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

Prepared by

Climate Prediction Center, NCEP/NOAA

September 11, 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**
  - ***Will a Central-Pacific El Nino develop during winter 2018-19?***

Overview

Pacific Ocean

- ENSO-neutral conditions continued in Aug 2018.
- Subsurface temperature remained above-average in the western-central Pacific, while negative temperature anomalies emerged in the Eastern Pacific.
- Majority of models favor El Nino development in Sep-Nov with 65% chances.
- Arctic sea ice extent was well below average in Aug 2018.

Indian Ocean

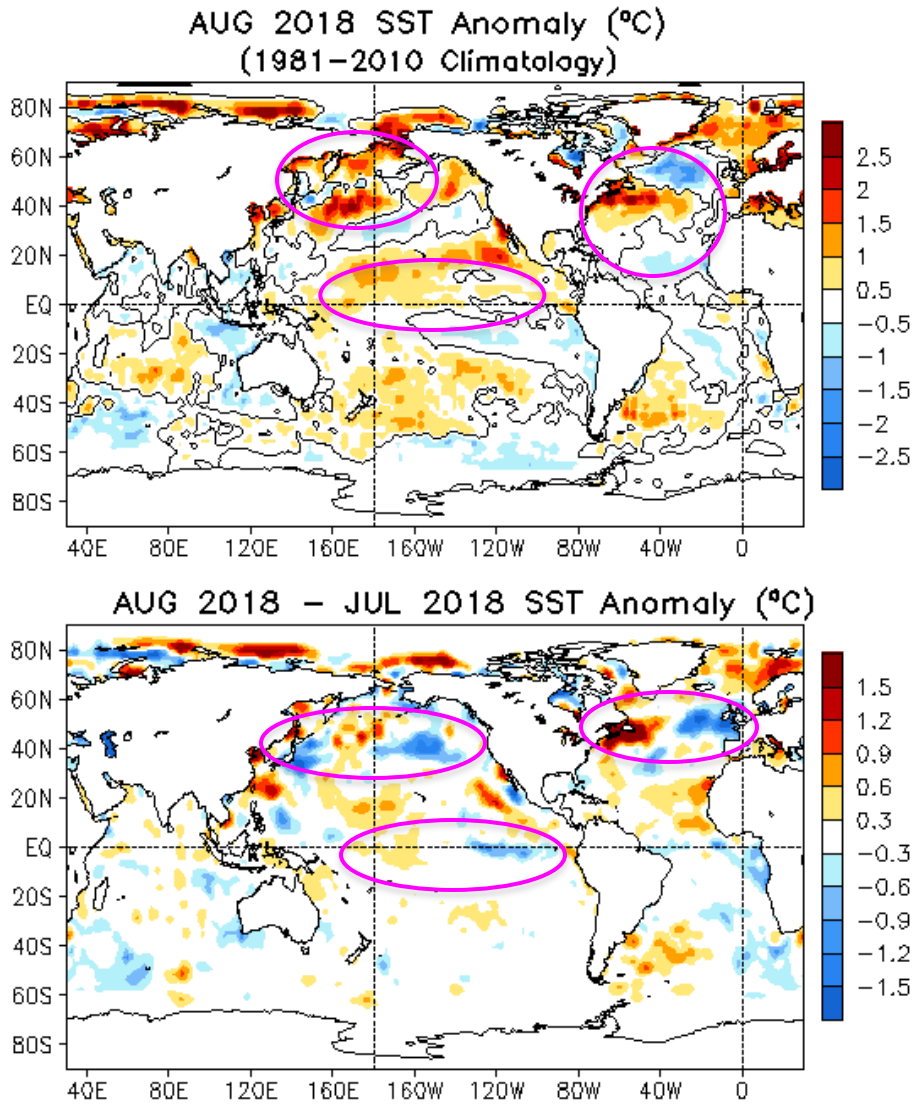
- Negative SSTAs dominated across the equatorial Indian Ocean.

Atlantic Ocean

- Positive NAO enhanced substantially in Aug 2018, with NAOI=+2.4.
- Atlantic Hurricane activity was quiet in Aug 2018, while the activity increased significantly during early September.

Global Oceans

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

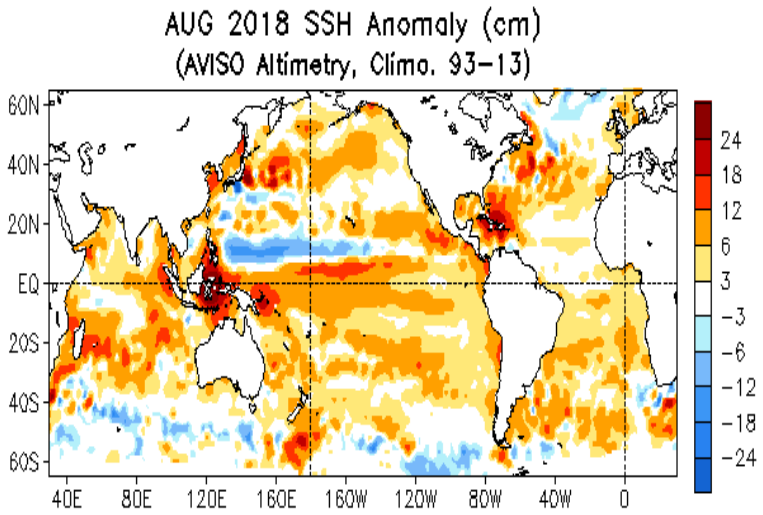


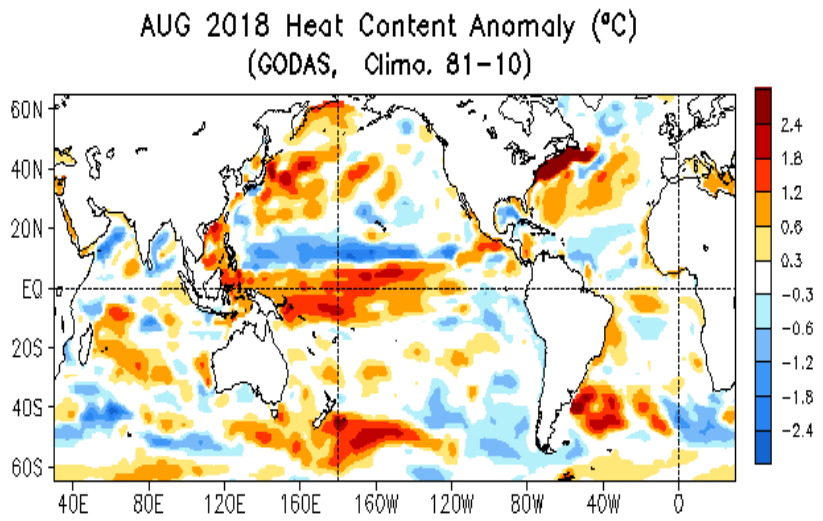
- **SSTs were slightly above average across most of the tropical Pacific Ocean.**
- **Strong positive SSTAs dominated in the mid-high latitudes of N. Pacific.**
- **Horseshoe/tripole-like SSTA pattern continued in the N. Atlantic.**
- **SSTAs were small in the tropical Indian and Atlantic Oceans.**

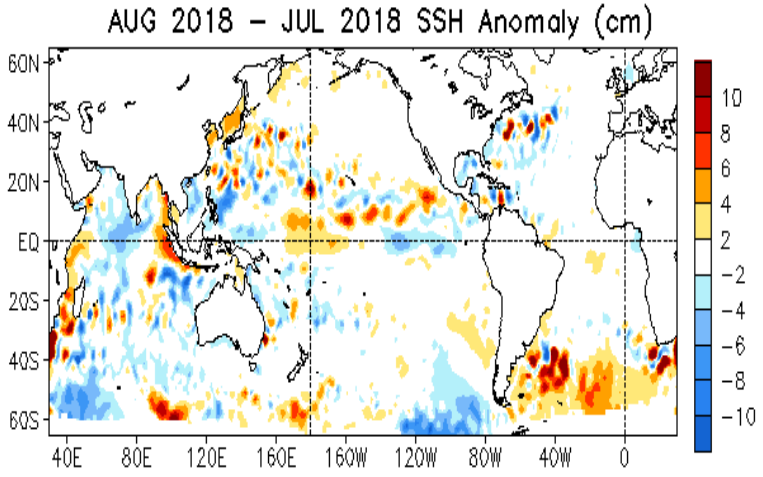
- **Positive (negative) SSTA tendencies presented near the Date line (eastern) equatorial Pacific.**
- **Large SSTA tendencies were observed in the mid-high latitude of N. Pacific and N. Atlantic.**

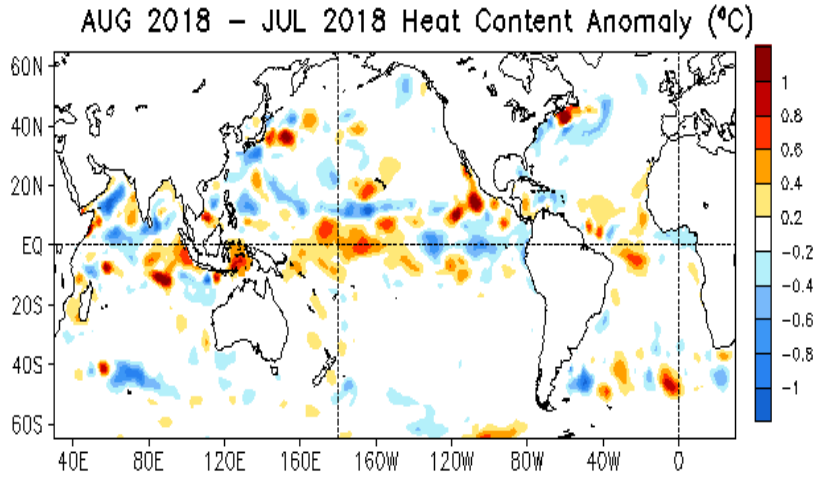
Fig. G1. Sea surface temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

Global SSH and HC300 Anomaly and Anomaly Tendency





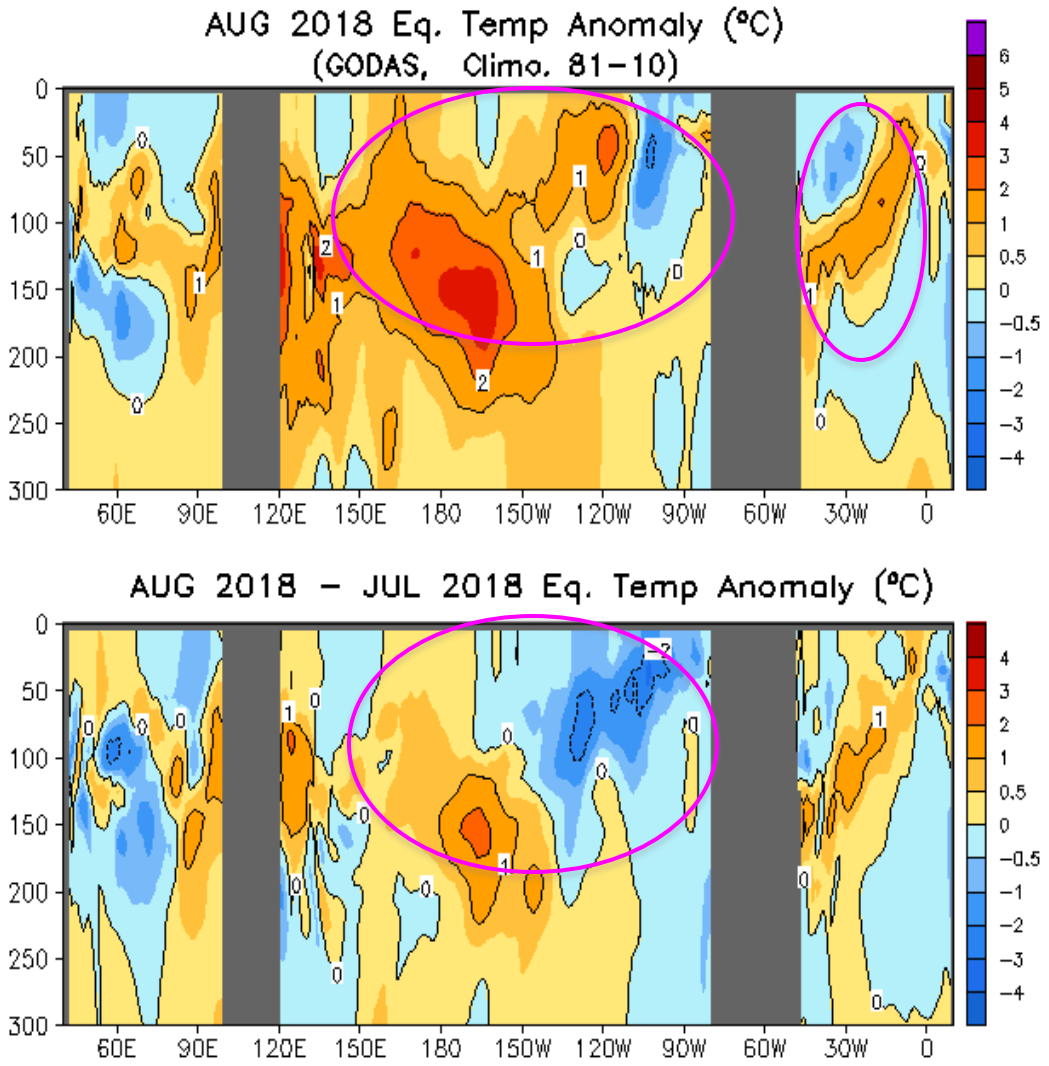




- **SSHA pattern was overall consistent with H300A pattern in the Pacific Ocean.**

- **Positive(negative) SSHA tendency was observed near the Date line (eastern Pacific Ocean.**

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



- **Positive temperature anomalies continued along the thermocline in the Western-Central equatorial Pacific, while negative temperature anomalies emerged in the far eastern Pacific.**

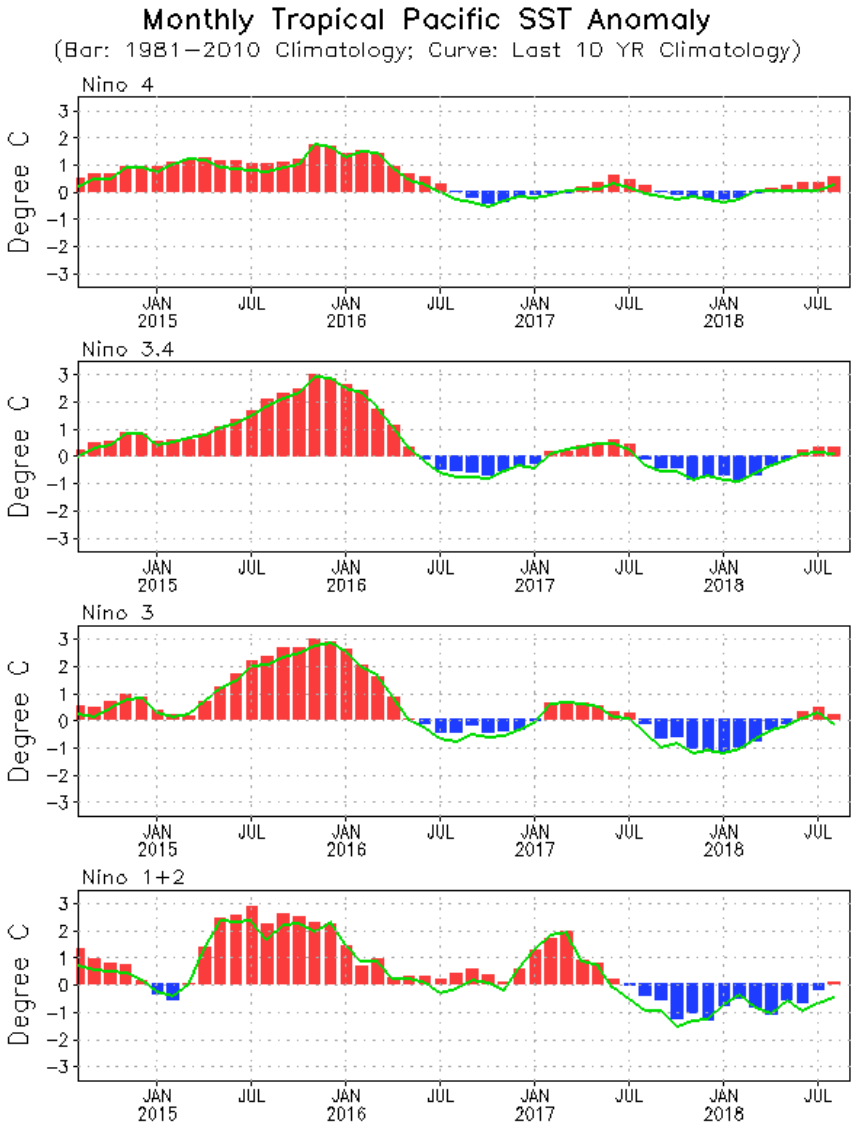
-**Positive temperature anomaly presented across most of the thermocline in the Atlantic Ocean.**

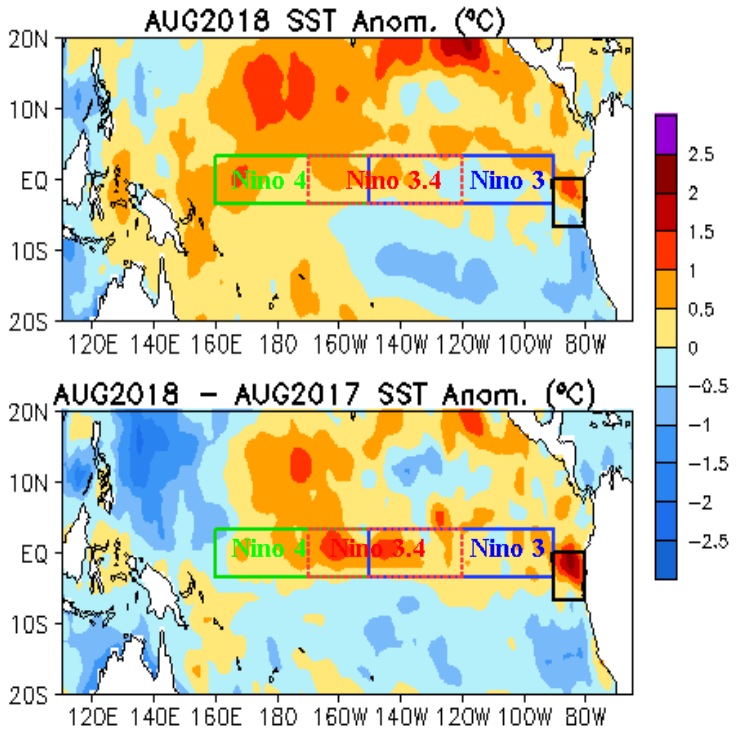
- **Positive (negative) temperature tendency presented along the thermocline in the western-central (eastern) Pacific Ocean.**

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

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific NINO SST Indices

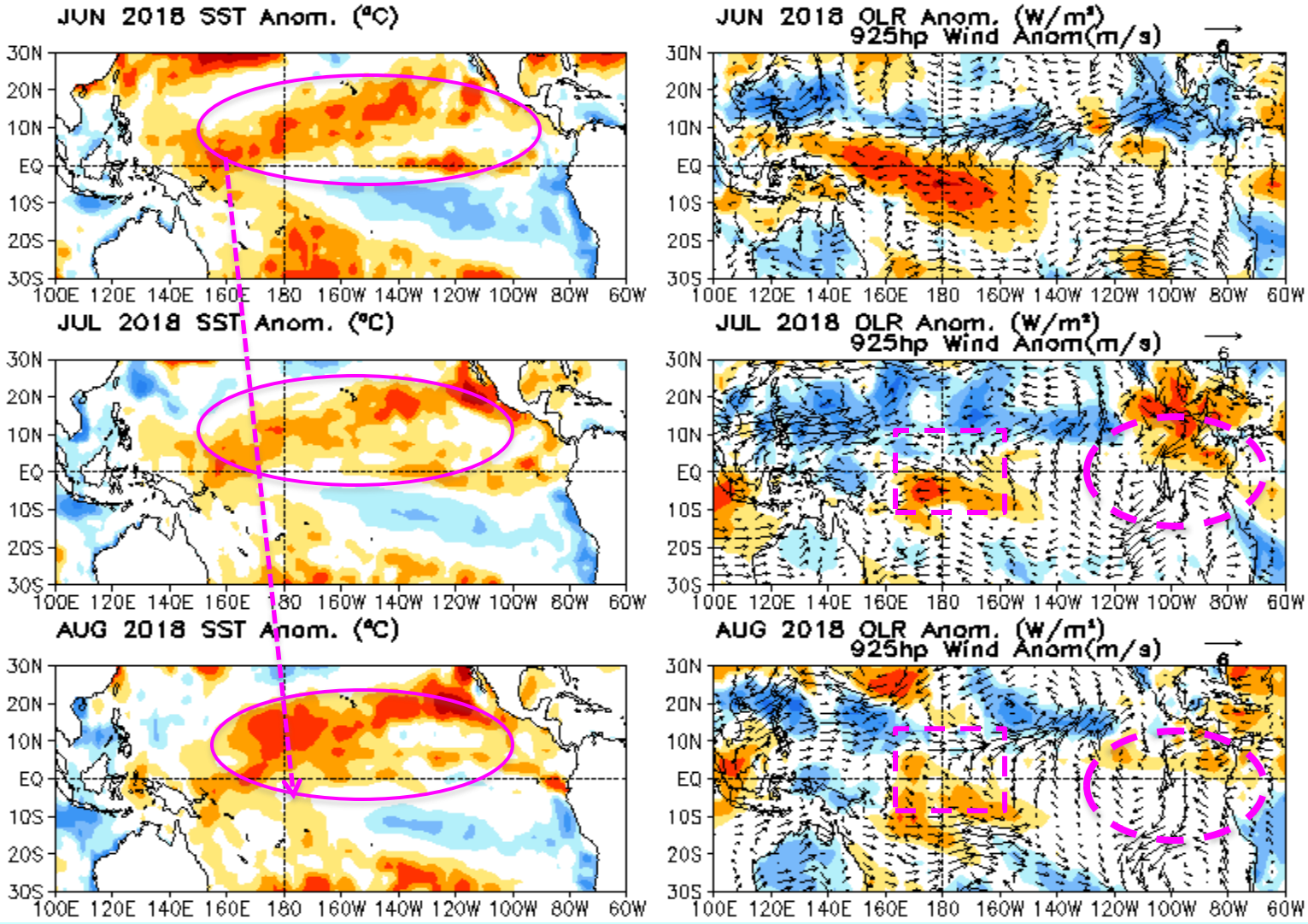




- **Nino 4 increased slightly in Aug 2018, with Nino 4 = 0.5 C.**
- **Nino3.4 = +0.3 C in Aug 2018.**
- **The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v5.**

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.

