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**

*** 2016-17 ENSO Prediction.**

*** 2016 Hurricane Season Outlook**

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."***
- **Positive SSTAs weakened in the tropical Pacific with NINO3.4=0.5°C in May 2016.**
- **Strong negative subsurface ocean temperature anomalies along the thermocline occupied the whole equatorial Pacific.**
- **Positive phase of PDO has persisted for 23 months, and weakened with PDOI=1.9 in May 2016.**

Indian Ocean

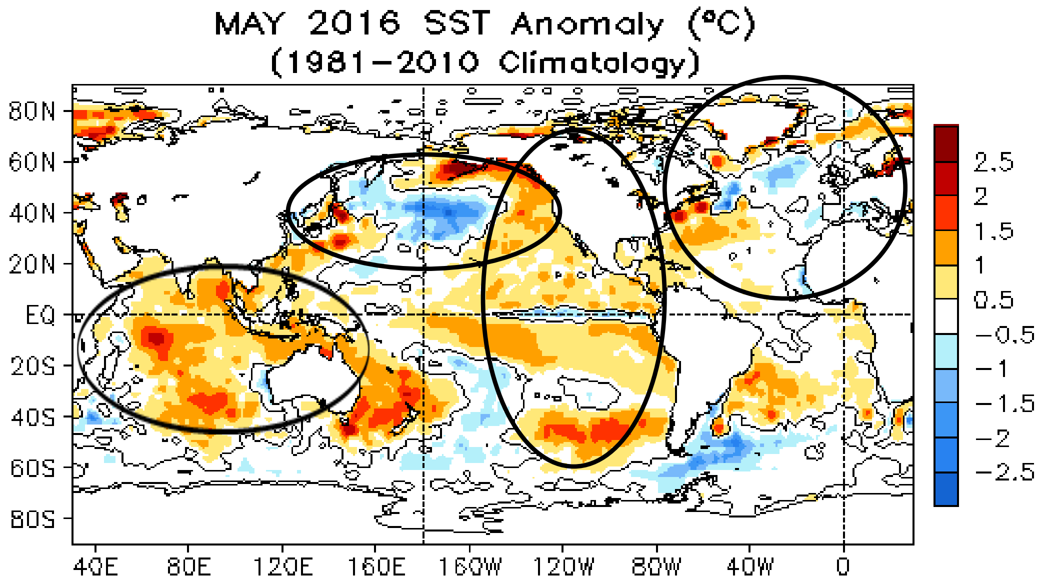
- **Positive SSTA was larger in the east than in the west.**

Atlantic Ocean

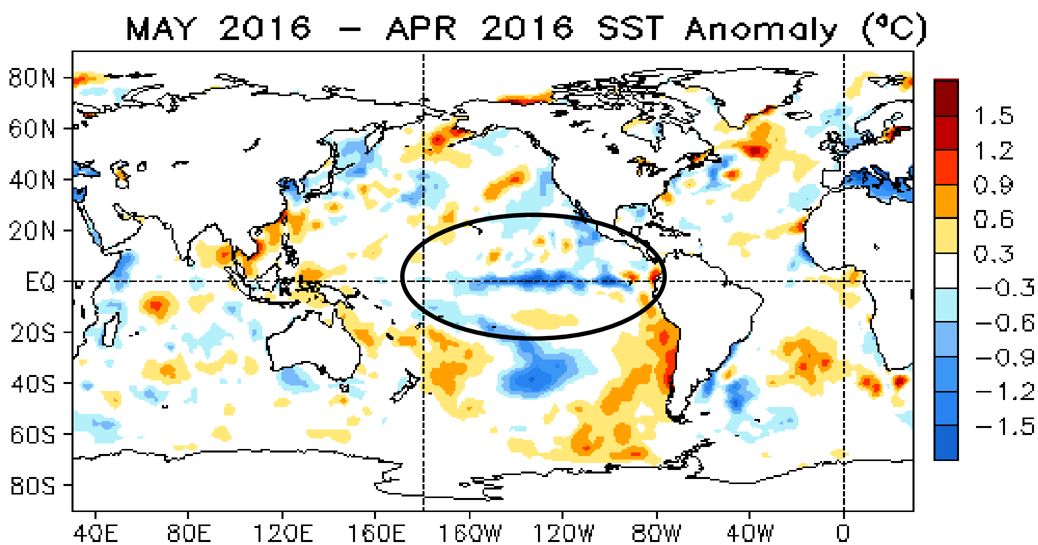
- **NAO switched to negative phase with NAOI= -0.7 in May 2016. SSTA was positive in the low-mid latitudes and negative in the high latitudes.**
- **On May 27, NOAA predicted near normal hurricane season in the Atlantic.**

Global Oceans

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



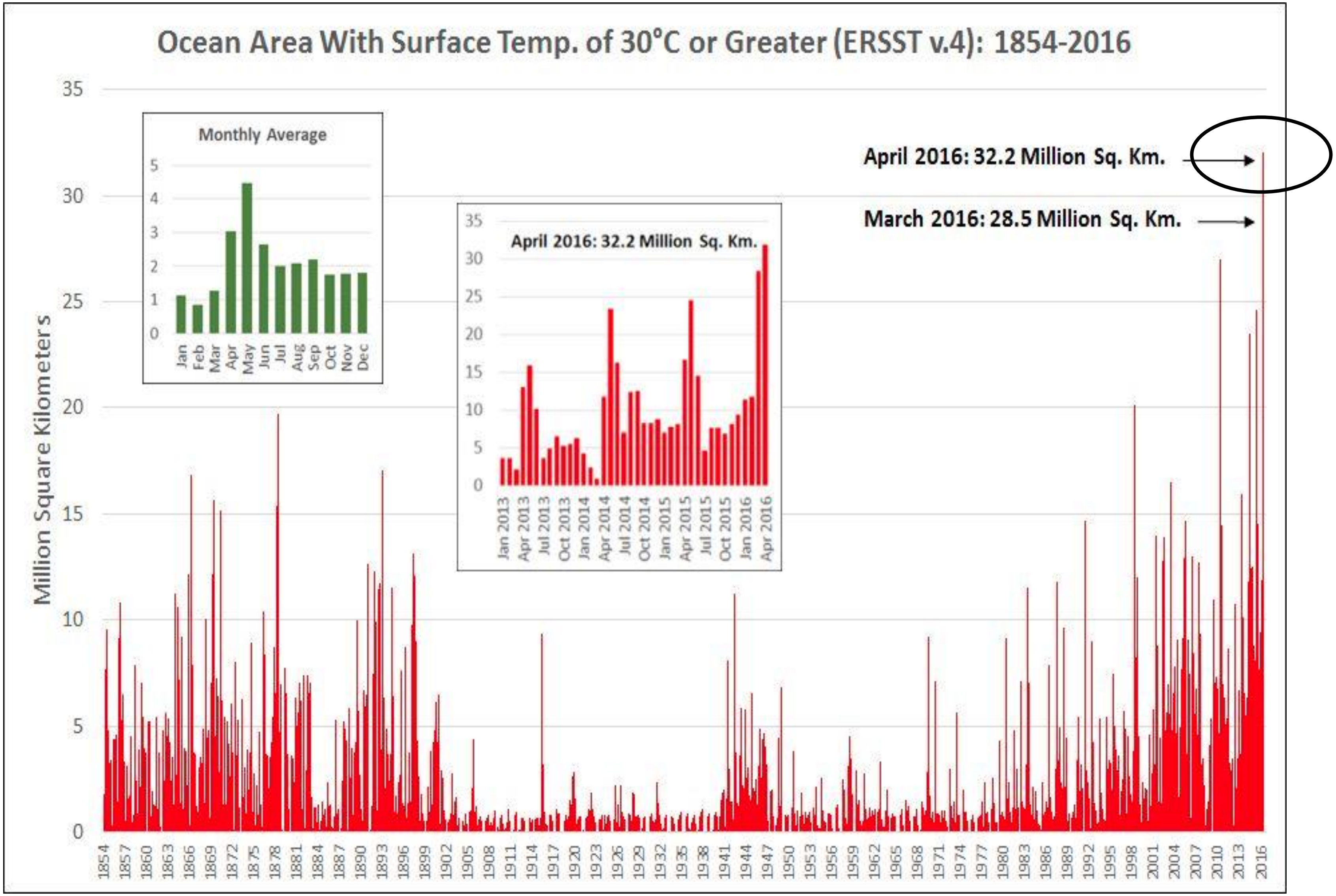
- Positive SSTA was dominant in the eastern Pacific, while cold SSTA was observed along the equator.
- SSTA pattern in N. Pacific was associated with positive phase of PDO.
- Horseshoe-like SSTA presented in N. Atlantic.
- SSTA was positive in the whole Indian Ocean.



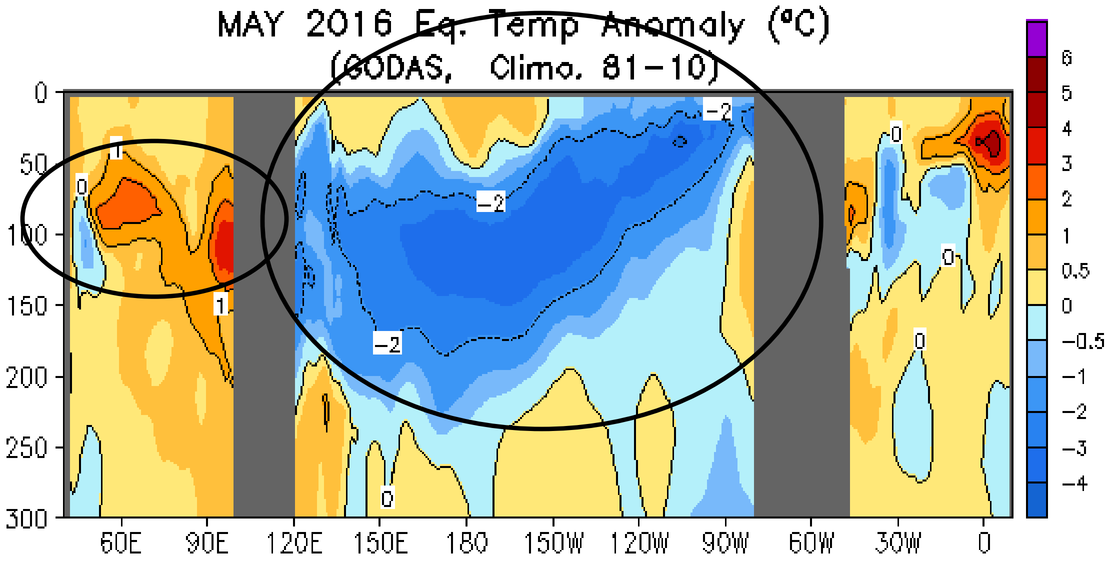
- Remarkable negative SSTA tendency in the central and eastern equatorial Pacific was associated with the decay of El Nino and potential of La Nina development.

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.

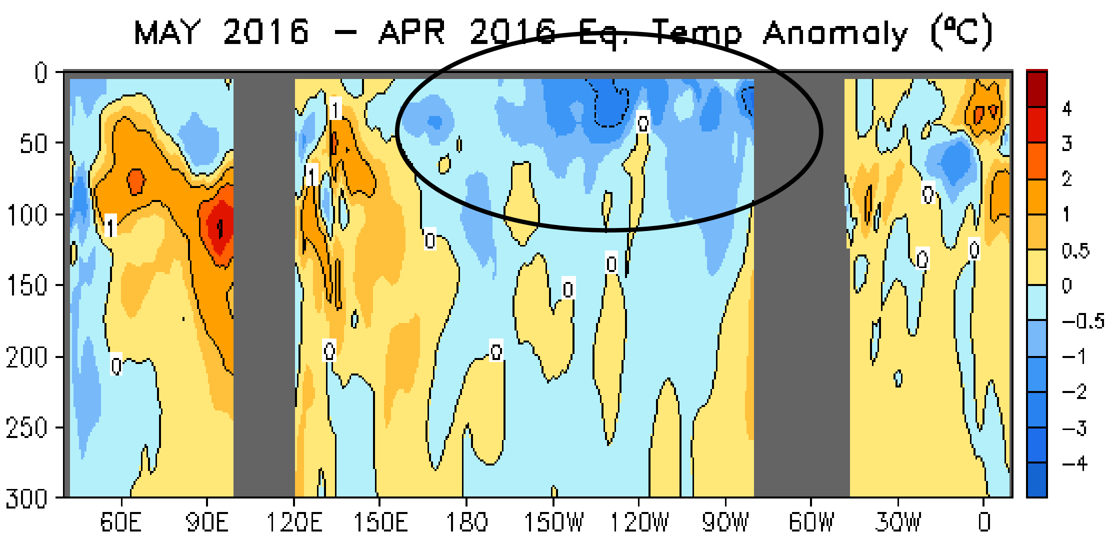
Dr. Brian Brettscheinder: The area of the worlds oceans with SST ≥30C from the ERSSTv4 was the largest in Apr2016 since Jan 1854



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

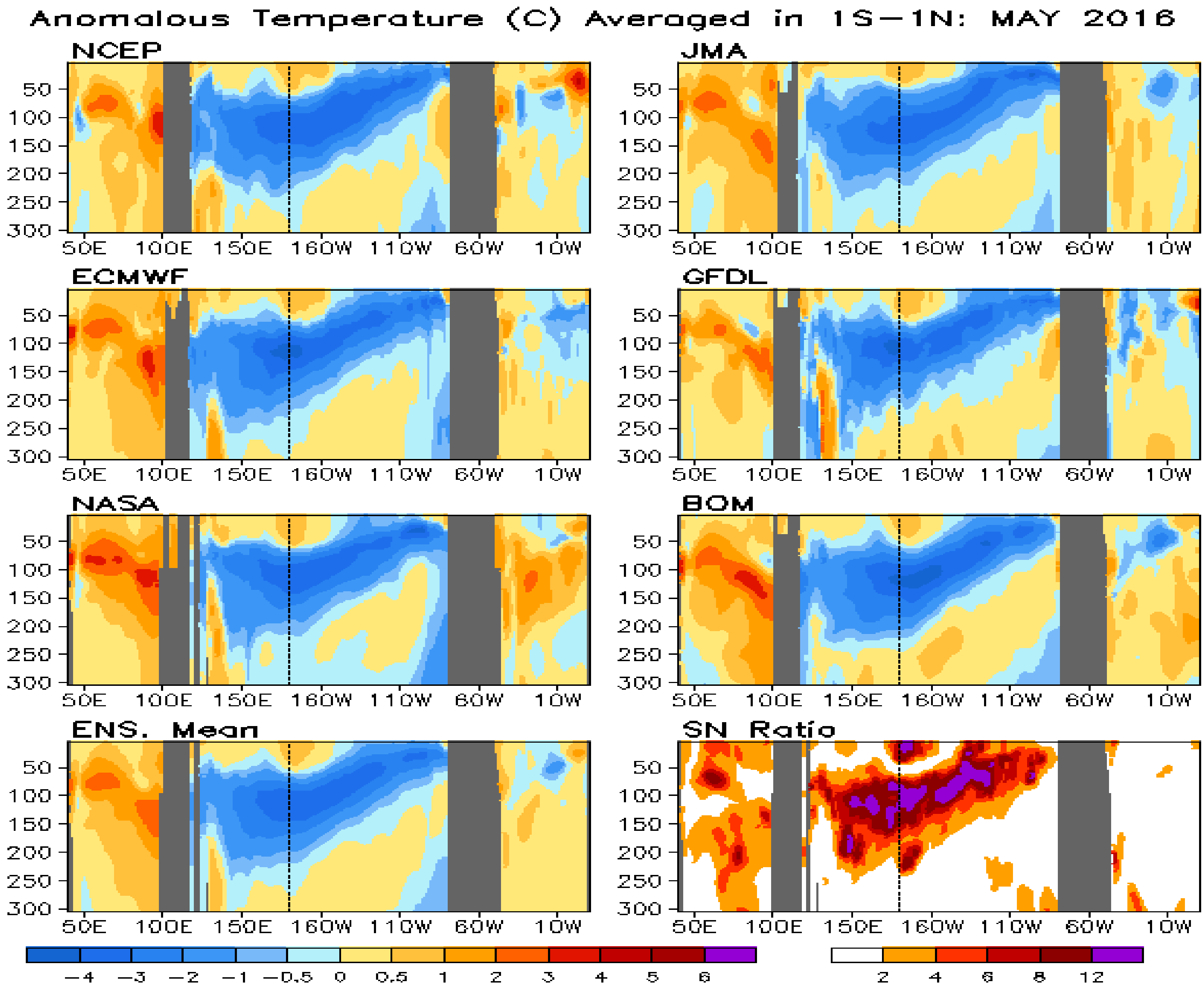


- Strong negative ocean temperature anomalies presented along the thermocline in the whole Pacific.
- Positive ocean temperature anomalies were confined near the surface in the western and central Pacific.
- Positive anomalies were observed in the Indian Ocean.



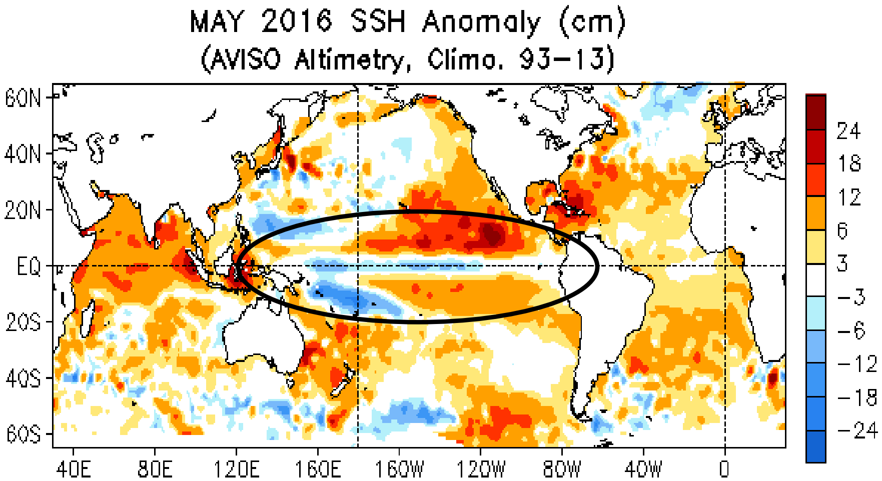
- The tendencies of ocean temperature anomalies were still mainly negative in the central and eastern Pacific, consistent with the tendency of decay of El Nino and potential of La Nina development .

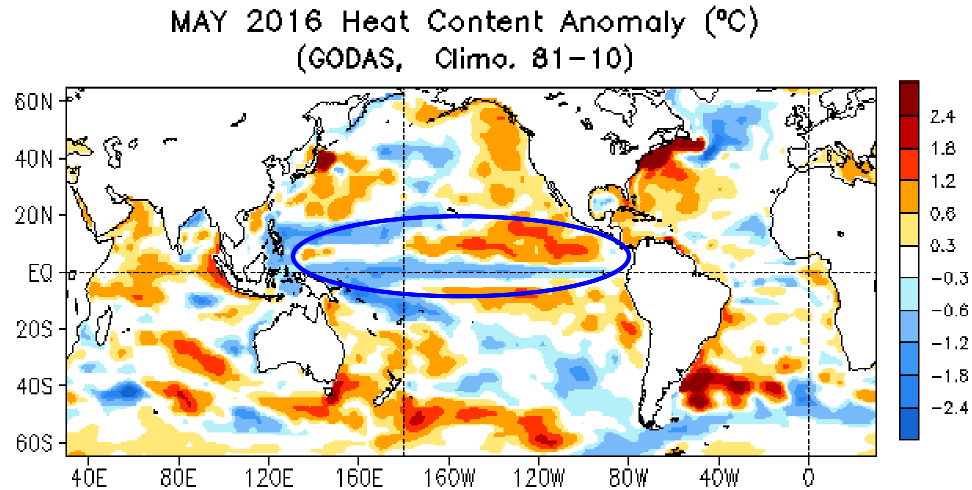
Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1981-2010 base period means.

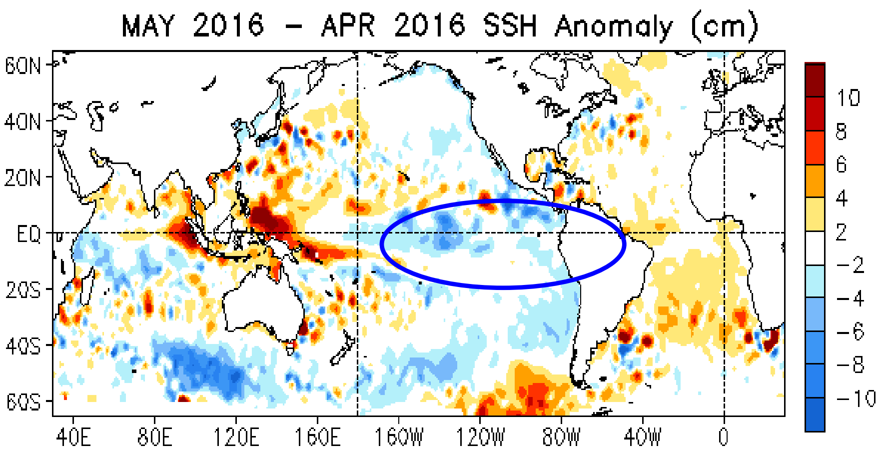


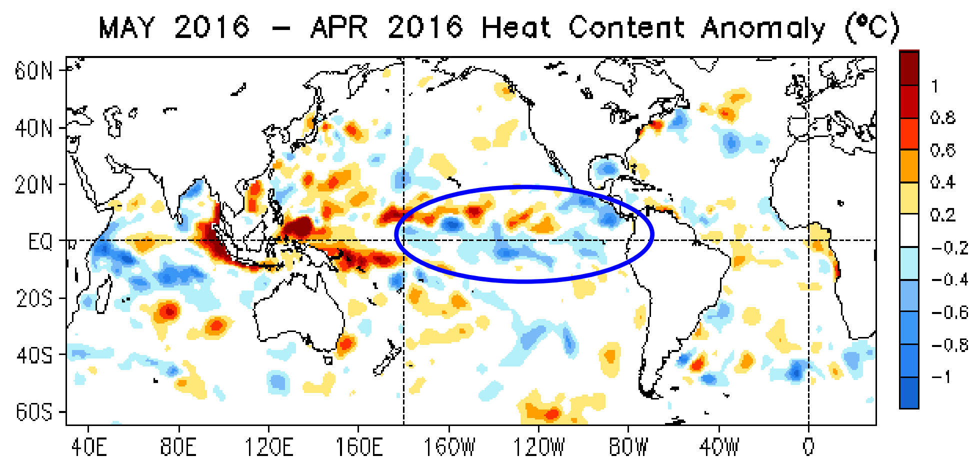
Anomalous Temperature (C) Averaged in 1S–1N: MAY 2016
NCEP
JMA
ECMWF
GFDL
NASA
BOM
ENS. Mean
SN Ratio
50
100
150
200
250
300
50E
100E
150E
160W
110W
60W
10W
−4 −3 −2 −1 −0.5 0 0.5 1 2 3 4 5 6
2 4 6 8 12

