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

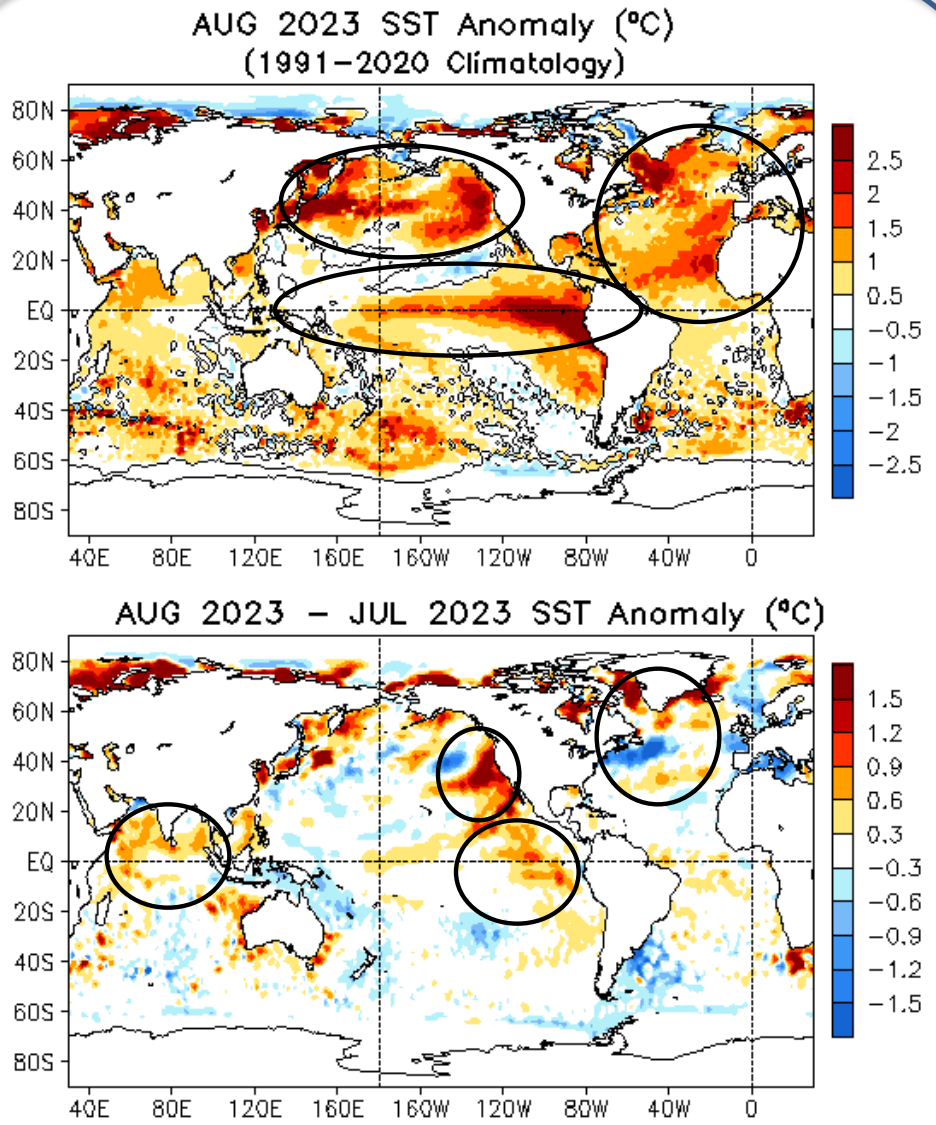
- Overview
- Recent highlights
  - Pacific Ocean
  - Arctic & Antarctic Oceans
  - Indian Ocean
  - Atlantic Ocean
- Global SSTA Predictions

Overview

- Pacific Ocean
  - The warming in the central and eastern equatorial Pacific strengthened in Aug 2023 with Niño3.4 = 1.3^{o}C
  - The strong coastal El Niño developed in Feb 2023 and continued to grow with Niño1+2= 3.3^{o}C in Aug 2023.
  - NOAA "ENSO Diagnostic Discussion" on 10 August 2023 stated "*El Niño is anticipated to continue through the Northern Hemisphere winter (with greater than 95% chance through December 2023 -February 2024)*".
  - The PDO has been in a negative phase since Jan 2020 with PDOI = -1.7 in Aug 2023.
  - Strong subsurface warming has persisted in the central north Pacific Ocean since 2020.
- Arctic and Antarctic Oceans
  - Average Arctic sea ice extent during Aug 2023 ranked the eighth lowest August since 1979.
  - Antarctic sea ice extent continues to track at historical low values.
- Indian Ocean
  - Positive Indian dipole mode index increased substantially in Aug 2023.
- Atlantic Ocean
  - SST warming during Jul-Aug 2023 hit the historical high for the same season since 1982.
  - Hurricane activity was active in Aug 2023.
  - Ongoing mass marine heatwave starting in June/July 2023 caused mass coral bleaching in Caribbean, Gulf of Mexico, and Florida Keys.

Global Oceans

Global SST Anomaly (°C) and Anomaly Tendency

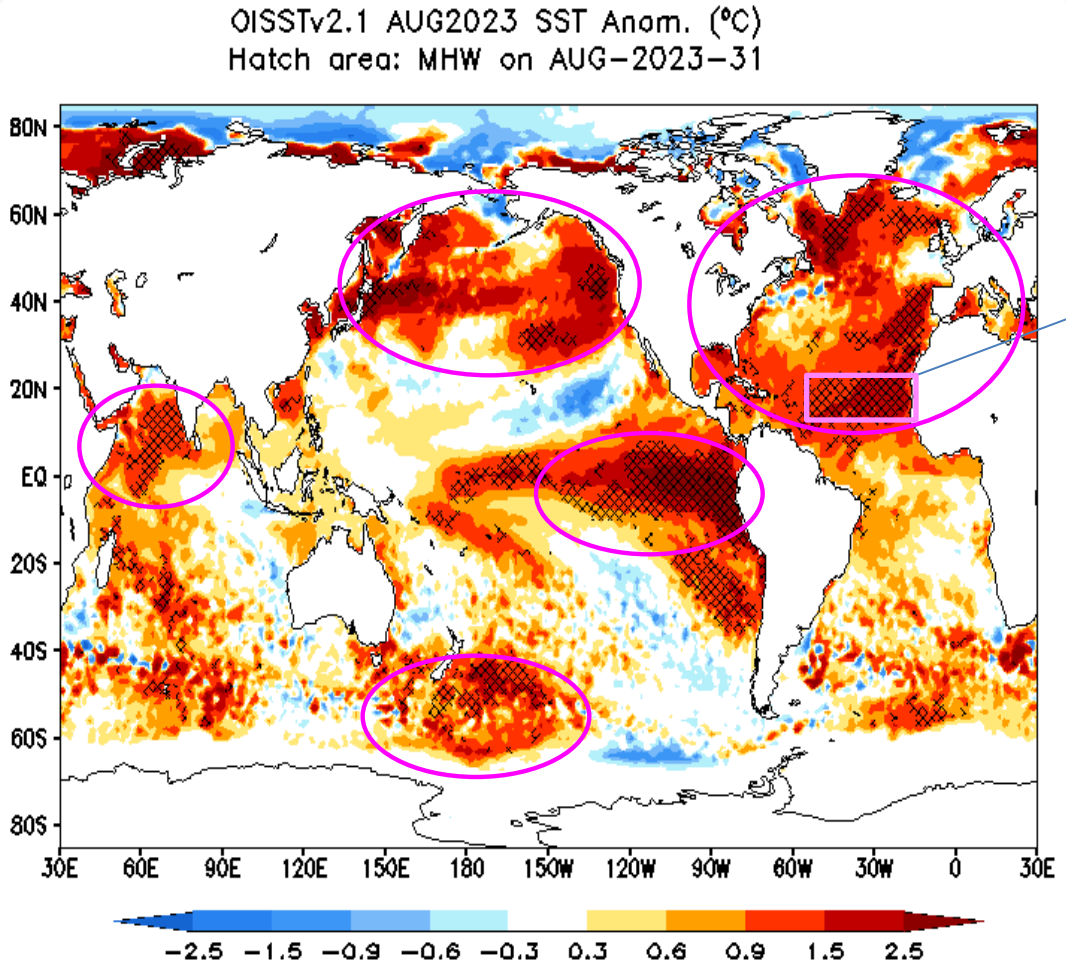


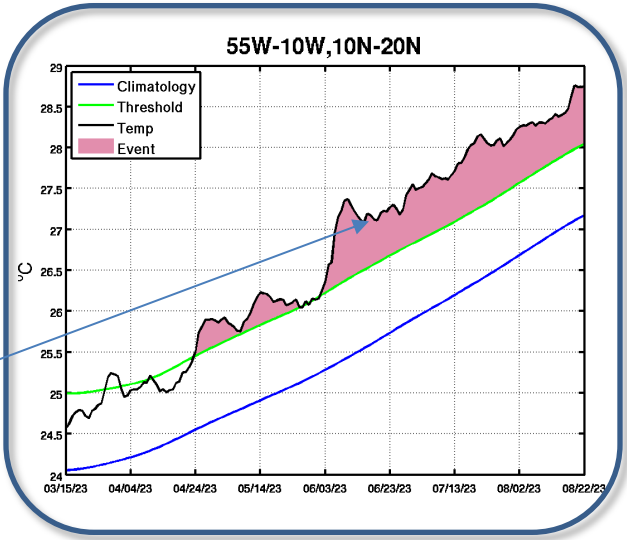
- SSTs were above average across most of the equatorial Pacific Ocean.
- The strong coastal El Niño condition persisted in Aug 2023.
- Strong positive SSTAs persisted in the North Pacific and the North Atlantic Oceans.

- Strong positive SSTA tendencies were observed near the west coast of the United States.
-Large SSTA tendencies were observed in the mid-to-high latitude of the North Atlantic Ocean.
-Positive SSTA tendencies were present in the central-eastern equatorial Pacific Ocean.
- Positive SSTA tendencies dominated the tropical Indian 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.

Global Monthly SST anomaly and Marine Heat Waves

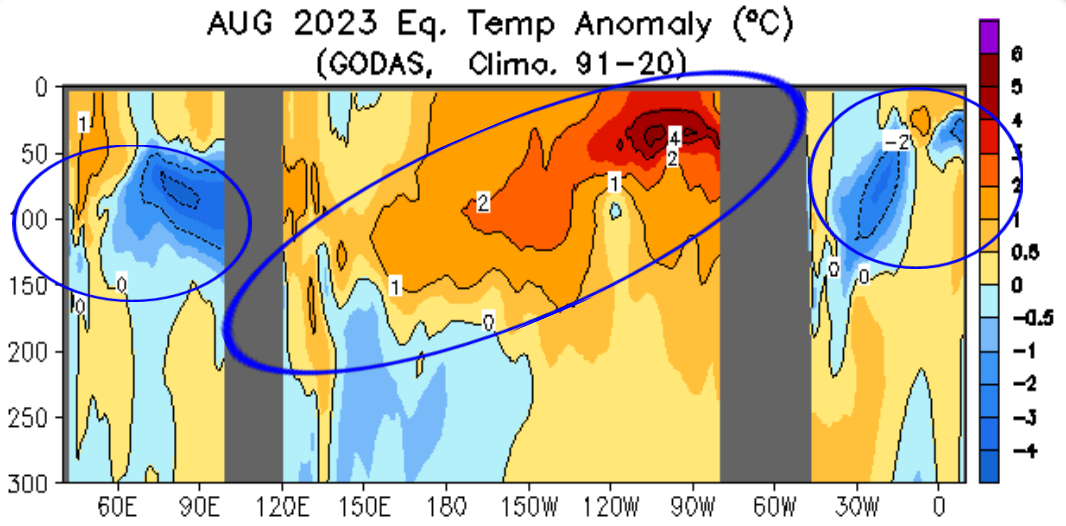


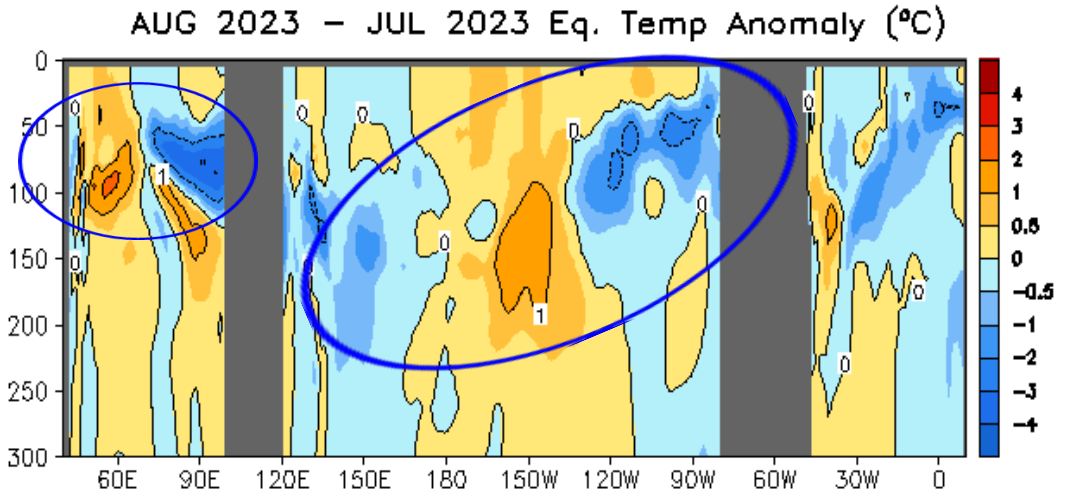


- MHWs were observed in the Northeast Pacific, Northwest Pacific, eastern equatorial Pacific , Southwest Pacific near New Zealand, Northeast Atlantic, Gulf of Mexico, Labrador basin and the Arabian Sea.

((Left panel) Monthly SST anomaly (shaded) and locations experiencing marine heat waves (hatched) by the end date labelled in the plot. (right panel) SST evolution at a specific location. Green line and blue line are the 90th percentile and daily climatology, respectively. Shaded area denotes the periods experiencing MHW. MHW is defined as a prolonged warming exceeding 90th percentile of daily SST for at least 14 consecutive days. Data is derived from NCEI OISSTv2.1 and the reference period is 1991-2020

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





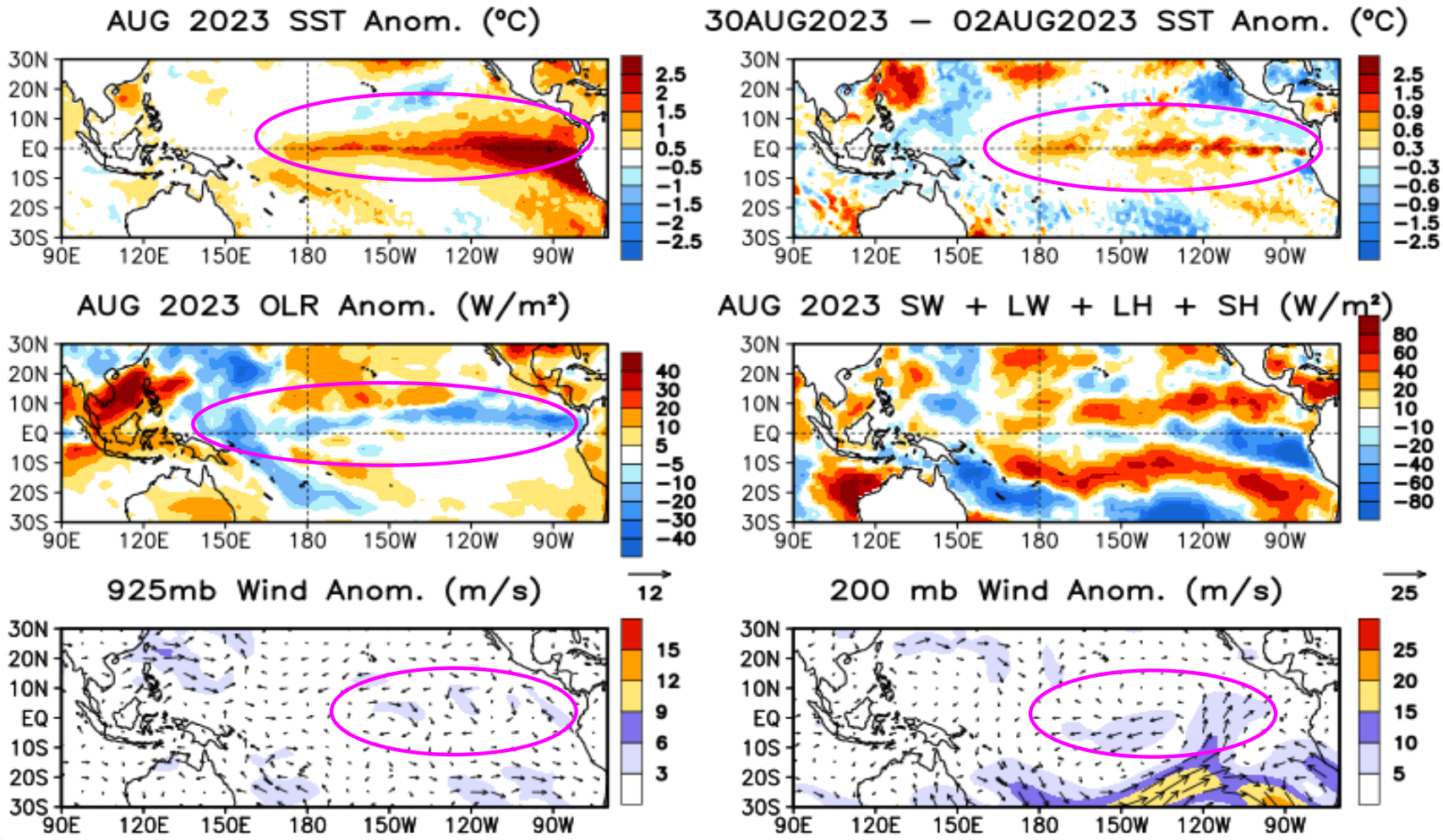
- Positive temperature anomalies were present along the thermocline in the Pacific.
- Negative(positive) temperature anomalies were observed along the eastern (western) thermocline in the Indian Ocean.
- Negative temperature anomaly dominated the thermocline in the Atlantic Ocean.

- Positive (negative) temperature anomaly tendency was present along the central (western and eastern) thermocline in the Pacific Ocean.
-Temperature anomaly tendency was negative (positive) along the thermocline in the eastern (western) Indian Ocean, favouring a positive IOD development.

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.

