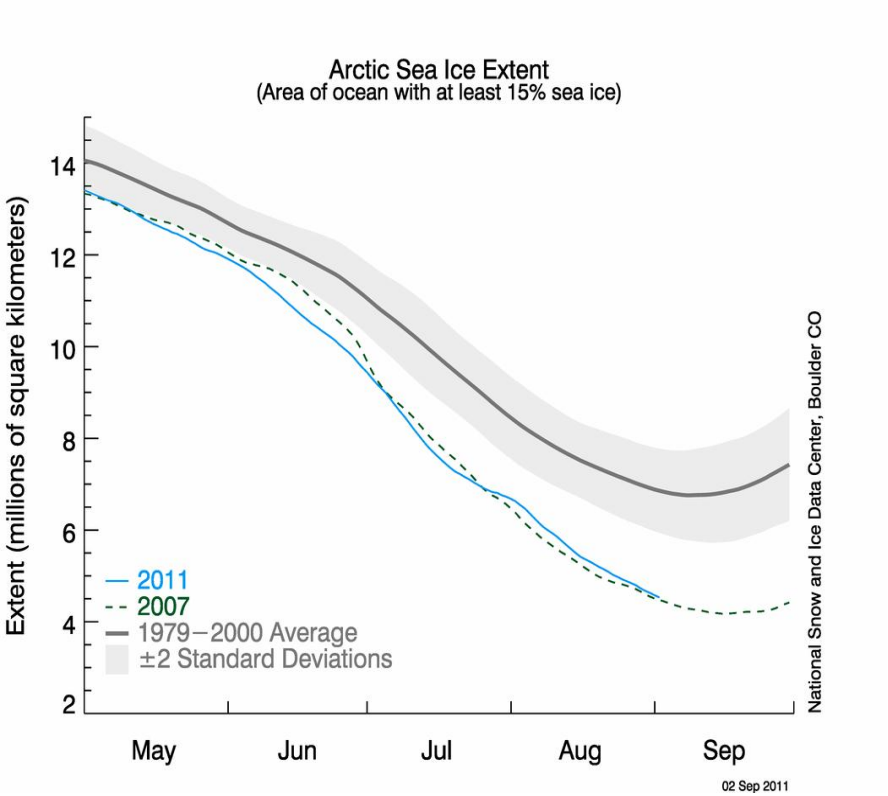


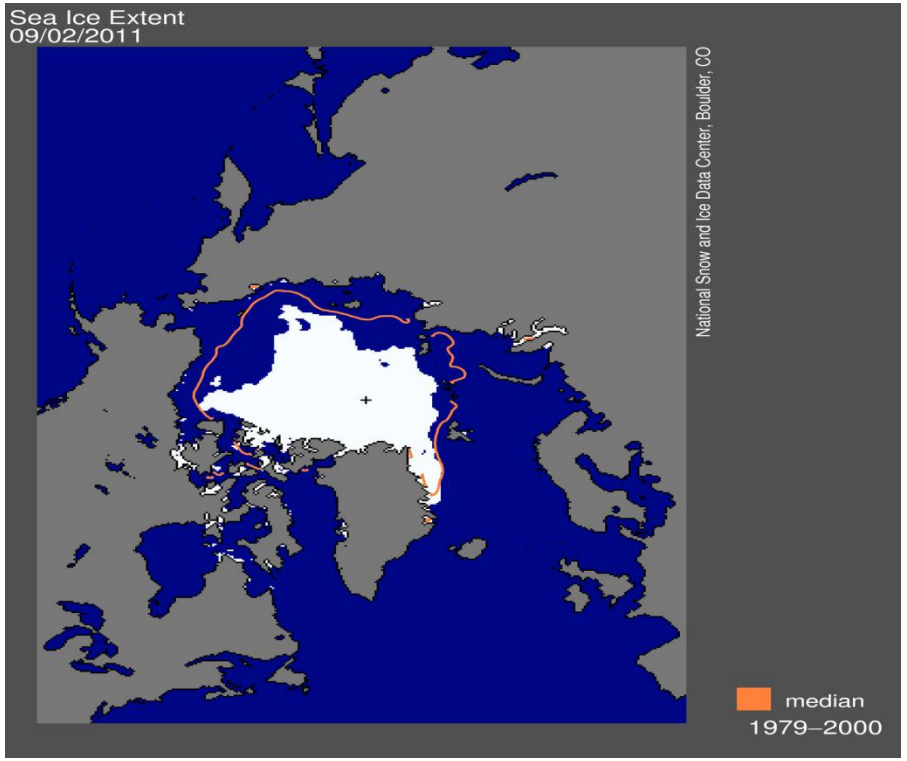
http://coastwatch.pfel.noaa.gov/FAST

Arctic Sea Ice

National Snow and Ice Data Center

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

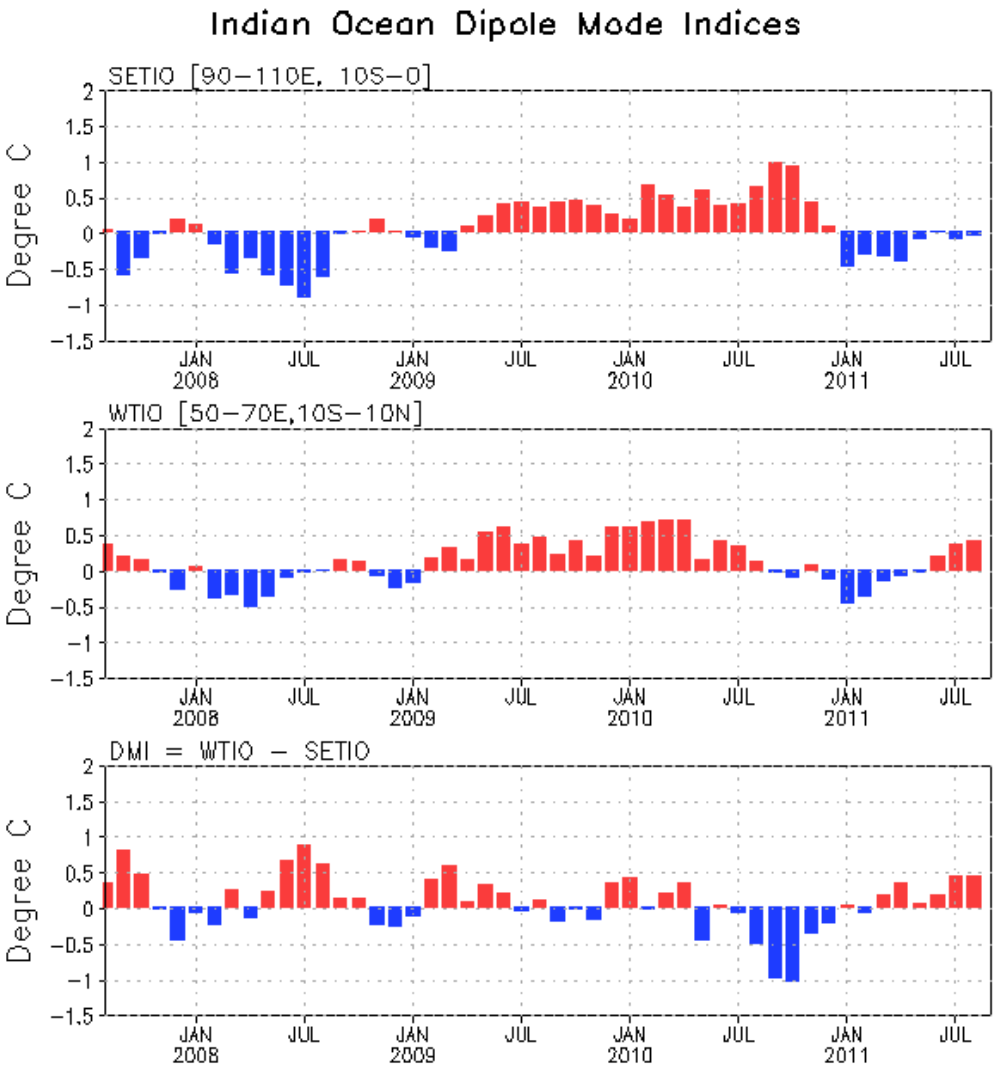


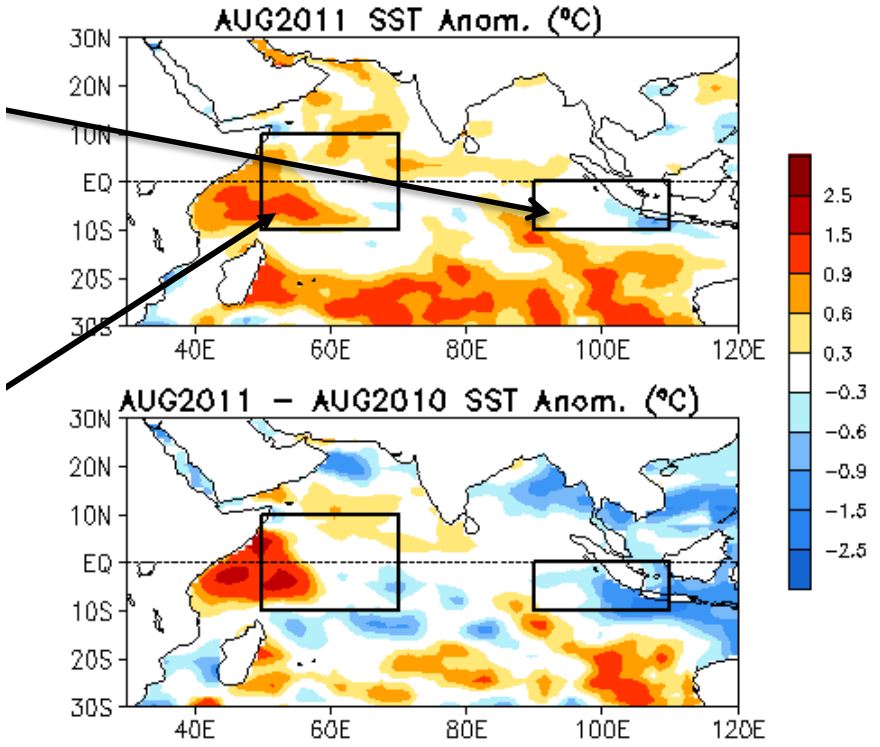


- **The Arctic sea ice extent continued to decline in Aug 2011, which was comparable with 2007, the record low year.**
- **Sea ice was particularly low in the Pacific side of the Arctic Ocean.**