Global SSH and HC300 Anomaly & Anomaly Tendency

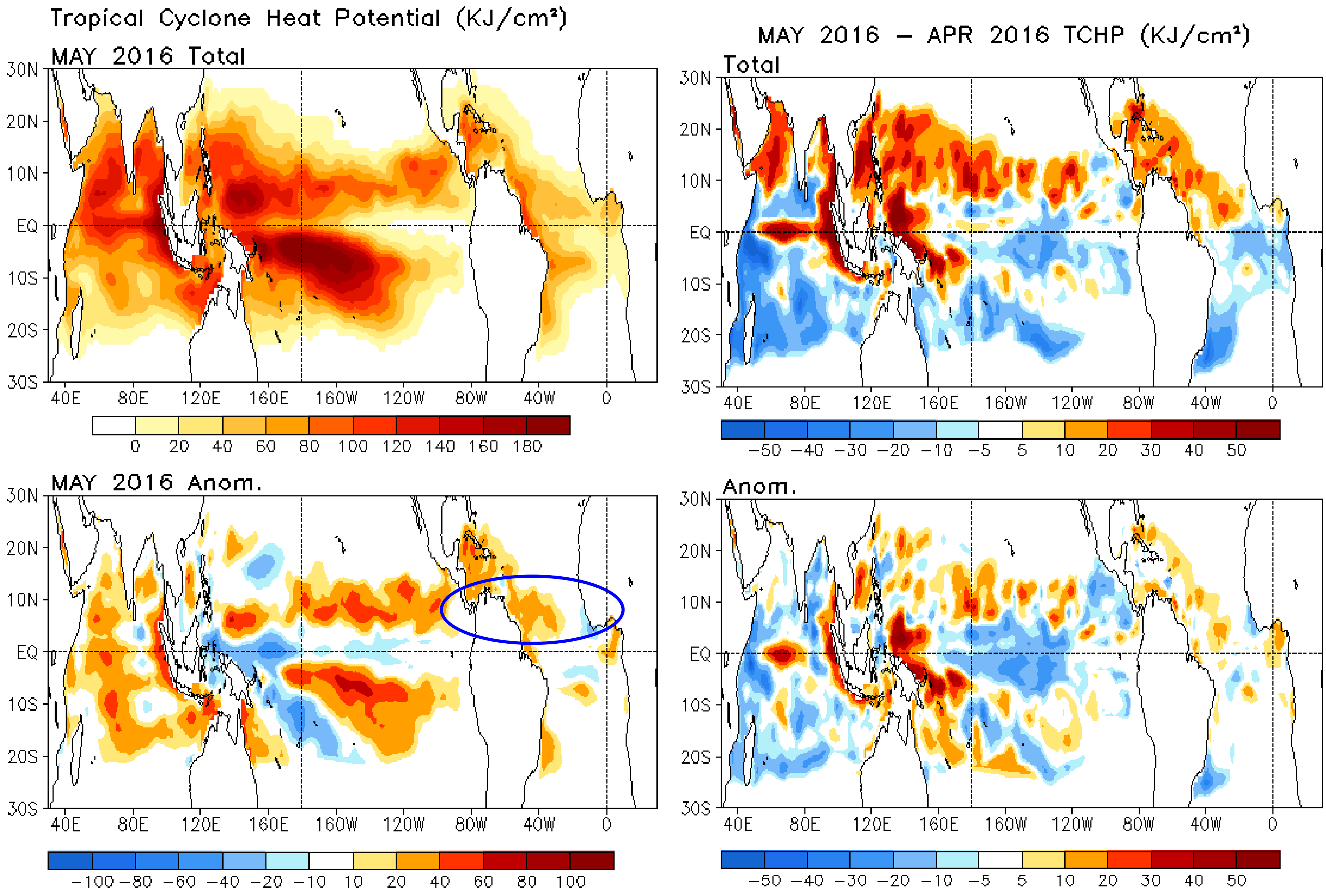








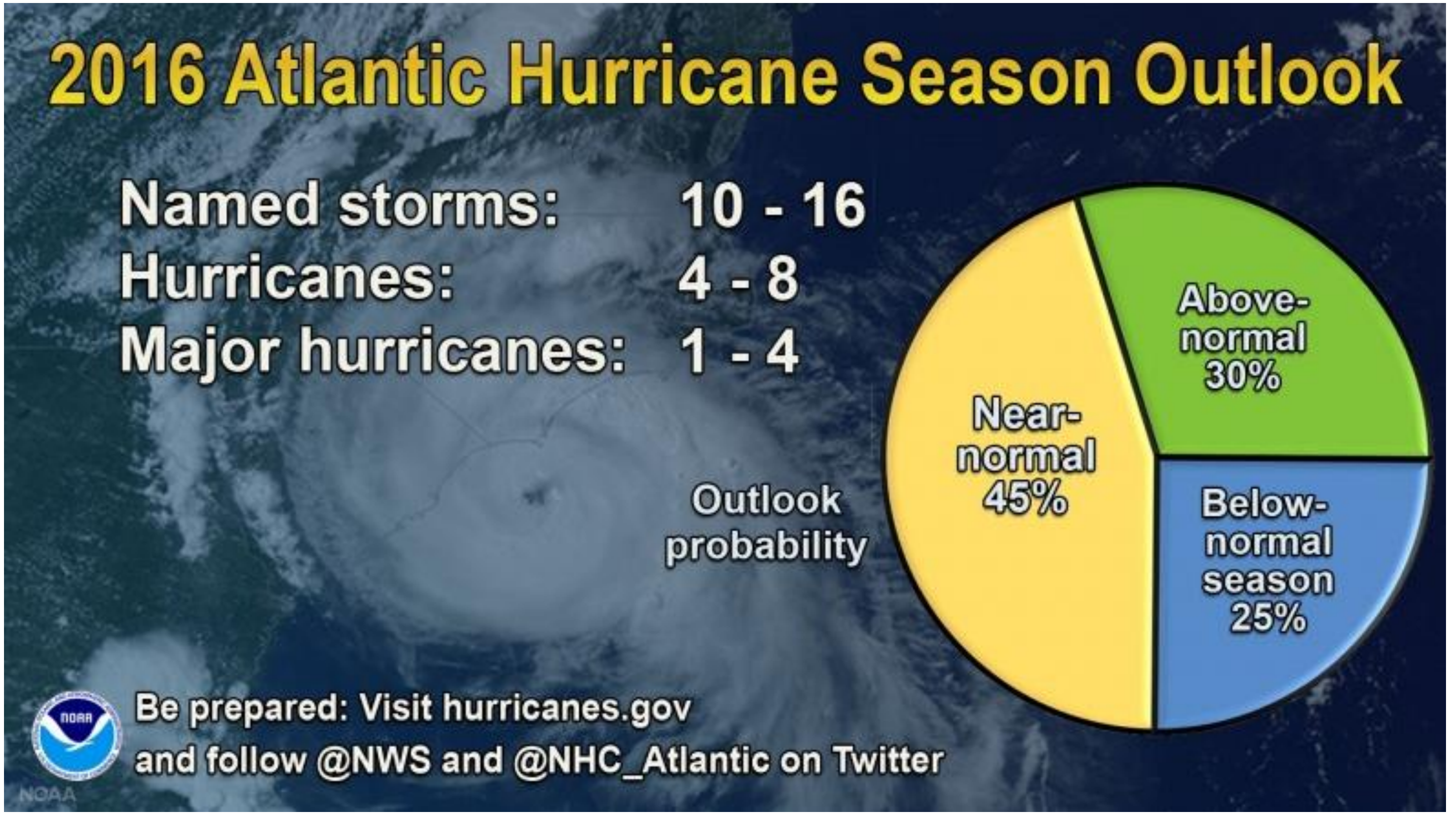
- The SSHA was overall consistent with HC300A: Positive (negative) HC300A is tied up with positive (negative) SSHA.
- Both SSHA and HC300A were negative along the equatorial Pacific, consisting with the decay of El Nino.
- Negative tendencies of SSHA and HC300A were observed in the central and eastern equatorial Pacific, consisting with the decay tendency of El Nino and potential of La Nina development.



Tropical Cyclone Heat Potential (KJ/cm²)
MAY 2016 Total
MAY 2016 – APR 2016 TCHP (KJ/cm²)
Total
MAY 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

NOAA Outlooks of 2016 Hurricane Season

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



NOAA's 2016 Atlantic Hurricane Season Outlook indicates that a near-normal hurricane season is most likely. The outlook calls for a 45% chance of a near-normal season, a 30% chance of an above-normal season, and a 25% chance of a below-normal season.

NOAA Outlooks of Hurricane Season in 2016

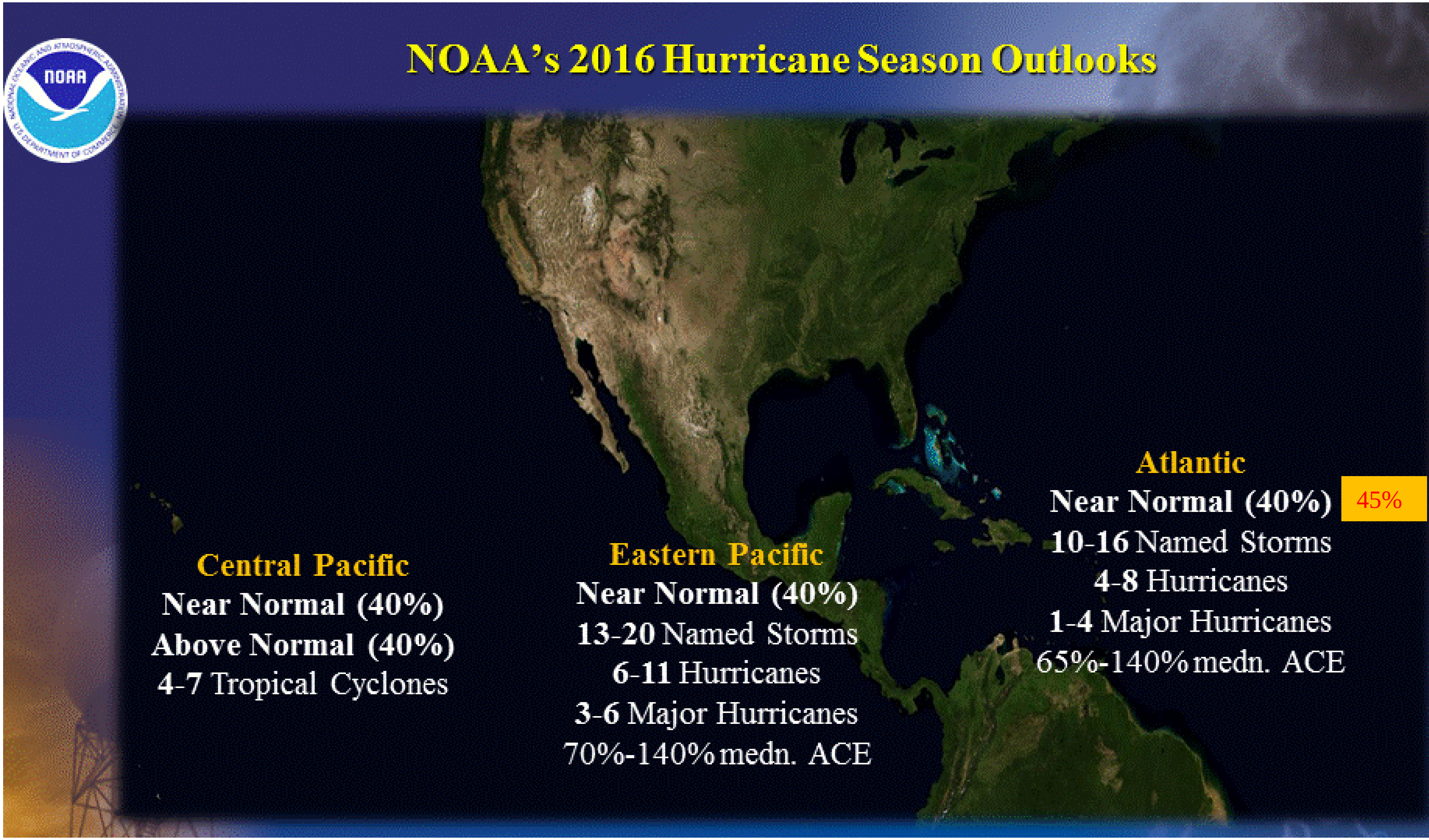
(http://www.cpc.ncep.noaa.gov/products/outlooks/hurricane.shtml/)

Atlantic	2016 prediction (issued on May 27)	1981-2010
Named storms	10-16	12.1
Hurricanes	4-8	6.4
Major hurricanes	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.

NOAA Outlooks of Hurricane Season in 2016

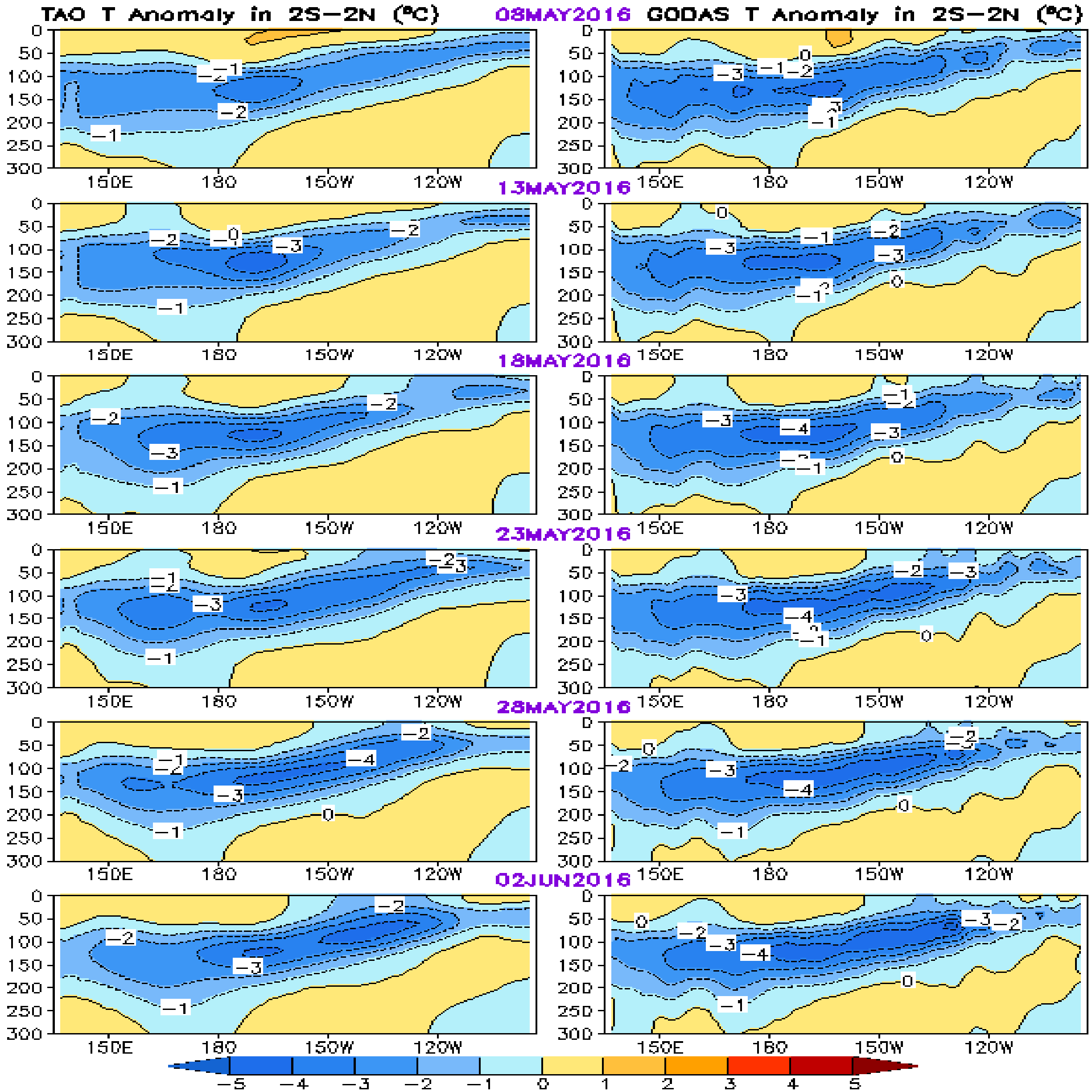
(http://www.cpc.ncep.noaa.gov/products/Epac_hurr/figure1.gif)



Tropical Pacific Ocean and ENSO Conditions

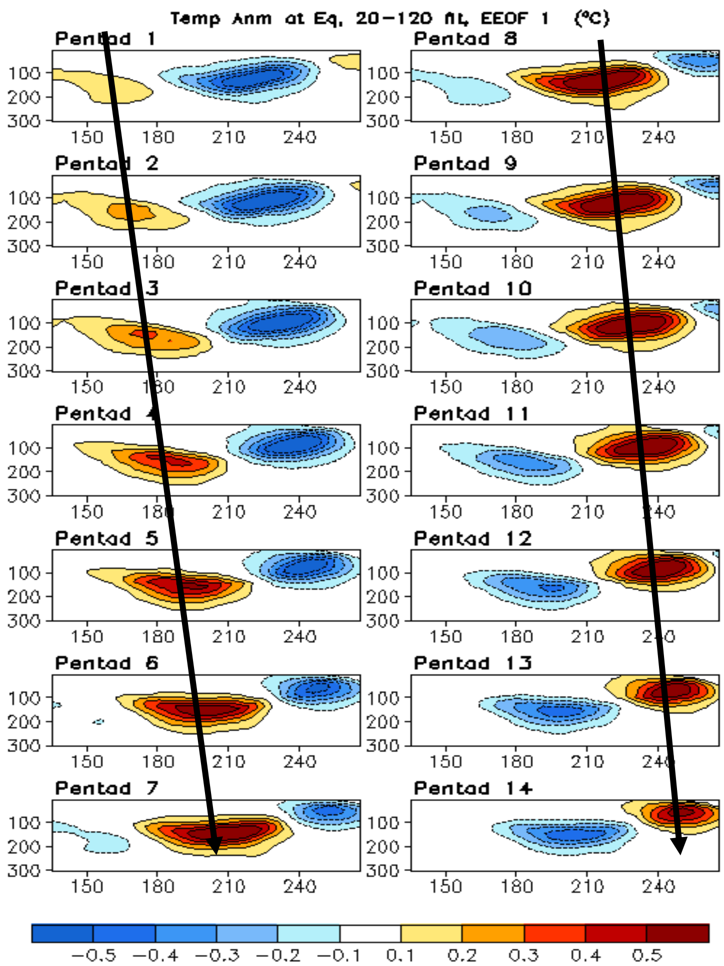
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

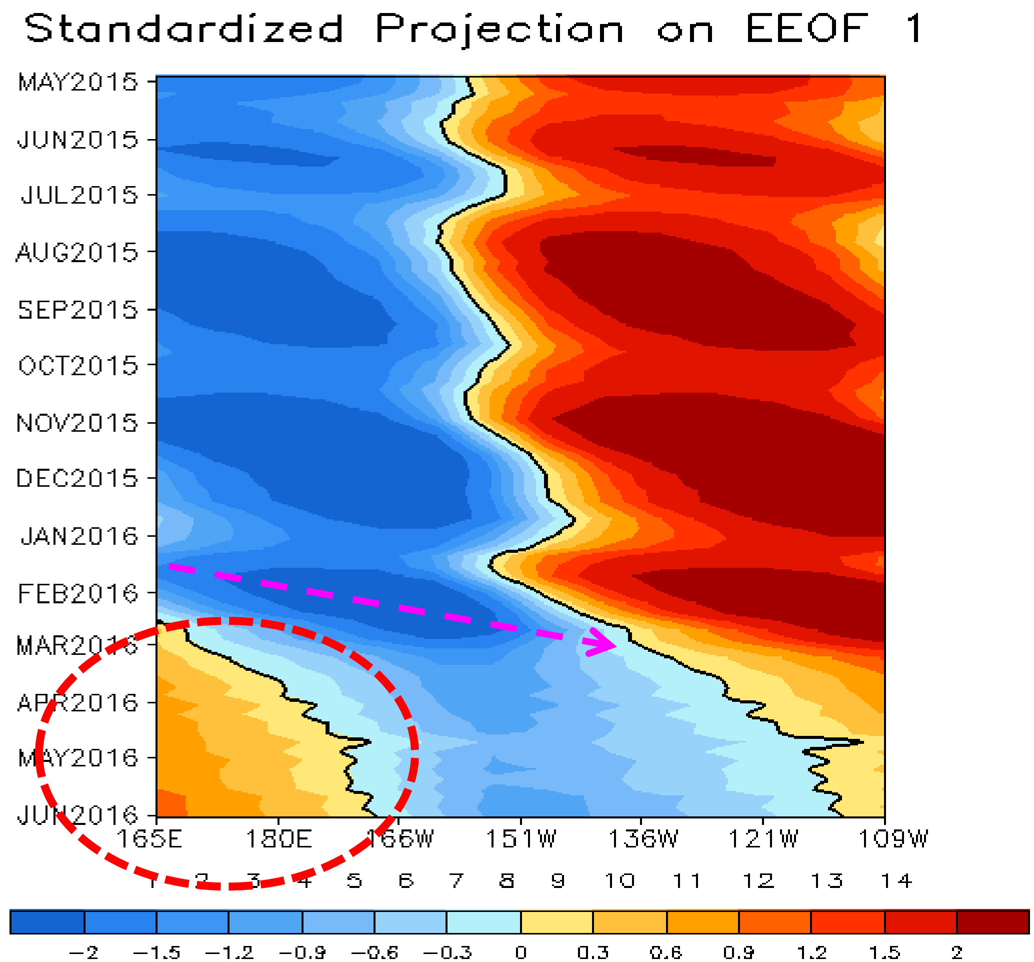
TAO GODAS



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

Oceanic Kelvin Wave (OKW) Index

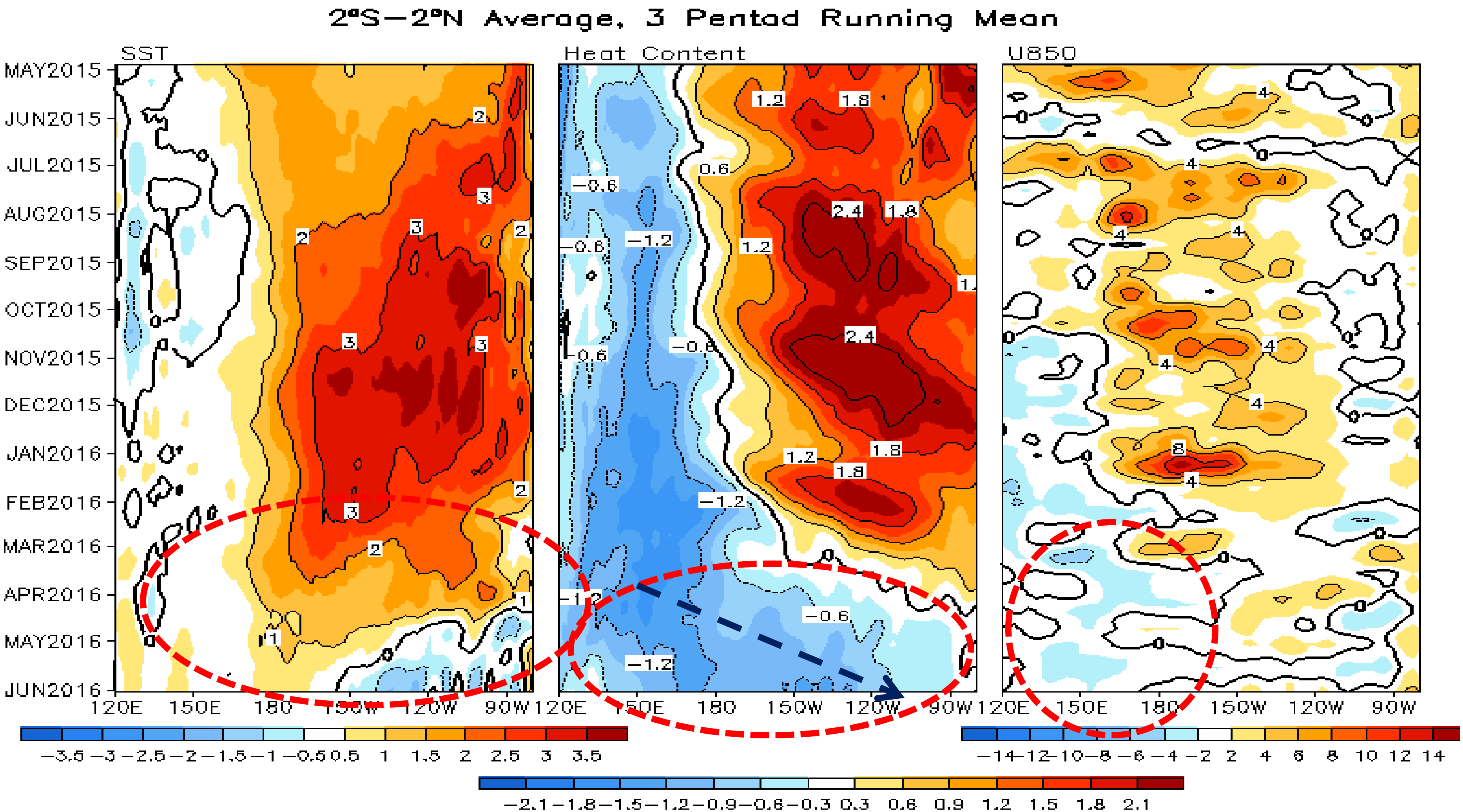




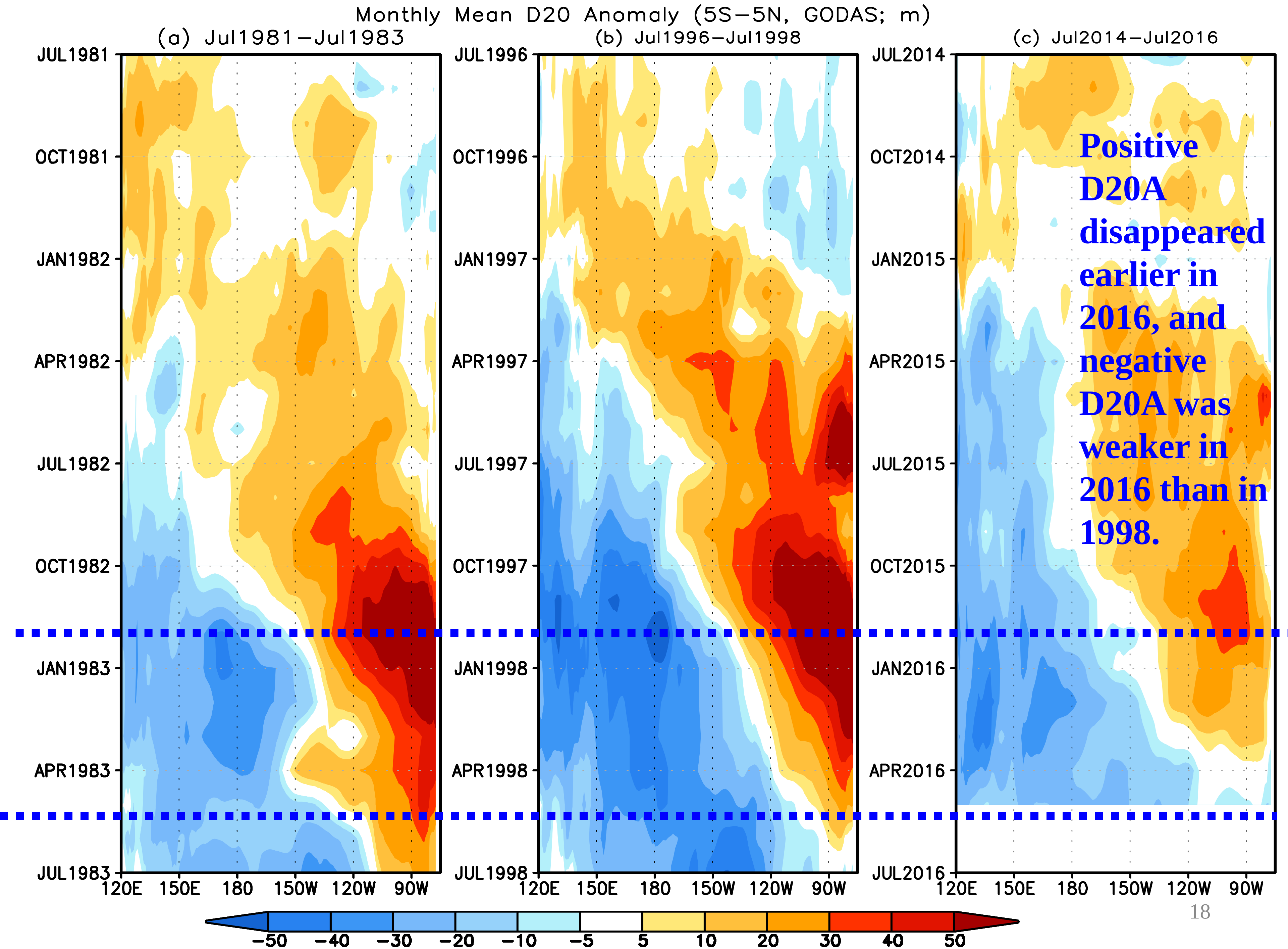
- Upwelling OKW (dashed line) emerged since Jan 2016 in the western Pacific. The upwelling may be associated with the observed strengthening of subsurface ocean cooling in the western and central Pacific and the eastward propagation.

