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

Prepared by

Climate Prediction Center, NCEP/NOAA

July 12, 2018

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**

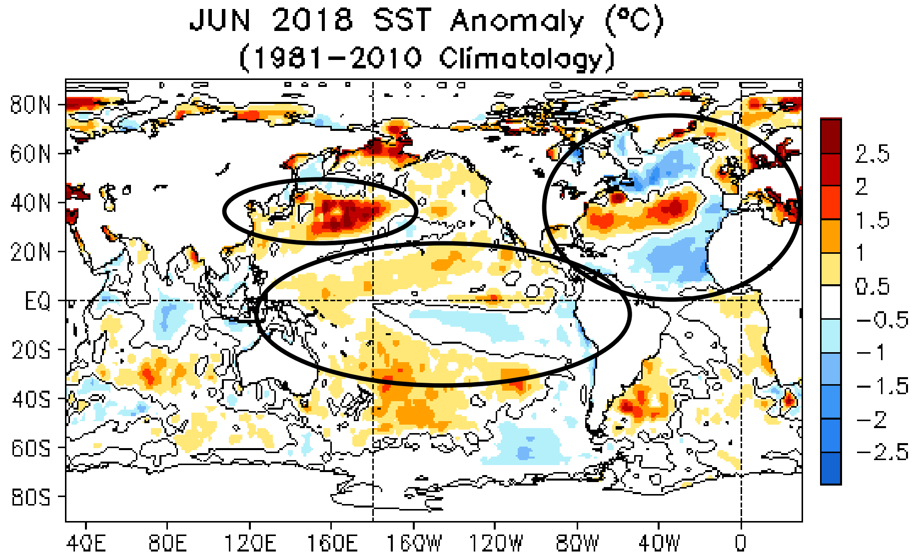
- ***ENSO Status, Forecast and Three ENSO Precursor Indices***
- ***Variations in North Atlantic SST and Ocean Heat Content***
- ***New Pentad Sea Surface Salinity Monitoring Products***

Overview

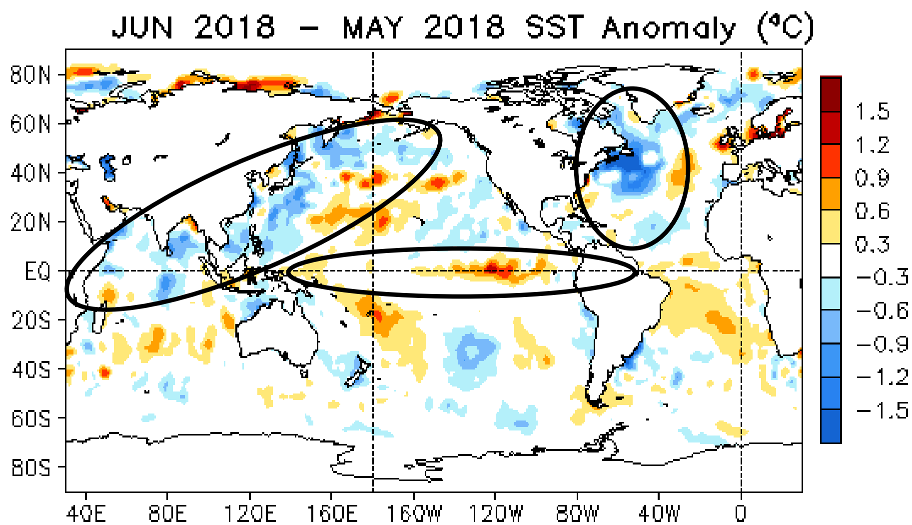
- **Pacific Ocean**
  - NOAA "ENSO Diagnostic Discussion" on 12 Jul 2018 issued: "ENSO-neutral is favored through Northern Hemisphere summer 2018, with the chance for El Niño increasing to 60-65% during fall, and to about 70% during winter 2018-19."
  - SSTAs were small in the central and eastern tropical Pacific with NINO3.4= +0.2^{o}C in Jun 2018.
  - Positive subsurface ocean temperature anomalies were present in the equatorial Pacific in Jun 2018.
  - SSTAs were positive in the N. Pacific with PDOI=-0.5 in Jun 2018.
- **Indian Ocean**
  - SSTAs were small in the tropical Indian Ocean.
- **Atlantic Ocean**
  - Positive NAO has persisted in Apr-Jun 2018 with NAOI=+1.4 in Jun 2018.
  - SST/HC300 anomalies have a tripole/horseshoe pattern with large positive anomalies in the middle latitudes of N. Atlantic and negative in lower and higher latitudes, which resembled the early 2014 and 2015 period.

<u>Global Oceans</u>

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



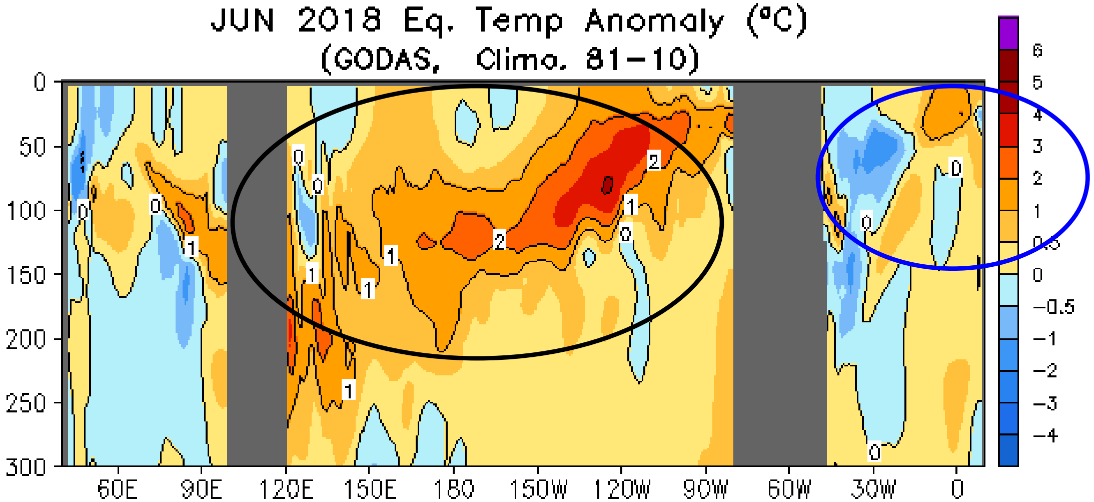
- **Positive (negative) SSTAs presented along the eq. Pacific, the northeast and southwest Pacific (southeast Pacific).**
- **Strong positive SSTAs presented in the western N. Pacific.**
- **Horseshoe / tripole-like SSTA pattern presented in the N. Atlantic.**
- **SSTAs were small in the tropical Indian Ocean.**



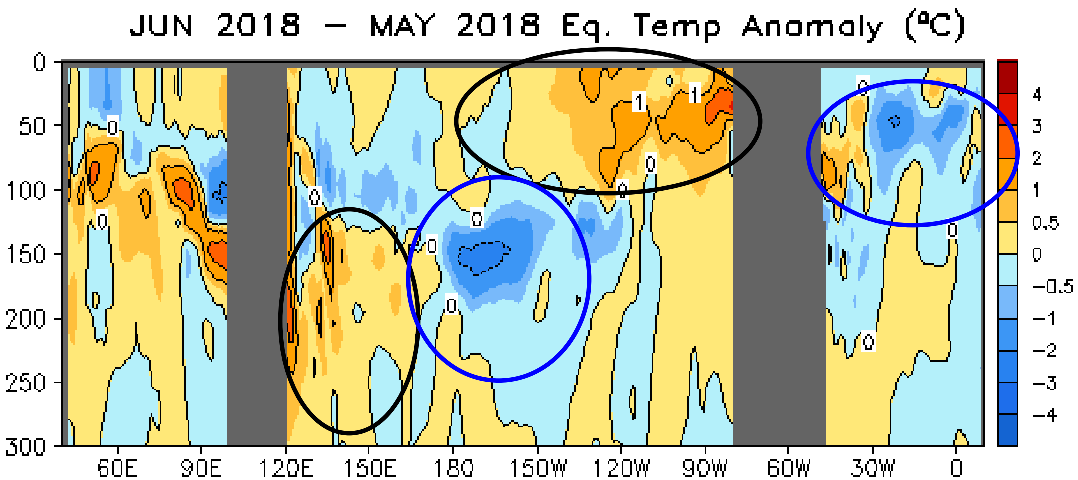
- **Positive SSTA tendencies were observed in the central-eastern equatorial Pacific.**
- **Negative SSTA tendencies were seen in the NW Pacific and NW Atlantic.**

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



- **Positive temperature anomalies presented along the thermocline in the equatorial Pacific.**
- **Positive (negative) anomalies were observed along the thermocline in the eastern (western) Atlantic Ocean.**

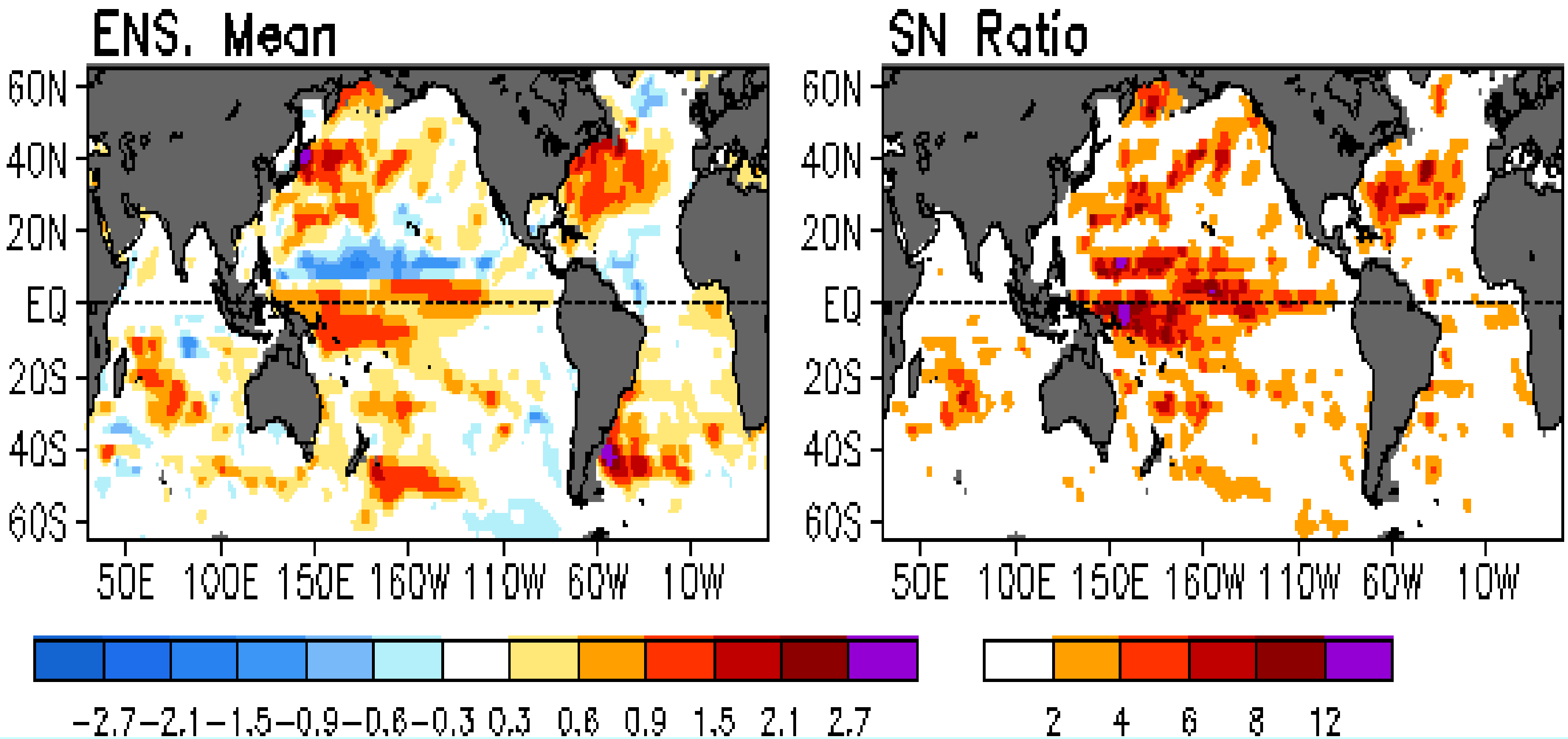


- **There was a tripole tendency pattern in the Pacific: positive in the west and east, and negative in the central.**
- **Positive (negative) tendencies were seen along the thermocline in the western (central-eastern) Atlantic Ocean.**

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

Upper 300m Ocean Heat Content Anom. from Real-Time Ocean Reanalysis Intercomparison

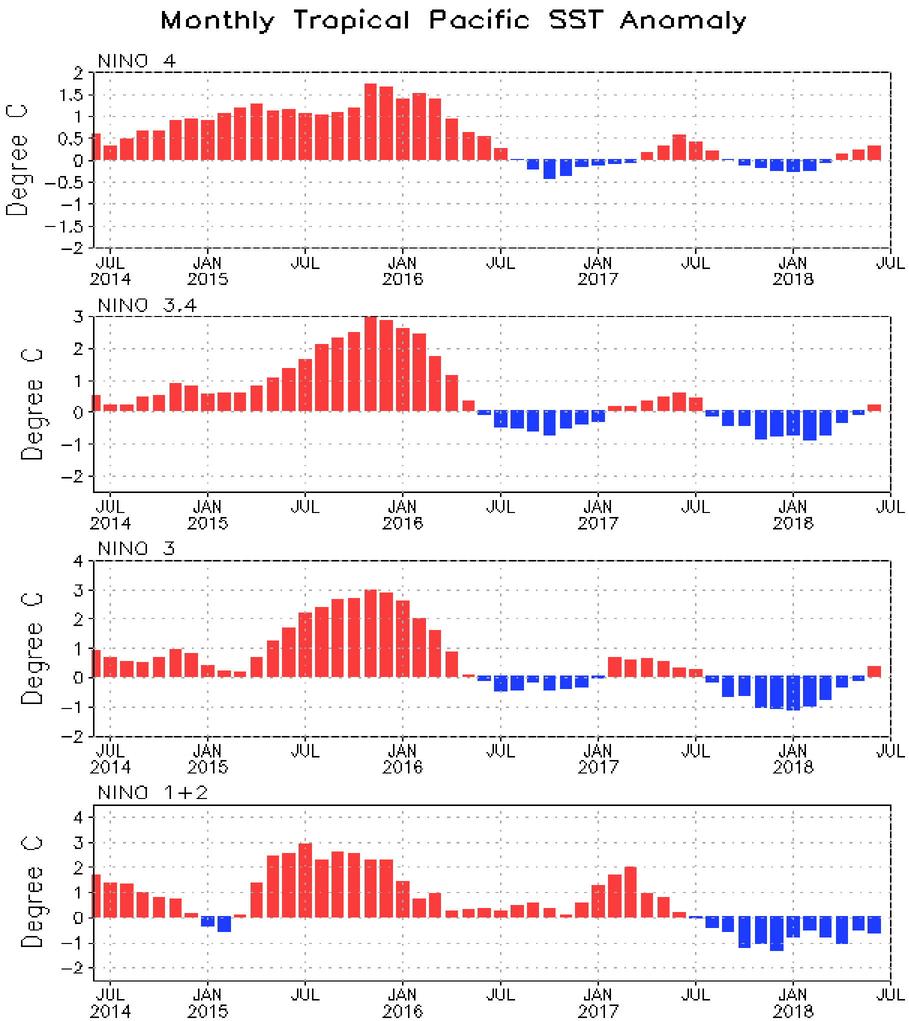
http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html

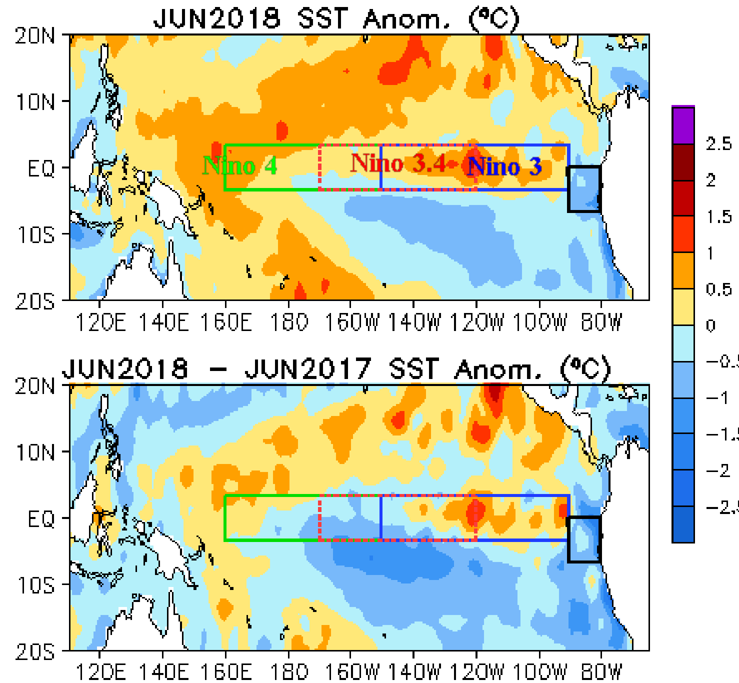


- According to the ensemble mean of six ocean reanalyses, upper 300m ocean heat content was above-average in the eq. Pacific and southwest Pacific, N. Pacific, N. Atlantic, and SW Indian Ocean, while below-average along 10N in the subtropical Pacific.
- The ratio of the ensemble mean (signal) and ensemble spread (noise) suggests that the signal is reliable in the tropical Pacific, part of N. Pacific, N. Atlantic and SW Indian Ocean.

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific NINO SST Indices





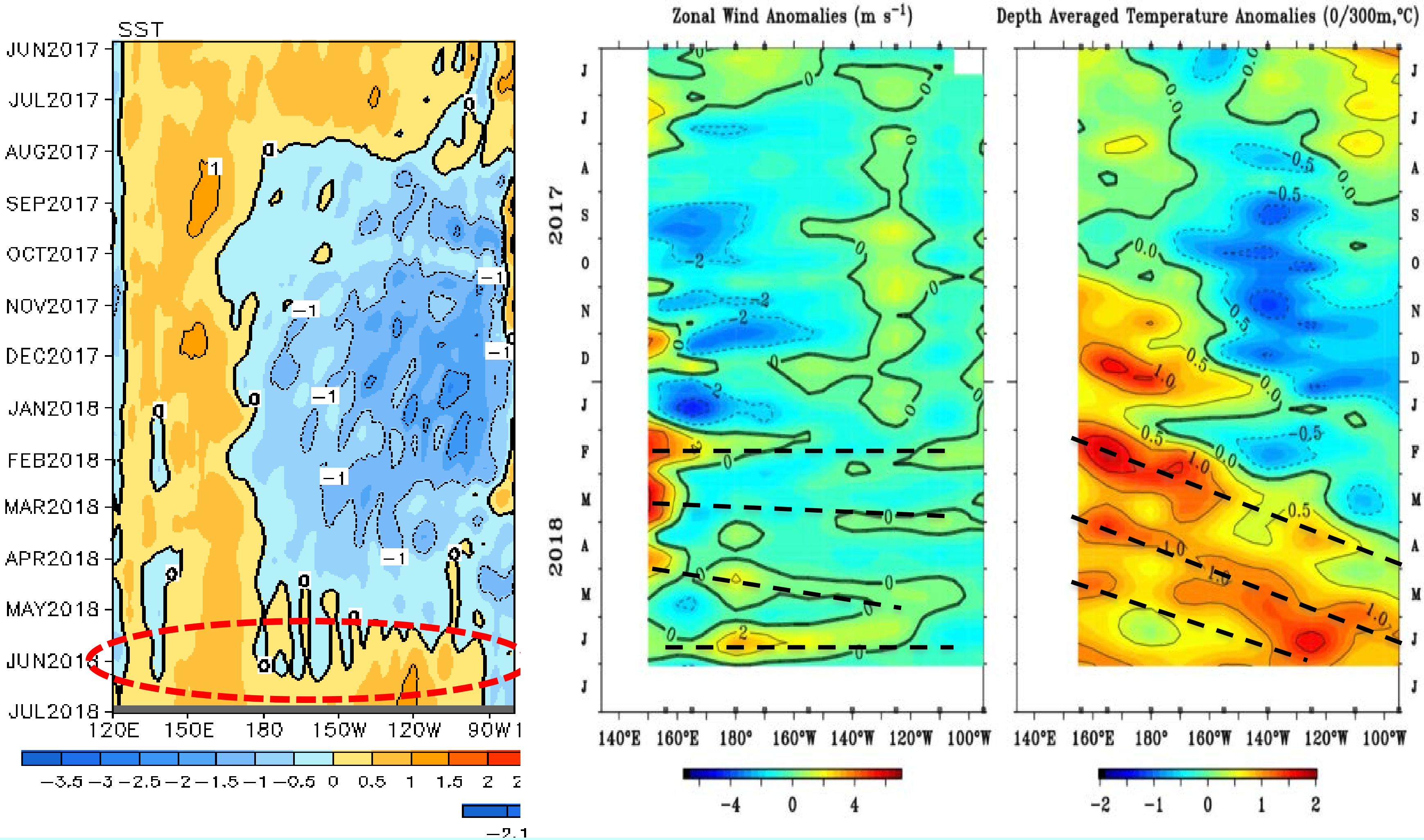
- All Nino indices were positive in Jun 2018 except Nino1+2.

- Nino3.4 = +0.2 C in Jun 2018.

- The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v5.