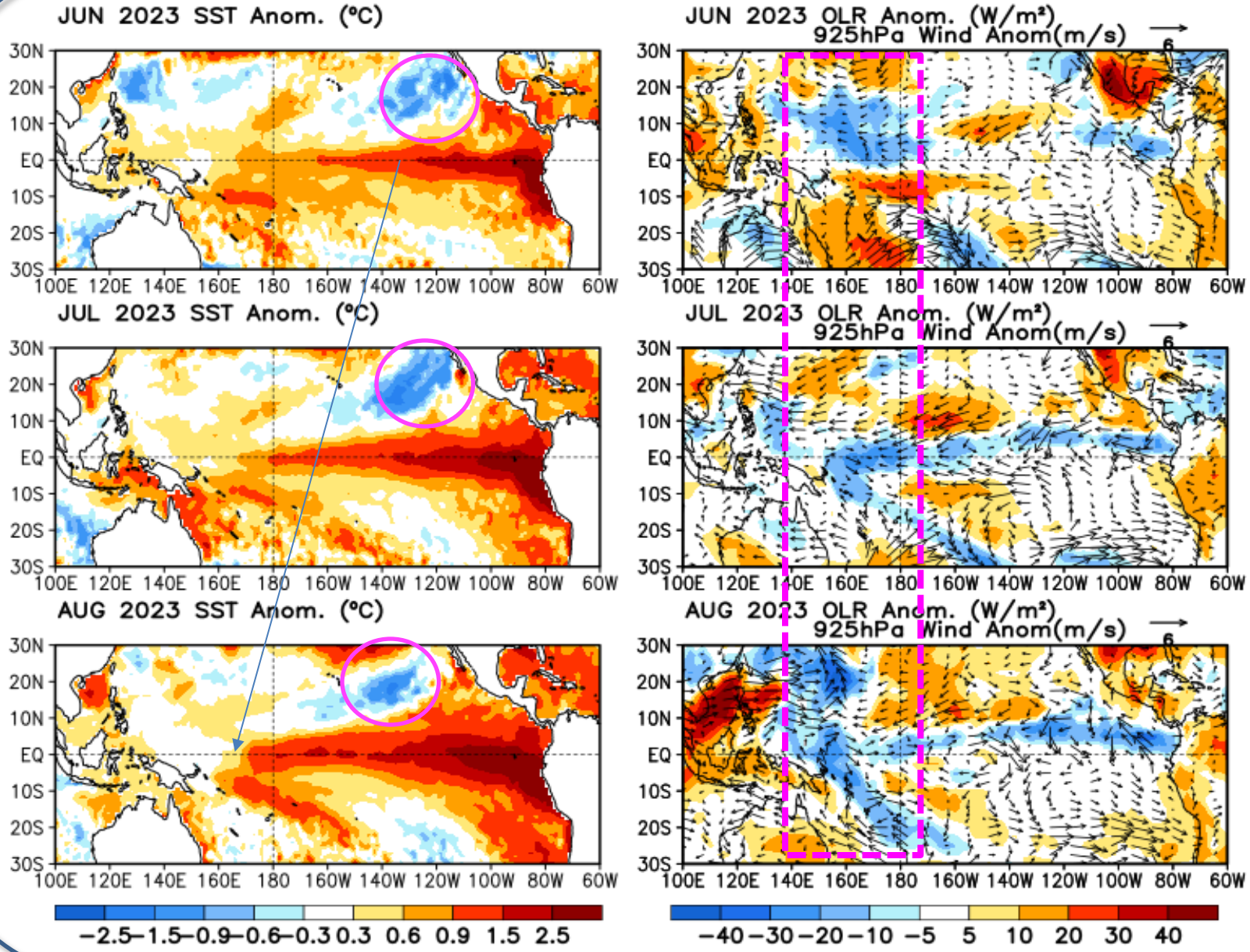
Tropical Pacific Ocean and ENSO Conditions

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

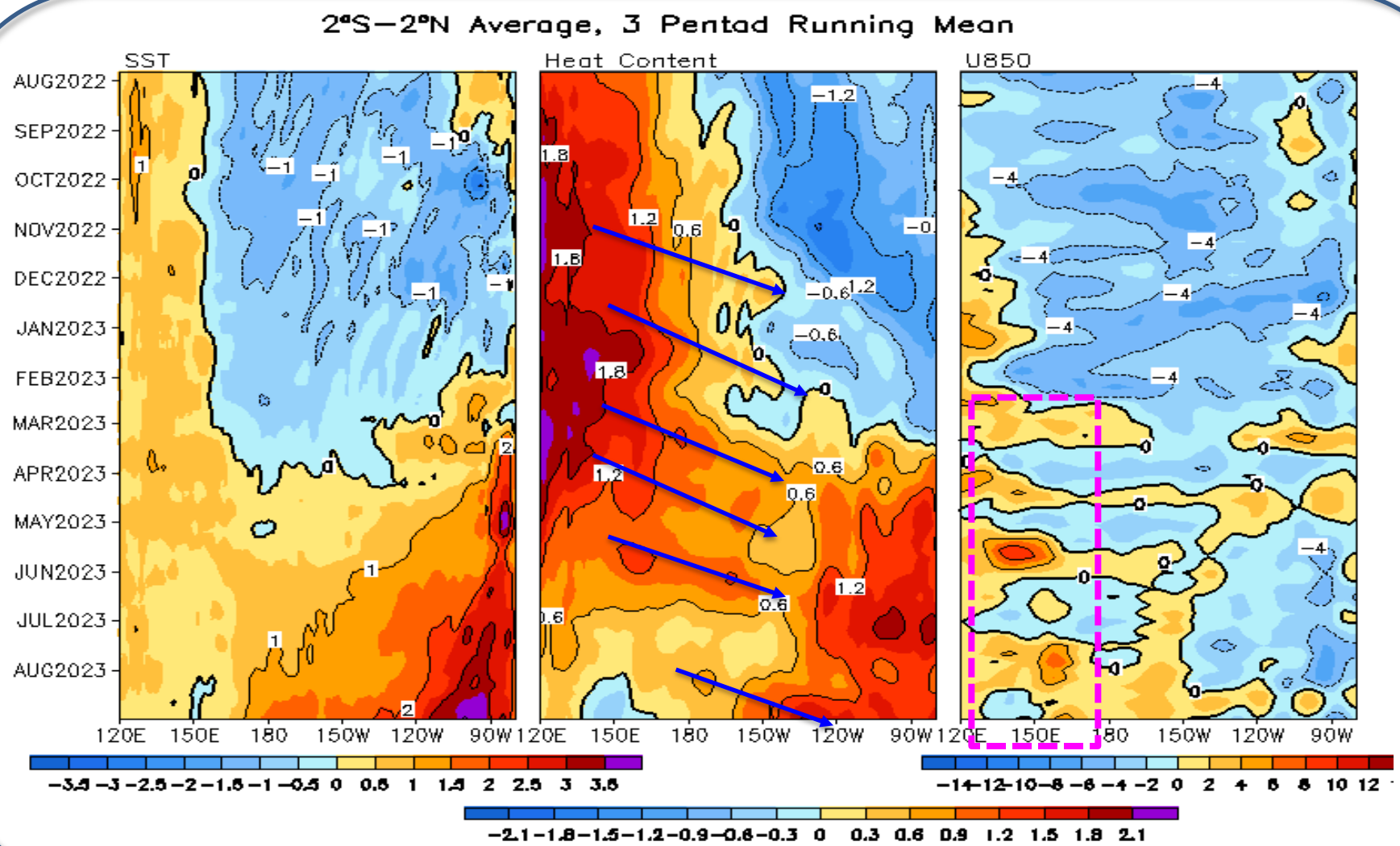


SSTAs (top-left), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right; positive means heat into the ocean), 925-mb wind anomaly vector and its amplitude (bottom-left),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

Westward Expansion & Evolution of Coastal El Niño



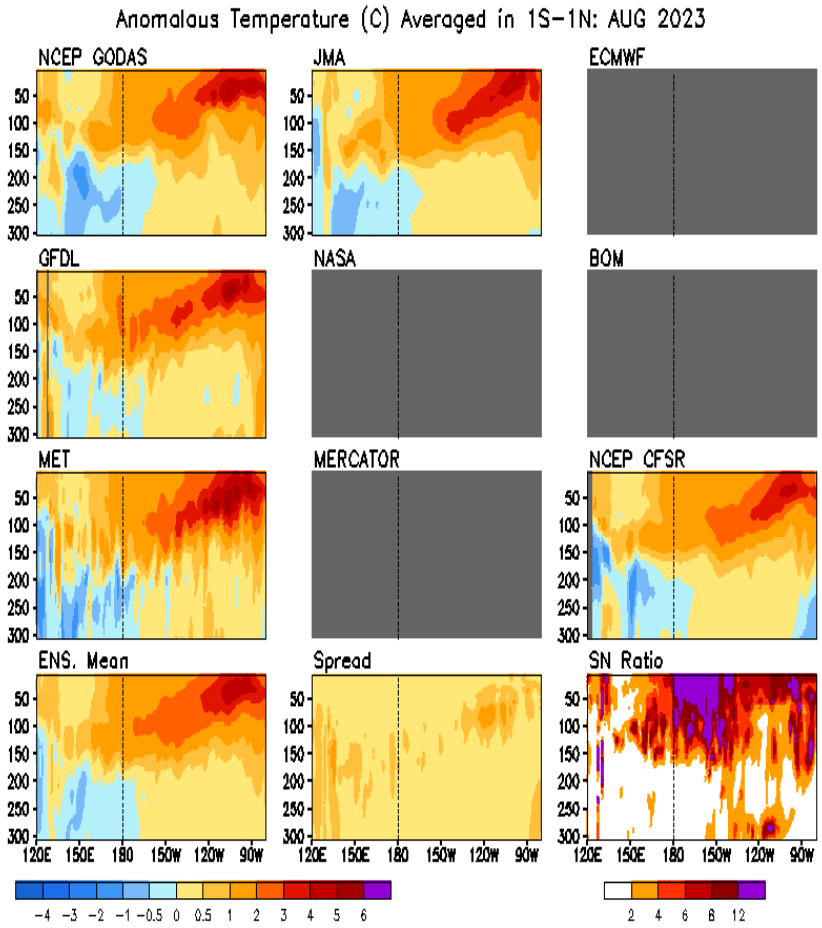
Equatorial Pacific SST (°C), HC300 (°C), u850 (m/s) Anomalies

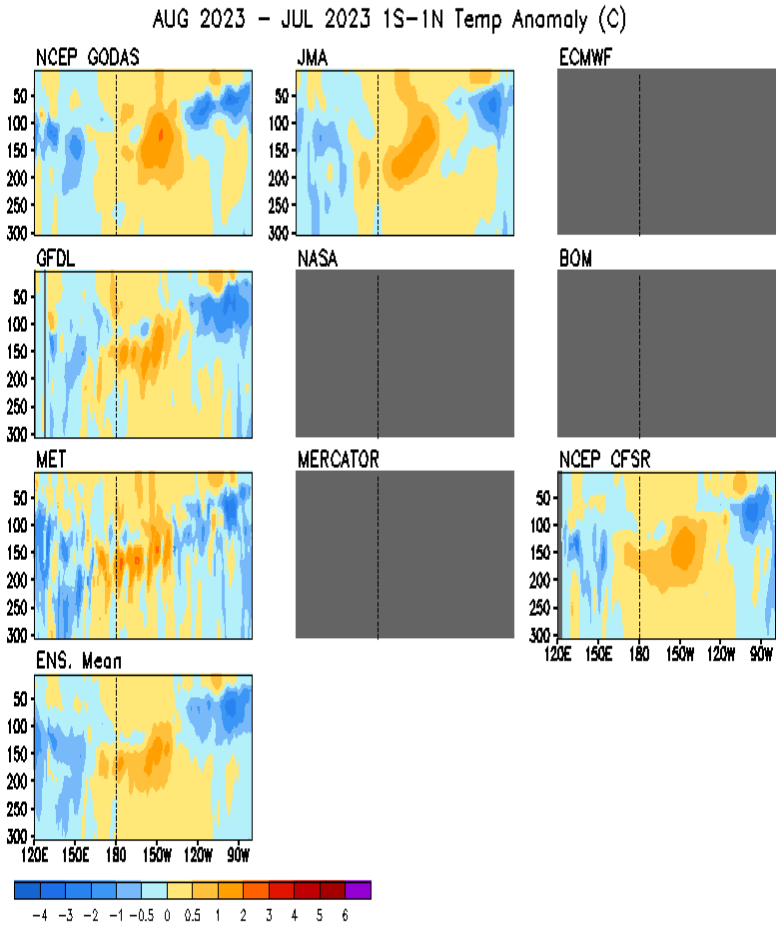


-Since Feb 2023, a set of westerly wind surges triggered downwelling Kelvin waves, helping to reinforce the subsurface warming in the central-eastern Pacific.

- Positive SST anomalies continued to strengthen and expanded westward.

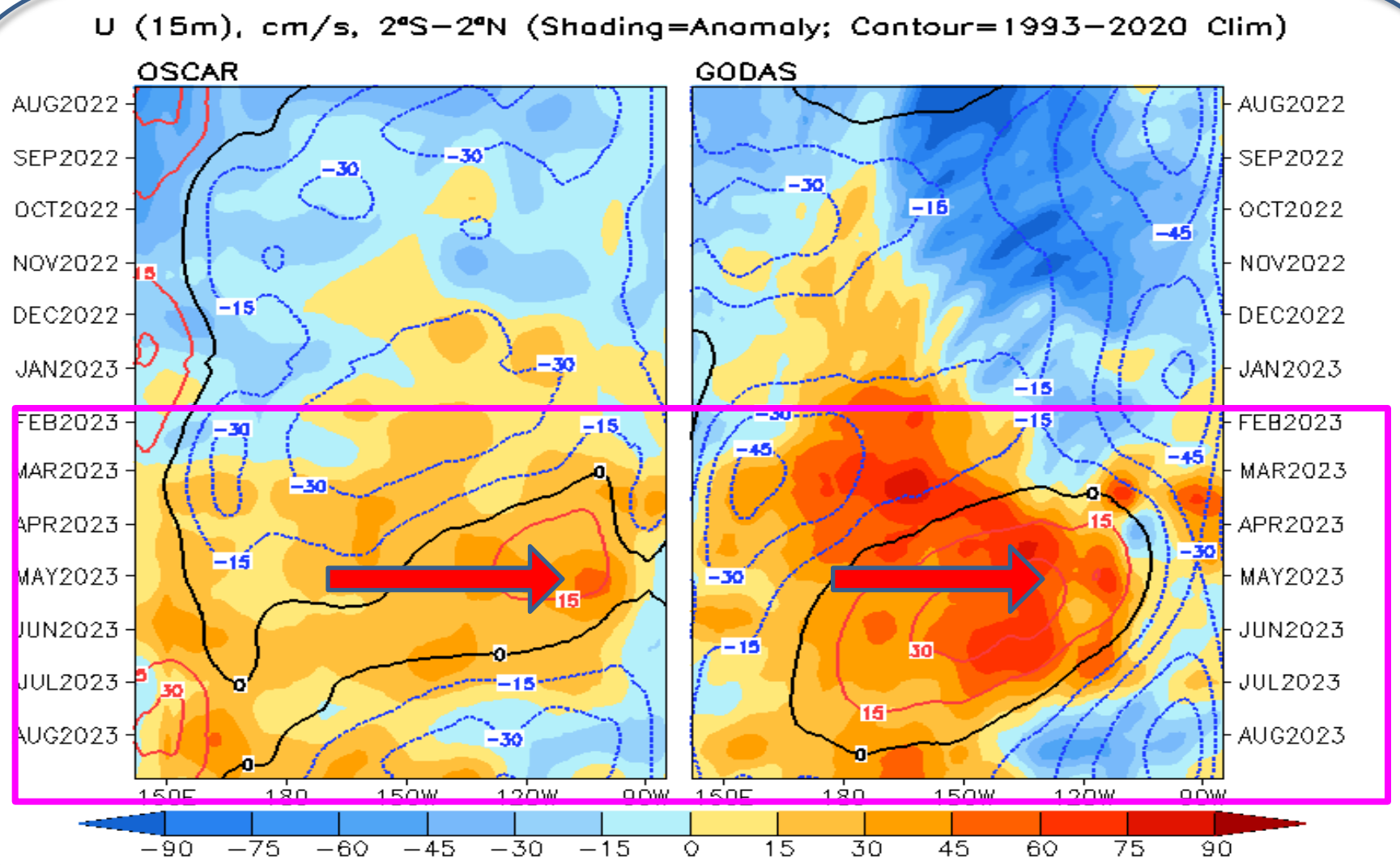
Multiple Ocean Reanalysis Intercomparison: Temperature Anomaly and Tendency at Equator





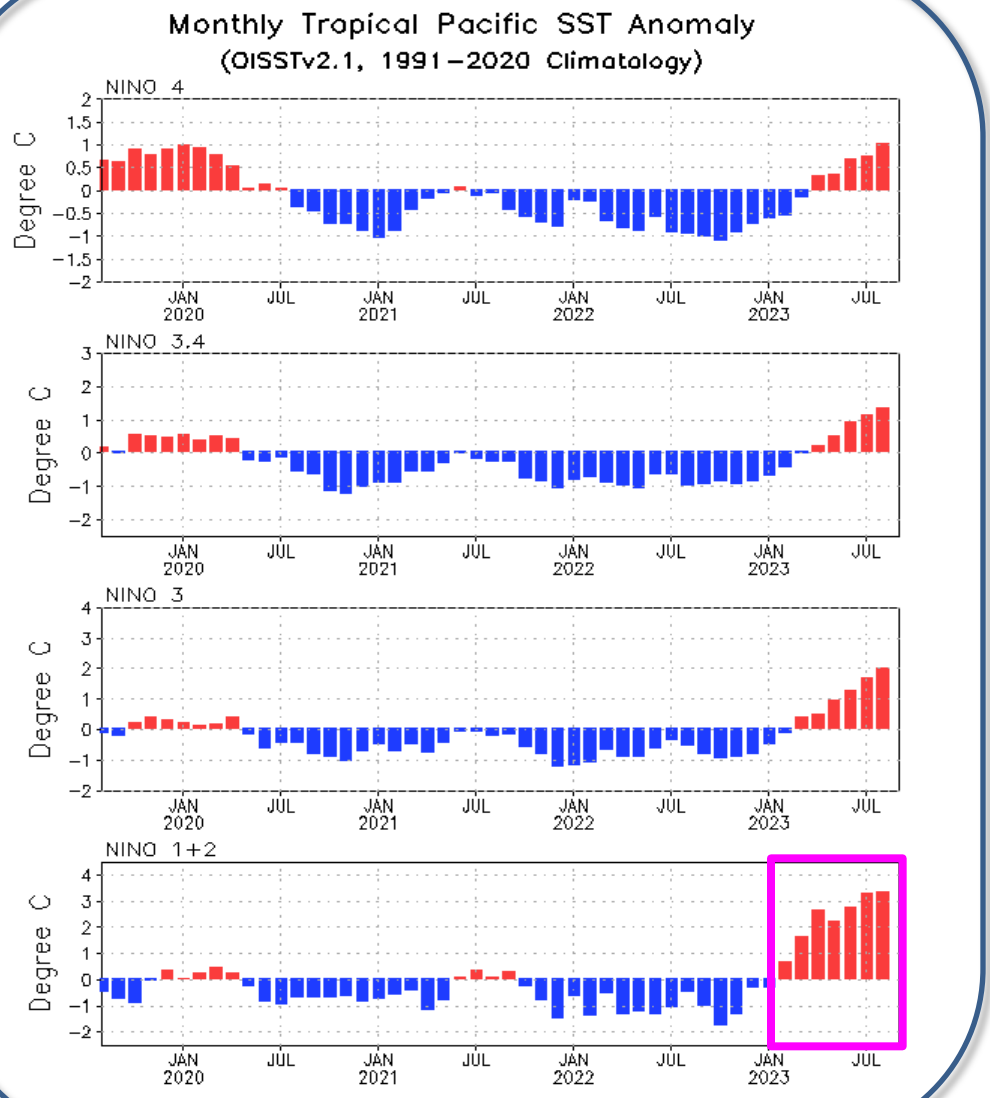
The monthly subsurface temperature data is obtained from the Real-time Ocean Reanalysis Intercomparison Project(https://www.cpc.ncep.noaa.gov/products/GODAS/multiora93_body.html).

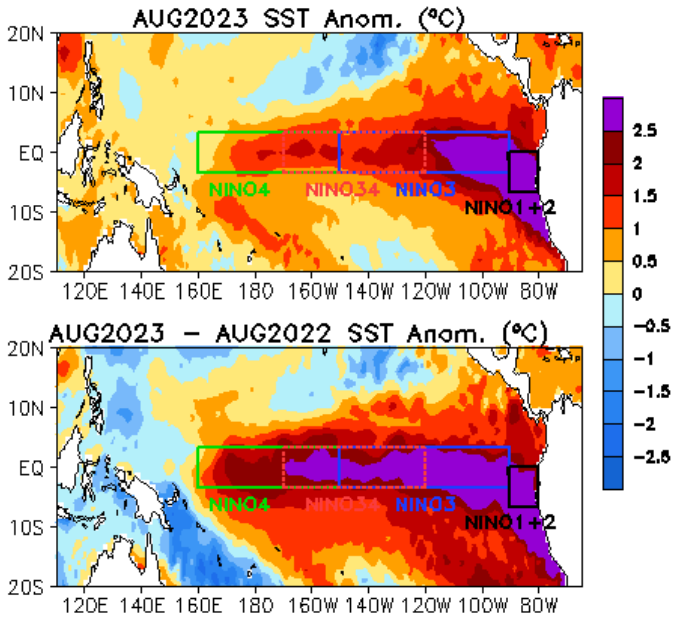
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- Anomalous eastward currents were present in the equatorial Pacific in both OSCAR and GODAS since Feb 2023, which were consistent with the growth of the positive SSTA.

