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 Ocean Observing and Monitoring Division (OOMD)

Outline

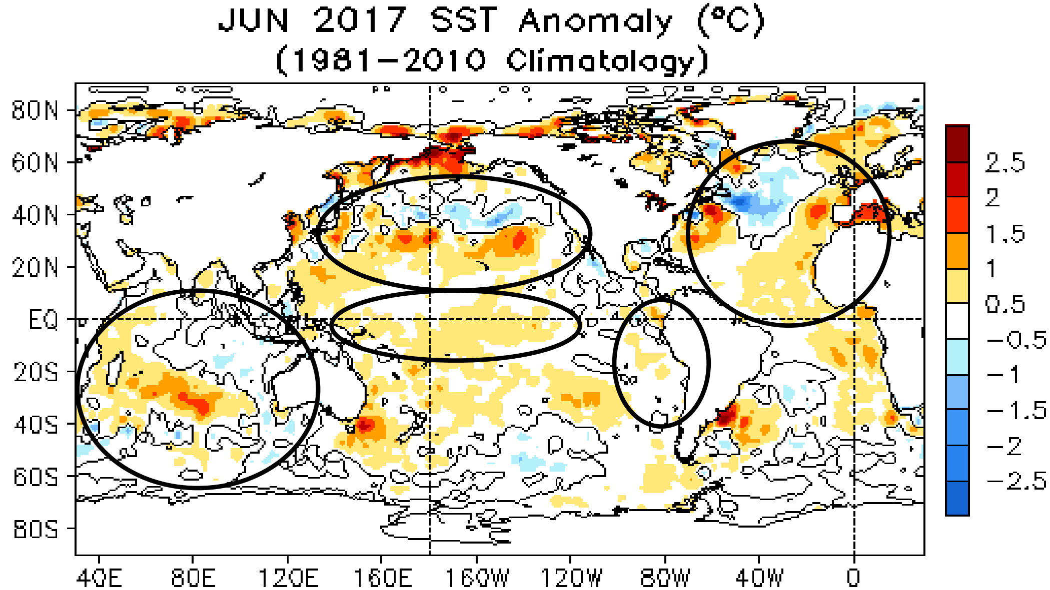
- **Overview**
- **Recent highlights**
  - ❖ Pacific/Arctic Ocean
  - ❖ Indian Ocean
  - ❖ Atlantic Ocean
- **Global SST Predictions**
  - ❖ *Review of official and model-based probabilistic ENSO forecast, NMME ENSO forecast starting from Mar-June 2017 I.C.*
  - ❖ *Two ENSO precursors based on thermocline anomaly*

Overview

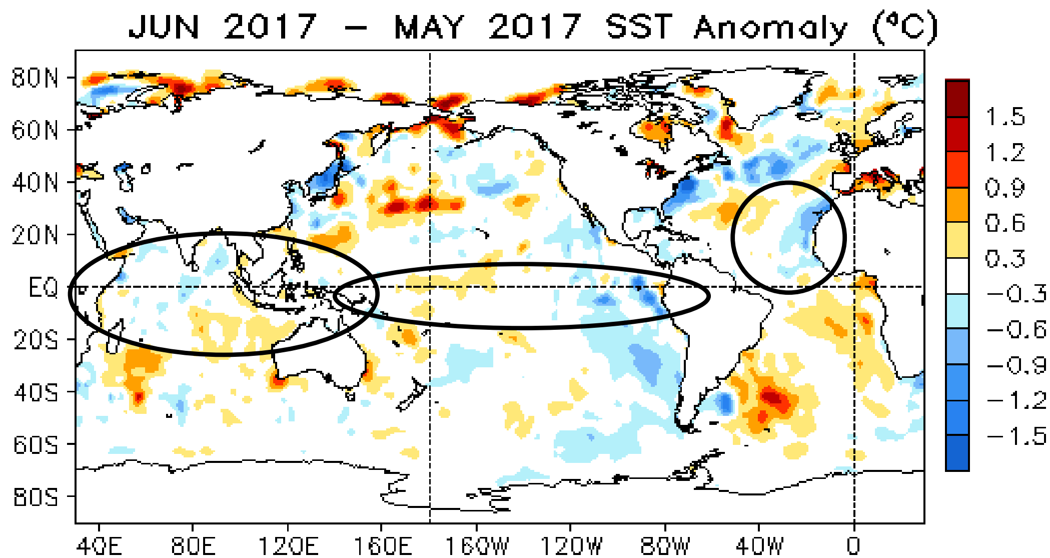
- **Pacific Ocean**
  - **NOAA "ENSO Diagnostic Discussion" on 8 June 2017 indicated *"ENSO-neutral is favored (50 to ~55% chance) through the Northern Hemisphere fall 2017."***
  - **Positive SSTAs strengthened in the central equatorial Pacific and weakened in the eastern Pacific with NINO3.4=0.6ºC in Jun 2017.**
  - **Positive (negative) ocean temperature anomalies were small and presented above (along) the thermocline in the equatorial Pacific in Jun 2017.**
  - **Positive phase of PDO has persisted for 8 months with PDOI=0.6 in Jun 2017.**
- **Indian Ocean**
  - **SSTAs were positive in the west and negative in the east in Jun 2017.**
- **Atlantic Ocean**
  - **NAO switched to positive phase again with NAOI=0.35 in Jun 2017, and SSTAs were positive in the tropical N. Atlantic.**

Global Oceans

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



- **Small SSTAs persisted in the central tropical Pacific associated with ENSO neutral, while positive SSTAs weakened in the Southern American Pacific coast connected with the decayed coastal El Nino.**
- **SSTAs in N. Pacific were associated with positive phase of PDO.**
- **Both positive and negative SSTAs were observed in N. Atlantic.**
- **In the Indian Ocean, SSTAs were positive in the west and negative in the east.**

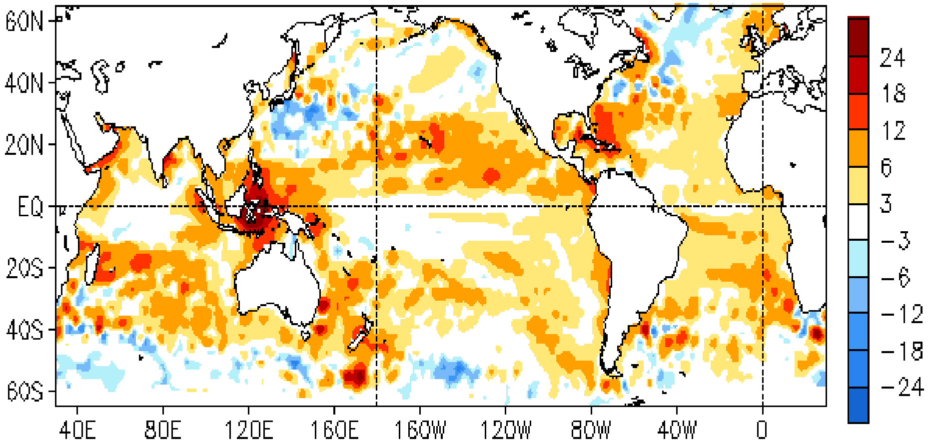


- **SSTA tendencies were positive in the central and negative in the eastern equatorial Pacific.**
- **SSTA tendencies were small in the tropical Indian Ocean.**
- **Negative SSTA tendencies presented in the tropical N. Atlantic along the African coast.**

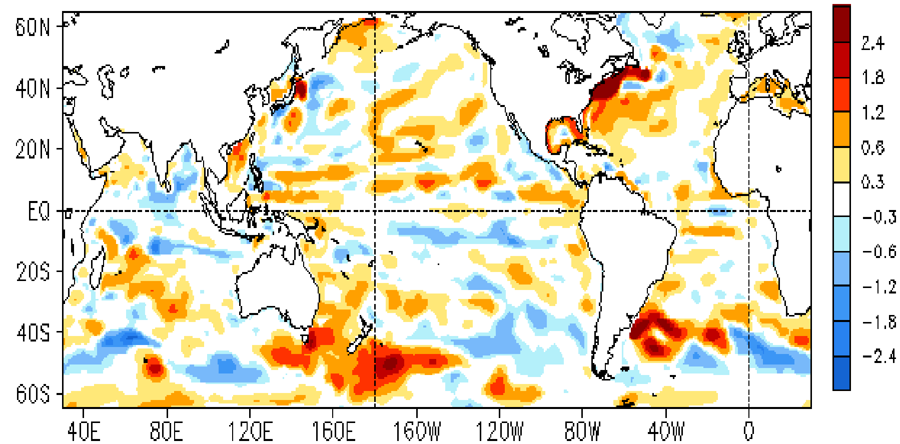
Fig. G1. Sea surface temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

Global SSH and HC300 Anomaly & Anomaly Tendency

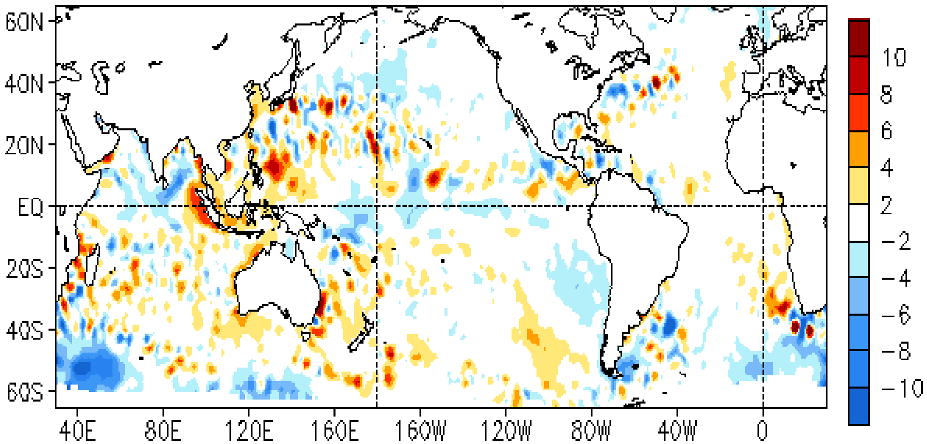
JUN 2017 SSH Anomaly (cm)
(AVISO Altimetry, Climo. 93-13)



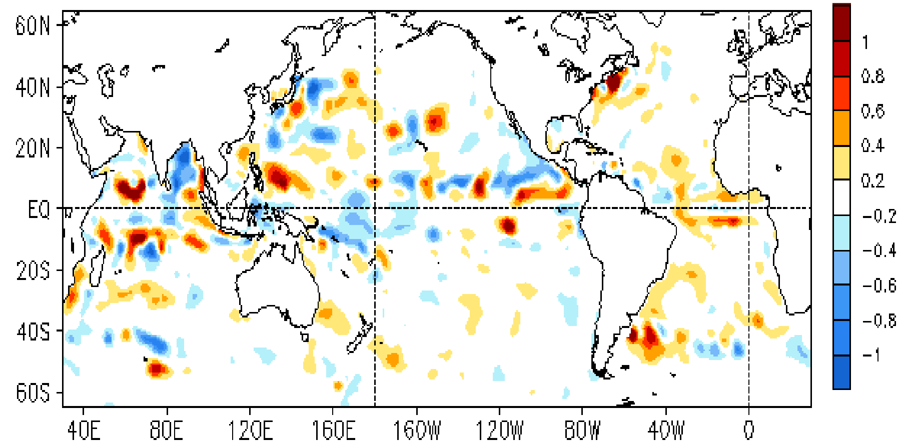
JUN 2017 Heat Content Anomaly (°C)
(GODAS, Climo. 81-10)



JUN 2017 − MAY 2017 SSH Anomaly (cm)

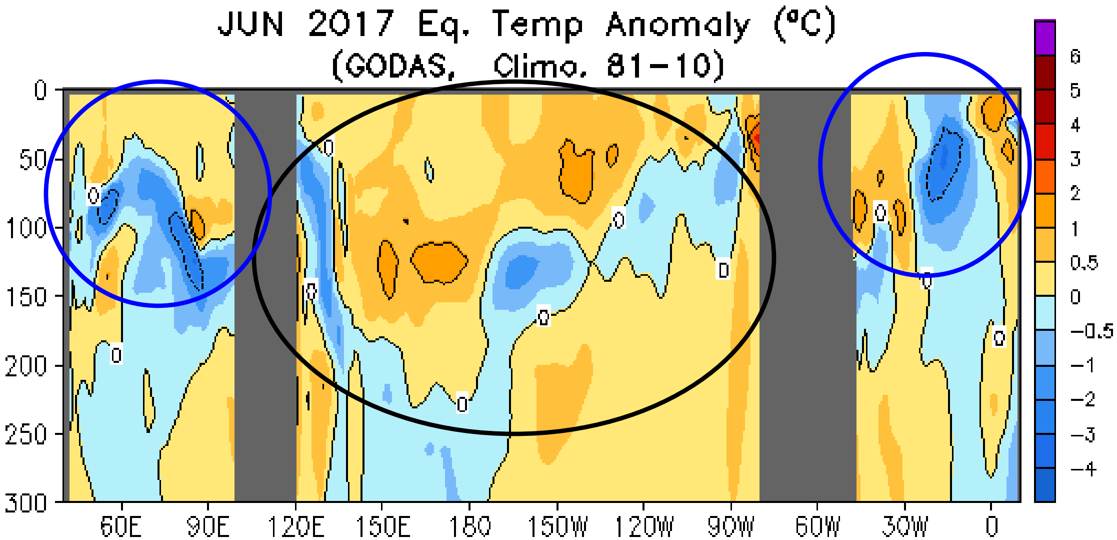


JUN 2017 − MAY 2017 Heat Content Anomaly (°C)

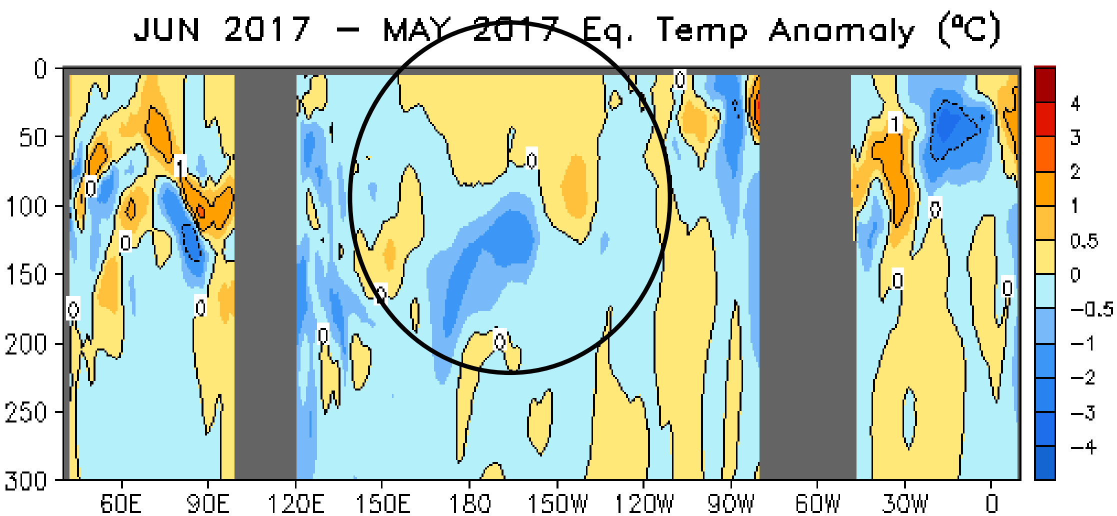


- The SSHA and HC300A had many detailed differences in Jun 2017.
- Overall, both SSHA and HC300A were small in the tropical Pacific, consisting with neutral phase of ENSO.

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



- **Positive (negative) ocean temperature anomalies were small and presented above (along) the thermocline.**
- **Both positive and negative ocean temperature anomalies were observed in the Indian and Atlantic Oceans.**



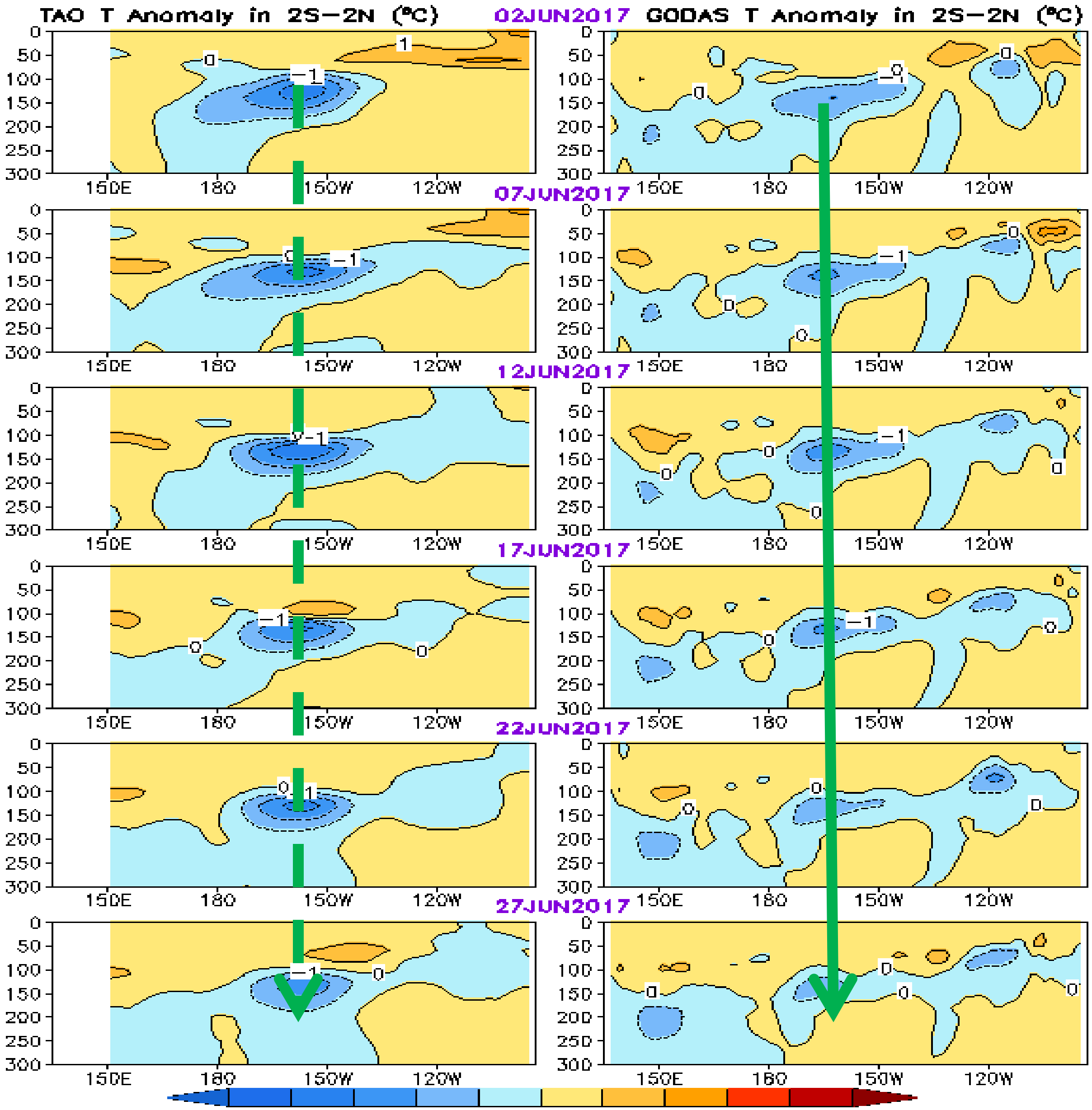
- **Ocean temperature anomaly tendencies were negative in the central Pacific along the thermocline, and positive in the central-eastern Pacific above the thermocline.**

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

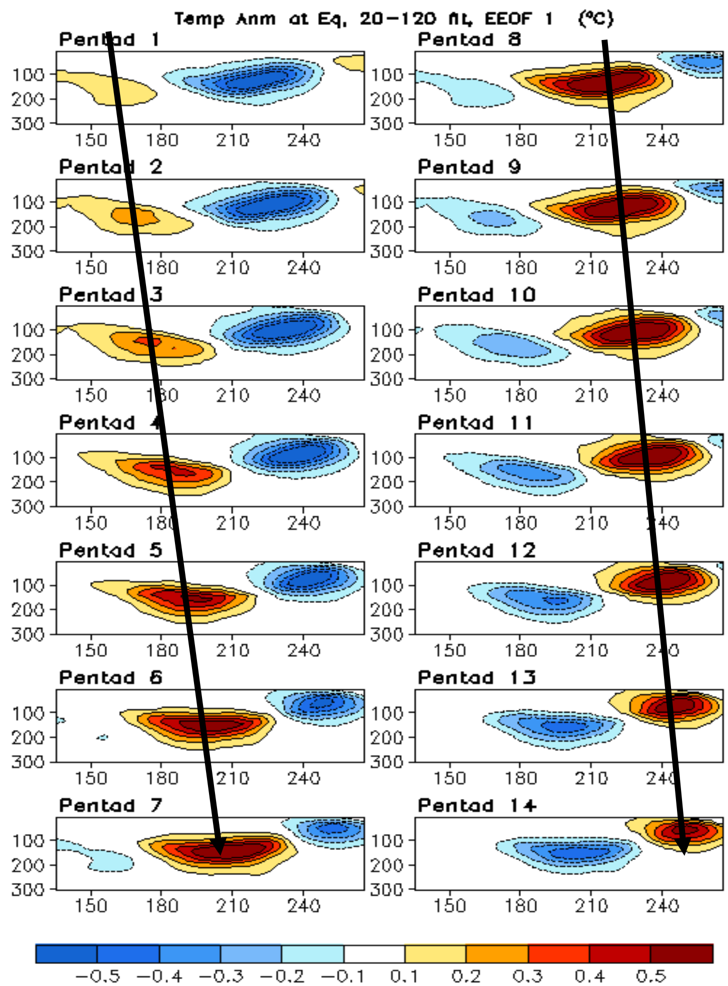
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

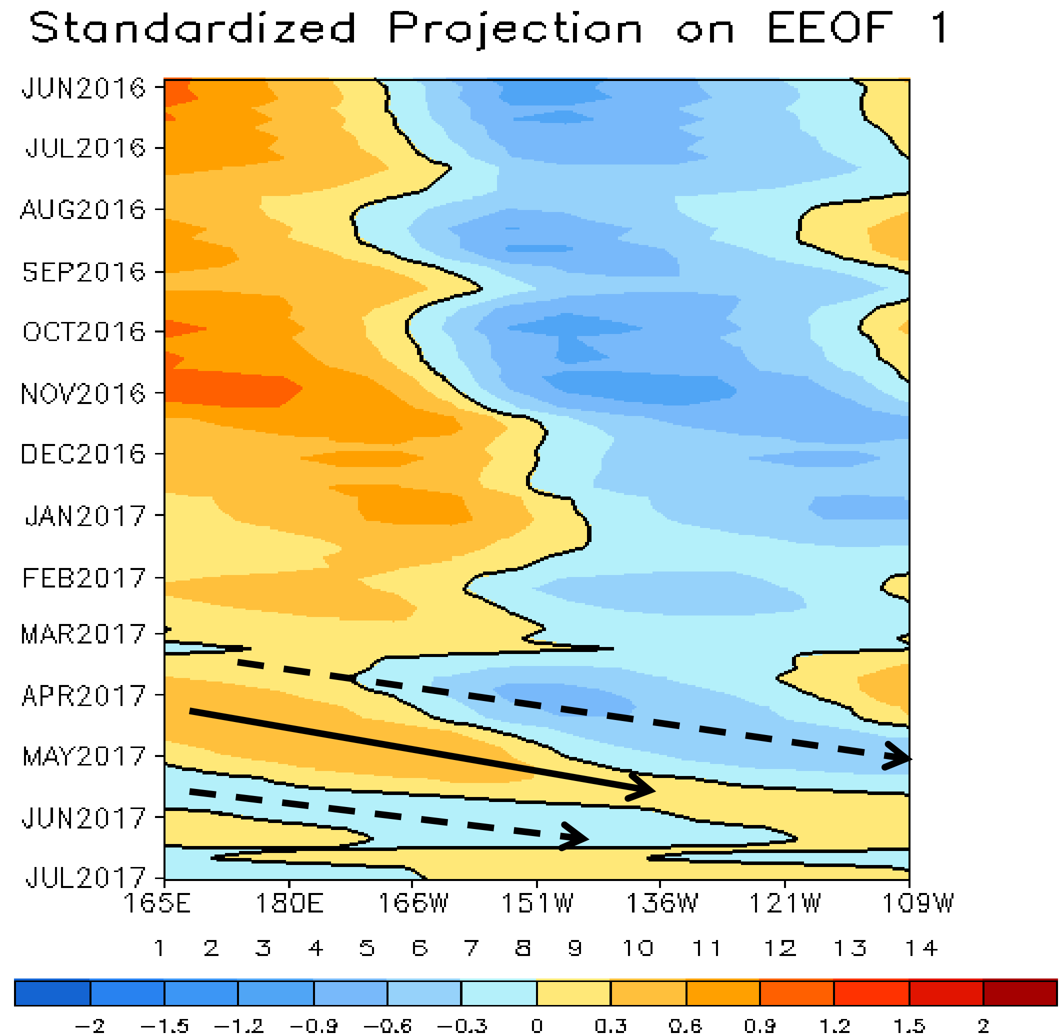
TAO GODAS



- **Negative ocean temperature anomalies presented the east-central Pacific without propagation since the pentad centered in May 18, 2017.**
- **The amplitude of the negative anomalies was larger in TAO than in GODAS.**

