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**

  - **Indian Ocean**

  - **Atlantic Ocean**

  - **Global SST Predictions**

- **Atlantic Hurricane Outlook and Observation**

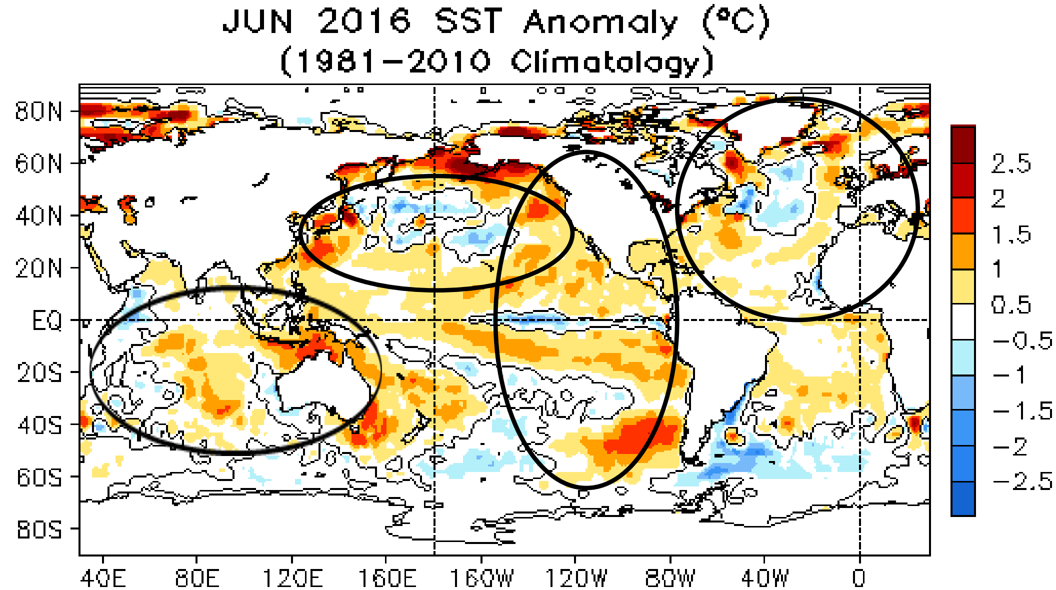
- **Will a La Nina still Come in 2016-17?**

Overview

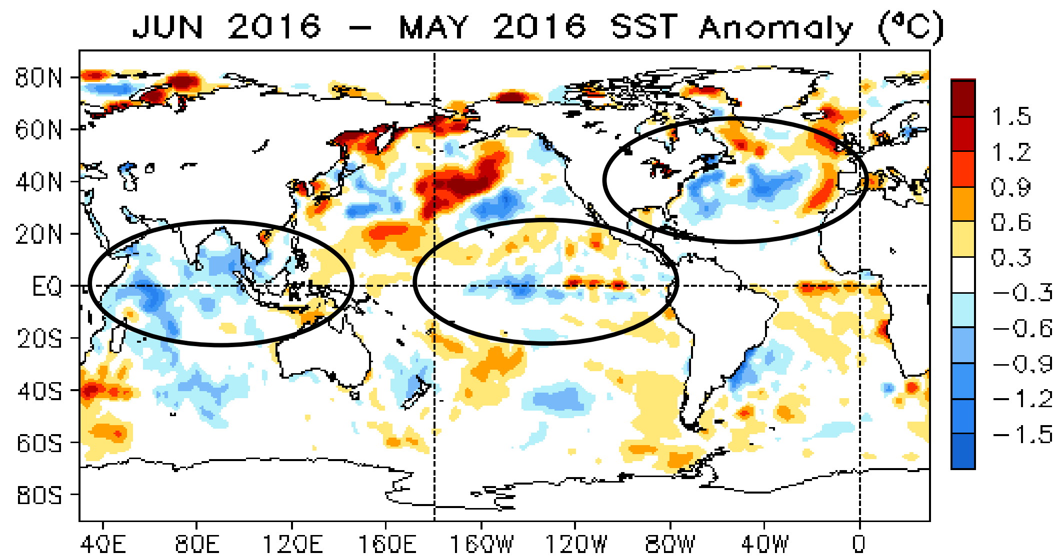
- **Pacific Ocean**
  - **NOAA "ENSO Diagnostic Discussion" on 9 June 2016 issued "Final El Nino Advisory/La Niña Watch" and suggested that *"ENSO-neutral conditions are present and La Niña is favored to develop during the Northern Hemisphere summer 2016, with about a 75% chance of La Niña during the fall and winter 2016-17."***
  - **SSTAs were small in the tropical Pacific with NINO3.4=-0.1^{o}C in Jun 2016.**
  - **Strong negative subsurface ocean temperature anomalies along the thermocline occupied the whole equatorial Pacific.**
  - **Positive phase of PDO has persisted for 24 months, and weakened with PDOI=+1.1 in Jun 2016.**
- **Indian Ocean**
  - **Positive SSTAs were in the central and eastern Ocean.**
- **Atlantic Ocean**
  - **NAO was in negative phase with NAOI=-0.1 in Jun 2016. SSTA was positive in the low-mid latitudes and negative in the high latitudes.**
  - **On May 27, NOAA predicted near normal hurricane season in the Atlantic.**

<u>Global Oceans</u>

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



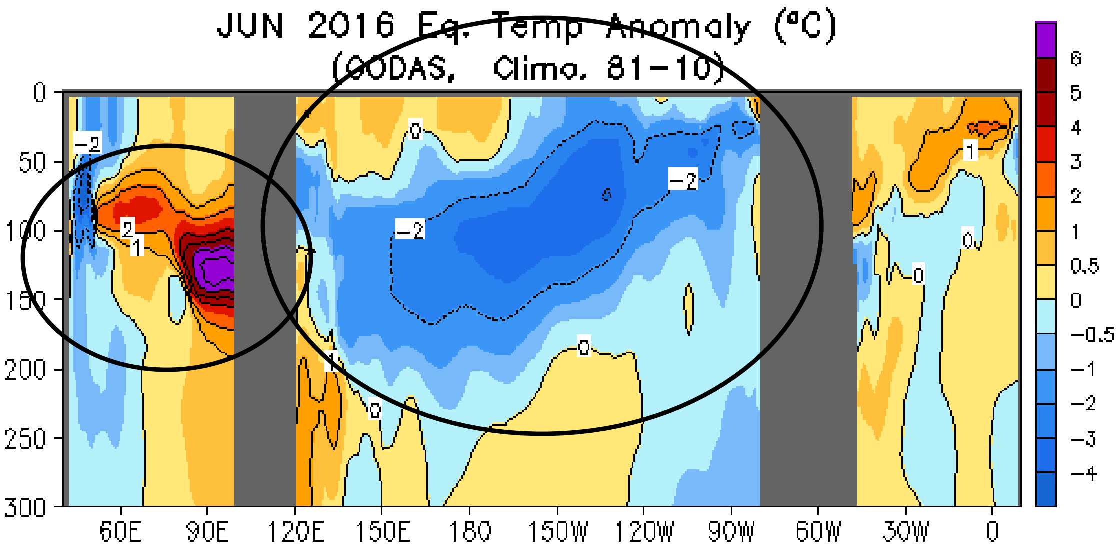
- Positive SSTA was dominant in the eastern Pacific, while cold SSTA was observed along the eastern equatorial Pacific.
- SSTA pattern in N. Pacific was associated with positive phase of PDO.
- Horseshoe-like SSTA presented in N. Atlantic.
- SSTA was positive in the central and eastern Indian Ocean.



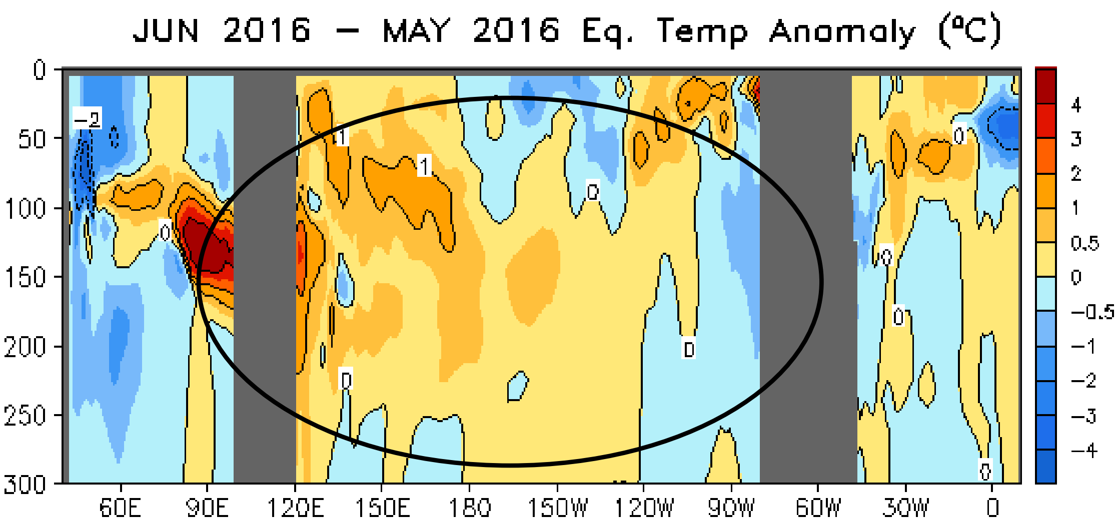
- Negative SSTA tendency presented in the central and eastern equatorial Pacific.
- SSTA tendency was negative in Indian Ocean and Mid-latitudes of North Atlantic Ocean.

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.

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

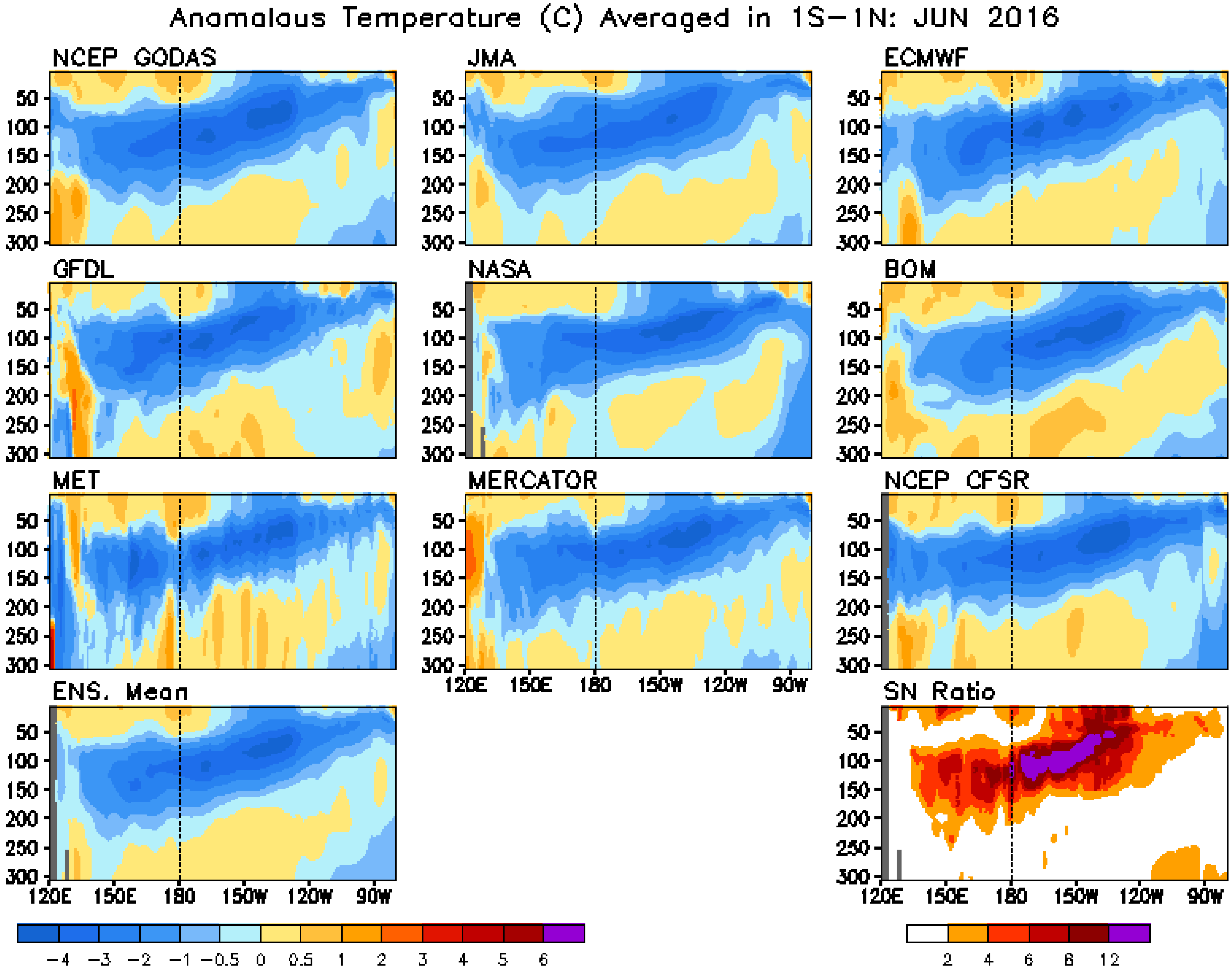


- Strong negative ocean temperature anomalies presented along the thermocline in the whole Pacific.
- Positive ocean temperature anomalies were confined near the surface in the western and central Pacific.
- Positive anomalies were observed in the Indian Ocean.



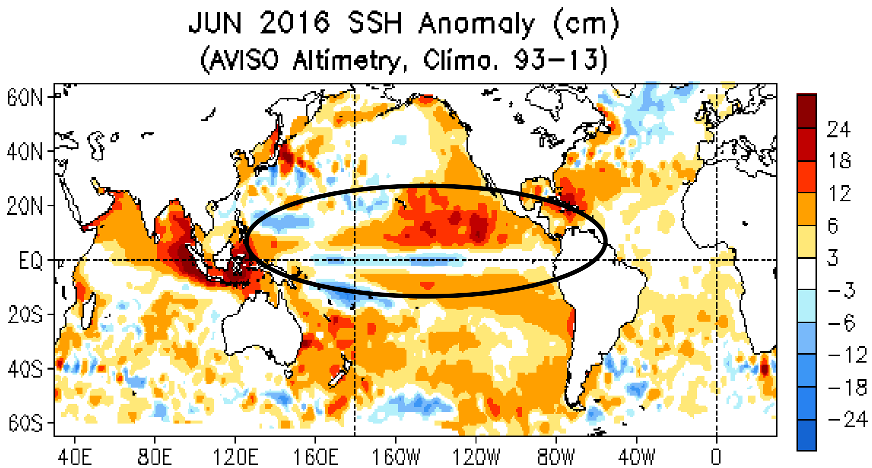
- Tendencies of ocean temperature anomalies became mainly positive along the thermocline in the Pacific.

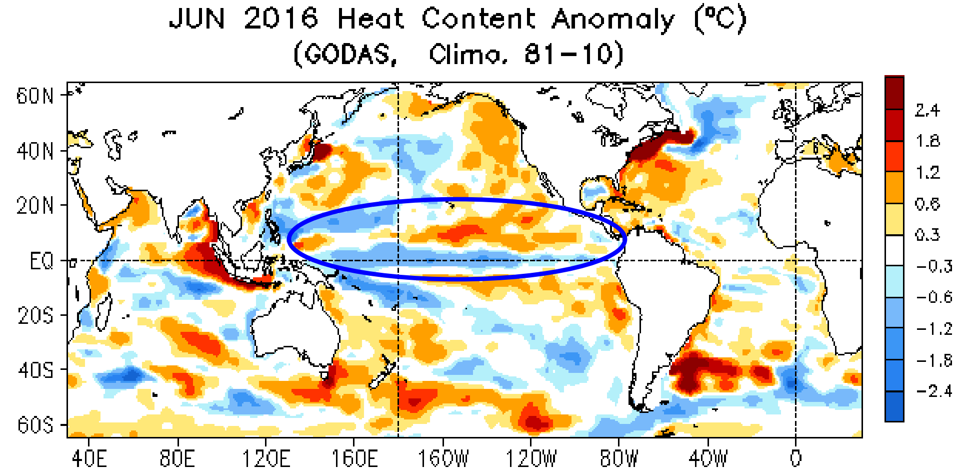
Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1981-2010 base period means.

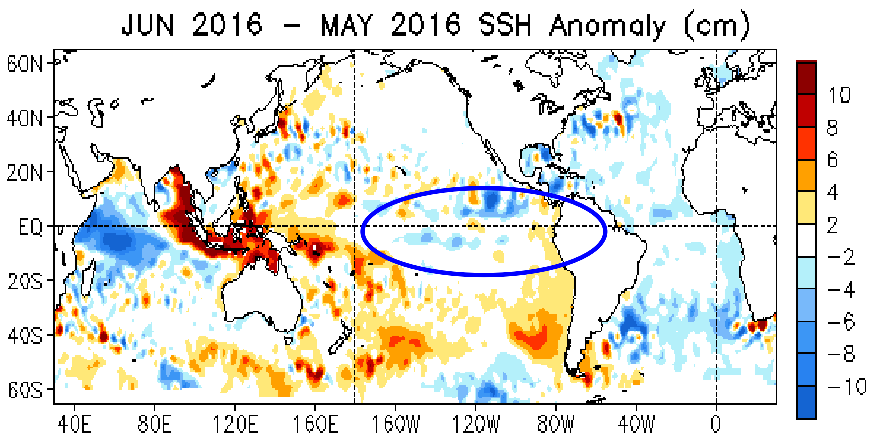


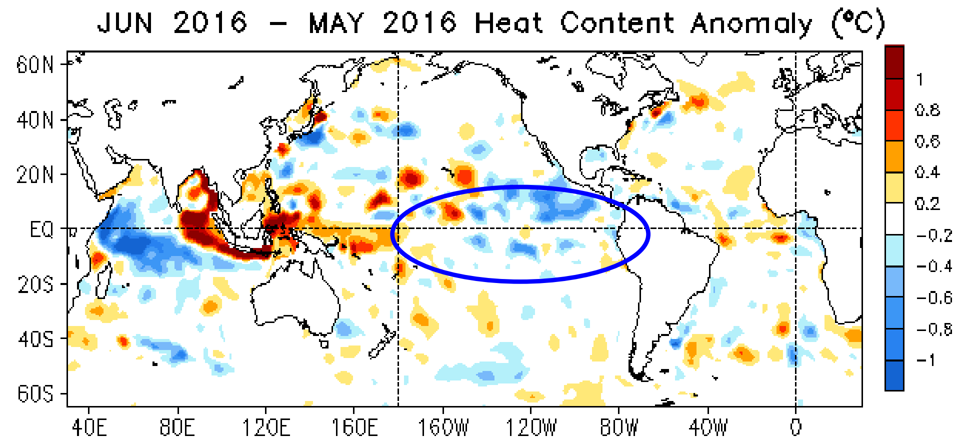
Anamalous Temperature (C) Averaged in 1S-1N: JUN 2016
NCEP GODAS
JMA
ECMWF
GFDL
NASA
BOM
MET
MERCATOR
NCEP CFSR
ENS. Mean
SN Ratio
50 100 150 200 250 300
120E 150E 180 150W 120W 90W
-4 -3 -2 -1 -0.5 0 0.5 1 2 3 4 5 6
2 4 6 8 12

Global SSH and HC300 Anomaly & Anomaly Tendency

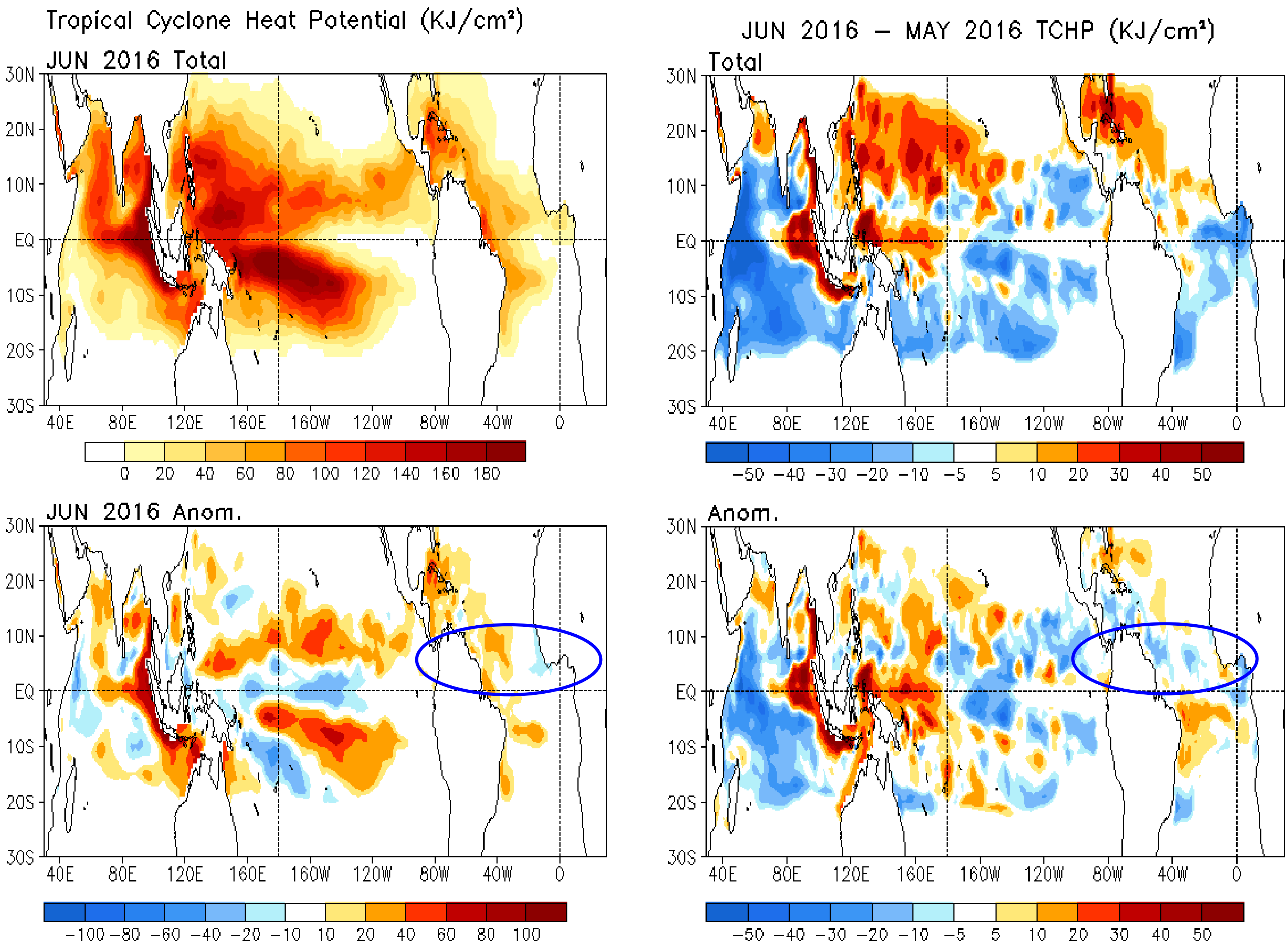








- The SSHA was overall consistent with HC300A: Positive (negative) HC300A is tied up with positive (negative) SSHA.
- Both SSHA and HC300A were small negative along the equatorial Pacific, reflecting the neutral phase of ENSO.
- Tendencies of both SSHA and HC300A were small in the central and eastern equatorial Pacific.