Evolution of Pacific Niño SST Indices





- All Niño indices strengthened in Aug 2023, with Niño3.4 = 1.3°C.

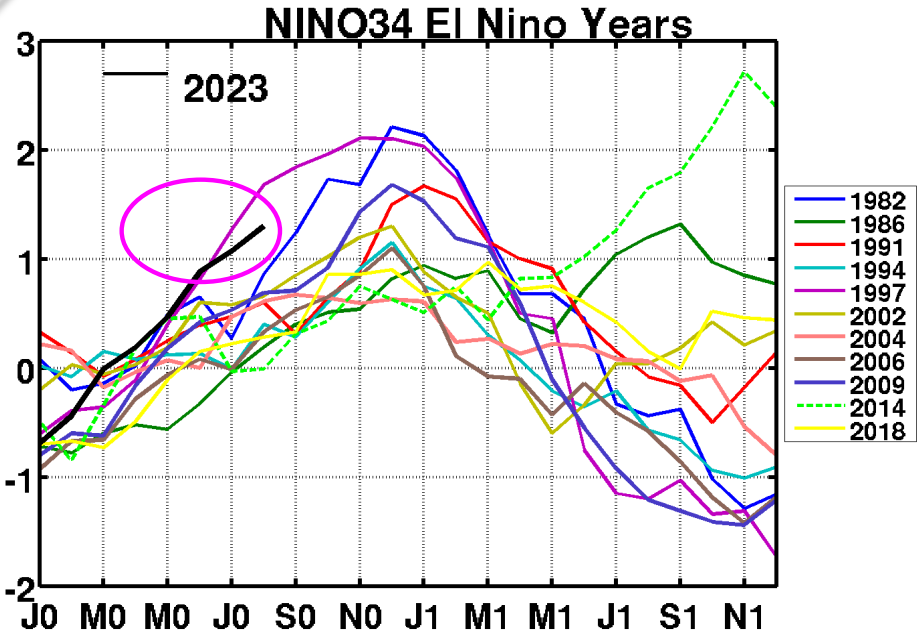
- A coastal El Niño developed in Feb 2023 and continued to grow with Niño1+2= 3.3°C in Aug 2023.

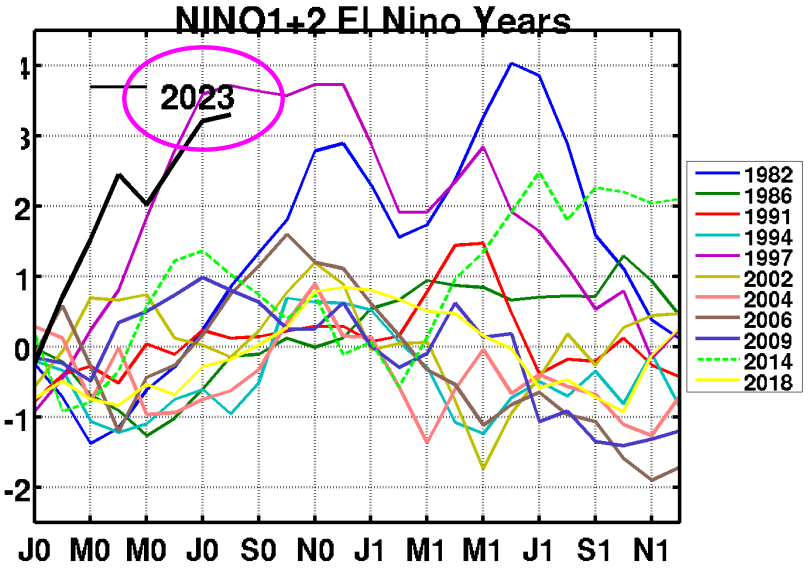
- Compared with Aug 2022, the tropical Pacific was much warmer in Aug 2023.

- The indices may have 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.

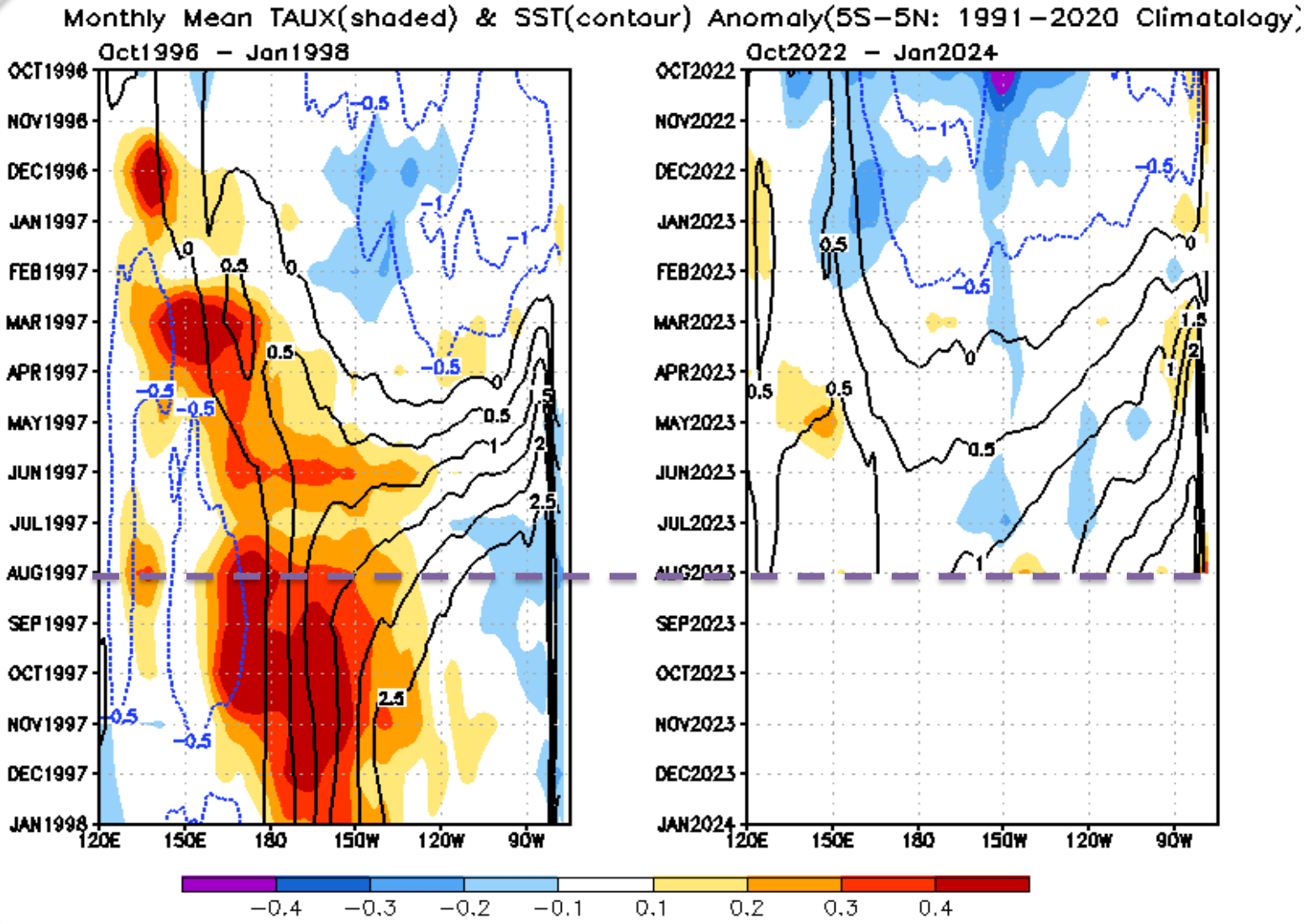
Evolution of NINO34 & NINO1+2 in El Niño Years





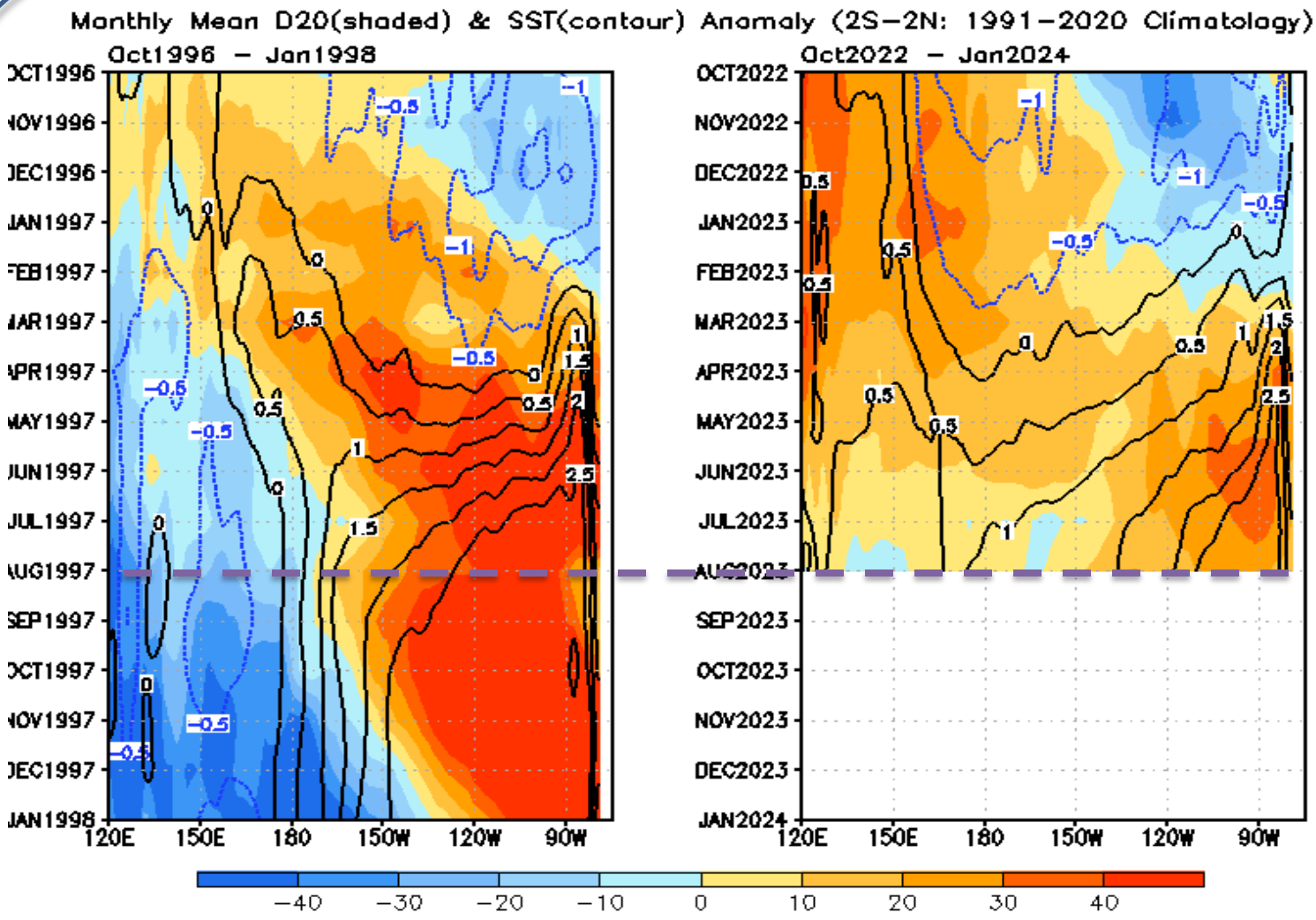
Nino 34 and NINO1+2 indice are derived from the NCEP OI SST analysis, and anomalies are departures from the 1991-2020 base period means

Evolution of Monthly Mean Zonal Wind Stress Anomaly across [5S-5N]



Data source: NCEP R2 reanalysis

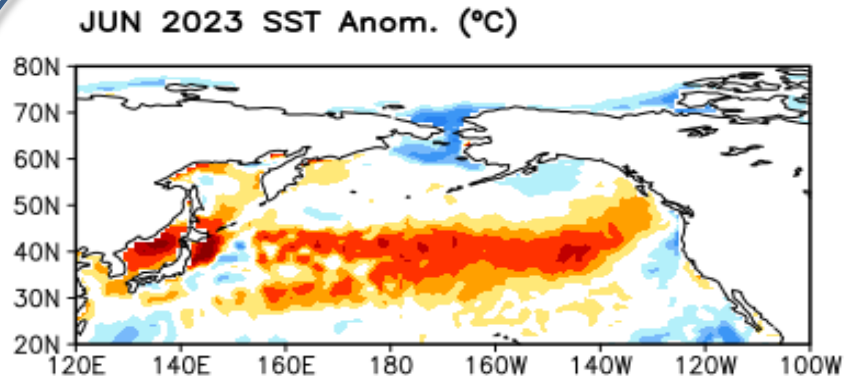
Evolution of Monthly Mean D20 Anomaly across [2S-2N]

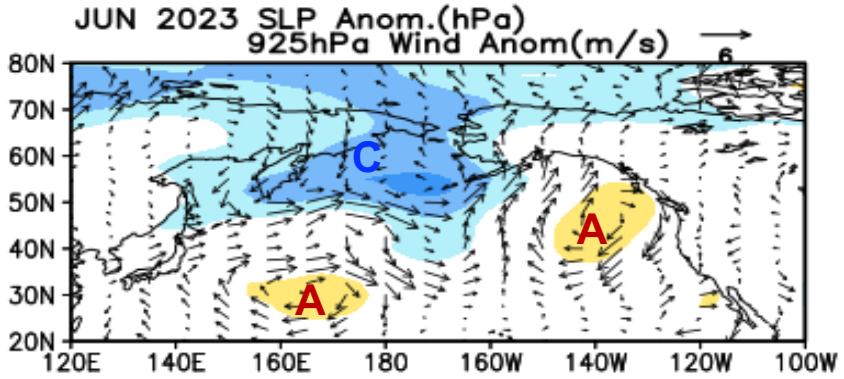


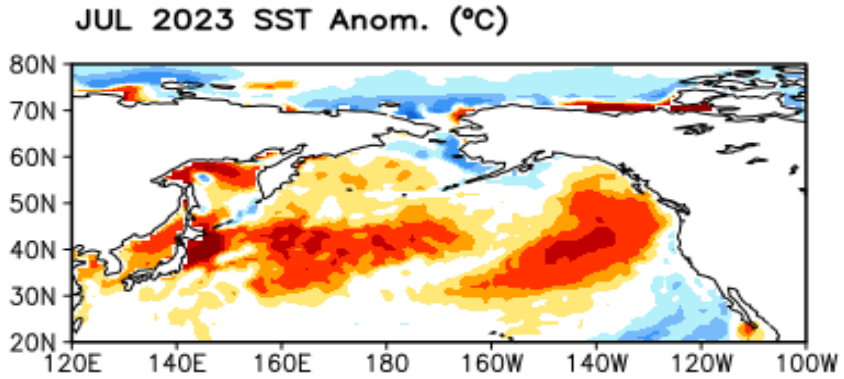
Data source: NCEP GODAS

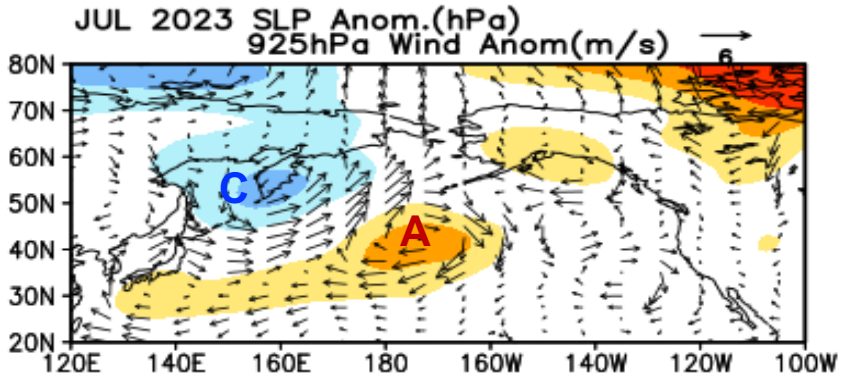
North Pacific & Arctic Oceans

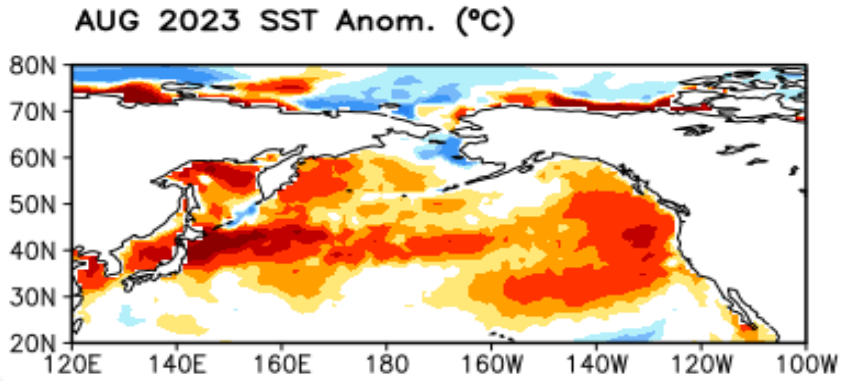
Last 3- month North Pacific SST, SLP, and uv925 anomalies

