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

Prepared by

Climate Prediction Center, NCEP/NOAA

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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

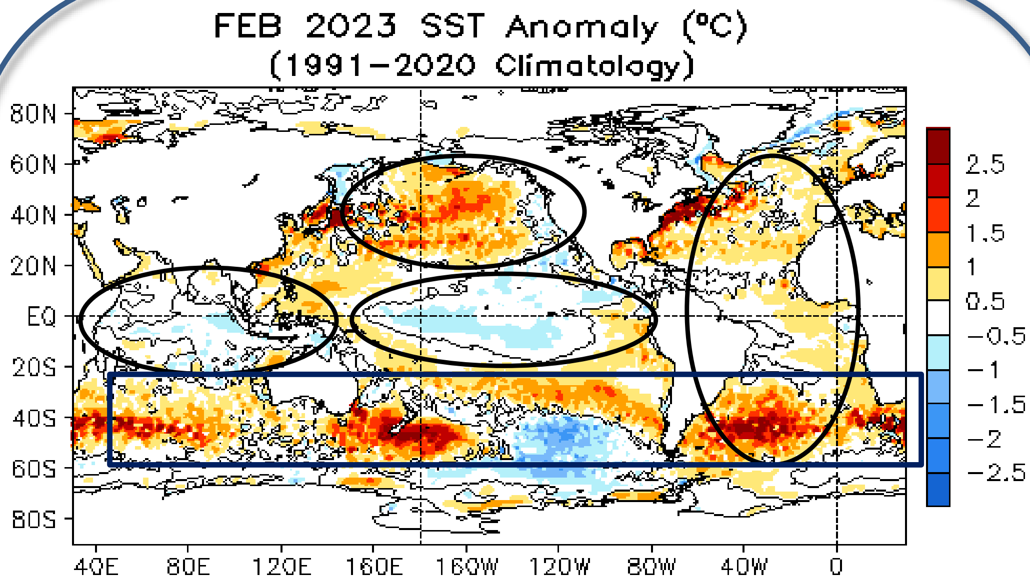
- Overview
- Recent highlights
  - Pacific Ocean
  - Arctic & Antarctic Oceans
  - Indian Ocean
  - Atlantic Ocean
- Global SSTA Predictions

Overview

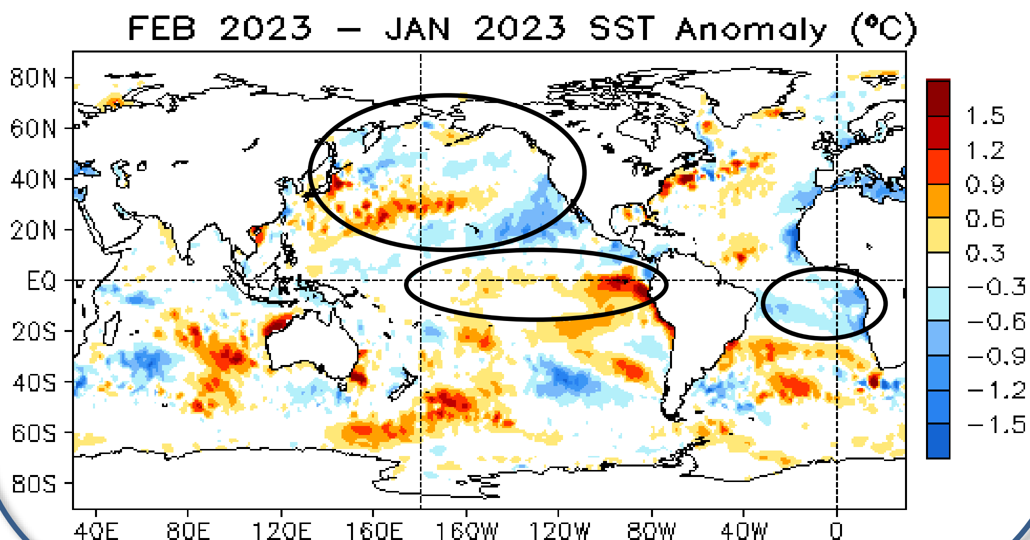
- Pacific Ocean
  - NOAA "ENSO Diagnostic Discussion" on 9 Mar 2023 stated "La Niña has ended and ENSO-neutral conditions are expected to continue through the Northern Hemisphere spring and early summer 2023."
  - La Niña conditions weakened with Niño3.4 = -0.56^{o}C (ERSSTv5) and -0.44 (OIv2.1) in Feb 2023.
  - Positive SSTAs persisted in the North Pacific in Feb 2023.
  - The PDO has been in a negative phase since Feb 2020 with PDOI = -1.1 in Feb 2023.
- Arctic and Antarctic Oceans
  - The Feb 2023 average Arctic sea ice extent was 14.18 million square kilometers, the third lowest Feb in the satellite record.
  - Antarctic sea ice extent tracked at record low extents.
- Indian Ocean
  - SSTAs were weak and mostly negative in the tropical Indian Ocean in Feb 2023.
- Atlantic Ocean
  - NAO switched to a positive phase in Jan 2023 with NAOI= 0.6 in Feb 2023.

Global Oceans

Global SST Anomaly (°C) and Anomaly Tendency



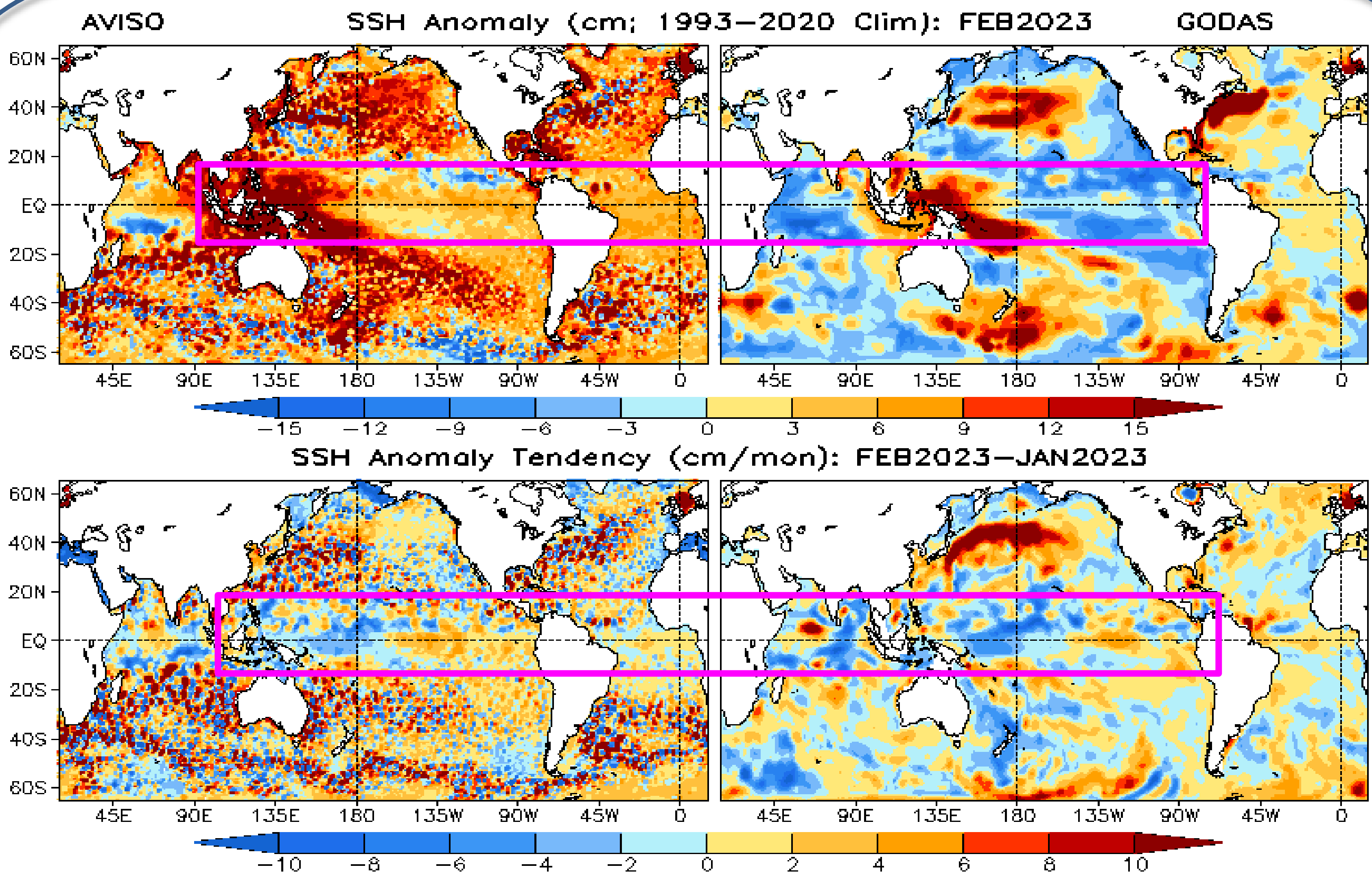
- Negative SSTAs were still presented in the central equatorial Pacific.
- Positive SSTAs were observed in the North Pacific and most of the Atlantic Ocean.
- Small SSTAs were observed in the tropical Indian Ocean.
- Appreciable positive and negative SSTAs were seen in the middle-latitudes of the Southern Hemisphere.



- Positive SSTA tendencies were observed in the eastern equatorial Pacific.
- Both positive and negative SSTA tendencies were evident in the North Pacific.
- Negative SSTA tendencies were in the tropical Southern Atlantic Ocean.

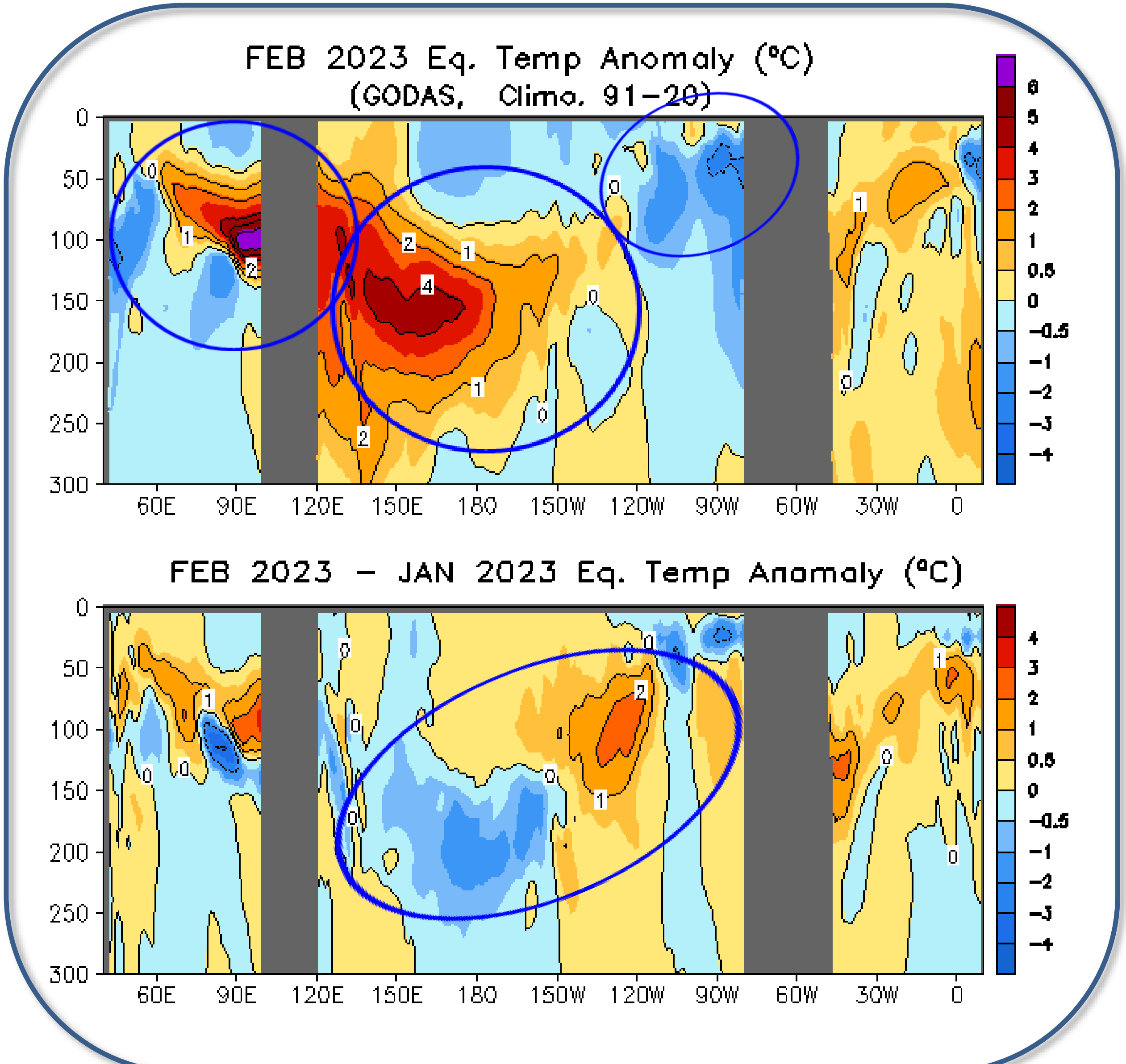
SSTAs (top) and SSTA tendency (bottom). Data are derived from the OIv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

AVISO & GODAS SSH Anomaly (cm) and Anomaly Tendency



- SSHAs still featured with a La Niña pattern in the tropical Pacific in GODAS.
- The tendencies indicated an increase of SSH in the eastern tropical Pacific.

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



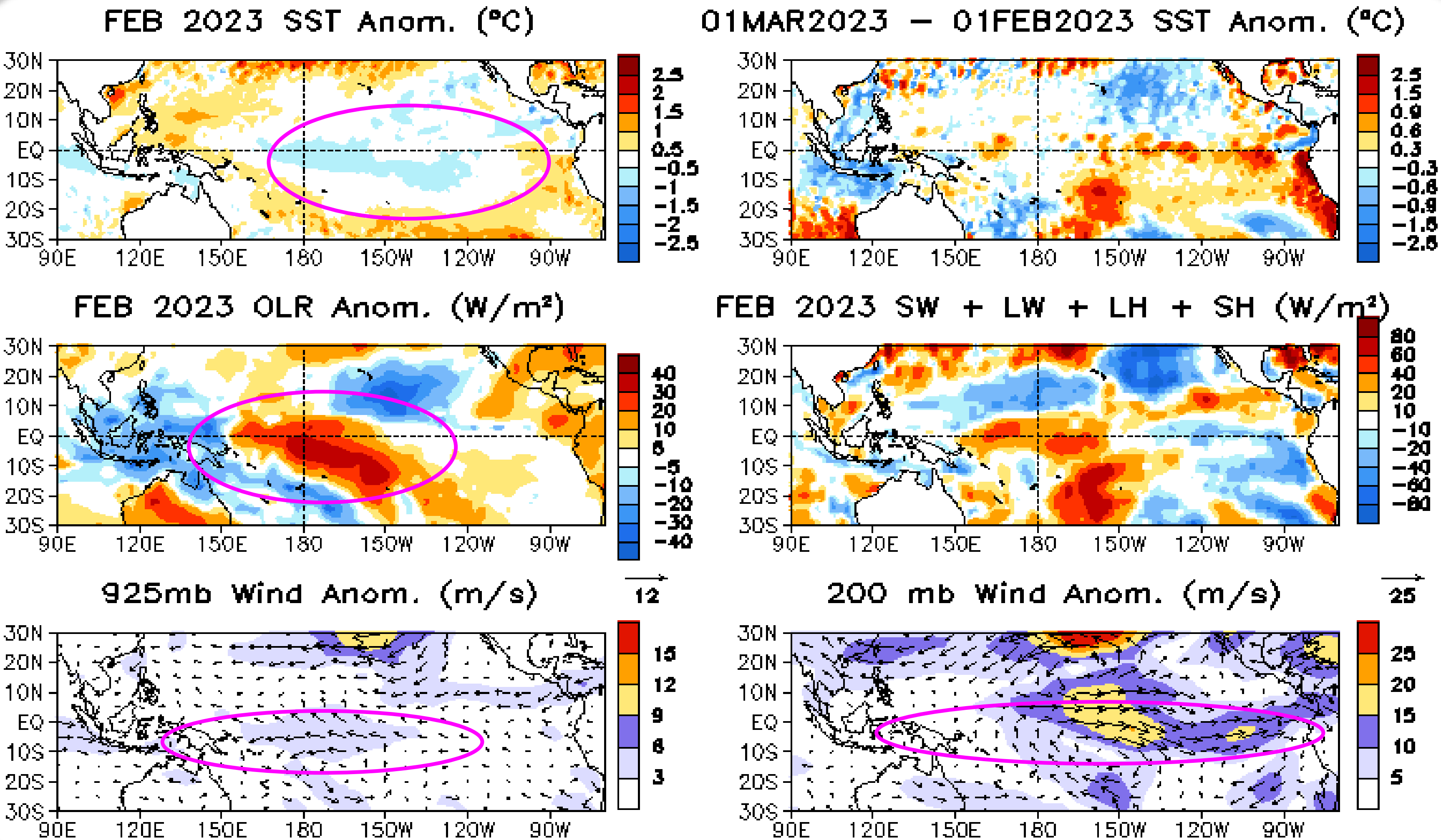
- Positive (negative) temperature anomalies were present along the thermocline in the western and central (eastern) equatorial Pacific.
- Positive (negative) temperature anomalies were observed along the eastern (western) equatorial thermocline in the Indian Ocean.

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

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 1991-2020 base period means.

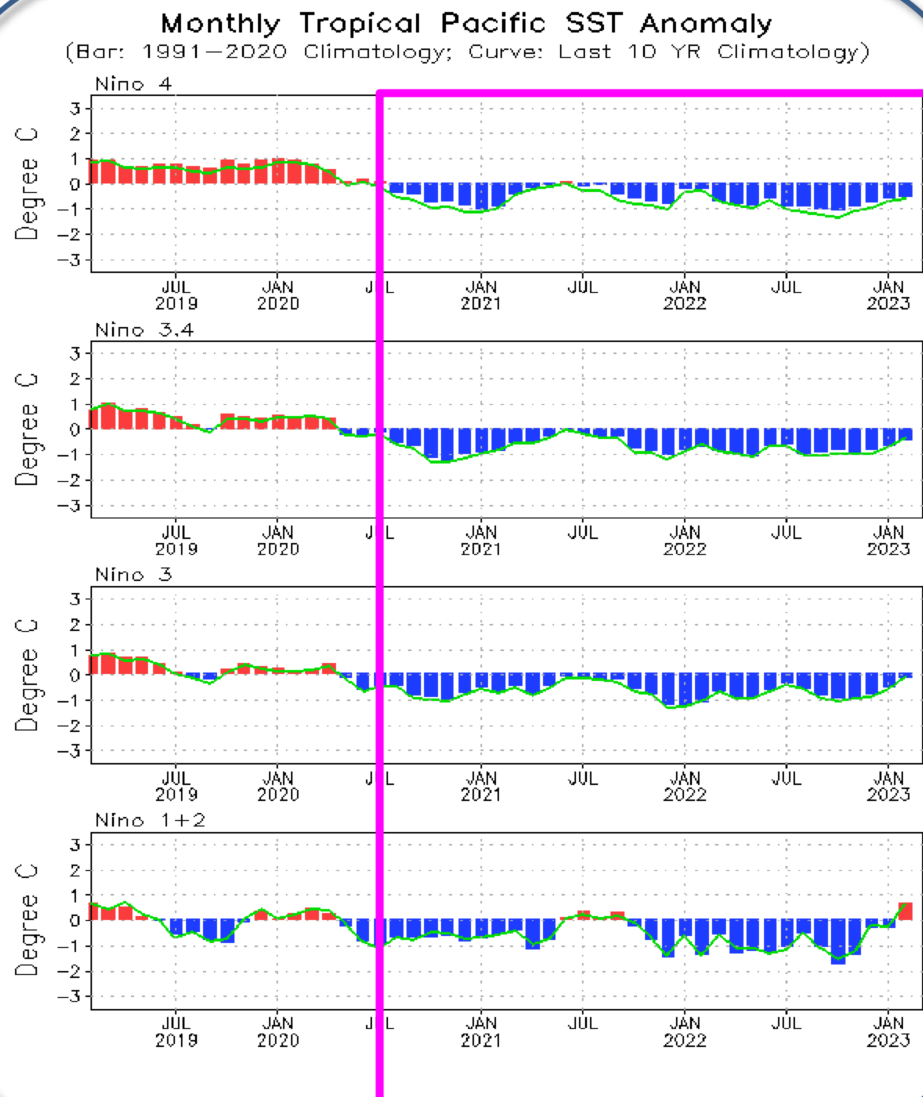
Tropical Pacific Ocean and ENSO Conditions

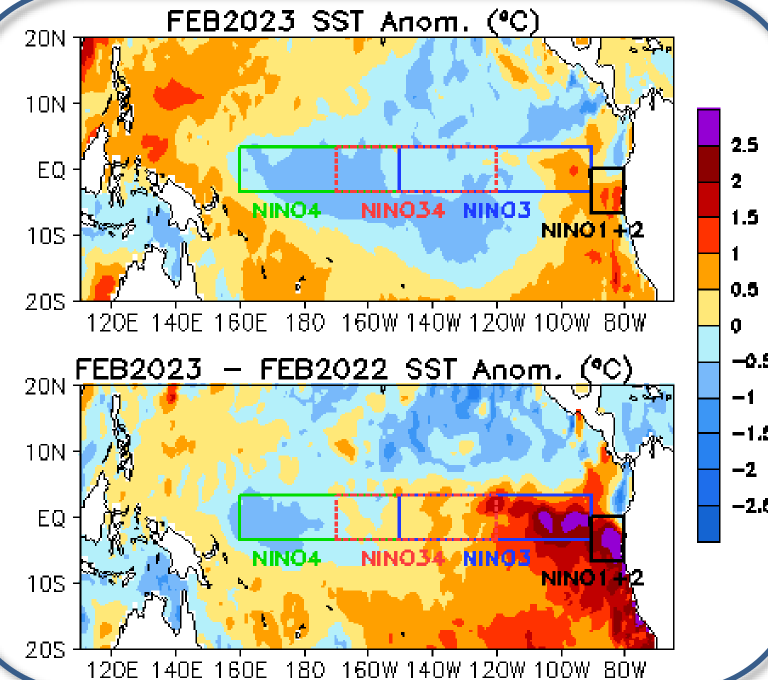
Tropical Pacific: SSTA, SSTA Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Winds



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 OIv2.1 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 1991-2020 base period means.

Evolution of Pacific Niño SST Indices





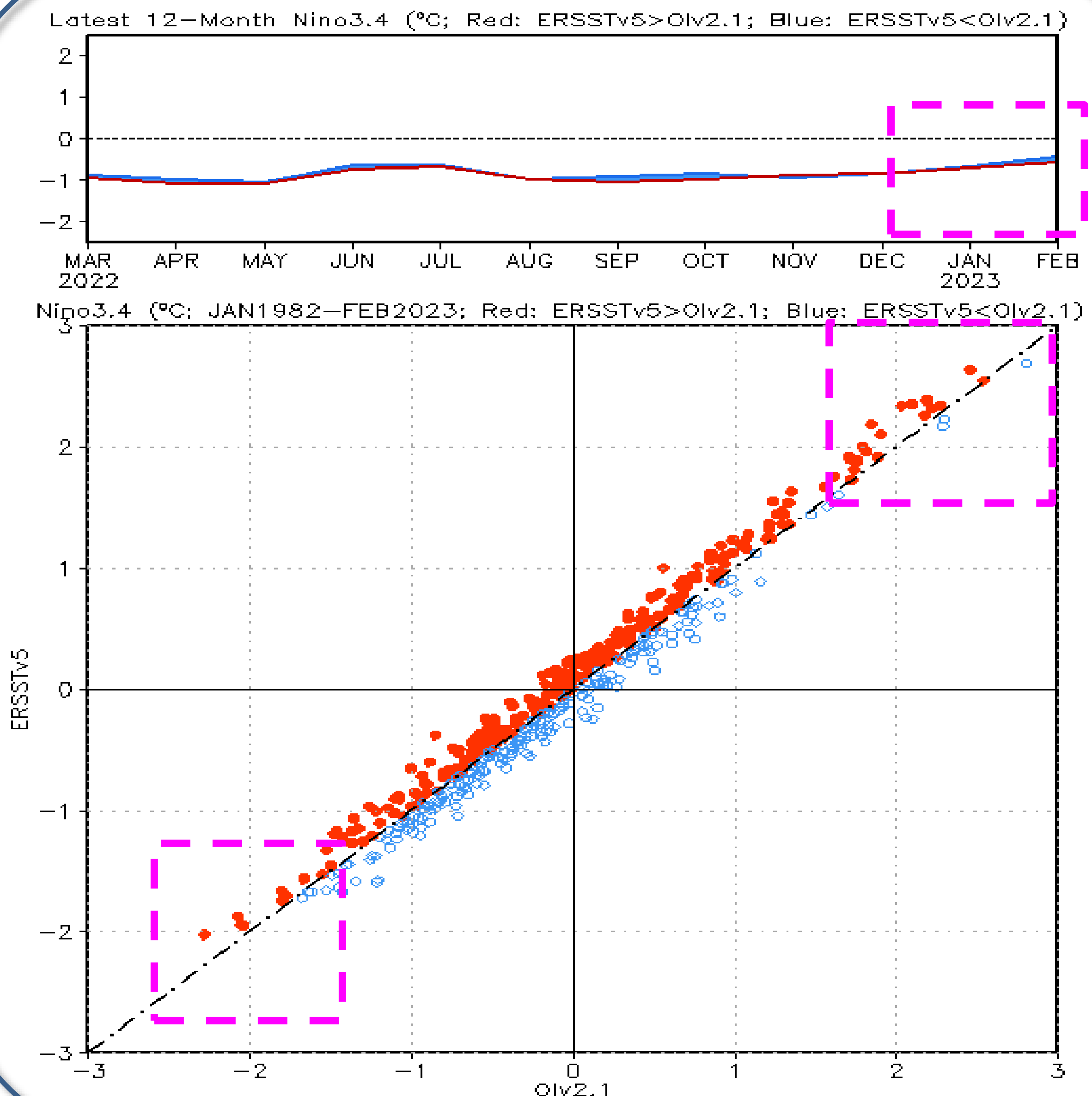
- All Niño indices warmed up in Feb 2023, with Niño3.4 = -0.44C (OIv2.1).

- Compared with Feb 2022, the central and eastern equatorial Pacific was warmer in Feb 2023.