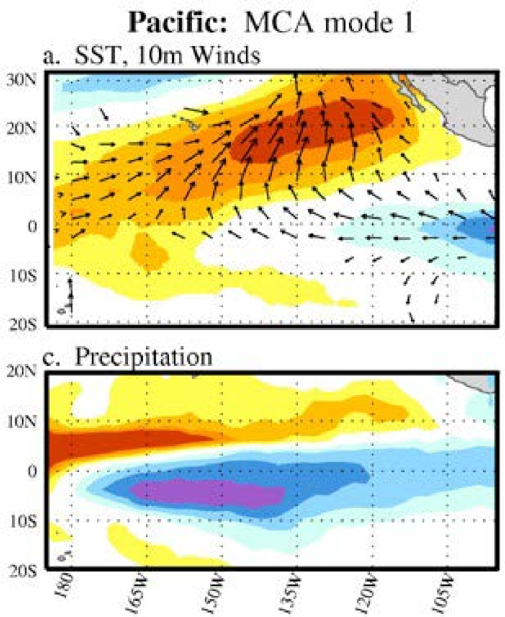
Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

Equatorial (2S-2N) Pacific SST (°C), Surface Zonal Wind (m/s) and HC300 (°C) Anomalies

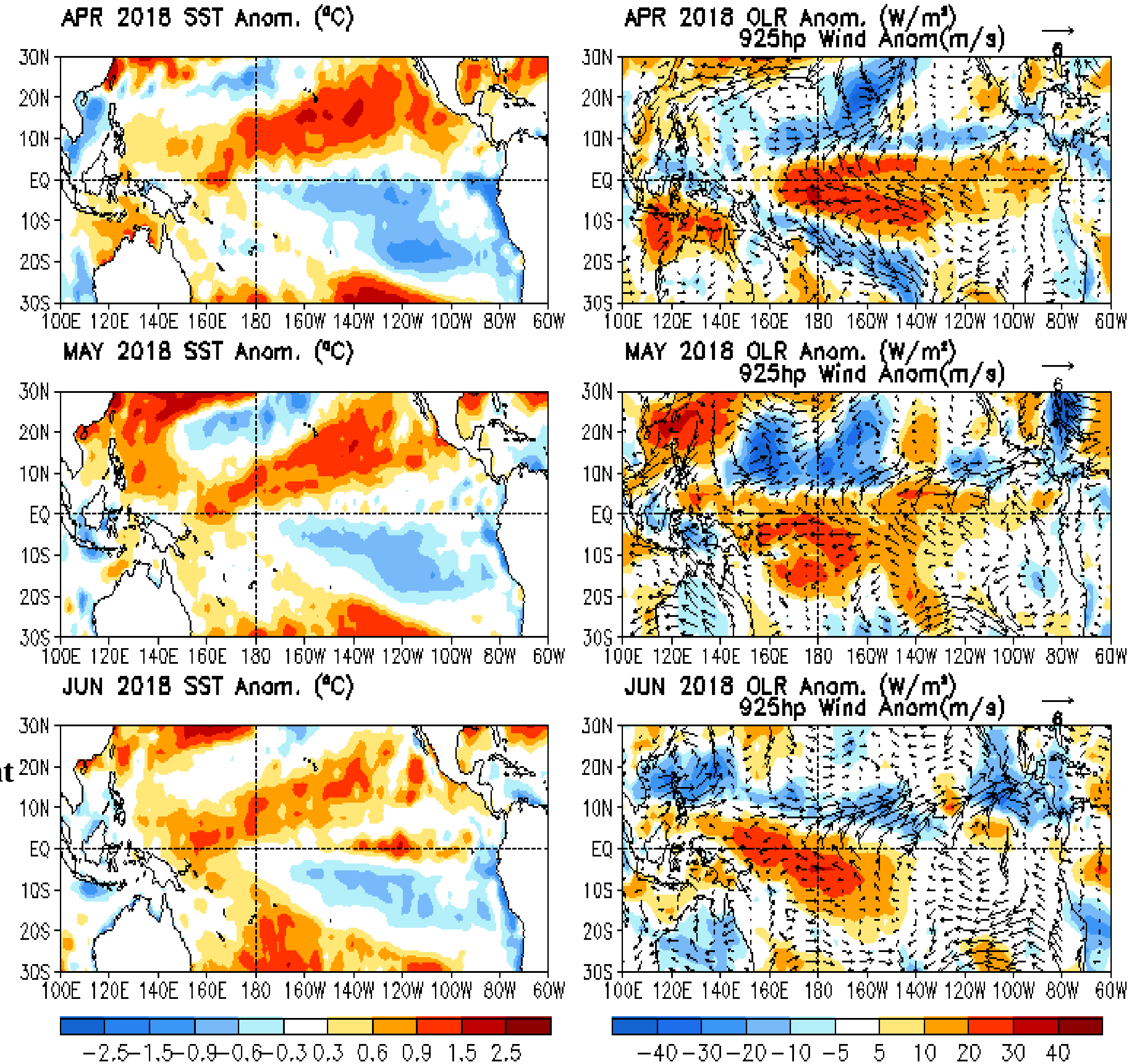


- **SSTA switched to positive in the central and eastern eq. Pacific in late May 2018.**
- **Three downwelling oceanic Kelvin waves propagated eastward in Feb-Jun 2018, which were associated with three westerly wind bursts in Feb, Mar and late Apr 2018 respectively.**

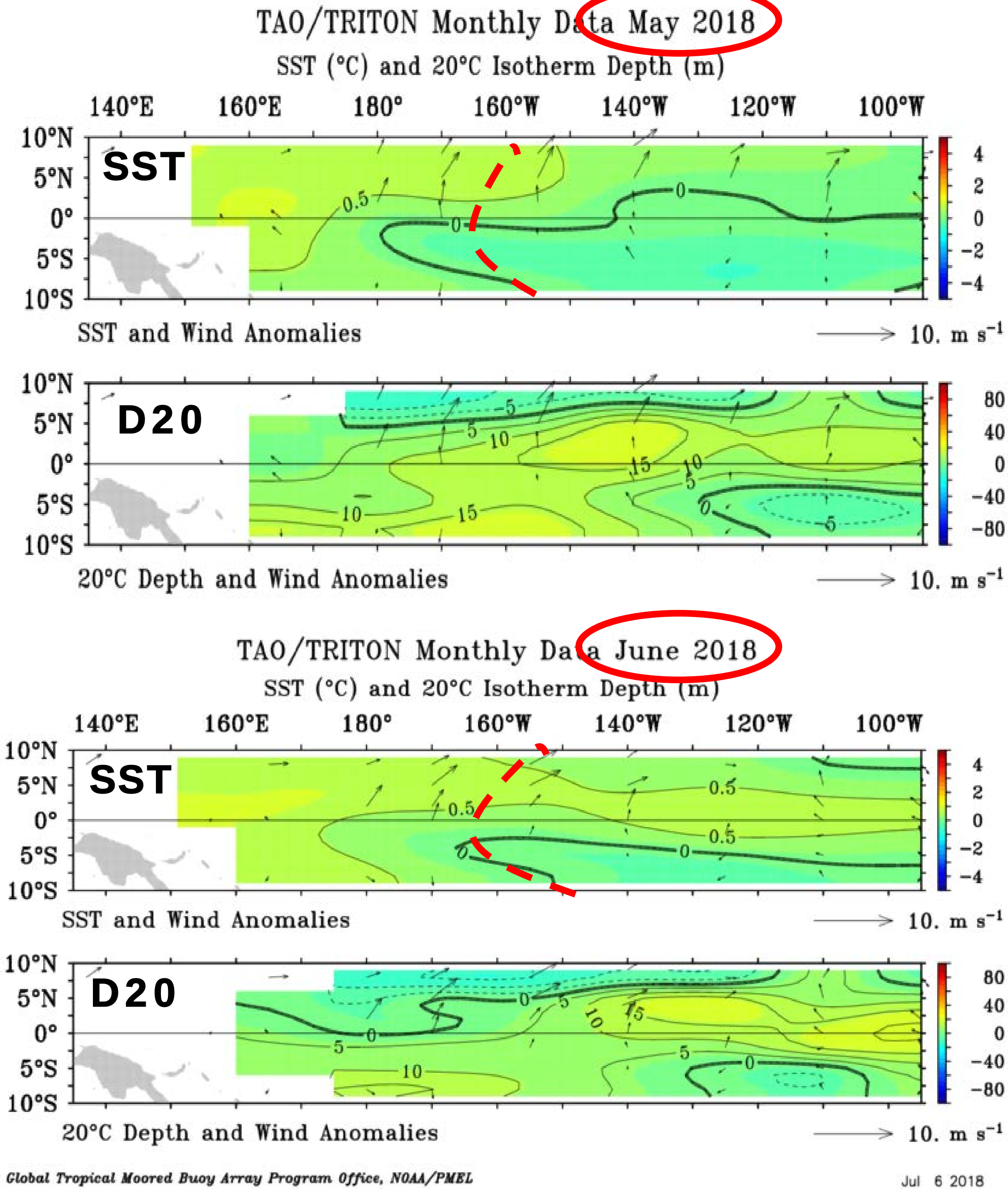
North Pacific Meridional Mode (NPMM)



http://www.aos.wisc.edu/~dvimont/MModes/Home.html



- **The patterns of SST, surface winds and OLR anomalies largely persisted in Apr-Jun 2018, and resemble the North Pacific Meridional Mode (NPMM) that are characterized by north-south SSTA dipole, cross equatorial wind anomalies, and enhanced (suppressed) convection north of the equator (on the equator).**



https://www.pmel.noaa.gov/tao/drupal/disdel/

- **In May and Jun 2018, the SST / Wind anomalies resemble the North Pacific Meridional Mode (NPMM): C-shape wind anomaly across the equator towards positive SSTA north of the eq.**

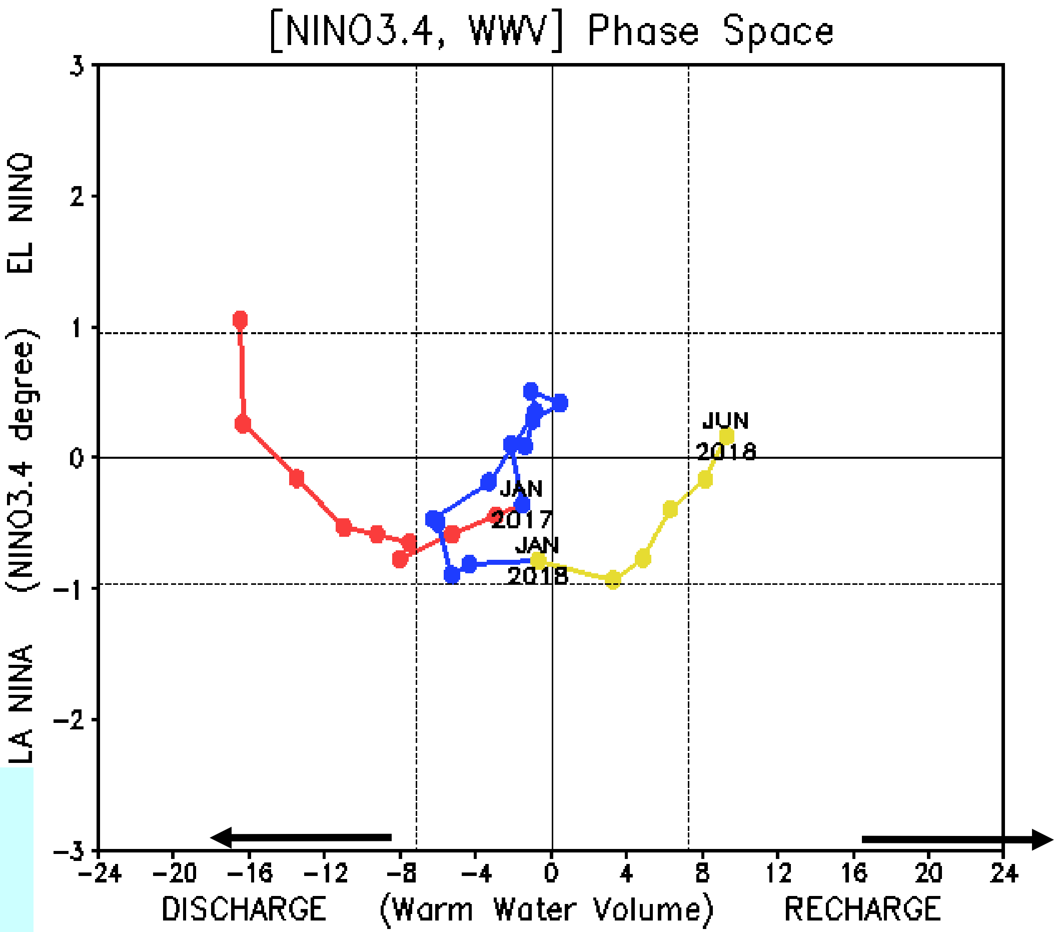
- **Positive D20 anom. in the eastern Pacific was consistent with the emergency of positive SSTA in the region.**

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).

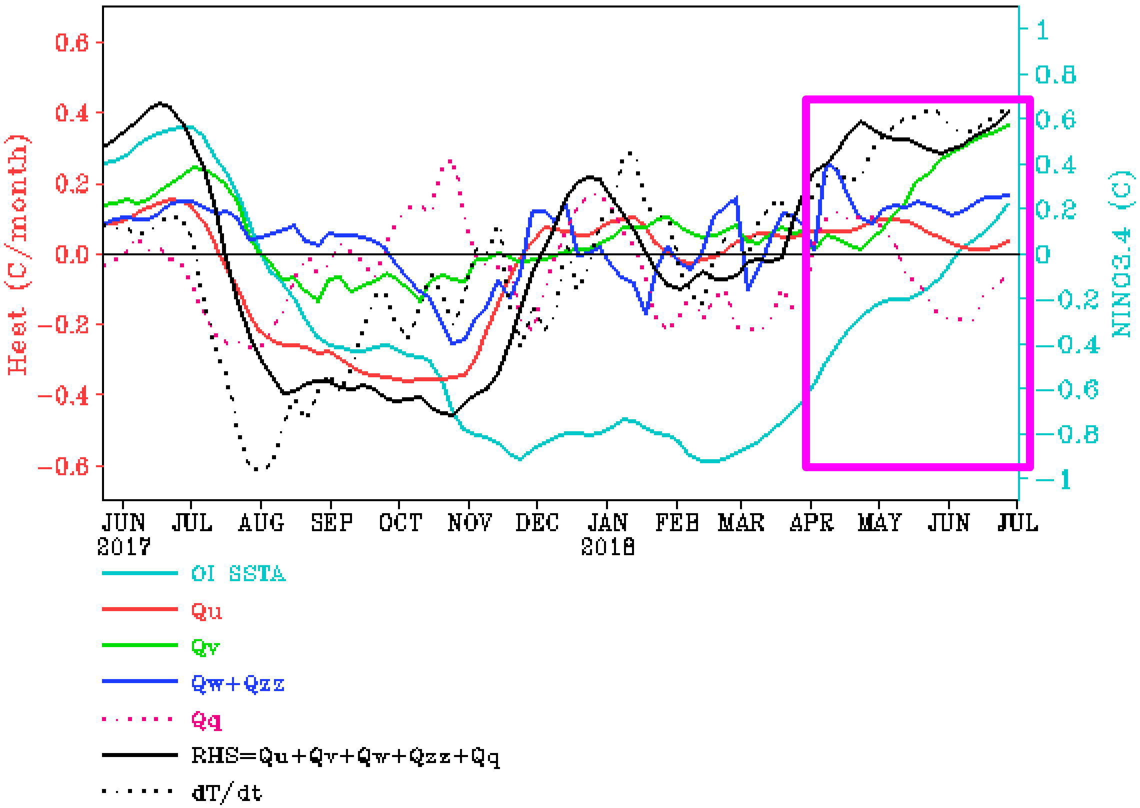
- Increase (decrease) of WWV indicates recharge (discharge) of the equatorial oceanic heat content.



- Equatorial Warm Water Volume (WWV) indicated a steady recharging in Feb-Jun 2018, favorable for El Nino development.

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

NINO3.4 Heat Budget



- **Both observed SSTA tendencies (dT/dt; dotted black line) and total heat budget (RHS; solid black line) in the Nino3.4 region were positive since later Mar 2018.**

- **All dynamical terms (Qu, Qv, Qw+Qzz) were positive, and total heat-flux (Qq) was negative in last month.**

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;

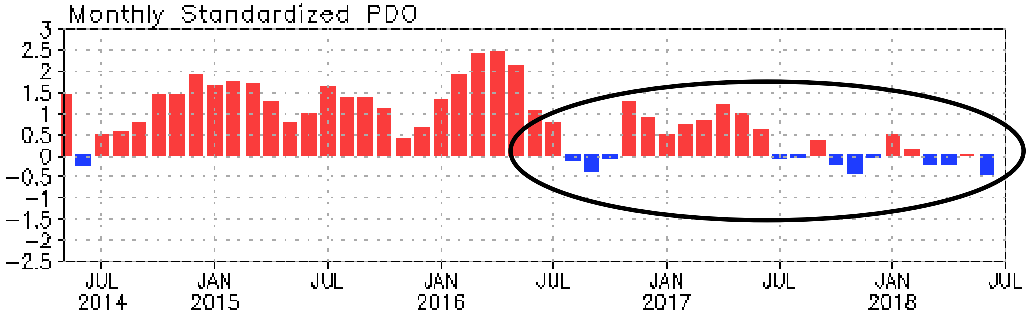
Qw: Vertical entrainment; Qzz: Vertical diffusion

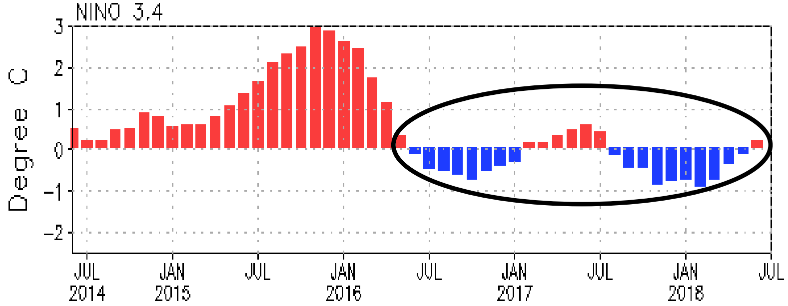
Qq: (Qnet - Qpen + Qcorr)/ρcph; Qnet = SW + LW + LH +SH;

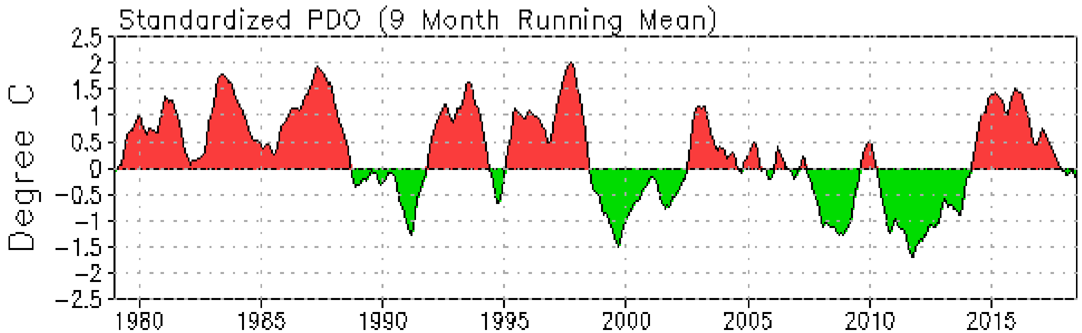
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

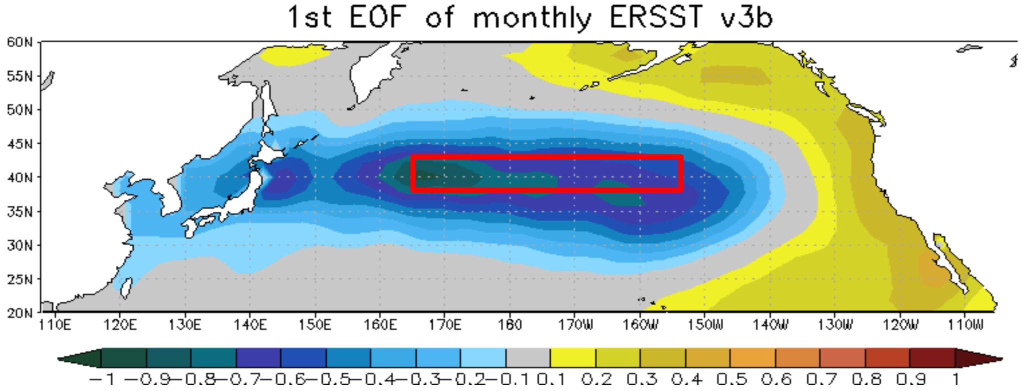
North Pacific & Arctic Oceans

PDO index









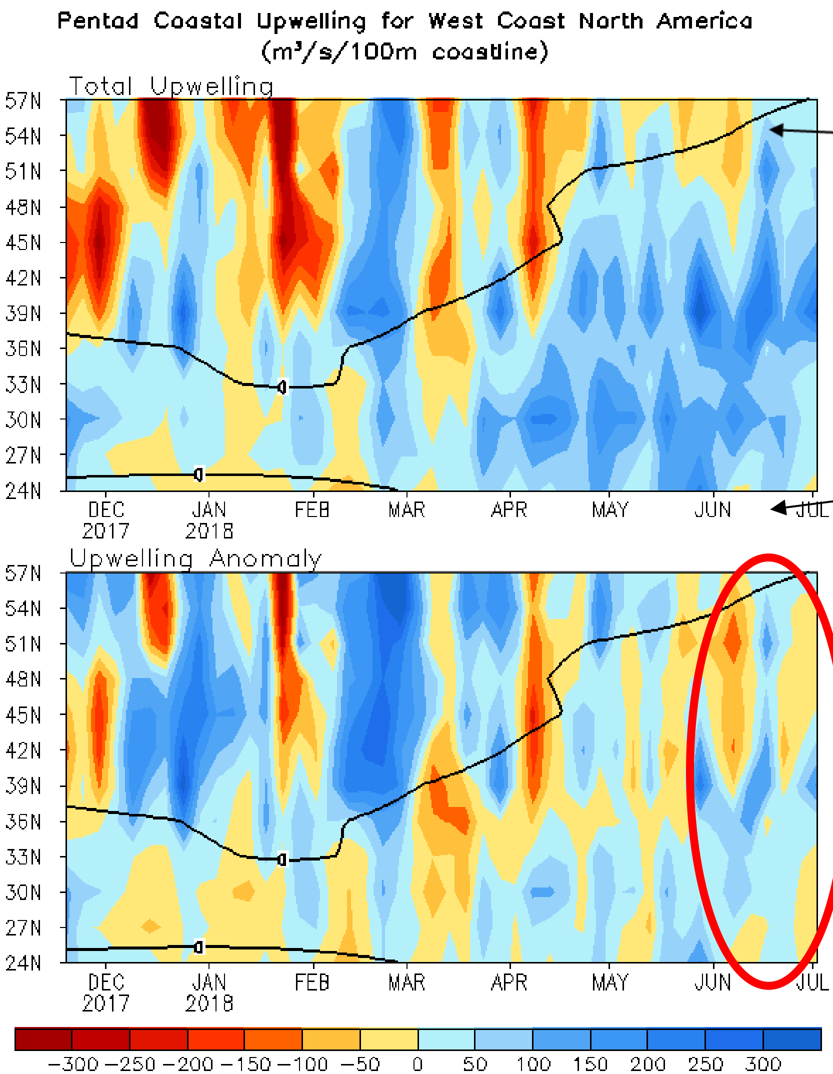
- **Positive SSTAs presented in the central North Pacific with PDO index =-0.5 in Jun 2018.**

