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

Prepared by

Climate Prediction Center, NCEP/NOAA

August 8, 2011

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

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

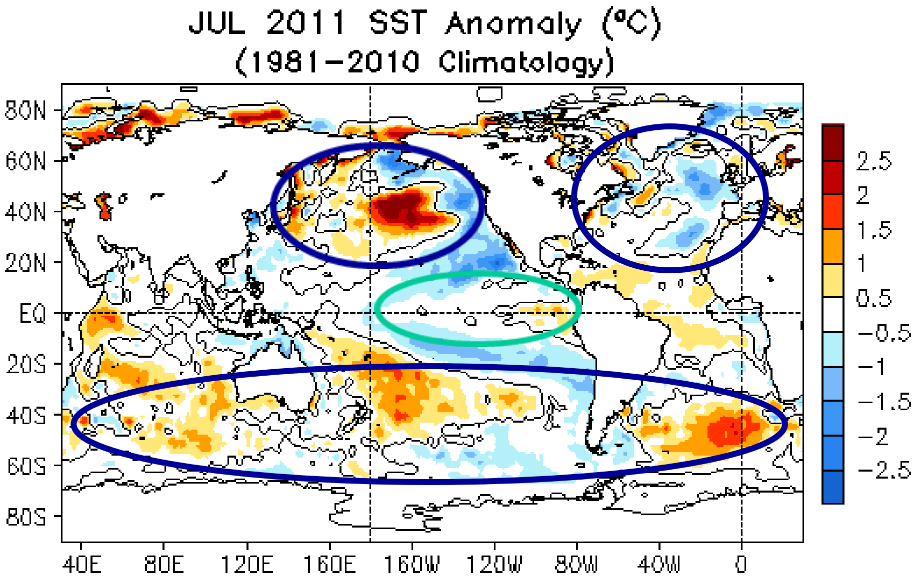
Outline

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

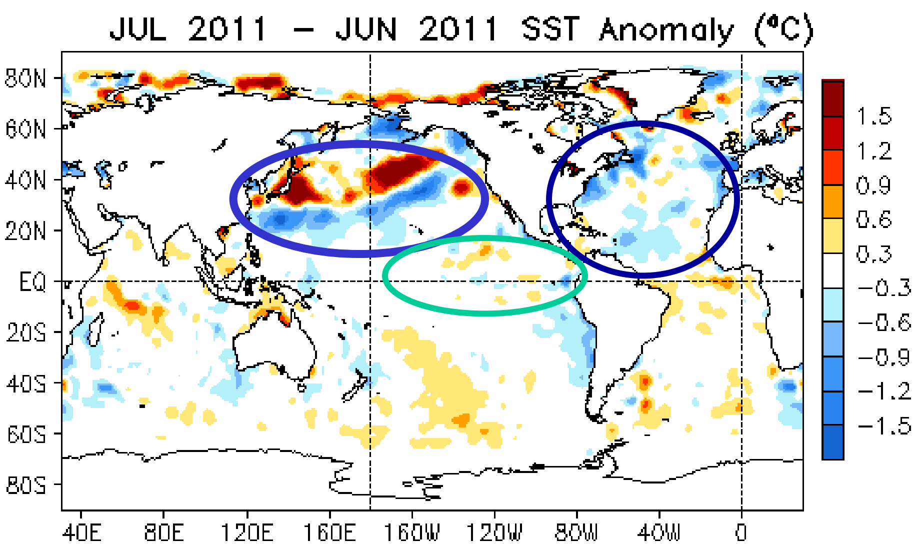
Overview

- **Pacific and Arctic Oceans**
  - **ENSO-neutral conditions prevailed with OISST NINO3.4=-0.21°C in Jul 2011.**
  - **NOAA/NCEP Climate Forecast System (CFS) suggests that the ENSO-neutral conditions are expected to last through the boreal summer.**
  - **Some models, including CFSv1 and CFSv2 predict a moderate La Nina event in coming boreal fall and winter.**
  - **Negative PDO intensified since Jun 2011, with PDOI=-2.16 in Jul 2011.**
  - **Artic sea ice extent continued to decline in Jul 2011.**
- **Indian Ocean**
  - **Positive SSTA developed along the African equatorial coast.**
- **Atlantic Ocean**
  - **Negative phase NAO presented since in May 2011 and intensified in Jun and Jul 2011, NAOI=-1.51 in Jul.**
  - **Positive SSTA continued in the Atlantic Hurricane Main Development Region.**

Global SST Anomaly (⁰C) and Anomaly Tendency



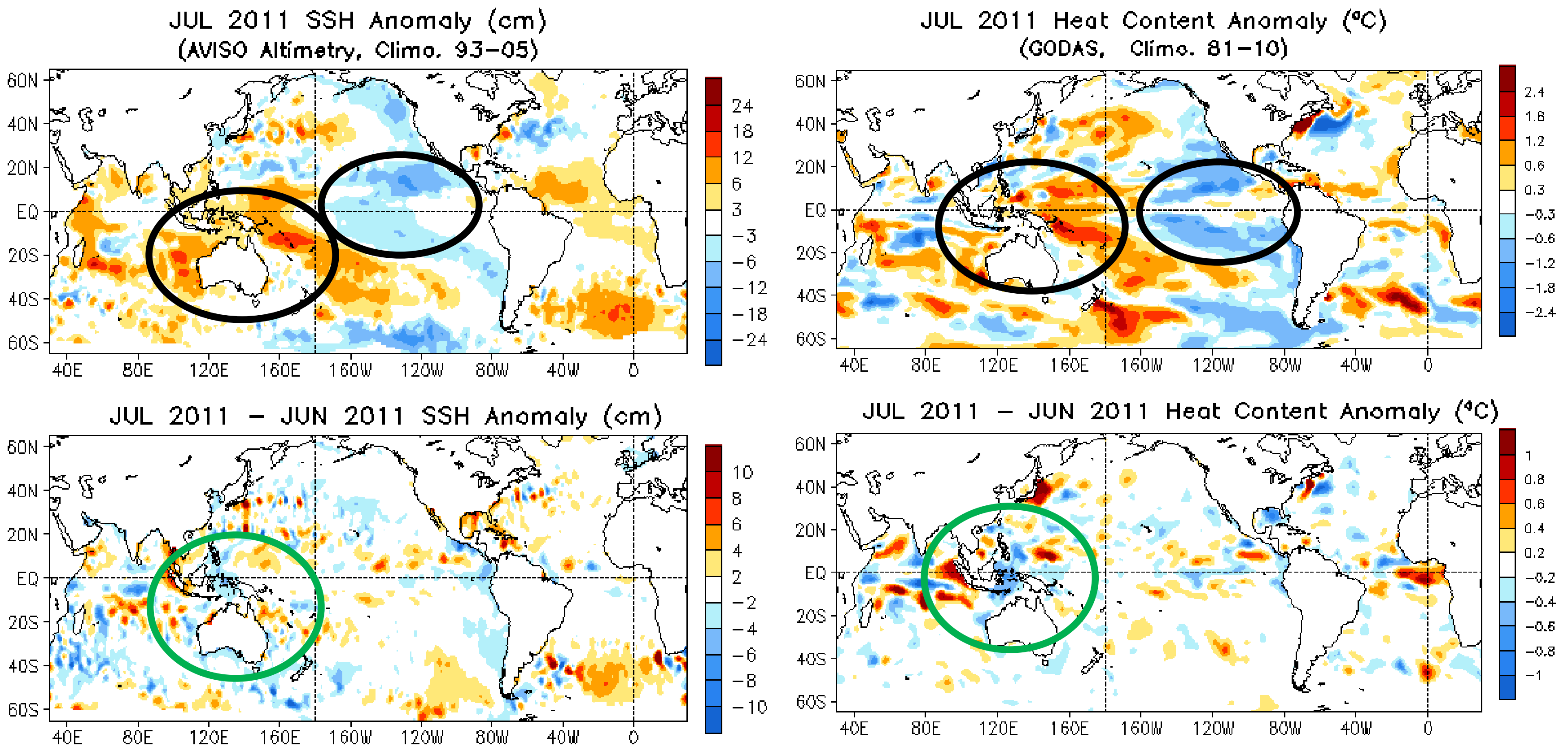
- Neutral SSTA persisted over the equatorial Pacific Ocean.
- A horseshoe pattern in the North Pacific intensified.
- Negative SSTA prevailed over the extratropical North Atlantic and SST in the tropical Atlantic was above normal.
- Positive SSTA was observed in mid-latitude southern oceans.



- Minor tendencies presented in the central and eastern tropical Pacific.
- The horseshoe pattern of North Pacific further intensified in Jul 2011.
- Small positive and large negative tendencies were observed in the 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 1981-2010 base period means.

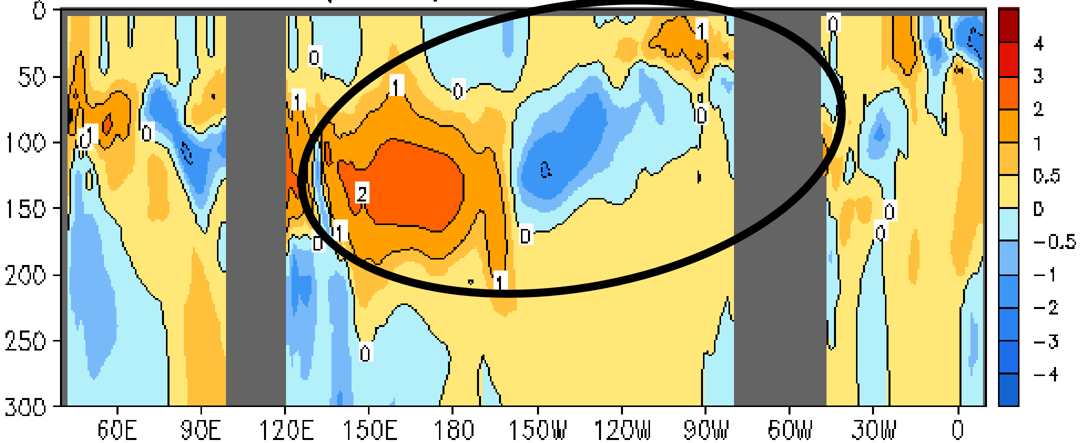
Global SSH/HC Anomaly (cm/°C) and Anomaly Tendency

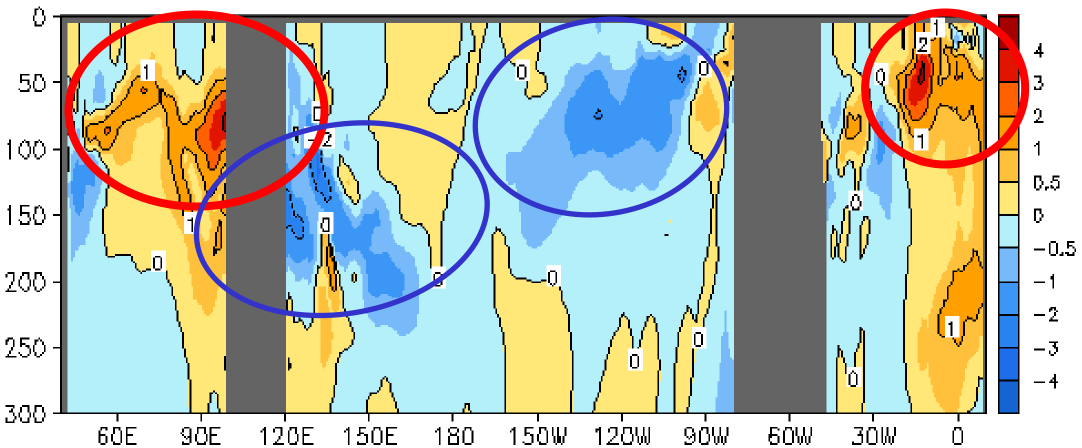


- **Positive SSH and Heat Content (HC) anomalies persisted in the western and southwestern tropical Pacific and near the west coast of Australia.**
- **Negative SSH and HC anomalies were observed off the equator in the east-central tropical Pacific, indicating the lingering effects of La Nina.**
- **SSH and HC anomalies as well as their tendencies were largely consistent, except in the Southern Ocean where biases in GODAS climatology are large (not shown).**

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

Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2^{o}S-2^{o}N



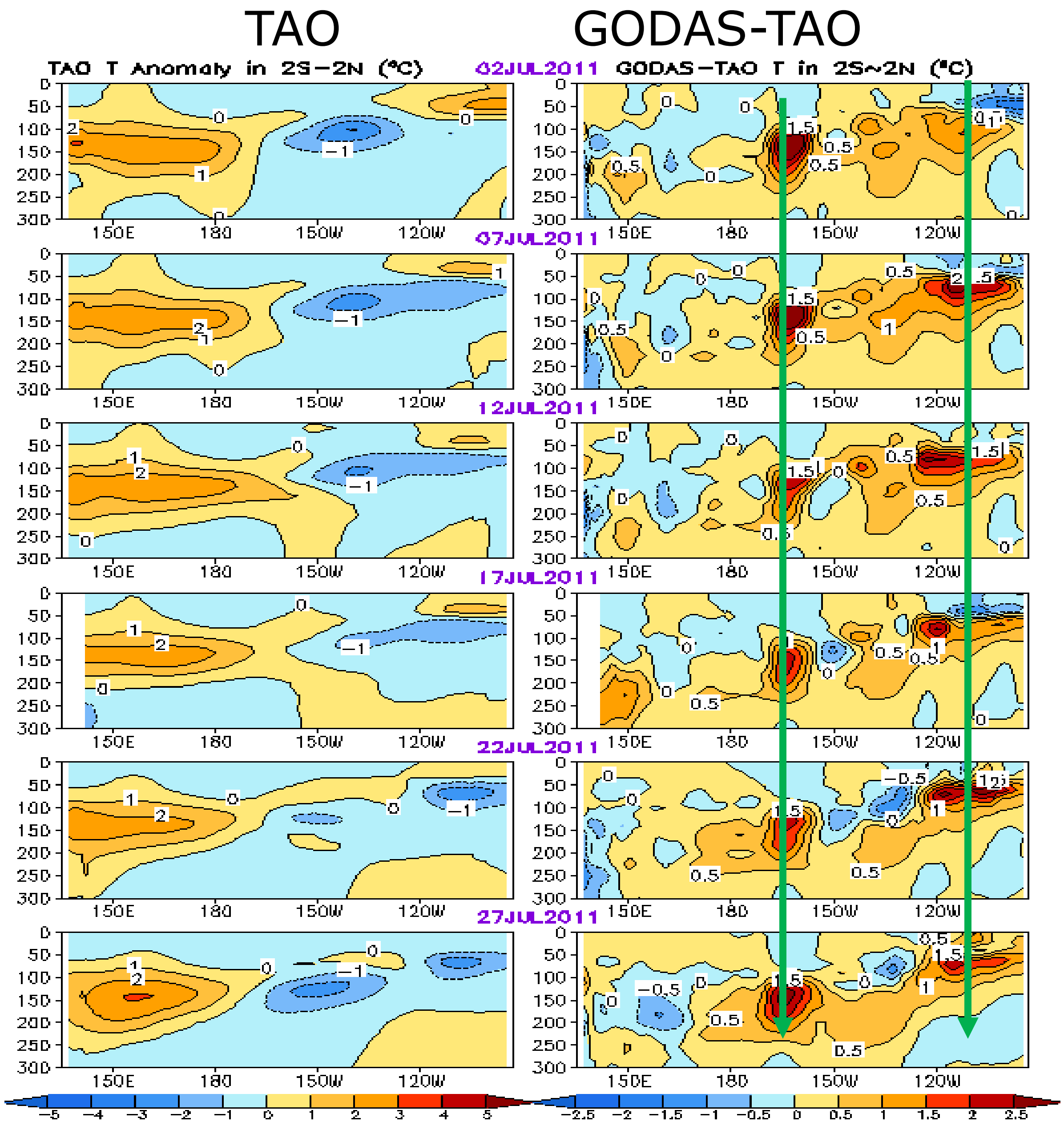


- Positive ocean temperature anomalies continued along the equatorial central and western Pacific thermocline.
- Negative ocean temperature anomalies prevailed near the equatorial thermocline of the eastern Pacific Ocean.
- Both negative and positive anomalies existed in the Indian and Atlantic Oceans.

- Compared with Jun, positive subsurface temperature anomalies weakened in the western Pacific and negative ones intensified in the east along the thermocline in Jul 2011.
- Positive ocean temperature anomaly tendencies existed along the thermocline in the equatorial Indian and Atlantic Oceans.

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



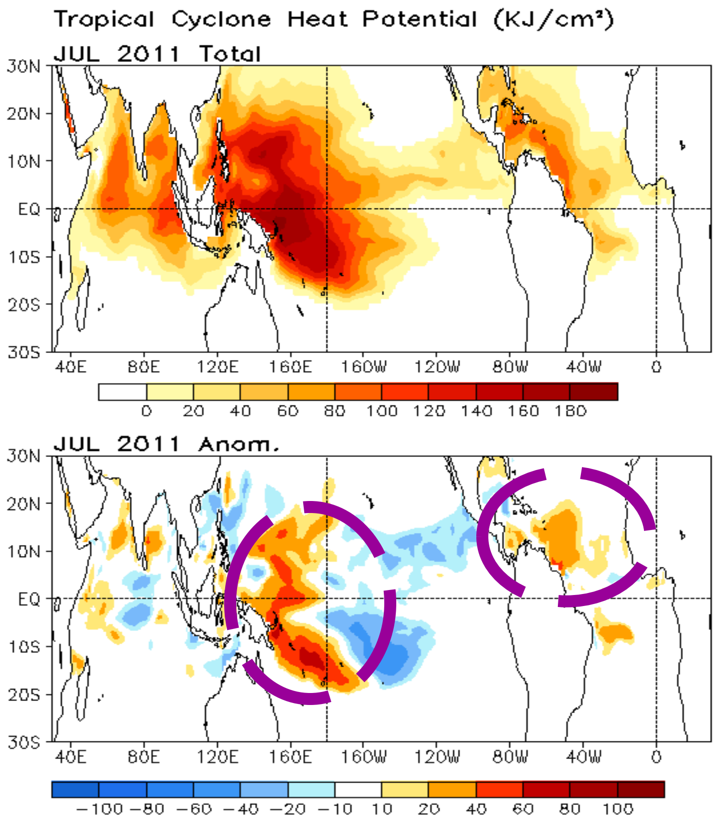
- **Positive (negative) ocean temperature anomalies are dominated in the western (eastern) Pacific.**