- 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 OIv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

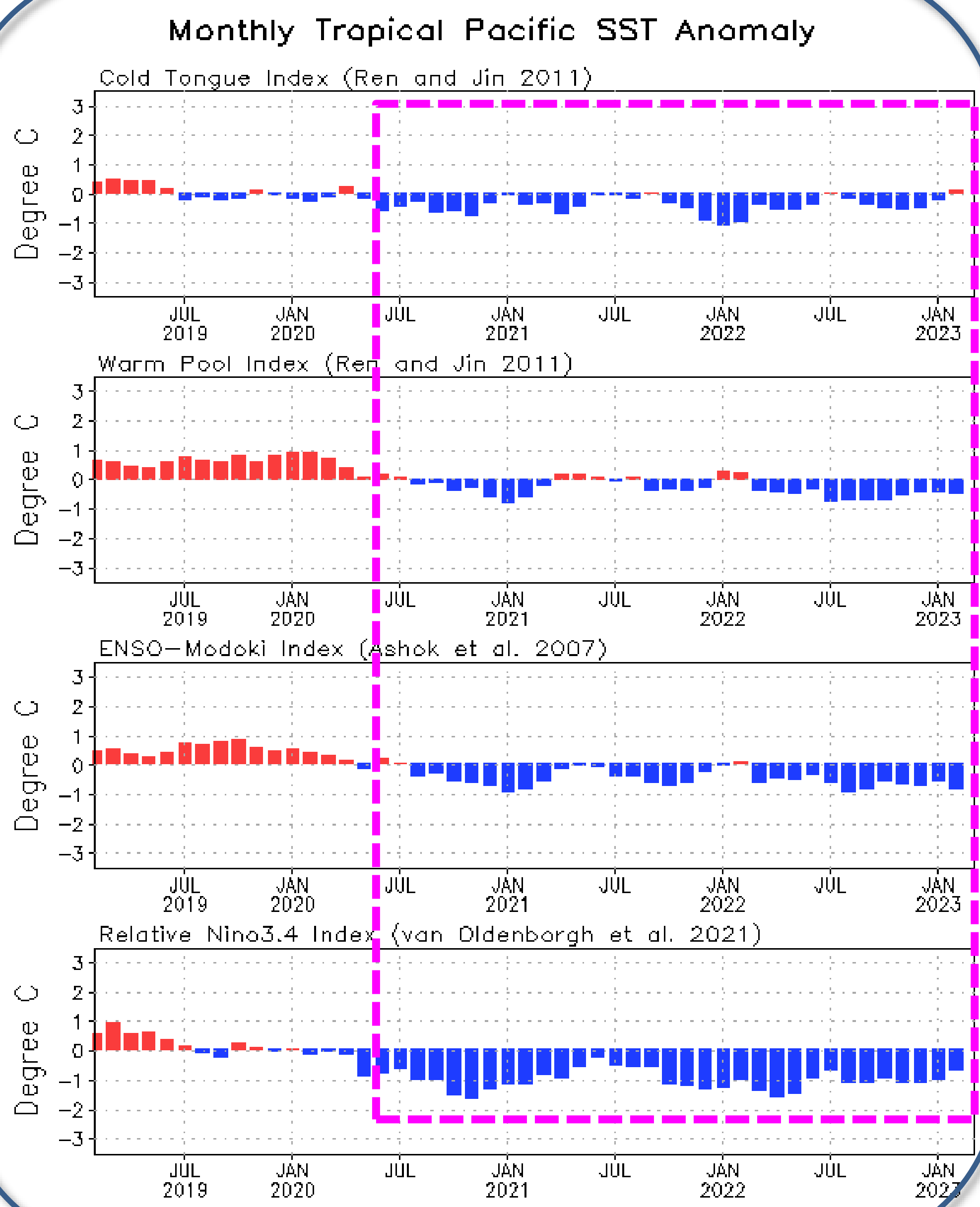
Comparison of ERSSTv5 & OIv2.1 Niño3.4 Index

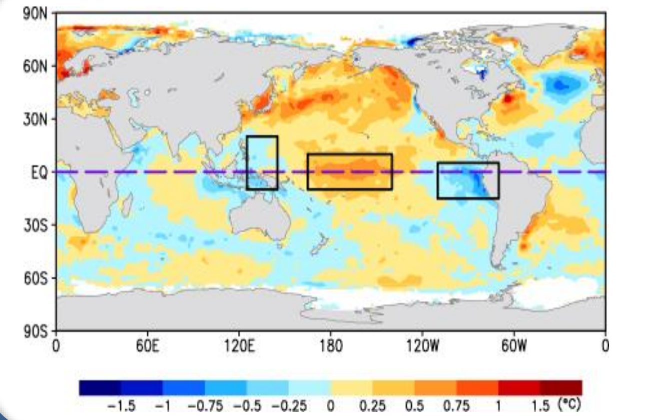


- Recently, ERSSTv5 is cooler than ERSSTv2.1: -0.44C (OIv2.1) & -0.56C (ERSSTv5).

- Historically, ERSSTv5 can be either warmer or cooler than OIv2.1.
- For both the extreme positive and negative (>1.5°C or <-1.5°C) Niño3.4, ERSSTv5 is mostly warmer than OIv2.1.
- During last few months, ERSSTv5 was similar to OIv2.1.

Evolution of Pacific Niño SST Indices



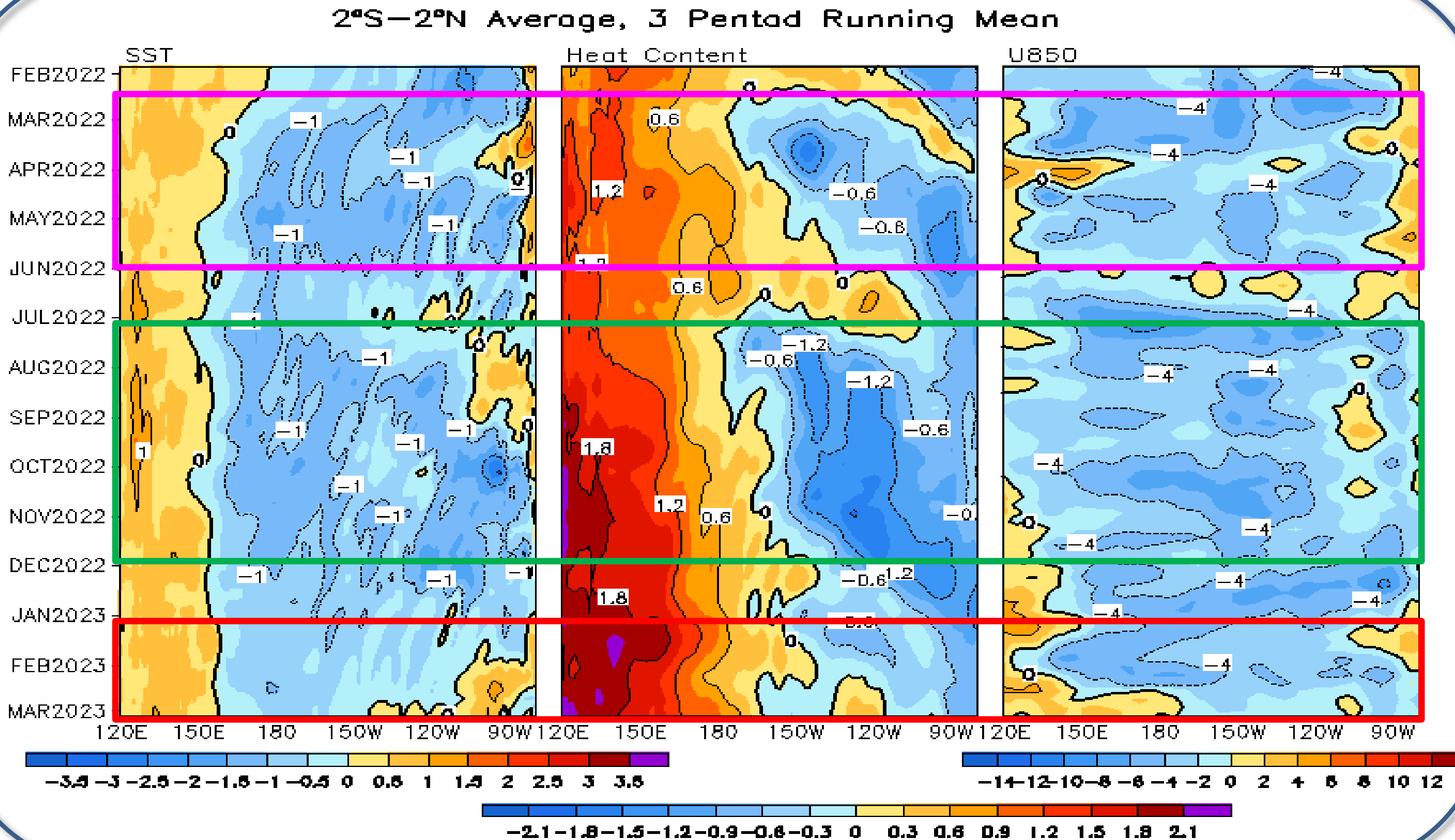


- Relative Niño3.4 index is now included in ENSO monitoring, which is defined as the conventional Niño3.4 index minus the SSTA averaged in the whole tropics (0°-360°, 20°S-20°N), in order to remove the global warming signal. Also, to have the same variability as the conventional Niño3.4 index, the relative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

Relative Niño3.4 data updated monthly at:

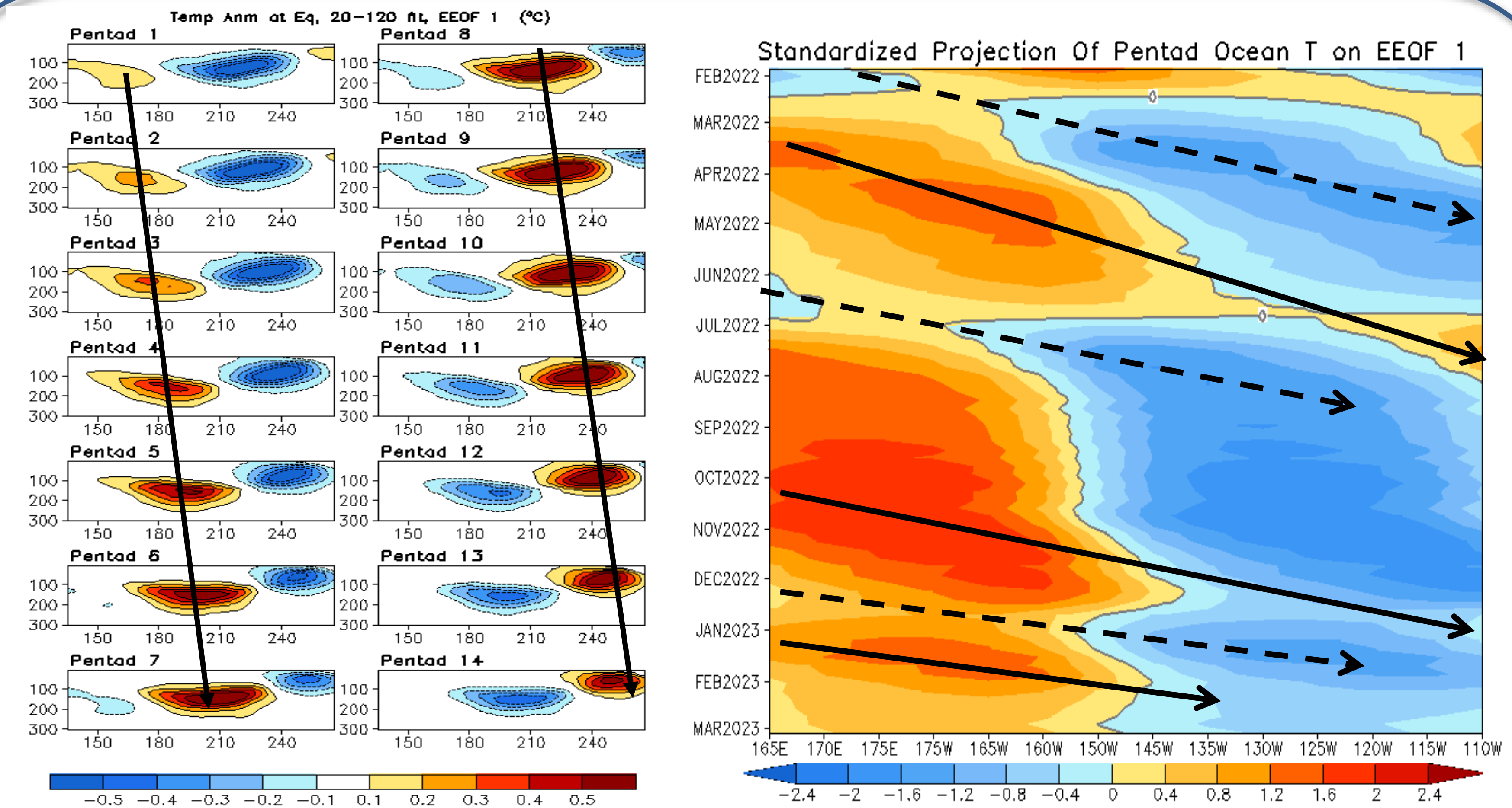
https://www.cpc.ncep.noaa.gov/data/indices/RONI.ascii.txt

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



- The evolution of the triple-dip La Niña SSTA in 2020-23 was linked to low-level zonal wind anomalies and Kelvin wave activities.

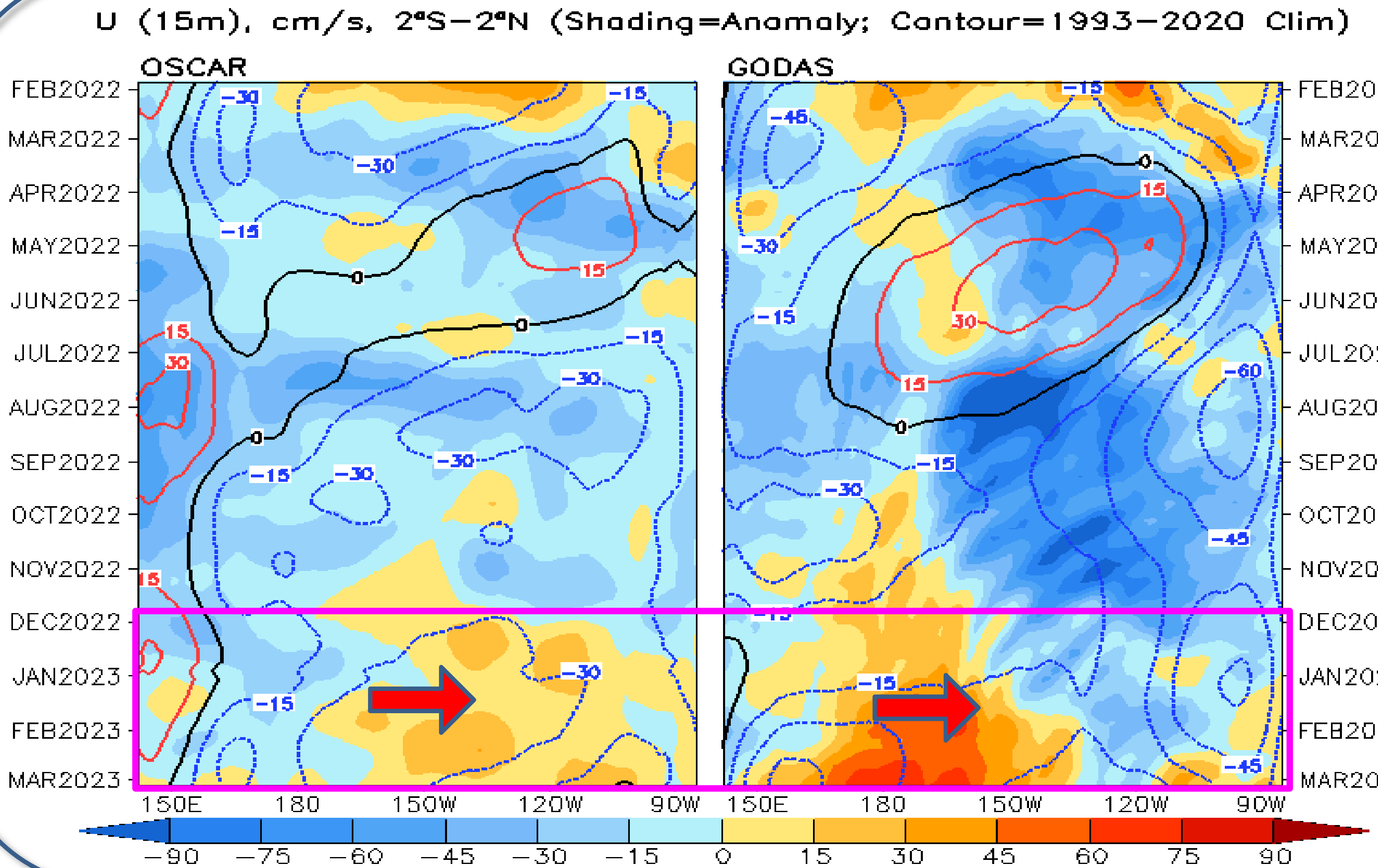
Oceanic Kelvin Wave (OKW) Index



- **Multiple weak downwelling and upwelling Kelvin waves were observed in 2022, leading to the small fluctuation of SSTA in the central and eastern equatorial Pacific.**
- **A weak downwelling Kelvin wave propagated eastward since Jan 2023.**

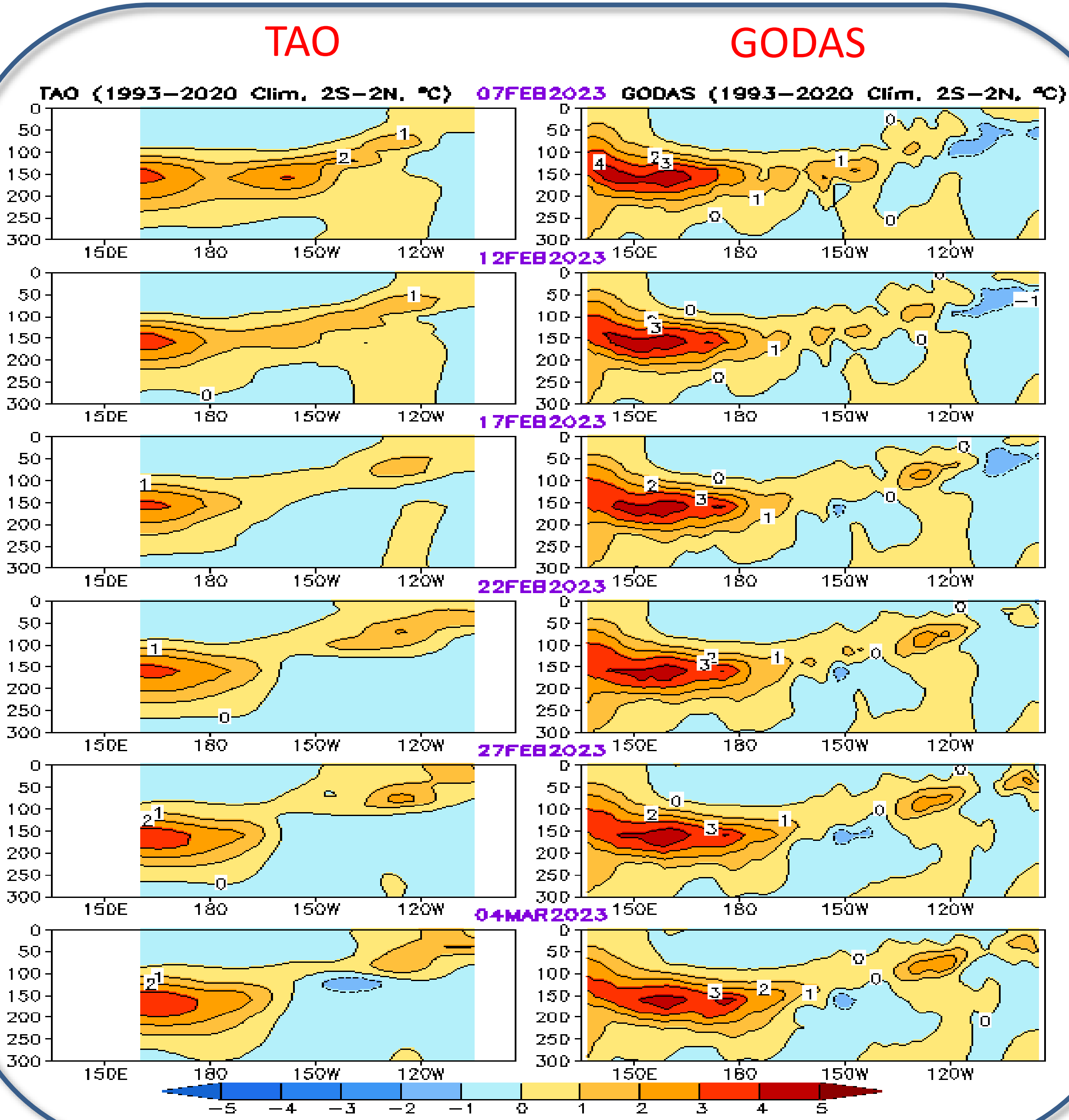
(OKW index is defined as standardized projections of total anomalies onto the 14 patterns of Extended EOF1 of equatorial temperature anomalies (Seo and Xue , GRL, 2005).)

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



- Anomalous eastward currents in the east-central equatorial Pacific in both OSCAR and GODAS since Dec 2022 were overall consistent with the weakening of the negative SSTA.

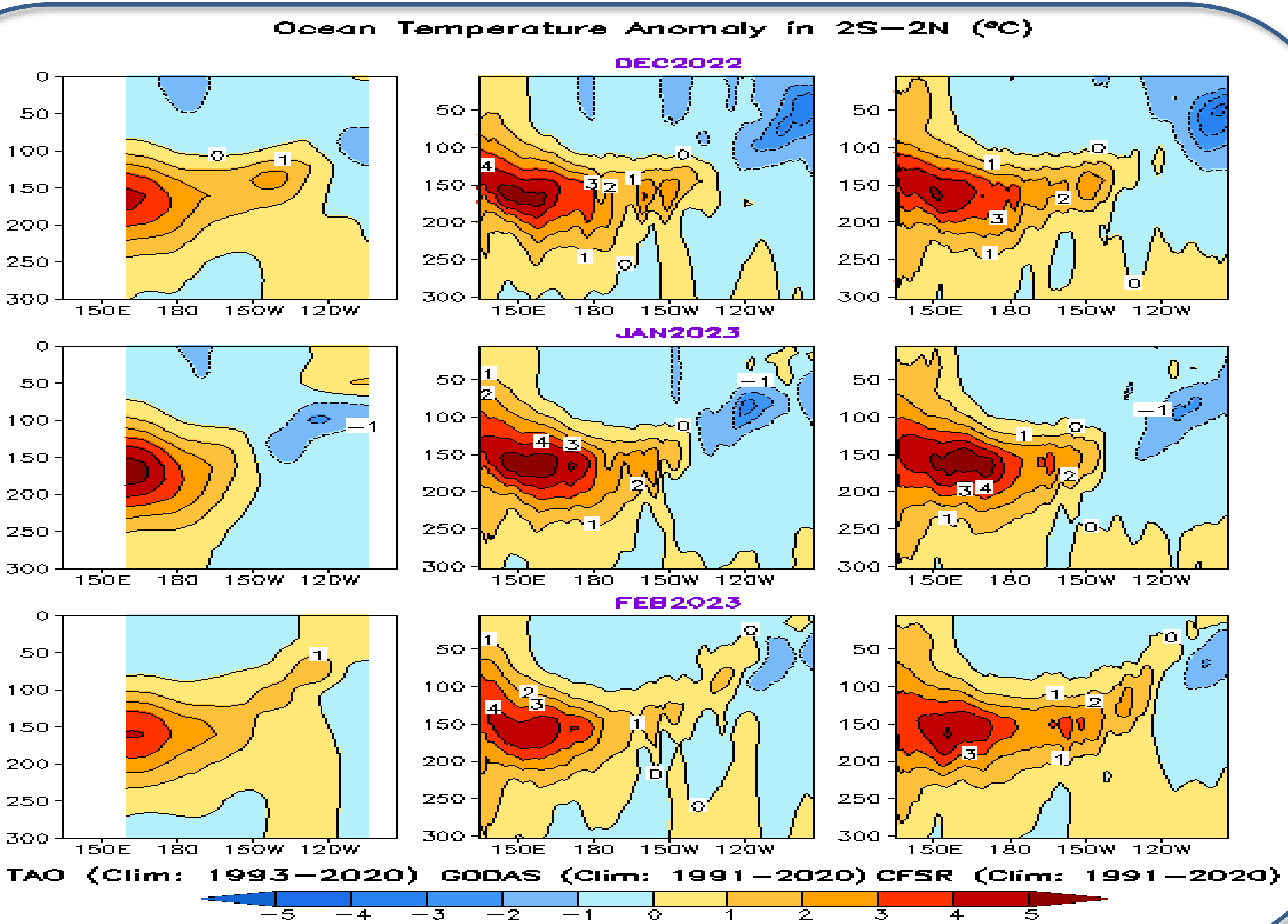
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly



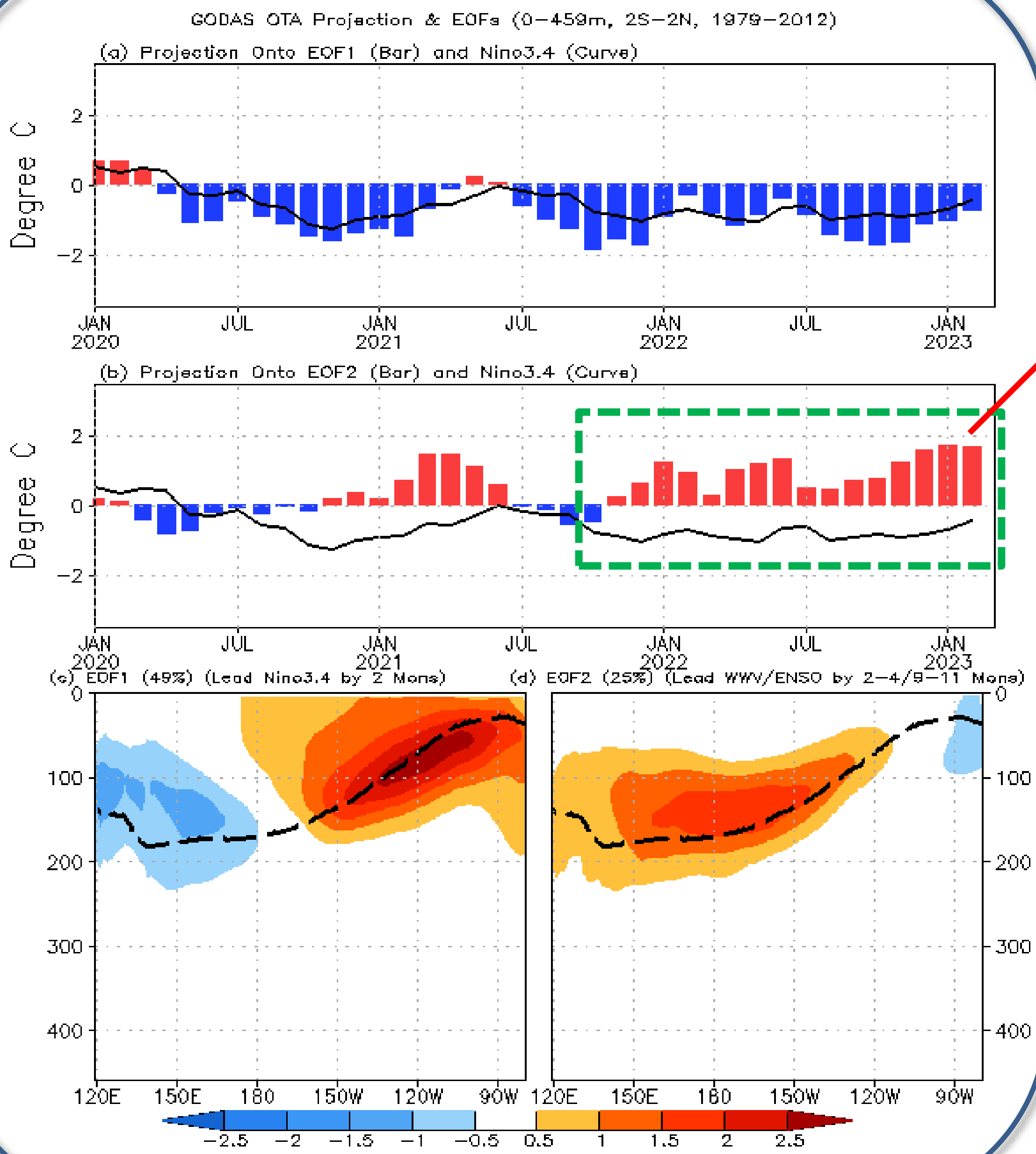
- Positive ocean temperature anomalies along the thermocline in the western and central Pacific extended eastward in the last month.

