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

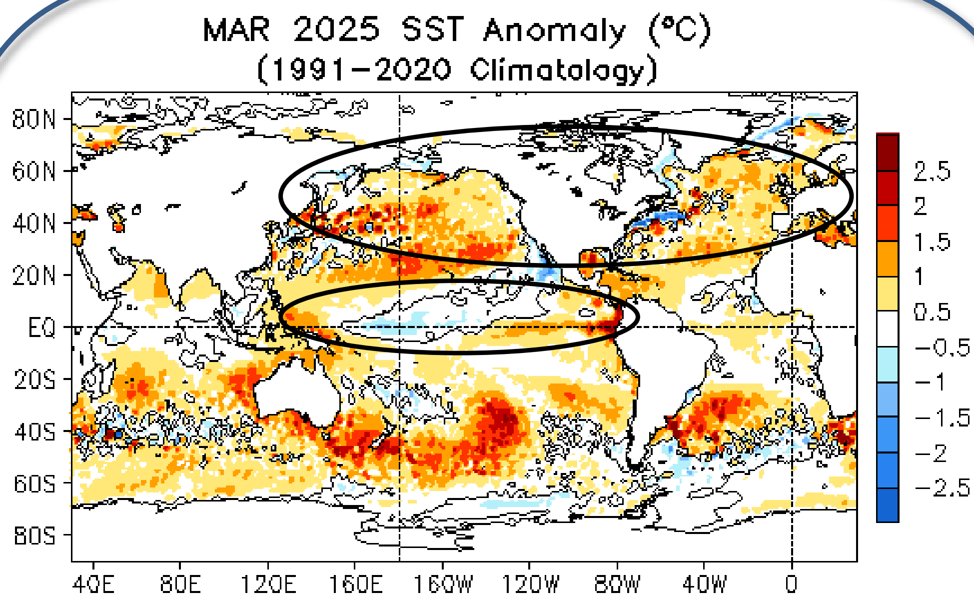
- **Overview**
- **Recent highlights**
  - Pacific Ocean
  - Arctic & Antarctic Oceans
  - Indian Ocean
  - Atlantic Ocean
- **Global SSTA Predictions**

Overview

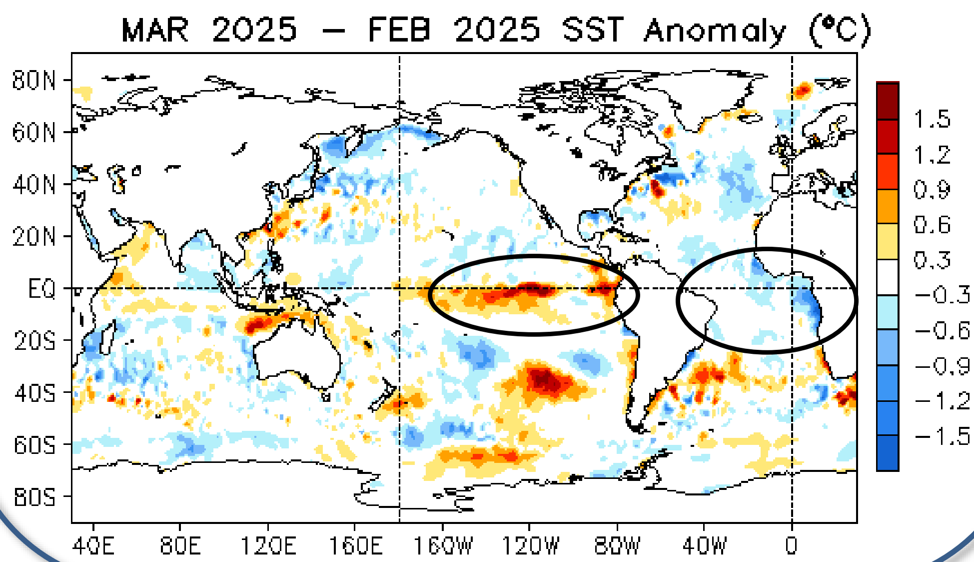
- **Pacific Ocean**
  - Negative SSTA in the equatorial central Pacific weakened further with Niño3.4 = 0.1^{o}C in March 2025.
  - Positive SSTA along the South American coast strengthened with Niño1+2 = 1.15^{o}C in March 2025.
  - NOAA "ENSO Diagnostic Discussion" issued *Final La Niña Advisory* on April 10, 2025.
  - The PDO has been in a negative phase since March 2020 with PDOI = -0.4 in March 2025.
- **Arctic & Antarctic Oceans**
  - The average March 2025 Arctic sea ice extent was 14.14 million km^2, the lowest March extent in the 47-year satellite record.
  - Antarctic sea ice extent was 3.0 million km^2 in March 2025, ranking 4th lowest March record since 1979.
  - CPC model-based forecasts call for a below-normal Arctic sea ice extent in 2025.
- **Indian Ocean**
  - SSTs were near average along the equatorial Indian Ocean in March 2025.
- **Atlantic Ocean**
  - Positive SSTA weakened in the tropical North Atlantic Ocean in March 2025.
  - NAO switched to a neutral phase in March 2025 with NAOI = -0.1.

Global Oceans

Global SST Anomaly (°C) and Anomaly Tendency



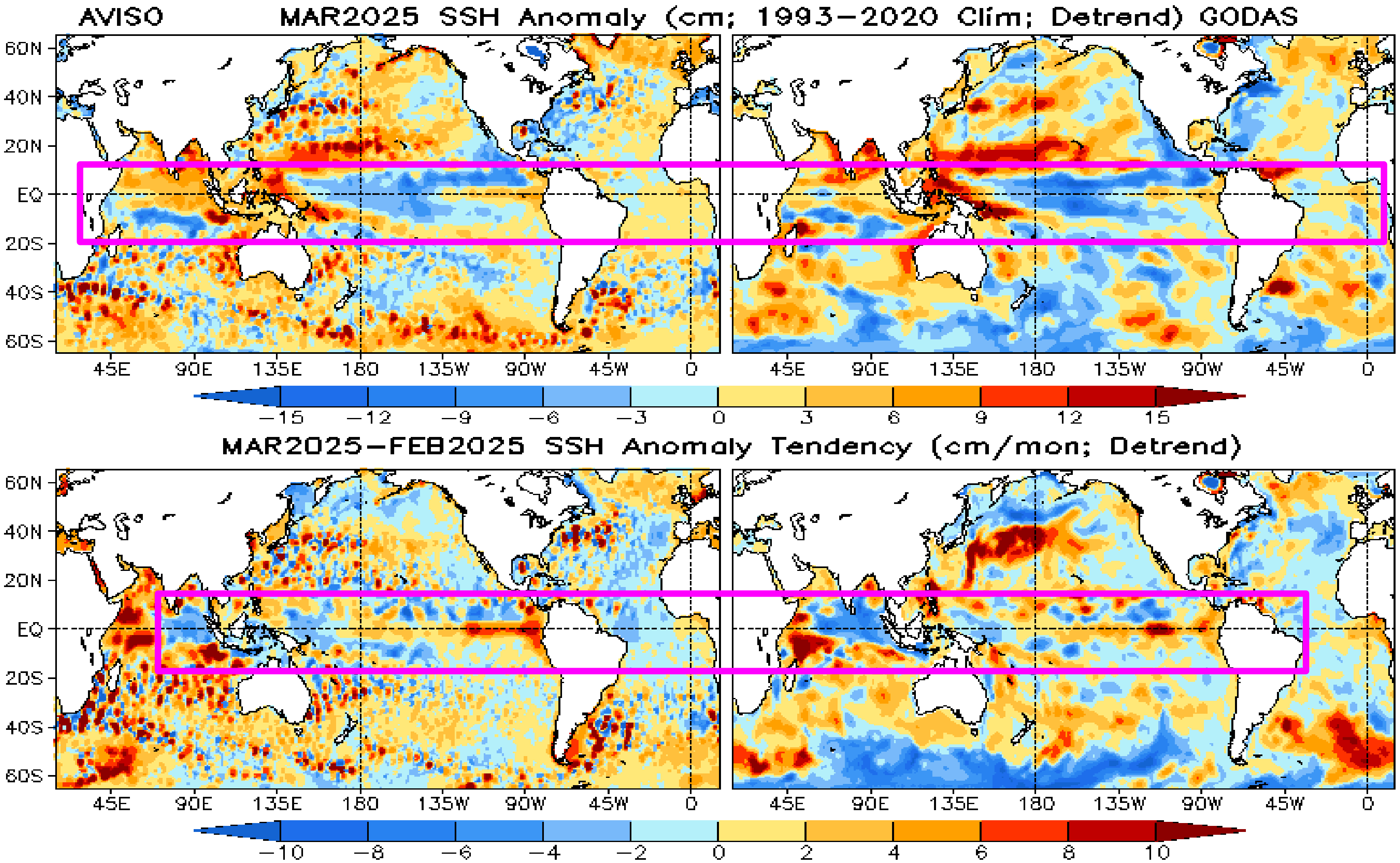
- Tropical SSTs were above average in the far-western and eastern Pacific and below average in the central Pacific.
- Positive SSTA persisted in the mid-latitudes of both the North Pacific and North Atlantic.
- SSTs were mostly near average in the equatorial Indian and Atlantic Oceans.



- Positive SSTA tendencies were observed in the east-central and far-eastern equatorial Pacific.
- SSTA tendencies were negative in the tropical eastern Atlantic Ocean.
- SSTA tendencies were small in the tropical Indian Ocean.

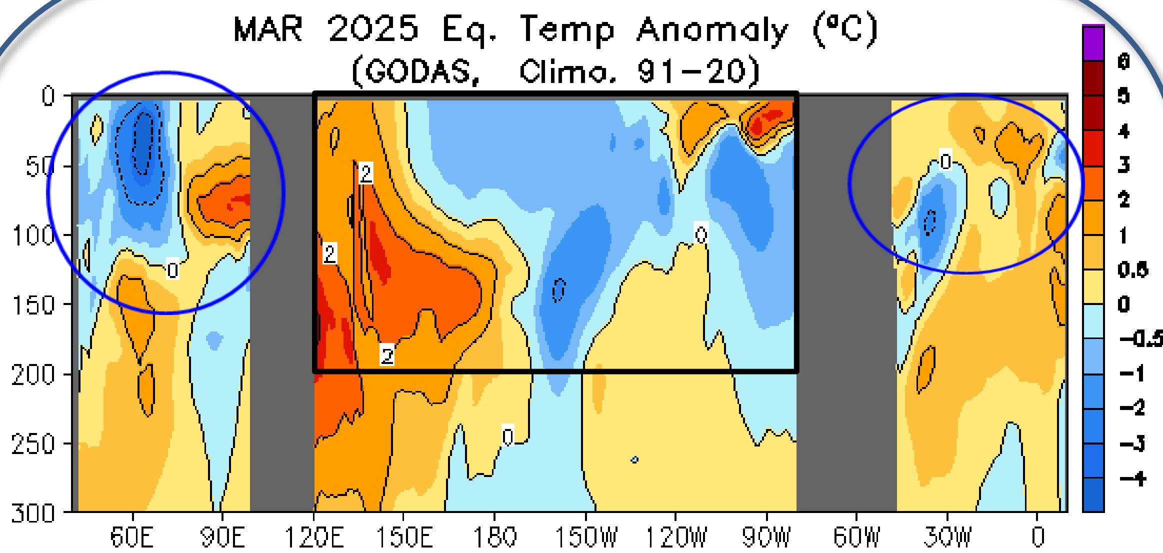
SSTA (top) and SSTA tendency (bottom). Data are derived from the OIv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

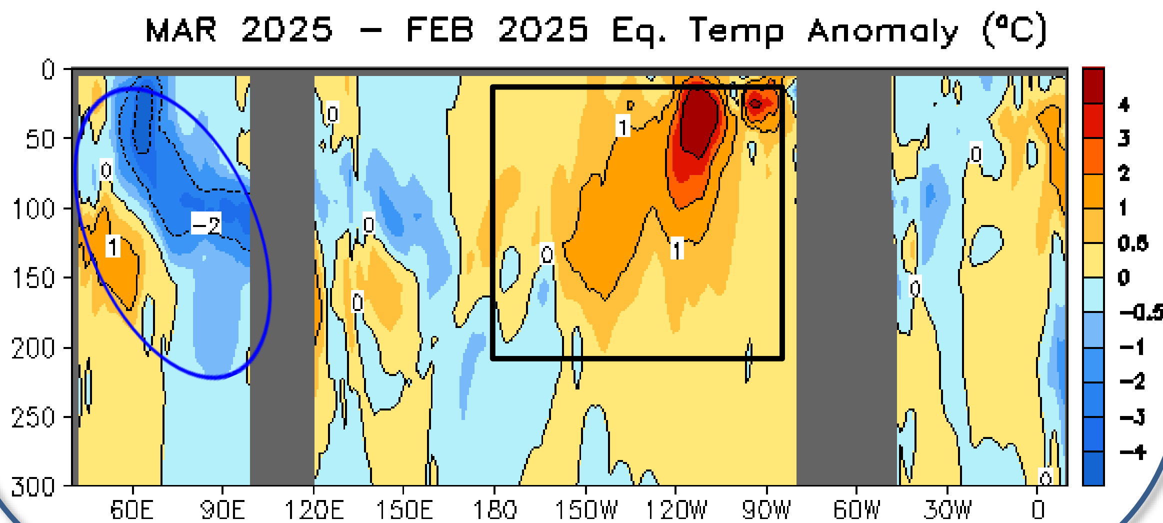
AVISO & GODAS SSH Anomaly (cm) and Anomaly Tendency



- Enhanced zonal contrast of SSH was observed across the tropical Pacific with above average in the west and east, and below average in the central Pacific.
- Positive SSH anomalous tendencies were observed in the eastern equatorial Pacific.

Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2ºS-2ºN





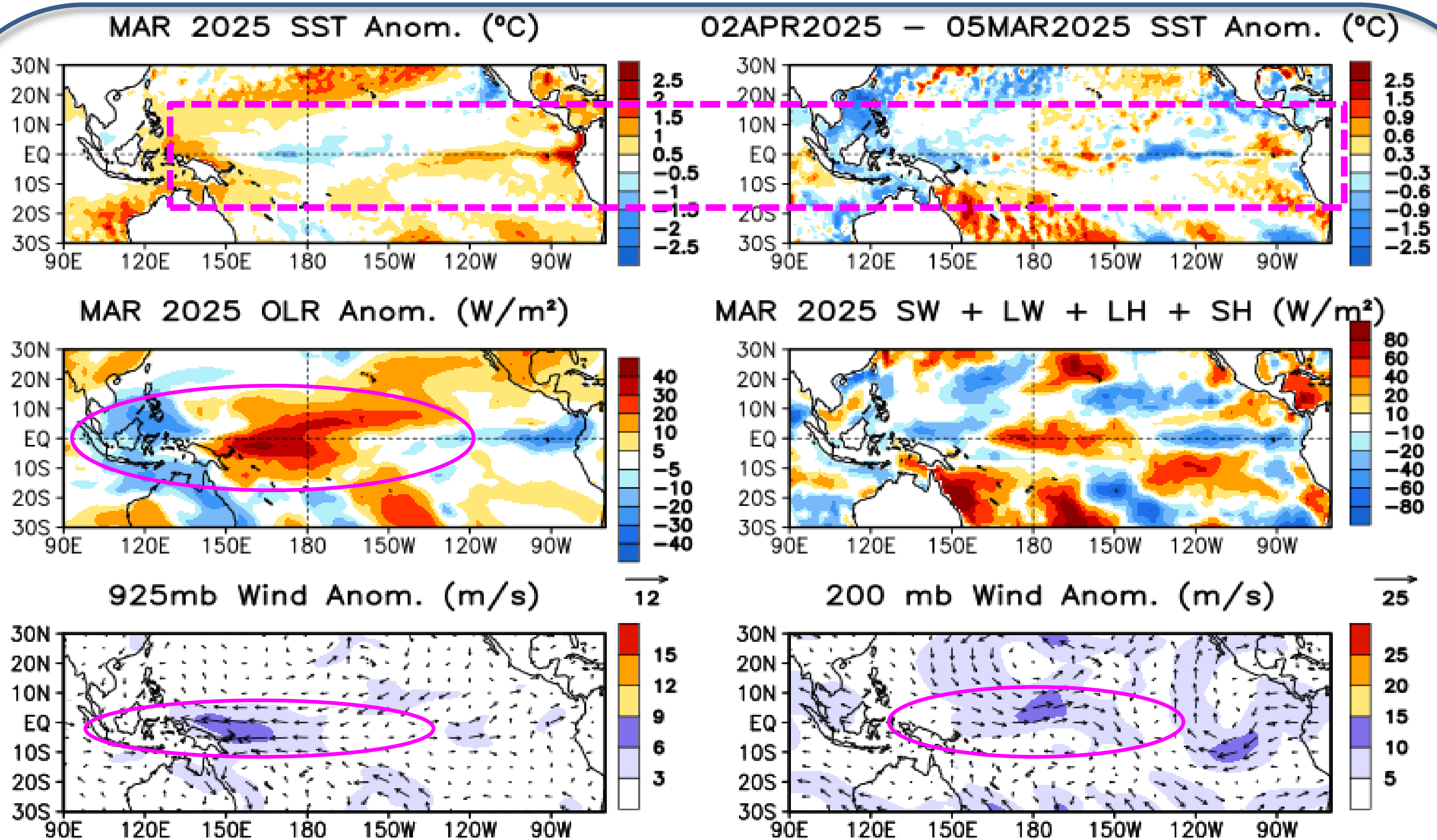
- The dipole pattern was persistent along the equatorial Pacific thermocline with negative (positive) temperature anomalies in the central (west), consistent with La Niña conditions.
- Positive (negative) temperature anomalies were observed in the upper 100 m of the eastern (western) Indian Ocean.
- Anomalies were small in the Atlantic Ocean.

- The dipole pattern weakened with positive temperature anomaly tendencies in the eastern Pacific Ocean.
- Both positive and negative temperature anomaly tendencies were present in the 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 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:
La Niña-like conditions weakened & warming emerged in the eastern tropical Pacific

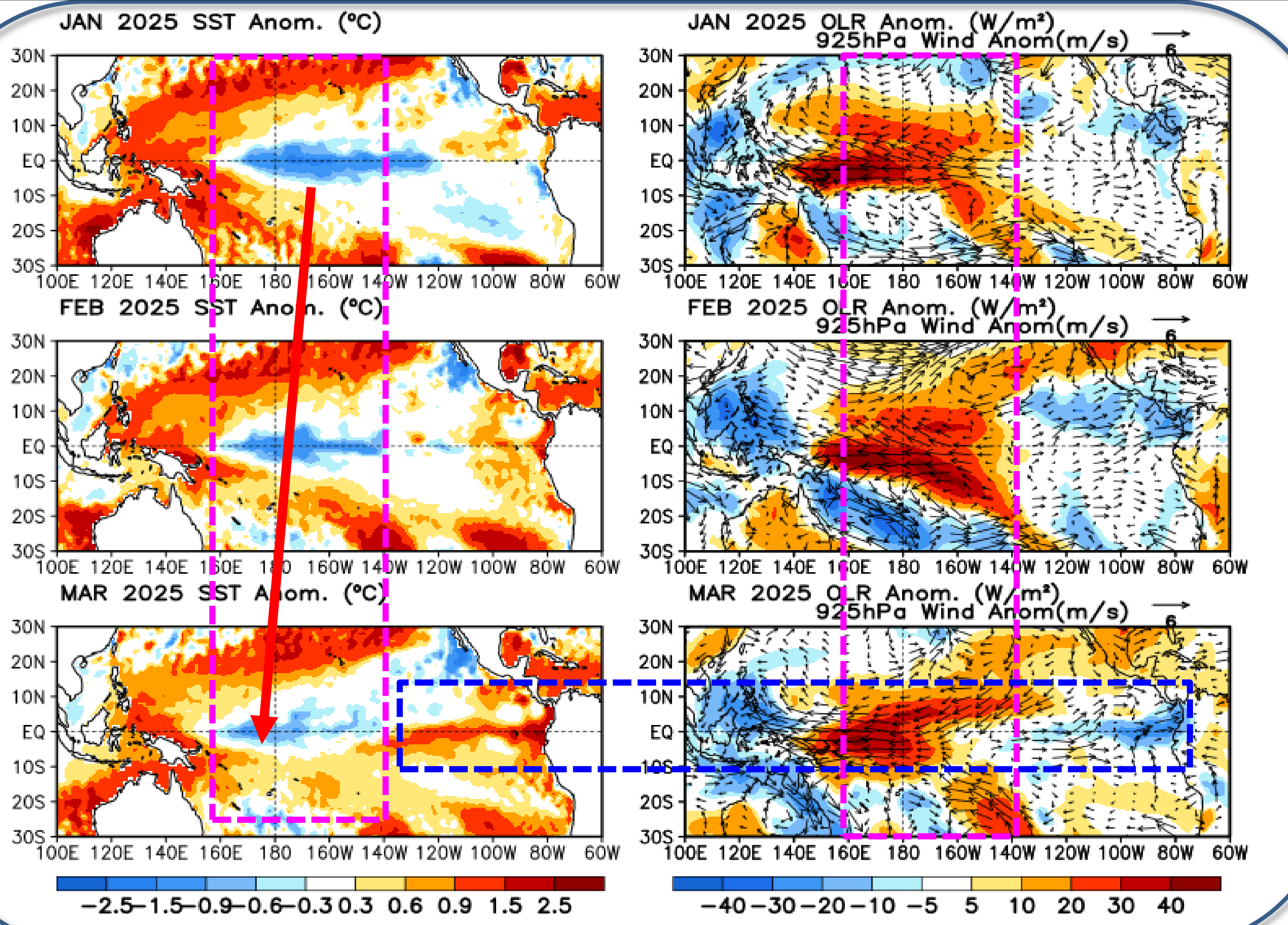


SSTA (top-left), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right; positive means heat into the ocean), 925-mb wind anomaly vector and its amplitude (bottom-left),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

Last 3-month Tropical Pacific Ocean SST, OLR, and uv925 Anomalies:

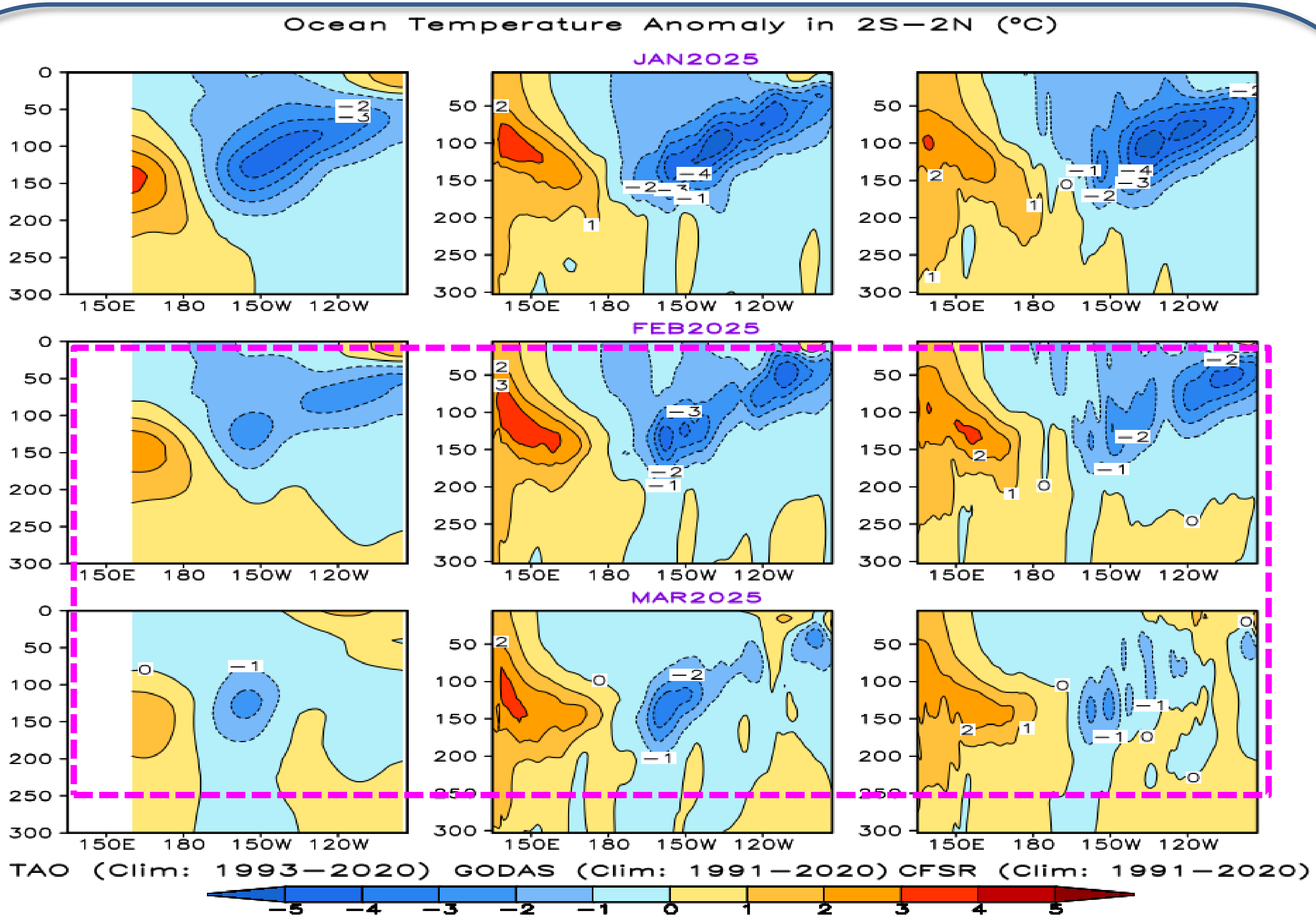
Negative SSTA weakened and shifted westward & easterly wind anomalies persisted in the tropical Pacific

The enhanced positive SSTA in the eastern Pacific were associated with westerlies in the eastern Pacific

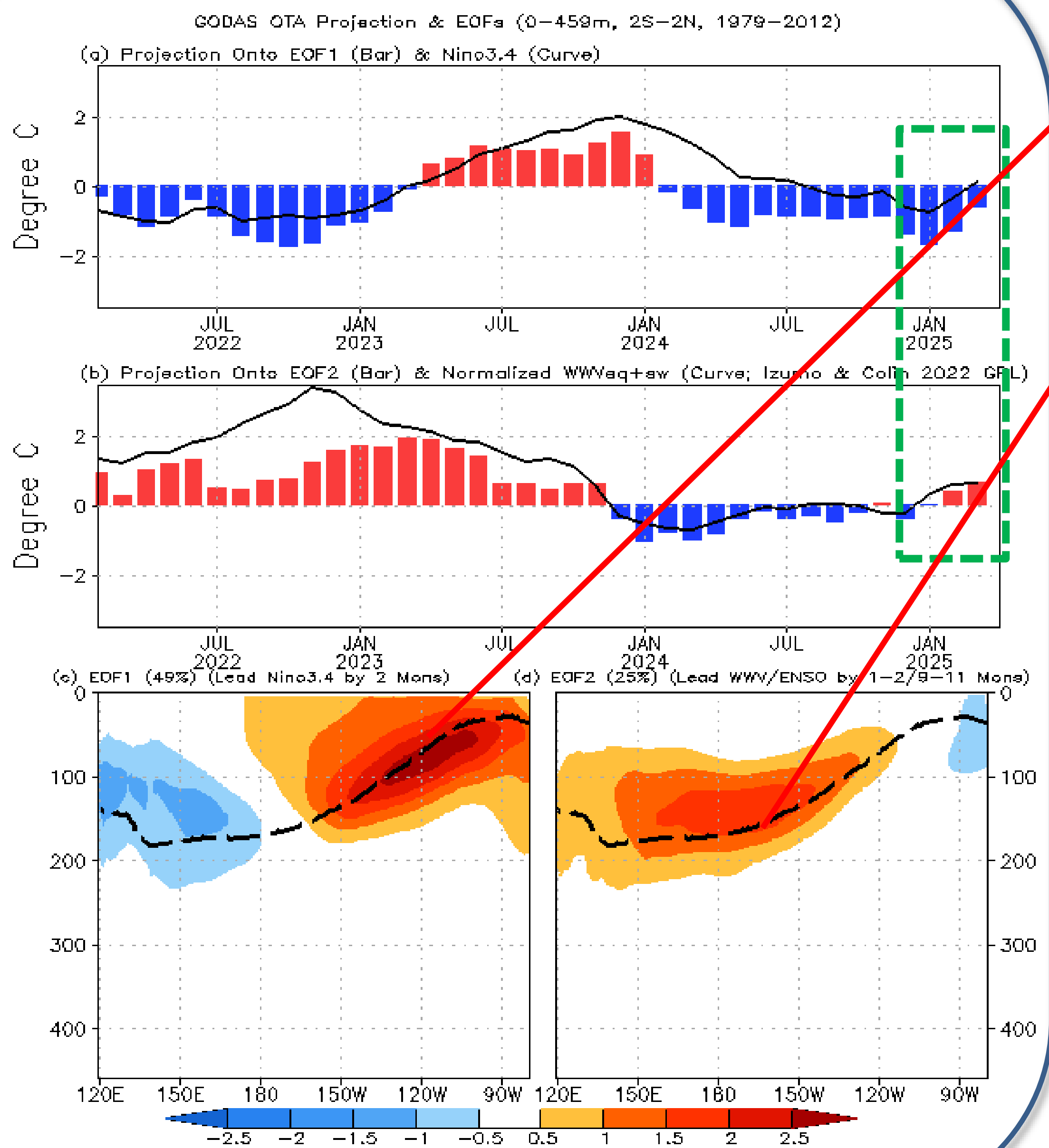


Monthly mean subsurface temperature anomaly along the Equator:

The dipole-like pattern & the negative anomalies in the eastern Pacific weakened in Mar 2025



Equatorial Sub-surface Ocean Temperature Monitoring



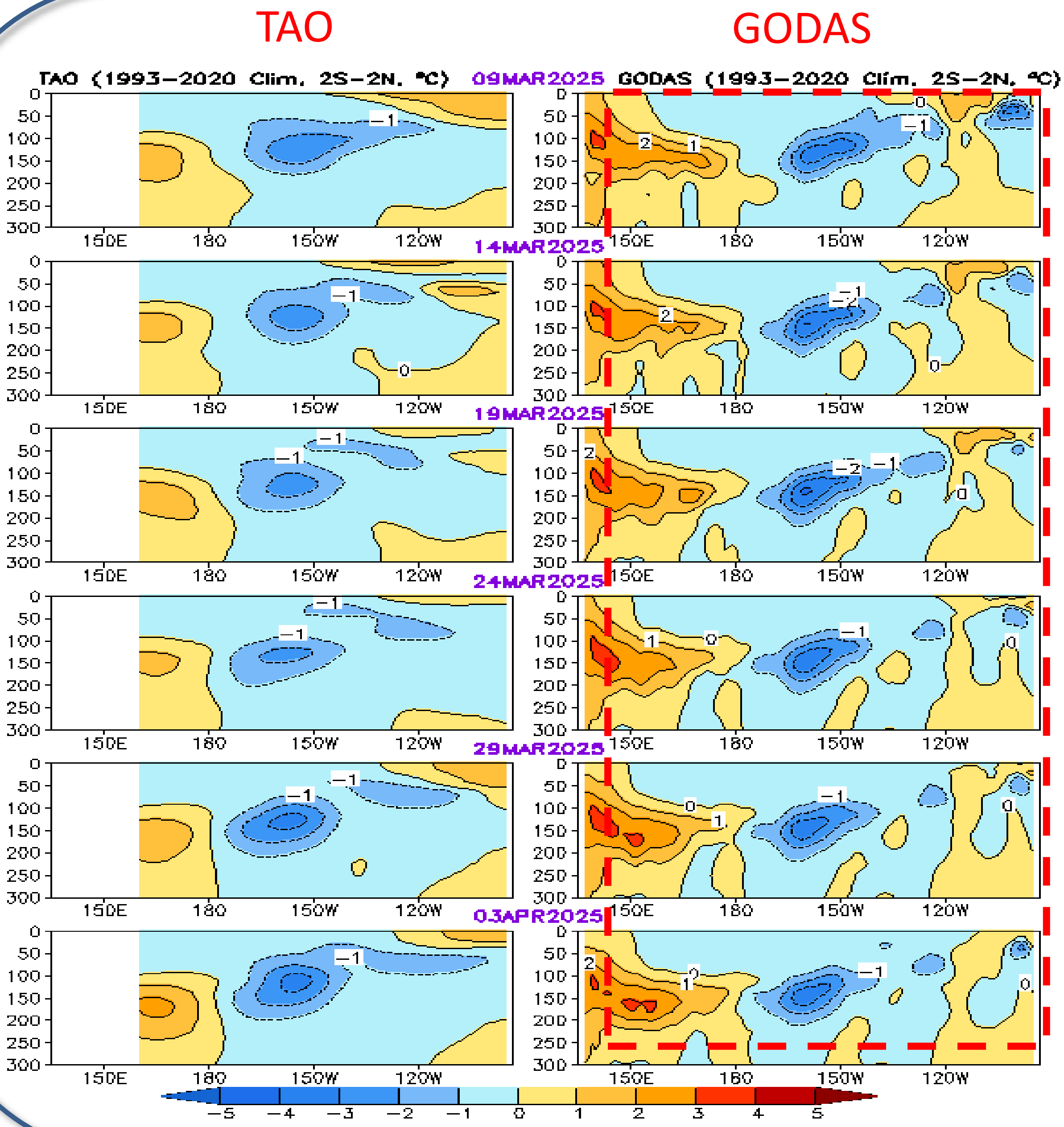
- The negative phase of the dipole mode has weakened since Feb 2025.
- WWV switched to a recharge phase in Feb 2025.

