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

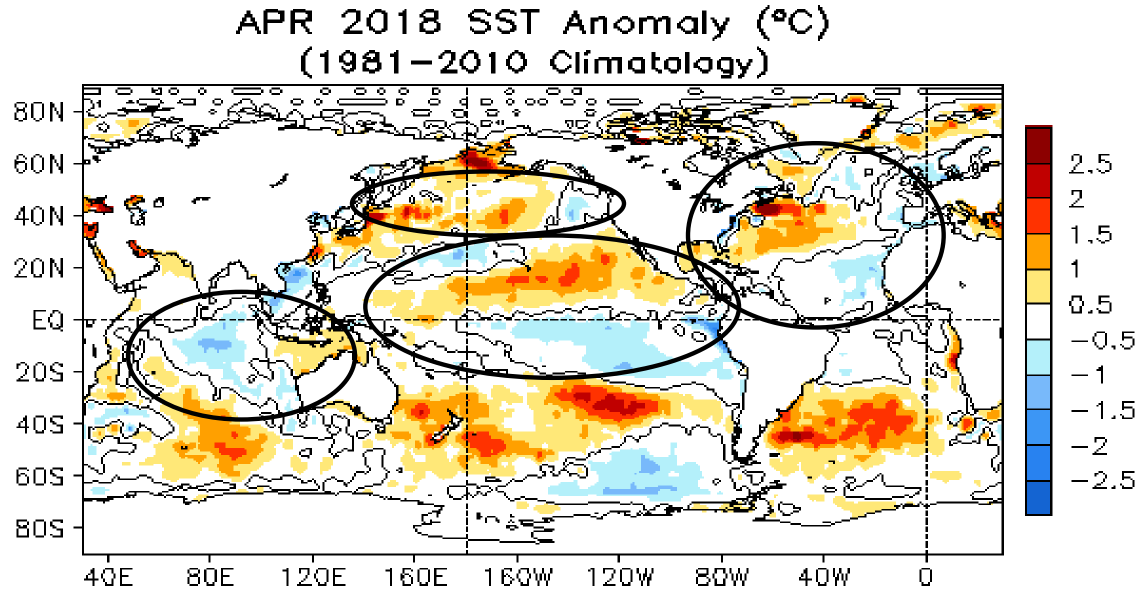
- **Overview**
- **Recent highlights**
  - **Pacific/Arctic Ocean**
  - **Indian Ocean**
  - **Atlantic Ocean**
  - **Global SST Predictions**
  - **Is an El Nino Coming?**
  - **Biases in CFSR and the Possible Impact on ENSO Forecast**

Overview

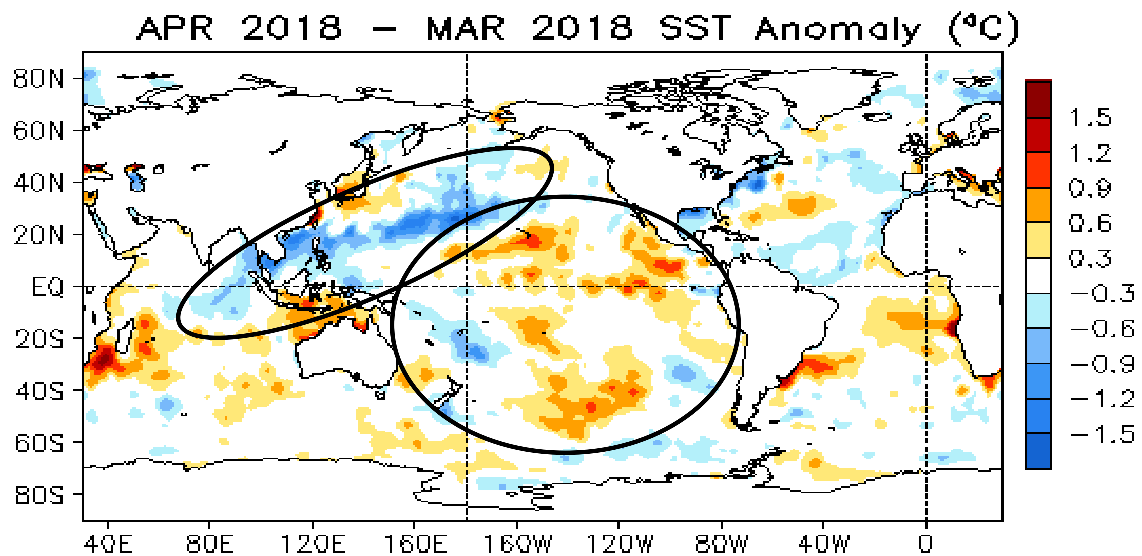
- **Pacific Ocean**
  - **NOAA "ENSO Diagnostic Discussion" on 10 May 2018 issued "Final La Niña Advisory" and indicated *"ENSO-neutral is favored through September-November 2018, with the possibility of El Niño nearing 50% by Northern Hemisphere winter 2018-19."***
  - **Negative SSTAs weakened in the eastern tropical Pacific with NINO3.4=-0.41^{o}C in Apr 2018.**
  - **Positive subsurface ocean temperature anomalies presented in the equatorial Pacific in Apr 2018.**
  - **SST anomalies were mainly positive in the N. Pacific with PDOI=-0.2 in Apr 2018.**
- **Indian Ocean**
  - **SSTs were negative in the east-central S. Indian Ocean in Apr 2018.**
- **Atlantic Ocean**
  - **NAO switched to positive phase with NAOI=1.2 in Apr 2018, and SSTAs were a tripole/horseshoe pattern with large positive anomalies in the middle latitudes of N. Atlantic.**

Global Oceans

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



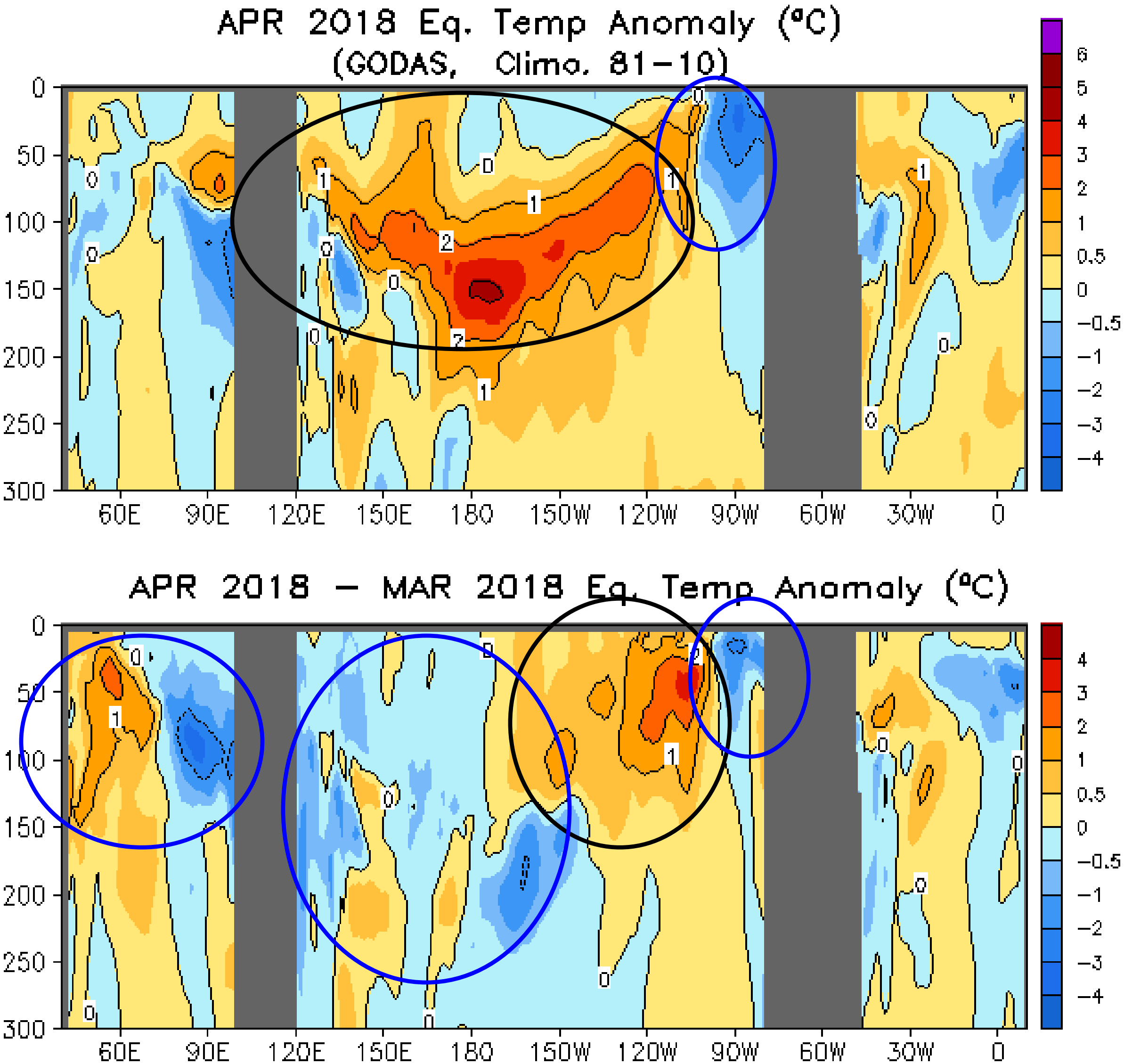
- SSTAs were positive (negative) in the NE (SE) tropical Pacific, showing a large meridional gradient in the E. Pacific.
- SSTAs were mainly positive in the N. Pacific.
- Horseshoe/tripole-like SSTA pattern presented in the N. Atlantic.
- SSTAs were negative in the east-central S. tropical Indian Ocean.



- Positive SSTA tendencies were observed in the central and eastern tropical Pacific, consisting with the decline of La Nina.
- Strong negative SSTA tendencies were seen in the NE Indian Ocean to the central N. Pacific via NW Pacific.

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.

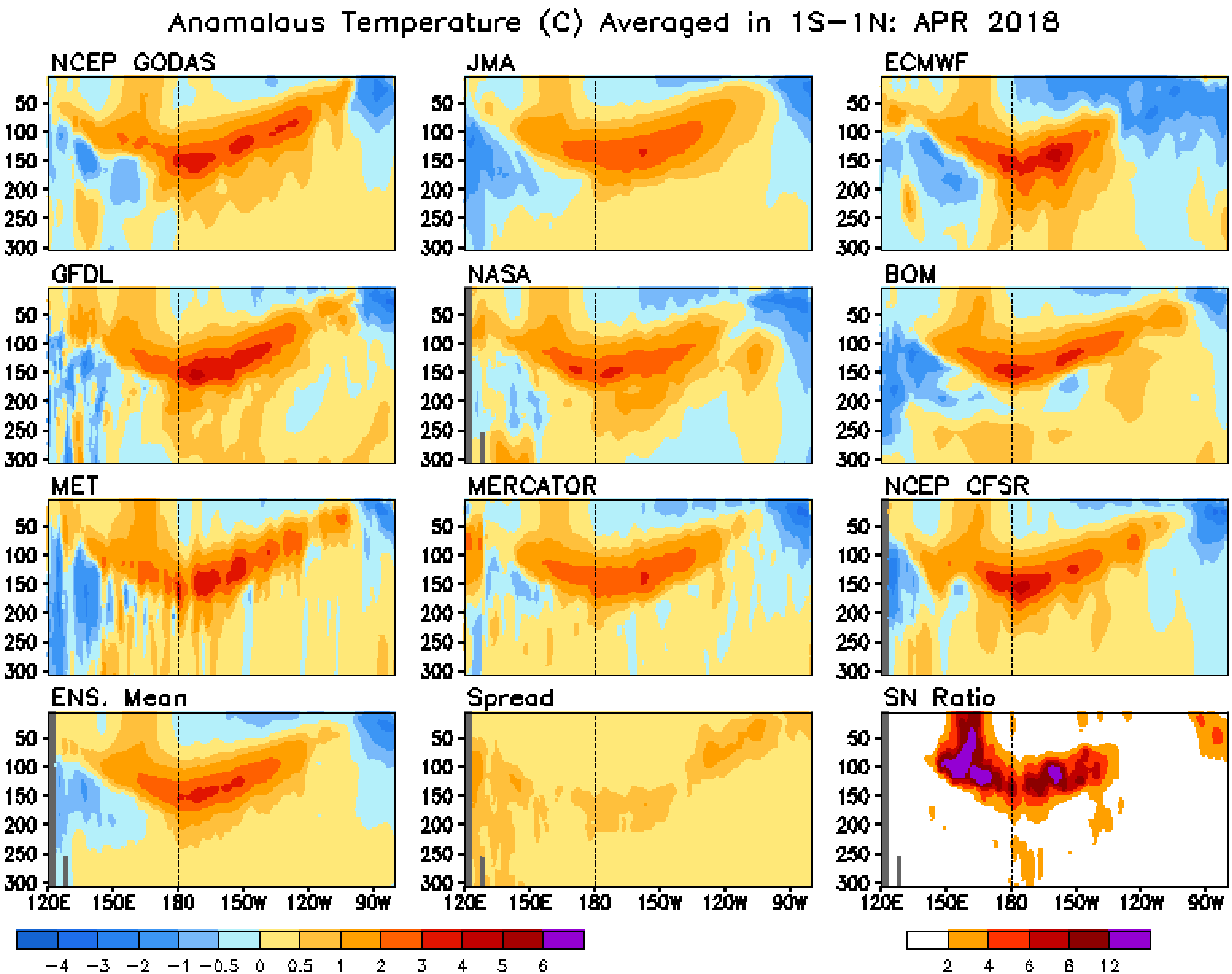
Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2°S-2°N



- Positive (negative) ocean temperature anomalies presented along the thermocline in the western-central (far-eastern) equatorial Pacific.

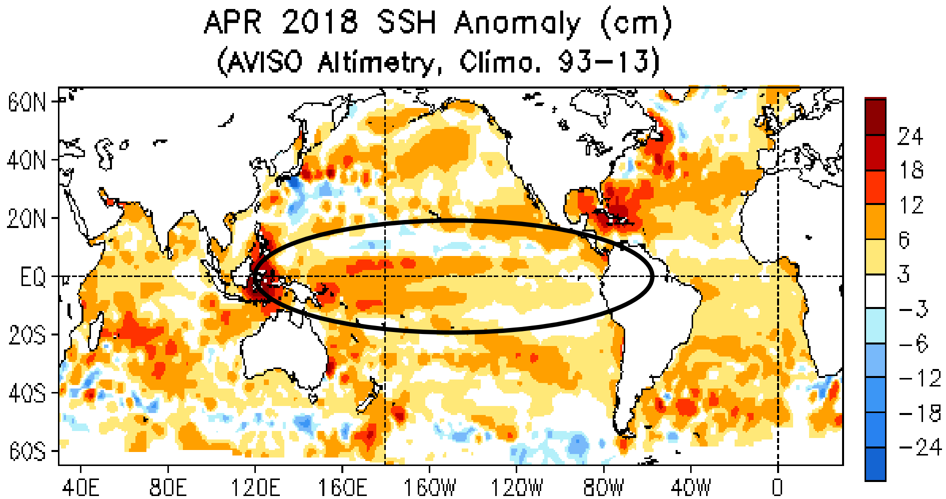
- There was a tripole tendency pattern in the Pacific: negative in the west and far-east, and positive in the east.
- Positive (negative) tendencies presented along the thermocline in the western (eastern) Indian Ocean.

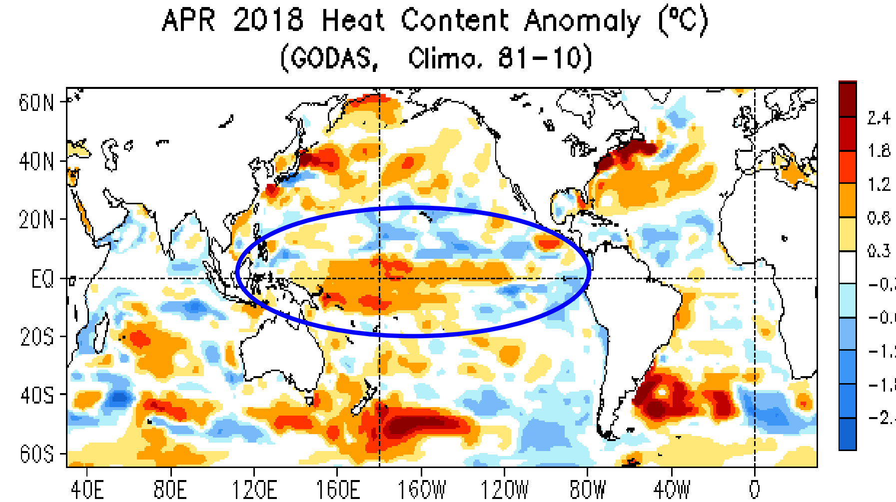
Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1981-2010 base period means.

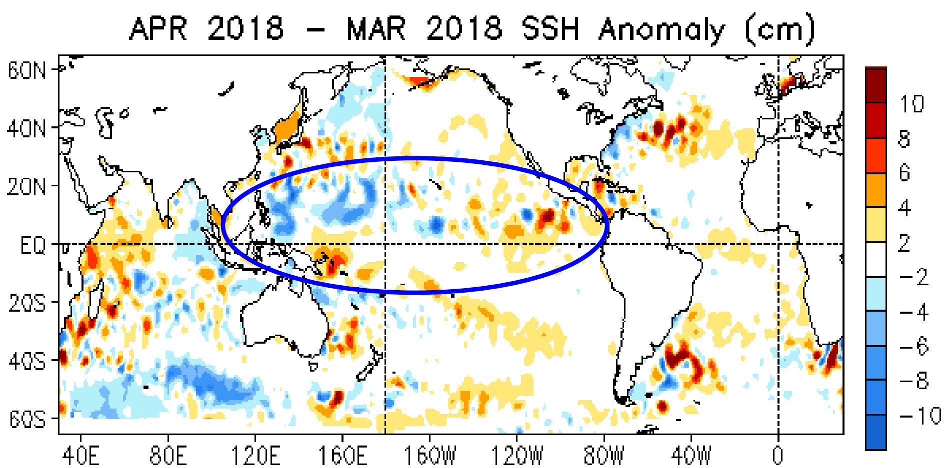


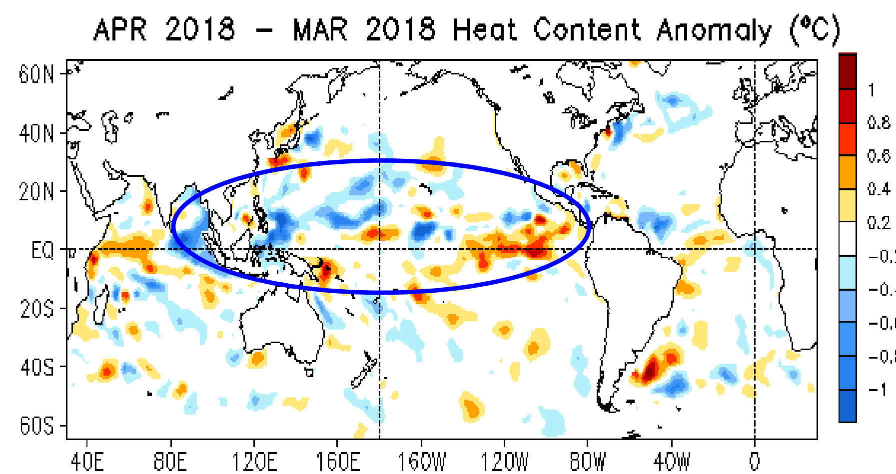
Anamalous Temperature (C) Averaged in 1S-1N: APR 2018
NCEP GODAS
JMA
ECMWF
GFDL
NASA
BOM
MET
MERCATOR
NCEP CFSR
ENS. Mean
Spread
SN Ratio
50
100
150
200
250
300
120E
150E
180
150W
120W
90W
-4 -3 -2 -1 -0.5 0 0.5 1 2 3 4 5 6
2 4 6 8 12

Global SSH and HC300 Anomaly & Anomaly Tendency



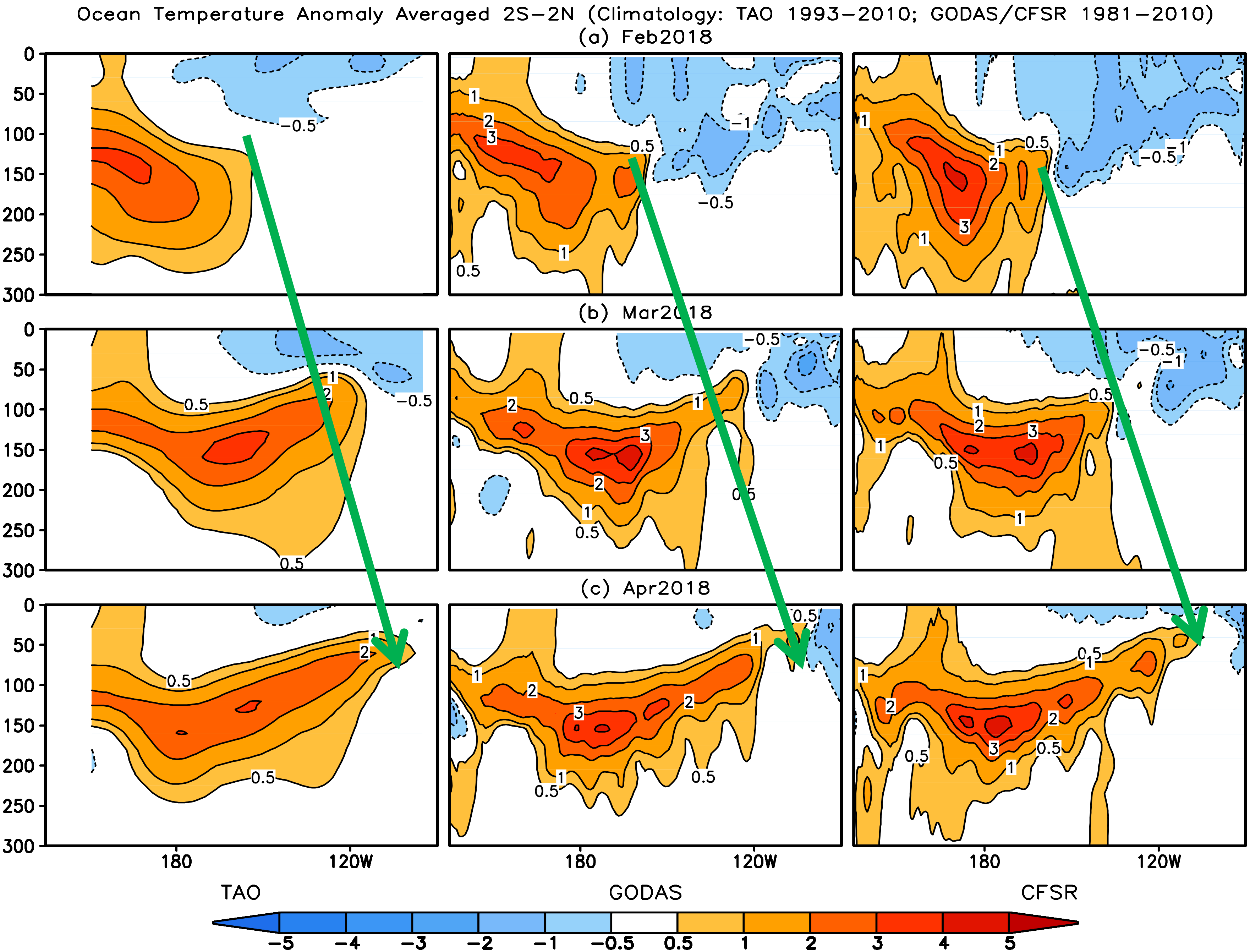






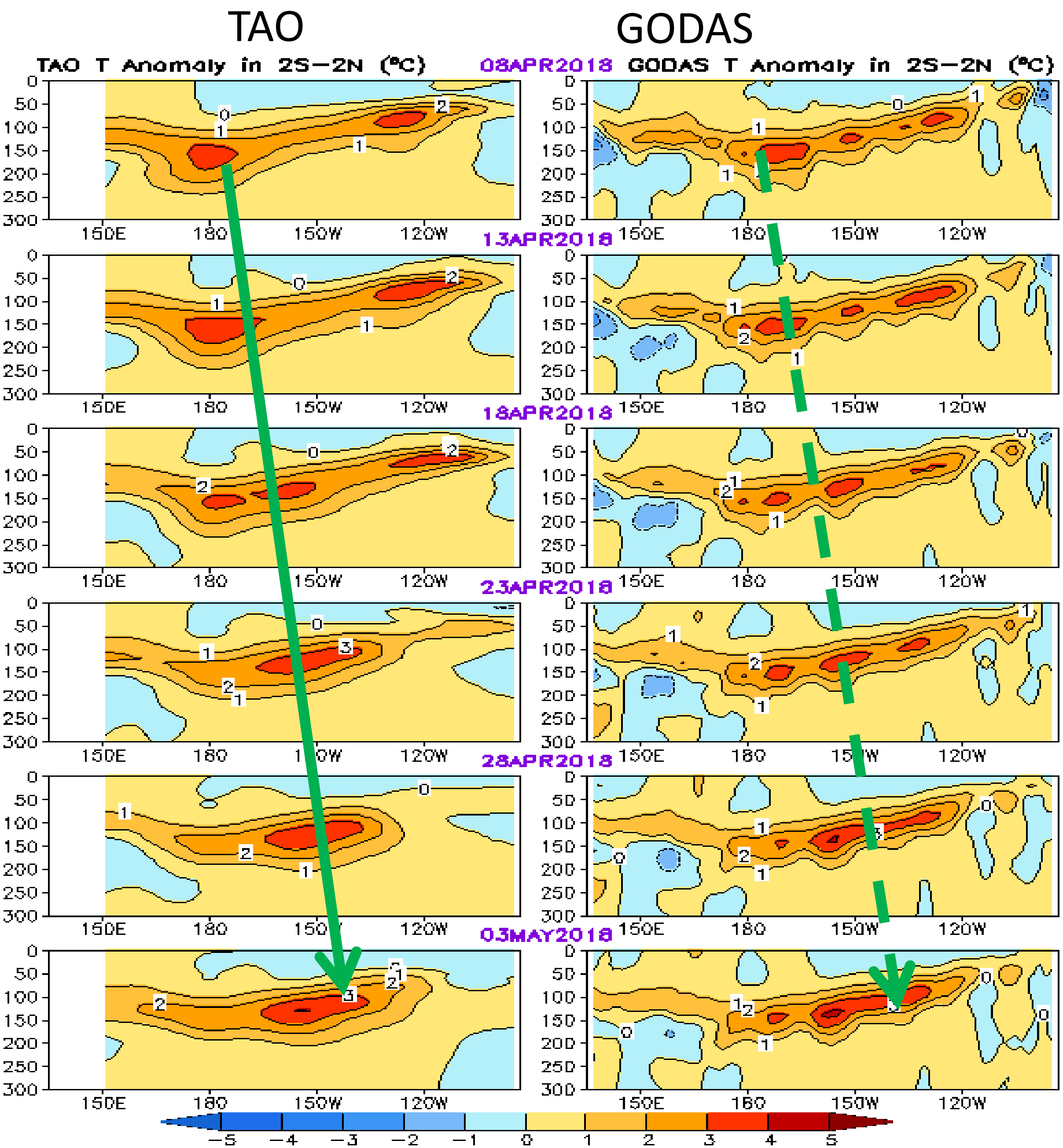
- **The SSHA pattern was overall consistent with HC300A pattern, but there were many detailed differences between HC300A and SSHA.**
- **Both SSHA and HC300A in the tropical Pacific were consisted with the decay phase of La Nina.**
- **The negative and positive tendencies of SSHA and HC300A in the tropical Pacific are associated with Kelvin wave activity.**