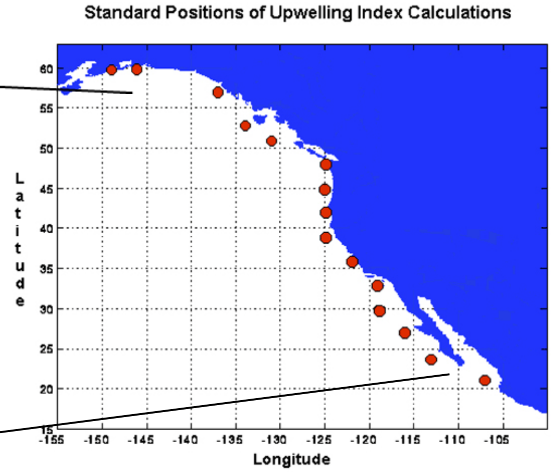
- **Statistically, ENSO leads PDO by 3-4 months, may through atmospheric bridge.**

- **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 America Western Coastal Upwelling





- **Both anomalous upwelling and downwelling were small.**

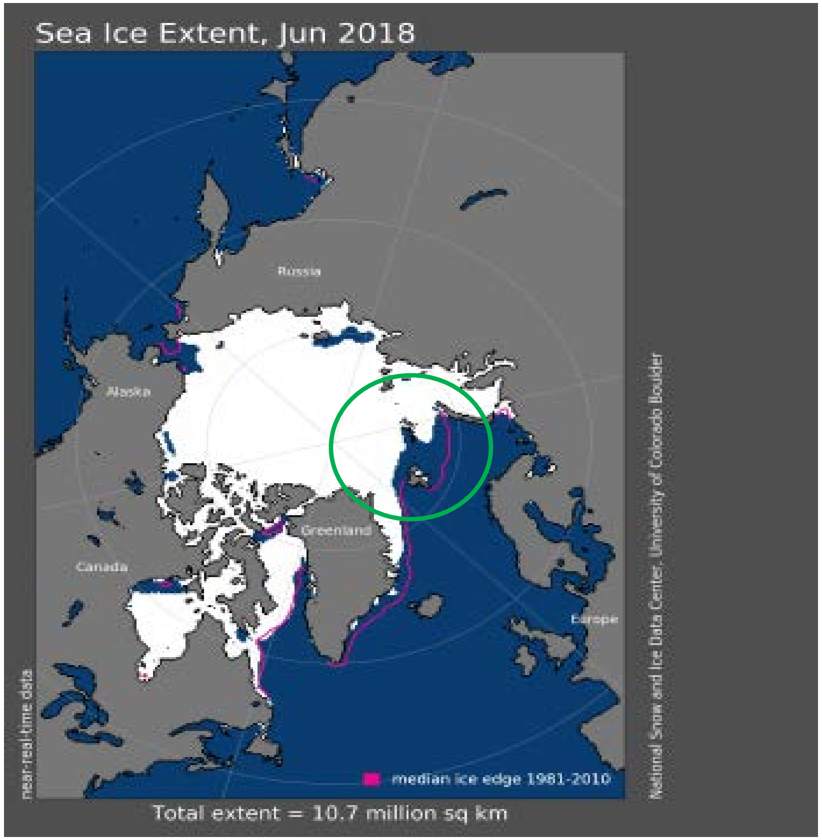
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport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

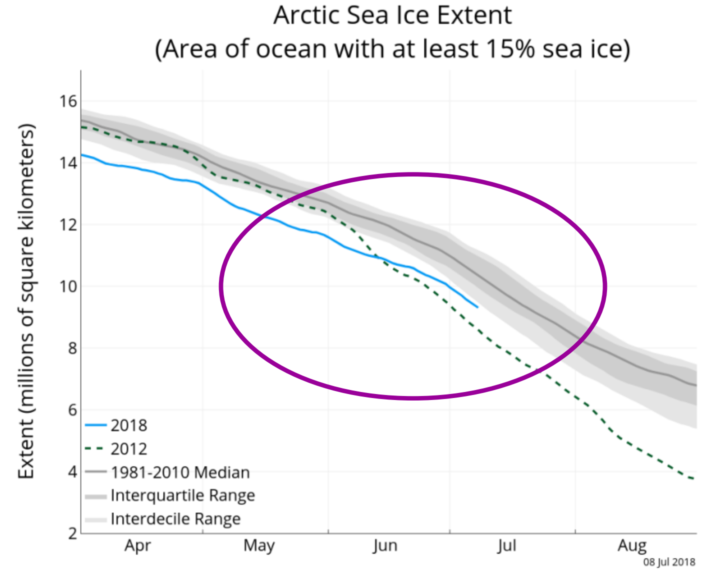
- **Area below (above) black line indicates climatological upwelling (downwelling) season.**
- **Climatologically upwelling season progresses from Mayil to July along the west coast of North America from 36°N to 57°N.**

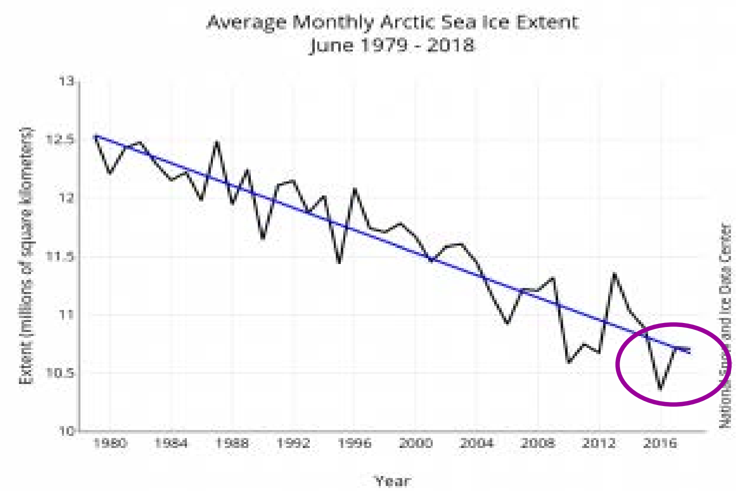
Arctic Sea Ice

National Snow and Ice Data Center

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

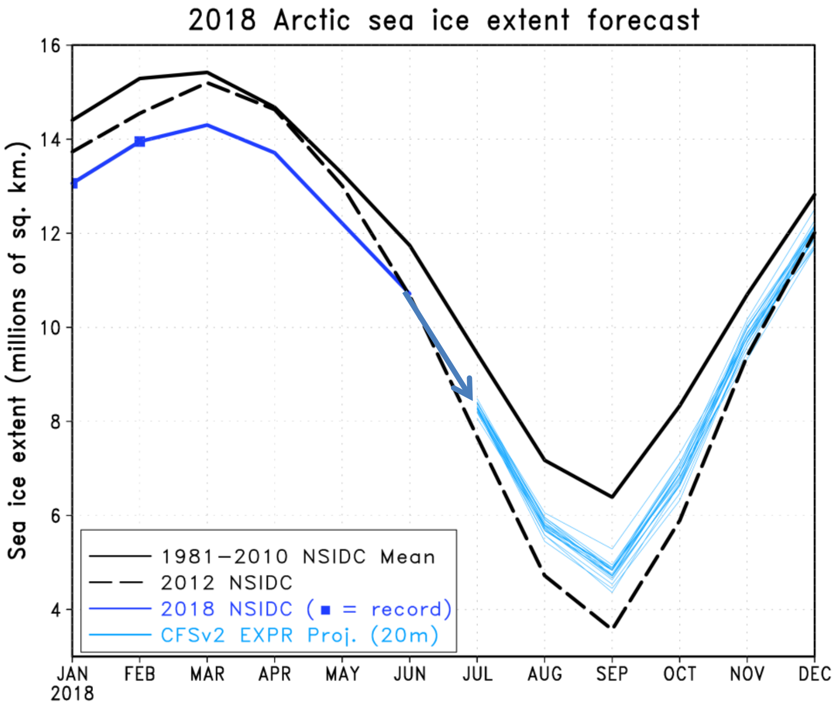




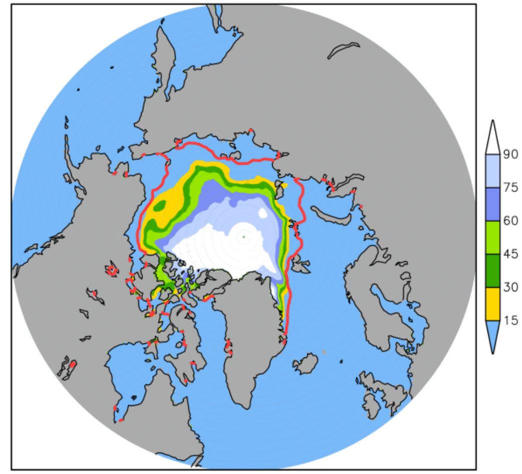


- **Arctic sea ice extent declined at a slightly slower-than average pace in Jun 2018. This was the fourth lowest June average extent in the satellite record.**

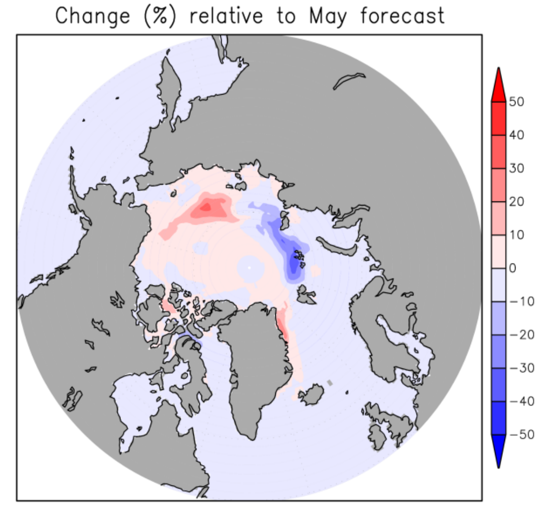
- **Despite the slow loss, warm conditions and winds from the south developed a large area of open water in the Laptev Sea.**

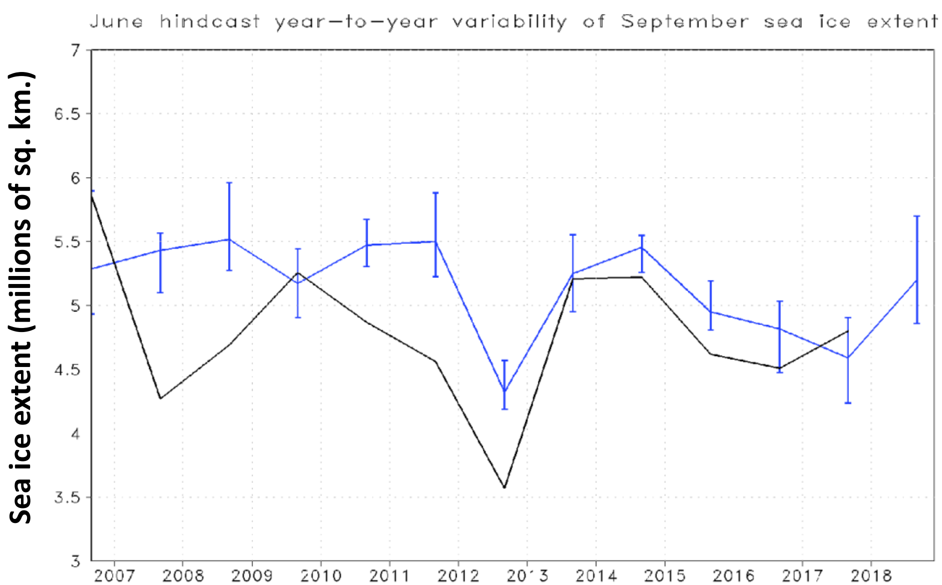


September 2018 SIC forecast



Red: 1981-2010 Climo.





Blue = Hindcasts (error bars denote ens. spread)
Black = NSIDC observations

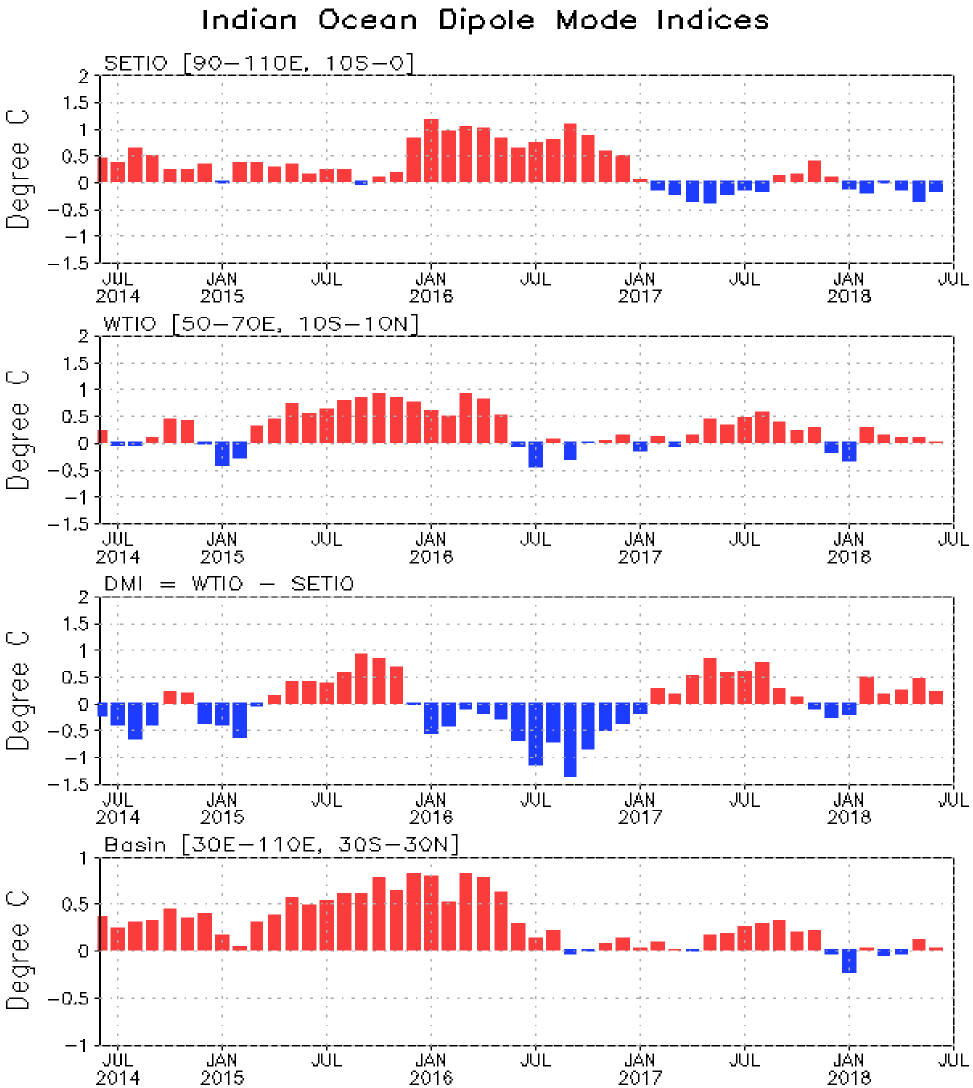
-20-member ensemble experimental CFS Arctic sea ice forecast was initialized June 21-25, 2018 using initial conditions from the CPC Sea ice Initialization System (CSIS).

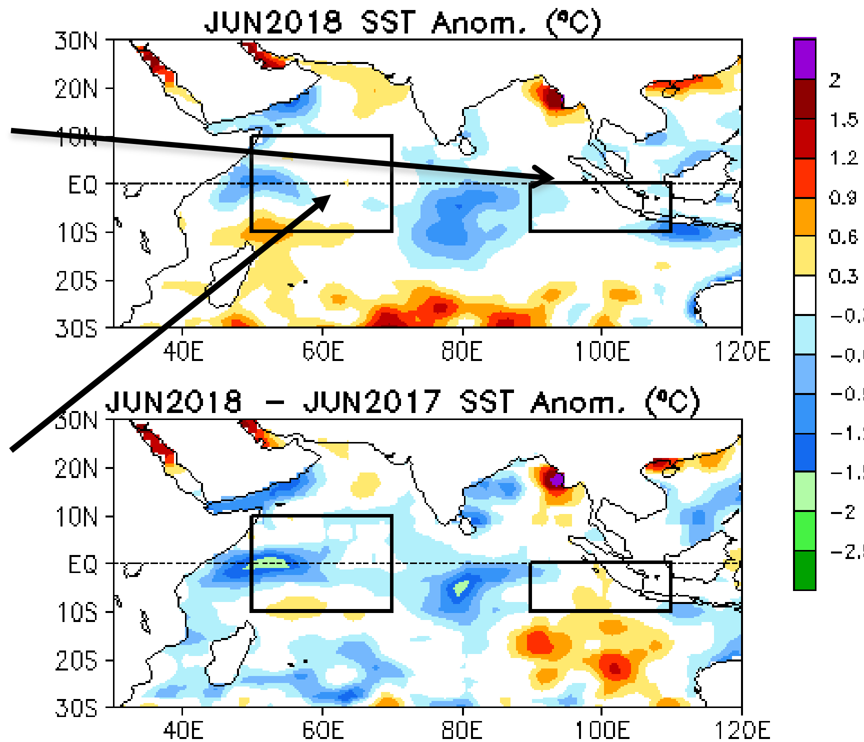
-The projected September Arctic sea ice extent based on this forecast is 4.77 +/- 0.19 * 10^6 km^2 (May forecast was 4.63 +/- 0.24 * 10^6 km^2)

-There is an increase in the mean and a decrease in the ensemble variability compared to last month.

Indian Ocean

Evolution of Indian Ocean SST Indices





- **All indices were near-neutral.**

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.

- SSTAs were weakly negative in part of the tropical Indian Ocean.

- SSTA tendency was mainly determined by heat fluxes.