Last Three Month SST, OLR and 925hPa Wind Anomalies



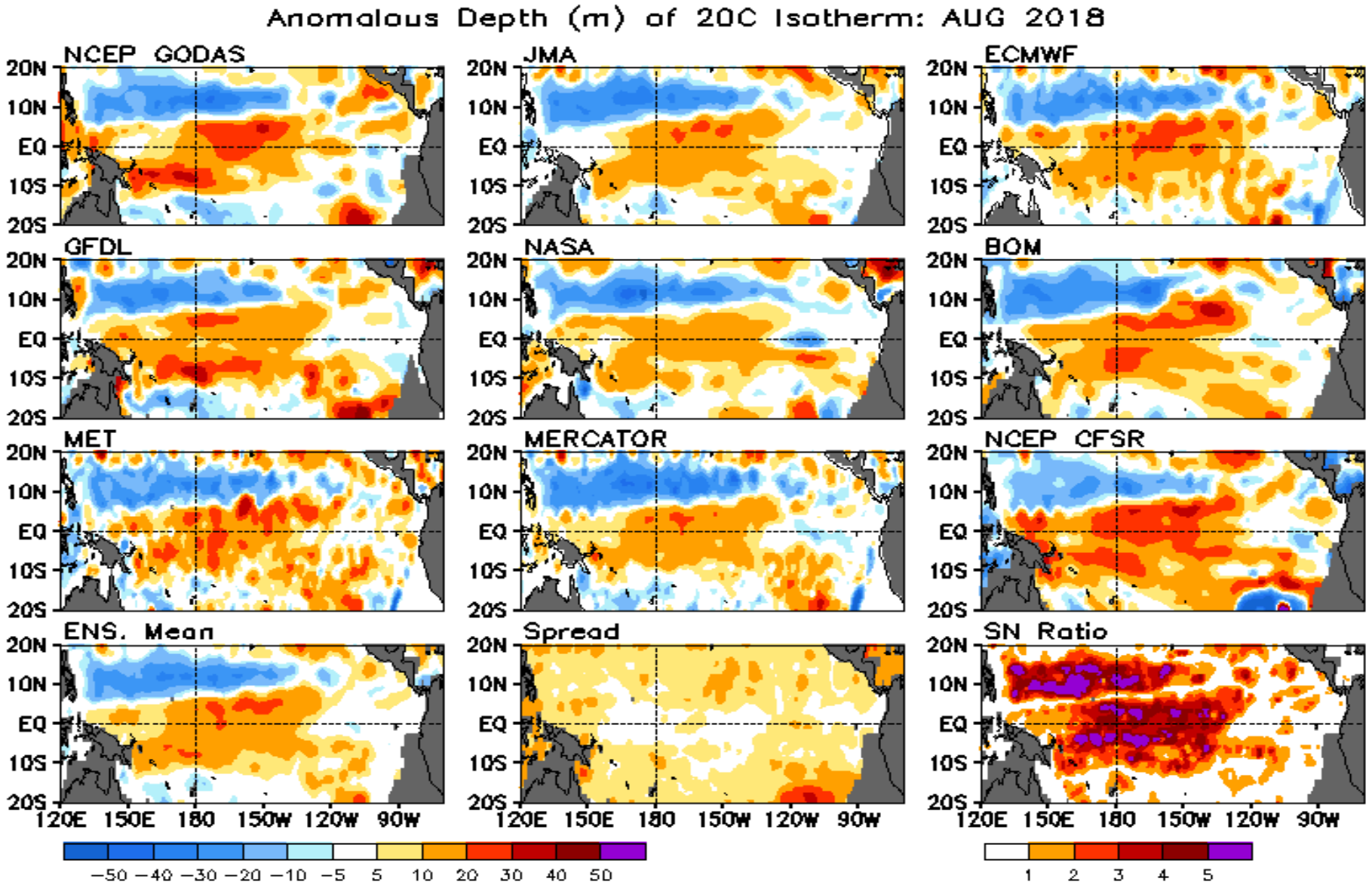
- **Most of positive SSTA were confined in the north of the equator.**

- **Negative SSTA in the far Eastern Pacific might be associated with the off-coastal wind anomalies.**

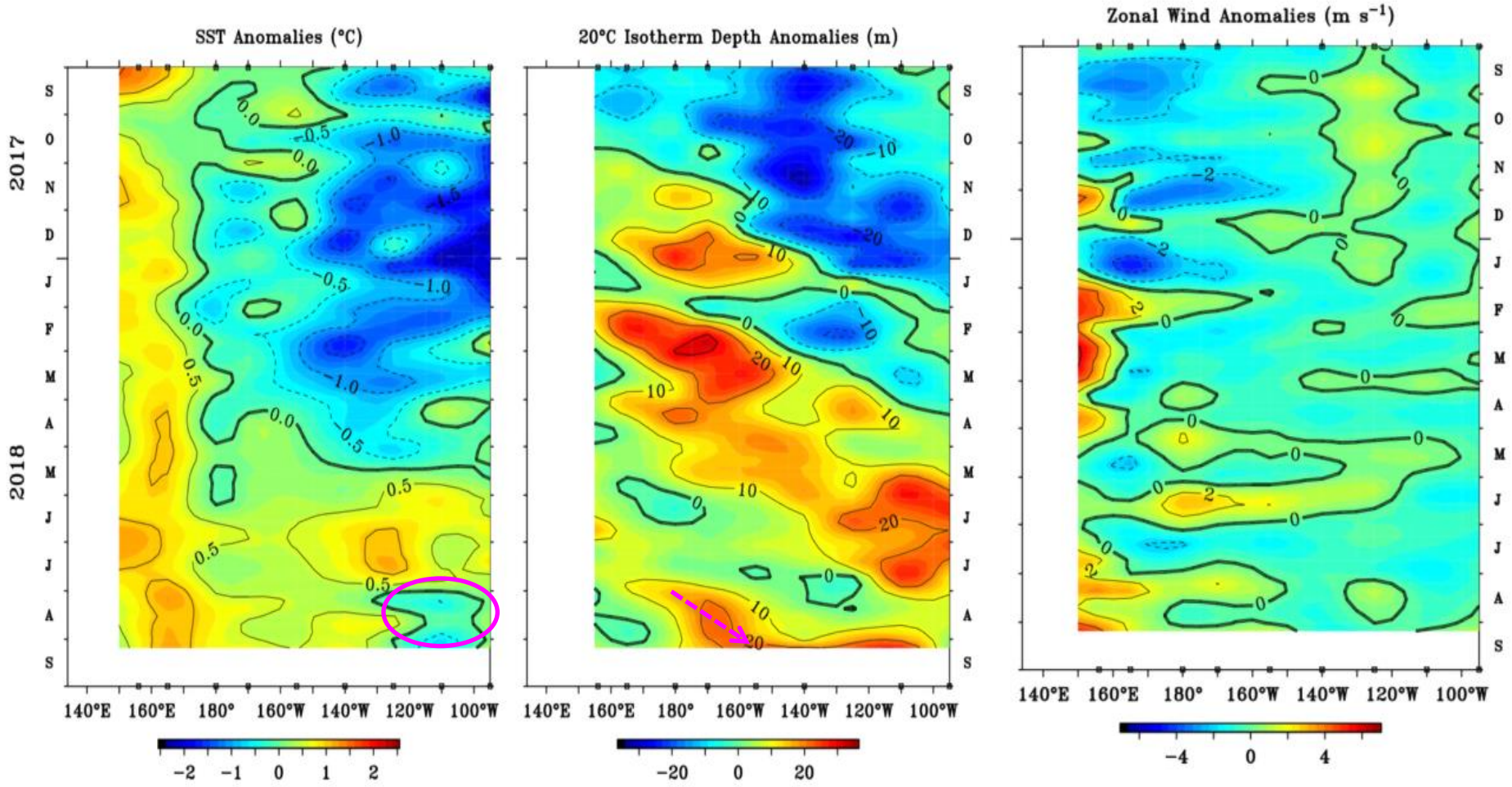
Real-Time Ocean Reanalysis Intercomparison: D20

Climatology : 1993-2013

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



TAO Equatorial (2S-2N) Pacific SST (°C), D20 (m) and Zonal wind(m/s) Anomalies



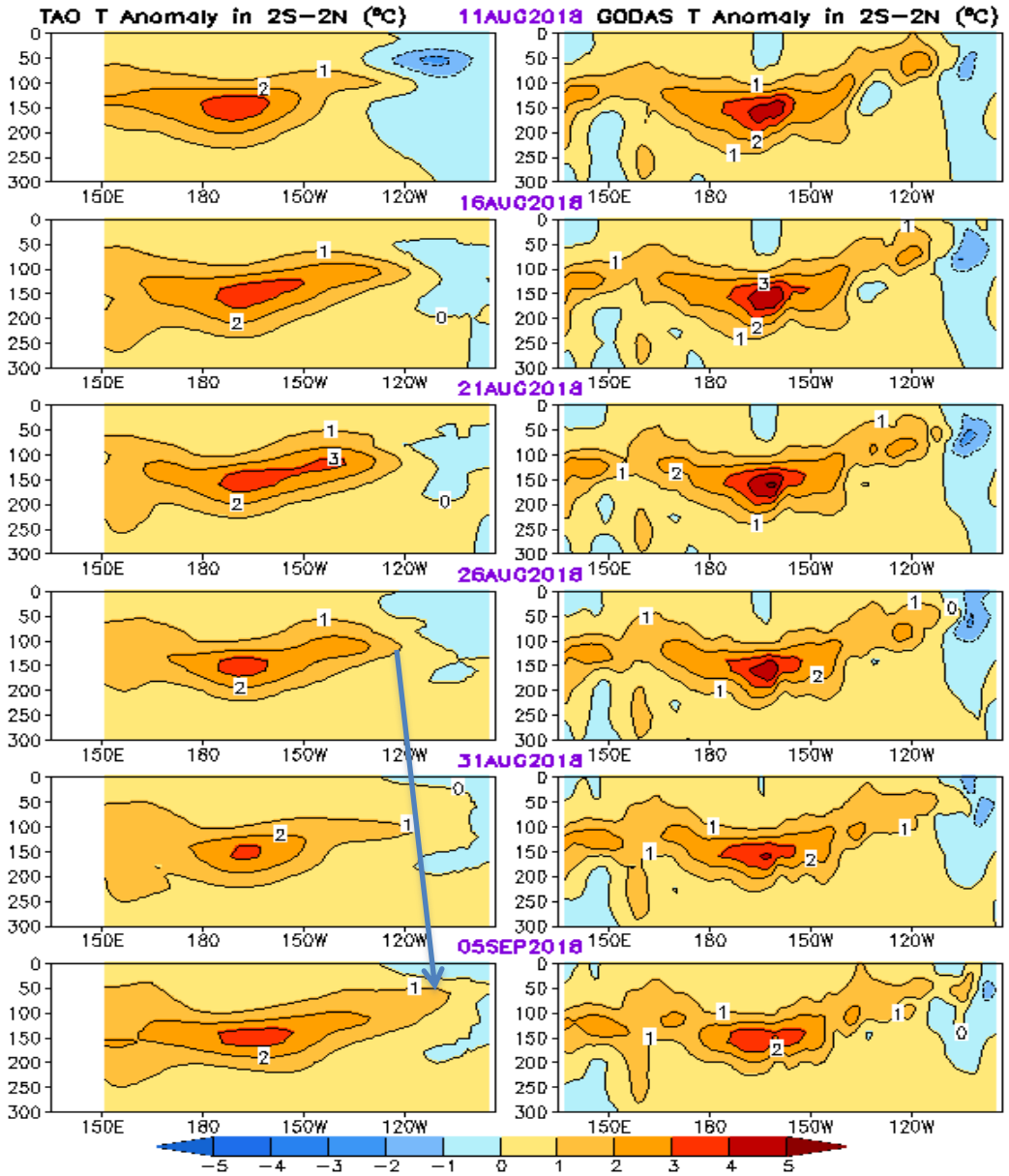
(https://www.pmel.noaa.gov/tao/drupal/disdel/)

- **SSTs were above average in the Western-Central Pacific, while negative SSTA emerged in the far Eastern Pacific since the end of Jul, 2018.**

- **A downwelling Oceanic Kelvin wave initiated in the mid-Jul propagated to the Date line in the end of July and extended to the E. Pacific by the end of Aug, 2018.**

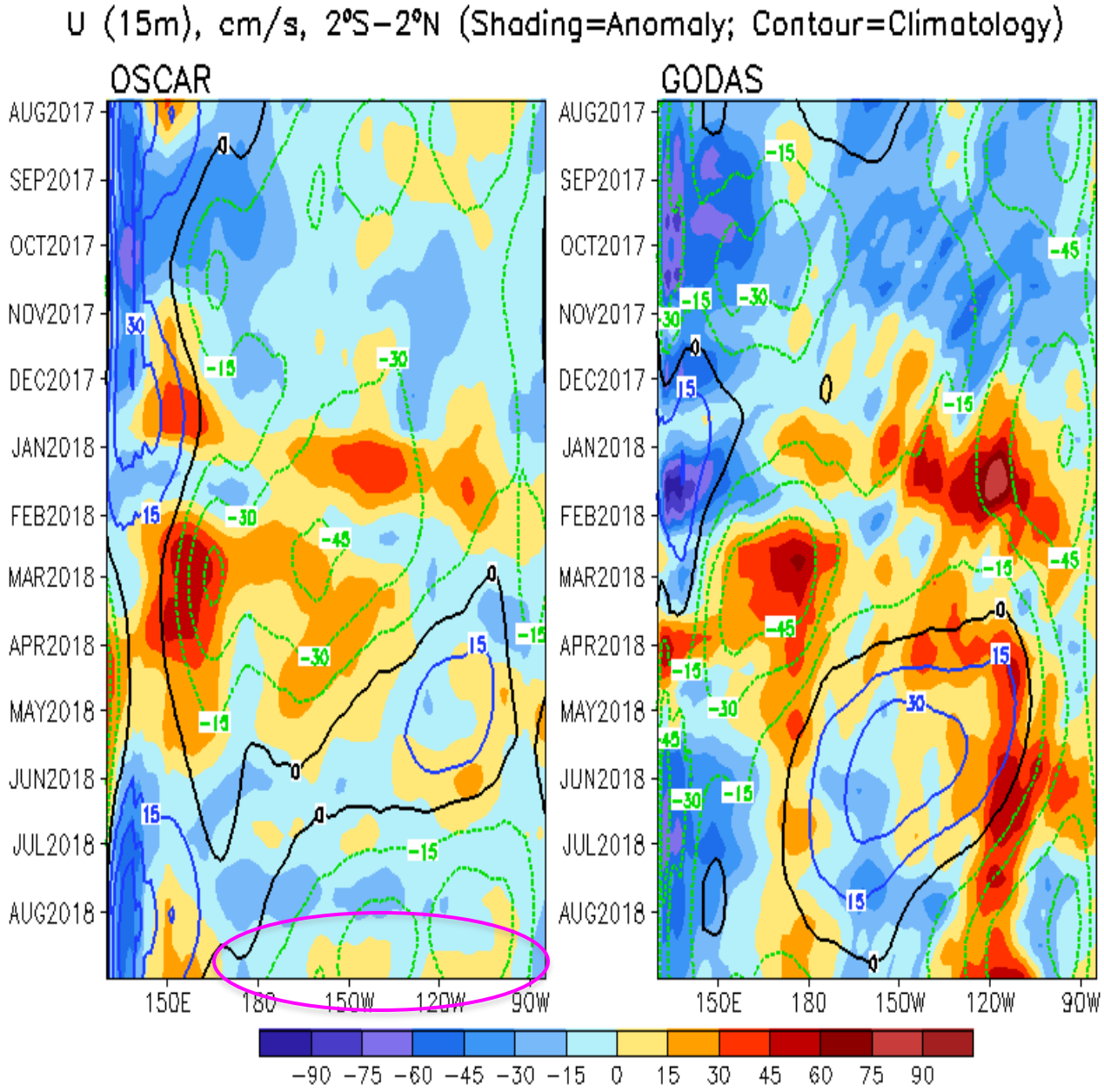
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

TAO GODAS



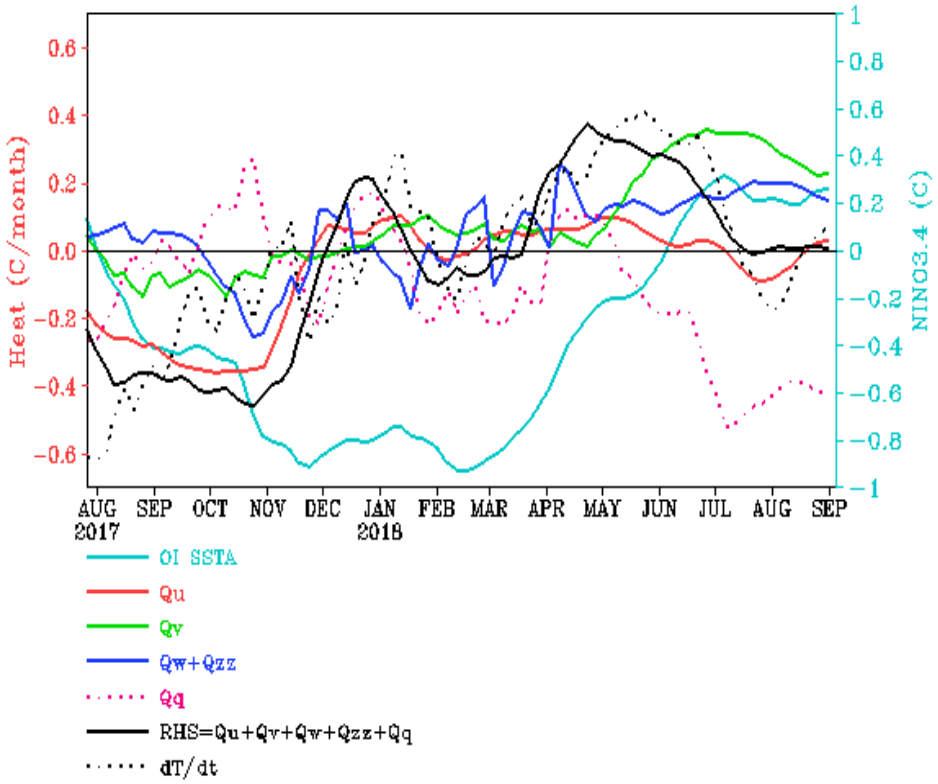
- **Positive subsurface temperature anomaly in the central Pacific propagated eastward during the last six pentads.**
- **Negative subsurface temperature anomaly in the far Eastern Pacific decayed since the mid-August.**

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



-Zonal current were near average cross the central-eastern Pacific in Aug 2018.

NINO3.4 Heat Budget



- Observed SSTA tendencies (dT/dt; dotted black line) switched to positive in the second half of Aug 2018.

- Meridional advection (Qv) and vertical terms (Qw+Qzz) remained positive.

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.

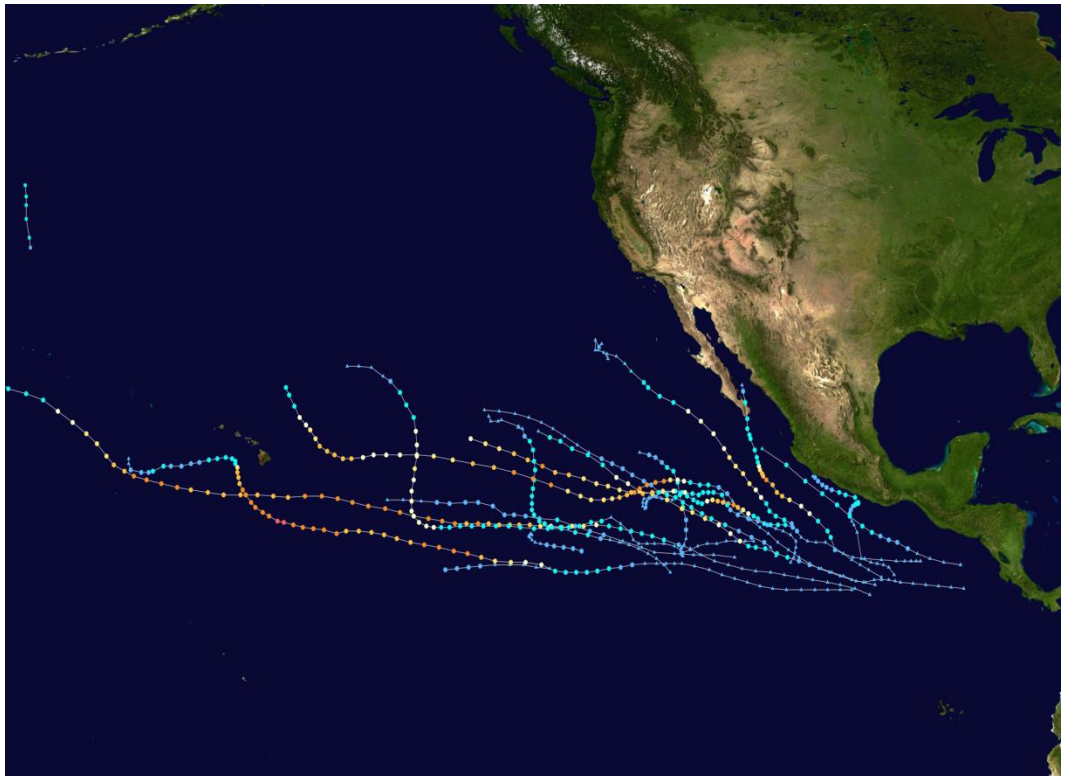
Qu: Zonal advection; Qv: Meridional advection;

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

2018 E. Pacific Hurricane Season



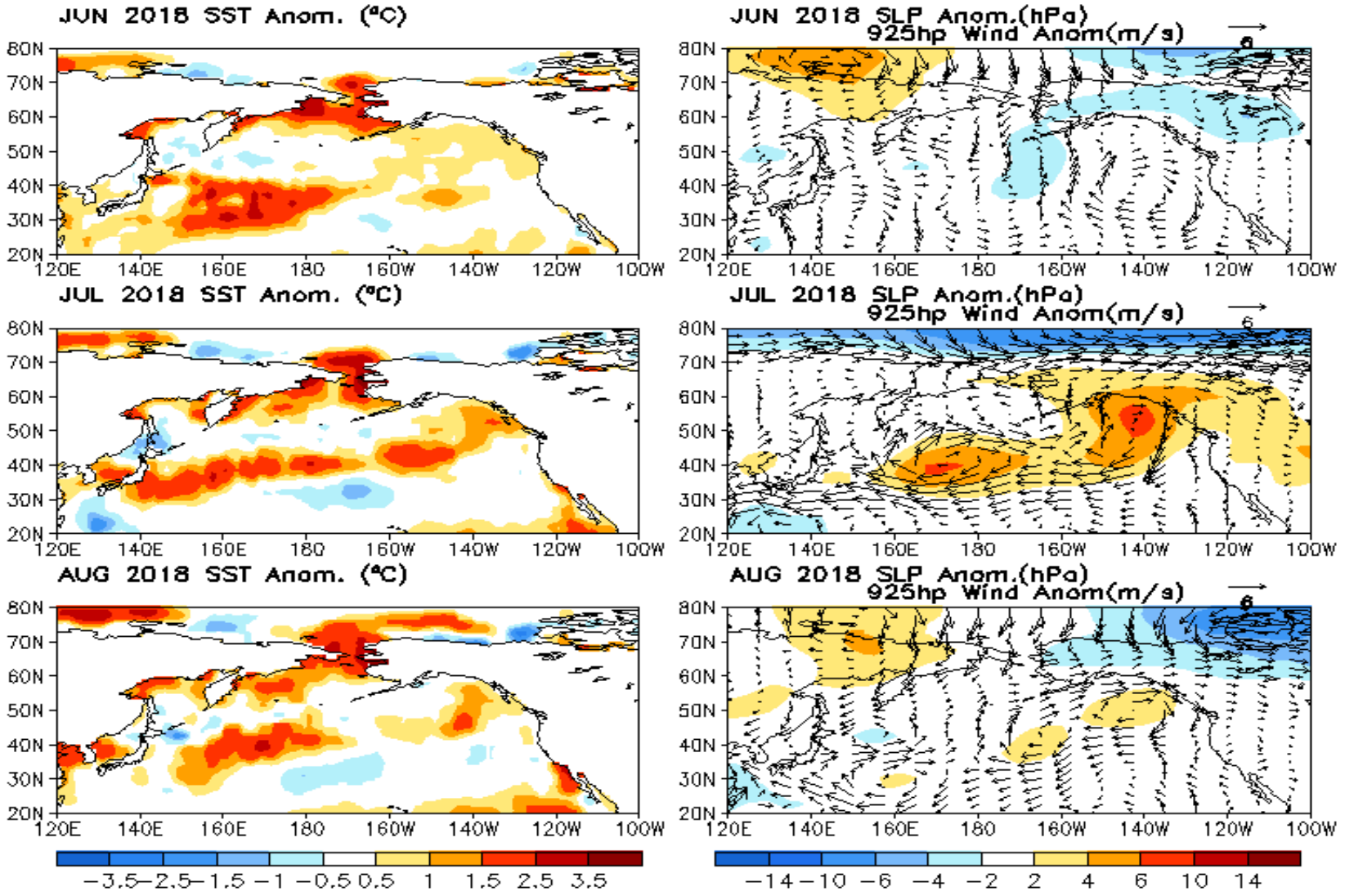
- Eight tropical storms formed during Aug 1 – Sep 9, with six developing into hurricanes and three became major hurricanes.

