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

Prepared by
Climate Prediction Center, NCEP/NOAA

January 8, 2016

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 Ocean Climate Observation Program (OCO)

Outline

- Overview
- Recent highlights
  - Pacific/Arctic Ocean

    El Niño, NE Pacific Conditions
  - Indian Ocean
  - Atlantic Ocean
- Global SST predictions

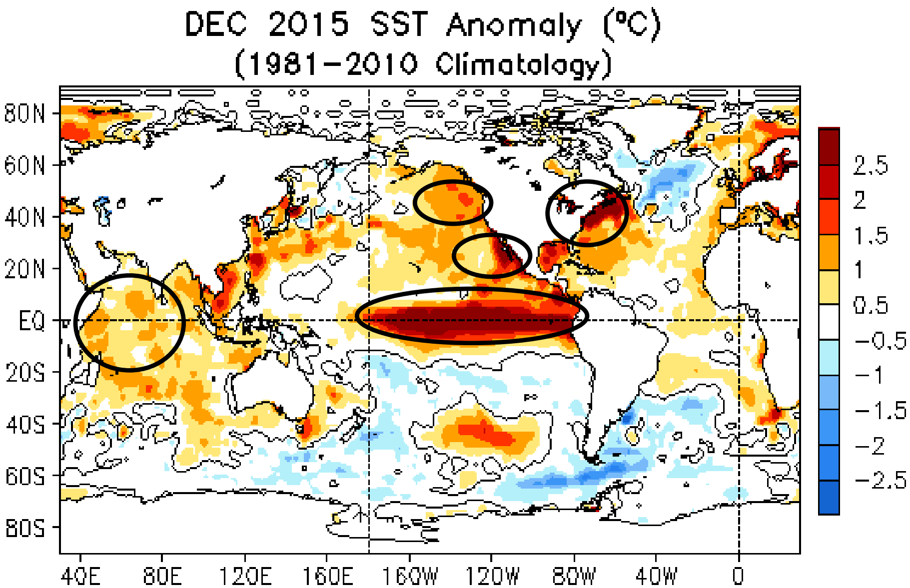
  El Niño, Blob/PDO, tropical North Atlantic

Overview

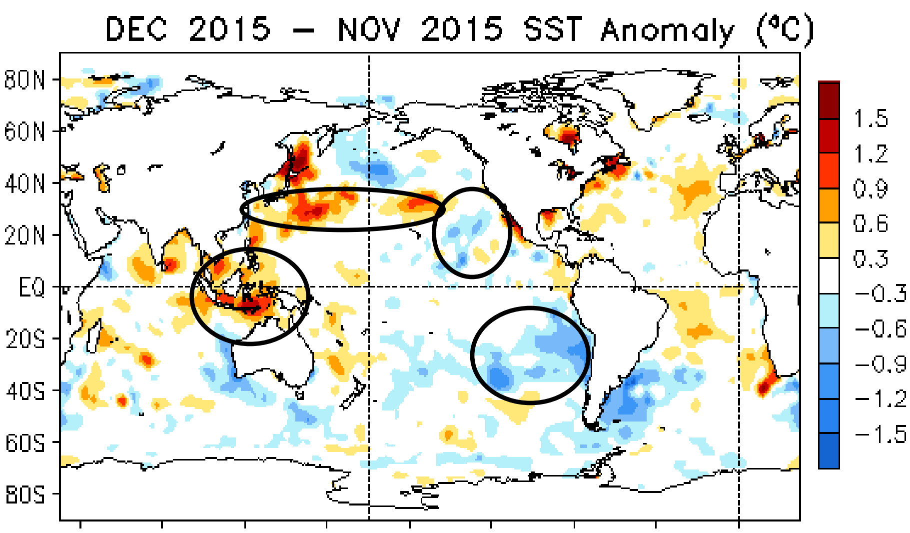
- **Pacific Ocean**
  - El Niño conditions weakened slightly in Dec 2015 and the atmospheric and oceanic anomalies reflect a strong El Niño.
  - Most models indicate that a strong El Niño will continue through the Northern Hemisphere winter 2015-16, followed by weakening and a transition to ENSO-neutral during the late spring or early summer.
  - The current conditions and recent evolution of the 2015 El Niño were compared with those of the 1982 and 1997 El Niño.
  - Upper ocean warming associated with the "Blob" has persisted since winter 2013/2014.
- **Indian Ocean**
  - Positive SSTA dominated most of the tropical Indian Ocean.
  - Southeastern tropical Indian Ocean (SETIO) Index increased.
- **Atlantic Ocean**
  - Positive NAO strengthened with NAO=+2.
  - SSTA were well above-average along the eastern coast of North America.

Global Oceans

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



- SSTA exceeded +2.5^{o}C across the central-eastern equatorial Pacific.
- Positive SSTA presented near the western and eastern coasts of North America.
- Positive SSTA continued in the tropical Indian Ocean.

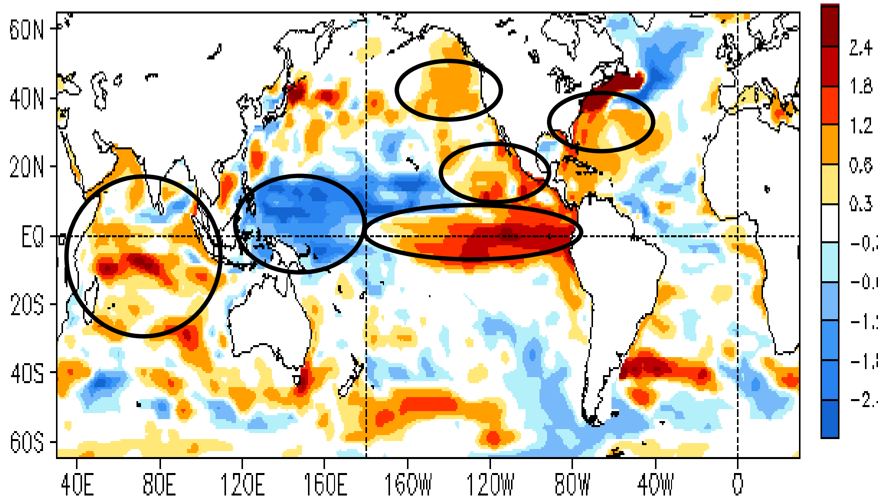


- Positive SSTA tendency was observed over the Maritime Continent and mid-latitude North Pacific.

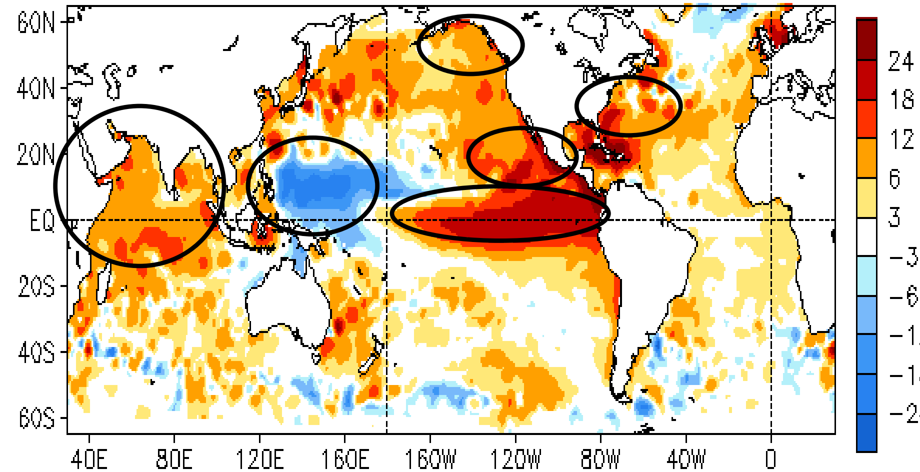
- Negative SSTA tendency presented in the southeast subtropical Pacific.

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.

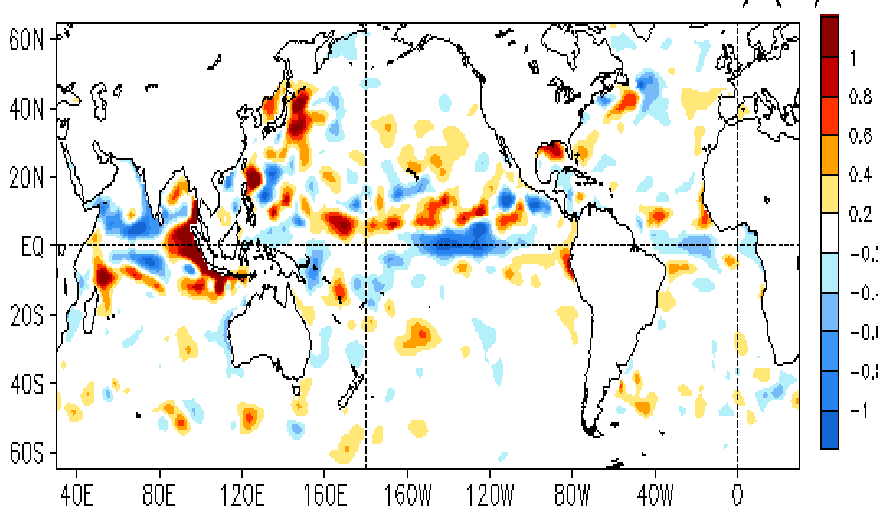
DEC 2015 Heat Content Anomaly (°C)
(GODAS, Climo. 81-10)



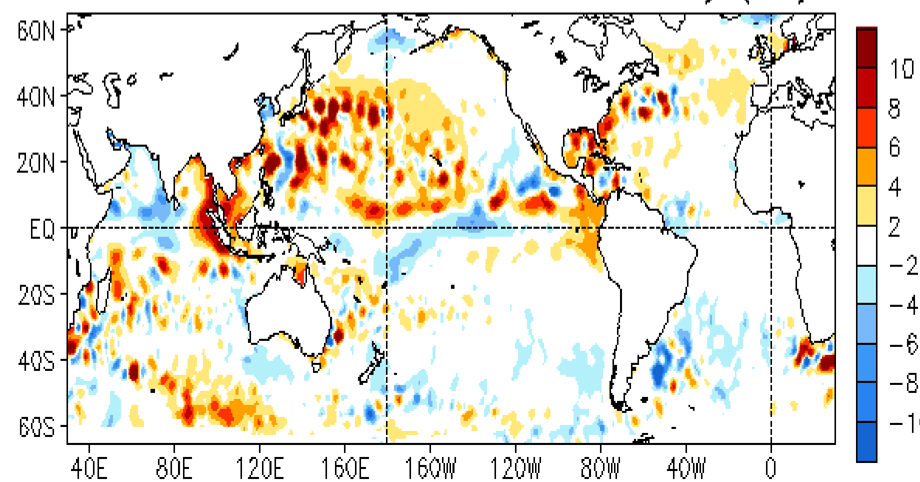
DEC 2015 SSH Anomaly (cm)
(AVISO Altimetry, Climo. 93-13)



DEC 2015 - NOV 2015 Heat Content Anomaly (°C)



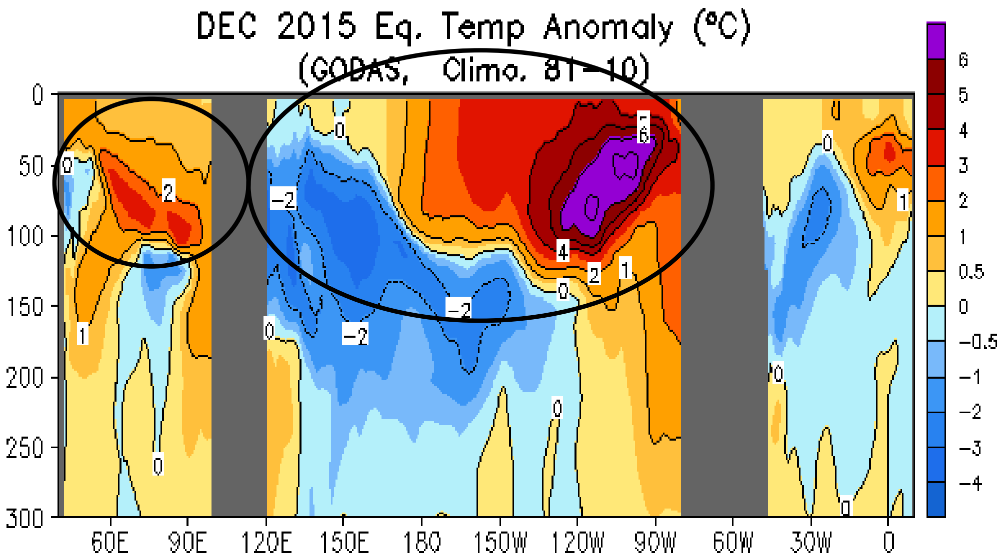
DEC 2015 - NOV 2015 SSH Anomaly (cm)



- **Patterns of upper 300m ocean heat content (HC300) and SSH anomaly were largely consistent with each other and also to the SST anomaly pattern except in the western Pacific.**

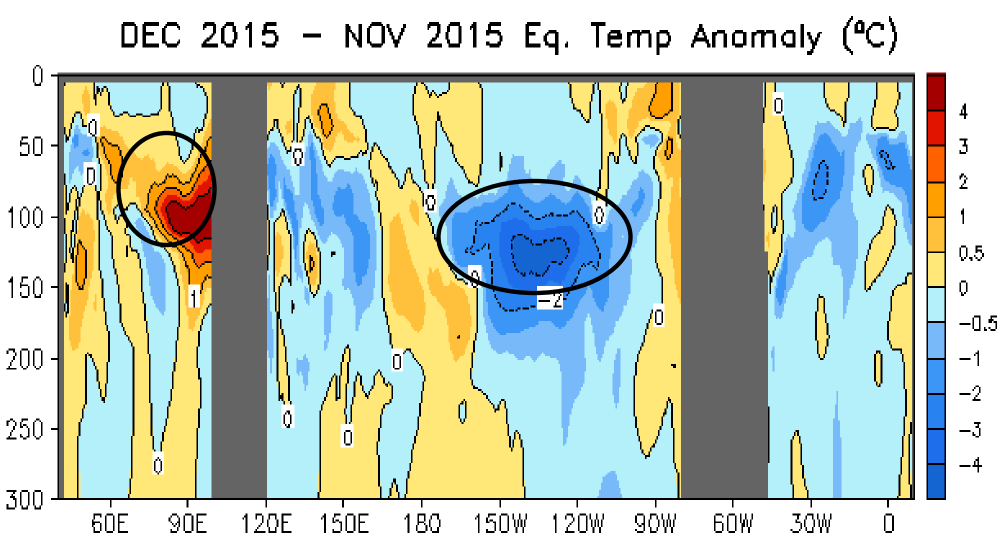
- **The tendency patterns in HC300 and SSH anomaly were largely consistent.**

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



- Positive (negative) temperature anomalies presented in the central-eastern (western) equatorial Pacific.

- Positive temperature anomalies dominated in the upper equatorial Indian Ocean.



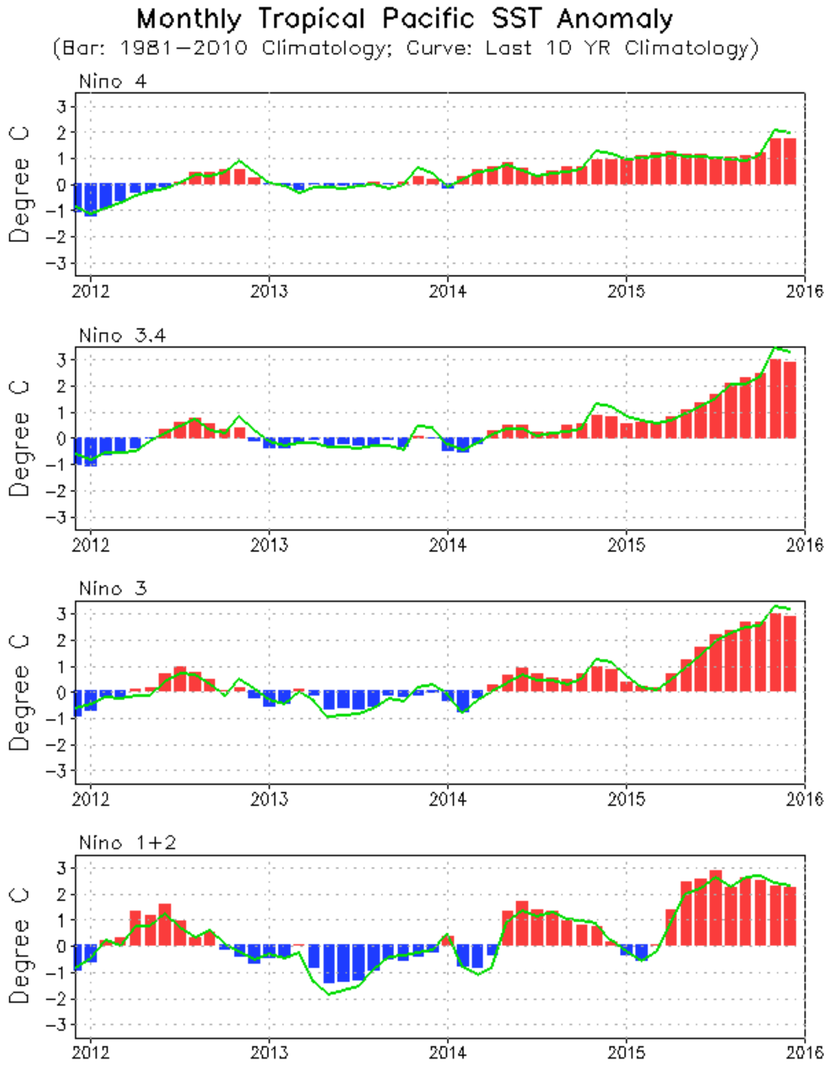
- Anomaly tendency was most prominent near the thermocline in the equatorial Pacific, with the largest amplitude around 140W.

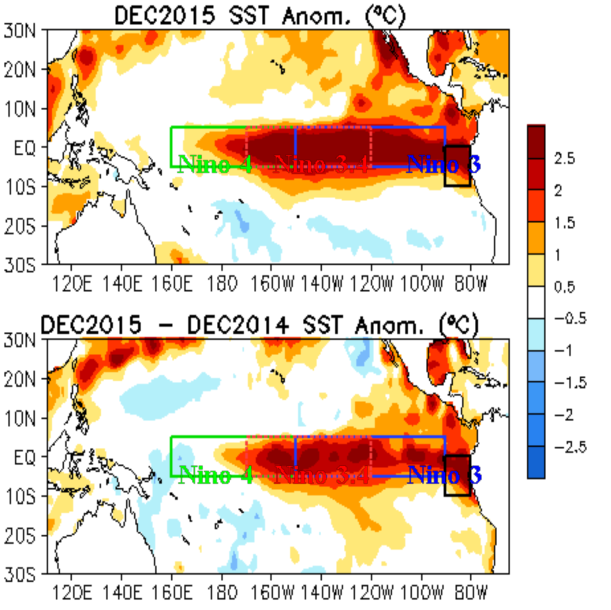
- Positive anomaly tendency was observed at 100m depth in the eastern Indian Ocean.

