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**
  - **Pacific/Arctic Ocean**

  (Multiple Ocean Reanalysis Products)
  - **Indian Ocean**
  - **Atlantic Ocean**
  - **Global SST Predictions**

  (Is El Nino Coming?)

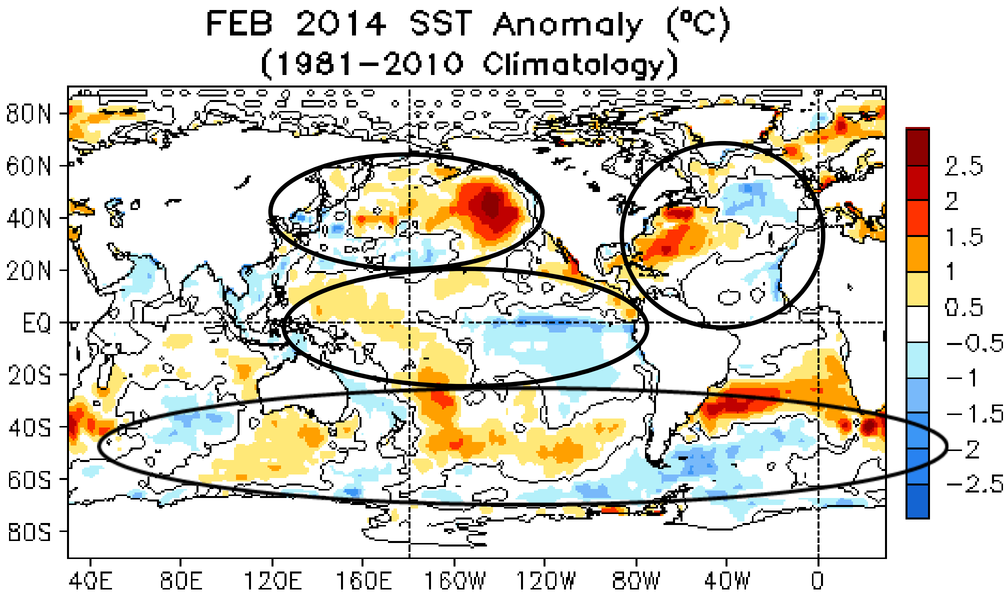
  (Challenge of ENSO Prediction)

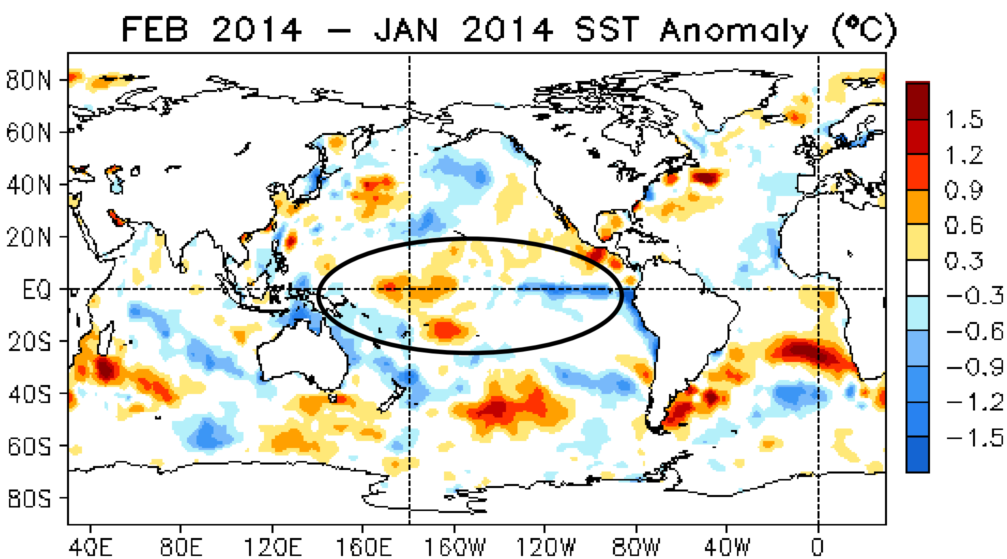
Overview

- **Pacific Ocean**
  - **ENSO neutral condition continued with NINO3.4=-0.6^{o}C in Feb 2014.**
  - **Positive anomalies of subsurface ocean temperature along the equator propagated eastward and westerly wind burst-like surface wind anomaly were observed in Feb 2014.**
  - **All models predicted a warming tendency in this year, some of the dynamical modes predicted an El Nino since this summer.**
  - **NOAA "ENSO Diagnostic Discussion" on 06 March 2014 issued "El Nino Watch" and suggested that "ENSO-neutral is expected to continue through the Northern Hemisphere spring 2014, with about a 50% chance of El Niño developing during the summer or fall".**
  - **Negative PDO persisted, with PDOI=-0.96 in Feb 2014.**
- **Indian Ocean**
  - **Small anomalies.**
- **Atlantic Ocean**
  - **NAO switched into positive phase with NAOI=1.07 in Feb 2014.**

Global Oceans

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



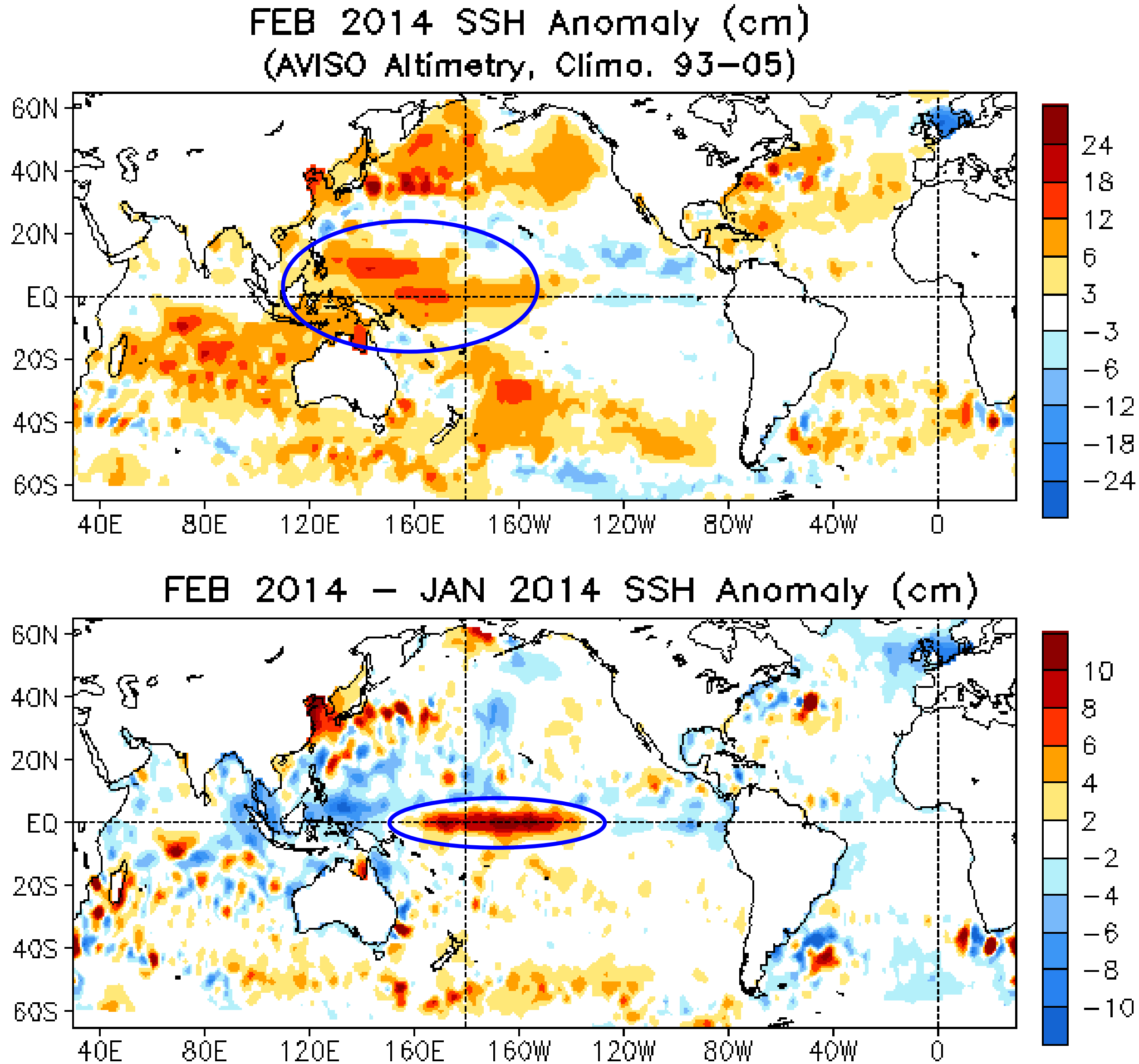


- **Positive (negative) SSTA persisted in the western (eastern) tropical Pacific.**
- **Strong positive SSTA presented in the northeastern Pacific and was associated with negative phase of PDO.**
- **Tripolar SST anomalies presented in the North Atlantic.**
- **Some large SSTAs existed in the South Ocean.**

- **Positive (negative) SST tendencies were observed in the central (eastern) equatorial Pacific 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 Anomaly (cm) and Anomaly Tendency

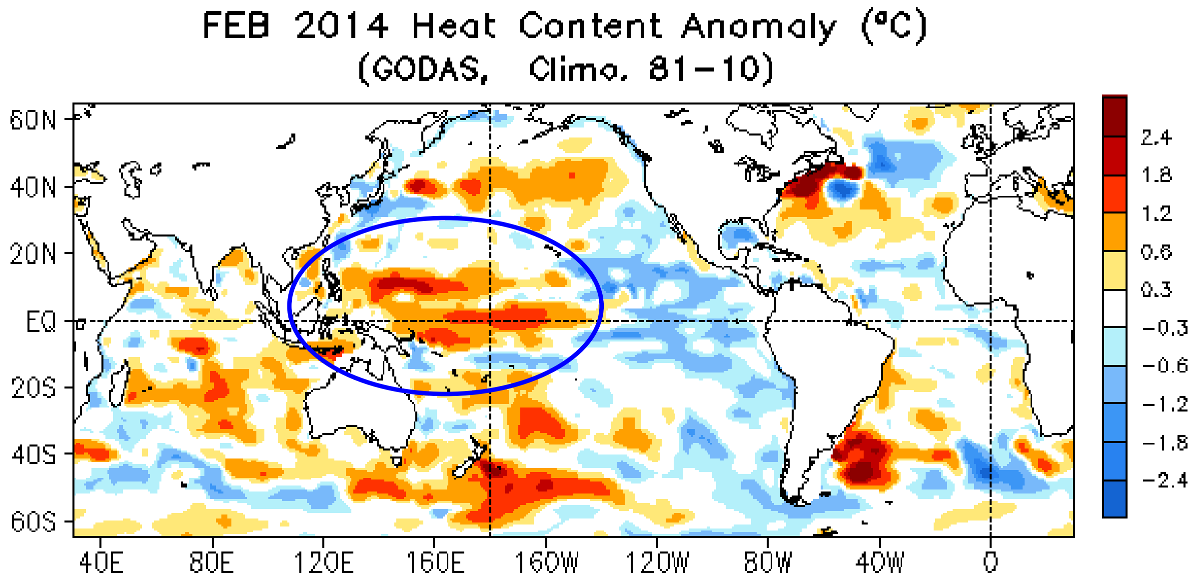


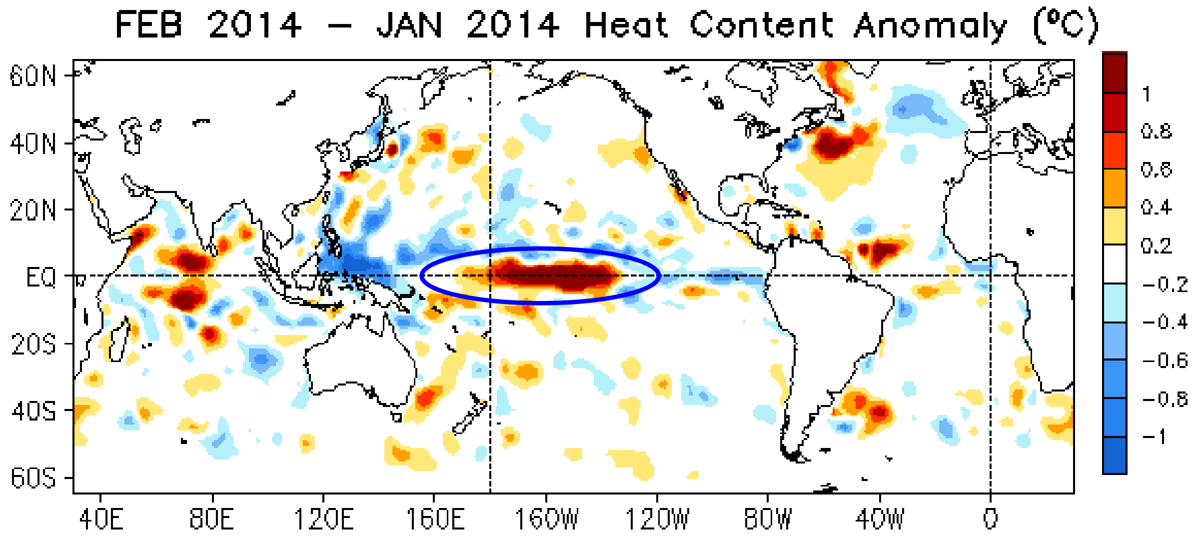
- **The SSH anomalies were overall consistent with SSTA:**

Positive (negative) SSTA is tied up with positive (negative) SSH anomaly.

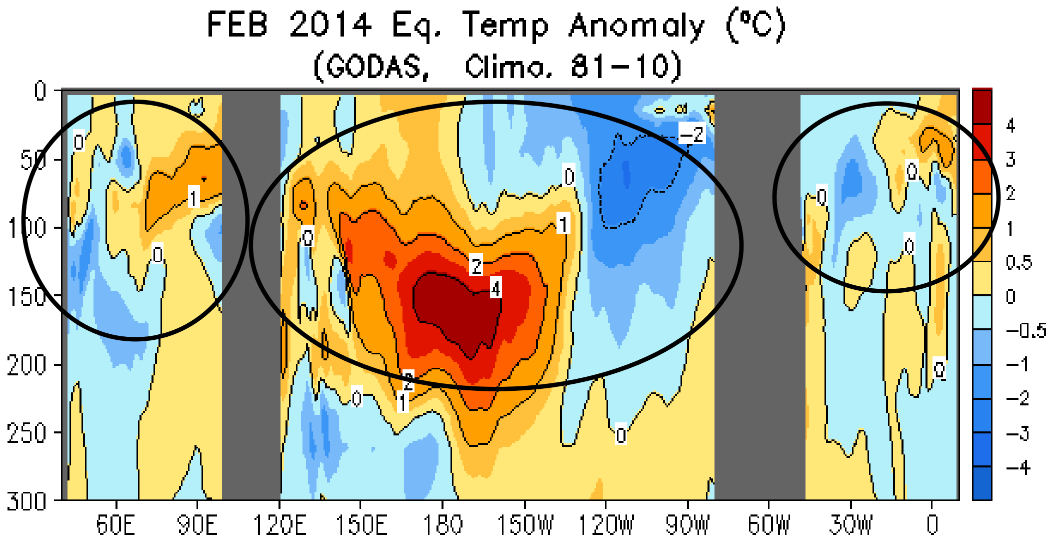
Positive SSH anomalies in the western tropical Pacific and strong positive tendency in the central equatorial Pacific may indicate the potential development of El Nino.

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



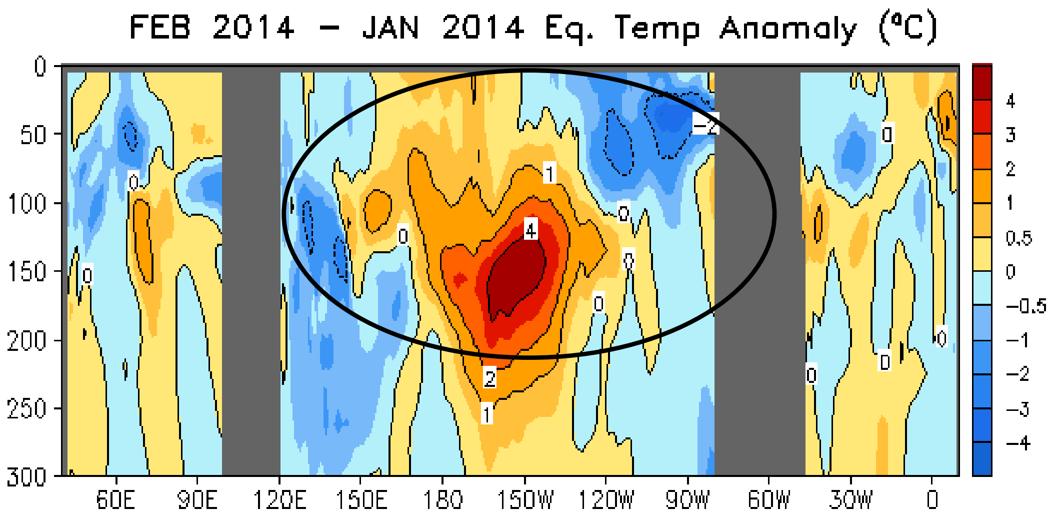


Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2^{O}S-2^{O}N



- Strong positive (weak negative) ocean temperature anomalies in the western (eastern) equatorial Pacific may suggest the potential development of a warm event in this year.

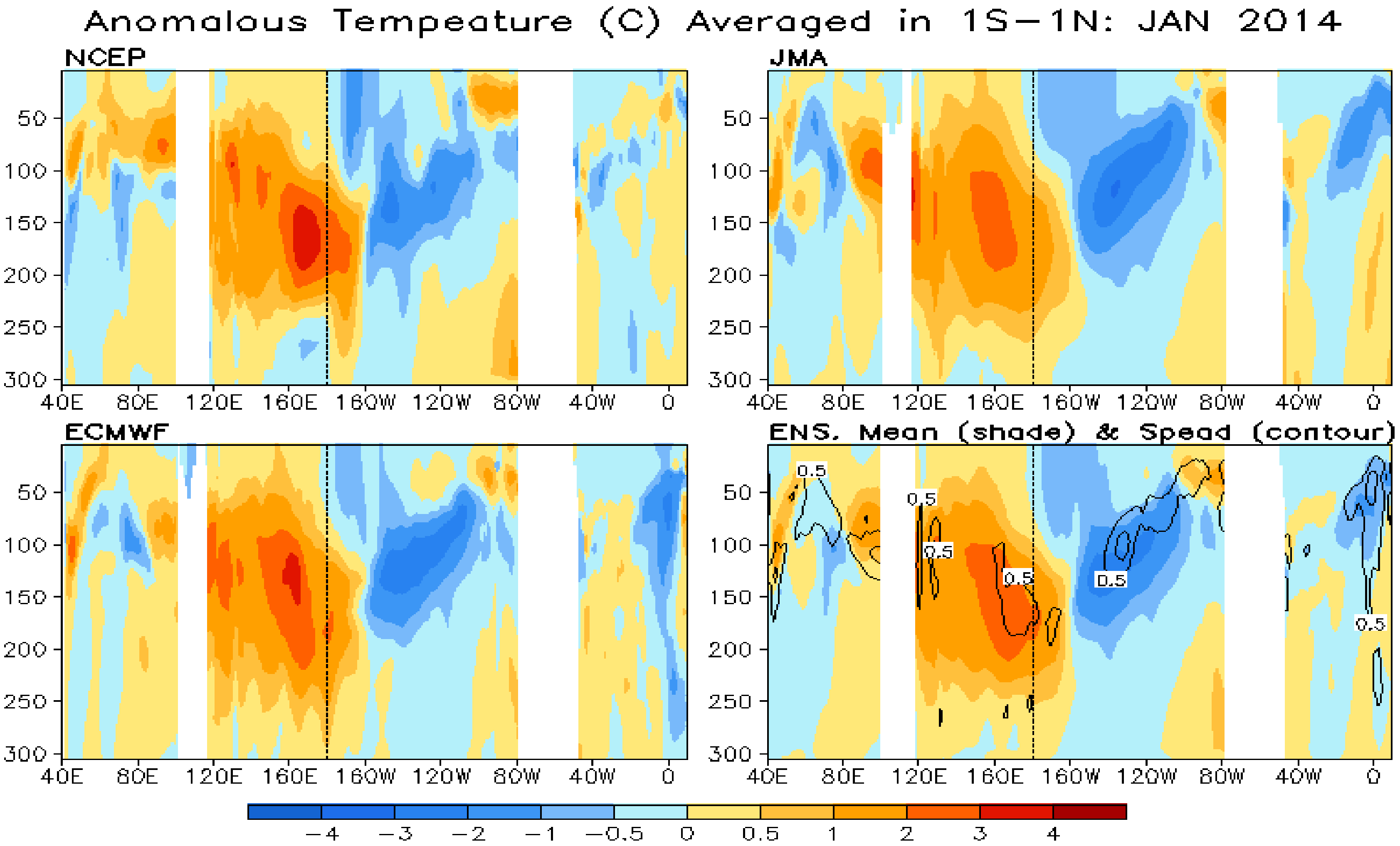
- Both positive and negative ocean temperature anomalies were small in the Indian and Atlantic Oceans.



- Ocean temperature tendencies were positive in the central-eastern Pacific and negative in the both sides, suggesting an eastward propagation of the positive ocean temperature anomalies along the equatorial Pacific.