Tropical Pacific Ocean and ENSO Conditions



Ocean Temperature Anomaly Averaged 2S–2N (Climatology: TAO 1993–2010; GODAS/CFSR 1981–2010)
(a) Feb2018
(b) Mar2018
(c) Apr2018
180
120W
TAO
GODAS
CFSR
−5 −4 −3 −2 −1 −0.5 0.5 1 2 3 4 5

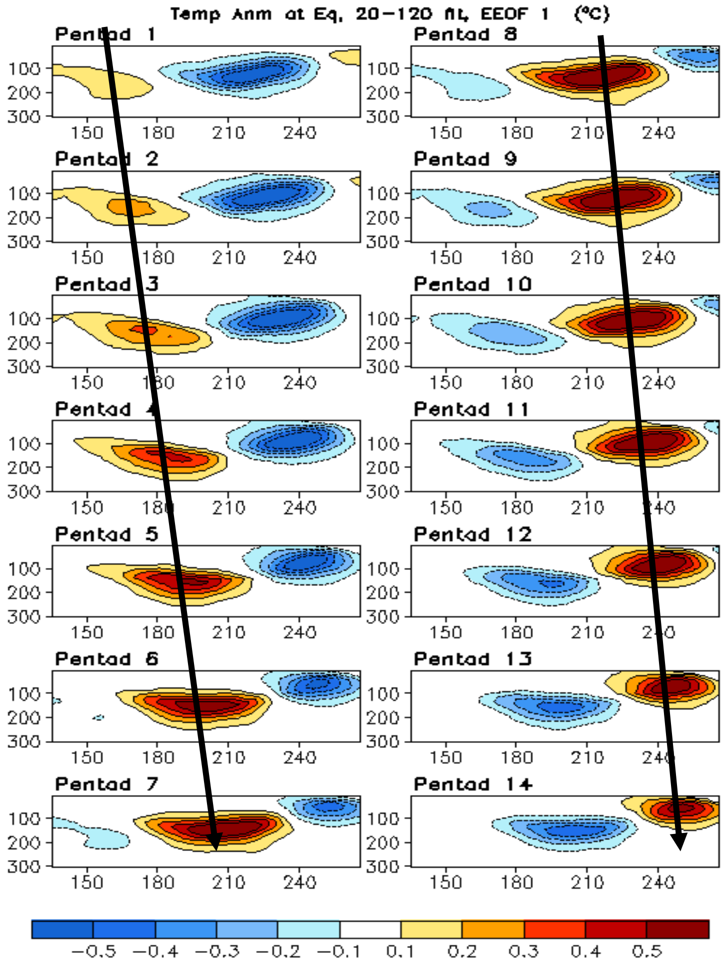
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

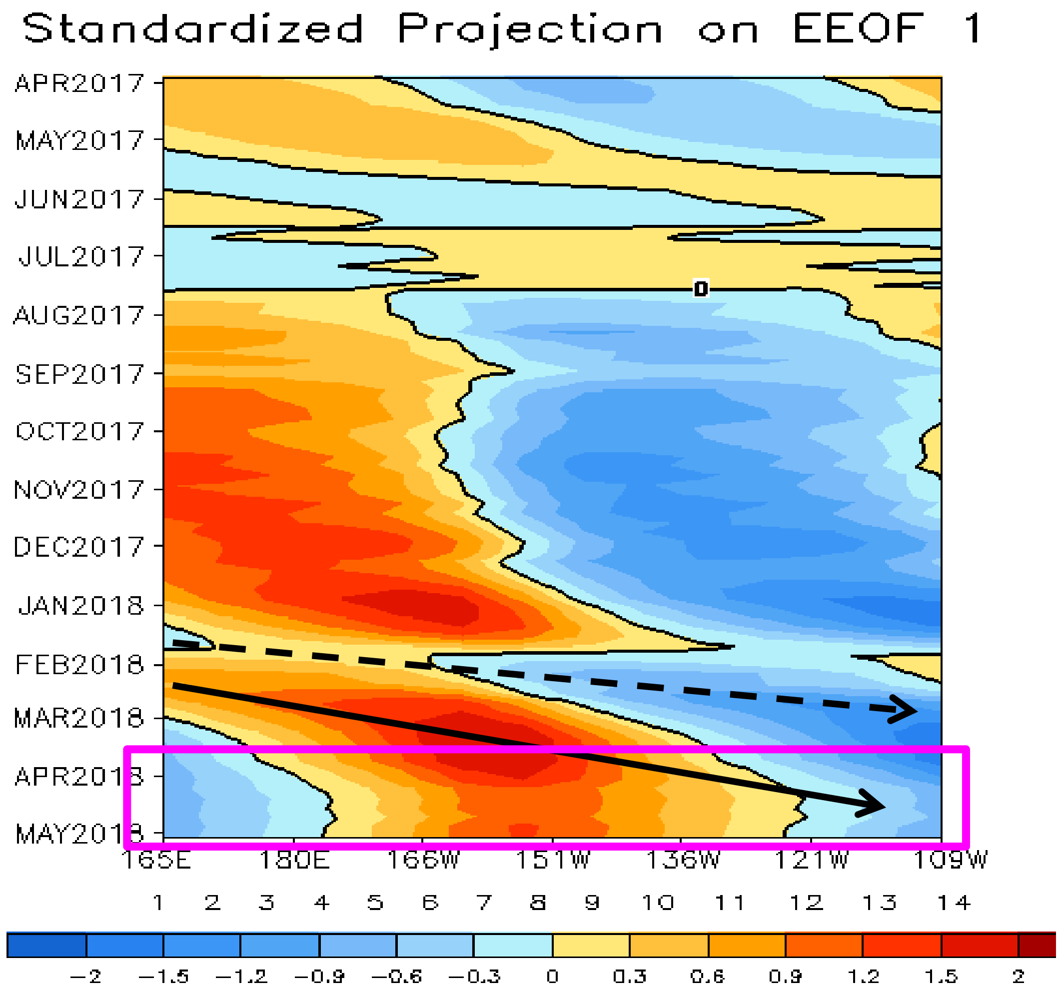


- **Positive ocean temperature anomalies in the western and central Pacific Ocean propagated eastward during last month and reached far-eastern Pacific, associated with eastward propagation of downwelling Kelvin wave.**

- **Both the anomalous amplitude and propagation speed are comparable between TAO and GODAS.**

Oceanic Kelvin Wave (OKW) Index

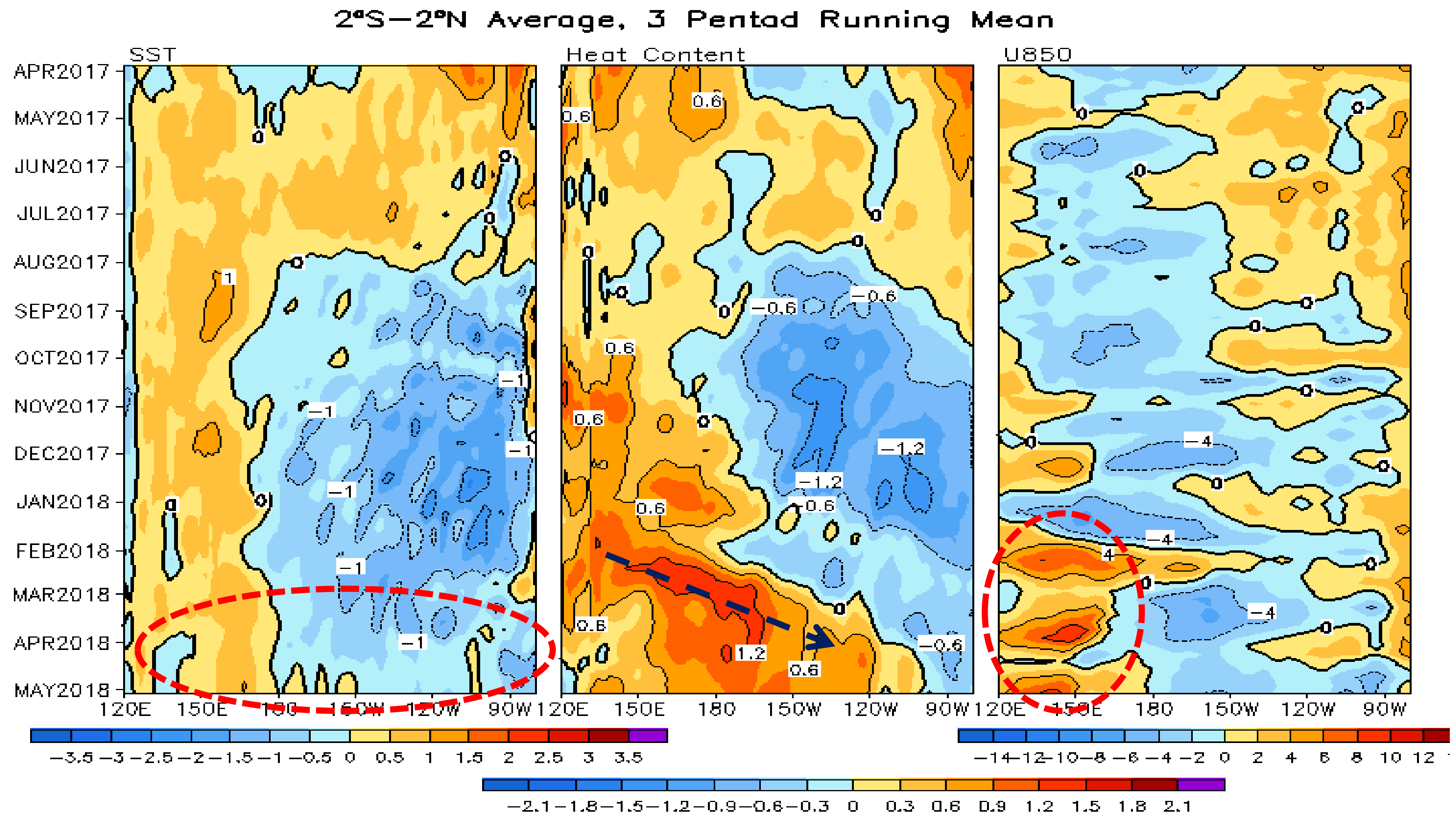




- A downwelling Kelvin wave propagated eastward from Feb - Mar 2018, and a stationary variation presented since Apr 2018.

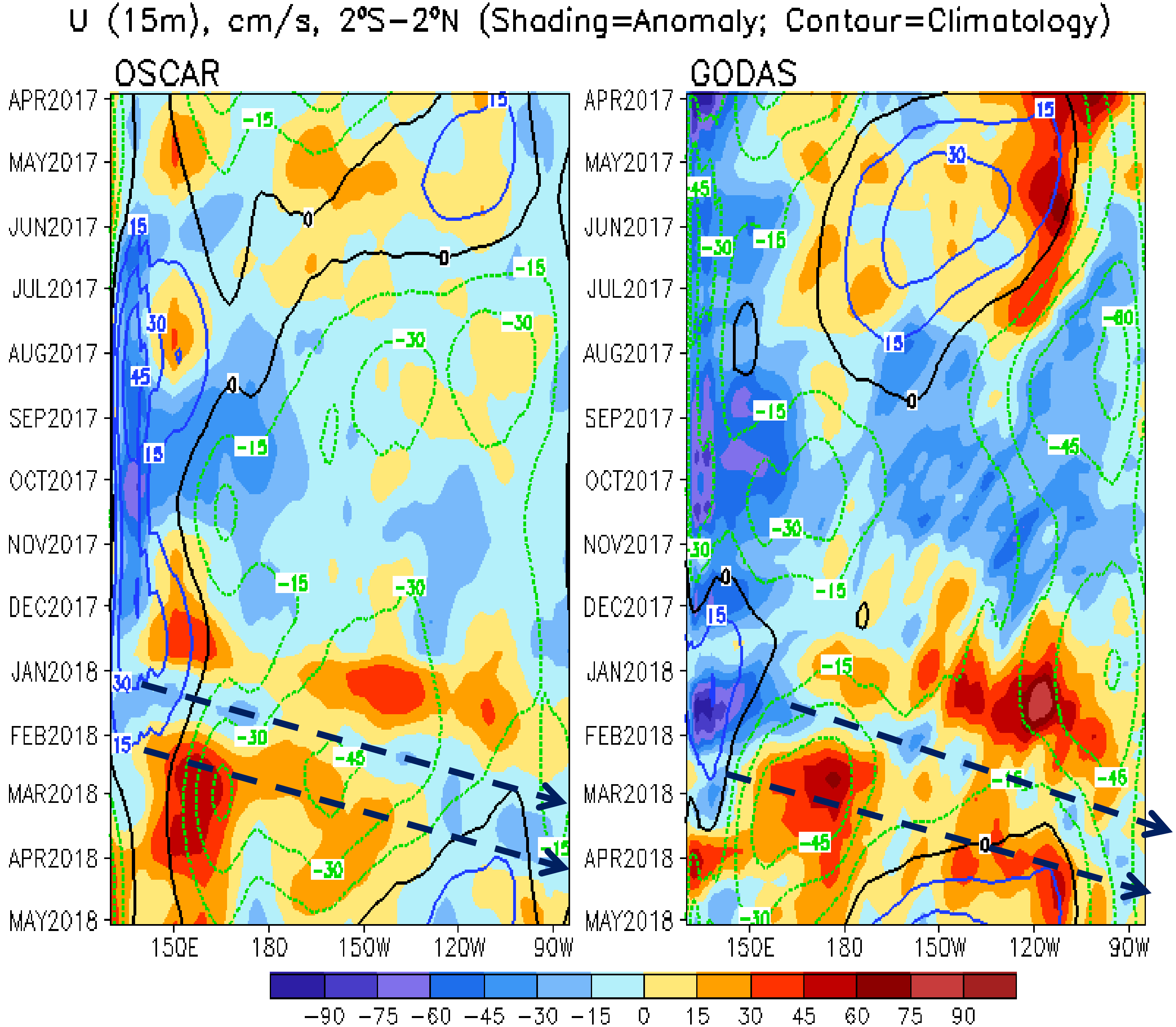
(OKW index is defined as standardized projections of total anomalies onto the 14 patterns of Extended EOF1 of equatorial temperature anomalies (Seo and Xue , GRL, 2005).)

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



- **Negative SSTA in the eastern Pacific weakened since Mar 2018.**
- **Positive HC300A in the western and central Pacific propagated eastward in Feb-Mar 2018.**
- **Three low-level westerly wind burst events were observed during Jan-Apr 2018.**

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



- Anomalous eastward currents weakened in Apr 2018 in OSCAR and GODAS.
- The anomalous currents showed some differences between OSCAR and GODAS.

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 recharging in Feb-Apr 2018.**

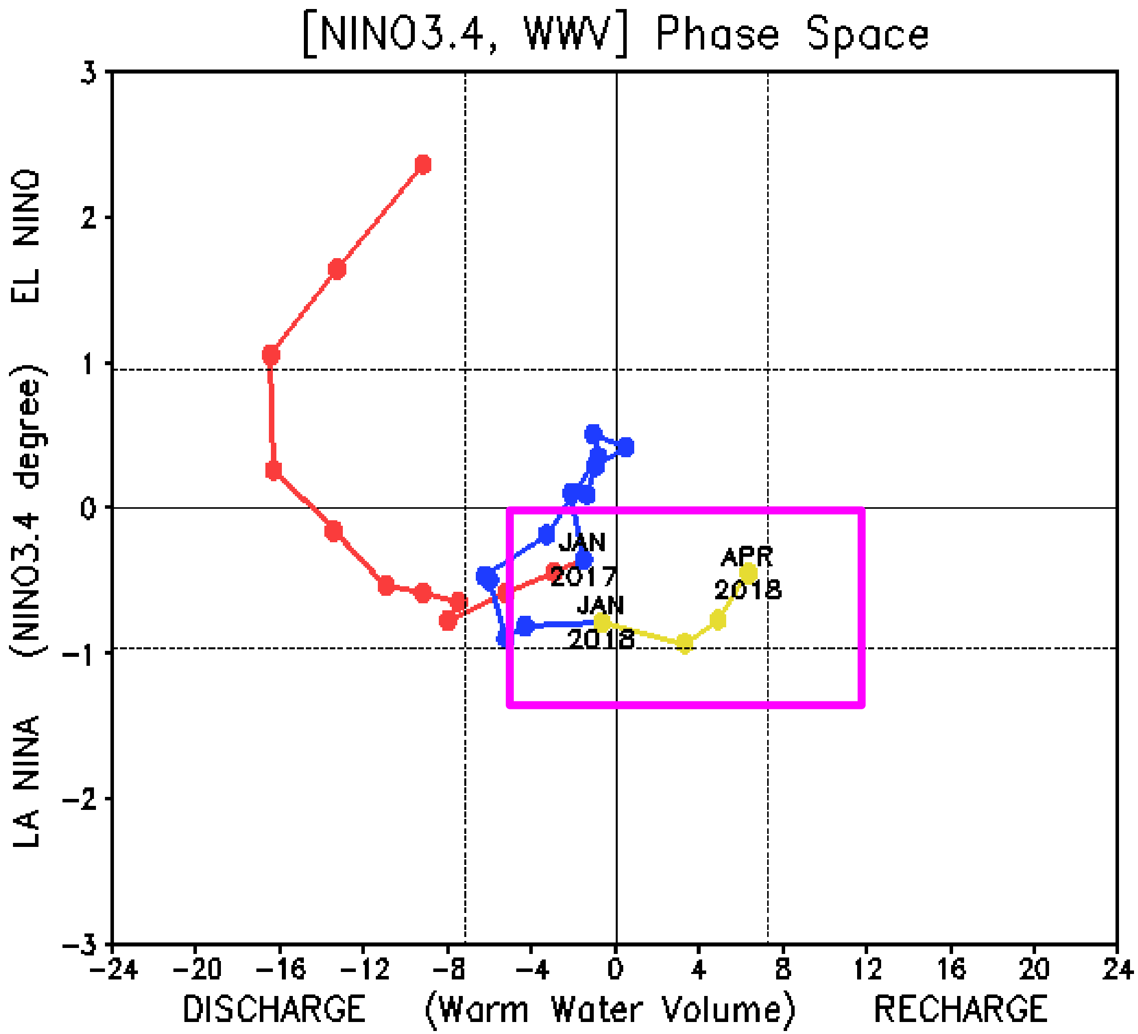
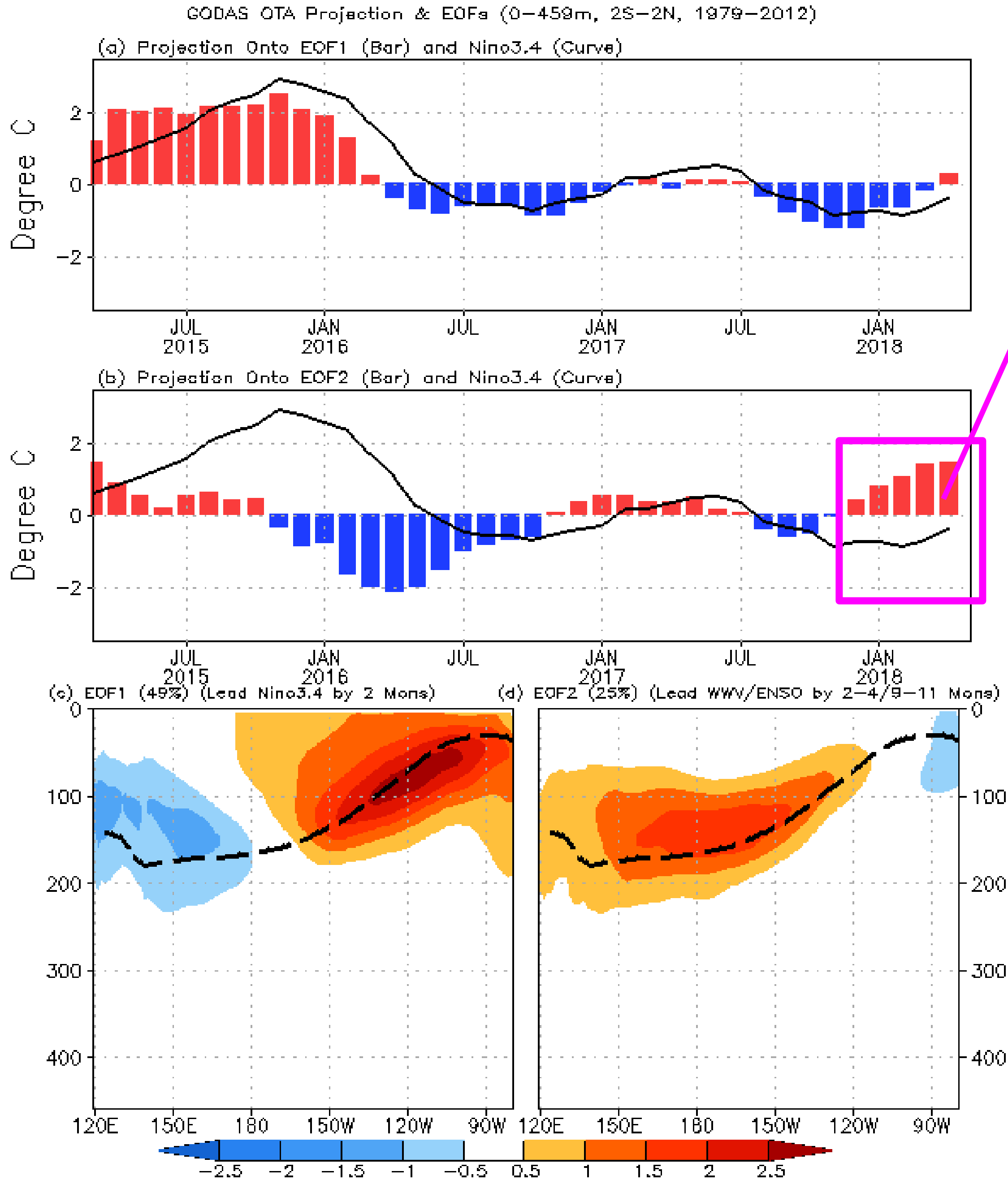


Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20°C in [120°E-80°W, 5°S-5°N] calculated with the NCEP's global ocean data assimilation system. Anomalies are departures from the 1981-2010 base period means.



Equatorial subsurface ocean temperature monitoring: ENSO was in recharge phase since Dec 2017.

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).

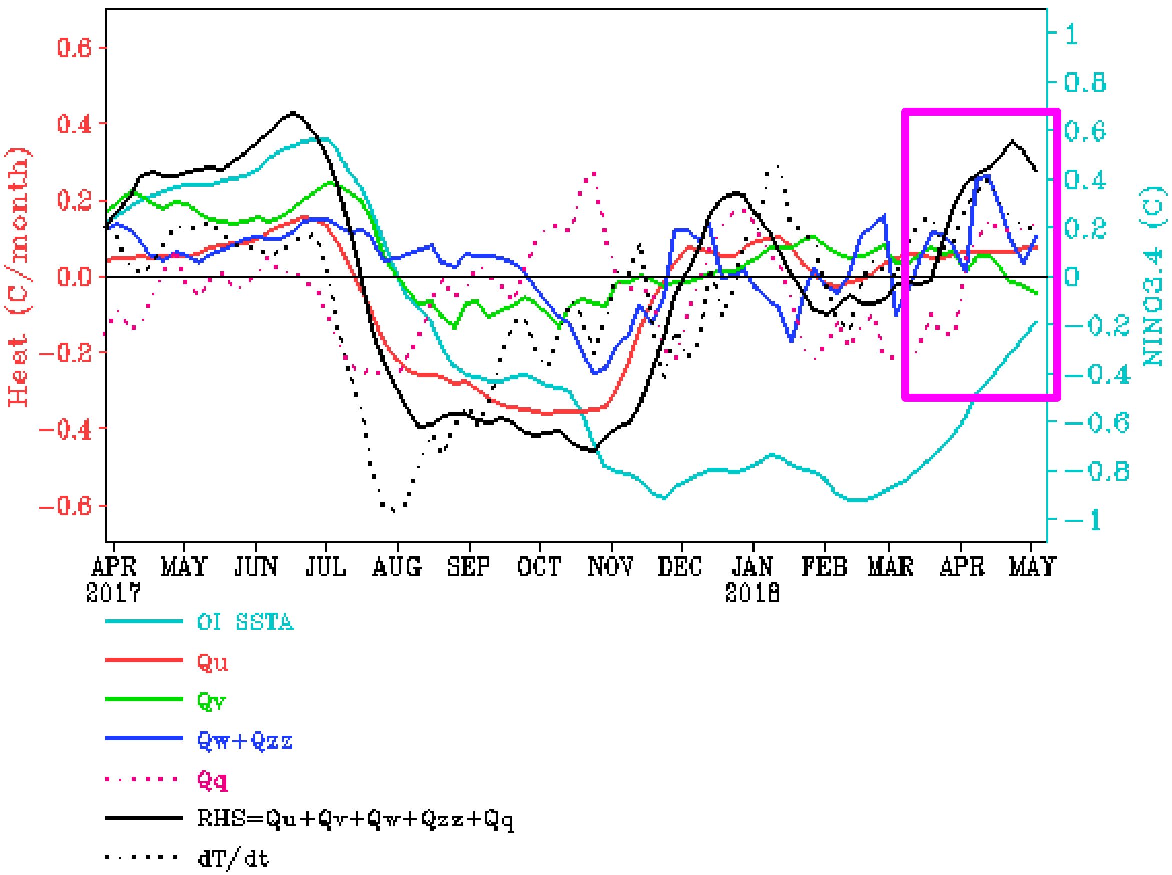
Recharge process: heat transport from outside of equator to equator : Negative -> positive phase of ENSO

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 tendencies (dT/dt; dotted black line) and total heat budget (RHS; solid black line) in the Nino3.4 region were positive.