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 Pacific Ocean and ENSO Conditions

Evolution of Pacific NINO SST Indices

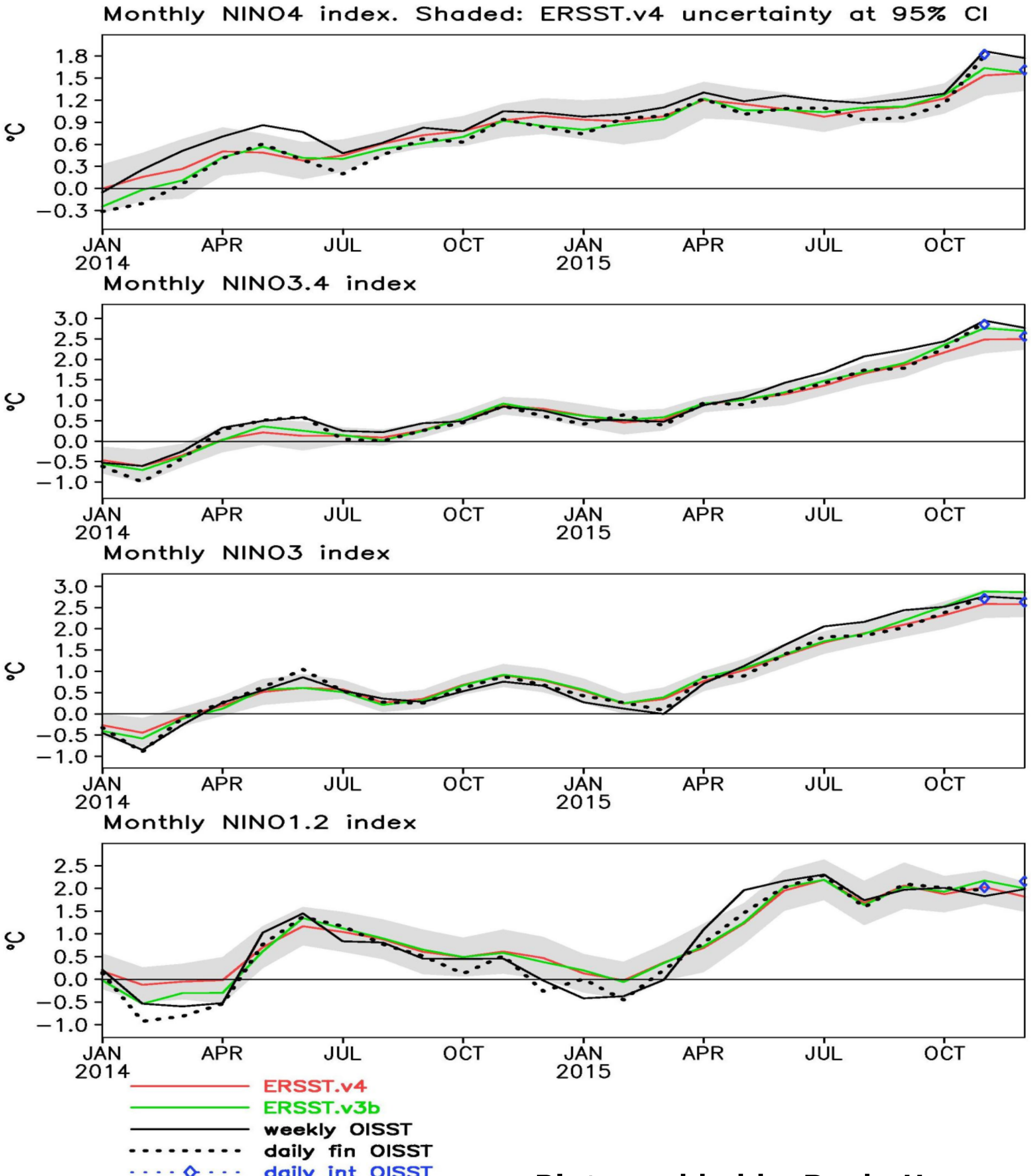




- All NINO indices except NINO4 decreased in Dec 2015.

- Nino3.4 = +2.82°C in Dec 2015, which is based on weekly OI SST.

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 (bar) and last ten year (green line) means.

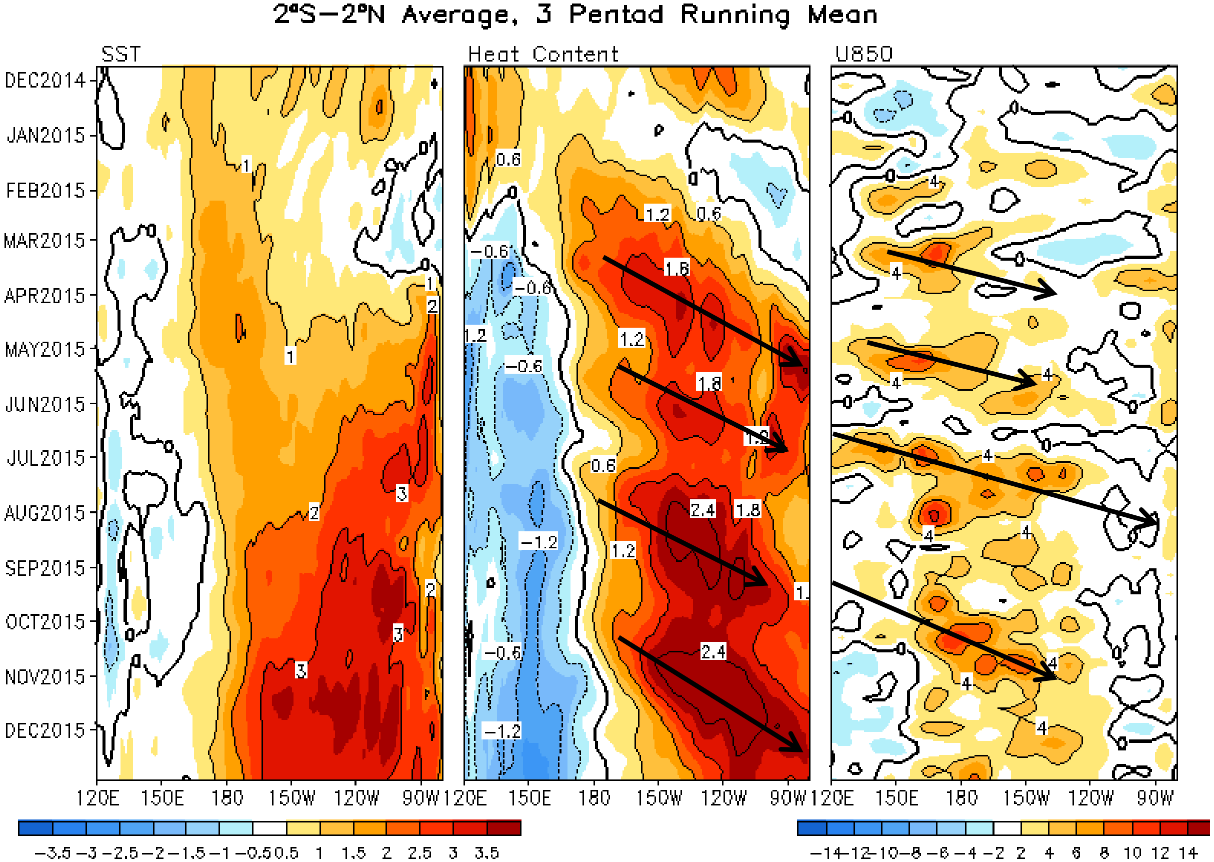


Plot provided by Boyin Huang

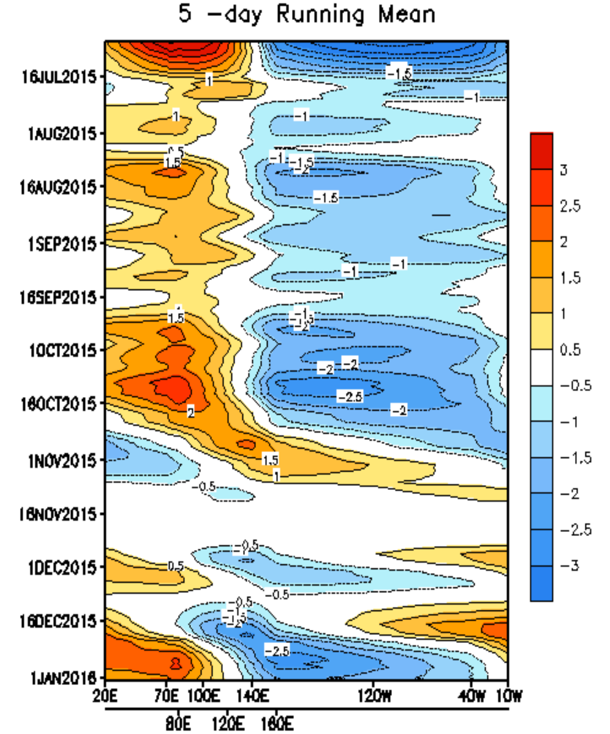
- NINO3.4 based on weekly OI SST (black line) is a few tenth degree higher than that based on ERSST.v4 (red line) in recent months, but all the indices are within the 95% confidence level of ERSST.v4 (shading).

- Note that the definition of ENSO events at NOAA (http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml) is based on ERSST.v4.

Equatorial Pacific SST (°C), HC300 (°C), u850 (m/s) and OLR(W/m²)Anomalies



CPC MJO Indices

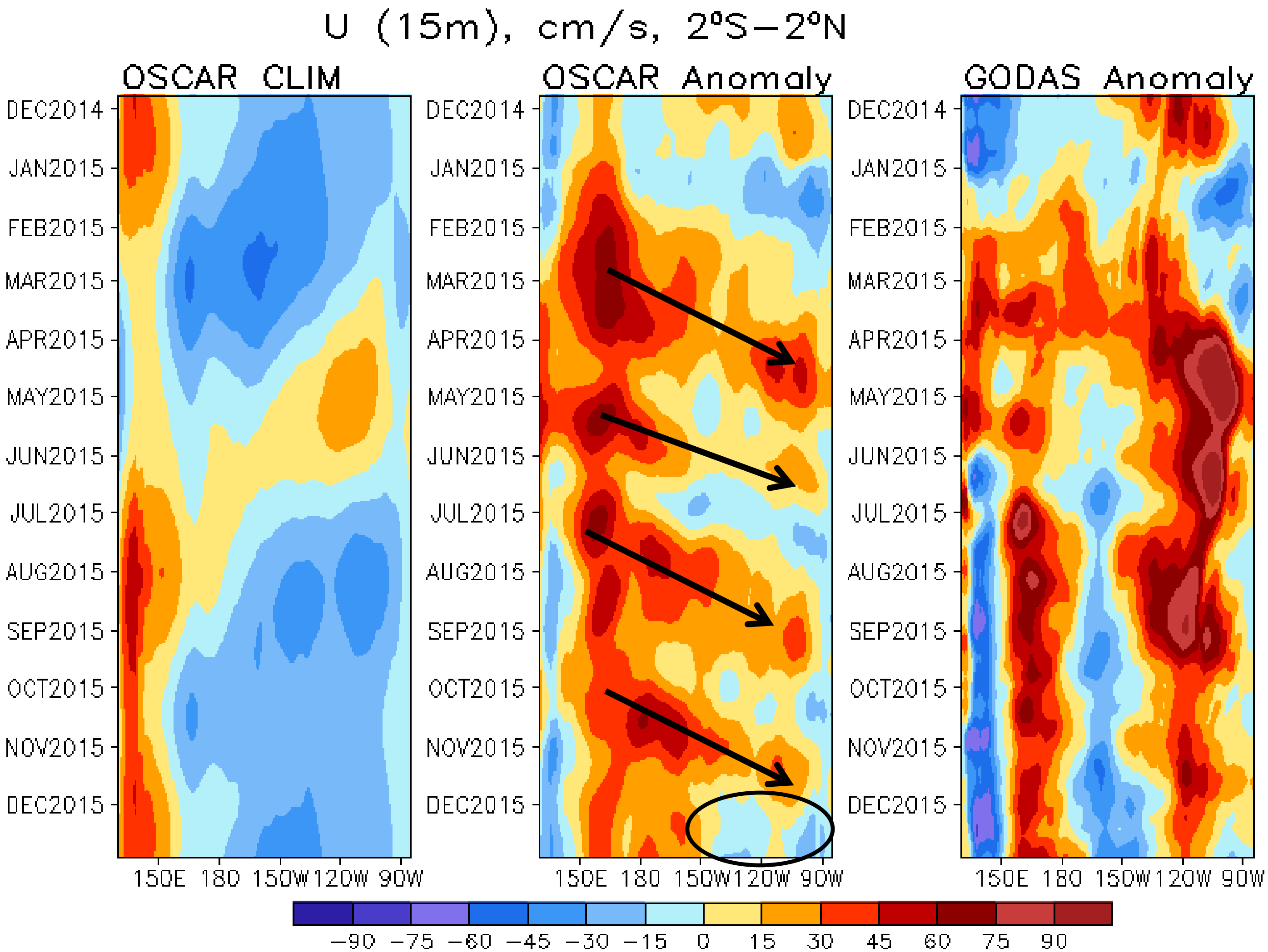


http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_mjo_index/mjo_index.shtml

- **Heat content anomaly was dominated by intraseasonal variability associated with four downwelling oceanic Kelvin wave episodes that were forced by four westerly wind burst events in Mar, May, Jul and Oct.**
- **However, SST anomaly was dominated by westward propagation in Apr-Oct 2015.**
- **Westerly wind anomaly were generally weak in Nov-Dec 2015, which was consistent with decreasing positive heat content anomalies in the past two months.**

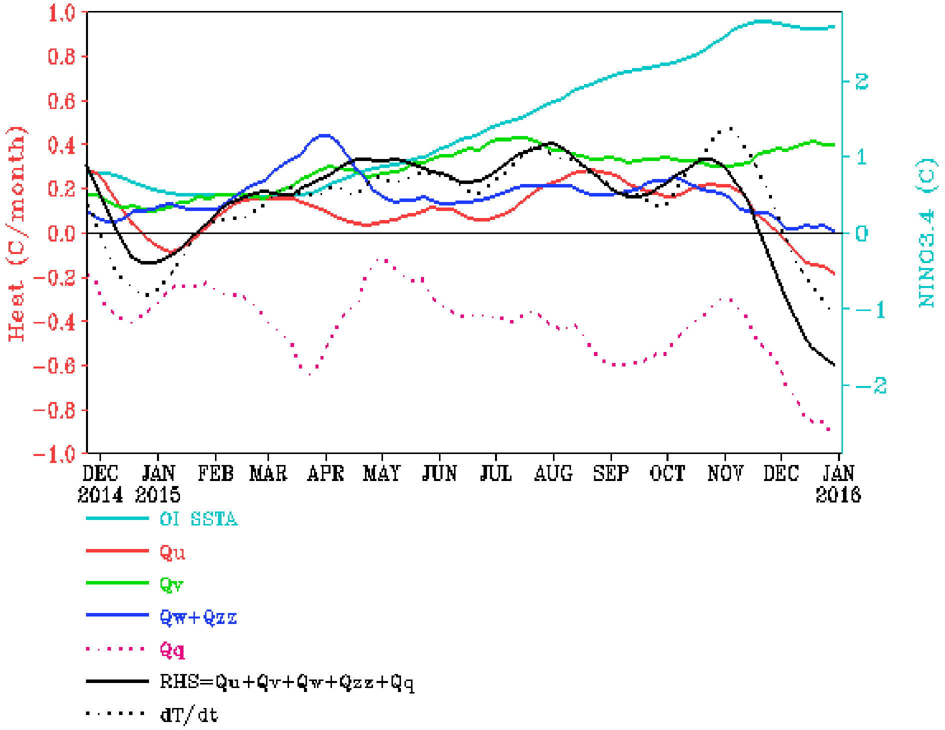
Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2°S-2°N and Outgoing Long-wave Radiation (OLR, right) averaged in 5°S-5°N. SST is derived from the NCEP OI 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 base period pentad means respectively.

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



- **Positive (negative) zonal current anomalies were associated with downwelling (upwelling) oceanic Kelvin waves.**
- **Westward zonal current anomalies emerged east of 150W in Dec 2015, favoring advective cooling in that region.**

NINO3.4 Heat Budget



- **SSTA tendency (dT/dt) in NINO3.4 region (dotted black line) was negative in Dec 2015, indicating a tendency for weakening NINO3.4.**

- **The cooling tendency was dominated by net surface heat fluxes (Qq) and zonal advection (Qu).**

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.

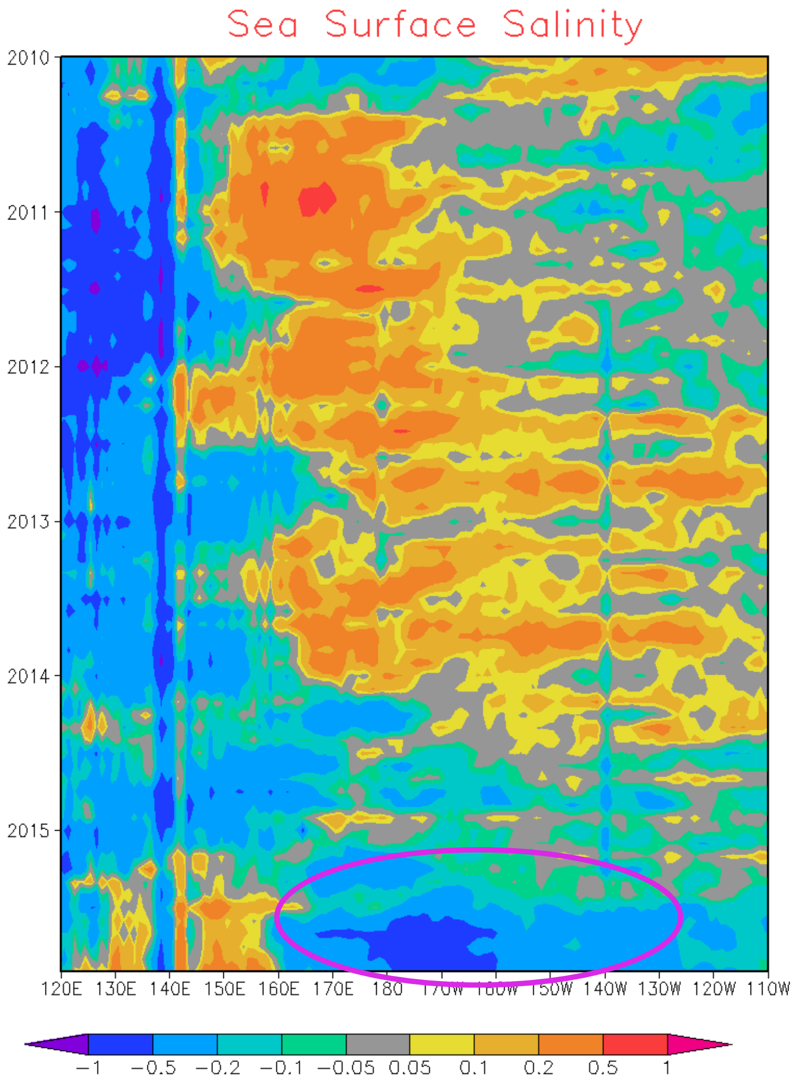
Qu: Zonal advection; Qv: Meridional advection;

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

Sea Surface Salinity (SSS)
Anomaly Evolution over Equatorial Pacific

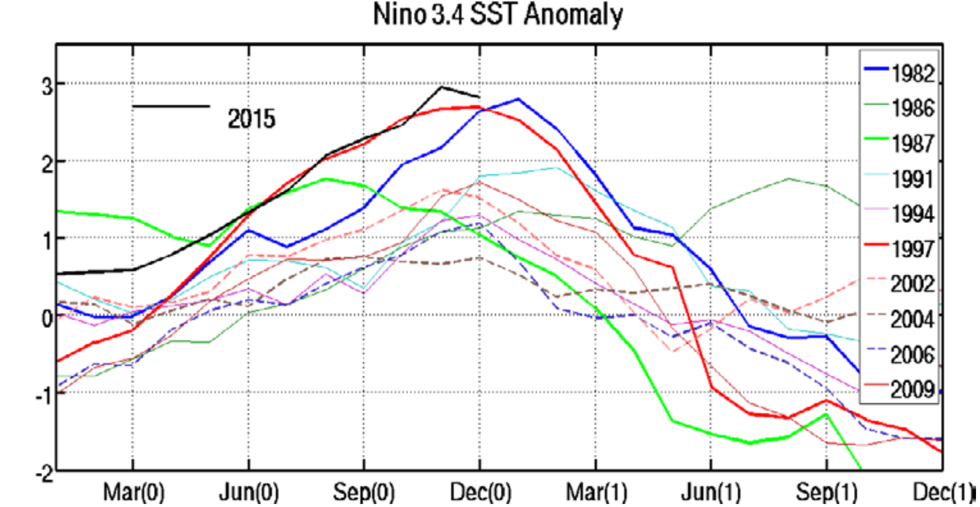


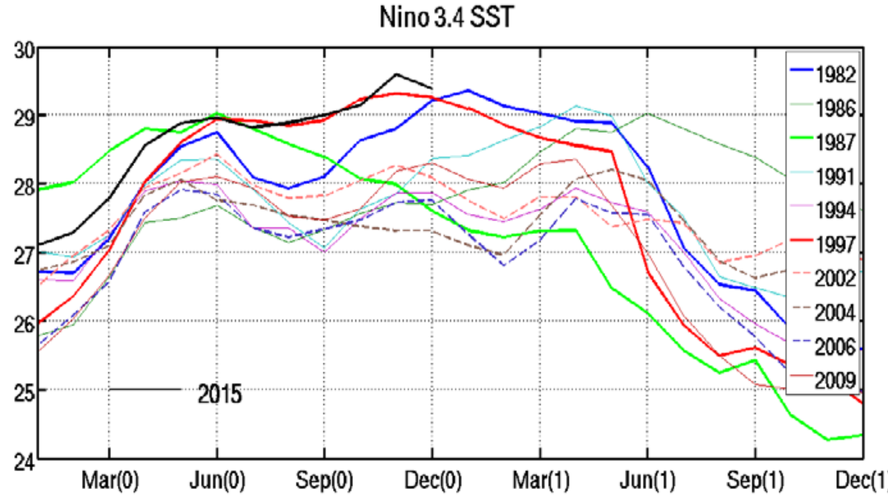
- Hovemoller diagram for equatorial SSS anomaly **(10ºS-10ºN)**

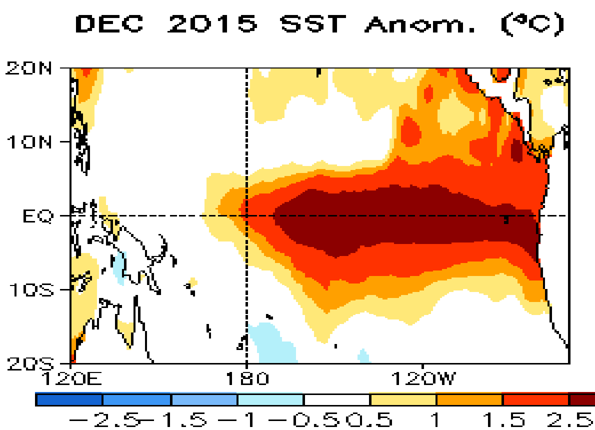
- Strong negative SSS anomaly persisted over the central and eastern Pacific, with the maximum SSS anomaly located around 170ºW. At the meantime, a stretch of positive SSS anomaly continued over the western Pacific from 130ºE – 160ºE, consistent with the strong El Nino conditions.

