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

Prepared by

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May 12, 2020

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 Global Ocean Monitoring and Observing Program (GOMO)

Outline

- **Overview**
- **Recent highlights**
  - **Pacific/Arctic Ocean**
  - **Indian Ocean**
  - **Atlantic Ocean**
- **Global SSTA Predictions**

➢ **North Pacific Marine Heatwave status and prediction**

Overview

- **Pacific Ocean**
  - **ENSO neutral conditions persisted (NINO3.4 = 0.47°C).**
  - **Positive SSTAs strengthened in the NE Pacific in Apr 2020. The PDO was in a negative phase (PDOI = -0.79).**

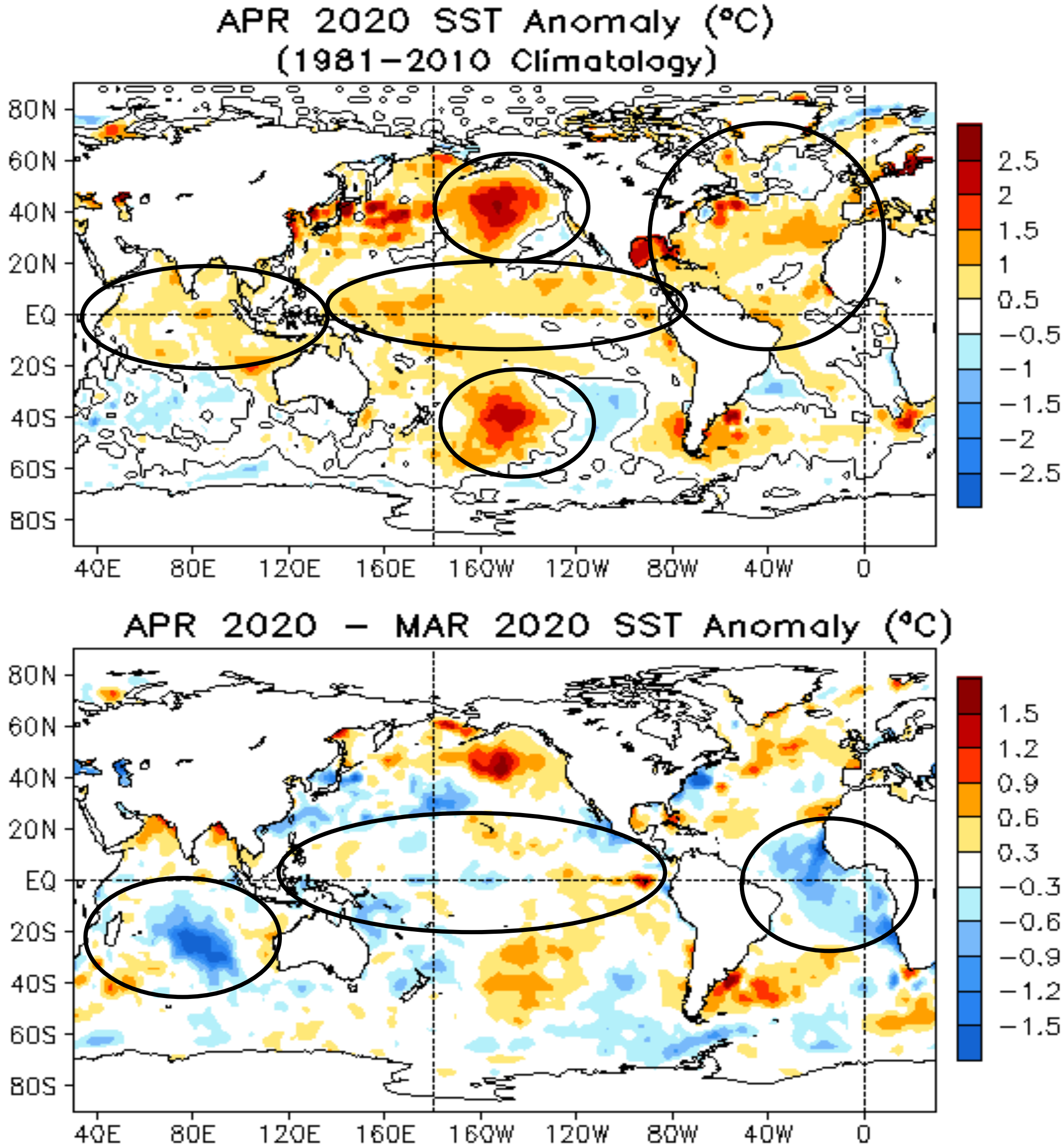
- **Indian Ocean**
  - **Positive SSTAs were present in the entire tropical Indian Ocean in Apr 2020.**

- **Atlantic Ocean**
  - **NAO switched to a negative phase in Apr 2020 with NAOI= -1.26.**
  - **The prolonged tripole SSTA pattern persisted in Apr 2020, but was weaker than in Mar 2020.**

- **Arctic Ocean**
  - **The pace of sea ice loss in April was faster than Mar 2020; its extent ranked as the 4th lowest since 1979.**

Global Oceans

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

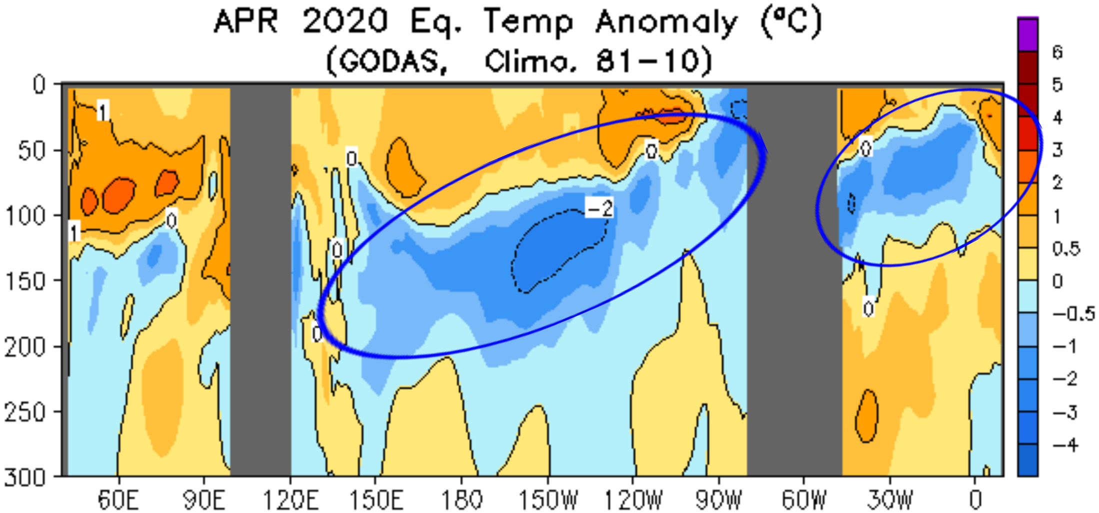


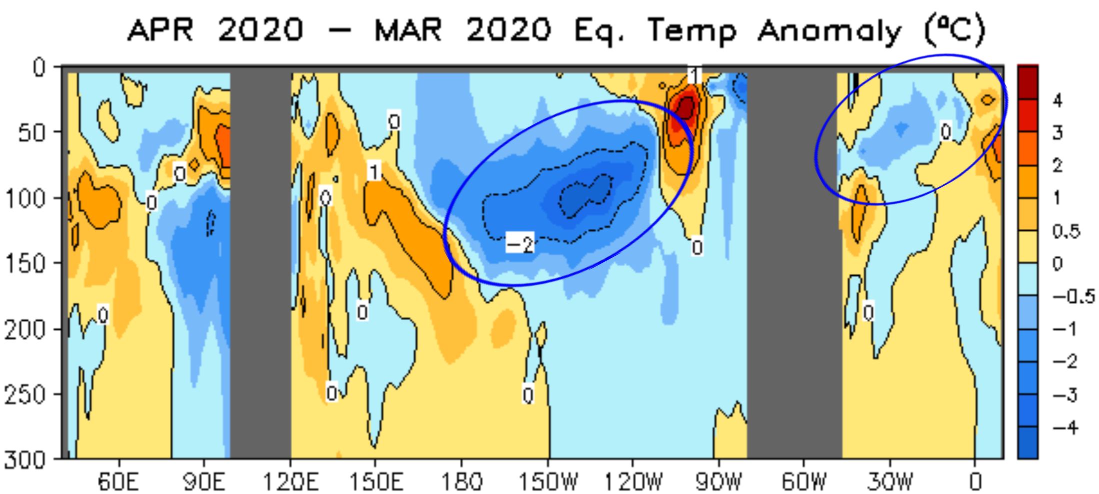
- Positive SSTAs persisted in most of the tropical Pacific.
- Positive SSTAs strengthened in the NE Pacific.
- Weak tripole SSTA pattern persisted in the North Atlantic.
- Weak positive SSTAs were present across the tropical Indian basin.
- Positive SSTAs were present in the South Pacific.

- SSTA tendencies were small in the tropical Pacific.
- Negative SSTA tendencies presented in the tropical Atlantic and central southern Indian 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^{O}S-2^{O}N





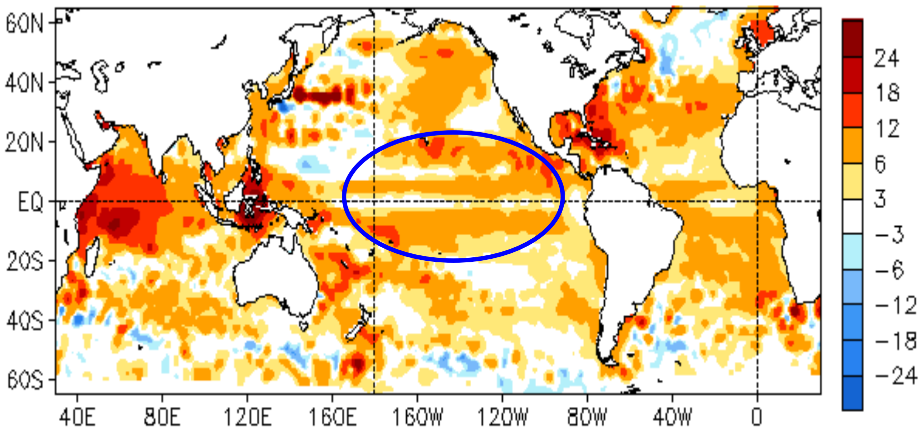
- **Negative temperature anomalies presented along the thermocline in both the equatorial Pacific and Atlantic Oceans.**
- **Positive temperature anomalies were observed in the upper ocean of three tropical basins.**

-Temperature anomaly tendency was negative along the thermocline in the central Pacific and Atlantic.

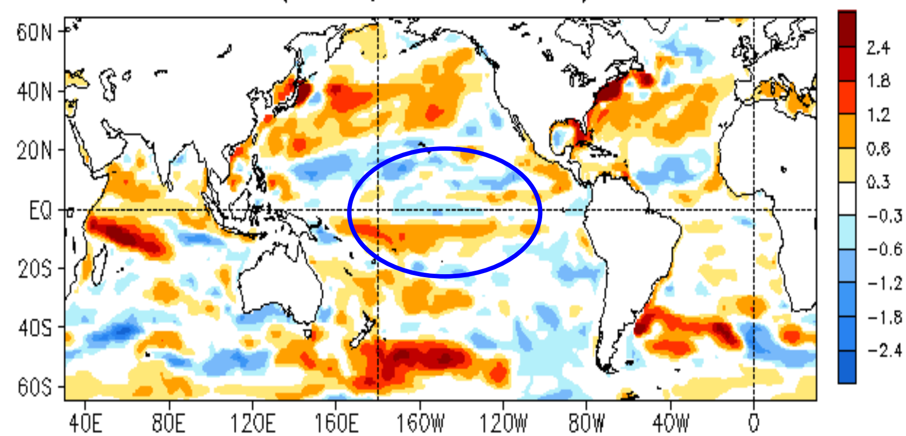
Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1981-2010 base period means.

Global SSH and HC300 Anomaly & Anomaly Tendency

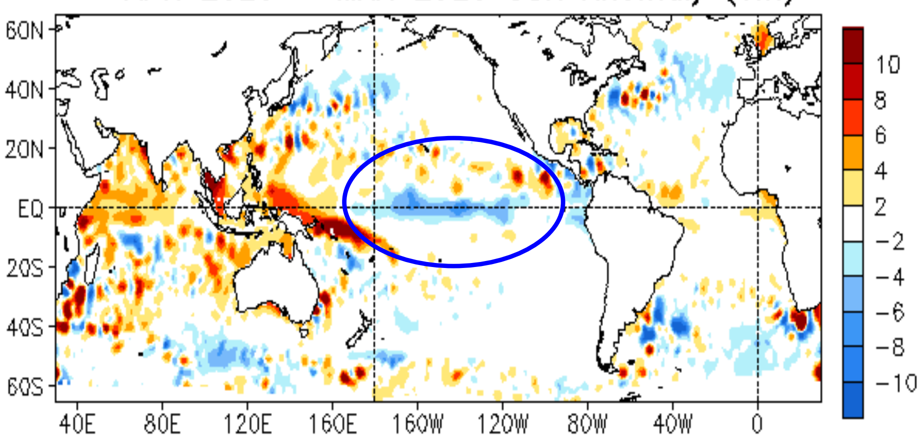
APR 2020 SSH Anomaly (cm)
(AVISO Altimetry, Climo. 93-13)



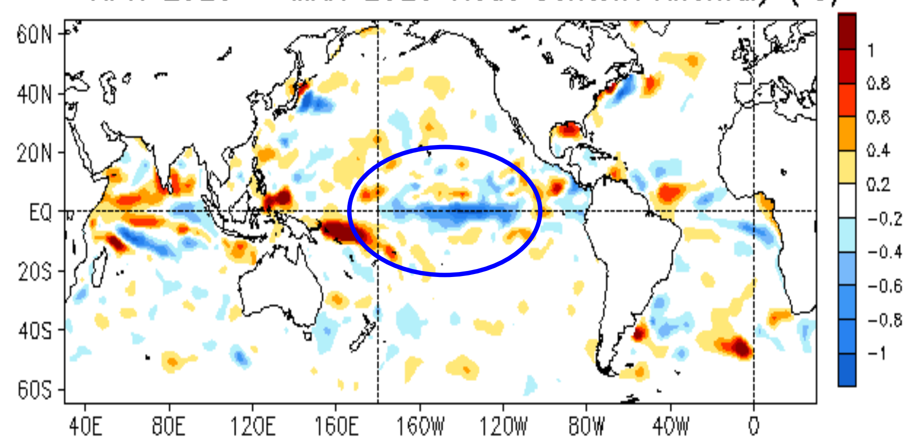
APR 2020 Heat Content Anomaly (°C)
(GODAS, Climo. 81-10)



APR 2020 - MAR 2020 SSH Anomaly (cm)



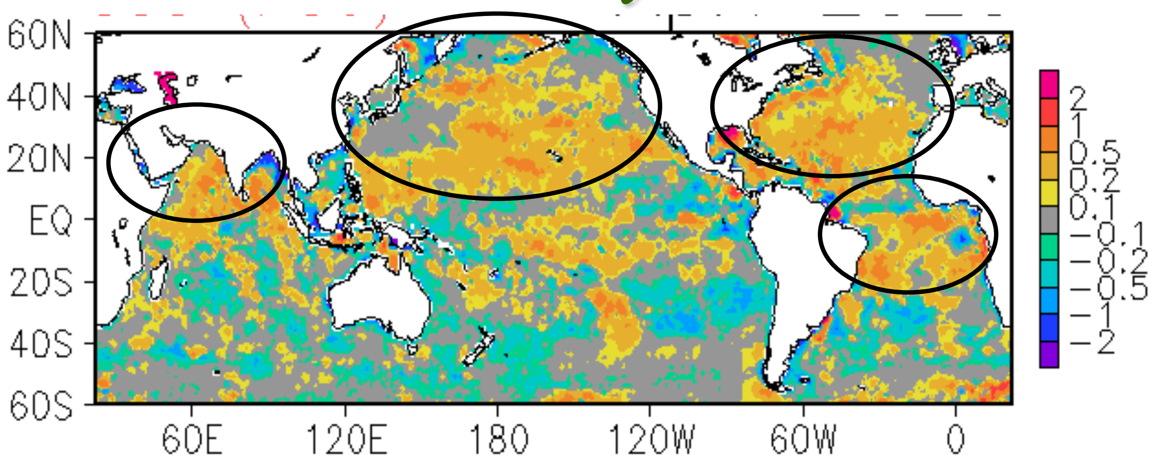
APR 2020 - MAR 2020 Heat Content Anomaly (°C)



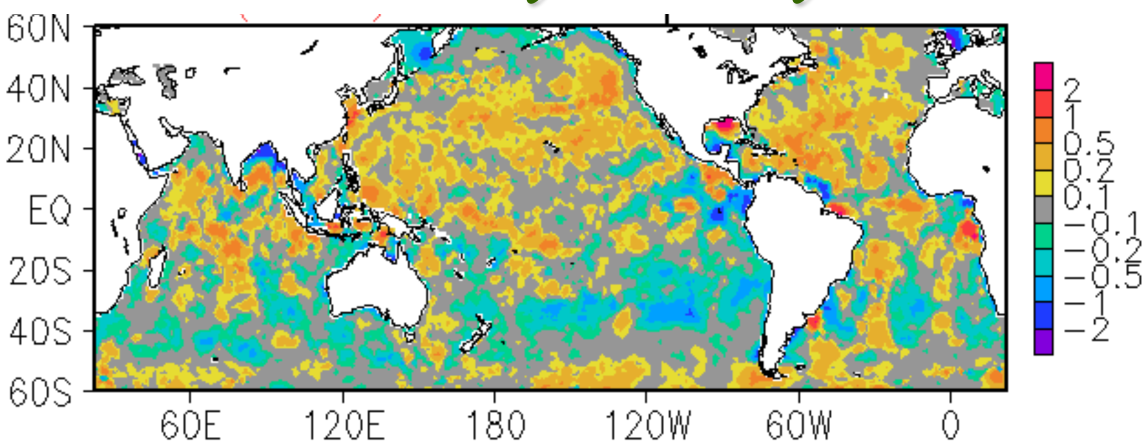
- **The SSHA pattern was overall consistent with the HC300A pattern, but with a significant trend component in SSHA.**
- **Both SSHA and HC300A tendencies were negative in the central equatorial Pacific.**

Global Sea Surface Salinity (SSS) for April 2020

Anomaly



Anomaly Tendency



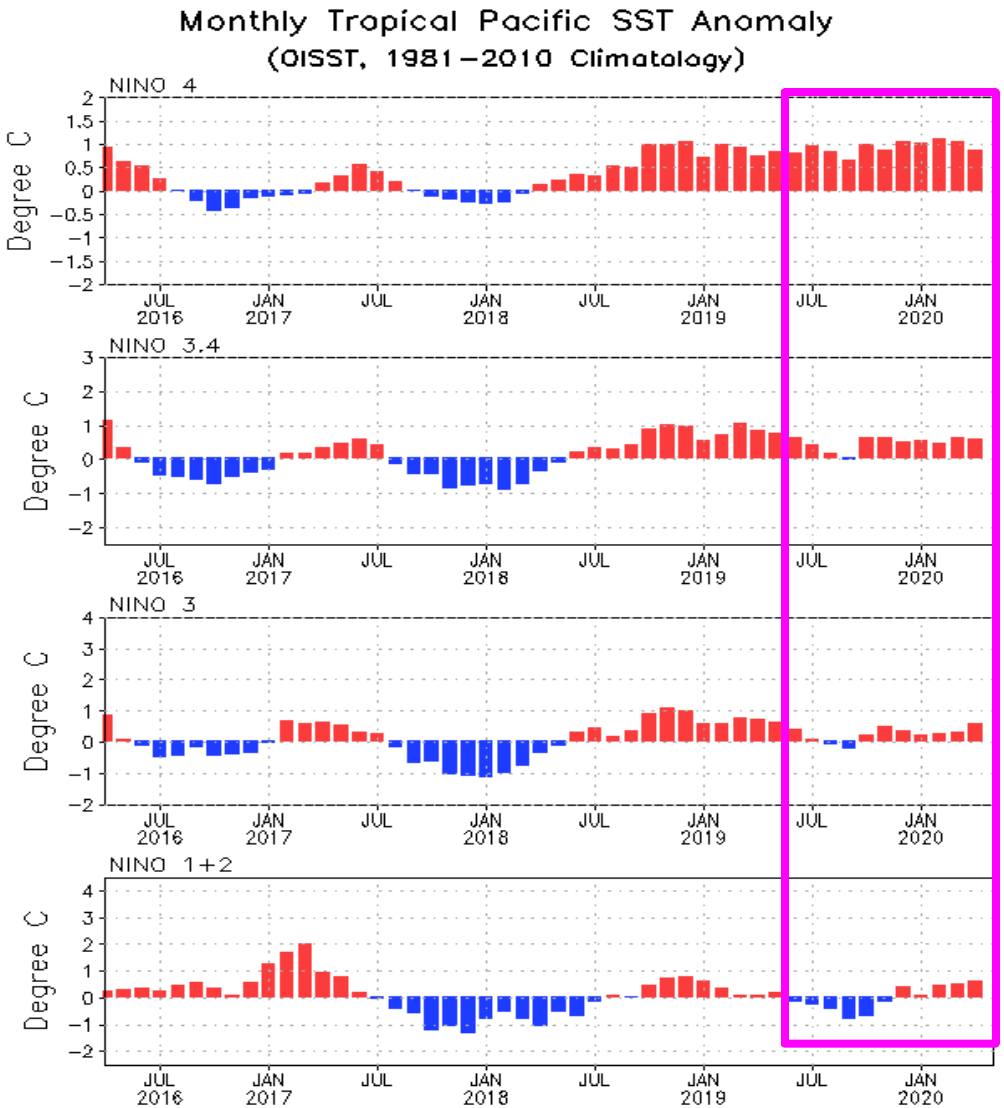
- **Positive SSS anomalies were present across most of the north hemisphere ocean, and the south tropical Atlantic.**

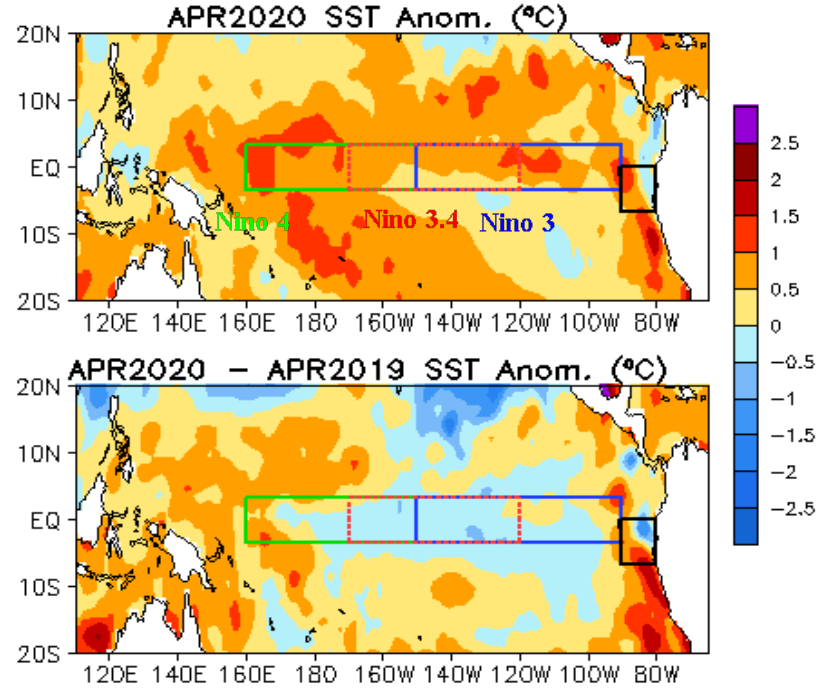
- **The tendency distribution similar to the anomaly one, suggesting a persistence and enhancement of the March state.**