- Both dynamical terms (Qu, Qv, Qw+Qzz) and heat-flux terms (Qq) were small 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.

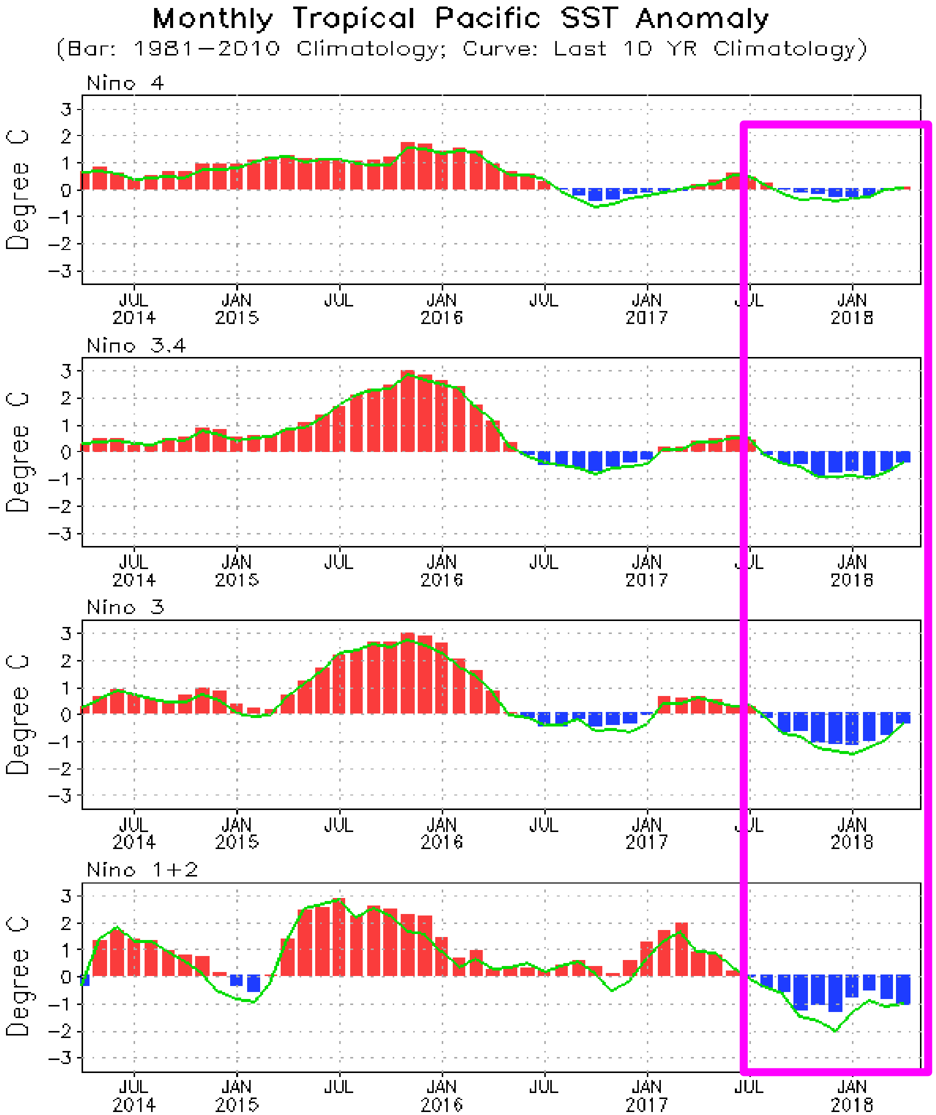
Qu: Zonal advection; Qv: Meridional advection;

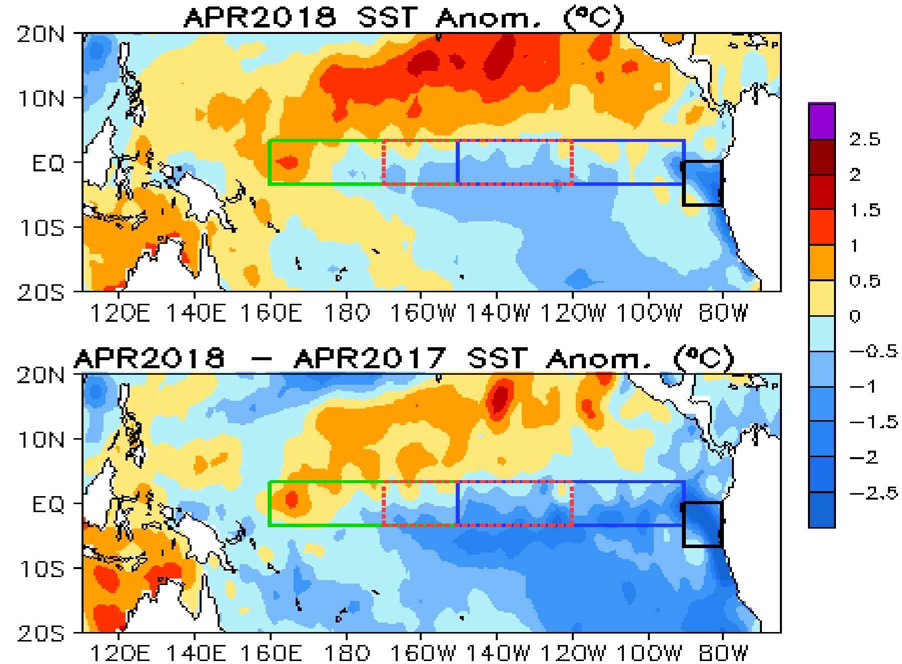
Qw: Vertical entrainment; Qzz: Vertical diffusion

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

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

Evolution of Pacific NINO SST Indices

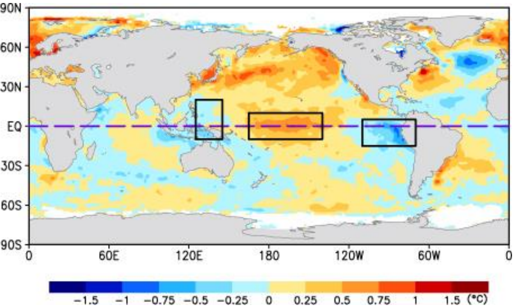


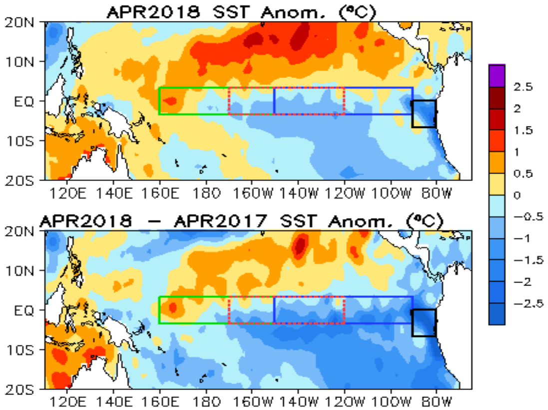


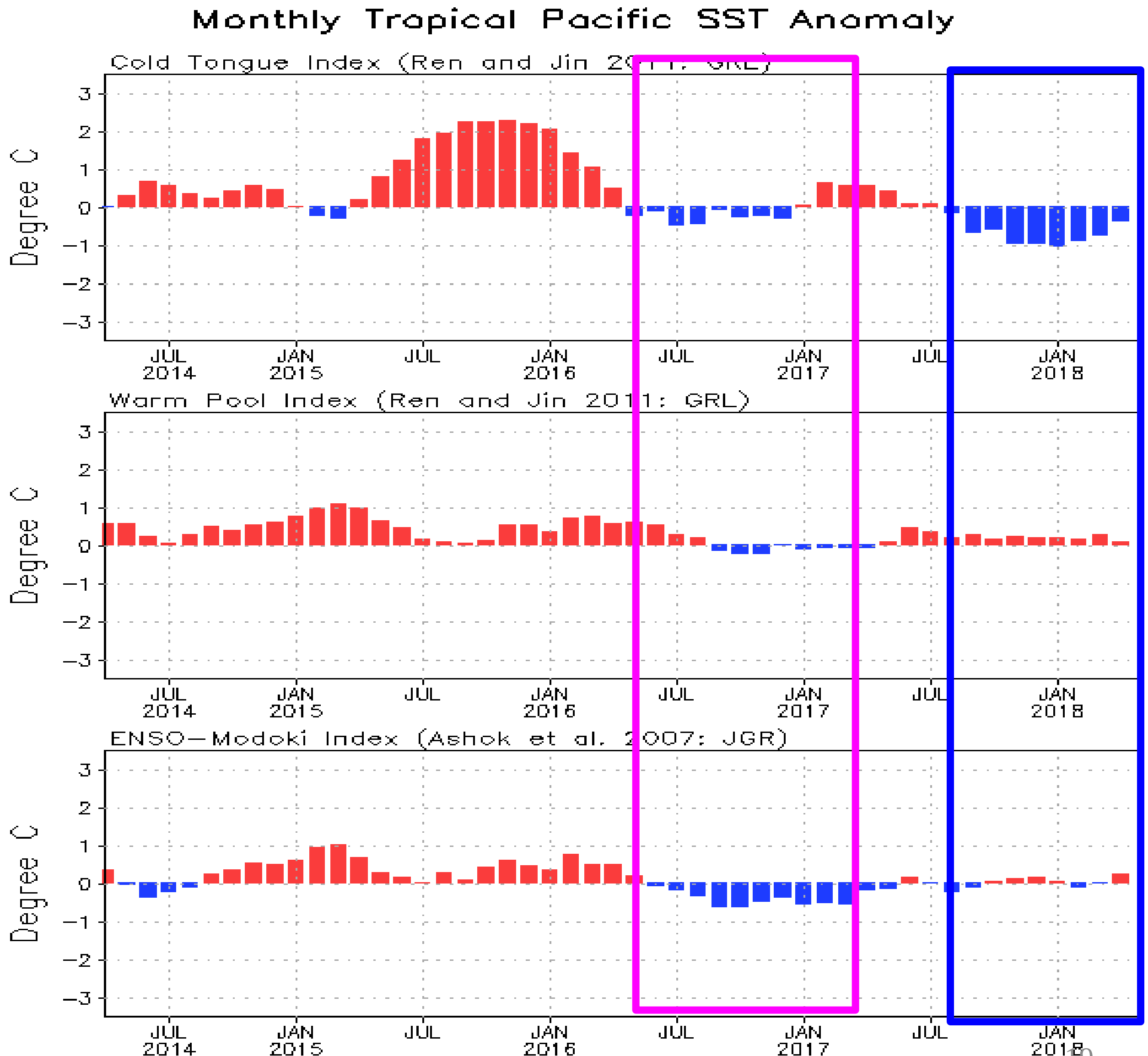
- **Nino4 became positive, and Nino3 and Nino3.4 were negative and weakened in Apr 2018.**
- **Nino3.4 = -0.41C in Apr 2018.**
- **Compared with last Apr, the central and eastern equatorial and southern Pacific was cooler in Apr 2018.**
- **The indices were calculated based on OISST. They may have some 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.

SSTA projections were larger in the cold tongue in 2017/18 La Nina than in 2016/17 La Nina







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

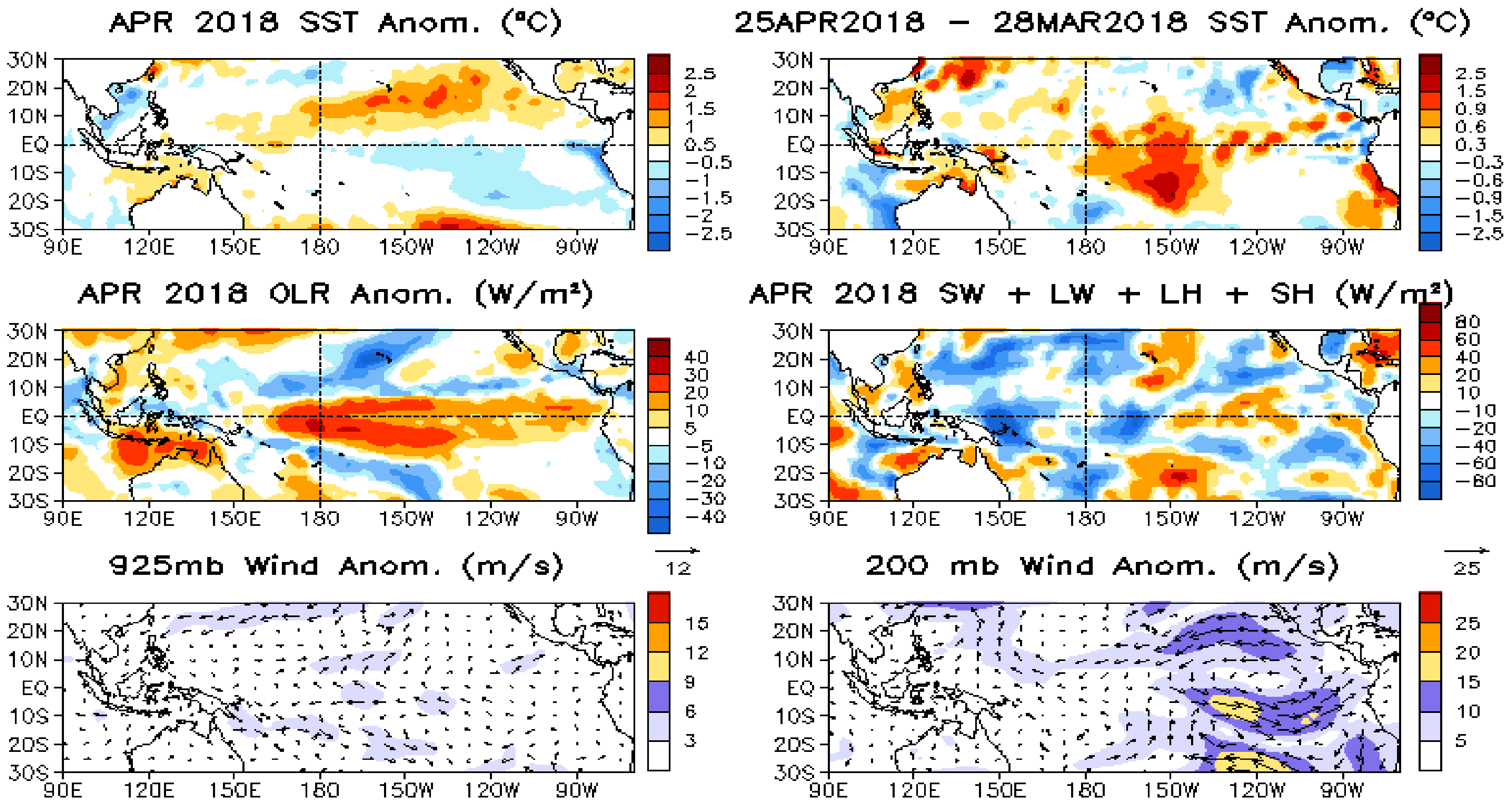
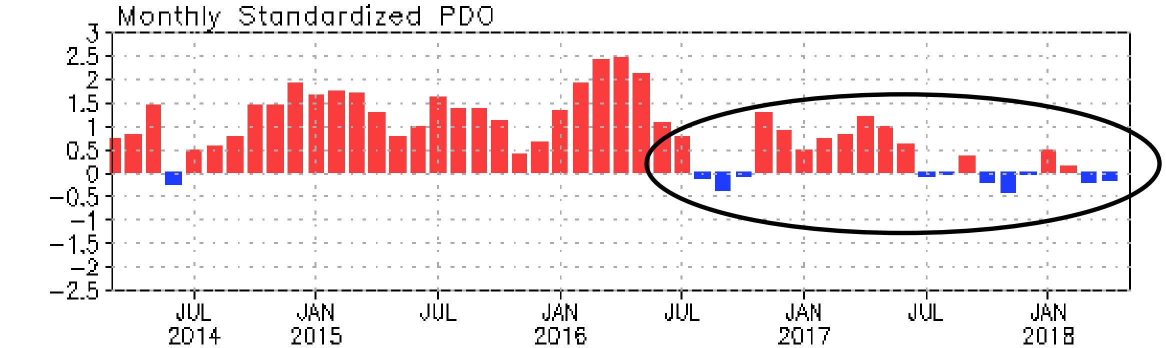
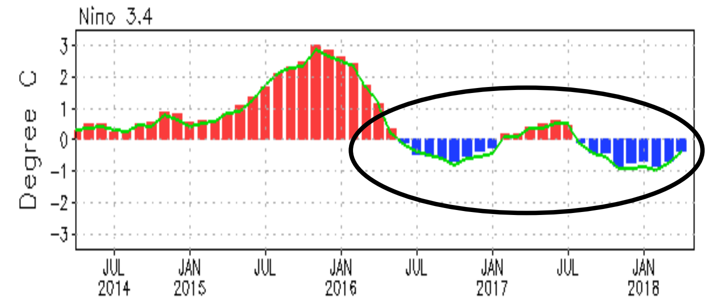


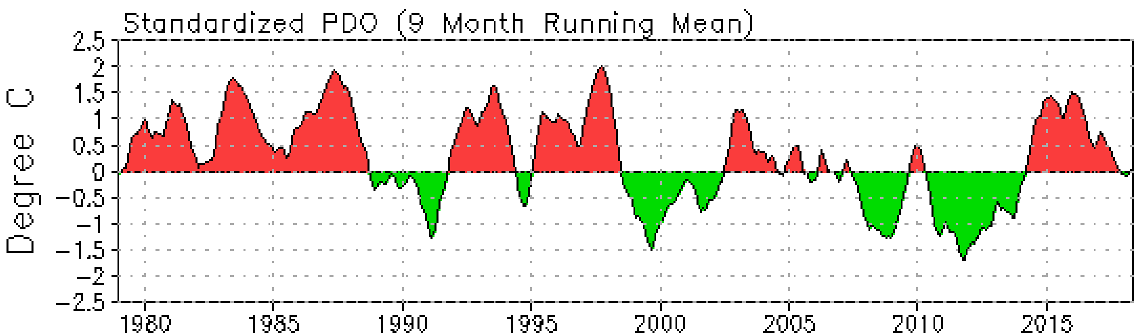
Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period means.

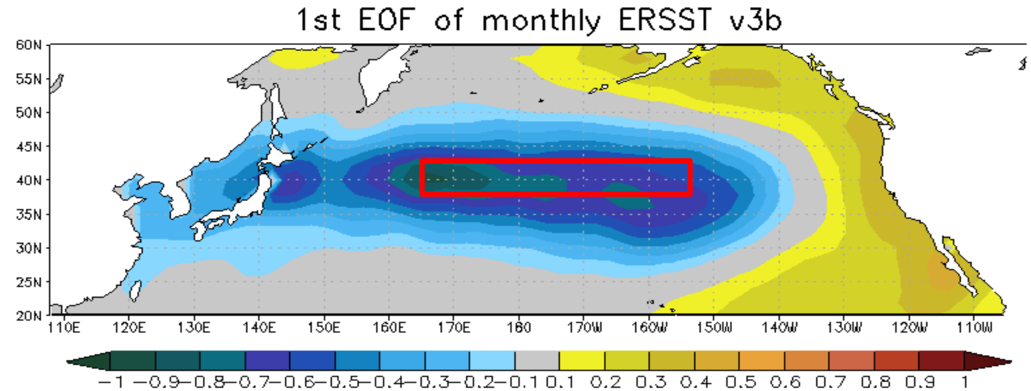
North Pacific & Arctic Oceans

PDO index









- The positive SSTAs presented with PDO index =-0.2 in Apr 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 Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

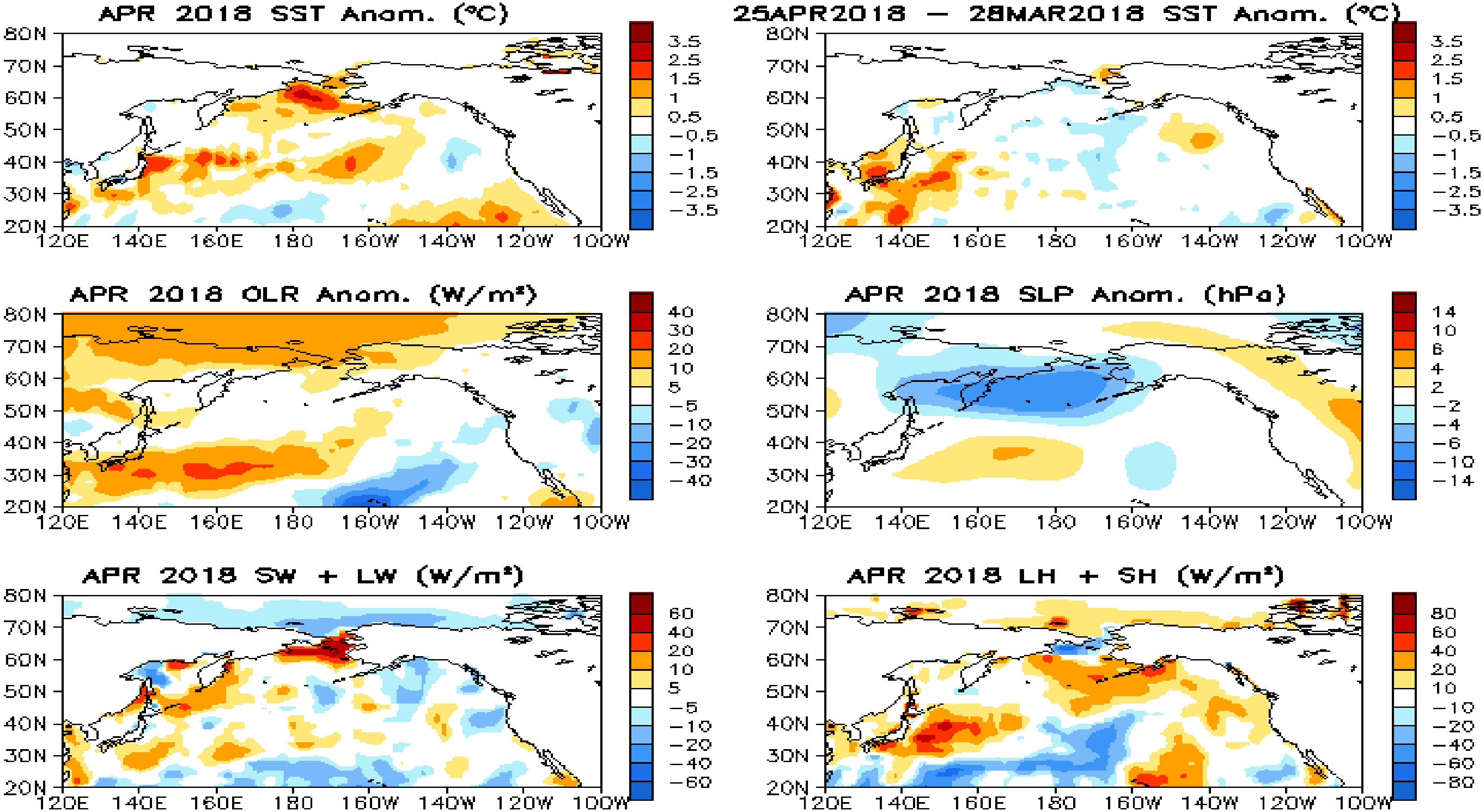
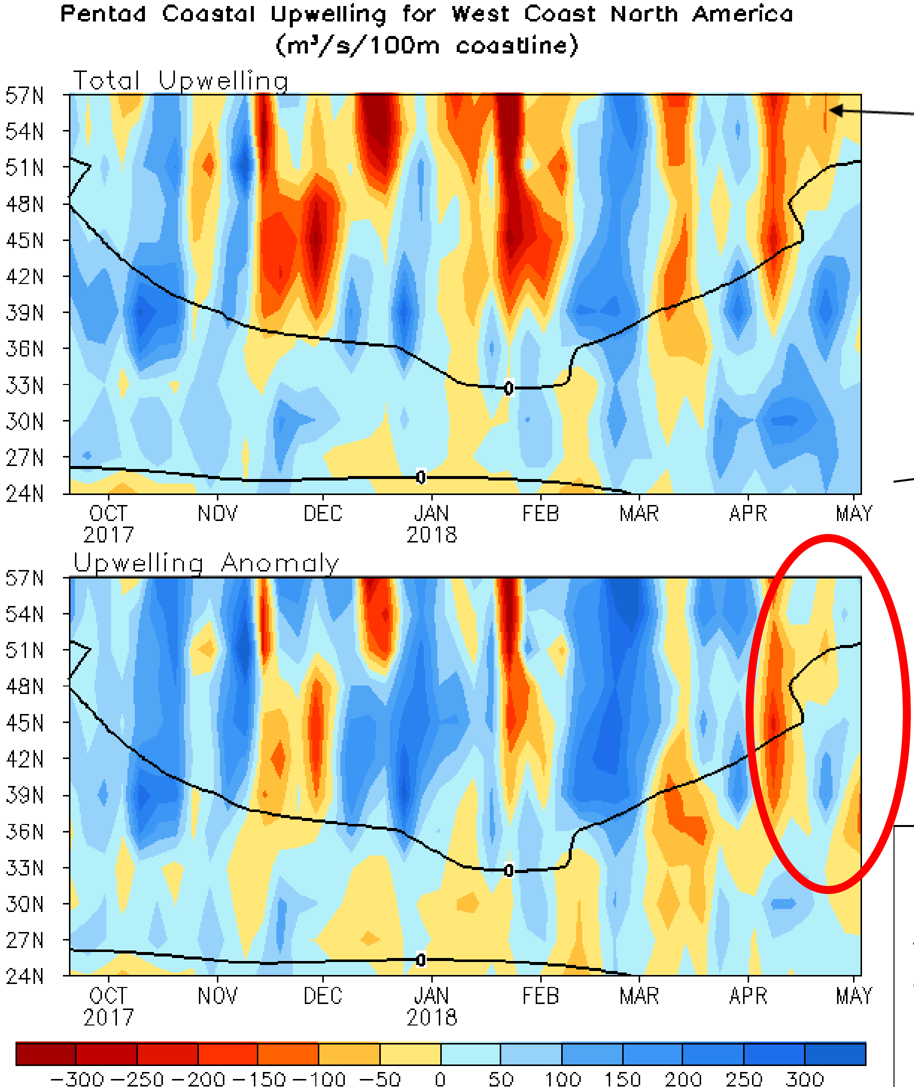
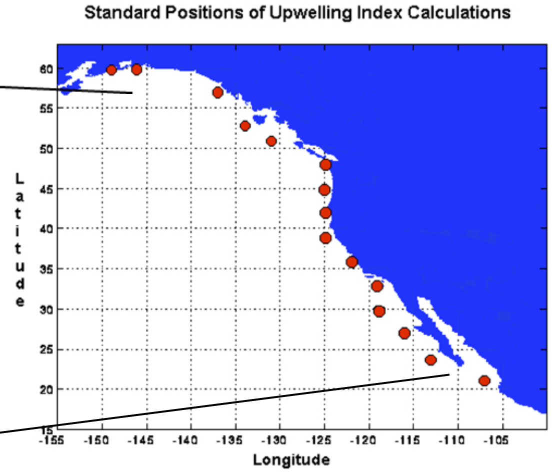


Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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

North America Western Coastal Upwelling





- Both anomalous upwelling and downwelling were small since mid-Apr 2018.