Oceanic Kelvin Wave (OKW) Index

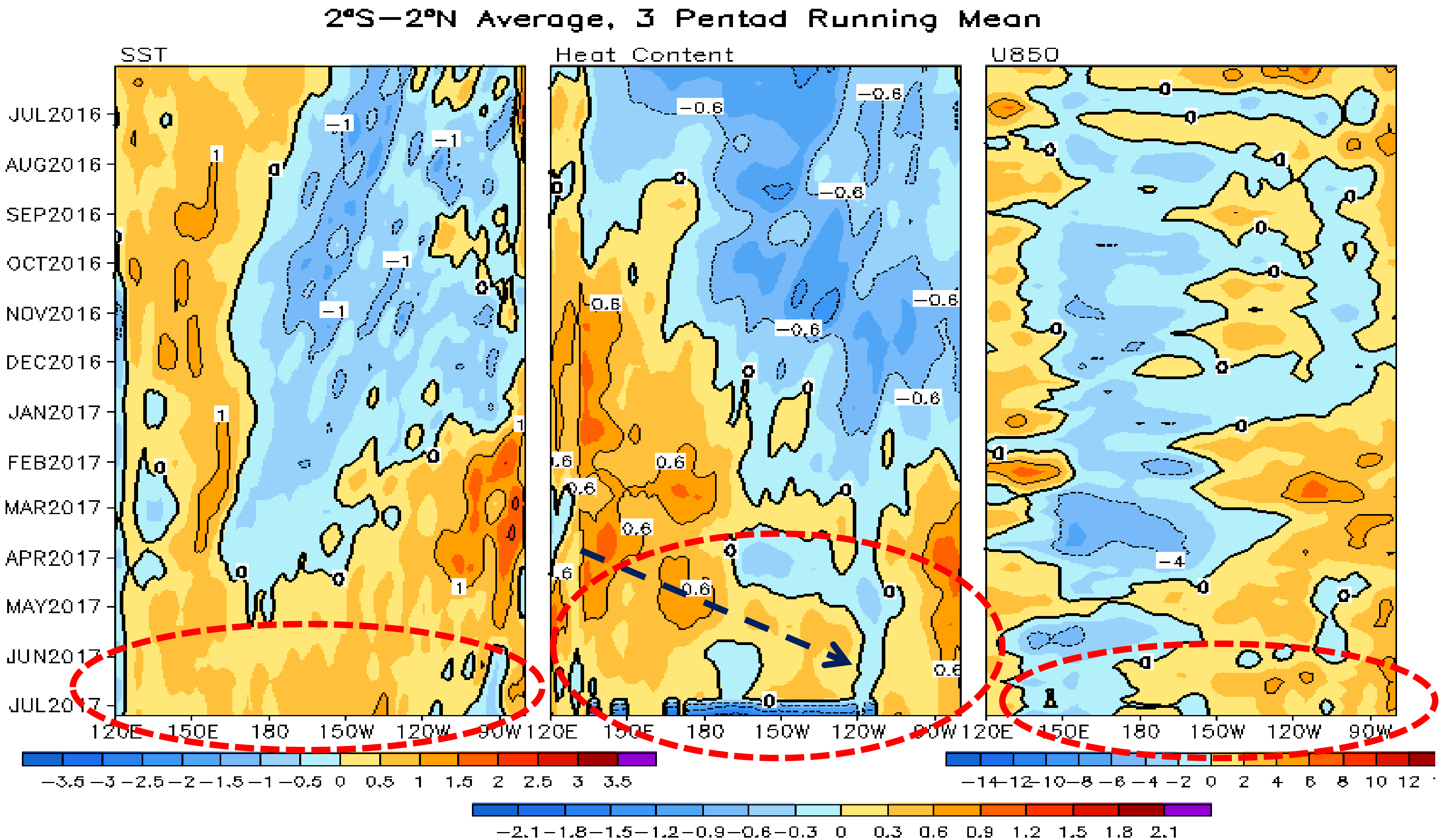




- **OKW activity was weak in last month.**

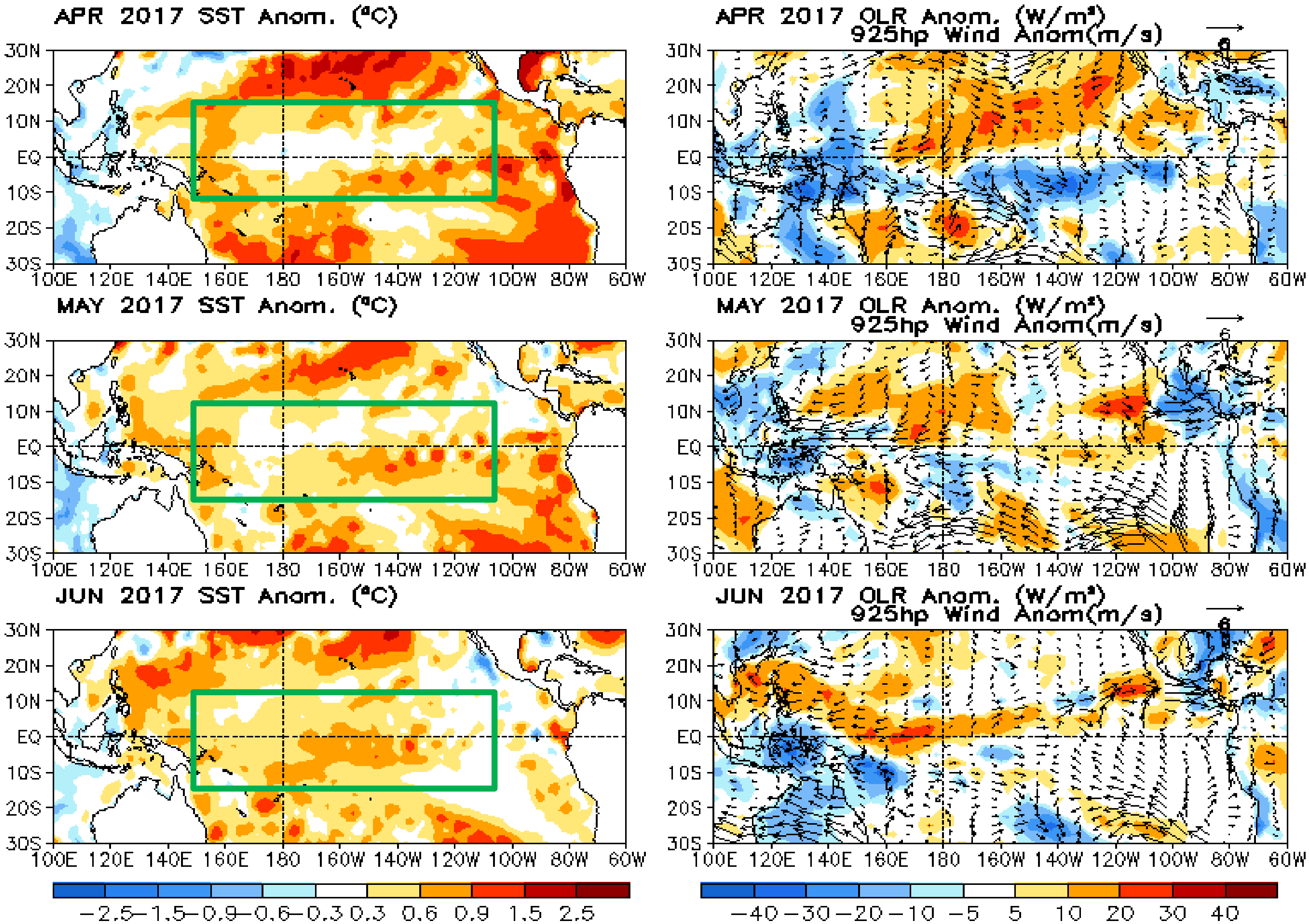
- *(OKW index is defined as standardized projections of total anomalies onto the 14 patterns of Extended EOF1 of equatorial temperature anomalies (Seo and Xue , GRL, 2005).)*

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



- **Positive SSTAs strengthened in the central and weakened in the eastern tropical Pacific in last month.**
- **Positive HC300A weakened in the western Pacific, and persisted in the eastern Pacific in last month.**
- **Low-level wind anomalies were weak westerly in the eastern equatorial Pacific and small in the western Pacific in Jun 2017.**

- Positive SSTAs strengthened in the central and weakened in the eastern tropical Pacific.



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

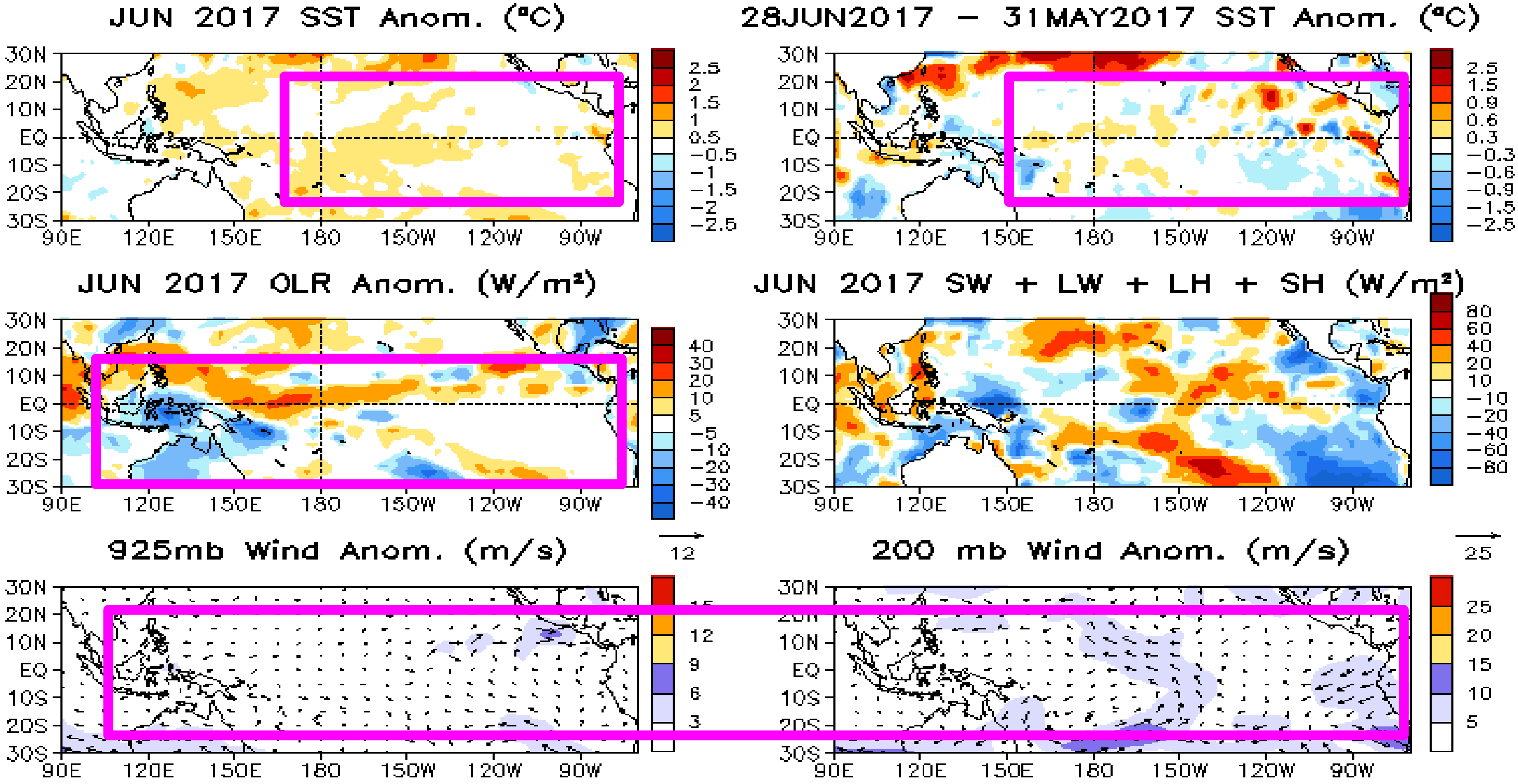
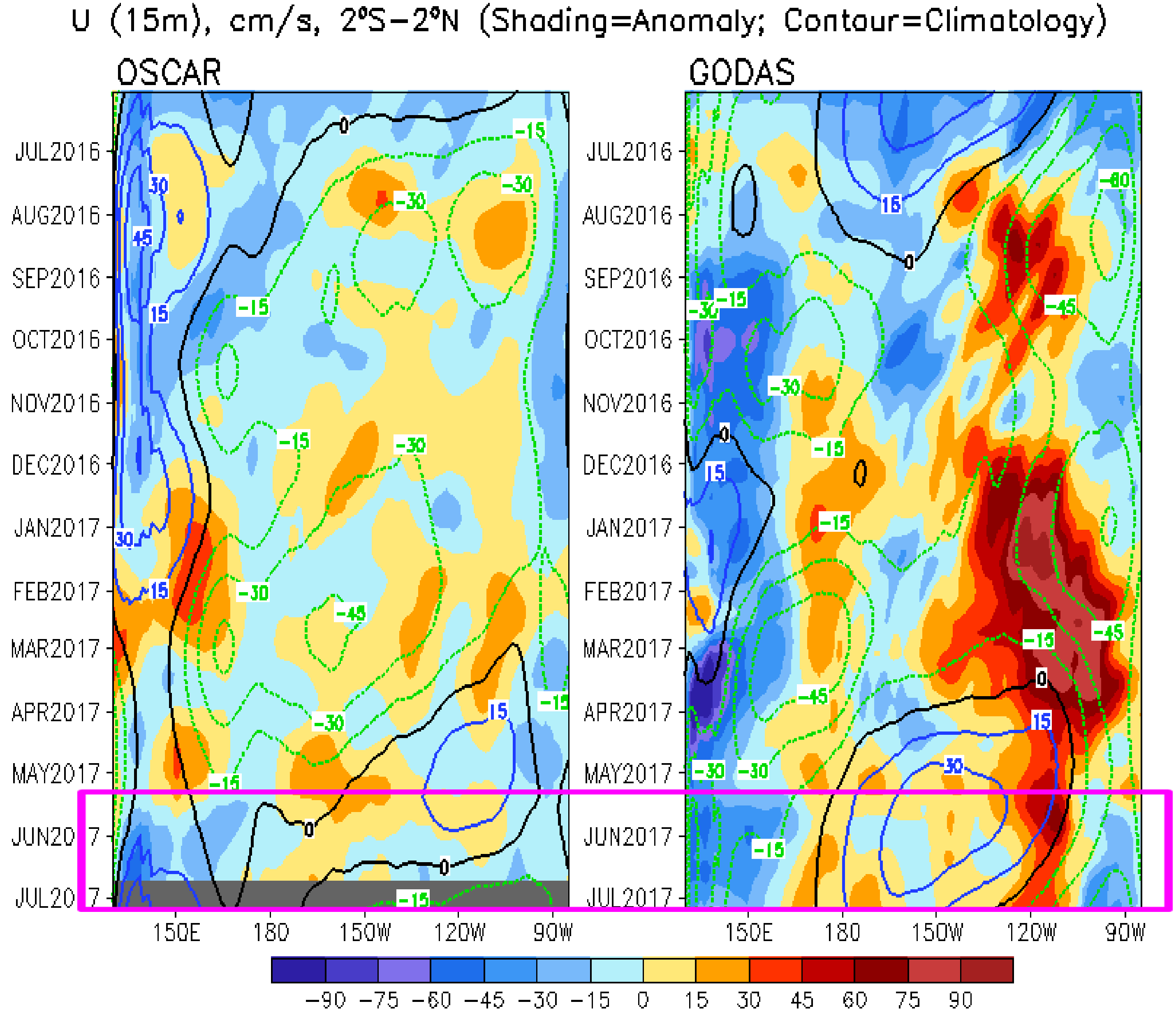


Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

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



- The anomalous currents showed large differences between OSCAR and GODAS during Nov 2016 – Apr 2017.

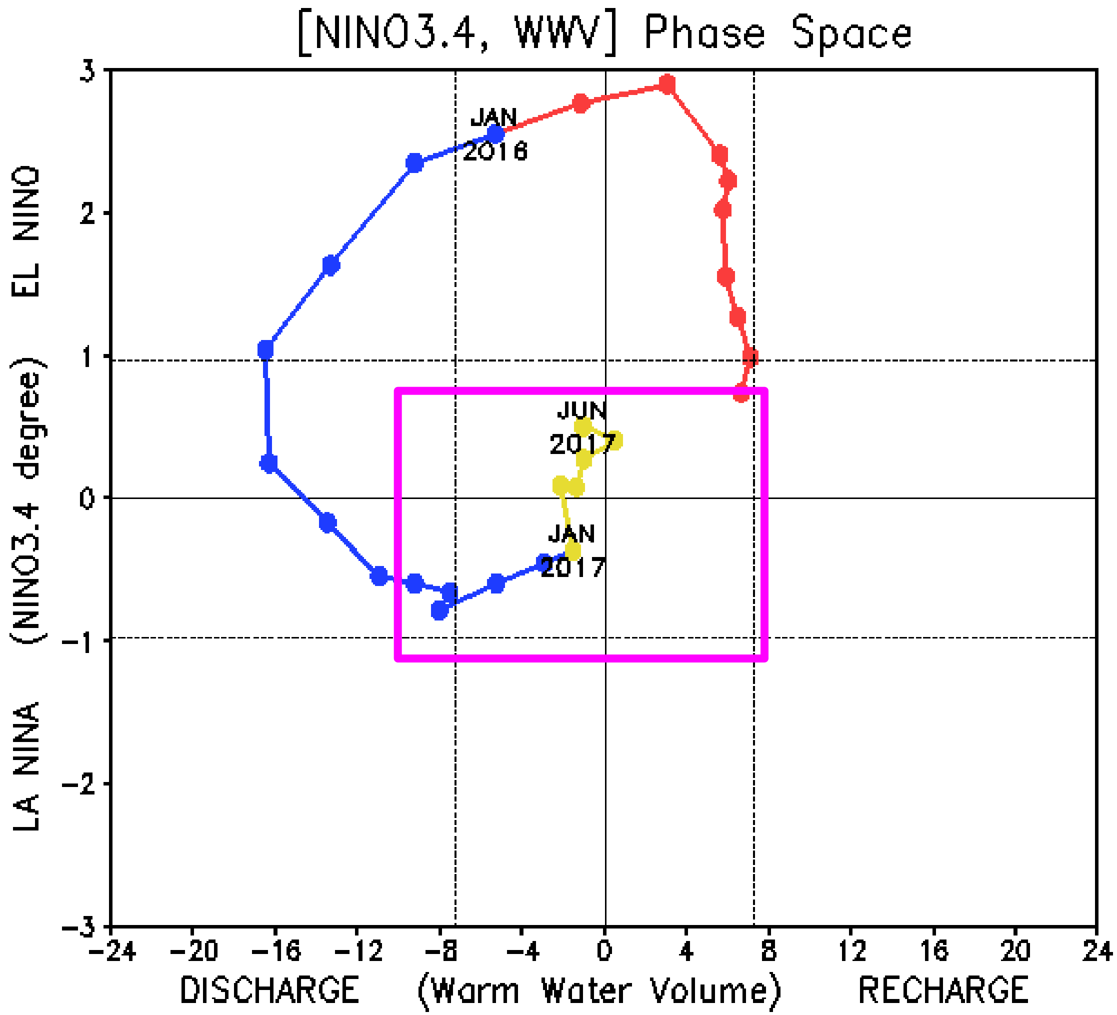
- Current anomalies were small in last 2 months.

Warm Water Volume (WWV) and NINO3.4 Anomalies

- WWV is defined as average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN]. Statistically, peak correlation of Nino3 with WWV occurs at 7 month lag (Meinen and McPhaden, 2000).

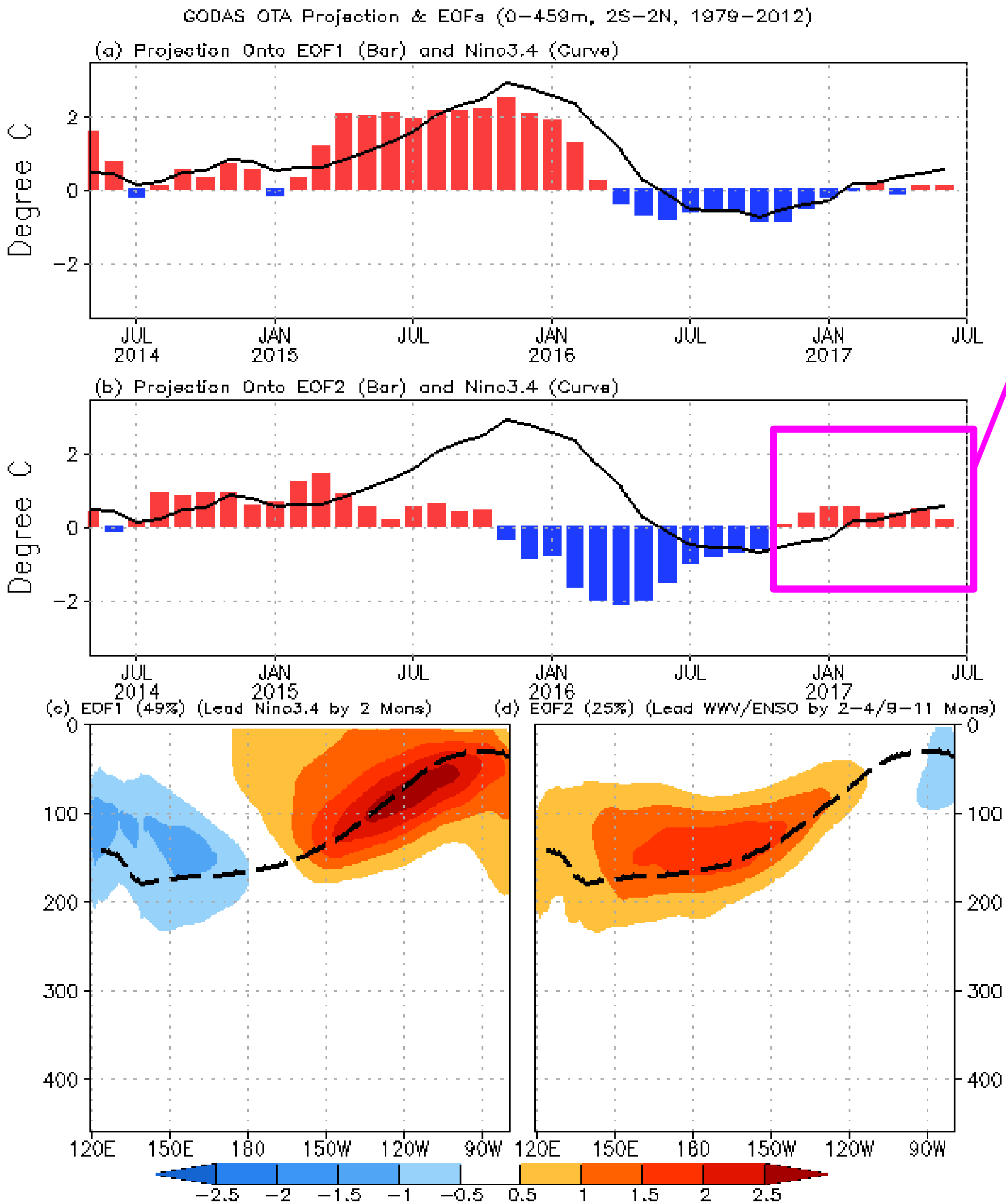
- Since WWV is intimately linked to ENSO variability (Wyrtki 1985; Jin 1997), it is useful to monitor ENSO in a phase space of WWV and NINO3.4 (Kessler 2002).