Blended Analysis of Surface Salinity (BASS) V0.Z (Xie et al. 2014)

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific NINO SST Indices



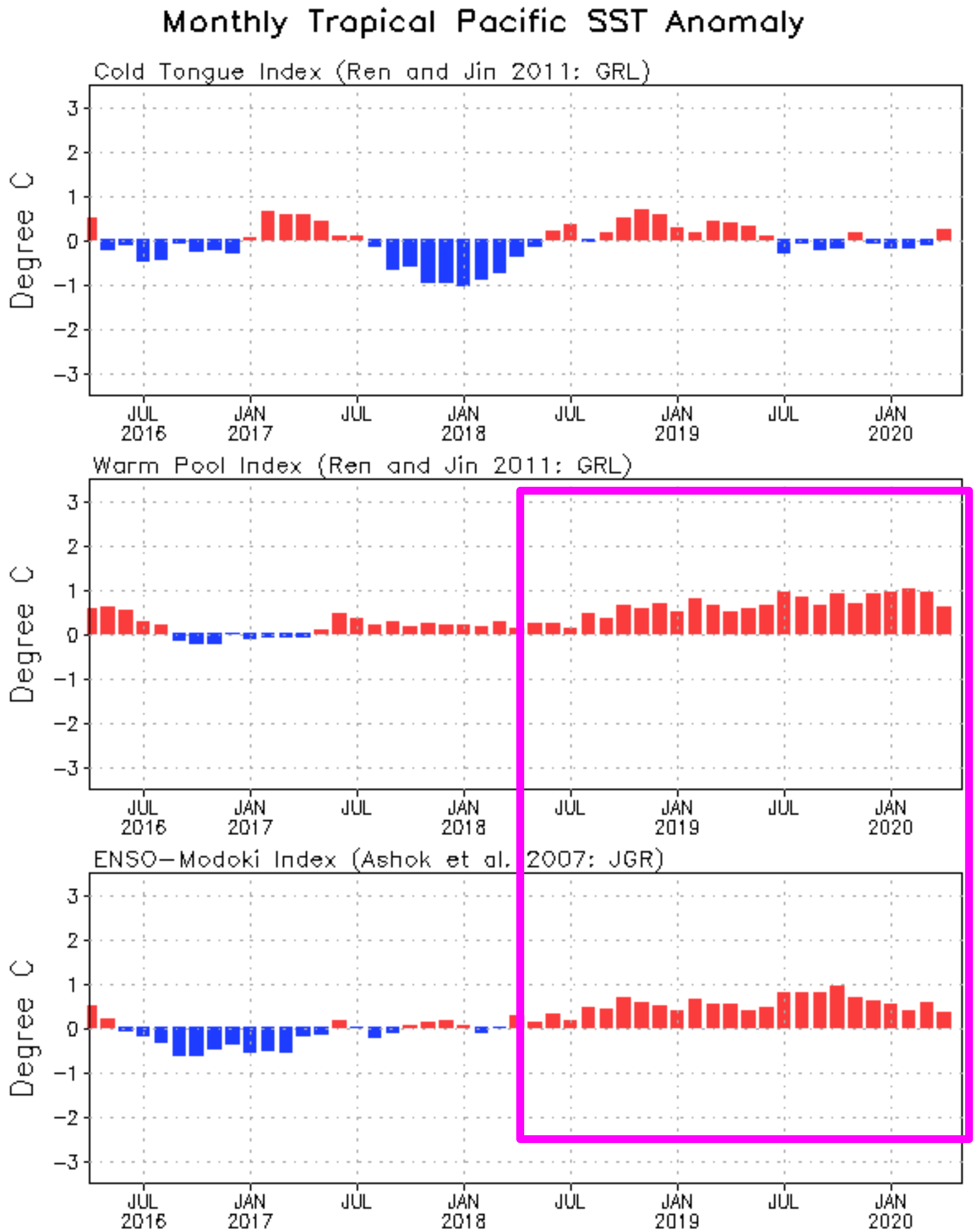


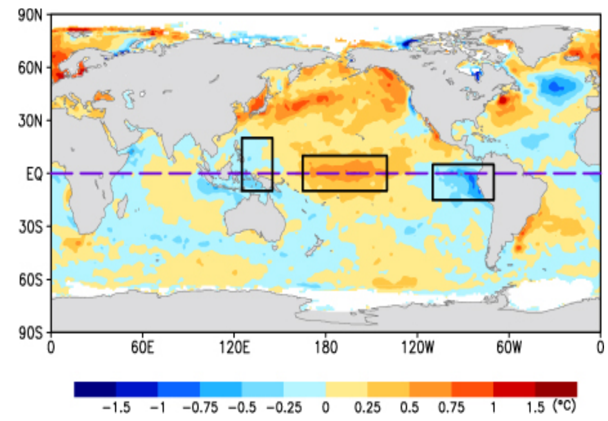
- **All Nino indices were positive, with Nino3.4 = 0.47C in Apr 2020.**

-Compared with Apr 2019, the central and eastern (western) equatorial Pacific was cooler (warmer) in Apr 2020.

- **The indices may have slight differences if calculations are based on different SST products.**

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.





- Warm pool and ENSO-Modoki indices remain positive since 2018, and weakened in Apr 2020.

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

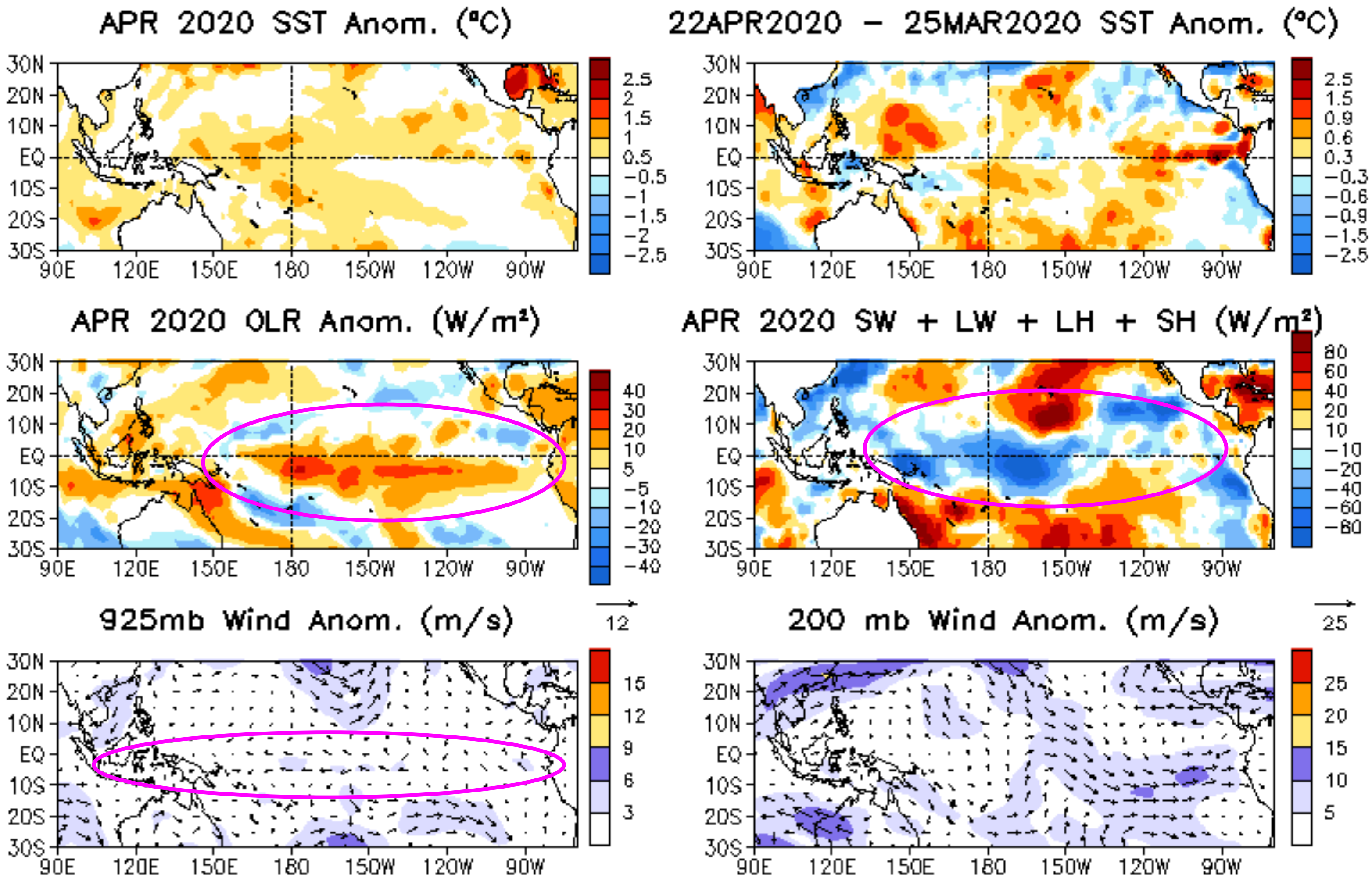
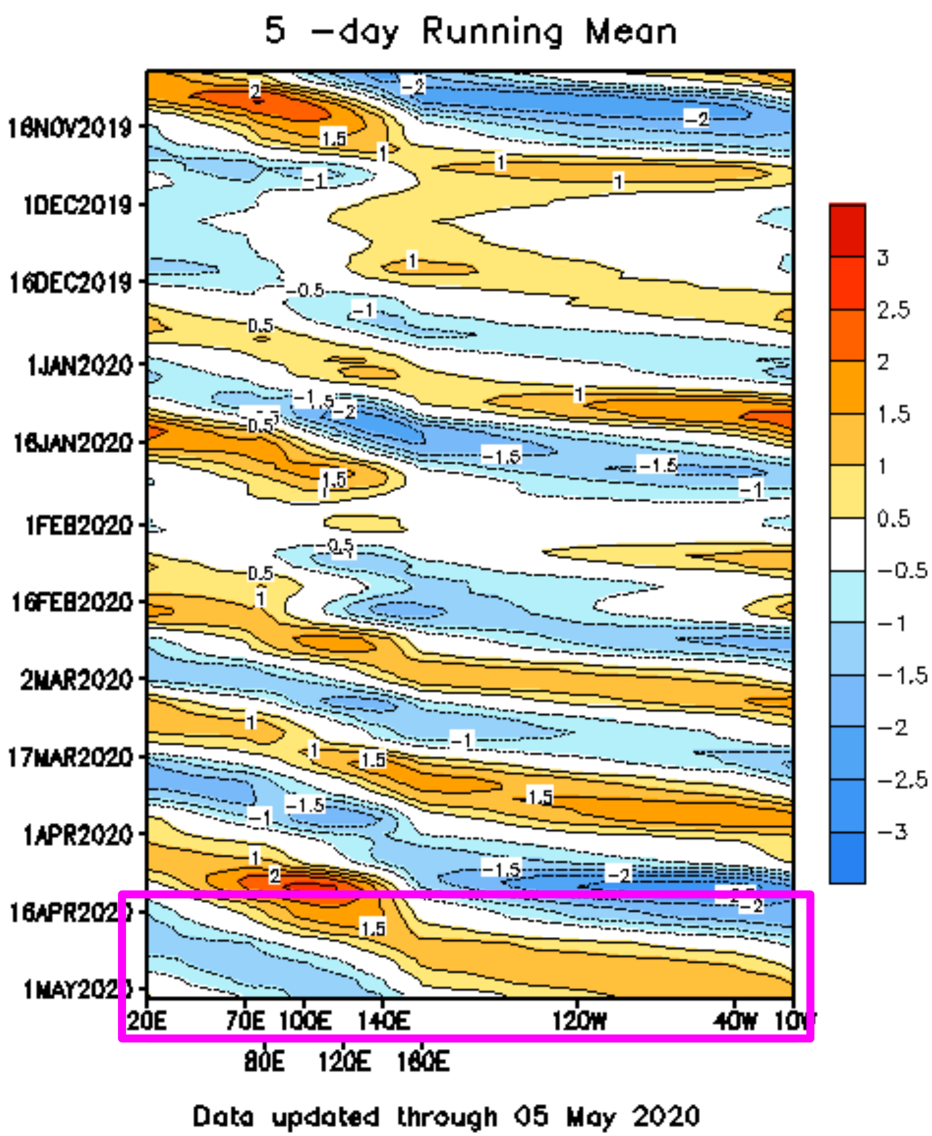
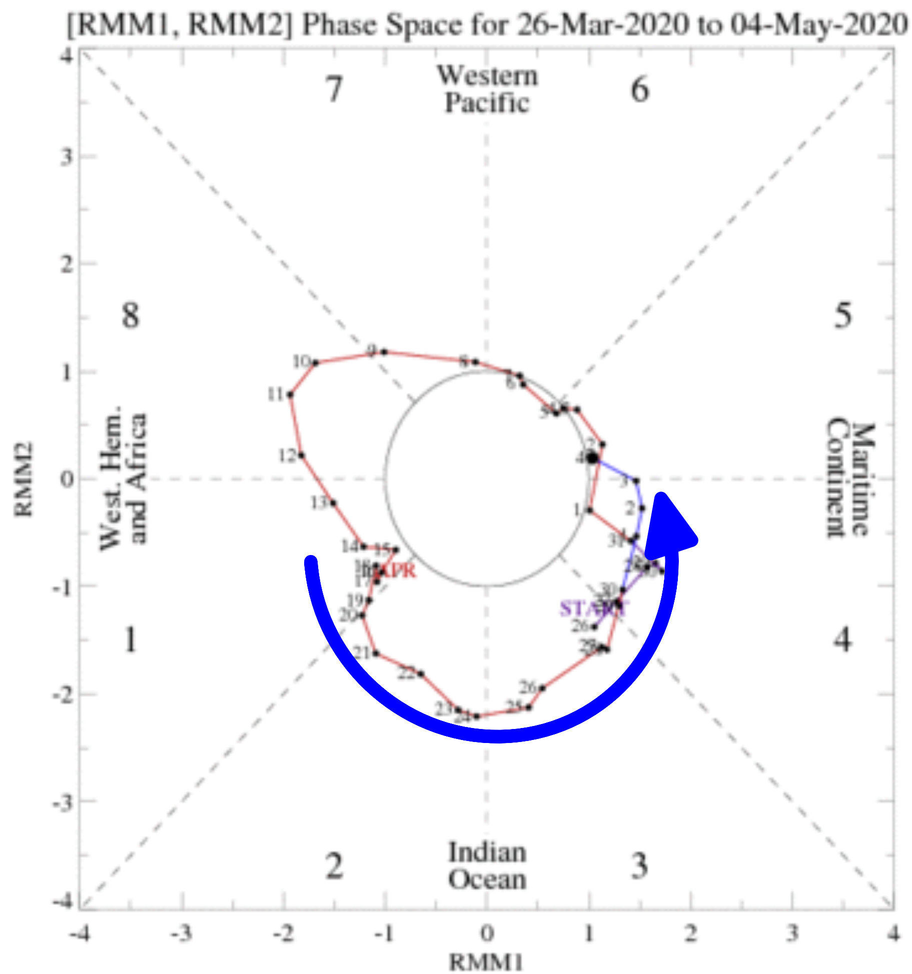


Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right; positive means heat into the ocean), 925-mb 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.

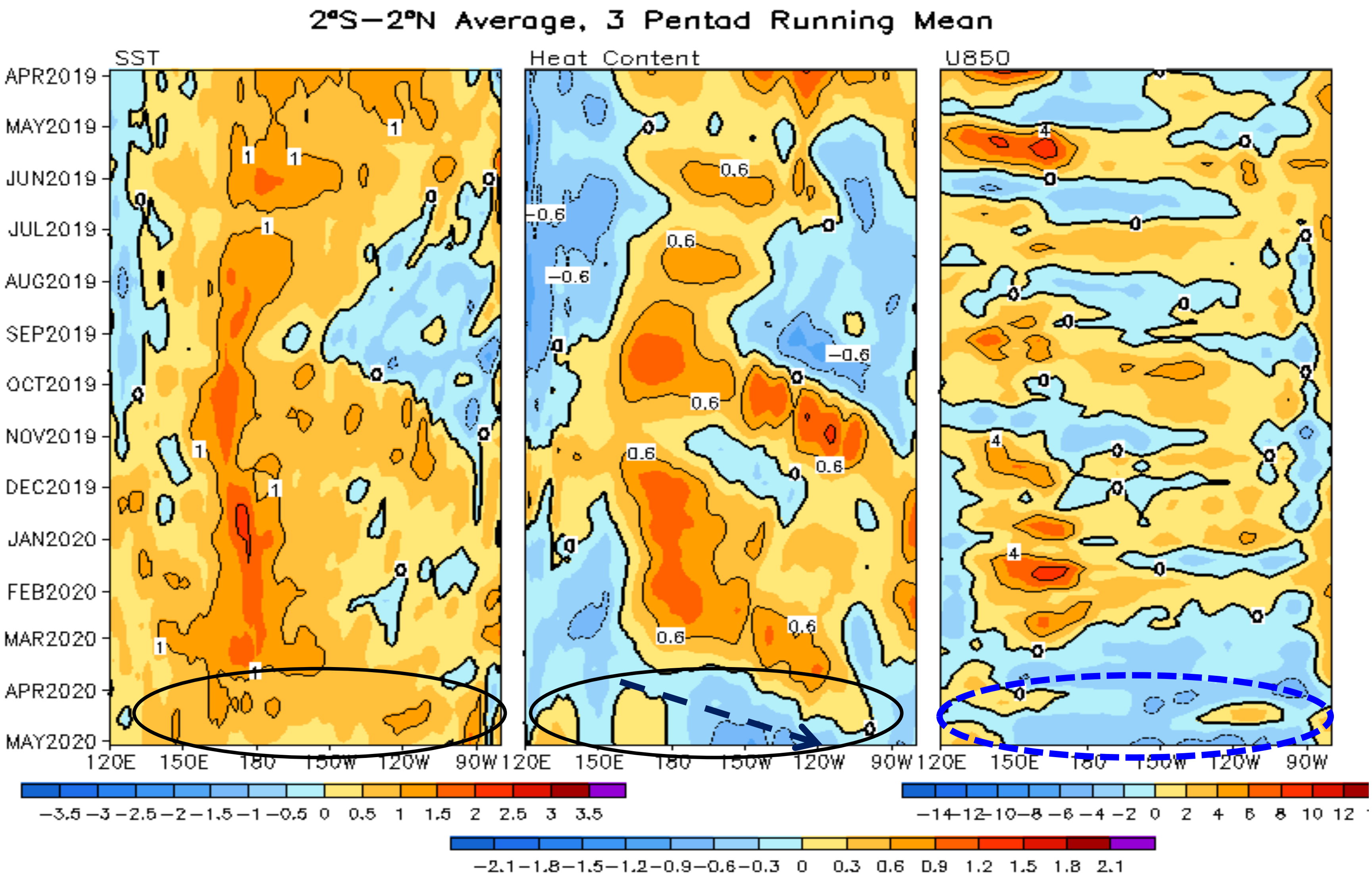
An MJO event occurred since mid-April 2020





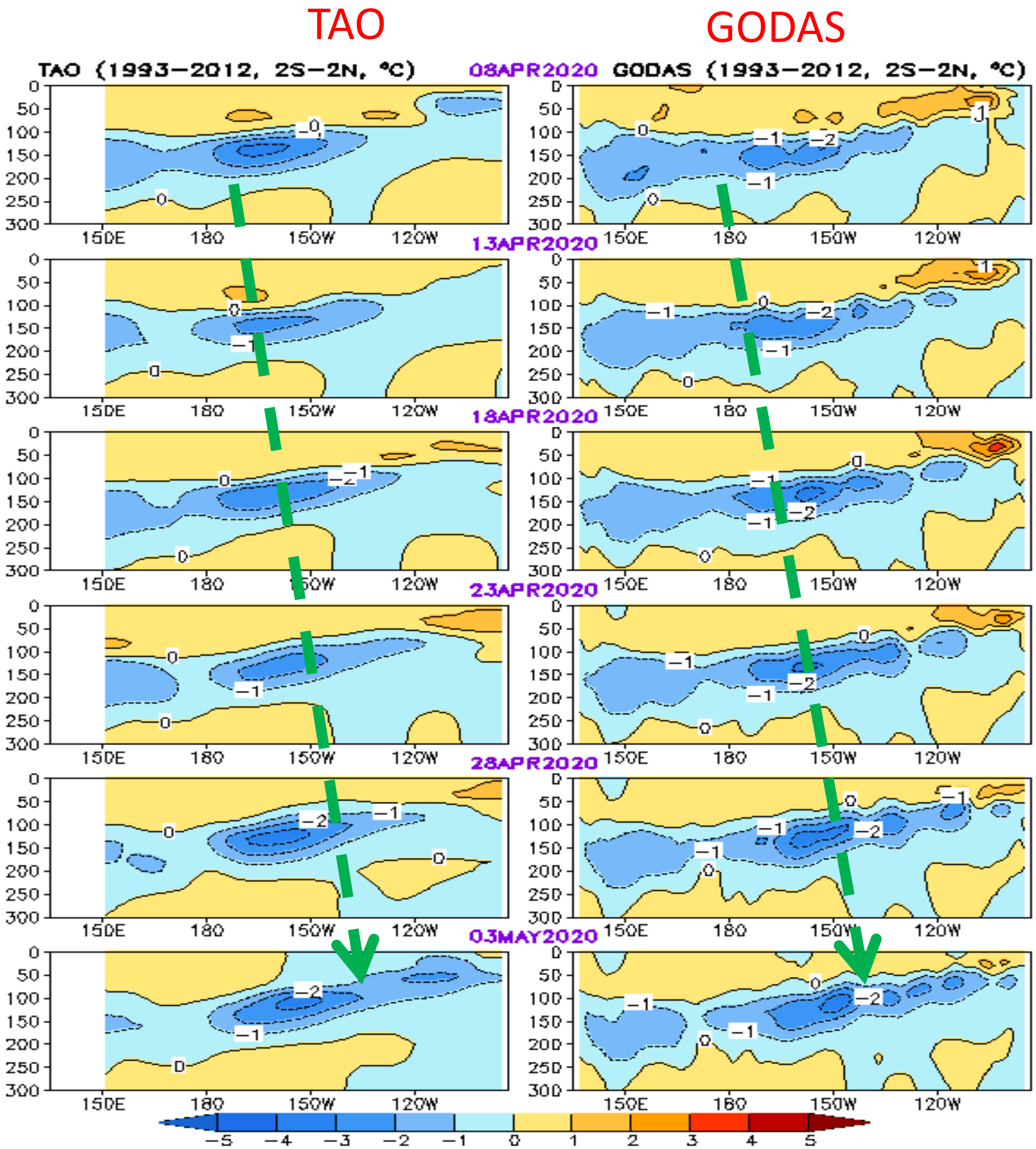
https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml#current