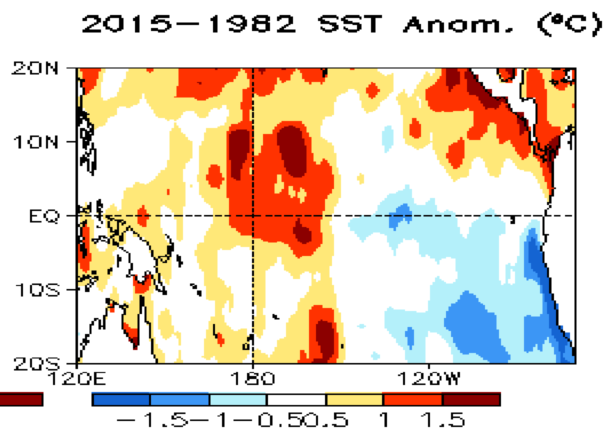
SSS :

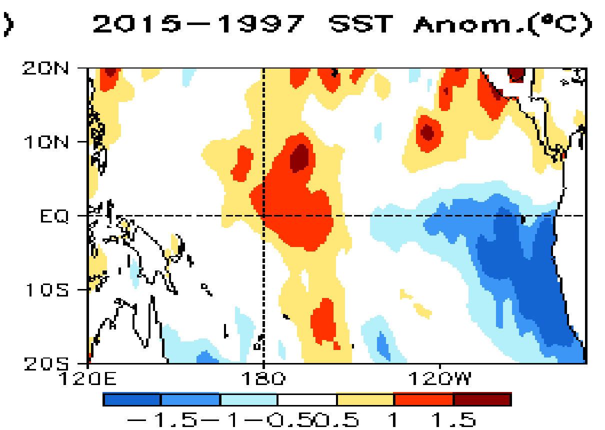
Blended Analysis of Surface Salinity (BASS) V0.Y
(a CPC-NESDIS/NODC-NESDIS/STAR joint effort)
(Xie et al. 2014)
ftp.cpc.ncep.noaa.gov/precip/BASS

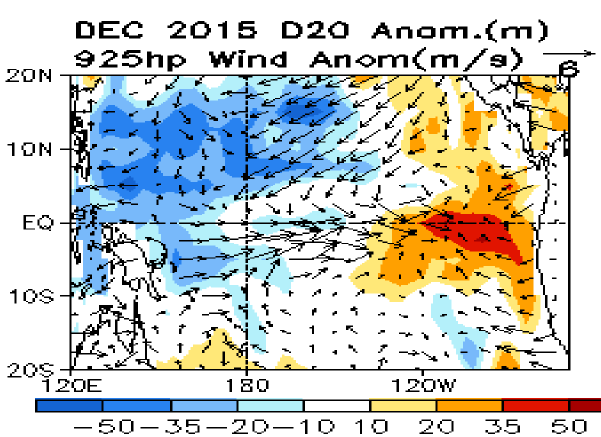

Nino 3.4 SST Anomaly
2015
1982
1986
1987
1991
1994
1997
2002
2004
2006
2009
3
2
1
0
-1
-2
Mar(0)
Jun(0)
Sep(0)
Dec(0)
Mar(1)
Jun(1)
Sep(1)
Dec(1)

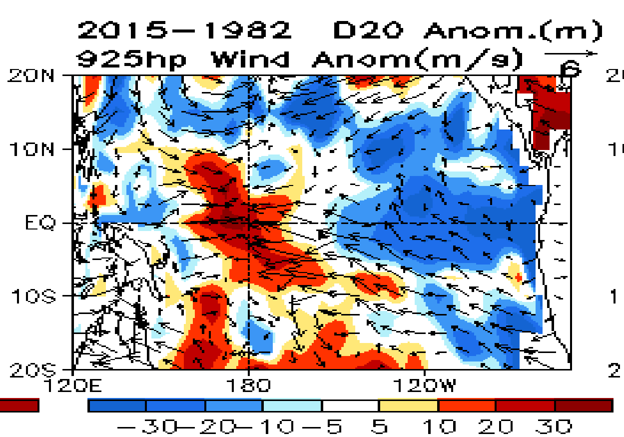

Nino 3.4 SST
2015
1982
1986
1987
1991
1994
1997
2002
2004
2006
2009
30
29
28
27
26
25
24
Mar(0)
Jun(0)
Sep(0)
Dec(0)
Mar(1)
Jun(1)
Sep(1)
Dec(1)

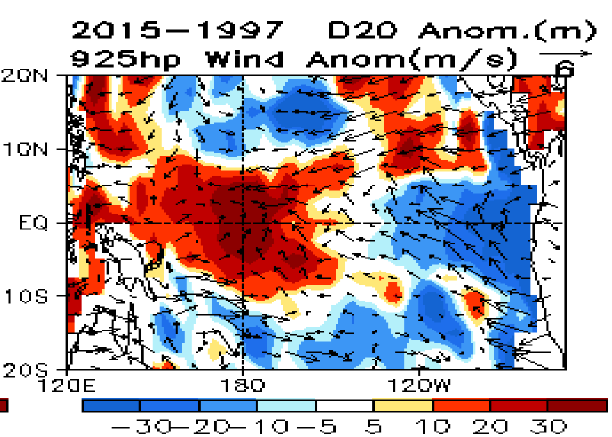

DEC 2015 SST Anom. (°C)
20N
10N
EQ
10S
20S
120E
180
120W
−2.5 −1.5 −1 −0.5 0.5 1 1.5 2.5


2015−1982 SST Anom. (°C)
20N
10N
EQ
10S
20S
120E
180
120W
−1.5 −1 −0.5 0.5 1 1.5


2015−1997 SST Anom.(°C)
20N
10N
EQ
10S
20S
120E
180
120W
−1.5 −1 −0.5 0.5 1 1.5


DEC 2015 D20 Anom.(m)
925hp Wind Anom(m/s)
6
20N
10N
EQ
10S
20S
120E
180
120W
−50 −35 −20 −10 10 20 35 50

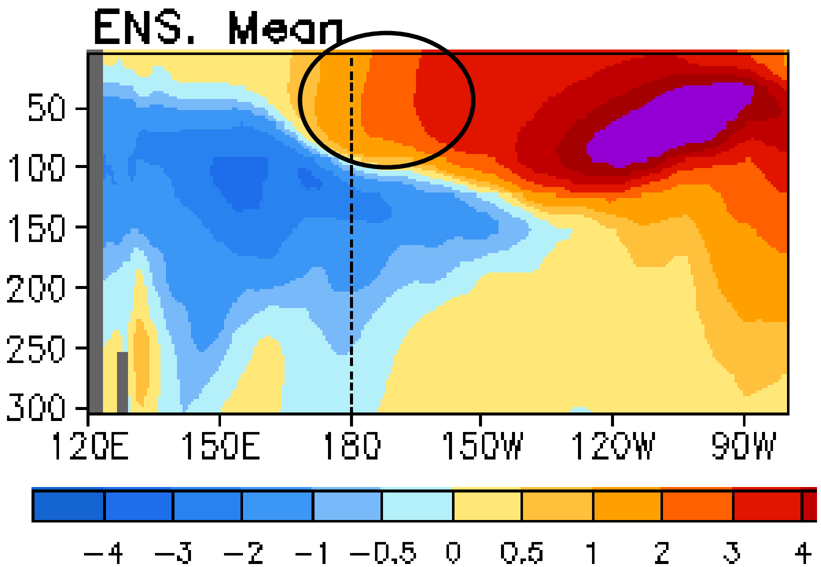

2015−1982 D20 Anom.(m)
925hp Wind Anom(m/s)
6
20N
10N
EQ
10S
20S
120E
180
120W
−30 −20 −10 −5 5 10 20 30


2015−1997 D20 Anom.(m)
925hp Wind Anom(m/s)
6
20N
10N
EQ
10S
20S
120E
180
120W
−30 −20 −10 −5 5 10 20 30

Real-time Ocean Reanalysis Intercomparison Project

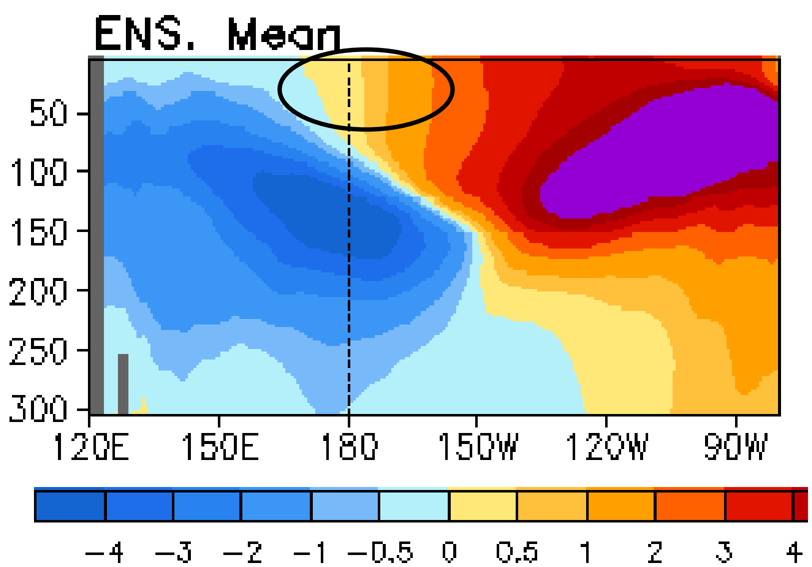
(http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html)

Dec 2015

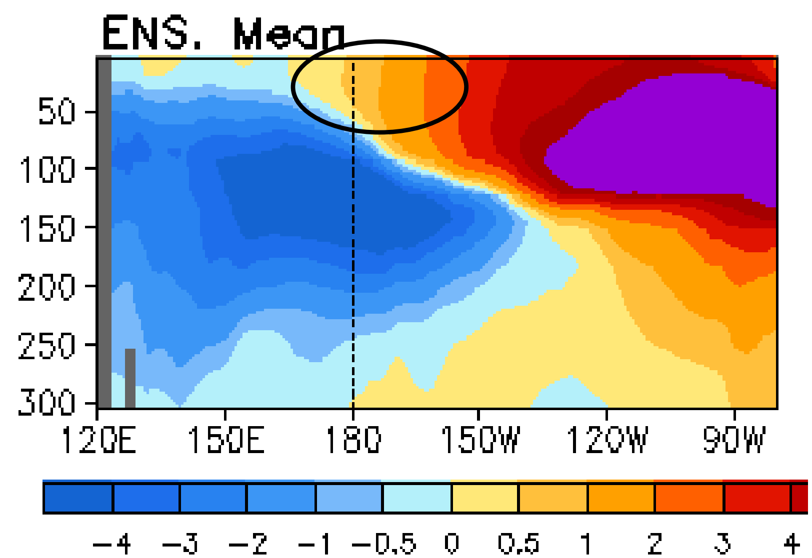


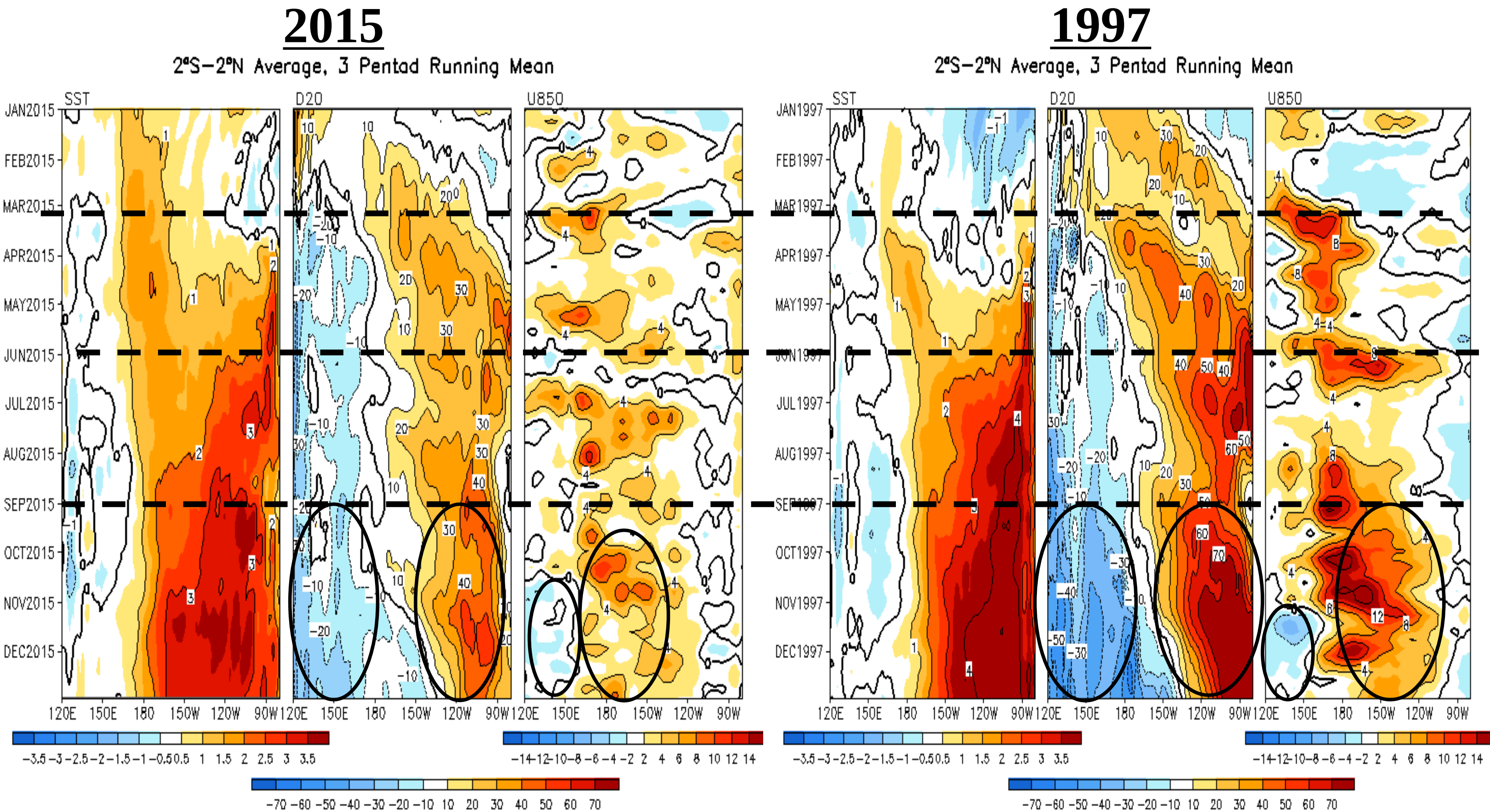
- **The subsurface temperature anomaly averaged in 1ºS-1ºN in Dec 2015 was warmer (colder) in the western-central (eastern) equatorial Pacific than in Dec 1982 and 1997, suggesting a westward shift of maximum warm anomaly and overall weaker amplitude of anomaly.**

Dec 1982

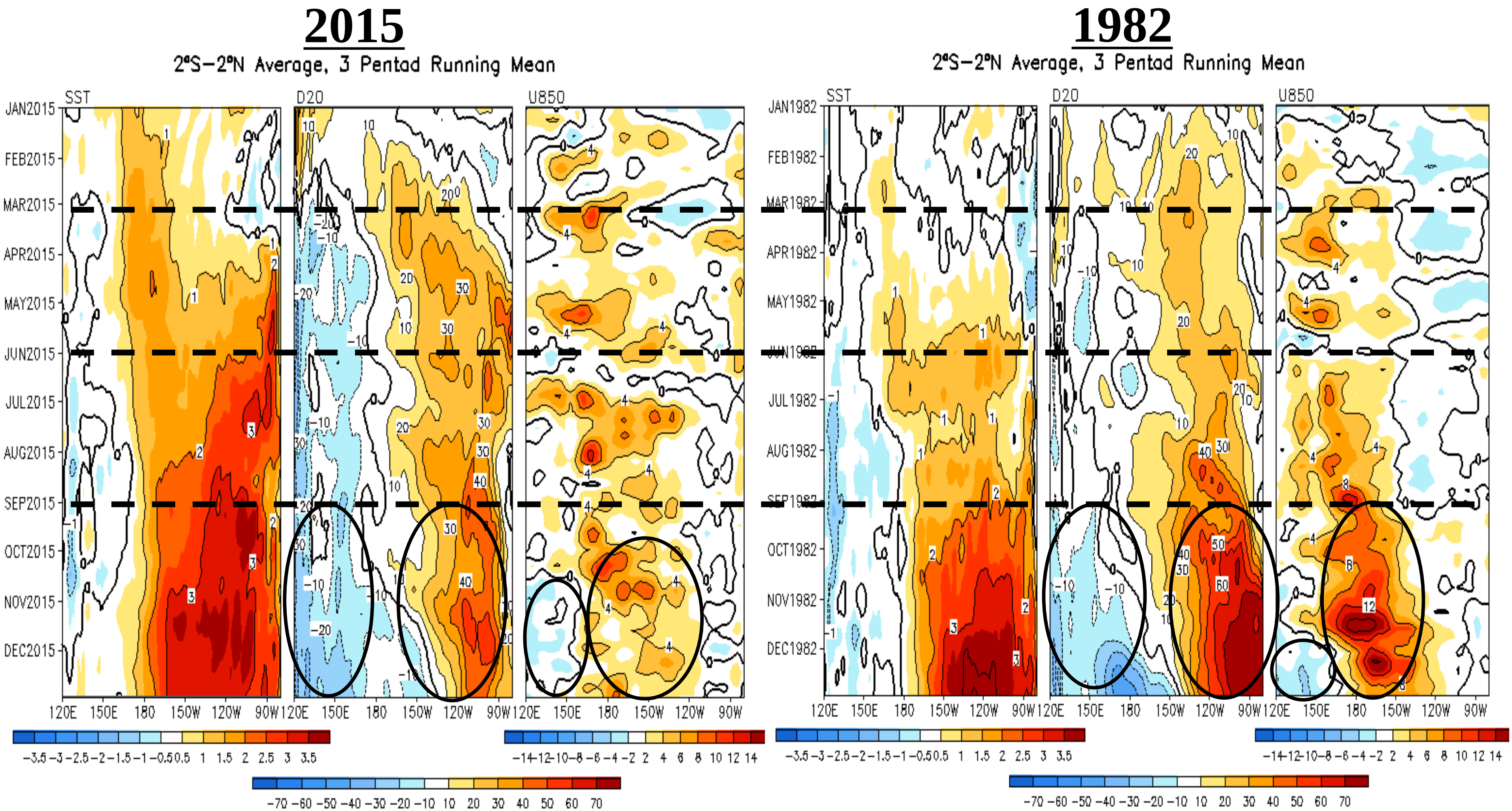


Dec 1997



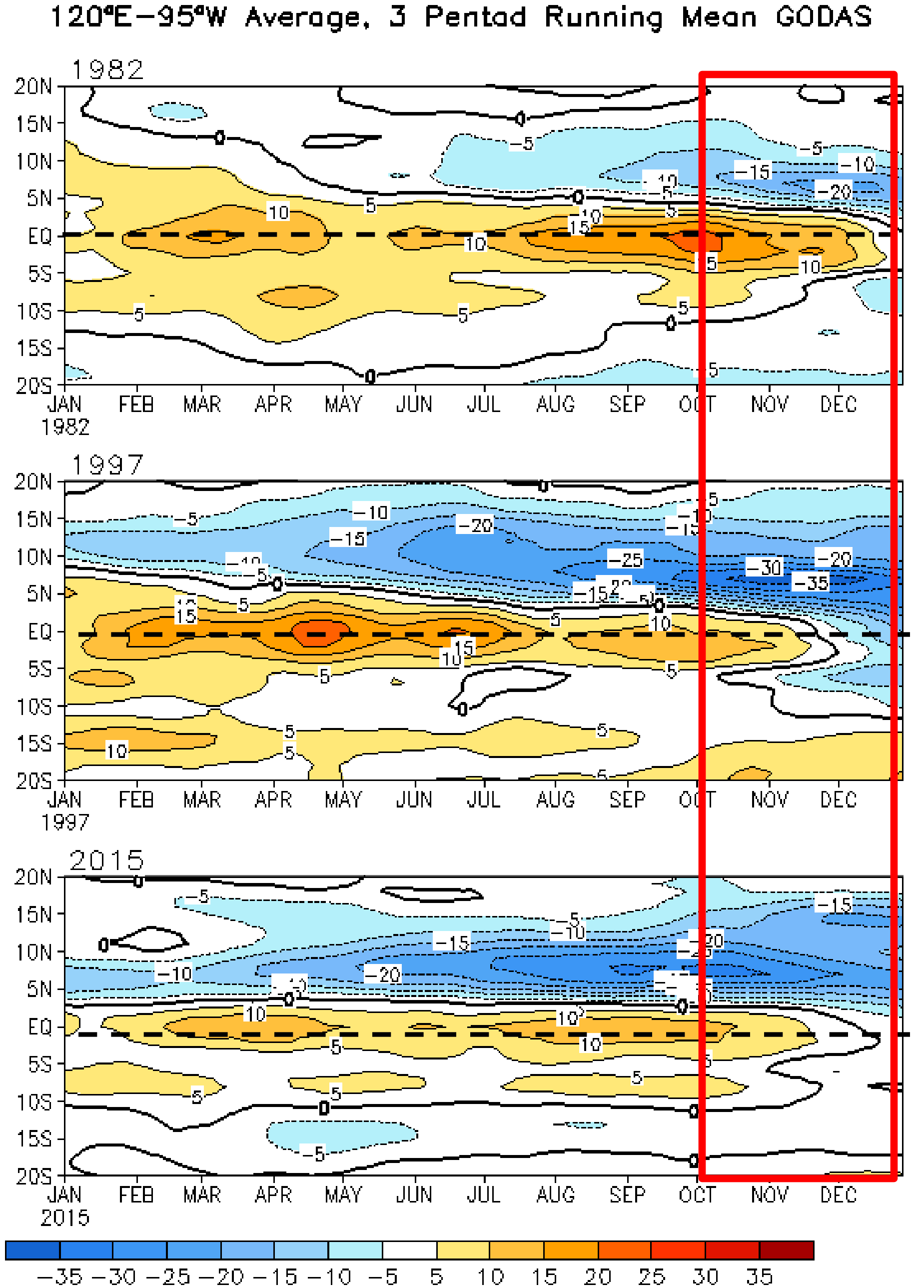


- Compared to 1997, westerly wind anomalies in 2015 were much weaker.
- Consistent with weaker westerly wind anomalies, the 20^oC depth anomaly dipole, positive in the east and negative in the west, was much weaker.