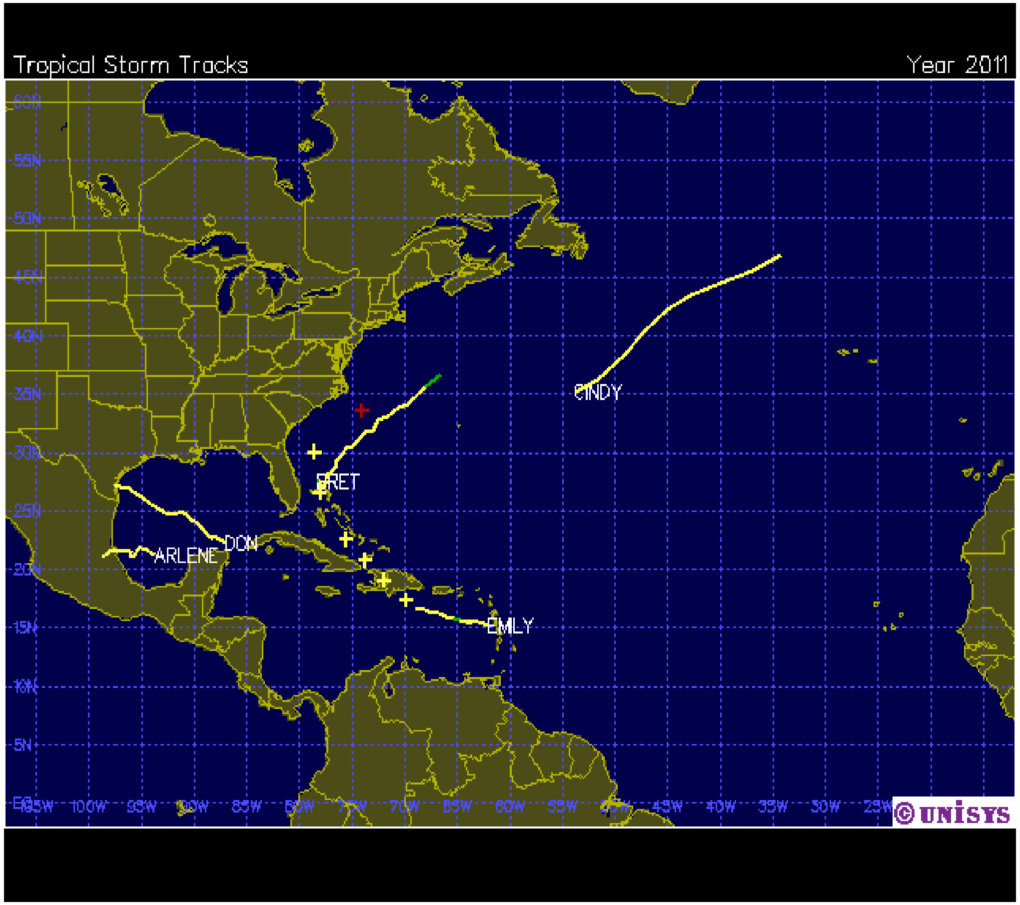
- **Compared with TAO, GODAS was still about 2°C too warm near the thermocline at 170W-160W and 120W-90W.**

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

- ***For example, buoy at 2S,95W was moved 6 km off station on 25 July and three days later , lost the wind and rain gauges. Finally on 29 July, the buoy stopped transmitting. The buoy at 00, 95W was pulled on (average daily depth of 468 and 474 meters) 25 and 27 July. The sensors on the IM tail all failed and did not report 29 July (Richard Crout, Chief Data Officer of NOAA/NWS/NDBC, personal communication).***

Tropical Cyclone Heat Potential, and Tropical Storm Activity in Atlantic





- **Positive TCHP anomalies in the tropical N. Atlantic**
- **Large positive TCHP anomalies presented between 125-175E of Pacific Ocean.**
- **By Aug. 3, 2011, 5 tropical storms have been formed in the North Atlantic Ocean.**

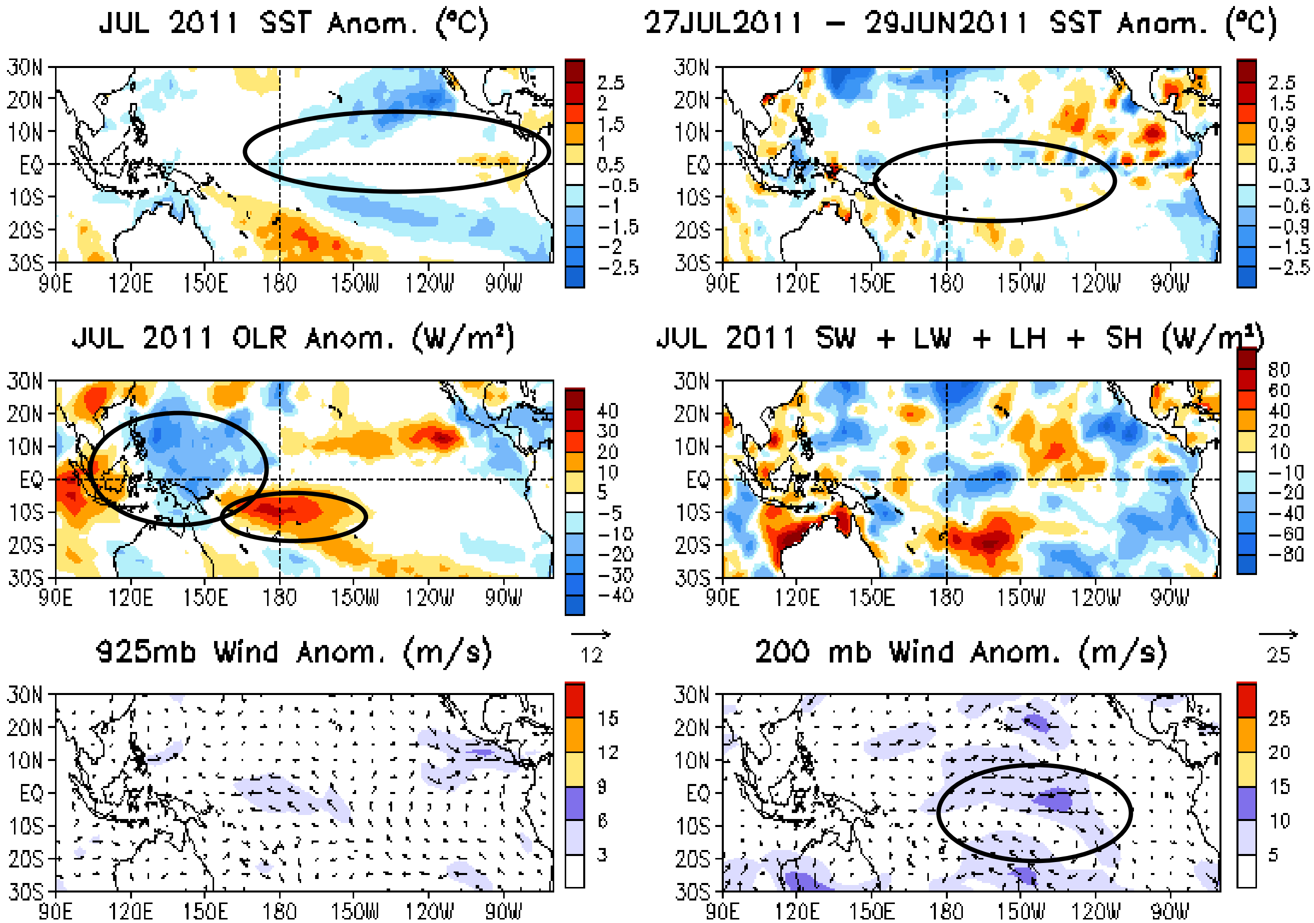
The tropical cyclone heat potential (hereafter TCHP), is defined as a measure of the integrated vertical temperature from the sea surface to the depth of the 26°C isotherm.

NOAA Predicts an Active Atlantic Hurricane Season in 2011

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

Tropical Pacific Ocean

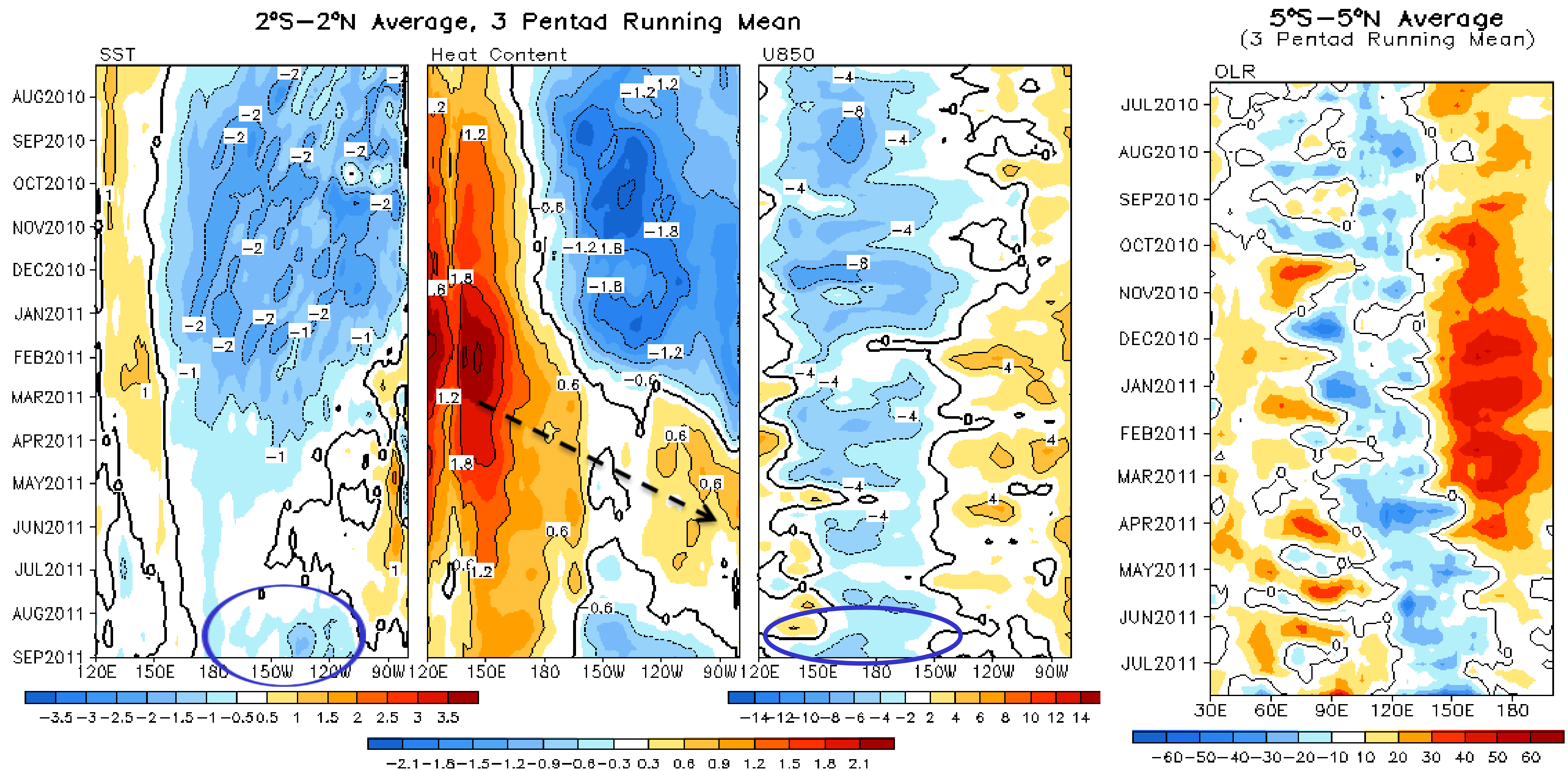
Tropical Pacific: SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Winds



- **Near-normal SST prevailed over much of the equatorial Pacific and small changes occurred in Jul.**
- **Convection was enhanced near the Philippine Sea and suppressed south of the equator near the dateline.**
- **Westerly wind anomalies in high level weakened but persisted over the central 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 1981-2010 base period means.

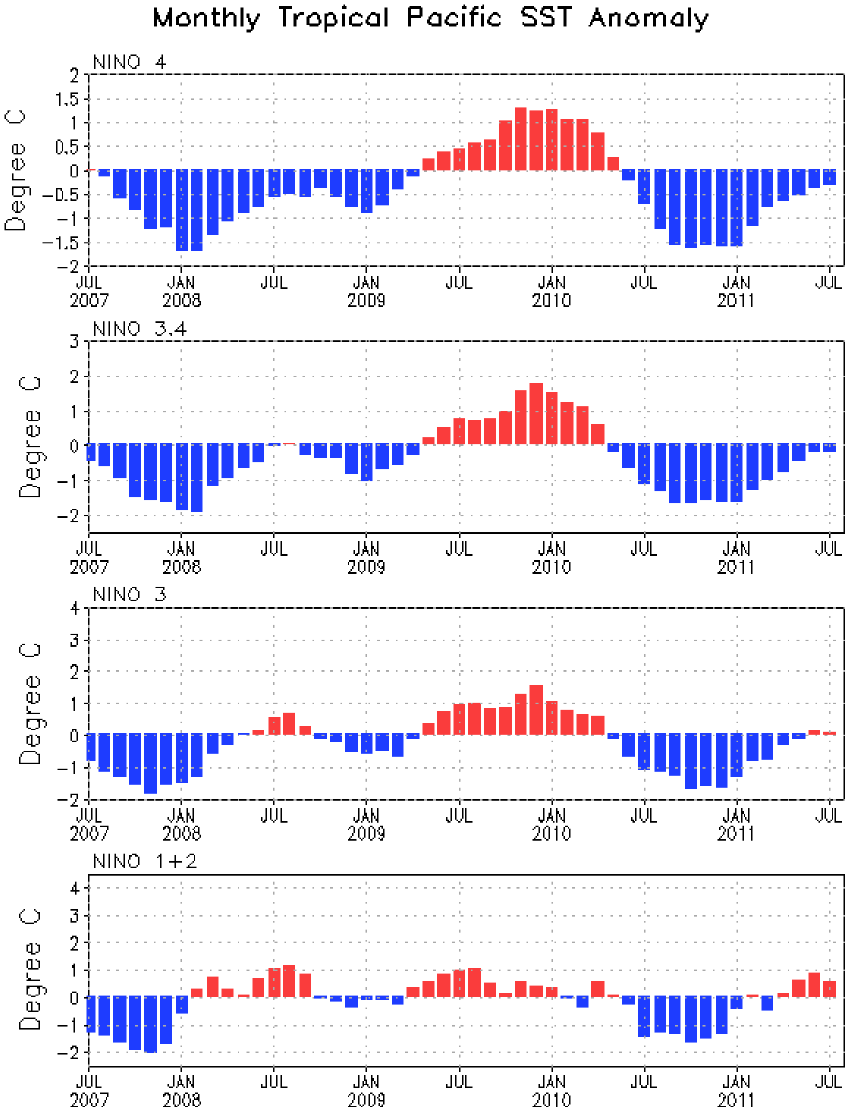
Evolution of Equatorial Pacific SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s), and OLR (W/m²) Anomaly

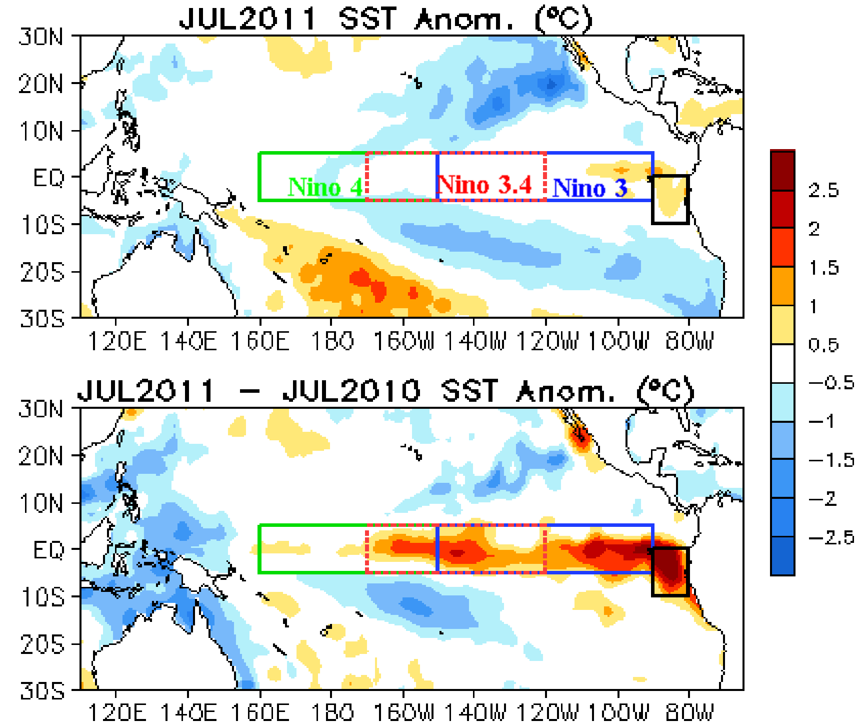


- **Positive HC anomalies appeared in the central and eastern equatorial Pacific since Feb 2011, weakened since May 2011.**
- **The SST in the far eastern equatorial Pacific was generally above-normal since Feb 2011, which might be attributed to the eastward propagation of down-welling kelvin waves and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

Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 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 1981-2010, 1982-2004, 1979-1995 base period pentad means respectively.

Evolution of Pacific NINO SST Indices





- **NINO4 and NINO3.4 indices were negative**
- **NINO3 and NINO1+2 indices were positive.**
- **Nino3.4 =-0.21 in Jul 2011.**
- **The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v3b.**

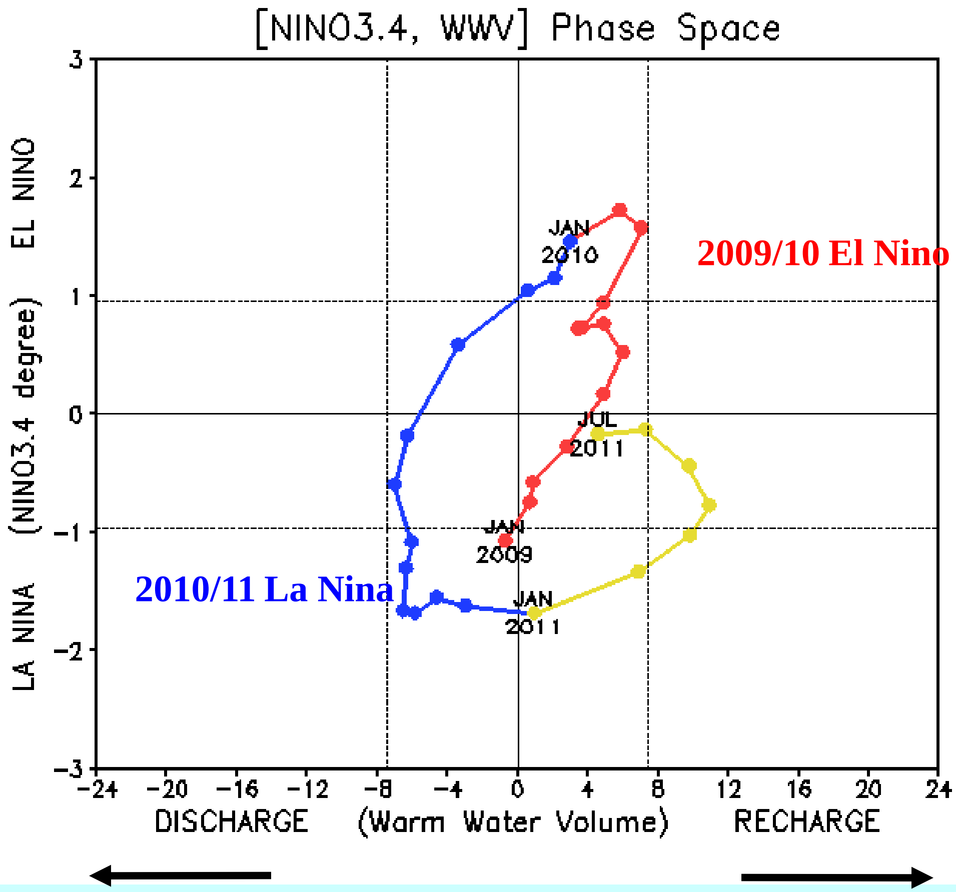
Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

Warm Water Volume (WWV) and NINO3.4 Anomalies

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

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

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



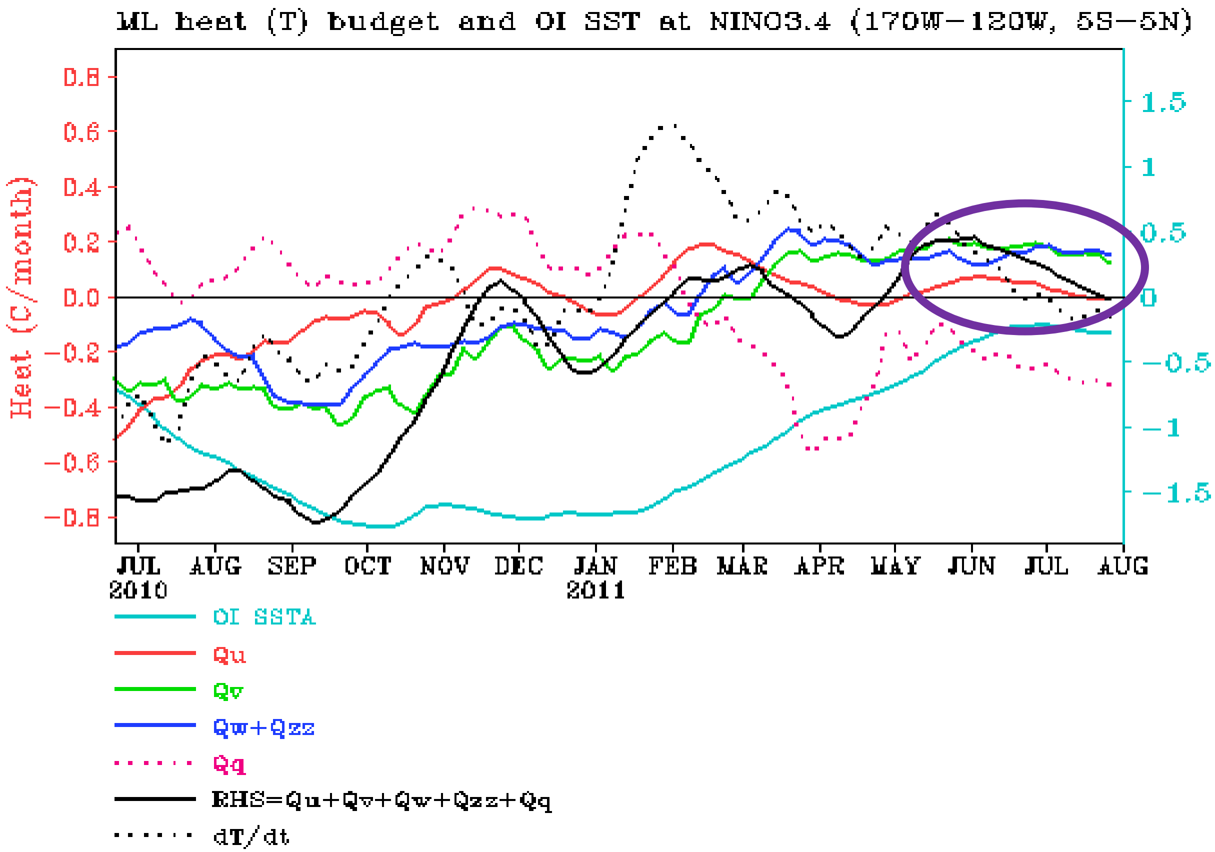
- WWV recharge enhanced significantly since Jan 2011 due to the downwelling Kelvin wave episodes and air-sea coupling that links the strengthening WWV with increasing NINO3.4.