Tropical Indian Ocean

Evolution of Indian Ocean SST Indices

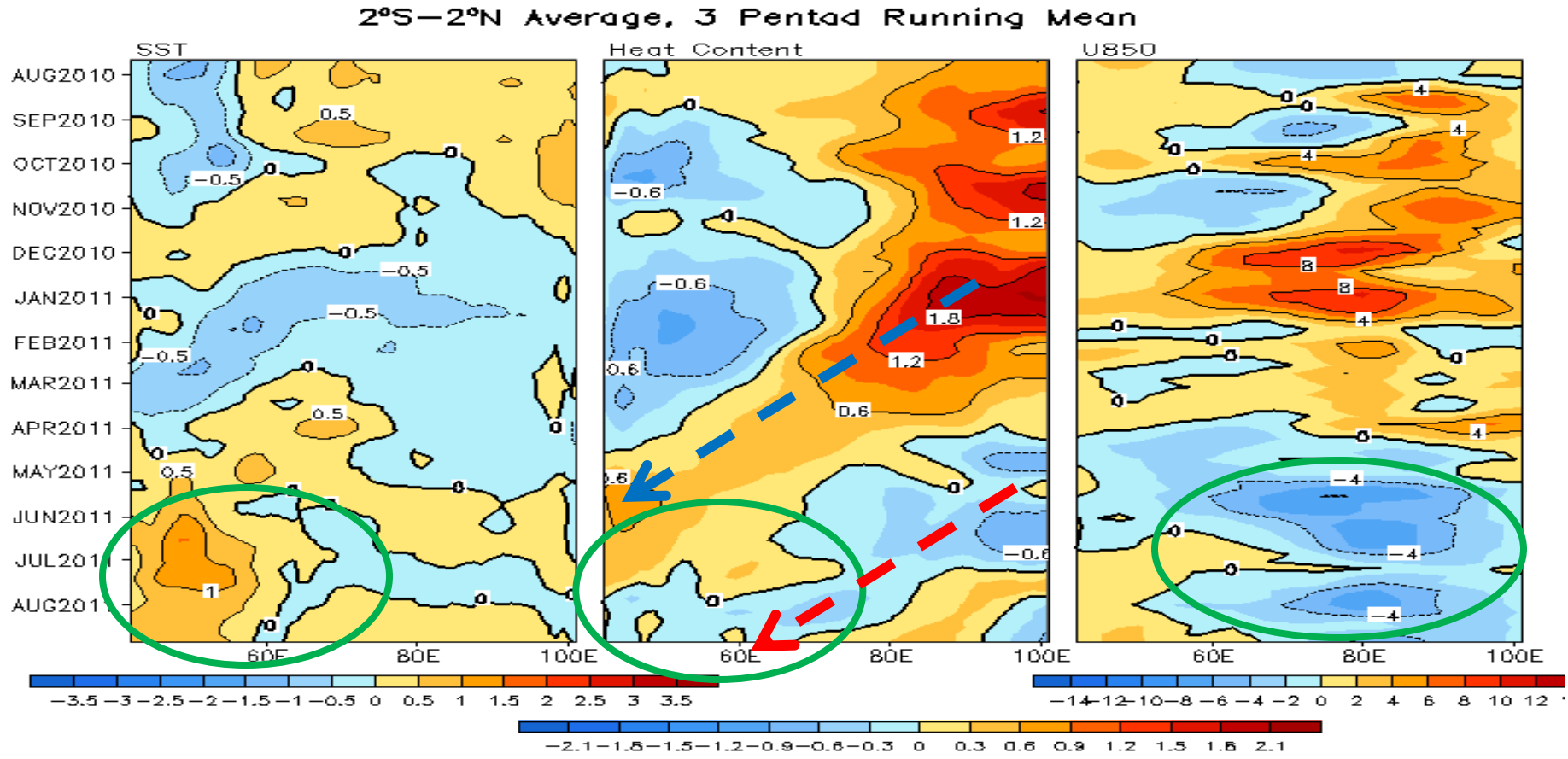




- **Positive western (WTIO) and near-normal eastern (SETIO) indices were observed since Jun 2011.**
- **DMI has been above normal since Mar 2011, and intensified since Jul 2011.**

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 1981-2010 base period means.

Recent Evolution of Equatorial Indian SST (ºC), 0-300m Heat Content (ºC), and 850-mb Zonal Wind (m/s) Anomalies

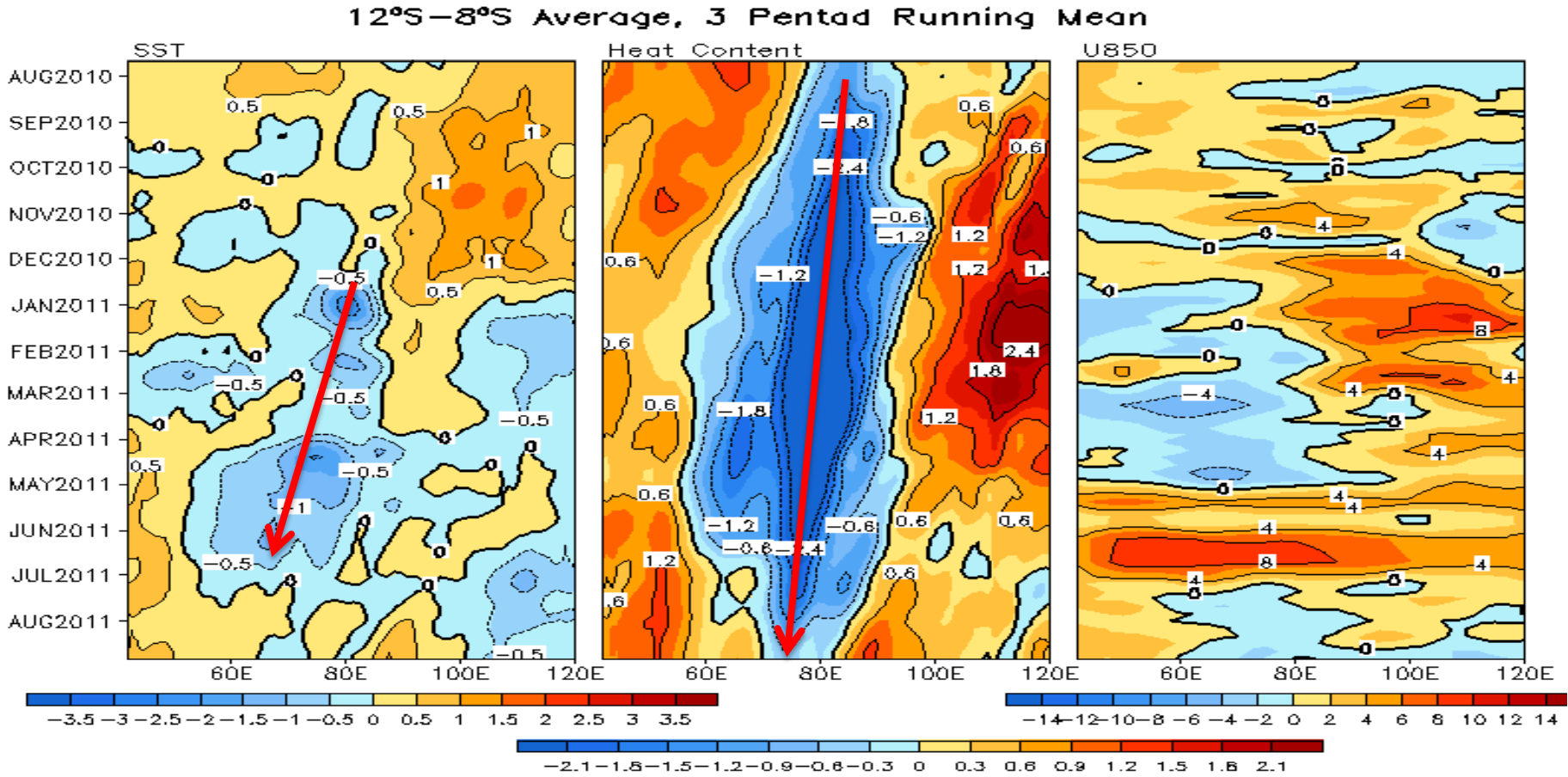


- **Positive SSTA emerged in the central Indian Ocean since Mar 2011 and intensified in the west since May 2011, consisting with the u850 anomalies.**

- **Positive (negative) heat content anomalies initiated in Dec 2010 (May 2011) and propagated westward, consistent with the variations of low-level winds.**

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 2ºS-2ºN and Outgoing Long-wave Radiation (OLR, right) averaged in 5ºS-5ºN. 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 1981-2010, 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)



- **Negative SSTA presented in the central tropical Indian Ocean since Dec 2010 and propagated westward, consistent with the westward propagation of HCA.**

- **Westerly wind anomalies prevailed over the southern tropical Indian Ocean during May-Jun 2011, and easterly wind anomalies observed in Aug 2011.**

- **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 1981-2010, 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.

- **SSTA was small, except for the positive SSTA observed along the coast of equatorial Africa.**
- **Positive SSTA tendency was observed in Arabian Sea, which was not consistent with the net surface heat flux anomalies, suggesting dynamical process contribution to the warming.**
- **Convection was enhanced in the north Indian Ocean.**

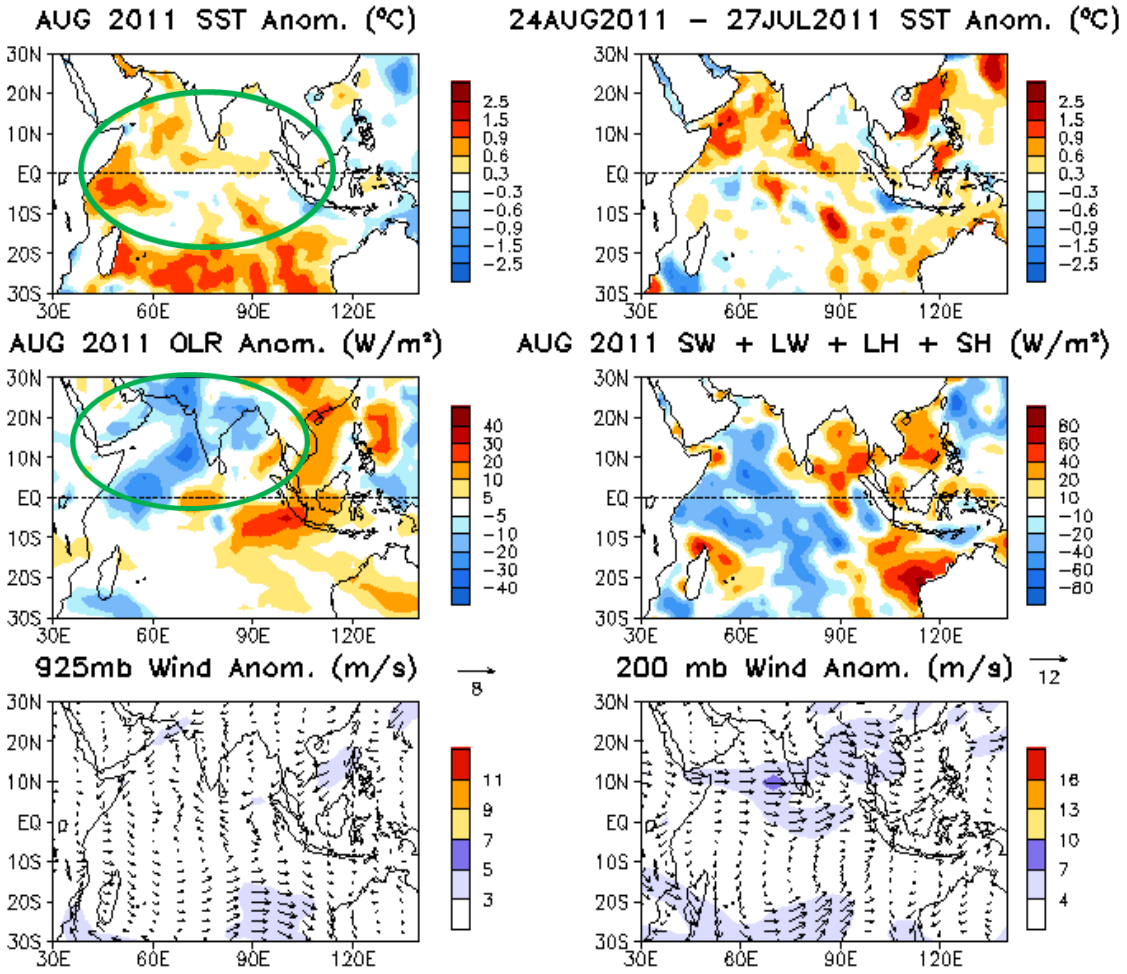
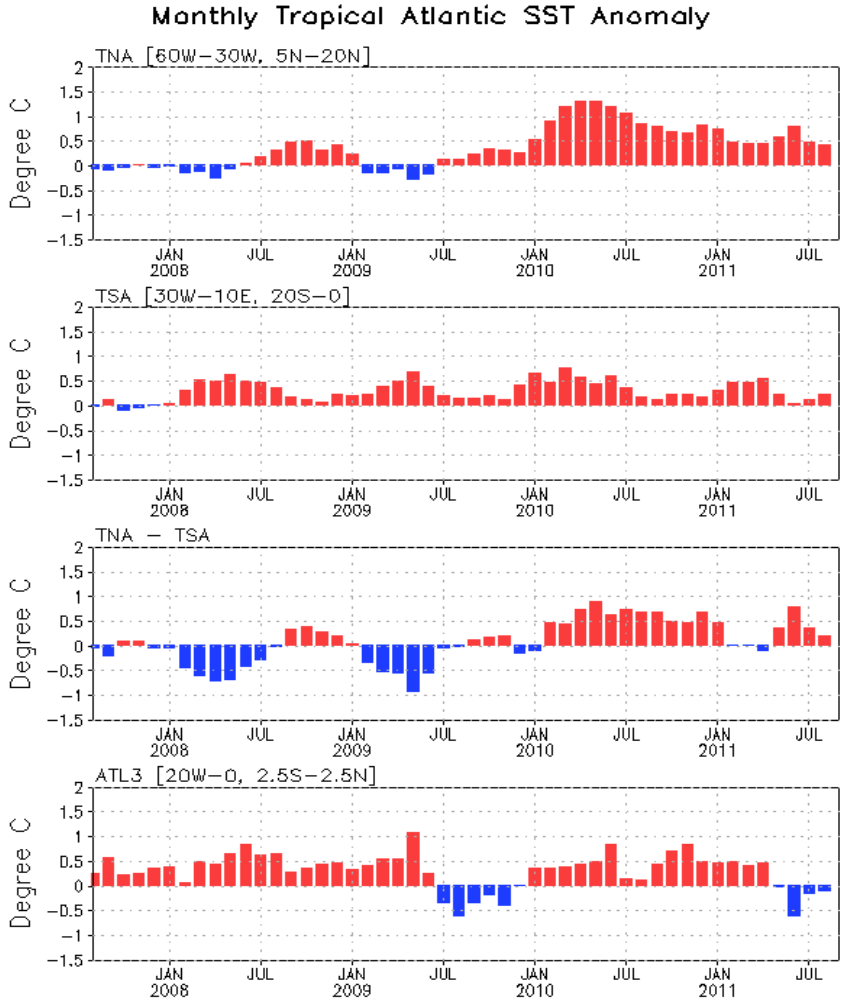
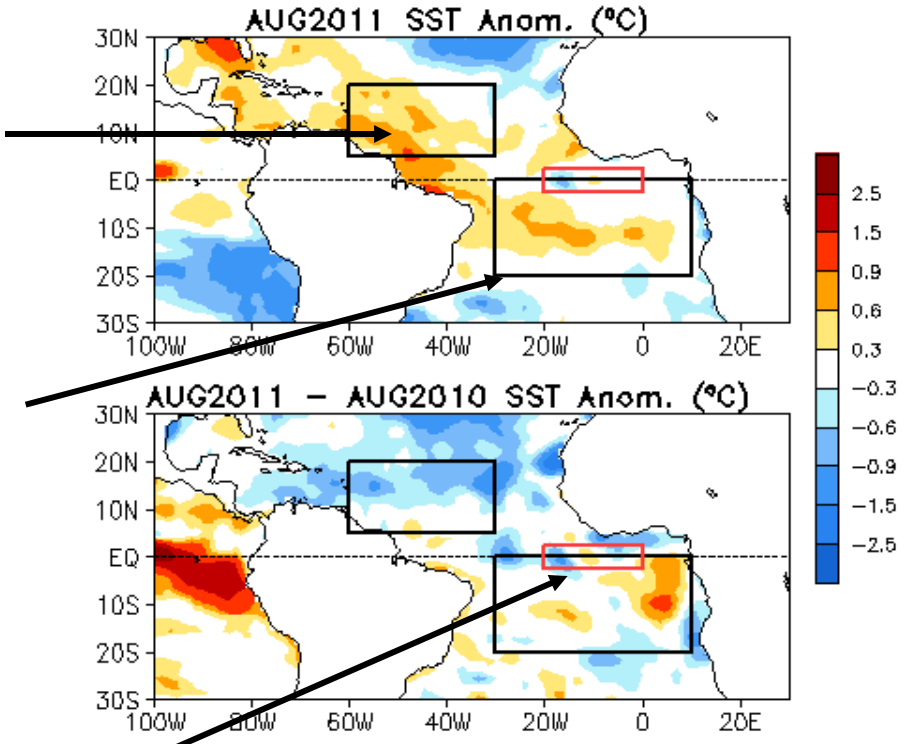