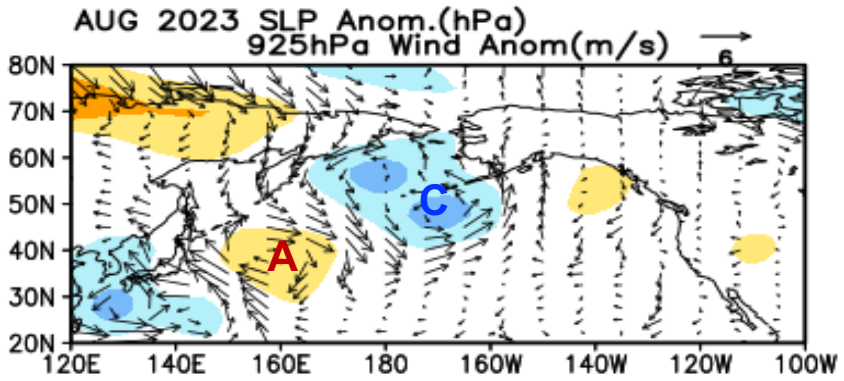


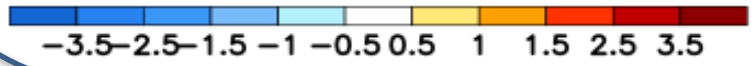


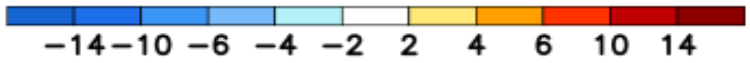




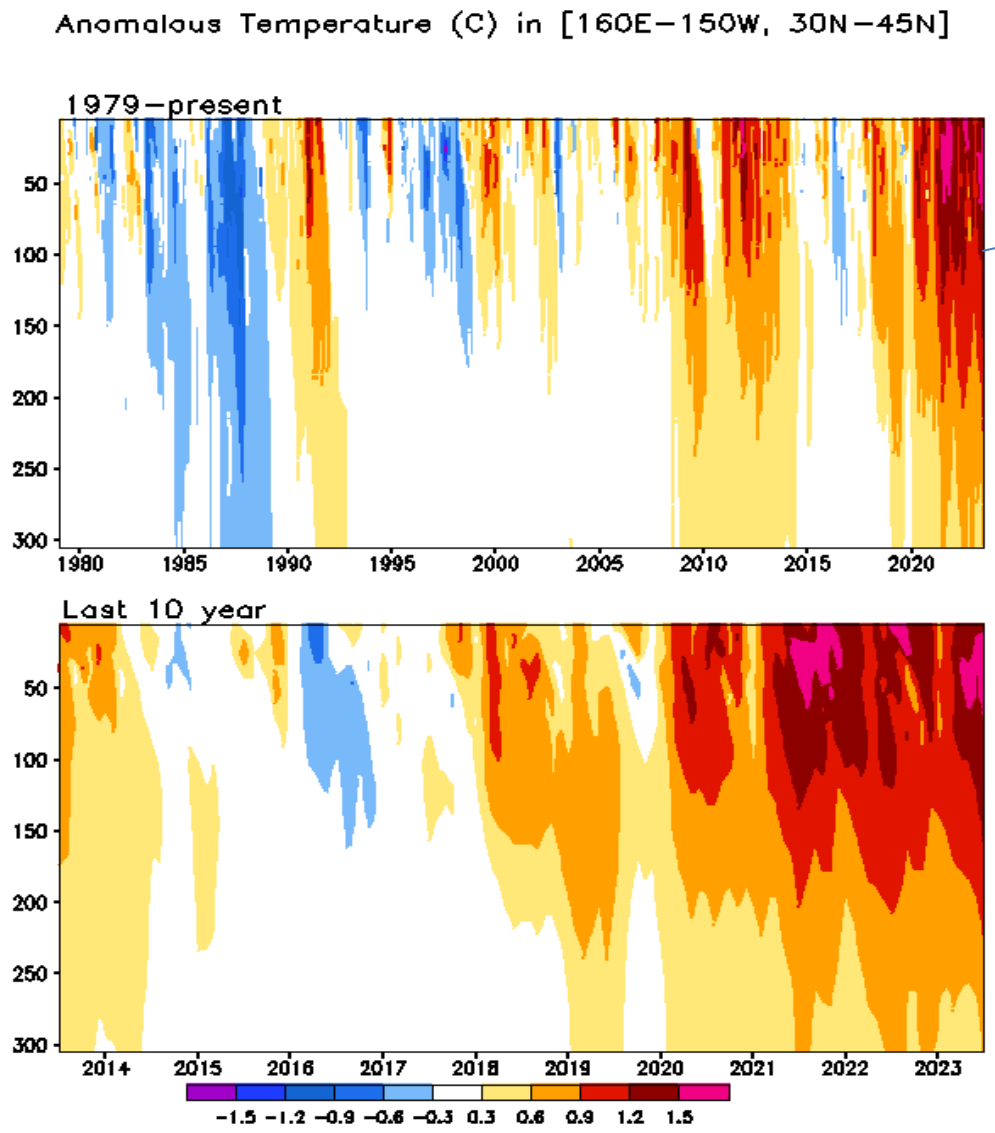


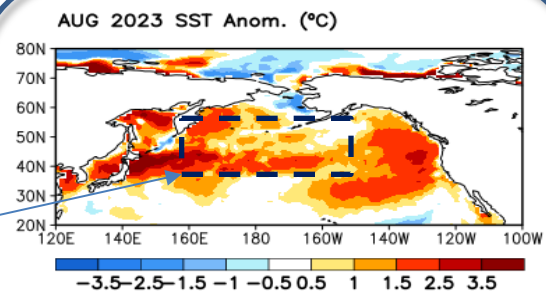


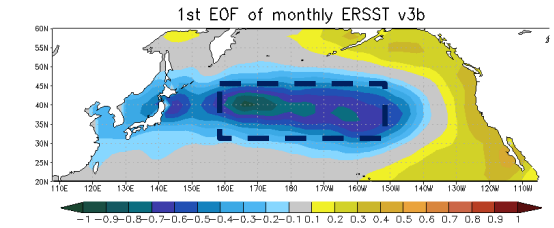




Subsurface Temperature Anomaly in the Northcentral Pacific

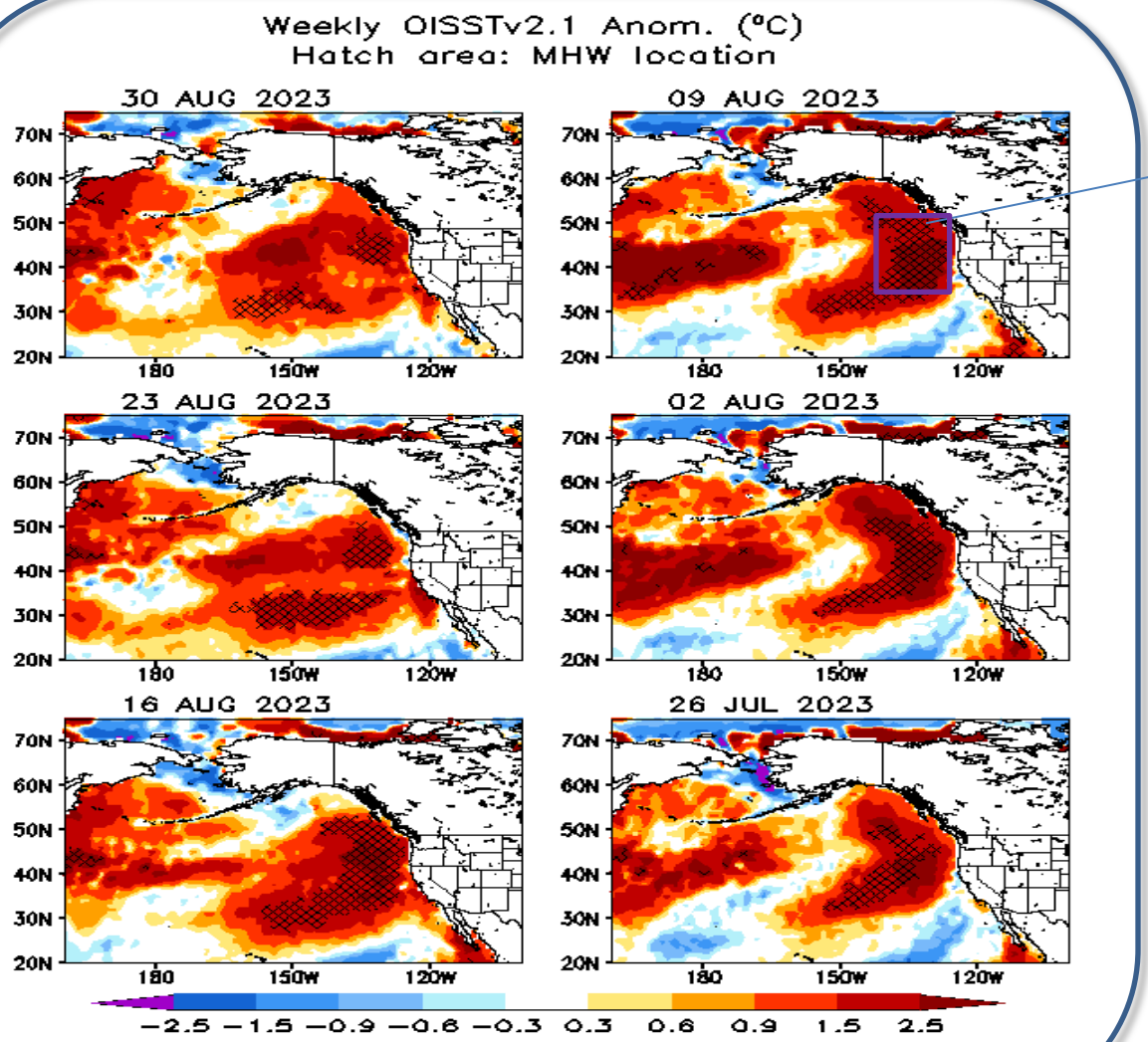


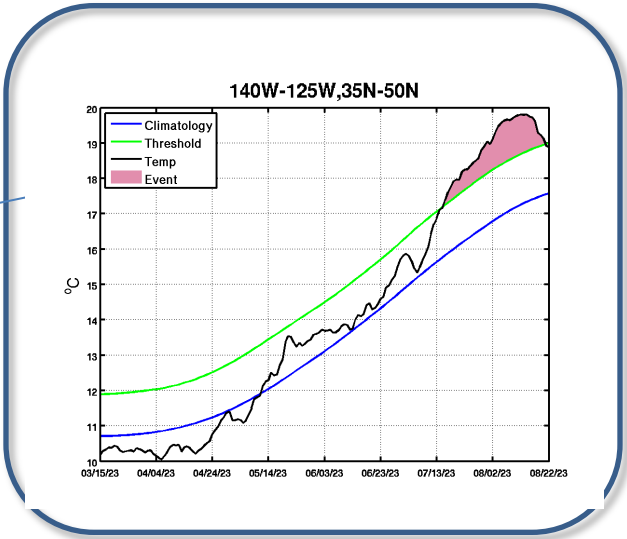




- Positive temperature anomaly (>0.9ºC) penetrated to 150m deep and persisted since 2020.
- Subsurface warming in the last three years is the strongest since 1979.

Weekly SST anomaly and MHWs in the North Pacific

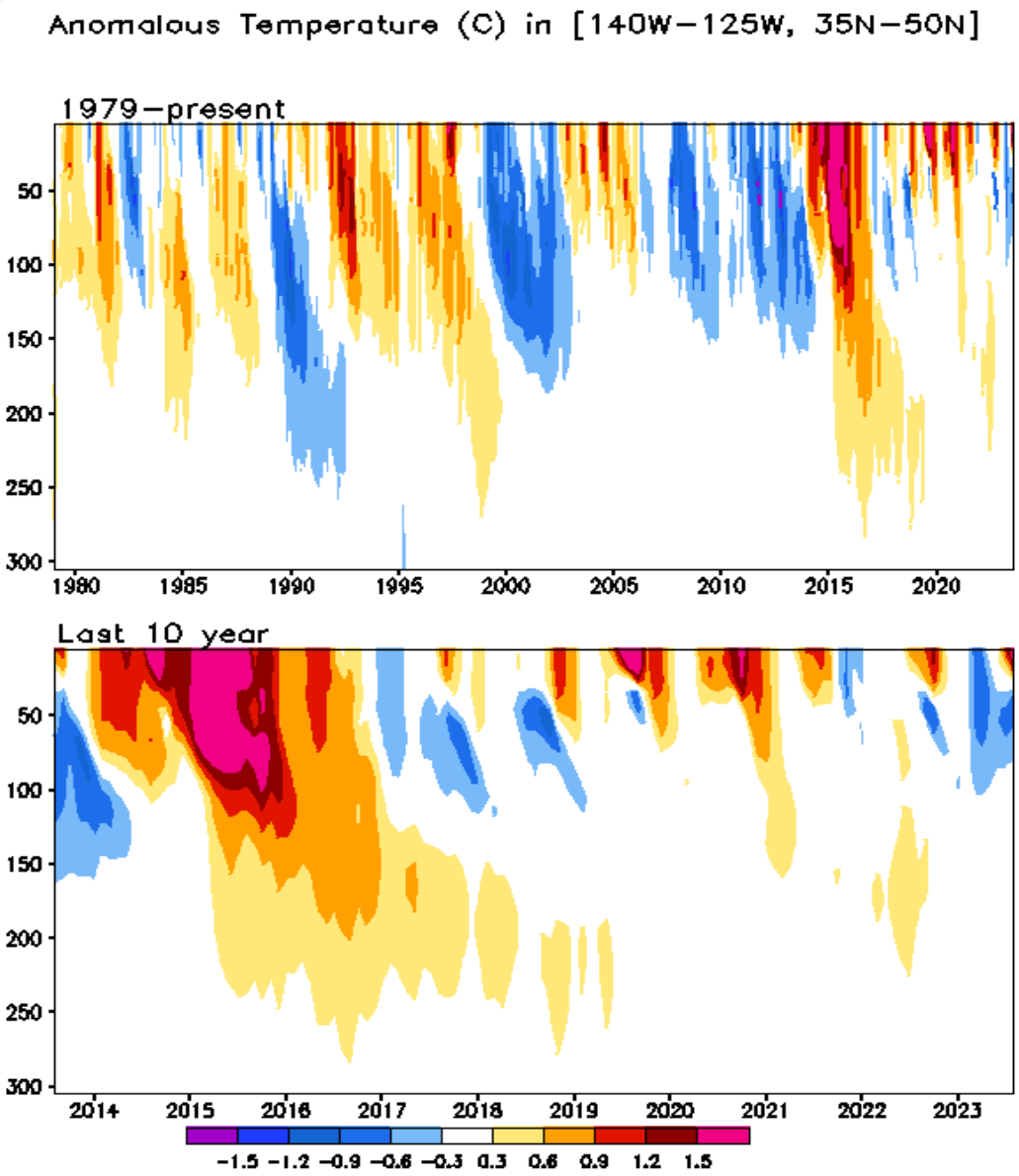


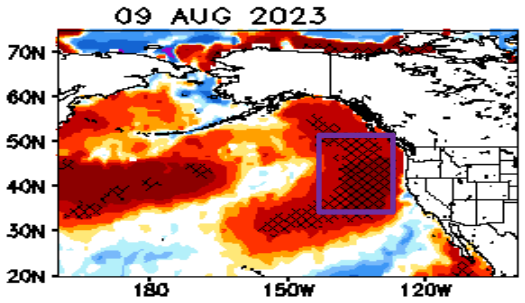


- MHWs persisted near the northwest coast of USA in Aug 2023.
- Considerable amount of anomalously warm waters persisted near the coast of California.

(Left panel) Weekly SST anomaly (shaded) and locations experience Marine heat waves (hatched) by the date labelled in the plot. (right panel) SST evolution at a specific location. Green line and blue line denote the seasonal 90th percentile and daily climatology, respectively. Shaded area denotes the periods experiencing MHW. MHW is defined as a discrete prolonged warmer than 90th percentile of daily SST for at least 14 days. Data is derived from NCEI OISSTv2.1 and the climatology reference period is 1991-2020

Subsurface Temperature Anomaly in the Northeast Pacific

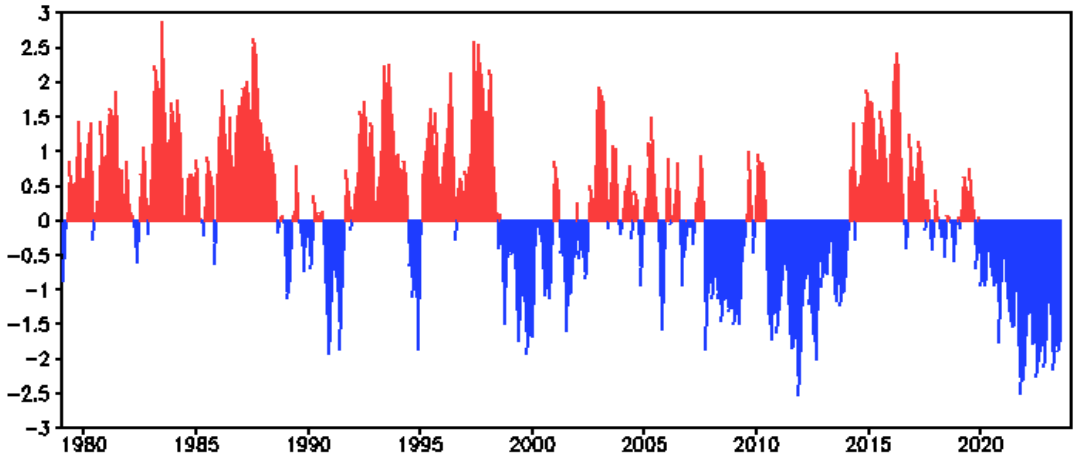




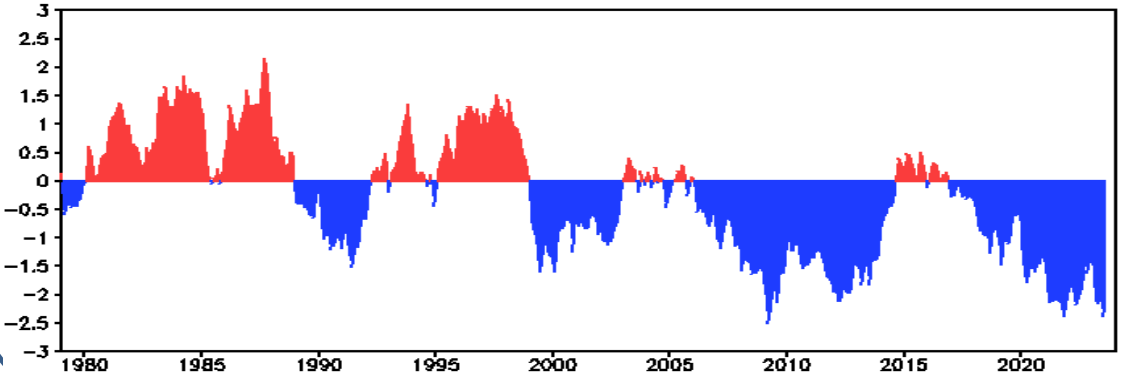
- Subsurface warm water was only confined in the upper 50m in Aug 2023.

Two Oceanic PDO indices

SST-based PDO (Wen et al. 2014: GRL)



H300-based PDO (Arun and Wen 2016:Mon.Wea.Rev.)



- The negative phase of PDO has persisted since Jan 2020 with PDOI = -1.7. in Aug 2023.

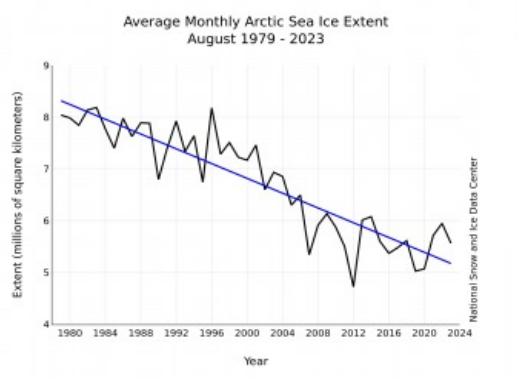
- Negative H300-based PDO index has persisted since Nov 2016, with HPDO = - 2.2 in Aug 2023.

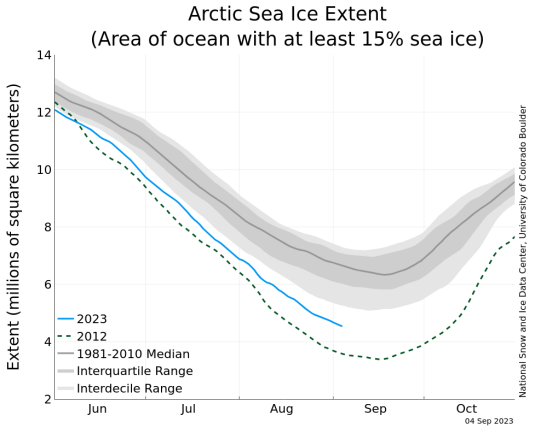
- SST-based PDO index has considerable variability both on seasonal and decadal time scales.

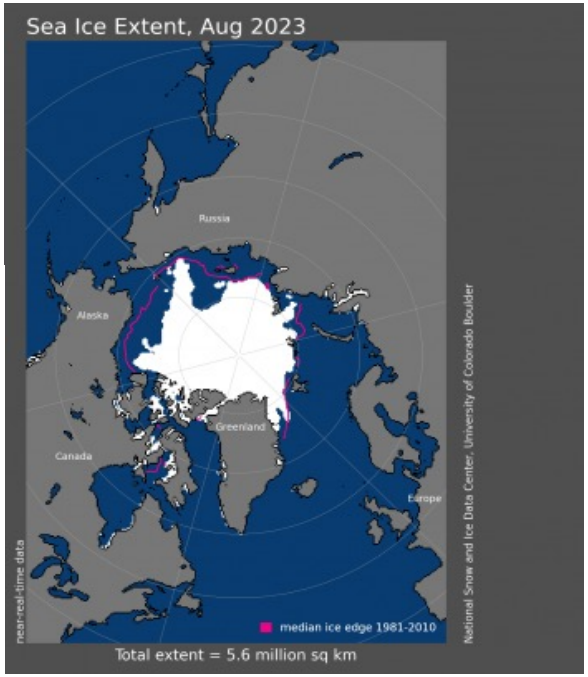
- H300-based PDO index highlights the slower variability and encapsulates an integrated view of temperature variability in the upper ocean.

