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

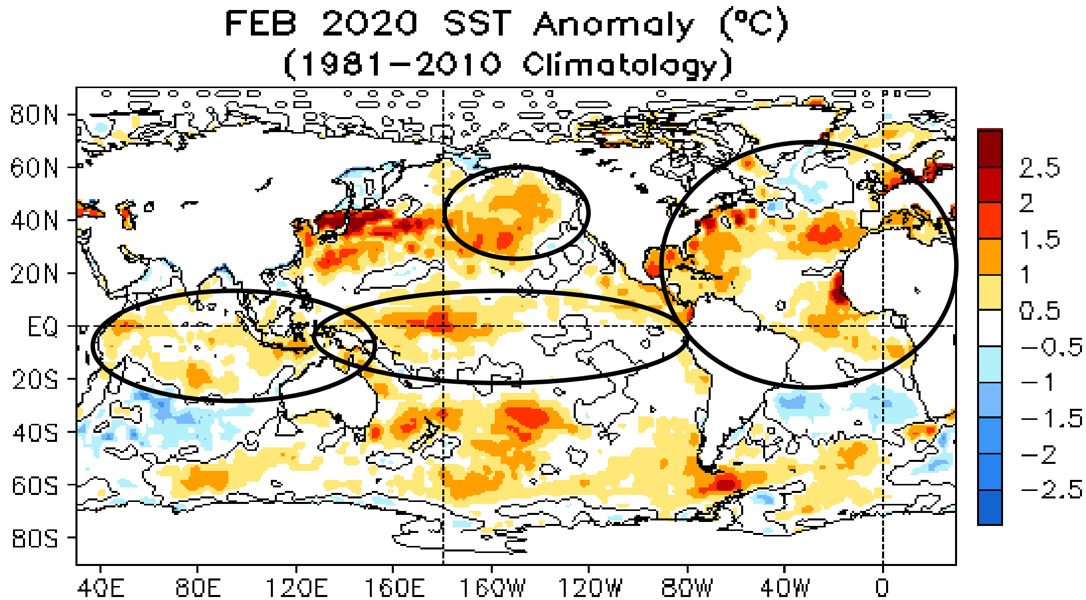
- **Overview**
- **Recent highlights**
  - **Pacific/Arctic Ocean**
  - **Indian Ocean**
  - **Atlantic Ocean**
- **Global SSTA Predictions**
- ***Uncoupled El Nino Warming***

Overview

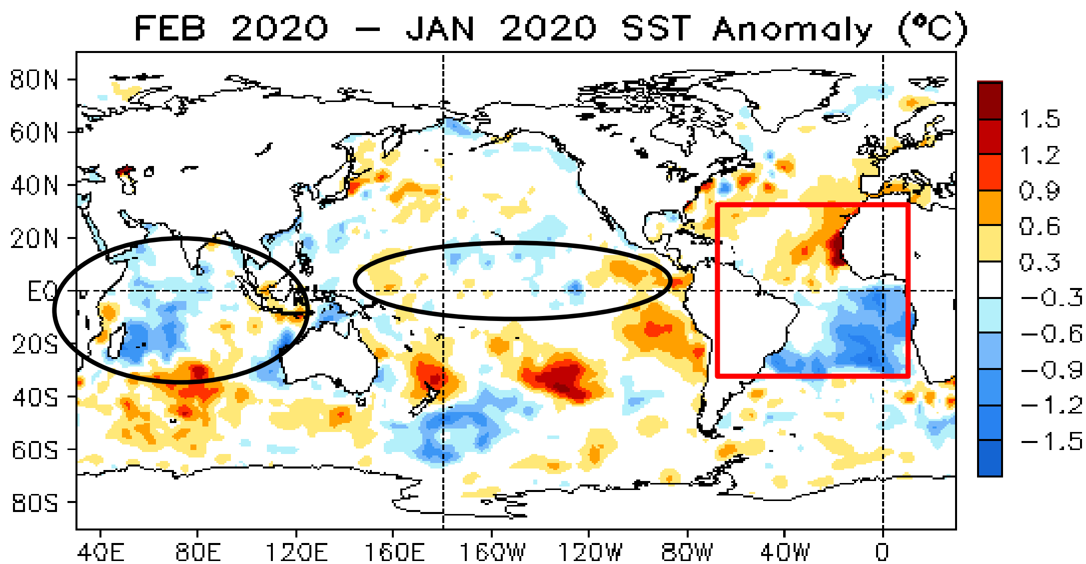
- **Pacific Ocean**
  - **NOAA "ENSO Diagnostic Discussion" on 12 Mar 2020 stated "*ENSO-neutral is favored for the Northern Hemisphere spring 2020 (~65% chance), continuing through summer 2020 (~55% chance).*"**
  - **ENSO neutral conditions persisted, and positive SSTAs were still present in the central tropical Pacific with NINO3.4=0.39^{o}C in Feb 2020.**
  - **Positive SSTAs weakened in the NE. Pacific in Feb 2020. The PDO index was negative with PDOI= -0.83 in Feb 2020.**
  - **Sea ice extent in the Arctic Ocean in Feb 2020 was the 13th lowest Feb extent in the satellite record.**
- **Indian Ocean**
  - **SSTAs were positive in the entire tropical Indian Ocean.**
  - **IOD switched to a negative phase in Feb 2020.**
- **Atlantic Ocean**
  - **NAO was in a positive phase with NAOI=0.98 in Feb 2020.**
  - **SSTAs were a tripole/horseshoe pattern with positive anomalies in the middle latitudes of N. Atlantic during 2013-2019.**

Global Oceans

Global SST Anomaly (^0C) and Anomaly Tendency

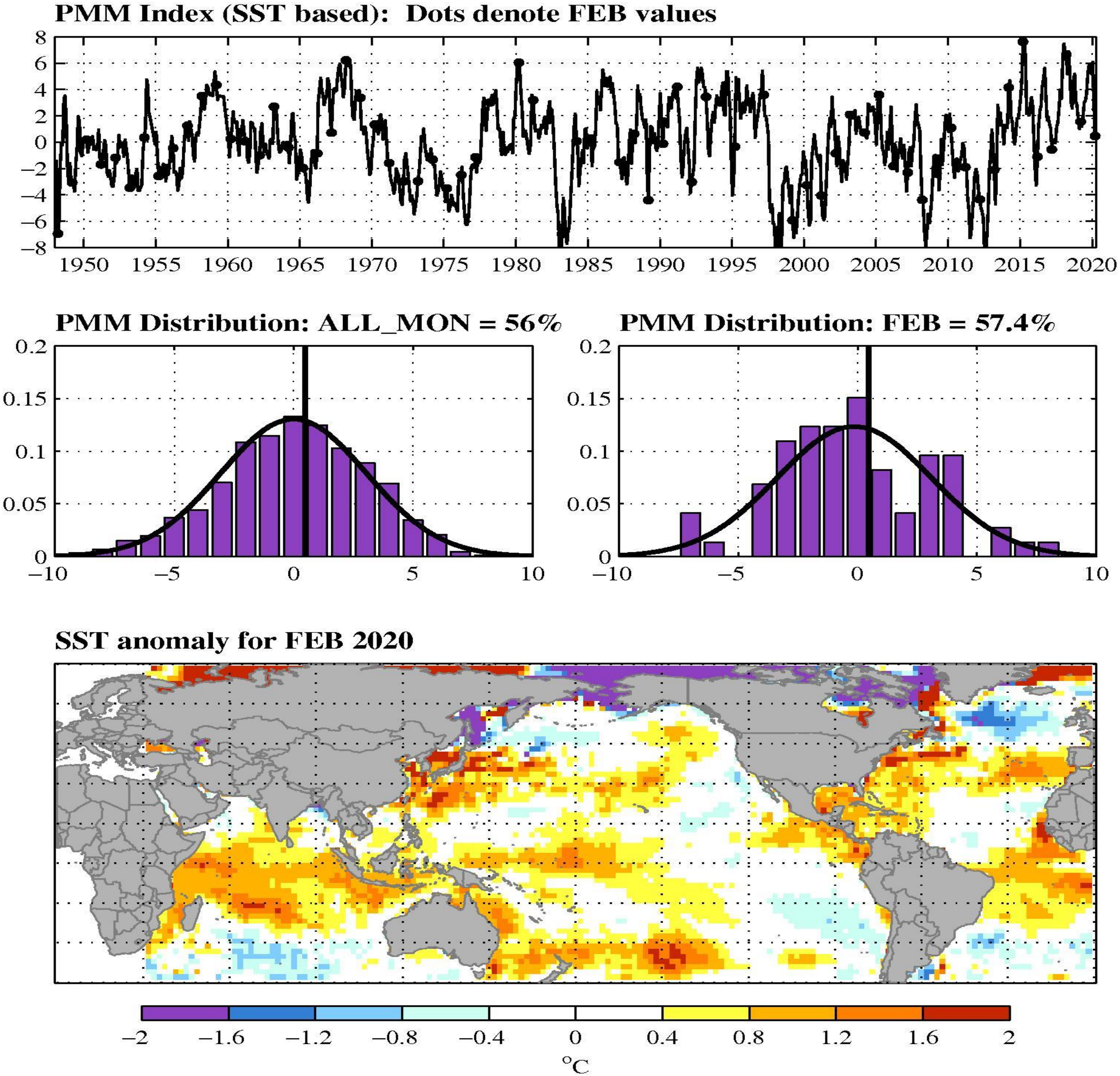


- Positive SSTAs persisted in the central tropical Pacific.
- Positive SSTAs weakened in the NE Pacific (Blob.2).
- Tripole-like SSTAs were observed in the North Atlantic and positive SSTAs in the tropical Atlantic were associated with an Atlantic Nino.
- In the tropical Indian Ocean, weak positive SSTAs were observed.



- SSTA tendencies were small in the tropical Pacific.
- SSTA tendencies in the Indian Ocean were positive(negative) in the east (west and central), implying decay of the positive phase of the latest Indian Ocean dipole event.
- Cooling (warming) tendency presented in the South (North) Atlantic Ocean.

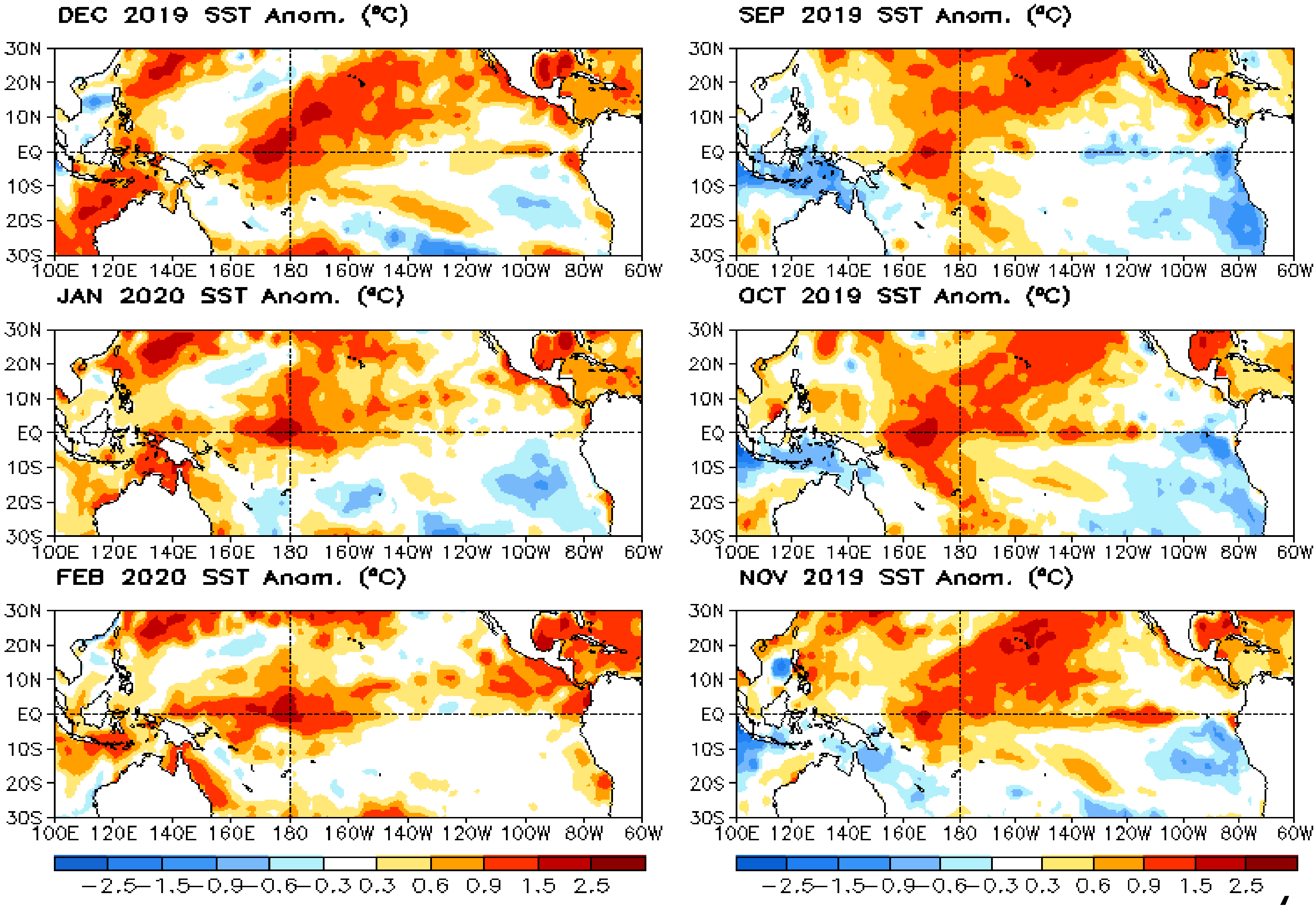
Fig. G1. Sea surface temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.



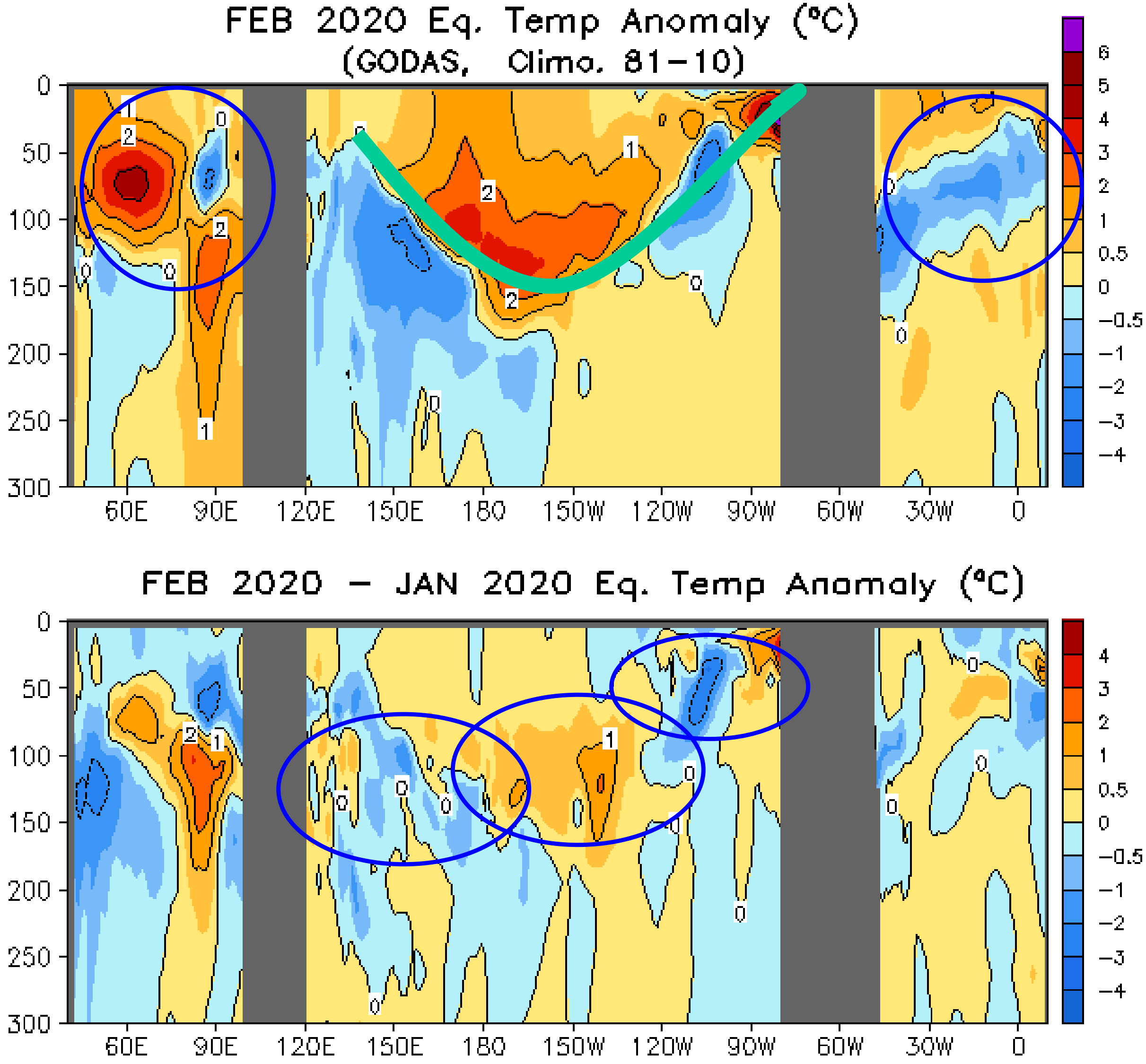
PMM was still in a positive phase, but weakened compared with previous months.

http://www.aos.wisc.edu/~dvimont/MModes/RealTime/pmm_current.jpg

SST Anomalies: Pacific Meridional Mode (PMM)



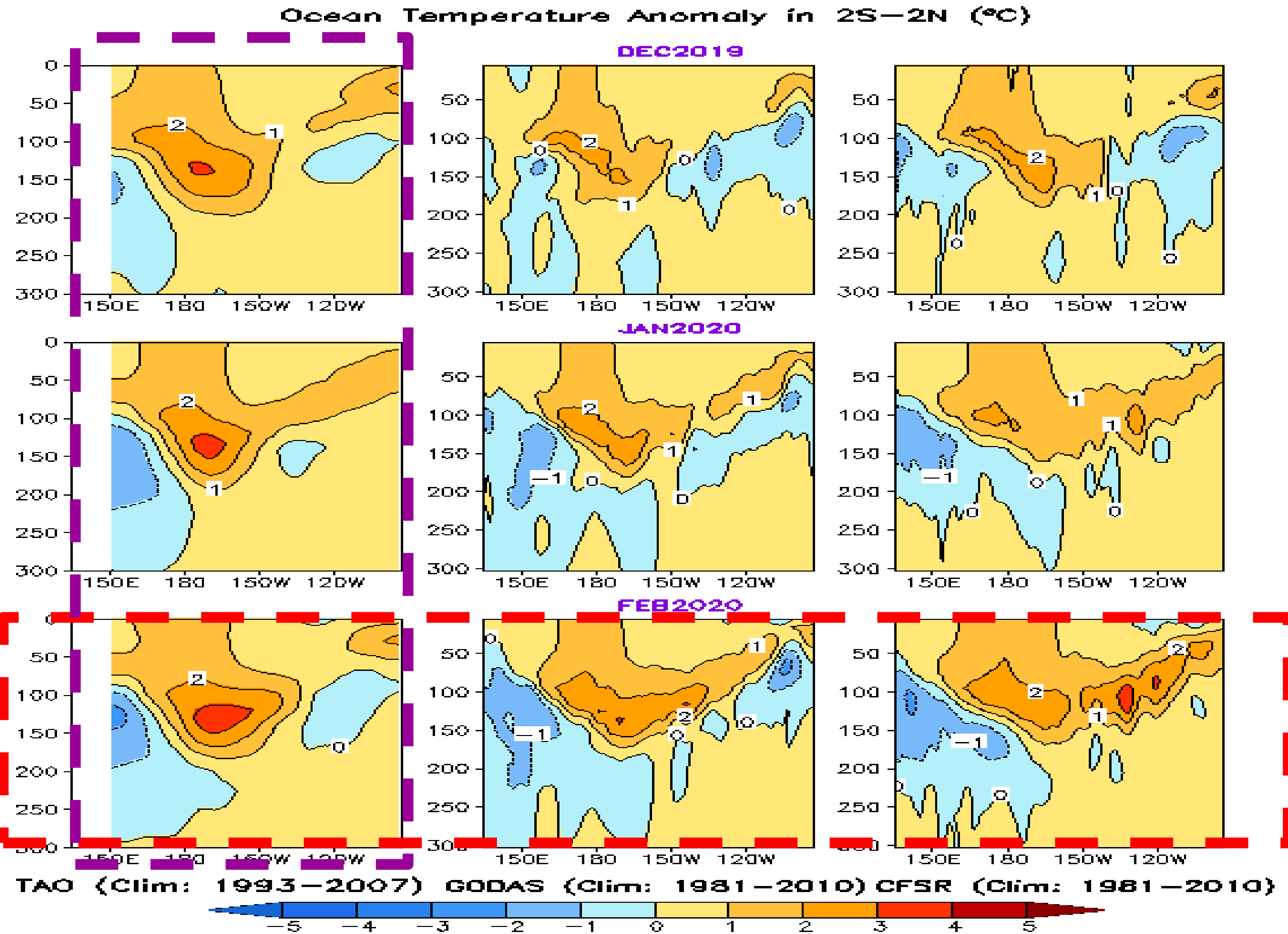
Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2°S-2°N



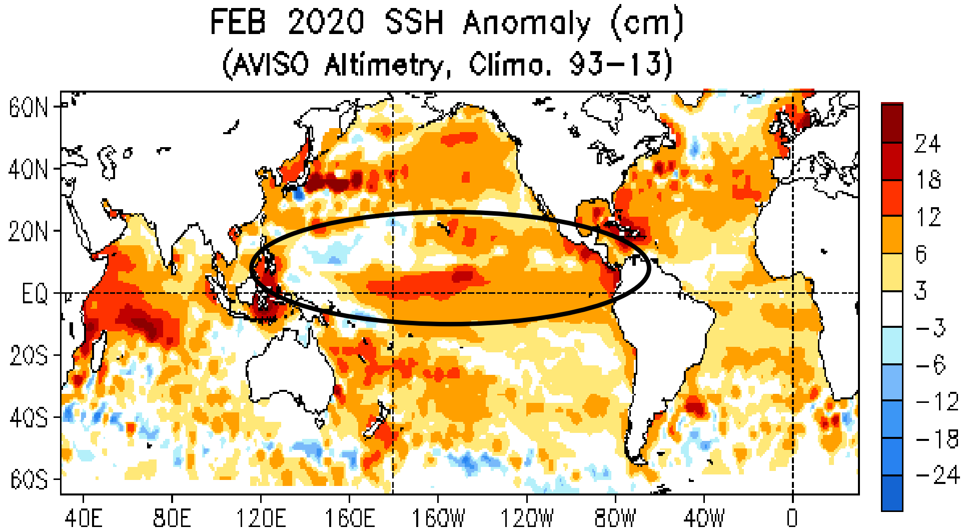
- **Positive (negative) ocean temperature anomalies presented in the upper-(lower-) layer in the tropical Pacific.**
- **Positive (negative) anomaly in the western (eastern) Indian Ocean may be associated with the residue of the latest strong IOD.**
- **Negative anomaly presented along the thermocline of Atlantic Ocean.**

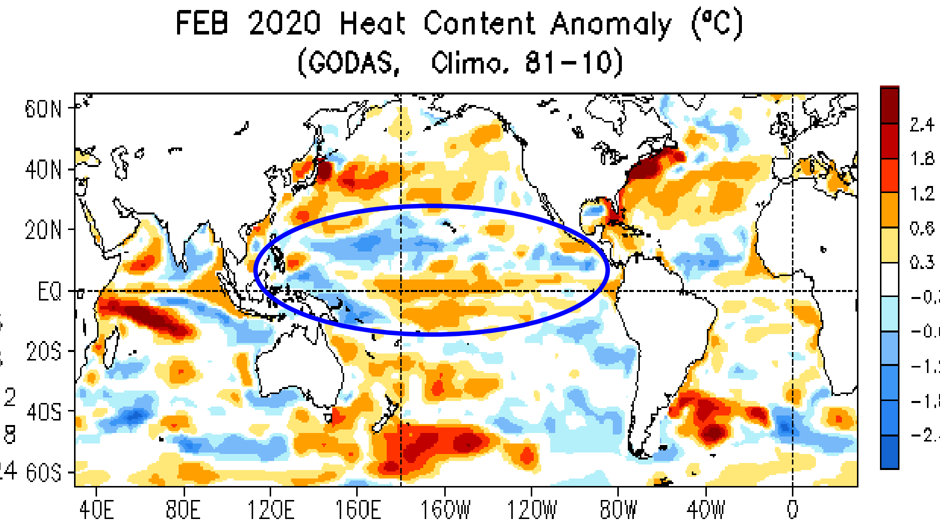
- **Negative (positive) anomalous ocean temperature tendency was observed in the western and central (east-central) Pacific.**

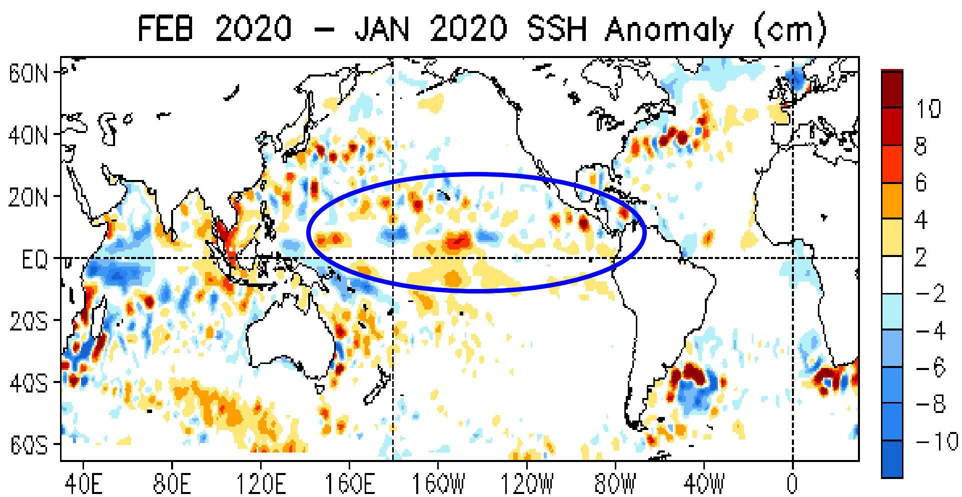
Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1981-2010 base period means.