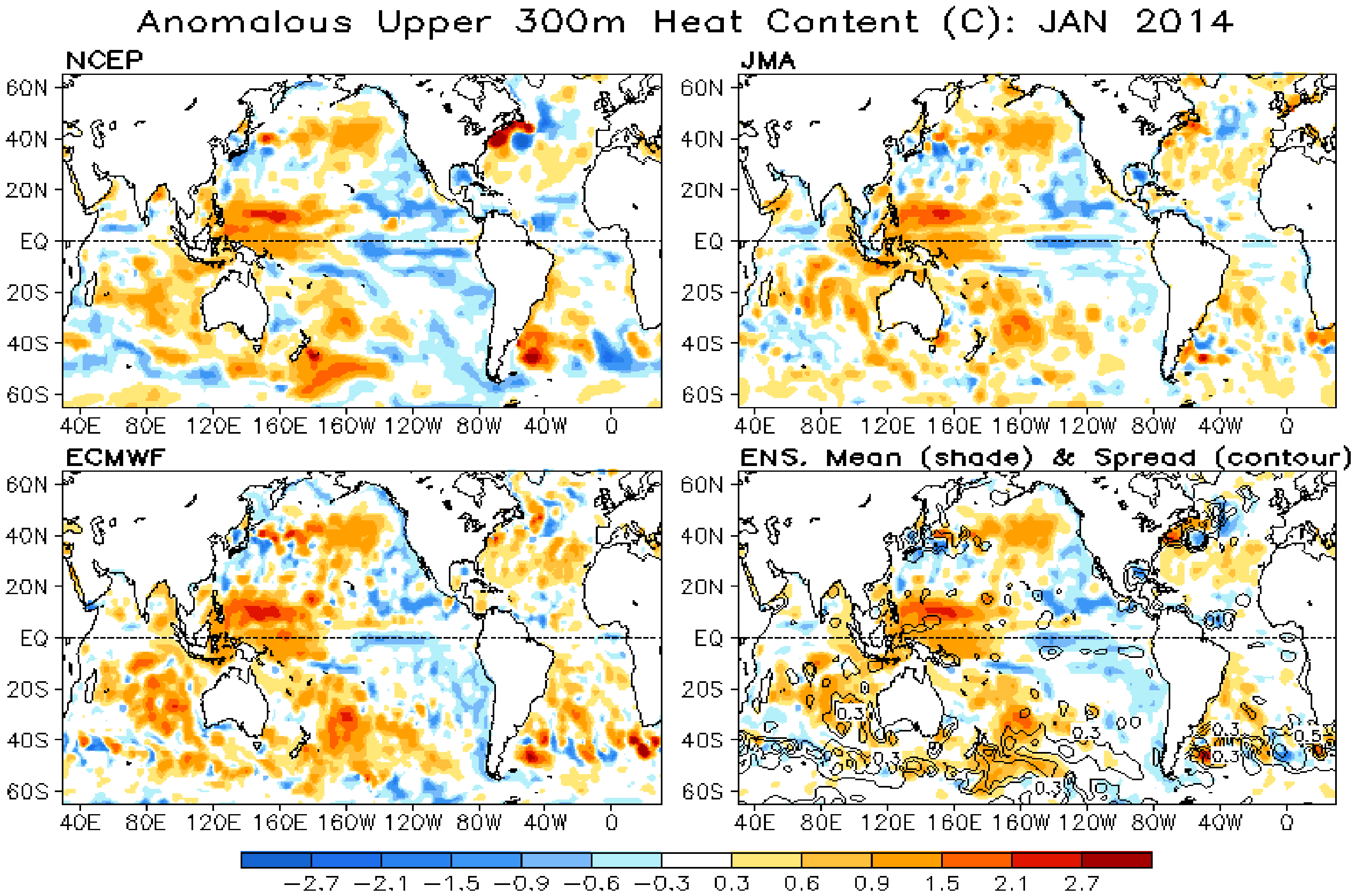
Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1981-2010 base period means.

Multiple Ocean Reanalyses: OTA along the Equator (Jan 2014)



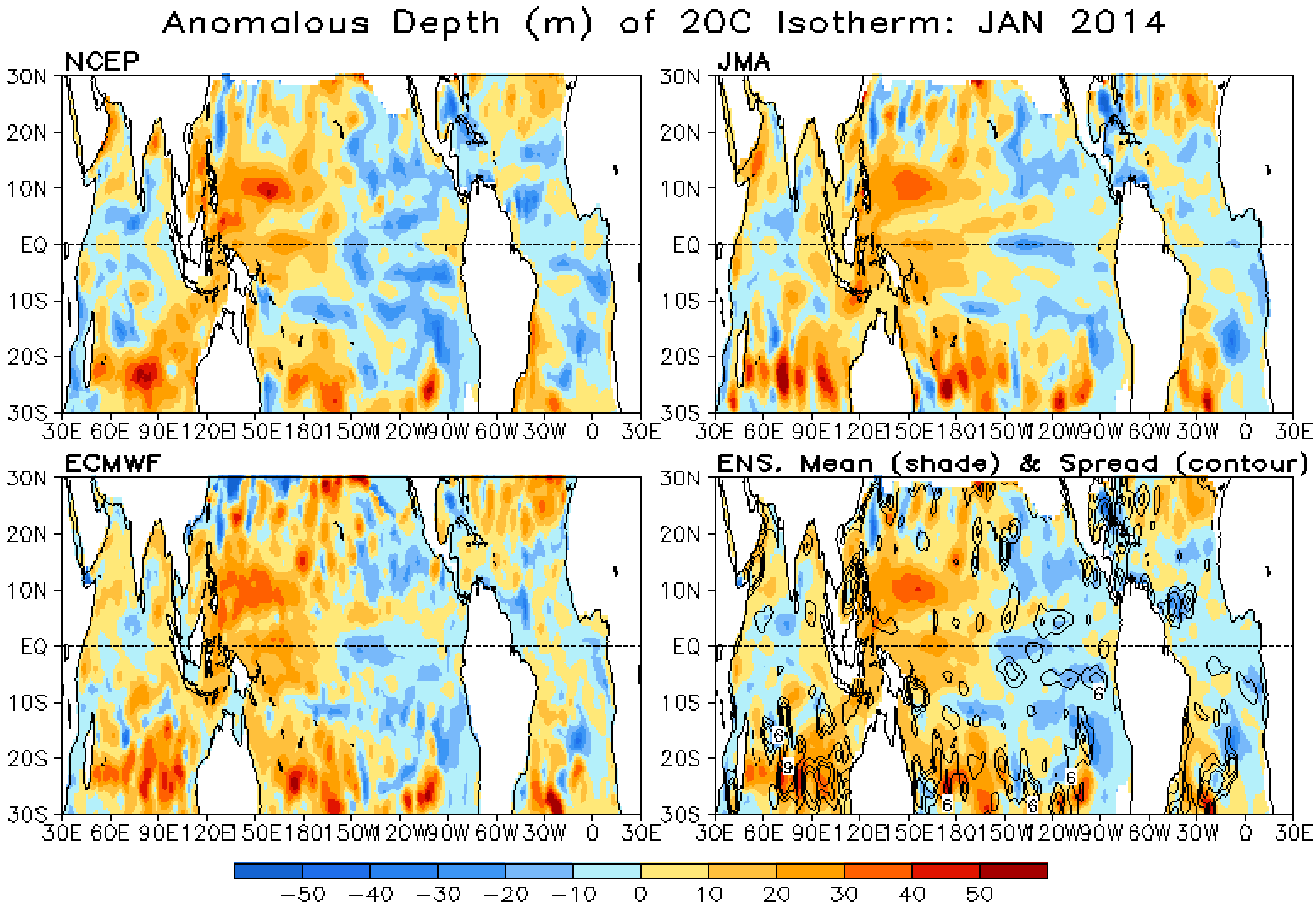
- **Three operational ocean reanalyses from NCEP, ECMWF, JMA showed similar pattern and comparable amplitude of ocean temperature anomalies along the equator, suggesting the reliability of these reanalyses.**
(http://origin.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html)

Multiple Ocean Reanalyses: HC300 (Jan 2014)



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

Multiple Ocean Reanalyses: D20 (Jan 2014)



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

More Products are coming from

Real Time Ocean Reanalysis Intercomparison

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

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

Tropical Pacific Ocean

Climate Indices

- **D20 anomaly in NINO3 & NINO4: last 4 years last 15 years 1979-present**
- **Warm Water Volume: last 4 years last 15 years 1979-present**
- **H300 anomaly in NINO3 & NINO4: last 4 years last 15 years 1979-present**

Spatial Maps

- **Equatorial temperature anomaly: last month month before last month 1979-present**
- **D20 anomaly: last month month before last month 1979-present**
- **Upper 300m heat content anomaly: last month month before last month 1979-present**

Global Ocean

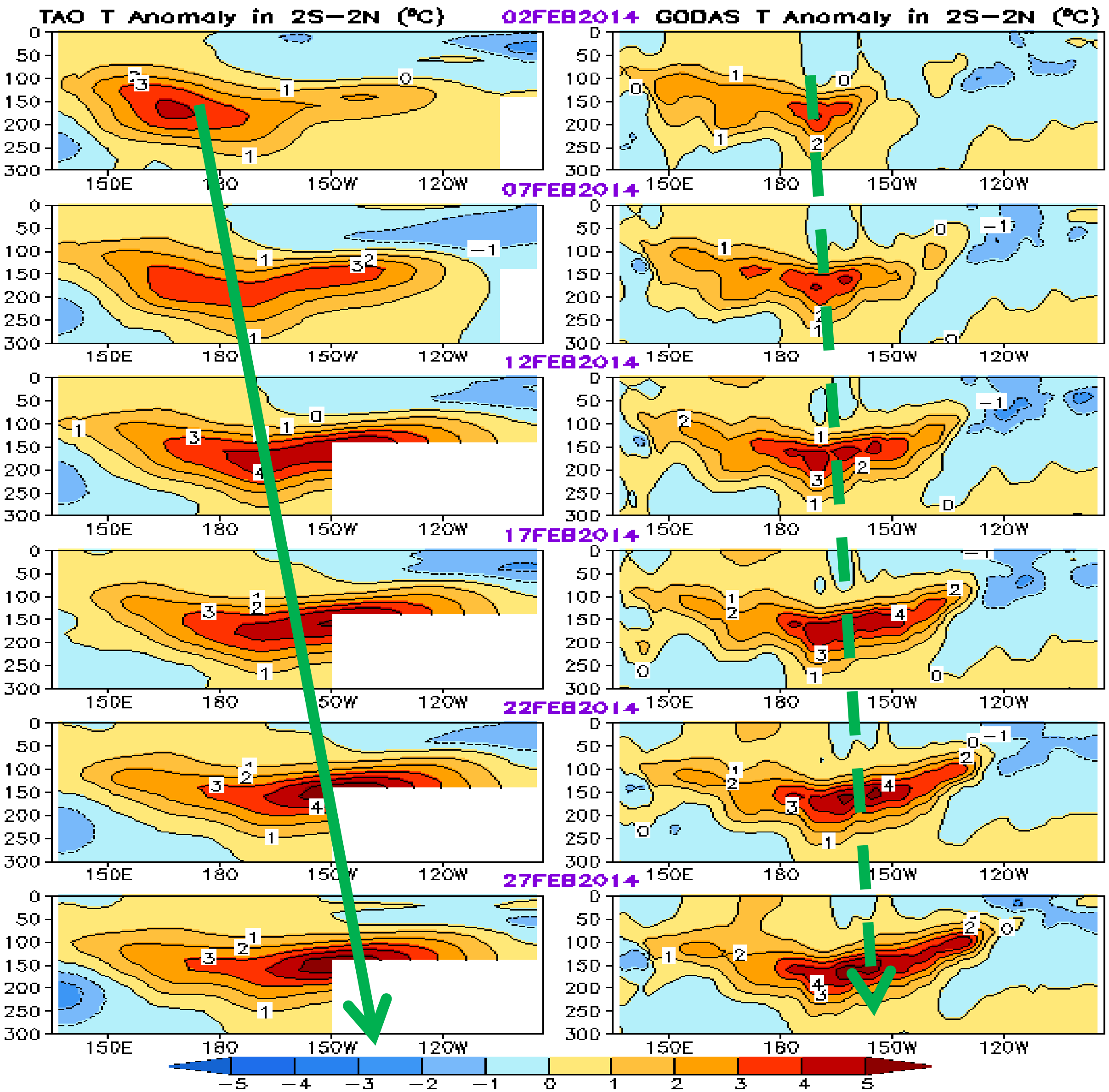
Spatial Maps

- **Equatorial temperature anomaly: last month month before last month 1979-present**
- **D20 anomaly: last month month before last month 1979-present**
- **H300 anomaly: last month month before last month 1979-present**

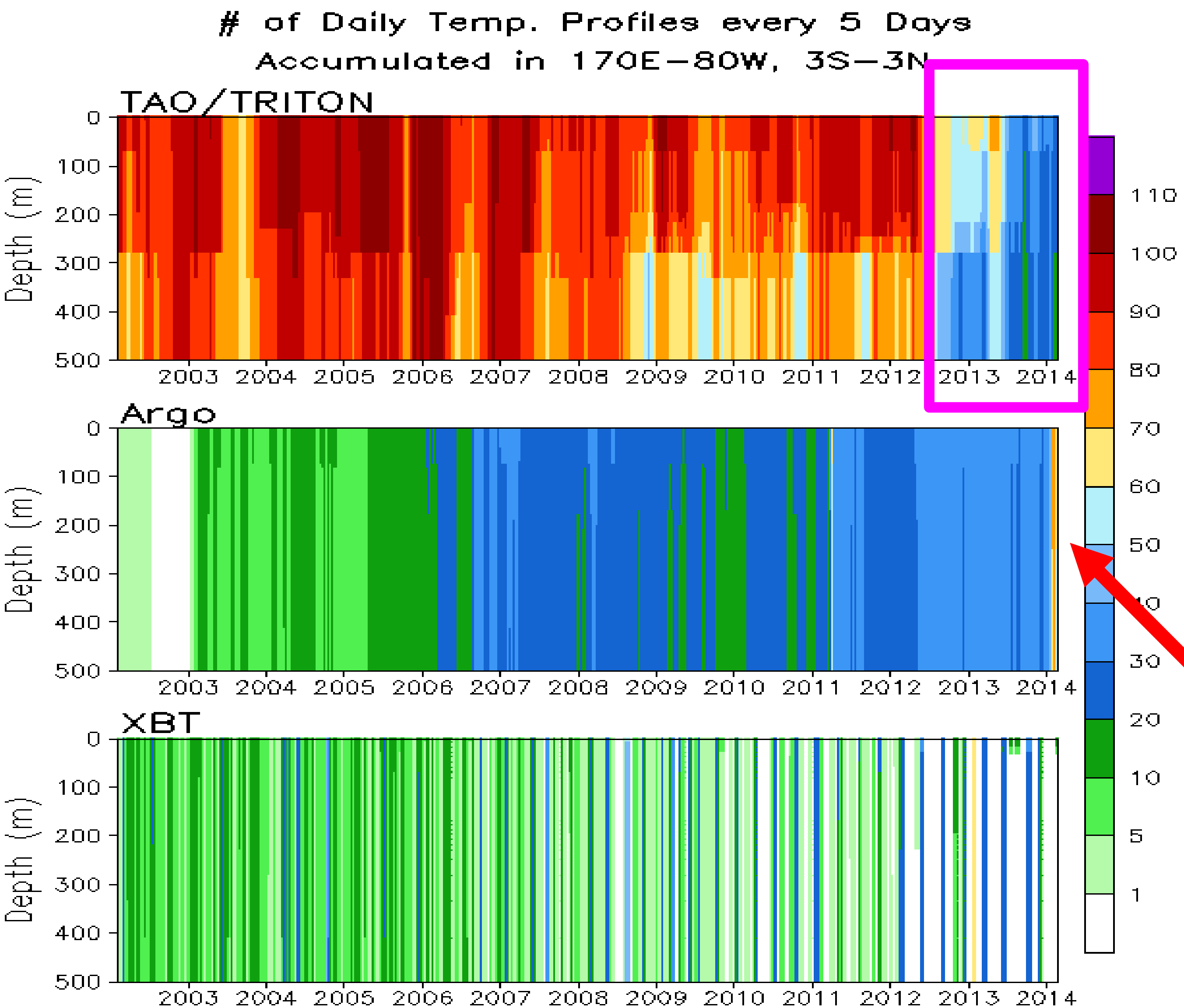
Tropical Pacific Ocean and ENSO Conditions

Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

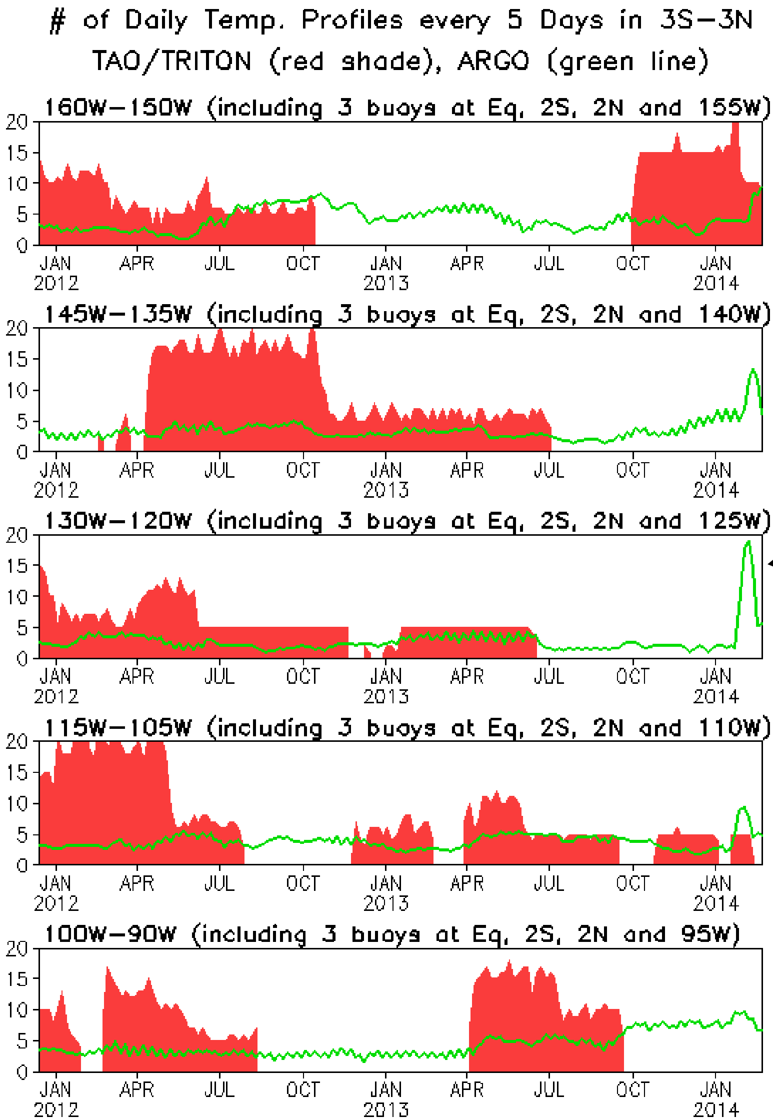
TAO GODAS

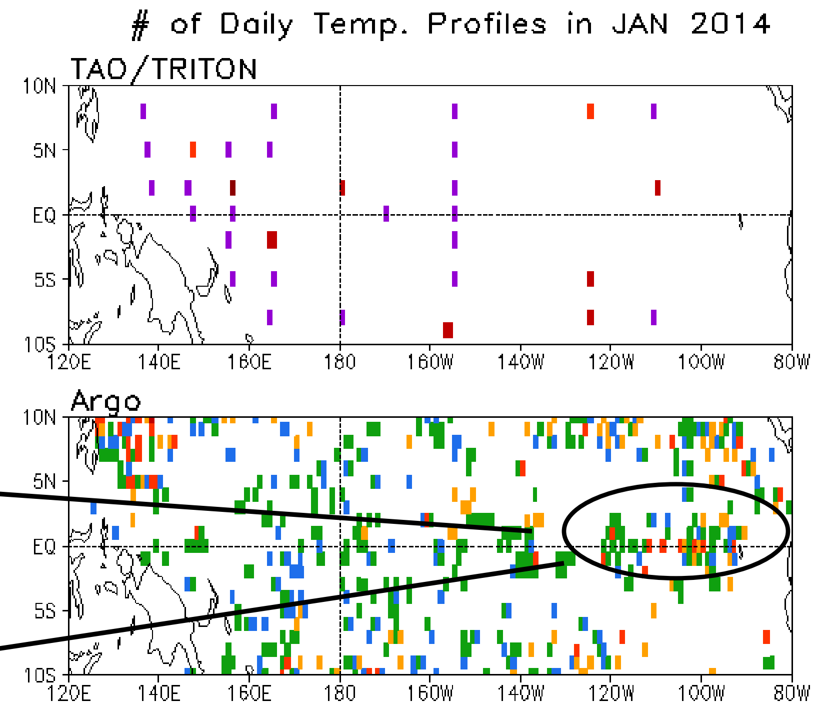


- **Strong positive ocean temperature anomalies propagated eastward.**
- **Compared with TAO, the propagation in GODAS seemed slower.**
- **Some TAO data missing may be a factor causing the differences between TAO and GODAS.**



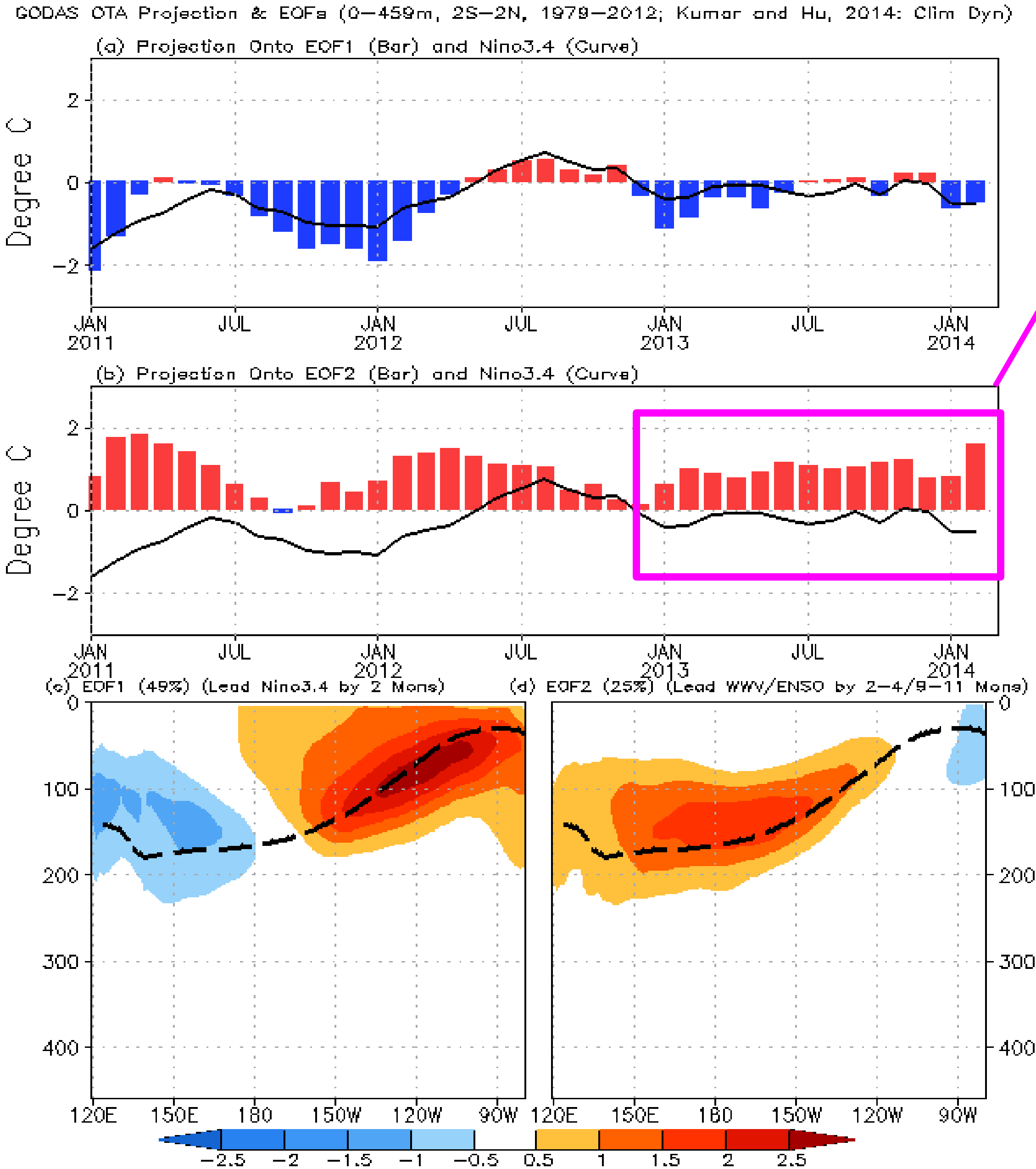
- **TAO data delivery rate decreased significantly since late 2012, and became worse since late 2013.**
- **There was a sharp increase of Argo data since late Jan 2014.**





- The sharp increase of Argo data since late Jan 2014 was due to deployment of iridium Argo floats in the eastern Pacific (courtesy of Dean Roemmich

http://sio-argo.ucsd.edu/historical.html)



Equatorial subsurface ocean temperature monitoring: Right now, it was in recharge phase; Overall recharge/discharge were weak in last 2 years.