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

Monthly mean subsurface temperature anomaly along the Equator: A consistent weakening tendency of the cold anomalies



Equatorial Sub-surface Ocean Temperature Monitoring



- The equatorial Pacific has been in a recharge phase since Nov 2021.

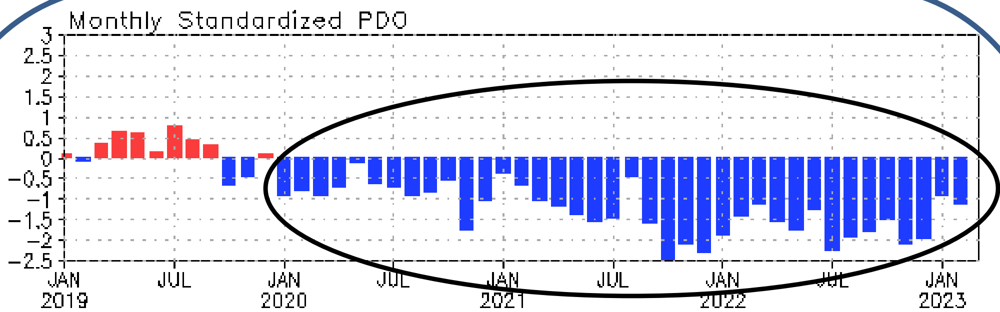
- Projection of ocean temperature anomalies onto EOF1 and EOF2; EOF1: Tilt/dipole mode (ENSO peak phase); EOF2: WWV mode.

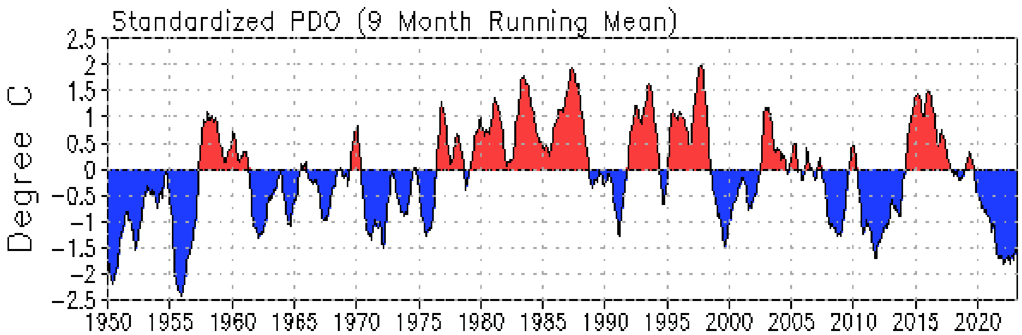
- Recharge/discharge oscillation (ENSO transition phase); Recharge process: heat transport from outside of equator to equator; Negative -> positive phase of ENSO

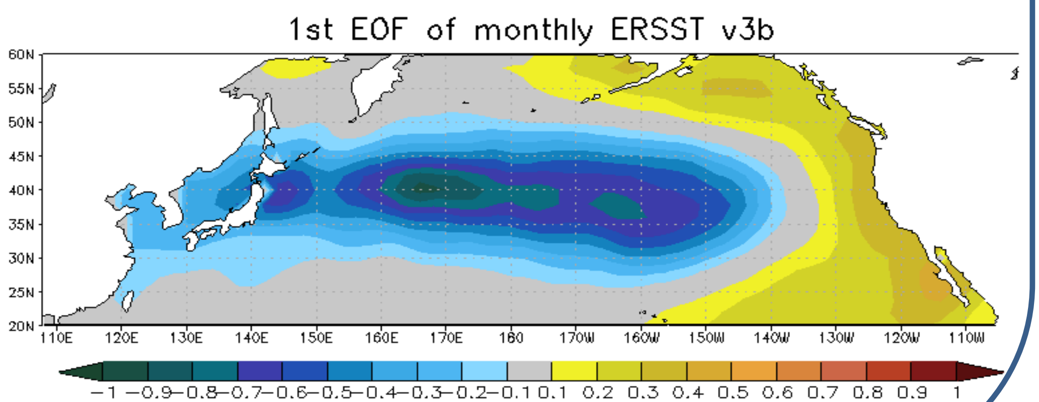
- For details, see: Kumar and Hu (2014) DOI: 10.1007/s00382-013-1721-0.

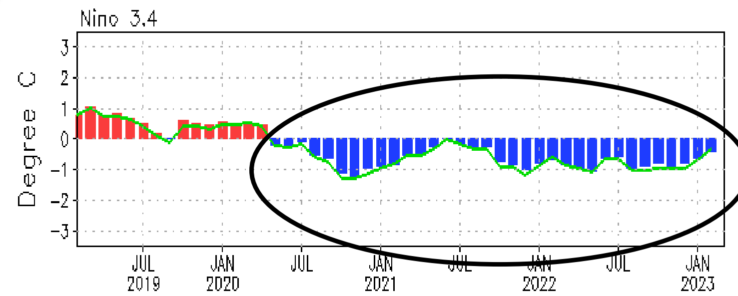
North Pacific & Arctic Oceans

Pacific Decadal Oscillation (PDO) Index







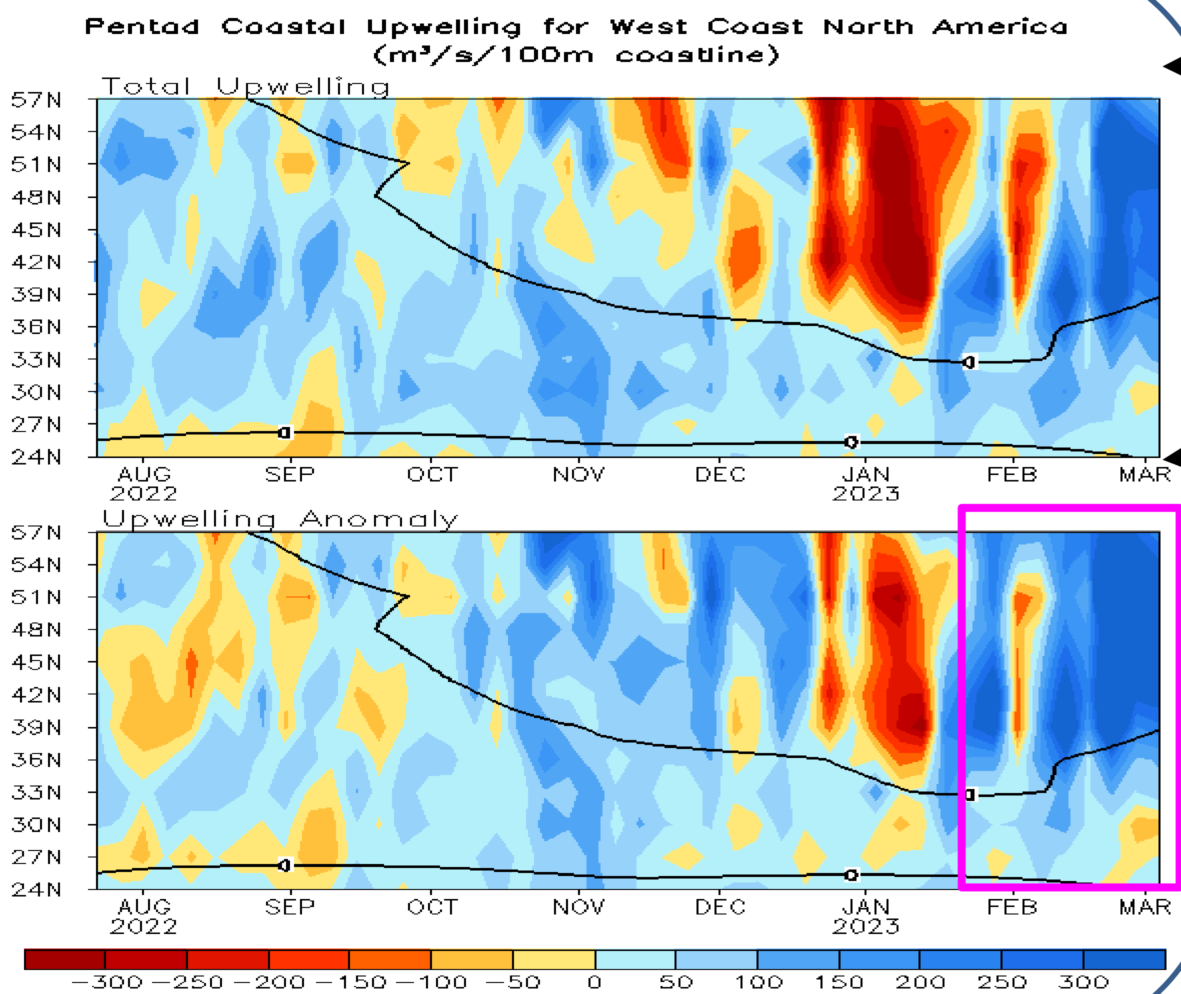


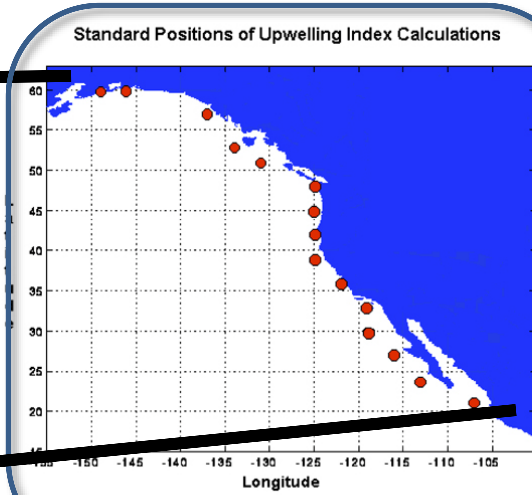
- The PDO has been in a negative phase since Feb 2020 with PDOI = -1.1 in Feb 2023.

- 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.

North America Western Coastal Upwelling

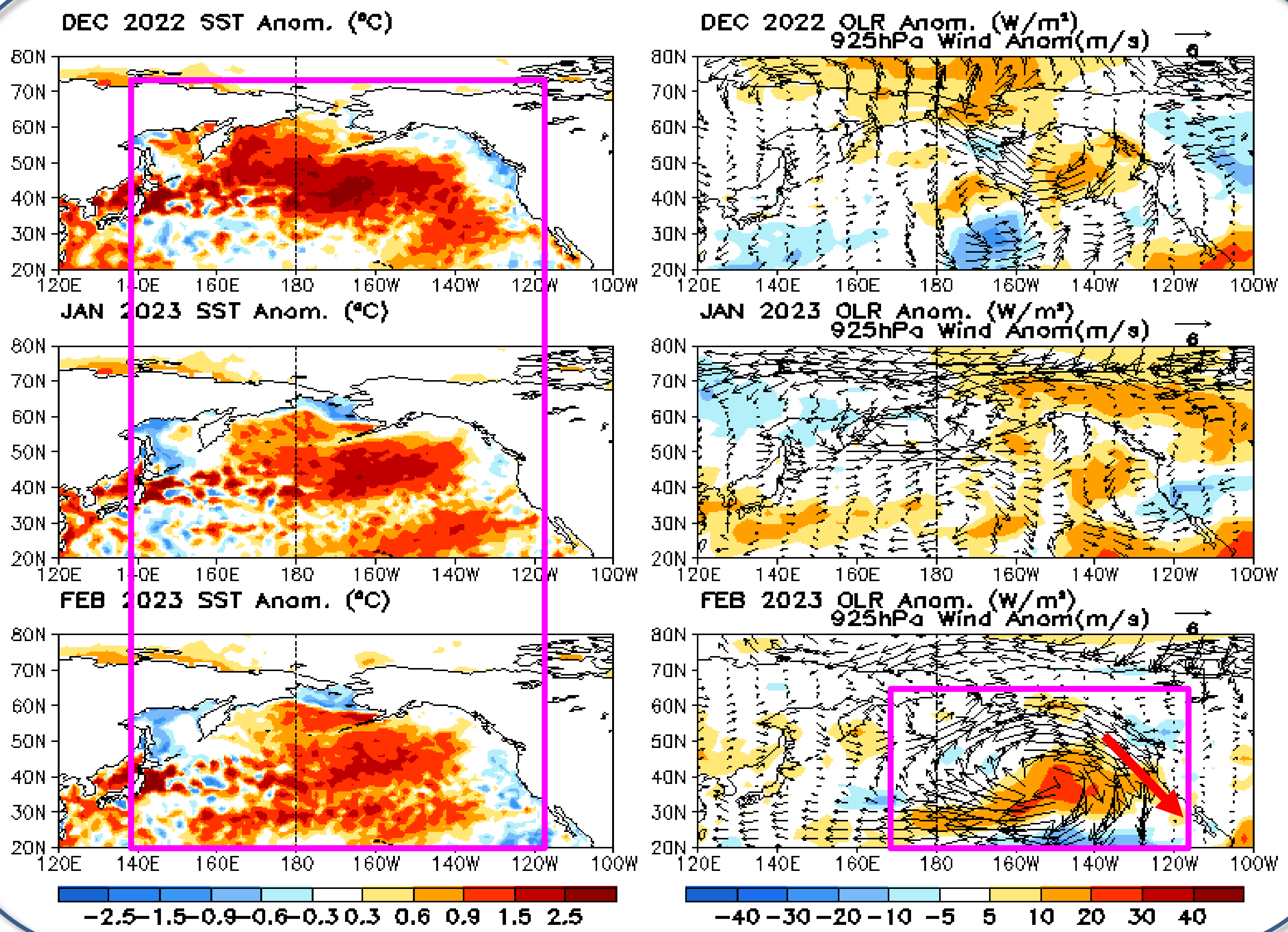




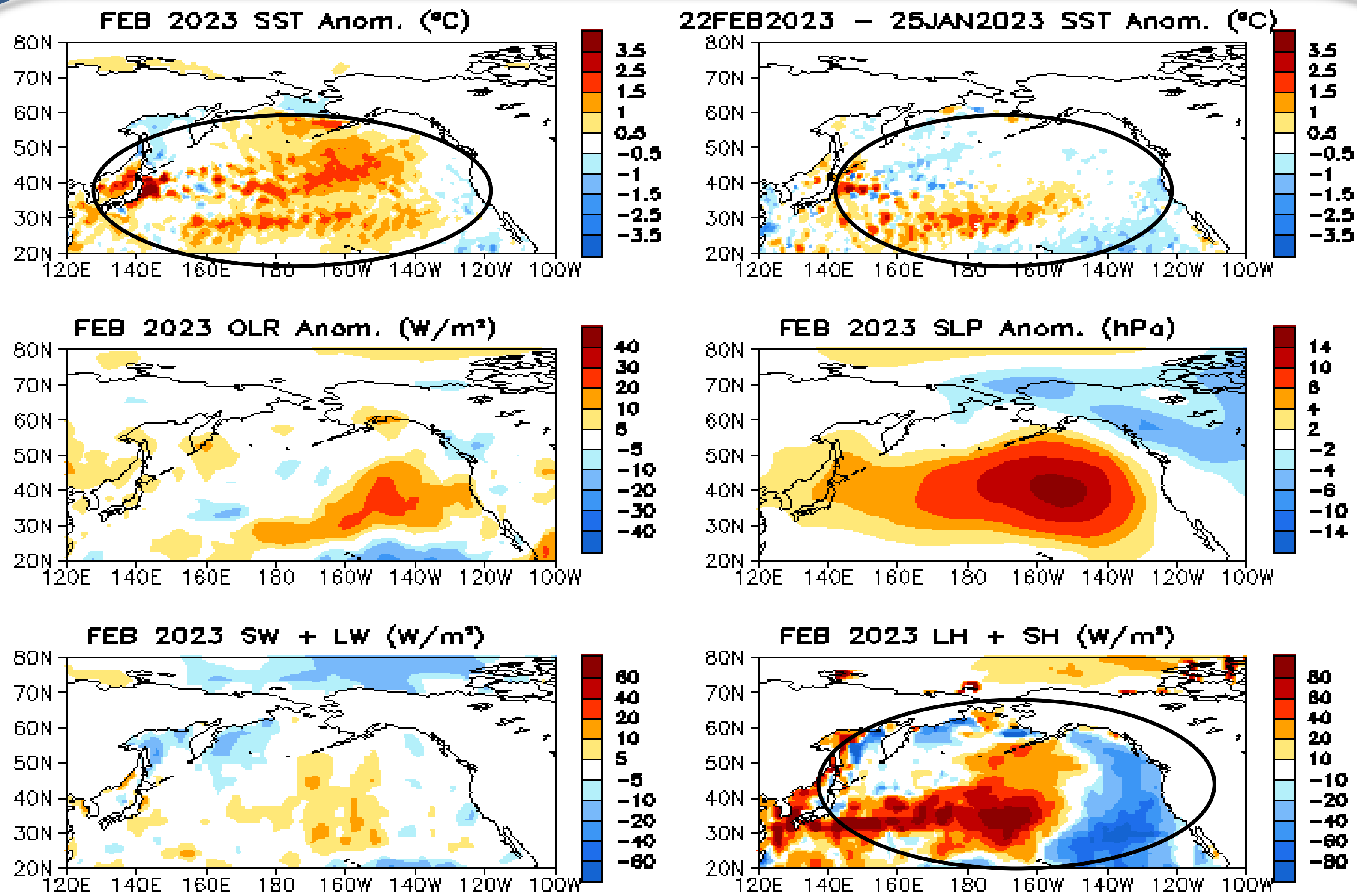
- Coastal anomalous upwelling was observed since mid-Jan 2023.

(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 (m³/s/100m coastline). Anomalies are departures from the 1991-2020 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 SST, OLR, and uv925 anomalies

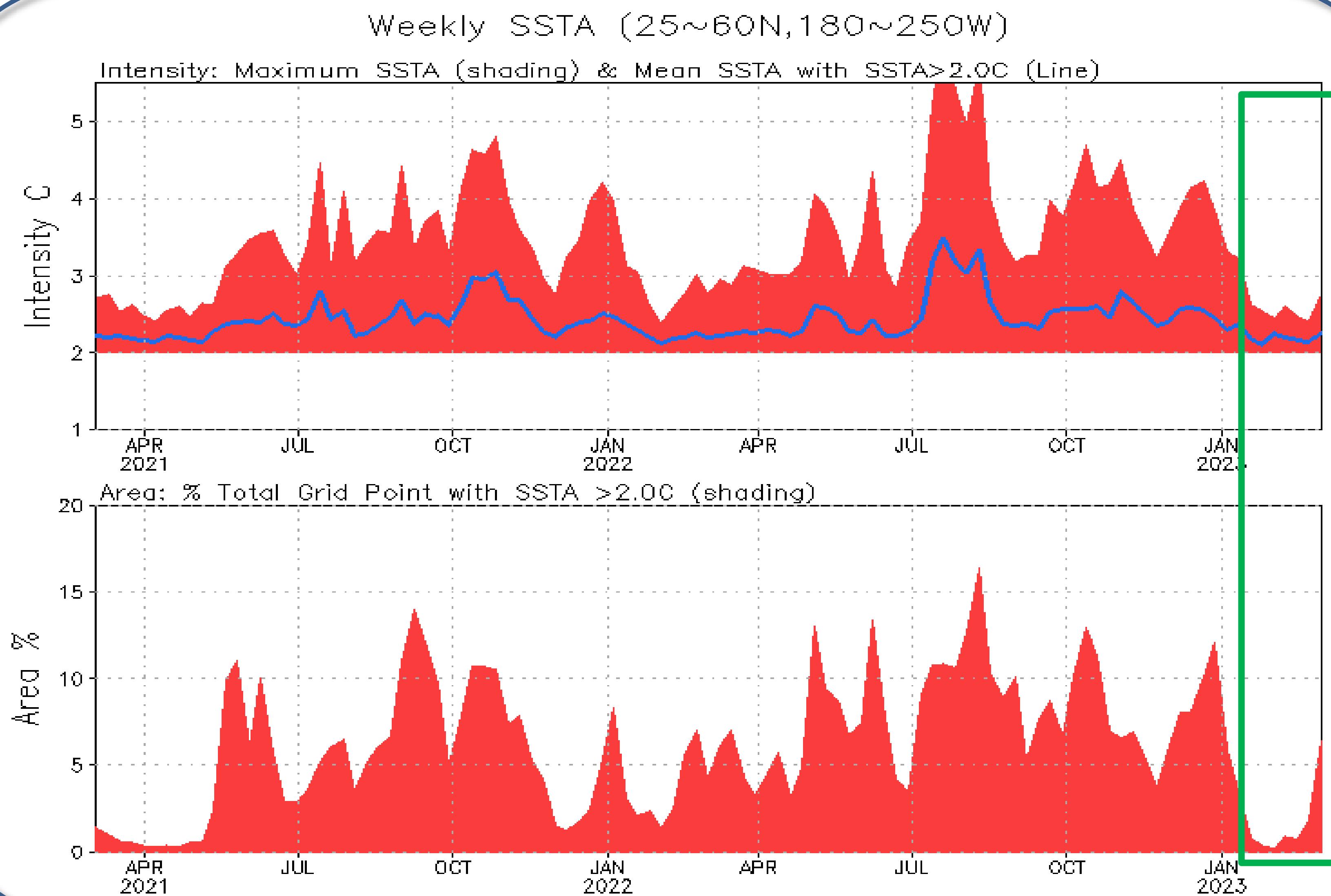


North Pacific & Arctic Ocean: SSTA, SSTA Tend., OLR, SLP, Sfc Rad, Sfc Flx Anomalies



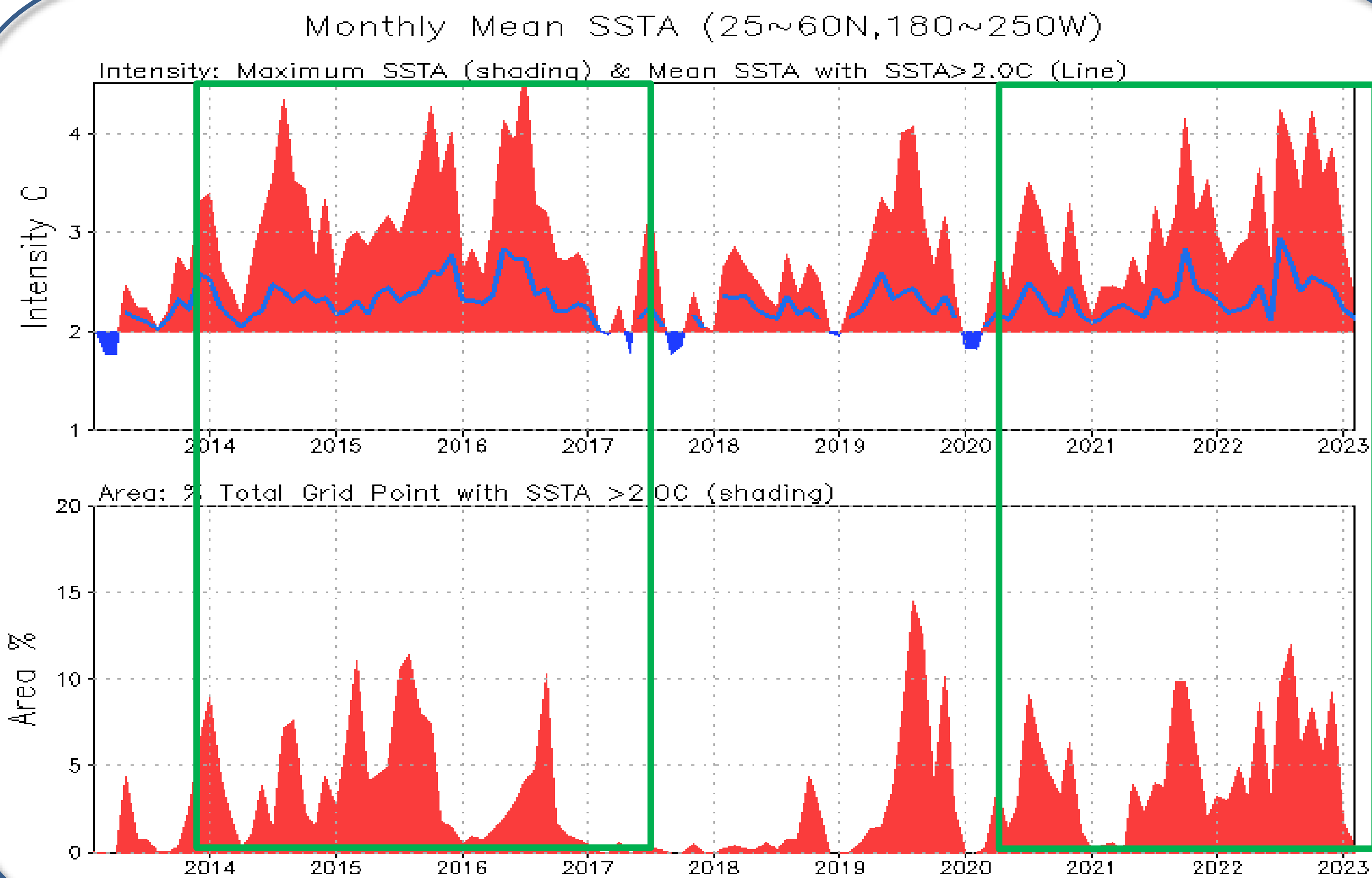
SSTA (top-left; OIv2.1 SST Analysis), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) (middle-left; NOAA 18 AVHRR IR), sea surface pressure (middle-right; NCEP CDAS), sum of net surface short- and long-wave radiation (bottom-left; positive means heat into the ocean; NCEP CDAS), sum of latent and sensible heat flux (bottom-right; positive means heat into the ocean; NCEP CDAS). Anomalies are departures from the 1991-2020 base period means.

