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

Prepared by

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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 SSTA Predictions**

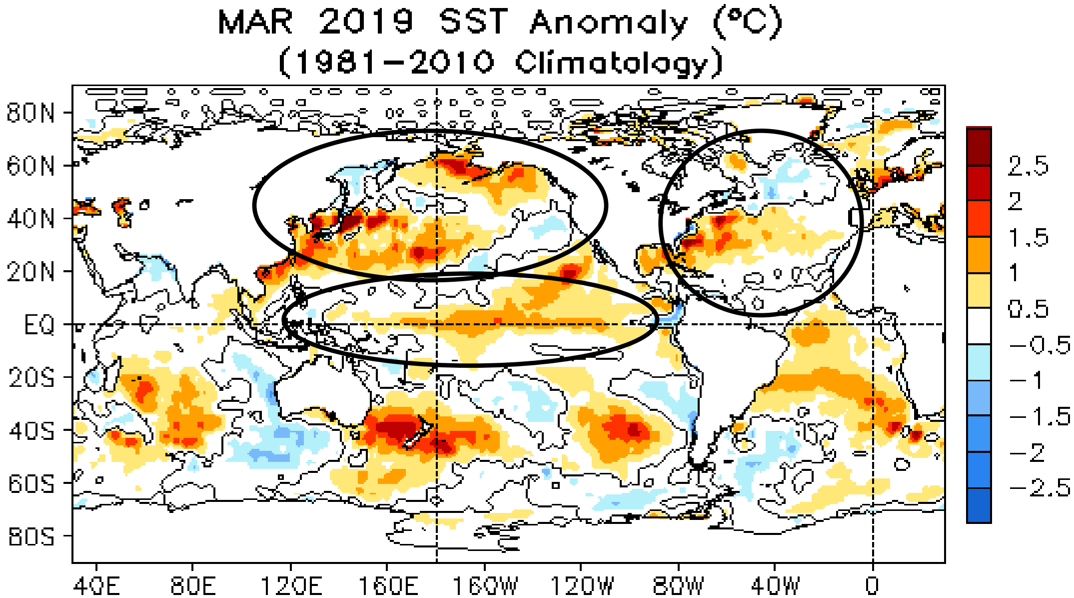
- **Evolution, Forecasting, and Impact of 2018/19 El Nino**

Overview

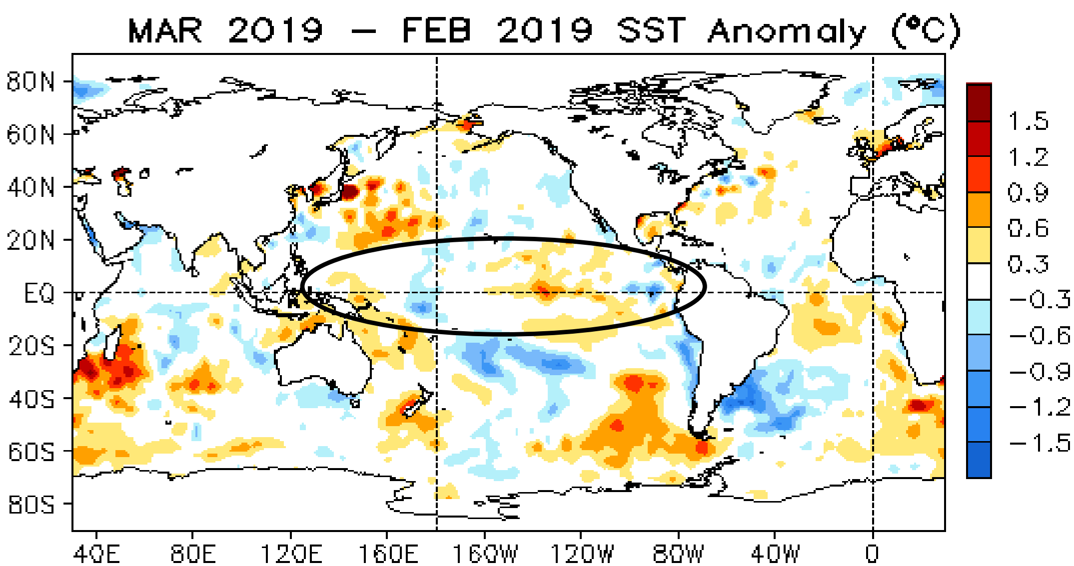
- **Pacific Ocean**
  - **NOAA "ENSO Diagnostic Discussion" on 11 Apr 2019 continuously issued "*El Nino Advisory*" and indicated that *"A weak El Niño is likely to continue through the Northern Hemisphere summer 2019 (65% chance) and possibly fall (50-55% chance)."***
  - **El Nino conditions were observed.**
  - **Positive SSTAs persisted in the central and eastern tropical Pacific with NINO3.4=0.98^{o}C in Mar 2019.**
  - **Positive (negative) subsurface ocean temperature anomalies in the eastern (western) tropical Pacific presented and propagated eastward in Mar 2019.**
  - **Positive SSTAs dominated in the N. Pacific in Mar 2019.**
- **Indian Ocean**
  - **SSTs were near average in the tropics in Mar 2019.**
- **Atlantic Ocean**
  - **NAO switched into a positive phase with NAOI=0.9 in Mar 2019, and SSTAs were a tripole/horseshoe pattern with positive anomalies in the middle latitudes of N. Atlantic during 2013-2019.**

Global Oceans

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



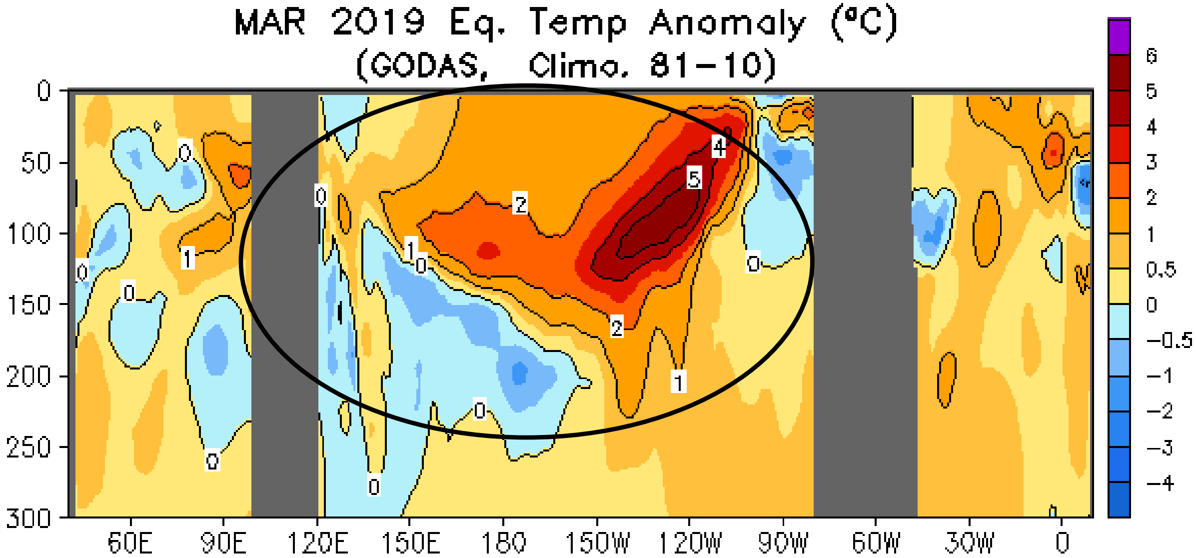
- **Positive SSTAs were mainly in the central and eastern tropical Pacific, consistent with El Nino conditions.**
- **Positive SSTAs dominated in the North Pacific.**
- **Horseshoe/tripole-like SSTA pattern persisted in the North Atlantic.**
- **In the Indian Ocean, SSTs were near average in the tropics.**



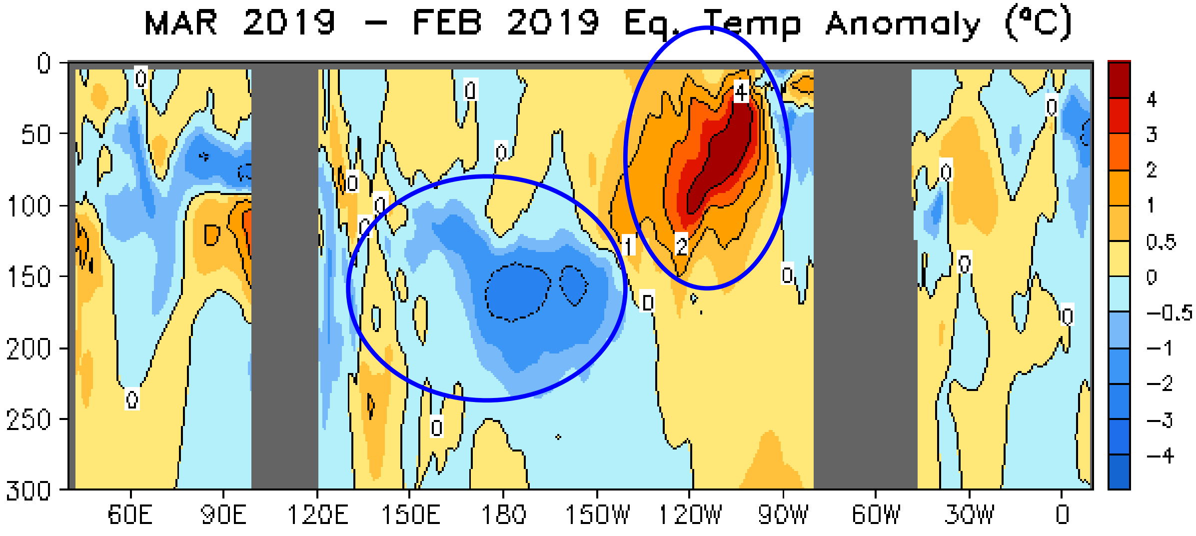
- **Both positive and negative SSTA tendencies were observed in the tropical Pacific Ocean.**
- **The SSTA tendencies were larger in SH than in NH oceans.**

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



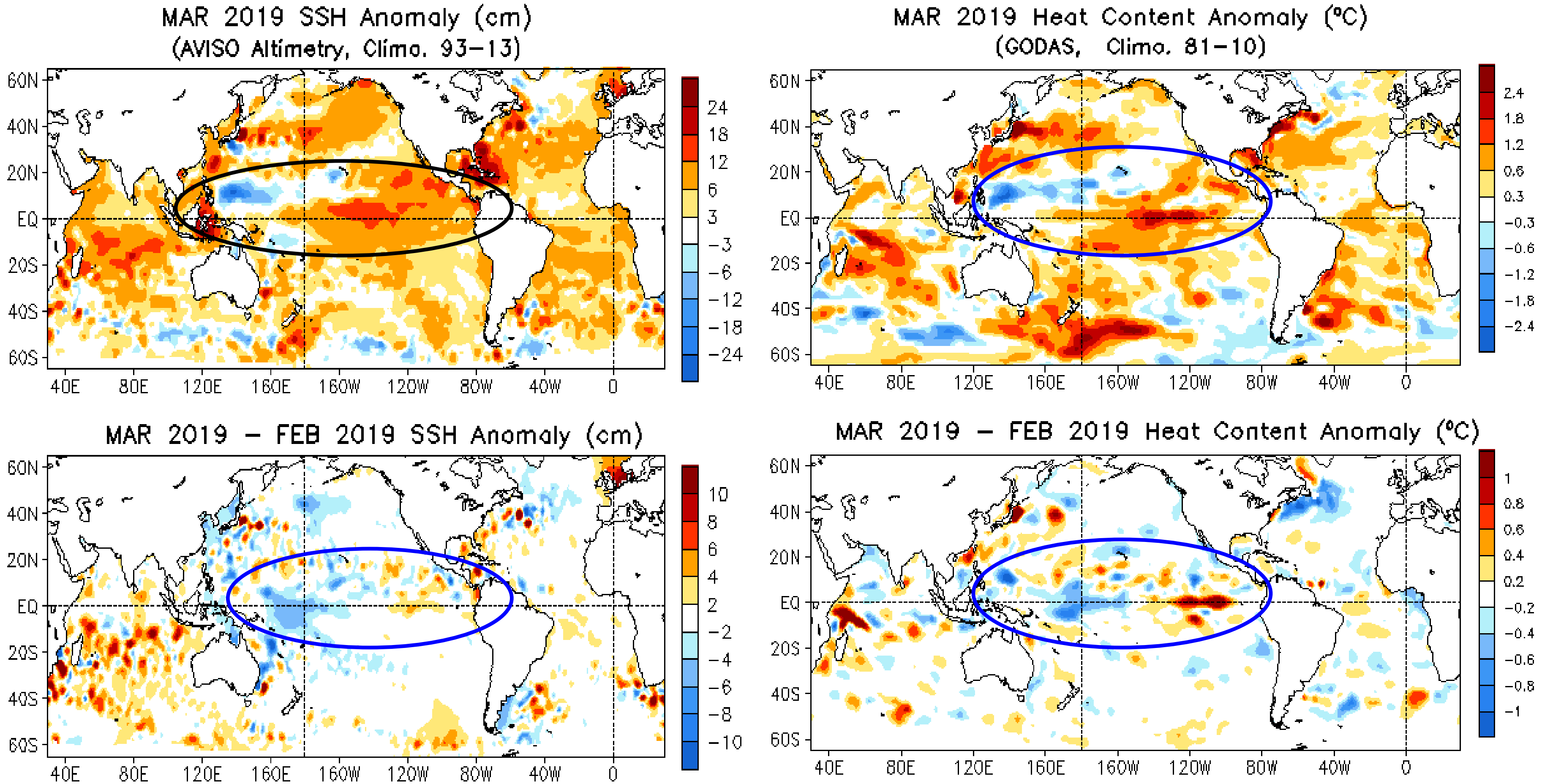
- **Positive (negative) ocean temperature anomalies presented along the thermocline in the eastern (western) Pacific.**
- **The maximum positive anomaly reached 5C.**



- **Anomalous ocean temperature tendency displayed a dipole pattern in the Pacific Ocean: positive in the east, and negative to the central.**

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.

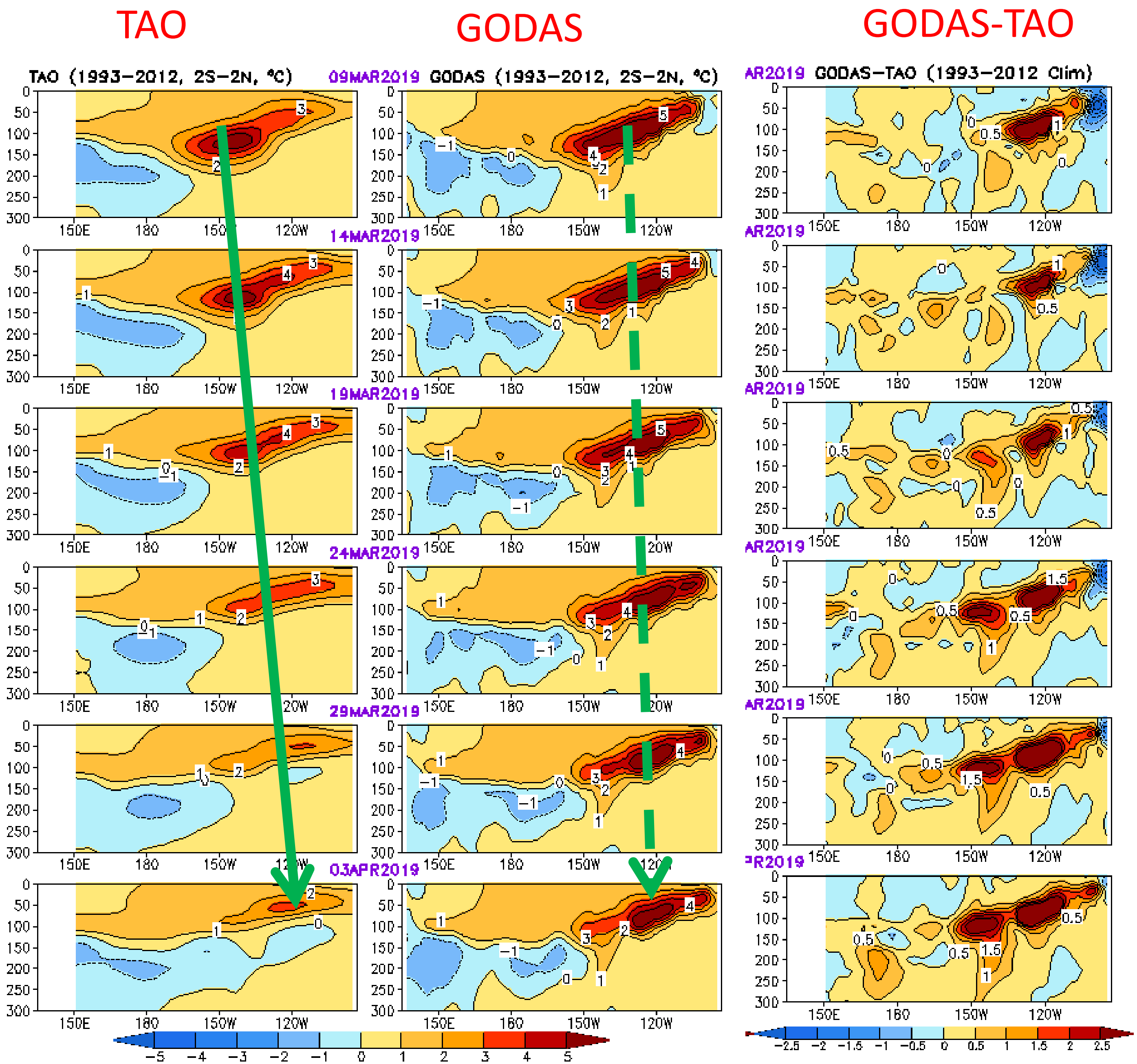
Global SSH and HC300 Anomaly & Anomaly Tendency



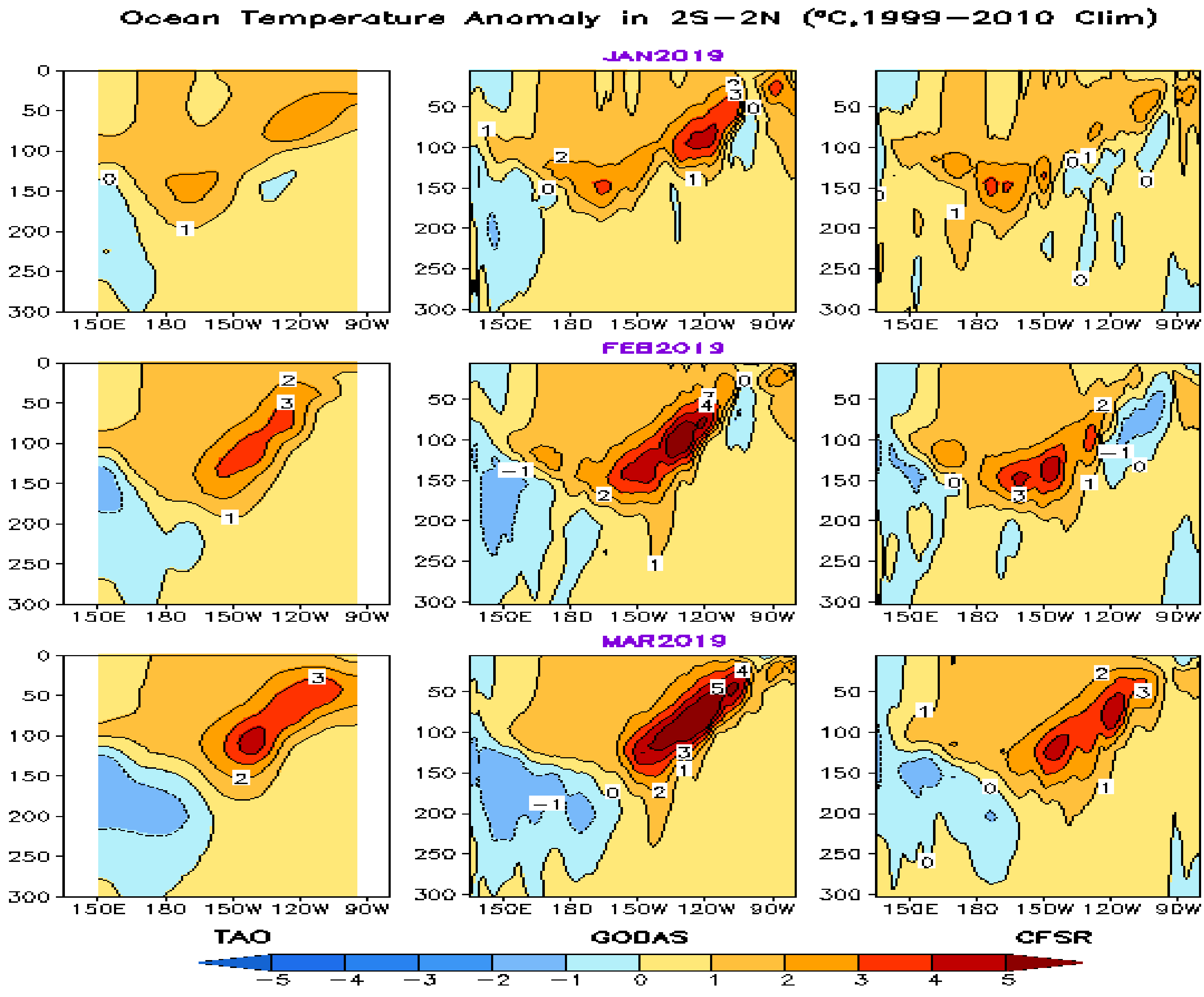
- **The SSHA pattern was overall consistent with the HC300A pattern, but there were many detailed differences between them.**
- **Both SSHA and HC300A in the tropical Pacific were consistent with El Nino conditions.**
- **Positive (negative) tendencies of SSHA and HC300A presented in the eastern (central) tropical Pacific. The positive tendency in HC300A is likely overestimated by GODAS, which is consistent with that in slides 6, 9, 10.**

Tropical Pacific Ocean and ENSO Conditions

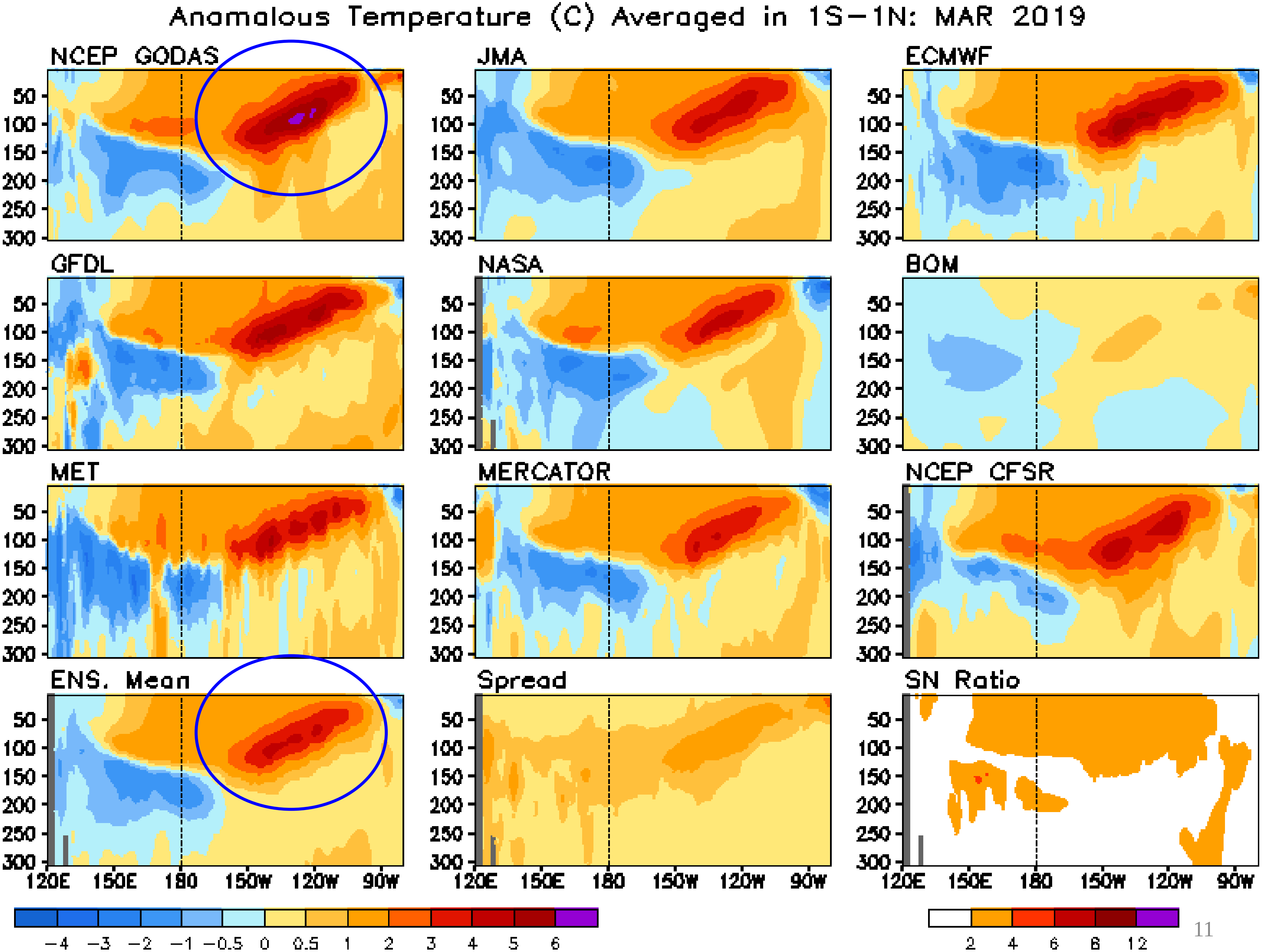
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly



- **Positive ocean temperature anomalies in the east in TAO weakened during the last month, while negative anomalies in the west propagated eastward.**
- **The positive anomalies of ocean temperature were larger in GODAS than in TAO, and the differences increased lately.**

