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

Prepared by
Climate Prediction Center, NCEP/NOAA

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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 Climate Observation Division (COD)

Outline

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

(Possibility of occurrence of an El Nino in 2014/15)

Overview

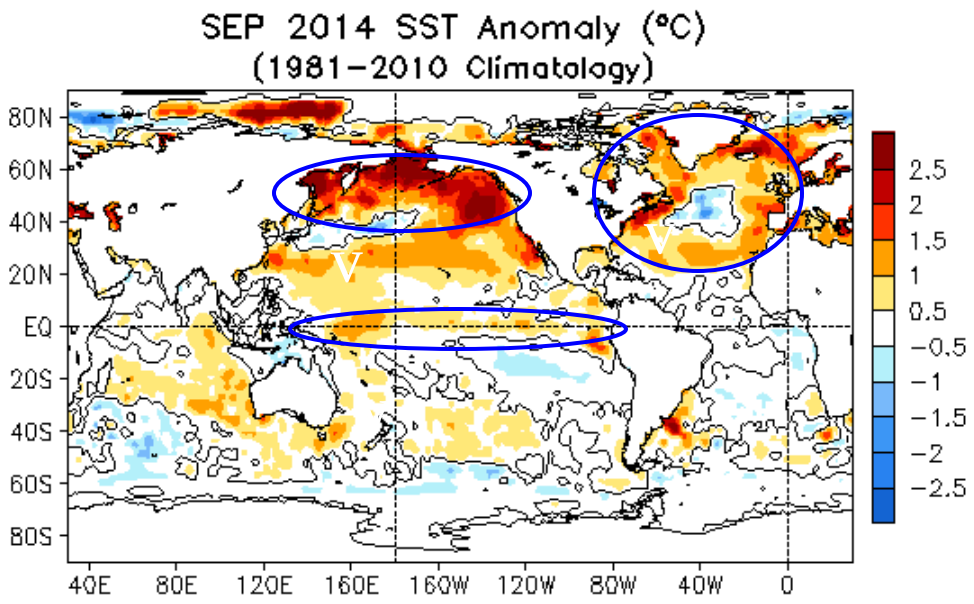
- **Pacific Ocean**
  - **ENSO neutral condition continued with OIv2 NINO3.4=0.5°C in September 2014.**
  - **Subsurface warming occupied the upper Pacific.**
  - **Majority of models predict a weak El Nino starting October-November season.**
  - **Positive PDO index increased in September, with PDO index = 0.74.**
  - **Strong positive SSTA continued in the high latitudes of the North Pacific and Arctic Oceans.**

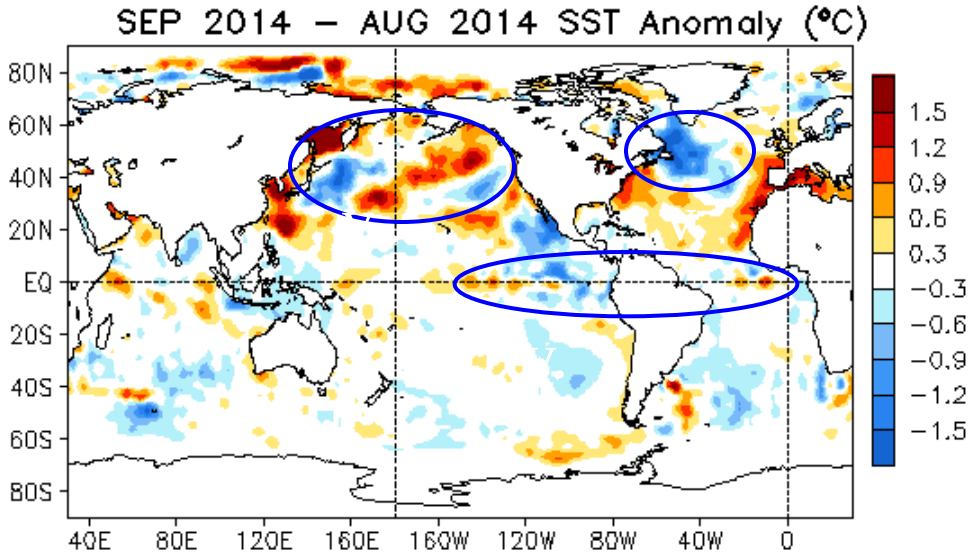
- **Indian Ocean**
  - **Indian dipole index remained below -0.4 in September.**

- **Atlantic Ocean**
  - **Near-normal SST continued in the hurricane Main Development Region.**
  - **NAO switched to positive phase, with NAO index = 1.7 in September 2014.**

Global Oceans

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



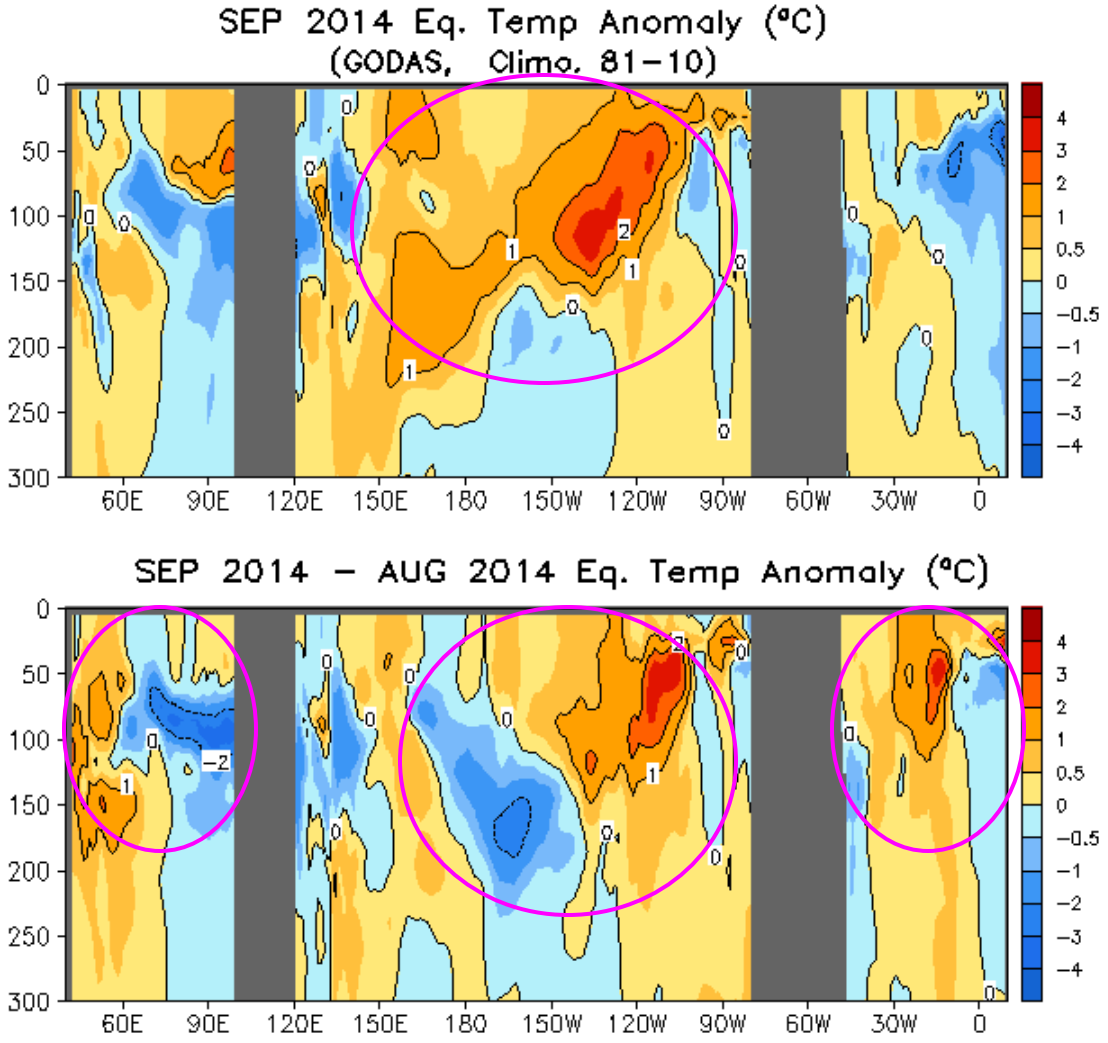


- **Strong warming continued in the high-latitude of North Pacific and the Arctic Ocean**
- **Positive SST anomalies dominated the North Atlantic.**
- **SST were above-average across much of equatorial Pacific Ocean.**
- **Positive SSTA dominated in the South Ocean.**

- **Both negative and positive SSTA tendencies were observed across the equatorial Pacific and Atlantic Oceans.**
- **Negative tendency presented in the Labrador basin.**
- **SST tendencies were large in the North Pacific and Arctic.**

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.

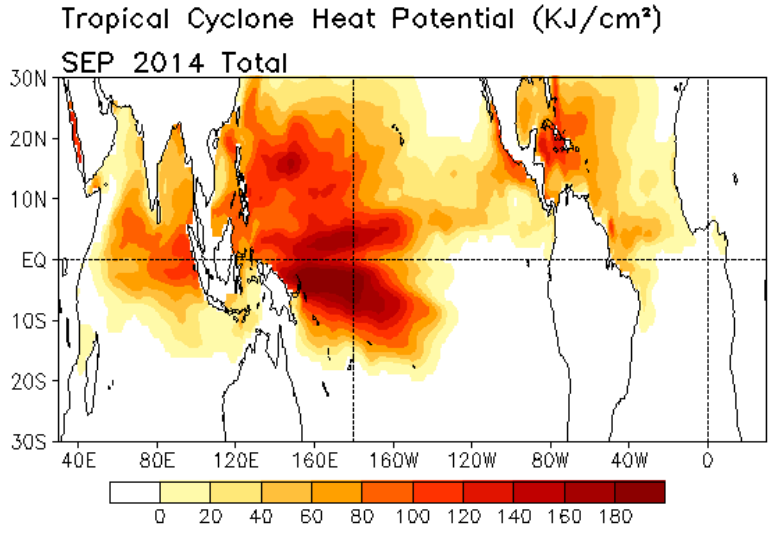
Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2°S-2°N

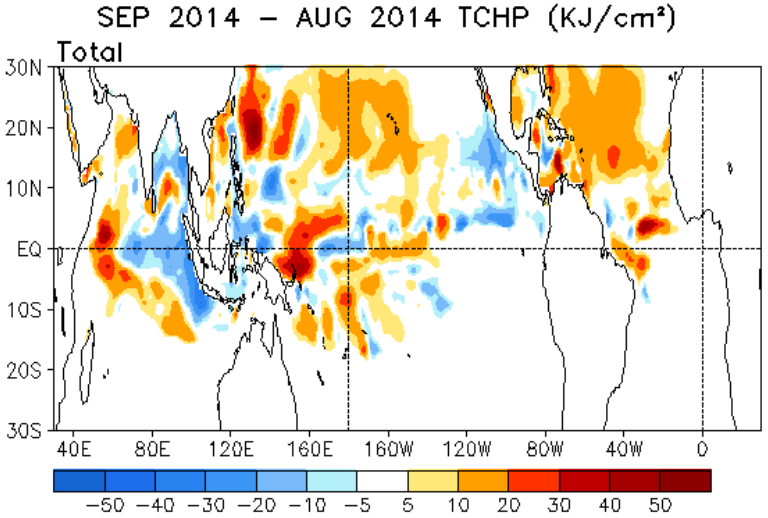


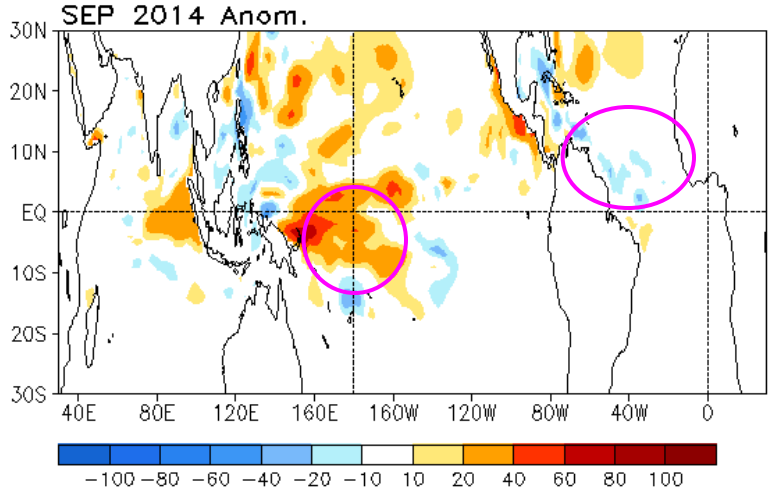
- **Positive subsurface temperature anomalies presented in most of the upper equatorial Pacific.**
- **Positive (negative) temperature tendency was observed near the thermocline in the eastern (western-central) Pacific.**
- **Positive subsurface temperature tendency dominated the upper Atlantic Ocean.**
- **Positive (negative) subsurface tendencies presented in the western (eastern) Indian Ocean.**

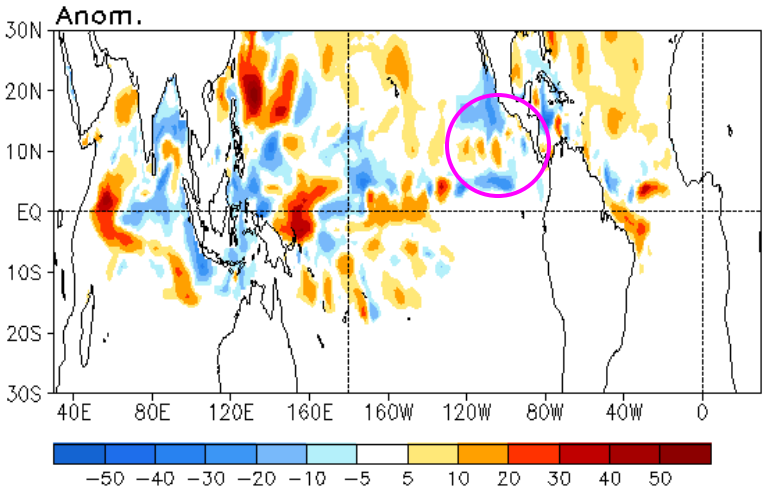
Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1981-2010 base period means.

Tropical Cyclone Heat Potential and Tendency







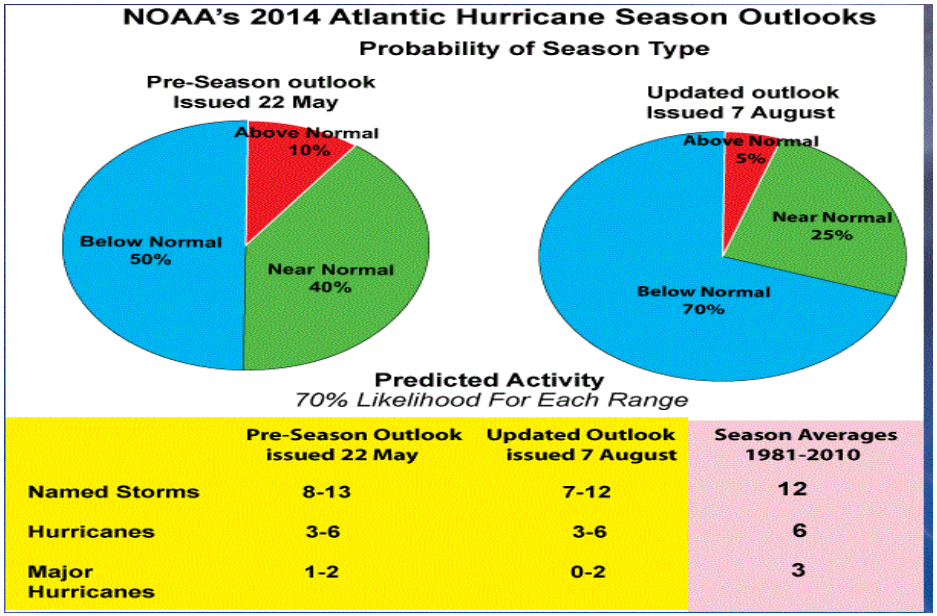


- **TCHP was above-normal in the equatorial central Pacific.**
- **TCHP in the north-eastern Pacific decreased substantially over the last month, and became weekly above-normal in September.**
- **TCHP was slightly below-normal in the Atlantic Hurricane Main Development Region.**

TCHP field is the anomalous heat storage associated with temperatures larger than 26˚ C.

NOAA's 2014 Hurricane Outlooks

(http://www.cpc.ncep.noaa.gov/products/outlooks)



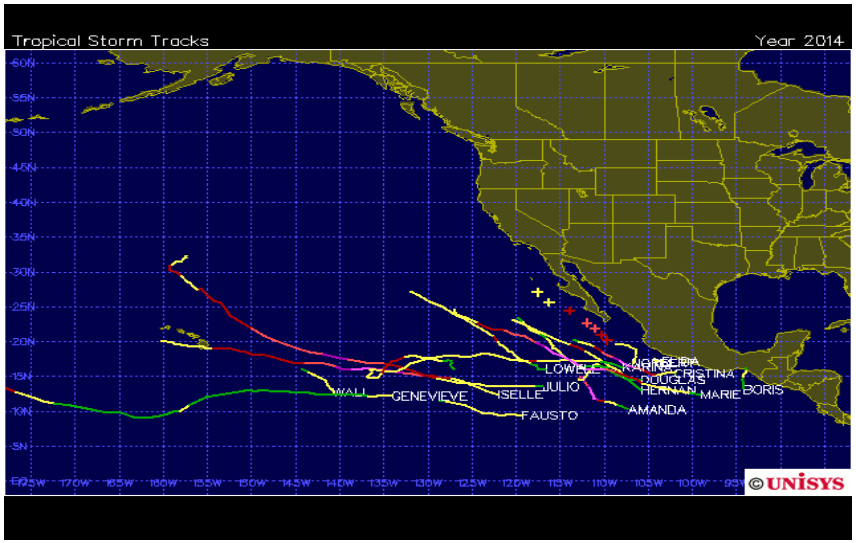
	Pre-Season Outlook issued 22 May	Updated Outlook issued 7 August	Season Averages 1981-2010
Named Storms	8-13	7-12	12
Hurricanes	3-6	3-6	6
Major Hurricanes	1-2	0-2	3

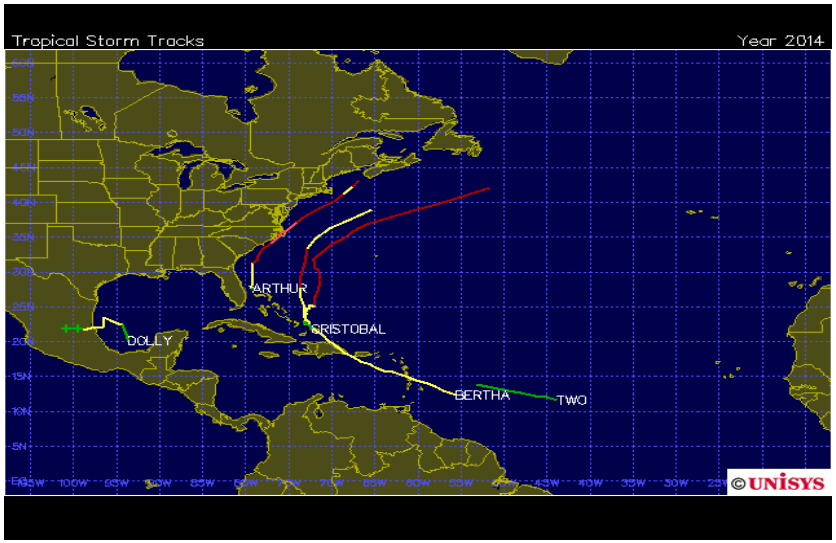
- **NOAA's 2014 Atlantic Hurricane Season outlooks issued in Aug. call for a 70% chance of a below-normal season in Atlantic.**

