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 Global Ocean Monitoring and Observing Program (GOMO)

Outline

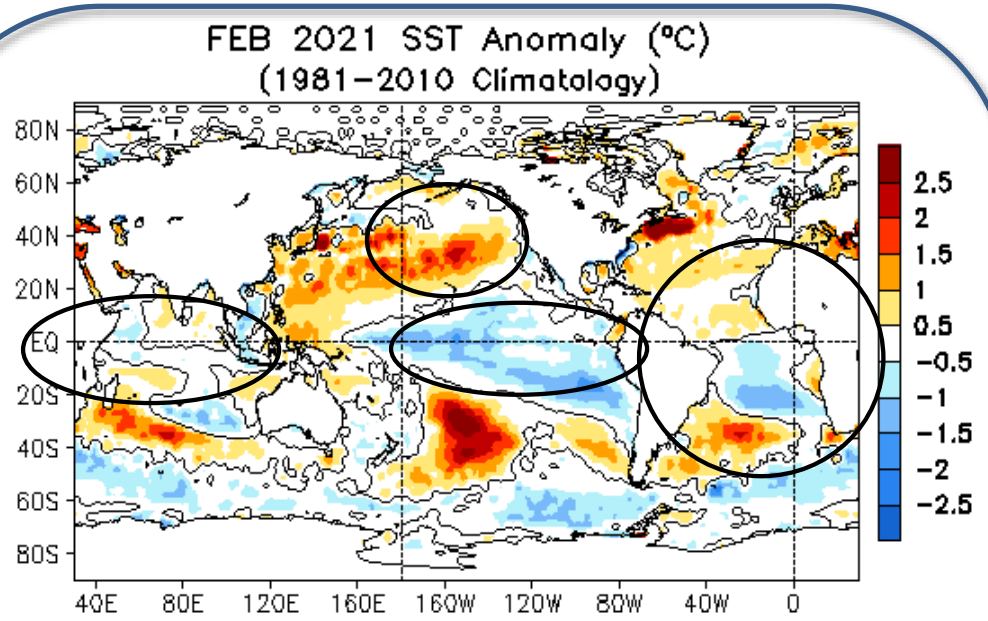
- Overview
- Recent highlights
  - Pacific/Arctic Ocean
  - Indian Ocean
  - Atlantic Ocean
- Global SSTA Predictions

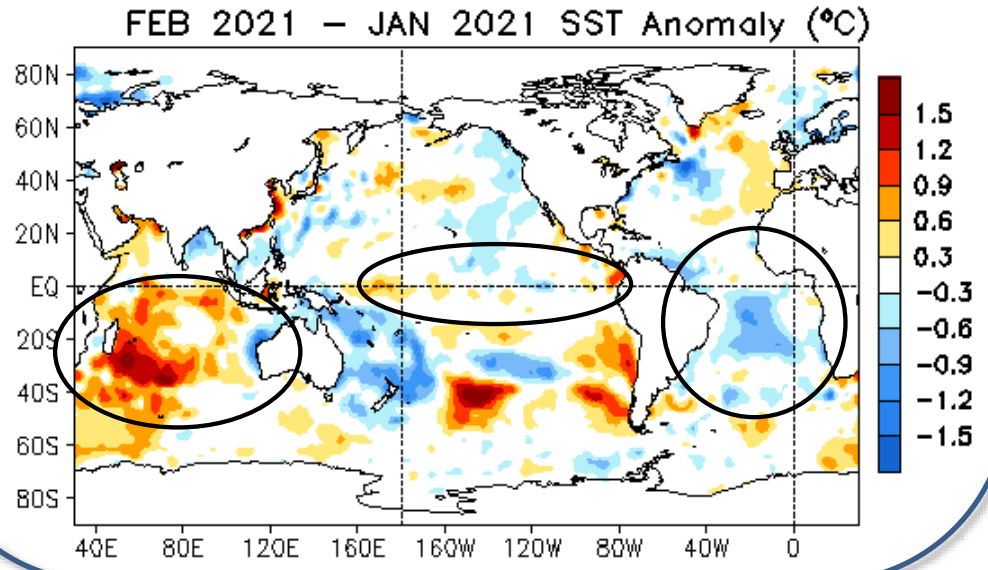
Overview

- Pacific Ocean
  - NOAA "ENSO Diagnostic Discussion" on 11 Mar 2021 stated *"There is a ~60% chance of a transition from La Niña to ENSO-Neutral during the Northern Hemisphere spring 2021 (April-June)."*
  - La Nina condition persisted with NINO3.4 = -1.03°C in Feb 2021.
  - The negative phase of PDO has persisted since Jan 2020 with PDOI = -0.68 in Feb 2021.
- Indian Ocean
  - SSTAs were small in the tropical Indian Ocean in Feb 2021.
- Atlantic Ocean
  - NAO was in a negative phase in Feb 2021 with NAOI= -0.29.
- Arctic Ocean
  - Arctic sea ice extent averaged for Feb 2021 was the 7th lowest in the satellite record.
  - With ICs in Jan & Feb 2021, CFSv2 predicted a near-normal sea ice extent during spring and early summer 2021.

Global Oceans

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



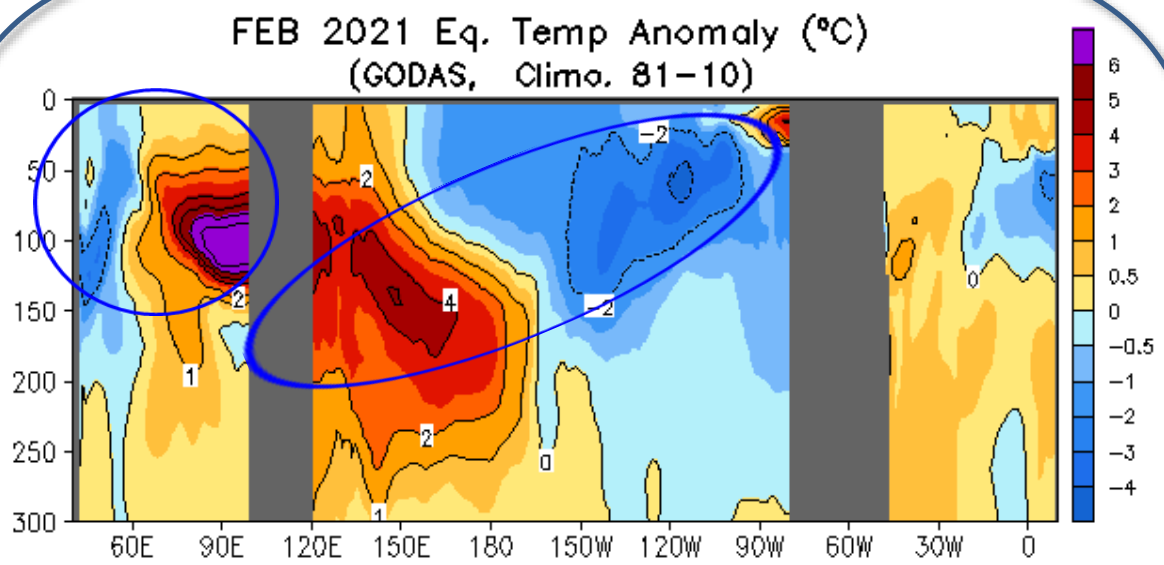


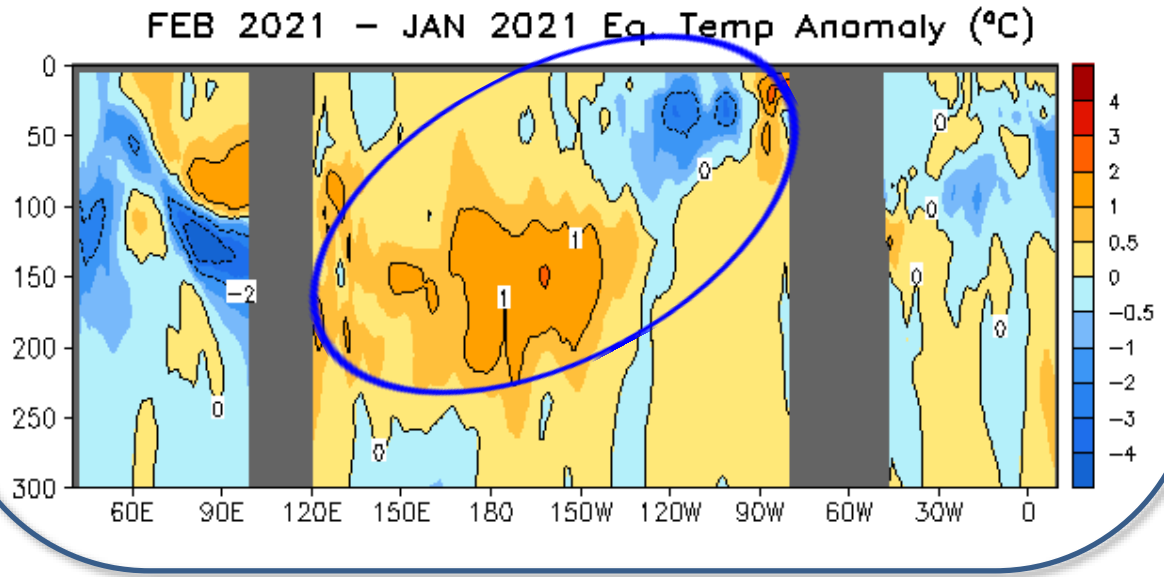
- Negative SSTAs persisted in the central and eastern tropical Pacific.
- Positive SSTAs were evident in the NE Pacific.
- Positive (negative) SSTAs were present in the tropical North (South) Atlantic Ocean.
- SSTAs were small in the tropical Indian Ocean.

- Both positive and negative SSTA tendencies were present in the central and eastern equatorial Pacific.
- Negative SSTA tendencies emerged in the tropical South Atlantic Ocean.
- Positive SSTA tendencies were observed in the SW Indian Ocean.

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



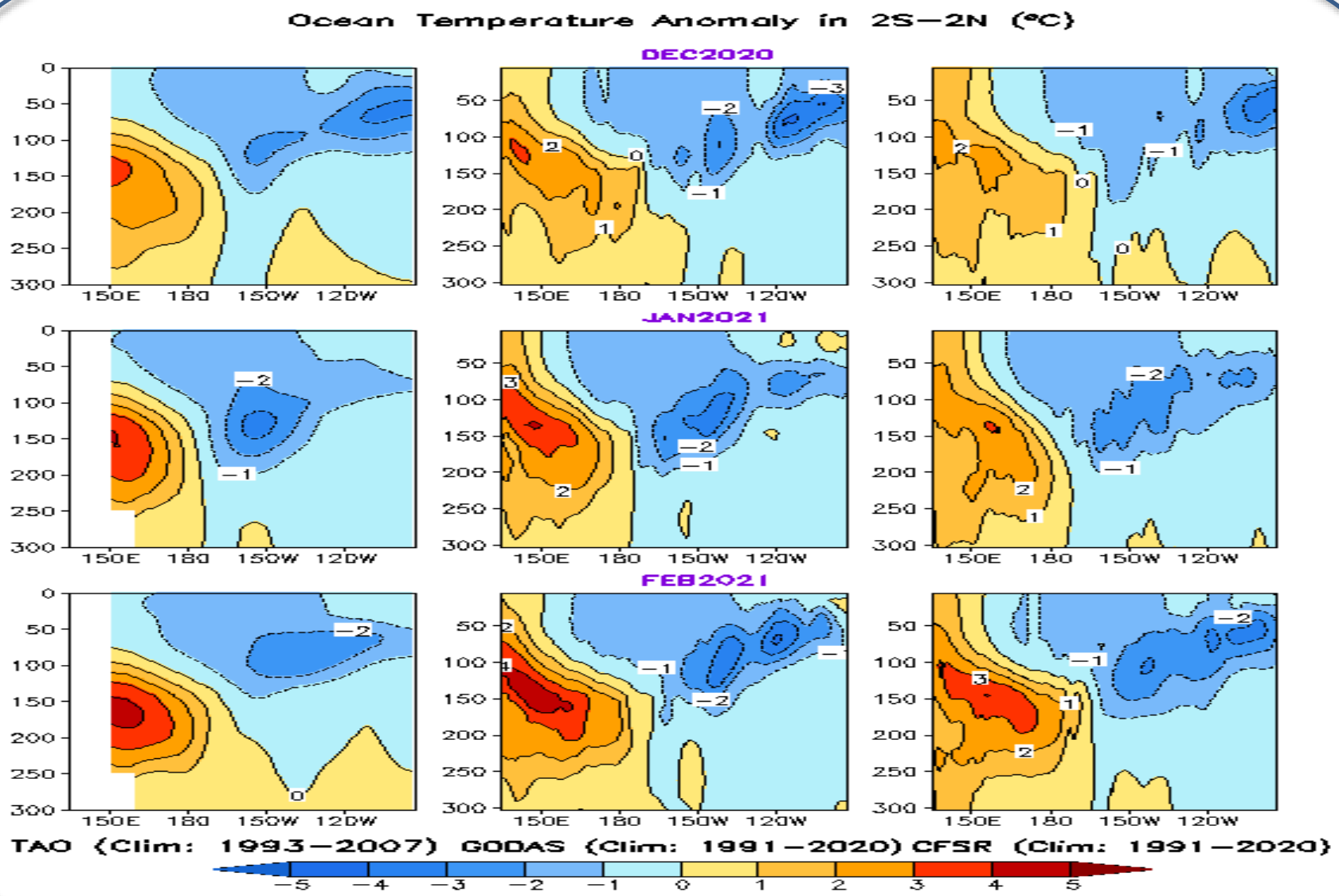


- A dipole-like temperature structure (tilt mode) persisted with positive (negative) in the western (eastern) Pacific.
- Positive anomalies have been observed in the eastern Indian Ocean since Oct 2020.

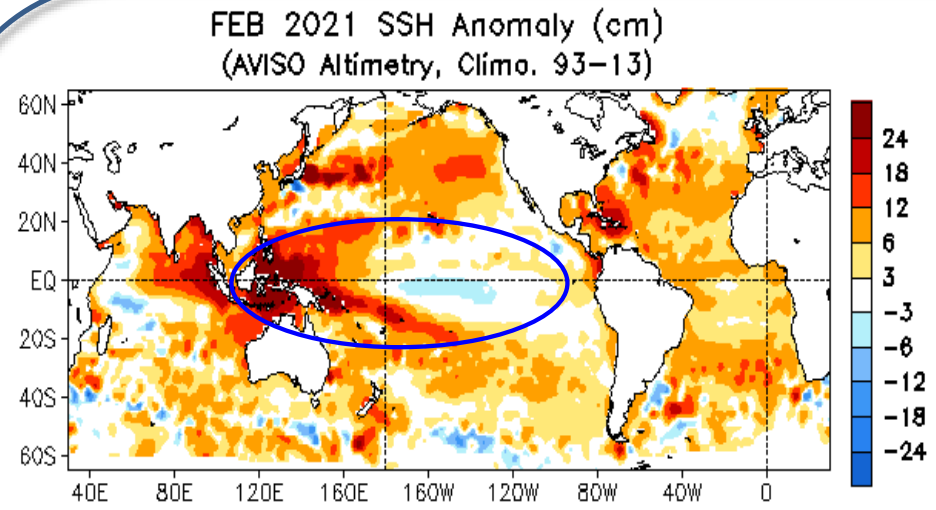
- Temperature anomaly tendency was positive (negative) along the thermocline in the western and central (eastern) Pacific.

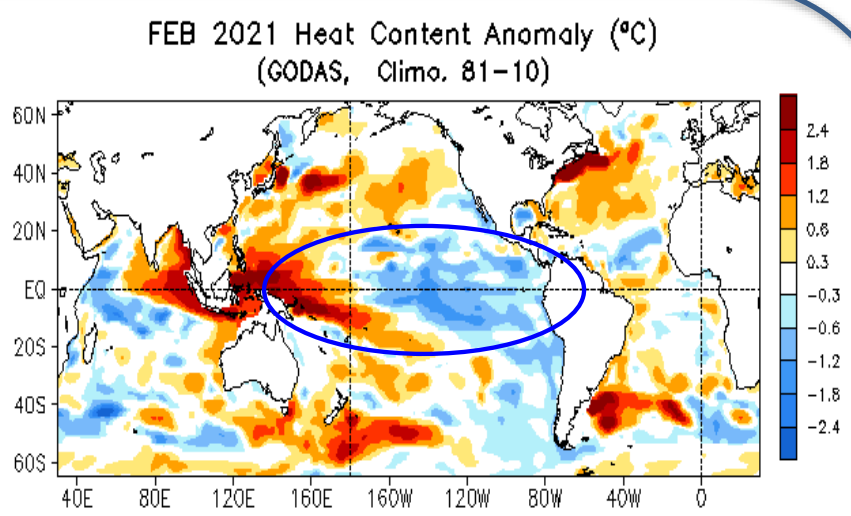
Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data is from the NCEP's global ocean data assimilation system. Anomalies are departures from the 1981-2010 base period means.

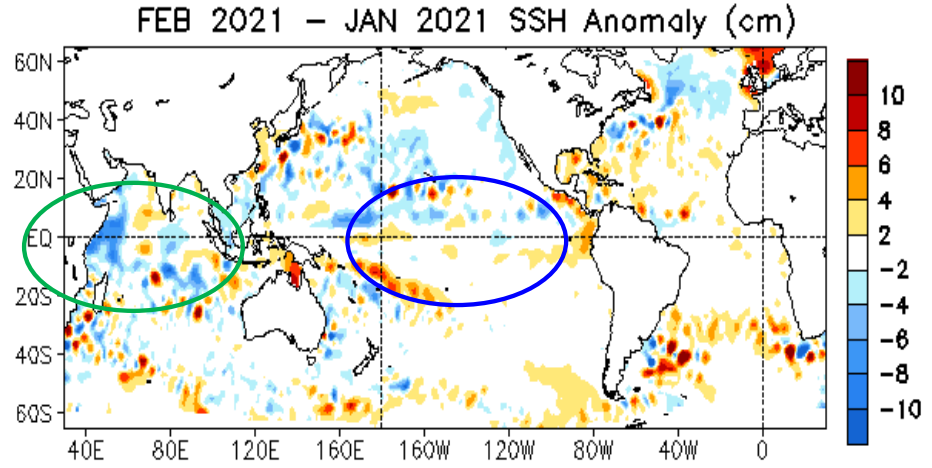
TAO, GODAS, & CFSR monthly mean subsurface temperature anomaly along the Equator during the last 3 months: *the positive anomalies in the western Pacific strengthened*

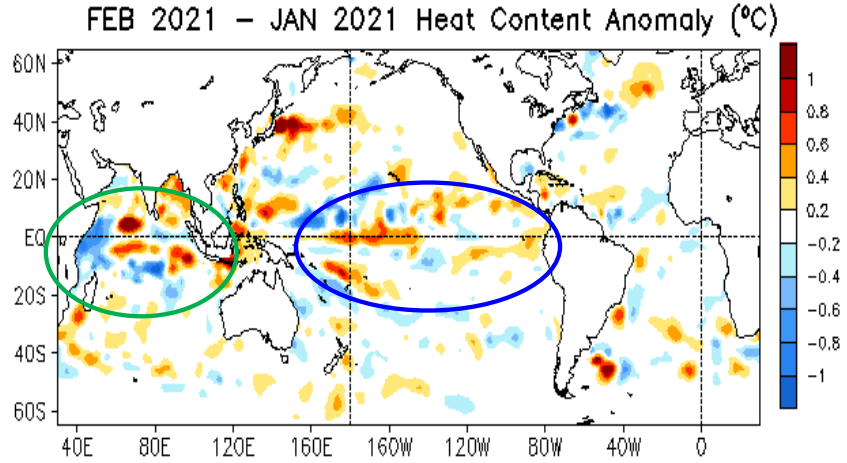


Global SSH and HC300 Anomaly & Anomaly Tendency





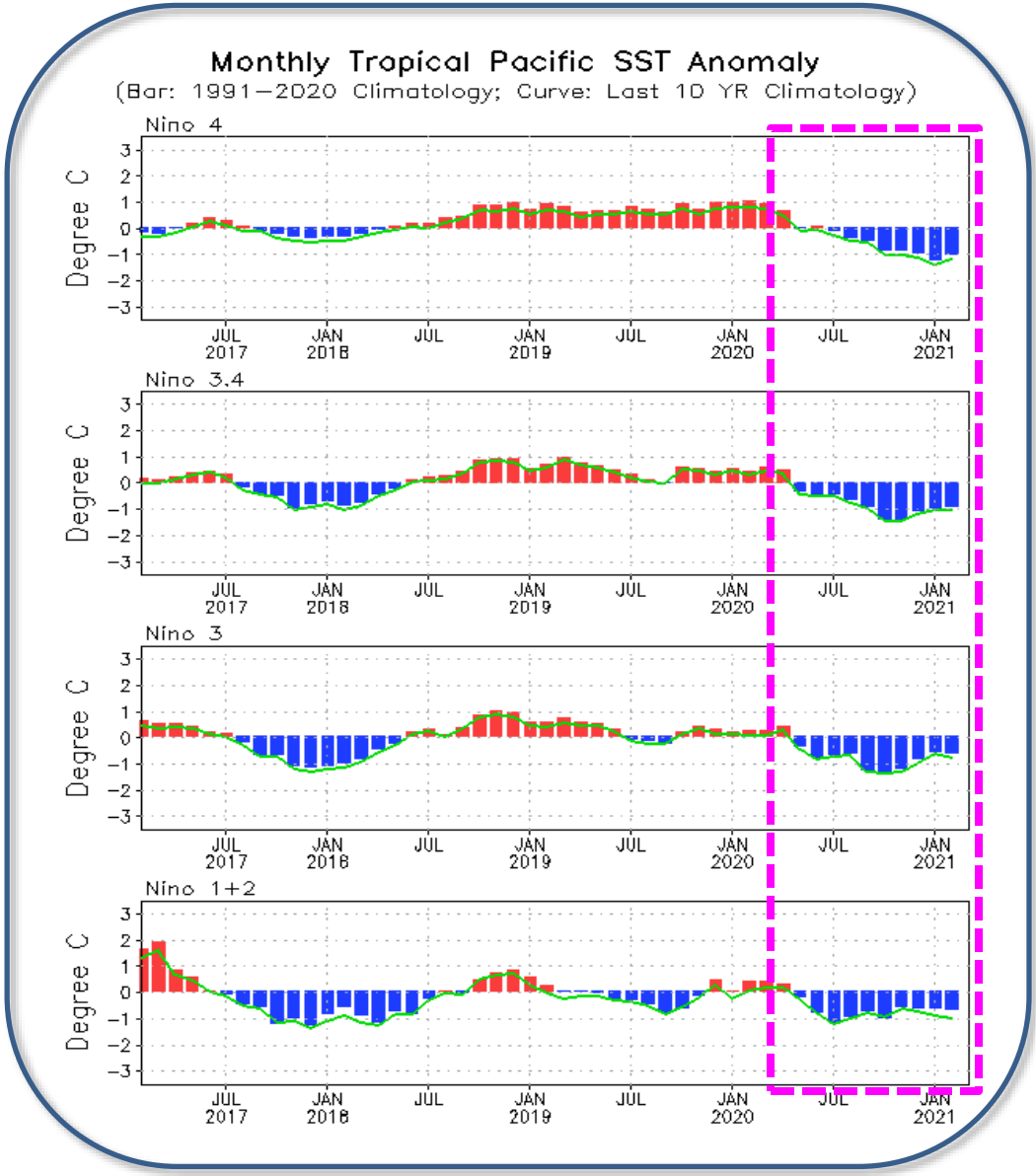


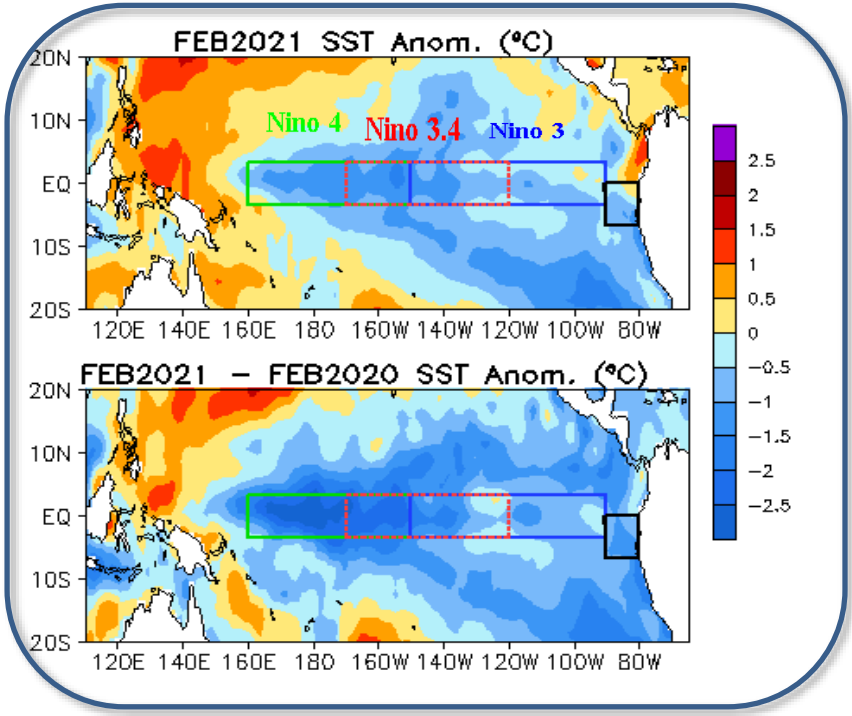


- The SSHA pattern was overall consistent with the HC300A pattern, but with a significant trend component in SSHA.
- Anomalous tendencies: small positive in the tropical Pacific; negative in the western tropical Indian Ocean.