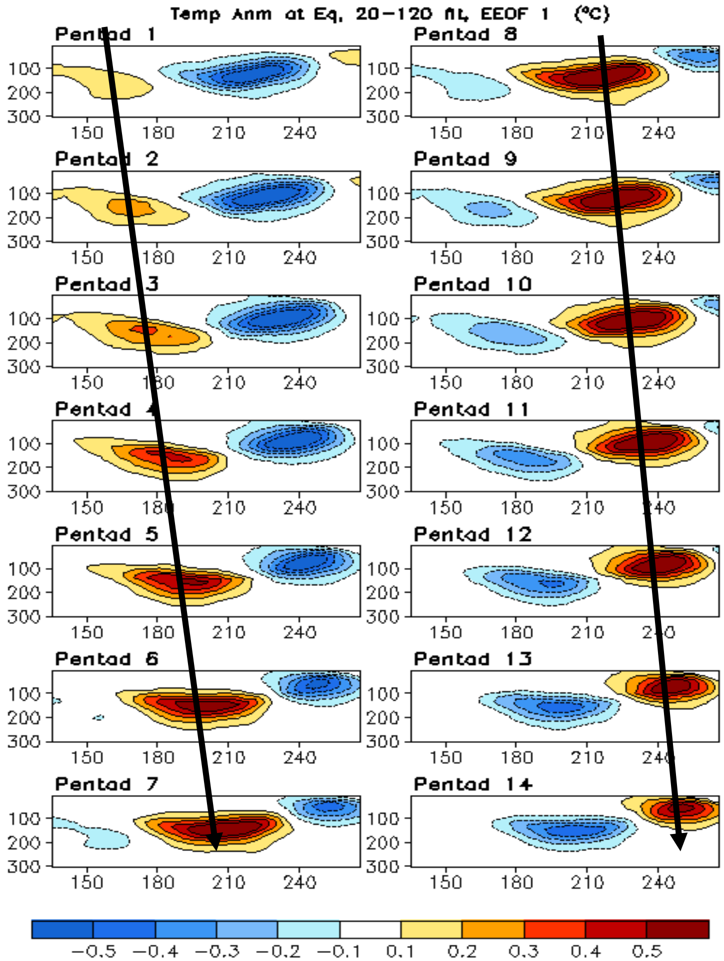


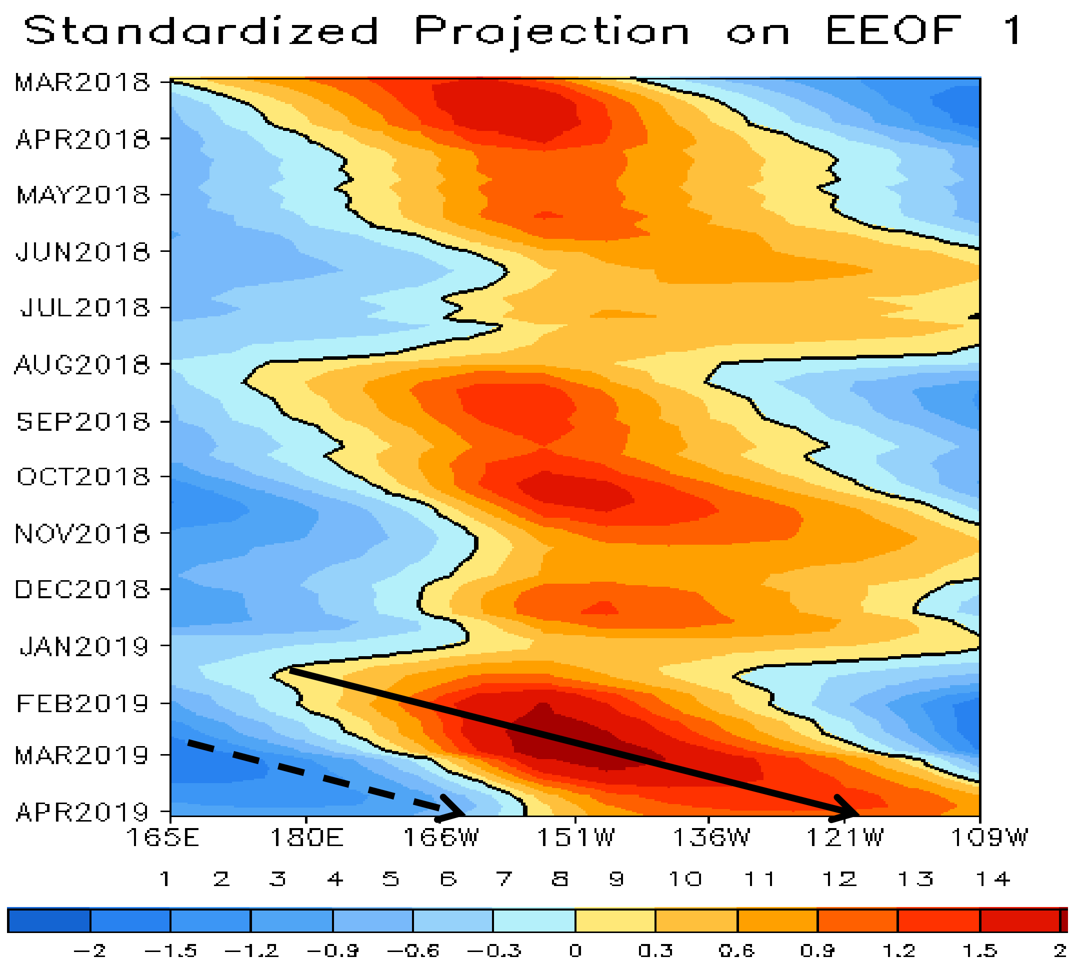
Ocean Temperature Anomaly in 2S-2N (°C,1999-2010 Clim)
JAN2019
FEB2019
MAR2019
TAO
GODAS
CFSR
150E 180 150W 120W 90W
0 50 100 150 200 250 300
-5 -4 -3 -2 -1 0 1 2 3 4 5



Anomalous Temperature (C) Averaged in 1S-1N: MAR 2019
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

Oceanic Kelvin Wave (OKW) Index



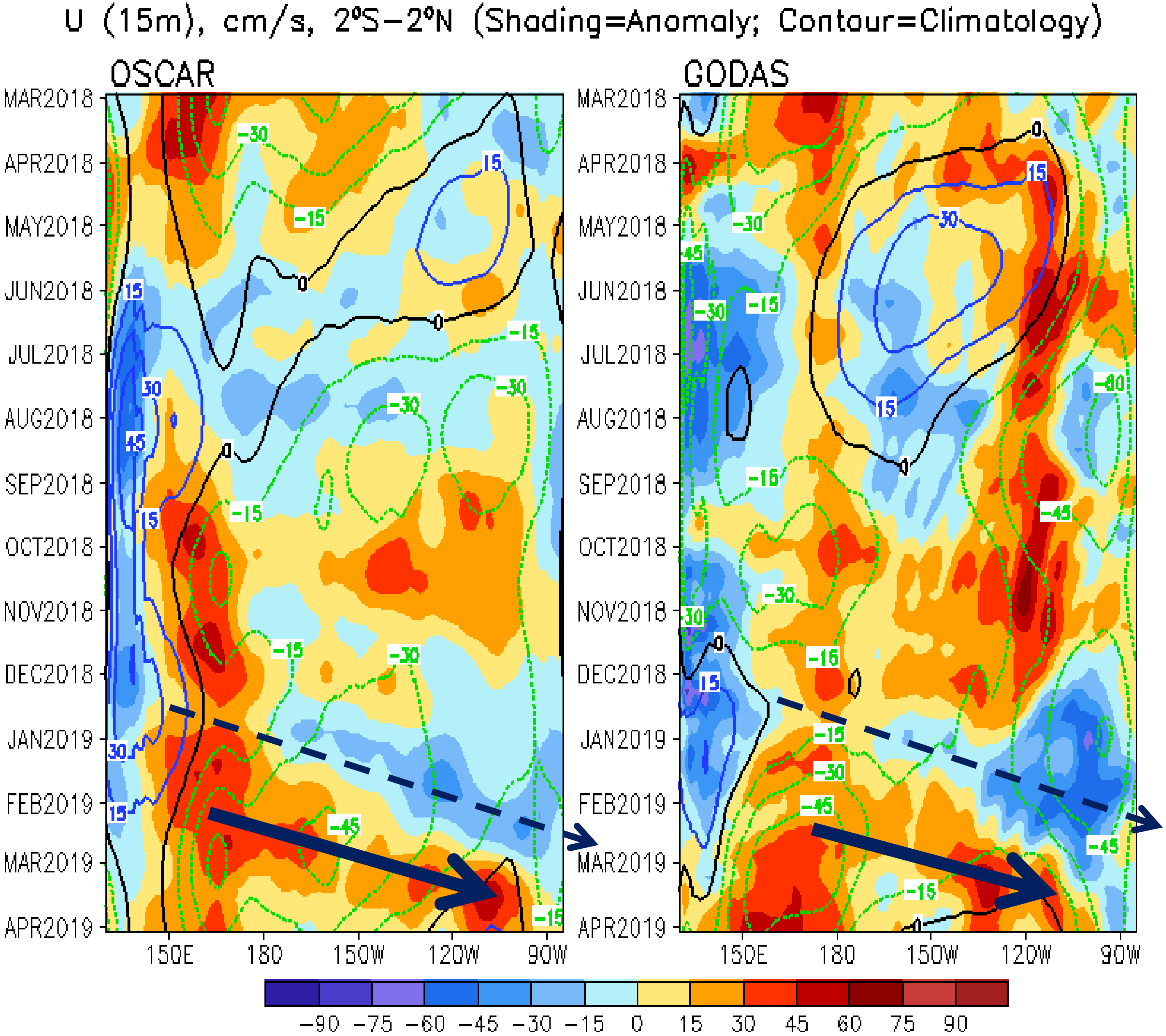


- A downwelling Kelvin wave presented from Jan- Mar 2019, leading to increasing positive subsurface temperature anomalies in the eastern tropical Pacific.

- A upwelling Kelvin wave initiated in late Jan 2019 and propagated eastward.

(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).)

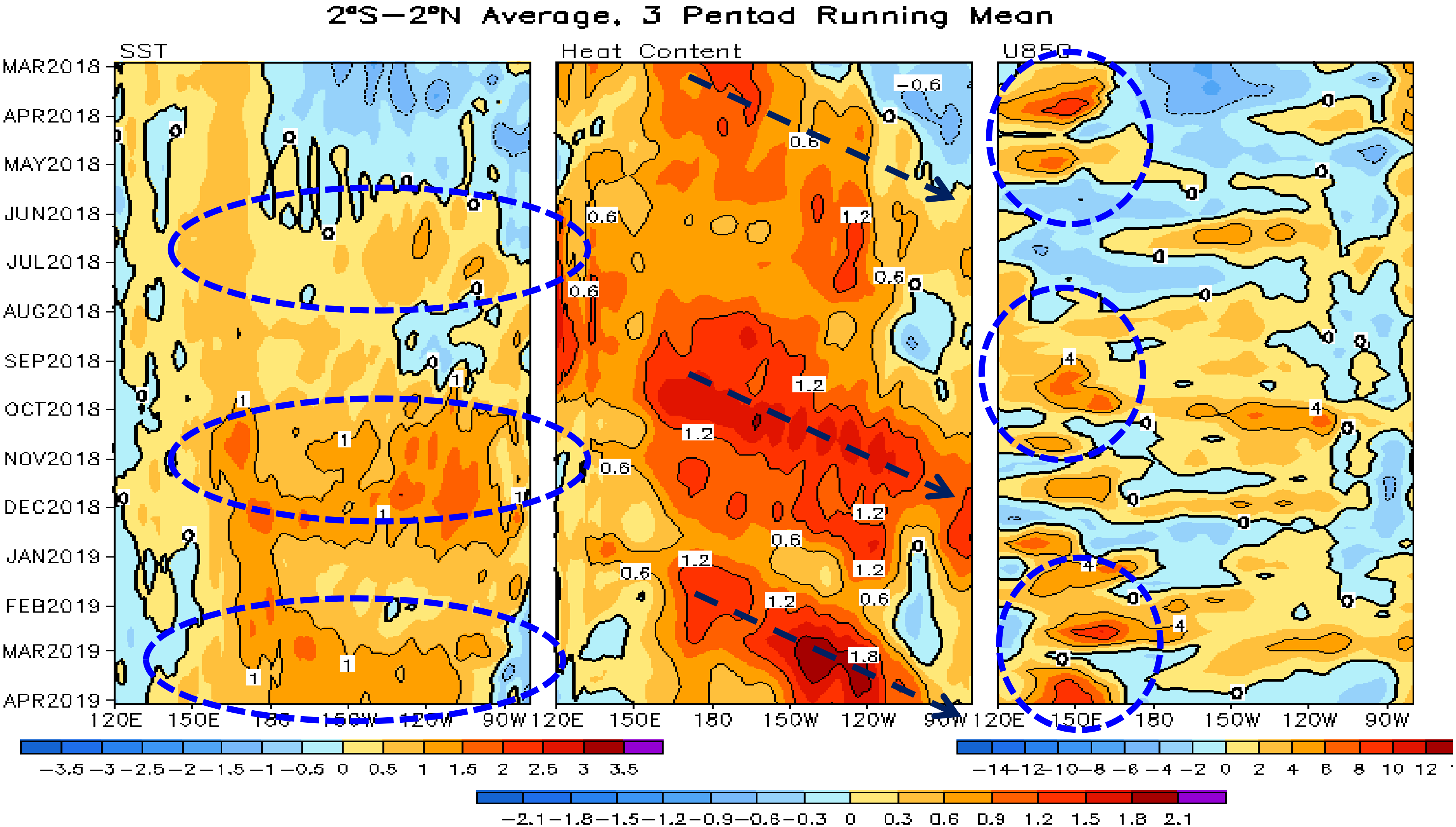
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- Anomalous eastward currents persisted during the last 2-3 months in OSCAR and GODAS. That was favorable for increase of the positive SSTA in the eastern tropical Pacific.

- The anomalous currents showed some differences between OSCAR and GODAS both in the anomalies and climatologies.

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



- **Positive SSTA in the central and eastern Pacific persisted in the last month.**
- **Positive HC300A propagated eastward in Mar 2019, and low-level westerly wind bursts were observed in Feb and Mar 2019.**

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 little change since Dec 2018.**

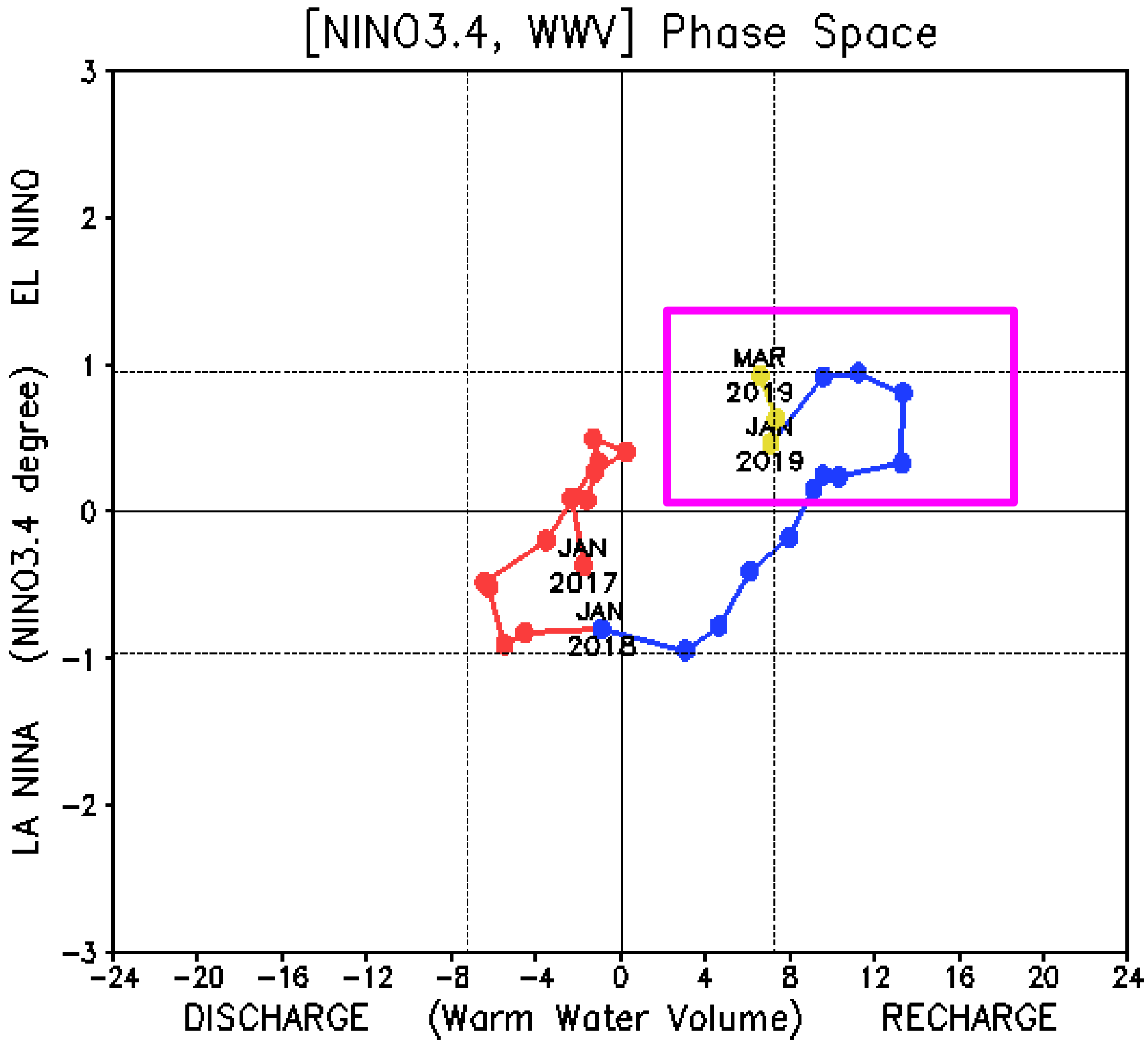
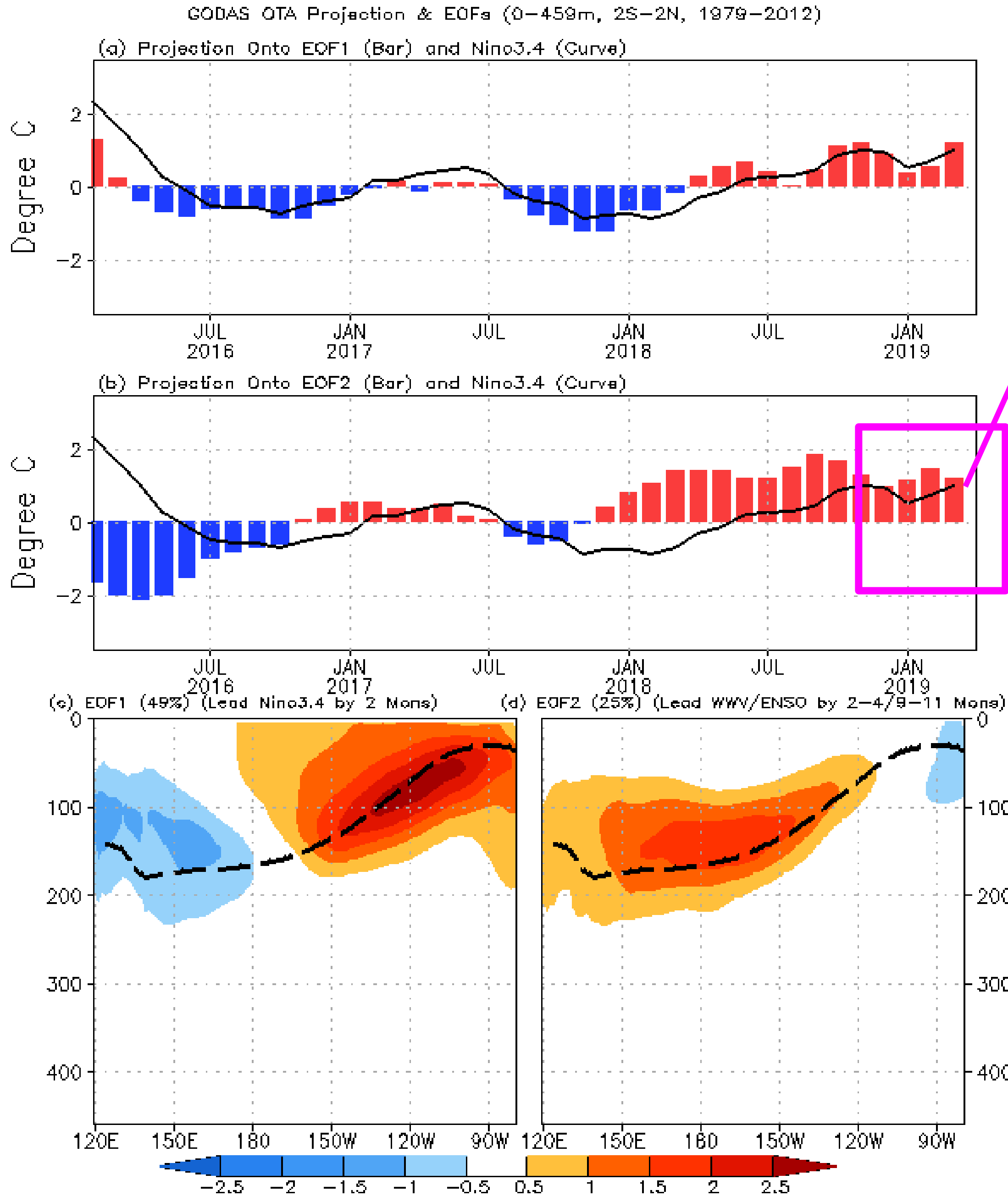


Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20°C in [120°E-80°W, 5°S-5°N] calculated with the NCEP's global ocean data assimilation system. Anomalies are departures from the 1981-2010 base period means.



Equatorial subsurface ocean temperature monitoring: ENSO was in a recharged phase in Mar 2019.

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).

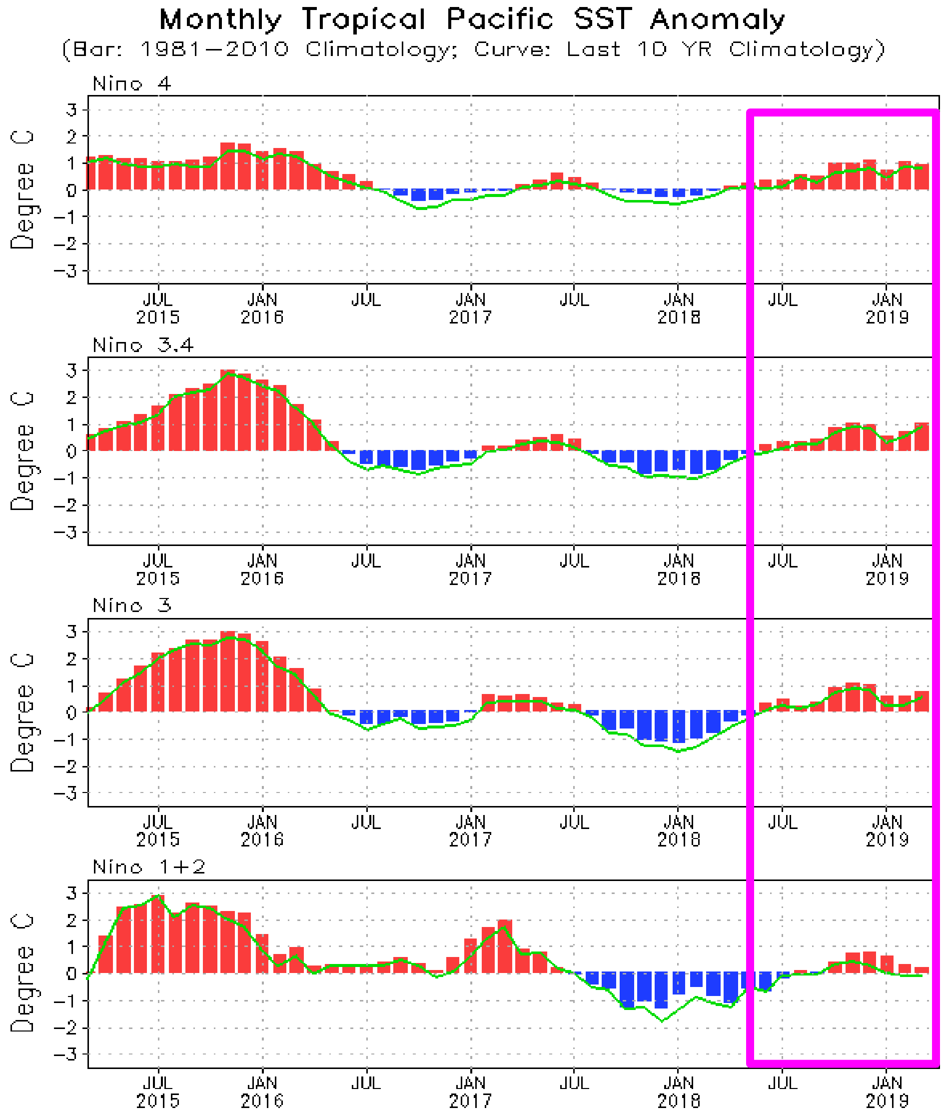
Recharge process: heat transport from outside of equator to equator : Negative -> positive phase of ENSO

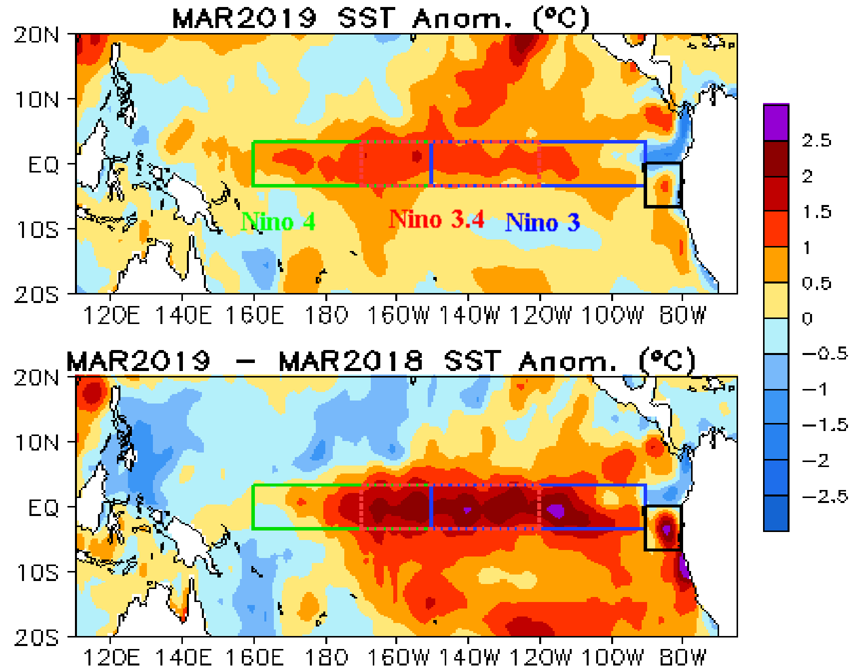
Discharge process: heat transport from equator to outside of equator: Positive -> Negative phase of ENSO

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*.