Tropical Cyclone Heat Potential (KJ/cm²)
JUN 2016 Total
JUN 2016 – MAY 2016 TCHP (KJ/cm²)
Total
JUN 2016 Anom.
Anom.
30N
20N
10N
EQ
10S
20S
30S
40E
80E
120E
160E
160W
120W
80W
40W
0
0 20 40 60 80 100 120 140 160 180
−50 −40 −30 −20 −10 −5 5 10 20 30 40 50
−100 −80 −60 −40 −20 −10 10 20 40 60 80 100

Atlantic Hurricane Activity by July 5, 2016

(https://en.wikipedia.org/wiki/2016_Atlantic_hurricane_season)

NOAA Outlooks of Hurricane Season in 2016

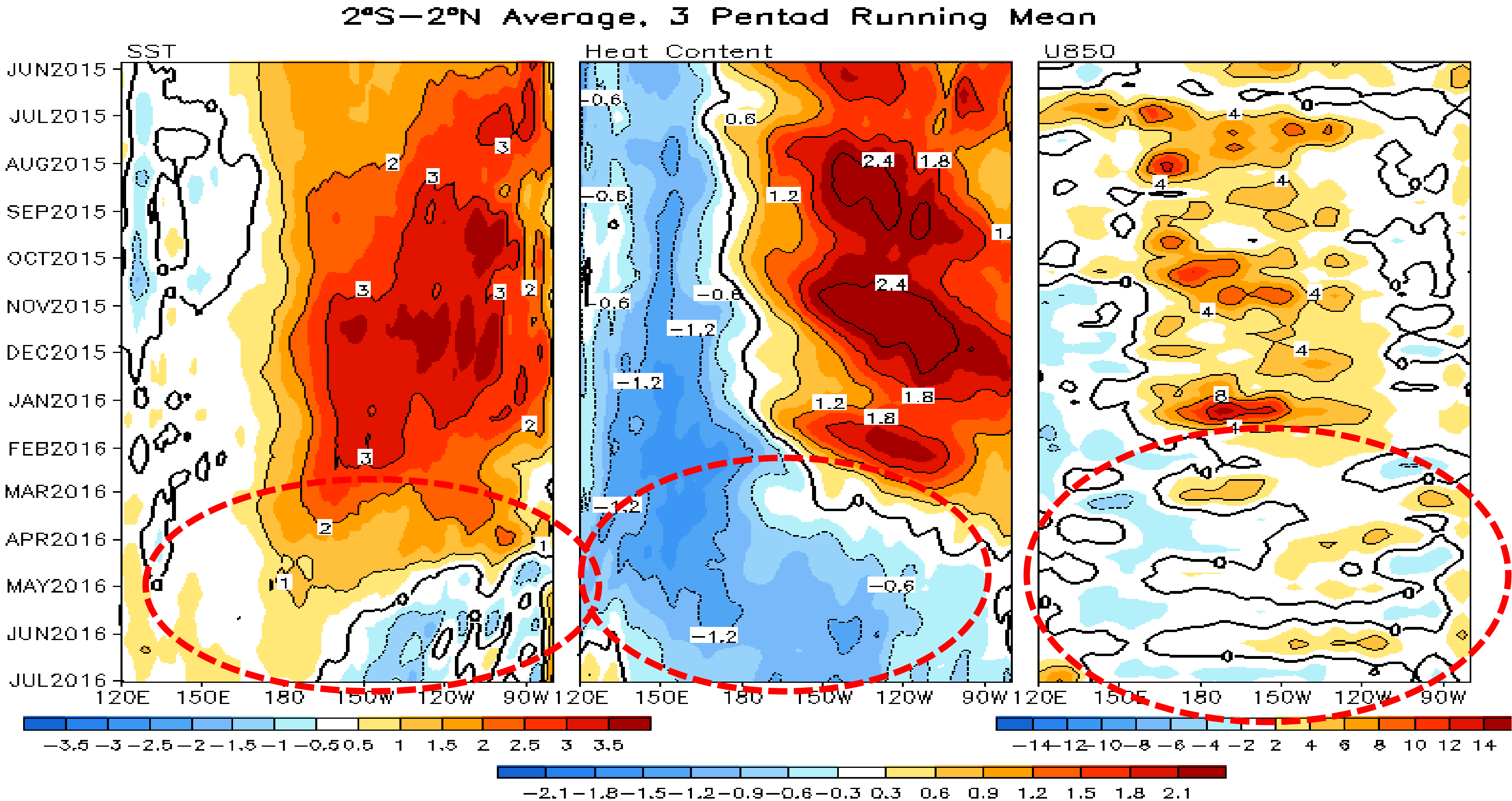
(http://www.cpc.ncep.noaa.gov/products/outlooks/hurricane.shtml/ https://en.wikipedia.org/wiki/2016_Atlantic_hurricane_season)

Atlantic	Observation by July 5, 2016	2016 prediction (issued on May 27)	1981-2010
Named storms	4	10-16	12.1
Hurricanes	1	4-8	6.4
Major hurricanes	0	1-4	2.7

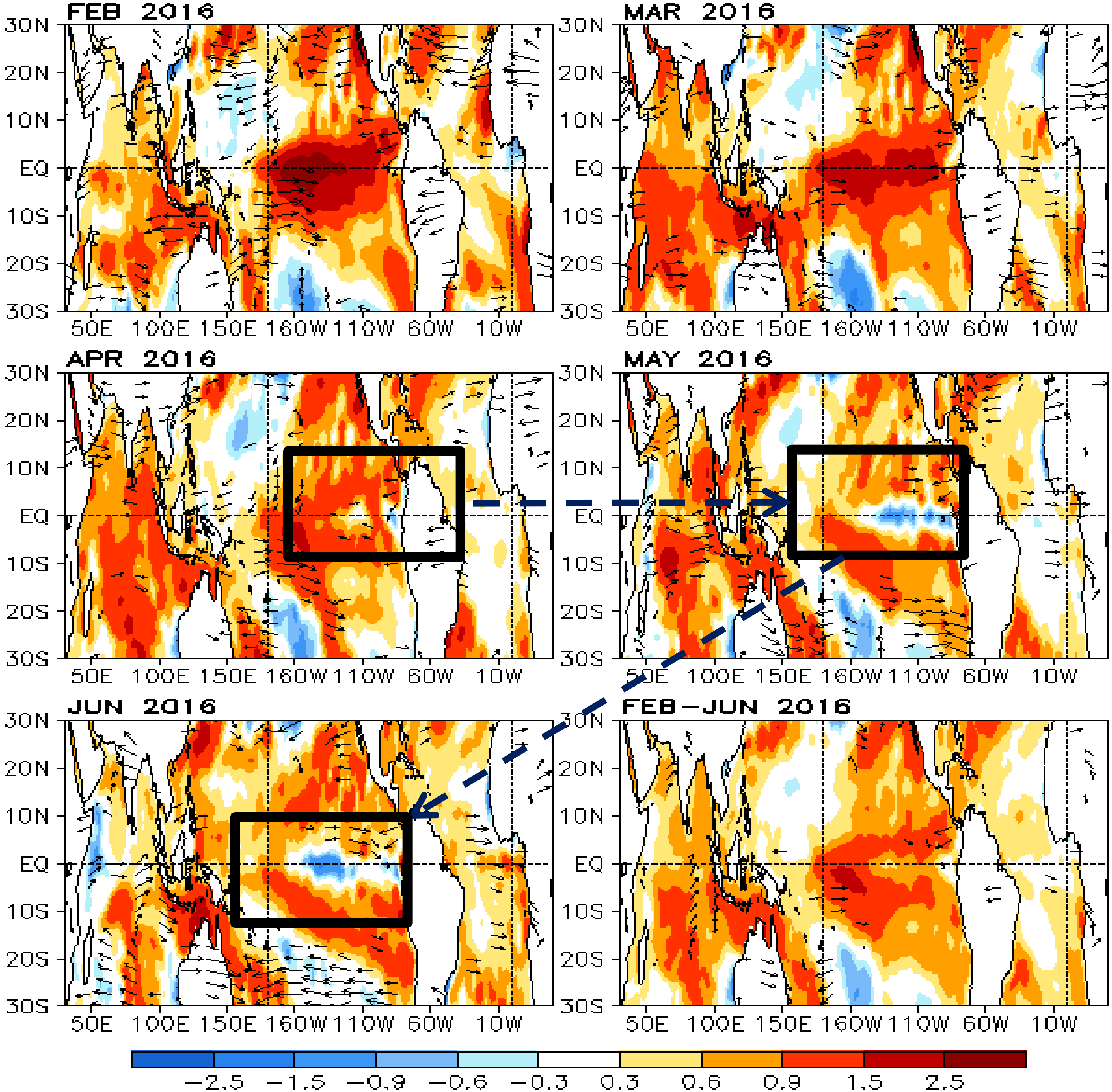
- Scenario 1: Above-normal season most likely if both La Niña and the conditions associated with the high-activity era and warm AMO develop.
- ***Scenario 2: Near-normal season most likely if La Niña develops and the conditions associated with a low-activity era and cool AMO also develop.***
- **Scenario 3: Below-normal season likelihood increases if La Niña does not develop and conditions typically associated with a low-activity era and cool AMO do develop.**

Tropical Pacific Ocean and ENSO Conditions

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

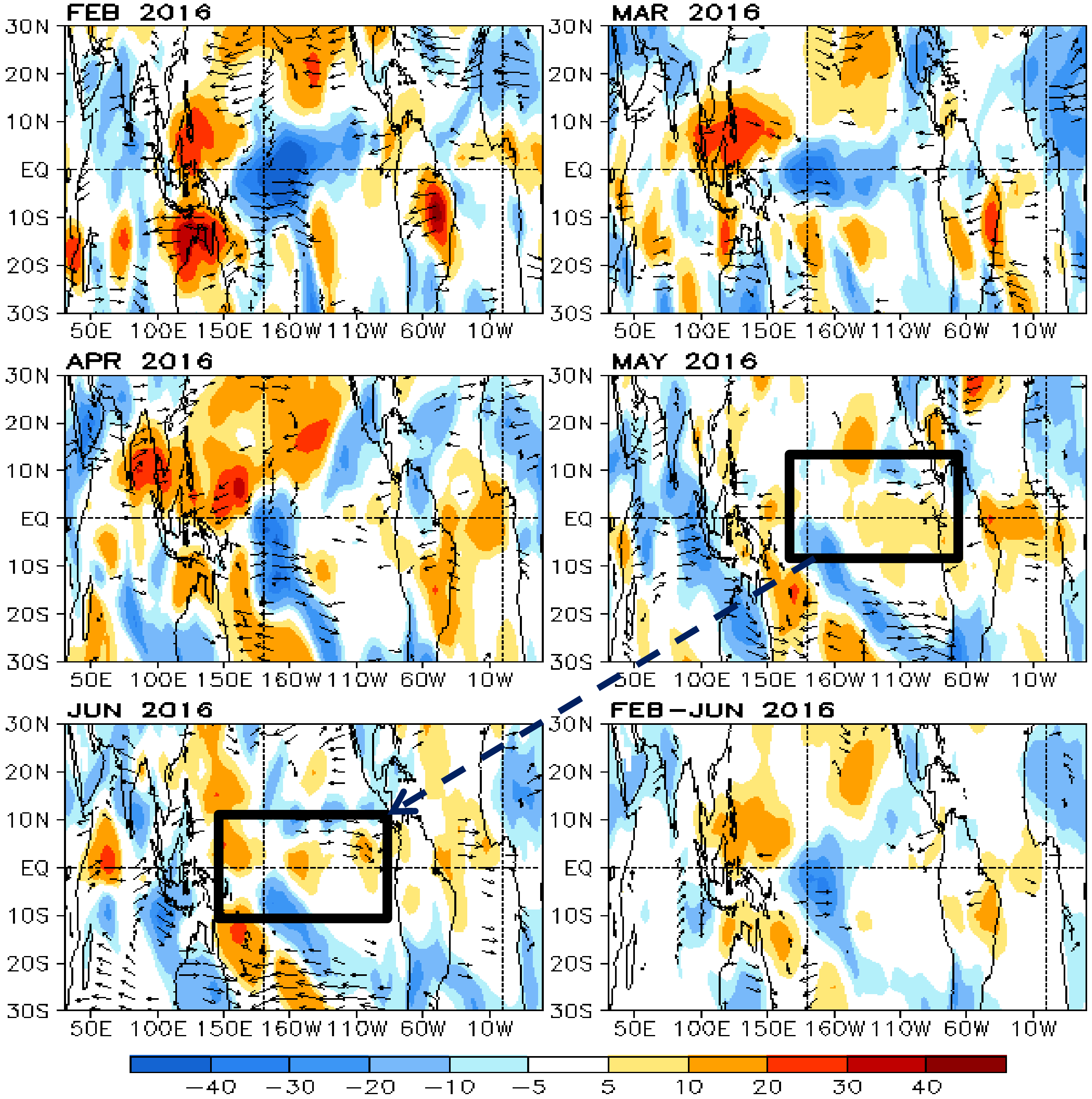


- **Negative SSTA emerged in the eastern equatorial Pacific in May 2016 and extended westward in Jun 2016.**
- **Positive HC300A disappeared, and negative occupied the equatorial Pacific since Mar 2016 and weakened in Jun 2016.**
- **Both easterly and westerly wind anomalies were small since Feb. 2016**



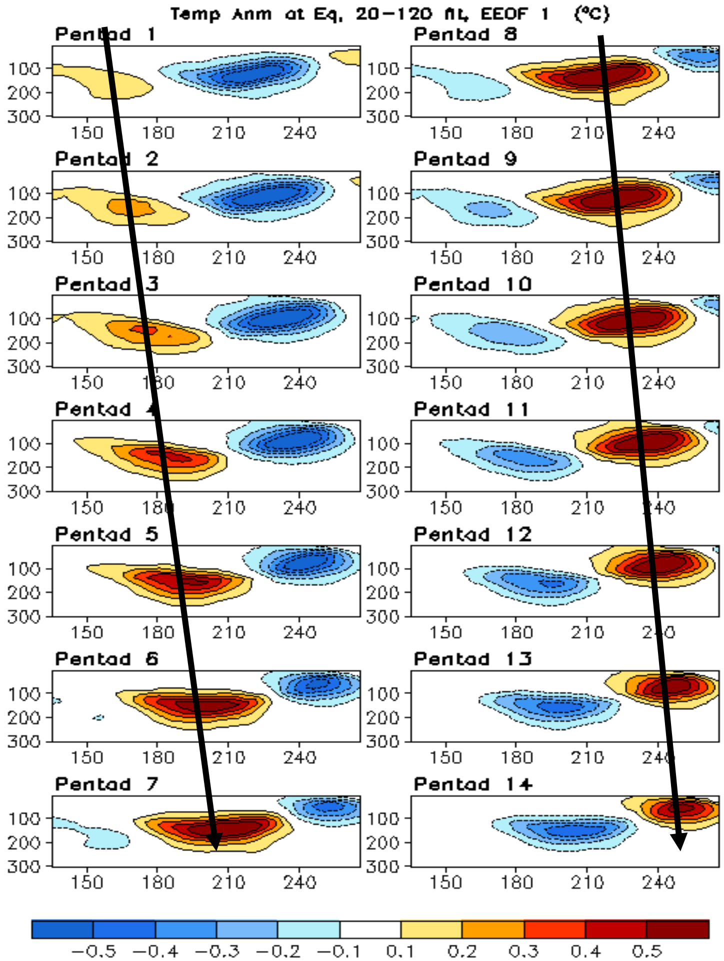
SSTA (shading) and UV850:

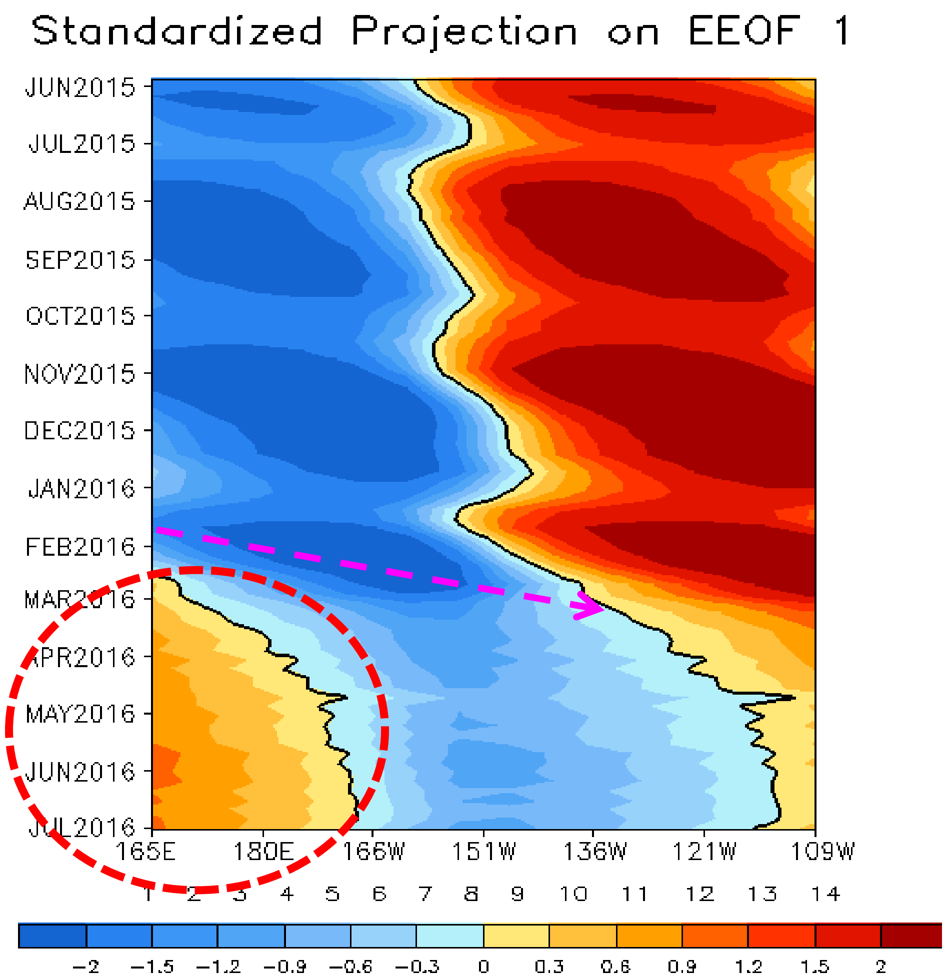
Little change from May to June in the tropical Pacific, consistent with the change of OLRA.



<u>OLRA (shading) and UV850:</u> Little change from May to June in the tropical Pacific, consistent with the change of SSTA.

Oceanic Kelvin Wave (OKW) Index



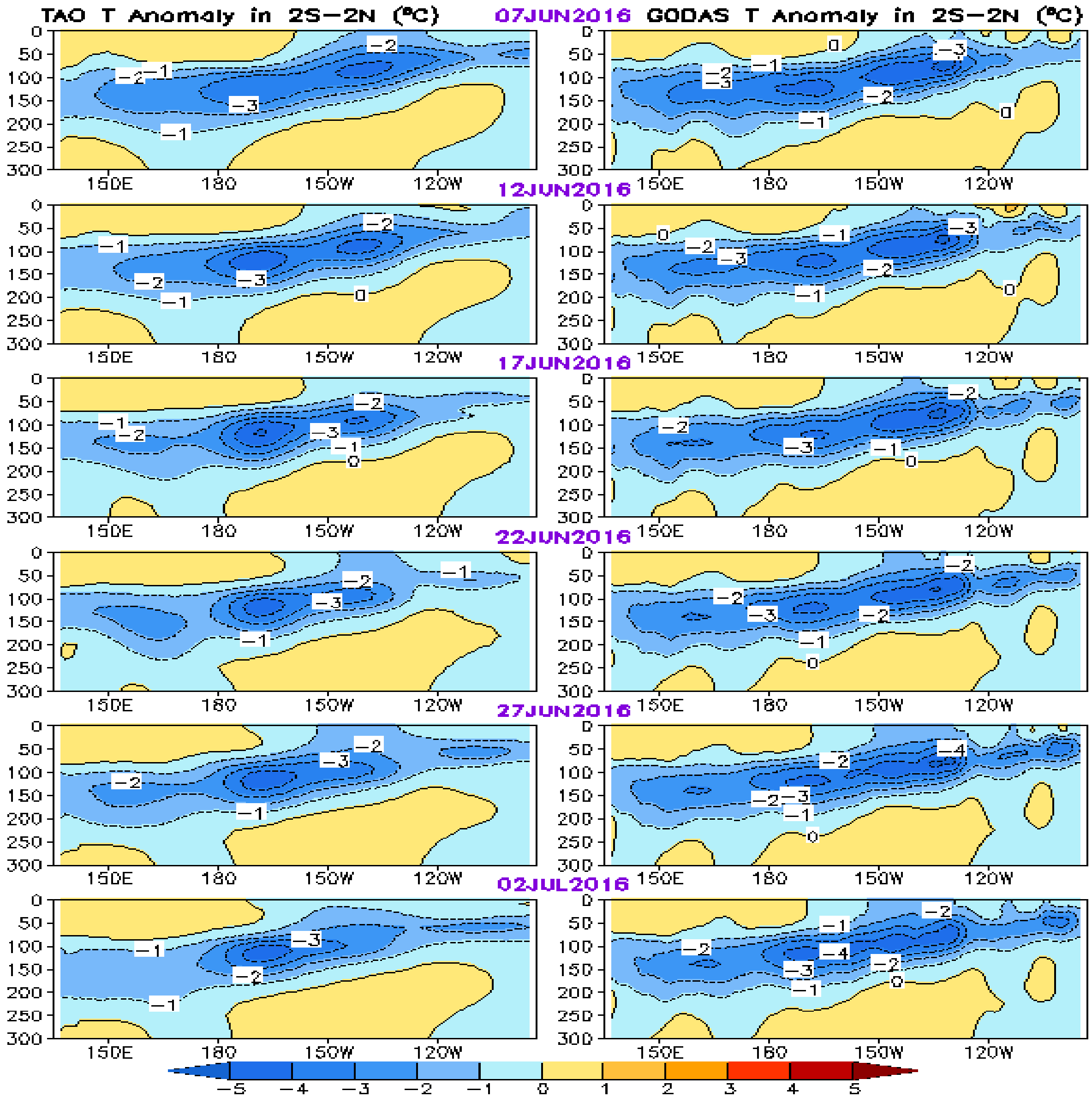


- **Upwelling OKW (dashed line) emerged since Jan 2016 in the western Pacific. The upwelling may be associated with the observed subsurface ocean cooling in the western and central Pacific and the eastward propagation.**

- *(OKW index is defined as standardized projections of total anomalies onto the 14 patterns of Extended EEOF1 of equatorial temperature anomalies (Seo and Xue , GRL, 2005).)*