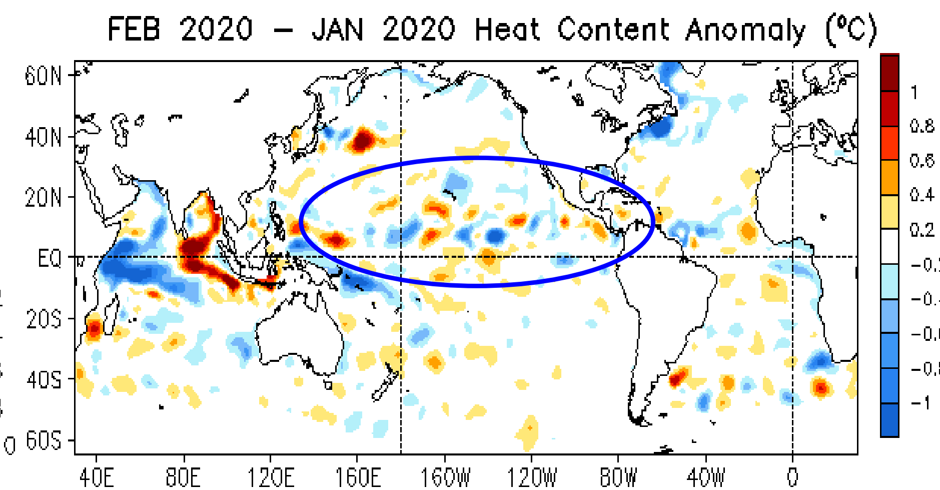

Ocean Temperature Anomaly in 2S-2N (°C)
DEC2019
JAN2020
FEB2020
150E 180 150W 120W
TAO (Clim: 1993-2007) GODAS (Clim: 1981-2010) CFSR (Clim: 1981-2010)
-5 -4 -3 -2 -1 0 1 2 3 4 5

Global SSH and HC300 Anomaly & Anomaly Tendency





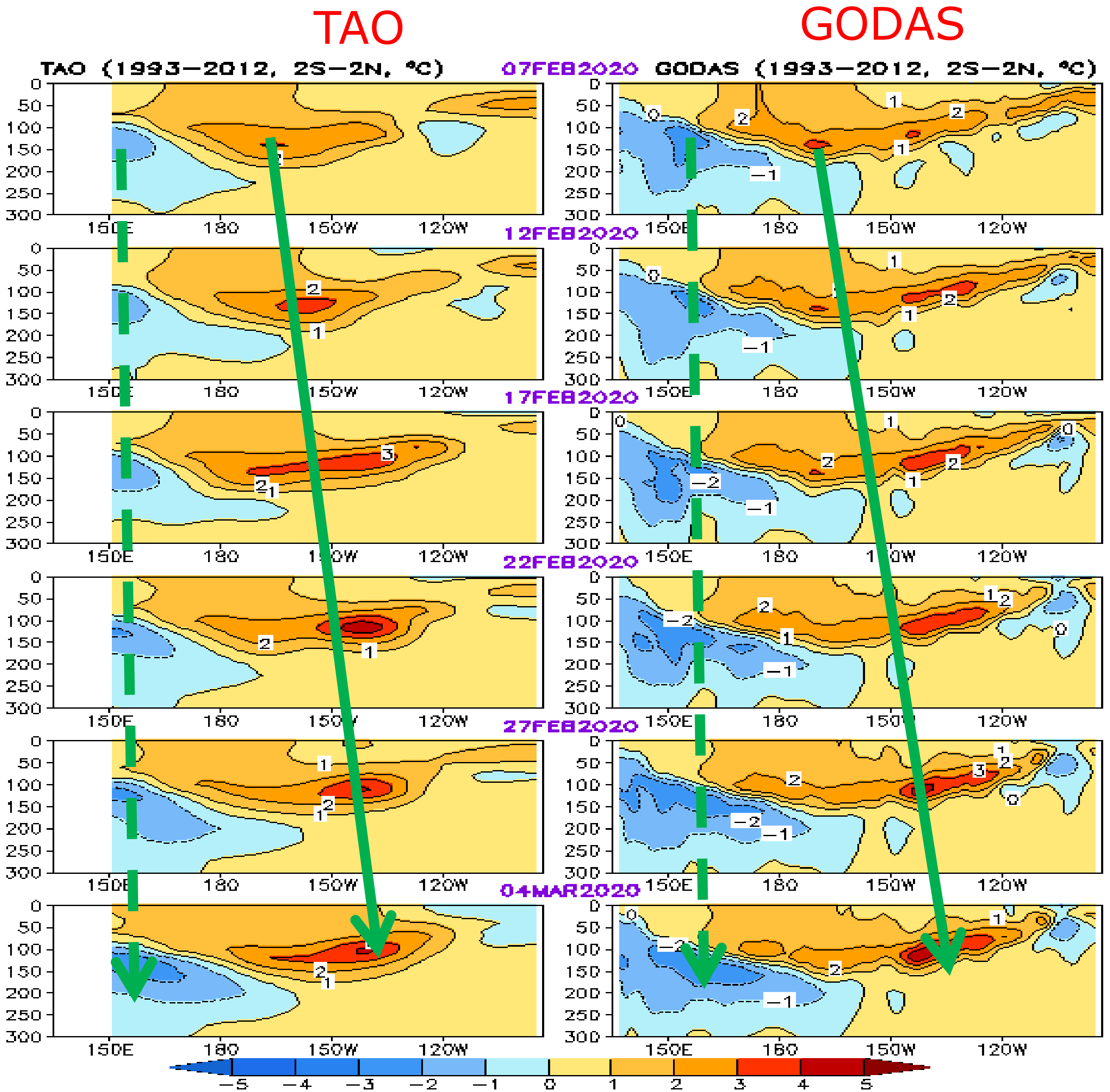




- **The SSHA pattern was overall consistent with the HC300A pattern, but there were many differences in details between them.**
- **Both SSHA and HC300A in the tropical Pacific were consistent with ENSO neutral.**

Tropical Pacific Ocean and ENSO Conditions

Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

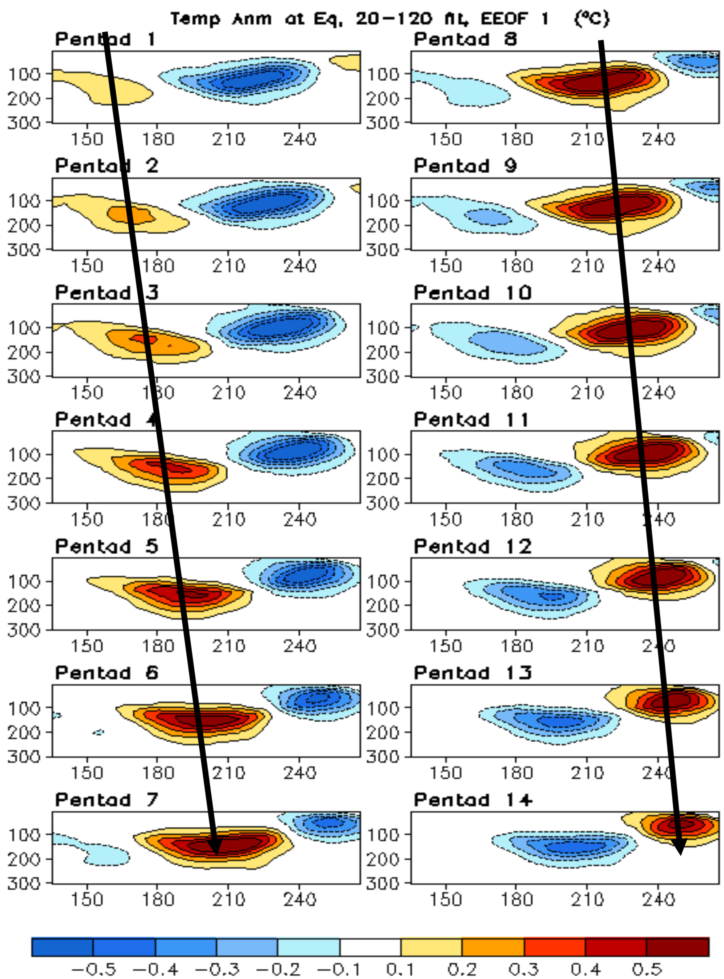


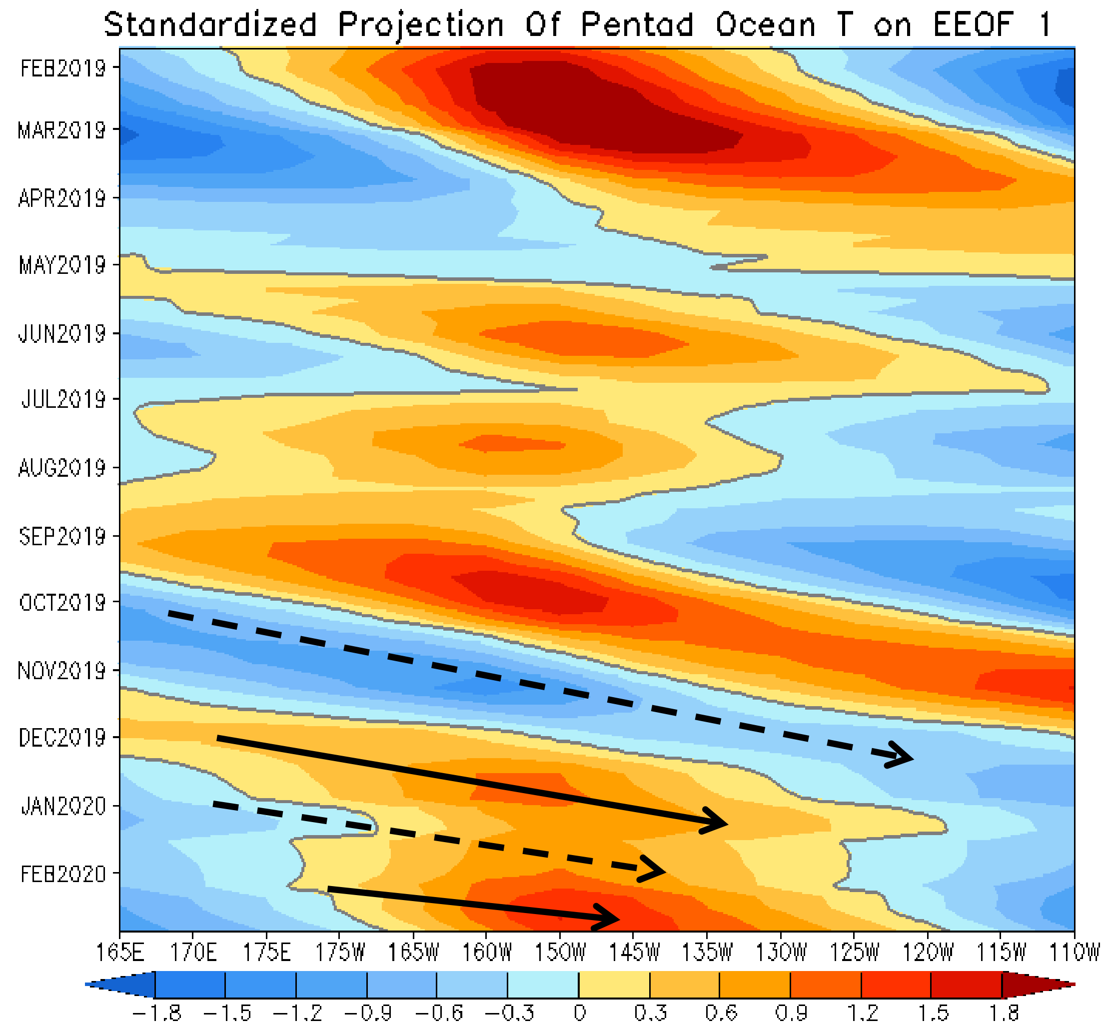
- Positive ocean temperature anomalies presented in the central and eastern Pacific during the last few pentads, and propagated eastward.

- Negative anomalies emerged in the western Pacific.

- The patterns of the ocean temperature anomalies between GODAS and TAO were similar.

Oceanic Kelvin Wave (OKW) Index

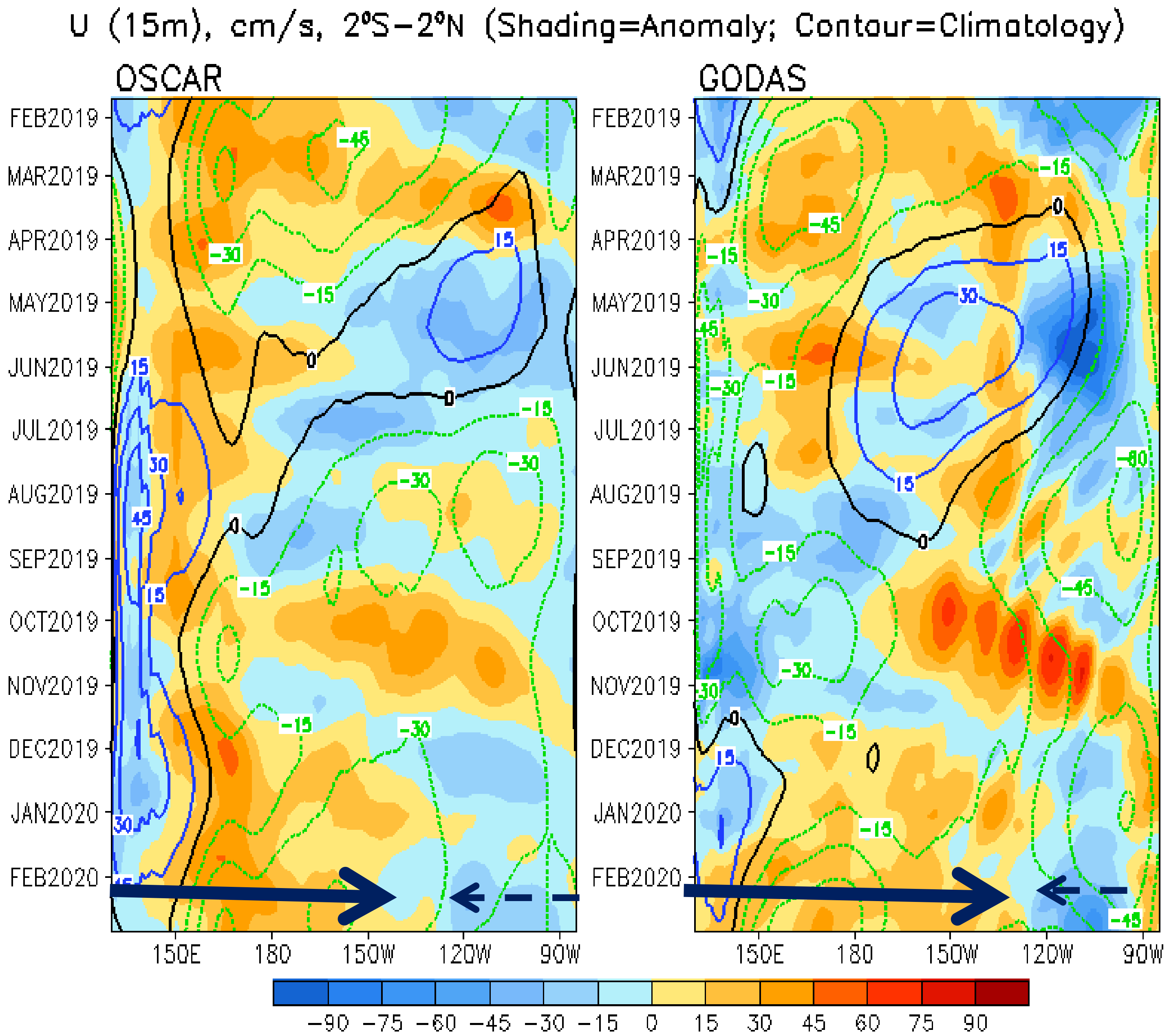




- **A downwelling Kelvin wave presented from Nov 2019, leading to the increase of positive subsurface temperature anomalies in the central tropical Pacific.**
- **During the last two months, Kelvin wave activity was weak.**

(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).)

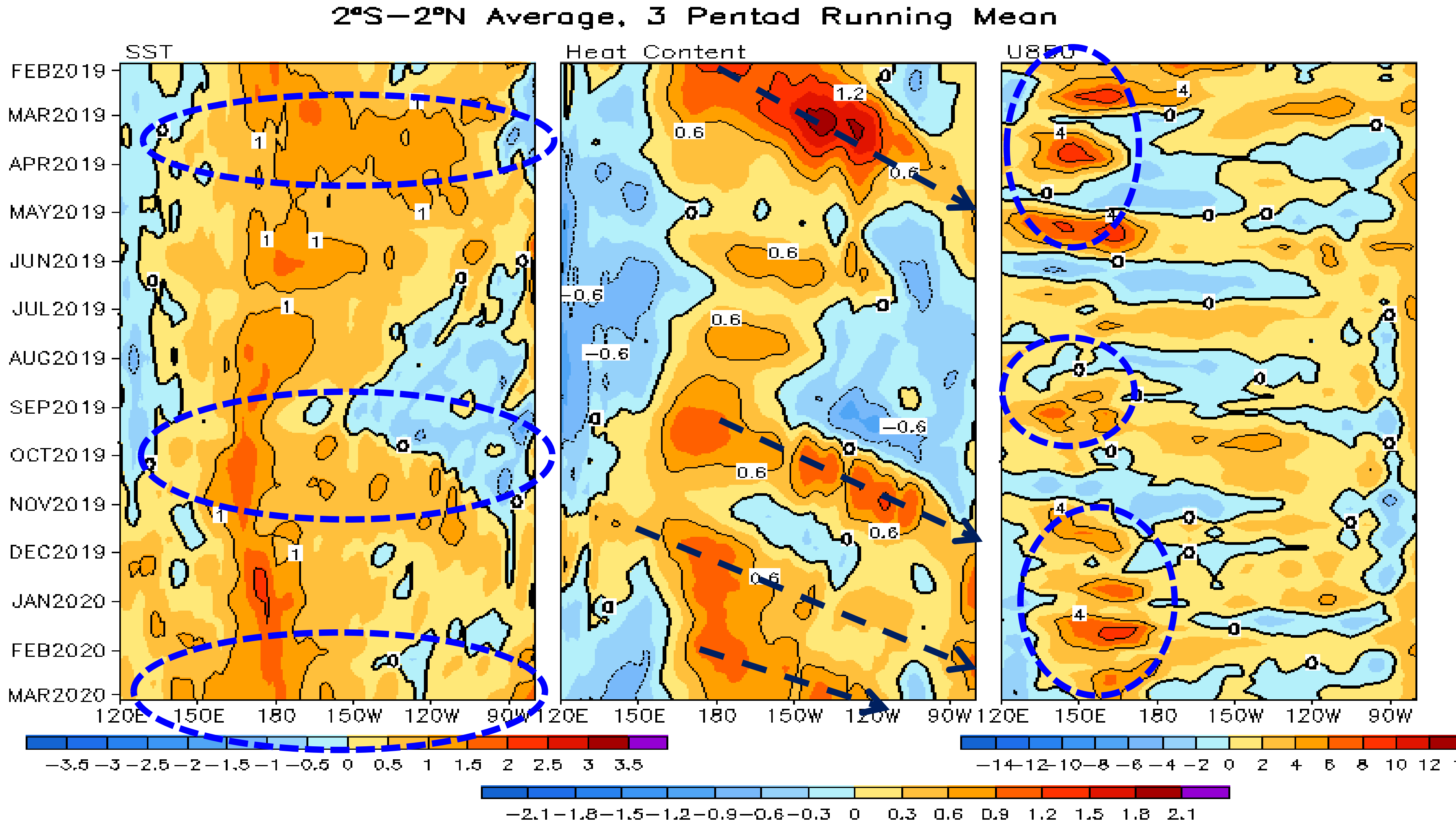
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- Anomalous eastward (westward) currents persisted in the western and central (eastern) Pacific in Feb 2020 in both OSCAR and GODAS.

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

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



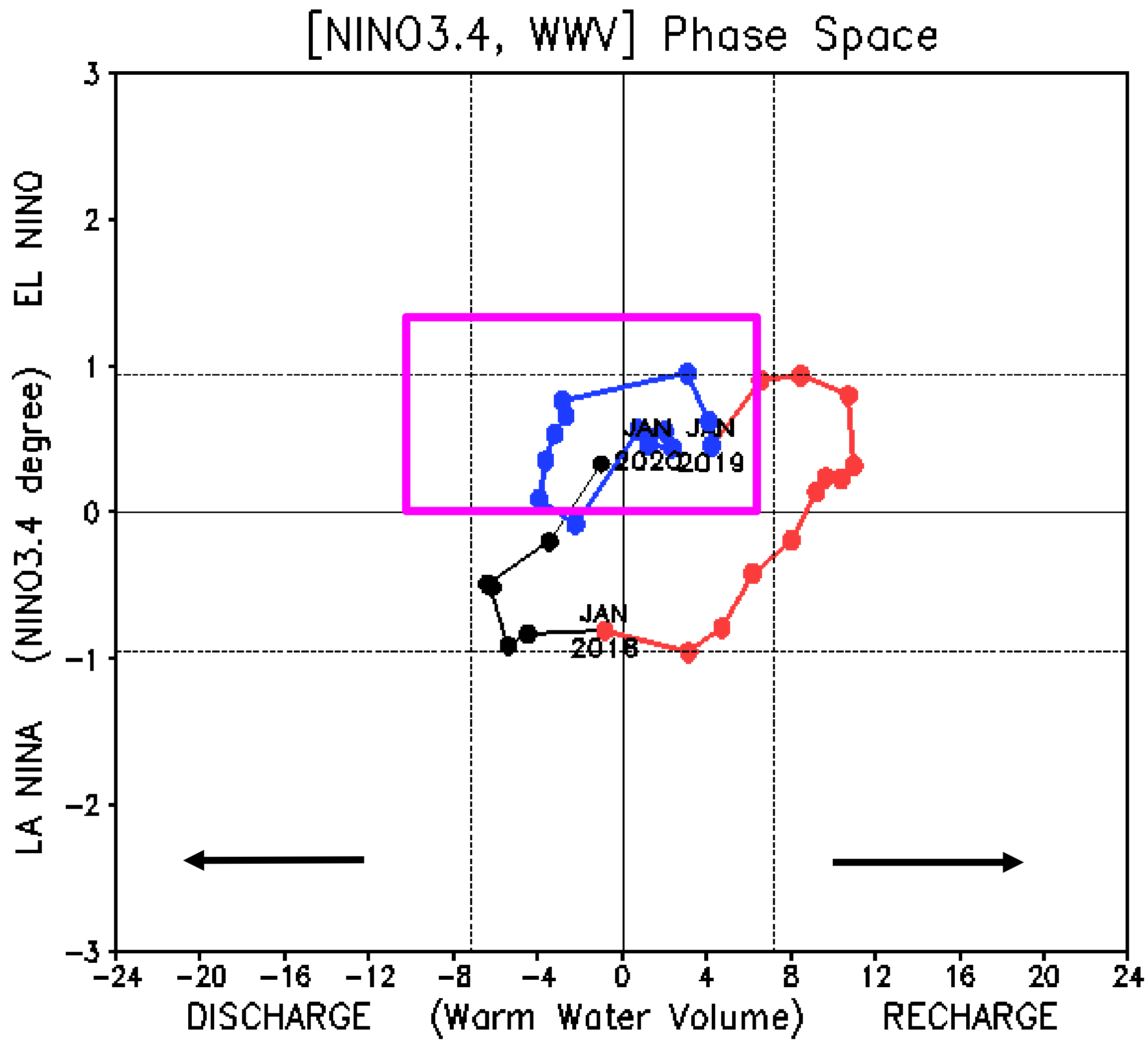
- **Positive SSTA in the entire Pacific persisted in the last month.**
- **Positive (negative) HC300A presented in the central & eastern (western) Pacific in Feb 2020.**
- **Westerly wind burst presented in late Feb 2020.**

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).**

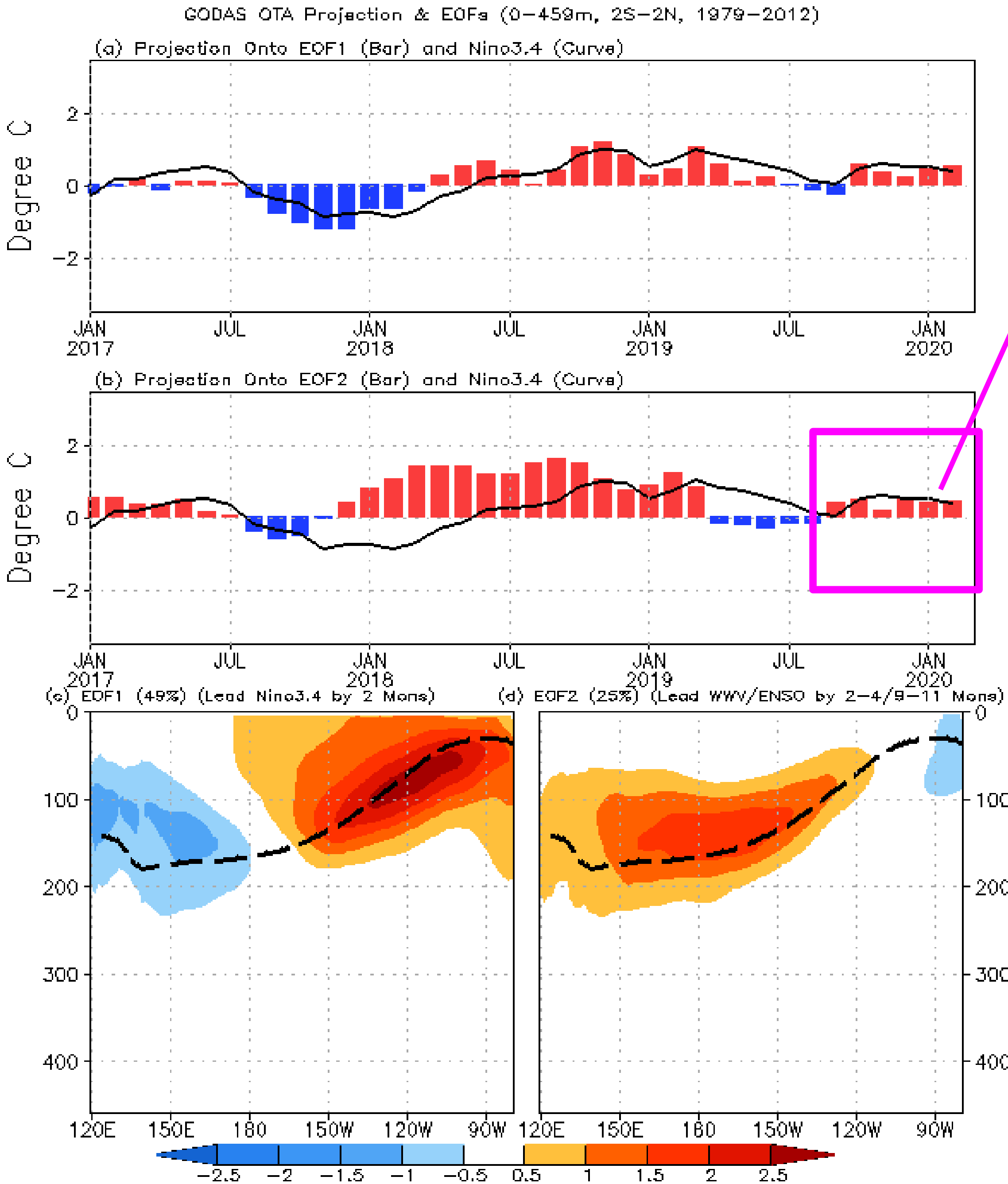
- **Since WWV is intimately linked to ENSO variability (Wyrtki 1985; Jin 1997), it is useful to monitor ENSO in a phase space of WWV and NINO3.4 (Kessler 2002).**

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



- **Equatorial Warm Water Volume (WWV) switched to a recharge phase in Oct 2019.**

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 recharge phase since Sep 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).