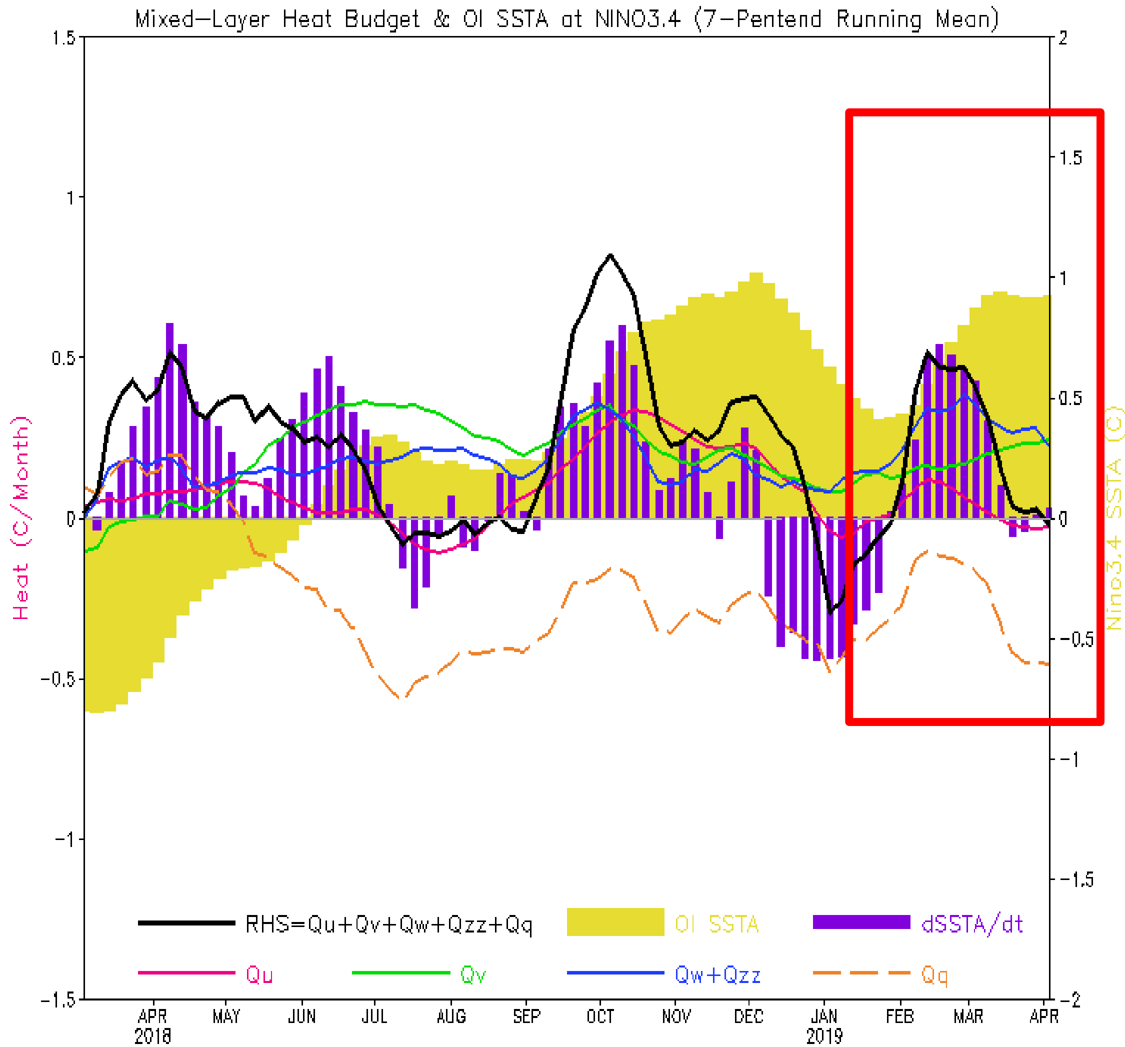
Evolution of Pacific NINO SST Indices





- Nino3 and Nino3.4 strengthened, and Nino4 and Nino1+2 weakened in Mar 2019.
- Nino3.4 = 0.98C in Mar 2019.
- Compared with last Mar, the central and eastern equatorial Pacific was much warmer in Mar 2019.
- 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.



NINO3.4 Heat Budget

- **Both observed SSTA tendencies (dSSTA/dt; bar) and total heat budget (RHS; black line) in the Nino3.4 region were near zero, may imply ENSO peak.**

- **Dynamical terms (Qv, Qw+Qzz) were positive, while zonal advection (Qu) and heat-flux term (Qq) were negative in Mar 2019.**

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;

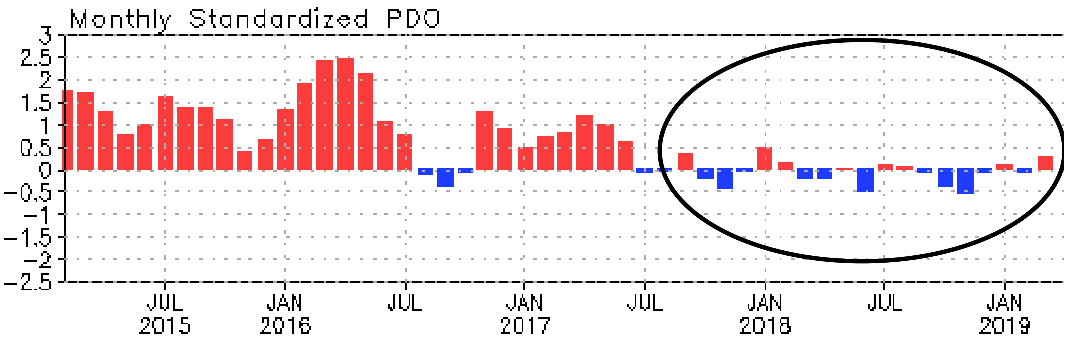
Qw: Vertical entrainment; Qzz: Vertical diffusion

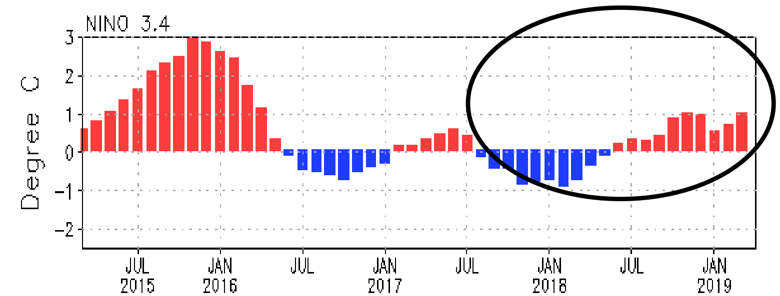
Qq: (Qnet - Qpen + Qcorr)/ρcph; Qnet = SW + LW + LH +SH;

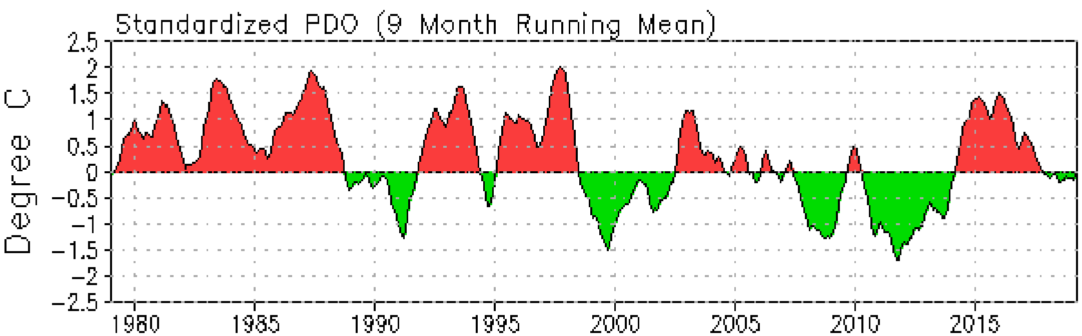
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

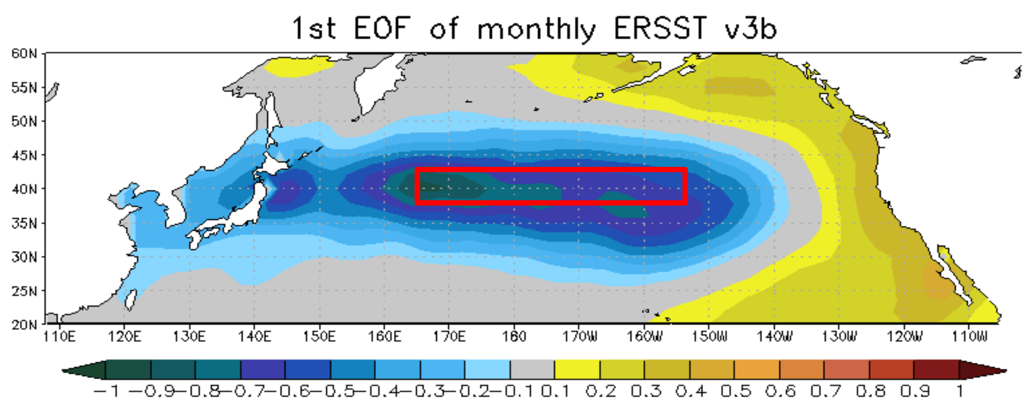
North Pacific & Arctic Oceans

PDO index









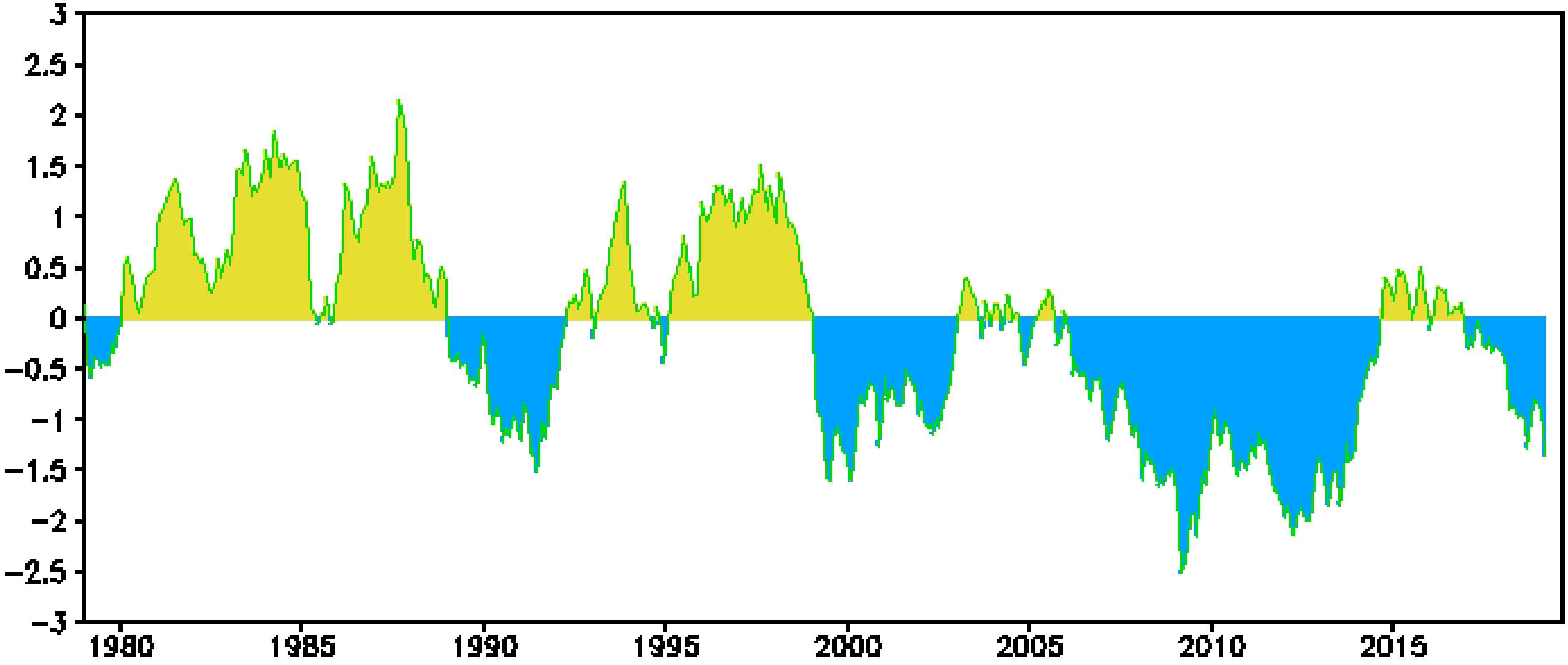
- The PDO index was small since Jul 2017 with PDOI= 0.3 in Mar 2019.

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

- During the last 1~2 years, ENSO and PDO seem disconnected.

- 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.



Definition of HC300-based PDO

H300 based PDO index (HPDO) is defined as the projections of monthly mean H300As from NCEP GODAS onto their first EOF vector in the North Pacific (20ºN-60ºN). The 30-yr period from 1981-2010 is used to derived the climatology and the EOF analysis. Compared to the conventional SST-based PDO (SPDO), HPDO provides a natural way to highlight the slower frequency variability in the SPDO and encapsulates an integrated view of temperature variability associated with the PDO in the upper ocean.

Kumar, A. and C. Wen, 2016: An Oceanic Heat Content–Based Definition for the Pacific Decadal Oscillation. Mon. Wea. Rev., ***144****, 3977–3984. DOI: 10.1175/MWR-D-16-0080.1*

Comments/Suggestions: Send to Dr. Caihong Wen

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

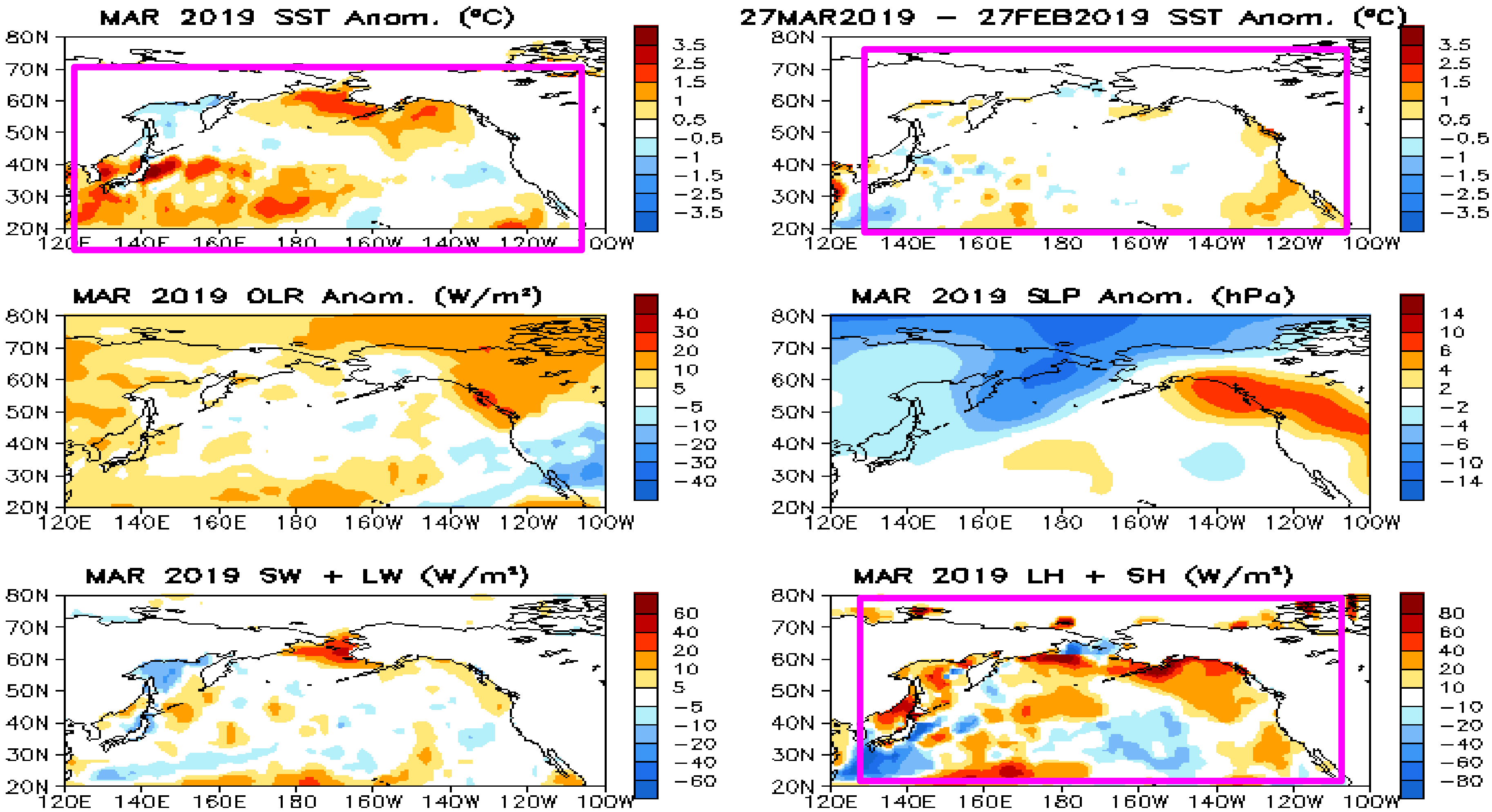
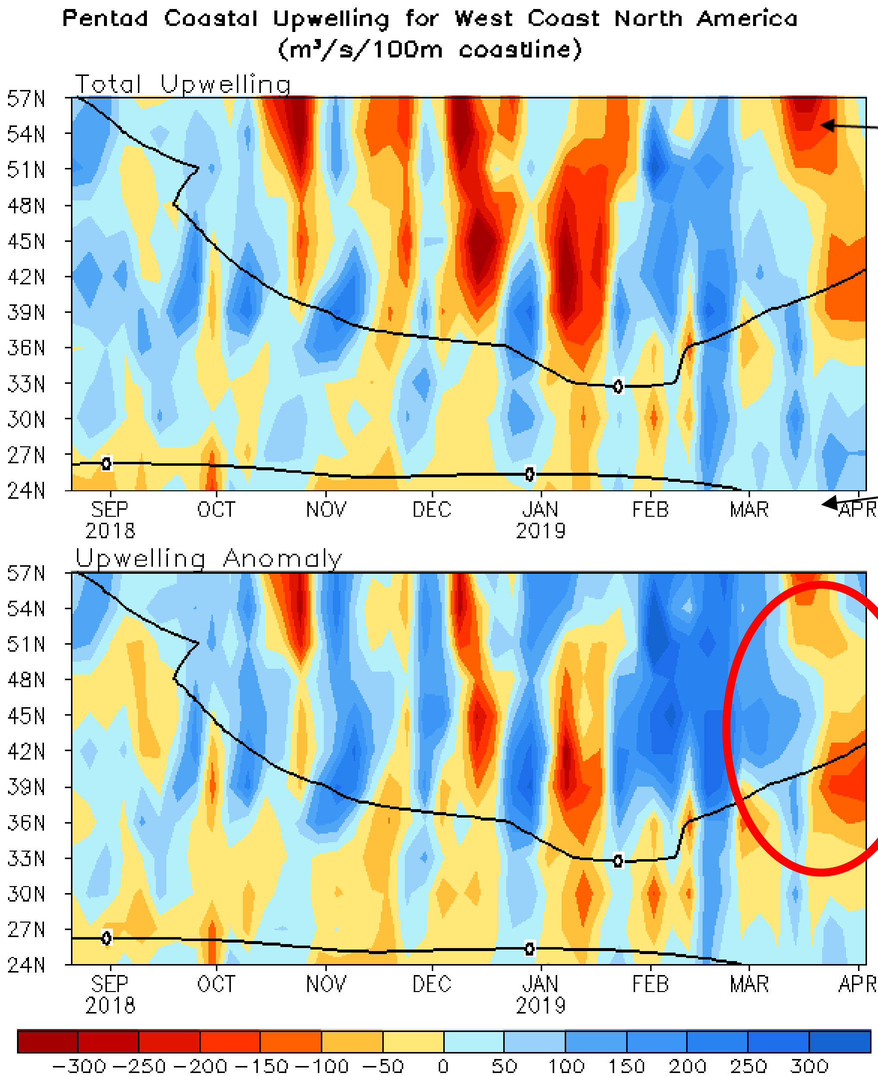
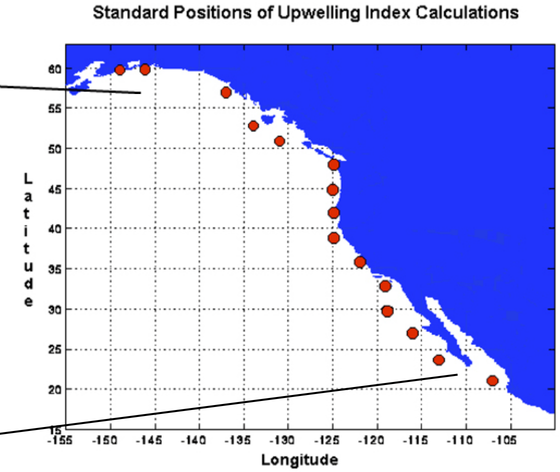


Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible 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





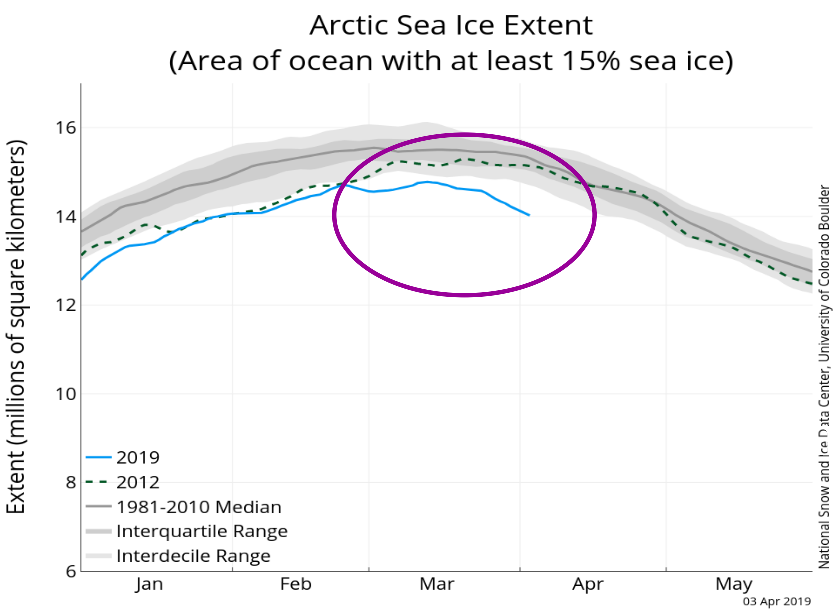
- **Anomalous upwelling switched to anomalous downwelling in mid-Mar 2019, may be associated with variation of the SLP anomalies along the coast.**

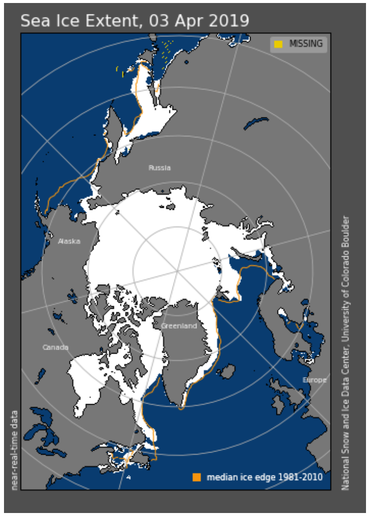
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point ($m^3/s/100m$ coastline). Anomalies are departures from the 1981-2010 base period pentad means.

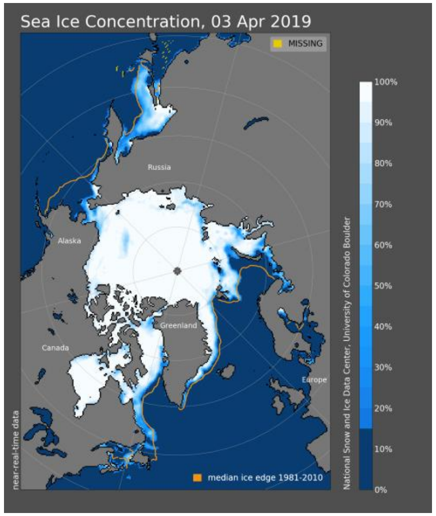
- **Area below (above) black line indicates climatological upwelling (downwelling) season.**
- **Climatologically upwelling season progresses from March to July along the west coast of North America from 36°N to 57°N.**