(https://en.wikipedia.org/wiki/2018_Pacific_hurricane_season)

E.Pac	2018 prediction (issued on May 24) 80% near or above normal	1981-2010	Observations (By Sep 9)
Named storms	14-20	15	16
Hurricanes	7-12	8	9
Major hurricanes	3-7	4	6

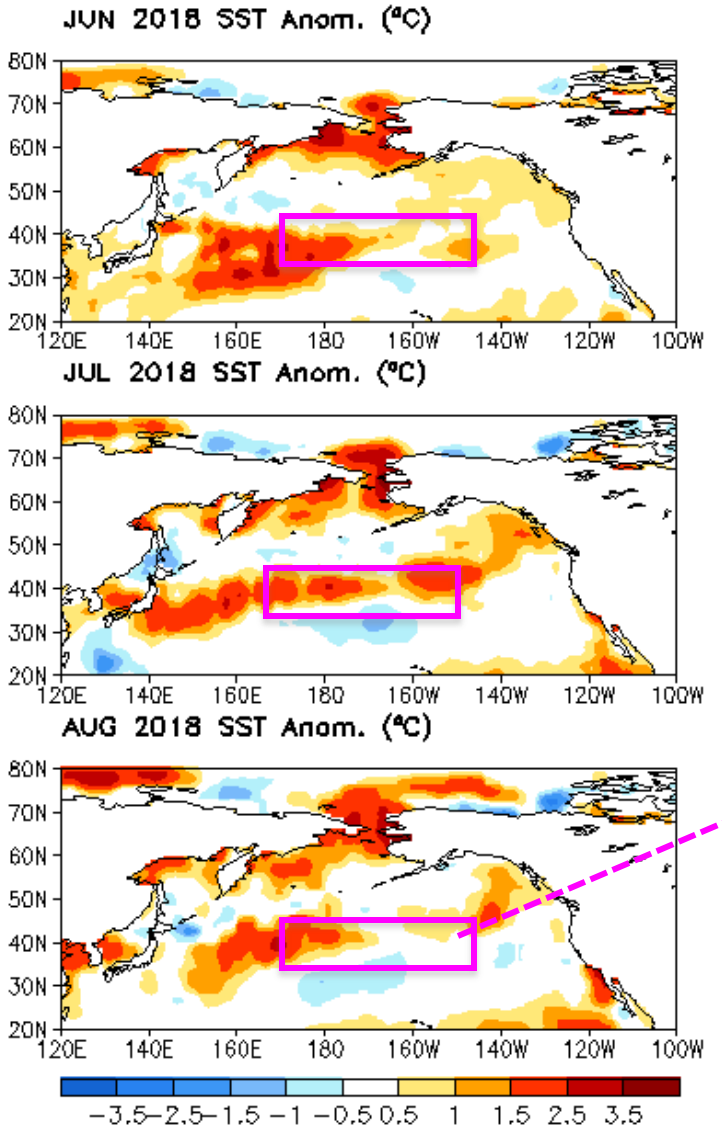
North Pacific & Arctic Oceans

Last Three Month SST, SLP and 925hp Wind Anomalies

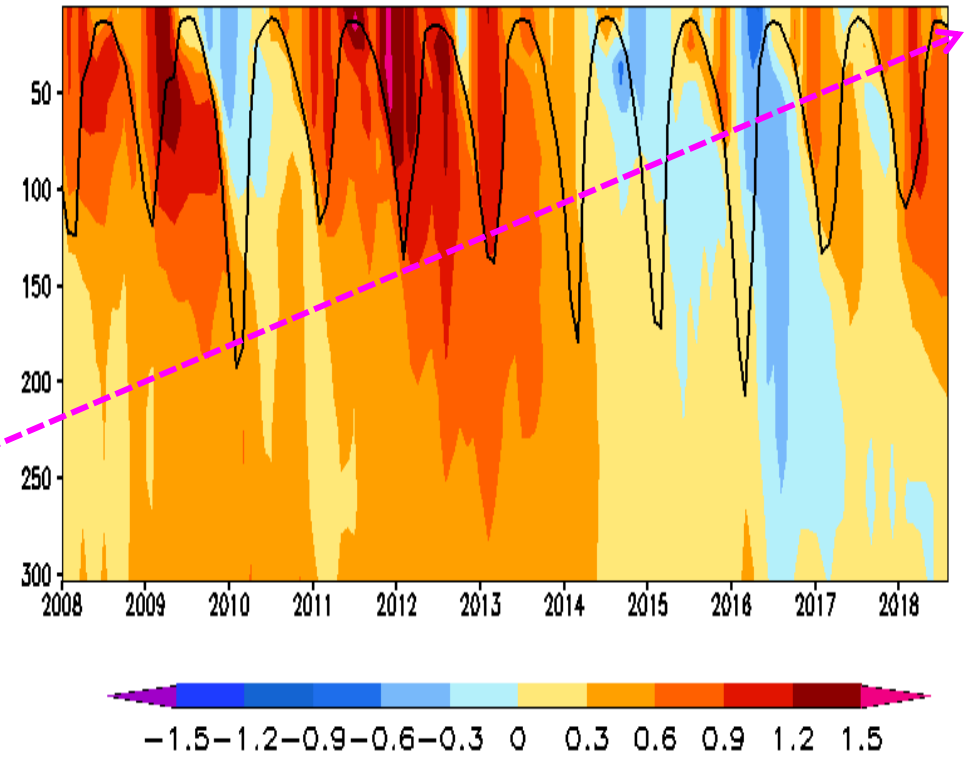


- **Distribution of SST anomalies between 20 - 50N varied month by month, owing to the high frequency changes in the atmospheric circulation.**

Subsurface Temperature Anomaly in the C. N Pacific



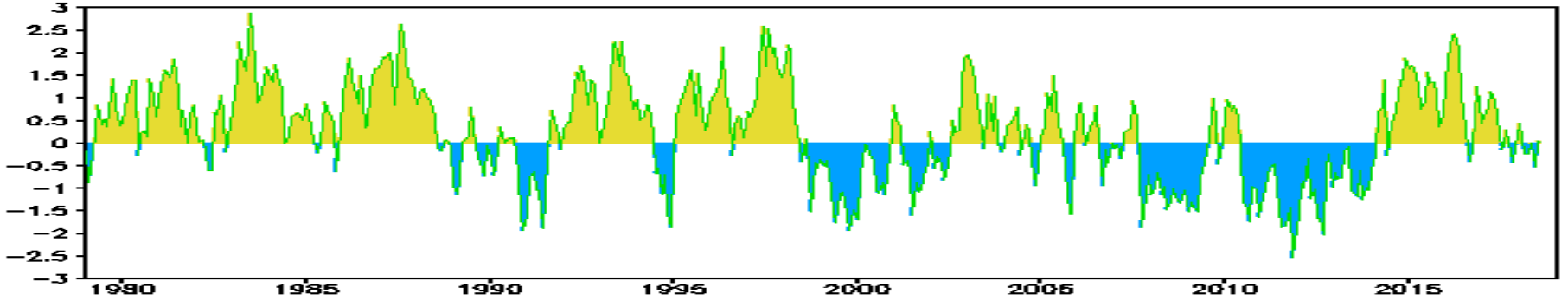
Temperature anomaly averaged in [170E-150W,30N-40N]



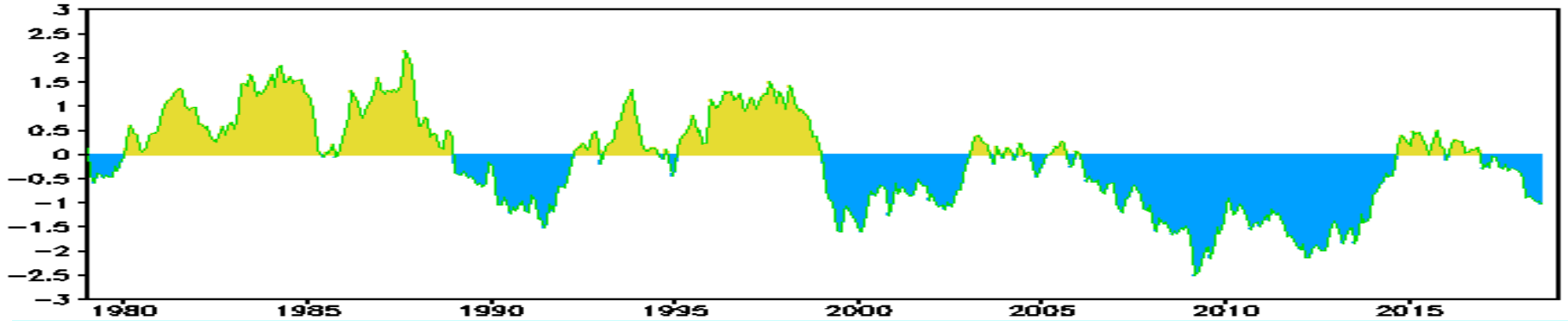
- **Positive subsurface temperature anomaly in the central North Pacific has persisted since 2016.**

Two Oceanic PDO indices

SST-based PDO



H300-based PDO



- **SST-based PDO index switched to positive phase in Aug 2018, with PDO index =0.03.**
- **Negative H300-based PDO index has persisted 11 months since Nov 2016, with HPDO = -1 in Aug 2018.**
- **SST-based PDO index has considerable variability both on seasonal and decadal time scales.**

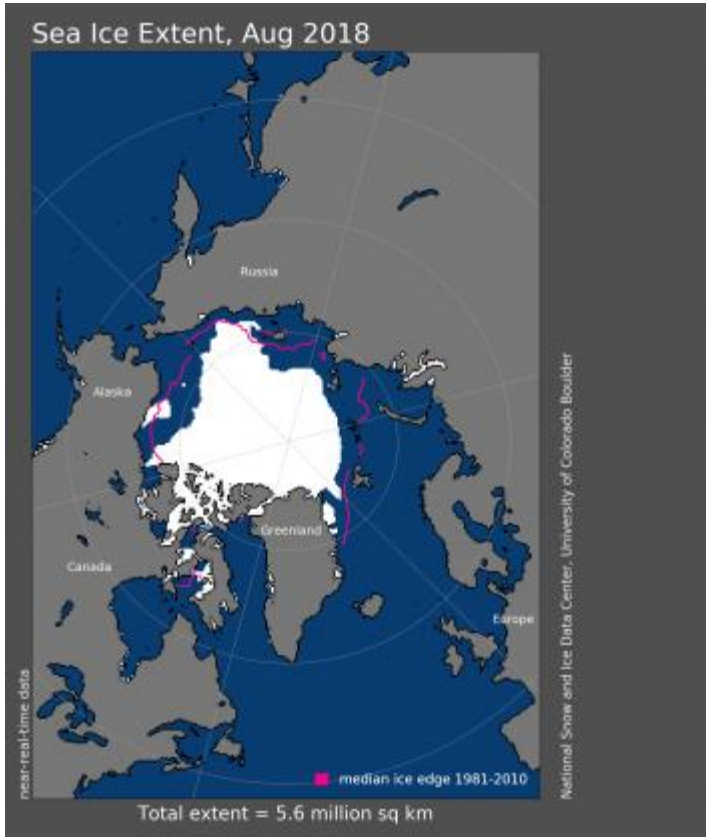
(H300-based PDO index is downloadable from http://www.cpc.ncep.noaa.gov/products/GODAS/PDO_body.html)

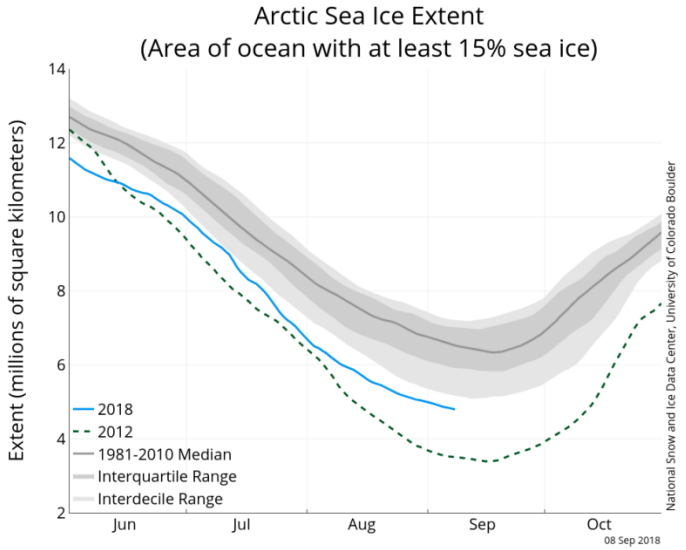
SST-based Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the ERSST v4 monthly SST anomalies onto the 1st EOF pattern. H300-based Pacific Decadal Oscillation is defined as the projection of monthly mean H300 anomalies from NCEP GODAS onto their first EOF vector in the North Pacific.

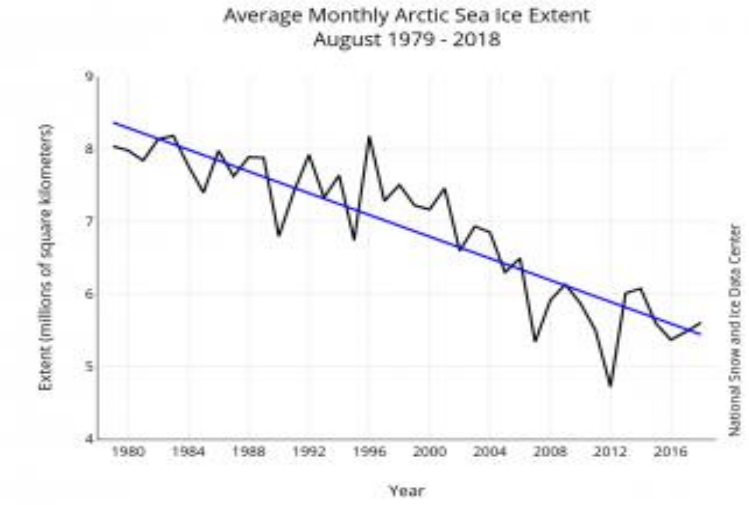
Arctic Sea Ice

National Snow and Ice Data Center

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



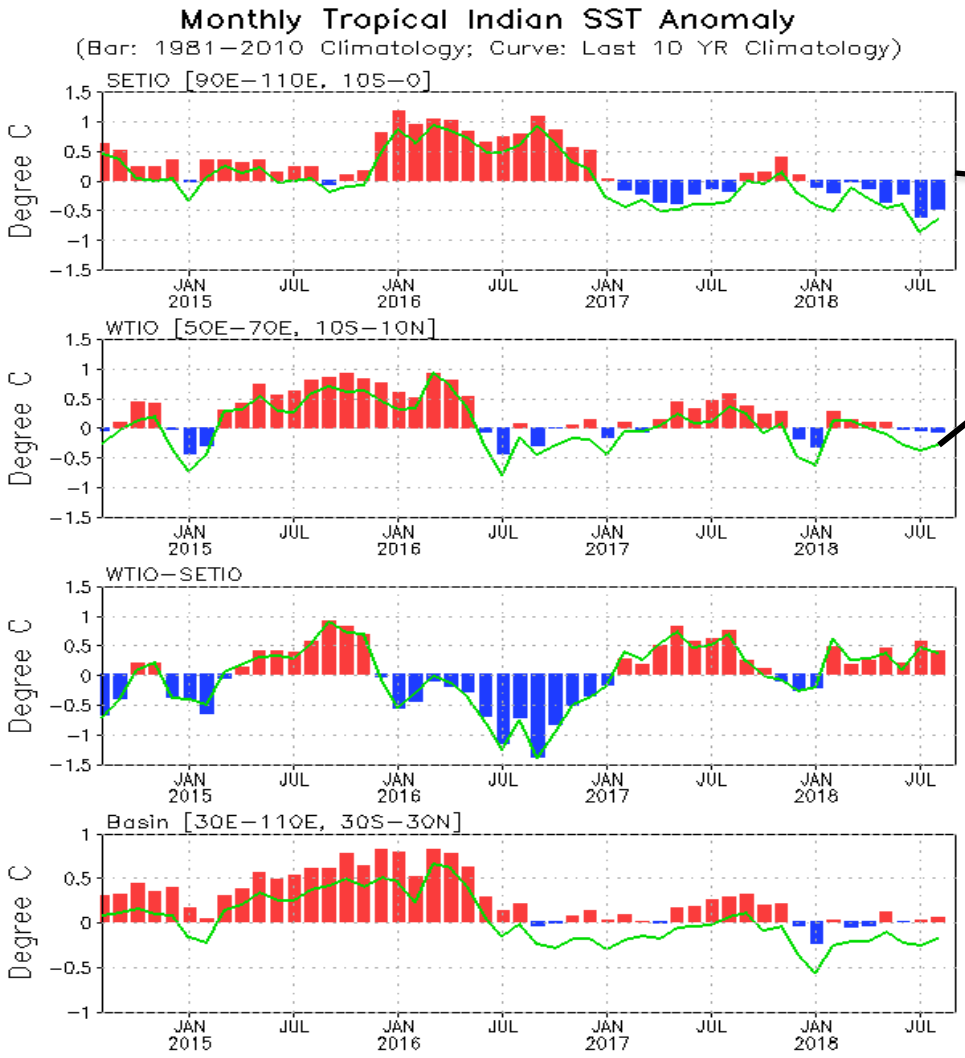


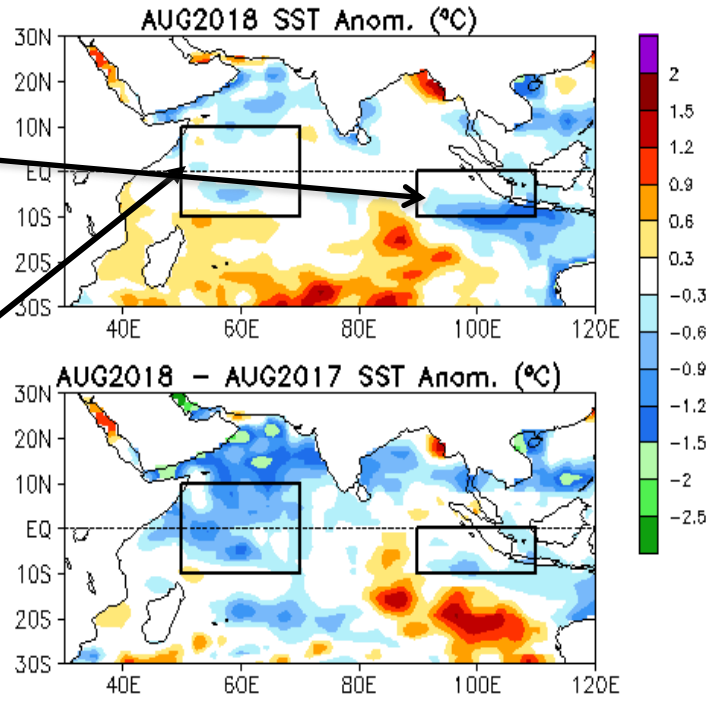


- **Arctic sea ice extent was well below average in Aug 2018.**
- **Aug 2018 was the seventh lowest Aug extent since 1979.**

Indian Ocean

Evolution of Indian Ocean SST Indices





- **Indian Dipole was positive since Feb 2018.**

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.