- 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

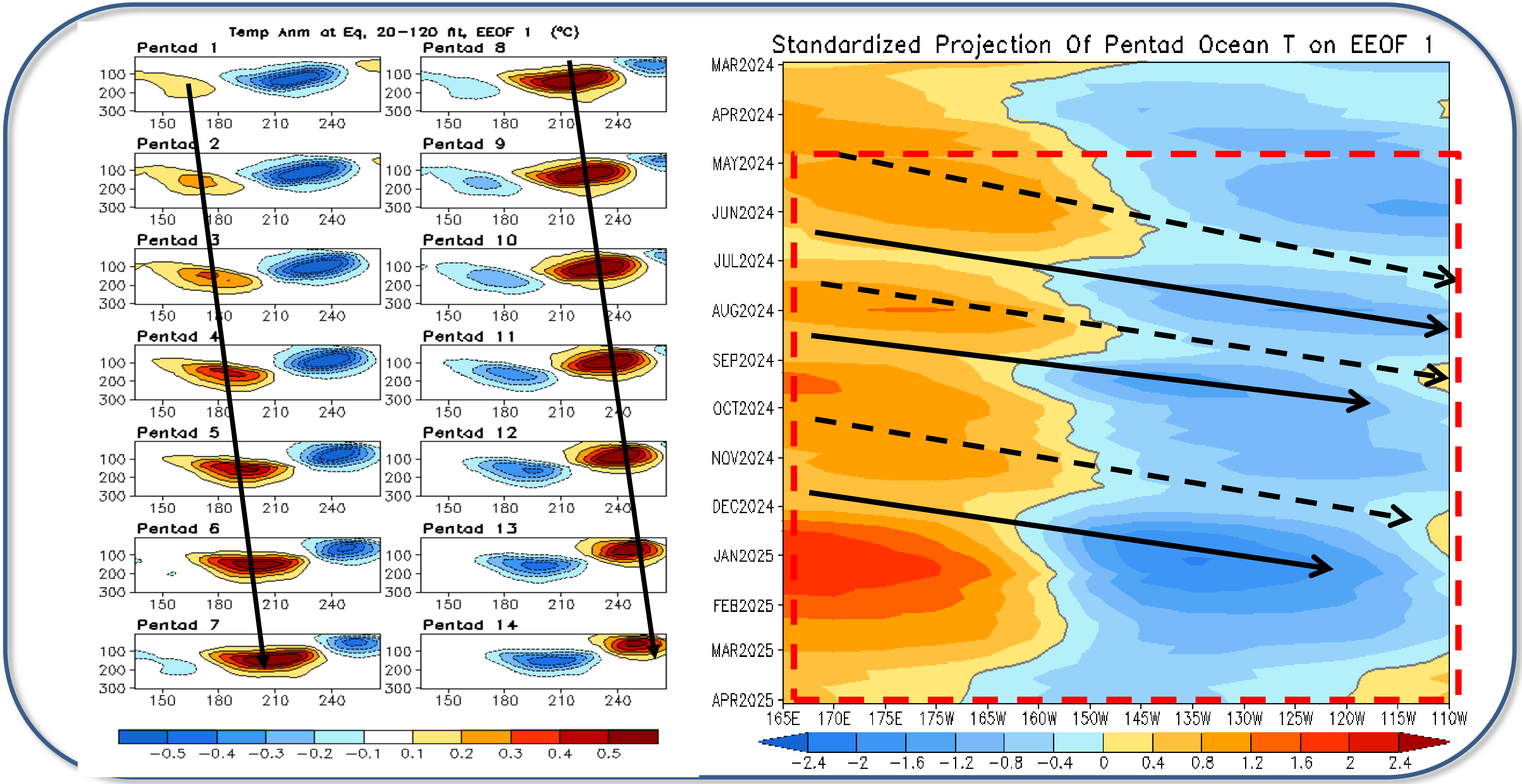
- For details, see: Kumar and Hu (2014) DOI: 10.1007/s00382-013-1721-0; Izumo & Colin (2022) DOI: 10.1029/2022GL101003.

Equatorial Pacific Ocean Temperature Pentad Mean Anomaly



- Positive (negative) ocean temperature anomalies along the thermocline in the western (east-central) Pacific persisted during the last month.
- The features of the ocean temperature anomalies were similar between GODAS and TAO analysis.

Oceanic Kelvin Wave (OKW) Index

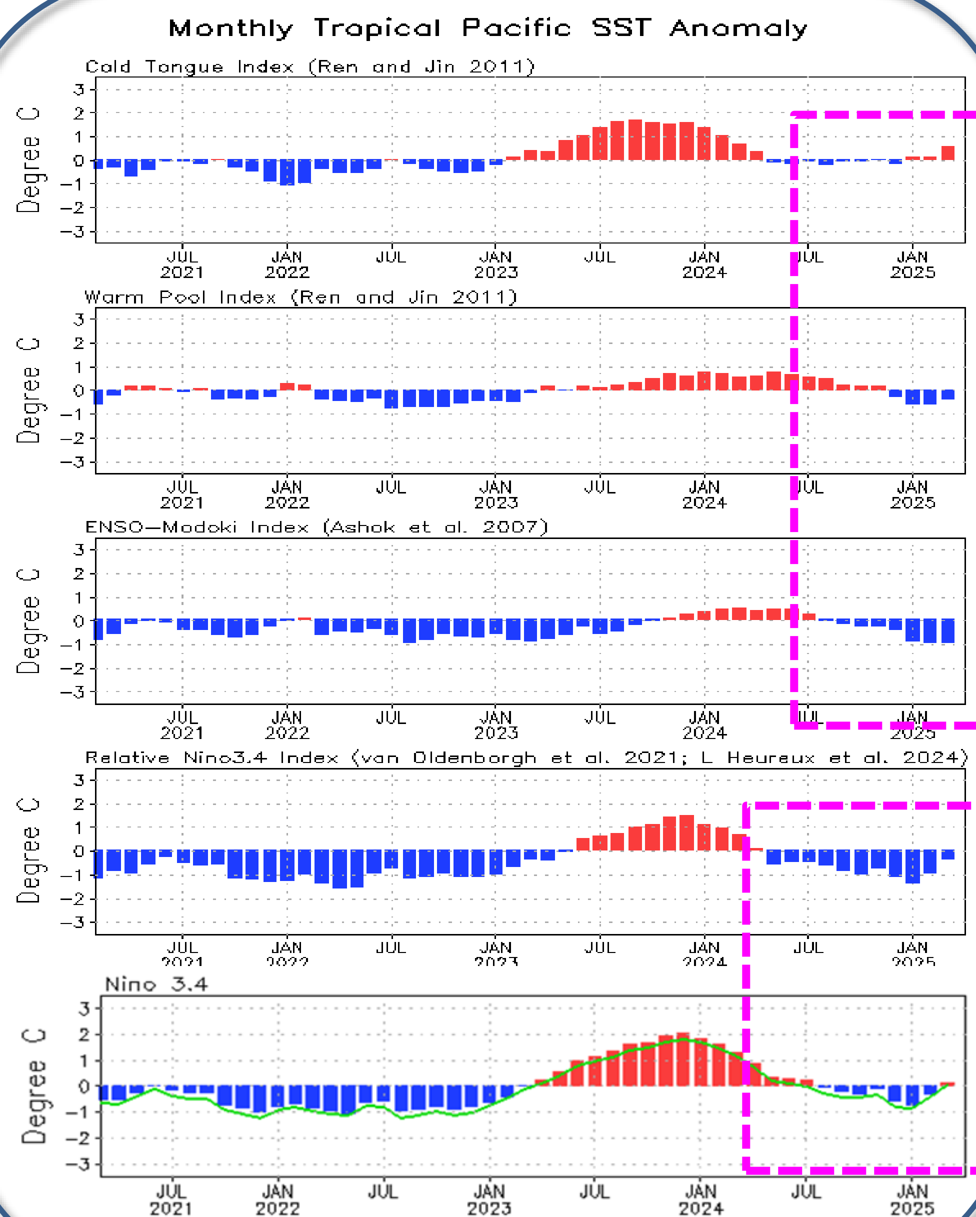


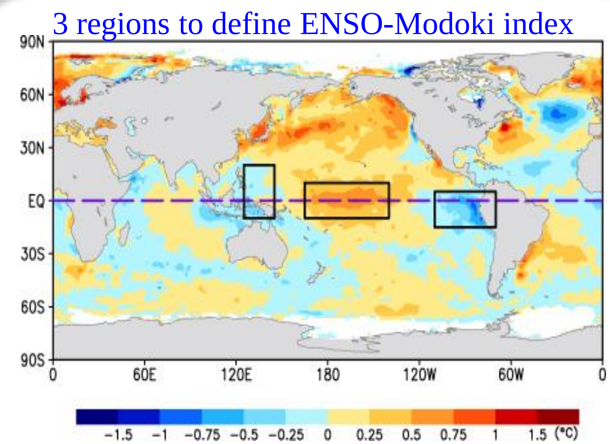
- **Multiple downwelling and upwelling Kelvin waves were observed in 2024-25, leading to fluctuations in SSTA in the central and eastern equatorial Pacific and ENSO evolution.**

- **Although there were some Kelvin wave-like fluctuations, the variations were mostly stationary since Feb 2024.**

(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).)

- rNiño3.4 has been cooler than Niño3.4 since May 2024
- The cooling center is in the central equatorial Pacific, meaning a CP-like La Niña conditions



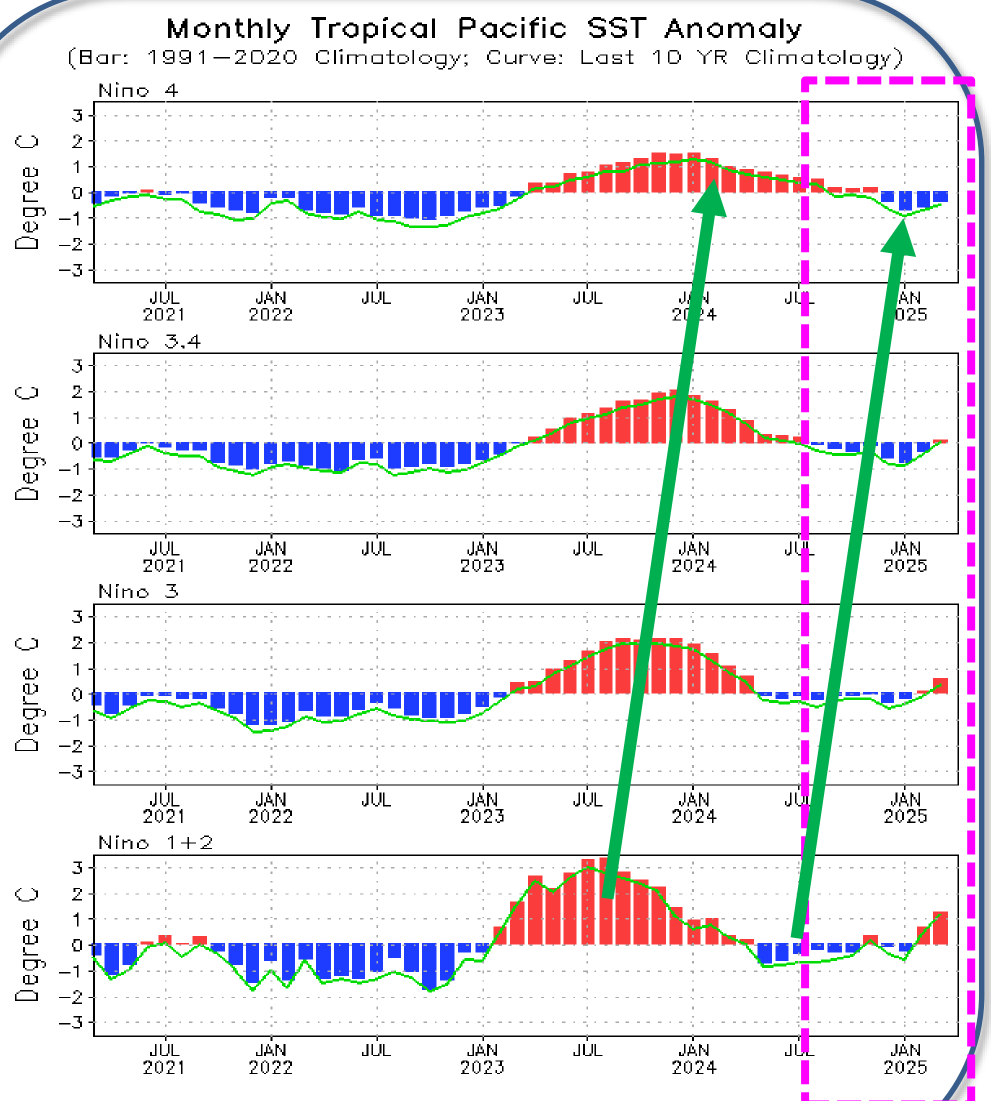


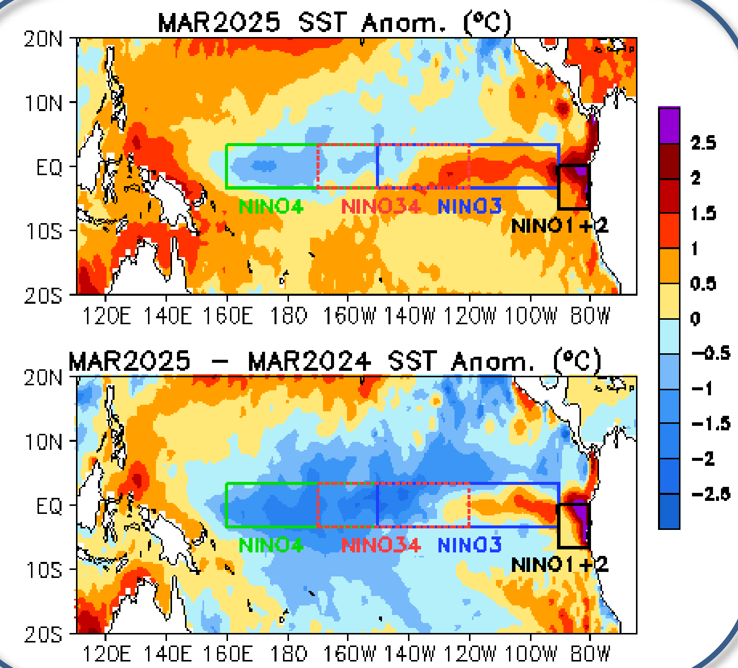
- Relative Niño3.4 index is now included in ENSO monitoring, which is defined as the conventional Niño3.4 index minus the SSTA averaged in the whole tropics (0º-360º, 20ºS-20ºN), in order to remove the global warming signal. Also, to have the same variability as the conventional Niño3.4 index, the relative Niño3.4 index is renormalized (Izumo et al. 2020: GRL, 10.1029/2019GL086182; van Oldenborgh et al. 2021: ERL, 10.1088/1748-9326/abe9ed; L'Heureux, et al. 2024: J. Climate, 10.1175/JCLI-D-23-0406.1).

Relative Niño3.4 data updated monthly at:

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

Evolution of Pacific Niño SST Indices





- In Mar 2025, all Niño indices warmed up with Niño3.4 = 0.1°C (0.0°C in ERSSTv5 data).

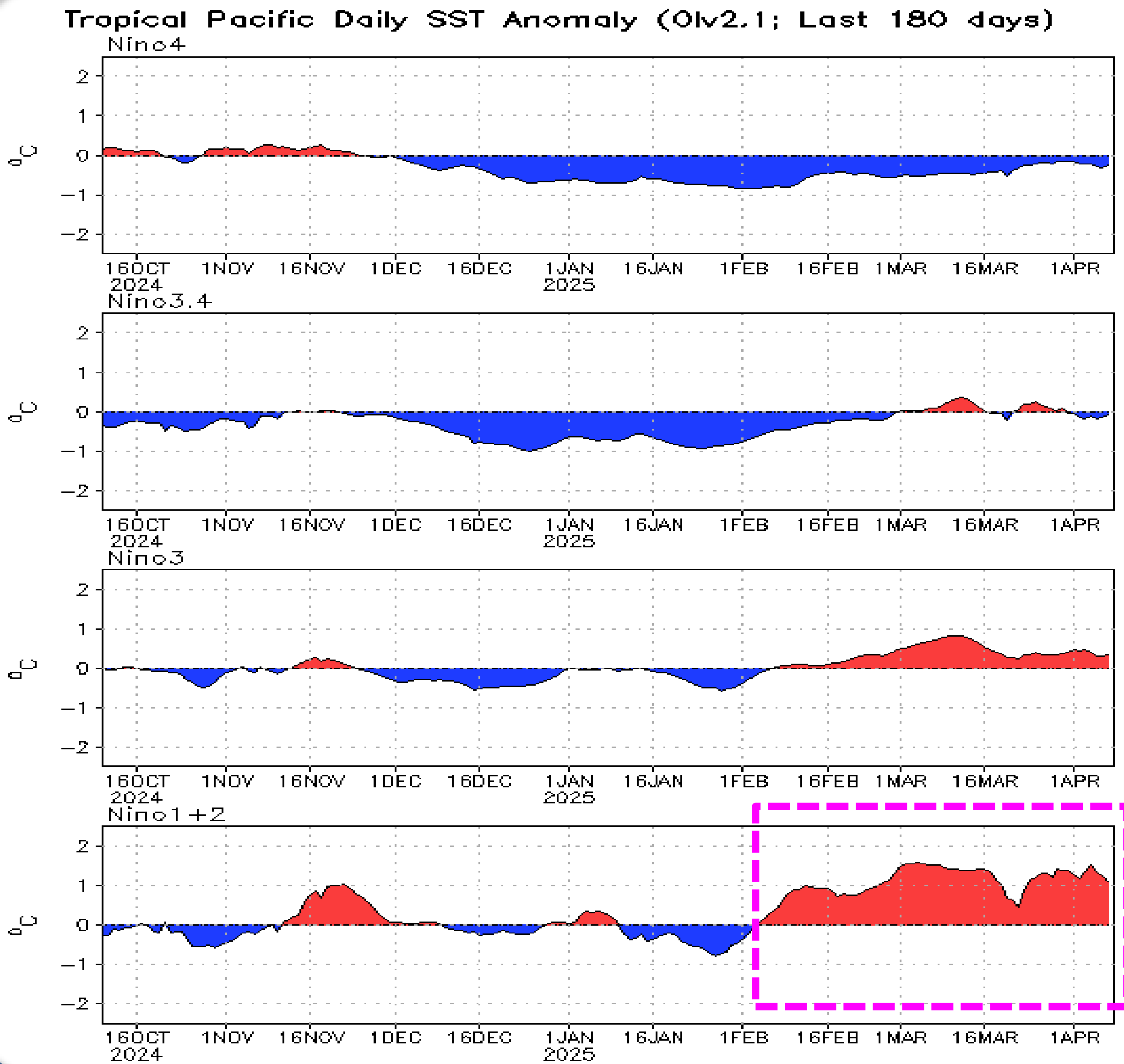
- Niño1+2 became positive with value of 0.69°C and 1.15°C in Feb & Mar 2025, respectively.

- Compared with Mar 2024, the tropical central (eastern) Pacific was cooler (warmer) in Mar 2025.

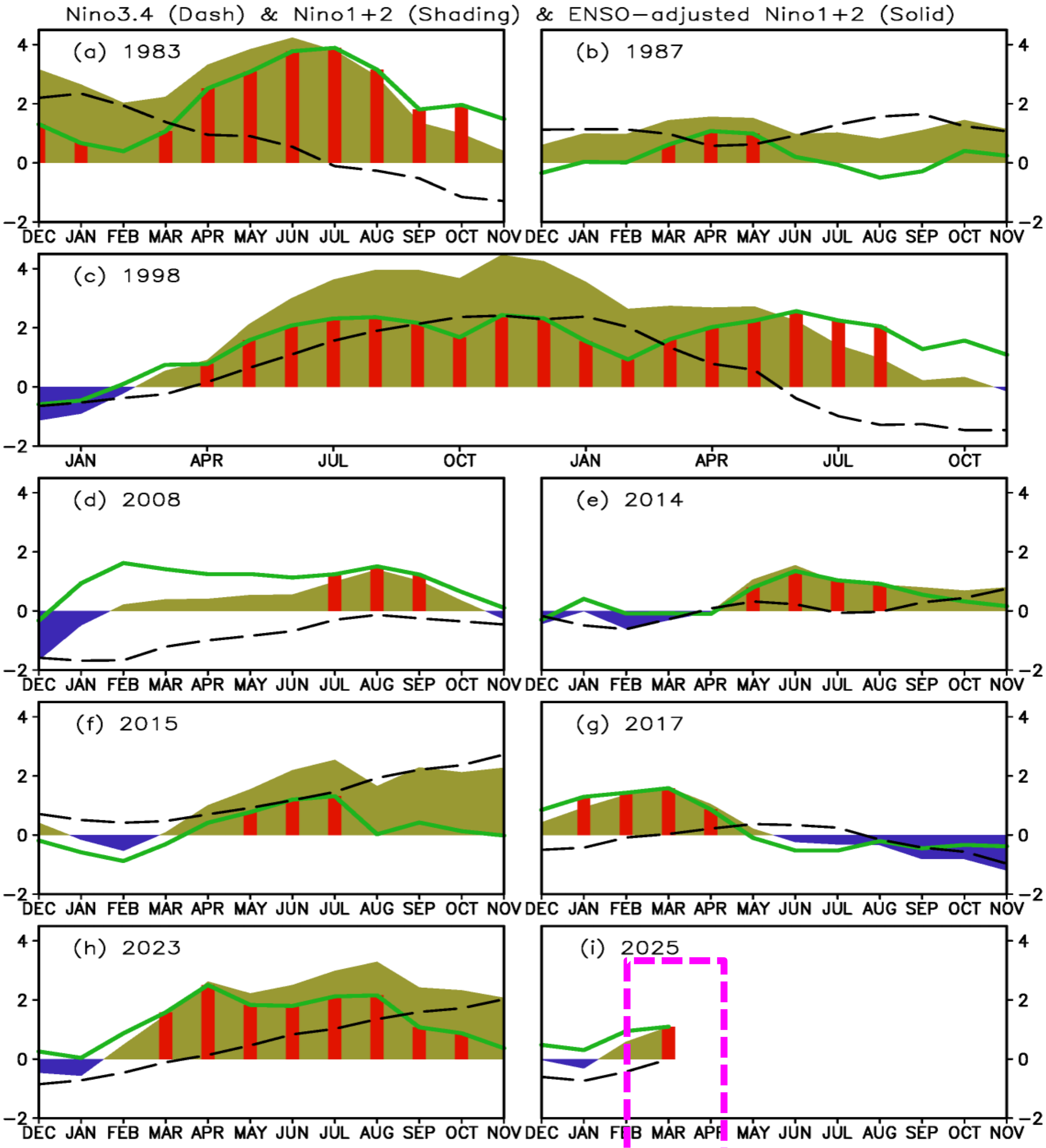
- The values of the indices may have differences if based on different SST products.

Niño region indices, calculated as the area-averaged monthly mean SSTA (°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.

Daily Niño SST Indices: Potential development of a coast El Niño



- Three mechanisms for a coastal El Nino occurrence (Hu et al. 2019; Clim. Dyn. DOI: 10.1007/s00382-018-4290-4):
- Southward shift of ITCZ after an extreme basin-scale El Nino (1983, 1987, & 1998);
- Westerly wind burst, downwelling Kelvin waves, similar to basin-scale El Nino (2014; 2015);
- Westerly wind anomalies and enhancement of the seasonal cycle extend the warm phase of the seasonal cycle (2008 & 2017).



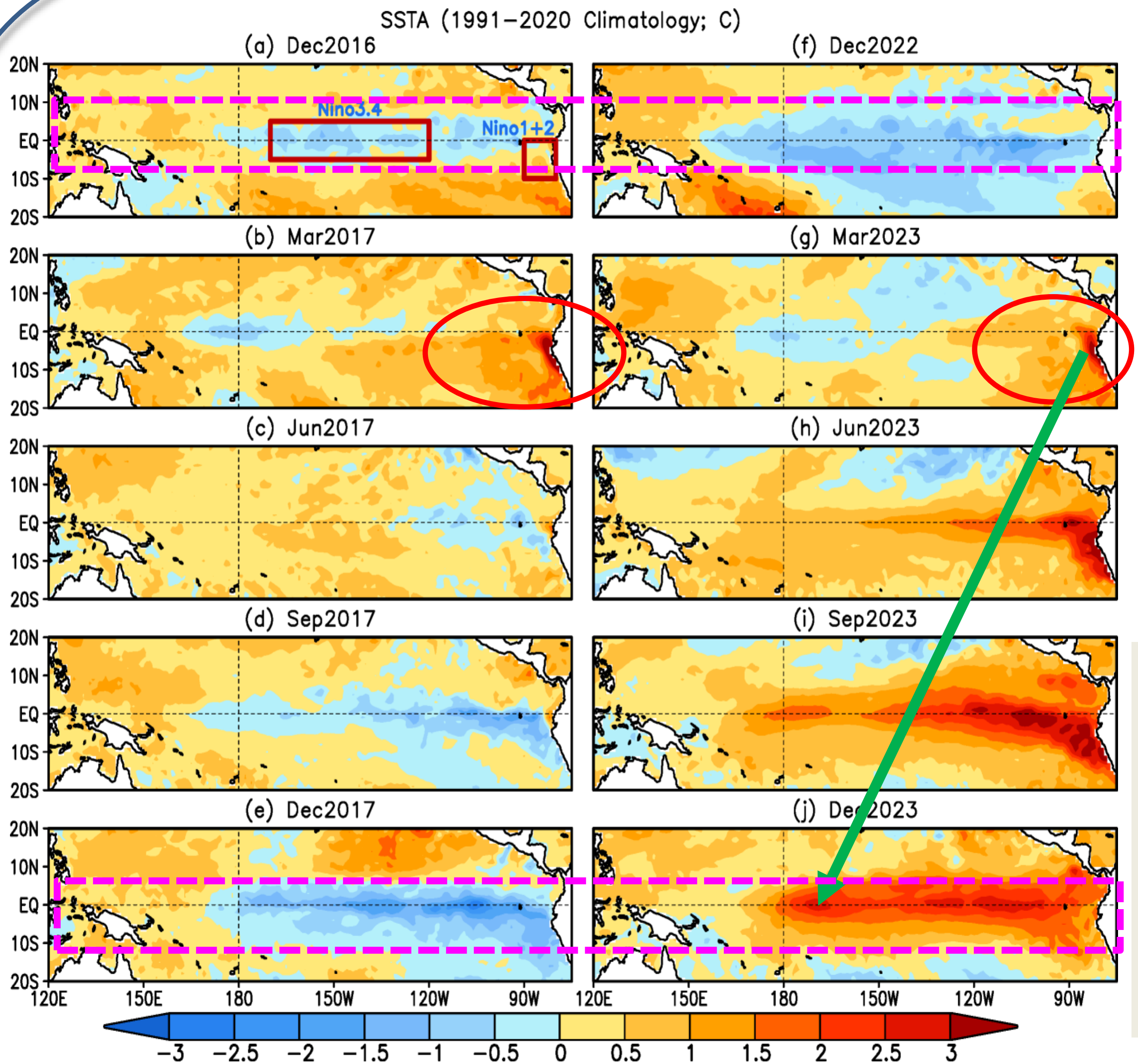
➢ Coast El Niño definition: Both the monthly mean Niño1+2 ≥ one STD (0.8°C) & ENSO-adjusted monthly mean Niño1+2 index ≥ one STD (0.6°C) with anomalies of this magnitude persisting for at least three consecutive overlapping months (Hu et al. 2019 Clim. Dyn.)