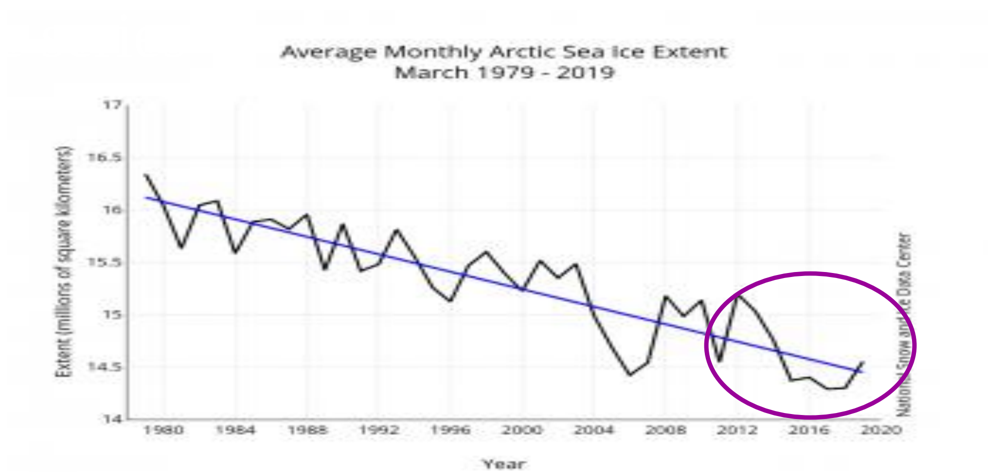
Arctic Sea Ice

National Snow and Ice Data Center
http://nsidc.org/arcticseaicenews/index.html







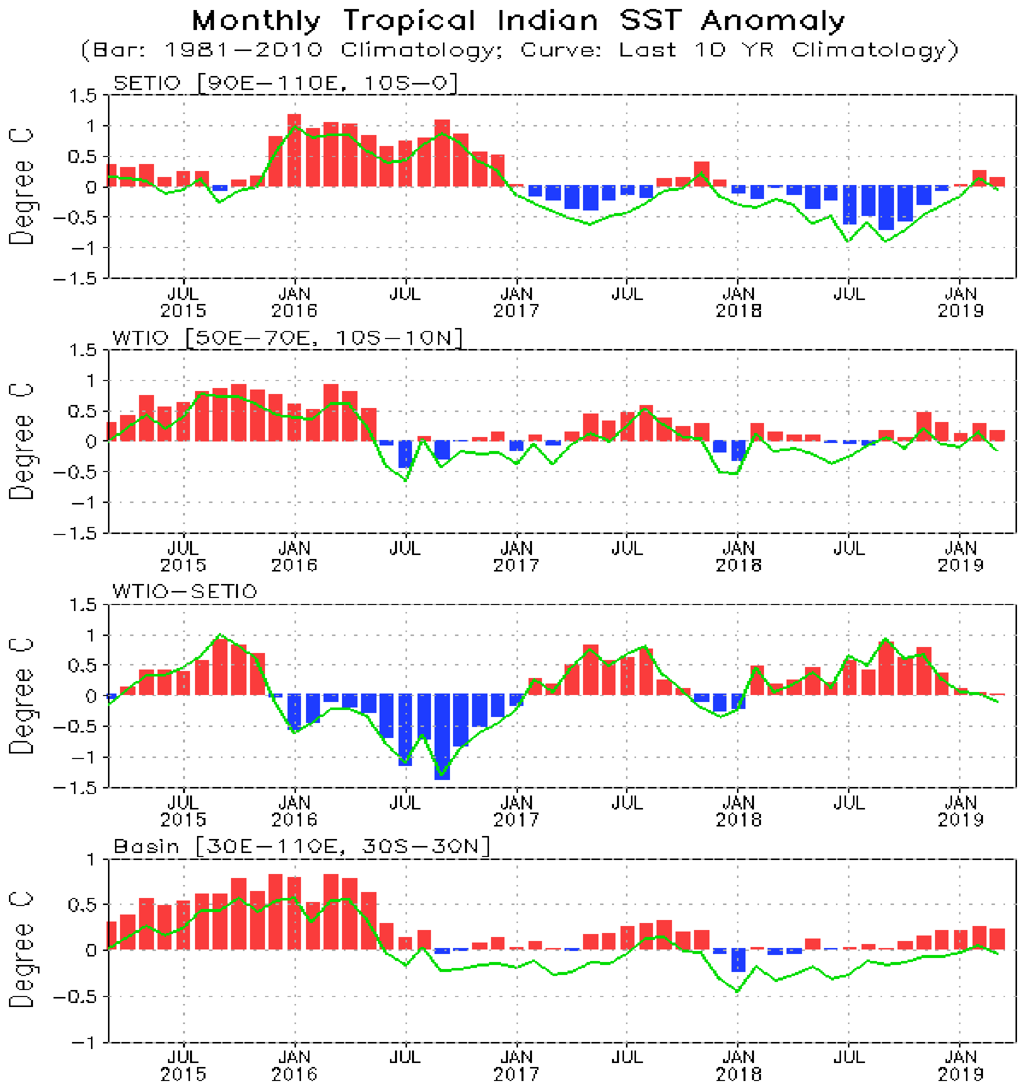


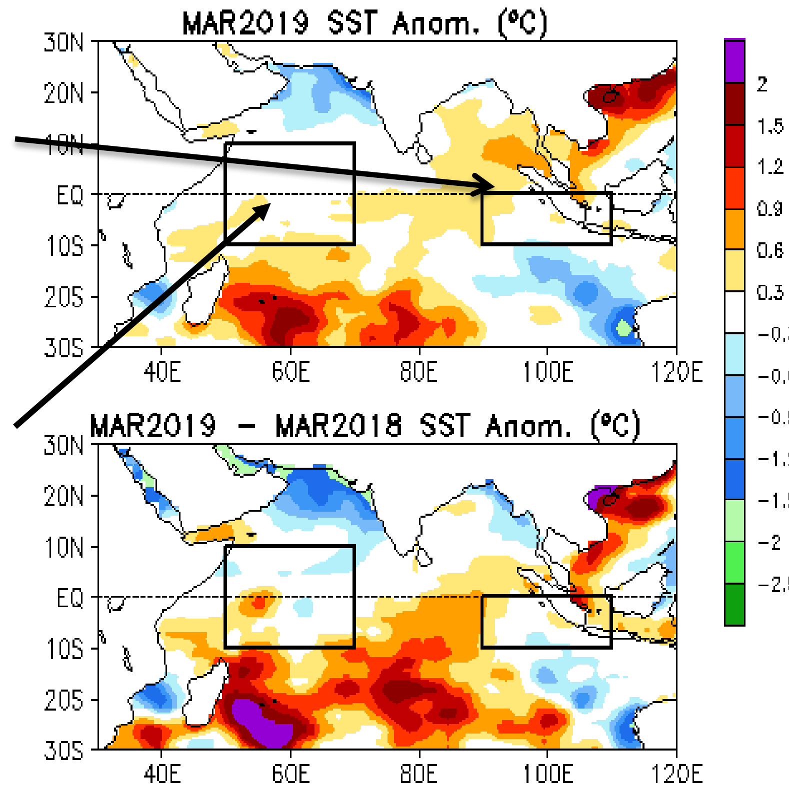
- Arctic sea ice extent appears to have reached its maximum extent on Mar 13, 2019, marking the beginning of the sea ice melt season.

- Arctic sea ice extent for Mar tied with 2011 for the 7th lowest extent in the 40-year satellite record.

Indian Ocean

Evolution of Indian Ocean SST Indices





- **Overall, tropical SSTAs were small positive.**

Fig. I1a. Indian Ocean Dipole region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the SETIO [90°E-110°E, 10°S-0] and WTIO [50°E-70°E, 10°S-10°N] regions, and Dipole Mode Index, defined as differences between WTIO and SETIO. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

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

- Overall SSTAs were small in the tropics.
- SSTA tendency seems not mainly determined by heat flux.
- Convections were suppressed over the North Indian Ocean.

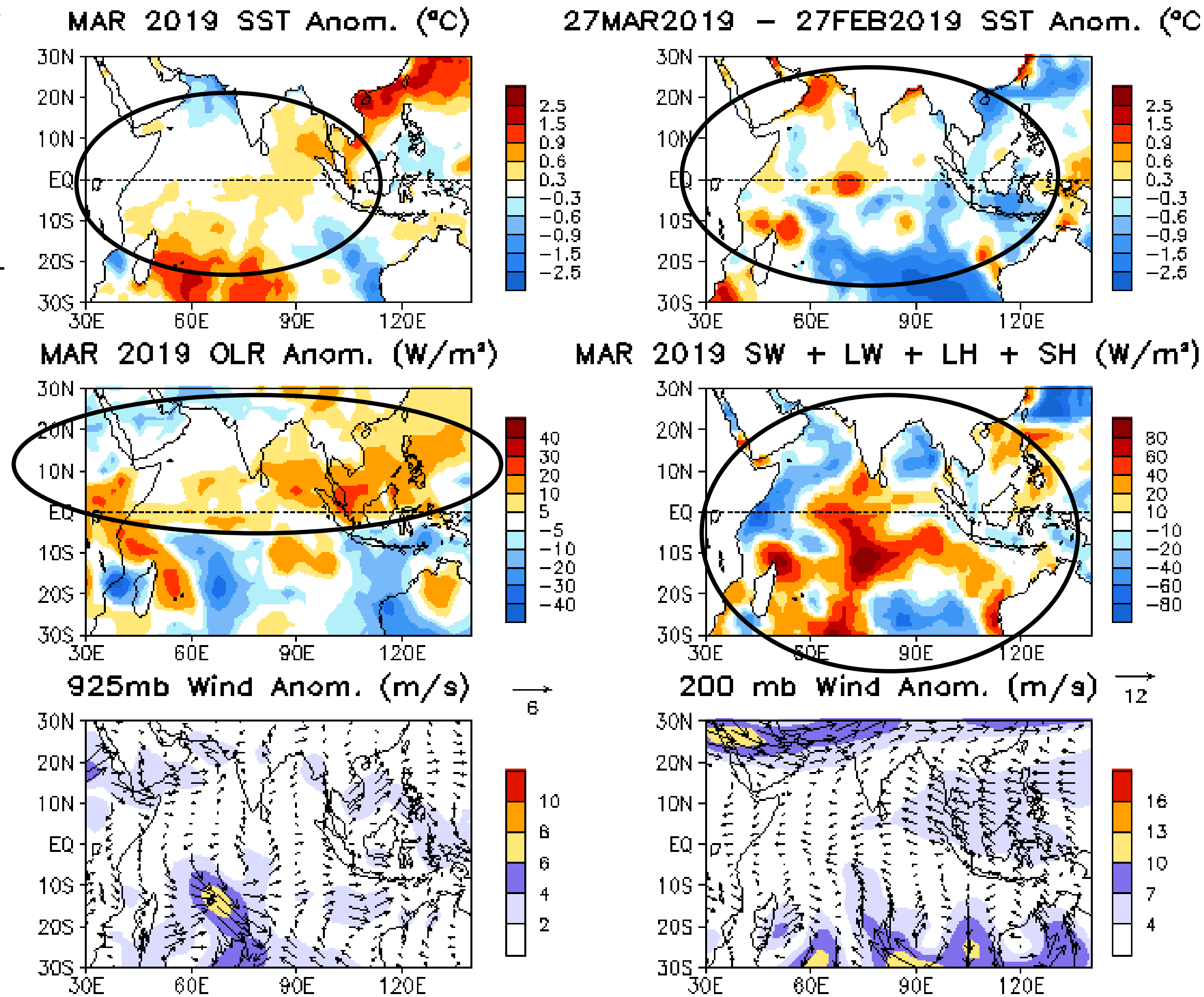
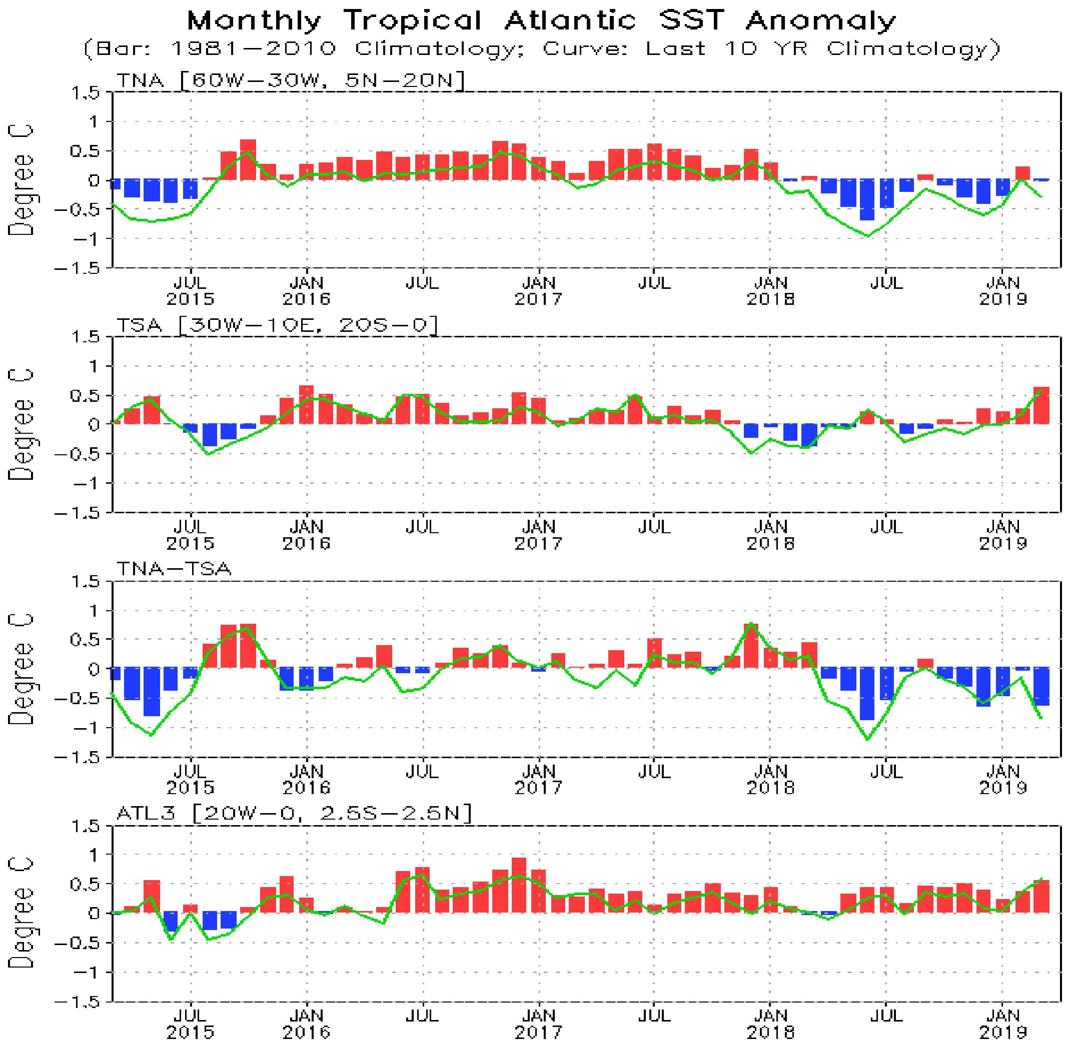
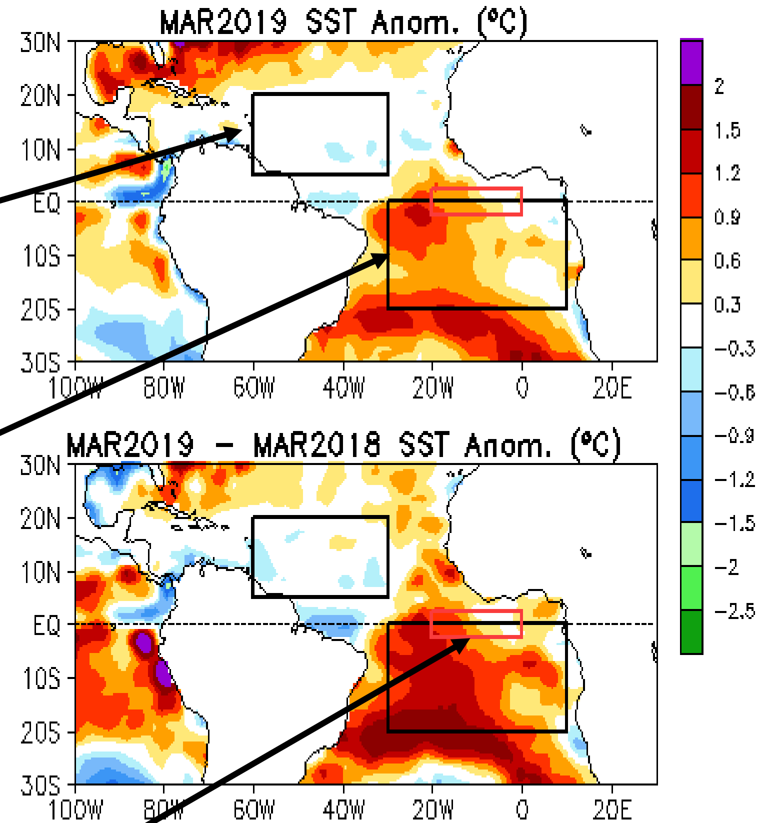


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

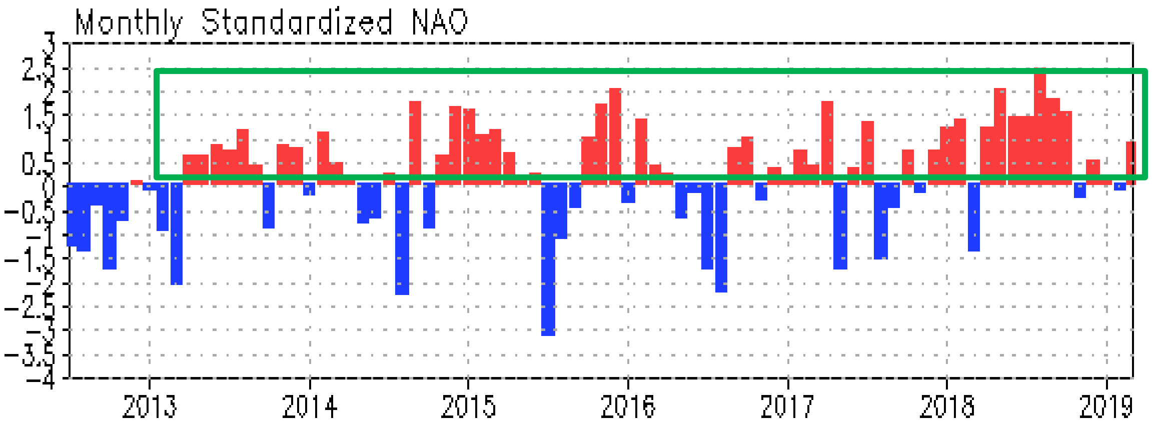


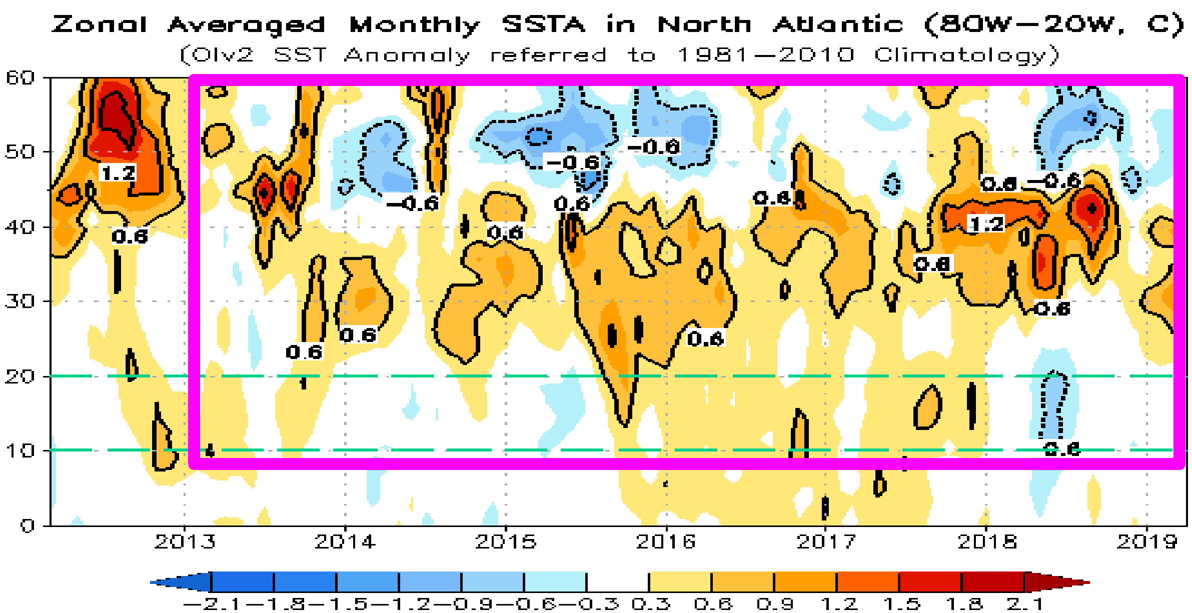


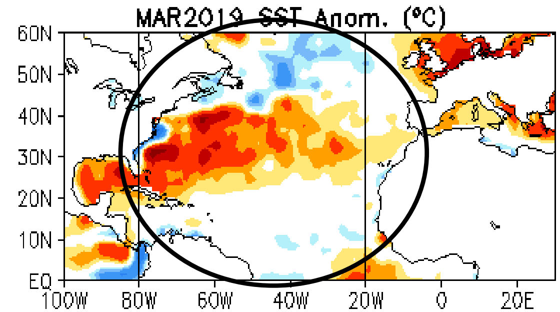
- **The dipole and TNA indices were negative, the TSA and ATL3 indices were positive in Mar 2019.**

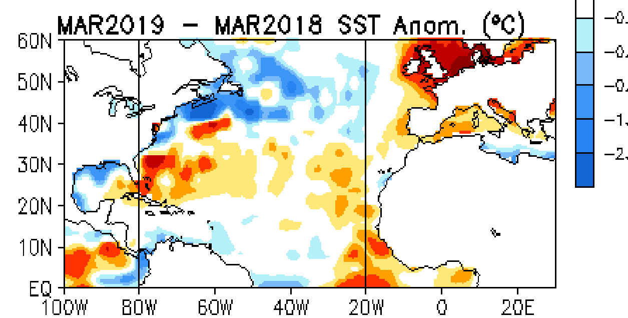
Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (ºC) for the TNA [60ºW-30ºW, 5ºN-20ºN], TSA [30ºW-10ºE, 20ºS-0] and ATL3 [20ºW-0, 2.5ºS-2.5ºN] regions, and Meridional Gradient Index, defined as differences between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

NAO and SST Anomaly in North Atlantic









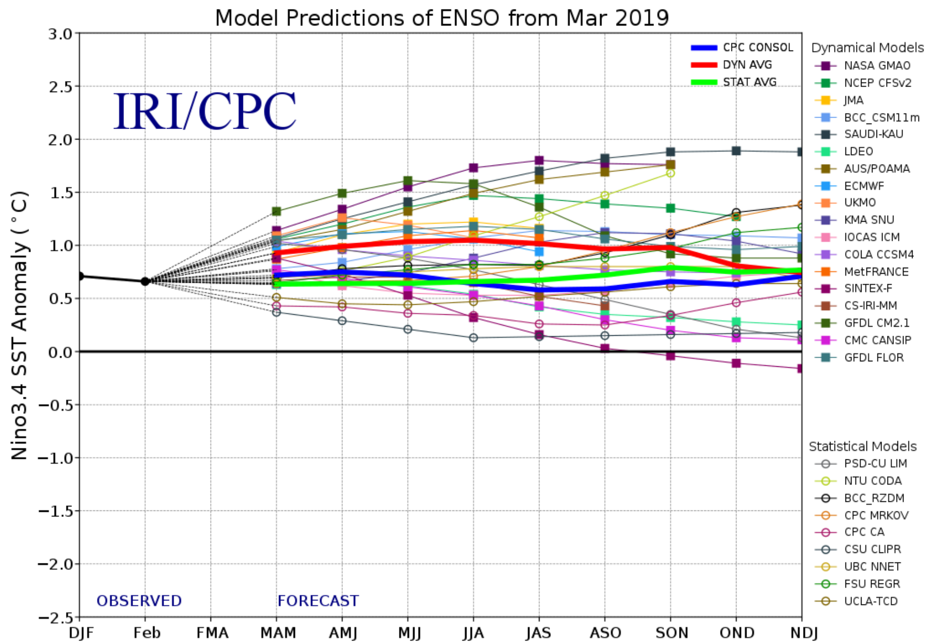
- NAO was in a positive phase with NAOI=0.9 in Mar 2019.

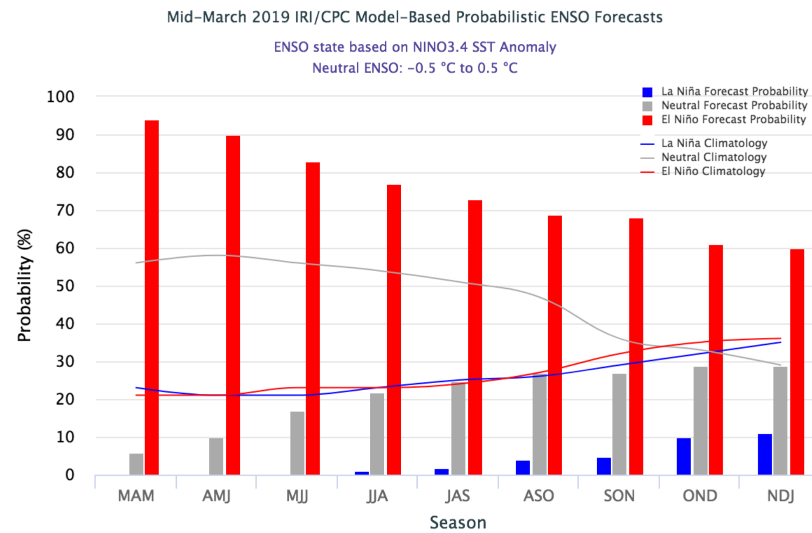
- SSTA was a tripole/horseshoe –like pattern with positive in the mid-latitudes and negative in the lower and higher latitudes, due to the long-term persistence of positive phase of NAO.