-**Outlook issued in May suggested a 50% chance of a above-normal season in E. Pacific.**

- **Five tropical storms including four hurricanes (1major) were formed in Atlantic by Oct. 6.**

- **19 tropical storms including 14 hurricanes (9major) were formed in E. Pacific by Oct.6.**

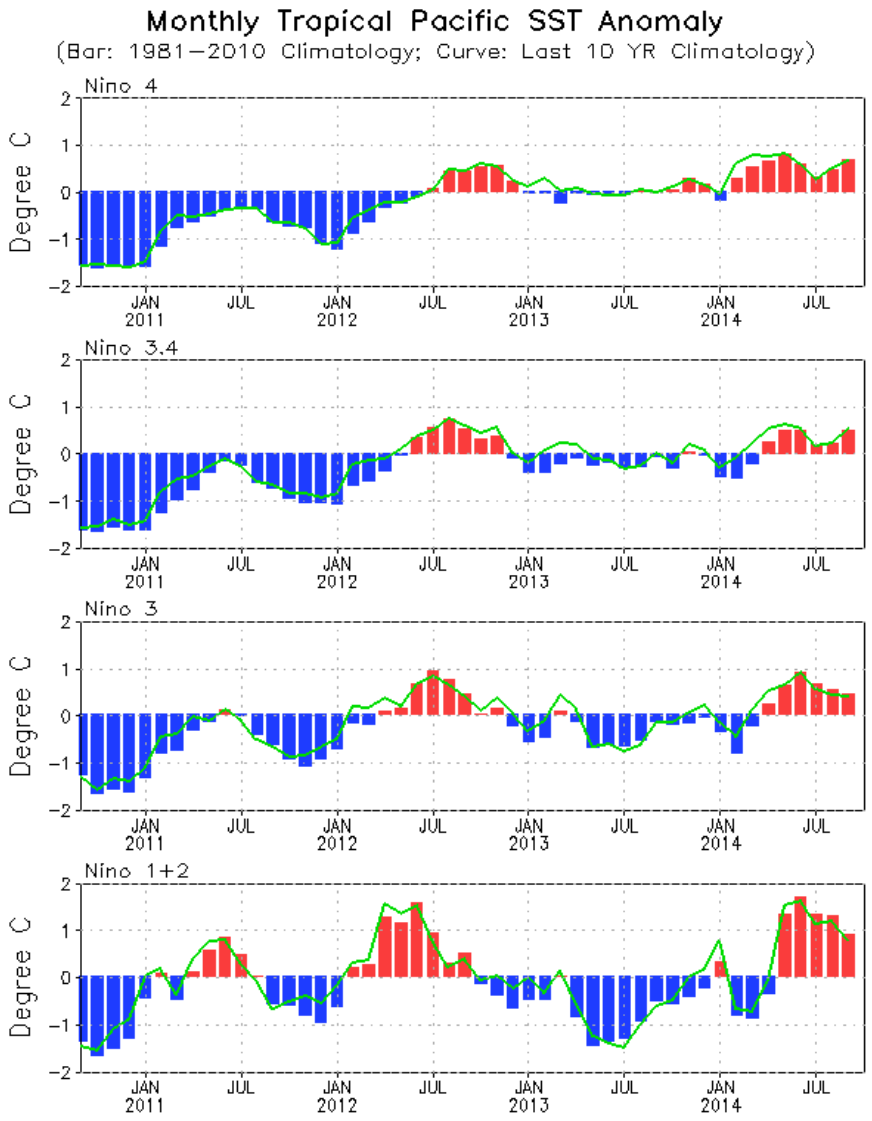


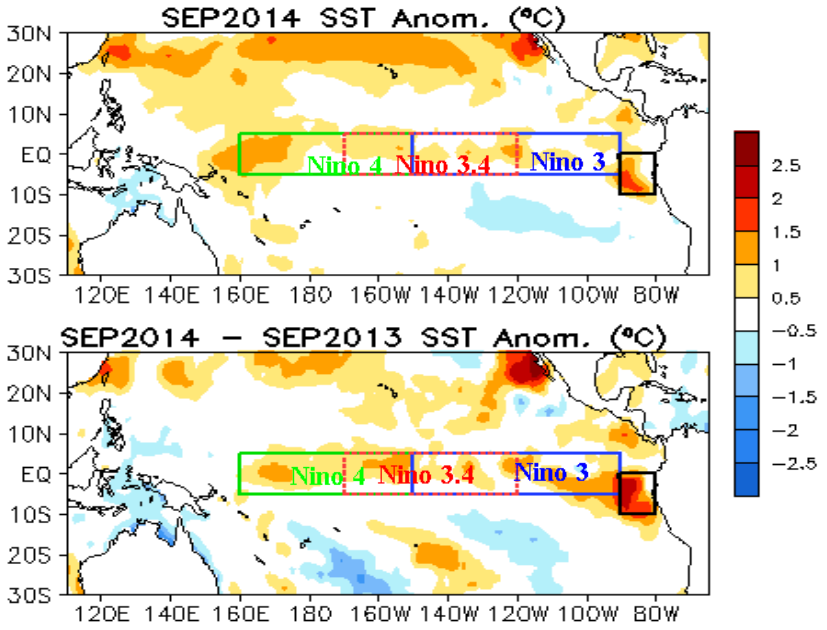


(http://weather.unisys.com/hurricane/)

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific NINO SST Indices





- **Nino4 and Nino 34 increased , while Nino3 and Nino1+2 decreased in September.**

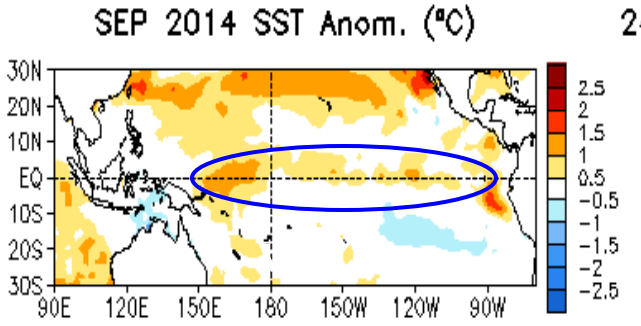
- **Nino3.4 = 0.47 in September.**

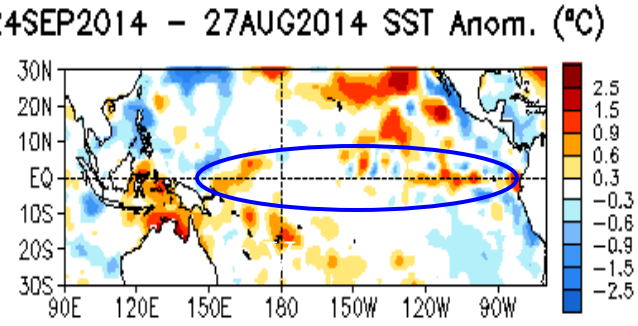
- **SST in September 2014 was warmer than that in September 2013 along the equatorial Pacific Ocean.**

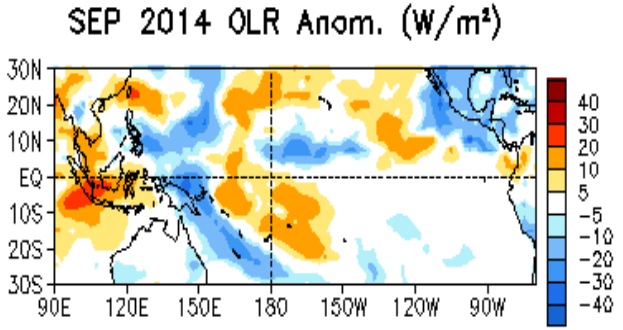
- **The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v3b.**

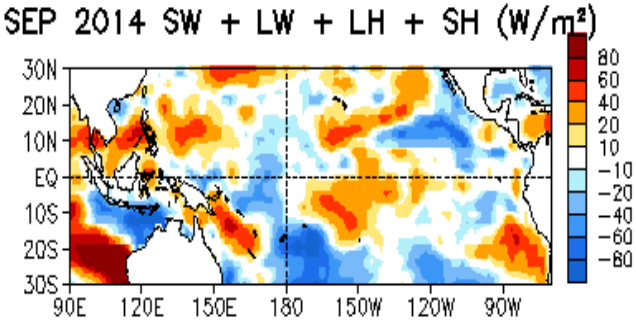
Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

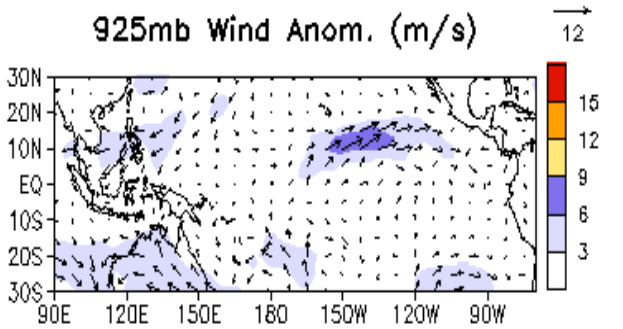
Tropical Pacific: SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Winds

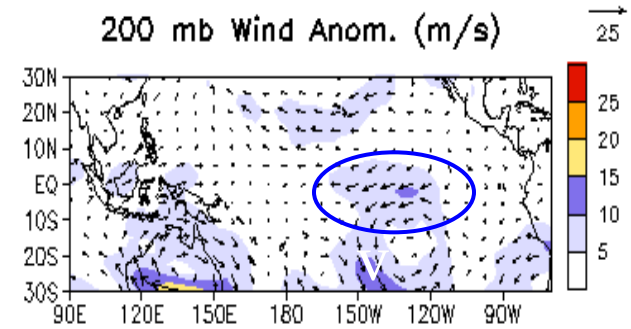








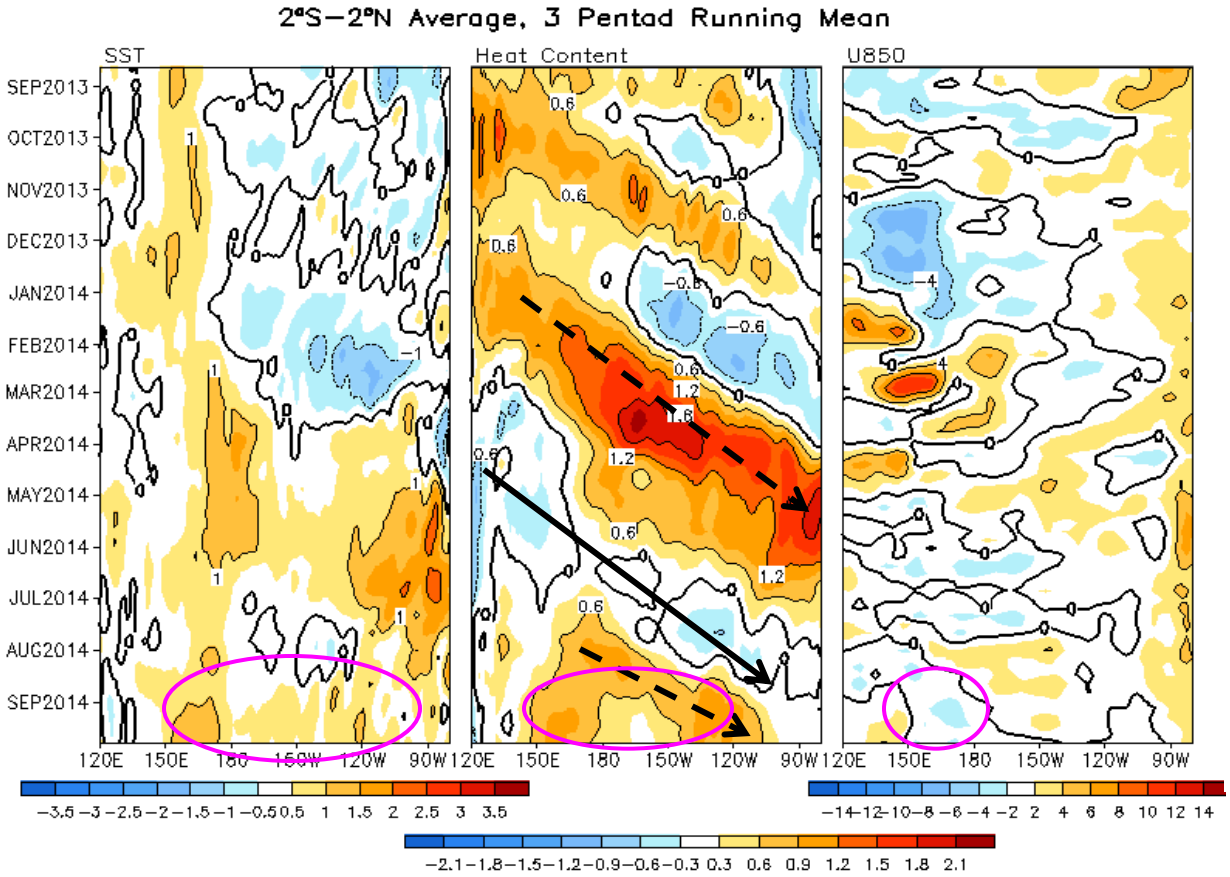




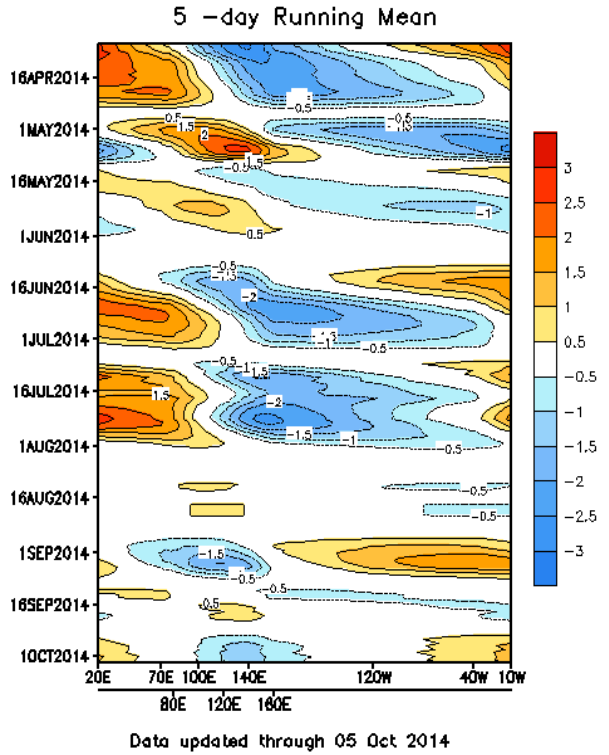
- **SST were above-normal across most of the equatorial Pacific.**
- **SST tendency was small near the equator.**
- **Convection was suppressed near Dateline and in the eastern Indian Ocean, and enhanced near New Guinea and Philippine.**
- **Easterly upper-level wind anomalies were observed over the central Pacific.**
- **Low-level winds were near-normal across most of the equatorial Pacific.**

op-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 1981-2010 base period means.

Equatorial Pacific SST (ºC), HC300 (ºC), and u850 (m/s) Anomalies



CPC MJO Indices



http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_mjo_index/mjo_index.shtml

- **Positive SSTA presented across much of the equatorial Pacific**
- **Positive H300 anomalies were observed near 150W-120W and west of date line in Sep., contributing to recent SST warming.**
- **Weak easterly low-level wind anomaly reemerged west of date line since late August.**

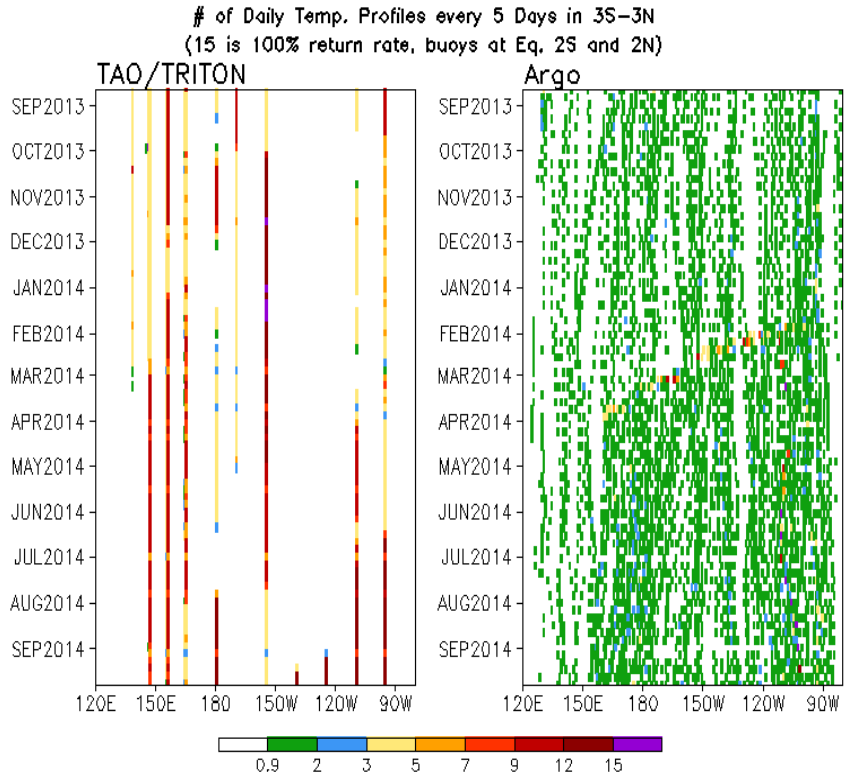
- **Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 8Weak easterly low-level wind anomaly reemerged west of date line since late August.**

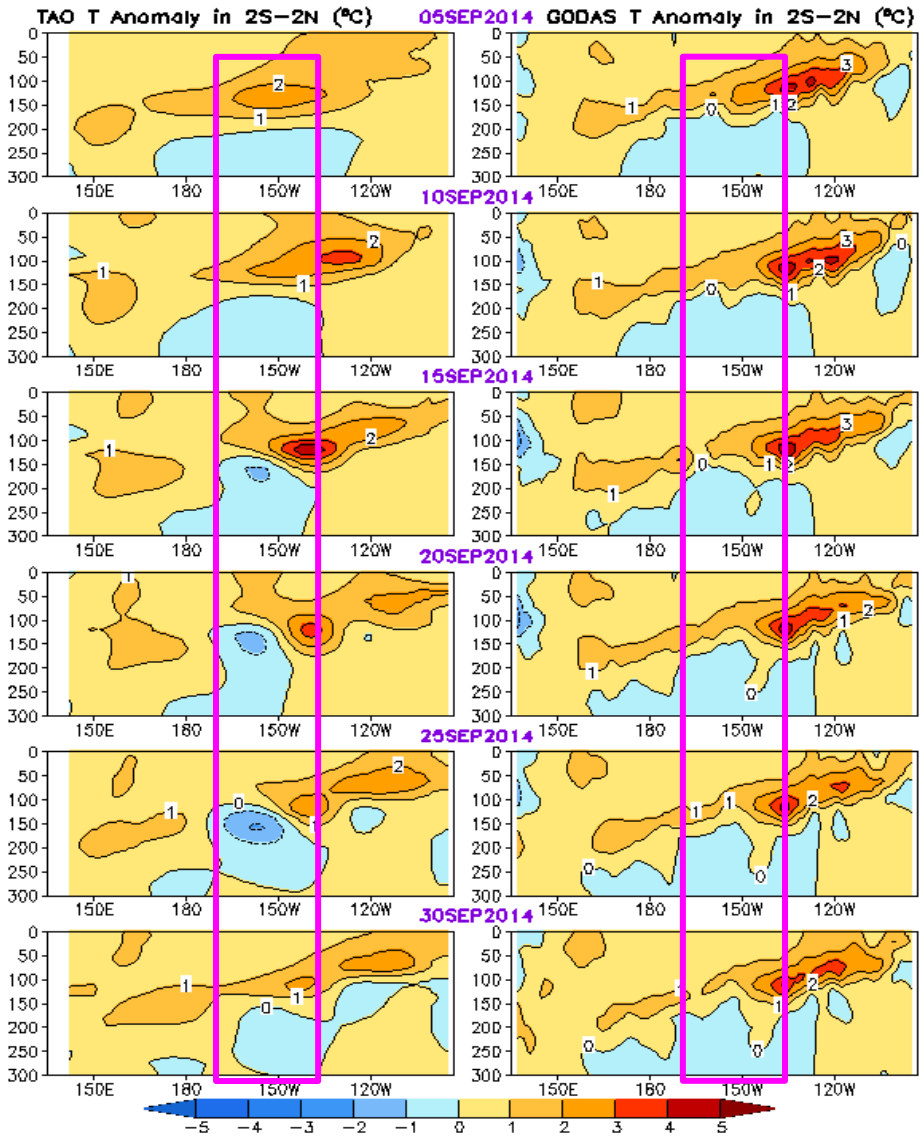
50-mb zonal wind (U850, middle-right) averaged in 2ºS-2ºN and Outgoing Long-wave Radiation (OLR, right) averaged in 5ºS-5ºN. SST is derived from the NCEP OI SST, heat content from the NCEP's global ocean data assimilation system, U850 from the NCEP CDAS. Anomalies for SST, heat content and U850/OLR are departures from the 1981-2010 base period pentad means respectively.

Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

- **Two TAO mooring lines at 140W and 125W were restored in September, which provides a good coverage for the first time since Jul. 2013.**

- **Negative subsurface anomaly emerged at 150-200m between 170W-135W, while this subsurface cooling was not seen from GODAS.**





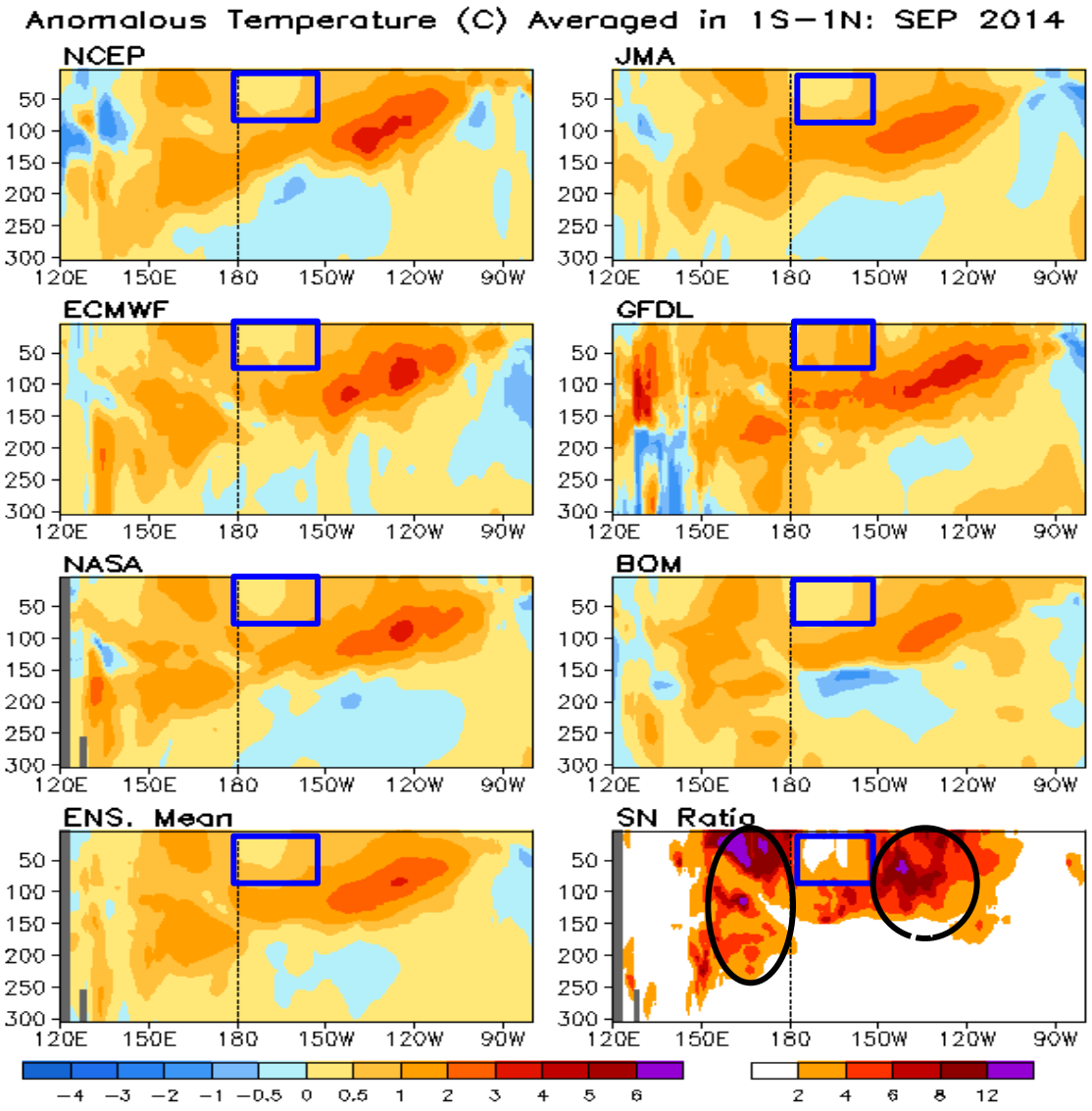
Real-Time Multiple Ocean Reanalysis Intercomparison

(http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html)

Longitude-Depth Temperature Anomaly in 1S-1N

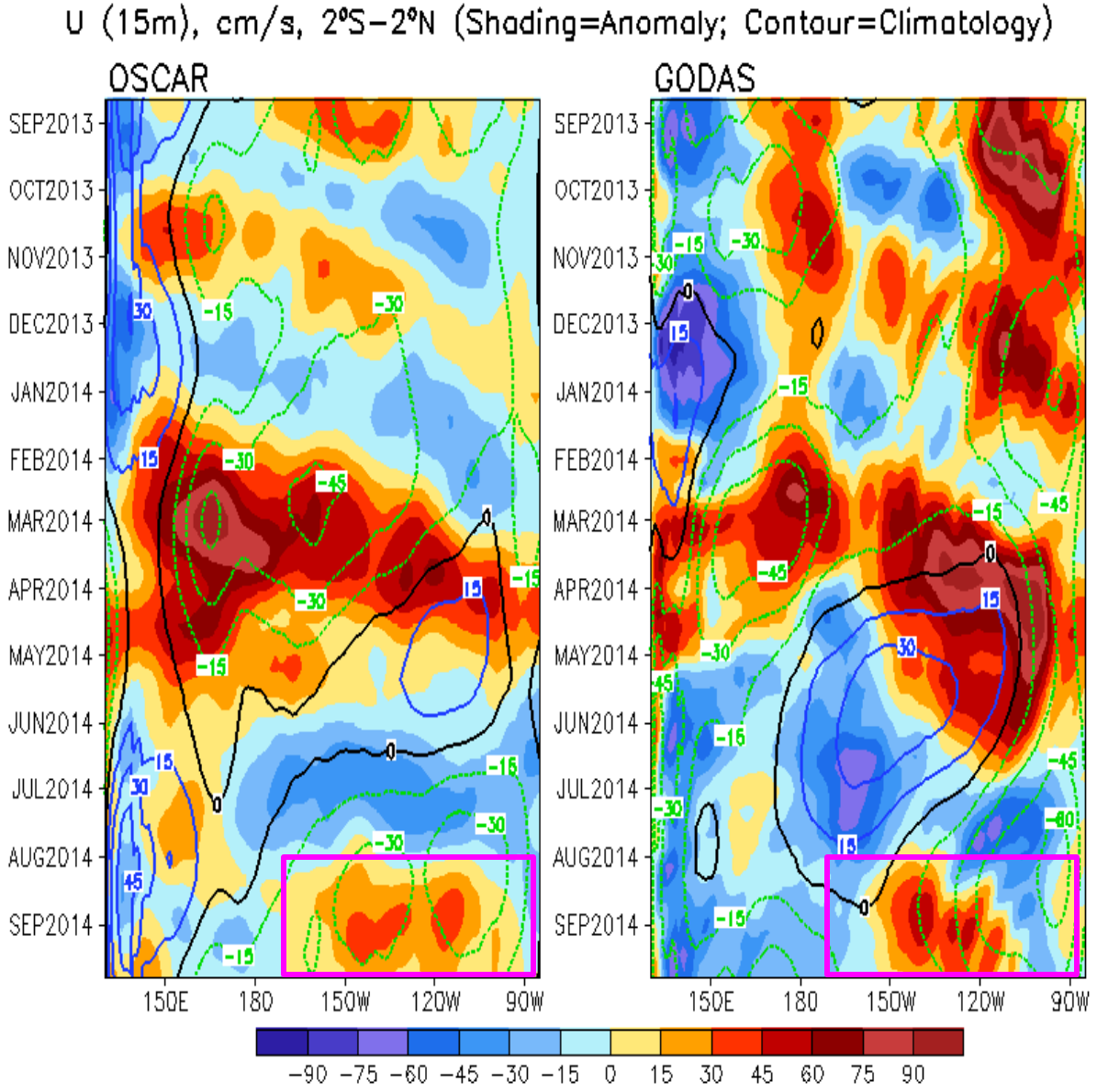
- **Positive subsurface temperature anomalies were well represented at all reanalysis data near west of Dateline and central-eastern Pacific.**

- **GFDL has strongest positive temperature anomalies at 0-100m between 180W-150W.**



1981-2010 Climatology

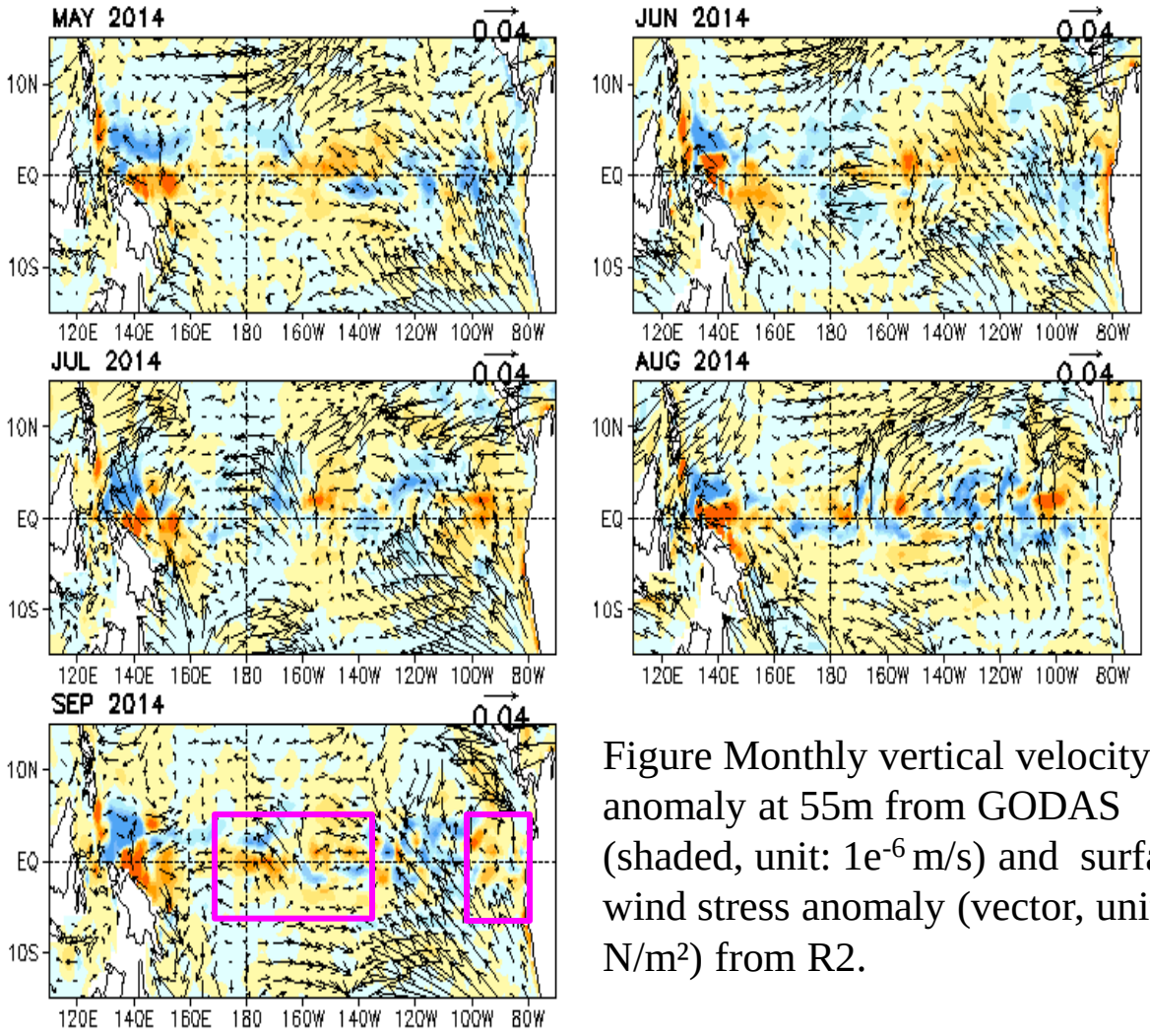
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- **Positive zonal current anomaly presented east of dateline since mid of Aug., contributing SST warming in September.**

-**Some detailed differences were noted for both anomaly and climatology between OSCAR and GODAS.**

Last Five Month W at 55m and Surface Windstress Anom.



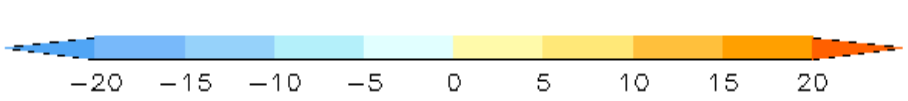
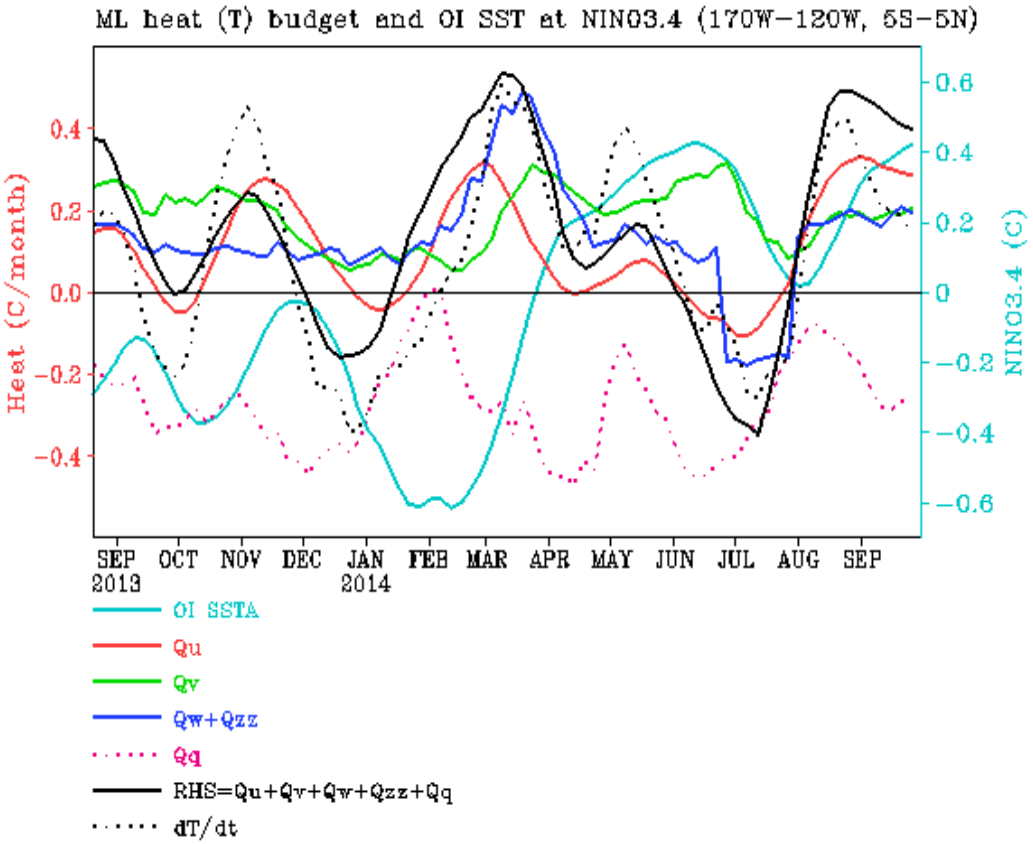


Figure Monthly vertical velocity anomaly at 55m from GODAS (shaded, unit: $1e^{-6}$ m/s) and surface wind stress anomaly (vector, unit: N/m^2) from R2.

- **Positive vertical velocity (W) anomaly (enhanced upwelling) dominated the western-central Pacific and far eastern Pacific in September, while negative W anomaly dominated between 140W-110W.**

- **Anomalous upwelling ($w'\partial T/\partial t$) tended to cool the mixed layer.**

NINO3.4 Heat Budget



- **SSTA tendency (dT/dt) in NINO3.4 (dotted line) was positive in Sep. 2014**

- **Qu , Qw+Qzz and Qv were positive in September.**

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;

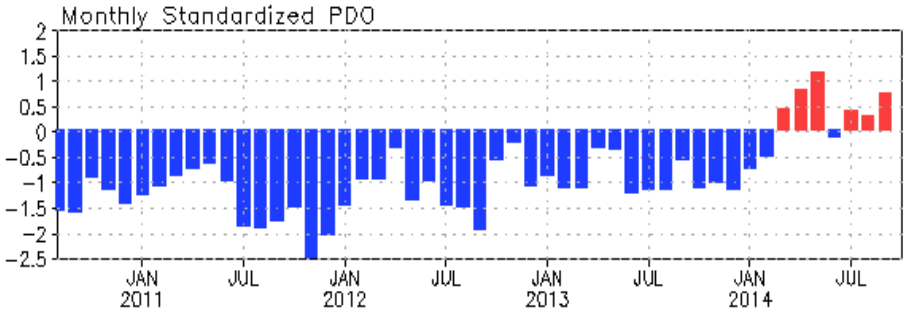
Qw: Vertical entrainment; Qzz: Vertical diffusion

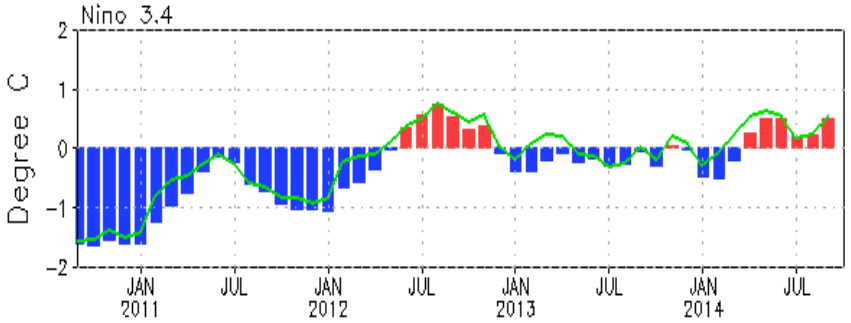
Qq: (Qnet - Qpen + Qcorr)/ρcph; Qnet = SW + LW + LH +SH;