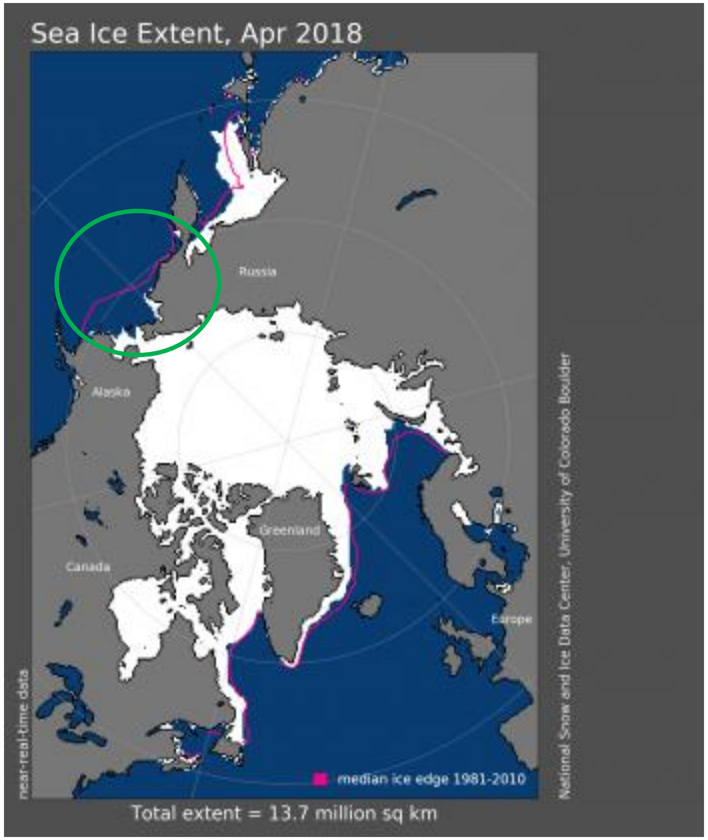
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport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

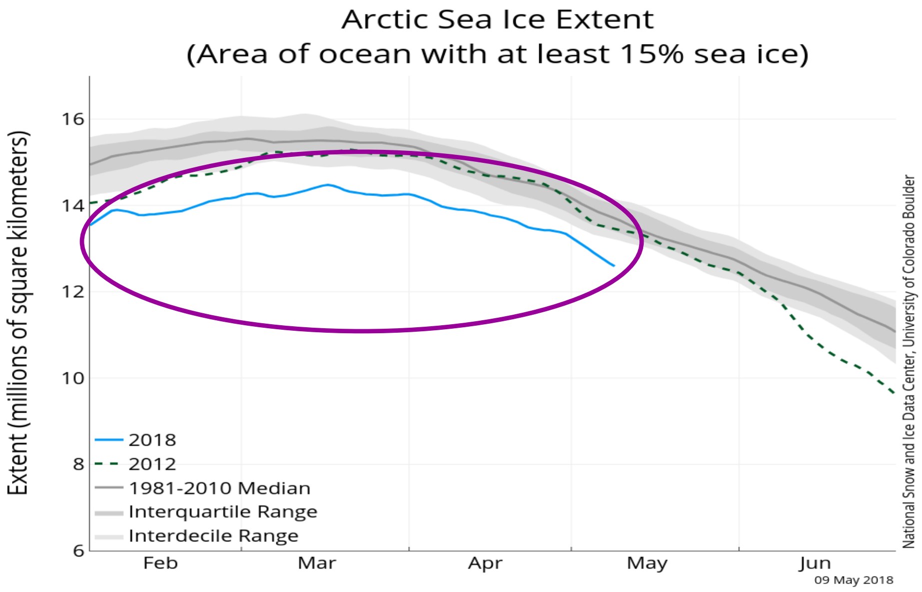
- **Area below (above) black line indicates climatological upwelling (downwelling) season.**
- **Climatologically upwelling season progresses from April to July along the west coast of North America from 36ºN to 57ºN.**

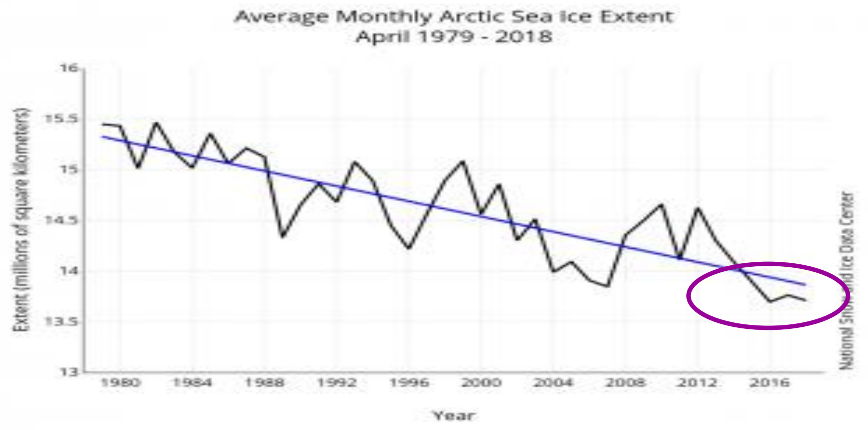
Arctic Sea Ice

National Snow and Ice Data Center

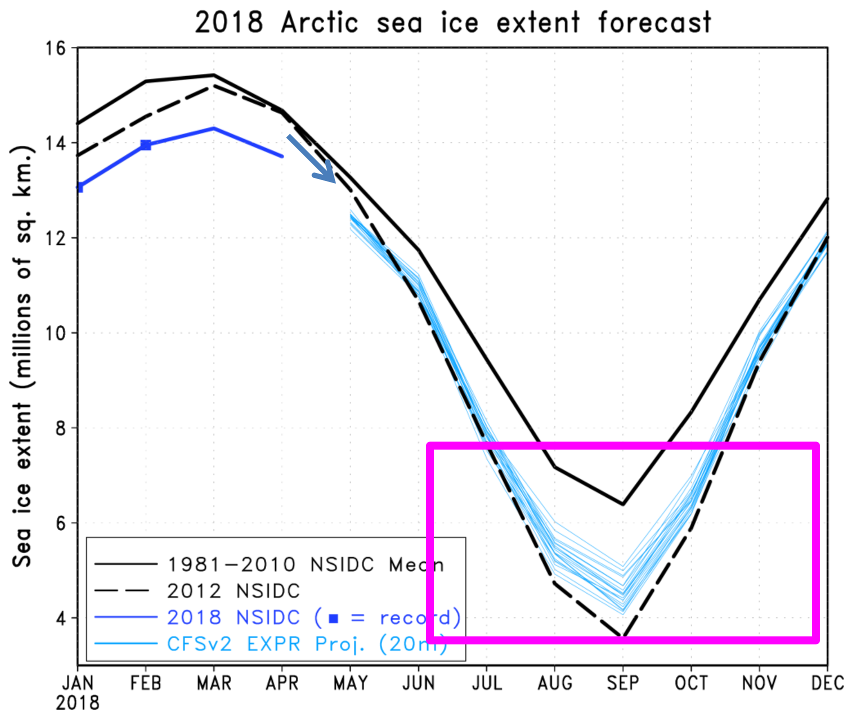
http://nsidc.org/arcticseaicenews/index.html

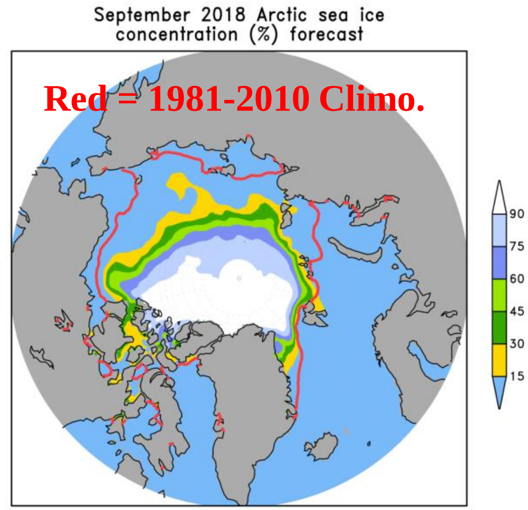


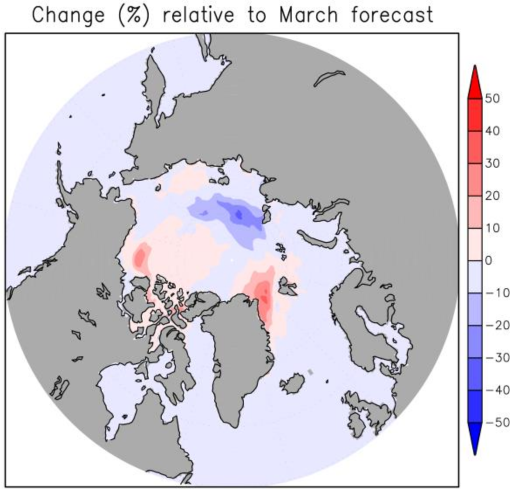


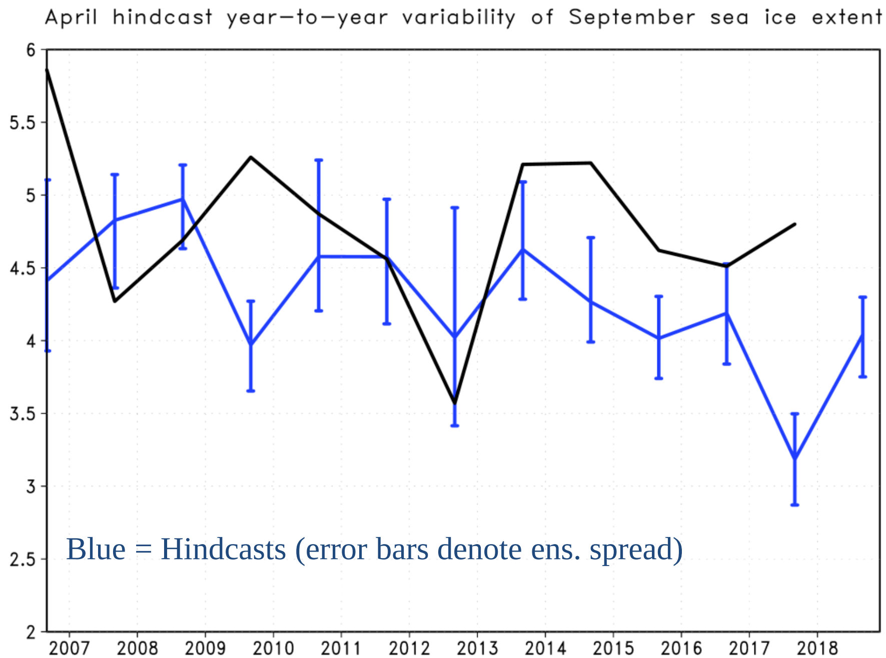


- Sea ice extent in the Bering Sea remains at record low levels for this time of year. Total ice extent over the Arctic Ocean also remains low.
- Given the uncertainty in measurements, NSIDC considers 2016 and 2018 as tying for lowest April sea ice extent on record.









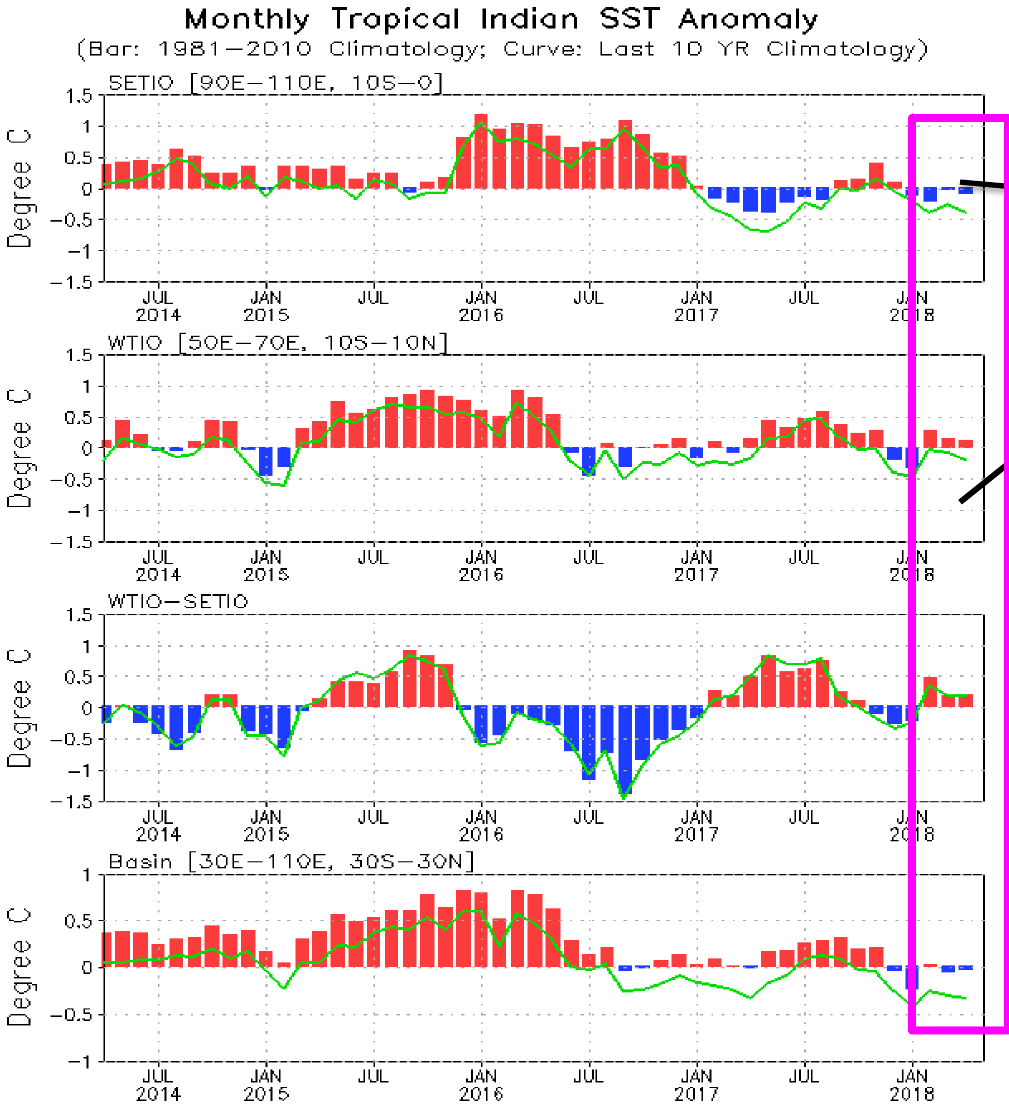
- 20-member ensemble experimental CFS Arctic sea ice forecast was initialized April 21-25, 2018 using initial conditions from the CPC Sea ice Initialization System (CSIS).

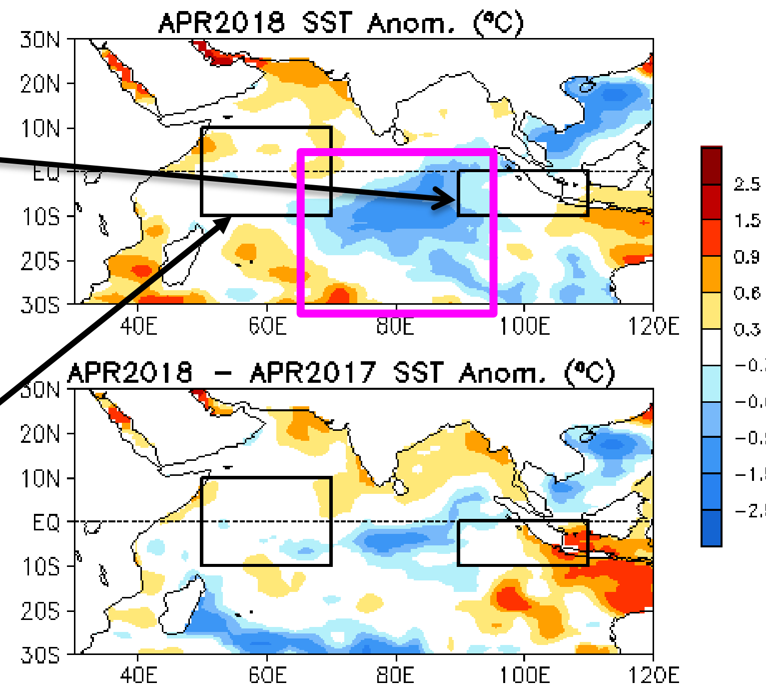
- The projected September Arctic sea ice extent based on this forecast is 4.50 +/- 0.29 * 10^6 km^2 (March forecast was 4.44 +/- 0.51 * 10^6 km^2)

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

Indian Ocean

Evolution of Indian Ocean SST Indices





- Values of all the indices were small in last two months.

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 small and positive in the west and negative in the central-east.
- SSTA tendency was partially determined by heat flux.

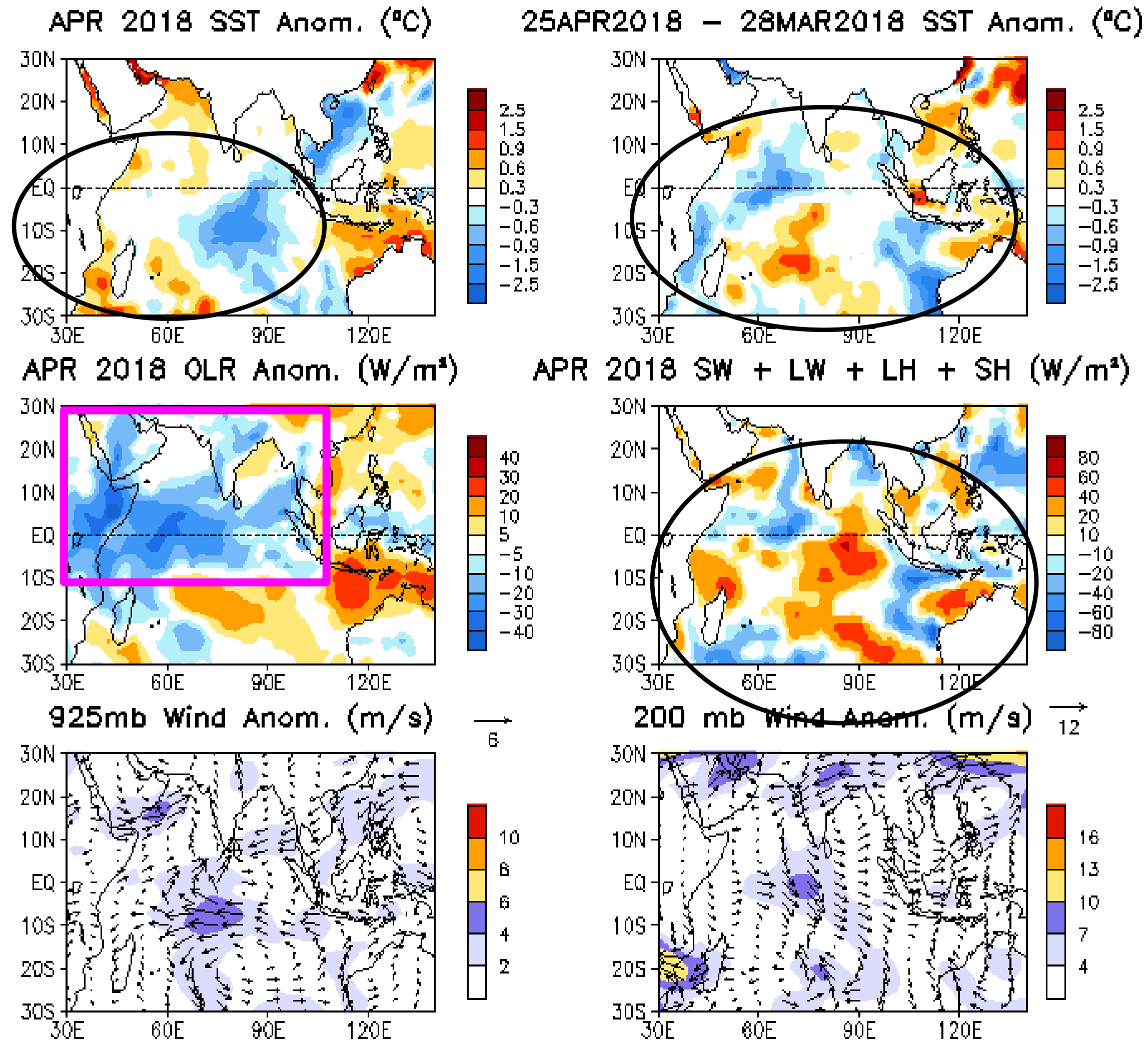
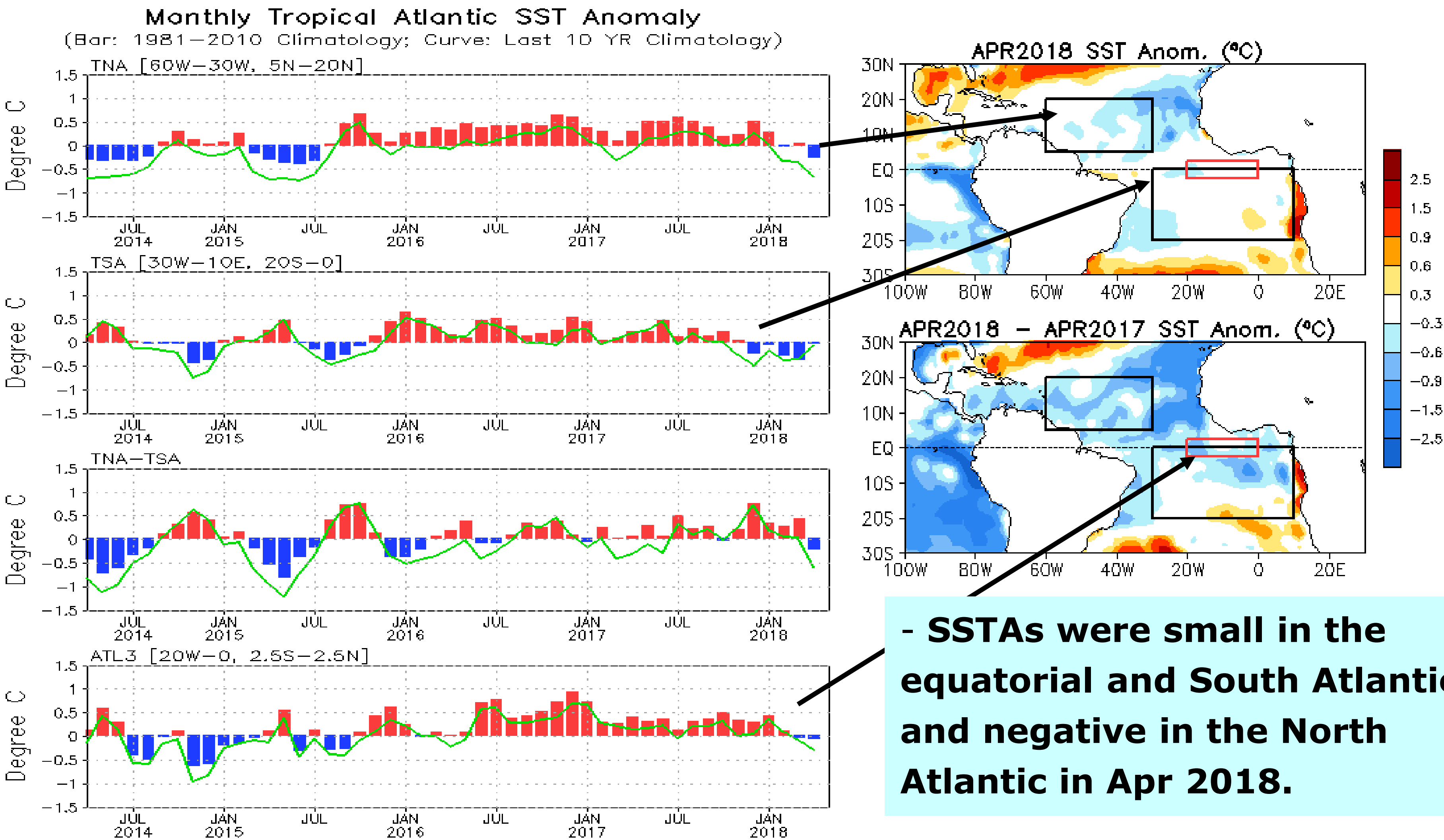