- **The SST and 20°C depth anomalies were stronger in 2015 than those in 1982 before September.**
- **However, associated with strong westerly wind anomalies since September 1982, the amplitude of 20°C depth anomaly grew rapidly and became stronger than that in 2015 since then.**

Zonal Average of 20ºC Depth anomaly

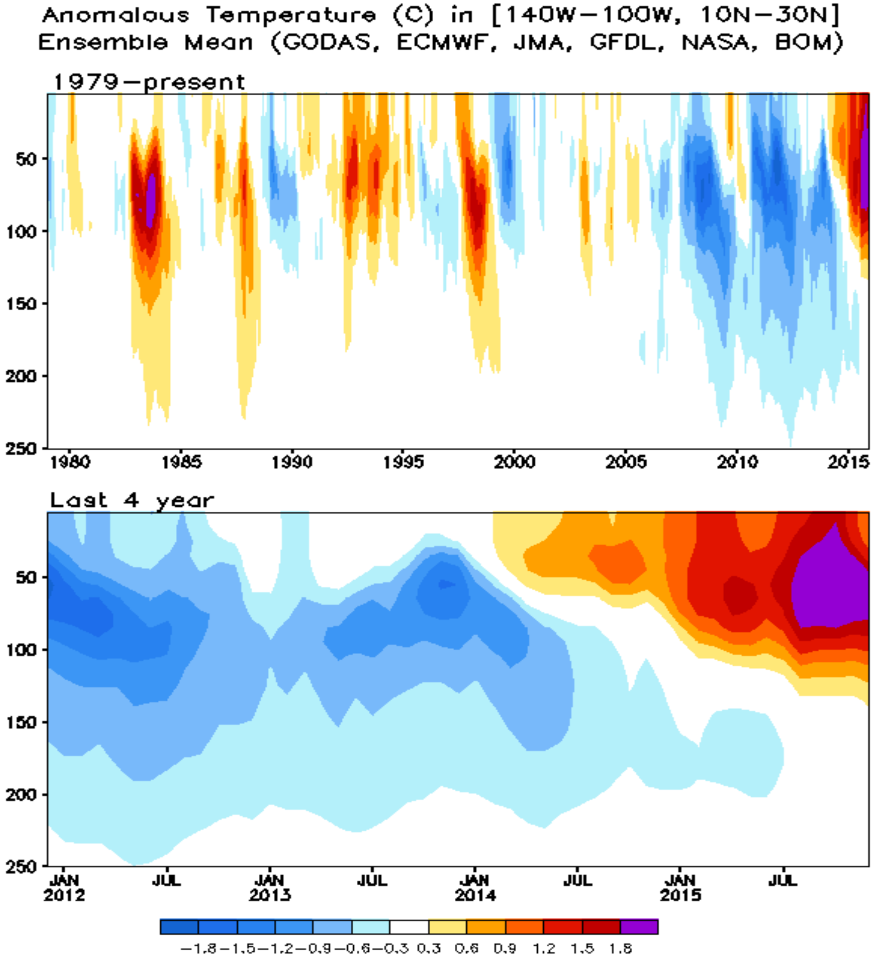


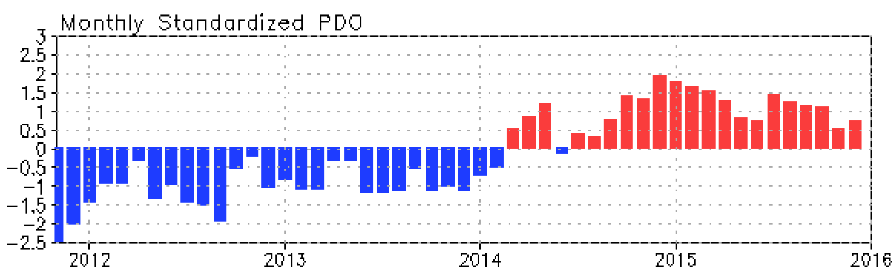
- There was warm (cold) water built up in 3S-3N (5N-10N) in spring 2015, which was similar to that in spring 1997 except the anomalies were weaker and more confined near the equator.

- For both the 1997 and 2015 El Nino, there was a rapid enhancement of the cold anomaly around 5N-15N in spring and summer.

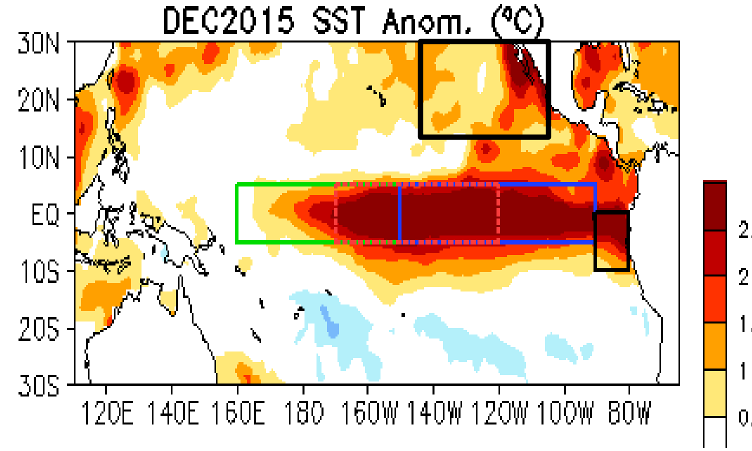
- During Oct-Dec, there was a rapid discharge of warm anomaly in 5S-5N in 1982 and 1997. Comparatively, the equatorial warm water discharge was much weaker in 2015.

- What is the implication of the weaker discharge for the phase transition of the El Nino?





NE Subtropical Pacific Warming

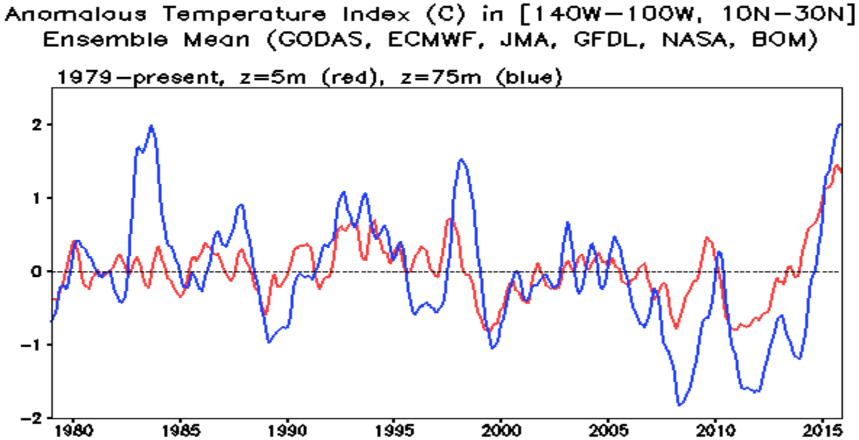


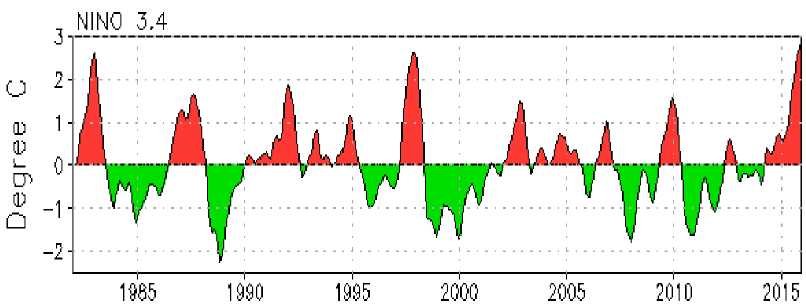
- **The strong positive SSTA in the NE subtropical Pacific [140°W-100°W, 10°N-30°N] emerged in early 2014, and the warming enhanced and migrated to the depth since then.**

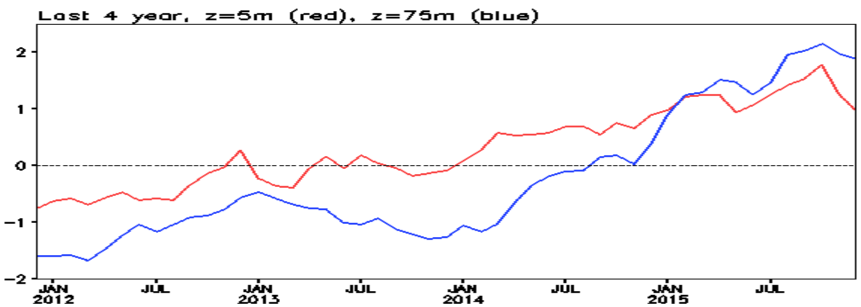
- **The development of positive SSTA in the region coincided with the switch to positive PDO phase.**

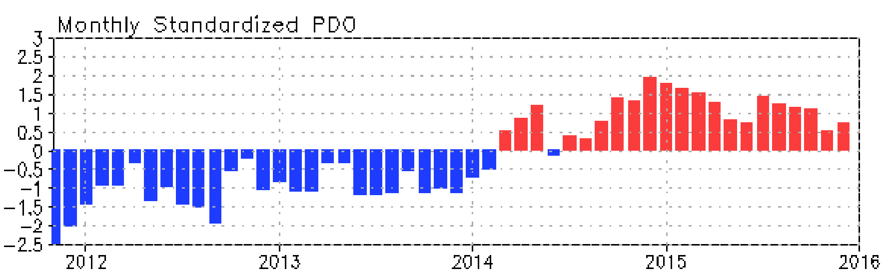
- **Positive SSTA weakened substantially near the surface, but persisted in the subsurface in Dec 2015.**

NE Subtropical Pacific Warming









- The strong positive SSTA in the NE subtropical Pacific [140°W-100°W, 10°N-30°N] (red line) **reached a historical high in Nov 2015**.

- The temperature anomaly at 75m (blue line) shows stronger signature of ENSO than the SSTA.

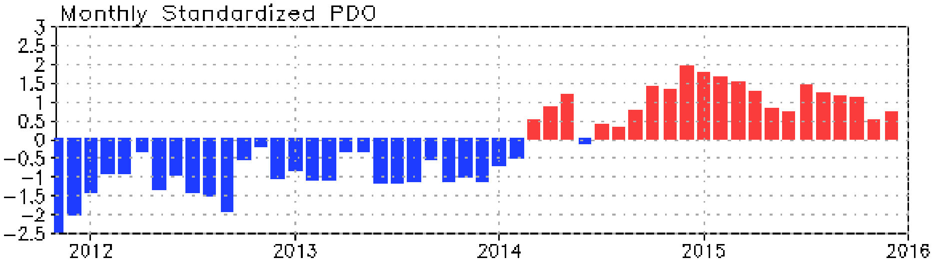
- The development of positive SSTA in the region coincided with the switch to positive PDO phase.

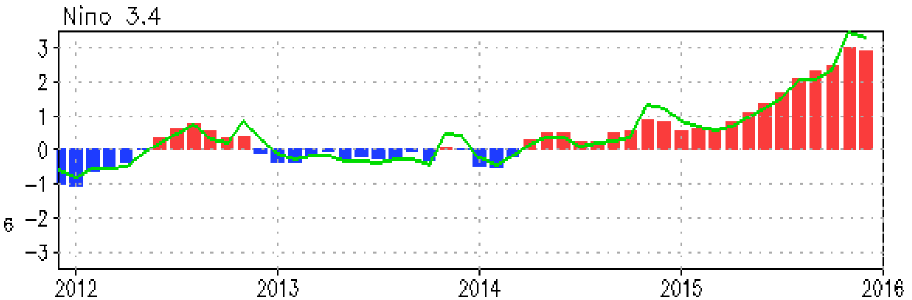
- The warming penetrated to 75m at the beginning of 2015 and had contributed to enhanced Eastern Pacific hurricane activity in 2015.

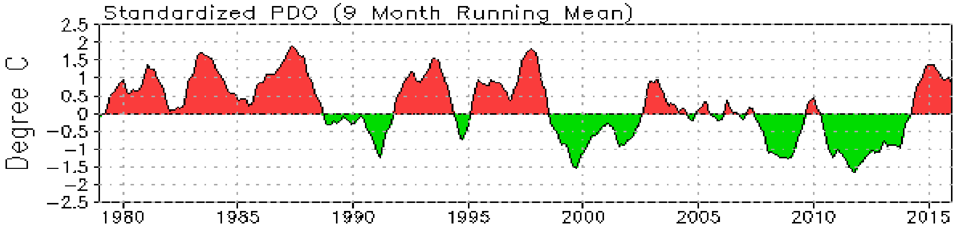
- **What physical processes contributed to the historical warming in 2015? Was the warming associated to the current El Nino?**

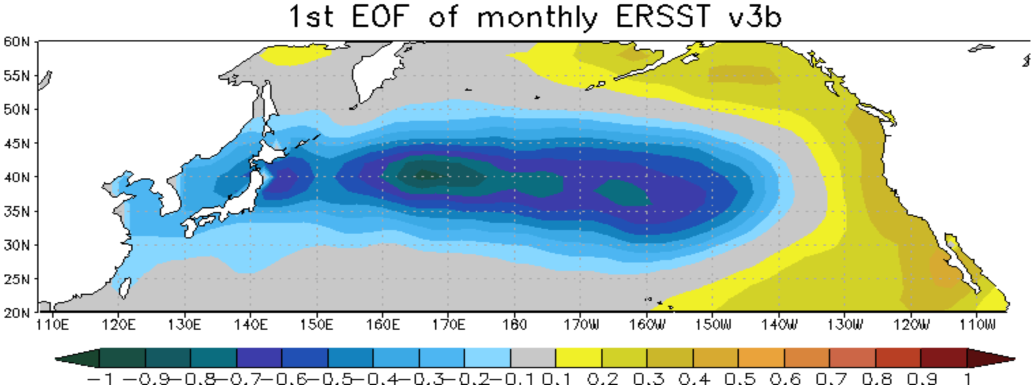
North Pacific & Arctic Oceans

Pacific Decadal Oscillation Index







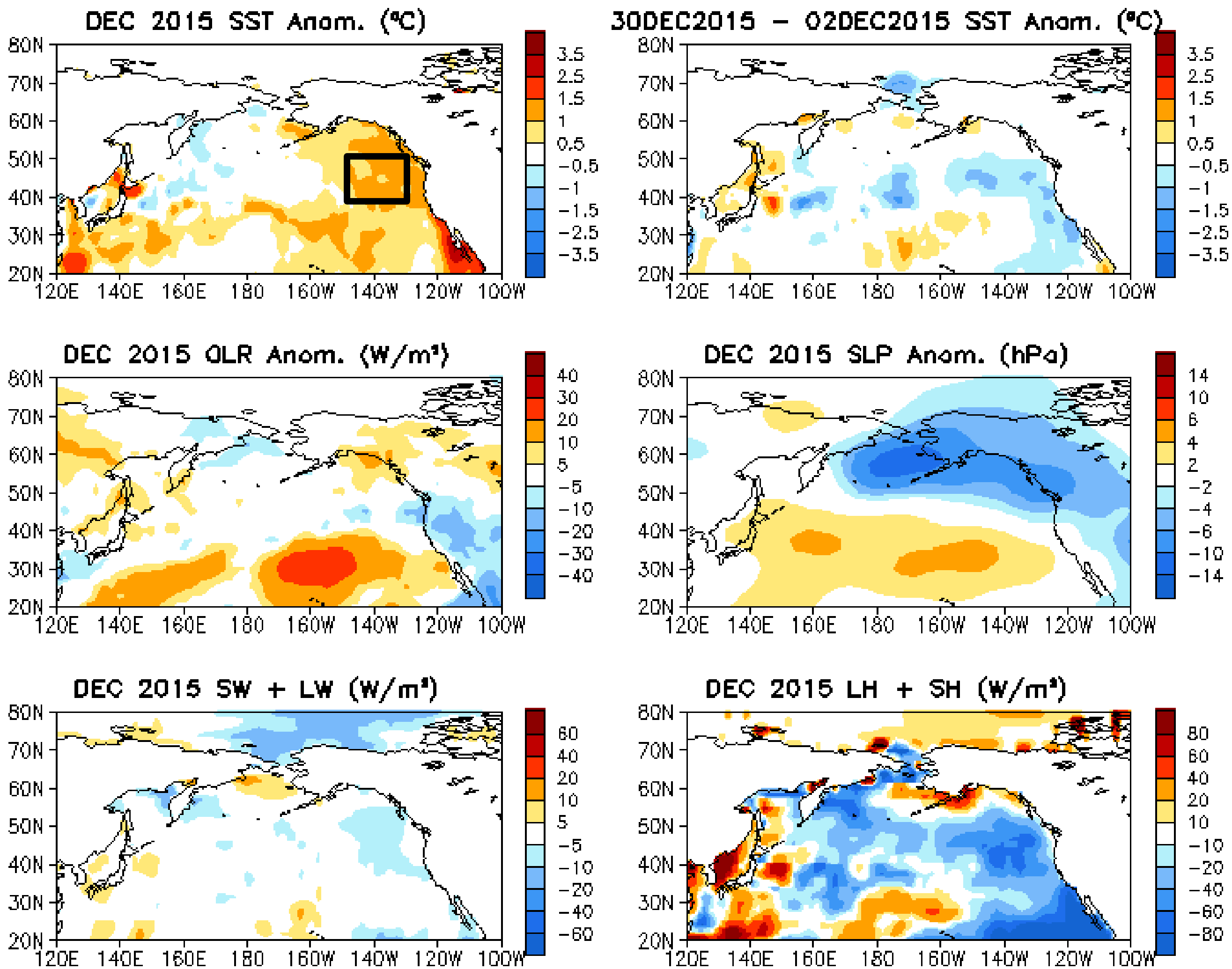


- Positive PDO has persisted for 18 months since July 2014 and positive PDO slightly increased with PDO=+0.7 in Dec 2015.