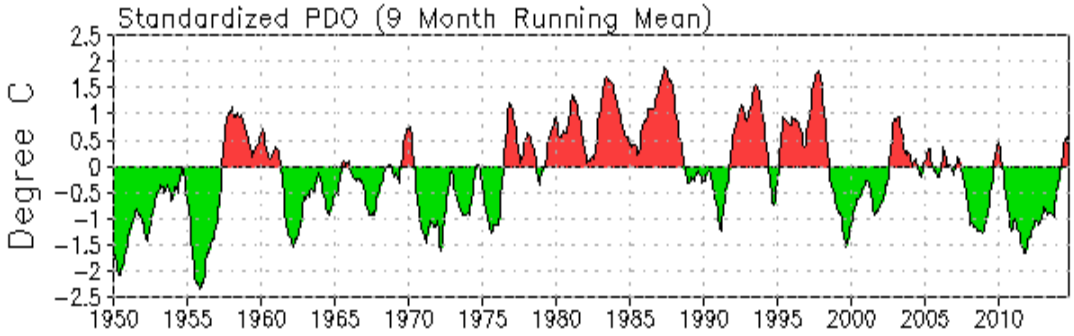
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

North Pacific & Arctic Oceans

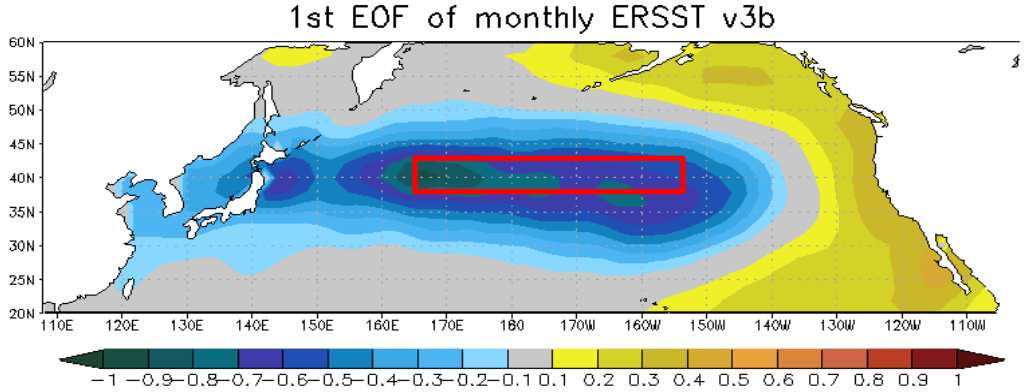
PDO index





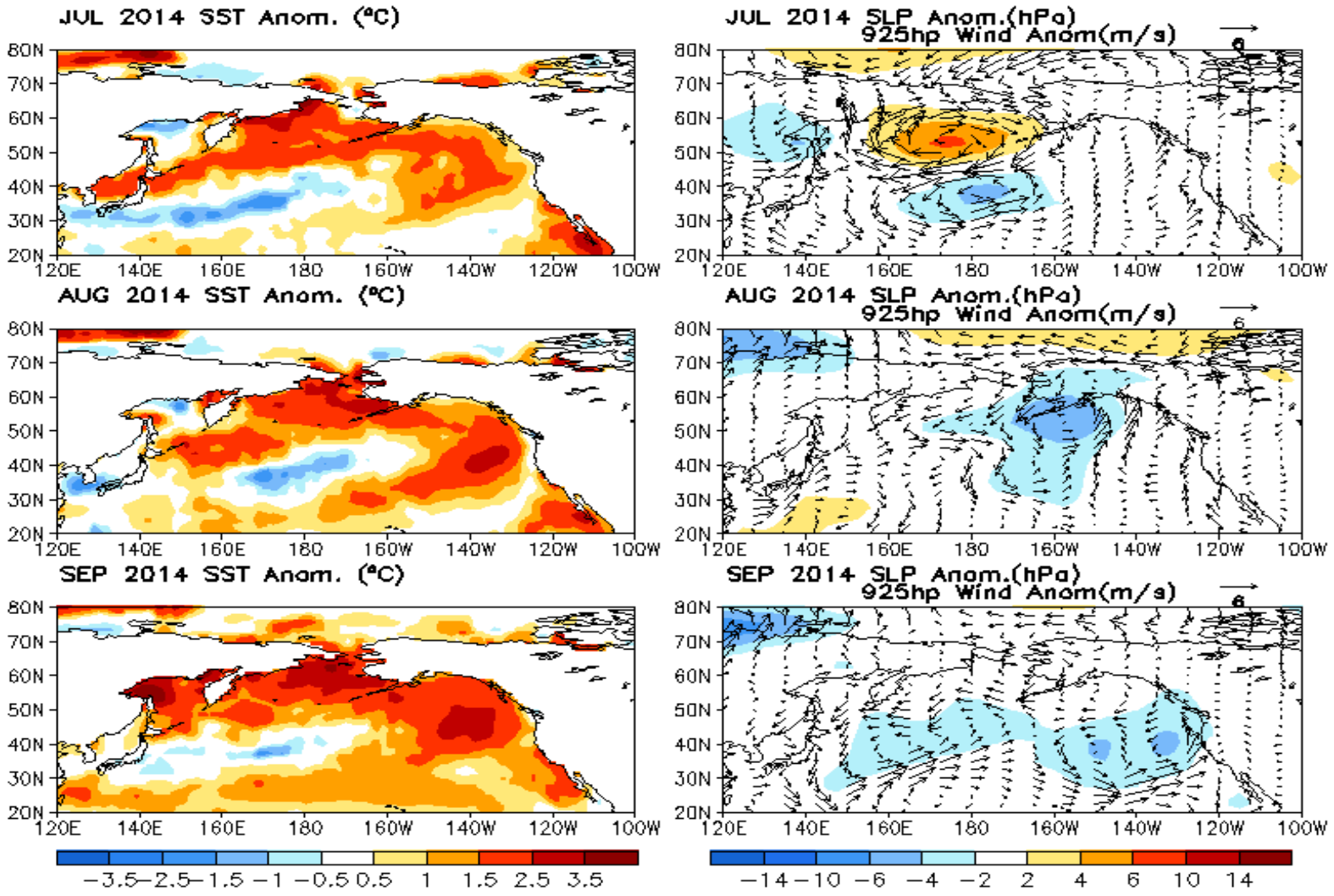


- **PDO index enhanced in Sep., with PDO index =0.74**



- **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.**

Last Three Month SST, OLR and 925hp Wind Anom.

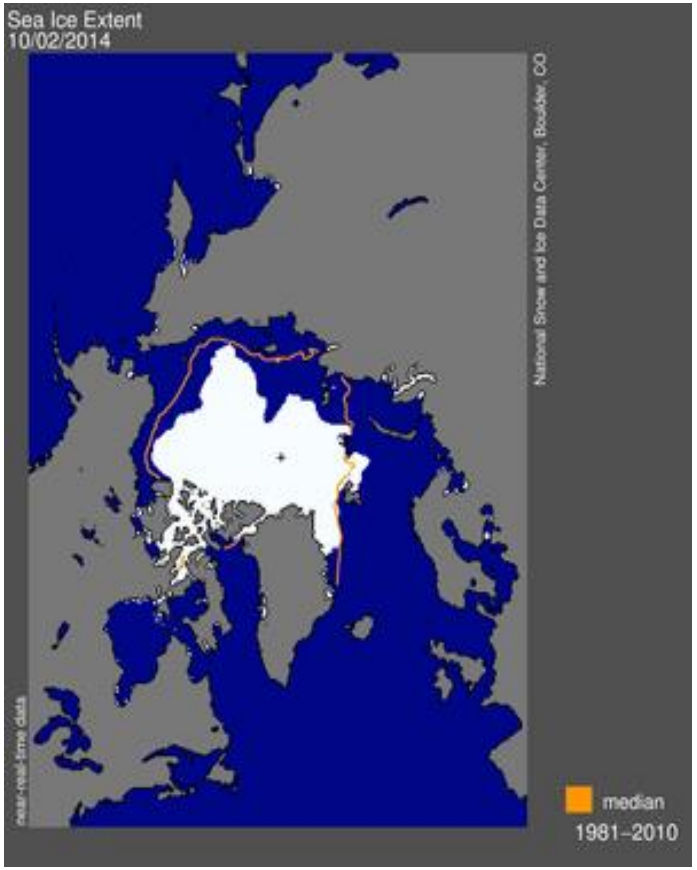


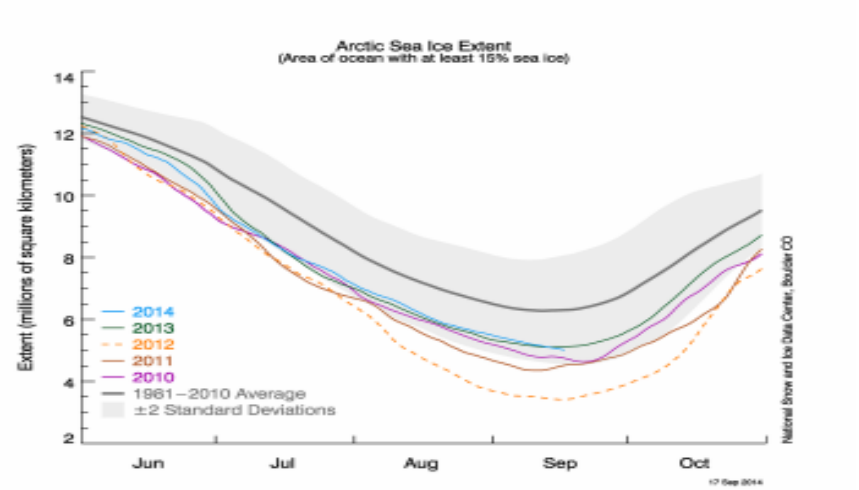
- **Strong SST warming persisted in the high-latitude of N. Pacific.**
- **Atmosphere circulation patterns varied over the past three months**

Arctic Sea Ice

National Snow and Ice Data Center

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

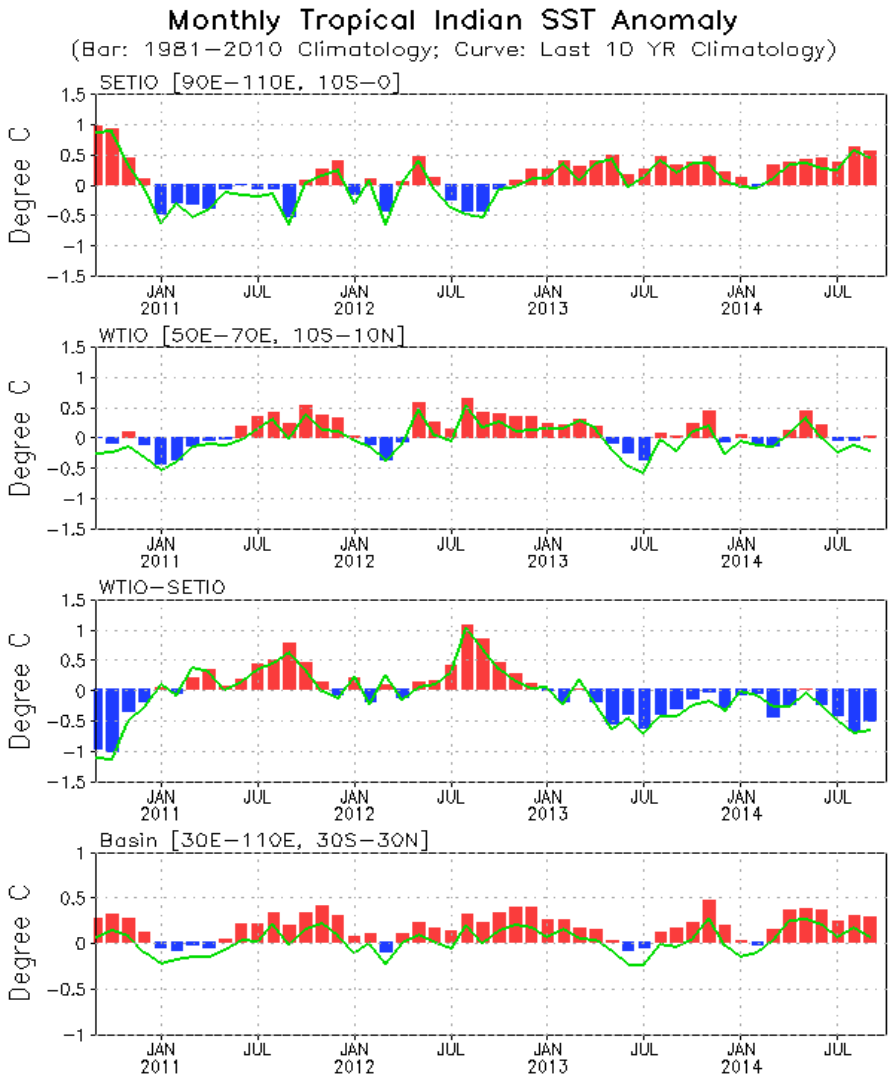


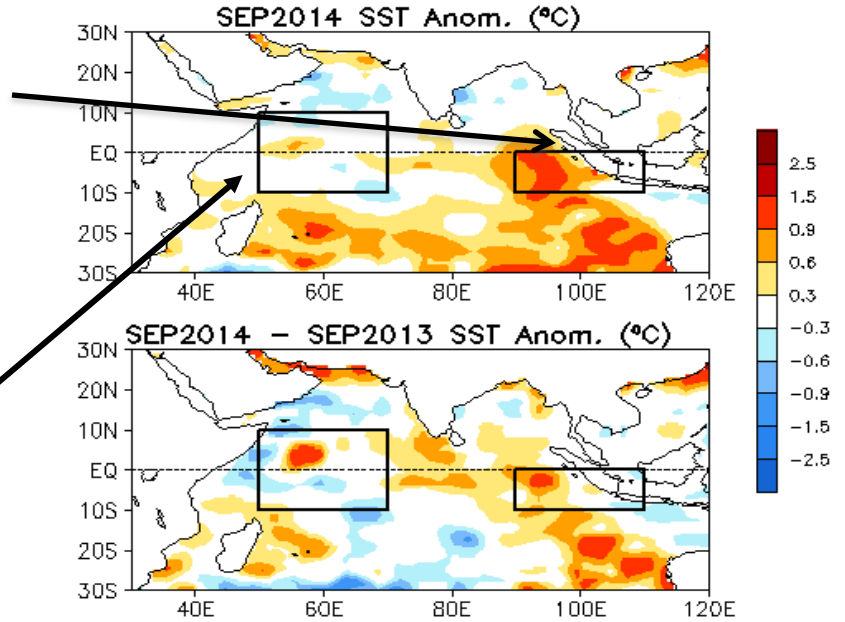


- **Arctic Sea ice extent reached minimum extent for 2014 in September.**
- **Arctic Sea ice extent in Sep. 2014 was very close to that in Sep. 2013.**

Indian Ocean

Evolution of Indian Ocean SST Indices





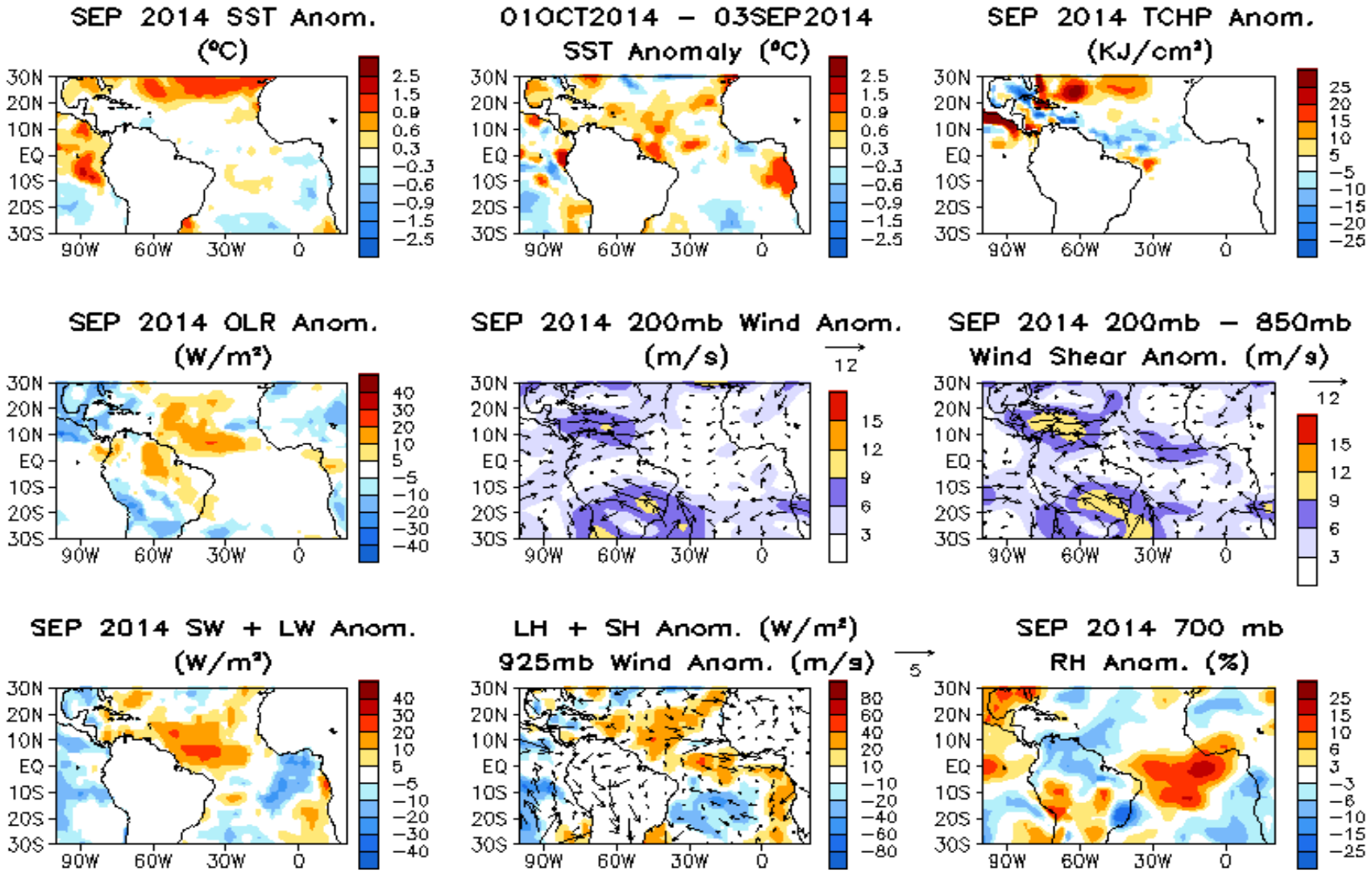
- **Positive SSTA was observed in the eastern tropical Indian Ocean and subtropical South Indian Ocean.**

- **Negative DMI continued in September.**

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.

