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

Prepared by

Climate Prediction Center, NCEP/NOAA

February 11, 2021

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

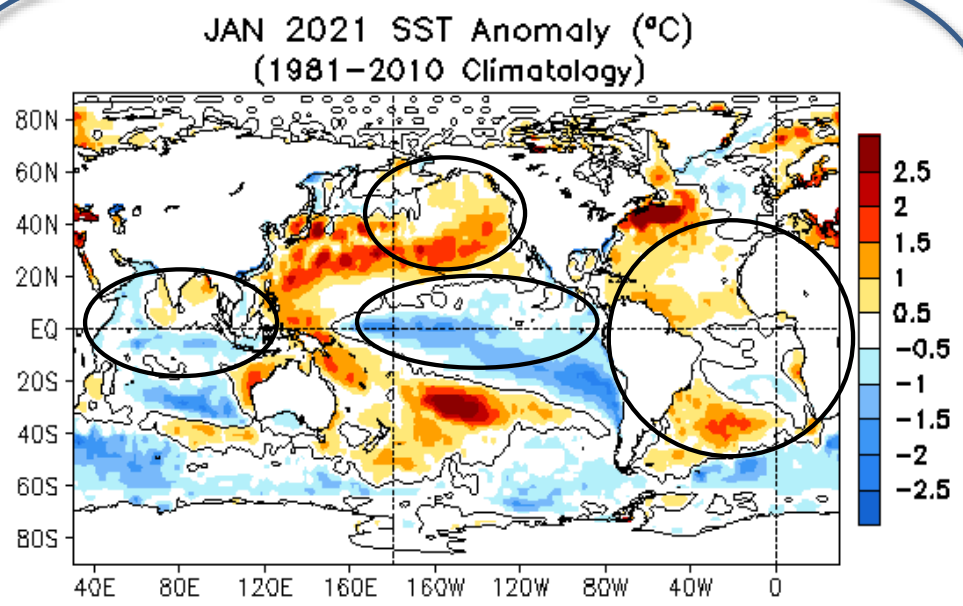
- Overview
- Recent highlights
  - Pacific/Arctic Ocean
  - Indian Ocean
  - Atlantic Ocean
- Global SSTA Predictions
- Special Topics
  - CFSR Resets and the Consequence
  - 2020 Annual Review

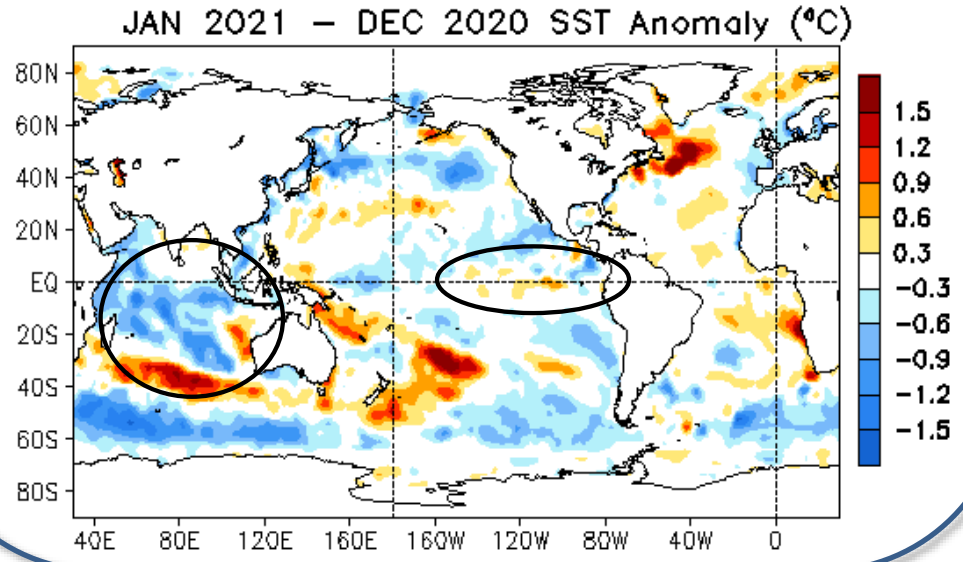
Overview

- Pacific Ocean
  - NOAA "ENSO Diagnostic Discussion" on 11 Feb 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 Niña condition persisted with Niño3.4 = -1.05^{o}C in Jan 2021.
  - Positive SSTAs persisted in the NE Pacific in Jan 2021.
  - The PDO has been in a negative phase since Jan 2020 and weakened since Dec 2020 with PDOI = -0.4 in Jan 2021.
- Indian Ocean
  - SSTs in the tropical Indian Ocean were below average in Jan 2021.
- Atlantic Ocean
  - NAO persisted in a negative phase in Jan 2021 with NAOI= -1.8.
  - The prolonged tripole pattern with positive SSTAs in the middle latitudes was evident during the last 5-6 years.
- Arctic Ocean
  - The sea ice extent in Jan 2021 ranked as the 6th lowest since 1979.

Global Oceans

Global SST Anomaly (°C) and Anomaly Tendency



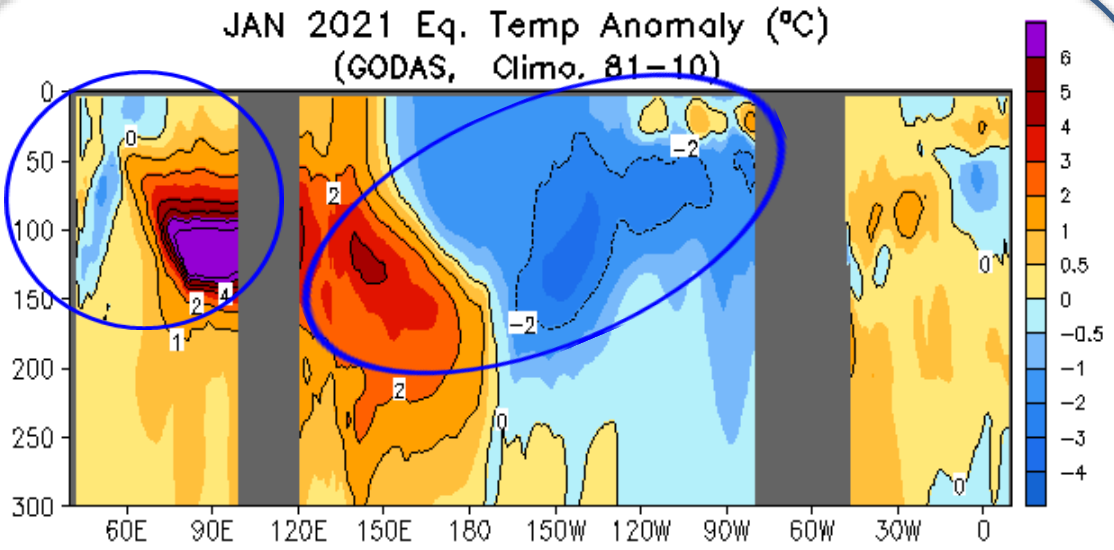


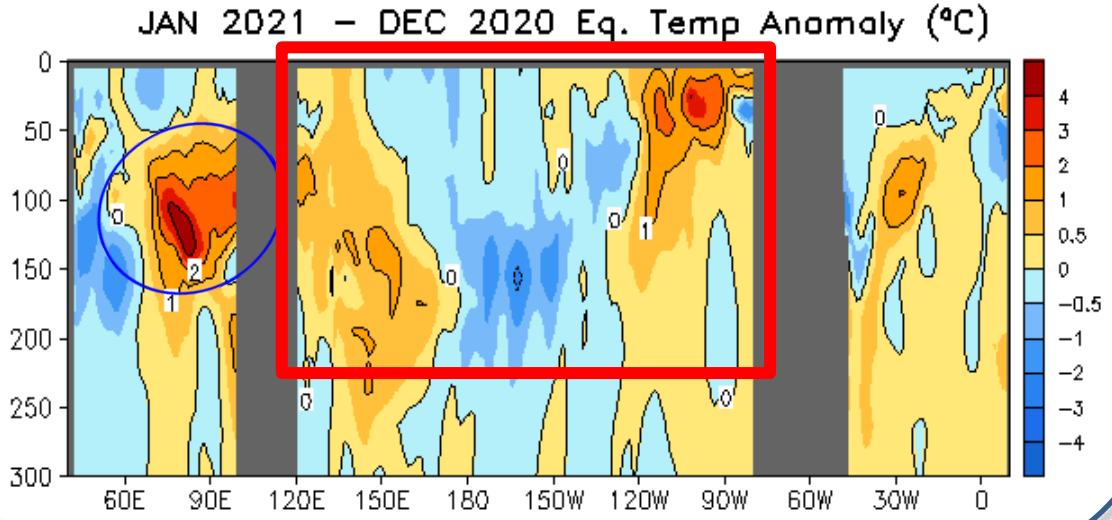
- Negative SSTAs persisted (weakened) in the central (eastern) equatorial Pacific.
- Positive SSTAs persisted in the northeastern Pacific.
- Positive (negative) SSTAs were observed across the tropical North (South) Atlantic.
- SSTs were mostly below average in the tropical Indian Ocean.

- Overall positive SSTA tendencies were observed in the eastern equatorial Pacific.
- Negative SSTA tendencies presented in the tropical Indian Ocean.

SSTAs (top) and SSTA tendency (bottom). Data are derived from the 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



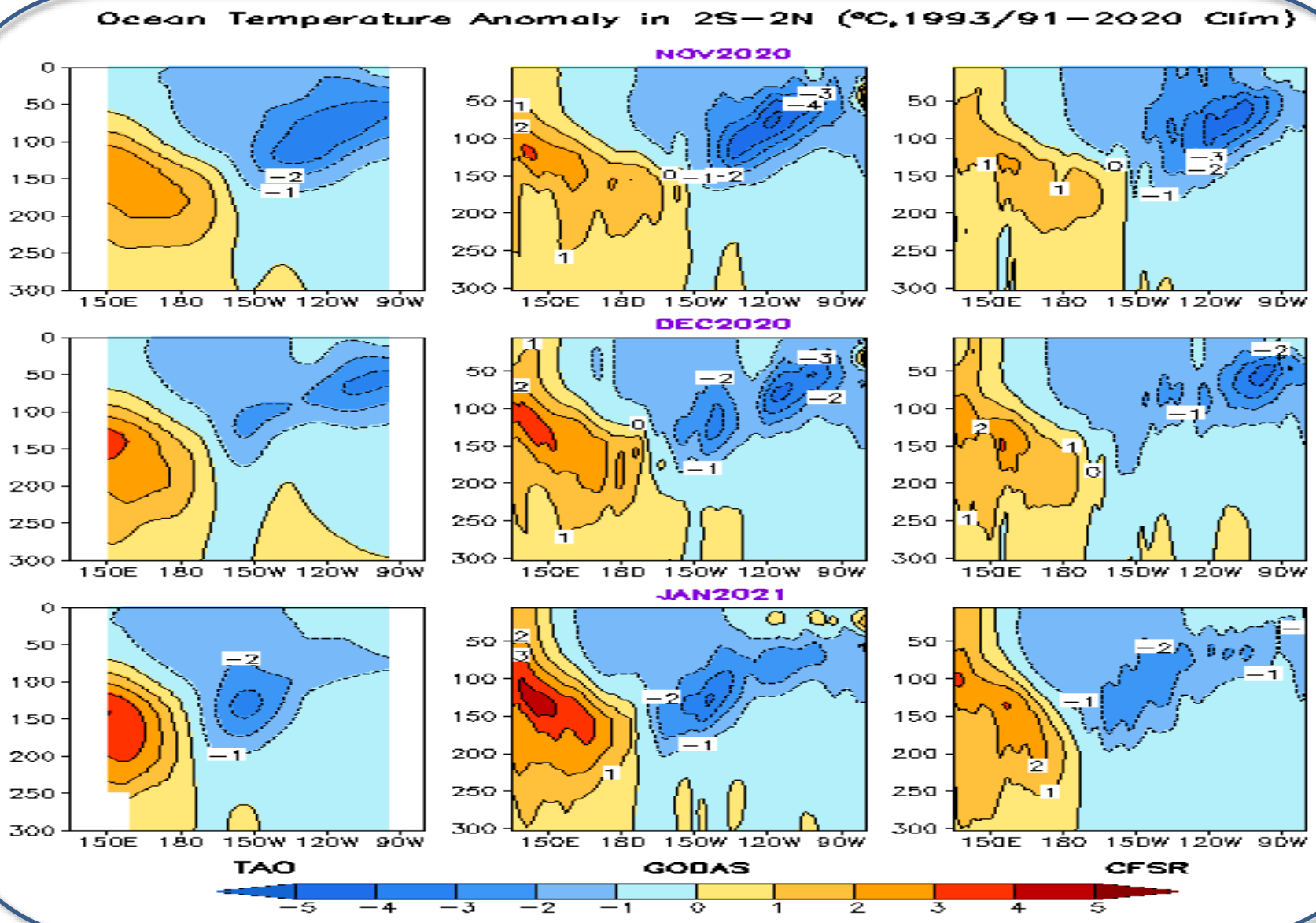


- Negative (positive) temperature anomalies presented along the thermocline in the central and eastern (western) equatorial Pacific.
- Strong positive temperature anomalies were observed in the eastern equatorial Indian Ocean.

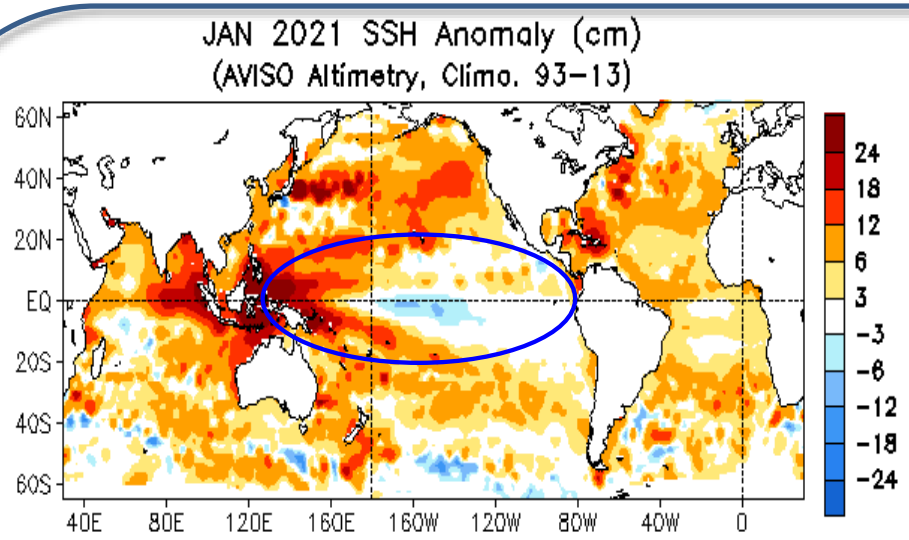
- Temperature anomaly tendency was positive along the thermocline in the western and far astern Pacific.
- Positive temperature anomaly tendency was evident in the eastern Indian Ocean.

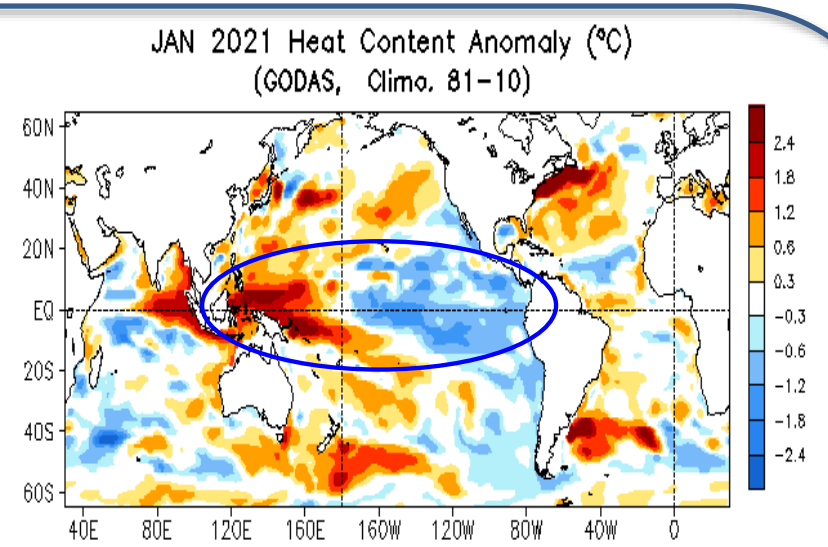
Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data is from the NCEP's GODAS. Anomalies are departures from the 1981-2010 base period means.

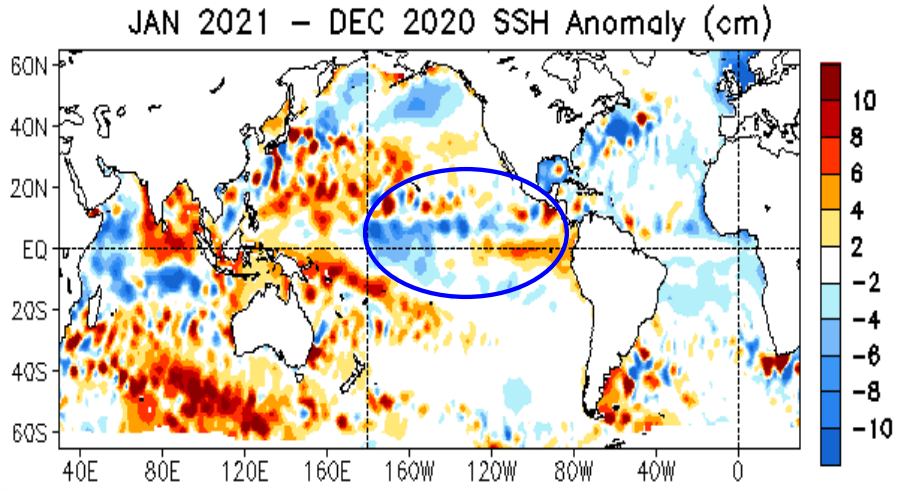
TAO, GODAS, & CFSR monthly mean subsurface temperature anomaly along the Equator during the last 3 months

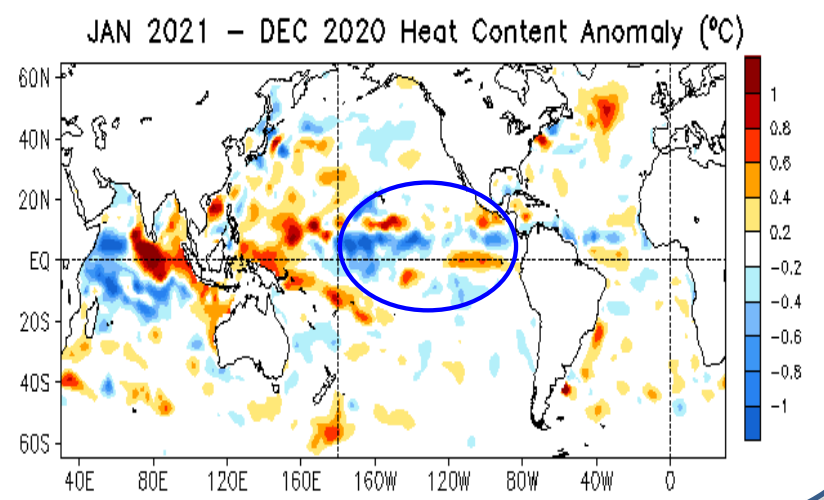


Global SSH and HC300 Anomaly & Anomaly Tendency





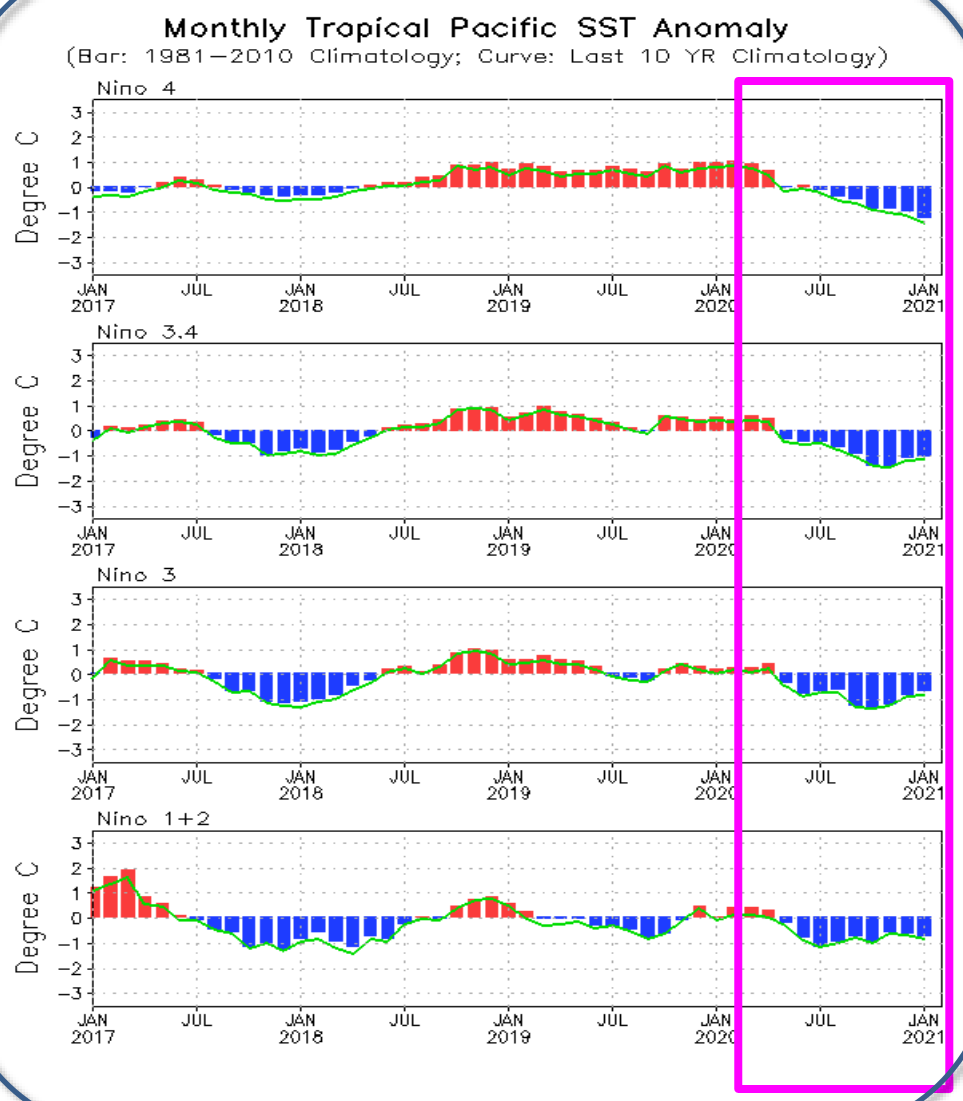


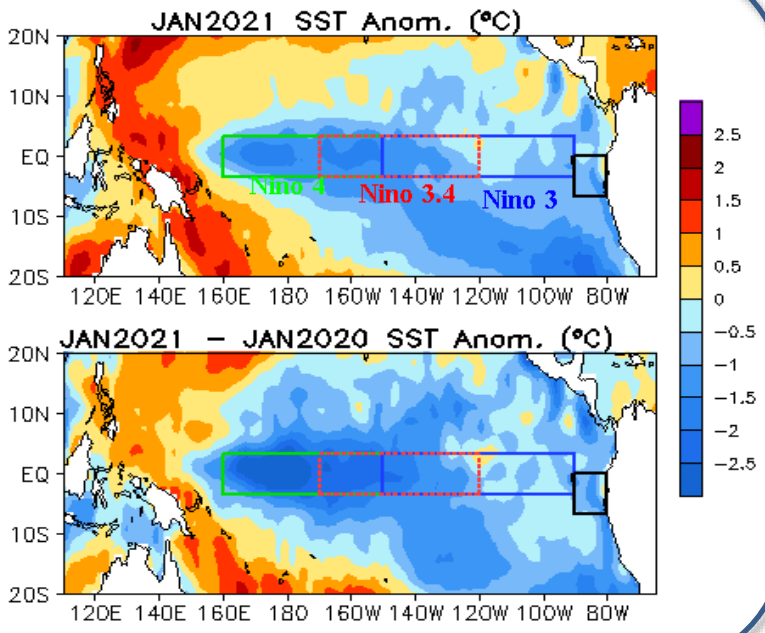


- The SSHA pattern was overall consistent with the HC300A pattern, but with a significant trend component in SSHA.
- Positive (negative) tendencies presented in the eastern (east-central) equatorial Pacific.

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific Niño SST Indices





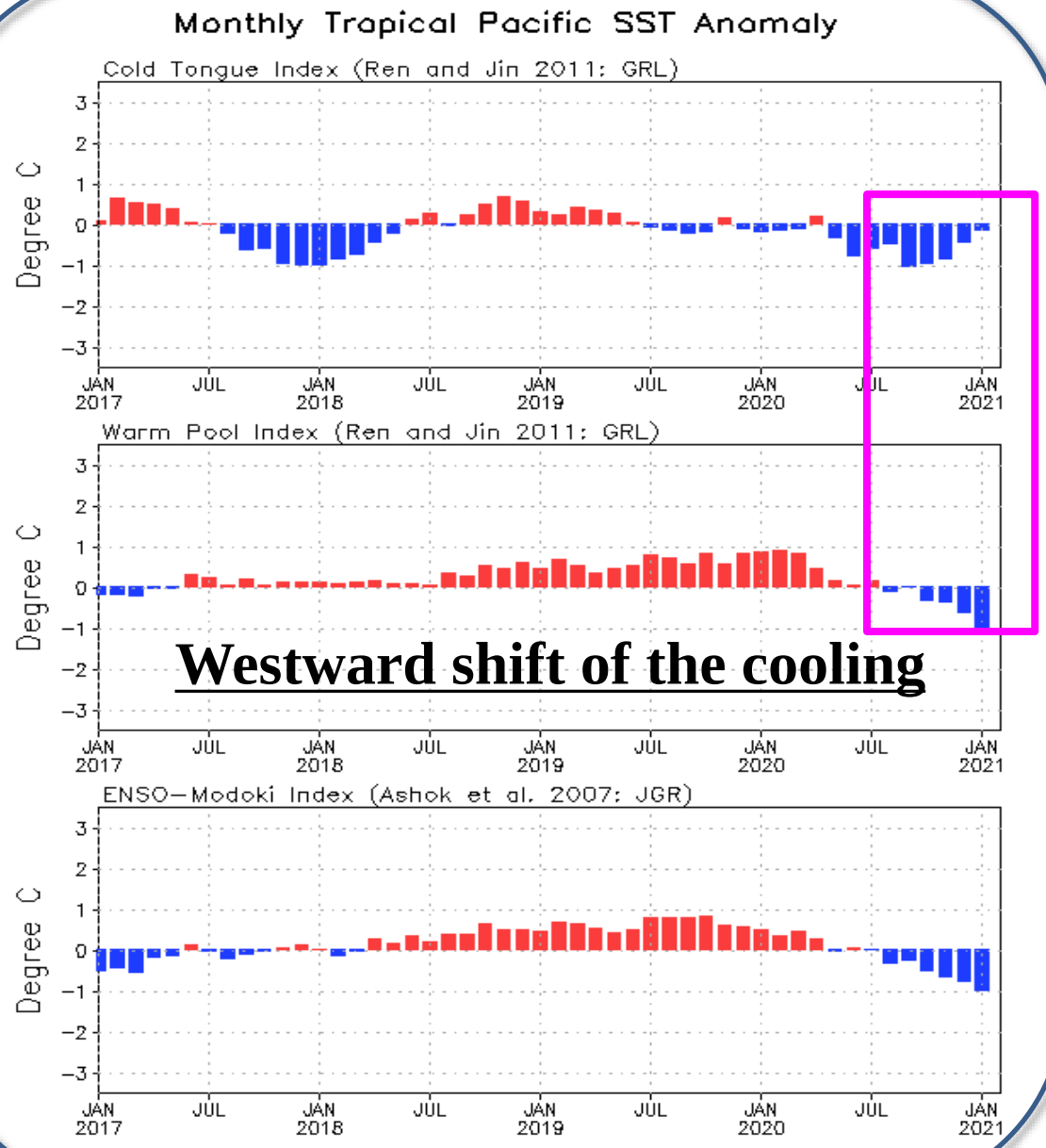
- The Niño3.4 and Niño3 indices weakened slightly in Jan 2021, with Niño3.4 = -1.05C.