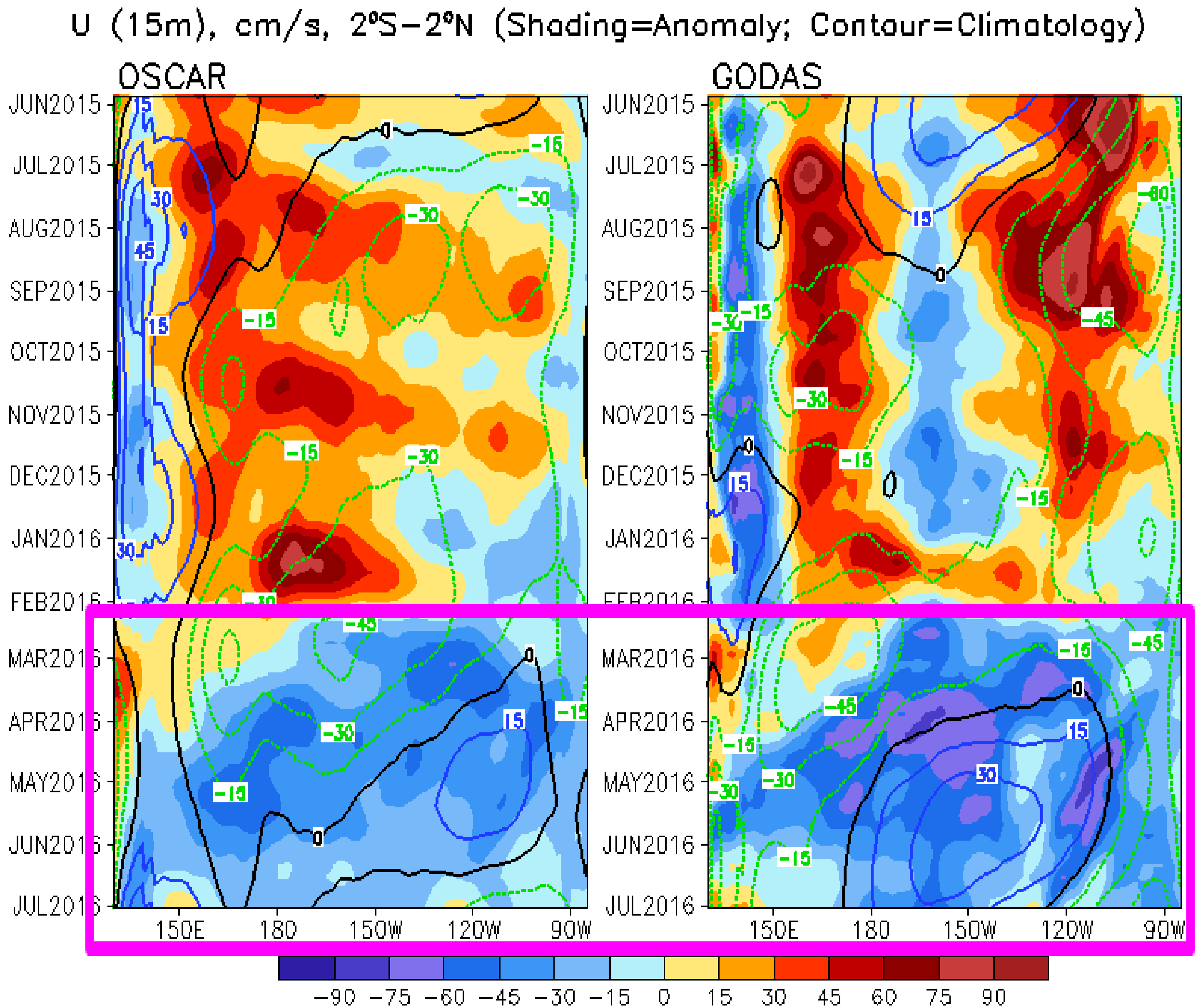
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

TAO GODAS



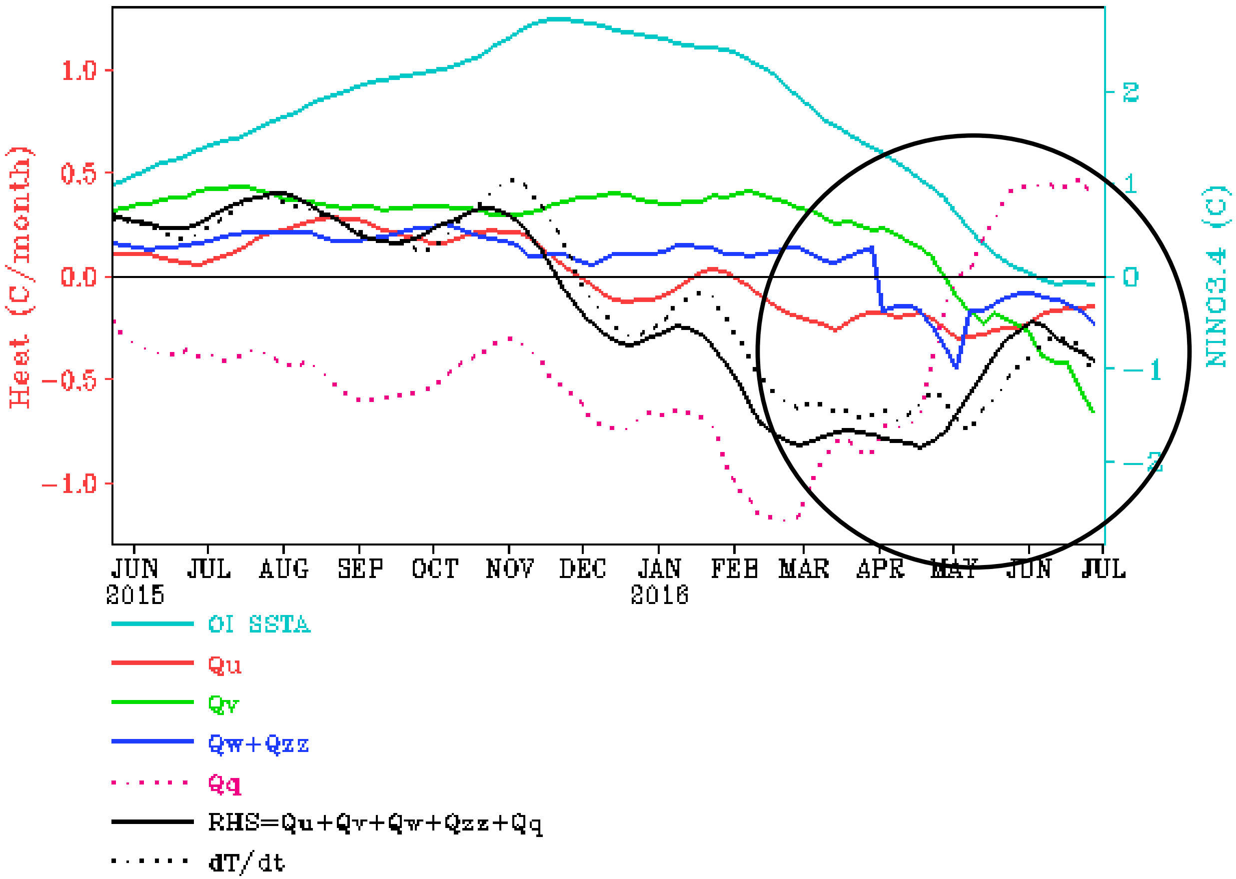
- **Ocean temperature anomalies were negative along the thermocline, and positive near the surface in the western and central Pacific.**
- **Both the anomalous pattern and propagation are comparable between TAO and GODAS.**

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



- **The anomalous current patterns were similar between OSCAR and GODAS.**
- **Anomalous westward current initiated in Feb 2016, strengthened in Mar-Apr 2016, and weakened in Jun 2016.**

NINO3.4 Heat Budget



- **Observed SSTA tendency (dT/dt) in NINO3.4 region (dotted black line) became negative since Dec 2015.**

- **All dynamical terms (Qu, Qv, Qw+Qzz) were small and negative, and heat flux term (Qq) was positive in Jun 2016, consistent with the decay of El Nino and possible development of a La Nina.**

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;

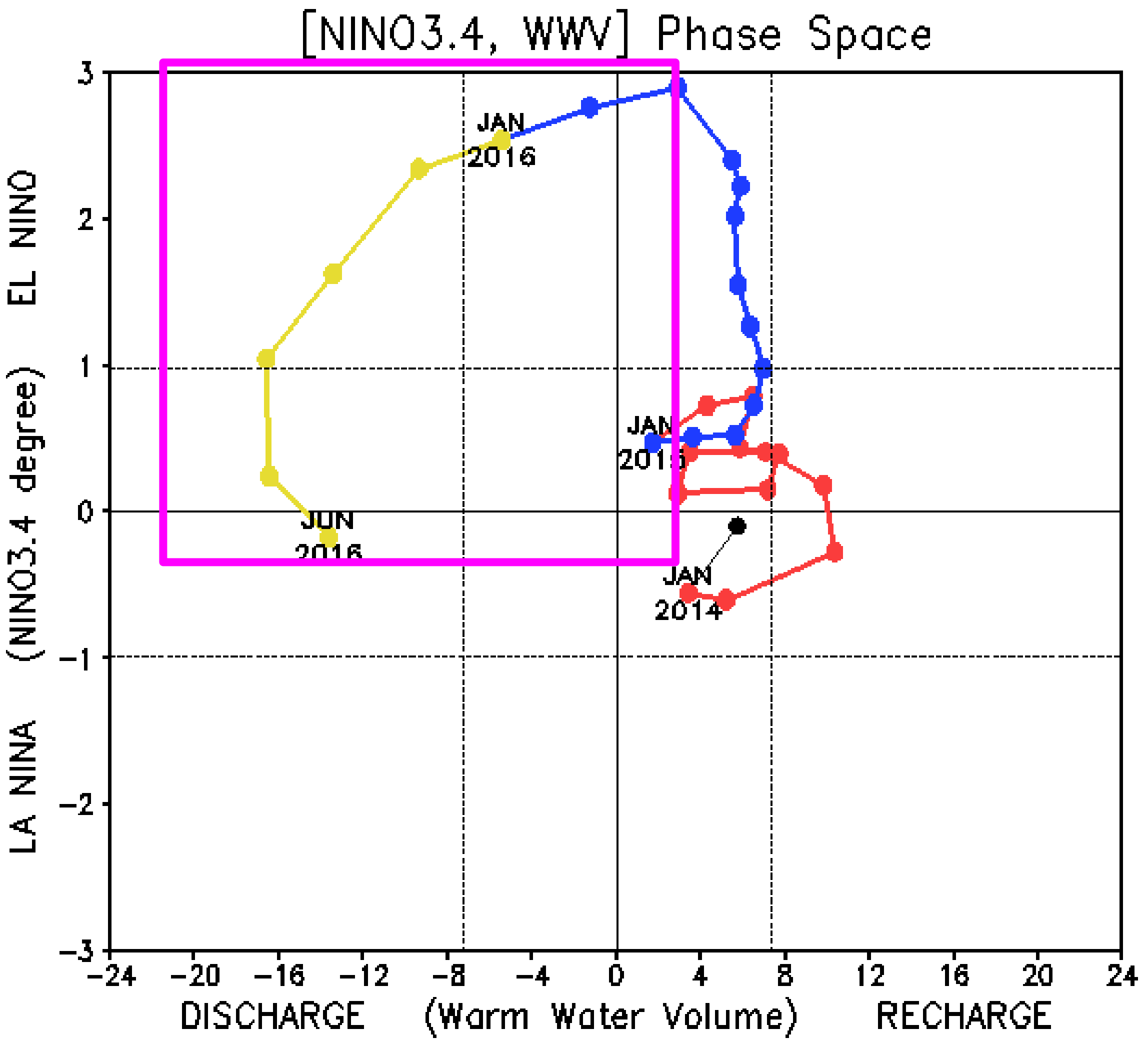
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

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).**

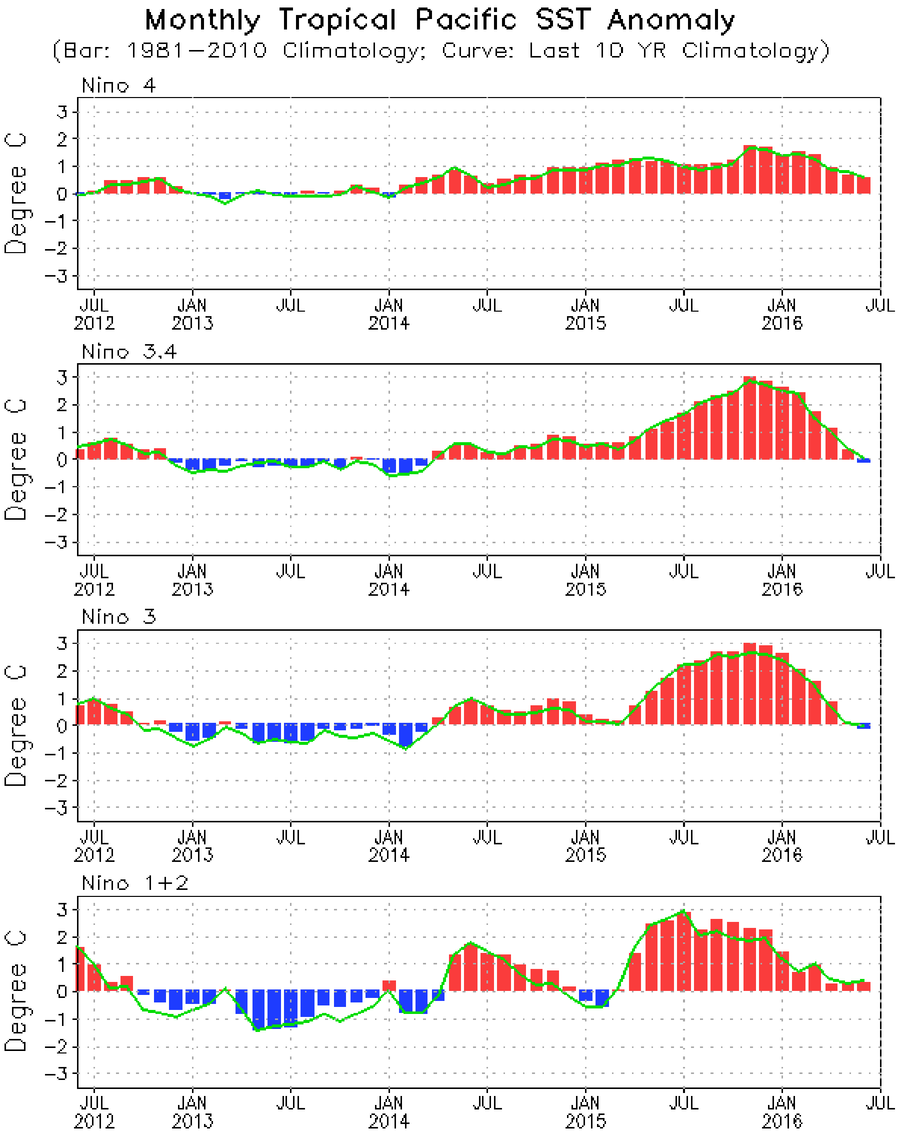
- **Increase (decrease) of WWV indicates recharge (discharge) of the equatorial oceanic heat content.**

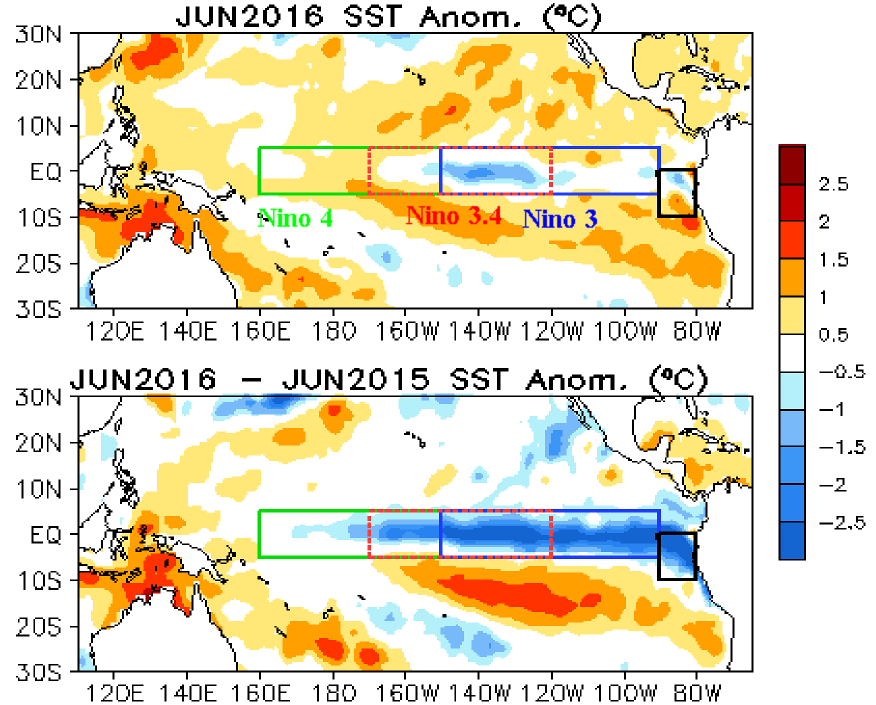


- **Equatorial Warm Water Volume (WWV) has been rapidly discharging since Nov 2015. The WWV change was small from Apr to Jun 2016.**

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.