N. Pacific Marine Heat Wave: Declined since Jan 2023



https://origin.cpc.ncep.noaa.gov/products/GODAS/MarineHeatWave.html

N. Pacific Marine Heat Wave



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NOAA/NWS/NCEP CPC Marine Heat Wave Webpage

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NOAA/NCEP Climate Prediction Center

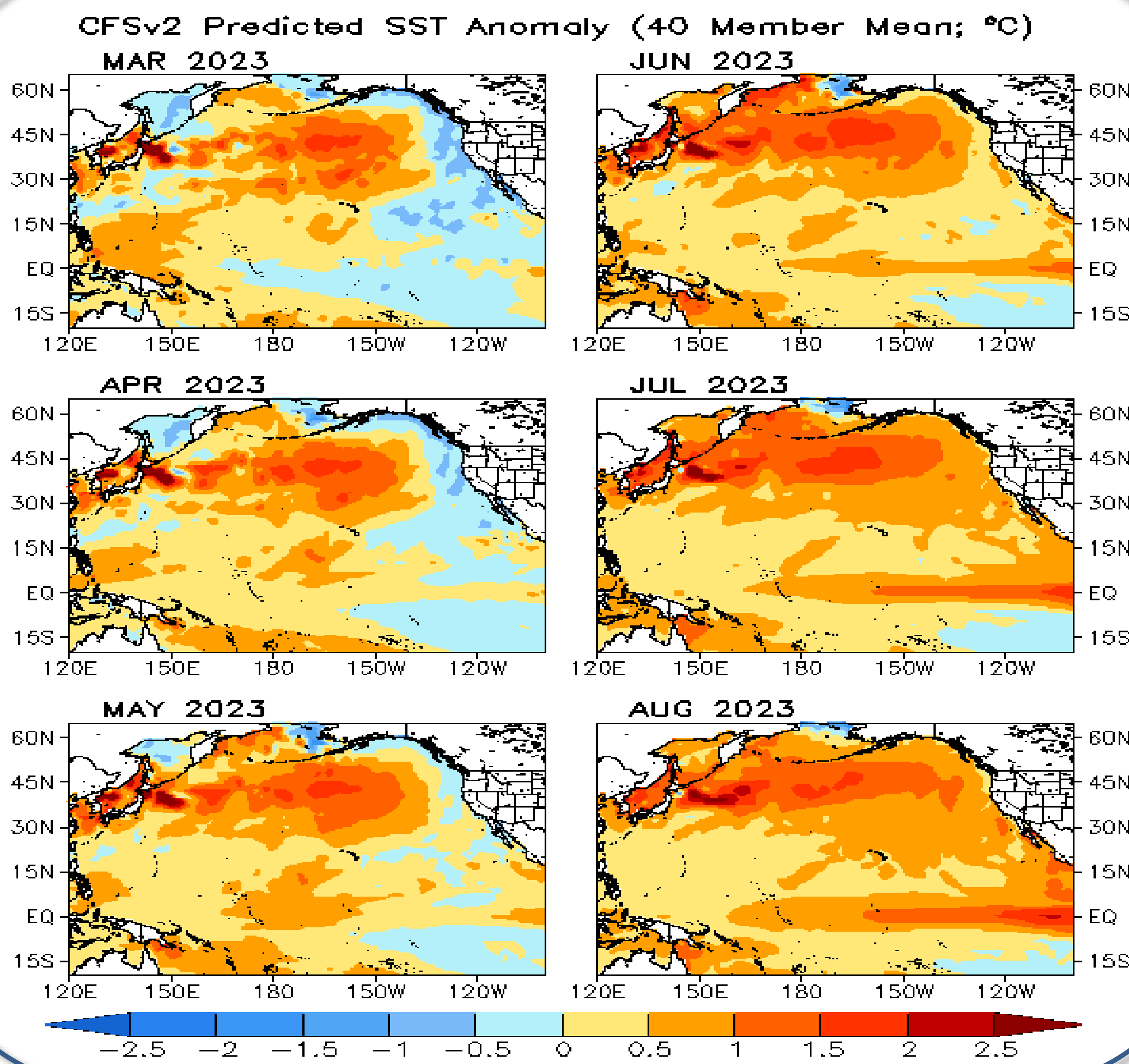
Marine Heatwave Monitoring and Forecast

- **Indices & Time Series**
  - N. Pacific MHW Intensity & Area Indices: Weekly Monthly
  - Regional Mean SST: Global Monthly & Nino3.4 Since 1854 N. Pacific Weekly Gulf of Alaska & Subtropical Coast Weekly

- **Spatial Distribution**
  - Global Monthly Anomaly
    - SST
  - N. Pacific Anomaly
    - Pentad Subsurface Ocean Temperature: 5m 55m 105m 155m
    - Weekly SST Weekly SST2
    - Pentad 300m Ocean Heat Content Pentad Ocean Surface Heigh Pentad Surface Heat Flux
    - 3-month SST, SLP, & UV925 SST Tendency & 3-Month Heat Flux
    - Ocean Temperature Profile GODAS Ocean Temperature Profile
  - N. Atlantic Anomaly
    - Weekly SSTA Monthly MDR SSTA
    - 3-month SST, SLP, & UV925 SST Tendency & 3-Month Heat Flux

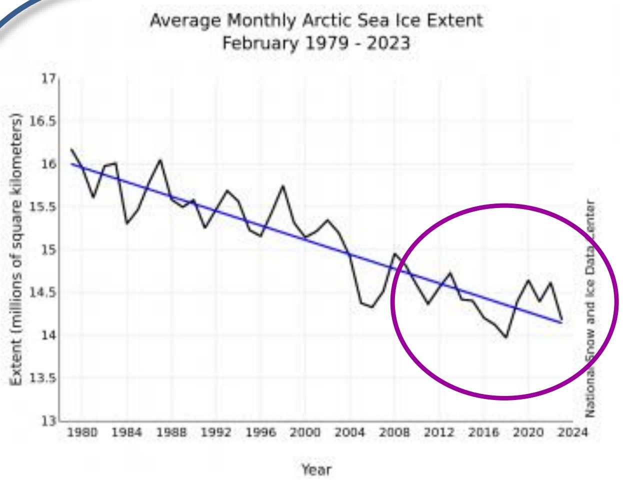
- **NMME & CFSv2 Forecasts**
  - Tropical N. Atlantic SSTA: NMME CFSv2
  - N. Pacific SSTA: NMME CFSv2
  - CFSv2: N. Pacific Sea Surface Height Anomaly
  - CFSv2 SSTA Index: Last month Last 9 months

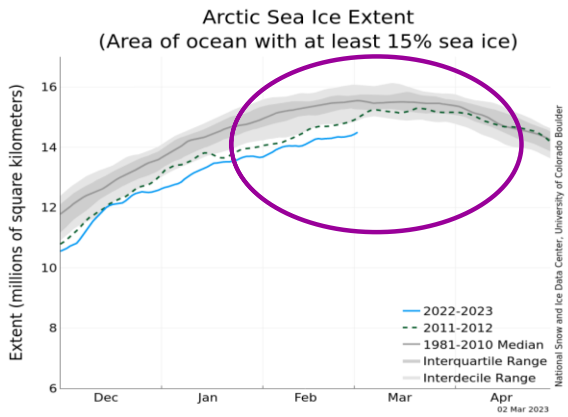
CFSv2 NE Pacific SSTA Predictions

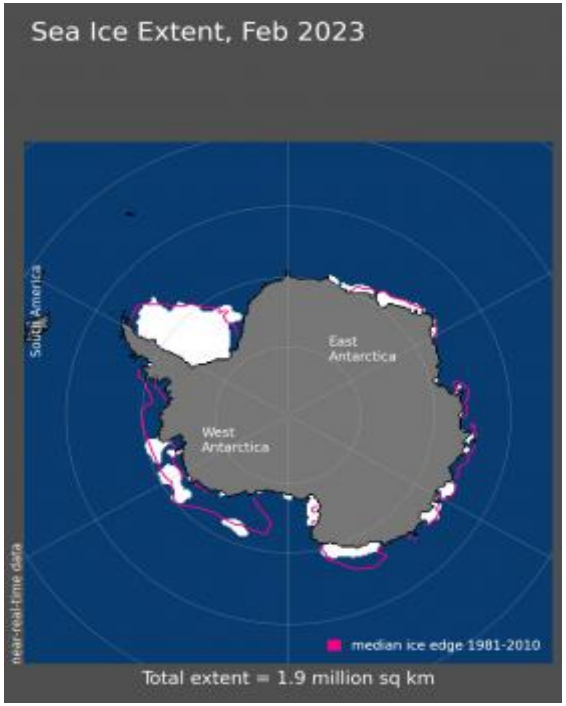


- The CFSv2 predicts above normal SSTs in the N. Pacific during spring – autumn 2023.

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

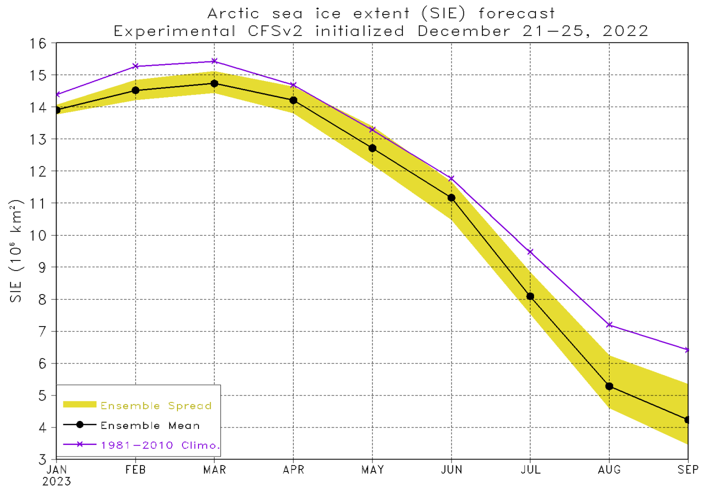


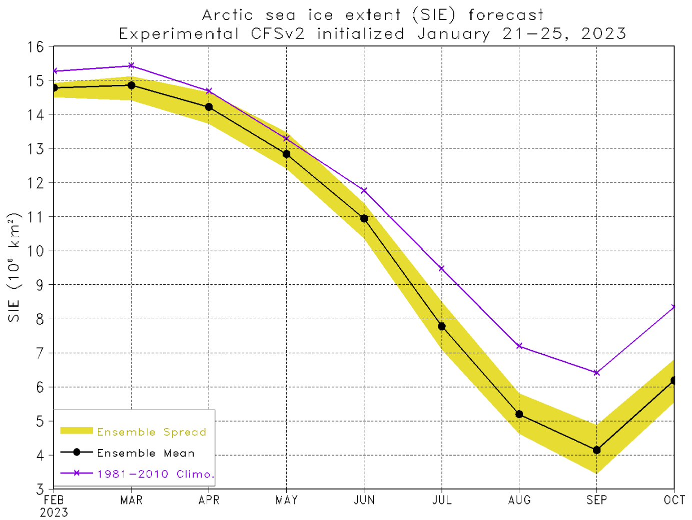


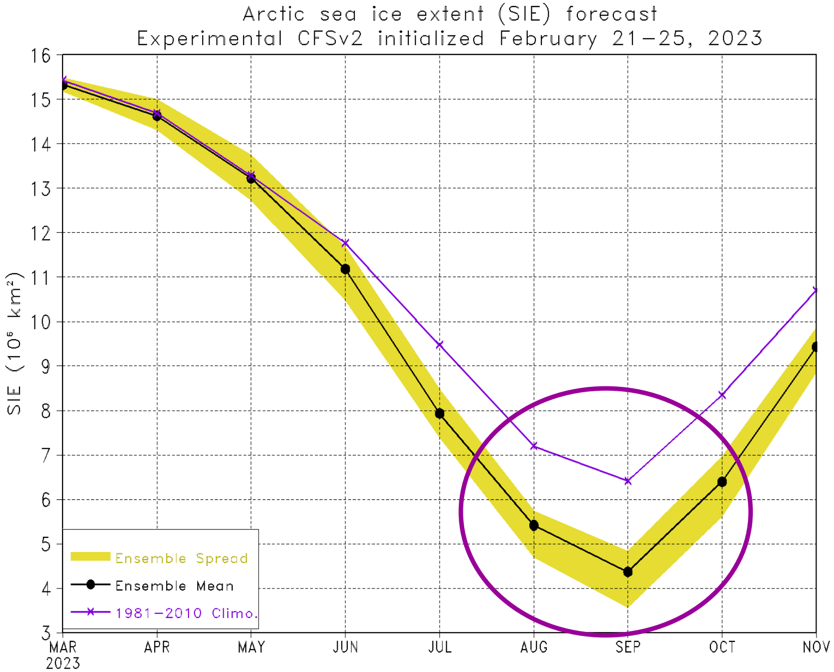


- The Feb 2023 average Arctic sea ice extent was 14.18 million square kilometers, the third lowest Feb in the satellite record.
- The downward linear trend in Feb sea ice extent over the 44-year satellite record is 2.8% per decade relative to the 1981 to 2010 average.
- Antarctic sea ice extent tracked at record low extents and has hit its minimum extent for the year, setting a new record low, and is now expanding.

NCEP/CPC Arctic Sea Ice Extent Forecast



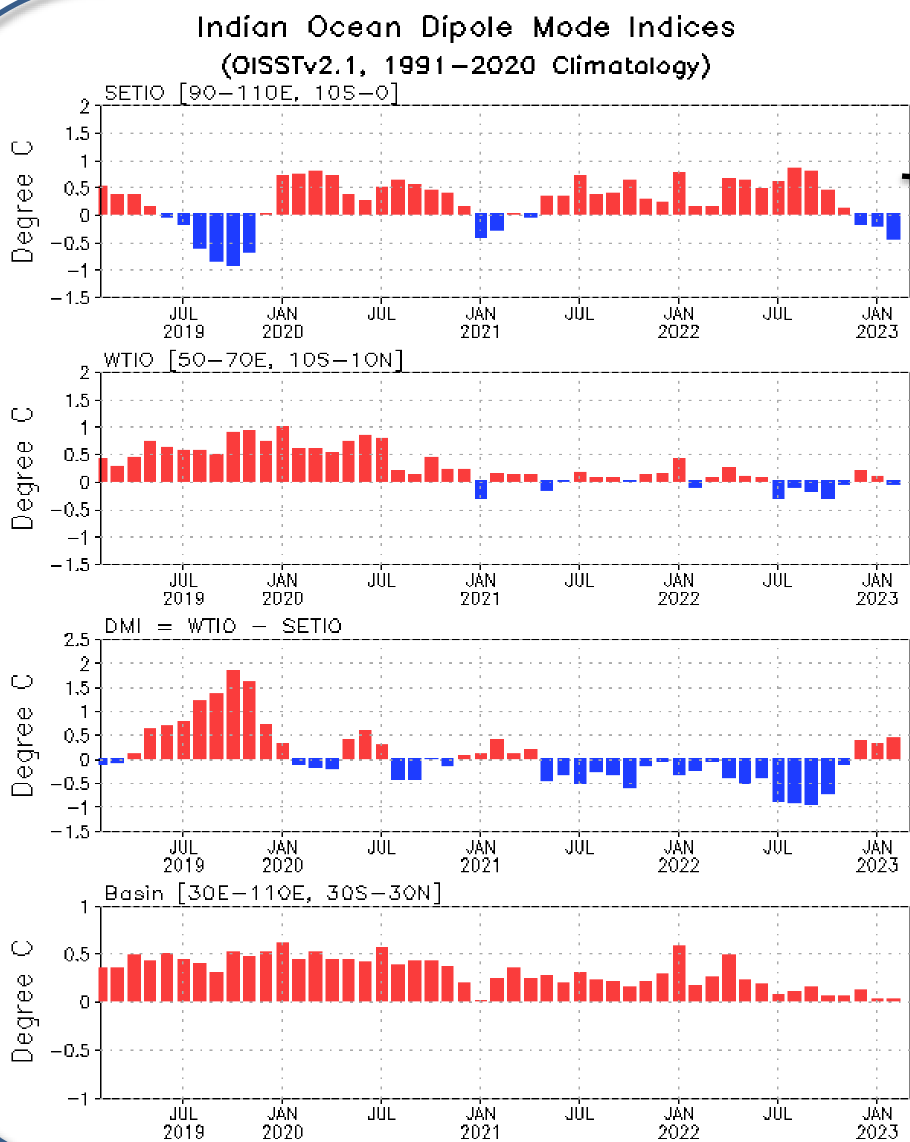


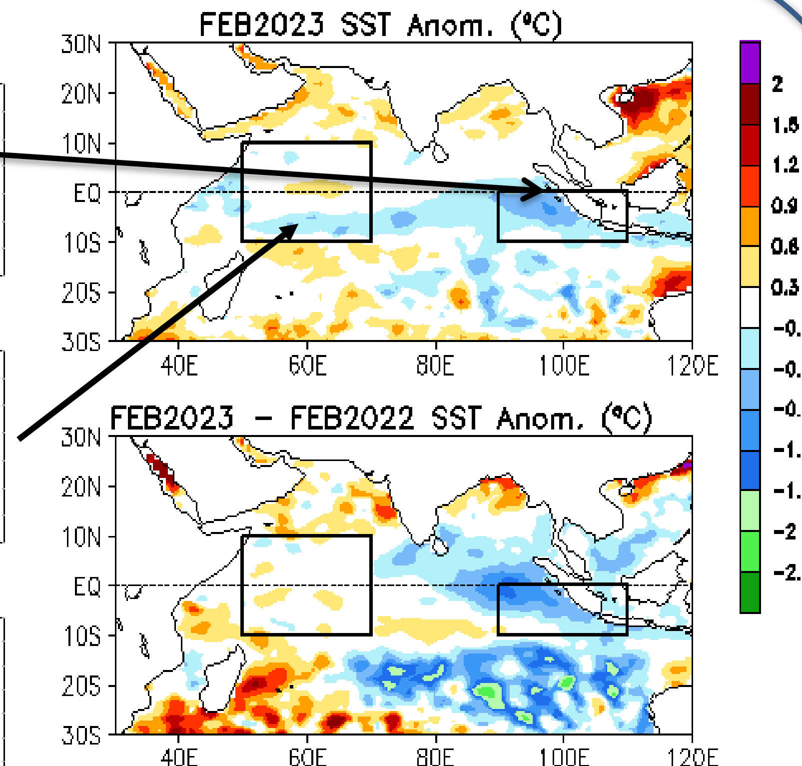


https://www.cpc.ncep.noaa.gov/products/people/wwang/seaice_seasonal/index.html

Indian Ocean

Evolution of Indian Ocean SST Indices



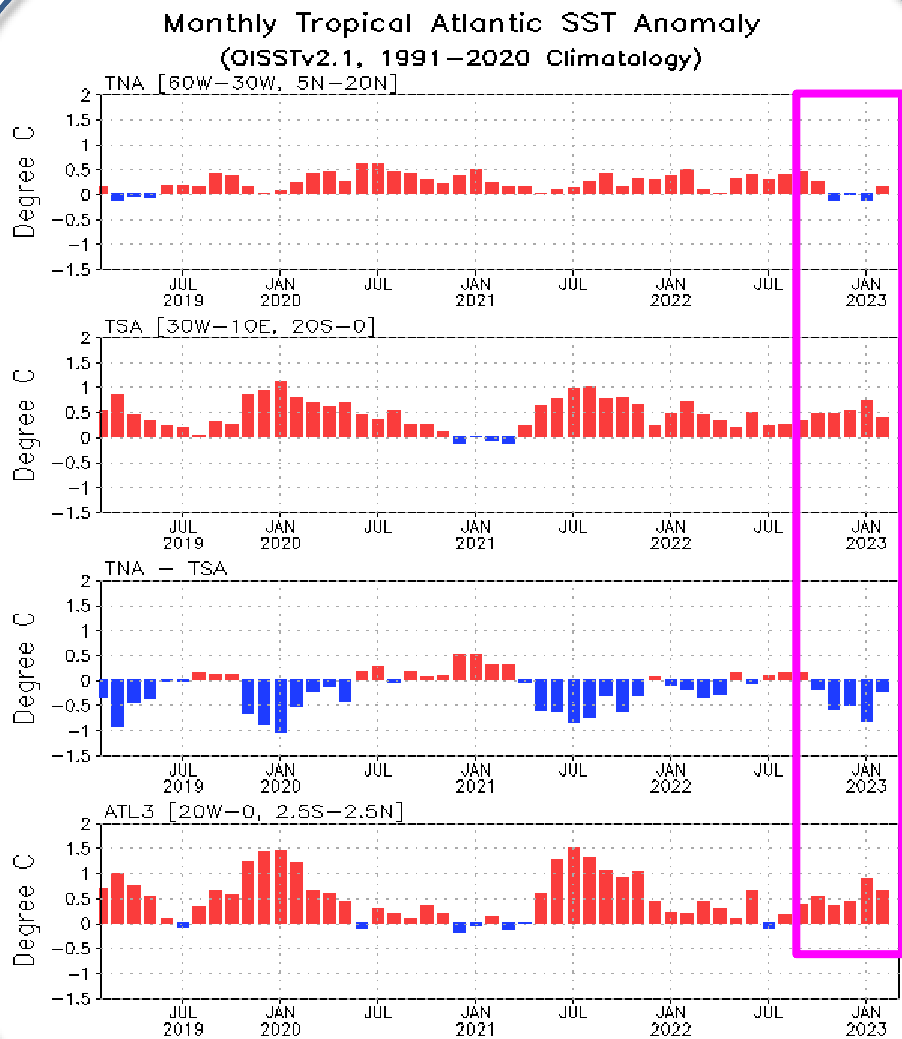


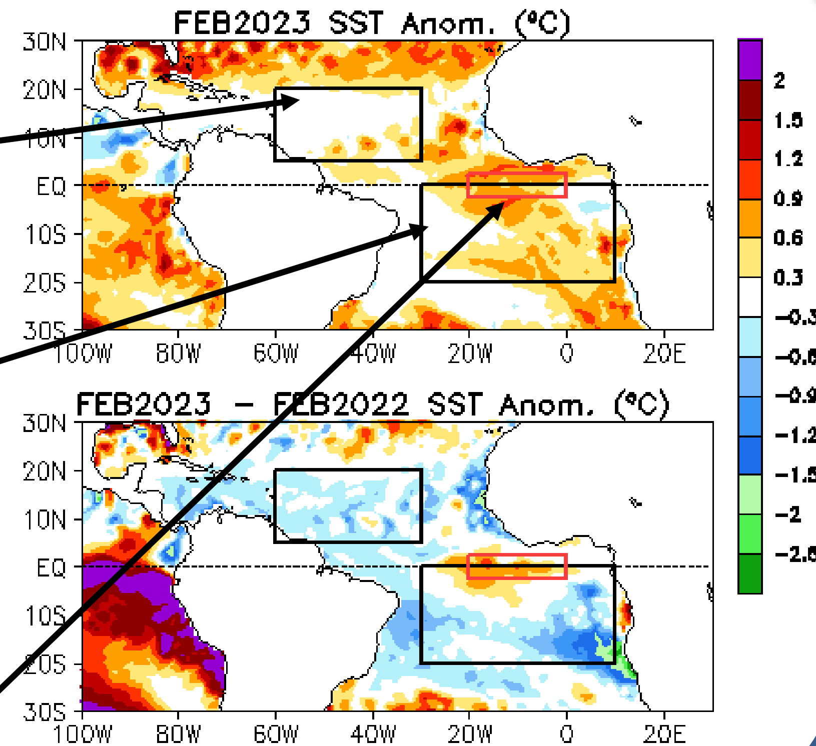
- Small (large) negative SSTAs were in the western (southeastern) tropical Indian Ocean in Feb 2023, resulting in a positive value of IOD index.

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 OIv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

Tropical and North Atlantic Ocean

Evolution of Tropical Atlantic SST Indices

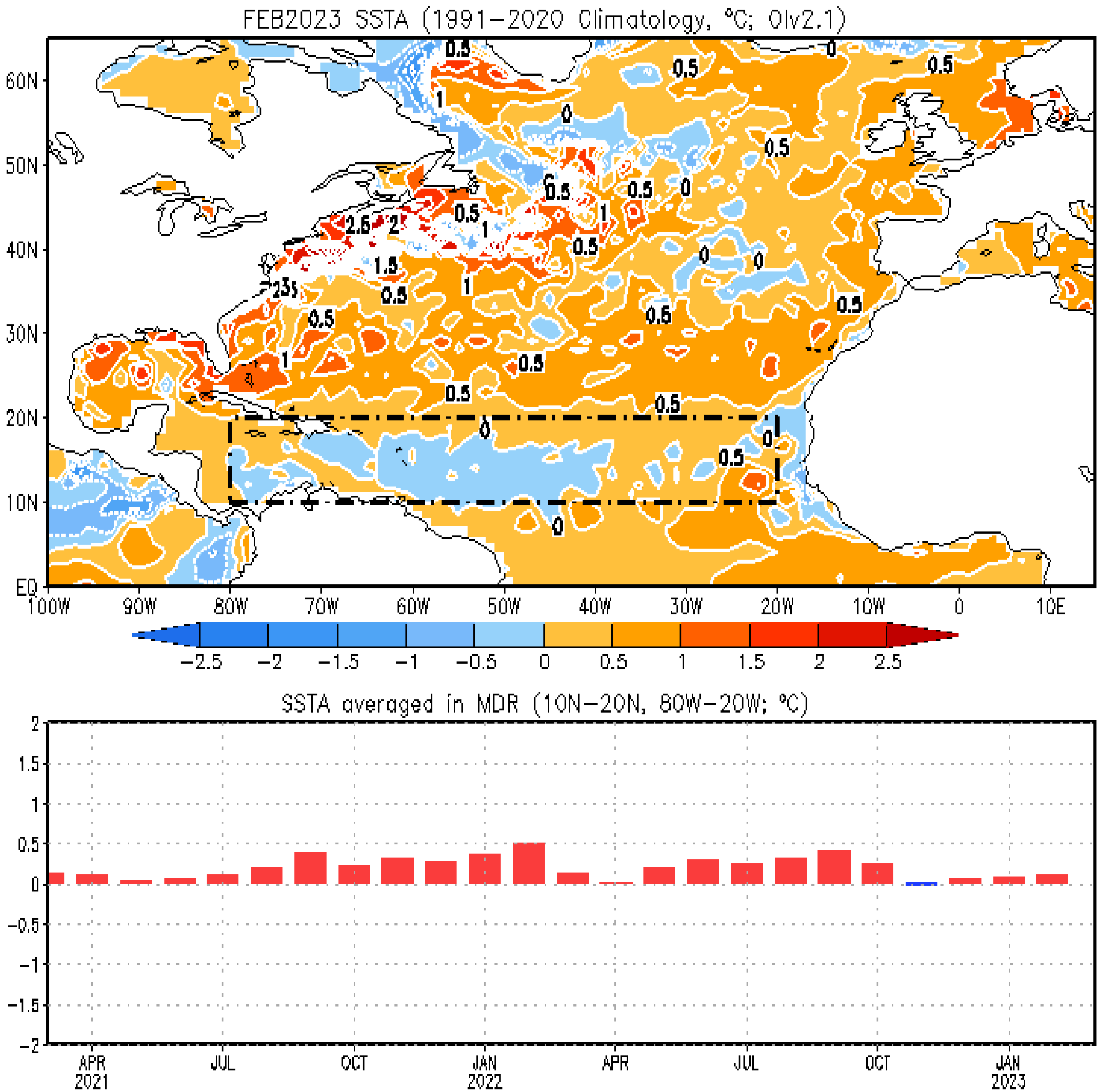




- Positive SSTAs were in the tropical South and North Atlantic.
- Positive ATL3 index weakened in Feb 2023.