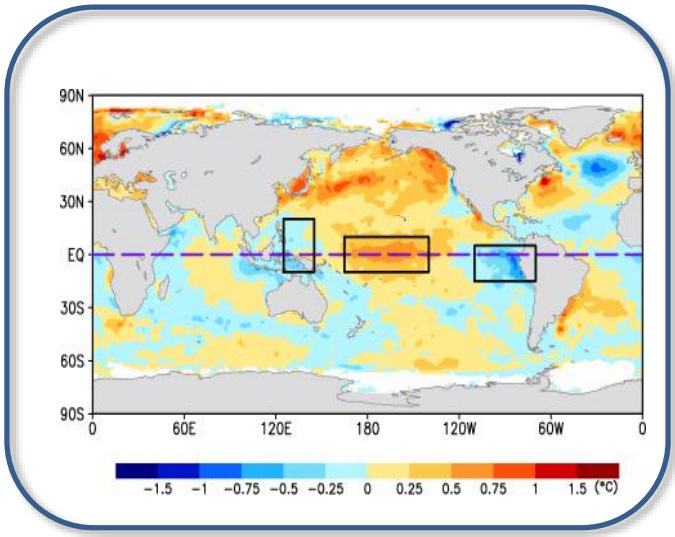
- Compared with Jan 2019, the central and eastern (far western) equatorial Pacific was cooler (warmer) in Jan 2021.

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

Niño region indices, calculated as the area-averaged monthly mean SSTAs (°C) for the specified region. Data are derived from the OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

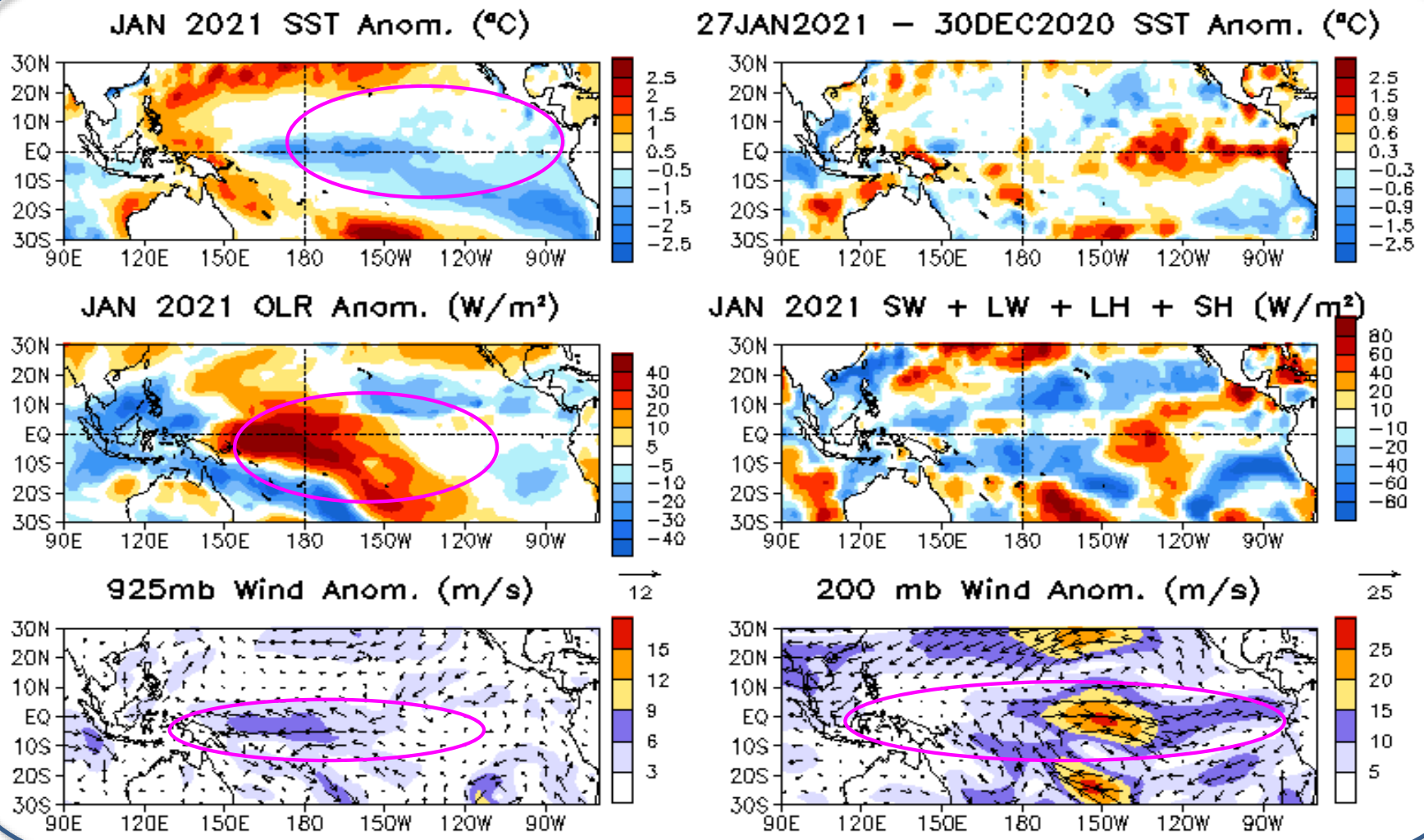
Monthly Tropical Pacific SST Anomaly





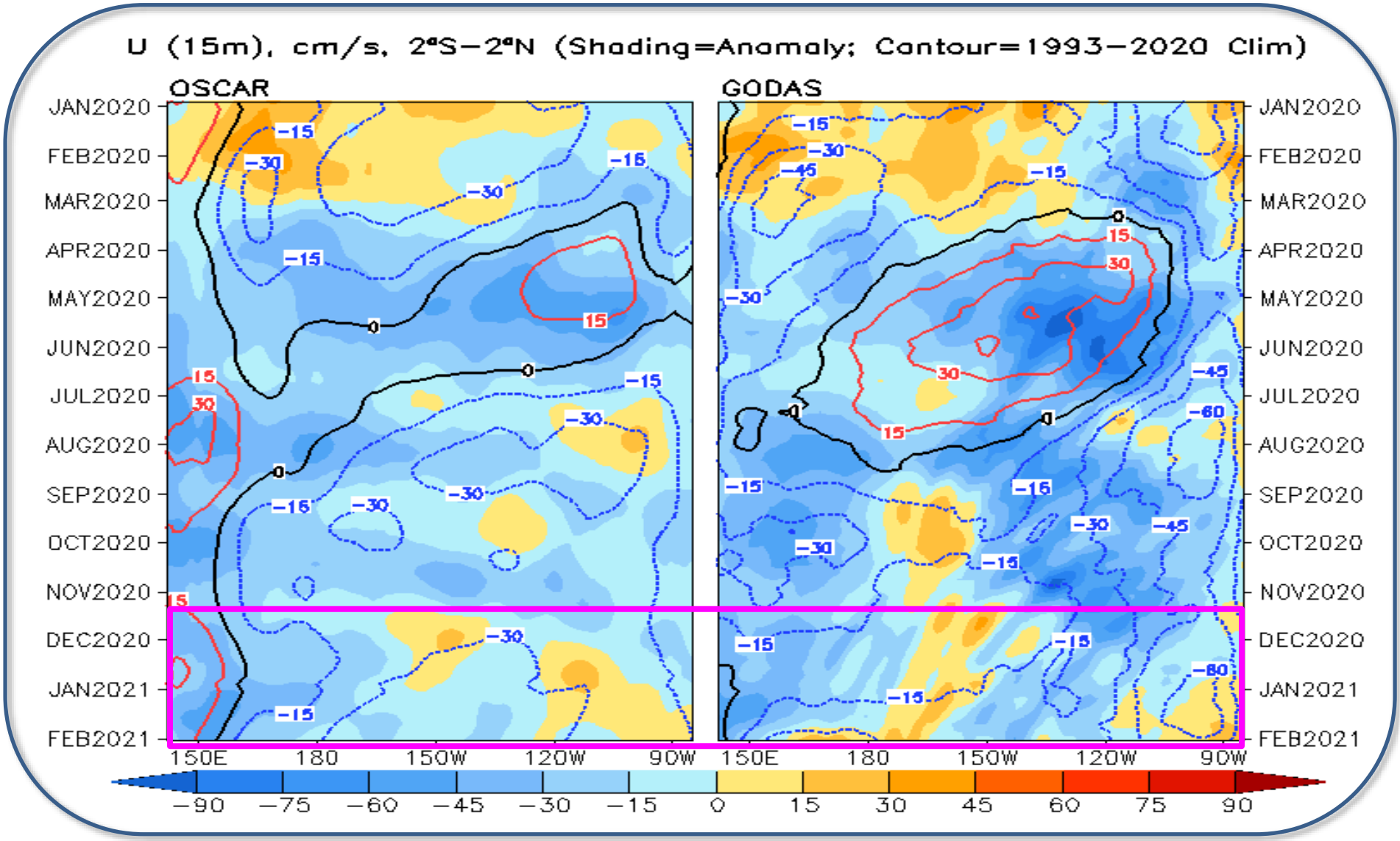
- The warm pool, cold tongue, ENSO-Modoki indices were negative in Jan 2021.

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



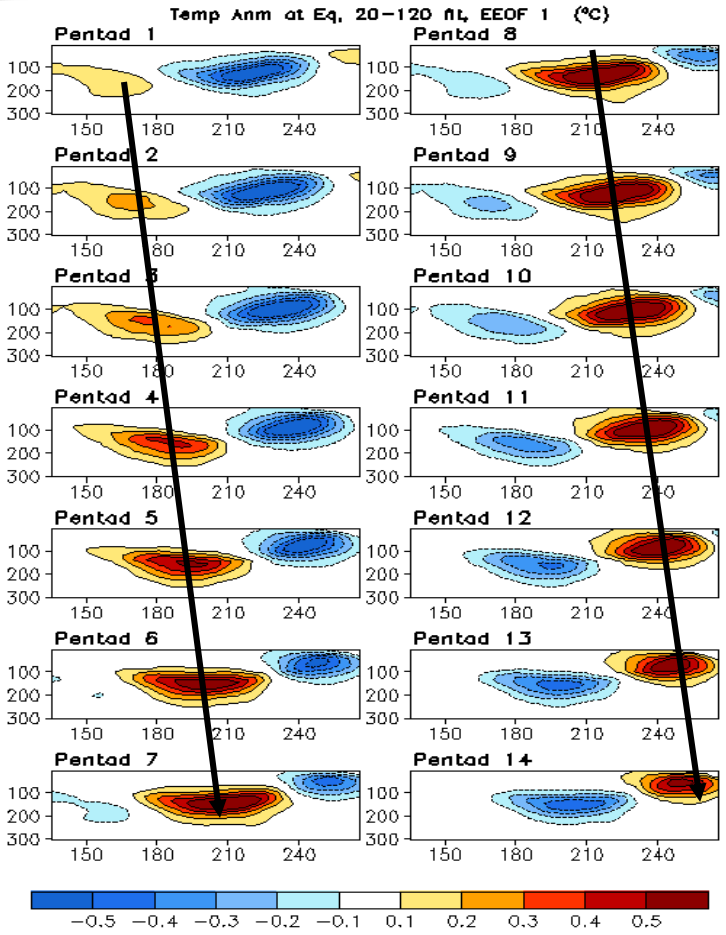
SSTAs (top-left), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right; positive means heat into the ocean), 925-mb wind anomaly vector and its amplitude (bottom-left),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

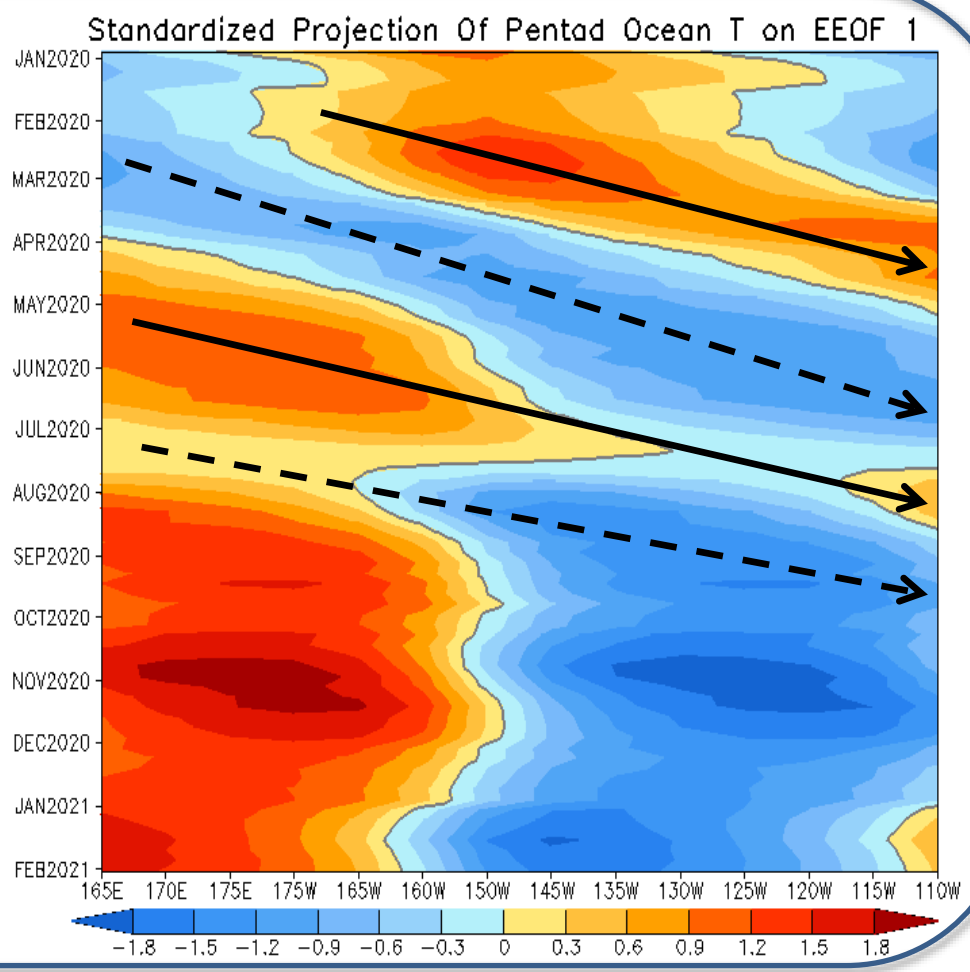
OSCAR&GODAS: Time Evolution of Equatorial Pacific Surface Zonal Current (cm/s)



- Anomalous westward currents and pockets of eastward currents were observed in the equatorial Pacific in both OSCAR and GODAS in Jan 2021.

Oceanic Kelvin Wave (OKW) Index



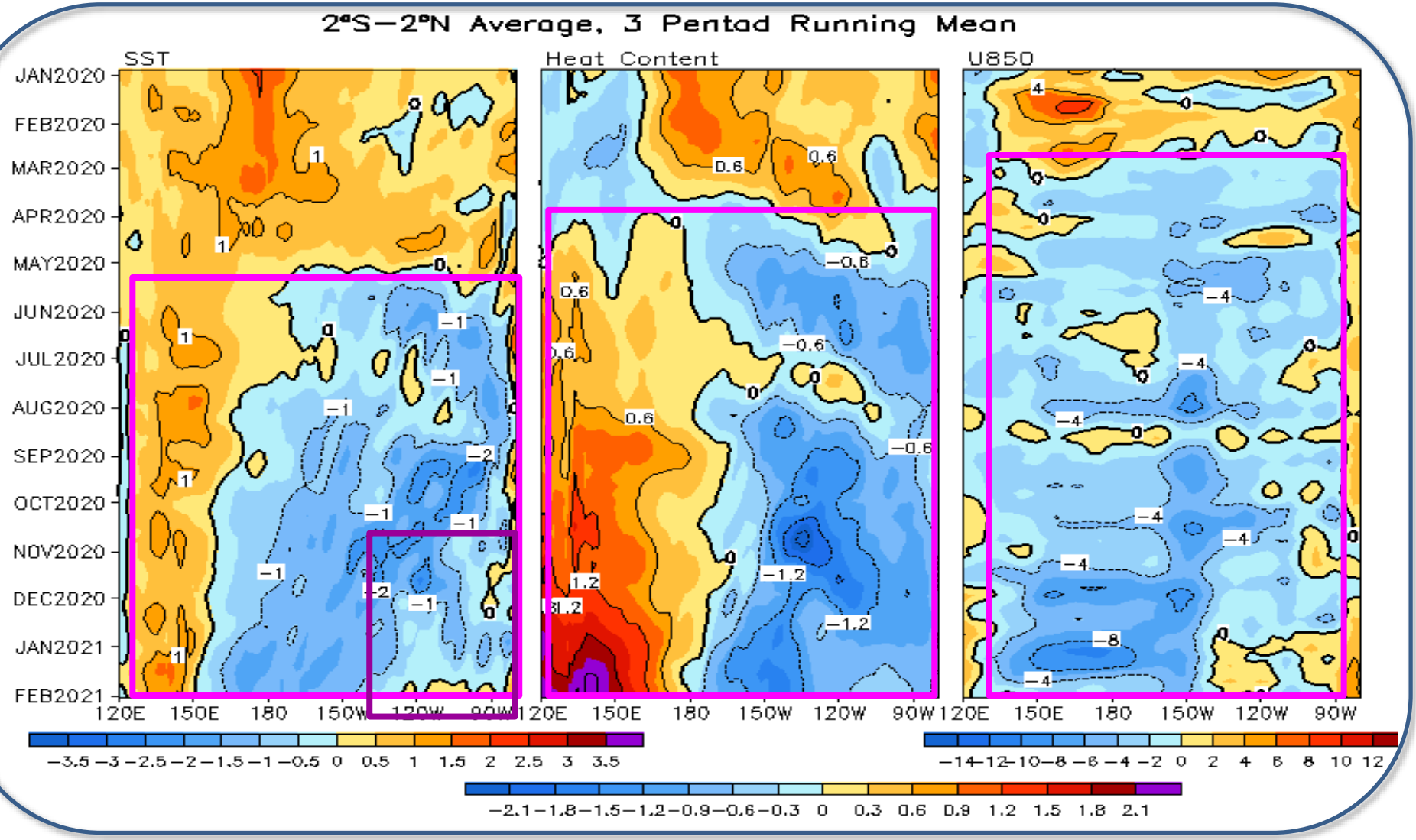


- **Upwelling Kelvin waves were initiated in Feb & Jul 2020, leading to the subsurface cooling in the eastern equatorial Pacific.**

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

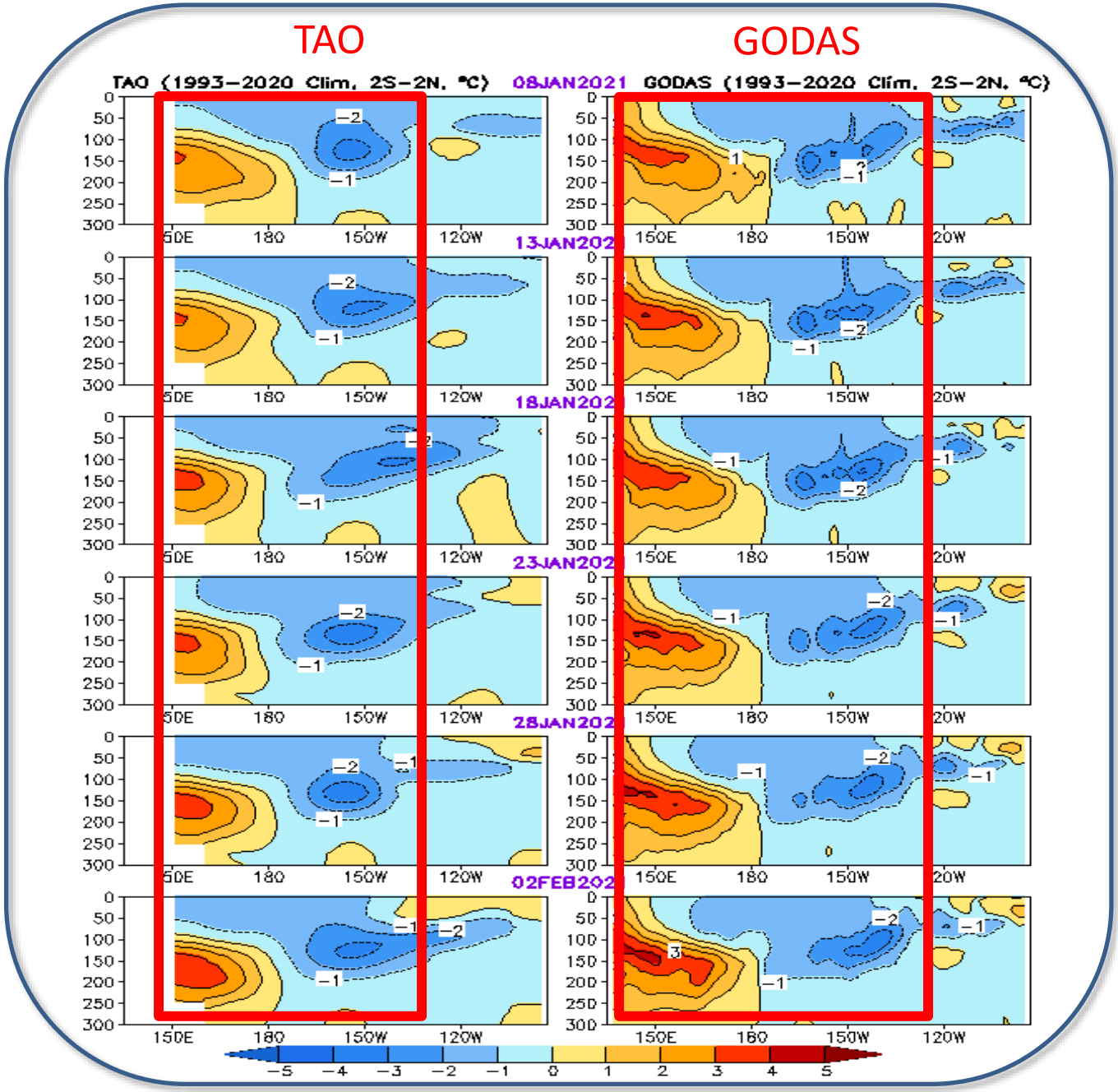
(OKW index is defined as standardized projections of total anomalies onto the 14 patterns of Extended EOF1 of equatorial temperature anomalies (Seo and Xue , GRL, 2005).)

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



- Easterly wind anomaly was present across the equatorial Pacific since Mar 2020.
- Below- (above-) average HC300 was observed in the eastern (western) Pacific since Apr 2020.
- Negative SSTA weakened in the eastern equatorial Pacific in Jan 2021.

Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

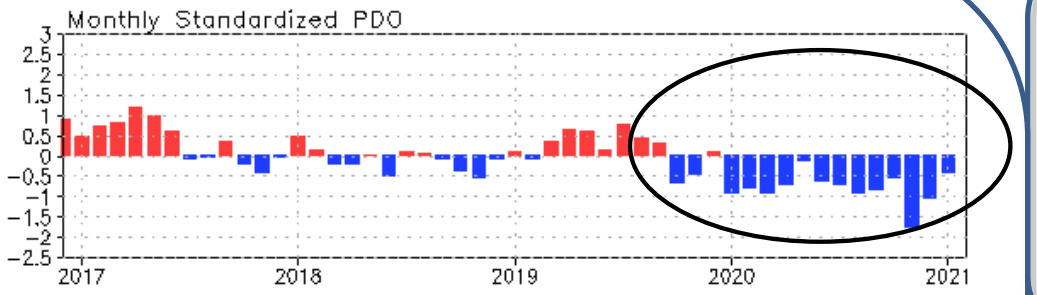


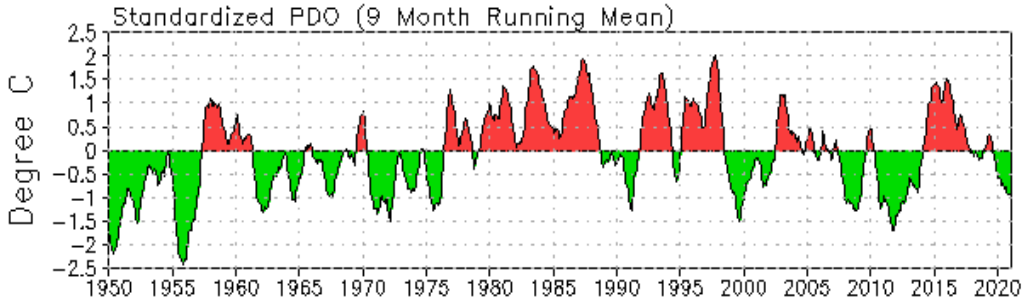
- Negative (positive) ocean temperature anomalies along the thermocline in the east-central (west) persisted in the last month, featuring a strong tilt/dipole mode

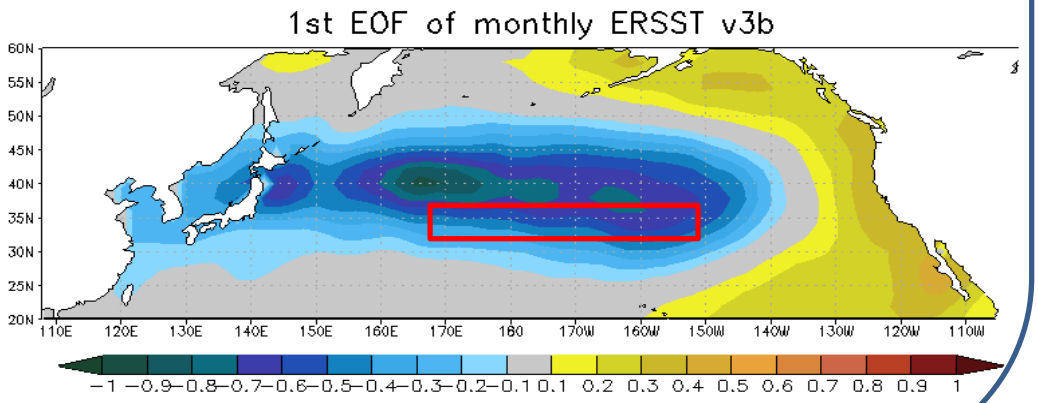
- The features of the ocean temperature anomalies were similar between GODAS and TAO analysis.