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

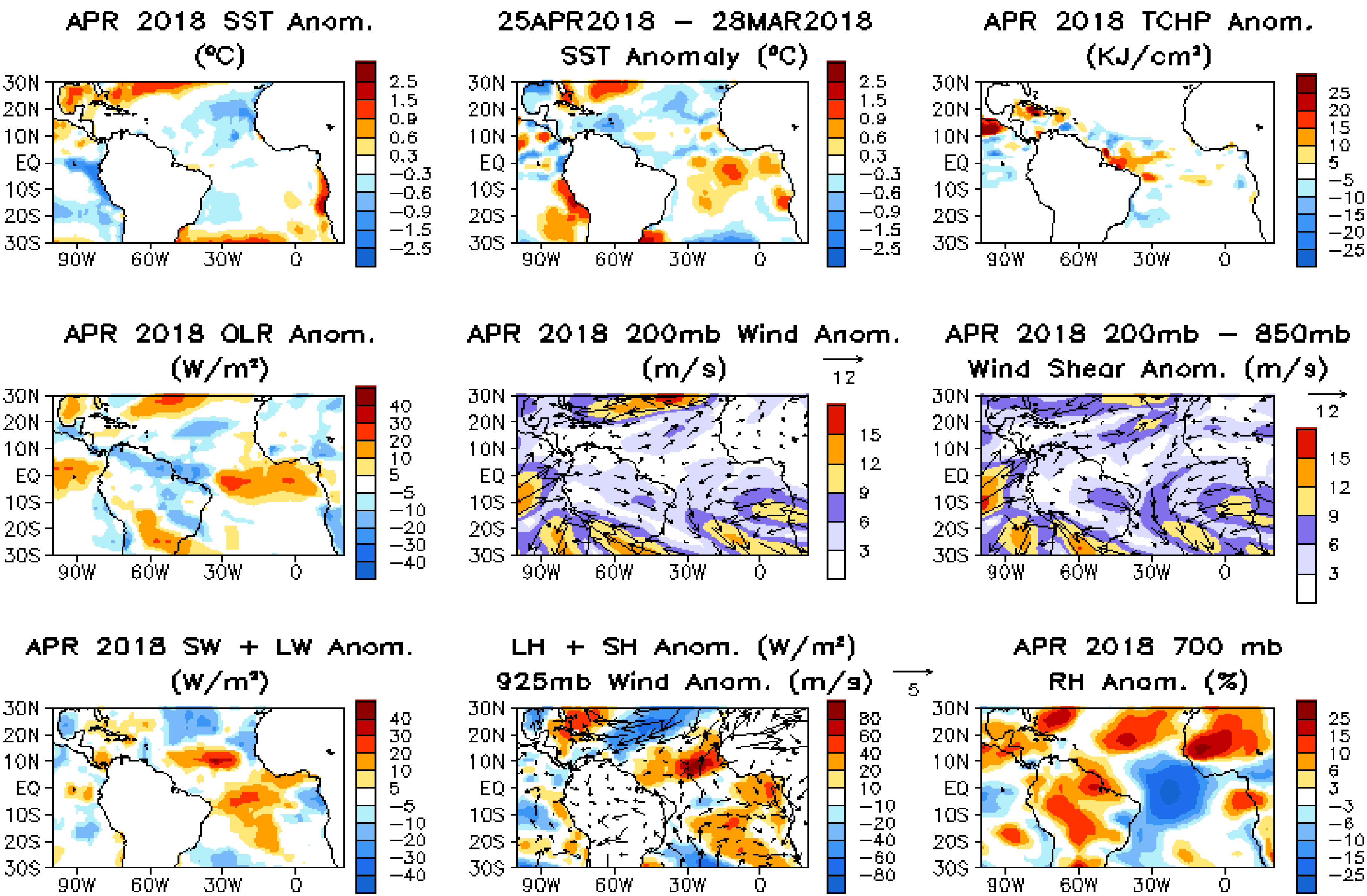
Evolution of Tropical Atlantic SST Indices



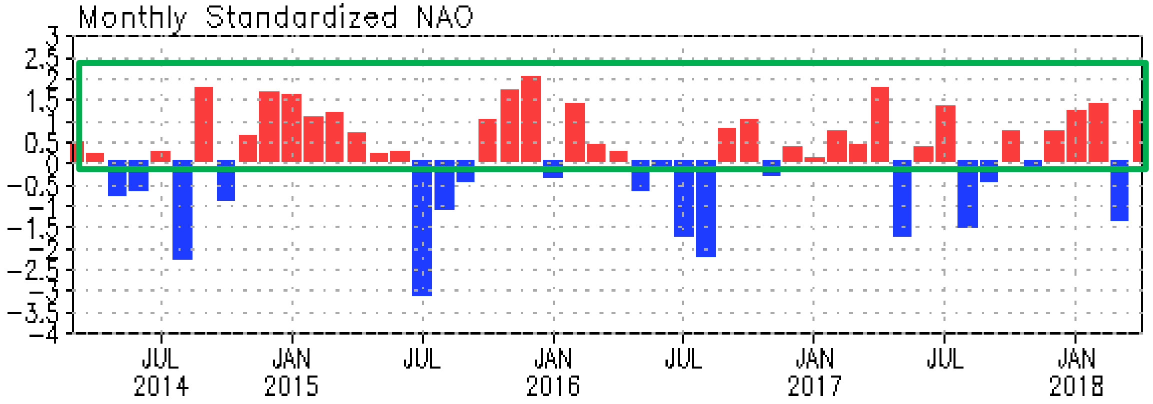
- SSTAs were small in the equatorial and South Atlantic and negative in the North Atlantic in Apr 2018.

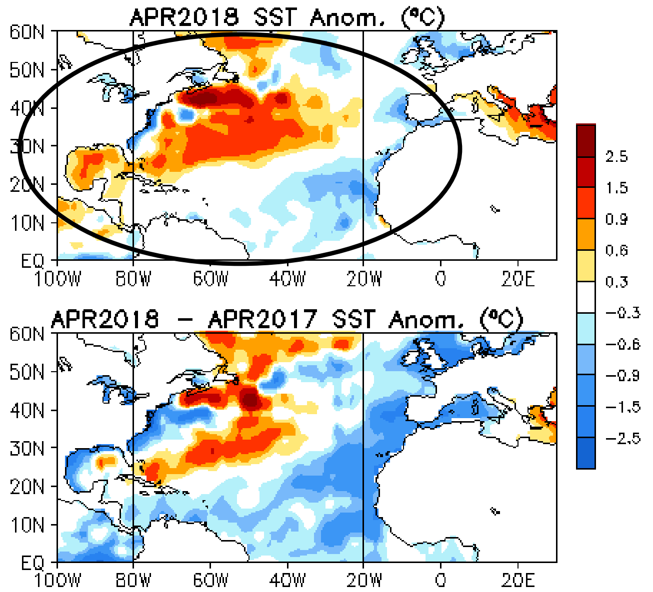
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (ºC) for the TNA [60ºW-30ºW, 5ºN-20ºN], TSA [30ºW-10ºE, 20ºS-0] and ATL3 [20ºW-0, 2.5ºS-2.5ºN] regions, and Meridional Gradient Index, defined as differences between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

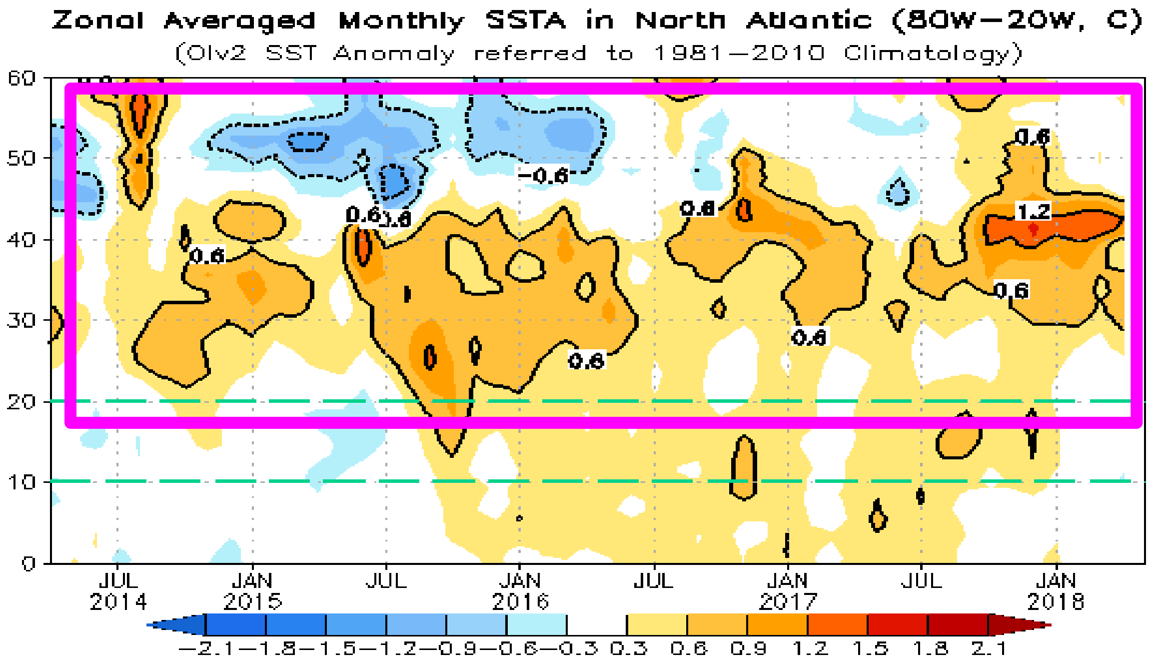
Tropical Atlantic:



NAO and SST Anomaly in North Atlantic







- NAO switched to positive phase with NAOI= 1.2 in Apr 2018.

- SSTA was a tripole/horseshoe –like pattern with positive in the mid- latitudes and negative in lower and higher latitudes.

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.

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

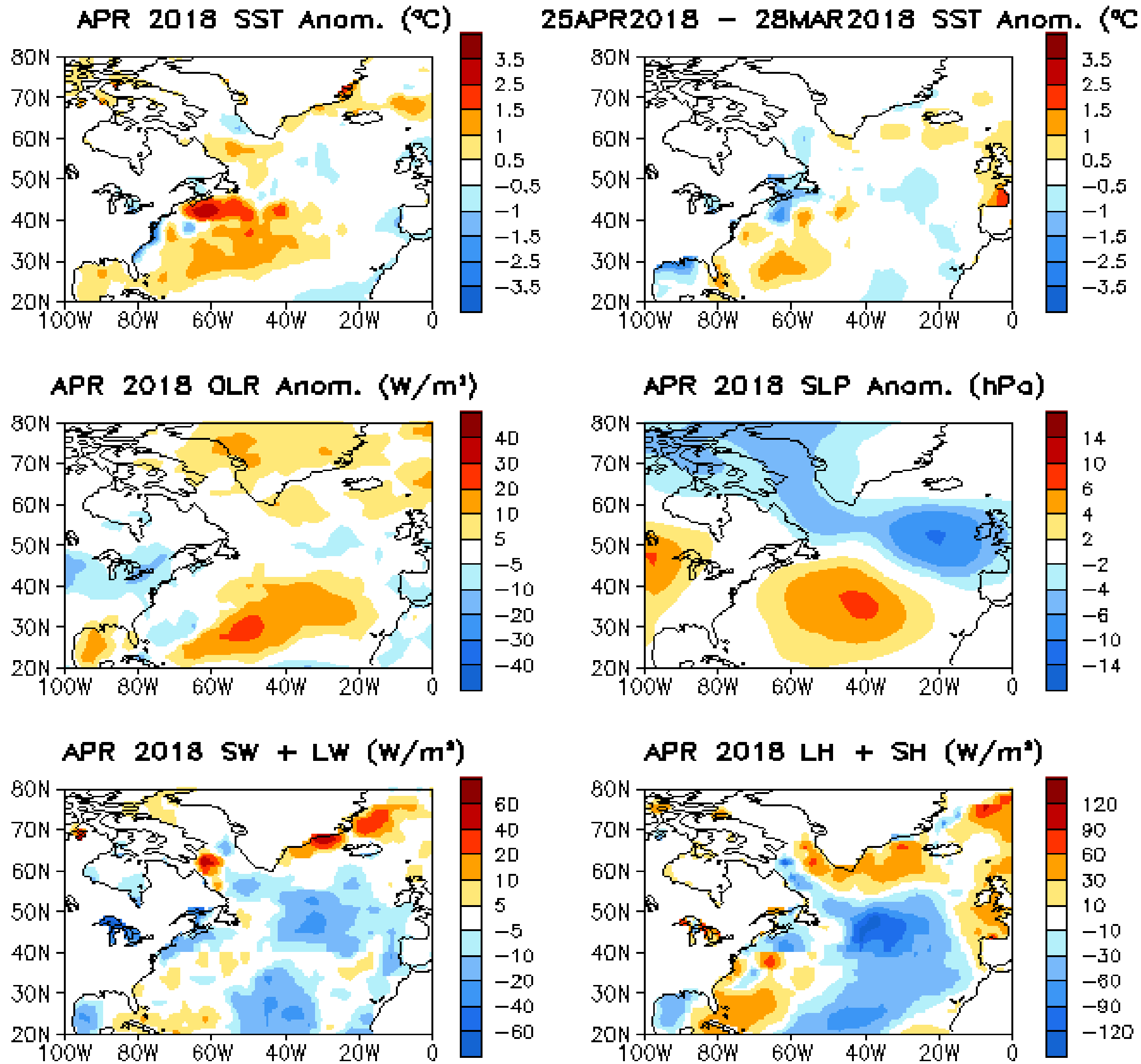


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

issued by

CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society
10 May 2018

ENSO Alert System Status: Final La Niña Advisory

Synopsis: ENSO-neutral is favored through September-November 2018, with the possibility of El Niño nearing 50% by Northern Hemisphere winter 2018-19.

During April 2018, the tropical Pacific returned to ENSO-neutral, as indicated by mostly near-to- below average sea surface temperatures (SSTs) along the equator (Fig. 1). The latest weekly Niño indices were near zero in all regions (between +0.2°C and -0.3°C), except for Niño-1+2, which remained negative (-0.6°C; Fig. 2). Subsurface temperature anomalies (averaged across 180°-100°W) remained positive (Fig. 3), due to the continued influence of a downwelling oceanic Kelvin wave (Fig. 4). Atmospheric indictors related to La Niña also continued to fade. While convection remained suppressed near and east of the Date Line, rainfall near Indonesia was also below average during the month (Fig. 5). Low-level winds were near average over most of the tropical Pacific Ocean, and upper-level winds were anomalous westerly over the eastern Pacific. Overall, the ocean and atmosphere system reflected a return to ENSO-neutral.

The majority of models in the IRI/CPC plume predict ENSO-neutral to continue at least through the Northern Hemisphere summer 2018 (Fig. 6). As the fall and winter approaches, many models indicate an increasing chance for El Niño. Therefore, the forecaster consensus hedges in the direction of El Niño as the winter approaches, but given the considerable uncertainty in ENSO forecasts made at this time of year, the probabilities for El Niño are below 50%. In summary, ENSO-neutral is favored through September-November 2018, with the possibility of El Niño nearing 50% by Northern Hemisphere winter 2018-19 (click CPC/IRI consensus forecast for the chance of each outcome for each 3-month period).

This discussion is a consolidated effort of the National Oceanic and Atmospheric Administration (NOAA), NOAA's National Weather Service, and their funded institutions. Oceanic and atmospheric conditions are updated weekly on the Climate Prediction Center web site (El Niño/La Niña Current Conditions and Expert Discussions). Forecasts are also updated monthly in the Forecast Forum of CPC's Climate Diagnostics Bulletin. Additional perspectives and analysis are also available in an ENSO blog. The next ENSO Diagnostics Discussion is scheduled for 14 June 2018. To receive an e-mail notification when the monthly ENSO Diagnostic Discussions are released, please send an e-mail message to: ncep.list.enso-update@noaa.gov.

Climate Prediction Center
National Centers for Environmental Prediction
NOAA/National Weather Service
College Park, MD 20740

NOAA/NCEP/CPC issued La Niña Watch on 14 September 2017

NOAA/NCEP/CPC issued La Niña Advisory on 9 November 2017

On 10 May 2018, NOAA/NCEP/CPC issued Final La Niña Advisory. **“ENSO-neutral is favored through September-November 2018, with the possibility of El Niño nearing 50% by Northern Hemisphere winter 2018-19.”**

NOAA/NCEP/CPC issued La Niña Watch on 14 September 2017

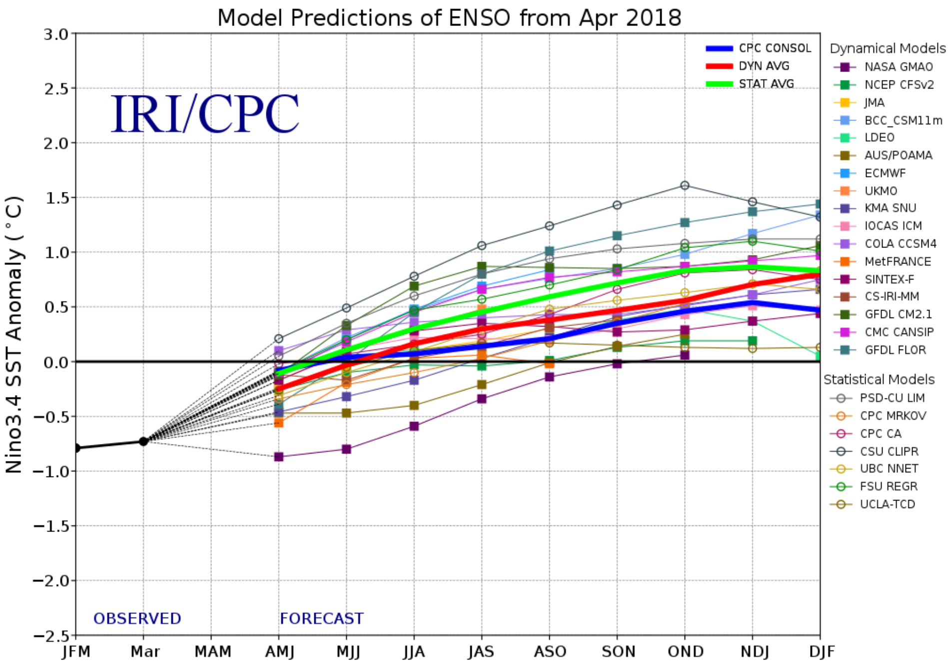
NOAA/NCEP/CPC issued La Niña Advisory on 9 November 2017

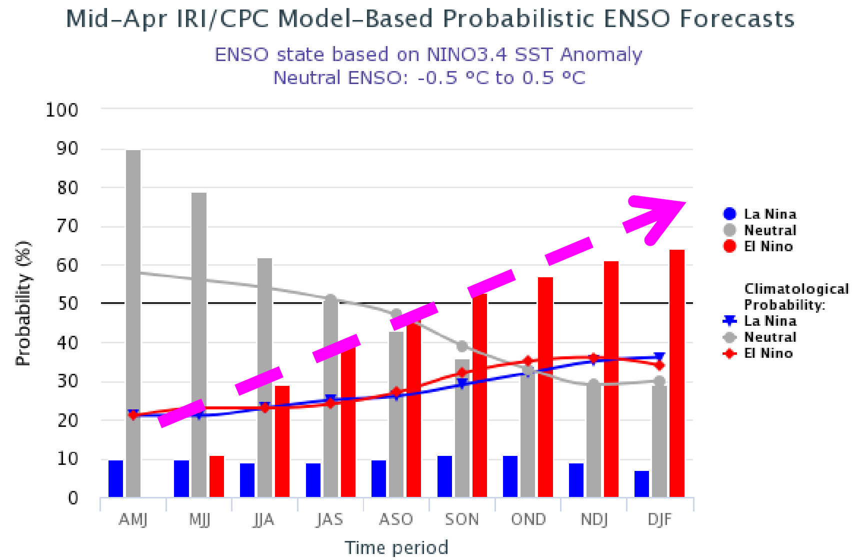
NOAA/NCEP/CPC issued last La Niña Advisory on 10 May 2018

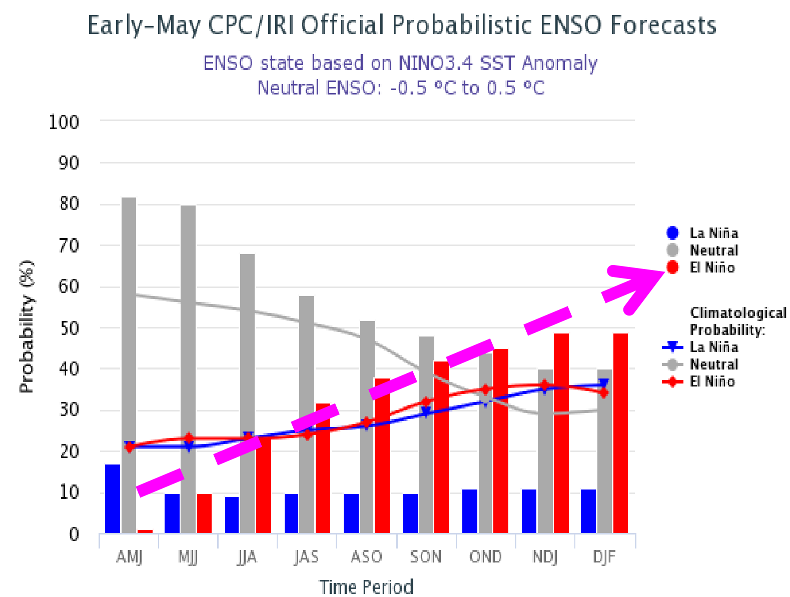
Season (Nino3.4)	SON17	OND17	NDJ17/18	DJF17/18	JFM18	FMA18
ERSSTv5	**-0.7**	**-0.9**	**-1.0**	**-0.9**	**-0.8**	**-0.6**
OIv2	**-0.6**	**-0.7**	**-0.8**	**-0.8**	**-0.8**	**-0.6**

A threshold of +/- 0.5°C for the Oceanic Niño Index (ONI) [3 month running mean of ERSST.v5 SST anomalies in the Niño 3.4 region (5°N-5°S, 120°-170°W)] is met for a minimum of 5 consecutive over-lapping seasons, based on centered 30-year base periods updated every 5 years.

IRI NINO3.4 Forecast Plum



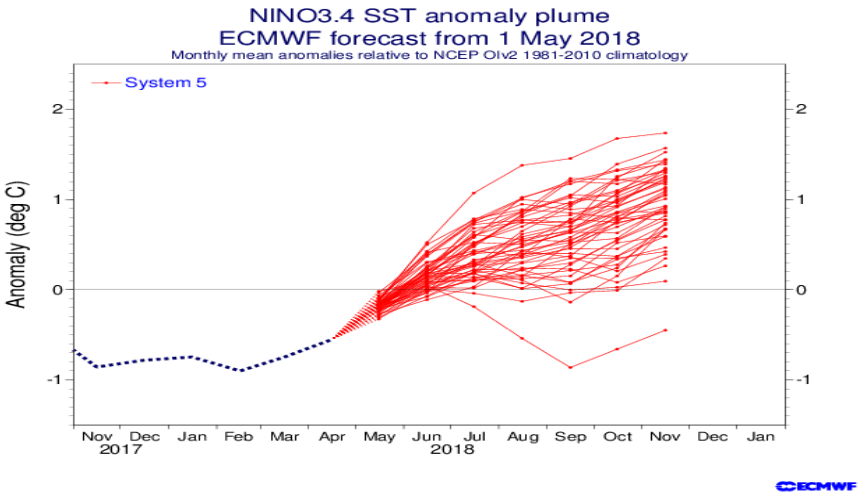




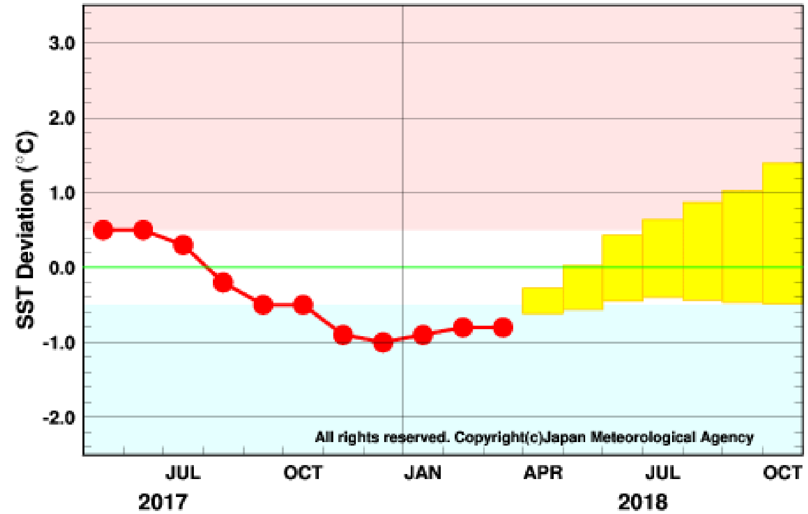
- **Majority of models predict ENSO-neutral or El Nino in 2018.**
- **NOAA "ENSO Diagnostic Discussion" on 10 May 2018 issued "Final La Niña Advisory" and indicated "ENSO-neutral is favored through September-November 2018, with the possibility of El Niño nearing 50% by Northern Hemisphere winter 2018-19."**