- **Negative SSTA continued across much of equatorial Indian Ocean.**

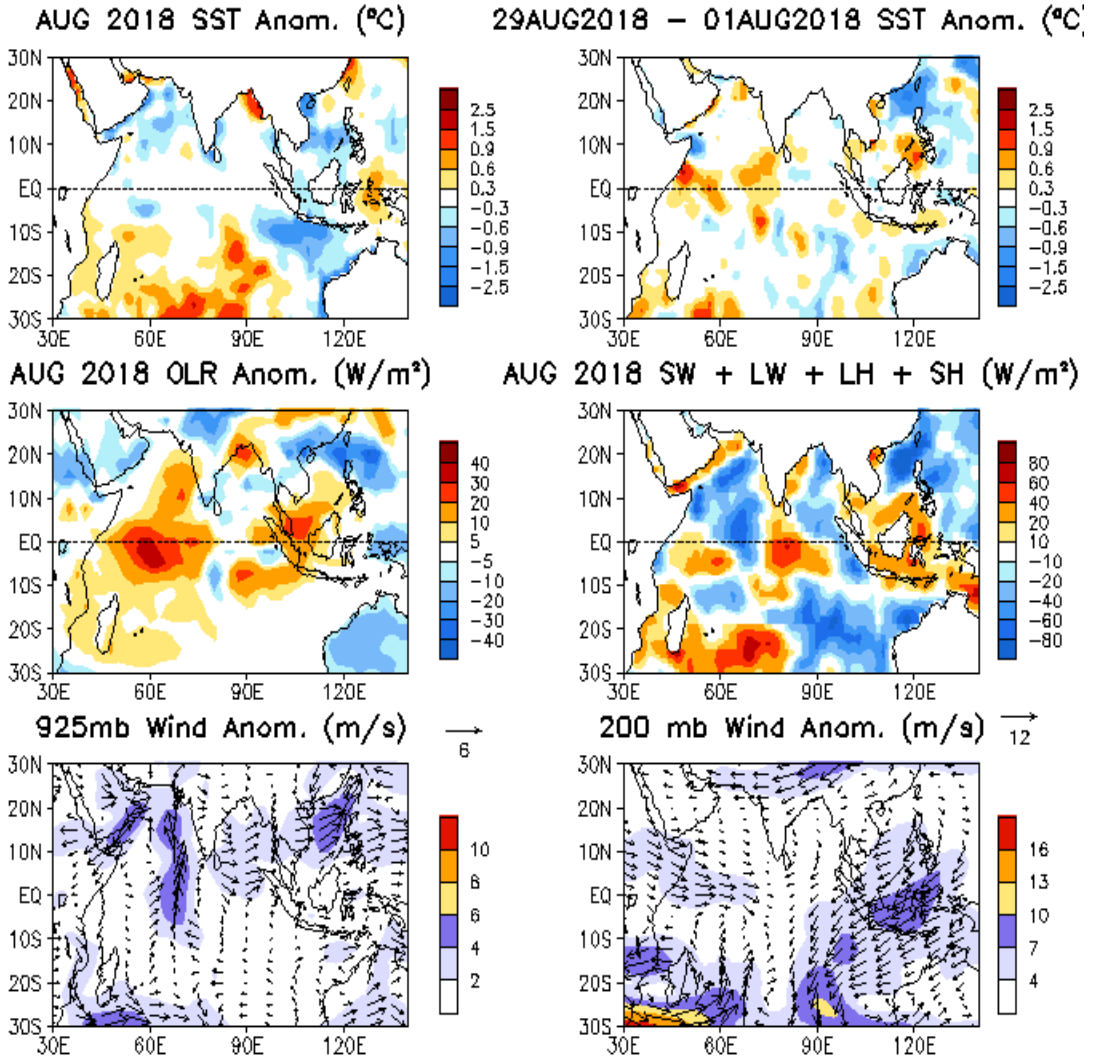
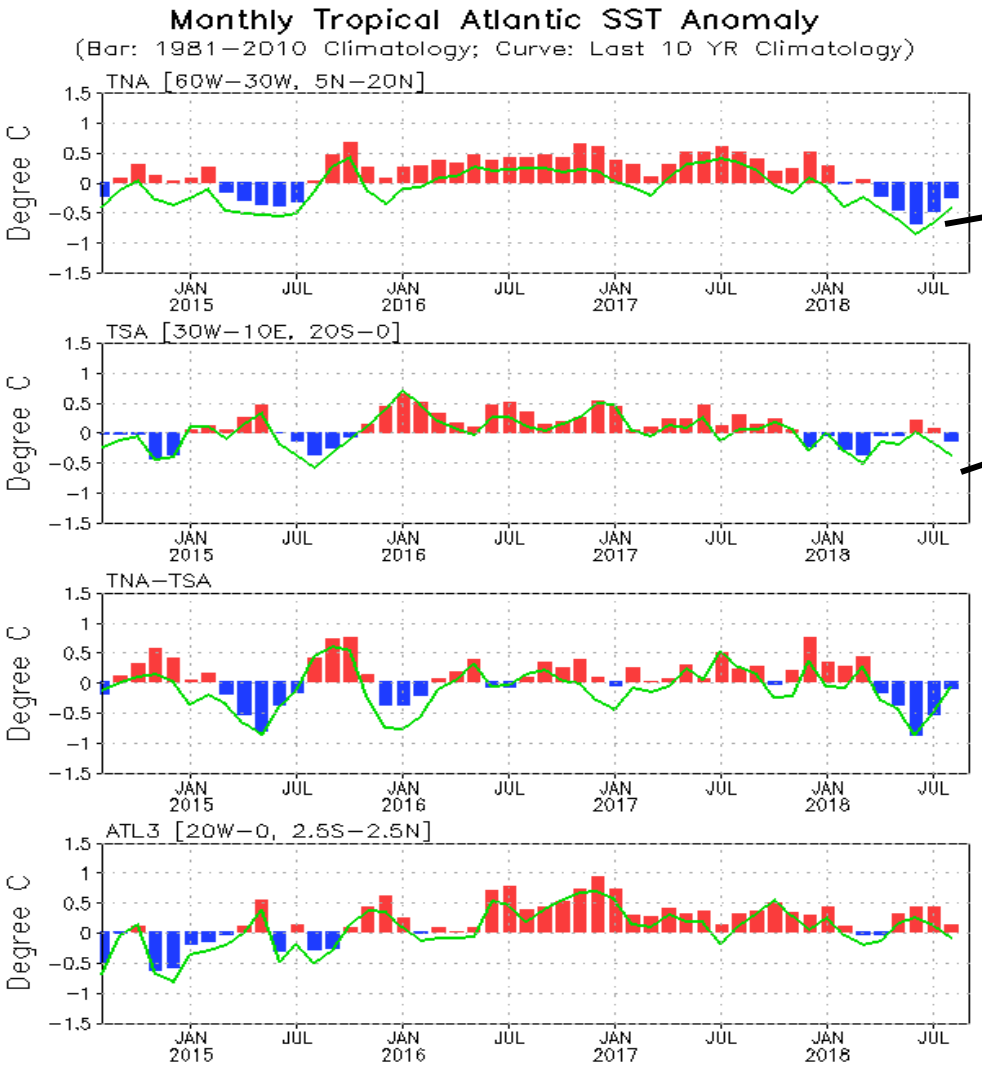
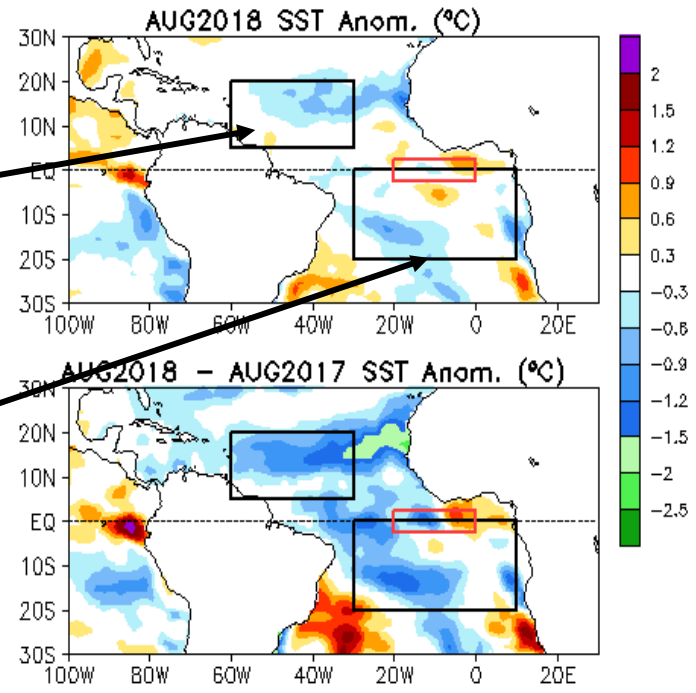


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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





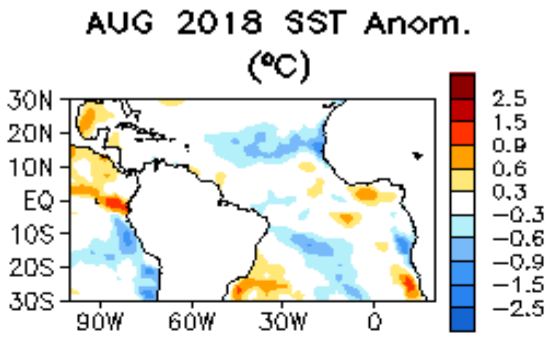
- TNA, TSA and the gradient mode (TNA-TSA) were near neutral in Aug 2018.

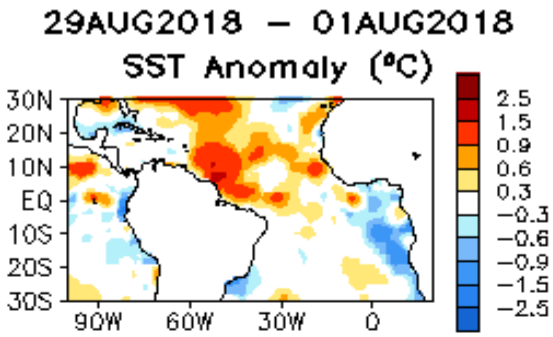
- The SST in the eastern tropical N Atlantic in Aug 2018 was about 2 degree colder than that in Aug 2017 .

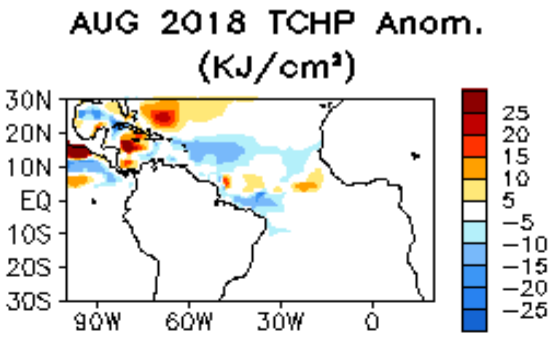
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the TNA [60°W-30°W, 5°N-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between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

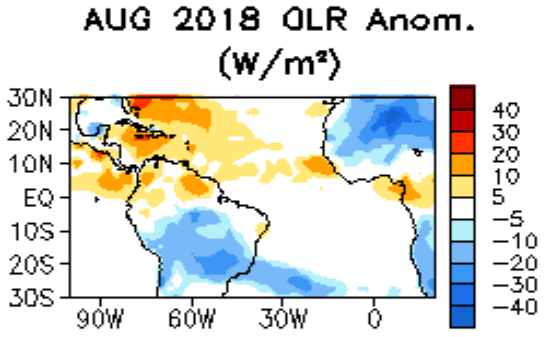
Tropical Atlantic:

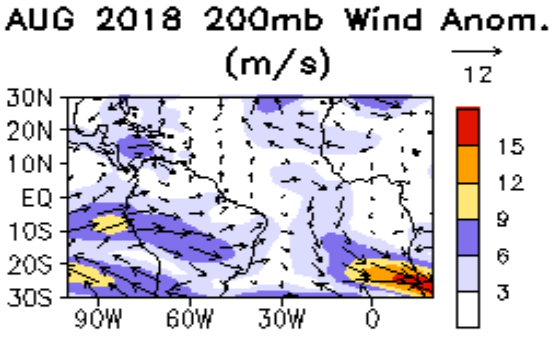
SST, SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, TCHP, 925-mb/200-mb Winds anom.

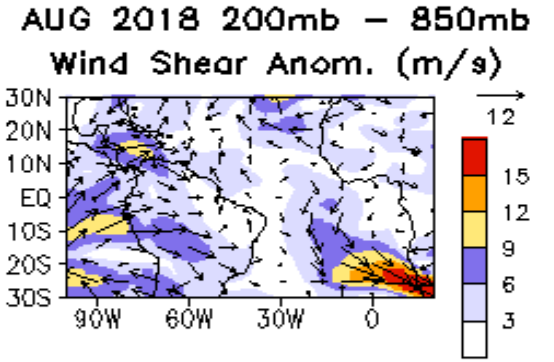


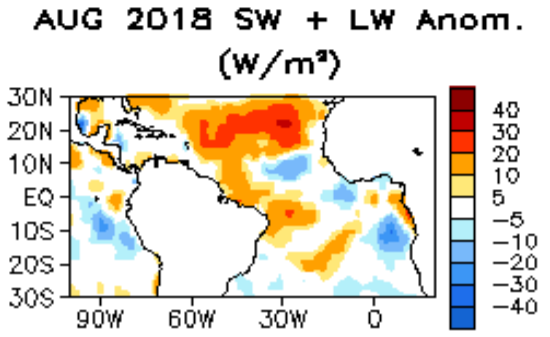


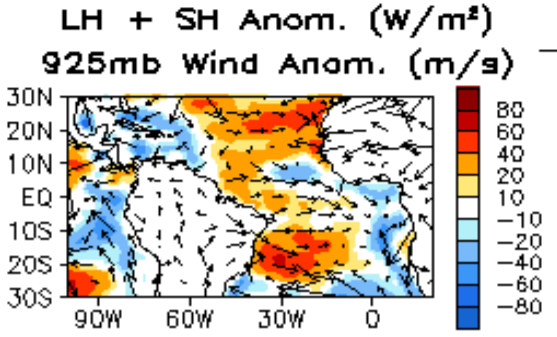


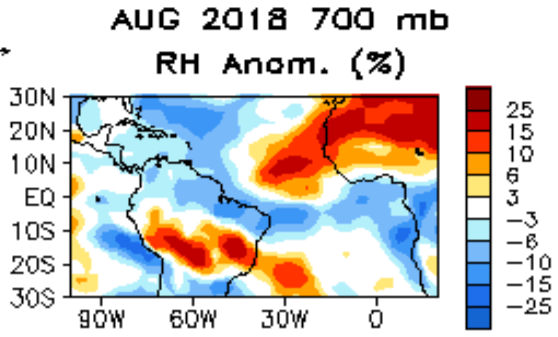




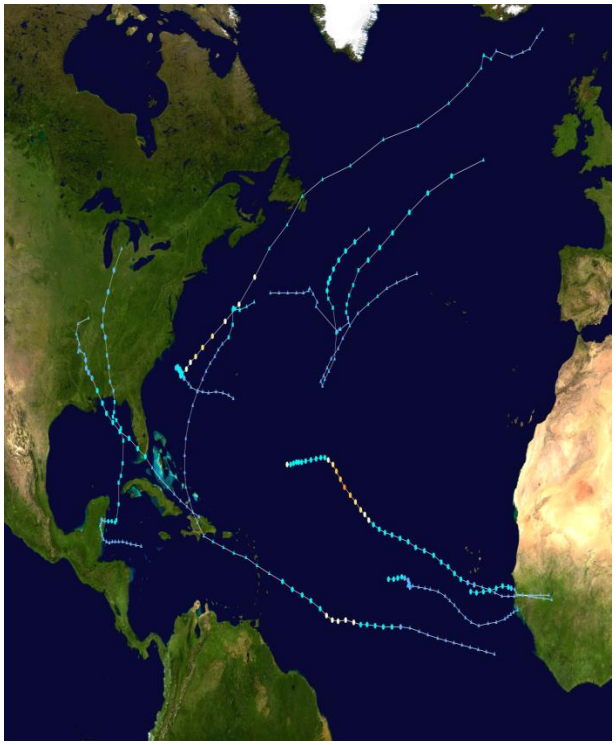




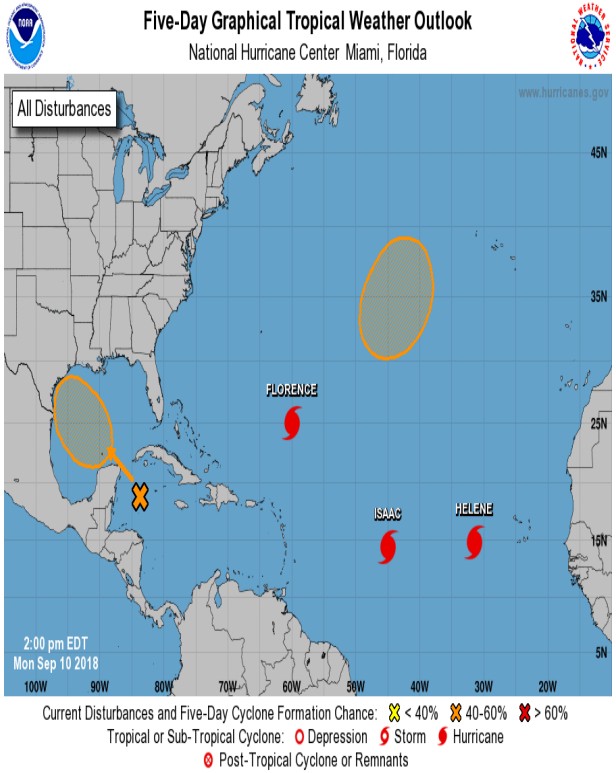




2018 Atlantic Hurricane Season Activities



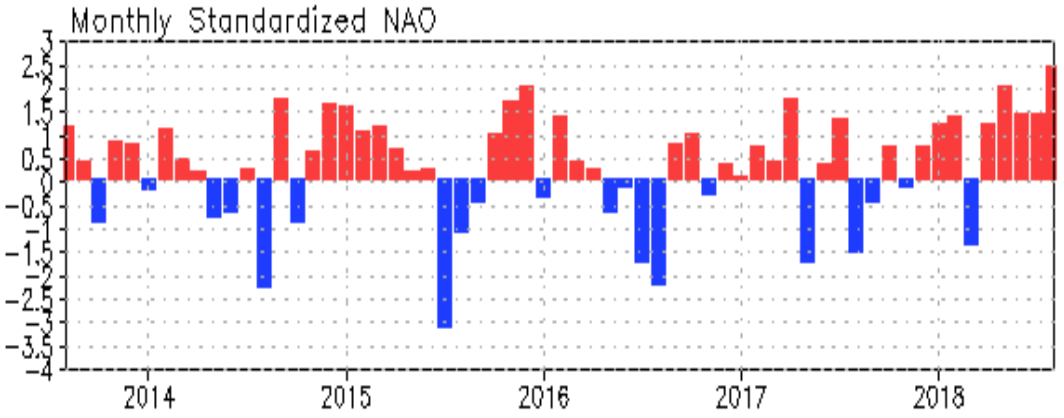
https://en.wikipedia.org/wiki/2018_Atlantic_hurricane_season

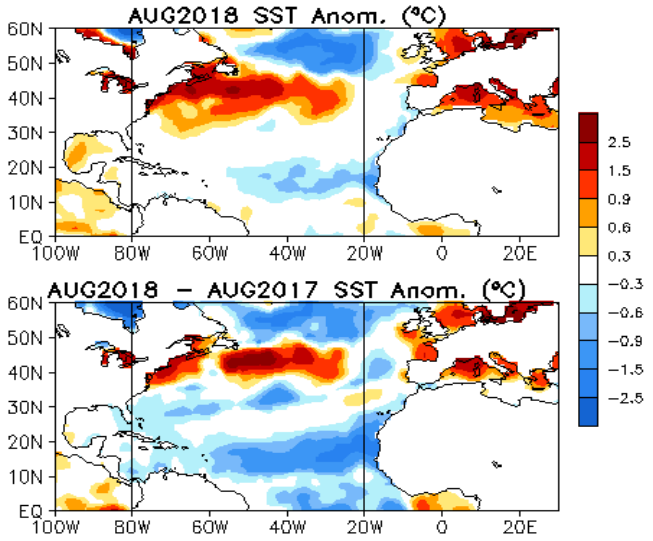


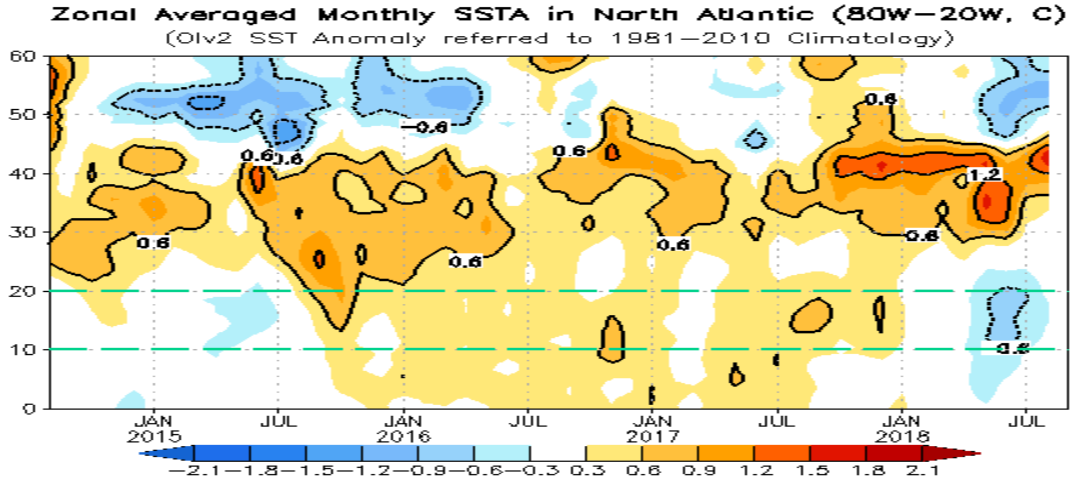
- **Two tropical storms formed in Aug 2018.**
- **Four tropical storms formed in early September, with two developing into hurricanes and one became major hurricane.**

Atlantic	2018 prediction (issued on May 24) Updated on Aug 9 60% below average	1981-2010	Observations (By Sep 9)
Named storms	(10-16) 9-13	12	9
Hurricanes	(5-9) 4-7	6	4
Major hurricanes	(1-4) 0-2	3	1

NAO and SST Anomaly in North Atlantic





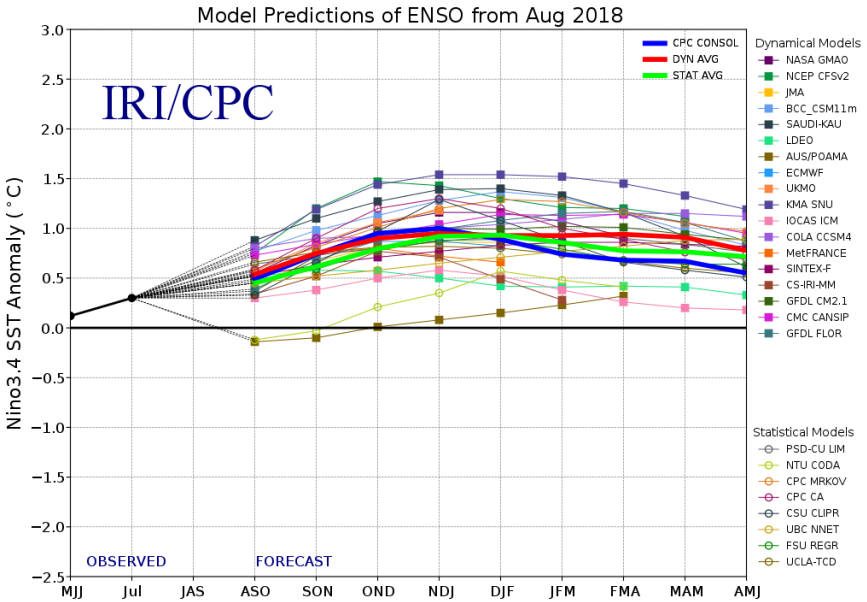


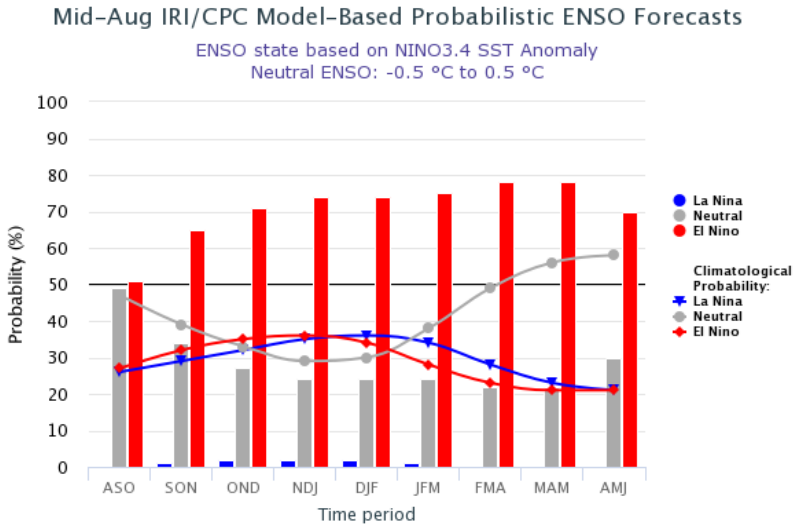
- **Positive NAO index enhanced substantially in Aug 2018, with NAOI= +2.4 in Aug 2018.**