- WWV recharge started to decrease since Apr 2011.

- ENSO-neutral conditions continued in Jul 2011.

Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] calculated with the NCEP's global ocean data assimilation system. Anomalies for WWV (NINO 3.4) are departures from the 1982-2004 (1981-2010) base period means.

NINO3.4 Heat Budget



- Small negative SSTA tendency (dT/dt) in NINO 3.4 (dotted line) observed in Jul, indicating the continuous ENSO-neutral conditions.
- Dynamical terms (Qv, Qw+Qzz,Qu) became positive since Feb 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 in Jul 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.

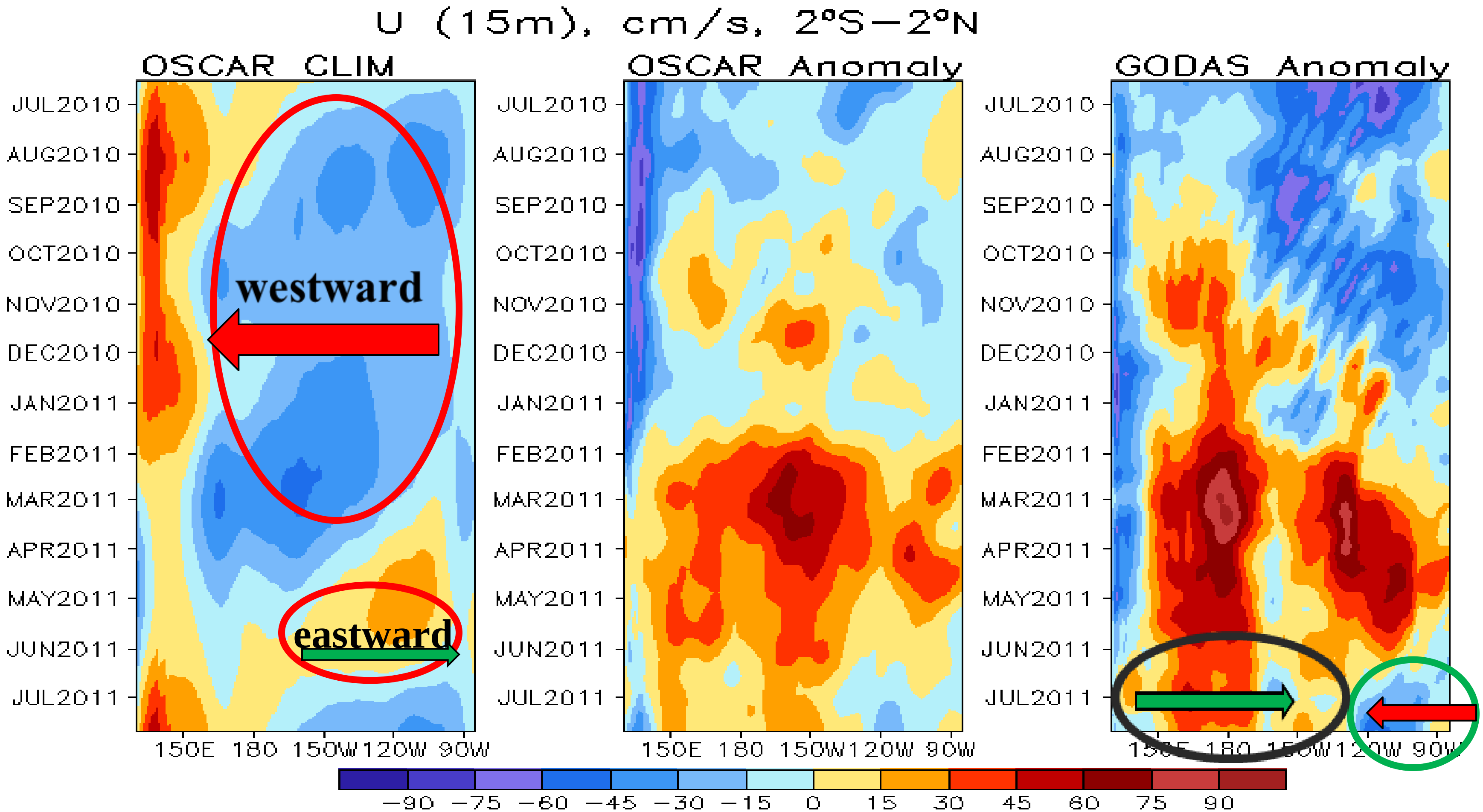
Qu: Zonal advection; Qv: Meridional advection;

Qw: Vertical entrainment; Qzz: Vertical diffusion

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

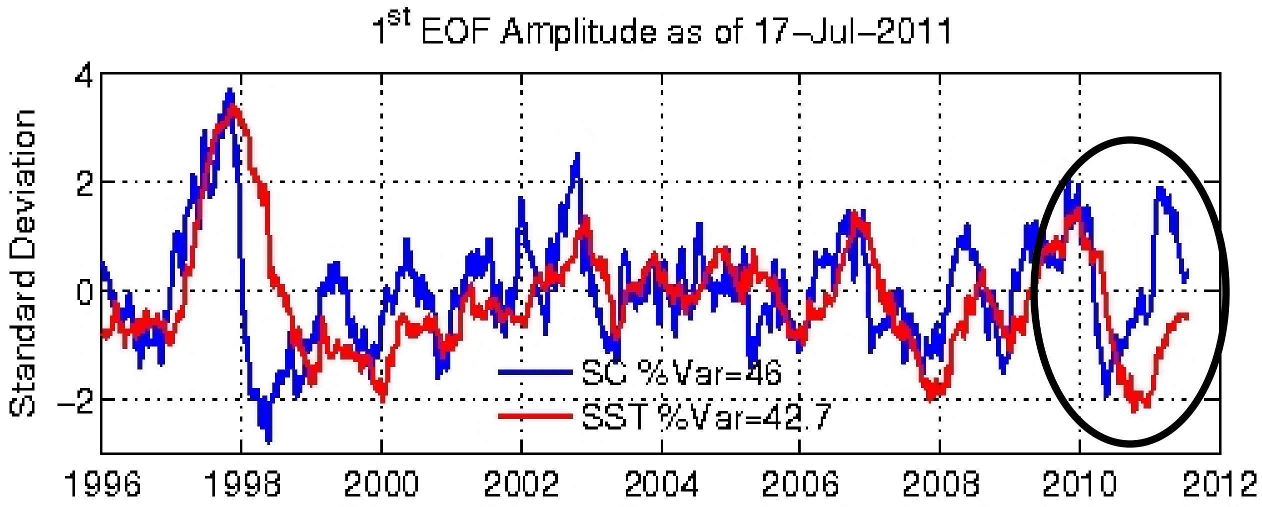
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

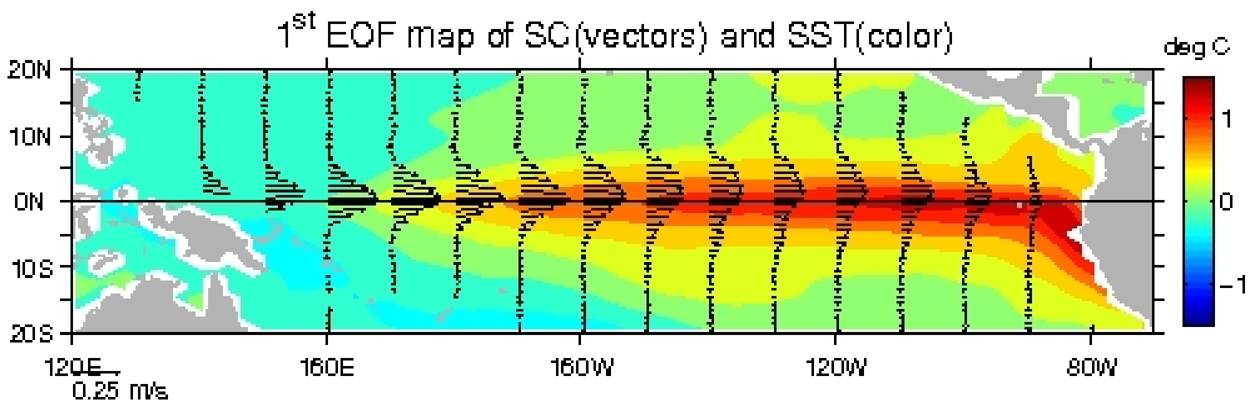
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- 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 Jul 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





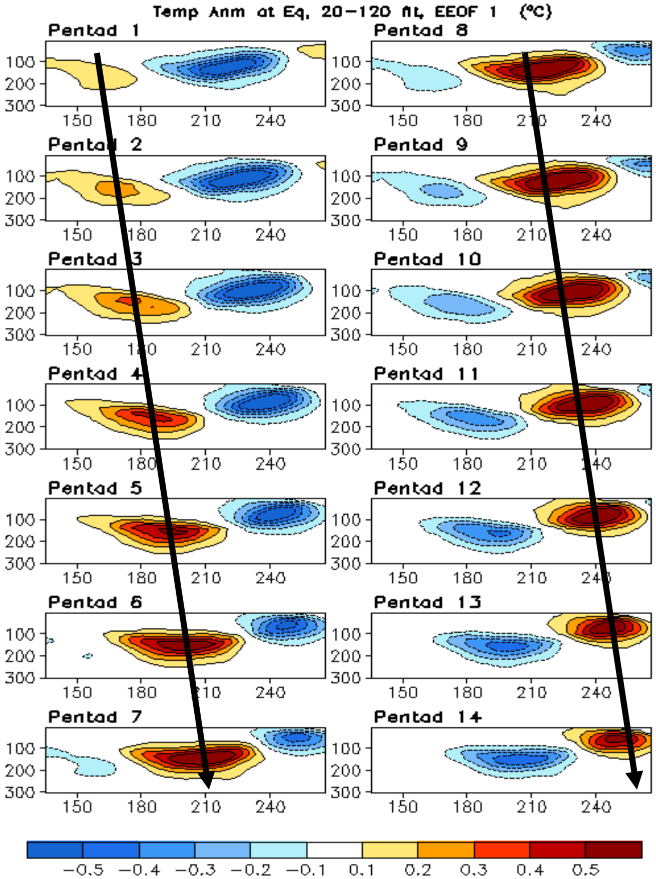
- Zonal current anomaly has become eastward since Dec 2010, and weakened in recent months.

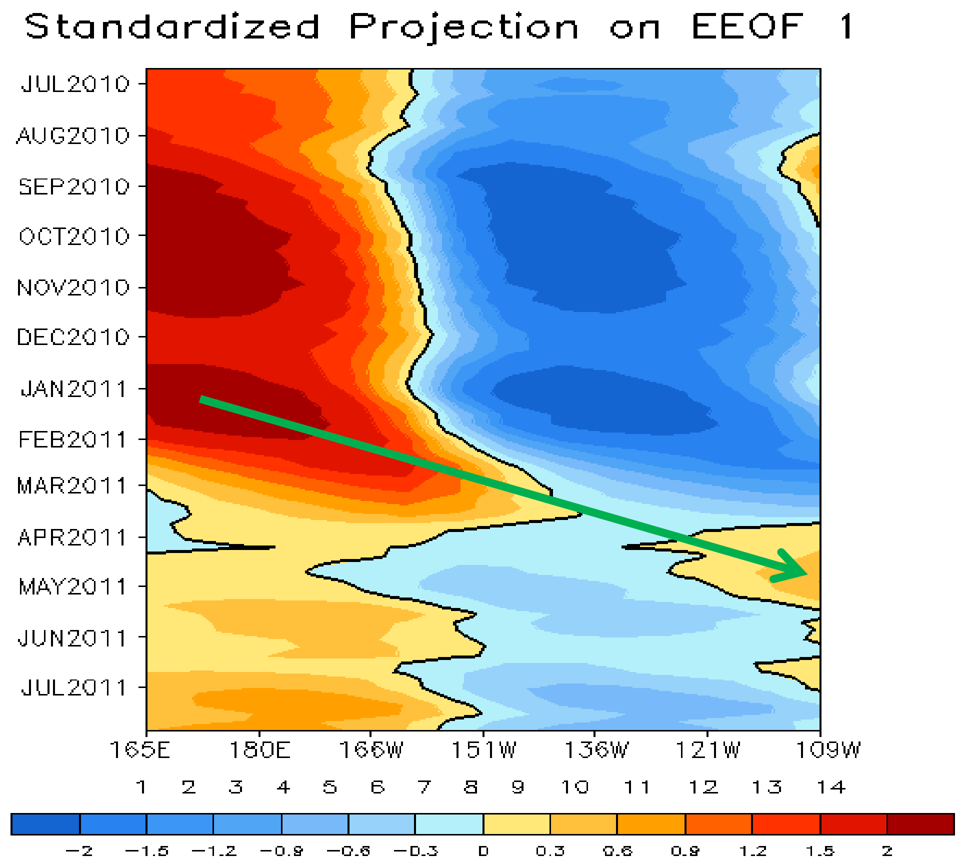
- On average, ocean surface zonal current anomaly leads the SSTA by a few months.

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



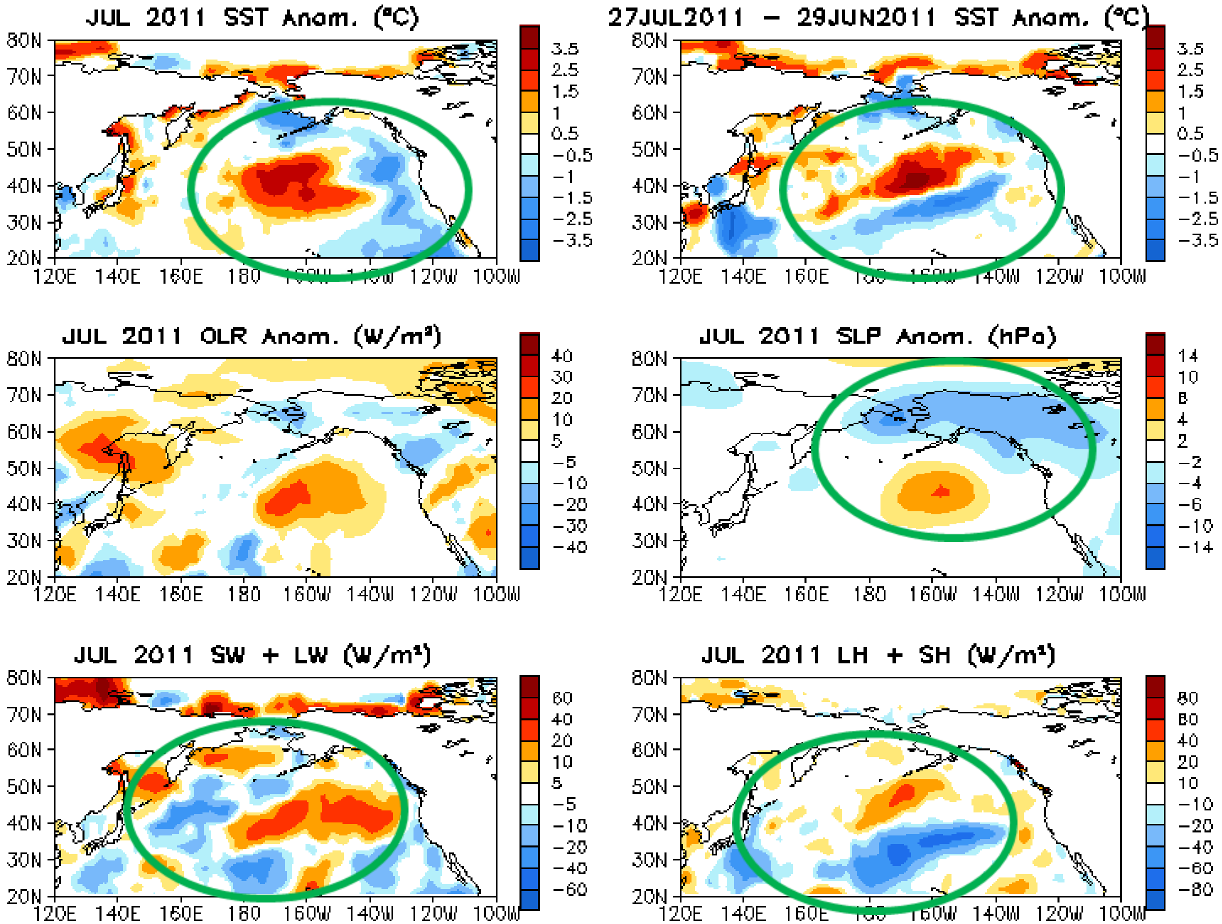


- Downwelling Kelvin wave initiated in late Jan 2011 in the W. Pacific arrived at the eastern coast in Apr 2011.