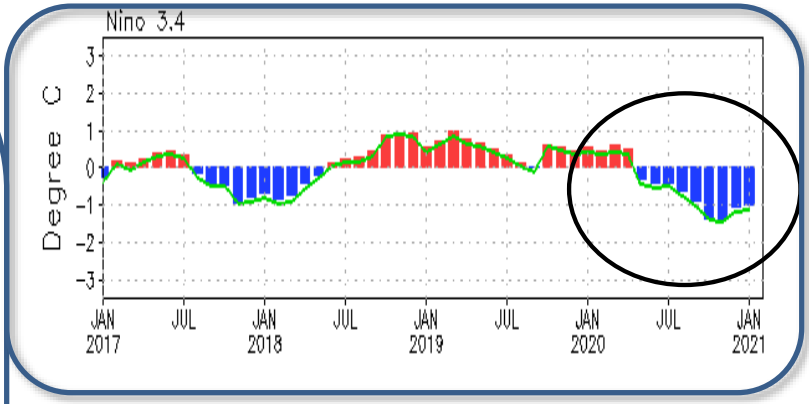
North Pacific & Arctic Oceans

Pacific Decadal Oscillation (PDO) Index







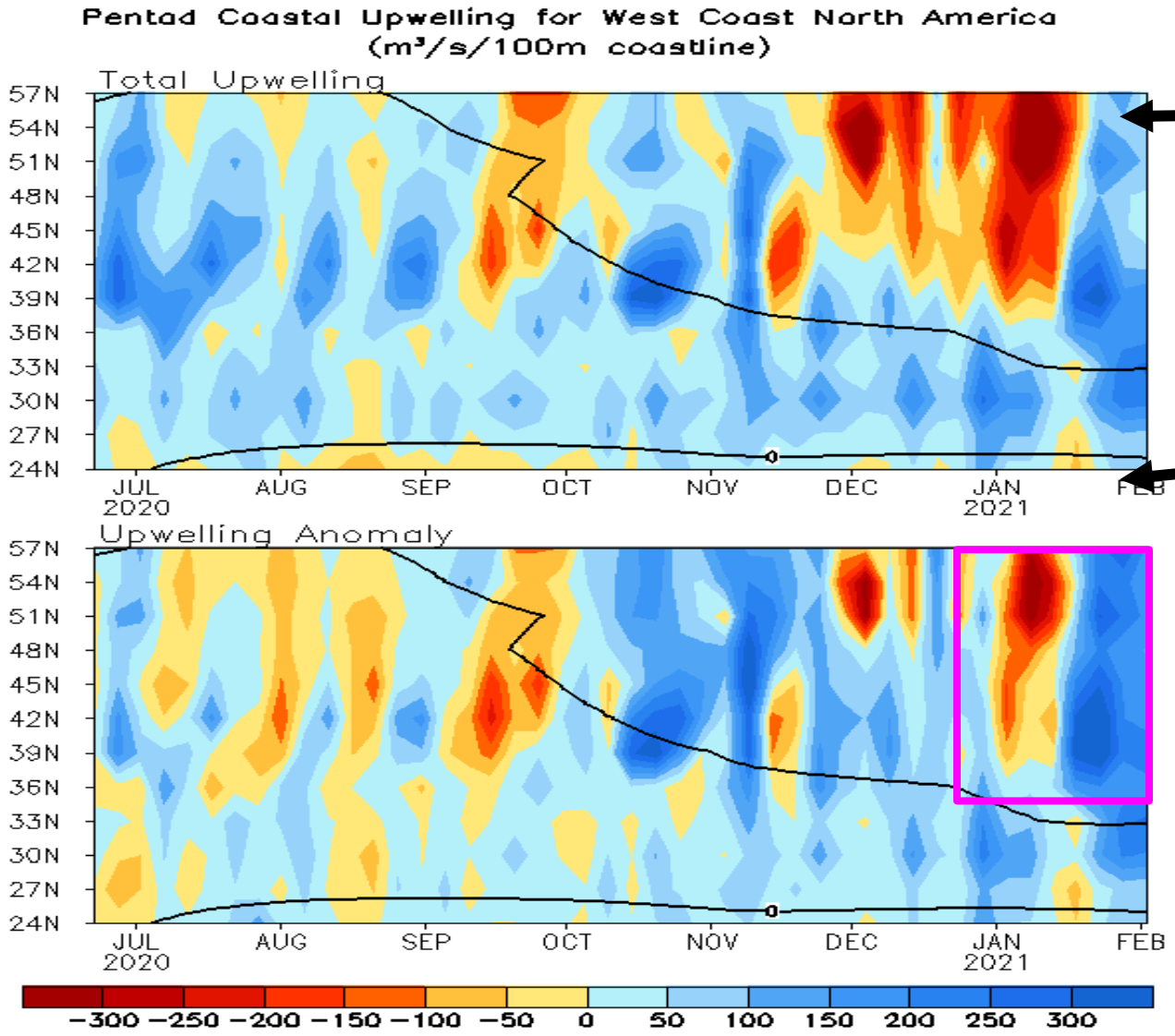


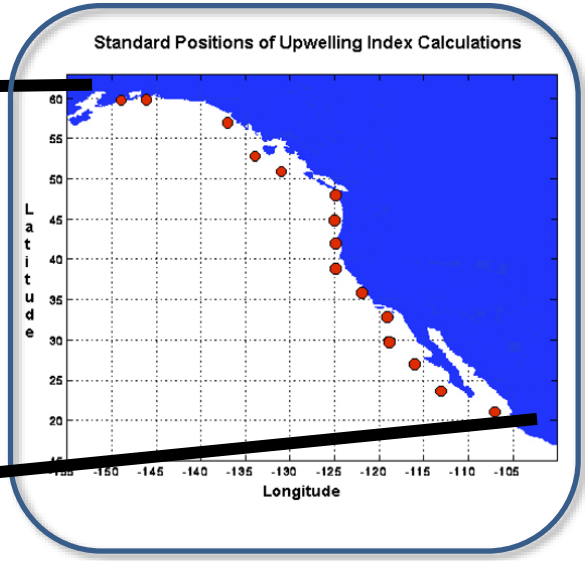
- The PDO has been in a negative phase since Jan 2020 and weakened since Dec 2020 with PDOI = -0.4 in Jan 2021.

- Statistically, ENSO leads PDO by 3-4 months, through teleconnection via atmospheric bridge, with El Niño (La Niña) 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

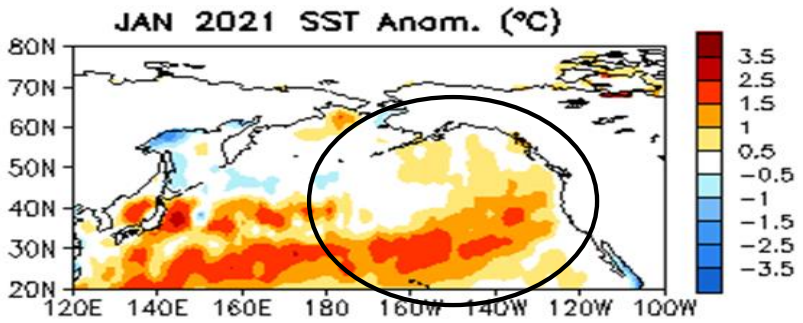


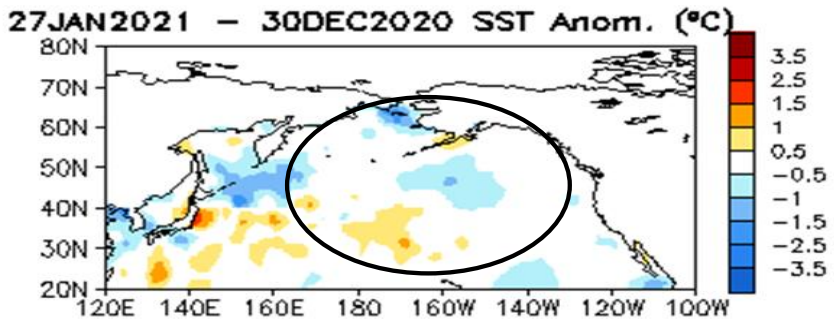


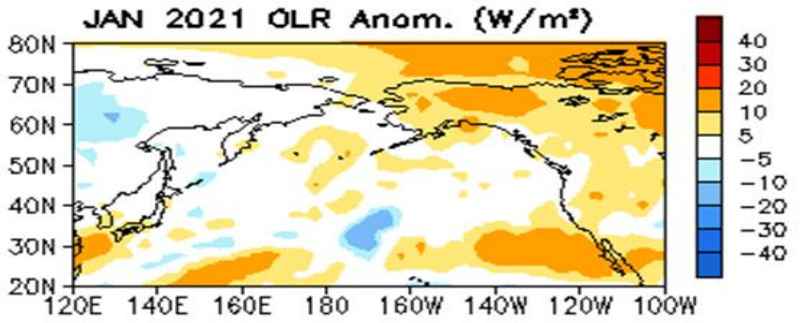
- Coastal anomalous downwelling (upwelling) was present north of 35°N in the 1st (2nd) half of Jan 2021.

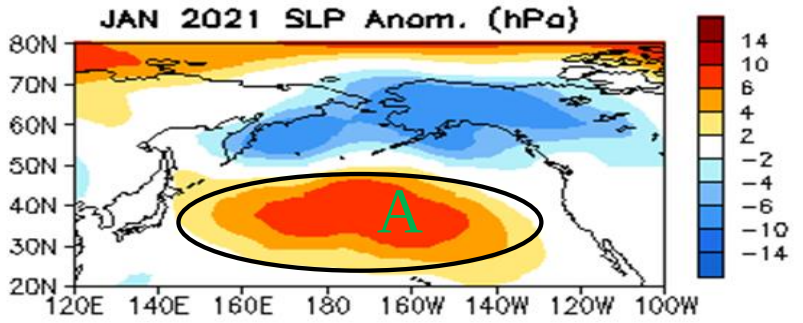
(top) Total and (bottom) anomalous upwelling indices at the 15 standard locations for the western coast of North America. Derived from the vertical velocity of the NCEP's GODAS and are calculated as integrated vertical volume transport at 50-meter depth from each location to its nearest coast point ($m^3/s/100m$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

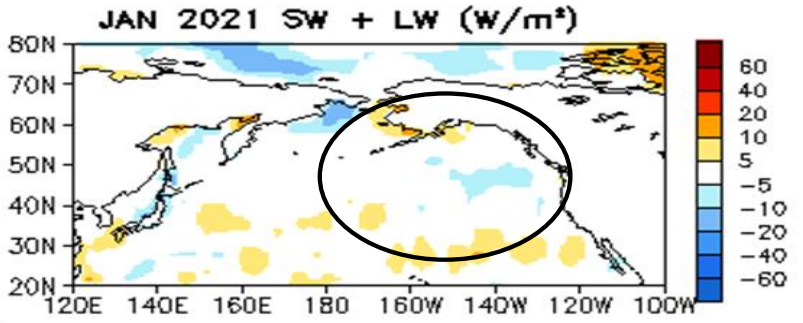
North Pacific & Arctic Ocean: SSTA, SSTA Tend., OLR, SLP, Sfc Rad, Sfc Flx Anomalies

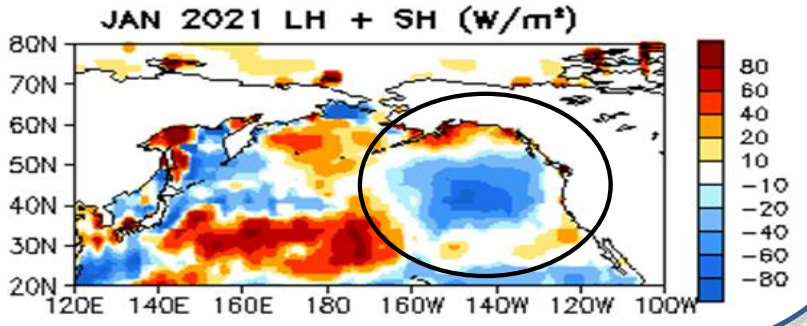






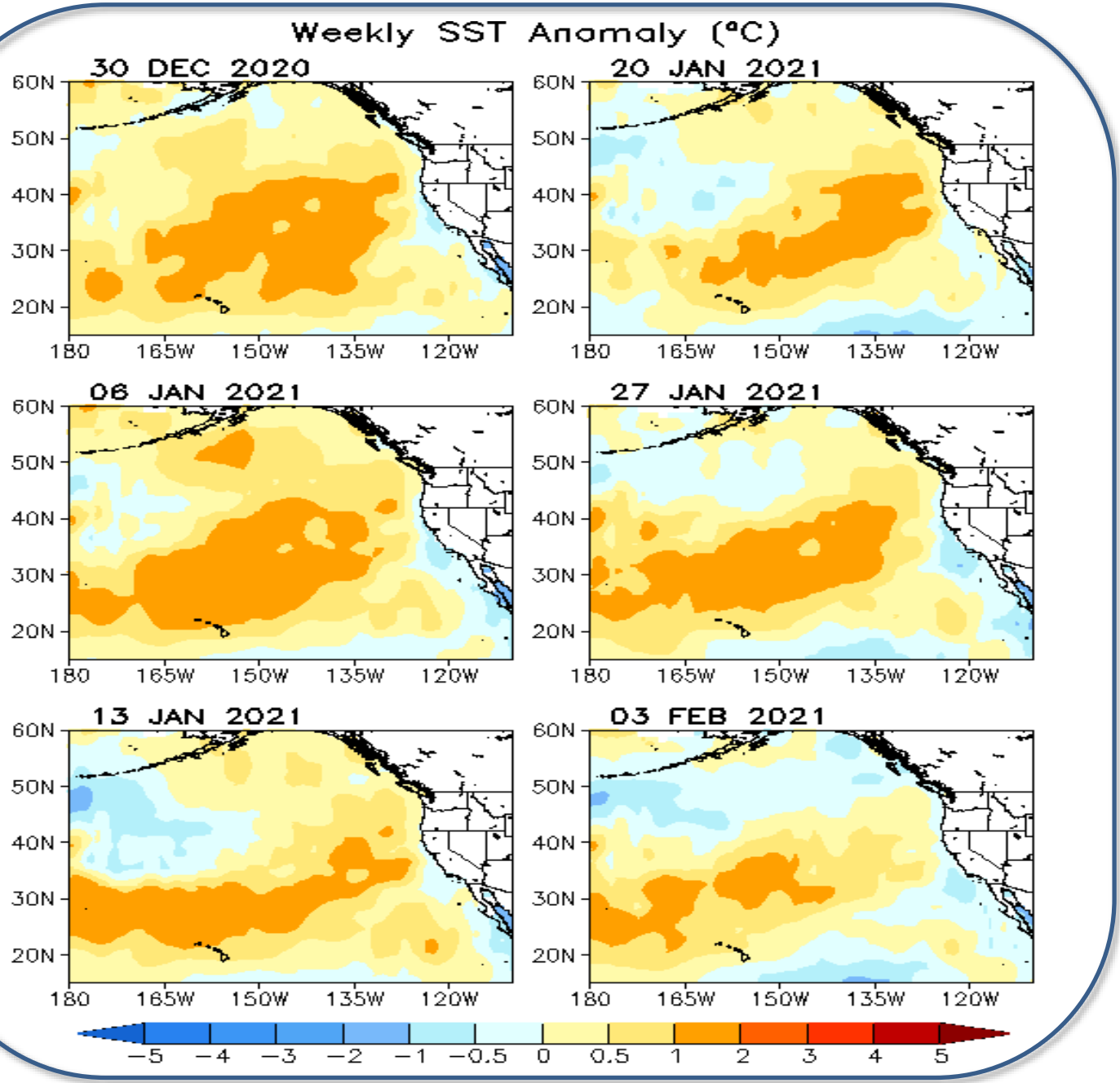






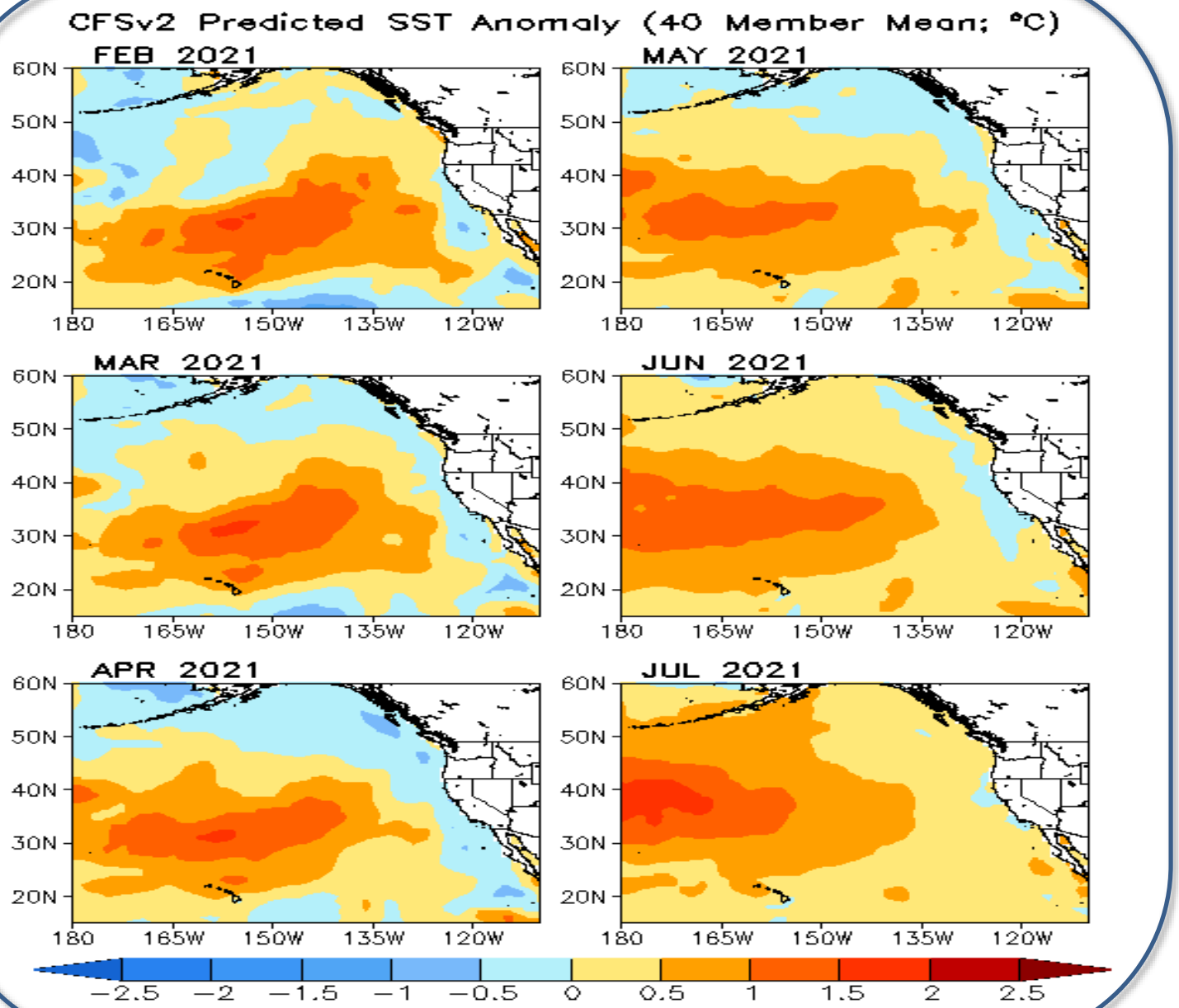
SSTA (top-left; OI SST Analysis), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) (middle-left; NOAA 18 AVHRR IR), sea surface pressure (middle-right; NCEP CDAS), sum of net surface short- and long-wave radiation (bottom-left; positive means heat into the ocean; NCEP CDAS), sum of latent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

Weekly SSTA evolutions in the NE Pacific



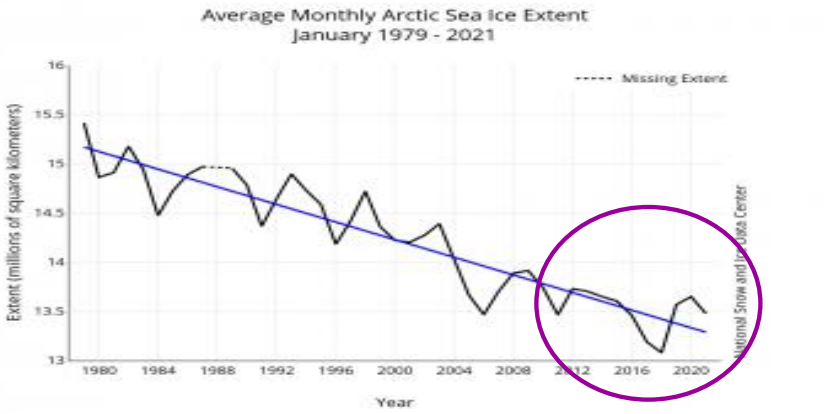
- The northeastern Pacific SST warming persisted during the last six weeks.

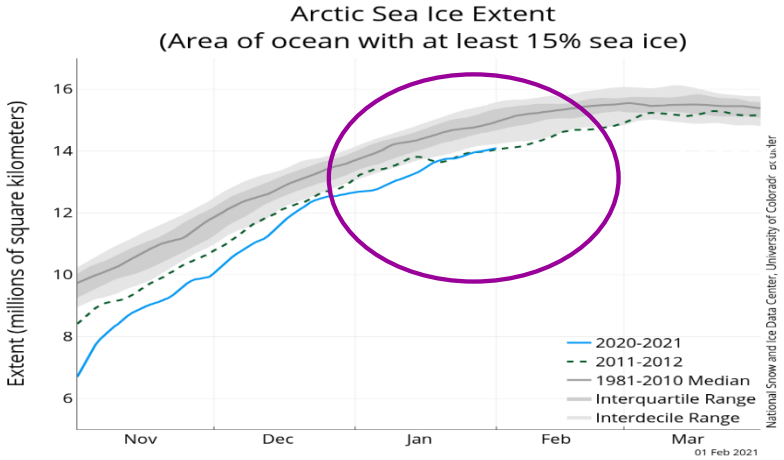
CFSv2 NE Pacific SSTA Predictions

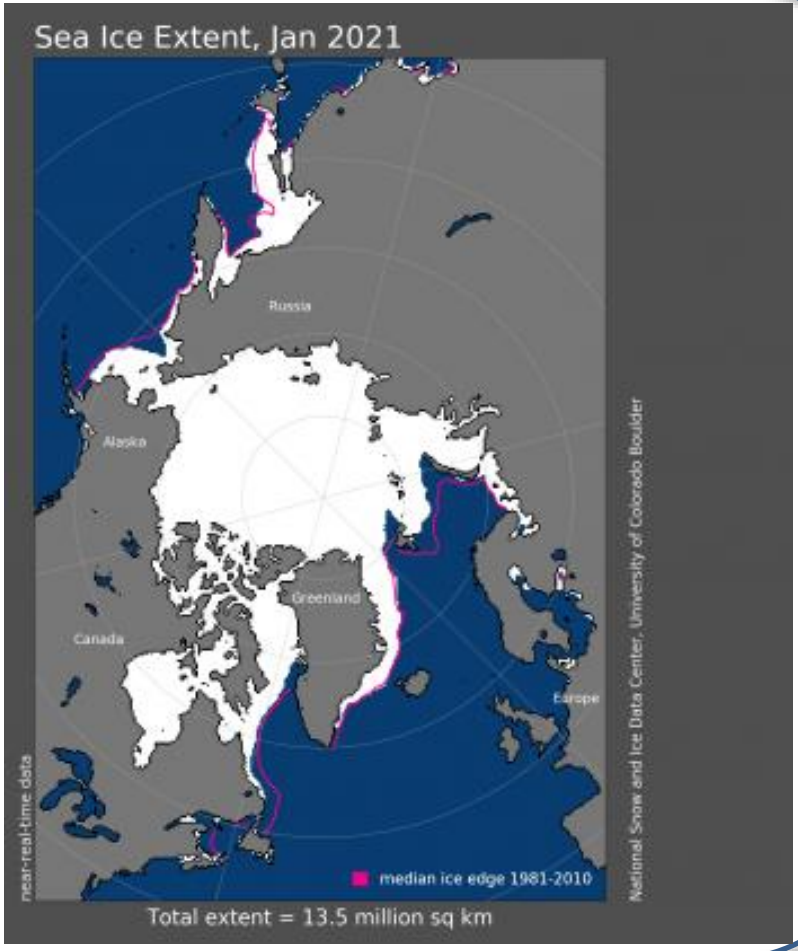


- The CFSv2 predicts the current SST warm state will continue.

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

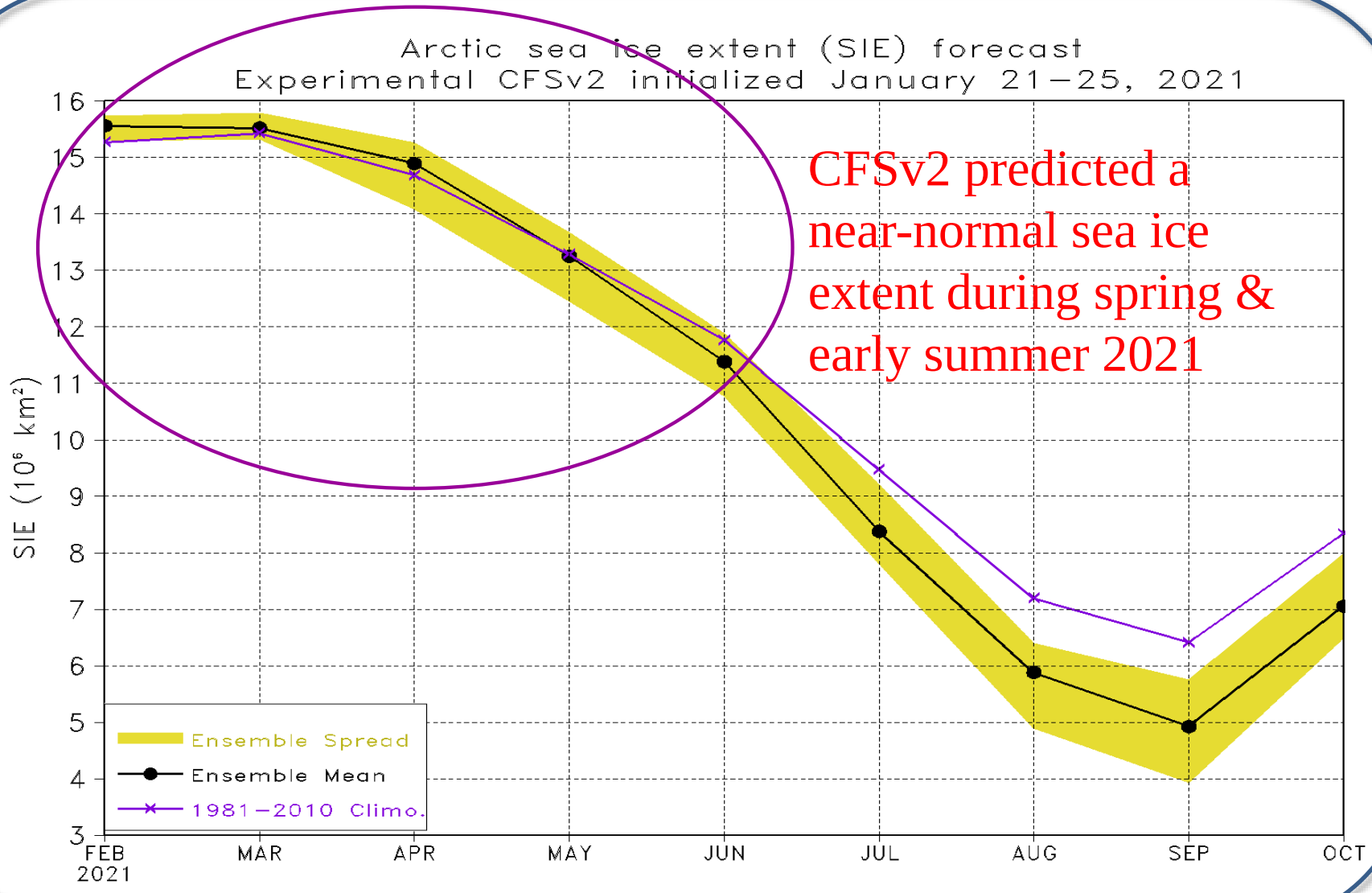






- Arctic sea ice extent averaged for Jan 2021 was the 6th lowest in the satellite record.
- Through 2021, the linear rate of decline for Jan sea ice extent is 3.1% per decade.