➢ 8 Coastal El Nino events since 1982:

1983 (Mar-Oct 1983)
1987 (Mar-May 1987)
1998 (Apr 1997-Aug 1998)
2008 (Jul-Sep 2008)
2014 (May-Aug 2014)
2015 (May-Jul 2015)
2017 (Jan-Apr 2017)

2023 (Mar-Oct 2023)

➢ Coastal El Nino normally peaks in spring or summer with the durations from 3 months (1987, 2008, 2015) to 17 months (1998).

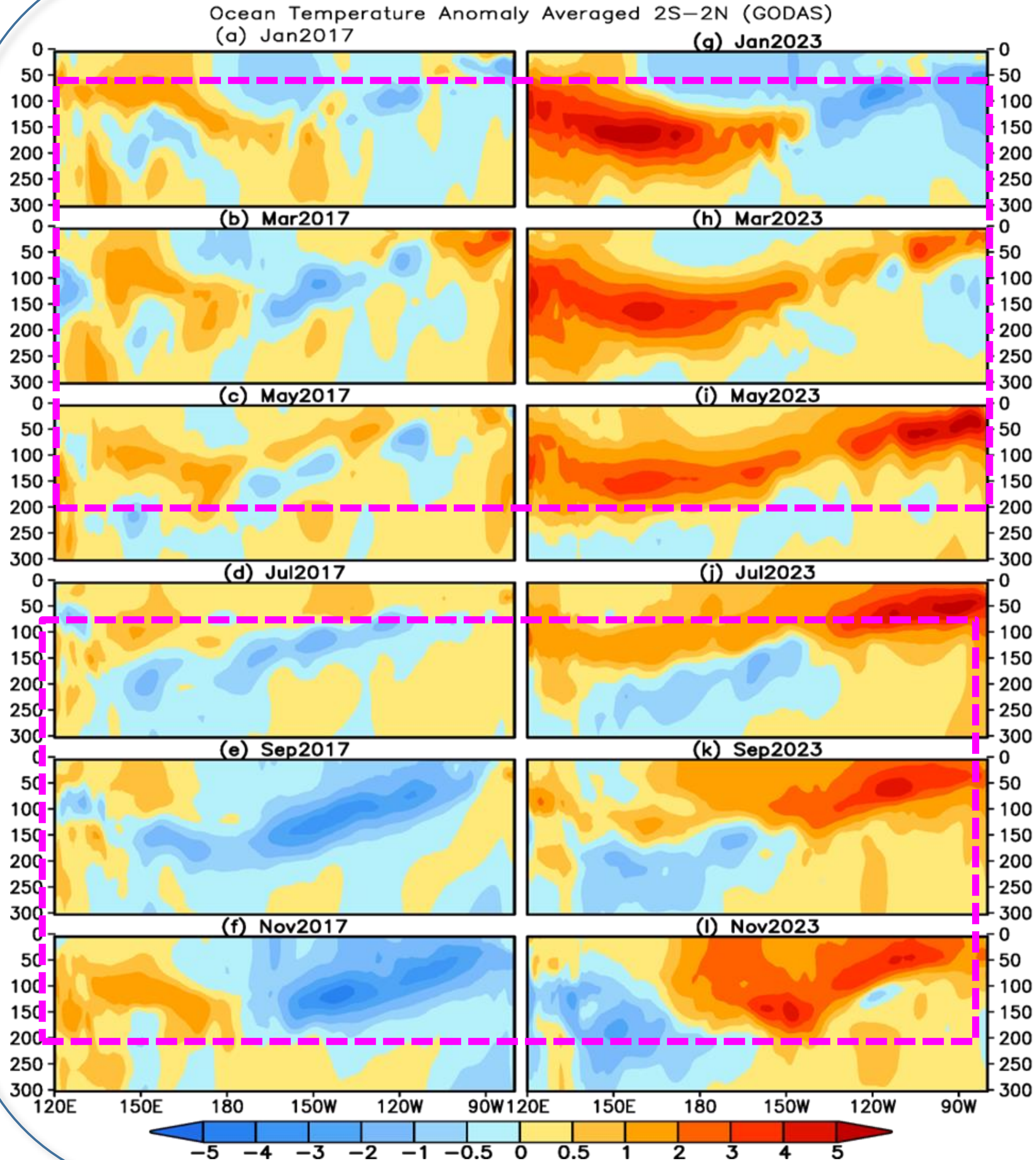


Divergent evolution:

- 2016-17: La Niña, coastal El Niño to La Niña.
- 2022-23: La Niña, coastal El Niño to El Niño.

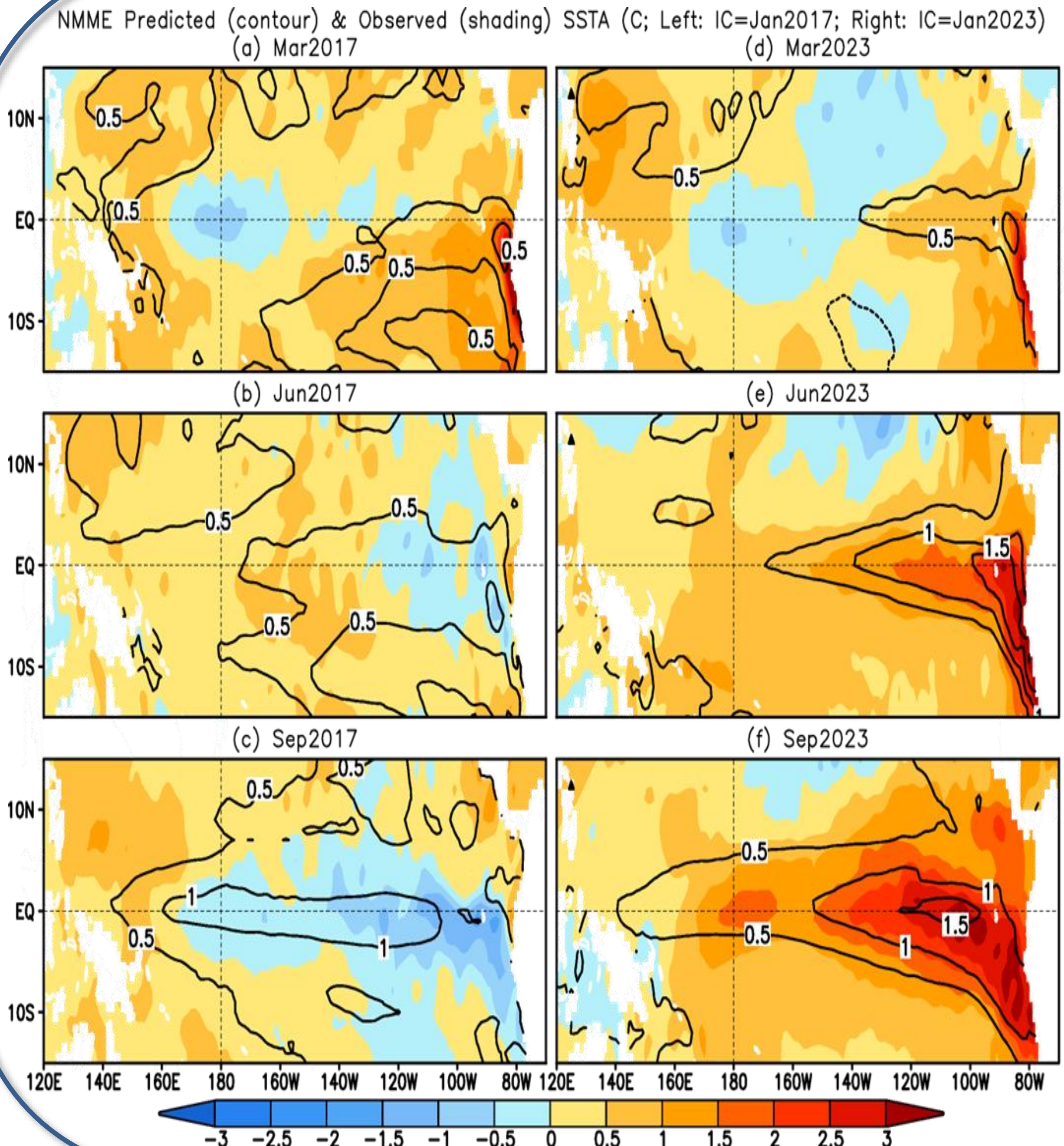
SSTAs in (a) Dec 2016, (b) Mar 2017, (c) Jun 2017, (d) Sep 2017, (e) Dec 2017, (f) Dec 2022, (g) Mar 2023, (h) Jun 2023, (i) Sep 2023, and (j) Dec 2023. The unit is °C. The rectangles in (a) represent the regions for the Niño3.4 and Niño1+2 indices.

Tan, et al., 2024: On the divergent Evolution of ENSO after the Coastal El Niños in 2017 and 2023. Geophys. Res. Lett., 51 (9), DOI: 10.1029/2024GL108198.



➢Subsurface ocean heat conditions are favorable (unfavorable) for a transition to El Niño in 2023 (2017).

GODAS ocean temperature anomalies averaged in 2°S-2°N in (a) Jan 2017, (b) Mar 2017, (c) May 2017, (d) Jul 2017, (e) Sep 2017, (f) Nov 2017, (g) Jan 2023, (h) Mar 2023, (i) May 2023, (j) Jul 2023, (k) Sep 2023, and (l) Nov 2023. The unit is °C.

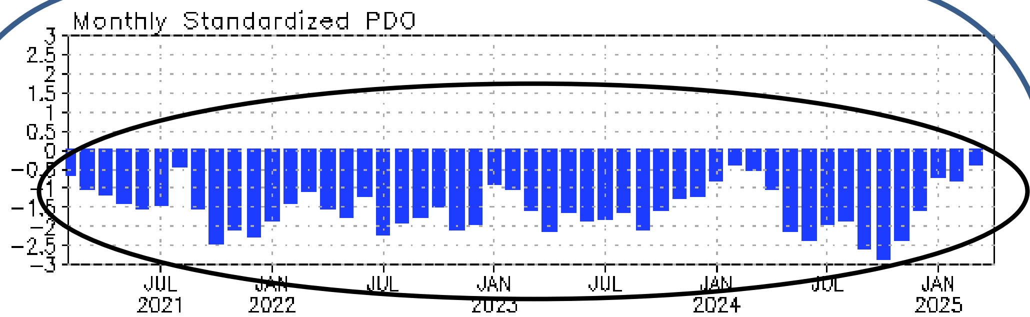


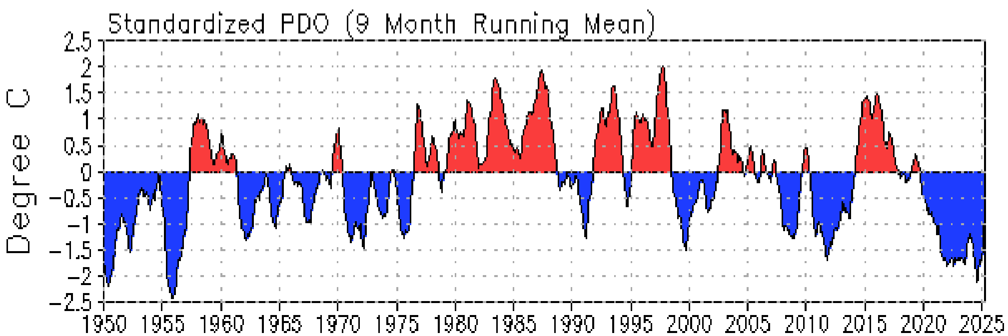
- The transition to La Niña in 2017 was not well predicted.
- The transition to El Niño in 2023 was well predicted, implying the importance of subsurface ocean heat conditions in ENSO prediction.

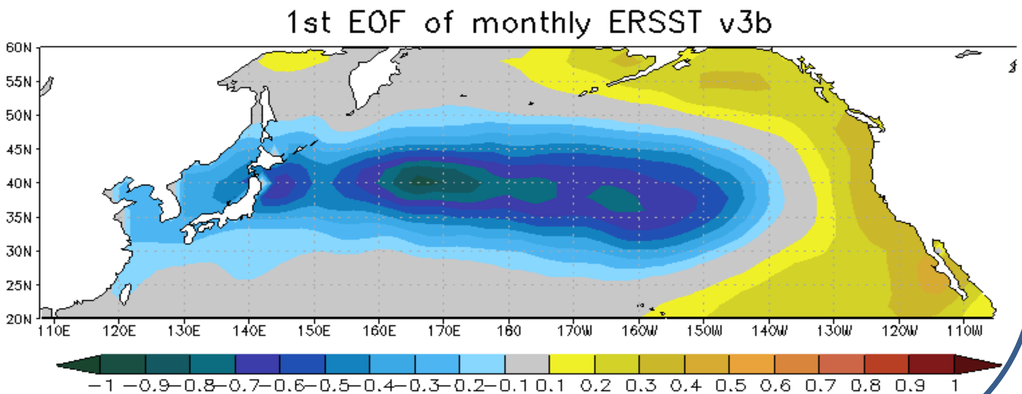
NMME predicted SSTAs (contours with interval of 0.5°C) in (a) Mar 2017, (b) Jun 2017, (c) Sep 2017 with initial conditions in Jan 2017, in (d) Mar 2023, (e) Jun 2023, and (f) Sep 2023 with initial conditions in Jan 2023. Shading represents the corresponding observations.

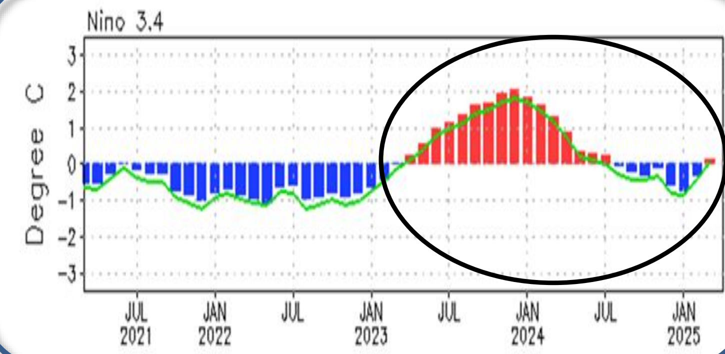
North Pacific, Arctic, & Antarctic Oceans

Pacific Decadal Oscillation (PDO) Index





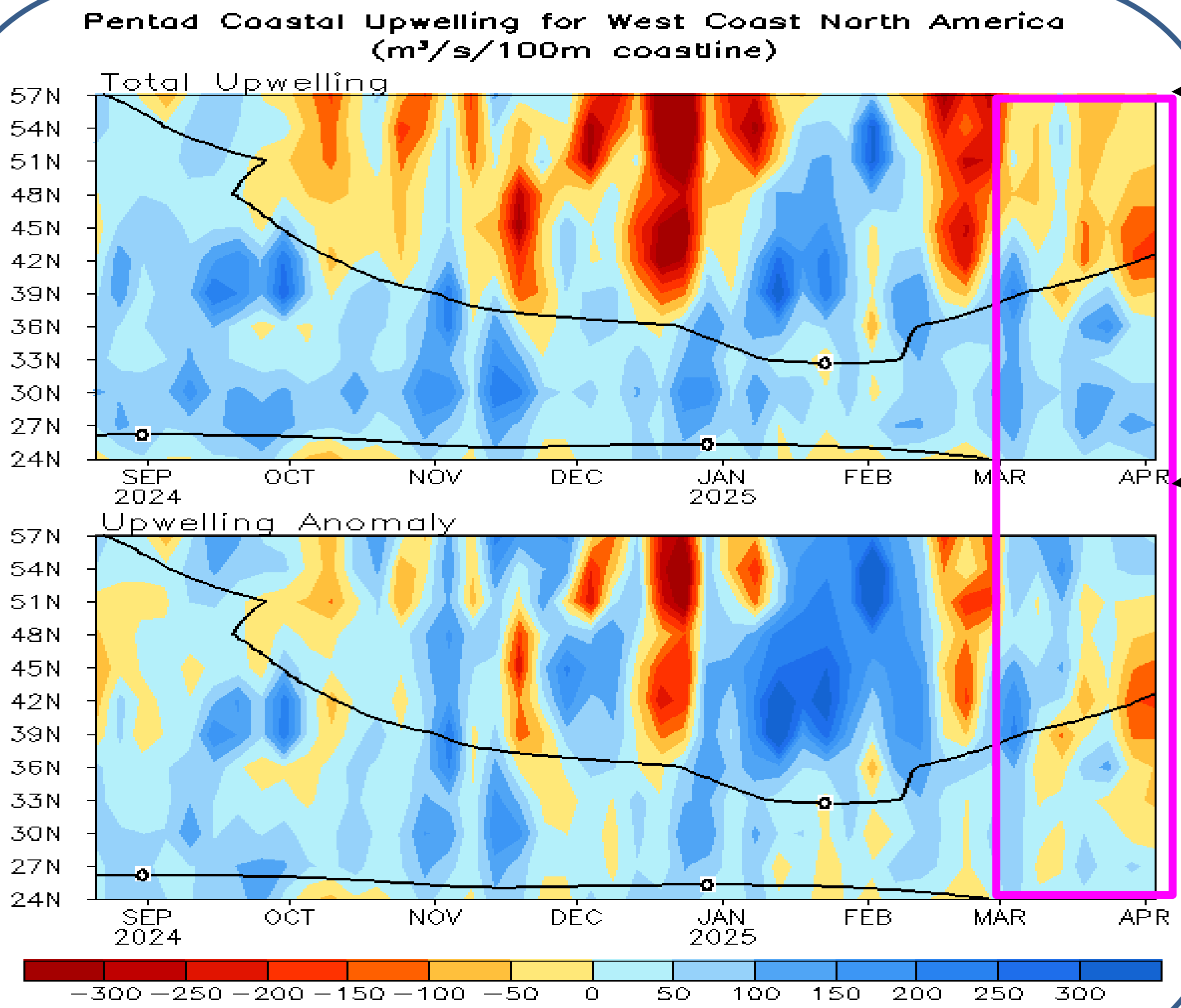


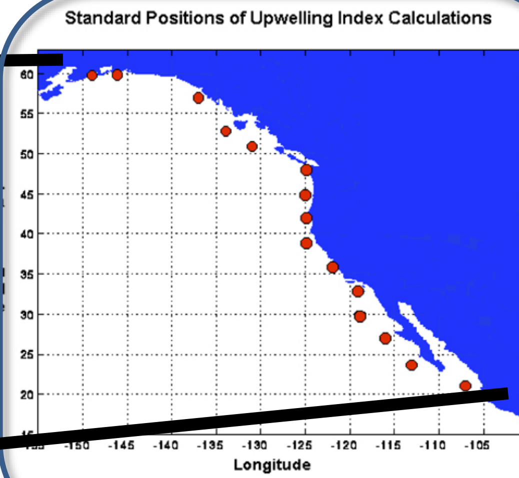


- The PDO has been in a negative phase since Mar 2020 and weakened in Mar 2025 with PDOI = -0.4.
- Simultaneous correlation of PDO & Niño3.4 indices is 0.43 in 1961-1990 and 0.50 in 1991-2020.
- Statistically, ENSO leads PDO by 3-4 months, through teleconnection via atmospheric bridge, with El Niño (La 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

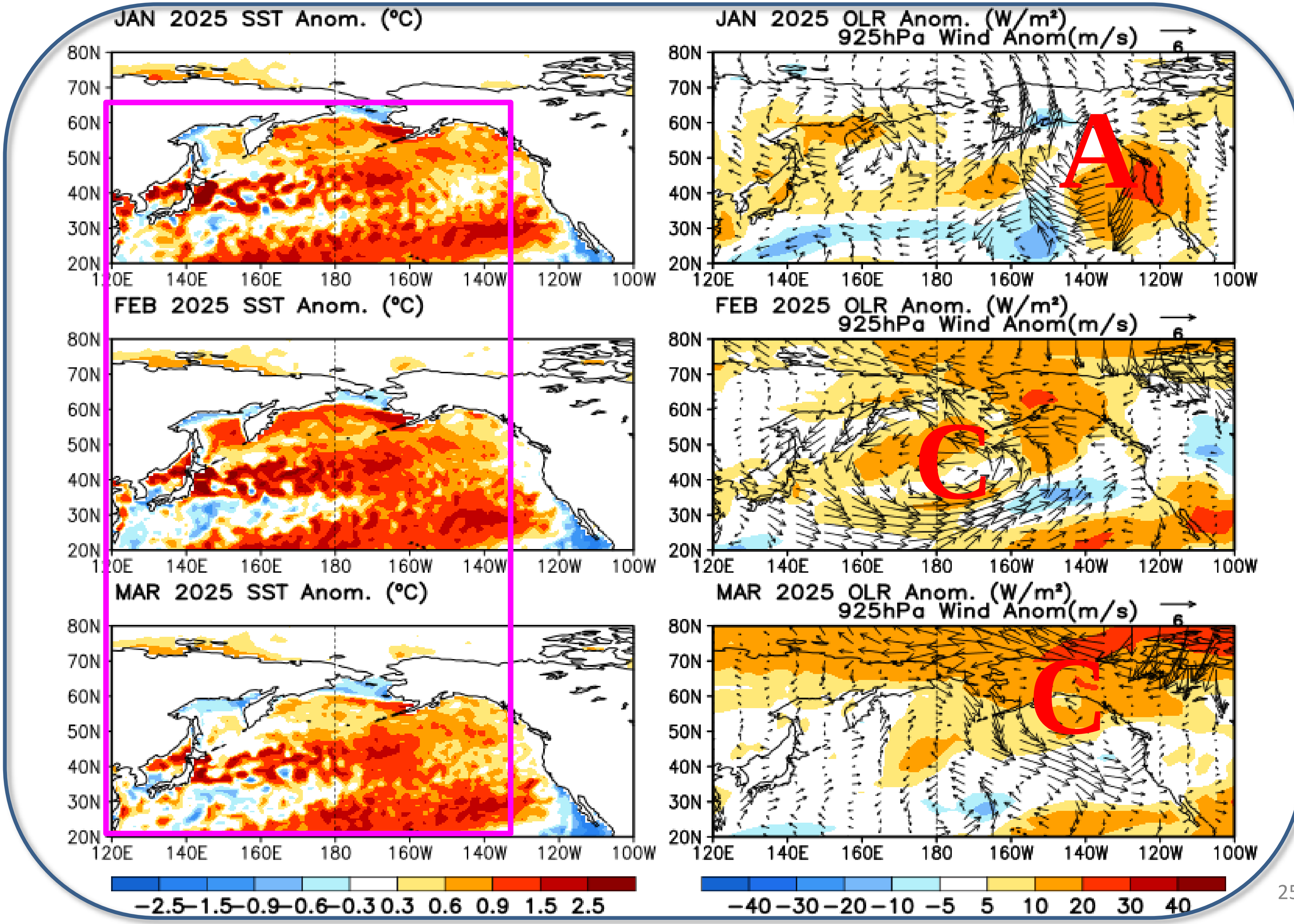




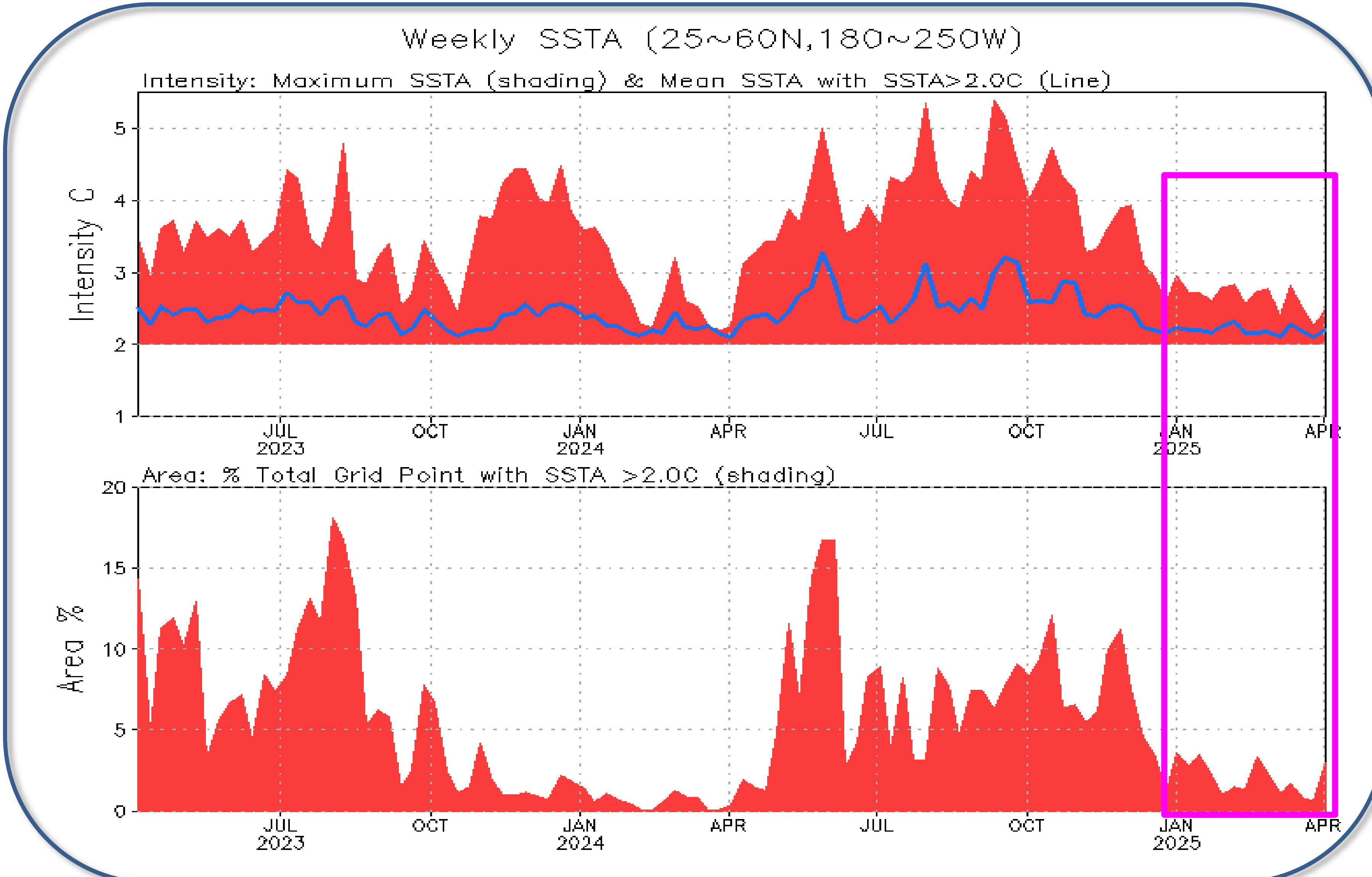
- Both anomalous upwelling and downwelling activity was weak in Mar 2025.

(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 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.