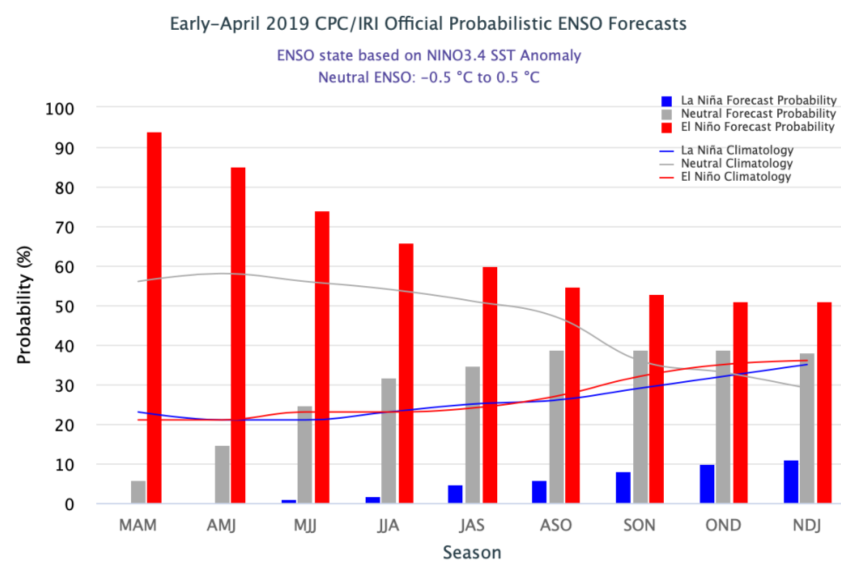
Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20ºN-90ºN (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80ºW and 20ºW (bottom). SST are derived from the NCEP OI SST analysis,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

ENSO and Global SST Predictions

IRI NINO3.4 Forecast Plum



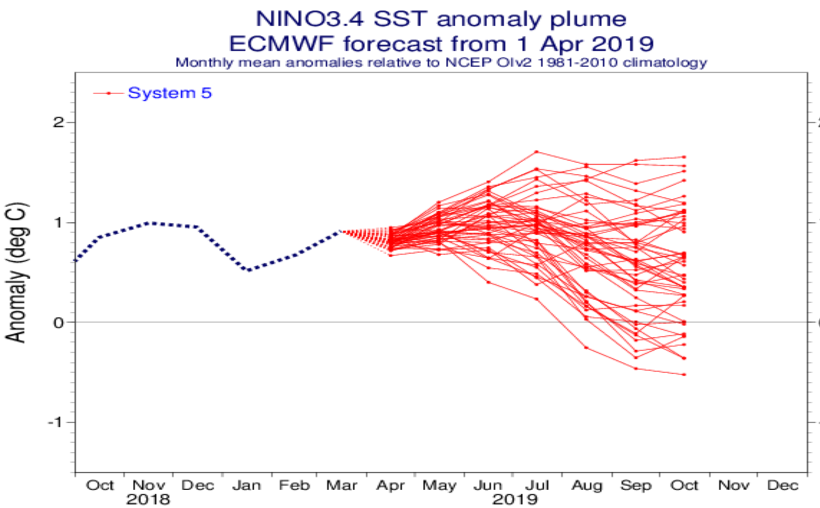




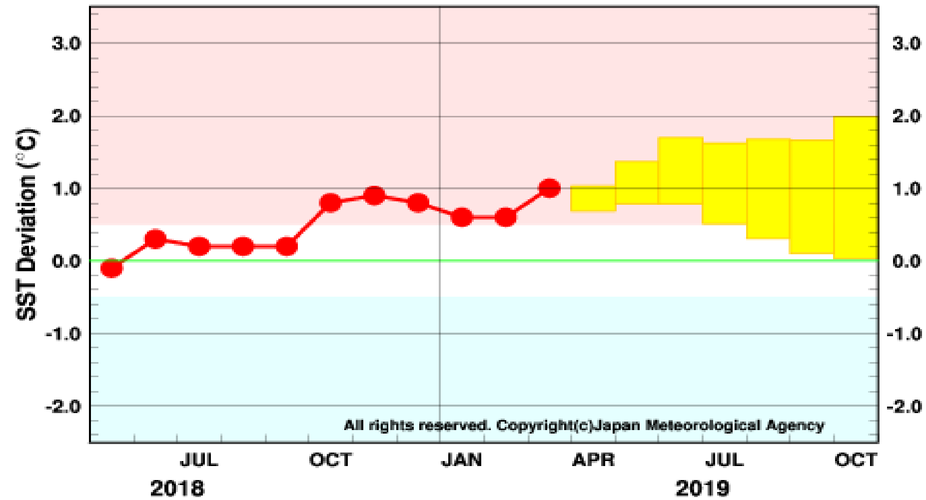
- **Majority of models predict continuation of El Nino in 2019.**
- **NOAA "ENSO Diagnostic Discussion" on 11 Apr 2019 continuously issued "*El Nino Advisory*" and indicated that *"A weak El Niño is likely to continue through the Northern Hemisphere summer 2019 (65% chance) and possibly fall (50-55% chance)."***

Individual Model Forecasts: Neutral or Weak El Nino

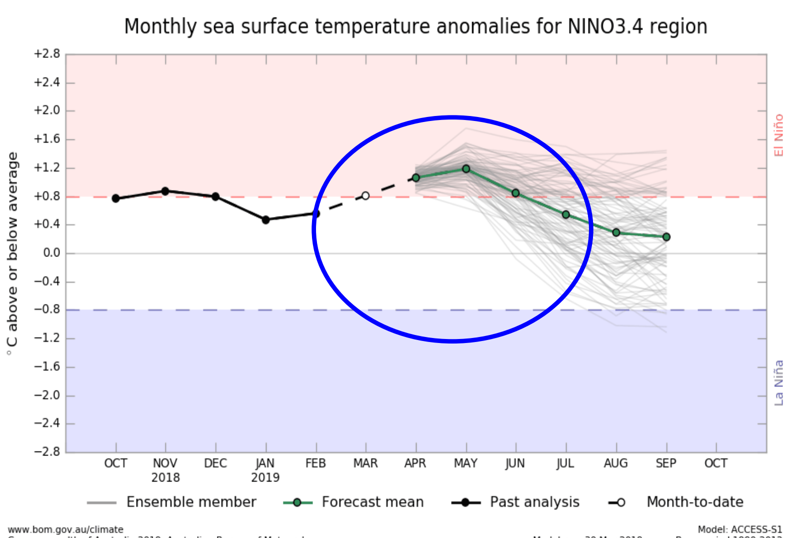
EC: Nino3.4, IC=01Apr 2019



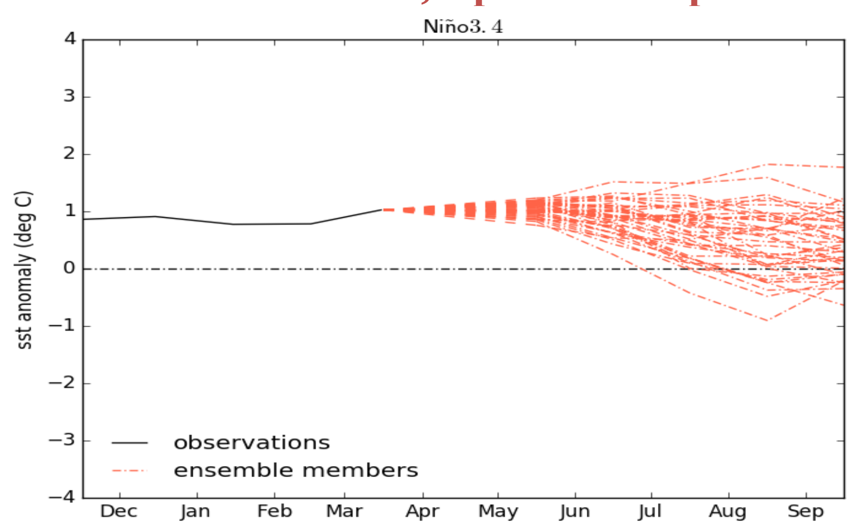
JMA: Nino3, Updated 10 Apr2019

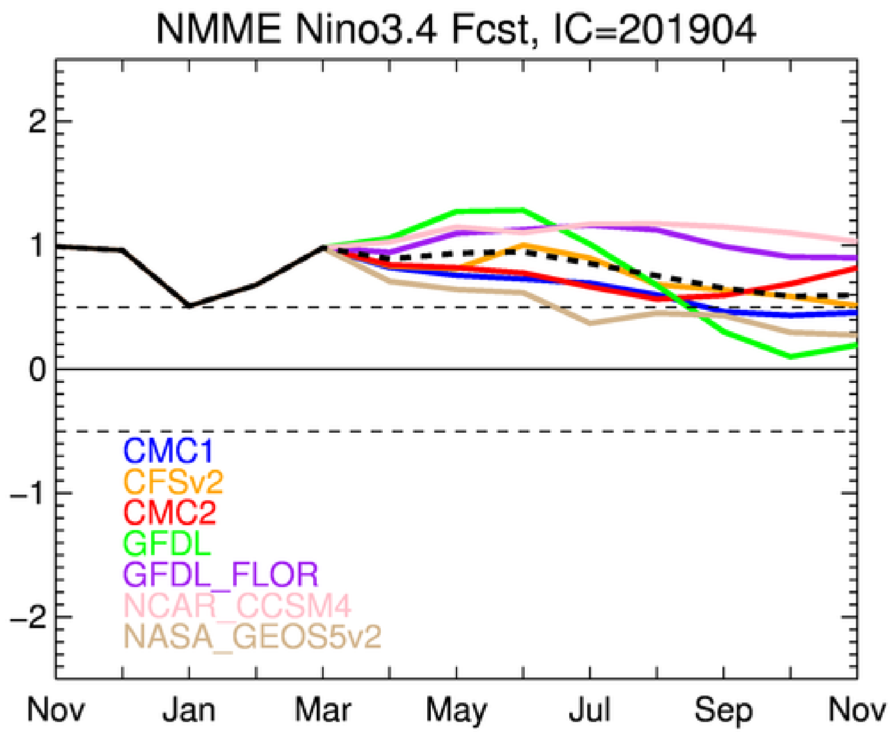


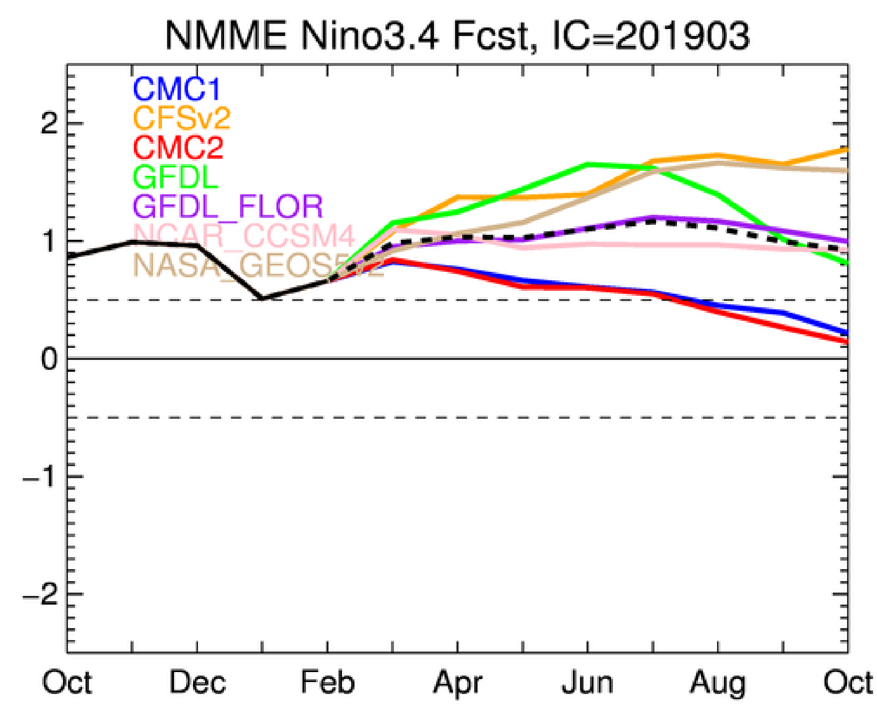
Australia: Nino3.4, Updated 30Mar 2019



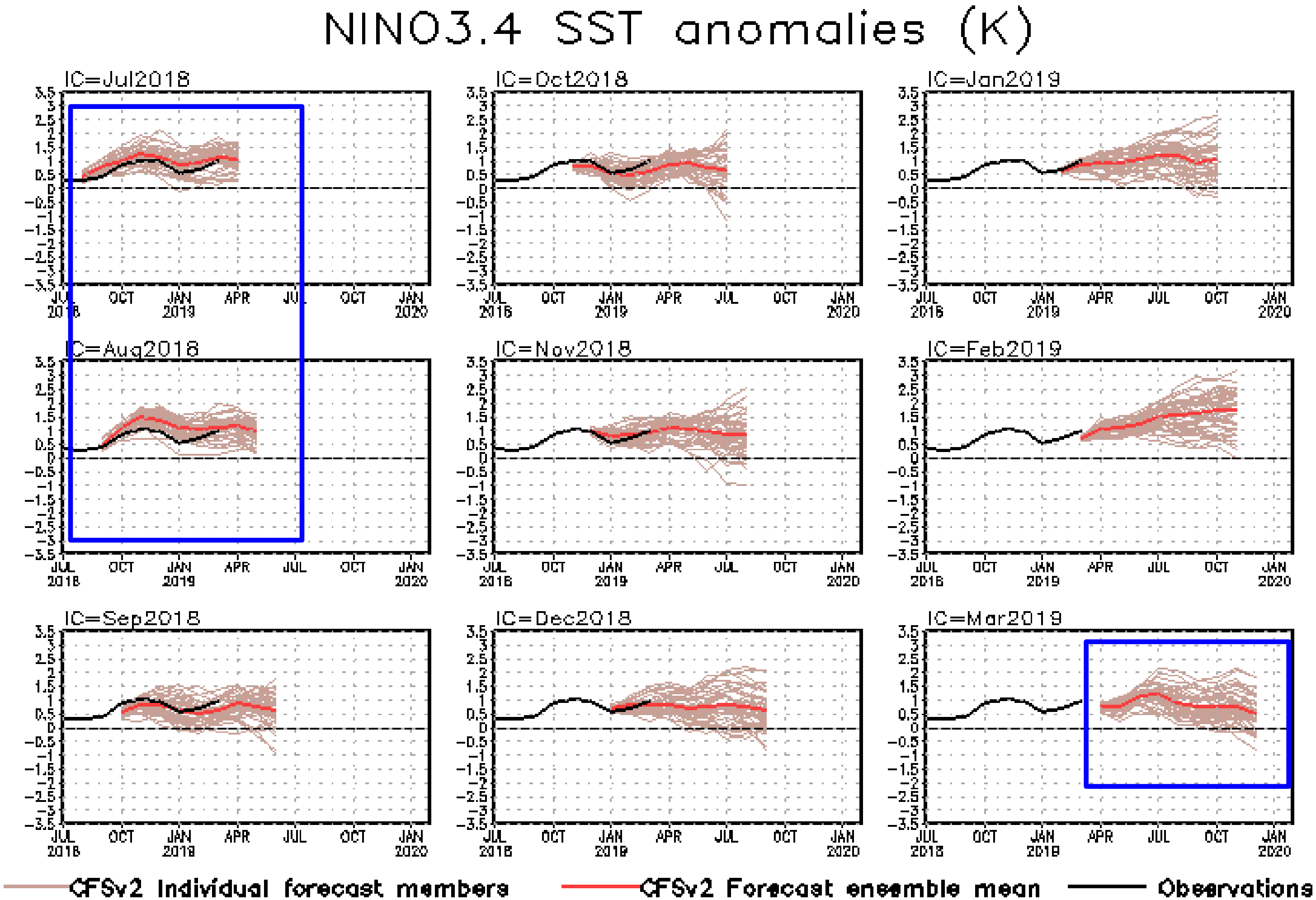
UKMO: Nino3.4, Updated 11 Apr 2019




NMME Nino3.4 Fcst, IC=201904
2
1
0
−1
−2
Nov
Jan
Mar
May
Jul
Sep
Nov
CMC1
CFSv2
CMC2
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2


NMME Nino3.4 Fcst, IC=201903
CMC1
CFSv2
CMC2
GFDL
GFDL_FLOR
NCAR_CCSM4
2
1
0
−1
−2
Oct
Dec
Feb
Apr
Jun
Aug
Oct

CFS Niño3.4 SST Predictions from Different Initial Months

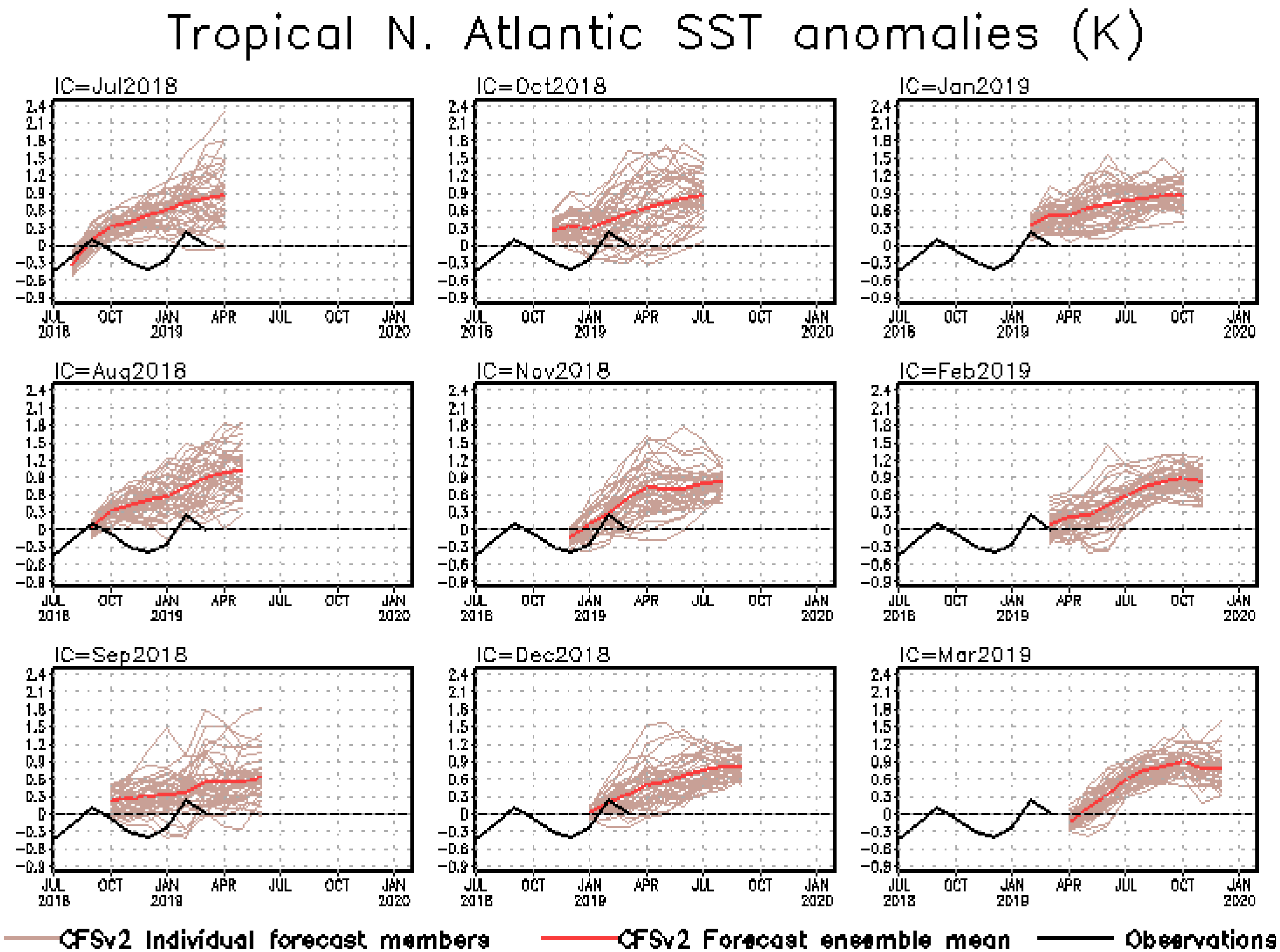


- Latest CFSv2 forecasts call for persistency of El Nino during summer-autumn 2019.
- CFSv2 predictions had warm biases with ICs in Jun-Aug 2018.

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.

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

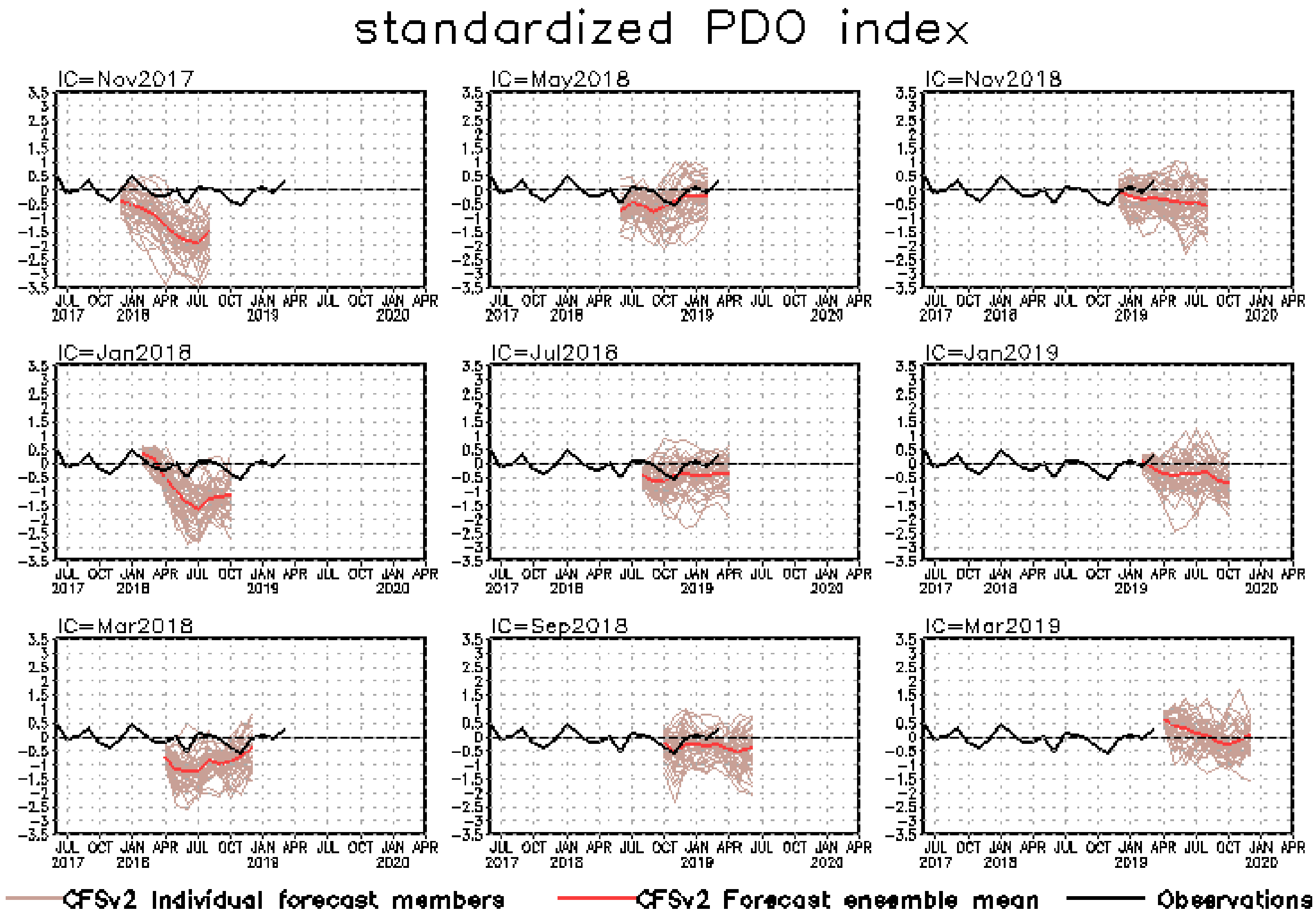
TNA is the SST anomaly averaged in the region of [60°W-30°W, 5°N-20°N].



- **Latest CFSv2 predictions call above normal SSTA in the tropical N. Atlantic in summer-autumn 2019, corresponding to the lag impact of forecast warming in the tropical Pacific.**

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



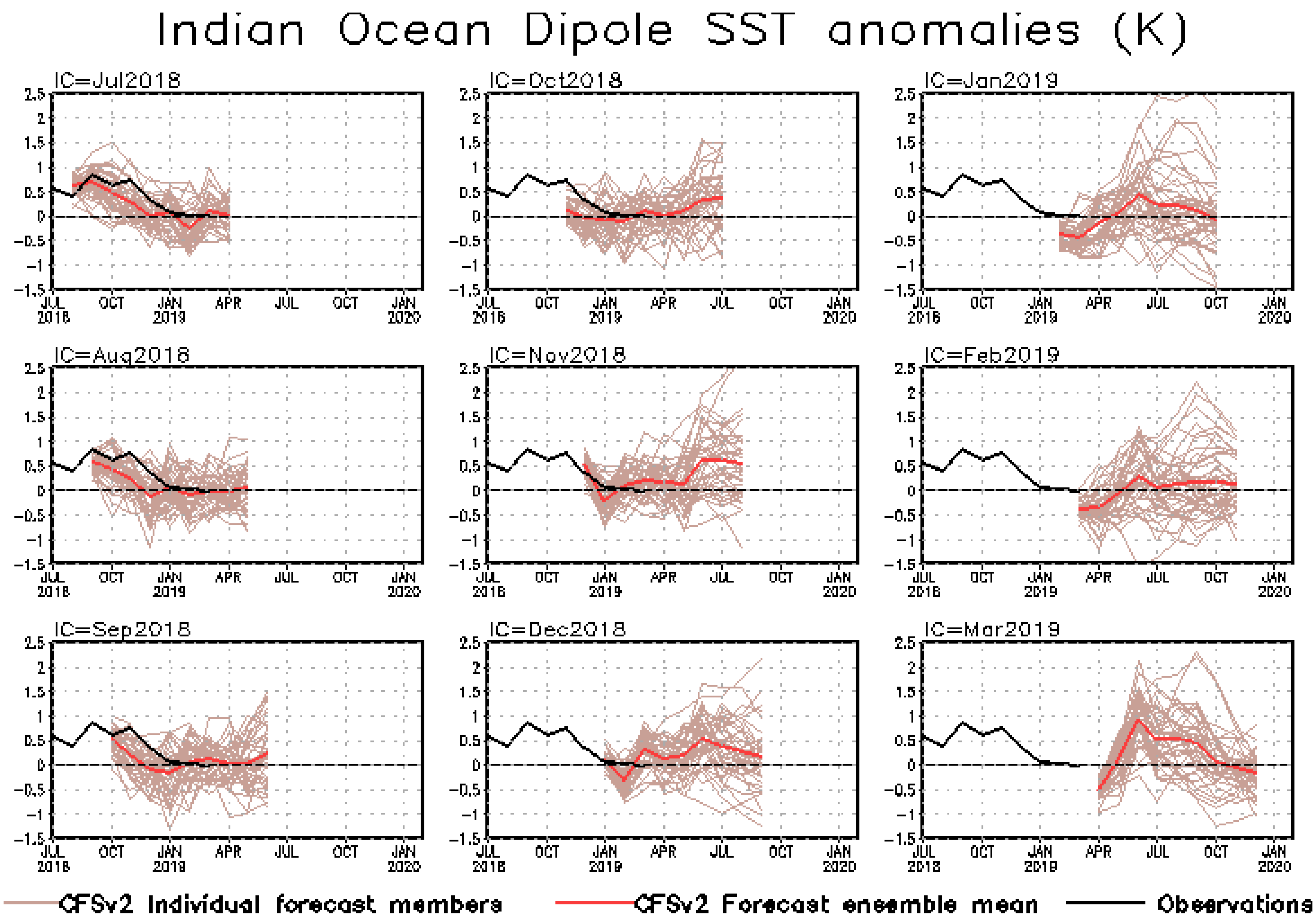
PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

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

- CFSv2 predicts a weak PDO in 2019.

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.