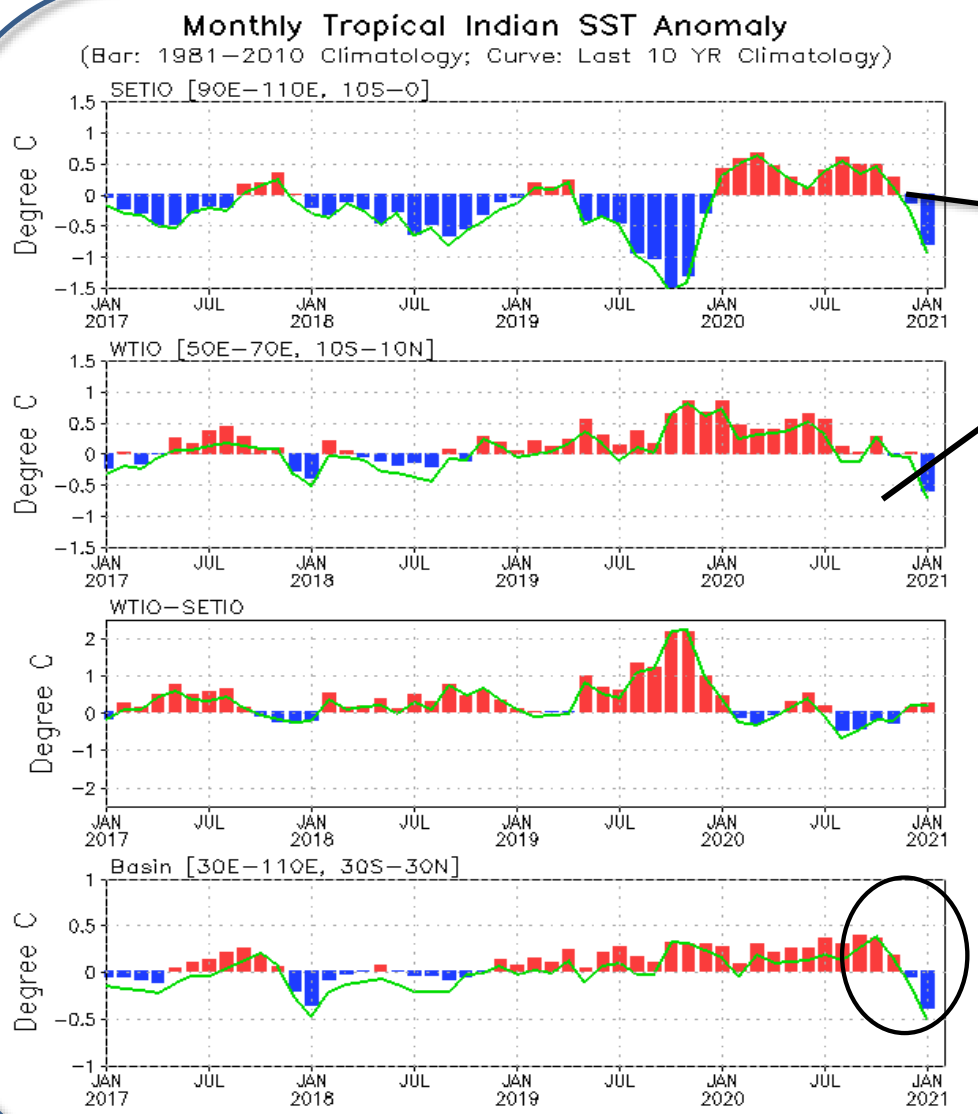
NCEP/CPC Arctic Sea Ice Extent Forecast

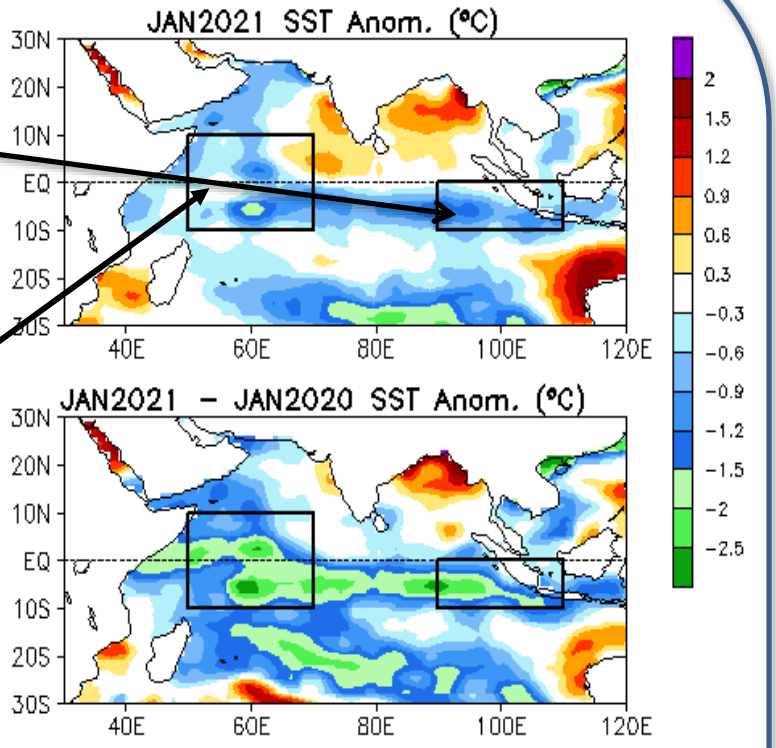


https://www.cpc.ncep.noaa.gov/products/people/wwang/seaice_seasonal/index.html

Indian Ocean

Evolution of Indian Ocean SST Indices

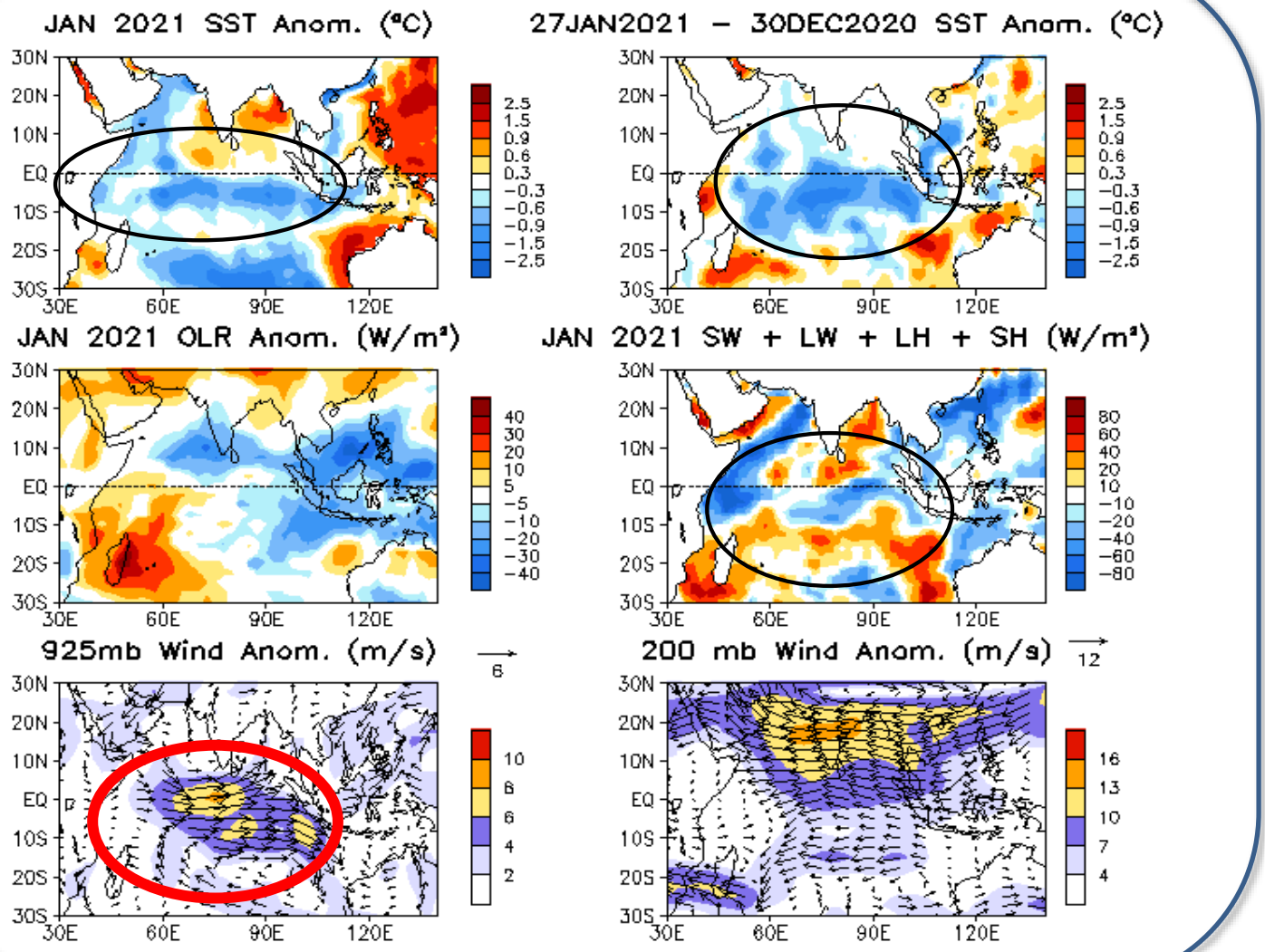




- SSTAs were mostly negative in the tropical Indian Ocean in Jan 2021.

Indian Ocean region indices, calculated as the area-averaged monthly mean SSTA (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 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.



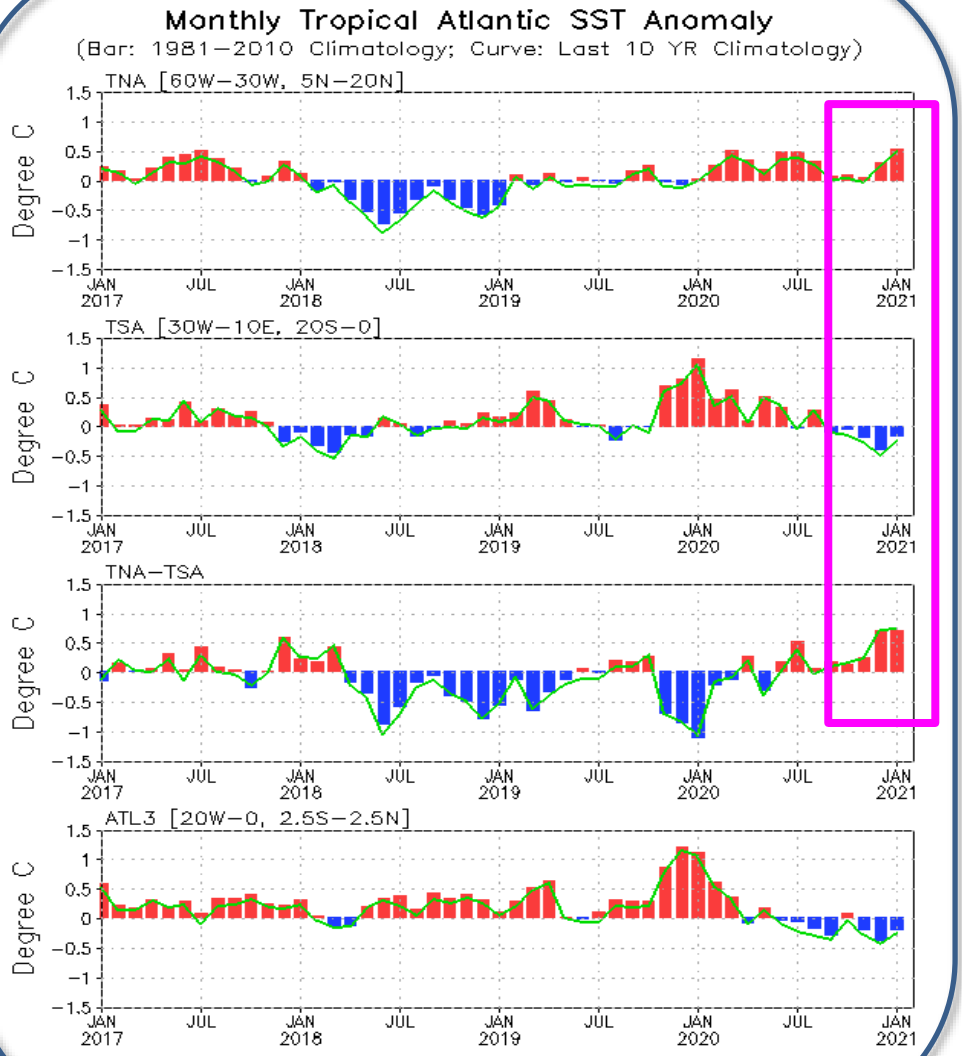
- SSTAs and the tendencies were overall negative in the tropical Indian Ocean.

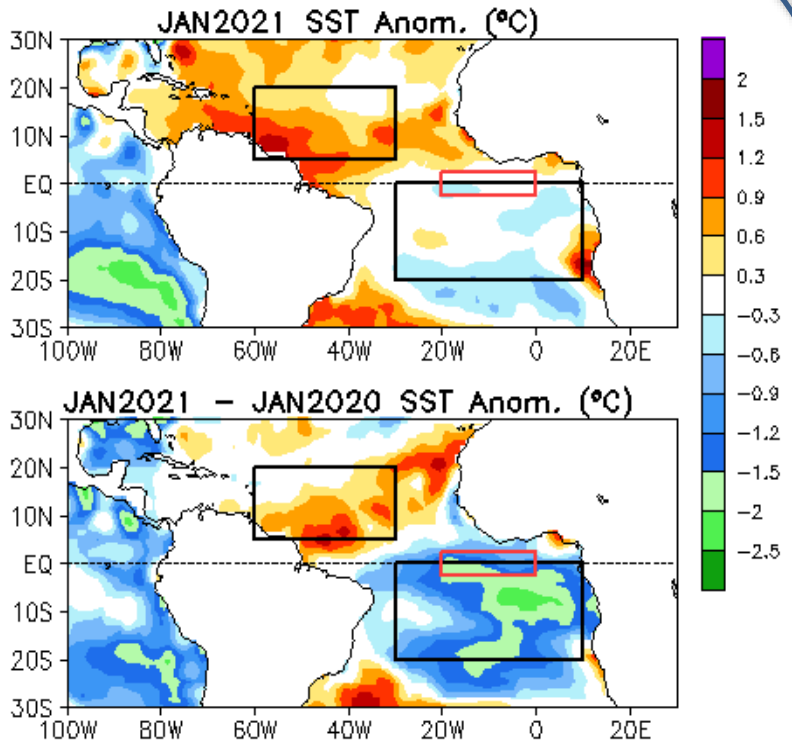
- Westerly wind anomaly persisted in the tropical Indian Ocean.

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.

Tropical and North Atlantic Ocean

Evolution of Tropical Atlantic SST Indices

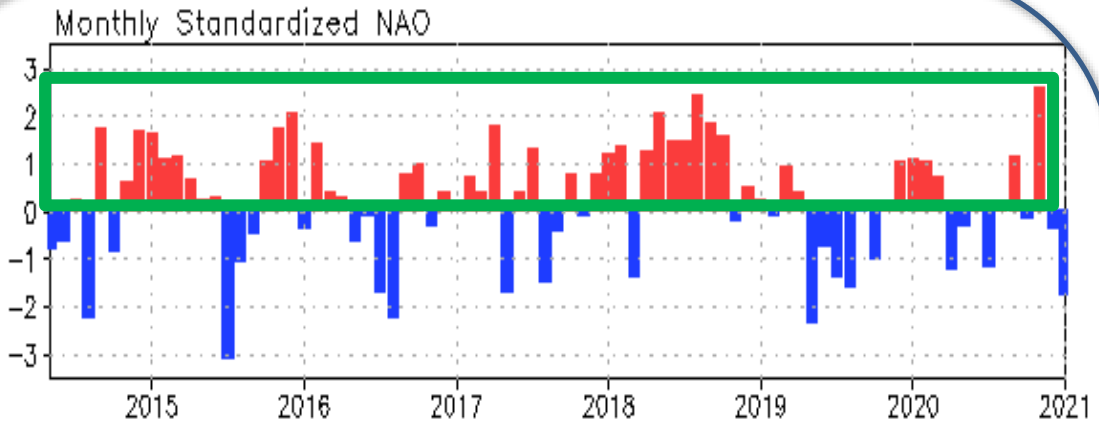


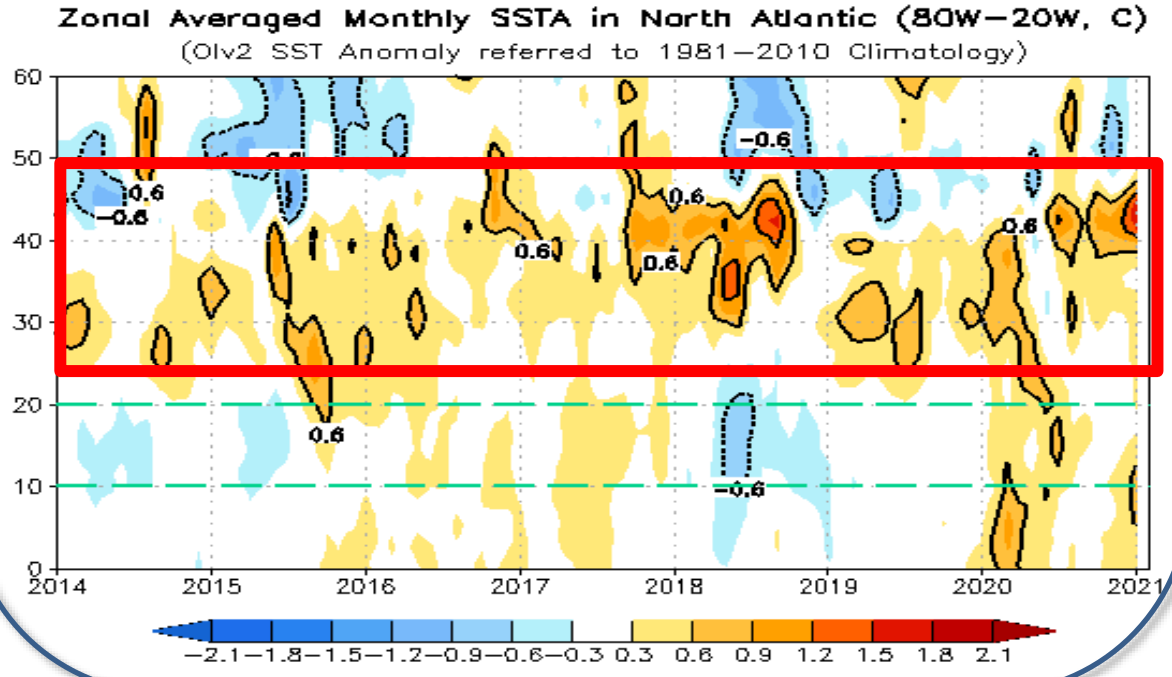


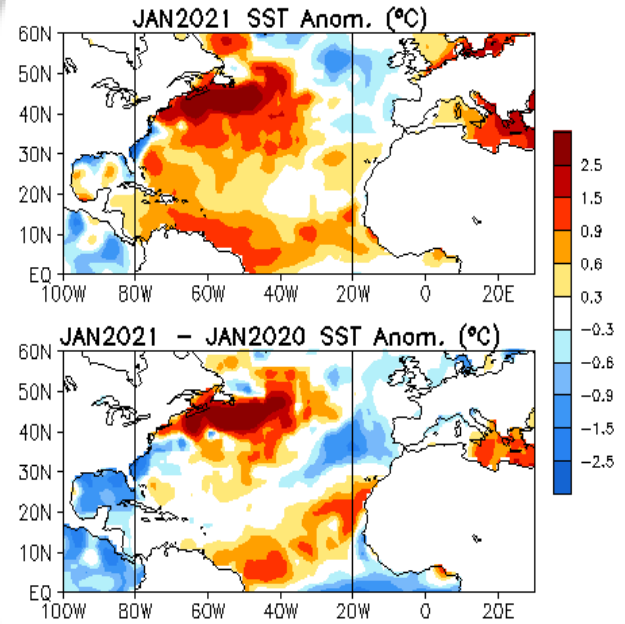
- Positive (negative) SSTAs in the tropical North (South) Atlantic feature a strong Atlantic meridional dipole mode during Dec 2020-Jan2021.

Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean SSTAs (^{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 OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

NAO and SST Anomaly in North Atlantic





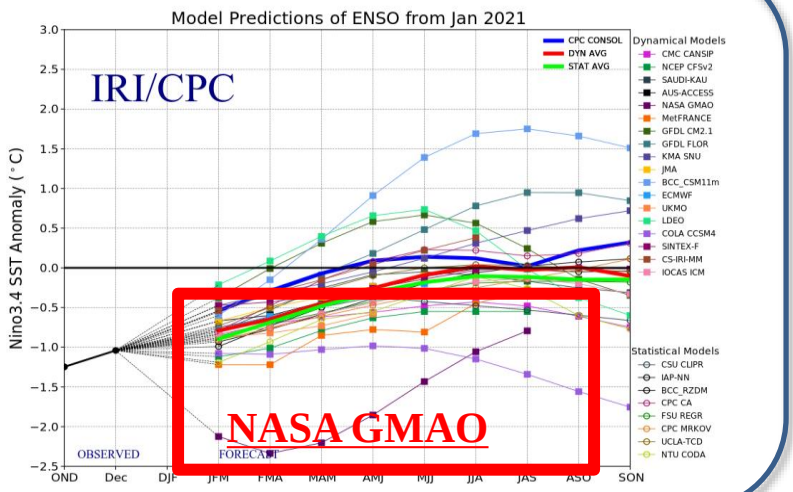


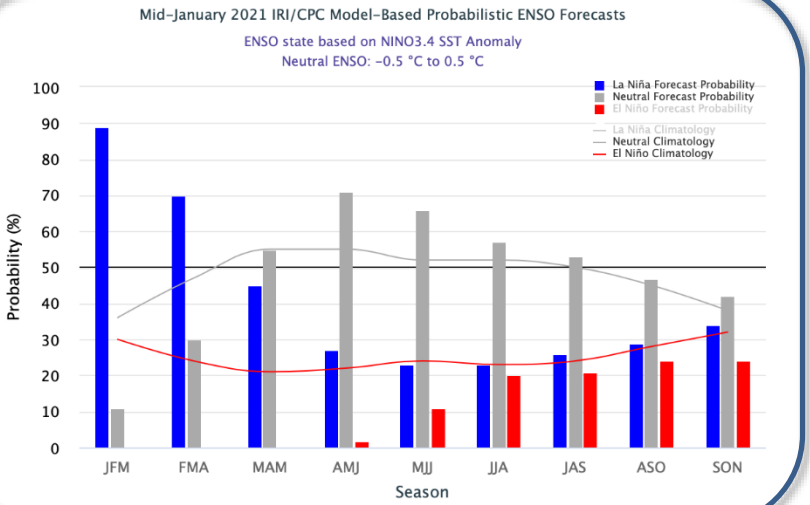
- NAO was in a negative phase in Jan 2021 with NAOI= -1.8.
- The prolonged positive SSTAs in the middle latitudes were evident, due to the domination of the positive phase of NAO during the last 5-6 years.

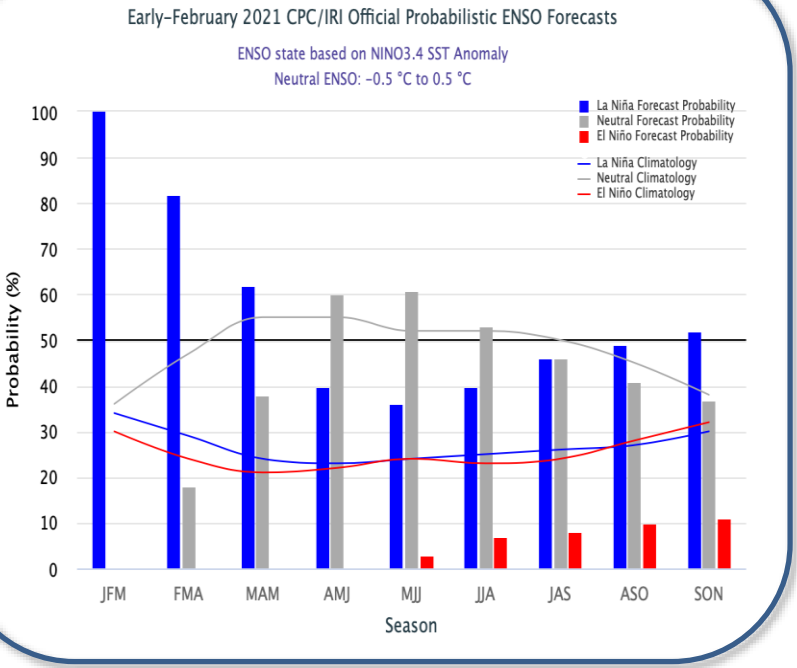
Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20°N-90°N. Time-latitude section of SSTAs averaged between 80ºW and 20ºW (bottom). SST are derived from the OI SST analysis, and anomalies are departures from the 1981-2010 base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

ENSO and Global SST Predictions

IRI/CPC Niño3.4 Forecast: Feb 2021



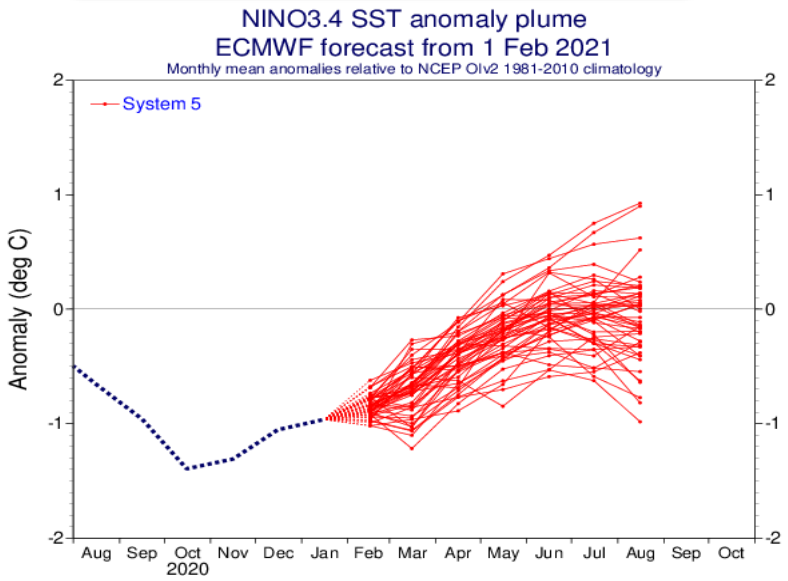




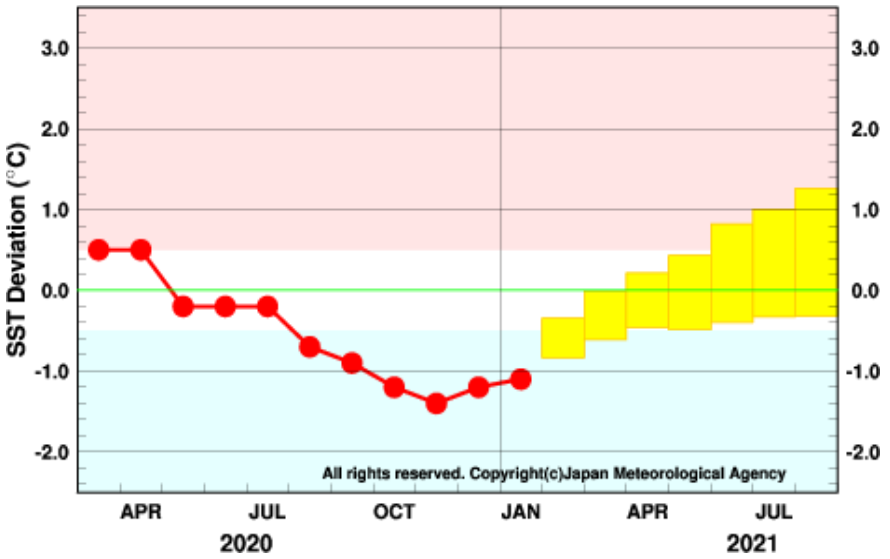
- **ENSO Alert System Status: La Niña Advisory**
- <u>Synopsis:</u> *There is a ~60% chance of a transition from La Niña to ENSO-Neutral during the Northern Hemisphere spring 2021 (April-June). .*