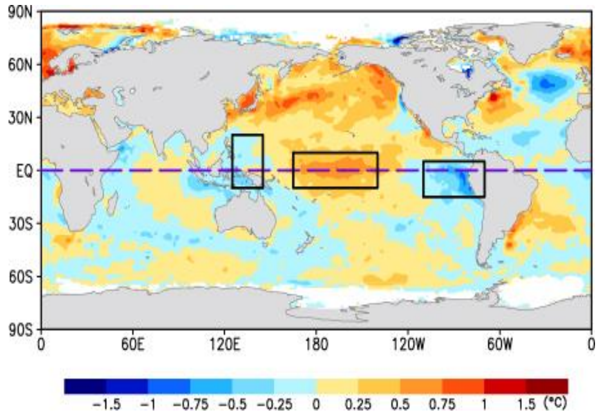
Recharge process: heat transport from outside of equator to equator : Negative -> positive phase of ENSO

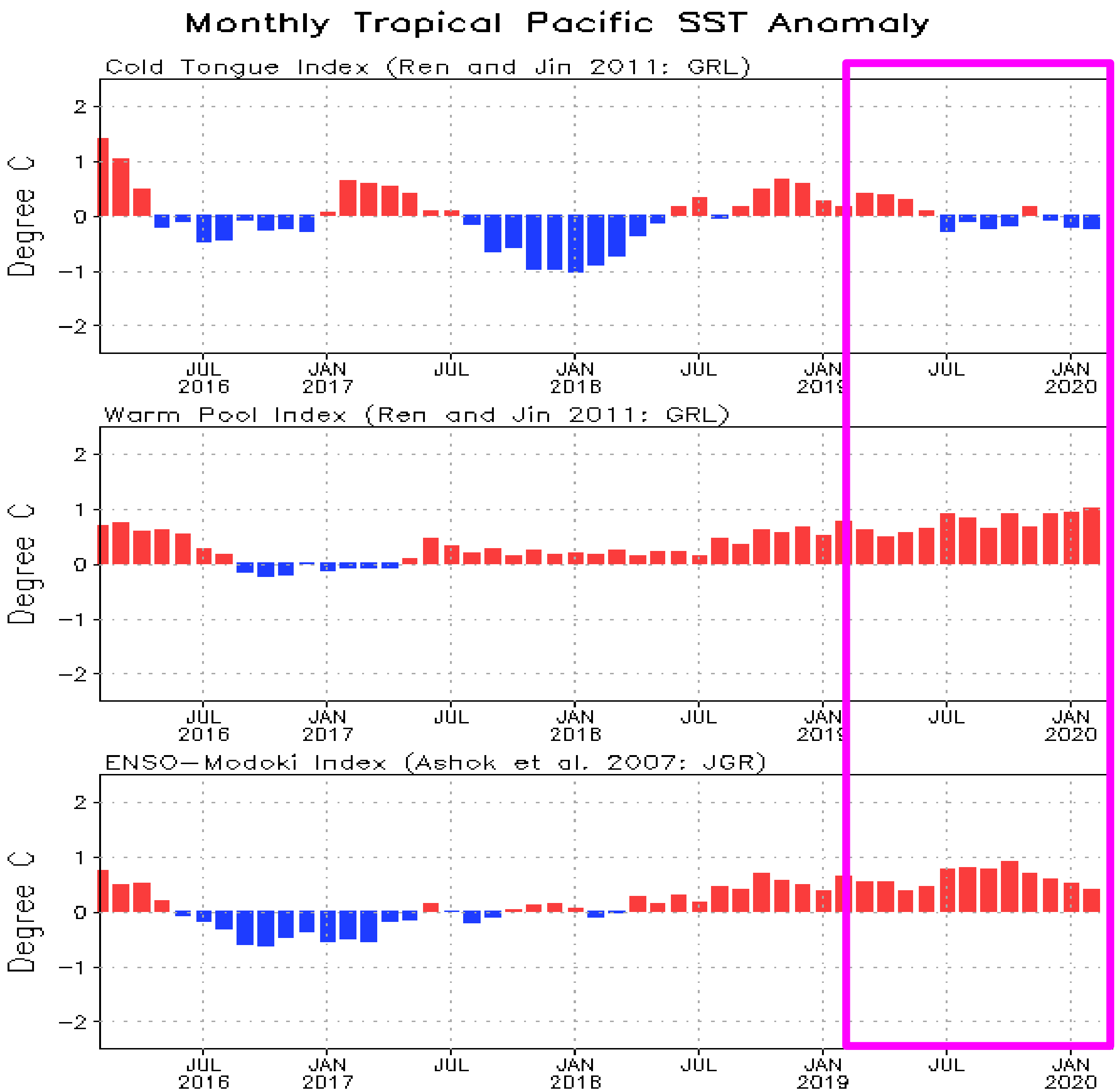
Discharge process: heat transport from equator to outside of equator: Positive -> Negative phase of ENSO

For details, see:

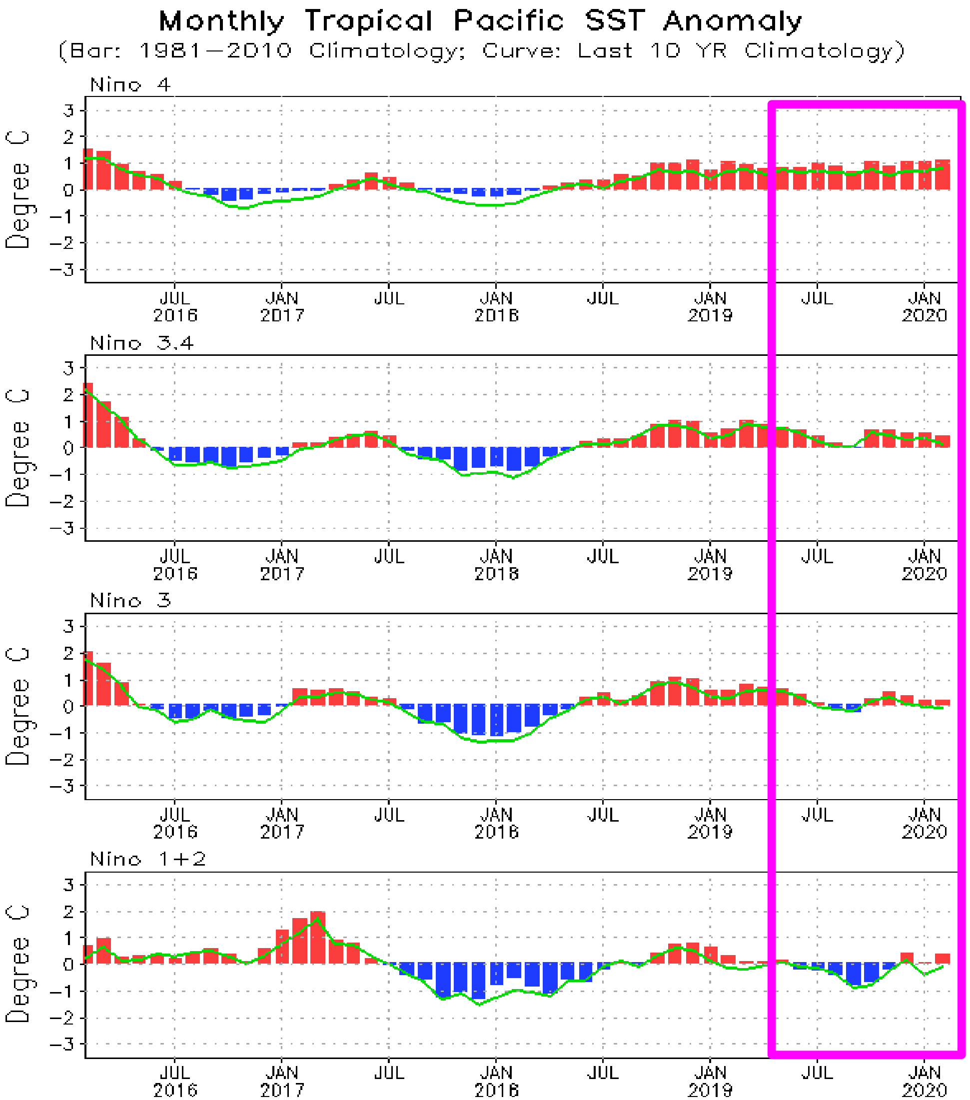
Kumar A, Z-Z Hu (2014) Interannual and interdecadal variability of ocean temperature along the equatorial Pacific in conjunction with ENSO. Clim. Dyn., 42 (5-6)**, 1243-1258.** *DOI: 10.1007/s00382-013-1721-0*.

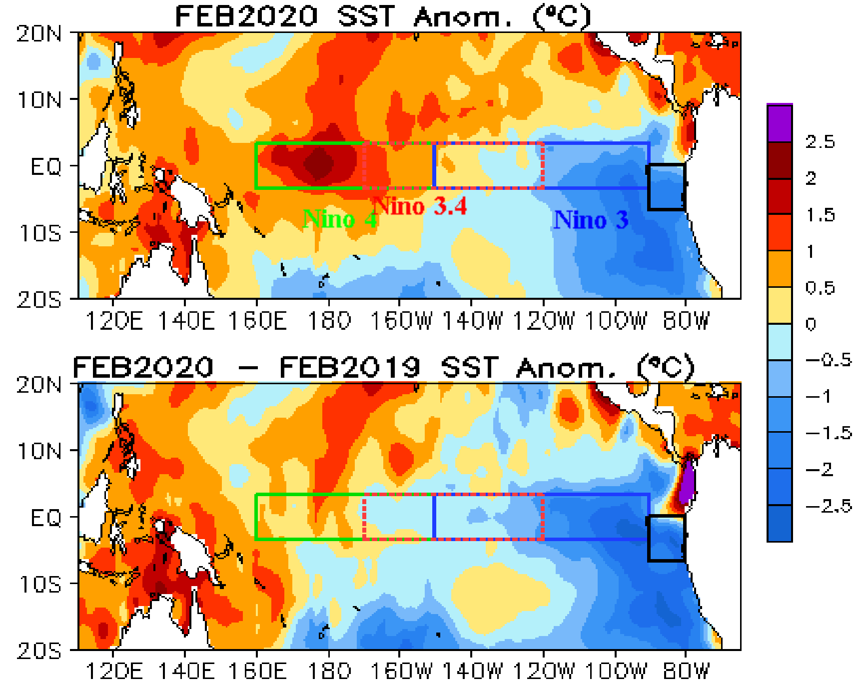
Positive SSTAs persisted in the warm pool, and SSTAs were negative in the cold tongue.





Evolution of Pacific NINO SST Indices

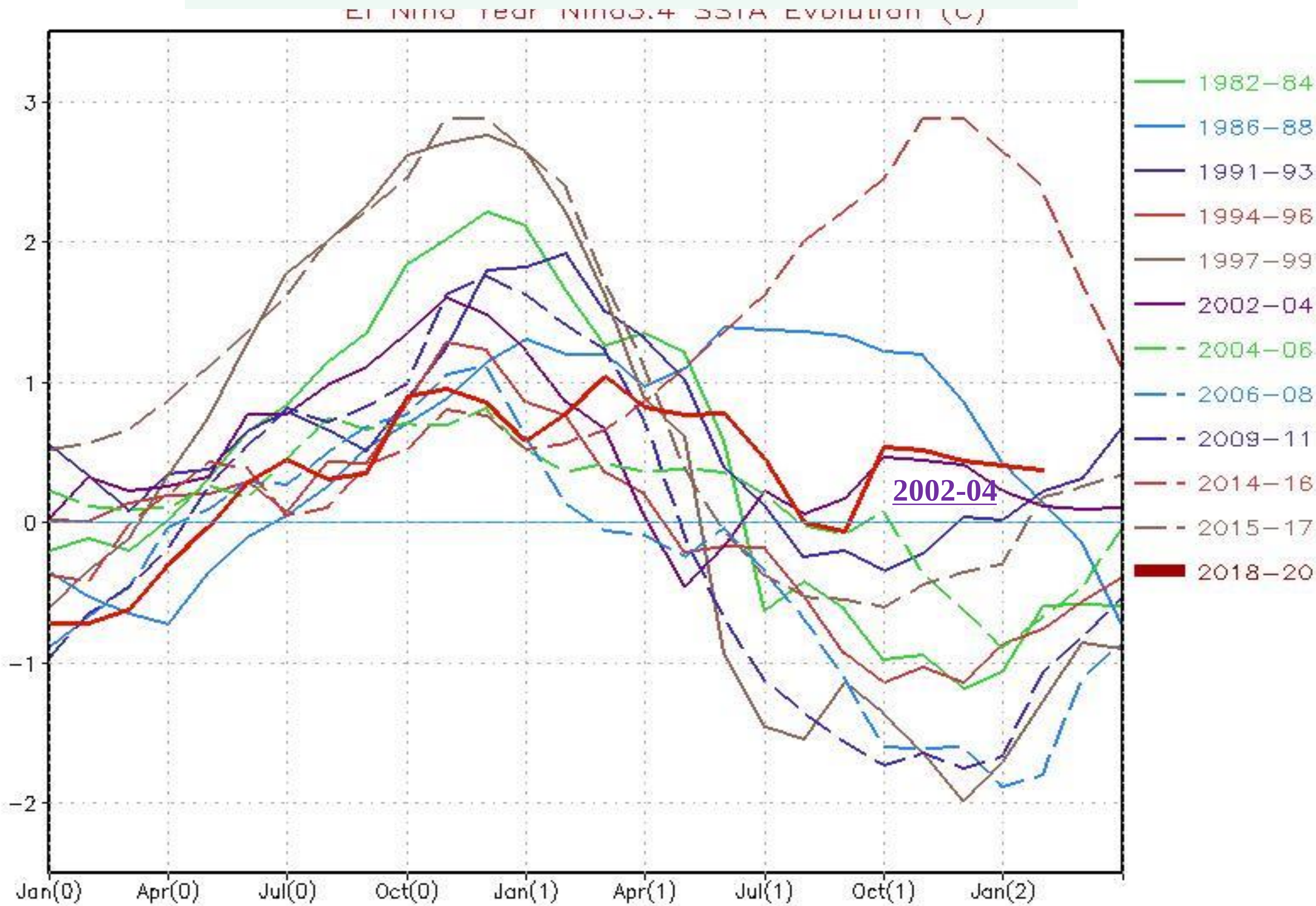




- **All Nino indices were positive with Nino3.4 = 0.39 C in Feb 2020.**
- **Compared with Feb 2019, the western (eastern) equatorial Pacific was warmer (colder) in Feb 2020.**
- **The indices may have some differences if different SST datasets were used in the calculations.**

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.

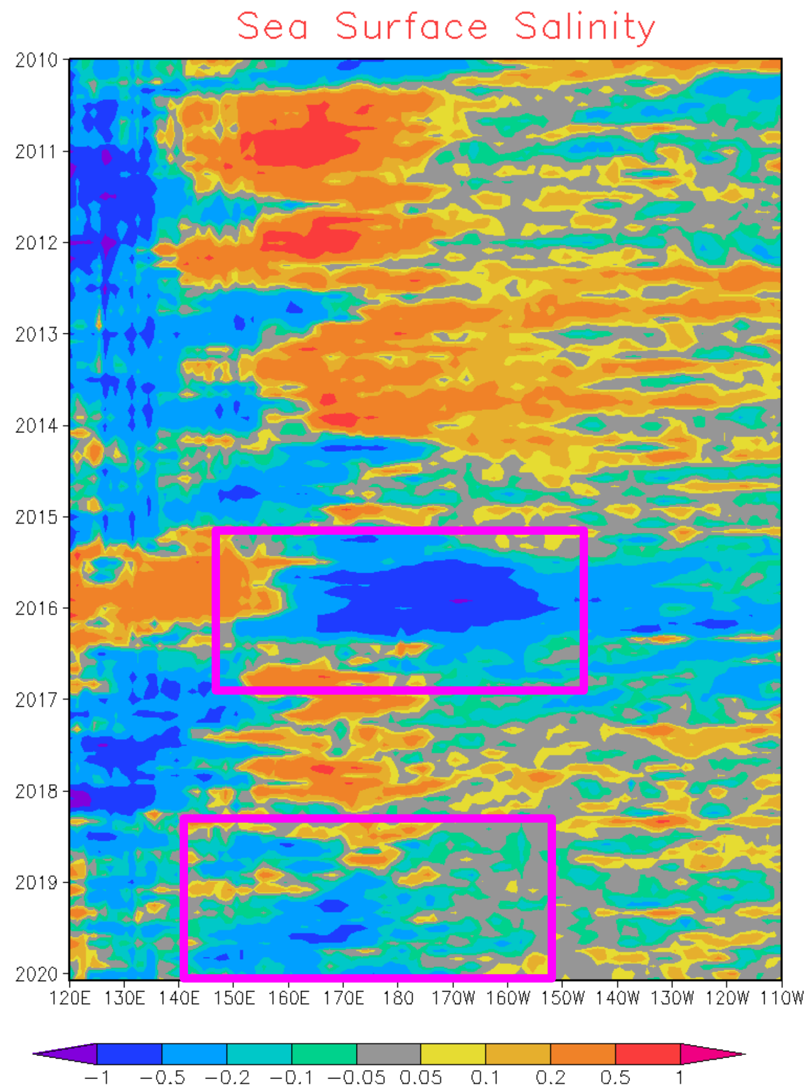
Nino3.4 Evolution In El Nino Years



Global Sea Surface Salinity (SSS)

Anomaly Evolution over Equatorial Pacific from Monthly SSS

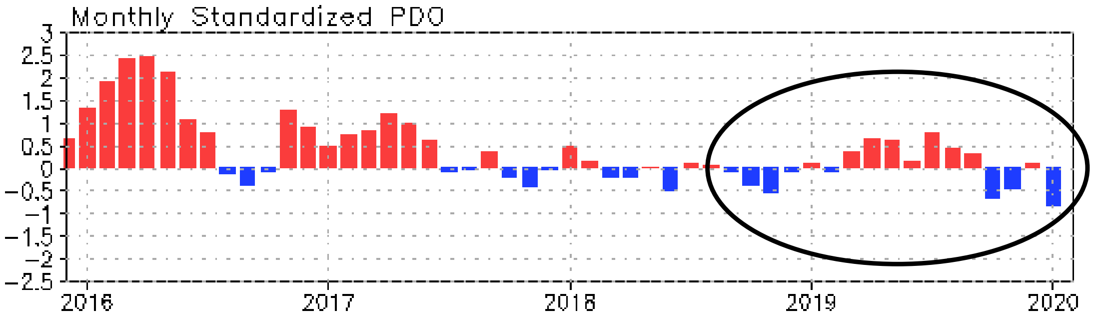
NOTE: Since June 2015, the BASS SSS is from in situ, SMOS and SMAP; before June 2015,The BASS SSS is from in situ, SMOS and Aquarius.

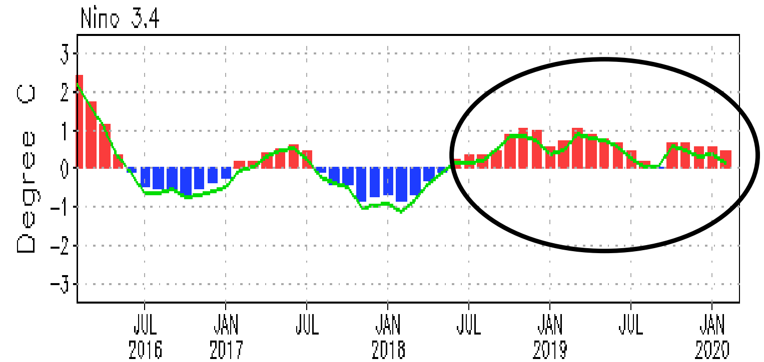


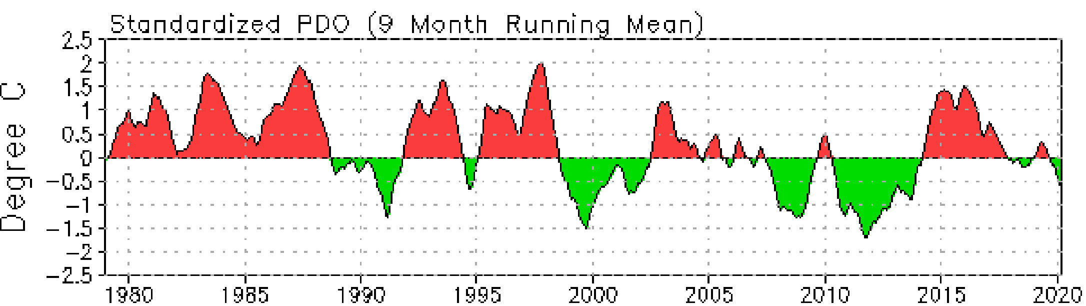
- Hovemoller diagram for equatorial SSS anomaly **(5˚ S-5˚ N);**
- In the equatorial Pacific Ocean, the SSS signal is negative west of 170° W; the SSS anomalies show positive/neutral signals east of 170° W.

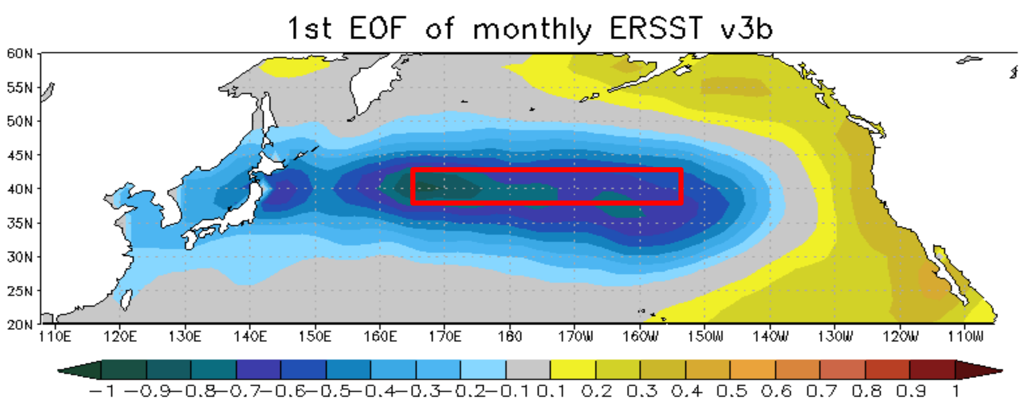
North Pacific & Arctic Oceans

PDO index









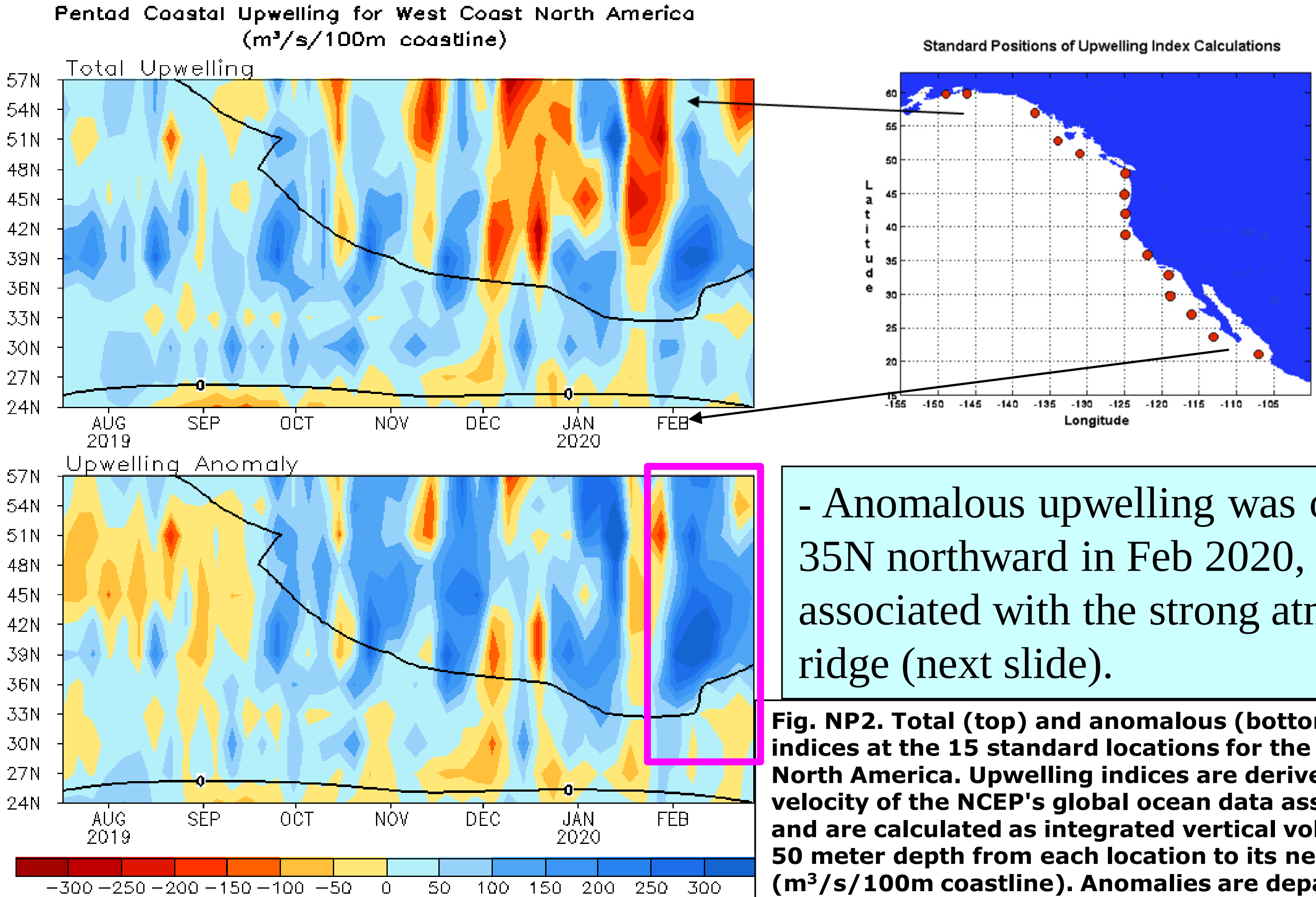
- The PDO index was negative with PDOI= -0.83 in Feb 2020.

- Statistically, ENSO leads PDO by 3-4 months, through teleconnection via 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



- Anomalous upwelling was observed in 35N northward in Feb 2020, that may be associated with the strong atmospheric ridge (next slide).