- **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



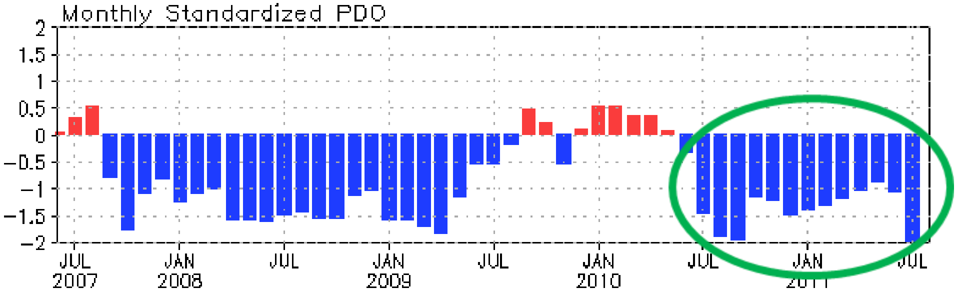
- Positive SSTA was observed in the central North Pacific and negative SSTA along the west coast of N. America in Jul 2011, consistent with the negative PDO index (next slide).

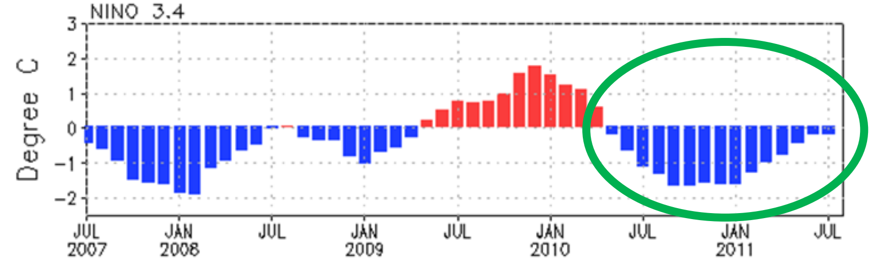
- Large SSTA warming tendency presented over the central North Pacific, consistent with the intensification of PDO-like pattern.

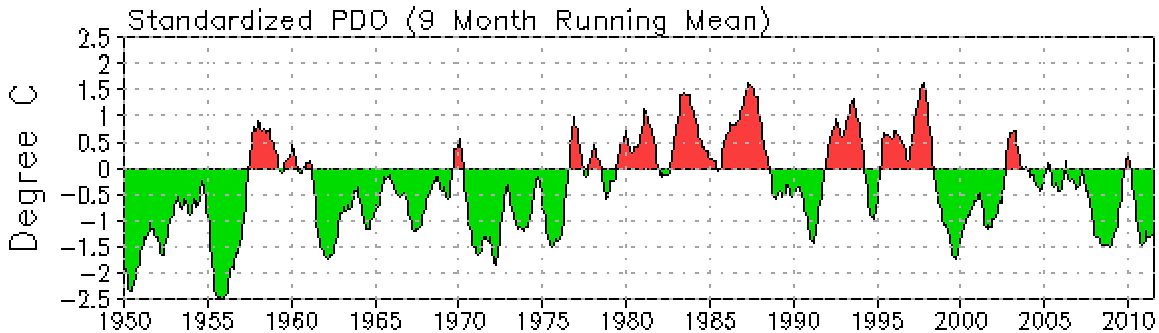
-Net surface heat flux anomalies contributed to the SST tendency in the North Pacific.

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

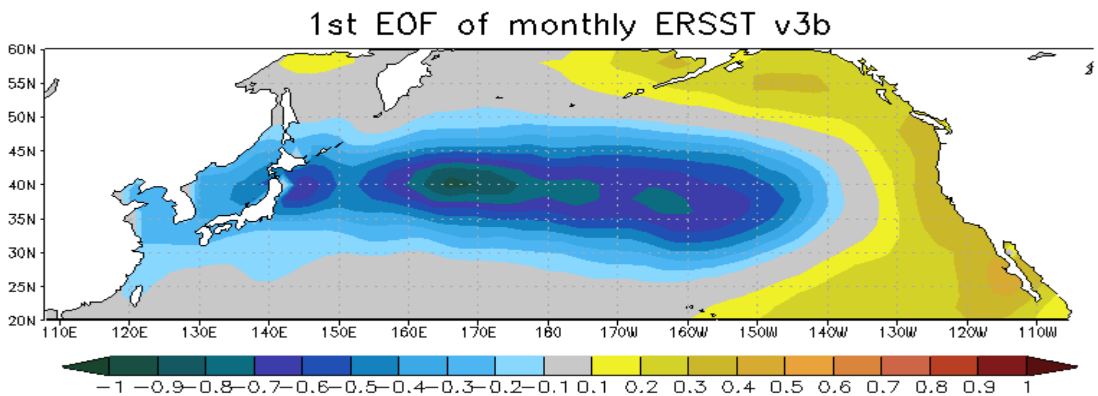






- The negative PDO intensified substantially in Jul with PDO index =-2.16.

- 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.



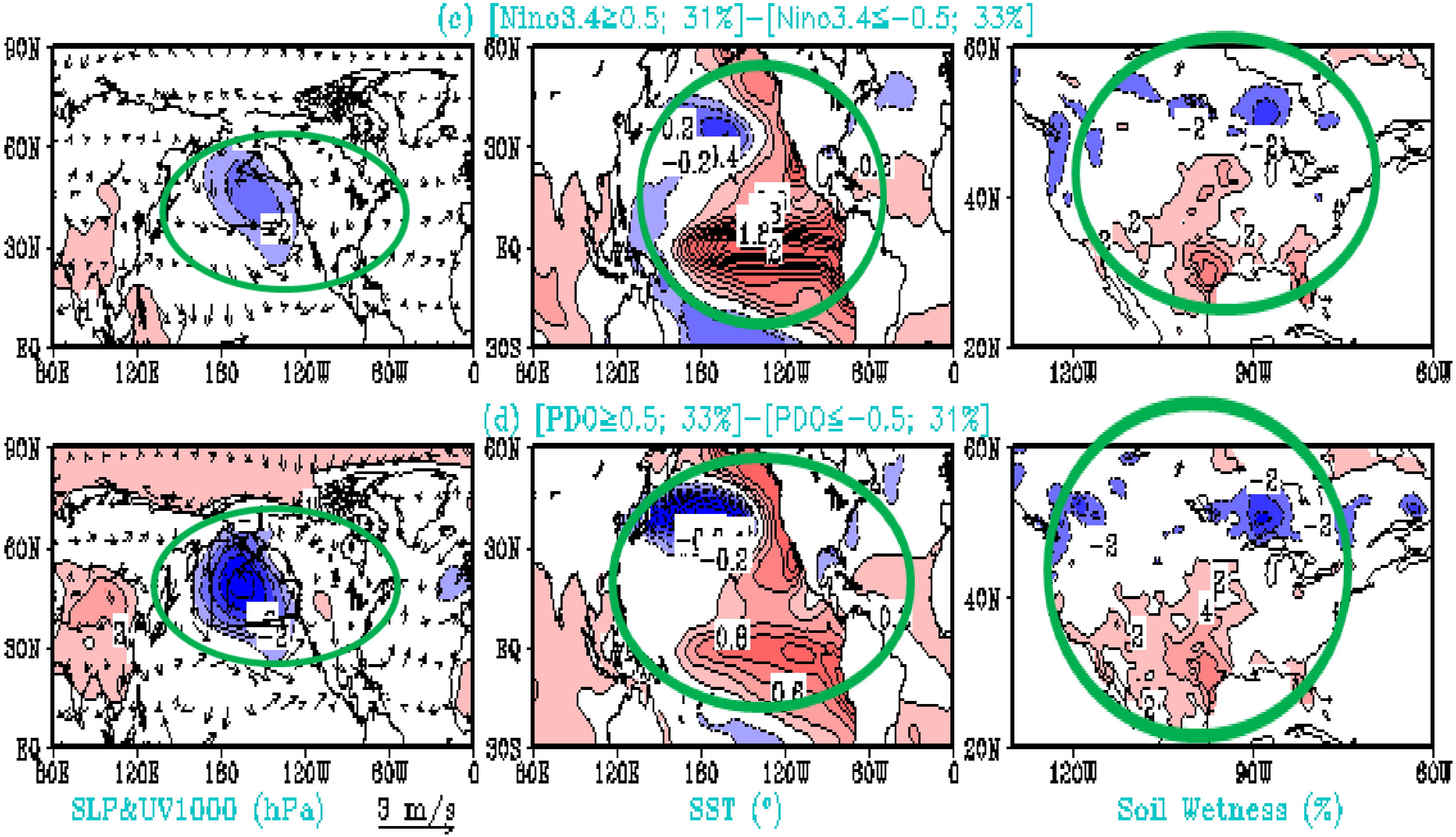
- Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.

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

Interferential impact of ENSO and PDO on U. S. Climate

(from Hu, Z.-Z. and B. Huang, 2009: Interferential impact of ENSO and PDO on dry and wet conditions in the U. S. Great Plains. J. Climate, 22 (22), 6047-6065.)

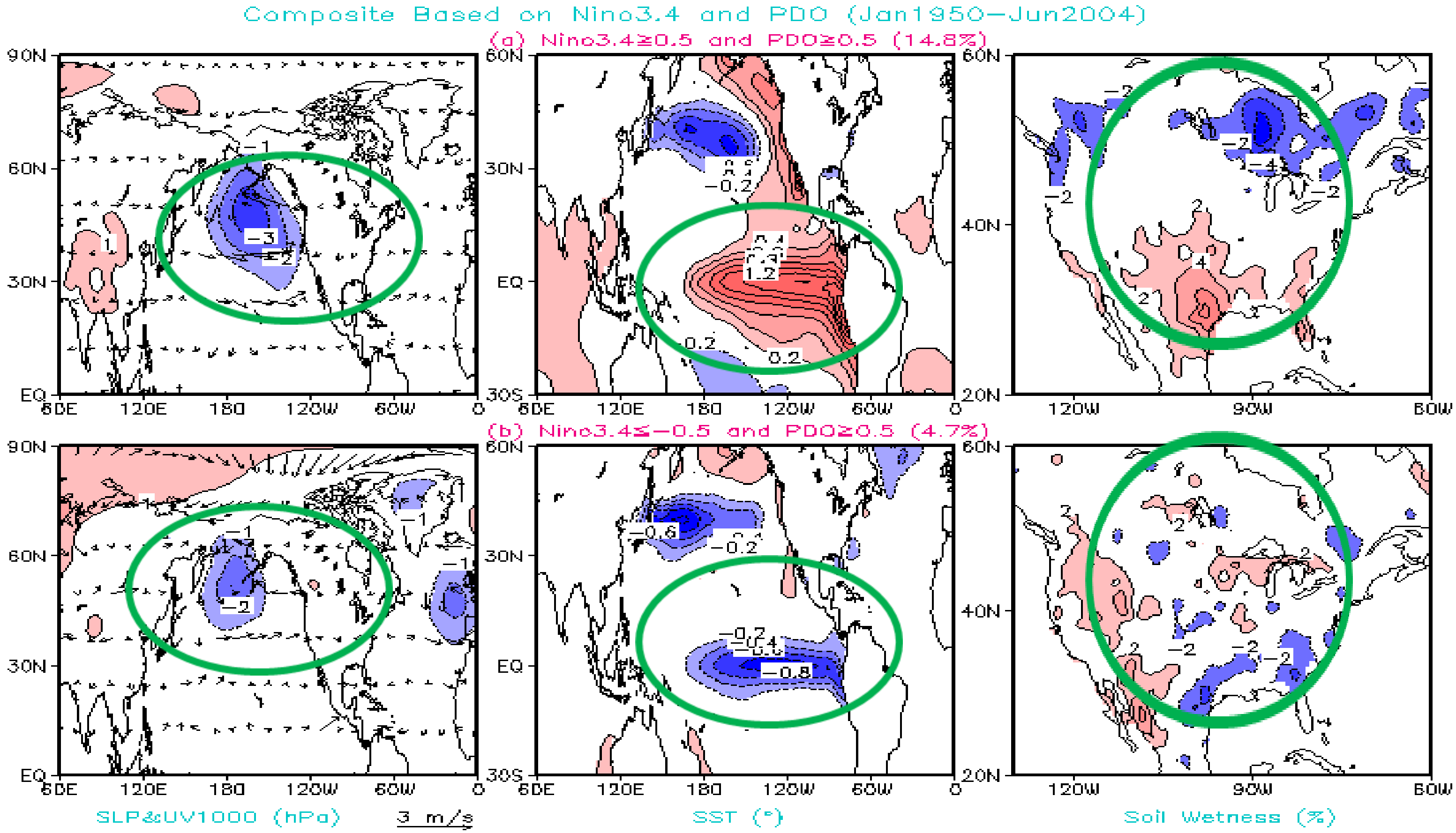
ENSO and PDO have similar impact on US climate



Interferential impact of ENSO and PDO on U. S. Climate

(from Hu, Z.-Z. and B. Huang, 2009: Interferential impact of ENSO and PDO on dry and wet conditions in the U. S. Great Plains. J. Climate, 22 (22), 6047-6065.)

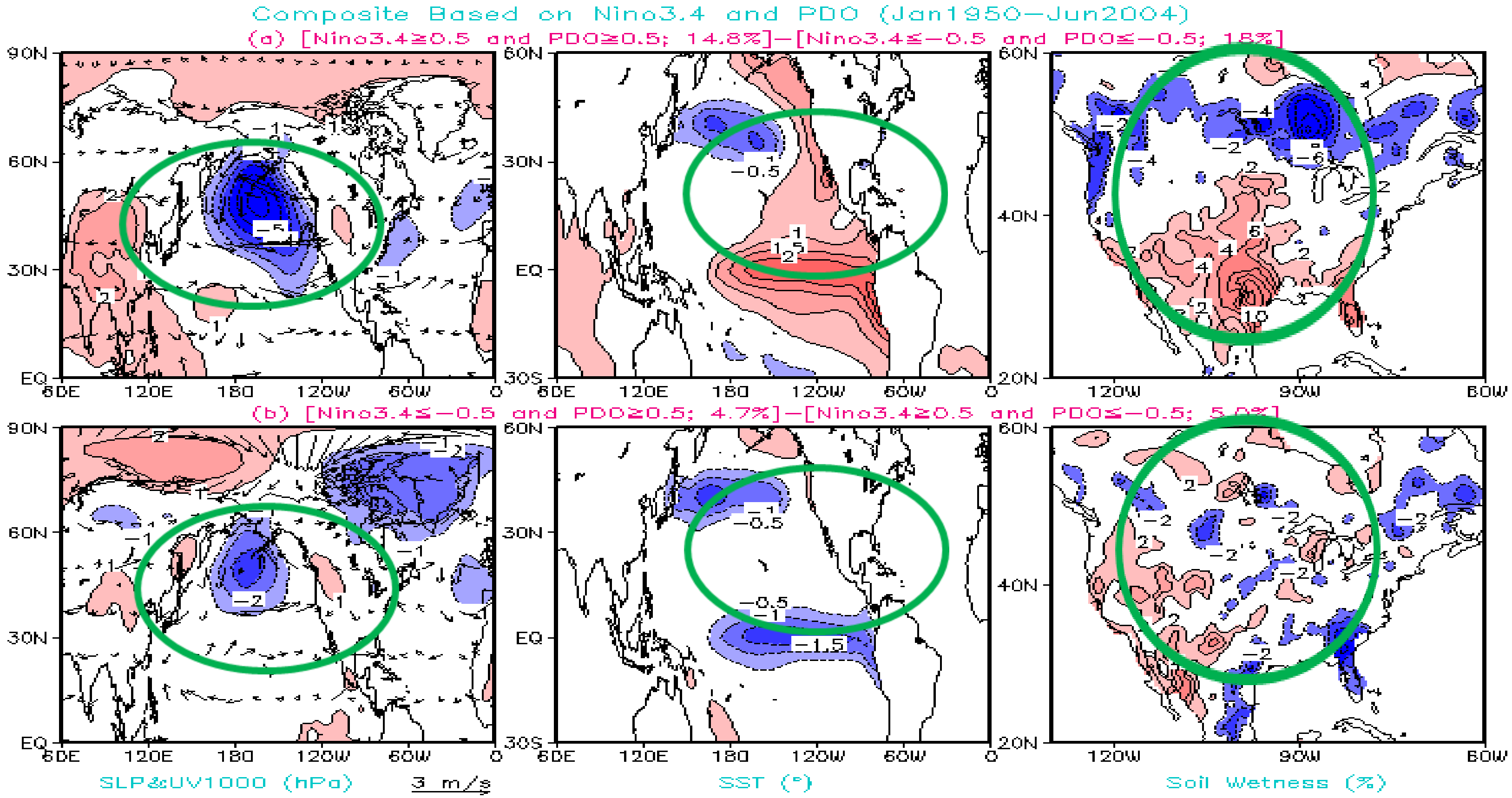
When ENSO and PDO are in phase, their impact on US climate is enhanced; when they are out of phase, their impact is suppressed



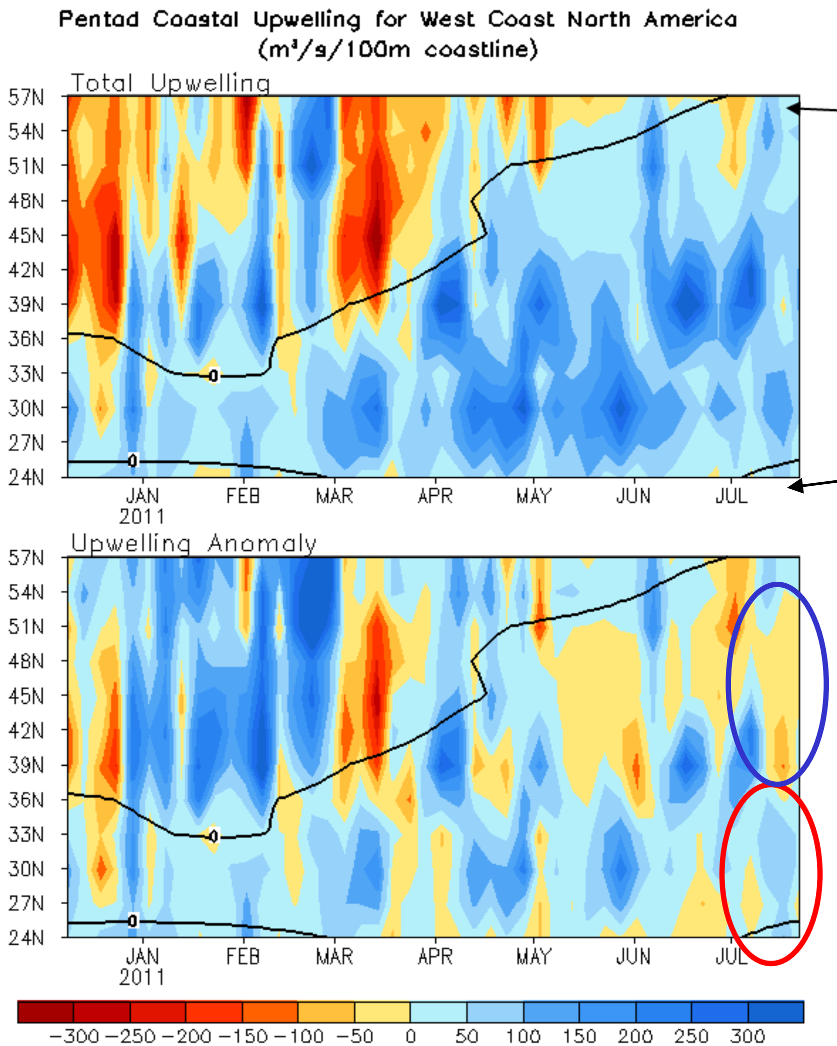
Interferential impact of ENSO and PDO on U. S. Climate

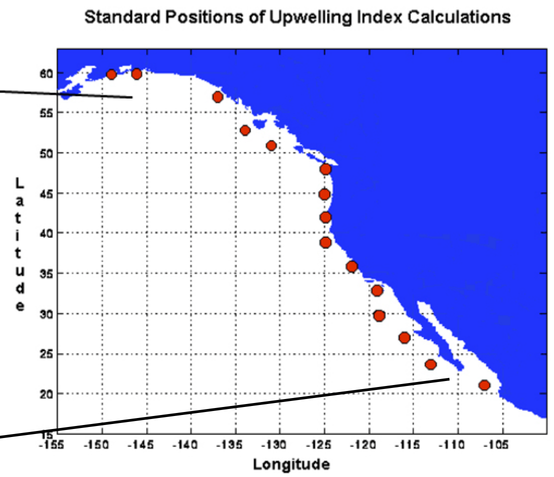
(from Hu, Z.-Z. and B. Huang, 2009: Interferential impact of ENSO and PDO on dry and wet conditions in the U. S. Great Plains. J. Climate, 22 (22), 6047-6065.)