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific NINO SST Indices

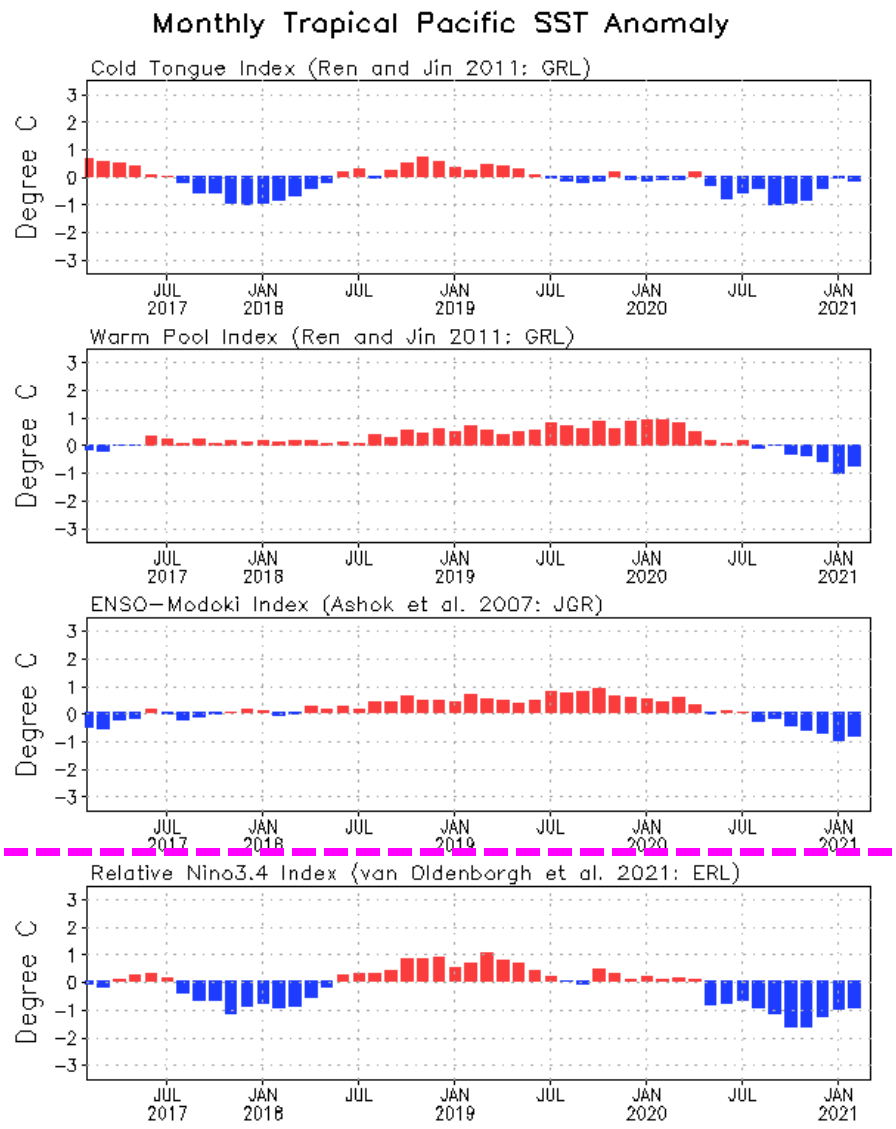


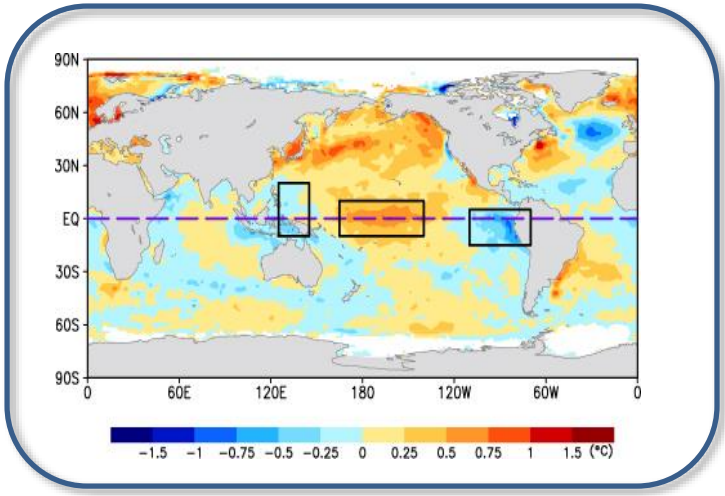


- All Nino indices were negative and persisted, with Nino3.4 = -1.03 °C in Feb.
- Compared with Feb 2020, the central and eastern tropical Pacific was cooler in Feb 2021.
- The indices may have slight differences if based on different SST products.

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.

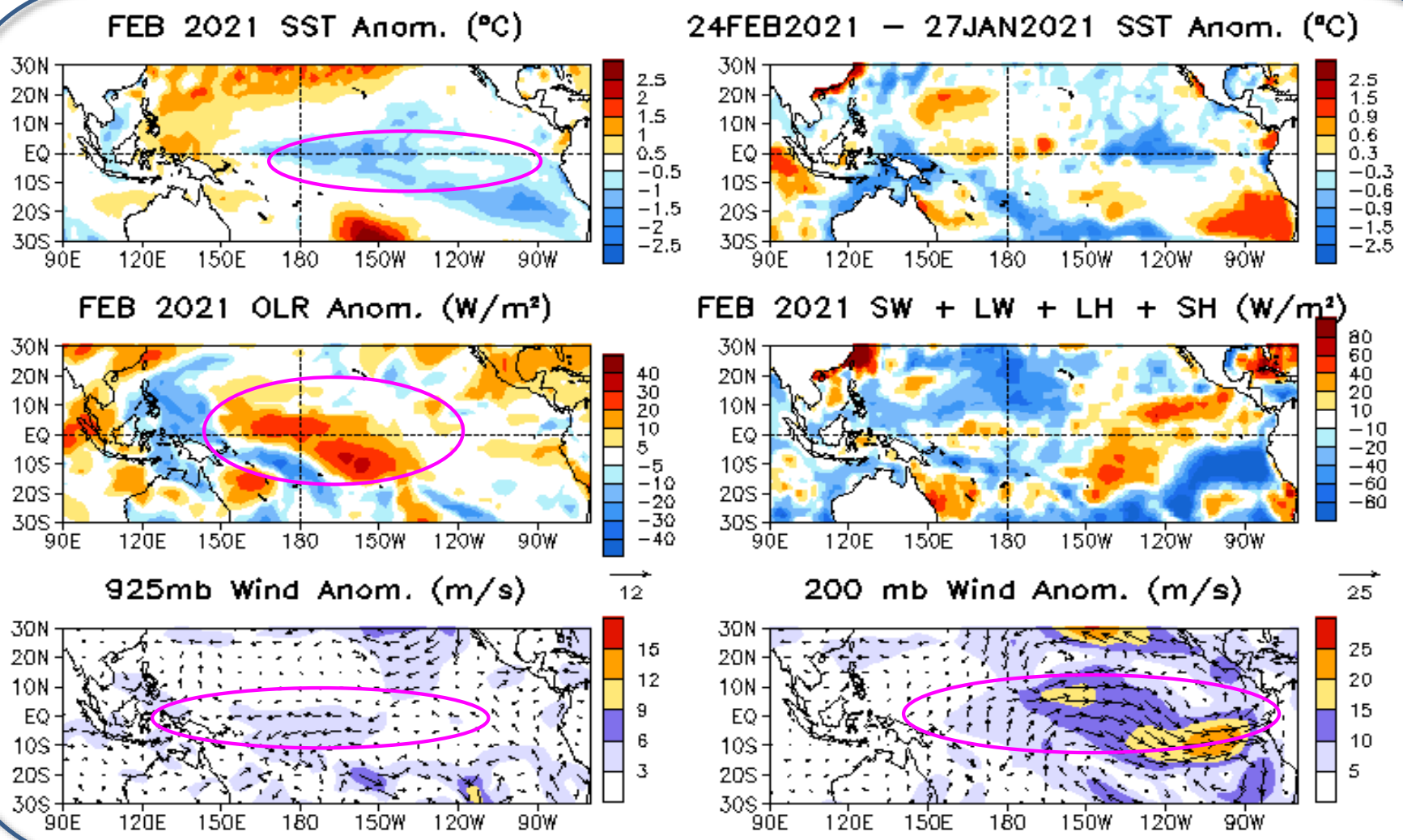
Monthly Tropical Pacific SST Anomaly





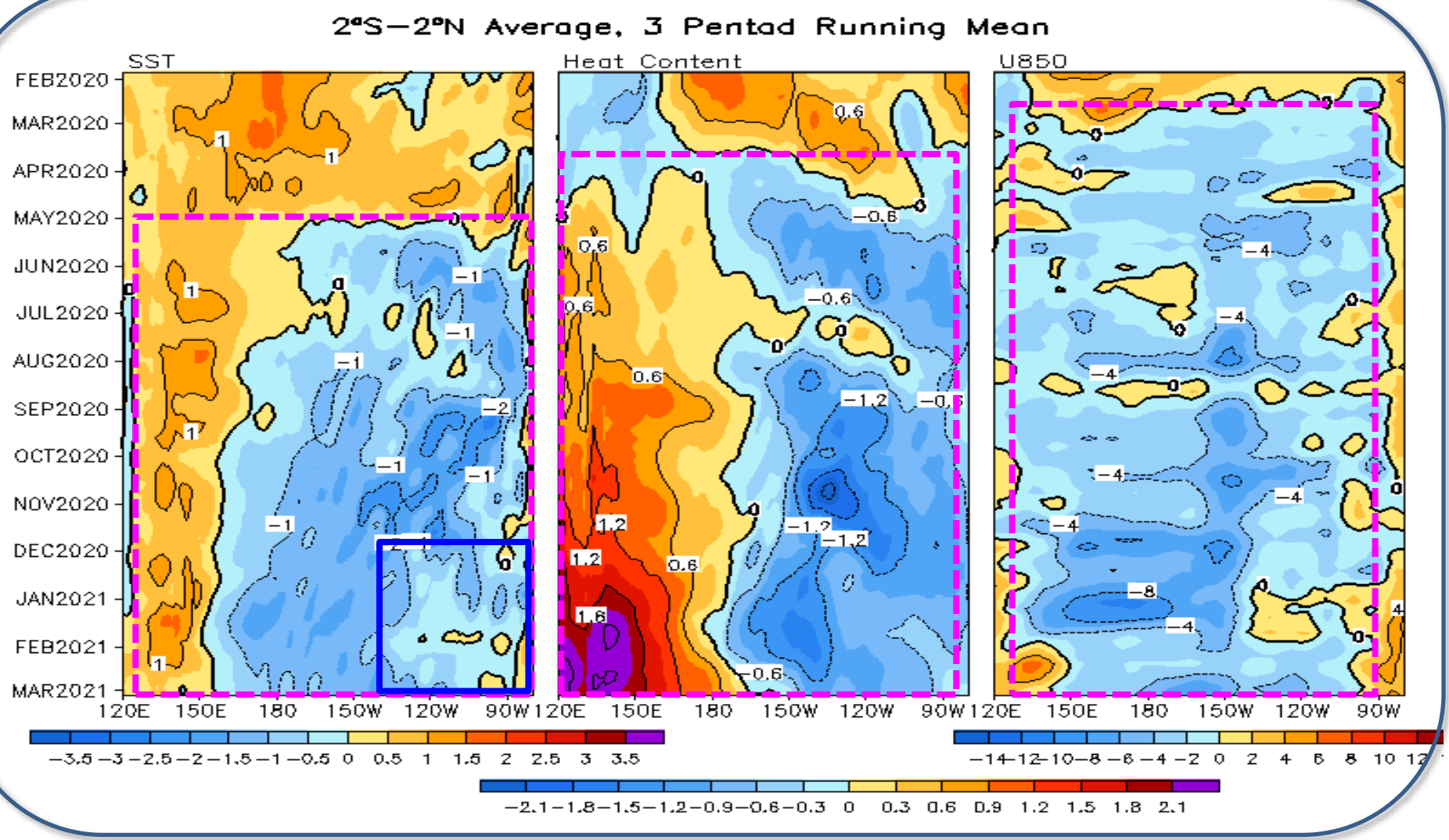
- Relative Nino3.4 index is now included, which is define as the conventional Niño3.4 index minus the SSTA averaged in the whole tropics (0°-360°, 20°S-20°N), in order to remove the global warming signal. Also, to have the same variability as the conventional Niño3.4 index, the relative Niño3.4 index is renormalized (van Oldenborgh et al. 2021: ERL, 10.1088/1748-9326/abe9ed) .

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



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.

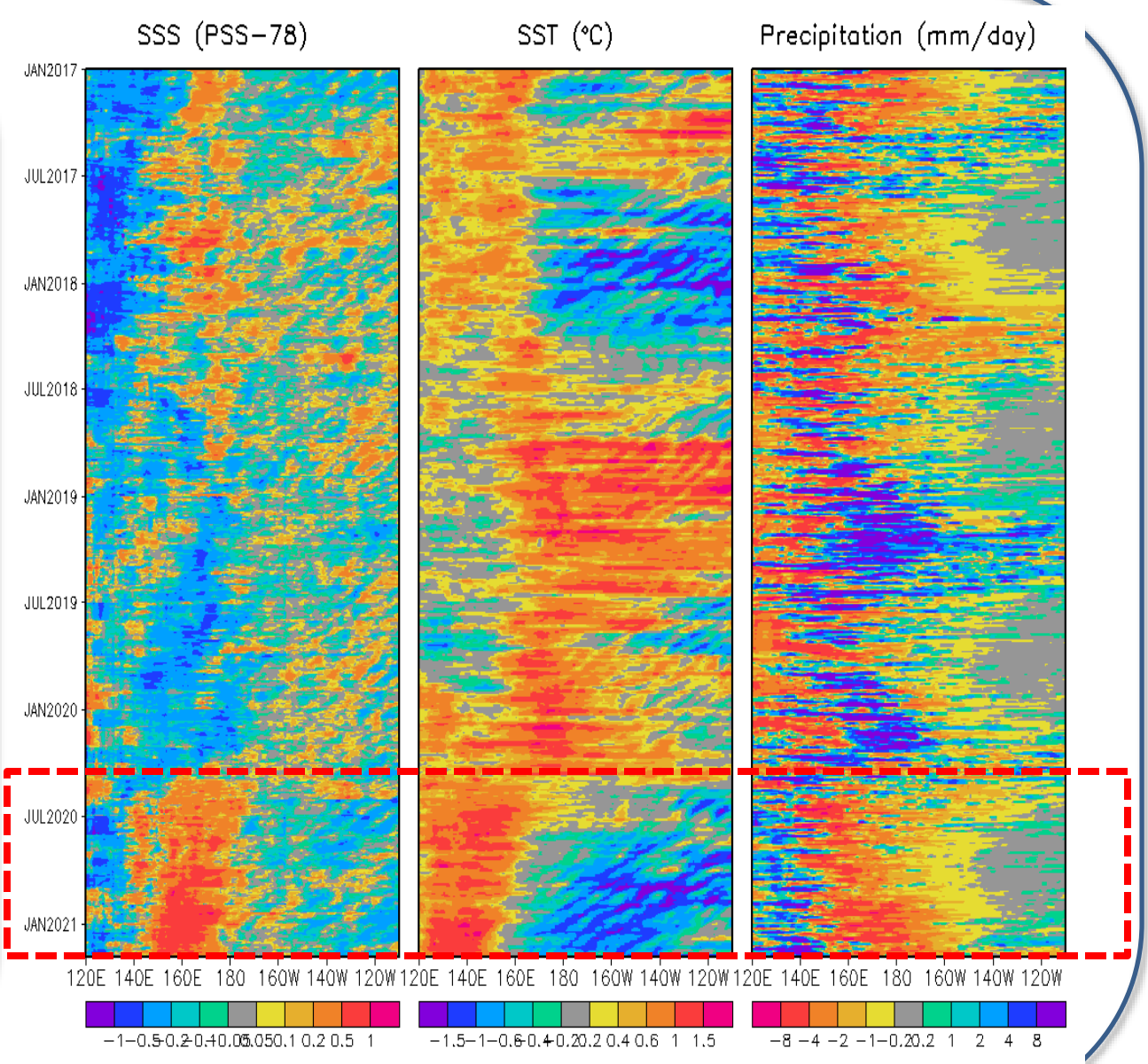
Equatorial Pacific SST (°C), HC300 (°C), u850 (m/s) Anomalies



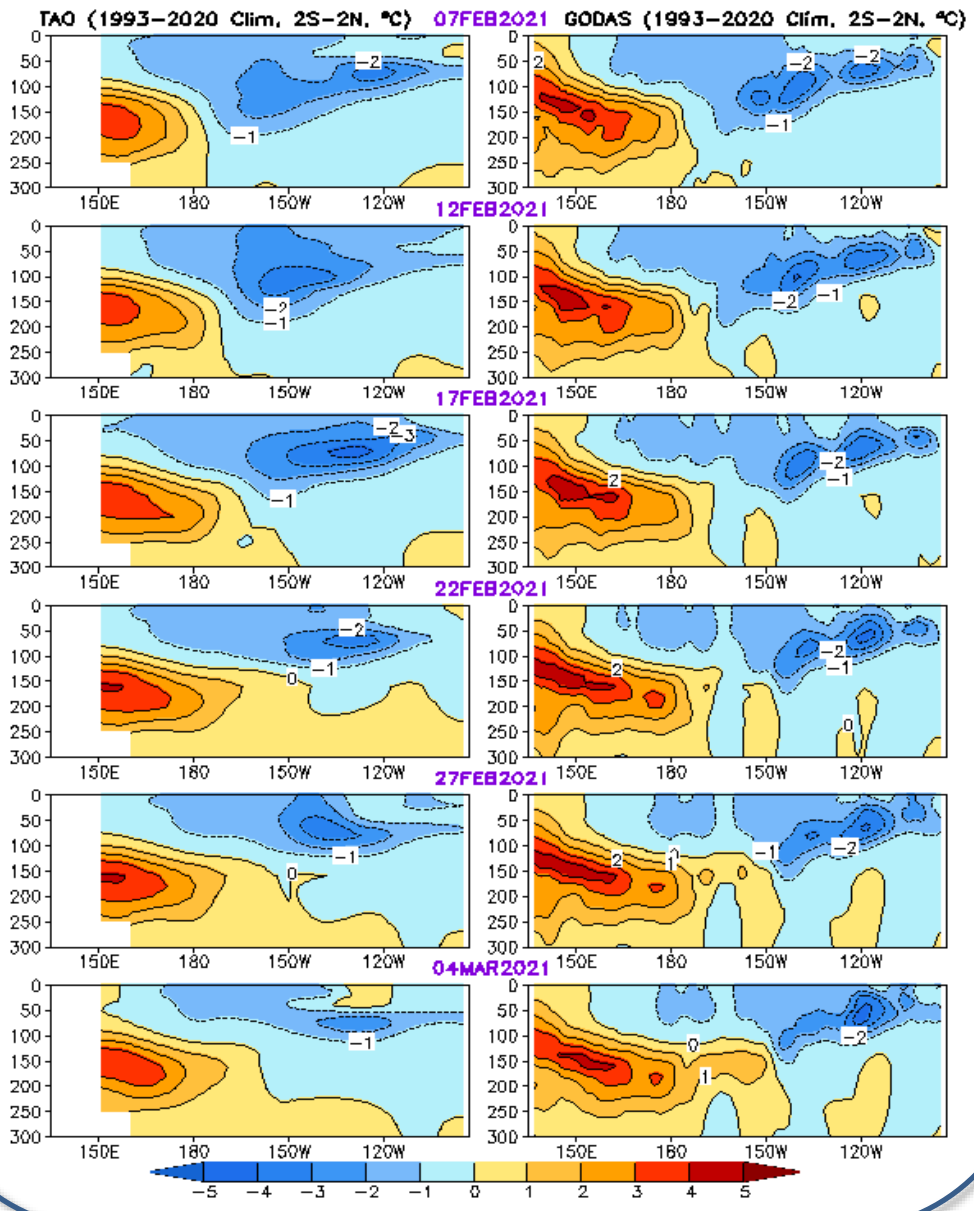
- Easterly wind anomaly was present across the equatorial Pacific since Mar 2020.
- Below- average HC300 has persisted in the eastern Pacific and above-normal HC300 has strengthened in the western Pacific since Apr 2020.
- Negative SSTAs have weakened in the eastern equatorial Pacific since Jan 2021.

Pentad SSS Anomaly Evolution over Equatorial Pacific

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.



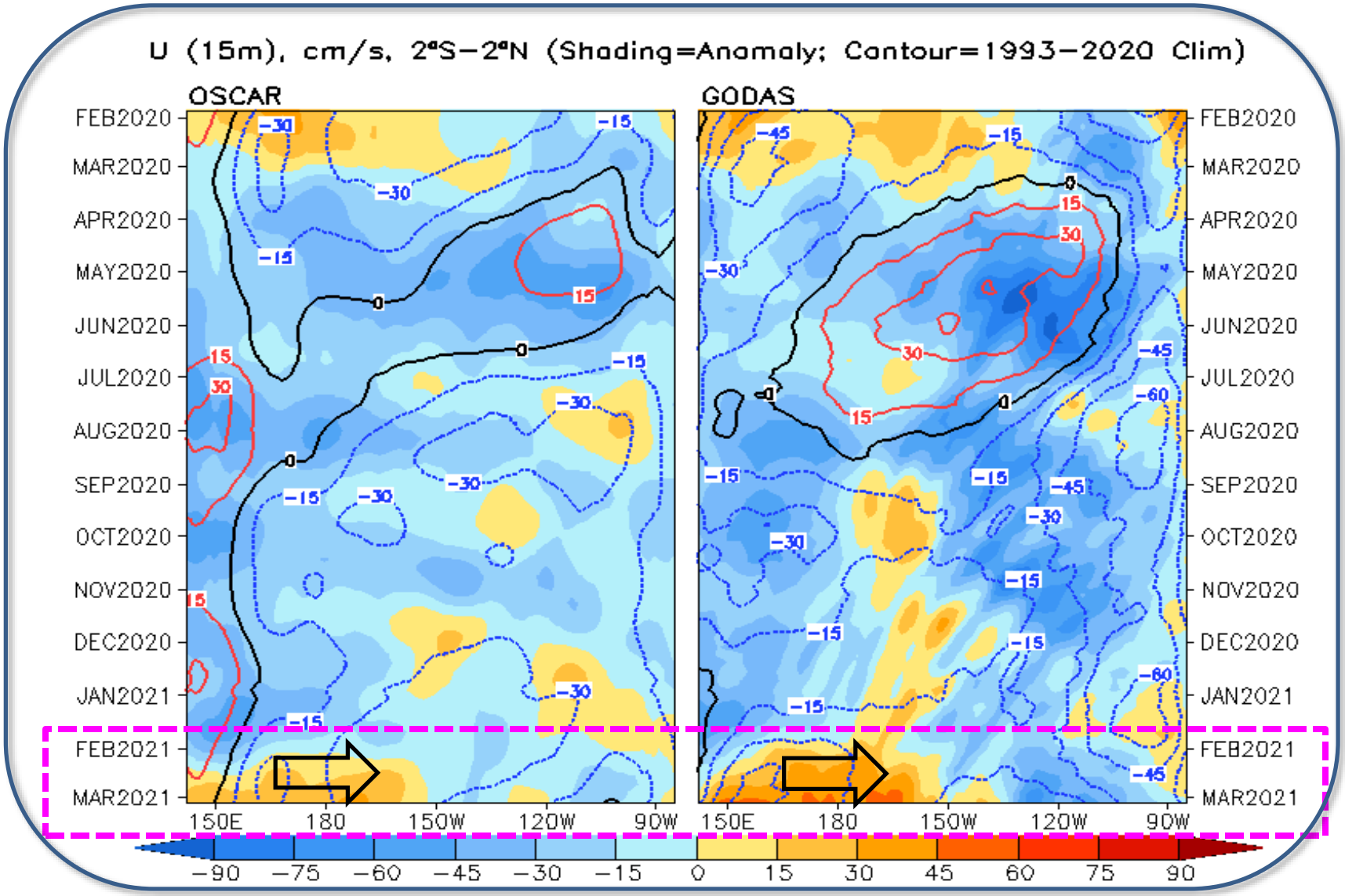
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly



- Negative (positive) ocean temperature anomalies along the thermocline in the east-central (west) persisted in the last 2-months, featuring a strong tilt/dipole mode

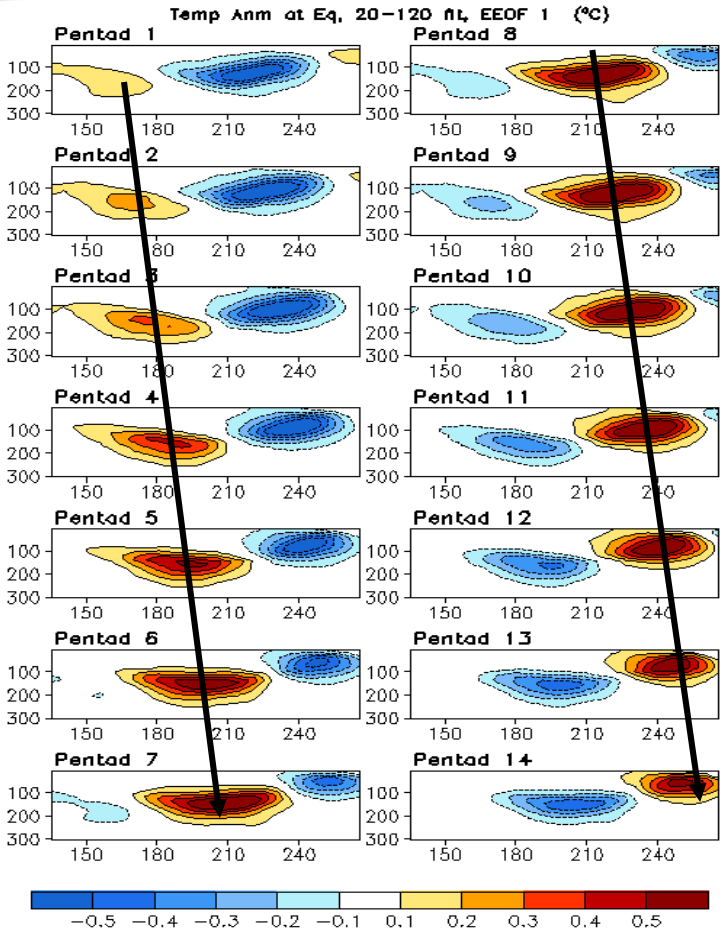
- The features of the ocean temperature anomalies were similar between GODAS and TAO analysis.