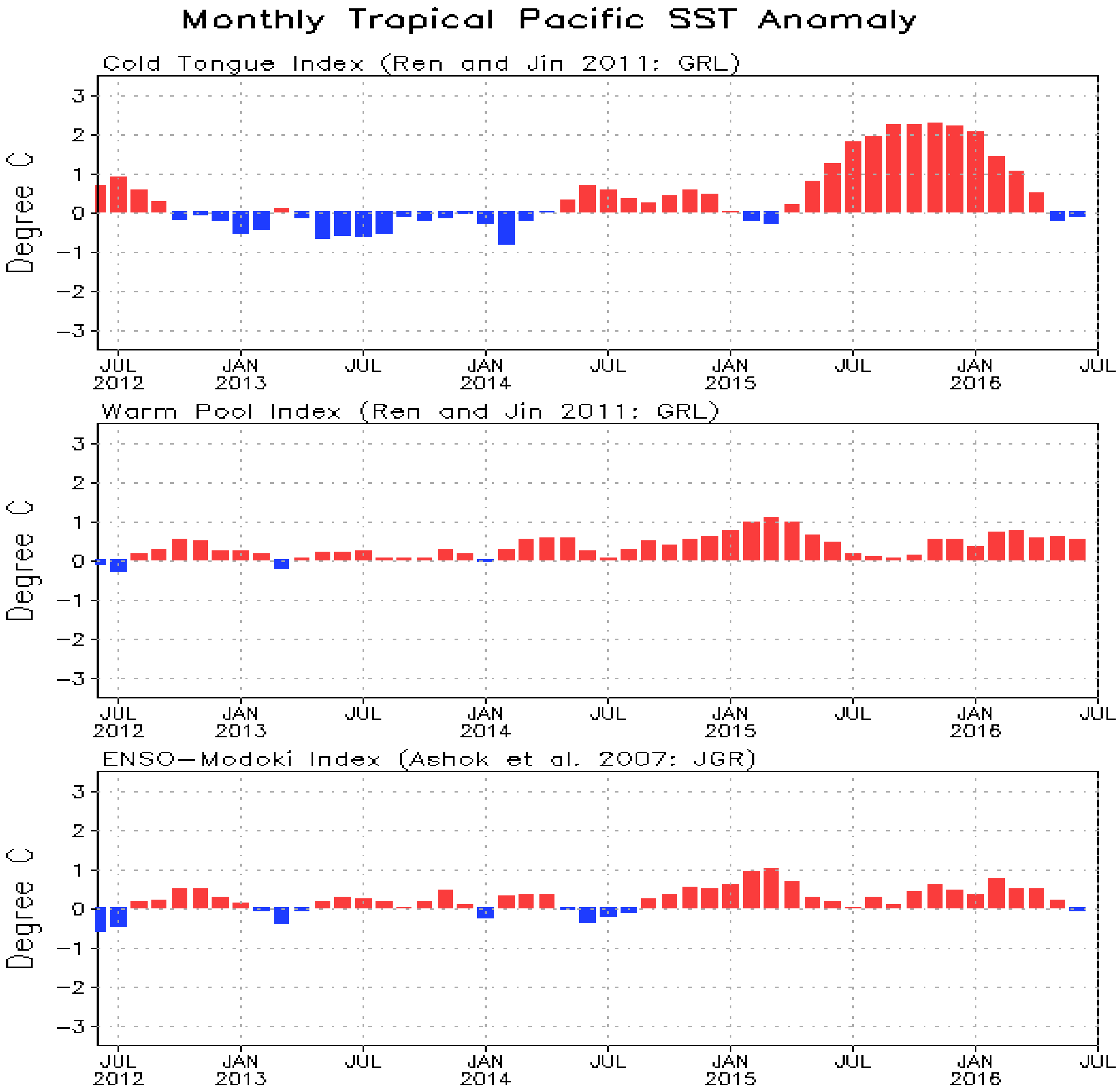
Evolution of Pacific NINO SST Indices



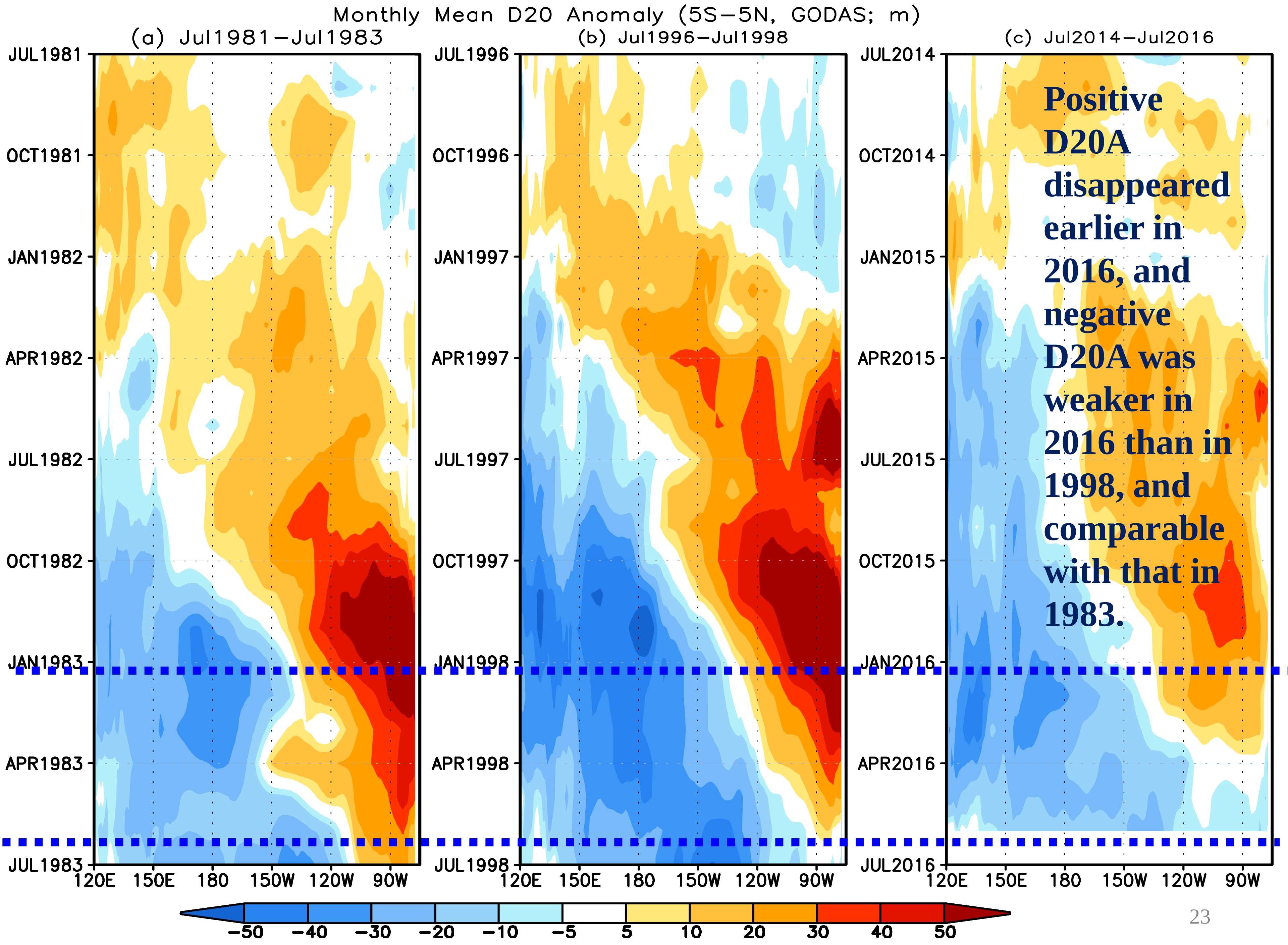


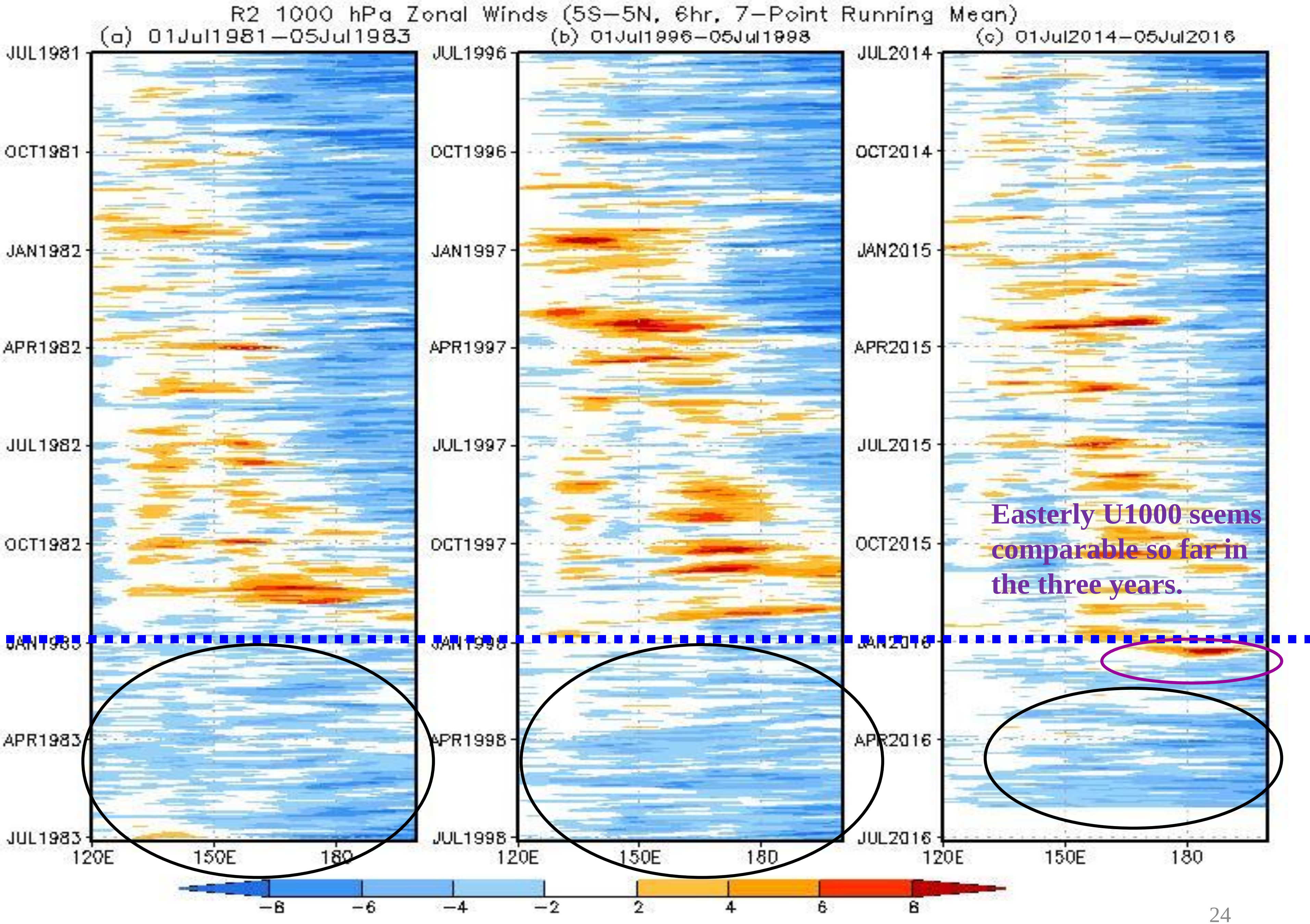
- All Nino indices had small values in Jun 2016.
- Nino3.4 = -0.1°C in Jun 2016.
- Compared with last Jun, the central and eastern equatorial Pacific was much cooler in Jun 2016.
- The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v4.

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.



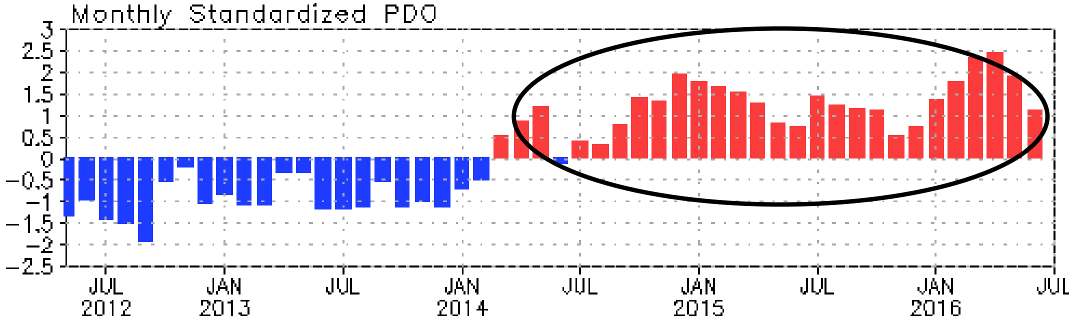
-2015/16 El Nino is a cold tongue (or EP, conventional) event.

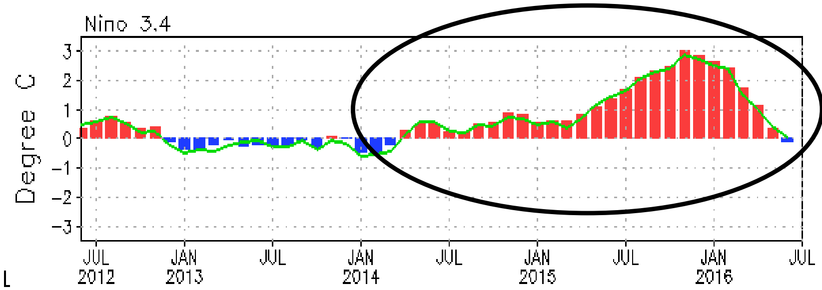

Monthly Mean D20 Anomaly (5S–5N, GODAS; m)
(a) Jul1981–Jul1983
(b) Jul1996–Jul1998
(c) Jul2014–Jul2016
JUL1981
OCT1981
JAN1982
APR1982
JUL1982
OCT1982
JAN1983
APR1983
JUL1983
JUL1996
OCT1996
JAN1997
APR1997
JUL1997
OCT1997
JAN1998
APR1998
JUL1998
JUL2014
OCT2014
JAN2015
APR2015
JUL2015
OCT2015
JAN2016
APR2016
JUL2016
120E 150E 180 150W 120W 90W
–50 –40 –30 –20 –10 –5 5 10 20 30 40 50
Positive D20A disappeared earlier in 2016, and negative D20A was weaker in 2016 than in 1998, and comparable with that in 1983.

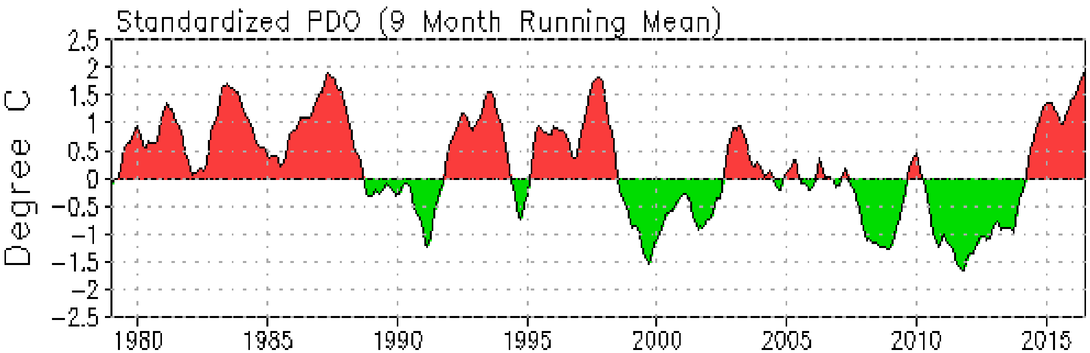

R2 1000 hPa Zonal Winds (5S–5N, 6hr, 7–Point Running Mean)
(a) 01Jul1981–05Jul1983
(b) 01Jul1996–05Jul1998
(c) 01Jul2014–05Jul2016
JUL1981
OCT1981
JAN1982
APR1982
JUL1982
OCT1982
JAN1983
APR1983
JUL1983
JUL1996
OCT1996
JAN1997
APR1997
JUL1997
OCT1997
JAN1998
APR1998
JUL1998
JUL2014
OCT2014
JAN2015
APR2015
JUL2015
OCT2015
JAN2016
APR2016
JUL2016
120E
150E
180
−8
−6
−4
−2
2
4
6
8
Easterly U1000 seems comparable so far in the three years.

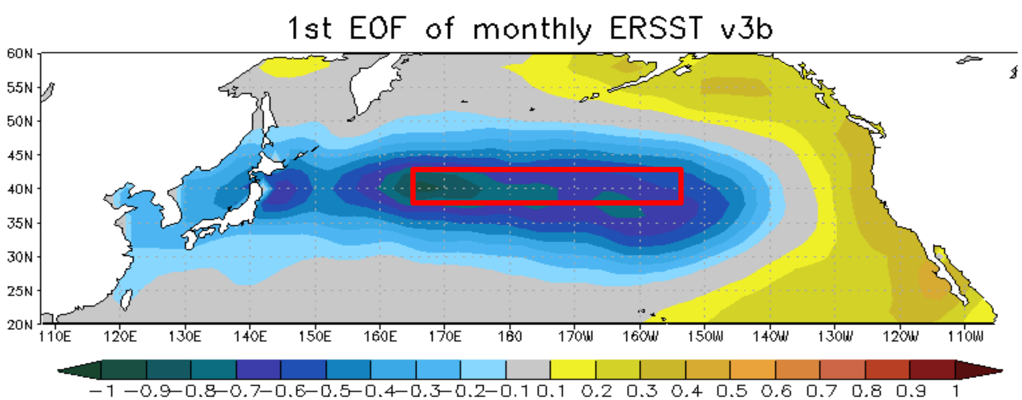
North Pacific & Arctic Oceans

PDO index









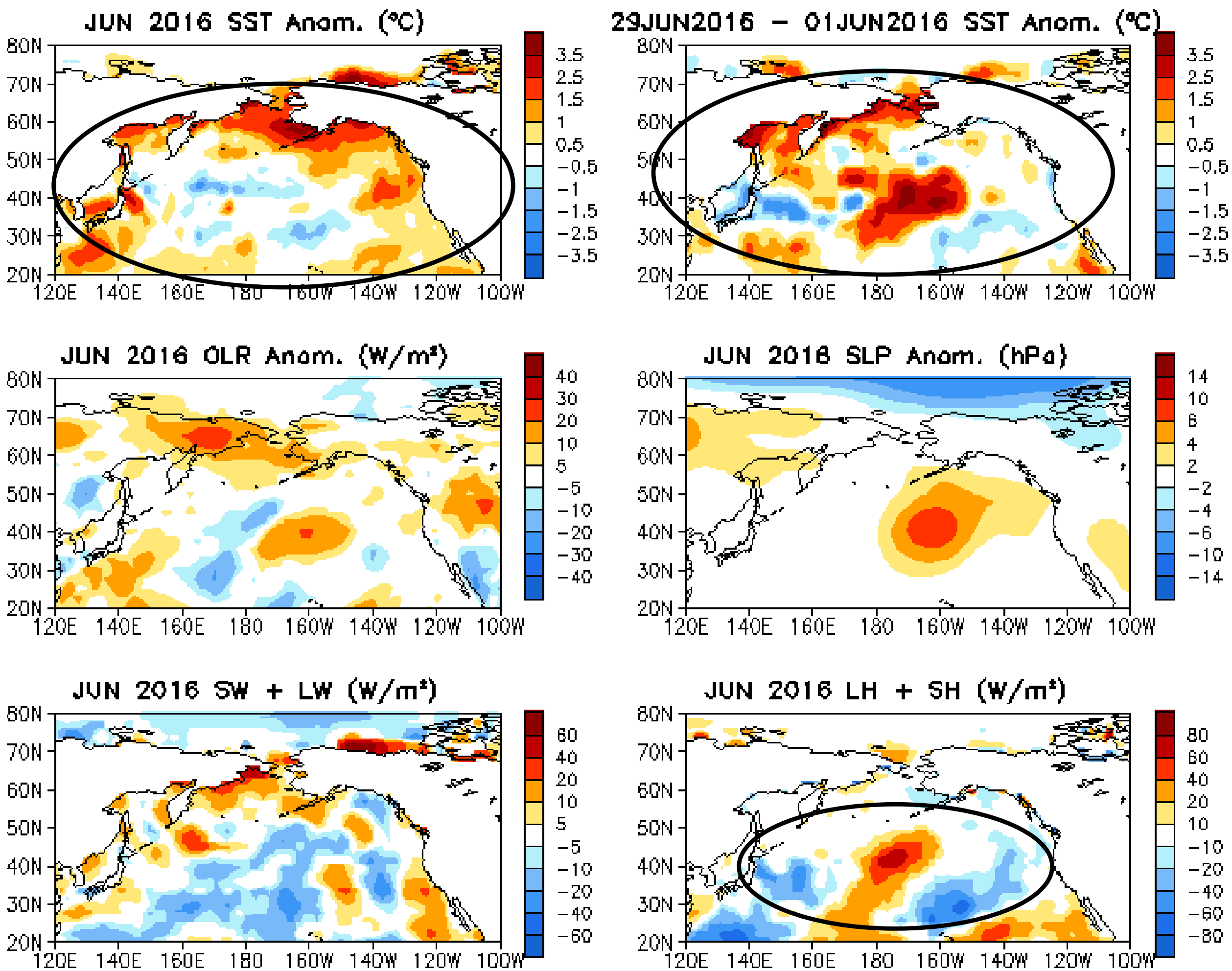
- The positive phase of PDO index has persisted 24 months since Jul 2014, and weakened with PDO index =1.1 in Jun 2016.

- Statistically, ENSO leads PDO by 3-4 months, 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.

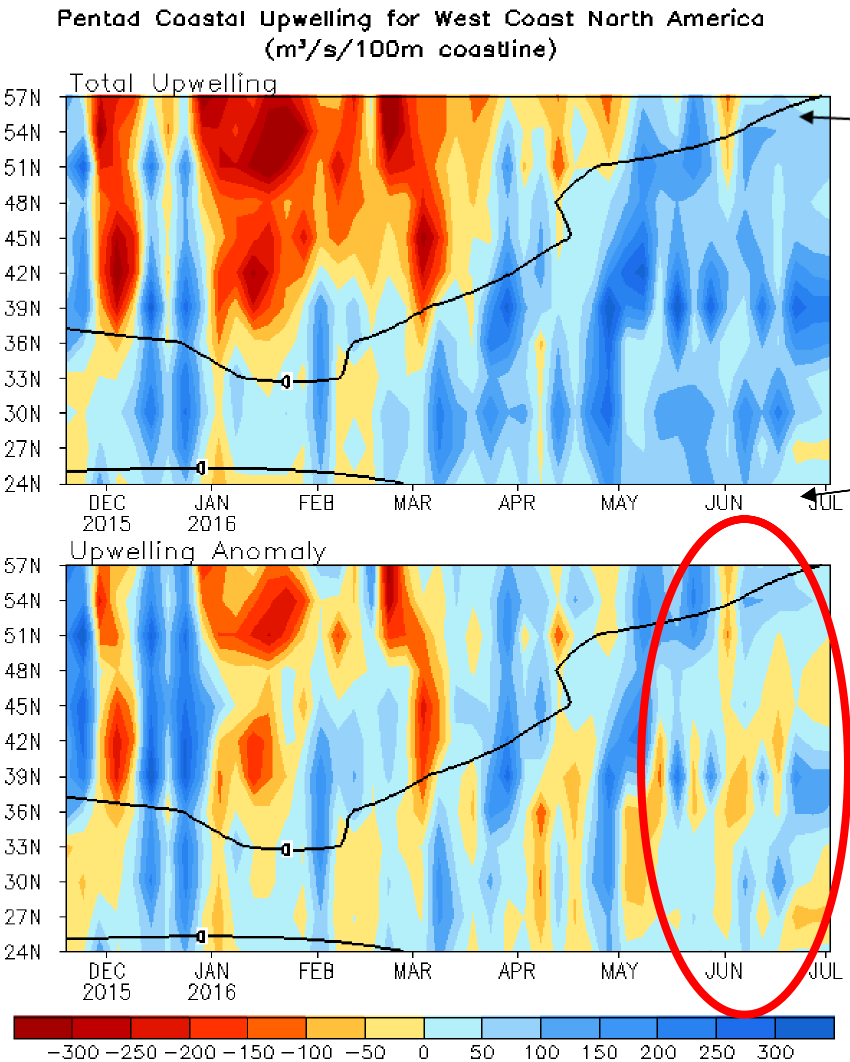
North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

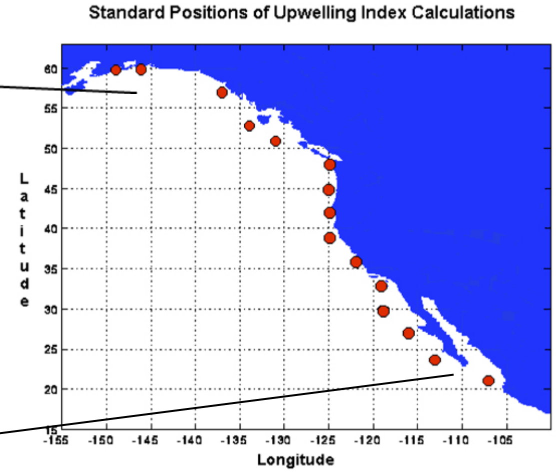


- Positive SSTA along the coast and negative in the open ocean consisted with the positive phase of PDO index (previous slide).
- The SST tendency was positive in the central N. Pacific, consistent with weakening of PDO.
- Above-normal SLP presented in the mid-high latitudes of N. Pacific.

Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible heat flux anomalies (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, sea surface pressure and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period means.

North America Western Coastal Upwelling





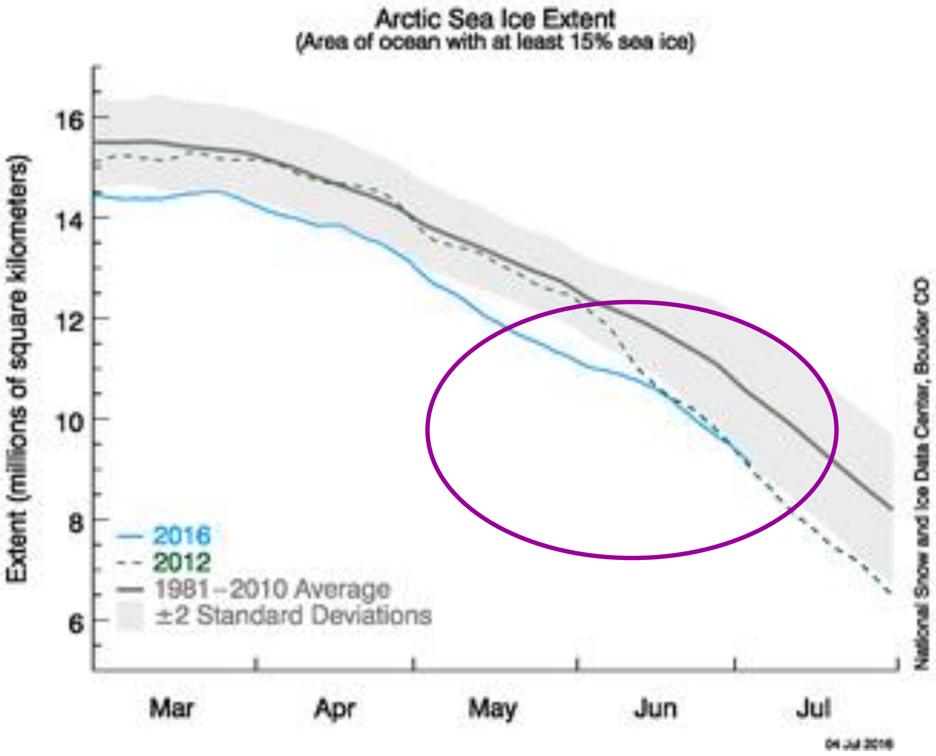
- Both anomalous upwelling and downwelling were small in recent months.