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



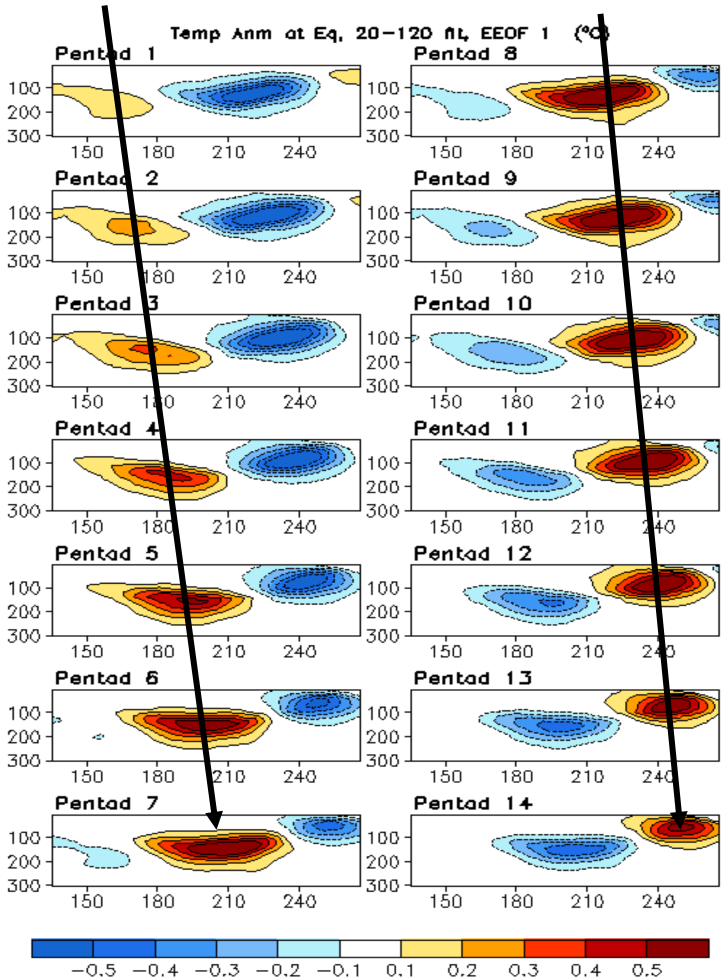
- **Partially contributed by the MJO event, easterly wind anomaly was present over the central Pacific in Apr 2020.**
- **Below-average HC300 was observed in the central Pacific in Apr 2020.**
- **Positive SSTA persisted in the entire equatorial Pacific.**

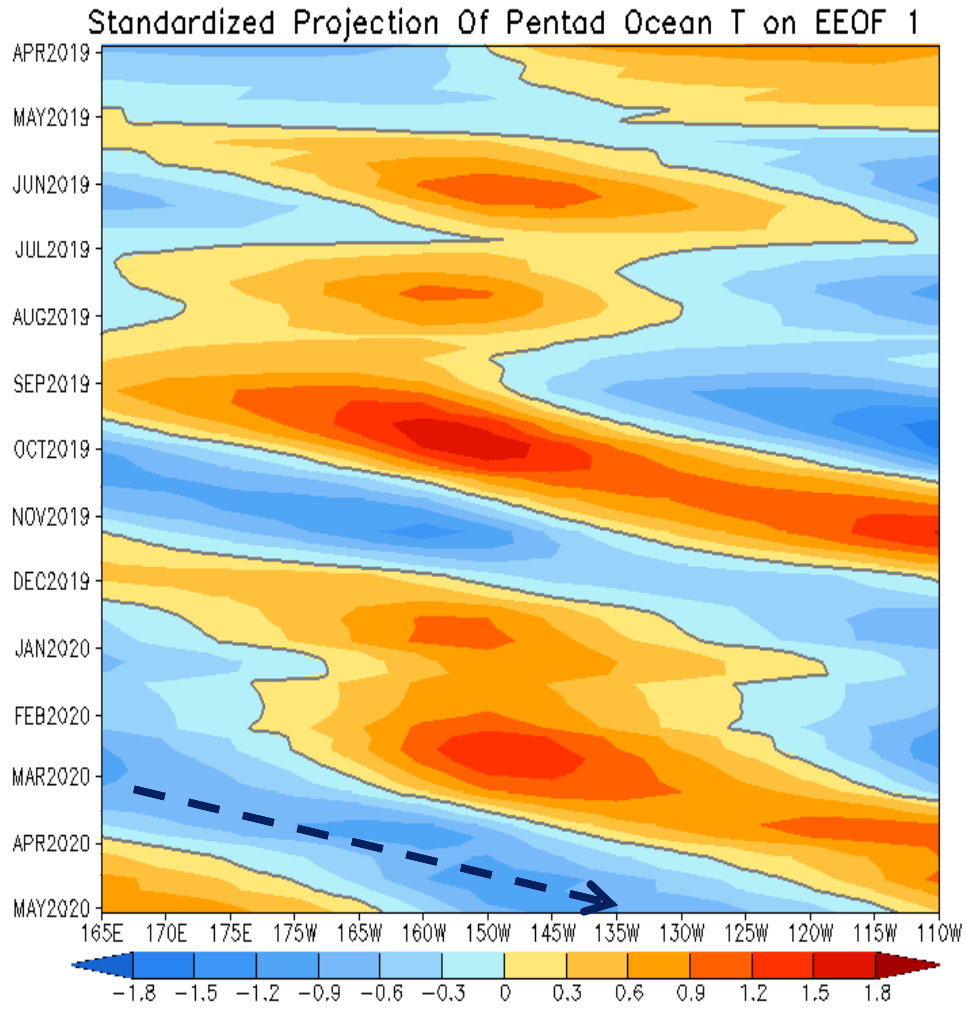
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly



- **Negative ocean temperature anomalies propagated slowly eastwards.**
- **The features of the ocean temperature anomalies were similar between GODAS and TAO analysis.**

Oceanic Kelvin Wave (OKW) Index

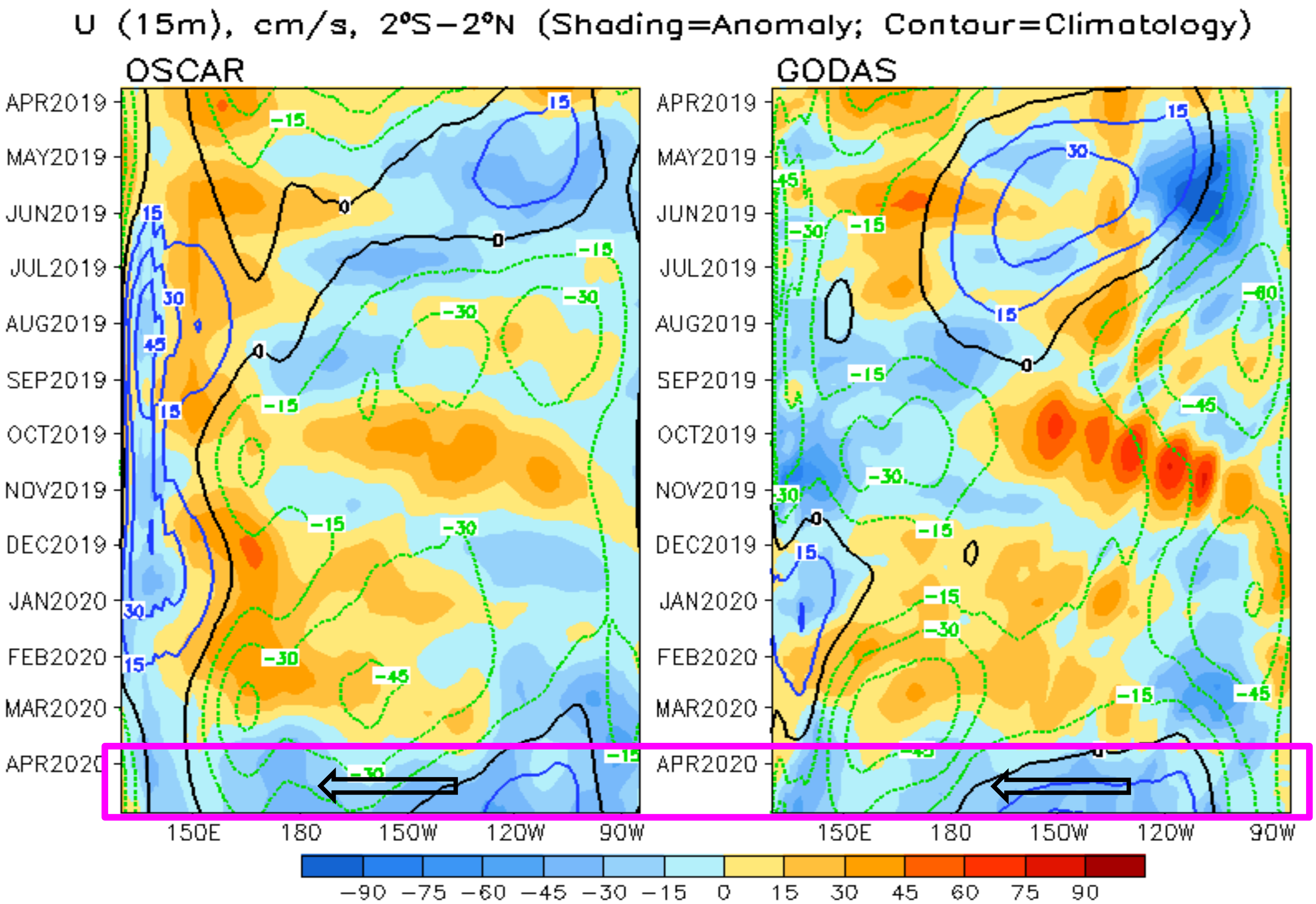




-Upwelling Kelvin wave activities were present in Mar-Apr 2020.

(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 westward currents were observed across much of the equatorial Pacific in Apr 2020 in both OSCAR and GODAS.

Warm Water Volume (WWV) and NINO3.4 Anomalies

- WWV is defined as average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN]. **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) has been in a discharge phase since Mar 2020.**

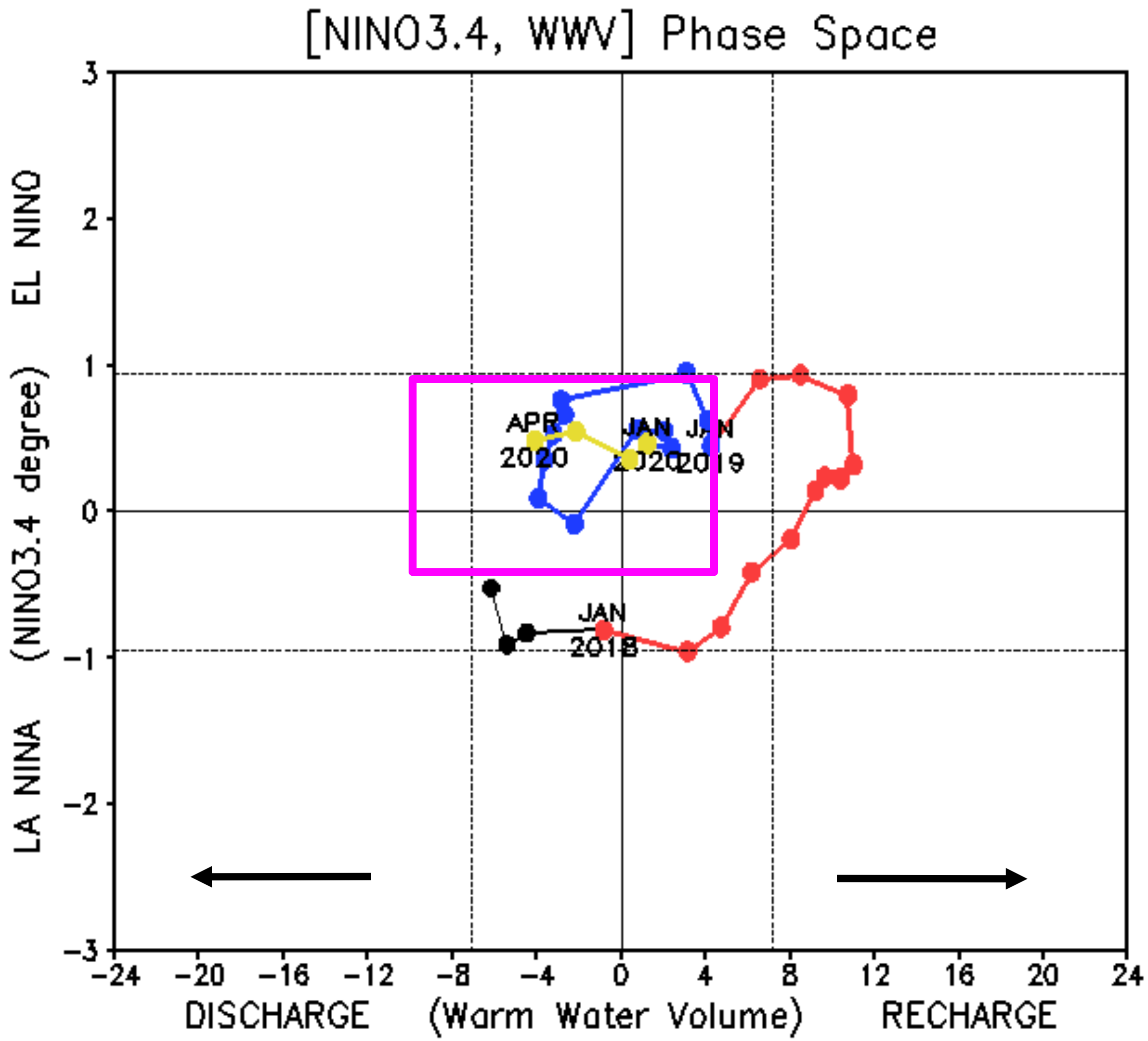
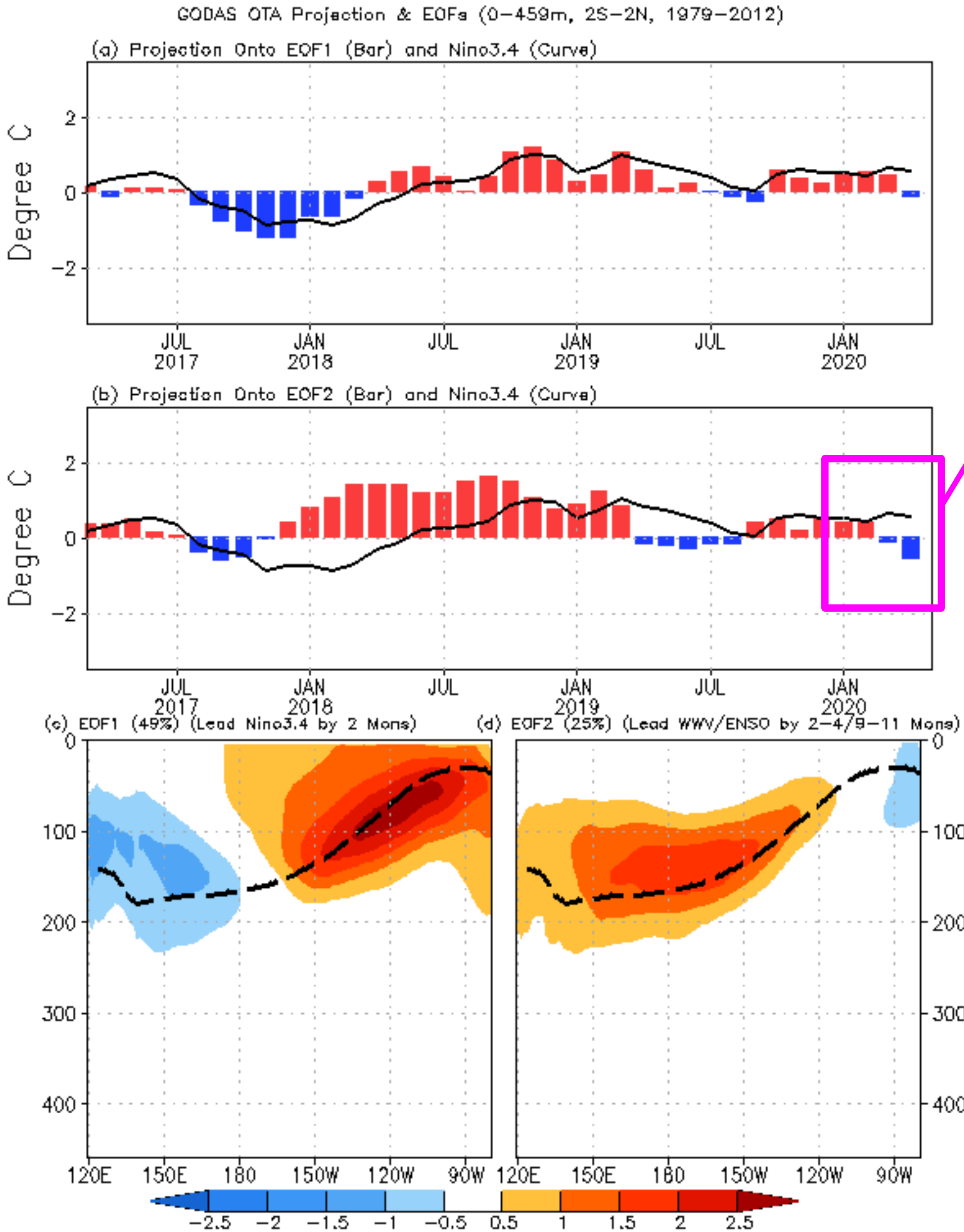


Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] calculated with the NCEP's global ocean data assimilation system. Anomalies are departures from the 1981-2010 base period means.

Equatorial subsurface ocean temperature monitoring: **The equatorial Pacific switched to a discharge phase since Mar 2020.**



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:

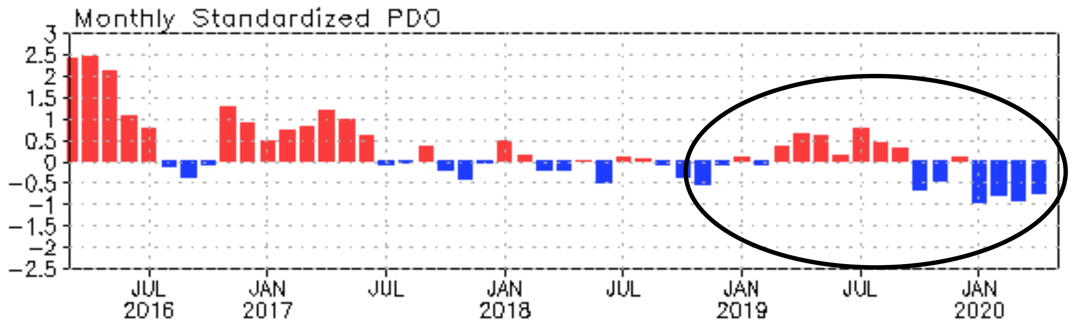
Positive -> Negative phase of ENSO

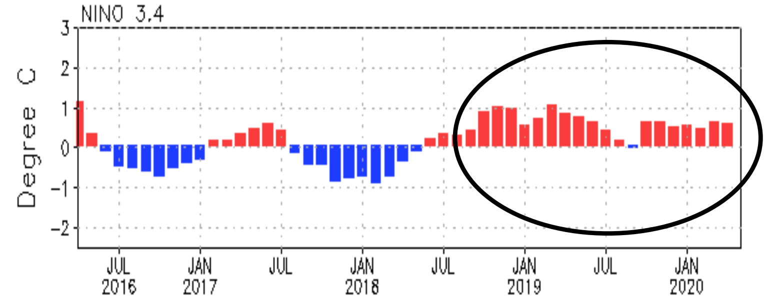
For details, see:

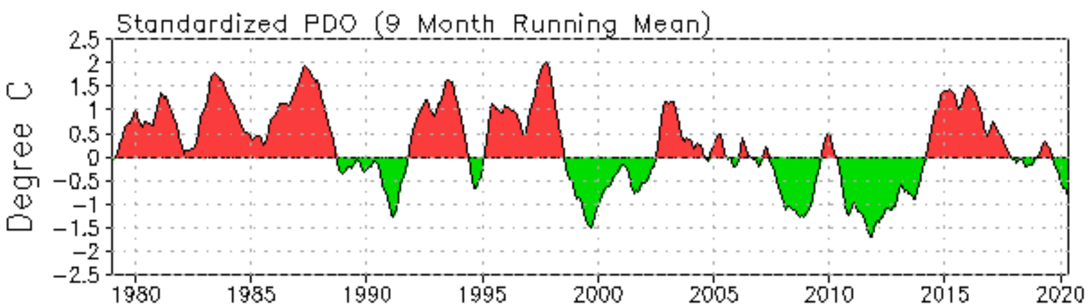
Kumar A, Z-Z Hu (2014) Interannual and interdecadal variability of ocean temperature along the equatorial Pacific in conjunction with ENSO. Clim. Dyn., 42 (5-6), **1243-1258.** *DOI: 10.1007/s00382-013-1721-0.*

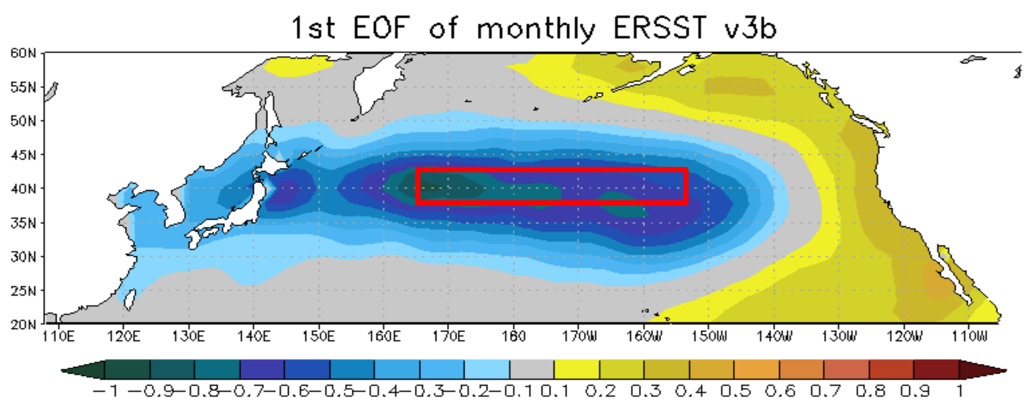
North Pacific & Arctic Oceans

PDO index









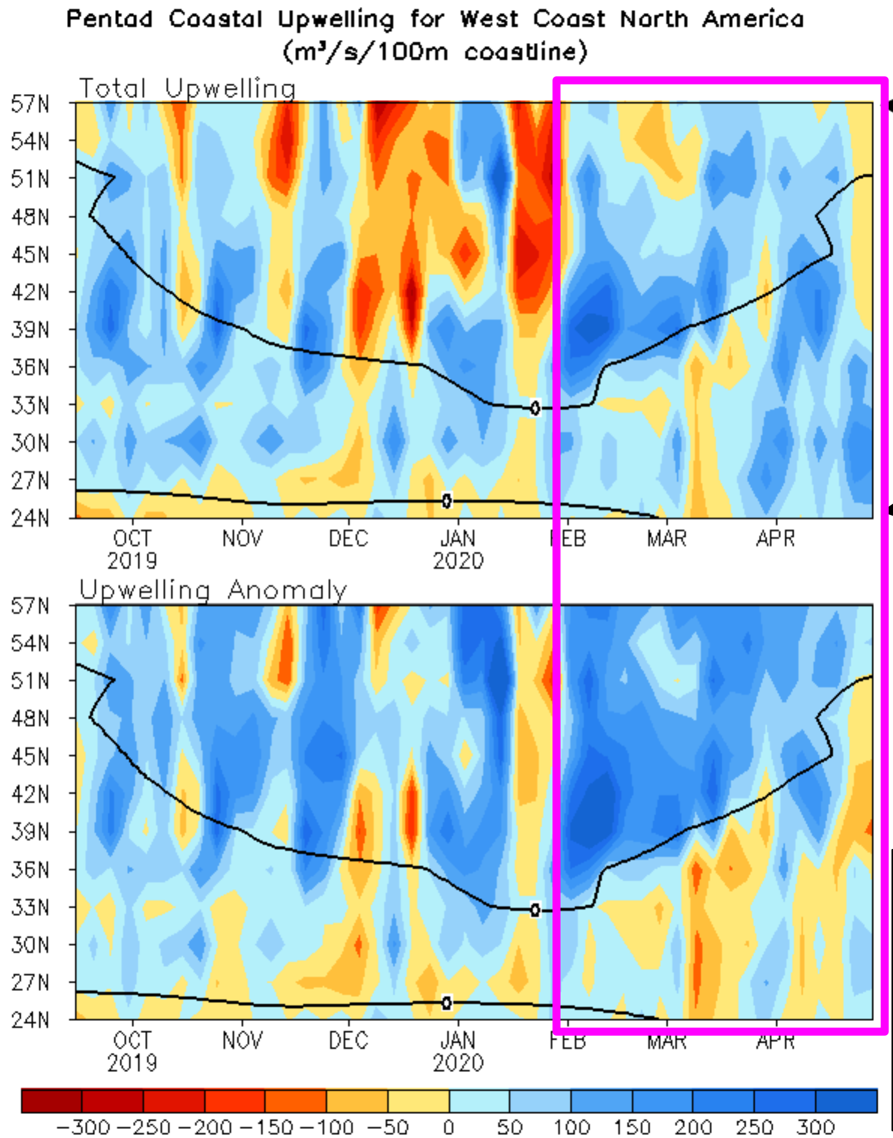
- The PDO was in a negative phase with PDOI = -0.79 in Apr 2020.