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

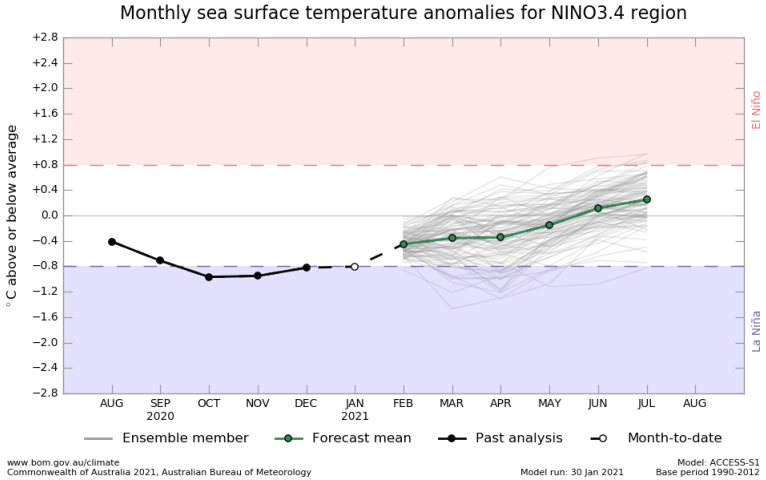
EC: IC= 01 Feb, 2021



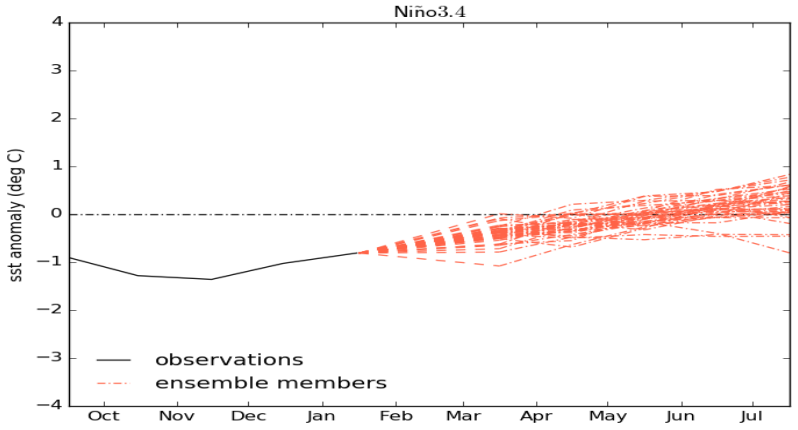
JMA: Updated 10 Feb, 2021



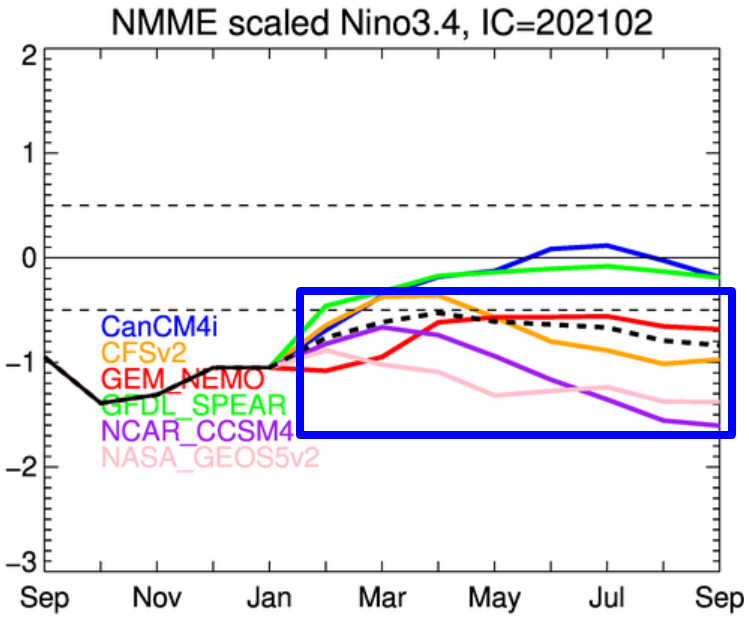
BOM: Updated 30 Jan, 2021

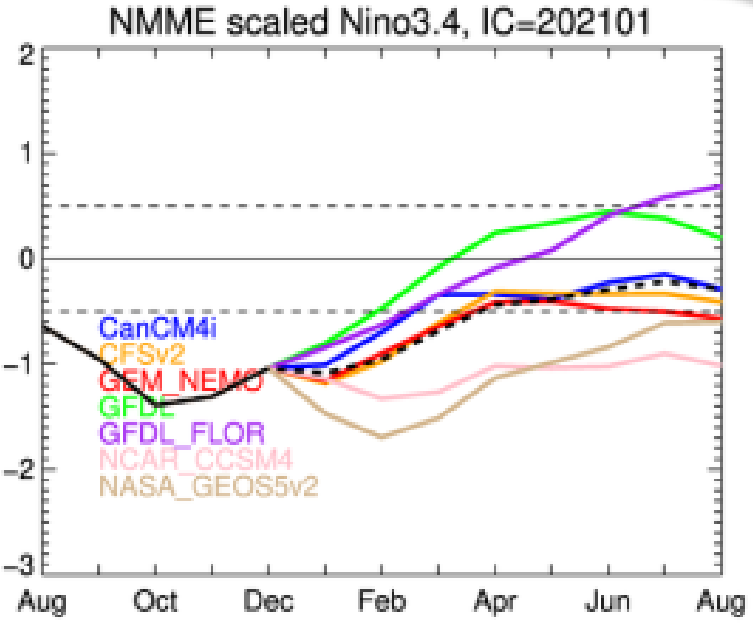


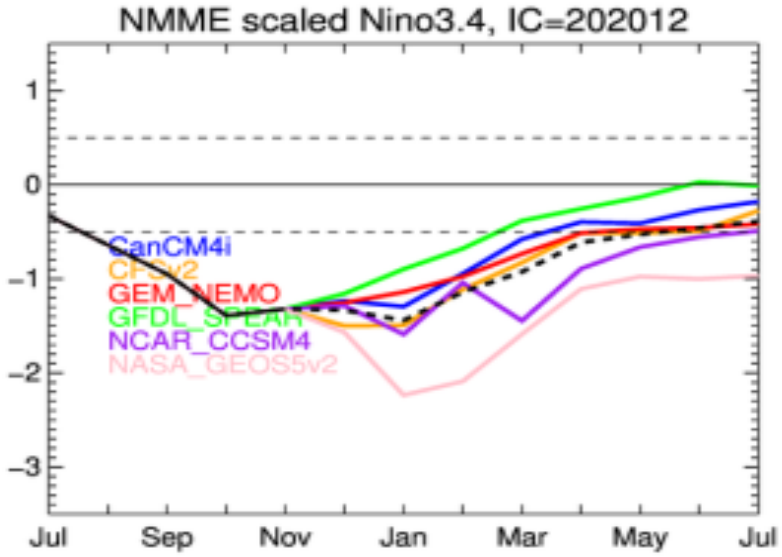
UKMO: Updated 11 Feb, 2021

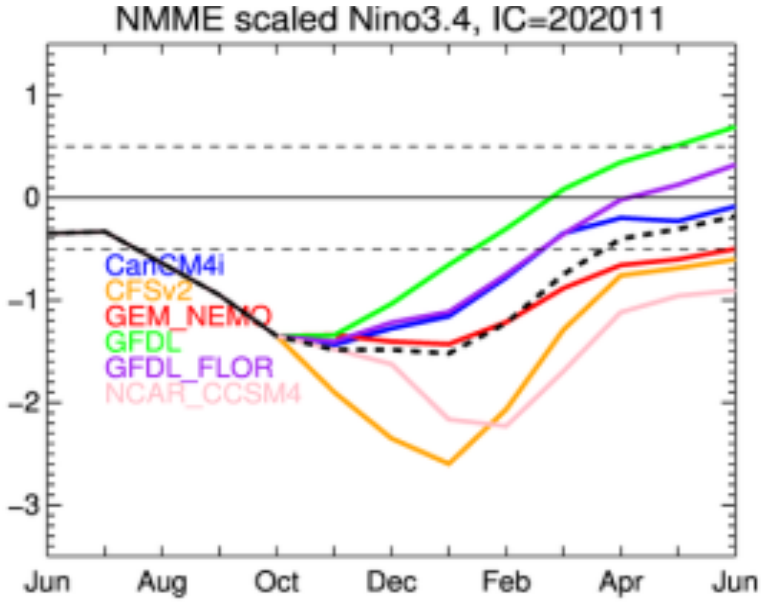


NMME forecasts from different initial conditions

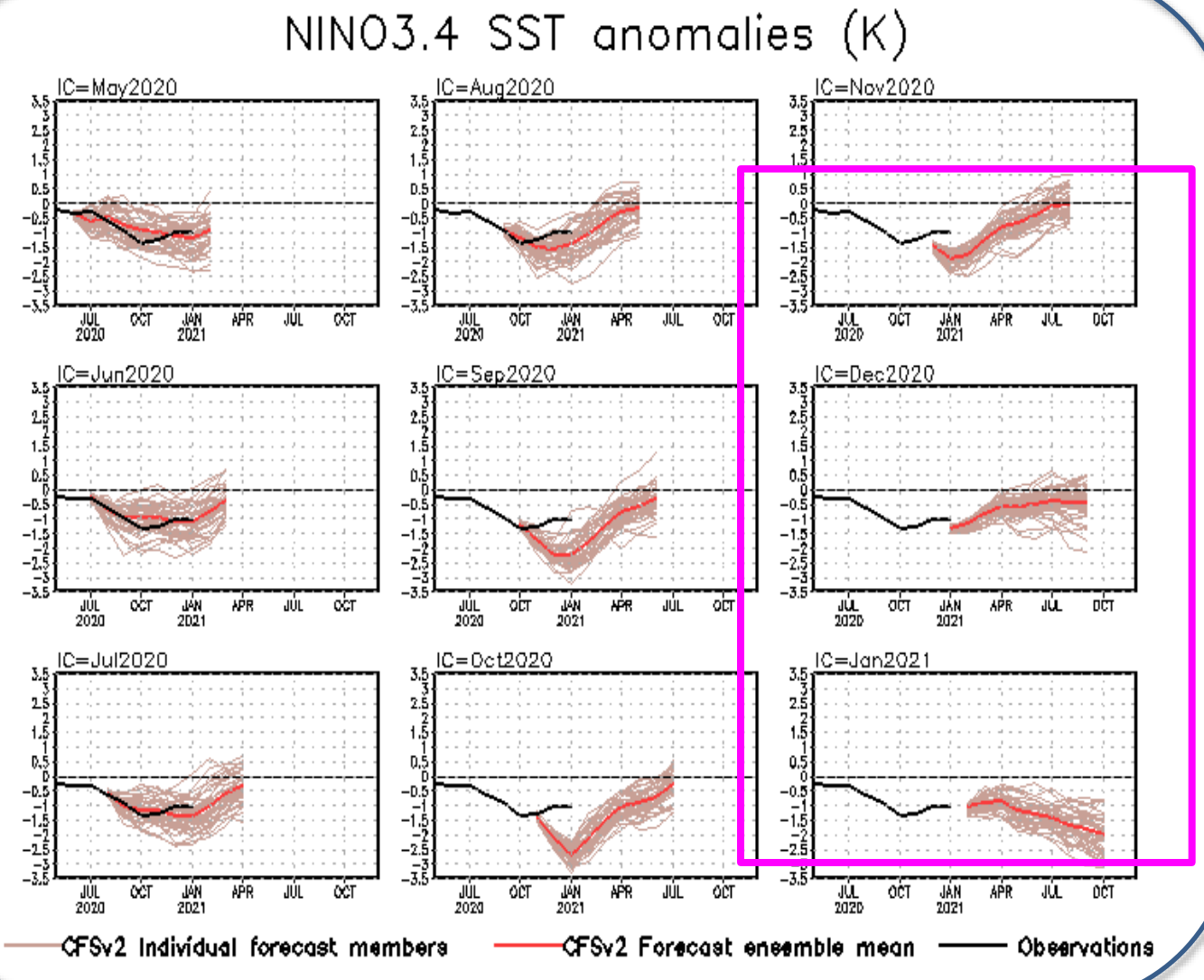








CFS Niño3.4 SST Predictions from Different Initial Months



- CFSv2 oceanic IC reset in 15Jan2021 led to strong cooling tendencies in the latest predictions.

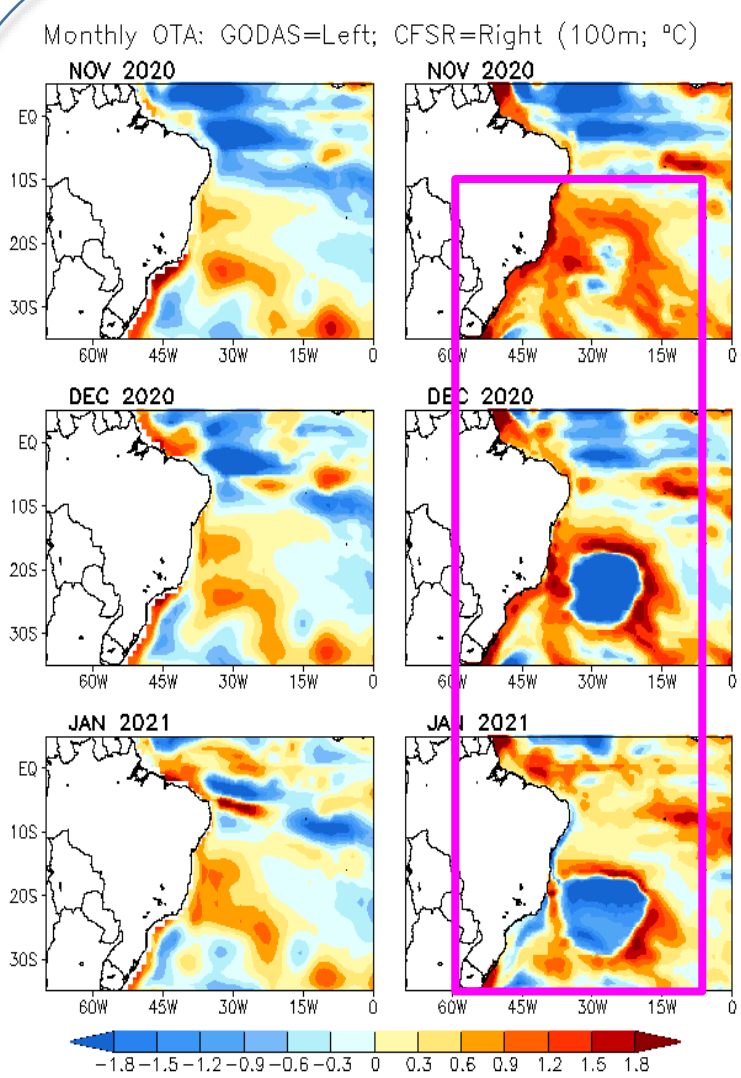
CFS Niño3.4 SST prediction from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1981-2010 base period means.

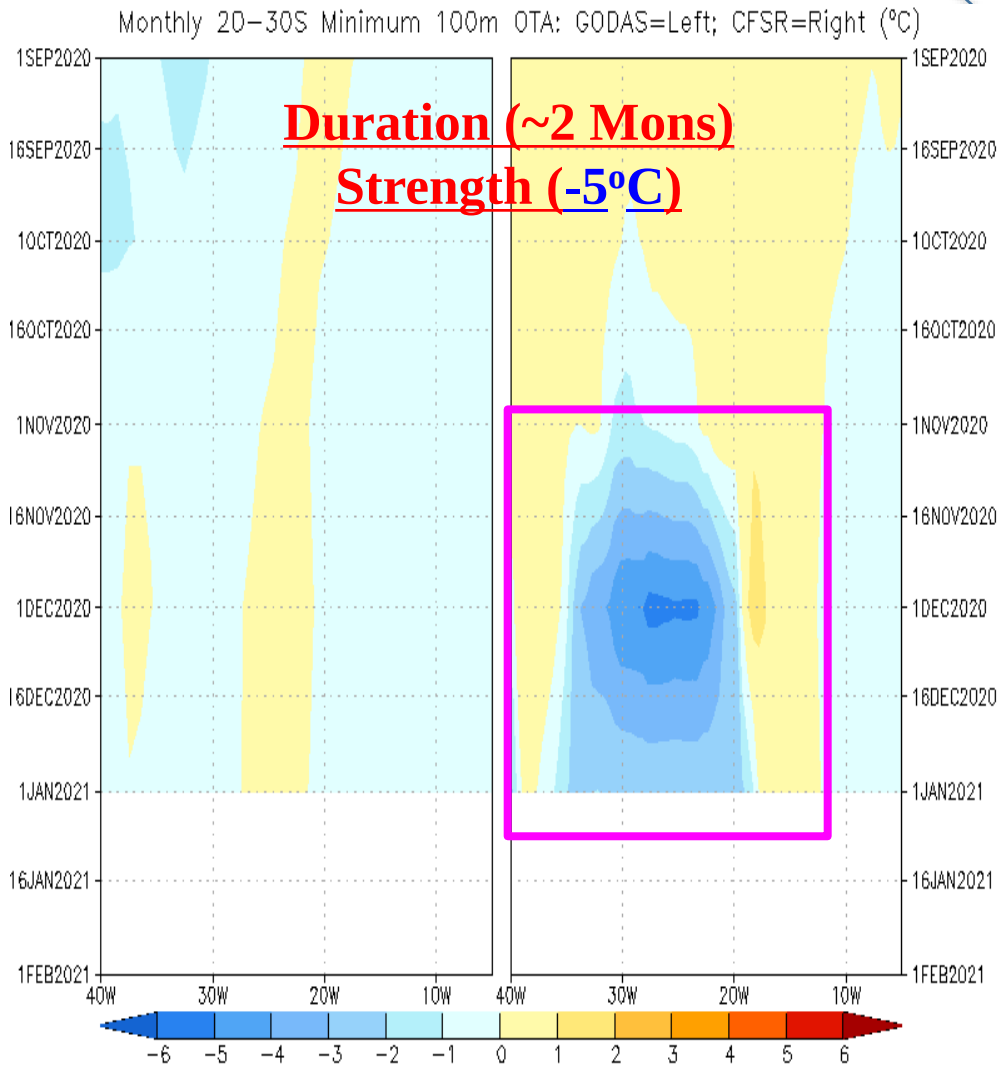
CFSR Resets & the Consequence

- **The CFSR reset is referred to an event that CFSR oceanic reanalysis is replaced by a parallel and offline reanalysis (done with the ocean component of CFSR).**

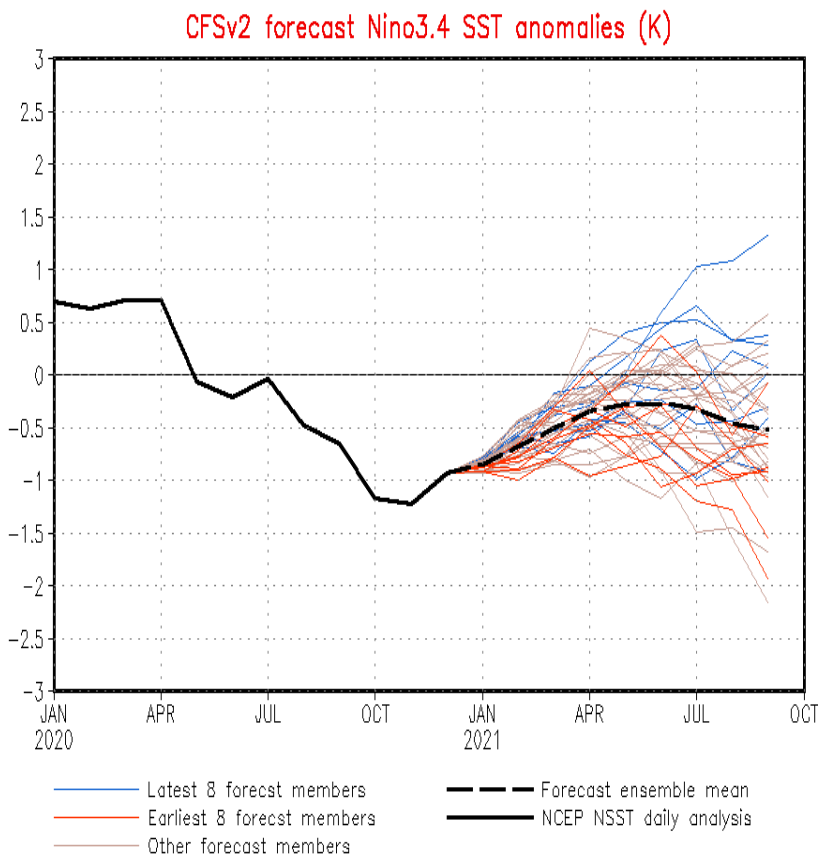
- **Two reset examples: 15Jan 2021; 29Mar 2016.**

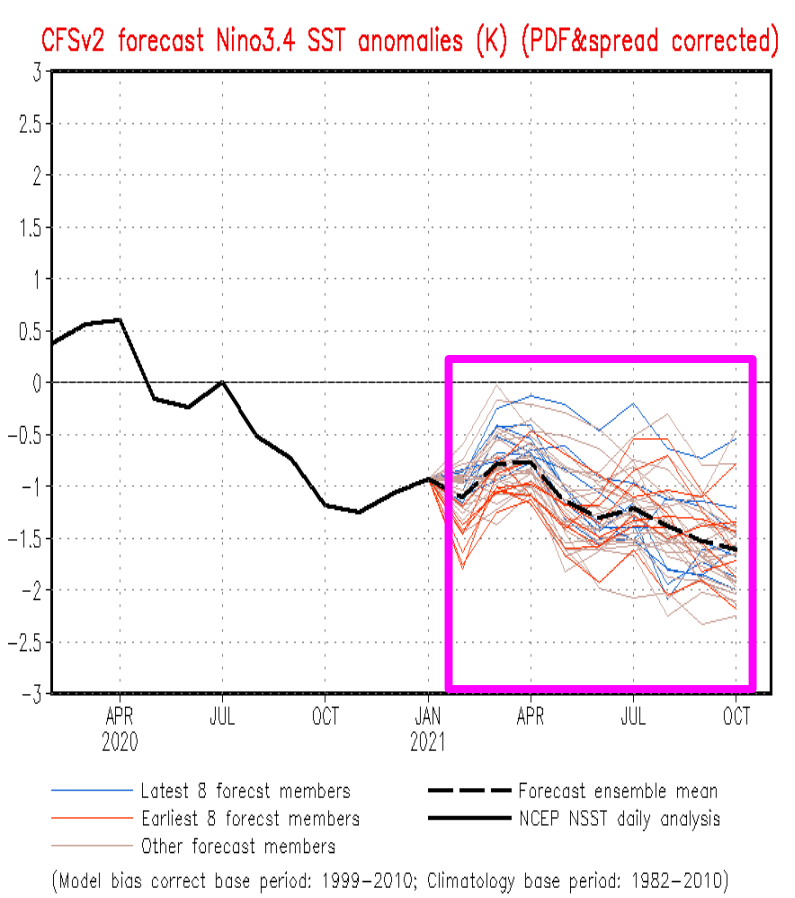
Jan 15, 2021





- The cold biases in the South Atlantic emerged around Nov 2020 and enhanced quickly with time (at 100m with maximum of -5°C around Dec 2020) .

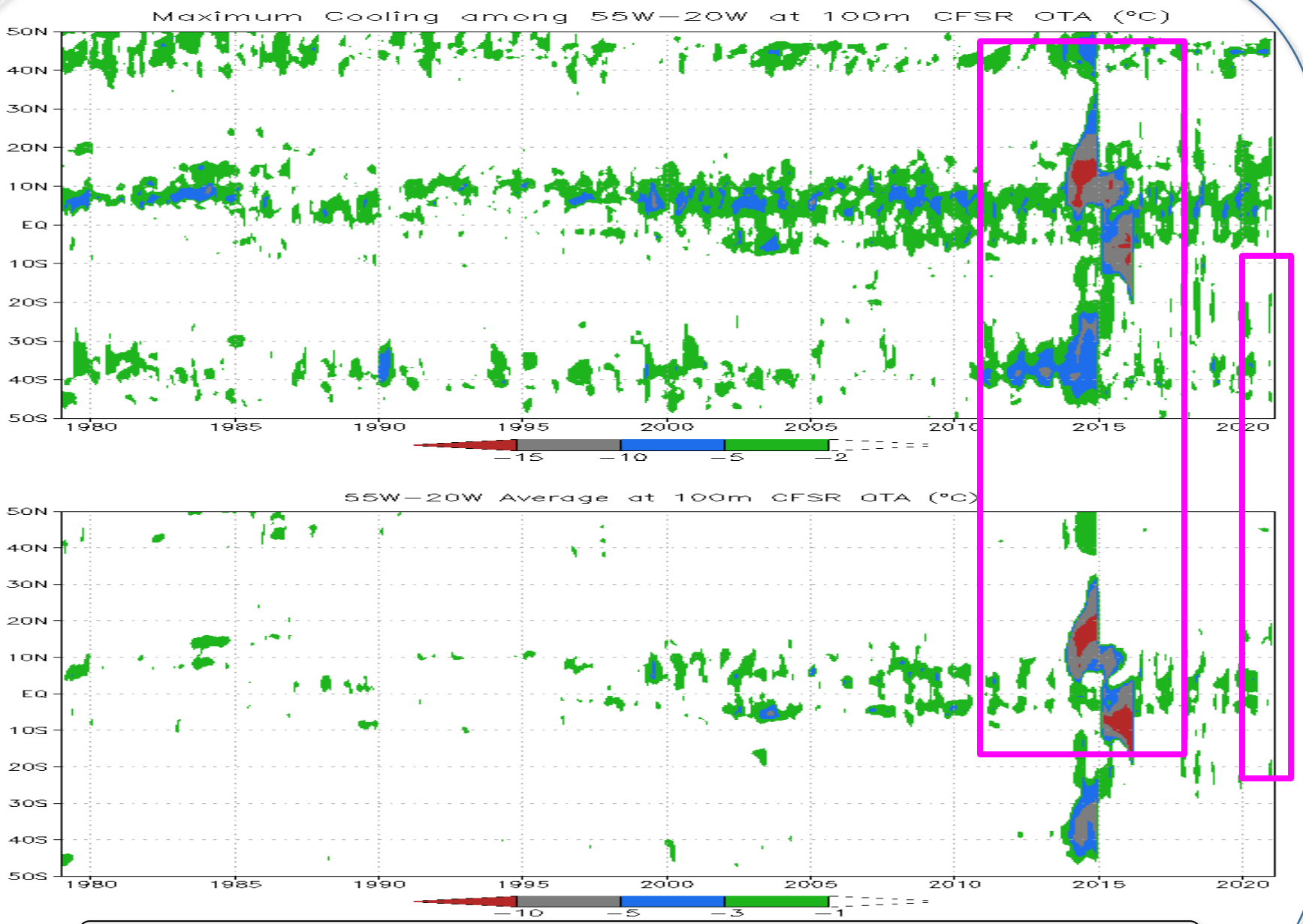




Before Reset: ICs= Jan 1-10, 2021

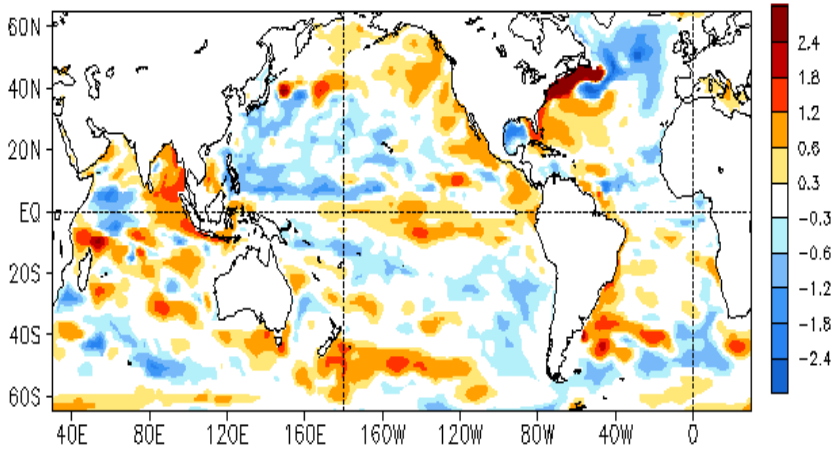
After Reset: ICs= Jan 18~27, 2021

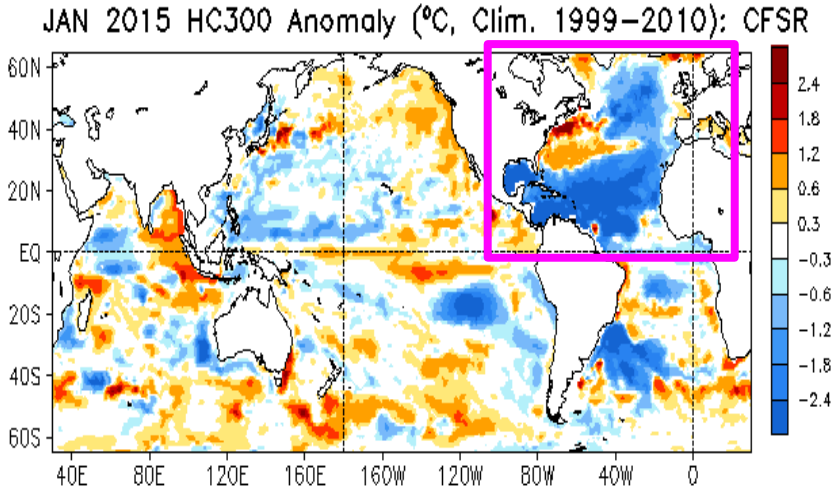
- The reset in Jan 15, 2021 led to a significant cooling tendency in the central and eastern tropical Pacific.