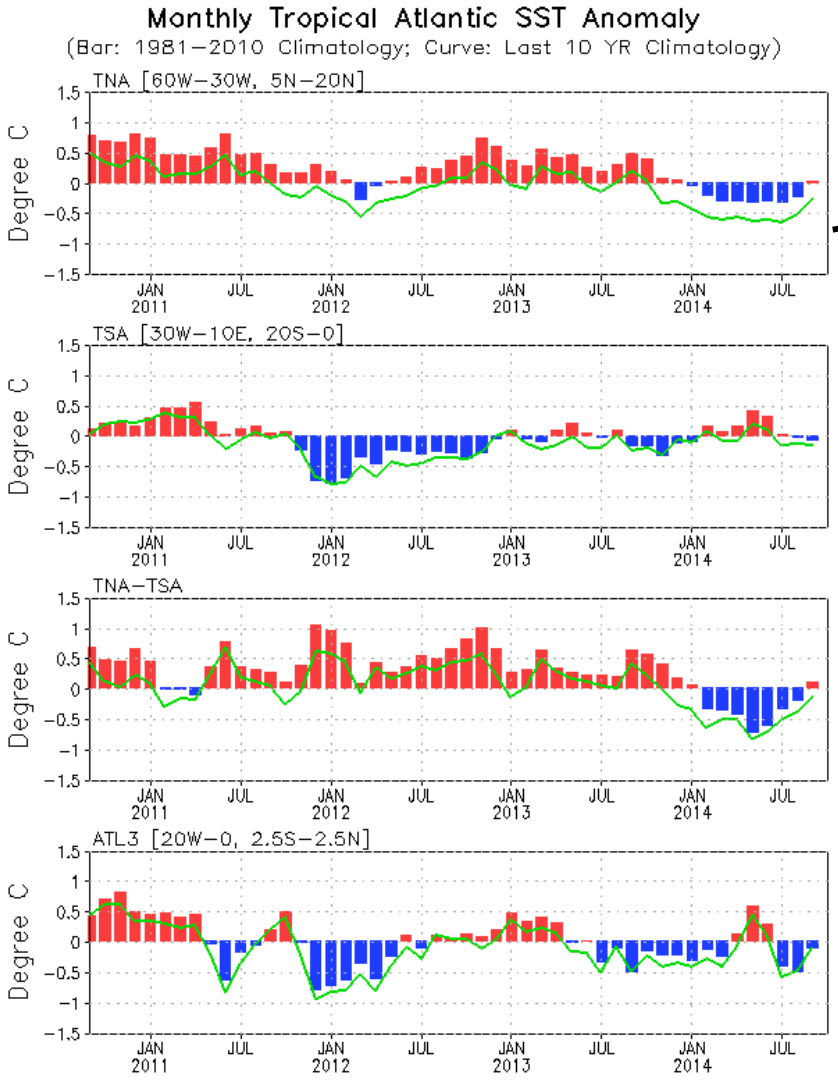
Tropical and North Atlantic Ocean

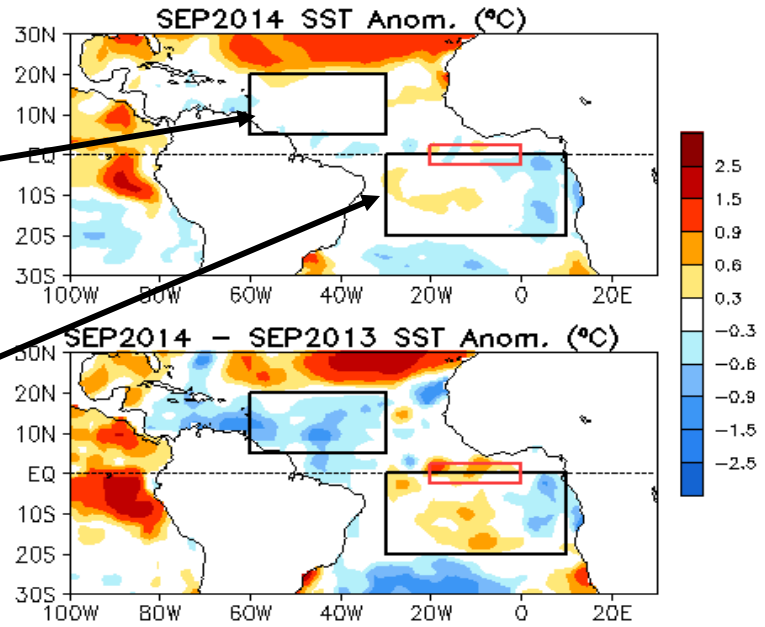
Tropical Atlantic:



- **Near-normal SSTA continued in the hurricane main development region.**
- **Convection was suppressed in the hurricane main development region.**

Evolution of Tropical Atlantic SST Indices



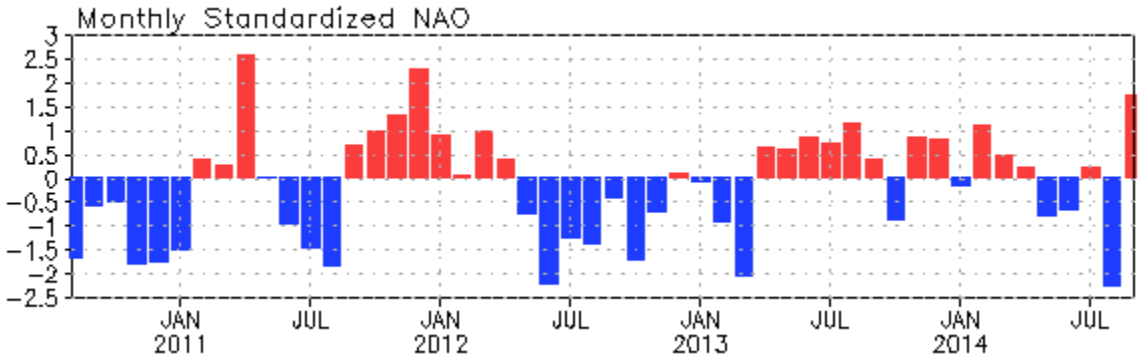


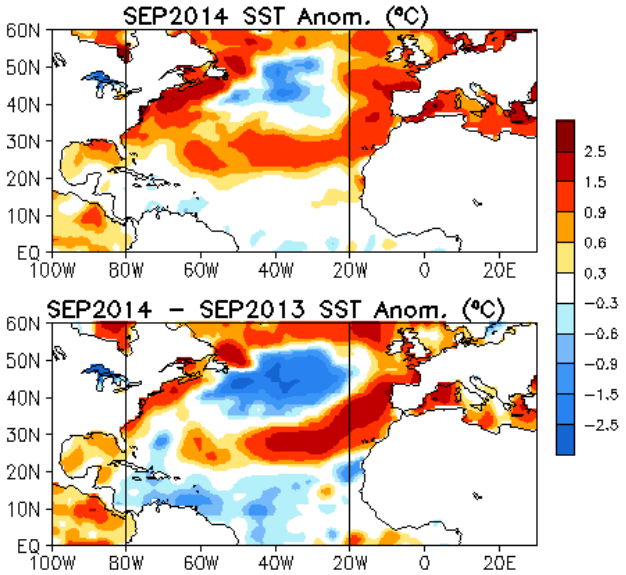
-TNA and TSA indices were near normal in September.

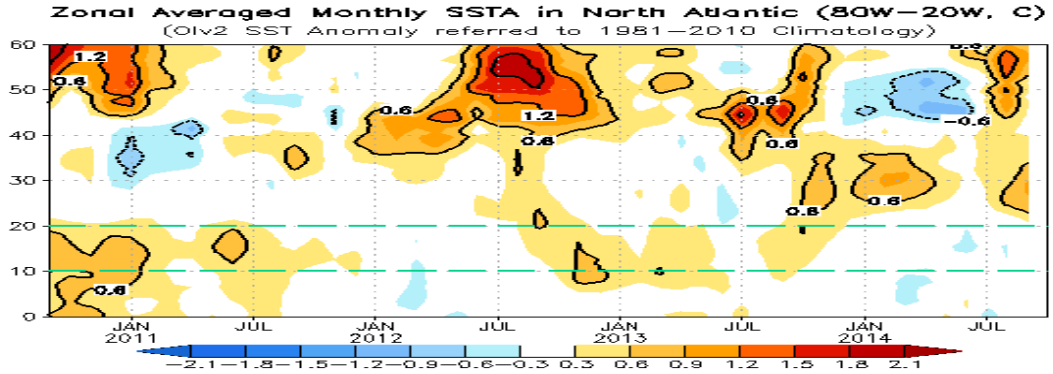
- Negative ATL3 SSTA weakened in Sep. 2014.

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.

NAO and SST Anomaly in North Atlantic





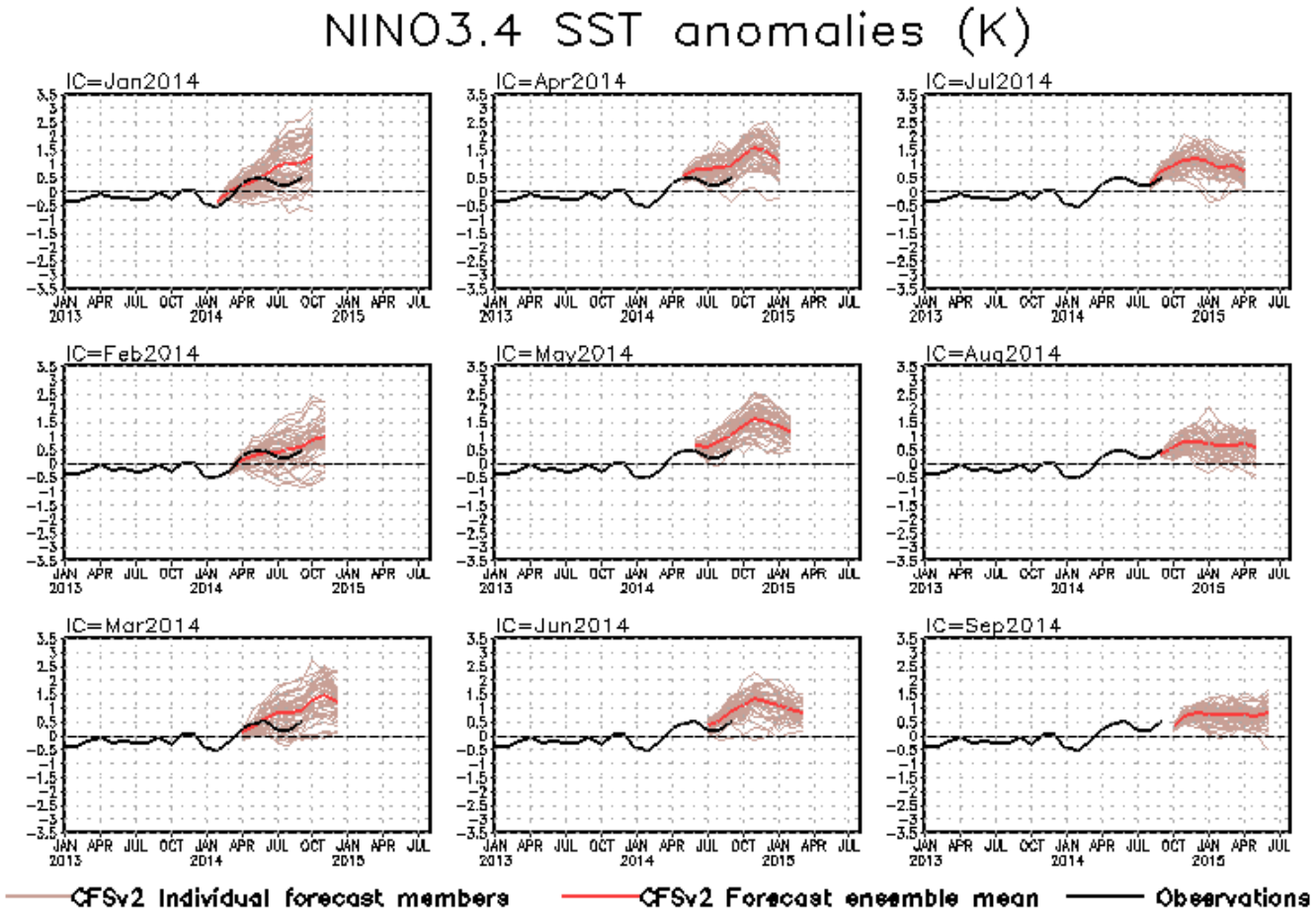


- NAO index switched to a strong positive phase , with NAO index= 1.7 in September 2014.
- Large positive SST anomaly presented near the east coast of Canada and Norwegian Sea.
- High-latitude North Atlantic SSTA are reversely related to NAO index (negative NAO coincides with SST warming).

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.

ENSO and Global SST Predictions

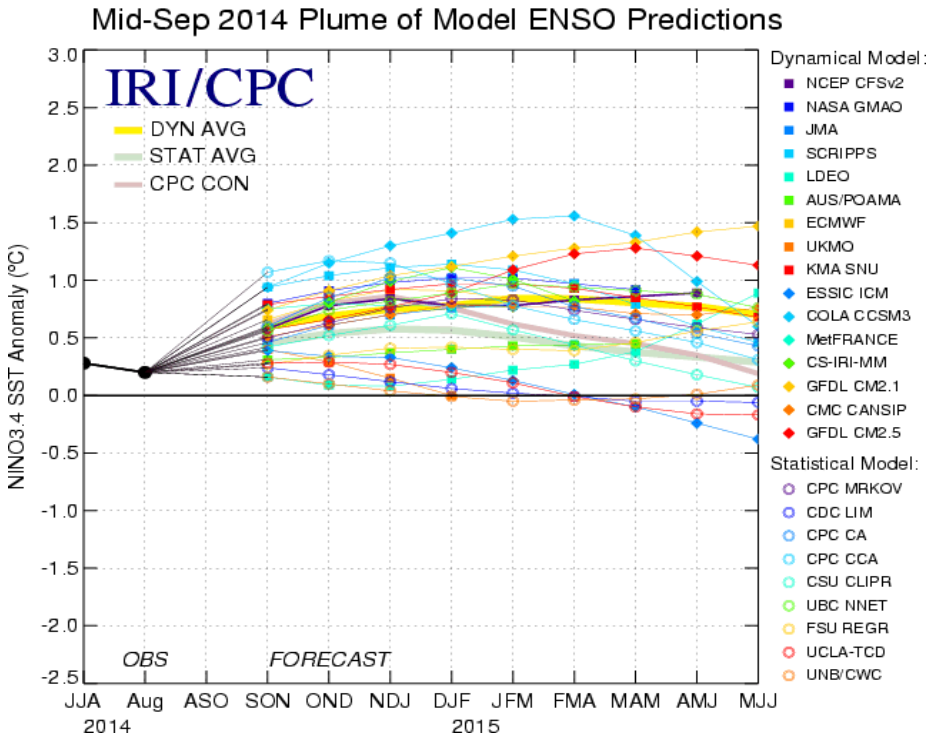
CFSv2 Niño3.4 SST Predictions from Different Initial Months

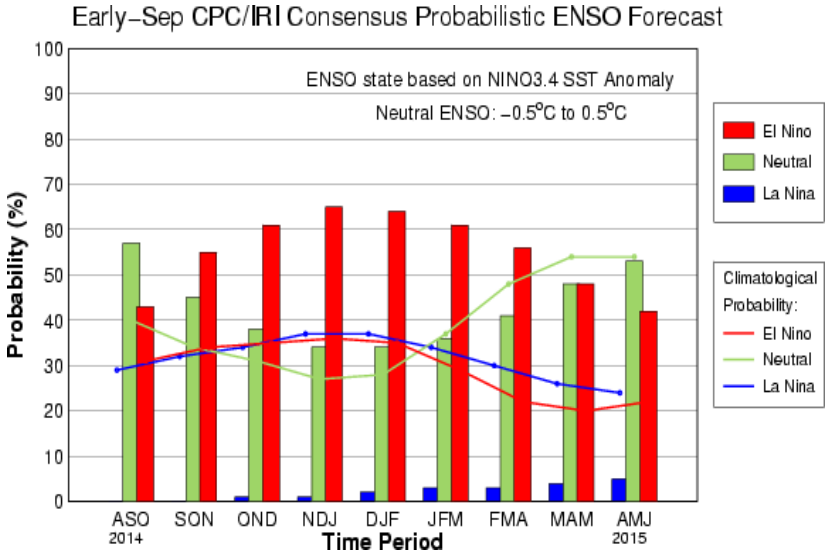


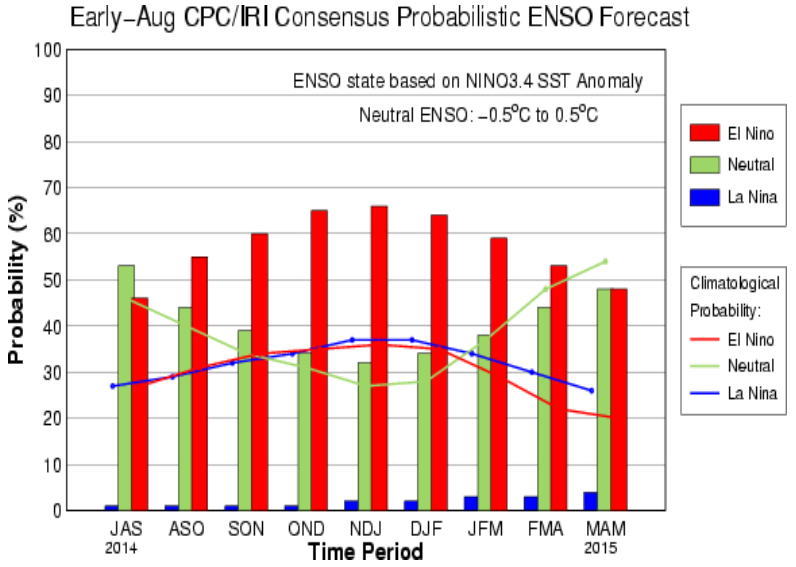
- **Latest CFSv2 predicted an El Niño to develop in Nov. and persist through Northern winter 2014-15.**

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). Anomalies were computed with respect to the 1981-2010 base period means.

IRI/CPC NINO3.4 Forecast Plum







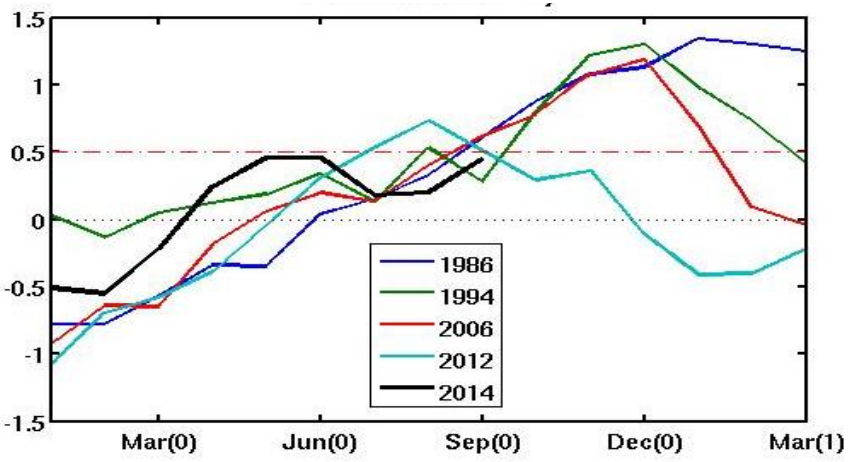
- **Most of models predict a weak El Niño to develop around October-November and persist through 2015 spring.**
- **The consensus forecast suggests that "Chances of El Niño are 60-65% during the Northern Hemisphere fall and winter."**