Projection of OTA onto EOF1 and EOF2 (2S-2N, 0-459m, 1979-2010)

EOF1: Tilt mode (ENSO peak phase);

EOF2: WWV mode, Recharge/discharge oscillation (ENSO transition phase).

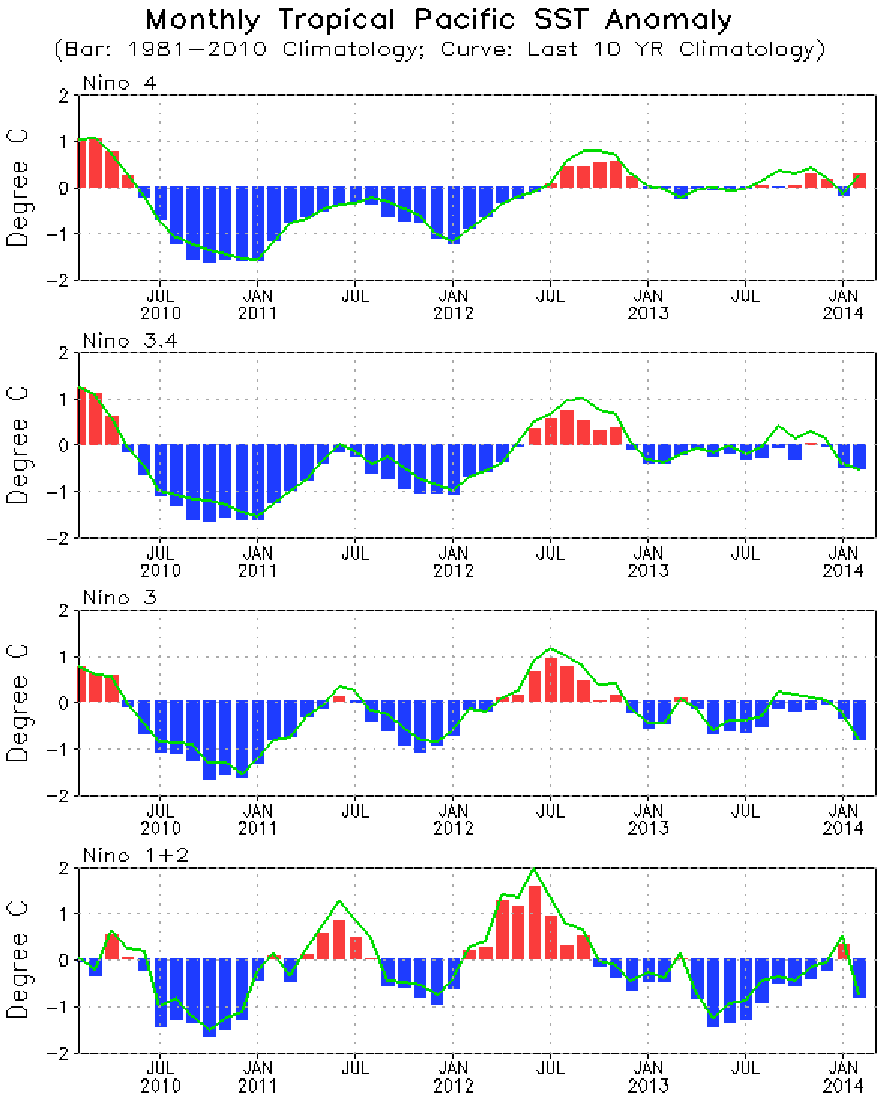
Recharge process: heat transport from outside of equator to equator : Negative -> positive phase of ENSO

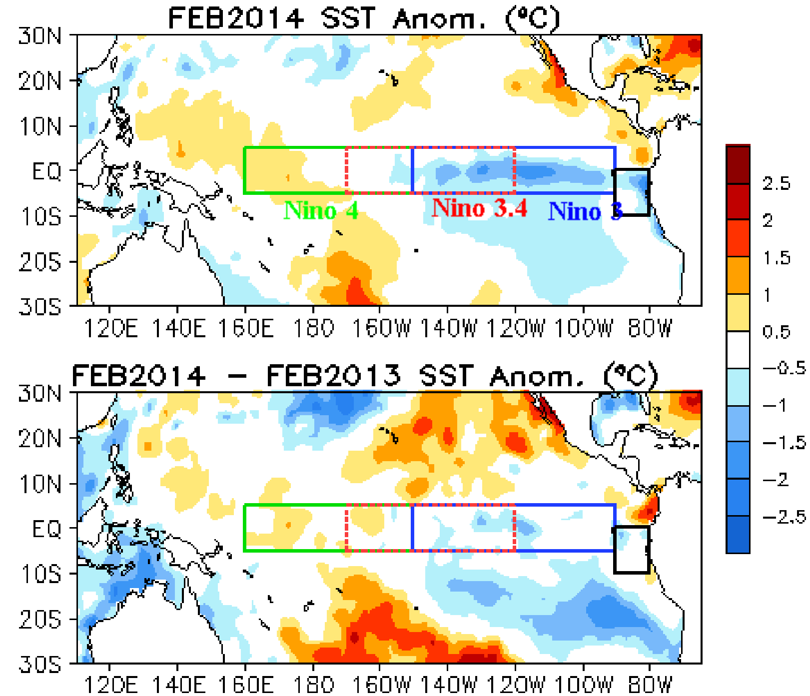
Discharge process: heat transport from equator to outside of equator: Positive -> Negative phase of ENSO

For details, see:

Kumar A, Z-Z Hu (2014) Interannual and interdecadal variability of ocean temperature along the equatorial Pacific in conjunction with ENSO. Clim. Dyn., 42 (5-6)**, 1243-1258.** *DOI: 10.1007/s00382-013-1721-0*.

Evolution of Pacific NINO SST Indices





- All NINO indices, except Nino4, were negative and strengthened in Feb 2014.

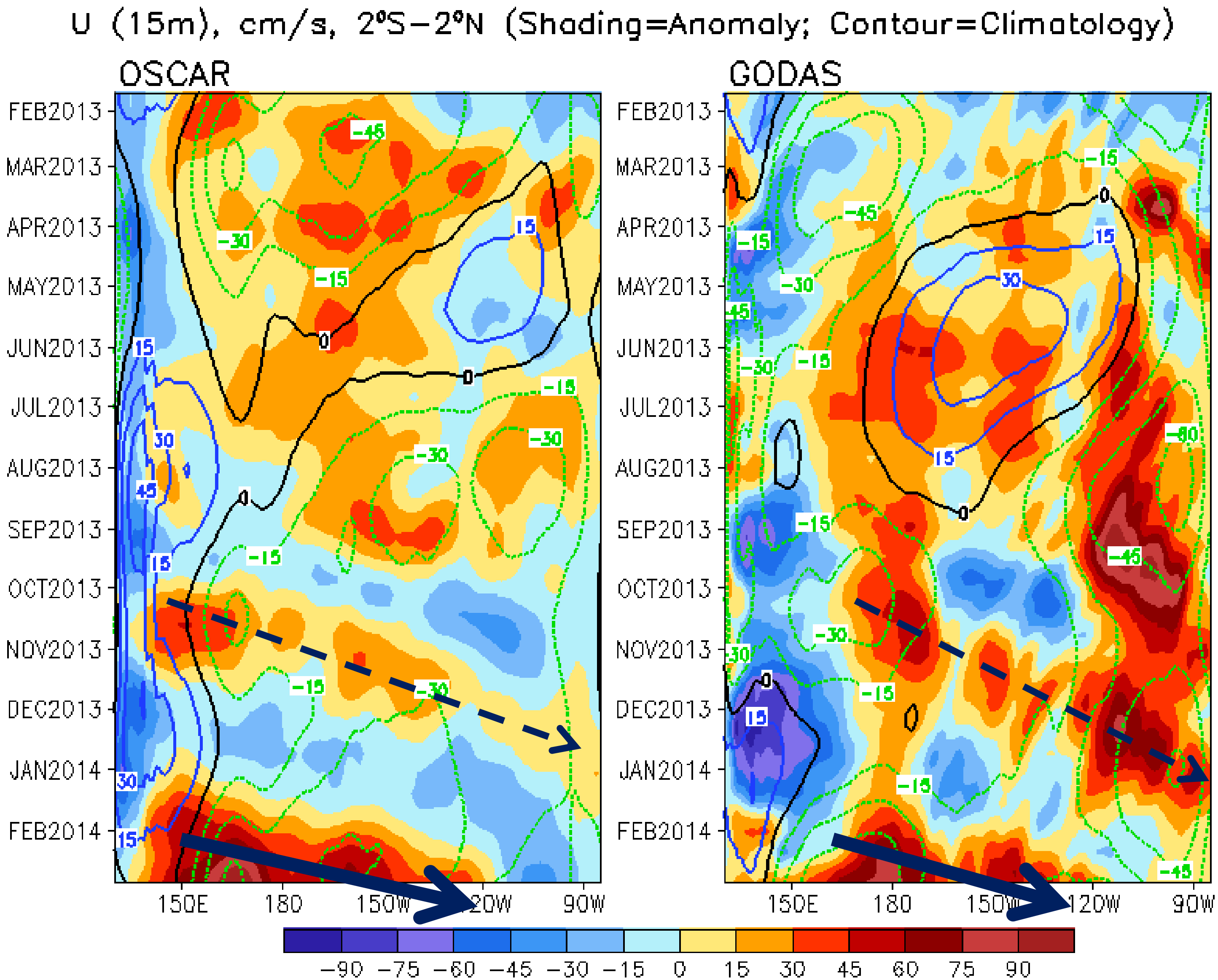
- Nino3.4 = -0.6°C in Feb 2014.

- Compared with last Feb, zonal SSTA gradient slightly enlarged in the equatorial Pacific in Feb 2014.

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

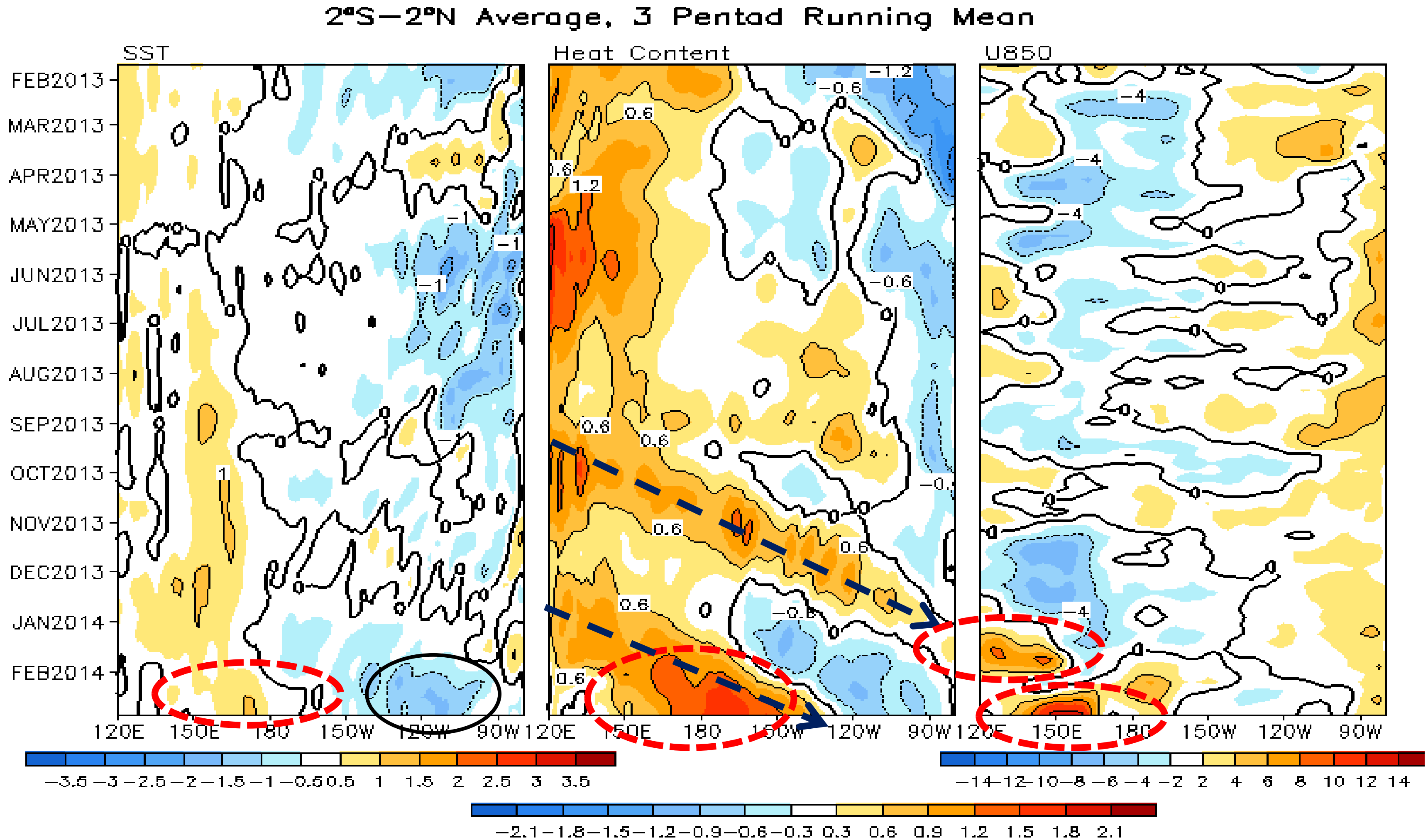
Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

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

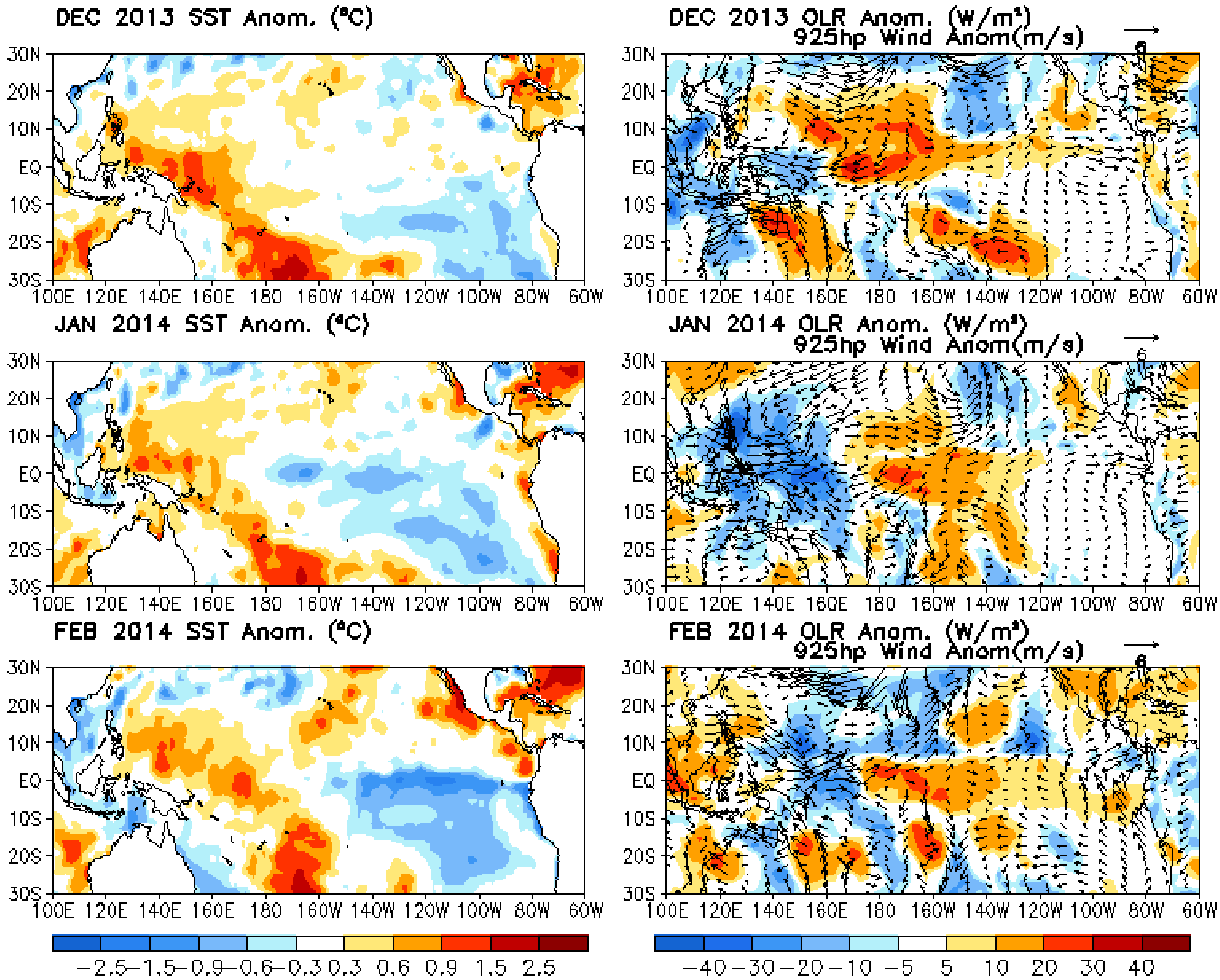


- The anomalous current pattern was similar between OSCAR and GODAS in the last about 6 months.
- Weak eastward current initiated in Oct 2013 and propagated eastward and reached the eastern boundary in Jan 2014.
- Another much stronger eastward anomalous currents presented in the central Pacific in Feb 2014. It is expected to propagate eastward, causing warming in the central and eastern Pacific in the coming months.