Last 3-month North Pacific SST, OLR, and uv925 anomalies

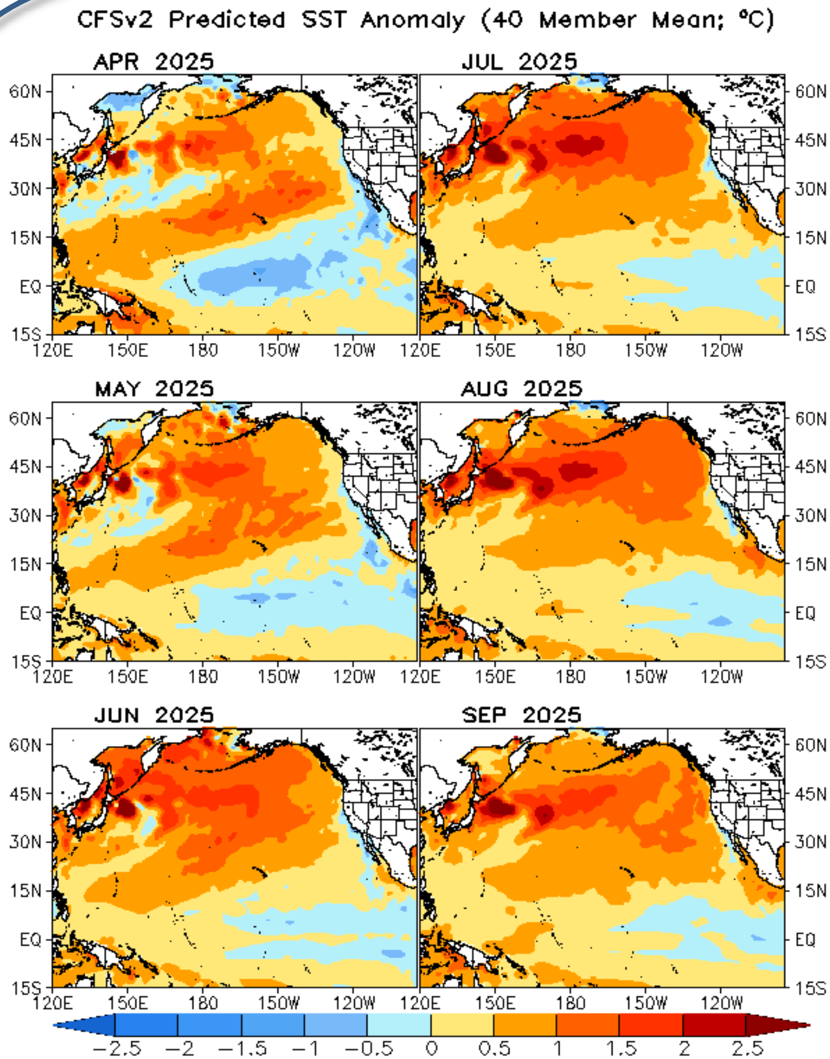


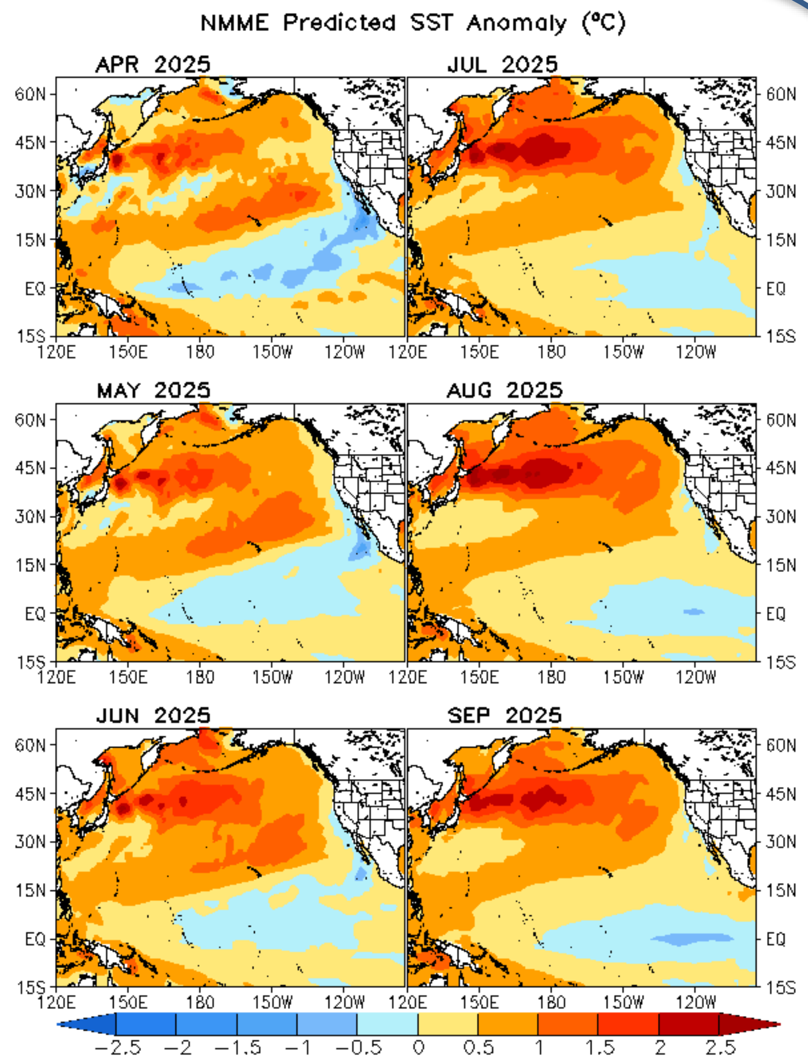
N. Pacific Marine Heat Wave: Weakened since Jan 2025



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

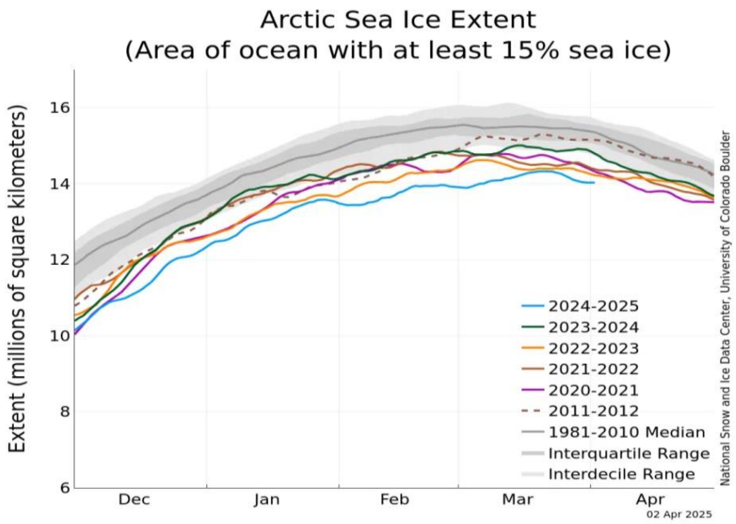
CFSv2 & NMME N. Pacific SST Anomaly Predictions

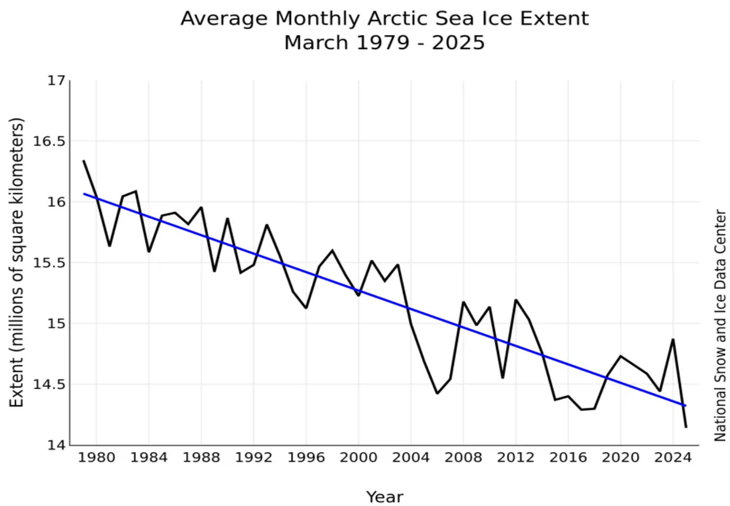


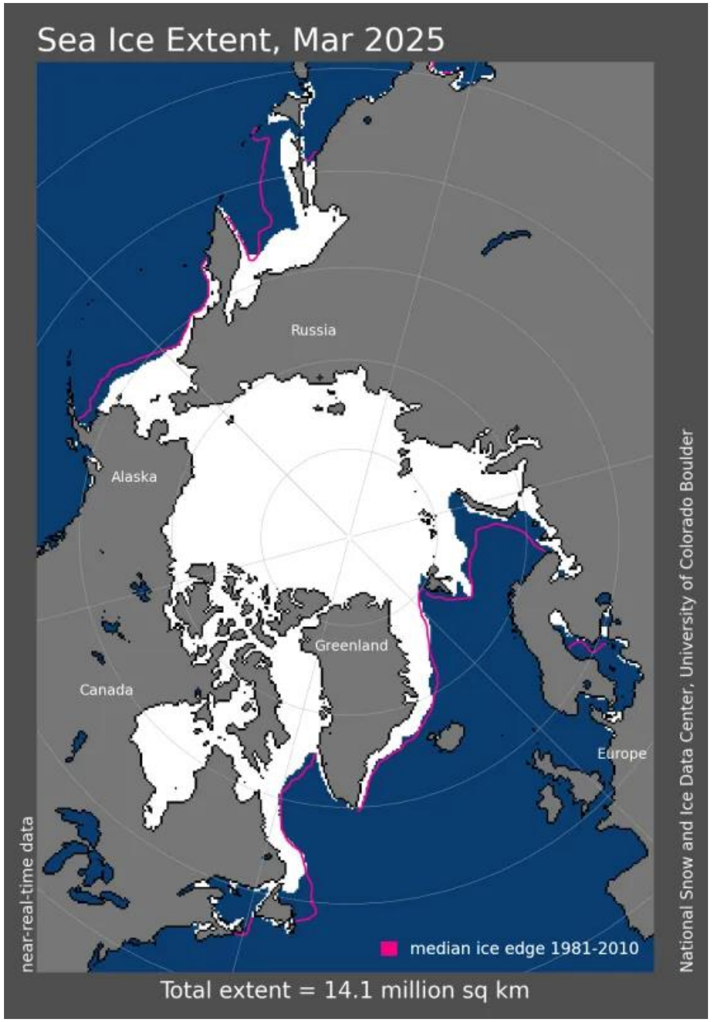


- CFSv2 & NMME predict that the current warm condition in the North Pacific will persist through fall 2025.

Arctic Sea Ice; NSIDC (https://nsidc.org/arcticseaicenews/)

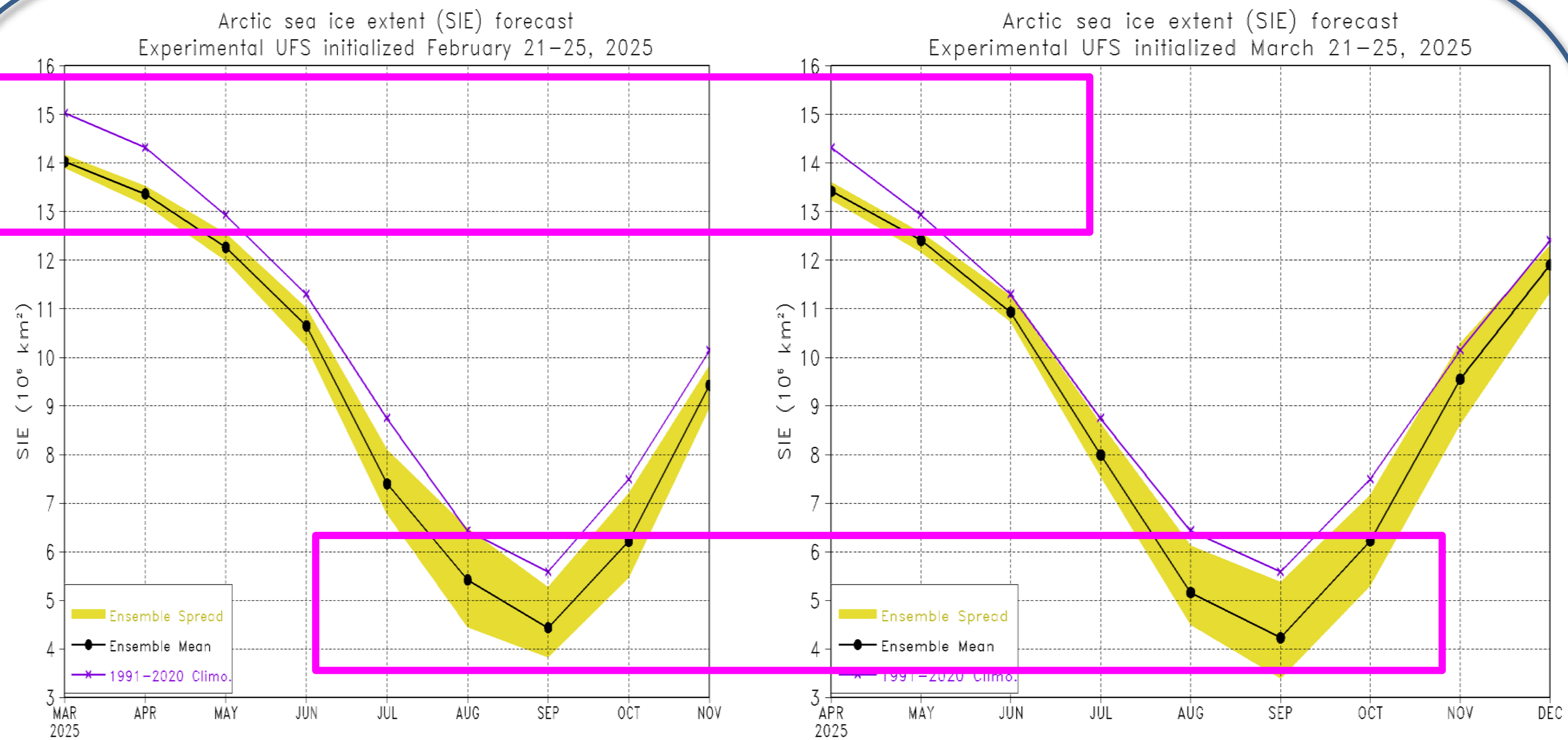






- The average Mar 2025 Arctic sea ice extent was 14.14 million km^2, the lowest March extent in the 47-year record.
- Including 2025, the downward linear trend for March is 2.5% per decade relative to the 1981 to 2010 average.
- Since 1979, sea ice extent in March has lost 1.71 million km^2, which is equivalent to the size of Alaska.

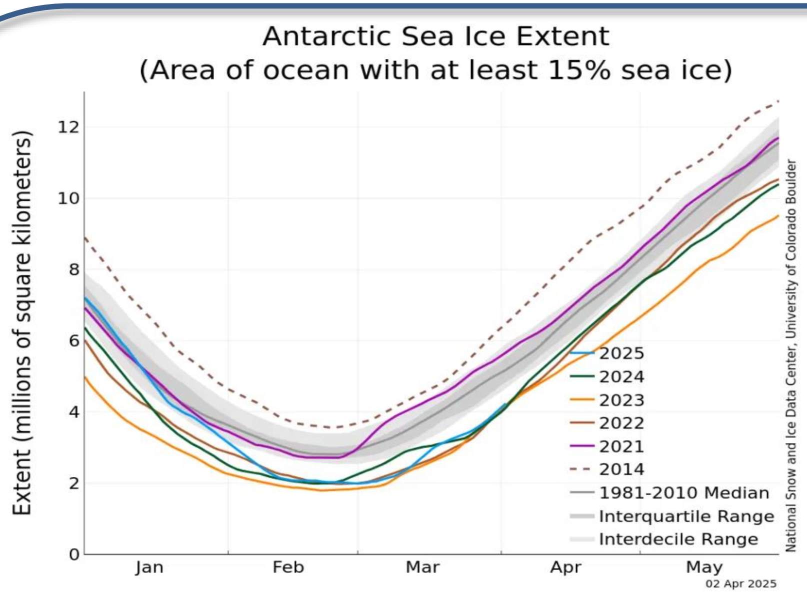
NCEP/CPC Arctic Sea Ice Extent (SIE) Forecast

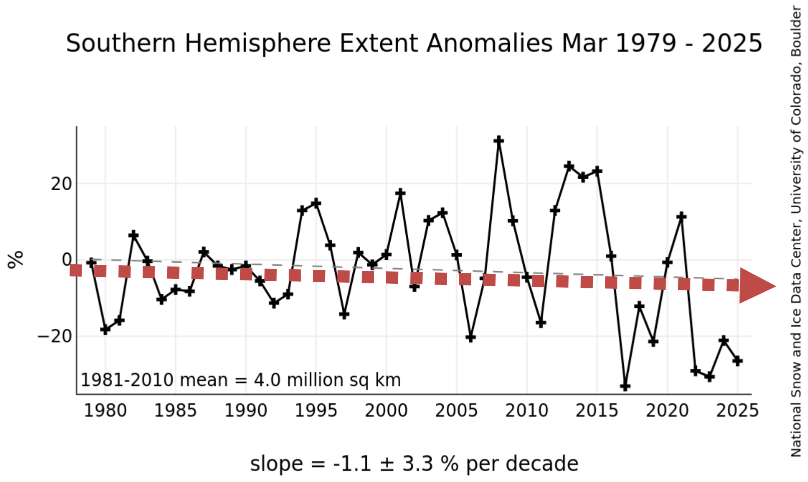


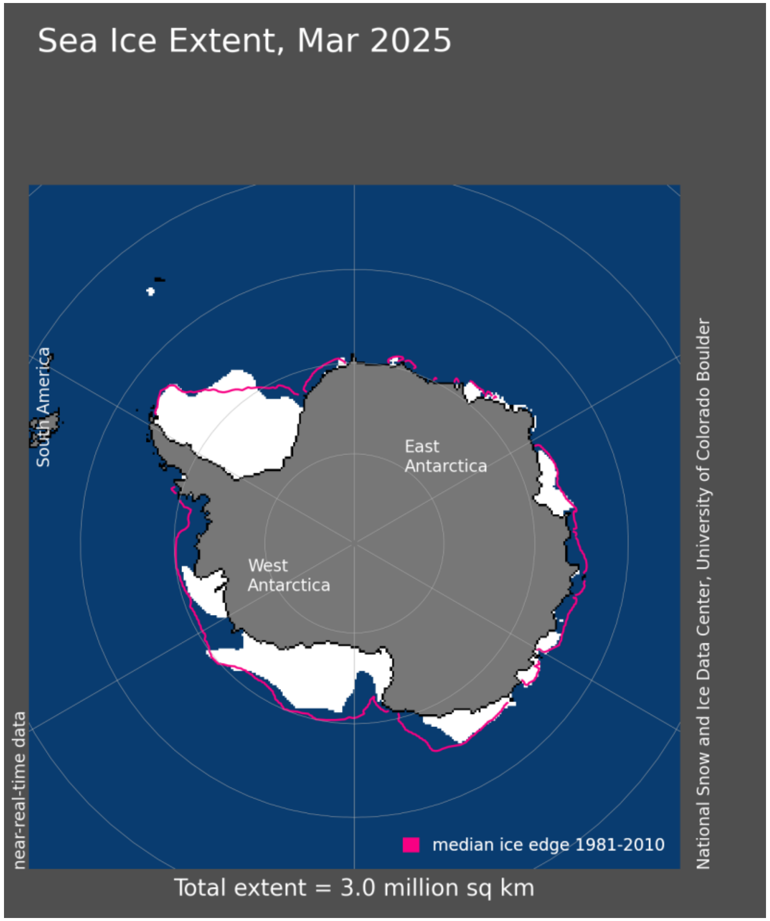
https://www.cpc.ncep.noaa.gov/products/people/jszhu/seaice_seasonal/index.html

- CPC model-based forecasts call for a below-normal Arctic sea ice extent through end of 2025.

Antarctic Sea Ice; NSIDC (https://nsidc.org/arcticseaicenews/)



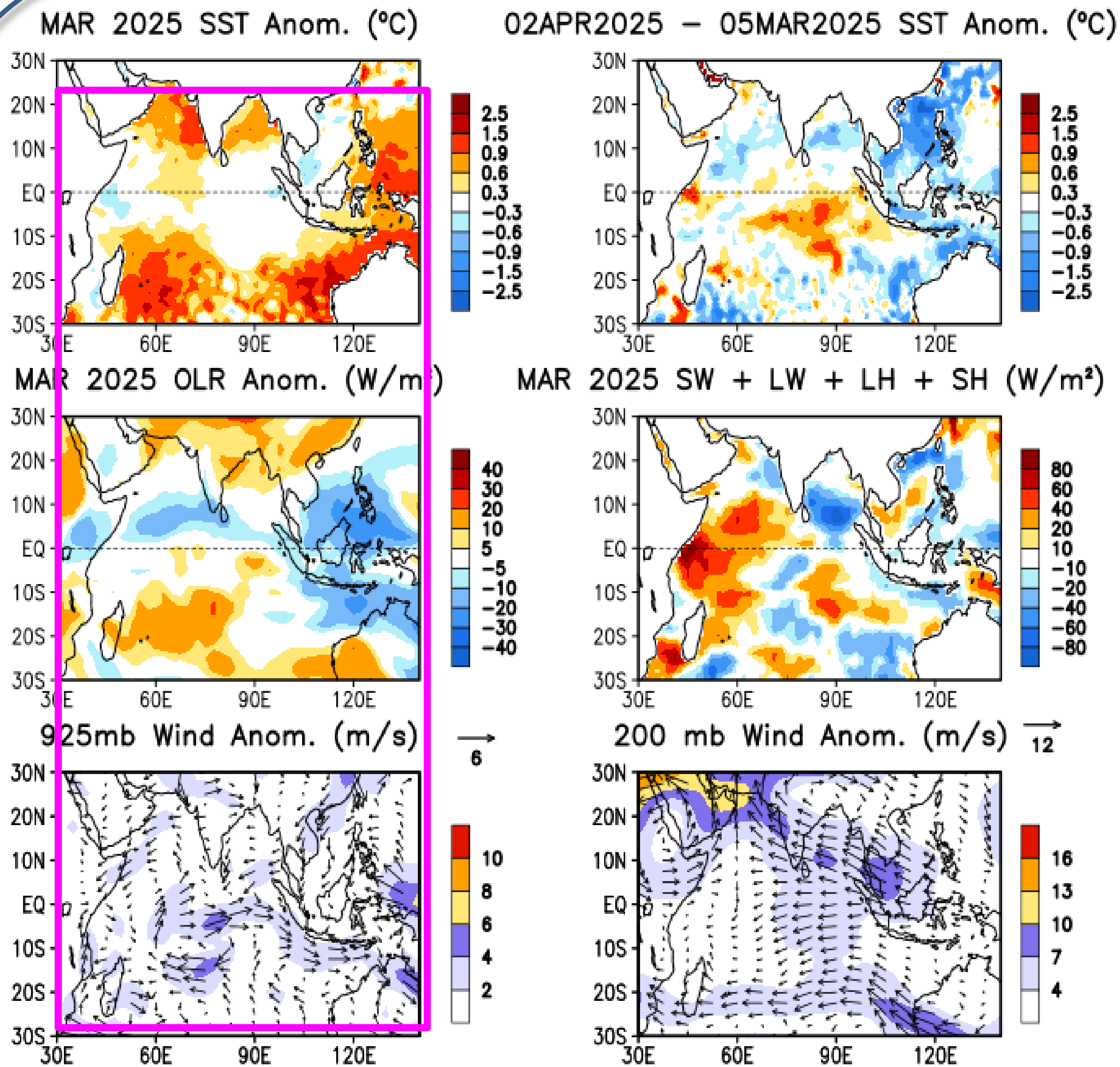




- Antarctic sea ice extent was 3.0 million km^2 in Mar 2025, ranking 4th lowest March record.

Indian Ocean

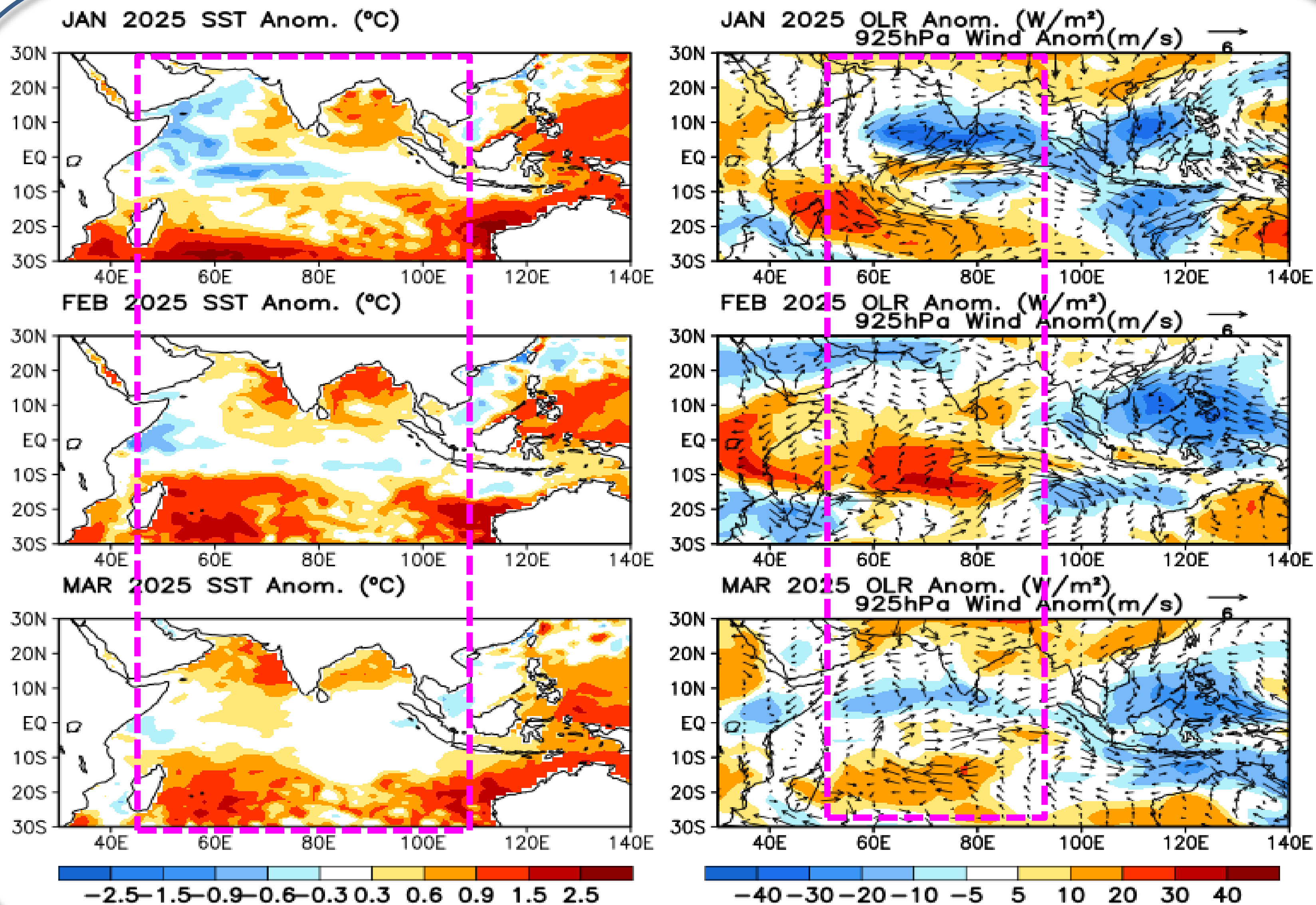
Tropical Indian: SSTA, SSTA Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Wind Anom.



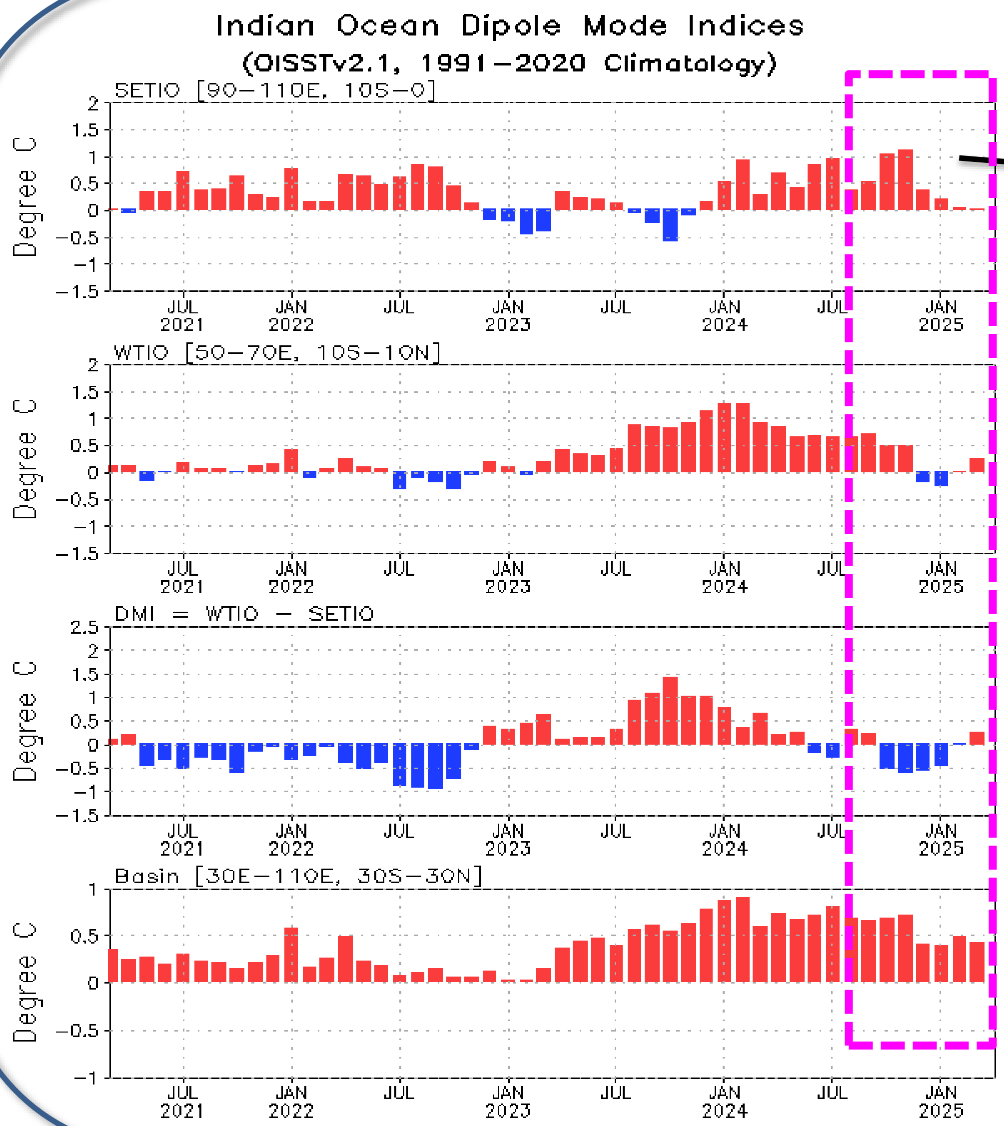
- SSTs were near average in the equatorial Indian Ocean in Mar 2025.