Individual Model Forecasts: neutral or El Nino

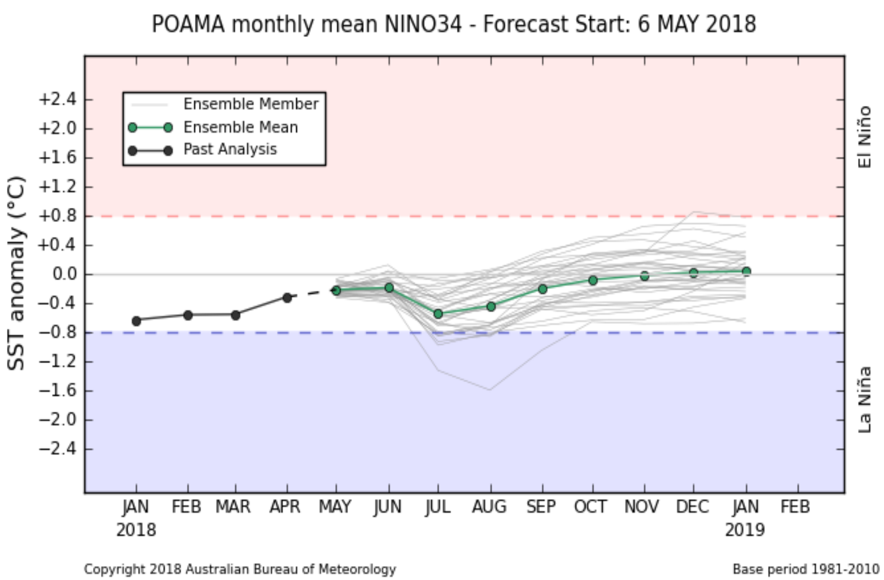
EC: Nino3.4, IC=01May2018



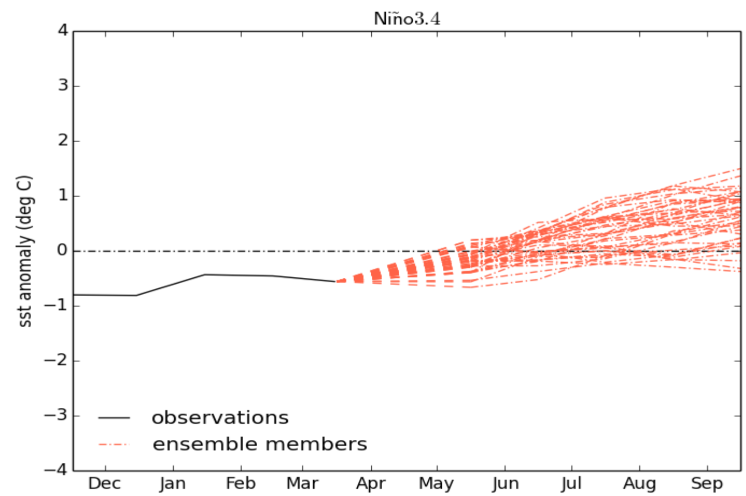
JMA: Nino3, IC/updated = 10 Apr 2018

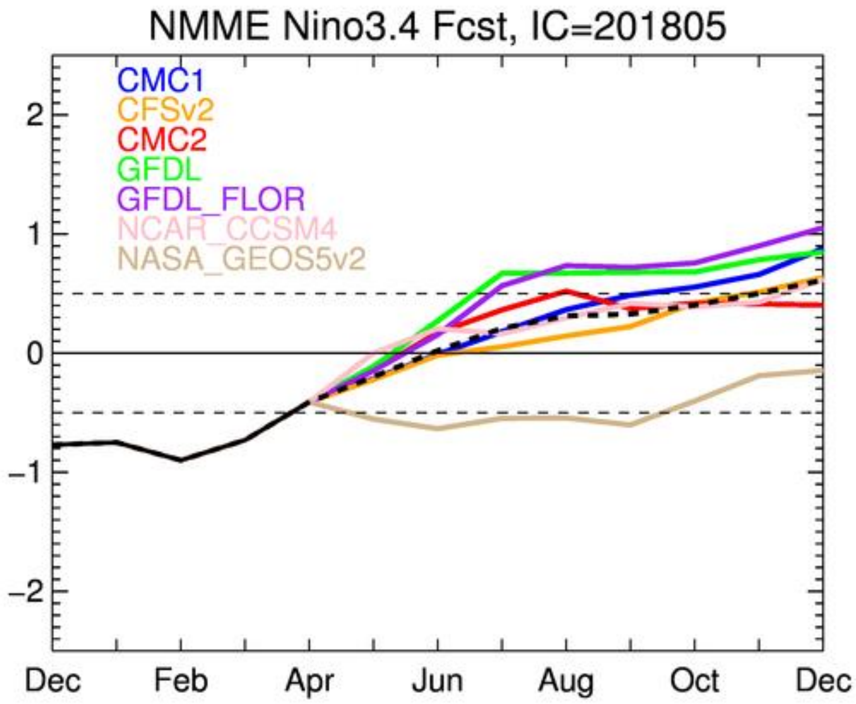


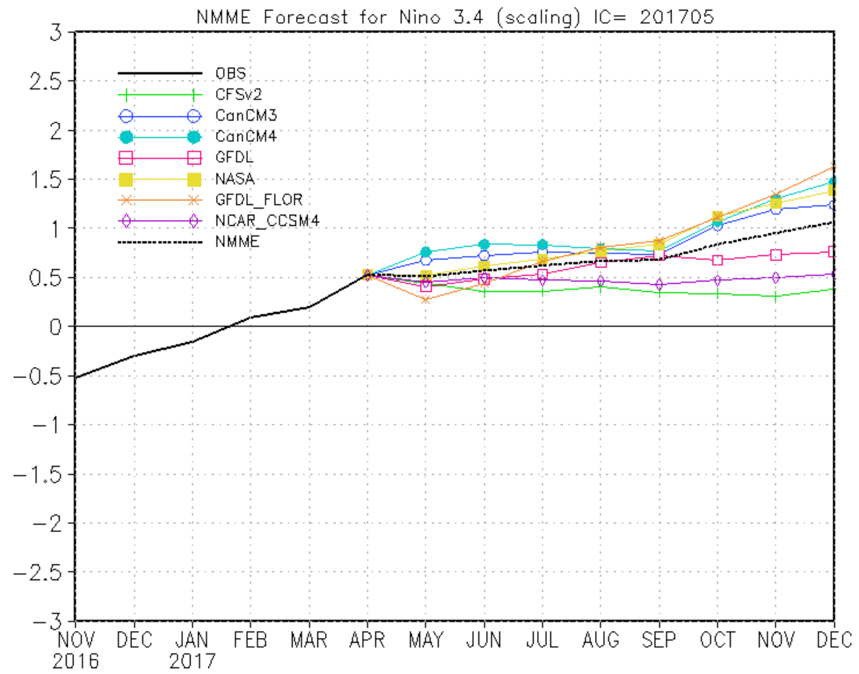
Australia: Nino3.4, IC=6 May 2018



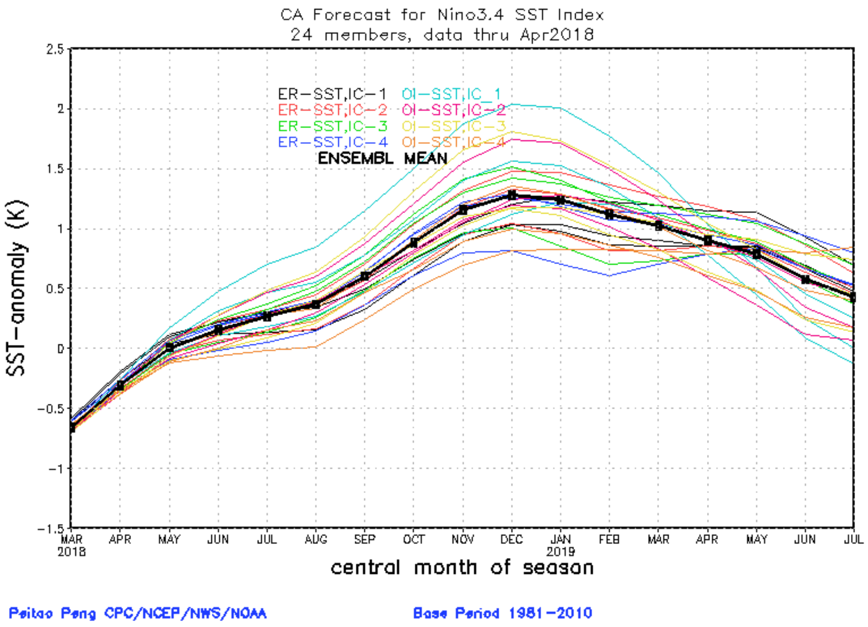
UKMO: Nino3.4, IC=Apr 2018



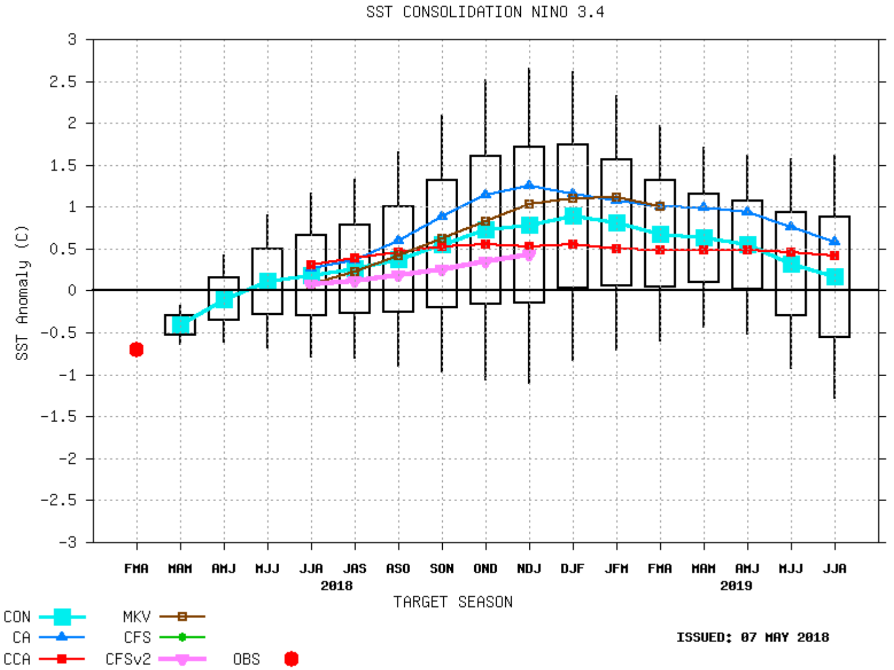

NMME Nino3.4 Fcst, IC=201805
CMC1
CFSv2
CMC2
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2
2
1
0
−1
−2
Dec
Feb
Apr
Jun
Aug
Oct
Dec


NMME Forecast for Nino 3.4 (scaling) IC= 201705
OBS
CFSv2
CanCM3
CanCM4
GFDL
NASA
GFDL_FLOR
NCAR_CCSM4
NMME
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
−3
NOV 2016
DEC
JAN 2017
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

CA with ICs through April 2018: El Nino (Peitao.Peng@noaa.gov)

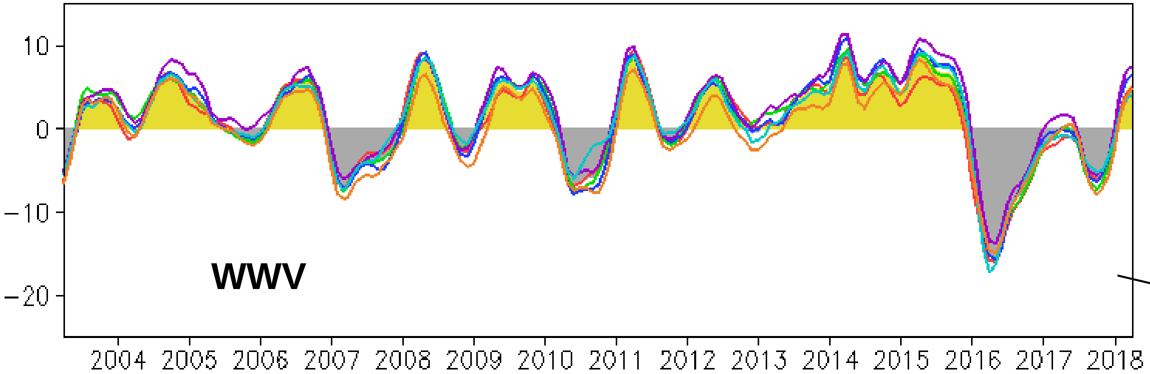


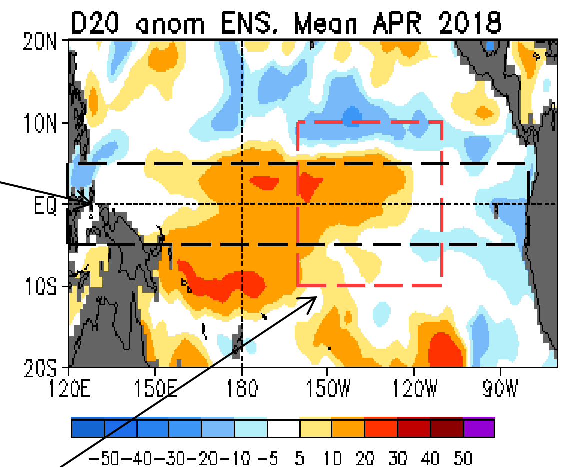
CPC CON (CA, CCA, MKV, CFSv2)

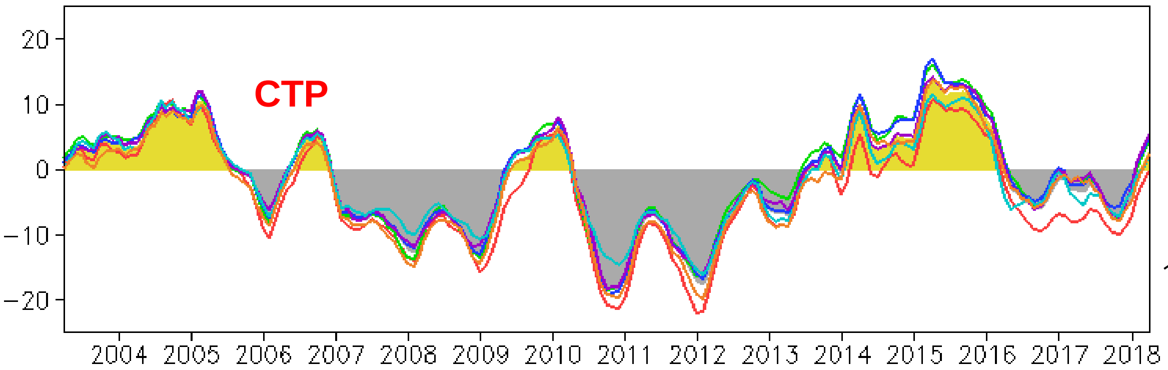


Two ENSO Precursors Based on Thermocline Anomaly

Ensemble Mean: NCEP JMA ECMWF GFDL NASA BOM







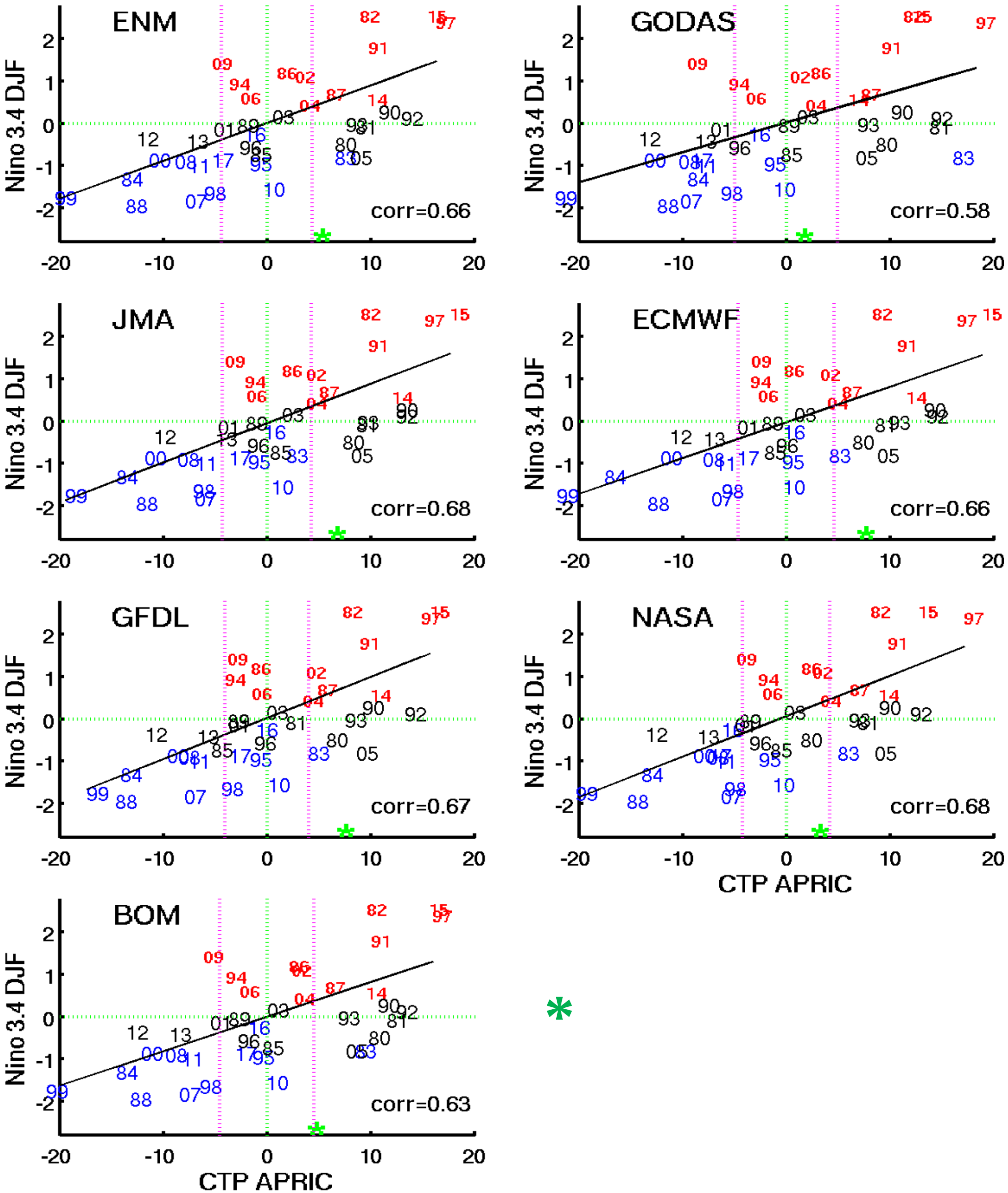
-Warm Water Volume (WWV) index is defined as average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN]. It is inferred from the slow ocean adjustment via zonal mean heat content exchange between the equatorial and off-equatorial regions.

- 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

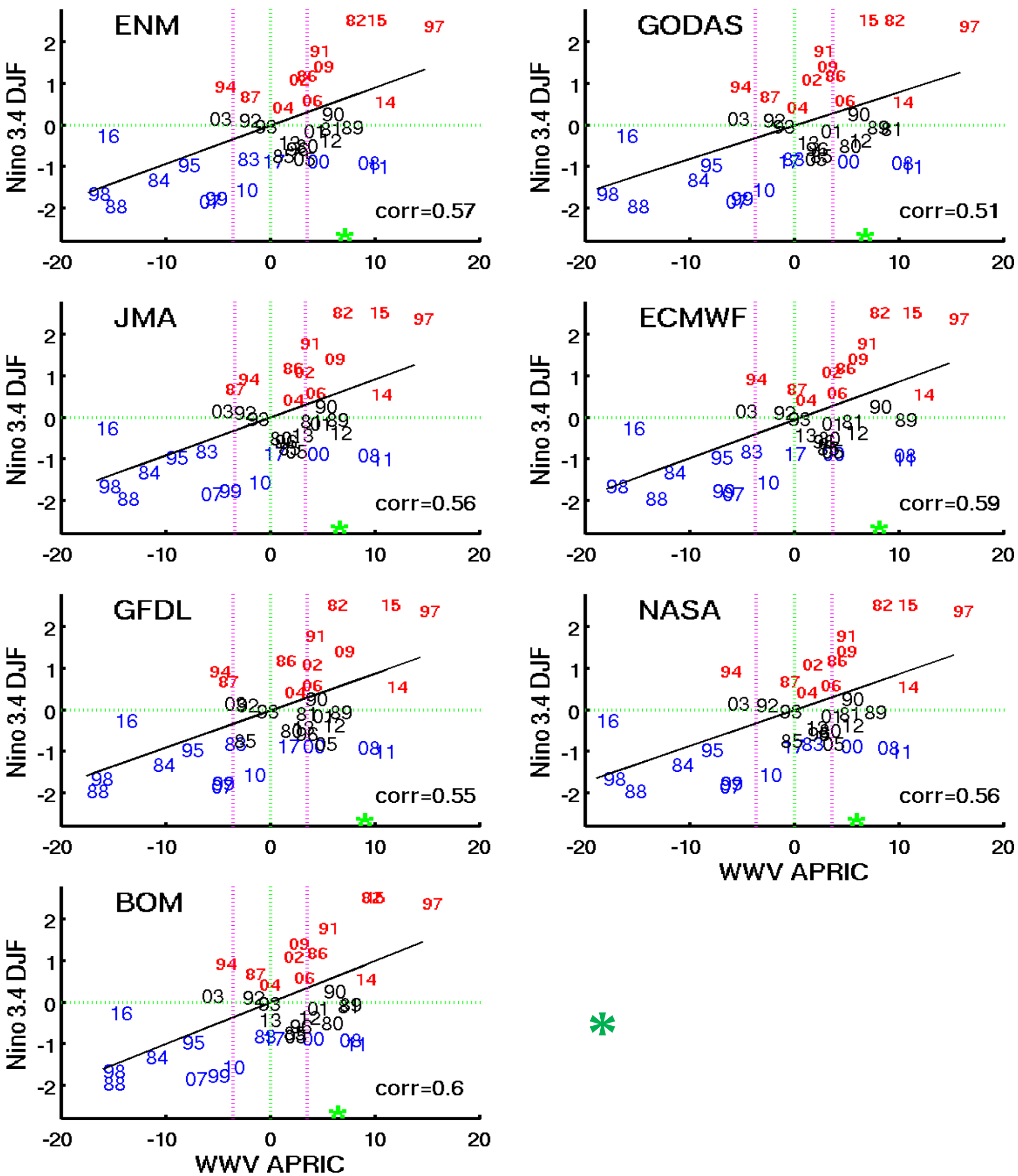
CTP(April).VS. Nino34 (DJF)



2x2 contingency table El Nino Case (1980-2017)	April
Percent Correct rate	0.7 (25/38)
Hit rate	0.5 (6/12)
False Alarm rate	0.5 (7/13)

Except for GODAS and NASA, CTP indices in Apr 2018 from the ensemble mean and other ocean reanalysis prefer El Nino condition in the coming Northern Hemispheric winter.

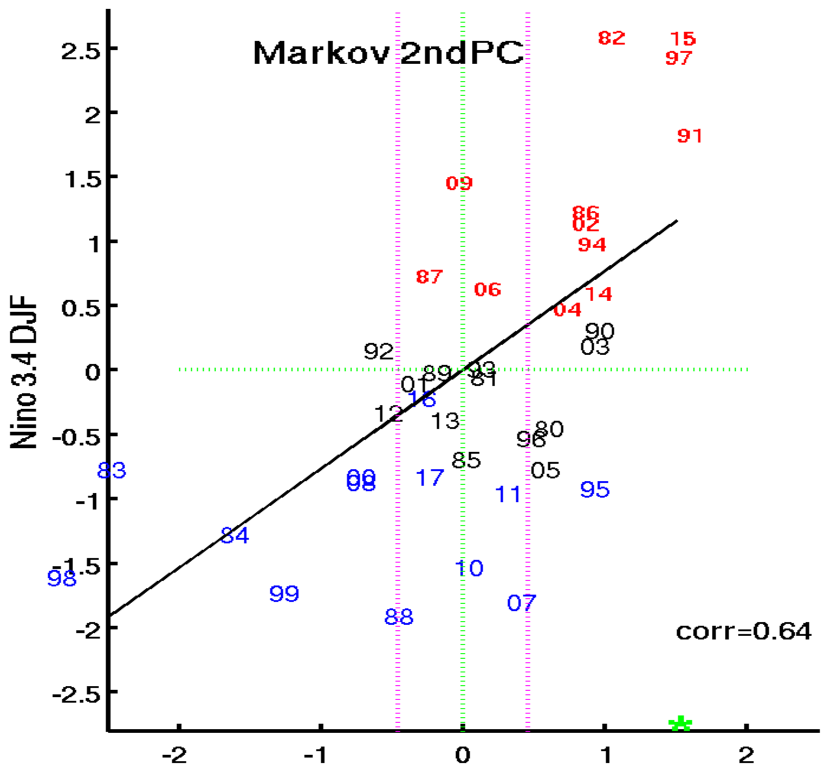
WWV(April).VS. Nino34 (DJF)



2x2 contingency table El Nino Case (1980-2017)	April
Percent Correct rate	0.7 (26/38)
Hit rate	0.5 (6/12)
False Alarm rate	0.5 (6/12)

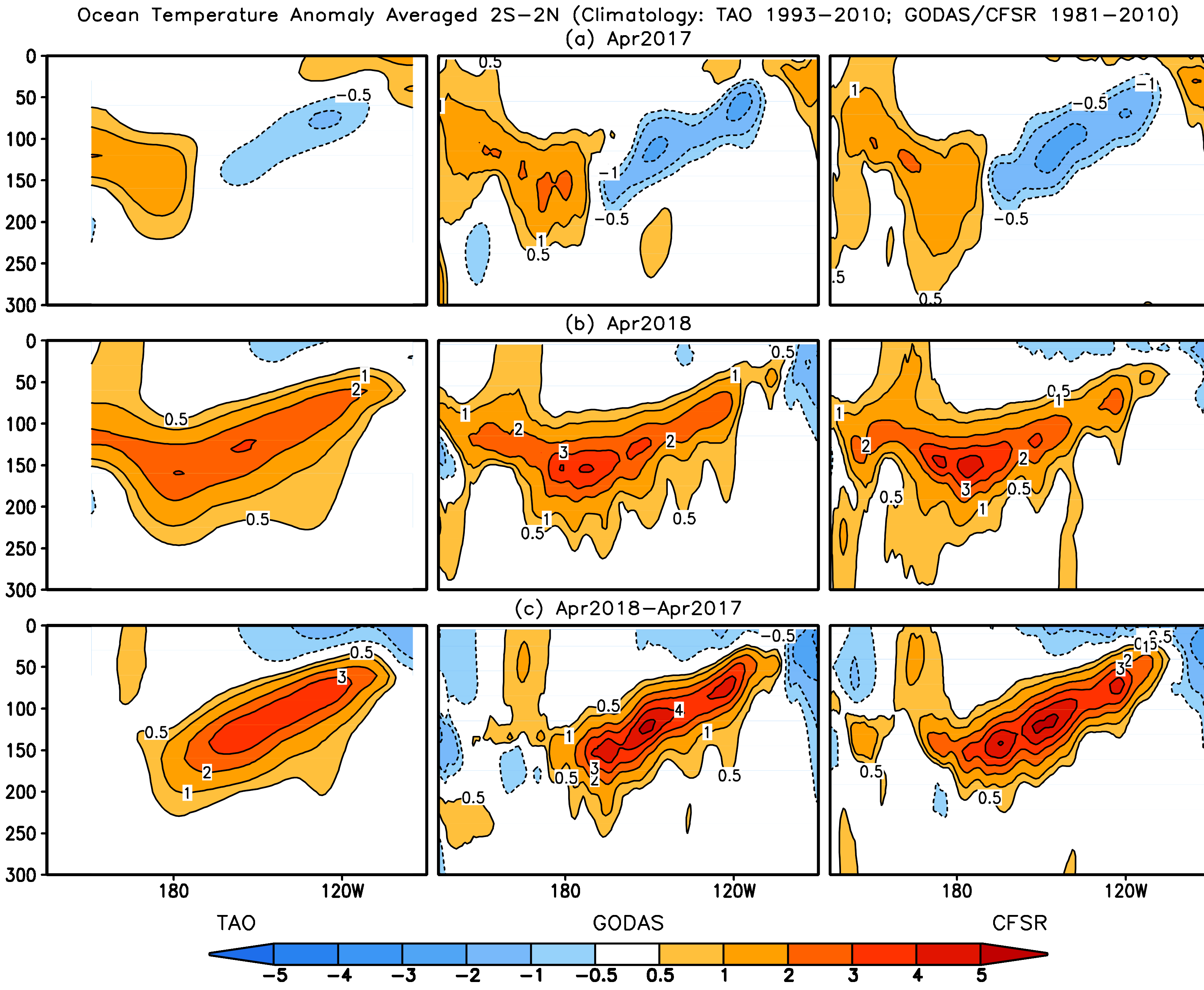
All WWV indices in Apr 2018 favor El Nino condition in the coming Northern Hemispheric winter.