- (OKW index is defined as standardized projections of total anomalies onto the 14 patterns of Extended EOF1 of equatorial temperature anomalies (Seo and Xue , GRL, 2005).)

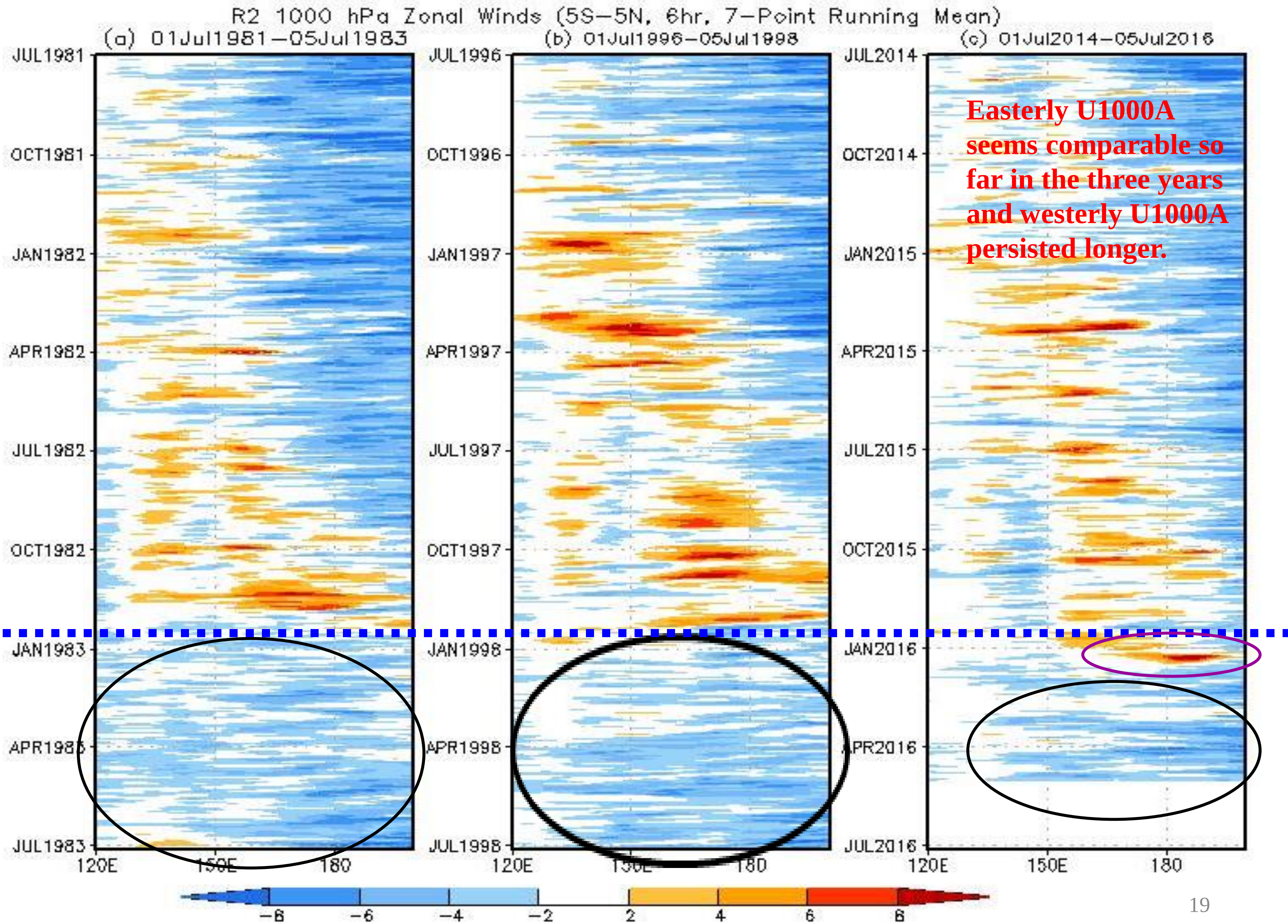
Equatorial Pacific SST (°C), HC300 (°C), u850 (m/s) Anomalies

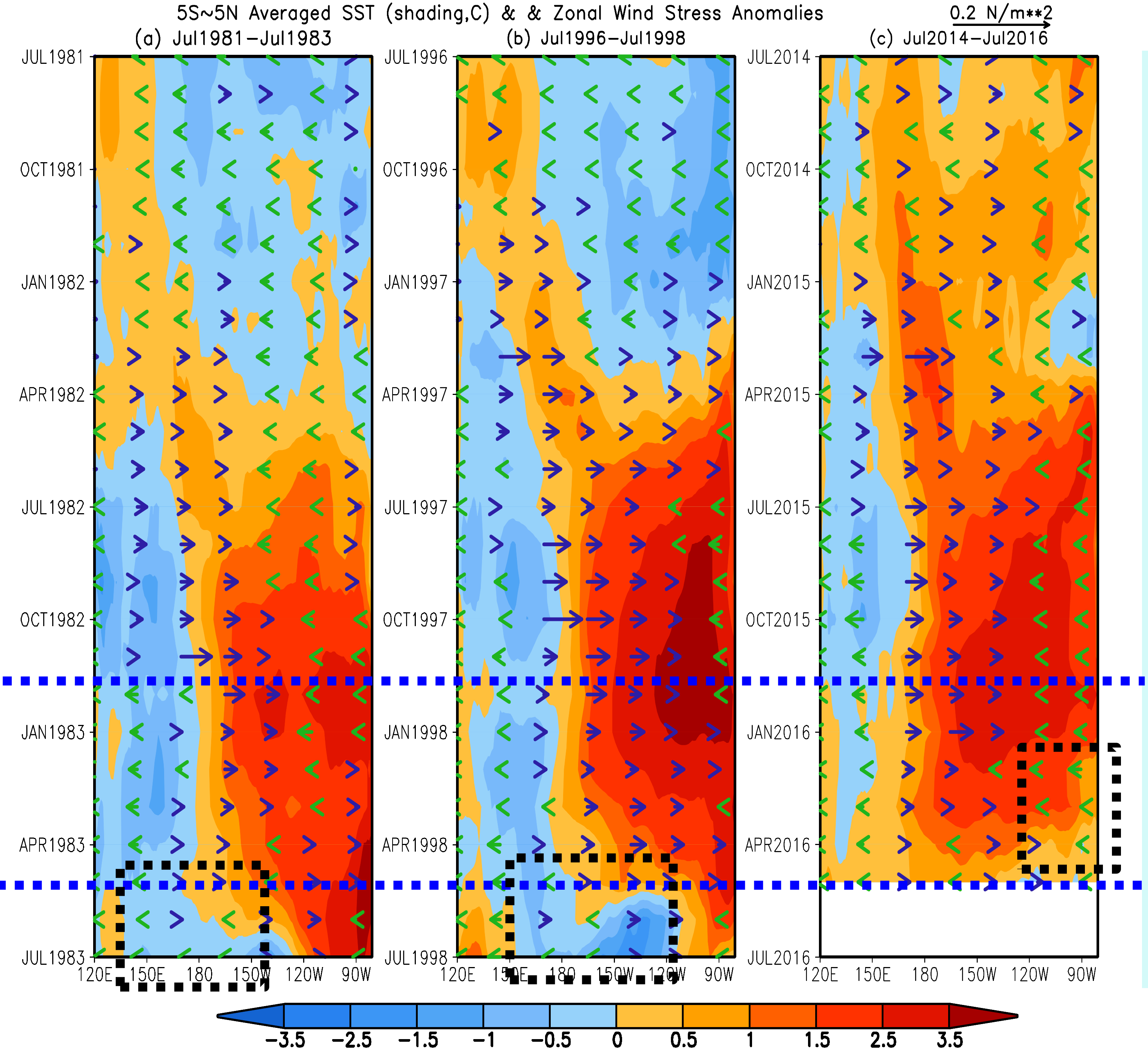


- **Positive SSTA weakened in the central equatorial Pacific, and negative SSTA emerged in the eastern equatorial Pacific in May 2016, which were associated with the development of negative HC300A.**
- **Positive HC300A disappeared, and negative occupied the equatorial Pacific in recent months.**
- **Easterly wind anomalies persisted in the western equatorial Pacific since March 2016, and they were consistent with the development and eastward propagation of negative HC300A**



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
Positive D20A disappeared earlier in 2016, and negative D20A was weaker in 2016 than in 1998.
−50 −40 −30 −20 −10 −5 5 10 20 30 40 50


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
Easterly U1000A seems comparable so far in the three years and westerly U1000A persisted longer.
–8
–6
–4
–2
2
4
6
8

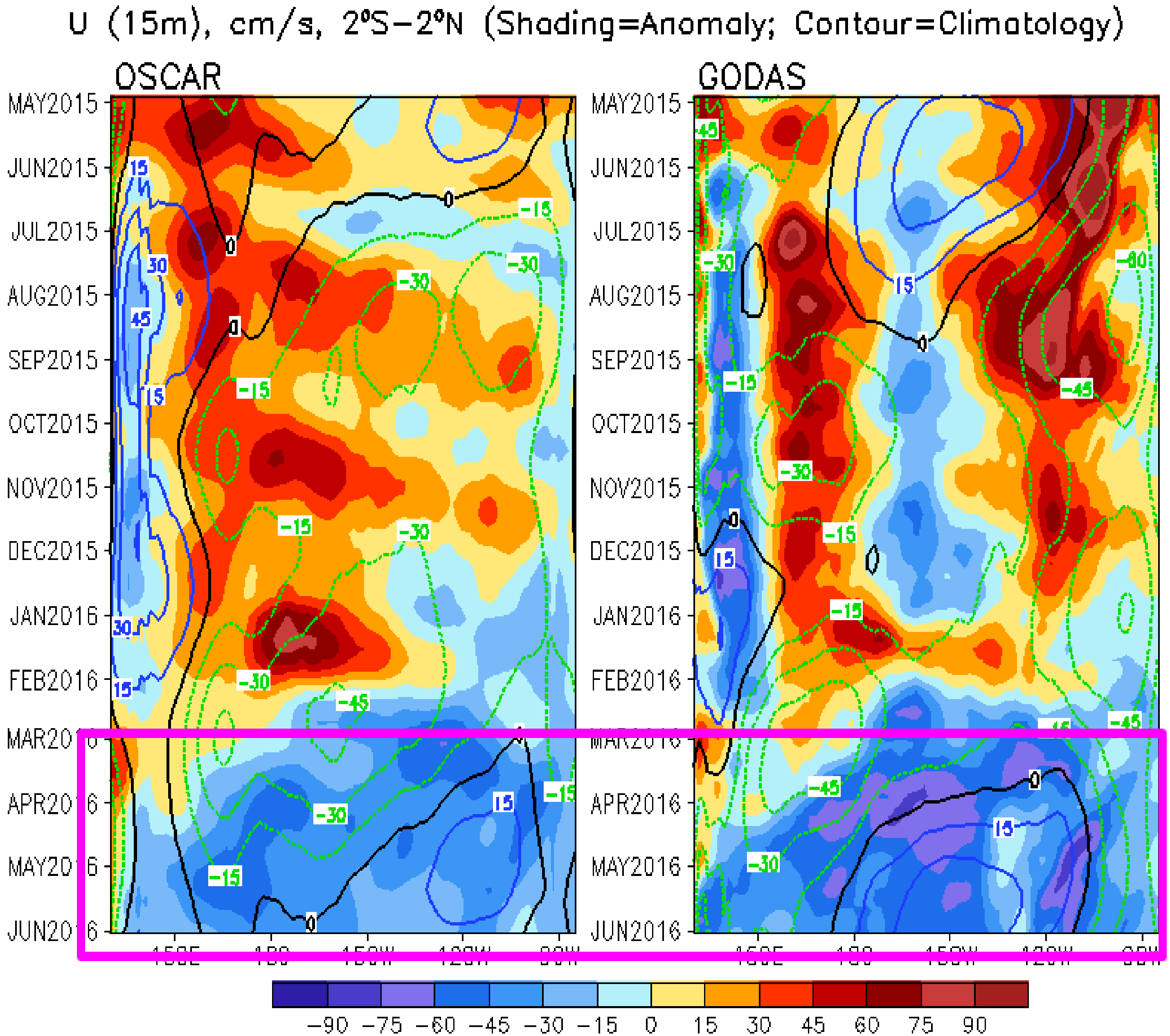


Compared with 1982-83 and 1997-98, *in 2015-16,*

(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.

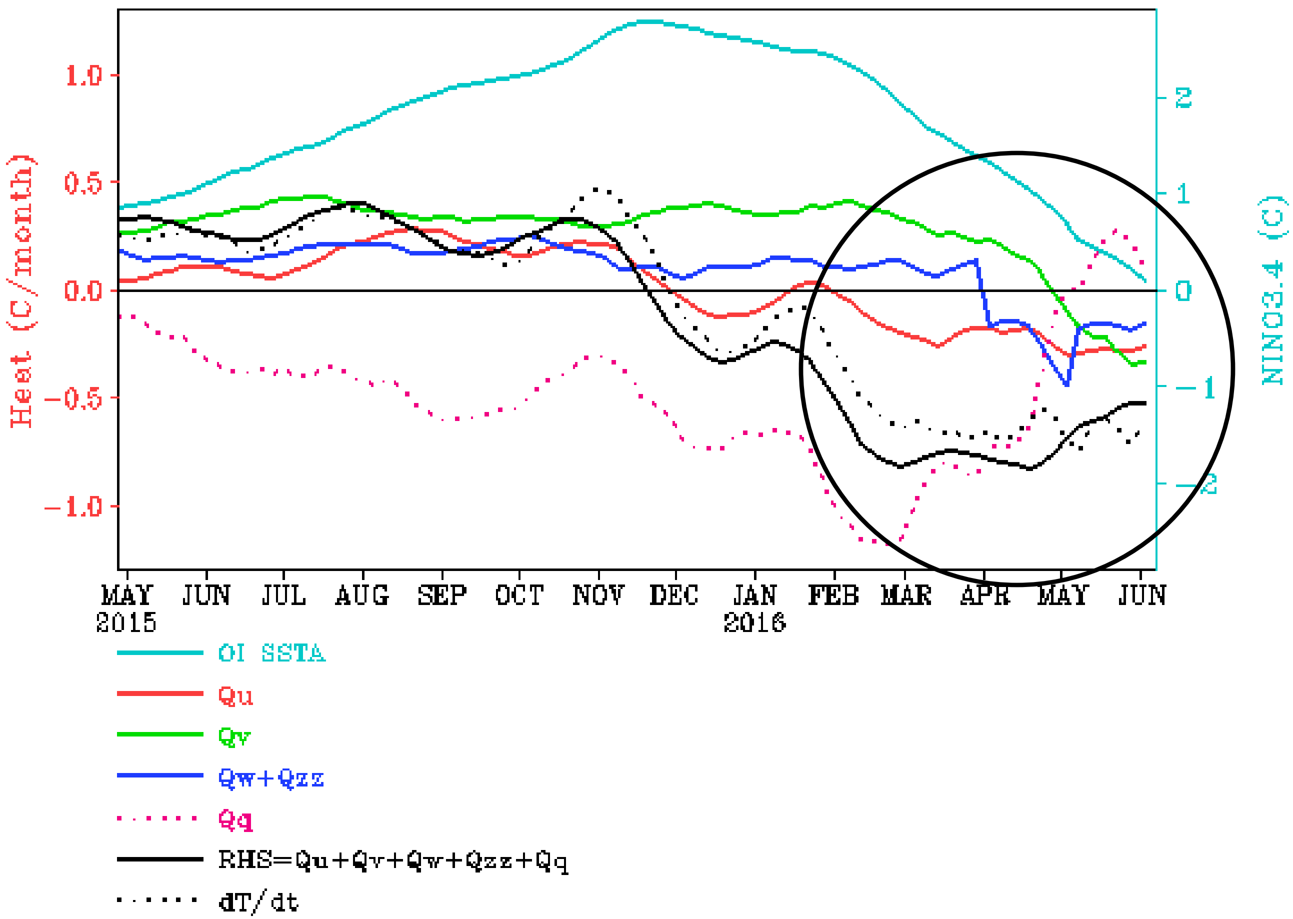
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- The anomalous current patterns were similar between OSCAR and GODAS.

- Anomalous westward current initiated in Feb 2016 and strengthened in Mar-Apr 2016. That was favorable for a cooling tendency in the central-eastern Pacific SST.

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 negative, and heat flux term (Qq) was positive in May 2016, consistent with the decay of El Nino.

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;

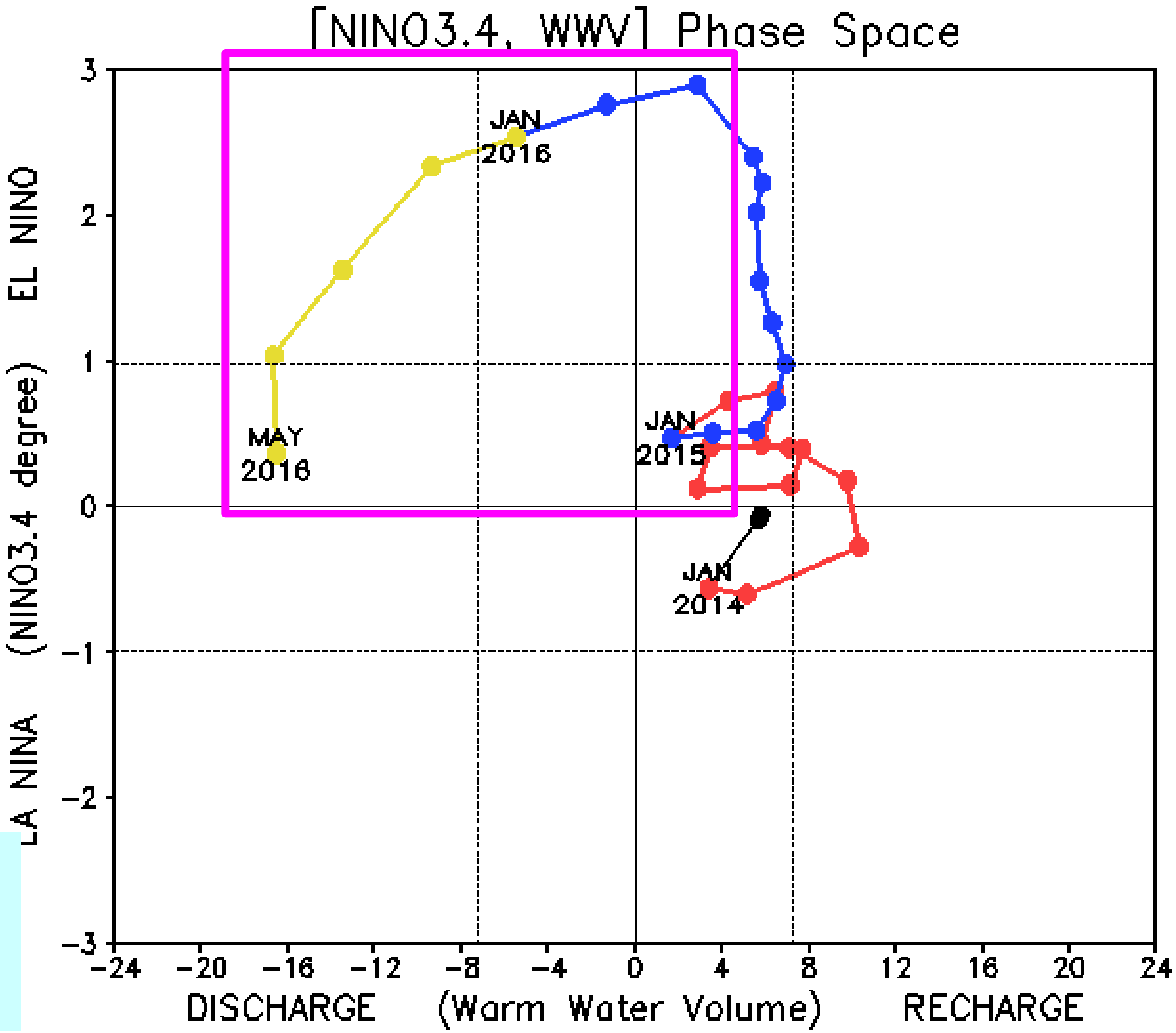
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

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).**

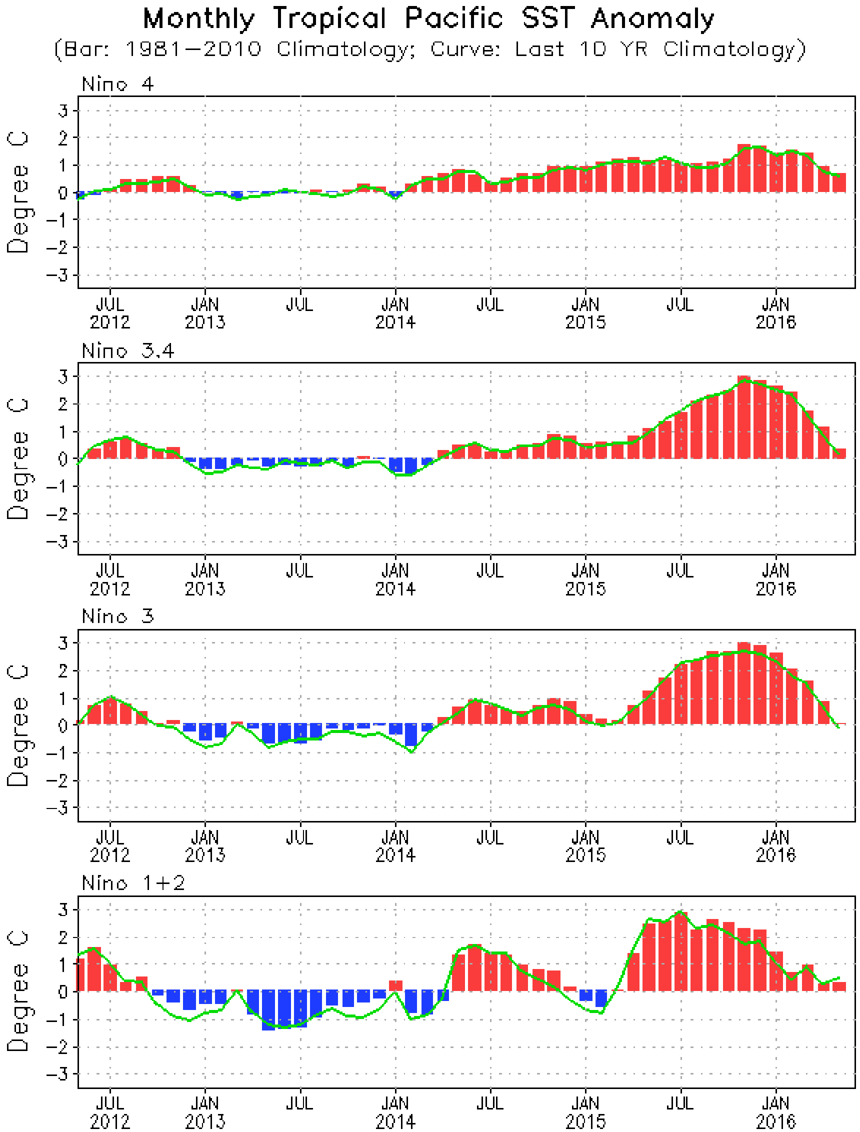
- **Increase (decrease) of WWV indicates recharge (discharge) of the equatorial oceanic heat content.**

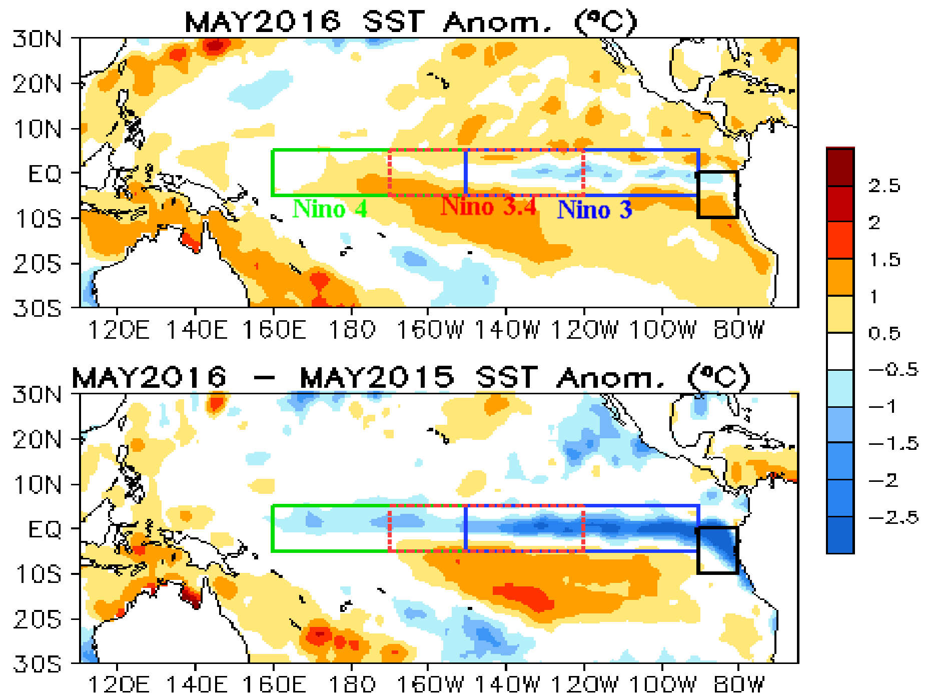


- Equatorial Warm Water Volume (WWV) has been rapidly discharging since Nov 2015. The WWV change was small from Apr to May 2016.