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

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

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

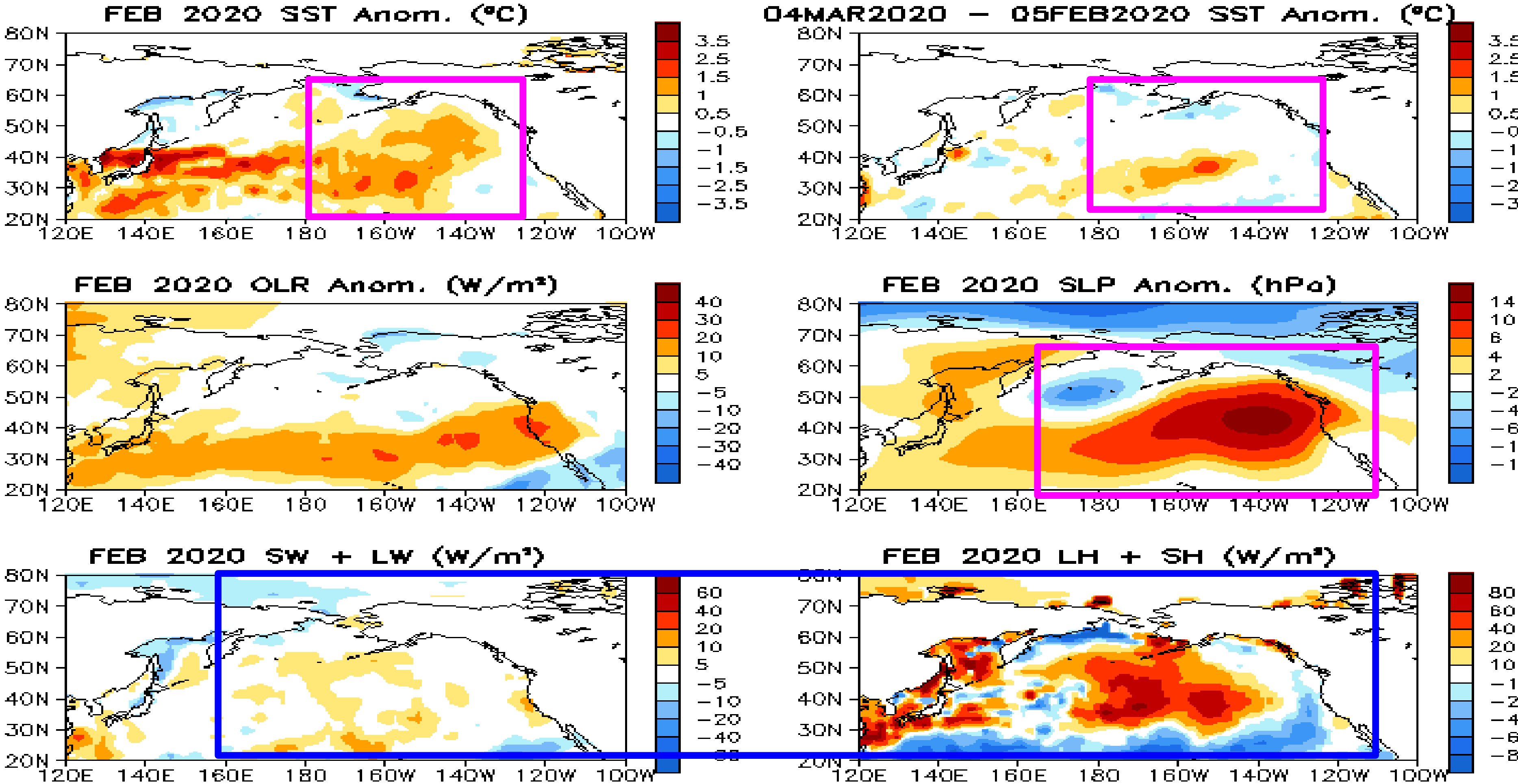
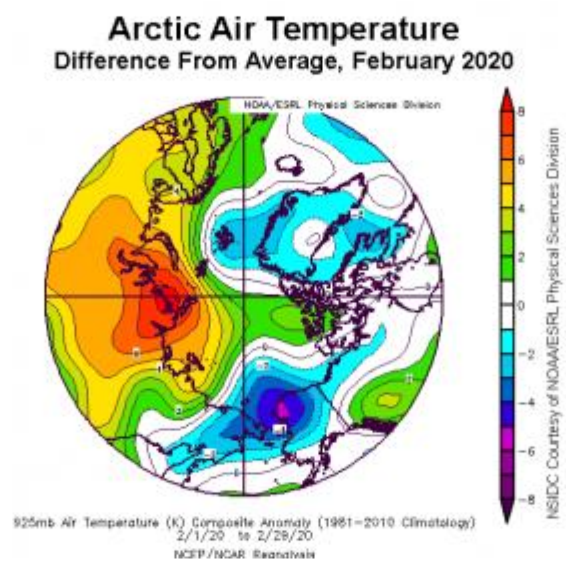


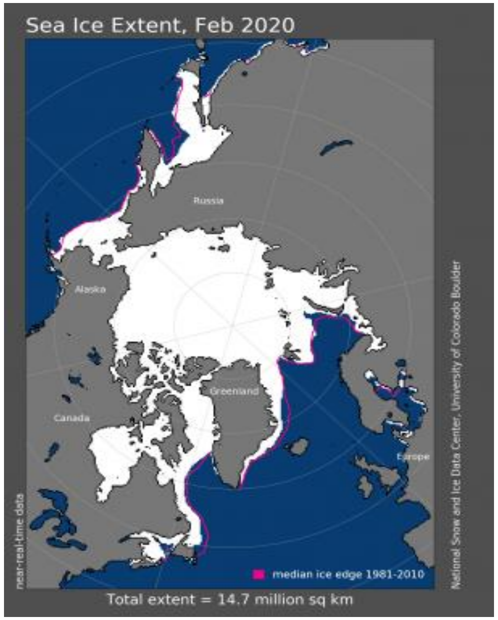
Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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

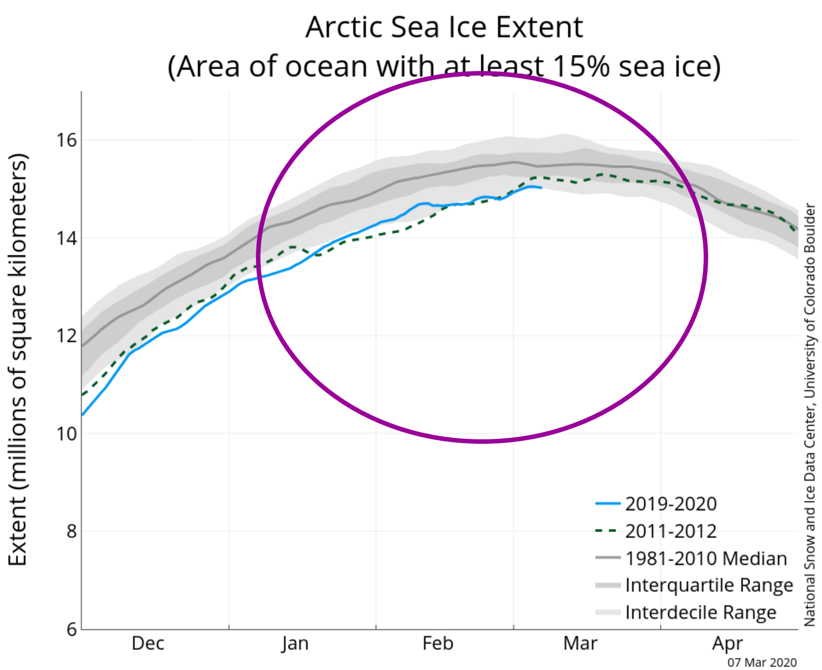
Arctic Sea Ice

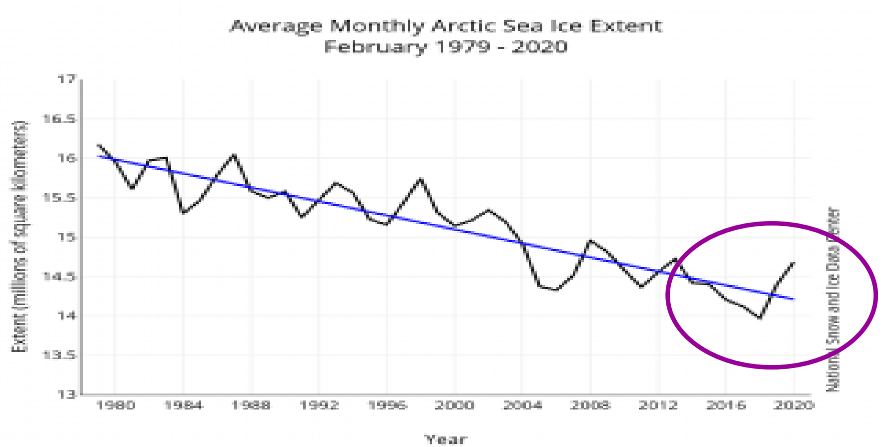
National Snow and Ice Data Center

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

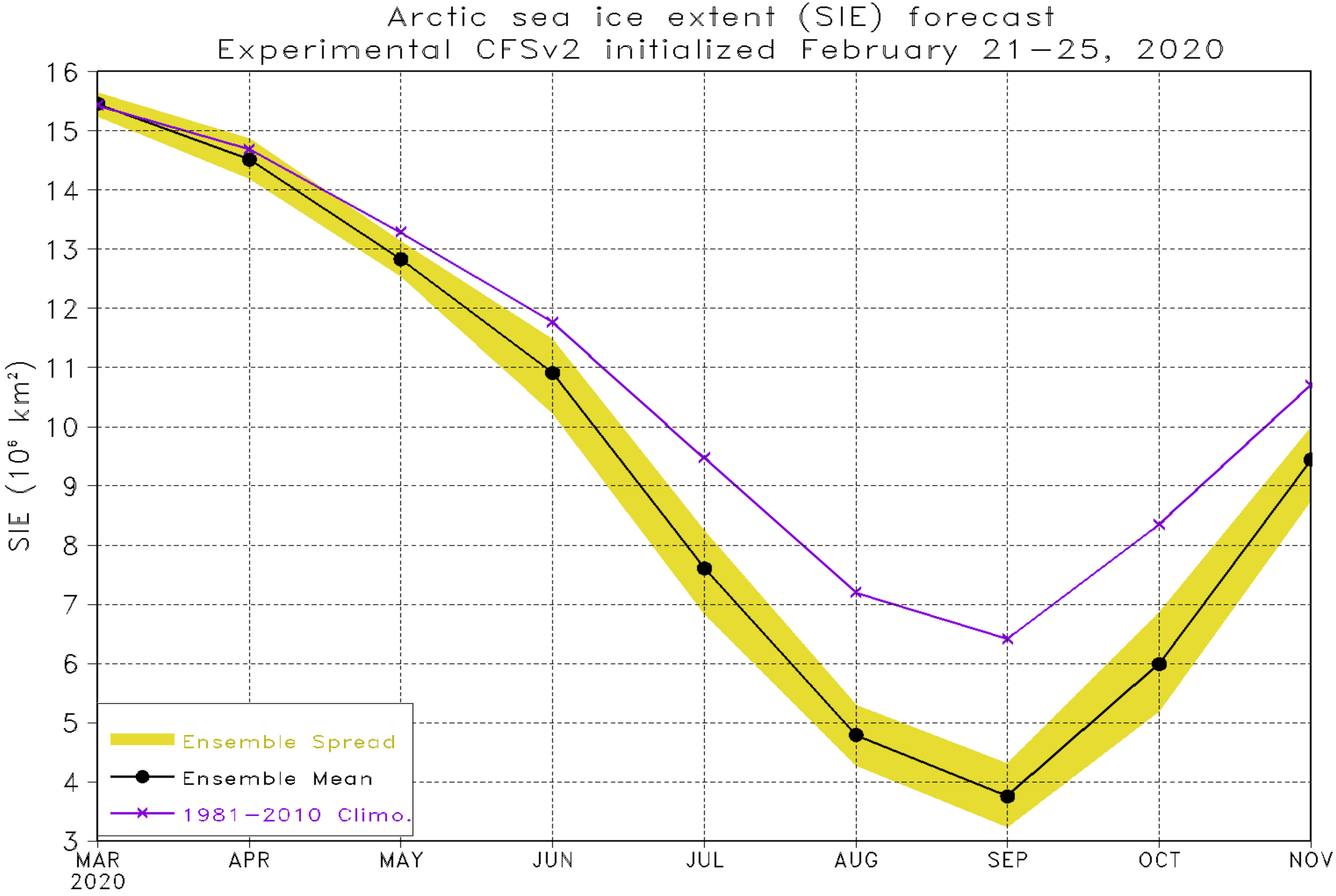








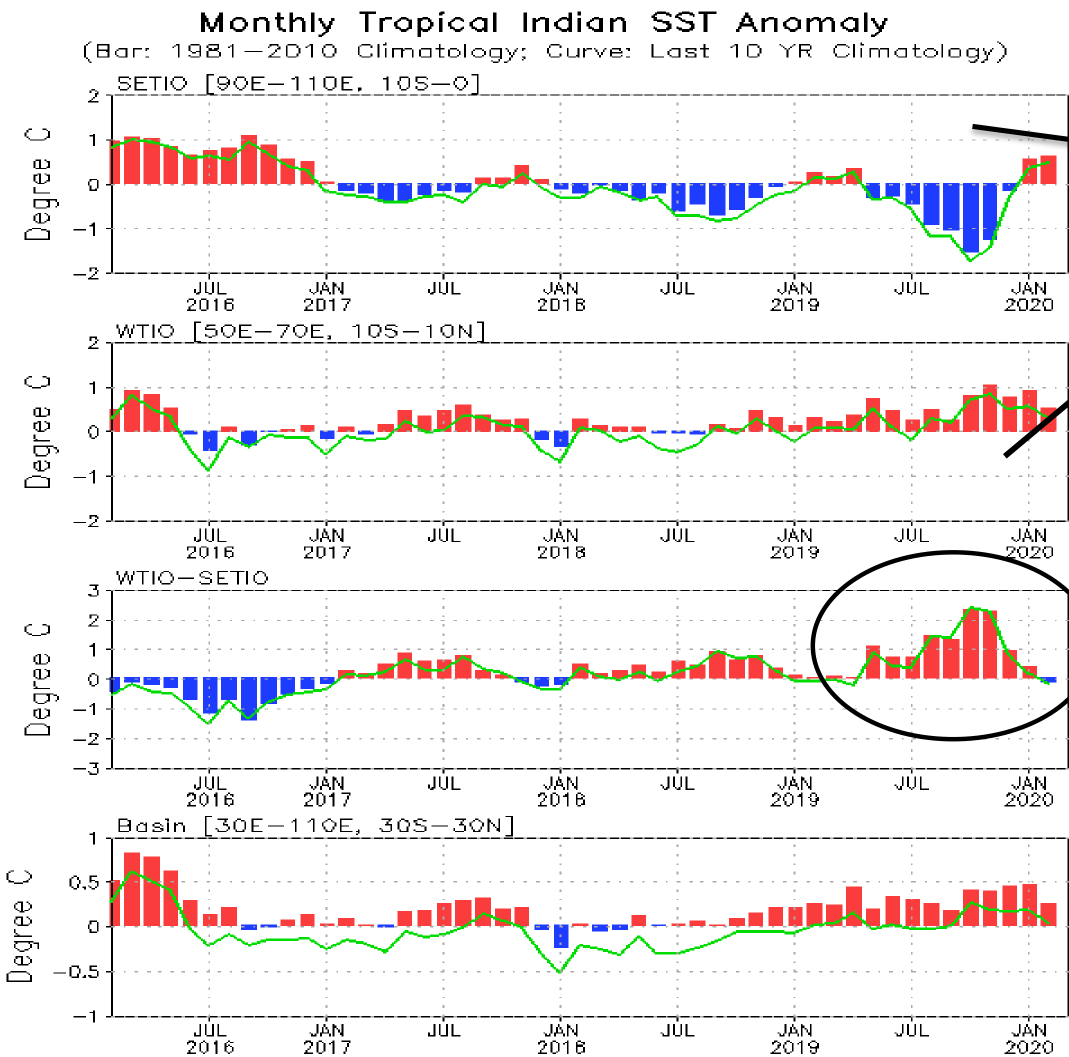
- **Arctic sea ice extent for Feb 2020 was the 13th lowest in the satellite record.**
- **Including 2020, the linear rate of decline for Feb ice extent is 2.91 percent per decade.**
- **Over the 42-year satellite record, the area of sea ice loss in the Arctic is comparable to the size of the state of Alaska.**

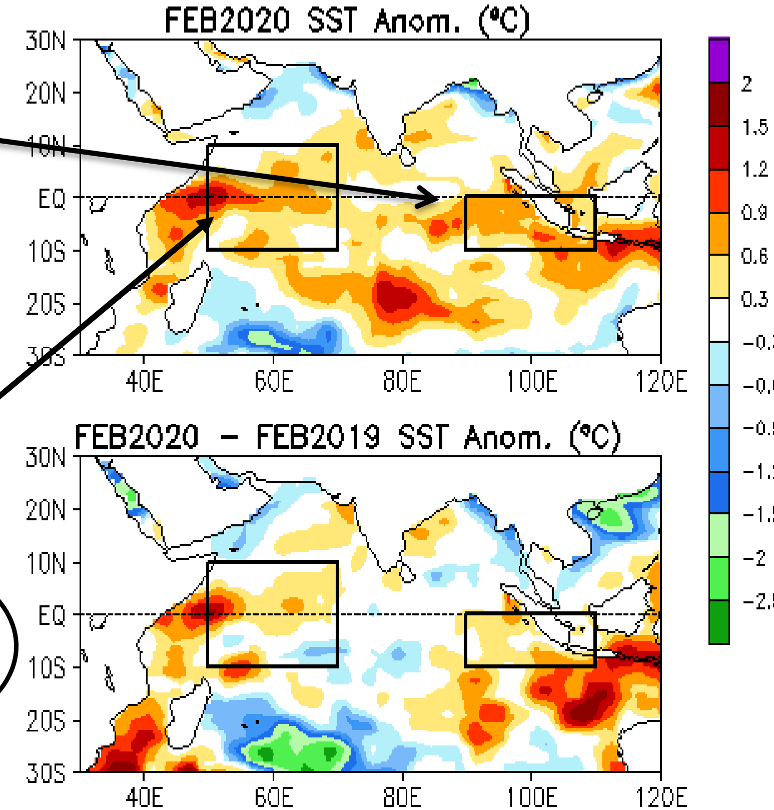


https://www.cpc.ncep.noaa.gov/products/people/wwang/seaice_seasonal/index.html

Indian Ocean

Evolution of Indian Ocean SST Indices

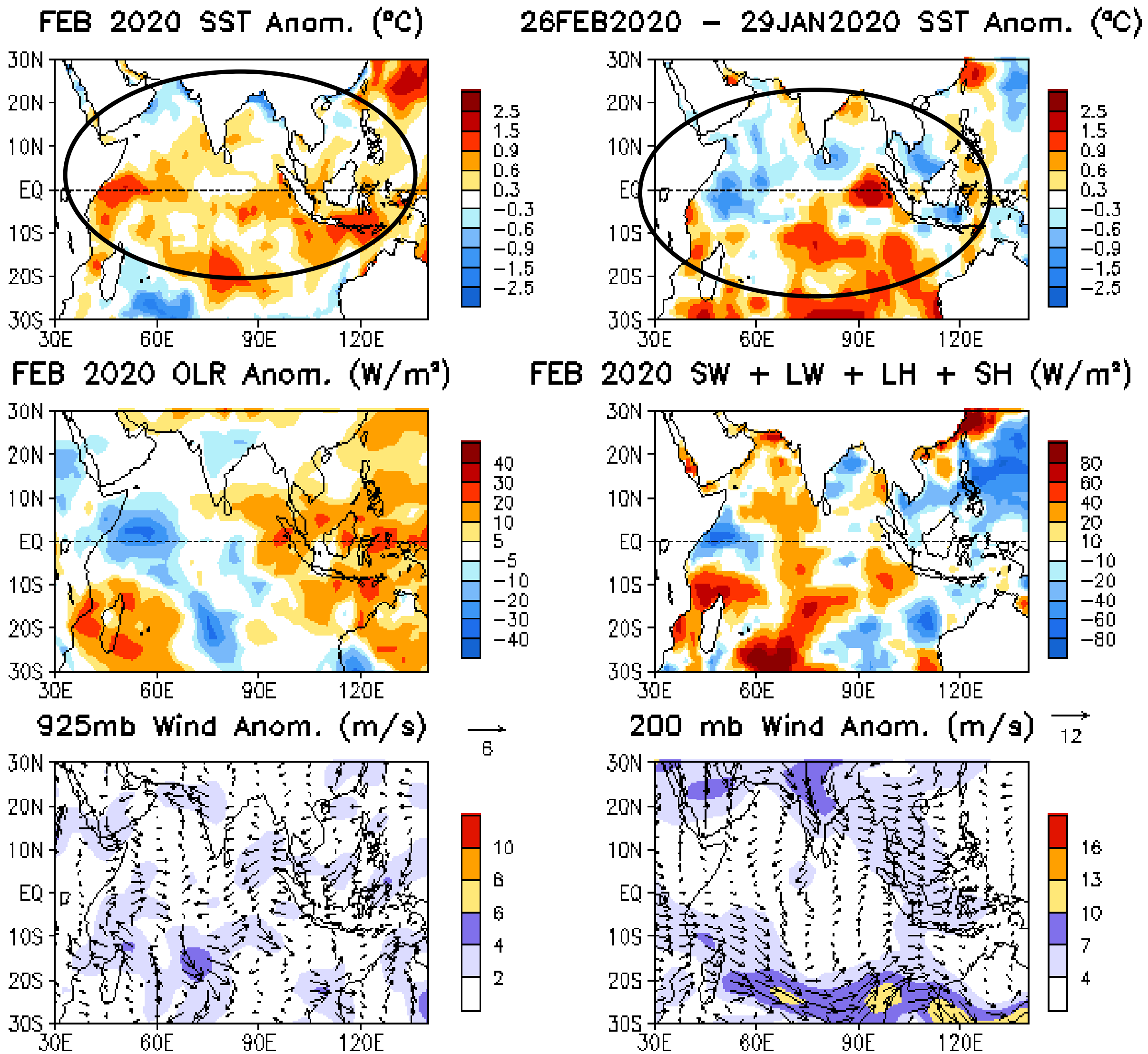




- **Positive SSTAs were in the entire tropical Indian Ocean.**
- **The positive phase of IOD peaked in Oct-Nov 2019 and it was in neutral phase since Jan 2020.**

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.



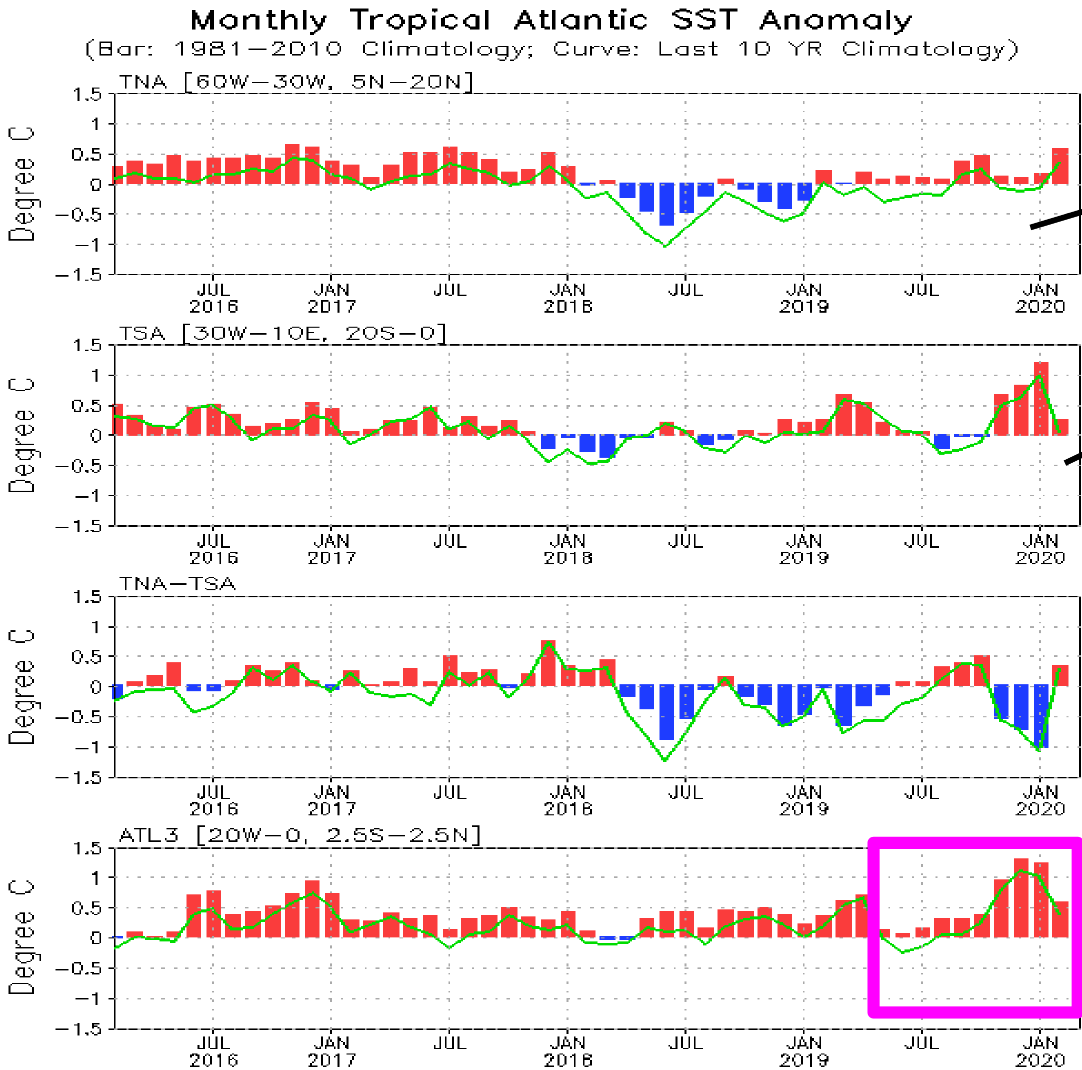
- SSTAs were positive in the entire tropical Indian Ocean.

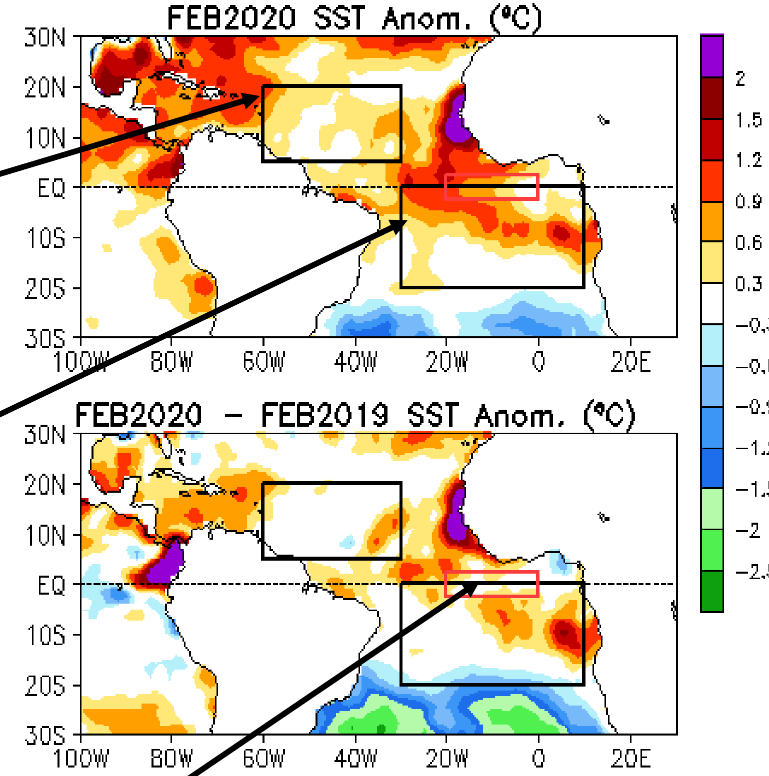
- Positive phase of IOD further decayed in Feb 2020.