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



- Equatorial Warm Water Volume (WWV) has been small since Dec 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.



Equatorial subsurface ocean temperature monitoring: Right now, ENSO was in recharge phase since Nov 2016.

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

EOF1: Tilt mode (ENSO peak phase);

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

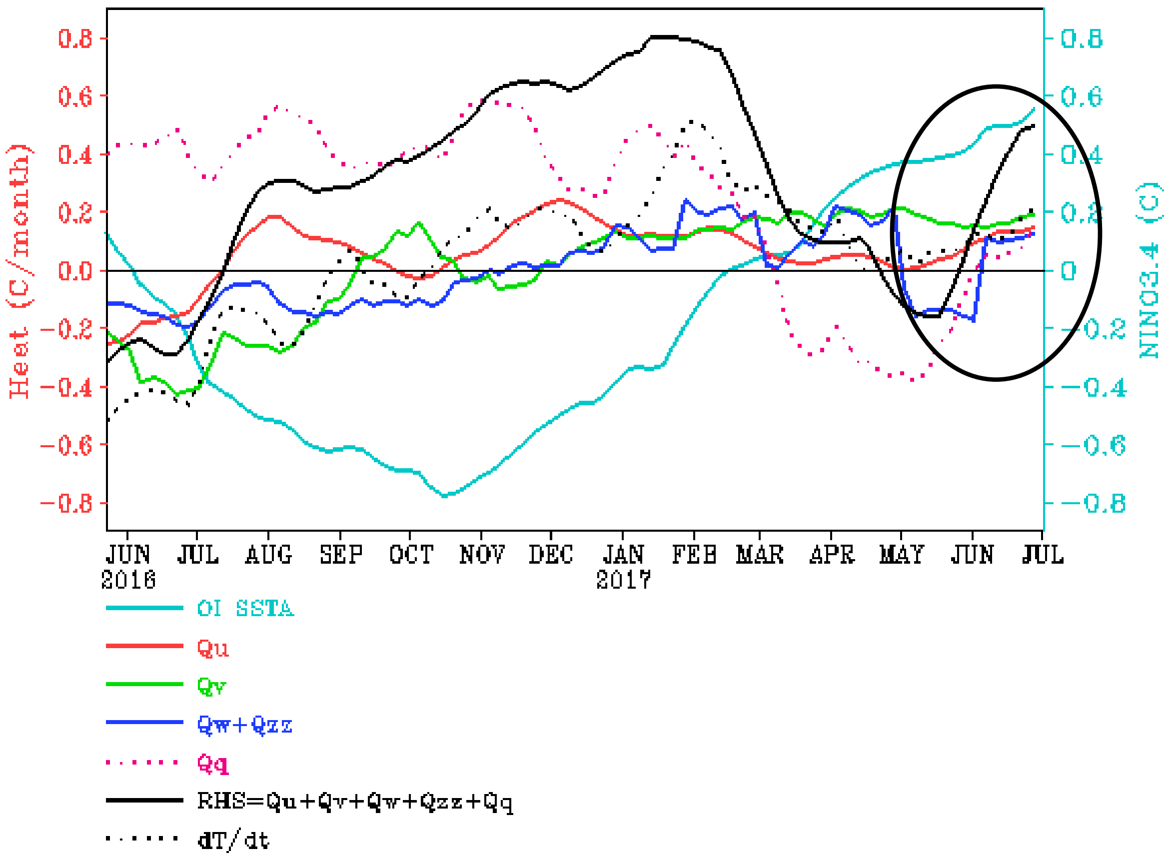
Recharge process: heat transport from outside of equator to equator : Negative -> positive phase of ENSO

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

For details, see:

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

NINO3.4 Heat Budget



- **Both observed SSTA tendency (dT/dt; dotted black line) and total budget tendency (RHS; solid black line) in Nino3.4 region were positive in Jun 2017, consisting with the decay of La Nina and transition to ENSO neutral condition.**

- **All dynamical terms (zonal advection Qu, meridional advection Qv, vertical terms Qw+Qzz), as well as heat flux term (Qq) were positive in Jun 2017.**

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.

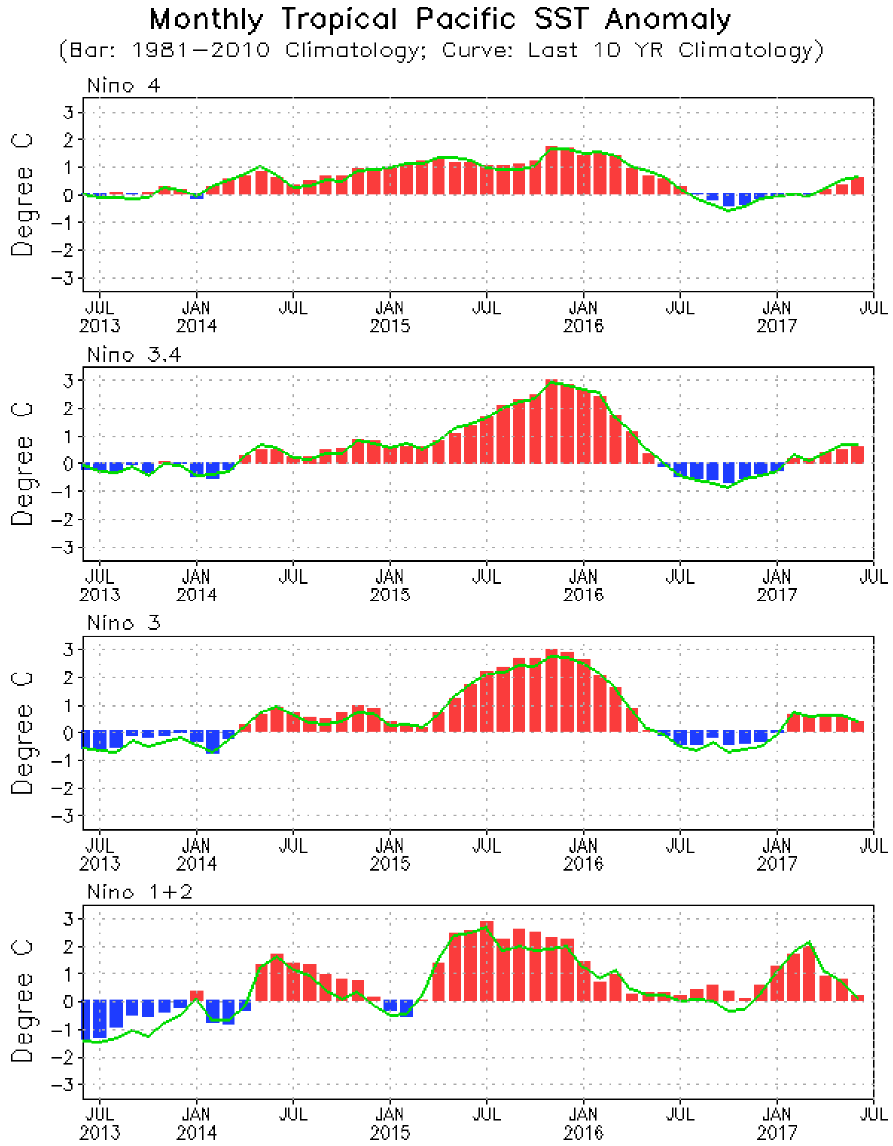
Qu: Zonal advection; Qv: Meridional advection;

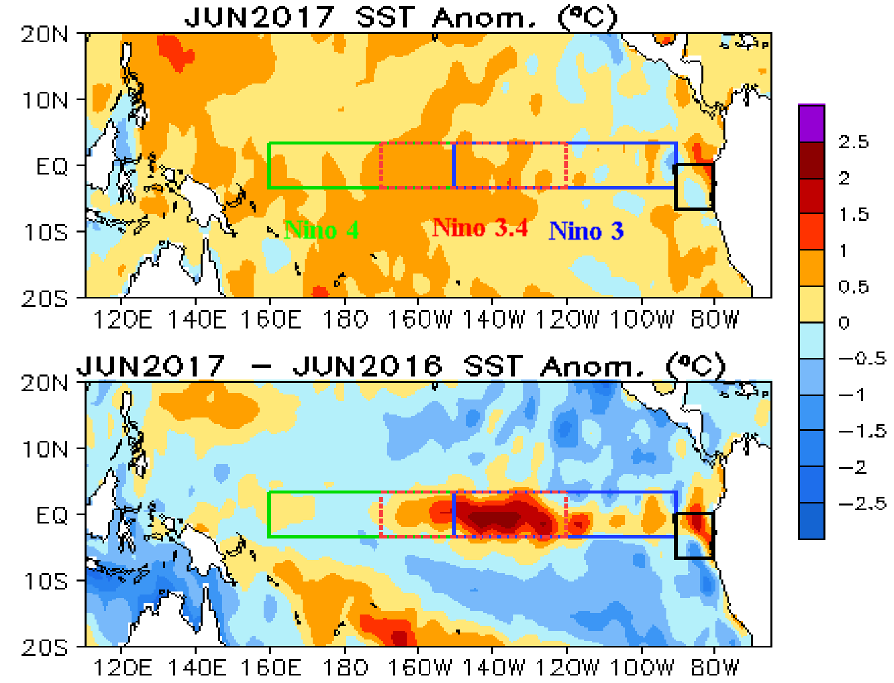
Qw: Vertical entrainment; Qzz: Vertical diffusion

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

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

Evolution of Pacific NINO SST Indices





- **All Nino indices were positive in Jun 2017. Nino4 and Nin3.4 increased, while Nino3 and Nino1+2 decreased in Jun 2017.**

- **Nino3.4 = 0.6°C in Jun 2017.**

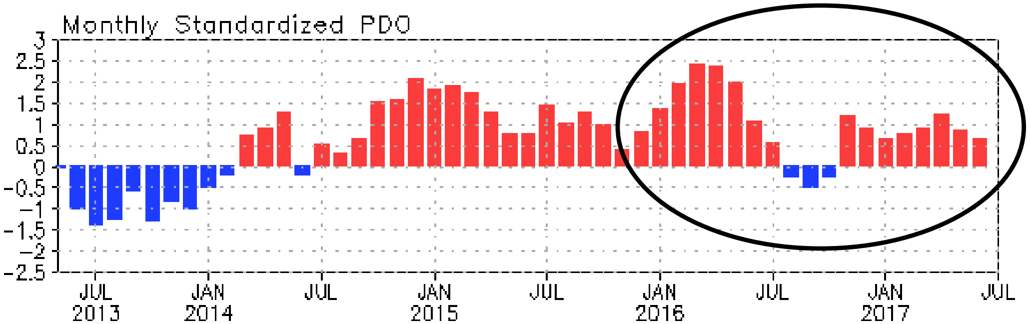
- **Compared with last Jun, the central and eastern equatorial Pacific was much warmer in Jun 2017.**

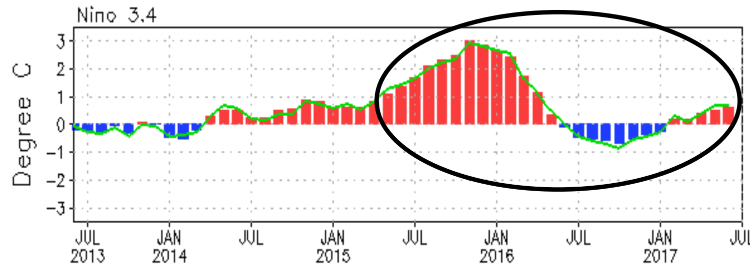
- **The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v4.**

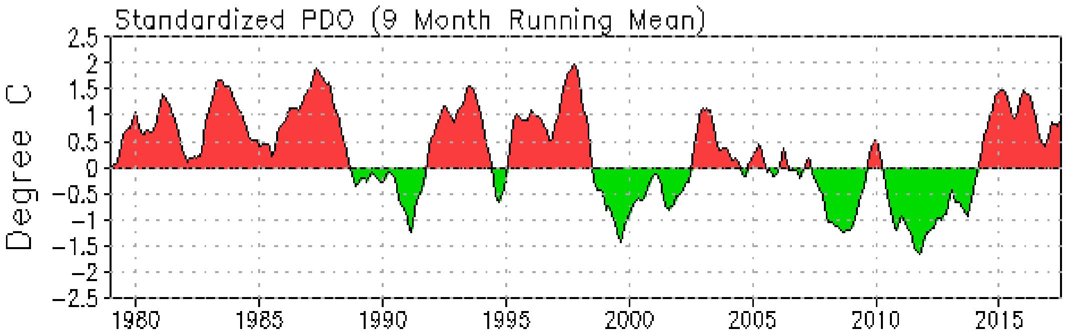
Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

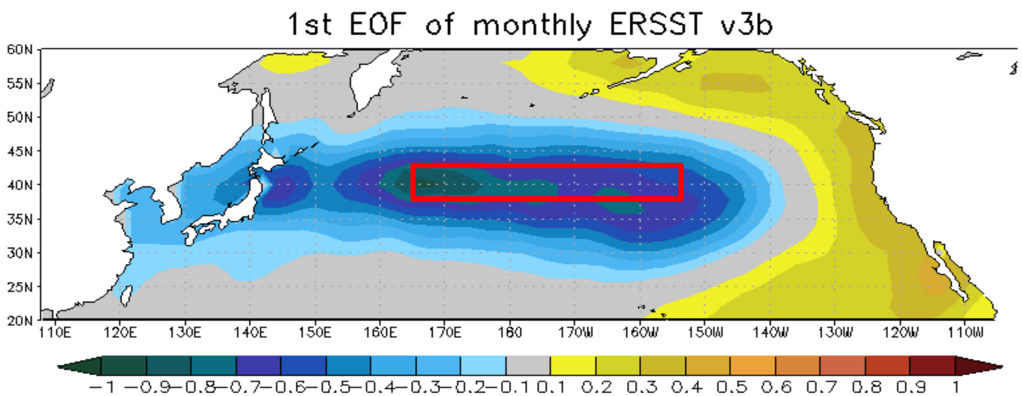
<u>North Pacific & Arctic Oceans</u>

PDO index









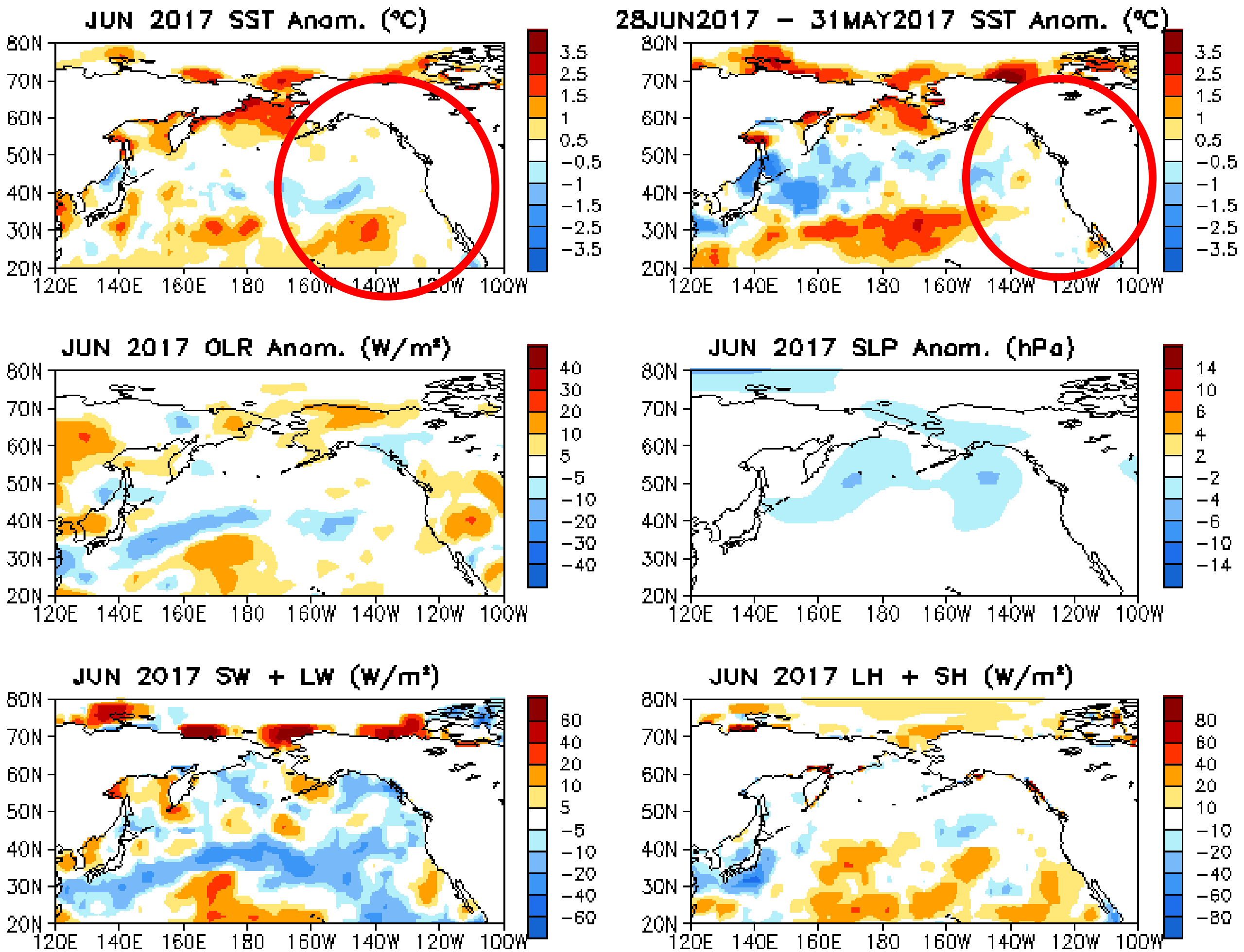
- **The positive phase of PDO index has persisted 8 months since Nov 2016 with PDO index =0.6 in Jun 2017.**

- **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.**

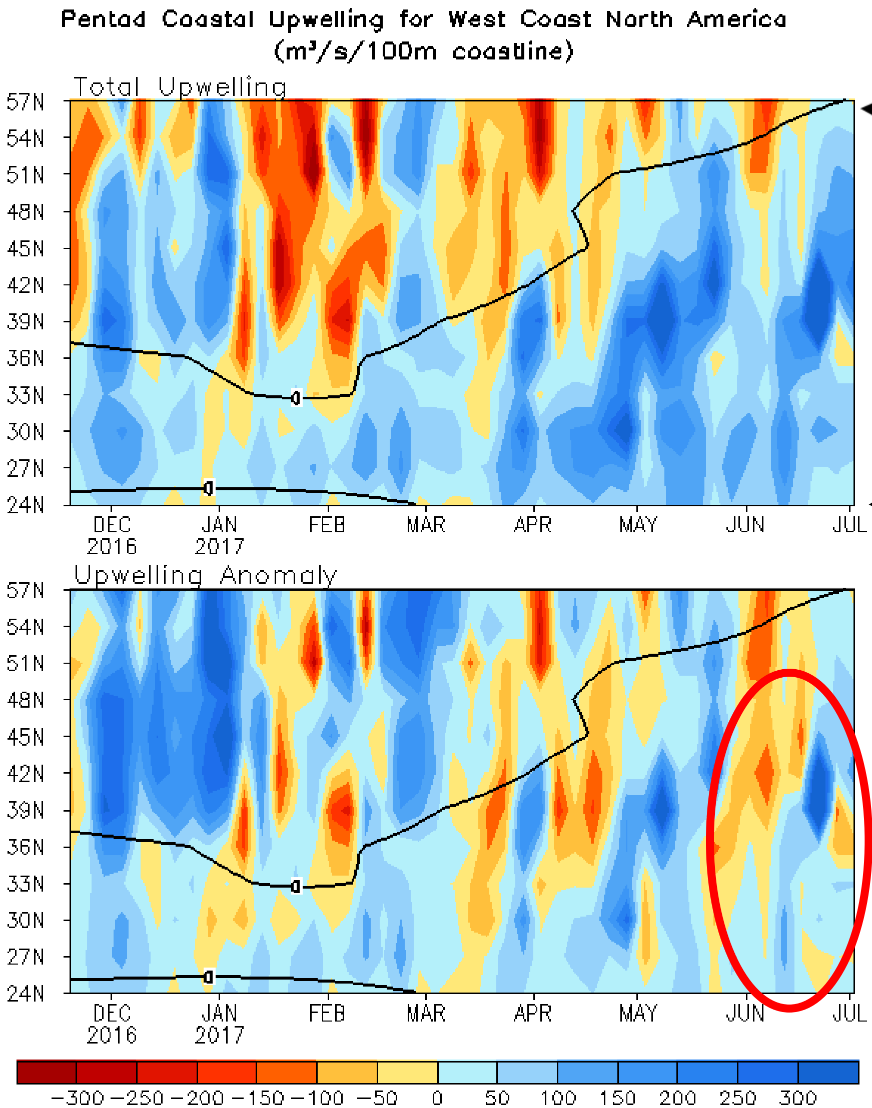
North Pacific & Arctic Ocean: SSTA, SSTA Tend., OLR, SLP, Sfc Rad, Sfc Flx

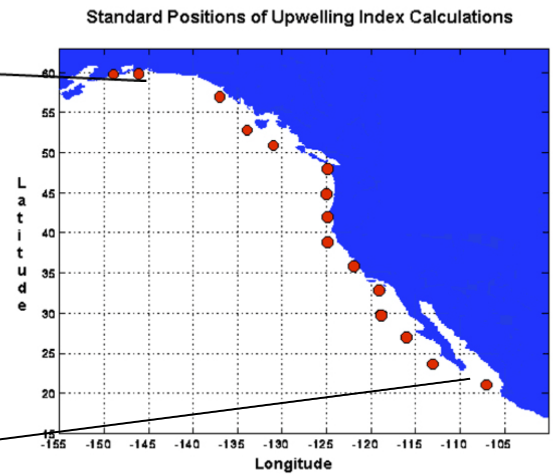


- Positive SSTA associated with so called "Blob" in the NE Pacific disappeared.

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 downwelling and upwelling presented along the coast in Jun 2017.**

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.