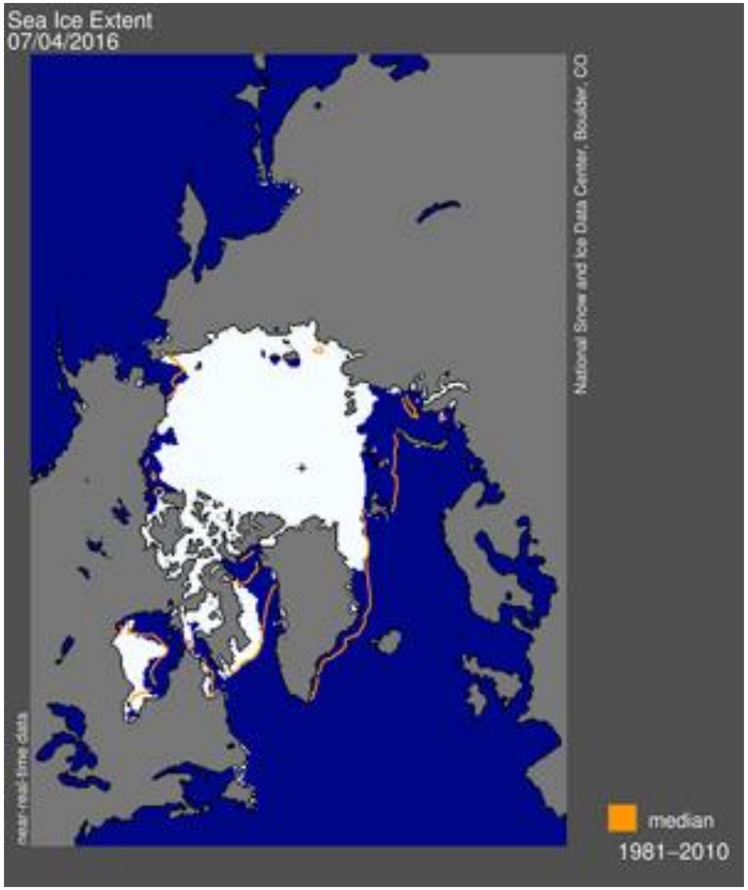
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport 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 36ºN to 57ºN.**

Arctic Sea Ice

National Snow and Ice Data Center
http://nsidc.org/arcticseaicenews/index.html

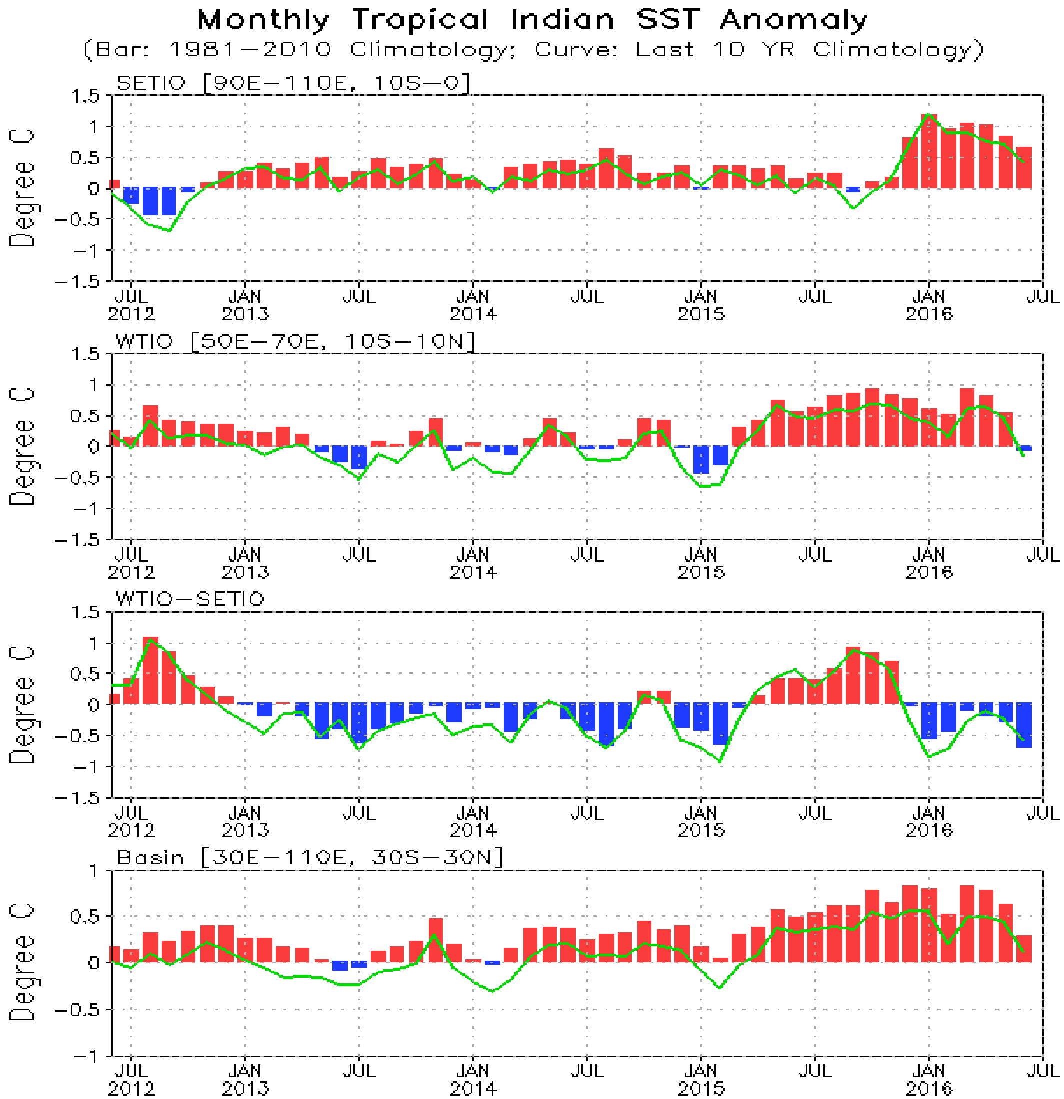


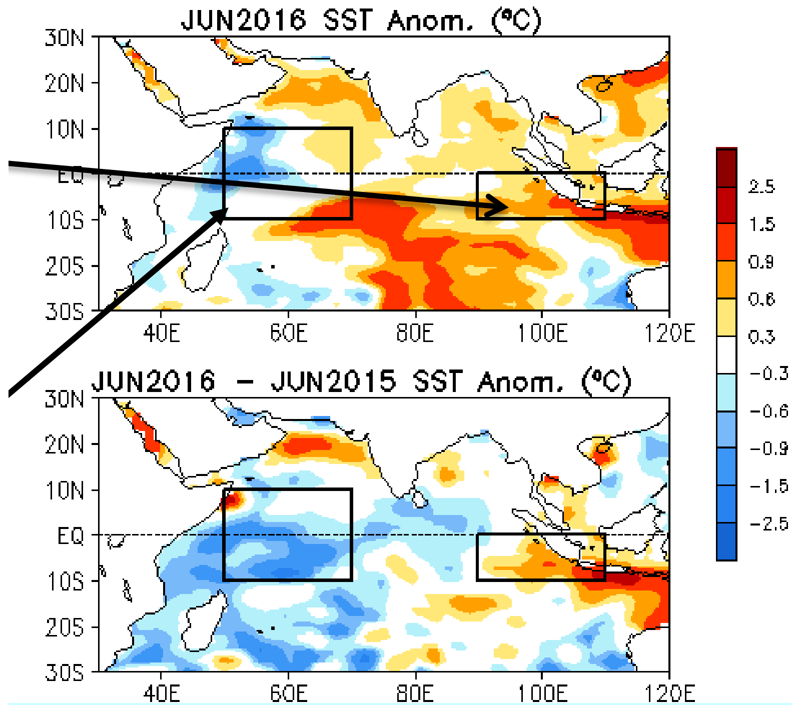


- **Arctic sea ice extent in Jun 2016 was about -2 standard deviations and comparable with that in 2012.**

<u>Indian Ocean</u>

Evolution of Indian Ocean SST Indices





- **SSTAs were negative in the west and positive in the central and east.**

- **DMI was below normal since Dec 2015.**

- **Compared with Jun 2015, cooling presented in the west and central and warming in the east in Jun 2016.**

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 SSTA was larger in the east than in the west.**
- **SSTA tendency was largely determined by heat flux.**
- **Convections were active over the Indian Peninsula.**

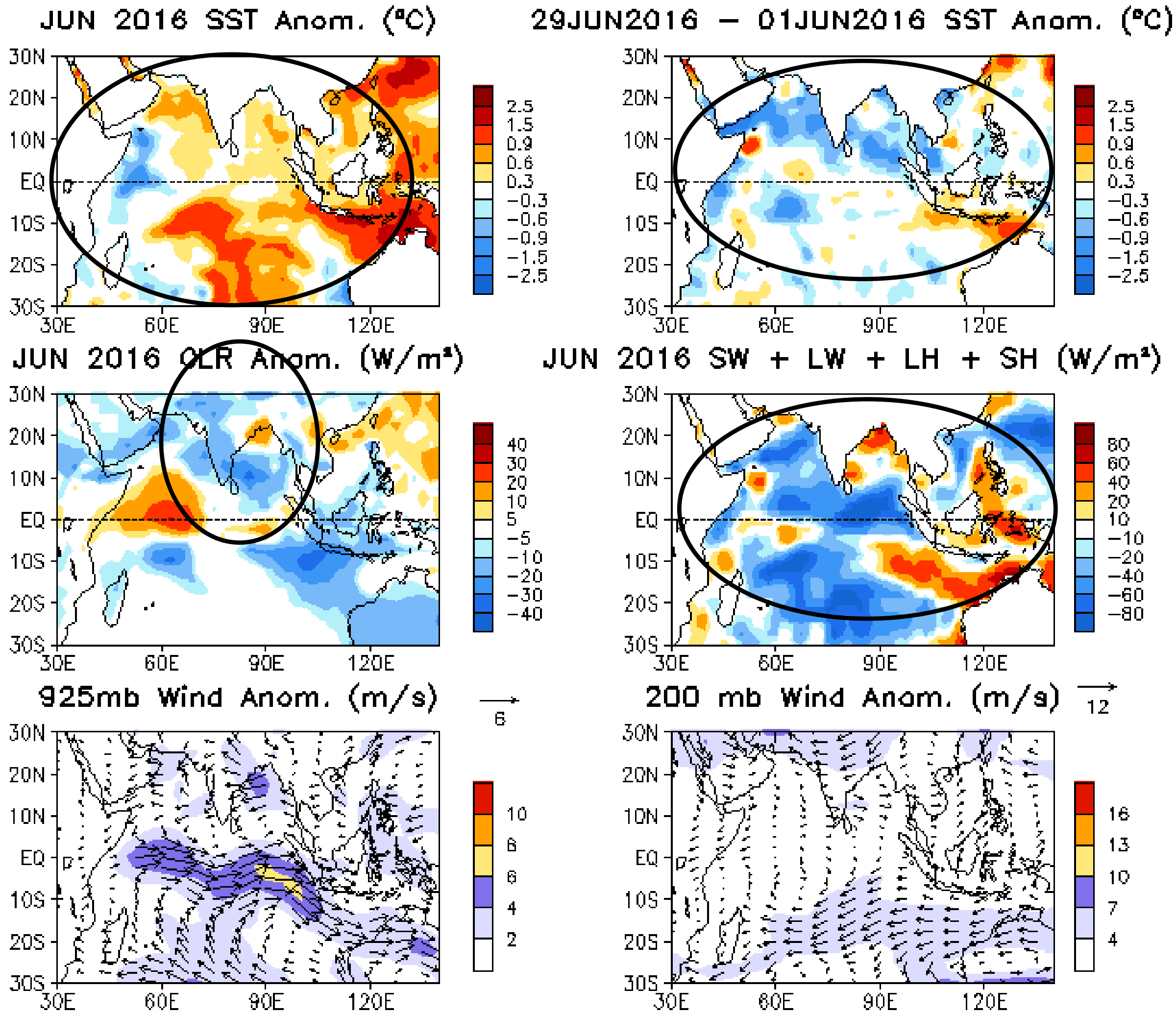
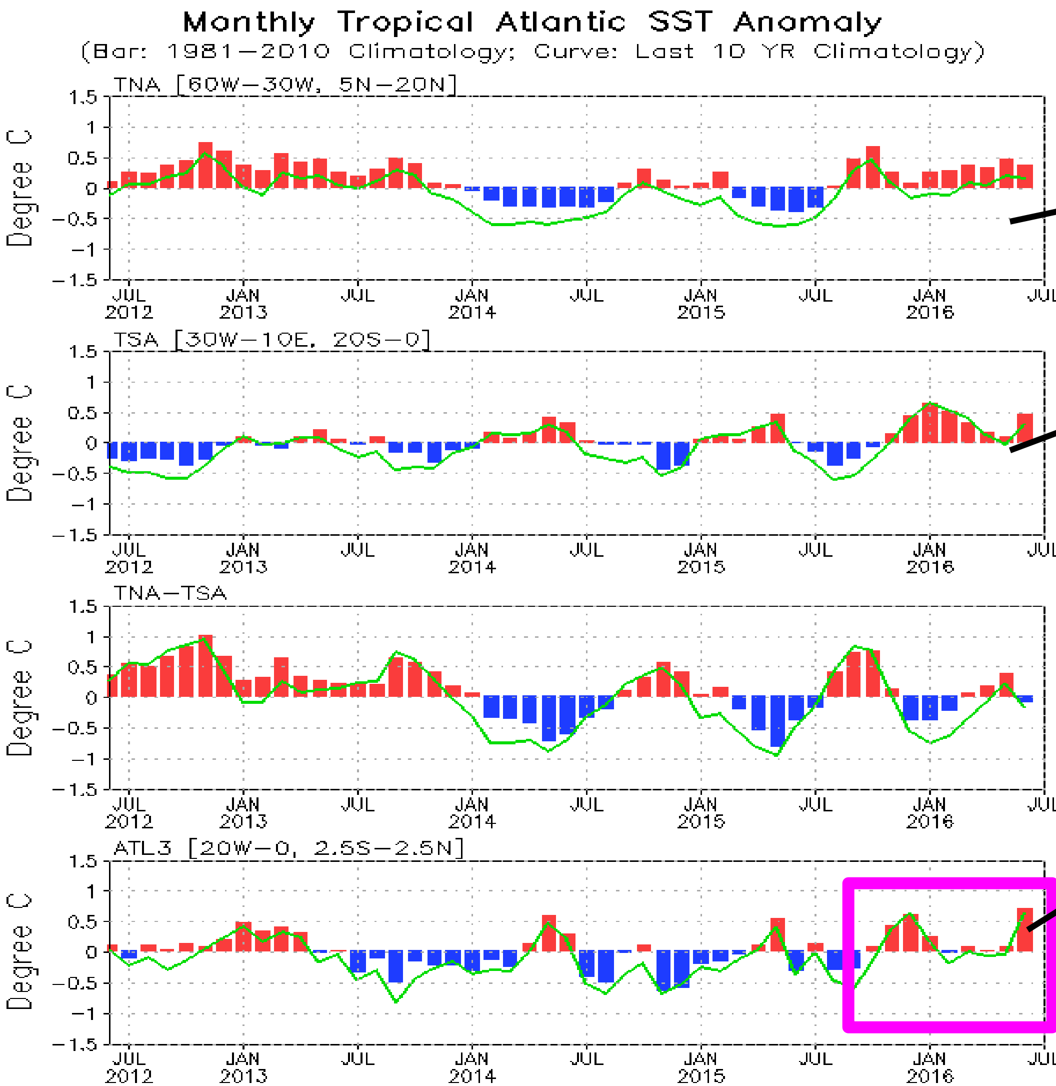
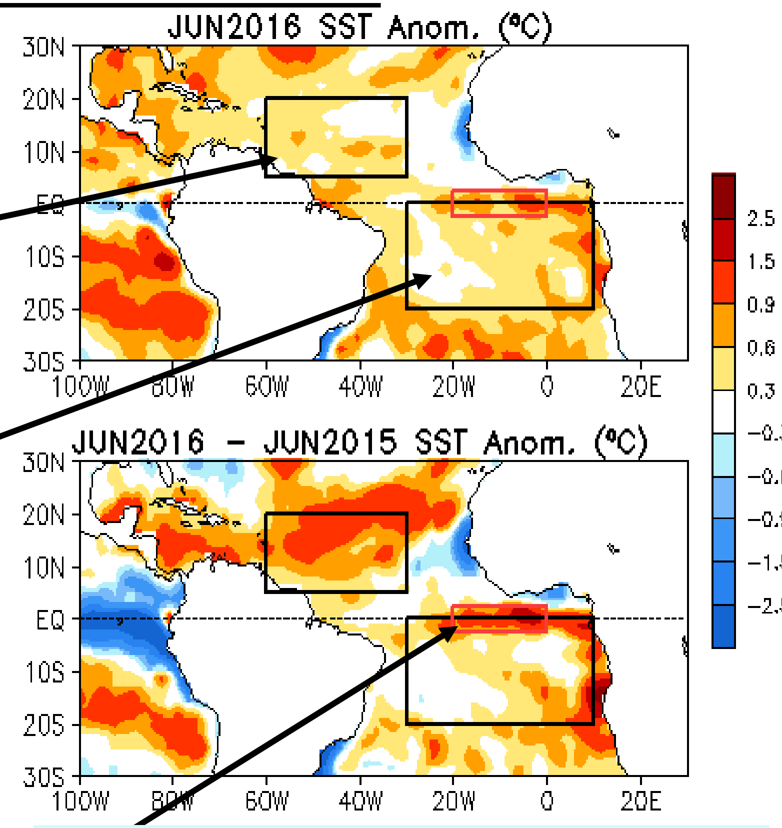


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

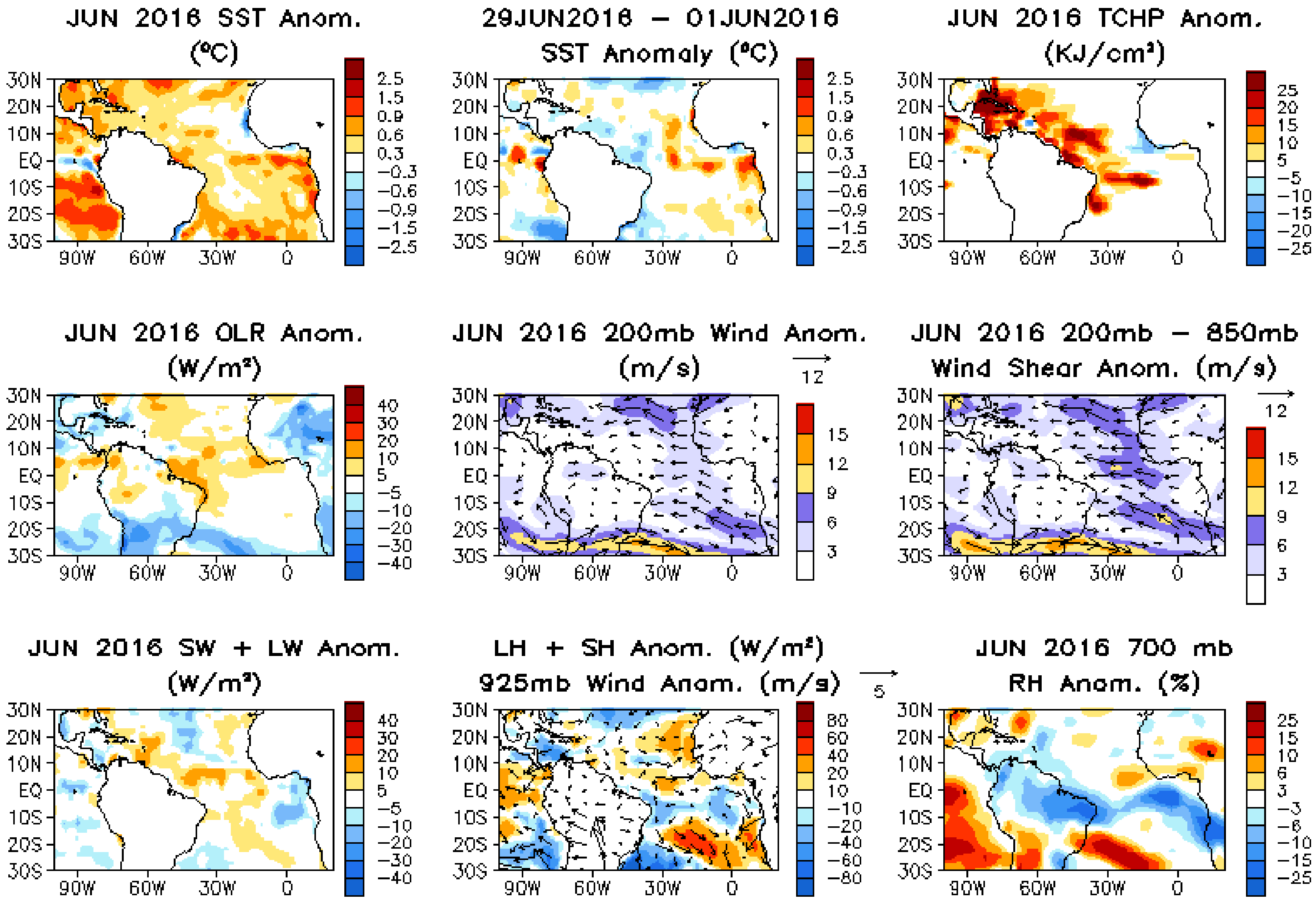




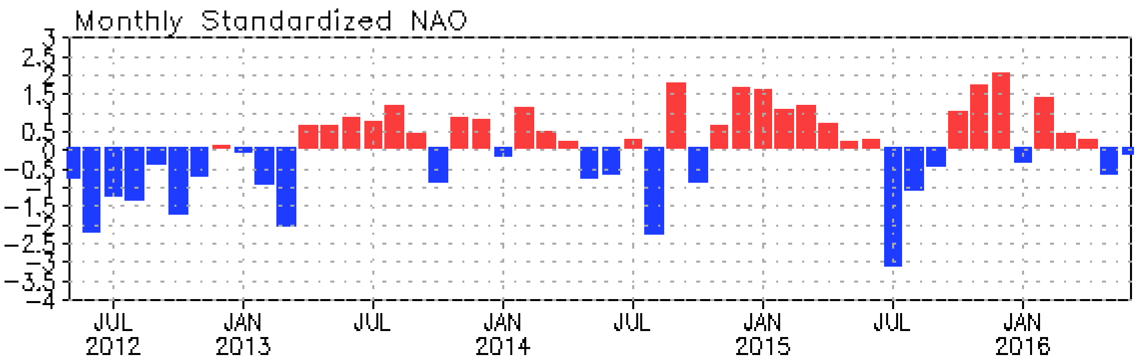
- **ATL3 index had large positive value in Jun 2016.**
- **Compared with Jun 2015, SST in the tropical NW Atlantic was warmer in Jun 2016.**

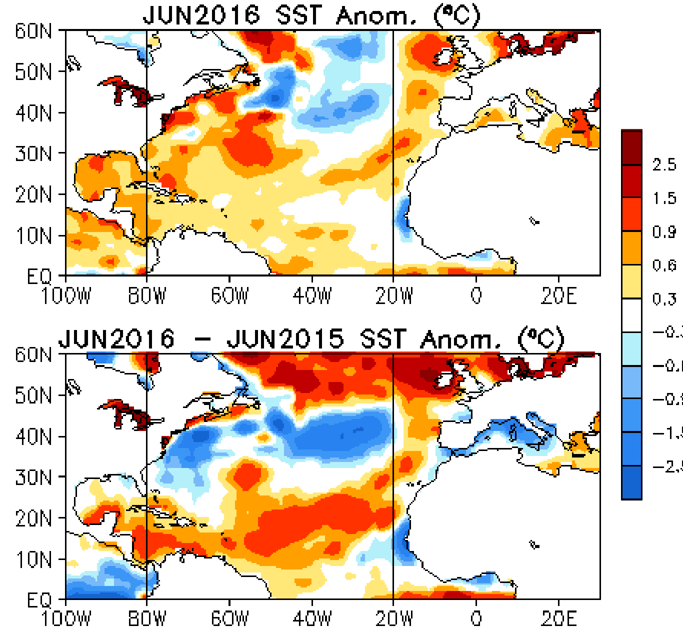
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (ºC) for the TNA [60ºW-30ºW, 5ºN-20ºN], TSA [30ºW-10ºE, 20ºS-0] and ATL3 [20ºW-0, 2.5ºS-2.5ºN] regions, and Meridional Gradient Index, defined as differences between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