When ENSO and PDO are in phase, their impact on US climate is enhanced; when they are out of phase, their impact is suppressed, may be due the overlap/cancellation of the anomalies in the NE Pacific



North America Western Coastal Upwelling





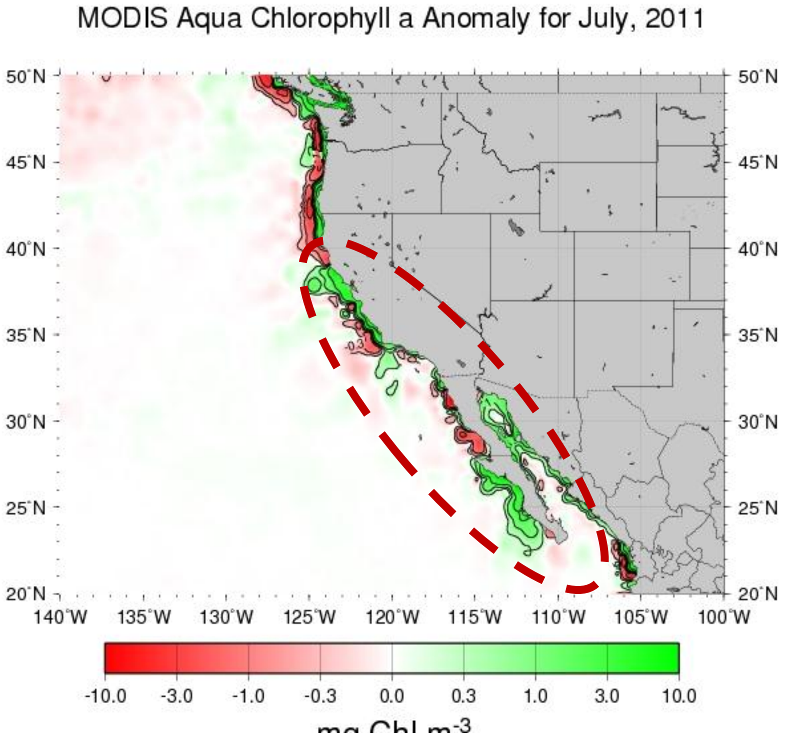
- Upwelling was enhanced at 24°N-36°N and suppressed in the north in Jul 2011, consistent with the SLP anomaly pattern.

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

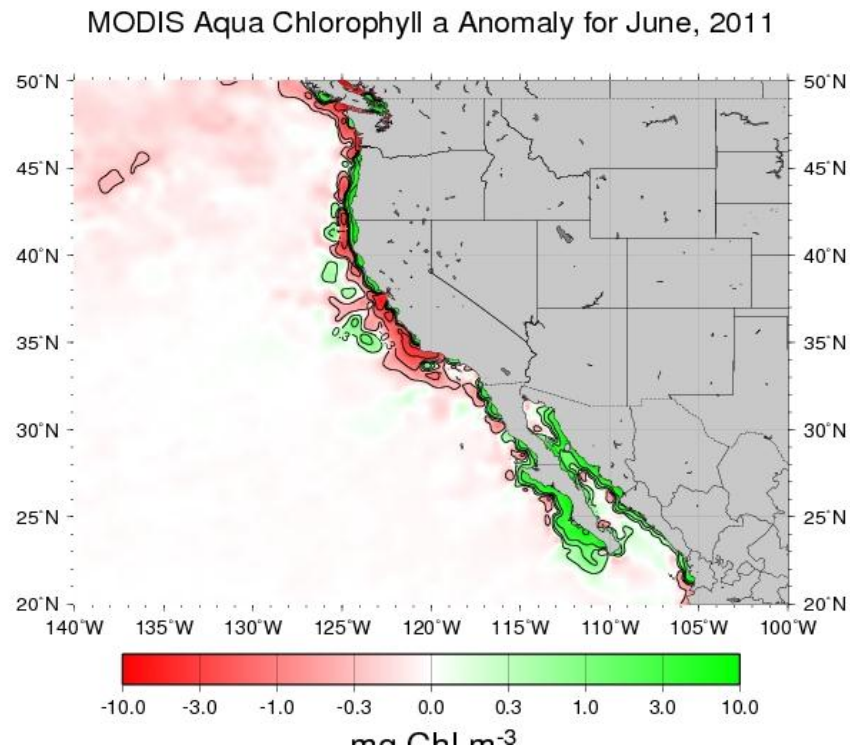
- Area below (above) black line indicates climatological upwelling (downwelling) season.

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

Monthly Chlorophyll Anomaly



- **Chlorophyll anomalies increased along the coastal regions and positive anomalies dominated at 20N-36N in Jul.**
- **The enhanced upwelling contributed to the increased chlorophyll anomalies.**

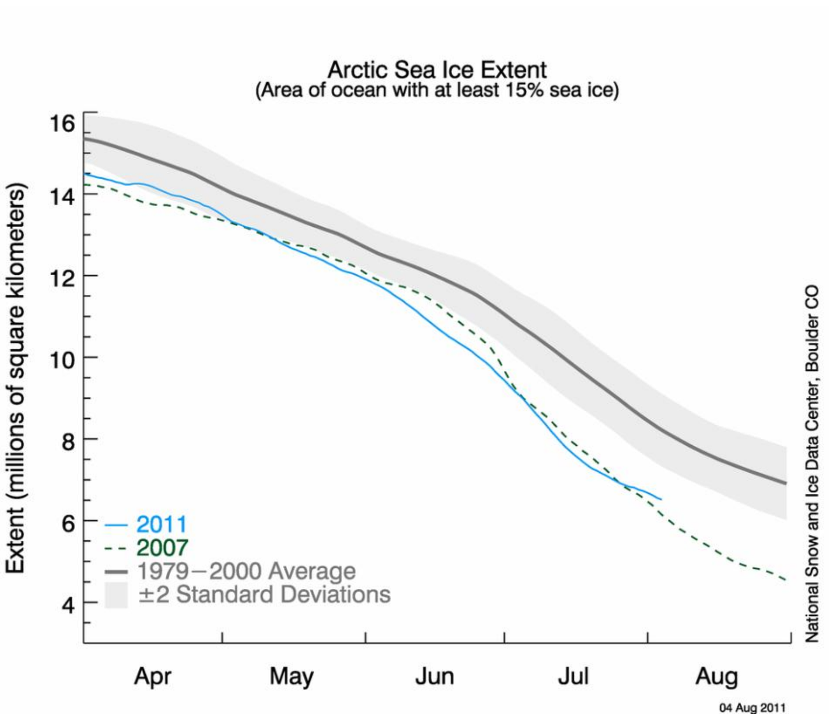


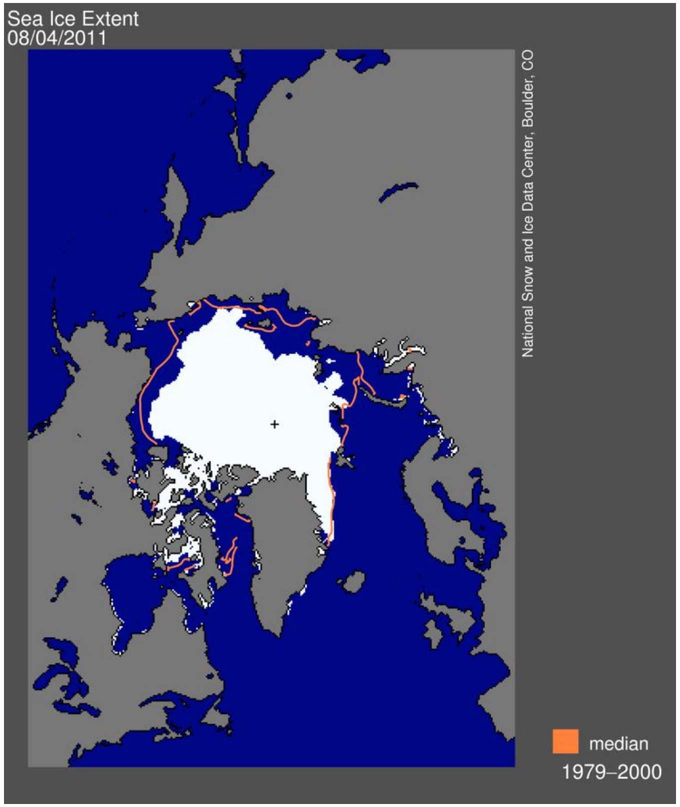
http://coastwatch.pfel.noaa.gov/FAST

Arctic Sea Ice

National Snow and Ice Data Center

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

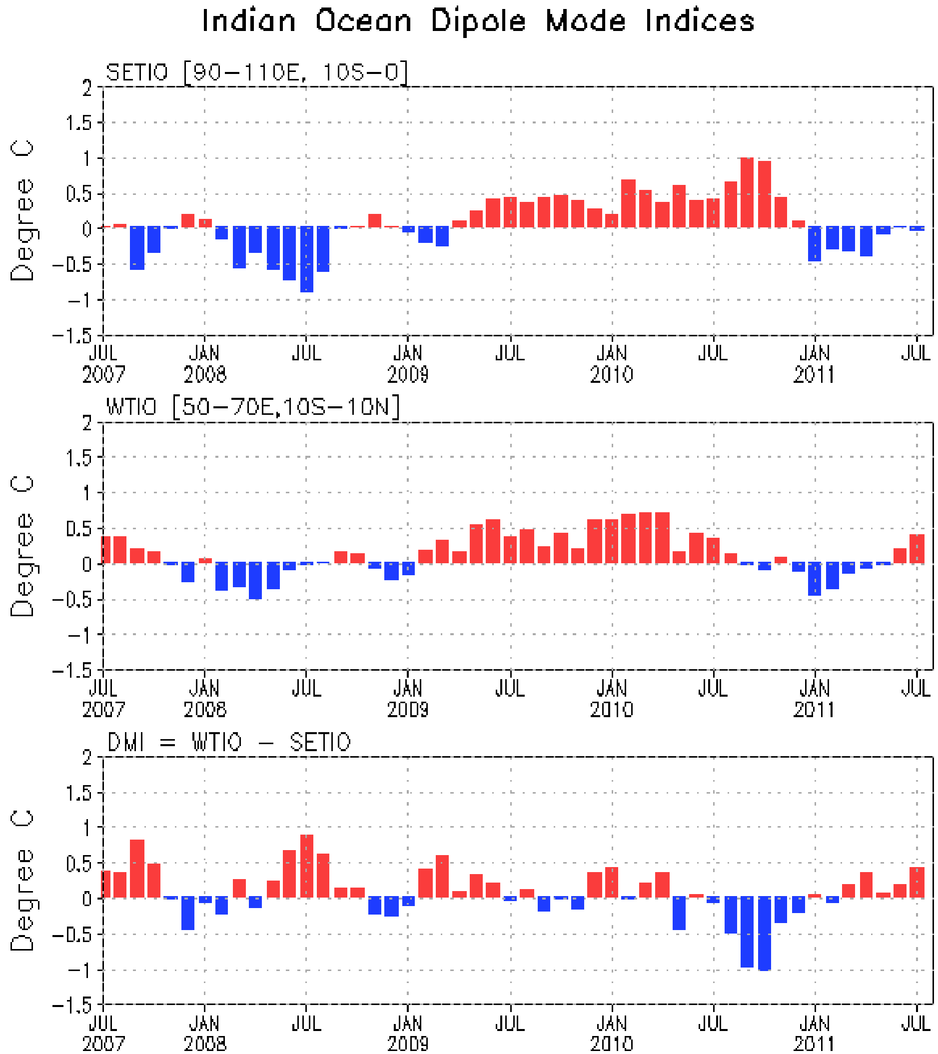


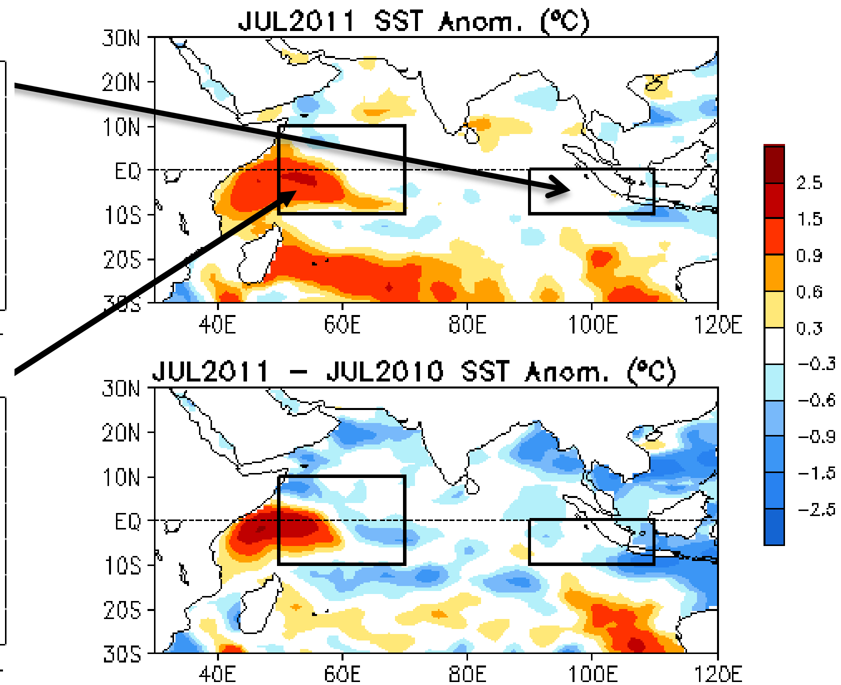


- The Arctic sea ice extent continued to decline in Jul 2011, which was comparable with 2007.
- Sea ice was particularly low in the Barents, Kara, and Laptev Seas (the far northern Atlantic region), Hudson Bay and Baffin Bay.

Tropical Indian Ocean

Evolution of Indian Ocean SST Indices

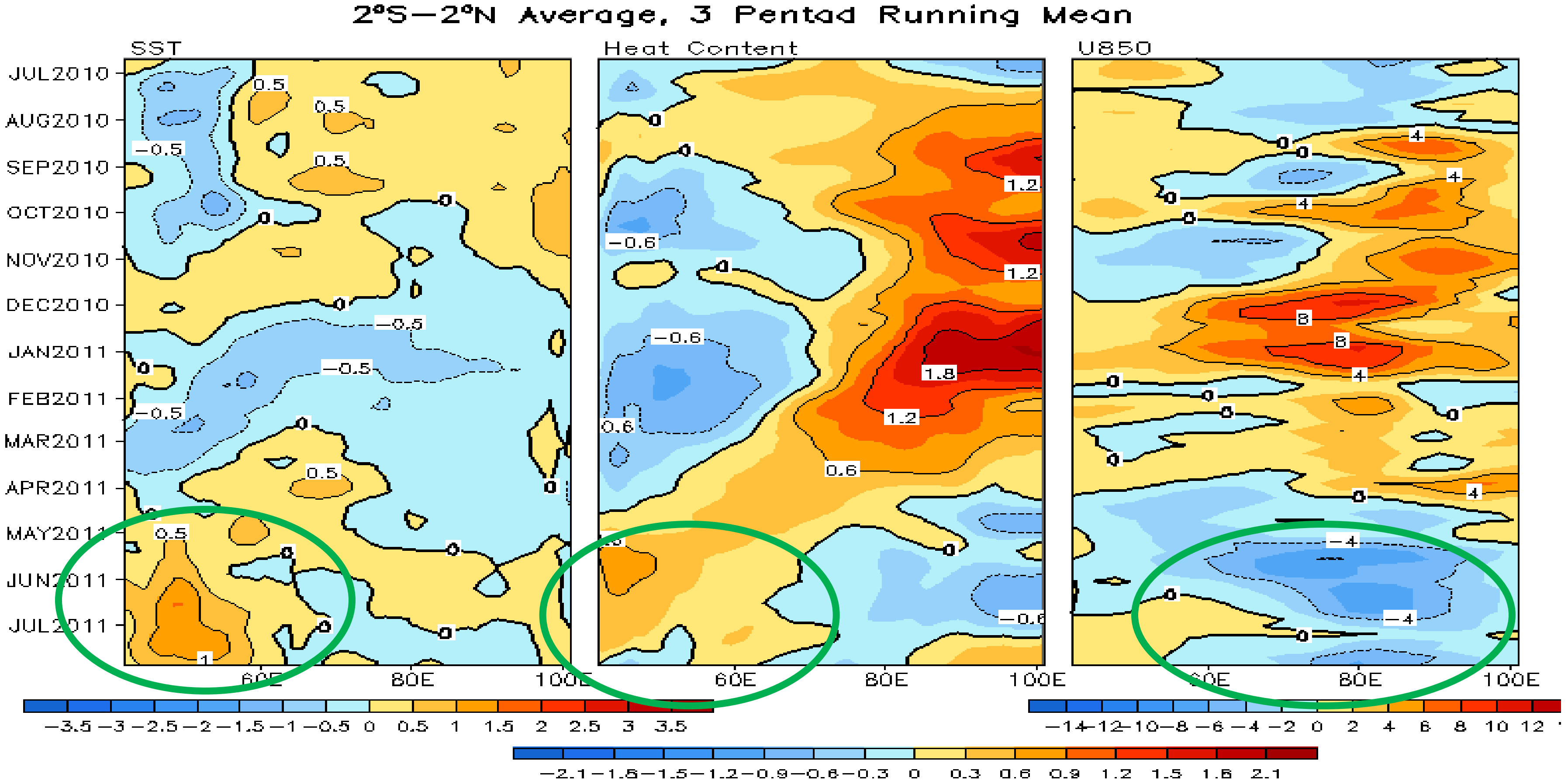




- **Positive western (WTIO) and near-normal eastern (SETIO) indices were observed in Jul 2011.**
- **DMI has been above normal since Mar 2011.**

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.