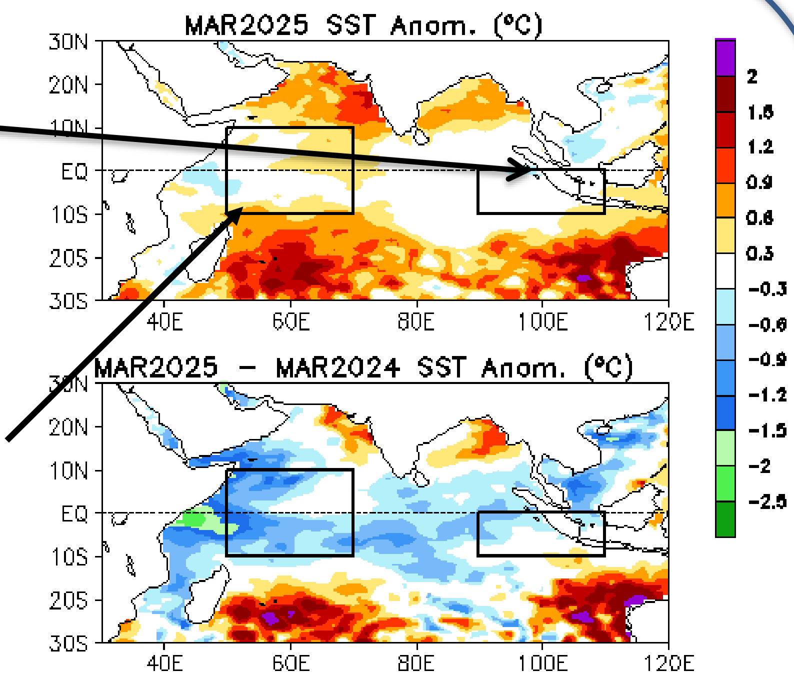
Last 3-month Tropical Indian Ocean SST, OLR, and uv925 Anomalies:

Westerly wind anomalies and dipole-like pattern weakened in Feb & Mar 2025



Evolution of Indian Ocean SST Indices



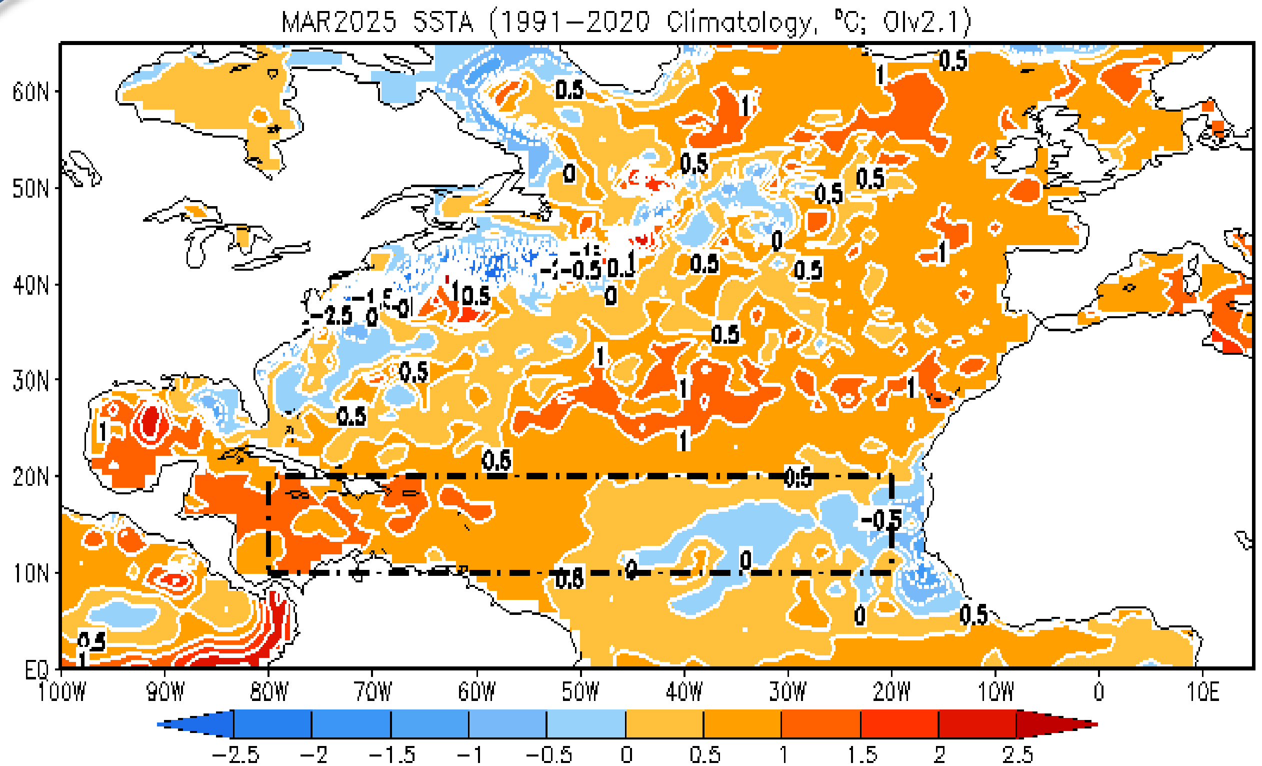


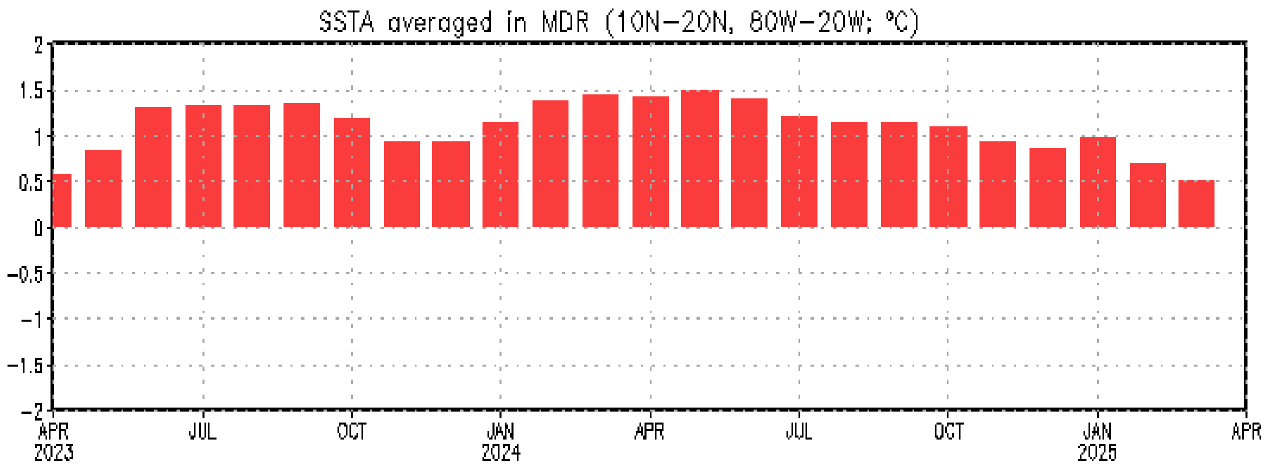
- The IOD & WTIO indices were positive in Mar 2025.
- Basin-wide warming featured a positive phase of the IOBM.

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

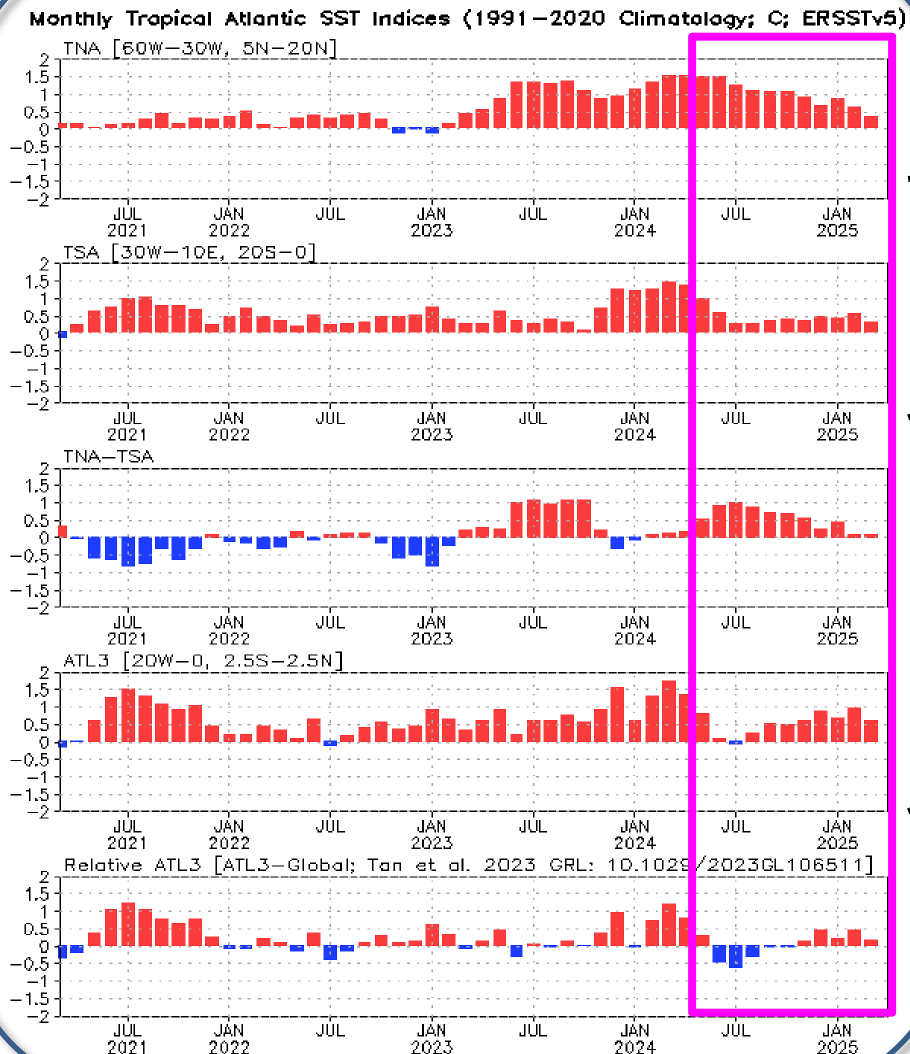
SSTA in the North Atlantic & MDR

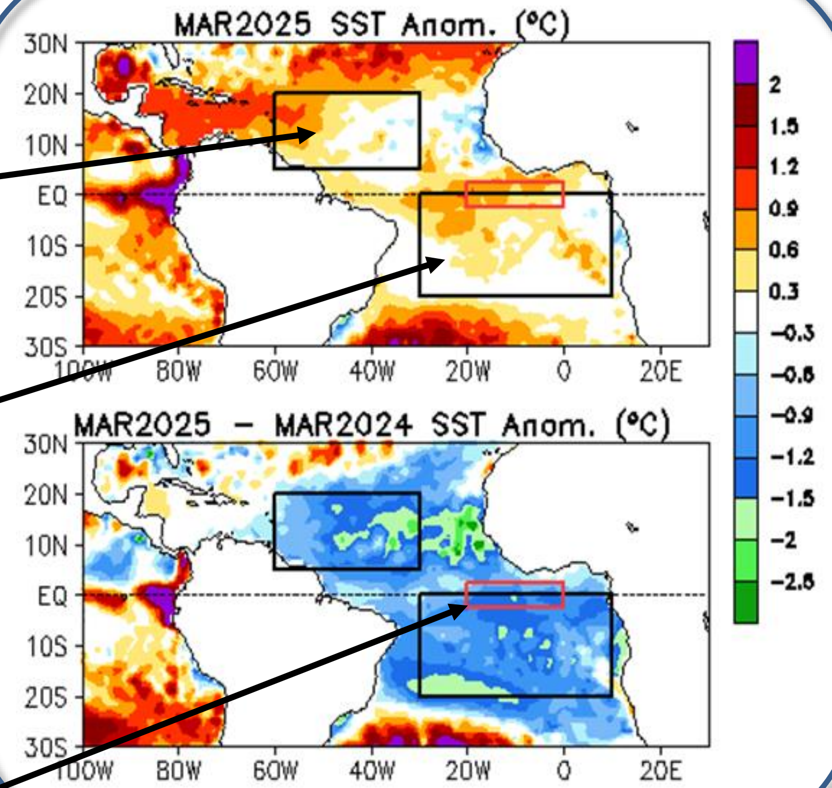




- Above-average SSTs dominated in the tropical and North Atlantic in Mar 2025.
- SSTs in the hurricane main development region (MDR) were above average during the last few years.

Evolution of Tropical Atlantic SST Indices

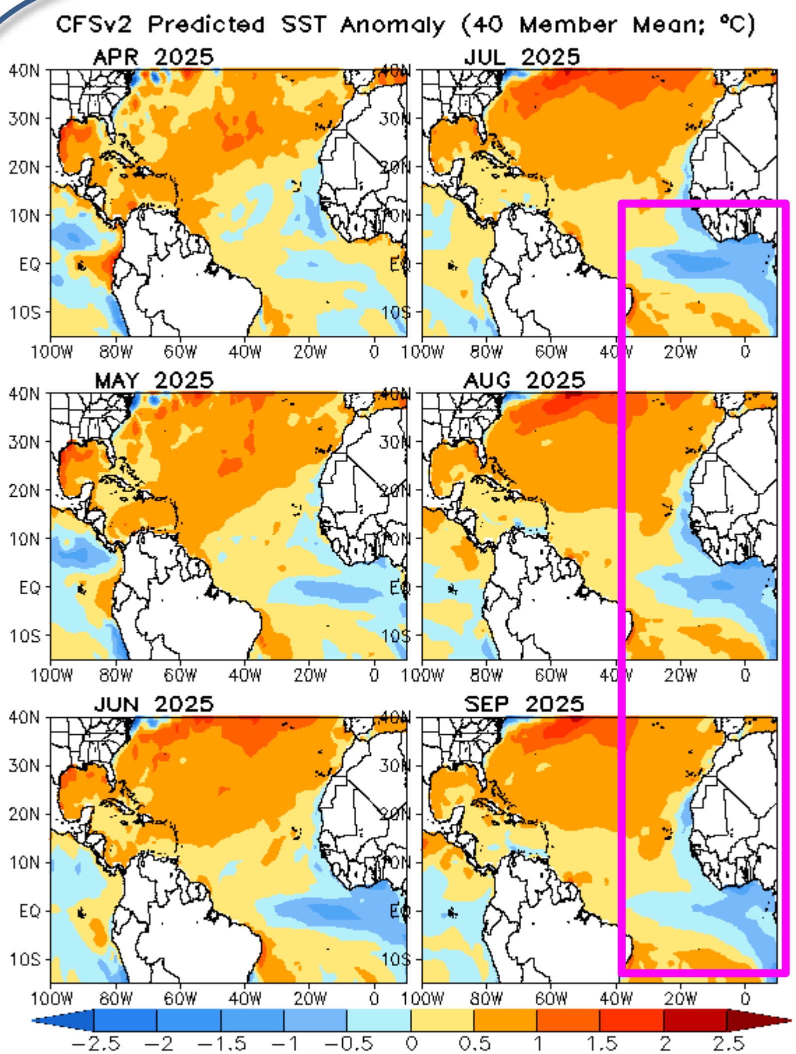


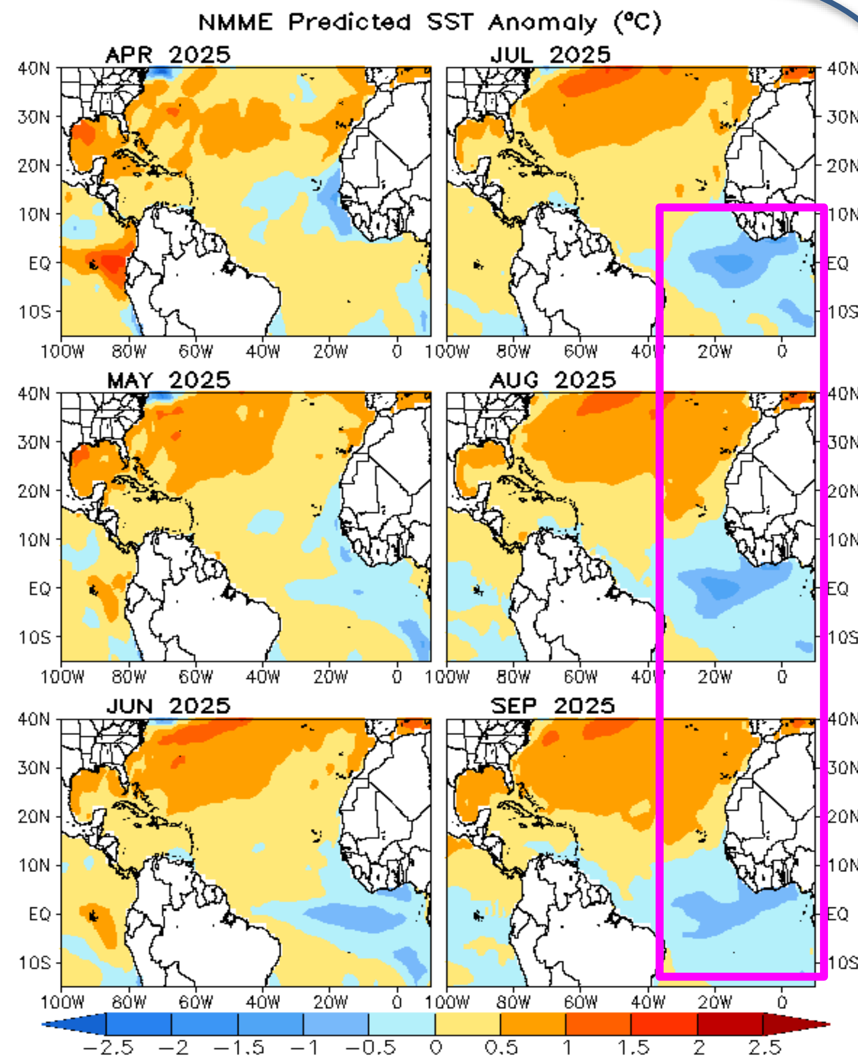


- Positive SSTA weakened in the tropical N. & S. Atlantic in Mar 2025.
- The relative ATL3 index (ATL3-Global; Tan et al. 2023, GRL DOI: 10.1029/2023GL106511) has been positive since Nov 2024.

Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean SSTA (^{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.

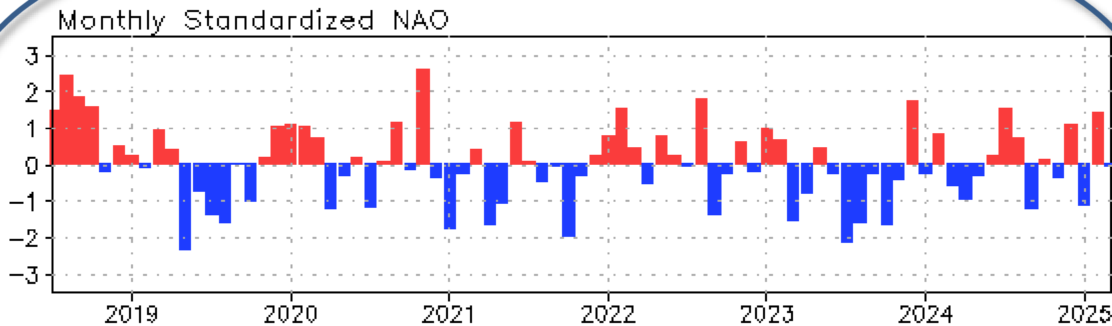
CFSv2 & NMME Atlantic SST Anomaly Predictions

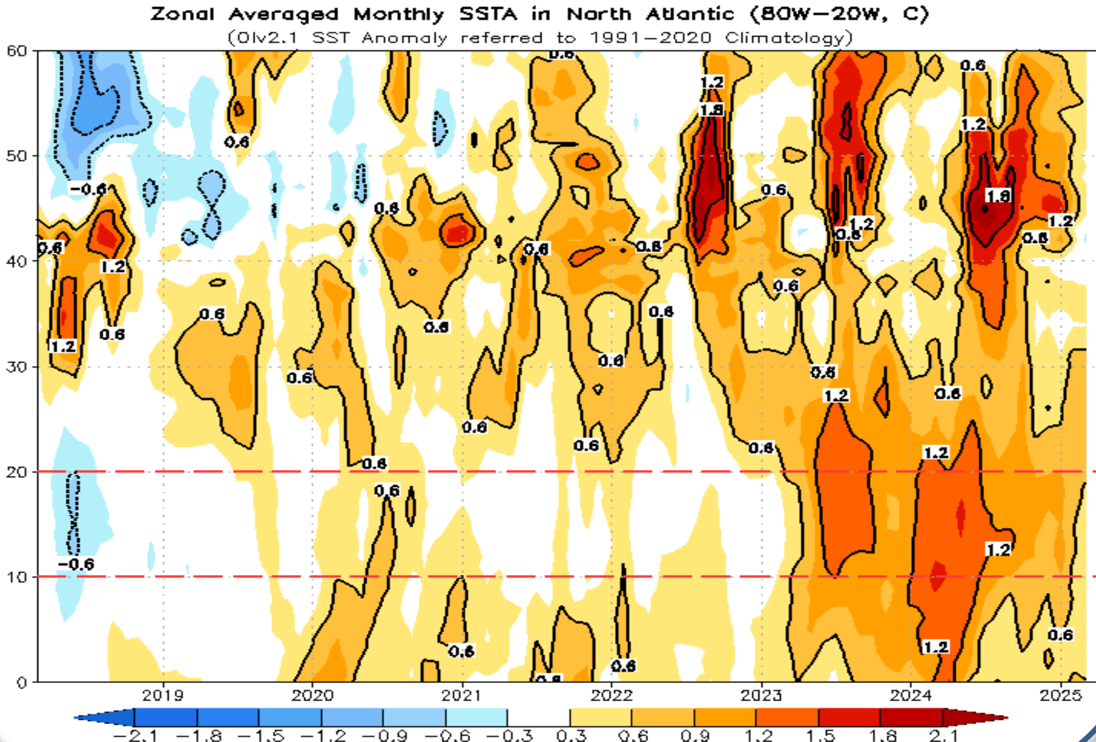


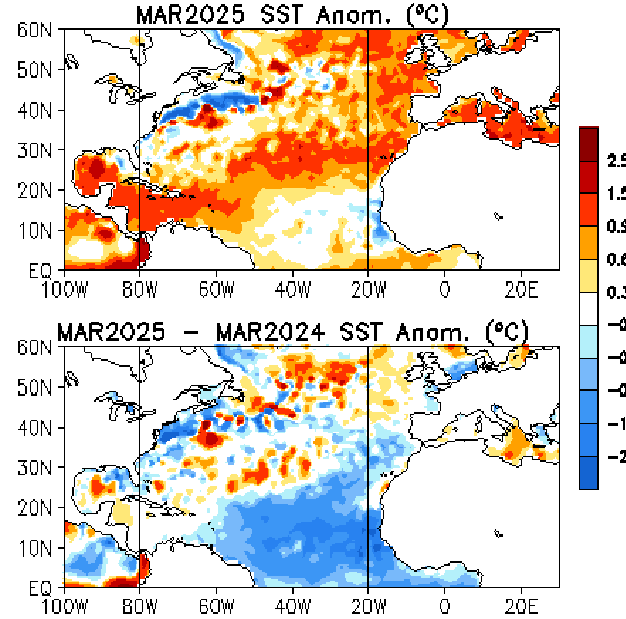


- CFSv2 predictions call for an Atlantic Niña during June-September 2025, while NMME predicts Atlantic Niña-like conditions.

NAO and SST Anomaly in North Atlantic





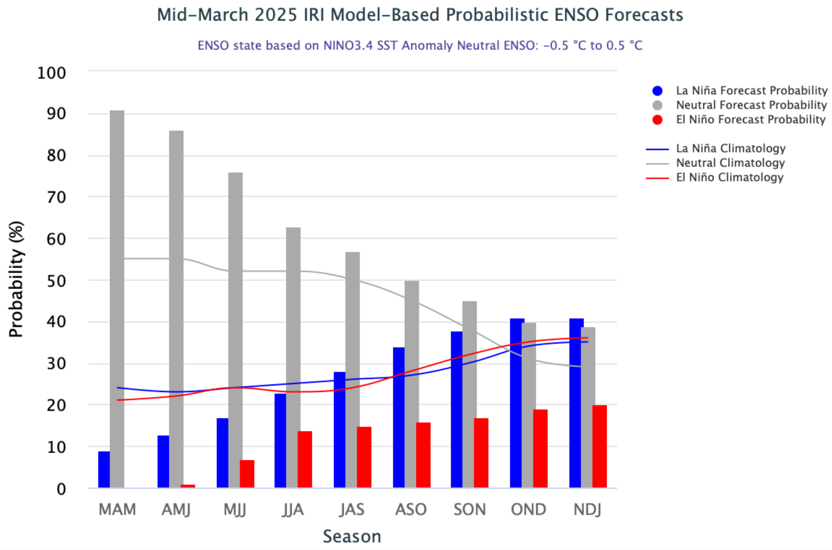


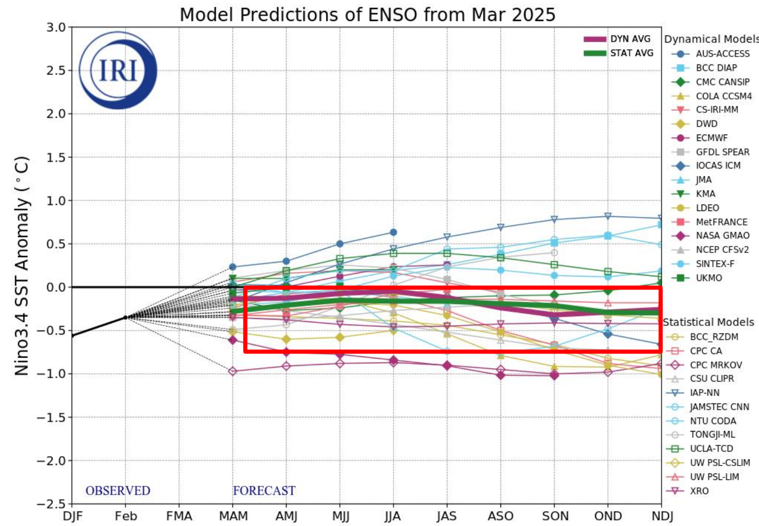
- NAOI =-0.1 in Mar 2025.
- The prolonged positive SSTA in the middle and high latitudes were evident during the last 5-6 years.

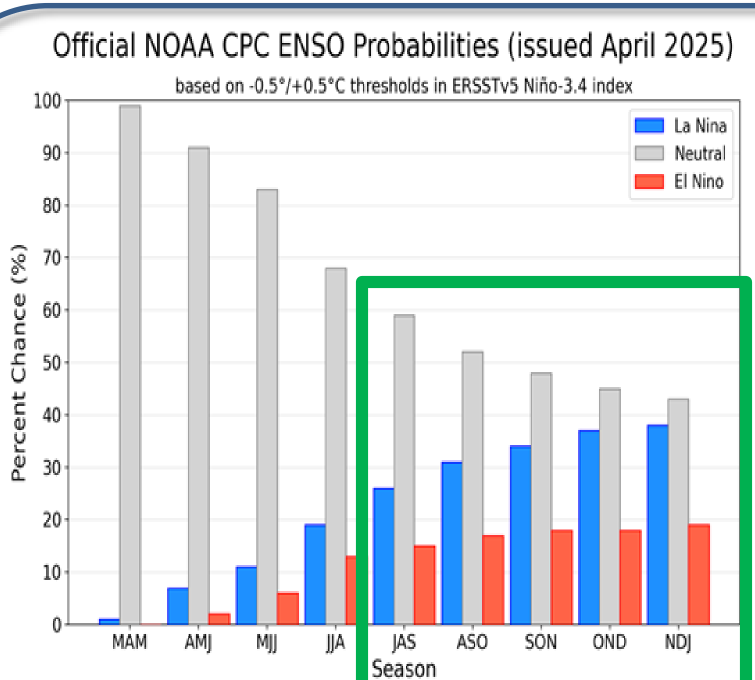
Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20ºN-90ºN. Time-latitude section of SSTA averaged between 80ºW and 20ºW (bottom). SST are derived from the OIv2.1 SST analysis, and anomalies are departures from the 1991-2020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

ENSO and Global SST Predictions

CPC & IRI Niño3.4 Forecast





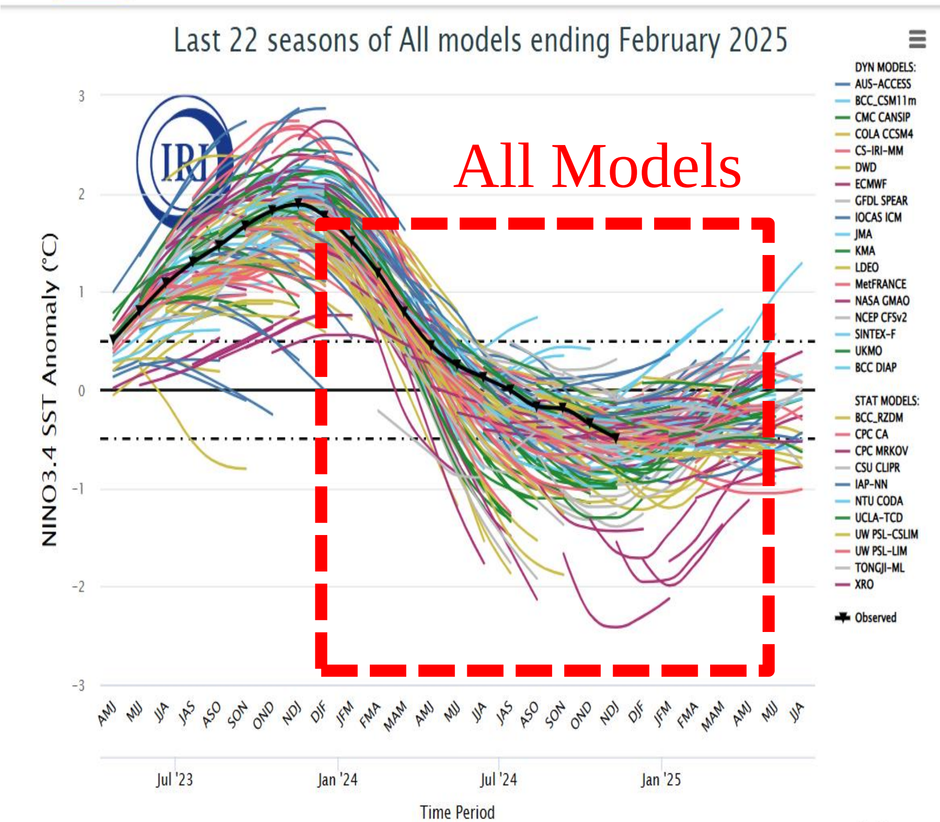


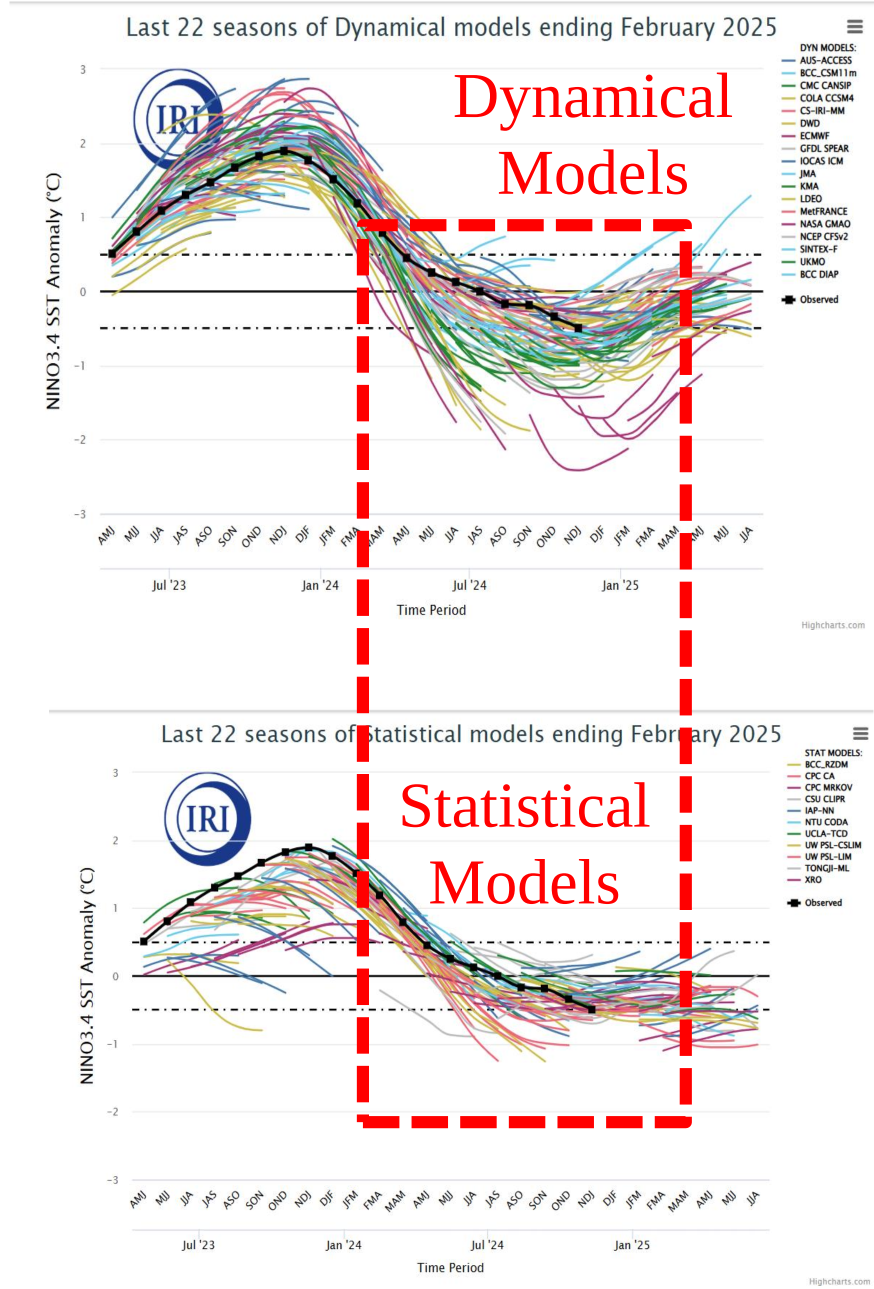
- Niño3.4 will be slightly below normal in the both dynamical and statistical model averages in 2025.