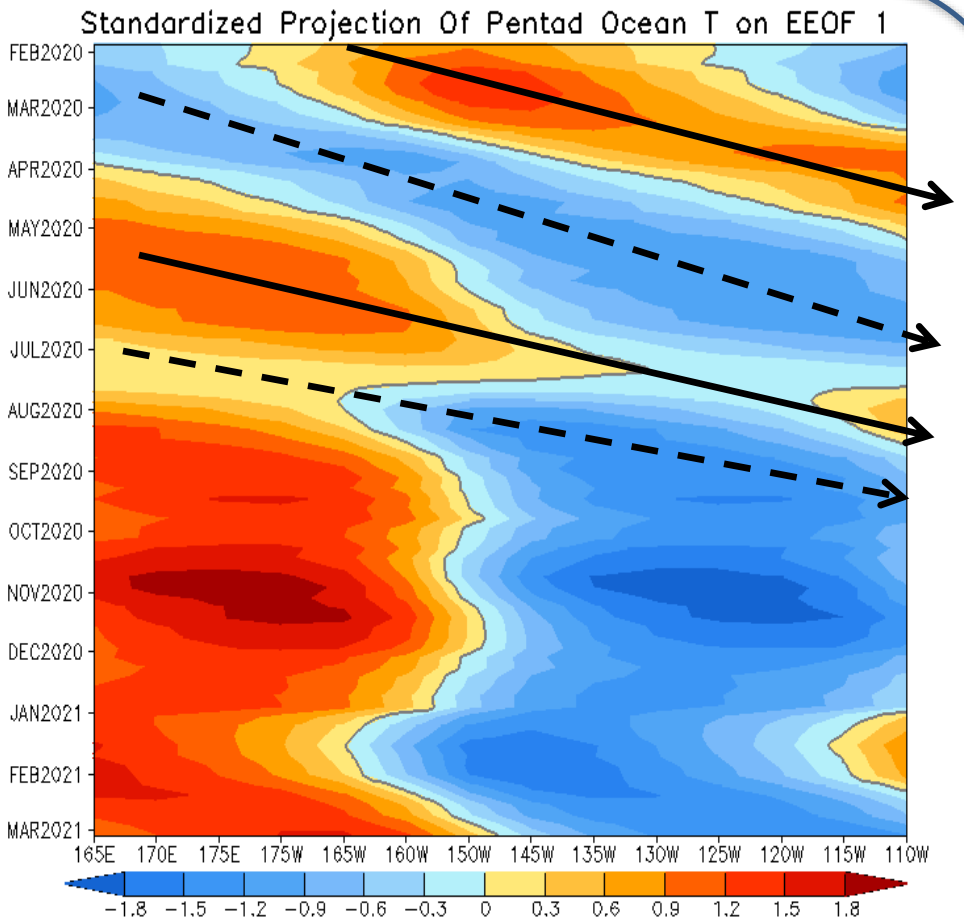
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- Anomalous eastward currents emerged in the western & central equatorial Pacific in both OSCAR and GODAS in Feb 2021.

Oceanic Kelvin Wave (OKW) Index



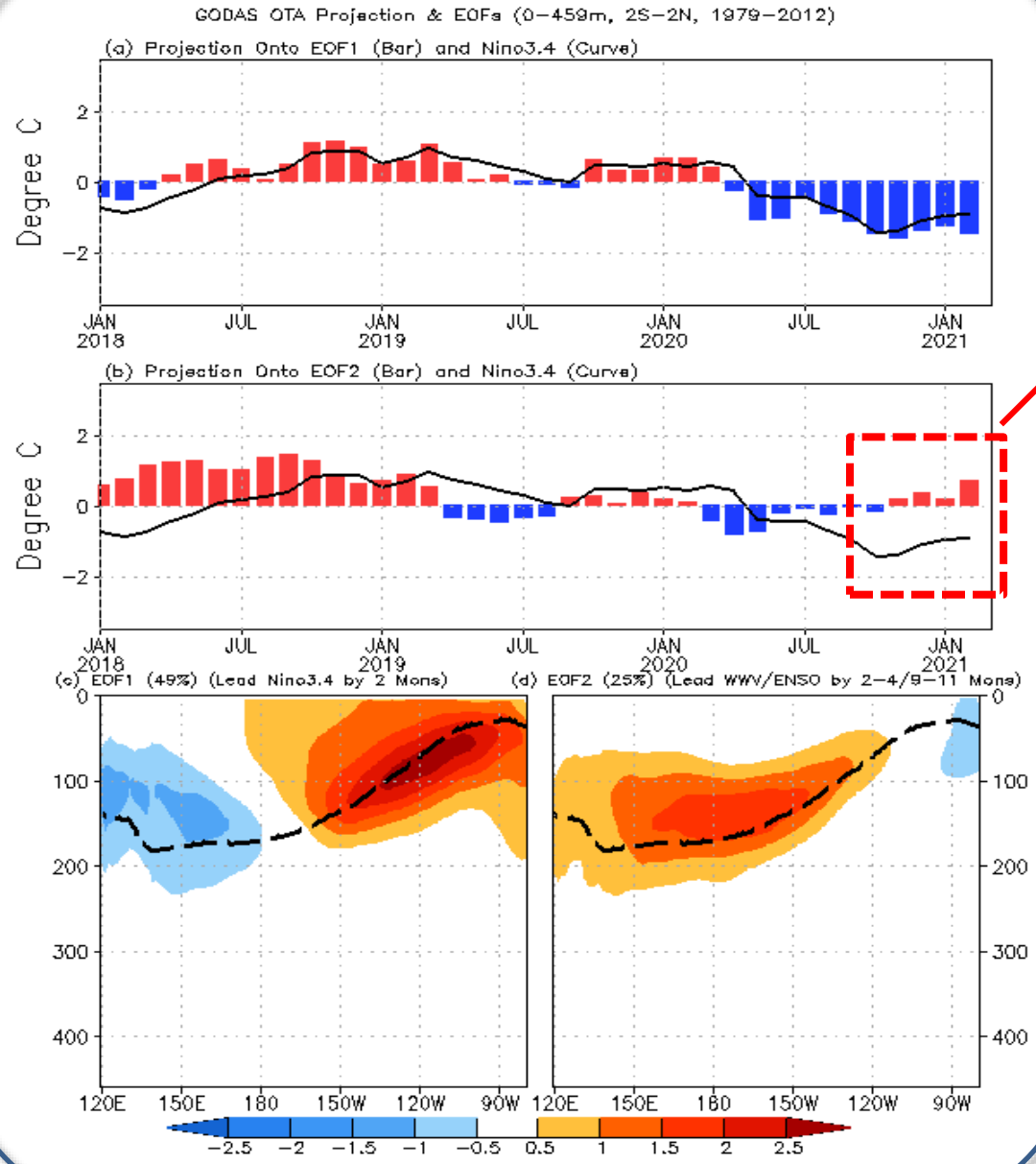


- Upwelling Kelvin waves were initiated in Feb & Jul 2020, leading to the subsurface cooling in the eastern equatorial Pacific.

- Since Aug 2020, stationary component with zonal contrast has dominated.

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

Equatorial Sub-surface Ocean Temperature Monitoring



- The tilt mode is dominant, and the equatorial Pacific has been in a weak recharge phase since Nov 2020.

- Projection of ocean temperature anomalies onto EOF1 and EOF2; EOF1: Tilt/dipole mode (ENSO peak phase); EOF2: WWV mode.

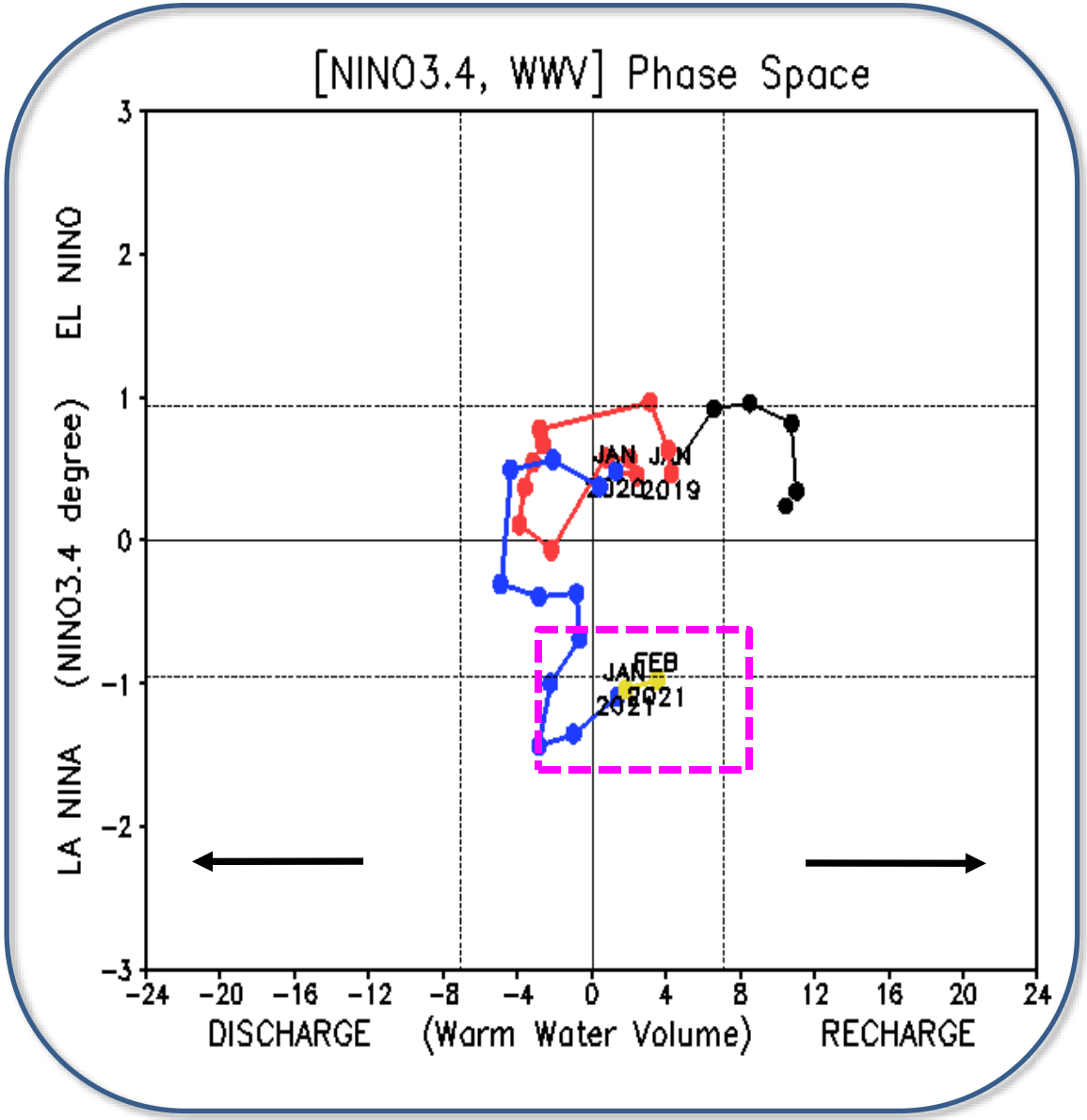
- Recharge/discharge oscillation (ENSO transition phase); Recharge process: heat transport from outside of equator to equator; Negative -> positive phase of ENSO

- For details, see: Kumar A, Z-Z Hu (2014) DOI: 10.1007/s00382-013-1721-0.

Warm Water Volume (WWV) and Niño3.4 Anomalies

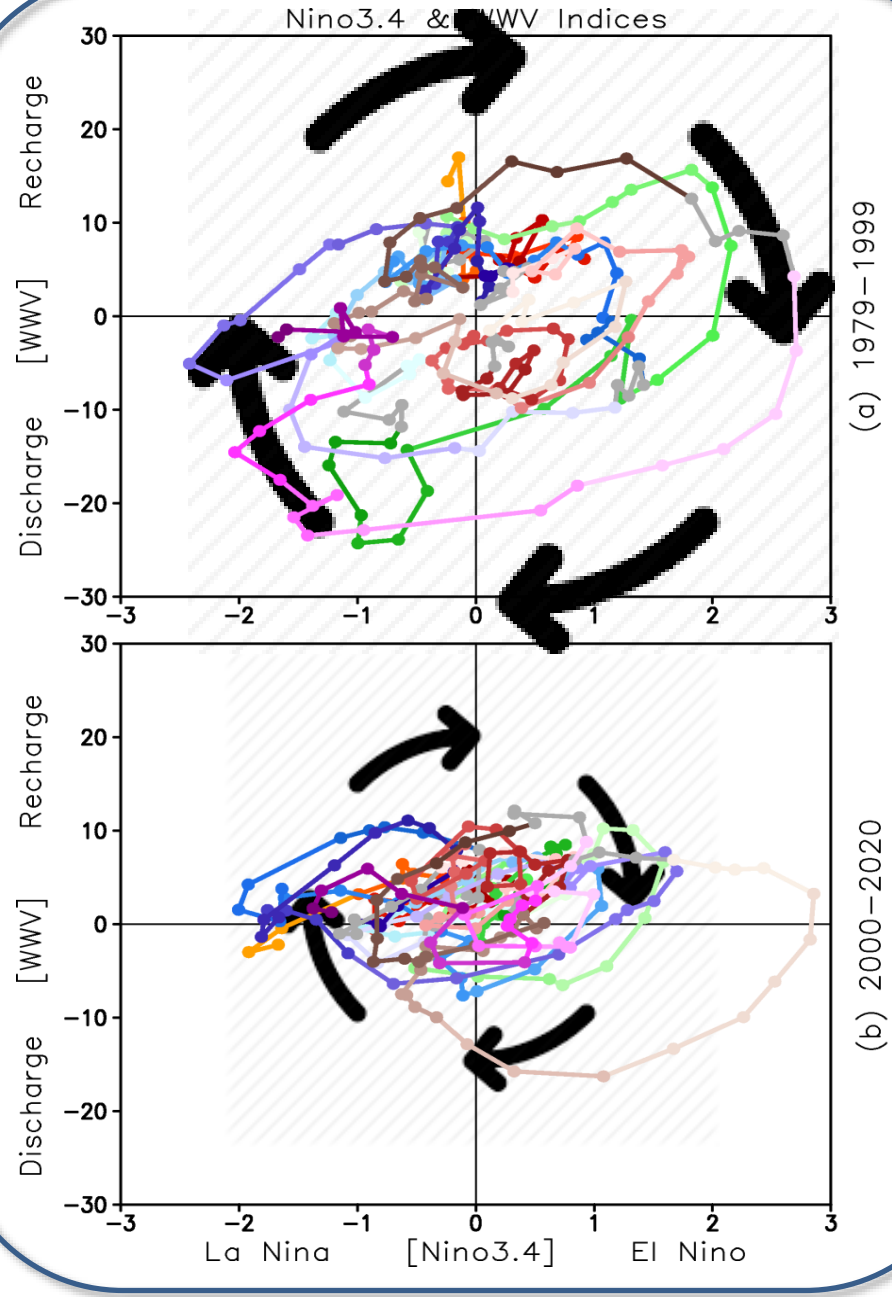
- Equatorial Warm Water Volume (WWV) was in a recharge phase in Jan-Feb 2021.

-As WWV is intimately linked to ENSO variability (Wyrtki 1985; Jin 1997), it is useful to monitor ENSO in a phase space of WWV and Niño3.4 (Kessler 2002).
- Increase (decrease) of WWV indicates recharge (discharge) of the equatorial oceanic heat content.



Phase diagram of Warm Water Volume (WWV) and Niño3.4 indices. WWV is the average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] calculated with the NCEP's GODAS. Anomalies are departures from the 1981-2010 base period means.

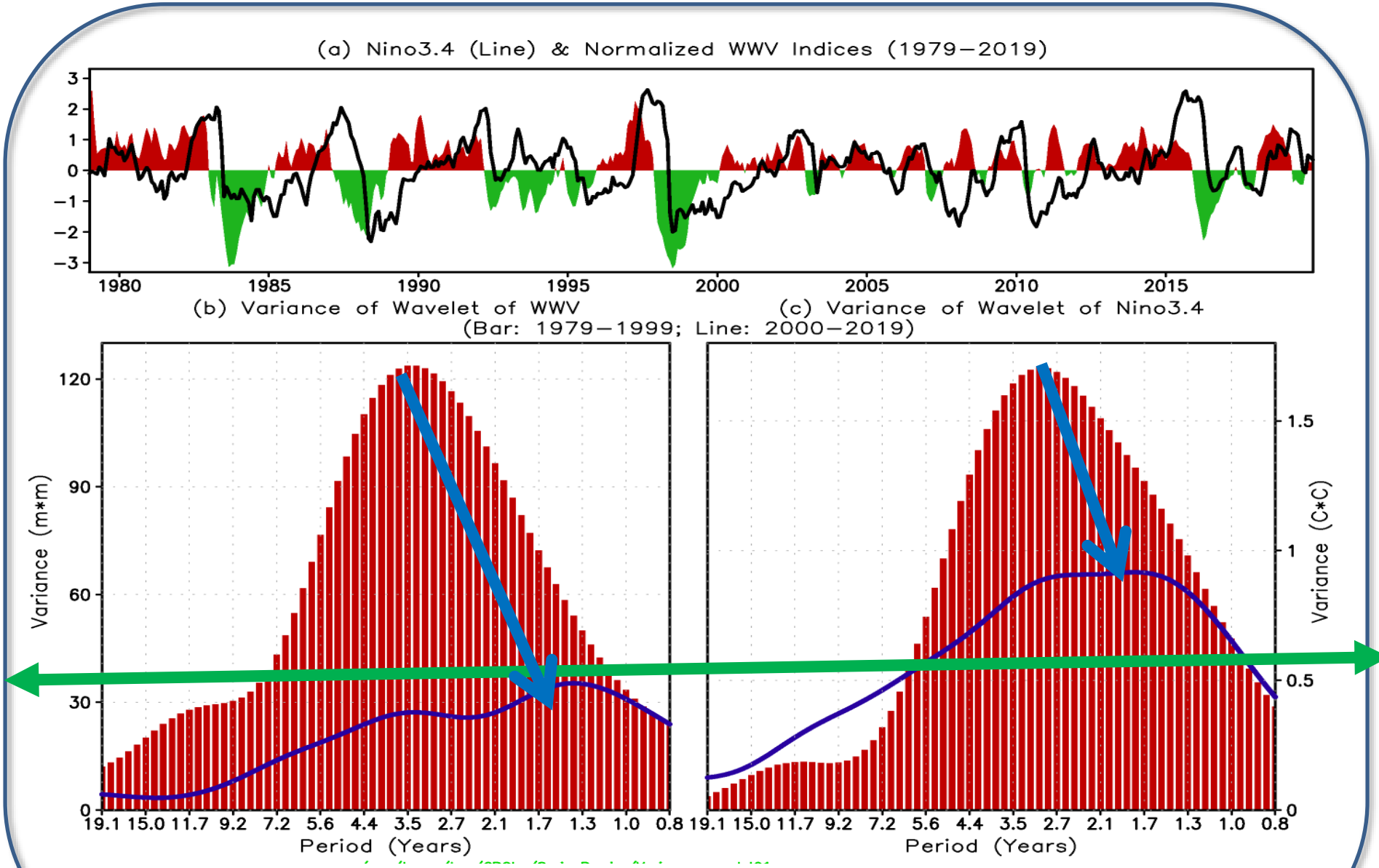
Interdecadal Shift of ENSO's Cycle



- Since 2000, the recharge/discharge process is less efficient in driving the phase transition of an ENSO cycle;
- ENSO became less periodical compared with that during 1979-99.

Li et al. 2020: On the interdecadal variation of the warm water volume in the tropical Pacific around 1999/2000. J. Geophys. Res.-Atmos., 125 (18), e2020JD033306. DOI: 10.1029/2020JD033306.