SST, D20 and 925hp Wind Anomalies in August

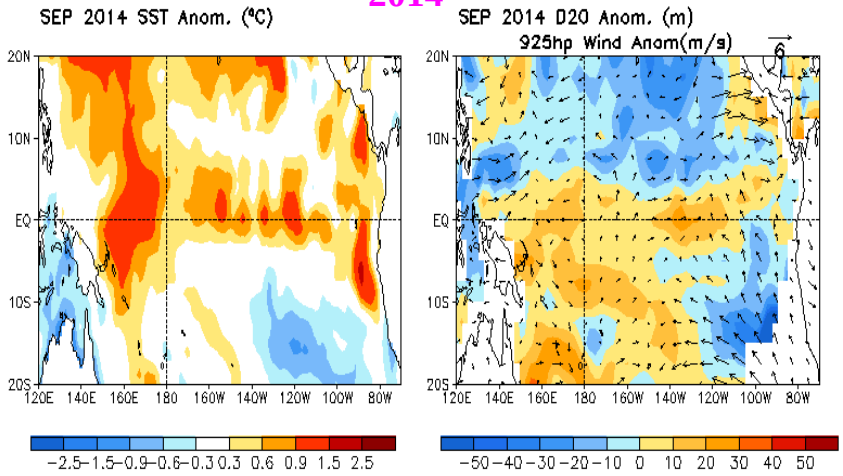
Late El Nino : 1986, 1994, 2006

Drop off El Nino: 2012

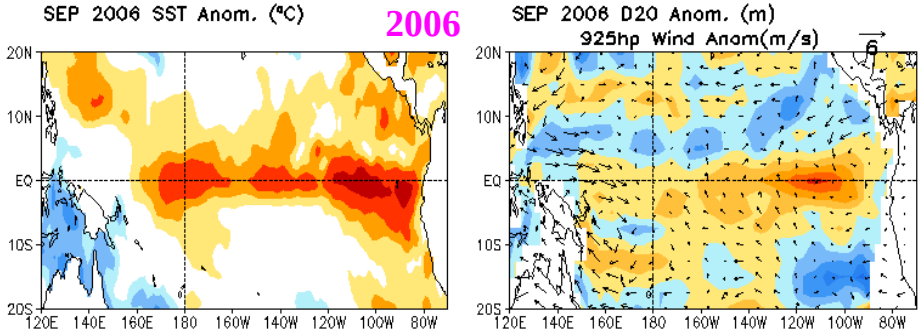
Nino34 SST Anomaly



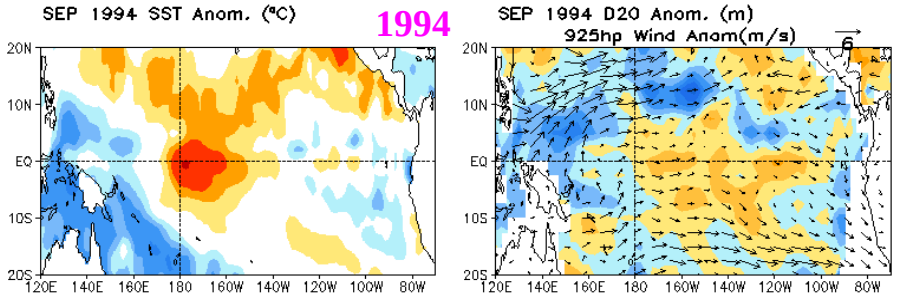
2014



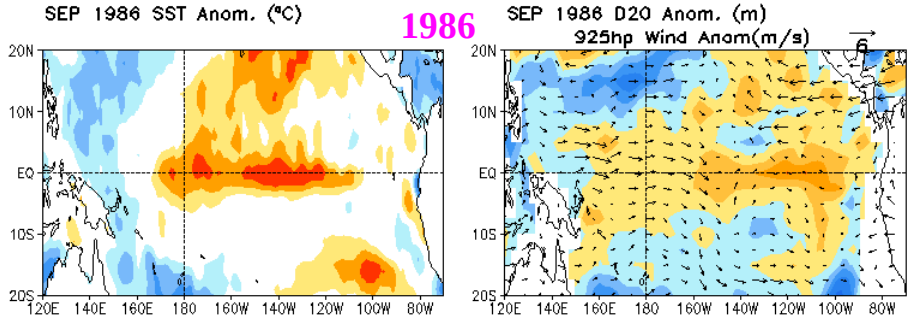
2006



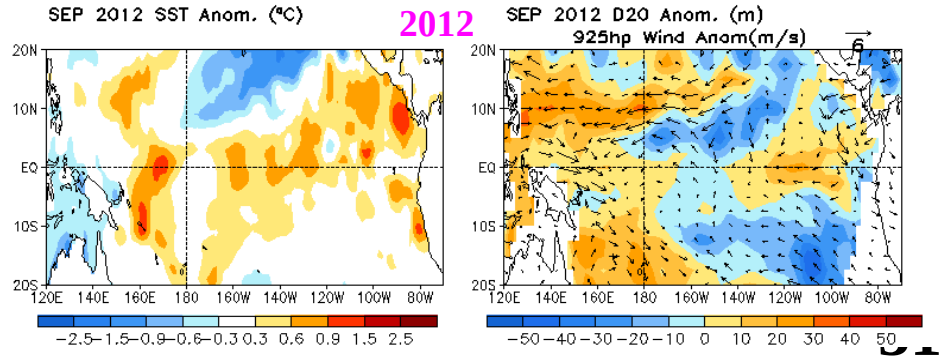
1994



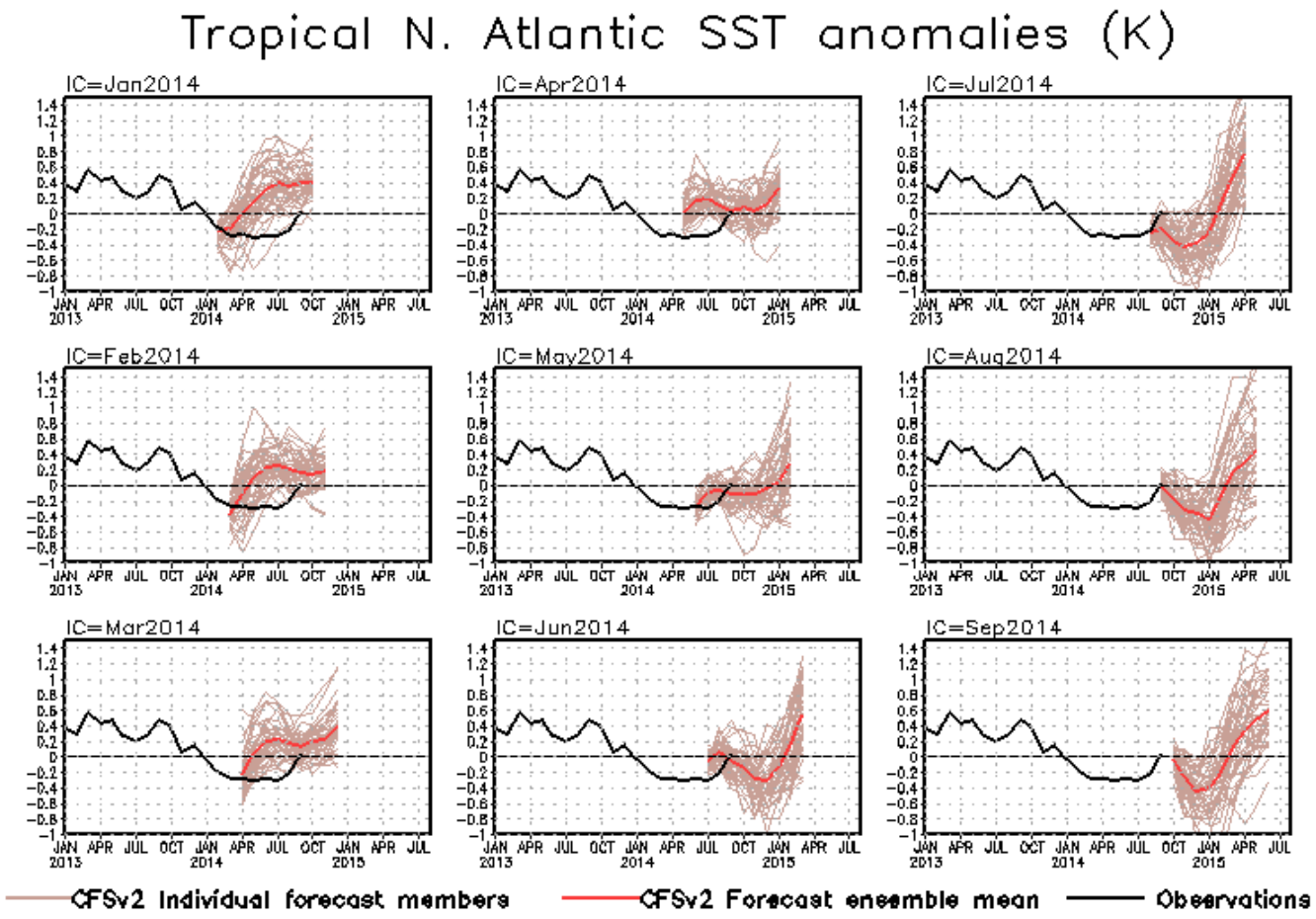
1986



2012



CFSv2 Tropical North Atlantic (TNA) SST Predictions from Different Initial Months

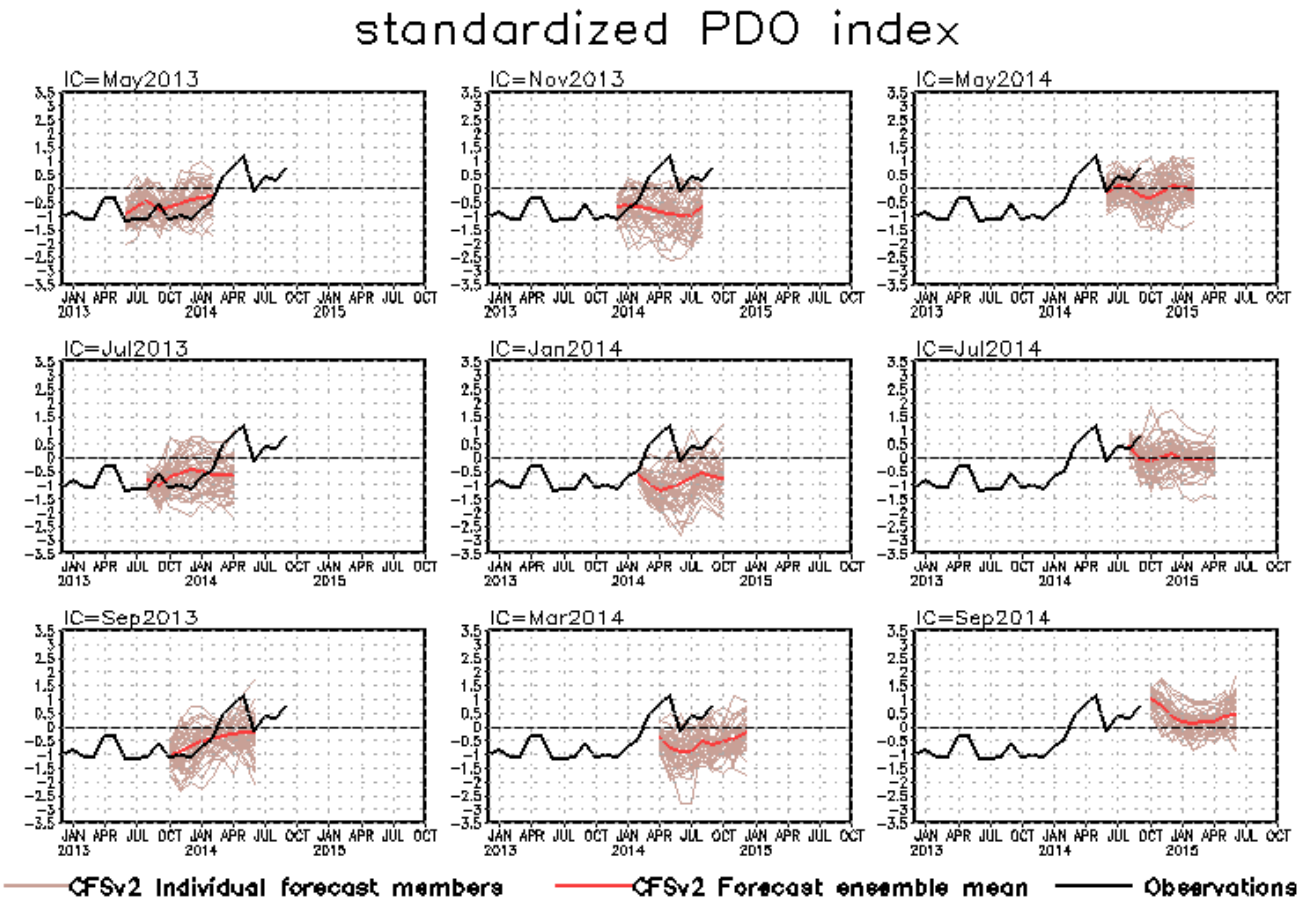


- **Forecast from September 2014 IC suggests below-normal SST in the tropical North Atlantic will persist through the Northern Hemisphere winter 2014-15.**

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

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). Anomalies were computed with respect to the 1981-2010 base period means.

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



-Latest Forecast at September 2014 IC calls for above-average PDO in next 9 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.

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). Anomalies were computed with respect to the 1981-2010 base period means.

Overview

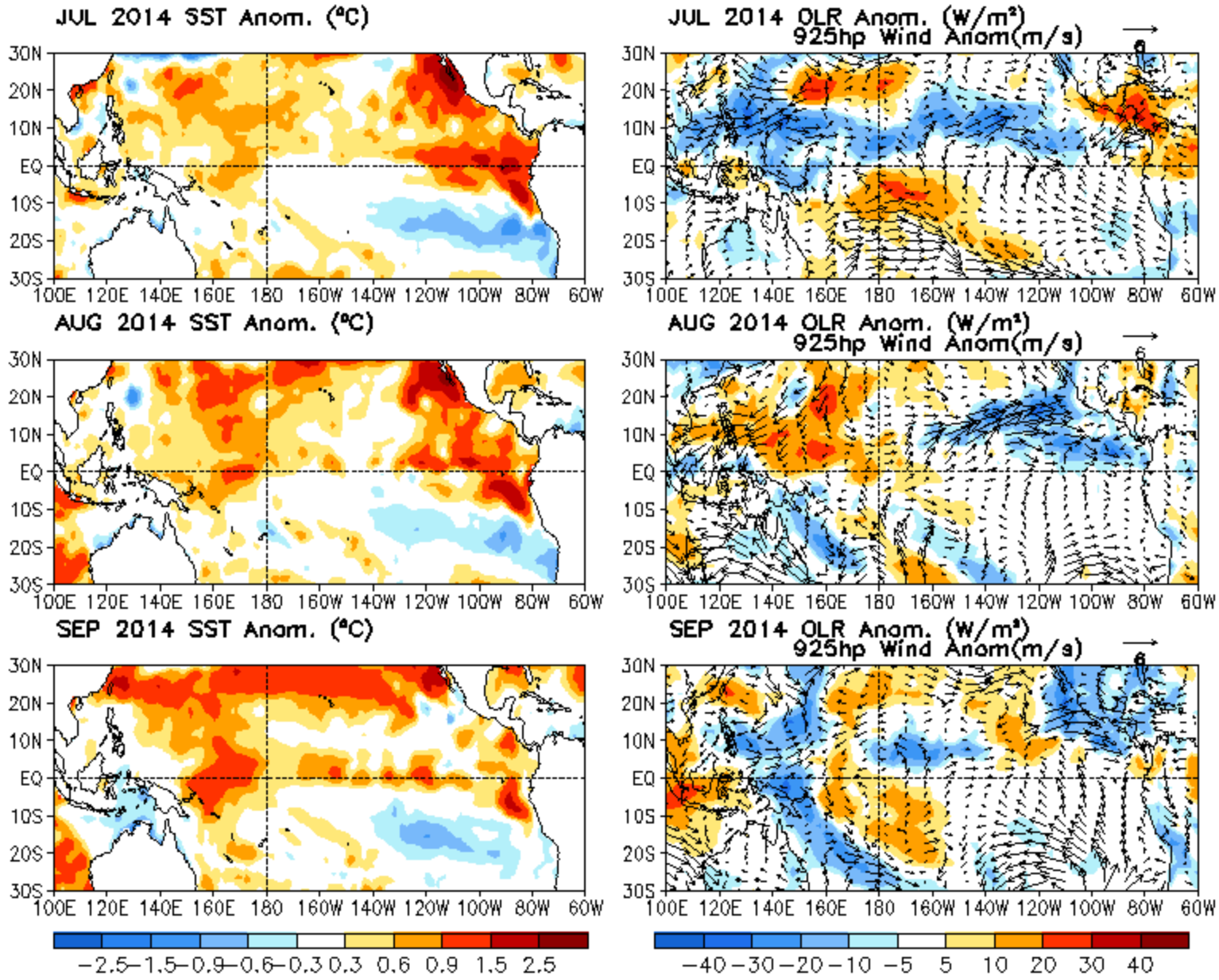
- **Pacific Ocean**
  - **ENSO neutral condition continued with OIv2 NINO3.4=0.5°C in September 2014.**
  - **Subsurface warming occupied the upper Pacific.**
  - **Majority of models predict a weak El Nino starting October-November season.**
  - **Positive PDO index increased in September, with PDO index = 0.74.**
  - **Strong positive SSTA continued in the high latitudes of the North Pacific and Arctic Oceans.**

- **Indian Ocean**
  - **Indian dipole index remained below -0.4 in September.**

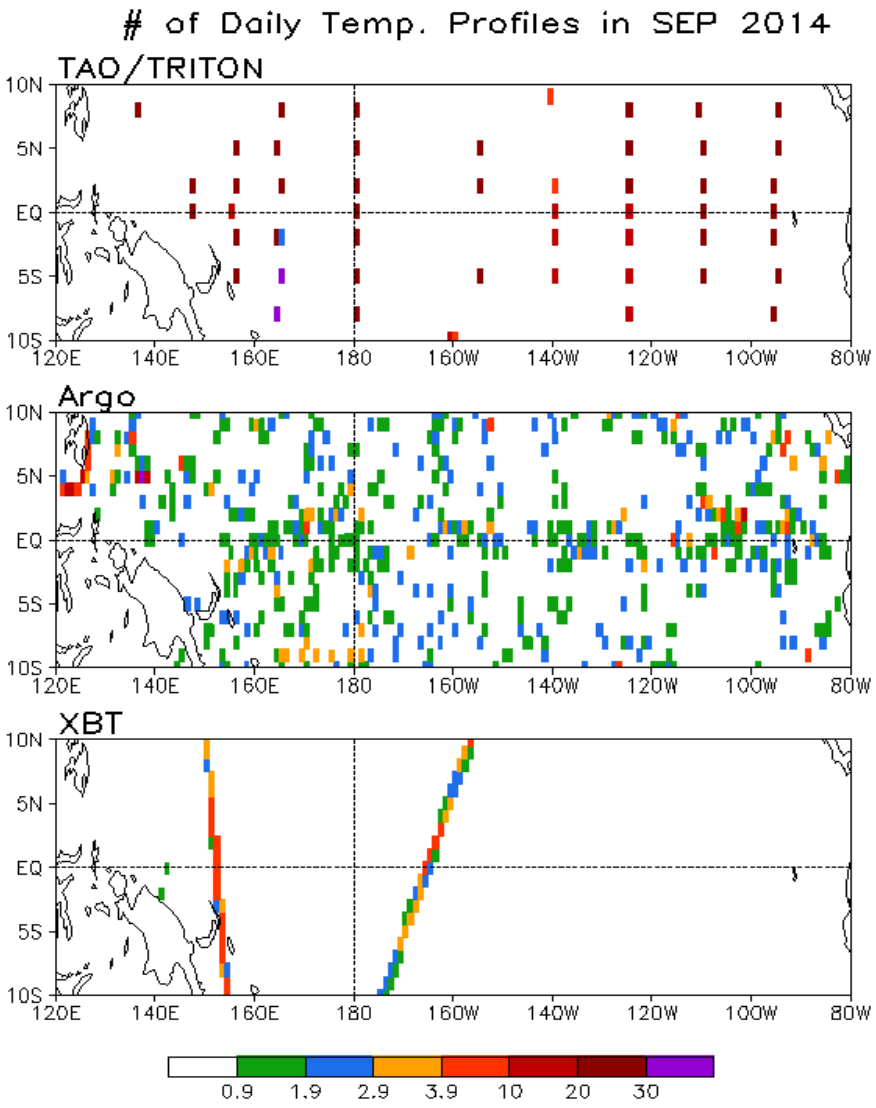
- **Atlantic Ocean**
  - **Near-normal SST continued in the hurricane Main Development Region.**
  - **NAO switched to positive phase, with NAO index = 1.7 in September 2014.**