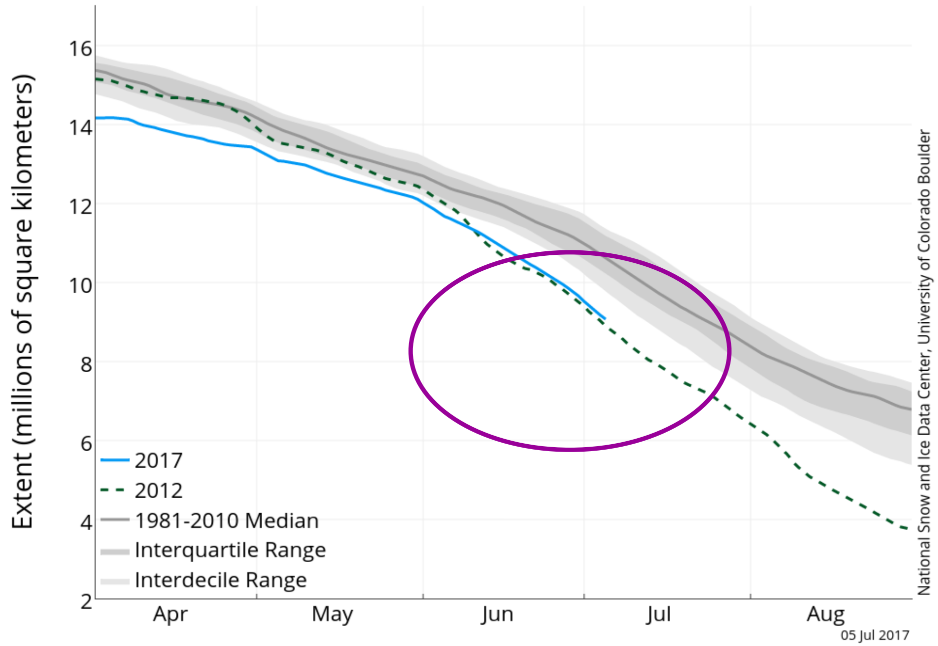
- **Area below (above) black line indicates climatological upwelling (downwelling) season.**
- **Climatologically upwelling season progresses from March to July along the west coast of North America from 36ºN to 57ºN.**

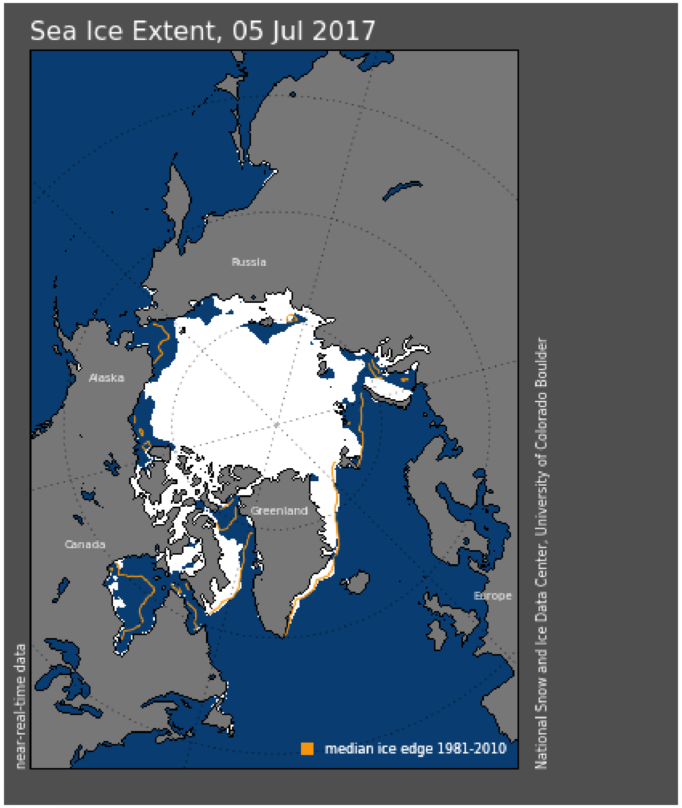
Arctic Sea Ice

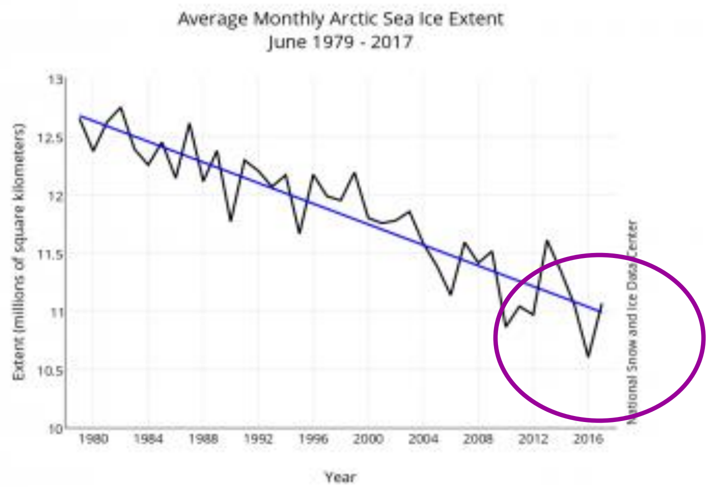
National Snow and Ice Data Center

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

Arctic Sea Ice Extent
(Area of ocean with at least 15% sea ice)



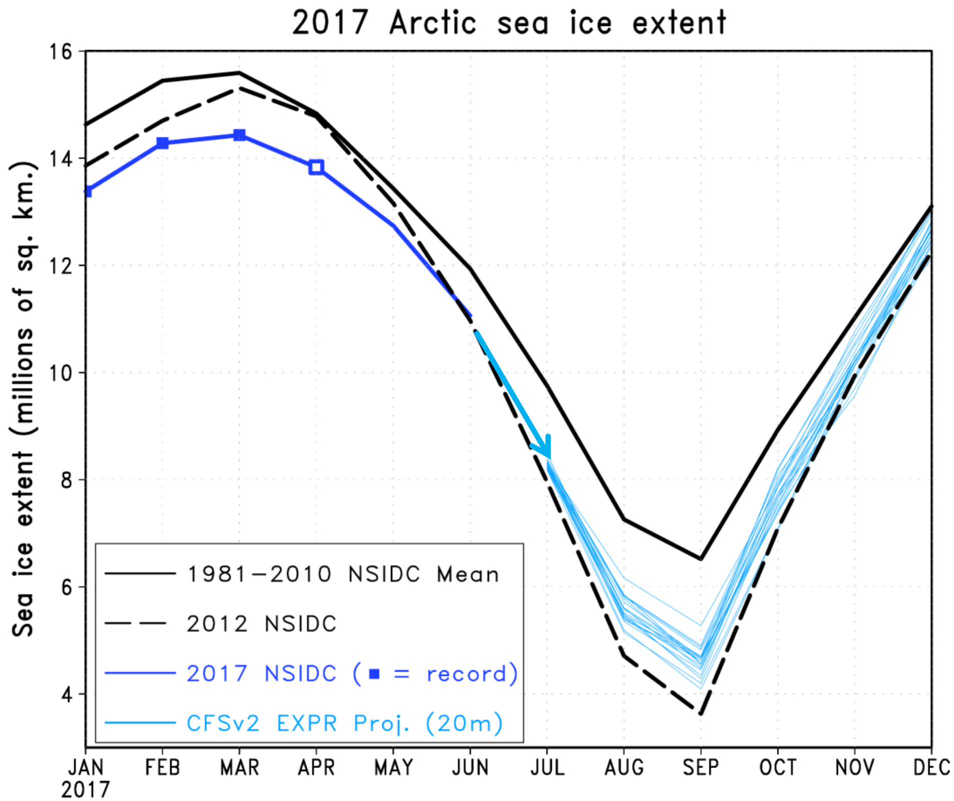


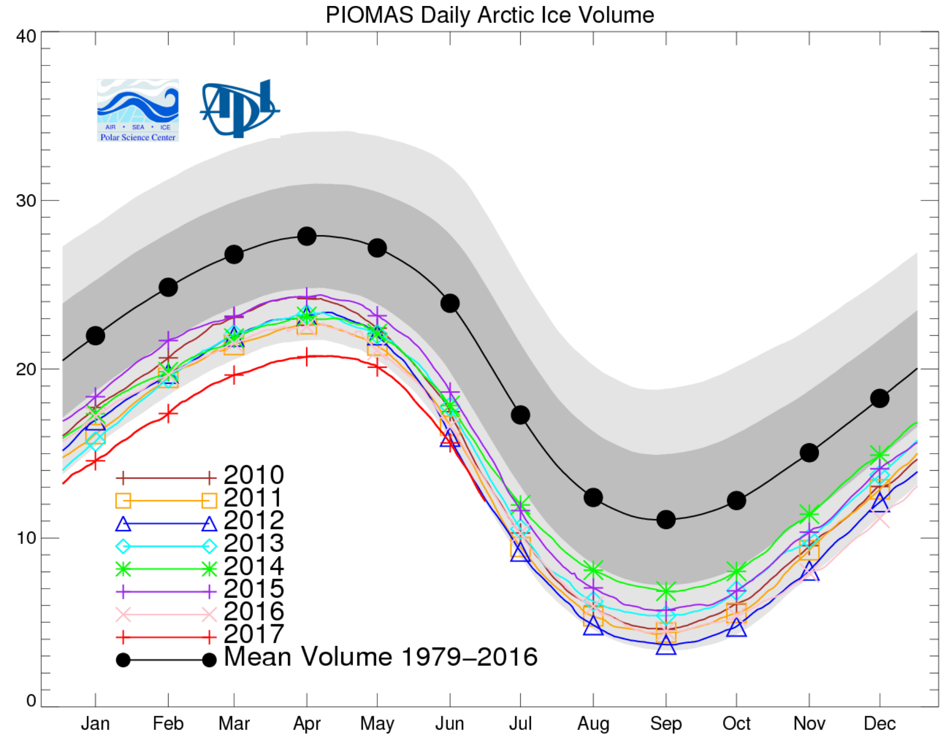


- Contrasting with the fairly slow start to the melt season in May, the ice retreat in June was at a faster than average rate.

- On July 2, Arctic sea ice extent was at the same level recorded in 2012 and 2016.

- Arctic sea ice extent for June 2017 was the sixth lowest in the satellite record.





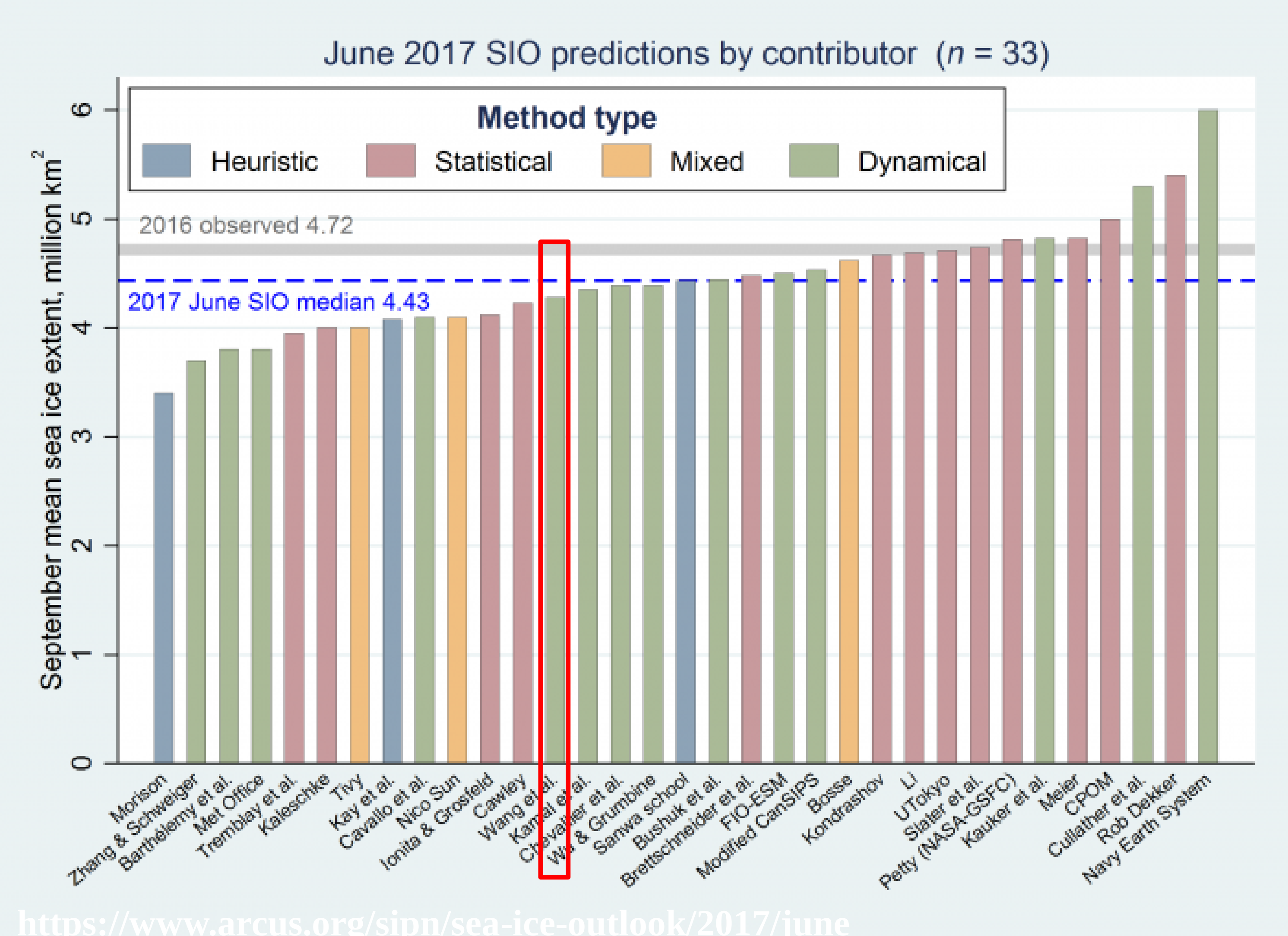
-Arctic sea ice has experienced steady decline throughout the month of June, with the rate of decline being slightly faster than the long term average

-Experimental June sea ice forecast adjusted upward to an ensemble mean prediction of <u>4.60 million km^2</u>, with no ensemble members forecasting a record minimum

-Sea ice volume is becoming less of an outlier (still on the low end of the 2010-2016 spectrum)

-Warm atmospheric temp. anomalies existed over Bering Strait/Chukchi Sea in June; cold anomalies over Canadian Archipelago and Barents Sea.

Arctic Sea Ice

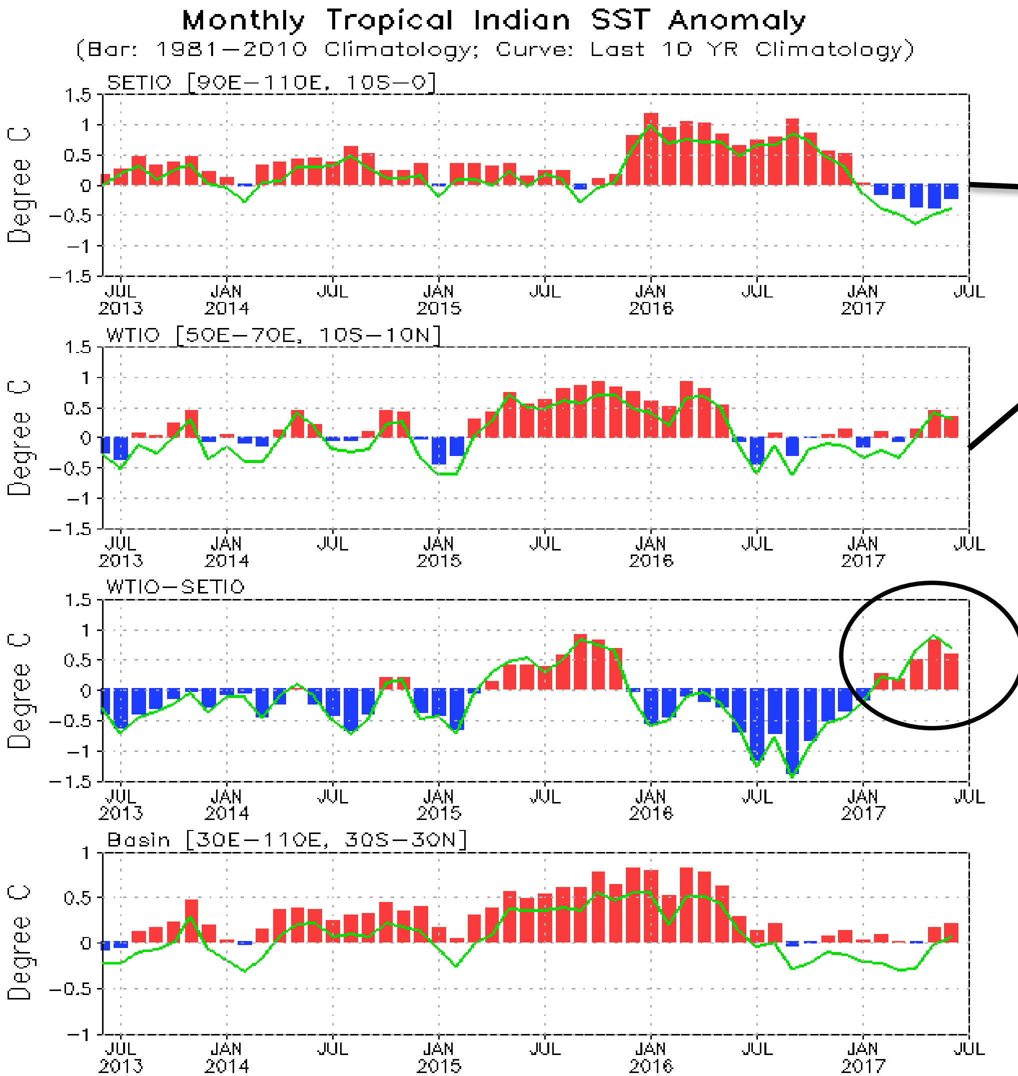


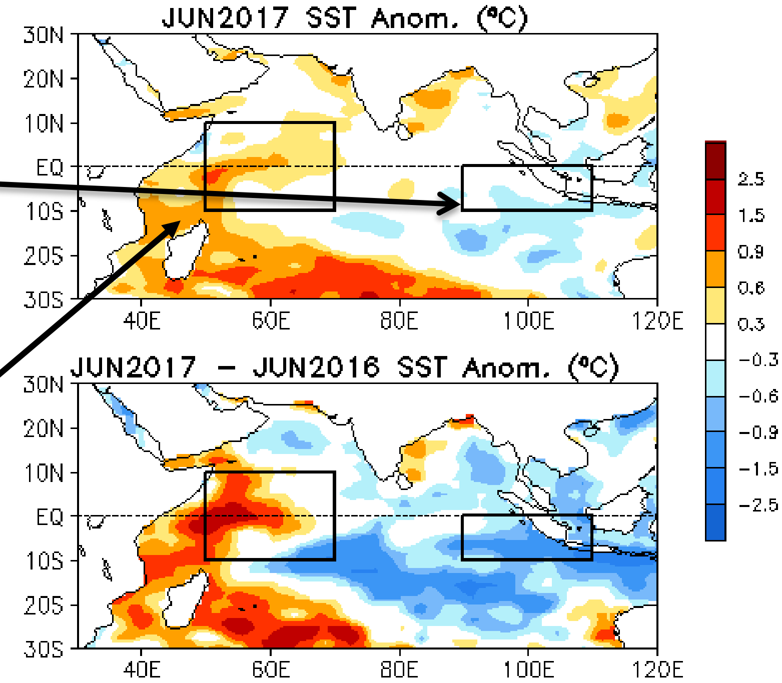
-Outlooks above are based on May data. Our September sea ice extent forecast from May of 4.28 million km^2 is close to the median of all outlooks (4.43 million km^2).

-September sea ice extent range is very large; 3.40 to 6.00 million km^2, conveying large uncertainty and sensitivity to forecasting methods.

Indian Ocean

Evolution of Indian Ocean SST Indices





- **Overall, SSTAs were positive in the western and negative in the eastern Indian Ocean, respectively.**
- **Dipole index was positive during last 5 months, and Basin index was positive in May and Jun 2017.**

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.

- Overall, SSTAs were positive in the west and negative in the east.
- SSTA tendency was positive in the central tropics and negative in the N. Indian Ocean, which were largely determined by heat flux anomalies.
- Convections were suppressed over the tropics.

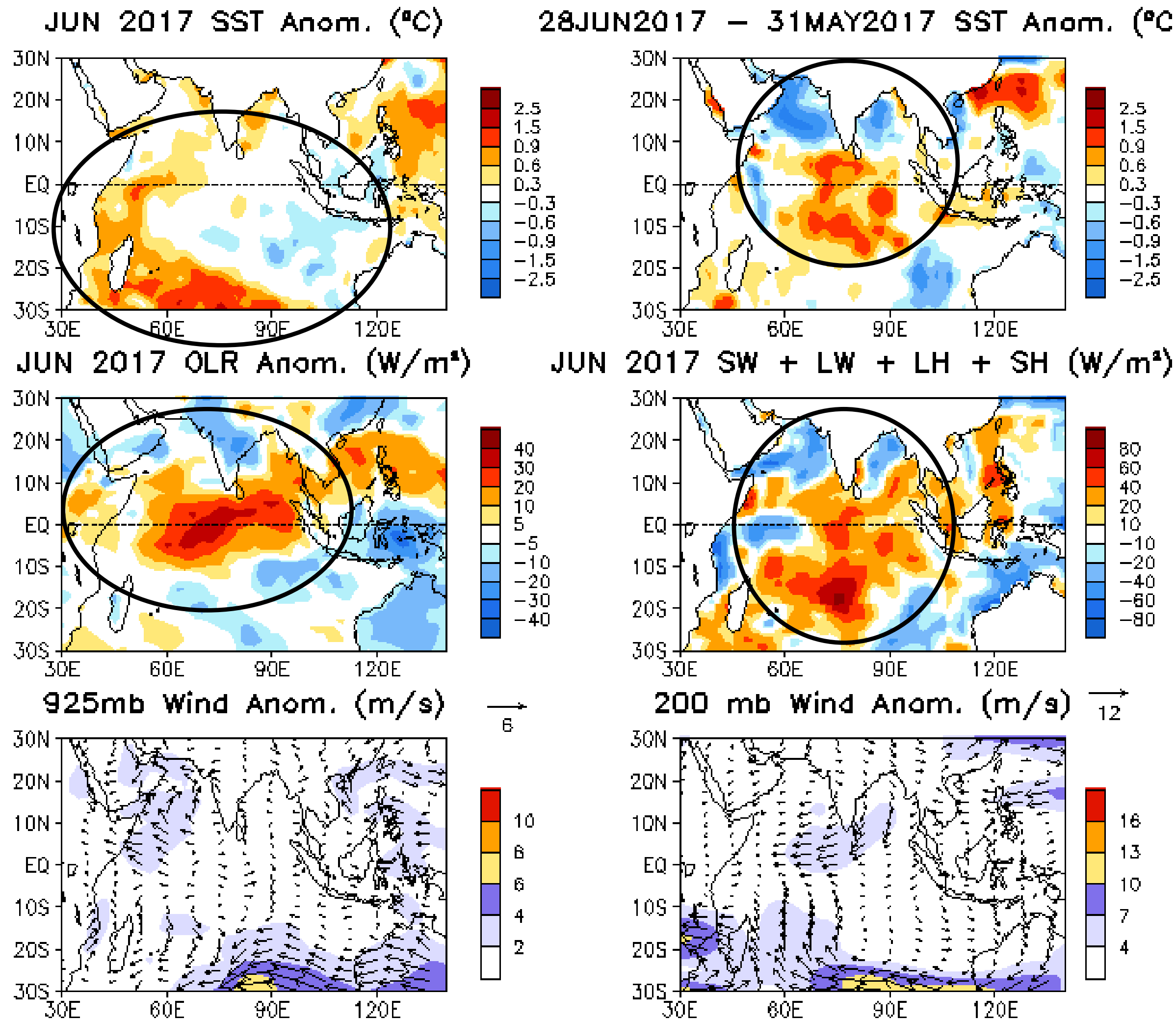
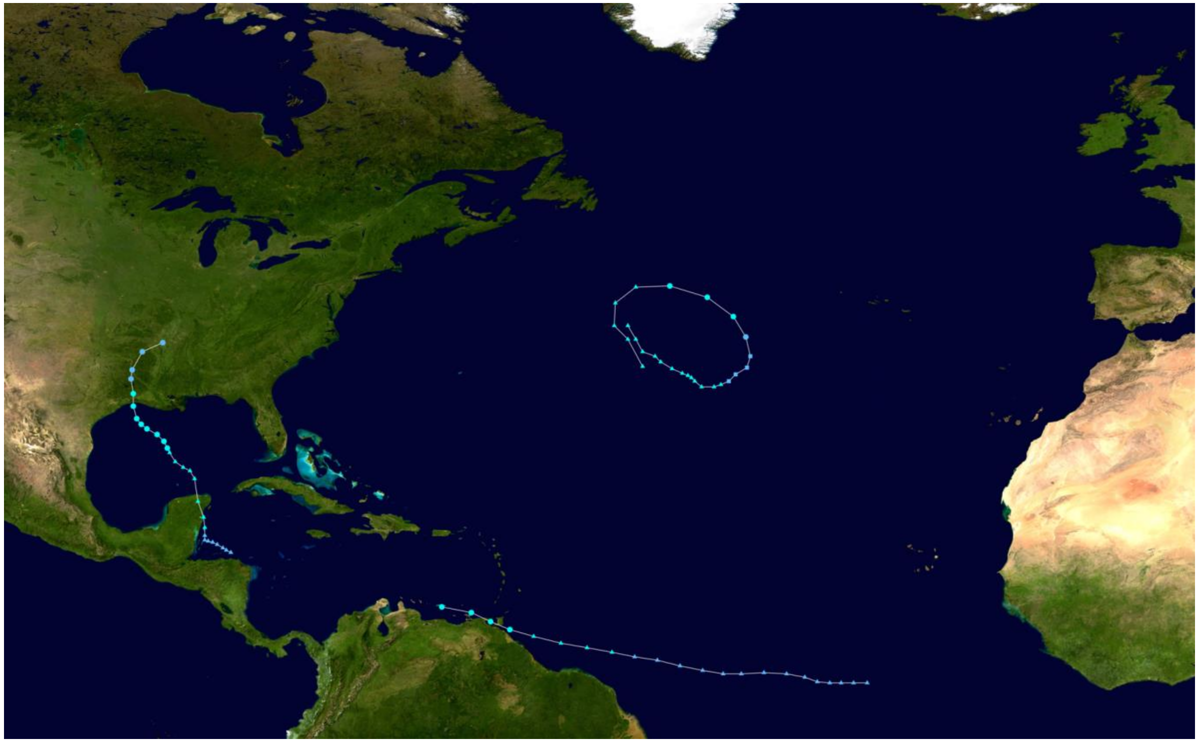