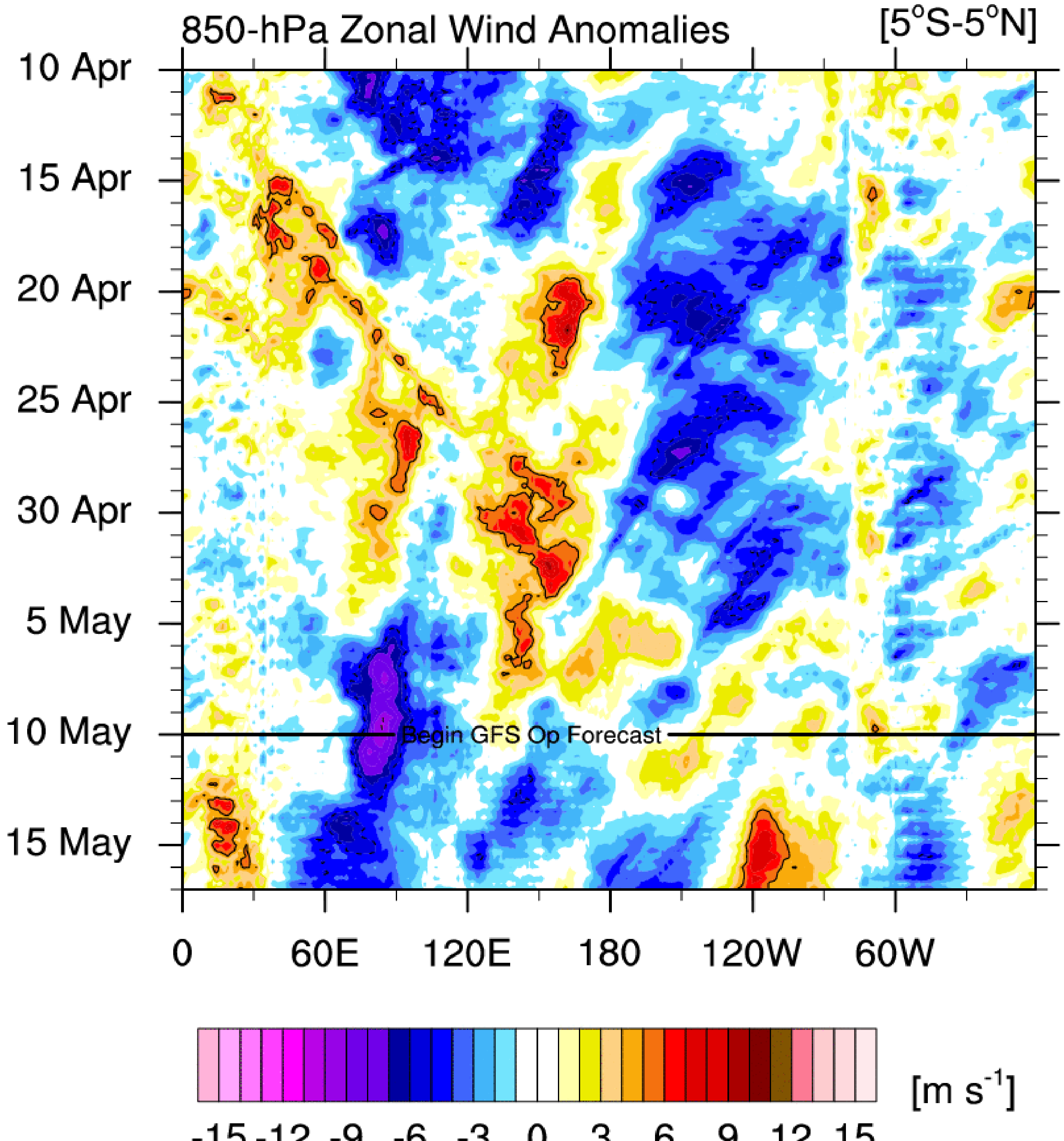
Markv(April).VS. Nino34 (DJF)



* Markv 2nd PC in Apr 2018

2x2 contingency table El Nino Case (1980-2017)	April
Percent Correct rate	0.8 (30/38)
Hit rate	0.75 (9/12)
False Alarm rate	0.4 (5/14)

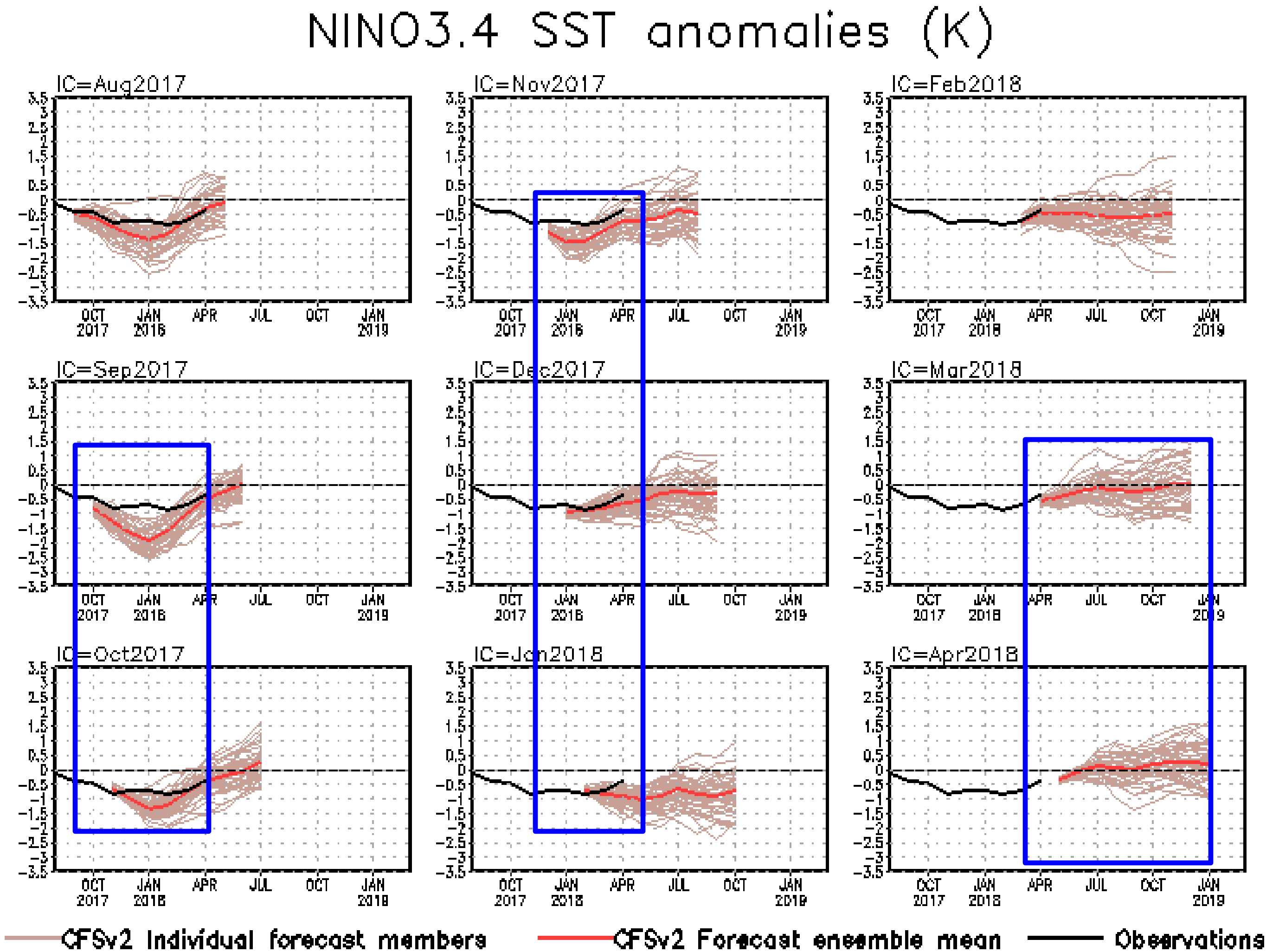

Ocean Temperature Anomaly Averaged 2S–2N (Climatology: TAO 1993–2010; GODAS/CFSR 1981–2010)
(a) Apr2017
(b) Apr2018
(c) Apr2018–Apr2017
0
50
100
150
200
250
300
180
120W
TAO
GODAS
CFSR
−5
−4
−3
−2
−1
−0.5
0.5
1
2
3
4
5



From: http://www.atmos.albany.edu/student/ventrice/real_time/timeLon/u.anom.30.5S-5N.gif

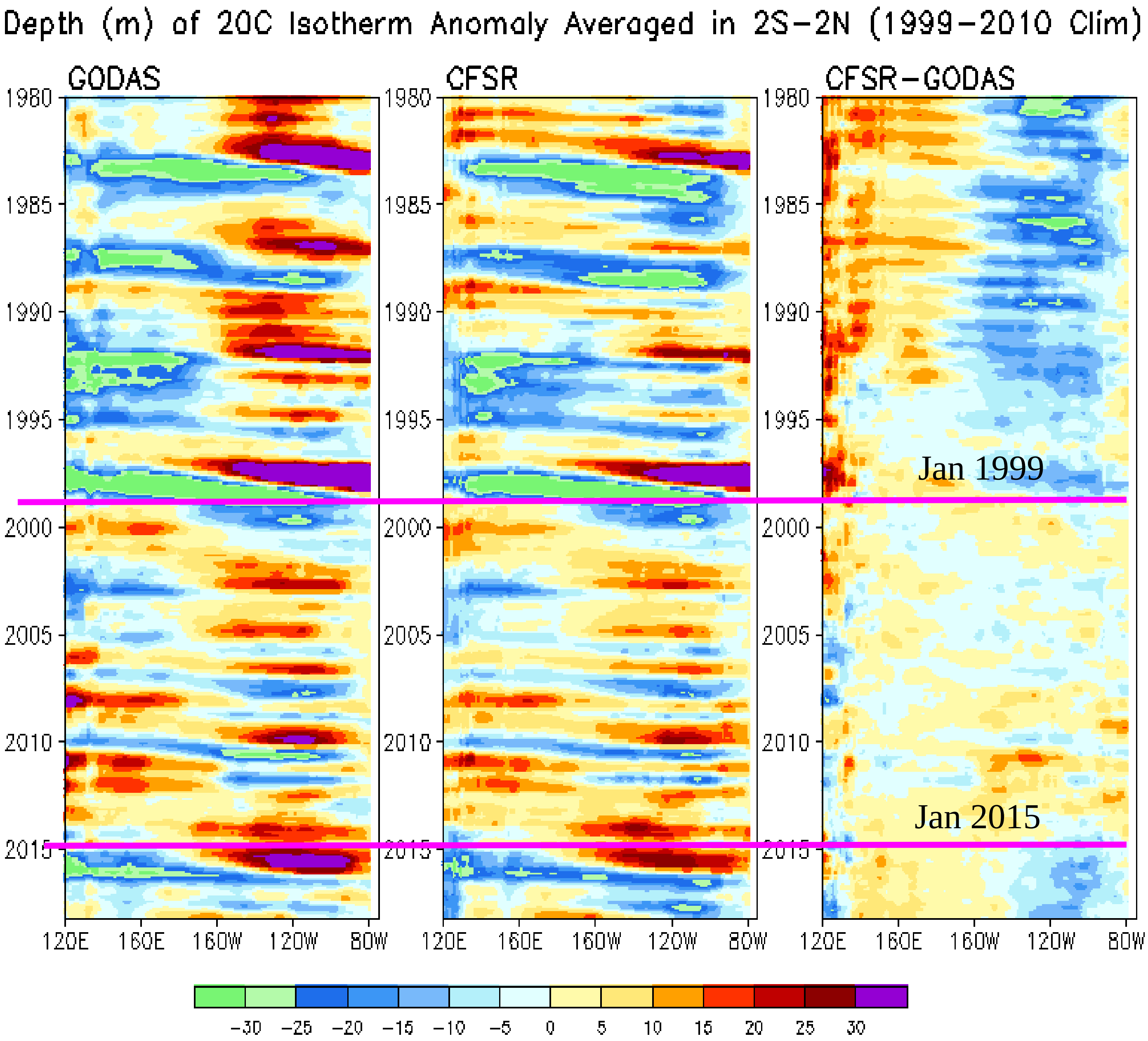
Biases in CFSR and the Possible Impact on ENSO Forecast

CFS Niño3.4 SST Predictions from Different Initial Months

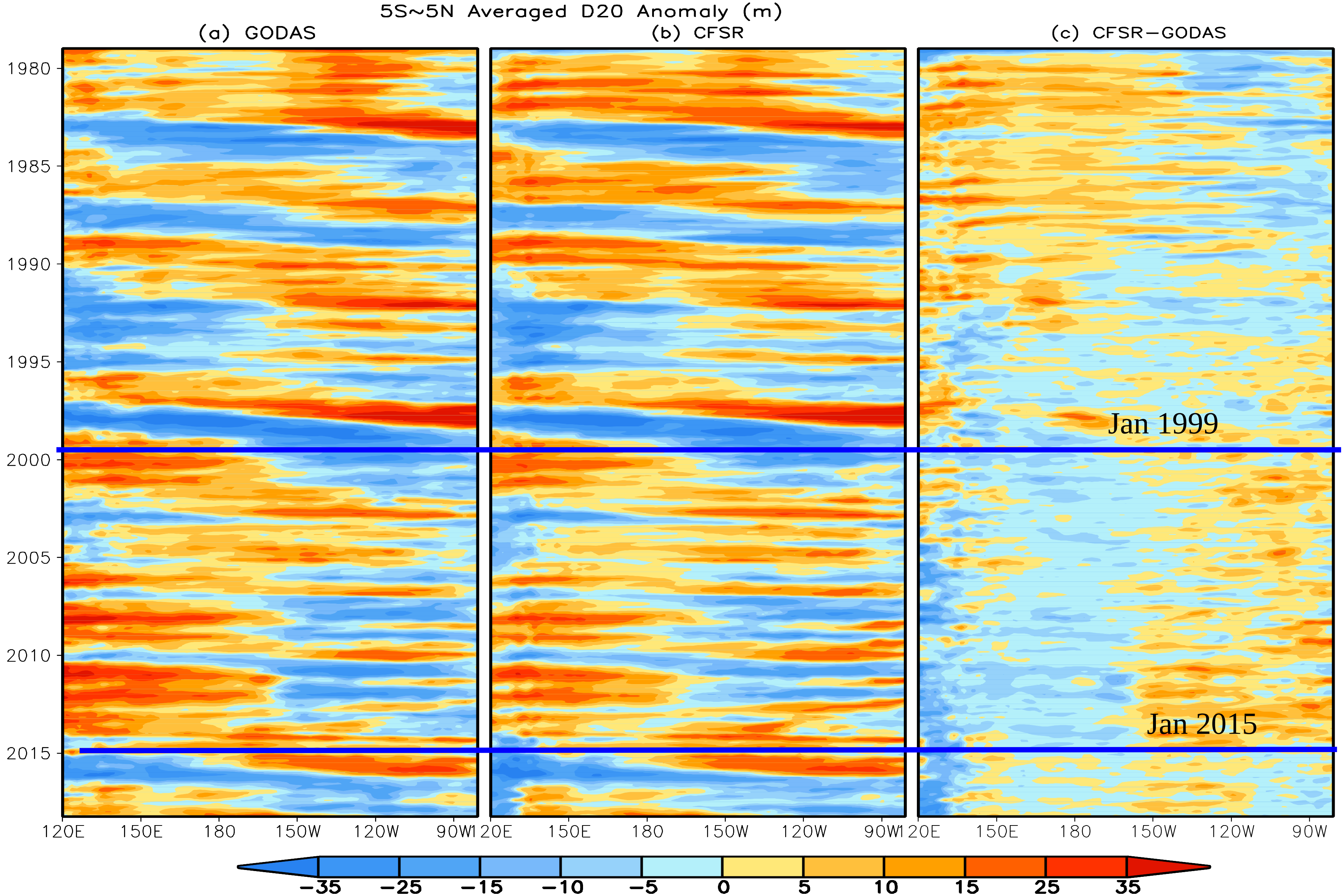


- Latest CFSv2 forecasts call for a ENSO-neutral during summer-autumn 2018.
- CFSv2 predictions had cold biases with ICs in Aug-Dec 2017 and Jan 2018.

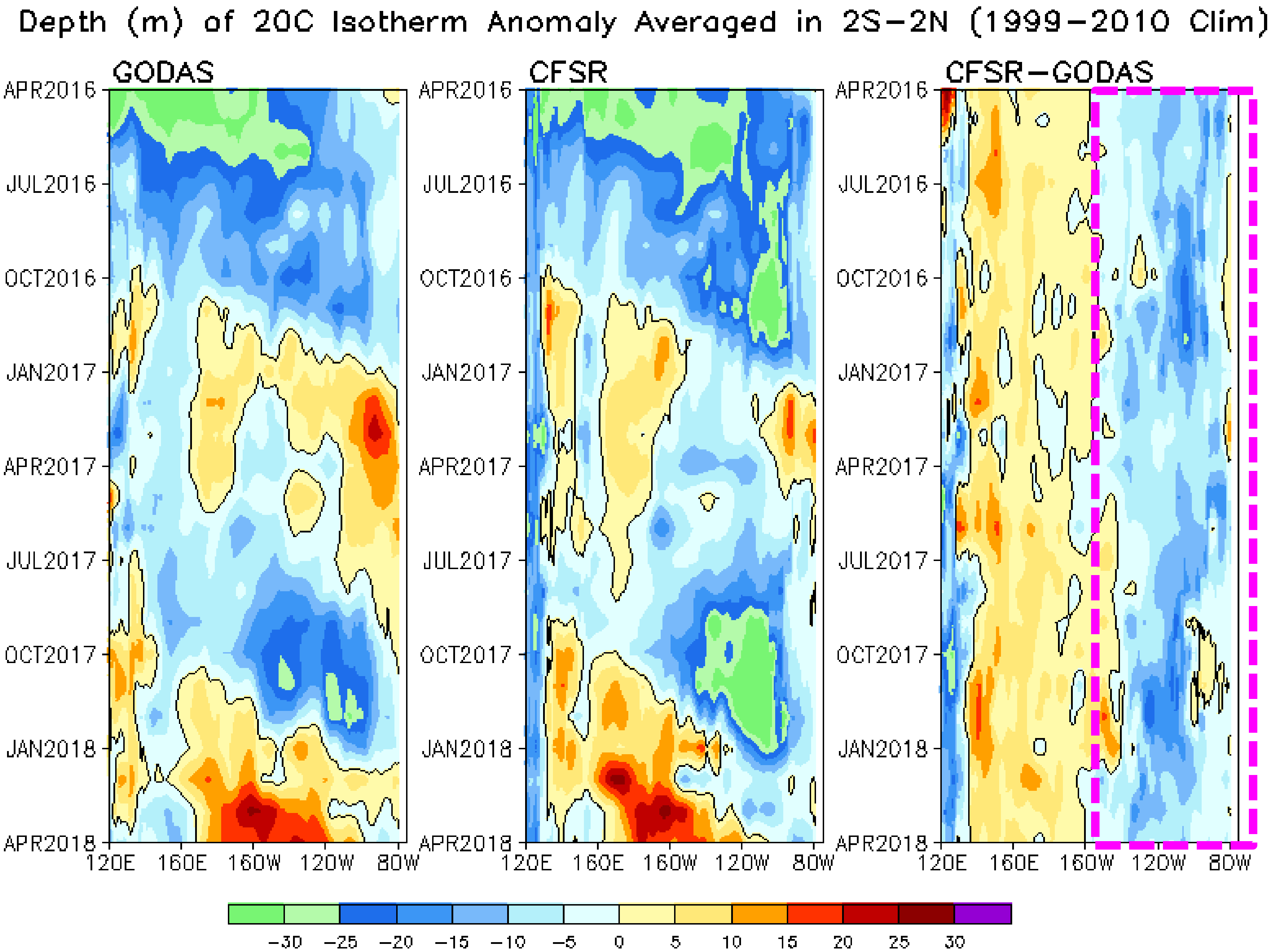
Fig. M1. CFS Nino3.4 SST prediction from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with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



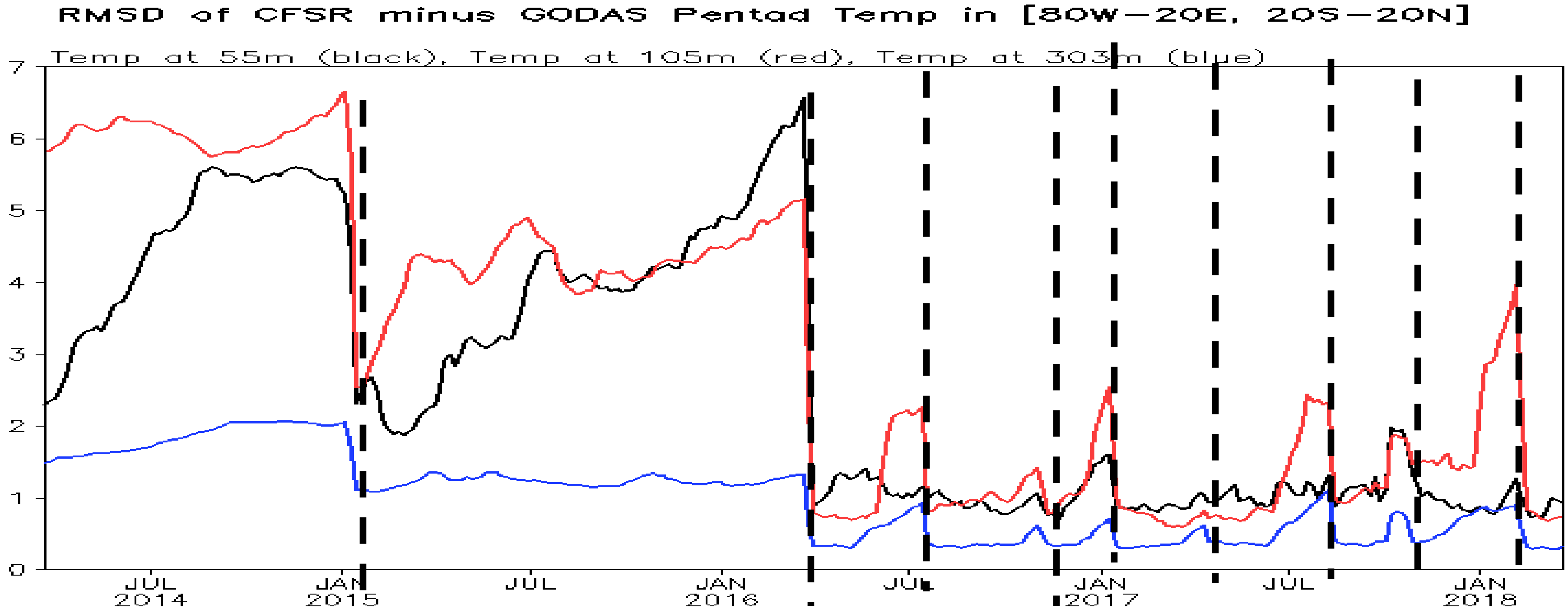
- **Based on the 1999-2010 climatology, the D20A of CFSR-GODAS reaches -10 m before 1999 and after 2015.**
- **The shift of the CFSR bias around 1999 was related to the shift of CFSR surface wind bias resulted from assimilation of ATOV satellite observations (Xue et al. 2011; Zhang et al. 2012).**
- **The shift of the CFSR bias around 2015 may be related to the reset of CFSR ocean conditions with a parallel GODAS run to control a cold bias growth in the tropical Atlantic ocean in CFSR (see slide 51).**



5S-5N Average D20 Anomalies; 1981-2010 climatology



Depth (m) of 20C Isotherm Anomaly Averaged in 2S-2N (1999-2010 Clim)
GODAS
CFSR
CFSR-GODAS
APR2016
JUL2016
OCT2016
JAN2017
APR2017
JUL2017
OCT2017
JAN2018
APR2018
120E
160E
160W
120W
80W
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30

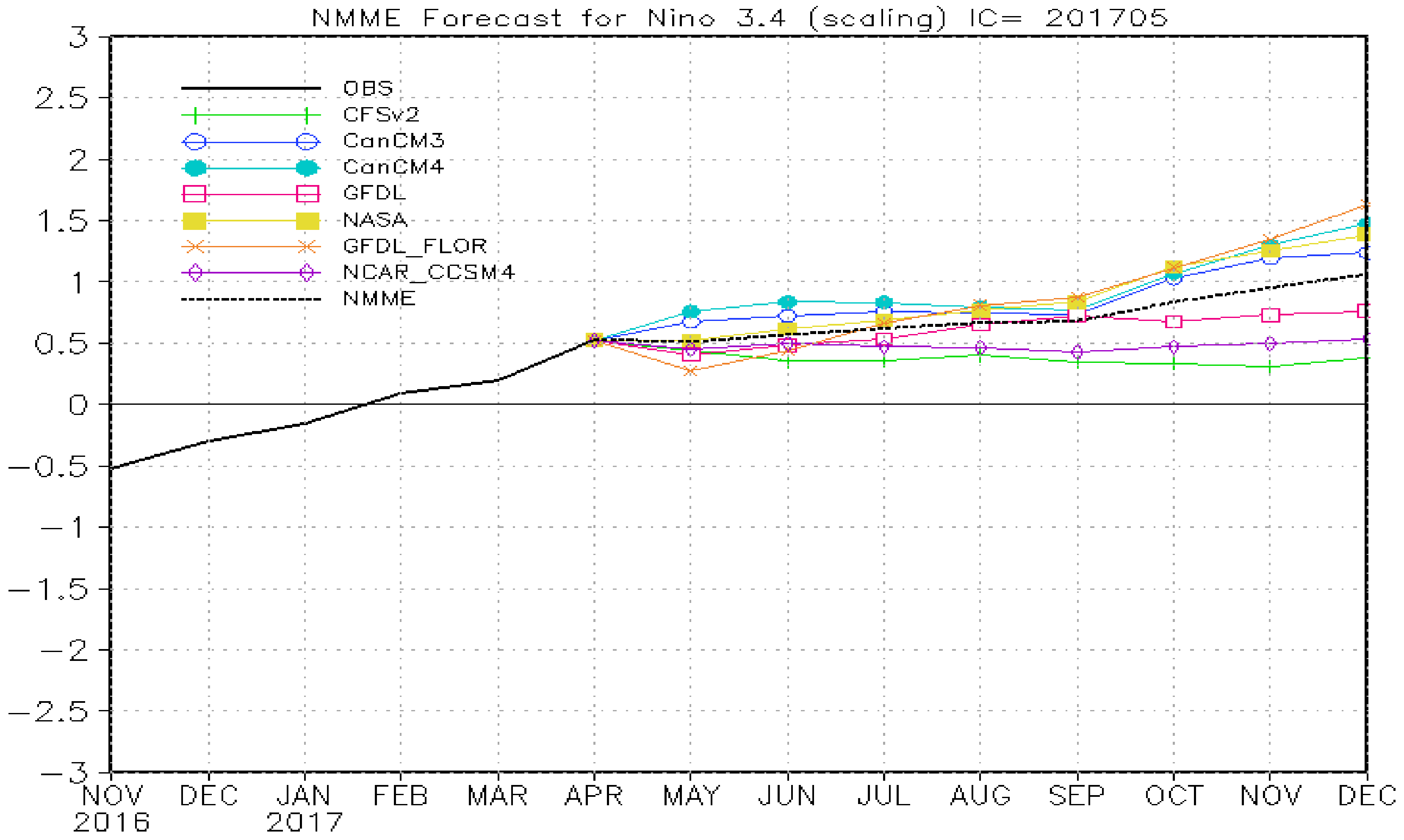


- A periodic reset of the CFSR ocean with the parallel GODAS run is used to remove the cold bias in the tropical Atlantic, which is indicated as a fast growth of RMSD between CFSR and GODAS. The cold biases were largest in 2014 and 2015.