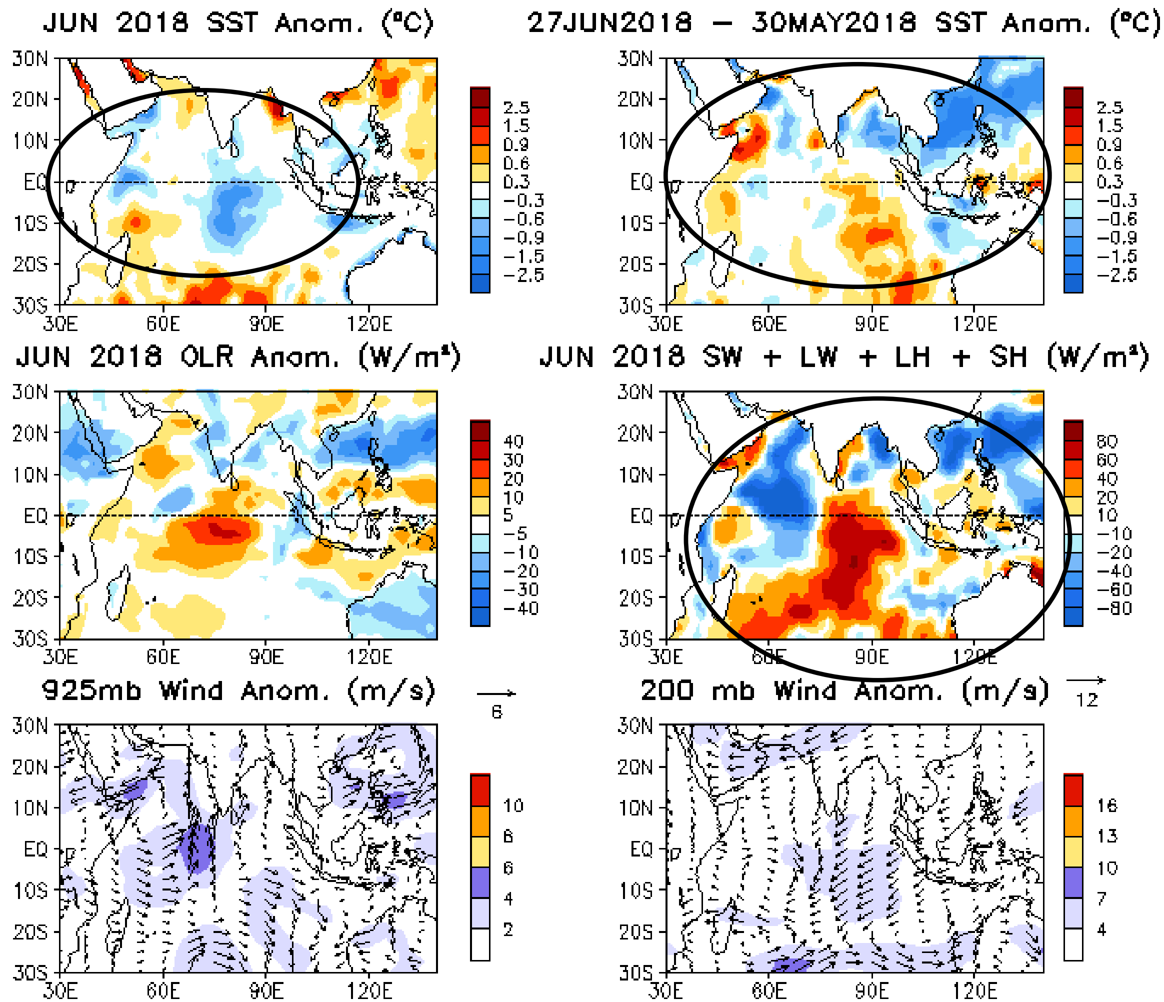
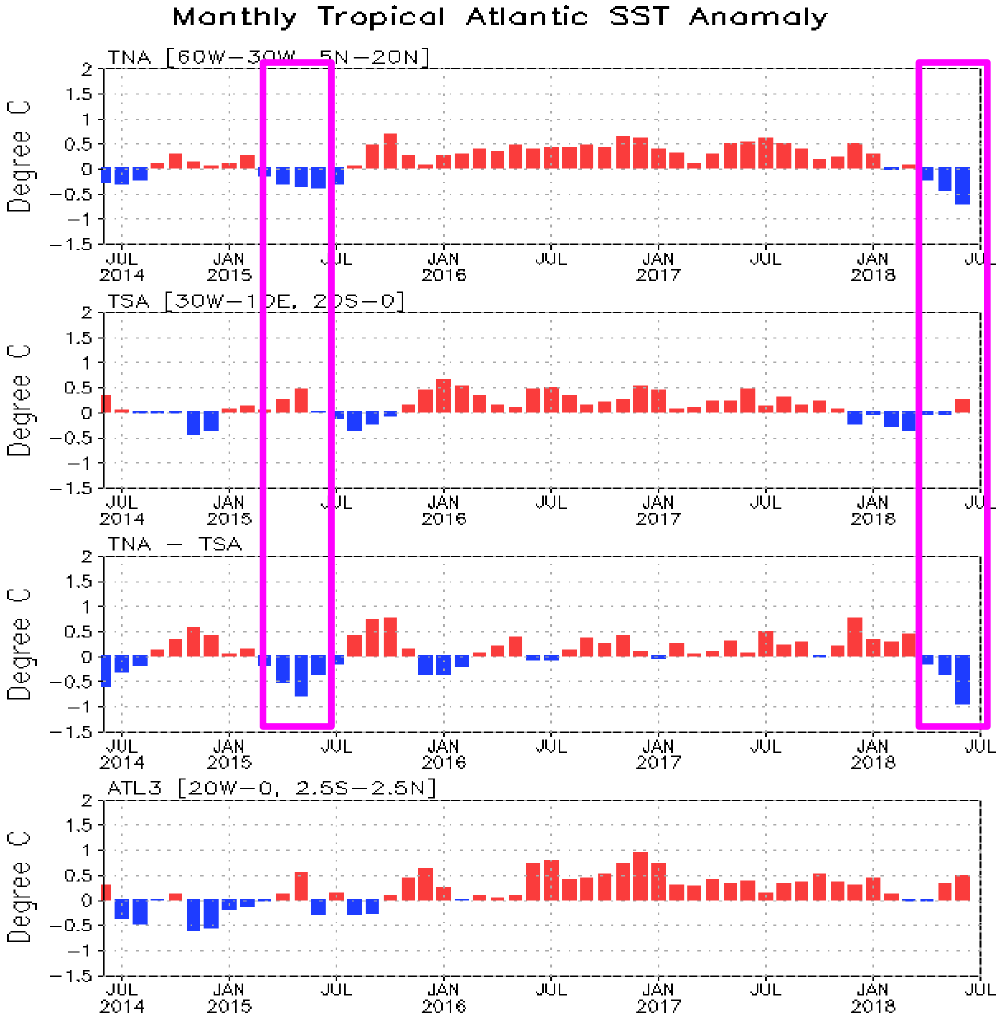
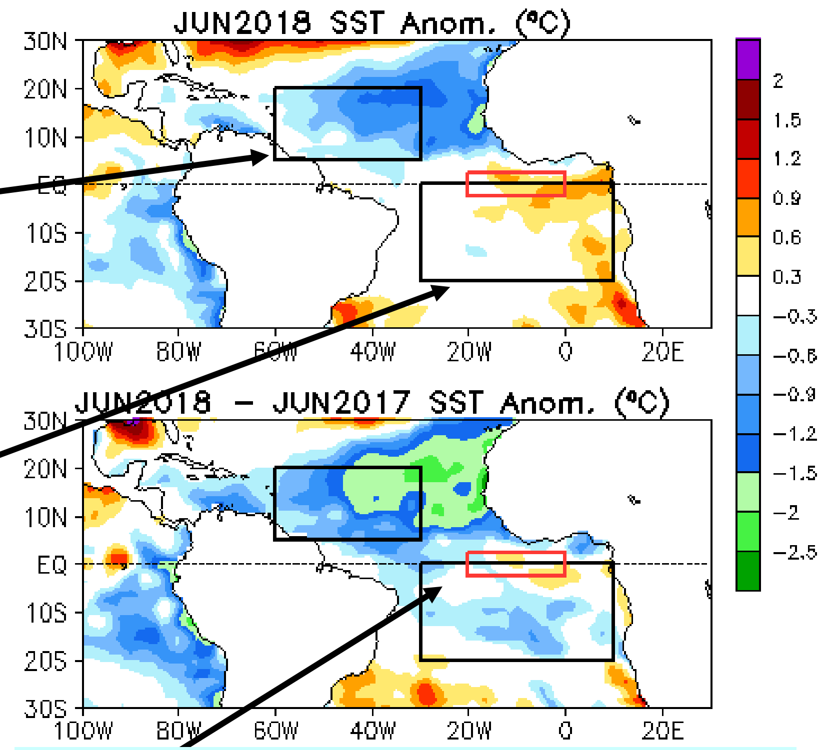


Fig. 12. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (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



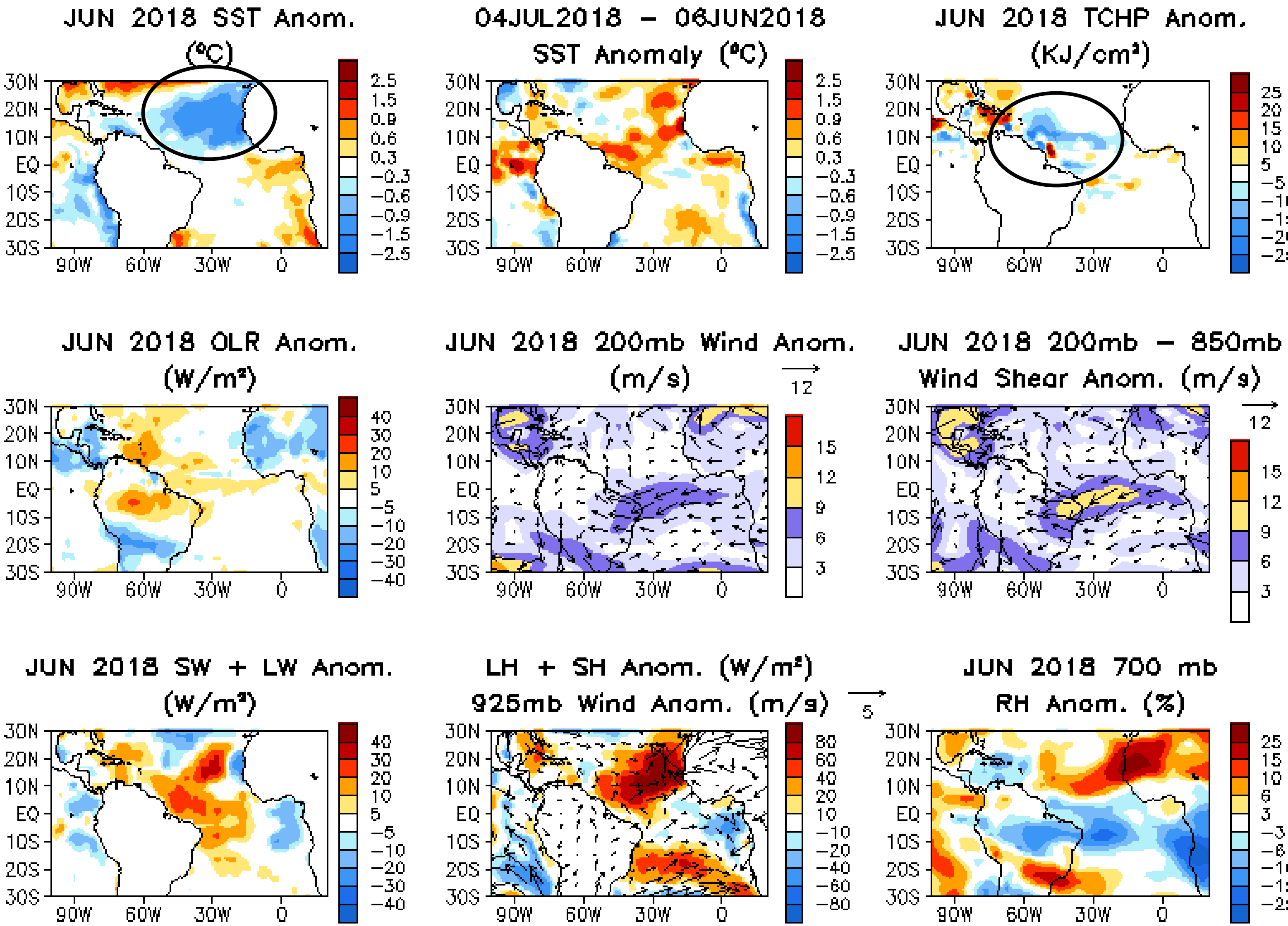


- Both TNA and the gradient mode (TNA-TSA) decreased rapidly since Apr 2018, which resembled the early 2015 period.

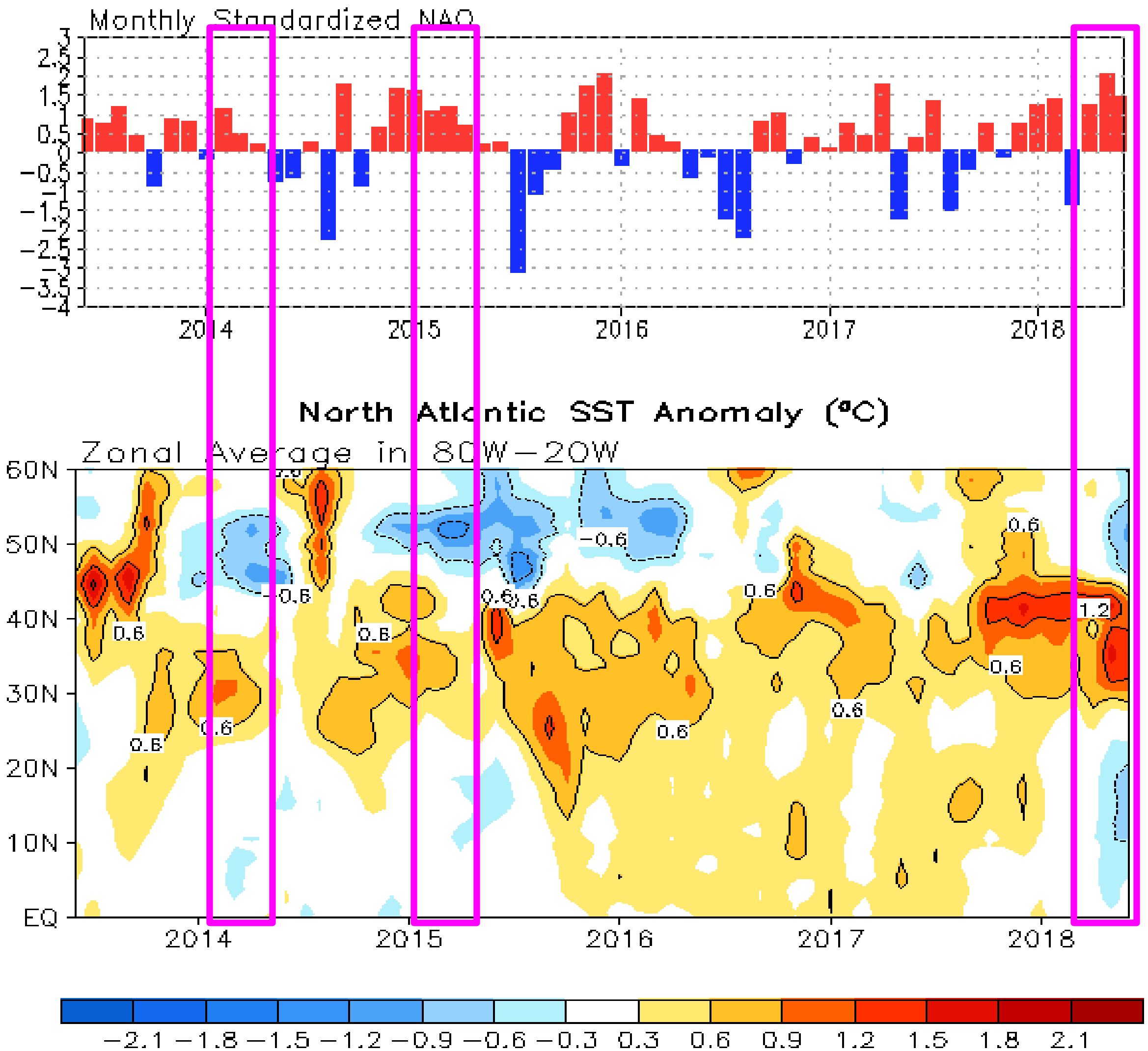
- **The SST in the eastern tropical N Atlantic in Jun 2018 was about 2 degree colder than that in Jun 2017 .**

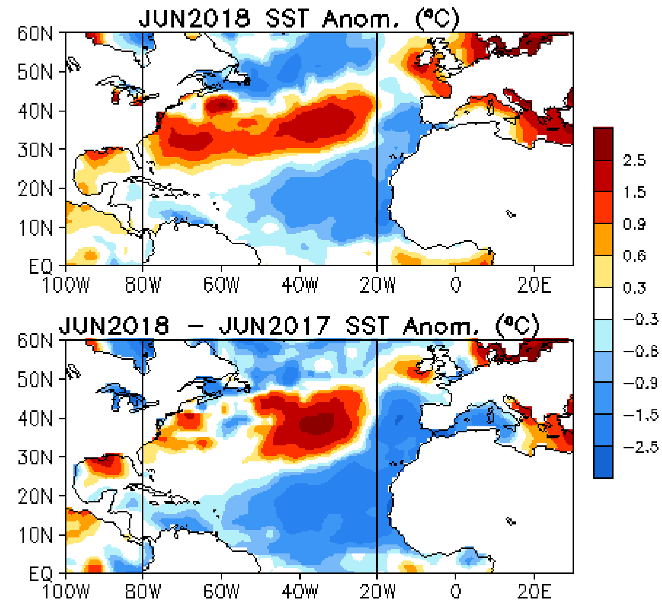
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the TNA [60°W-30°W, 5°N-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between 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: SST, TCHP, OLR, Winds, Humidity and Surface Fluxes



NAO and SST Anomaly in North Atlantic

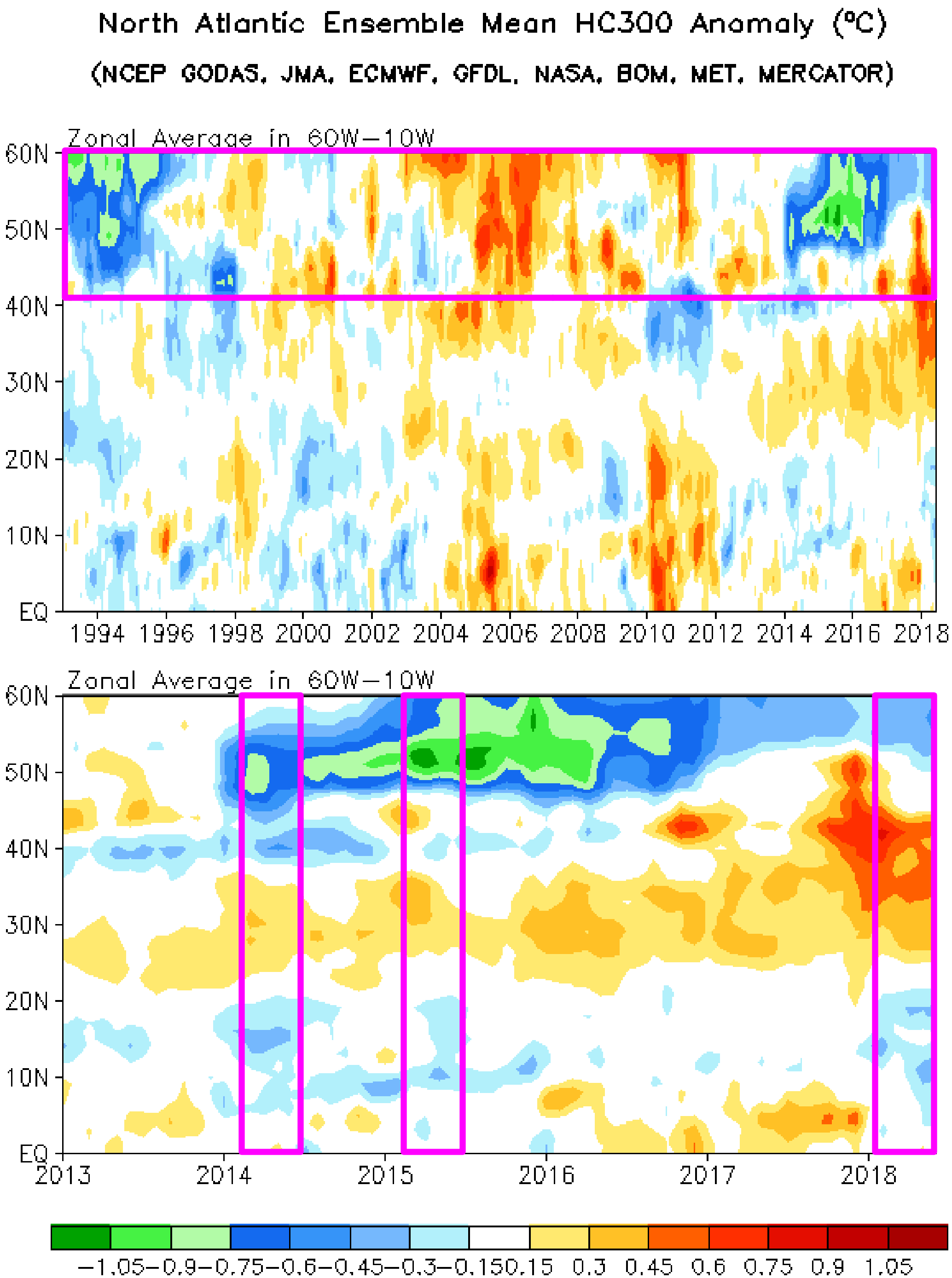


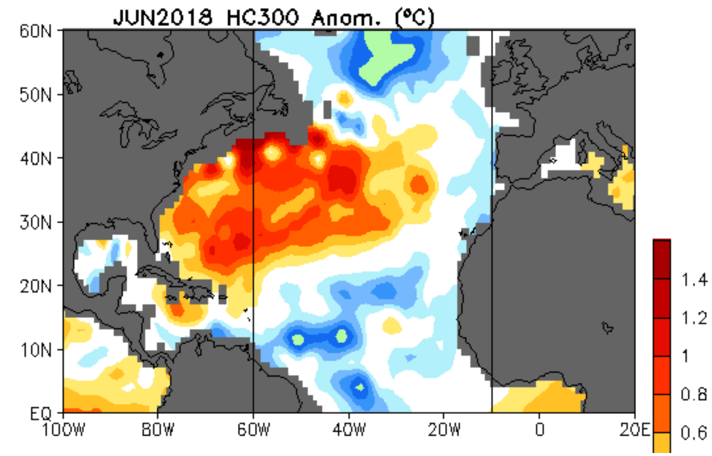


- NAO was in a positive phase with NAOI= +1.4 in Jun 2018.

- SSTA has a tripole/horseshoe pattern with positive in the mid- latitudes and negative in lower and higher latitudes, which resembled the early 2004 and 2015 period.

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.