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

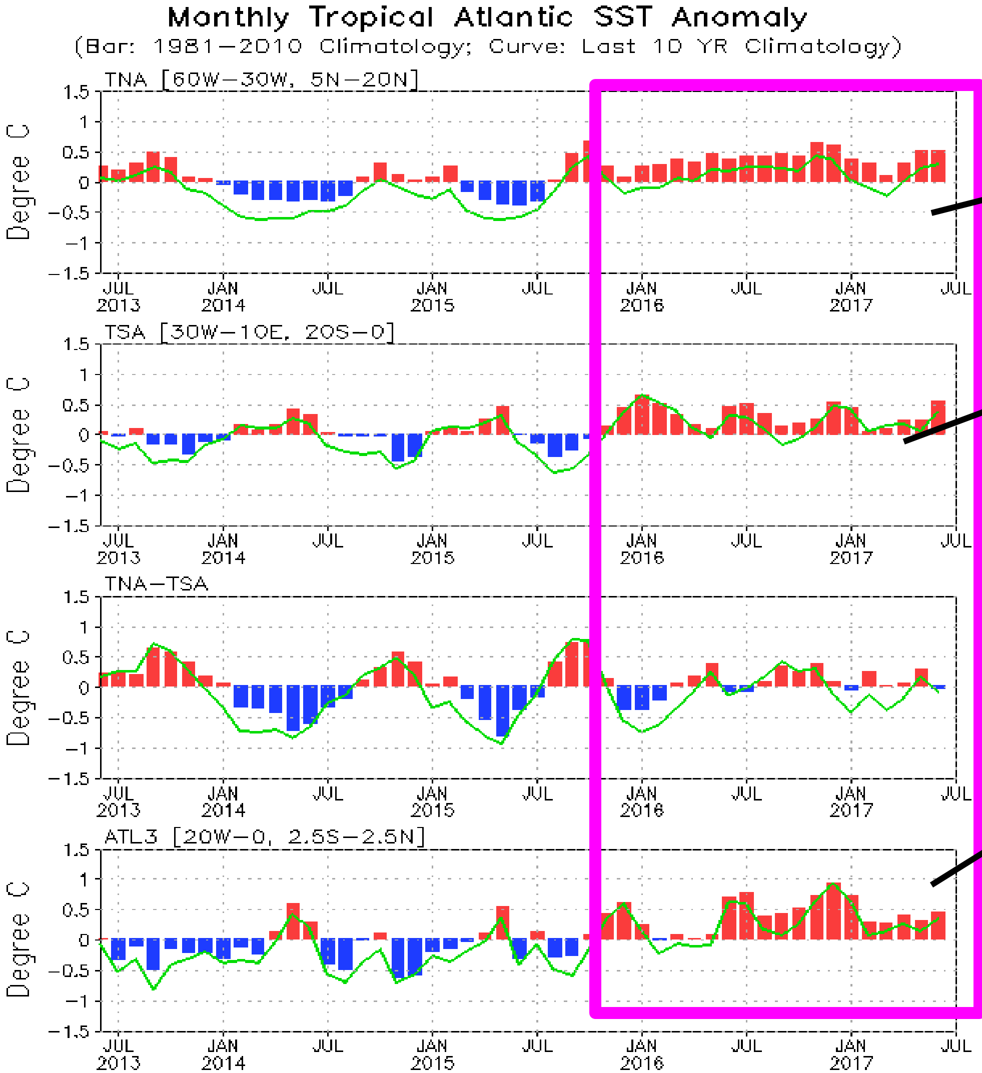
Atlantic Hurricane Activity by July 10, 2017

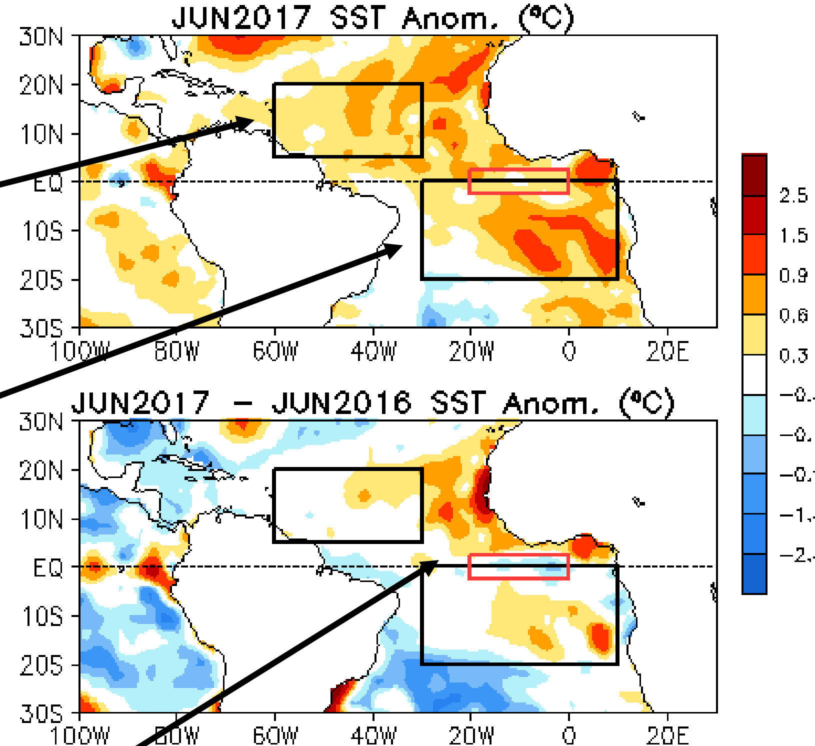
(https://en.wikipedia.org/wiki/2017_Atlantic_hurricane_season)



Atlantic	2017 prediction (issued on May 25)	1981-2010	Observations (By Jul 10)
Named storms	11-17	12.1	3
Hurricanes	5-9	6.4	0
Major hurricanes	2-4	2.7	0
ACE range of the median, which includes Arlene in Apr	75%-155%		

Evolution of Tropical Atlantic SST Indices

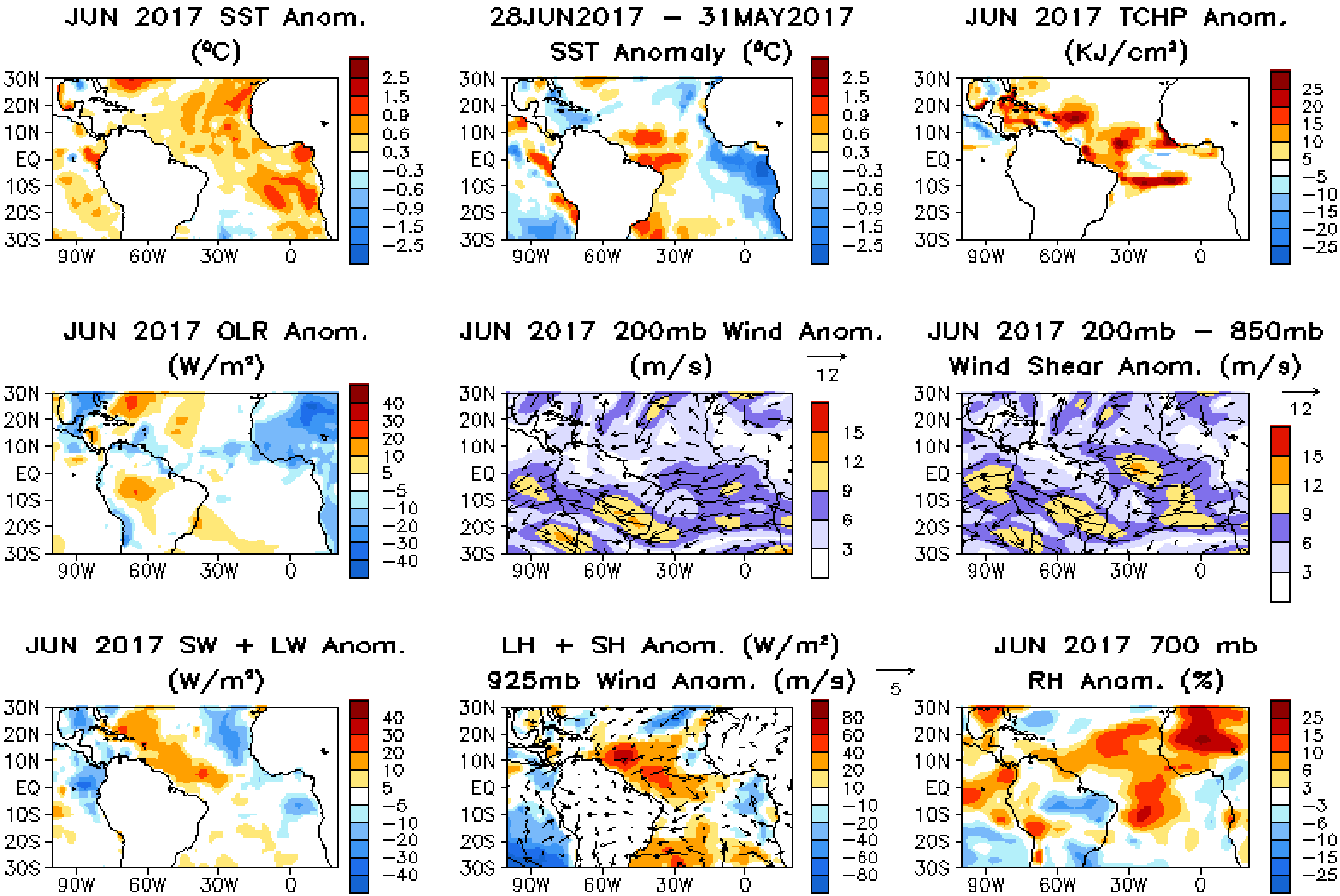




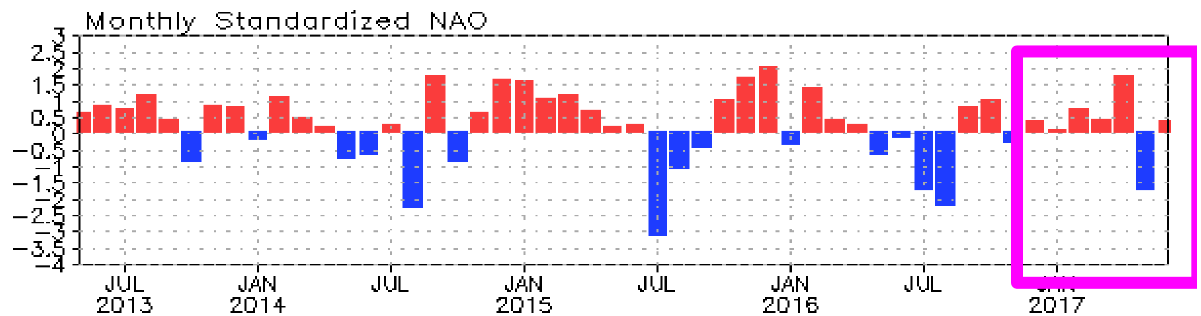
- **Overall, SSTAs in the tropical Atlantic Ocean were positive.**
- **Except the dipole index, all the other indices were positive in Jun 2017.**

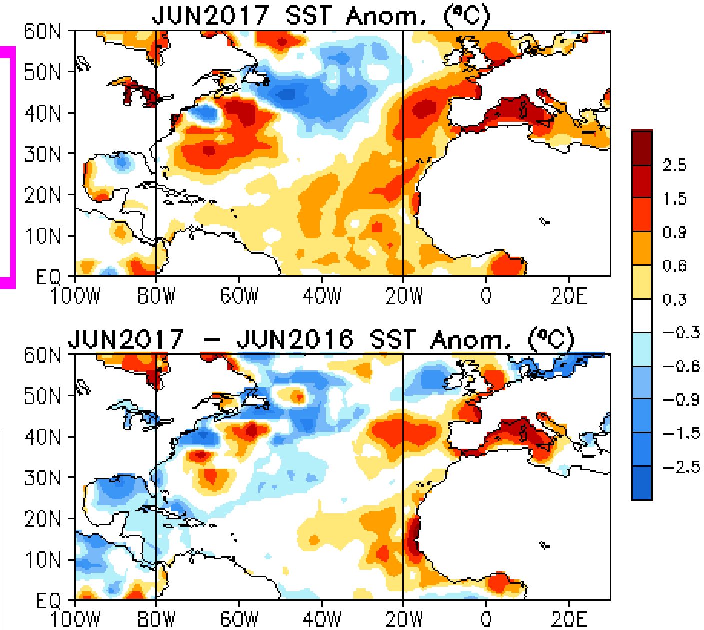
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the TNA [60°W-30°W, 5°N-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between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

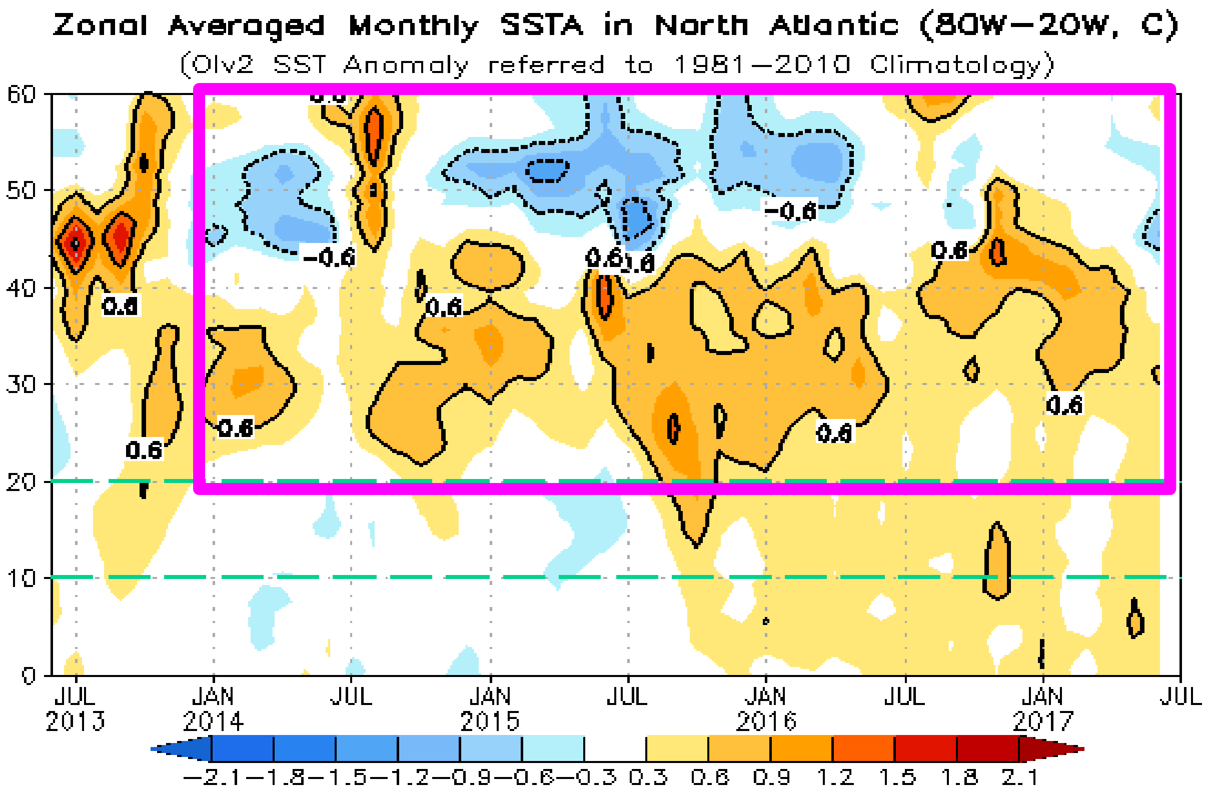
Tropical Atlantic:



NAO and SST Anomaly in North Atlantic







- NAO switched to positive phase again with NAOI=0.35 in Jun 2017.
- SSTA was positive in the middle latitudes and negative in the high latitudes during last 3 years, probably due to the impact of positive phase of NAO.

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.

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

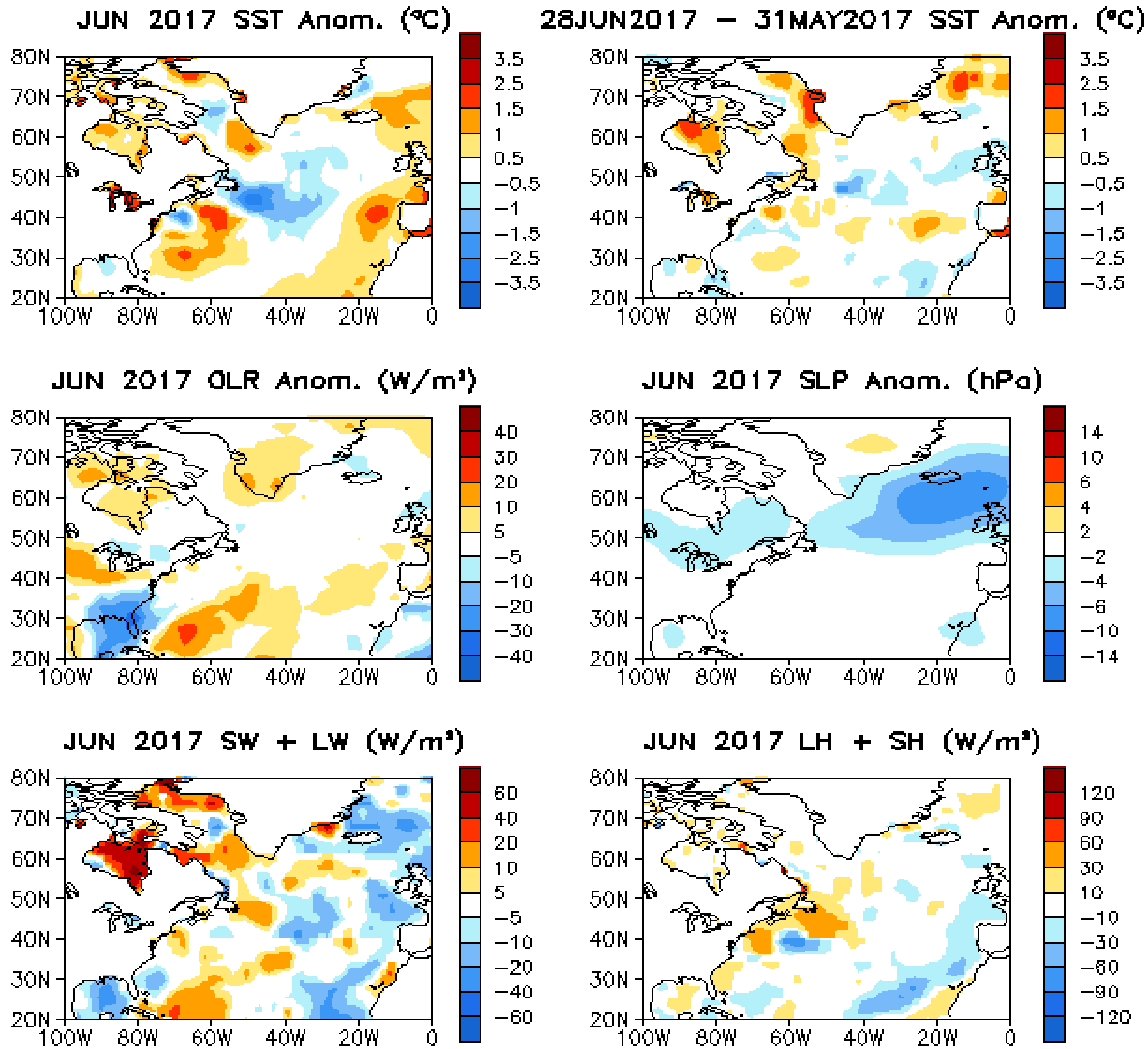
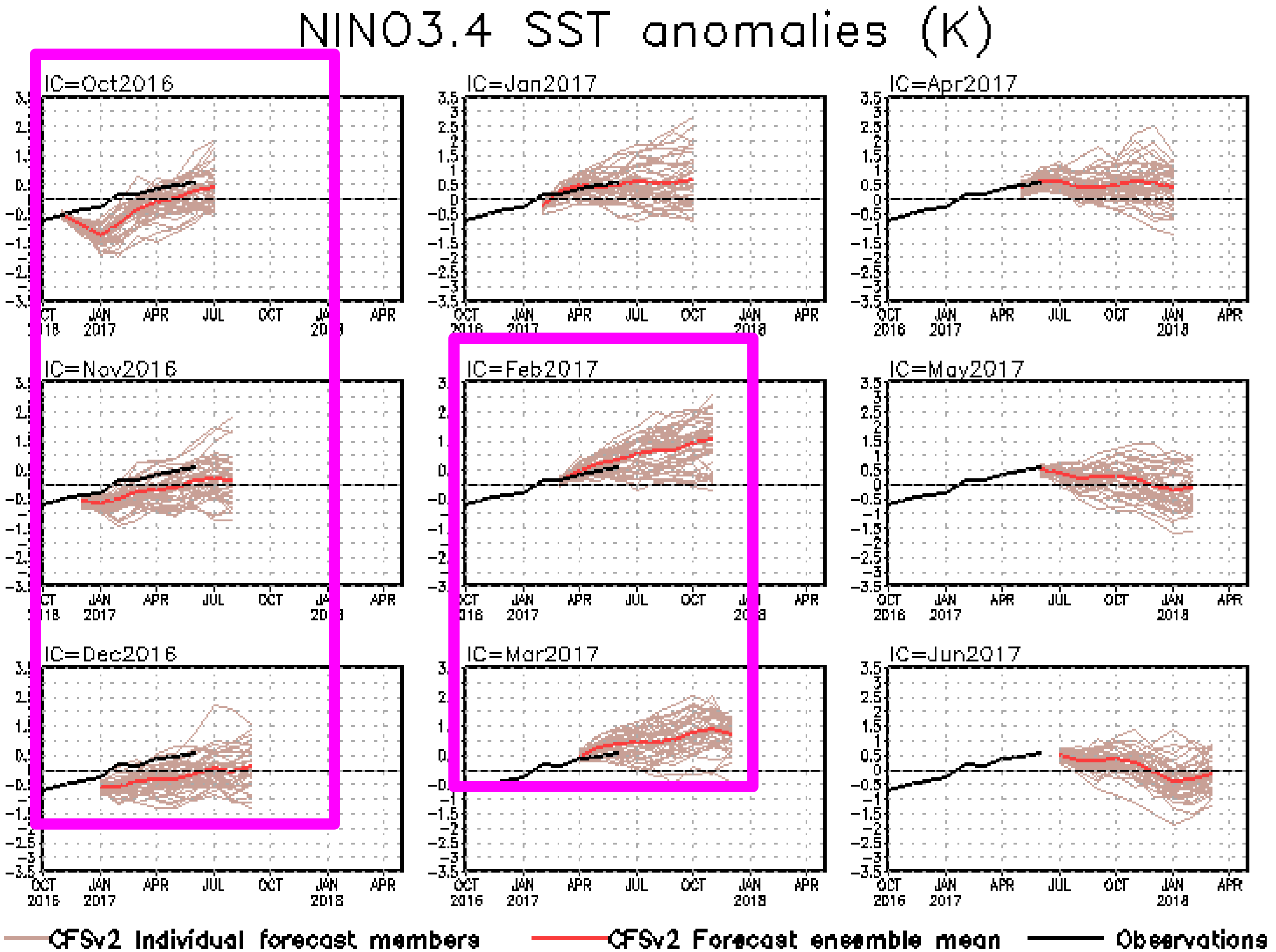


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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

ENSO and Global SST Predictions

CFS Niño3.4 SST Predictions from Different Initial Months

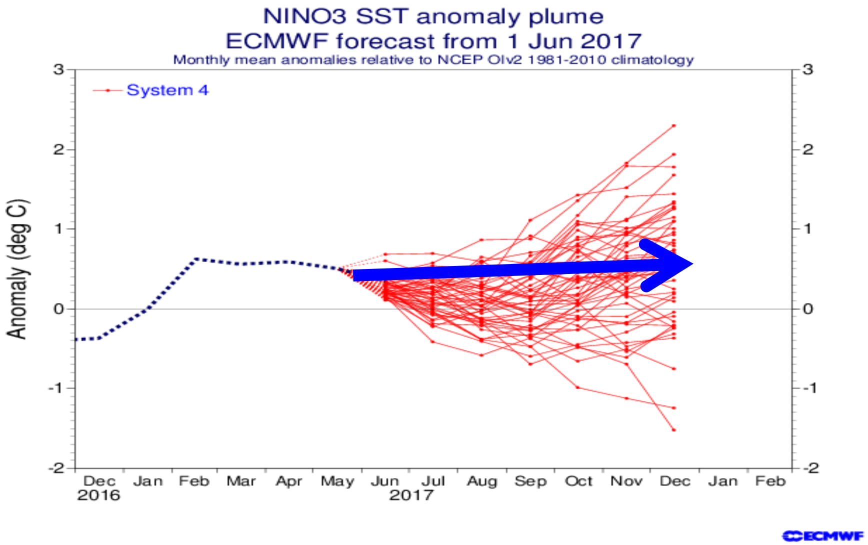


- Latest CFSv2 forecasts call for ENSO neutral in 2017.
- CFSv2 predictions had cold biases with ICs in Jun-Dec 2016 and warm biases with ICs in Feb-Mar 2017.