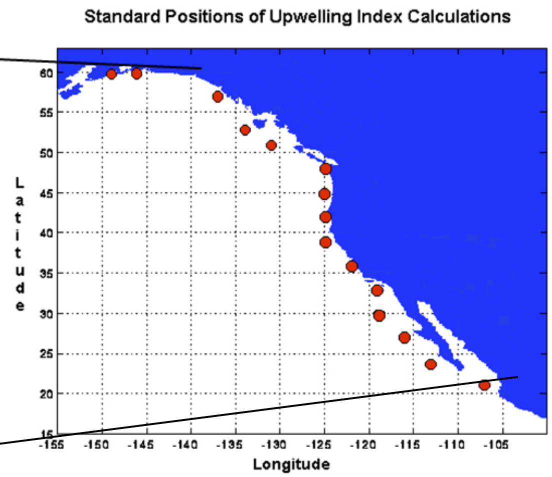
- Statistically, ENSO leads PDO by 3-4 months, through teleconnection via atmospheric bridge, with El Nino (La Nina) associated with positive (negative) PDO Index.

- 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



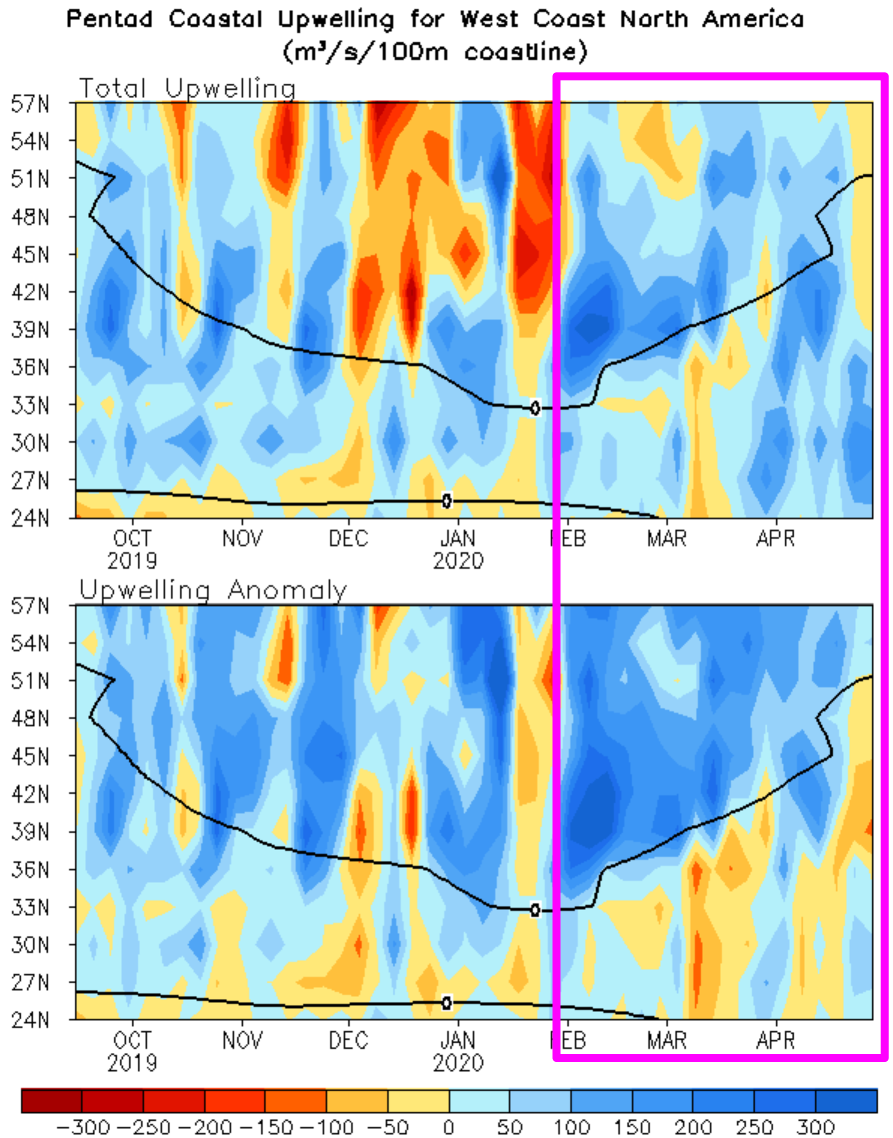


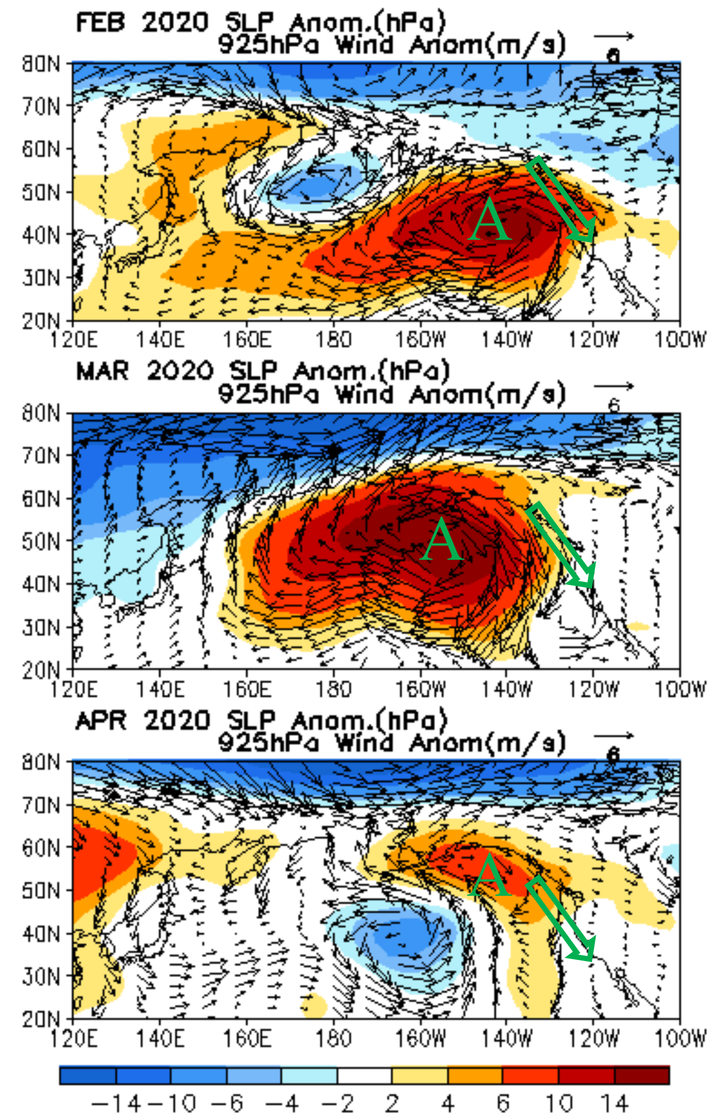
- Upwelling north of 35N was stronger than average since Feb 2020.

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 America Western Coastal Upwelling

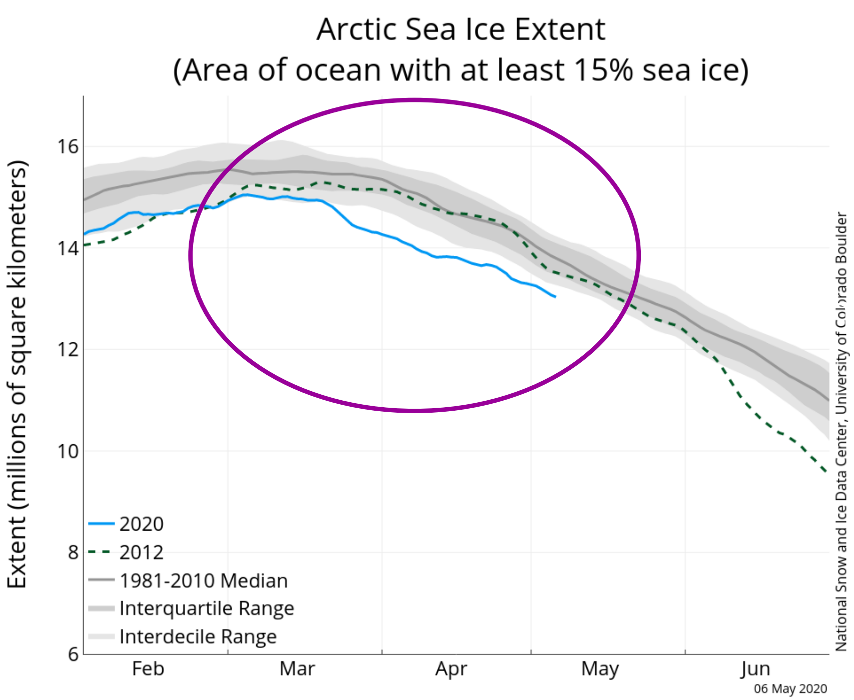


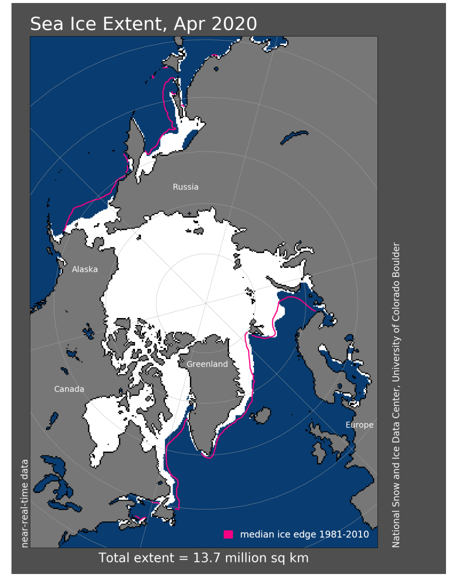


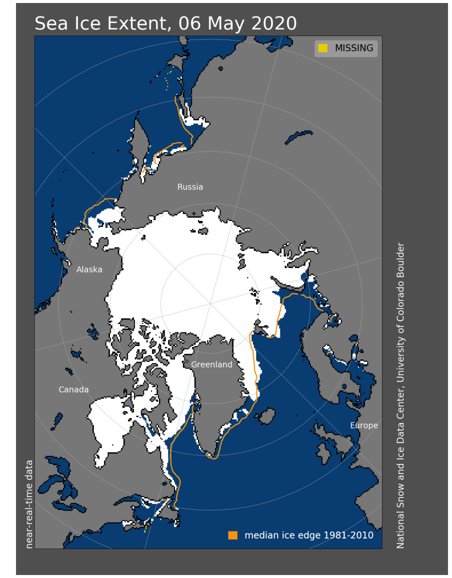
- **Area below (above) black line indicates climatological upwelling (downwelling) season.**
- **Climatologically upwelling season progresses from March to July along the west coast of North America from 36ºN to 57ºN.**

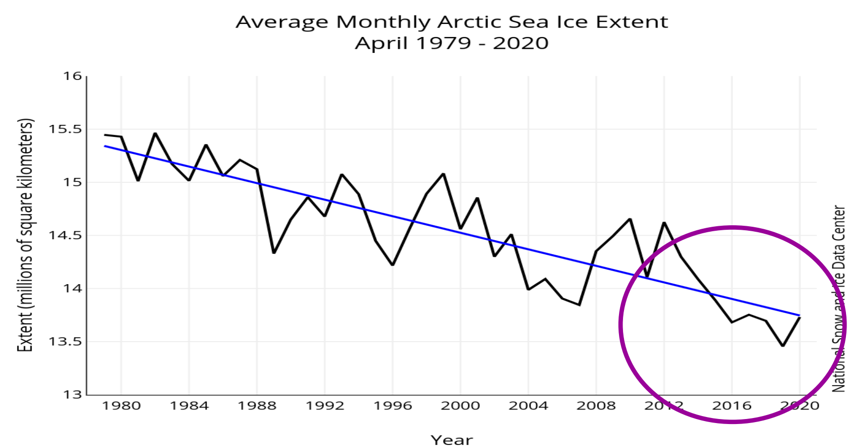
Arctic Sea Ice

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





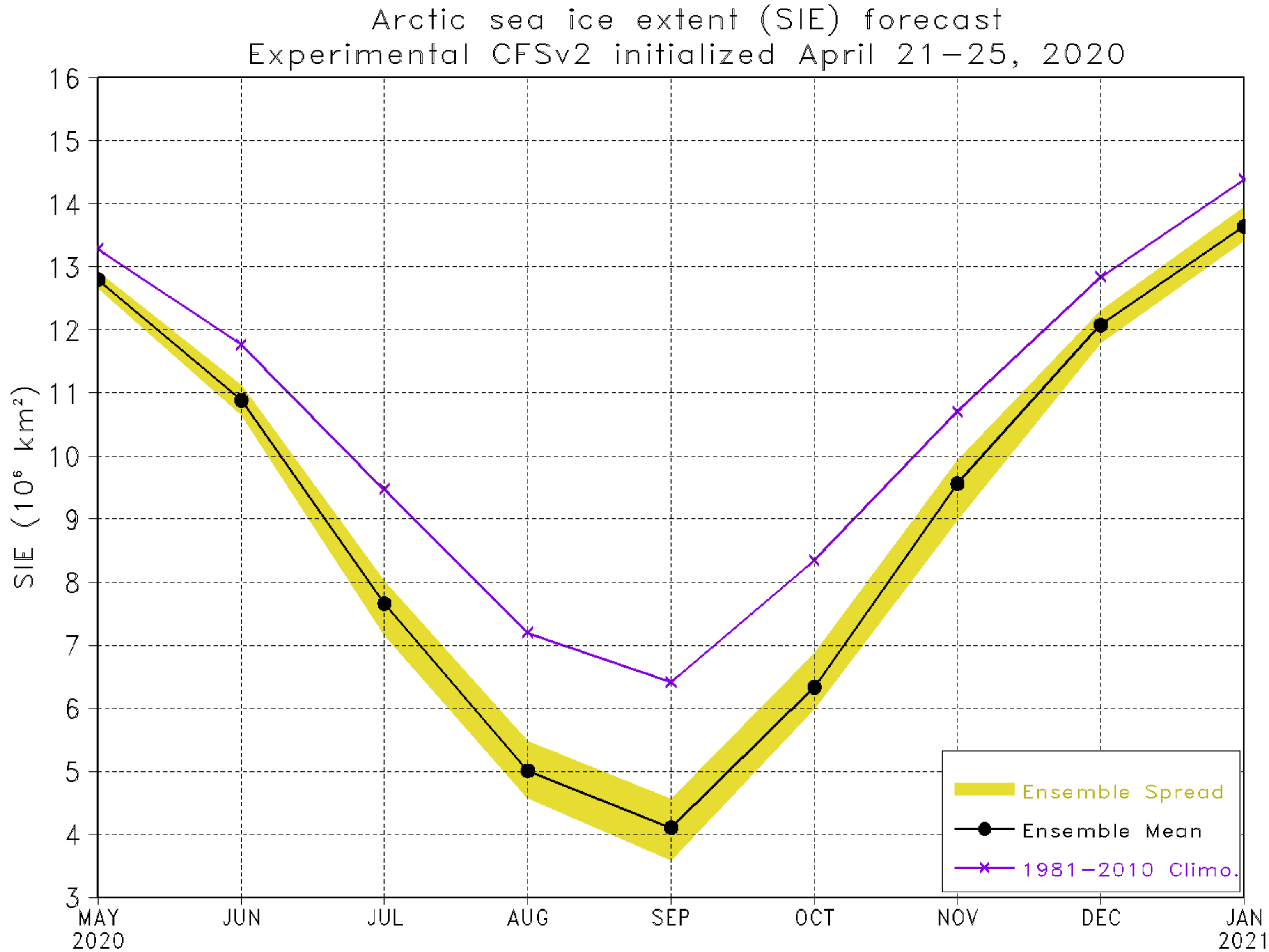




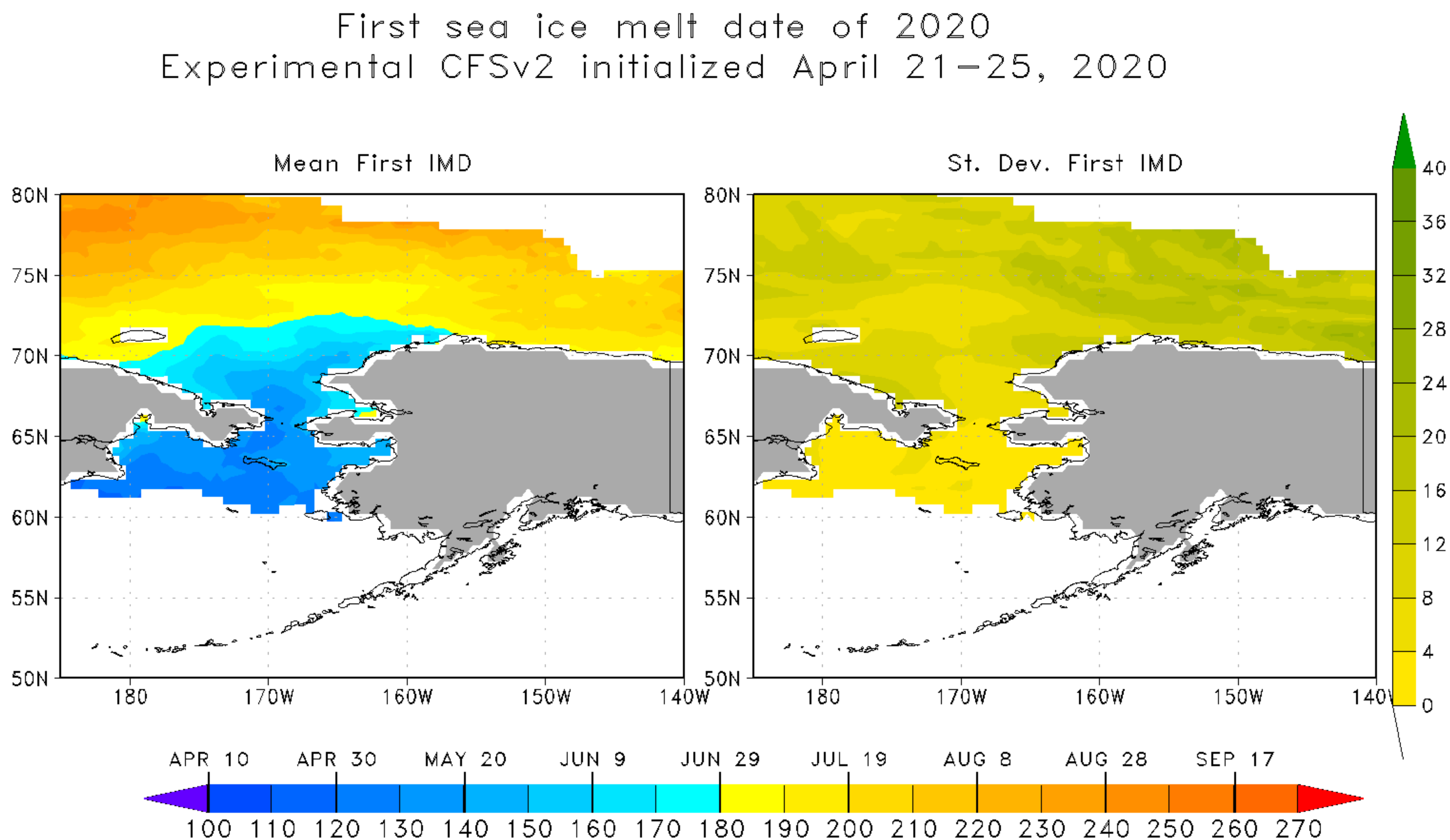
- **Arctic sea ice extent was well below the normal in Apr 2020.**

- **The monthly average extent for Apr 2020 of 13.73 million square kilometers ended up as the fourth lowest since satellite observations in 1979.**