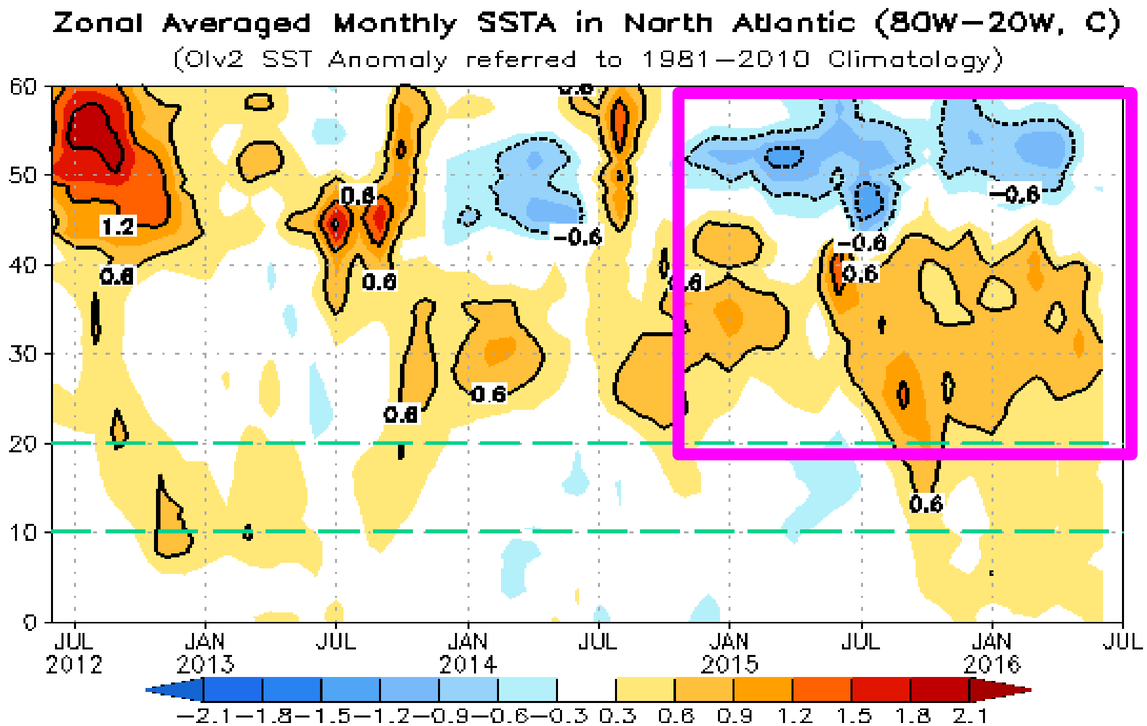
Tropical Atlantic:



NAO and SST Anomaly in North Atlantic





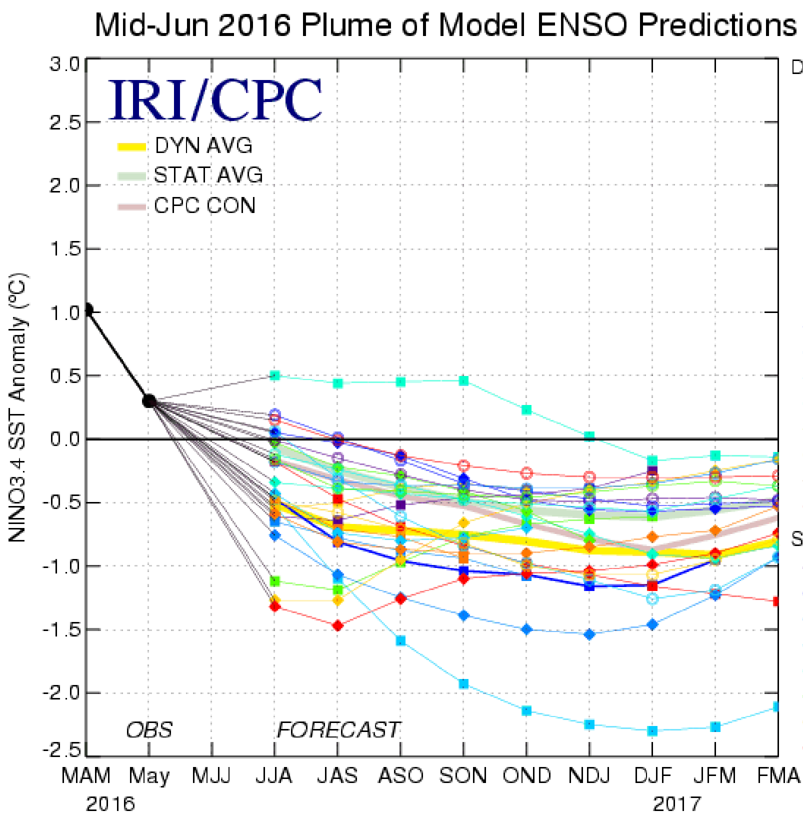


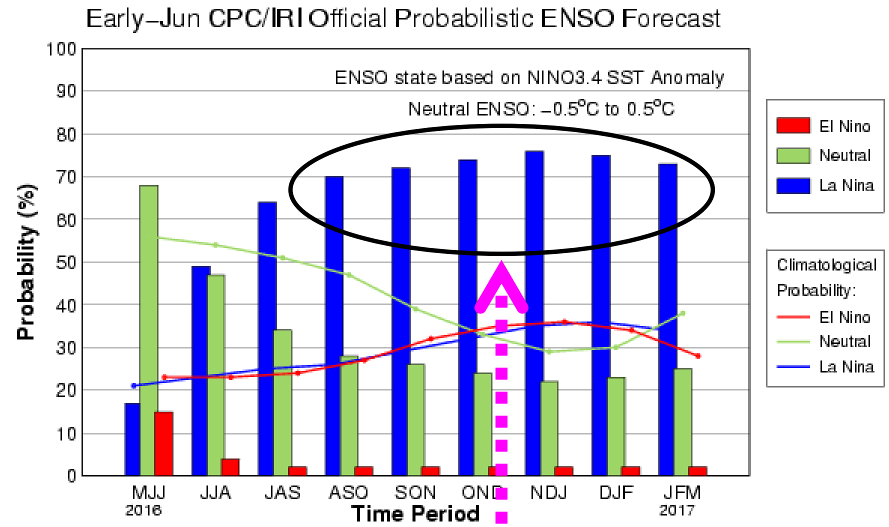
- NAO was in negative phase with NAOI= -0.1 in Jun 2016.
- Both positive SSTA in the low and middle latitudes and negative in the high latitudes weakened, may be due to the phase switch of NAO and ENSO transition to neutral.

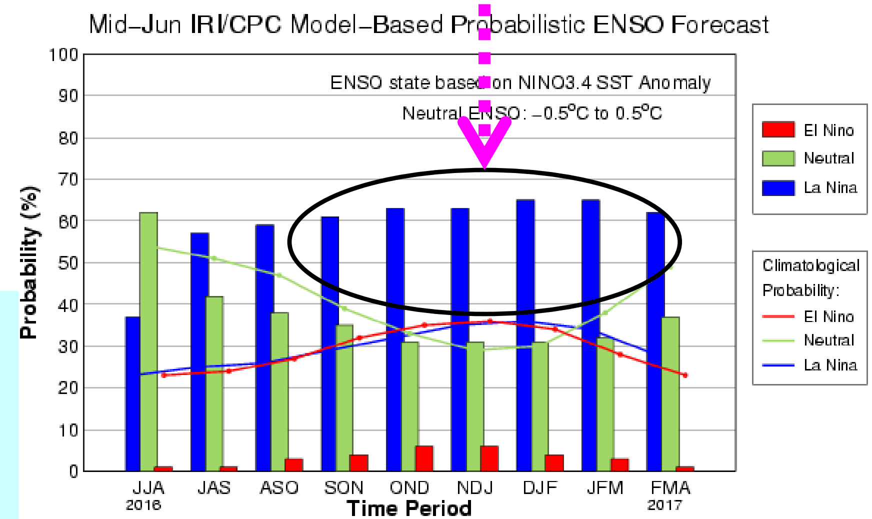
Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20°N-90°N (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80°W and 20°W (bottom). SST are derived from the NCEP OI SST analysis,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

ENSO and Global SST Predictions

IRI NINO3.4 Forecast Plum



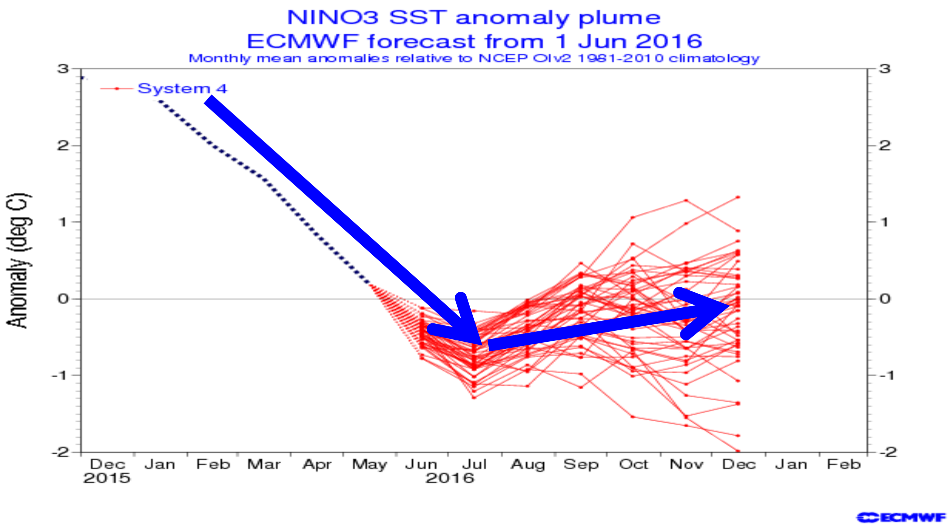




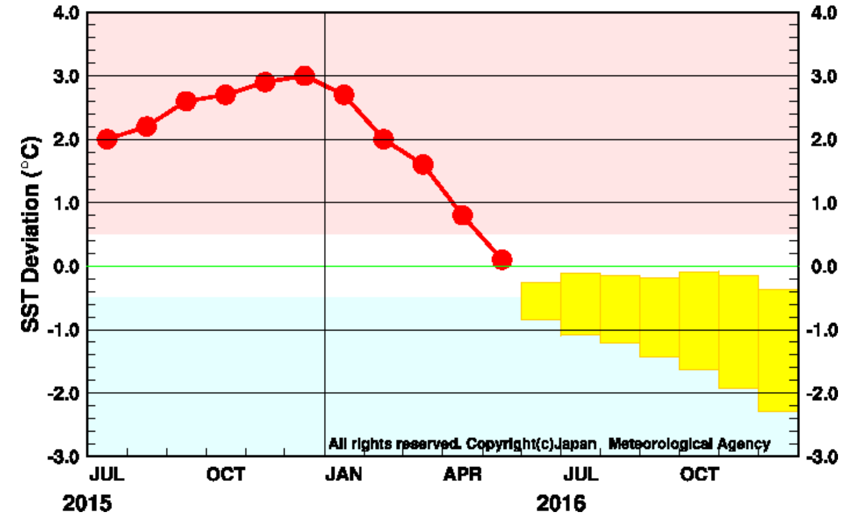
- **Majority of models predicted a La Nina started since the second half of 2016, and some models predicted neutral.**
- **NOAA "ENSO Diagnostic Discussion" on 9 June 2016 issued "Final El Nino Advisory/La Niña Watch" and suggested that *"ENSO-neutral conditions are present and La Niña is favored to develop during the Northern Hemisphere summer 2016, with about a 75% chance of La Niña during the fall and winter 2016-17"***

Individual Model Forecasts: neutral or (boardline) La Nina

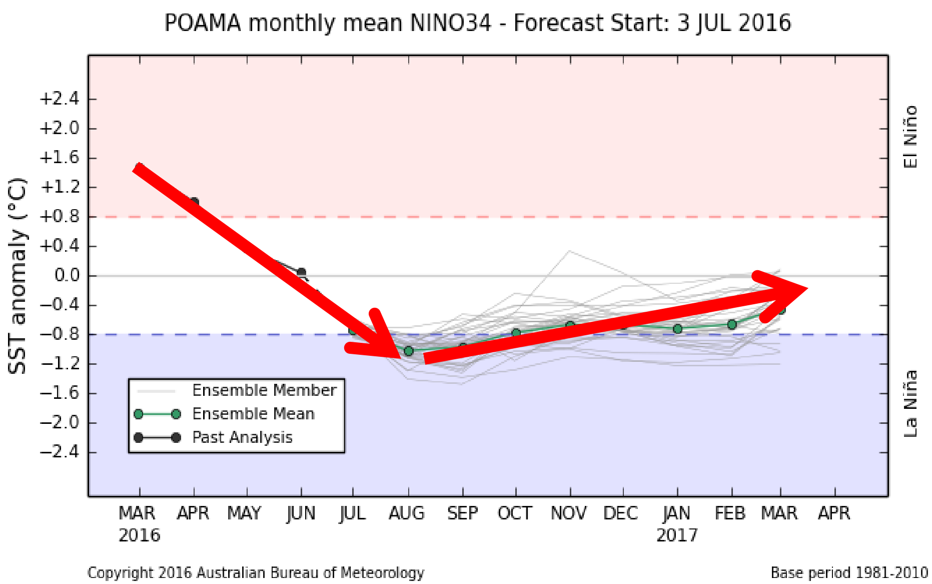
EC: Nino3.4, IC=01June2016



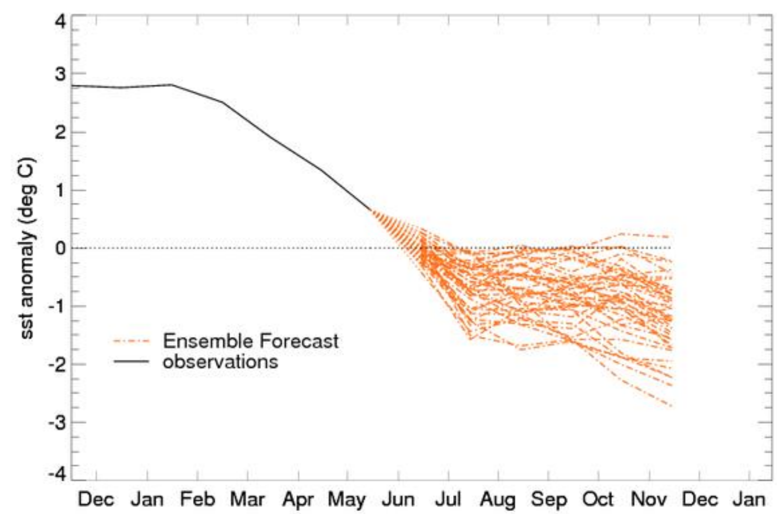
JMA: Nino3, IC= June 2016

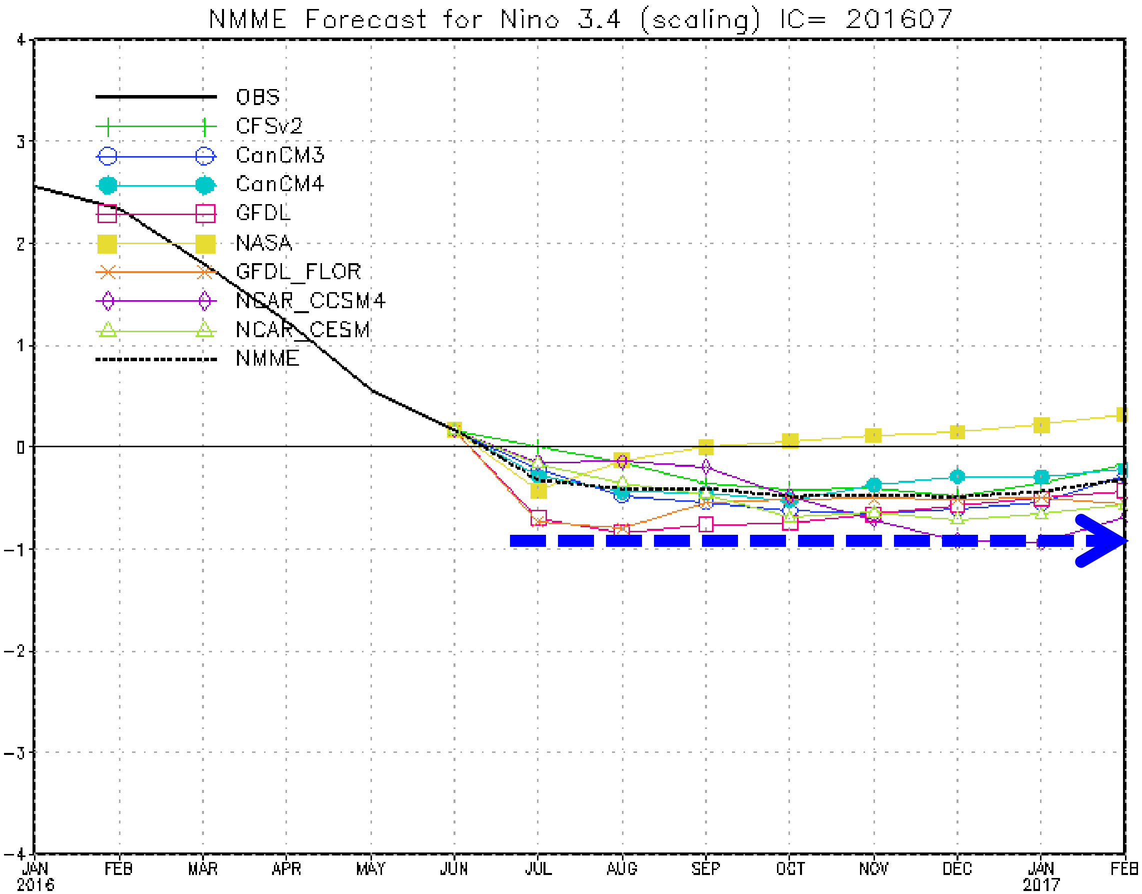


Australia: Nino3.4, IC=3 Jul 2016



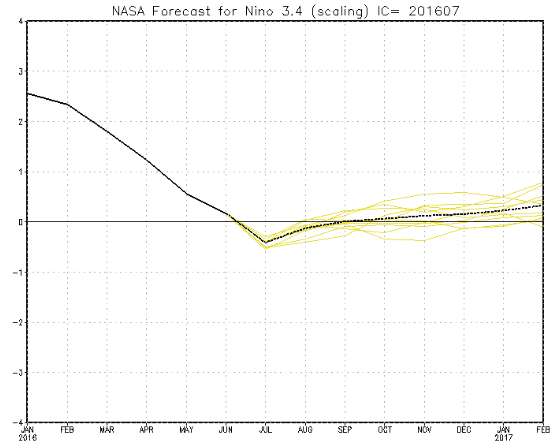
UKMO: Nino3.4, IC=Jun 2016





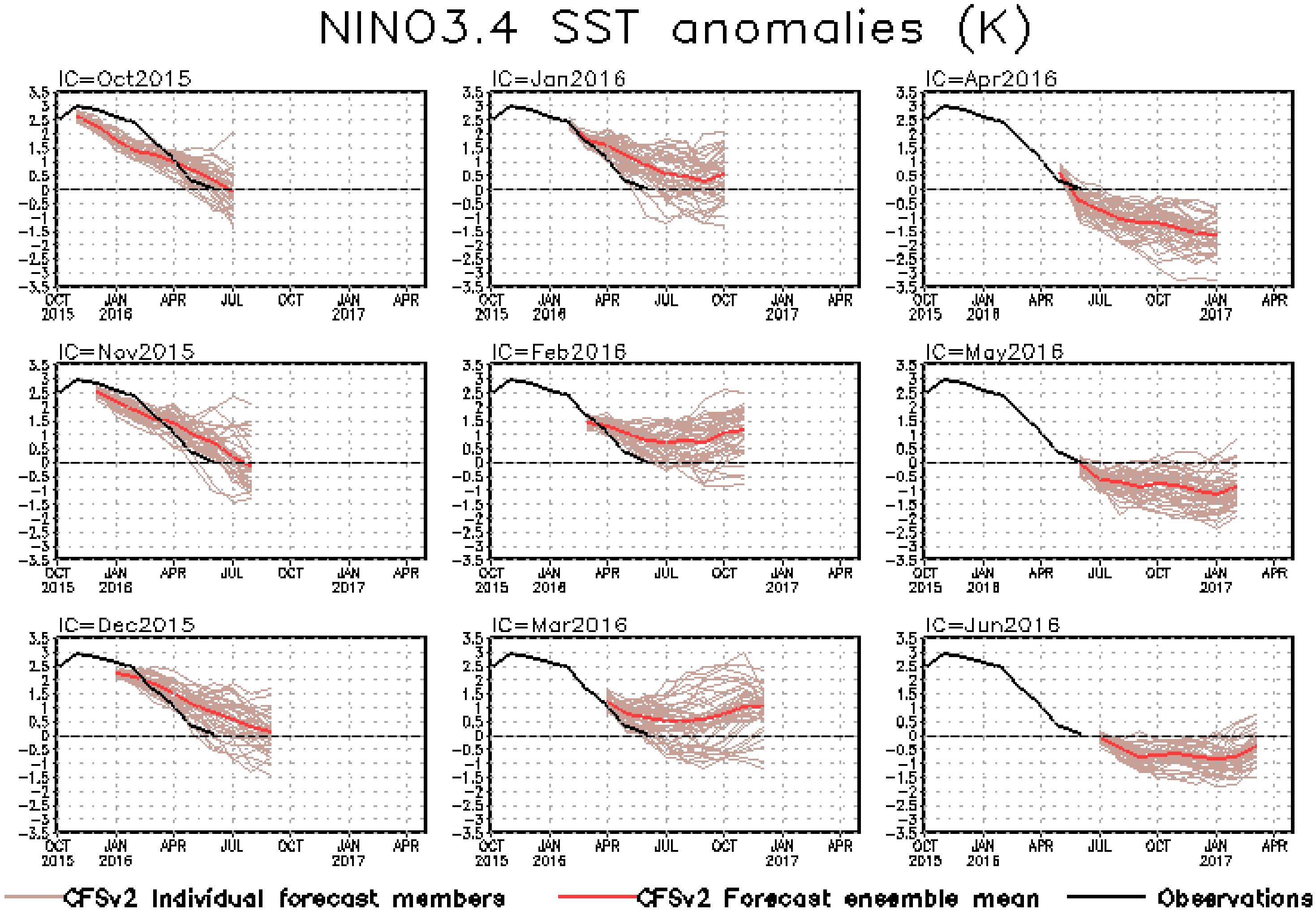
- **NMME models suggest a transition to weak La Nina conditions in later summer and fall.**

- **The impact of the biases in CFSR ocean ICs in the tropical Atlantic during past a few months seems eliminated in both the CFSv2 and CCSM4.**



Note: The forecast plume here is scaled, and the CFSv2 Nino3.4 forecast shown in next Slide is not scaled. Not-scaled Nino3.4 is slightly colder (-0.7C) than the scaled one.

CFS Niño3.4 SST Predictions from Different Initial Months



- **CFSv2 predicted a La Nina started from early Autumn of 2016.**

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.