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.

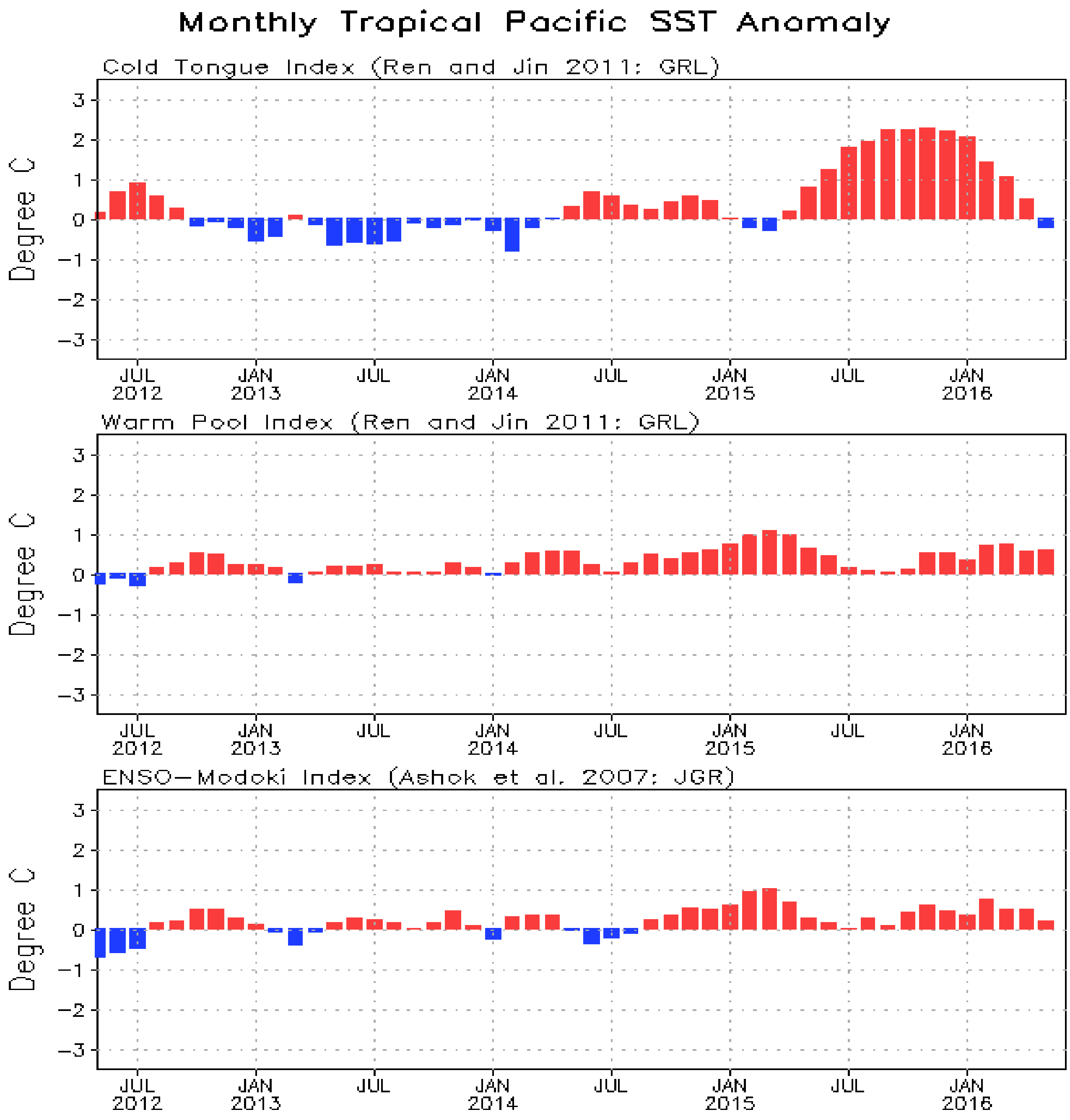
Evolution of Pacific NINO SST Indices





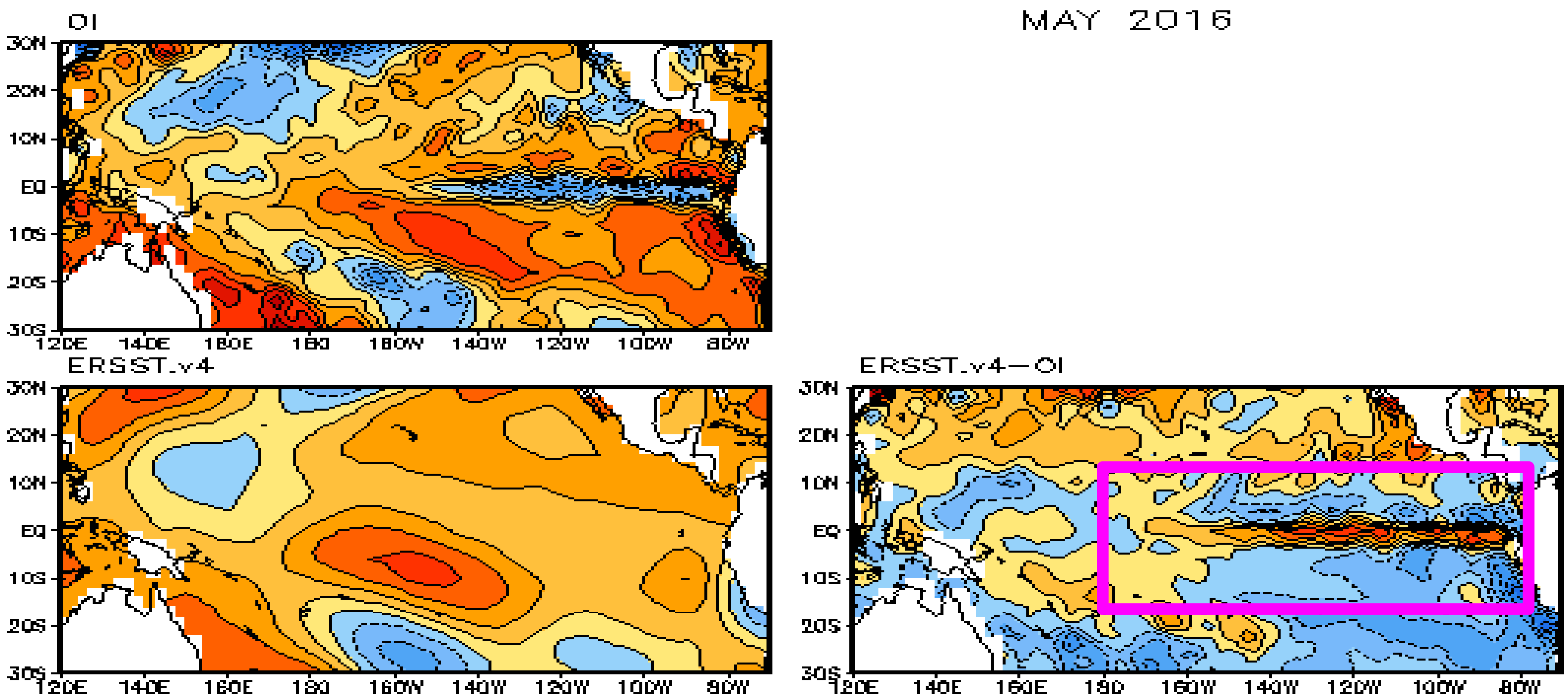
- **All Nino indices were still positive, but weakened in May 2016.**
- **Nino3.4 = 0.5°C in May 2016.**
- **Compared with last May, the central and eastern equatorial Pacific was cooler in May 2016.**
- **The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v4.**

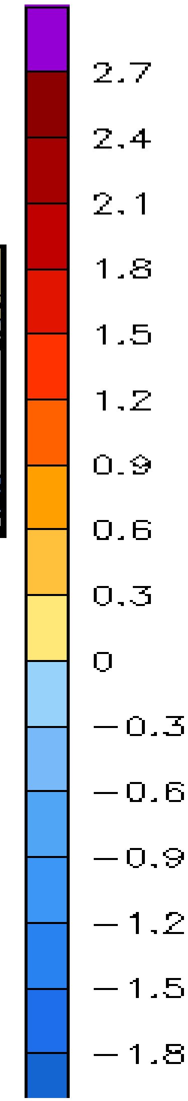
Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.



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

ERSSTv4 and OIv2 SST Comparison (From Michelle L'Heureux)

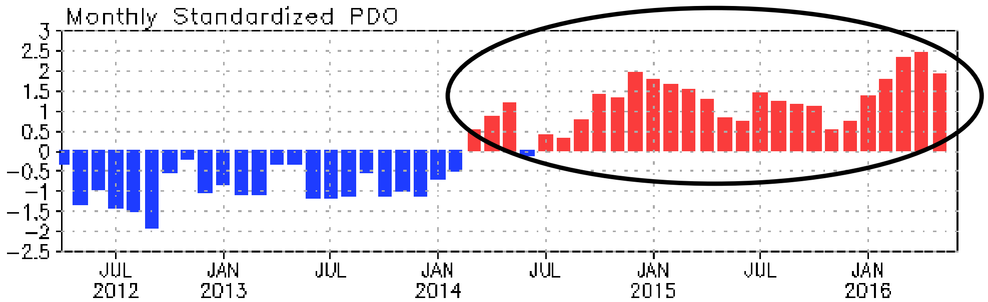


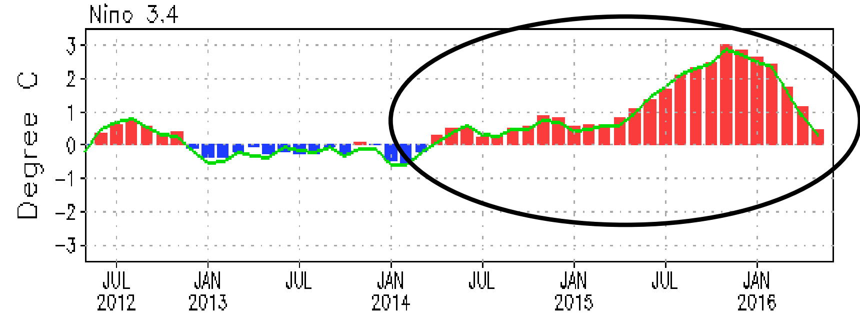


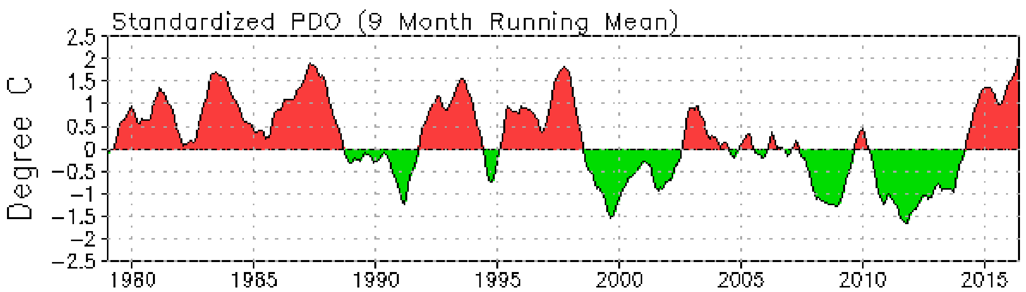
Nino3.4	March	April	May	MAM
ERSST4	1.5	1.1	0.6	1.1
OIv2	1.7	1.1	0.4	1.1
OIv2-ERSST4	0.2	0	-0.2	0.0

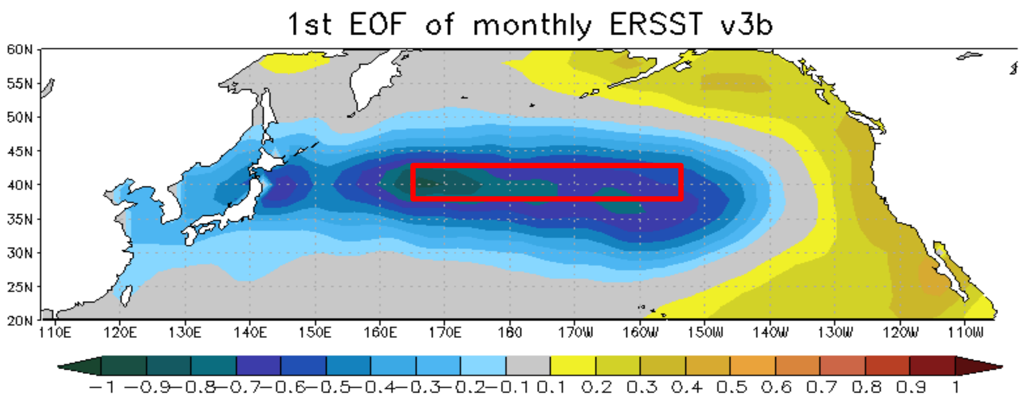
North Pacific & Arctic Oceans

PDO index









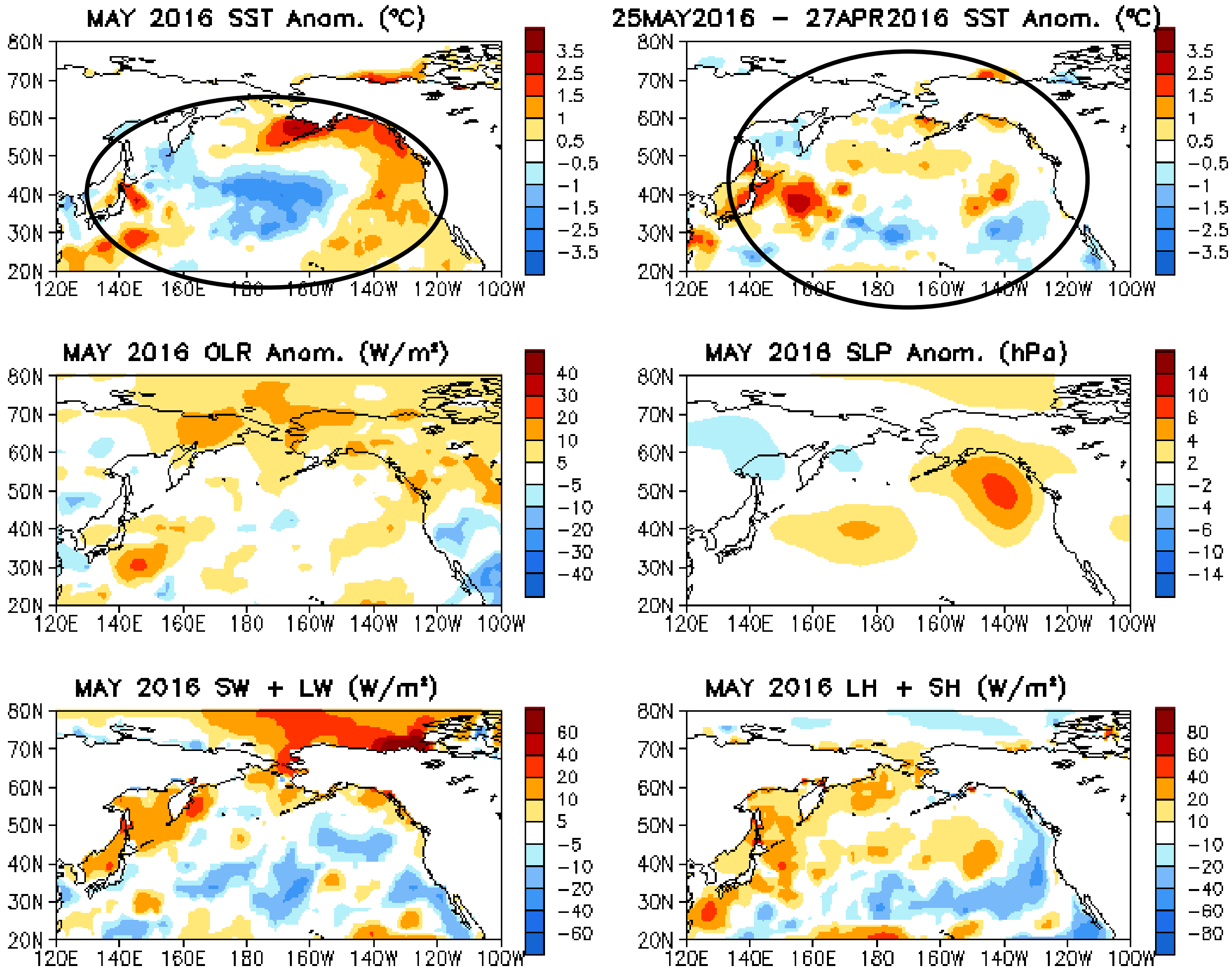
- The positive phase of PDO index has persisted 23 months since Jul 2014, and weakened with PDO index =1.9 in May 2016.

- 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.

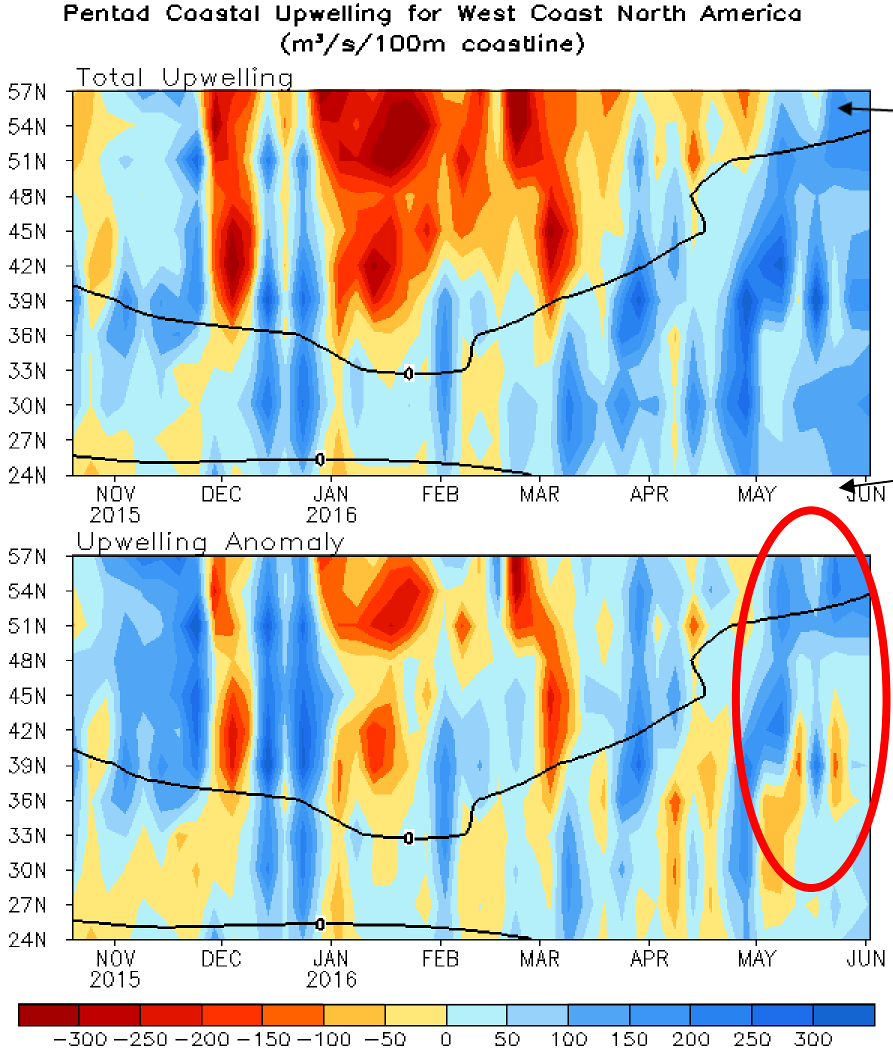
North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

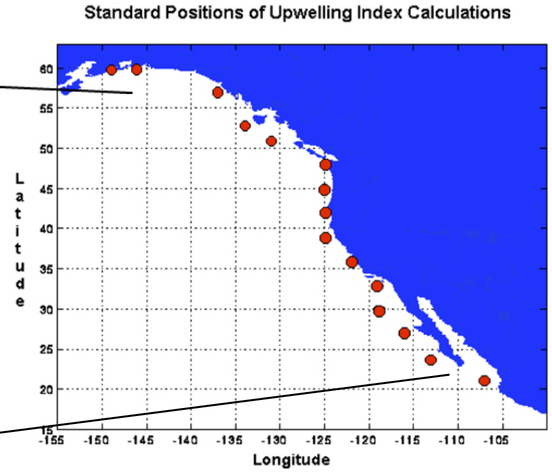


- **Positive SSTA presented in the NE. Pacific, consistent with the positive phase of PDO index (previous slide).**
- **The SST tendency was small in N. Pacific, and it was determined mainly by heat flux.**
- **Above-normal SLP presented in the mid-high latitudes of N. Pacific.**

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





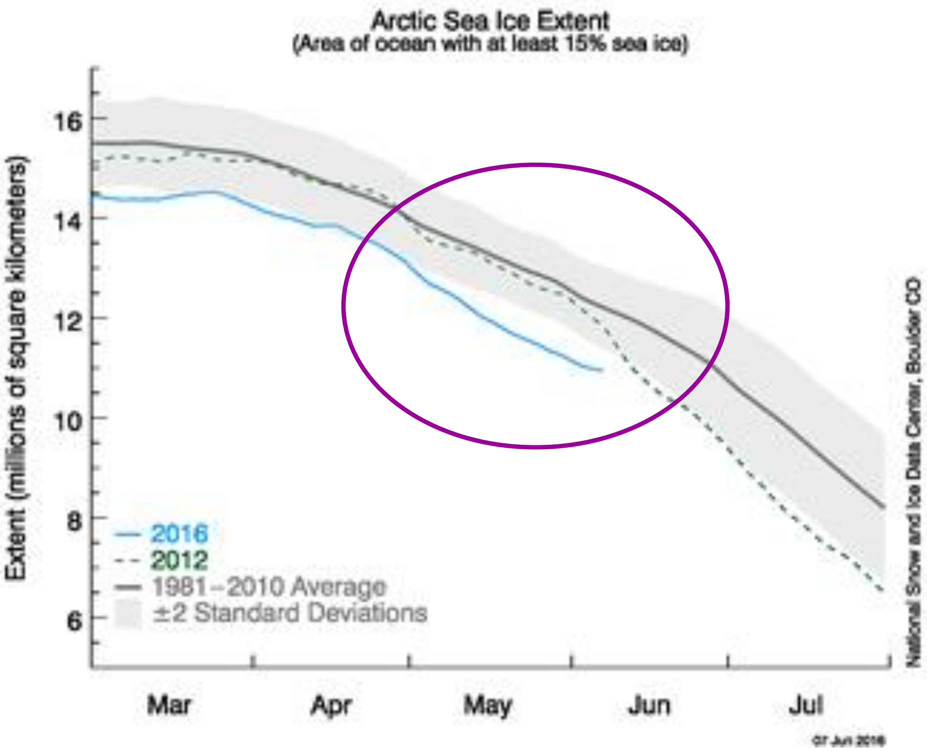
- Anomalous upwelling was in high latitudes and downwelling presented middle latitudes in May 2016.