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

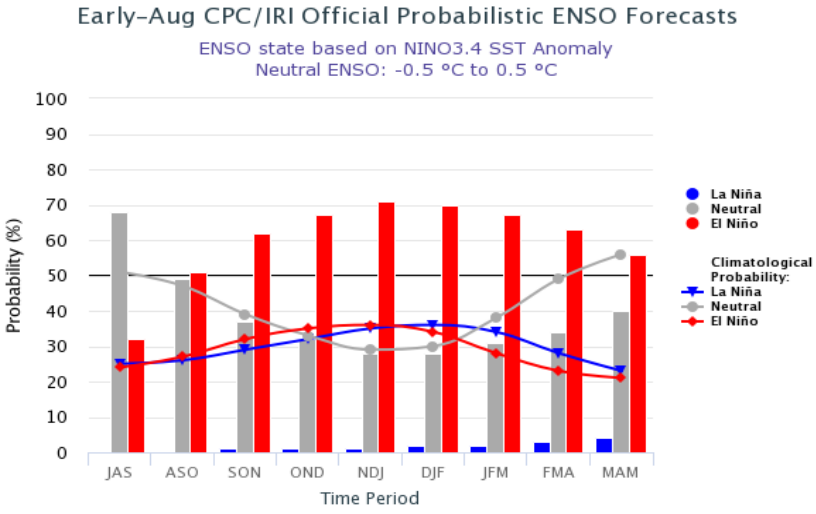
Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20ºN-90ºN (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80ºW and 20ºW (bottom). SST are derived from the NCEP OI SST analysis,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

ENSO and Global SST Predictions

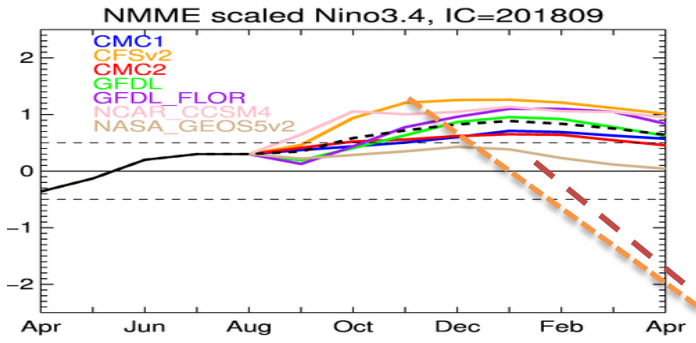




- **The majority of models favor El Nino development by Sep-Nov with about 65% chance, and rising to 70% for winter 2018-19.**

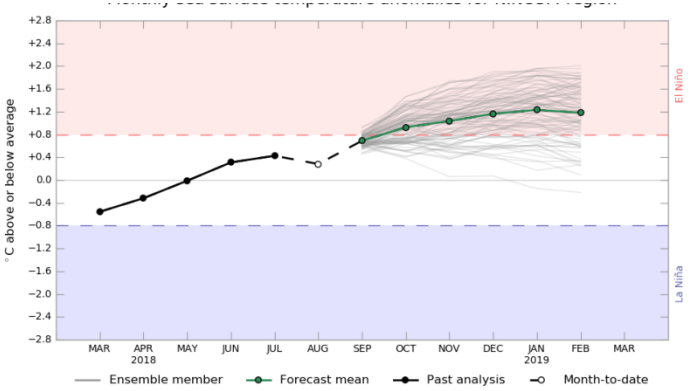


Individual Model Forecasts and Oceanic IC conditions

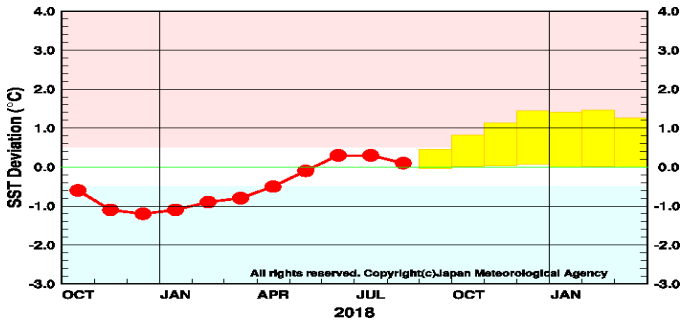


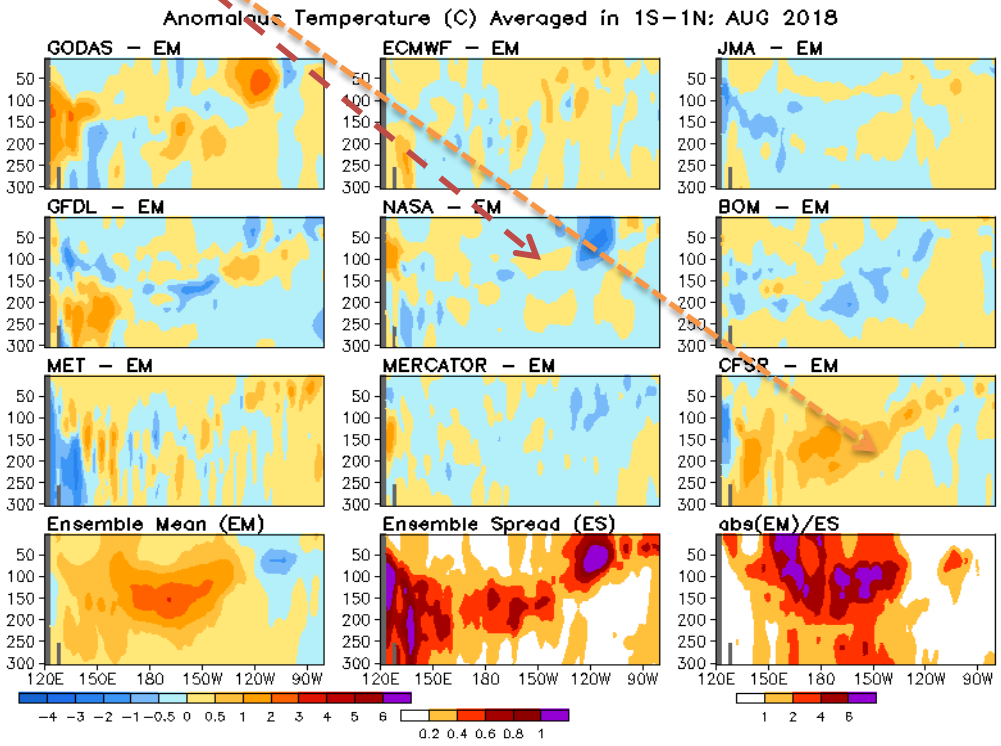
- **Compared to the ensemble mean of nine ocean reanalyses, the NASA had a cold bias near the surface in the eastern Pacific, while the CFSR had a warm bias near the thermocline in the western-central Pacific. This is consistent with the relatively colder (warmer) NINO3.4 forecast by NASA_GEOS5v2 (CFSv2 and NCAR_CCSM4 that were initialized by CFSR)**

Australia: Nino3.4, IC= 25 Aug 2018



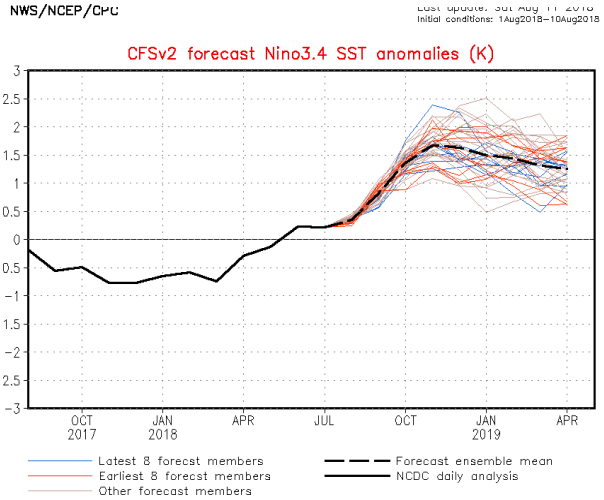
JMA: Nino3, IC/updated = 10 Sep 2018



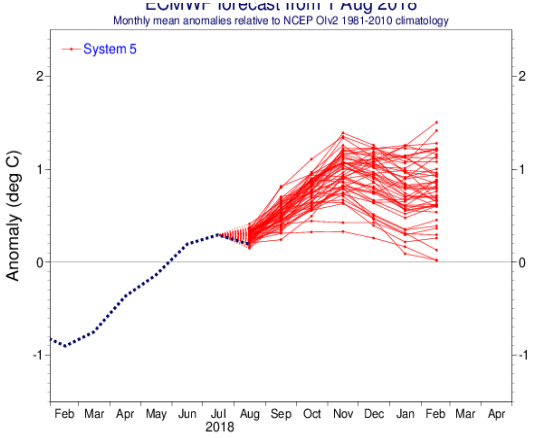


Changes in NINO3.4 predictions

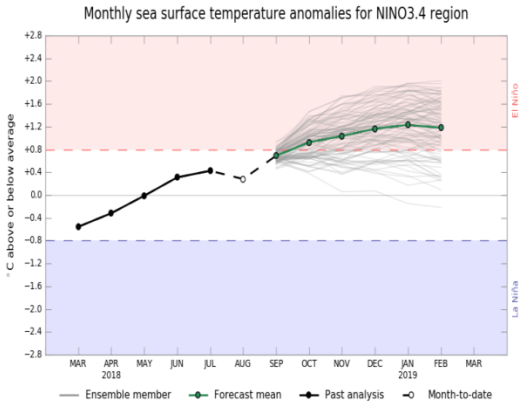
CFSv2 IC= 10 Aug 2018



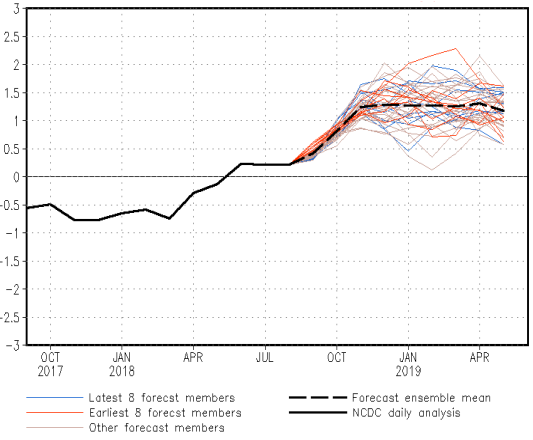
ECMWF IC= 1 Aug 2018



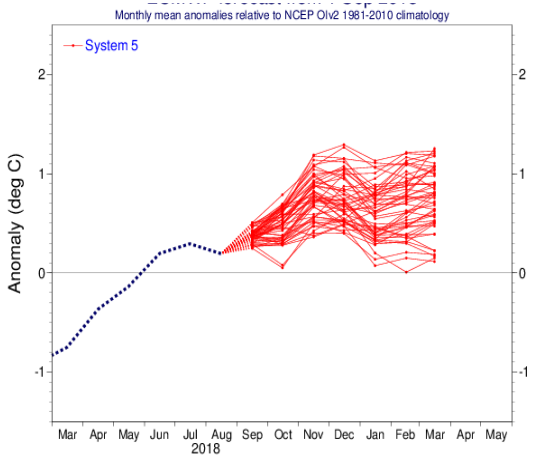
BOM, IC= 25 Aug 2018



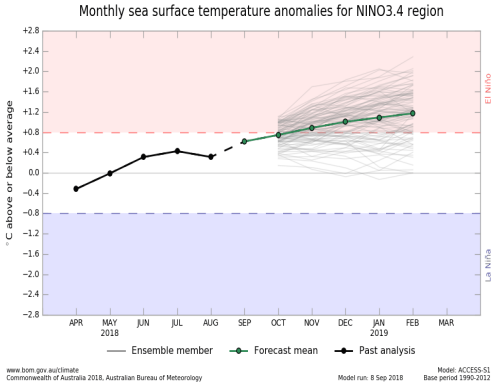
CFSv2 IC= 10 Sep 2018



ECMWF IC= 1 Sep 2018

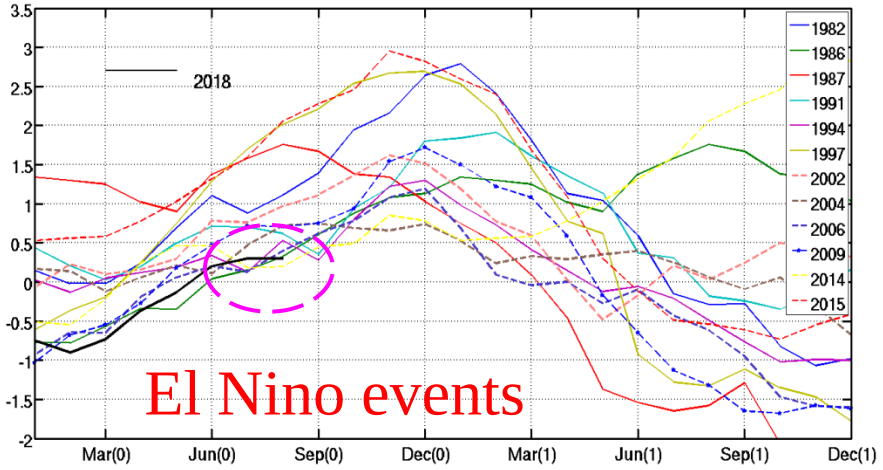


BOM IC= 8 Sep 2018

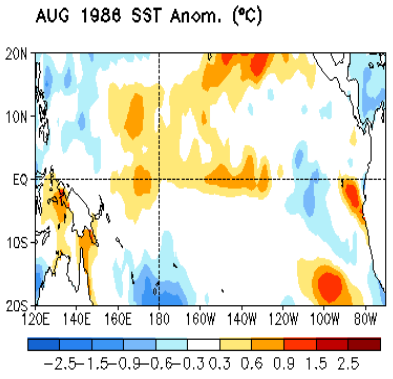


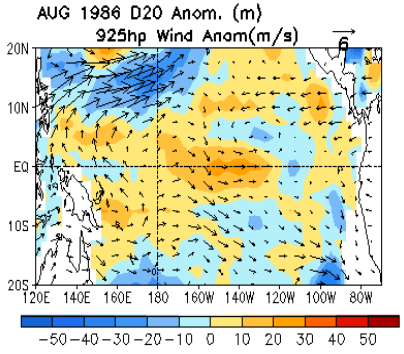
SST,D20 and 925hPa Wind anomalies in August

NINO3.4 Anomaly

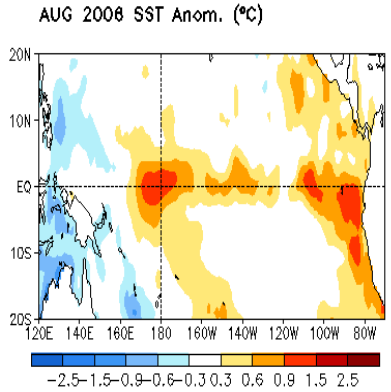


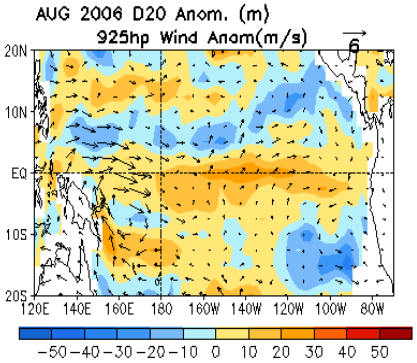
1986



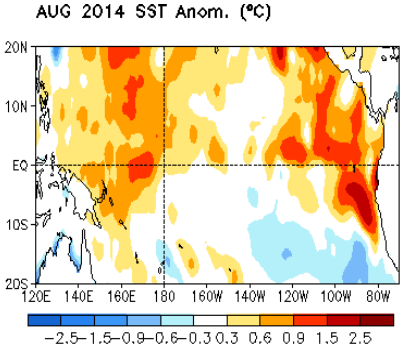


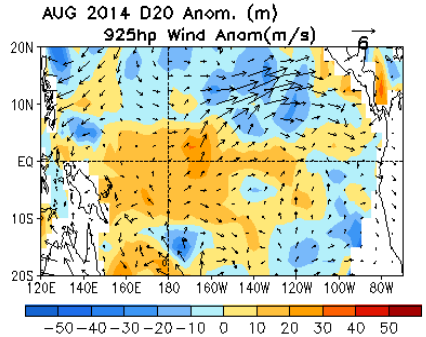
2006



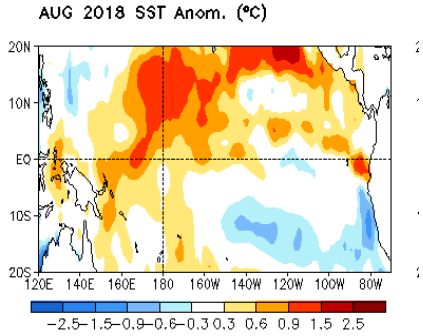


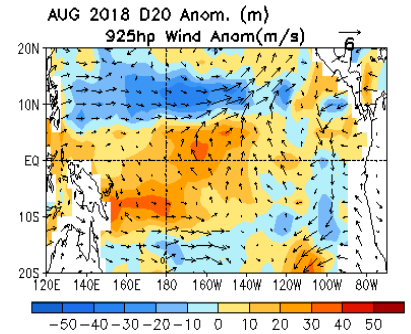
2014





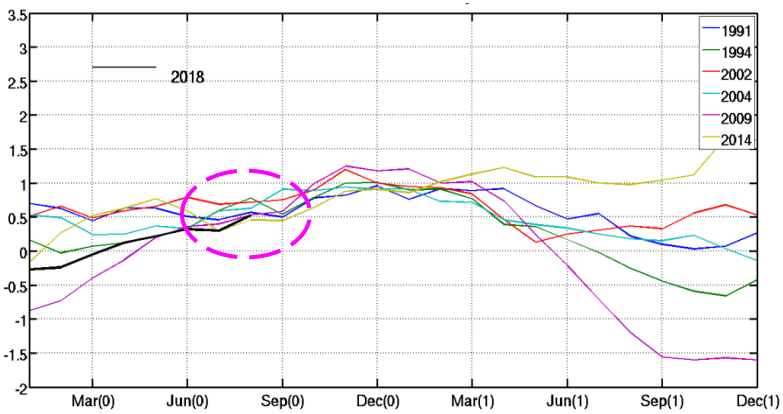
2018



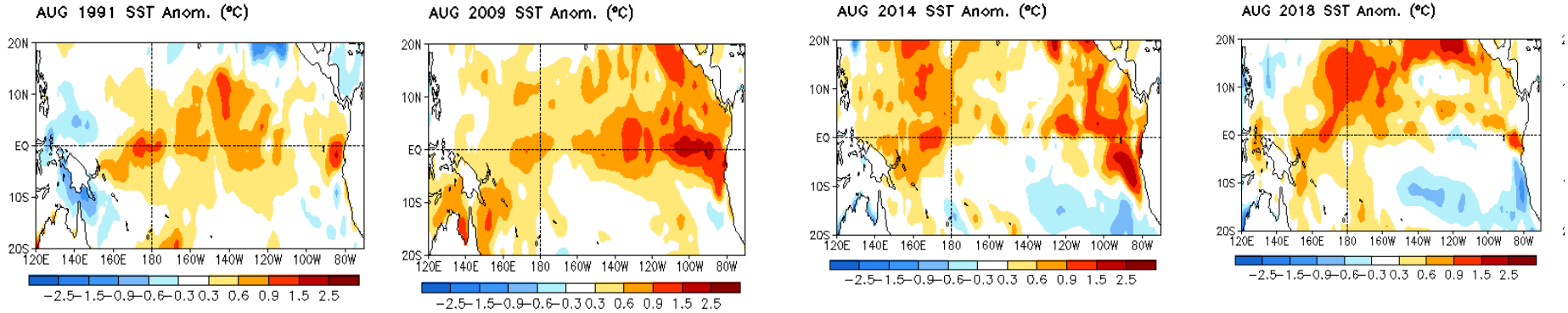


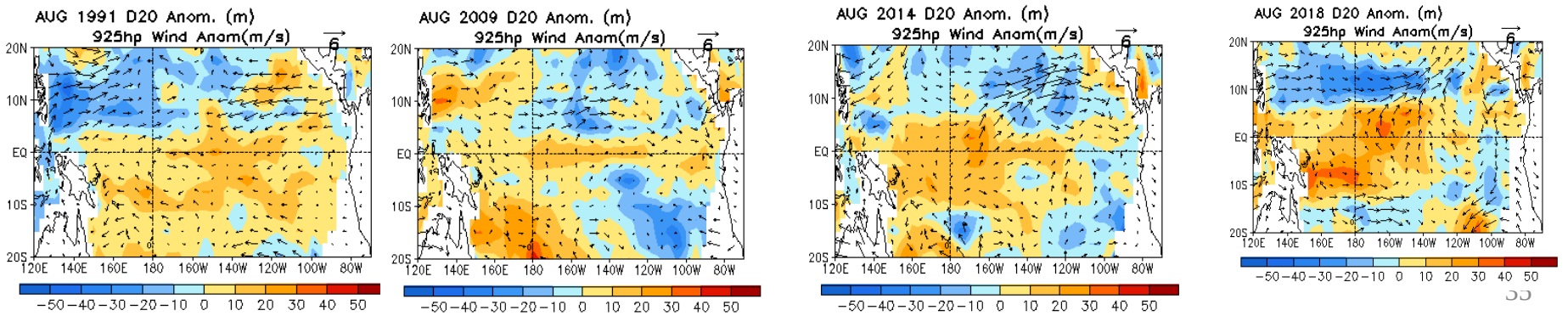
SST,D20 and 925hPa Wind anomalies in August