Nino3.4 & WWV Indices: Whitening & shifting to higher frequencies



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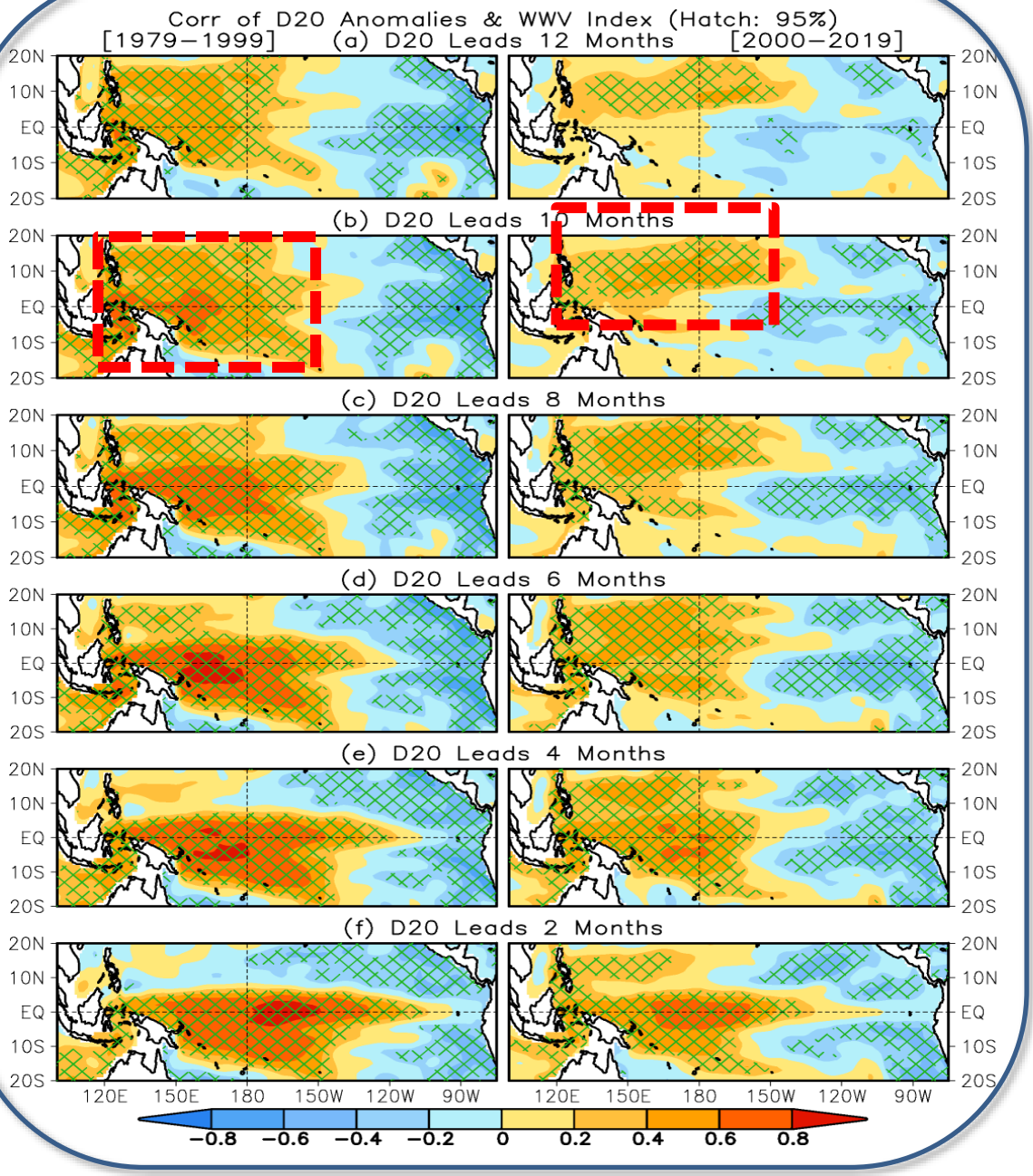
Interdecadal Shift of ENSO's Cycle

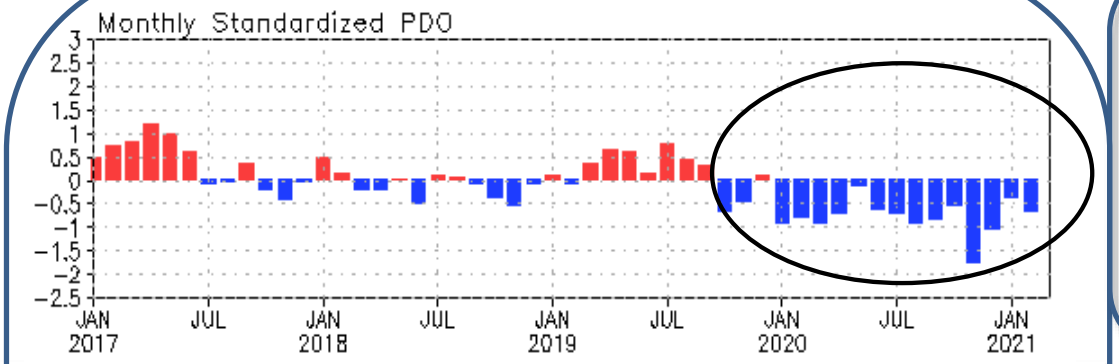


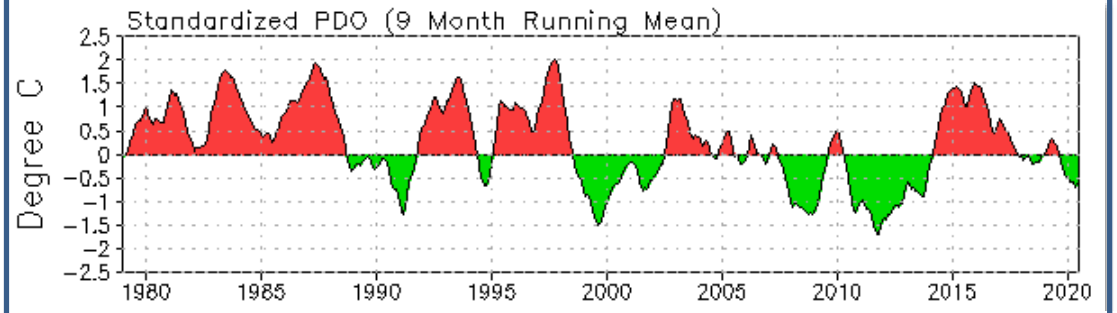
- The connection weakened since 2000.
- The geographical origin of precedent thermocline anomalies has shown a northwestward migration since 2000, implying that the extra-tropics play a more important role.

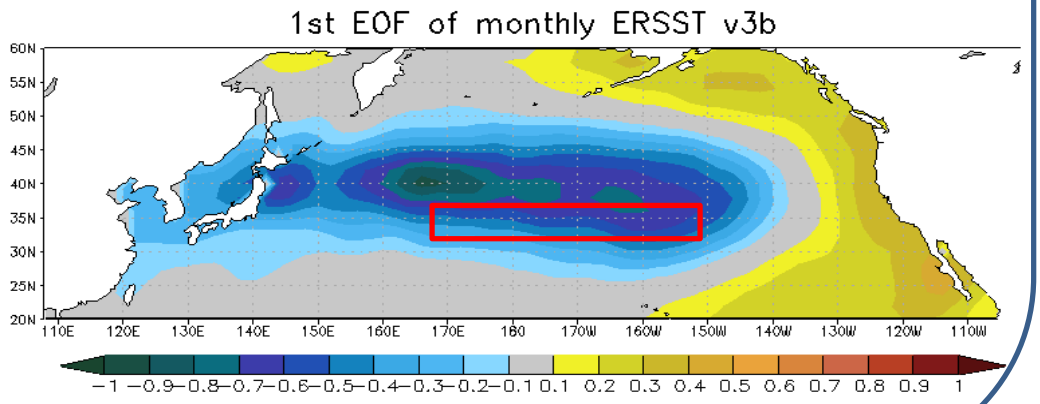
Li et al. 2020: On the interdecadal variation of the warm water volume in the tropical Pacific around 1999/2000. J. Geophys. Res.-Atmos., 125 (18), e2020JD033306. DOI: 10.1029/2020JD033306.

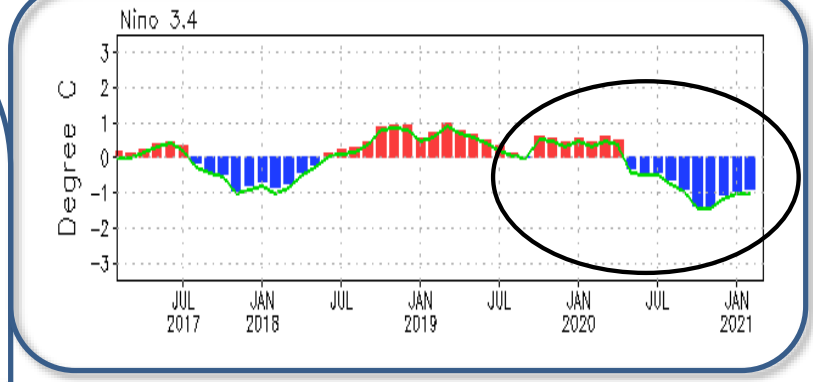
North Pacific & Arctic Oceans

Pacific Decadal Oscillation (PDO) Index







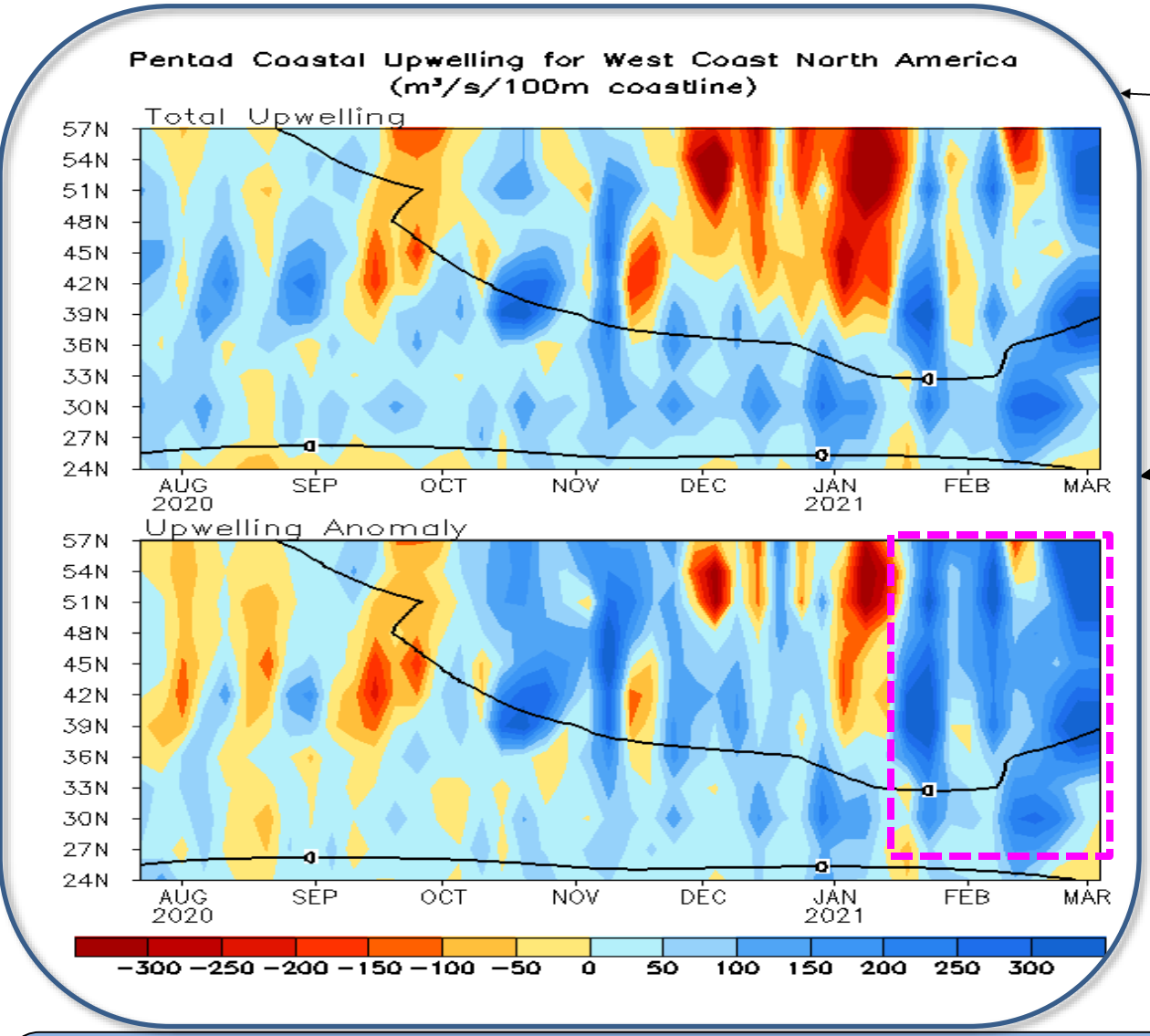


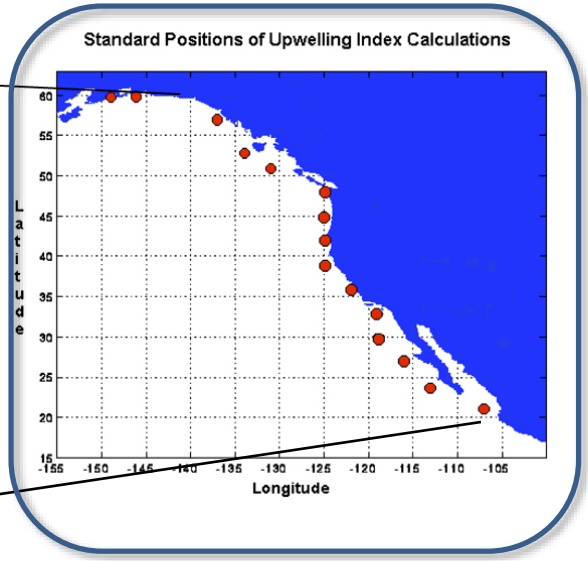
- The negative phase of PDO has persisted since Jan 2020 with PDOI = -0.68 in Feb 2021.

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

• PDO 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

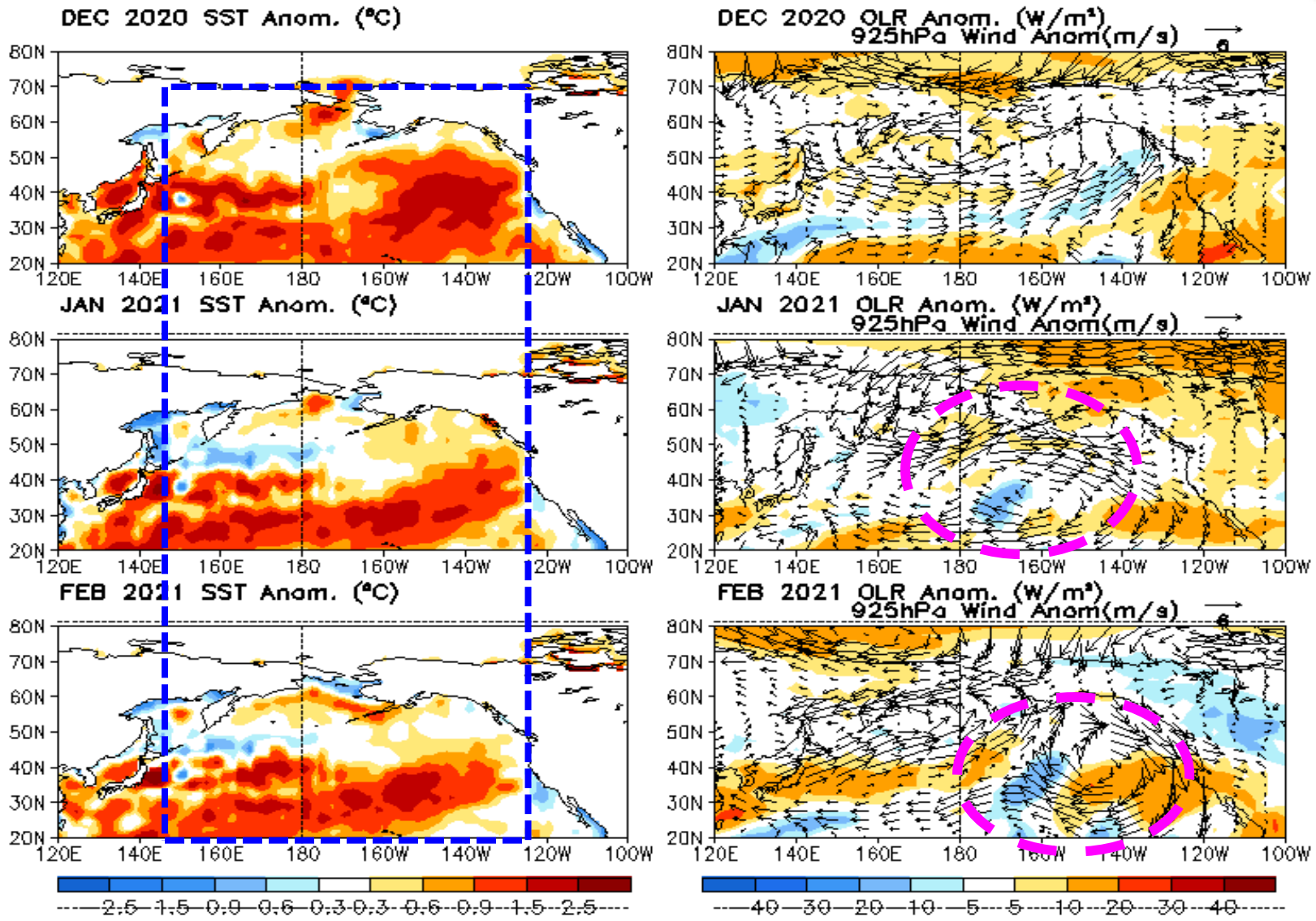




- Coastal anomalous upwelling has been present north of 27°N since 2nd half of Jan 2021.

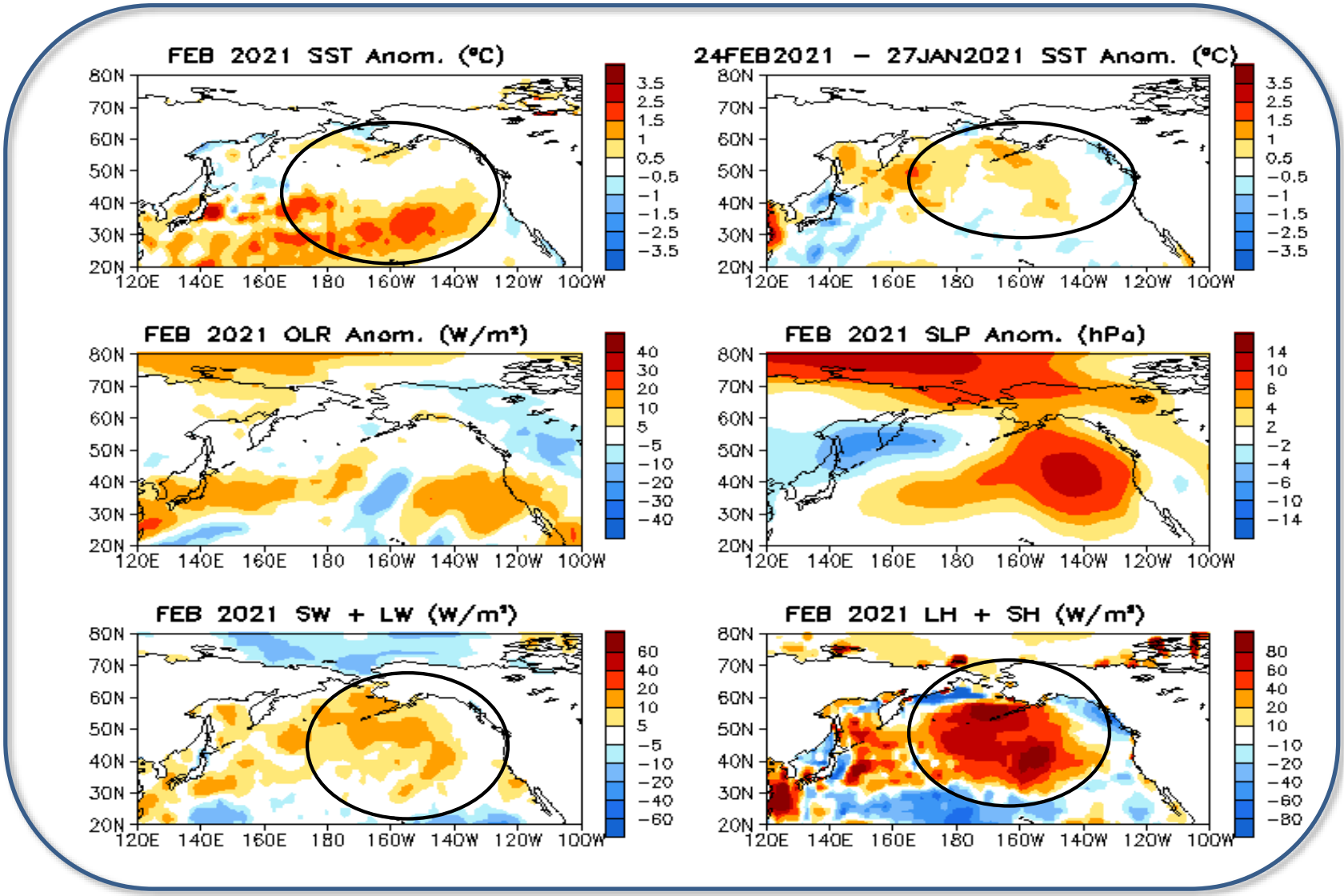
(top) Total and (bottom) anomalous upwelling indices at the 15 standard locations for the western coast of North America. derived from the vertical velocity of the NCEP's GODAS and are calculated as integrated vertical volume transport at 50-meter depth from each location to its nearest coast point ($m^3/s/100m$ 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 surface SST and circulation anomalies



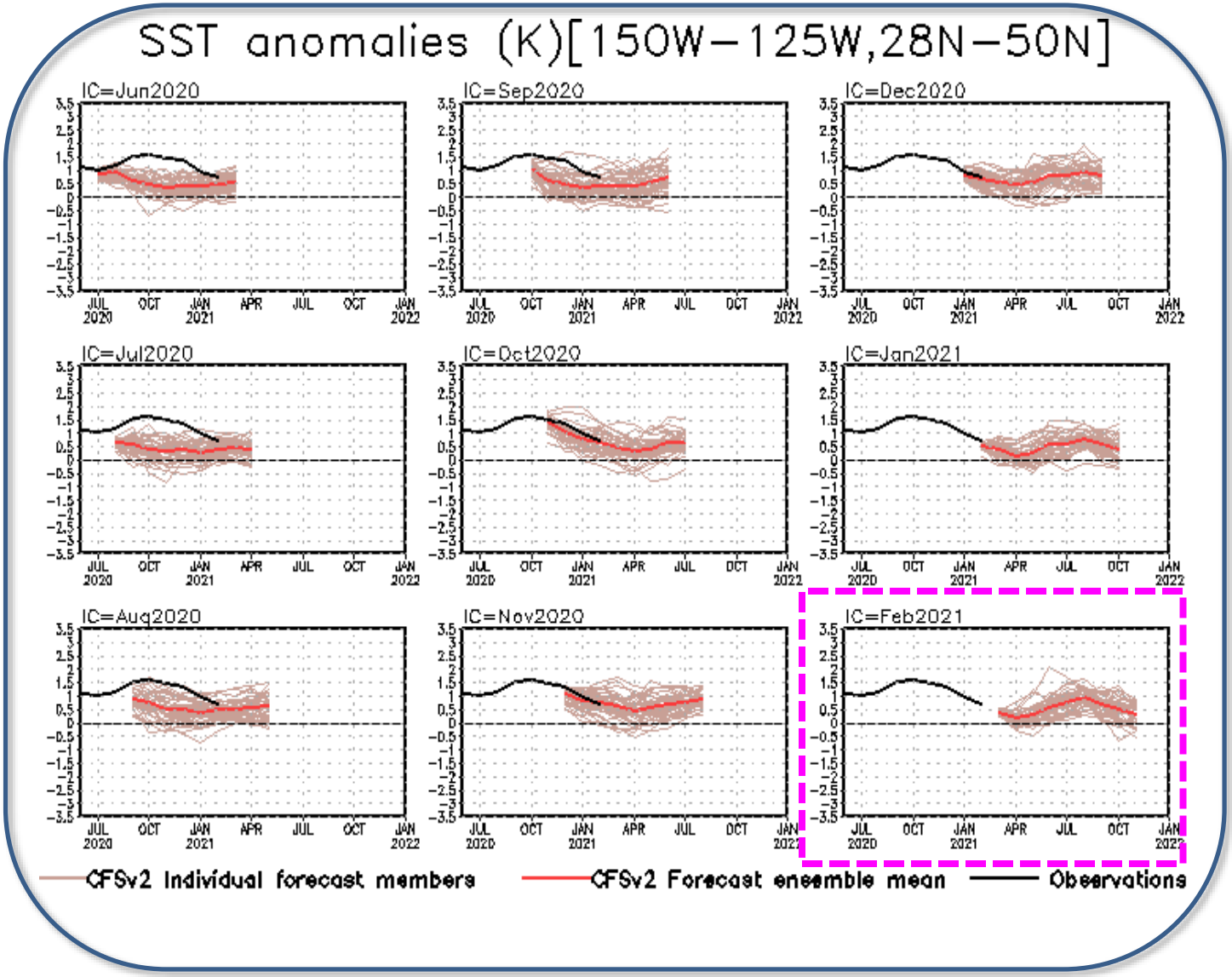
Data source: NCEP/NCAR Reanalysis 1

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



Sea surface temperature (top-left; NCEP OI SST Analysis), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) (middle-left; NOAA 18 AVHRR IR), sea surface pressure (middle-right; NCEP CDAS), sum of net surface short- and long-wave radiation (bottom-left; positive means heat into the ocean; NCEP CDAS), sum of latent and sensible heat flux (bottom-right; positive means heat into the ocean; NCEP CDAS). Anomalies are departures from the 1981-2010 base period means.