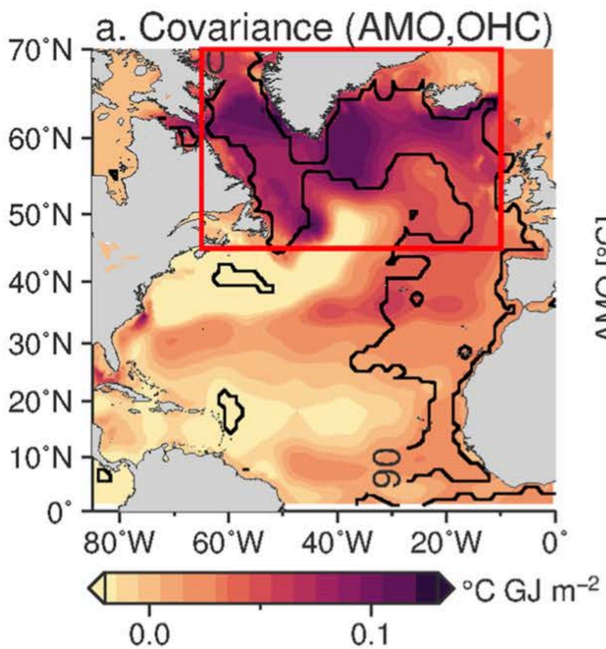


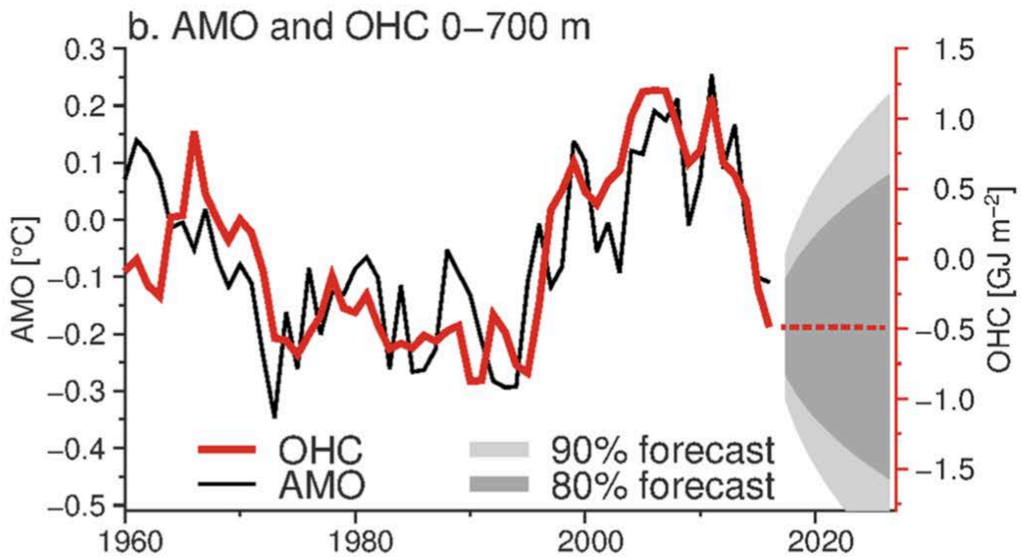


- HC300 anomaly has a tripole/horseshoe pattern with positive in the mid- latitudes and negative in lower and higher latitudes, which resembled the early 2014 and 2015 period.

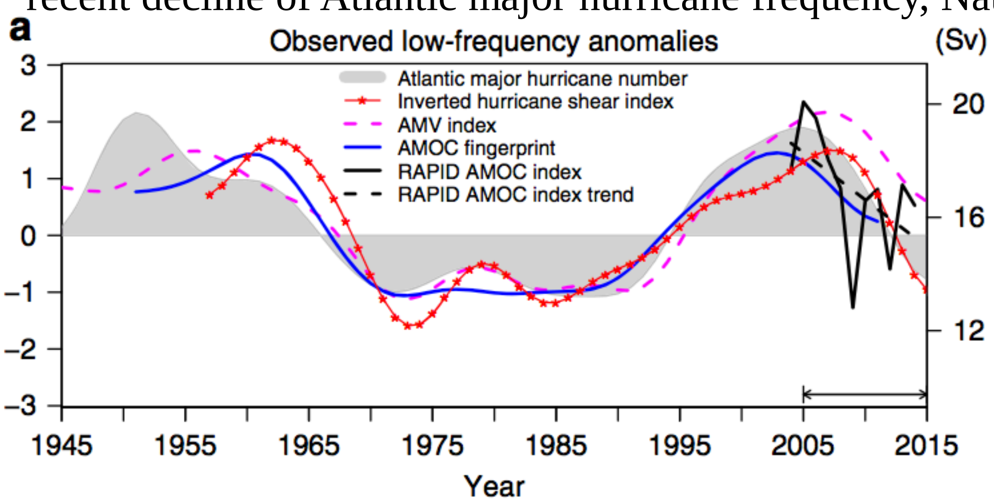
- The "cold blob" in the subpolar gyre in 2014-2016 was comparable to that before 1996, and it weakened and continued into 2017-2018, indicating the continued weakening of AMO (Frajka-Williams et al. 2018).

Frajka-Williams et al. 2018: Emerging negative Atlantic Multidecadal Oscillation index in spite of warm subtropics, Scientific Reports.



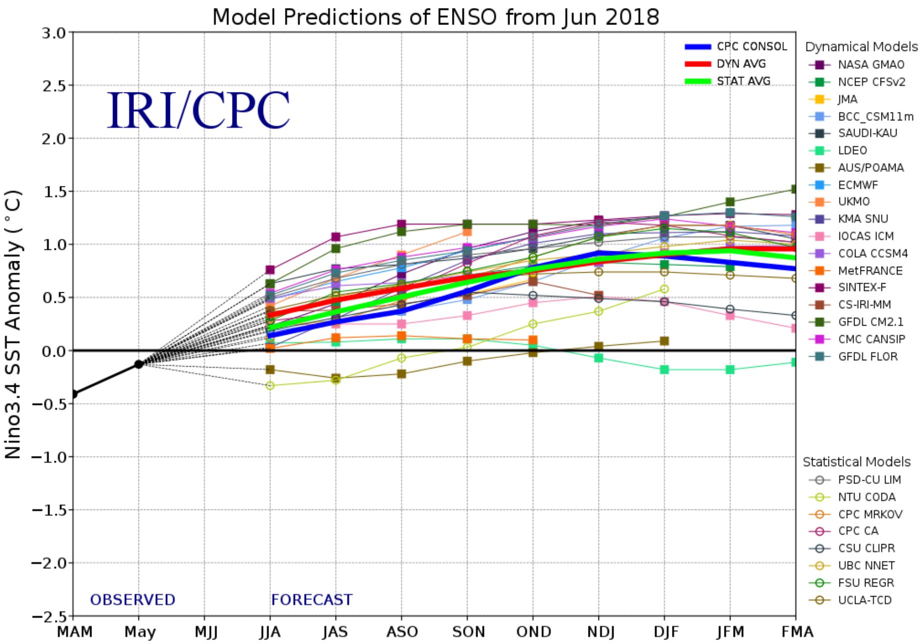


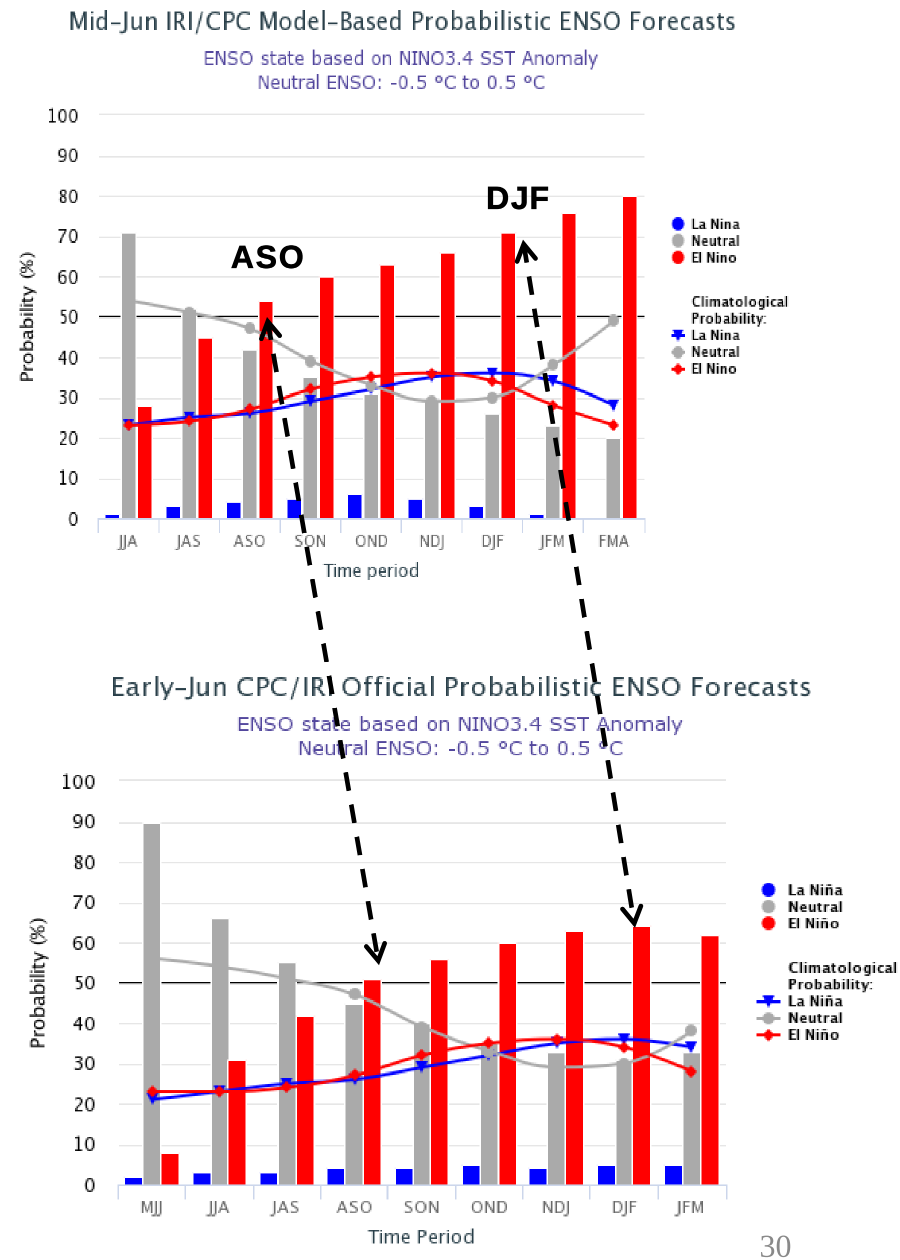
Yan et al. 2018: The role of Atlantic overturning circulation in the recent decline of Atlantic major hurricane frequency, Nature.



- The weakening AMO since 2005 is unfavourable for Atlantic hurricane activity.

ENSO and Global SST Predictions

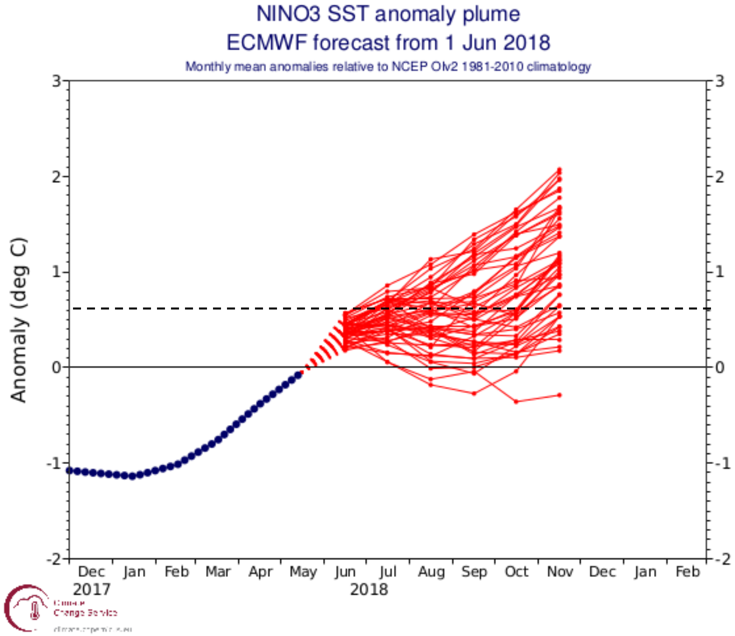




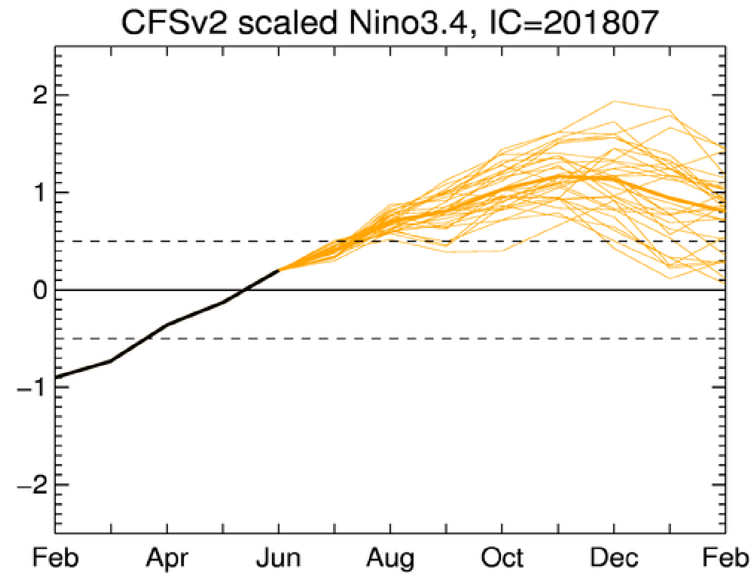
- **The majority of models predict an El Nino in 2018.**
- **The consensus of model forecasts (Mid-Jun IRI/CPC Model-Based Forecast) is consistent with the consensus of human forecasts (Early-Jun CPC/IRI Official Forecast). However, the peak probability of the former is 80% located in FMA 2018 while the peak probability of the later is 64% located in NDJF.**

Individual Model Forecasts: El Nino

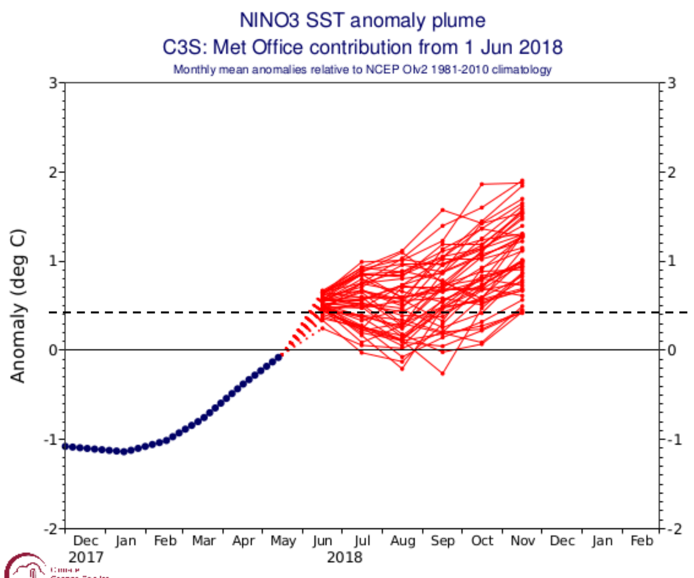
ECMWF: Nino3.4, IC= 1 Jun 2018



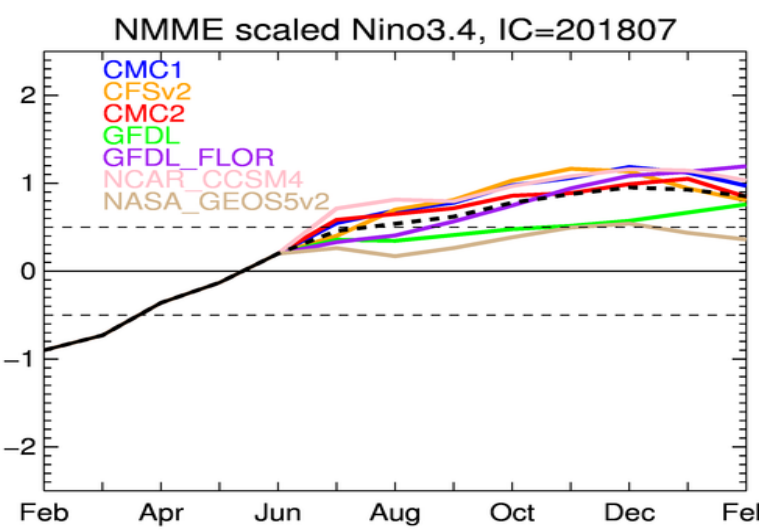
NCEP CFSv2: Nino3.4, IC= 1 Jul 2018



UKMO: Nino3.4, IC= 1 Jun 2018

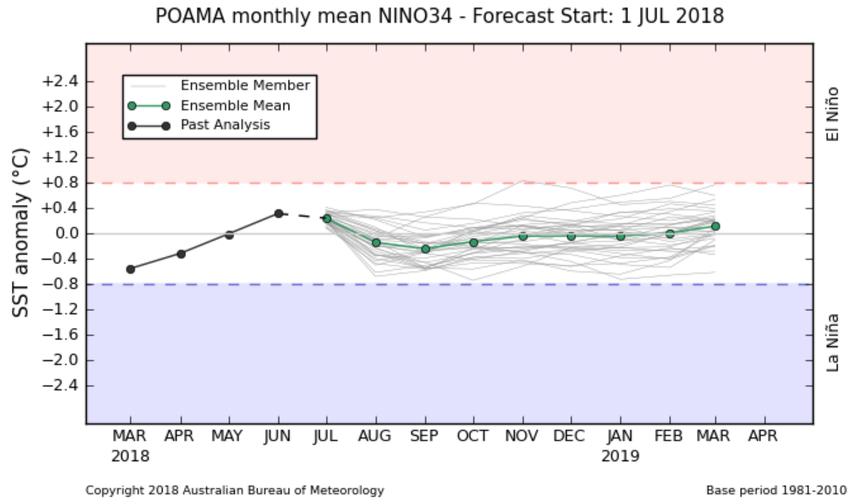


NMME: Nino3.4, IC= 1 Jul 2018

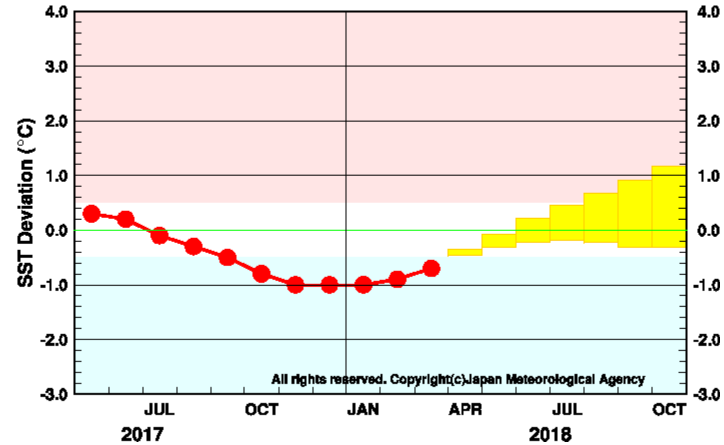


Individual Model Forecasts: Neutral or Boundary El Nino

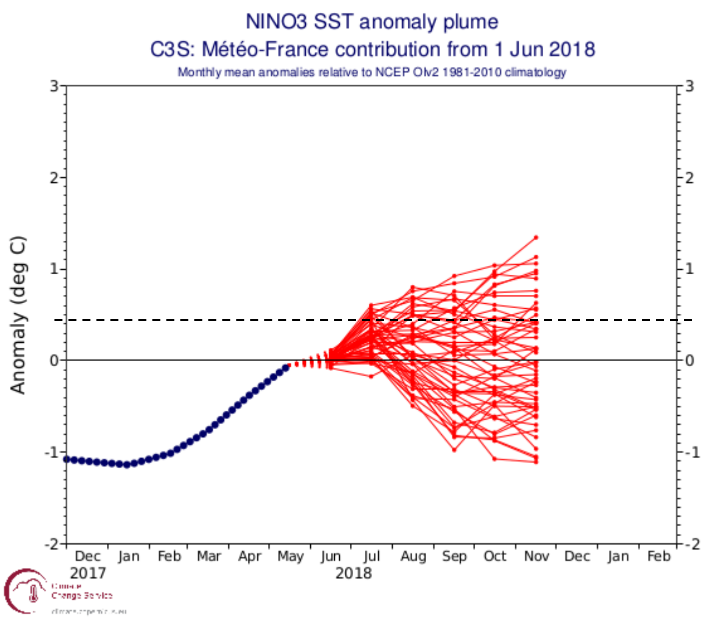
Australia: Nino3.4, IC= 1 Jul 2018



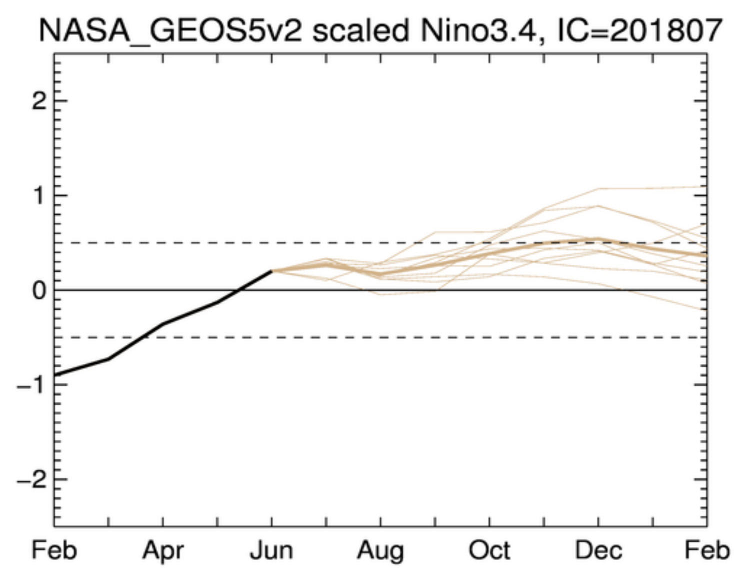
JMA: Nino3, IC/updated = 10 Jun 2018



Meteo-France: Nino3.4, IC= 1 Jun 2018



NASA: Nino3.4, IC= 1 Jul 2018



CPC's Markov Model NINO3.4 Forecast

(http://www.cpc.ncep.noaa.gov/products/people/yxue/ENSO_forecast_clim81-10_godas.html)