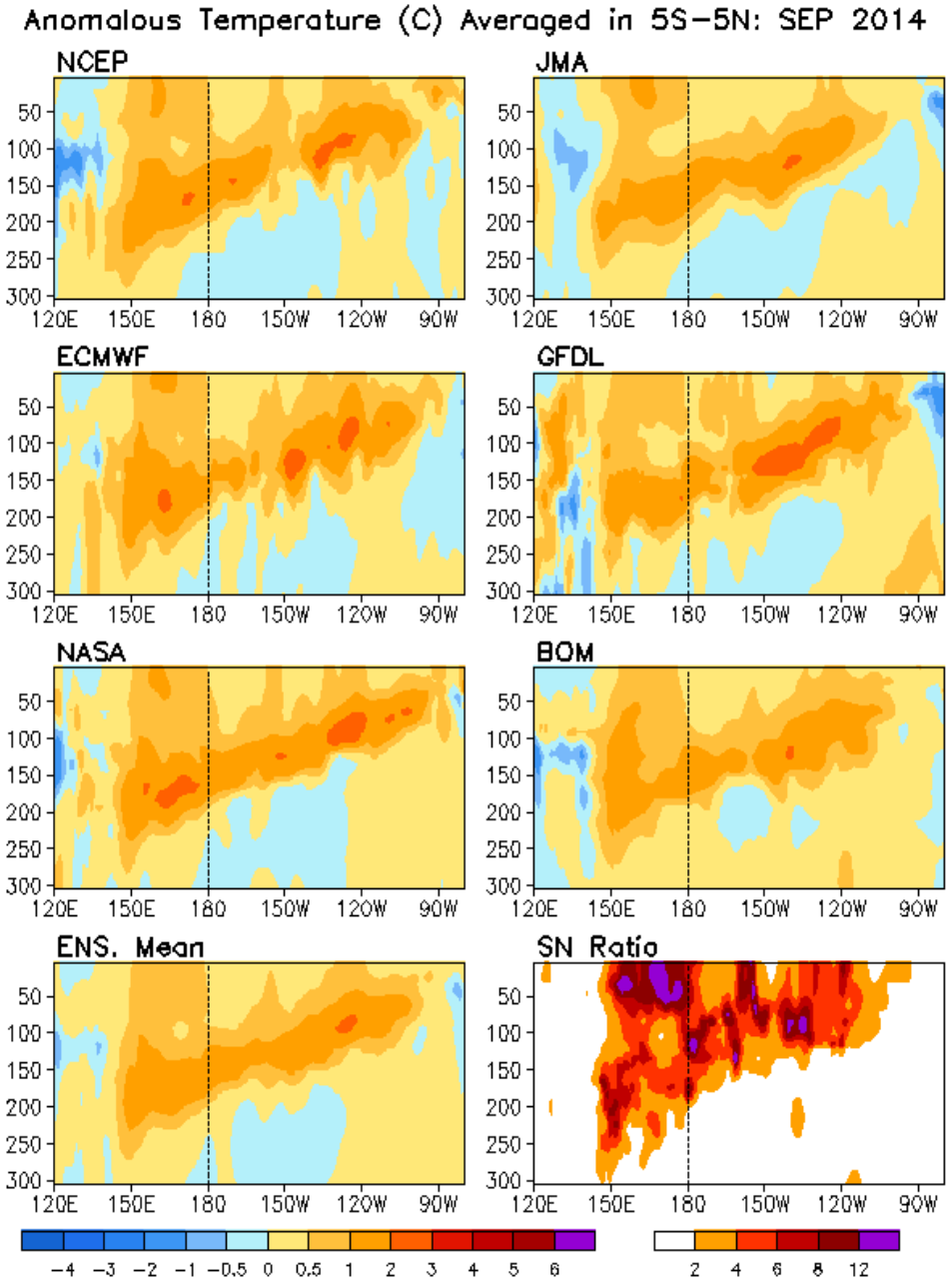
Backup Slides

Last Three Month SST, OLR and 925hp Wind Anom.



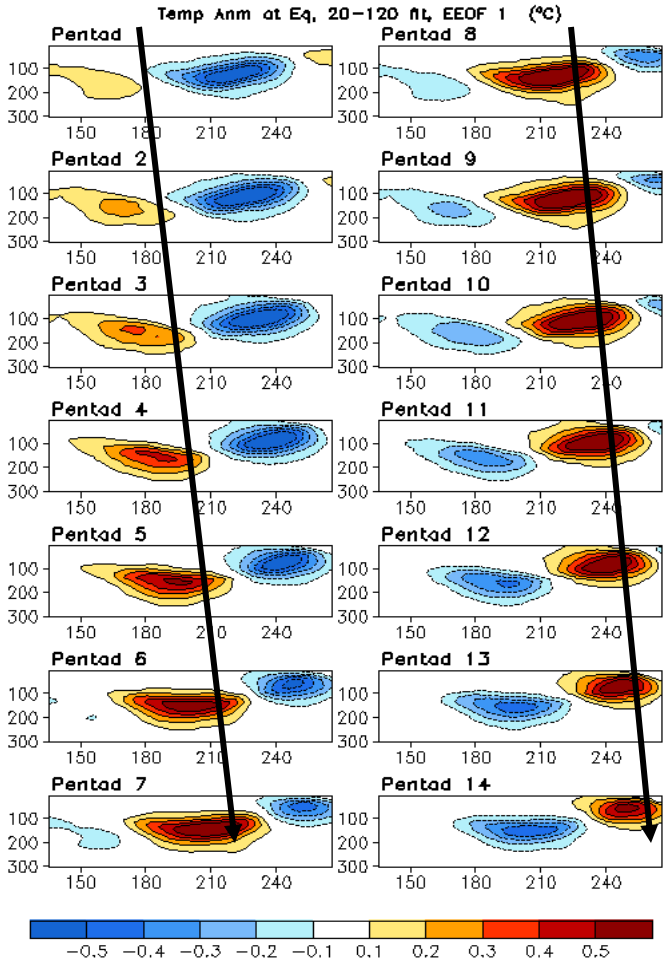
Real-Time Multiple Ocean Reanalysis Intercomparison

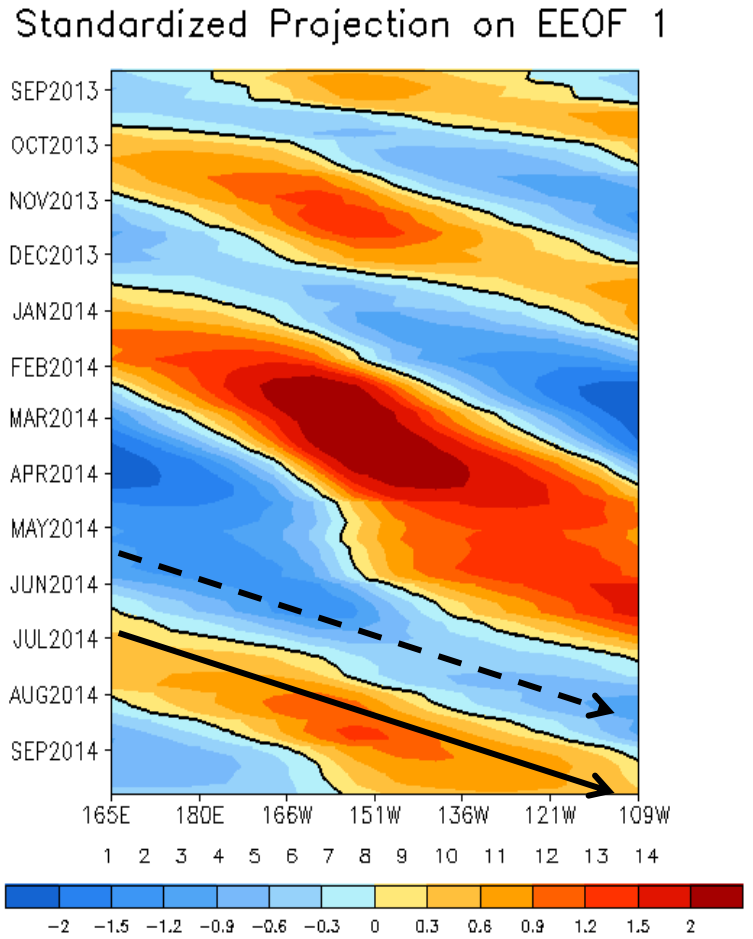




1981-2010 Clim

Oceanic Kelvin Wave (OKW) Index





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.

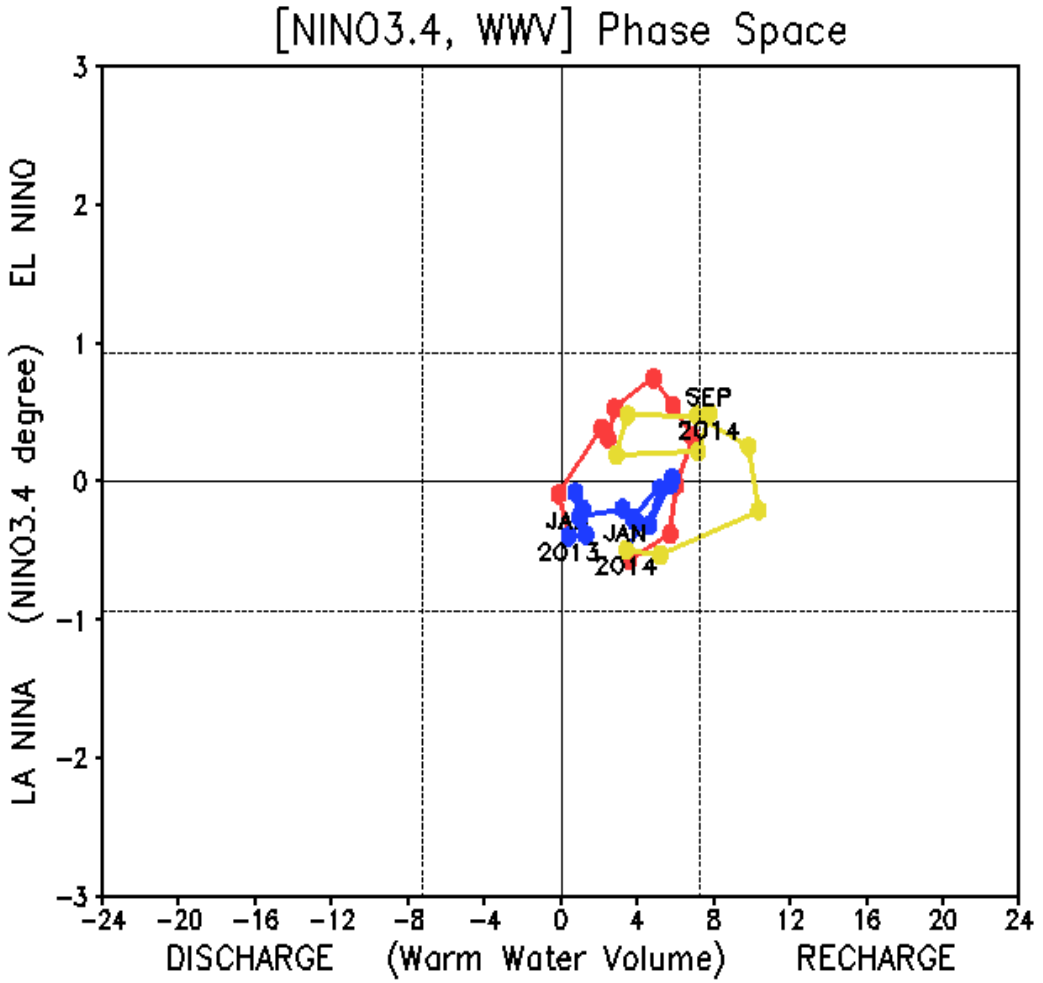
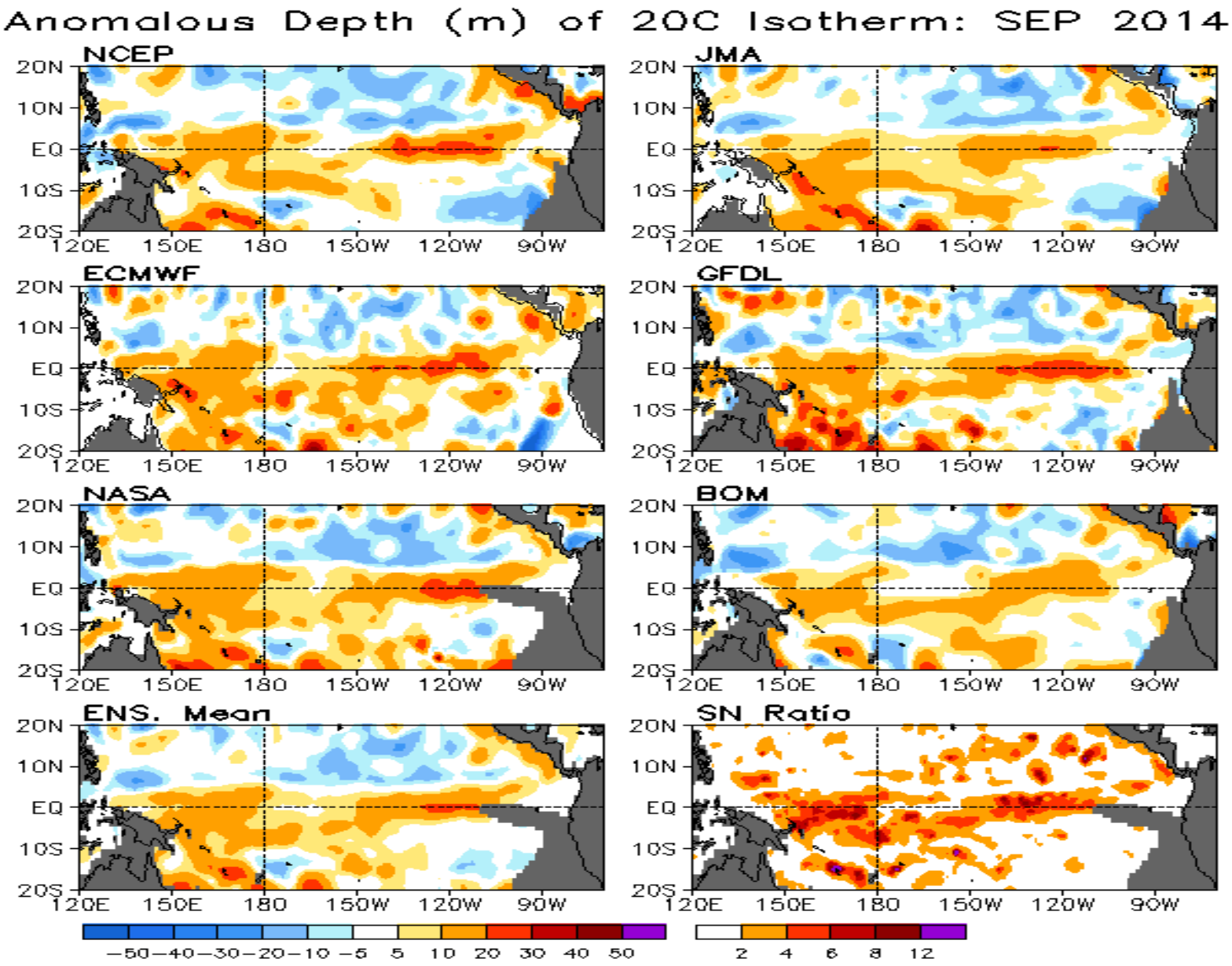


Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20°C in [120°E-80°W, 5°S-5°N] calculated with the NCEP's global ocean data assimilation system. Anomalies are departures from the 1981-2010 base period means.

D20 Anomaly (1981-2010 Clim.)



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

- Positive SSTA dominated across the whole Indian Ocean.
- Little changes in SSTA during the last four weeks.
- Convection was enhanced (suppressed) over the western (eastern) Indian Ocean.

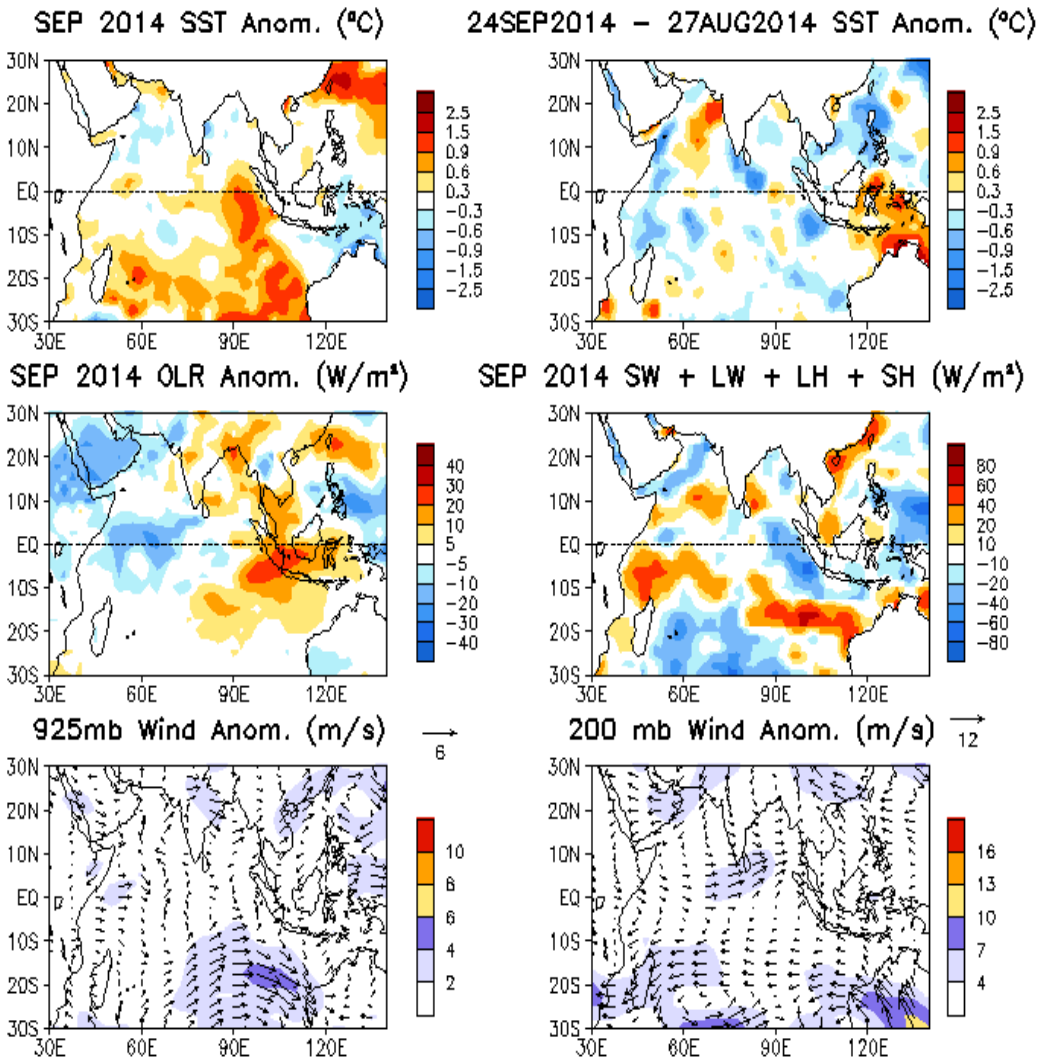


Fig. I2. Sea surface temperature (SST) anoı Radiation (OLR) anomalies (middle-left), su heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from 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 1981-2010 base period means.