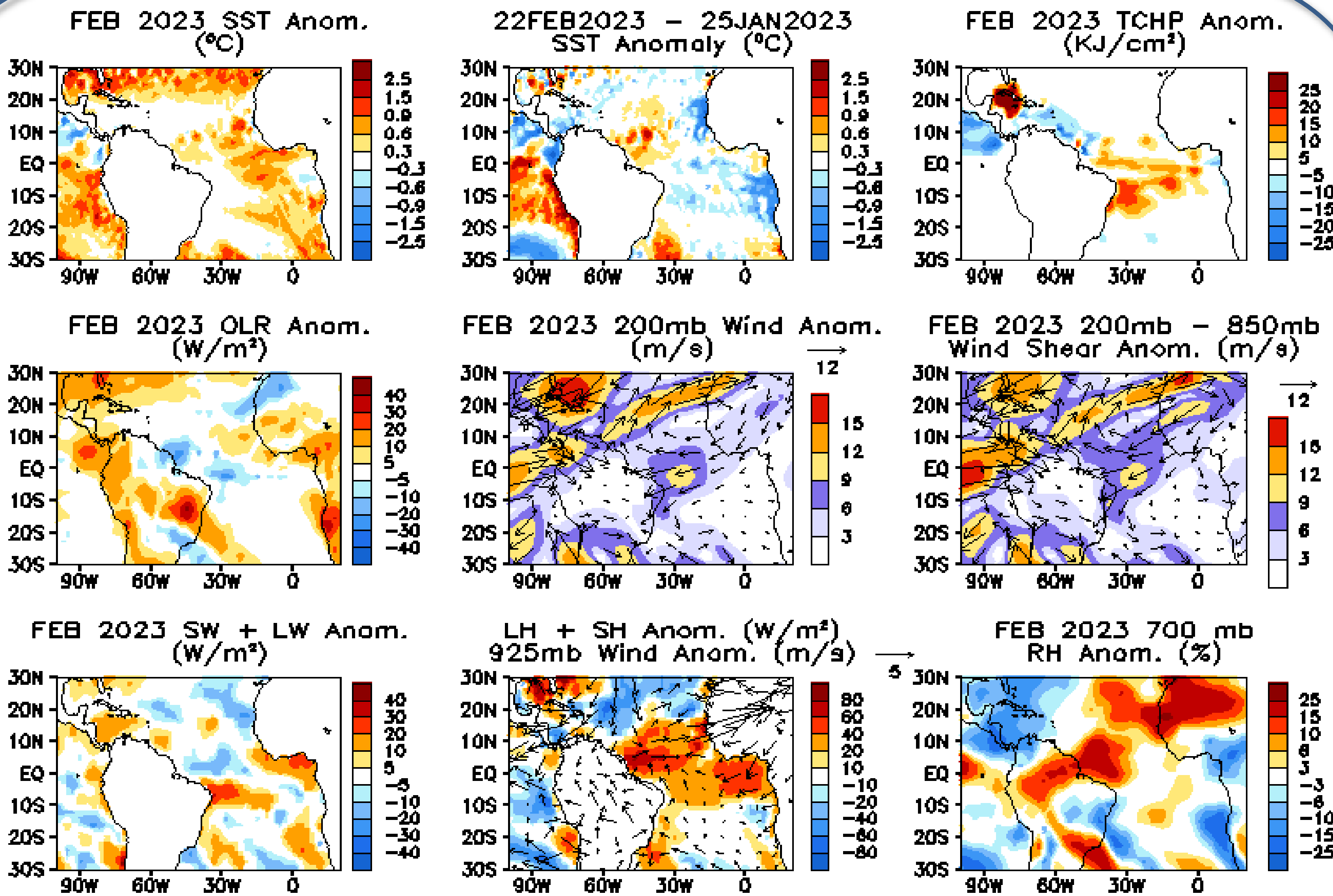
Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean SSTAs (^{O}C) for the TNA [60^{O}W-30^{O}W, 5ºN-20^{O}N], TSA [30^{O}W-10^{O}E, 20^{O}S-0] and ATL3 [20^{O}W-0, 2.5^{O}S-2.5^{O}N] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the OIv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

SSTAs in the North Atlantic & MDR

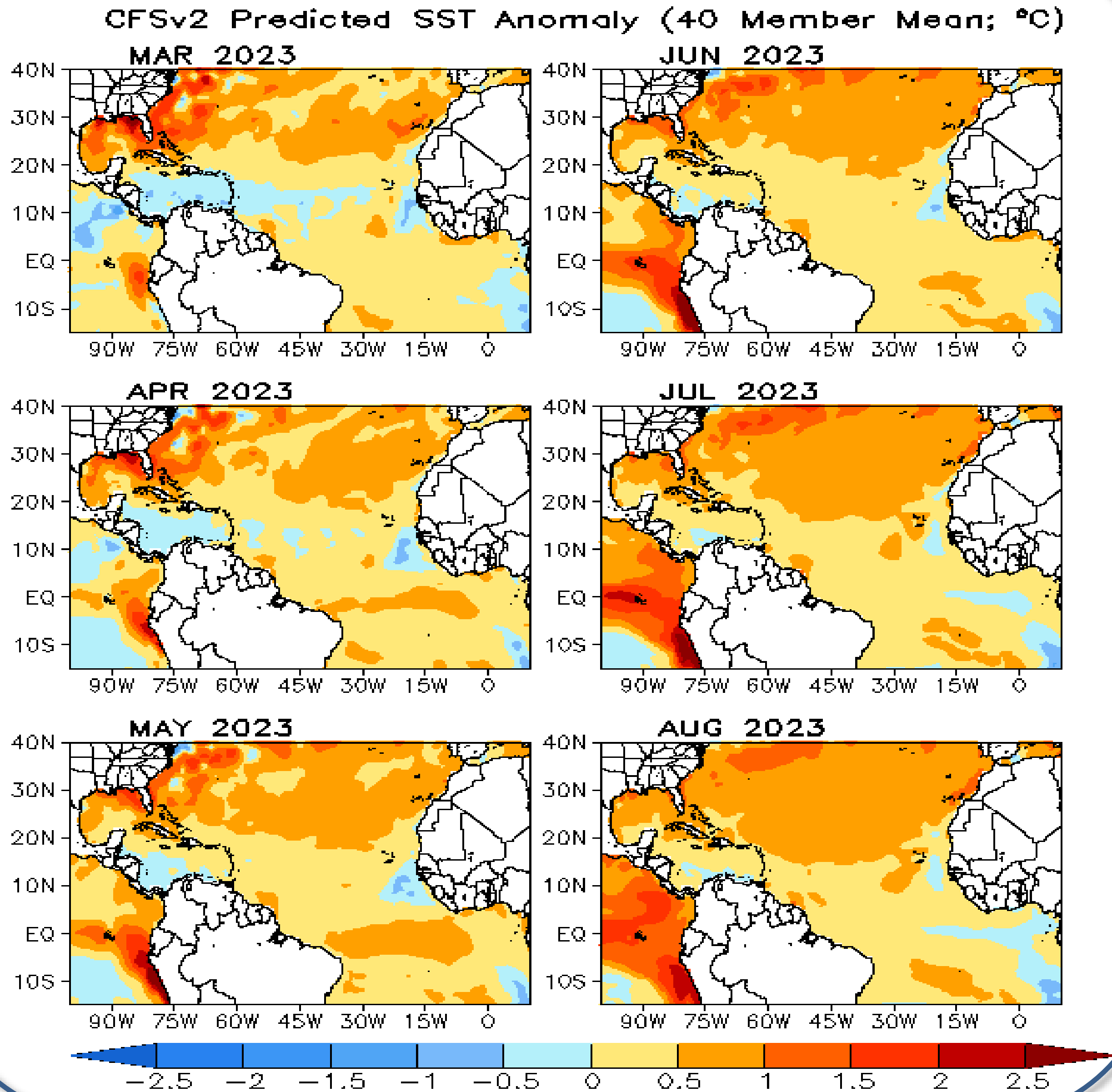


- SST in MDR was near average in Feb 2023.

Tropical Atlantic: SST, SST tend., TCHP, OLR, 200 hPa wind, wind share, heat flex, & RH anom.

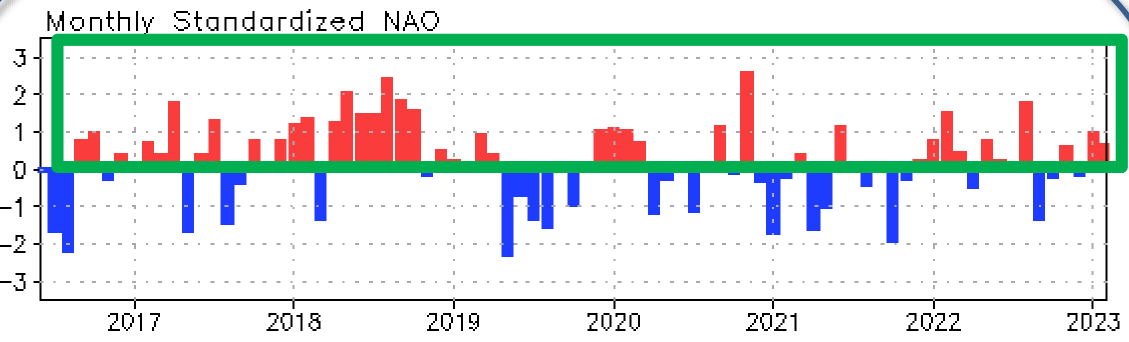


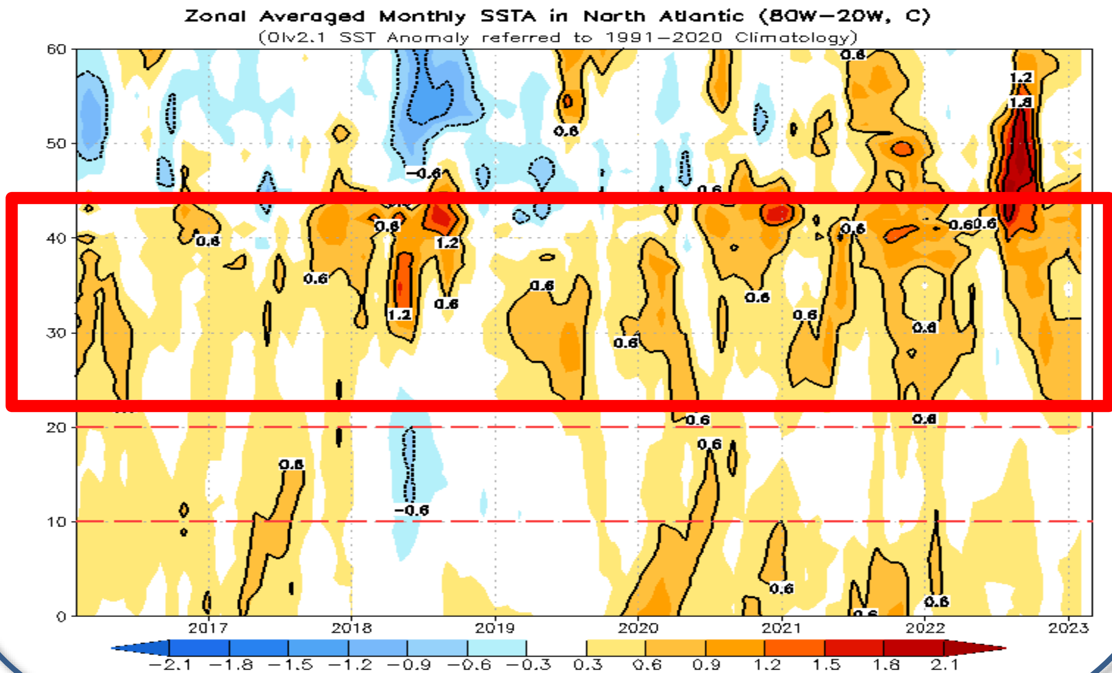
CFSv2 Atlantic SSTA Predictions

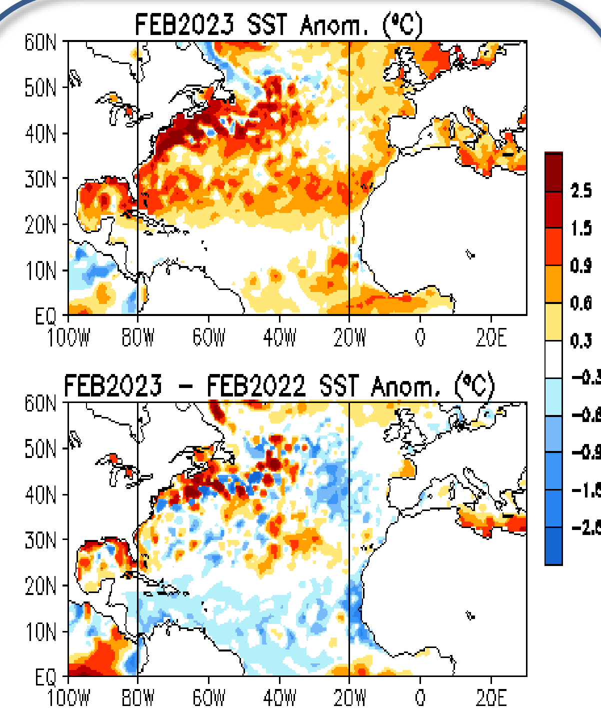


- Latest CFSv2 predictions call above-normal SST in the middle latitudes of the N. Atlantic in the next 6 months.

NAO and SST Anomaly in North Atlantic





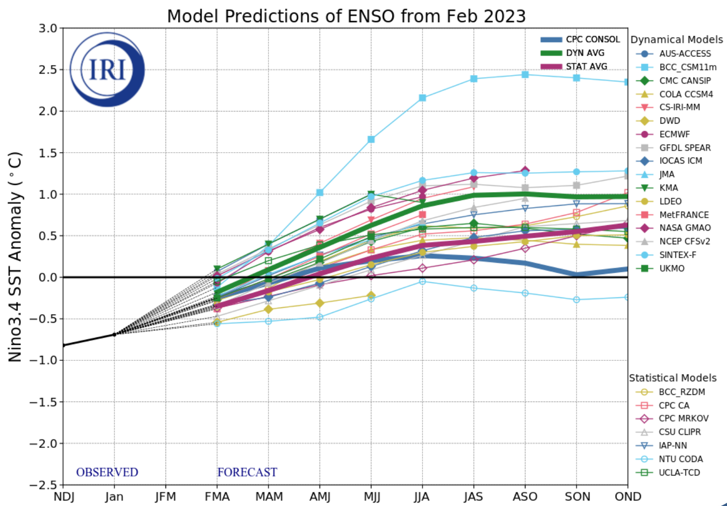


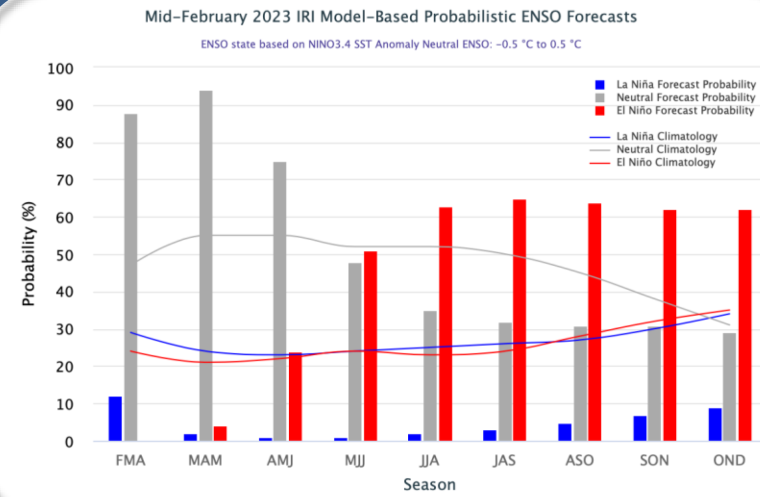
- NAO switched to a positive phase in Jan 2023 with NAOI= 0.6 in Feb 2023.
- The prolonged positive SSTAs in the middle latitudes were evident, due to the domination of the positive phase of NAO during the last 5-6 years.

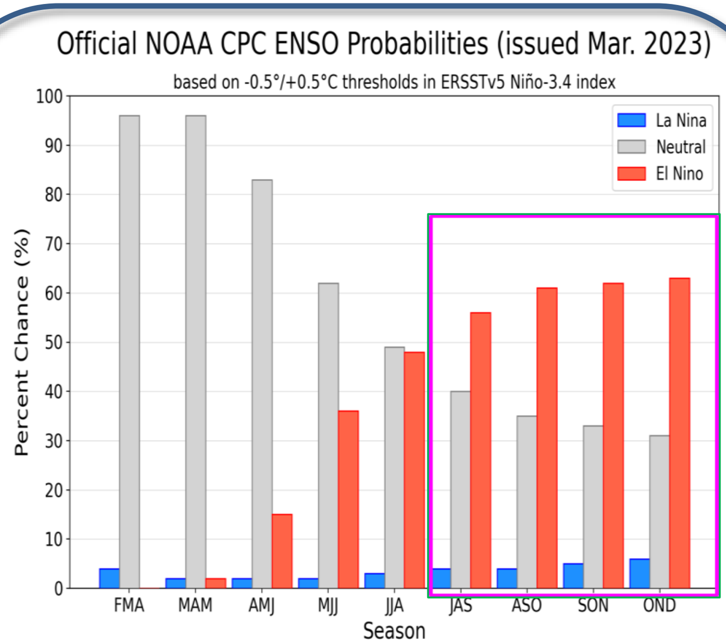
Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20^{O}N-90^{O}N. Time-latitude section of SSTAs averaged between 80ºW and 20ºW (bottom). SST are derived from the OIv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

ENSO and Global SST Predictions

IRI/CPC Niño3.4 Forecast

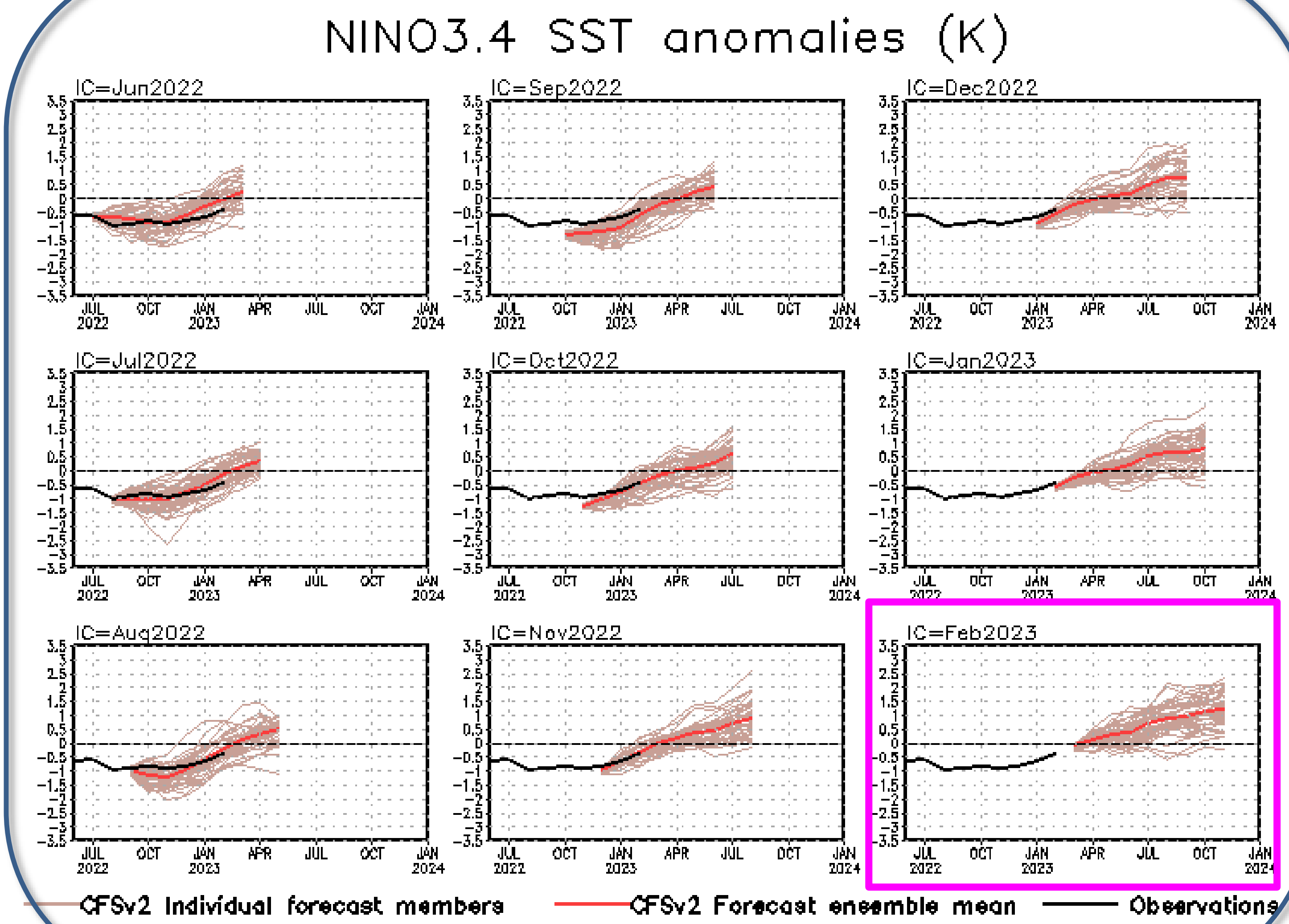






- **ENSO Alert System Status: La Niña Advisory**
- Synopsis: *"La Niña has ended and ENSO-neutral conditions are expected to continue through the Northern Hemisphere spring and early summer 2023."*

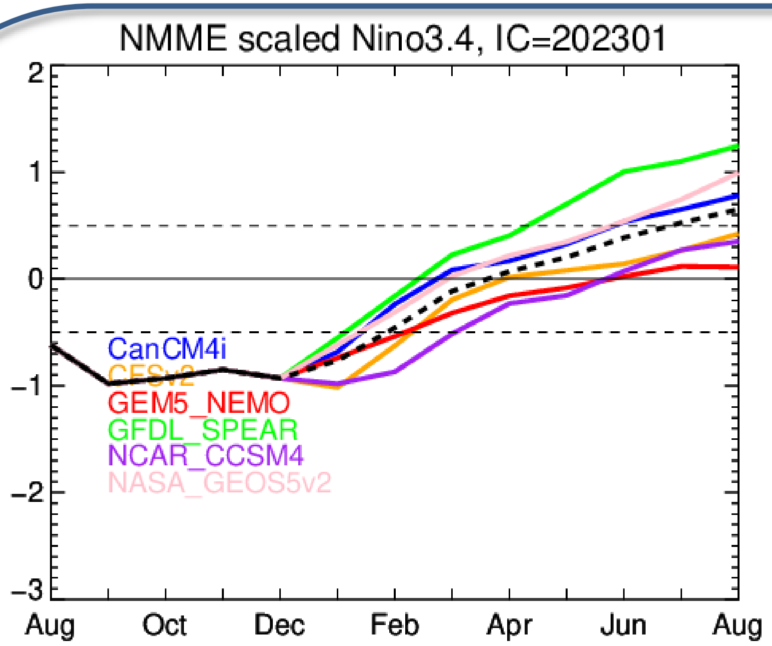
CFS Niño3.4 SST Predictions from Different Initial Months

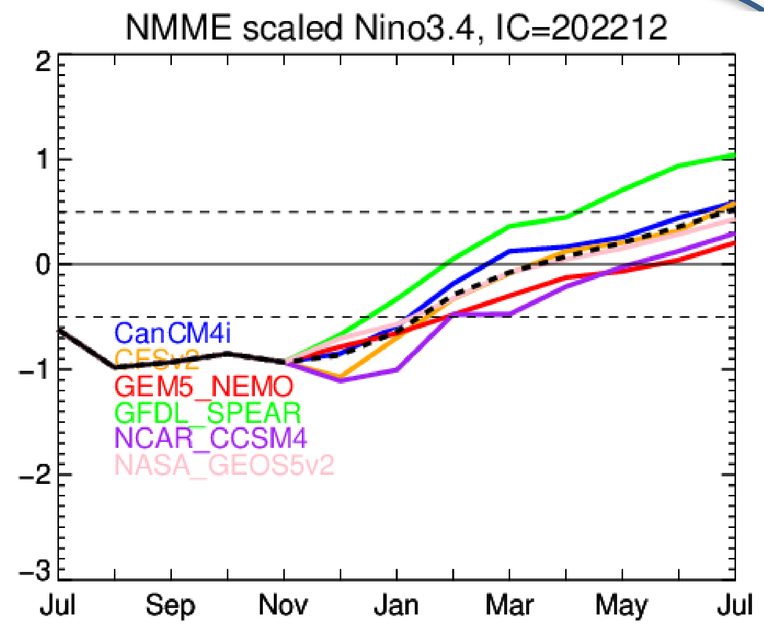


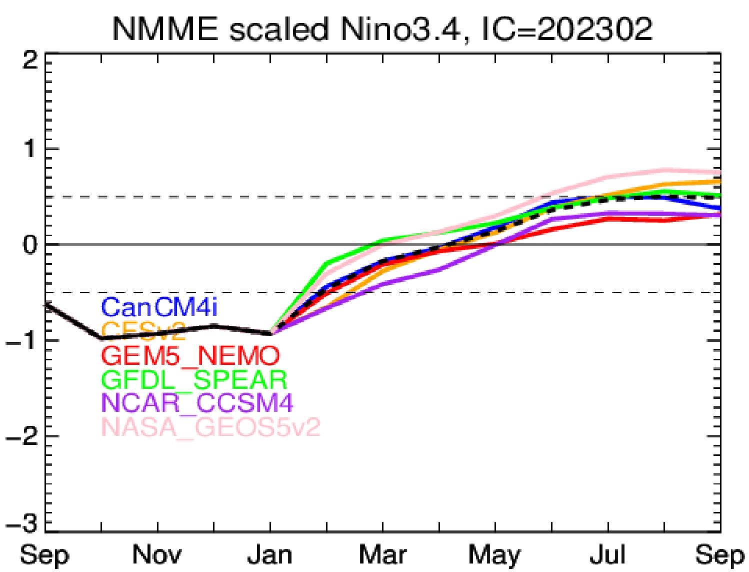
- The latest CFSv2 forecasts call an El Niño in the second half of 2023.

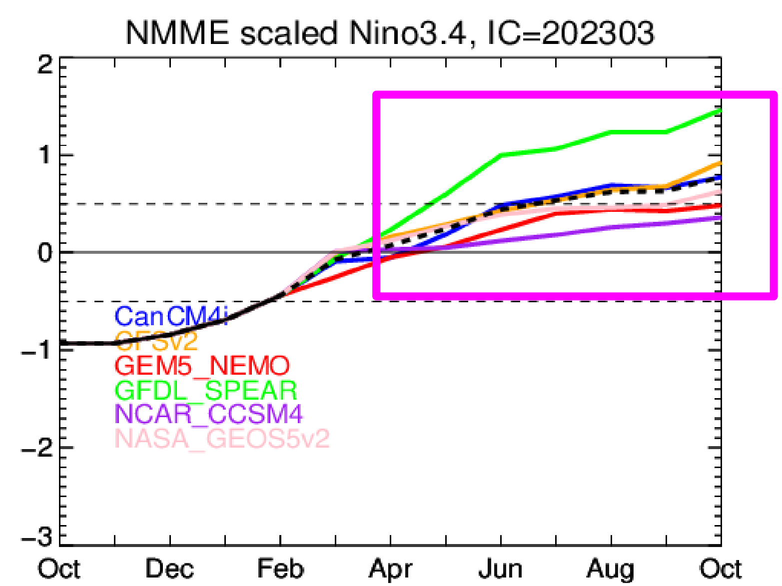
CFS Niño3.4 SST prediction from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1991-2020 base period means.