- **The pace of sea ice decline in April was near average, faster than in Mar 2020.**



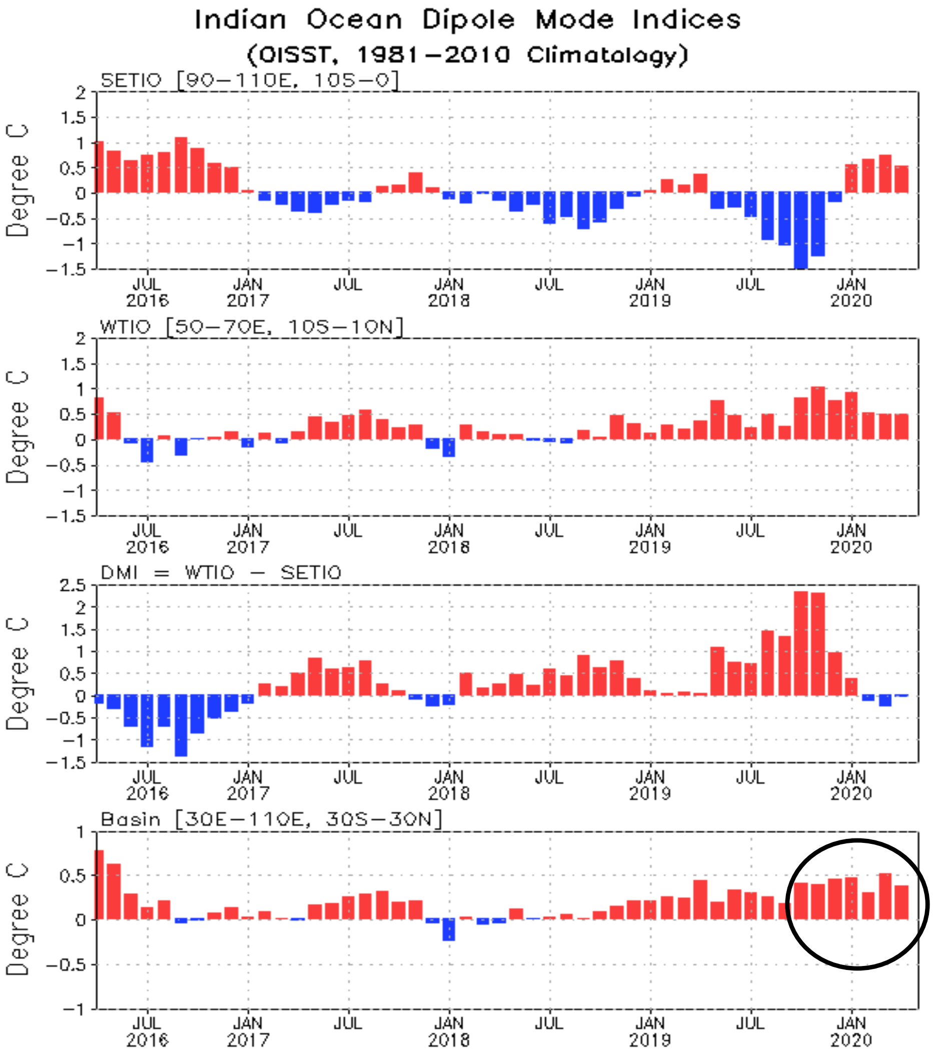
https://www.cpc.ncep.noaa.gov/products/people/wwang/seaice_seasonal/index.html

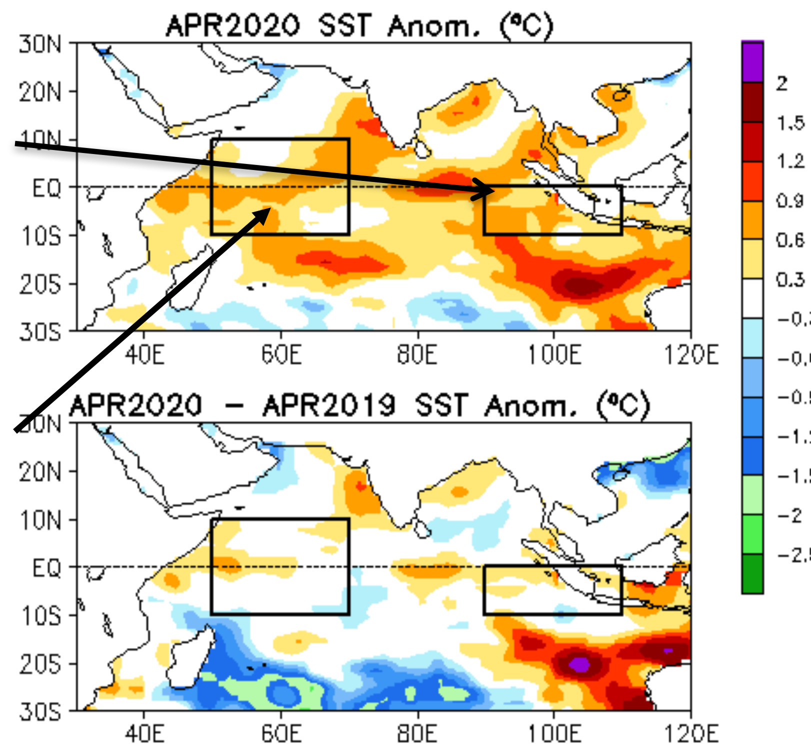


https://www.cpc.ncep.noaa.gov/products/people/wwang/seaice_seasonal/index.html

Indian Ocean

Evolution of Indian Ocean SST Indices





- **Positive SSTAs were present in the entire tropical Indian Ocean in Apr 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 overall positive in the entire tropical Indian Ocean.

- Convections were suppressed (enhanced) over the eastern Indian Ocean and the Maritime Continent (the western Indian Ocean).

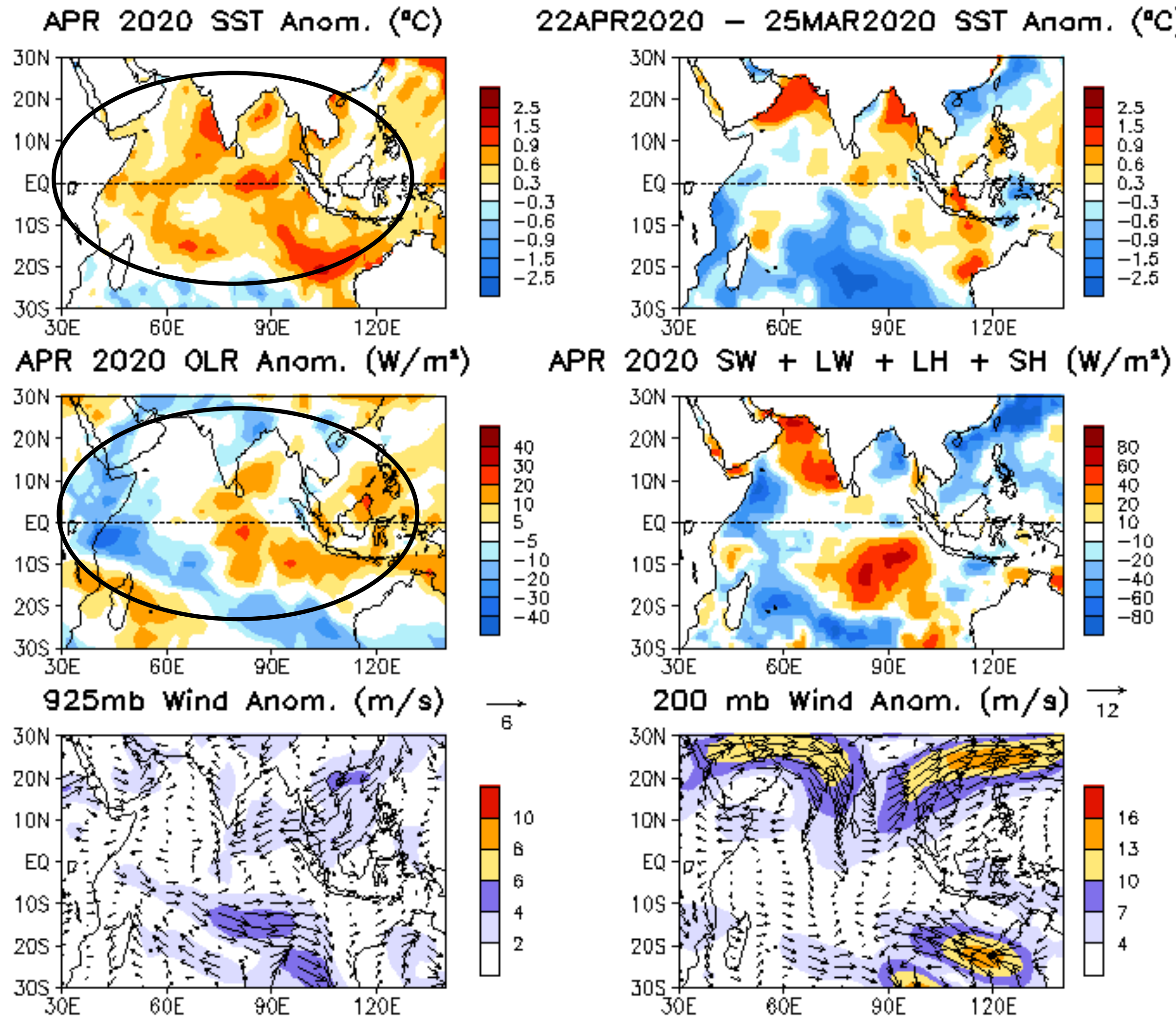
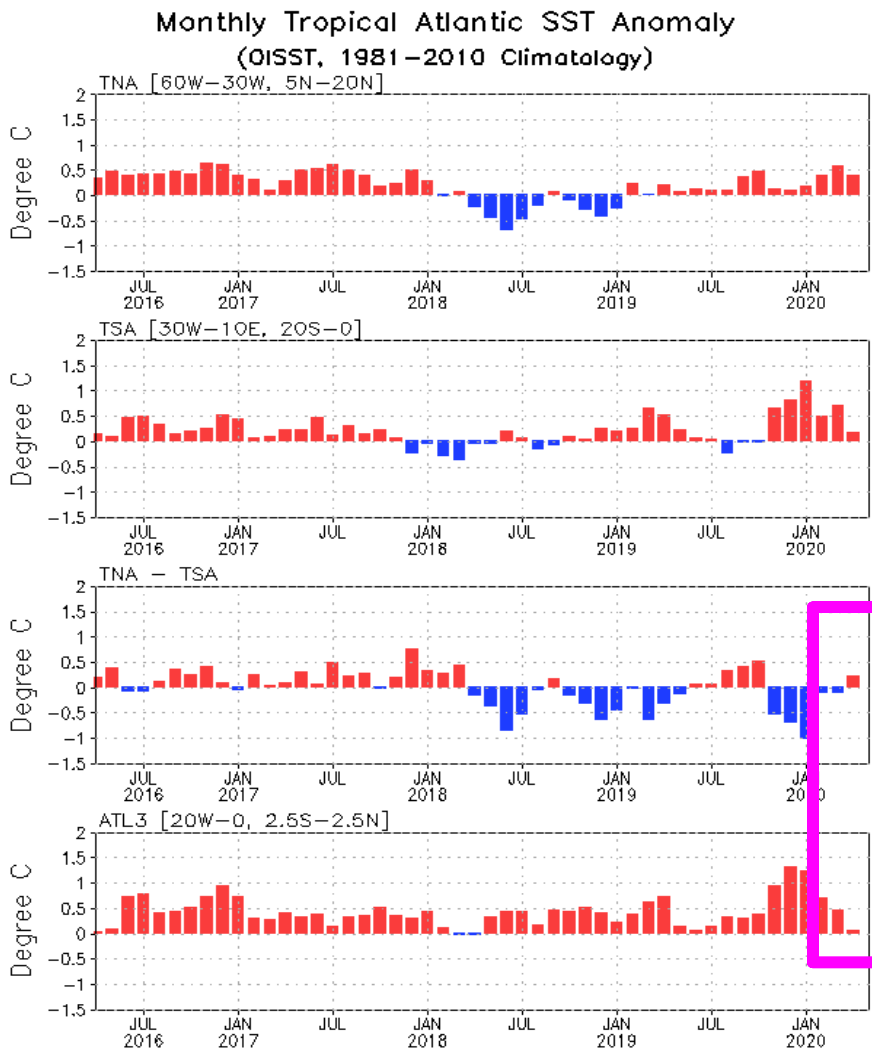
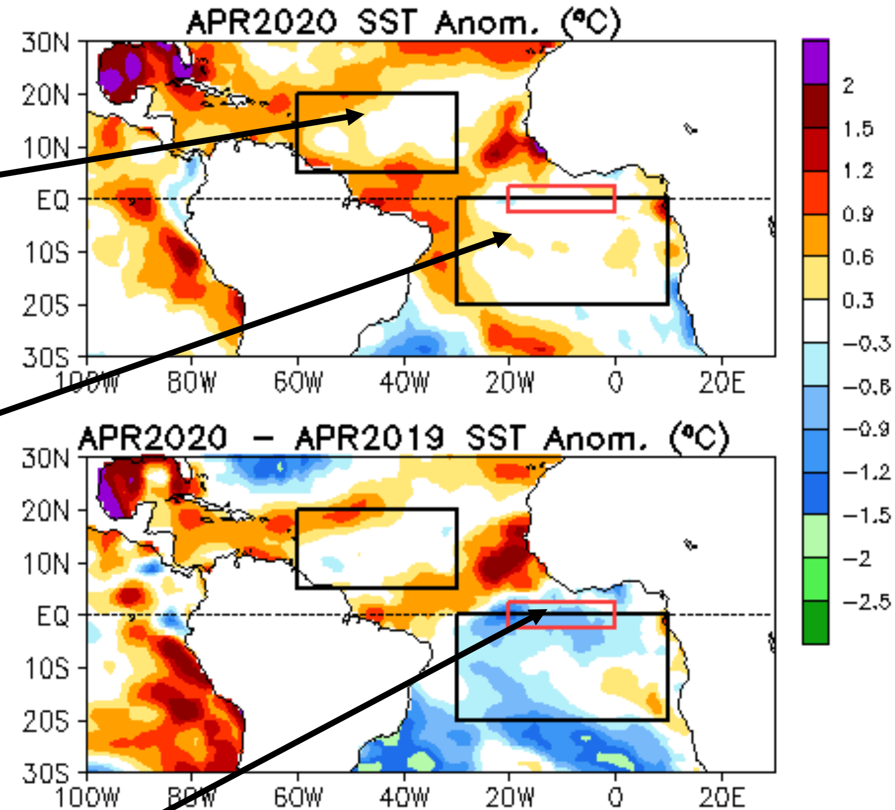


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

<u>Tropical and North Atlantic Ocean</u>

Evolution of Tropical Atlantic SST Indices

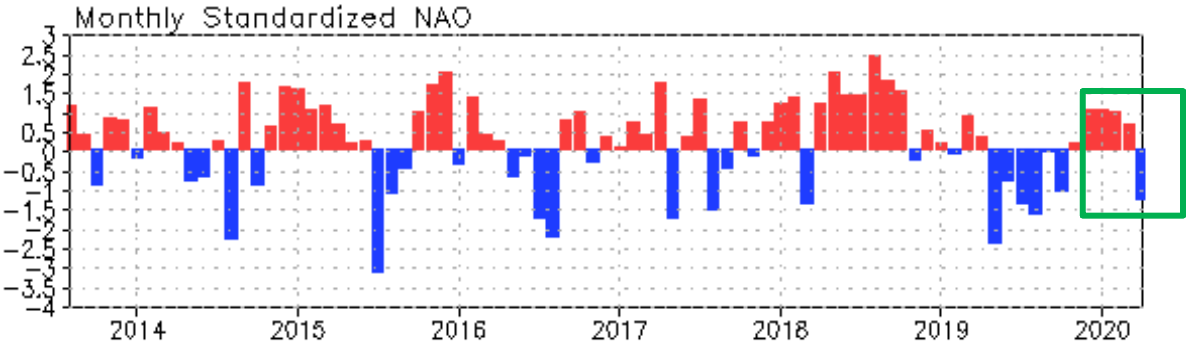


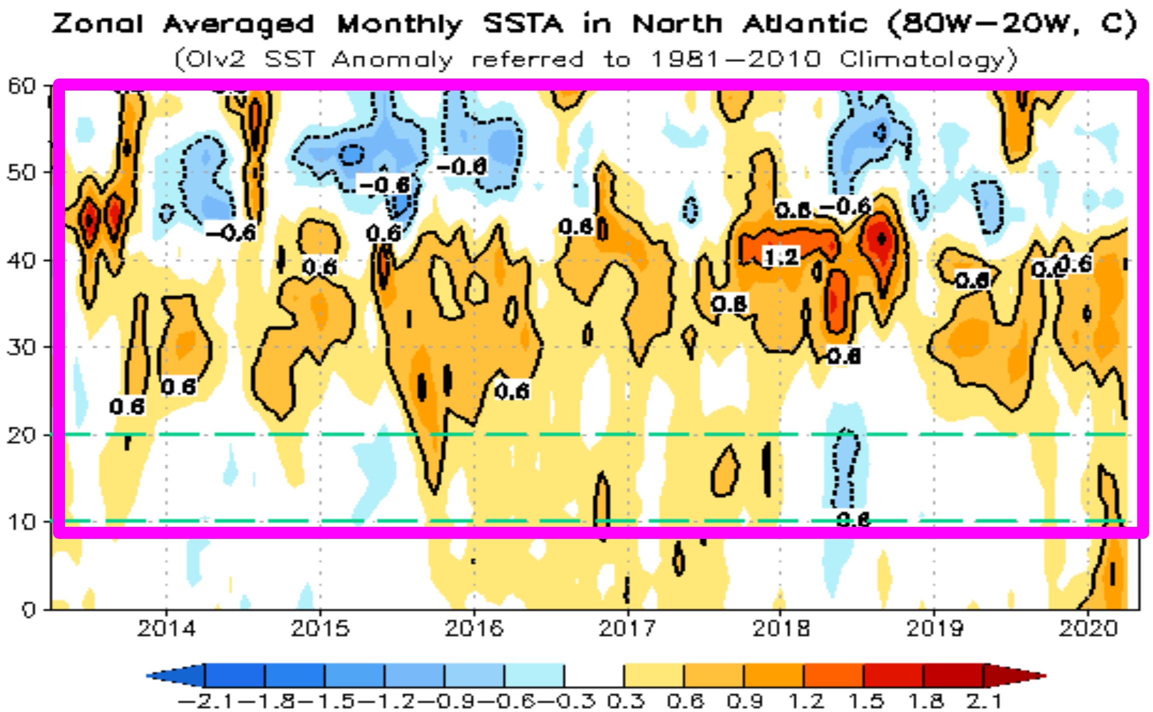


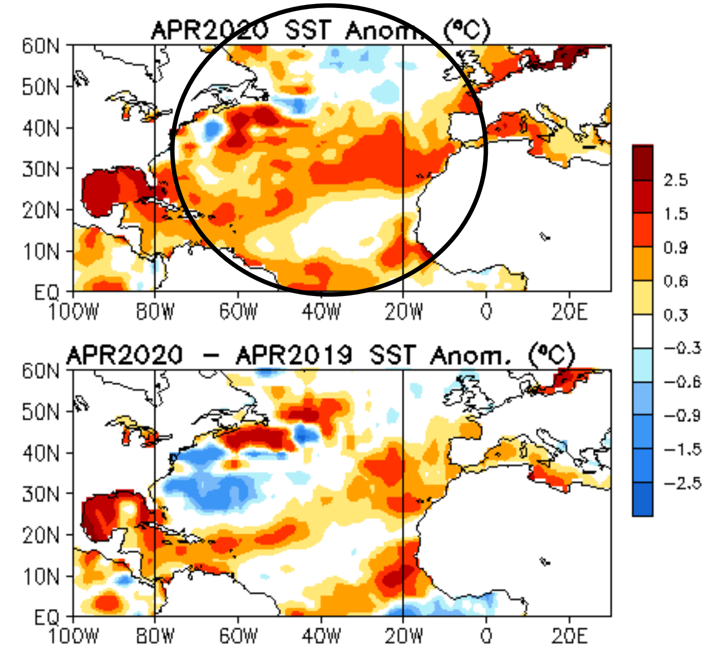
- Indices representing the Atlantic Meridional and Nino modes were small (<0.5 C) in Apr 2020.

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

NAO and SST Anomaly in North Atlantic





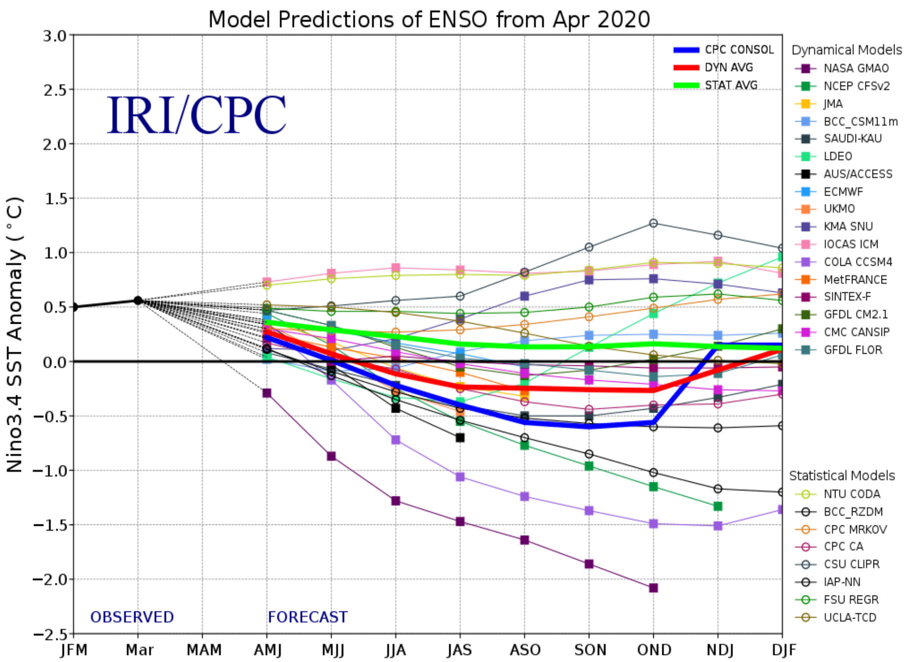


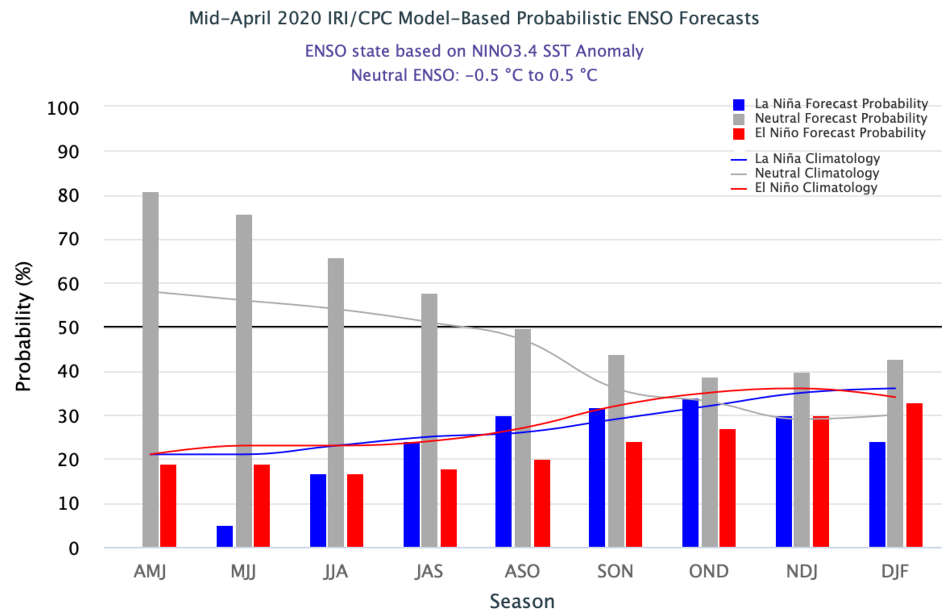
- NAO switched to a negative phase in Apr 2020 with NAOI= -1.26.
- The prolonged tripole SSTA pattern persisted in Apr 2020, but weaker than in Mar 2020 due to the change in NAO phase.