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

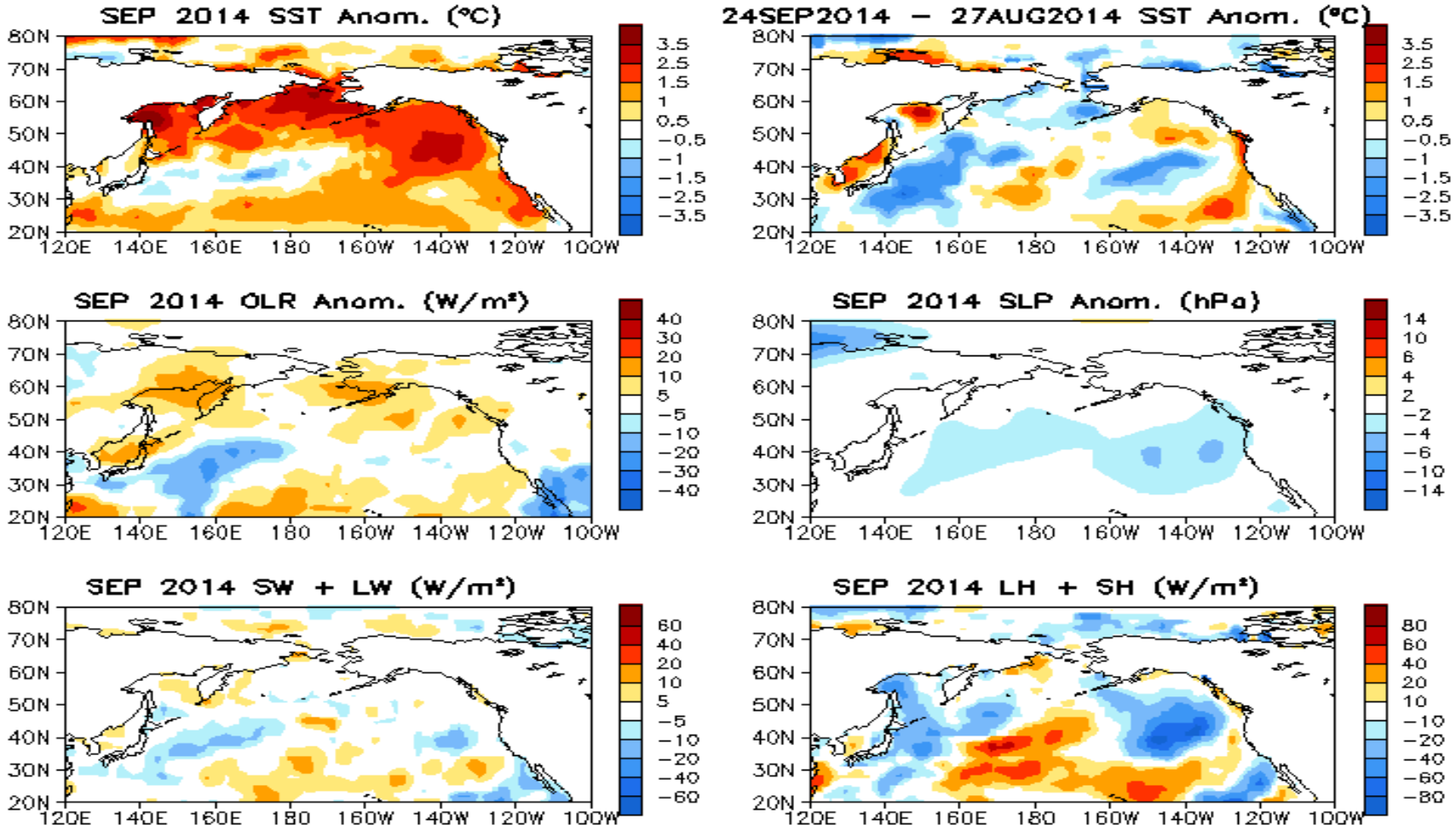
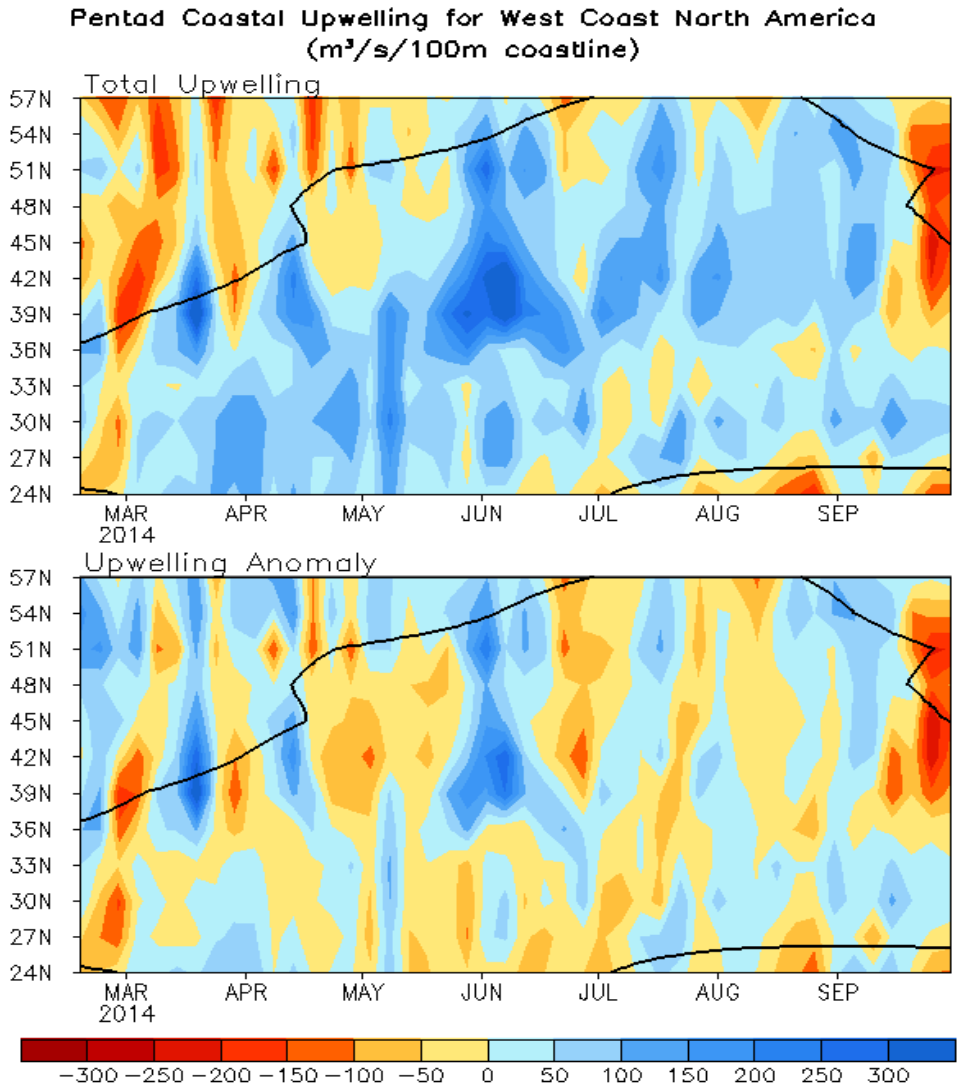
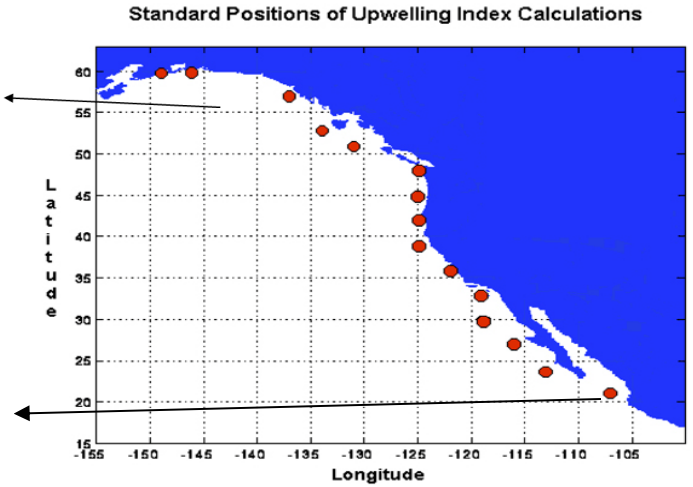


Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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

North America Western Coastal Upwelling





- **Upwelling weakened north of 36N in September.**

2. Total (top) and anomalous (bottom) upwelling at the 15 standard locations for the western coast of America. Upwelling indices are derived from the vertical y of the NCEP's global ocean data assimilation system, e calculated as integrated vertical volume transport at ter depth from each location to its nearest coast point /100m coastline). Anomalies are departures from the 2010 base period pentad means.

- **Area below (above) black line indicates climatological upwelling (downwelling) season.**
- **Climatologically upwelling season progresses from March to July along the west coast of North America from 36ºN to 57ºN.**

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

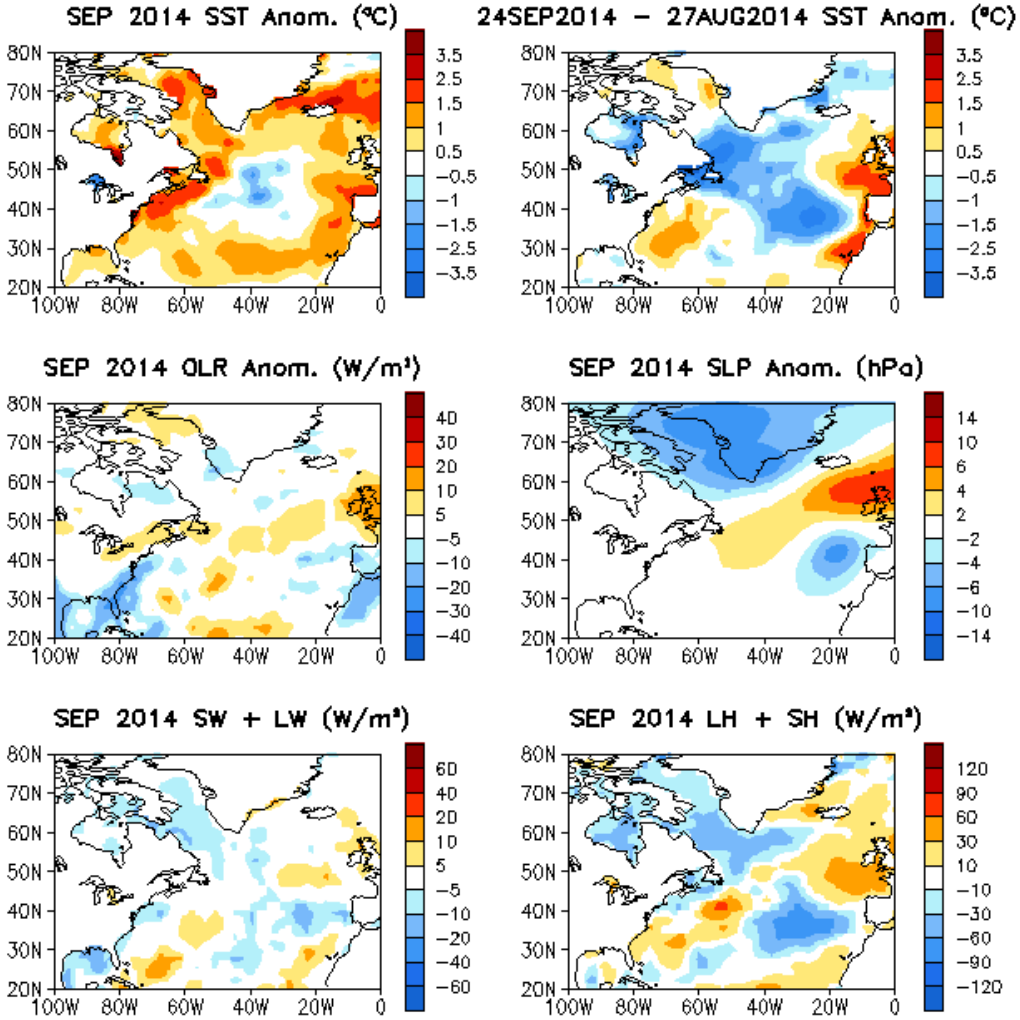
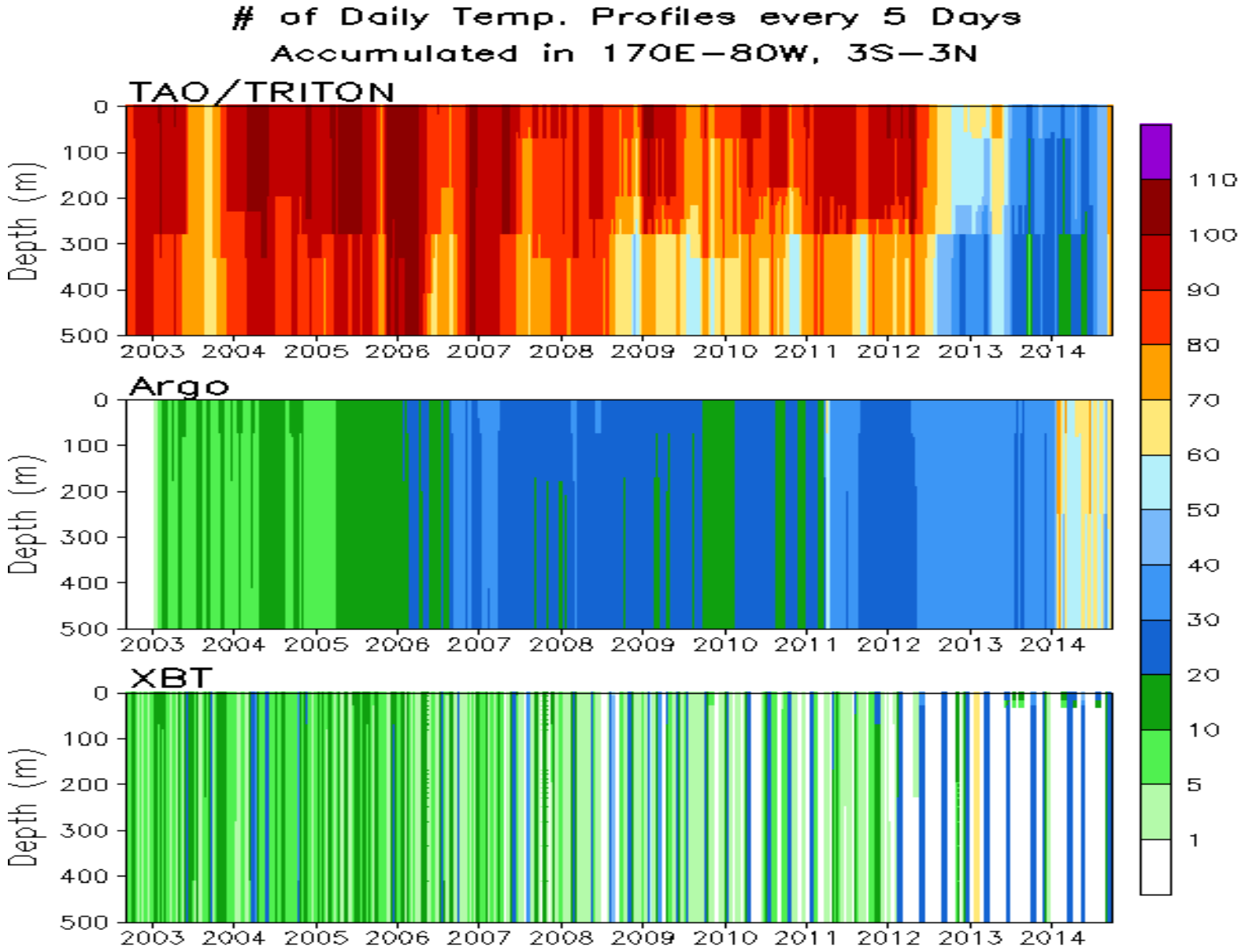
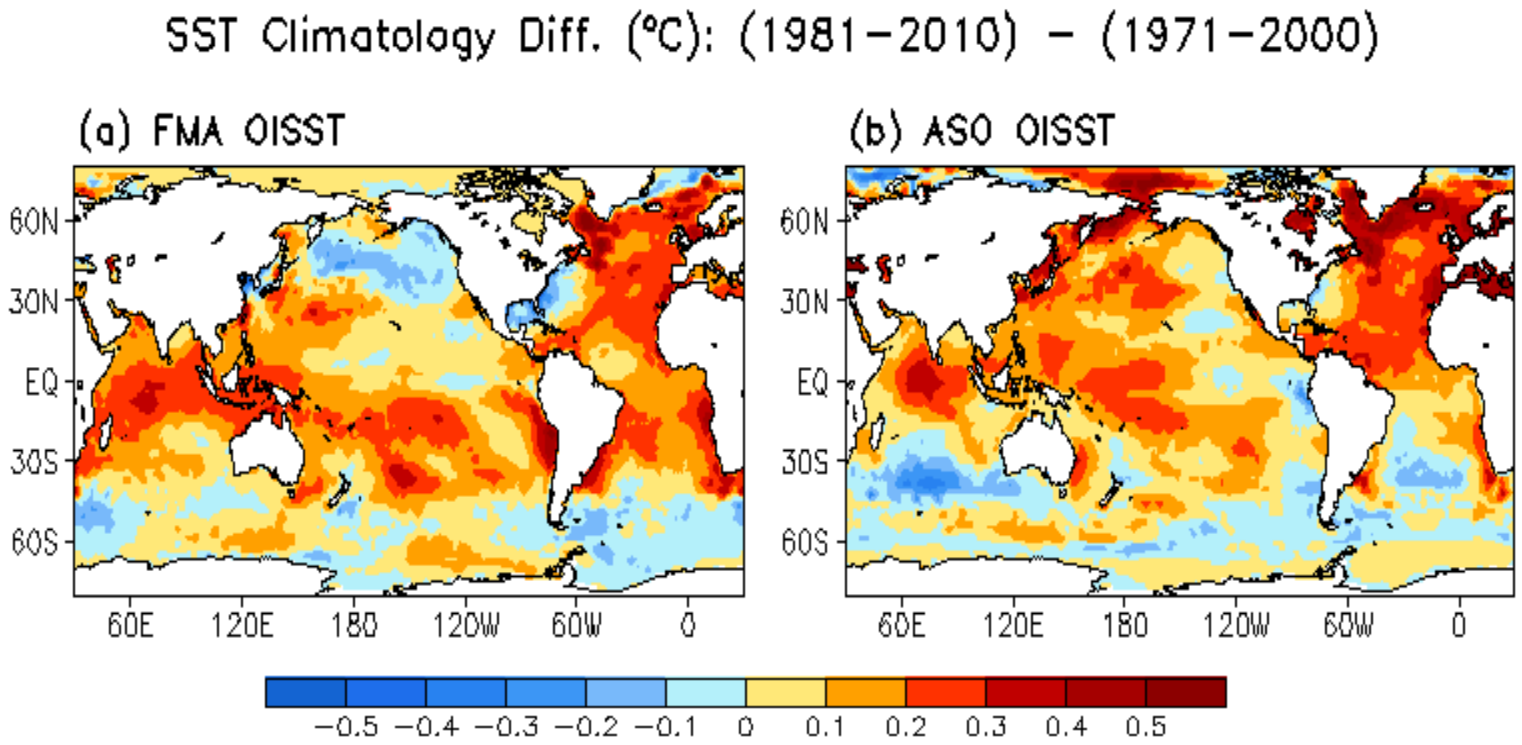


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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


# of Daily Temp. Profiles every 5 Days
Accumulated in 170E–80W, 3S–3N
TAO/TRITON
Argo
XBT
Depth (m)
0
100
200
300
400
500
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
110
100
90
80
70
60
50
40
30
20
10
5
1

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.**

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)**

Data Sources and References

- **Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)**
- **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!

Real Time Multiple Ocean Reanalysis Intercomparison

(with contributions from NCEP, ECMWF, JMA, GFDL, NASA, BOM based on 1981-2010 Climatology)

(Background Information)

Tropical Pacific Ocean

- **Climate Indices**
  - Depth of 20C isotherm anomaly in NINO3: last 4 years last 15 years 1979-present
  - Depth of 20C isotherm anomaly in NINO4: last 4 years last 15 years 1979-present
  - Upper 300m heat content anomaly in NINO3: last 4 years last 15 years 1979-present
  - Upper 300m heat content anomaly in NINO4: last 4 years last 15 years 1979-present
  - Warm Water Volume: last 4 years last 15 years 1979-present
  - Warm Water Volume average in last two months ending in:
    Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

- **Spatial Maps**
  - Equatorial temperature anomaly: last month month before last month 1979-present
  - Depth of 20C isotherm anomaly: last month month before last month 1979-present
  - Upper 300m heat content anomaly: last month month before last month 1979-present

Global Ocean

- **Spatial Maps**
  - Equatorial temperature anomaly: last month month before last month 1979-present
  - Depth of 20C isotherm anomaly: last month month before last month 1979-present
  - Upper 300m heat content anomaly: last month month before last month 1979-present

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