NMME forecasts from different initial conditions



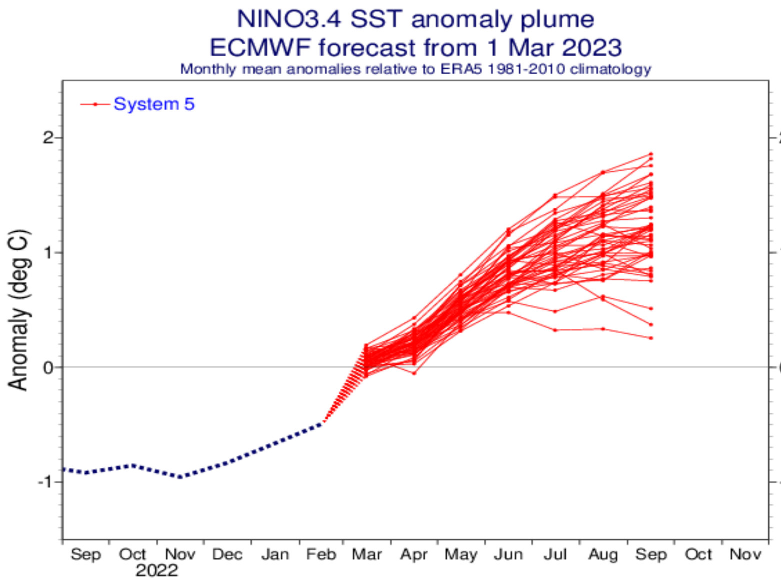




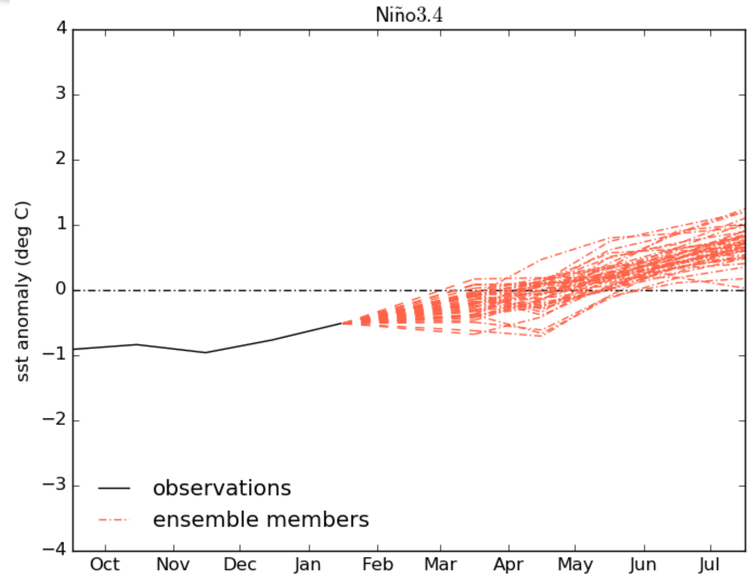


Individual Model Forecasts: La Niña will return to neutral in spring

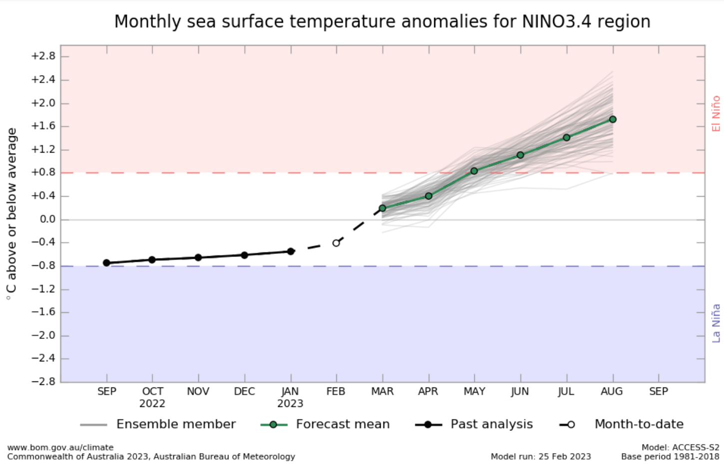
EC: Niño3.4, IC= 1 Mar 2023



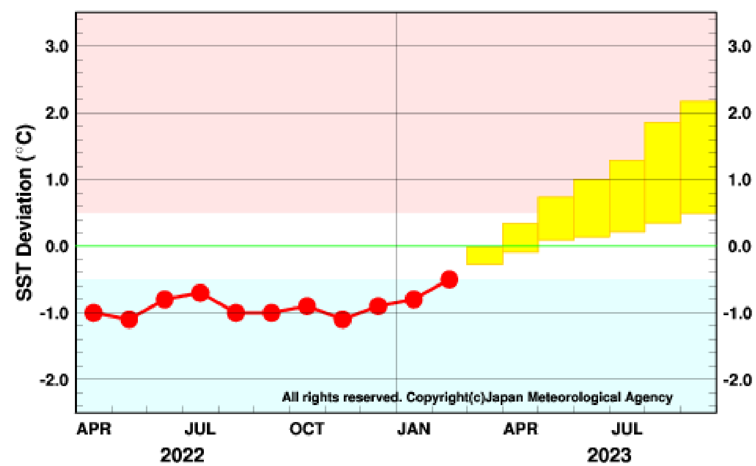
UKMO: Niño3.4, Updated 11 Feb 2023



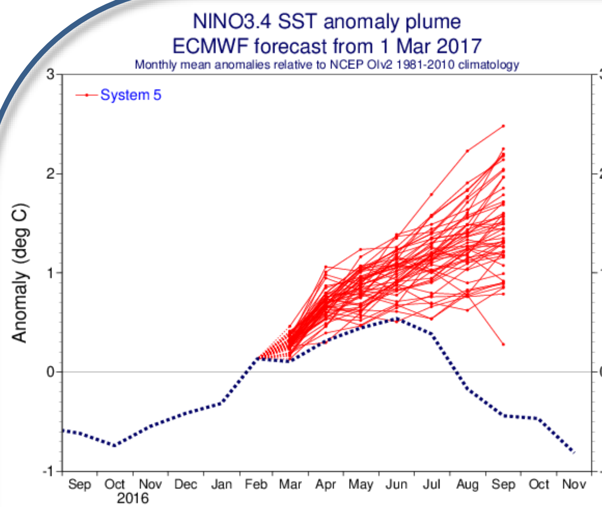
BOM: Niño3.4, Updated 25 Feb2023

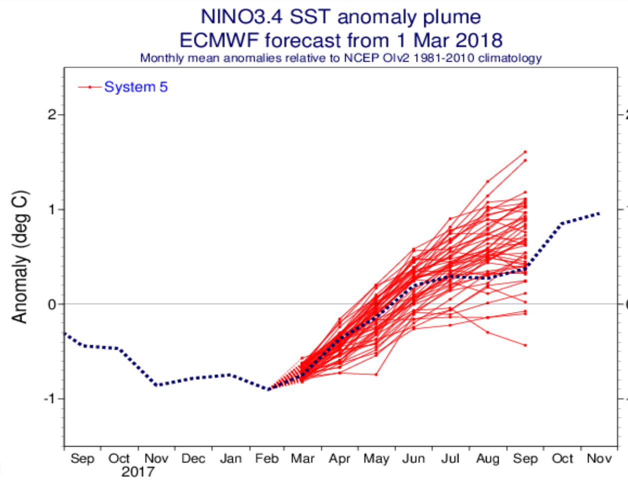


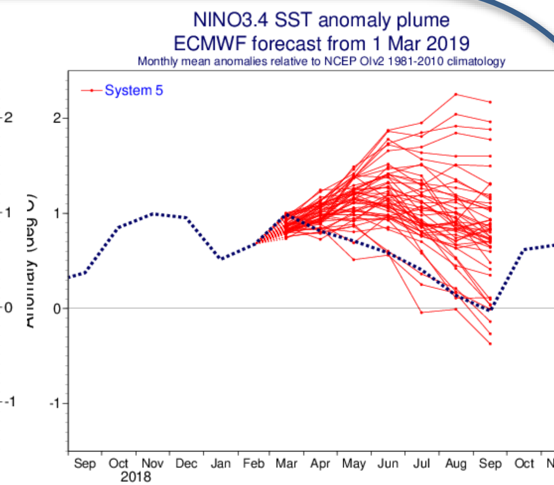
JMA: Niño3.4, Updated 10 Mar 2023

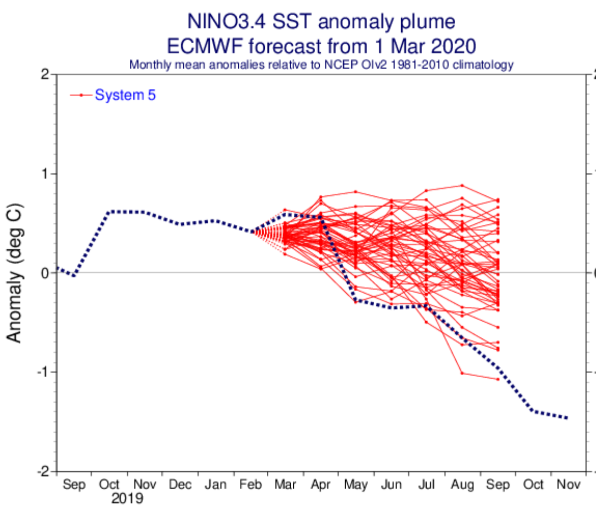


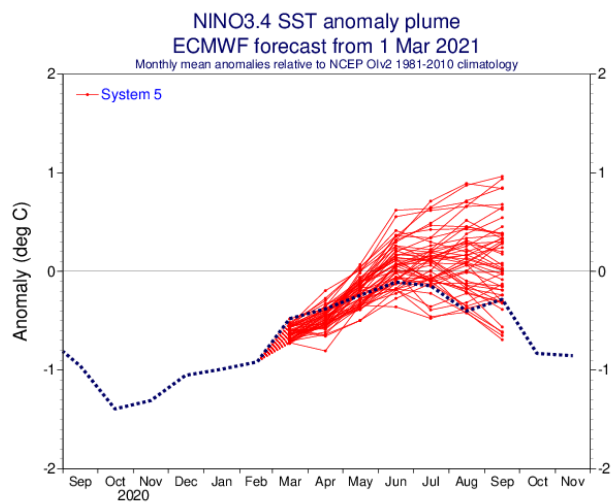
ECMWF Forecasts: warm bias in March IC runs since 2017

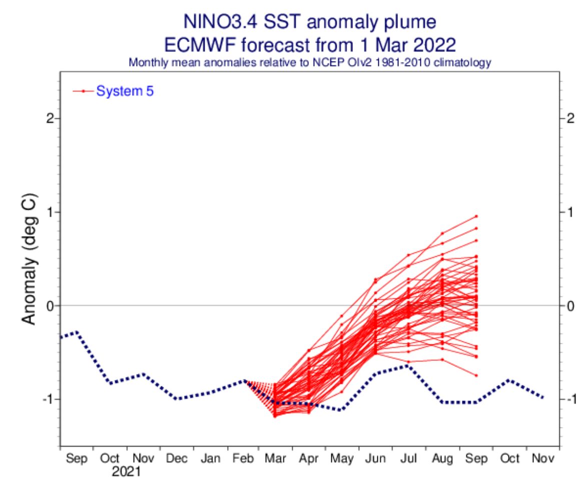




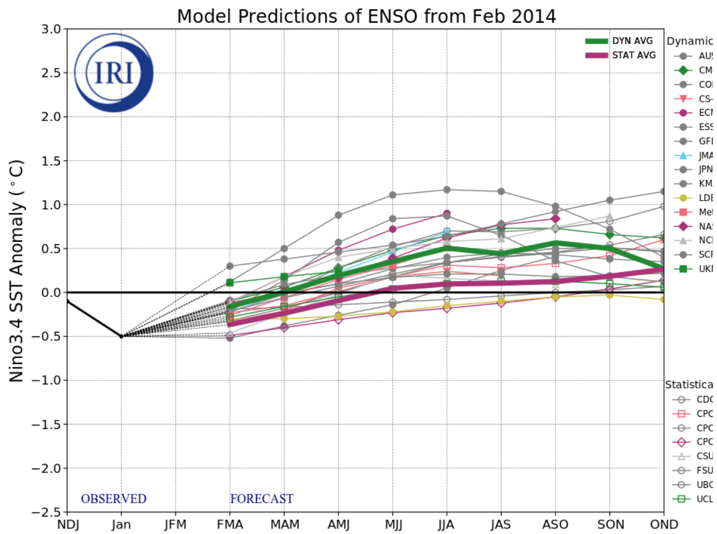


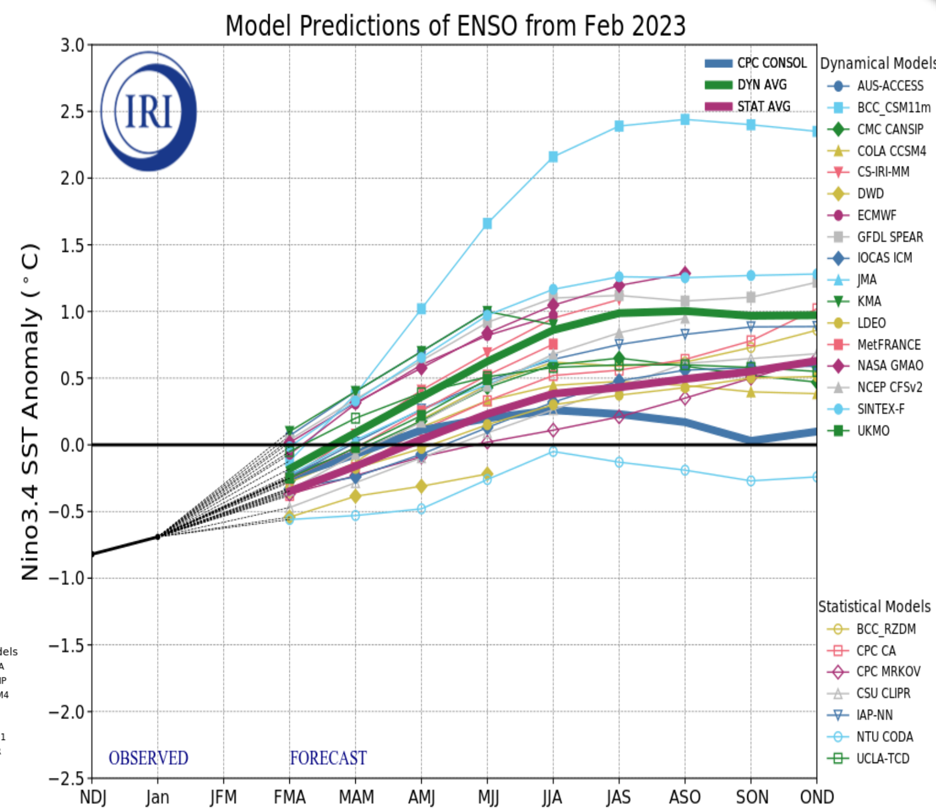


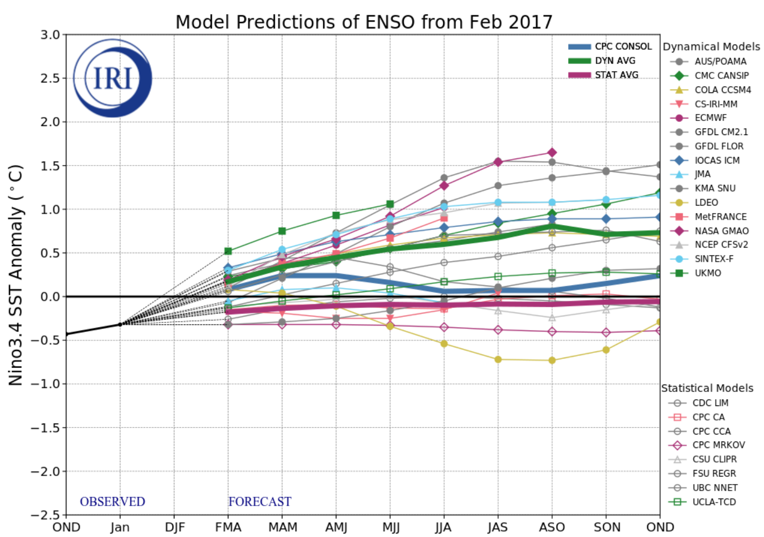


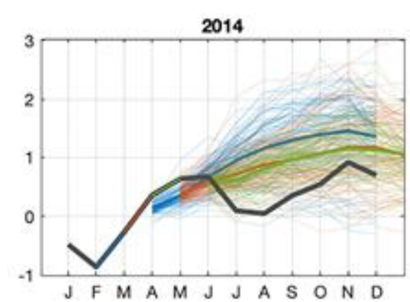


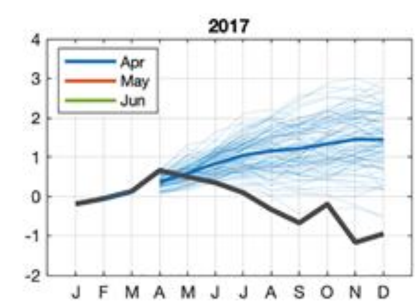
2023 ENSO Forecast, 2014 & 2017 El Nino False Alarm











Excessive Momentum and False Alarms in Late-Spring NMME ENSO Forecasts
(Courtesy of Michelle L'Heureux)

Geophysical Research Letters

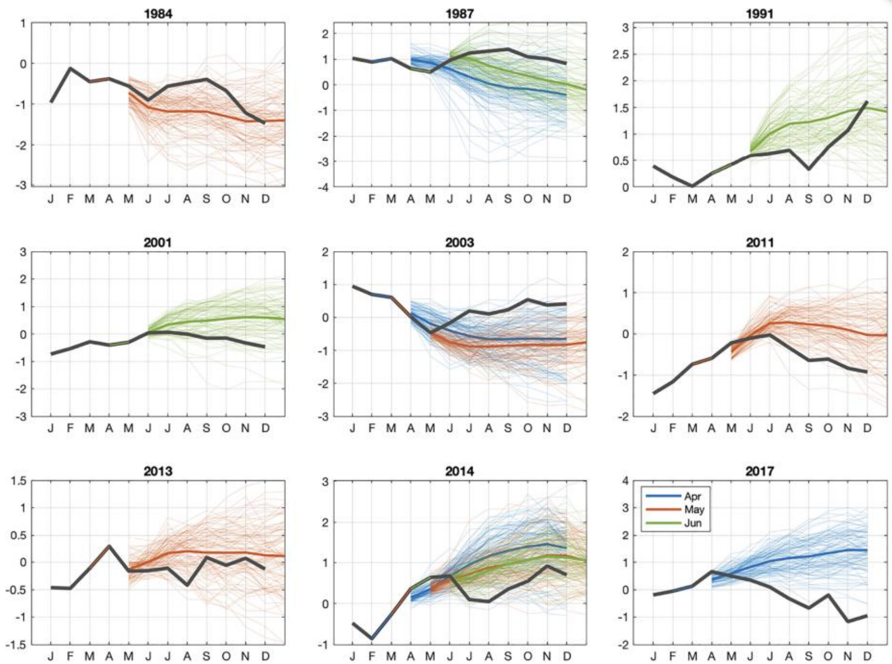
Research Letter | Free Access

Excessive Momentum and False Alarms in Late-Spring ENSO Forecasts

Michael K. Tippett, Michelle L. L'Heureux, Emily J. Becker, Arun Kumar

First published: 28 March 2020 | https://doi.org/10.1029/2020GL087008 | Citations: 6

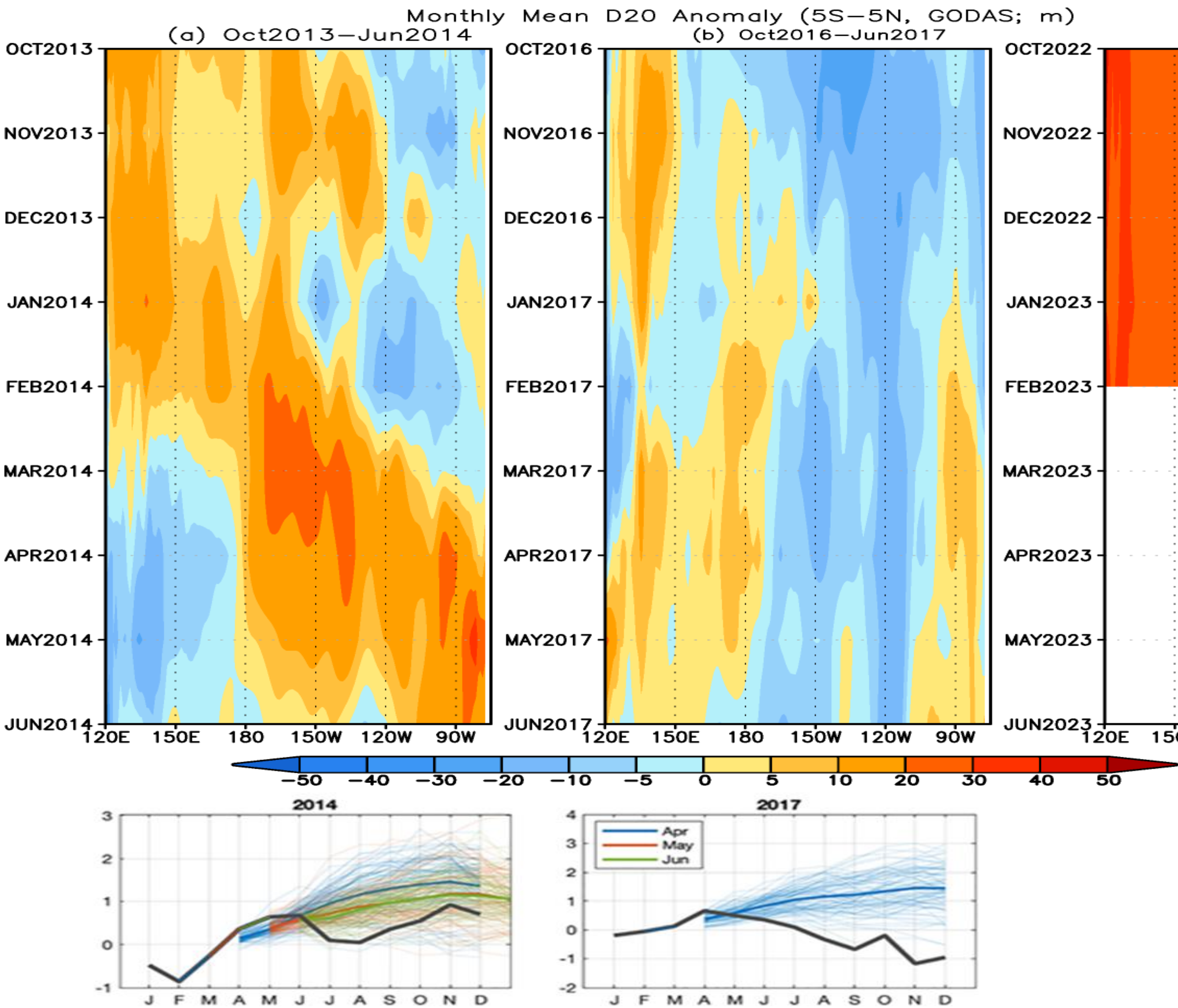
This article was corrected on 1 AUG 2020. See the end of the full text for details.



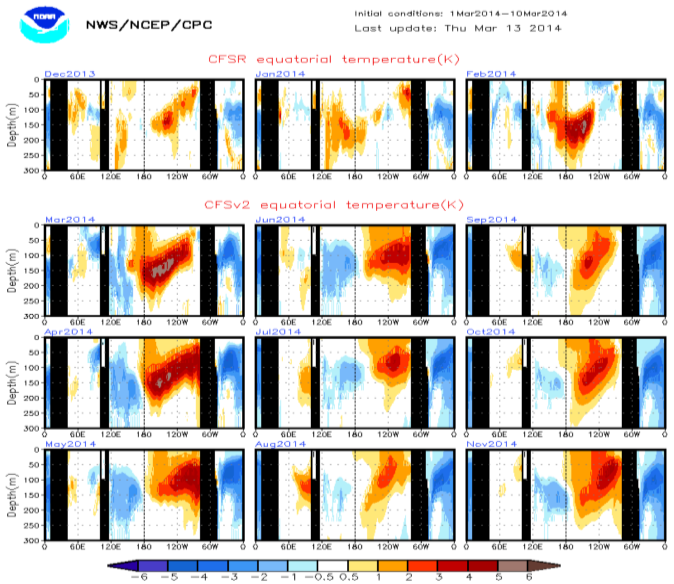
Abstract

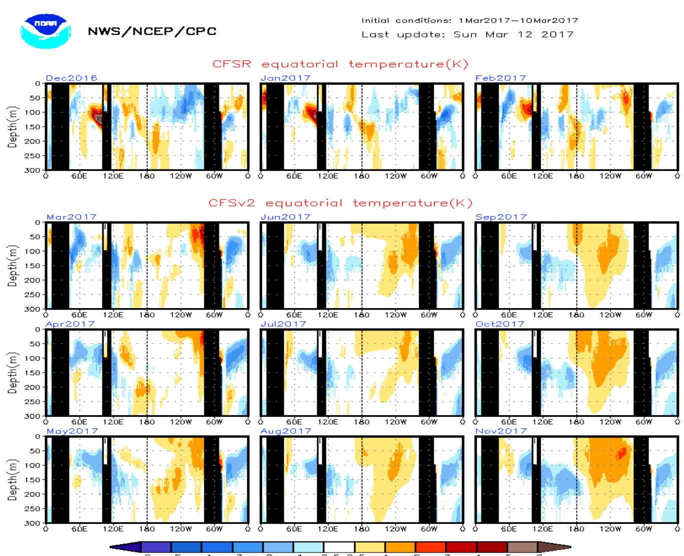
The unanticipated stalled El Niño-Southern Oscillation (ENSO) evolution of 2014 raises questions about the reliability of the coupled models that were used for forecast guidance. Here we have analyzed the skill and reliability of forecasts of the Niño 3.4 tendency (3-month change) in the North American multimodel ensemble (1982–2018). We found that forecasts initialized April–June (AMJ) have "excessive momentum" in the sense that the forecast Niño 3.4 tendency is more likely to be a continuation of the prior observed conditions than it should be. Models tend to predict warming when initialized after observed warming conditions and cooling when initialized after observed cooling conditions. Excessive momentum appears in AMJ forecast busts and false alarms including the 2014 one. In some models, excessive momentum appears to be related to model formulation rather than initialization. A concerning trend is that four of the nine years with AMJ forecast busts occurred in the last decade.