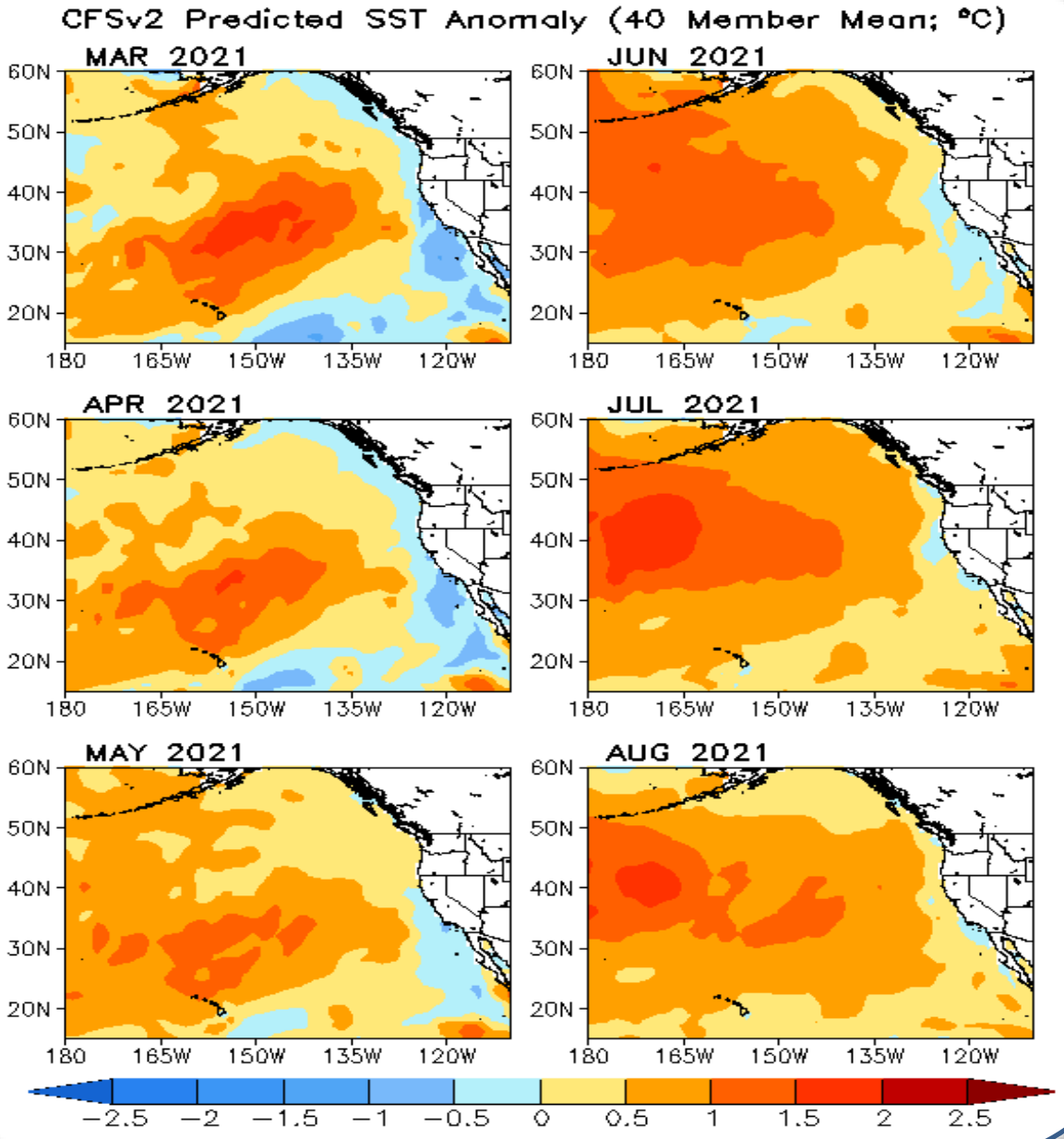
CFS NE Pacific Marine Heatwave Index Predictions from Different Initial Months



- Earlier CFSv2 predictions underestimated the strength of NP Marine Heatwave;
- Latest CFSv2 predictions suggest that the current warm state will continue in 2021.

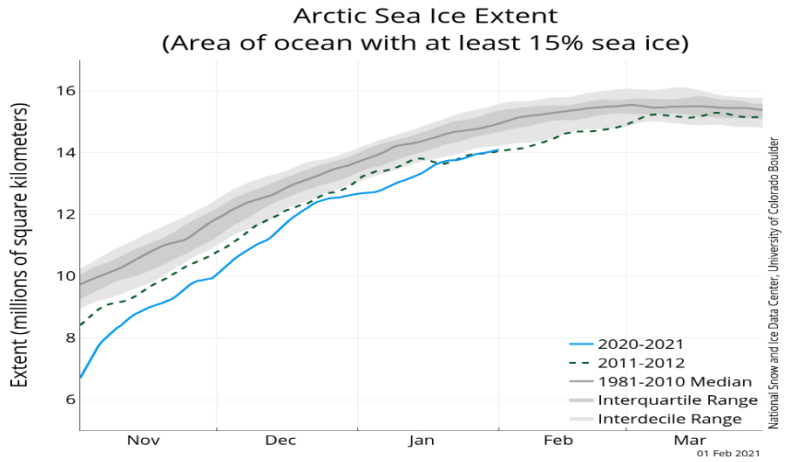
CFS NE Pacific SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect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

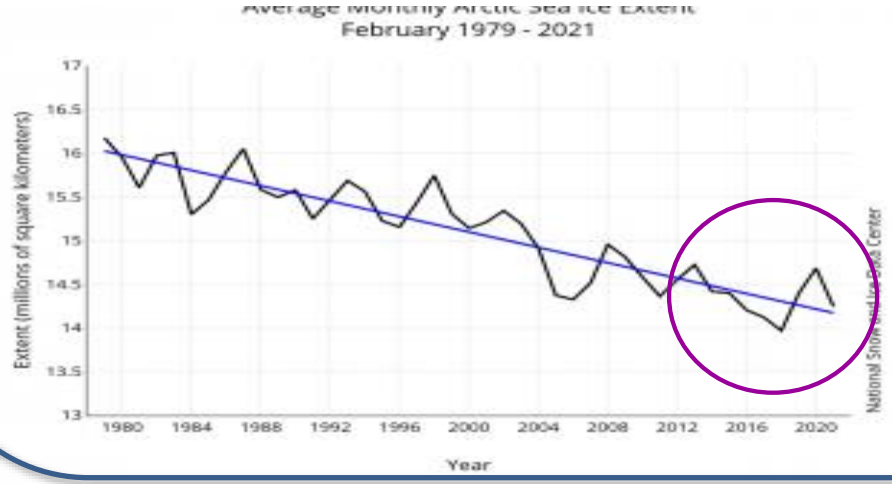
CFSv2 NE Pacific Marine Heatwave Predictions

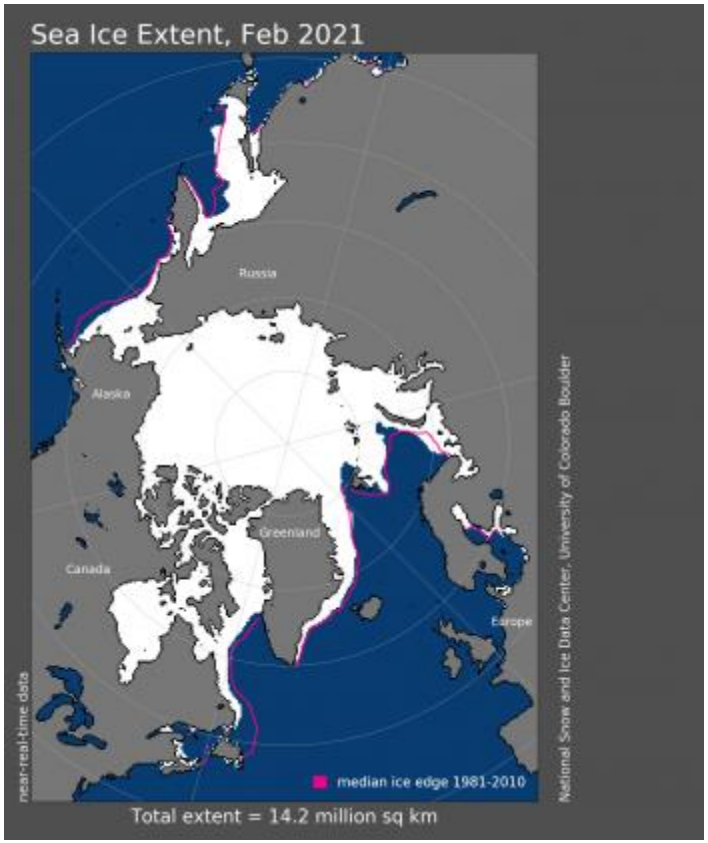


- Latest CFSv2 predictions suggest that the current warm state will continue in the next 6 months.

Arctic Sea Ice; NSIDC (http://nsidc.org/arcticseaicenews/index.html)

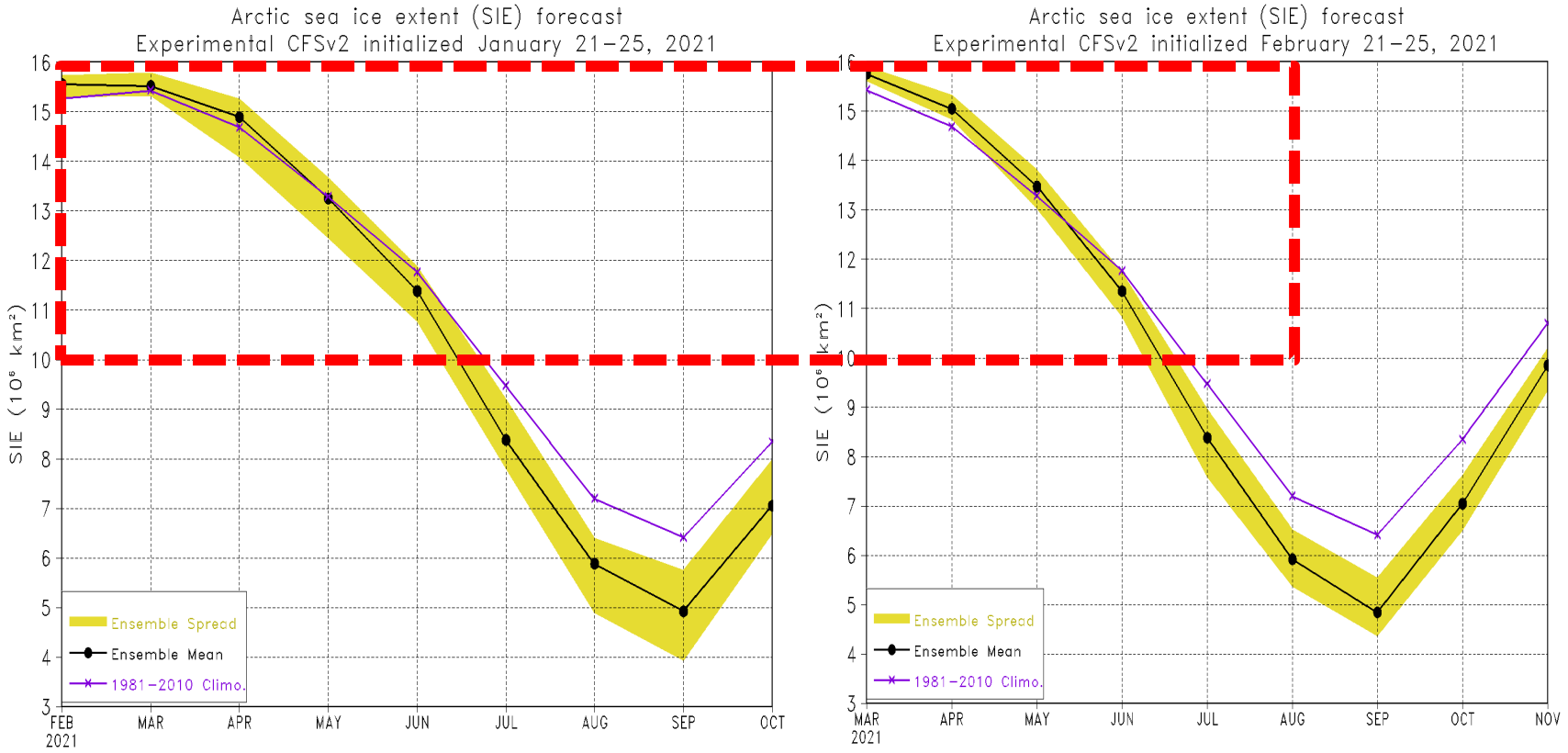






- Arctic sea ice extent averaged for Feb 2021 was the 7th lowest in the satellite record.
- Through 2021, the linear rate of decline for Feb sea ice extent is 2.9% per decade. This corresponds to a trend of 43,800 km^2 per year, which is roughly twice the size of the state of New Hampshire.

NCEP/CPC Arctic Sea Ice Extent Forecasts

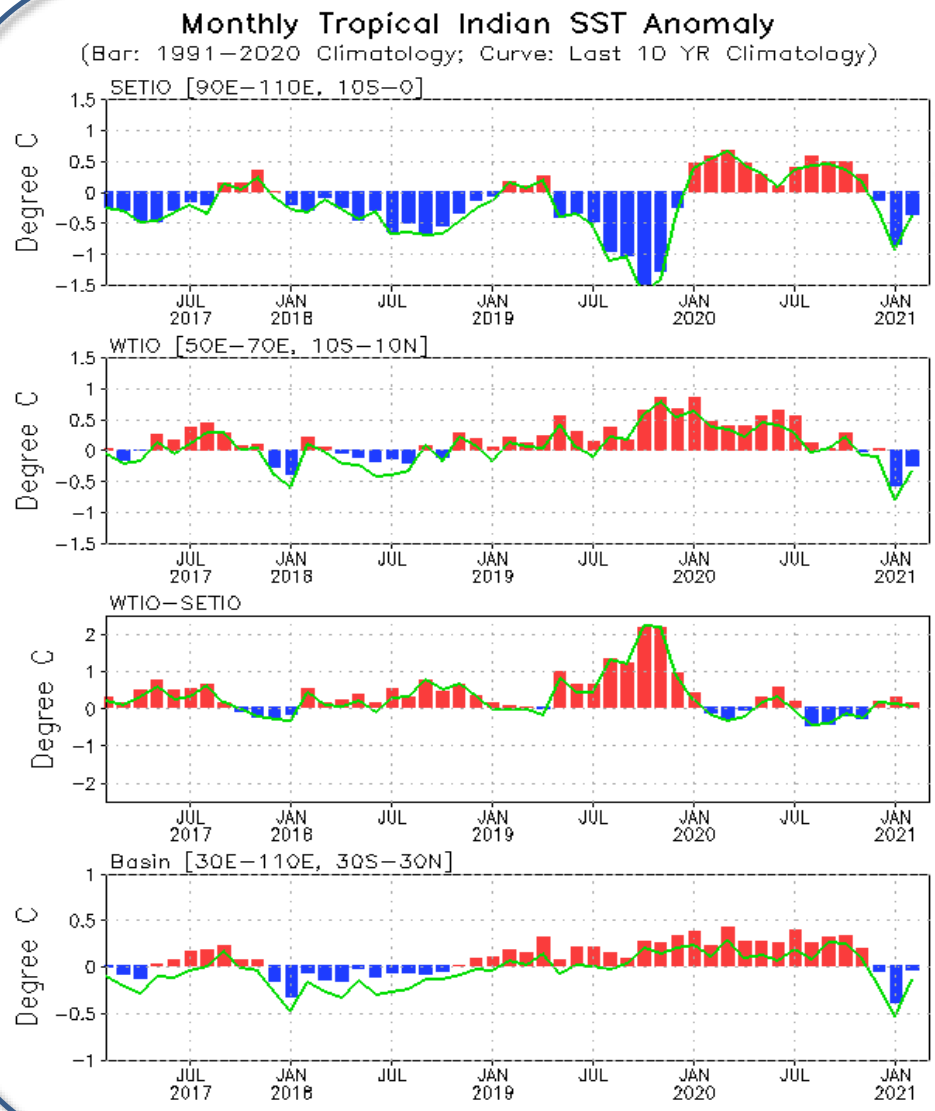


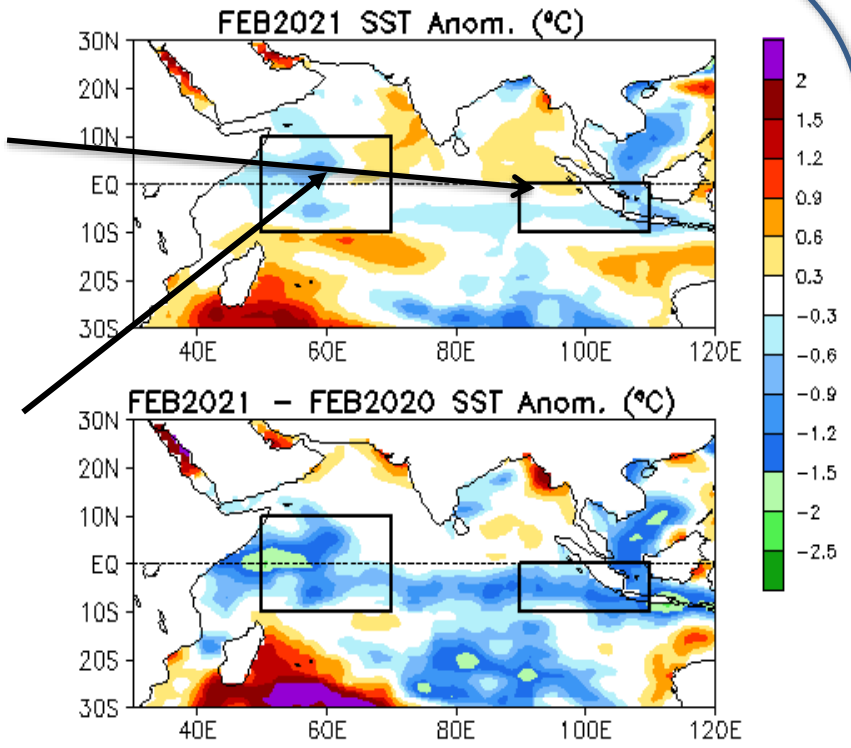
With ICs in Jan & Feb 2021, CFSv2 predicted a near-normal sea ice extent during spring & early summer 2021.

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

Indian Ocean

Evolution of Indian Ocean SST Indices

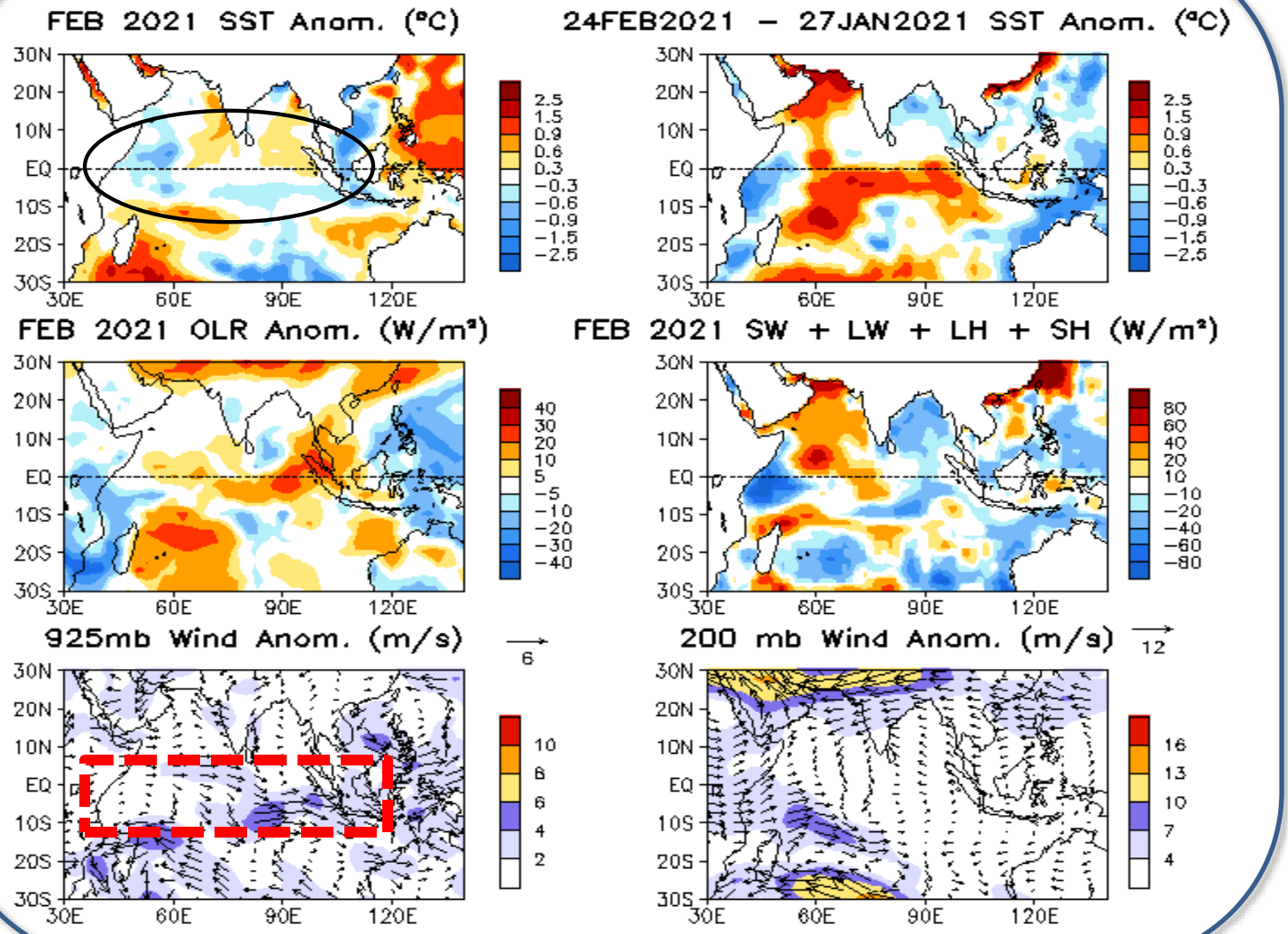




- Overall, SSTAs were small in the tropical Indian Ocean in Feb 2021.