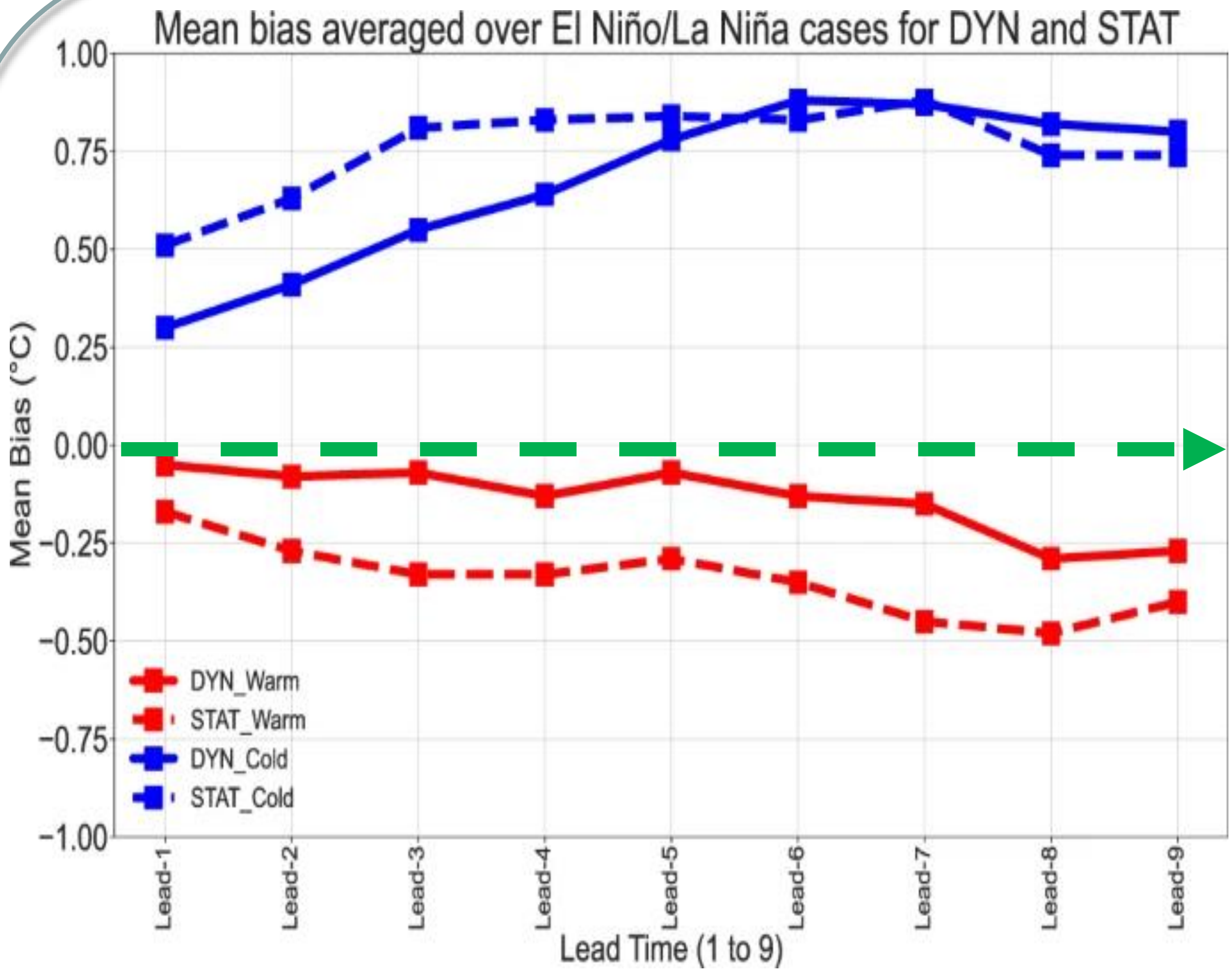
- **On April 10, 2025, CPC issued: Final La Niña Advisory.**

- <u>Synopsis</u>: "*ENSO-neutral is favored during the Northern Hemisphere summer, with a greater than 50% chance through August-October 2025.*"

- ➤ Majority of climate (dynamical & statistical; IRI) models persistently predicted a La Niña in 2024/25 with ICs in 2024
- ➤ The cold biases are larger in the dynamical models than in the statistical models.



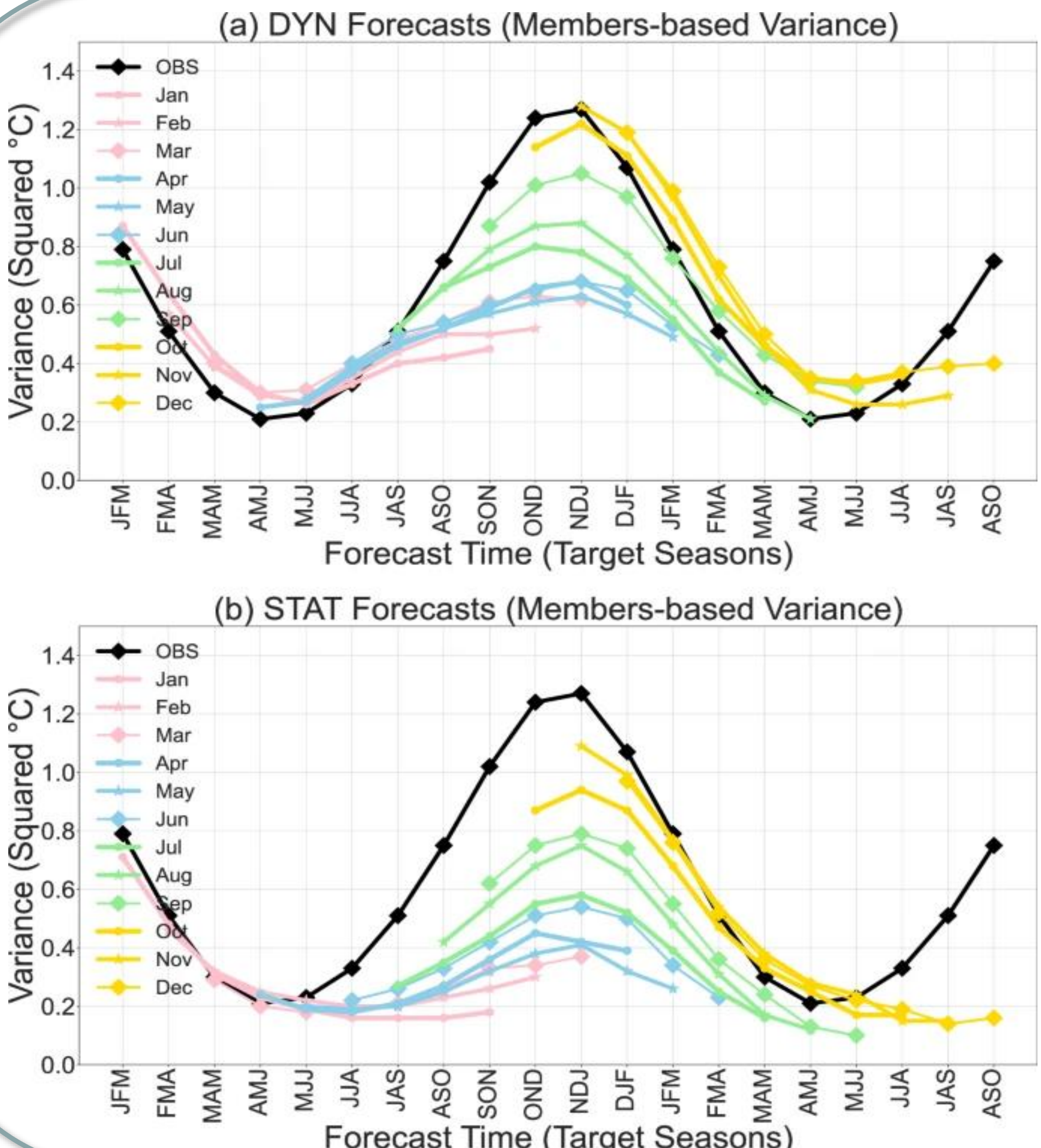




- "The DYN forecasts outperform STAT forecasts with a pronounced advantage in forecasts initiated from late boreal winter through spring."
- IRI ENSO Predictions Plume: 253 real-time forecasts of the Niño 3.4 index issued from Feb 2002 to Feb 2023 with 30 dynamical models (DYN) & 13 statistical models (STAT).

Fig. 6: Mean bias averaged over El Niño and La Niña cases for DYN and STAT real-time forecasts

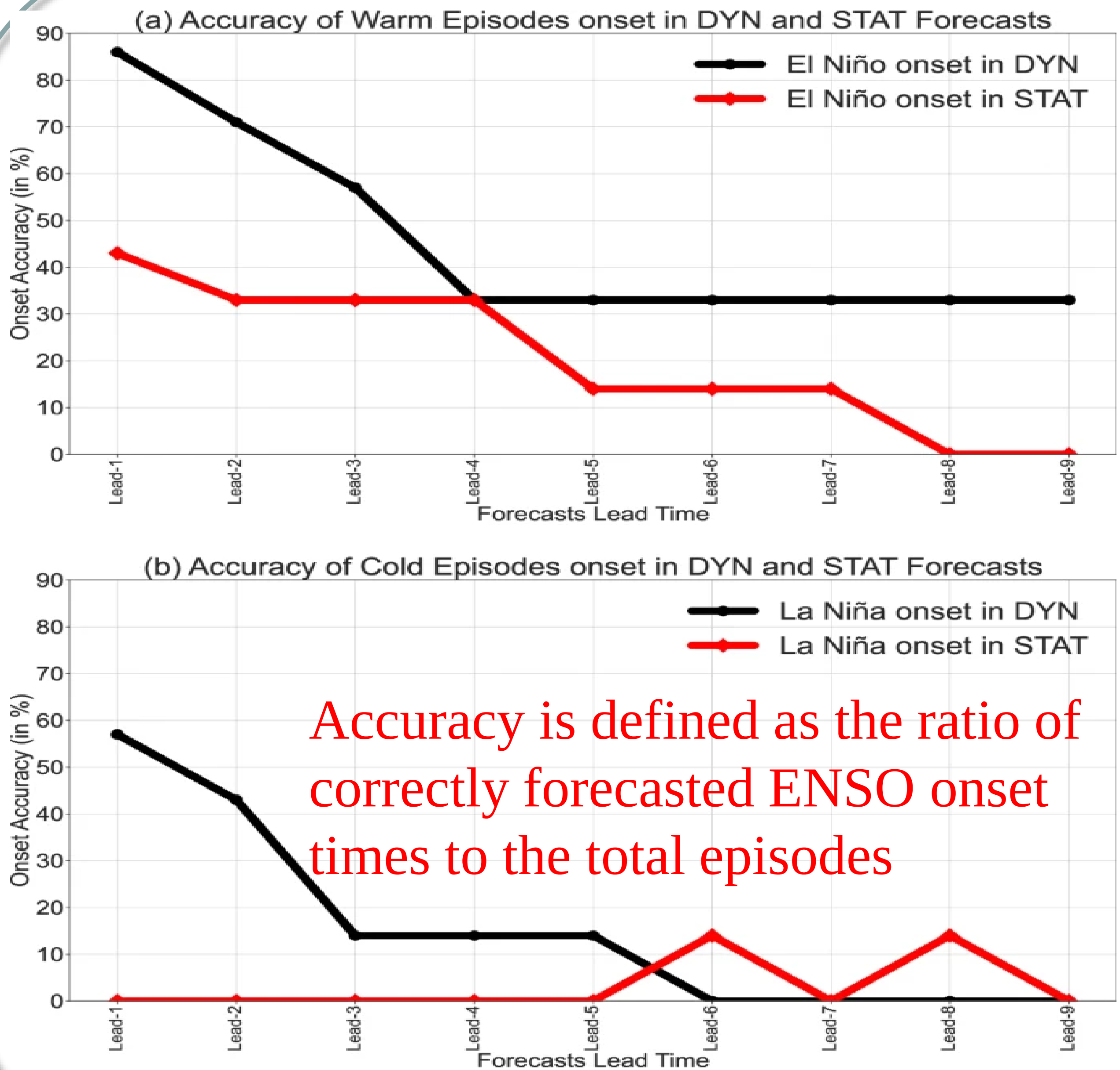
(Ehsan, MA, L'Heureux, ML, Tippett, MK et al., 2024: Real-time ENSO forecast skill evaluated over the last two decades, with focus on the onset of ENSO events. npj Clim Atmos Sci 7, 301 (DOI: 10.1038/s41612-024-00845-5)



➢ "Overall, the lead and start-time dependent interannual variances from both DYN and STAT are notably lower compared to the observed variance for each target season."

Fig. 4: Observed and lead dependent seasonal march of Variance of the Niño 3.4 Index

(Ehsan, MA, L'Heureux, ML, Tippett, MK et al., 2024: Real-time ENSO forecast skill evaluated over the last two decades, with focus on the onset of ENSO events. npj Clim Atmos Sci 7, 301 (DOI: 10.1038/s41612-024-00845-5)



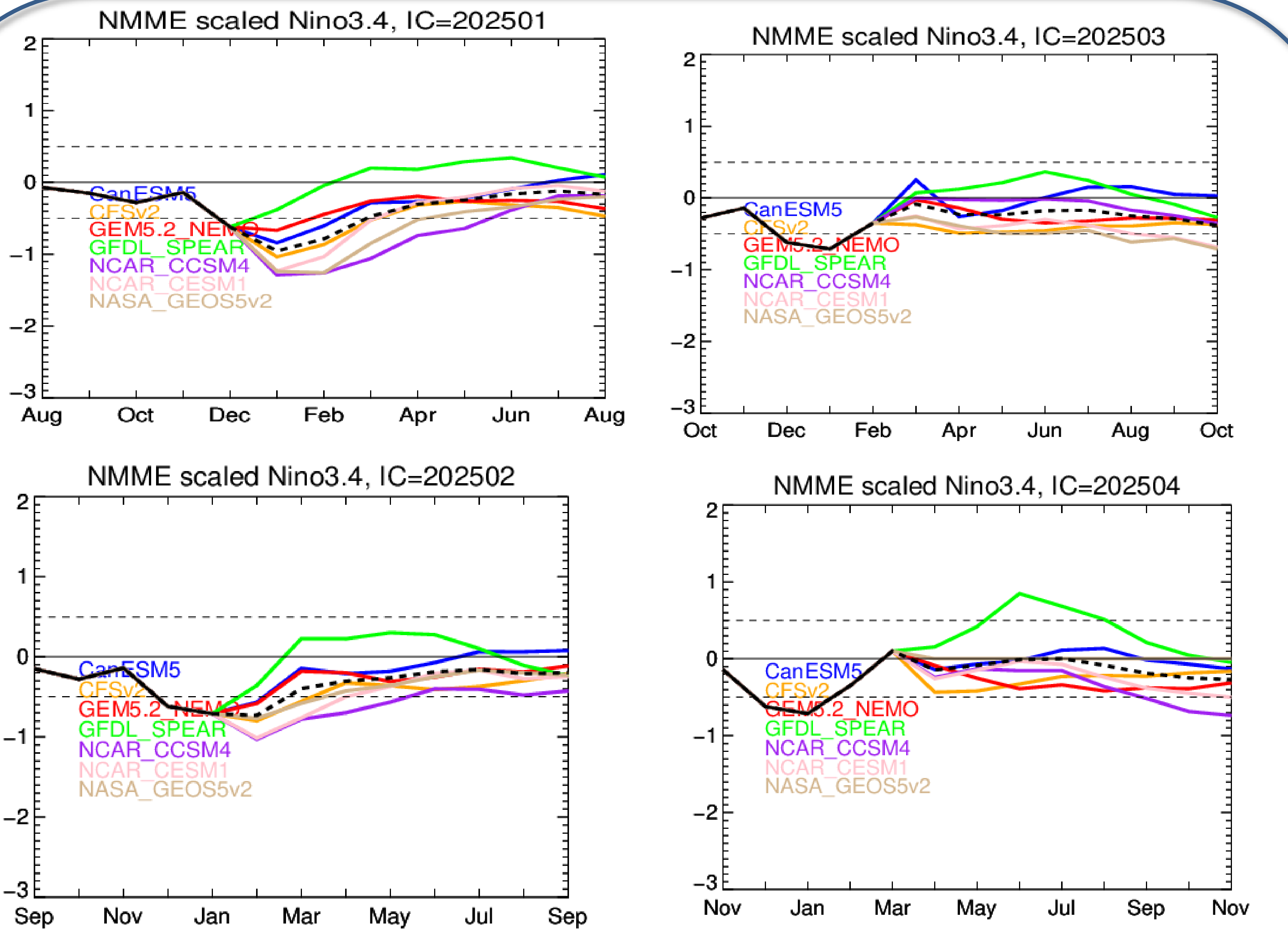
Accuracy is defined as the ratio of correctly forecasted ENSO onset times to the total episodes

- "The analysis uncovers an asymmetry in predicting the onset of cold and warm ENSO episodes, with warm episode onsets being better forecasted than cold onsets in both DYN and STAT models."
- "The DYN forecasts are found to be valuable for predicting warm and cold ENSO episode onsets at least several months in advance, while STAT forecasts are less informative about ENSO phase transitions."

Fig. 8: Accuracy of Real-Time STAT and DYN Forecasts for Warm and Cold ENSO Episodes

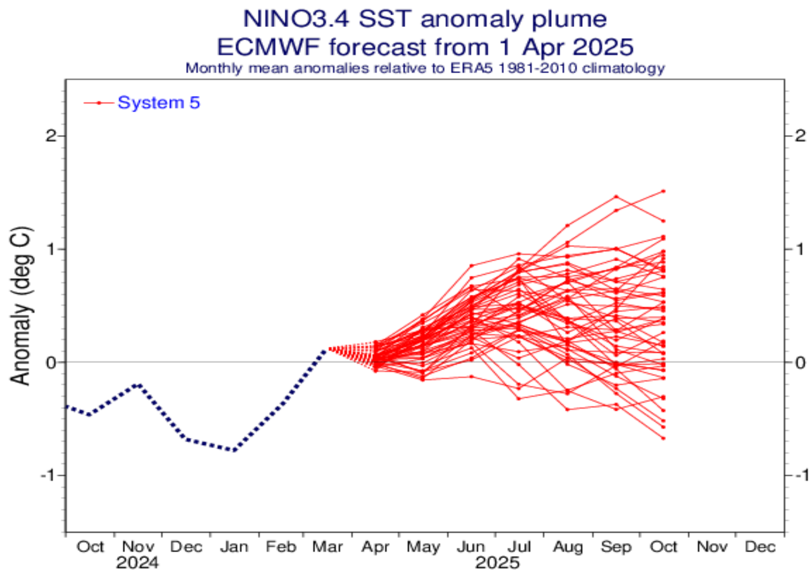
(Ehsan, MA, L'Heureux, ML, Tippett, MK et al., 2024: Real-time ENSO forecast skill evaluated over the last two decades, with focus on the onset of ENSO events. npj Clim Atmos Sci 7, 301 (DOI: 10.1038/s41612-024-00845-5)