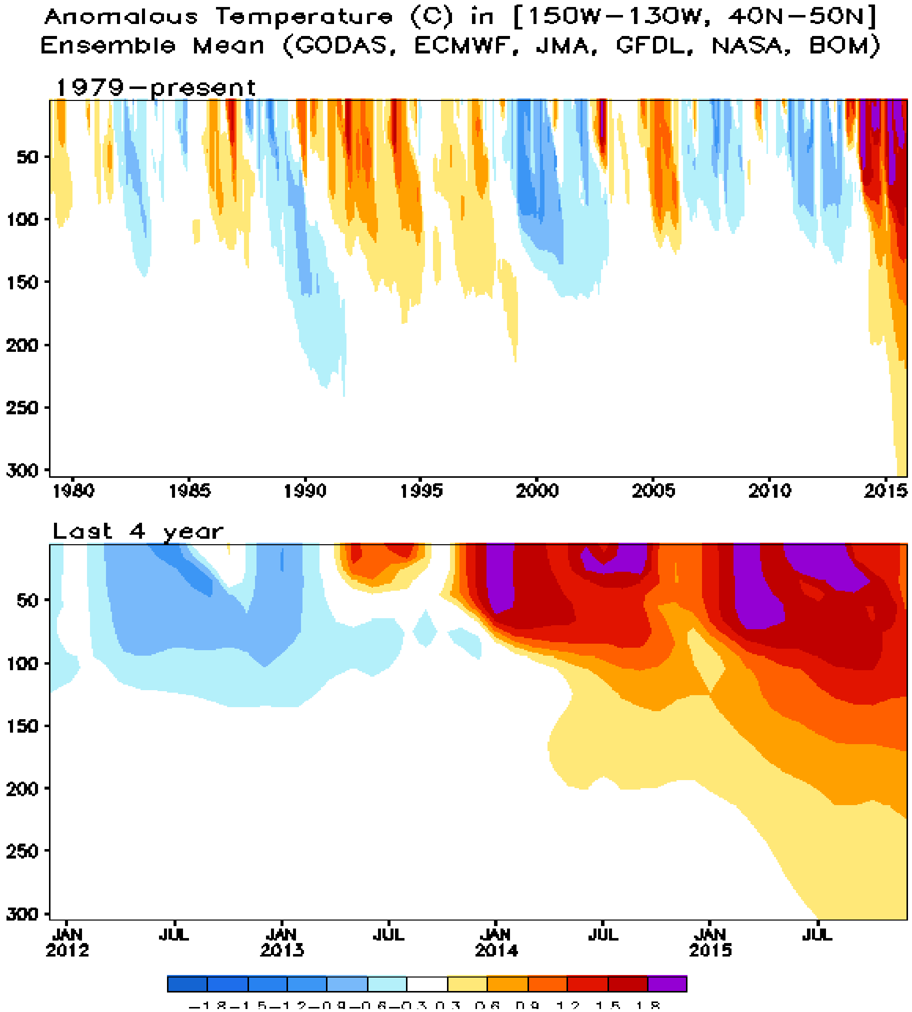
- Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.

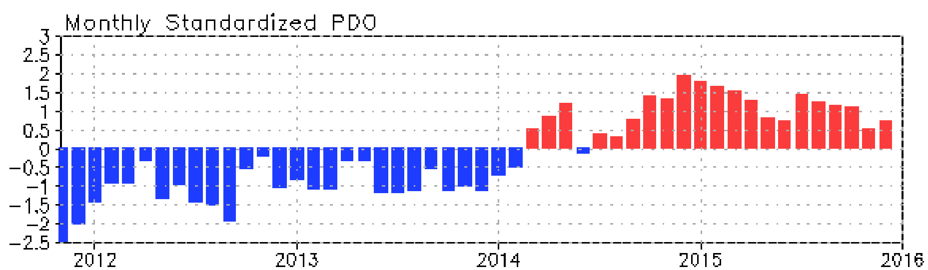
- The PDO index differs slightly from that of JISAO, which uses a blend of UKMET and OIv1 and OIv2 SST.

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

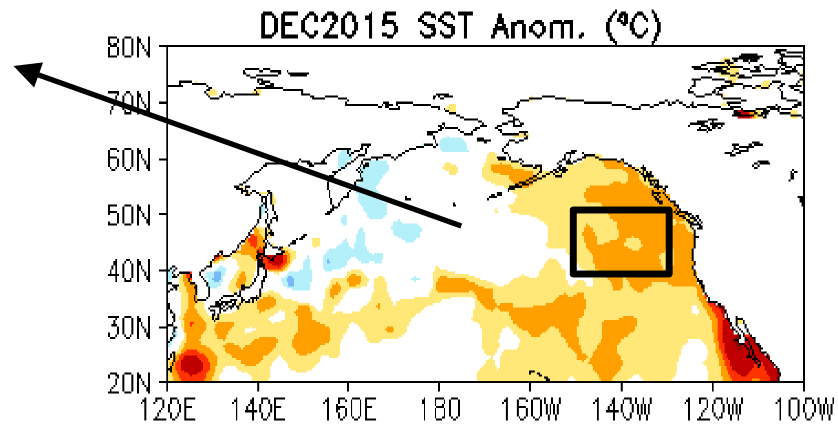


- Positive SSTA in the NE Pacific ("Blob") weakened.
- A north-south dipole SLP pattern, anomalous cyclone and anticyclone, were observed in the North Pacific.





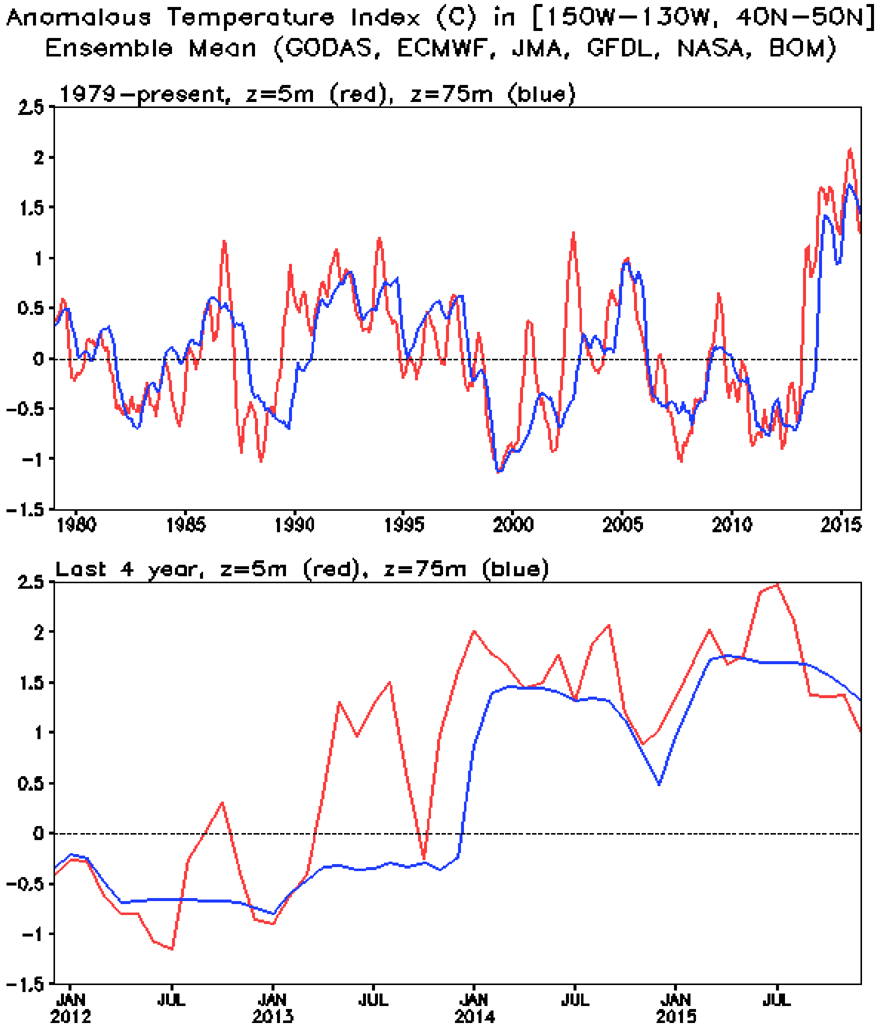
“Blob” in North Pacific

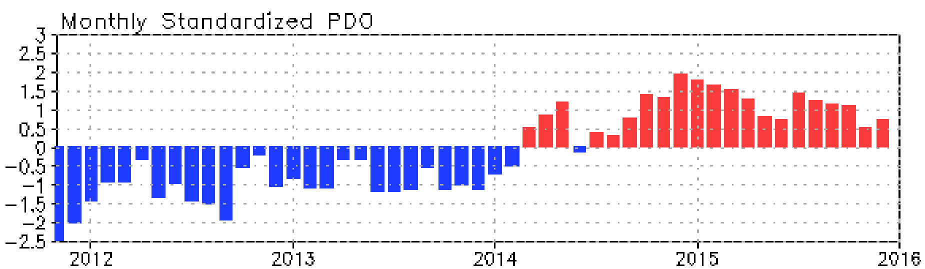


- Record SST warming appeared near the west coast of North America in late 2013, referred to as “Blob” by Bond et al. (2015).

- The warming in the NE Pacific box [150°W-130°W, 40°N-50°N] started near the surface in late 2013 and has persisted and extended to depth since then.

- The development of the enhanced warming in late 2013 seems associated with the switch to positive PDO phase.





"Blob" in North Pacific

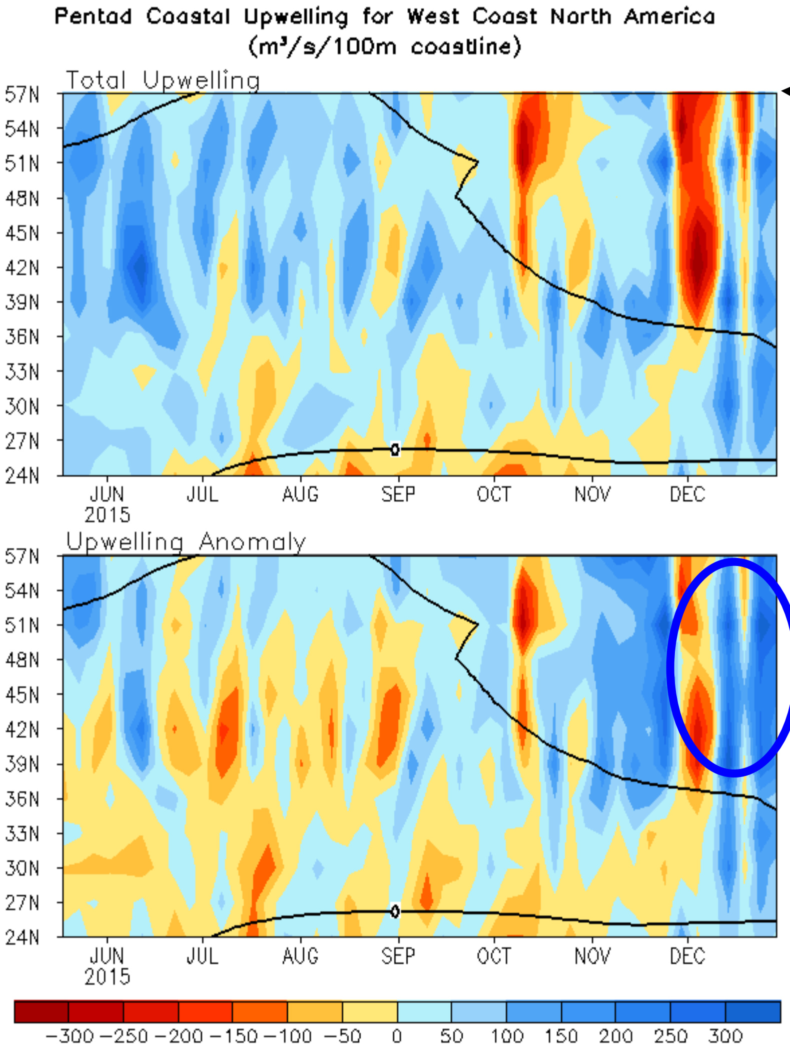
- Record SST warming appeared offshore of the west coast of North America in late 2013, referred to as "Blob" by Bond et al. (2015).

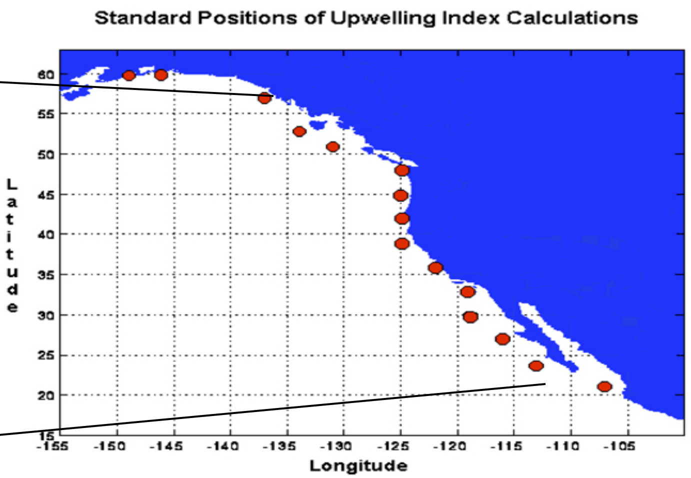
- The strong positive SSTA in the NE Pacific [150ºW-130ºW, 40ºN-50ºN] (red line) reached a historical high in Jun-Jul 2015, and had weakened substantially since then, approaching to the value as that in winter 2014/15.

- The warming at 5m (red line) developed around spring 2013, while the warming at 75m (blue line) emerged around Jan 2014, lagging behind the surface warming by 9 months.

- The onset of the warming at 75m coincided with the switch to positive PDO phase.

North America Western Coastal Upwelling





- Consistent with anomalous anticyclone, anomalous upwelling was observed along the west coast of N. America.

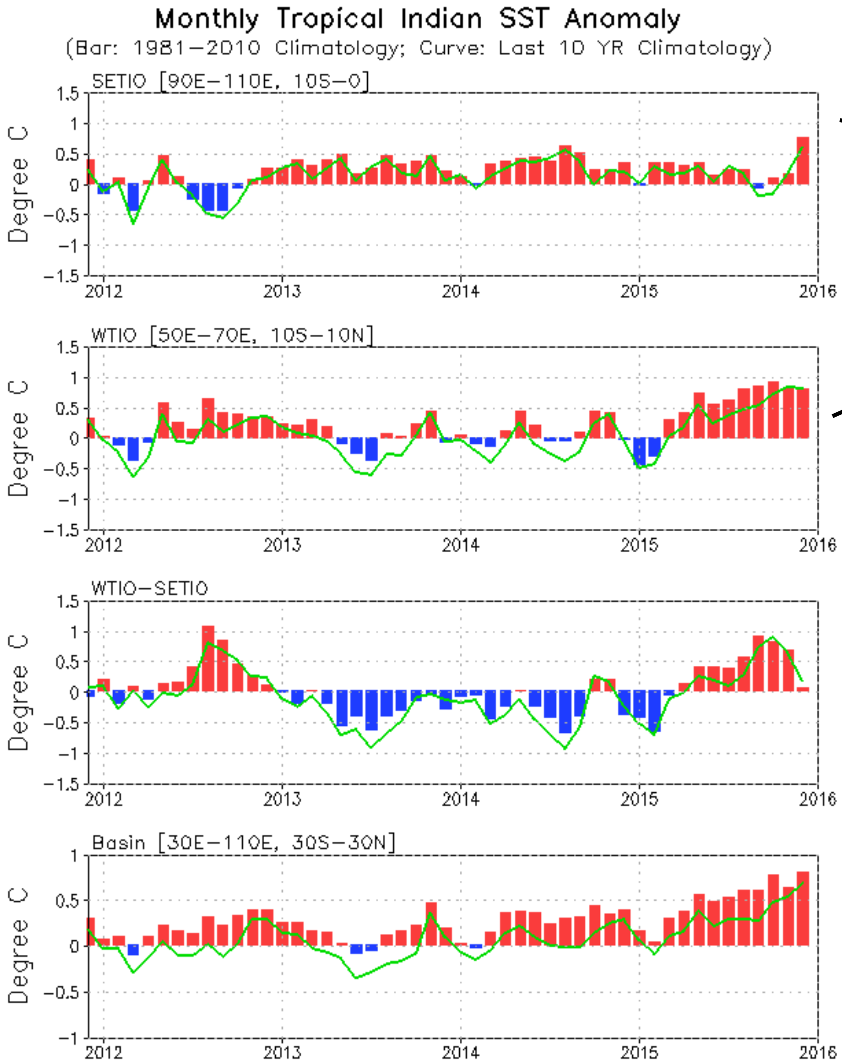
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point ($m^3/s/100m$ coastline). Anomalies are departures from the 1981-2010 base period pentad means.

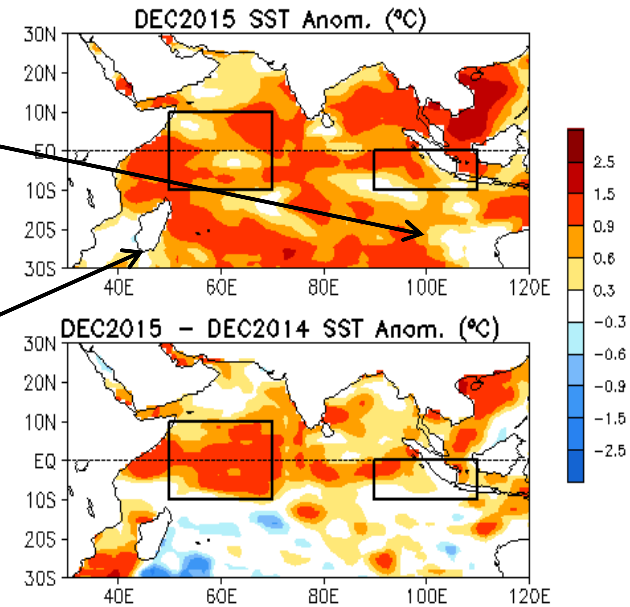
- Area below (above) black line indicates climatological upwelling (downwelling) season.

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

Indian Ocean

Evolution of Indian Ocean SST Indices





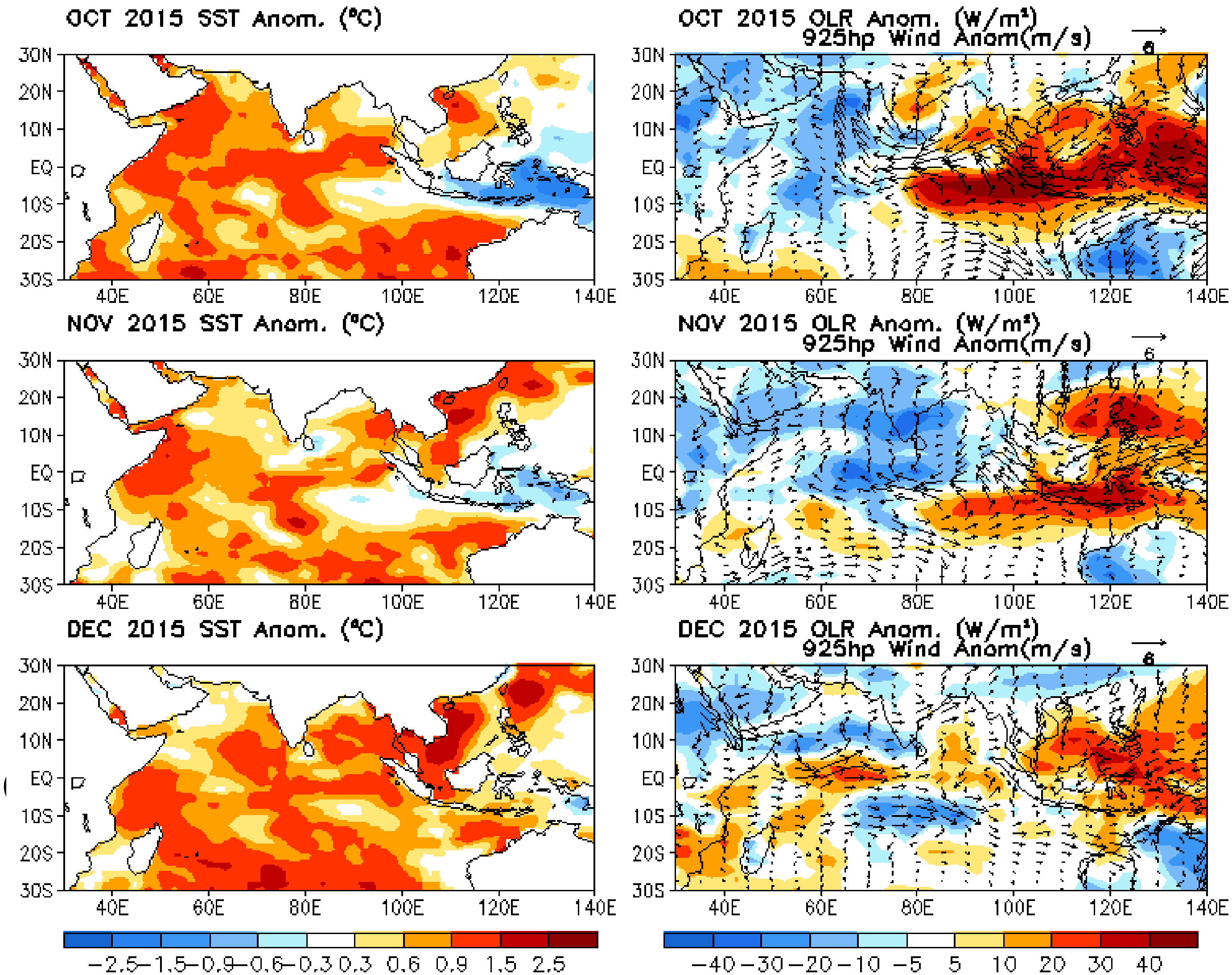
- The southeastern tropical Indian Ocean (SETIO) warmed up to 0.7C above-normal.