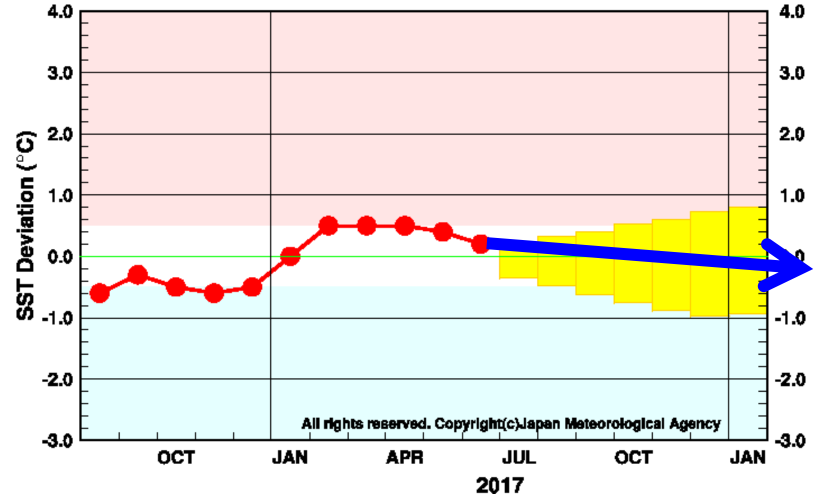
Fig. M1. CFS Nino3.4 SST prediction from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1981-2010 base period means.

Individual Model Forecasts: neutral or (borderline) El Nino

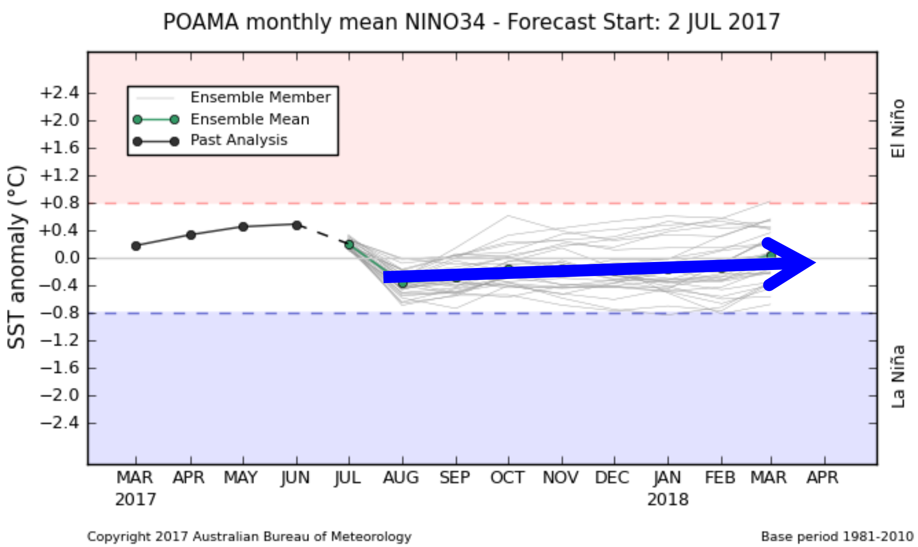
EC: Nino3.4, IC=01Jun 2017



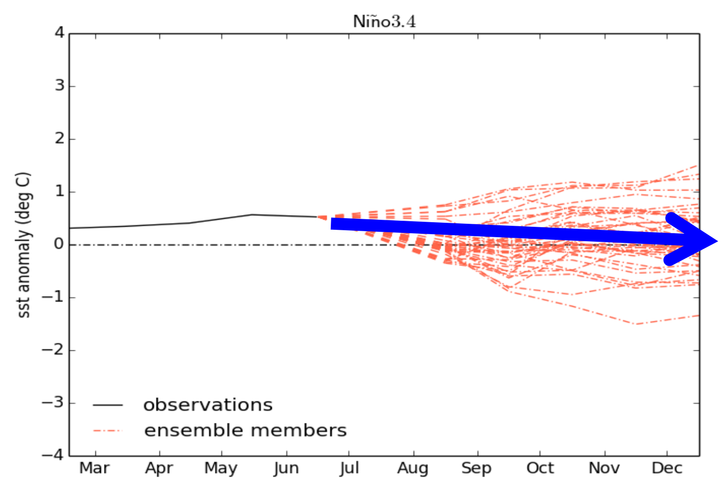
JMA: Nino3, IC=Jul 2017



Australia: Nino3.4, IC= 2 Jul 2017



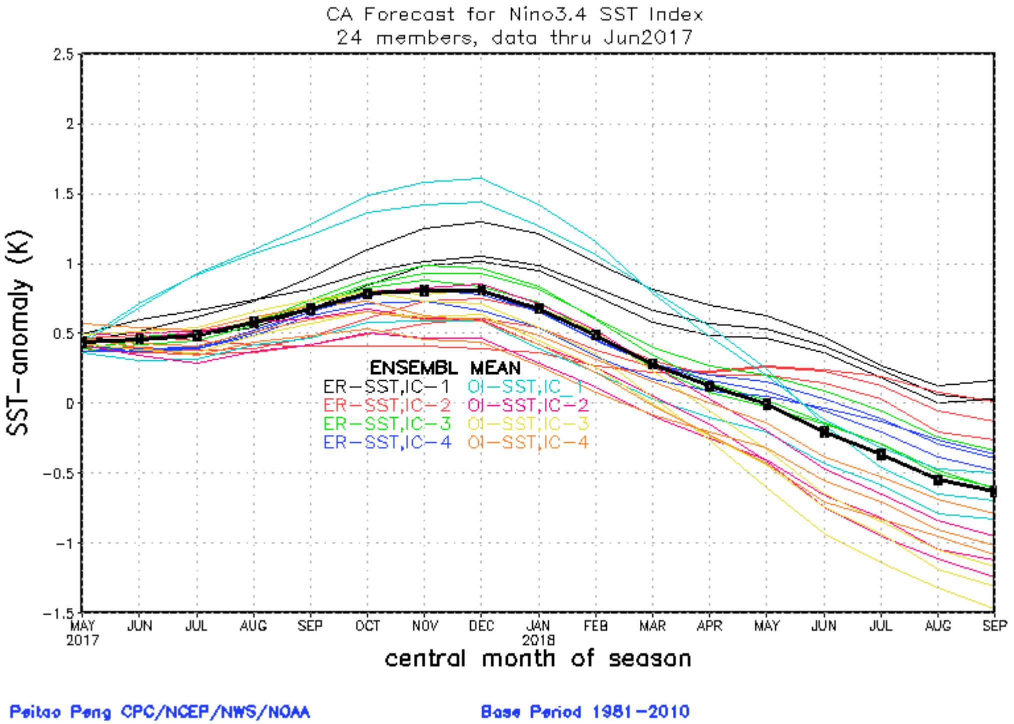
UKMO: Nino3.4, IC=Jul 2017

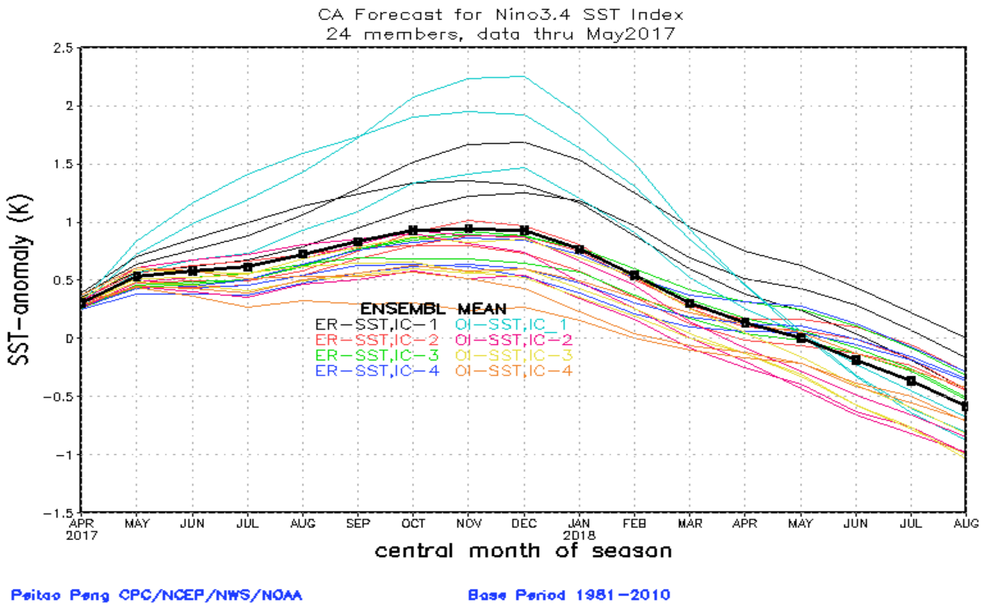


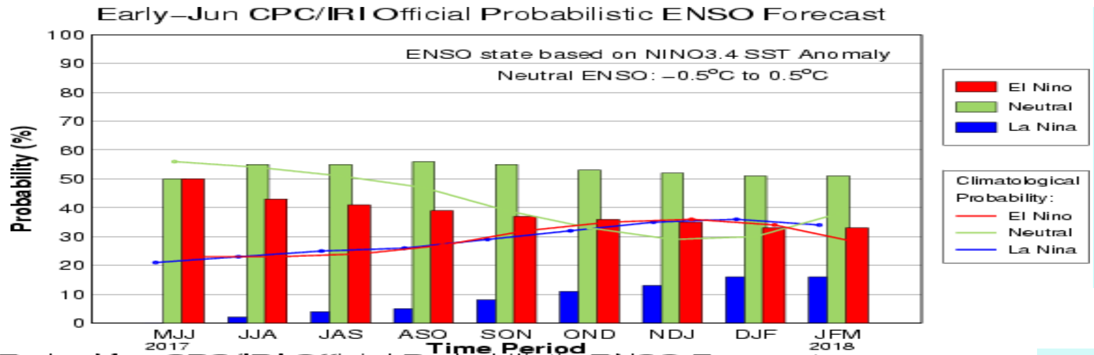
Analog forecasts:

Nino3.4 amplitude declined in forecast with IC in Jun 2017, compared with that with IC in May 2017.

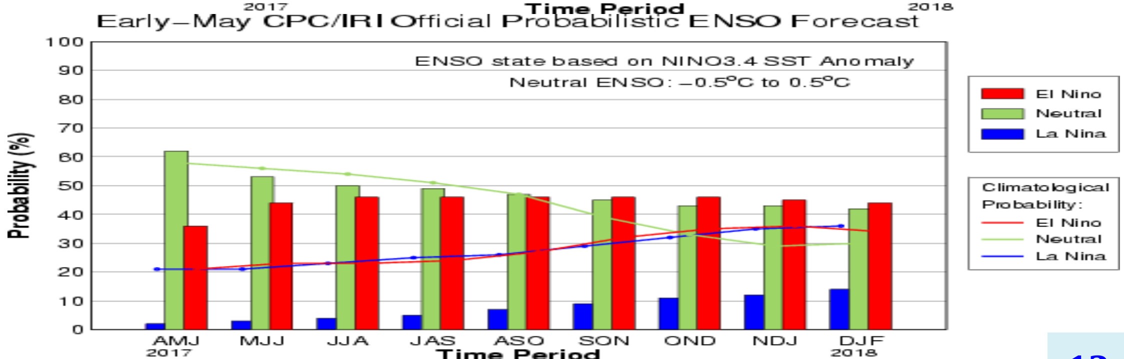
(From Dr. Peitao Peng)



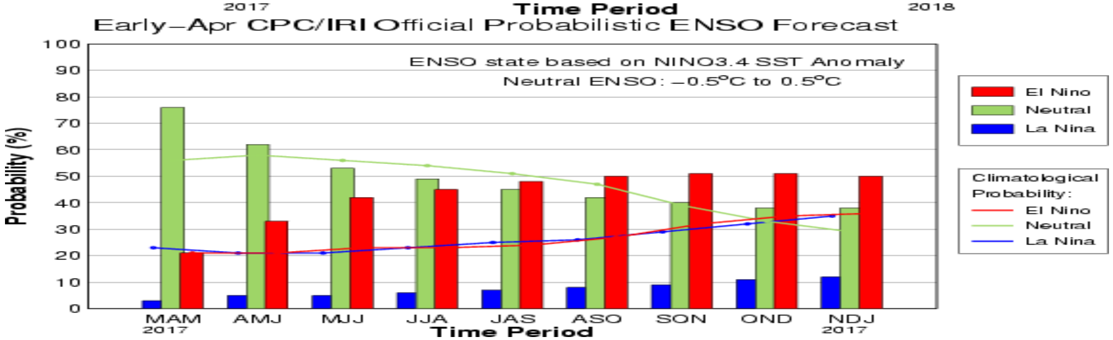




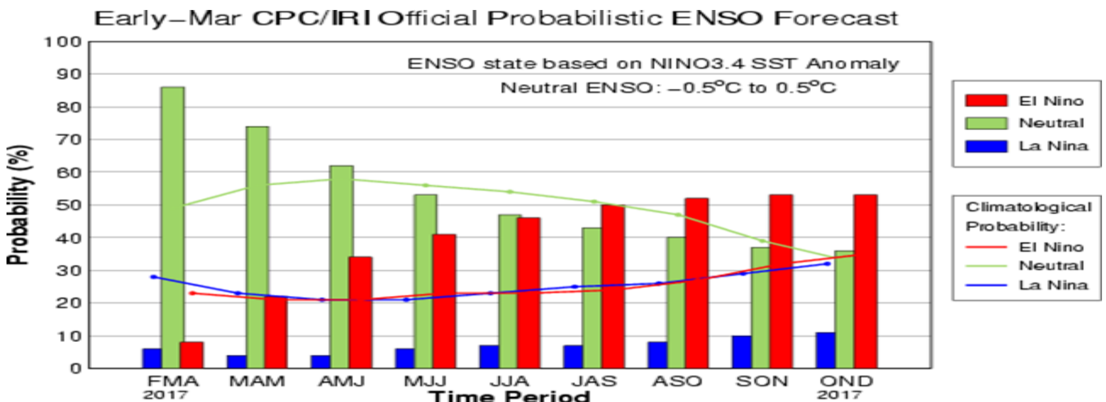
8 June 2017: "ENSO-neutral is favored (50 to ~55% chance) through the Northern Hemisphere fall 2017."



11 May 2017: "ENSO-neutral and El Niño are nearly equally favored during the Northern Hemisphere summer and fall 2017."

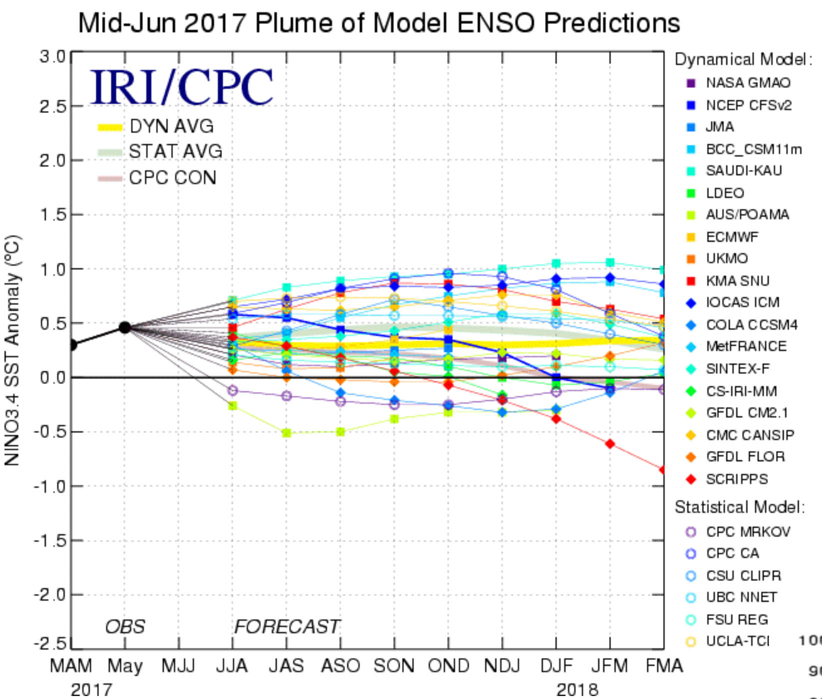


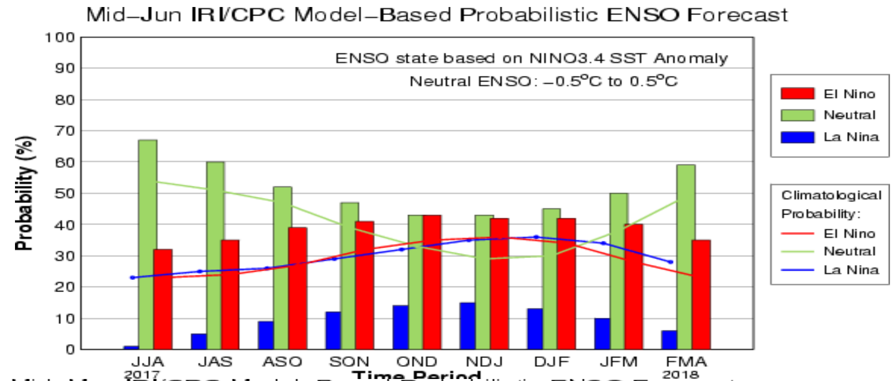
13 Apr 2017: "ENSO-neutral conditions are favored to continue through at least the Northern Hemisphere spring 2017, with increasing chances for El Niño development by late summer and fall."

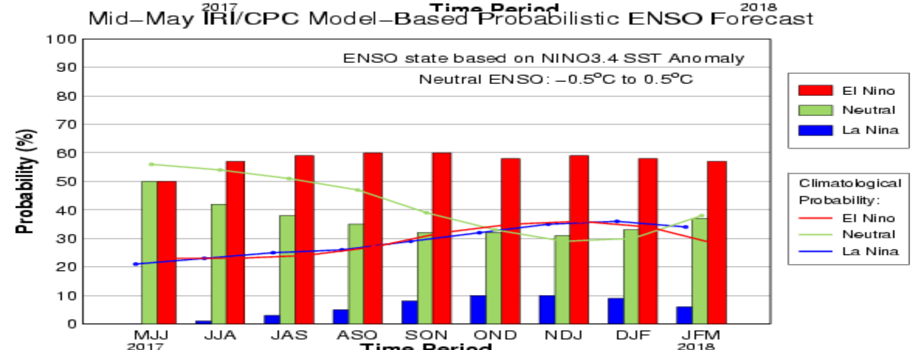


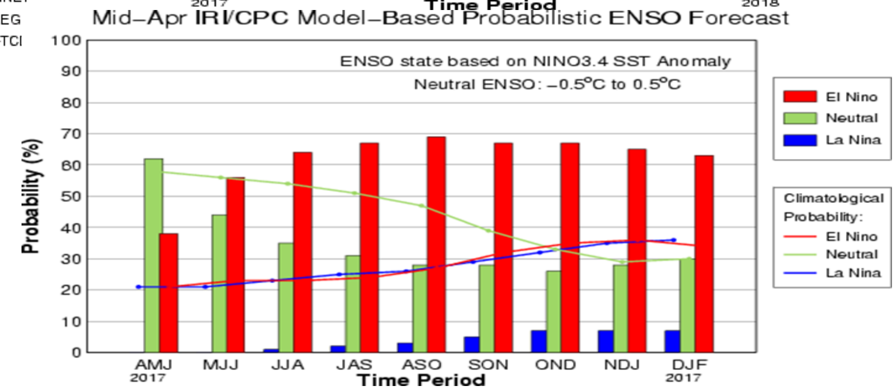
09 Mar 2017: "ENSO-neutral conditions are favored to continue through at least the Northern Hemisphere spring 2017, with increasing chances for El Niño development into the fall."

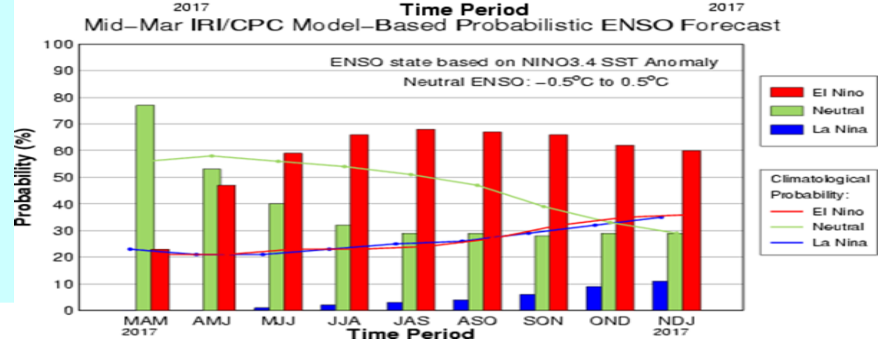
IRI NINO3.4 Forecast Plum





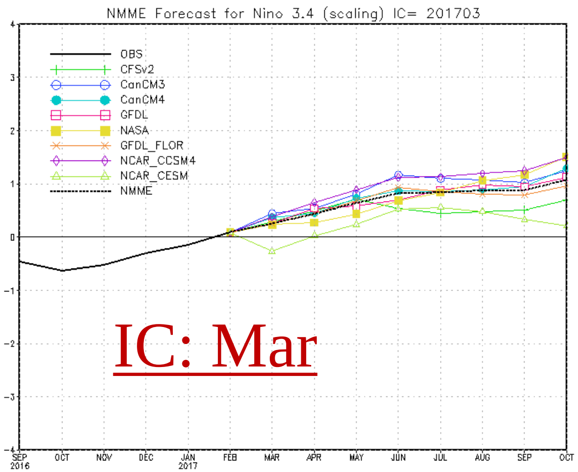


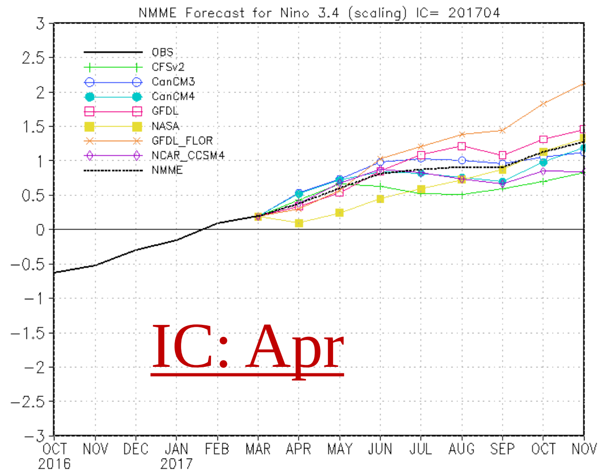


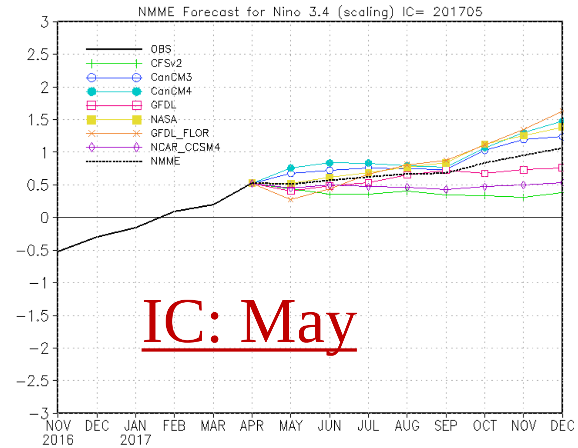


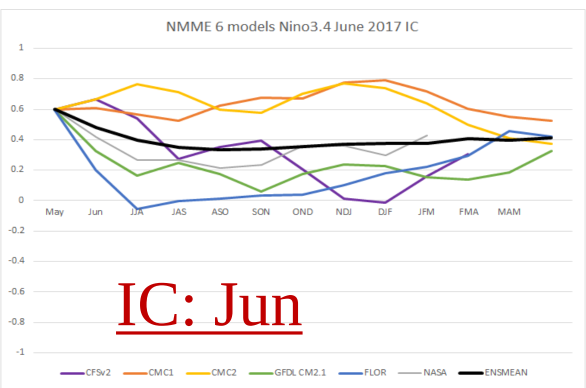
- **Many models with ICs in Jun 2017 favor a weak El Niño by the Northern Hemisphere summer 2017, continuing through winter 2017-18.**