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (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 1981-2010 base period means.

Tropical Atlantic Ocean

Evolution of Tropical Atlantic SST Indices





- **Tropical Atlantic was much cooler in Aug 2011 than in Aug 2010.**

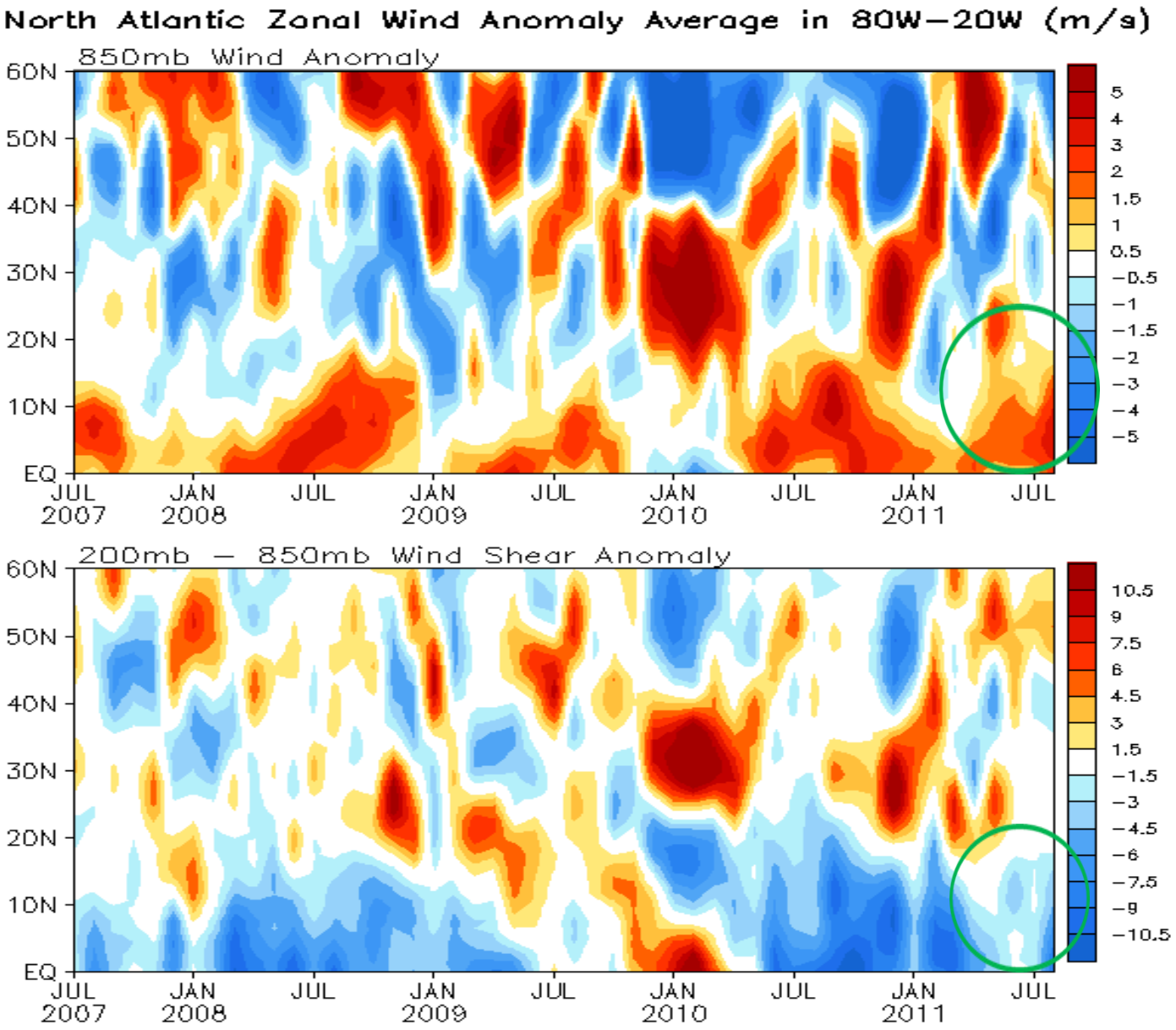
- **Positive SSTA persisted in both TNA and TSA since Feb 2011.**

- **Meridional Gradient Mode (TNA-TSA) was above-normal since May 2011.**

- **Small negative ATL3 SST was observed in Aug 2011.**

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 1981-2010 base period means.

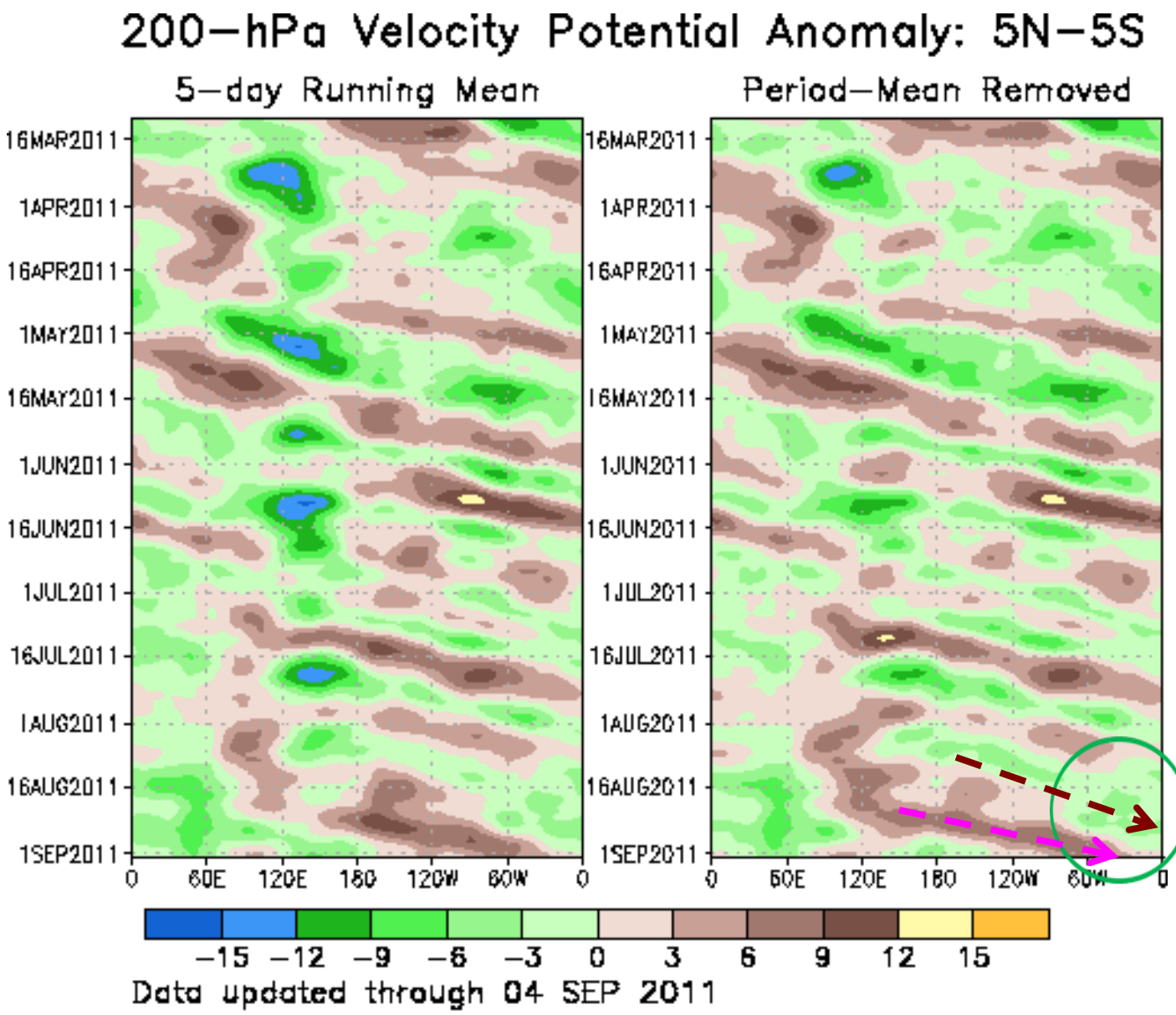
North Atlantic U850 and U200-U850



- Westerly wind anomaly strengthened at 850 hPa in the tropical North Atlantic Ocean.

- Wind shear between 200 hPa and 850 hPa weakened. That is favorable for hurricane development in the coming months over the tropical North Atlantic Ocean.

MJO or Subseasonal Activity?



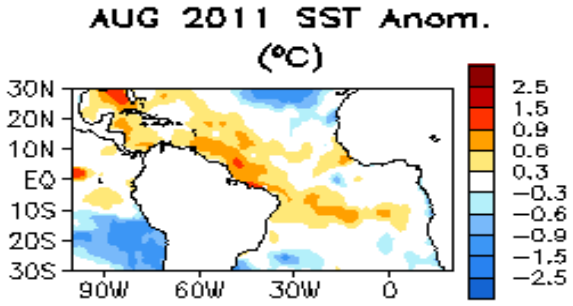
- The MJO phase in the Atlantic sector has been favorable for convection for the last two weeks, which helps explain all the TC activity we've been seeing.