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

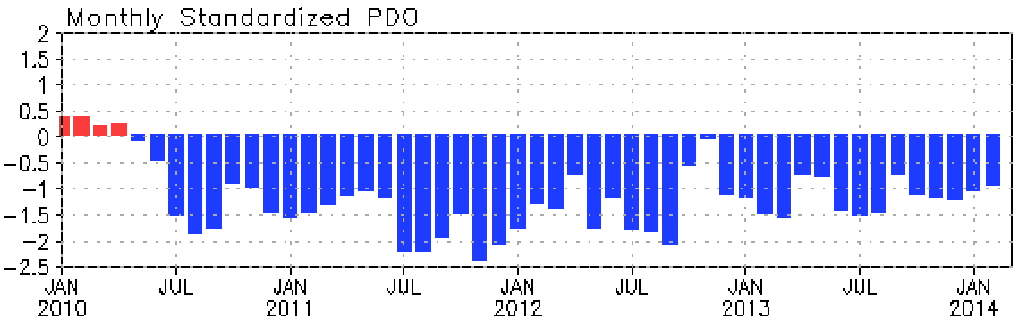


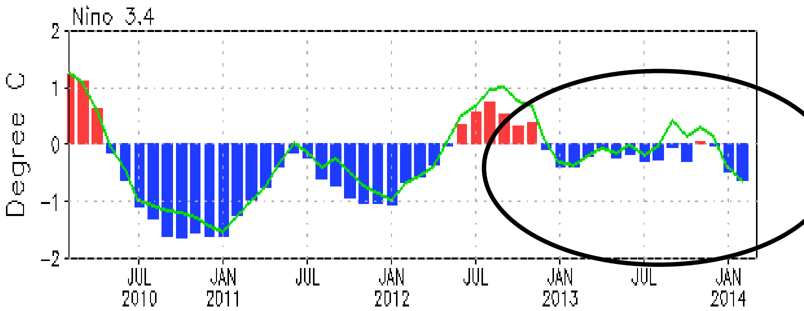
- **Positive (negative) SSTA presented in the western (eastern) equatorial Pacific in Feb 2014.**
- **Positive HC300 anomalies initiated in Sep. 2013 and Dec 2013, respectively, and propagated eastward, consistent with ocean surface current anomalies (last slide)**
- **Strong westerly wind anomalies emerged around 150E in Feb 2014, maybe a westerly wind burst event.**

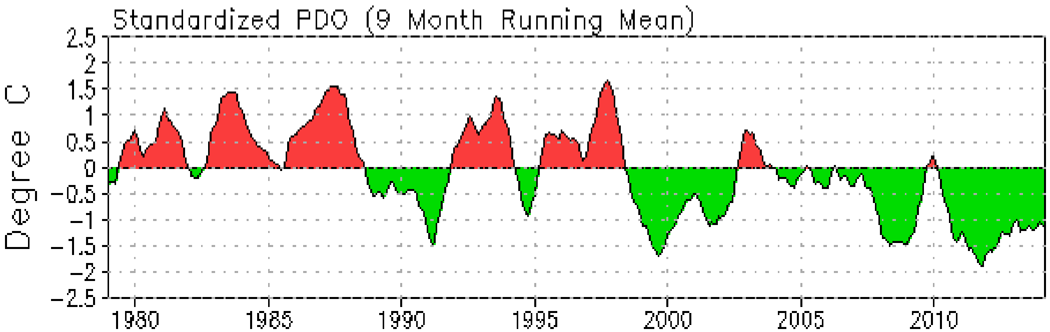

DEC 2013 SST Anom. (°C)
DEC 2013 OLR Anom. (W/m²)
925hp Wind Anom(m/s)
JAN 2014 SST Anom. (°C)
JAN 2014 OLR Anom. (W/m²)
925hp Wind Anom(m/s)
FEB 2014 SST Anom. (°C)
FEB 2014 OLR Anom. (W/m²)
925hp Wind Anom(m/s)
6
30N 20N 10N EQ 10S 20S 30S
100E 120E 140E 160E 180 160W 140W 120W 100W 80W 60W
−2.5 −1.5 −0.9 −0.6 −0.3 0.3 0.6 0.9 1.5 2.5
−40 −30 −20 −10 −5 5 10 20 30 40

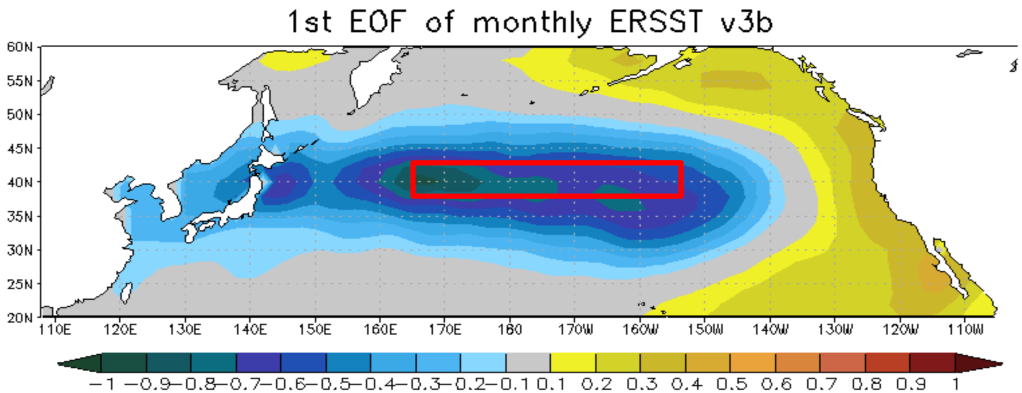
North Pacific & Arctic Oceans

PDO index









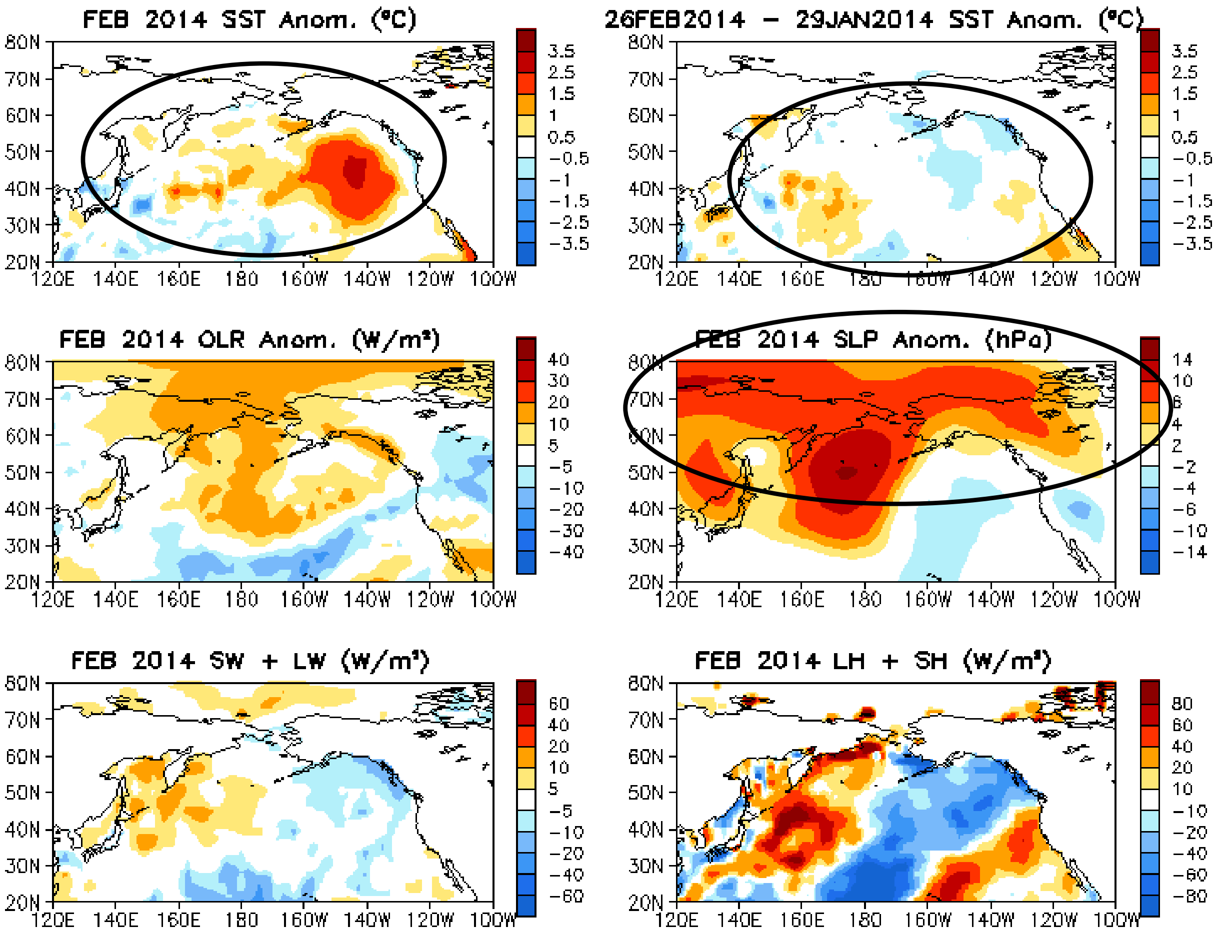
- **The negative PDO index has persisted near 4 years (46 months) since May 2010 with PDO index =-0.96.**

- **Statistically, ENSO and PDO are connected, may 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.**

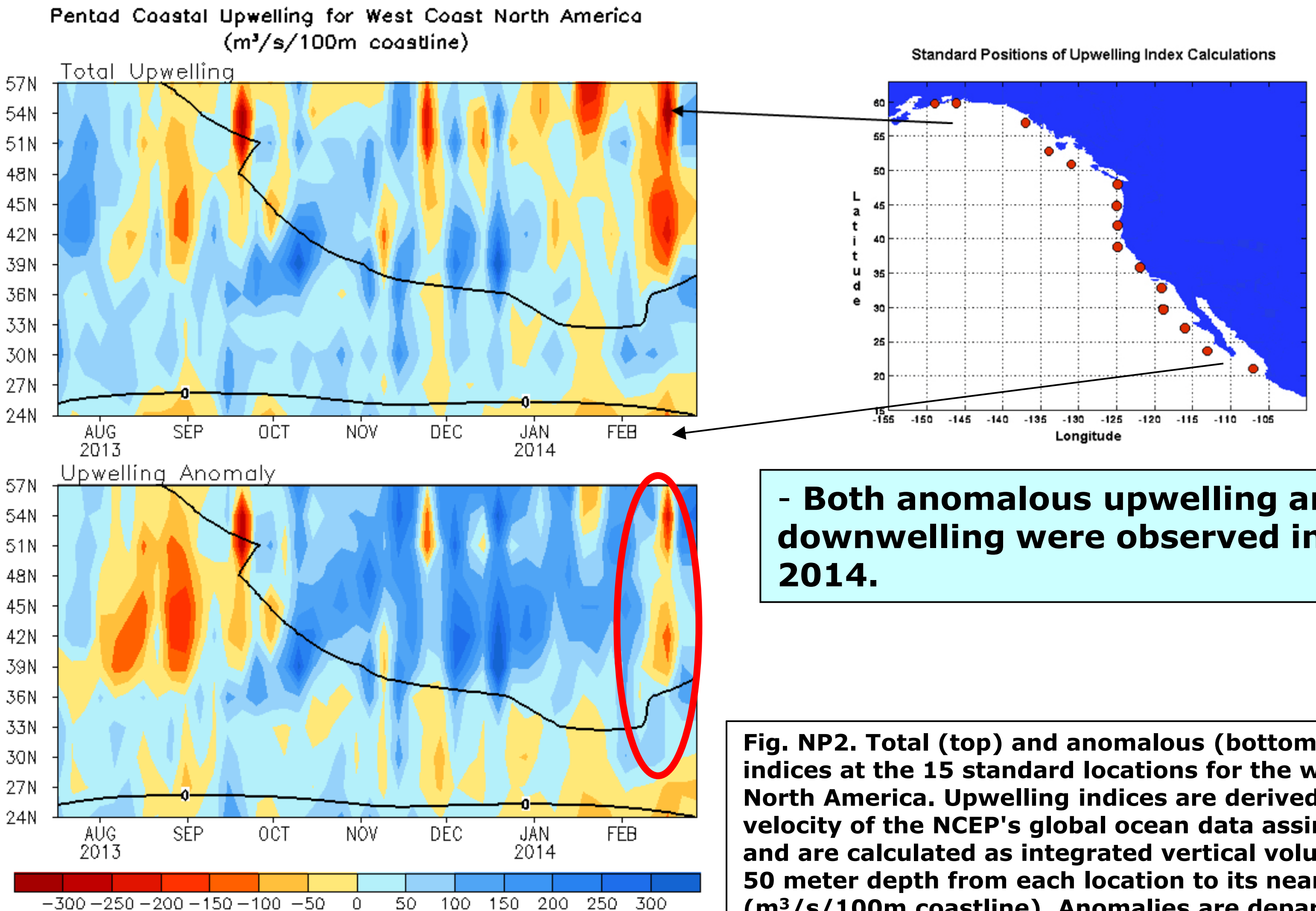
North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx



- Positive (negative) SSTA presented in the northeastern Pacific, consistent with the negative PDO index (previous slide).
- The SST tendency was small in North Pacific.
- Above-normal sea level pressure presented in the high latitudes.

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



- **Both anomalous upwelling and downwelling were observed in Feb. 2014.**

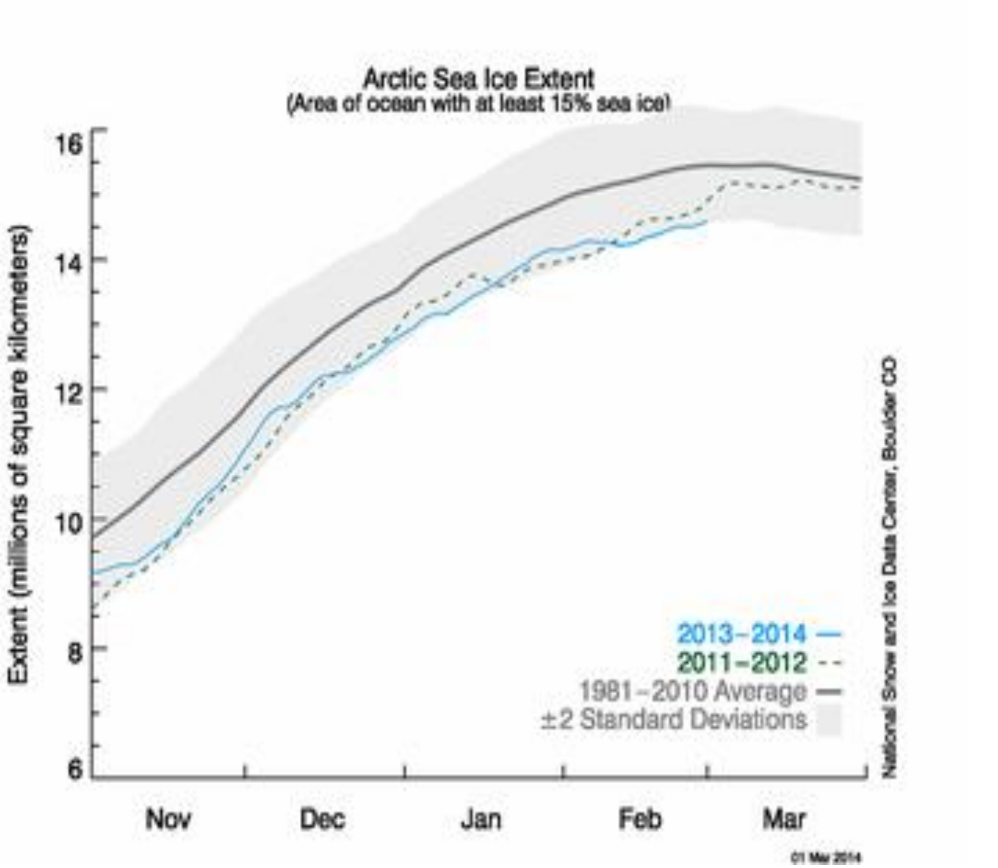
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point (m³/s/100m coastline). Anomalies are departures from the 1981-2010 base period pentad means.

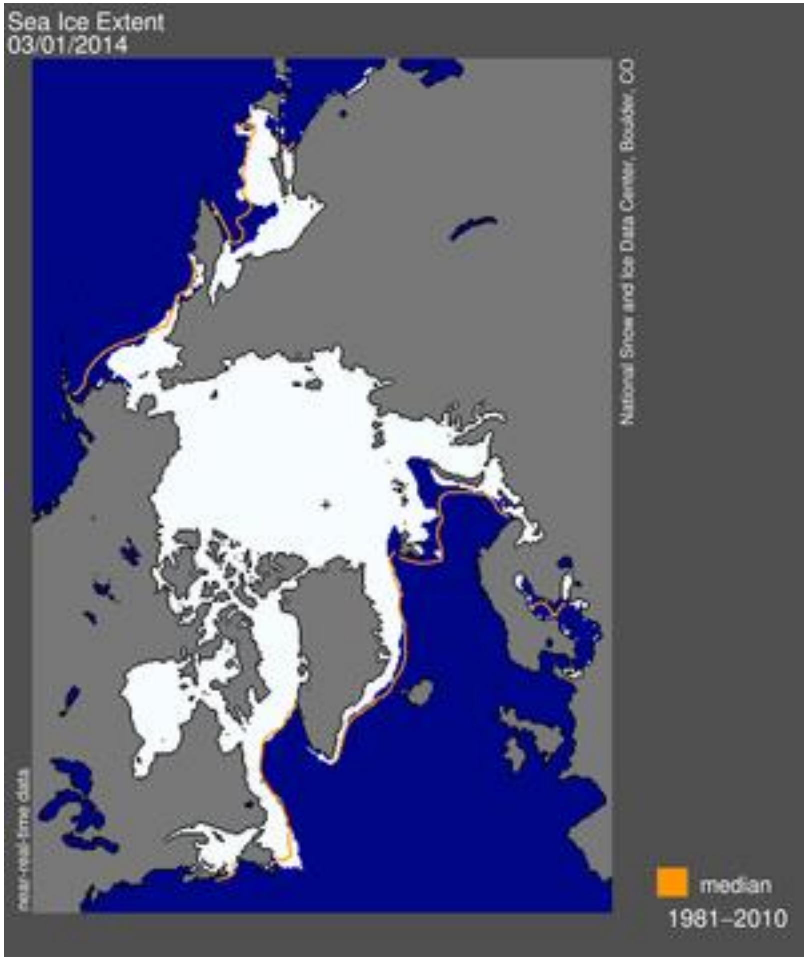
- **Area below (above) black line indicates climatological upwelling (downwelling) season.**
- **Climatologically upwelling season progresses from March to July along the west coast of North America from 36°N to 57°N.**

Arctic Sea Ice

National Snow and Ice Data Center

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

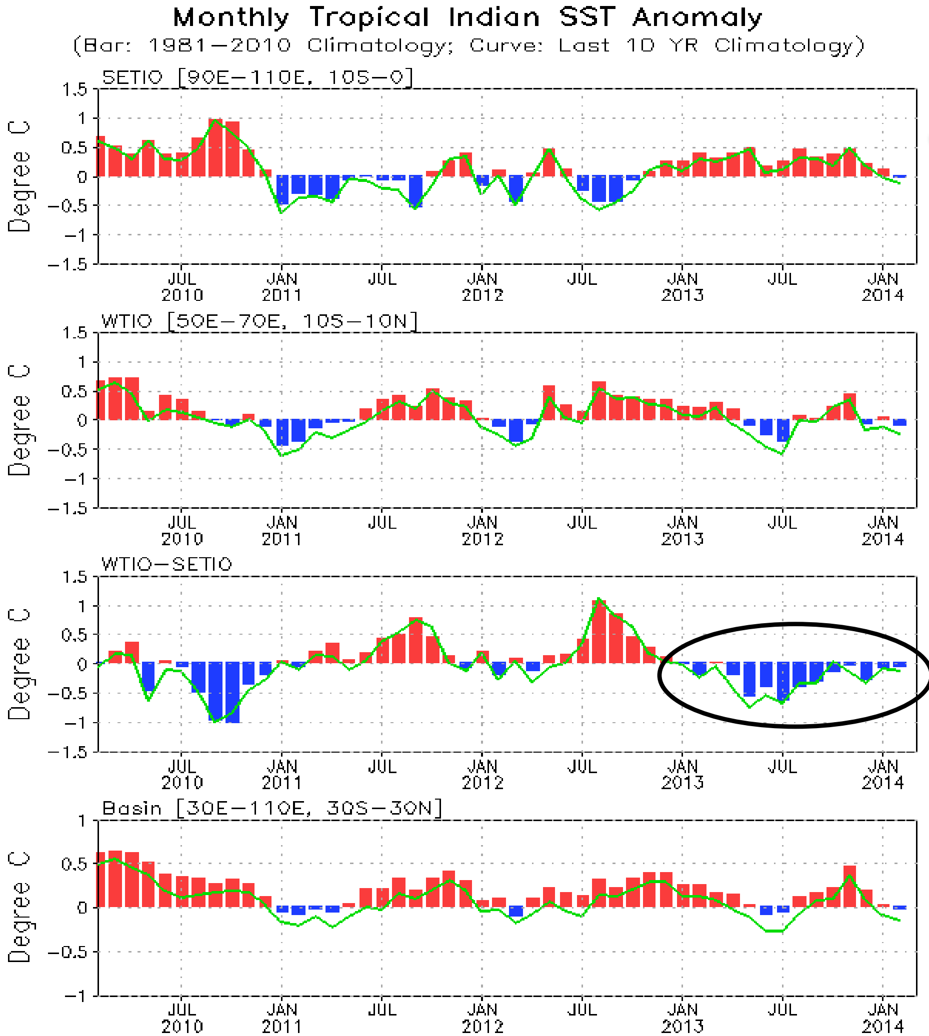


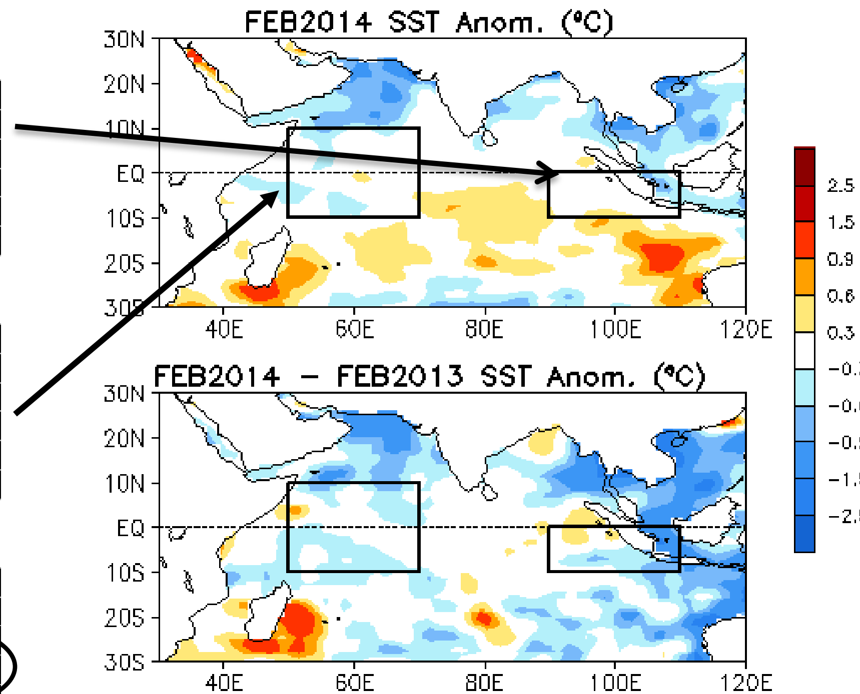


- Arctic sea ice extent in 2013-14 was close to -2 standard deviations and comparable to that in 2011-12.

Indian Ocean

Evolution of Indian Ocean SST Indices





- **SSTA was small.**
- **DMI was below normal since Apr 2013.**

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

- Positive (negative) SSTA in the south (north) and its tendency were small.
- Convections were enhanced over the western and suppressed over the eastern Indian Ocean.