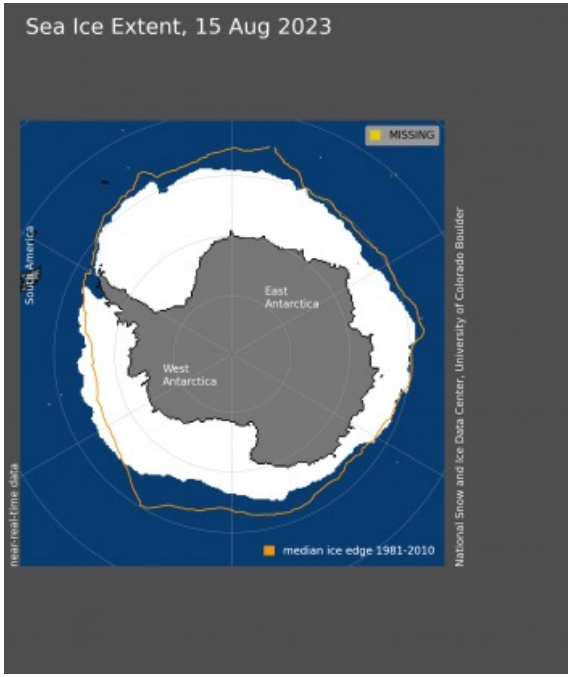
SST-based PDO is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly ERSSTv5 SST anomalies onto the 1st EOF pattern. H300-based Pacific Decadal Oscillation is defined as the projection of monthly mean H300 anomalies from NCEP GODAS onto their first EOF vector in the North Pacific. PDO indices are downloadable from https://www.cpc.ncep.noaa.gov/products/GODAS/ocean_briefing.shtml.

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





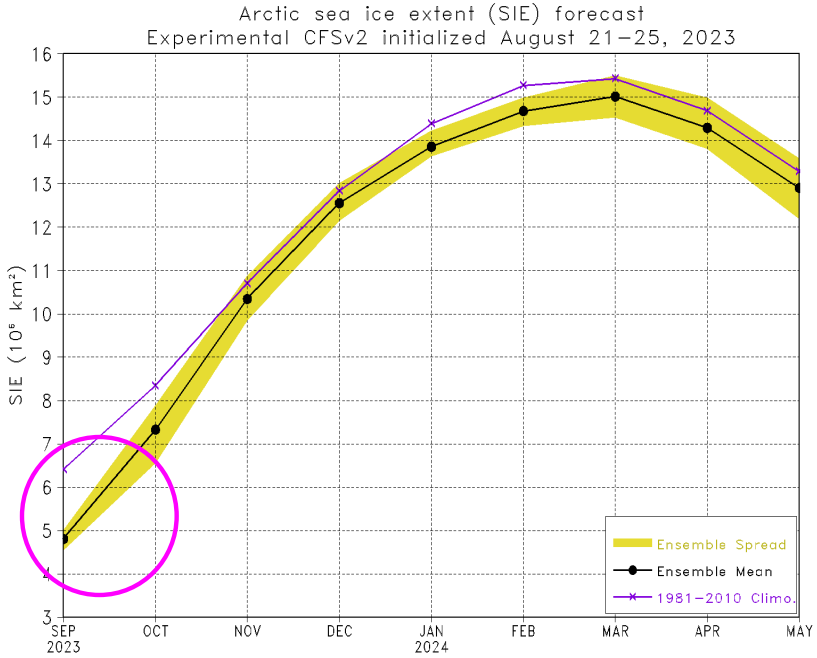




- Average Arctic sea ice extent during Aug 2023 was 5.6 million square kilometers, the eighth lowest August in the satellite record.
- Antarctic sea ice extent is continuing to track at extreme record low levels since 1979.

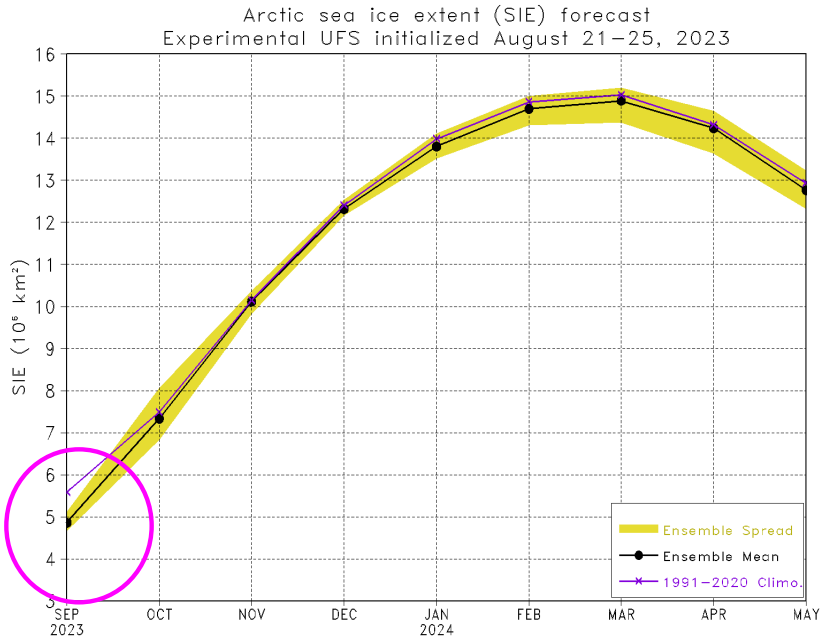
NCEP/CPC Arctic Sea Ice Extent (SIE) Forecast

CFSm5



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

UFS

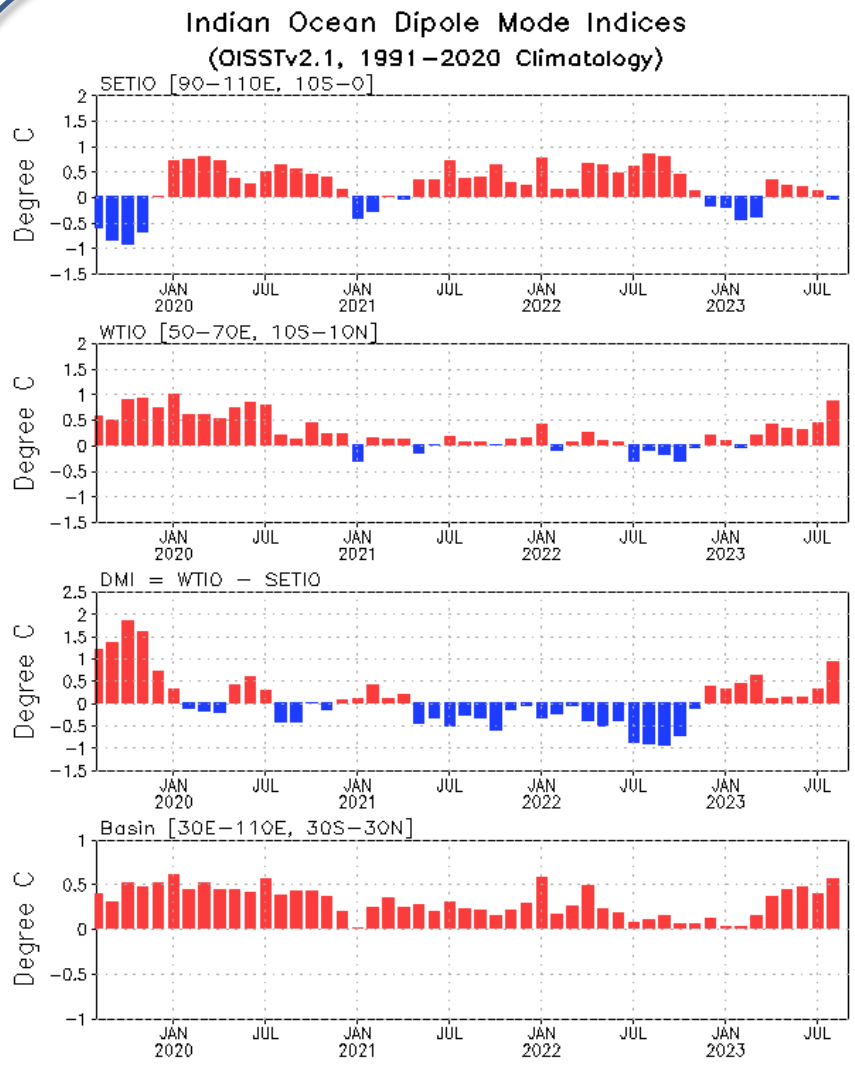


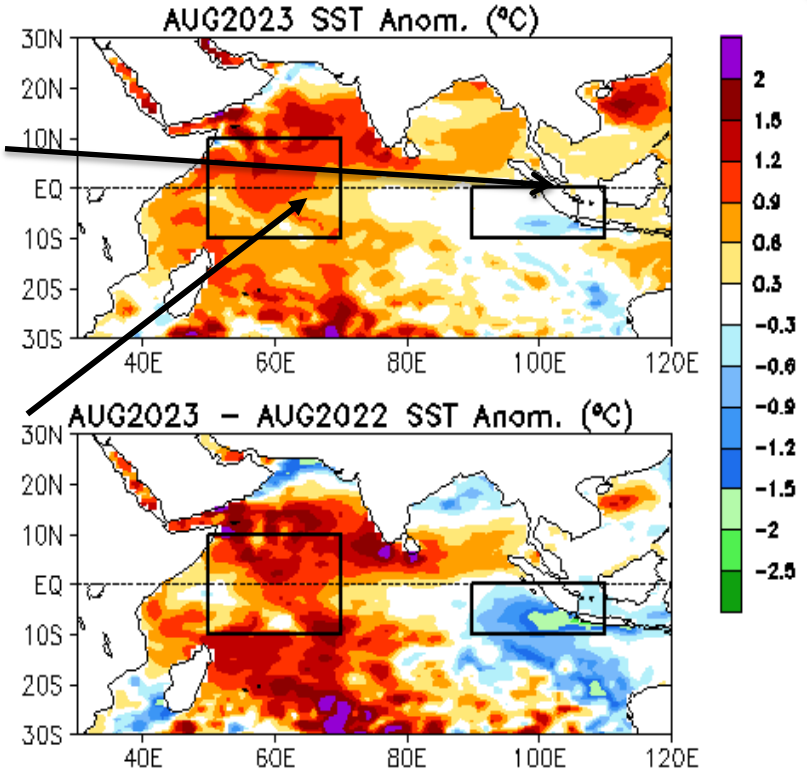
https://www.cpc.ncep.noaa.gov/products/people/jszhu/seaice_seasonal/index.html

- Both CFSm5 and UFS forecasts suggest SIE will be around 5 million square kilometers in Sep 2023.

Indian Ocean

Evolution of Indian Ocean SST Indices

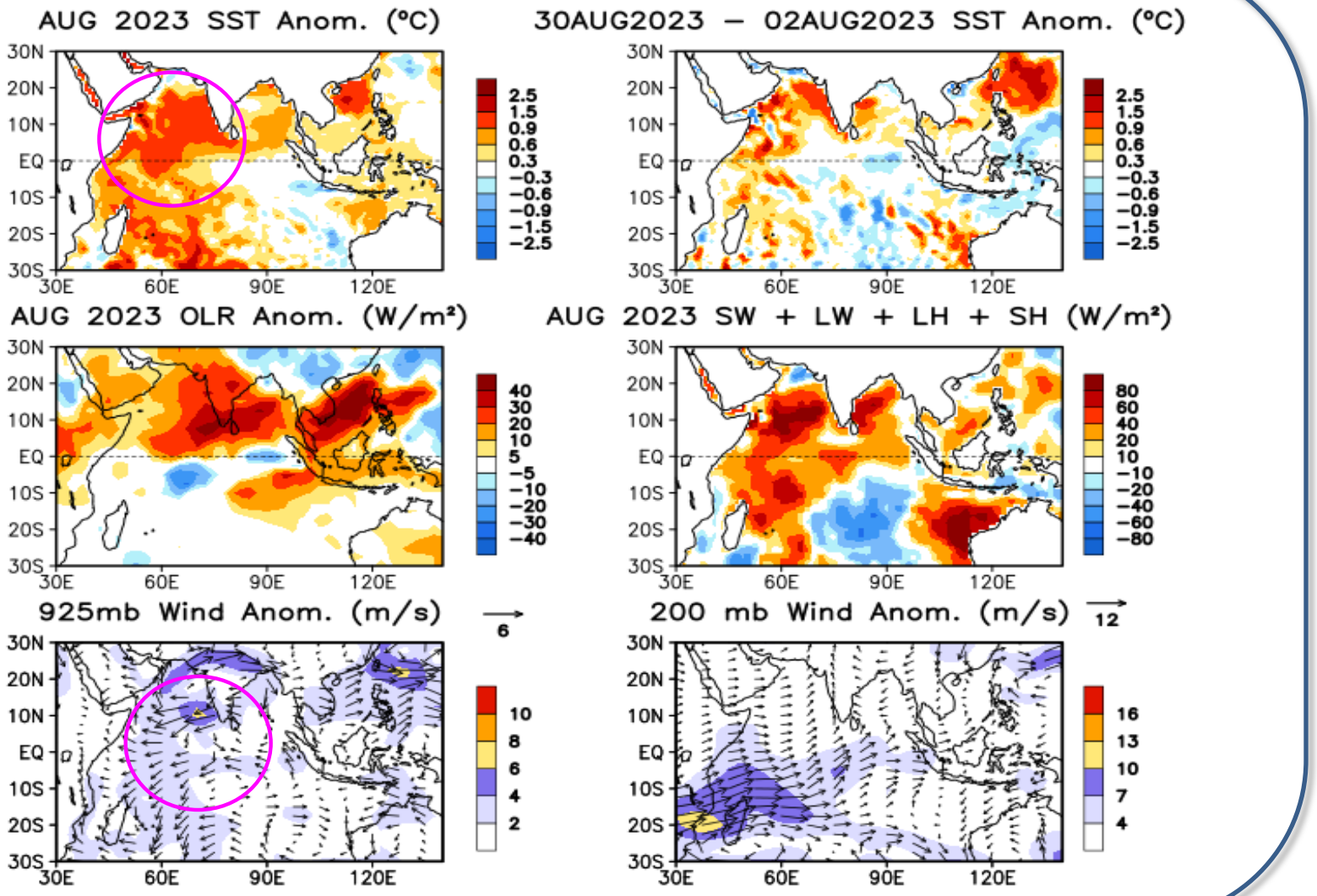




- Positive SSTAs dominated most of the tropical Indian Ocean basin in Aug 2023.
- Indian dipole mode index (DMI) increased substantially in Aug 2023.

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.

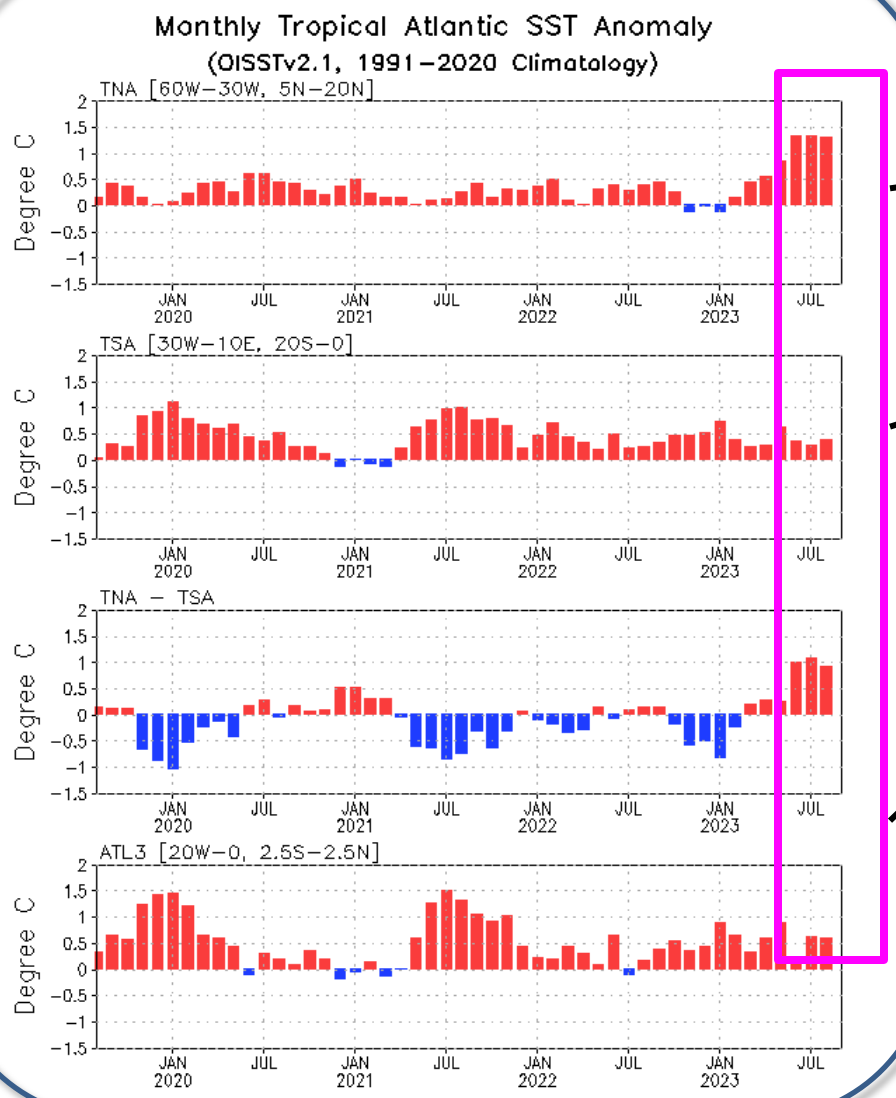
Tropical Indian: SSTA, SSTA Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Wind Anom.