- The warming in the western tropical Indian Ocean (WTIO) persisted.

- The warming in the basin average SSTA continued.

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 departures from the 1981-2010 base period means and the recent 10 year means are shown in bars and green lines.

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

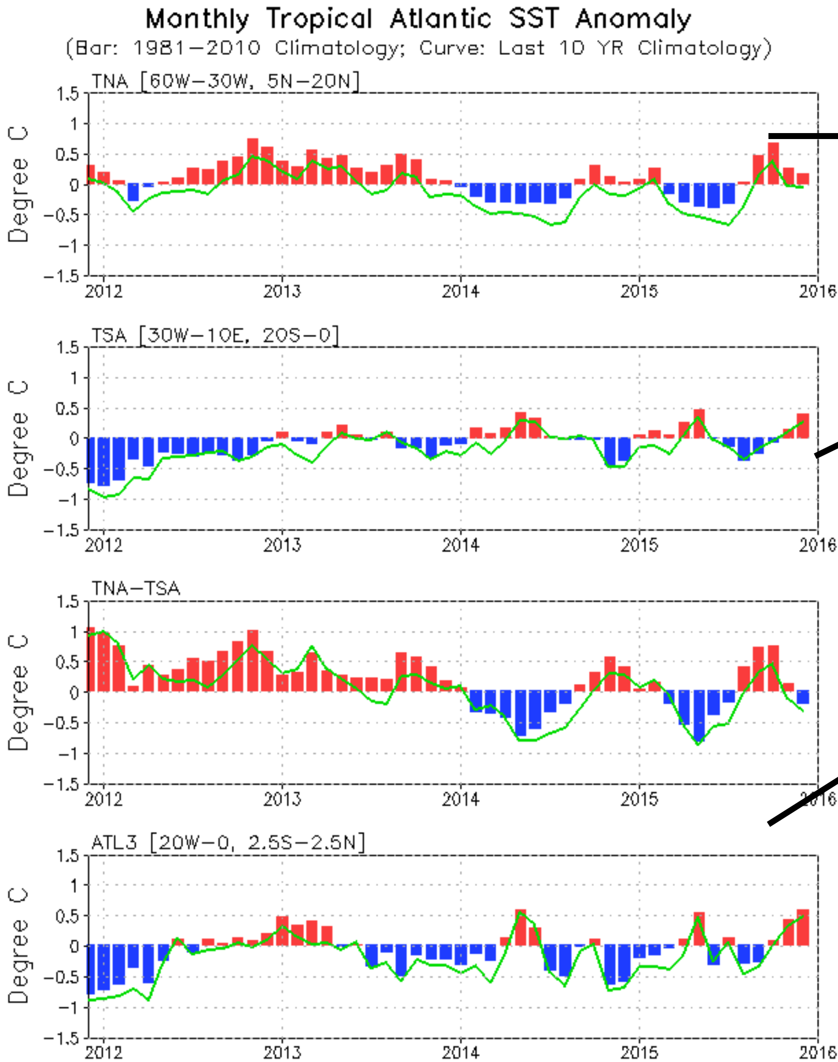


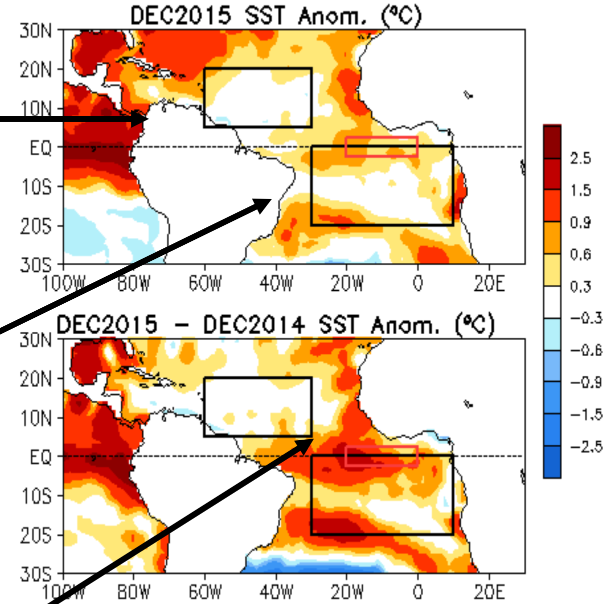
- **Positive SSTA exceeding +0.9C covered most of the tropical Indian Ocean.**

- **Westerly wind anomalies were observed in the central tropical Indian Ocean, which was in contrast with easterly wind anomalies dominated in the last two months.**

Tropical and North Atlantic Ocean

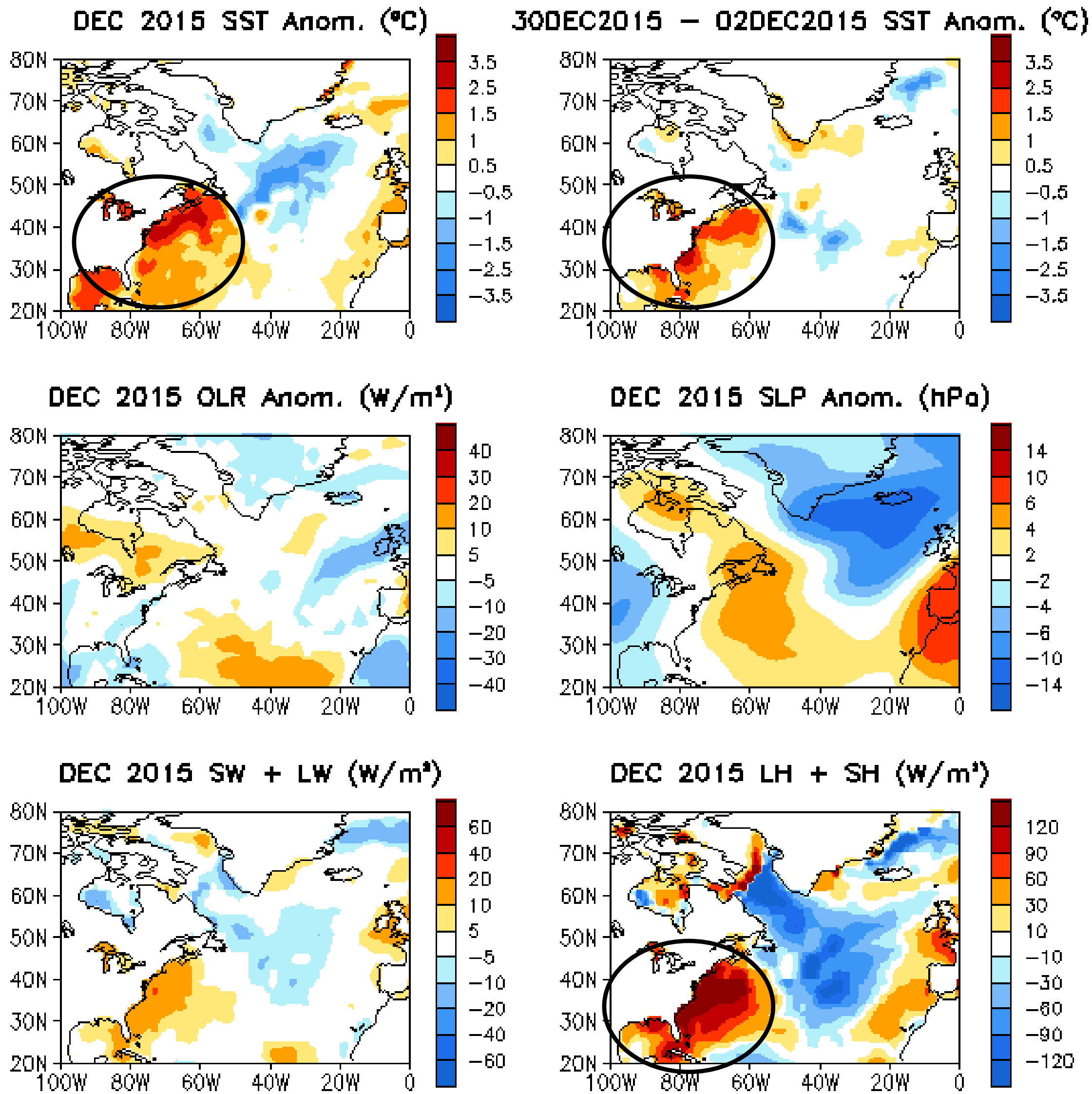
Evolution of Tropical Atlantic SST Indices





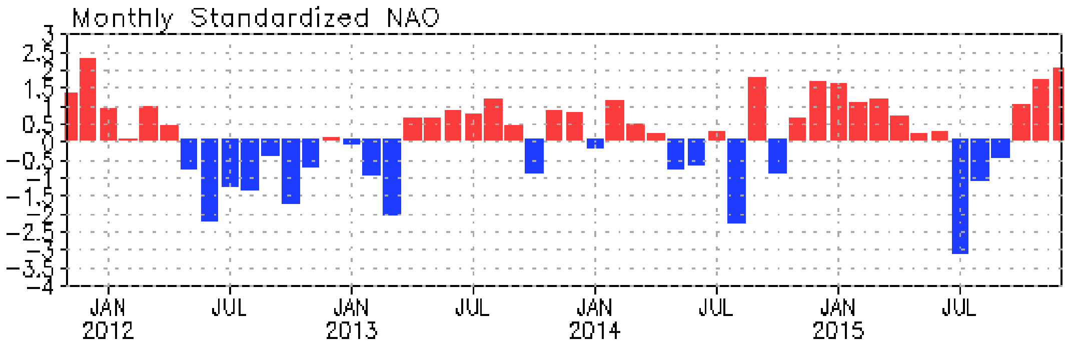
- Positive SSTA in the tropical North Atlantic (TNA) weakened in Dec 2015.
- Positive Meridional Gradient Mode Index (TNA-TSA) switched to negative in Dec 2015.

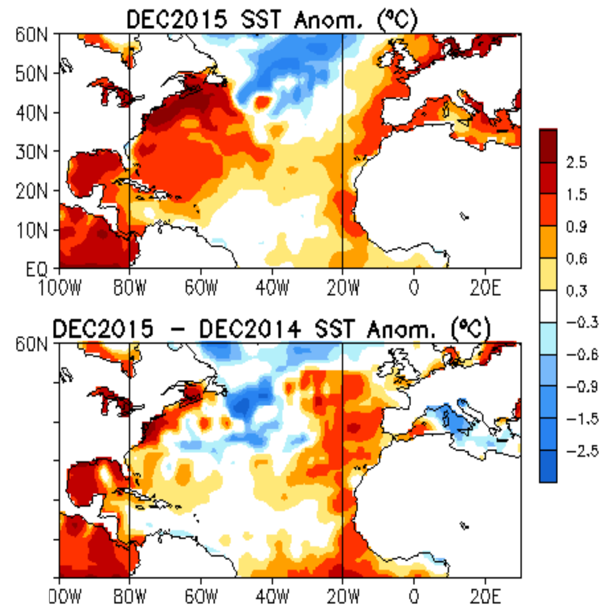
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the TNA [60°W-30°W, 5°N-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the NCEP OI SST analysis, and departures from the 1981-2010 base period means and the recent 10 year means are shown in bars and green lines.

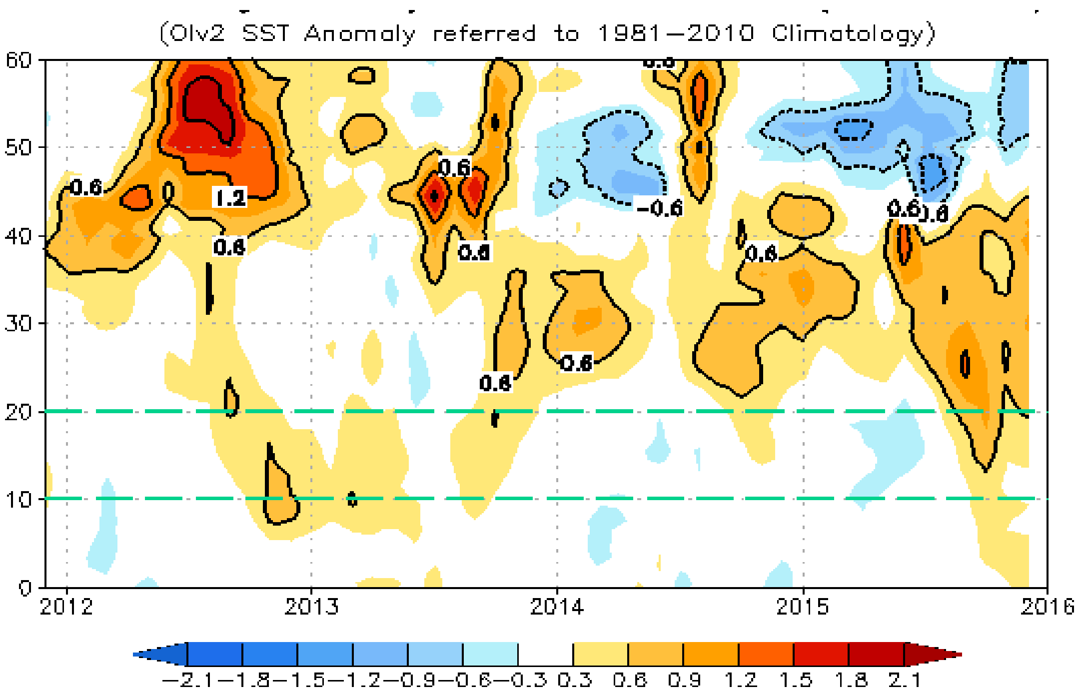


- **Warming along the east coast of North America enhanced due to surface flux forcing.**

NAO and SST Anomaly in North Atlantic





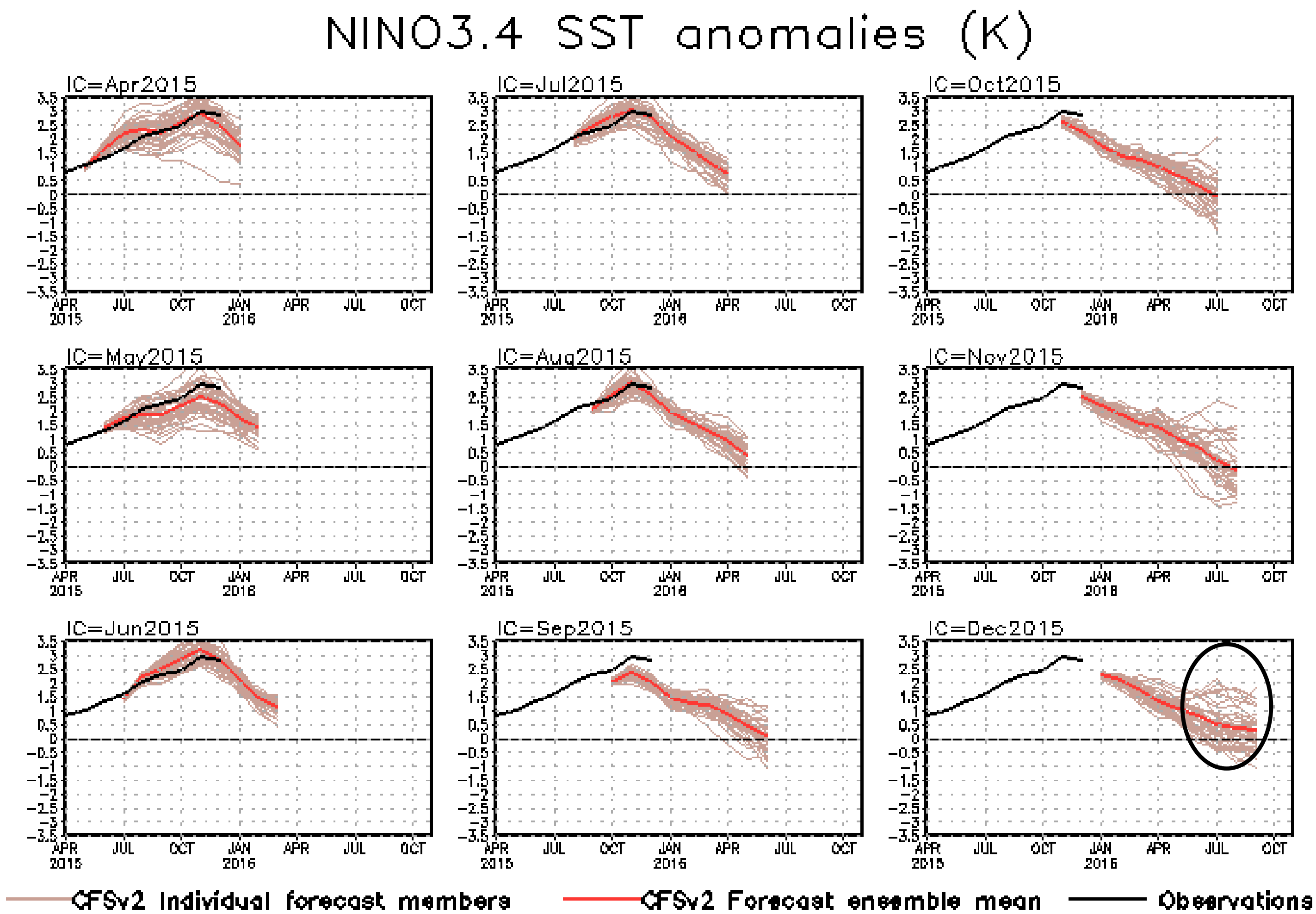


- NAO strengthened with NAO=+2. in Dec 2015.
- Persistent positive NAO was associated with SST cooling (warming) in high-latitude and subtropics (mid-latitude).

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.