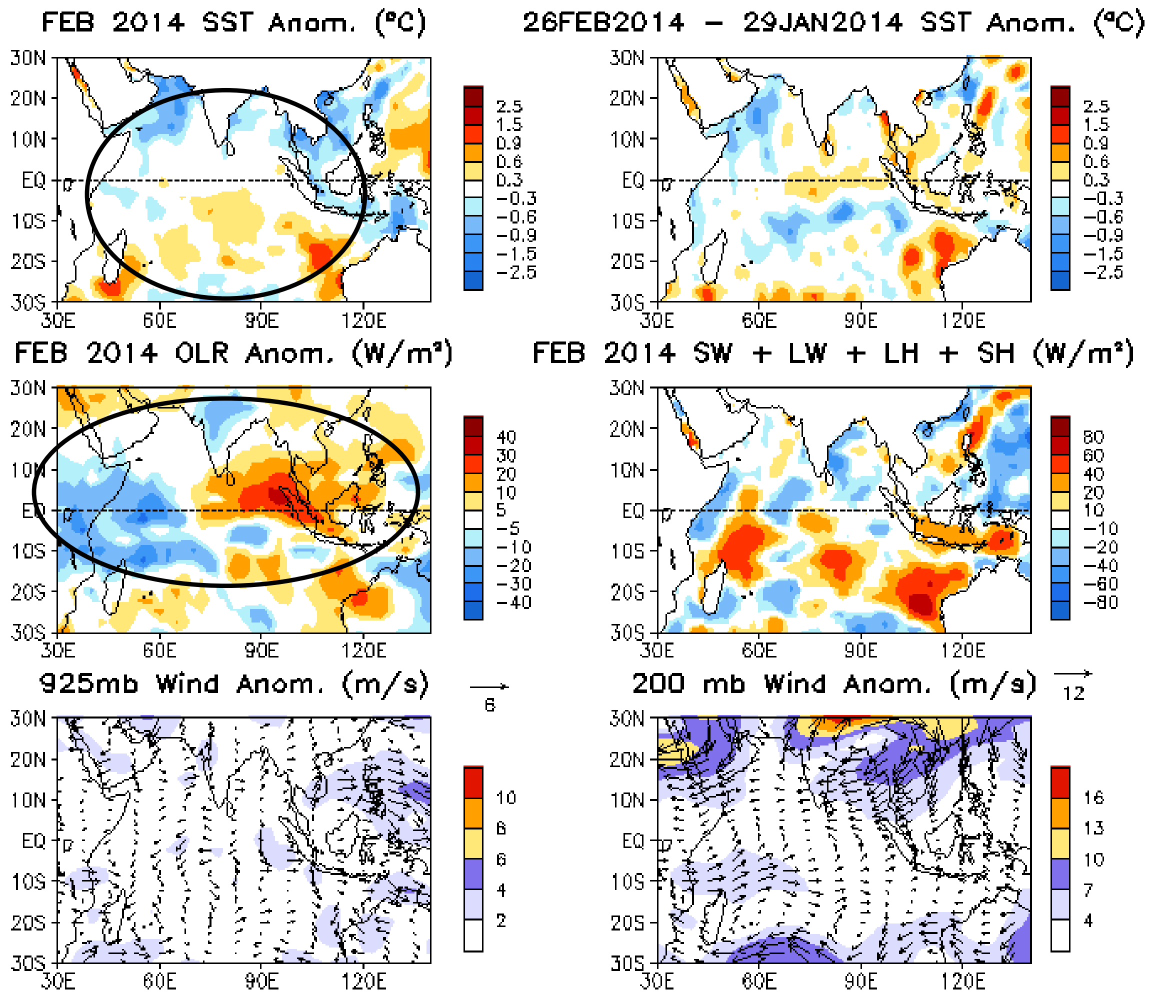
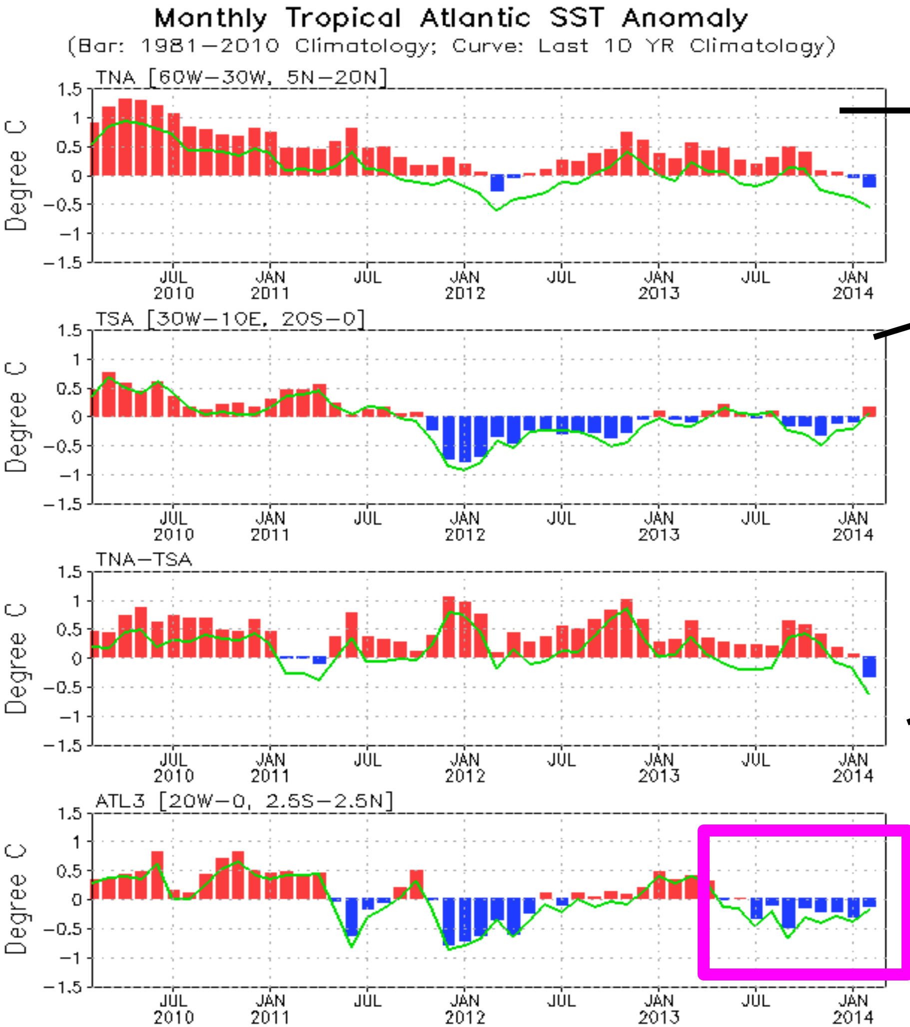
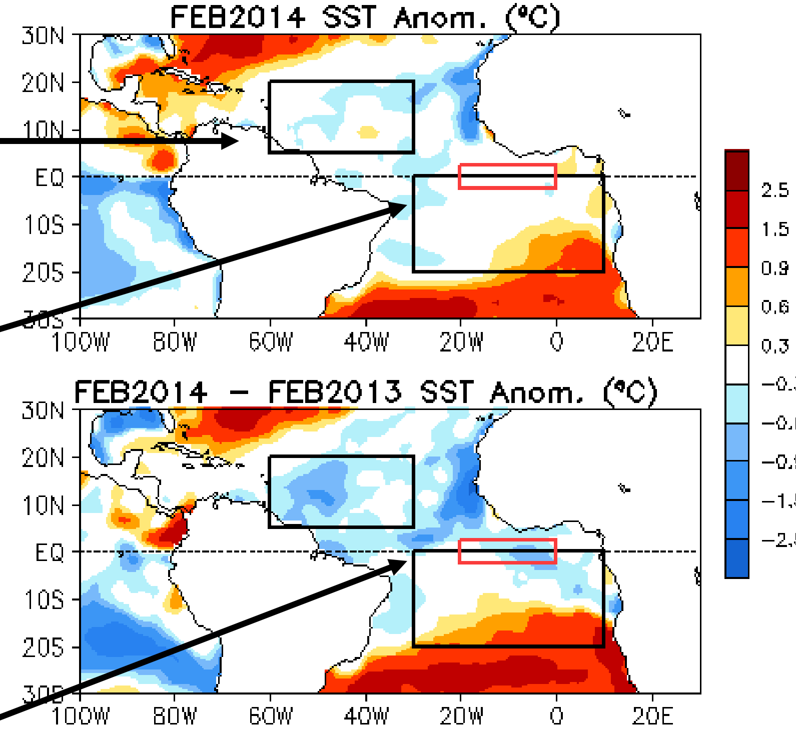


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

Tropical and North Atlantic Ocean

Evolution of Tropical Atlantic SST Indices

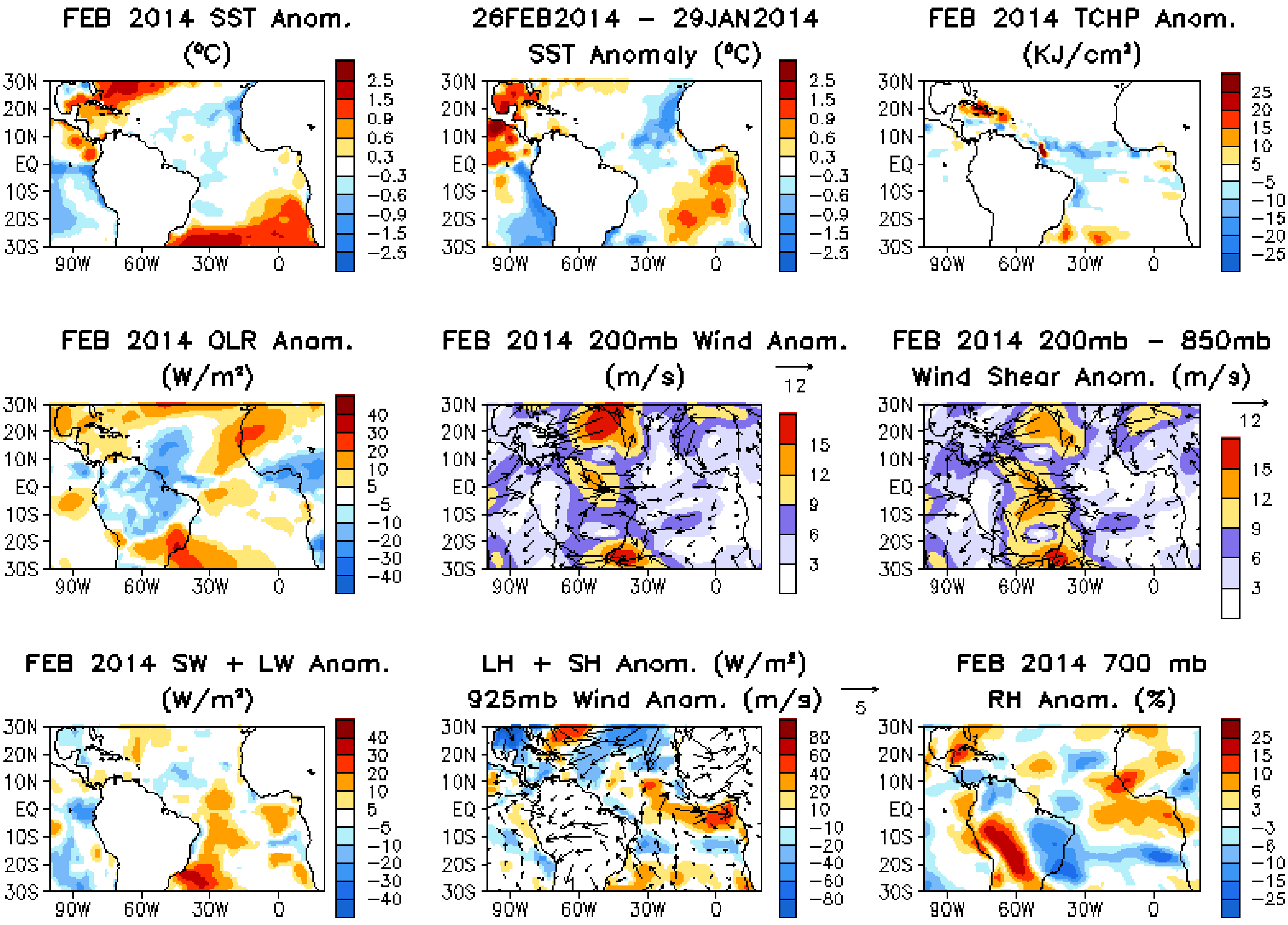




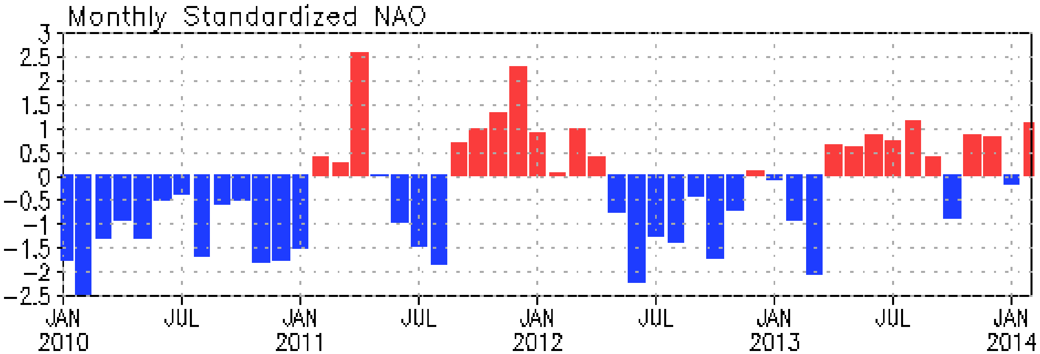
- **Tropical North Atlantic (TNA) index was small since Nov 2013.**
- **Tropical South Atlantic (TSA) index was small since Dec 2012.**
- **Meridional Gradient Mode (TNA-TSA) switched to negative phase in Feb 2014.**
- **ATL3 SSTA has been negative since Jul 2013.**
- **Tropical Atlantic in Feb was cooler in 2014 than in 2013.**

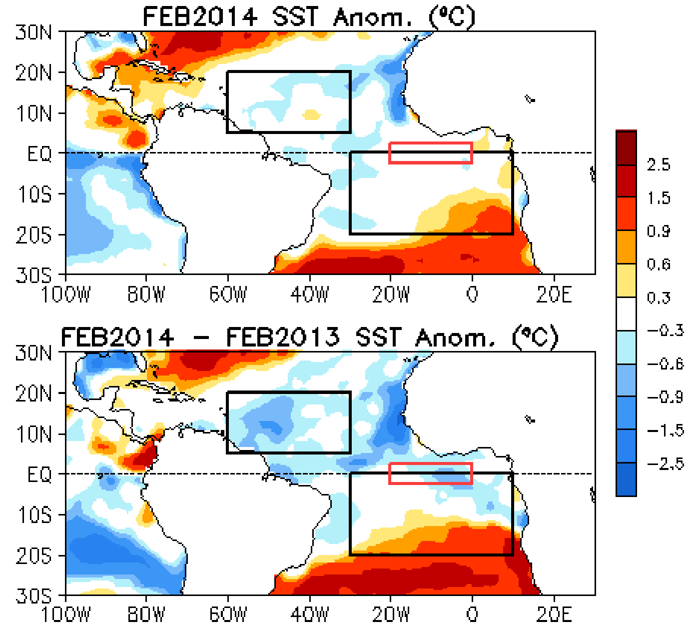
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (ºC) for the TNA [60ºW-30ºW, 5ºN-20ºN], TSA [30ºW-10ºE, 20ºS-0] and ATL3 [20ºW-0, 2.5ºS-2.5ºN] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

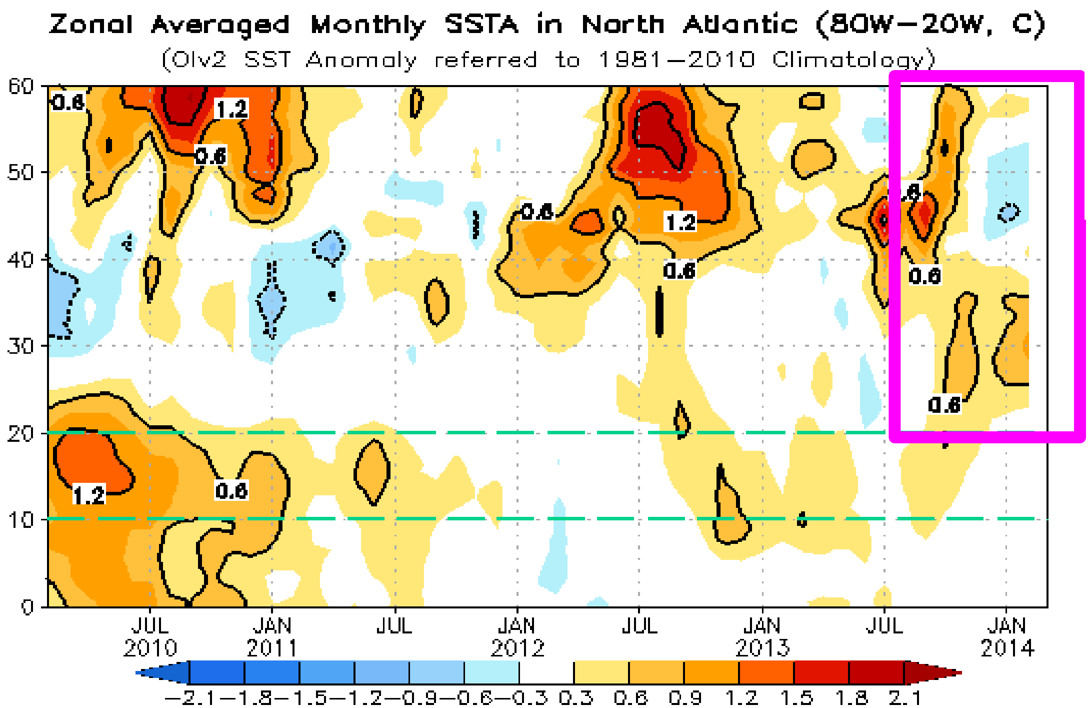
Tropical Atlantic:



NAO and SST Anomaly in North Atlantic





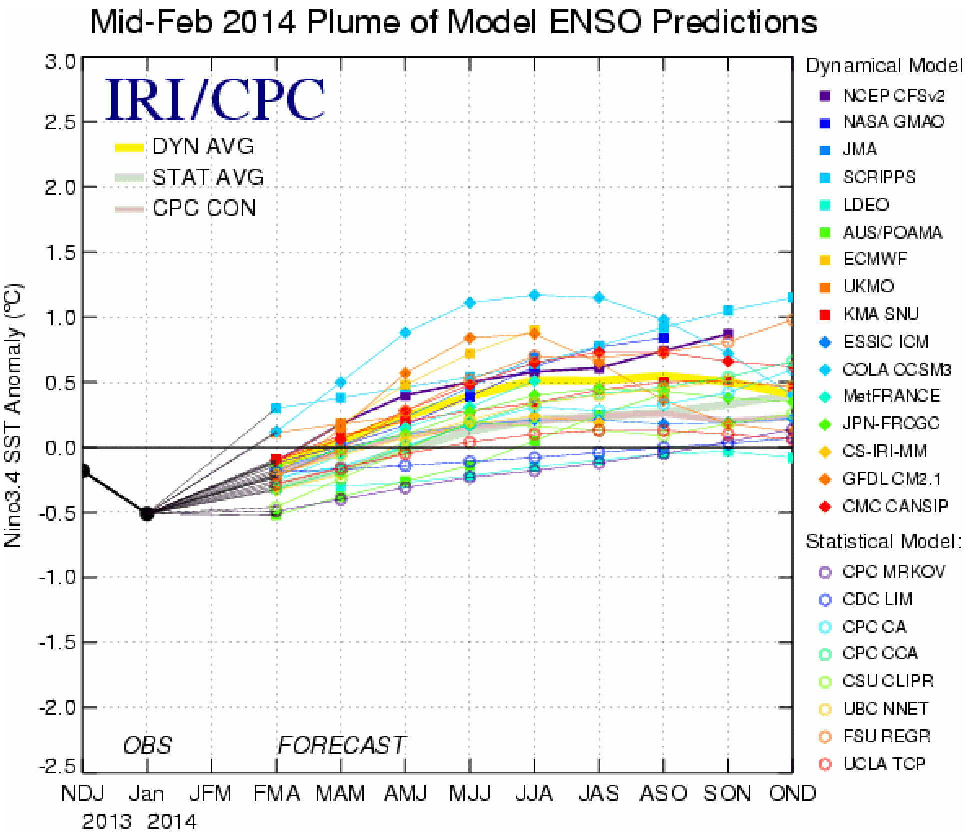


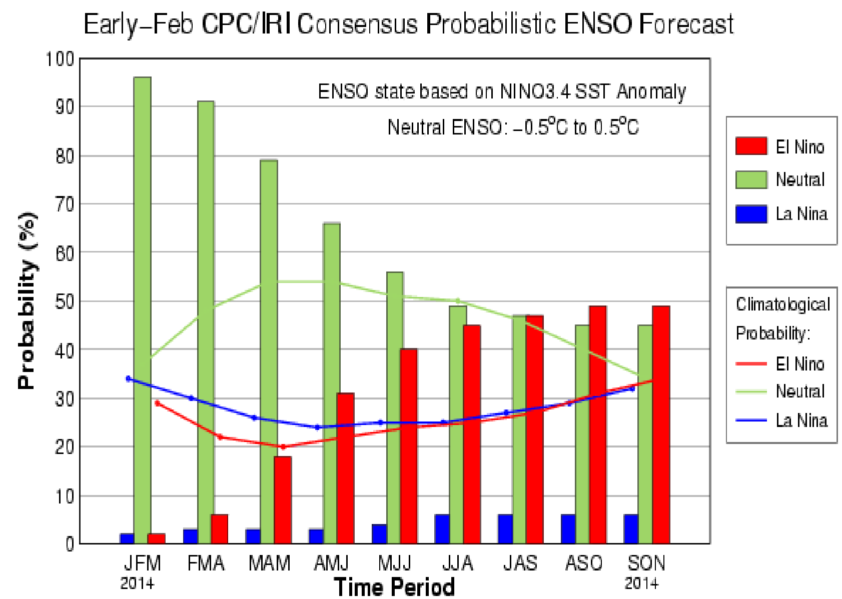
- NAO switched into positive phase again with NAOI=1.07 in Feb 2014.
- North Atlantic zonal mean SSTAs were small in the past months, may due to weak and positive-negative fluctuated NAO.