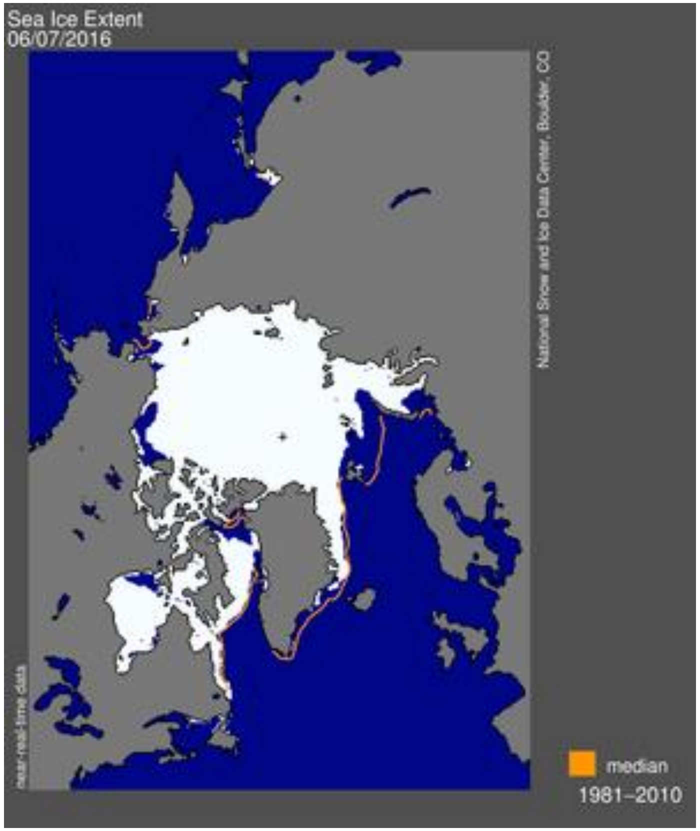
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport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

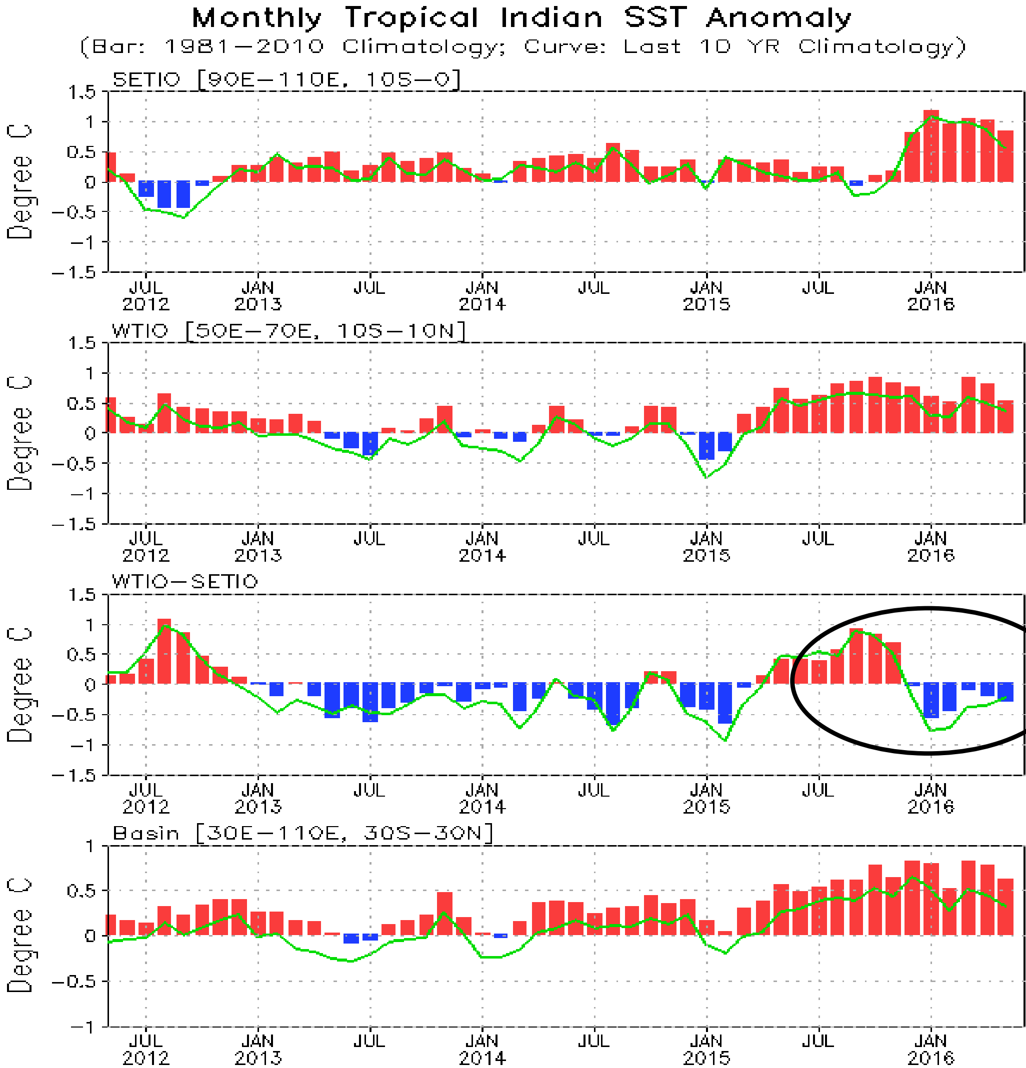


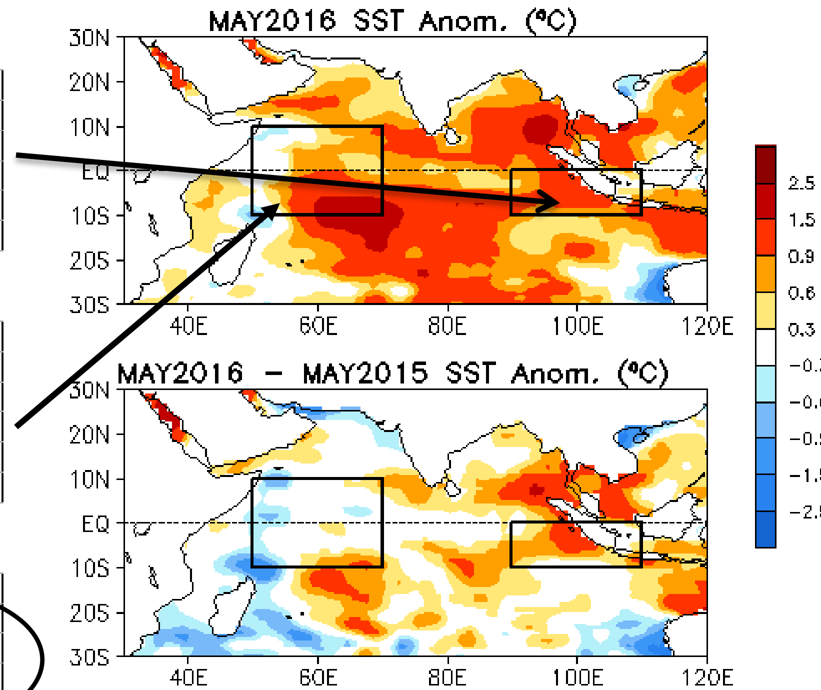


- **Arctic sea ice extent in May 2016 was smaller than -2 standard deviations and less than that in 2012.**

Indian Ocean

Evolution of Indian Ocean SST Indices





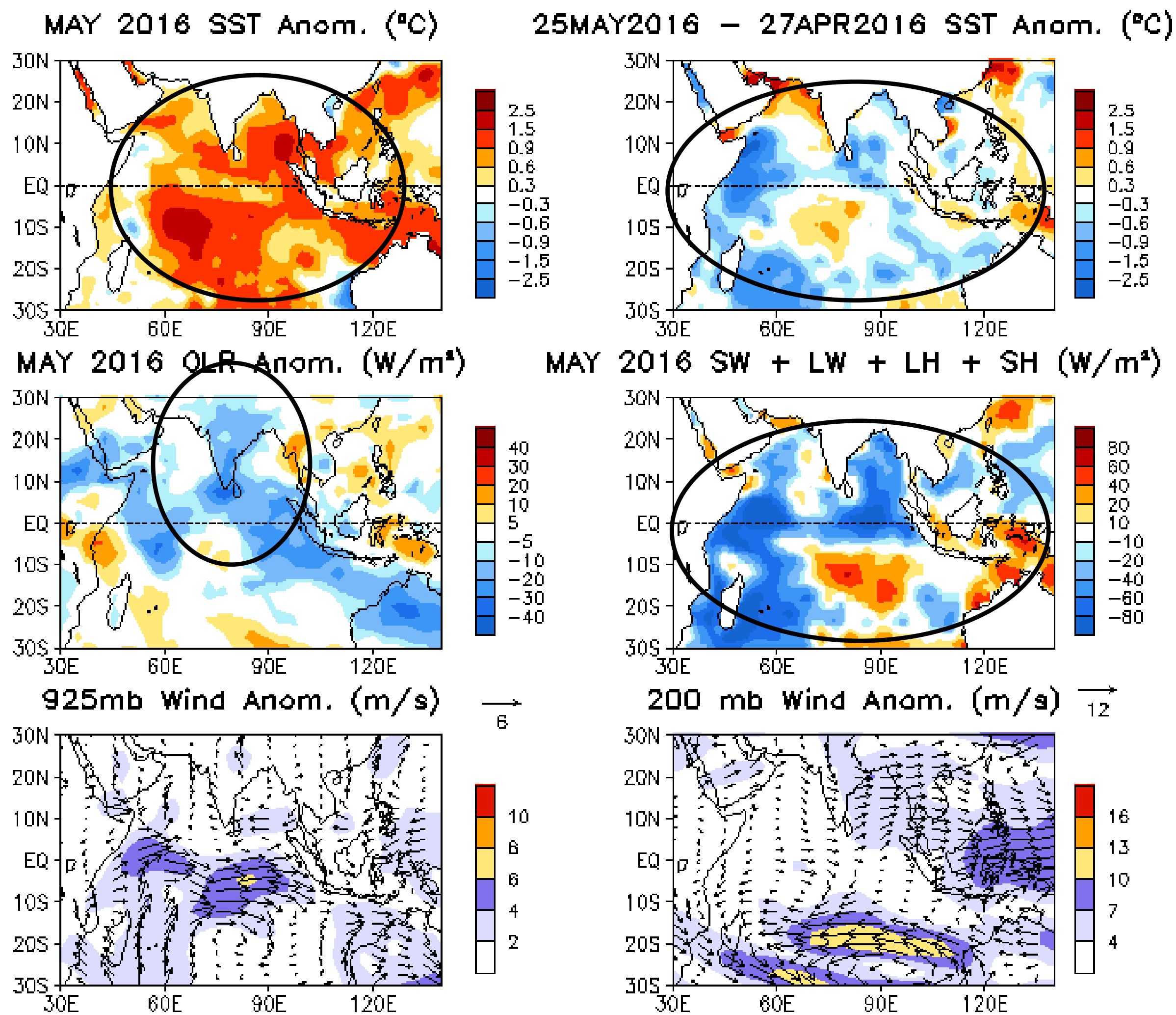
- Positive SSTA was larger in the east than in the west.

- DMI was below normal since Dec 2015.

- Compared with May 2015, the warming in the east was larger in May 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.

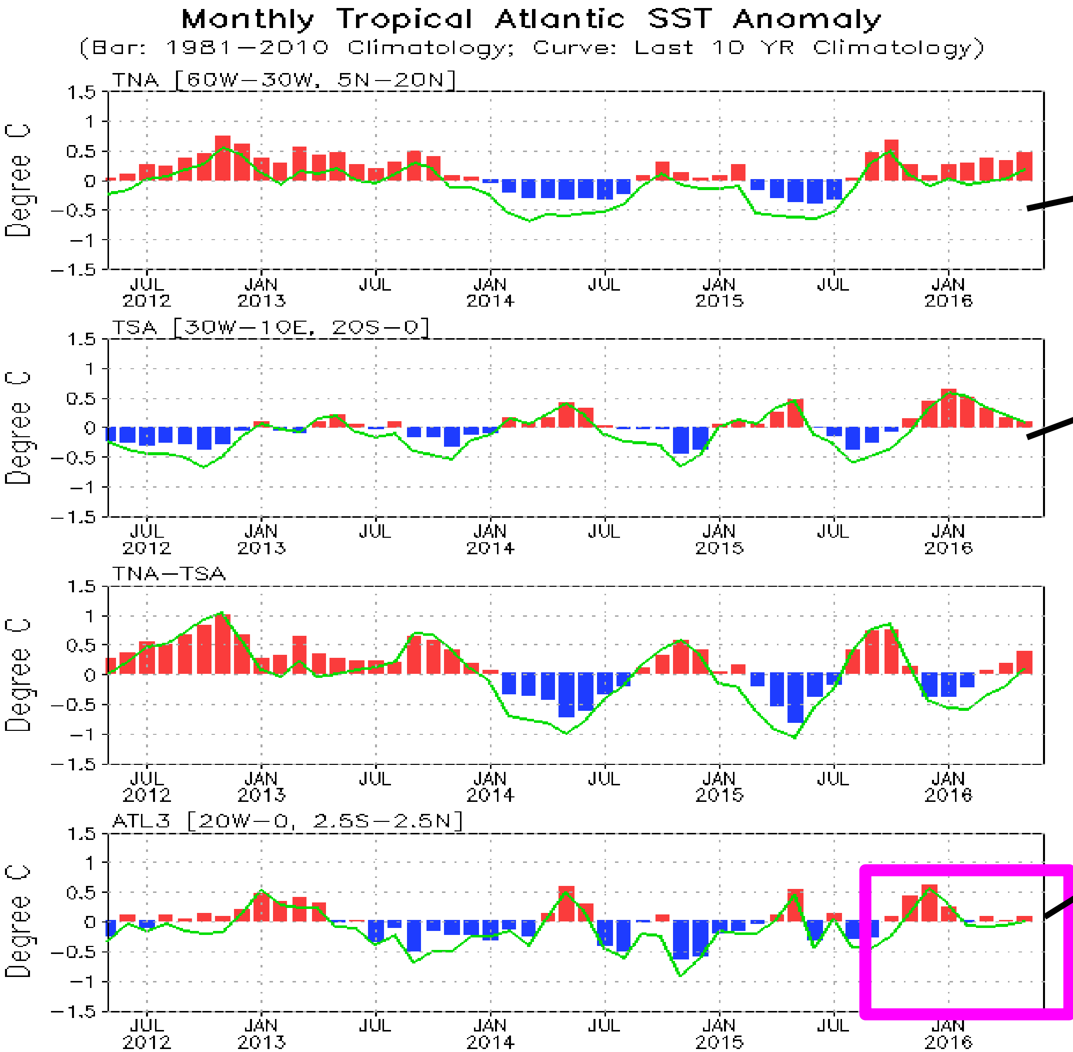


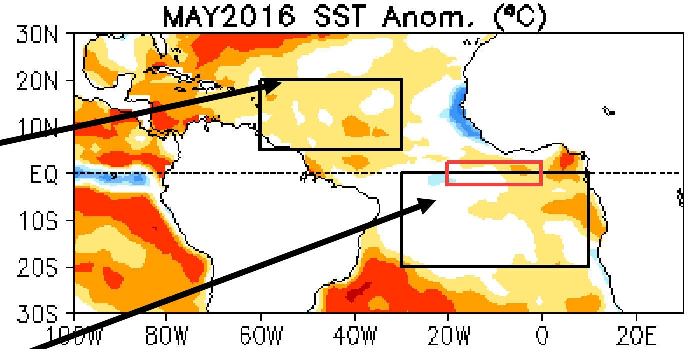
- Positive SSTA was larger in the east than in the west.
- SSTA tendency was largely determined by heat flux.
- Convections were active over the Indian Peninsula.

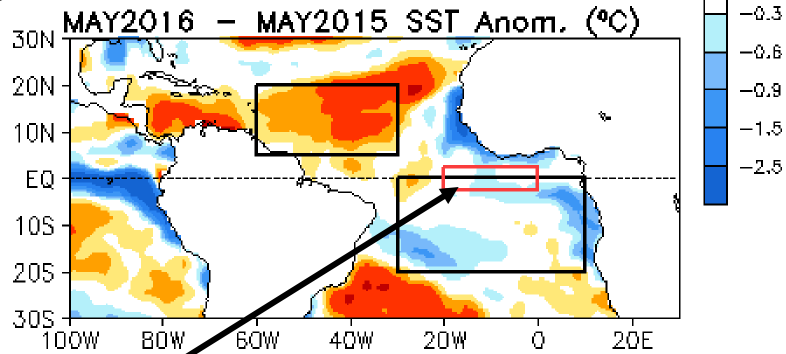
Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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



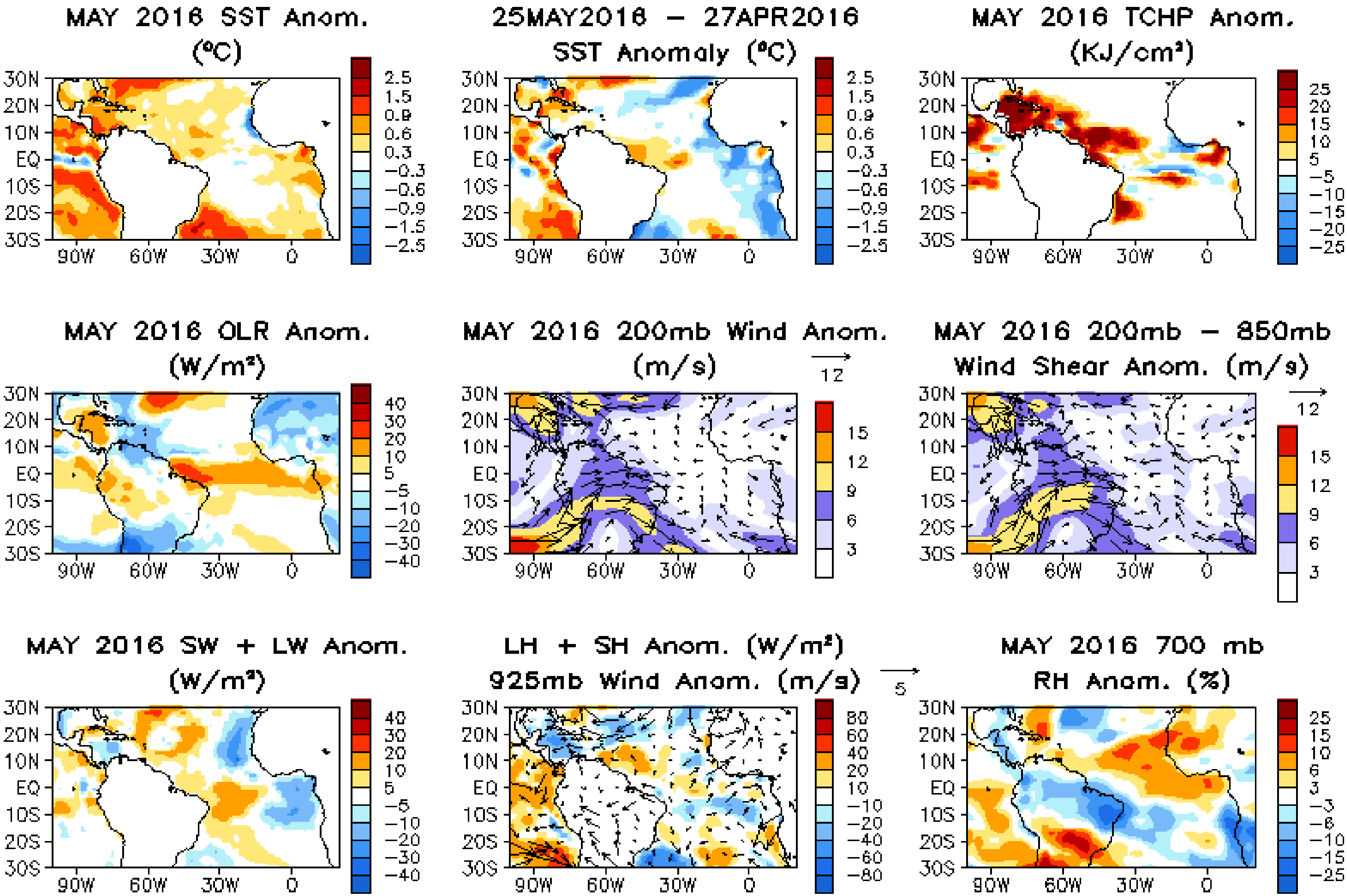




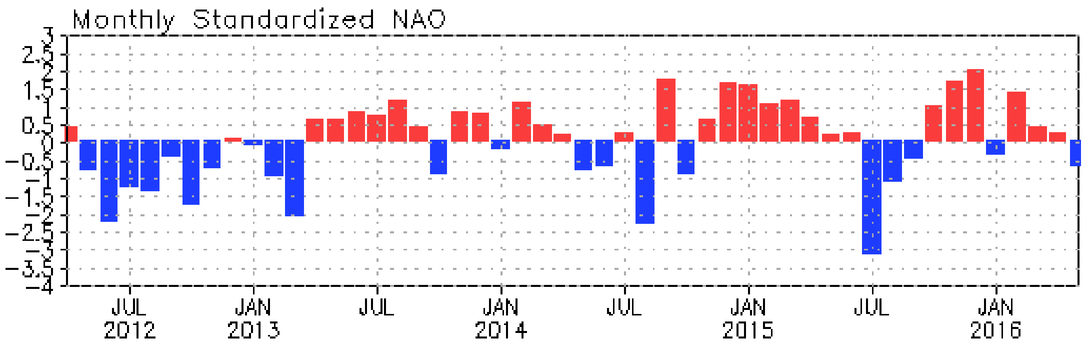
- **ATL3 index had small positive values since March 2016.**
- **Compared with May 2015, SST in the N. tropical Atlantic was warmer in May 2016.**

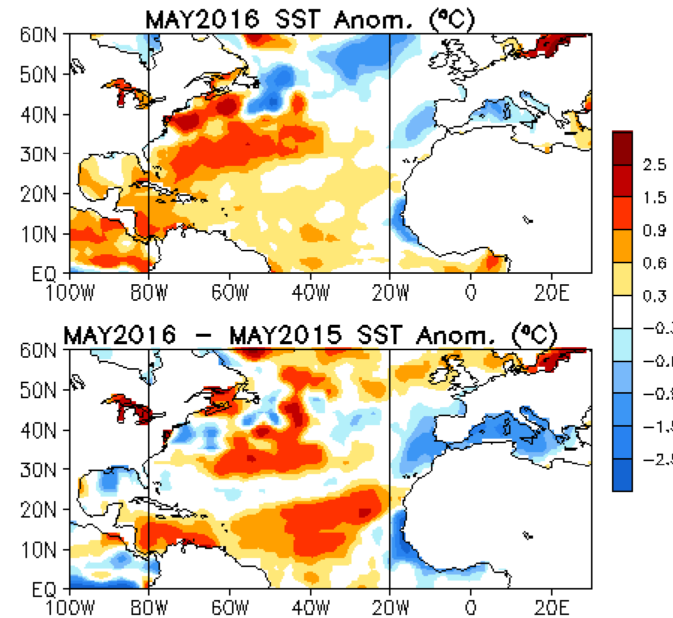
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (ºC) for the TNA [60ºW-30ºW, 5ºN-20ºN], TSA [30ºW-10ºE, 20ºS-0] and ATL3 [20ºW-0, 2.5ºS-2.5ºN] regions, and Meridional Gradient Index, defined as differences between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