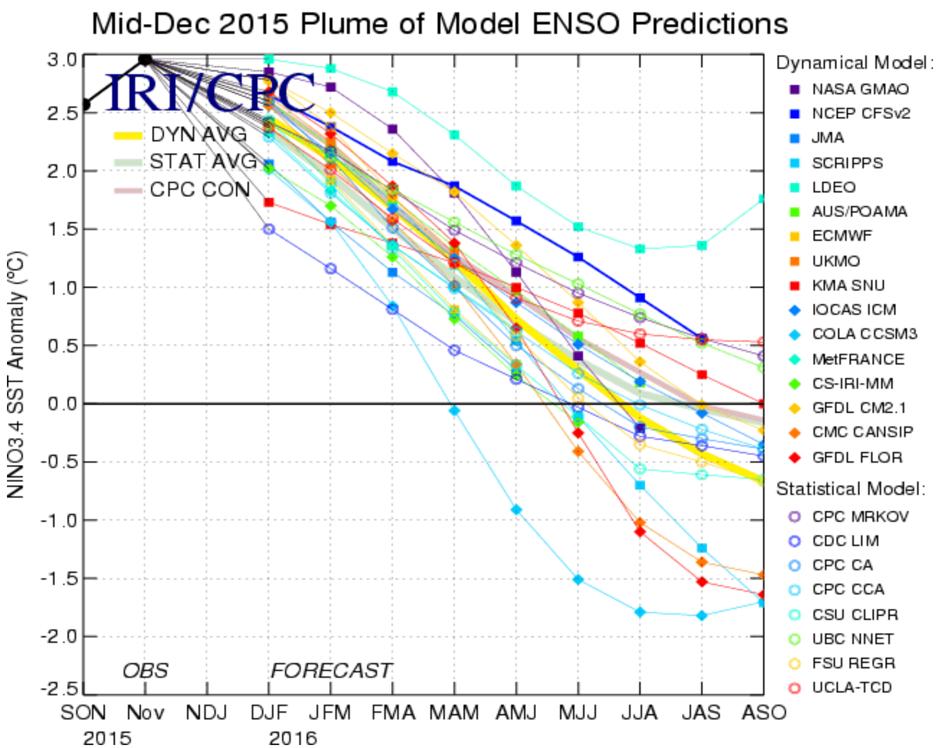
Global SST Predictions

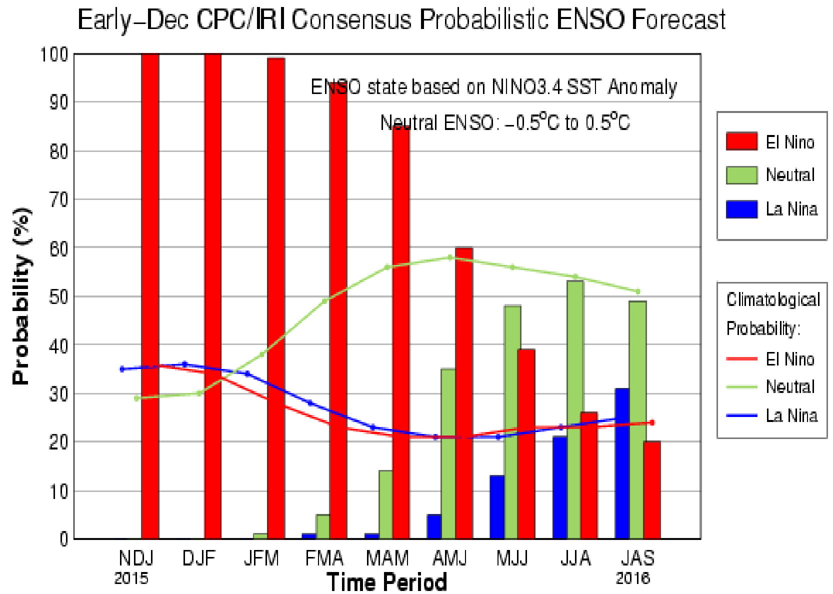
NCEP CFSv2 NINO3.4 Forecast

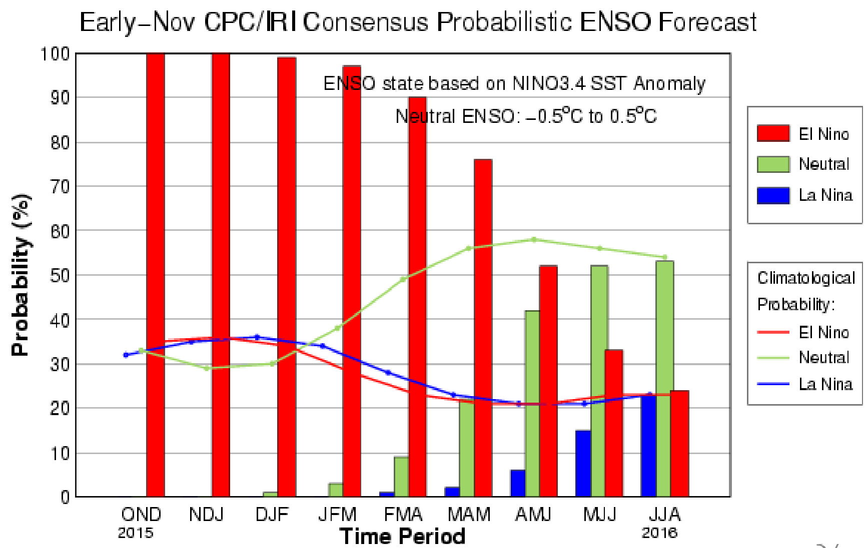


- CFSv2 predicted Nino3.4 will gradually dissipate through northern hemisphere winter/spring with a transition into neutral conditions by summer 2016.
- The ensemble spread in the CFSv2 forecasts is noticeably large during summer 2016, indicating uncertainties in forecasting of the transition phase.

IRI NINO3.4 Forecast Plum





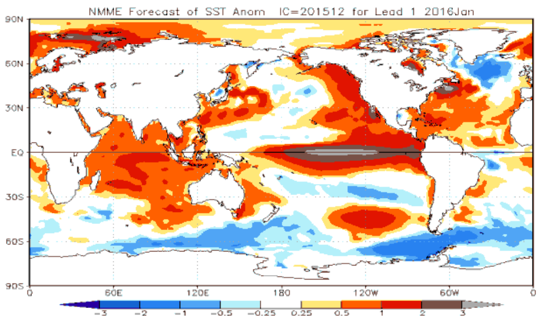


- **NOAA "ENSO Diagnostic Discussion" on Dec 10 2015 states that "El Niño is expected to remain strong through the Northern Hemisphere winter 2015-16, with a transition to ENSO-neutral anticipated during late spring or early summer 2016."**

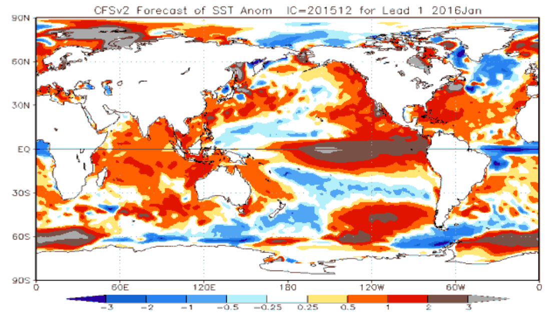
Comparison of NCEP CFSv2 and NMME SST Prediction

IC= 201512

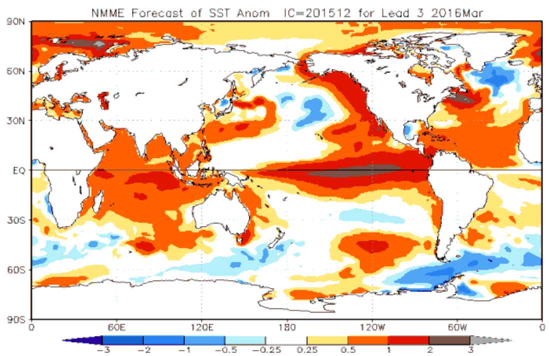
NMME Jan2016



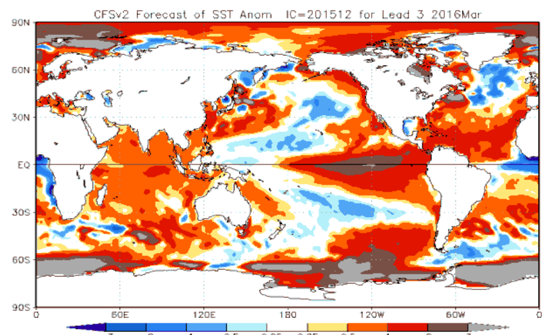
CFSv2 Jan2016



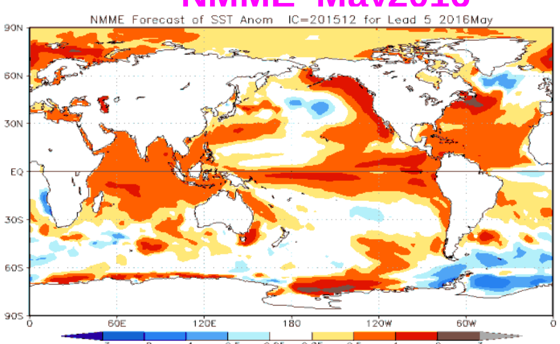
NMME Mar2016



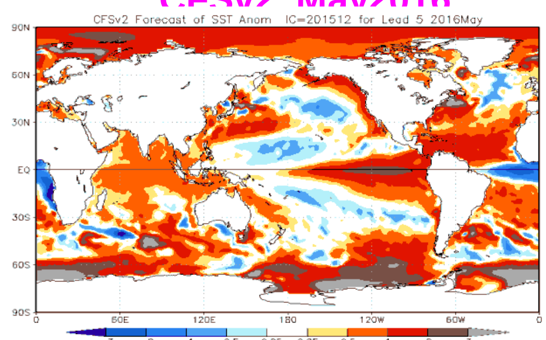
CFSv2 Mar2016



NMME May2016



CFSv2 May2016

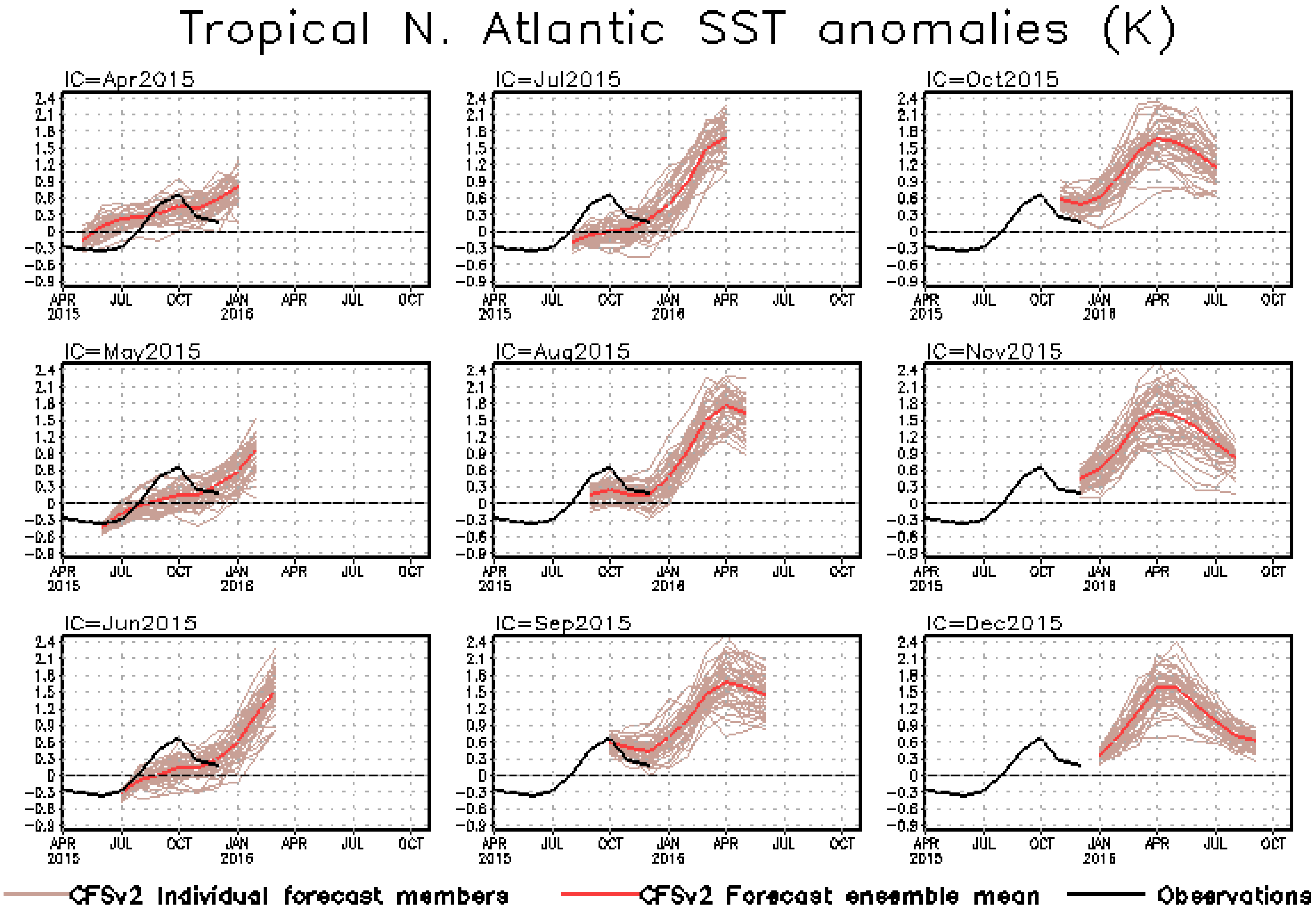


- CFSv2 predicted the “Blob” SSTA will dissipate rapidly, while NMME suggested it will persist into spring.

- CFSv2 predicted much stronger warming in the tropical North Atlantic in spring 2016 than NMME did.

38

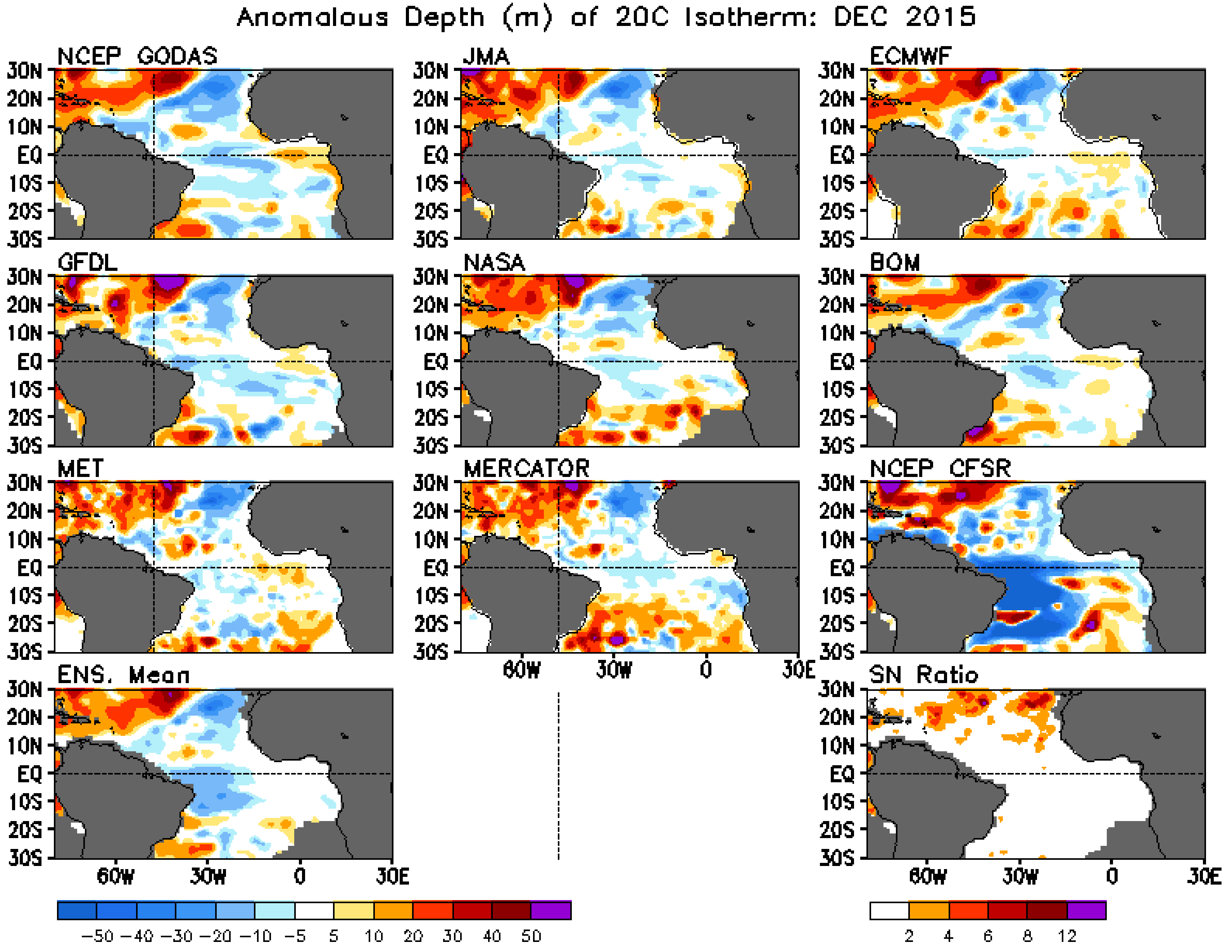
NCEP CFSv2 Tropical North Atlantic SST Forecast



- CFSv2 predicted tropical North Atlantic SSTA will grow rapidly in early 2016.

Real-Time Multiple Ocean Reanalyses Intercomparison

(1993-2013 Climatology)



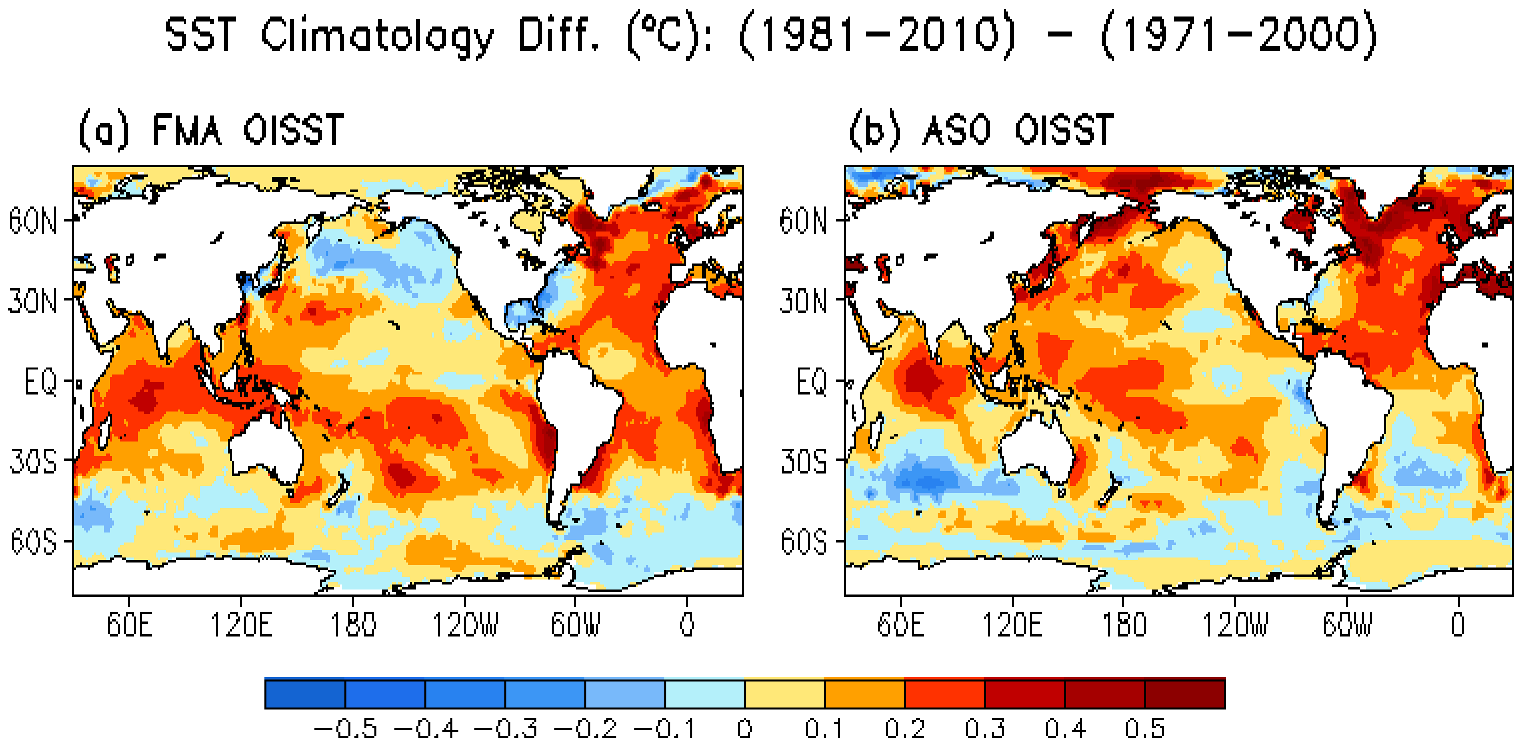
Overview

- **Pacific Ocean**
  - **El Niño conditions weakened slightly in Dec 2015 and the atmospheric and oceanic anomalies reflect a strong El Niño.**
  - **Most models indicate that a strong El Niño will continue through the Northern Hemisphere winter 2015-16, followed by weakening and a transition to ENSO-neutral during the late spring or early summer.**
  - **The current conditions and recent evolution of the 2015 El Niño were compared with those of the 1982 and 1997 El Niño.**
  - **Upper ocean warming associated with the "Blob" has persisted since winter 2013/2014.**
- **Indian Ocean**
  - **Positive SSTA dominated most of the tropical Indian Ocean.**
  - **Southeastern tropical Indian Ocean (SETIO) Index increased.**
- **Atlantic Ocean**
  - **Positive NAO strengthened with NAO=+2.**
  - **SSTA were well above-average along the eastern coast of North America.**

Switch to 1981-2010 Climatology

- **SST from 1971-2000 to 1981-2010**
  - **Weekly OISST.v2, monthly ERSST.3b**
- **Atmospheric fields from 1979-1995 to 1981-2010**
  - **NCEP CDAS winds, sea level pressure, 200mb velocity potential, surface shortwave and longwave radiation, surface latent and sensible fluxes, relative humidity**
  - **Outgoing Long-wave Radiation**
- **Oceanic fields from 1982-2004 to 1981-2010**
  - **GODAS temperature, heat content, depth of 20°C, sea surface height, mixed layer depth, tropical cyclone heat potential, surface currents, upwelling**
- **Satellite data climatology 1993-2005 unchanged**
  - **Aviso Altimetry Sea Surface Height**
  - **Ocean Surface Current Analyses – Realtime (OSCAR)**

Be aware that new climatology (1981-2010) was applied since Jan 2011



1971-2000 SST Climatology (Xue et al. 2003):
http://www.cpc.ncep.noaa.gov/products/predictions/30day/SSTs/sst_clim.htm

1981-2010 SST Climatology: http://origin.cpc.ncep.noaa.gov/products/people/yxue/sstclim/

- The seasonal mean SST in February-April (FMA) increased by more than 0.2°C over much of the Tropical Oceans and N. Atlantic, but decreased by more than 0.2°C in high-latitude N. Pacific, Gulf of Mexico and along the east coast of U.S.