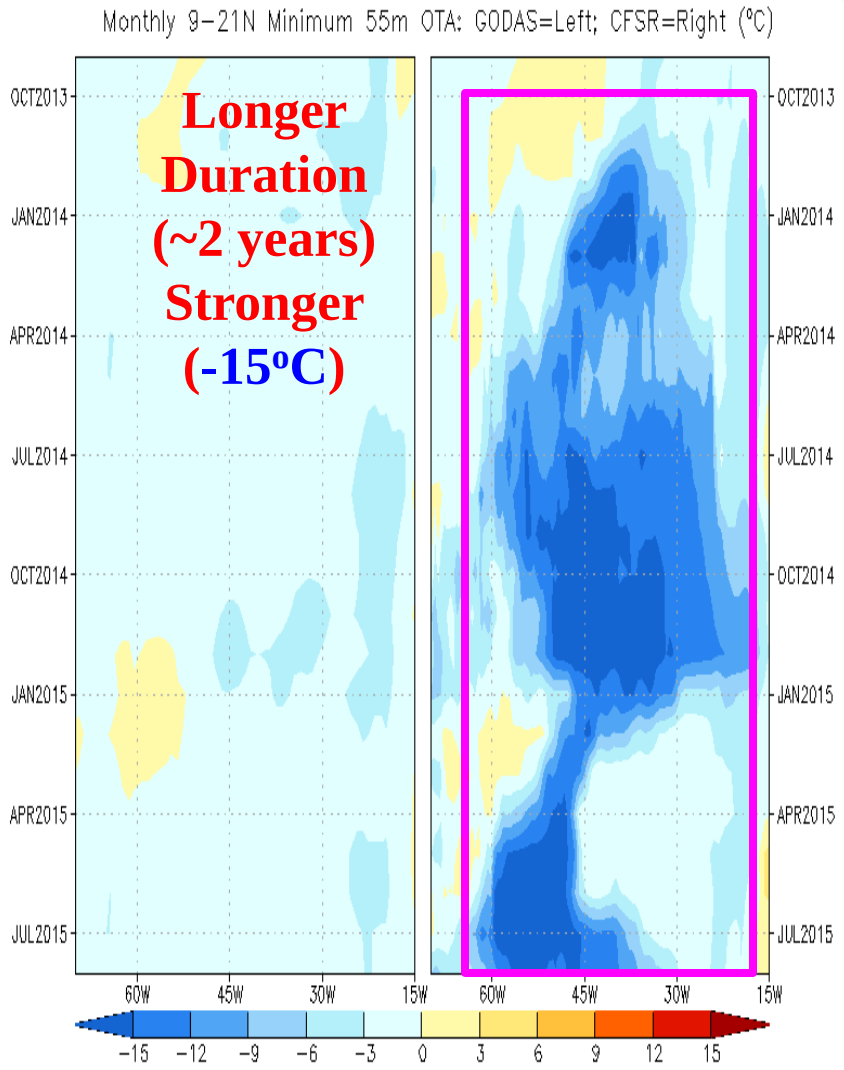


- Maximum (top) & mean (bottom) cooling among 55ºW-20ºW at 100m

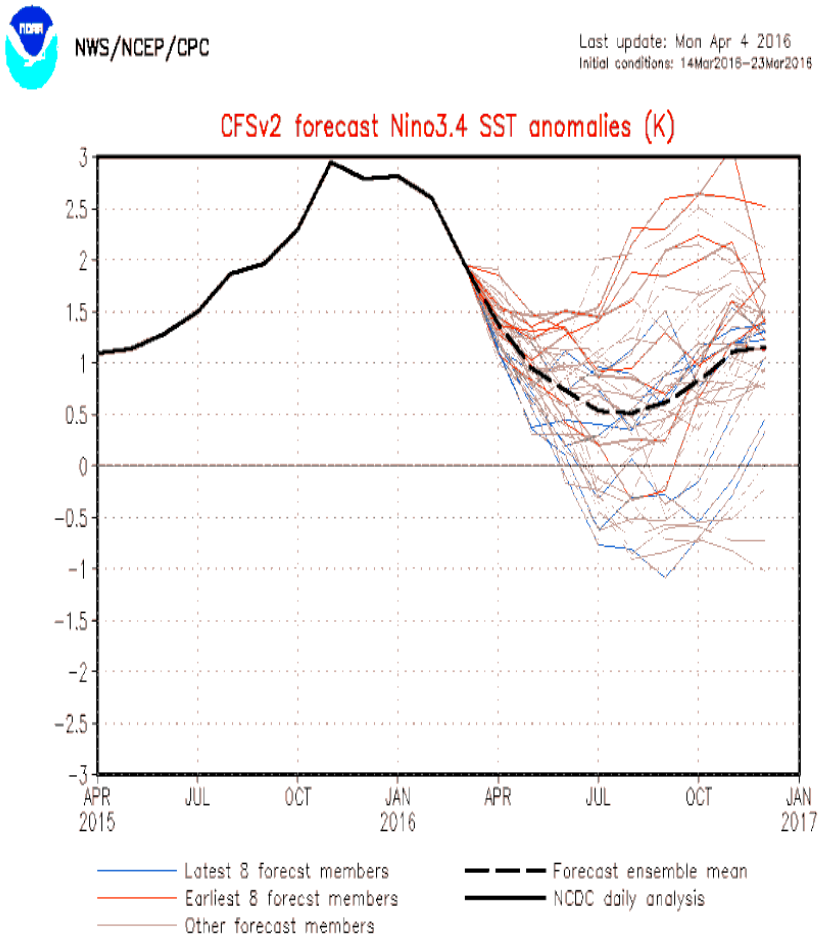
29 March, 2016



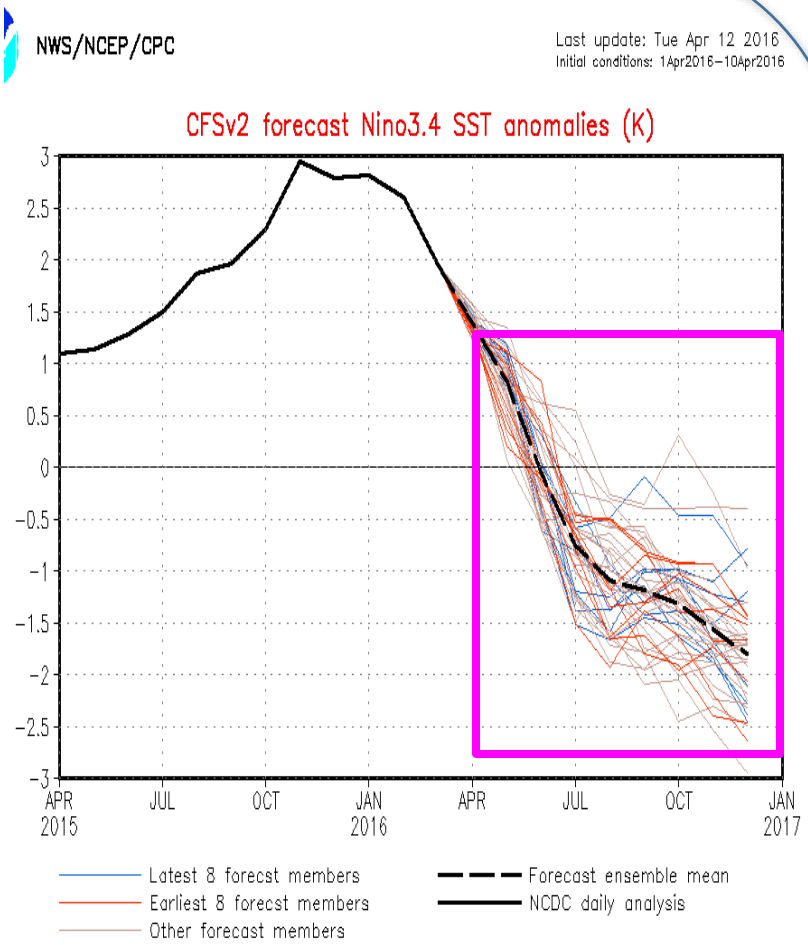




- The cold biases in the tropical North Atlantic emerged around Oct 2013 and enhanced quickly with time (at 55m with maximum cooling of -15°C around Jul-Dec 2014) .



Before Rest: ICs=Mar 14-23, 2016



After Reset: ICs=Apr 1-10, 2016

- The reset in Mar 29, 2016 led to a cooling tendency in the central and eastern tropical Pacific.

CFSR Resets & the Consequence

- **The CFSR resets in 15Jan 2021 & 29Mar 2016** *(by removing the cold biases in the North & South Atlantic Ocean*) **led to strong cooling tendencies in CFSv2 ENSO predictions.**

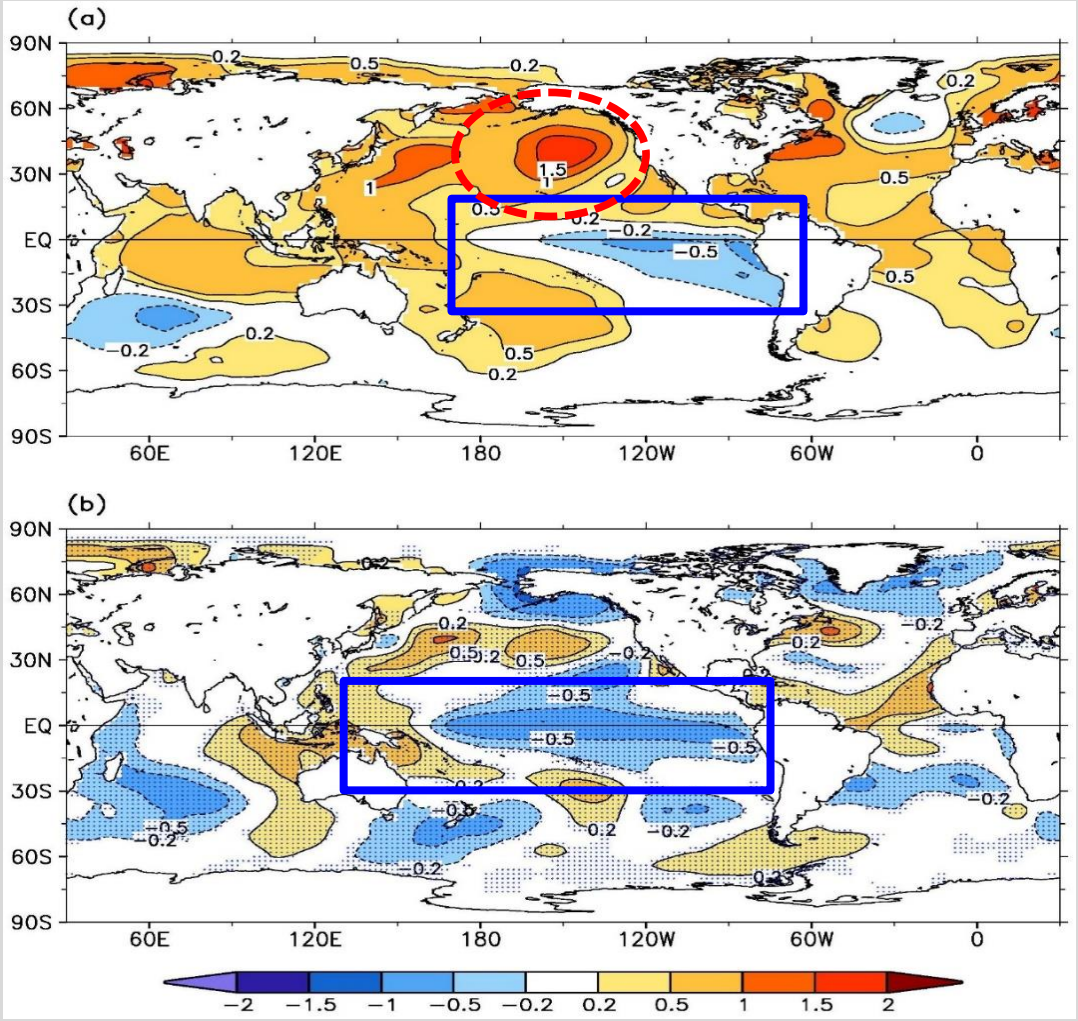
- **It will be useful for CFSR and CFSv2 users if the reset times can be documented.**

- **It is unclear how long of the impact of the resets on CFSv2 forecast (***tropics/ENSO & extra-tropics***) lasts.**

- **Objective criteria may be needed to decide when to reset.**

2020 Annual Review

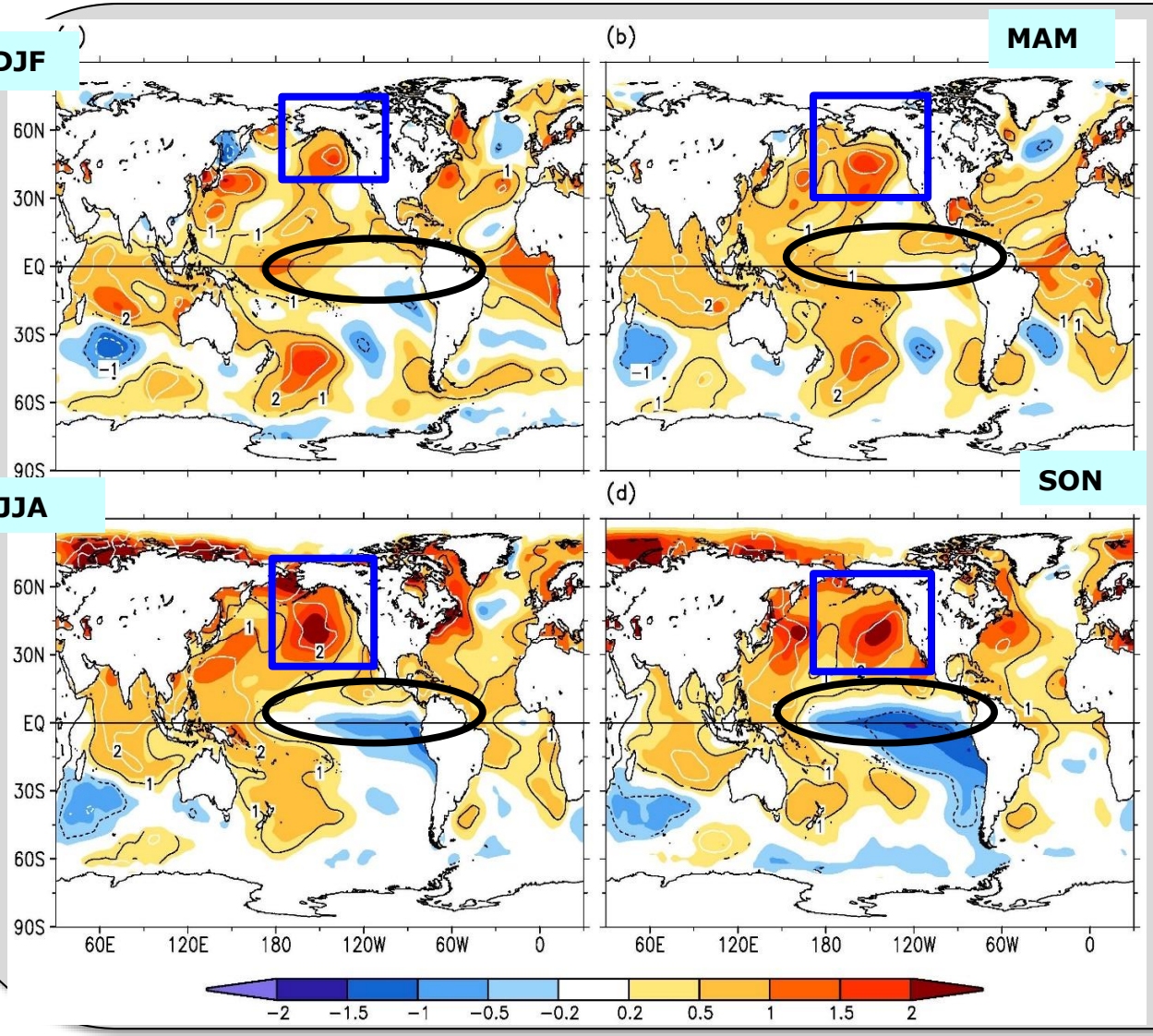
2020 Yearly Mean ERSSTv5 SSTA & Tendency



- **The cooling tendency in the tropical Pacific was associated with the transition from the weak El Niño in 2018-19 to the moderate La Niña in 2020-21.**
- **The pronounced SSTAs in the N. Pacific were attributed to the marine heatwaves.**

- Fig. 3.1. (a) Annually averaged SSTAs in 2020, and (b) Difference of annually averaged SSTAs between 2020 and 2019. SSTAs (°C) are relative to 1981–2010 climatology. The SSTAs and their differences are assessed using 1000-member ERSSTv5 ensemble, and the SST difference is significant at 95% level in stippled area in (b).
- ***BAMS State of the Climate in 2020 by Huang et al.***

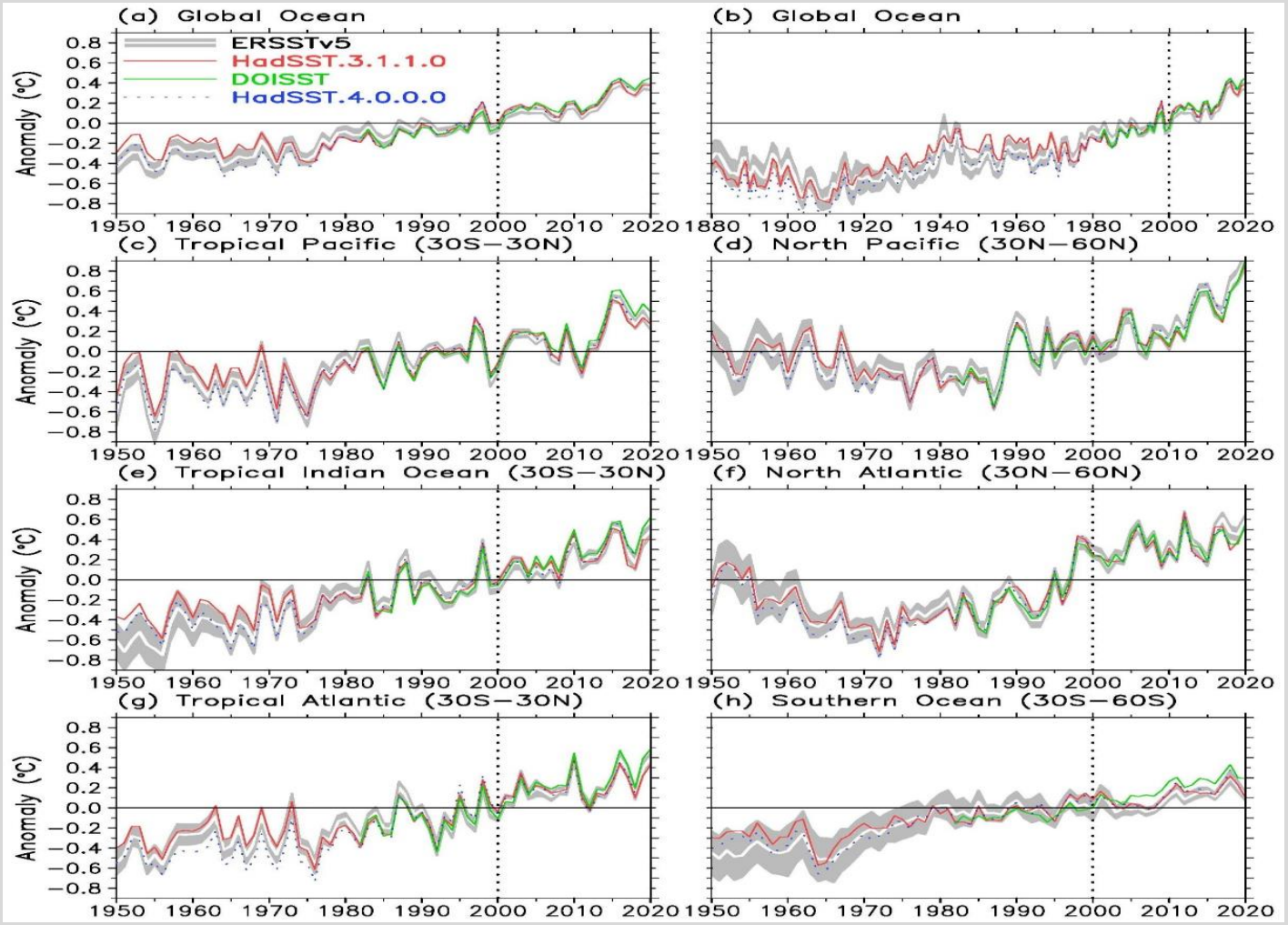
Seasonal Mean ERSSTv5 SSTA in 2020



- **The negative SSTAs in the tropical Pacific were associated with the development of the moderate La Niña in 2020-21.**
- **The pronounced SSTAs in the N. Pacific were attributed to the marine heatwaves.**

- Fig 3.2. Seasonally-averaged SSTAs of ERSSTv5 (°C; shading) for (a) Dec 2019 to Feb 2020, (b) Mar to May 2020, (c) Jun to Aug 2020, and (d) Sep to Nov 2020. The normalized seasonal mean SSTA based on seasonal mean standard deviation 1 std. dev. over 1981-2010 are indicated by contours of -2 (dashed white) -1 (dashed black), 1 (solid black), and 2 (solid white).
- BAMS State of the Climate in 2020 by Huang et al.

Yearly Mean SSTA Indices



- SSTAs in 2020 (+0.39°C) were smaller than in 2019 (+0.41°C).

- The year 2020 was the third-warmest year after the record year of 2016 (+0.44°C) and 2019.

- Fig. 3.3. Annually-averaged SSTAs of ERSSTv5 (solid white) and 2 std. dev. (grey shading) of ERSSTv5, SSTAs of DOISST (solid green), and SSTAs of HadSST.3.1.1.0 (solid red) and HadSST.4.0.0.0 (dotted blue) in 1950–2020 except for (b). (a) Global oceans, (b) Global oceans in 1880–2020, (c) Tropical Pacific, (d) Tropical Indian, (e) Tropical Atlantic, (f) North Pacific, (g) North Atlantic, and (h) Southern Oceans. The year 2000 is indicated by a vertical black dotted line.

- BAMS State of the Climate in 2020 by Huang et al.

Linear Trend Values

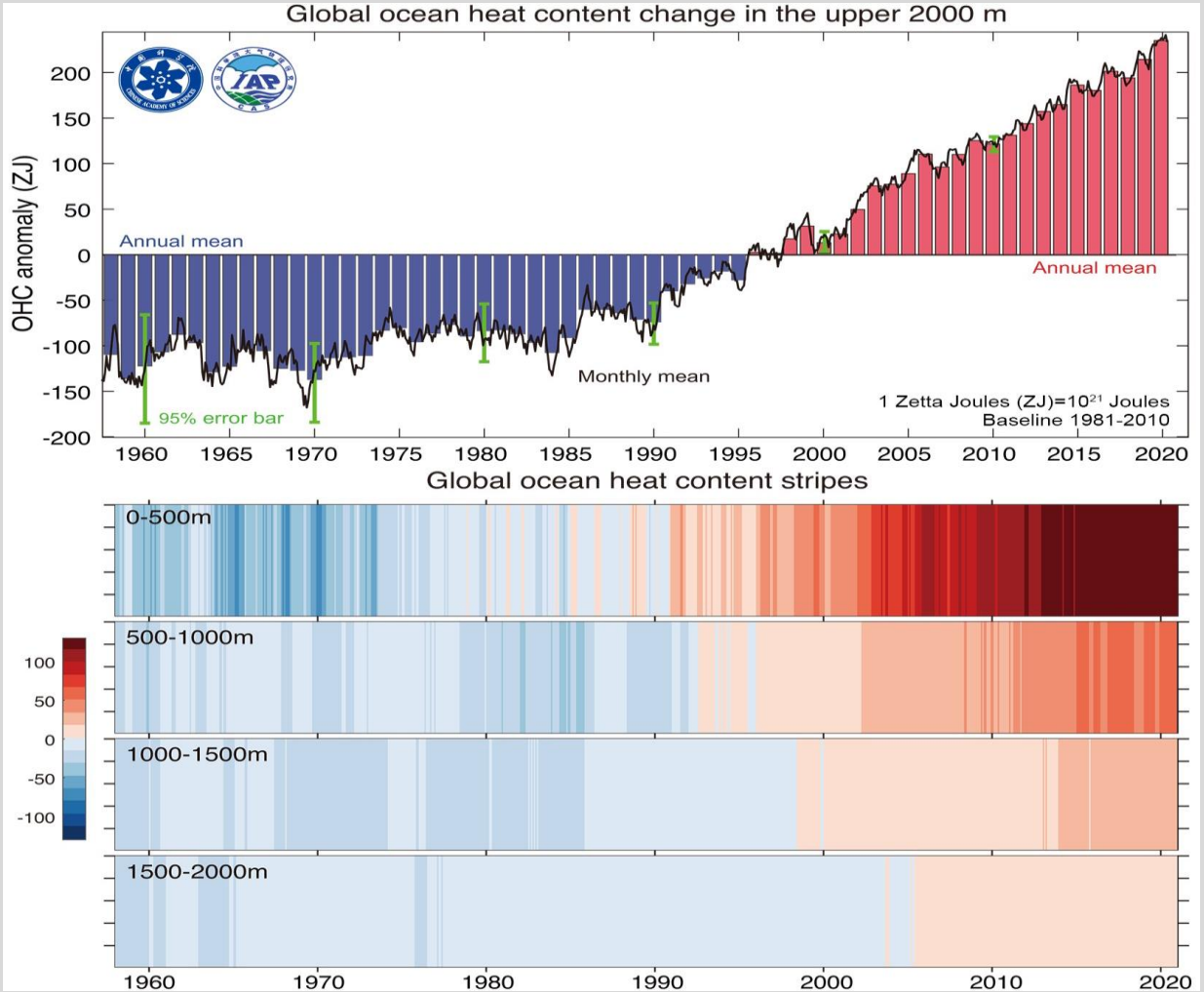
Product	Region	2000–2020	1950–2020
HadSST.3.1.1.0	Global	0.144±0.058	0.088±0.016
DOISST	Global	0.197±0.054	N/A
ERSSTv5	Global	0.171±0.069	***0.103±0.013***
ERSSTv5	Tropical Pacific (30°S–30°N)	0.177±0.165	0.102±0.027
ERSSTv5	North Pacific (30°N–60°N)	0.357±0.137	**0.081±0.040**
ERSSTv5	Tropical Indian Ocean (30°S–30°N)	0.209±0.089	**0.143±0.018**
ERSSTv5	North Atlantic (30°N–60°N)	0.135±0.090	0.110±0.047
ERSSTv5	Tropical Atlantic (30°S–30°N)	0.153±0.093	0.111±0.020
ERSSTv5	Southern Ocean (30°S–60°S)	0.116±0.057	0.098±0.016

- Overall, the warming trends of the global oceans since the 1950s persisted.
- The linear trends of globally annually averaged SSTAs were $0.10^{o} \pm 0.01^{o}C$ $decade^{-1}$ over 1950–2020.
- The warming trend was the largest in the tropical Indian Ocean & the smallest in the North Pacific.