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.

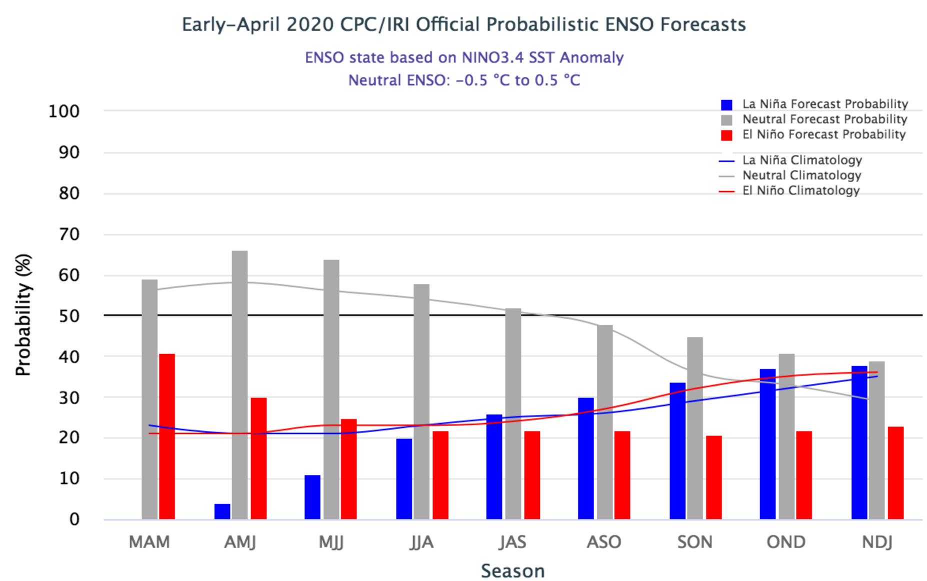
ENSO and Global SST Predictions

IRI NINO3.4 Forecast Plum



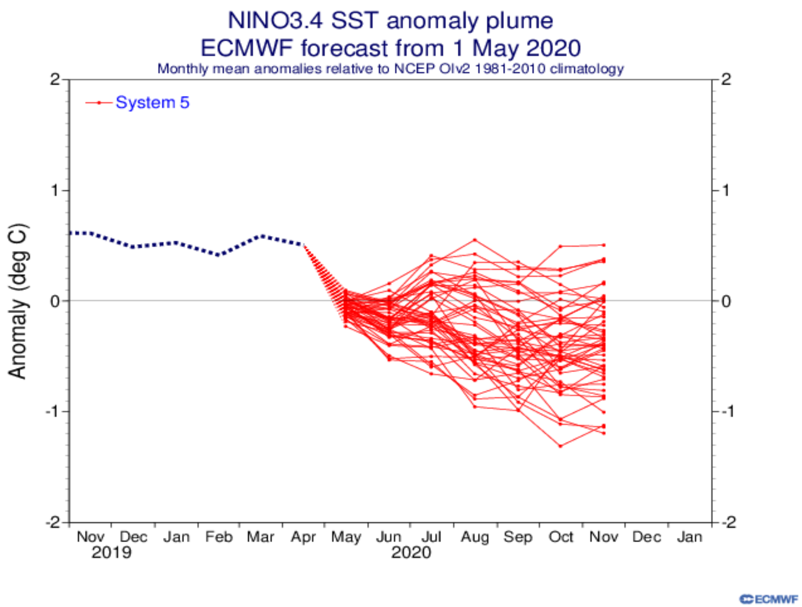


- **Predictions with ICs in Apr 2020 diverged greatly; most models predicted a ENSO-neutral state through boreal summer/fall 2020.**
- **NOAA "ENSO Diagnostic Discussion" on 9 Apr 2020 stated that *"ENSO-neutral is favored for the Northern Hemisphere summer 2020 (~60% chance), remaining the most likely outcome through autumn."***

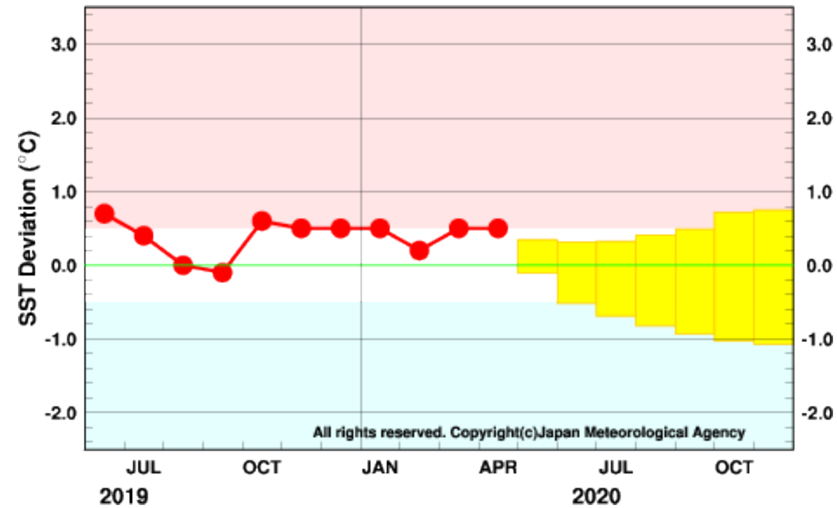


Individual Model Forecasts: ENSO-Neutral or Boardline La Nina

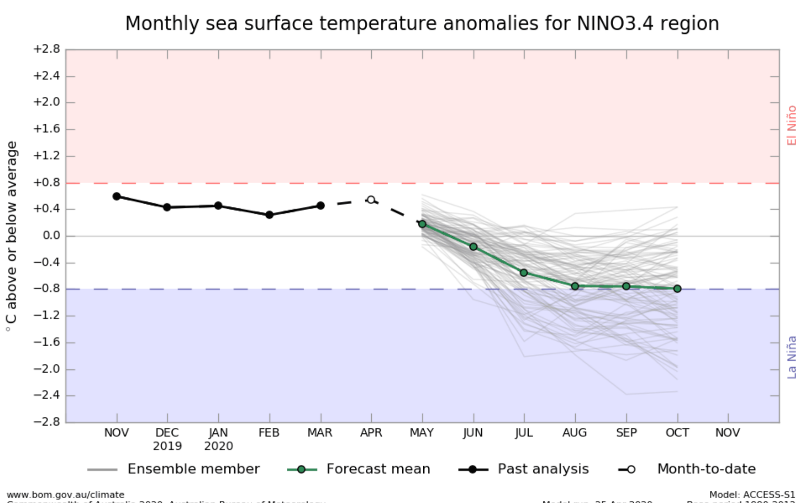
EC: Nino3.4, IC=01May 2020



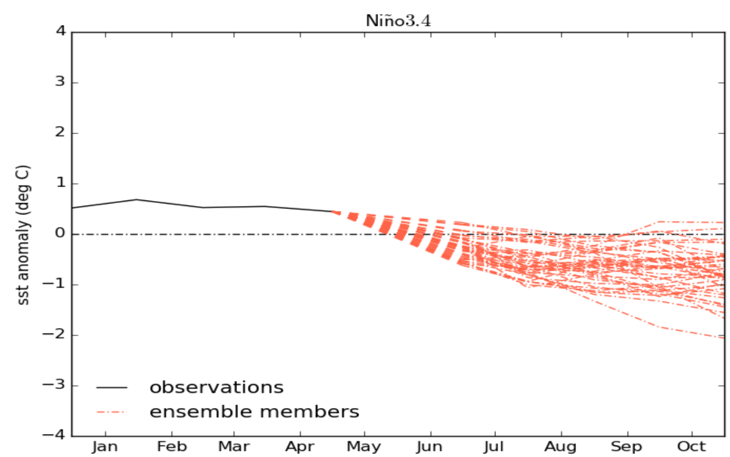
JMA: Nino3.4, Updated 12May 2019

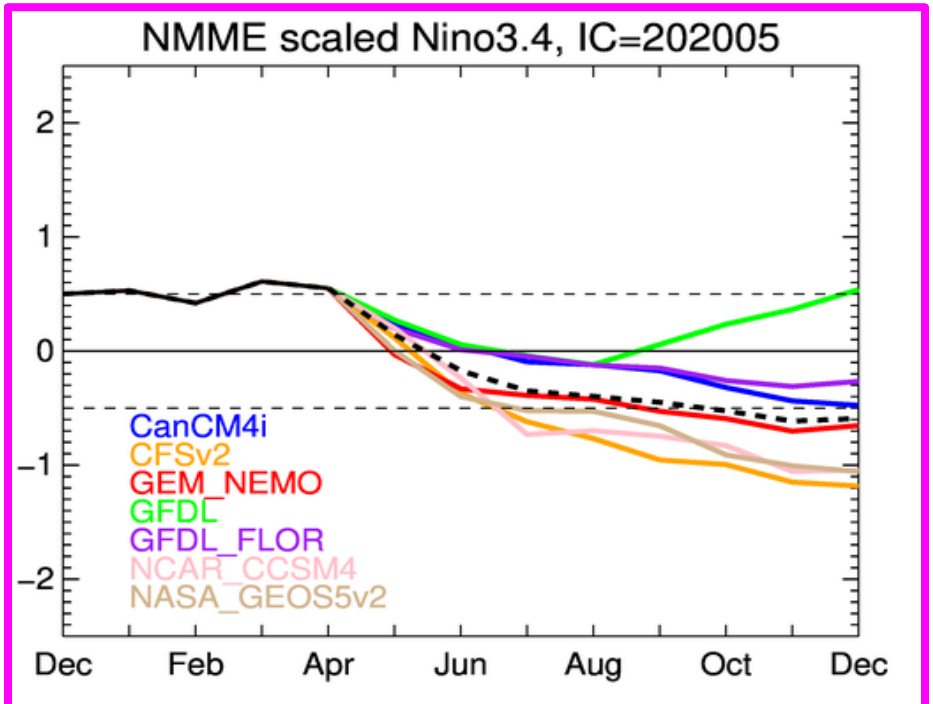


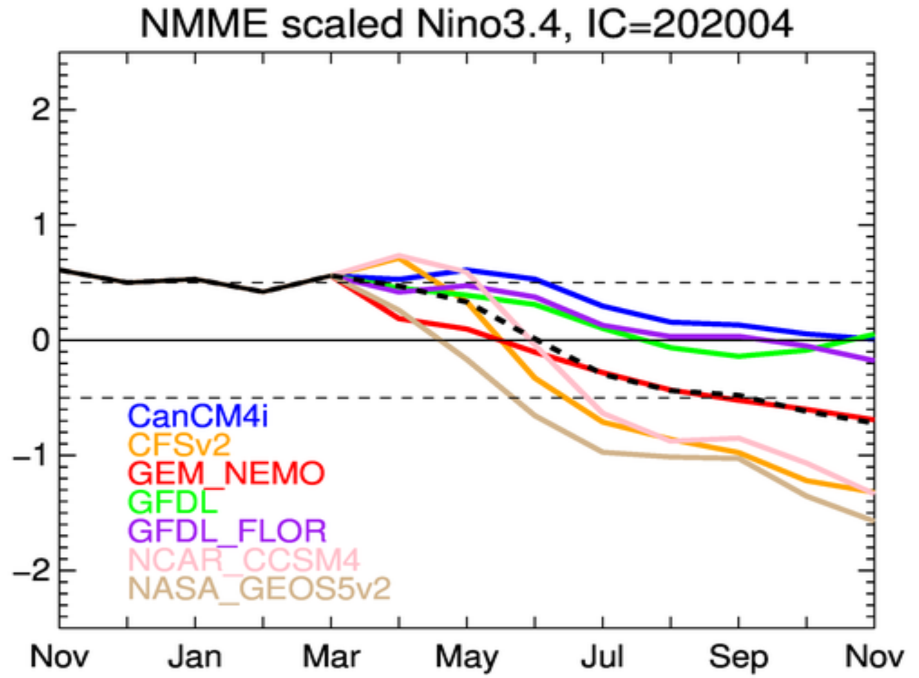
Australian BOM: Nino3.4, Updated 25 Apr 2020

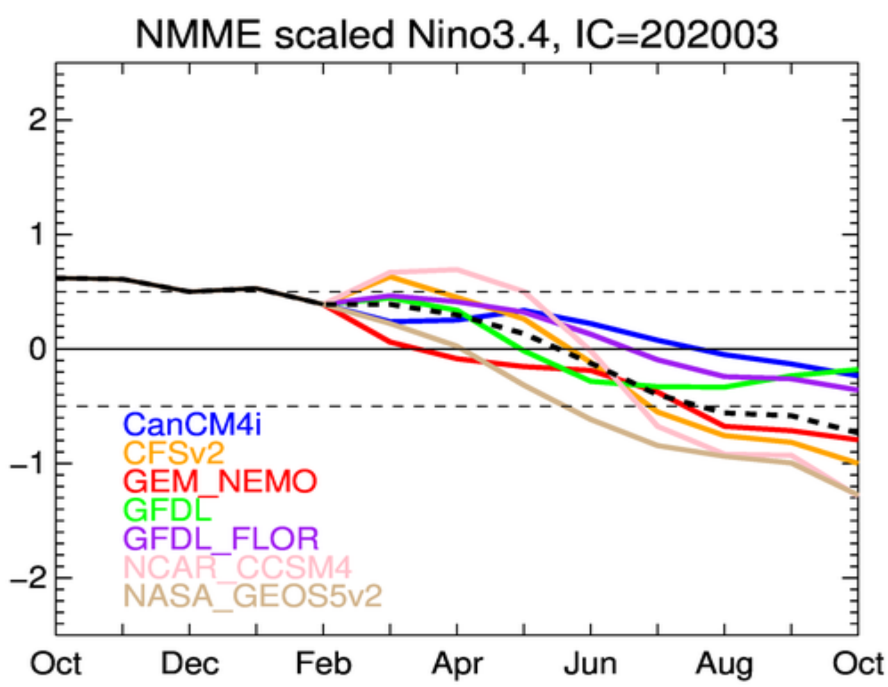


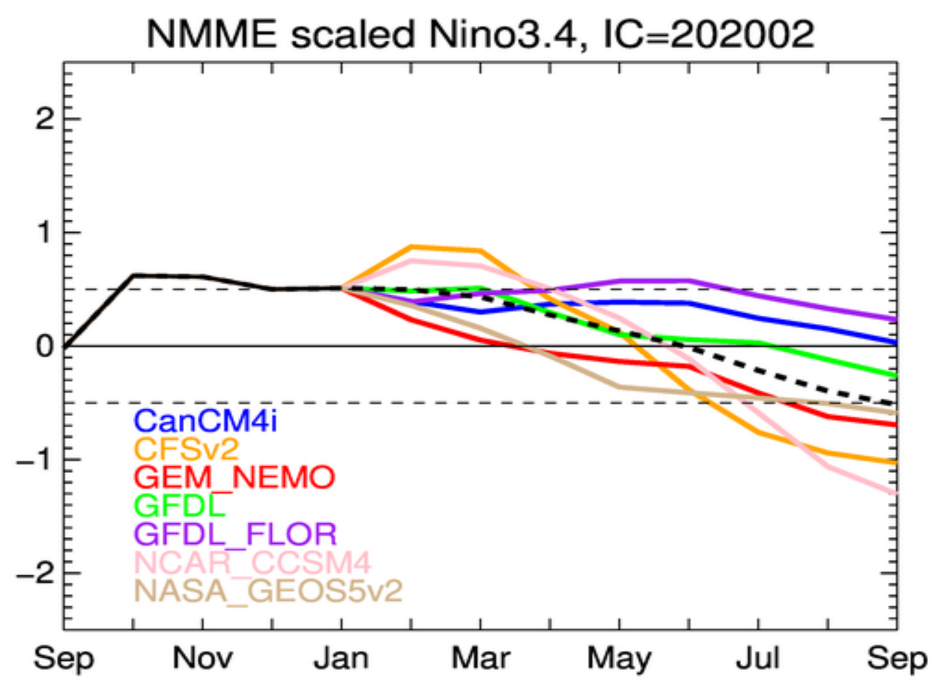
UKMO: Nino3.4, Updated 11May 2019



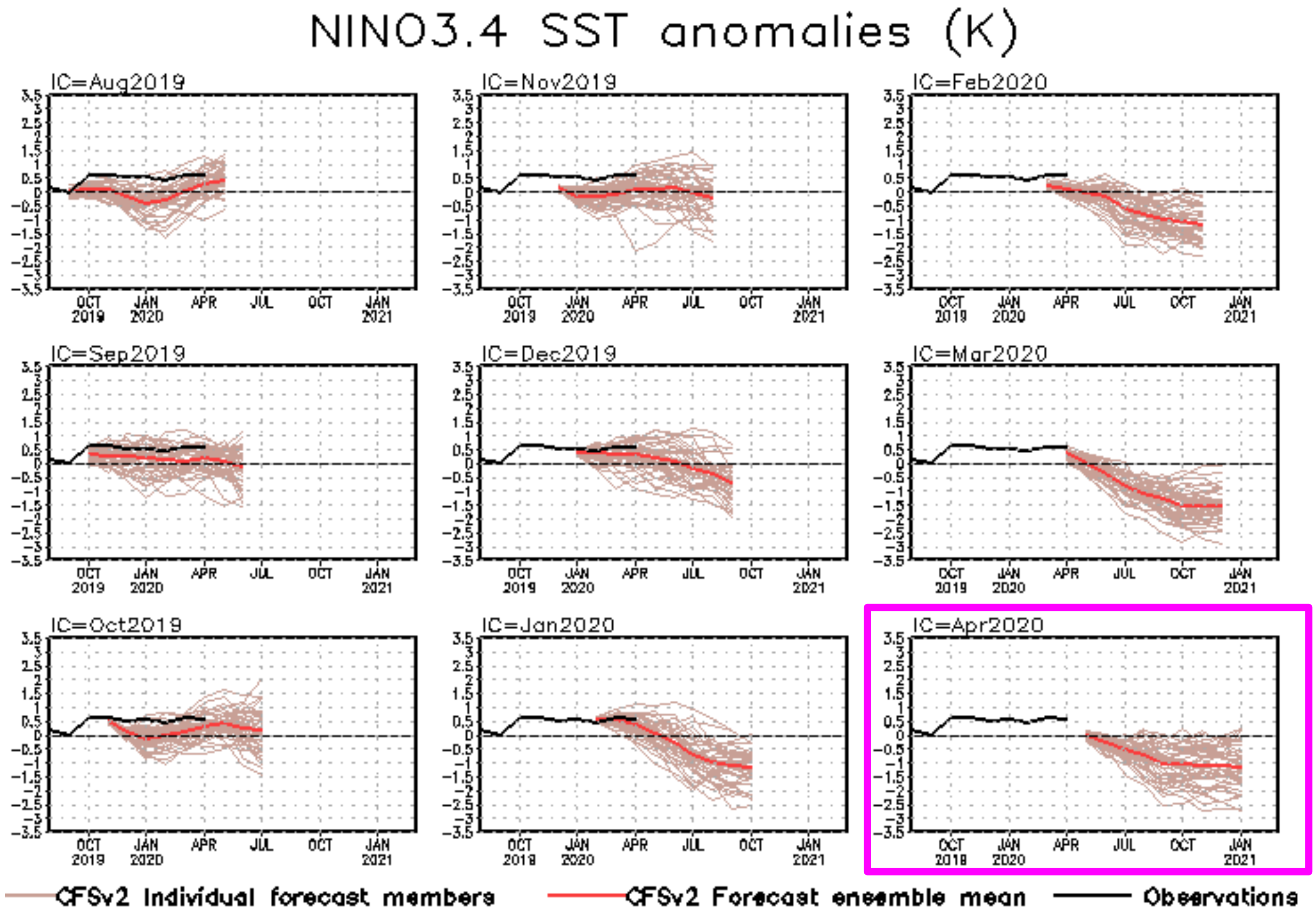

NMME scaled Nino3.4, IC=202005
2
1
0
−1
−2
Dec
Feb
Apr
Jun
Aug
Oct
Dec
CanCM4i
CFSv2
GEM_NEMO
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2


NMME scaled Nino3.4, IC=202004
2
1
0
−1
−2
Nov
Jan
Mar
May
Jul
Sep
Nov
CanCM4i
CFSv2
GEM_NEMO
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2


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=202002
2
1
0
−1
−2
Sep
Nov
Jan
Mar
May
Jul
Sep
CanCM4i
CFSv2
GEM_NEMO
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2

CFS Niño3.4 SST Predictions from Different Initial Months

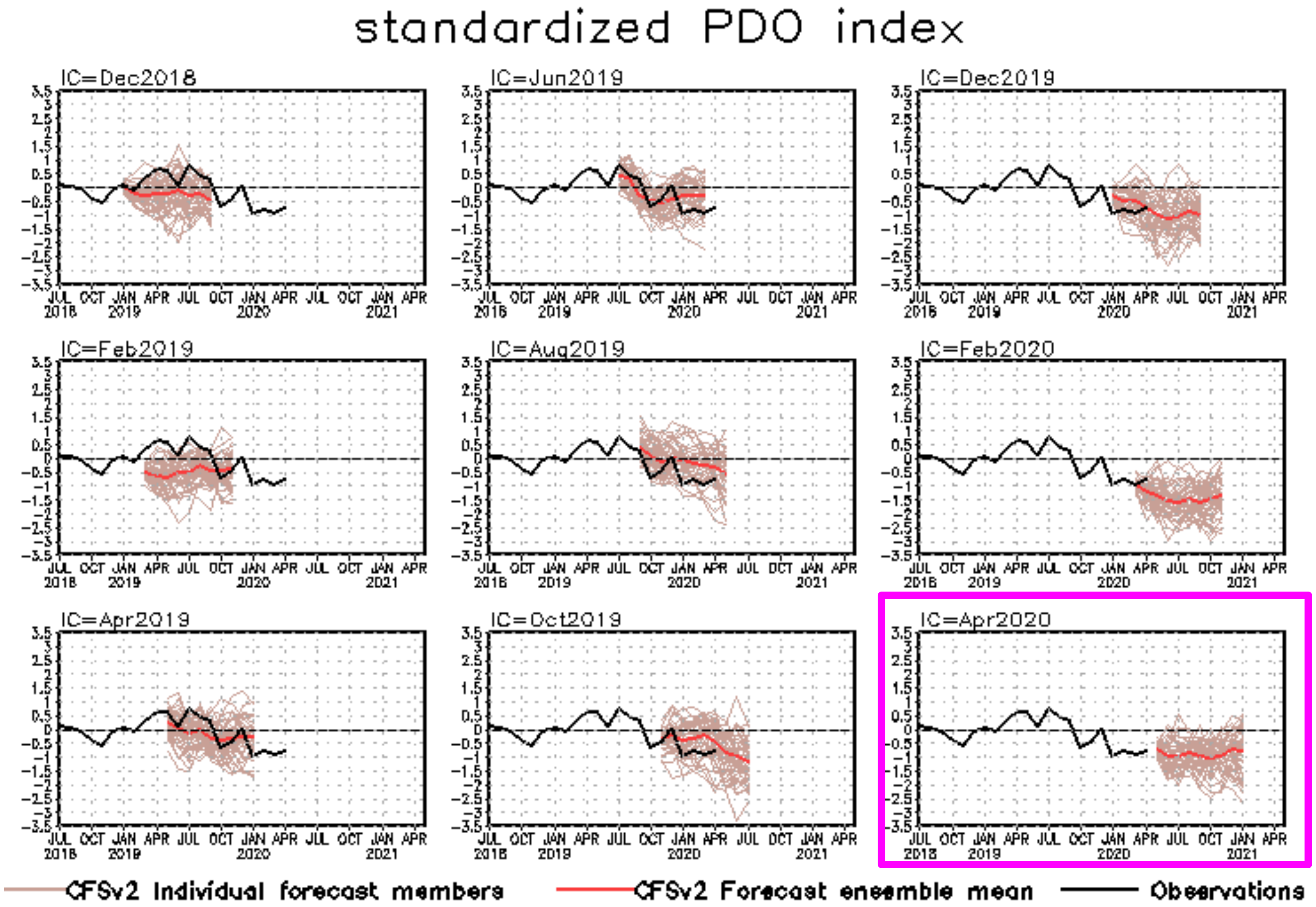


- CFSv2 had a cold forecast bias with ICs during May-Dec 2019.