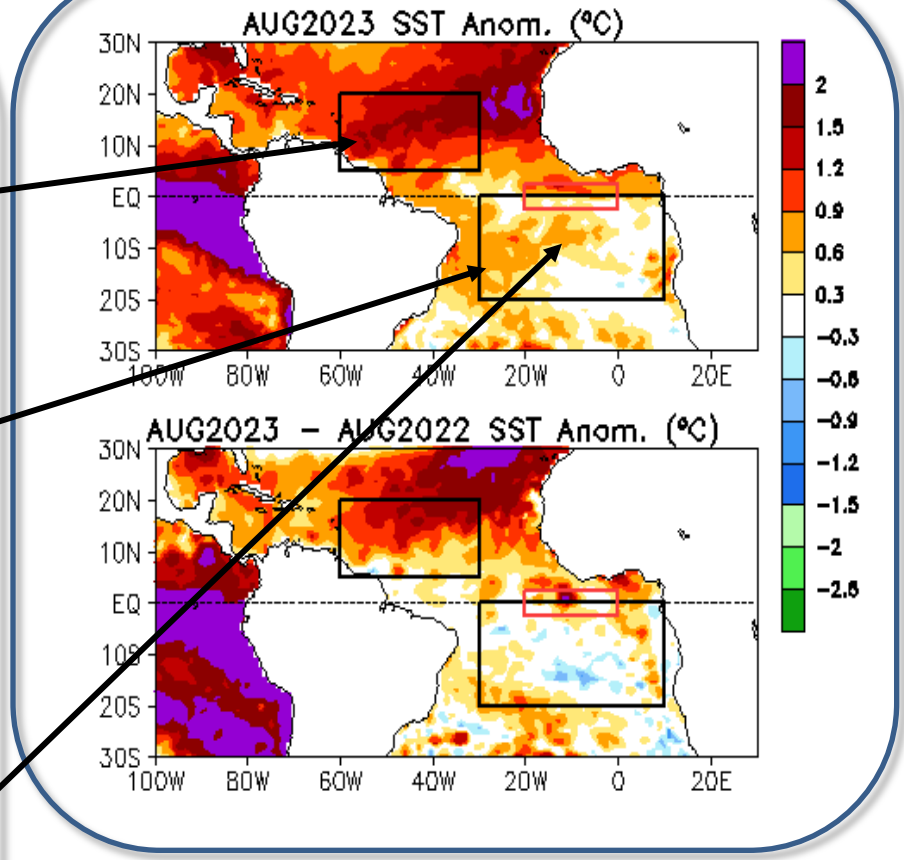


SSTAs (top-left), SSTA tendency (top-right), OLR anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right).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

Tropical and North Atlantic Ocean

Evolution of Tropical Atlantic SST Indices

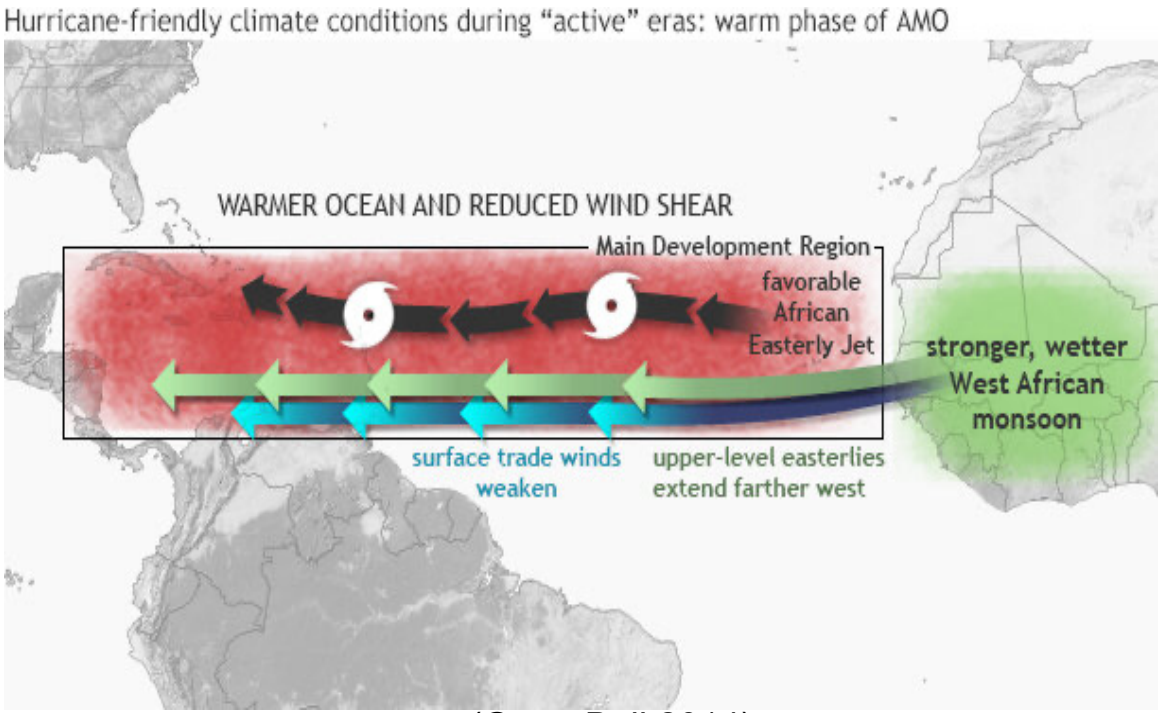




- Strong positive SSTA in the tropical north Atlantic persisted in Aug 2023, contributing to the large value of meridional mode index.
- Positive ATL3 index persisted in Aug 2023.

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.

Hurricane-friendly Climate Conditions



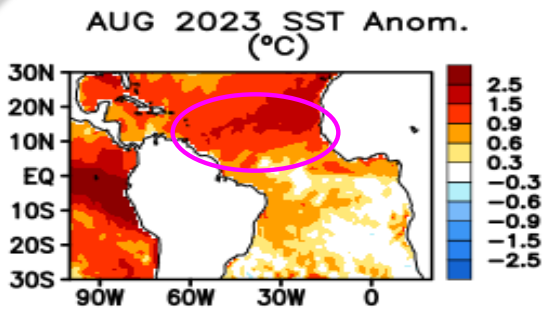
(Gerry Bell,2014)

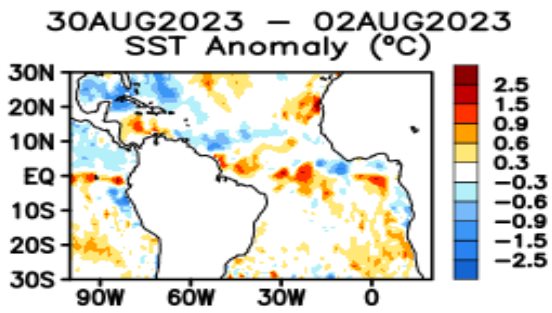
https://www.climate.gov/news-features/blogs/enso/impacts-el-ni%C3%B1o-and-la-ni%C3%B1a-hurricane-season

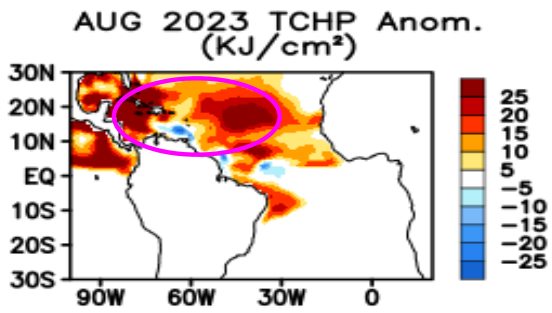
Established theories:

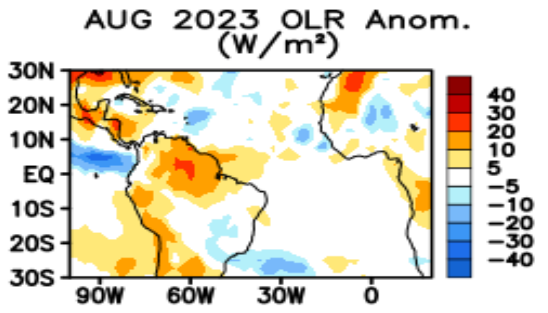
- Warm phase of Atlantic Multi-decadal Oscillation (AMO)
- Warmer SSTs across the Atlantic hurricane main development region
- Reduced wind shear (i.e ENSO impact)
- Stronger West African monsoon

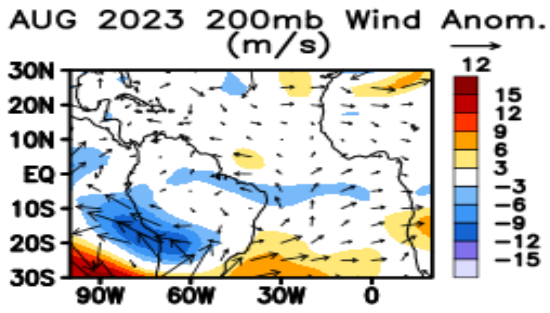
Tropical Atlantic: SST, SST tend., TCHP, OLR, 200 hPa wind, wind share, heat flex, & RH anom.

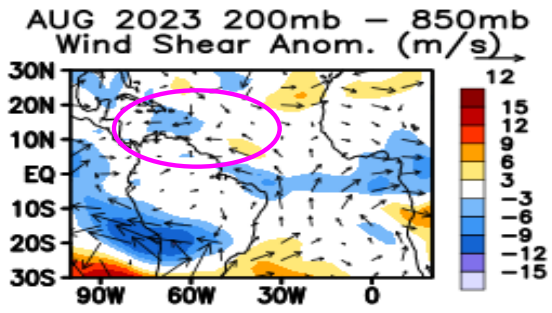


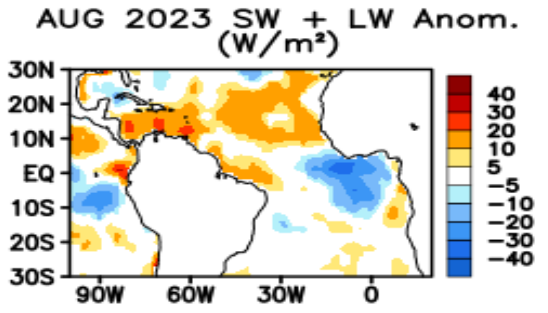


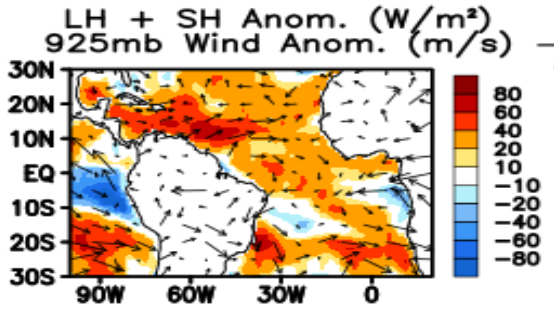


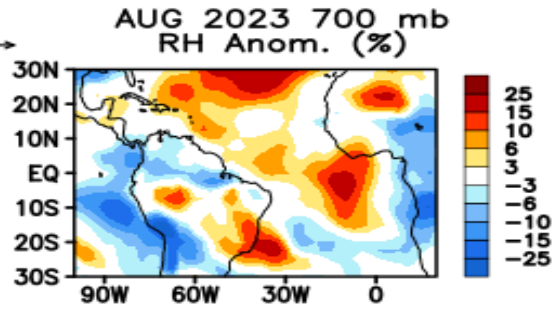






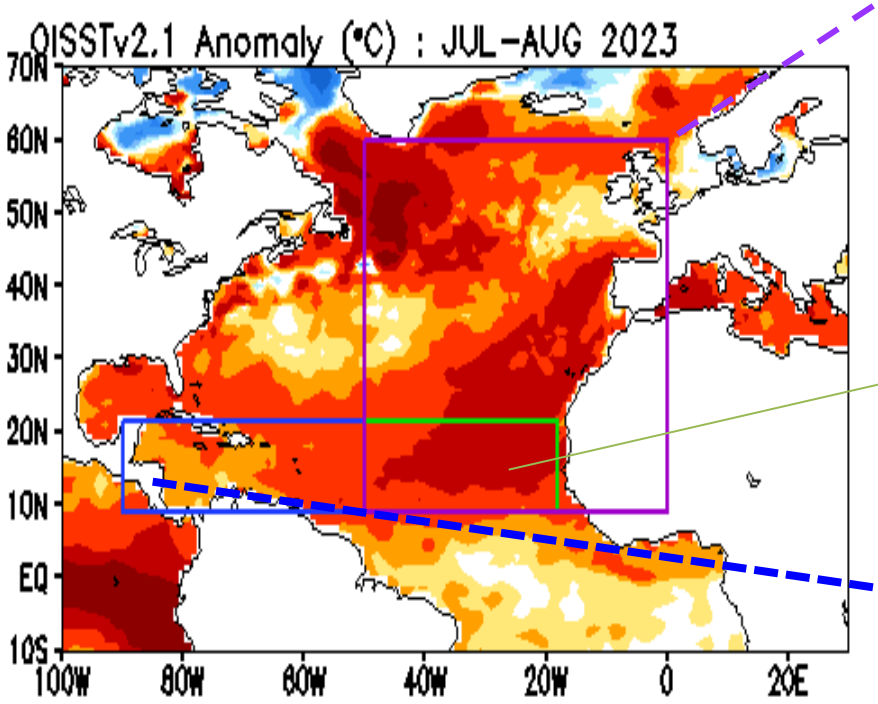


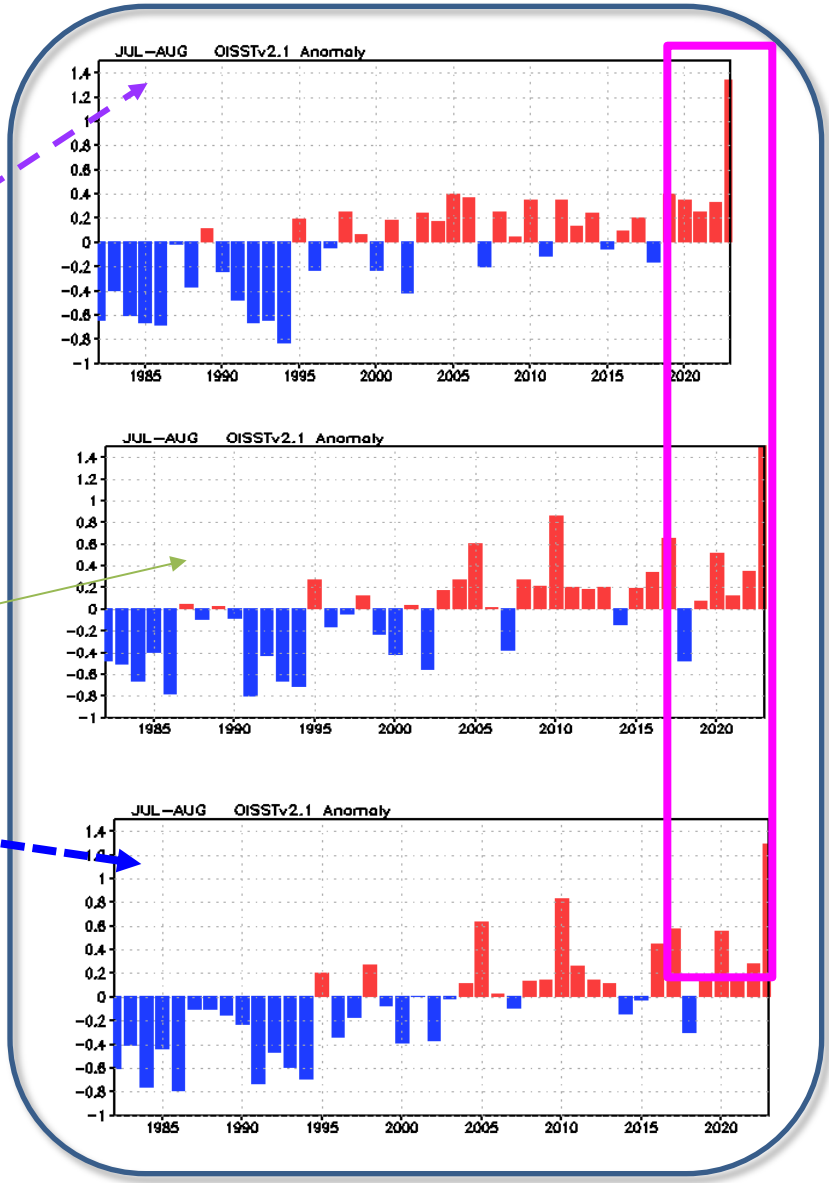




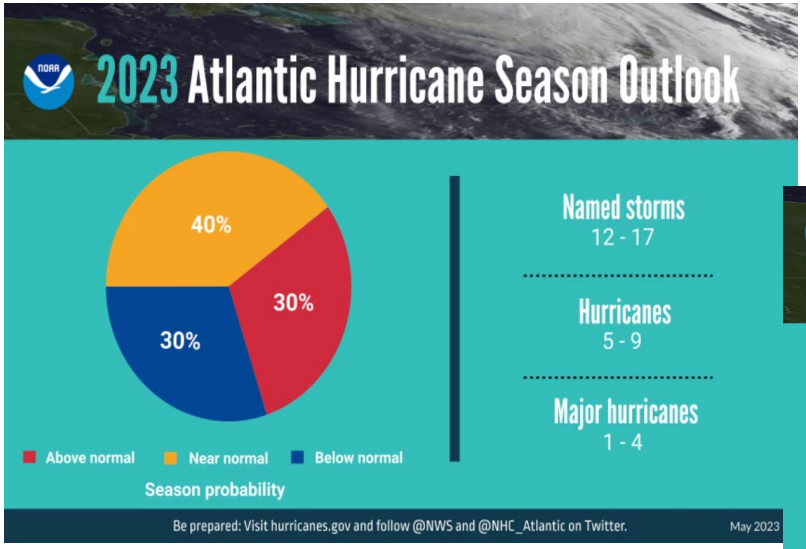
Top Row: SSTA (left; OI SST), SSTA tendency (central), Tropical Cyclone Heat Potential anomaly (right; GODAS).
Middle row: OLR (left; NOAA 18 AVHRR IR), UV200 (central; NCEP CDAS), UV200-UV850 (right; NCEP CDAS) anomalies.
Bottom row: SW+LW (left), LH+SH (central), Relative humidity at 700 hPa (right; NCEP CDAS) anomalies.
Anomalies are departures from the 1991-2020 base period means.

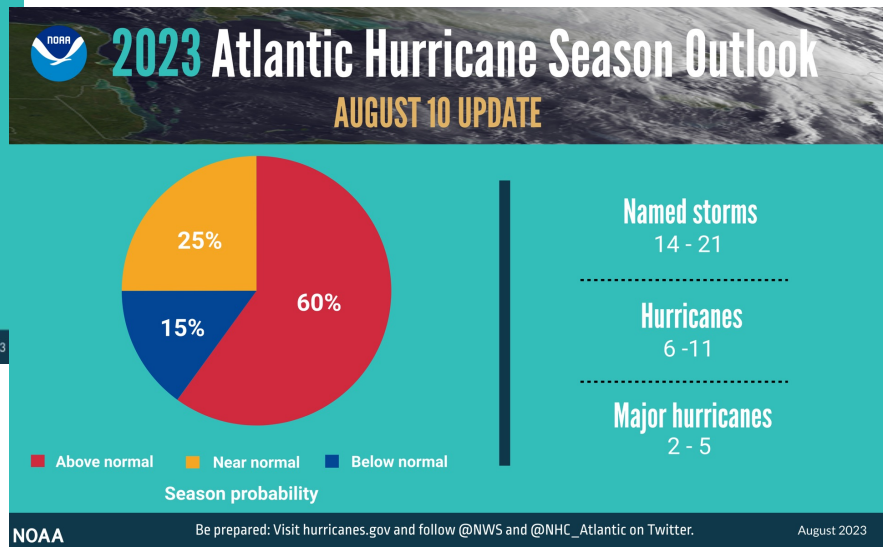
Evolution of SST anomaly in the North Atlantic





2023 Atlantic Hurricane Season Outlook Update





- NOAA forecasters have increased the likelihood of an above-normal Atlantic hurricane season from 30% in outlook issued in May to 60% in August outlook update.
- Main climate factors expected to influence the 2023 Atlantic hurricane activity are : the ongoing El Niño, the warm phase of the Atlantic Multi-Decadal Oscillation and record-warm Atlantic SSTs.
- Likelihood of greater activity rises due to record-warm Atlantic SST .