NINO4 Anomaly

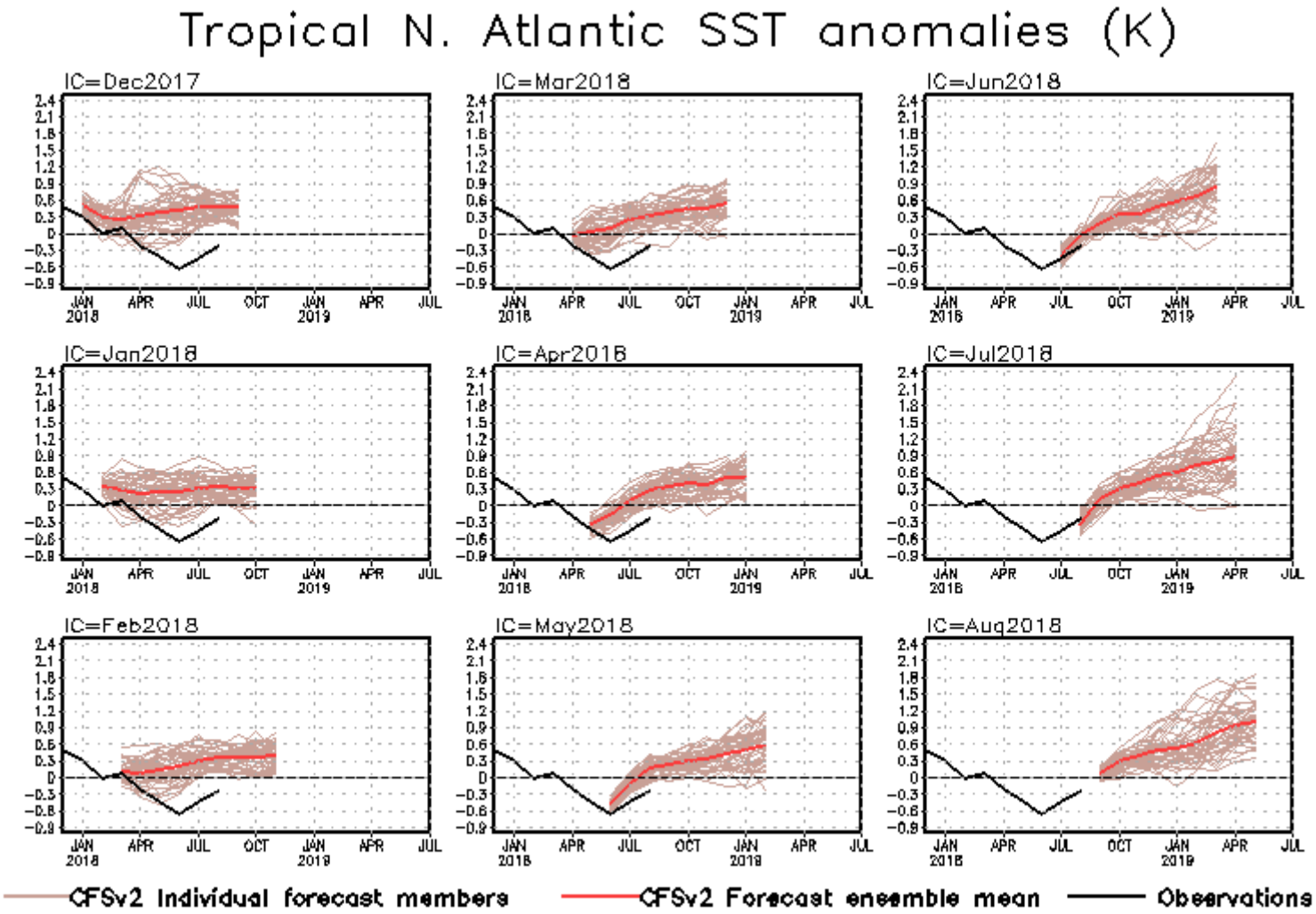


1991 2009 2014 2018





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].

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.

Acknowledgements

- Dr. Zeng-Zhen Hu , Yan Xue and Arun Kumar: 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

Back up

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

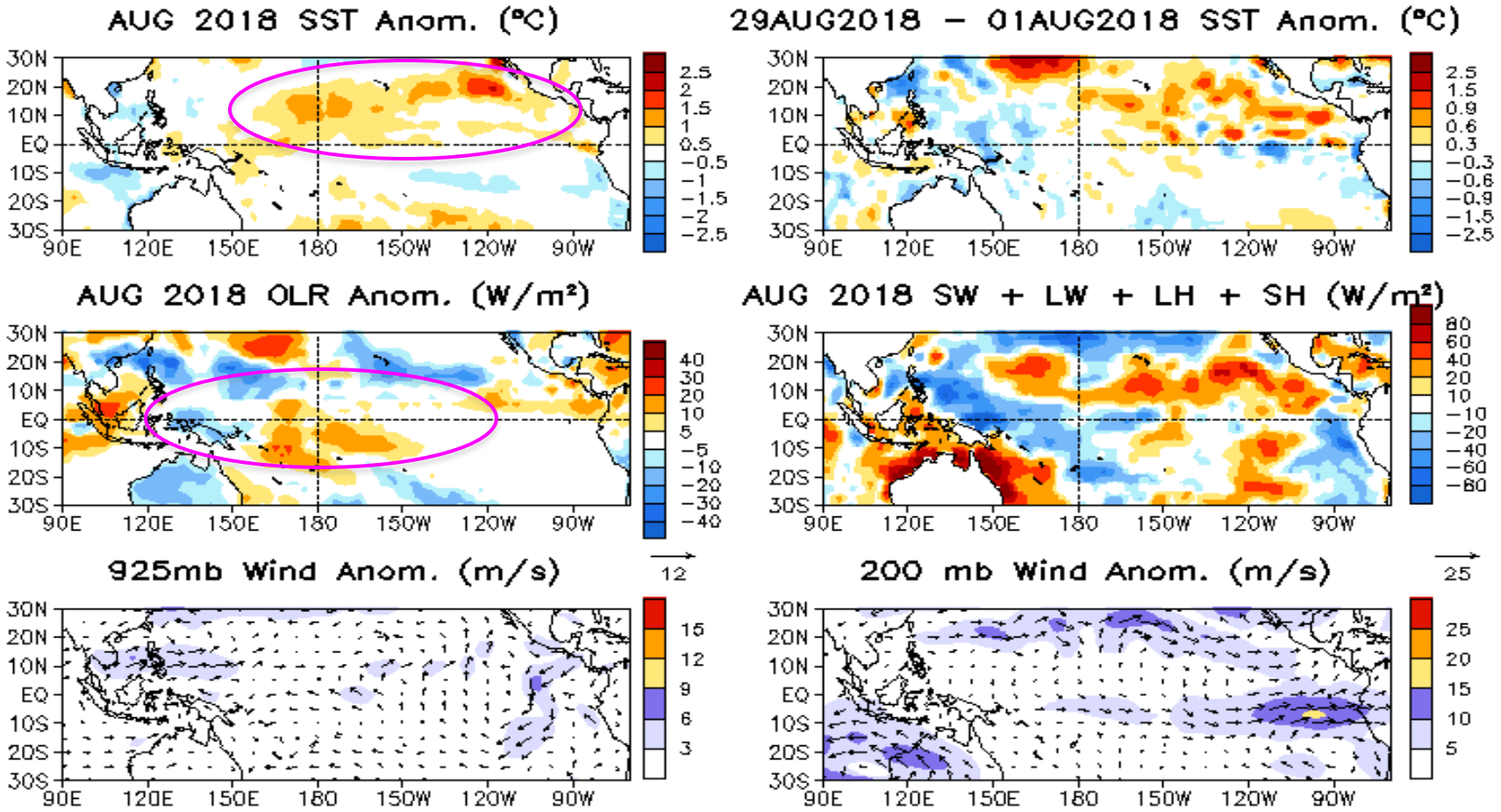
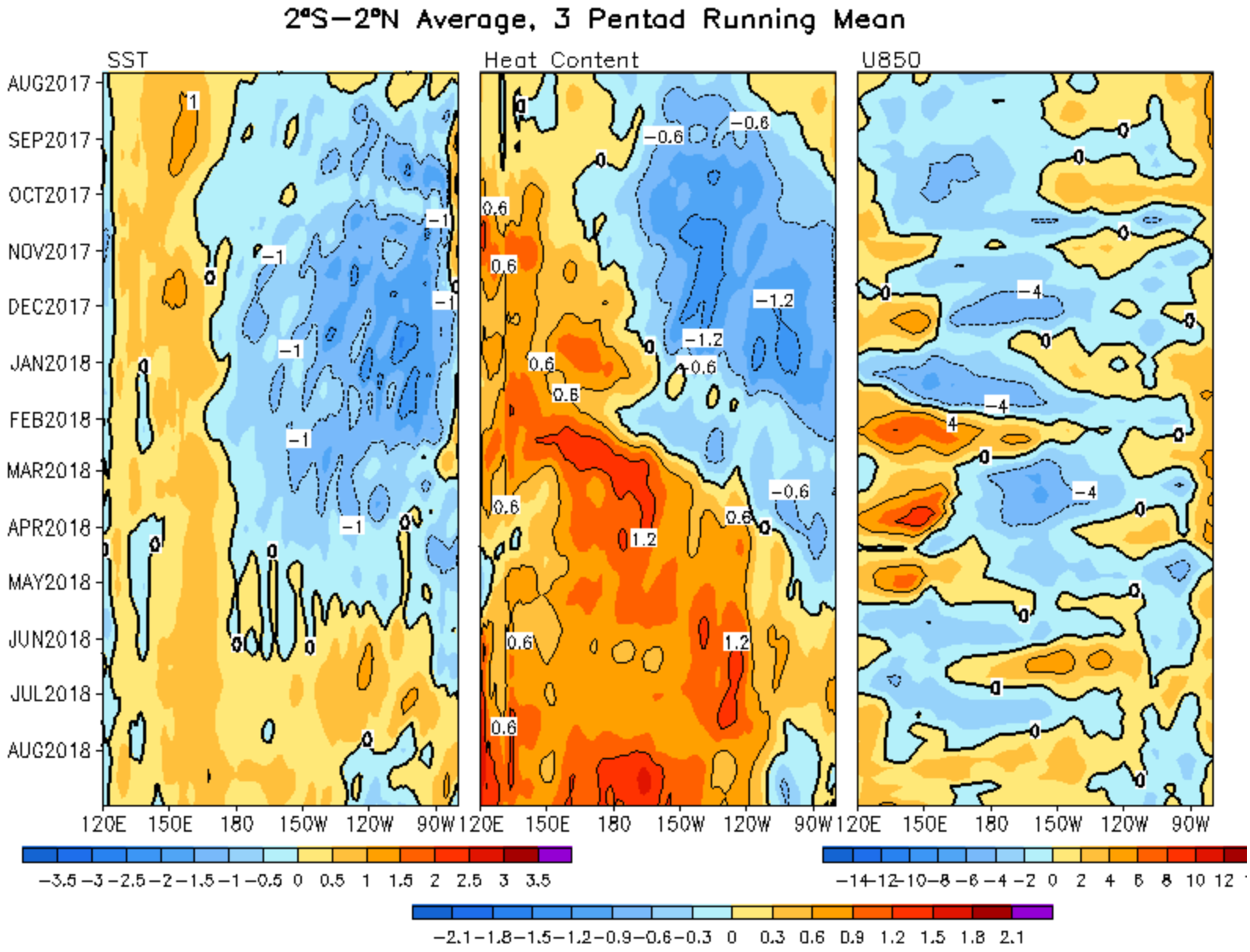
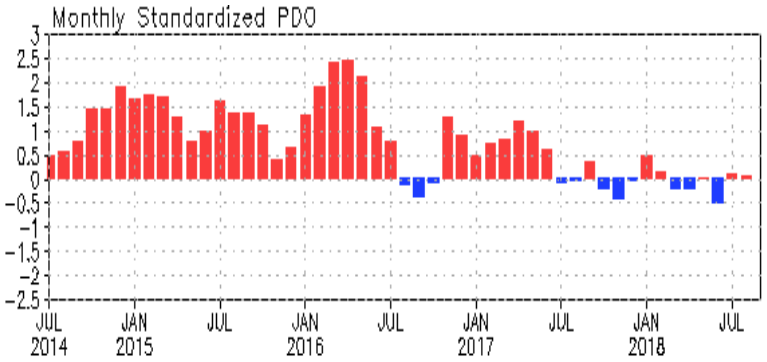


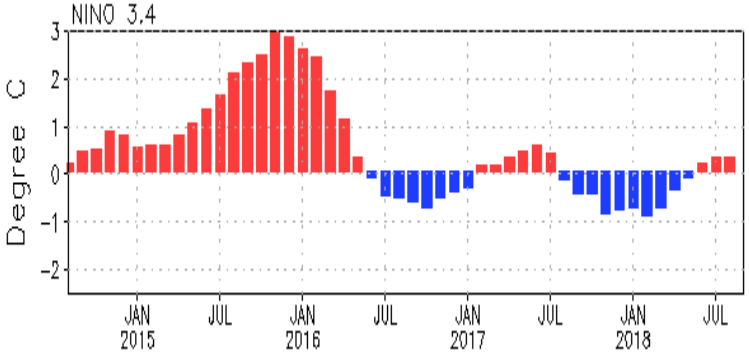
Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

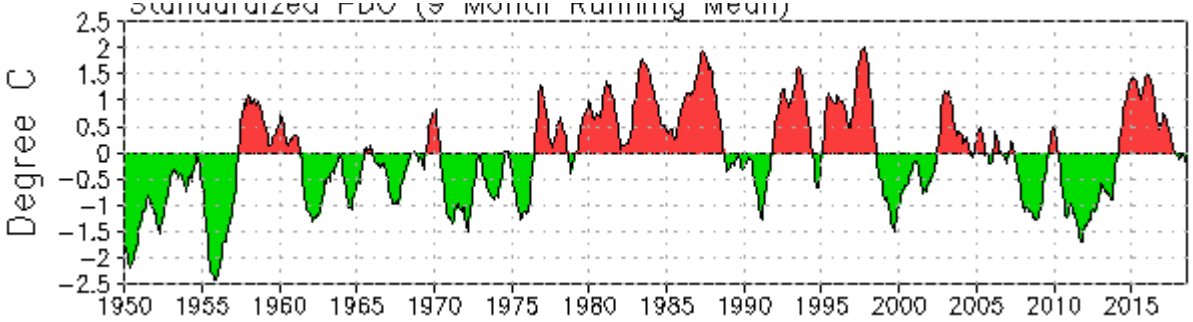
Equatorial (2S-2N) Pacific SST (°C), Surface Zonal Wind (m/s) and HC300 (°C) Anomalies

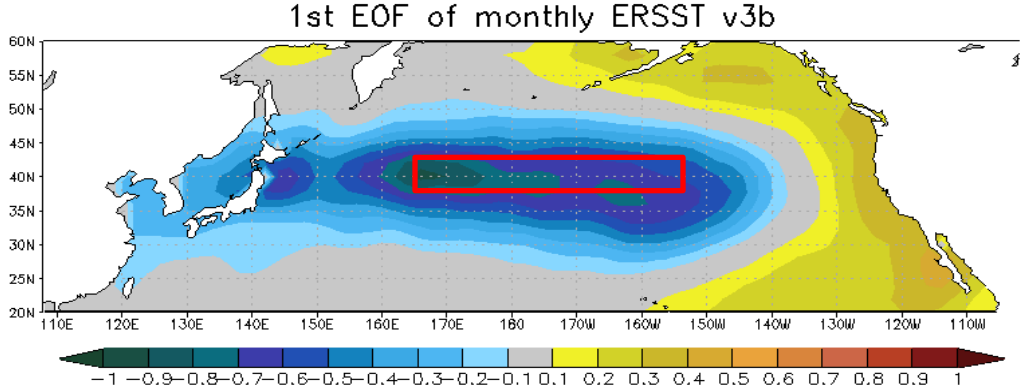


PDO index









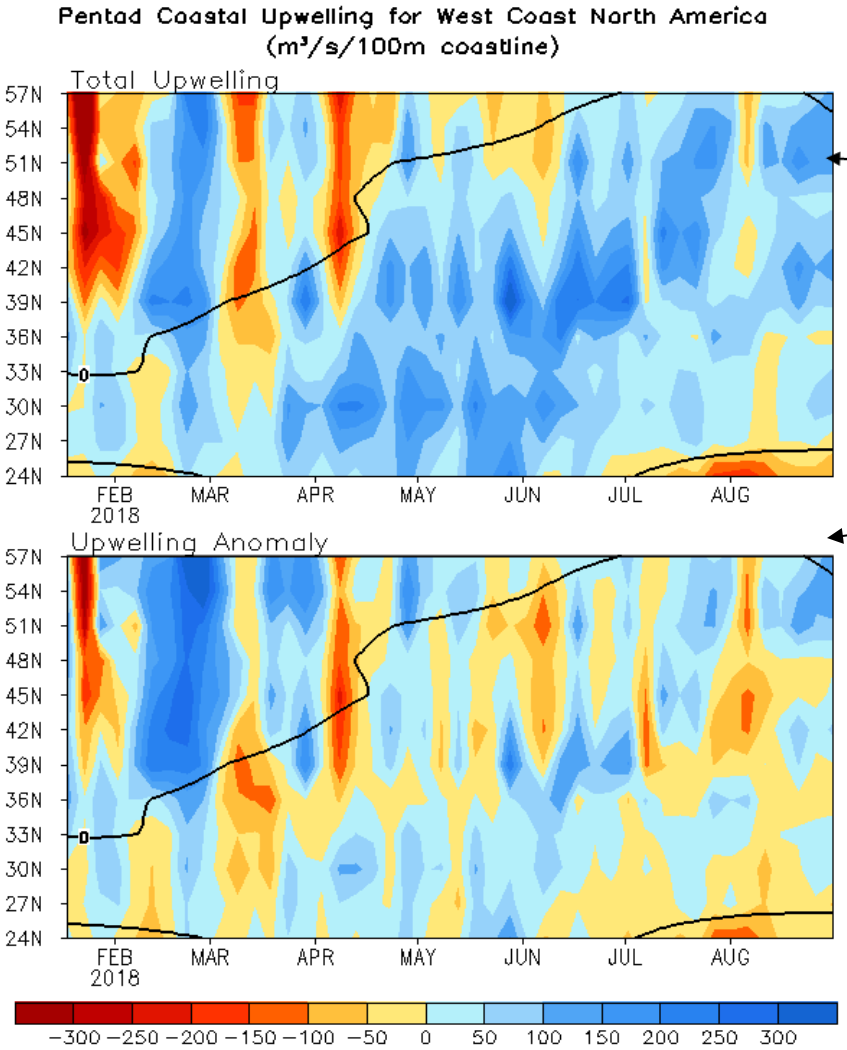
-PDO index =0.03 in Aug 2018.

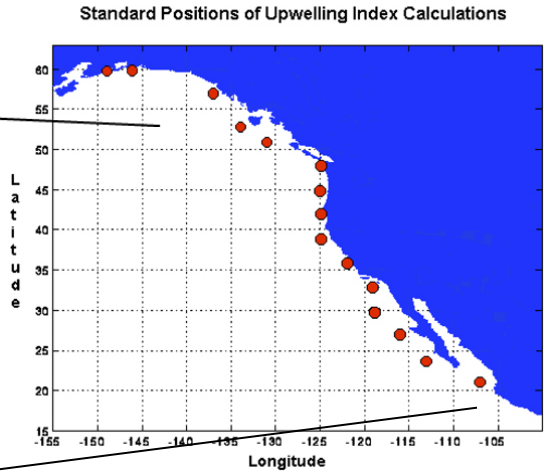
- Statistically, ENSO leads PDO by 3-4 months, may through atmospheric bridge.