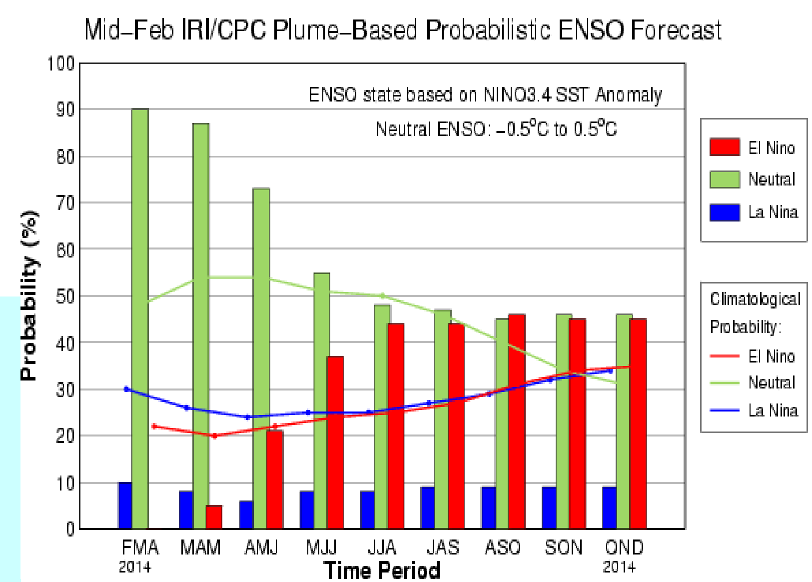
Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20ºN-90ºN (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80ºW and 20ºW (bottom). SST are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

ENSO and Global SST Predictions

IRI NINO3.4 Forecast Plum





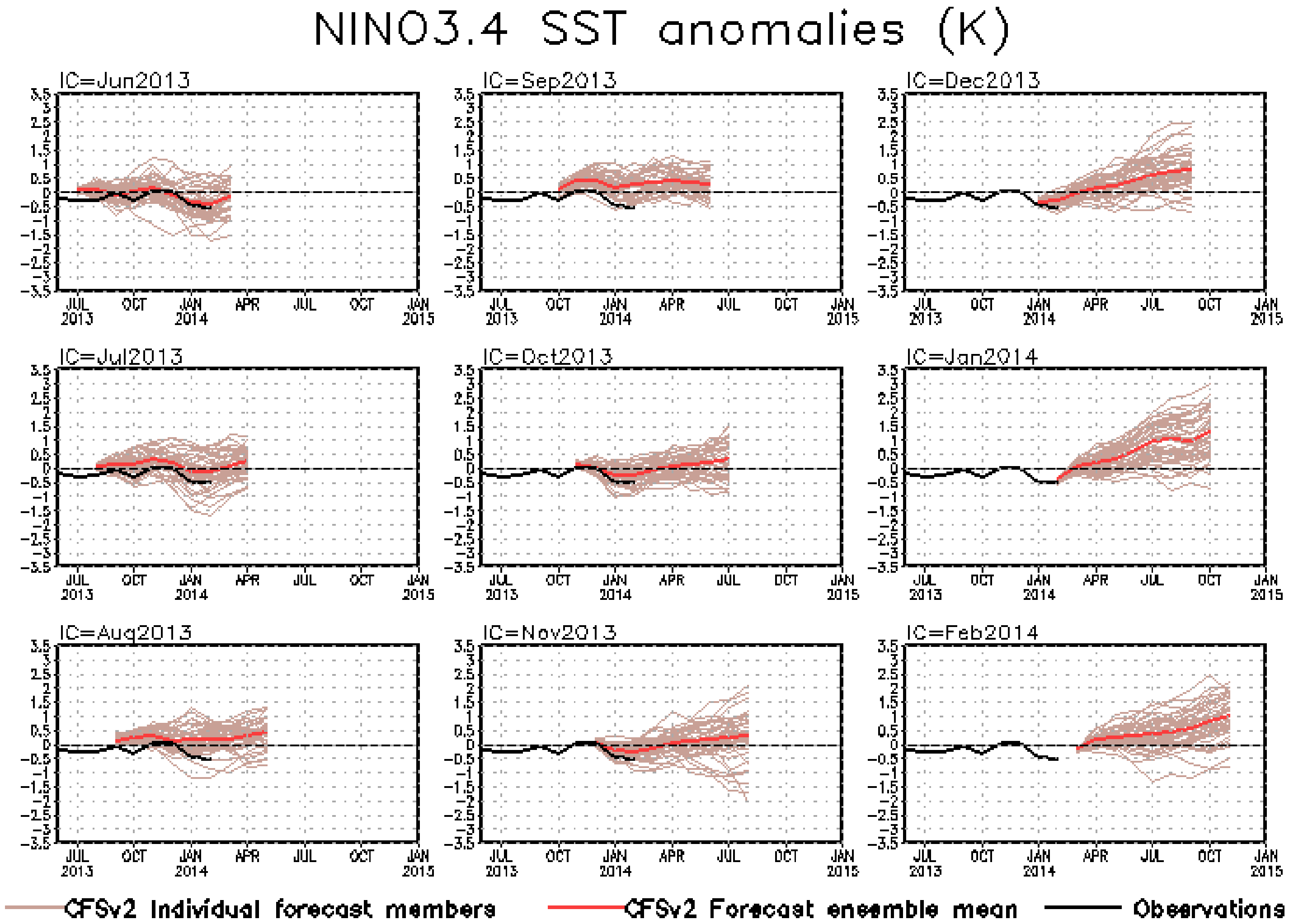


- All models predicted a warming tendency and a majority of dynamical models predicted an El Nino in second half of 2014.

- Consensus probabilistic forecasts slightly favor a warm phase of ENSO in 2014.

- NOAA "ENSO Diagnostic Discussion" on 06 March 2014 issued "El Nino Watch" and suggests that "ENSO-neutral is expected to continue through the Northern Hemisphere spring 2014, with about a 50% chance of El Niño developing during the summer or fall"

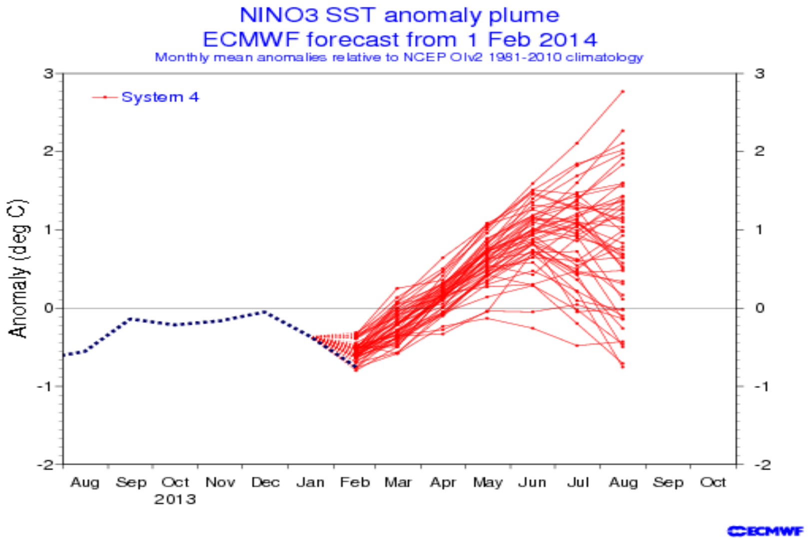
CFS Niño3.4 SST Predictions from Different Initial Months



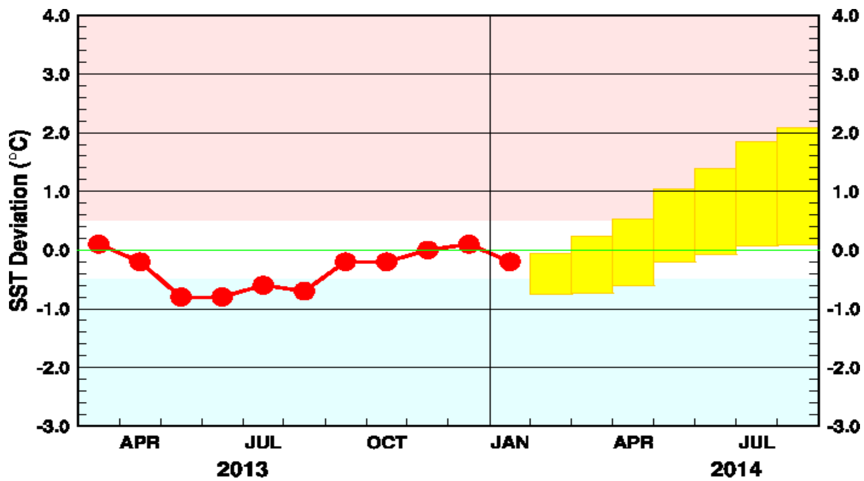
- **CFSv2 predicts a warming tendency, and suggests development of a weak El Nino in second half of 2014.**

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.

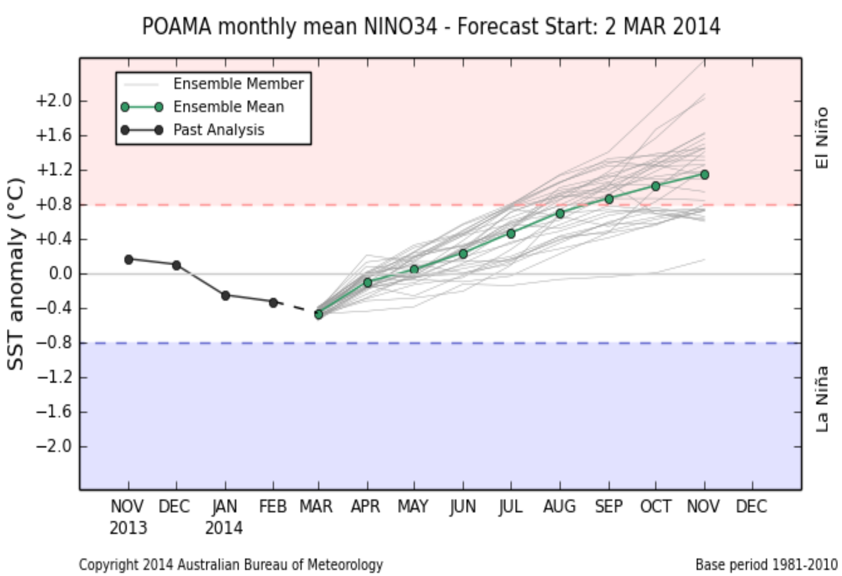
Individual Model Forecasts: warming tendency or neutral



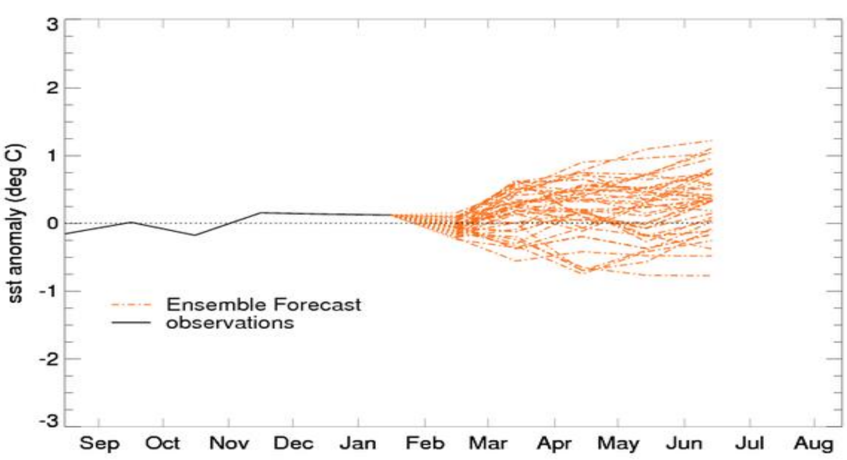
JMA: Nino3, IC=Jan 2014



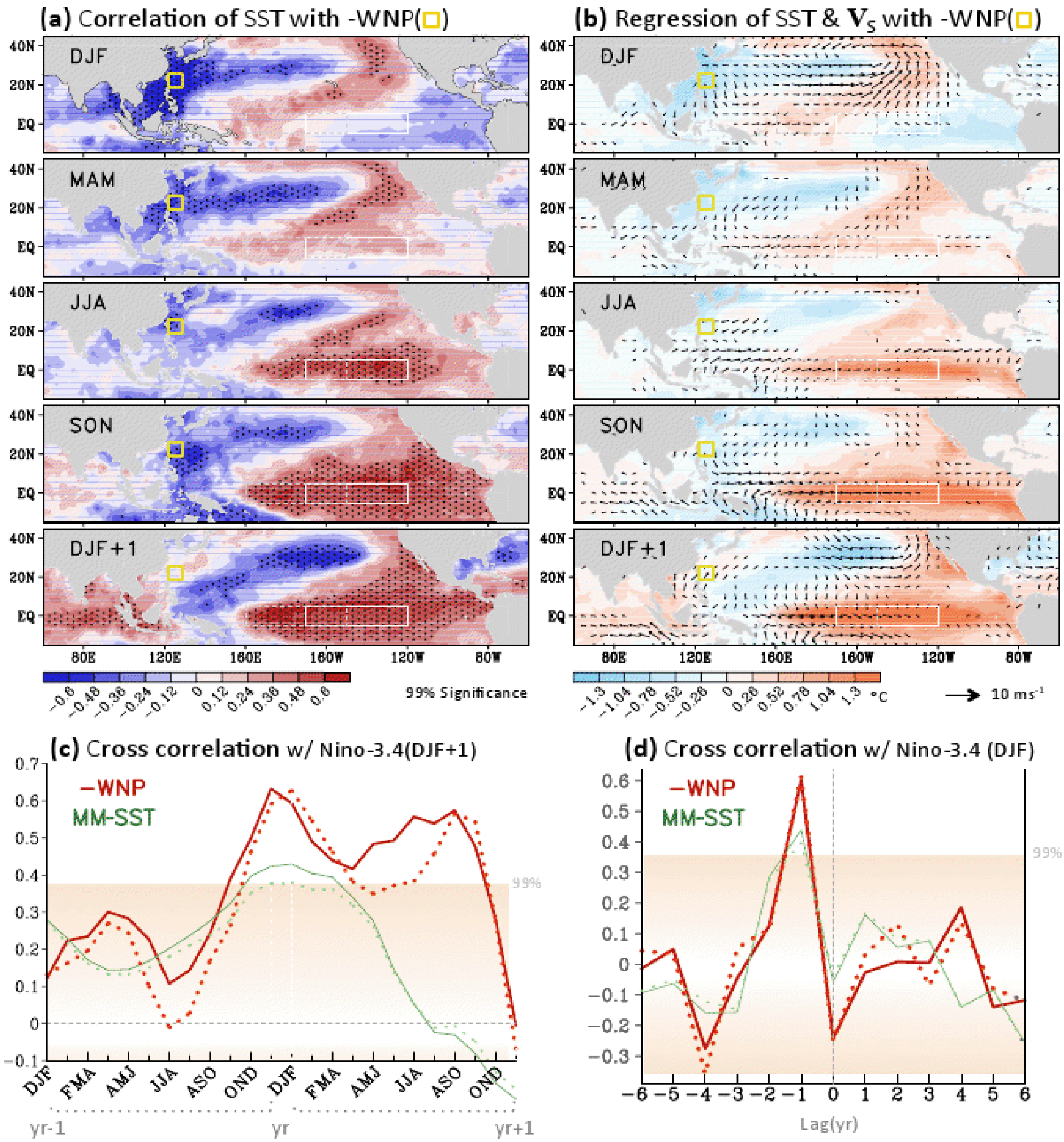
Australia: Nino3.4, IC=02Mar2014



UKMO: Nino3.4, IC=Feb2014



Western North Pacific Variability and ENSO



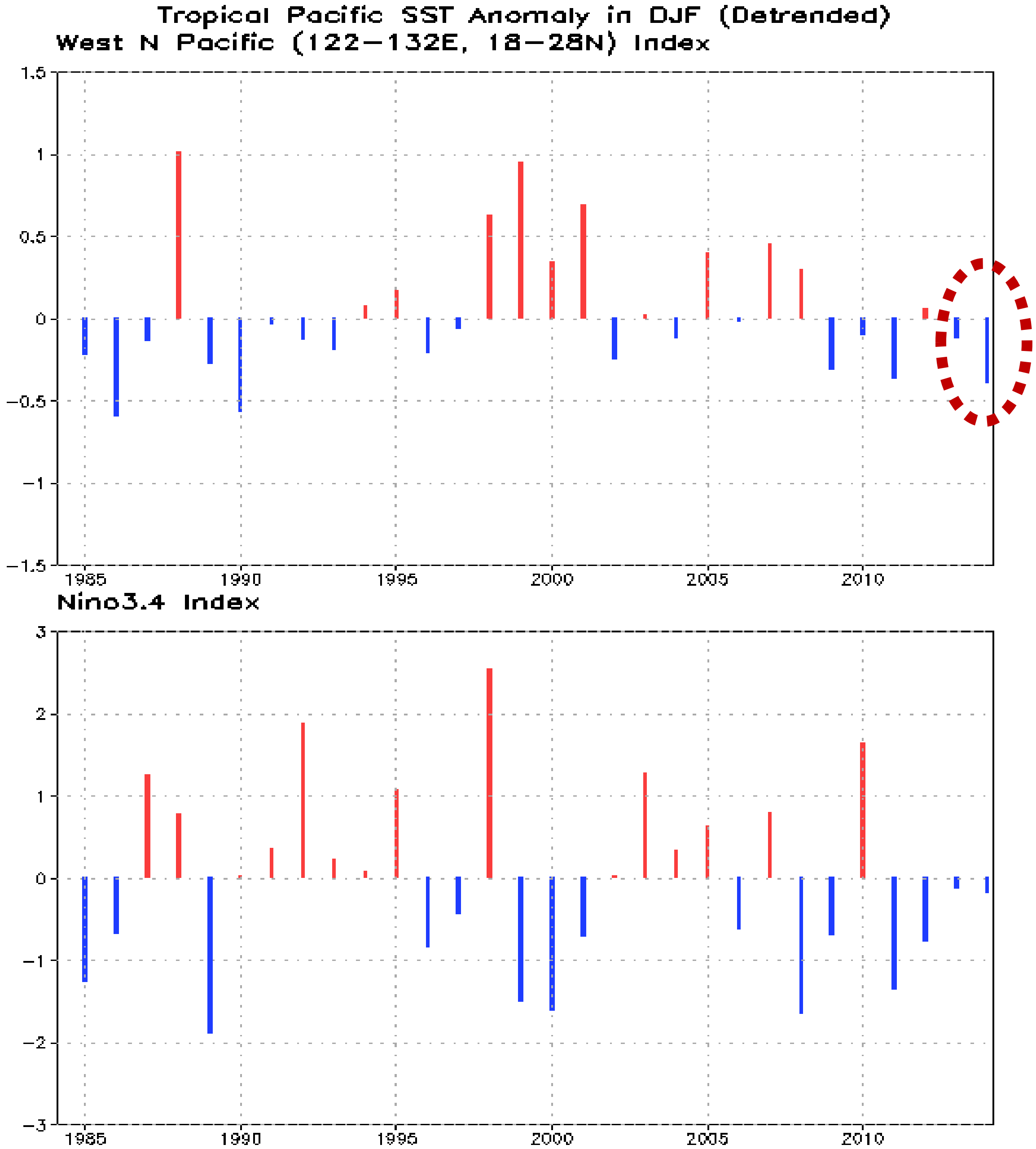
(a)DJF Cooling over the WNP is followed by a warming in the equatorial Pacific in next winter

(b)The correlation between WNP and ENSO is higher than that between meridional mode and ENSO.

(c) The frequency of WNP variability is higher than ENSO.

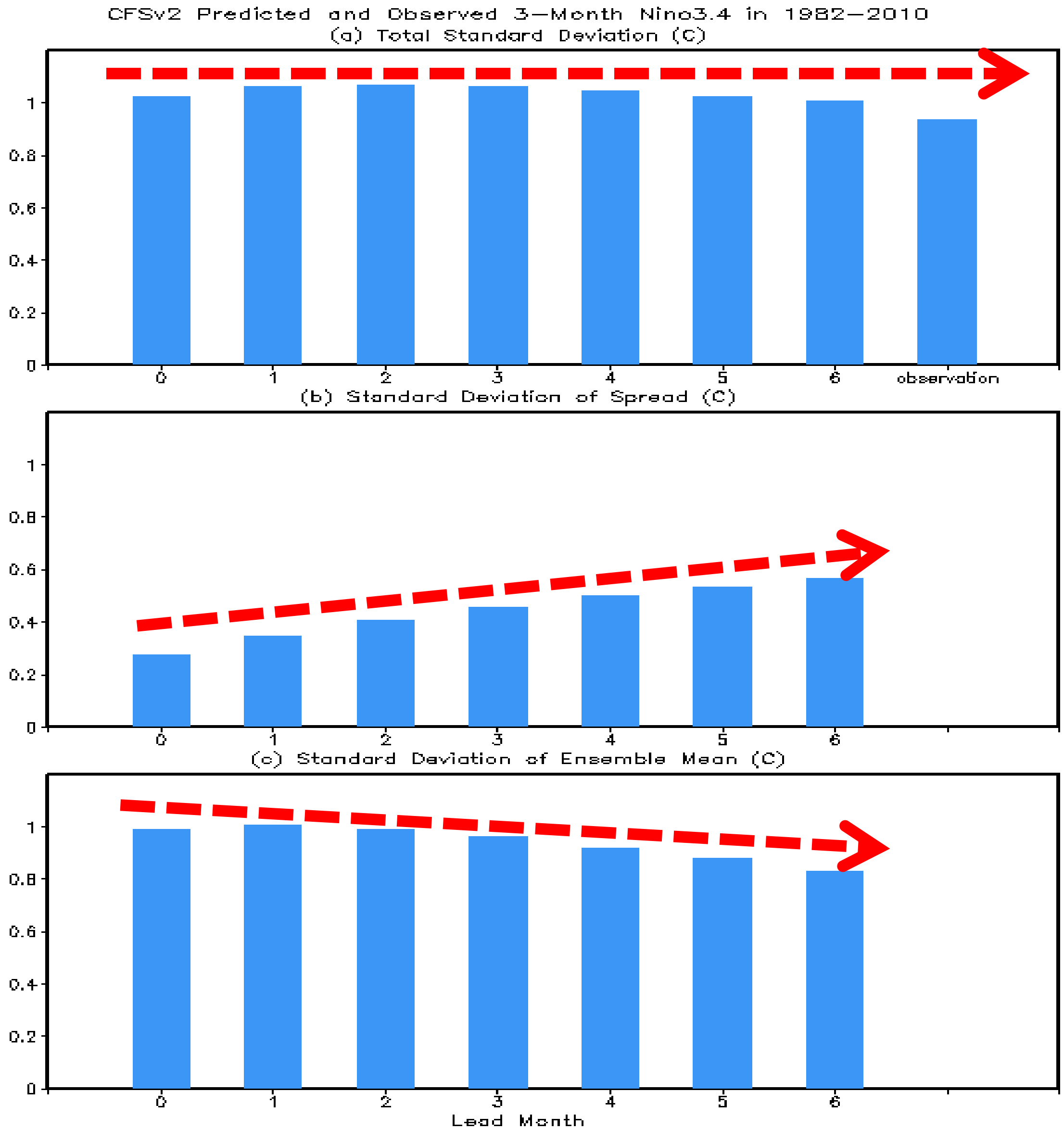
From:

Wang, S.-Y., M. L'Heureux, and H.-H. Chia, 2012: ENSO Prediction One Year in Advance Using Western North Pacific Sea Surface Temperatures. GRL, 39, L05702. DOI: 10.1029/2012GL050909.