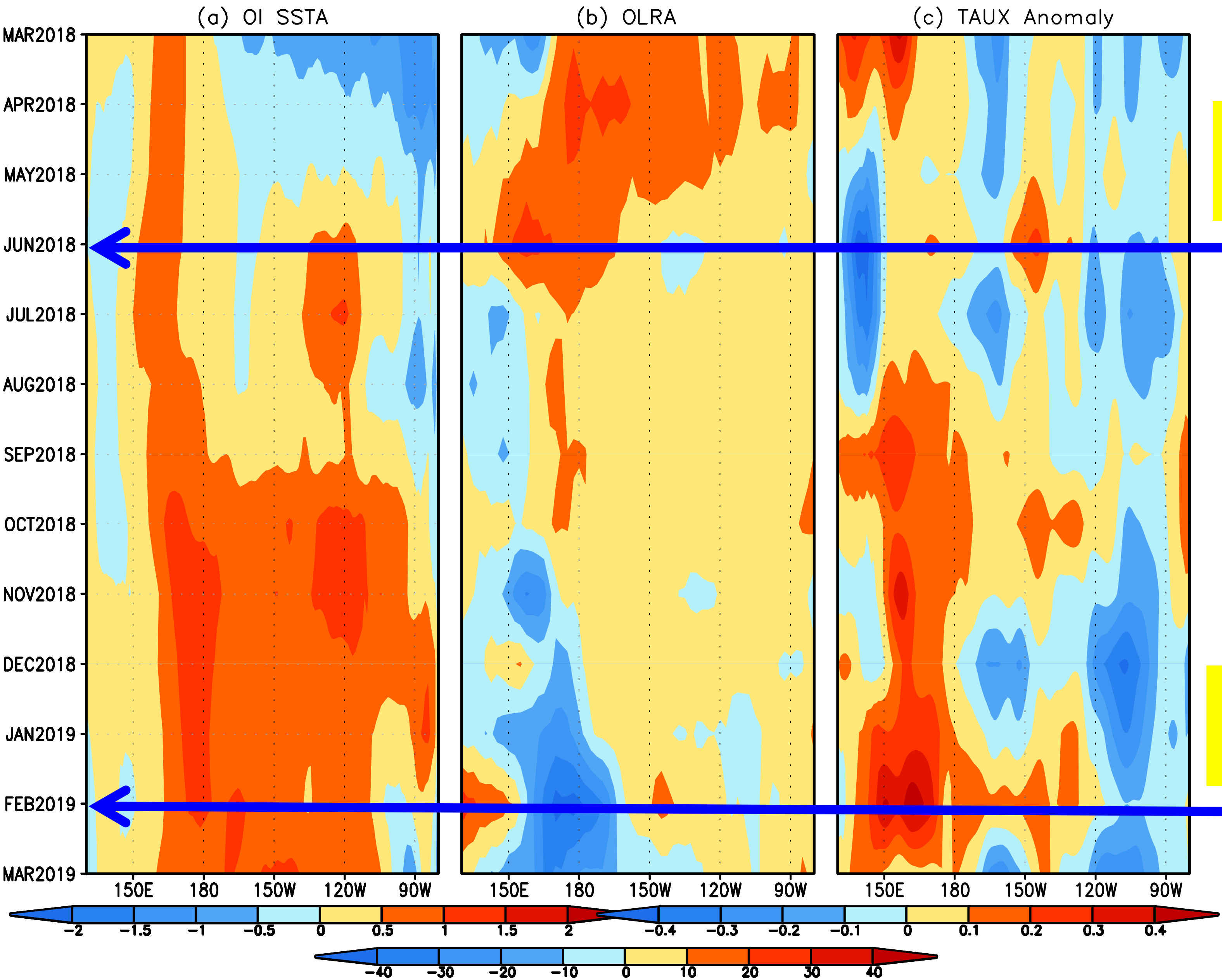
Evolution, Forecasting, and Impact of 2018/19 El Nino

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2018	-0.9	-0.8	-0.6	-0.4	-0.1	0.1	0.1	0.2	0.4	0.7	0.8	0.8
2019	0.8	0.8										

For historical purposes, periods of below and above normal SSTs are colored in blue and red when the threshold is met for a minimum of 5 consecutive overlapping seasons. The Oceanic Nino Index is one measure of the ENSO, and other indices can confirm whether features consistent with a coupled ocean-atmosphere phenomenon accompanied these periods.

https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

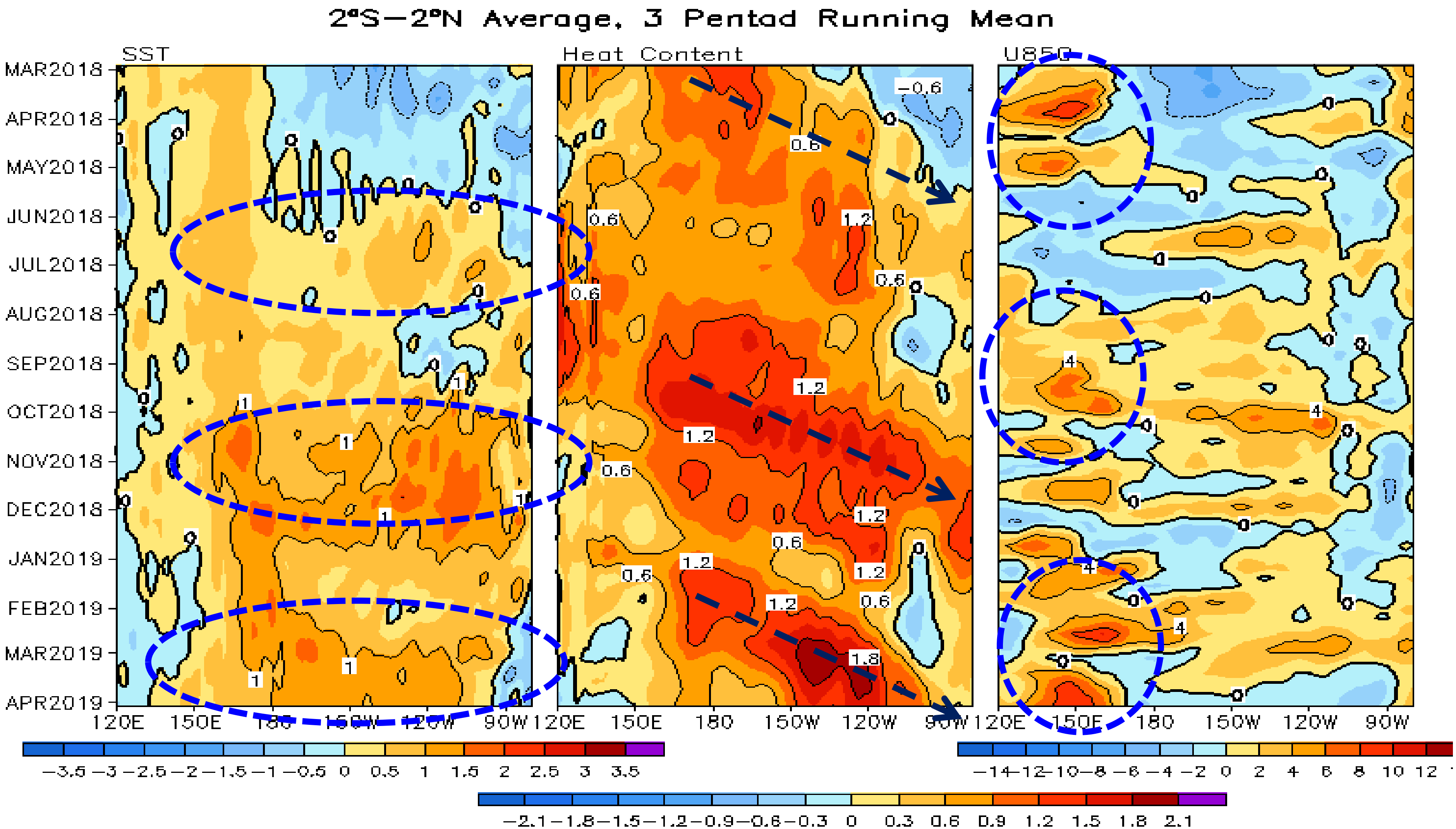
SST & OLR & TAUX Anomalies



CPC issued El Nino Watch on 14 June, 2018

CPC issued El Nino Advisory on 14 Feb, 2019

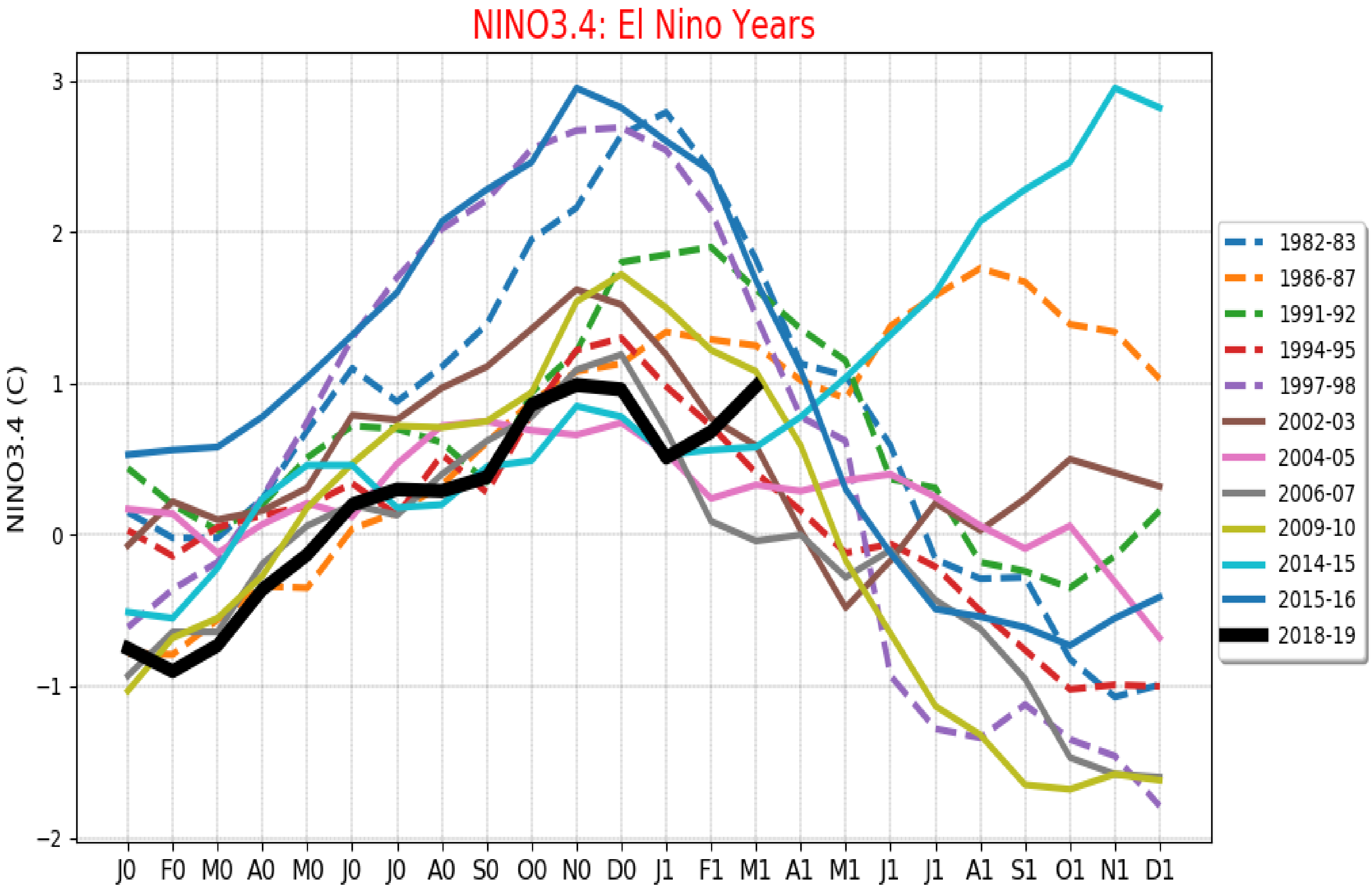
Equatorial Pacific SST (°C), HC300 (°C), u850 (m/s) Anomalies



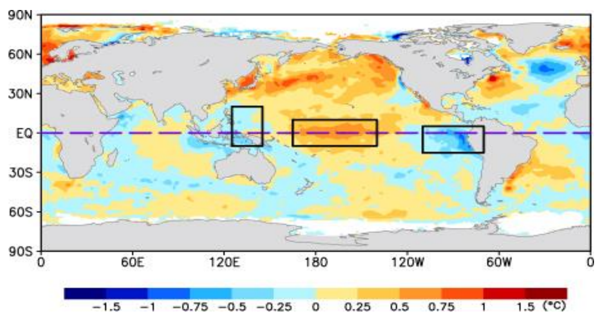
- **Positive SSTA in the central and eastern Pacific persisted in the last month.**
- **Positive HC300A propagated eastward in Mar 2019, and low-level westerly wind bursts were observed in Feb and Mar 2019.**

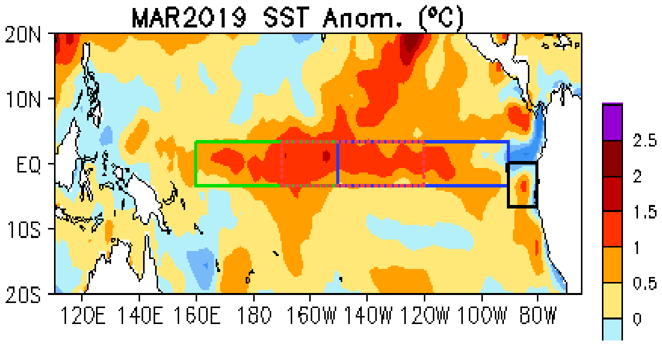
Nino3.4 Evolution In El Nino Years

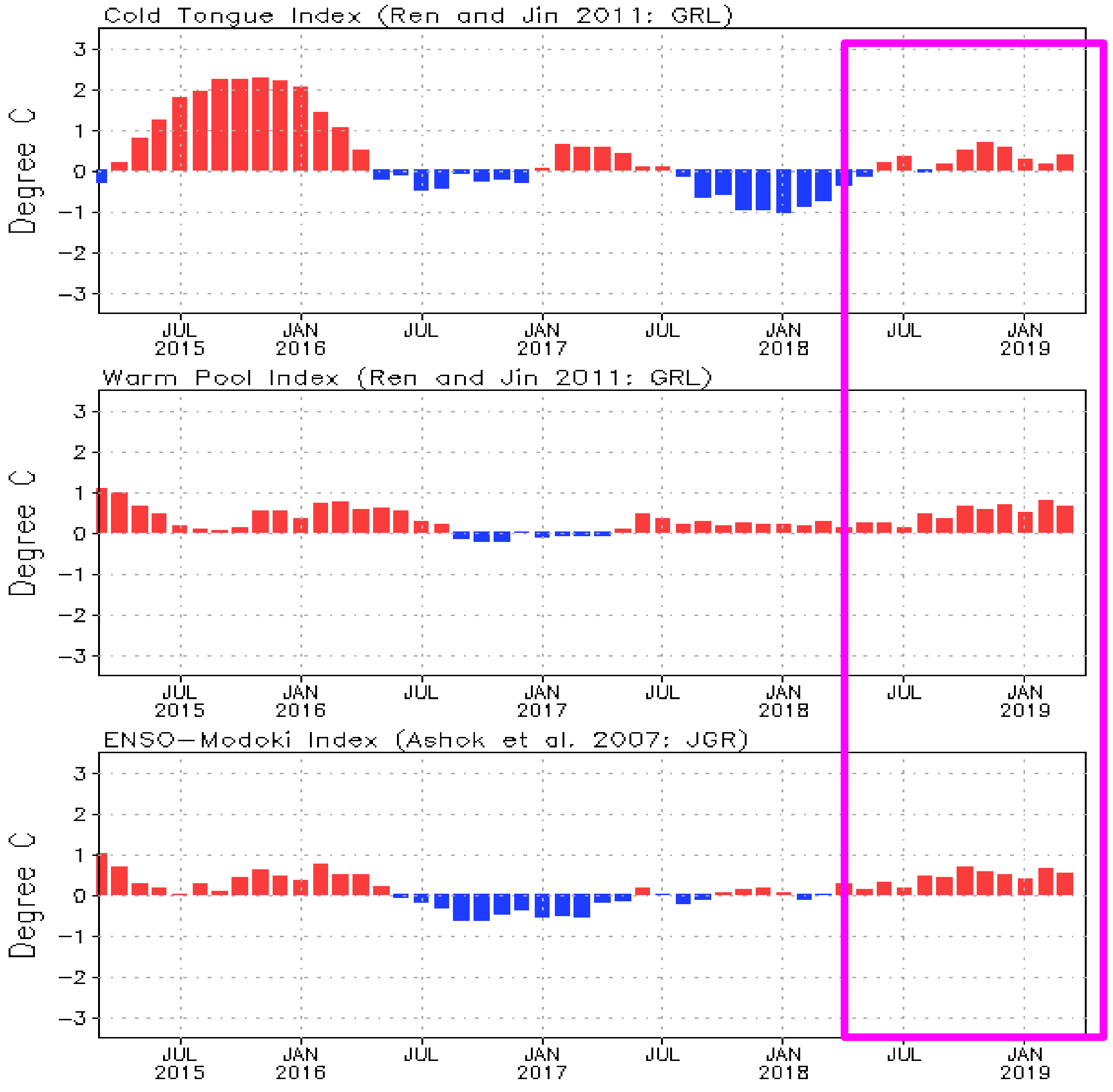
Provided by Yan Xue

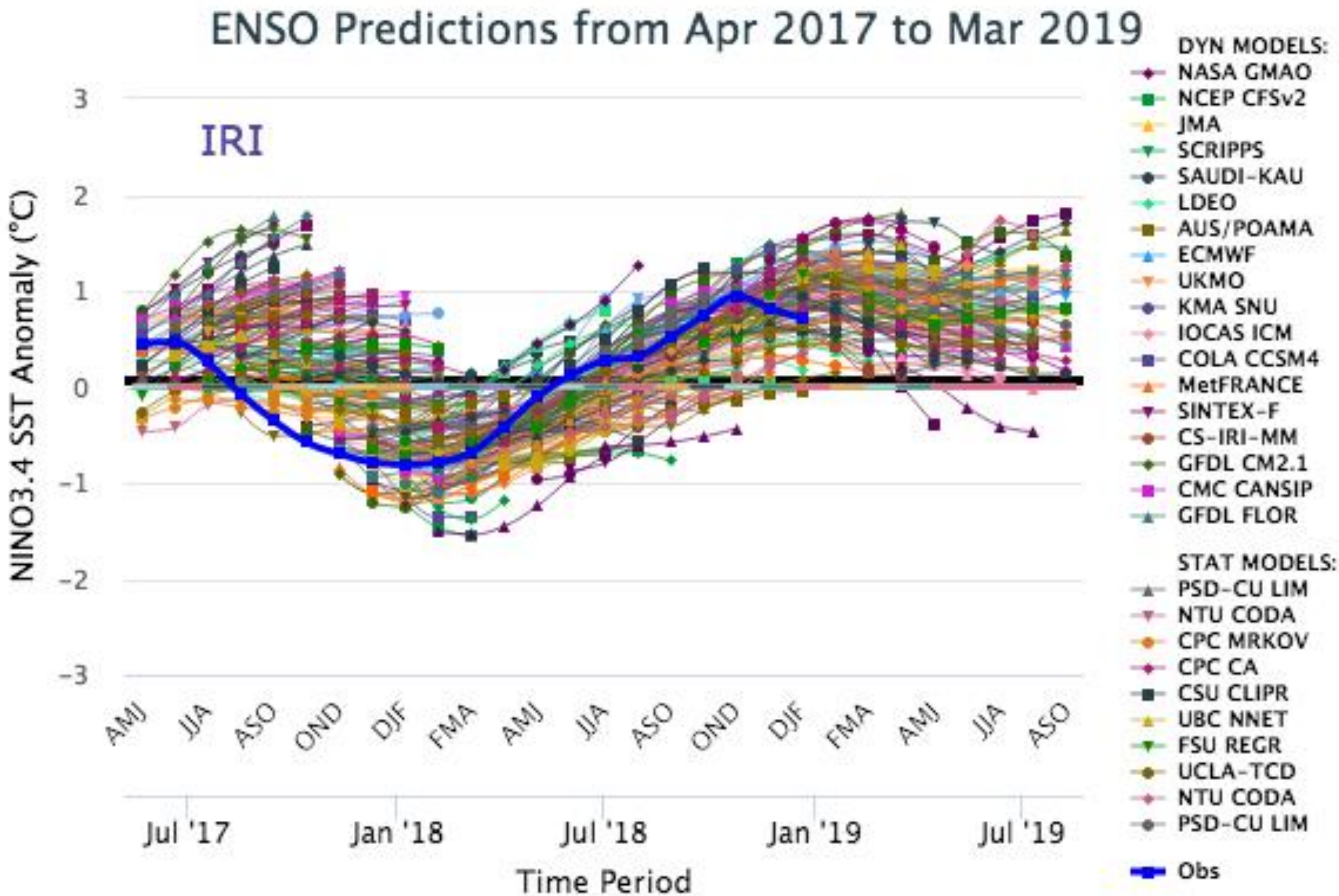


Positive SSTAs were larger in the warm pool than in the cold tongue, so 2018/19 event is CP or CP/EP mixed type El Nino.