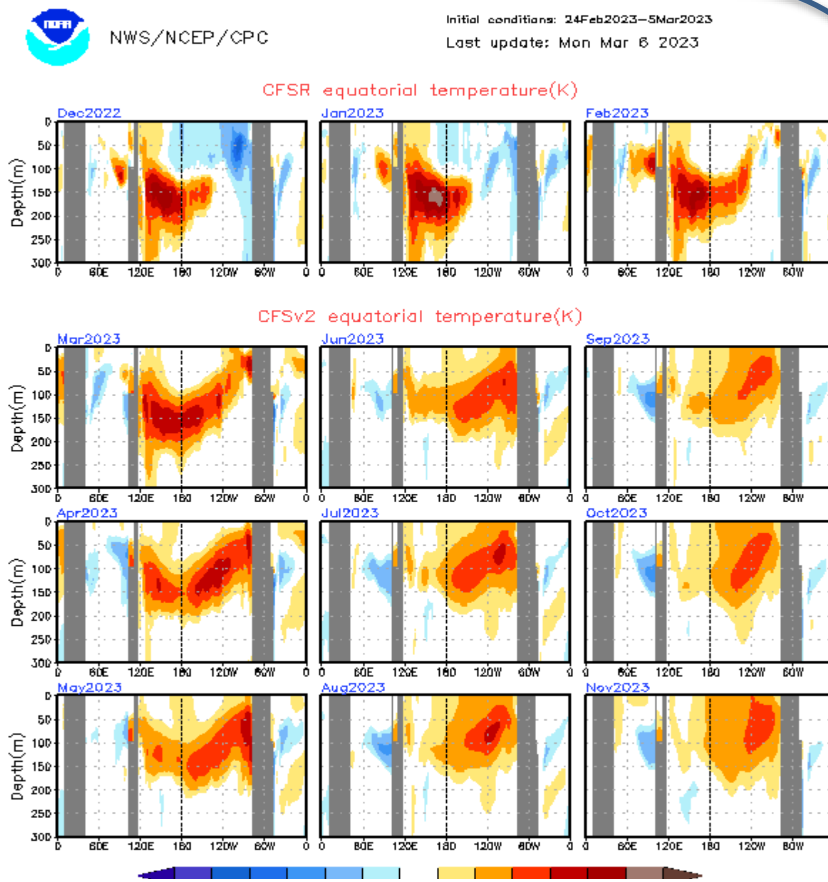
Equatorial D20 anomalous evolution in 2013/14, 2016/17 & 2022/23

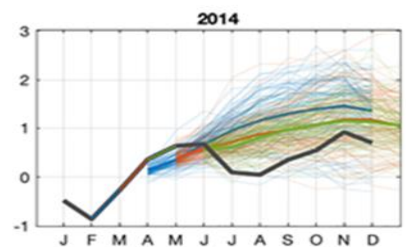


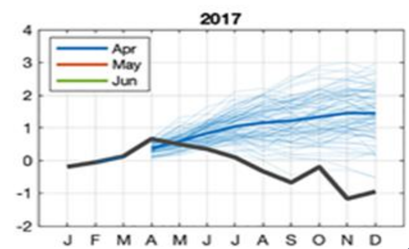
Subsurface ocean T in CFSR and CFSv2 in 2013/14, 2016/17 & 2022/23: The warming is stronger in 2023 than in 2017 *(Courtesy of Wanqiu Wang)*



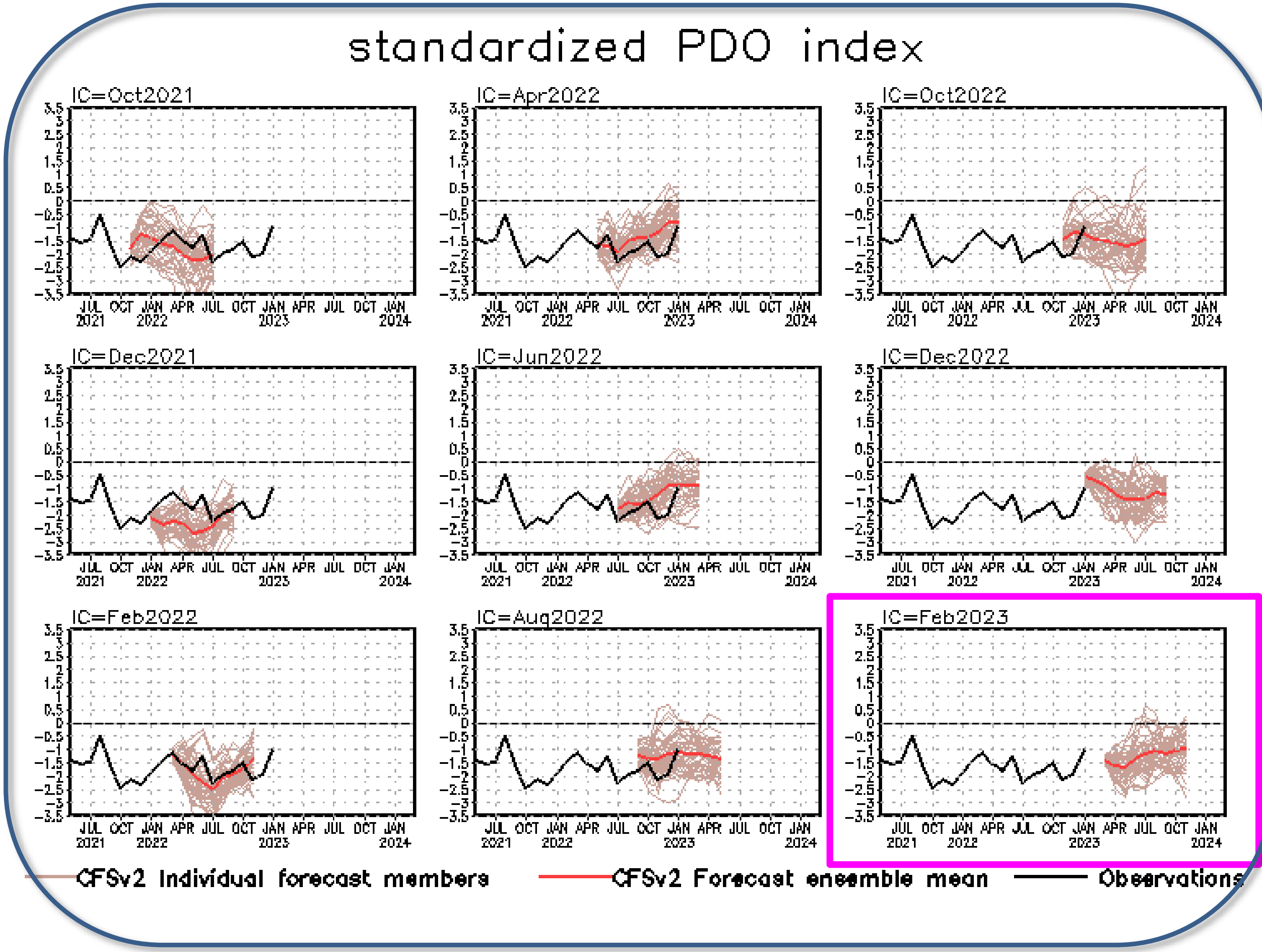








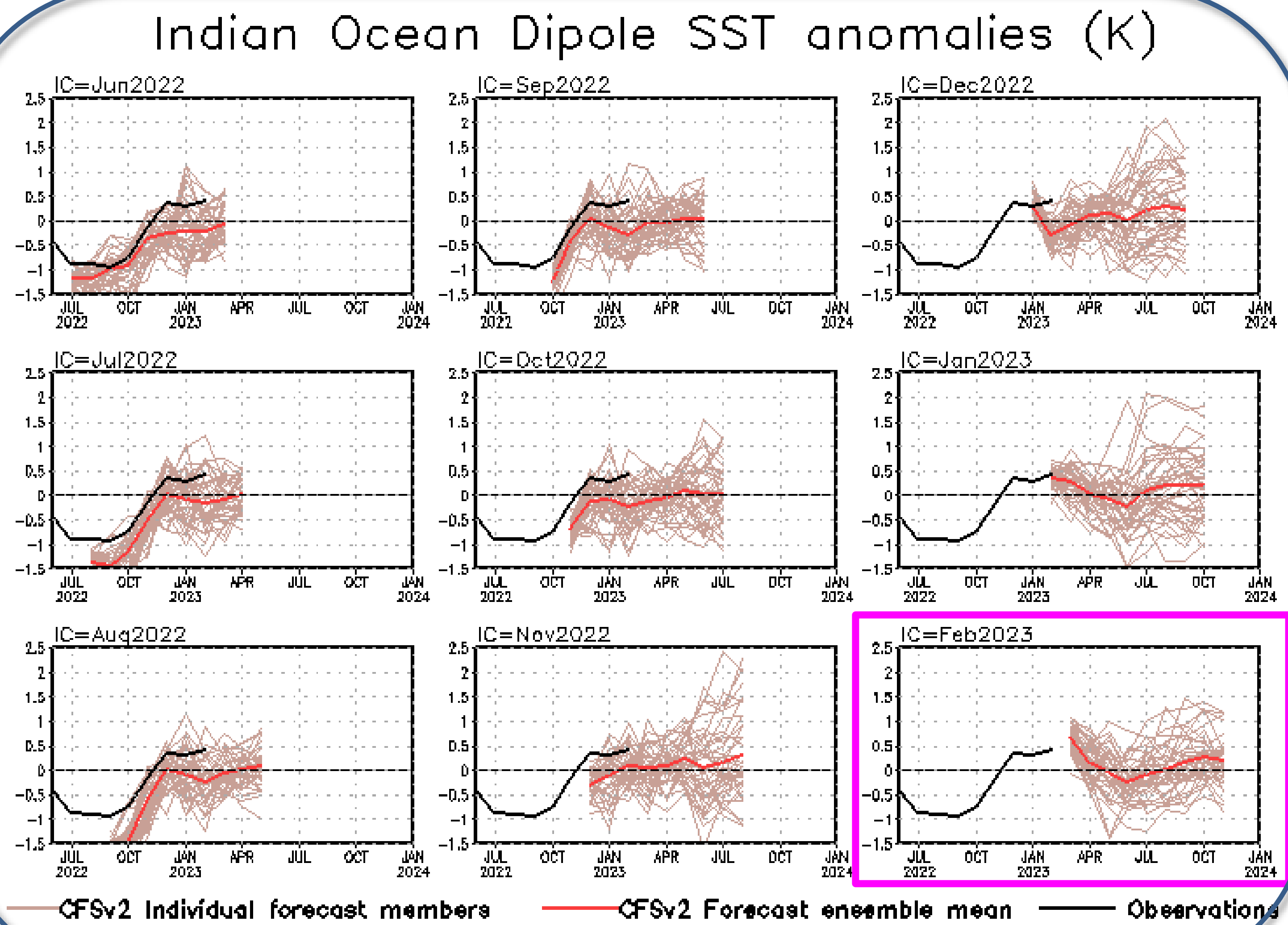
CFS Pacific Decadal Oscillation (PDO) Index Predictions from Different Initial Months



- CFSv2 predicts a persistent negative phase of PDO through autumn 2023.

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 1991-2020 base period means. PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110ºE-100ºW, 20ºN-60ºN]. CFS PDO index is the standardized projection of CFS SST forecast anomalies onto the PDO EOF pattern.

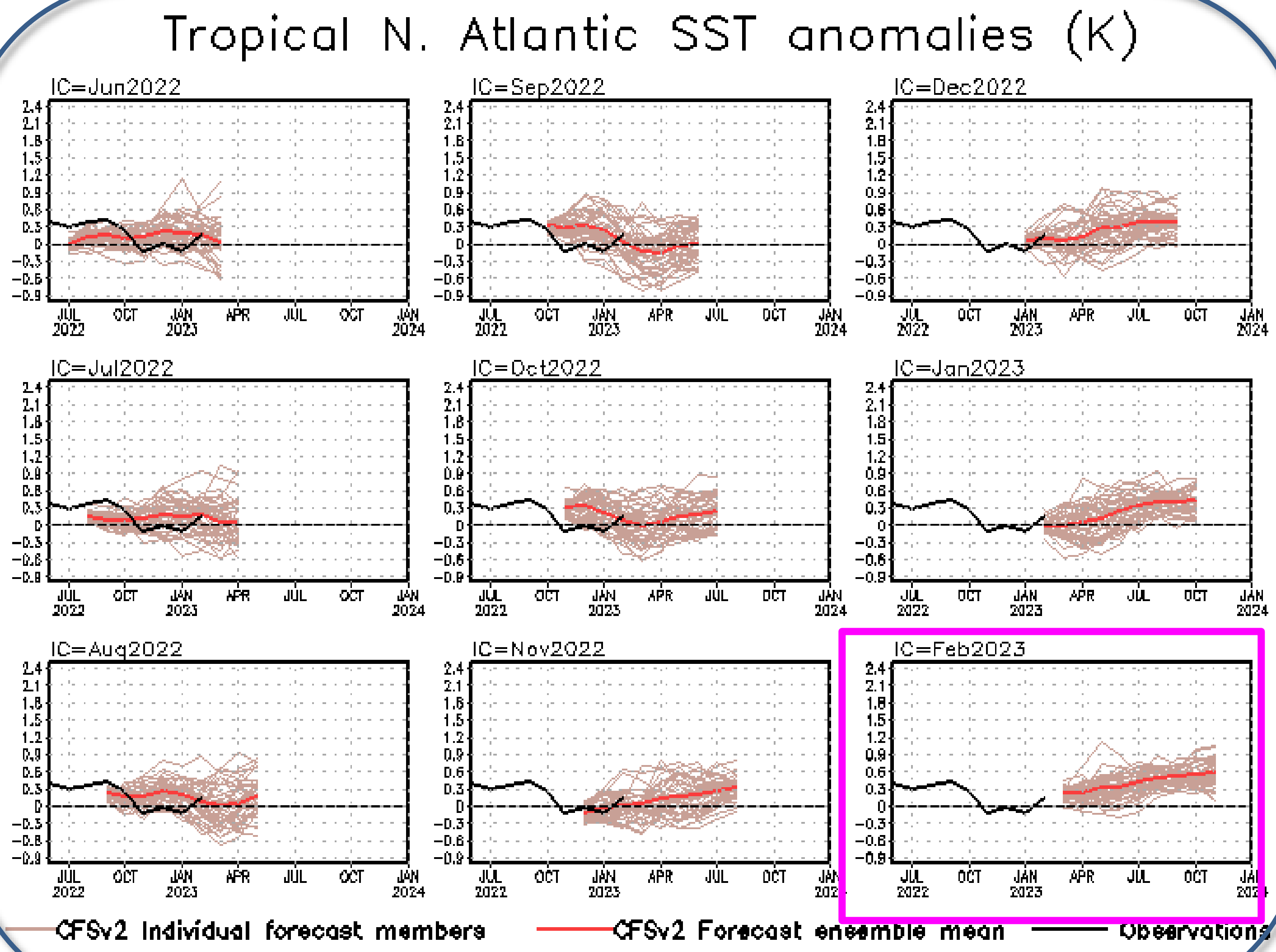
NCEP CFS DMI SST Predictions from Different Initial Months



- CFSv2 predicts a near-normal IOD through autumn 2023.

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 1991-2020 base period means.

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



- Latest CFSv2 predictions call for above-normal SST in the tropical North Atlantic.

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 1991-2020 base period means. TNA is the SST anomaly averaged in the region of [60oW-30oW, 5oN-20oN].

Acknowledgement

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

- Drs. Pingping Xie provided the BASS/CMORPH/CFSR EVAP package

- Dr. Wanqiu Wang provides the sea ice forecasts and maintains the CFSv2 forecast archive

Please send your comments and suggestions to:

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Jieshun.Zhu@noaa.gov
Zeng-Zhen.Hu@noaa.gov

Data Sources (climatology is for 1991-2020)

- **NCEP/CPC Ocean Monitoring & Briefing Operation (Hu et al., 2022, BAMS)**
- **Weekly Optimal Interpolation SST (OIv2.1 SST; Huang et al. 2021)**
- **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

BAMS Article

Global Ocean Monitoring and Prediction at NOAA Climate Prediction Center

15 Years of Operations

Zeng-Zhen Hu, Yan Xue, Boyin Huang, Arun Kumar, Caihong Wen, Pingping Xie, Jieshun Zhu, Philip J. Pegion, Li Ren, and Wanqiu Wang

ABSTRACT: Climate variability on subseasonal to interannual time scales has significant impacts on our economy, society, and Earth's environment. Predictability for these time scales is largely due to the influence of the slowly varying climate anomalies in the oceans. The importance of the global oceans in governing climate variability demonstrates the need to monitor and forecast the global oceans in addition to El Niño–Southern Oscillation in the tropical Pacific. To meet this need, the Climate Prediction Center (CPC) of the National Centers for Environmental Prediction (NCEP) initiated real-time global ocean monitoring and a monthly briefing in 2007. The monitoring covers observations as well as forecasts for each ocean basin. In this paper, we introduce the monitoring and forecast products. CPC's efforts bridge the gap between the ocean observing system and the delivery of the analyzed products to the community. We also discuss the challenges involved in ocean monitoring and forecasting, as well as the future directions for these efforts.

KEYWORDS: Ocean; Atmosphere-ocean interaction; ENSO; Climate prediction; Oceanic variability; Climate services

https://doi.org/10.1175/BAMS-D-22-0056.1
Corresponding author: Zeng-Zhen Hu, zeng-zhen.hu@noaa.gov
In final form 15 August 2022

Hu, Z.-Z., Y. Xue, B. Huang, A. Kumar, C. Wen, P. Xie, J. Zhu, P. Pegion, L. Ren, and W. Wang, 2022: Global ocean monitoring and forecast at NOAA Climate Prediction Center: 15 Years of Operations. *Bull. Amer. Meteor. Soc.*, **103 (12),** E2701–E2718. DOI: 10.1175/BAMS-D-22-0056.1.

Backup Slides

Global Sea Surface Salinity (SSS): Anomaly for February 2023

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

Large-scale patterns of fresh water flux and surface salinity (SSS) remain quite similar to those for the last month. Wet precipitation anomalies are weakened slightly over the western tropical Pacific around the Maritime Continent, causing weaker freshening SSS anomaly over the region. Positive precipitation anomaly is also observed over the tropical eastern Pacific offshore of Ecuador and Columbia, creating slightly freshened SSS anomaly. Saltier SSS anomaly over the western Pacific is also weakened, reflecting reduced E-P anomaly there.

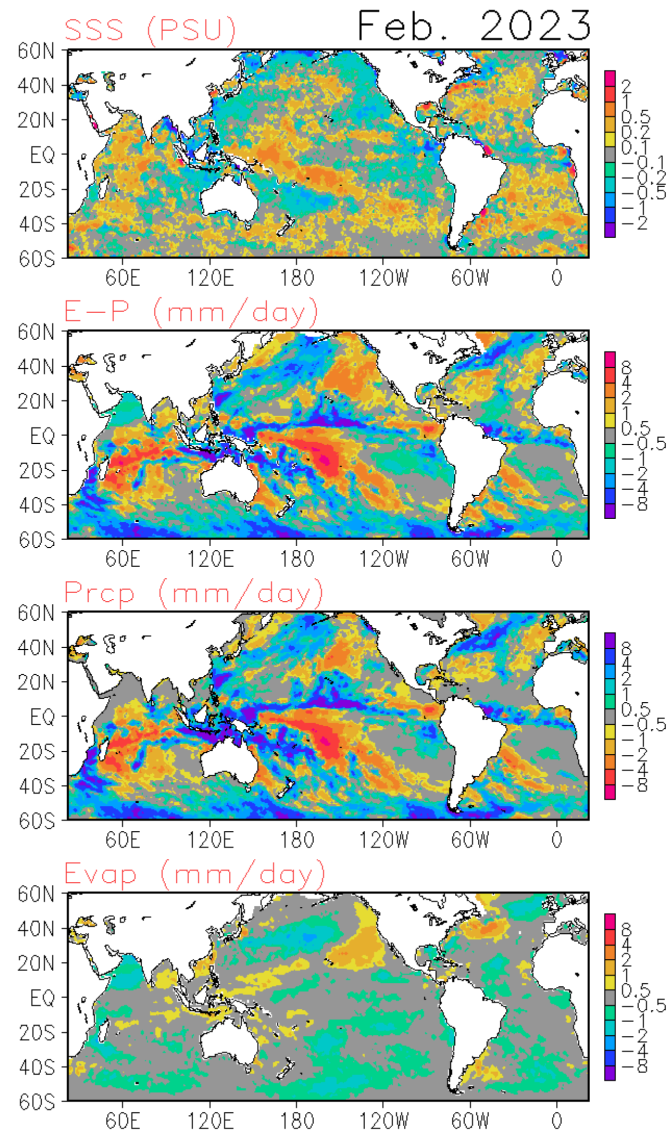
SSS : Blended Analysis of Surface Salinity (BASS) V0.Z

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

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

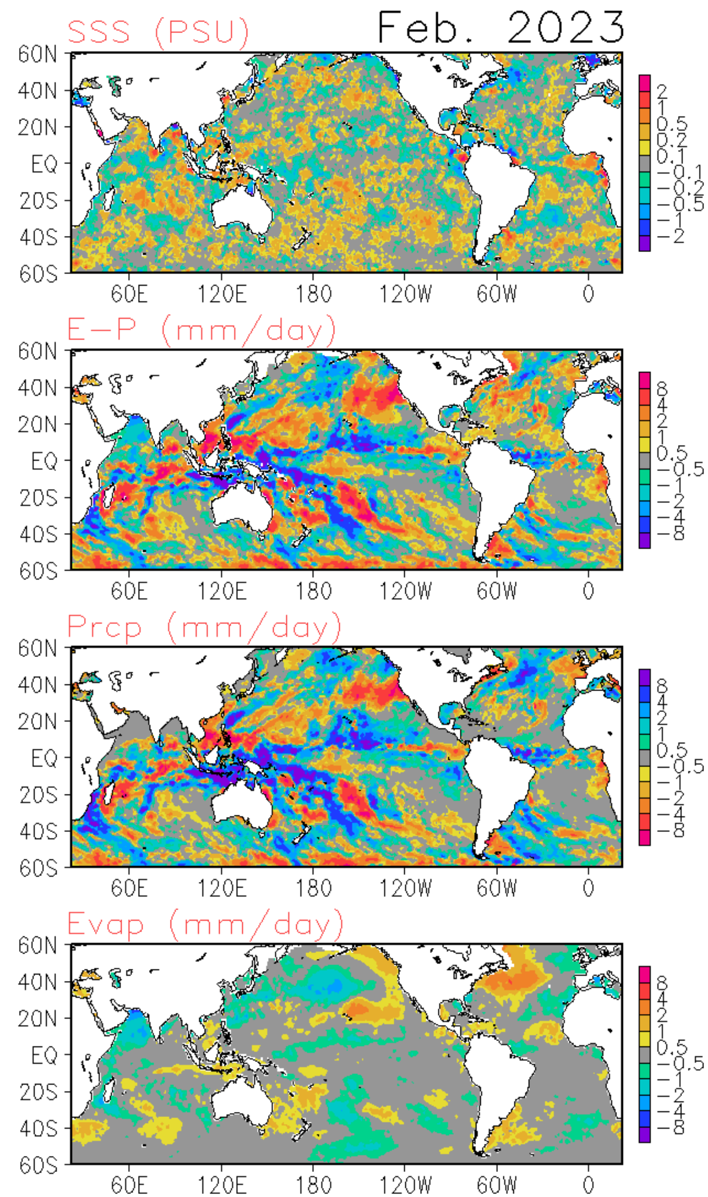
Precipitation: CMORPH adjusted satellite precipitation estimates

Evaporation: Adjusted CFS Reanalysis



Global Sea Surface Salinity (SSS): Tendency for February 2023

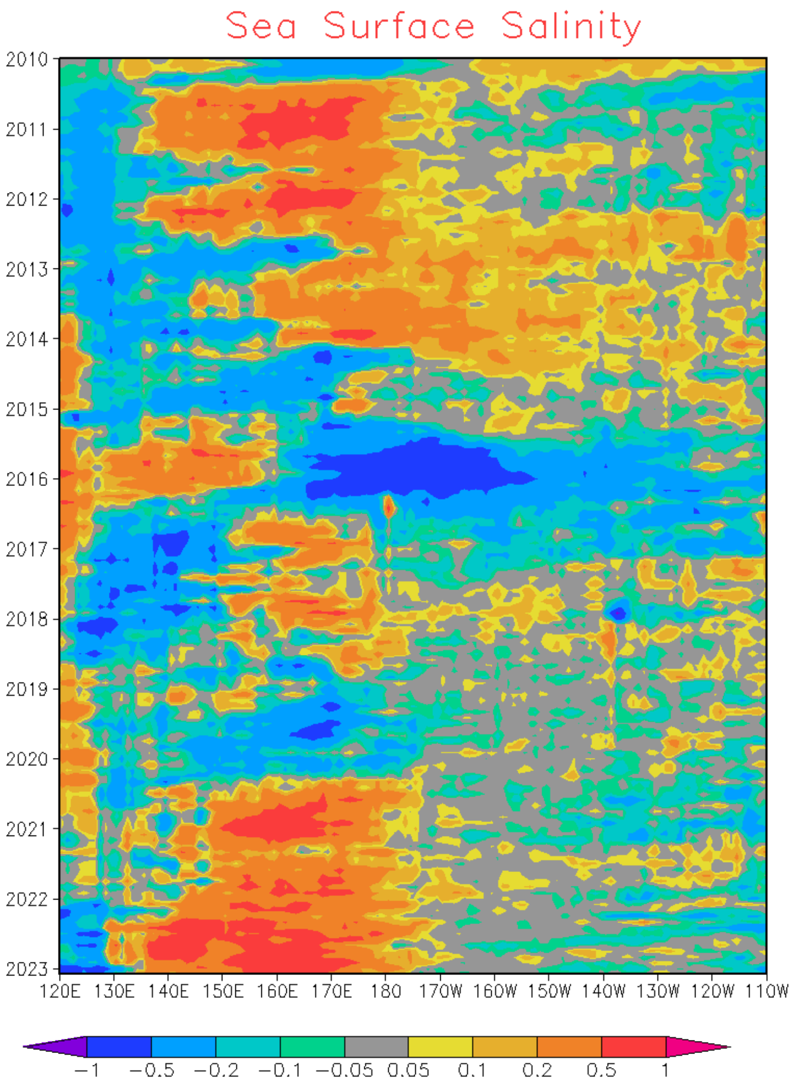
Atlantic ITCZ is intensified and a band of precipitation appeared over the eastern equatorial Pacific south of the equator, causing freshened SSS anomalies over the region. Saltier SSS tendency is observed over the western tropical Pacific in the region of suppressed fresh water influx. Also noticeable are dotted regions of saltier SSS tendencies offshore of several major river mouths offshore of NE Brazil, West Columbia, eastern China and South India, likely attributable to the reduced river runoffs.