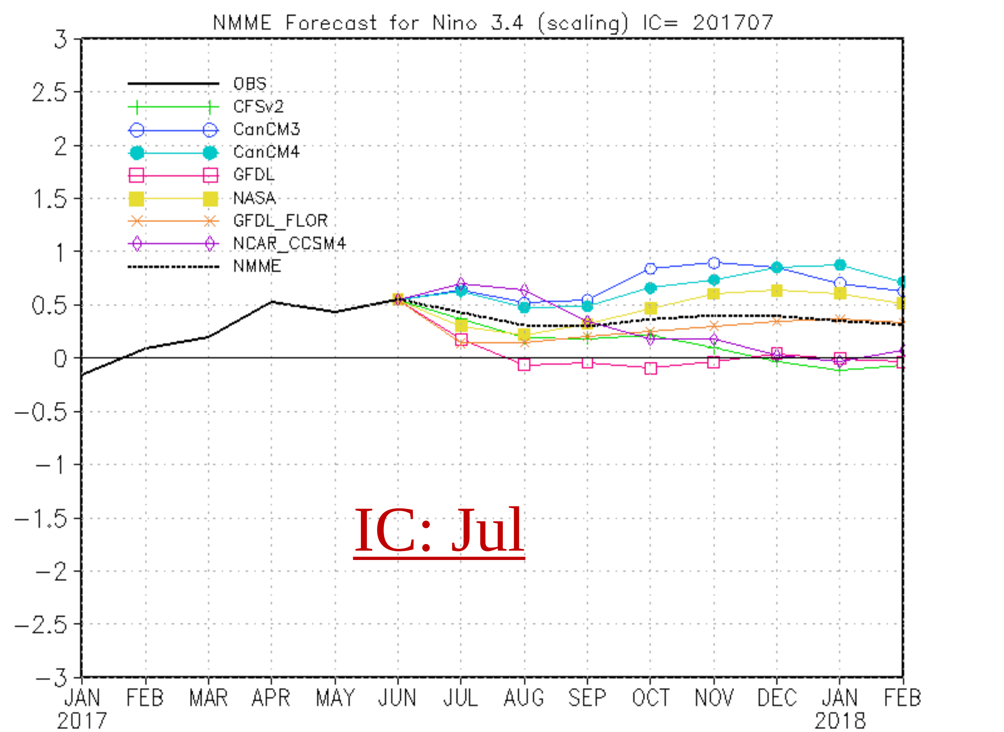
Large Uncertainty: 7 NMME Models with ICs in Mar-Jul 2017



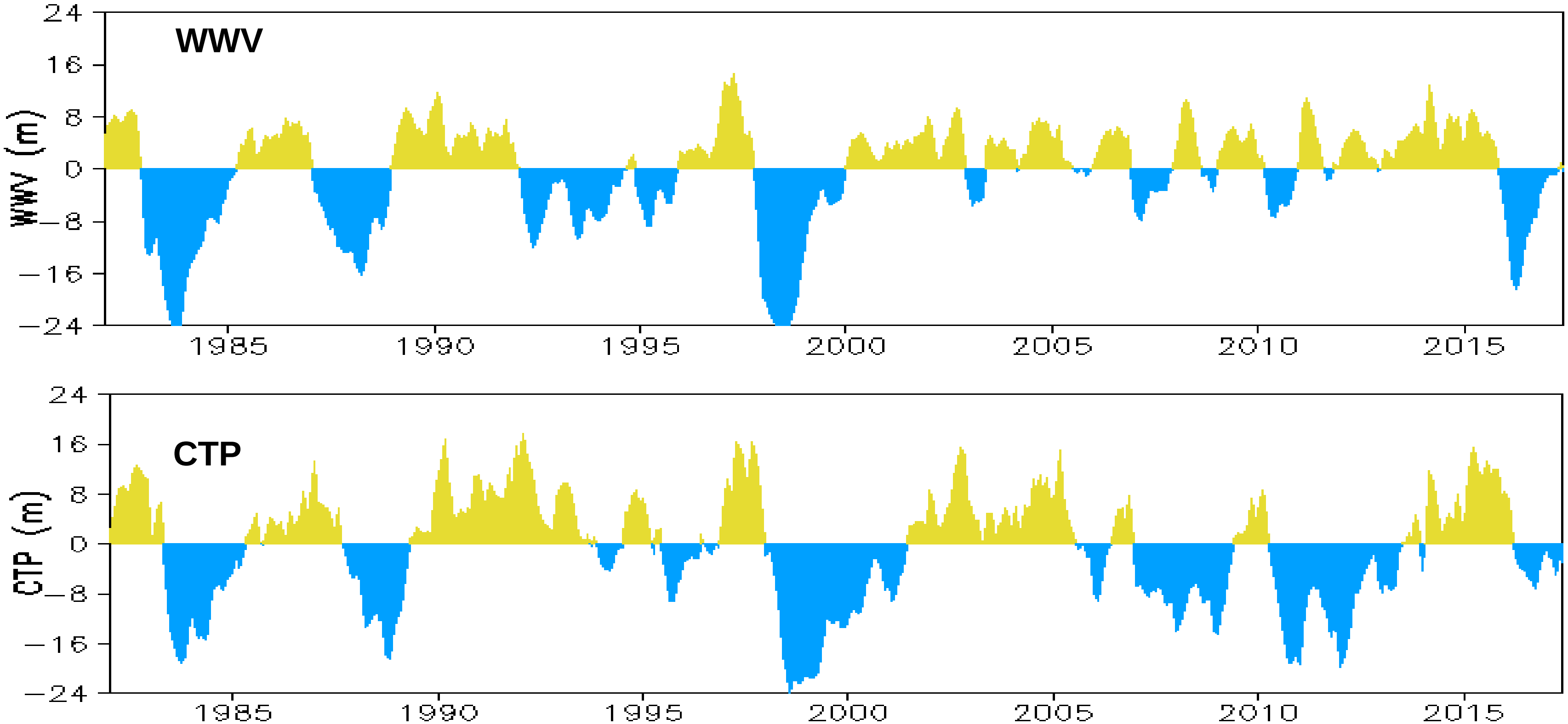








Two ENSO Precursors Based on Thermocline Anomaly

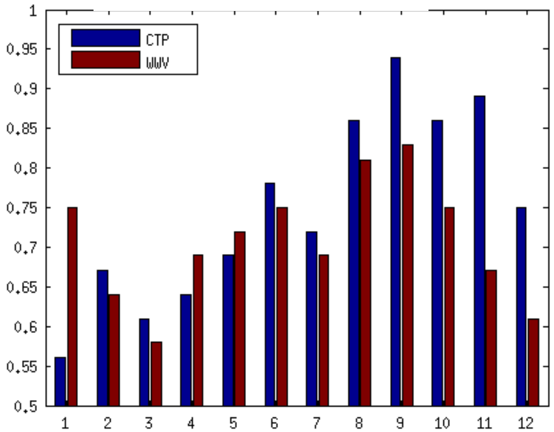


- **Warm Water Volume (WWV) index is defined as average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN]. It is inferred from the slow ocean adjustment via zonal mean heat content exchange between the equatorial and off-equatorial regions.**
- **Central tropical Pacific (CTP) index is defined as average of depth of 20ºC in [160ºW-110ºW, 10ºS-10ºN]. It includes equatorial thermocline variations involving the equatorial wave processes in response to the wind-stress-curl anomalies and off-equatorial thermocline variations related with Subtropical cells (STCs).**

Meinen, C. S., and M. J. McPhaden, 2000: Observations of warm water volume changes in the equatorial Pacific and their relationship to El Niño and La Niña. *J.Climate*, **13,** 3551-3559.
Wen C, Kumar A, Xue Y, McPhaden MJ (2014) Changes in tropical pacific thermocline depth and their relationship to ENSO after 1999. *J Climate* 27:7230–7249

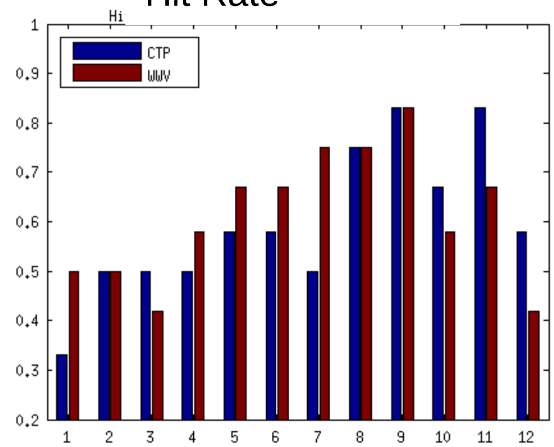
2x2 contingency table for El Nino case

Percent correct



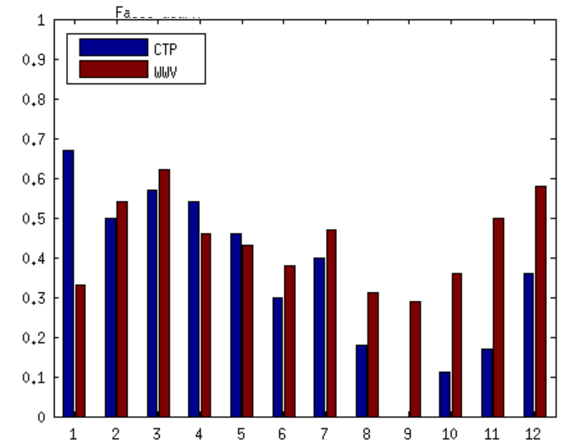
Month

Hit Rate

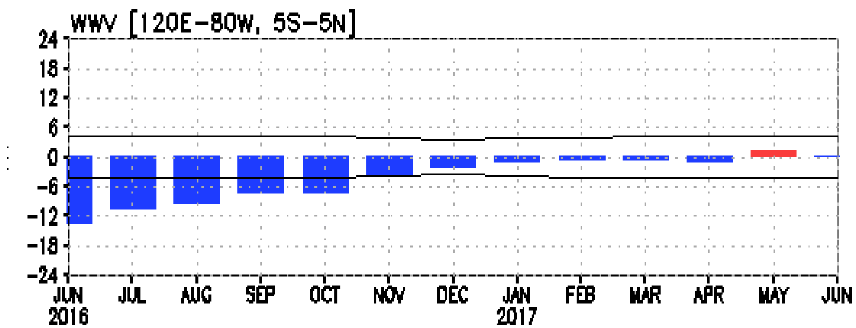


Month

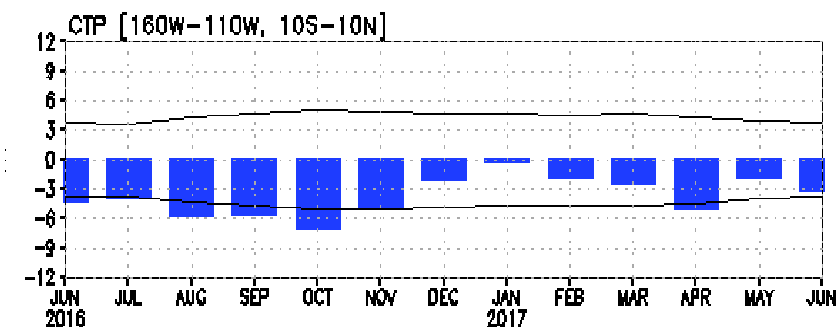
False Alarm



Month



Forecast criterion: 0.5 monthly standard deviation (black lines)

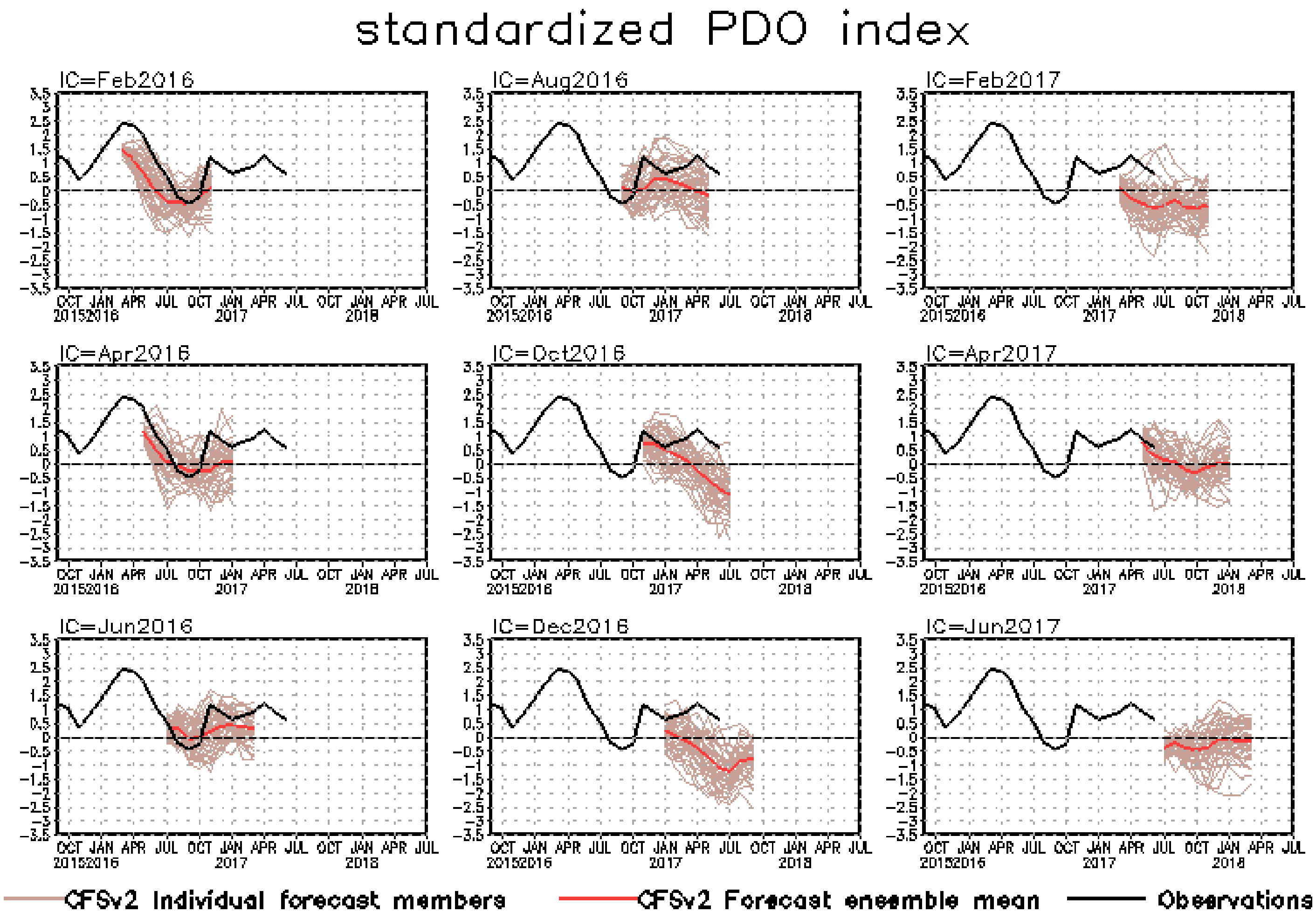


- Both WWV and CTP indices are within 0.5 STD in Jun 2017, indicating a high probability of neutral conditions during winter 2017/18.

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.

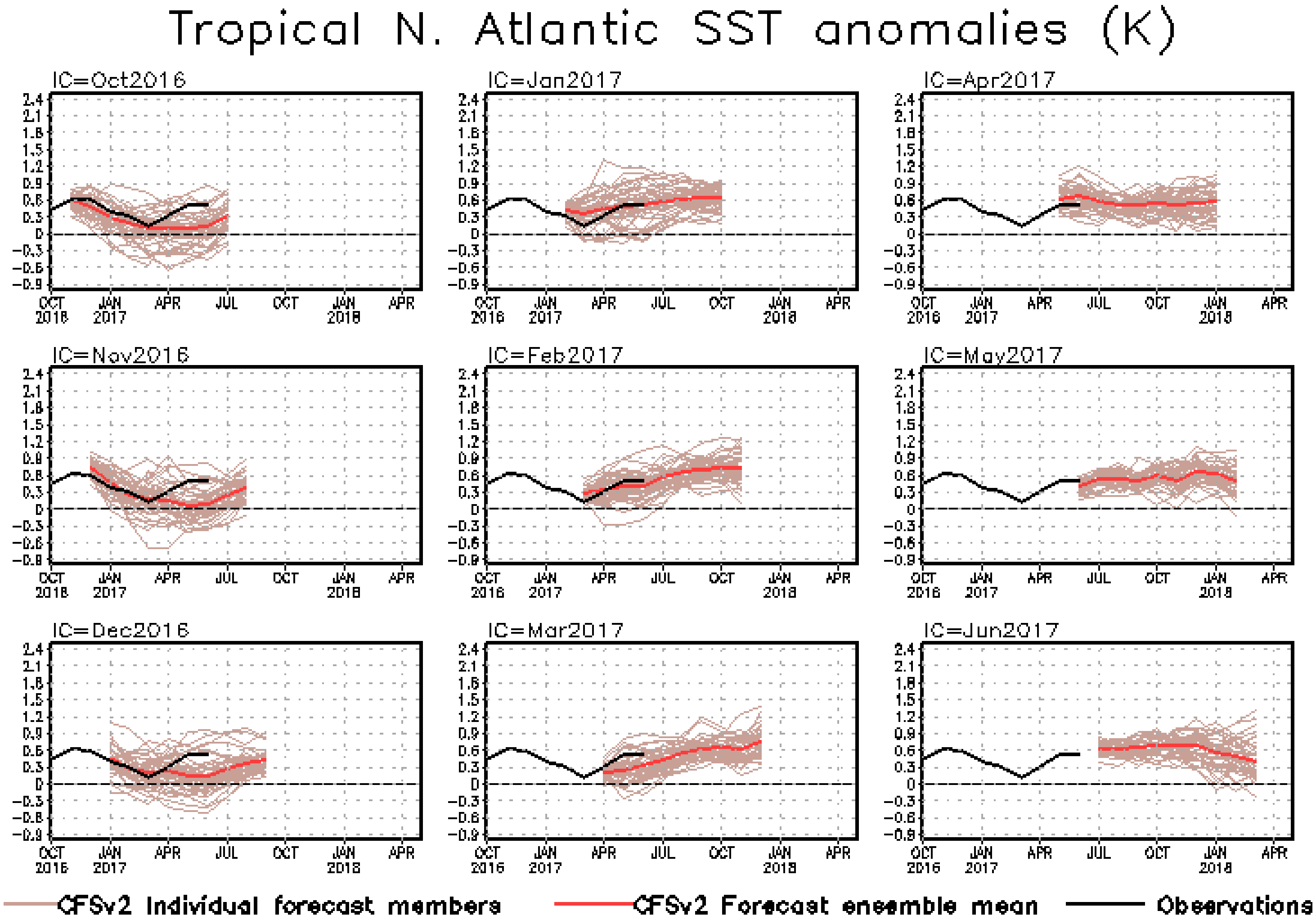


- CFSv2 predicts a neutral phase of PDO in 2017.

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.

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

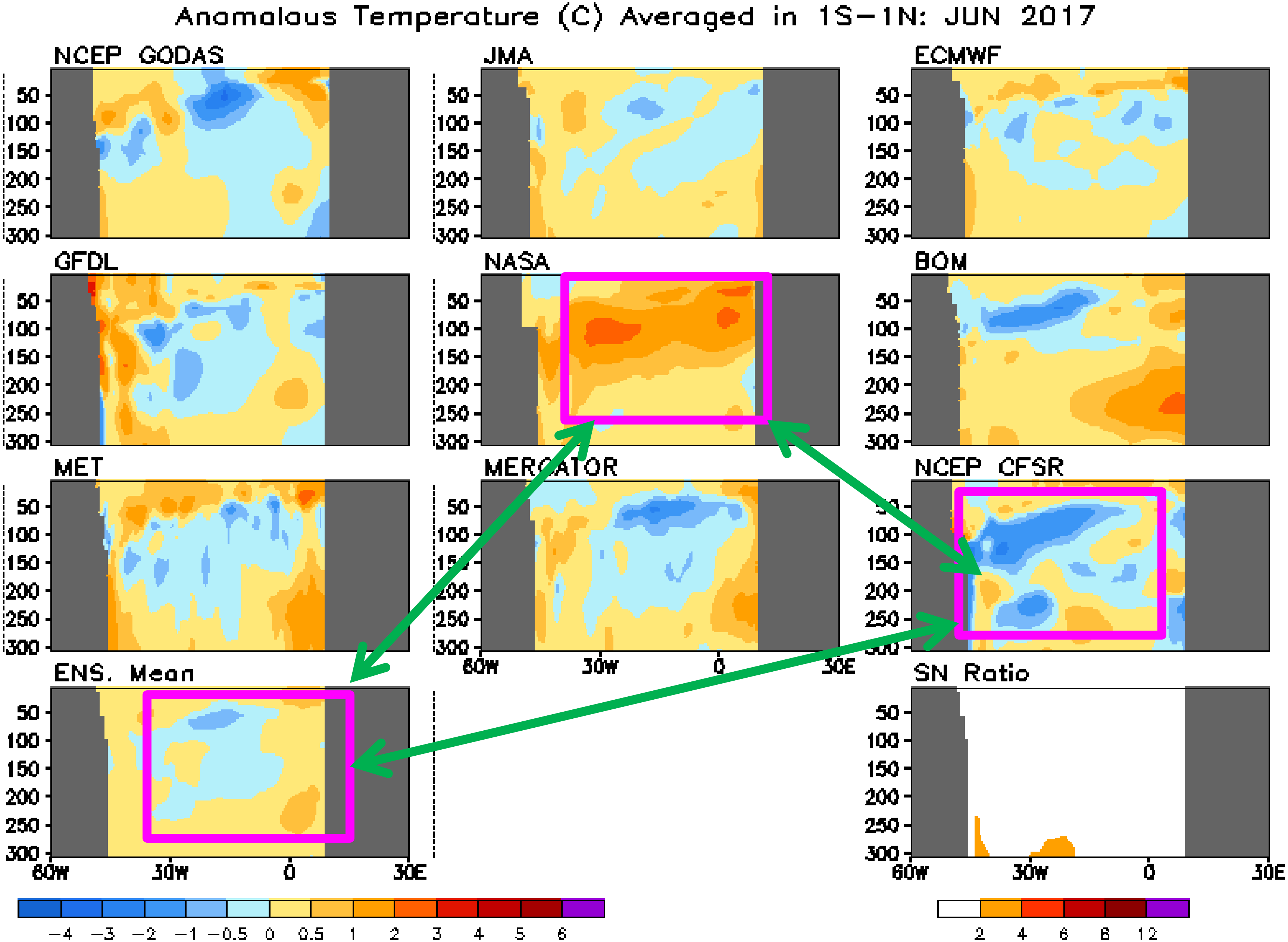
TNA is the SST anomaly averaged in the region of [60°W-30°W, 5°N-20°N].