An analogue method to predict tropical SST and ENSO

(From Dr. Peitao Peng: Peitao.Peng@noaa.gov)

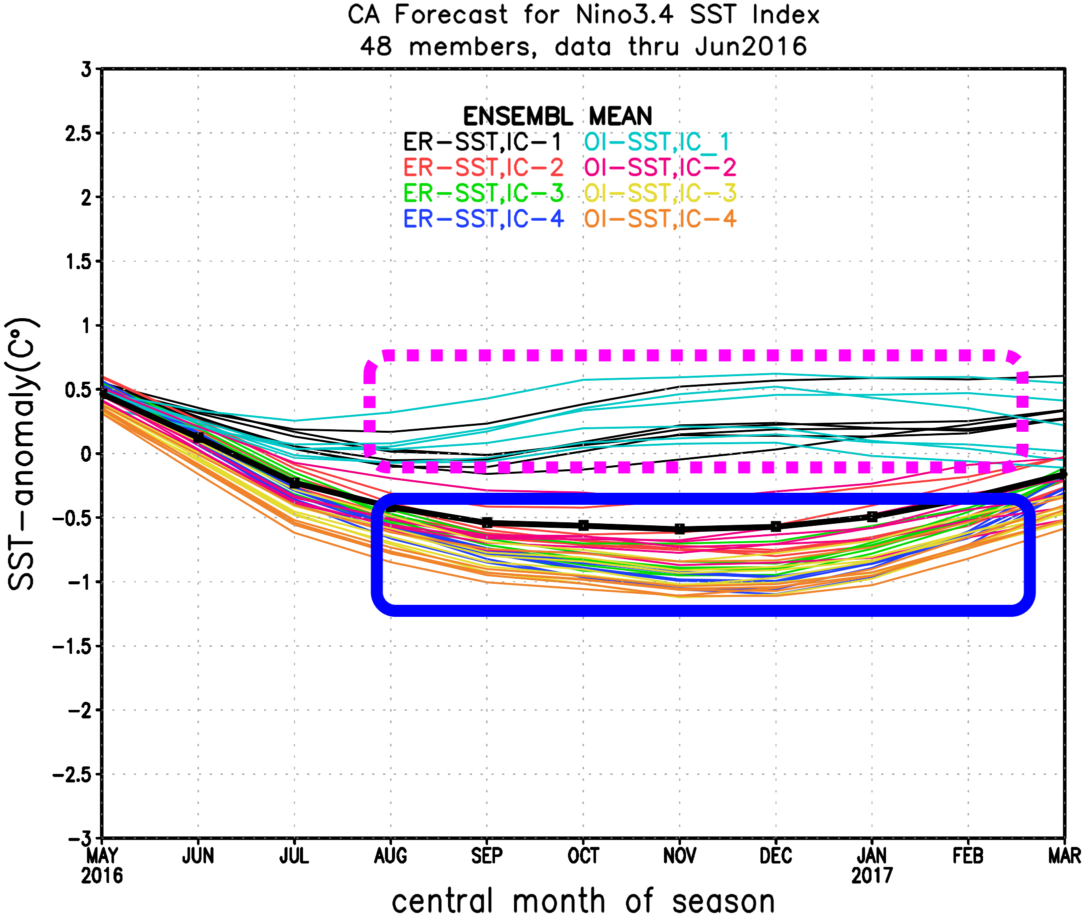
- ❑ Use weighted average of historical data to approximate current data (IC);
- ❑ The weights are obtained by minimizing the RMS error;
- ❑ Construct forecast by applying the weights to the lagged data in history

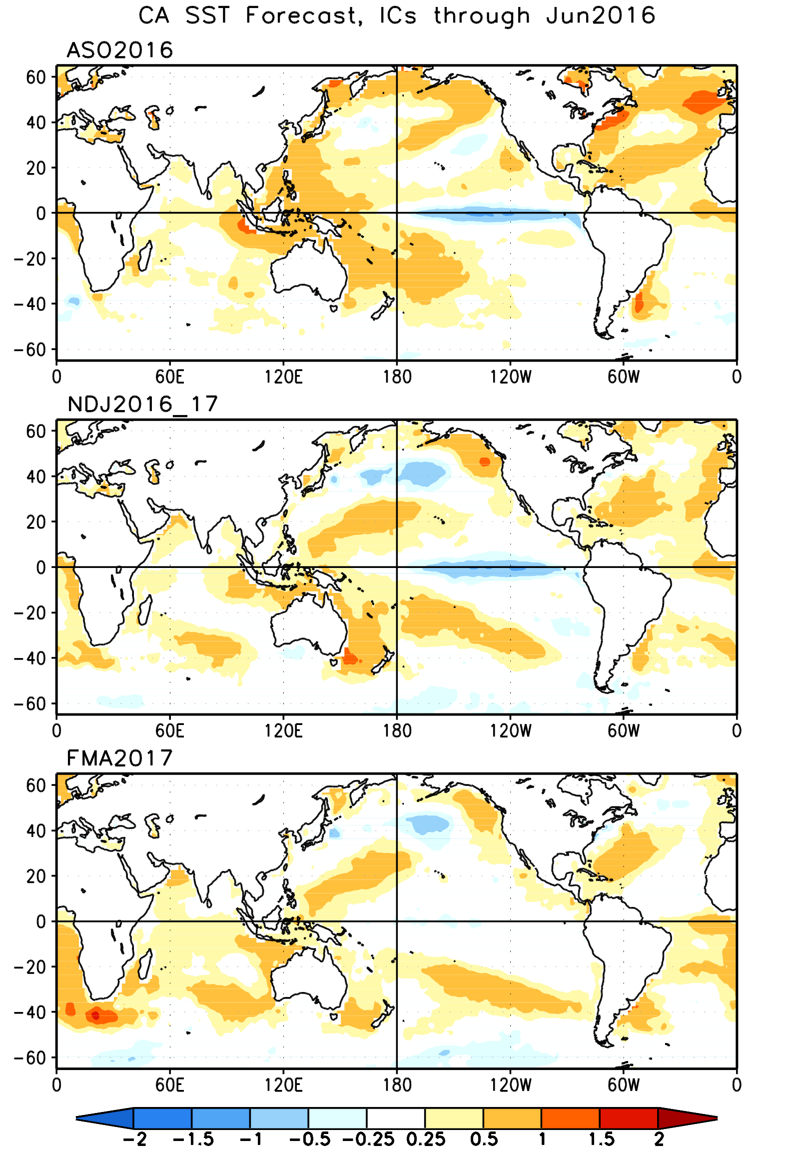
1. Use both HAD-OI SST and ERSST since 1948;
2. Choose EOF truncations at 20, 25, 30, 40, 50, 60;
3. Have season number 1 to 4 in ICs;

Combine 1-3 above to have a 48-member ensemble

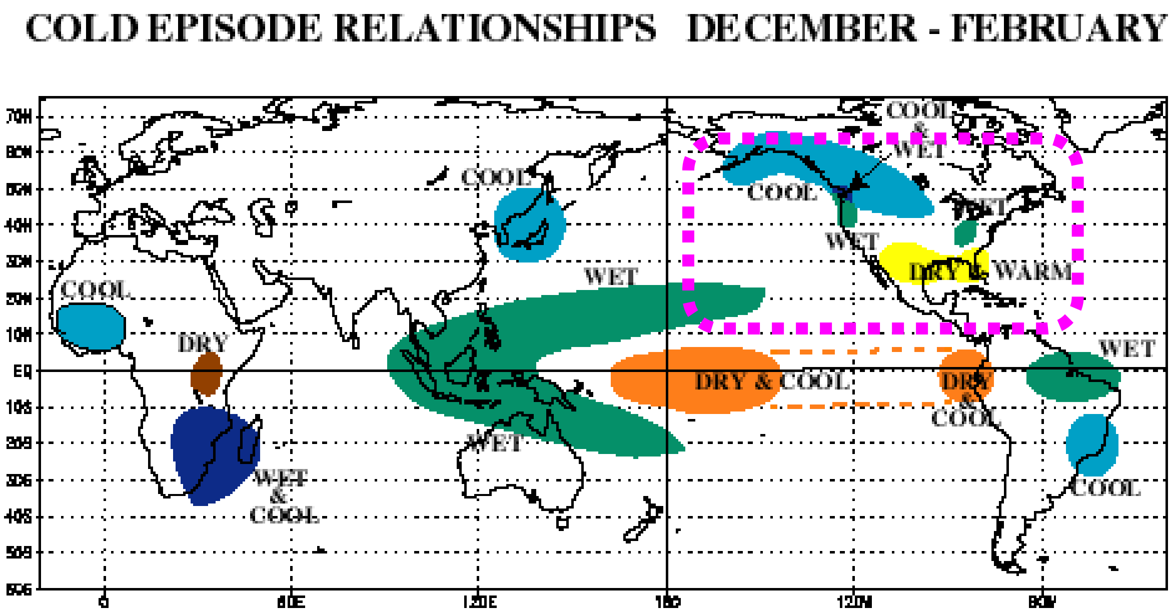
CA 48-member Ensemble Forecast for SST

(From Peitao.peng@noaa.gov)

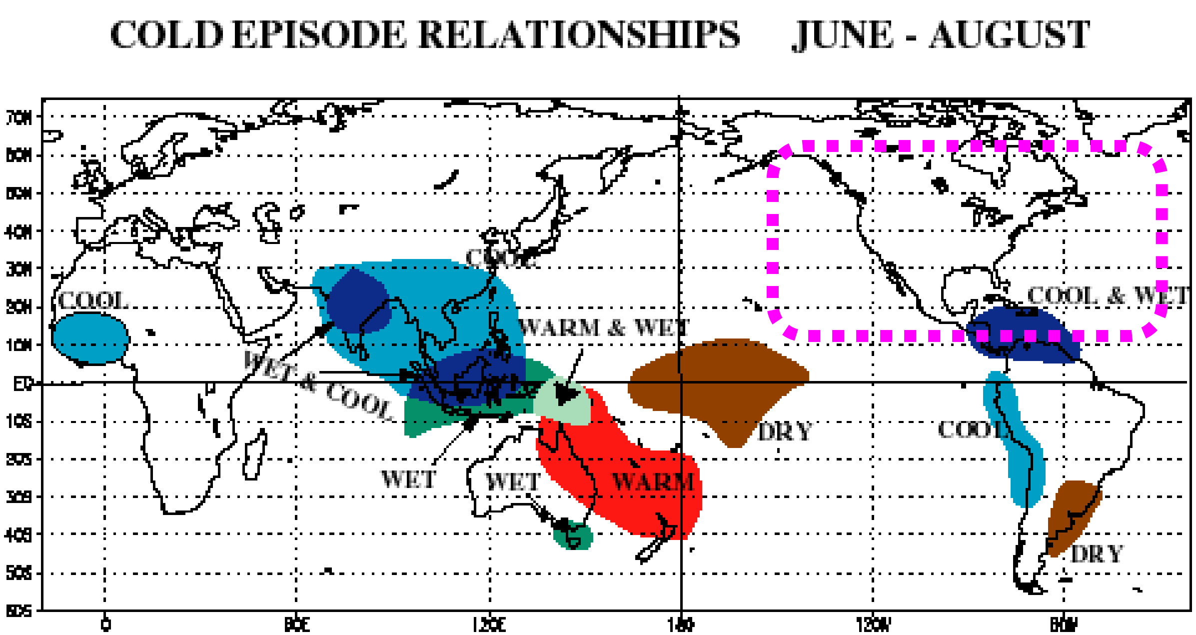




Neutral or weak & moderate La Nina is expected for 2016/17 winter



La Nina Impacts in DJF

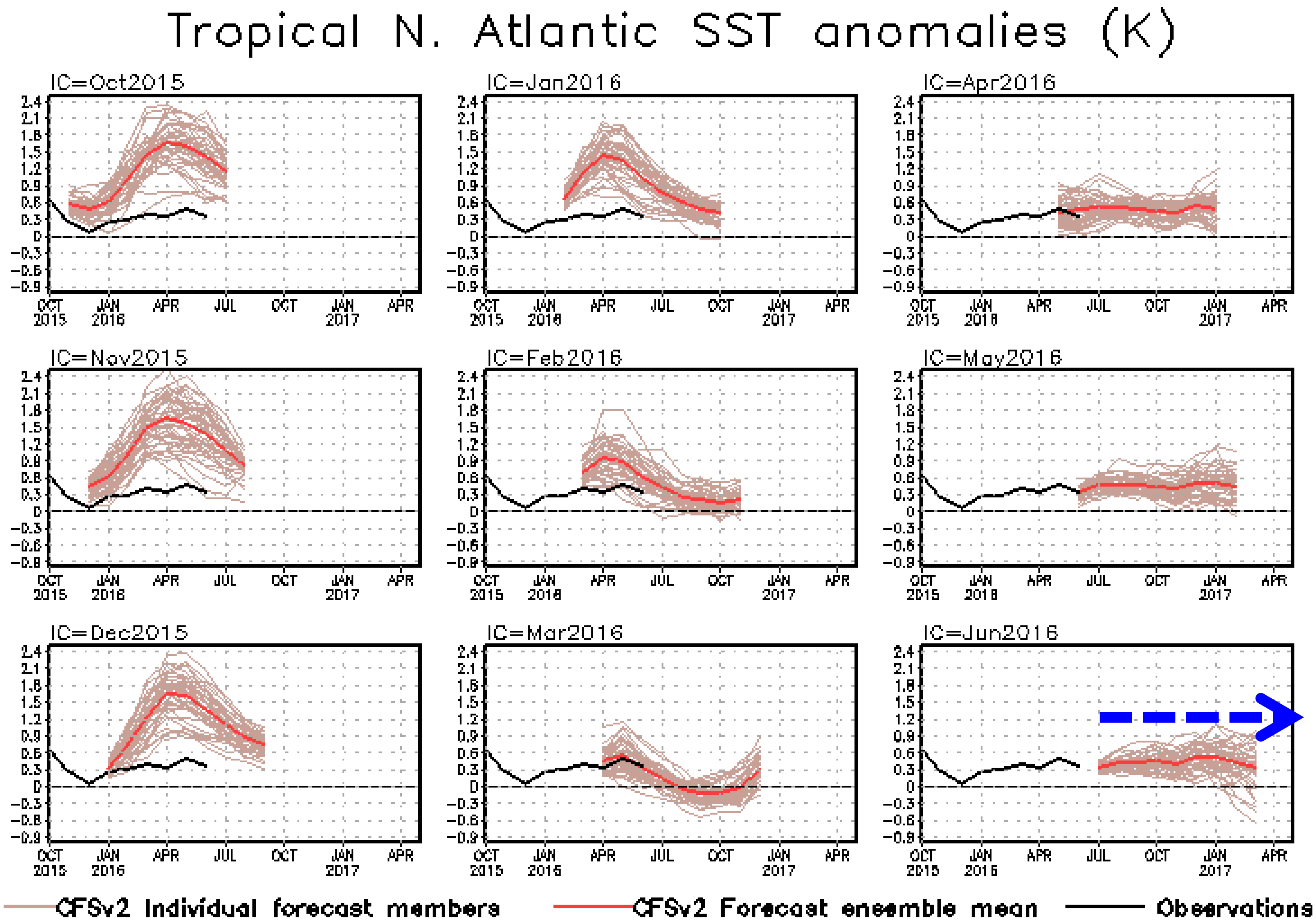


La Nina Impacts in JJA

https://en.wikipedia.org/wiki/La_Ni%C3%B1a#/media/File:La_Nina_regional_impacts.gif

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

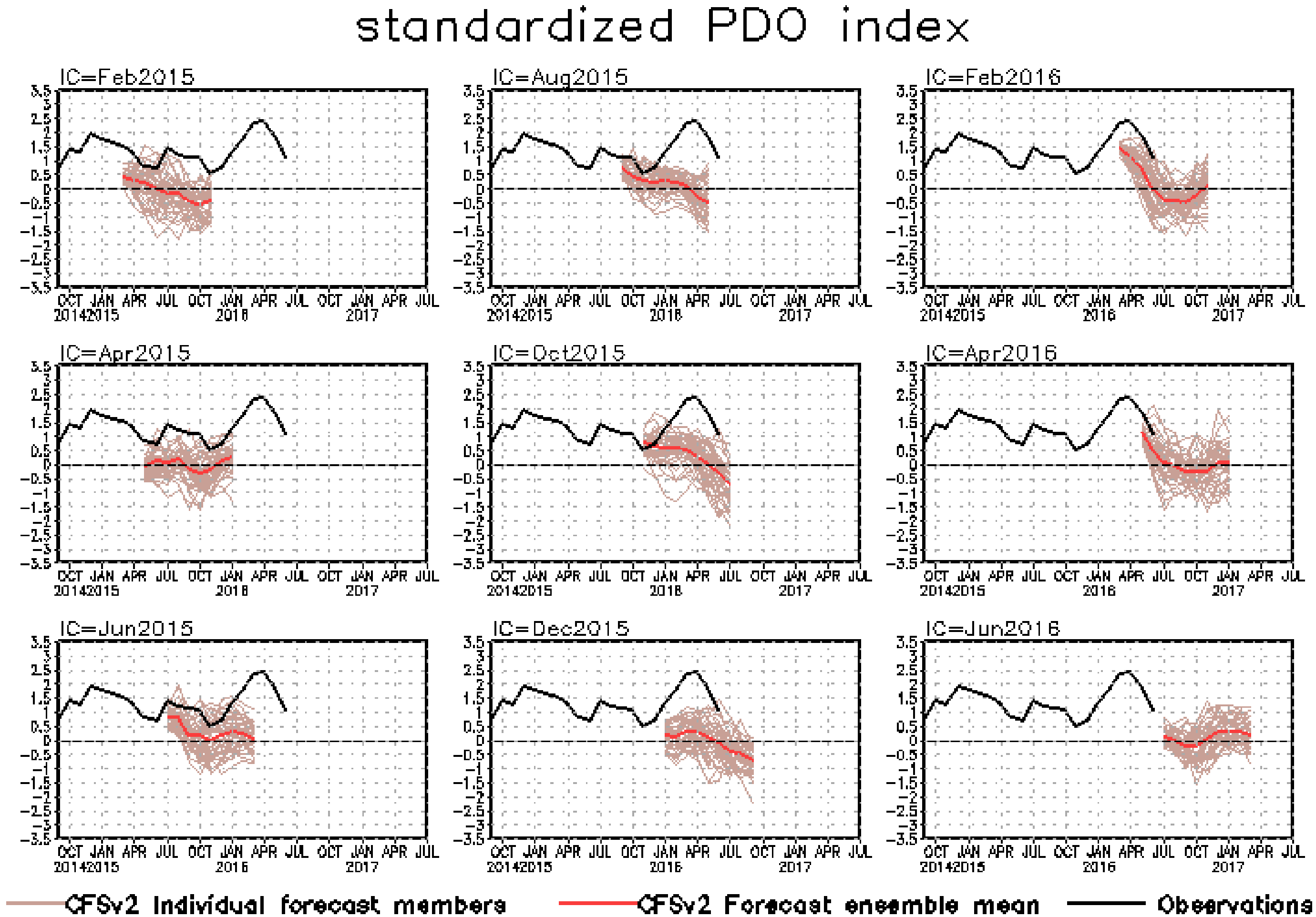
TNA is the SST anomaly averaged in the region of [60°W-30°W, 5°N-20°N].



- Latest CFSv2 predictions call slightly above normal SSTA in tropical N. Atlantic since summer 2016.

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

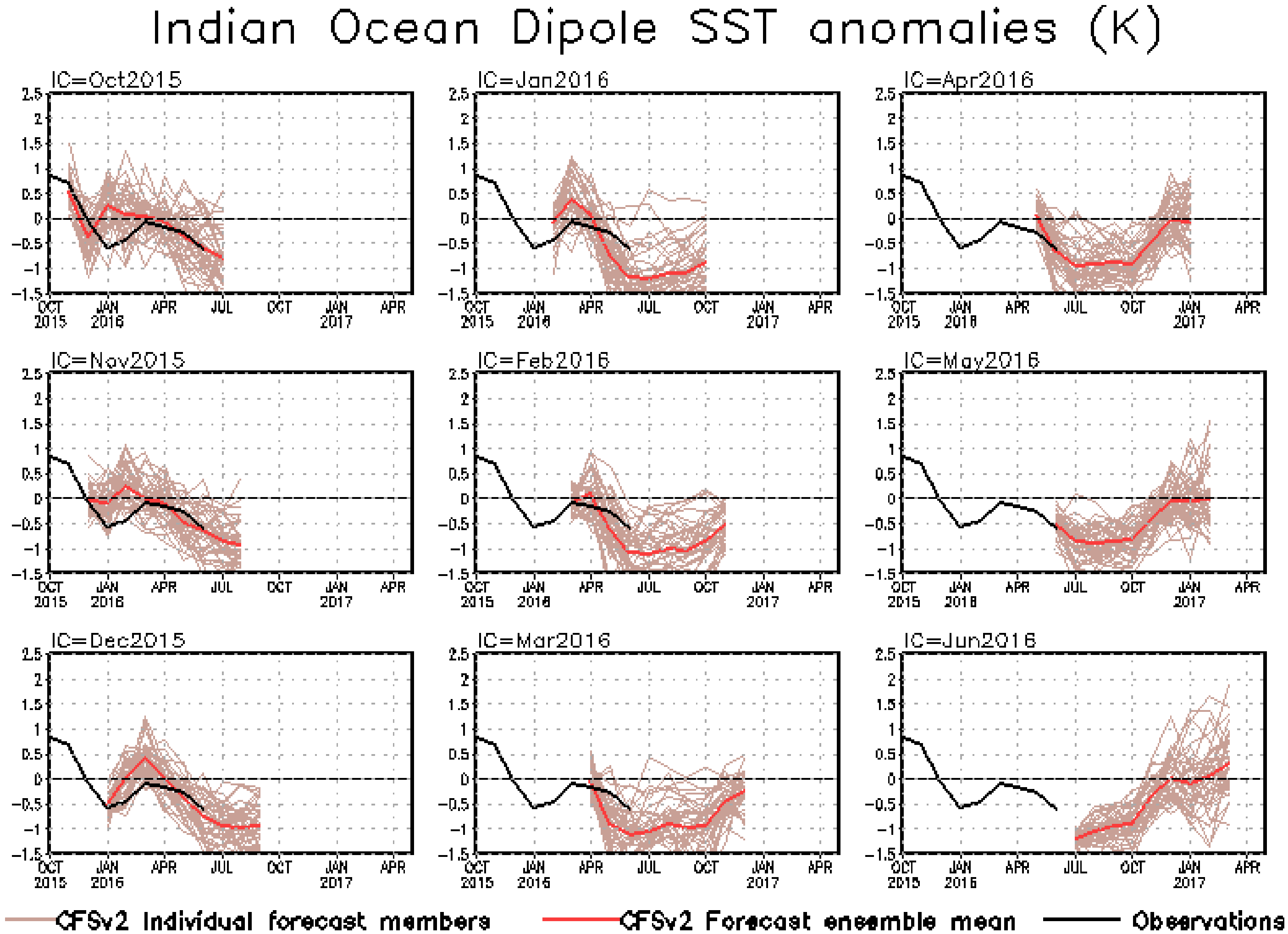


PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

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.