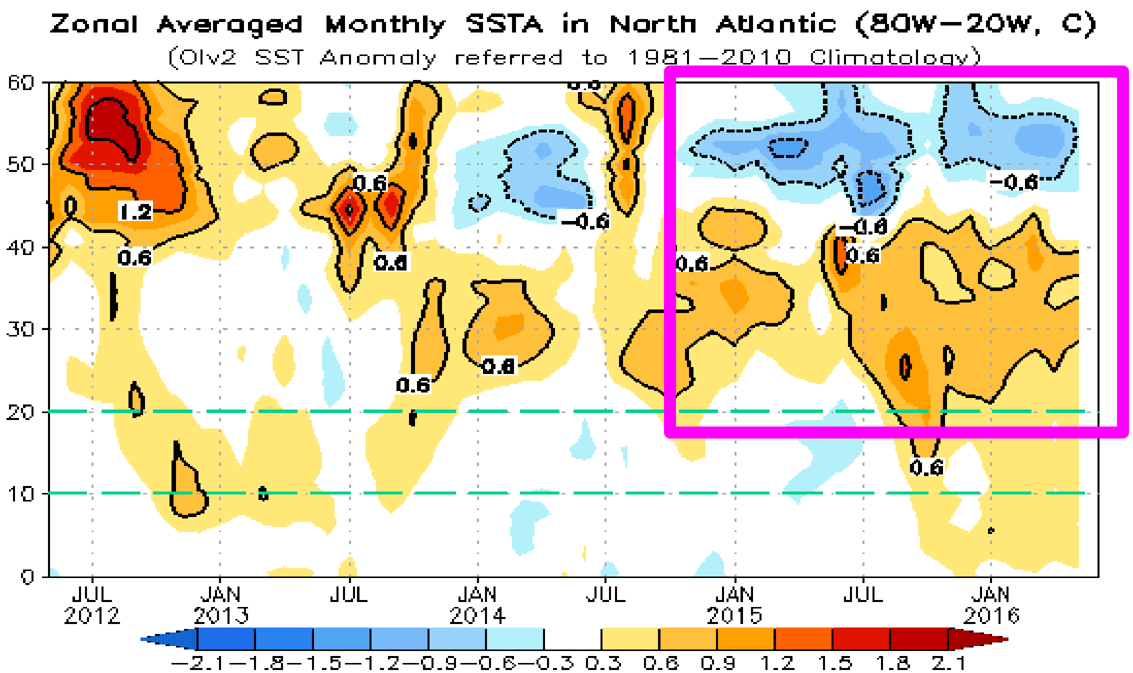
Tropical Atlantic:



NAO and SST Anomaly in North Atlantic







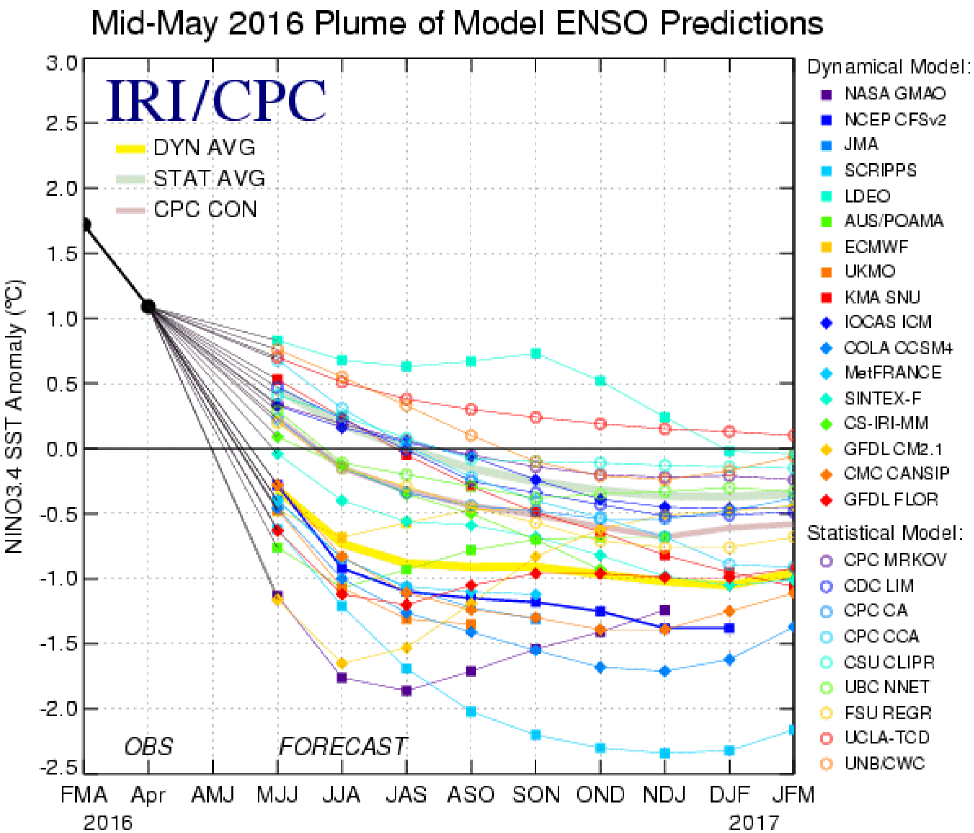
- NAO switched to negative phase with NAOI= -0.7 in May 2016.

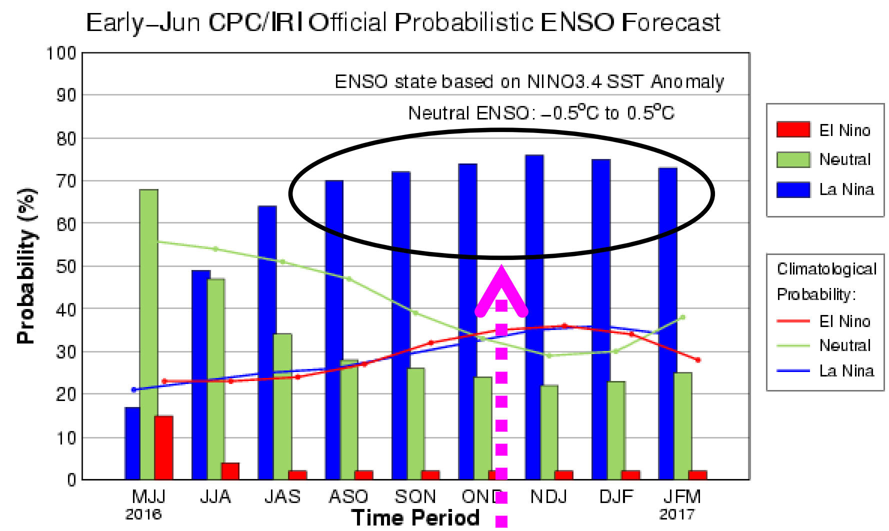
- SSTA was positive in the low and middle latitudes and negative in the high latitudes since autumn 2015, may be due to the influence of positive phase of both NAO and El Nino.

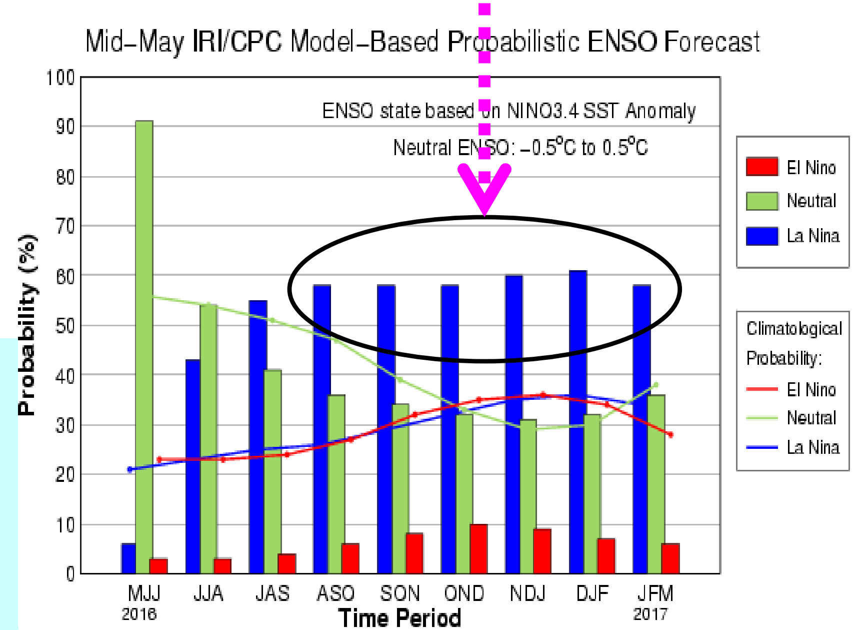
Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20ºN-90ºN (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80ºW and 20ºW (bottom). SST are derived from the NCEP OI SST analysis,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

ENSO and Global SST Predictions

IRI NINO3.4 Forecast Plum



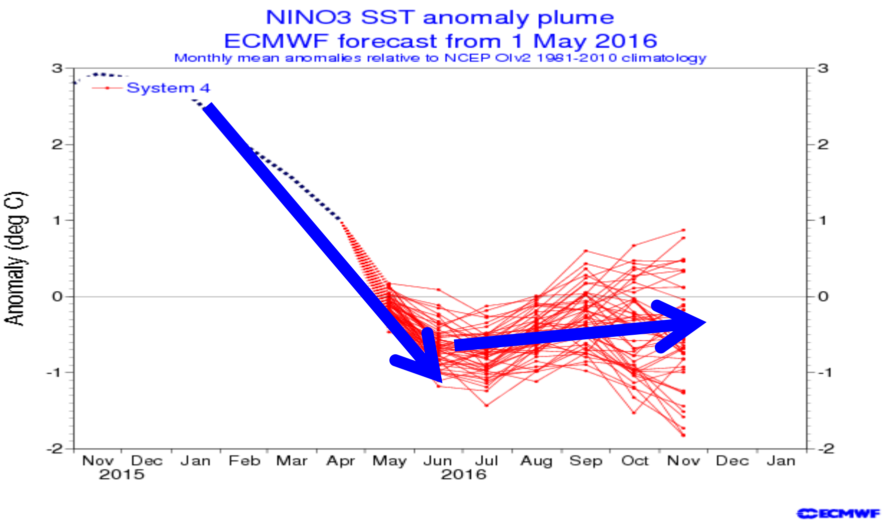




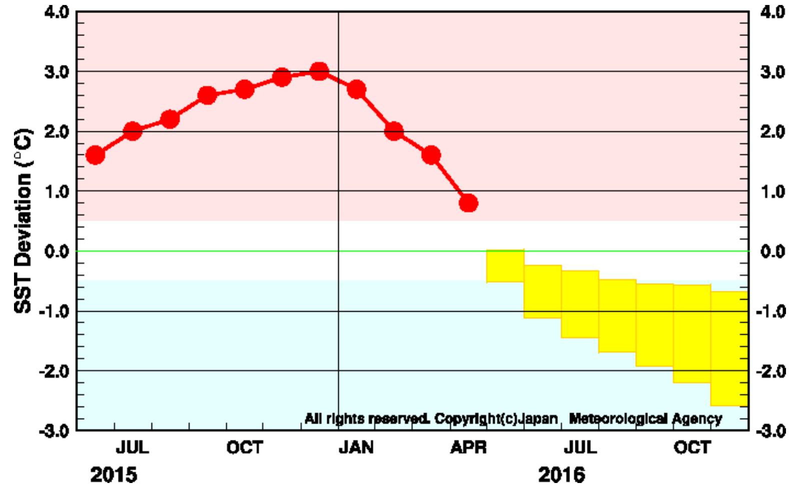
- **Majority of models predicted a La Nina started since the second half of 2016, and some models predicted neutral.**
- **NOAA "ENSO Diagnostic Discussion" on 9 June 2016 issued "Final El Nino Advisory/La Niña Watch" and suggested that *"ENSO-neutral conditions are present and La Niña is favored to 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 La Nina

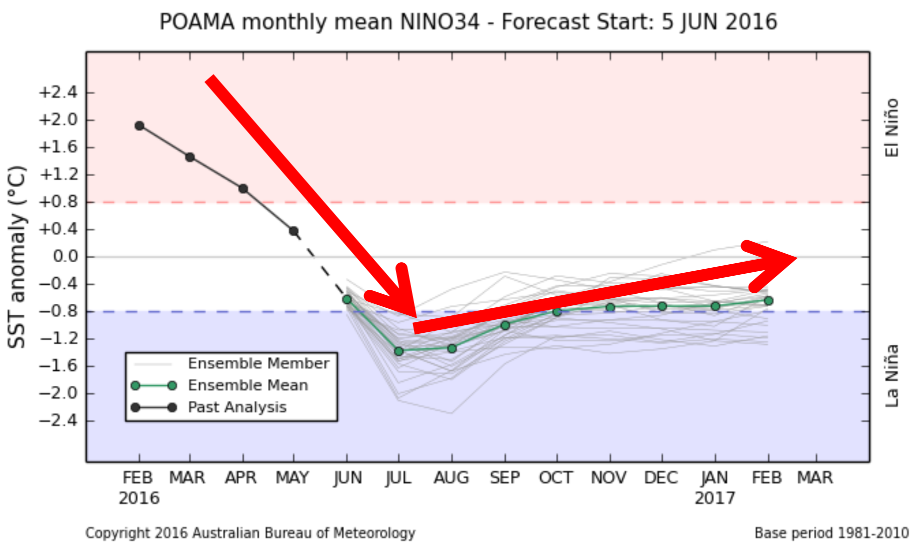
EC: Nino3.4, IC=01May2016



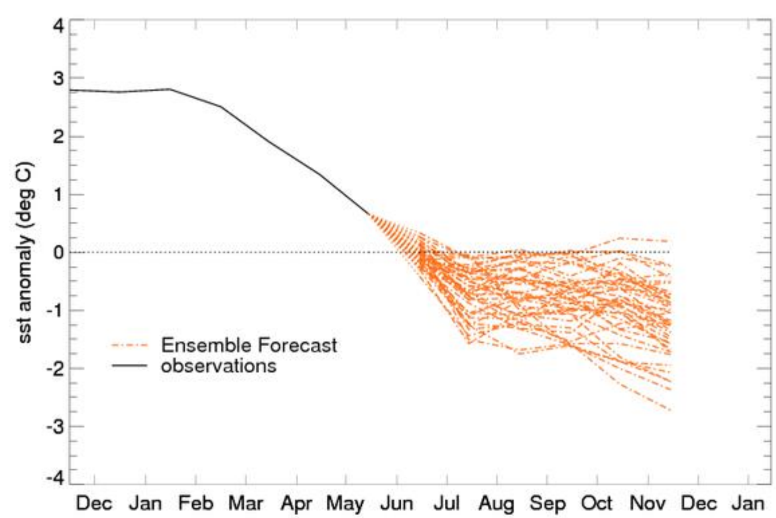
JMA: Nino3, IC= May 2016

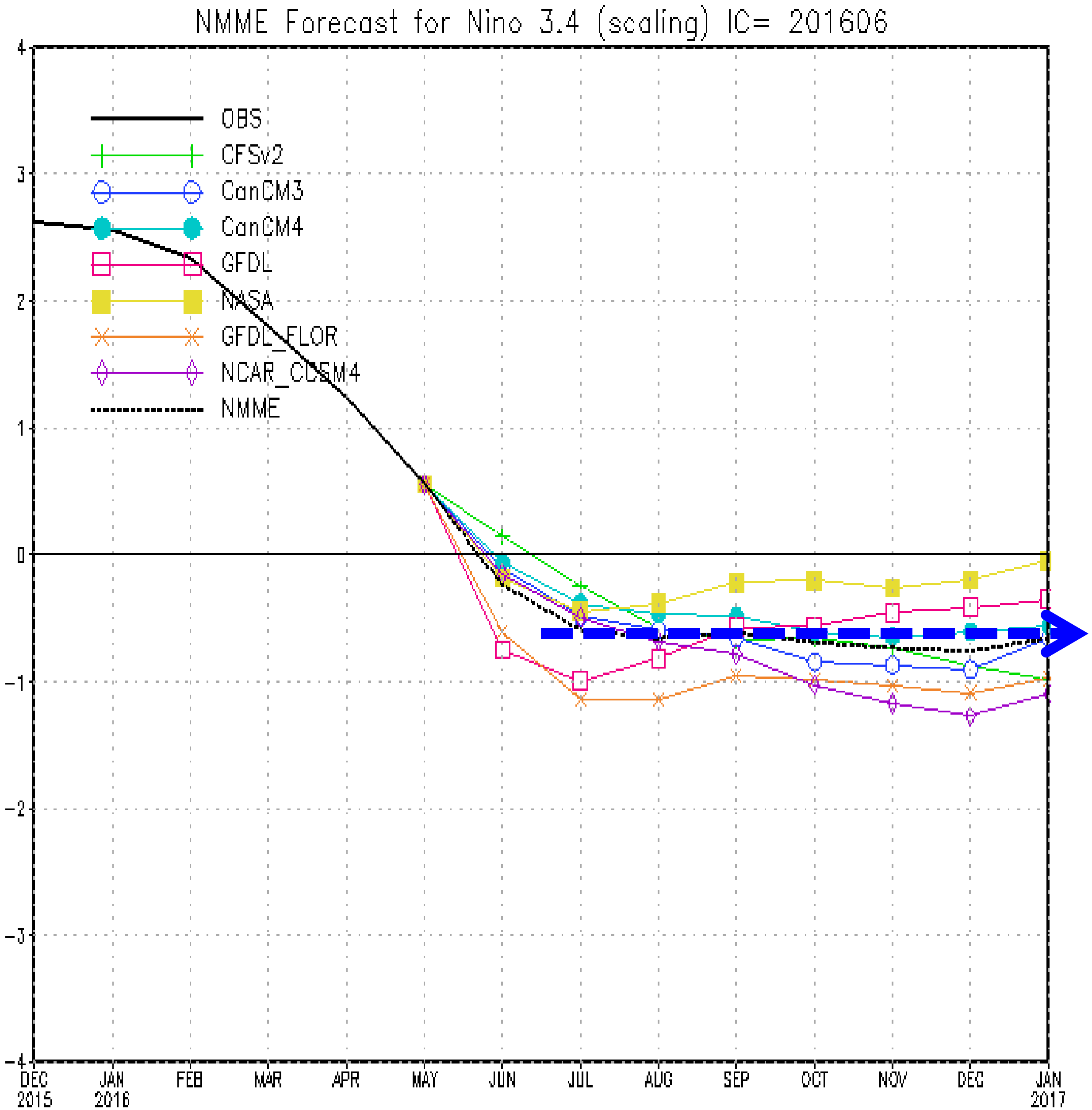


Australia: Nino3.4, IC=5 Jun 2016



UKMO: Nino3.4, IC=Jun 2016

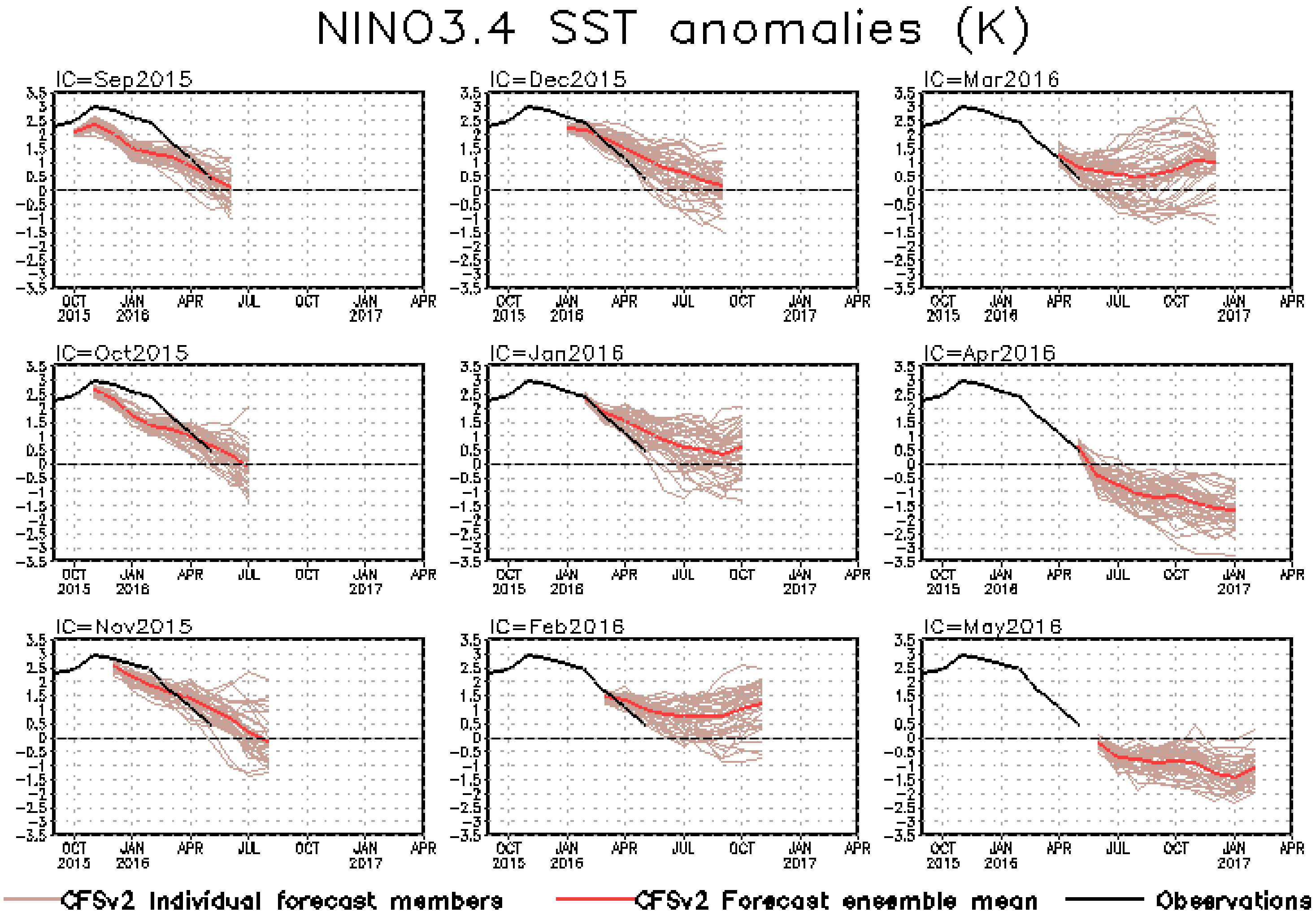




- **NMME models suggest a transition to weak La Nina conditions in later summer and fall.**

- **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.**

CFS Niño3.4 SST Predictions from Different Initial Months



- CFSv2 predicted a La Nina started from second half 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)

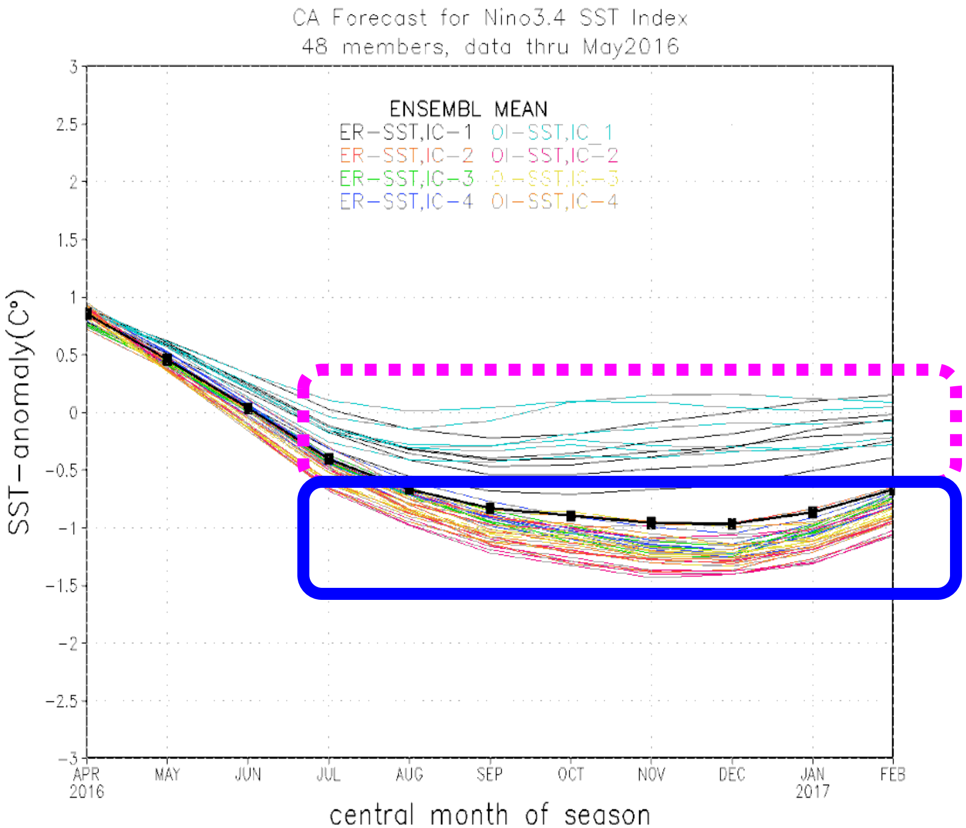
- ❑ Use weighted average of historical data to approximate current data (IC);
- ❑ The weights are obtained by minimizing the RMS error;
- ❑ Construct forecast by applying the weights to the lagged data in history