WNP and Nino3.4 indices:

2013/14DJF WNP index was negative (-0.37), predicting an El Nino event in 2014/15.



Challenge of ENSO predictions:

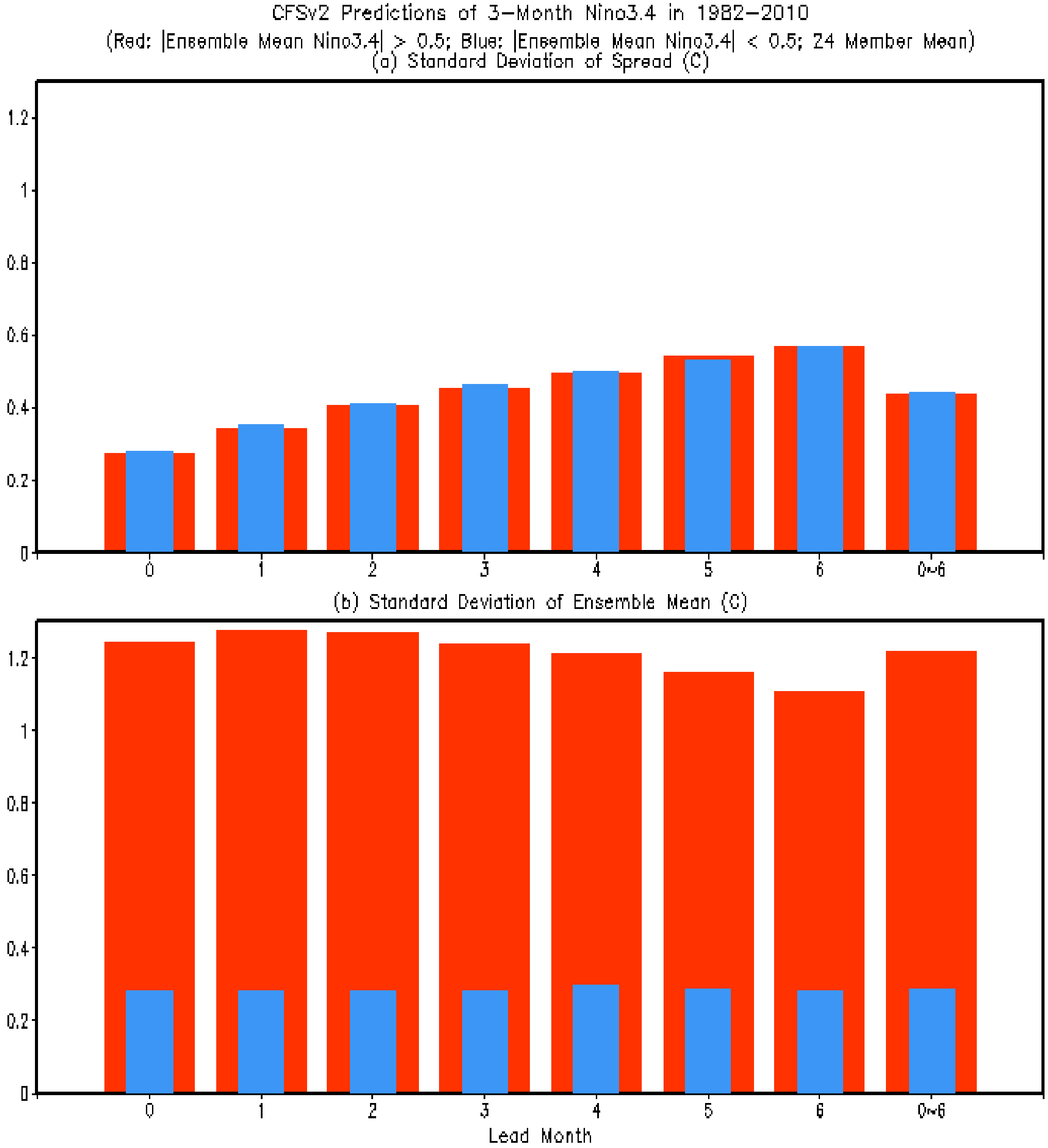
a) Stable total standard deviation

b) Increase of standard deviation of spread with lead time

c) Decrease of standard deviation of ensemble mean with lead time and decrease of the S/N ratio with lead time

From:
Kumar, A. and Z.-Z. Hu, 2014: How variable is the uncertainty in ENSO sea surface temperature prediction? *J. Climate* (published online).

(a) total standard deviation, standard deviation related to (b) noise and (c) signal of Niño3.4 SST index for lead 0 to 6 months of CFSv2 hindcasts, respectively. The total and noise standard deviation are averages of 24 values computed based on individual predictions. The most-right-hand bar in the top panel is the standard deviation for the observation. The unit is ^{o}C.



Challenge of ENSO predictions:

Spread is comparable between large and small amplitude of ensemble mean anomaly

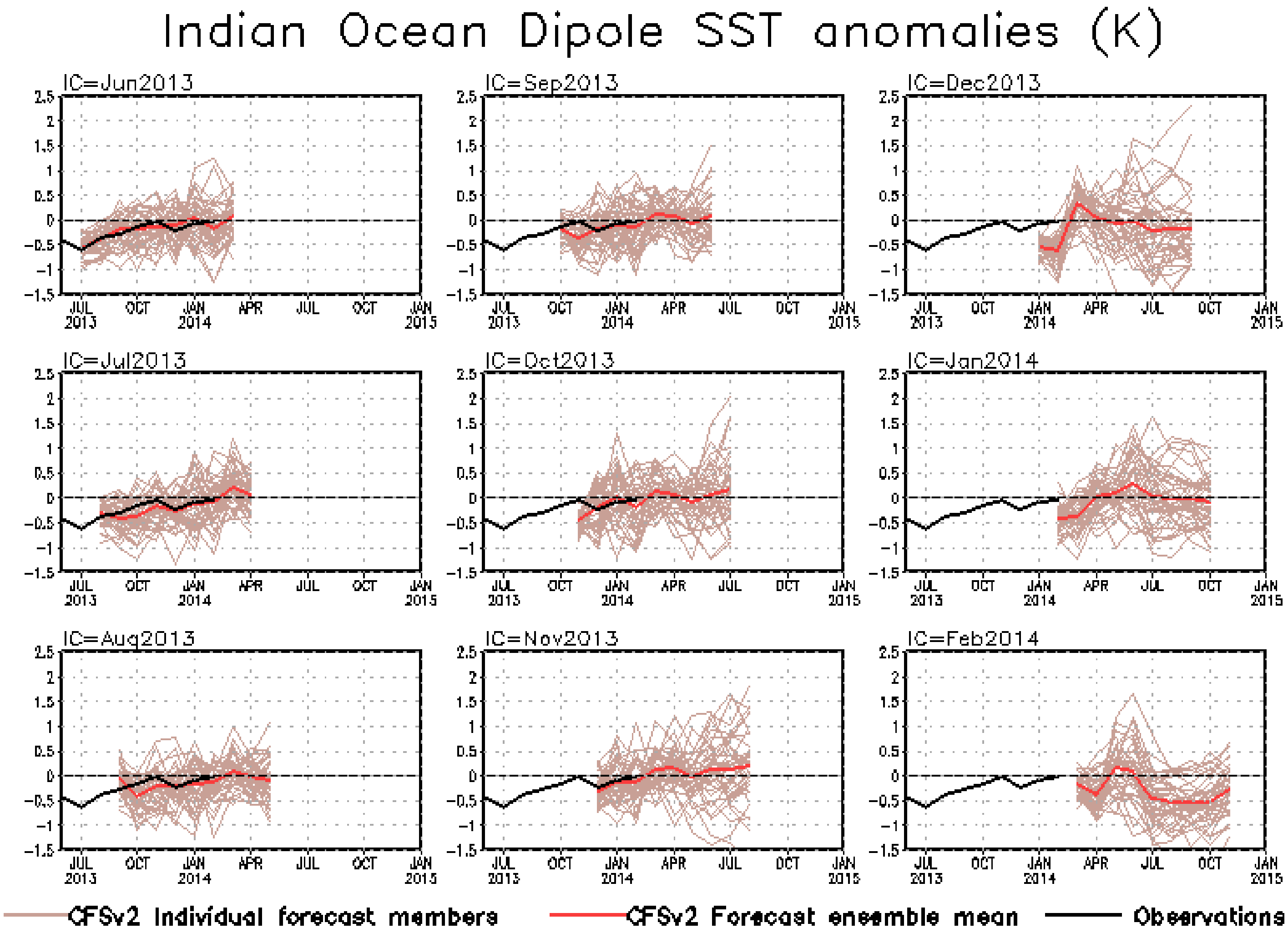
No relationship between spread and ensemble mean

Predictability depends on signals instead of noise.

Thus, ENSO prediction skills rely on its phase and amplitude: *transition (peak) phase has low (high) skill*

From:
Kumar, A. and Z.-Z. Hu, 2014: How variable is the uncertainty in ENSO sea surface temperature prediction? *J. Climate* (published online).

NCEP CFS DMI SST Predictions from Different Initial Months



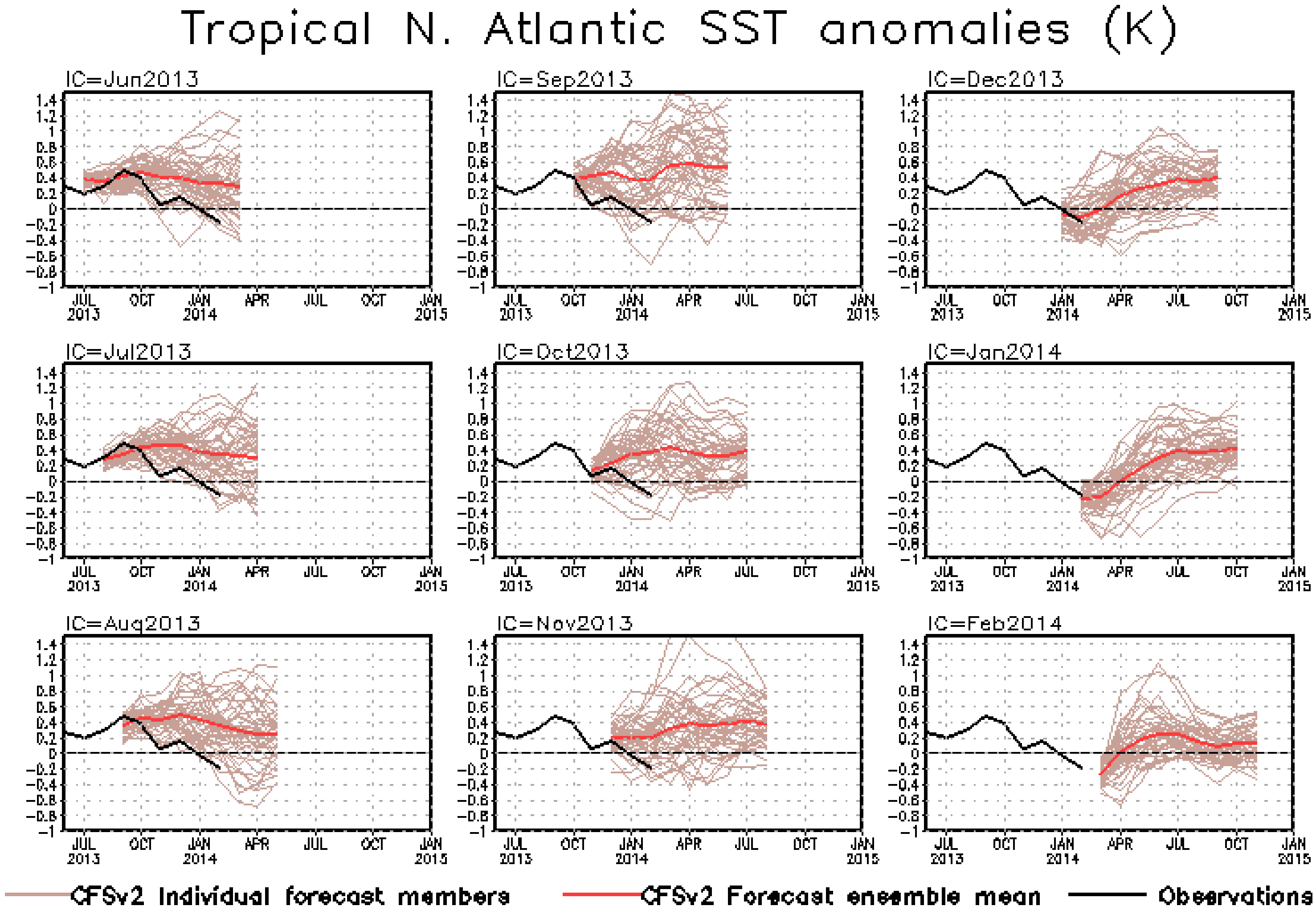
DMI = WTIO- SETIO

SETIO = SST anomaly in [90ºE-110ºE, 10ºS-0]

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

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.

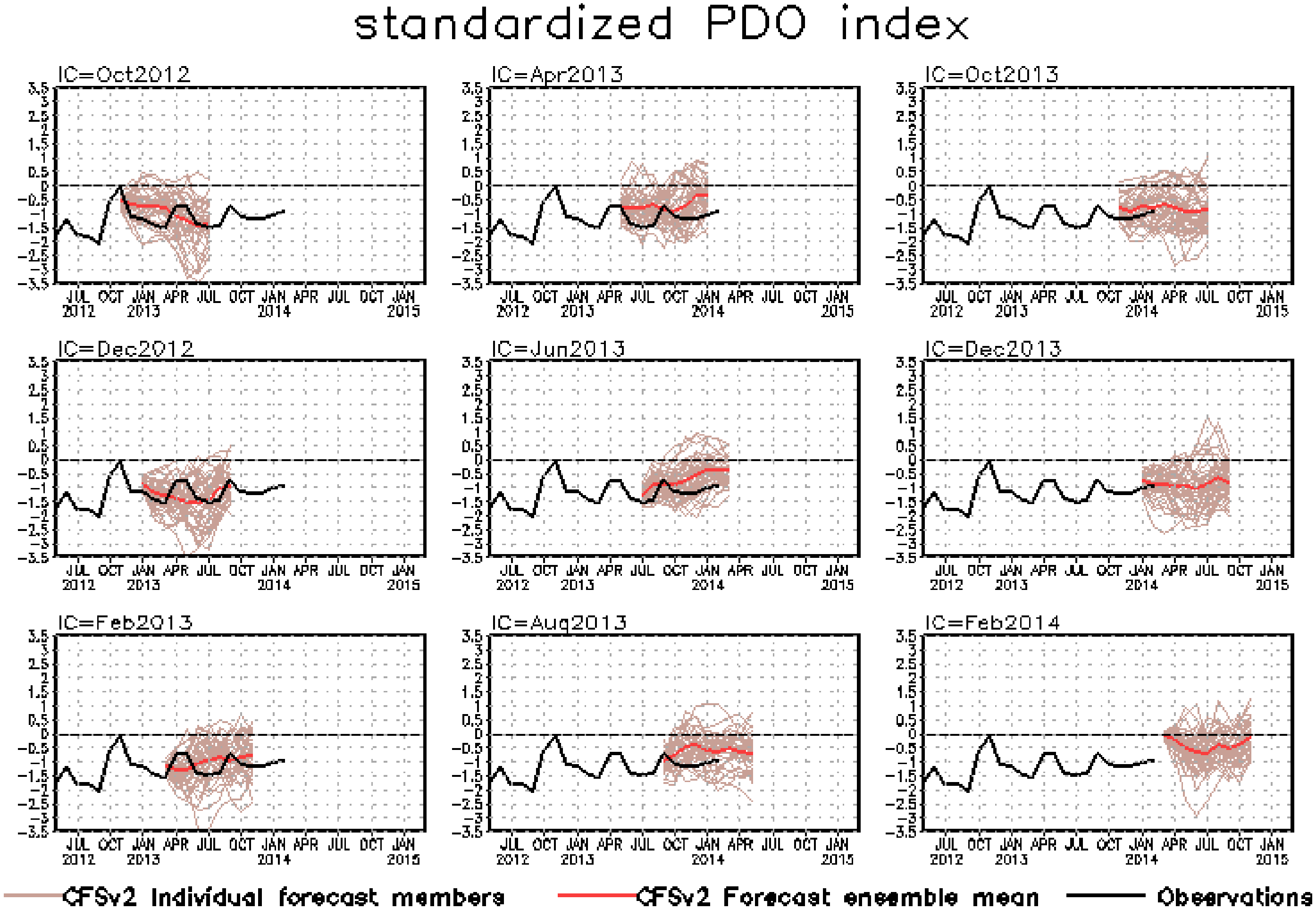
CFS Tropical North Atlantic (TNA) SST Predictions from Different Initial Months



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

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



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 NINO3.4=-0.6°C in Feb 2014.**
  - **Positive anomalies of subsurface ocean temperature along the equator propagated eastward and westerly wind burst-like surface wind anomaly were observed in Feb 2014.**
  - **All models predicted a warming tendency in this year, some of the dynamical modes predicted an El Nino since this summer.**
  - **NOAA "ENSO Diagnostic Discussion" on 06 March 2014 issued "El Nino Watch" and suggested that "ENSO-neutral is expected to continue through the Northern Hemisphere spring 2014, with about a 50% chance of El Niño developing during the summer or fall".**
  - **Negative PDO persisted, with PDOI=-0.96 in Feb 2014.**
- **Indian Ocean**
  - **Small anomalies.**
- **Atlantic Ocean**
  - **NAO switched into positive phase with NAOI=1.07 in Feb 2014.**

Backup Slides

Warm Water Volume (WWV) and NINO3.4 Anomalies

- WWV is defined as average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN]. 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.

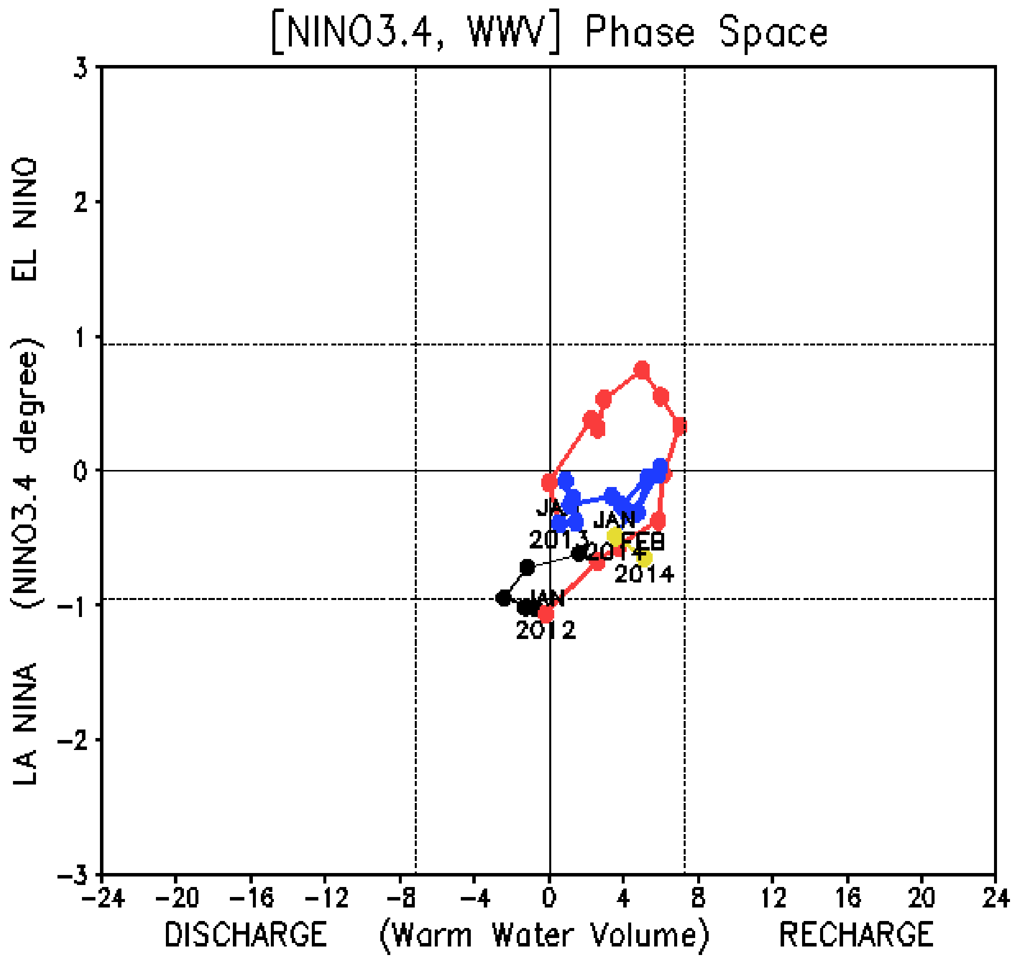
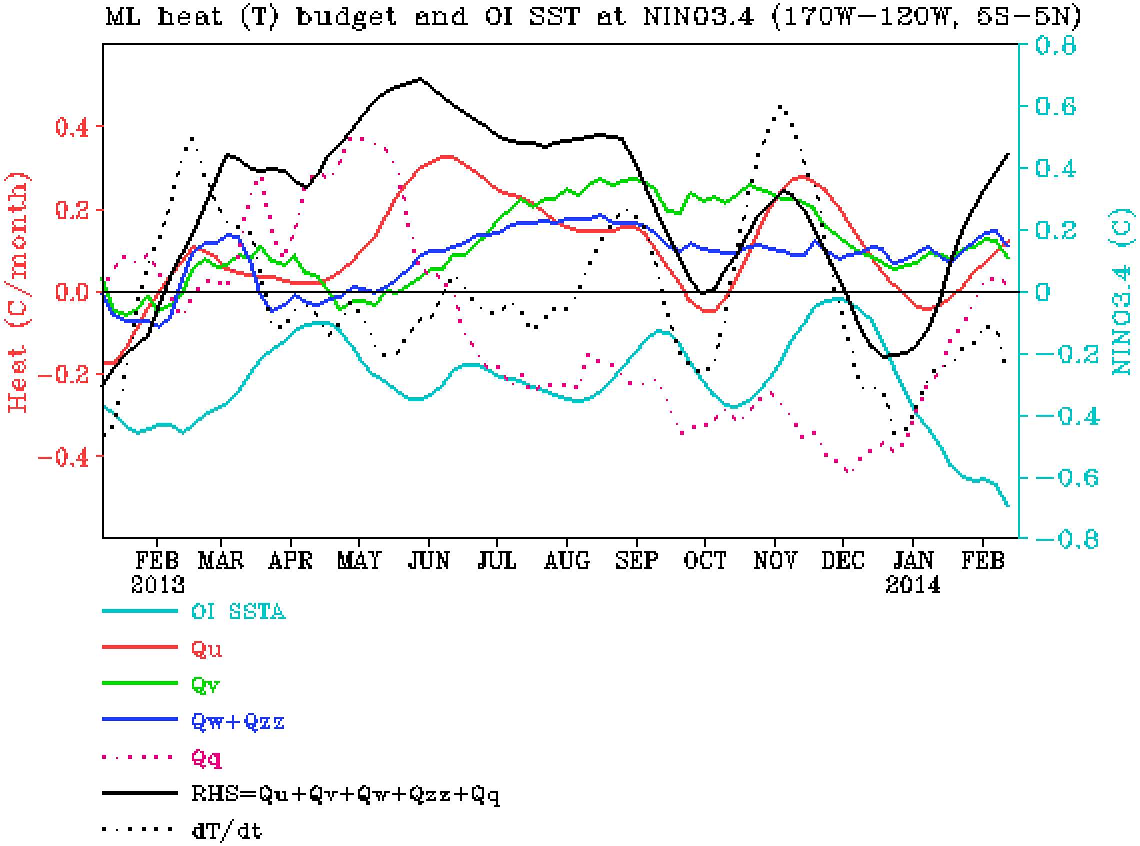


Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] calculated with the NCEP's global ocean data assimilation system. Anomalies are departures from the 1981-2010 base period means.