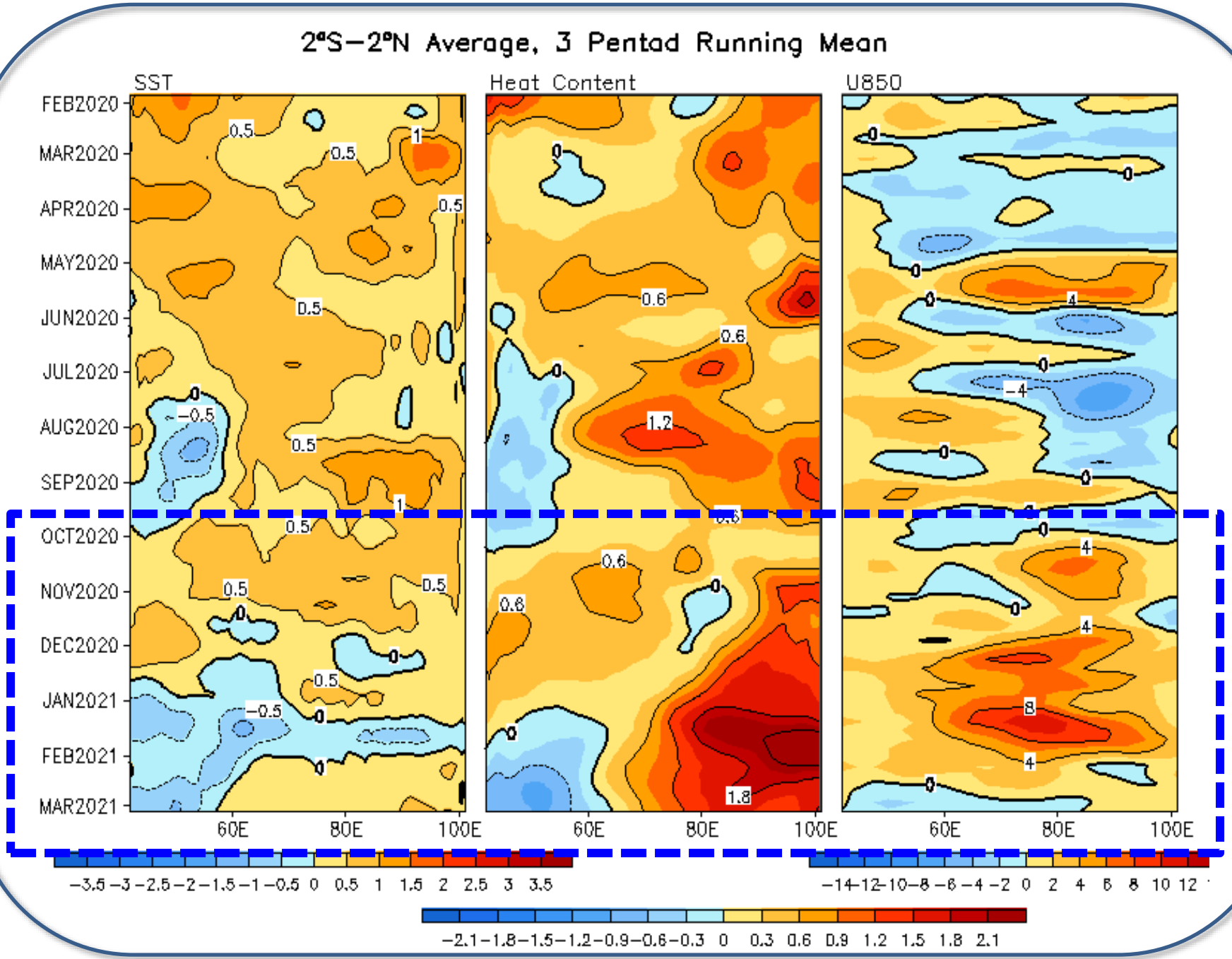
Indian Ocean Dipole region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (OC) for the SETIO [90ºE-110ºE, 10ºS-0] and WTIO [50ºE-70ºE, 10ºS-10ºN] regions, and Dipole Mode Index, defined as differences between WTIO and SETIO. Data are derived from the NCEP OI SST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

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



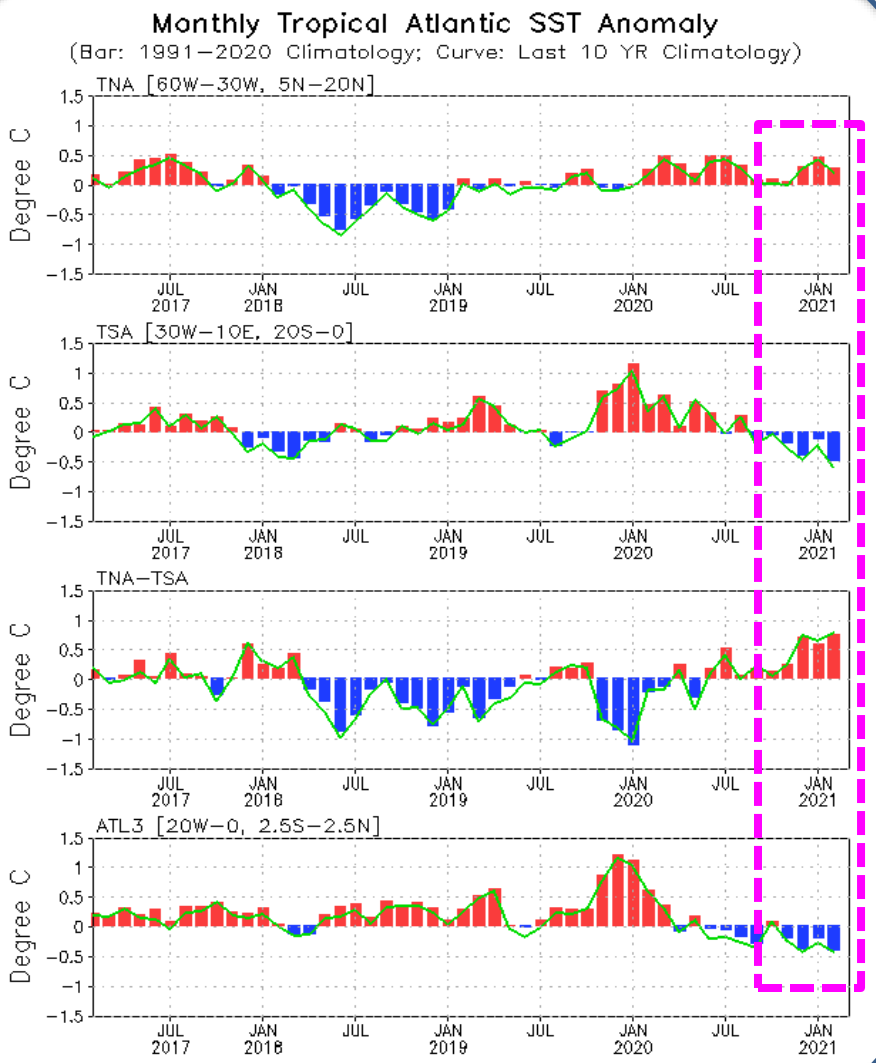
- SSTAs were small and the tendencies were mostly positive in the tropical Indian Ocean.
- Westerly wind anomaly persisted in the tropical Indian Ocean, leading to the subsurface warming in the eastern Indian Ocean.

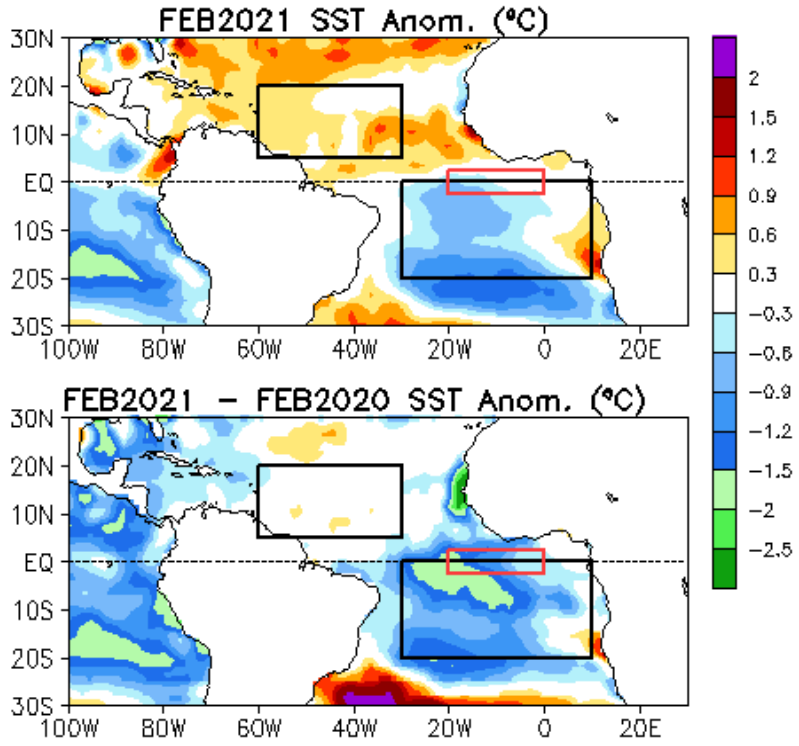
SSTAs (top-left), SSTA tendency (top-right), OLR anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the 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.


2°S–2°N Average, 3 Pentad Running Mean
SST
Heat Content
U850
FEB2020
MAR2020
APR2020
MAY2020
JUN2020
JUL2020
AUG2020
SEP2020
OCT2020
NOV2020
DEC2020
JAN2021
FEB2021
MAR2021
60E
80E
100E
−3.5 −3 −2.5 −2 −1.5 −1 −0.5 0 0.5 1 1.5 2 2.5 3 3.5
−14 −12 −10 −8 −6 −4 −2 0 2 4 6 8 10 12
−2.1 −1.8 −1.5 −1.2 −0.9 −0.6 −0.3 0 0.3 0.6 0.9 1.2 1.5 1.8 2.1

Tropical and North Atlantic Ocean

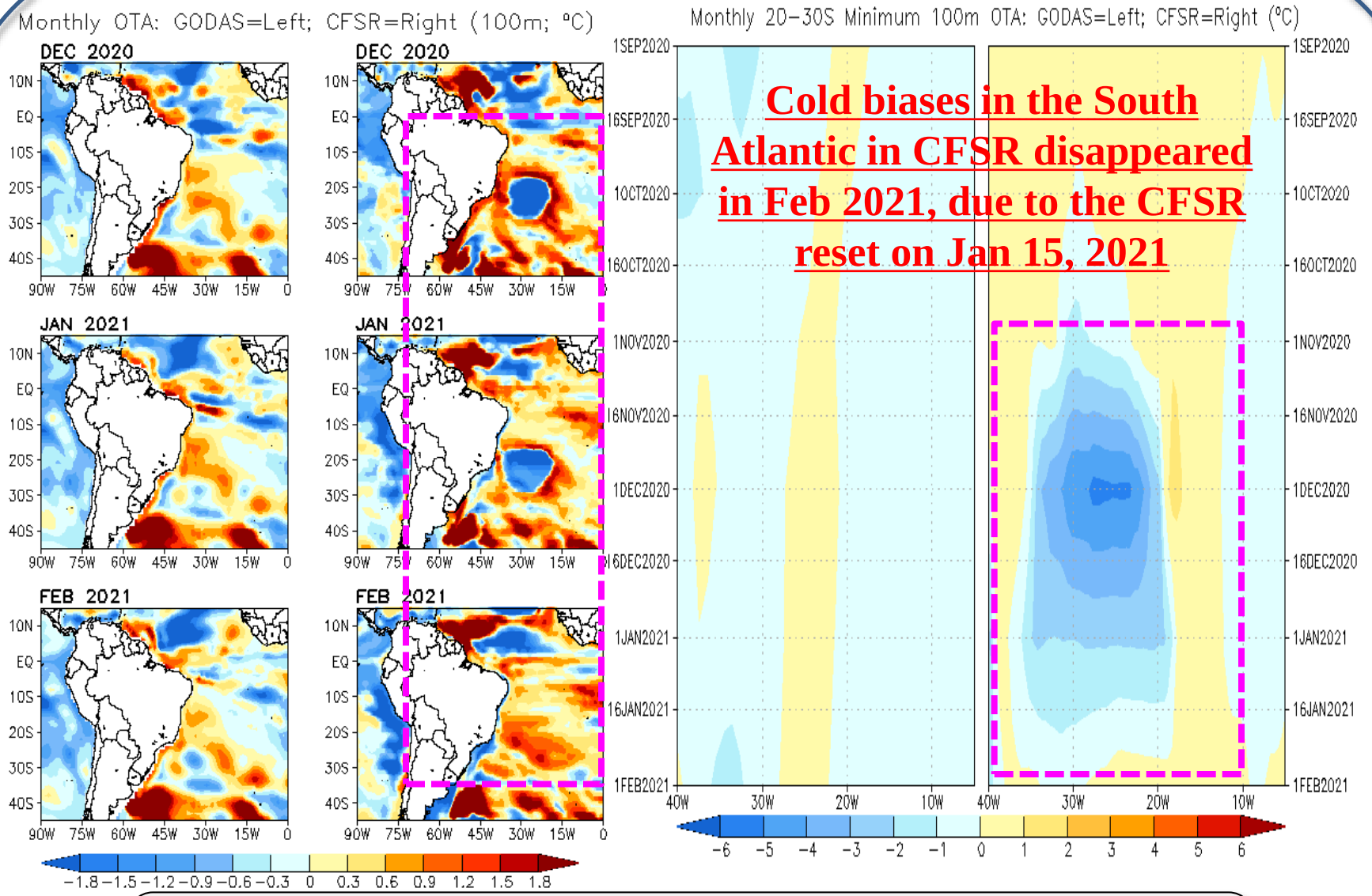
Evolution of Tropical Atlantic SST Indices





- Positive (negative) SSTAs in the tropical North (South) Atlantic feature a strong Atlantic meridional dipole mode during Dec 2020-Feb 2021.

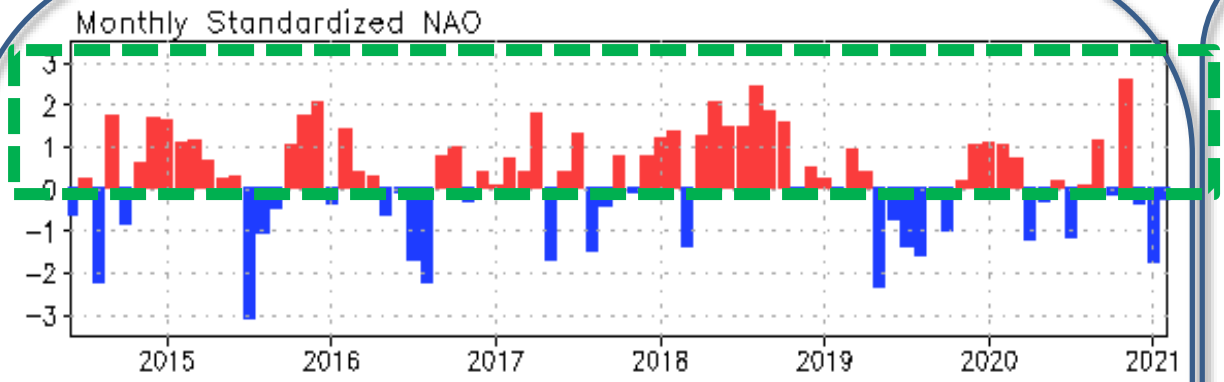
Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (^{O}C) for the TNA [60^{O}W-30^{O}W, 5ºN-20^{O}N], TSA [30^{O}W-10^{O}E, 20^{O}S-0] and ATL3 [20^{O}W-0, 2.5^{O}S-2.5^{O}N] regions, and Meridional Gradient Index, defined as 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.

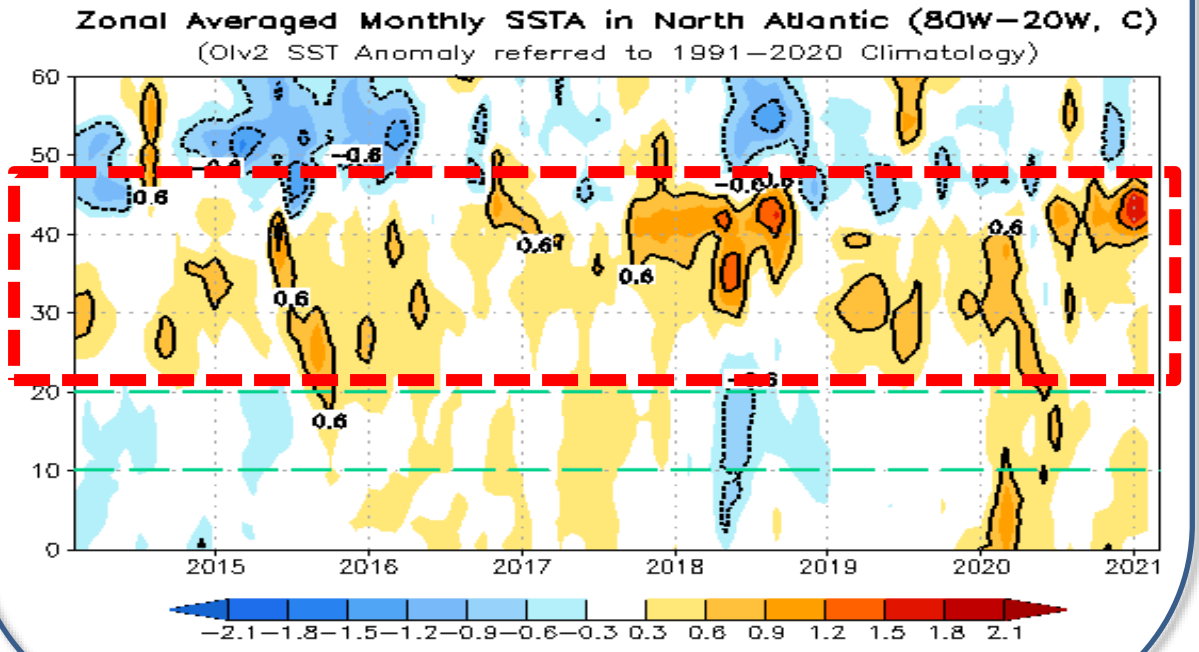


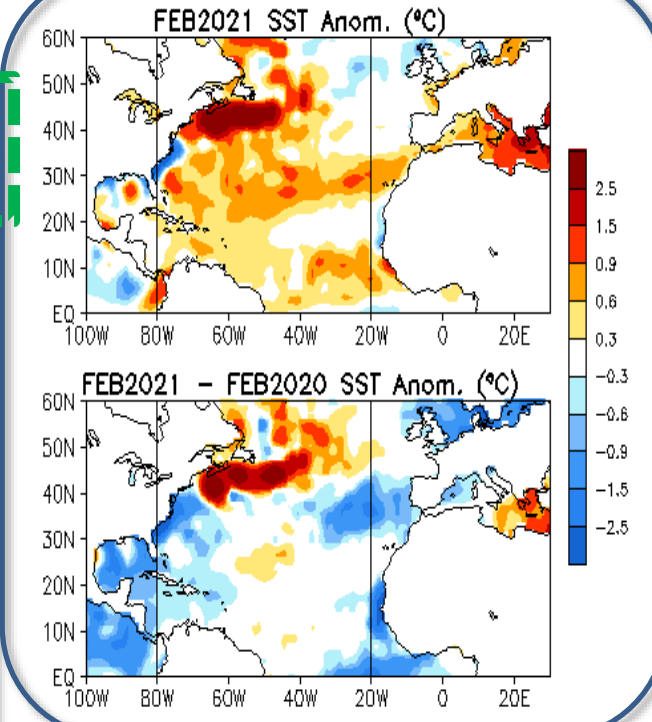
Cold biases in the South Atlantic in CFSR disappeared in Feb 2021, due to the CFSR reset on Jan 15, 2021

- The cold biases in the South Atlantic emerged around Nov 2020, enhanced quickly with time (at 100m with maximum of -5ºC around Dec 2020), and disappeared in Feb 2021 due to the CFSR reset in Jan 15, 2021.

NAO and SST Anomaly in North Atlantic





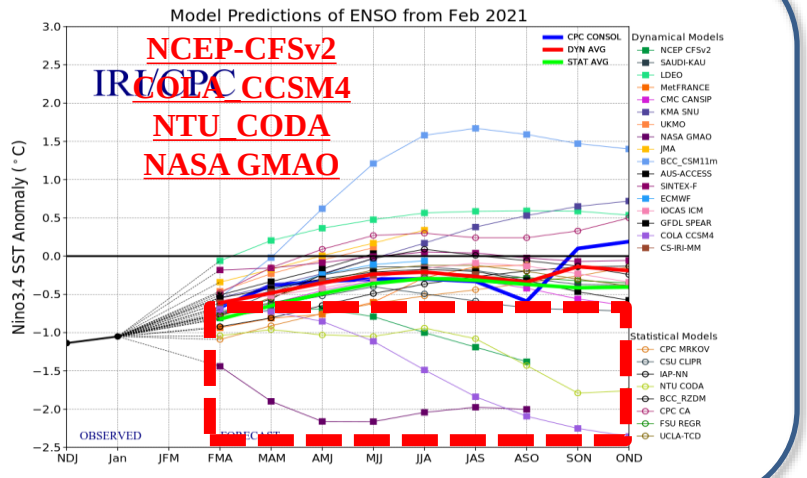


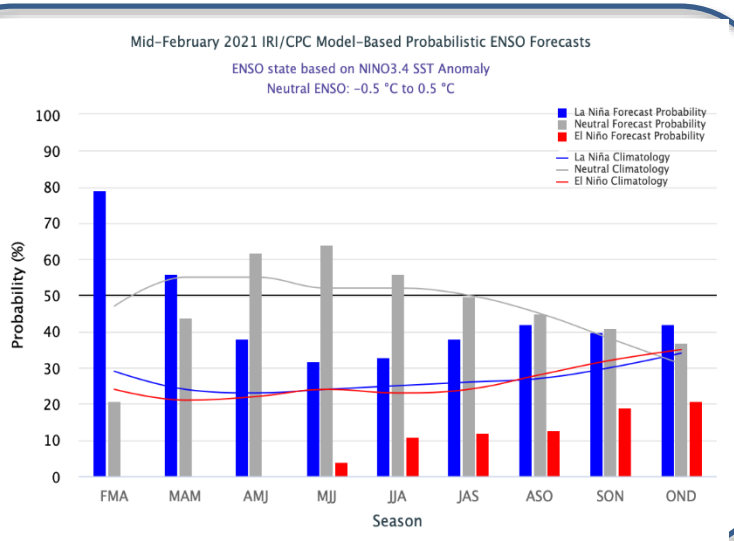
- NAO was in a negative phase in Feb 2021 with NAOI= -0.29.
- The prolonged positive SSTAs in the middle latitudes were evident, due to the domination of the positive phase of NAO during the last 5-6 years.

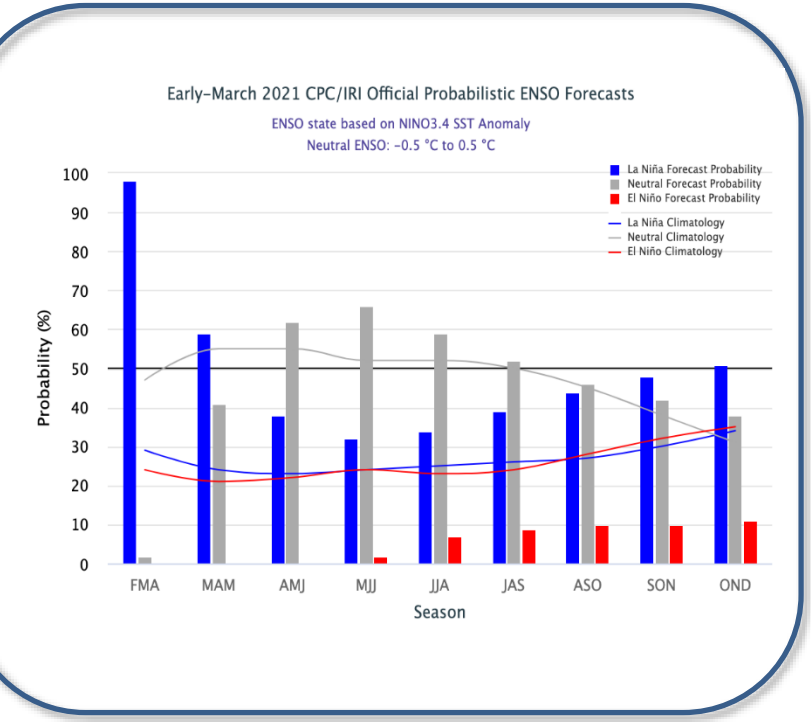
Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20°N-90°N (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80ºW and 20ºW (bottom). SST are derived from the NCEP OI SST analysis, and anomalies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

ENSO and Global SST Predictions

IRI/CPC Niño3.4 Forecast



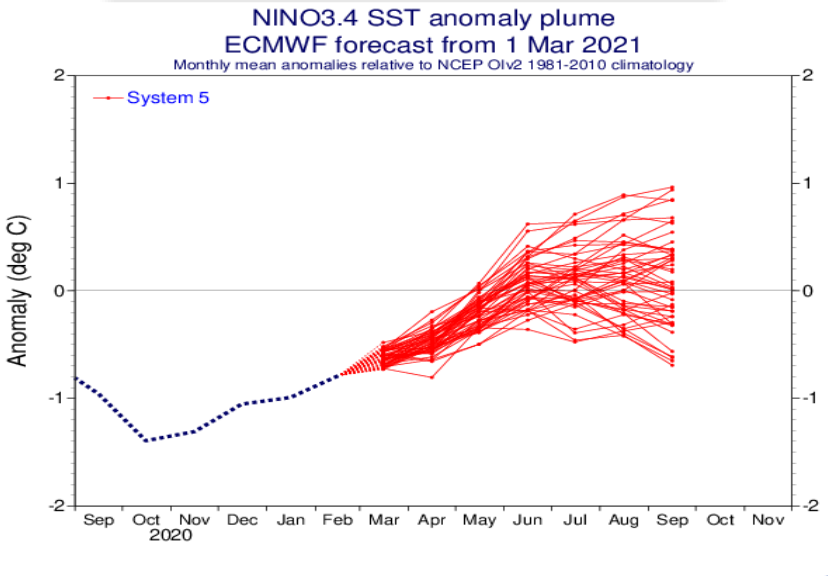




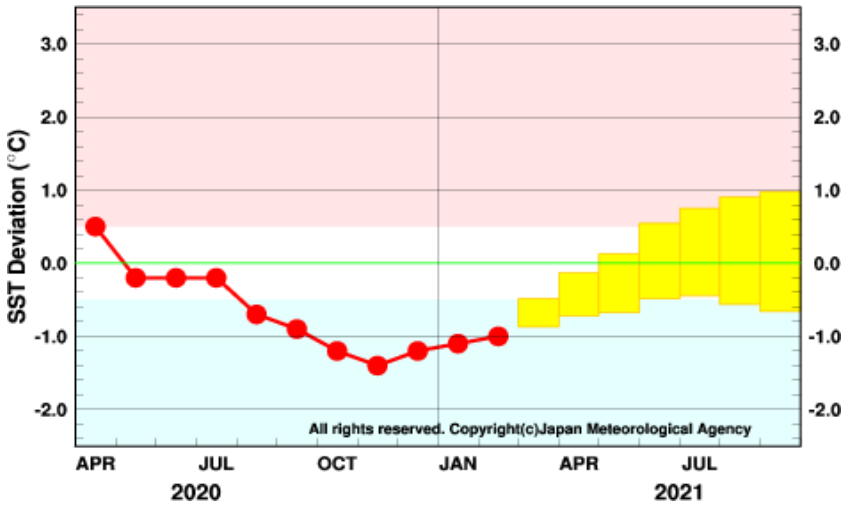
- **ENSO Alert System Status: La Niña Advisory**
- Synopsis: *There is a ~60% chance of a transition from La Niña to ENSO-Neutral during the Northern Hemisphere spring 2021 (April-June).*