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

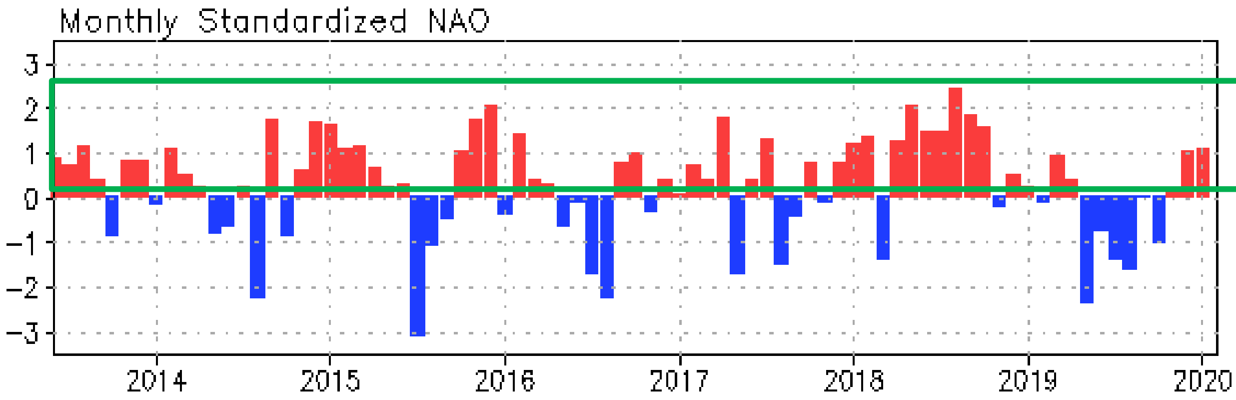


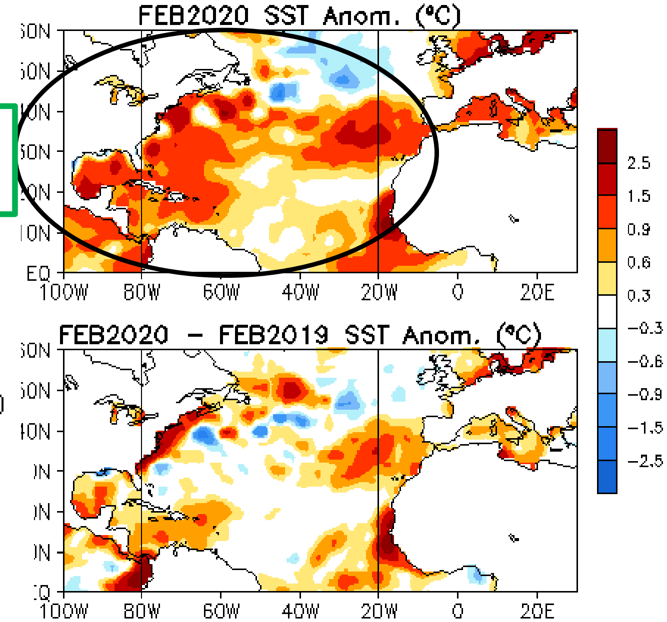


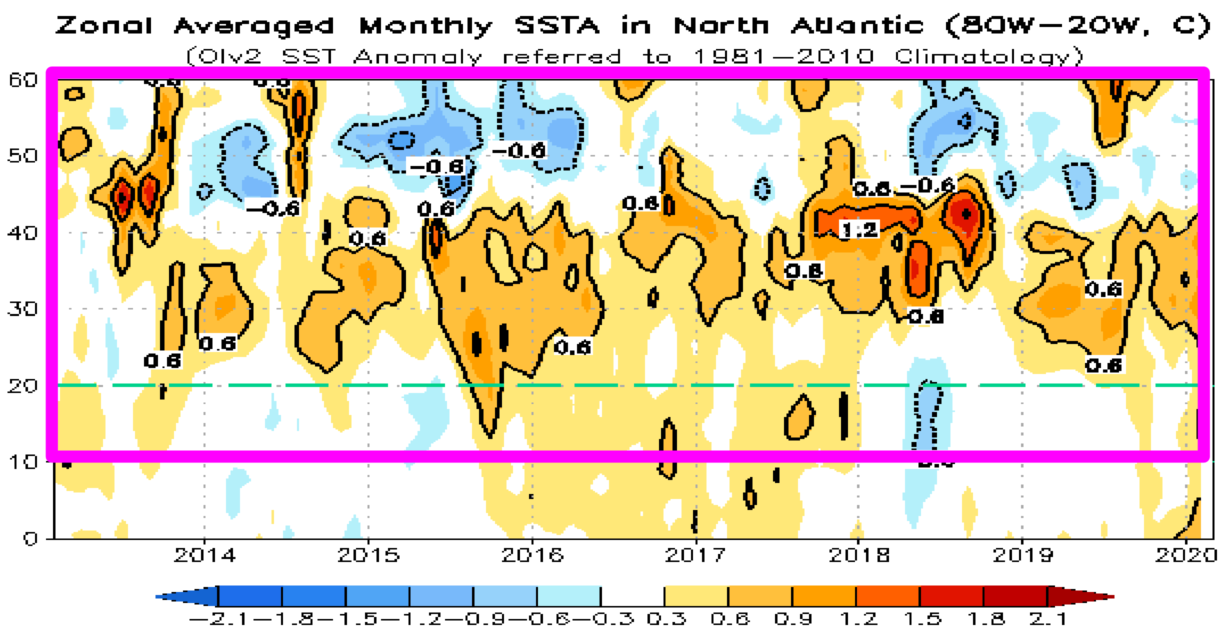
- **The dipole mode switched to positive phase.**
- **ATL3 (Atlantic Nino) weakened since Dec 2019, consistent with the evolution of subsurface ocean condition along the equatorial Atlantic (slide 8).**

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





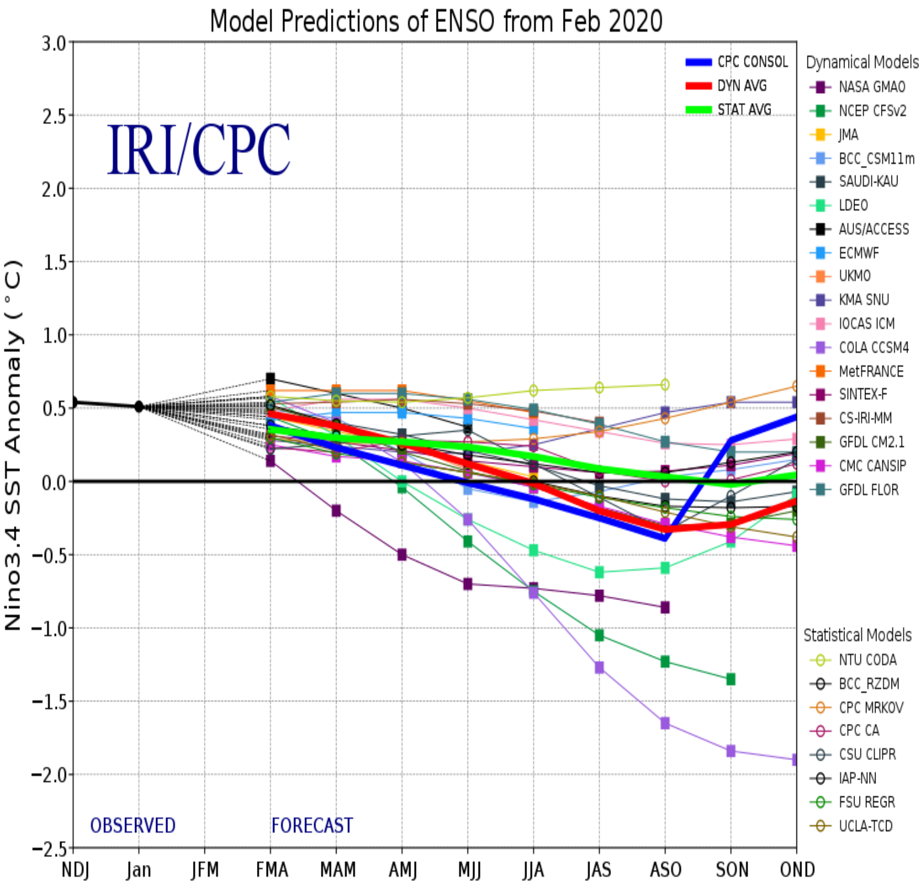


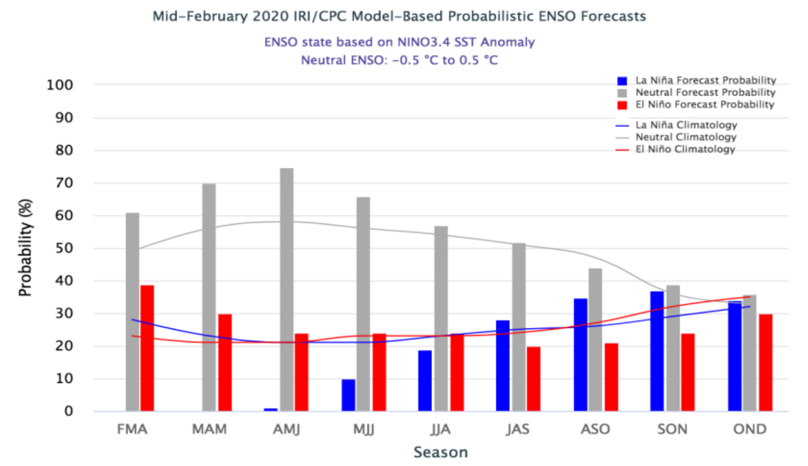
- NAO was still in a positive phase with NAOI= 0.98 in Feb 2020.
- SSTA was a tripole/horseshoe –like pattern with positive in the mid-latitudes and negative in the lower and higher latitudes, due to the long-term persistence of a positive phase of NAO.

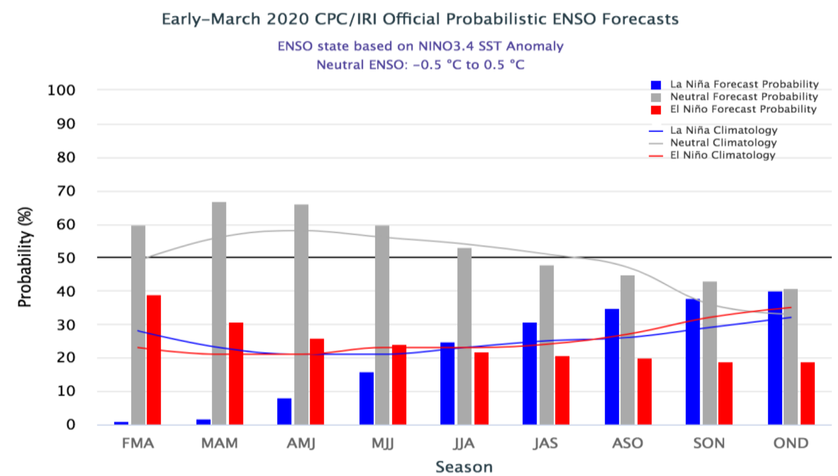
Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20ºN-90ºN (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80ºW and 20ºW (bottom). SST are derived from the NCEP OI SST analysis,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

ENSO and Global SST Predictions

IRI NINO3.4 Forecast Plume



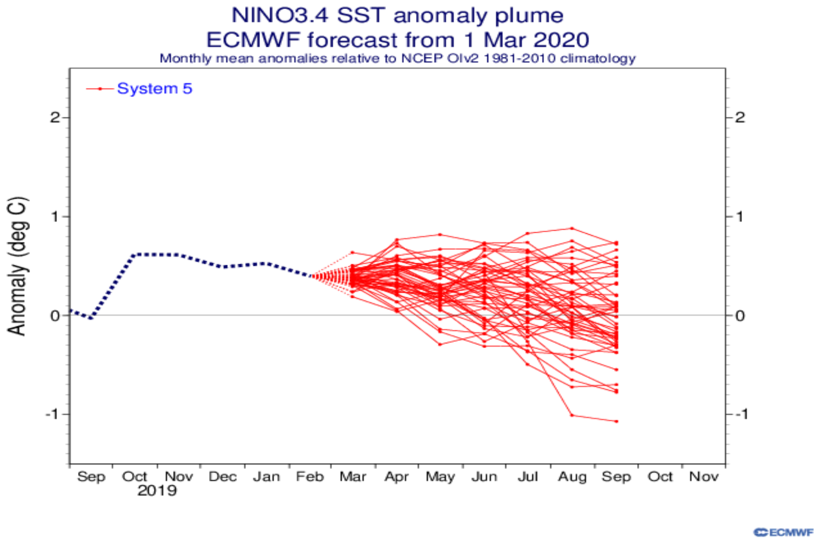




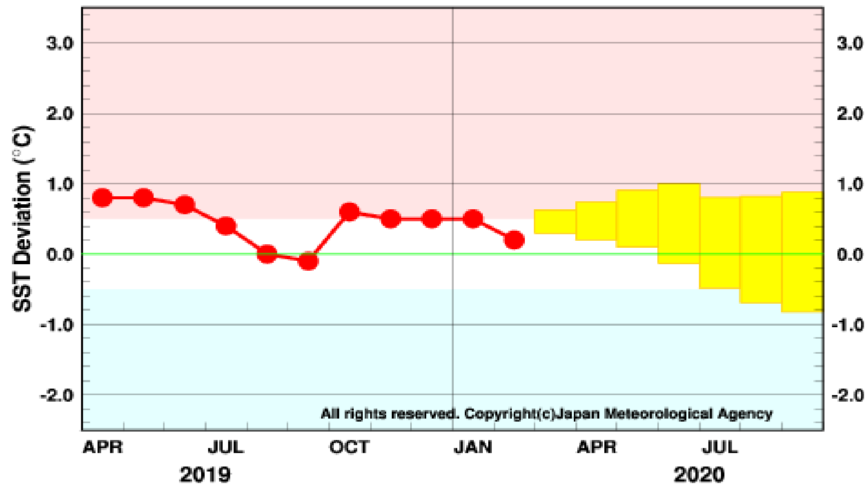
- **Majority of models predict continuation of ENSO-neutral with ICs in Feb 2020.**
- **NOAA "ENSO Diagnostic Discussion" on 12 Mar 2020 stated that** ***"ENSO-neutral is favored for the Northern Hemisphere spring 2020 (~65% chance), continuing through summer 2020 (~55% chance)."***

Individual Model Forecasts: Neutral Condition

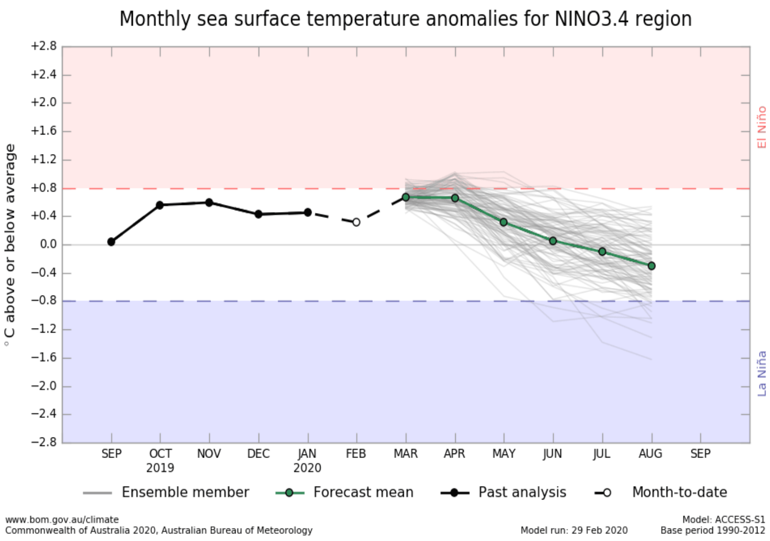
EC: Nino3.4, IC=01 Mar 2020



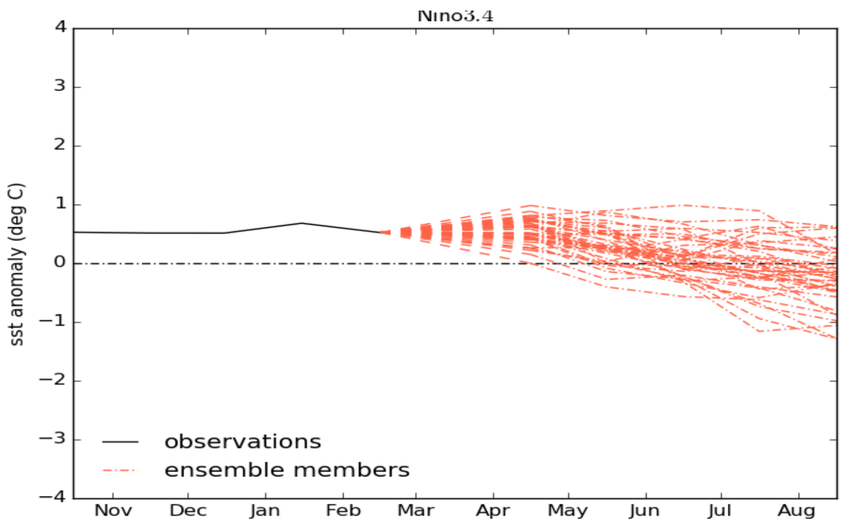
JMA: Nino3.4, Updated 10 Mar 2020

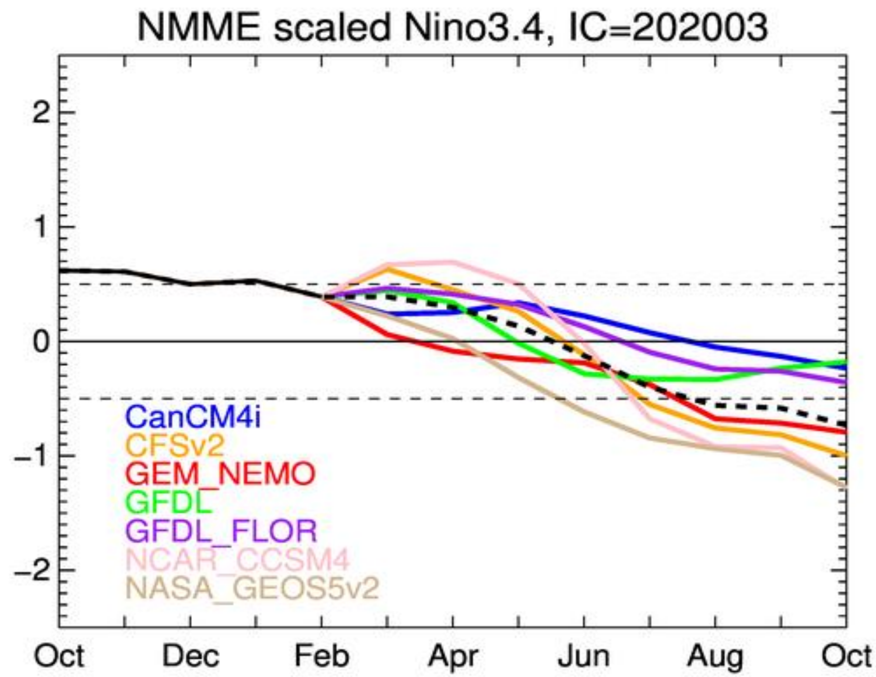


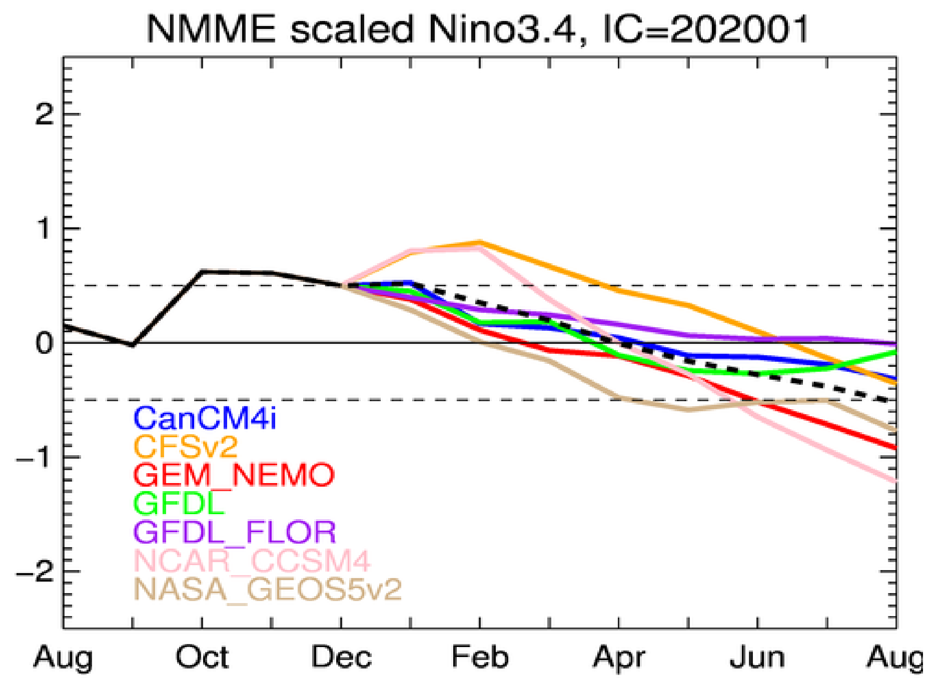
Australia: Nino3.4, Updated 29 Feb 2020

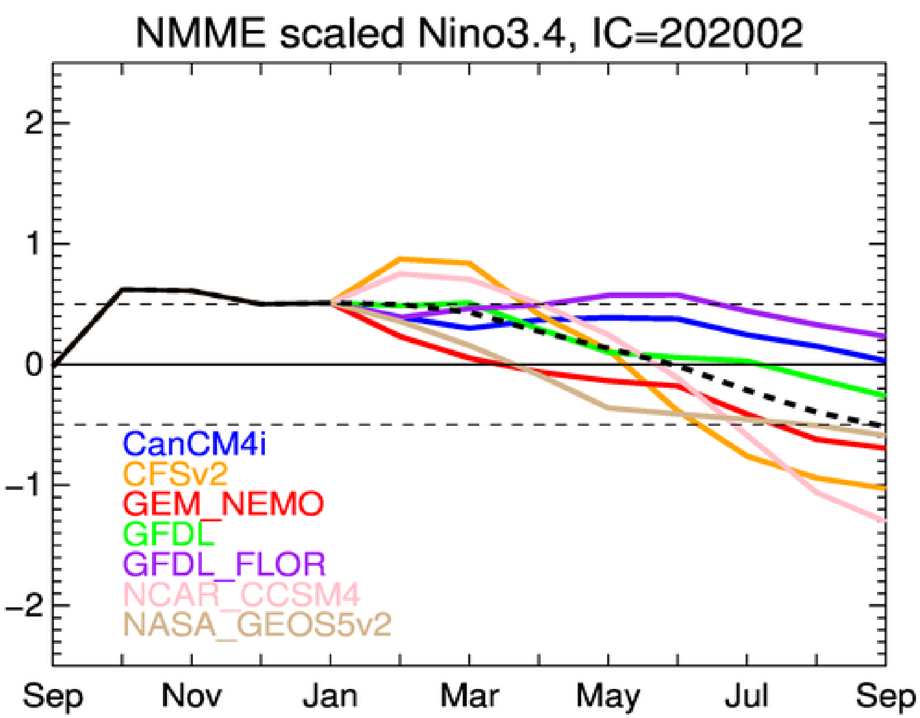


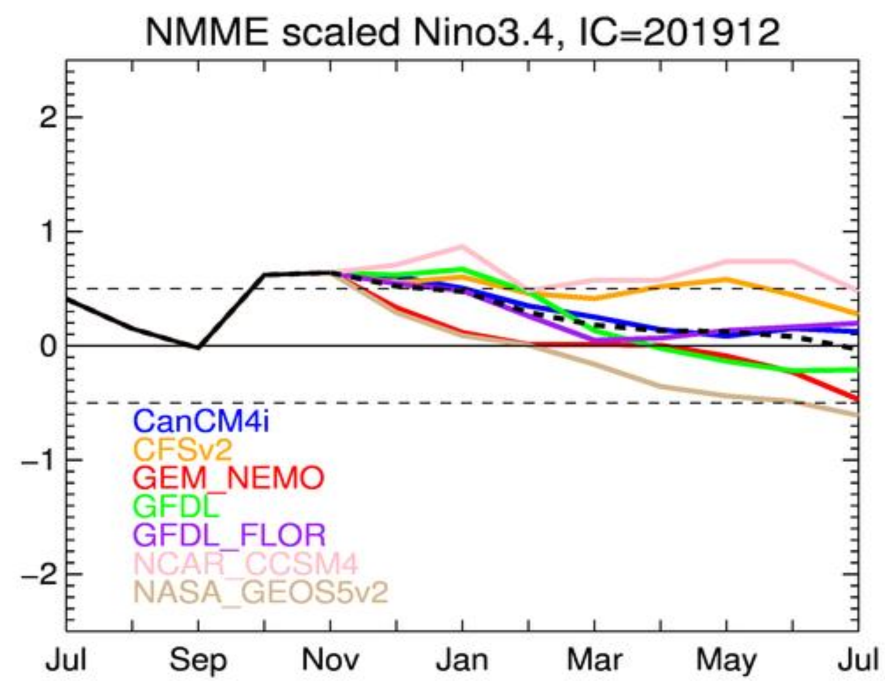
UKMO: Nino3.4, Updated 11 Mar 2020



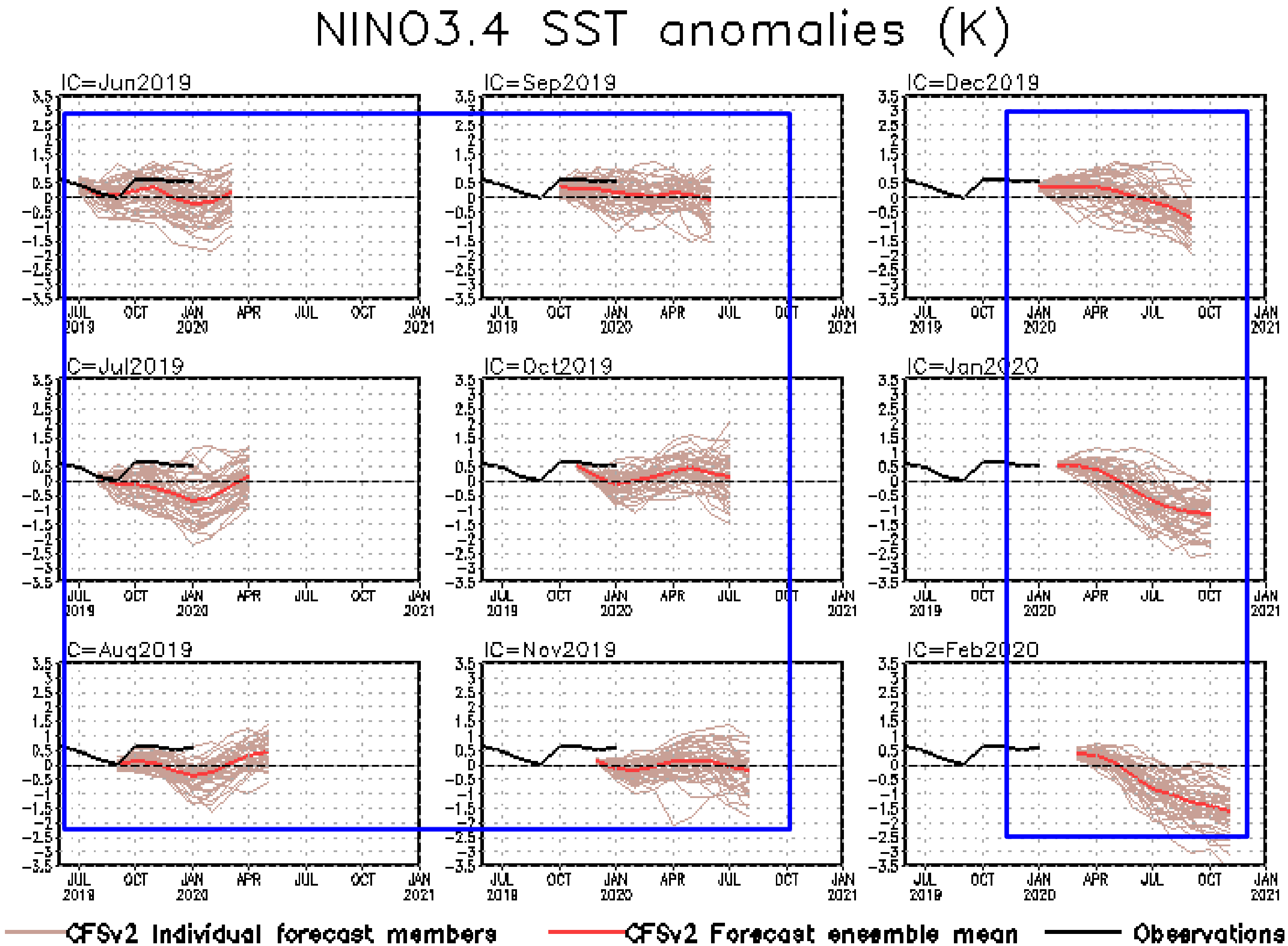

NMME scaled Nino3.4, IC=202003
2
1
0
−1
−2
Oct
Dec
Feb
Apr
Jun
Aug
Oct
CanCM4i
CFSv2
GEM_NEMO
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2