- The latest forecasts call for a La Nina event, but predicted strength is weaker than March predictions.

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 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].

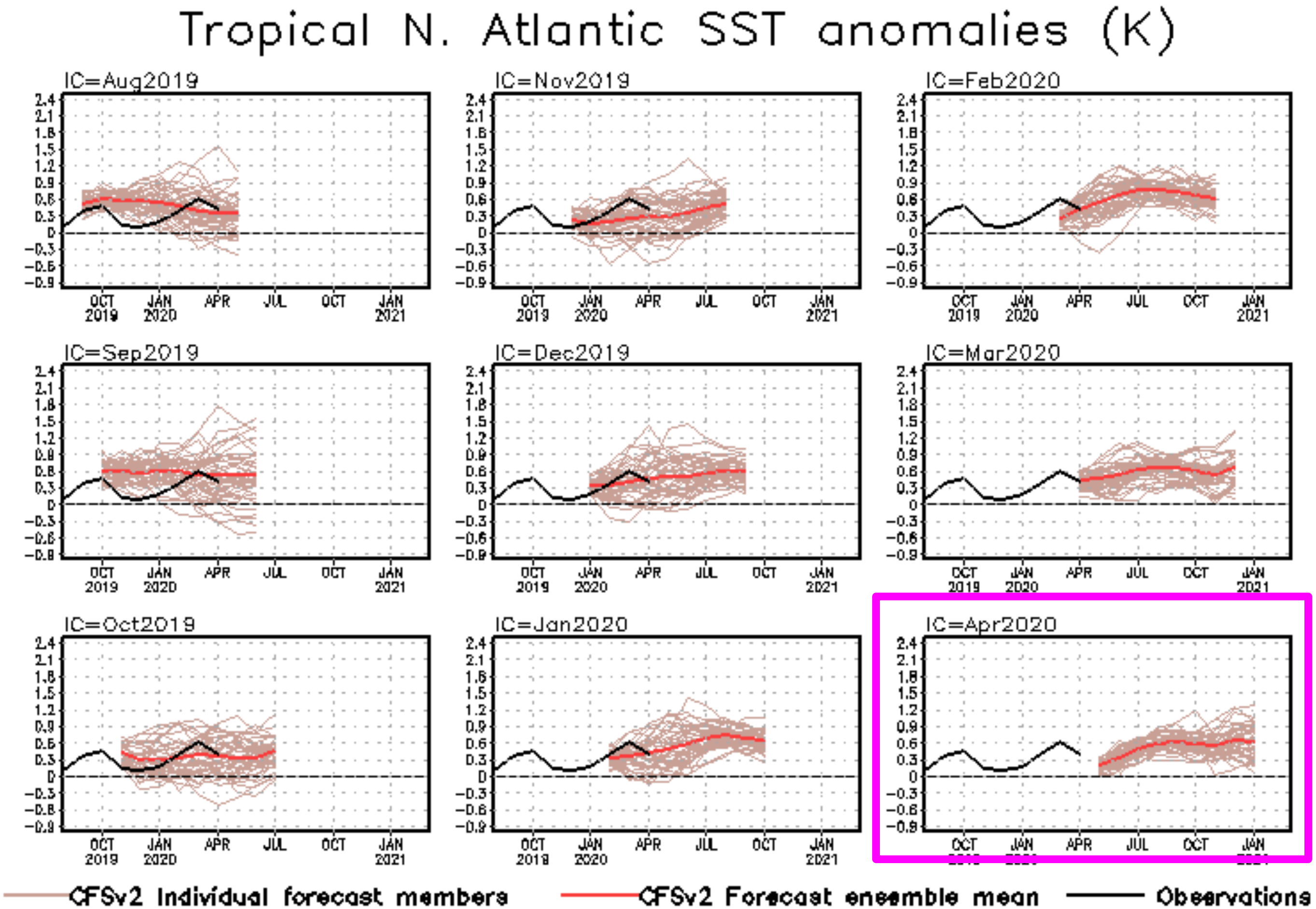
CFS PDO index is the standardized projection of CFS SST forecast anomalies onto the PDO EOF pattern.

- **CFSv2 predicts a negative phase of PDO in coming seasons.**

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.

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].

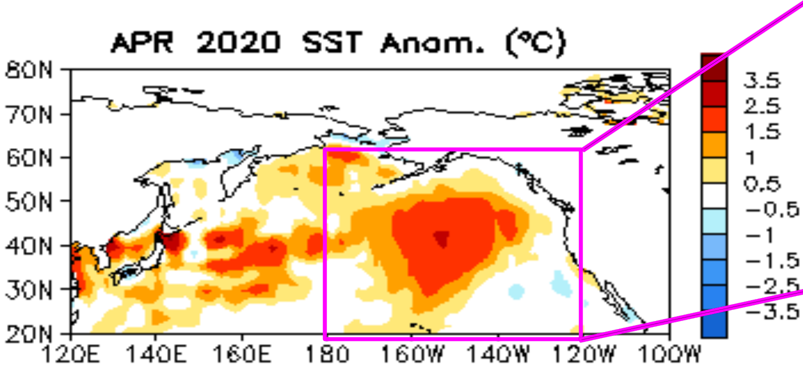


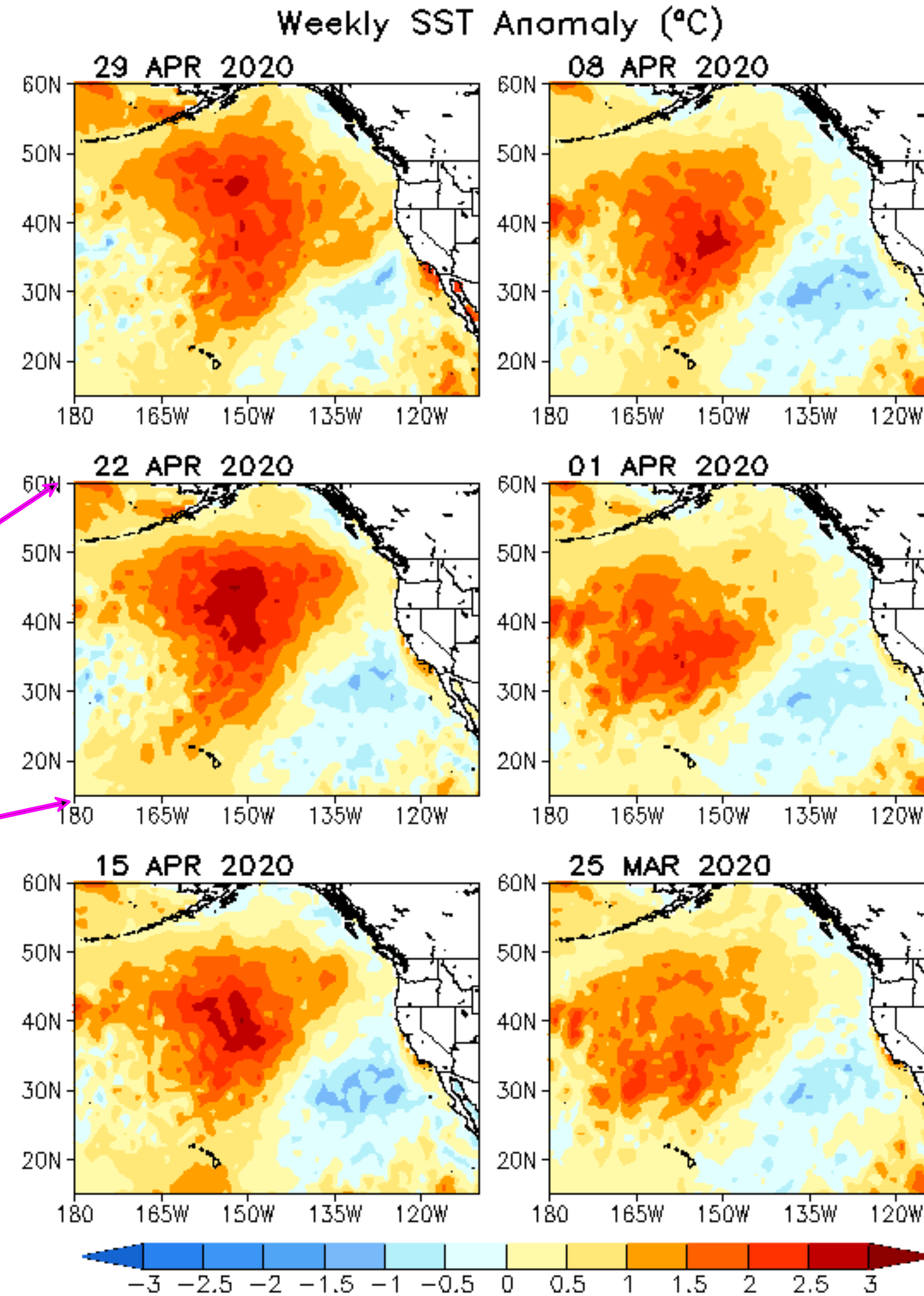
- Latest CFSv2 predictions call above normal SSTA in the tropical N. Atlantic in 2020.

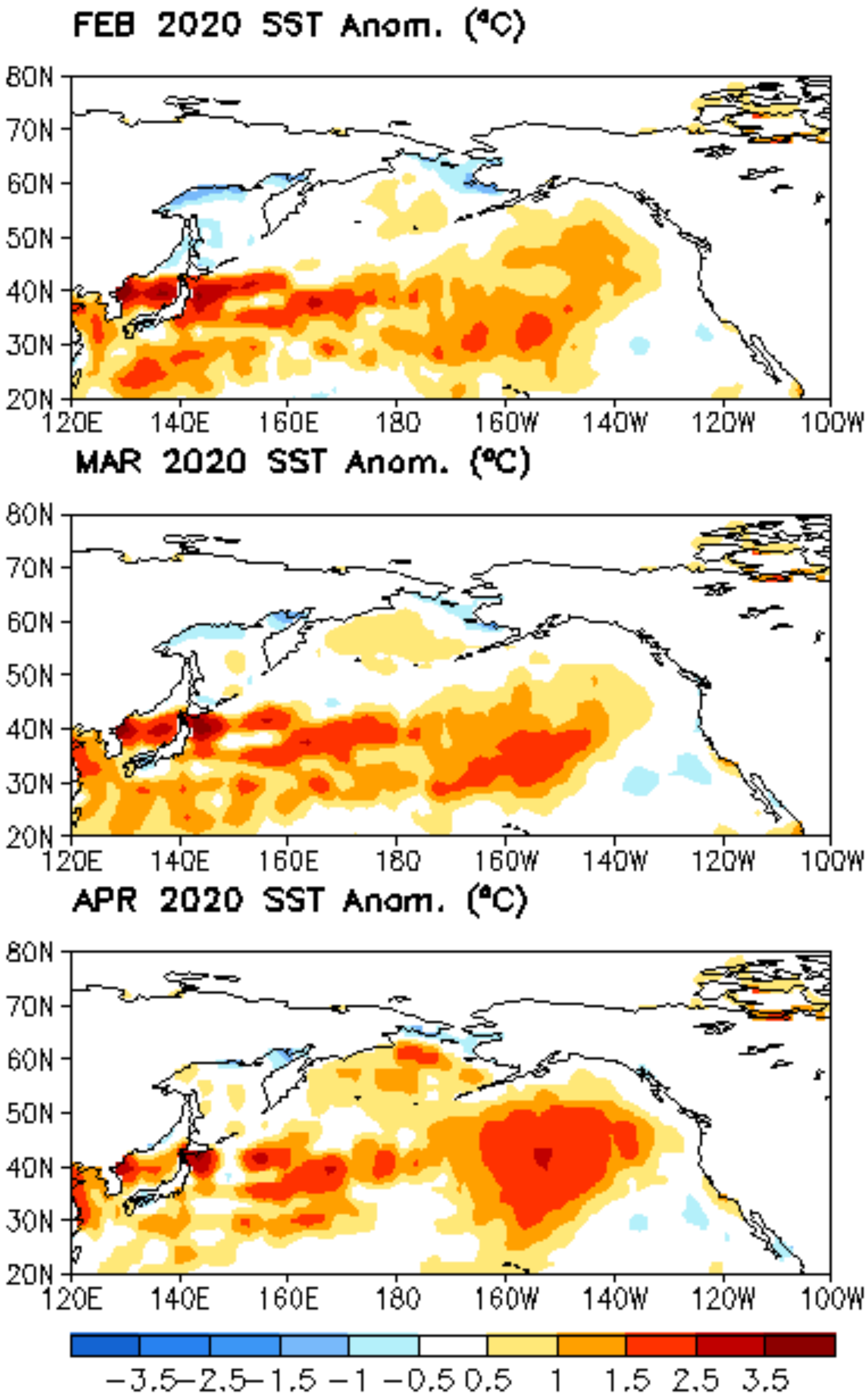
Fig. M3. CFS Tropical North Atlantic (TNA) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies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

North Pacific Marine Heatwave Status and Prediction

Marine Heatwave strengthened in North Pacific in April 2020






FEB 2020 SST Anom. (°C)
MAR 2020 SST Anom. (°C)
APR 2020 SST Anom. (°C)
80N
70N
60N
50N
40N
30N
20N
120E
140E
160E
180
160W
140W
120W
100W
−3.5
−2.5
−1.5
−1
−0.5
0.5
1
1.5
2.5
3.5

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

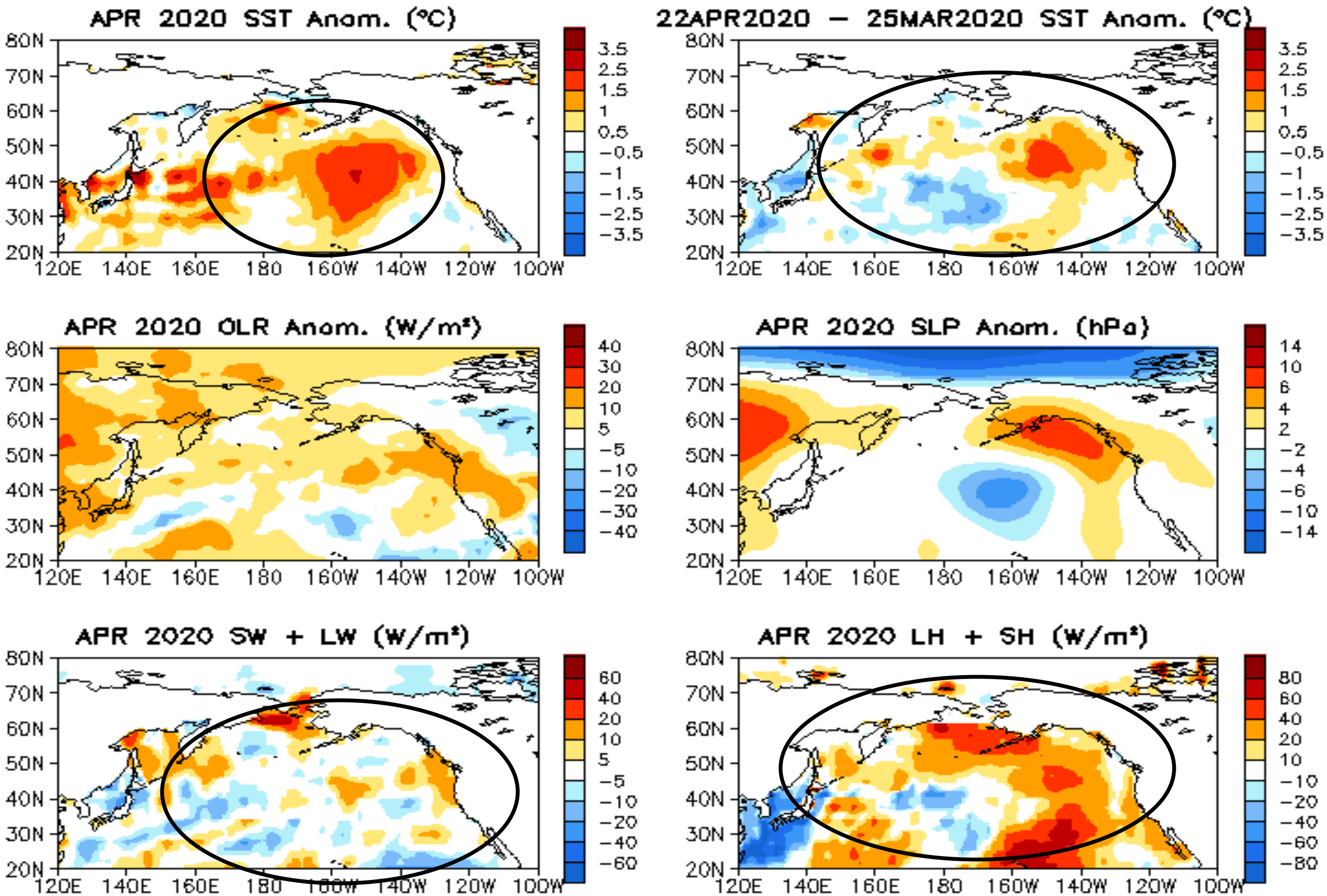
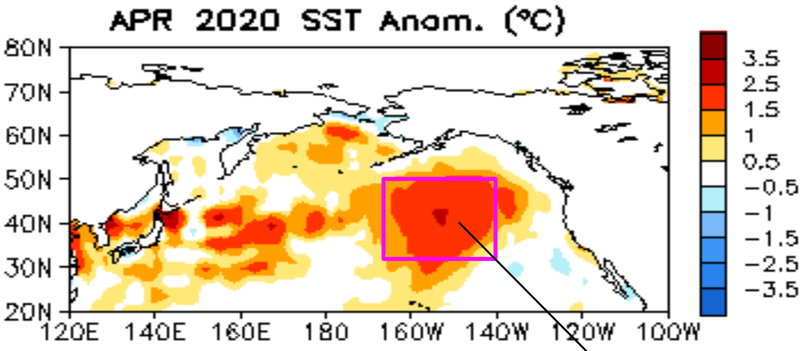
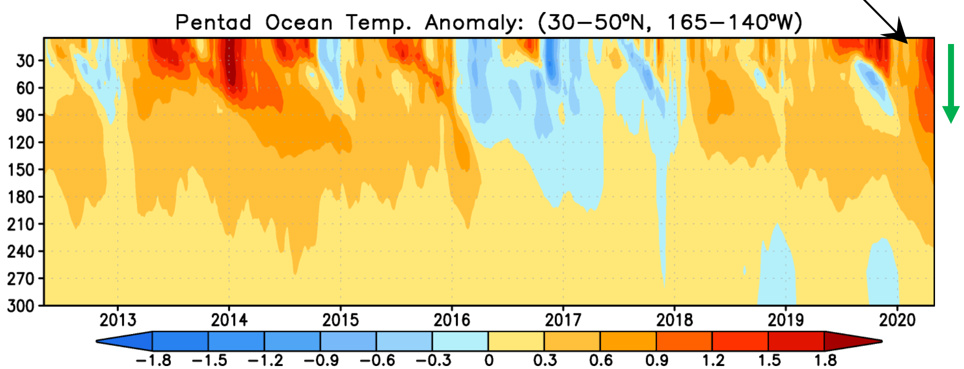
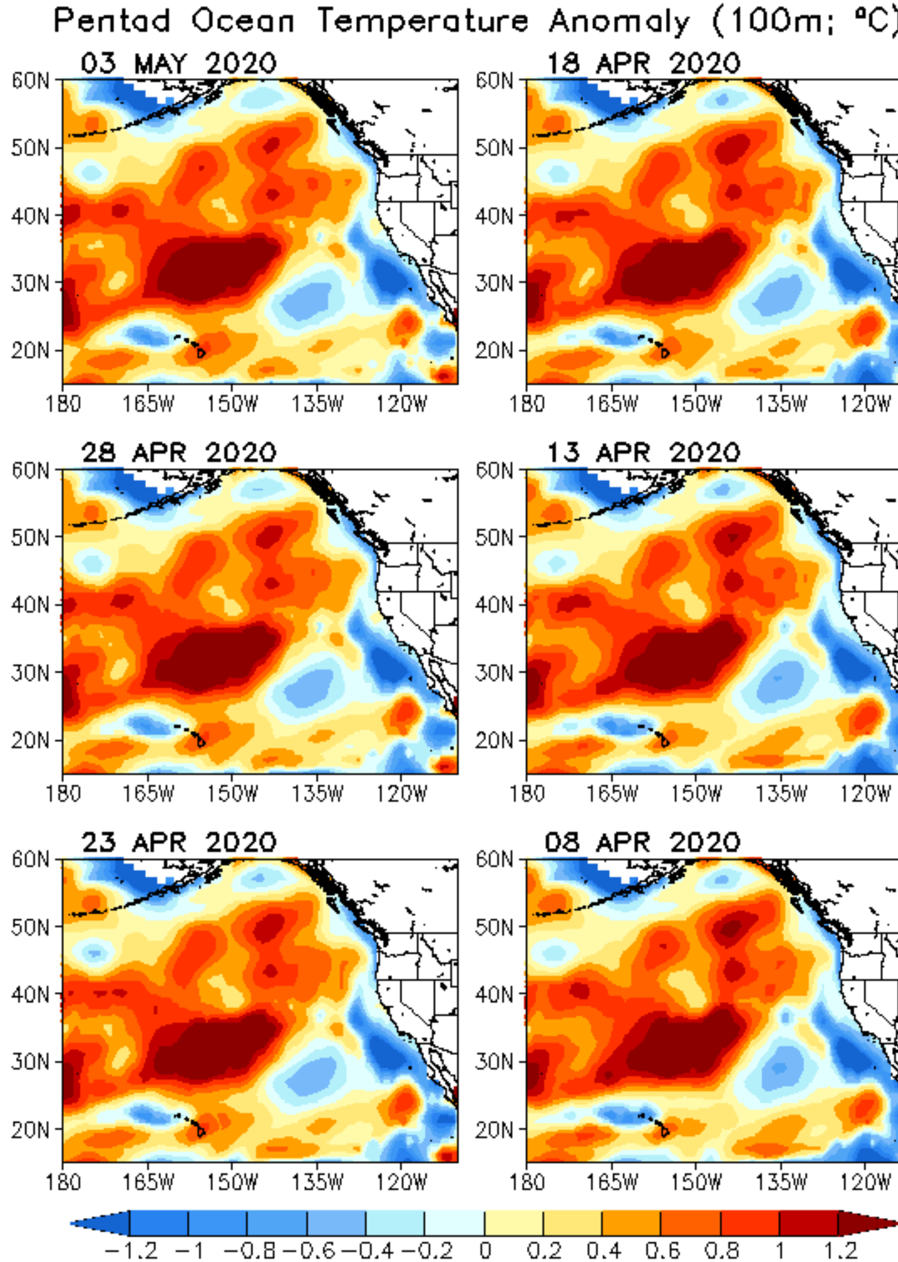


Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left; positive means heat into the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

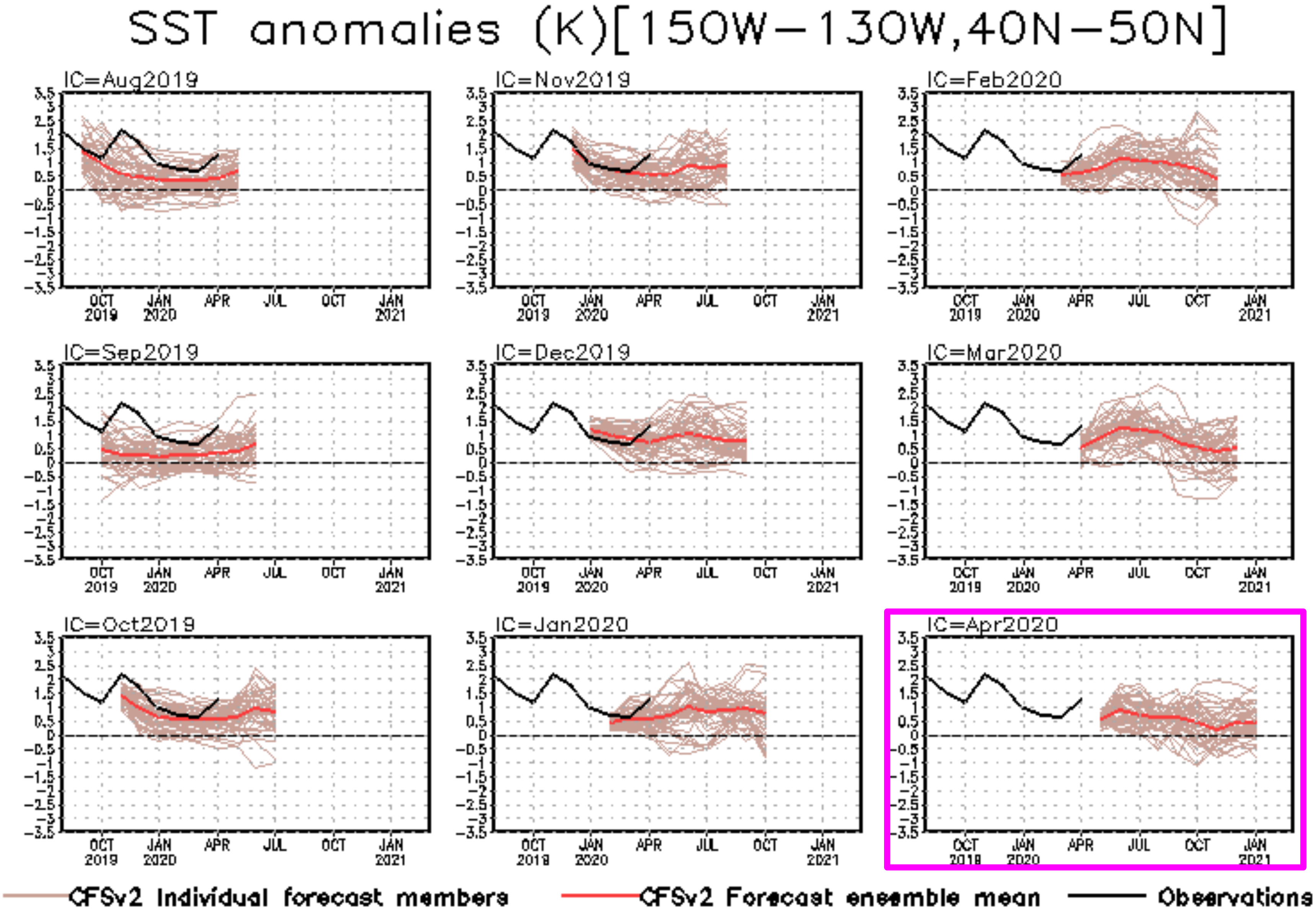
The warming has extended to depth in Apr 2020.







CFS NE Pacific Marine Heatwave Index Predictions
from Different Initial Months



Acknowledgements

❖ Drs. Zeng-Zhen Hu, Caihong Wen, and Arun Kumar: reviewed PPT, and provide insightful suggestions and comments

❖ Drs. Li Ren and Pingping Xie provided the BASS/CMORPH/CFSR EVAP package

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

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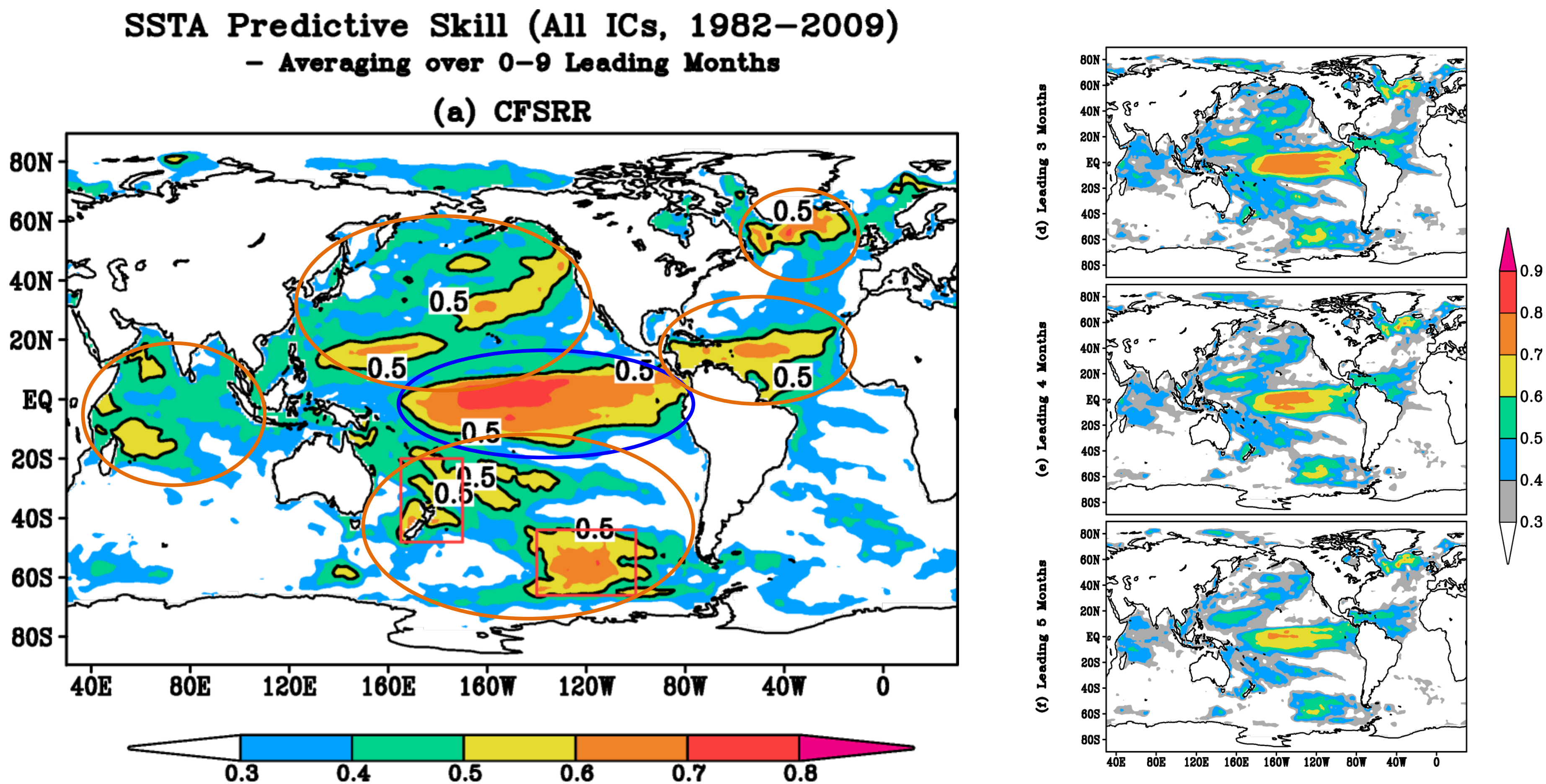
Backup Slides

Spatial Distribution of SSTA prediction skill with CFSv2



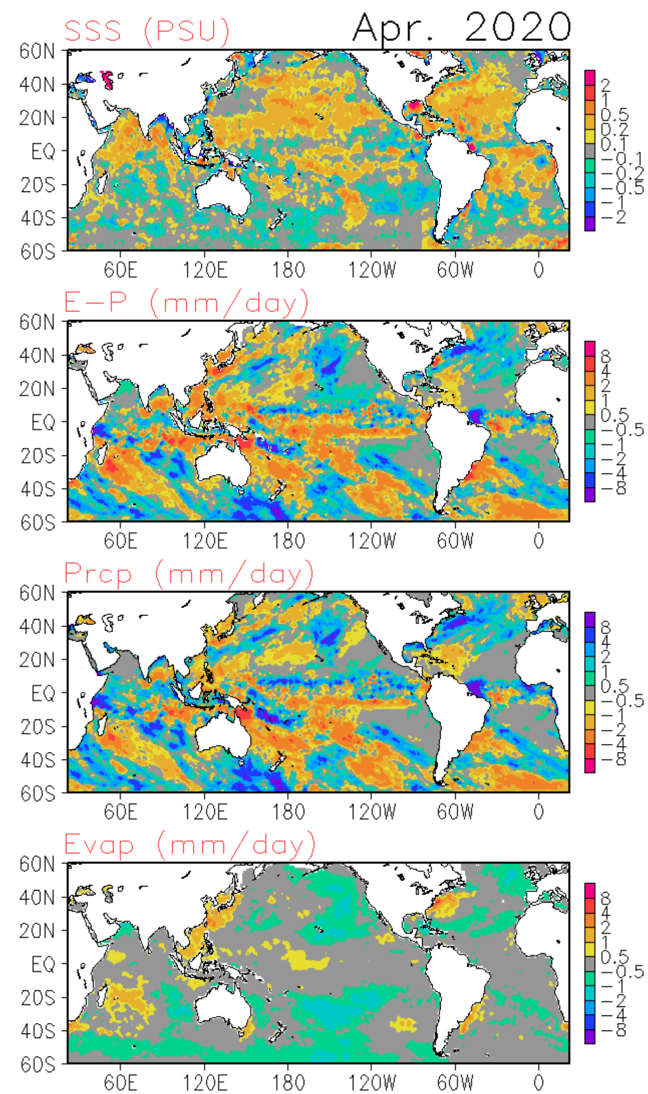
(Guan et al. 2014)

- **ENSO-related SST presents the highest prediction skill;**
- **Other skillful regions include: tropical North Atlantic, South Pacific, tropical Indian Ocean, part of extratropical North Pacific,…**

Global Sea Surface Salinity (SSS)

Anomaly for April 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.
- Positive SSS anomalies appear in most areas within the latitudes between 0° and 40°N in the N. Pacific Ocean and N. Atlantic Ocean, and between 0° and 20°N in the Indian Ocean. Negative SSS signal in the west equatorial Pacific region is persistent but weakening. While, in the eastern equatorial Pacific Ocean, negative SSS anomalies appear, which is accompanied with increased precipitation. Negative SSS anomalies are in the northern region of Bay of Bengal and is likely caused by increased precipitation.



- **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

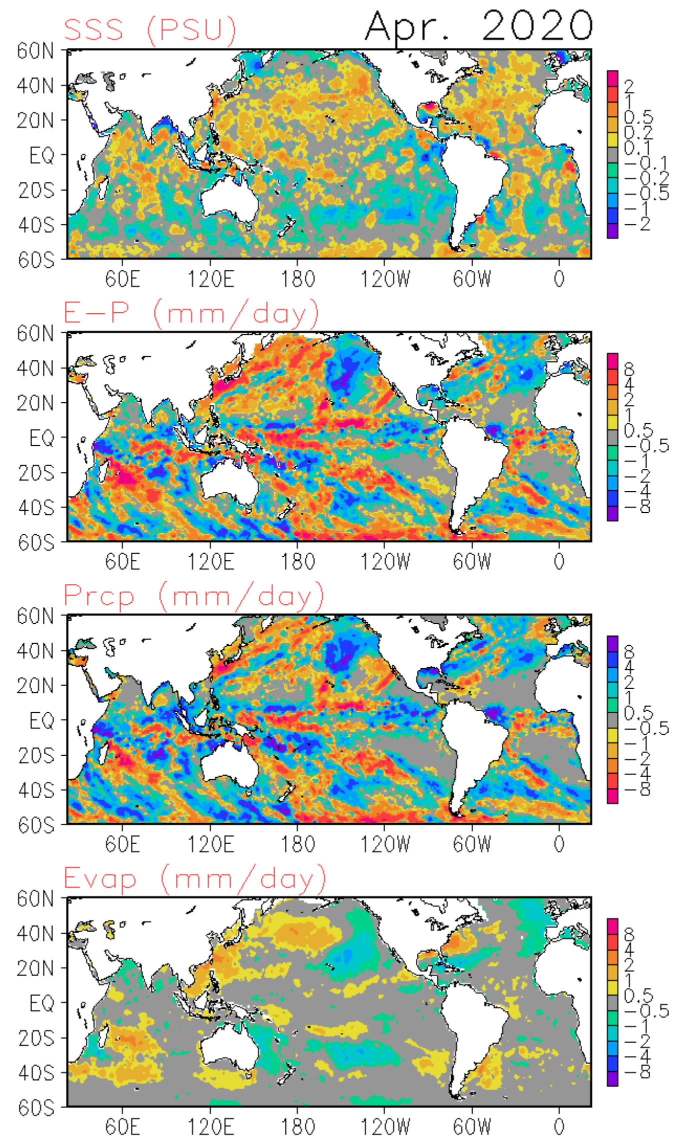
  Precipitation: CMORPH adjusted satellite precipitation estimates

  Evaporation: Adjusted CFS Reanalysis

Global Sea Surface Salinity (SSS)

Tendency for April 2020

Compared with last month, the SSS continued increasing in most areas of the N. Pacific ocean, N. Atlantic and N. Indian Ocean. The SSS signal became negative in the east Equatorial Pacific Ocean with increased precipitation in the area. The SSS decreased in the Bay of Bengal especially in the North region, and such signal is accompanied with increased precipitation. In the equator of Atlantic Ocean, the increased SSS is likely due to the reduced precipitation.

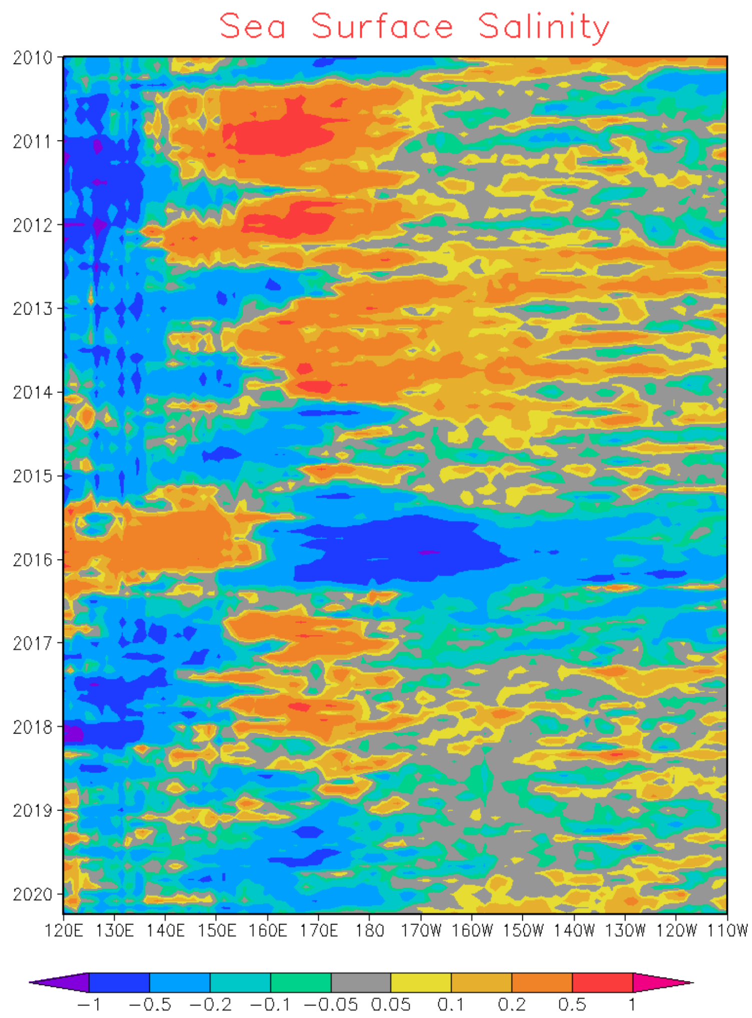


Global Sea Surface Salinity (SSS)

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.

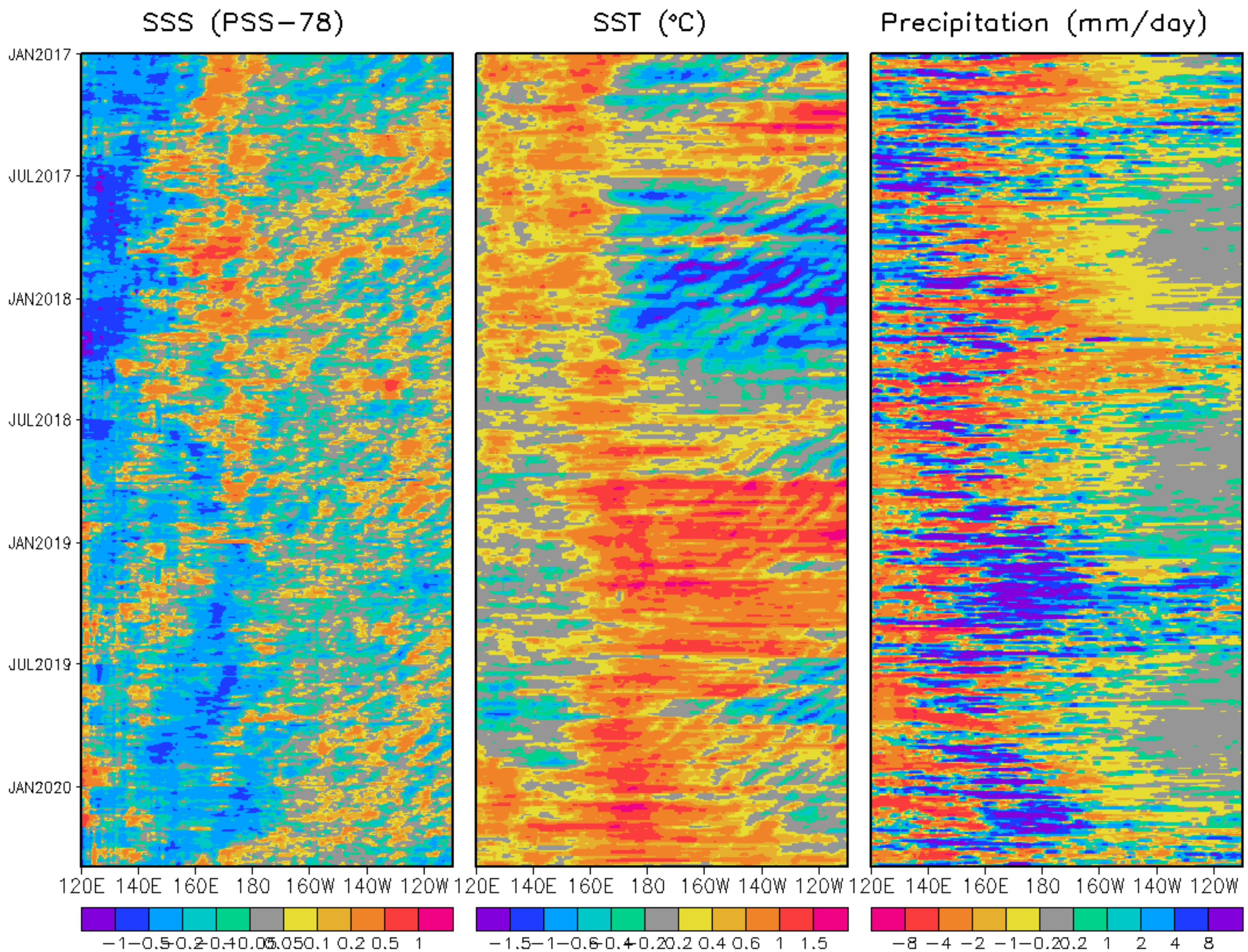
- Hovemoller diagram for equatorial SSS anomaly **(5˚S-5˚N);**
- In the equatorial Pacific Ocean, the SSS signal is negative west of 170°W; the SSS shows positive anomalies east of 170°W, while negative SSS signal appears east of 125°W.



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.



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 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 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