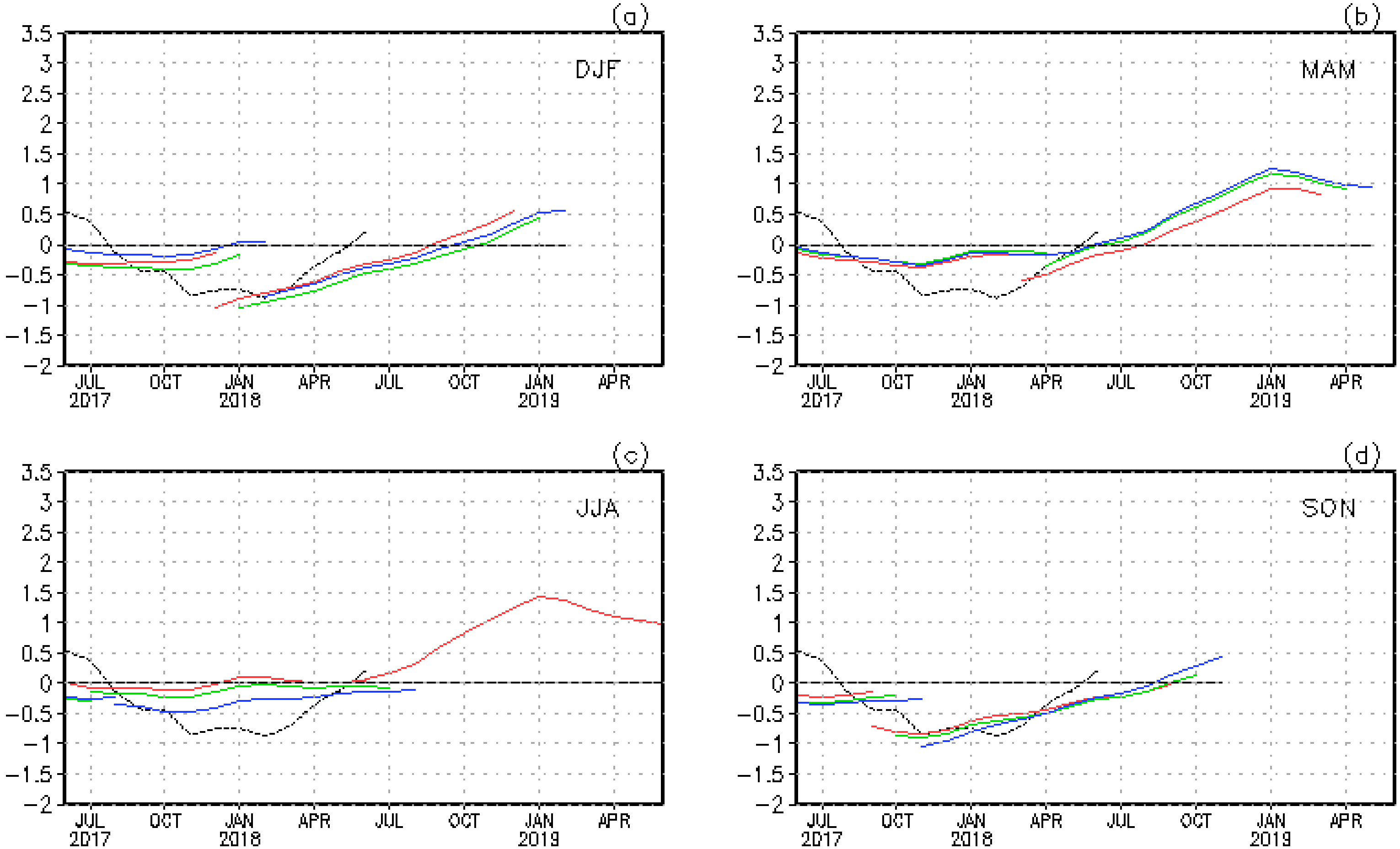
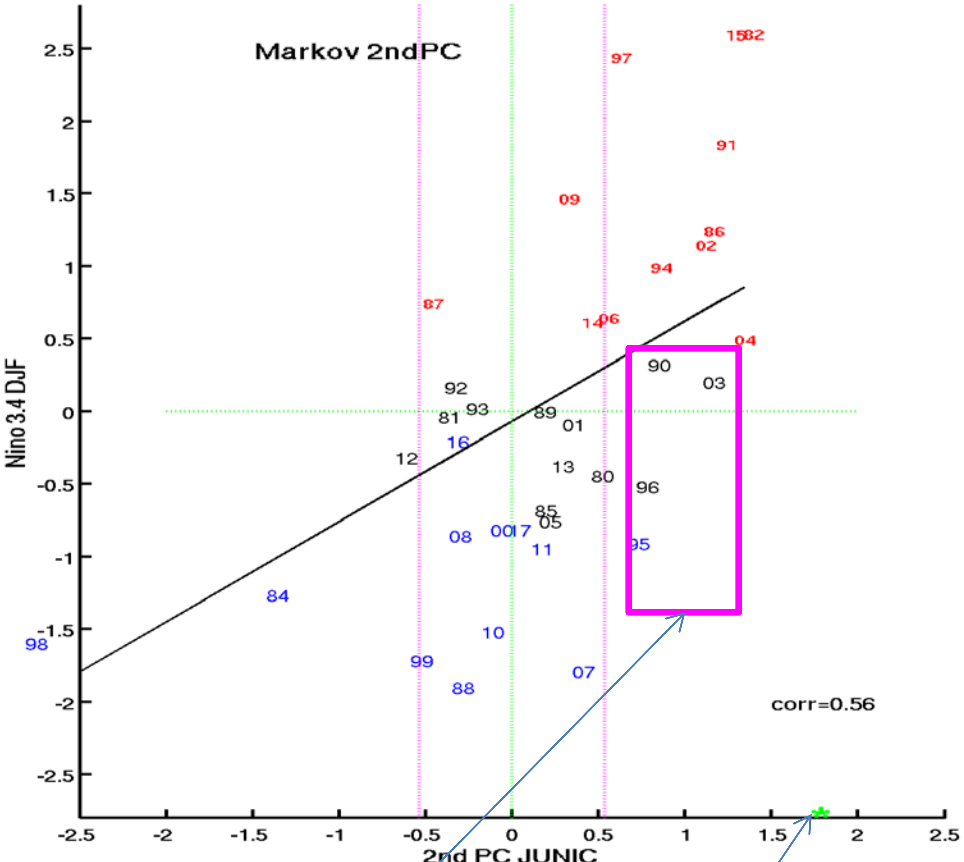
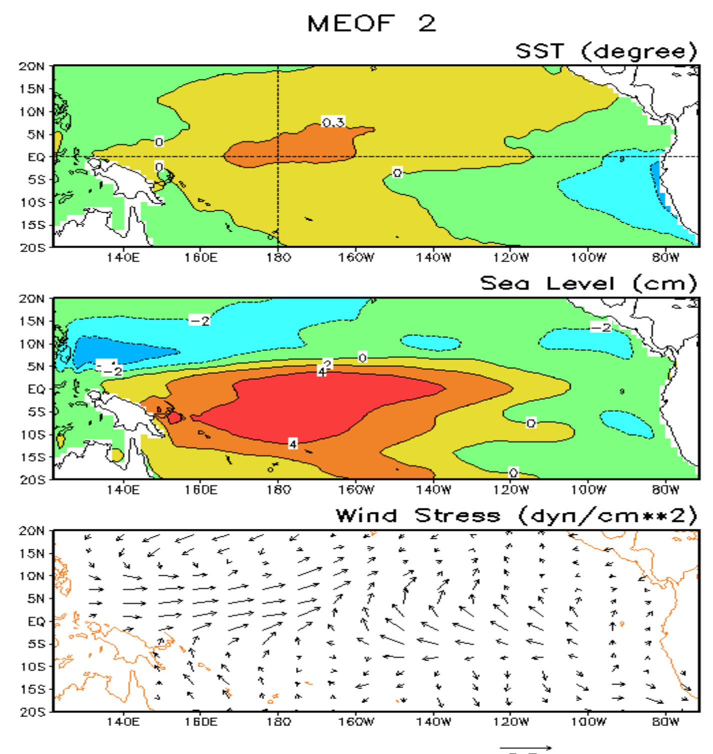


Fig. 4. Time evolution of NINO3.4 forecasts up to 12 lead months by the Markov model initiated monthly up to June 2018 . Shown in each panel are the forecasts grouped by three consecutive starting months: (a) is for December, January and February, (b) is for March, April and May, (c) is for June, July and August and (d) is for September, October and November. The observed NINO3.4 SST anomalies are shown in the heavy−dashed lines.

ENSO Precursor: Markov PC2 vs. NINO3.4 in DJF



2x2 contingency table El Nino Case (1980-2017)	June Criterion: 0.53=0.5 STD
Percent correct rate	0.8 (30/38)
Hit rate	0.67 (8/12)
False alarm rate	0.33 (4/12)

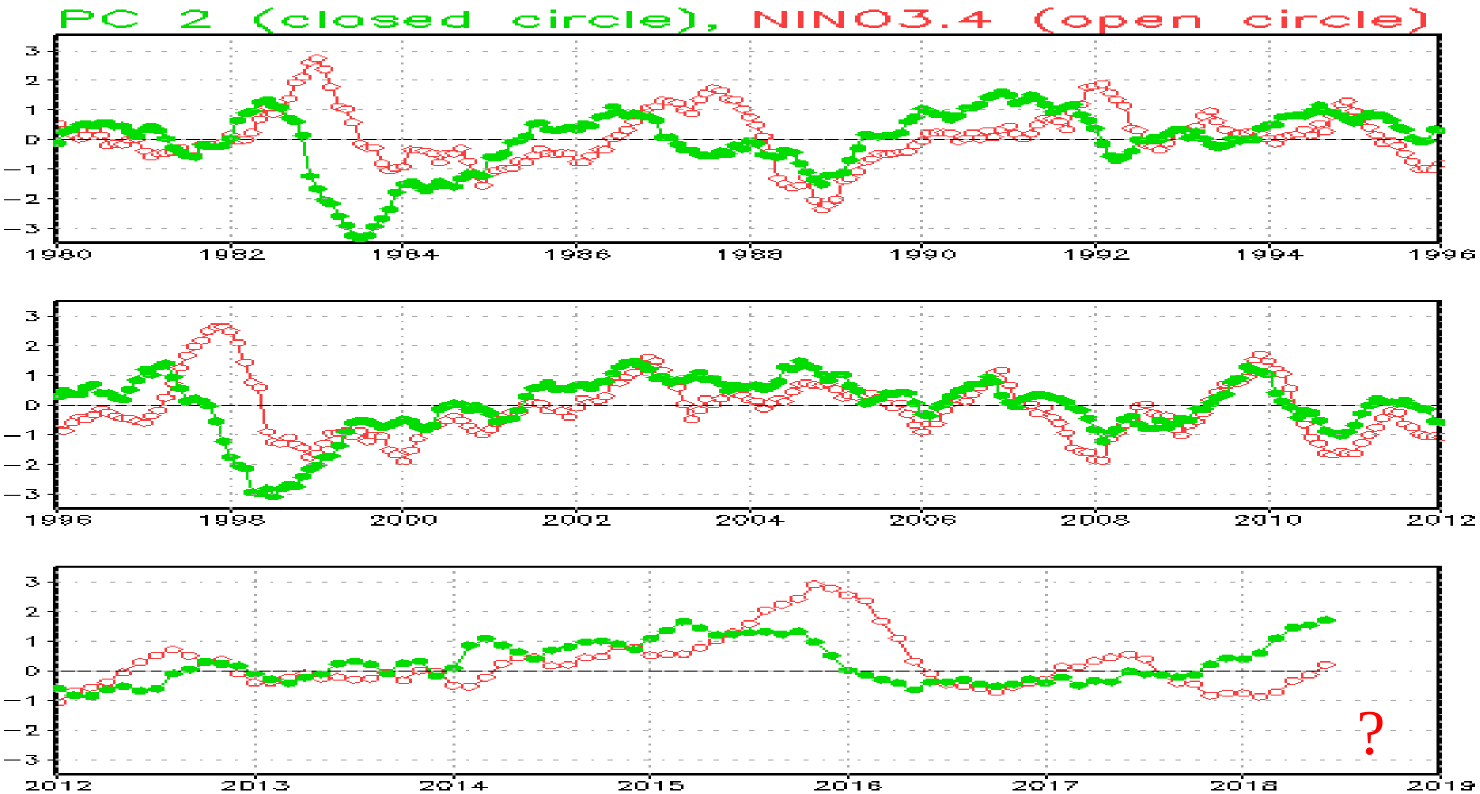


False alarms:

90
95
96
03

* **Markov 2nd PC in June 2018**

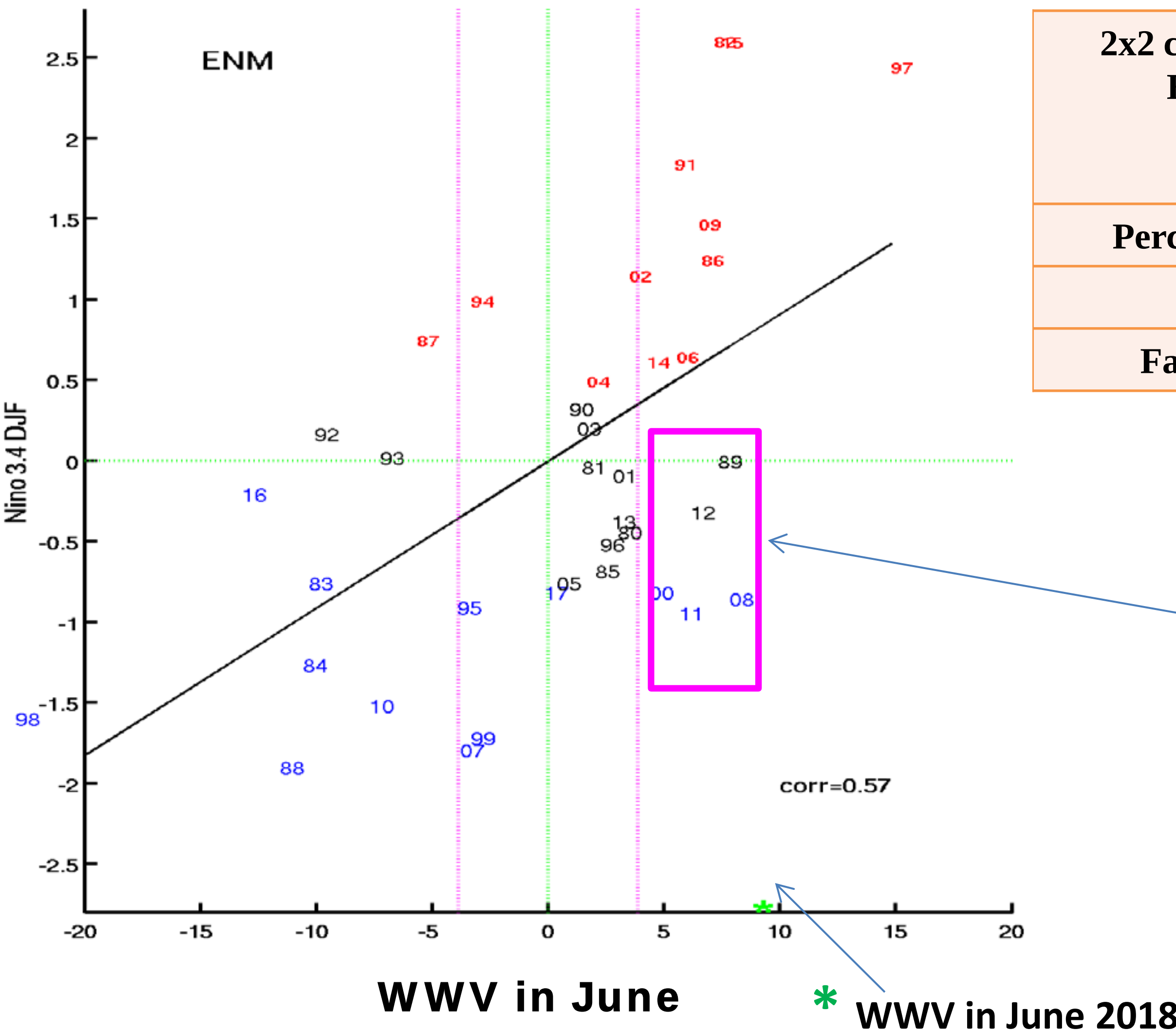
http://www.cpc.ncep.noaa.gov/products/people/yxue/ENSO_forecast_clim81-10_godas.html



PC2	82	86	91	94	97	02	04	06	09	14	15	18
Mar	0.9	0.5	1.3	0.8	1.3	0.6	0.5	0.0	-0.1	1.1	1.7	1.1
Apr	1.0	0.8	1.5	0.8	1.4	0.8	0.6	0.1	-0.1	0.9	1.5	1.4
May	1.3	0.8	1.4	0.8	1.0	0.8	0.8	0.3	0.1	0.6	1.2	1.5
Jun	1.3	1.1	1.2	0.8	0.6	1.1	1.3	0.5	0.3	0.4	1.2	1.7

Using PC2 = 0.5 as criterion in at least two consecutive months, 06 and 09 would be missed

ENSO Precursor: Warm Water Volume (WWV) vs. NINO3.4 in DJF

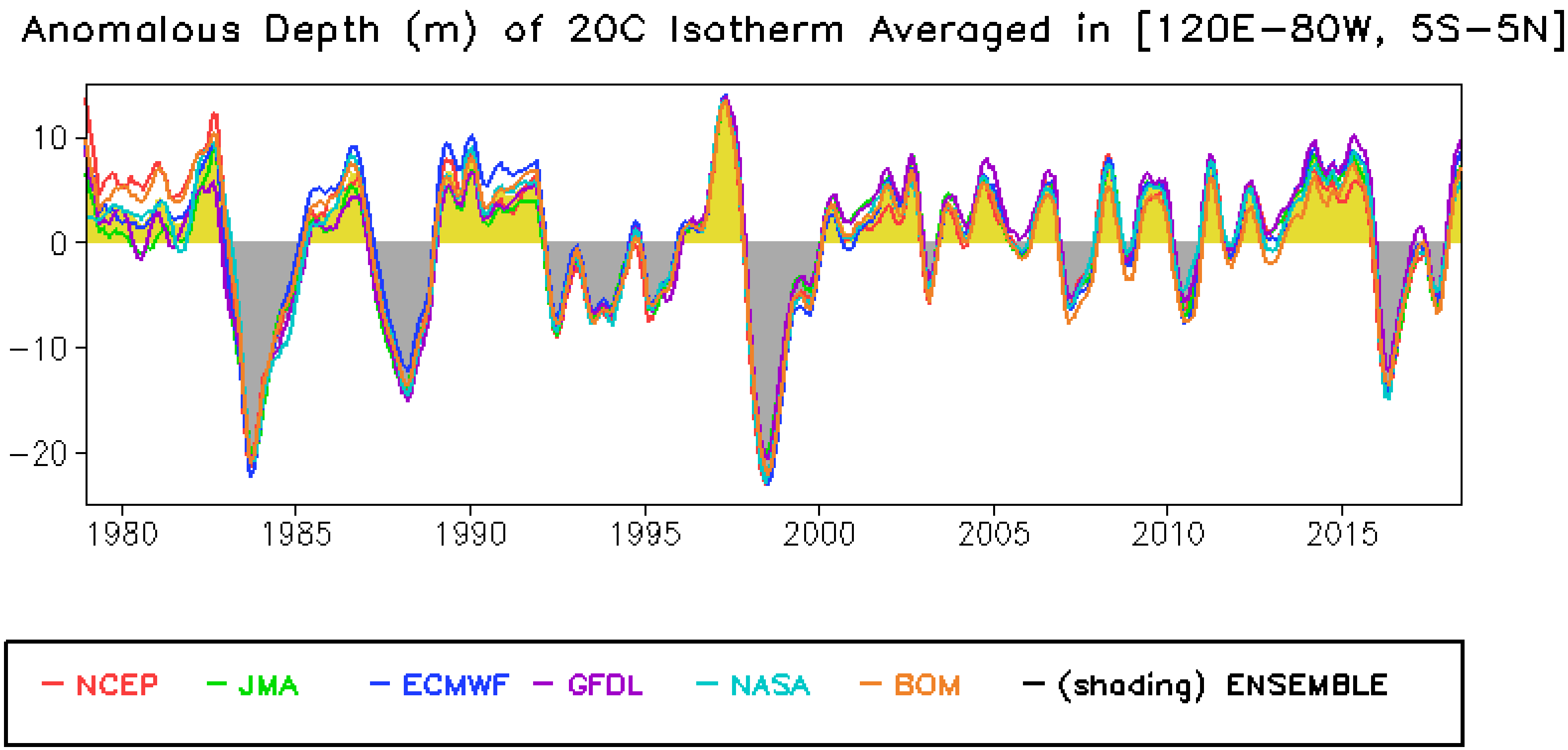


2x2 contingency table El Nino Case (1980-2017)	June Criterion: 3.9 = 0.5 STD
Percent correct rate	0.76 (29/38)
Hit rate	0.67 (8/12)
False alarm rate	0.4 (5/13)

False alarms:
89
00
08
11
12

Data downloadable from http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html