NMME scaled Nino3.4, IC=202001
2
1
0
−1
−2
Aug
Oct
Dec
Feb
Apr
Jun
Aug
CanCM4i
CFSv2
GEM_NEMO
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2


NMME scaled Nino3.4, IC=202002
2
1
0
−1
−2
Sep
Nov
Jan
Mar
May
Jul
Sep
CanCM4i
CFSv2
GEM_NEMO
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2


NMME scaled Nino3.4, IC=201912
2
1
0
−1
−2
Jul
Sep
Nov
Jan
Mar
May
Jul
CanCM4i
CFSv2
GEM_NEMO
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2

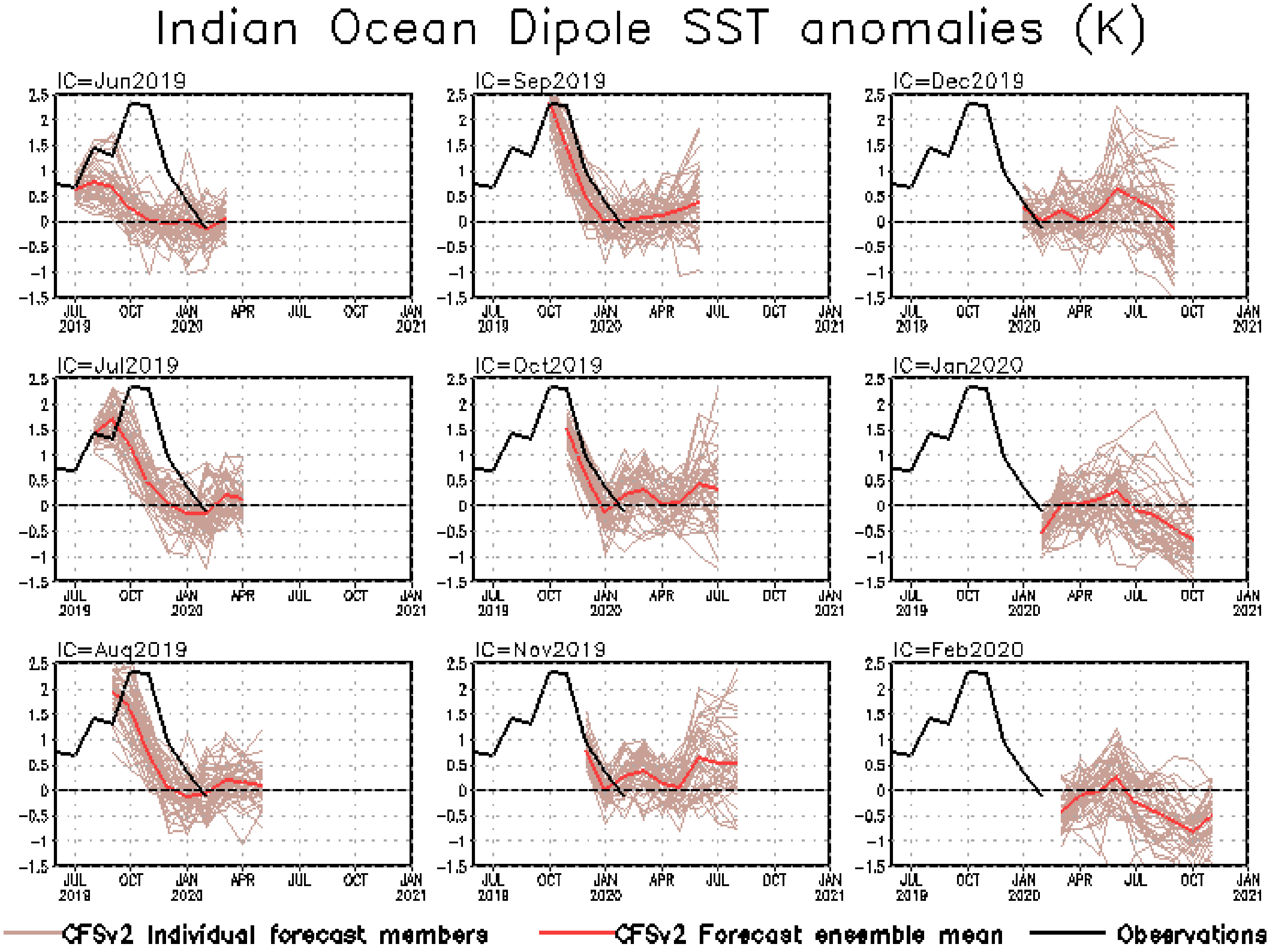
CFS Niño3.4 SST Predictions from Different Initial Months



- CFSv2 had cold bias with ICs during May-Nov 2019.
- The latest forecasts call for ENSO neutral until early summer 2020, for La Nina since mid-summer.

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.

NCEP CFS DMI SST Predictions from Different Initial Months



DMI = WTIO- SETIO

SETIO = SST anomaly in [90°E-110°E, 10°S-0]

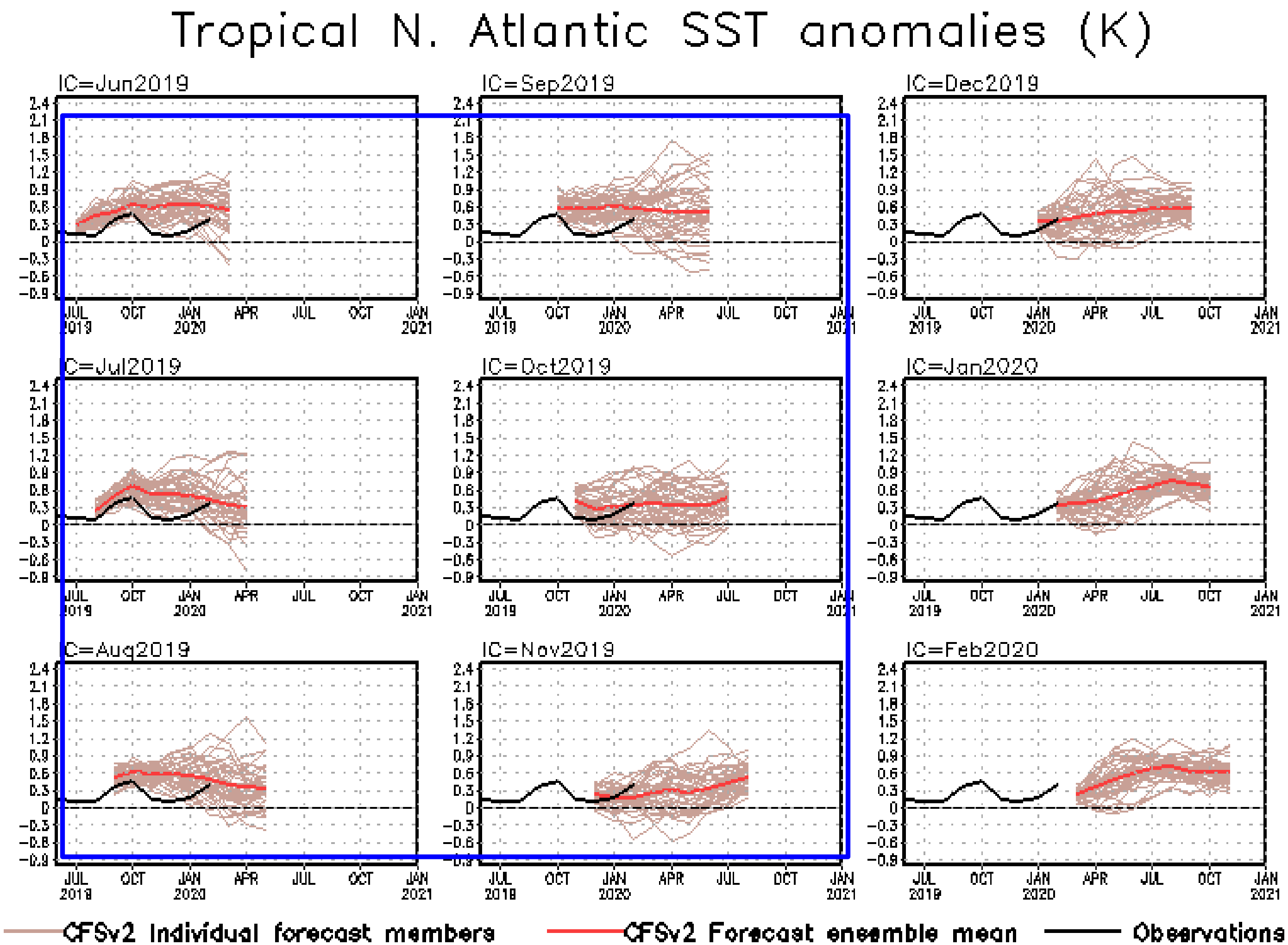
WTIO = SST anomaly in [50°E-70°E, 10°S-10°N]

- **Latest CFSv2 predictions call neutral or negative phase of IOD in 2020.**

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.

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

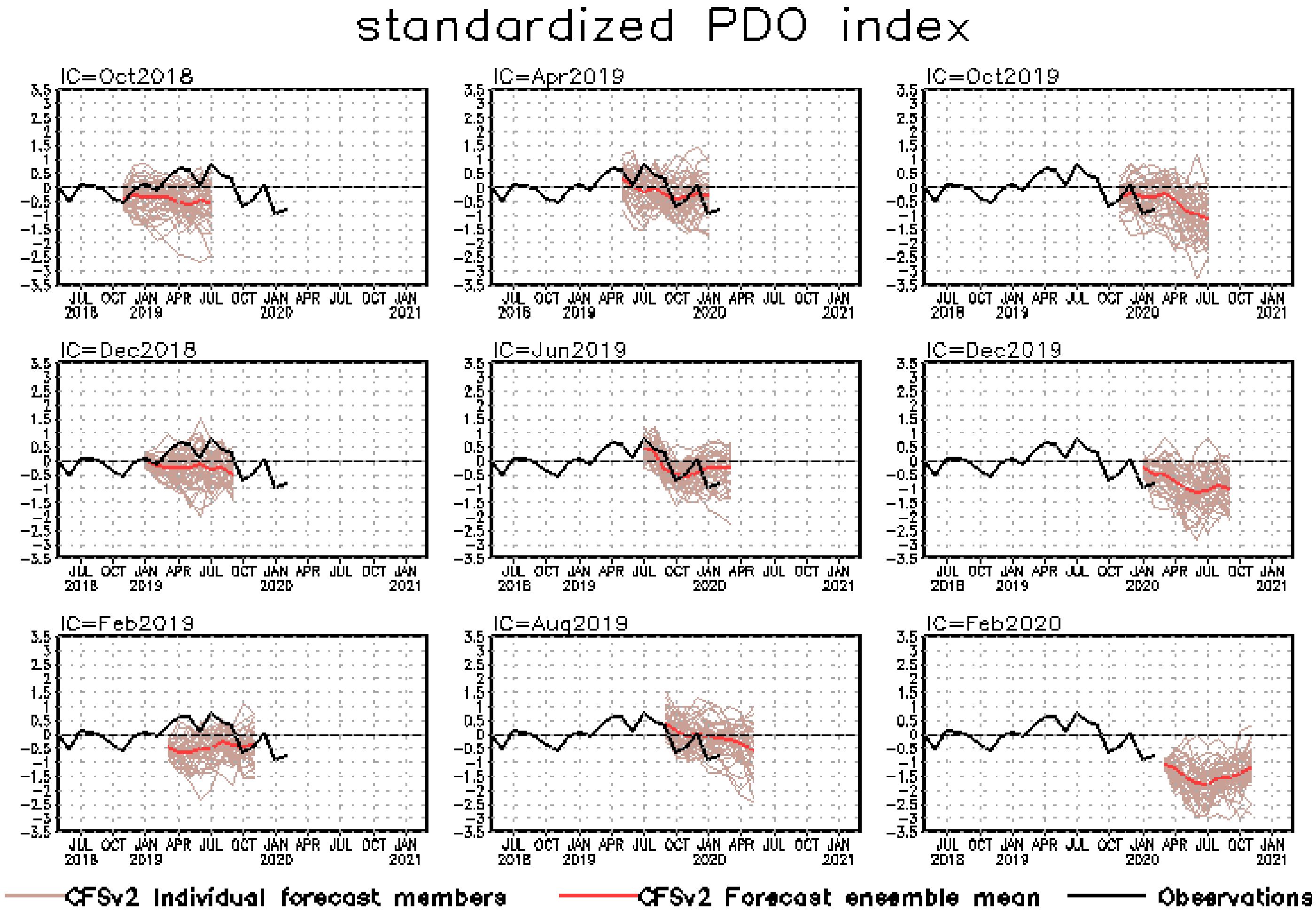
TNA is the SST anomaly averaged in the region of [60°W-30°W, 5°N-20°N].



- **Predictions had warm biases for ICs in Sep 2018-Oct 2019.**
- **Latest CFSv2 predictions call above normal SSTA in the tropical N. Atlantic in 2020.**

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



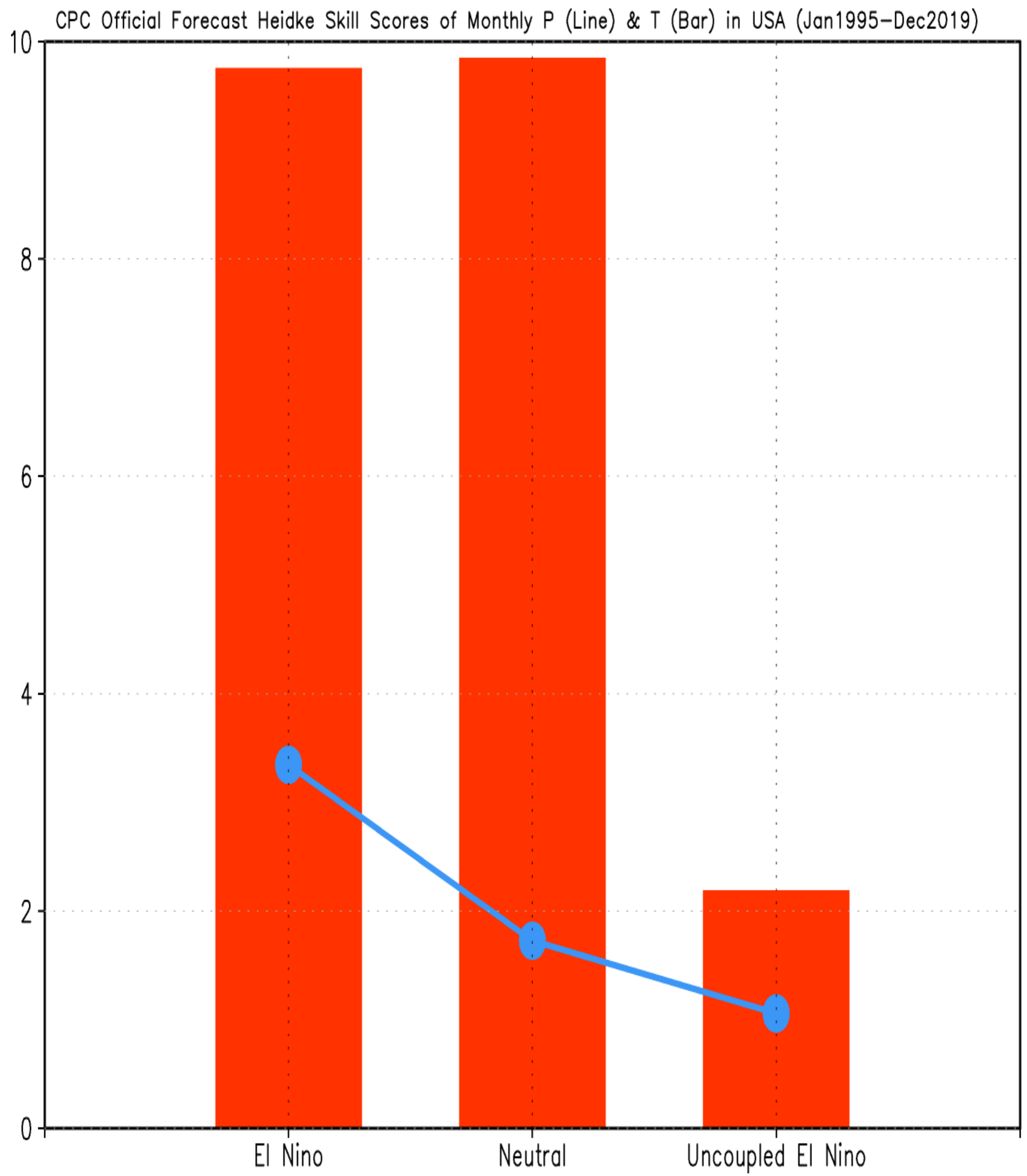
PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

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 2020.**

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.

Uncoupled El Nino Warming



CPC Official Forecast Heidke Scores of Monthly Precipitation (line) & Temperature (bar) of All Forecasts:

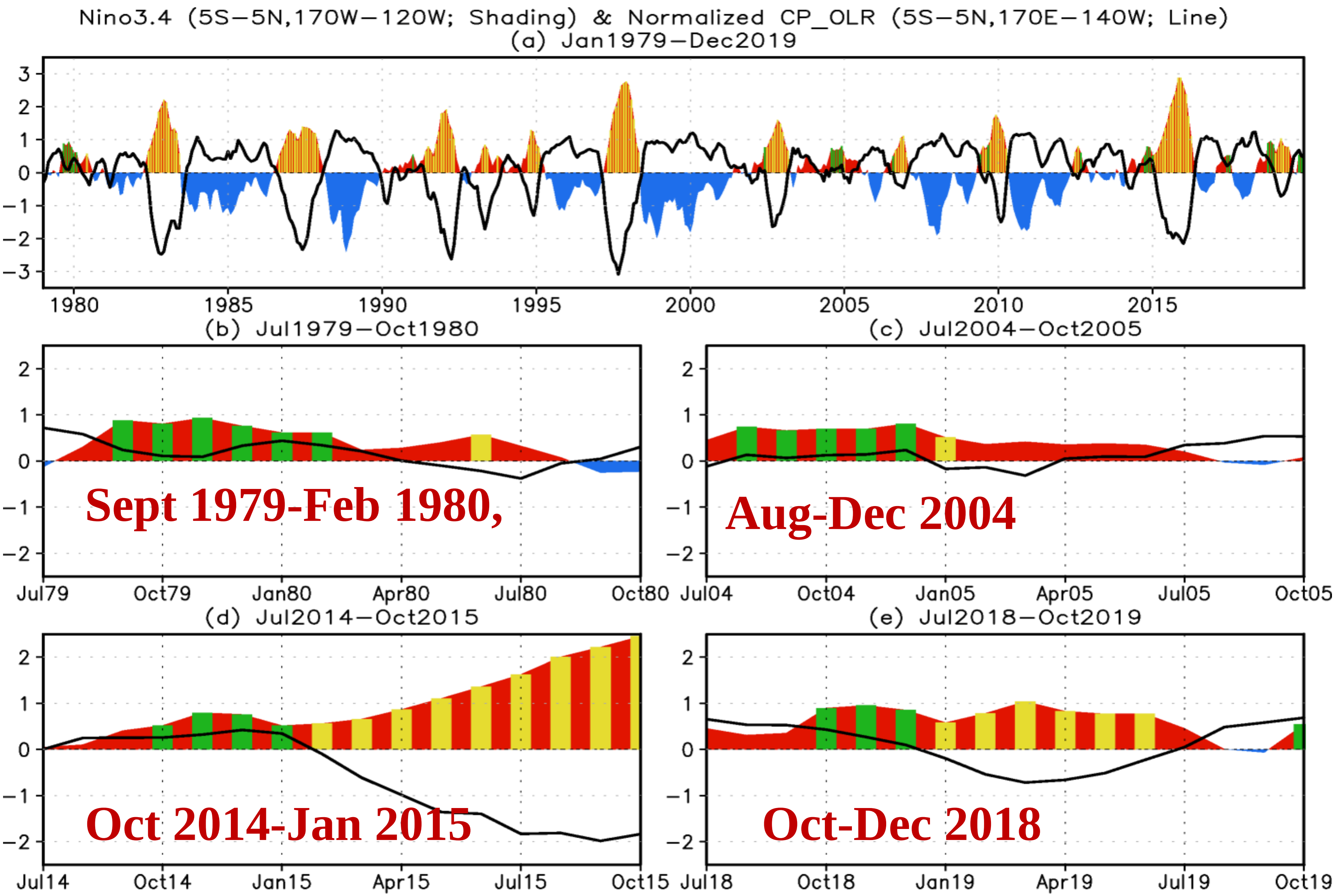
- **NCEP/CPC Official Monthly P & T Forecast Skills are the lowest in uncoupled El Nino warming.**
- **El Nino seems no contribution to temperature forecast skill.**
- **Why???**

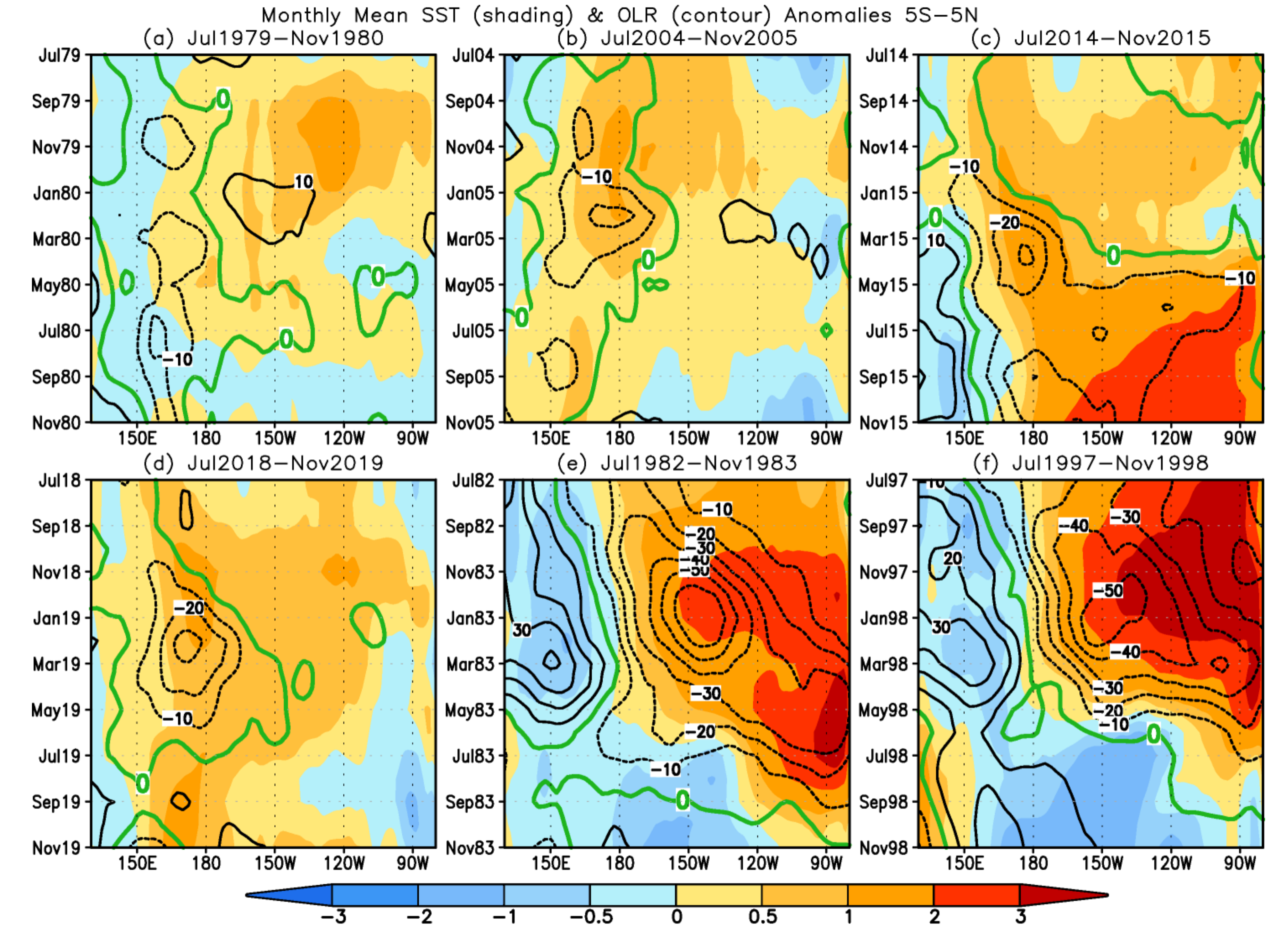
What is the uncoupled El Nino Warming?