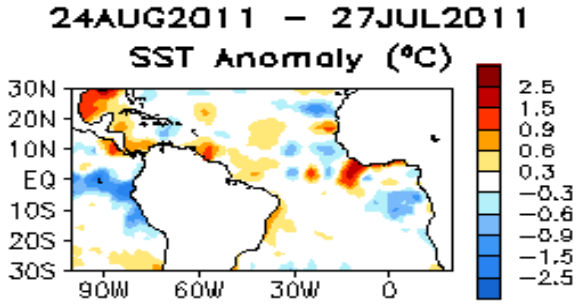
- However, now MJO is moving into an inactive phase in the Atlantic sector (brown shades).

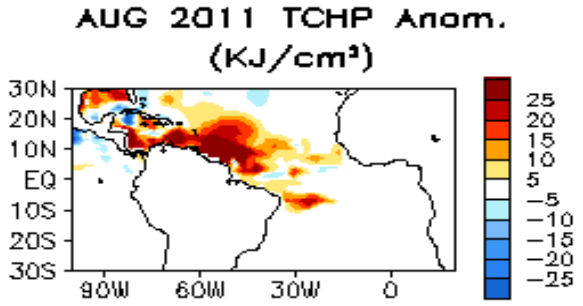
- We may continue to see TC activity because we're nearing the peak of the season (Sept. 10th) but the MJO may mean it won't be quite as bad.

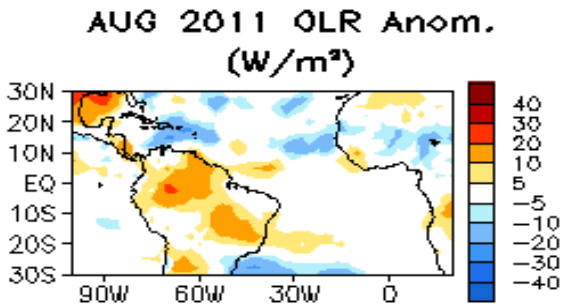
(Quote from Dr. David Enfield, NOAA/AOML)

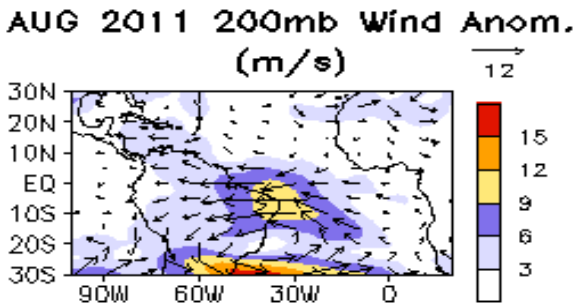
Tropical Atlantic:

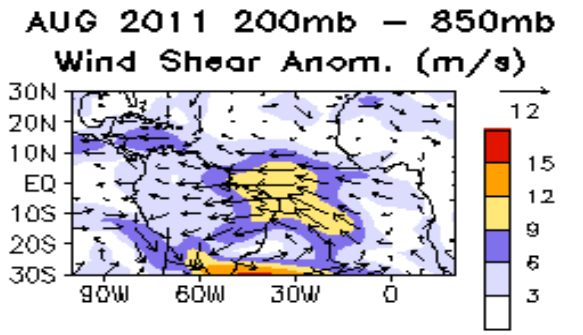


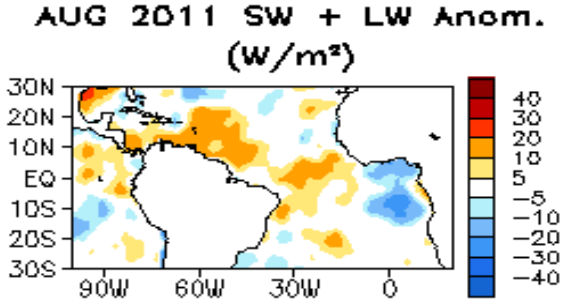


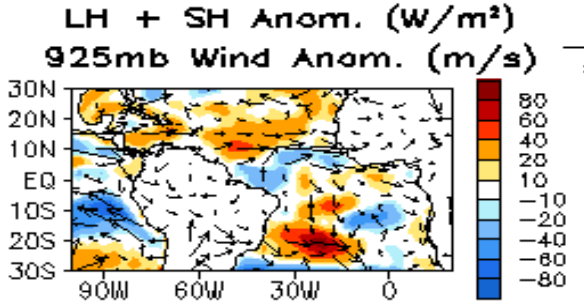


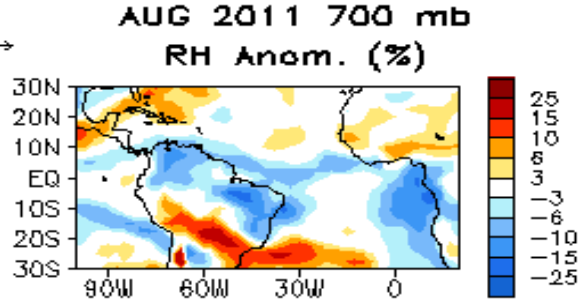








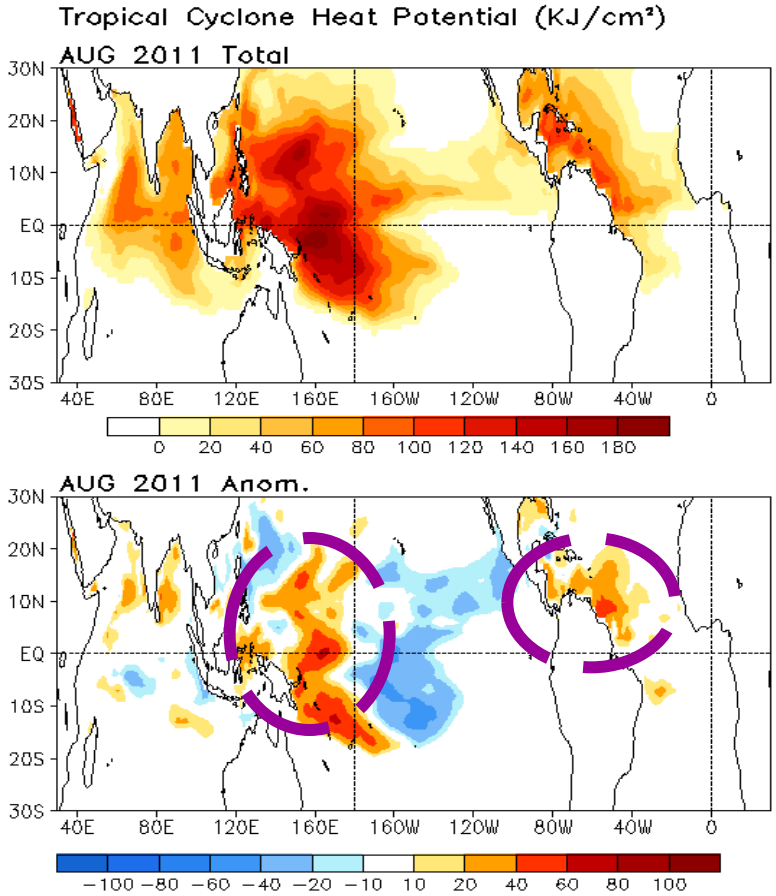


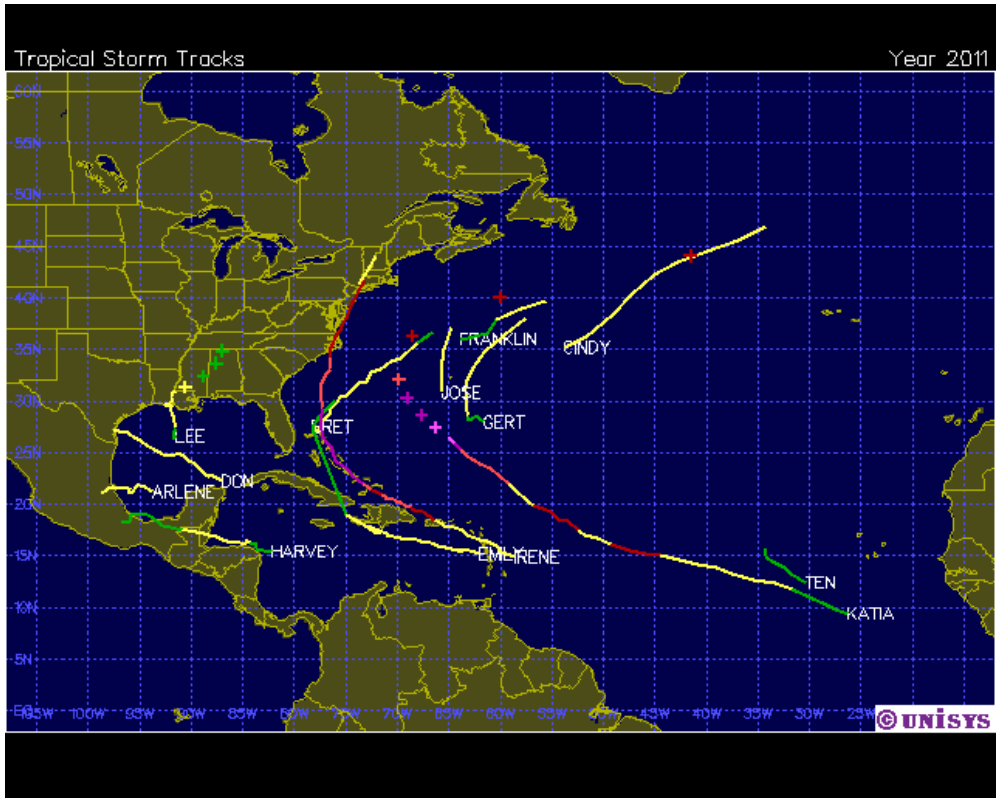


- **Positive SSTA continued in the Atlantic Hurricane Main Development Region (MDR).**

- **Above-normal SST and TCHP anomalies, and small wind shear in hurricane MDR are favorable for hurricane development.**

Tropical Cyclone Heat Potential, and Tropical Storm Activity in Atlantic





- **Positive TCHP anomalies persisted in the tropical N. Atlantic**
- **Large positive TCHP anomalies presented between 125-175E of Pacific Ocean.**
- **By Sep. 6, 2011, 10 tropical storms, and 2 hurricanes (category 3, 4) formed in the North Atlantic Ocean.**

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.

NOAA Predicts an Active Atlantic Hurricane Season in 2011

	May 19	Aug. 4	*Observation by Sep. 6*
Named storms	12-18	14-19	*12*
Hurricanes	6-10	7-10	*2*
Major hurricanes	3-6	3-5	*2*
ACE %	105-200	135-215	

North Atlantic Ocean

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

- **Horseshoe SSTA pattern presented in Aug 2011.**
- **SSTA tendency was consistent with surface heat flux.**
- **Positive (negative) SLP anomalies prevailed north (south) of 60N, consist with the negative NAO.**