Individual Model Niño3.4 Forecasts: *La Niña will return to neutral in spring*

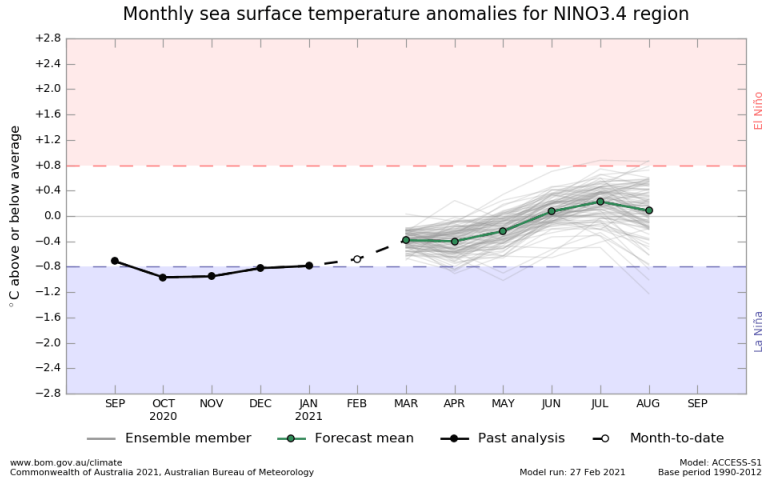
EC: IC= 01 Mar, 2021



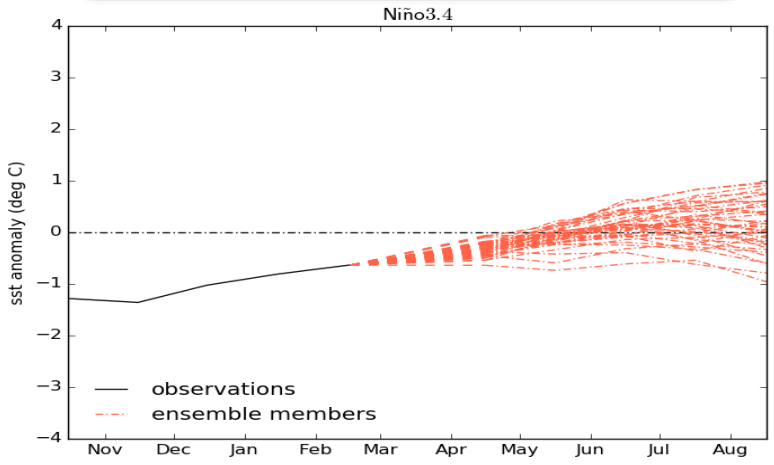
JMA: Updated 10 Mar, 2021



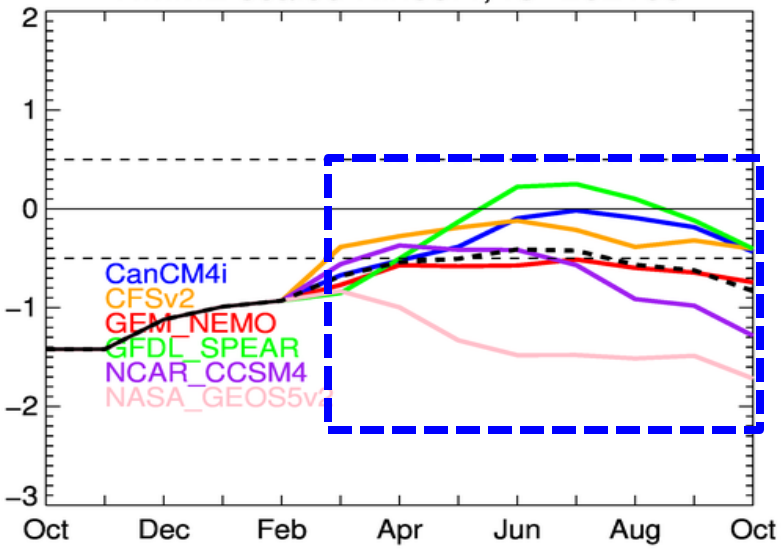
BOM: Updated 27 Feb, 2021

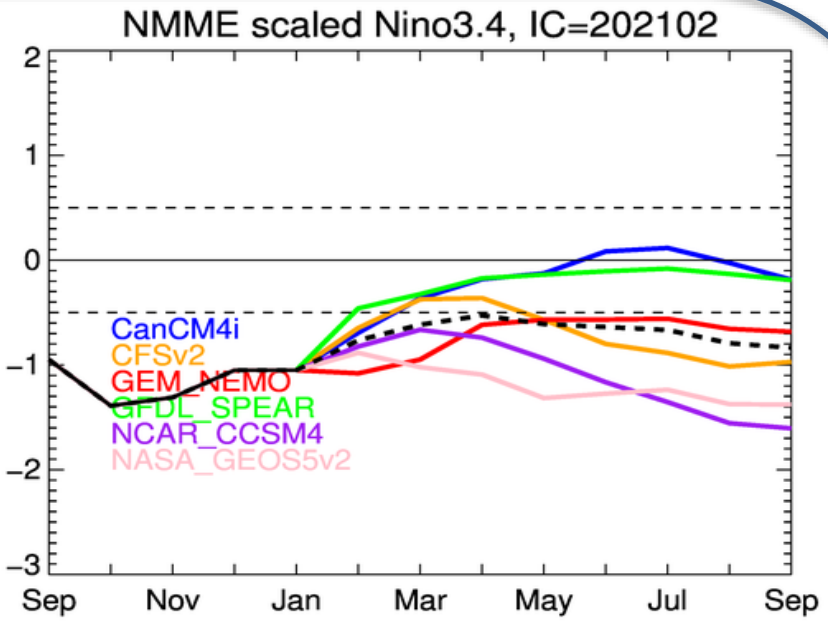


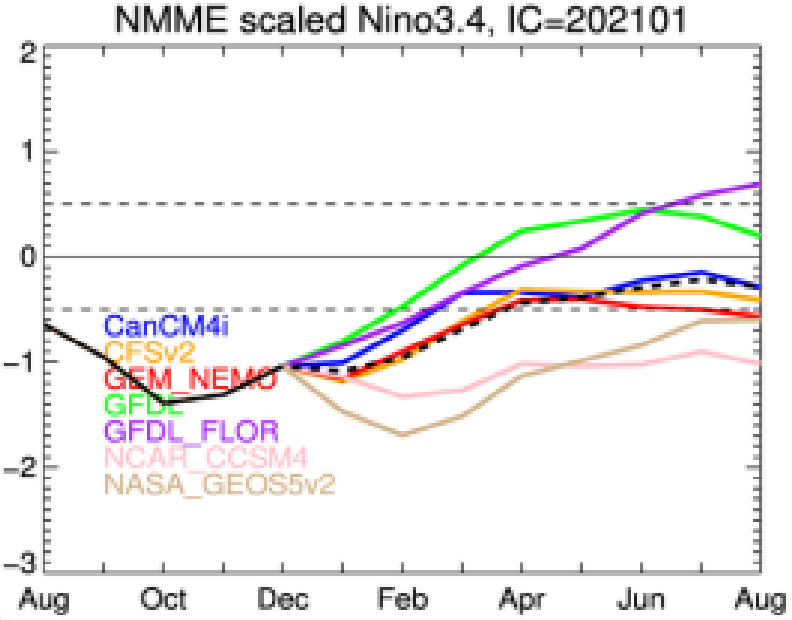
UKMO: Updated 11 Mar, 2021

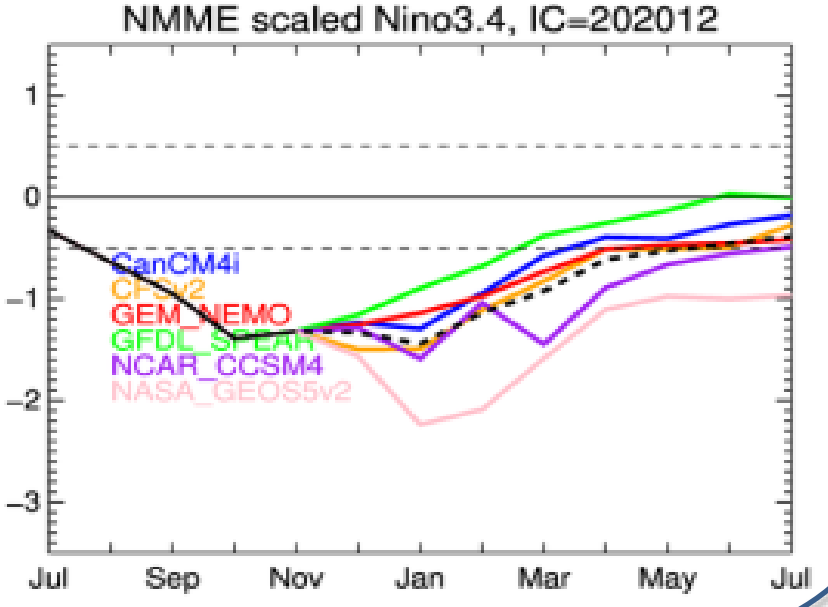


NMME forecasts from different initial conditions

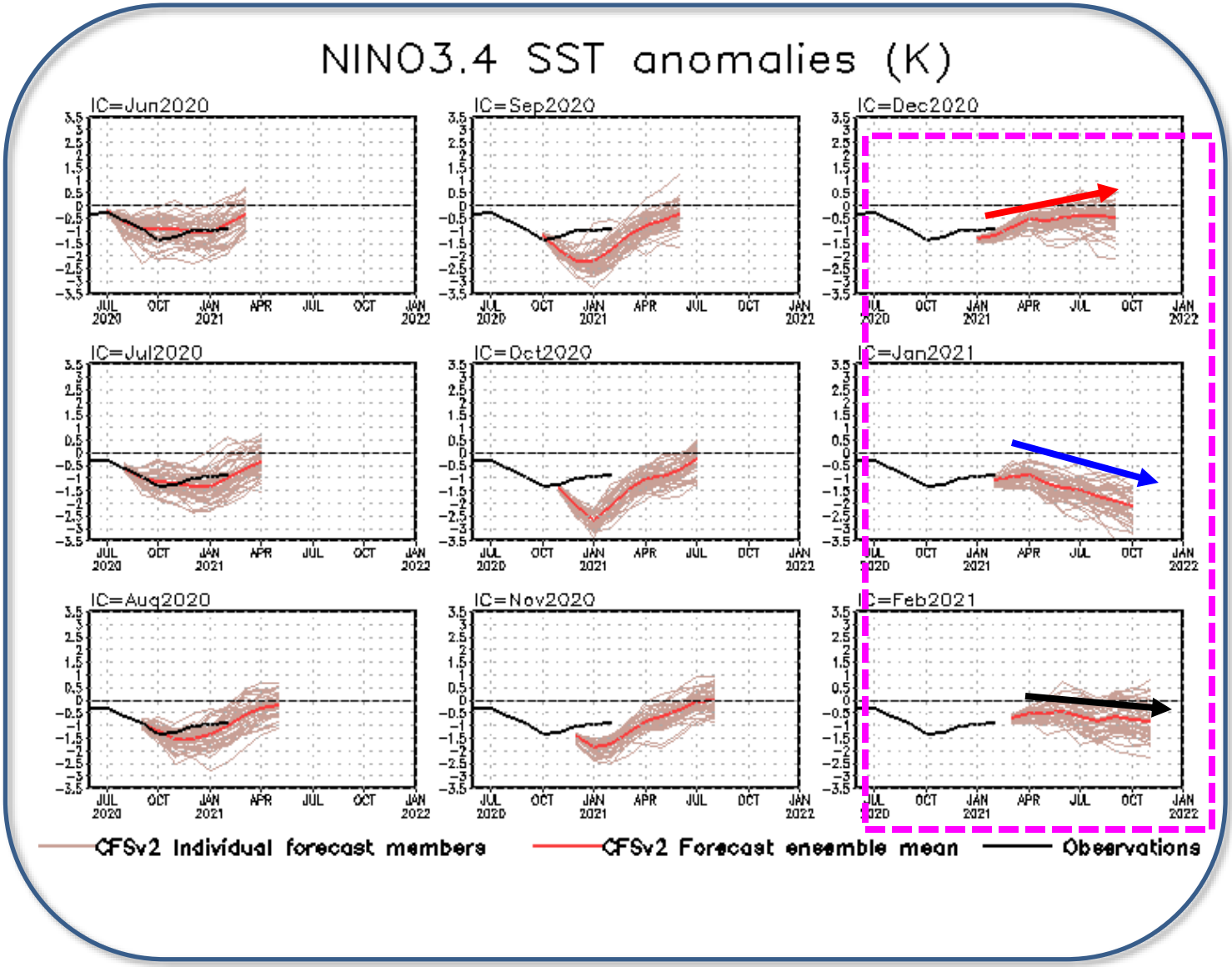








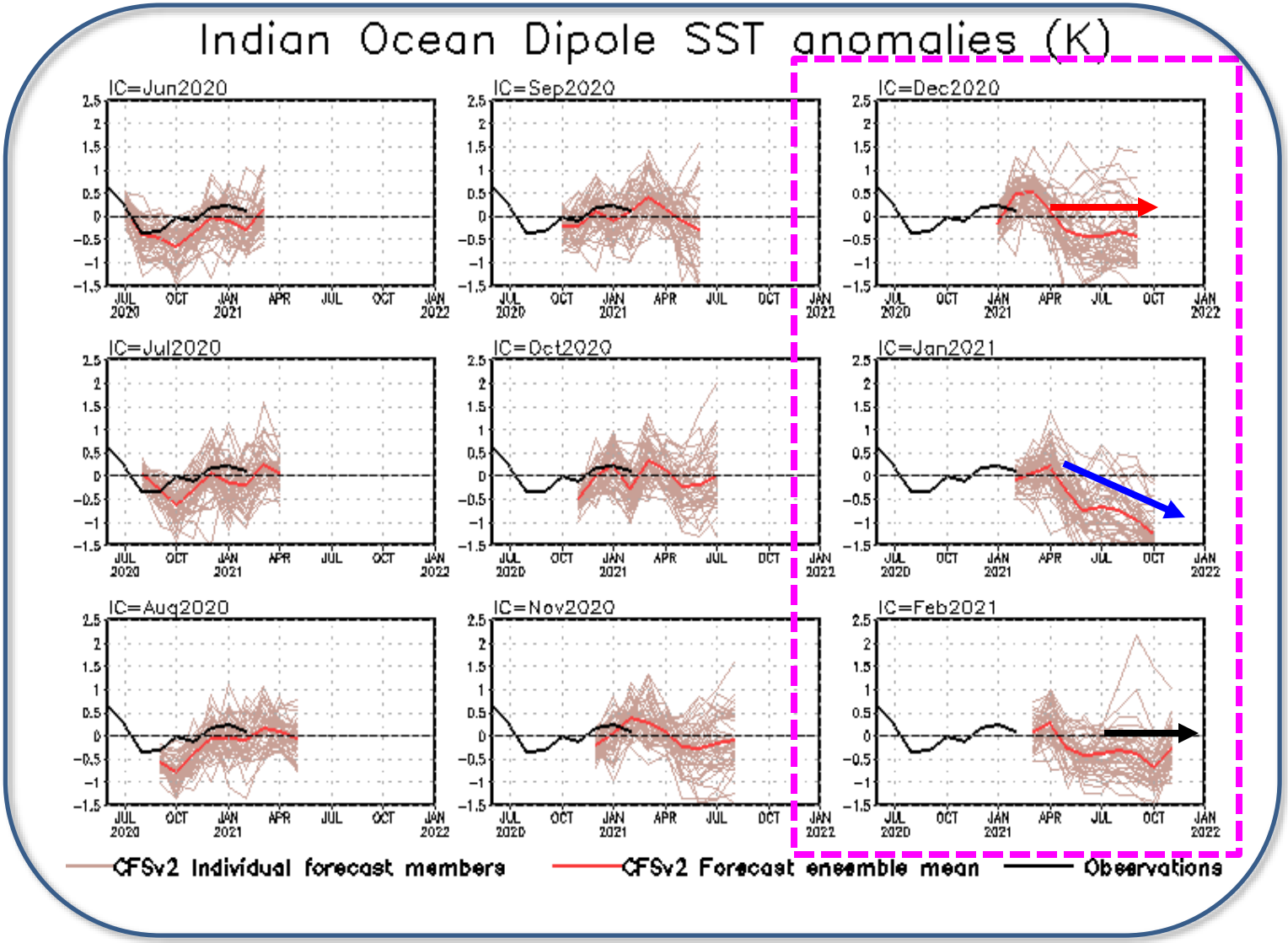
CFS Niño3.4 SST Predictions from Different Initial Months



- CFSv2 oceanic IC reset on 15Jan2021 led to strong cooling tendencies in the predictions, especially with ICs in Jan 2021.

CFS Niño3.4 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.

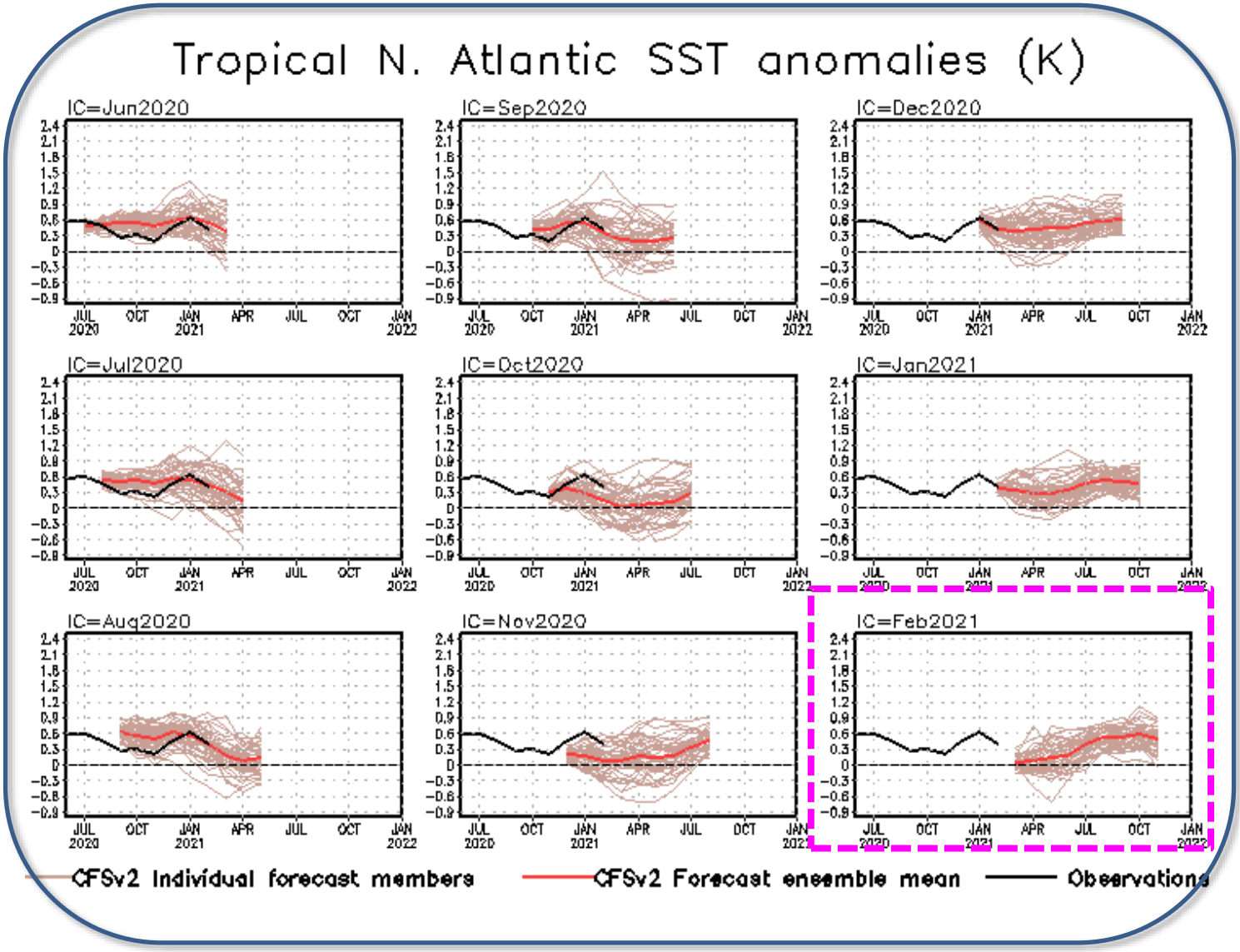
NCEP CFS DMI SST Predictions from Different Initial Months



- Latest CFSv2 predicts a negative phase of IOD in 2021.

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.

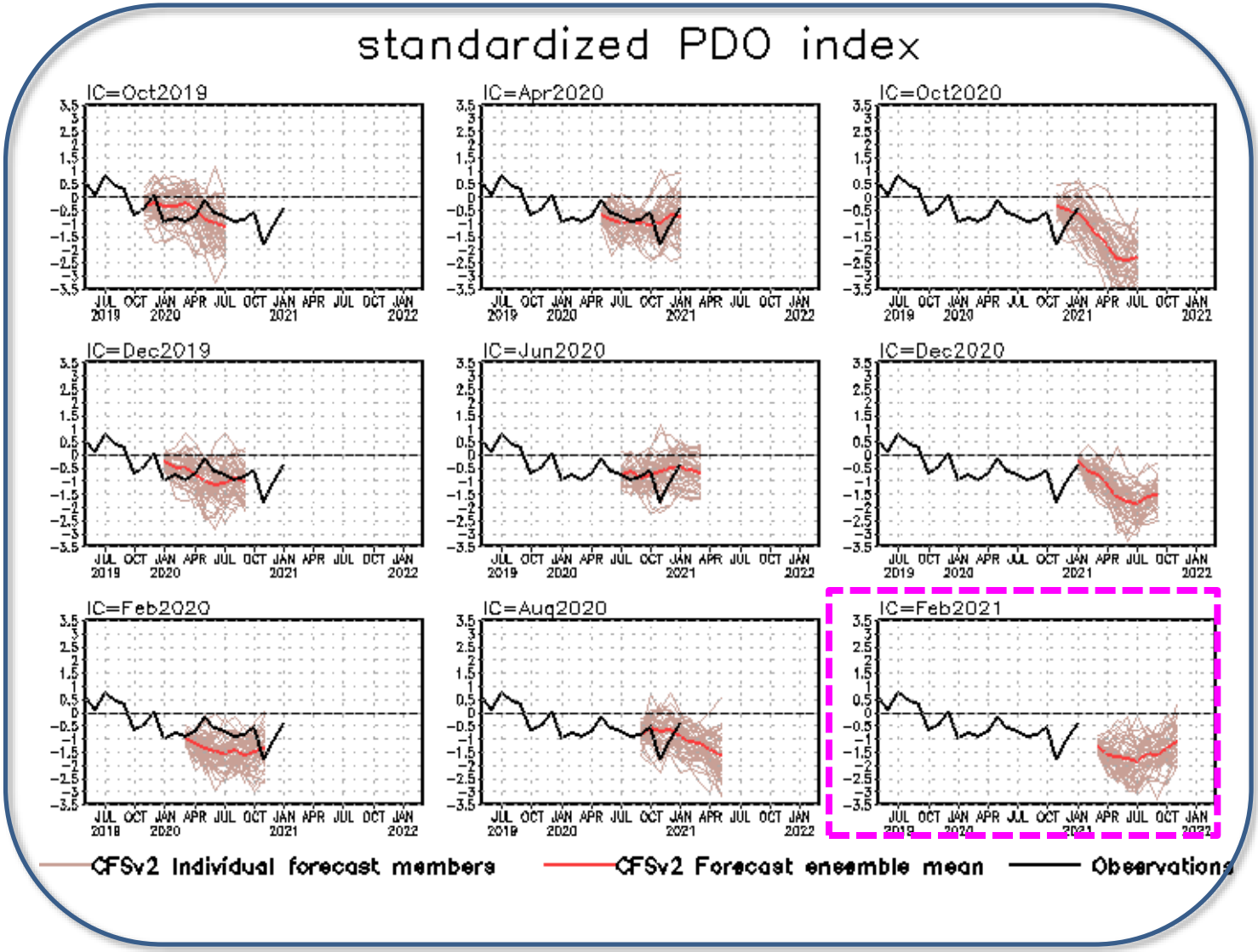
CFS Tropical North Atlantic (TNA) SST Predictions from Different Initial Months



- Latest CFSv2 predictions call for above normal SSTA in the tropical N. Atlantic in 2021.