(https://www.noaa.gov/news-release/noaa-forecasters-increase-atlantic-hurricane-season-prediction-to-above-normal)

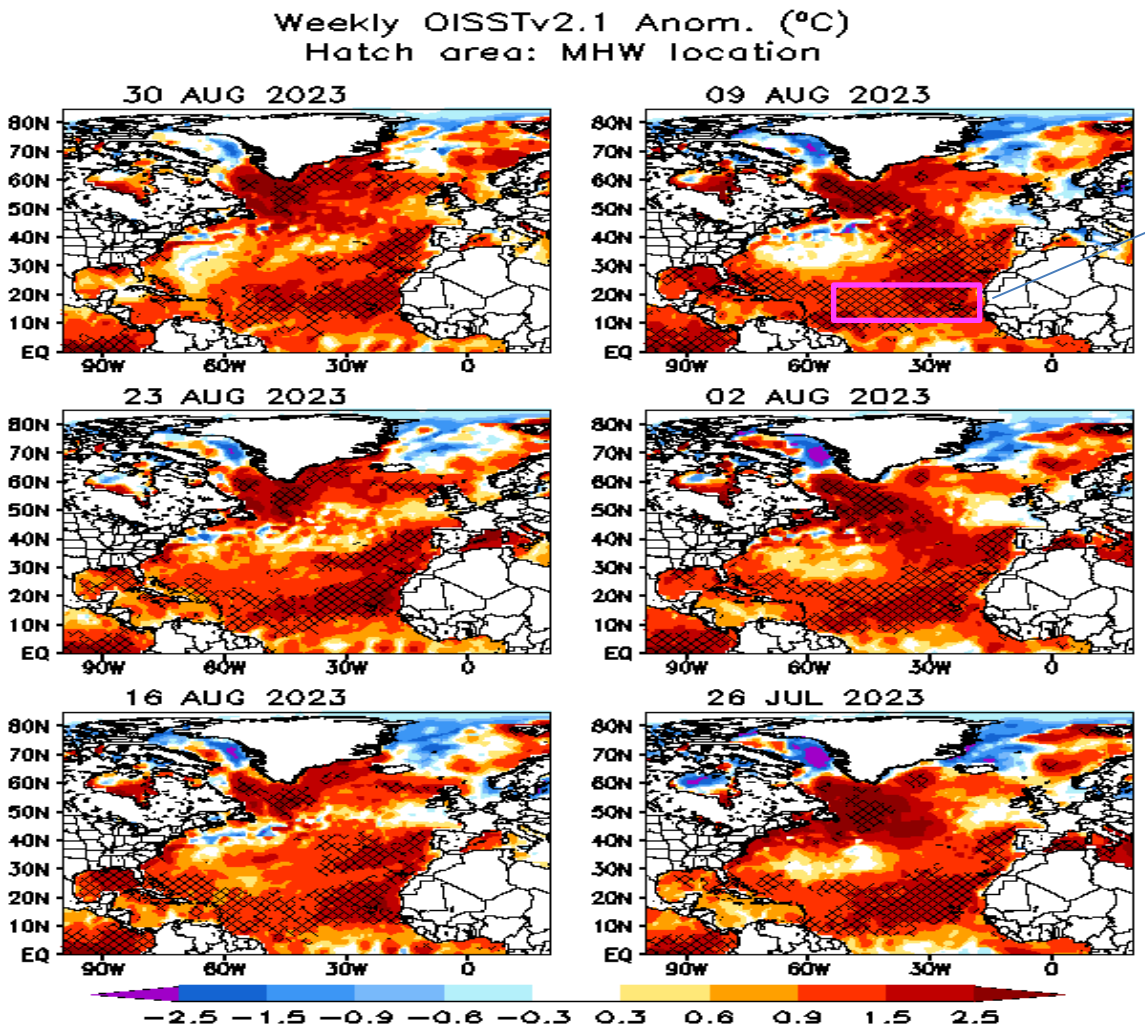
2023 Atlantic Hurricane Season Activities

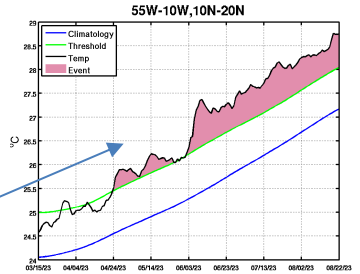
https://en.wikipedia.org/wiki/2023_Atlantic_hurricane_season

- By 11 Sep 2023, fourteen tropical storms formed, with four developing into hurricane and three major hurricanes.

Atlantic	Observations (By Sep 11)	Updated Outlook (Aug) 60% above-normal	Outlook (May 25) 40% near-normal	(1991-2020)
Total storms	14	14-21	12-17	14
Hurricanes	4	6-11	5-9	7
Major hurricanes	3	2-5	1-4	3

Weekly SST anomaly and MHWs in the North Atlantic

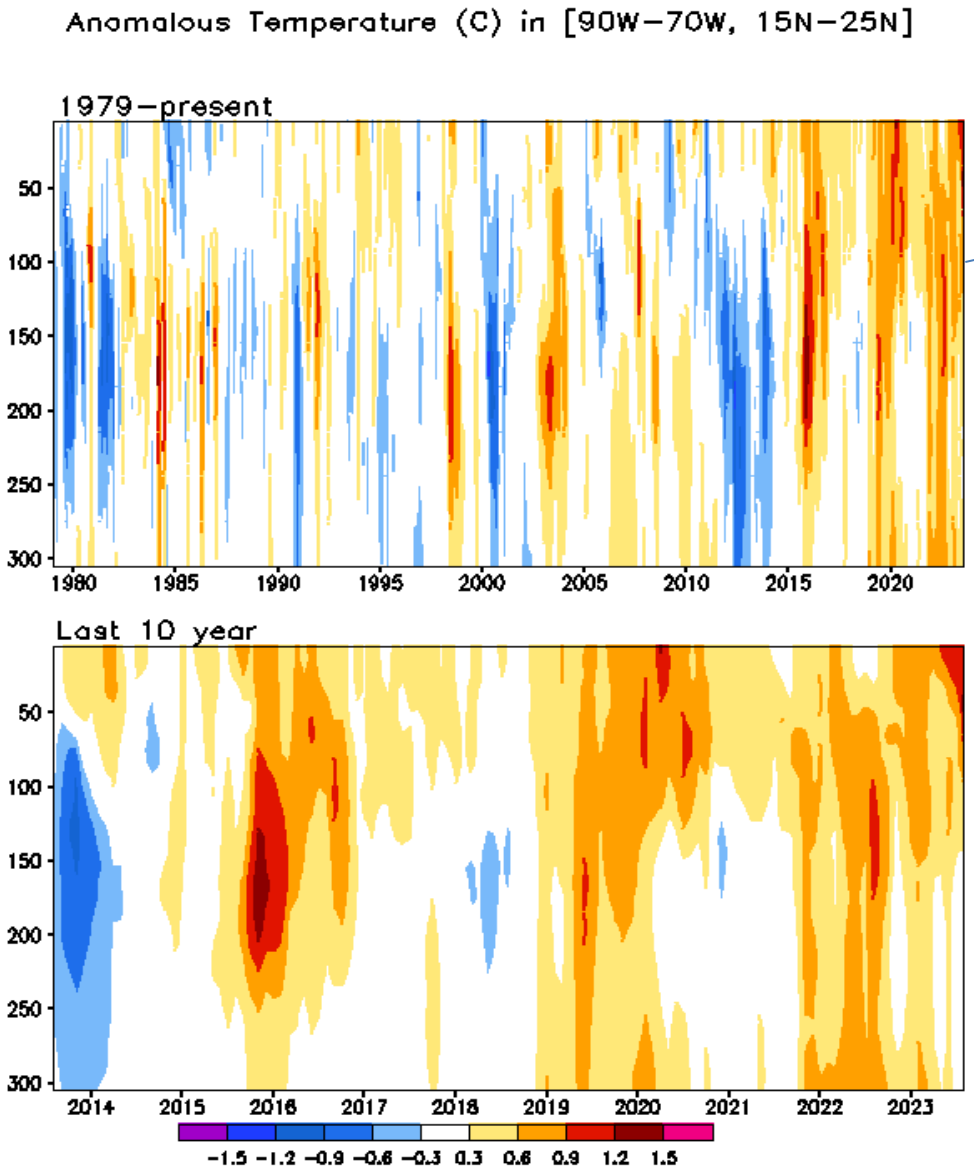


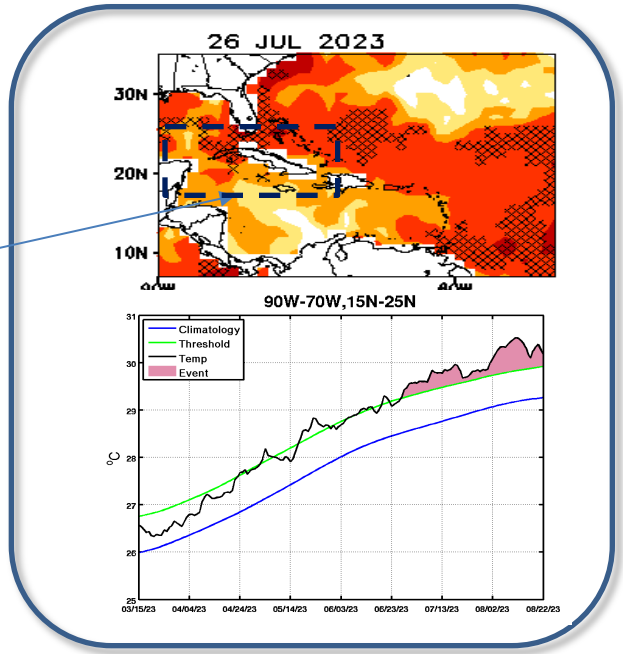


- Strong MHWs continued near the west coast of North Africa.
- MHWs near the Caribbean, Gulf of Mexico were developed in early July and persisted through Aug 2023.
- MHWs continued near the Larbrador basin.

(Left panel) Weekly SST anomaly (shaded) and locations experience Marine heat waves (hatched) by the date labelled in the plot. (right panel) SST evolution at a specific location. Green line and blue line denote the seasonal 90th percentile and daily climatology, respectively. Shaded area denotes the periods experiencing MHW. MHW is defined as a discrete prolonged warmer than 90th percentile of daily SST for at least 14 days. Data is derived from NCEI OISSTv2.1 and the climatology reference period is 1991-2020

Subsurface Temperature Anomaly in southern Gulf of Mexico





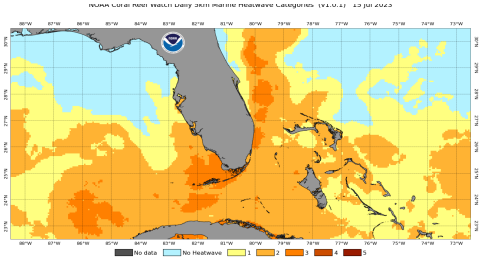
- Subsurface warming near the Florida has persisted since 2014.

Impact of MHWs on Corals and Marine ecosystems in Florida

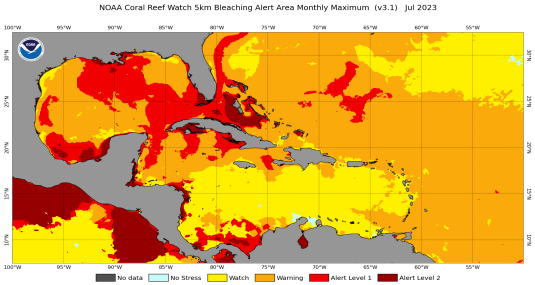
(Courtesy of Dr. Gang Liu)

NOAA Coral Reef Watch

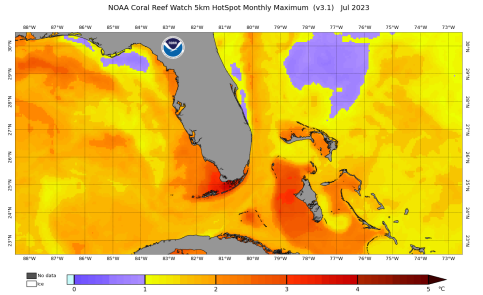
MHWs Categories (July 15)

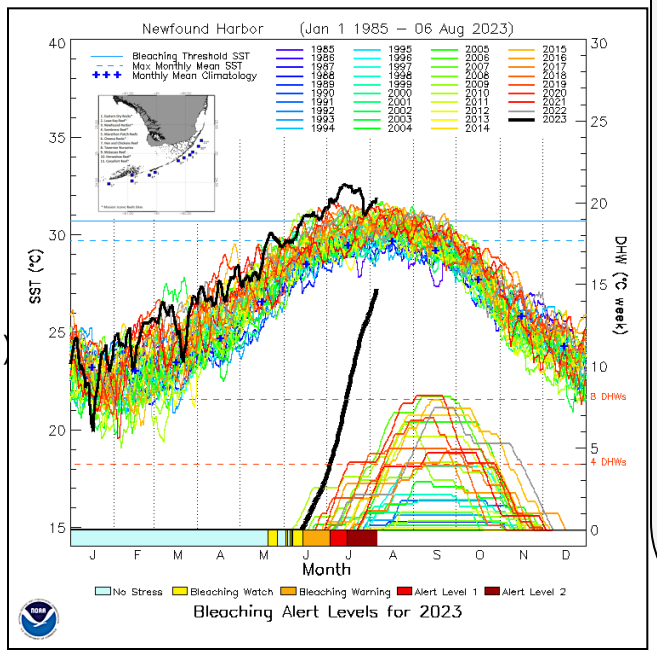


Coral Bleaching Alert Areas (July Maximum)

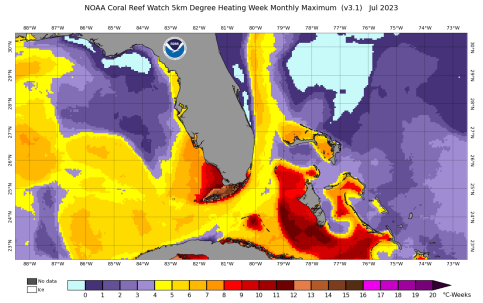


Coral Bleaching HotSpots (July Maximum)





Degree Heating Weeks (July Maximum)



- Mass coral bleaching in the eastern equatorial Pacific, Caribbean, Gulf of Mexico, and Florida Keys resulted from ongoing marine heatwave starting in June/July 2023.

- Situation in the Florida Keys is unprecedented in its severity & extent for so early in the summer season.

https://coralreefwatch.noaa.gov/product/marine_heatwave/

Impact of MHWs on Corals and Marine ecosystems in Florida

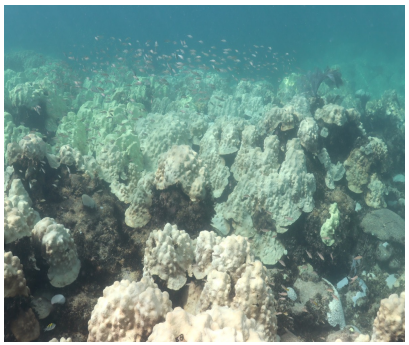
(Courtesy of Dr. Gang Liu)

Unprecedented (month before usual peak of heat stress/bleaching): Ongoing marine heatwave across South Florida, the Gulf of Mexico, and the greater Caribbean has caused widespread, significant bleaching since June. Since early July, widespread, severe bleaching and significant mortality have been reported in many locations in the Florida Keys.

Example: Complete bleaching at Cheeca Rocks, Florida was observed July 31- August 1 by NOAA AOML scientists & partners. Cheeca Rocks had some of the highest coral cover in the Florida Keys and had demonstrated persistence in the wake of the 2014 and 2015 bleaching events.

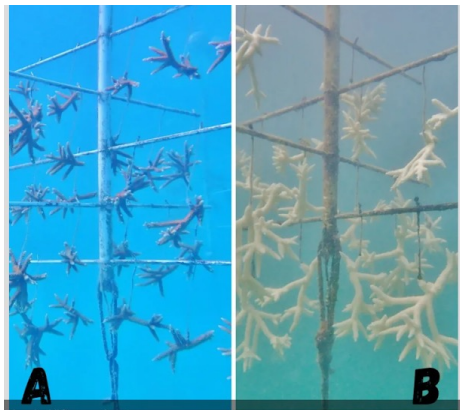
Actions: NOAA and its partners have conducted rescue missions to protect local genets and ensure coral survival, including evacuating live corals from wild habitats and natural coral nurseries to land-based facilities. NOAA and the State of Florida have issued Interim Protocols for the Management of In-Water Nurseries, Coral Transport, and Coral Outplanting.

Credit: Coral Restoration Foundation



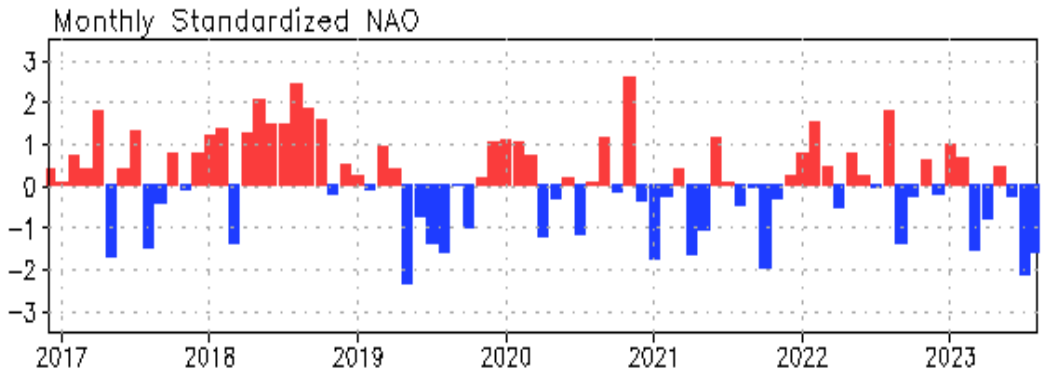
Credit: NOAA AOML

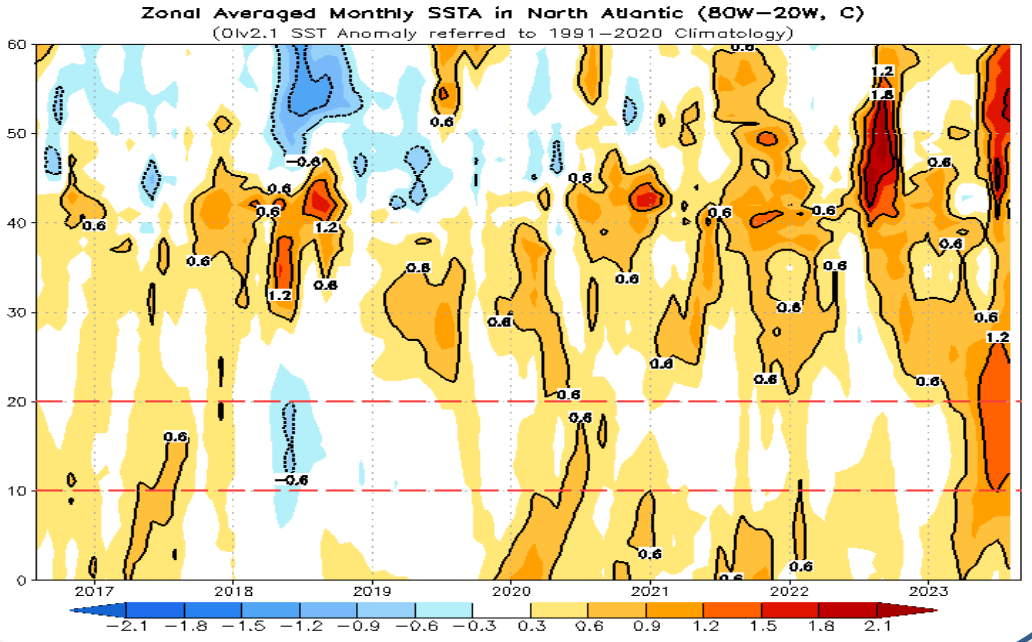
Credit: NOAA AOML

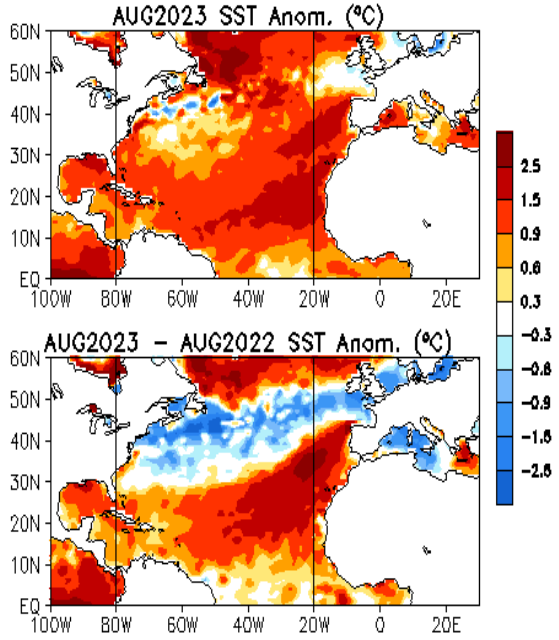


Credit: Florida FWCC

NAO and SST Anomaly in North Atlantic





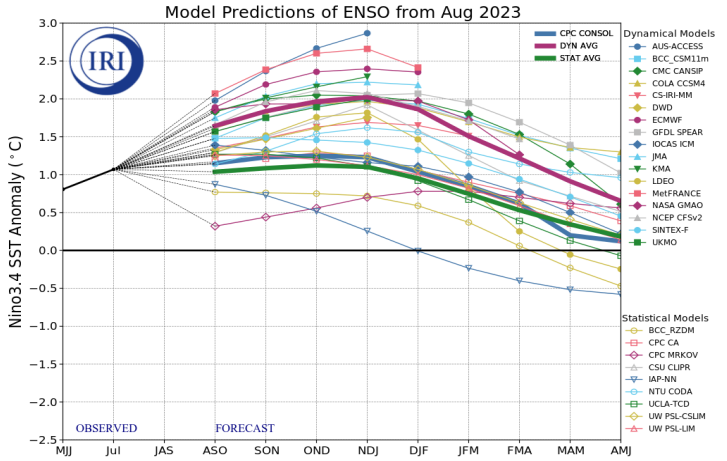


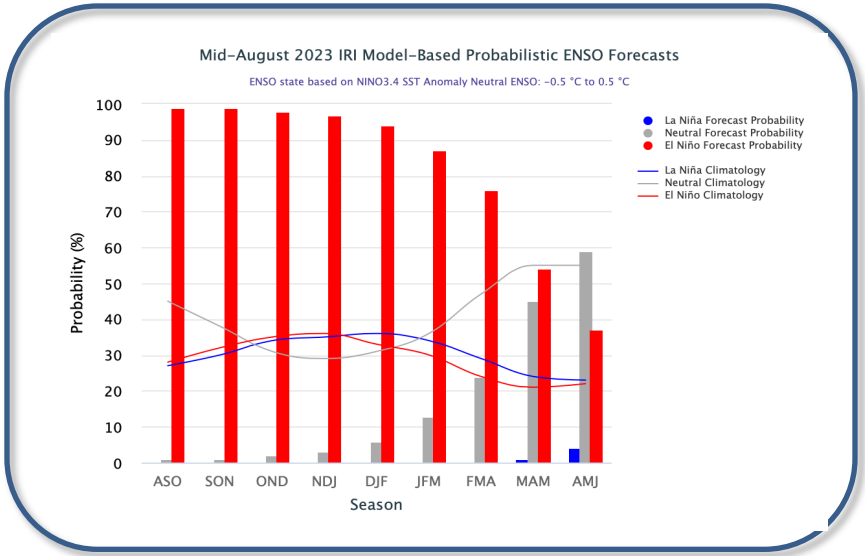
- Negative NAO weakened slightly in Aug 2023.
- Strong warming continued in the eastern North Atlantic Ocean.
- The prolonged positive SSTAs in the middle latitudes were evident, due to dominance of the positive phase of NAO during the last 5-6 years.