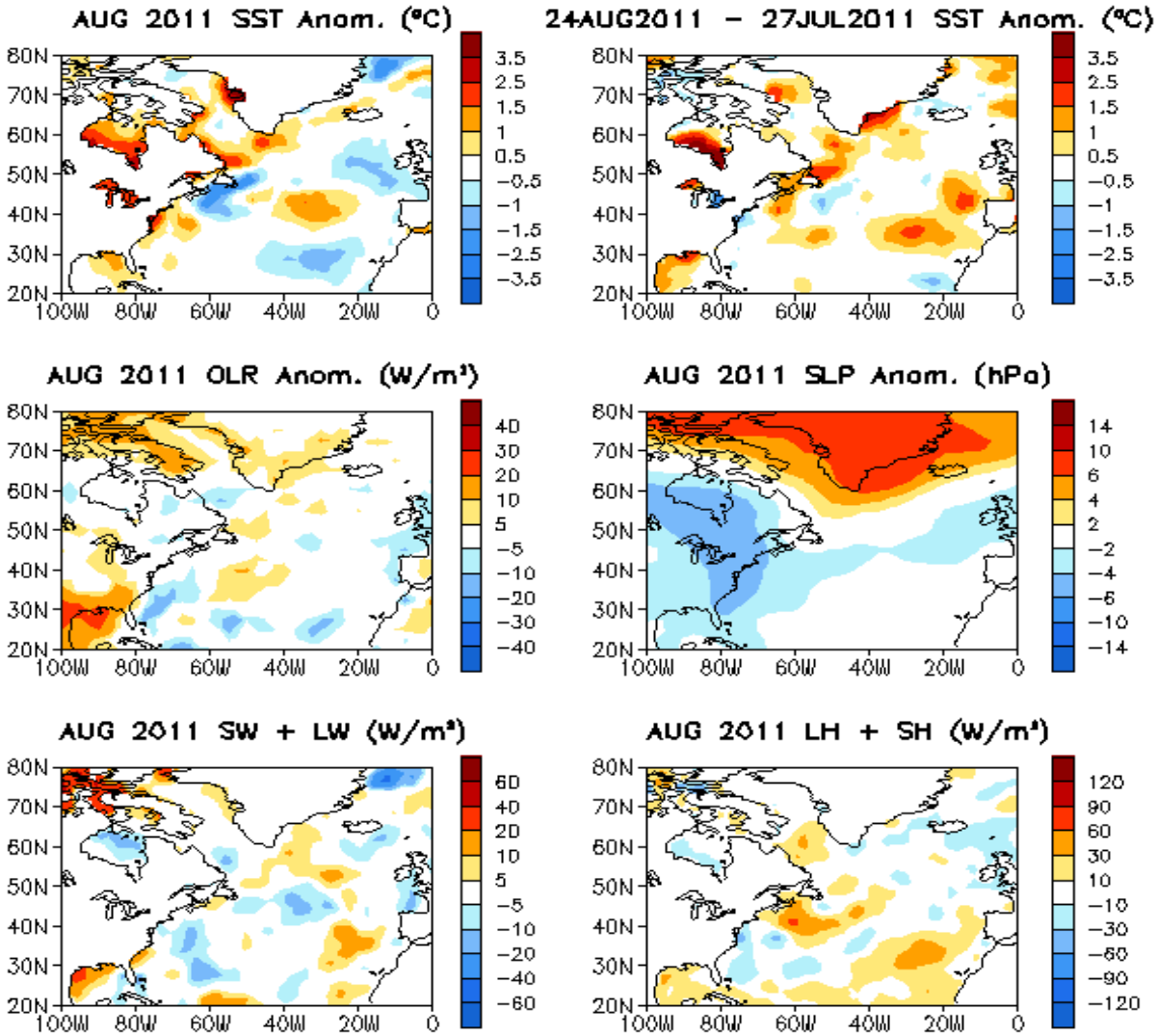
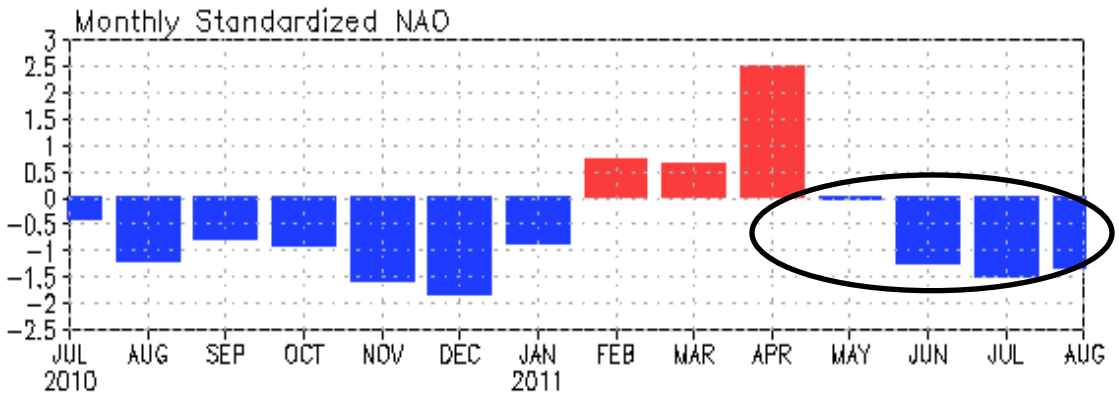
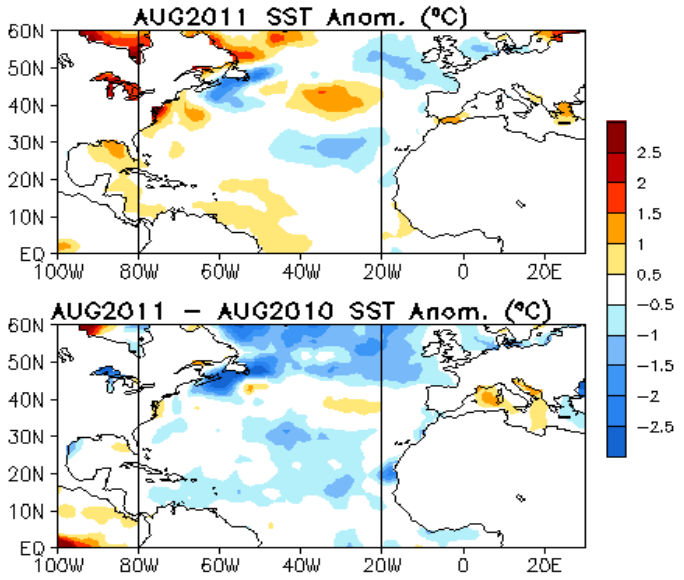
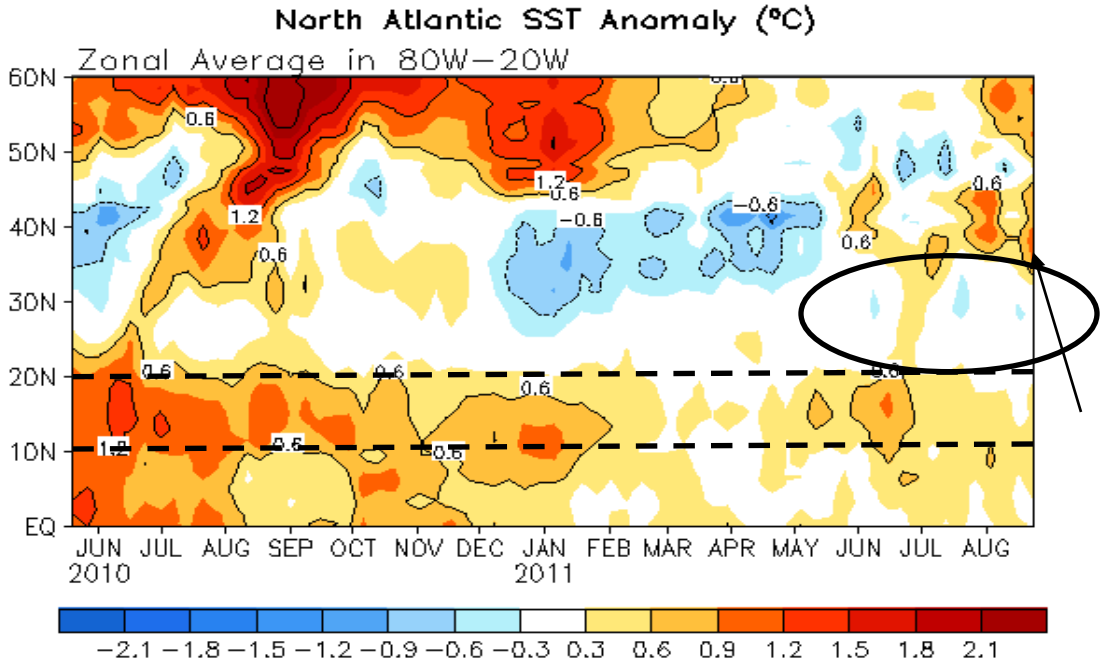


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible 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 1981-2010 base period means.

NAO and SST Anomaly in North Atlantic



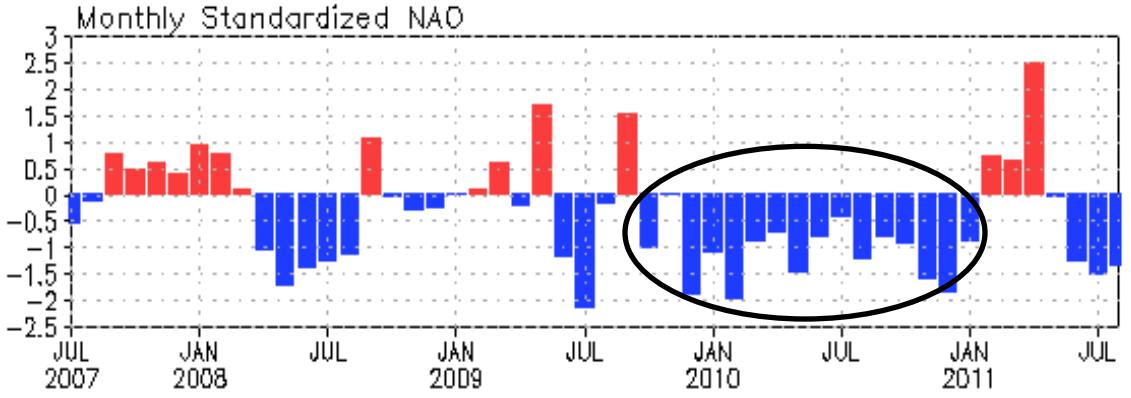


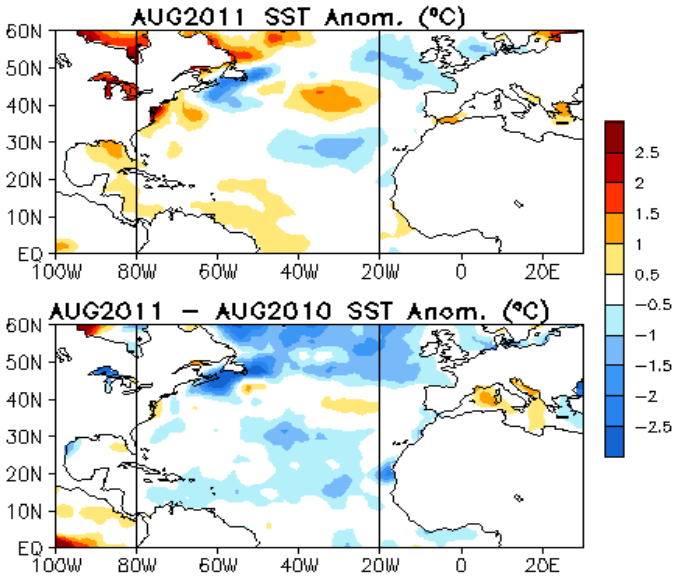


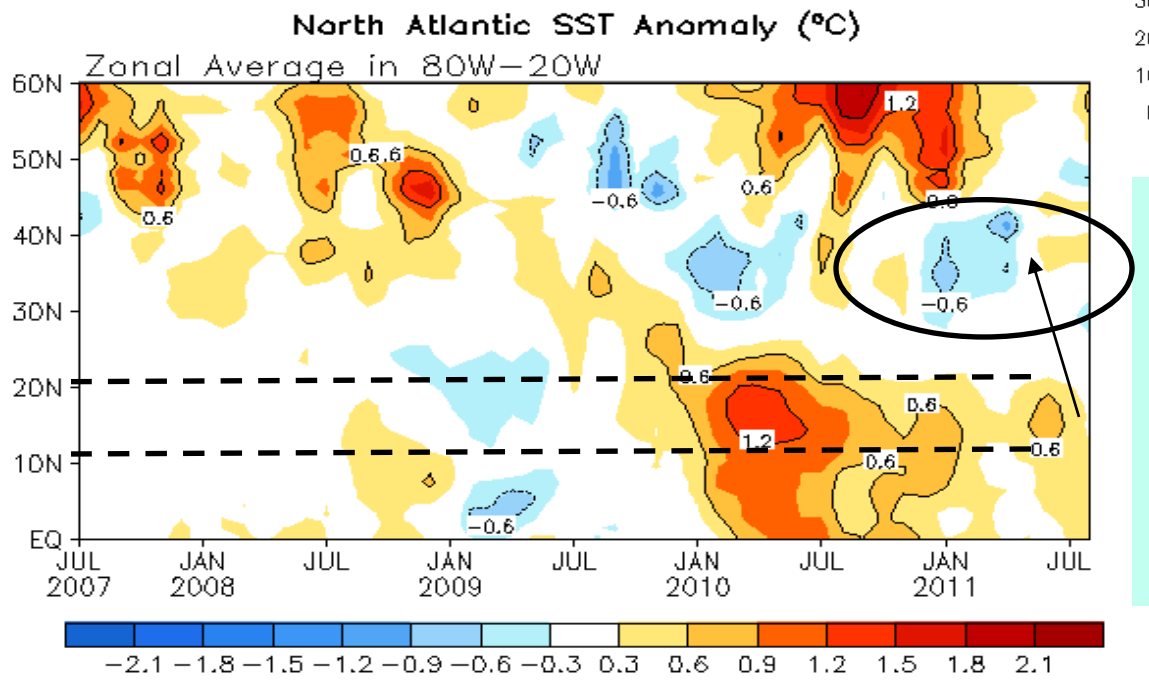
- **Negative NAO persisted in Aug 2011 with NAOI=-1.4.**
- **Tripole or horseshoe pattern weakened since Mar 2011, and vanished in Jun-Jul.**
- **A horseshoe pattern of SSTA in Aug 2011 may suggest the lingering impact of La Nina on North Atlantic Ocean.**

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 1981-2010 base period means.