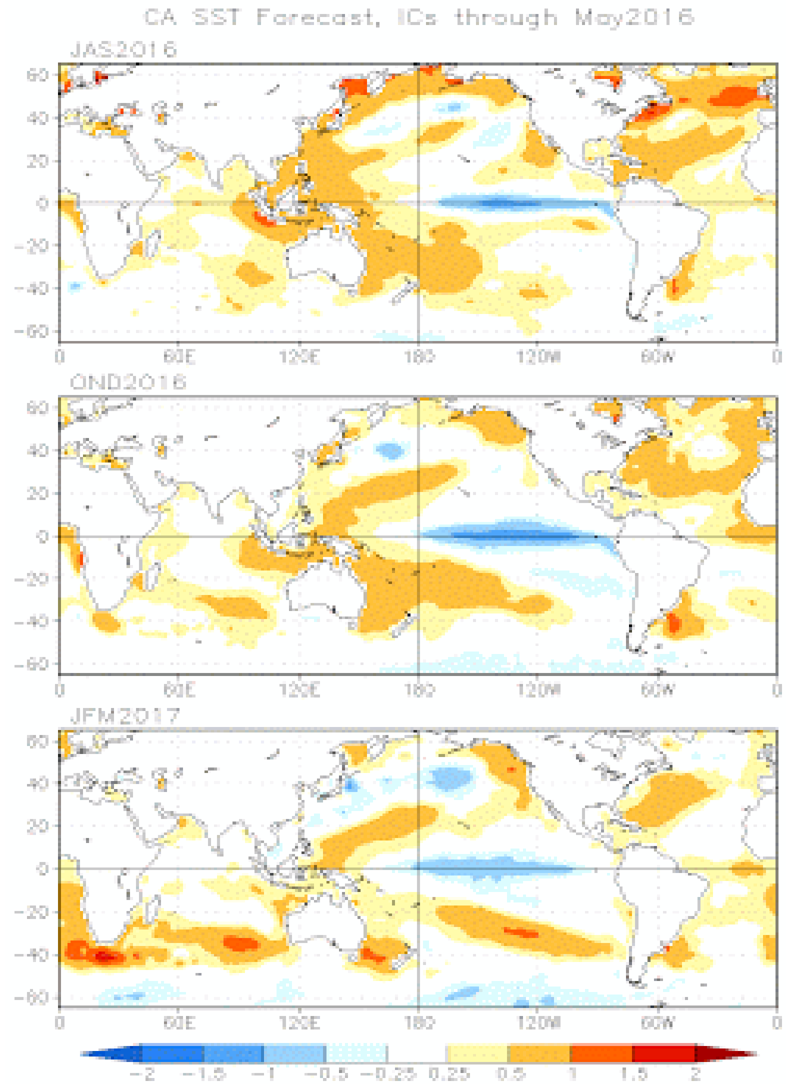
1. Use both HAD-OI SST and ERSST since 1948;
2. Choose EOF truncations at 20, 25, 30, 40, 50, 60;
3. Have season number 1 to 4 in ICs;

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

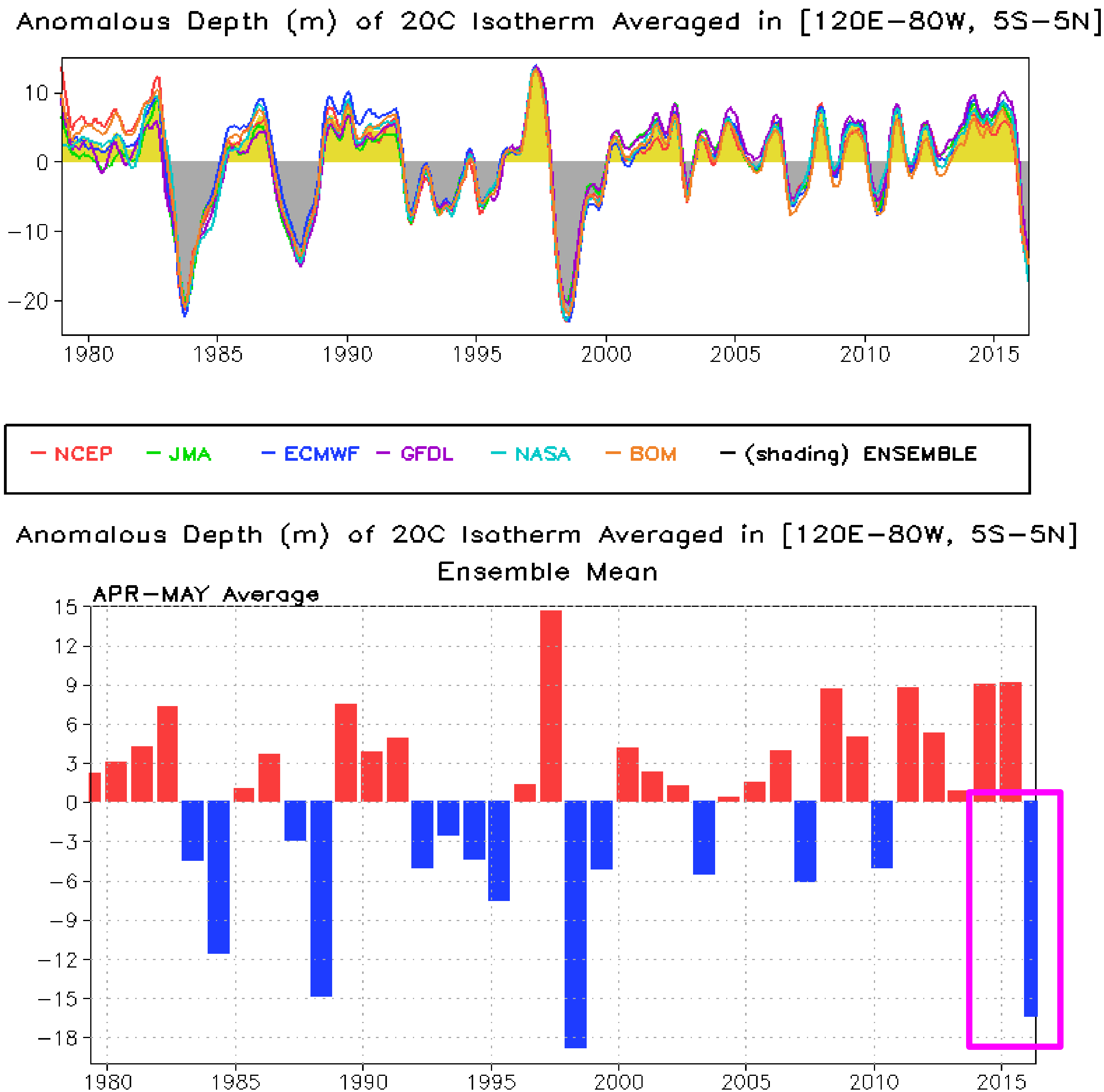
CA 48-member Ensemble Forecast for SST

(From Peitao.peng@noaa.gov)





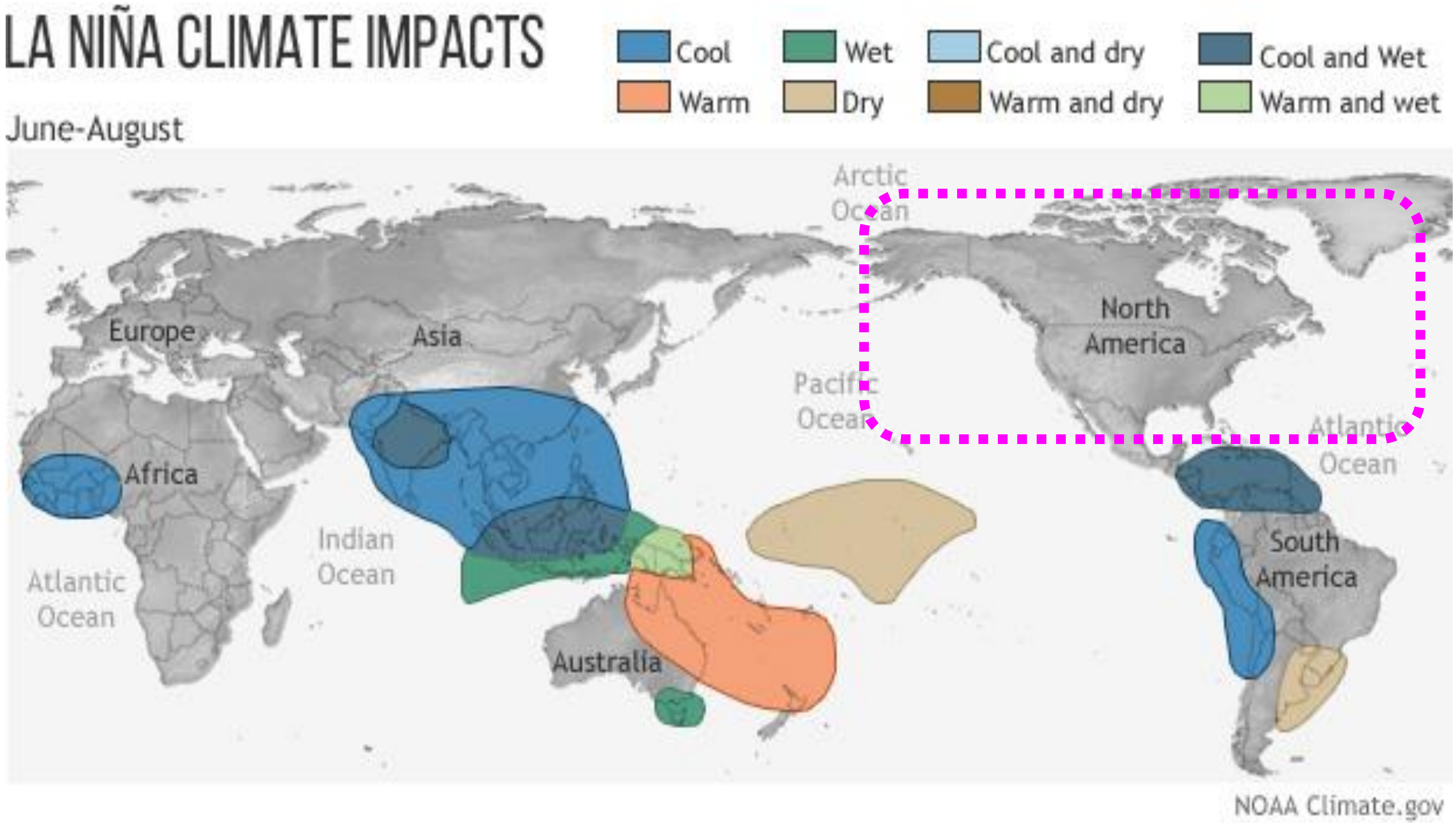
Neutral or weak & moderate La Nina is expected for 2016/17 winter



The WWV for Apr-May 2016 is the second lowest after 1998 since 1979.

La Nina Impacts in JJA: Little impact on USA

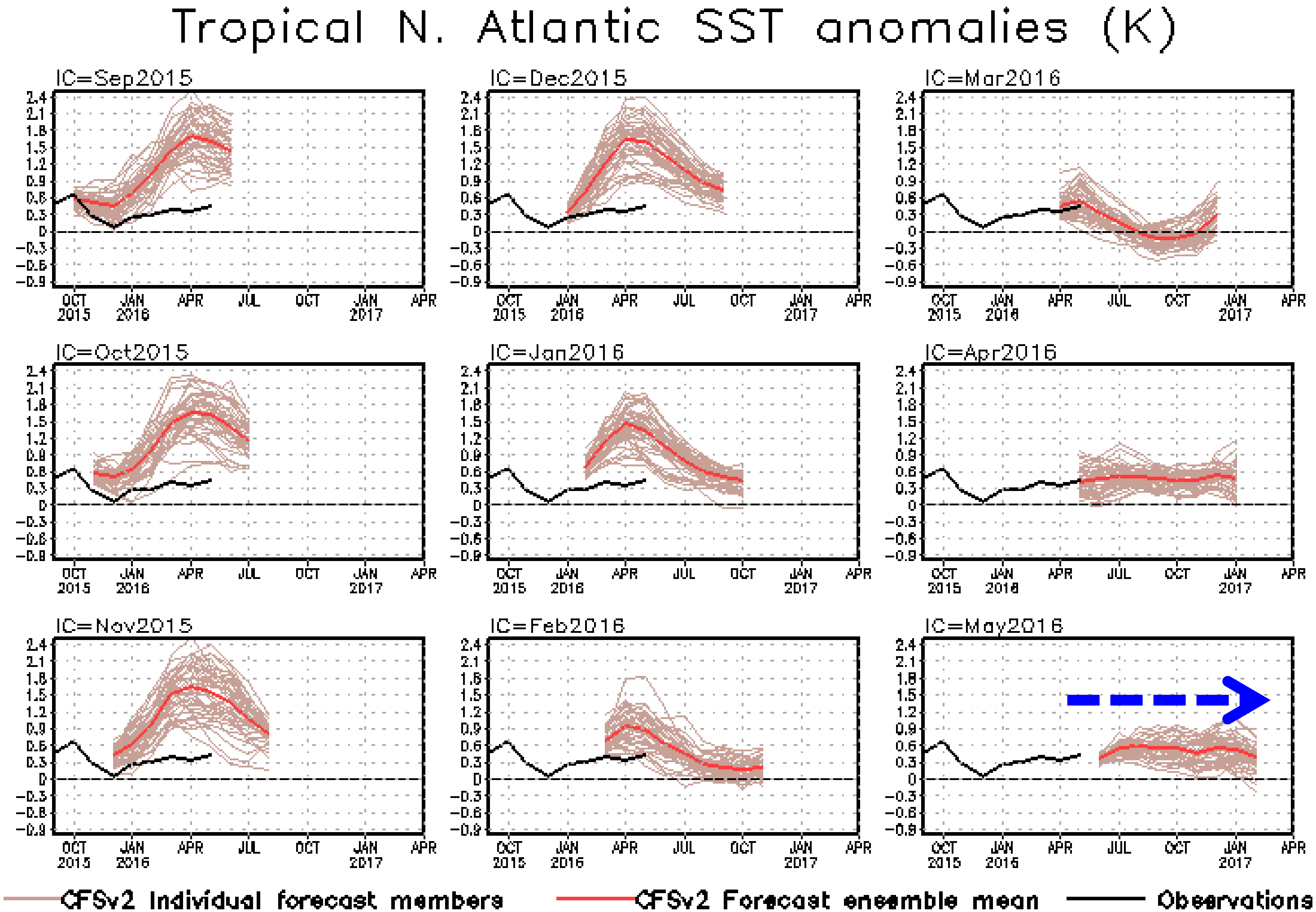
(Emily Becker: May 2016 El Niño/La Niña update: Switcheroo!)



https://www.climate.gov/news-features/blogs/enso/may-2016-el-ni%C3%B1ola-ni%C3%B1a-update-switcheroo

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

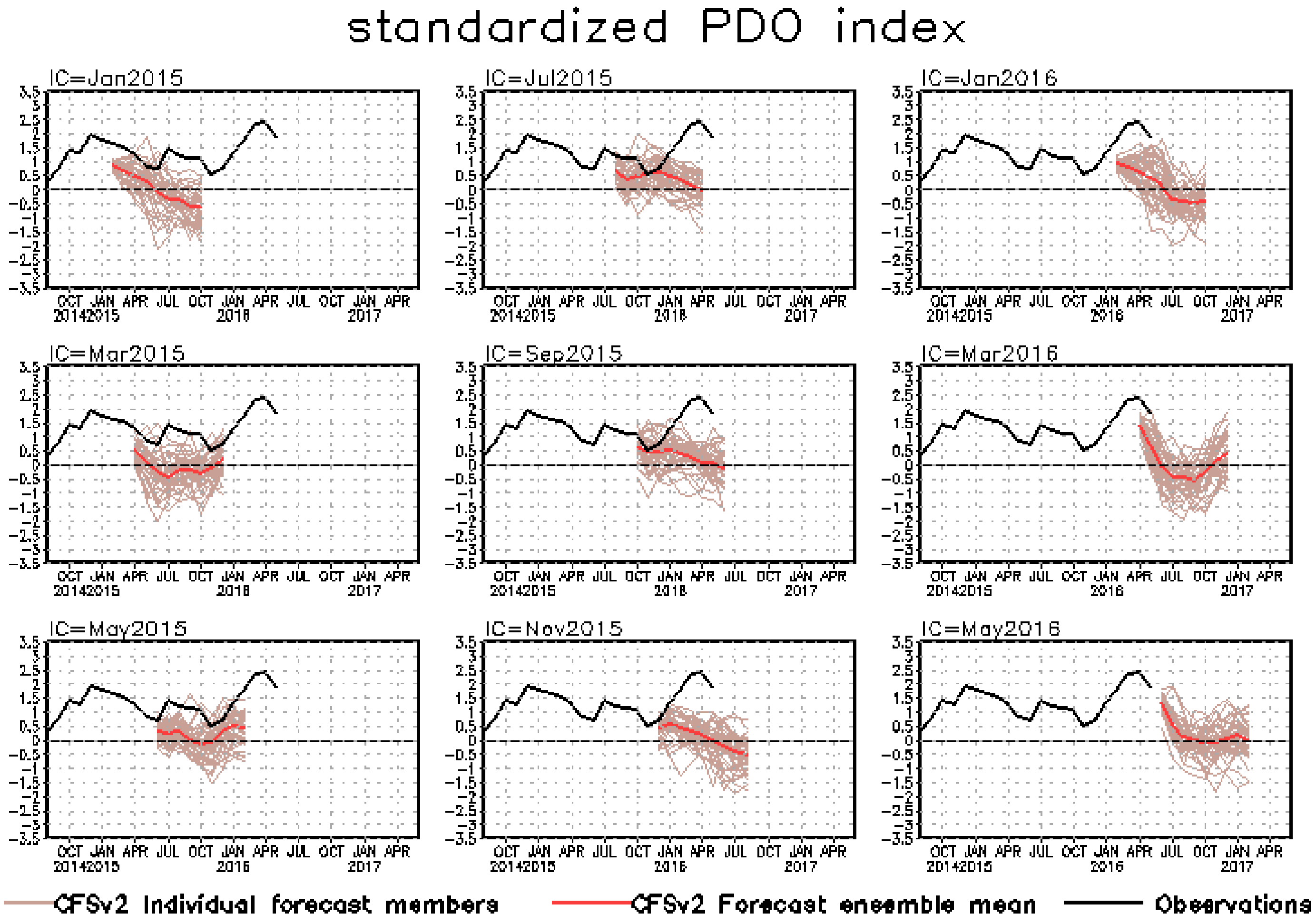
TNA is the SST anomaly averaged in the region of [60°W-30°W, 5°N-20°N].



- Latest CFSv2 predictions call slightly above normal SSTA in tropical N. Atlantic in summer and autumn 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

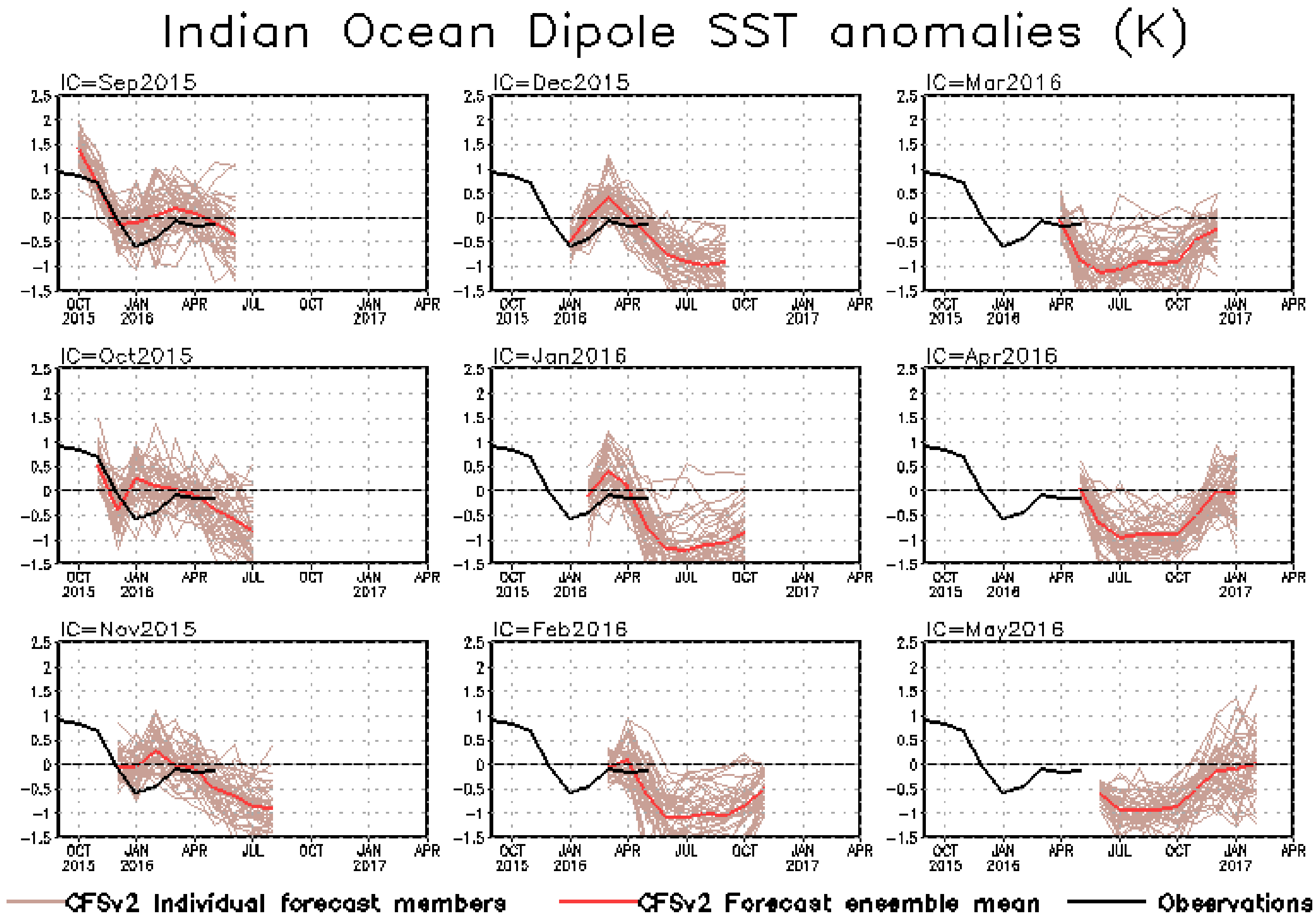


PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

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 [90°E-110°E, 10°S-0]

WTIO = SST anomaly in [50°E-70°E, 10°S-10°N]

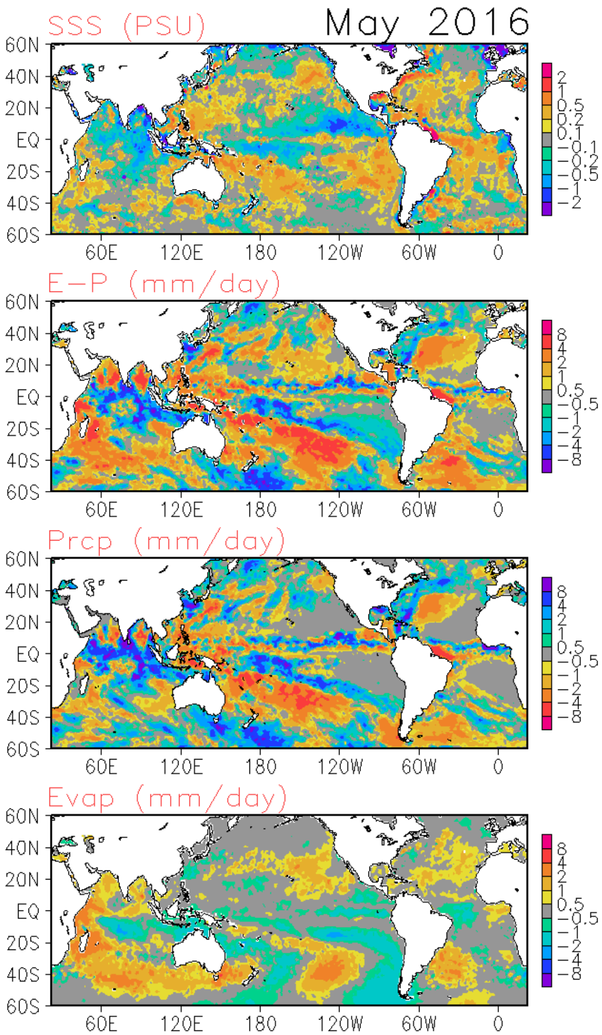
Fig. M2. CFS Dipole Model Index (DMI) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast 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.