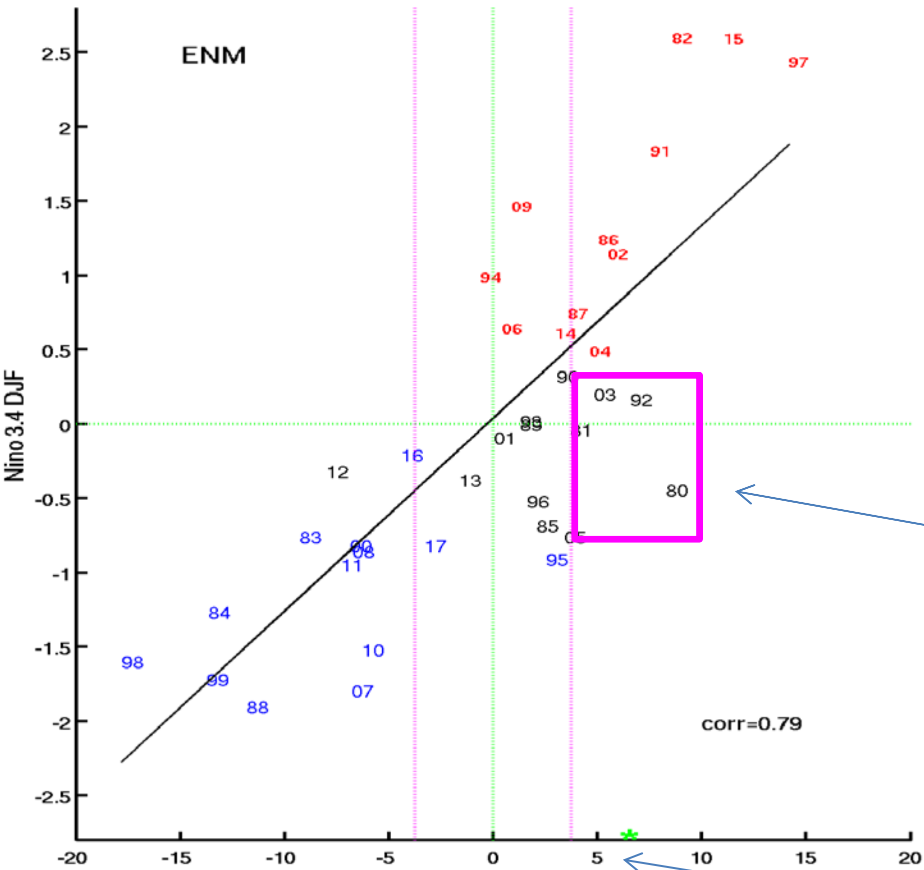
Warm Water Volume (WWV)



ENM WWV	82	86	91	94	97	02	04	06	09	14	15	18
Mar	**6.9**	3.5	2.7	-6.9	**12.0**	**4.9**	-1.0	1.5	1.5	**10.7**	**8.0**	**4.8**
Apr	**7.2**	2.5	3.8	-5.3	**14.7**	1.8	0.2	3.0	4.1	**9.9**	**9.2**	**6.1**
May	**7.3**	**4.7**	**6.0**	-3.5	**14.4**	0.6	0.5	**4.8**	**5.8**	**8.1**	**9.0**	**8.1**
Jun	**7.2**	**6.6**	**5.5**	-3.3	**14.8**	3.5	1.6	**5.5**	**6.5**	**4.2**	**7.4**	**8.8**

Using WWV=3.9 as criterion in at least two consecutive months, 94, 02 and 04 would be missed

ENSO Precursor: Central Tropical Pacific D20 (CTP) vs. NINO3.4 in DJF



CTP in June

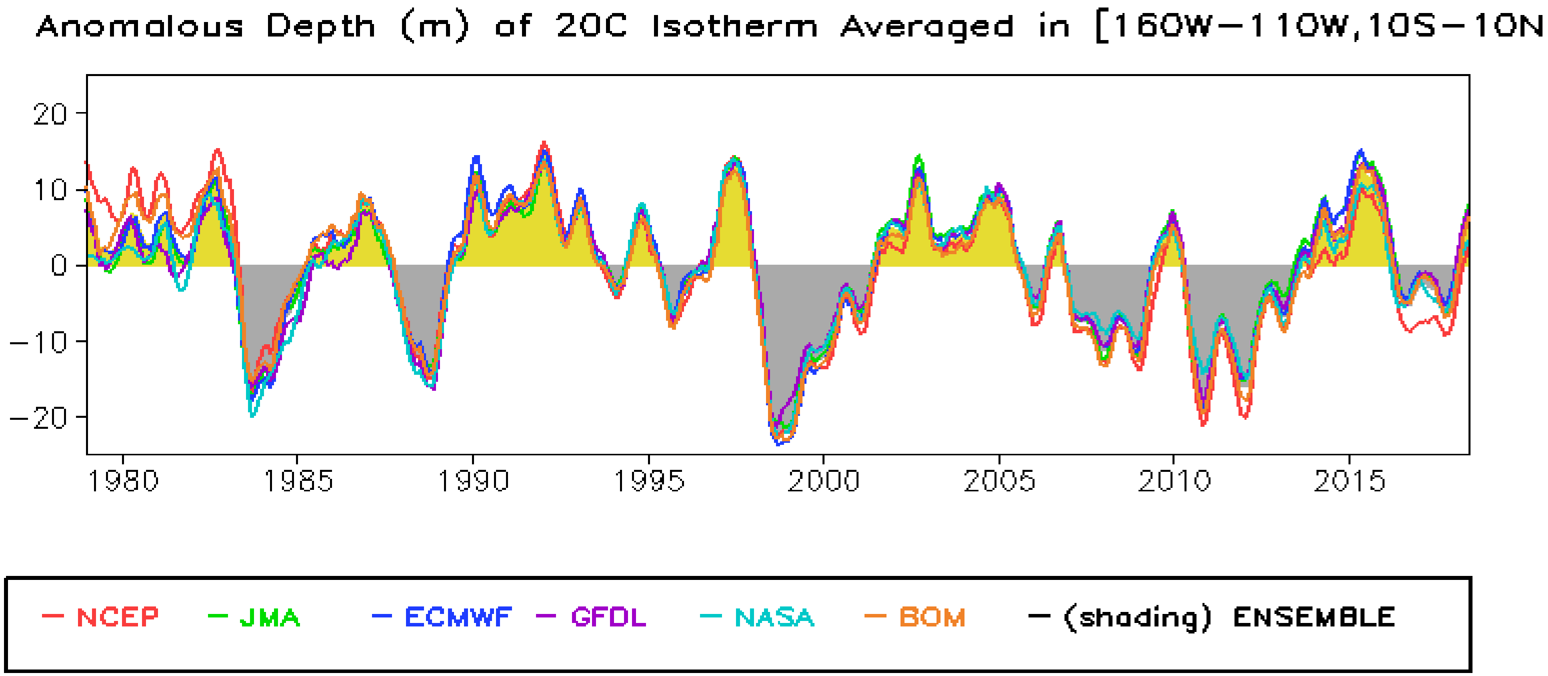
* **CTP in June 2018**

2x2 contingency table El Nino Case (1980-2017)	June Criterion: 3.8 = 0.5 STD
Percent correct rate	**0.8 (30/38)**
Hit rate	**0.6 (7/12)**
False alarm rate	**0.3 (3/10)**

False alarms:
80
92
03

Data downloadable from http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html

Central Tropical Pacific D20 Anom. (CTP)



ENM CTP	82	86	91	94	97	02	04	06	09	14	15	18
Mar	**7.0**	3.7	**6.0**	-4.3	**6.0**	3.2	1.3	-6.9	-9.2	**11.7**	**14.2**	2.0
Apr	**8.9**	0.9	**9.8**	-3.6	**16.3**	2.7	3.2	-2.5	-5.3	**9.7**	**15.4**	**4.1**
May	**9.3**	1.8	**8.9**	-1.1	**15.7**	3.0	**6.2**	-1.0	-2.5	**7.4**	**11.9**	**7.2**
Jun	**8.6**	**5.0**	**7.6**	-0.6	**14.2**	**5.5**	**4.6**	0.4	0.9	2.9	**11.0**	**6.0**

Using WWV=3.8 as criterion in at leas two consecutive months, 94, 02, 06 and 09 would be missed

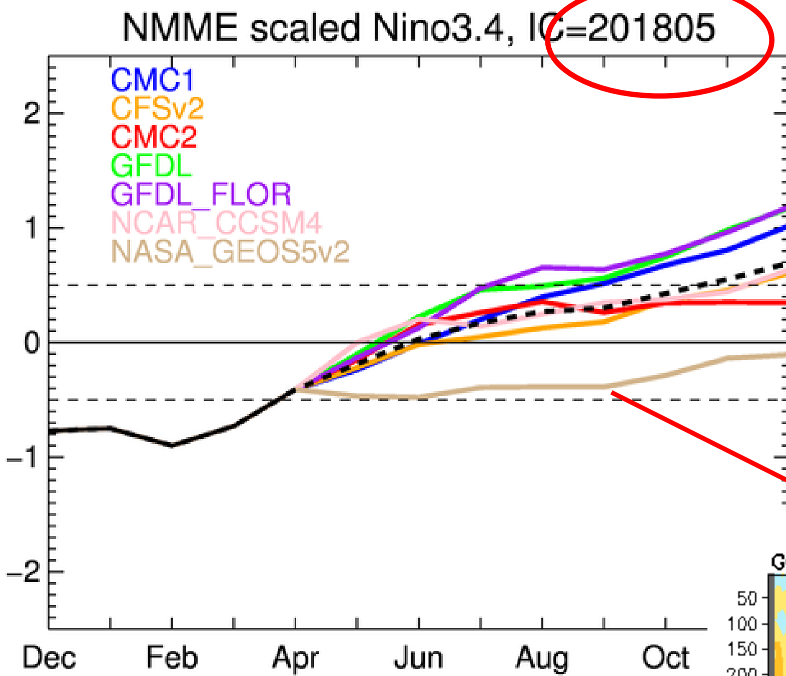
The three ENSO precursors are useful since they provide a high chance of probability for the 2018/19 El Nino winter

Hits	82	86	91	94	97	02	04	06	09	14	15	18
Markov PC2	✔	✔	✔	✔	✔	✔	✔	✖	✖	✔	✔	✔
WWV	✔	✔	✔	✖	✔	✖	✖	✔	✔	✔	✔	✔
CTP	✔	✔	✔	✖	✔	✖	✔	✖	✖	✔	✔	✔

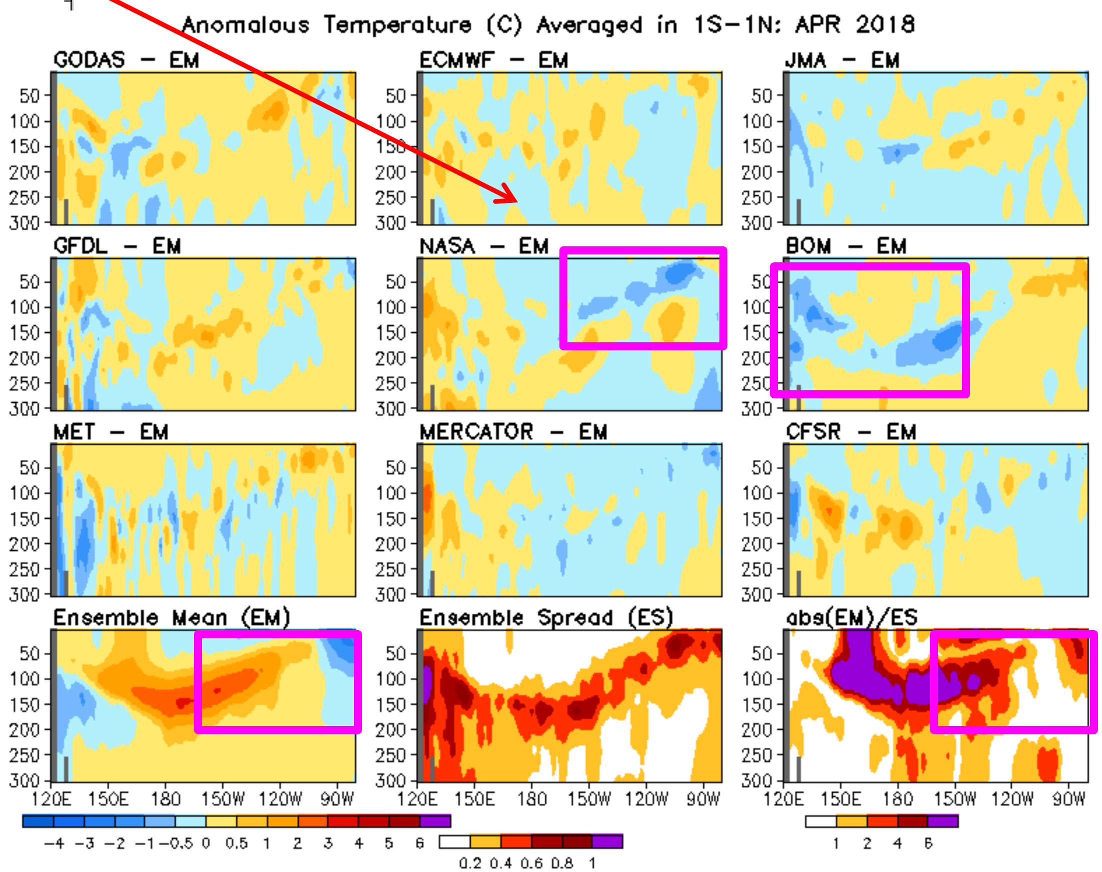
If we require all the three indices have to meet their criteria, then we could have missed 94, 02, 04, 06 and 09 events. But the values of those indices are still useful in monitoring the potential for El Nino development.

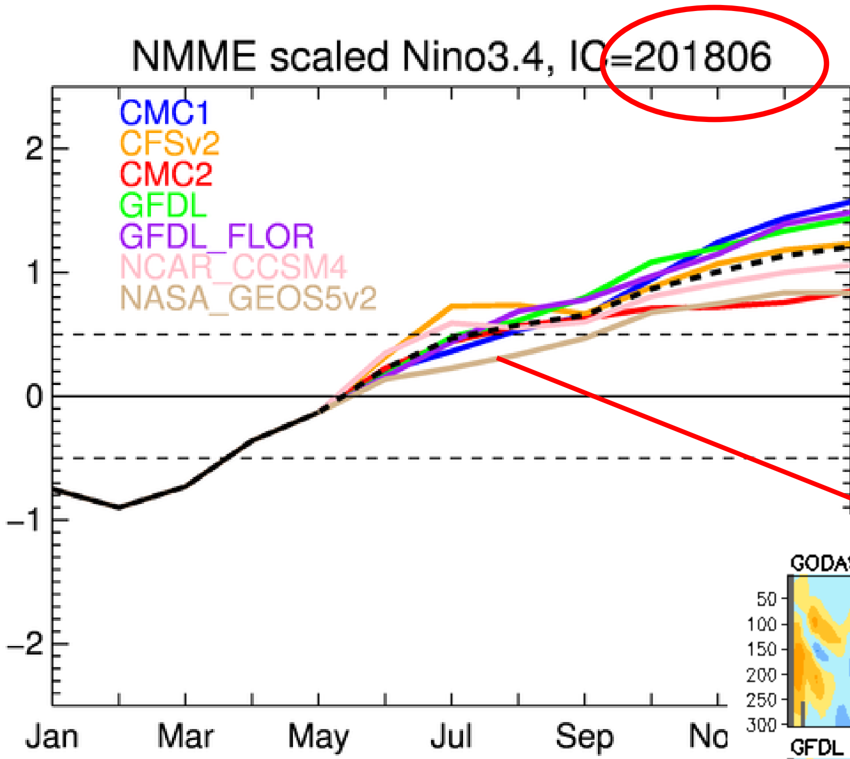
False Alarms	1980-1999	2000-2017
Markov PC2	90, 95, 96	03
WWV	89	00, 08, 11, 12
CTP	80, 92	03

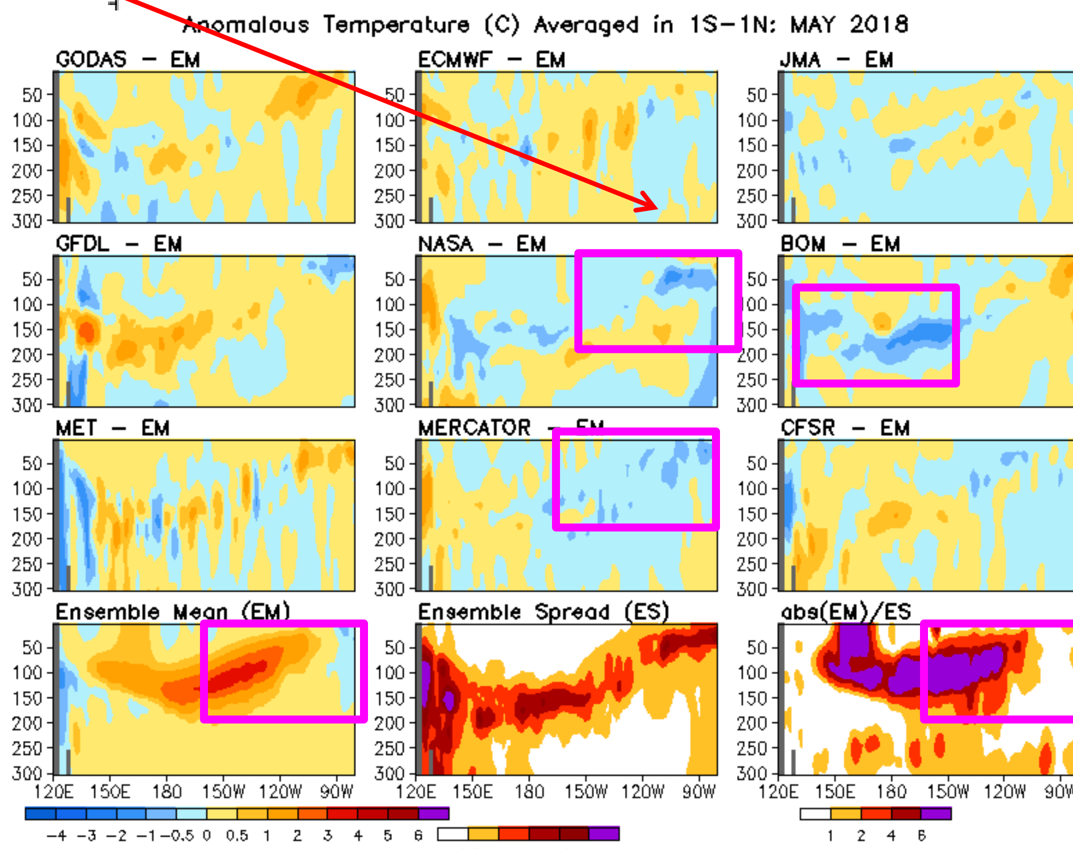
Since we require all the three indices have to meet their criteria and the false alarms are not shared by all the indices, so we can discard all the false alarms.

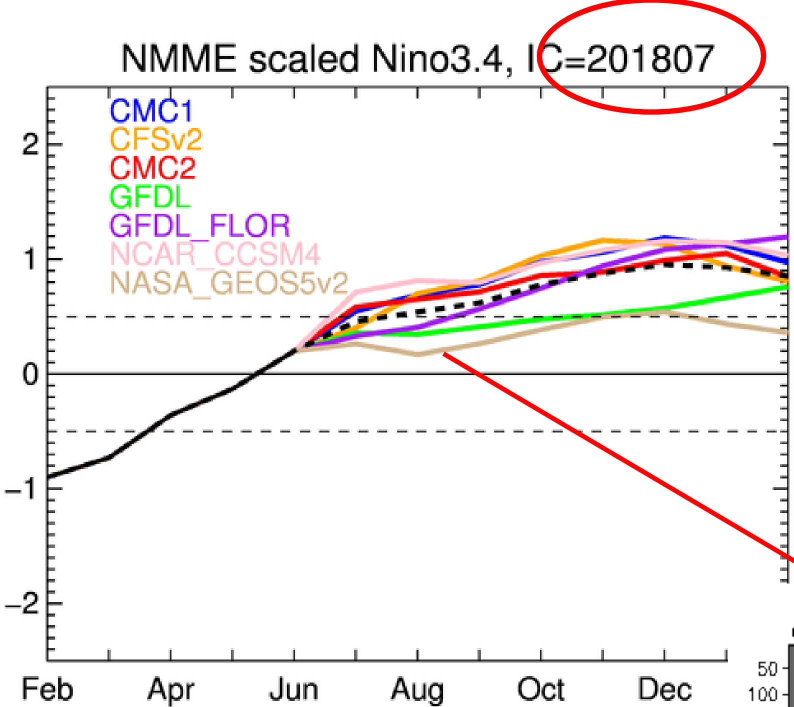


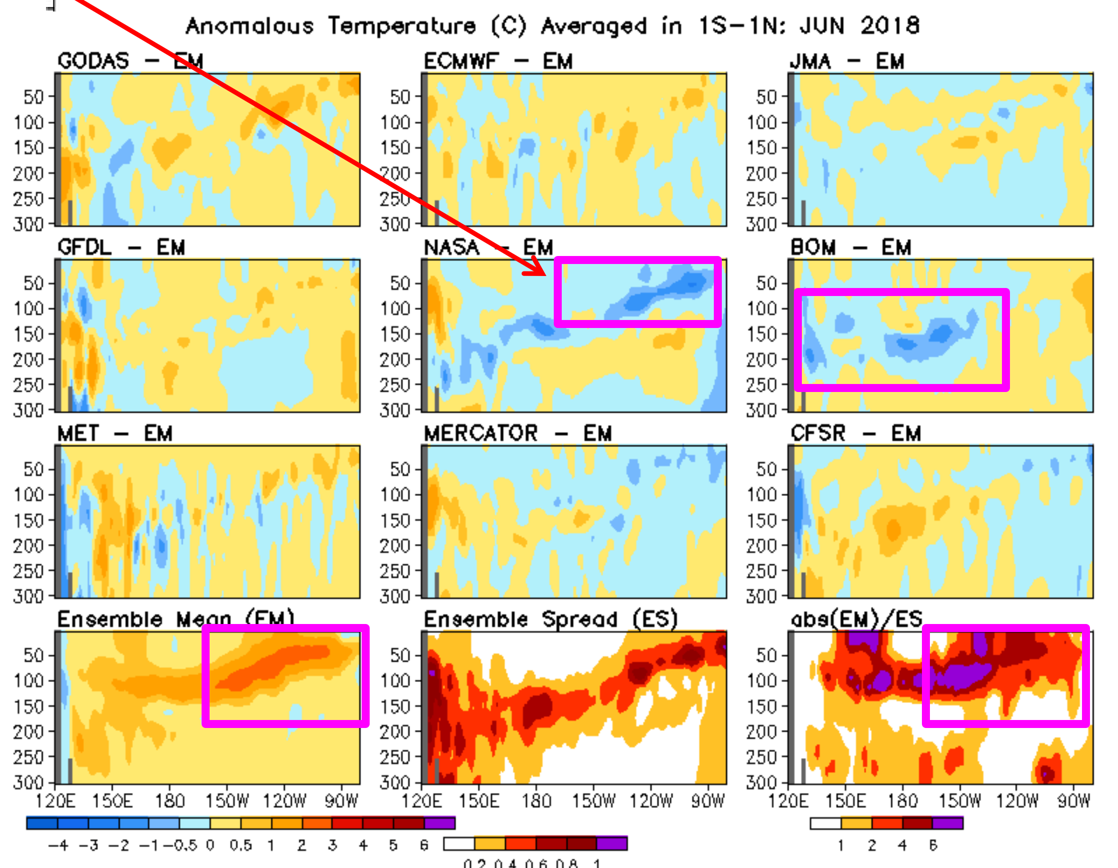
http://www.cpc.ncep.noaa.gov/products/GODAS/multiora93_body.html