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. TNA is the SST anomaly averaged in the region of [60oW-30oW, 5oN-20oN].

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



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

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. 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.

Acknowledgements

- Drs. Jieshun Zhu, 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 archive

Please send your comments and suggestions to:

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Caihong.Wen@noaa.gov

Jieshun.Zhu@noaa.gov

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

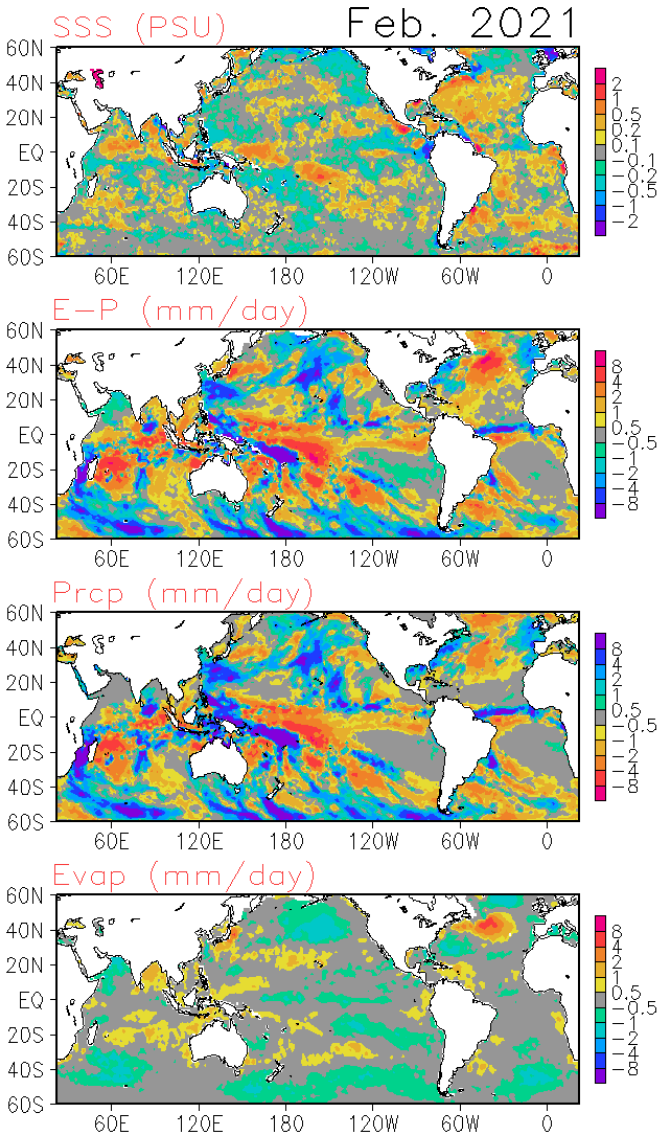
  http://www.cpc.ncep.noaa.gov/products/GODAS/multiora93_body.html

Backup Slides

Global Sea Surface Salinity (SSS): Anomaly for February 2021

New Update: The NCEI SST data used in the quality control procedure has been updated to version 2.1 since May 2020;

Positive SSS anomaly continues in the western equator Pacific Ocean and SPCZ region, which is likely caused by the reduced precipitation. Positive SSS anomalies appear in most areas in the central N. Pacific ocean. Positive SSS anomaly along and north of Equator in the Indian Ocean is likely due to decreased precipitation. Positive SSS anomaly continues between equator and 40° N in the North Atlantic Ocean.



SSS : Blended Analysis of Surface Salinity (BASS) V0.Z

(a CPC-NESDIS/NODC-NESDIS/STAR joint effort)

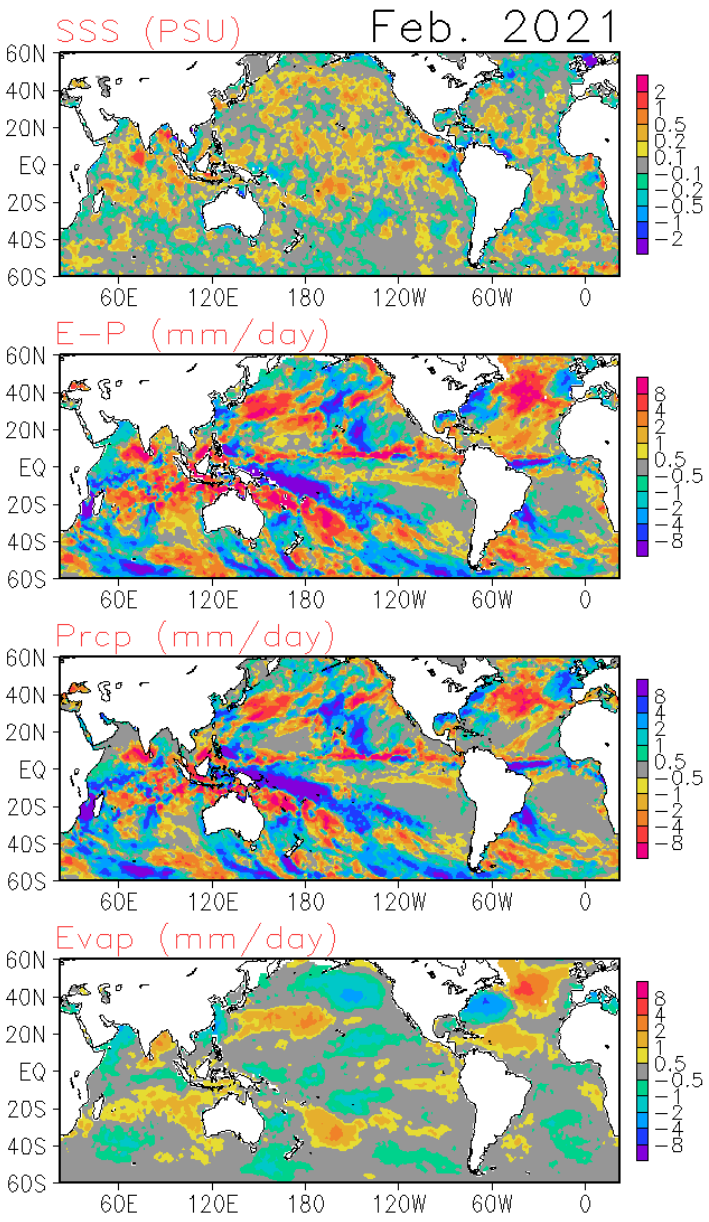
ftp.cpc.ncep.noaa.gov/precip/BASS

Precipitation: CMORPH adjusted satellite precipitation estimates

Evaporation: Adjusted CFS Reanalysis

Global Sea Surface Salinity (SSS): Tendency for February 2021

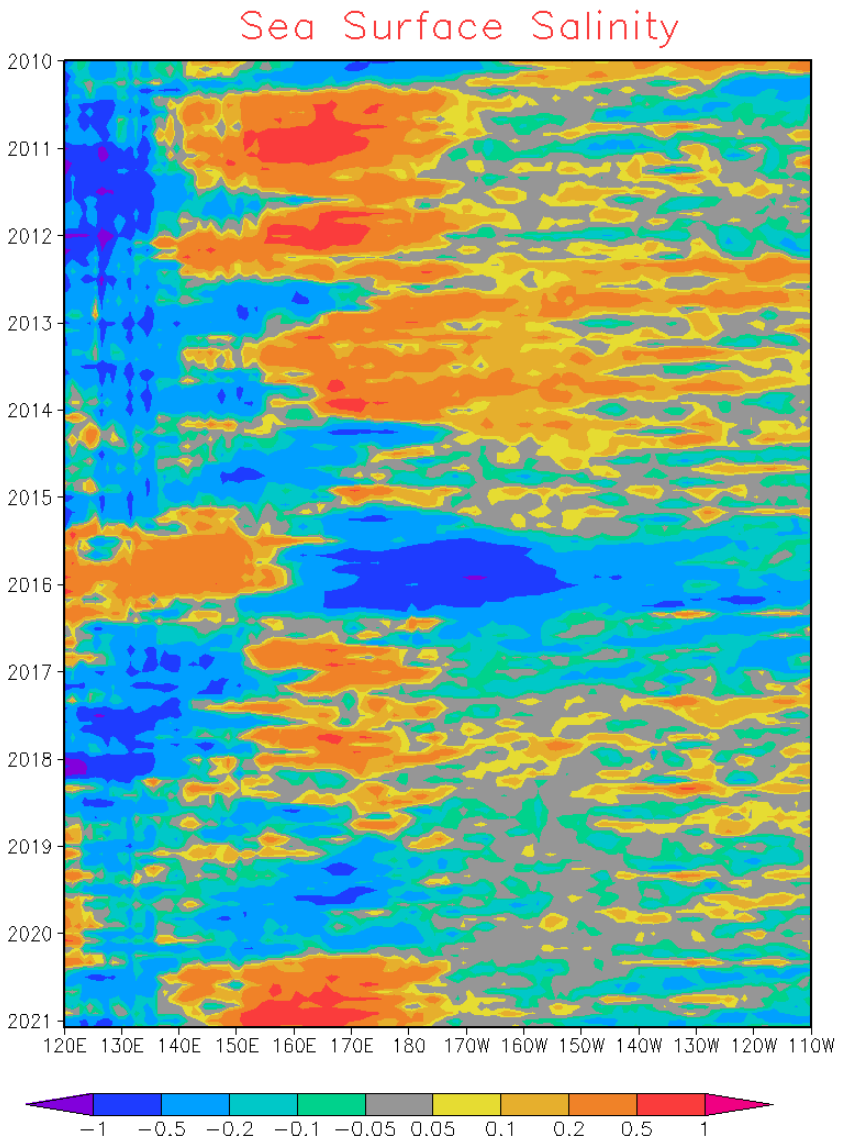
Compared with last month, SSS between equator and 20° N increased. SSS increased in the Indian Ocean north of 20° S, which is likely caused by reduced precipitation. SSS in the North Atlantic Ocean increased in most of the area between 30° S and 30° N. In the Bay of Bengal, SSS increased with reduced precipitation in the area.



Monthly SSS Anomaly Evolution over Equatorial Pacific

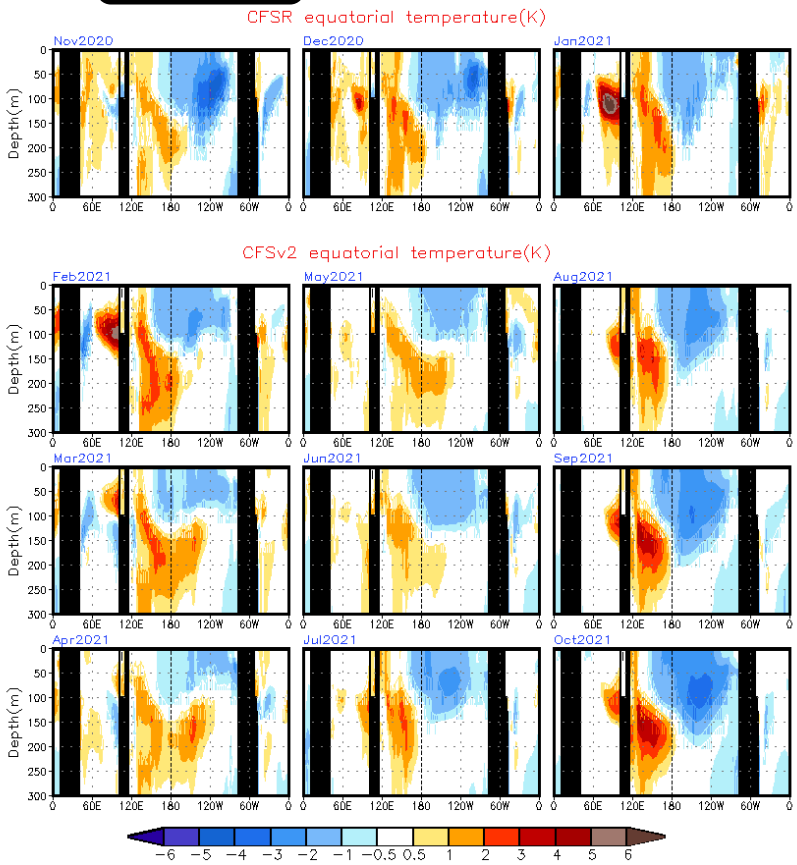
NOTE: Since June 2015, the BASS SSS is from in situ, SMOS and SMAP; before June 2015,The BASS SSS is from in situ, SMOS and Aquarius.

- Hovemoller diagram for equatorial SSS anomaly **(5° S-5° N);**
- In the equatorial Pacific Ocean, west of 140° E, negative SSS signal continues; positive SSS signal also continues between 140° E and 170° W; while negative SSS signal appears east of 160° W with stronger negative signal east of 130° W.



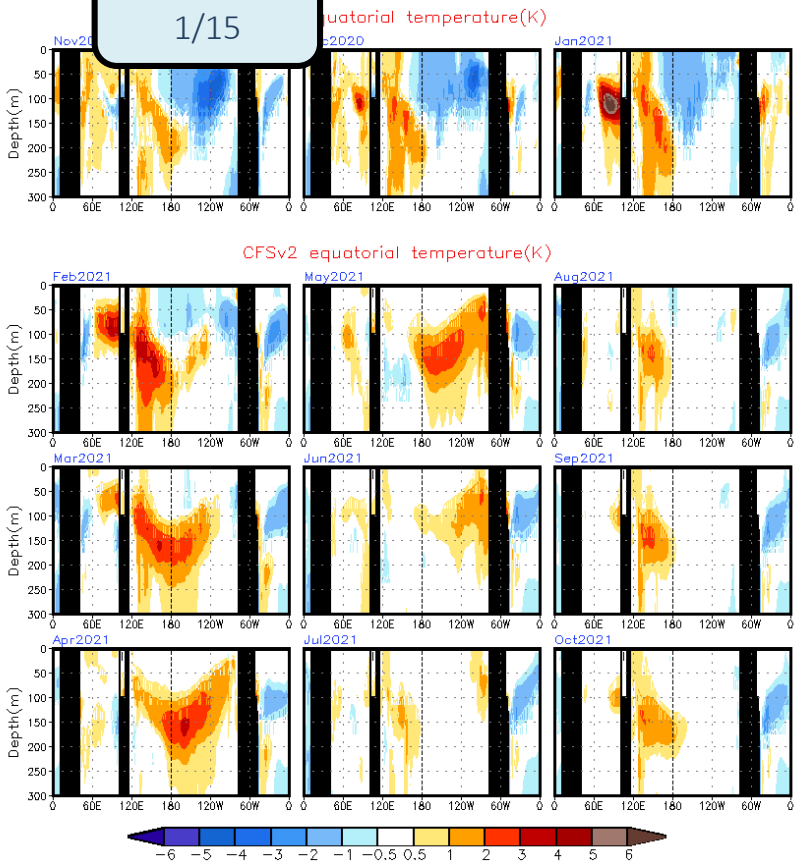
After 1/15

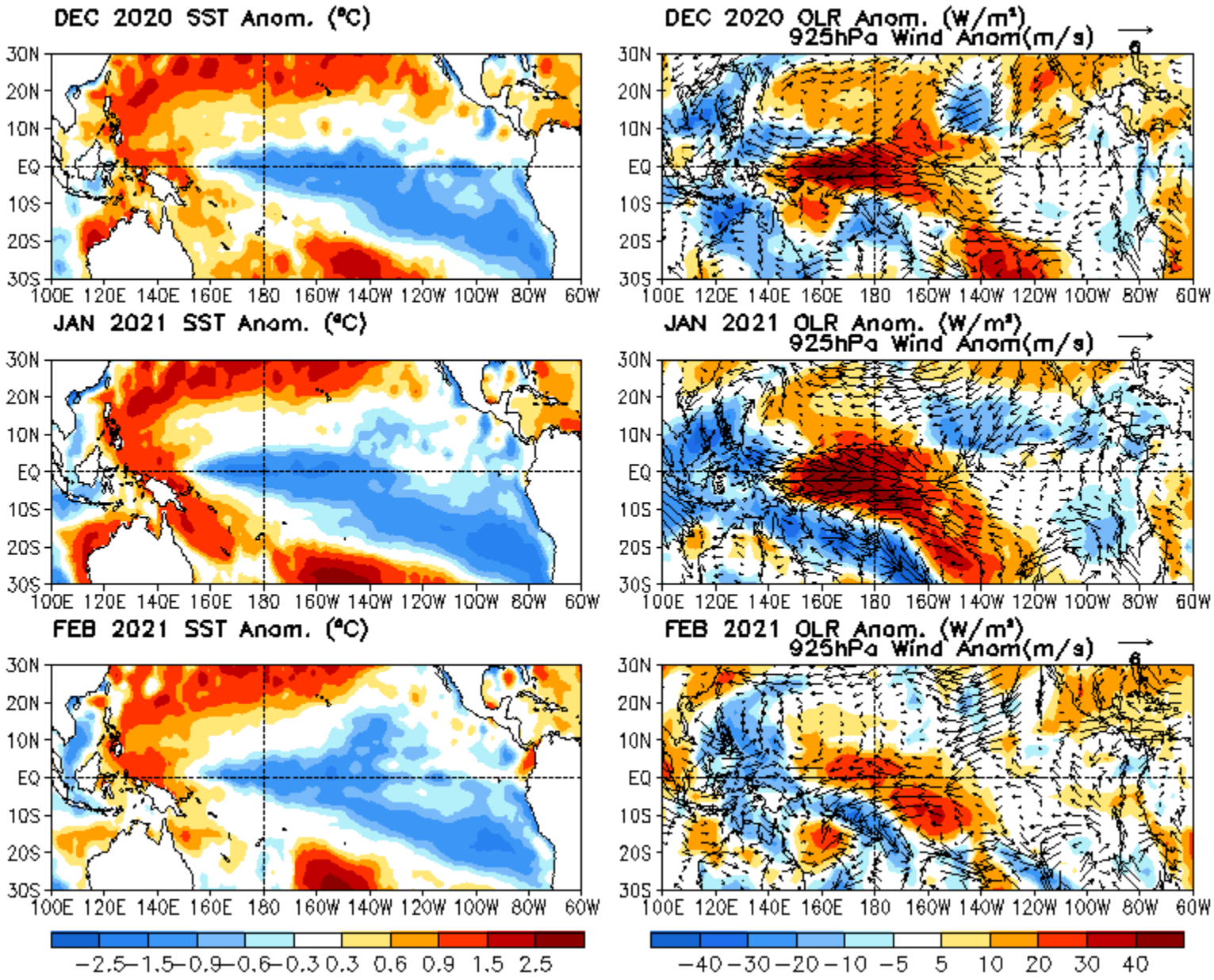
Initial conditions: 15Jan2021–24Jan2021
Last update: Mon Jan 25 2021



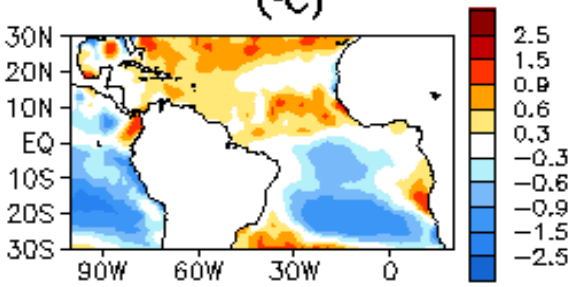
Before 1/15

Initial conditions: 5Jan2021–14Jan2021
Last update: Mon Jan 25 2021

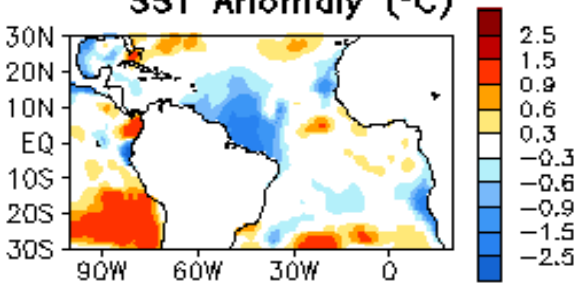



DEC 2020 SST Anom. (°C)
DEC 2020 OLR Anom. (W/m²)
925hPa Wind Anom(m/s)
JAN 2021 SST Anom. (°C)
JAN 2021 OLR Anom. (W/m²)
925hPa Wind Anom(m/s)
FEB 2021 SST Anom. (°C)
FEB 2021 OLR Anom. (W/m²)
925hPa Wind Anom(m/s)
30N
20N
10N
EQ
10S
20S
30S
100E 120E 140E 160E 180 160W 140W 120W 100W 80W 60W
−2.5 −1.5 −0.9 −0.6 −0.3 0.3 0.6 0.9 1.5 2.5
−40 −30 −20 −10 −5 5 10 20 30 40

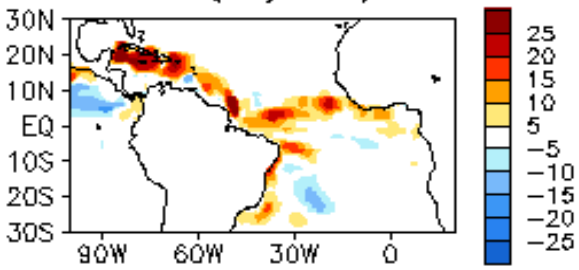
FEB 2021 SST Anom. (°C)



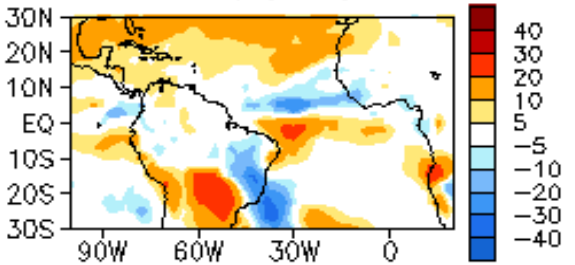
24FEB2021 – 27JAN2021 SST Anomaly (°C)



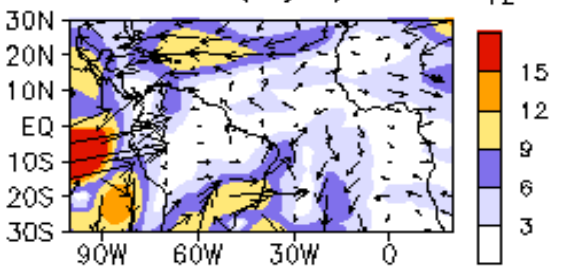
FEB 2021 TCHP Anom. (KJ/cm²)



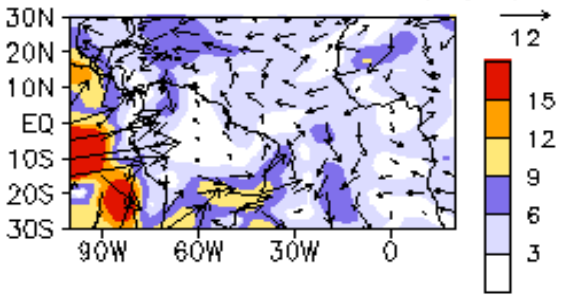
FEB 2021 OLR Anom. (W/m²)



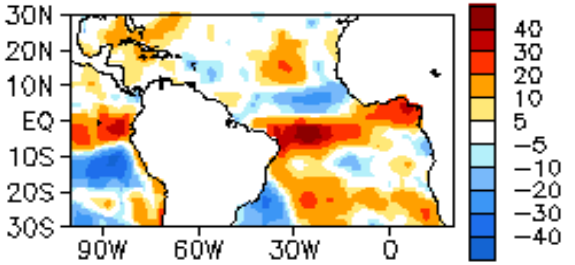
FEB 2021 200mb Wind Anom. (m/s)



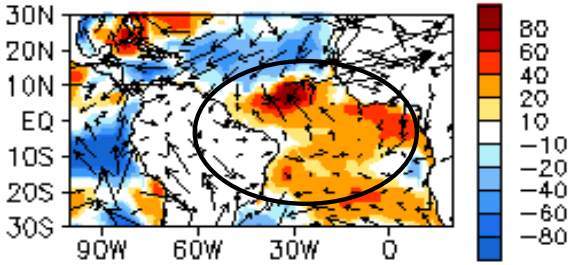
FEB 2021 200mb – 850mb Wind Shear Anom. (m/s)



FEB 2021 SW + LW Anom. (W/m²)



LH + SH Anom. (W/m²)
925mb Wind Anom. (m/s)



FEB 2021 700 mb RH Anom. (%)