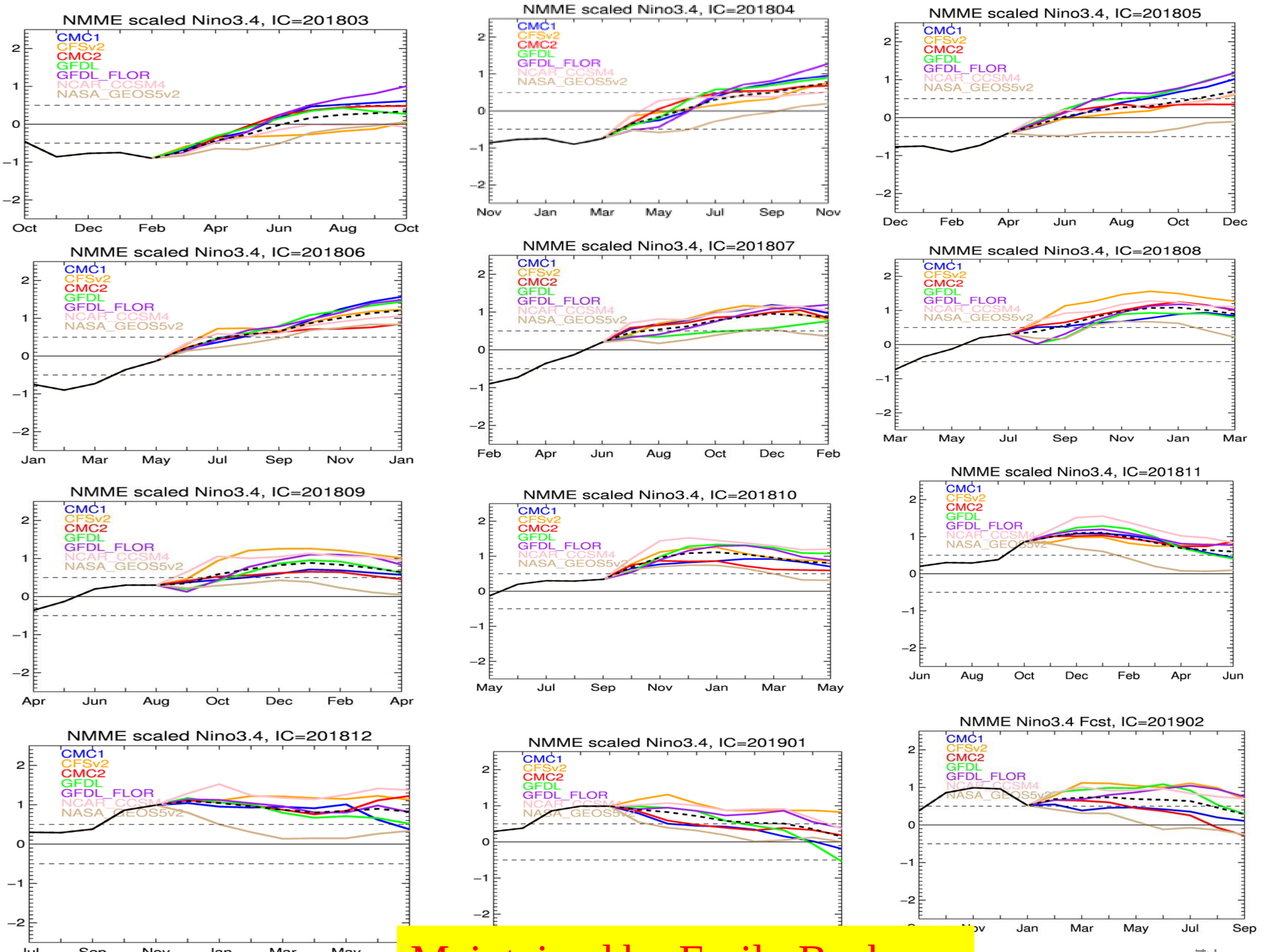




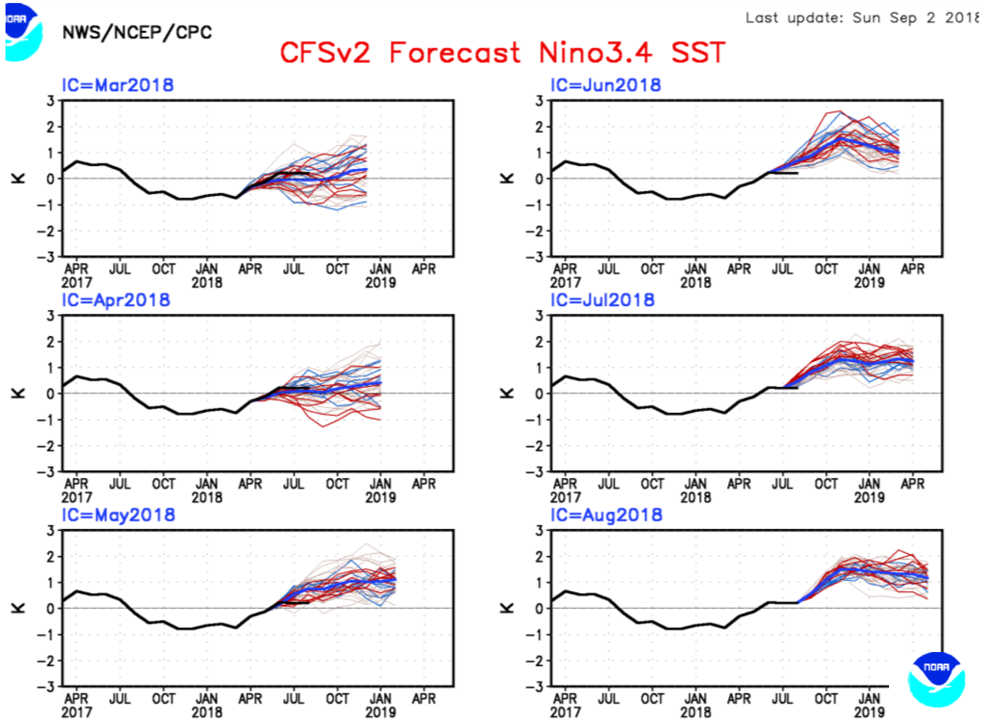


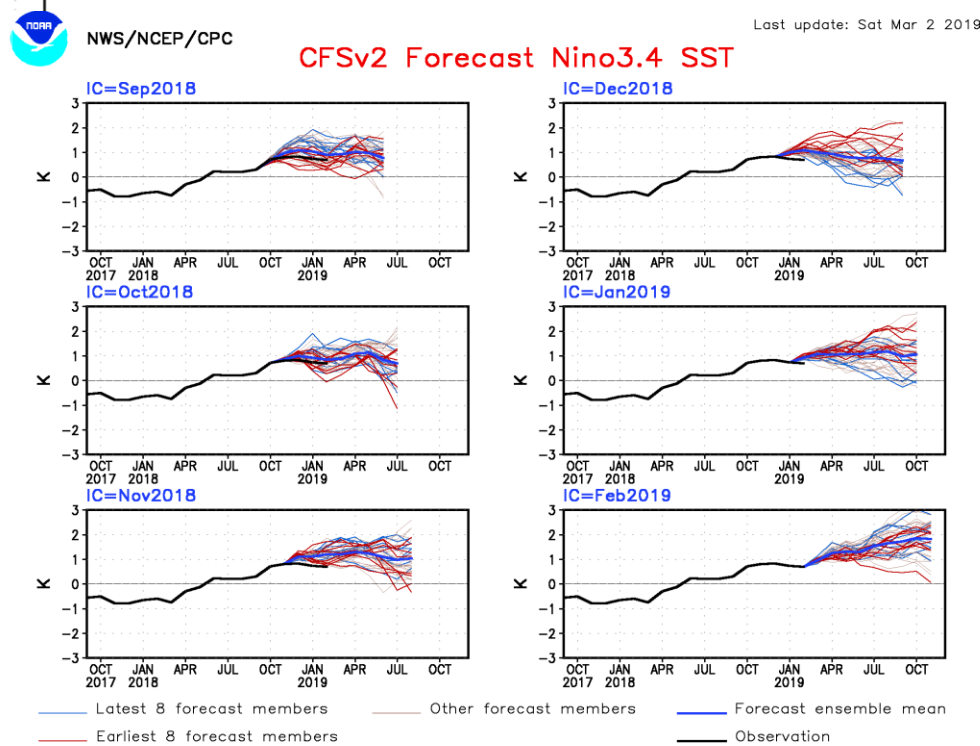


https://iri.columbia.edu/wp-content/uploads/2019/03/all.png



Maintained by Emily Becker

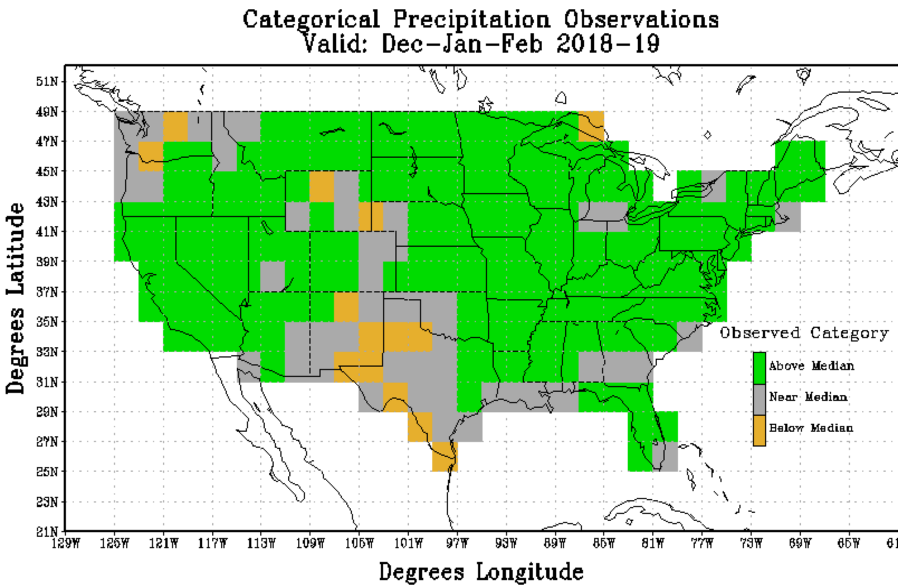


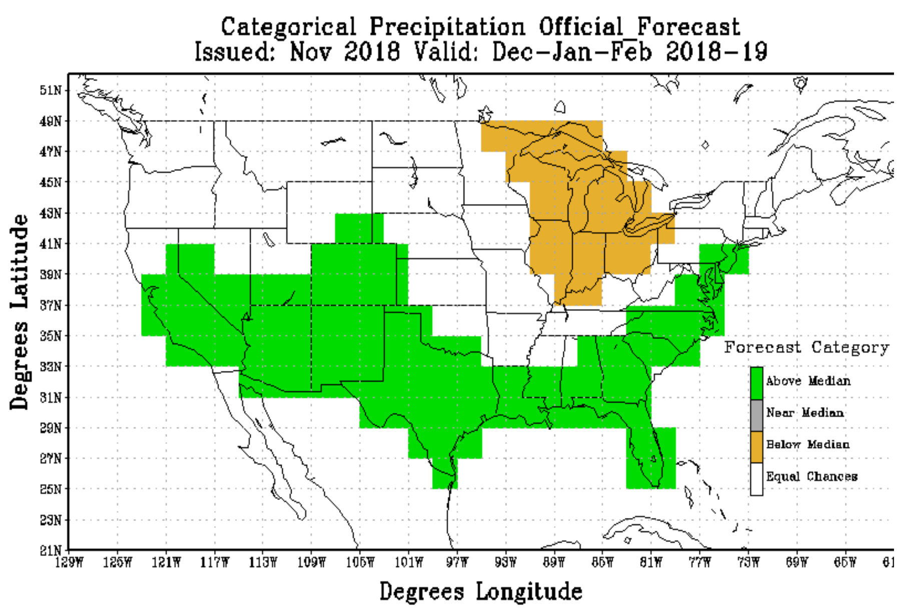


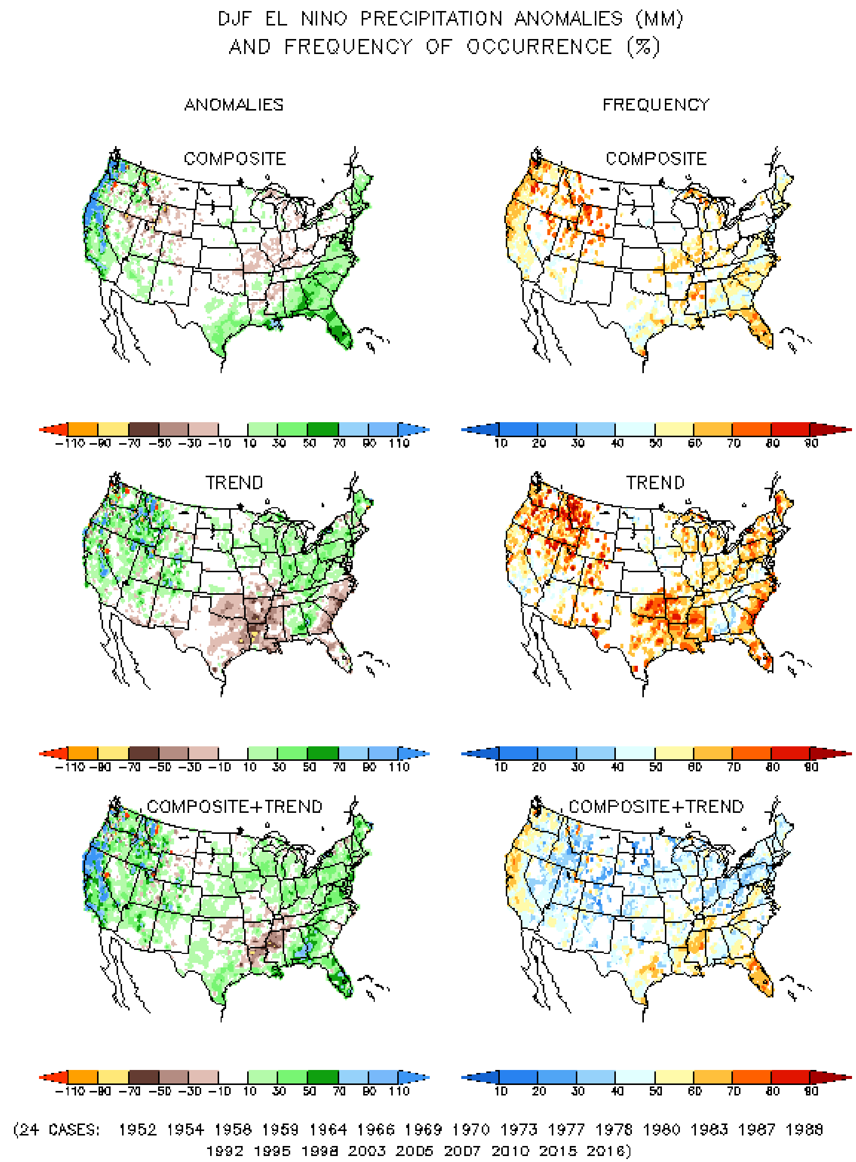
Maintained by Wanqiu Wang

DJF Precipitation Anomaly

(Non-Equal Chance forecasts: **15.16%**; All forecasts: **7.97%**)

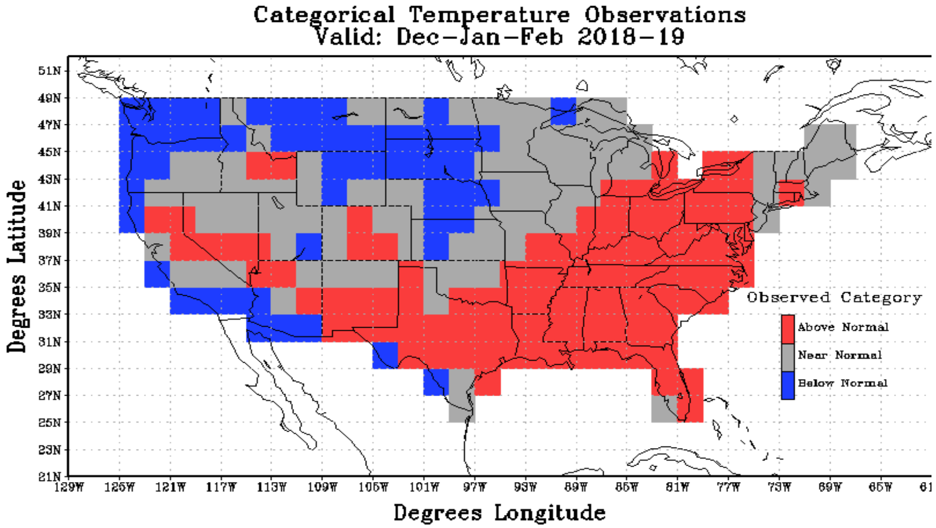


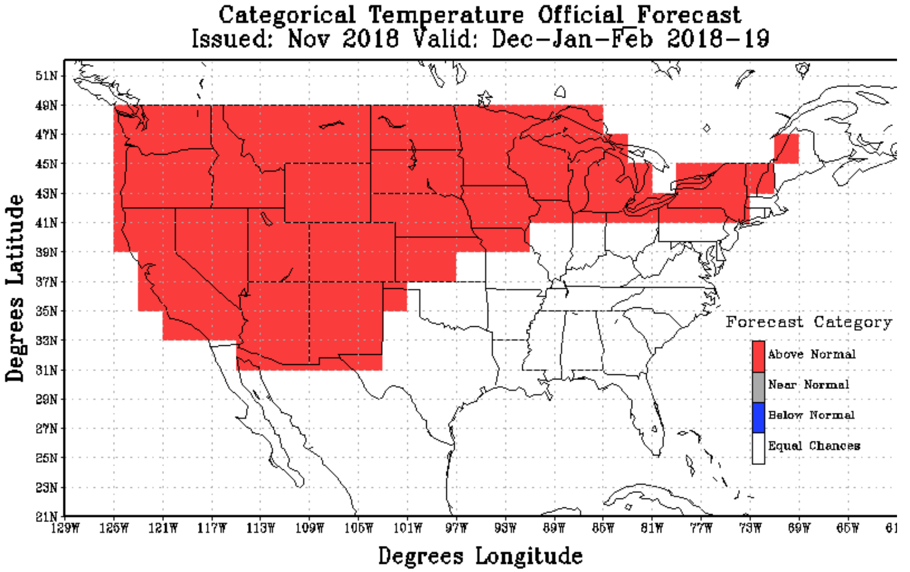


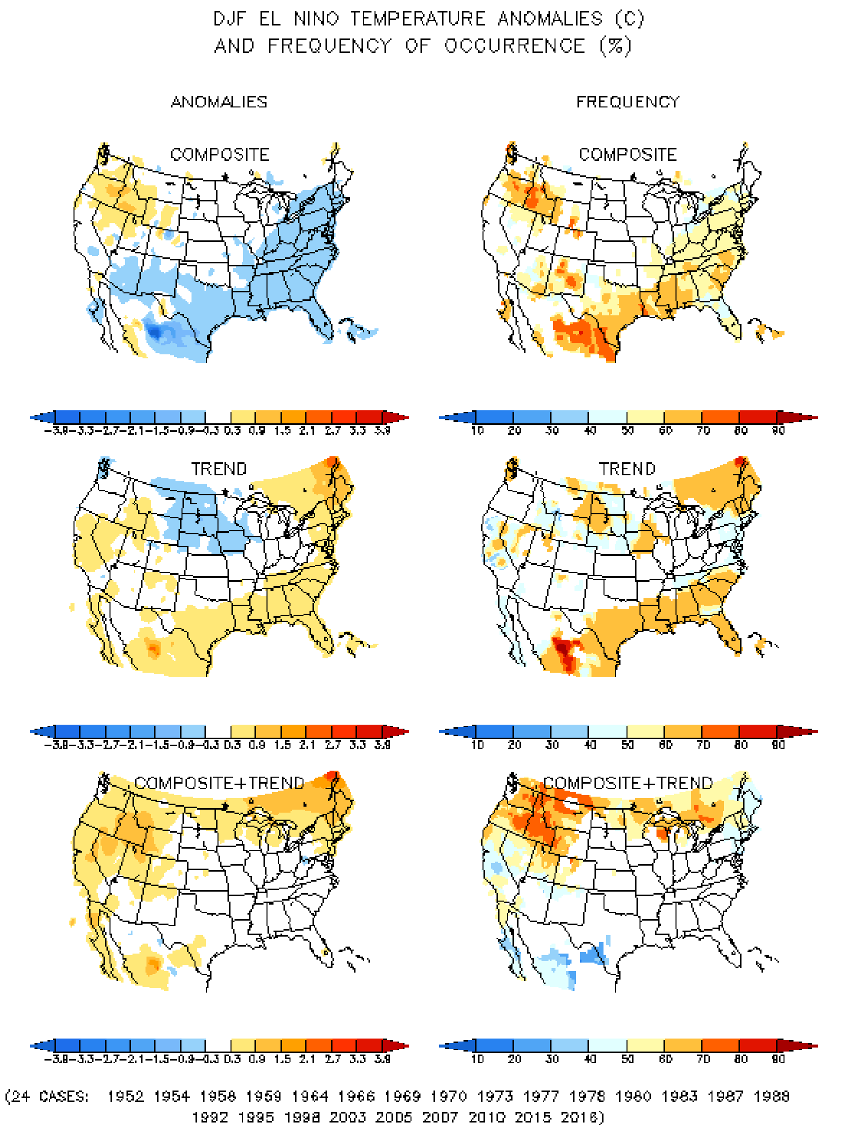


DJF Temperature Anomaly

(Non-Equal Chance forecasts: **-20.00%**; All forecasts: **-12.93%**)

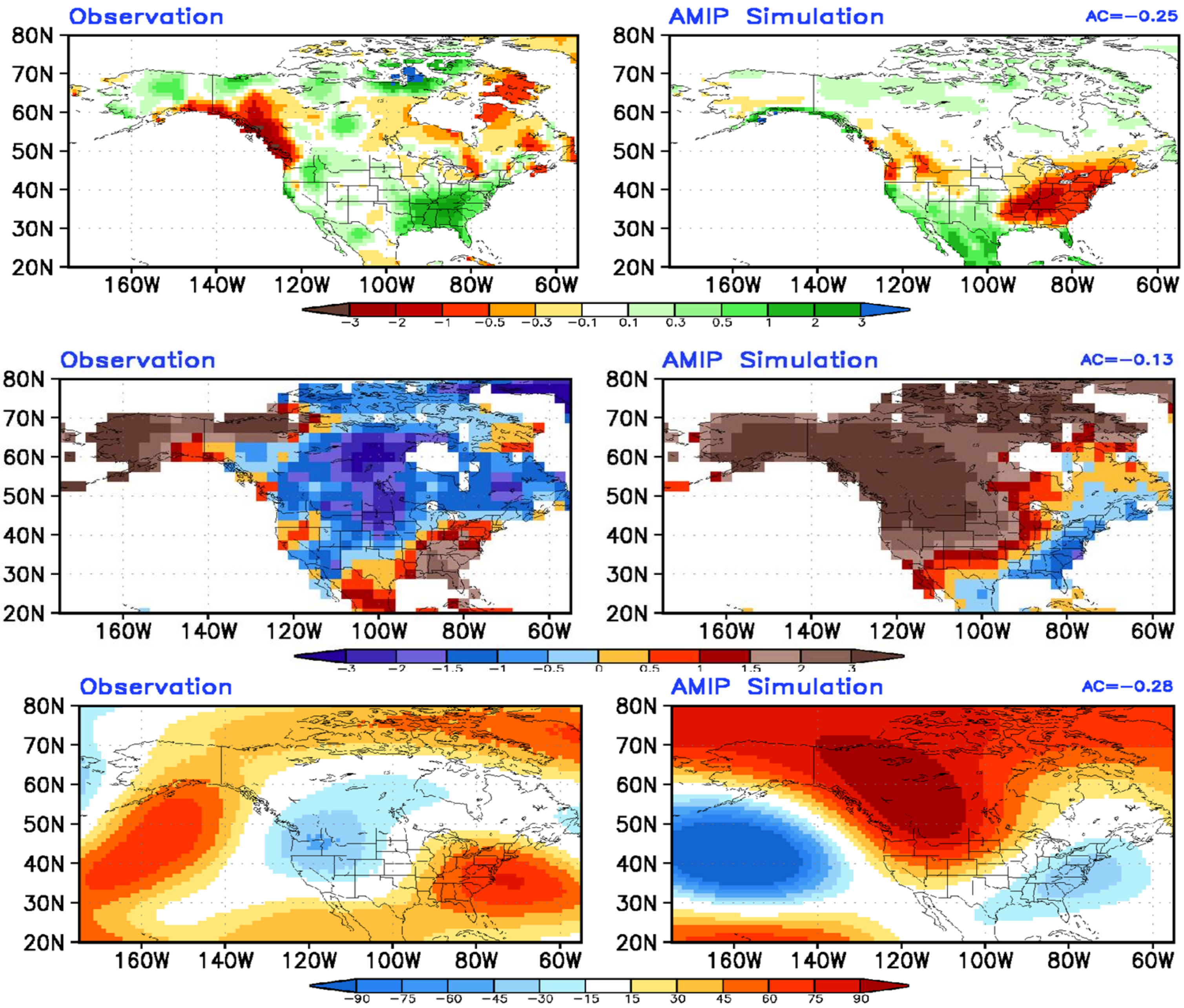






2018/19 DJF Observed and AMIP Simulated Prate; T2m & Z200 Anomalies

From
Arun Kumar,
Mingyue Chen
& Bhaskar Jha



Prate

T2m

Z200

- A weak warm event occurred since SON 2018;
- The maximum SST warming presented in the central tropical Pacific and it is a CP or CP/EP mixed type El Nino;
- NMME models basically captured the evolution with ICs since Mar 2018;
- US climate anomalies in DJF 2018/19 were not a typical (EP) El Nino forced pattern.

Acknowledgements

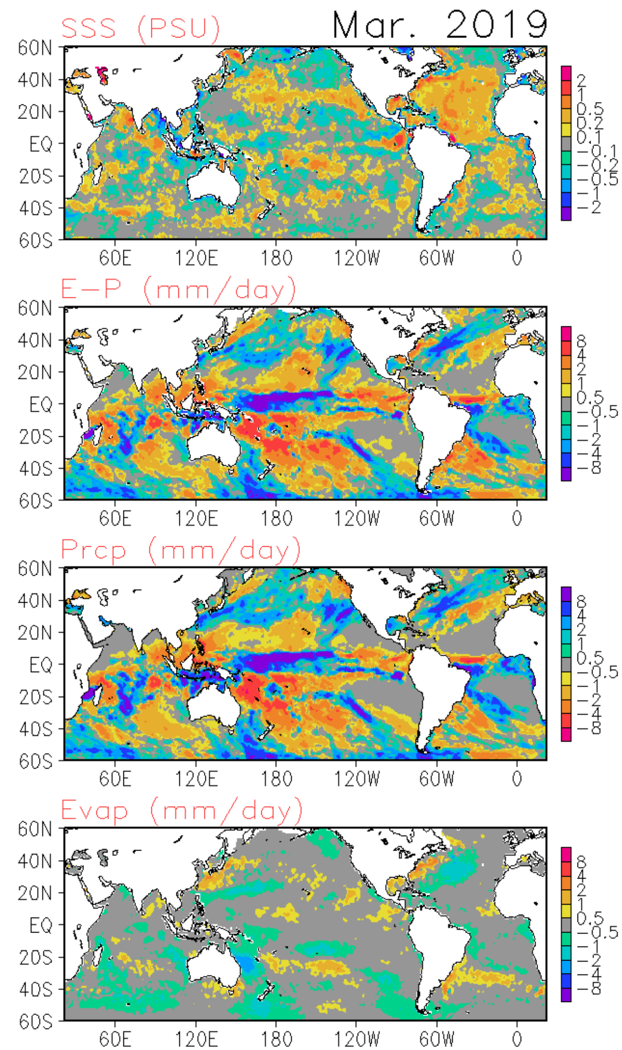
- Drs. Caihong Wen, Yan Xue, and Arun Kumar: reviewed PPT, and provide insight and constructive suggestions and comments
- Drs. Li Ren and Pingping Xie provided the BASS/CMORPH/CFSR EVAP package
- Dr. Emily Becker provided the NMME NINO3.4 plot
- Dr. Wanqiu Wang maintained the CFSv2 forecast achieve
- Dr. Bhaskar Jha maintained the AMIP runs.

Backup Slides

Global Sea Surface Salinity (SSS)

Anomaly for March 2019

- **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 positive SSS signal around 20°N in the Pacific Ocean appeared this month with the enhanced freshwater input in these areas, which suggests that oceanic advection/entrainments likely contribute to such positive SSS anomalies. The positive SSS signal became stronger along the eastern equatorial Pacific Ocean, which is co-incident with reduced freshwater input. The positive SSS signal in the majority of the N. Atlantic Ocean from equator to 40°N continues.



- **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

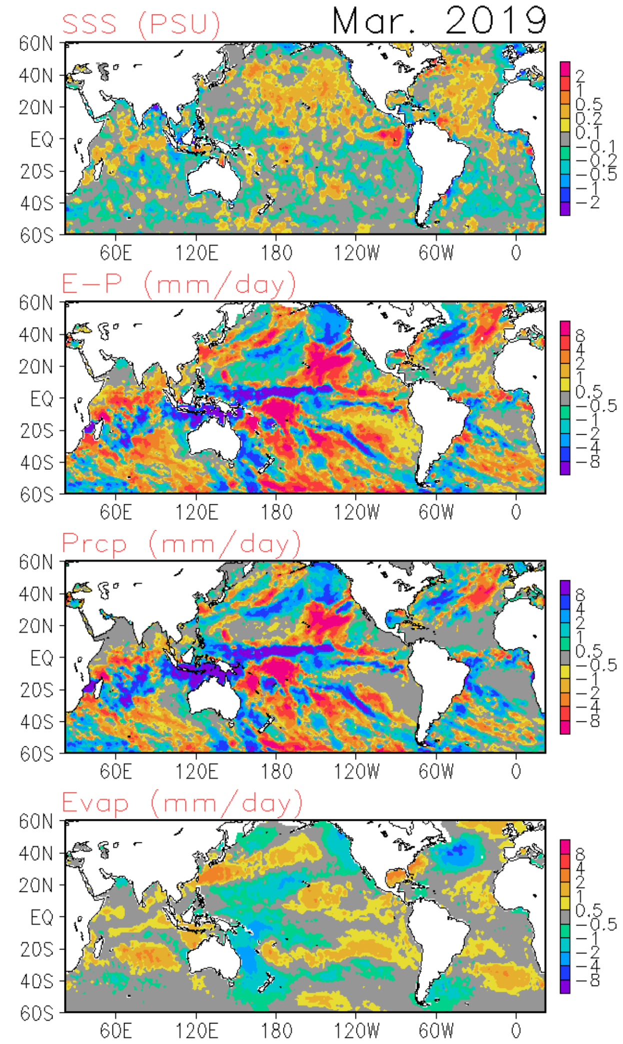
  Precipitation: CMORPH adjusted satellite precipitation estimates

  Evaporation: Adjusted CFS Reanalysis

Global Sea Surface Salinity (SSS)

Tendency for March 2019

Compared with last month, the SSS increased between equator and 40ºN in the Pacific Ocean, particularly in the east basin. In the Equatorial region of the Pacific Ocean, the SSS increased in the eastern region, which is co-incident with reduced precipitation. The SSS increased between equator and 40ºN in the Atlantic ocean as well. The SSS continues decreasing in most of the areas in the southern Ocean (south of 30ºS), which is likely caused by oceanic advection and/or entrainments.

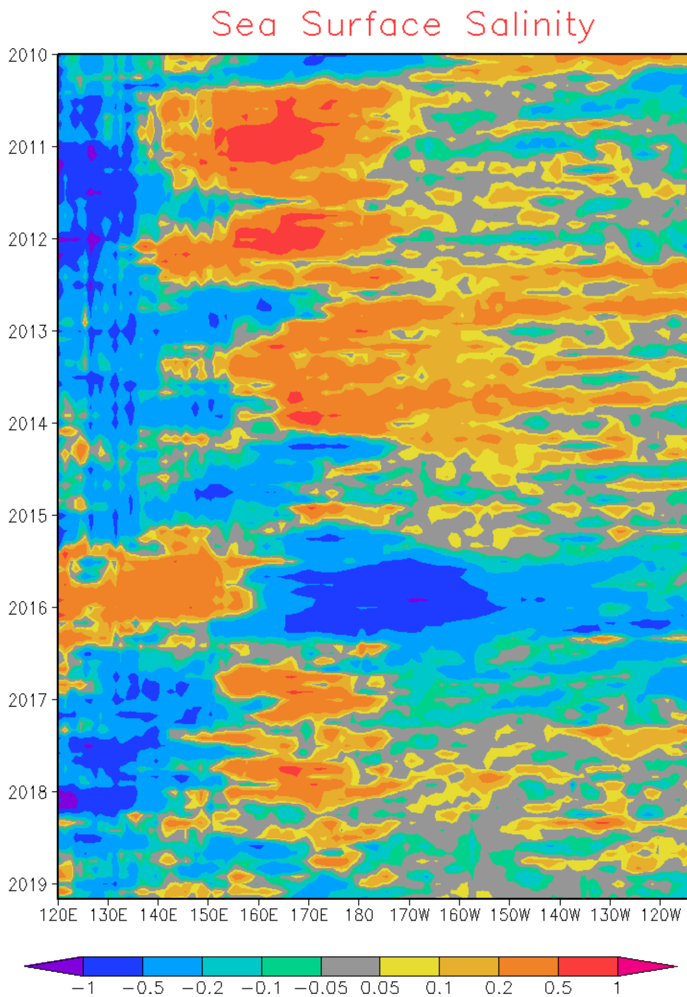


Global Sea Surface Salinity (SSS)

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.