NAO and SST Anomaly in North Atlantic



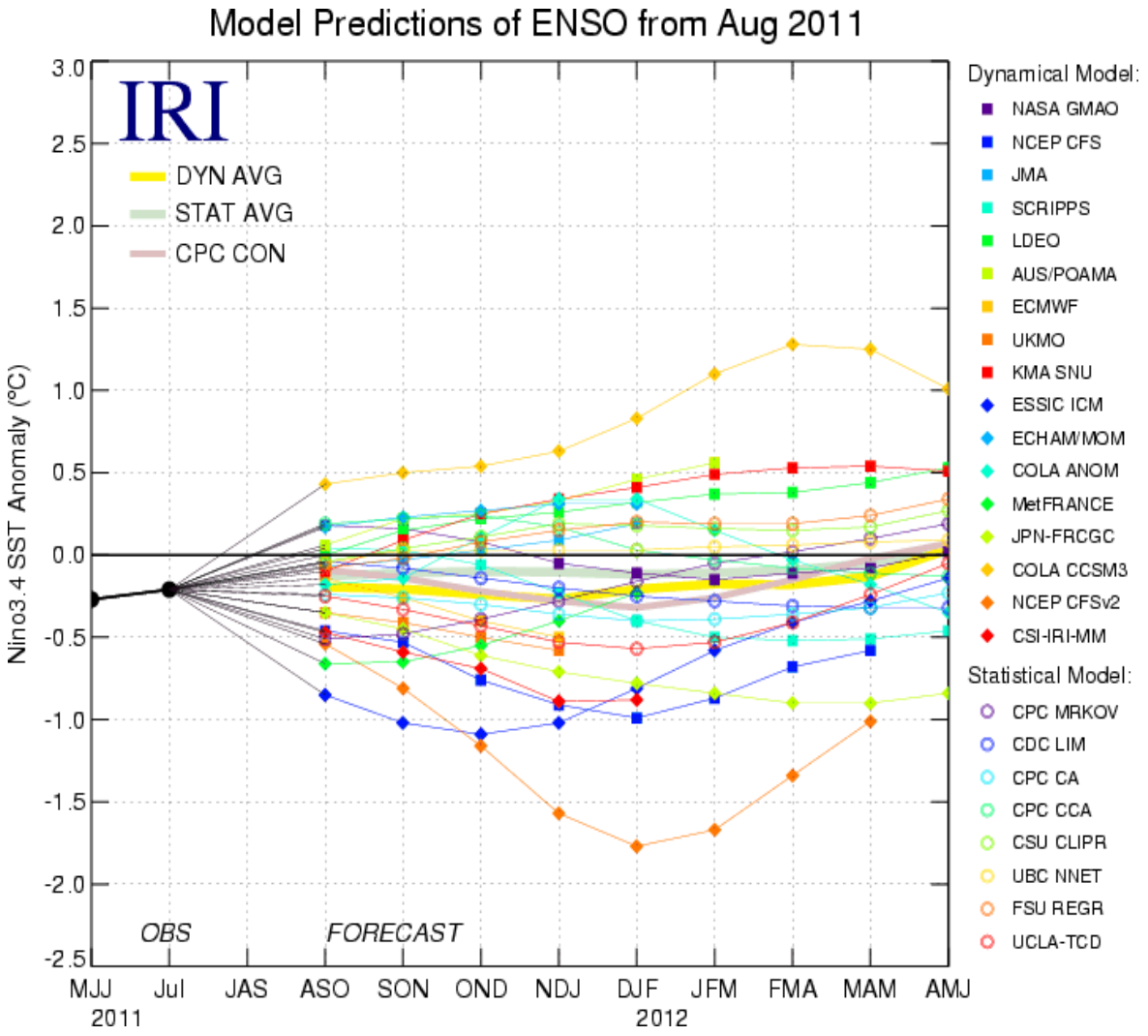




- **Negative NAO persisted in Aug 2011 with NAOI=-1.4.**
- **Tripole or horseshoe pattern weakened since Mar 2011, and vanished in Jun-Jul.**
- **A horseshoe pattern of SSTA in Aug 2011 may suggest the lingering impact of La Nina on North Atlantic Ocean.**
- **Warming in the low and high-latitudes of N. Atlantic is much weaker in summer 2011 than in summer 2010, probably due to the contrary impact of El Nino in 2010 and La Nina in 2011.**

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 1981-2010 base period means.

CFS SST Predictions and Ocean Initial Conditions

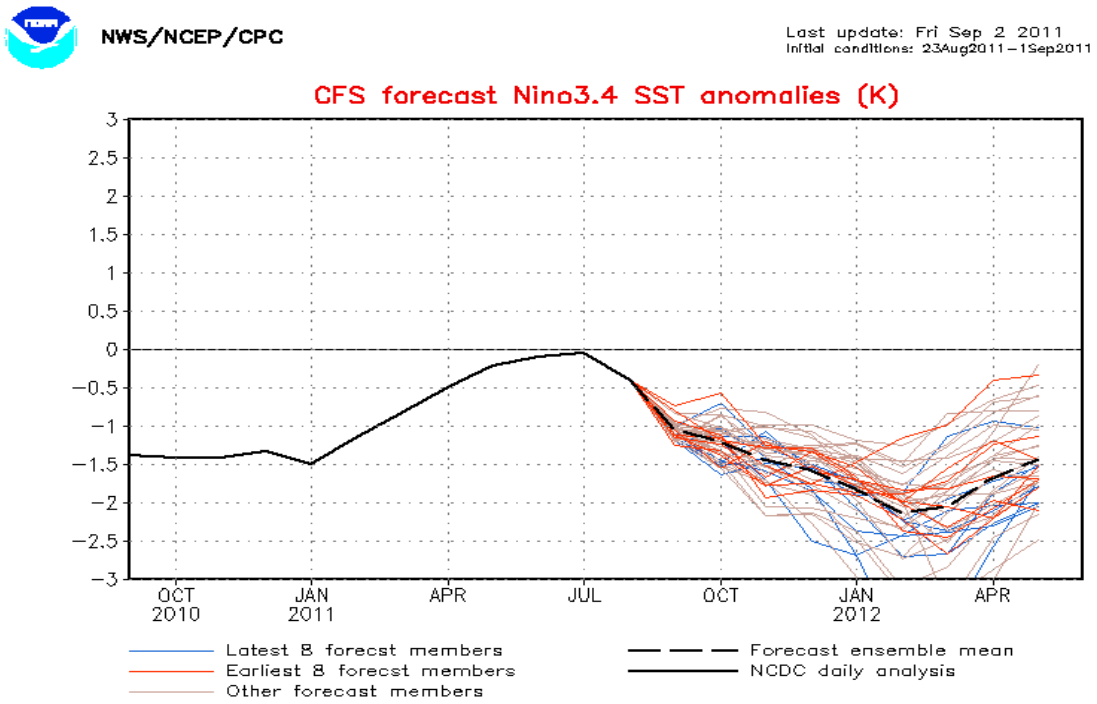


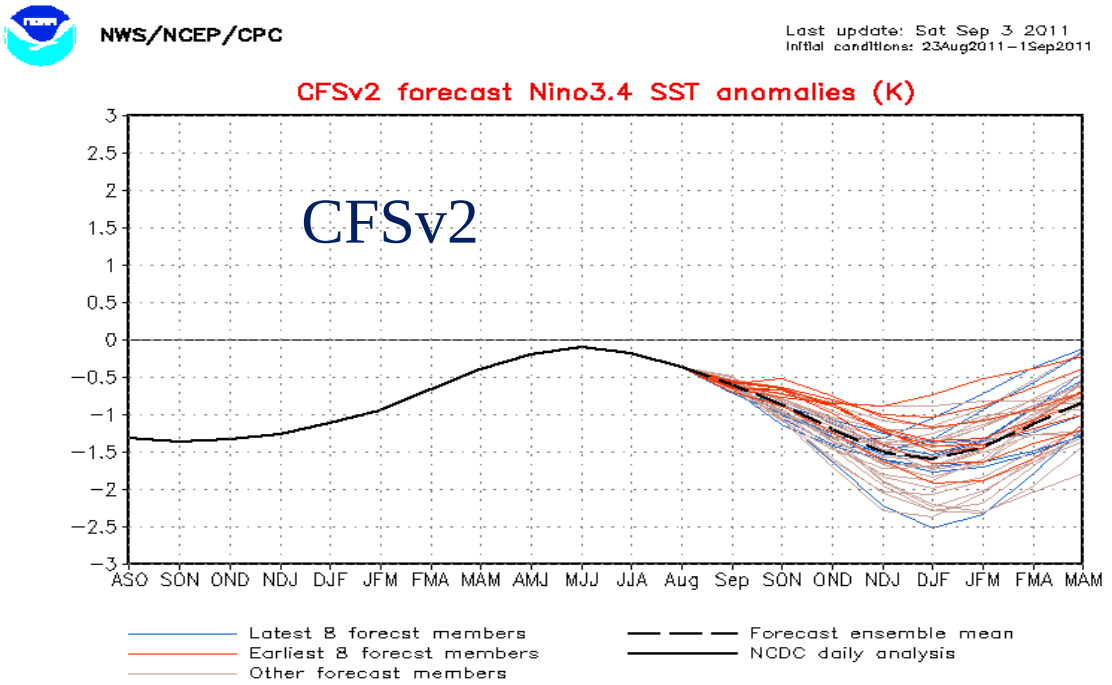
ENSO Forecasts Collected by IRI:

- The majority of models predicted ENSO-neutral conditions until summer 2012.

- Some models have predicted increasingly negative SST anomalies in the Nino-3.4 region during the upcoming Northern Hemisphere fall and winter.

- NOAA/NWS/NCEP/CPC has issued La Nina watch on Aug. 4, 2011, is going to issue La Nina Advisory on Sep. 8, 2011.

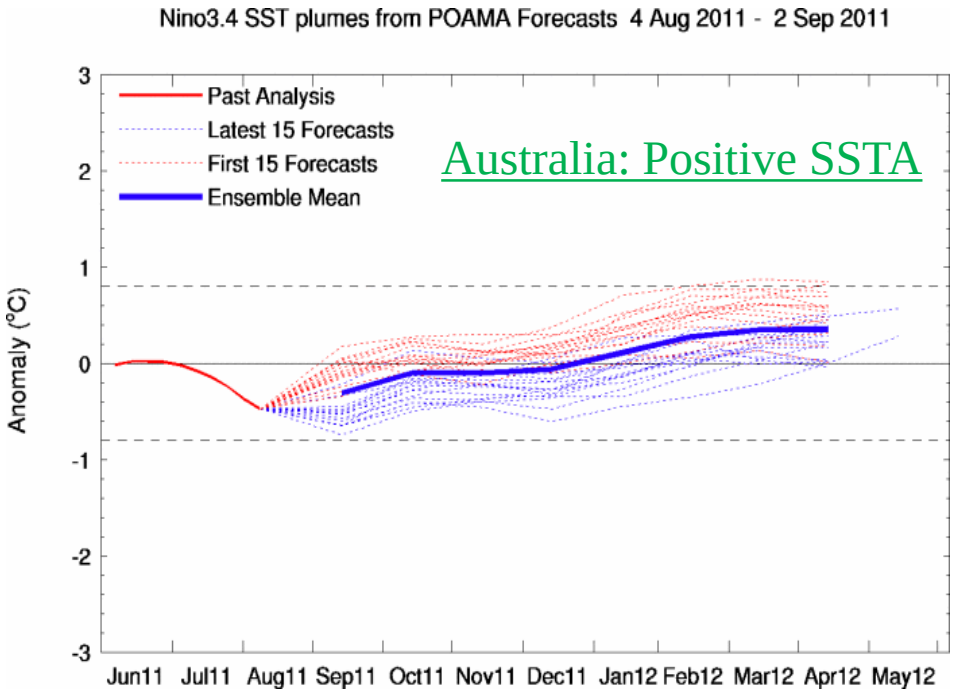




NCEP CFSv1 and v2 ENSO Forecasts:

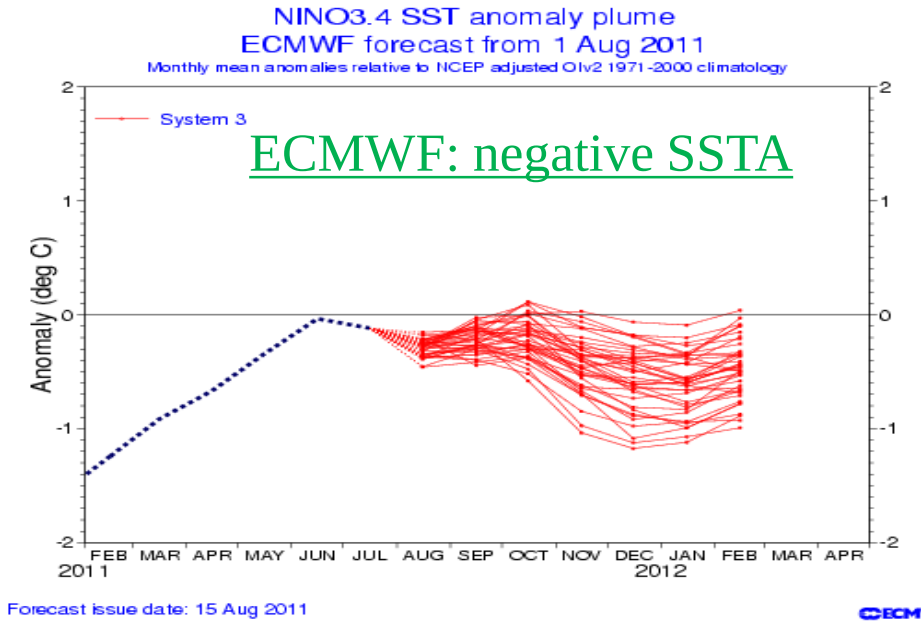
- Both CFSv1 and CFSv2 predicted that moderate La Nina condition might rebound in fall and persist up to early 2012.

- NOAA/NWS/NCEP/CPC has issued La Nina watch on Aug. 4, 2011, is going to issue La Nina Advisory on Sep. 8, 2011.

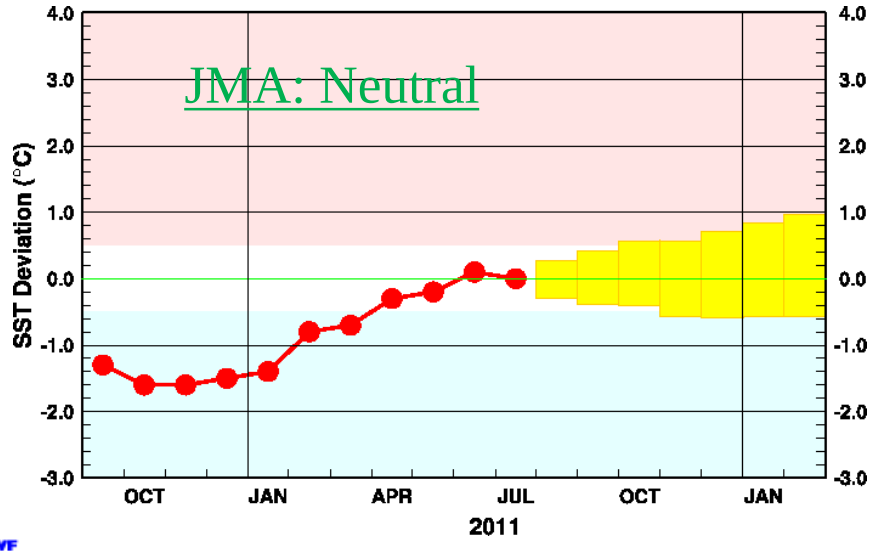


Australia: Positive SSTA

- Large spread among models: some examples.

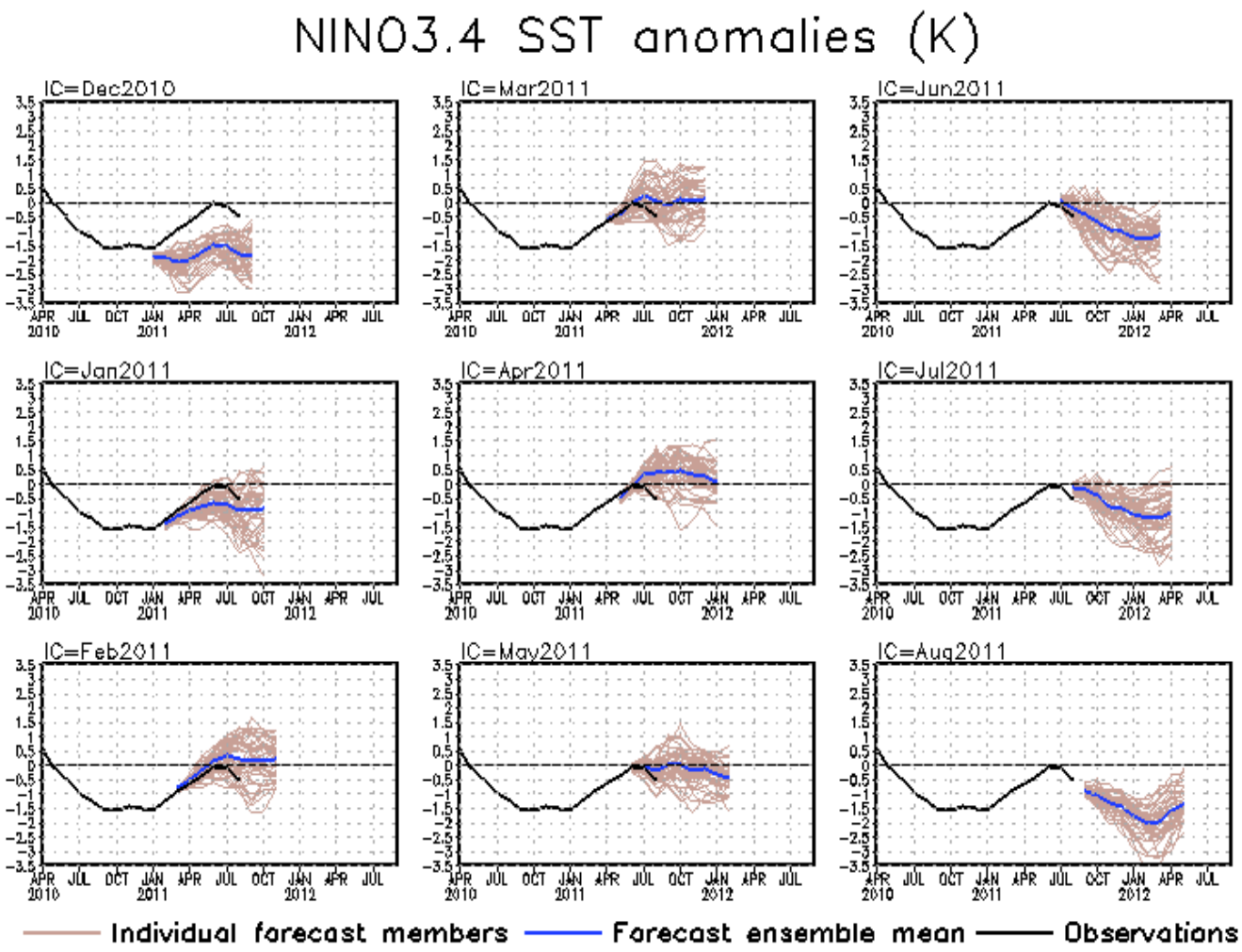


ECMWF: negative SSTA



JMA: Neutral

CFS Niño3.4 SST Predictions from Different Initial Months



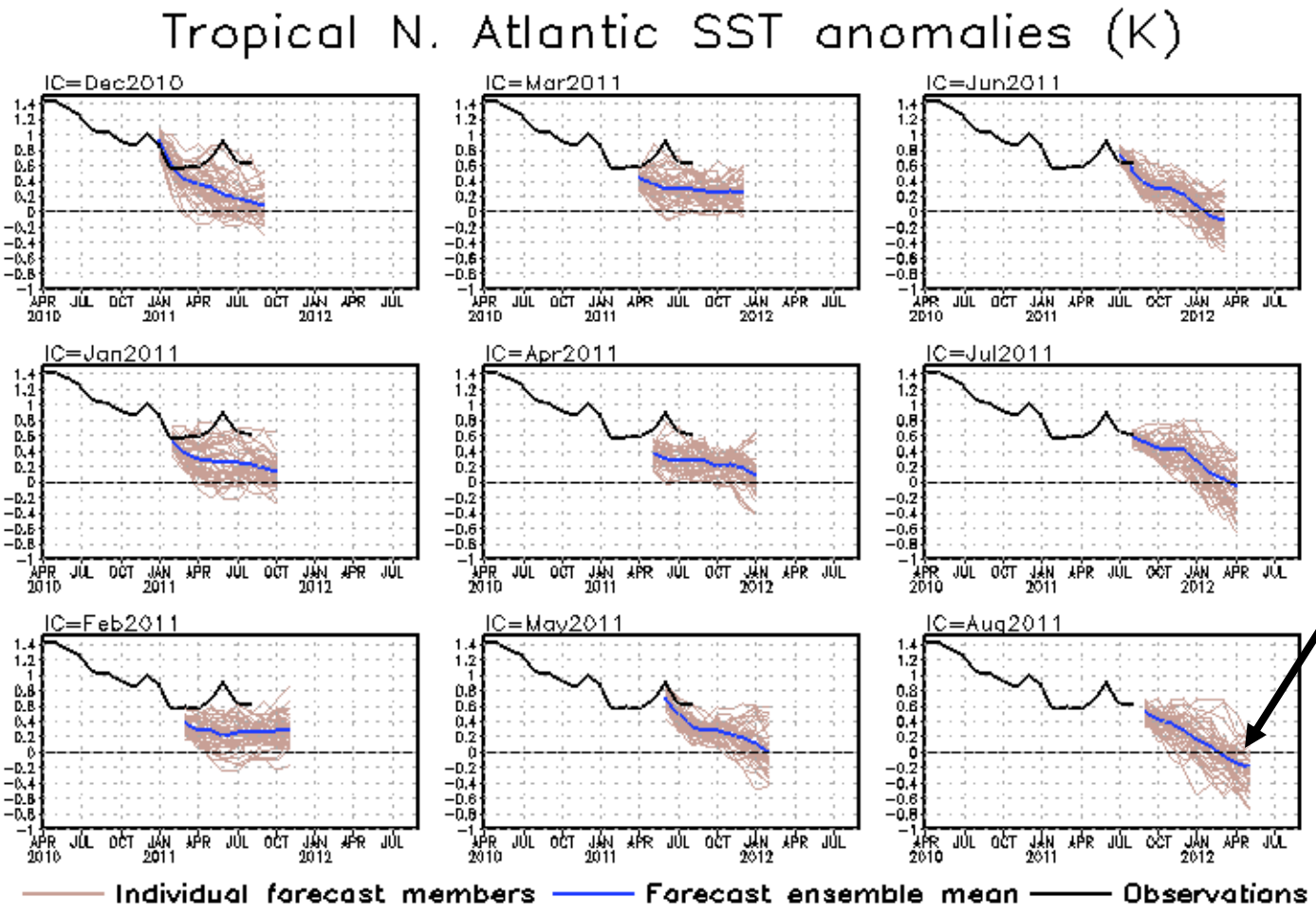
- **Forecasts had cold biases from Dec 2010-Jan 2011 I.C. and warm biases from Feb 2011-Jul 2011 I.C. The recent forecast biases can be alleviated through statistical model corrections (*http://www.cpc.ncep.noaa.gov/products/people/wwang/cfs_fcst*).**

- **The latest forecasts from Aug 2011 I.C. suggest that La Nina conditions may develop in fall and winter 2011/12.**

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 1981-2010 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].