- Compared to FMA, the seasonal mean SST in August-October (ASO) has a stronger warming in the tropical N. Atlantic, N. Pacific and Arctic Ocean, and a weaker cooling in Gulf of Mexico and along the east coast of U.S.

Backup Slides

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

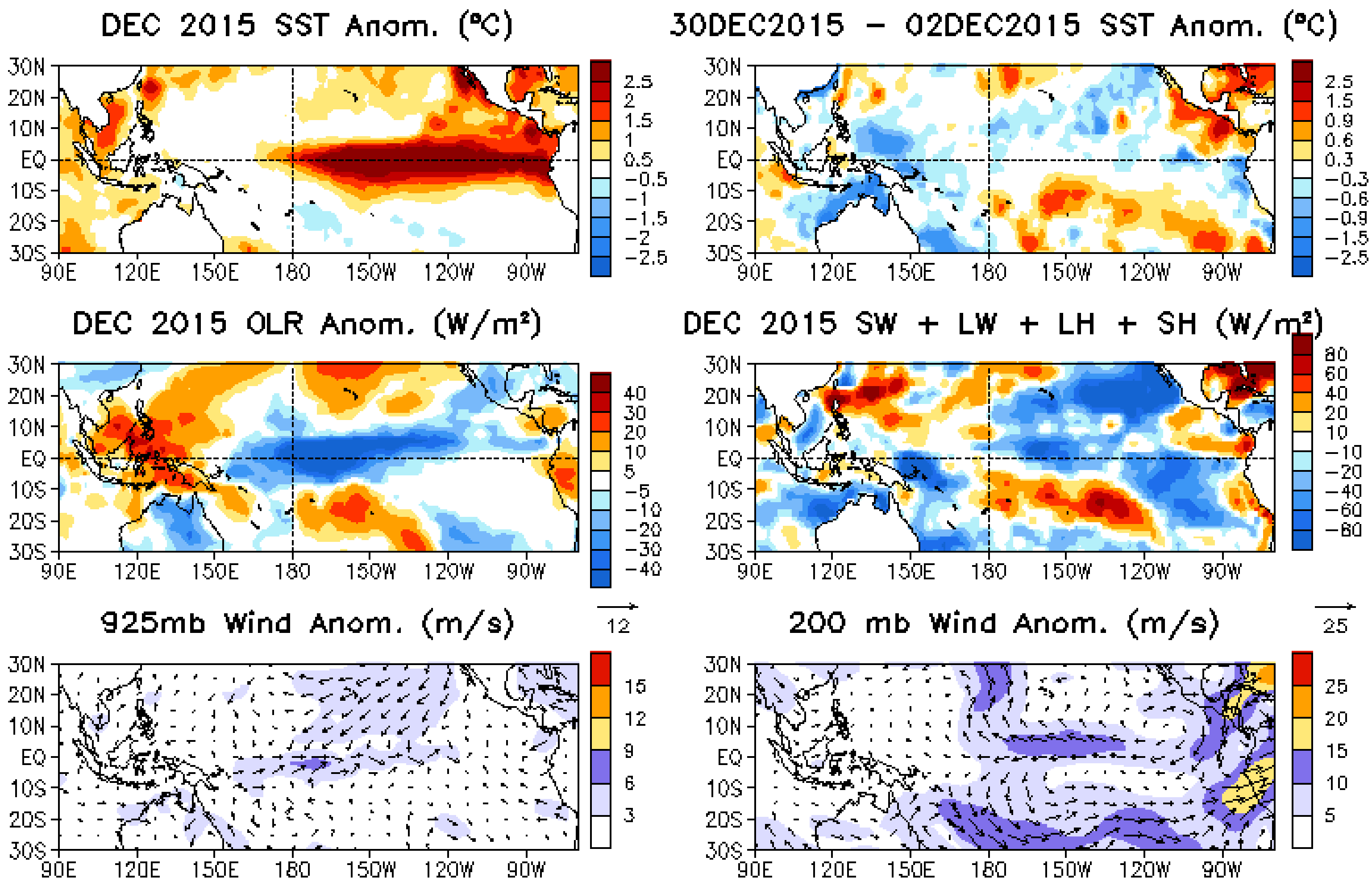
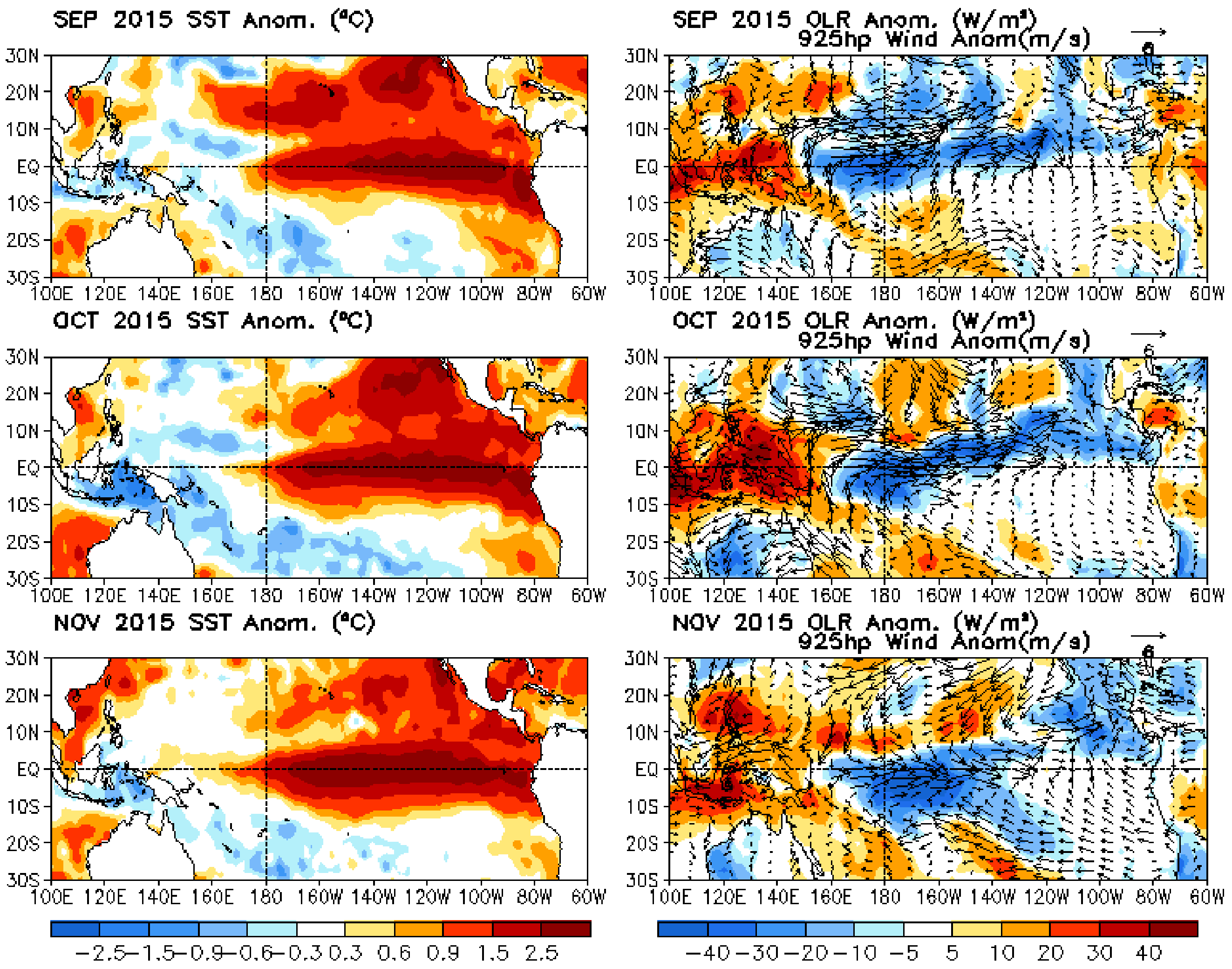


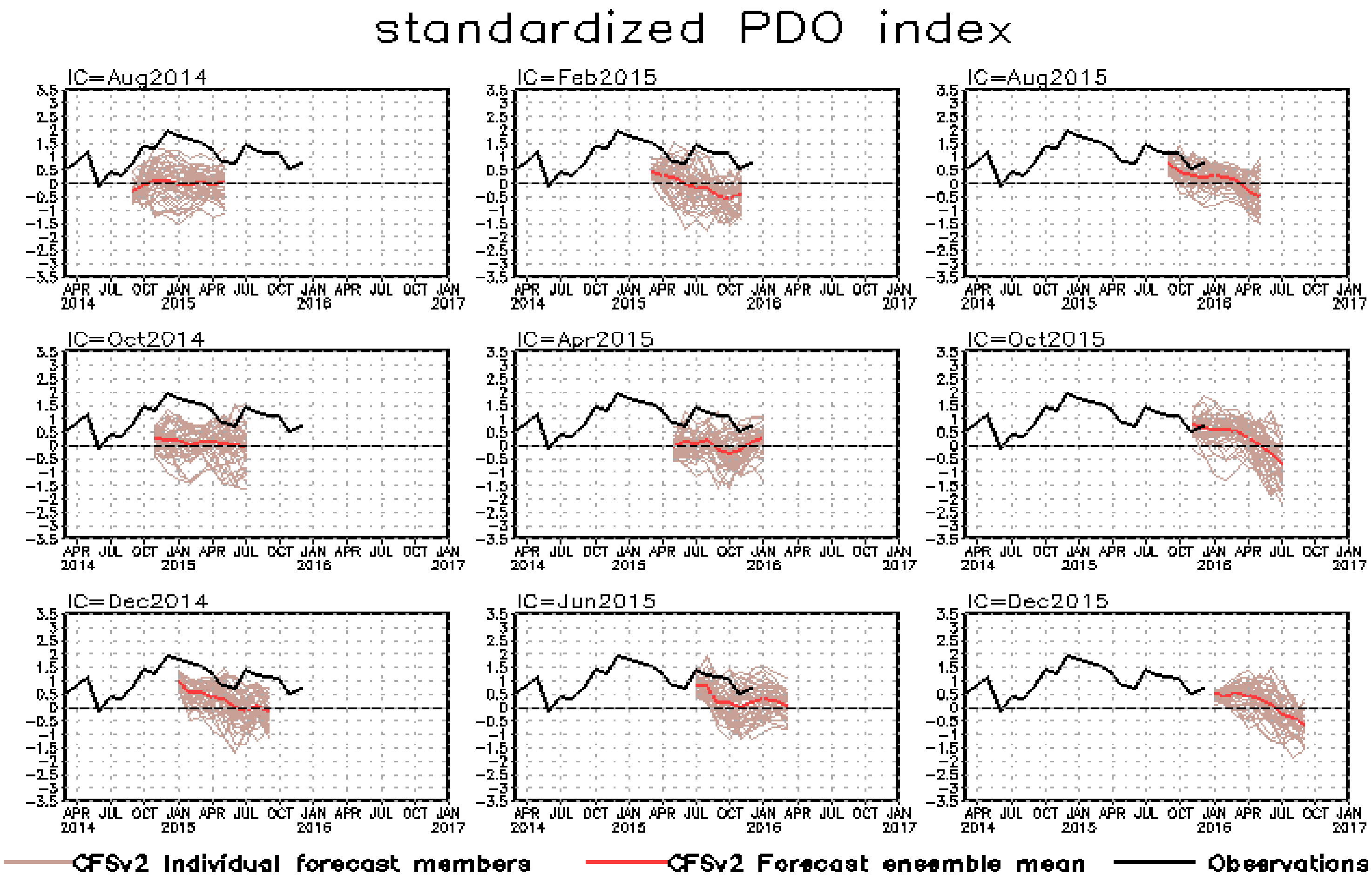
Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

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



- **Negative SSTA in the far W. Pacific weakened, and positive SSTA in the C.-E. Pacific extended further west.**
- **The atmospheric signature of the El Nino, suppressed (enhanced) convection over the Maritime Continent (near the Dateline), persisted in Nov 2015.**

NCEP CFSv2 Pacific Decadal Oscillation (PDO) Forecast

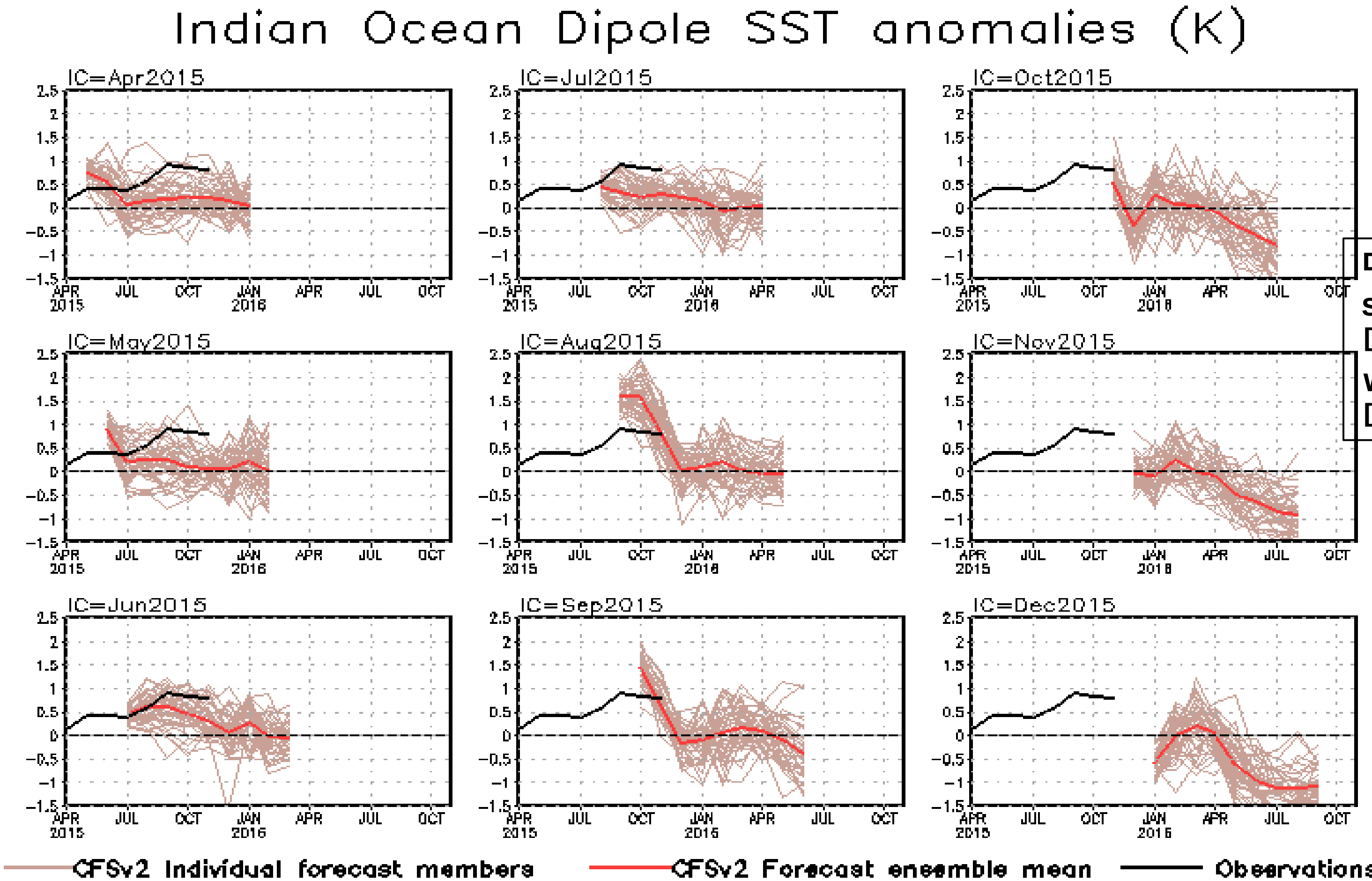


PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

CFS PDO index is the standardized projection of CFS SST forecast anomalies onto the PDO EOF pattern.

- Latest CFSv2 prediction suggests weak negative PDO phase will persist through the coming winter and regain strength in next spring and summer.

NCEP CFS DMI SST Predictions from Different Initial Months

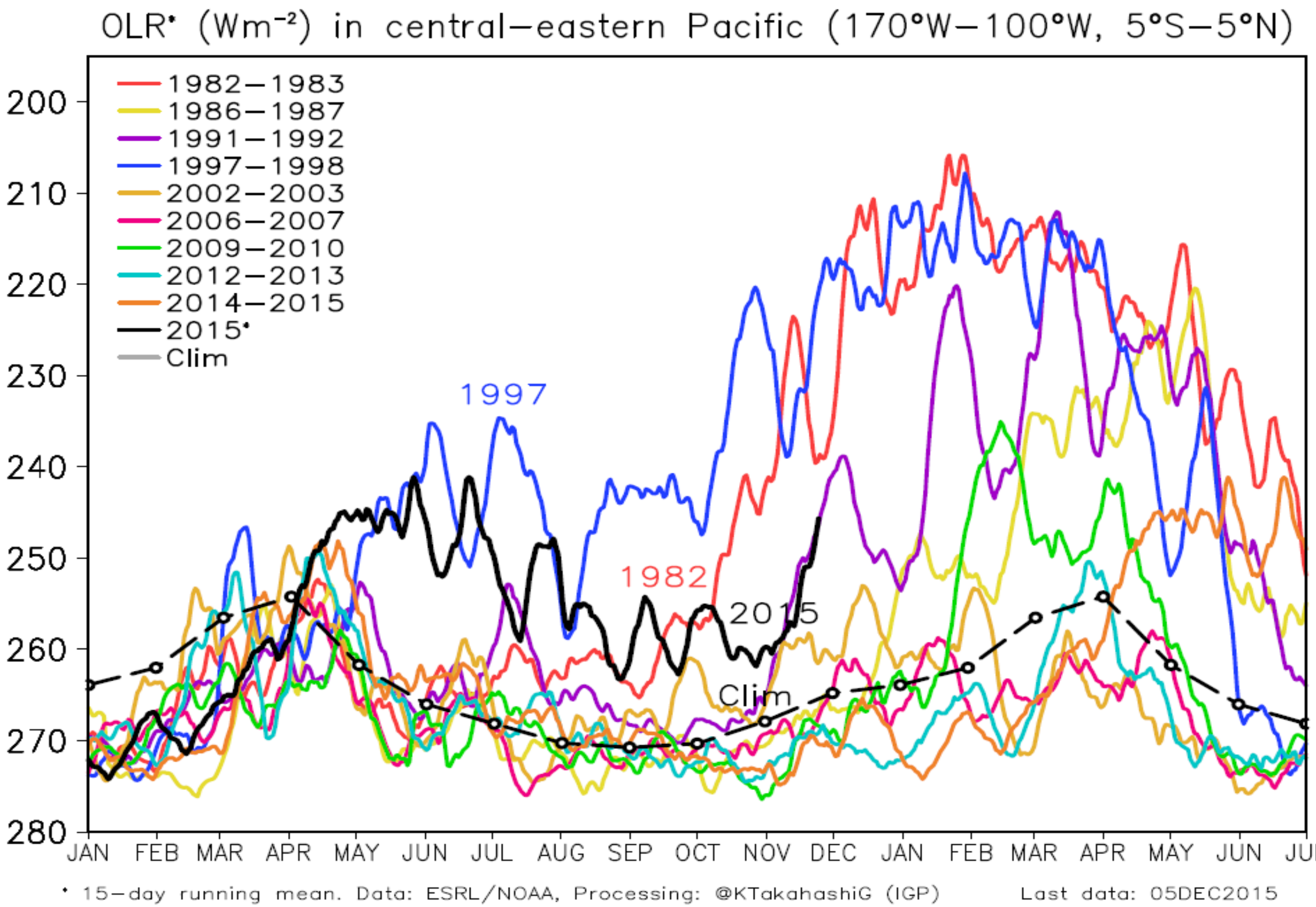


DMI = WTIO- SETIO

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.



Plot provided by Ken Takahashi

- **Enhanced convection (OLR is below climatology) in the central-eastern Pacific (170W-100W, 5S-5N) in spring/early summer 2015 was comparable to that in 1997, but it has weakened gradually since Jun 2015.**
- **Convection rebounded substantially in Nov 2015, but it was still weaker than that in 1982 and 1997 -→ possibly different impacts on teleconnection (Chiodi and Harrison 2013)?**