NMME forecasts from different initial conditions

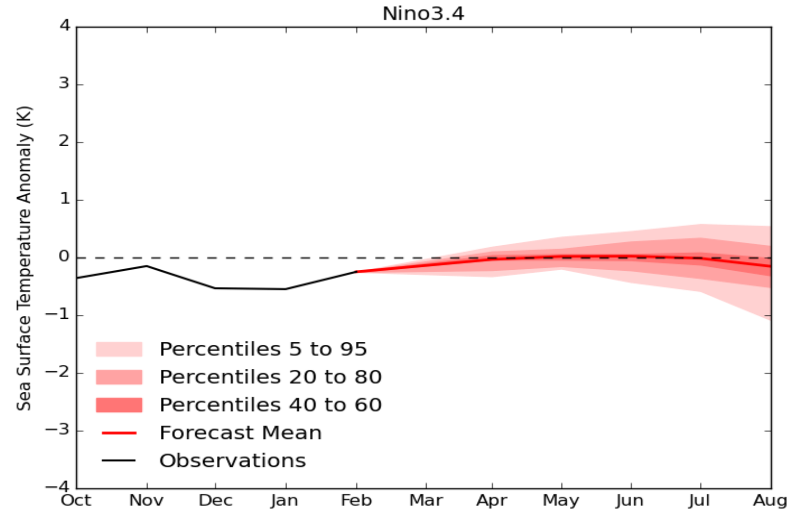


Individual Model Forecasts: Near and above normal Nino3.4 in summer & fall 2025

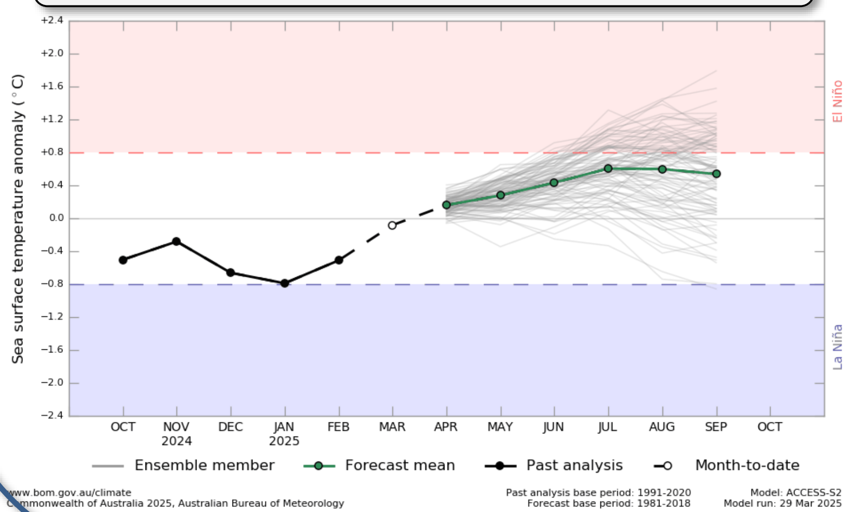
EC: Niño3.4, IC= 1 Apr 2025



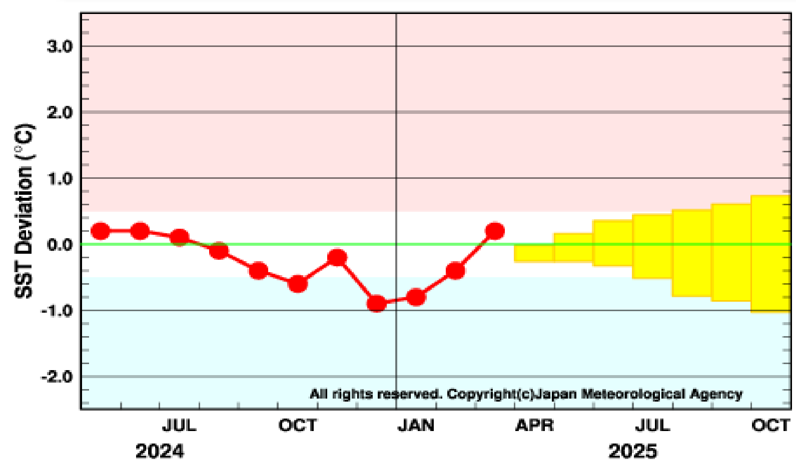
UKMO: Niño3.4, Updated 11 Mar 2025



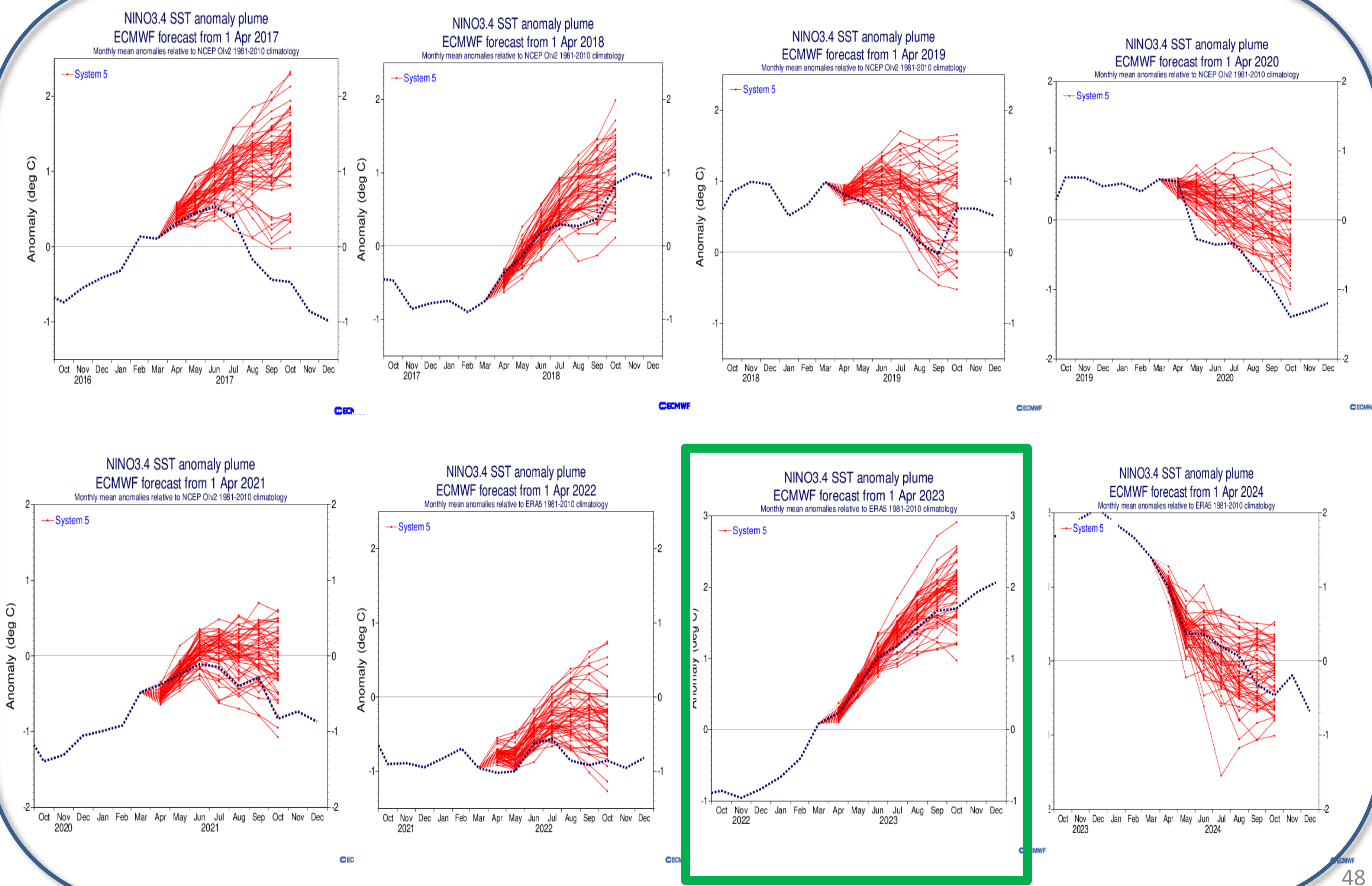
BOM: Niño3.4, Updated 29 Mar 2025



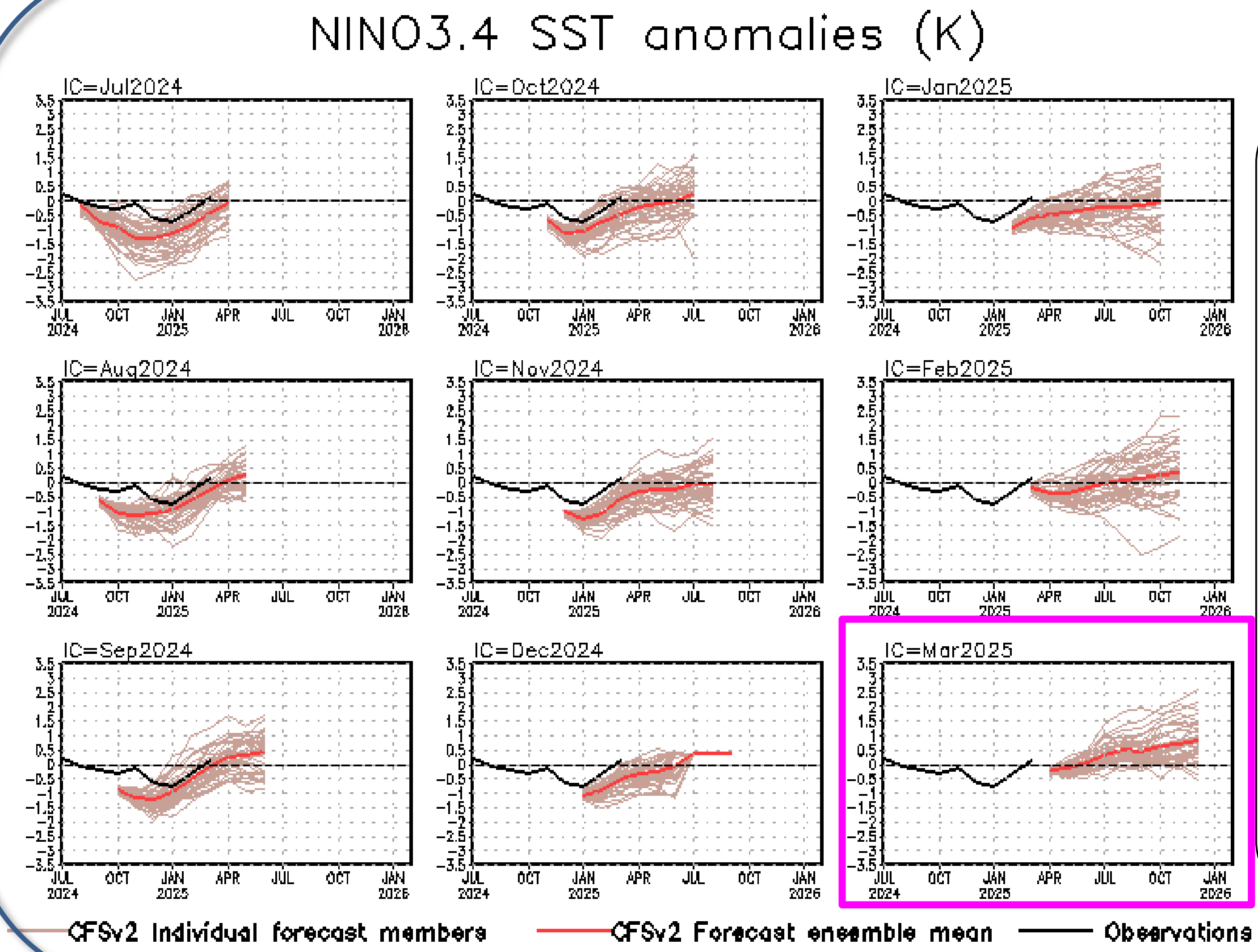
JMA: Niño3.4, Updated 10 Apr 2025



ECMWF Forecasts with ICs in Apr since 2017: Most years had warm biases



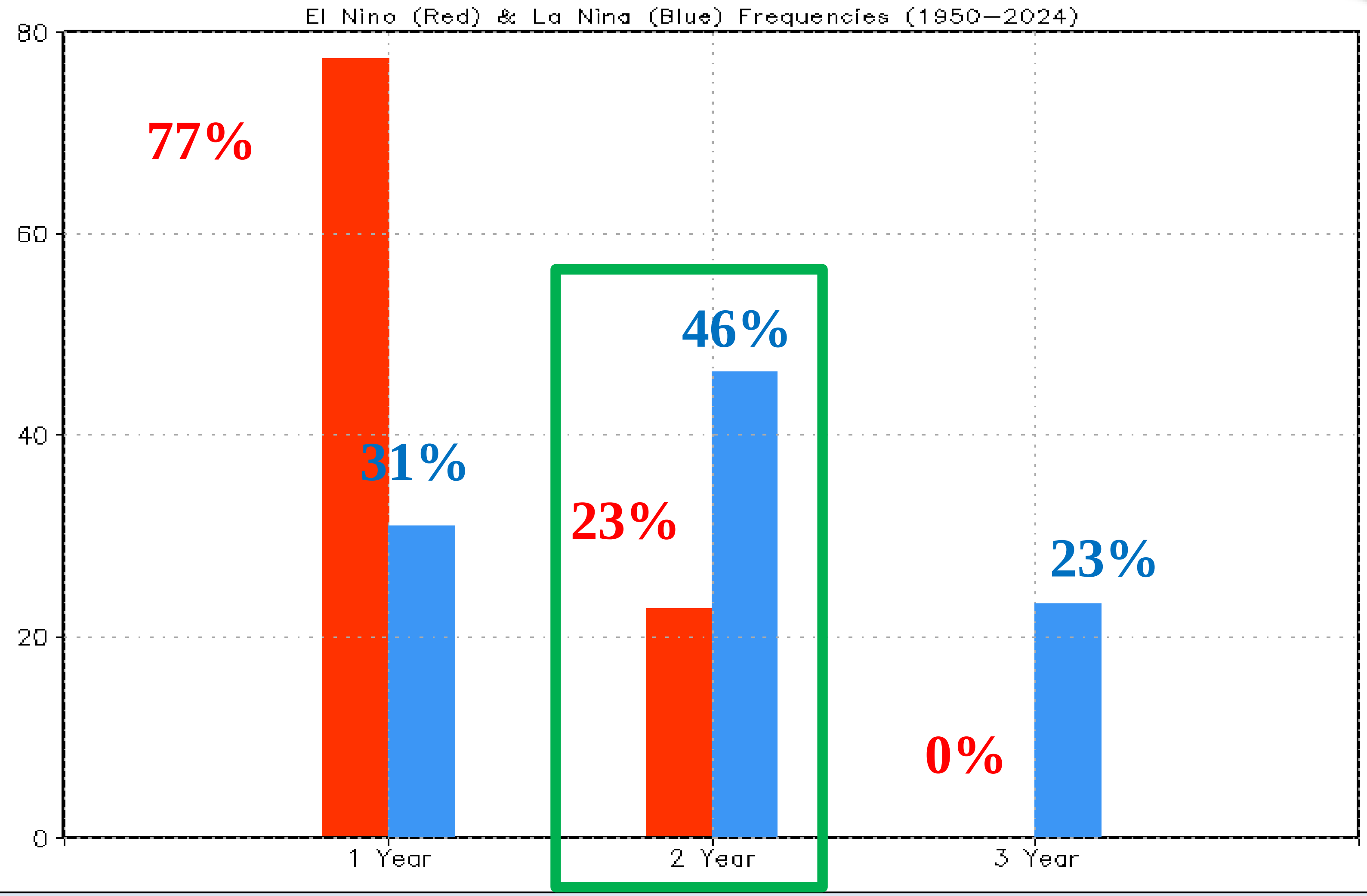
CFS Niño3.4 SST Predictions from Different Initial Months



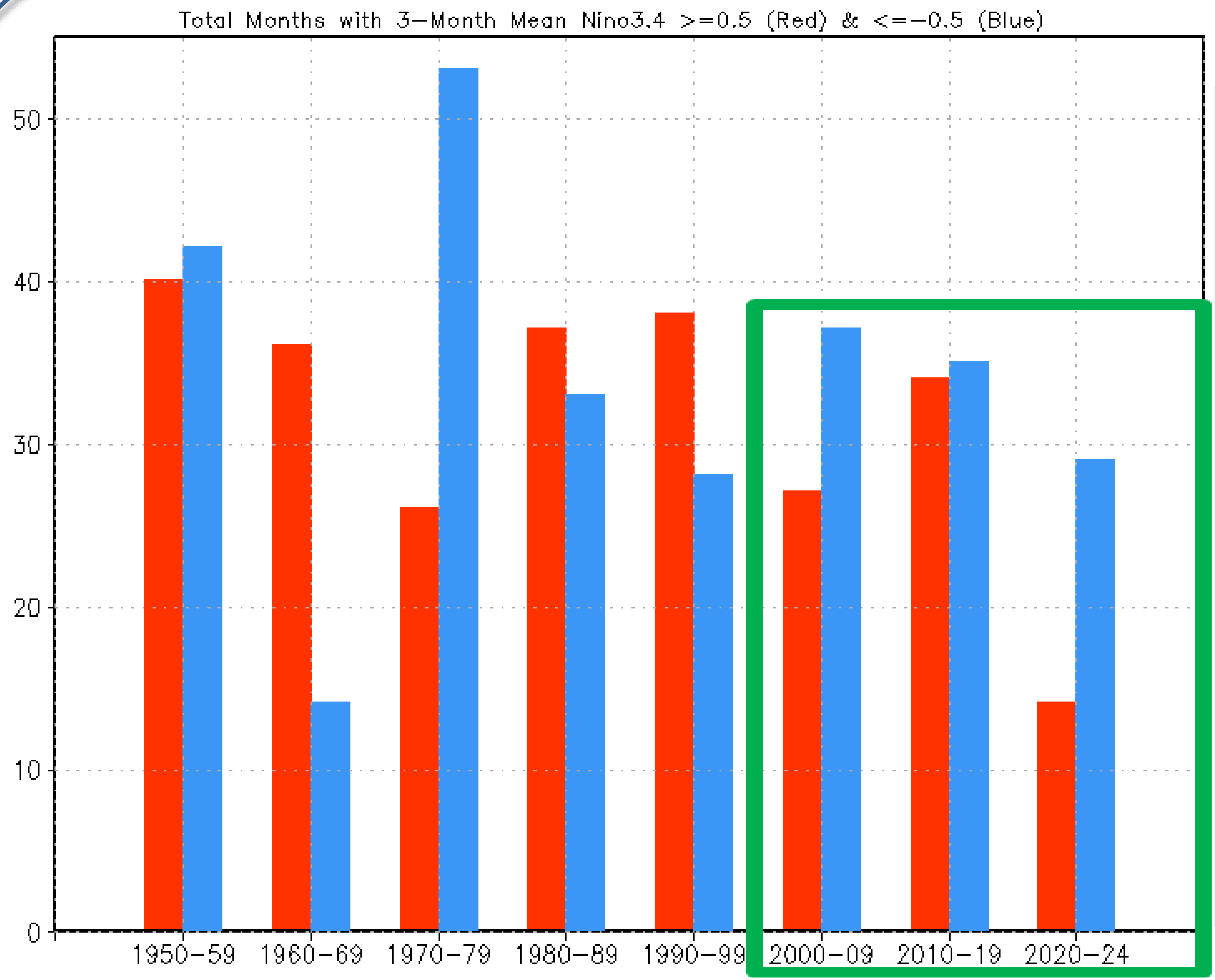
- The latest CFSv2 forecasts warming tendencies in spring-fall 2025.
- Cold biases are seen in the forecasts with ICs in Jun 2024-Jan 2025.

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.

Percentages (%) of single-, double-, and triple-year El Niños (red bars) and La Niñas (blue bars) during 1951-2024



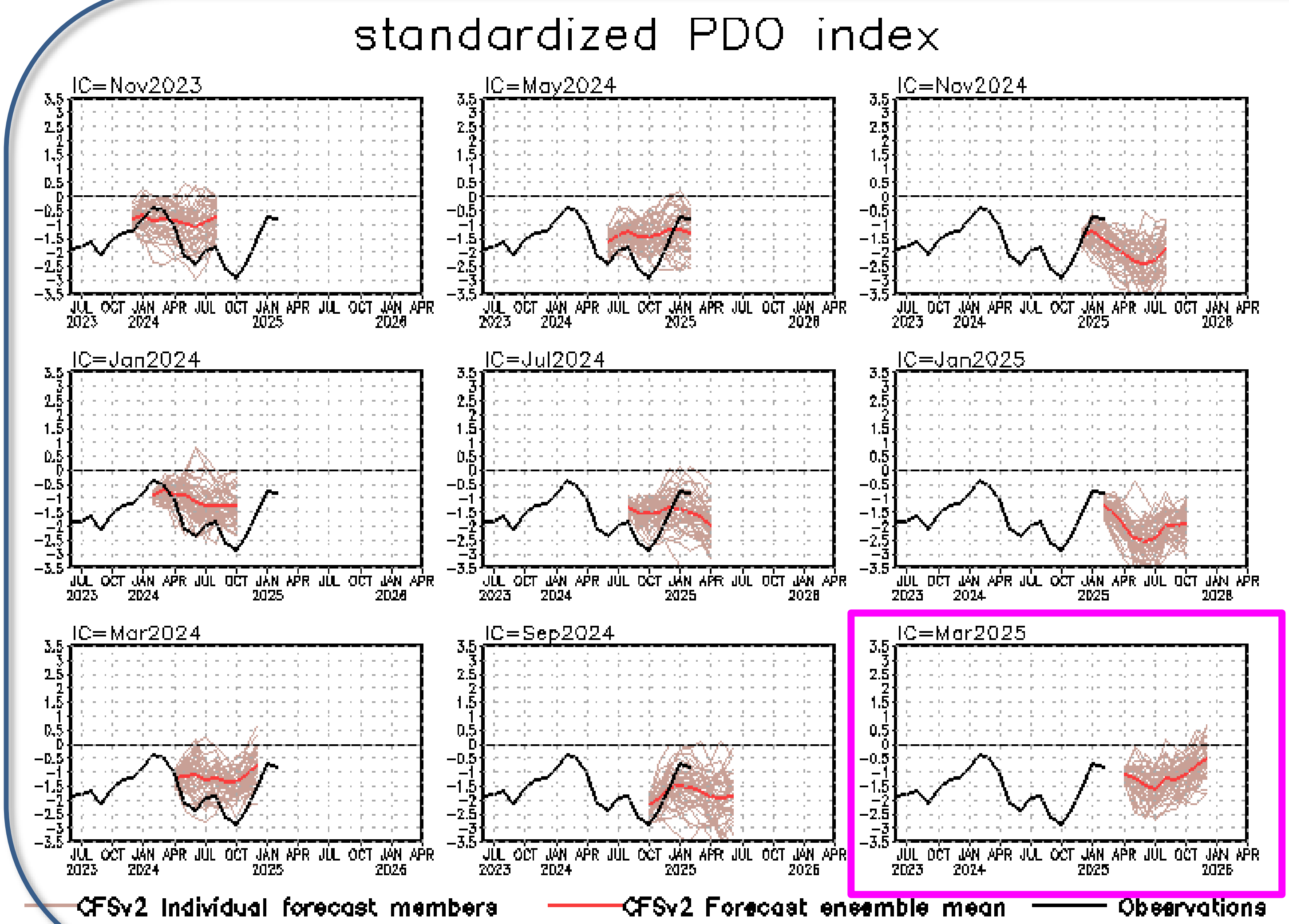
Gao, Z., et al., 2023: Single-Year and Double-Year El Niños. Climate Dyn. DOI: 10.1007/s00382-022-06425-8.



- In CPC ONI (with climatology based on centered 30-year base periods updated every 5 years), it seems that there are more La Niña than El Niño since 2000.

https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

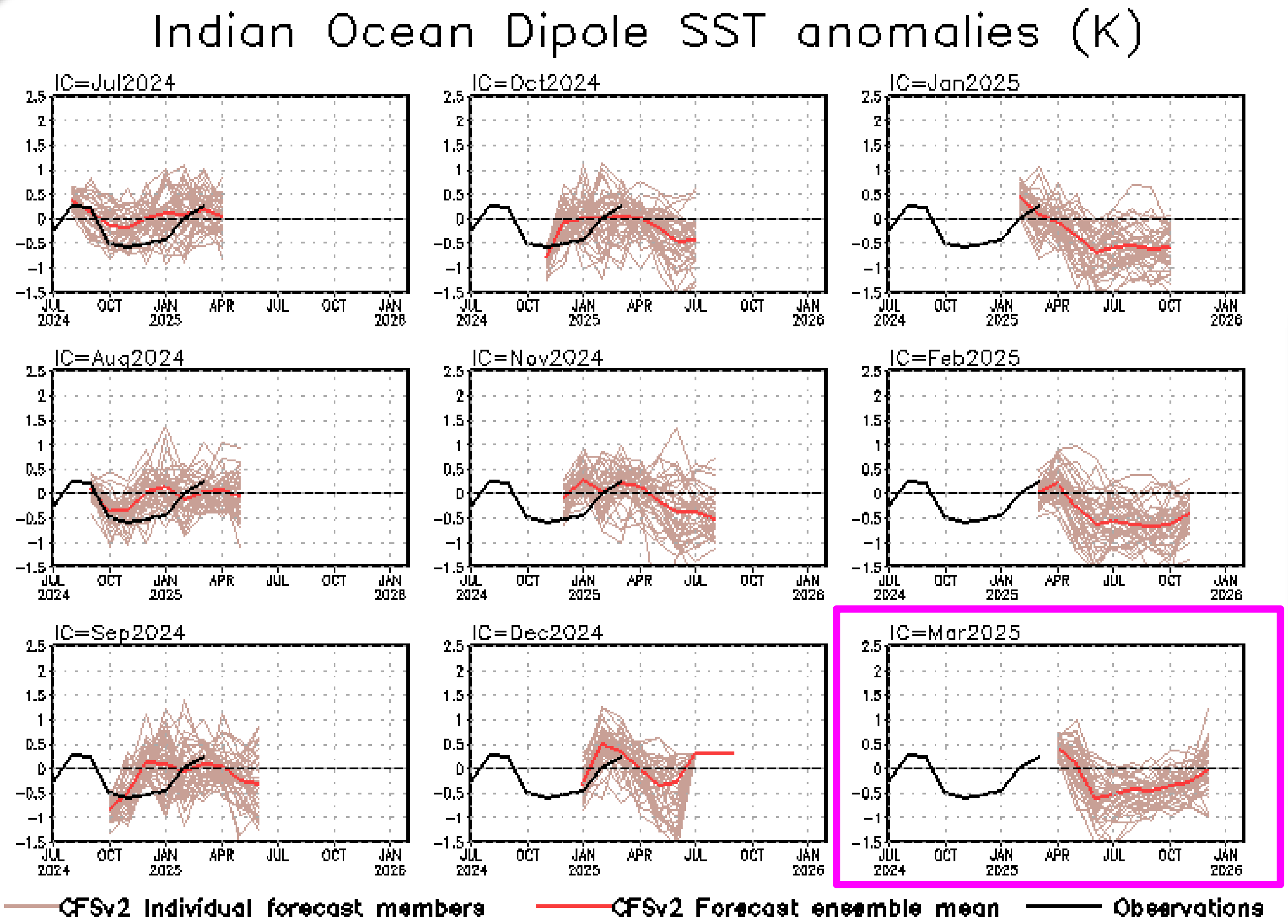
NCEP CFSv2 PDO Index Predictions from Different Initial Months



- CFSv2 predicts a persistent negative phase of PDO in 2025.
- Most forecasts had large warm biases with initial conditions in early 2024.

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 [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.

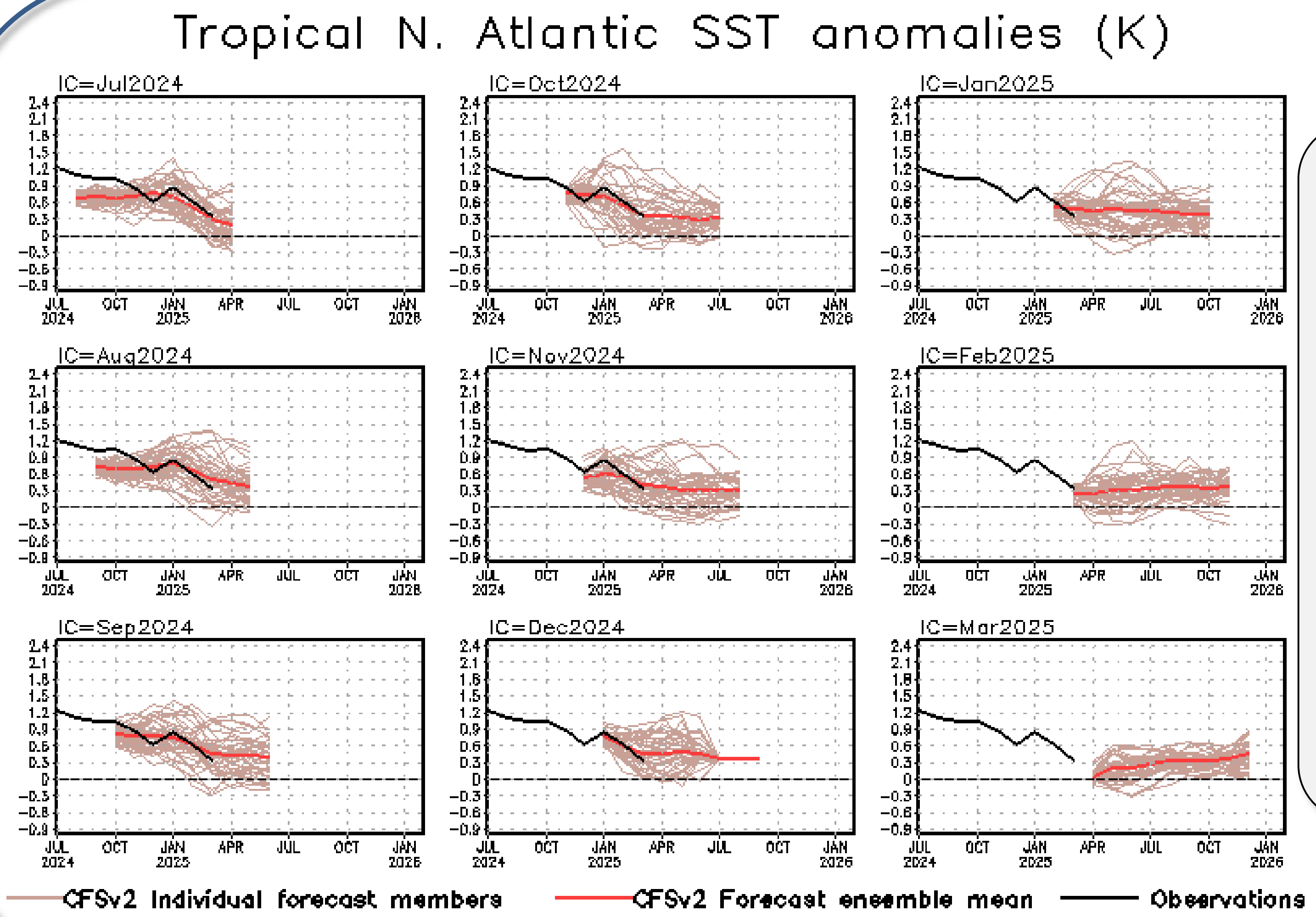
NCEP CFSv2 DMI SST Predictions from Different Initial Months



- CFSv2 predicts a transition to a negative phase of IOD in late spring-early summer 2025.

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.

NCEP CFSv2 Tropical North Atlantic (TNA) SST Predictions from Different Initial Months



- Latest CFSv2 predictions call for above-normal SSTA persistent 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 gave insightful suggestions and comments

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

- Drs. Jieshun Zhu & Wanqiu Wang maintained the sea ice forecasts

Please send your comments and suggestions to:

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Zeng-Zhen.Hu@noaa.gov

Data Sources (climatology is for 1991-2020)

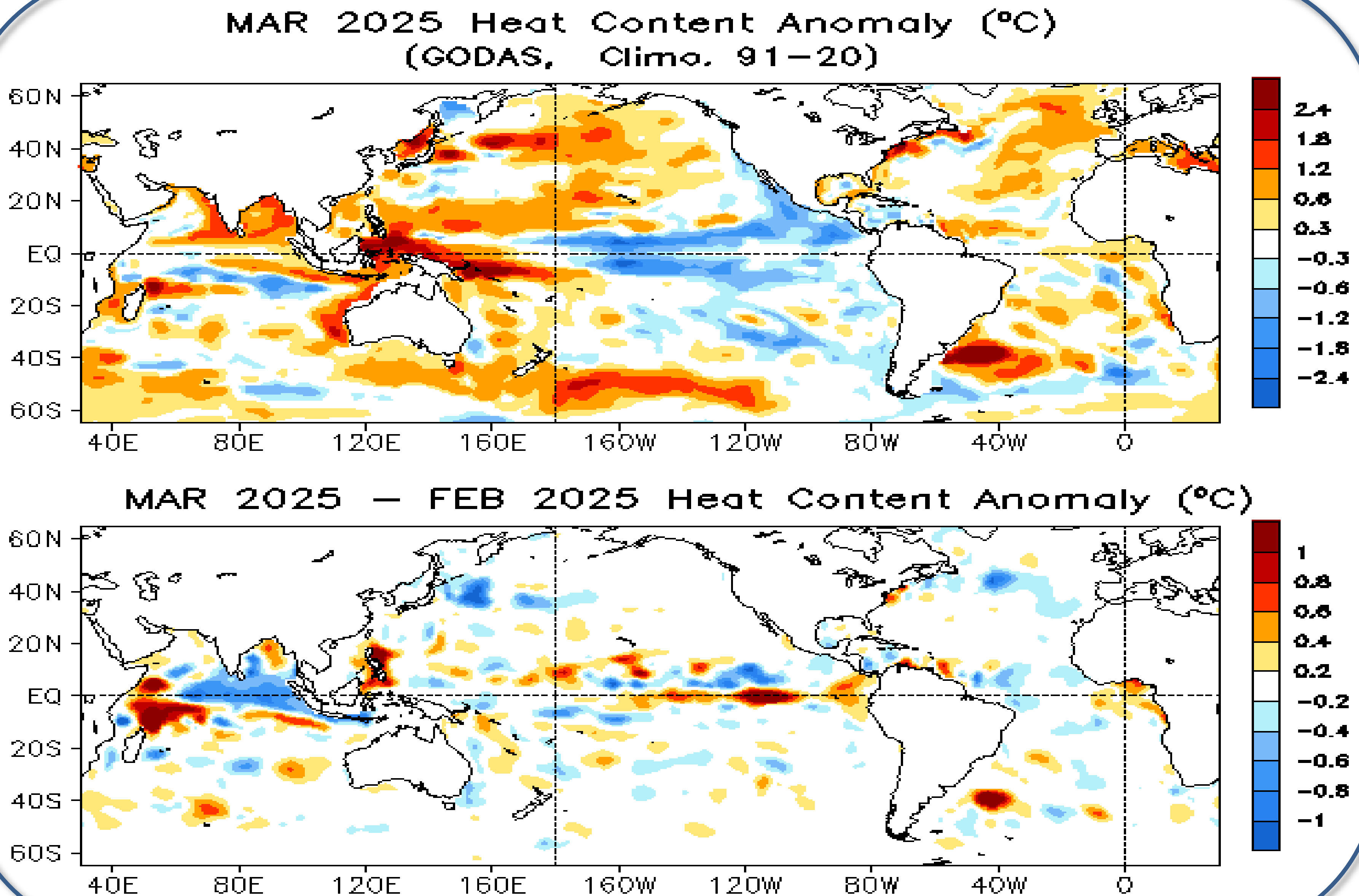
- **NCEP/CPC Ocean Monitoring & Briefing Operation (Hu et al., 2022, BAMS)**
- **Weekly Optimal Interpolation SST (OIv2.1 SST; Huang et al. 2021)**
- **Extended Reconstructed SST (ERSST) v5 (Huang et al. 2017)**
- **Blended Analysis of Surface Salinity (BASS) (Xie et al. 2014)**
- **CMORPH precipitation (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

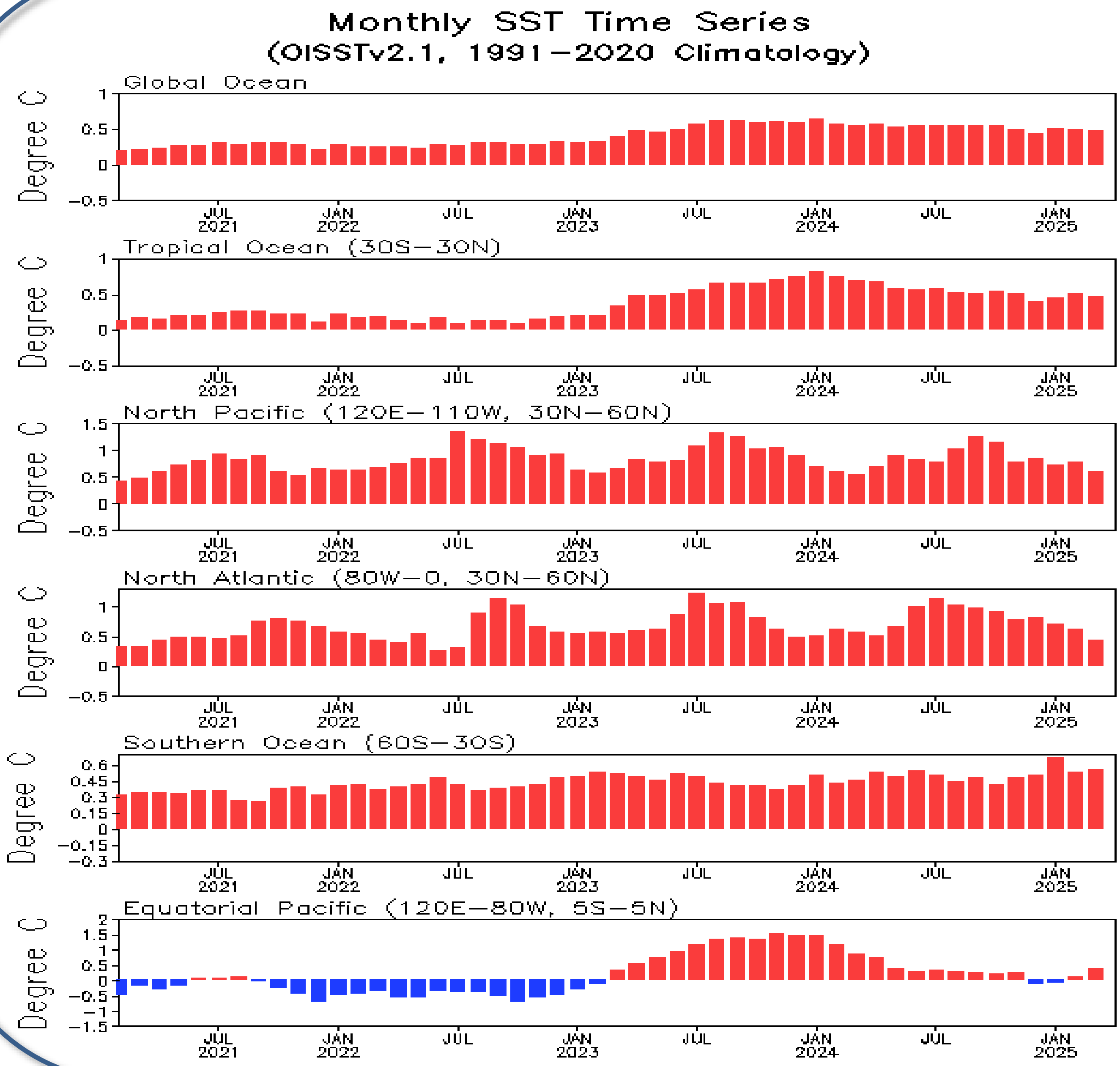
  http://www.cpc.ncep.noaa.gov/products/GODAS/multiora93_body.html

Backup Slides

Global HC300 Anomaly & Anomaly Tendency



Evolution of Basin-Averaged SST Anomalies

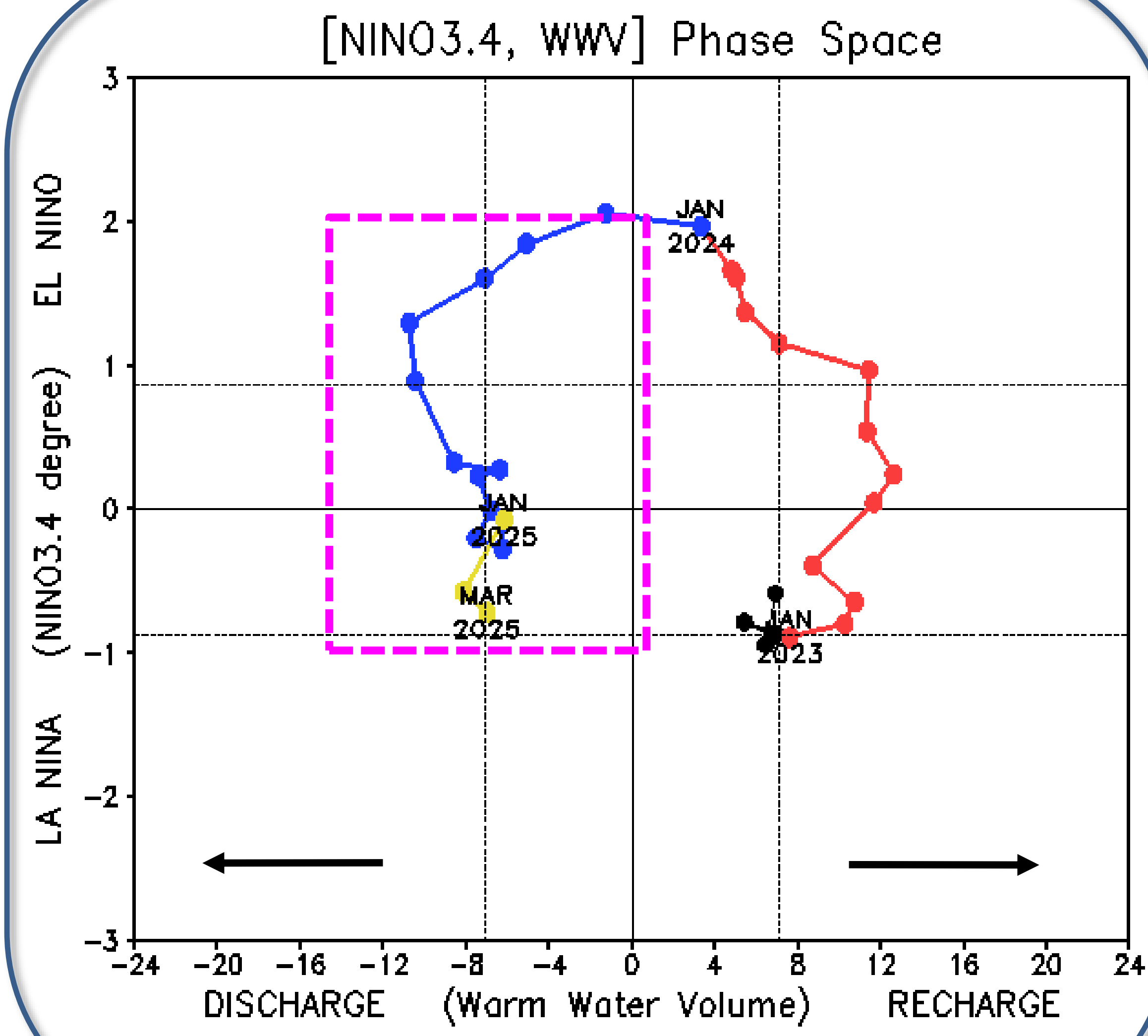


Monthly mean OISSTv2.1 SSTA for global, tropical, N. Pacific, N. Atlantic, Southern Ocean, and equatorial Pacific averages since Jan 2021.