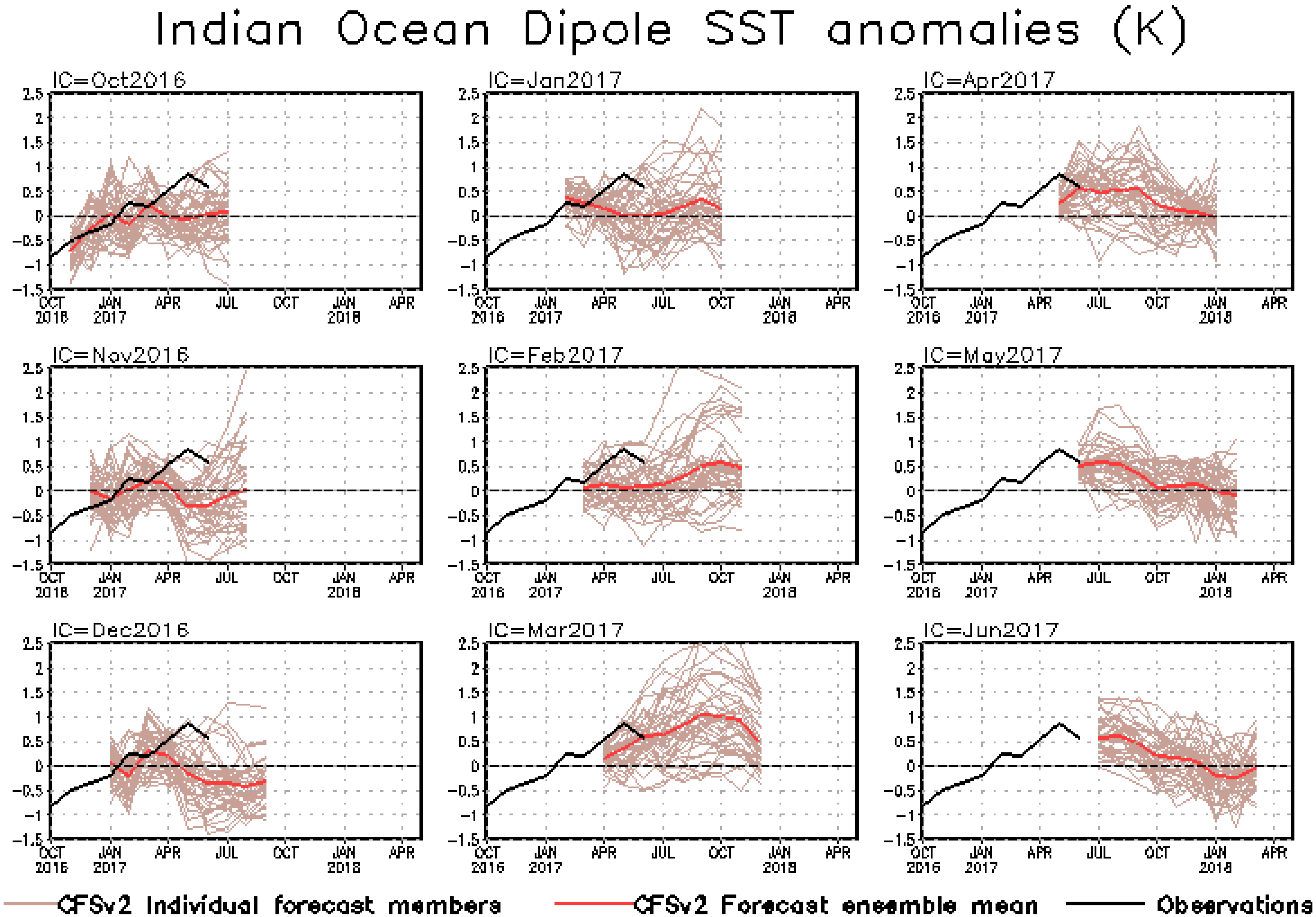
- Latest CFSv2 predictions call persistently above normal SST in the tropical N. Atlantic in 2017.

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.

CFSR (NASA) was much cooler (warmer) than the ensemble mean along the thermocline of Atlantic



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.

Acknowledgements

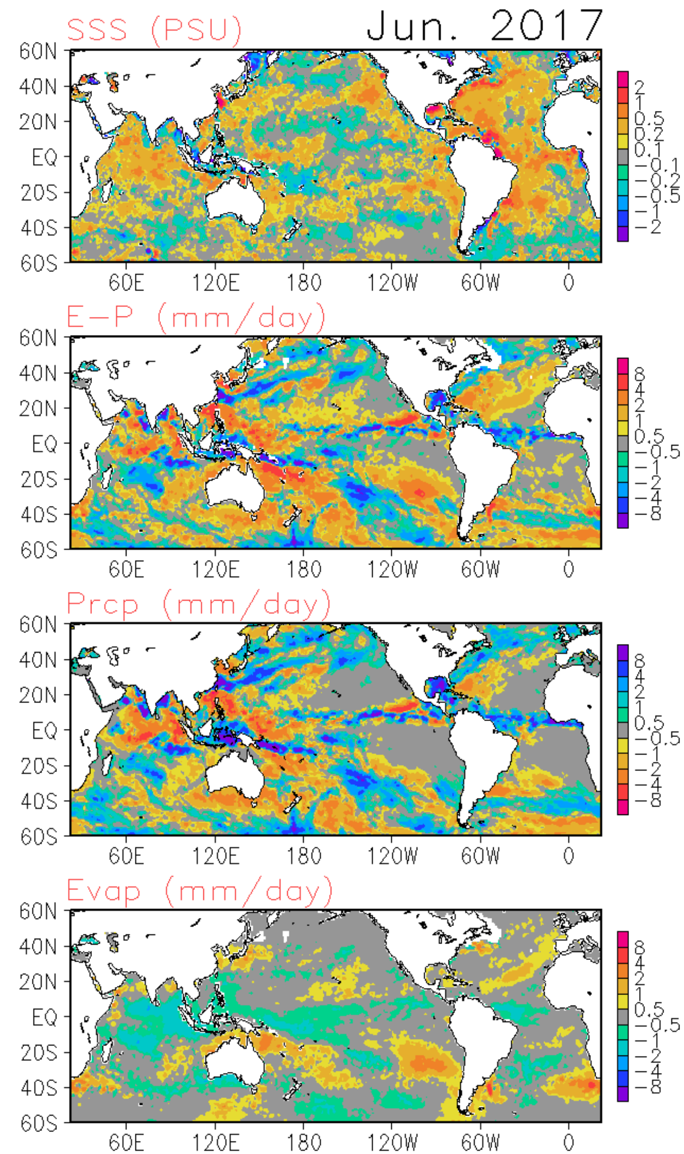
- Drs. Caihong Wen, Arun Kumar, and Yan Xue: reviewed PPT, and provide insight and constructive suggestions and comments
- Dr. Caihong Wen: Prepared slides 42-43.
- Drs. Li Ren and Pingping Xie: Provided SSS slides
- Dr. Emily Becker: Provided NMME plots
- Dr. Peitao Peng: Provide Analog forecast plots
- Drs. Thomas Collow and Wanqiu Wang: Supplied sea ice slides
- Dr. Kathleen Dohan: Updated OSCAR current

Backup Slides

Global Sea Surface Salinity (SSS)

Anomaly for June 2017

- 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 SSS anomaly in the majority of the Indian Ocean (north of 20°S) is positive, except some areas in the Bay of Bengal. Such anomalies are likely caused by the reduction of the net freshwater input caused by less of precipitation. The positive SSS anomaly continues in the Atlantic ocean from 40°S to 40°N with stronger signals along the Gulf Stream. The negative SSS anomaly in the subartic N. Pacific ocean (40°N to 60°N) continues, while, the negative SSS anomaly between the equator and 20°N became weaker. In the west basin of the Equatorial Pacific region, the SSS anomaly became positive.



- **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

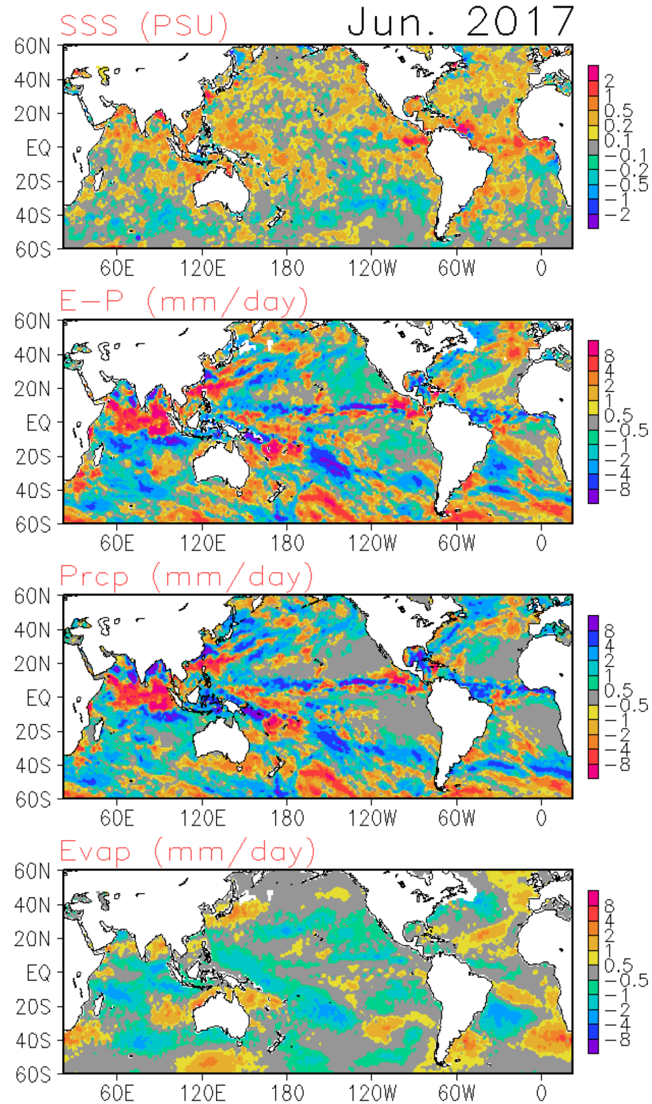
  Precipitation: CMORPH adjusted satellite precipitation estimates

  Evaporation: CFS Reanalysis

Global Sea Surface Salinity (SSS)

Tendency for June 2017

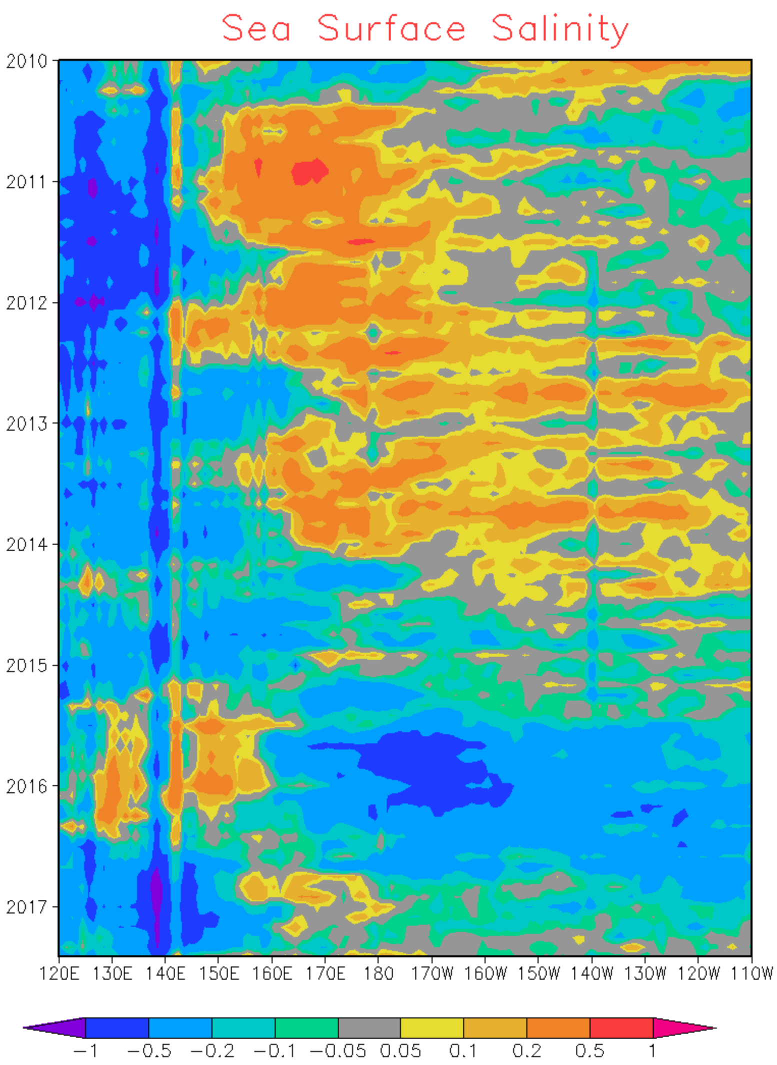
Compared with last month, the salinity in most area of the N. Pacific and N. Atlantic Ocean shows increases. Specifically, the SSS in the west basin of equatorial Pacific Ocean and along the equator in the Atlantic Ocean significantly increased. The SSS increase in the Atlantic Ocean is likely caused by the ocean current/mixing process. However, the SSS increase in the western equatorial Pacific Ocean is caused by the reduction of precipitation in this region. A strong reduction of net freshwater flux input between Equator and 20°N of the Indian Ocean led to the SSS increase in this region.



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

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

- In the western equatorial Pacific Ocean, from 120°E to 150°E, the negative SSS signal continues. While, the SSS anomaly in the central equatorial Pacific region between 155°E to 170°W started to changing from neutral to positive condition this month. The SSS is likely becoming negative east of 170°W. The signals in both the central and east equatorial Pacific Ocean are weak.

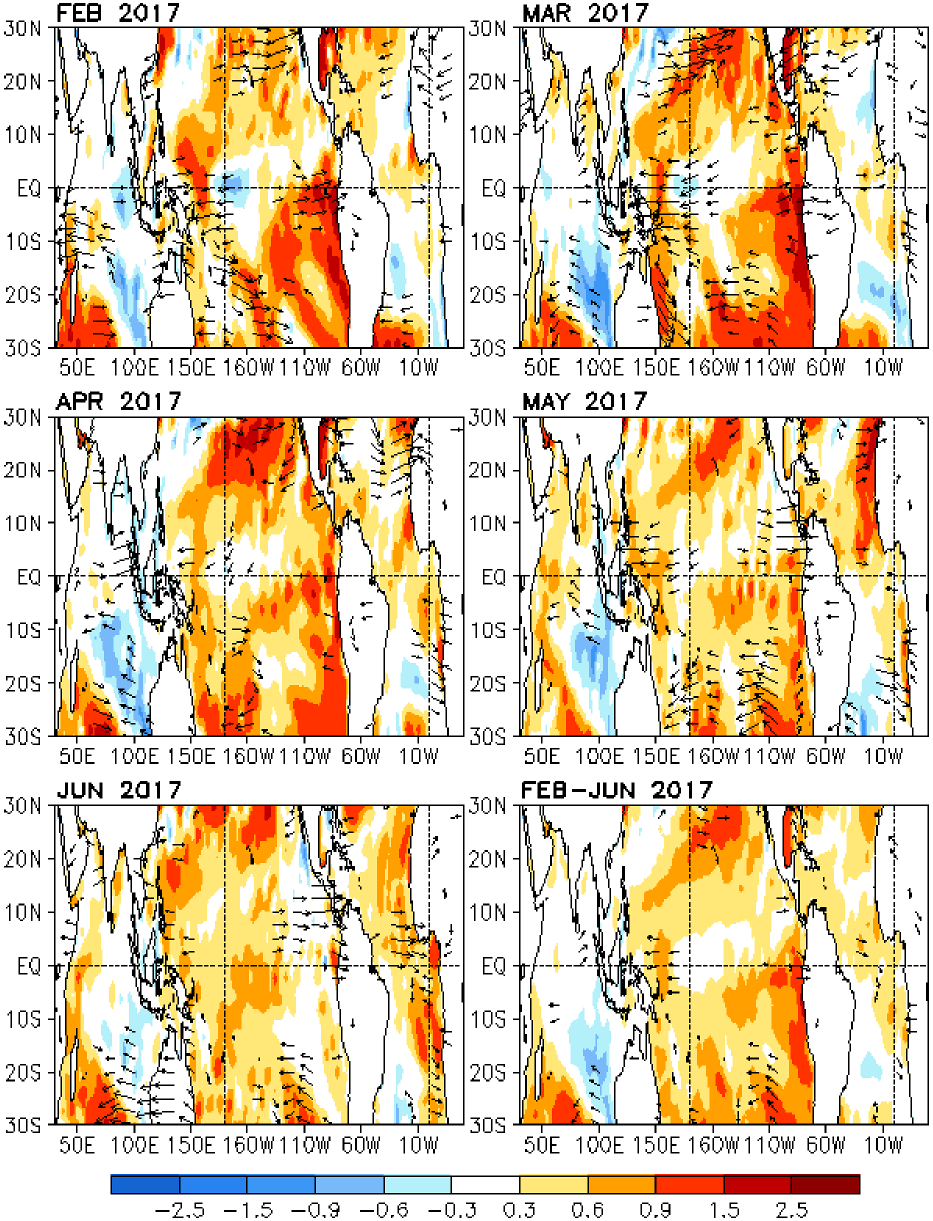


Data Sources and References

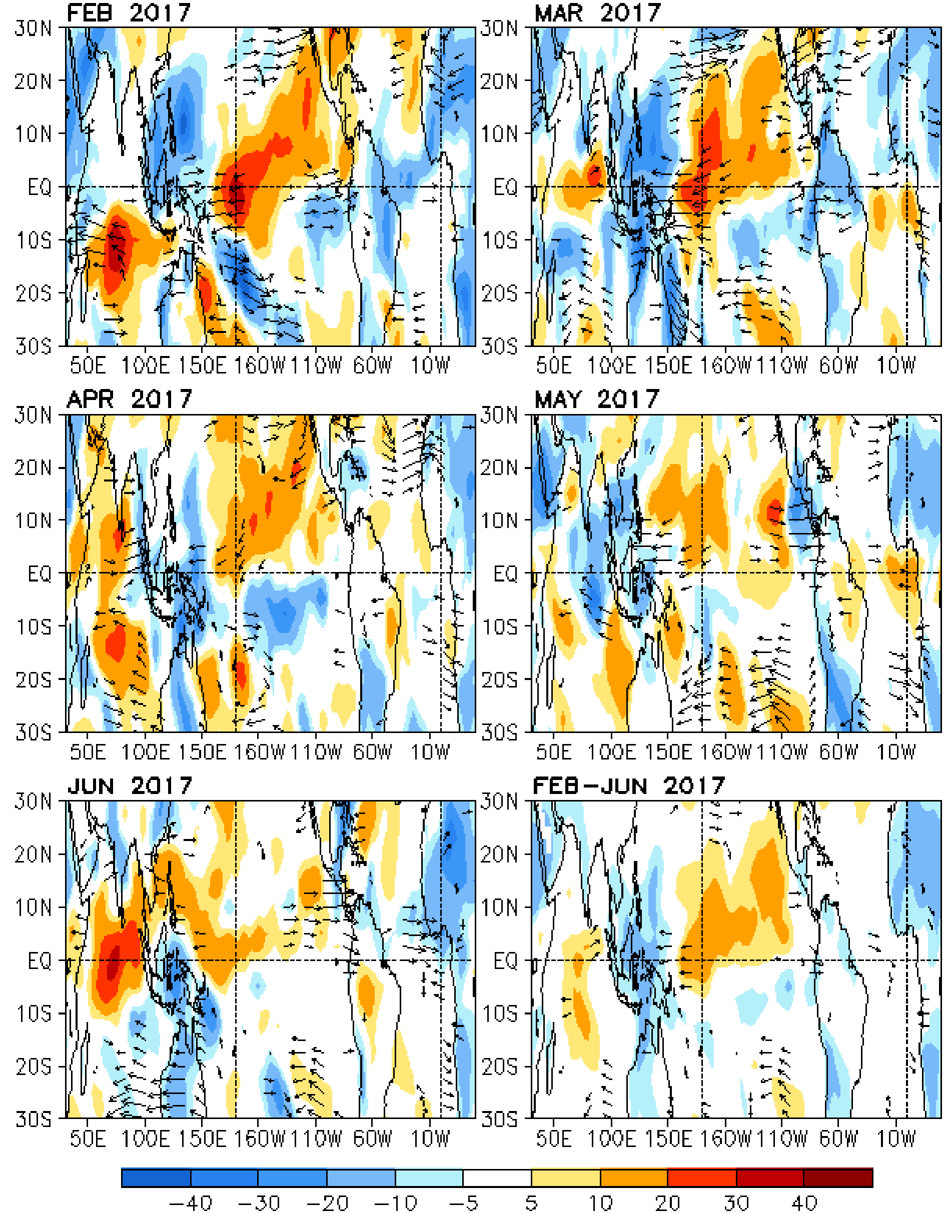
- **Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)**
- **NCEP CDAS winds, surface radiation and heat fluxes**
- **NESDIS Outgoing Long-wave Radiation**
- **NDBC TAO data (http://tao.ndbc.noaa.gov)**
- **PMEL TAO equatorial temperature analysis**
- **NCEP's Global Ocean Data Assimilation System temperature, heat content, currents (Behringer and Xue 2004)**
- **Aviso Altimetry Sea Surface Height**
- **Ocean Surface Current Analyses – Realtime (OSCAR)**

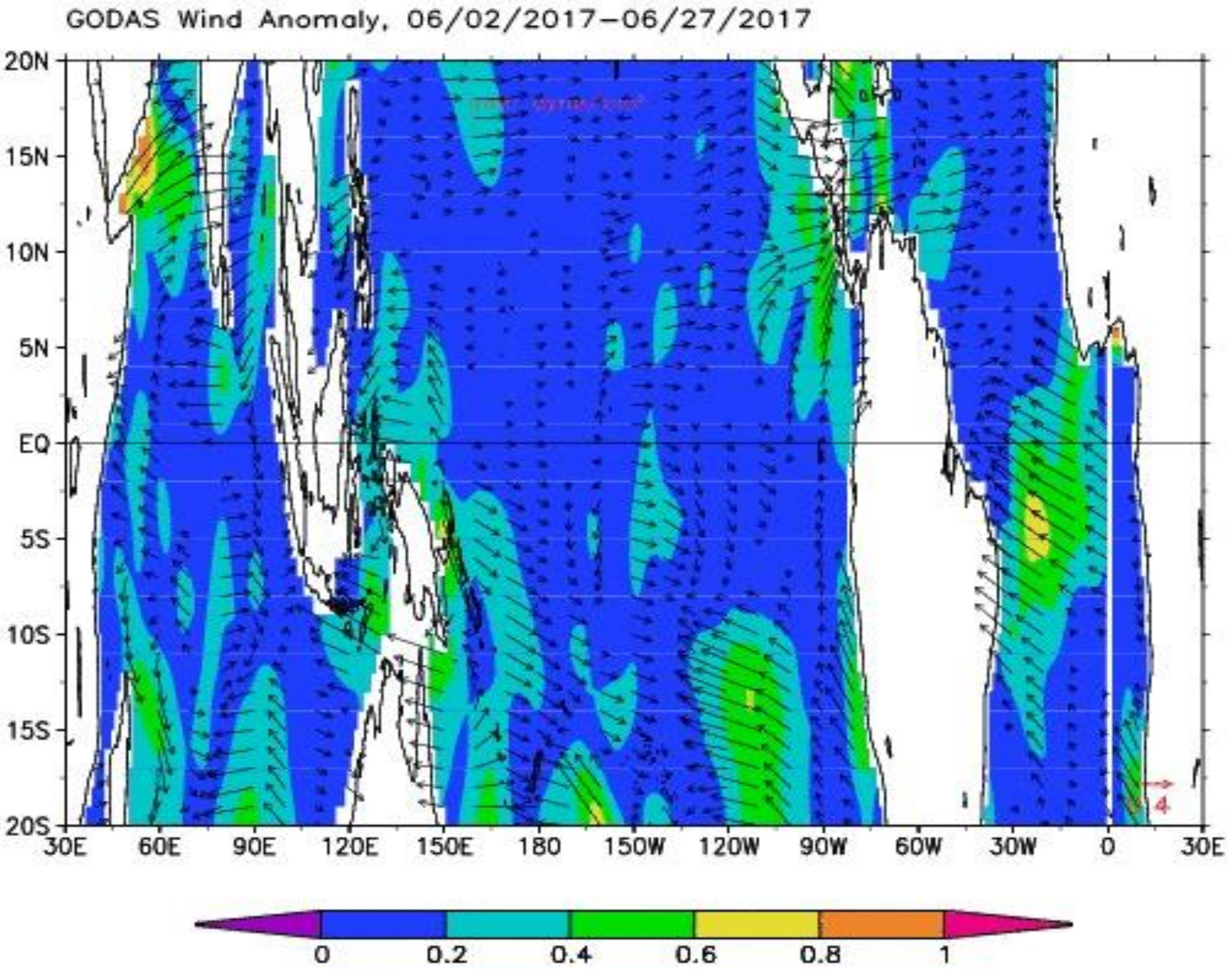
Please send your comments and suggestions to Yan.Xue@noaa.gov. Thanks!

SST and uv850



OLR and uv850





GODAS Wind Anomaly, 06/02/2017-06/27/2017
20N
15N
10N
5N
EQ
5S
10S
15S
20S
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
30E
4
0
0.2
0.4
0.6
0.8
1

Failure Forecast in 2012 with ICs in Mar-Nov 2012