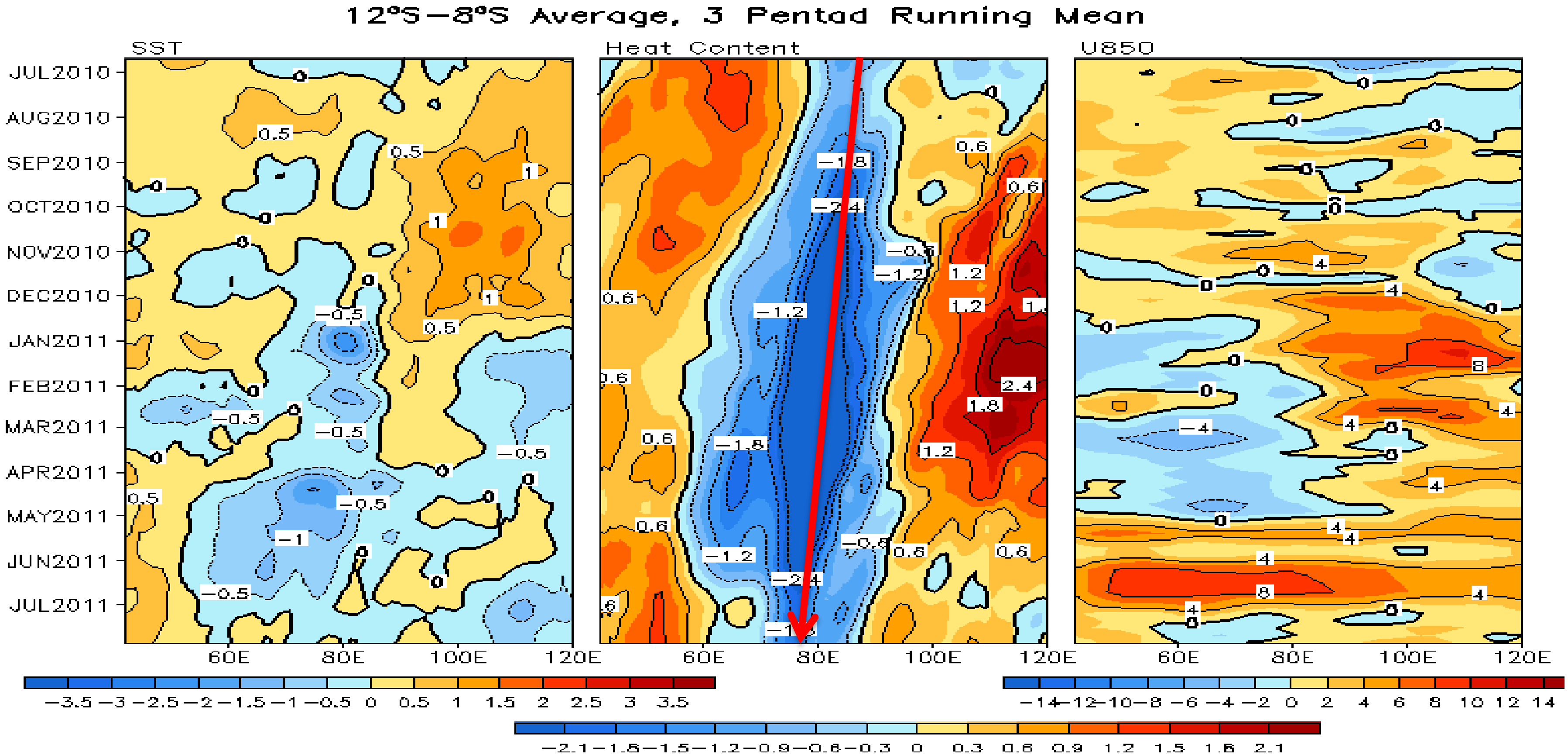
Recent Evolution of Equatorial Indian SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s) and OLR (W/m²) Anomalies



- **Positive SSTA emerged in the central Indian Ocean since Mar 2011 and intensified in the west in Jul 2011.**
- **Positive (negative) heat content anomaly presented in the west and east (central) Indian Ocean in response to anomalous easterly wind forcing in the tropical Indian Ocean.**

Fig. I3. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2°S-2°N and Outgoing Long-wave Radiation (OLR, right) averaged in 5°S-5°N. SST are derived from the NCEP OI SST, heat content from the NCEP's global ocean data assimilation system, and U850 from the NCEP CDAS. Anomalies for SST, heat content and U850/OLR are departures from the 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 SST presented around 70E since Apr 2011 and weakened since Jun 2011, which is consistent with the HC.
- Westerly wind anomalies prevailed over the southern tropical Indian Ocean since May 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.

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

- Convection was suppressed in the eastern equatorial Indian Ocean.

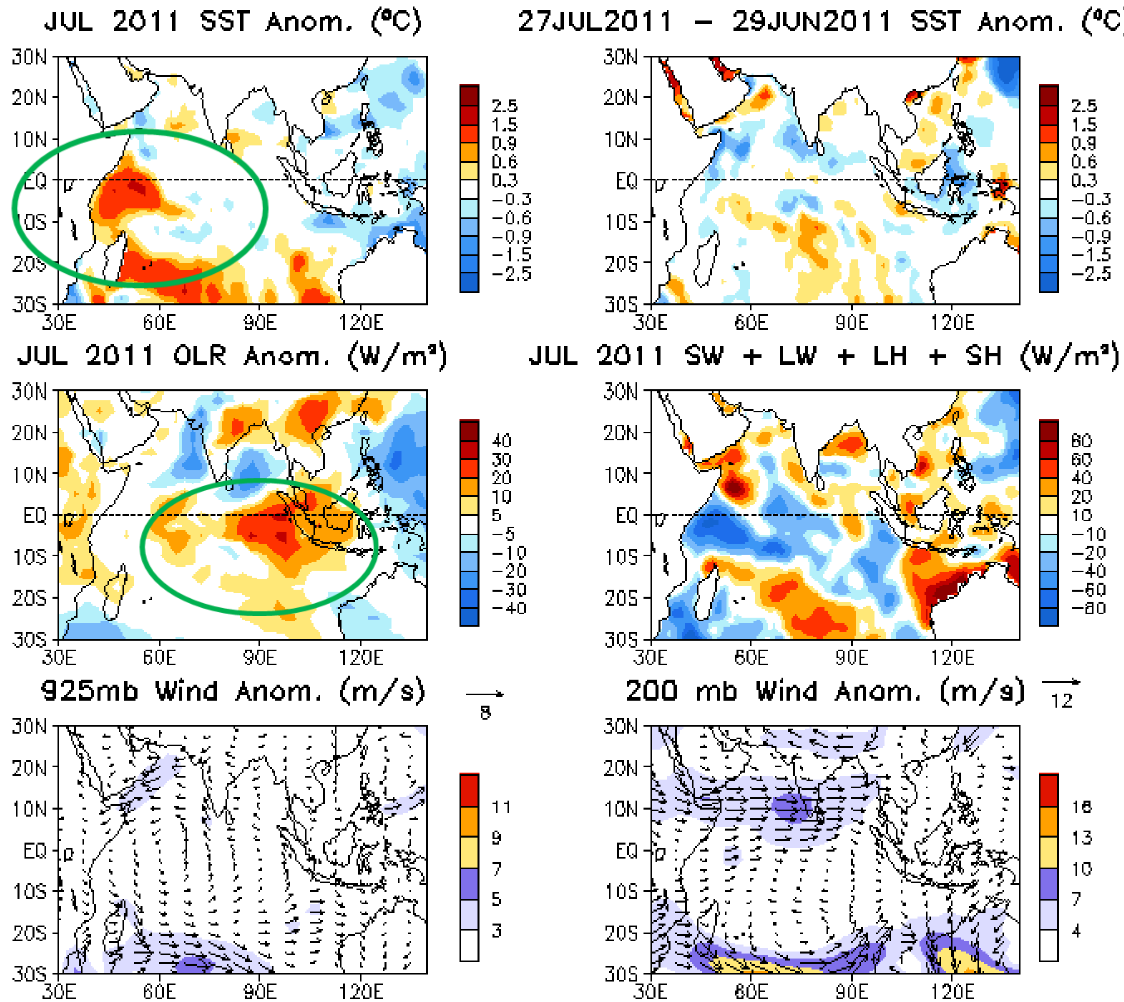
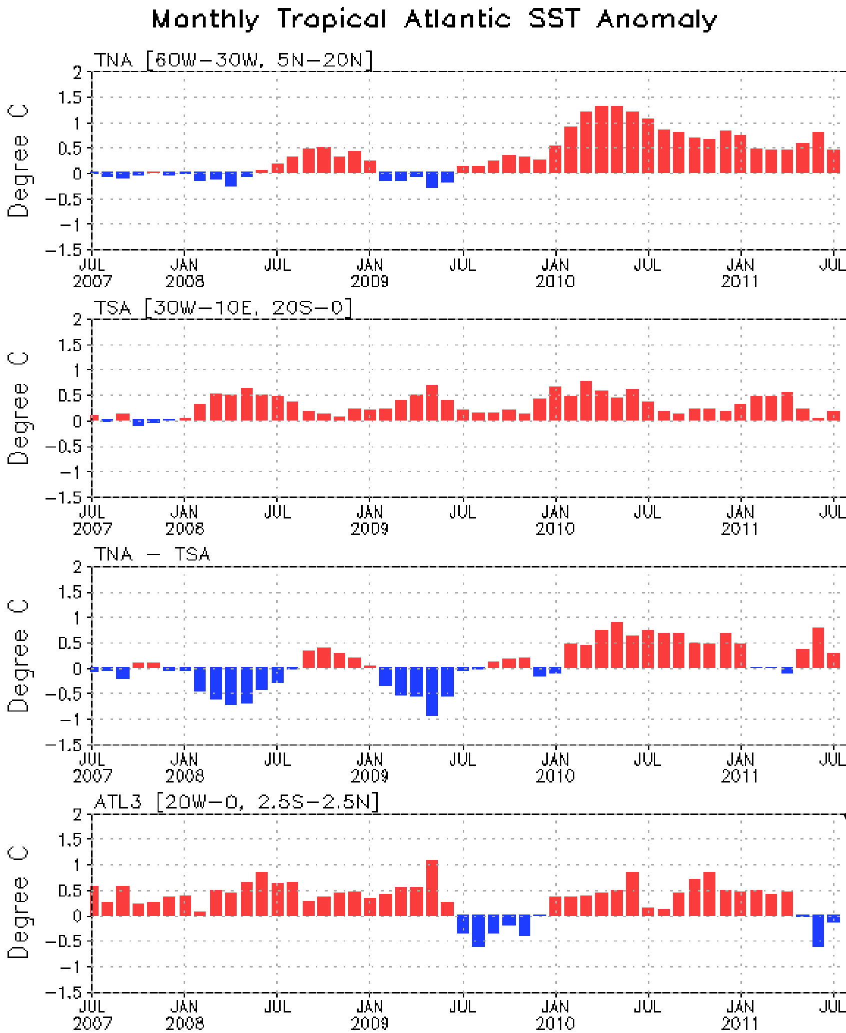
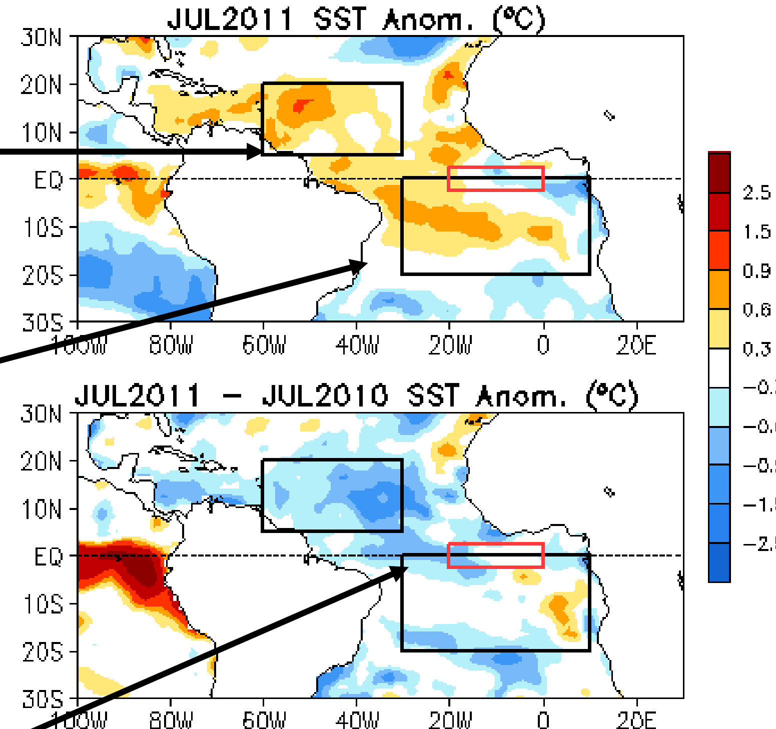


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

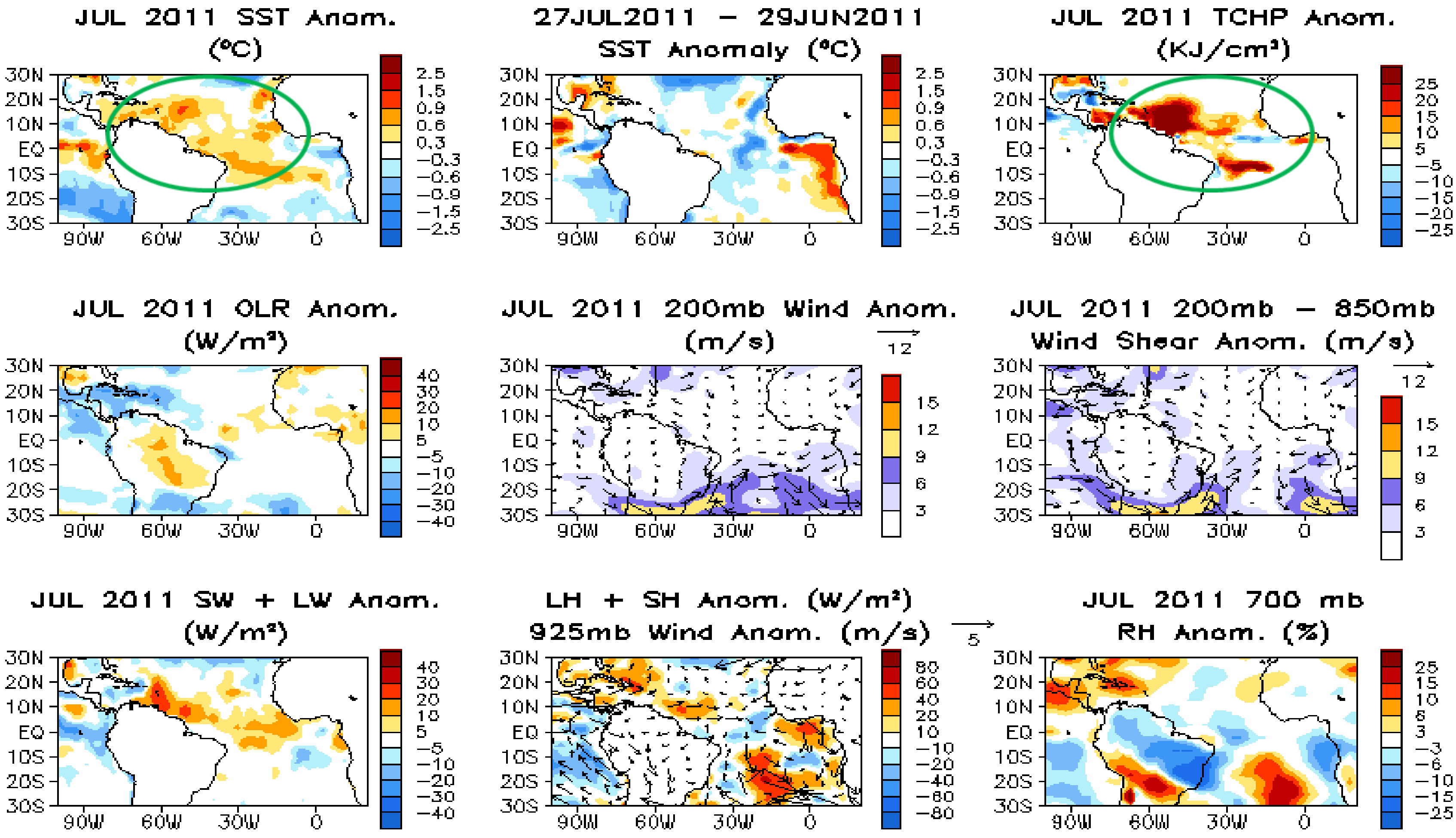




- **Tropical Atlantic was much cooler in Jul 2011 than in Jul 2010.**
- **Positive SSTA persisted in both TNA and TSA since Feb 2011.**
- **Meridional Gradient Mode (TNA-TSA) was above-normal since May 2011.**
- **Minor negative ATL3 SST was observed in Jul.**

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.

Tropical Atlantic:



- **Positive SSTA continued in the Atlantic Hurricane Main Development Region (MDR).**
- **Above-normal TCHP anomaly in hurricane MDR is favorable for hurricane development.**

North Atlantic Ocean

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

- Tripole SST pattern vanished in Jul.
- SSTA tendency was consistent with surface heat flux.
- Positive SLP anomalies prevailed north of 60N, consist with the negative NAO.