Monthly SSS Anomaly Evolution over Equatorial Pacific

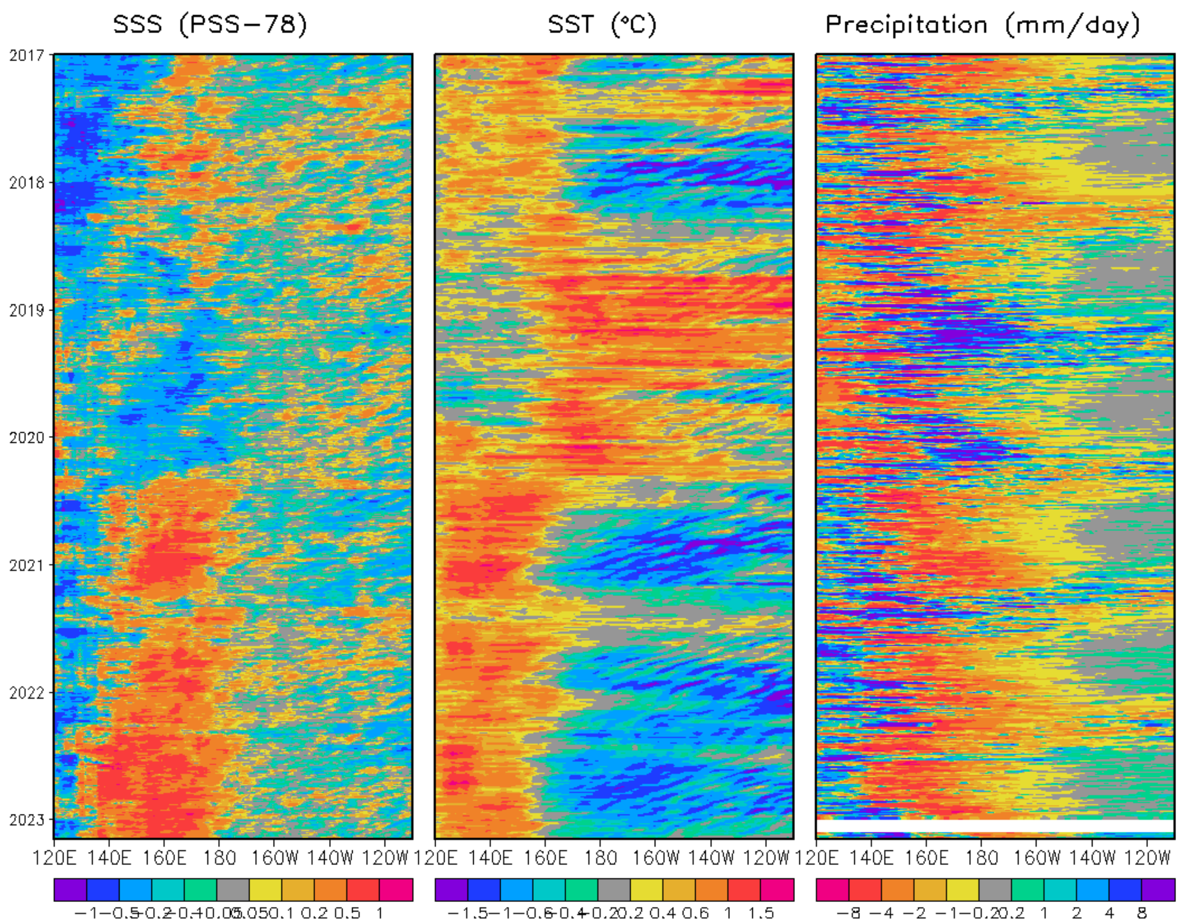
NOTE: Since June 2015, the BASS SSS is from in situ, SMOS and SMAP; before June 2015,The BASS SSS is from in situ, SMOS and Aquarius.

- Hovmoller diagram for equatorial SSS anomaly **(5˚S-5˚N);**
- Positive SSS anomalies continued over the western equatorial Pacific (135ºE-155ºE) and are enhanced over the Central Equatorial Pacific between 160ºE and 170ºW. A wave of weak freshen salinity appears over the eastern equatorial Pacific.



Pentad SSS Anomaly Evolution over Equatorial Pacific

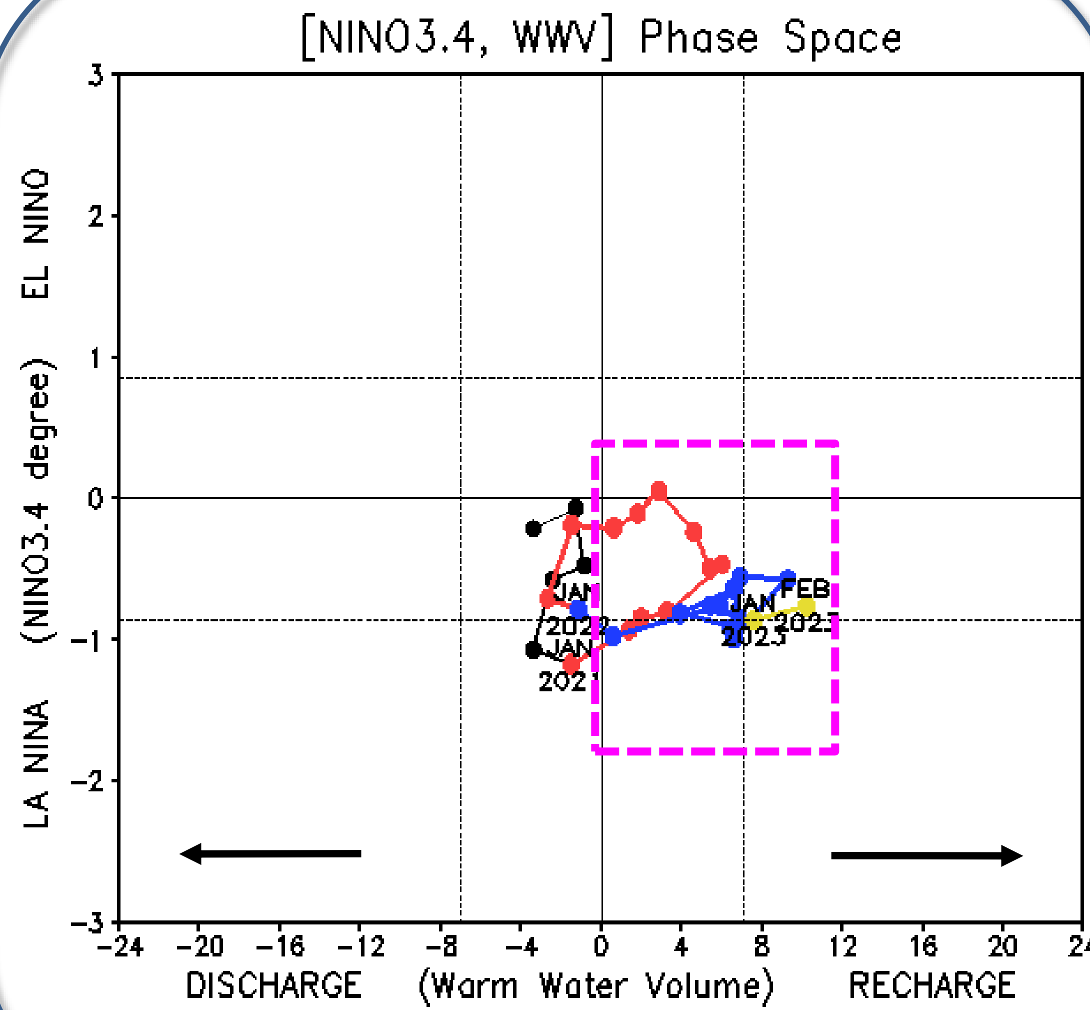
Figure caption: Hovmoller diagram for equatorial (5°S-5°N) 5-day mean SSS, SST and precipitation anomalies. The climatology for SSS is Levitus 1994 climatology. The SST data used here is the OISST V2 AVHRR only daily dataset with its climatology being calculated from 1985 to 2010. The precipitation data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



Warm Water Volume (WWV) and Niño3.4 Anomalies

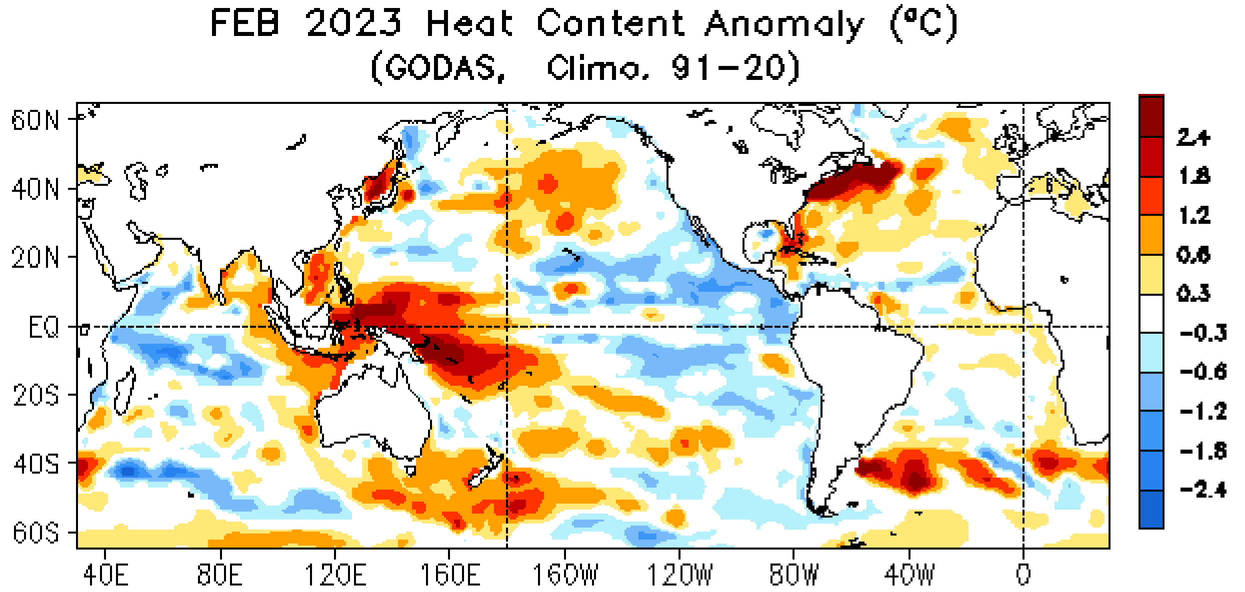
- Equatorial Warm Water Volume (WWV) was in a recharge phase in Feb 2023.

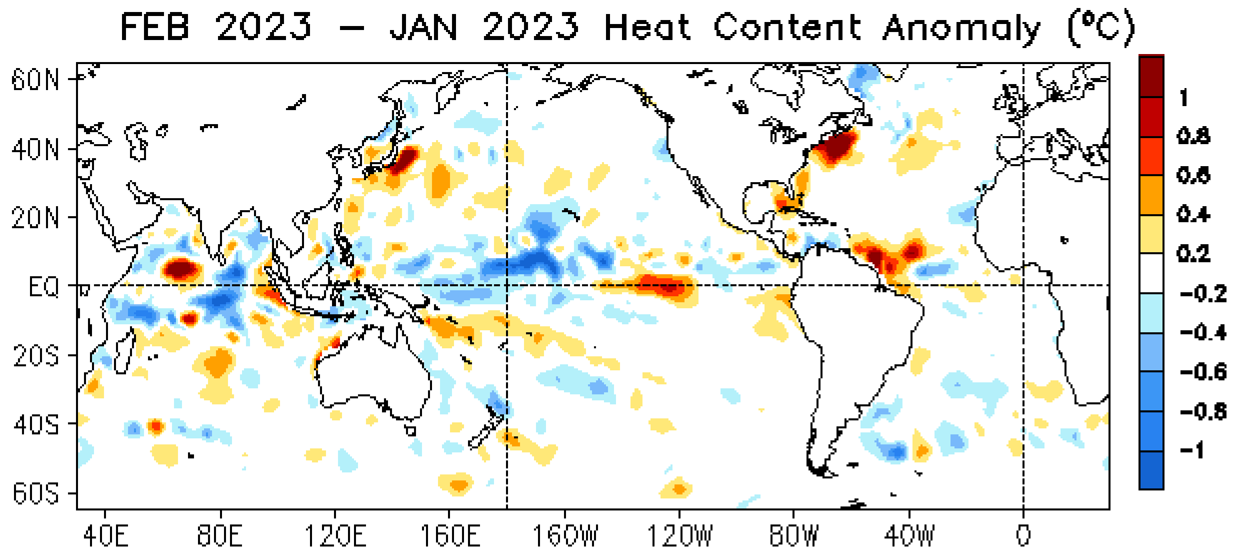
-As WWV is intimately linked to ENSO variability (Wyrtki 1985; Jin 1997), it is useful to monitor ENSO in a phase space of WWV and Niño3.4 (Kessler 2002).
- Increase (decrease) of WWV indicates recharge (discharge) of the equatorial oceanic heat content.



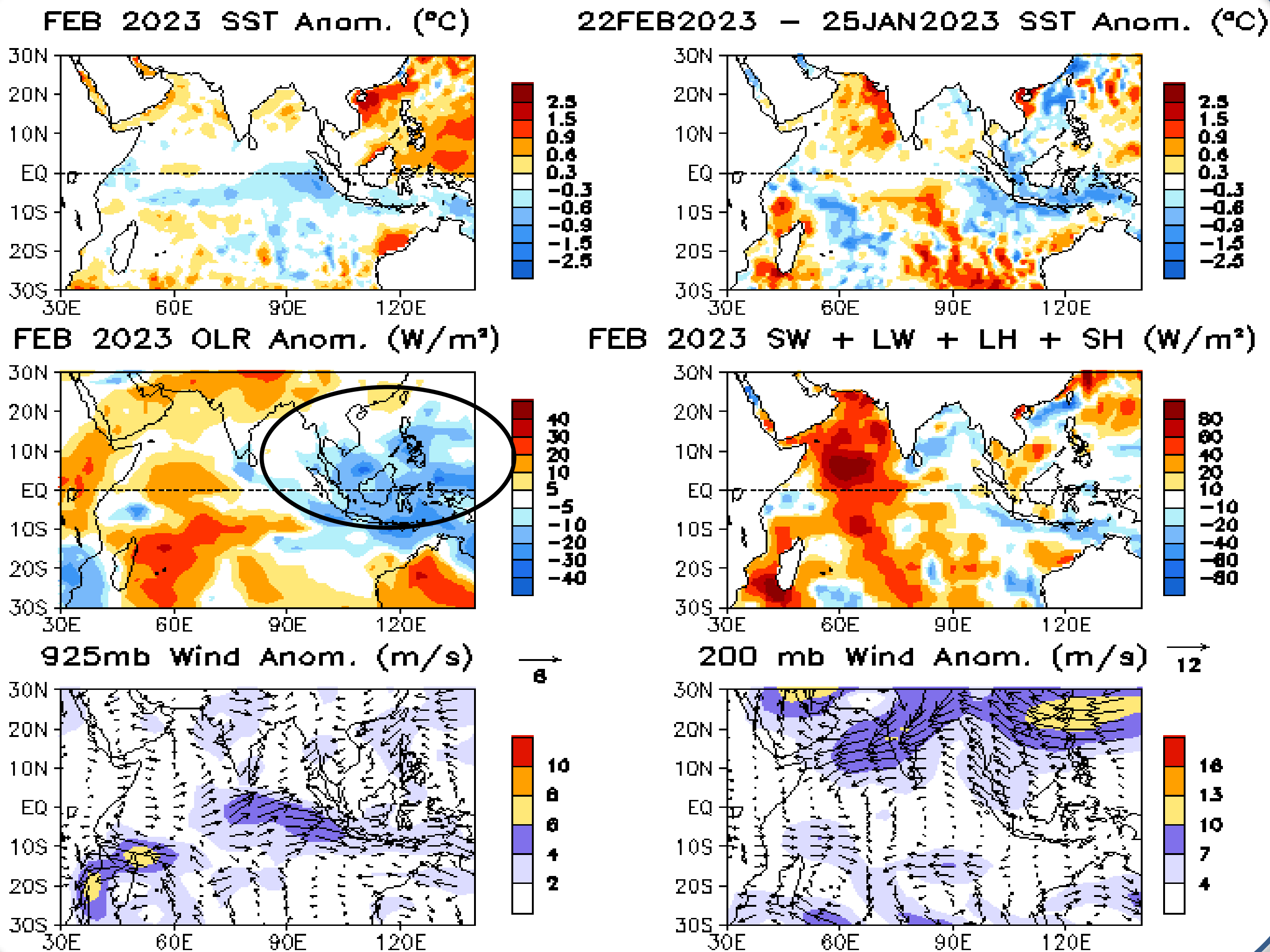
Phase diagram of Warm Water Volume (WWV) and Niño3.4 indices. WWV is the average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] calculated with the NCEP's GODAS. Anomalies are departures from the 1991-2020 base period means.

Global HC300 Anomaly & Anomaly Tendency





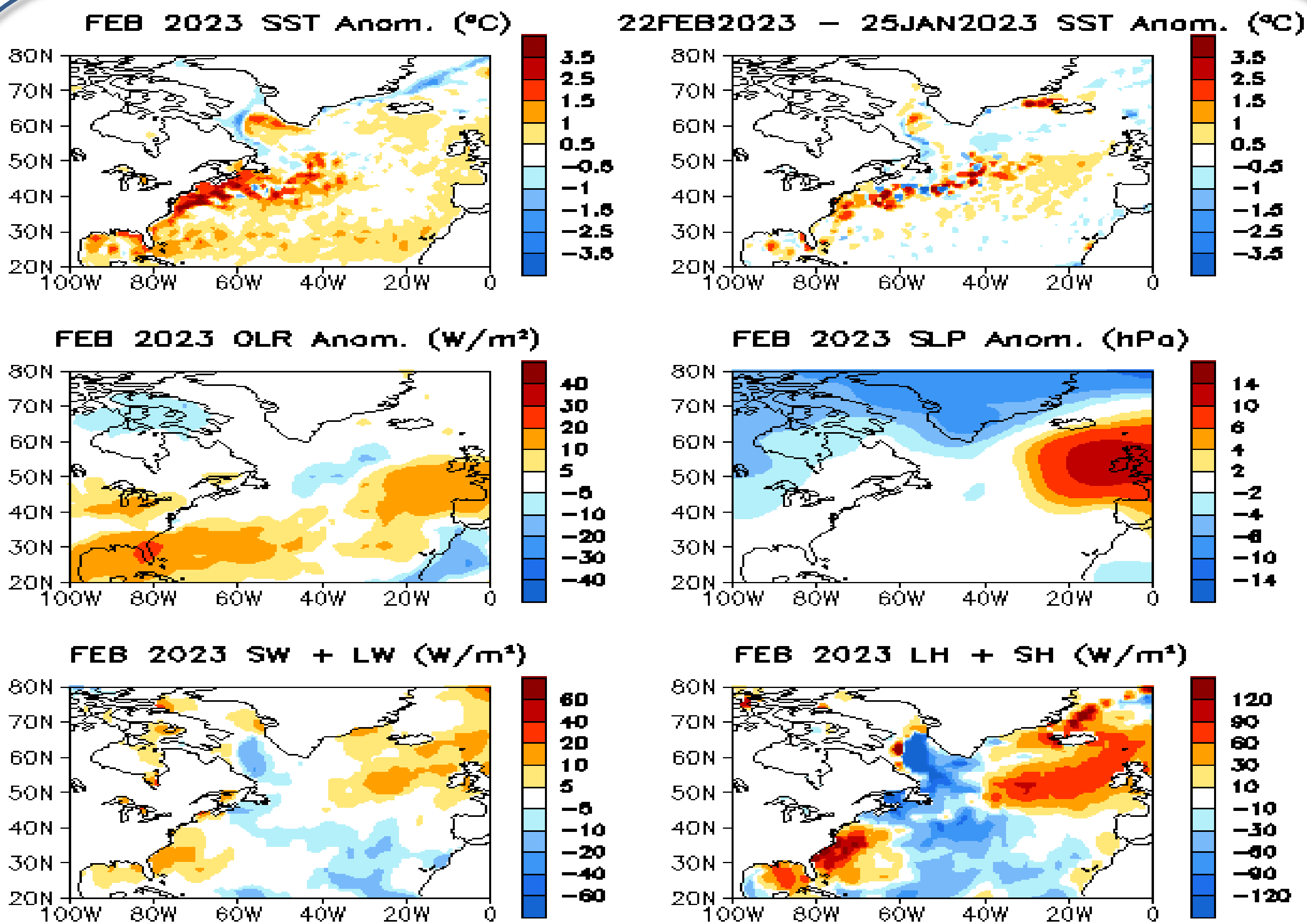
Tropical Indian: SSTA, SSTA Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Wind Anom.



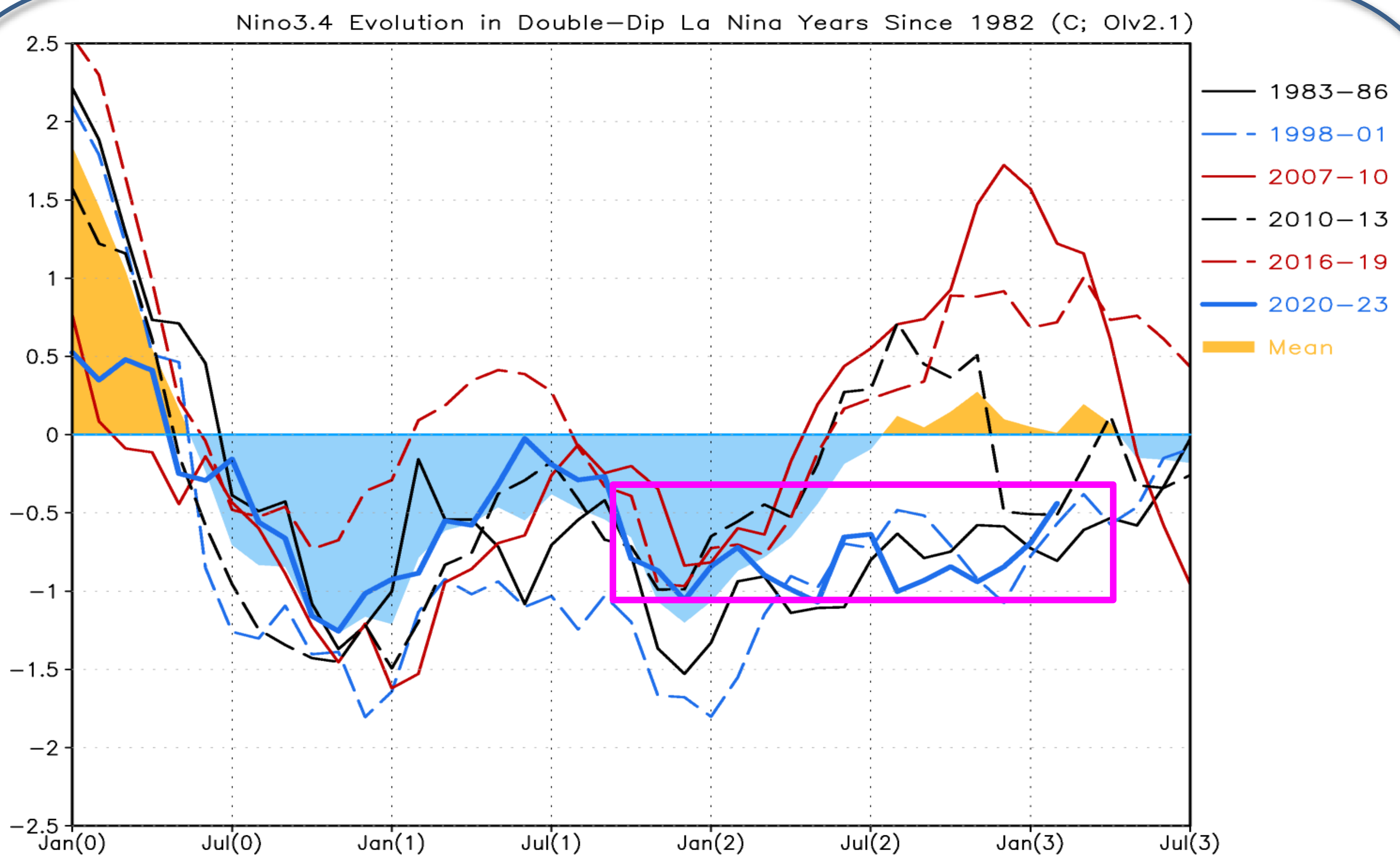
Convection was enhanced (suppressed) over the eastern (western) Indian Ocean.

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 OIv2.1 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 1991-2020 base period means.

N. Atlantic: SST, SST tend., OLR, SLP, & heat flex anom.

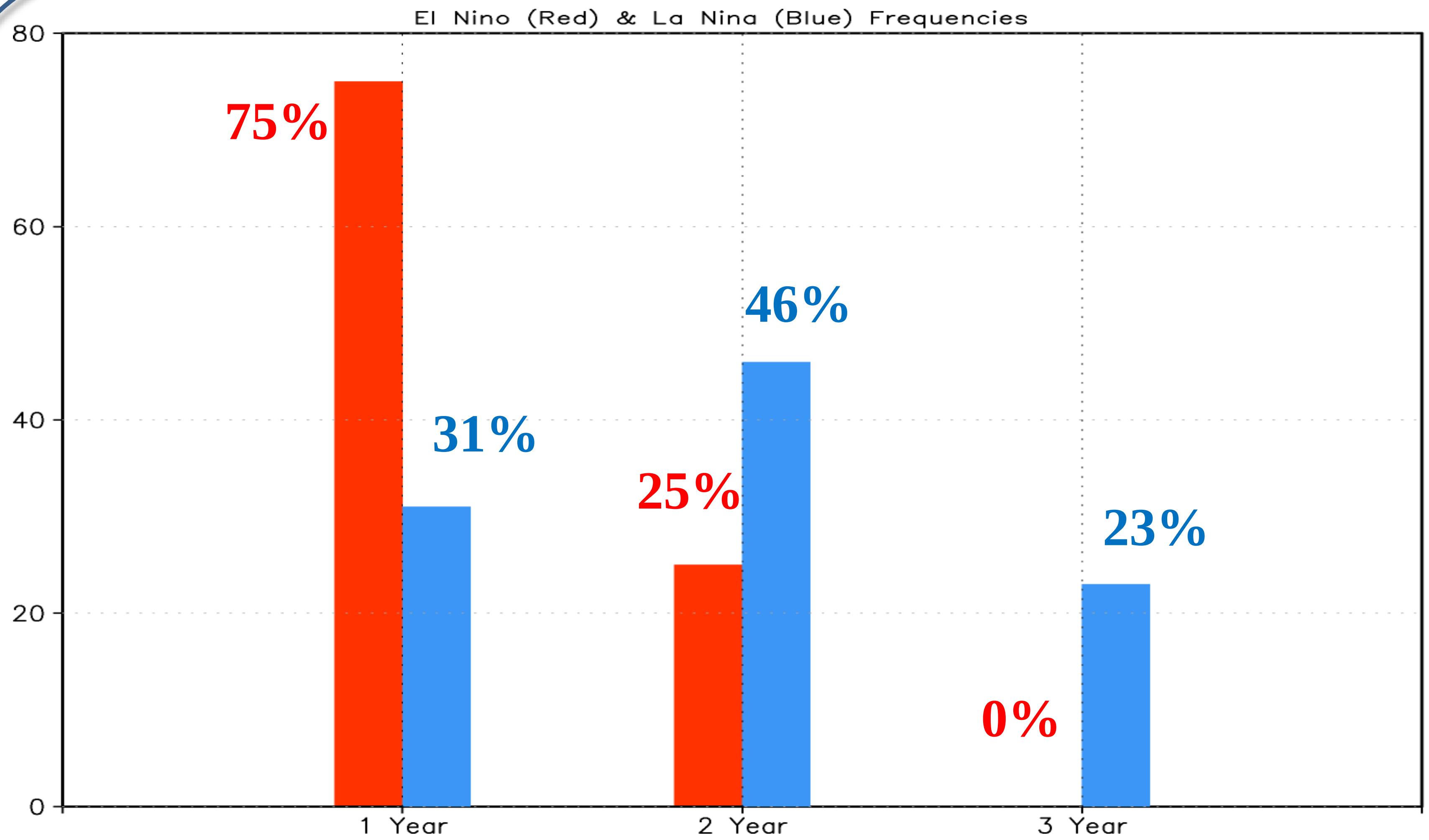


Niño3.4 Evolution in Double & Triple dip La Niña Years Since 1982 (OIv2.1; C)



During 1982-2022, among 6 double-dip La Niñas, 2 (2007-09 & 2016-18) were followed by El Niño; 2 (1998-00; 2020-22) by a 3rd-year La Niña, & 2 (1983-85 & 2010-12) by neutral.

Percentages (%) of single-, double-, and triple-year El Niños (red bars) and La Niñas (blue bars) during 1951-2022



Gao, Z., et al., 2023: Single-Year and Double-Year El Niños. Climate Dyn. DOI: 10.1007/s00382-022-06425-8.