- Table 3.1. Linear trends (°C $decade^{-1}$) of annually and regionally averaged SSTAs from ERSSTv5, HadSST3, and DOISST. The uncertainties at 95% confidence level are estimated by accounting for the effective sampling number quantified by lag-1 auto correlation on the degrees of freedom of annually-averaged SST series.

- BAMS State of the Climate in 2020 by Huang et al.

Warmest Ocean Since 1955: Global Ocean HC of Upper 2,000 Meters

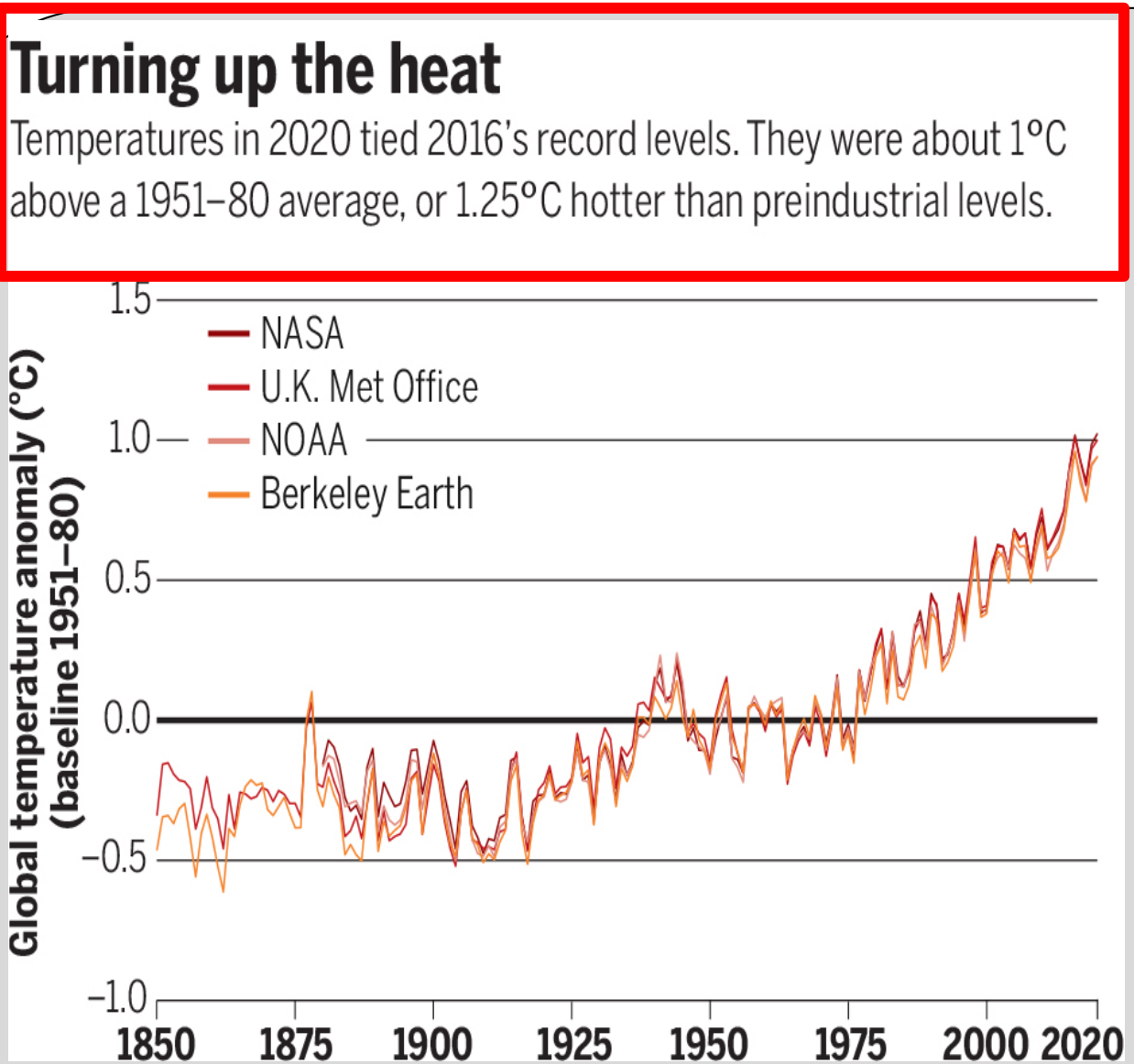


Rank	Year	IAP	NOAA
1	2020	234	211
2	2019	214	210
3	2017	202	189
4	2018	195	196
5	2015	186	180

Table 1. Ranked order of the hottest five years of the ocean, since 1955. The OHC values are anomalies for the upper 2000 m in units of ZJ relative to the 1981−2010 average.

- Figure 1. (Upper) Global upper 2000 m OHC from 1958 through 2020. The histogram presents annual anomalies relative to a 1981−2010 baseline, with positive anomalies shown as red bars and negative anomalies as blue. (Bottom) Global 0−500 m, 500−1000 m, 1000−1500 m, and 1500−2000 m OHC stripes from 1958 to 2020. Units: ZJ.
- ***Cheng, et al. 2021: Upper Ocean Temperatures Hit Record High in 2020. Adv. Atmos. Sci. DOI: 10.1007/s00376-021-0447-x***

Global surface (land & ocean) temperatures in 2020 tied record highs in 2016



"…. 2020 essentially tied records set in 2016. But the years were nothing alike. Temperatures in 2016 were boosted by a strong El Niño, ...

Last year, however, the Pacific entered La Niña, which has a cooling effect."

- Voosen, P. 2021: Global temperatures in 2020 tied record highs, Science, 334-335.

2020 Annual Review

- SSTAs in 2020 (+0.39°C) were smaller than in 2019 (+0.41°C). The year 2020 was the third-warmest year after the record year of 2016 (+0.44°C) and 2019.
- Overall, the warming trends of the global oceans since the 1950s persisted with the linear trends of globally annually averaged SSTAs of $0.10^{o} \pm 0.01^{o}$C decade^{-1} over 1950–2020.
- The warming trend was the largest in the tropical Indian Ocean and the smallest in the North Pacific.
- 2020 global ocean (HC2000) was the warmest since 1955.
- Global surface air temperature in 2020 tied 2016's record levels since 1850 with 1°C above 1951-80 average or 1.25°C hotter than preindustrial levels.

Acknowledgement

- 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 maintains the CFSv2 forecast archive

- Dr. Boyin Huang provided the annual review plots

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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

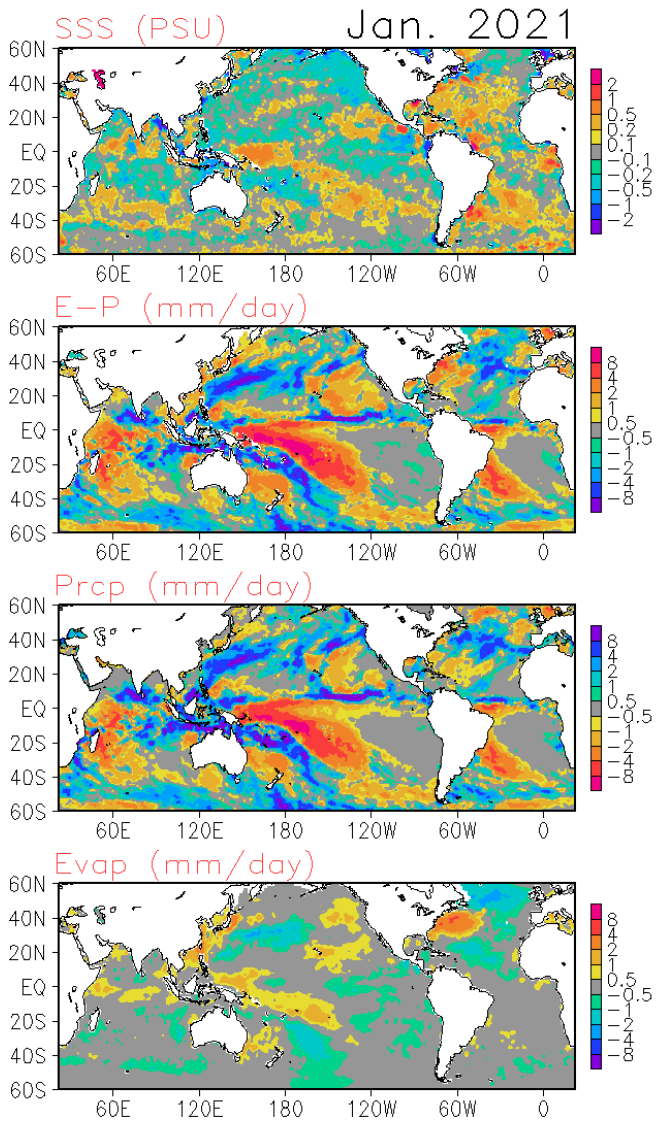
  http://www.cpc.ncep.noaa.gov/products/GODAS/multiora93_body.html

Backup Slides

Global Sea Surface Salinity (SSS): Anomaly for January 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, which is likely caused by the reduced precipitation. Negative SSS anomaly along the storm track and in the northeast subarctic Pacific Ocean is likely due to heavier precipitation. Positive SSS anomaly in the SPCZ region is accompanied with decreased precipitation. Positive SSS anomaly appears between equator and 40° N in the North Atlantic Ocean.



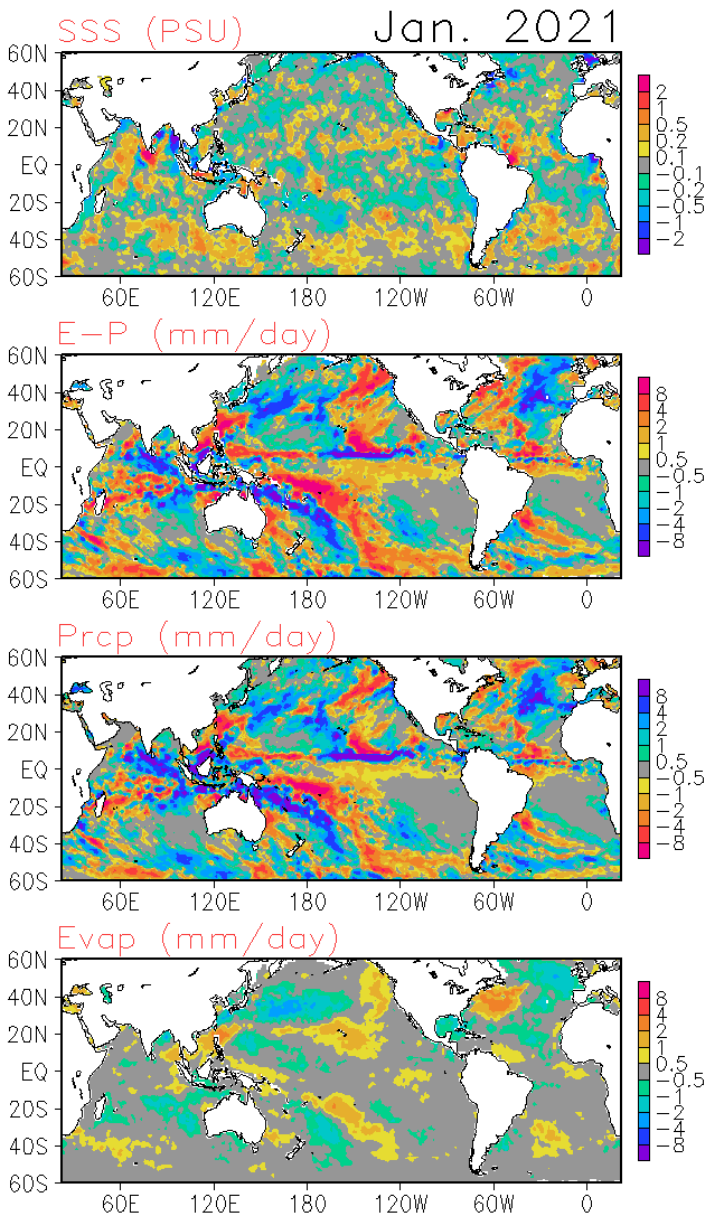
SSS : Blended Analysis of Surface Salinity (BASS) V0.Z
(a CPC-NESDIS/NODC-NESDIS/STAR joint effort)
ftp.cpc.ncep.noaa.gov/precip/BASS

Precipitation: CMORPH adjusted satellite precipitation estimates

Evaporation: Adjusted CFS Reanalysis

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

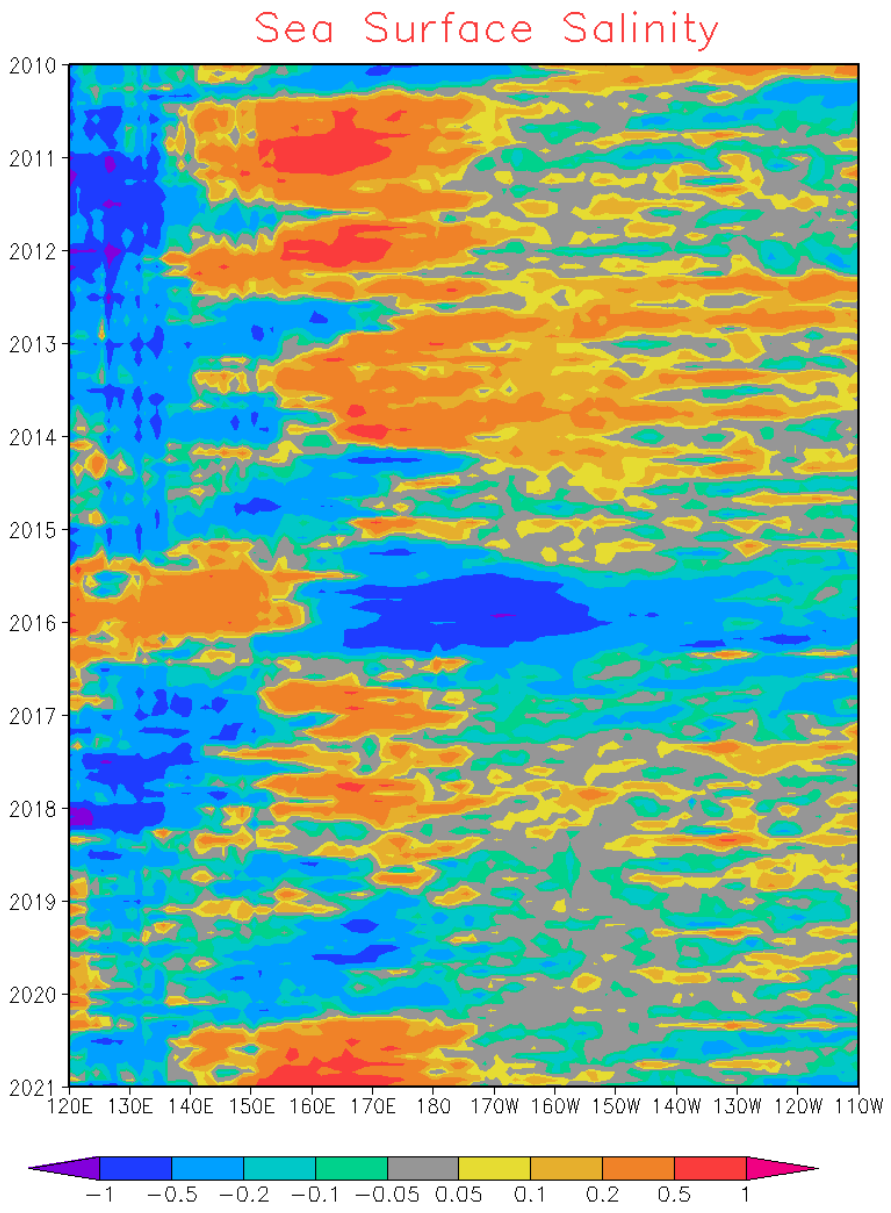
Compared with last month, SSS in the western Equatorial Pacific Ocean decreased. SSS in the east basin between equator and 20° N in Pacific Ocean increased with reduced precipitation in the area. SSS in the North Atlantic Ocean increased between equator and 20° N with stronger signal appearing in the west basin. In the Bay of Bengal, SSS decreased which is likely caused by increased precipitation



Monthly SSS Anomaly Evolution over Equatorial Pacific

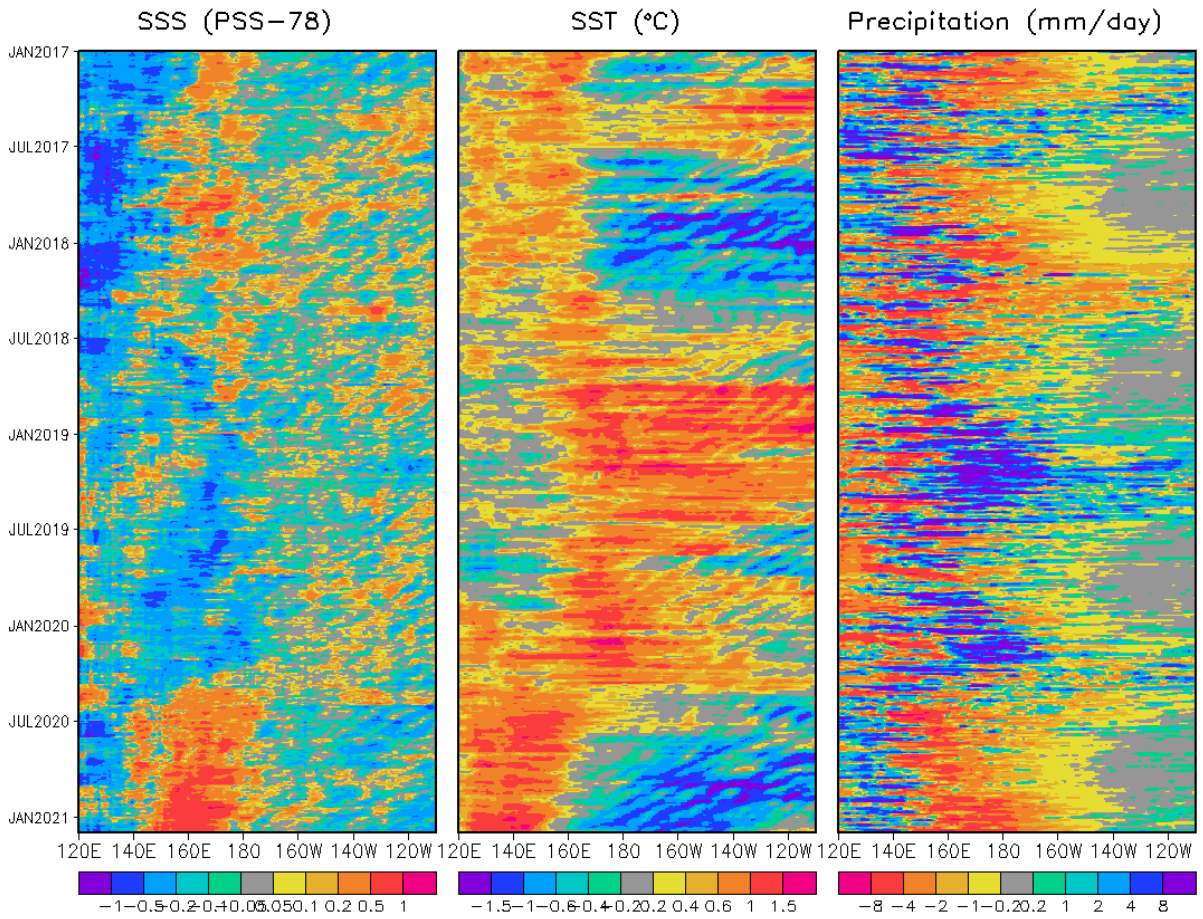
NOTE: Since June 2015, the BASS SSS is from in situ, SMOS and SMAP; before June 2015,The BASS SSS is from in situ, SMOS and Aquarius.

- 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/ neutral SSS signal appears east of 160° W with stronger negative signal east of 130° W.



Pentad SSS Anomaly Evolution over Equatorial Pacific

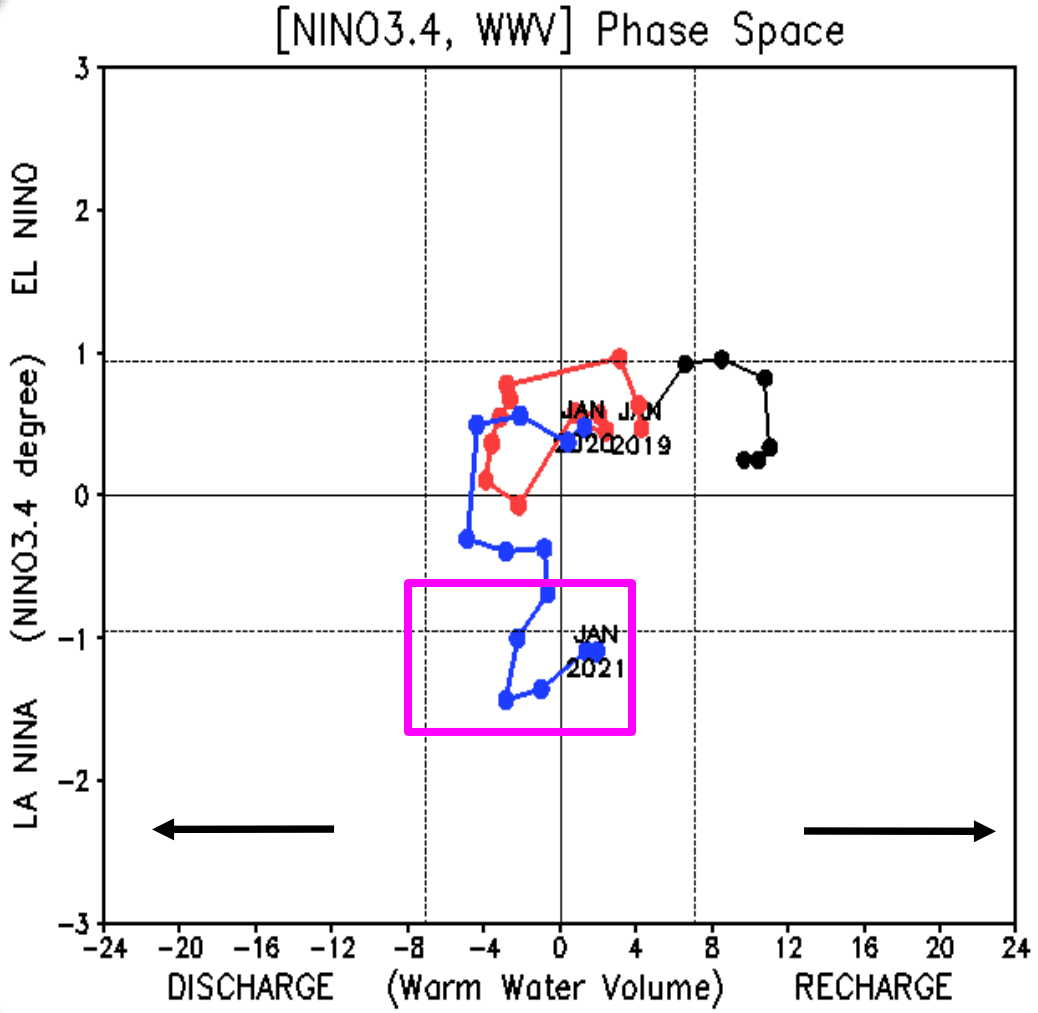
Figure caption:
Hovemoller diagram for equatorial (5° S-5° N) 5-day mean SSS, SST and precipitation anomalies. The climatology for SSS is Levitus 1994 climatology. The SST data used here is the OISST V2 AVHRR only daily dataset with its climatology being calculated from 1985 to 2010. The precipitation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



Warm Water Volume (WWV) and Niño3.4 Anomalies

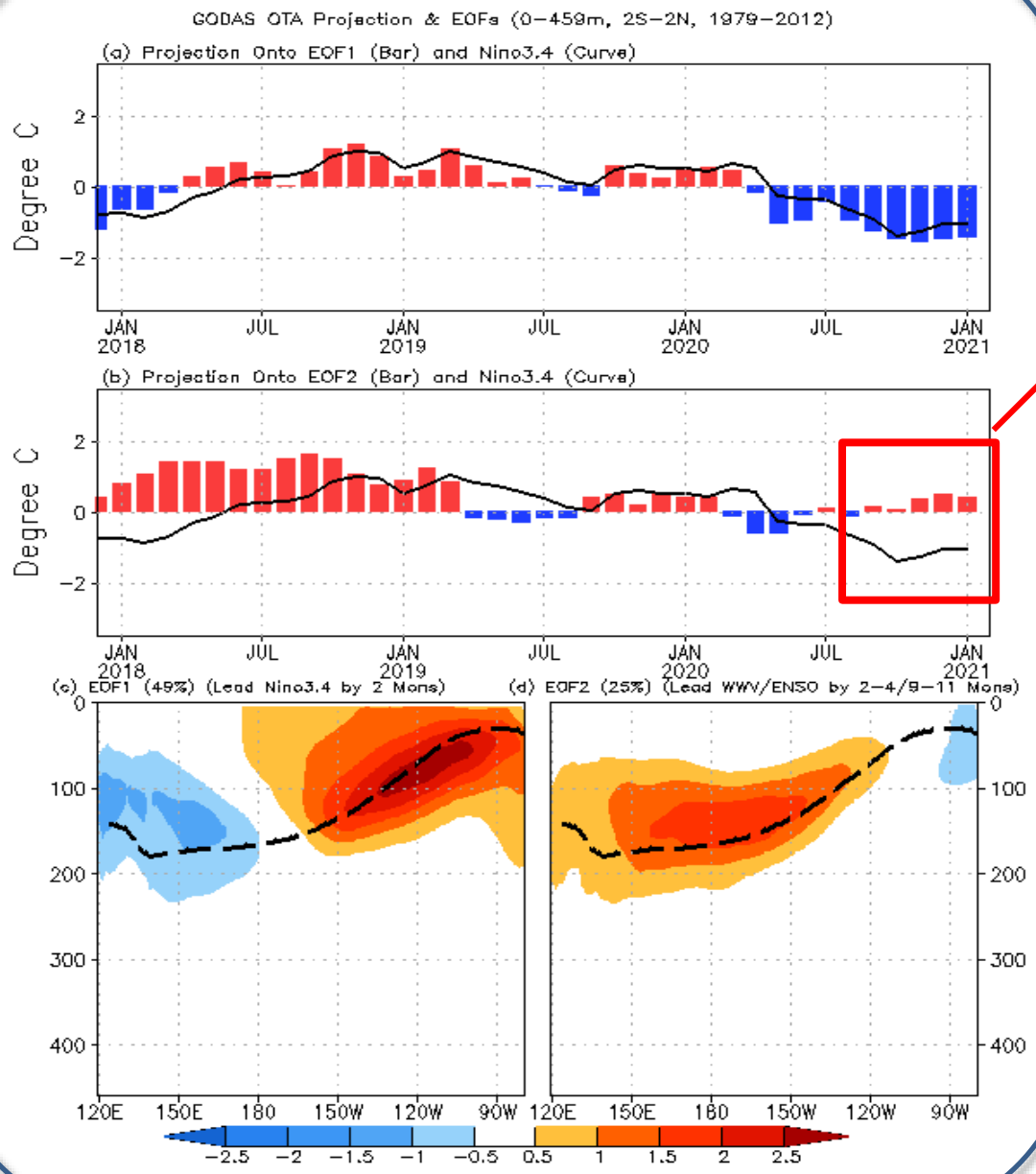
- Equatorial Warm Water Volume (WWV) was in a recharge phase in Jan 2021.

-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.