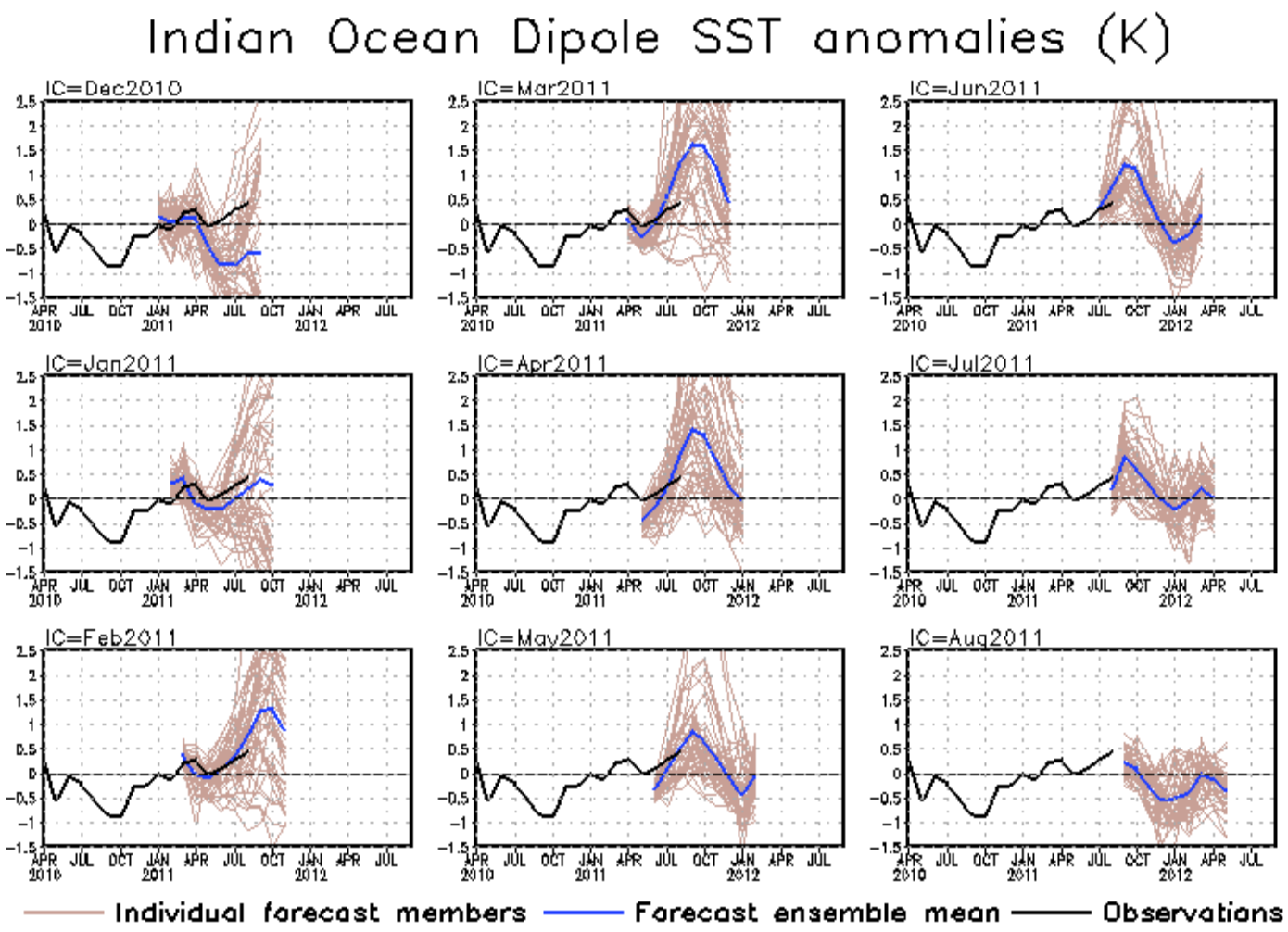


- Cold forecast biases were evident, may due to the fact that the NAO and the impact of NAO and ENSO as well as long-term trend were poorly predicted.

- Latest forecasts suggest that the tropical North Atlantic SST will be near-normal in Winter and Spring 2012.

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 1981-2010 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]

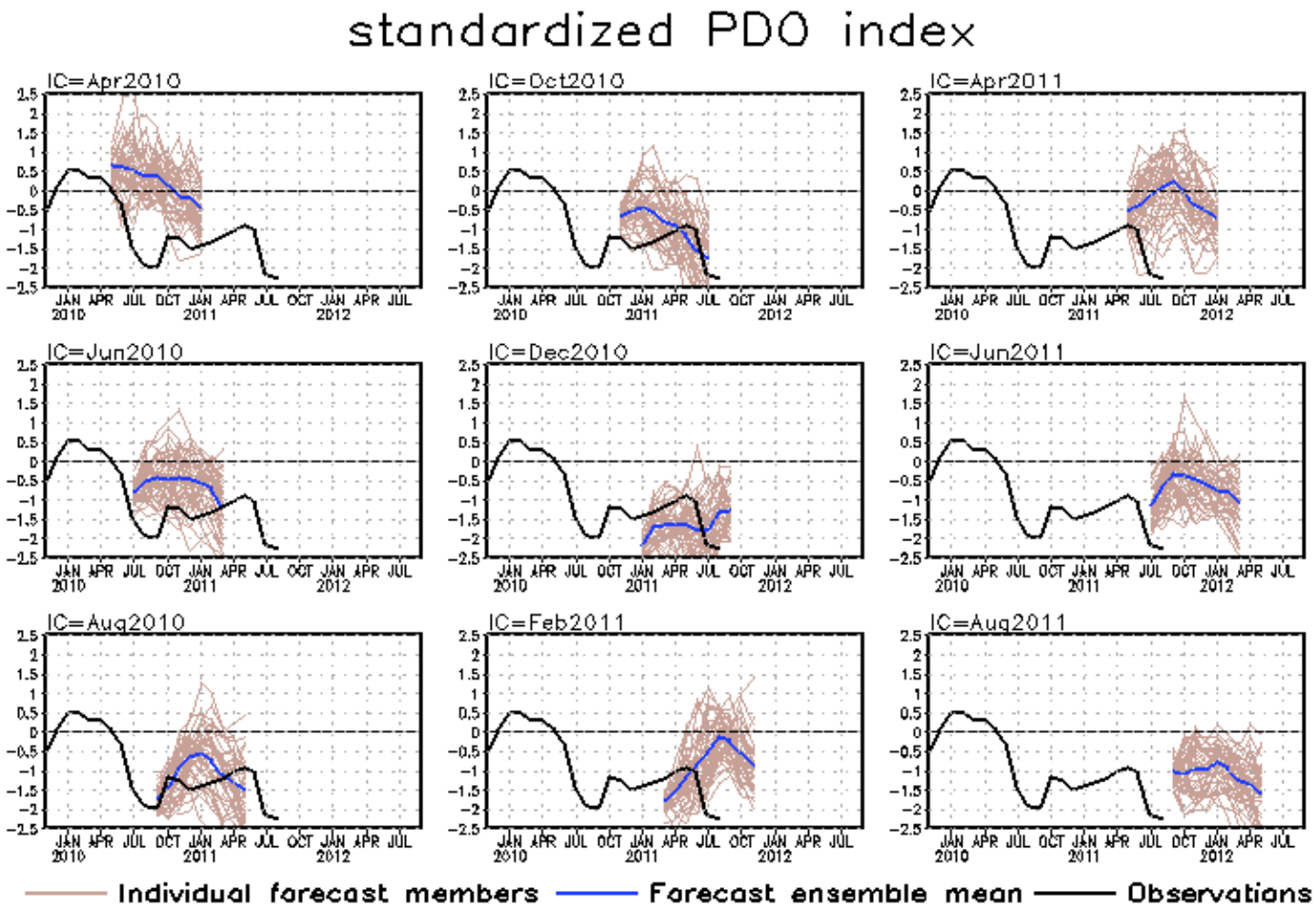
WTIO = SST anomaly in [50°E-70°E, 10°S-10°N]

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

- Contrasting to forecasting a positive IOD using I.C. in Jan-Jun 2011, latest forecasts from Aug 2011 I.C. suggest IOD will be in near-neutral condition in the next 9 month.

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 1981-2010 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 Mar-Sep 2010 have large warm biases.

- Latest forecasts from Aug 2011 I.C. suggest that the PDO will be negative throughout the second half of 2011 and into early 2012.

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 1981-2010 base period means.

Overview

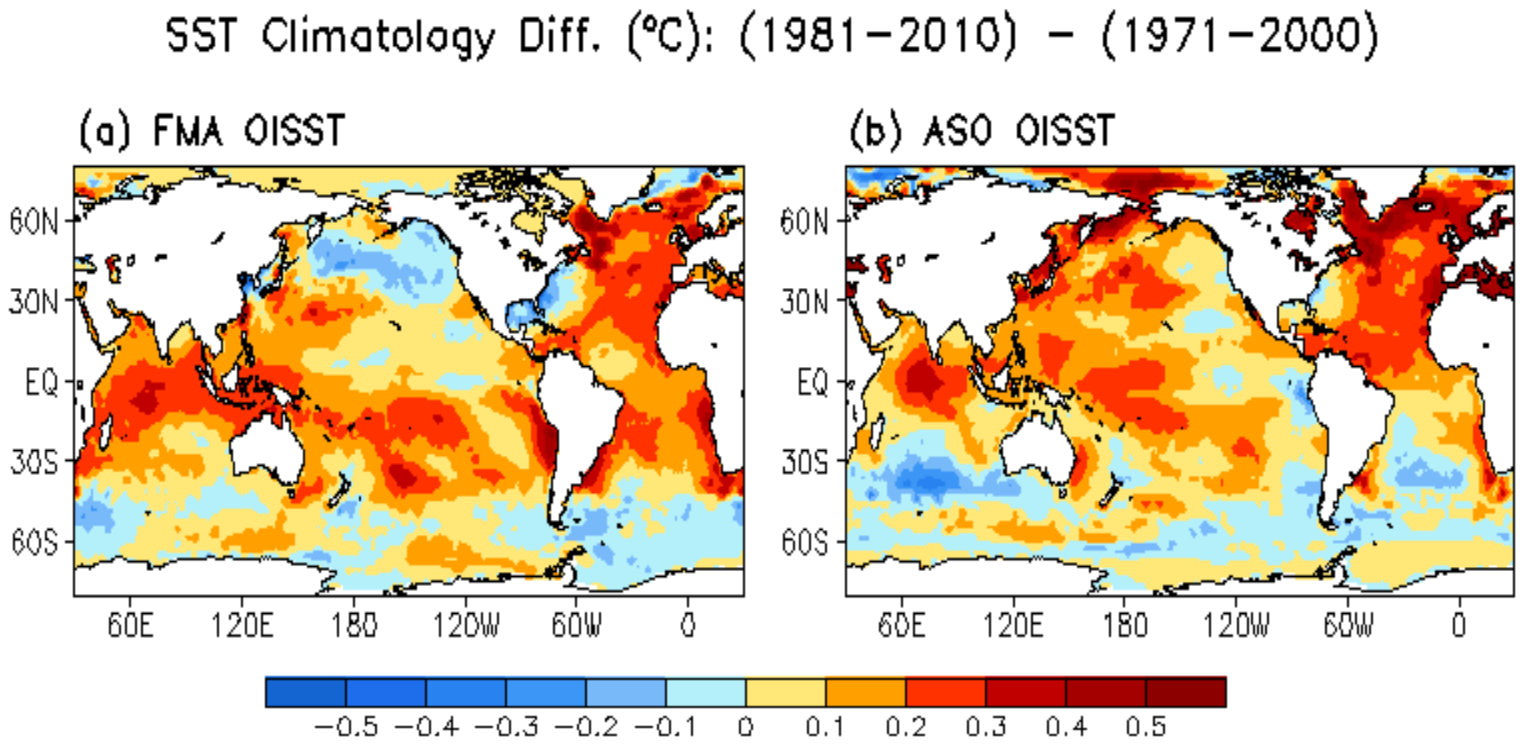
- **Pacific and Arctic Oceans**
  - La Nina conditions rebounded with OISST NINO3.4=-0.6°C in Aug 2011.
  - Some models, including CFSv1 and CFSv2 predict a moderate La Nina event in coming boreal fall and winter.
  - Negative PDO persisted, with PDOI=-2.3 in Aug 2011.
  - Artic sea ice extent continued to decline in Aug 2011.
- **Indian Ocean**
  - Positive SSTA developed along the African equatorial coast.
- **Atlantic Ocean**
  - Negative phase NAO presented since May 2011 and intensified in Jun and Jul 2011, and persisted in Aug 2011 with NAOI=-1.4.
  - Positive SSTA continued and small wind shear observed 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!