- 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

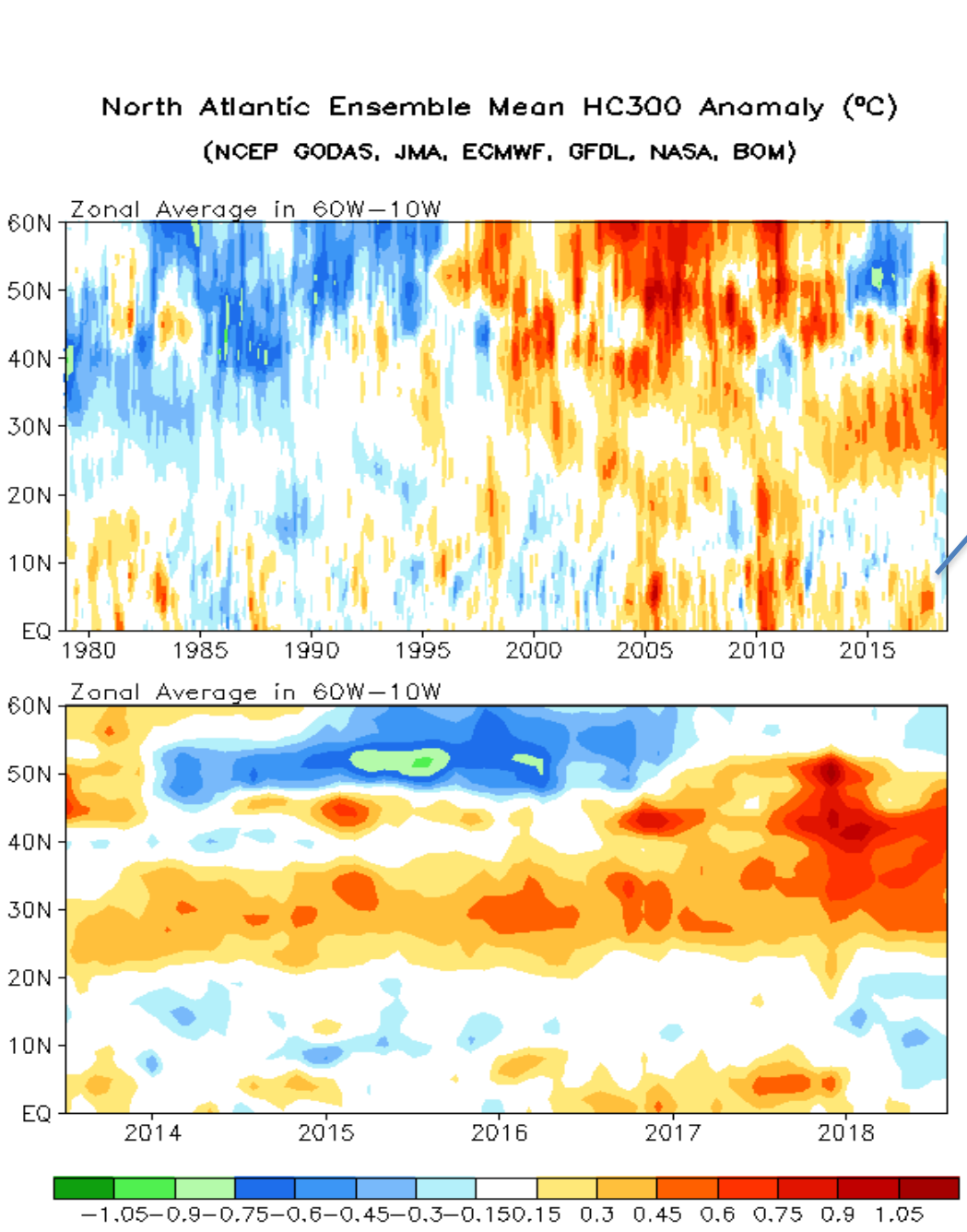


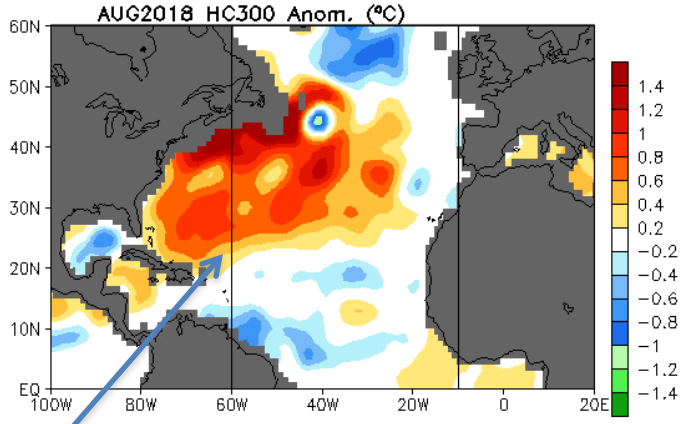


- **Both anomalous upwelling and downwelling were small.**

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.**

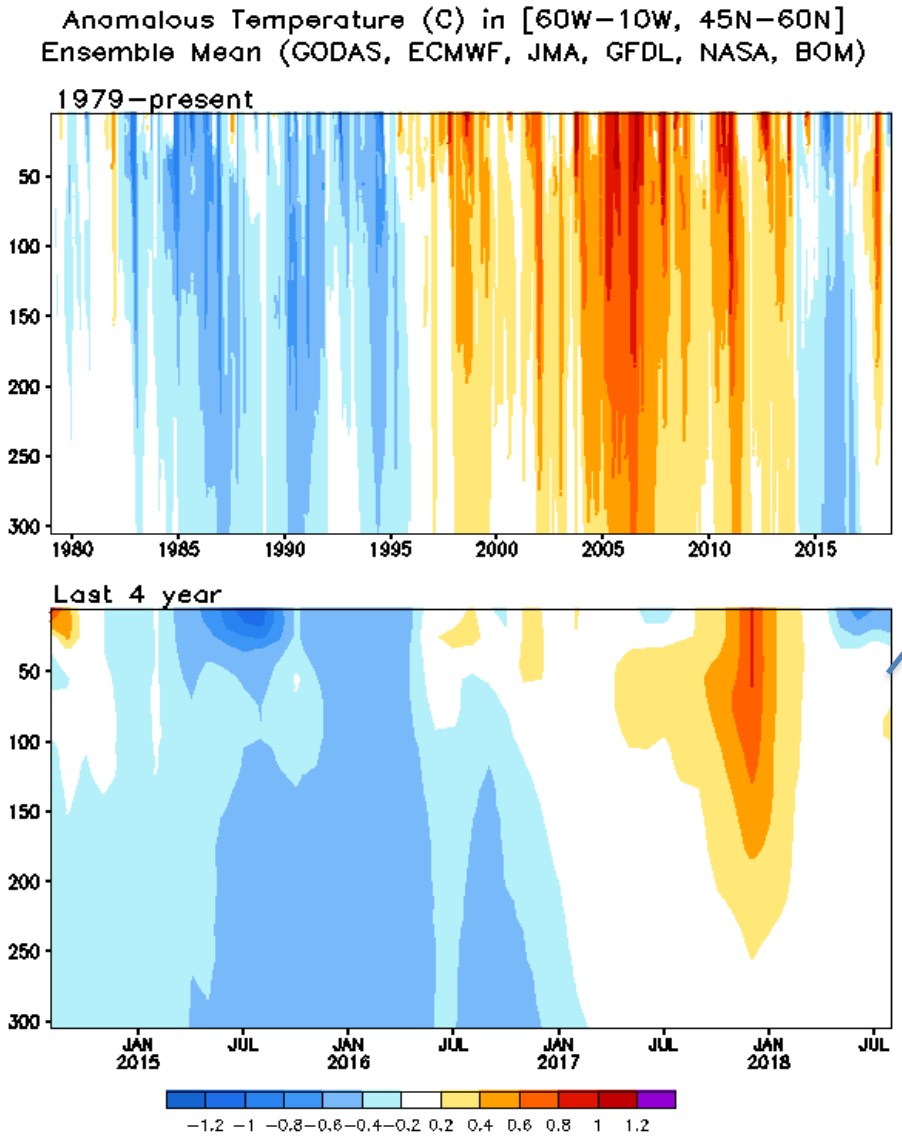


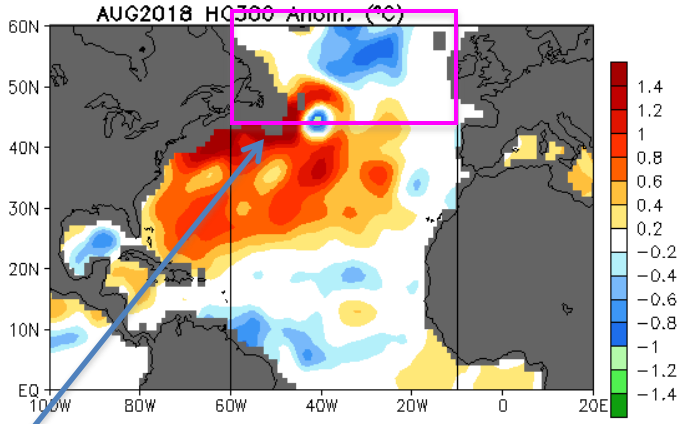


- HC300 anomaly has a tripole/horseshoe pattern with positive in the mid- latitudes and negative in lower and higher latitudes.

-The "cold blob" in the subpolar gyre in 2014-2016 was comparable to that before 1996.

- The "cold blob" weakened substantially during 2017-2018.





- Negative temperate anomaly in the subpolar North Atlantic was only observed near the surface since Mar 2018.

CPC's Markov Model NINO3.4 Forecast

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

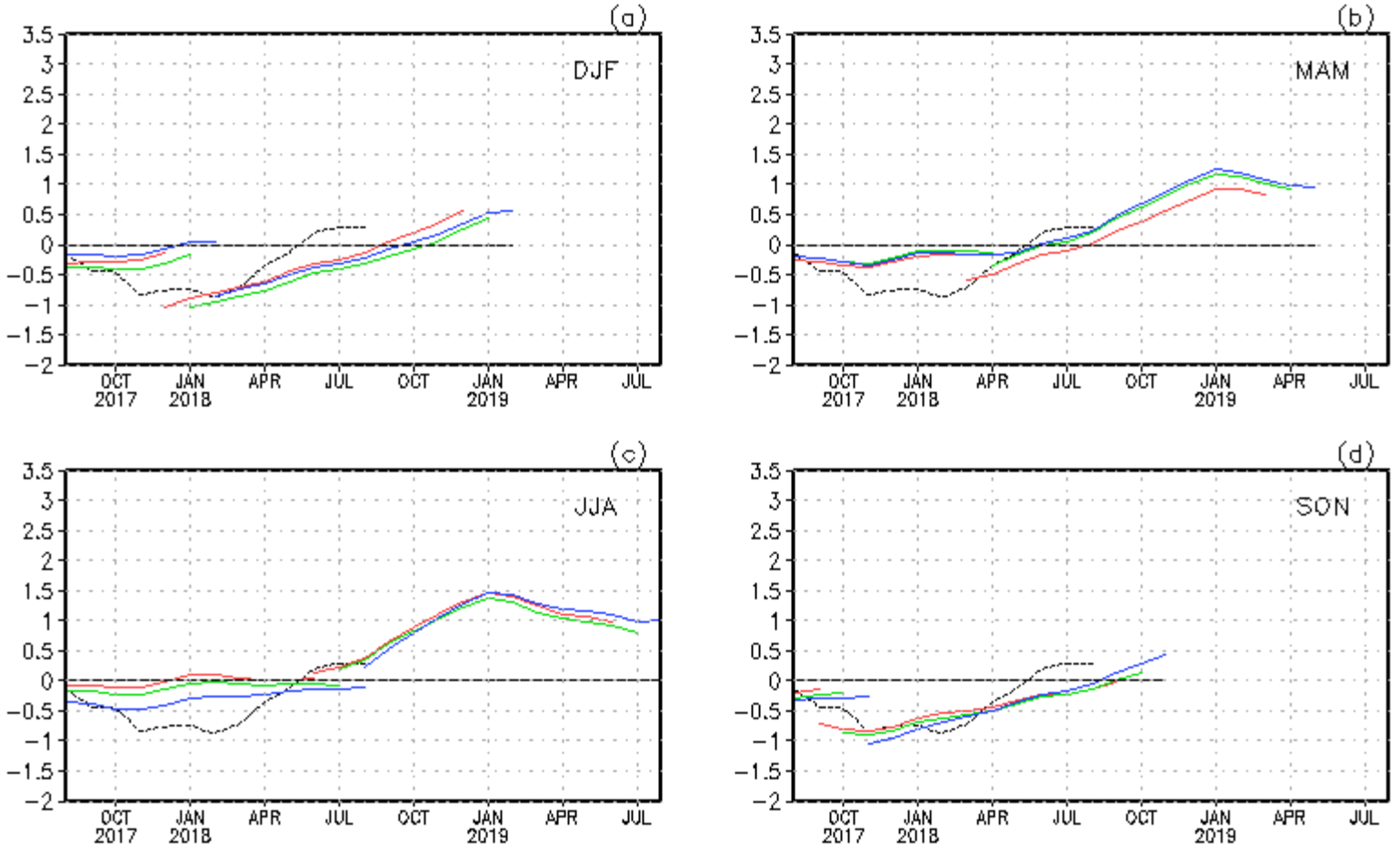
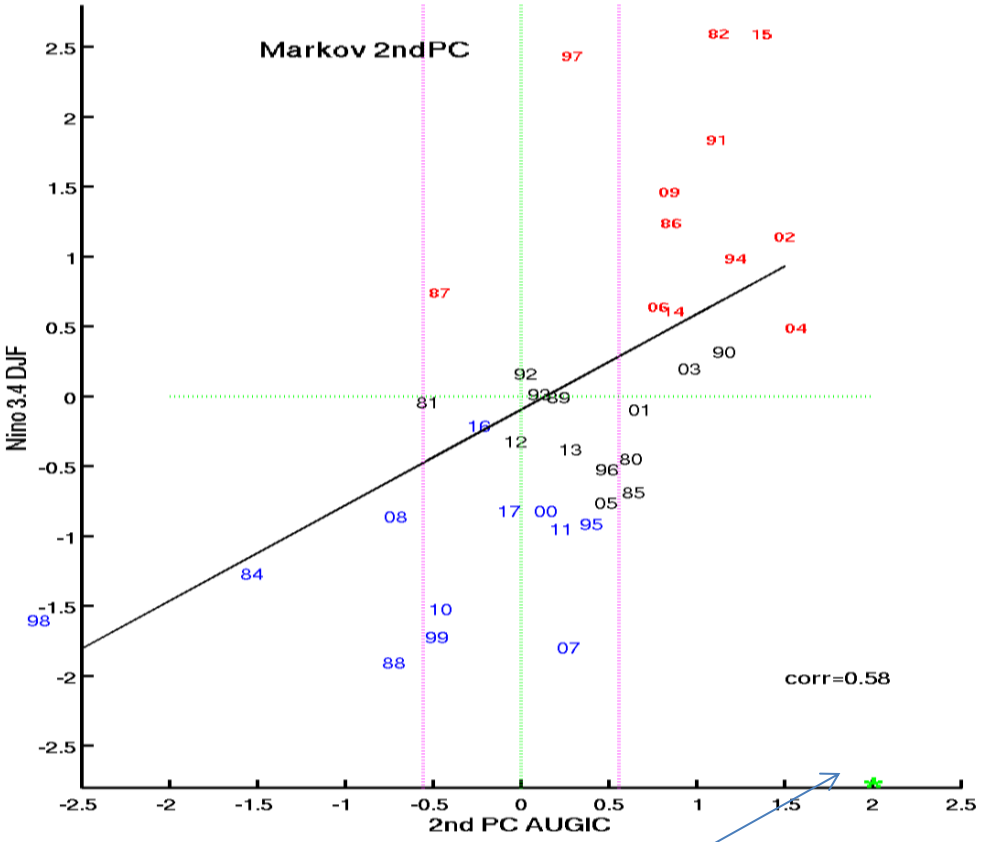


Fig. 4. Time evolution of NINO3.4 forecasts up to 12 lead months by the Markov model initiated monthly up to August 2018 . Shown in each panel are the forecasts grouped by three consecutive starting months: (a) is for December, January and February, (b) is for March, April and May, (c) is for June, July 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

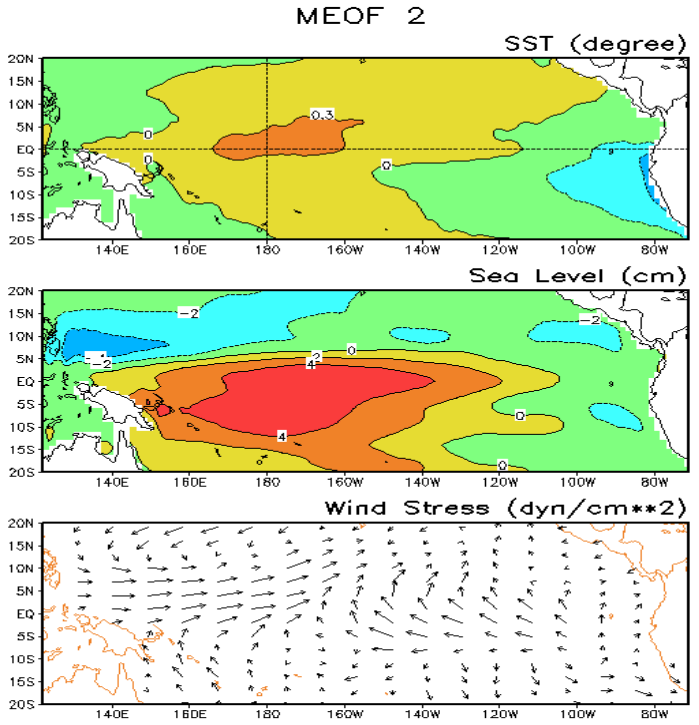


2x2 contingency table El Nino Case (1980-2017)	Aug Criterion: 0.56=0.5 STD
Percent correct rate	0.84 (32/38)
Hit rate	0.83(10/12)
False alarm rate	0.3 (4/12)

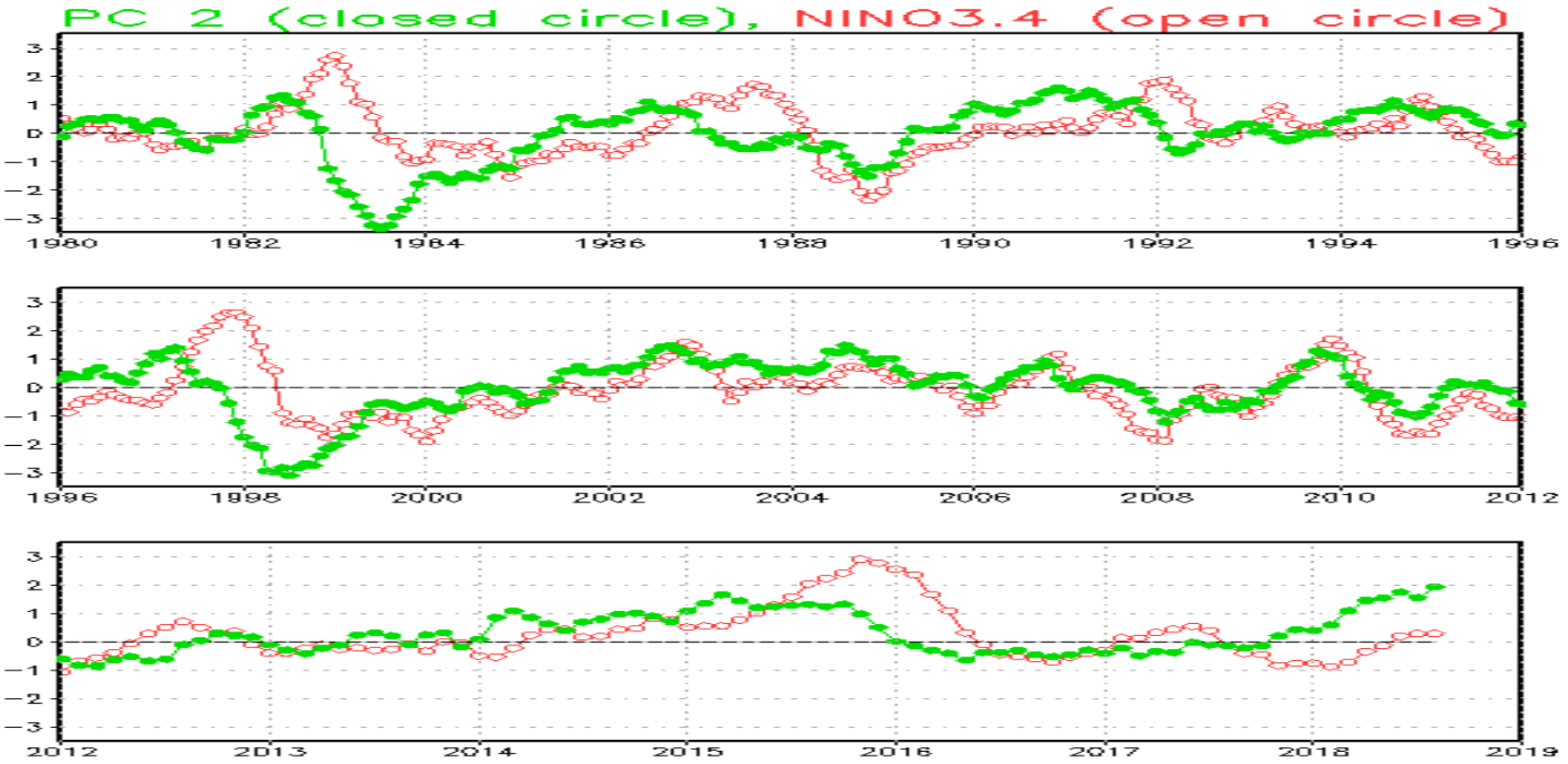
False alarms:

85
90
01
03

* Markov 2nd PC in August 2018

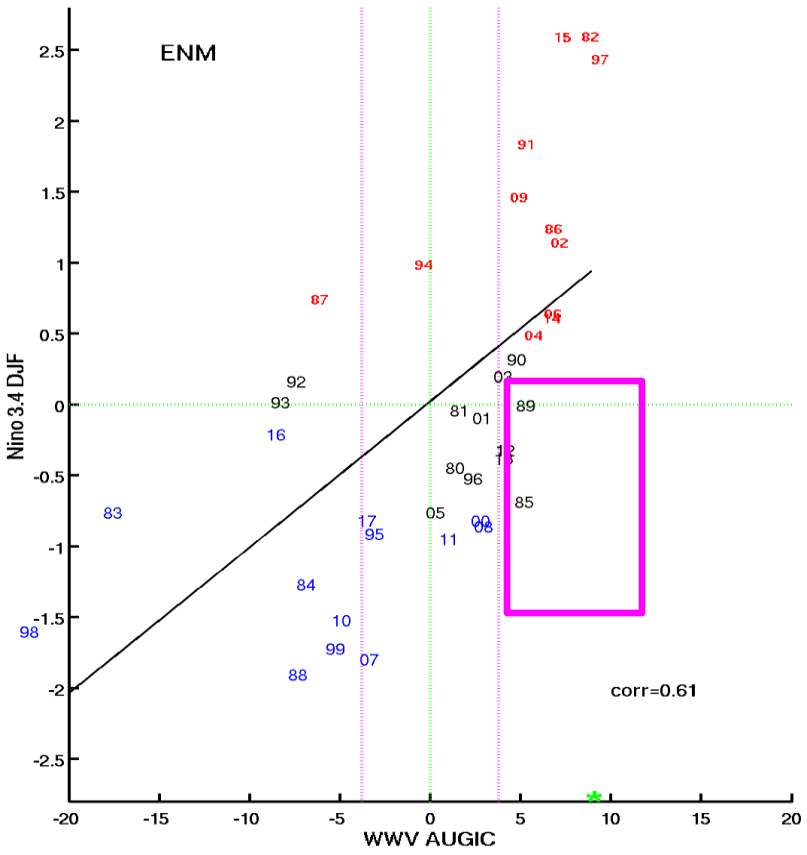


http://www.cpc.ncep.noaa.gov/products/people/yxue/ENSO_forecast_clim81-10_godas.html



PC2	82	86	91	94	97	02	04	06	09	14	15	18
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**
Jul	**1.1**	**0.9**	**0.9**	**0.9**	0.1	**1.3**	**1.2**	**0.6**	0.4	**0.7**	**1.3**	**1.6**
Aug	**1.1**	**0.8**	**1.1**	**1.2**	0.2	**1.4**	**1.5**	**0.7**	0.8	**0.8**	**1.3**	**1.9**