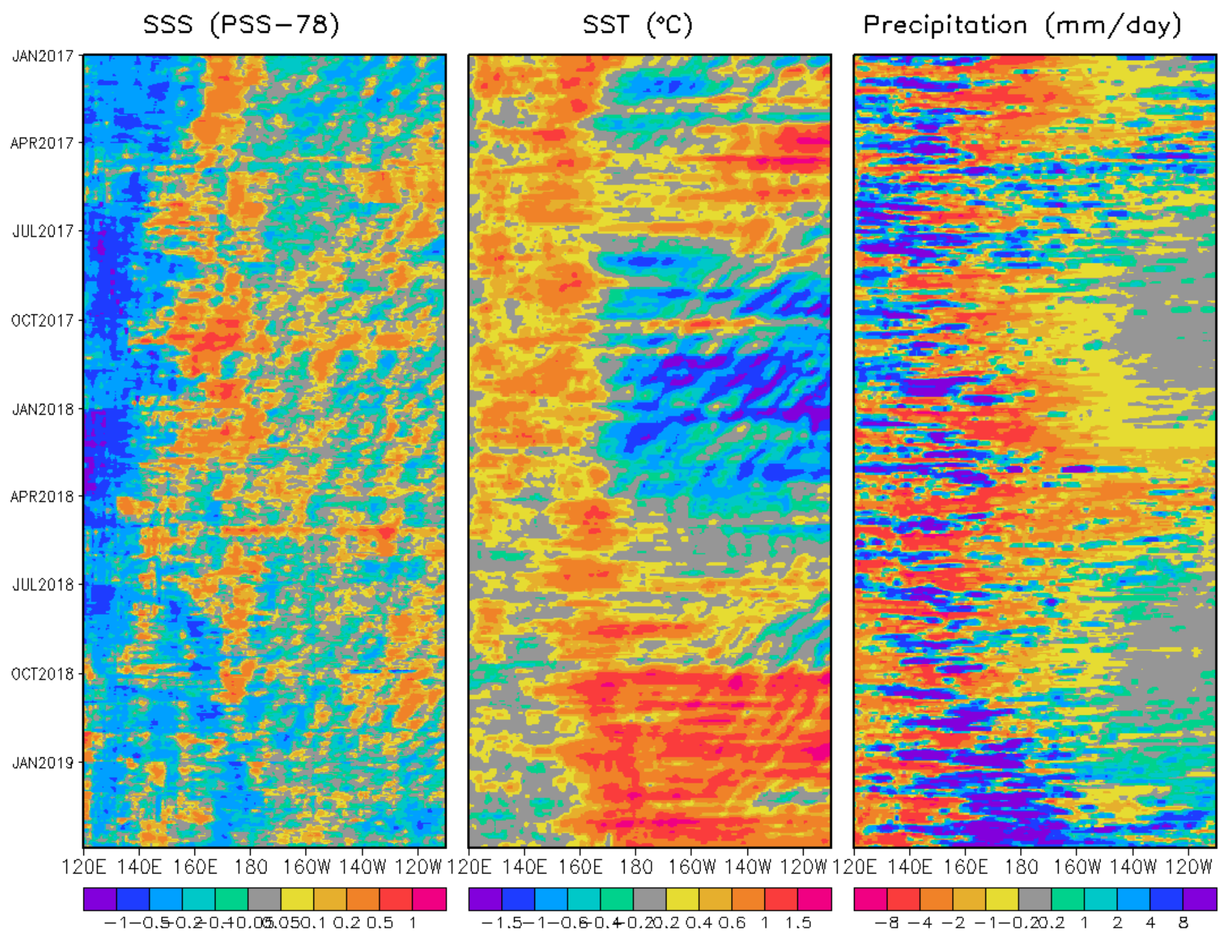
- Hovemoller diagram for equatorial SSS anomaly **(5˚S-5˚N);**
- In the equatorial Pacific Ocean, the SSS signal starts to change to positive from 140°E to 160°E, the SSS appears neutral in most of the regions east of 160°W



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.



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

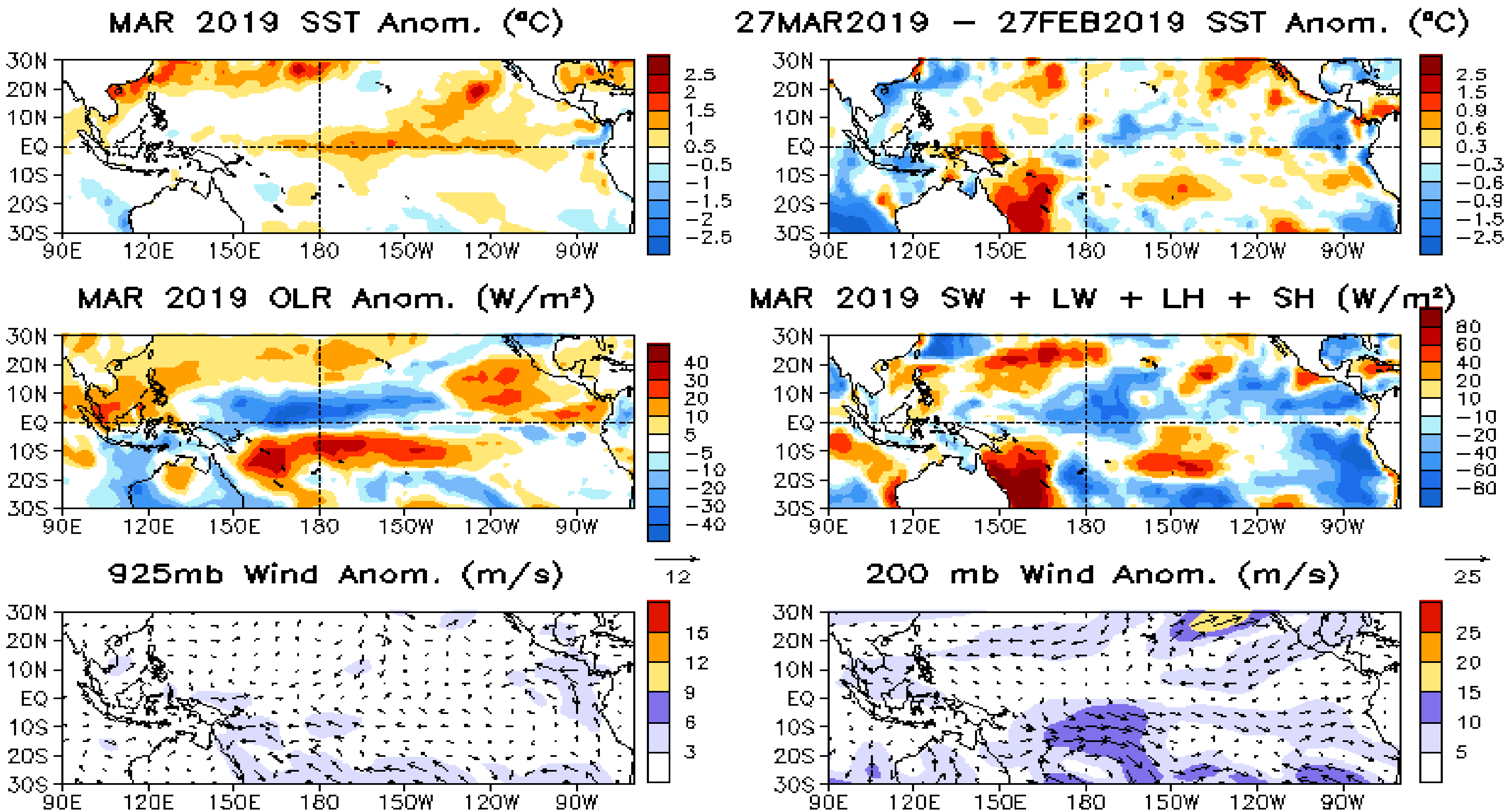
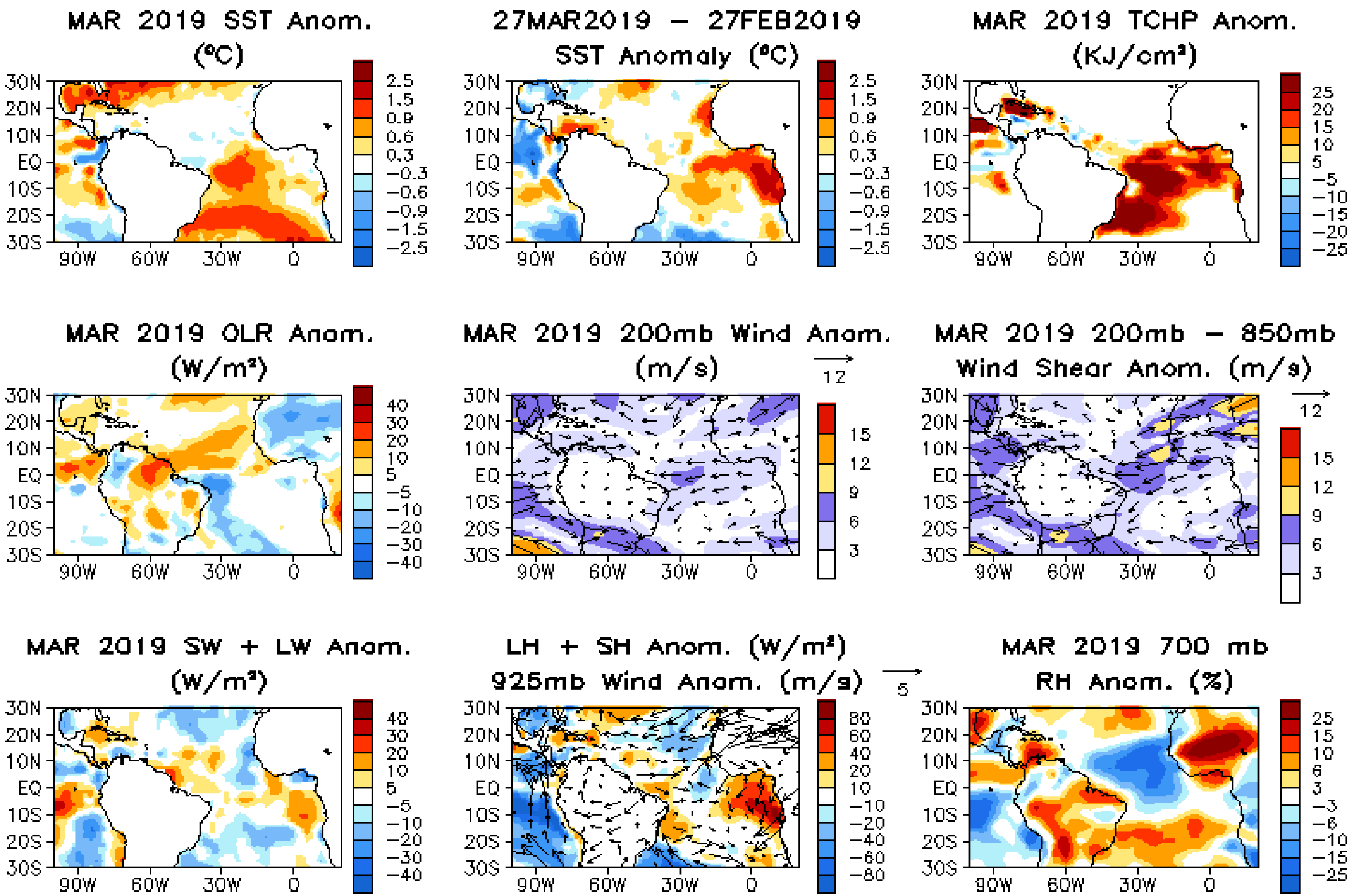


Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

Tropical Atlantic:



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

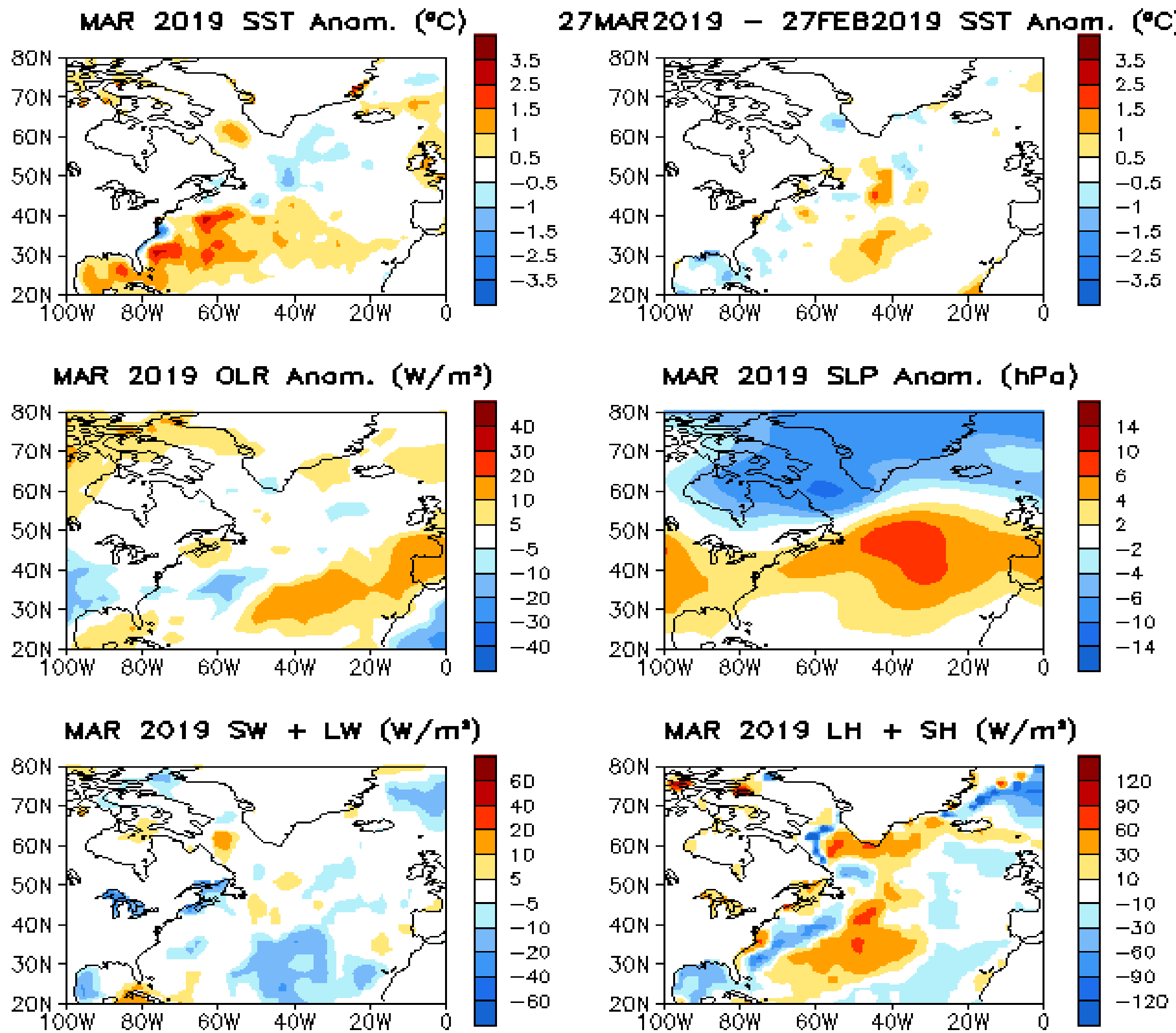
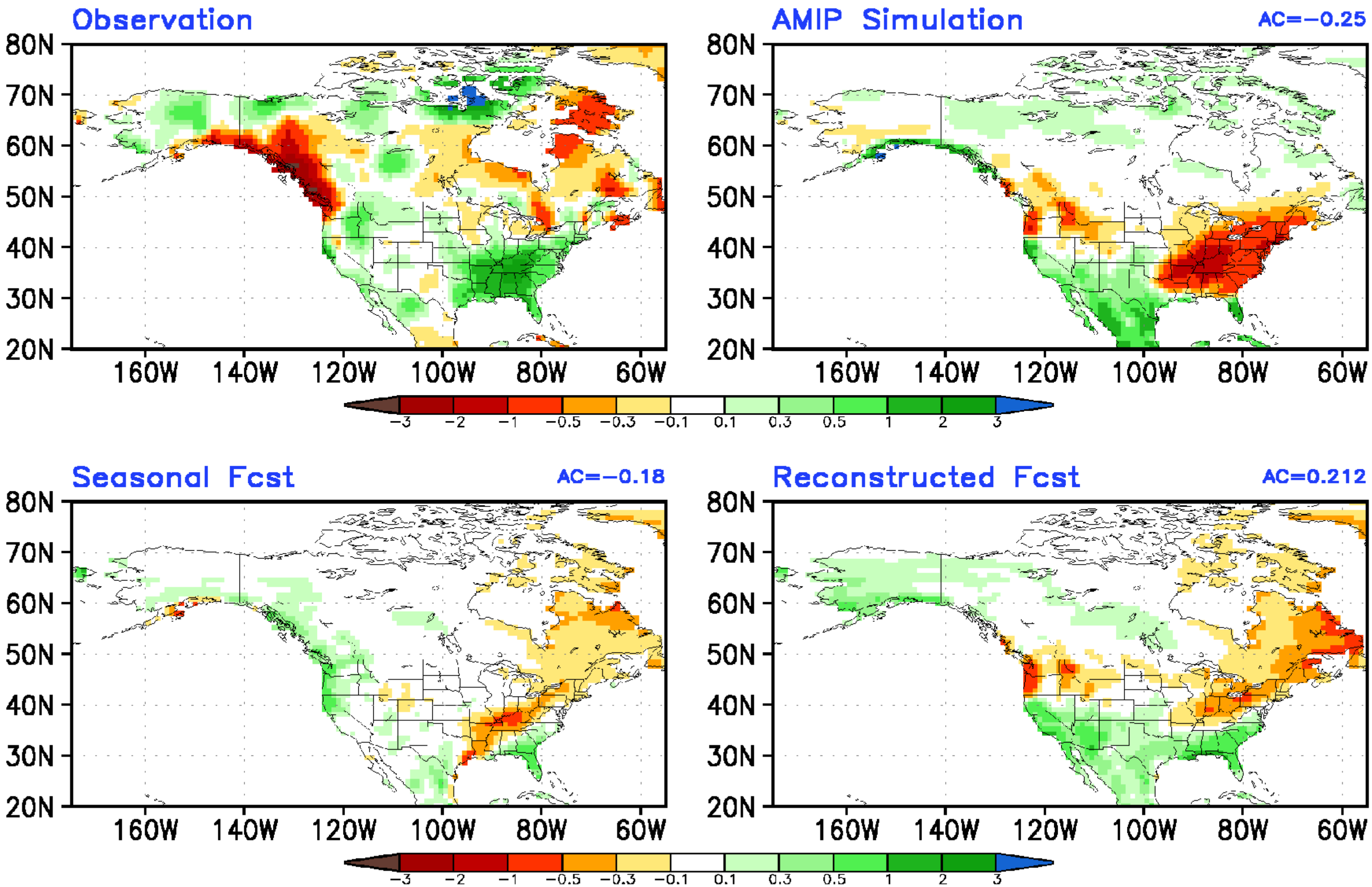


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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

DJF2018/2019 Observed & Model Simulated/Forecast Ensemble Average Anomalies Prec(mm/day)



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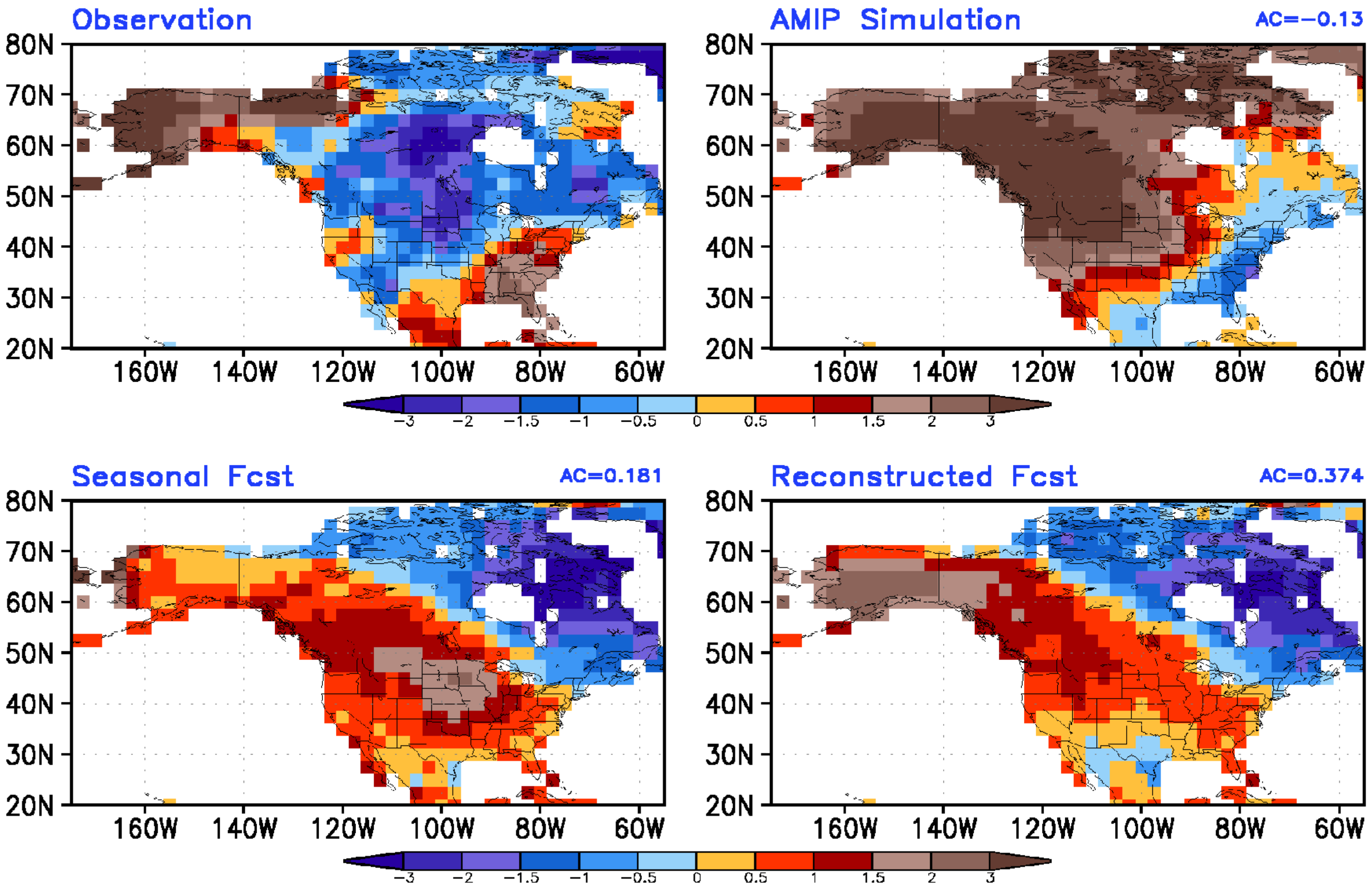
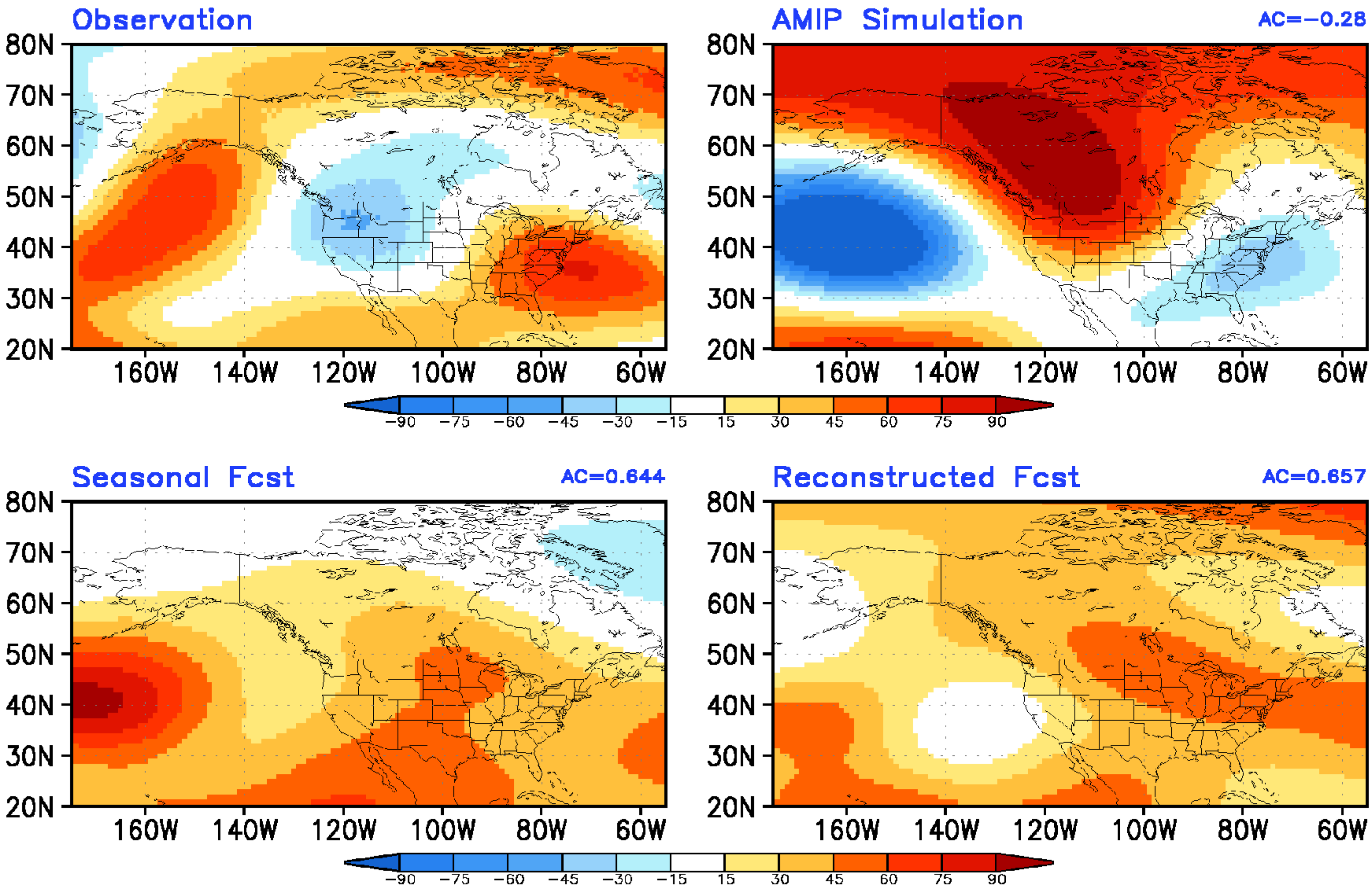
DJF2018/2019 Observed & Model Simulated/Forecast Ensemble Average Anomalies T2m(K)



From Arun Kumar & Mingyue Chen

DJF2018/2019 Observed & Model Simulated/Forecast Ensemble Average Anomalies z200(m)



From Arun Kumar & Mingyue Chen

Data Sources and References

(climatology is for 1981-2010)

- **Weekly Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)**
- **Extended Reconstructed Sea Surface Temperature (ERSST) v5 (Huang et al. 2017)**
- **Blended Analysis of Surface Salinity (BASS) (Xie et al. 2014)**
- **CMORPH precipitation (Xie et al. 2017)**
- **CFSR evaporation adjusted to OAFlux (Xie and Ren 2018)**
- **NCEP CDAS winds, surface radiation and heat fluxes (Kalnay et al. 1996)**
- **NESDIS Outgoing Long-wave Radiation**
- **NCEP's Global Ocean Data Assimilation System temperature, heat content, currents (Behringer and Xue 2004)**
- **Aviso altimetry sea surface height from CMEMS**
- **Ocean Surface Current Analyses – Realtime (OSCAR)**
- **In situ data objective analyses (IPRC, Scripps, EN4.2.1, PMEL TAO)**
- **Operational ocean reanalyses from Real-time Ocean Reanalysis Intercomparison Project**

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

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

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