Equatorial Sub-surface Ocean Temperature Monitoring

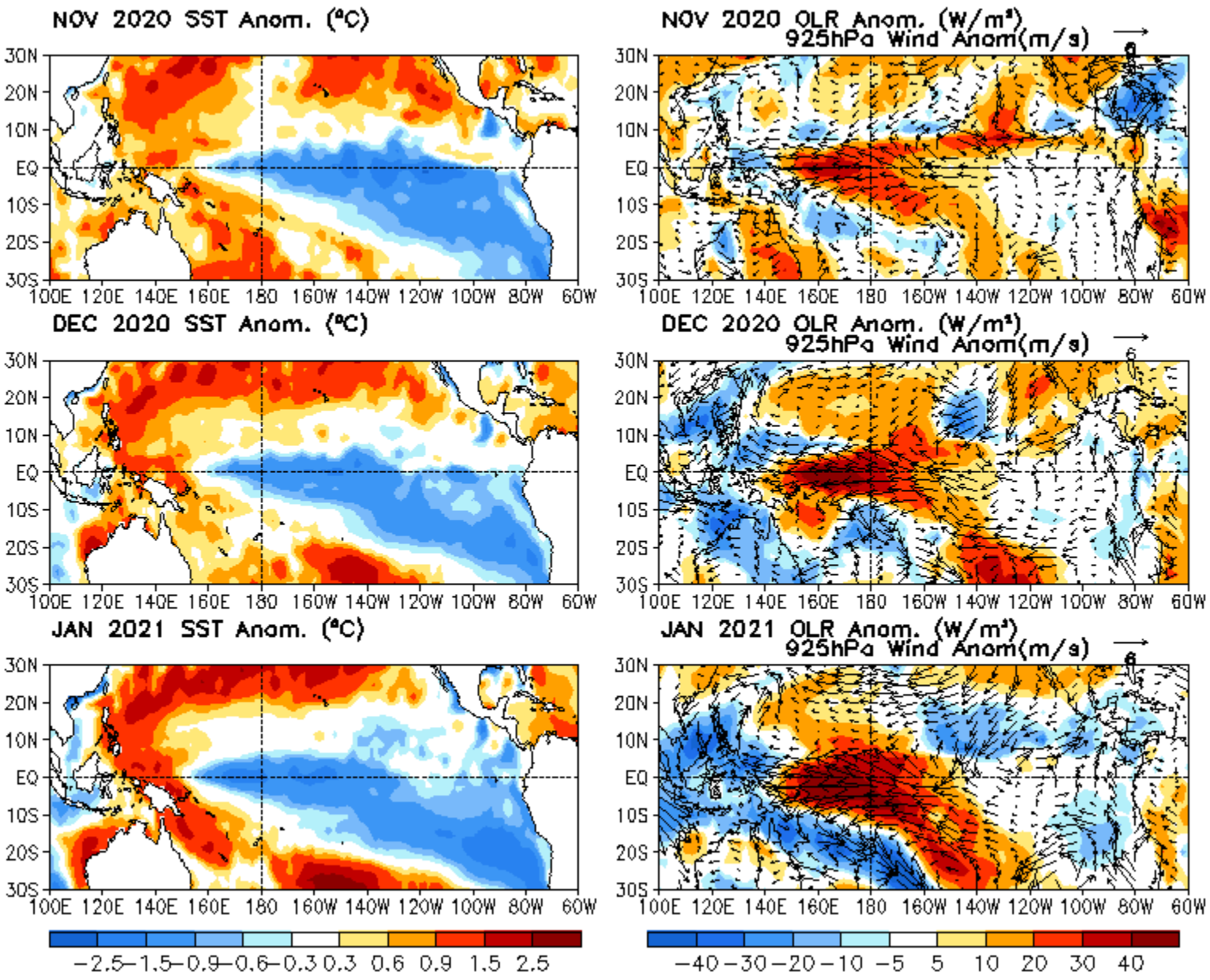


- The equatorial Pacific switched to a recharge phase after Sep 2020, but it is weak.

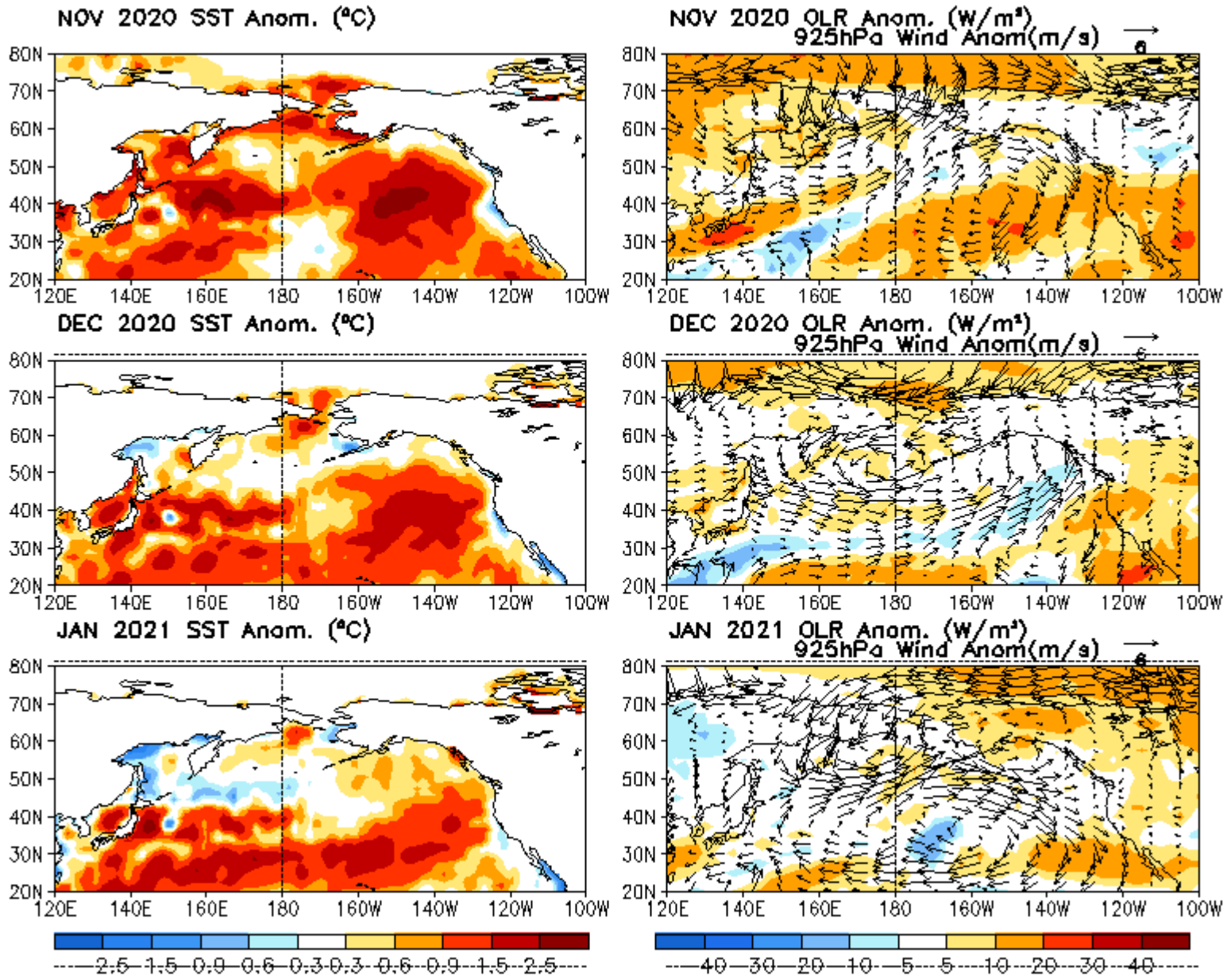
- Projection of ocean temperature anomalies onto EOF1 and EOF2; EOF1: Tilt/dipole mode (ENSO peak phase); EOF2: WWV mode.

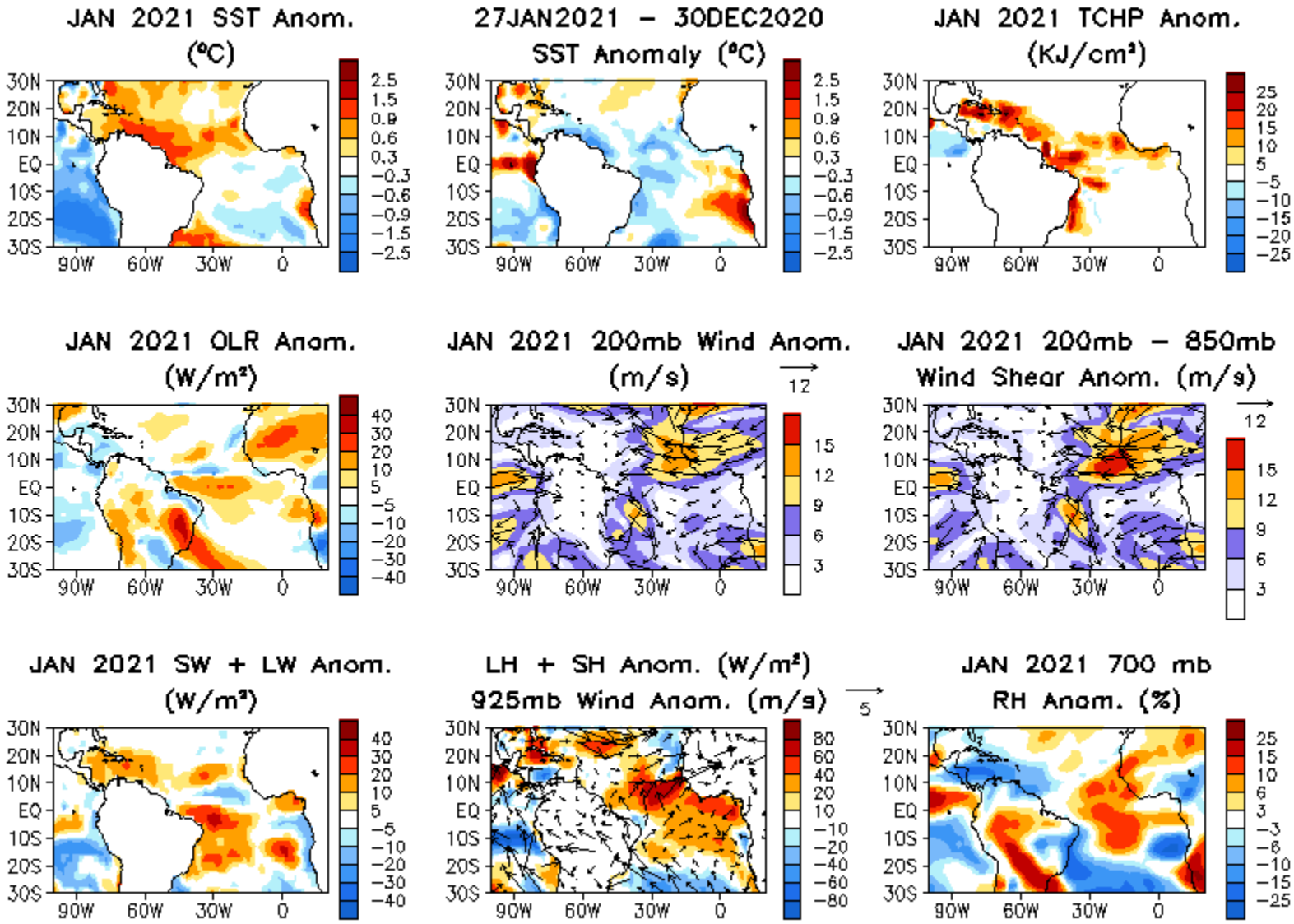
- Recharge/discharge oscillation (ENSO transition phase); Recharge process: heat transport from outside of equator to equator; Negative -> positive phase of ENSO

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

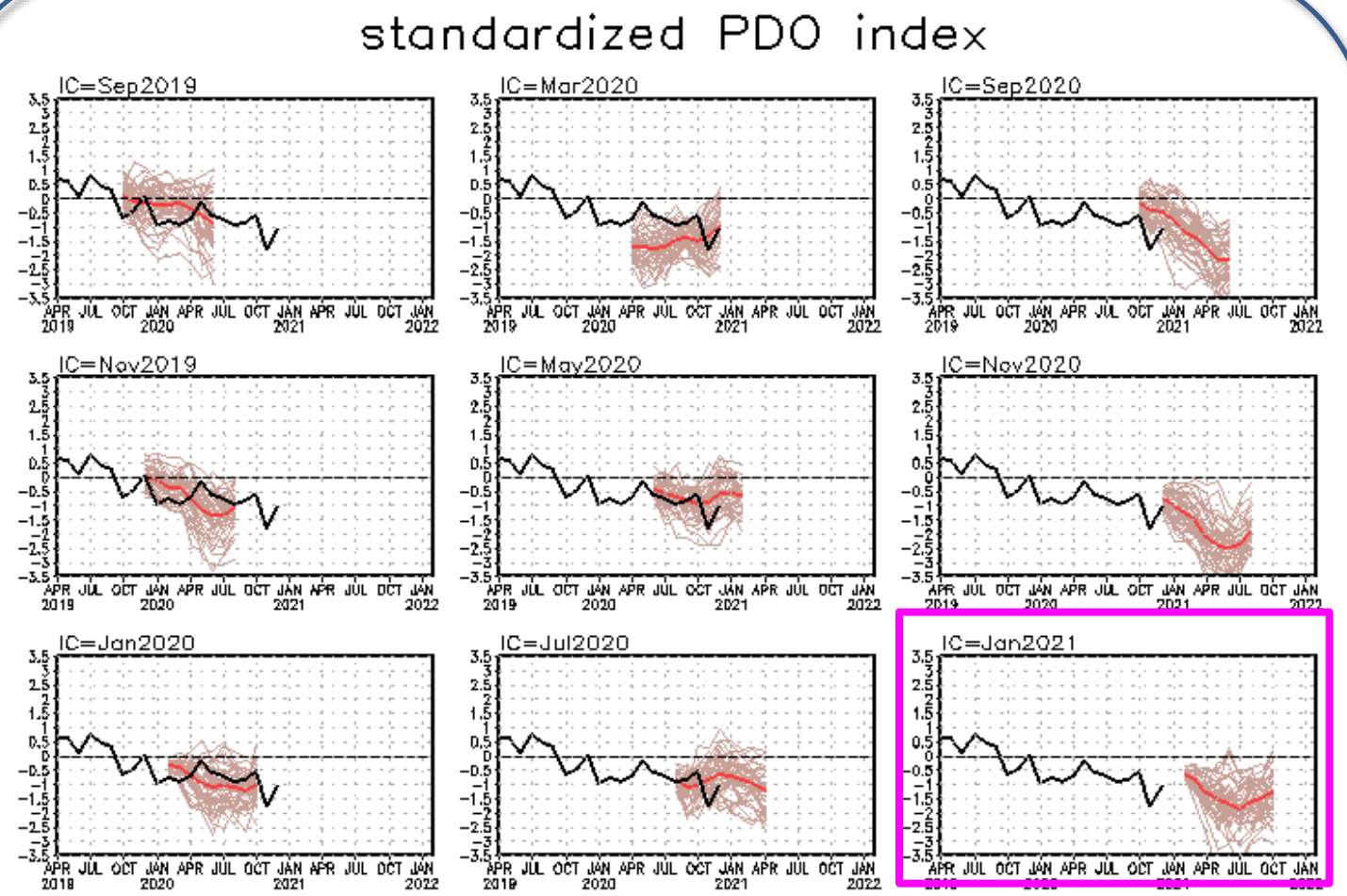

NOV 2020 SST Anom. (°C)
NOV 2020 OLR Anom. (W/m²)
925hPa Wind Anom(m/s)
DEC 2020 SST Anom. (°C)
DEC 2020 OLR Anom. (W/m²)
925hPa Wind Anom(m/s)
JAN 2021 SST Anom. (°C)
JAN 2021 OLR Anom. (W/m²)
925hPa Wind Anom(m/s)
30N
20N
10N
EQ
10S
20S
30S
100E 120E 140E 160E 180 160W 140W 120W 100W 80W 60W
−2.5 −1.5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

North Pacific SST, OLR, and uv925 anomalies




JAN 2021 SST Anom. (°C)
27JAN2021 – 30DEC2020 SST Anomaly (°C)
JAN 2021 TCHP Anom. (KJ/cm²)
JAN 2021 OLR Anom. (W/m²)
JAN 2021 200mb Wind Anom. (m/s)
JAN 2021 200mb – 850mb Wind Shear Anom. (m/s)
JAN 2021 SW + LW Anom. (W/m²)
LH + SH Anom. (W/m²)
925mb Wind Anom. (m/s)
JAN 2021 700 mb RH Anom. (%)
30N
20N
10N
EQ
10S
20S
30S
90W
60W
30W
0

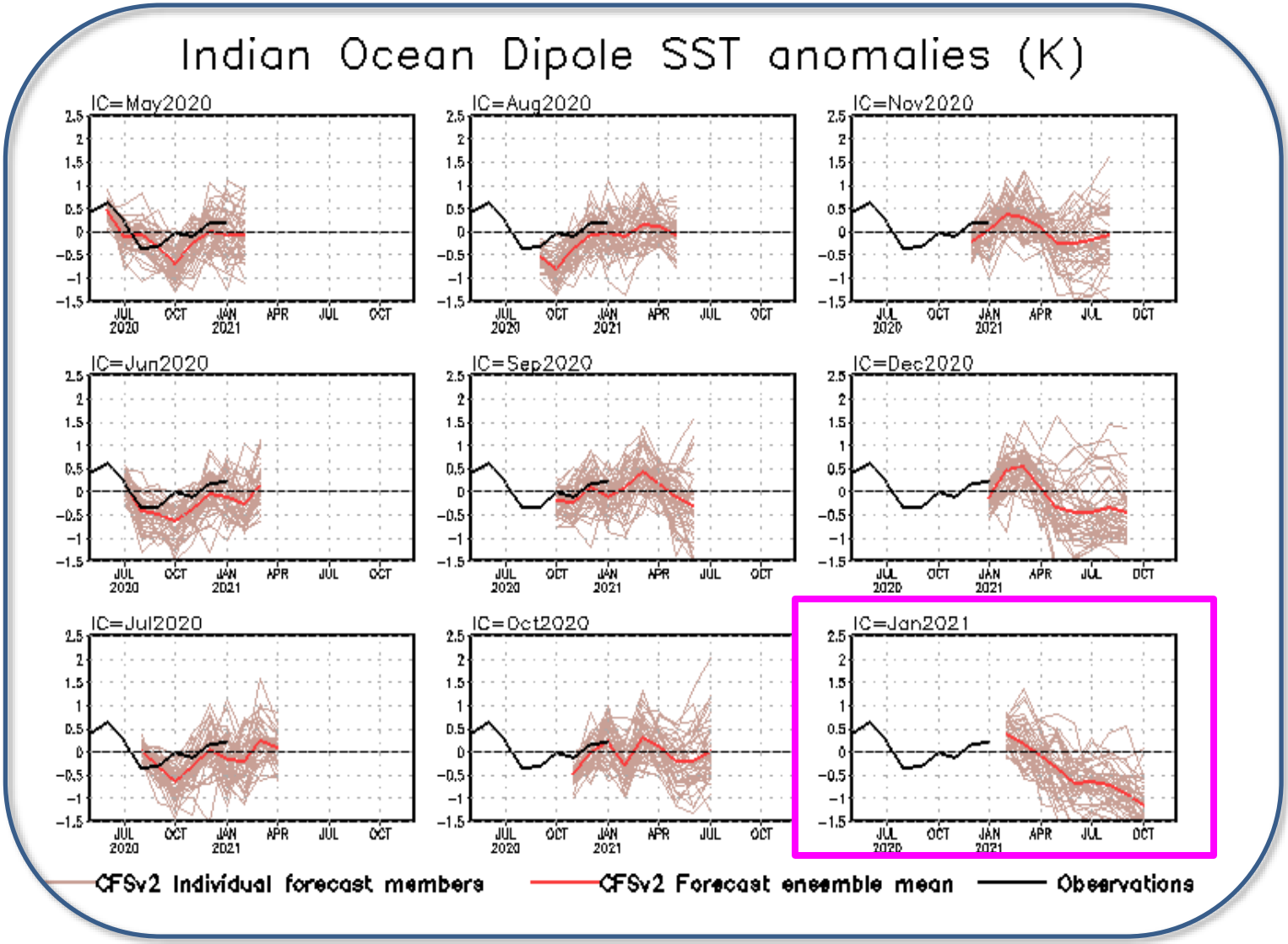
CFS Pacific Decadal Oscillation (PDO) Index Predictions from Different Initial Months



- CFSv2 predicts a negative phase of PDO in 2021.

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.

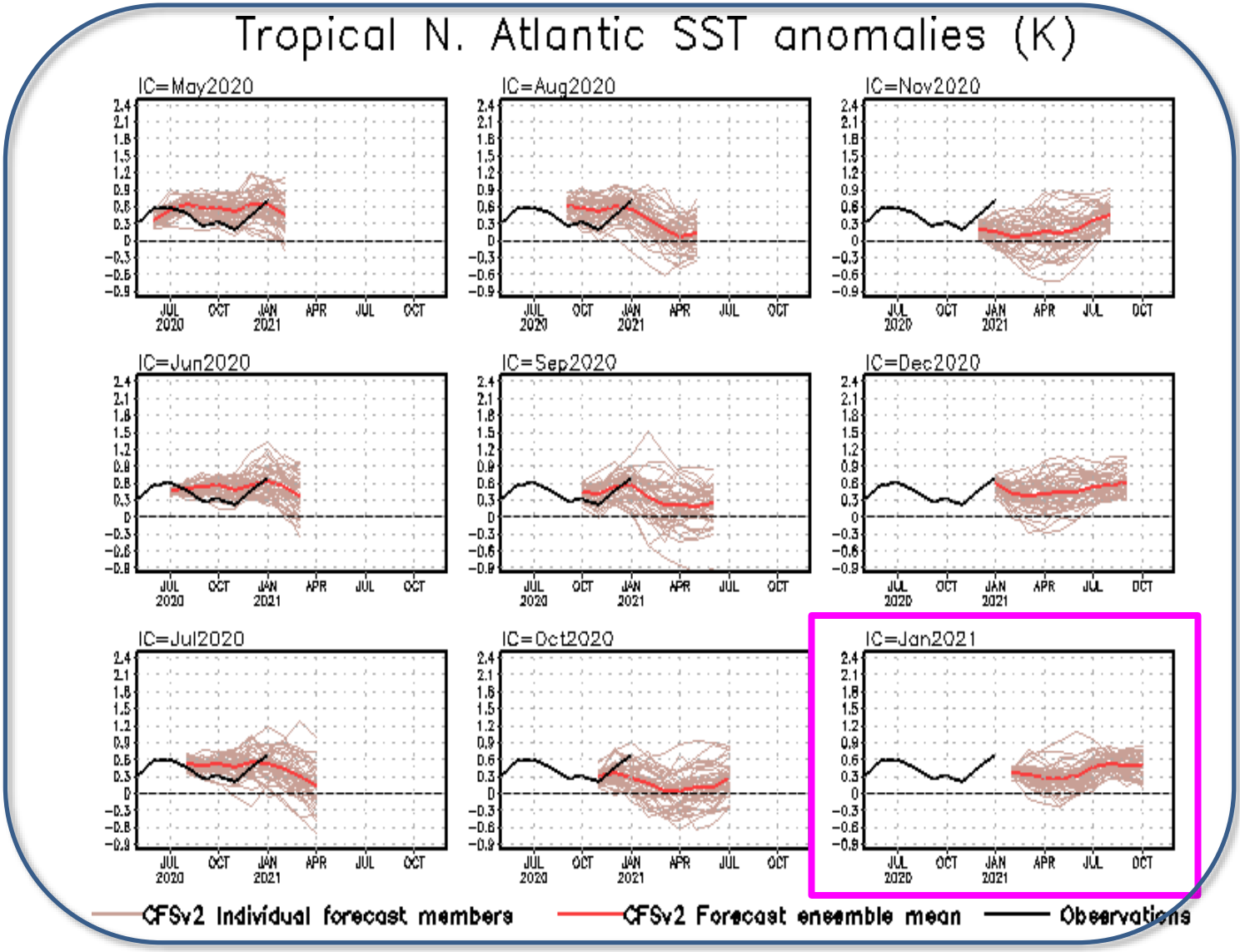
NCEP CFS DMI SST Predictions from Different Initial Months



- 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 North Atlantic in 2021.

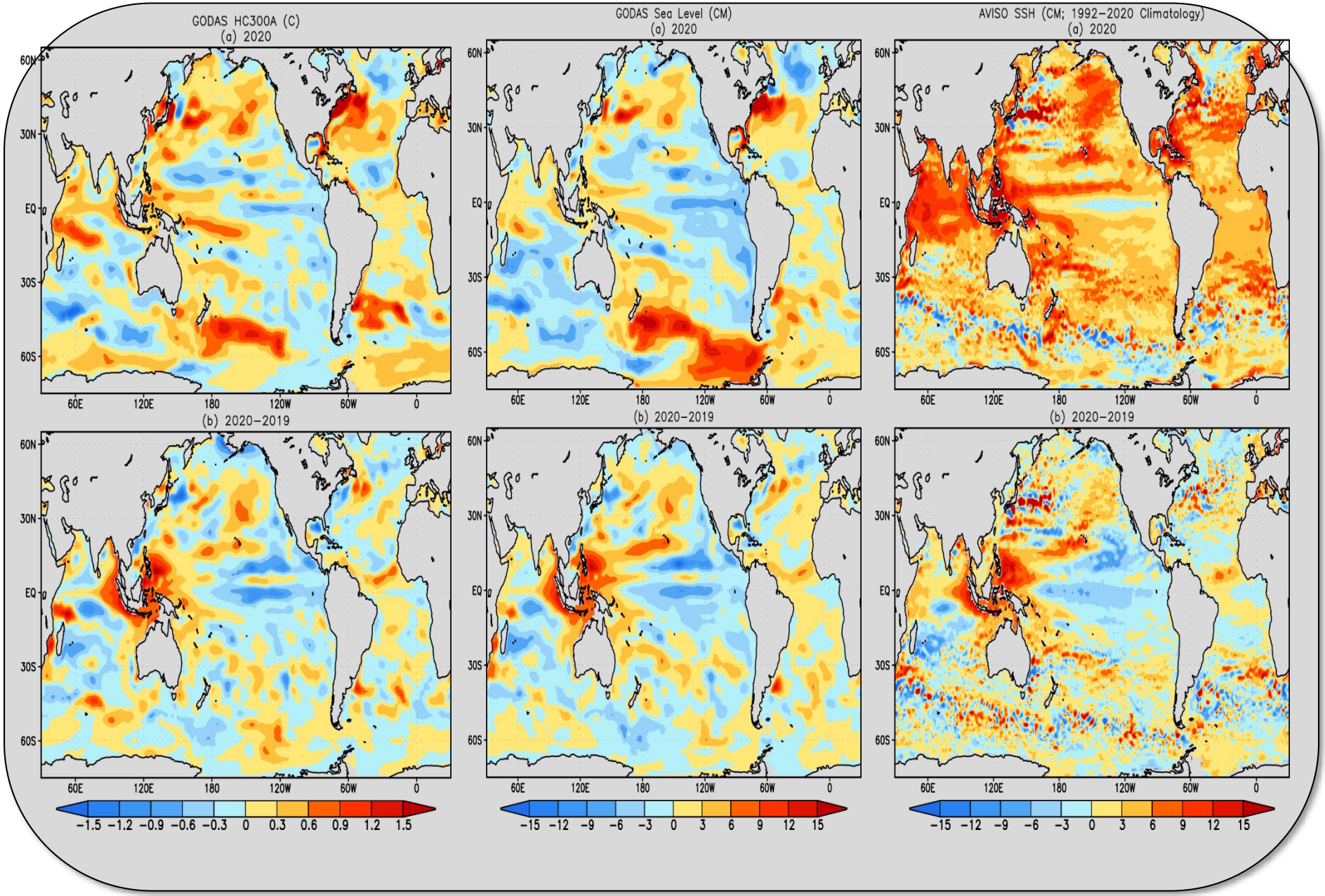
CFS Tropical North Atlantic (TNA) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1981-2010 base period means. TNA is the SST anomaly averaged in the region of [60oW-30oW, 5oN-20oN].

GODAS HC300A & SSHA, AVISO SSHA in 2020 and 2020-2019

GODAS HC300A & Tendency

GODAS SSHA

AVISO SSHA: 1992-2020



R2 Wind Stress & CMAP Precip Anomalies in 2020 and 2020-2019