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



WWV in Aug

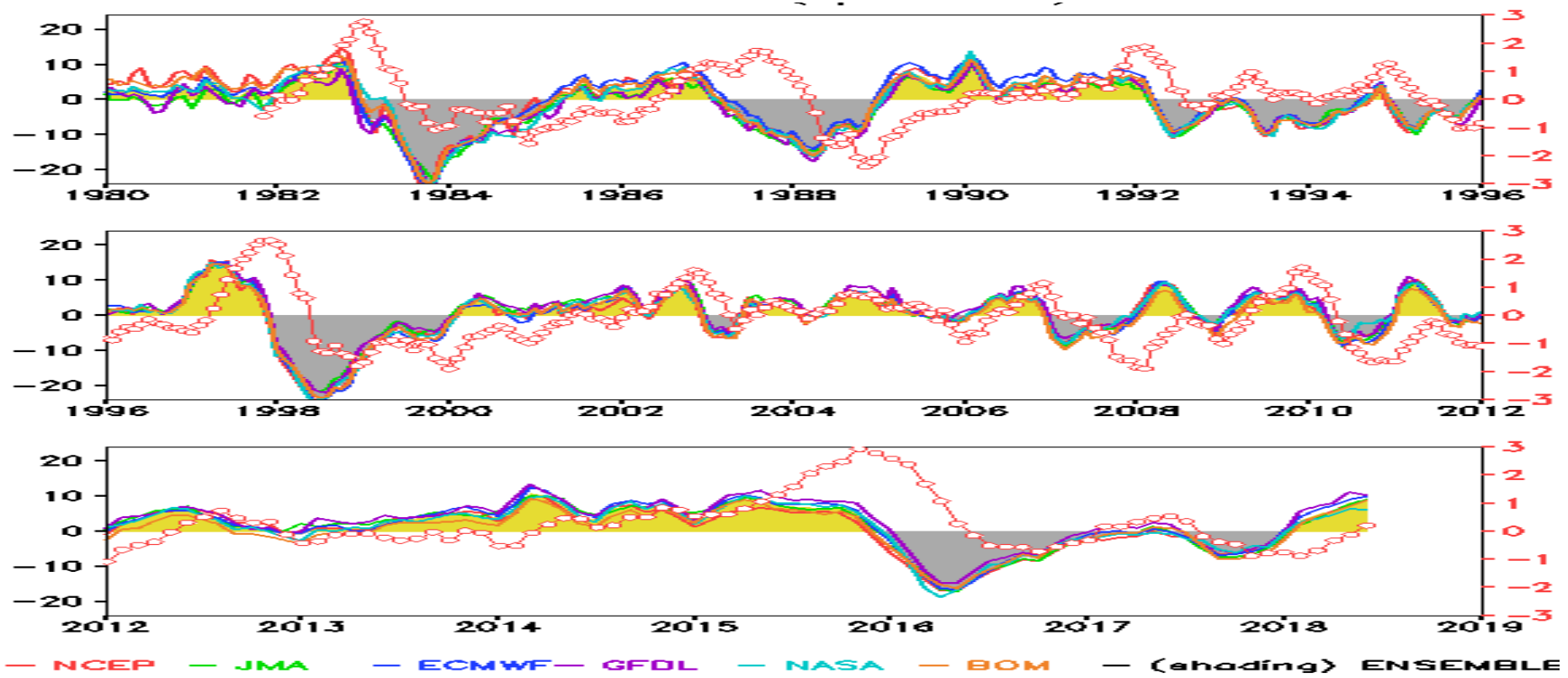
* **WWV in Aug 2018**

2x2 contingency table El Nino Case (1980-2017)	August Criterion: 3.8 = 0.5 STD
Percent correct rate	0.9 (33/38)
Hit rate	0.83 (10/12)
False alarm rate	0.23(3/13)

False alarms:
85
89
90

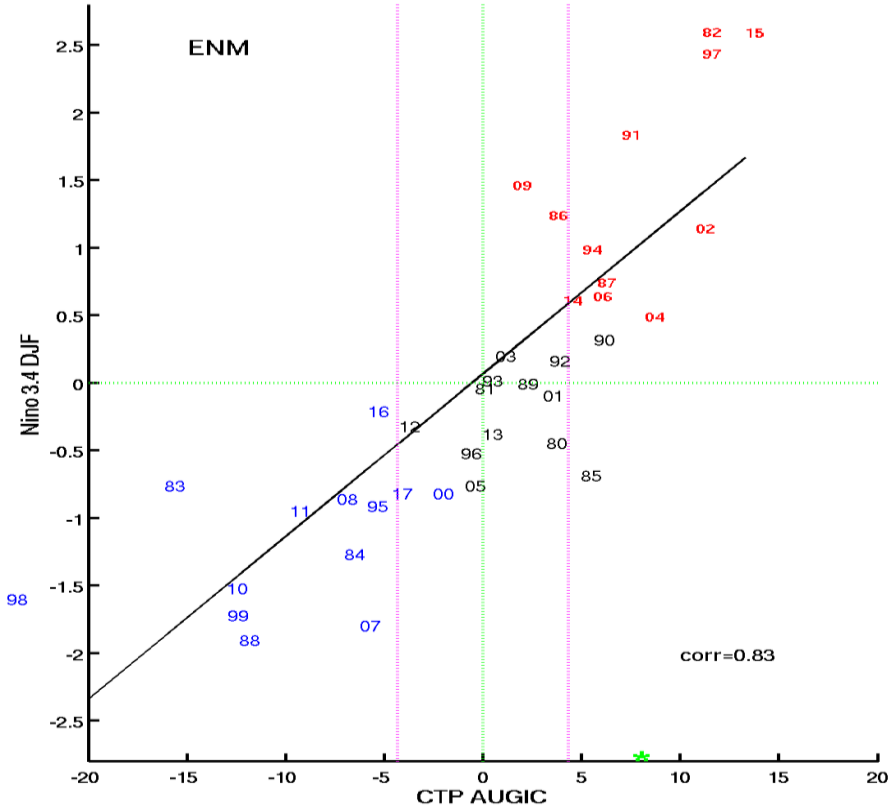
Data downloadable from http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html

Warm Water Volume (WWV) & NINO3.4 (open circles)



ENM WWV	82	86	87	91	94	97	02	04	06	09	14	15	18
May	7.3	4.7	-3.1	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	-5.7	5.5	-3.3	14.8	3.5	1.6	5.5	6.5	4.2	7.4	8.8
Jul	7.4	6.2	-7.2	5.9	-3.1	12.1	4.7	5.5	4.4	5.2	3.1	7.0	8.2
Aug	8.4	6.3	-9.2	4.4	-0.4	9.3	9.0	7.0	6.3	4.2	7.6	6.6	8.5

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



2x2 contingency table El Nino Case (1980-2017)	Aug Criterion: 4.3 = 0.5 STD
Percent correct rate	0.87 (33/38)
Hit rate	0.75 (9/12)
False alarm rate	0.2 (2/11)

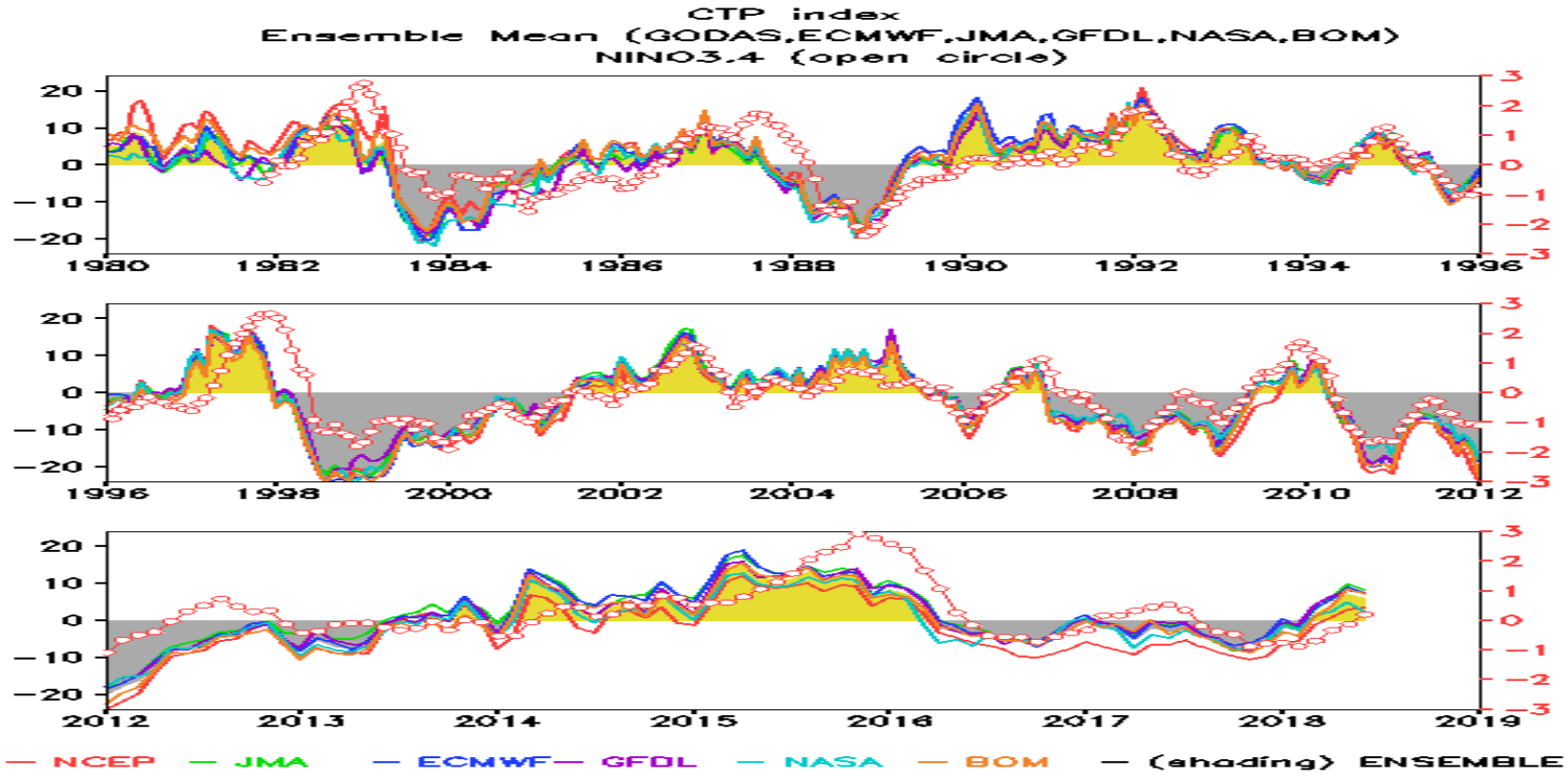
False alarms:
90
85

CTP in August

* **CTP in August 2018**

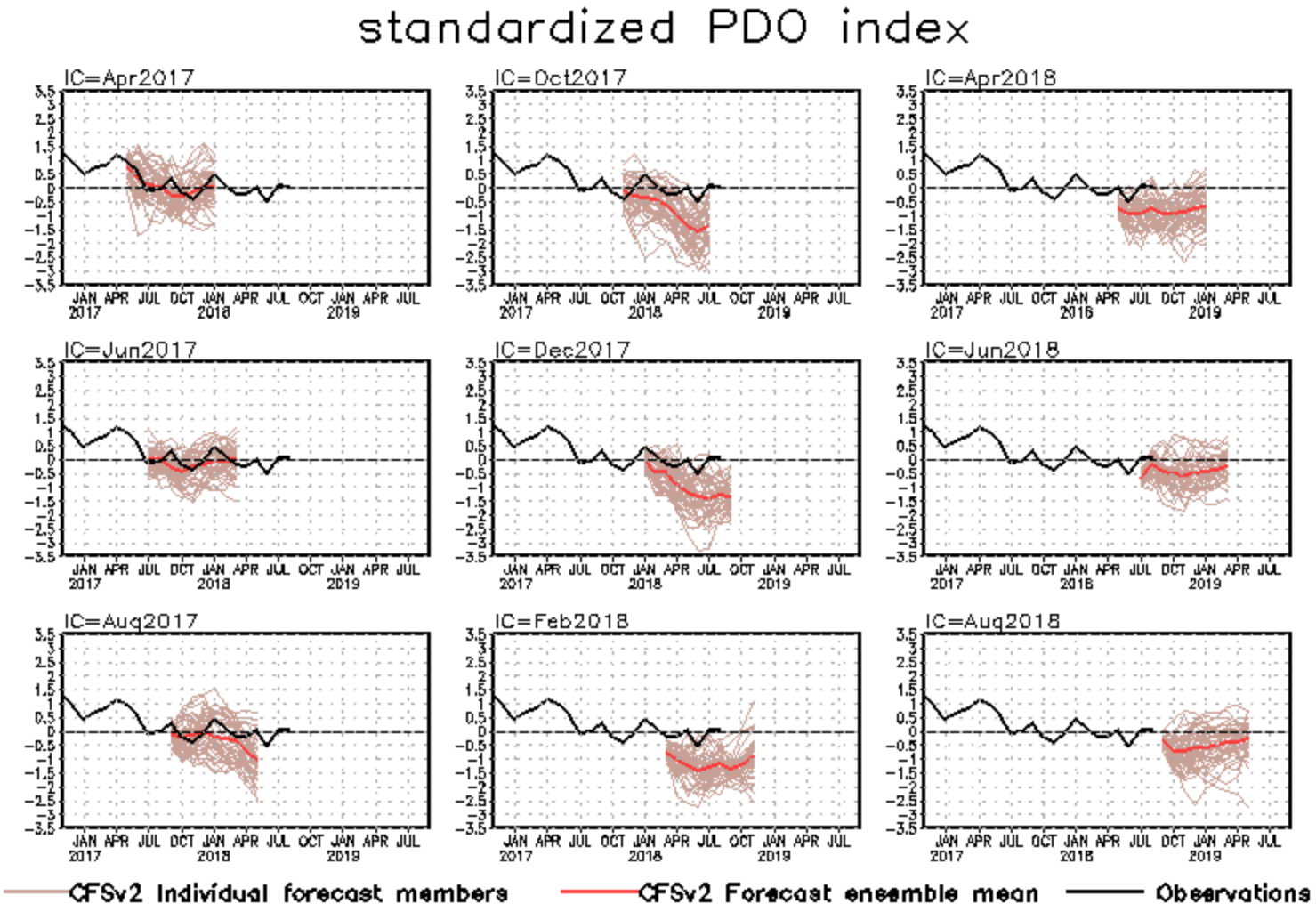
Data downloadable from http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html

Central Tropical Pacific (CTP) Index & NINO3.4 (open circles)



ENM CTP	82	86	91	94	97	02	04	06	09	14	15	18
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**
Jul	**8.3**	**2.4**	**7.6**	-0.8	**10.3**	**6.8**	**10.4**	2.1	1.8	1.4	**11.2**	**6.8**
Aug	**11.1**	3.3	**7.0**	**5.0**	**11.1**	**10.8**	**8.2**	**5.6**	1.5	4.0	**13.3**	**7.5**

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.

CPC's Sea Surface Salinity (SSS) Monitoring Products

- **Monthly SSS**
  - *BASS (Blended Analysis of Surface Salinity, Xie 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*

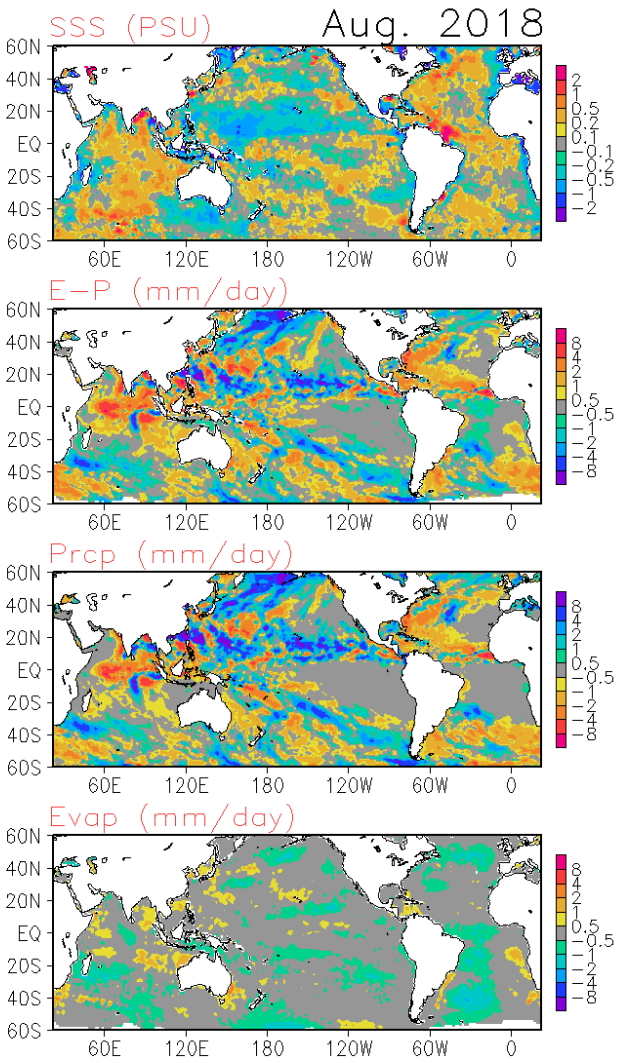
Global Sea Surface Salinity (SSS)

Anomaly for August 2018

- **New Update: The input satellite sea surface salinity of SMAP from NSAS/JPL was changed from Version 4.0 to Near Real Time product in August 2018.**
- **Attention: There is no SMAP SSS available in July 2018**
- A large scale of negative SSS signal between equator and 20° N in the N. Pacific Ocean continues this month. This negative SSS signal is likely caused by the increased precipitation in this area. In most of the Indian ocean, SSS shows positive signals. North of 20° S of the Indian ocean, the positive signal is co-incident with reduced precipitation; while south of 20° S, an increased precipitation happened which suggests that the positive SSS is possibly caused by the oceanic advection/entrainment. Positive SSS signal appears in most area north of 20° S in the Atlantic Ocean, where the precipitation is reduced.

- **Data used**

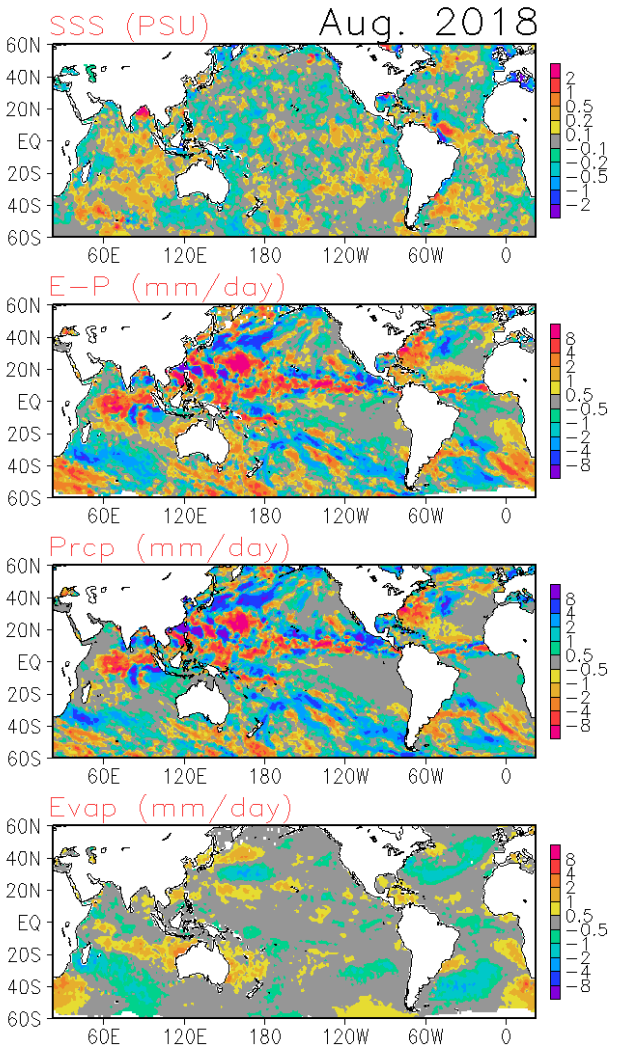
  SSS : Blended Analysis of Surface Salinity (BASS) V0.Z
  (a CPC-NESDIS/NODC-NESDIS/STAR joint effort)
  (Xie et al. 2014)
  ftp.cpc.ncep.noaa.gov/precip/BASS
  Precipitation: CMORPH adjusted satellite precipitation estimates
  Evaporation: Adjusted CFS Reanalysis



Global Sea Surface Salinity (SSS)

Tendency for August 2018

Compared with last month, the SSS in most of the open ocean in the Indian Ocean increases. The SSS in the bay of Bengal significantly increases as well. The SSS in the North Atlantic ocean, along the gulf stream region increases which is accompanied with reduced precipitation. The SSS decreases south Australia between 100° E and 180° E. In the Sea of Okhotsk, the SSS continued decreasing this month.

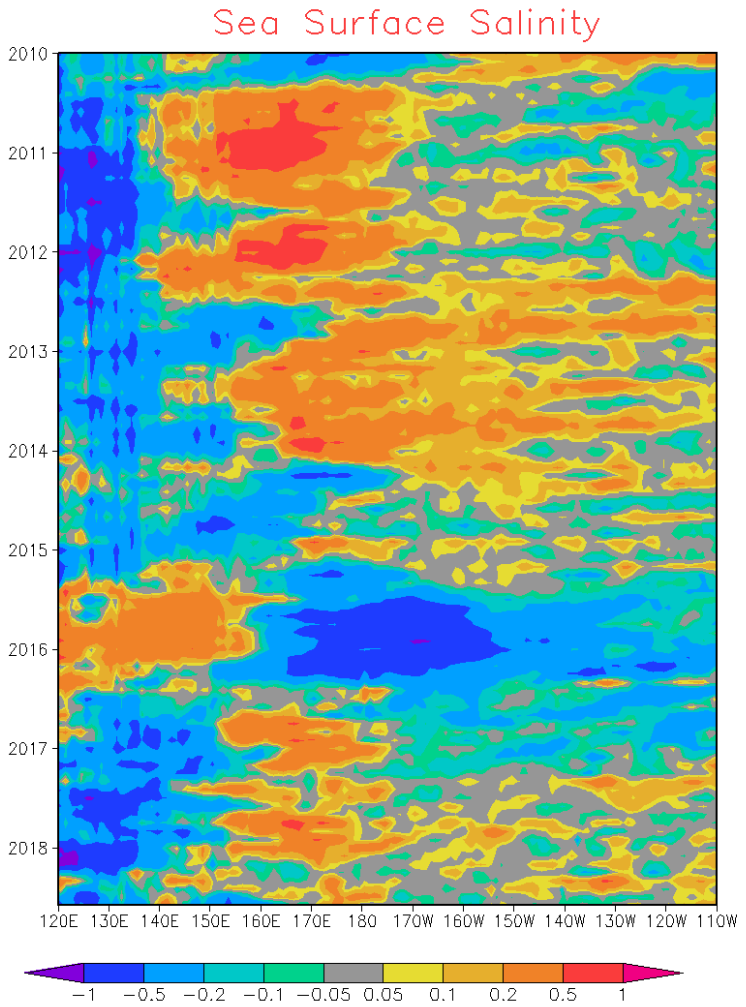


Global Sea Surface Salinity (SSS)

Anomaly Evolution over Equatorial Pacific from Monthly SSS

NOTE: Since June 2015, the BASS SSS is from in situ, SMOS and SMAP; before June 2015,The BASS SSS is from in situ, SMOS and Aquarius.

- Hovemoller diagram for equatorial SSS anomaly **(5˚ S-5˚ N);**
- In the equatorial Pacific Ocean, from 120˚ E to 150˚ E, the negative SSS signal continues in this month. The SSS anomalies east of 150˚ E became weaker; while east of 170˚ E, the anomalies favored to be negative.



Global Sea Surface Salinity (SSS)

Anomaly Evolution over N. of Equatorial Pacific from Pentad SSS

Figure caption:
Hovemoller diagram for equatorial (5˚ S-5˚ N) 5-day mean SSS, SST and precipitation anomalies. The climatology for SSS is Levitus 1994 climatology. The SST data used here is the OISST V2 AVHRR only daily dataset with its climatology being calculated from 1985 to 2010. The precipitation data used here is the adjusted CMORPH dataset with its climatology being calculated from 1999 to 2013.