Backup Slides

Global Sea Surface Salinity (SSS)

Anomaly for May 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 and negative anomaly in the western 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 is likely caused by ocean current advection since the precipitation is decreased and the evaporation is increased 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

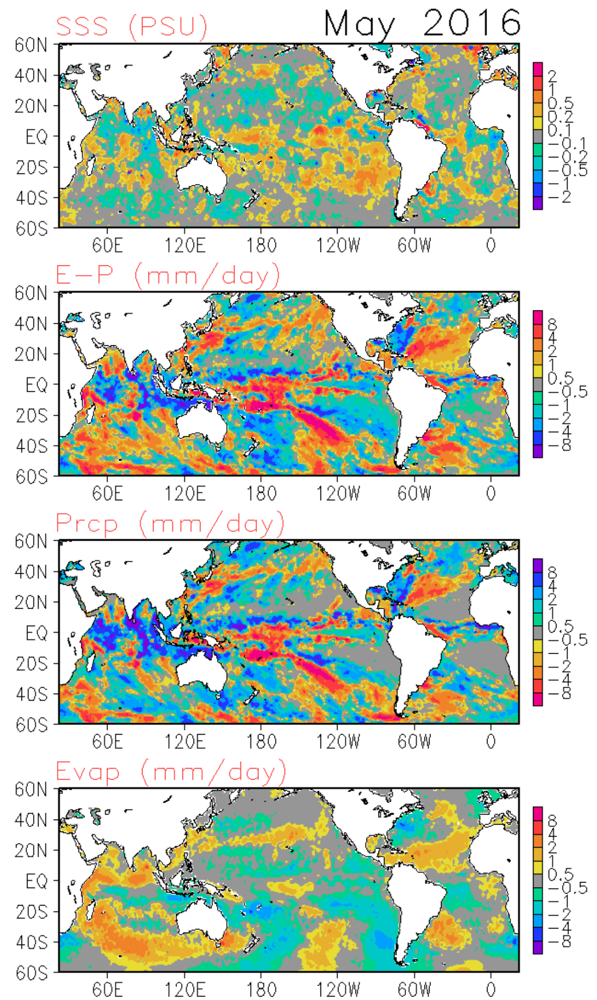
  Evaporation:

  CFS Reanalysis

Global Sea Surface Salinity (SSS)

Tendency for May 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. Negative SSS anomalies continue in the Eastern Equatorial Pacific region north of Equator where positive precipitation anomalies are found. SSS becomes fresher in the majority of the North Indian Ocean, which is likely caused by positive precipitation anomalies. In the subtropics of the North Pacific Ocean, the SSS becomes fresher, partly due to the positive precipitation anomalies. The decreasing of the evaporation in both the west and east South Pacific Ocean regions producing two horseshoe patterns with a positive anomalies between them

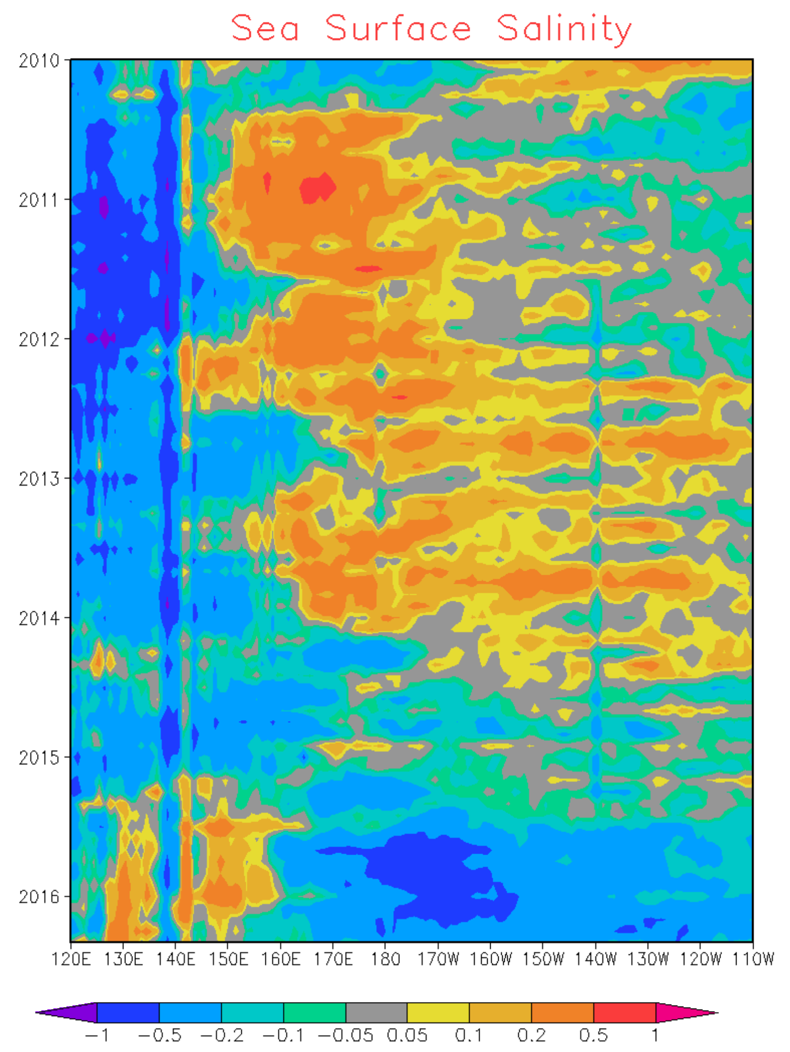


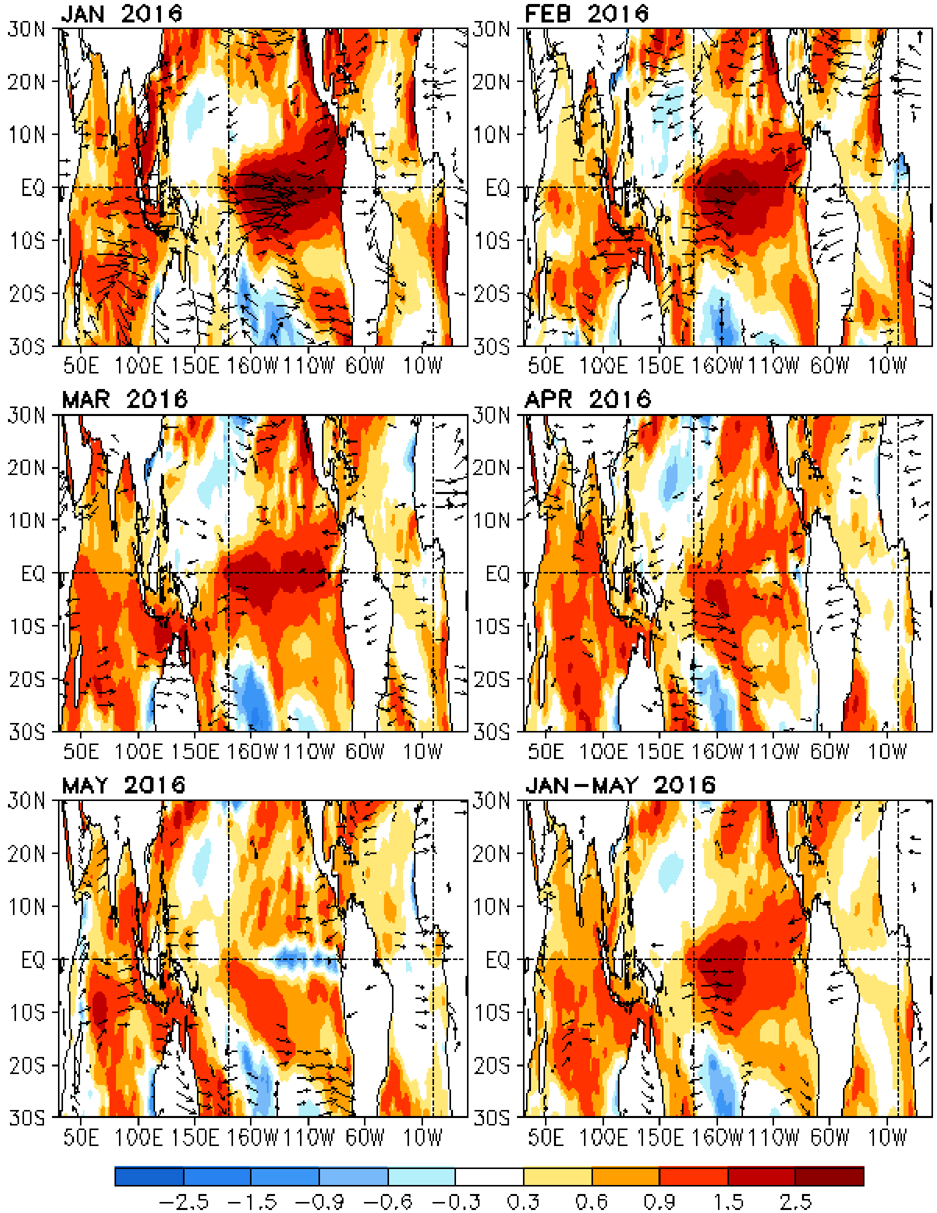
Global Sea Surface Salinity (SSS)

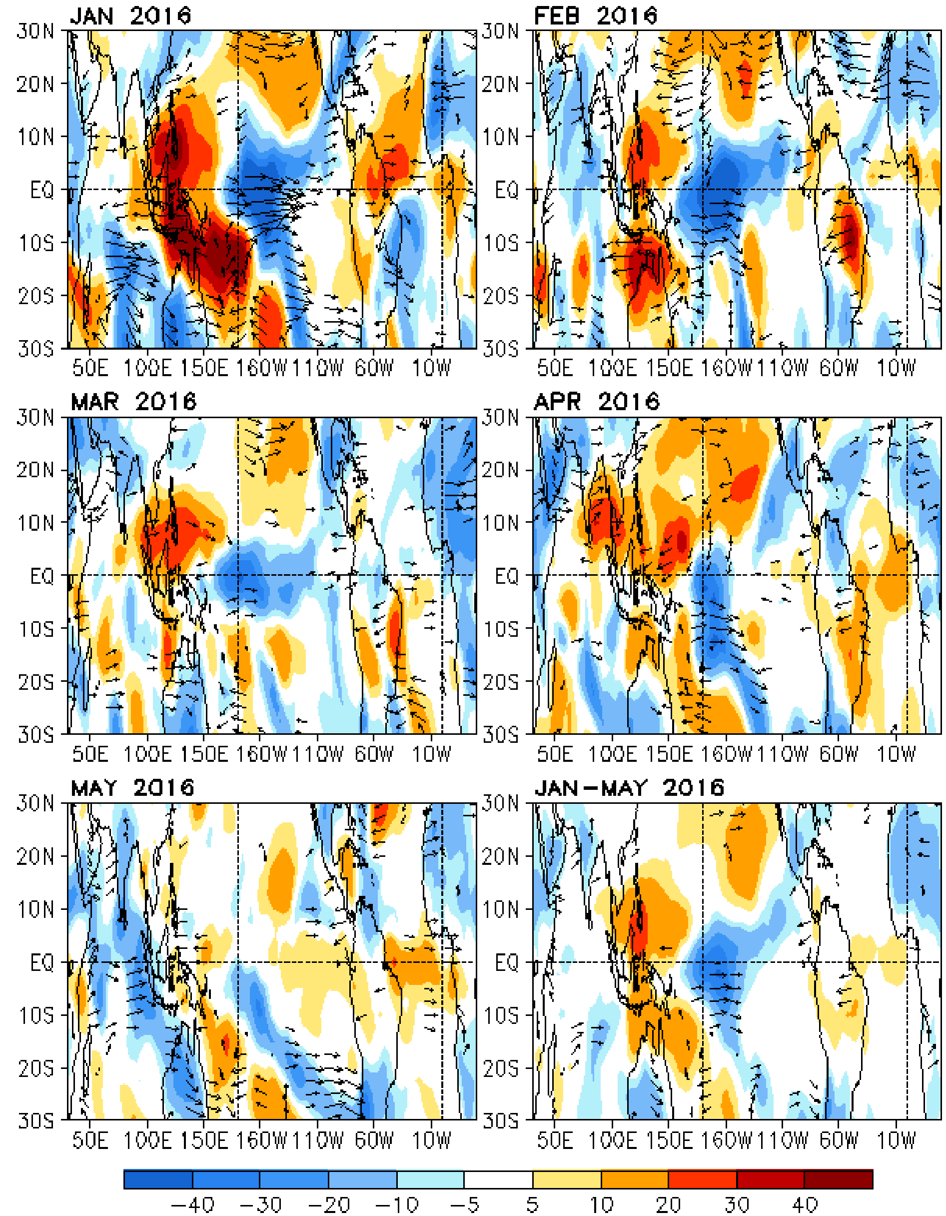
Anomaly Evolution over Equatorial Pacific

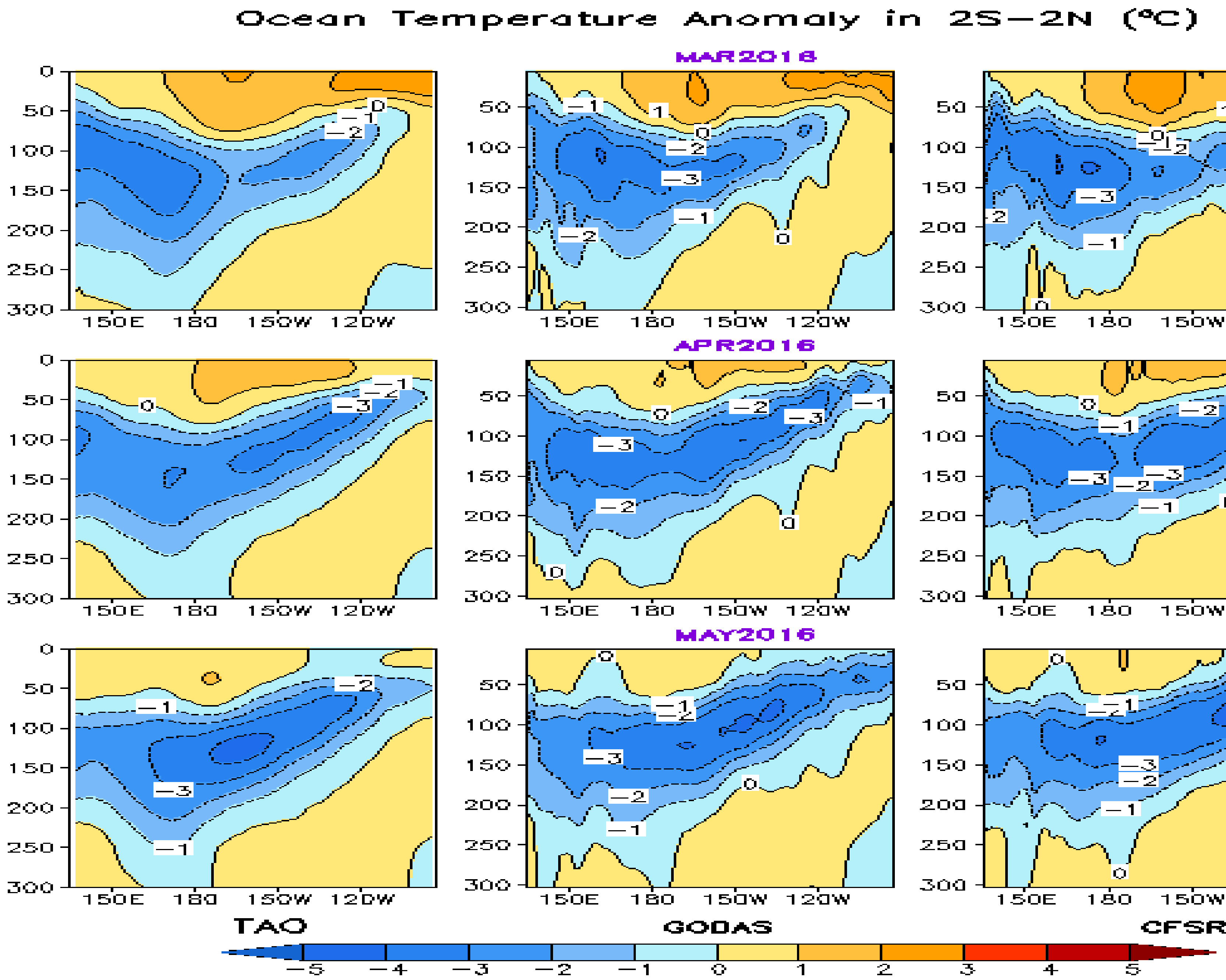
- Hovemoller diagram for equatorial SSS anomaly **(10ºS-10ºN);**

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




JAN 2016
FEB 2016
MAR 2016
APR 2016
MAY 2016
JAN−MAY 2016
30N 20N 10N EQ 10S 20S 30S
50E 100E 150E 160W 110W 60W 10W
−2.5 −1.5 −0.9 −0.6 −0.3 0.3 0.6 0.9 1.5 2.5


JAN 2016
FEB 2016
MAR 2016
APR 2016
MAY 2016
JAN−MAY 2016
30N 20N 10N EQ 10S 20S 30S
50E 100E 150E 160W 110W 60W 10W
−40 −30 −20 −10 −5 5 10 20 30 40


Ocean Temperature Anomaly in 2S-2N (°C)
MAR2016
APR2016
MAY2016
0
50
100
150
200
250
300
150E
180
150W
120W
TAO
GODAS
CFSR
-5
-4
-3
-2
-1
0
1
2
3
4
5

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

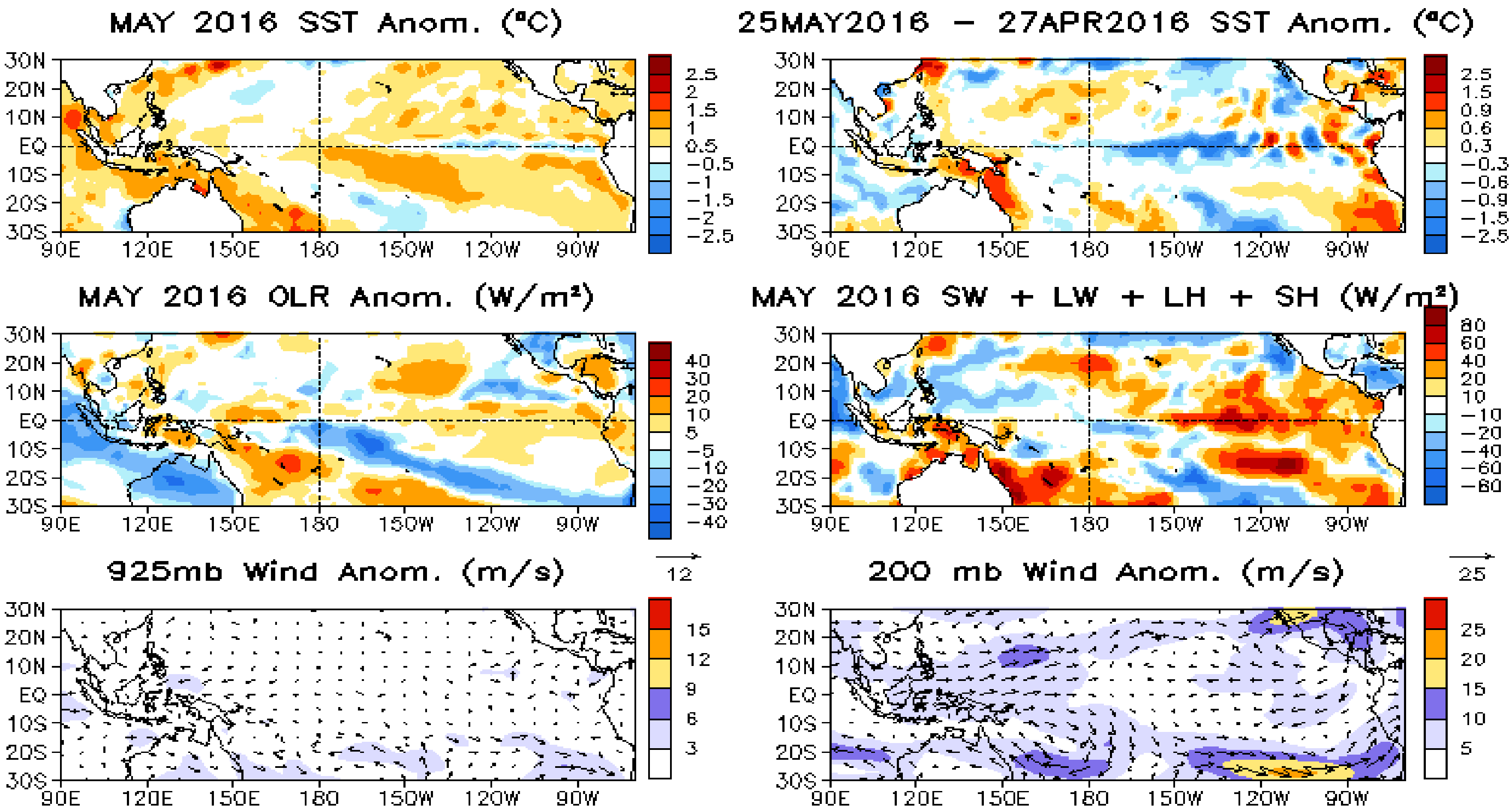


Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

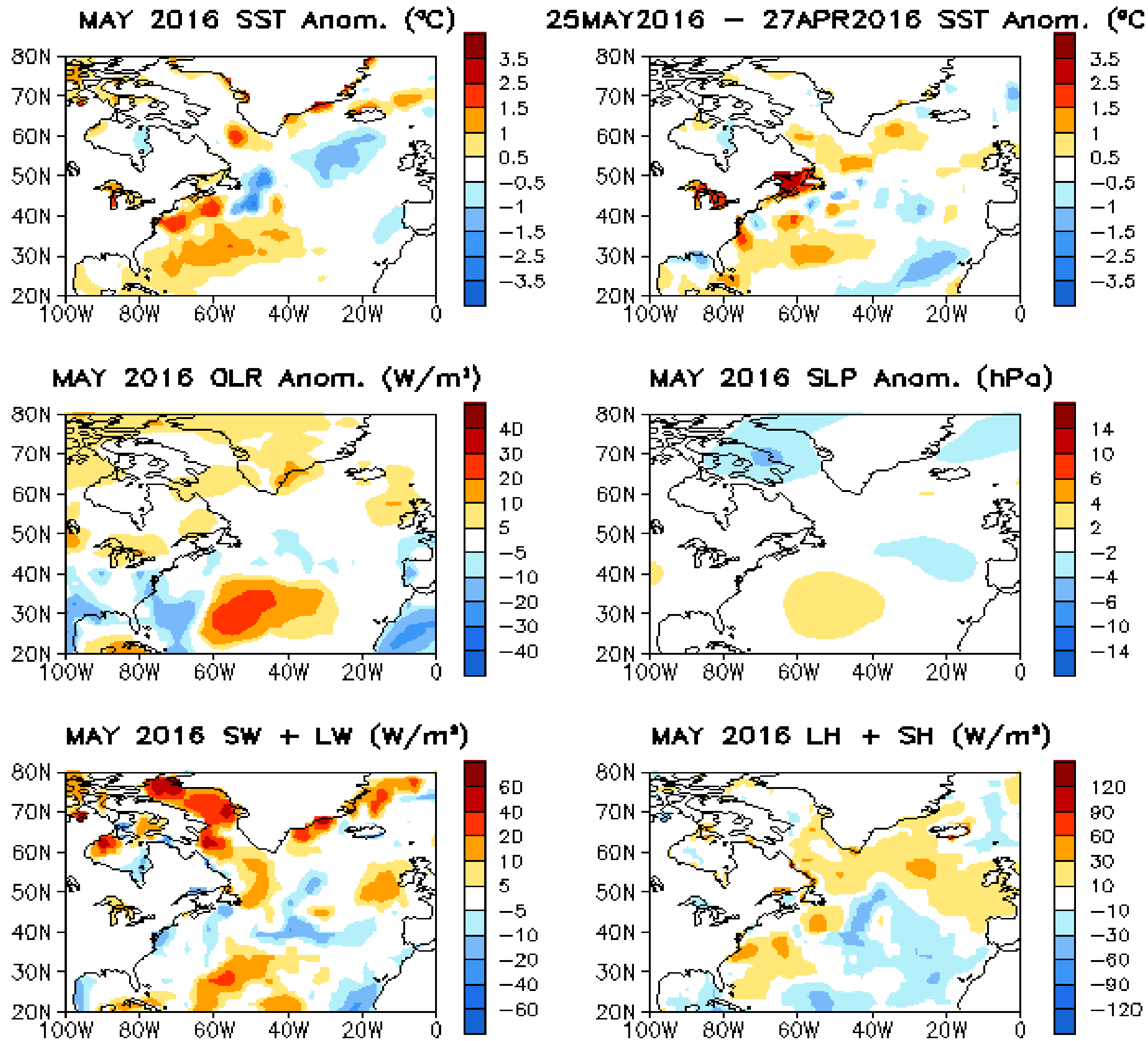


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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