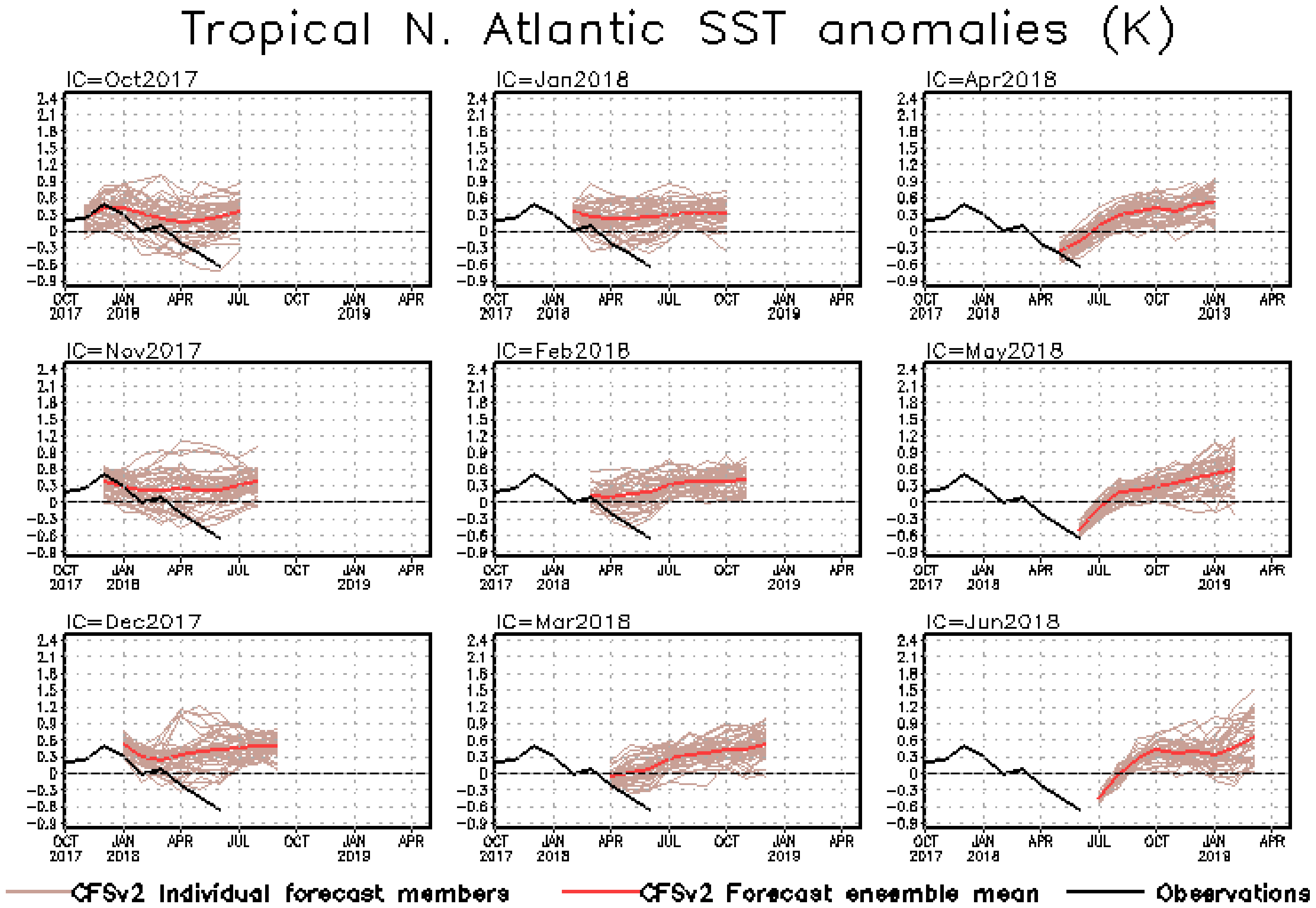

NMME scaled Nino3.4, IC=201806
CMC1
CFSv2
CMC2
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2
2
1
0
−1
−2
Jan
Mar
May
Jul
Sep
No


Anomalous Temperature (C) Averaged in 1S−1N: MAY 2018
GODAS − EM
ECMWF − EM
JMA − EM
GFDL − EM
NASA − EM
BOM − EM
MET − EM
MERCATOR − EM
CFSR − EM
Ensemble Mean (EM)
Ensemble Spread (ES)
abs(EM)/ES
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
0.2 0.4 0.6 0.8 1
1 2 4 6





- **The NASA ocean initial conditions had cold biases in the eq. thermocline in the central-eastern Pacific, which likely contributed to the colder NINO3.4 forecast compared to other NMME models.**
- **The BOM ocean initial conditions had cold biases in the eq. thermocline in the western-central Pacific, which are consistent with the fact that the BOM has forecast ENSO-neutral conditions.**



- **The CFSv2 missed the recent cooling in the tropical N. Atlantic.**

CPC's Sea Surface Salinity (SSS) Monitoring Products

- **Monthly SSS**
  - *BASS (Blended Analysis of Surface Salinity, Xiet et al. 2014)*
  - *combining information from in situ measurements and satellite retrievals*
  - *1.0^o over the global ocean, Monthly from January 2010*
  - *Supporting CPC's Monthly Ocean Briefing in real-time*

- **Pentad SSS**
  - *Resolving SSS variations associated with MJO and oceanic mesoscale processes and interactions with ENSO*
  - *In situ pentad mean salinity data from NCEI*
  - *Satellite retrievals from multiple satellites (*NASA/SMAP, ESA/SMOS, NASA/Aquarius)
  - *OI-based blending technique developed for monthly analysis revised for pentad applications*

Primary Features of the Pentad Global SSS Monitoring Package

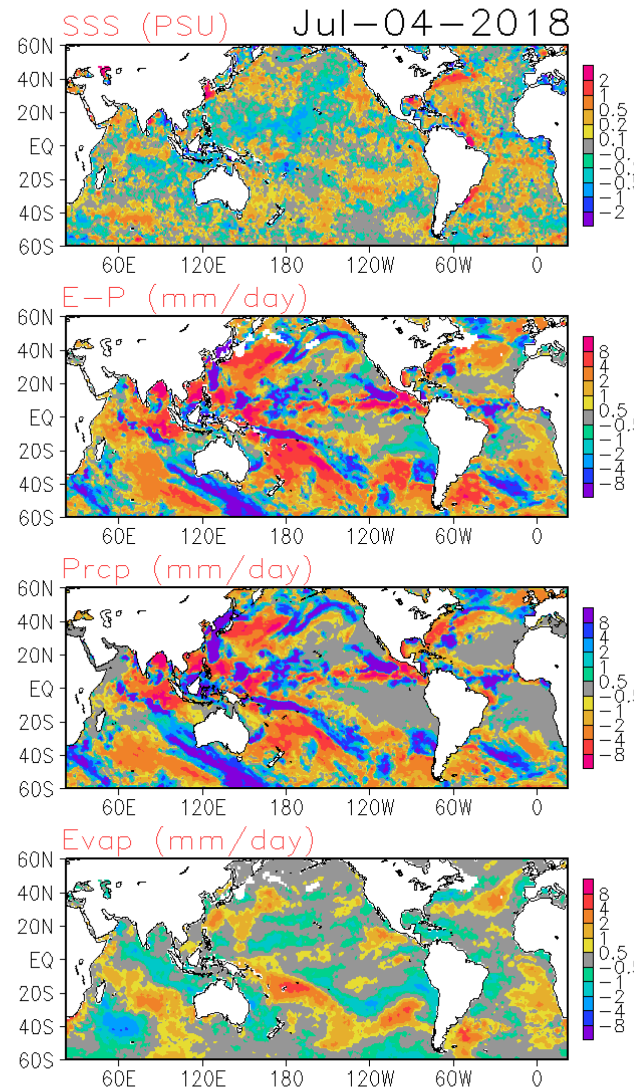
- Refined Resolution
  - *daily updated pentad*
  - *Spatial resolution kept at 1.0^{o}lat/lon due to restriction in inputs*

- Reduced Production Latency
  - *2 days after the ending date for each pentad*

- Composed of SSS , E, P, and E-P
  - *SSS: BASS/Pentad (in situ – Satellite Blended Analysis)*
  - *E: CFSR Evaporation adjusted against OAFlux*
  - *P: Bias Corrected CMORPH satellite precipitation estimates*

Global Sea Surface Salinity (SSS)
Anomaly for 06/30 -07/04 of 2018

- The positive SSS signal appeared in the northwest Pacific Ocean. Such large scale signal is likely caused by reduced/increased precipitation/evaporation. The negative SSS signal in the Indonesia-Pacific equatorial region, especially in the south, is co-incident with increasing precipitation. In the Gulf Stream, the positive SSS signal with the reduced precipitation. Also, the negative SSS in the east basin of Bay of Bengal with reduced freshwater flux input suggests that the oceanic advection dominates the SSS change in that region.



Data used

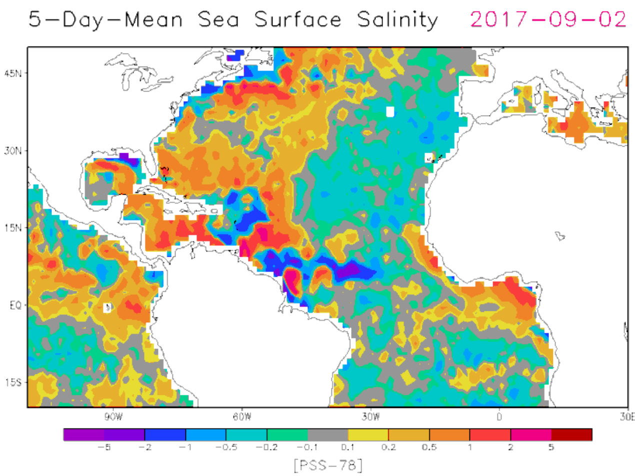
SSS : Pentad Blended Analysis of Sea Surface Salinity (BASS). The input data for this product includes the in-situ sea surface salinity (SSS) from NCEI, the SMAP SSS from NASA/JPL and SMOS SSS from ESA.

Precipitation: CMORPH adjusted satellite precipitation estimates

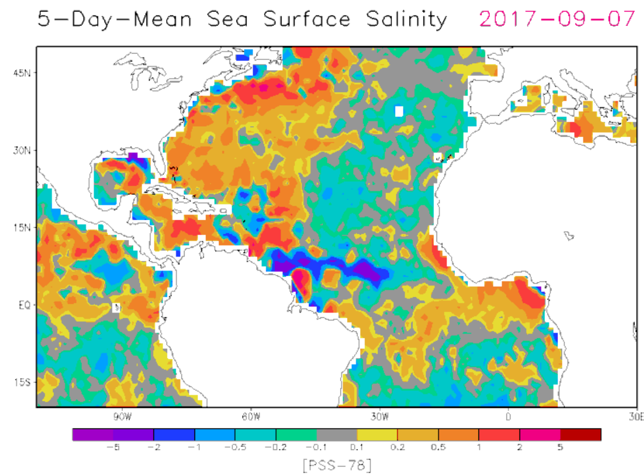
Evaporation: Adjusted CFS Reanalysis

SSS Variations during Hurricane Irma

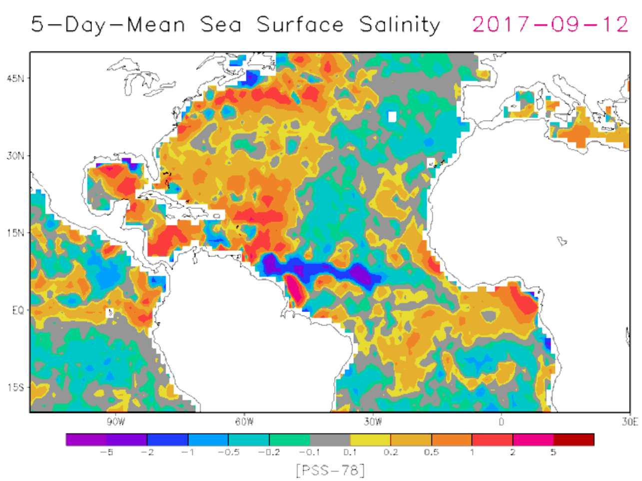
2017-09-02



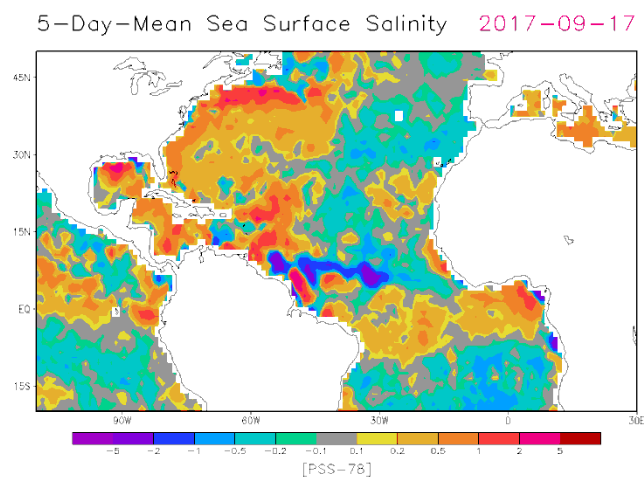
2017-09-07



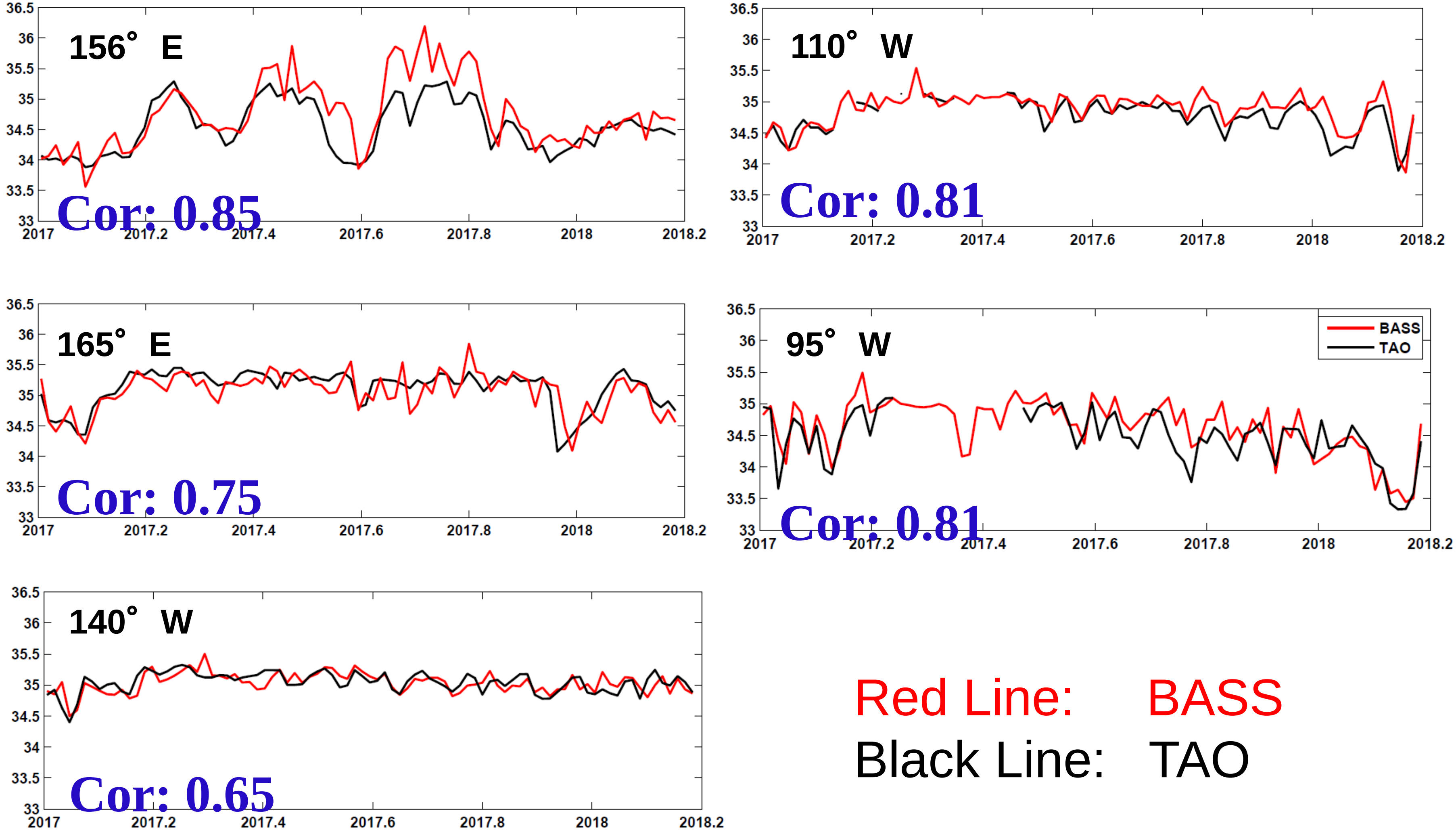
2017-09-12



2017-09-17



Comparison of Blended SSS with TAO / TRITON



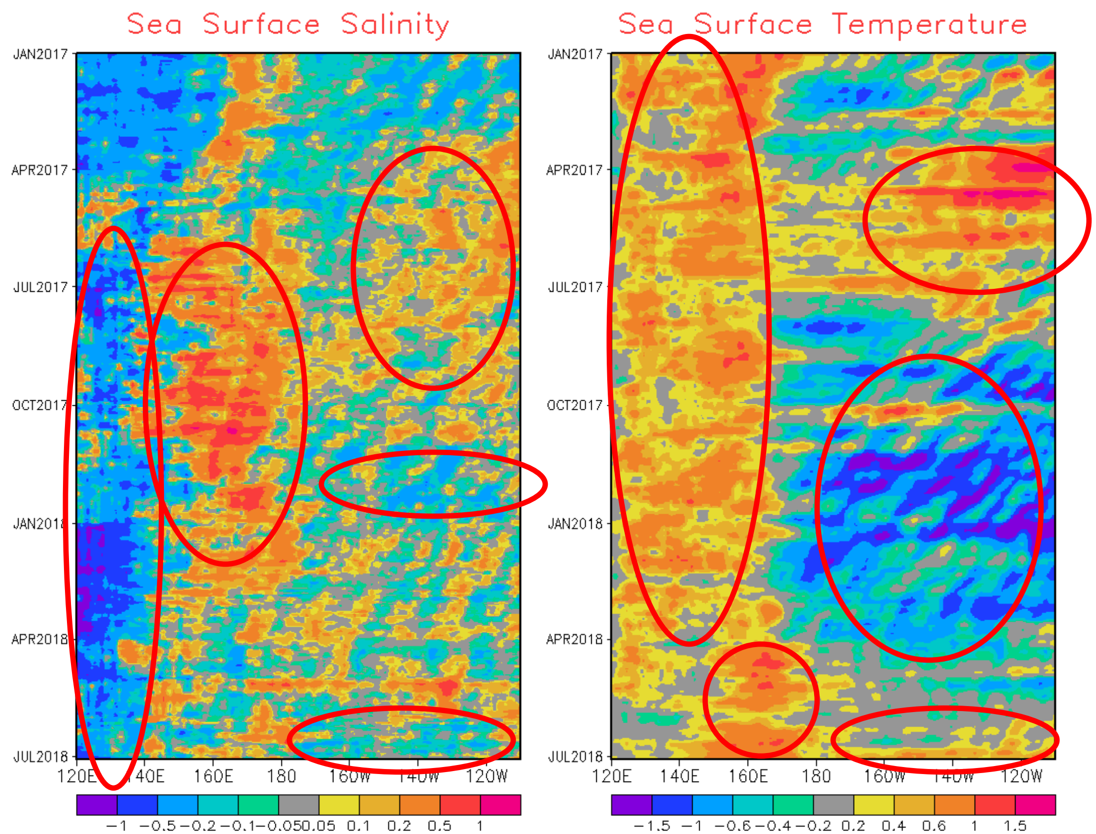
Red Line: BASS

Black Line: TAO

SSS Variations during ENSO

- During the 17/18 La Nina, negative (positive) SSS anomaly (SSSA) presented west of 140E (between 140E-180E), while both positive and negative SSSA occupied in the eastern Pacific
- Negative SSSA emerged in the central-eastern Pacific in Jun 2018, consistent with the emergency of positive SSTA in the region.
- The negative SSSA in the far western Pacific weakened in the past few months, which was consistent with the eastward shift of the positive SSTA center since Apr 2018.

Equatorial SSS and SST anom. in (5° S-5° N)



Feedbacks on SSS Products

Pingping.Xie@noaa.gov

- Any requirements and suggestions on
  - *Time / space resolution of the products*
  - *Additional variables required (e.g. quality index)*
  - *Additional diagnostic fields / tools and attribution analysis (e.g. budget analysis)*

Acknowledgements

- Dr. Caihong Wen: Provided ENSO precursor plots and reviewed PPT, and provided insight and constructive suggestions and comments

- Drs. Li Ren and Pingping Xie: Provided SSS slides

- Dr. Emily Becker: Provided NMME plot

- Drs. Thomas Collow and Wanqiu Wang: Provided sea ice slides