An uncoupled warming event is defined as an event with

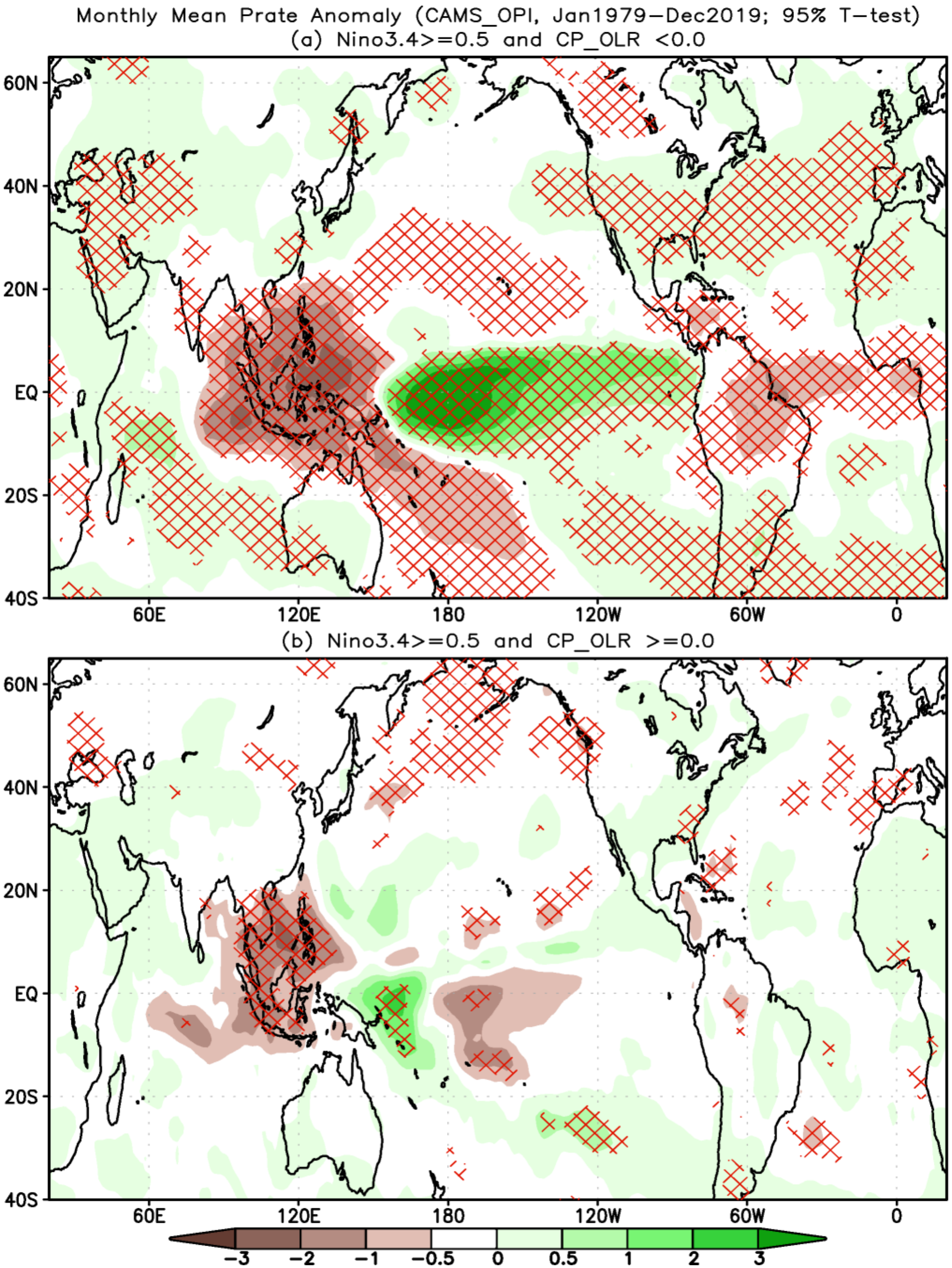
- (a) a monthly mean Niño3.4 index ≥ 0.5^{o}C;
- (b) Central Pacific OLR (CP_OLR) index >0.0;
- (c) (a) & (b) persist for at least 3 consecutive months.

4 uncoupled warming events since 1979: Sep 1979-Feb 1980, Aug-Dec 2004, Oct 2014-Jan 2015, & Oct-Dec 2018

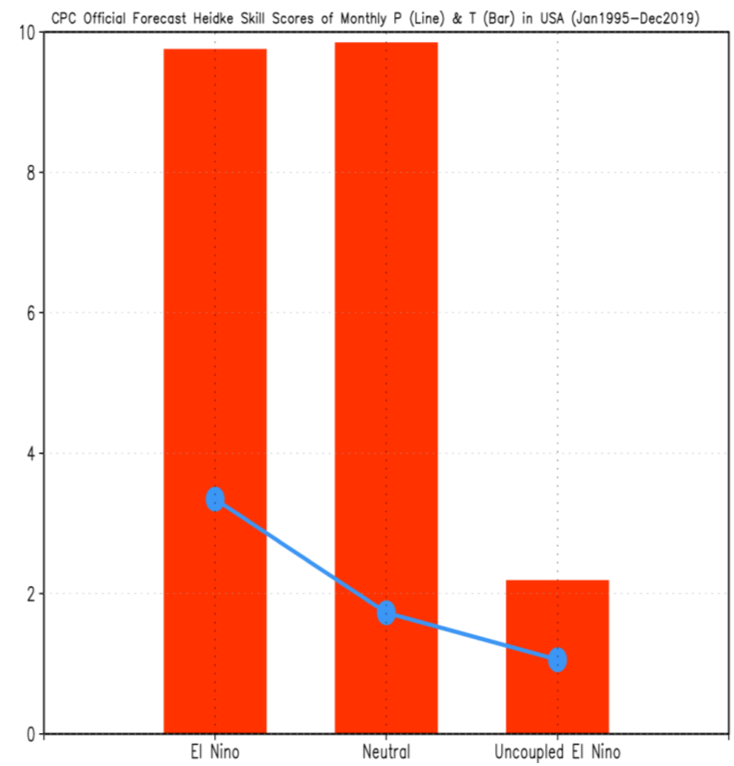


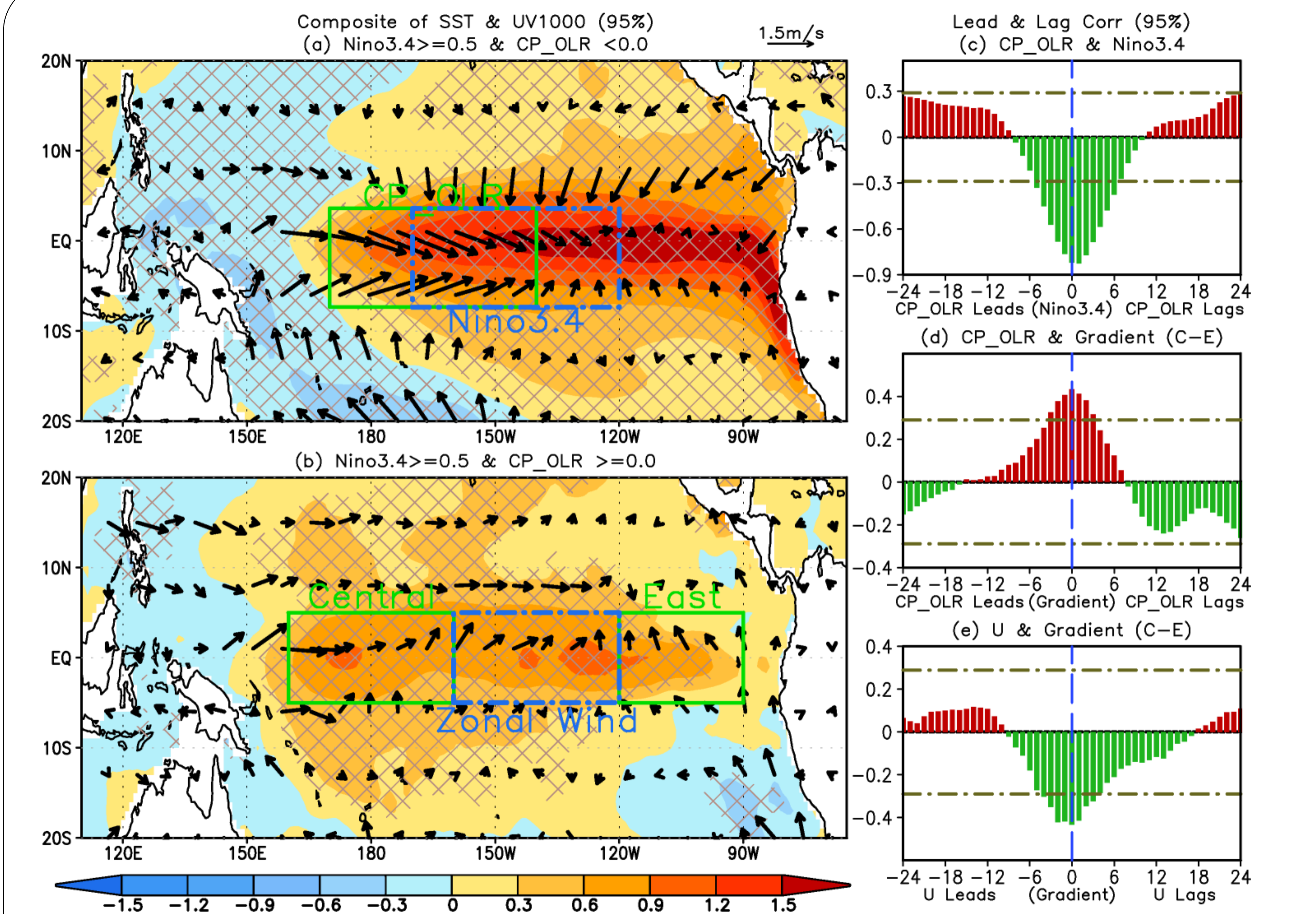


Monthly Mean SST (shading) & OLR (contour) Anomalies 5S-5N
(a) Jul1979–Nov1980
(b) Jul2004–Nov2005
(c) Jul2014–Nov2015
(d) Jul2018–Nov2019
(e) Jul1982–Nov1983
(f) Jul1997–Nov1998
150E 180 150W 120W 90W
−3 −2 −1 −0.5 0 0.5 1 2 3



- Composite of precipitation for coupled and uncoupled El Nino
- CPC official forecast skills of T/P in El Nino, uncoupled El Nino and neutral
- **So we must distinguish El Nino and uncoupled El Nino**





Composite of SST & UV1000 (95%)
(a) Nino3.4>=0.5 & CP_OLR <0.0
1.5m/s
CP_OLR
Nino3.4
(b) Nino3.4>=0.5 & CP_OLR >=0.0
Central
East
Zonal Wind
20N
10N
EQ
10S
20S
120E
150E
180
150W
120W
90W
−1.5
−1.2
−0.9
−0.6
−0.3
0
0.3
0.6
0.9
1.2
1.5
Lead & Lag Corr (95%)
(c) CP_OLR & Nino3.4
CP_OLR Leads (Nino3.4) CP_OLR Lags
(d) CP_OLR & Gradient (C−E)
CP_OLR Leads (Gradient) CP_OLR Lags
(e) U & Gradient (C−E)
U Leads (Gradient) U Lags
−24
−18
−12
−6
0
6
12
18
24

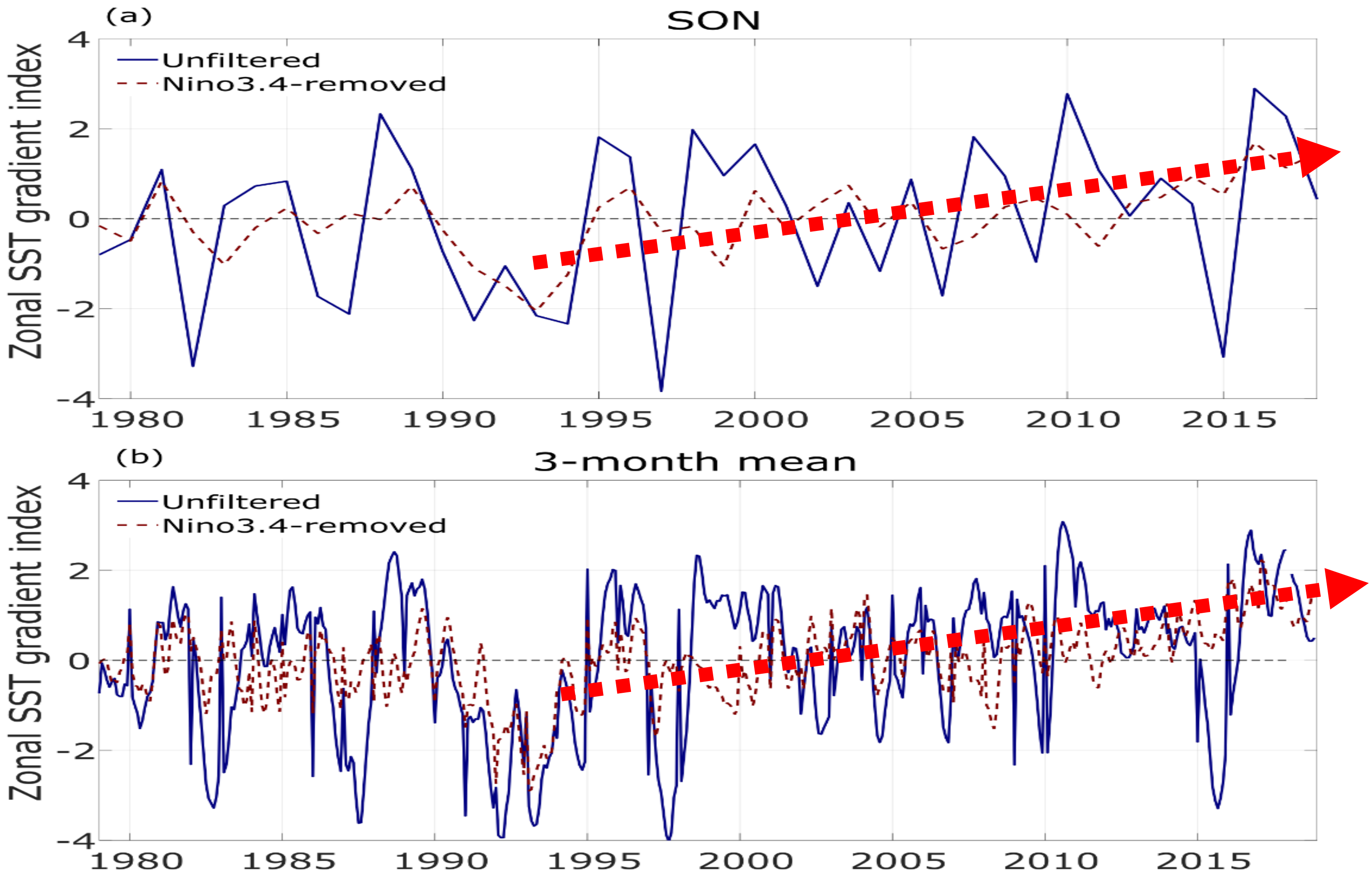
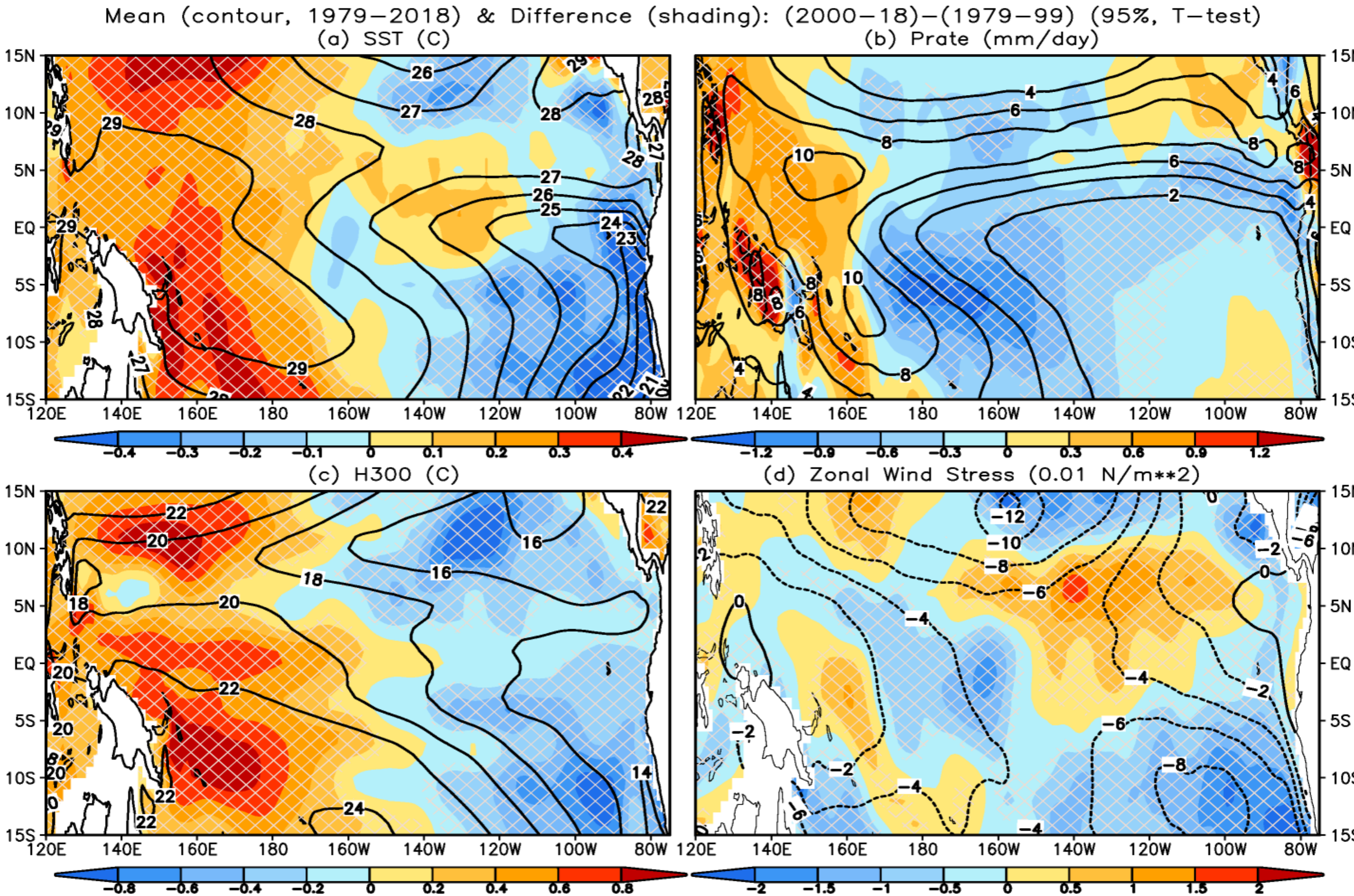


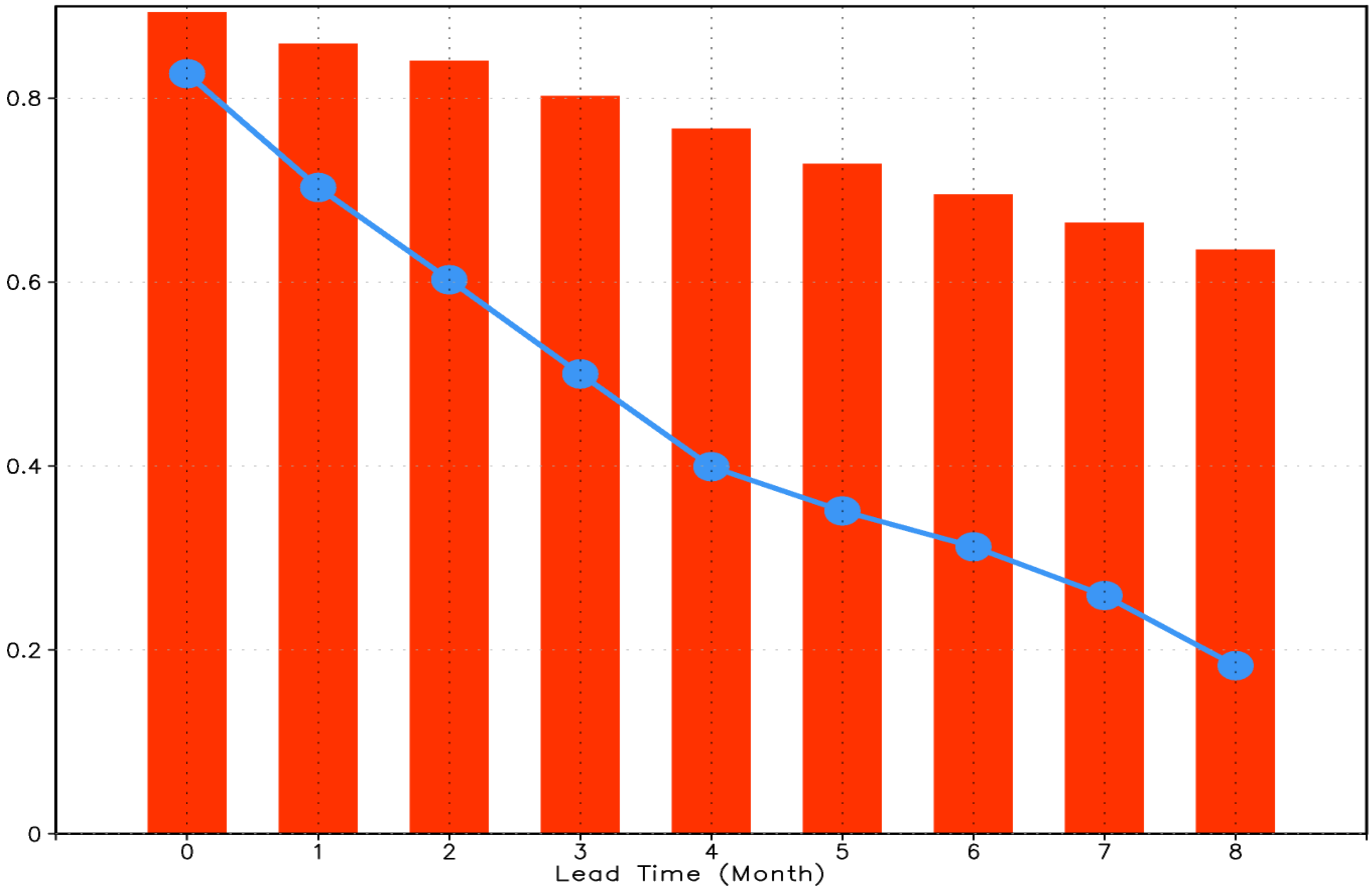
Fig. S3. Time series of unfiltered (red) and residual (blue) zonal SST gradient index for (a) SON and (b) all three-month seasonal means.

Johnson et al. GRL 2019: zonal SST gradient index is defined as the difference between the standardized SSTA averaged over a box near Papua New Guinea (10°S–10°N, 130°E–170°E) and the standardized SSTA averaged over a box in the central Pacific (10°S–10°N, 180°–140°W).

The zonal gradients are overall increased



Lead-time dependent prediction skill of CFSv2 predicted Niño3.4 (bar) and zonal gradient of SSTA (the central (5°S-5°N, 160°E-160°W) minus the eastern (5°S-5°N, 120°W-90°W) tropical Pacific; line) indices. The skill is defined as the linear correlation between the ensemble mean of 20 forecast members and observations in Jan 1982-Dec 2018



Acknowledgements

❖ Drs. Jieshun Zhu, Caihong Wen, and Arun Kumar: reviewed PPT, and provide insightful and constructive suggestions and comments

❖ Drs. Li Ren and Pingping Xie provided the SSS slides

❖ Dr. Wanqiu Wang provided the sea ice forecasts and maintained the CFSv2 forecast achieve

Please send your comments and suggestions to:

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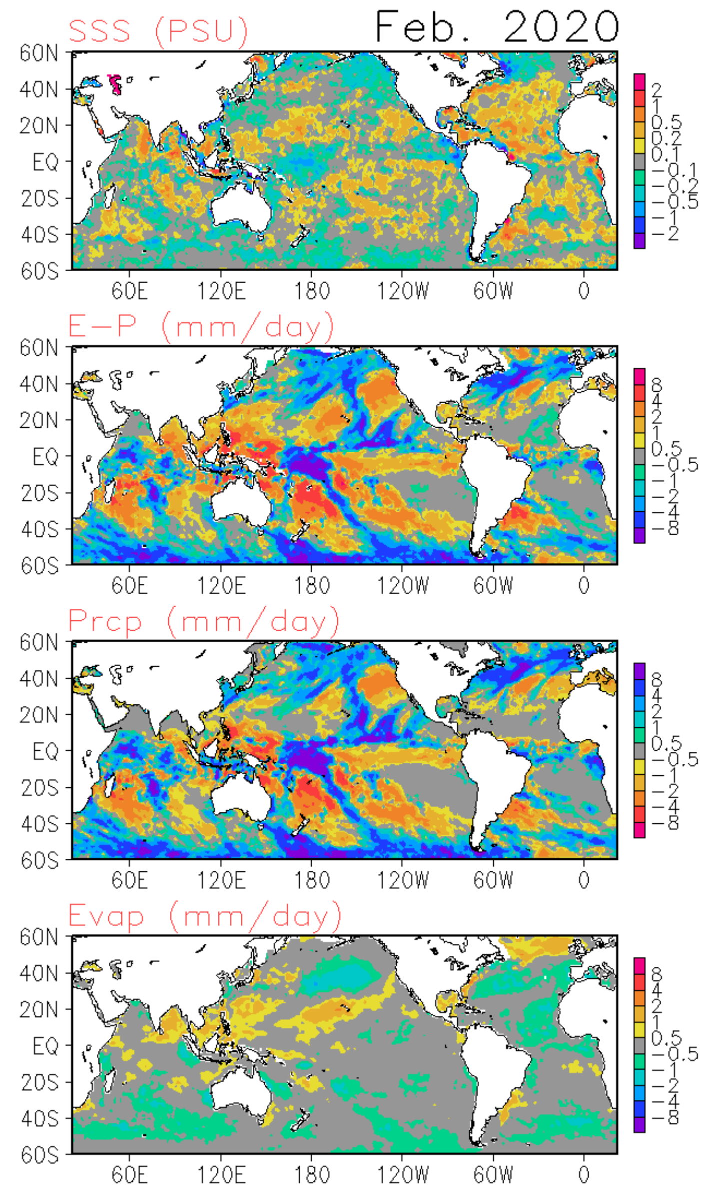
Jieshun.Zhu@noaa.gov

Backup Slides

Global Sea Surface Salinity (SSS)

Anomaly for February 2020

- 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.
- Negative SSS anomalies in the subarctic N. Pacific ocean and N. Atlantic ocean along the storm track continues, which are likely caused by the enhanced precipitation. Negative SSS signal in the west equatorial Pacific region is persistent with enhanced precipitation as well. Negative SSS appears along the circumpolar gyre in the Southern Ocean which is co-incident with increased precipitation. In the Bay of Bengal, positive SSS is accompanied with reduced freshwater input.