- The dates of the resets can be identified as the time when the RMSD rapidly decreased **(2015: Jan) (2016: Mar, Jul, Nov) (2017: Jan, 18Apr, Aug, Oct) (2018: Feb)**

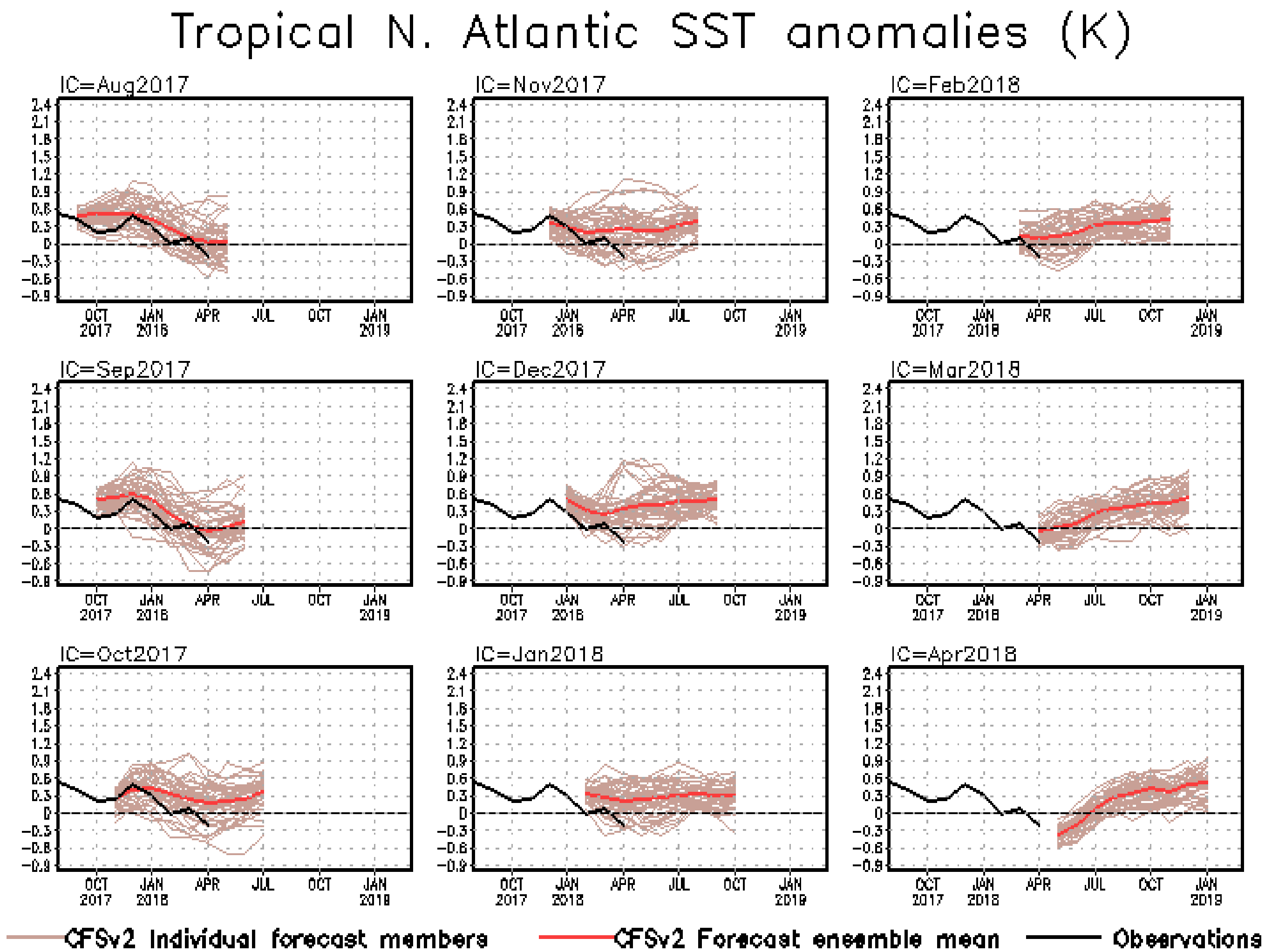
- There were cold biases in D20 anomaly in MDR in Mar-Apr 2015, 2016, 2017, which might contributed to the cold biases in the summer MDR SST forecast.

Emily Becker: "**CFSv2 and CCSM4 both respond to the CFSR re-re-adjustment with flat forecasts, while GEOS5, FLOR, and CanCM3&4 are sticking with weak-moderate El Nino. The ensemble mean of both original and PDF-adjusted call for ONI about +1C, peaking in OND/NDJ. Overall, the probabilities are confident for El Nino, but the magnitude is pretty borderline**."



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

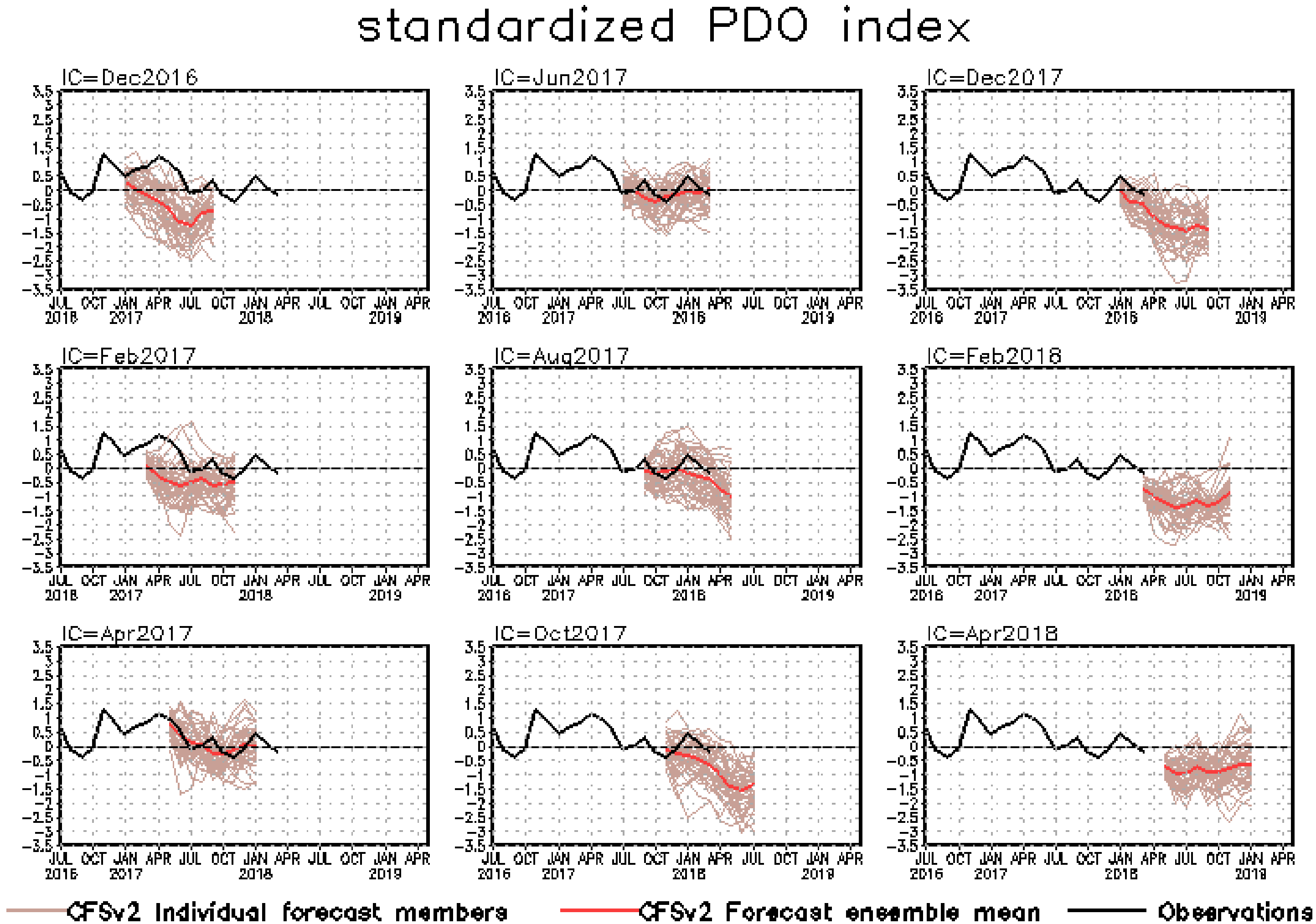
TNA is the SST anomaly averaged in the region of [60°W-30°W, 5°N-20°N].



- **Latest CFSv2 predictions call above normal SSTA in tropical N. Atlantic in summer-autumn 2018.**

Fig. M3. CFS Tropical North Atlantic (TNA) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1981-2010 base period means.

CFS Pacific Decadal Oscillation (PDO) Index Predictions from Different Initial Months



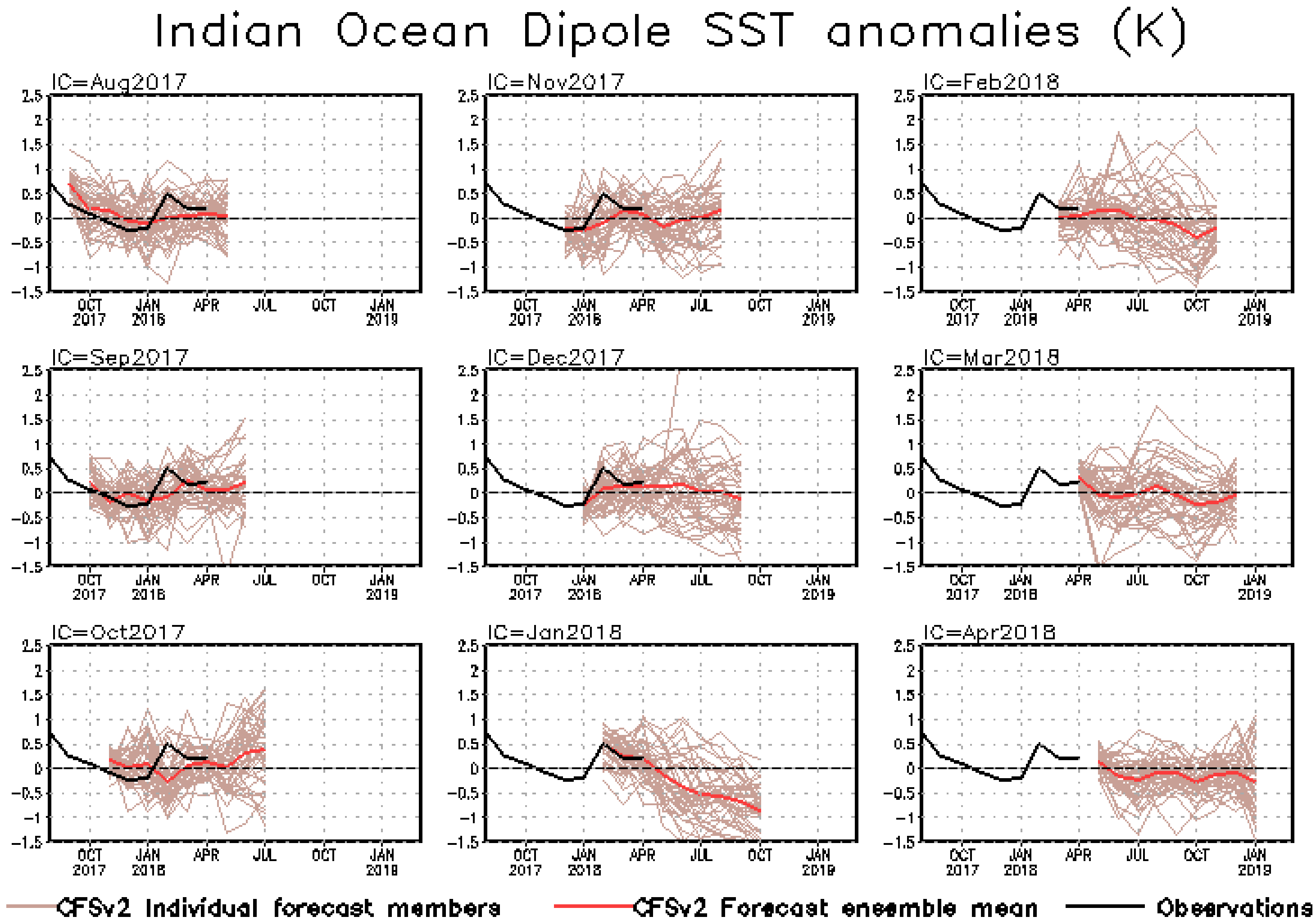
PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

CFS PDO index is the standardized projection of CFS SST forecast anomalies onto the PDO EOF pattern.

- CFSv2 predicts a negative phase of PDO in 2018.

Fig. M4. CFS Pacific Decadal Oscillation (PDO) index predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1981-2010 base period means.

NCEP CFS DMI SST Predictions from Different Initial Months



DMI = WTIO- SETIO

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

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

Fig. M2. CFS Dipole Model Index (DMI) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology for 1981-2006 was removed, and replaced by corresponding observation climatology for the same period. Anomalies were computed with respect to the 1981-2010 base period means.

Acknowledgements

- Drs. Caihong Wen, Yan Xue, and Arun Kumar: reviewed PPT, and provide insight and constructive suggestions and comments

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

- Dr. Emily Becker: timely provided NMME plot

- Dr. Peitao Peng: updated CA ENSO forecast

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

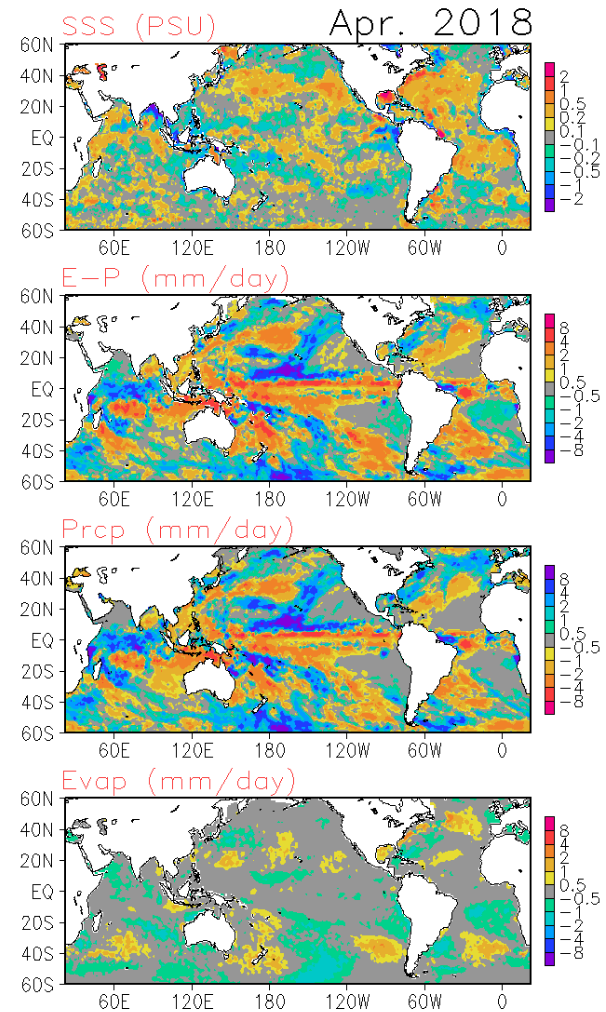
- Dr. Dan Collins: Updated CPC CON forecast

Backup Slides

Global Sea Surface Salinity (SSS)

Anomaly for April 2018

- **New Update: The input satellite sea surface salinity of SMAP from NSAS/JPL was changed from Version 3.0 to Version 4.0 in January 2018.**
- The negative SSS signal continued in the Indonesia equatorial Pacific, meanwhile, the precipitation was reduced in this area, which indicates that the negative SSS is probably caused by oceanic advection/entrainment. The heavier precipitation in the west basin of South Pacific subtropics causes the persistent negative SSS in this region. In the Bay of Bengal, the negative SSS signal continued in the northern basin. In the Atlantic Ocean, the positive SSS signal between 20ºS to 40ºN also continued in this month.



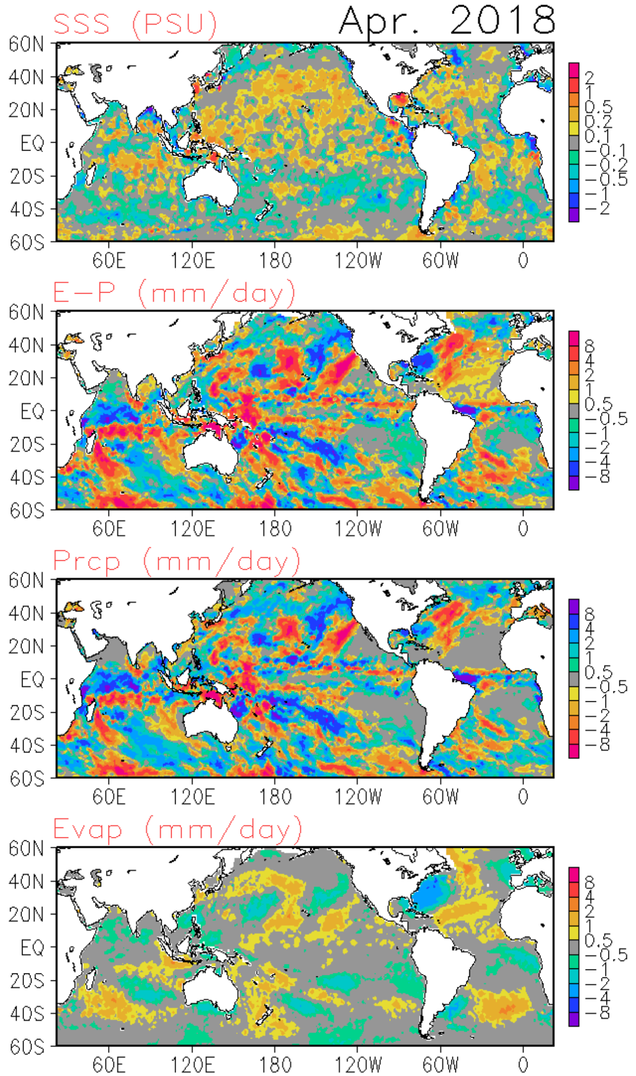
- **Data used**

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 April 2018

Compared with last month, the SSS in the northern basin of Bay of Bengal decreased possibly due to ocean advection/entrainment. In the west basin of the South Pacific subtropics, the SSS decreased with the precipitation increasing in this area. A large scale of SSS increasing appeared in the North Pacific Ocean from equator to 40°N. The SSS increased in the subtropics of North Atlantic ocean with reduced freshwater input.

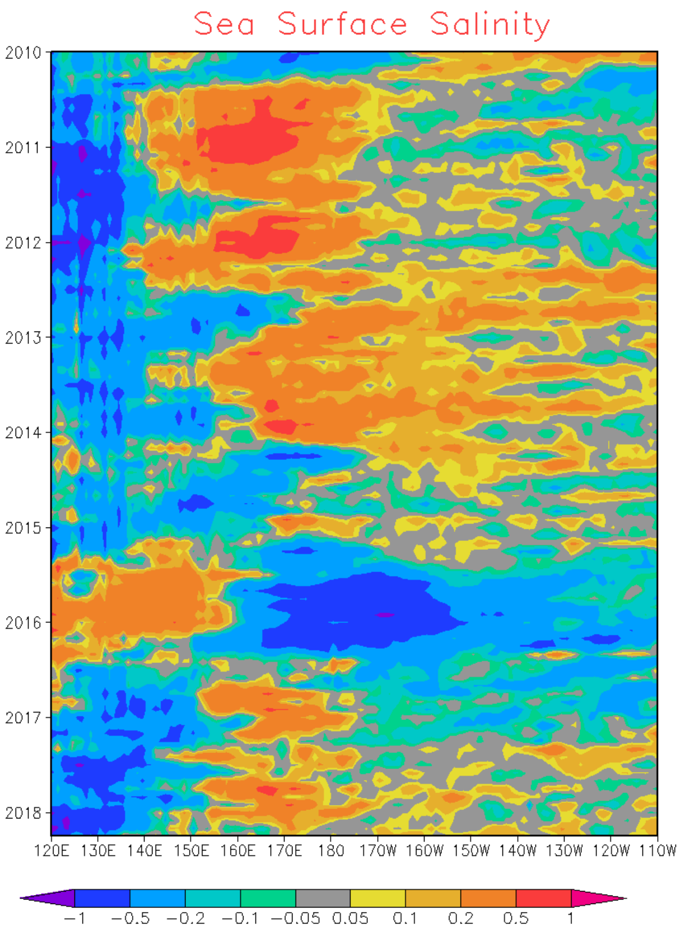


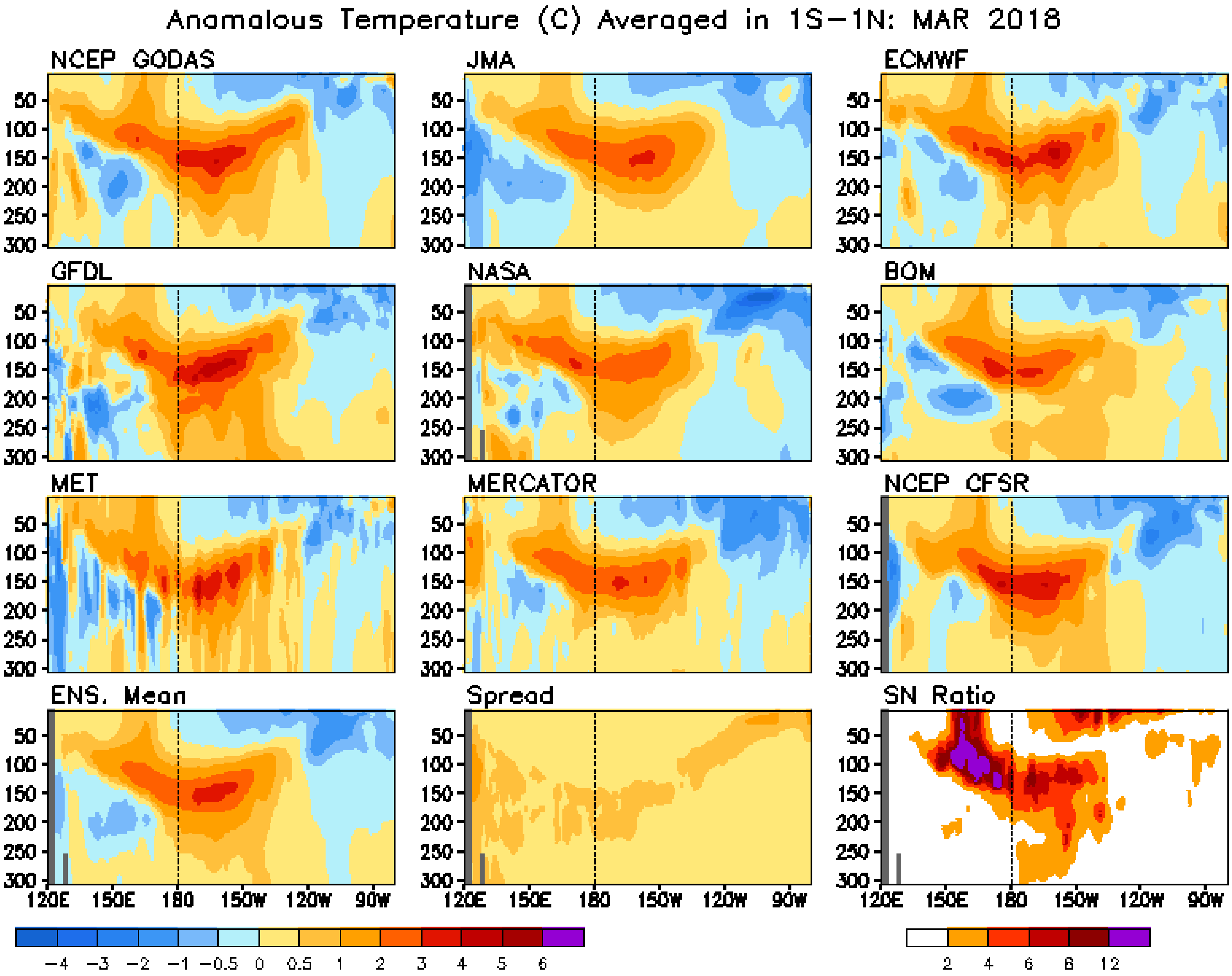
Global Sea Surface Salinity (SSS)

Anomaly Evolution over Equatorial Pacific

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 positive SSS anomaly signal in the central equatorial Pacific (150°E to 170°W) Ocean becomes weaker. Meanwhile, the SSS west of 170°W becomes positive this month.




Anamalous Temperature (C) Averaged in 1S-1N: MAR 2018
NCEP GODAS
JMA
ECMWF
GFDL
NASA
BOM
MET
MERCATOR
NCEP CFSR
ENS. Mean
Spread
SN Ratio
50
100
150
200
250
300
120E
150E
180
150W
120W
90W
-4 -3 -2 -1 -0.5 0 0.5 1 2 3 4 5 6
2 4 6 8 12