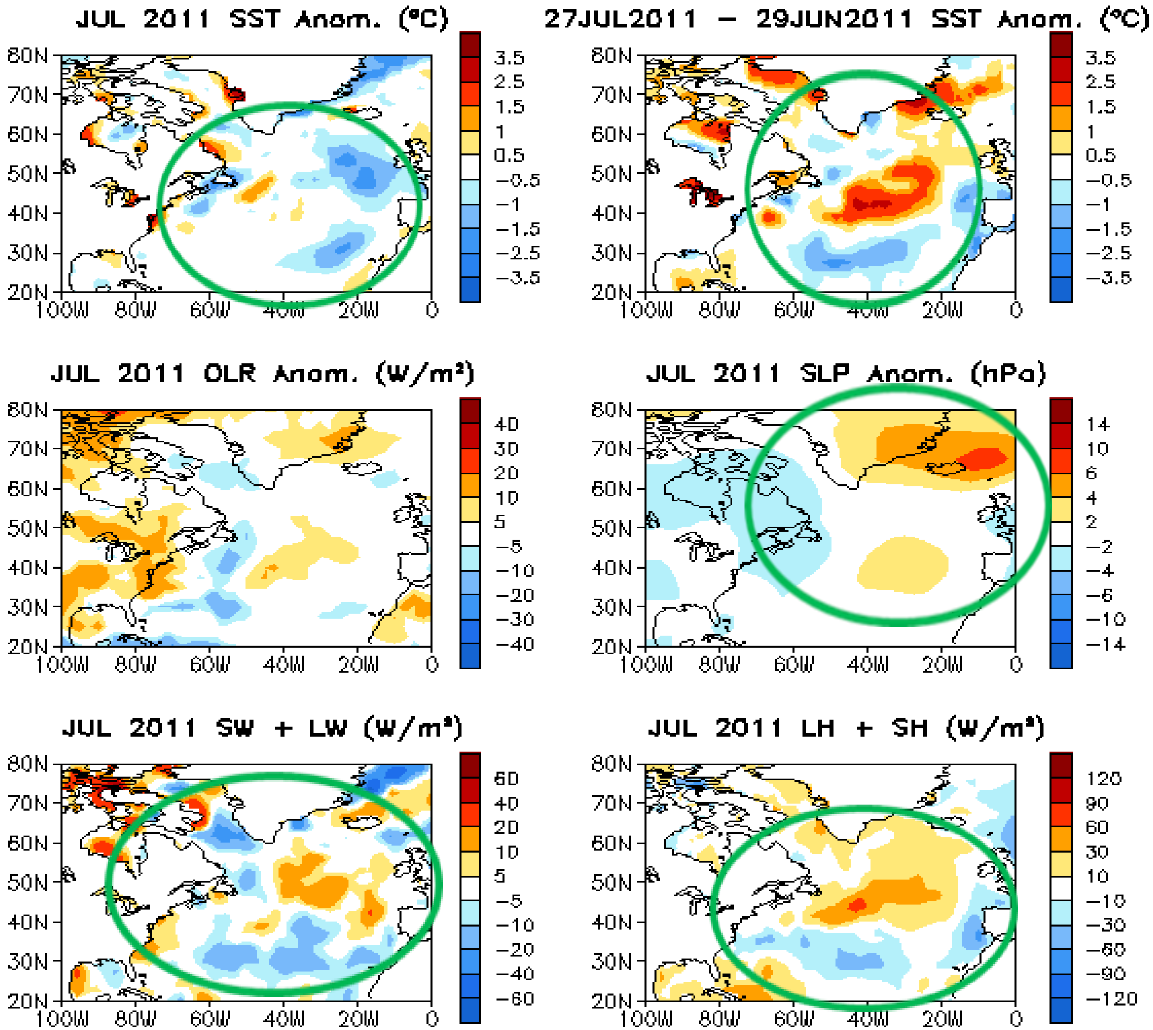
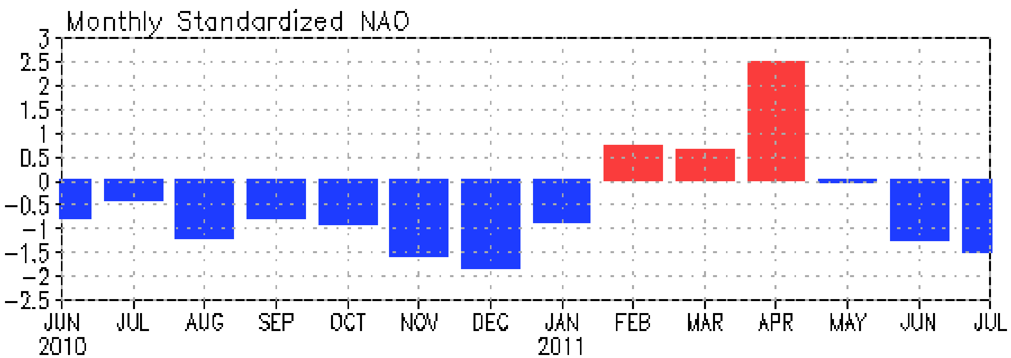
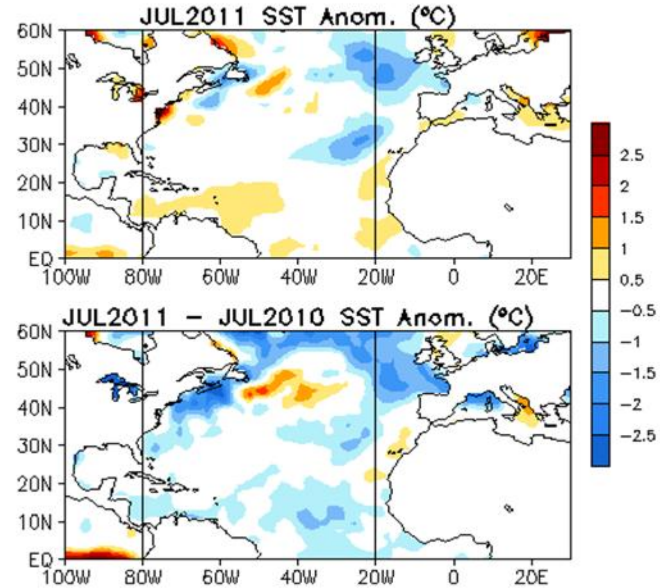
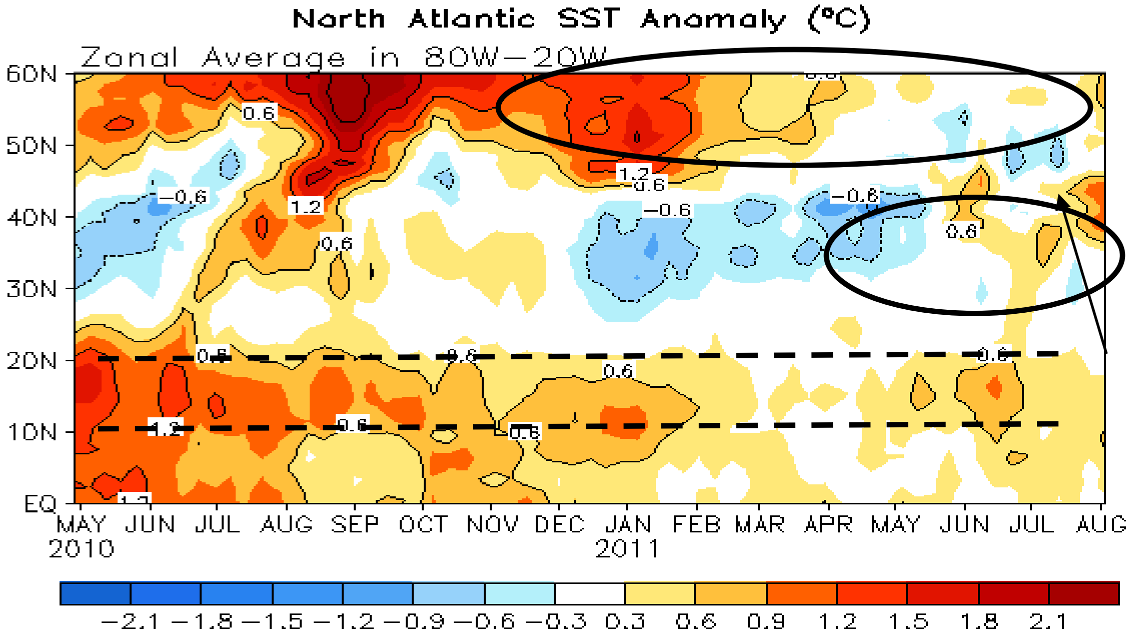


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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



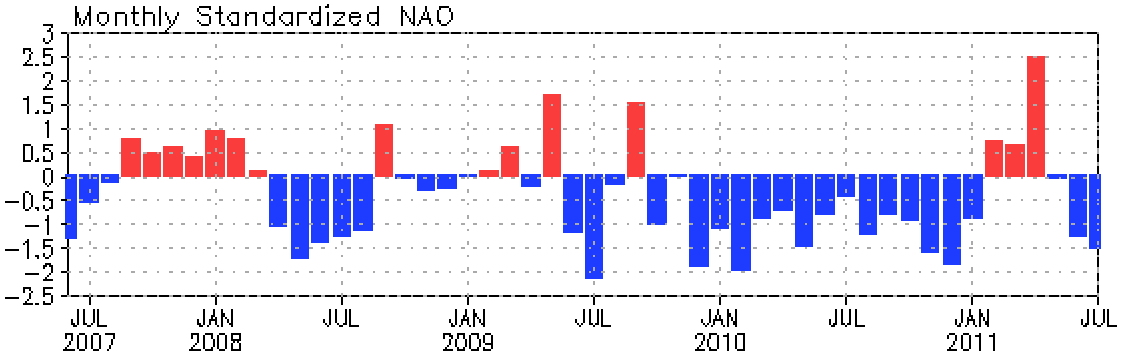


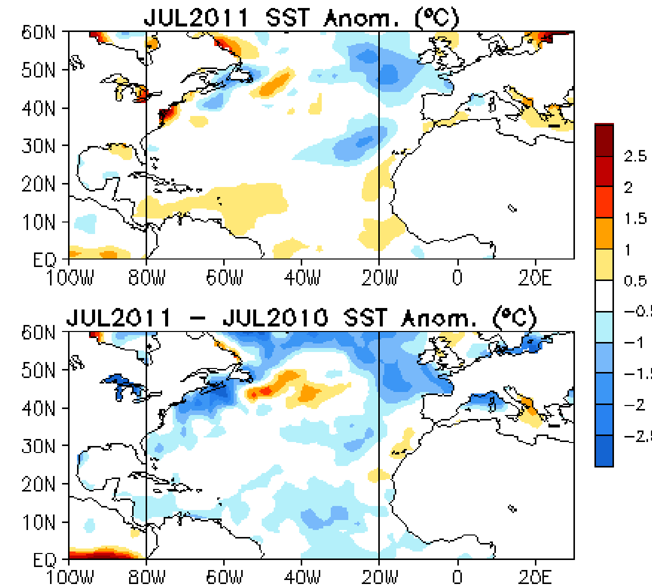


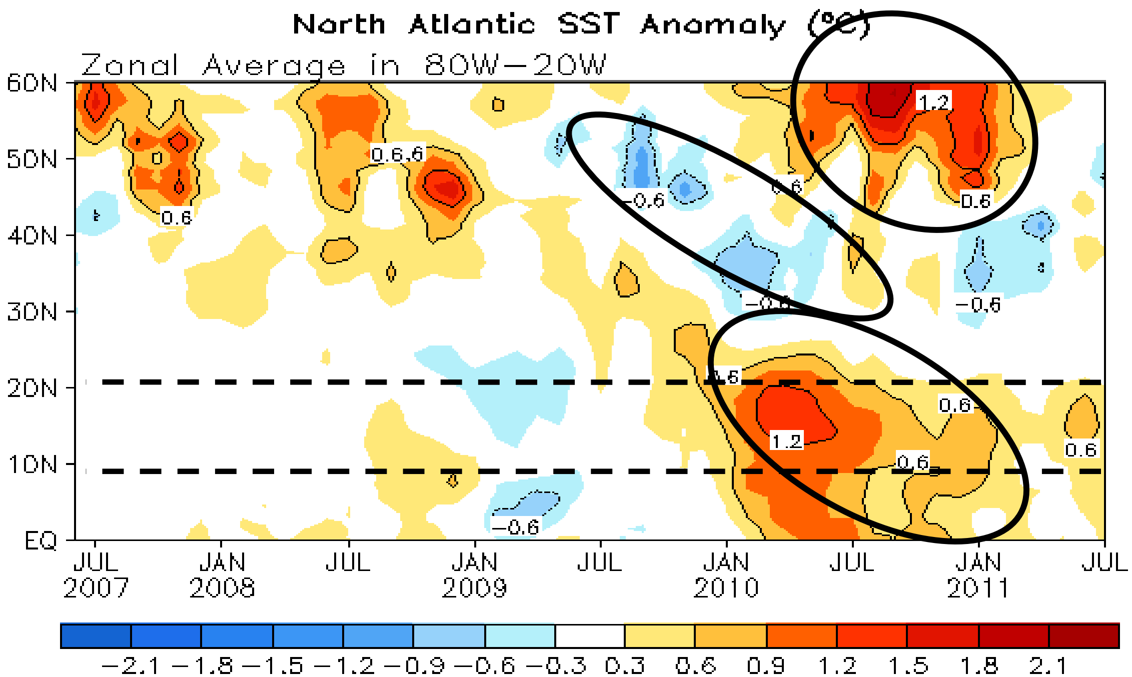
- **Negative NAO further intensified in Jul 2011 with NAOI=-1.51.**
- **Tripole or horseshoe pattern weakened since Mar 2011, and vanished in Jun-Jul.**
- **The tripole or horseshoe pattern of SSTA might re-occur if the NAO continues to be in negative phase in following months.**

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 1981-2010 base period means.

NAO and SST Anomaly in North Atlantic





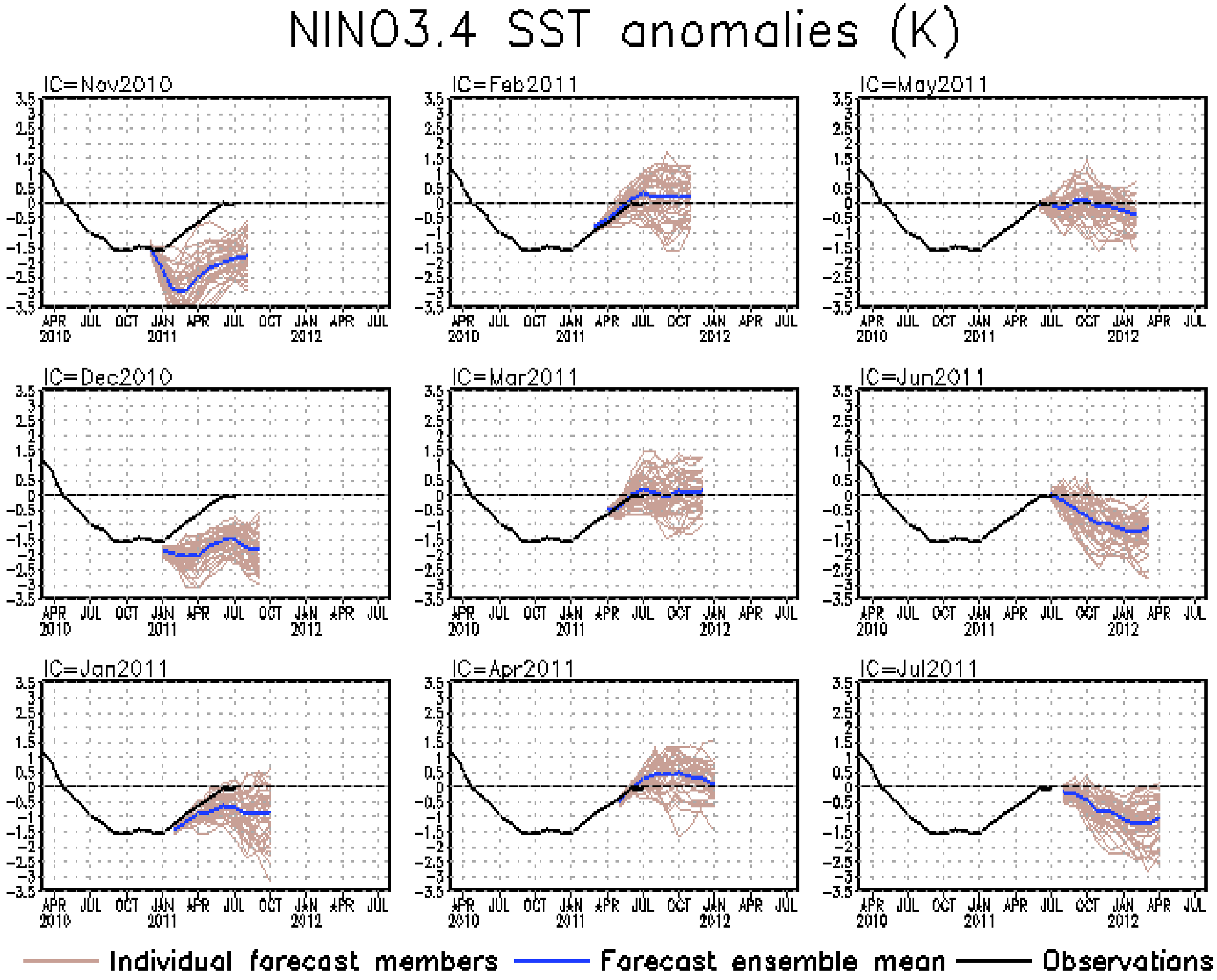


- **Negative NAO further intensified in Jul 2011 with NAOI=-1.51.**
- **Tripole or horseshoe pattern weakened since Mar 2011, and vanished in Jun-Jul.**
- **The tripole or horseshoe pattern of SSTA might re-occur if the NAO continues to be in negative phase in following months.**

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

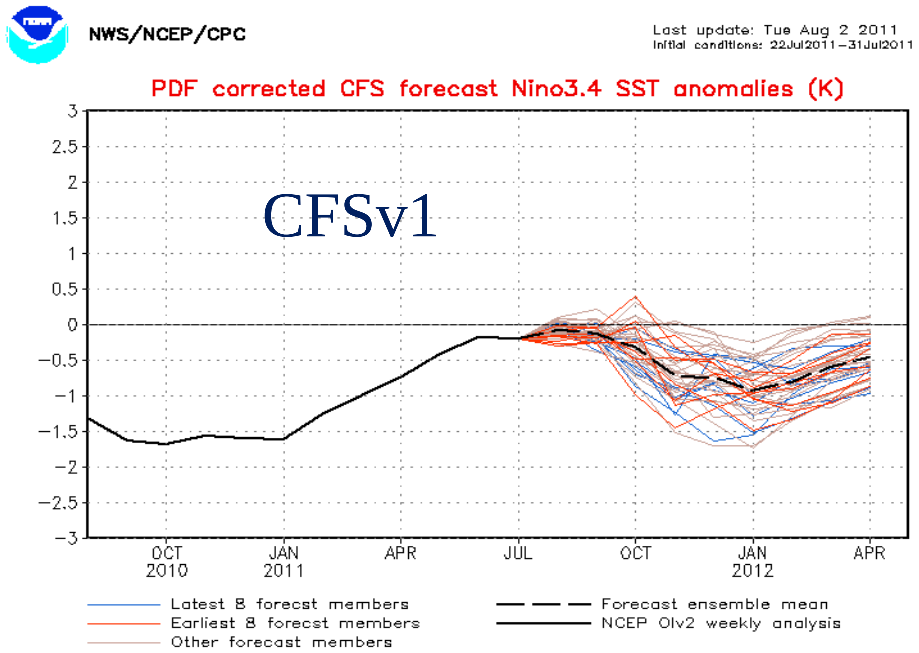
CFS Niño3.4 SST Predictions from Different Initial Months

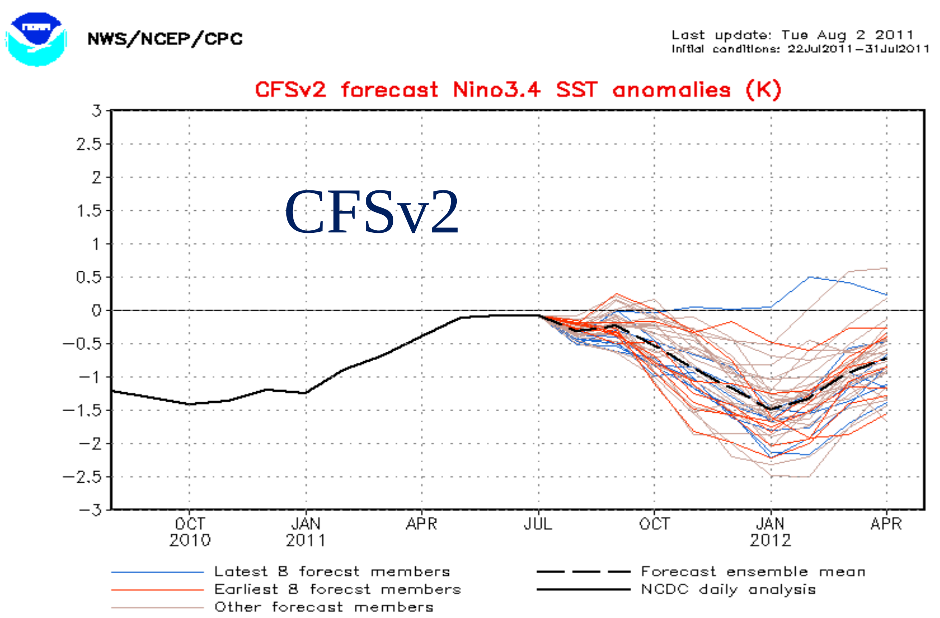


- Forecasts from Nov 2010-Jan 2011 I.C. had cold biases. The recent cold forecast biases can be alleviated through statistical model corrections (*http://www.cpc.ncep.noaa.gov/products/people/wwang/cfs_fcst*).

- The latest forecasts from Jul 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.