Warm Water Volume (WWV) and Niño3.4 Anomalies

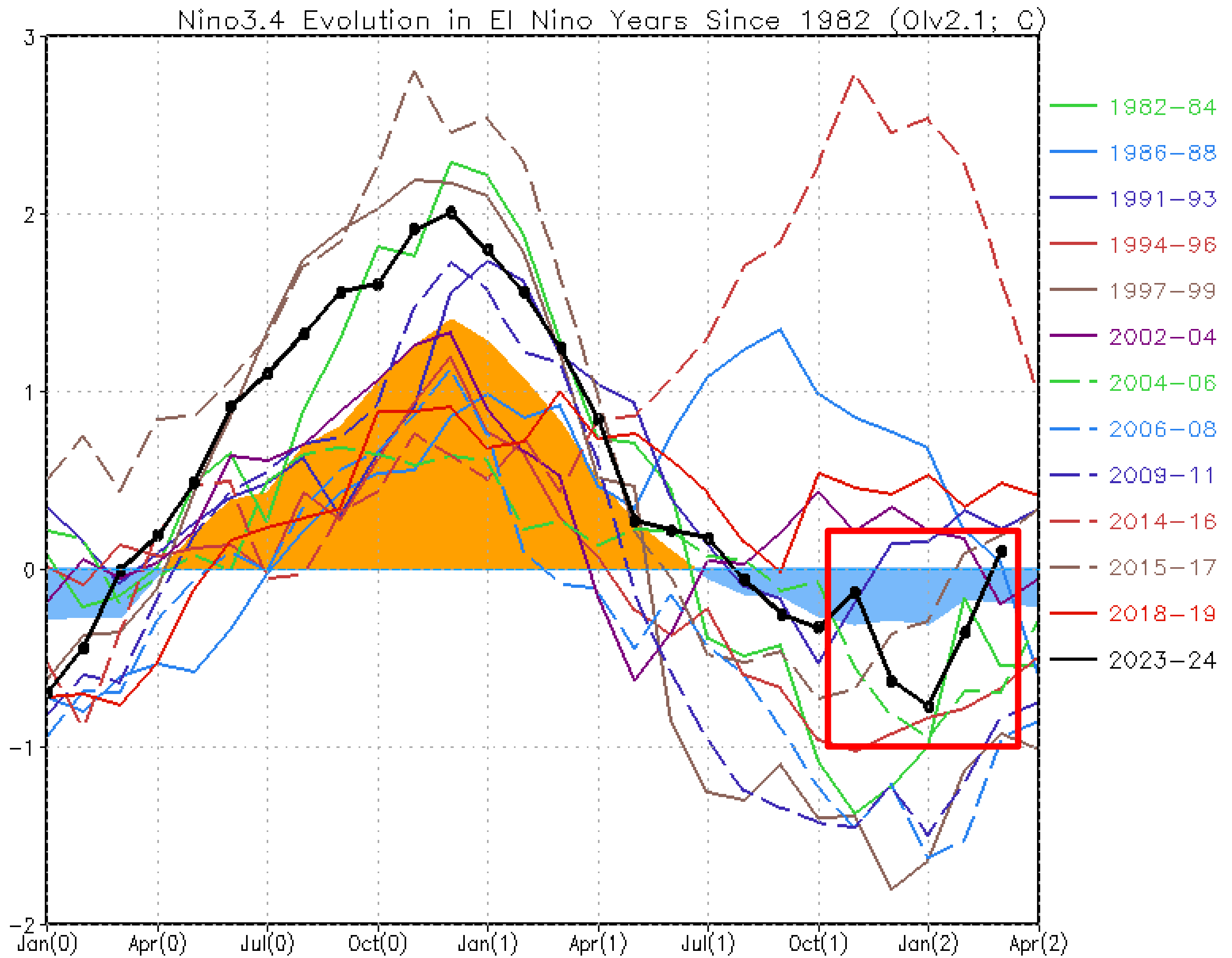
- Pacific equatorial Warm Water Volume (WWV) switched to a discharge phase after Feb 2024.

-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.

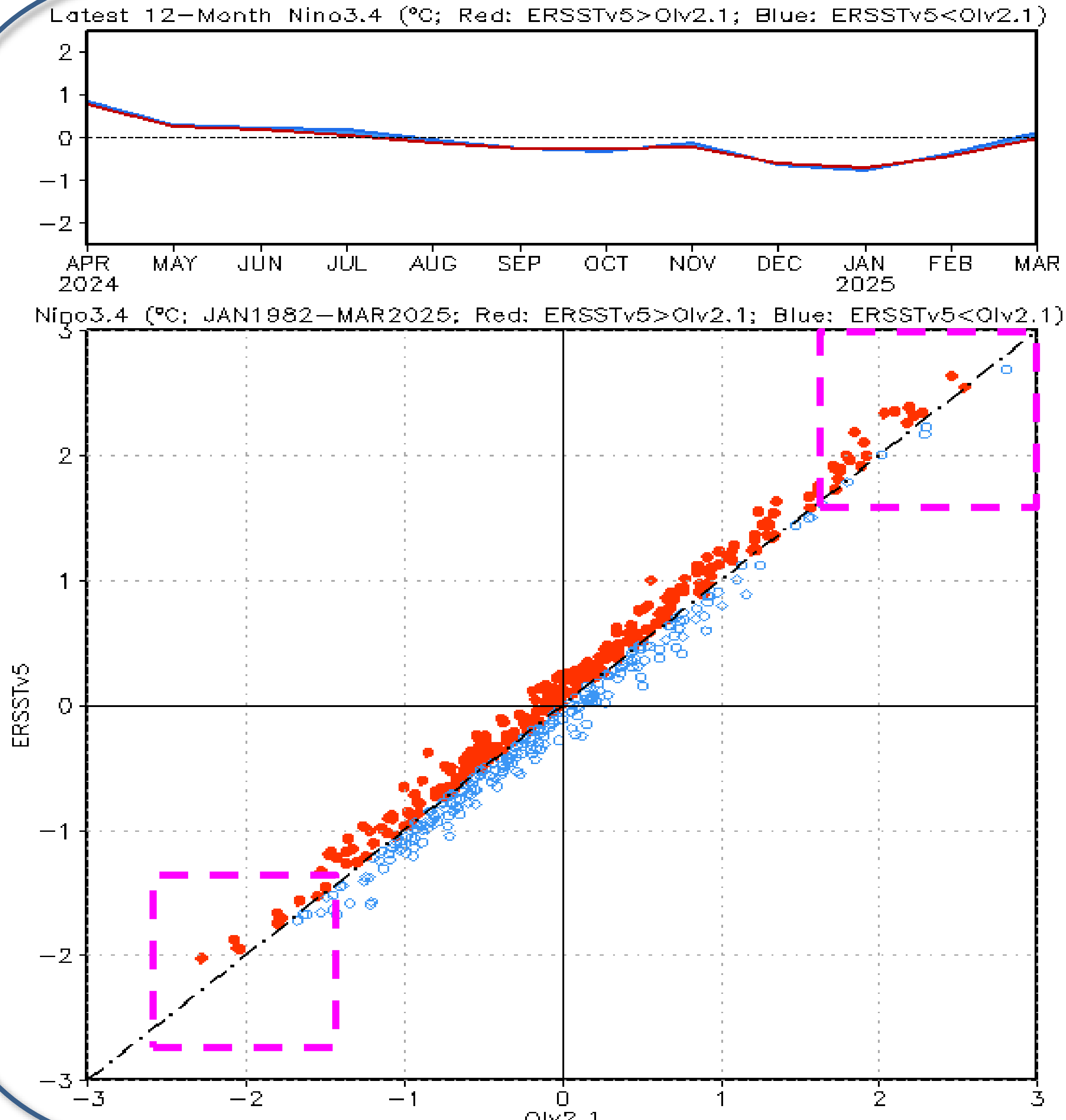


Phase diagram of Warm Water Volume (WWV) and Niño3.4 indices. WWV is the average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] calculated with the NCEP's GODAS. Anomalies are departures from the 1991-2020 base period means.

Niño3.4 evolution after an El Niño

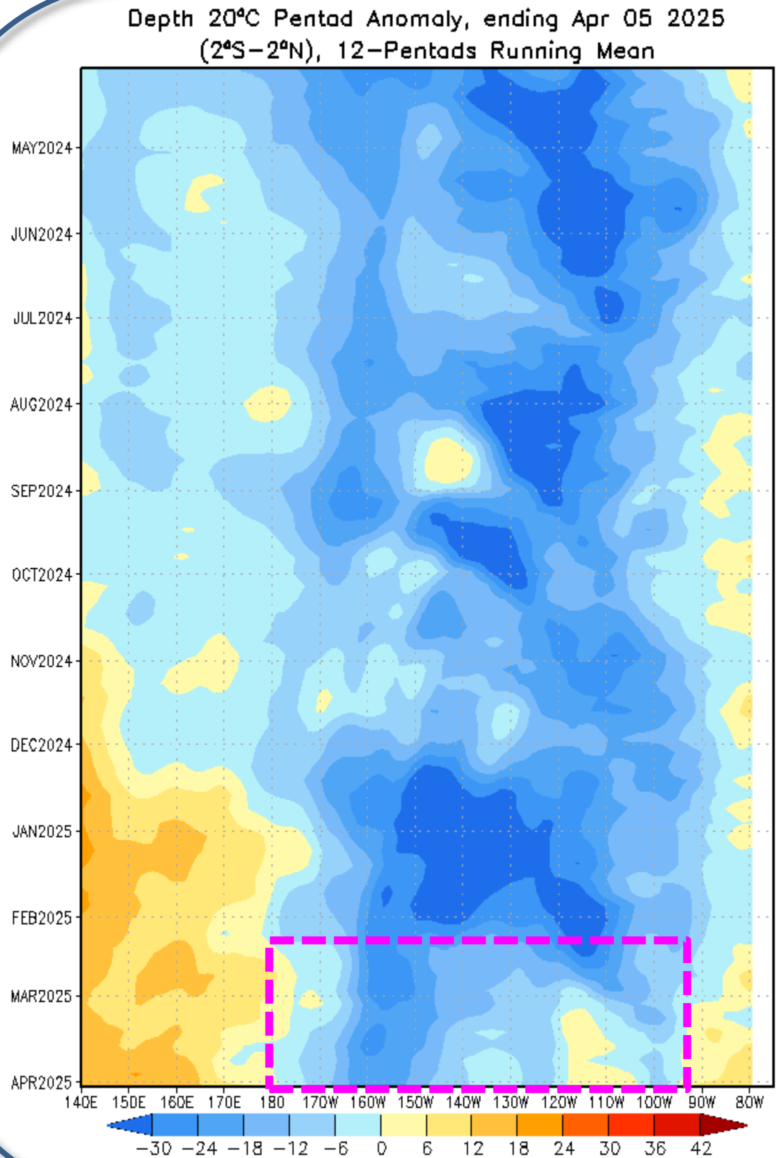


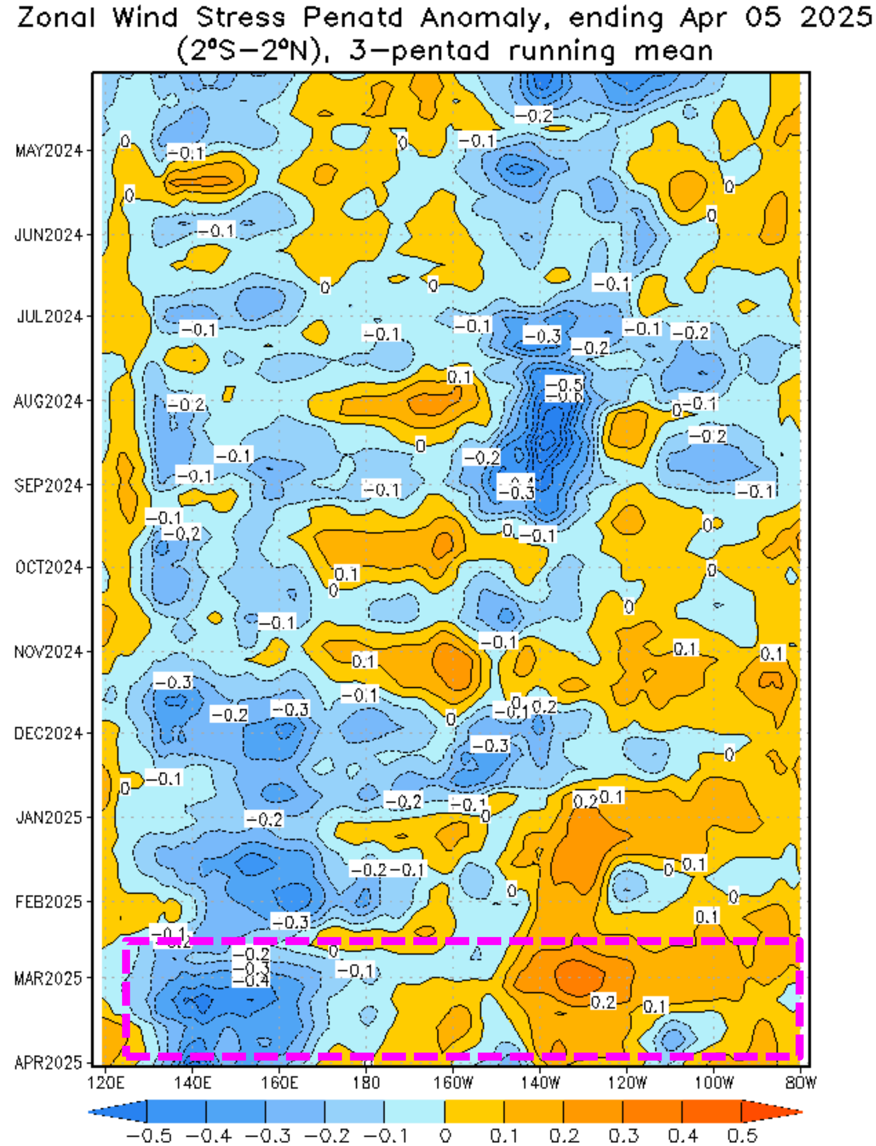
Comparison of ERSSTv5 with OIv2.1 Niño3.4 Index



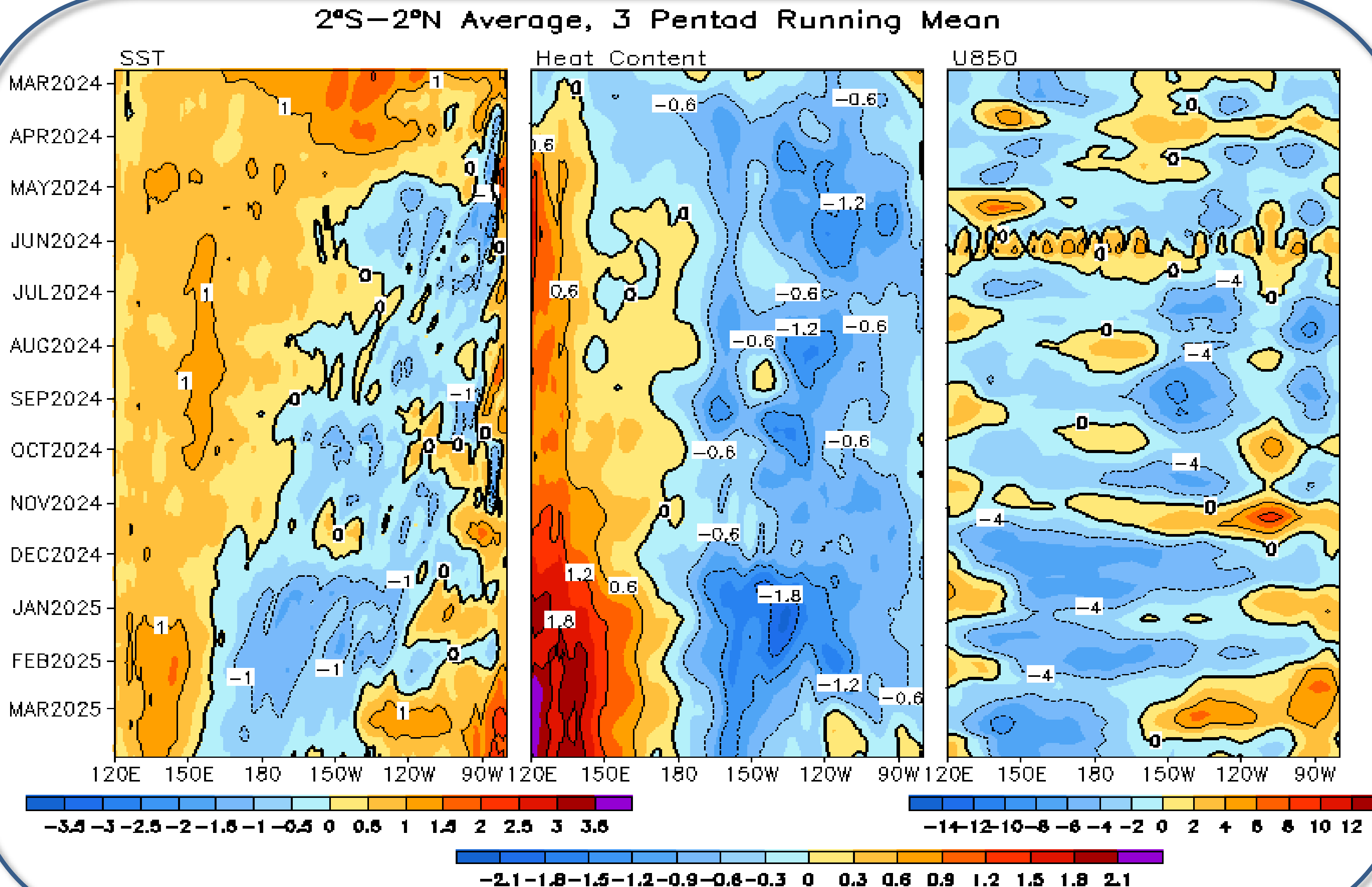
- During the last year, ERSSTv5 was close to OIv2.1.
- Sometimes, ERSSTv5 is either warmer or cooler than OIv2.1.
- For both the extreme positive and negative (>1.5^{o}C or <-1.5^{o}C) Niño3.4, ERSSTv5 is mostly warmer than OIv2.1.

Evolution of Pentad D20 and Taux anomalies along the equator



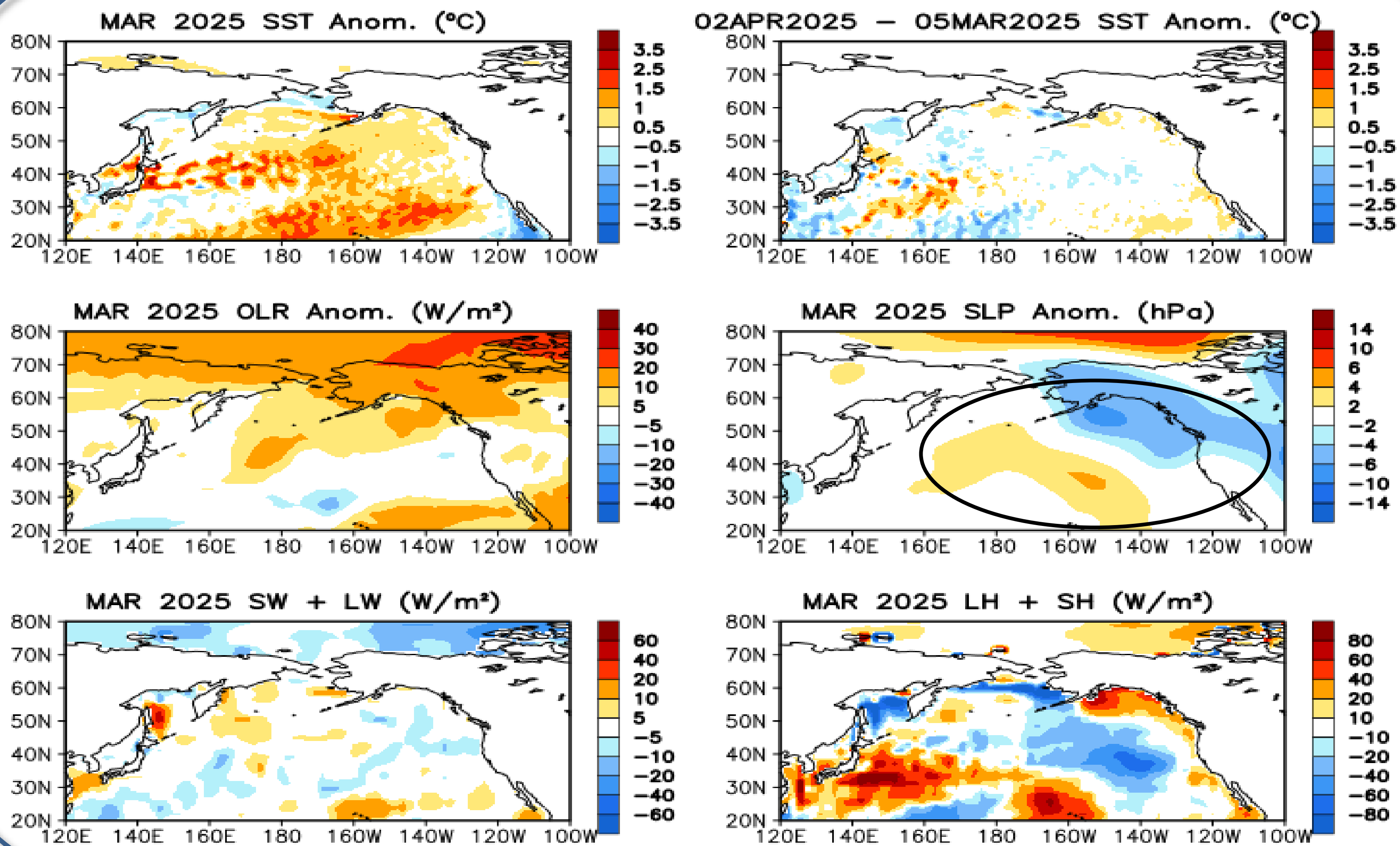


Equatorial Pacific SST (ºC), HC300 (ºC), u850 (m/s) Anomalies



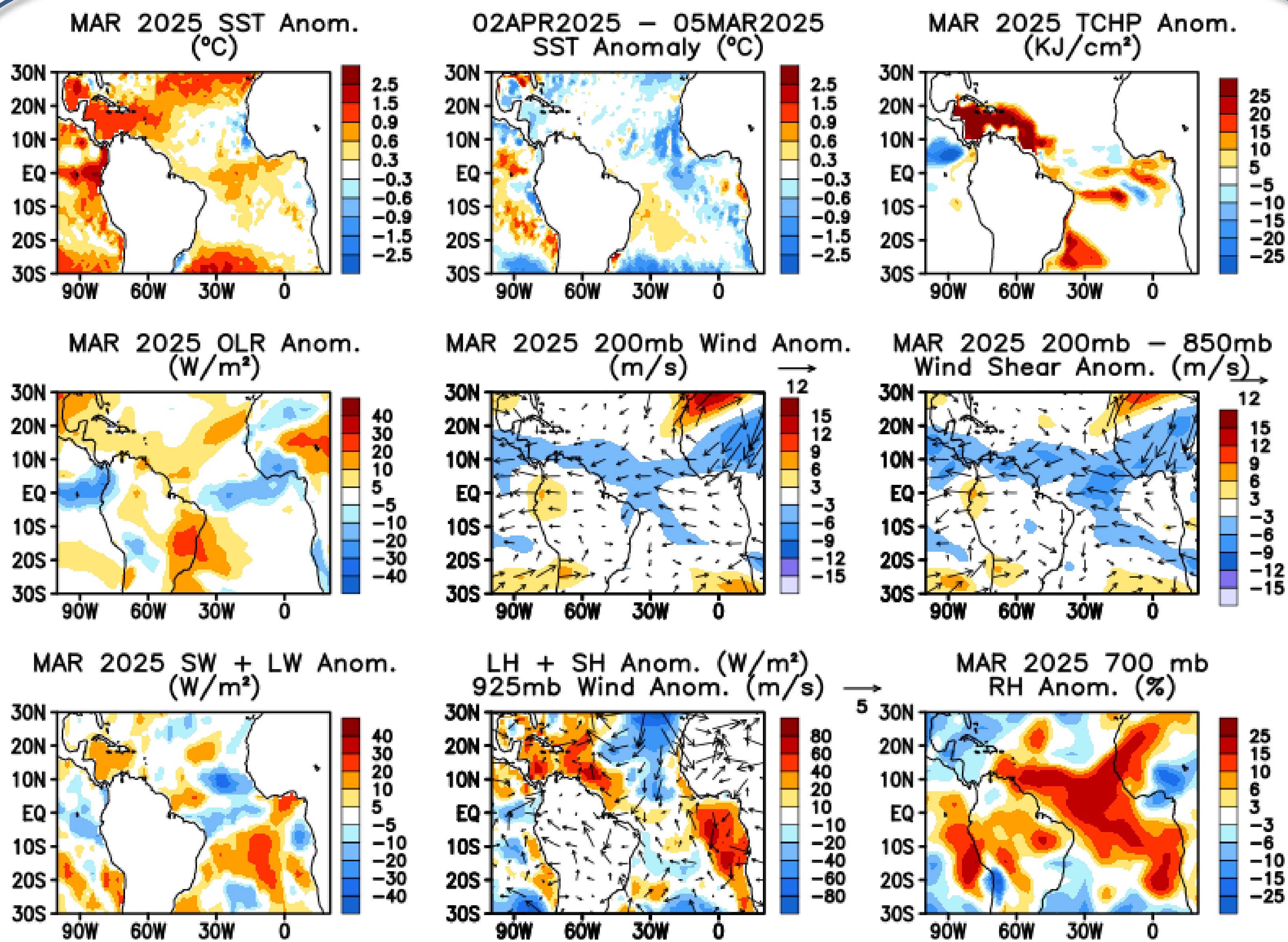
- Since Feb 2024, easterly wind anomalies have present, consistent with decrease in heat content and SST.

North Pacific 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.

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



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