NINO3.4 Heat Budget



- SSTA tendency (dT/dt) in NINO3.4 (dotted line) was small negative in Feb 2014.

- Both Qu, Qv and Qw+Qzz were positive in Feb 2014.

- The total heat budget term (RHS) had large warm biases compared with the tendency (dT/dt) since Dec 2013.

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

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

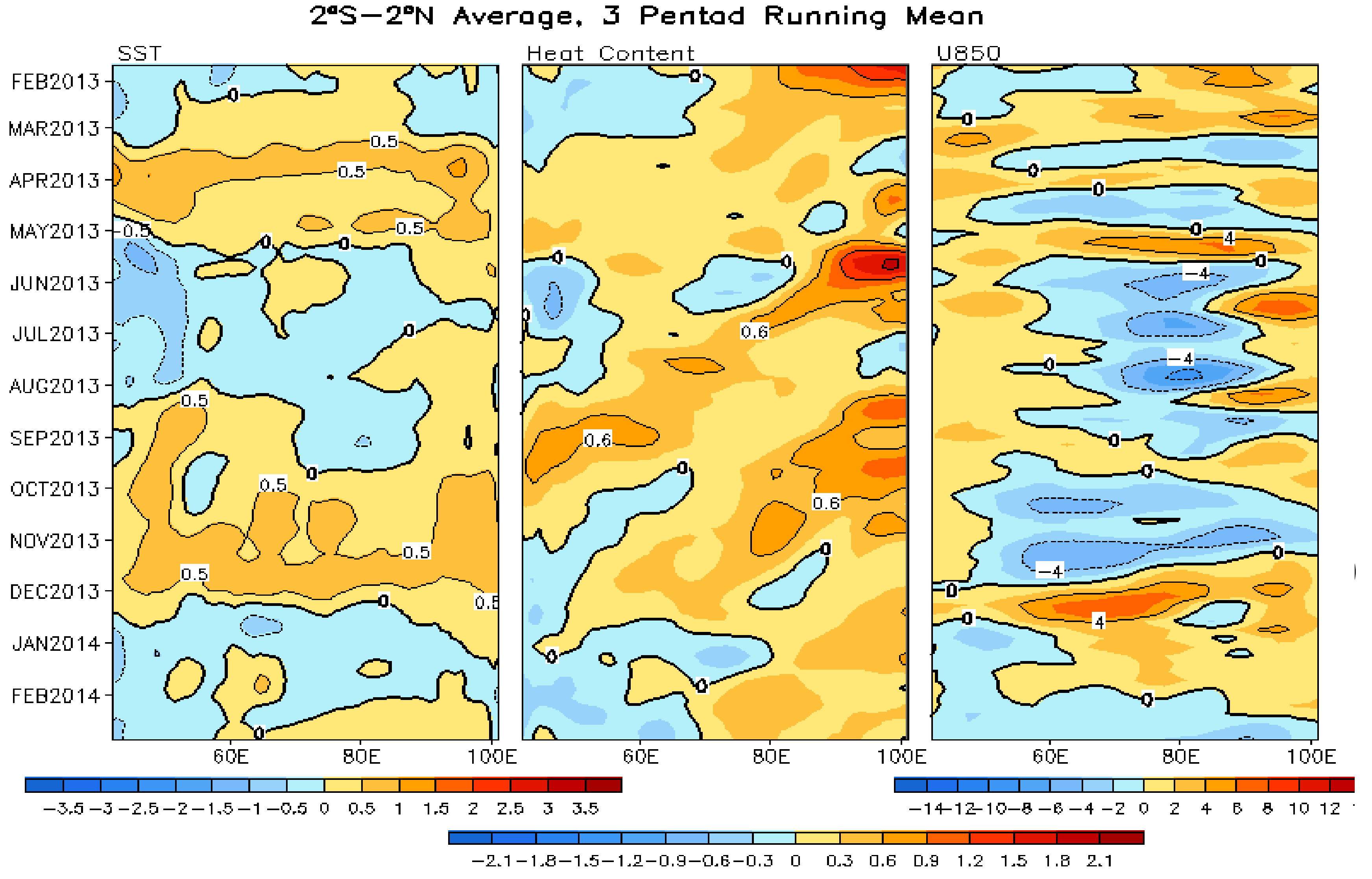


Fig. I3. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2ºS-2ºN and Outgoing Long-wave Radiation (OLR, right) averaged in 5ºS-5ºN. SST are derived from the NCEP OI SST, heat content from the NCEP's global ocean data assimilation system, and U850 from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period pentad means.

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

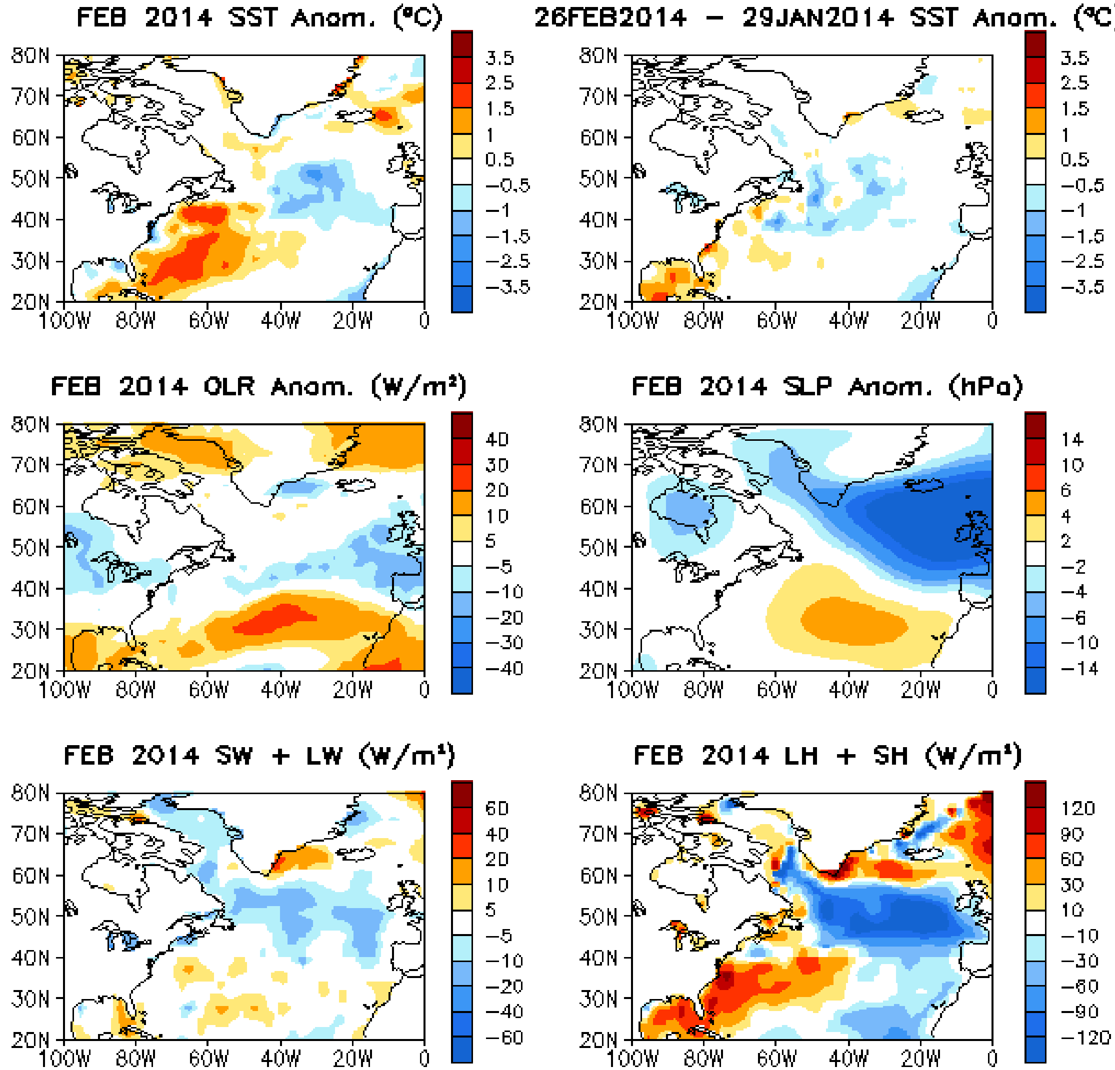
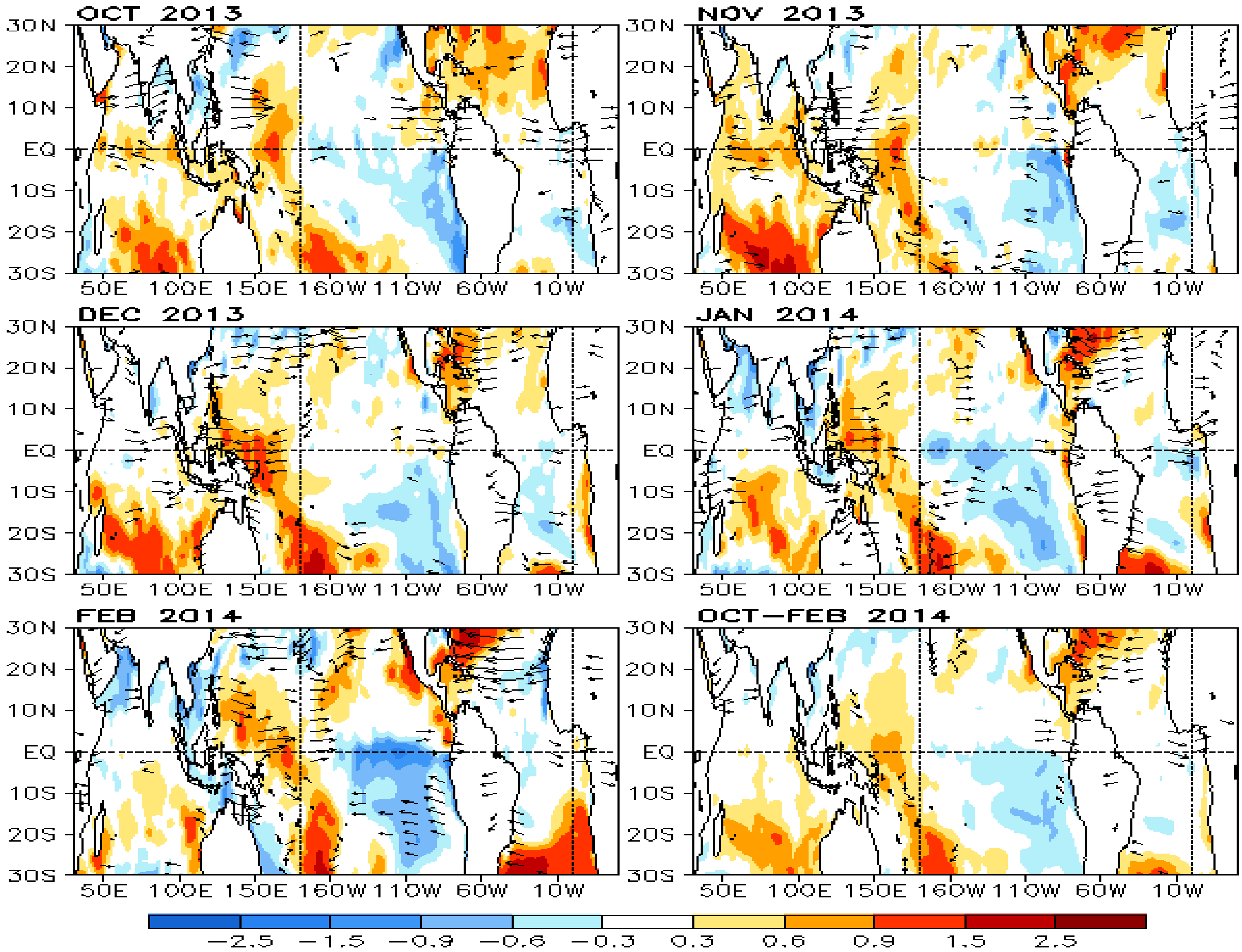


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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

Evolution of SST and 850mb Wind Anom.



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

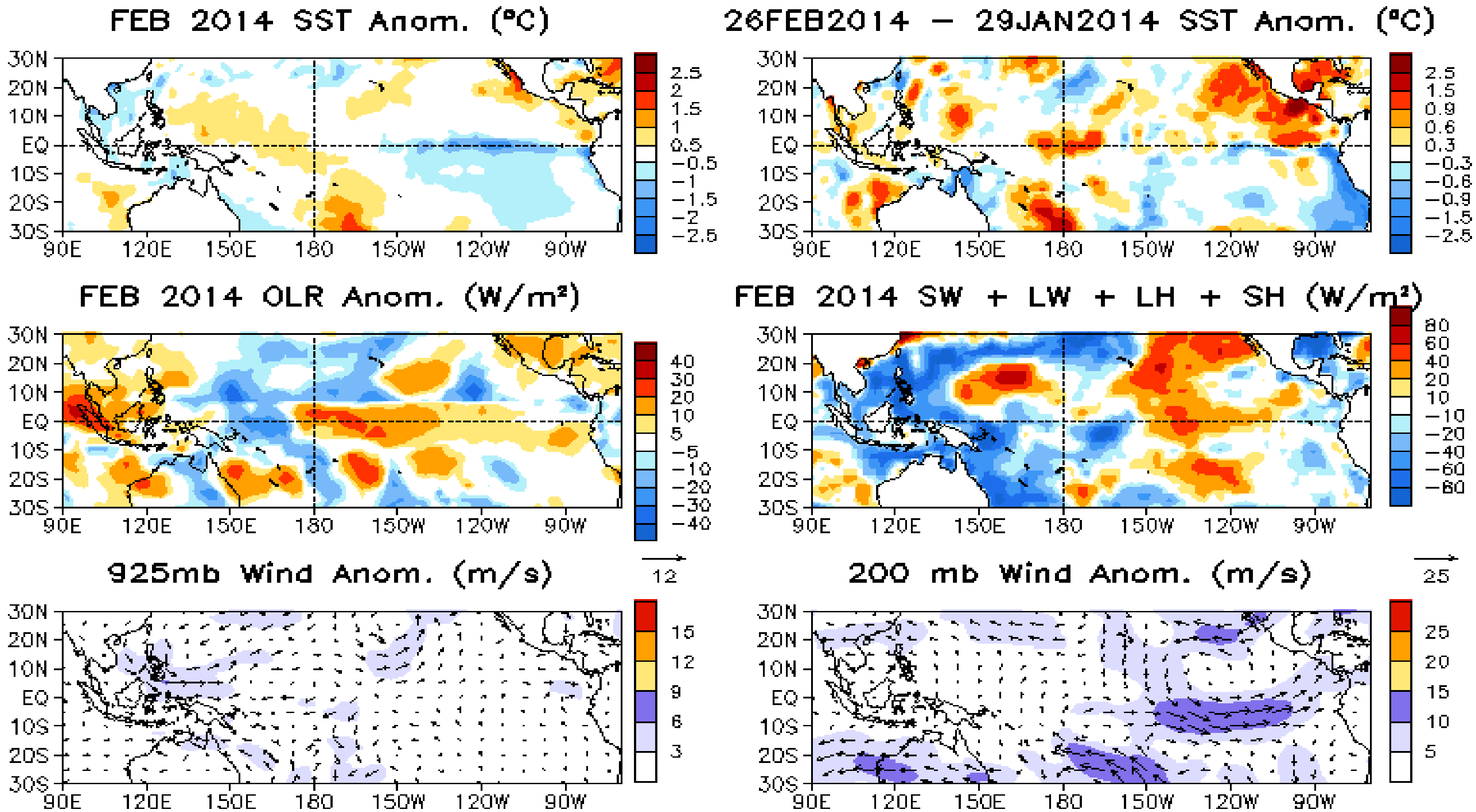
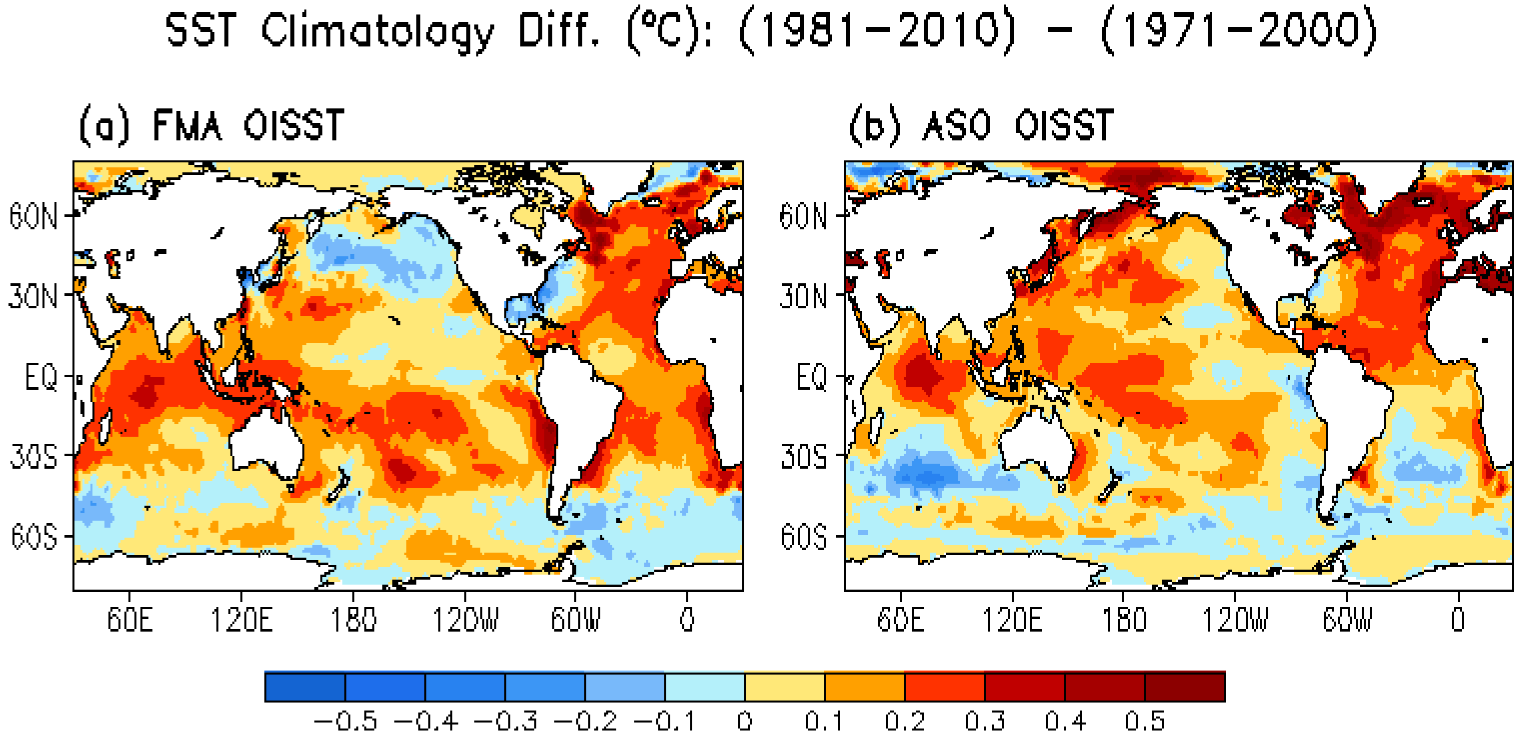


Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (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 1981-2010 base period means.

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^{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)**

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!