NCEP CFS DMI SST Predictions from Different Initial Months



DMI = WTIO- SETIO

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

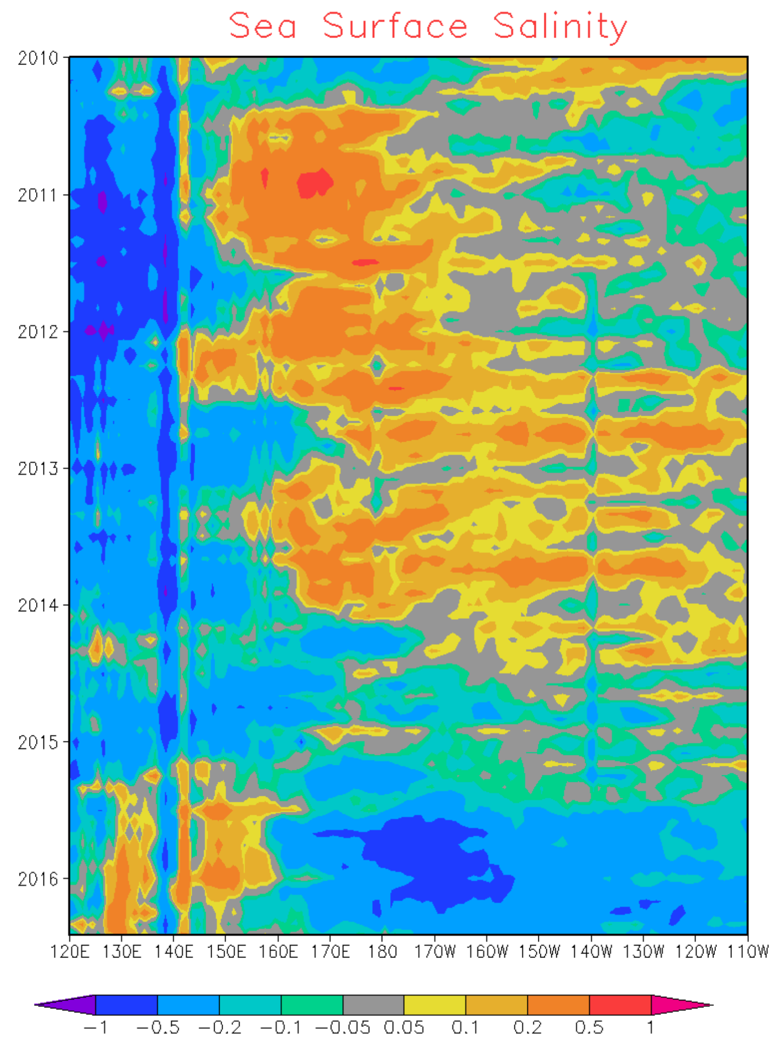
WTIO = SST anomaly in [50ºE-70ºE, 10ºS-10ºN]

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.

Global Sea Surface Salinity (SSS)
Anomaly Evolution over Equatorial Pacific

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

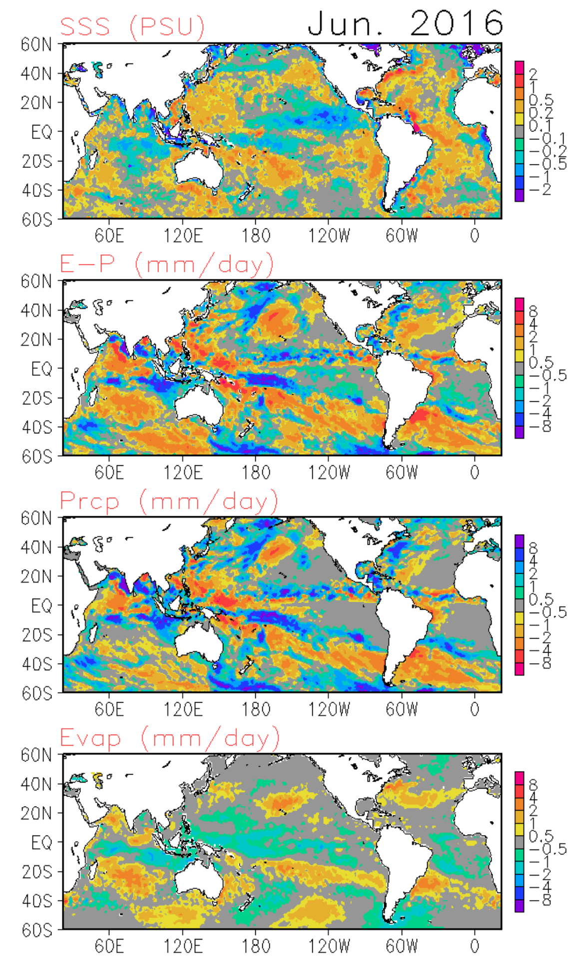
- The anomaly evolution in this region shows similar pattern as last month. Negative SSS in the Eastern Equatorial Pacific from 160ºE to 110ºW has been present for more than a year, but its maximum anomalies centered from 180ºE to 160ºW was continually reducing in recent months. At the meantime, a stretch of positive SSS anomaly remains over the western Pacific and eastern Indian Ocean from 130ºE – 160ºE;



Global Sea Surface Salinity (SSS)

Anomaly for June 2016

- NOTE: Since Aquarius terminated operations, the blended SSS analysis is from in situ and SMOS only from June 2015. Please report to us any suspicious data issues!
- The El Nino condition continues in this month producing positive precipitation anomaly over the eastern and central tropical Pacific Ocean. The enhanced flux water flux maintains the fresh SSS anomaly across most of the tropical Pacific. The fresh SSS anomaly in Bay of Bengal and Arabian sea continues and is caused by ocean current advection since the precipitation is decreased and the evaporation is increased in these regions. Enhanced precipitation likely cause the salinity decrease in the Java Sea in the Indo-Pacific region. in the Southern Ocean between 120°W and 30°W, the significant increase of precipitation compensates the evaporation decrease, which doesn't produce significant salinity changes in these regions



- **Data used**

  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

  Precipitation:

  CMORPH adjusted satellite precipitation estimates

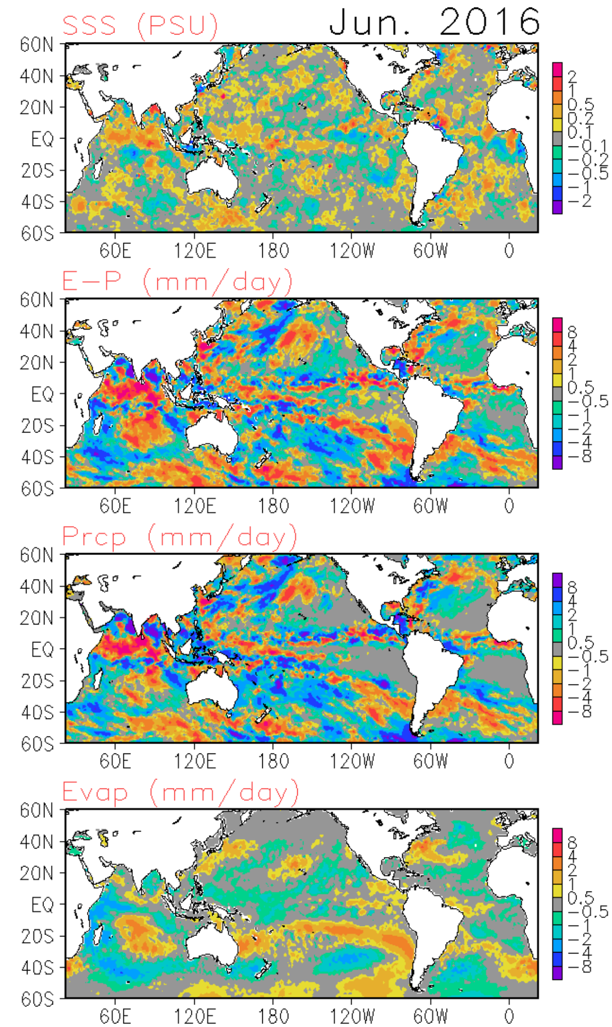
  Evaporation:

  CFS Reanalysis

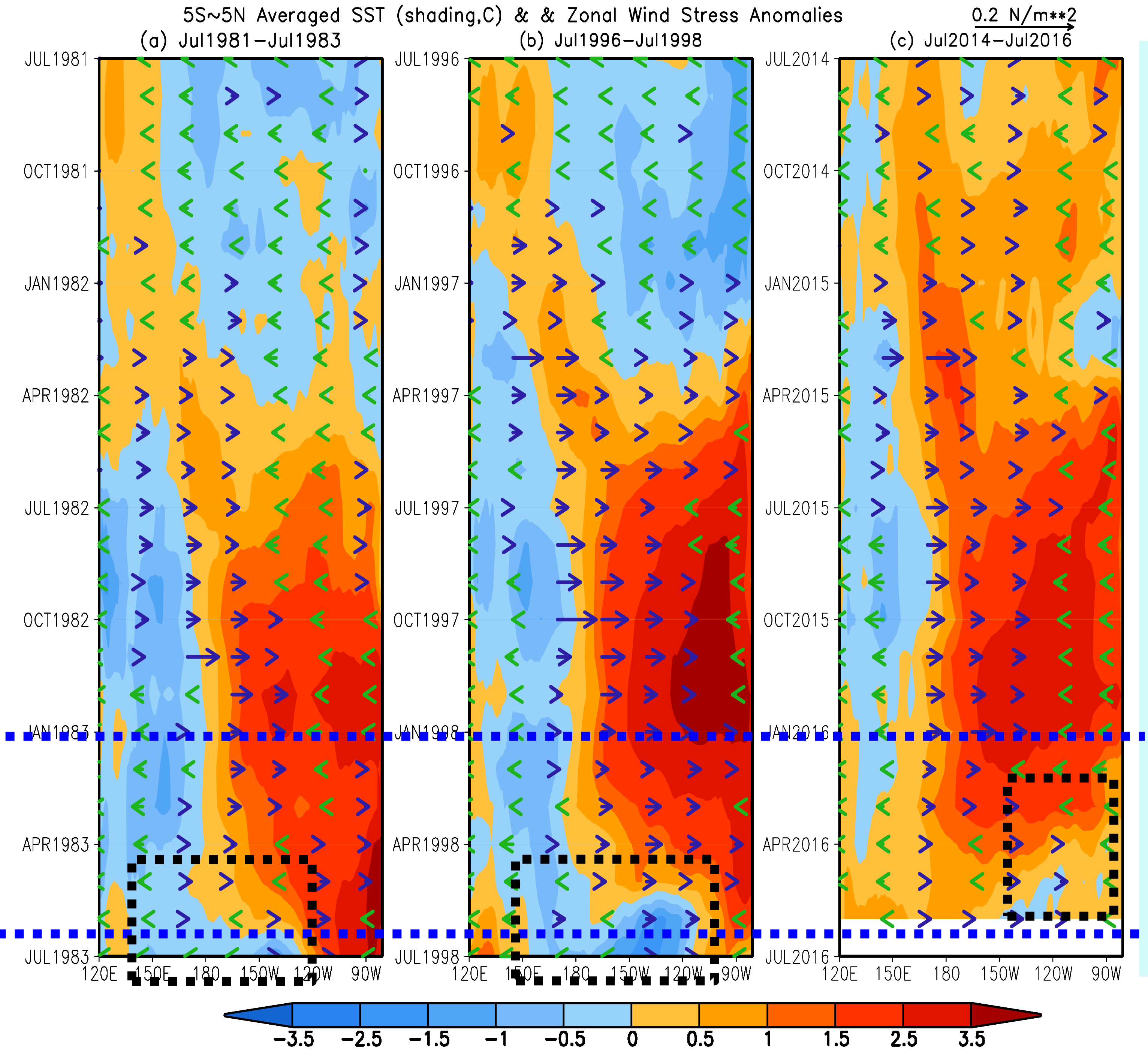
Global Sea Surface Salinity (SSS)

Tendency for June 2016

Compared with last month, positive SSS anomalies continue on the equator region due to reduced precipitation, which likely indicates the weakening of the El Nino. SSS becomes saltier in the east basin of the North Pacific Ocean, which is likely caused by decrease of precipitation. In the North Indian Ocean except the Bay of Bengal and Arabian Sea, the SSS becomes saltier, mostly likely due to the positive precipitation anomalies. Significant precipitation increase in the Indo-Pacific region produces large amount of fresh water input in this region. The two horseshoe patterns of evaporation anomalies in the Southern Ocean changed to an opposite ‘C’ shape with negative anomalies being surrounded by positive anomalies.



Backup Slides

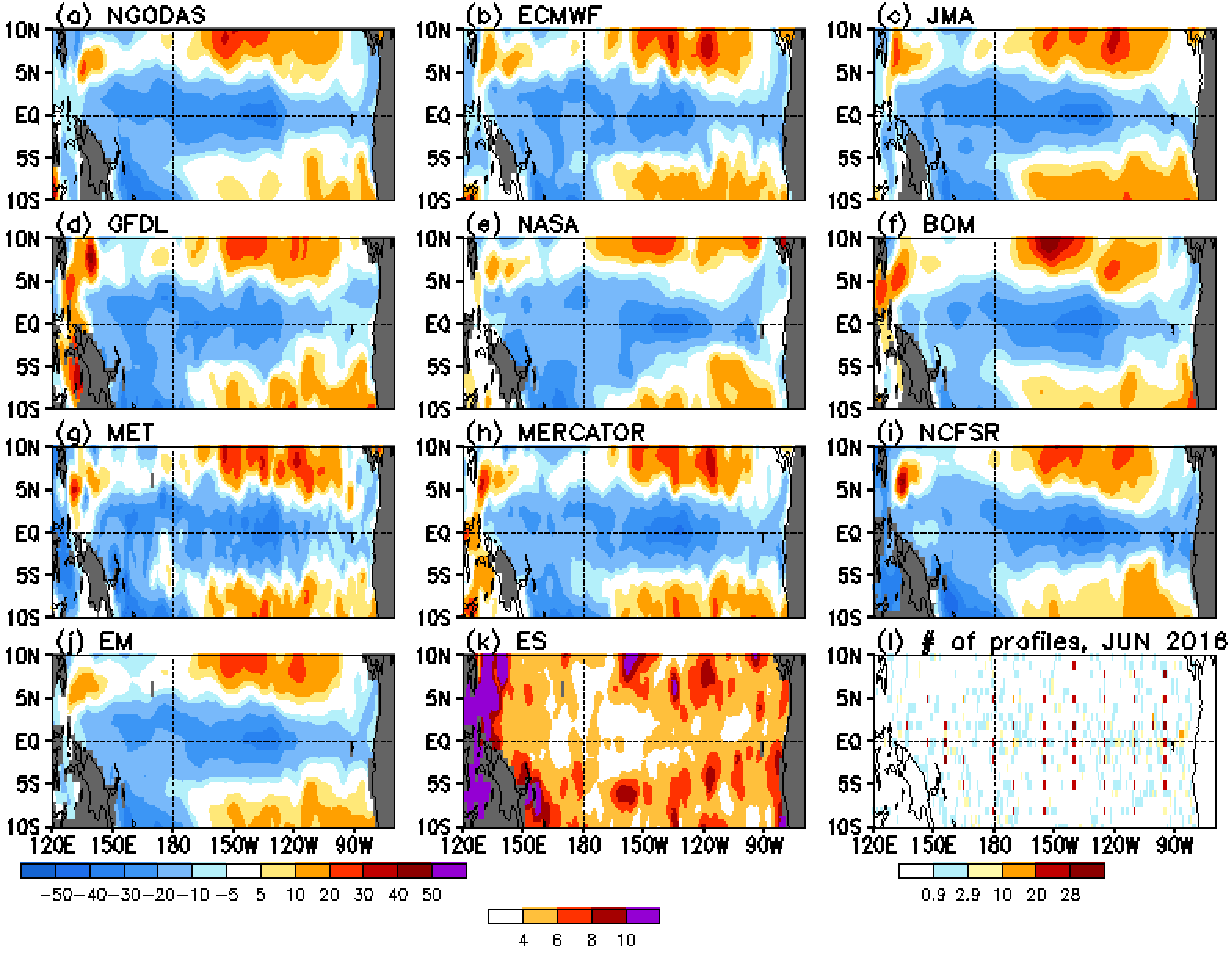


Compared with 1982-83 and 1997-98, *in 2015-16,*

(a) Transition from positive to negative D20A occurred earlier;

(b) Positive SSTA decline started from the coast instead of the central and eastern open ocean.

D20 anomalies and number of profile (From Dr. Caihong Wen)



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

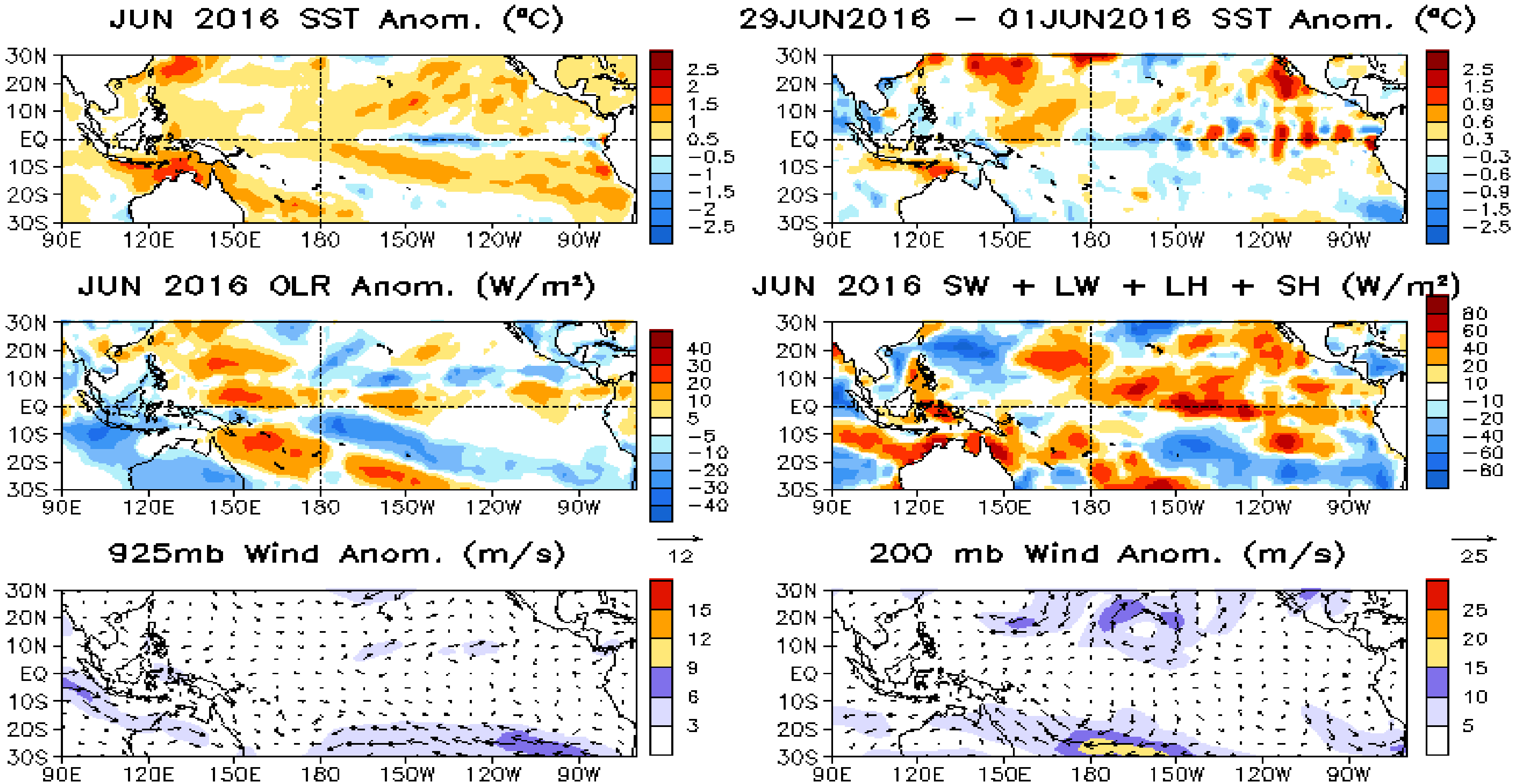


Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

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

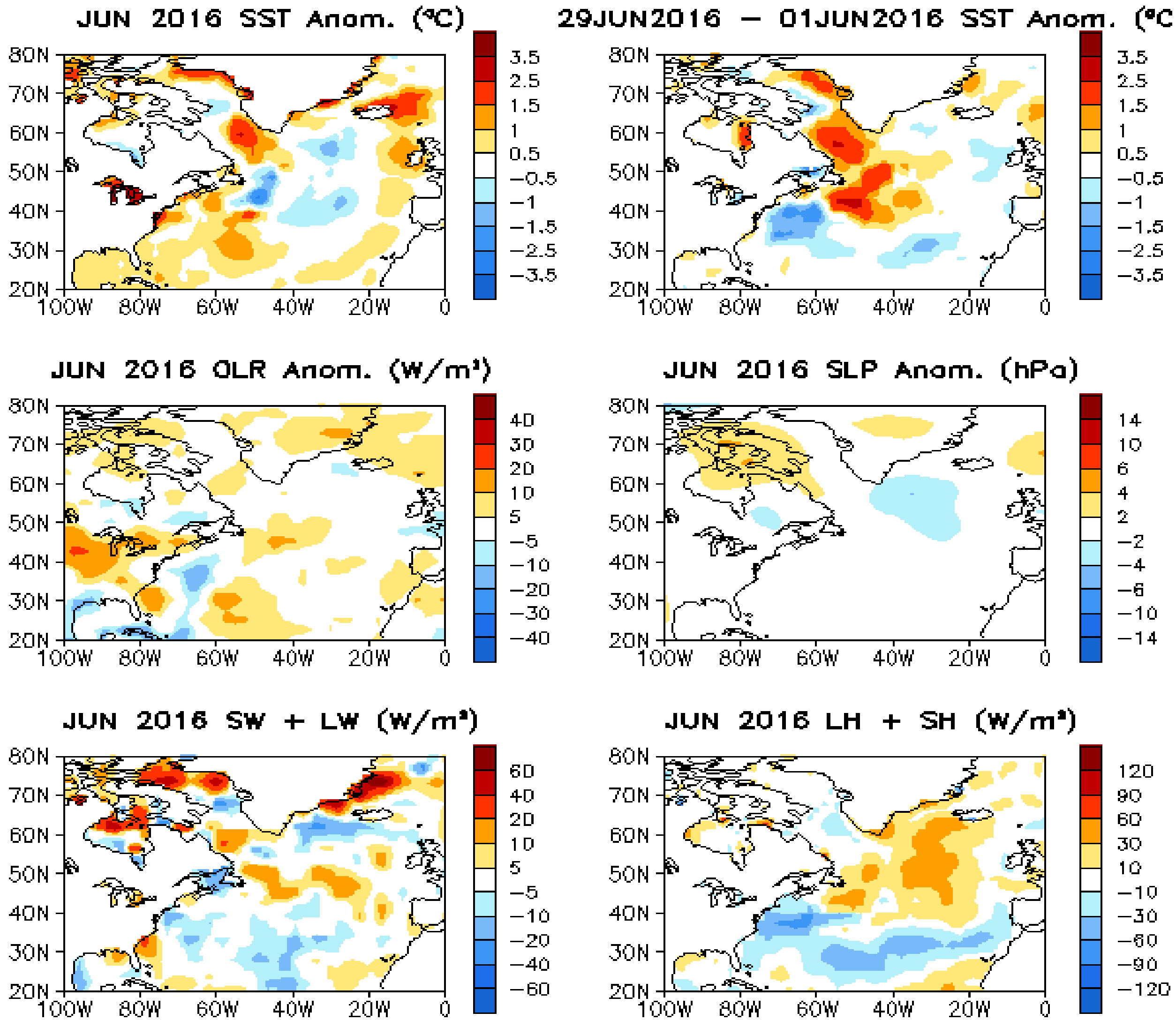


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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

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.ndbc.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!