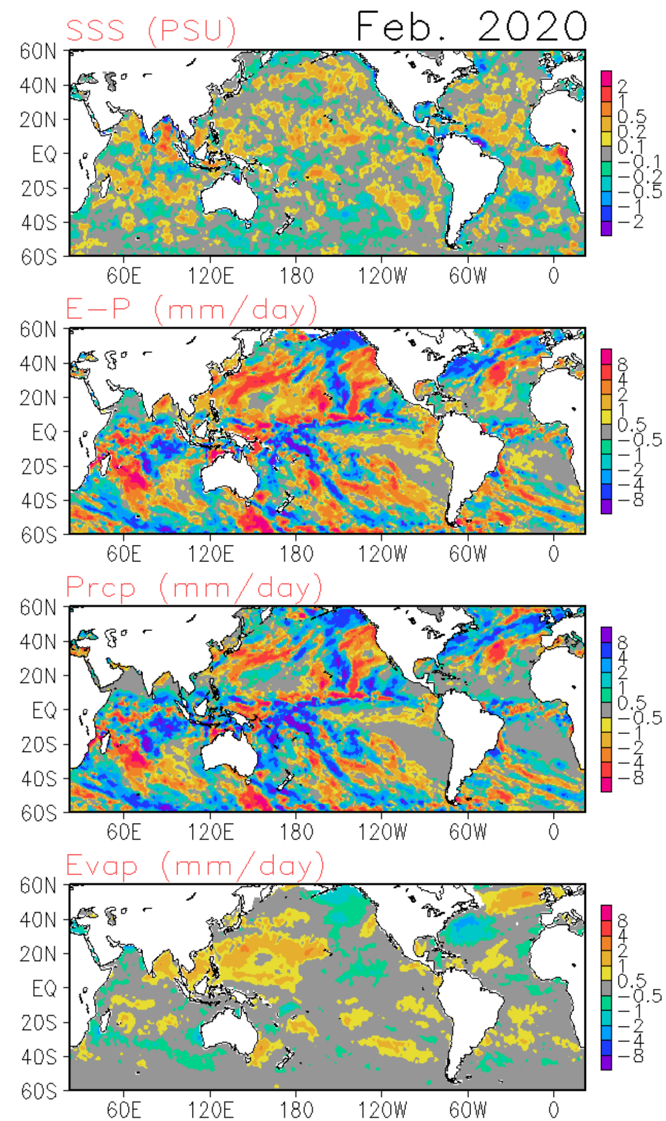
- **Data used**

  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 February 2020

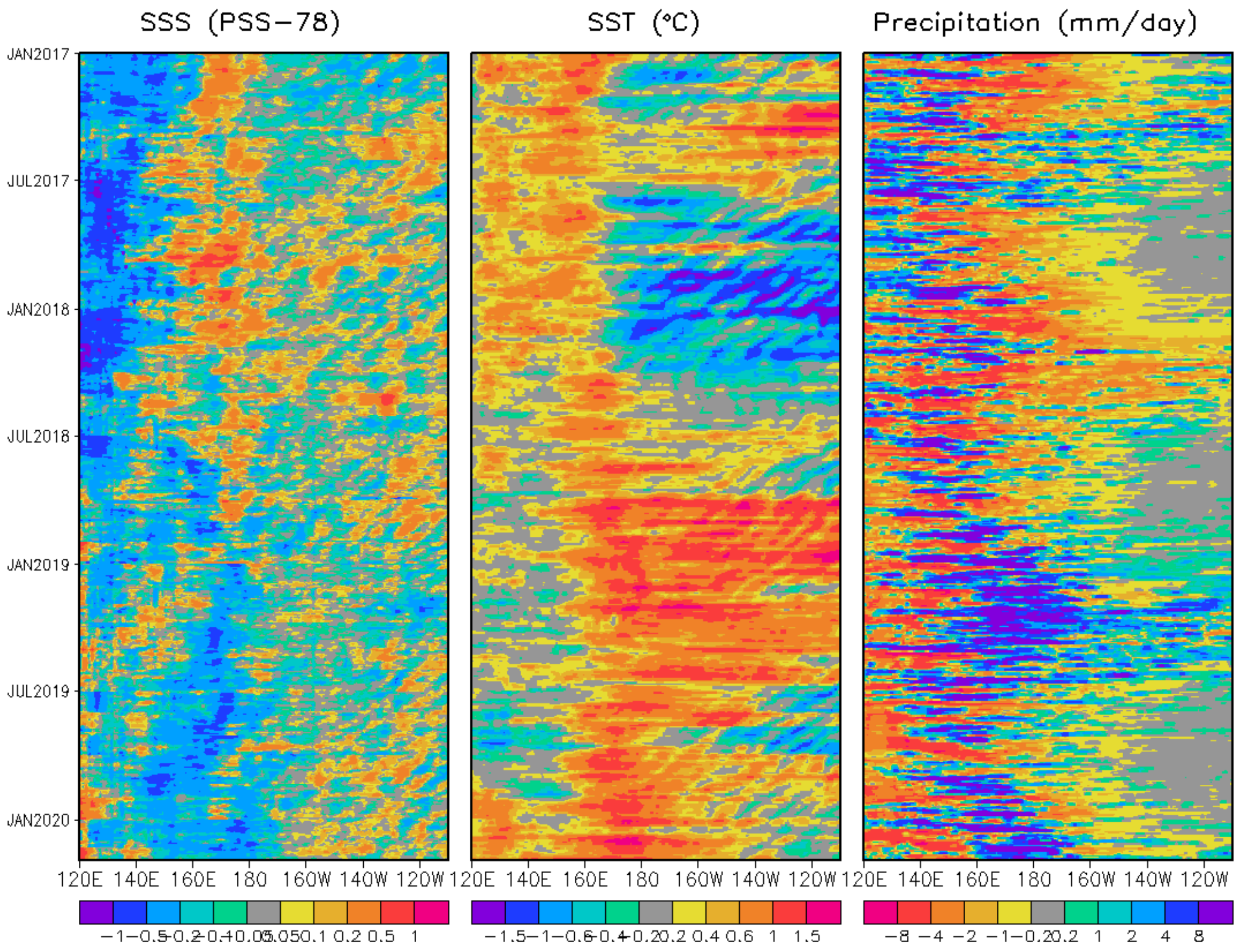
Compared with last month, the SSS increased in the subarctic N. Pacific ocean along the storm track. The SSS signal is positive between equator and 20° N in the north Pacific ocean. The increased SSS in the Bay of Bengal is accompanied with reduced freshwater input. In the Southern Ocean, the SSS decreased in most of the circumpolar region which is probably due to both the oceanic advection and increased precipitation.



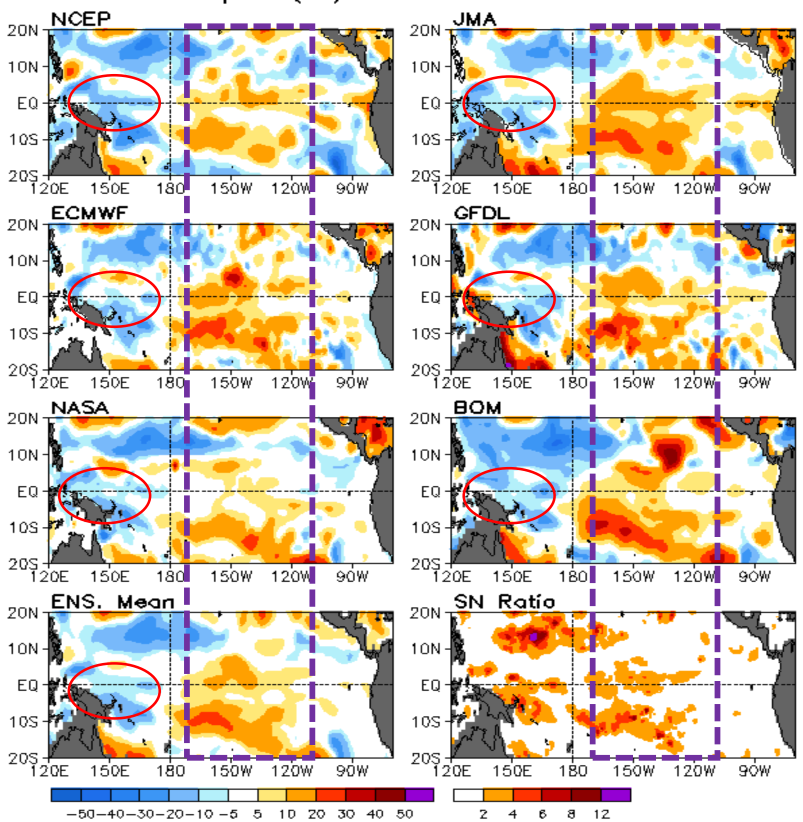
Global Sea Surface Salinity (SSS)

Anomaly Evolution along the Equatorial Pacific from Pentad SSS

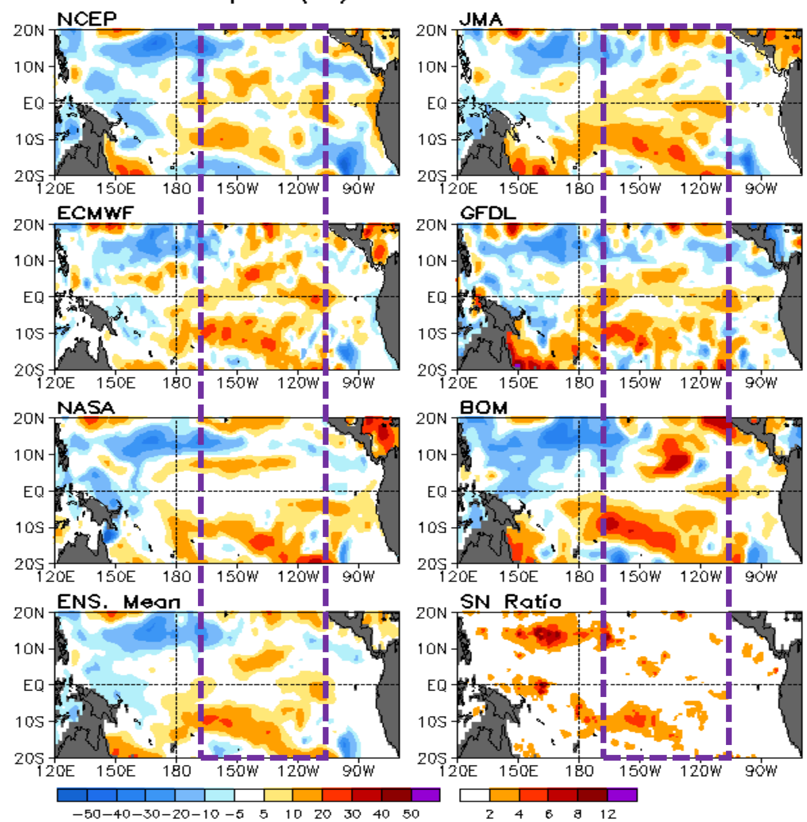
Figure caption:
Hovemoller diagram for equatorial (5° S-5° N) 5-day mean SSS, SST and precipitation anomalies. The climatology for SSS is Levitus 1994 climatology. The SST data used here is the OISST V2 AVHRR only daily dataset with its climatology being calculated from 1985 to 2010. The precipitation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



Anomalous Depth (m) of 20C Isotherm: FEB 2020



Anomalous Depth (m) of 20C Isotherm: JAN 2020



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

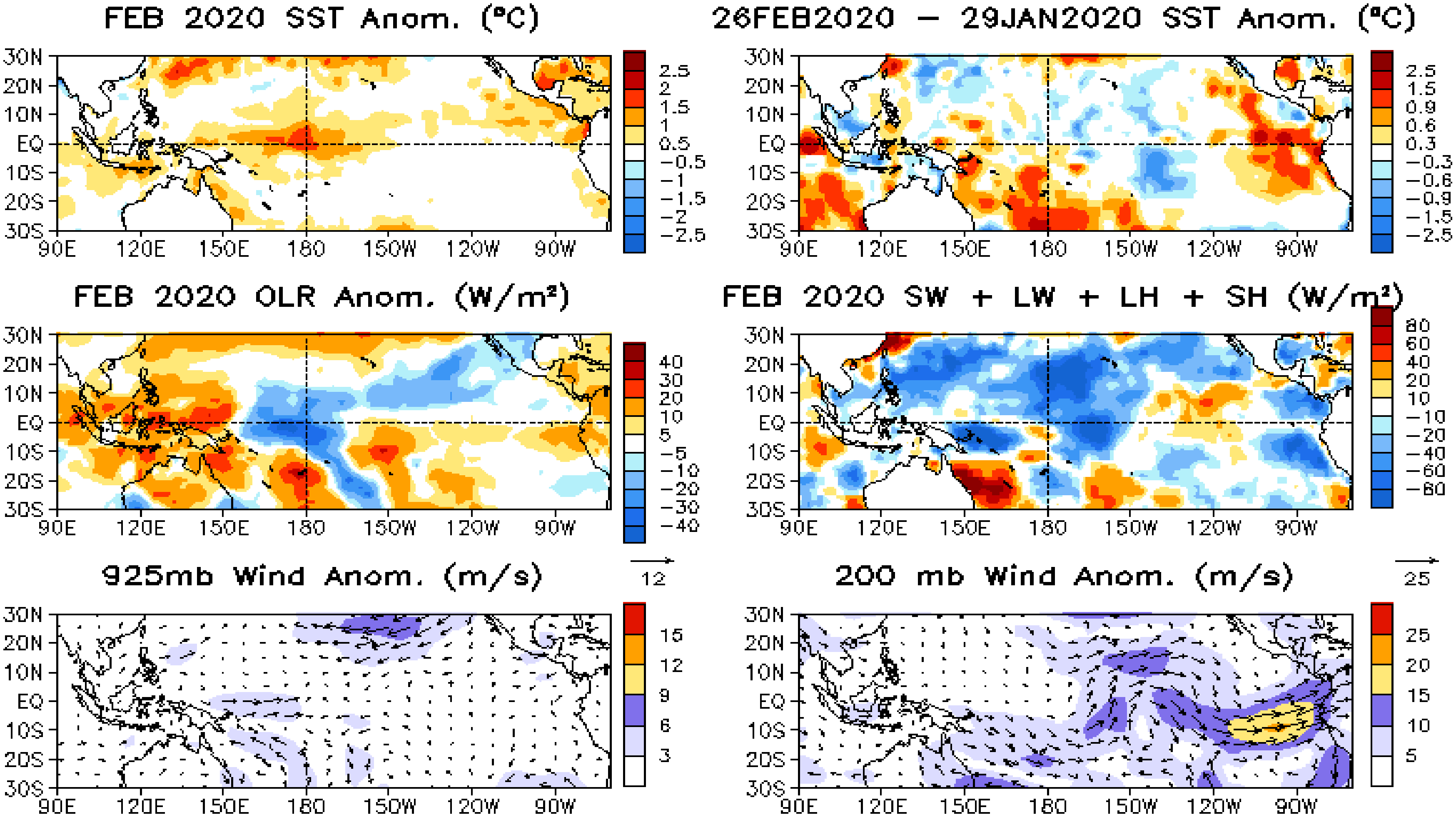
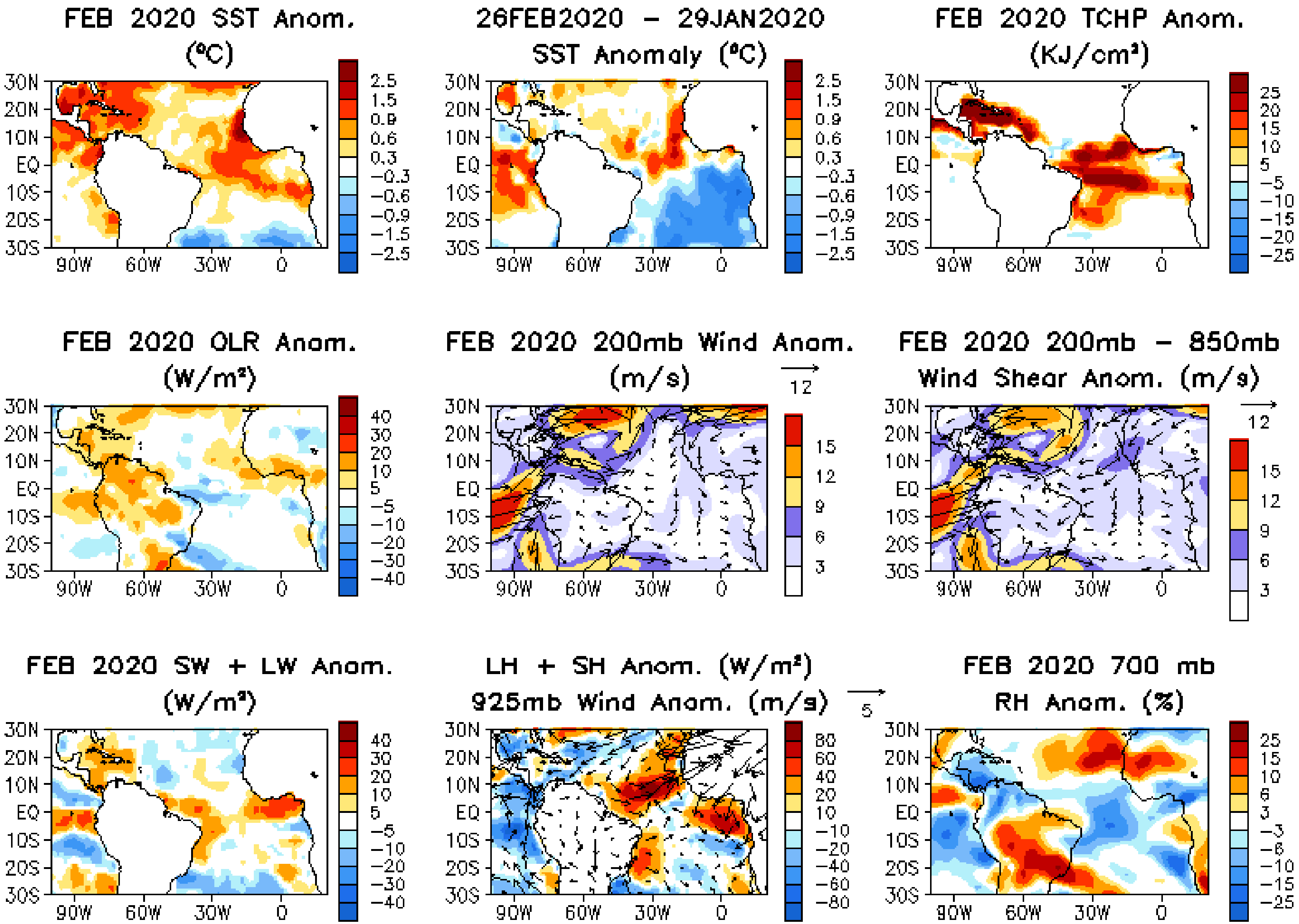


Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

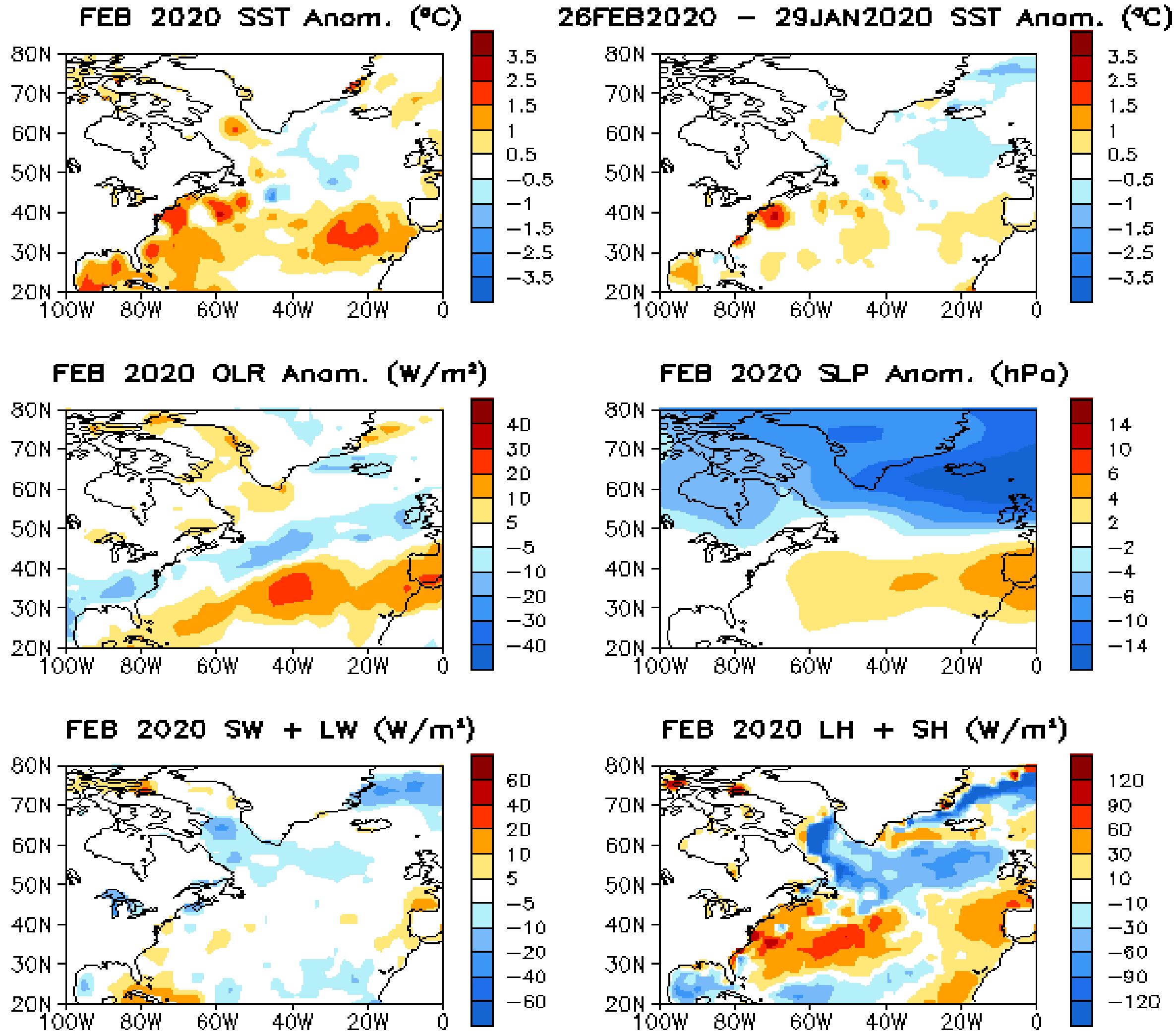
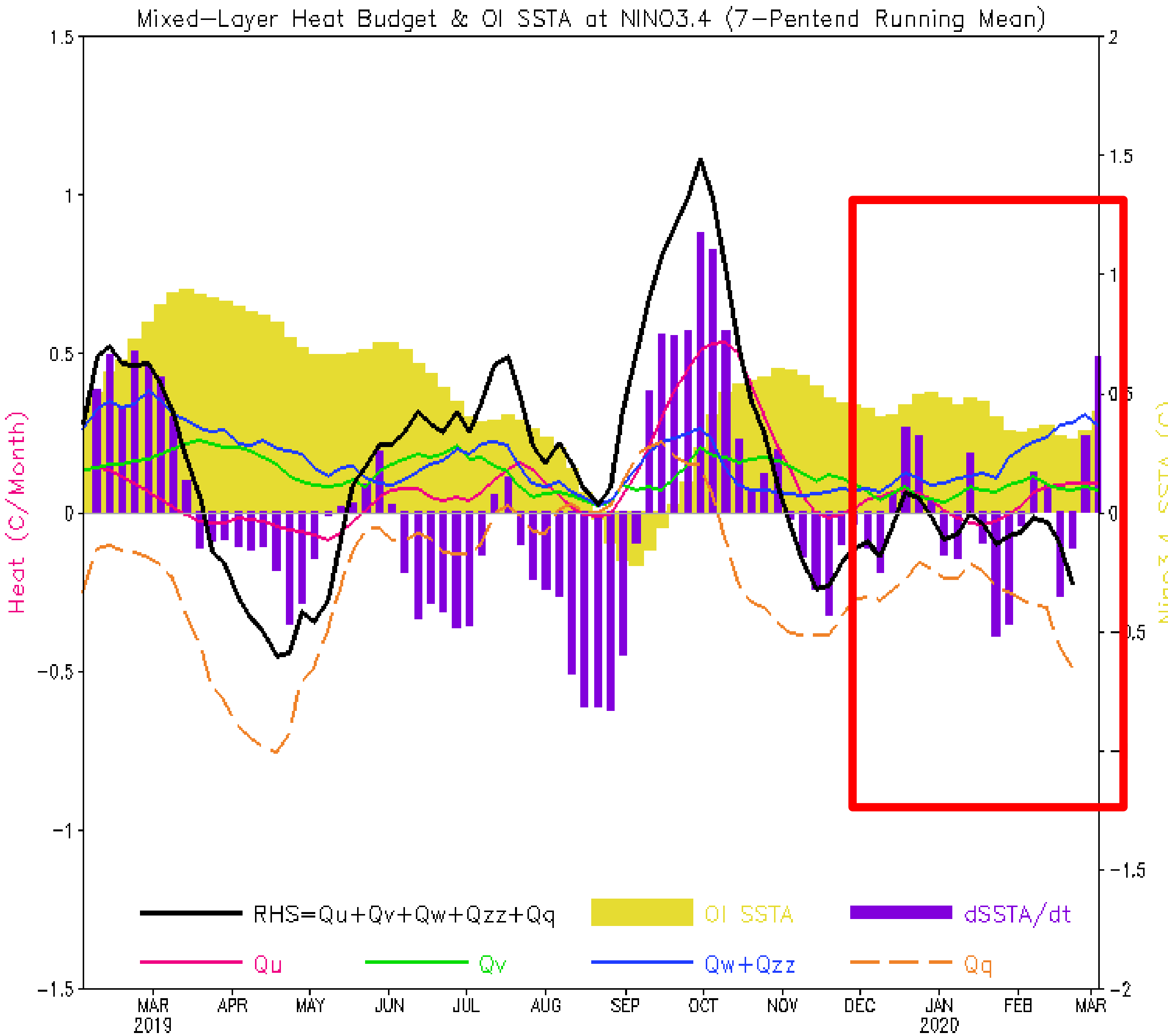


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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



NINO3.4 Heat Budget

- **Observed SSTA tendency (dSSTA/dt; bar) was positive and total heat budget (RHS; black line) was negative in last two pentads.**

- **Dynamical terms (Qu, Qv, Qw+Qzz) were small positive, and heat-flux term (Qq) was negative in Feb 2020.**

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

Data Sources (climatology is for 1981-2010)

- ❖ Weekly Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)
- ❖ Extended Reconstructed SST (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 (Liebmann and Smith 1996)
- ❖ NCEP's GODAS temperature, heat content, currents (Behringer 2007)
- ❖ Aviso altimetry sea surface height from CMEMS (Pujol et al. 2016)
- ❖ Ocean Surface Current Analyses – Real-time (OSCAR; Dohan and Maximenko 2010)
- ❖ In situ data objective analyses (IPRC, Scripps, EN4.2.1, PMEL TAO; McPhaden et al. 1998)

➢ Operational 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