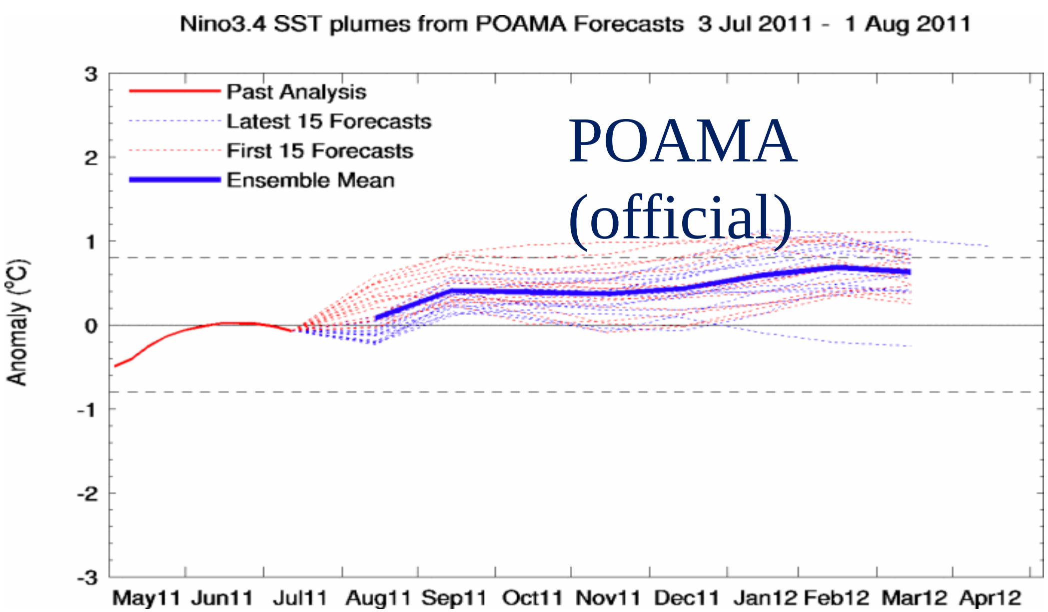


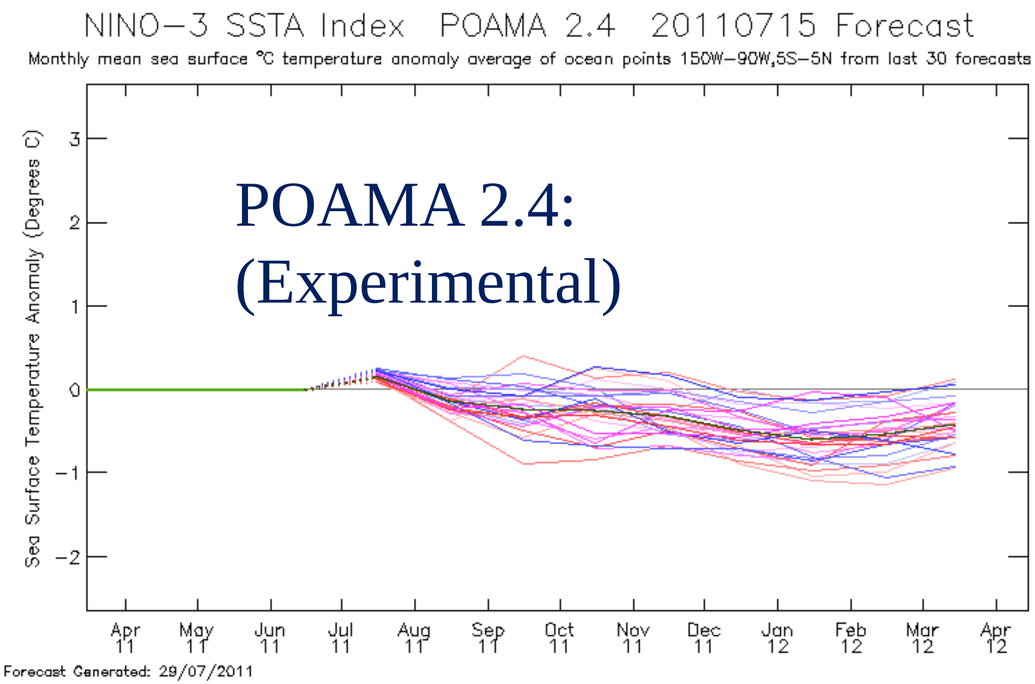


NCEP CFSv1 and v2 ENSO Forecasts:

- Both CFSv1 and CFSv2 predicted that ENSO-neutral condition will continue to last through Northern summer 2011 and 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.



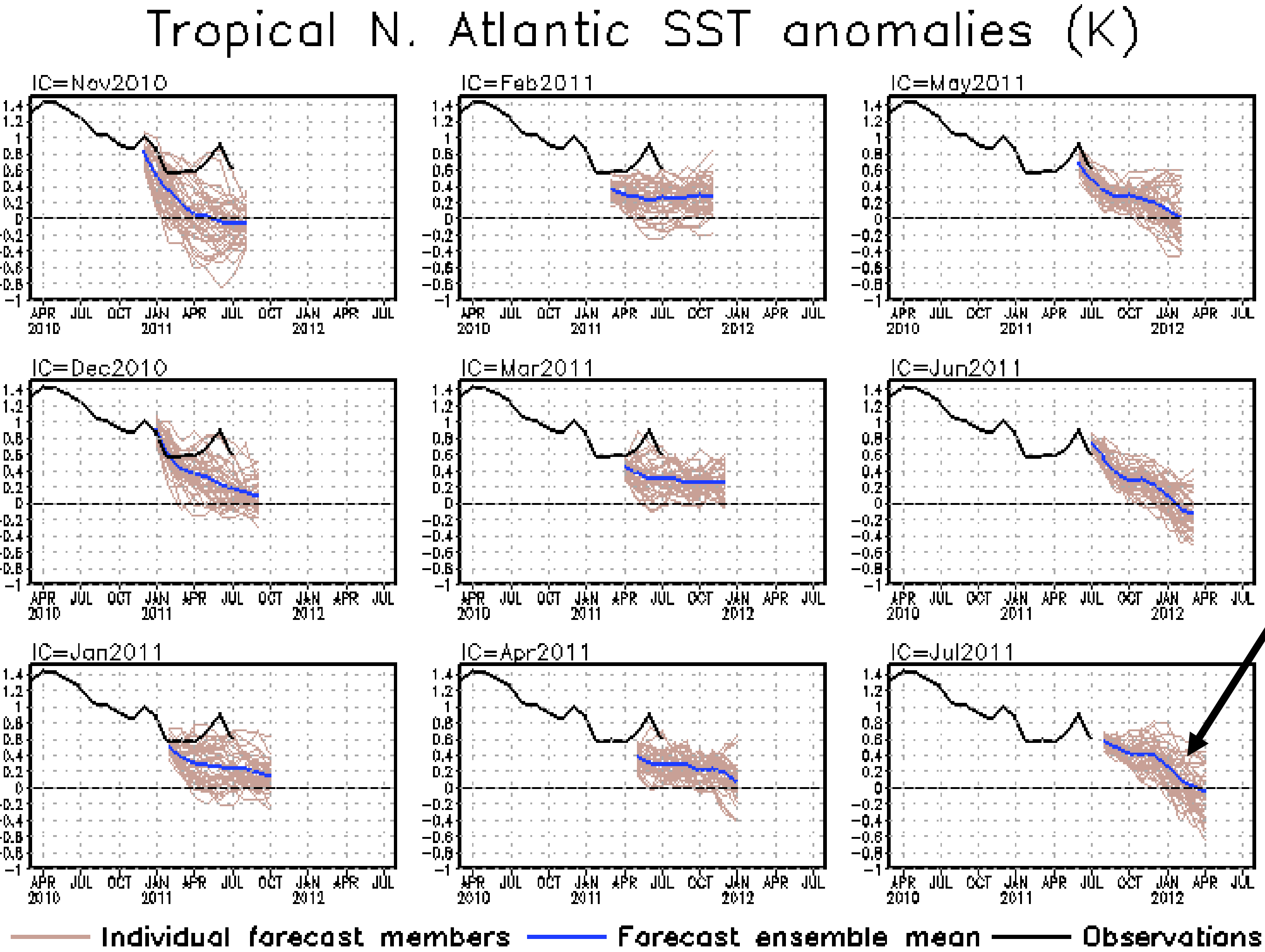


Predictive Ocean Atmosphere Model for Australia (POAMA) <u>ENSO Forecasts:</u>

- Large spread among models, even for a similar model with different versions.

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

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

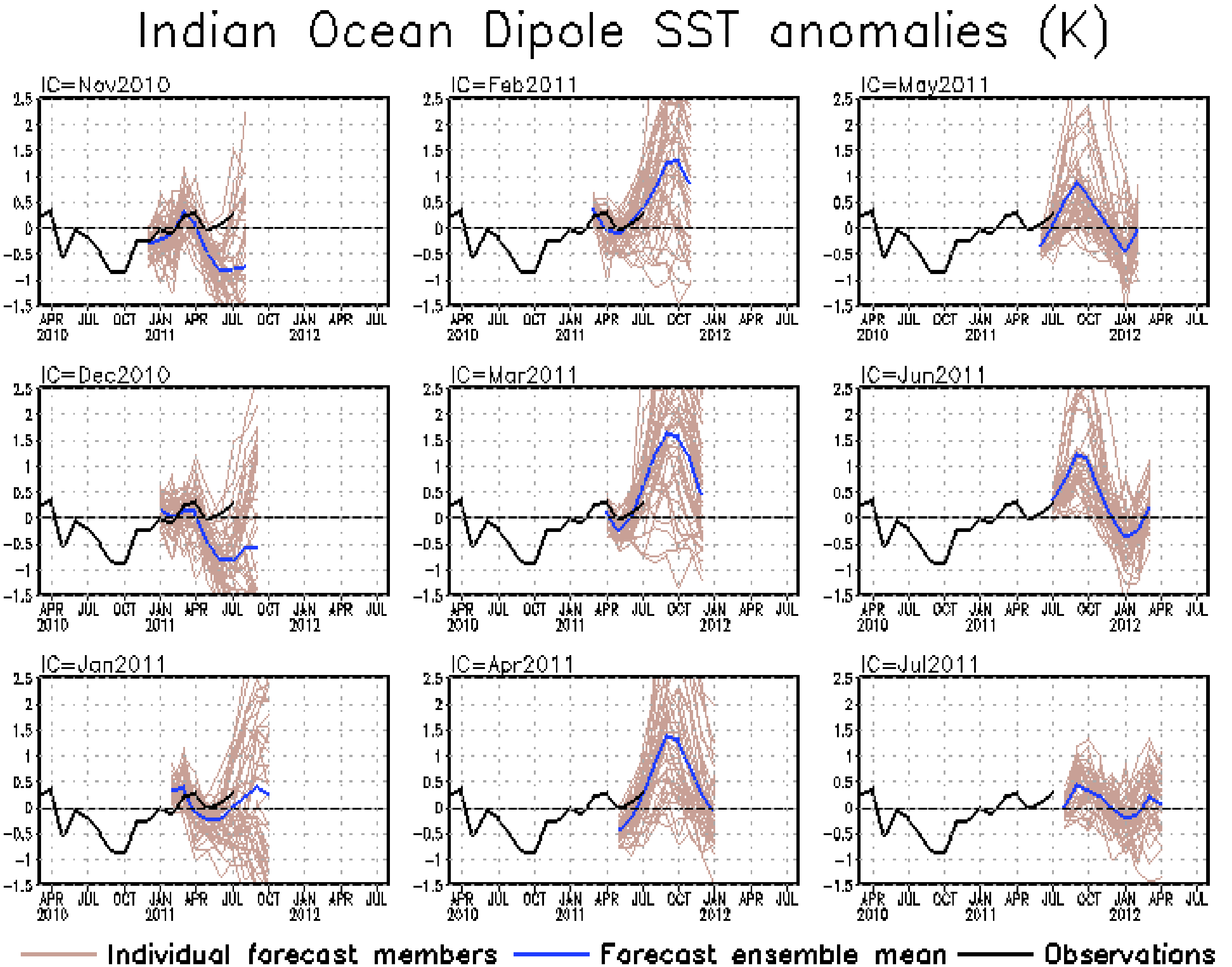


- Cold forecast biases were evident, may due to the fact that the NAO and its impact as well as long-term trend were poorly predicted.

- Latest forecasts suggest that the tropical North Atlantic SST will be near-normal in 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 [90ºE-110ºE, 10ºS-0]

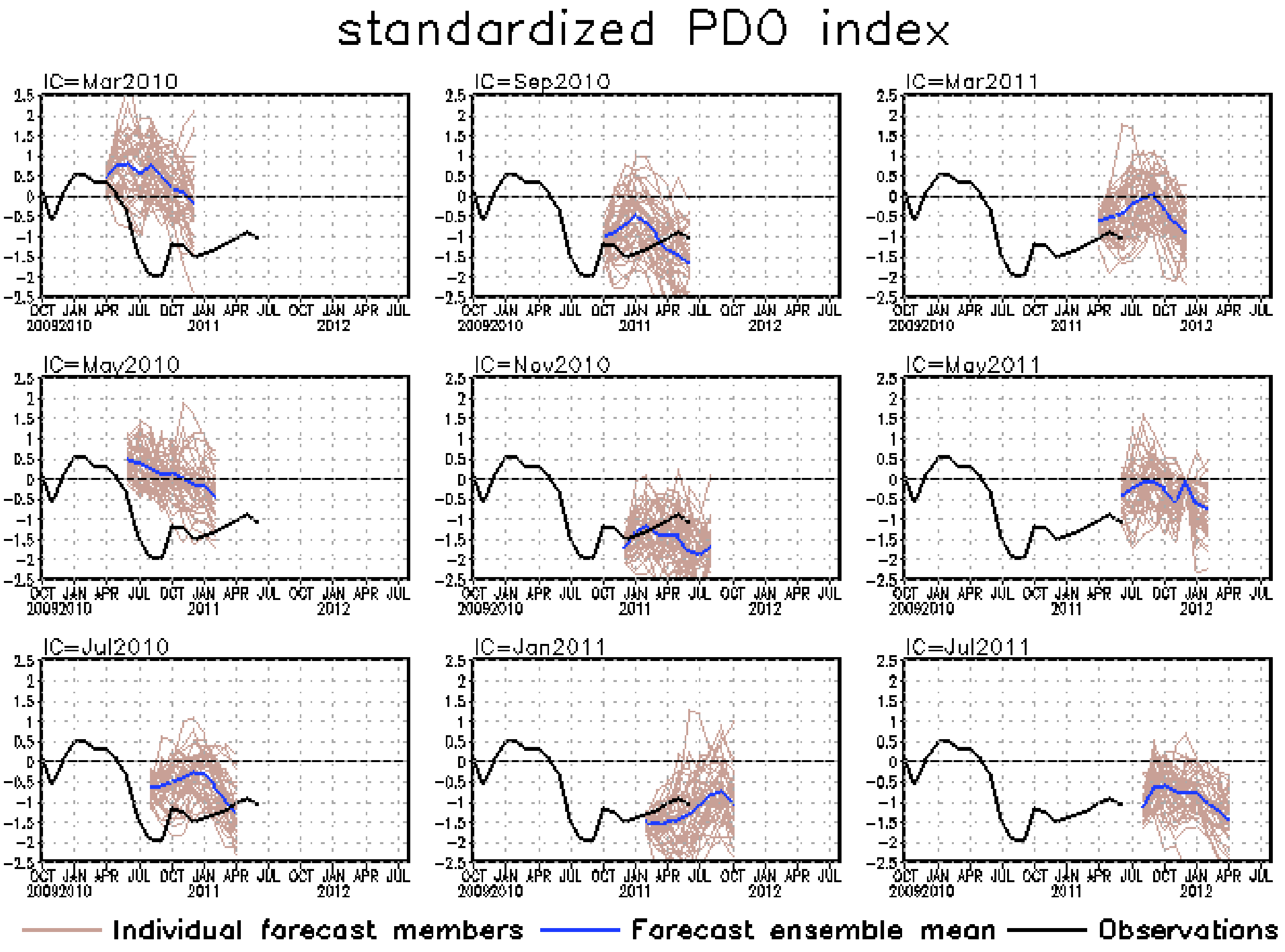
WTIO = SST anomaly in [50ºE-70ºE, 10ºS-10ºN]

- 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 Jul 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 Jul 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

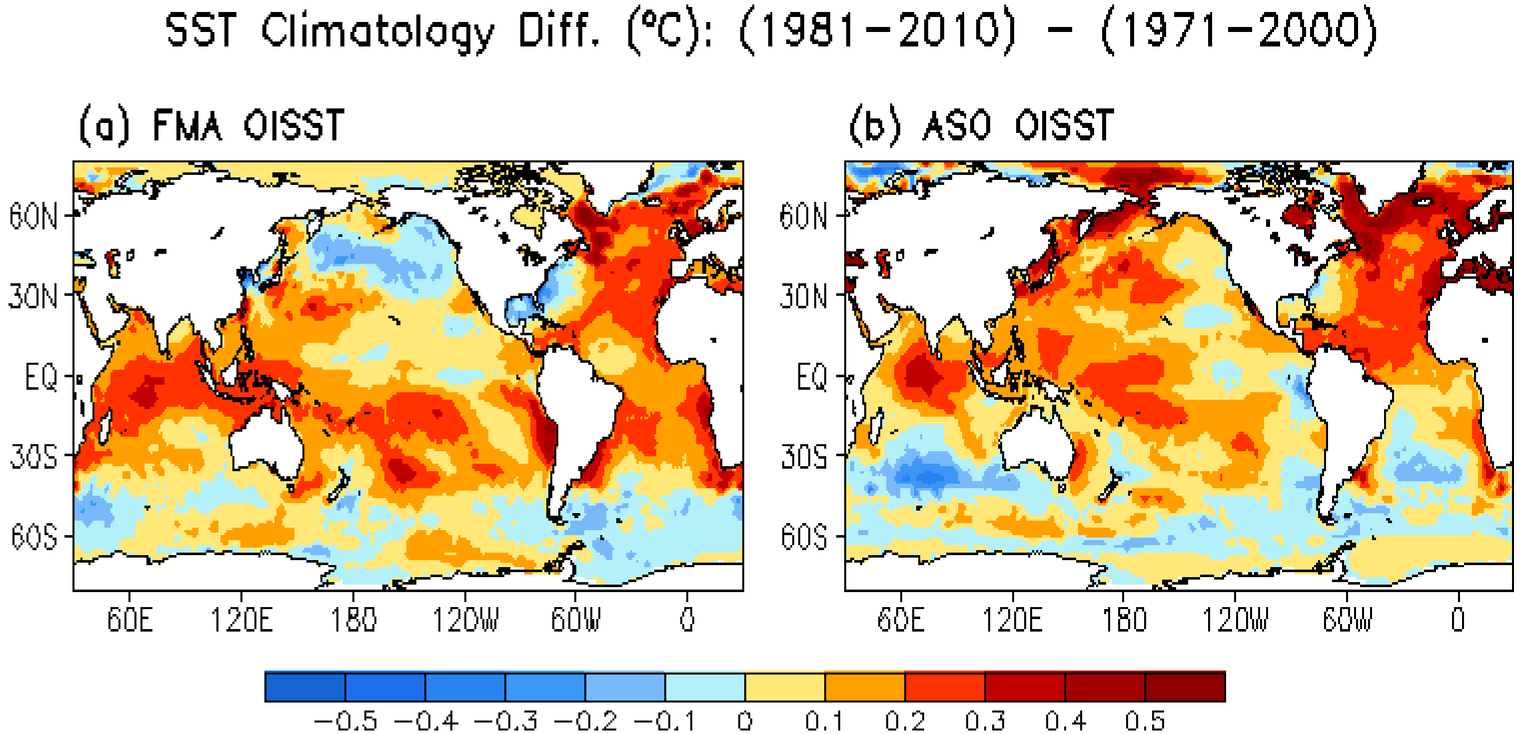
- **Pacific and Arctic Oceans**
  - **ENSO-neutral conditions prevailed with OISST NINO3.4=-0.21°C in Jul 2011.**
  - **NOAA/NCEP Climate Forecast System (CFS) suggests that the ENSO-neutral conditions are expected to last through the boreal summer.**
  - **Some models, including CFSv1 and CFSv2 predict a moderate La Nina event in coming boreal fall and winter.**
  - **Negative PDO intensified since Jun 2011, with PDOI=-2.16 in Jul 2011.**
  - **Artic sea ice extent continued to decline in Jul 2011.**
- **Indian Ocean**
  - **Positive SSTA developed along the African equatorial coast.**
- **Atlantic Ocean**
  - **Negative phase NAO presented since in May 2011 and intensified in Jun and Jul 2011, NAOI=-1.51 in Jul.**
  - **Positive SSTA continued in the Atlantic Hurricane Main Development Region.**

Backup Slides

Switch to 1981-2010 Climatology

- **SST from 1971-2000 to 1981-2010**
  - **Weekly OISST.v2, monthly ERSST.3b**
- **Atmospheric fields from 1979-1995 to 1981-2010**
  - **NCEP CDAS winds, sea level pressure, 200mb velocity potential, surface shortwave and longwave radiation, surface latent and sensible fluxes, relative humidity**
  - **Outgoing Long-wave Radiation**
- **Oceanic fields from 1982-2004 to 1981-2010**
  - **GODAS temperature, heat content, depth of 20^{o}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!