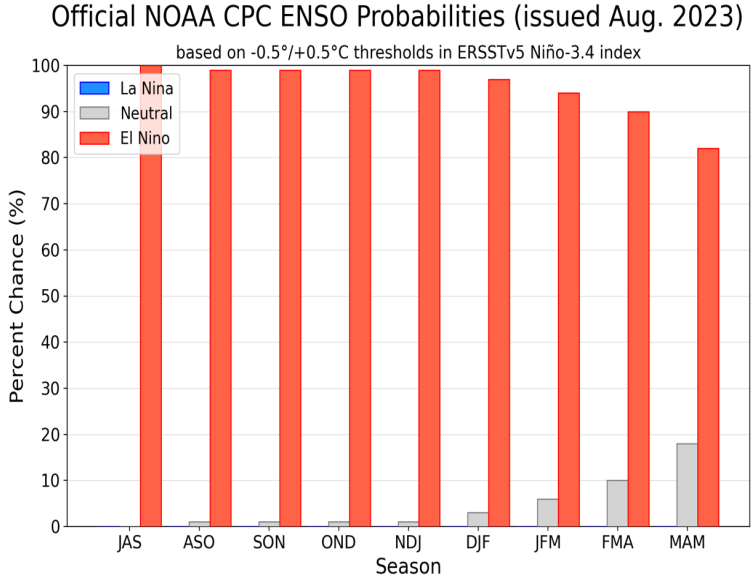
Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20°N-90°N. Time-latitude section of SSTAs averaged between 80ºW and 20ºW (bottom). SST are derived from the OIv2.1 SST analysis, and anomalies are departures from the 1991-2020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

ENSO and Global SST Predictions

IRI/CPC Niño3.4 Forecast

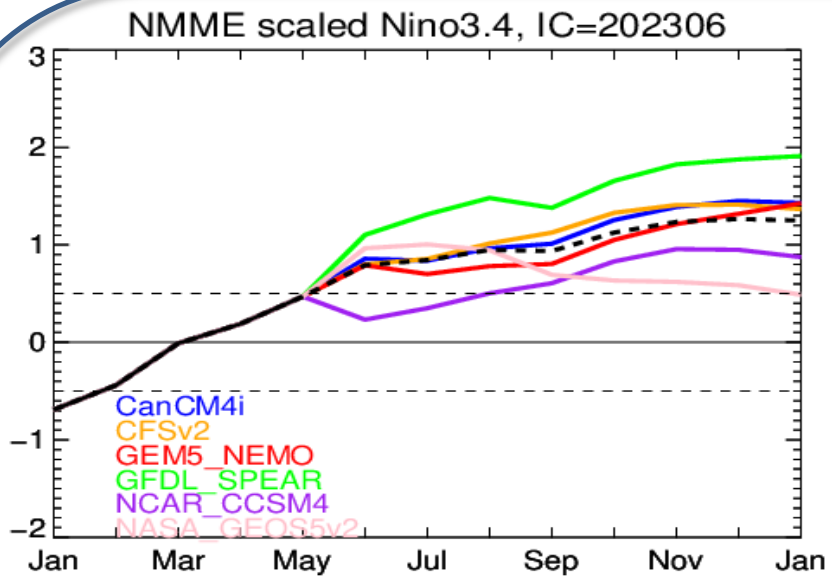


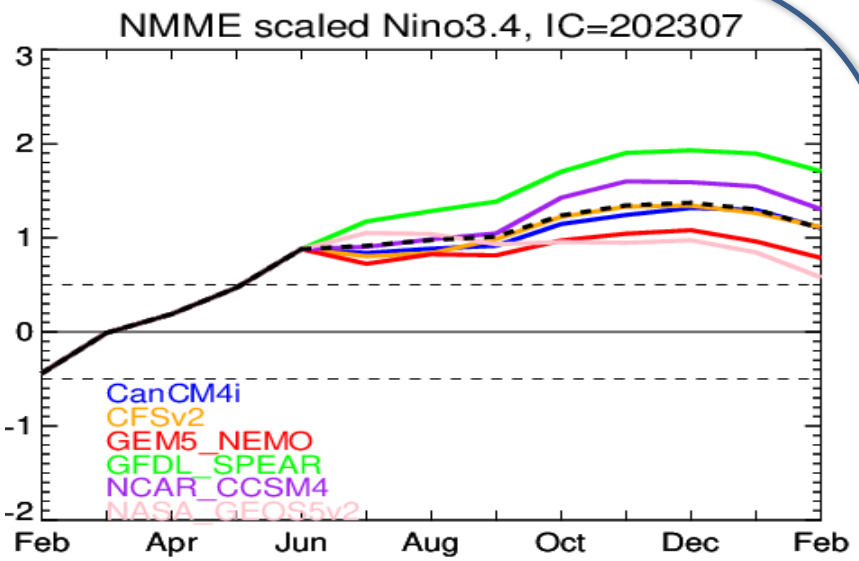


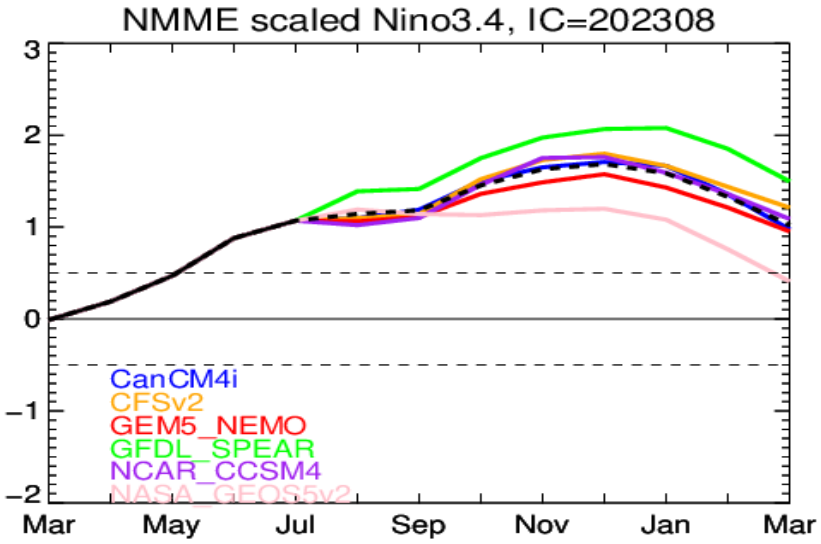


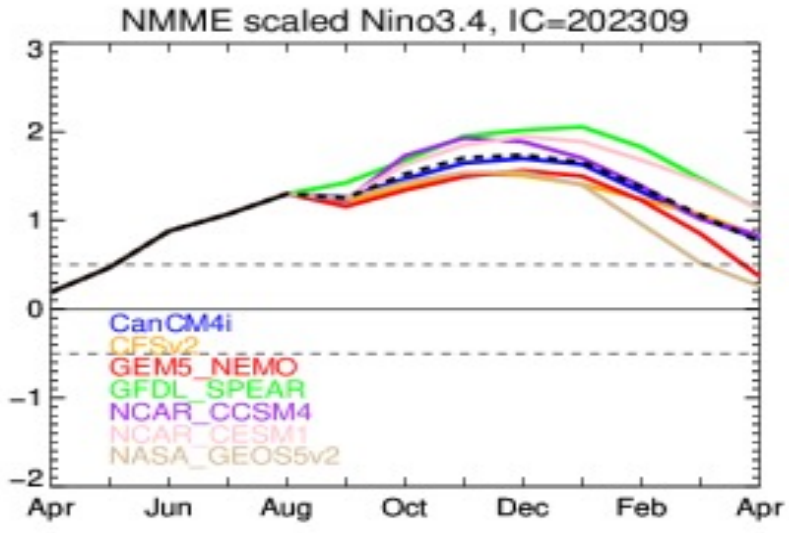
- Most of models forecasted that El Niño conditions will continue through the Northern Hemisphere winter 2023-24.
- Dynamical model ensemble mean favors of a strong El Niño in the coming winter.
- **ENSO Alert System Status issued on 10 Aug 2023: El Niño Advisory**
- Synopsis: *"El Niño is anticipated to continue through the Northern Hemisphere winter (with greater than 95% chance through December 2023 - February 2024"*

NMME forecasts from different initial conditions



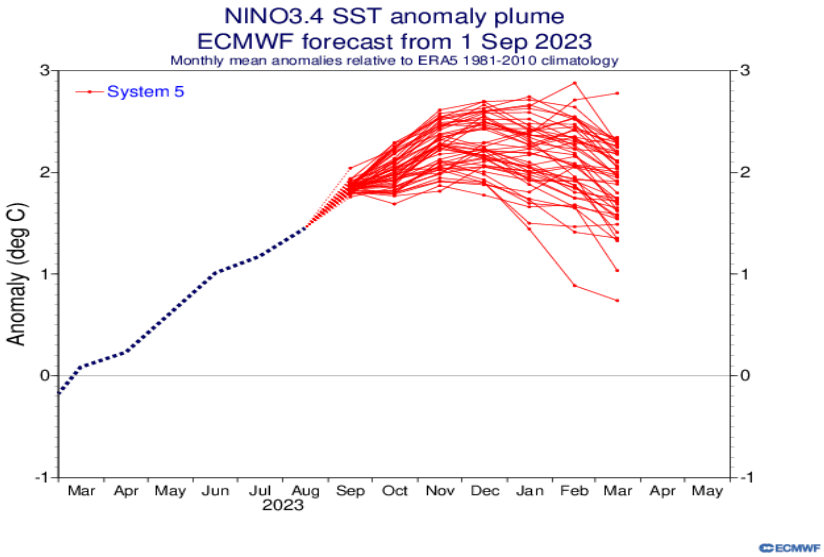




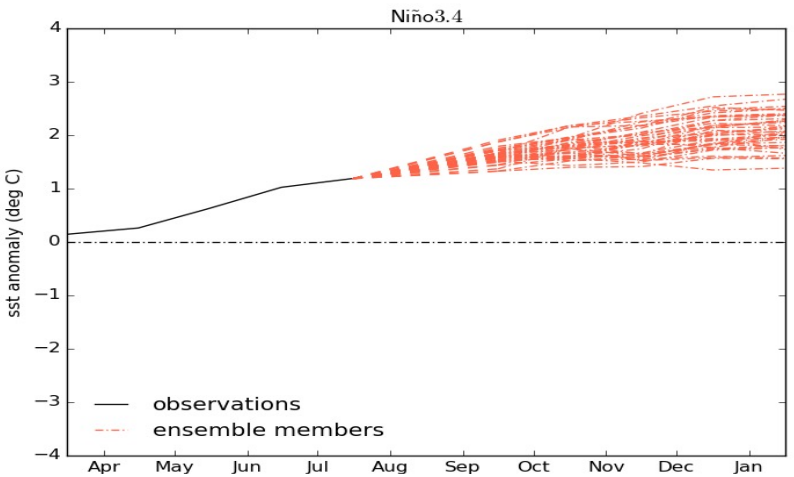


Individual Model Forecasts: A strong El Niño in 2023

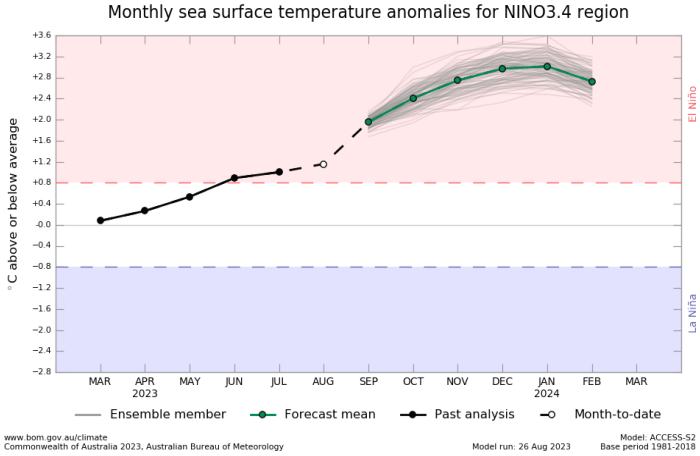
EC: Niño3.4, IC= 1 Sep 2023



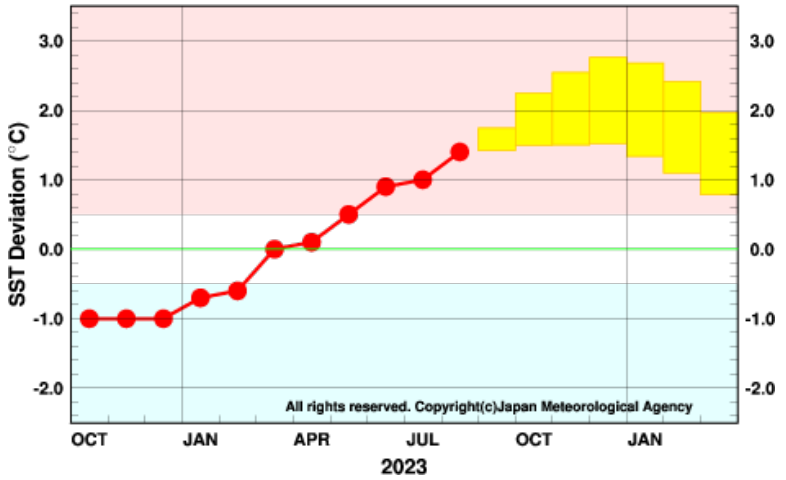
UKMO: Niño3.4, Updated 21 Aug 2023



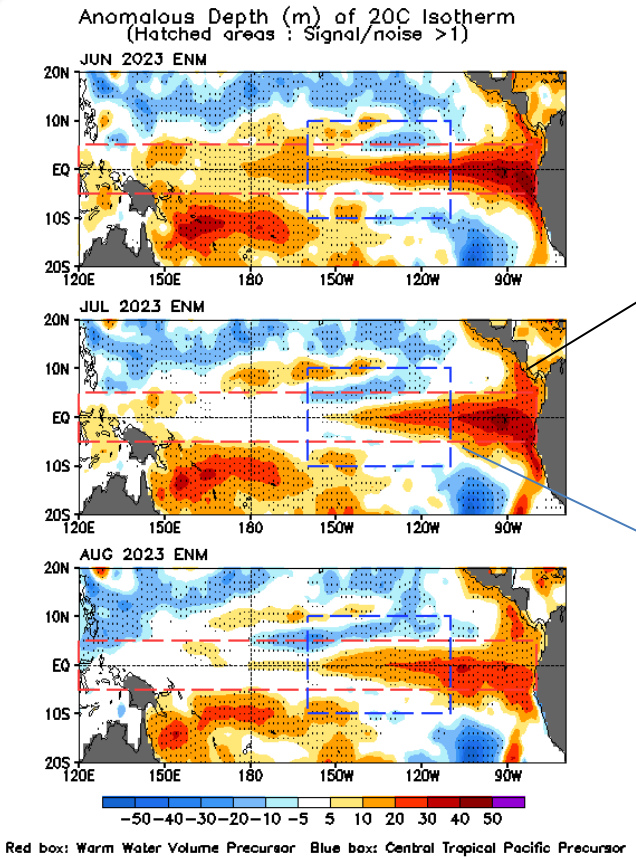
BOM: Niño3.4, Updated 26 Aug 2023

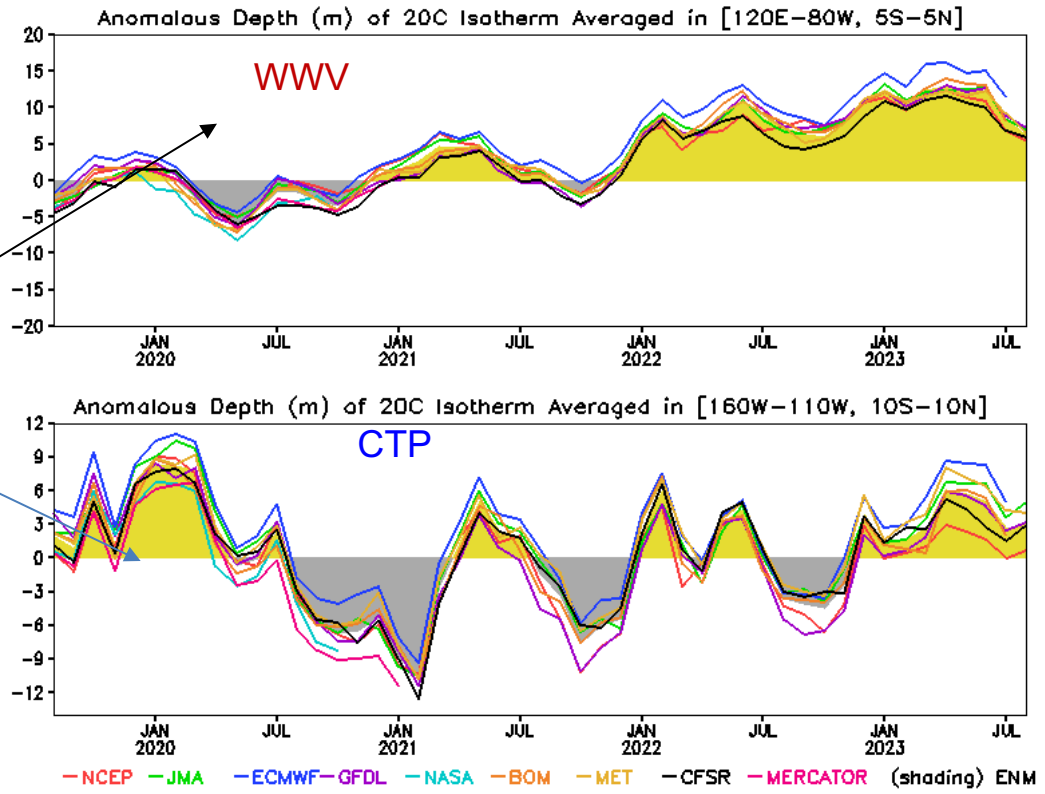


JMA: Niño3.4, Updated 11 Sep 2023



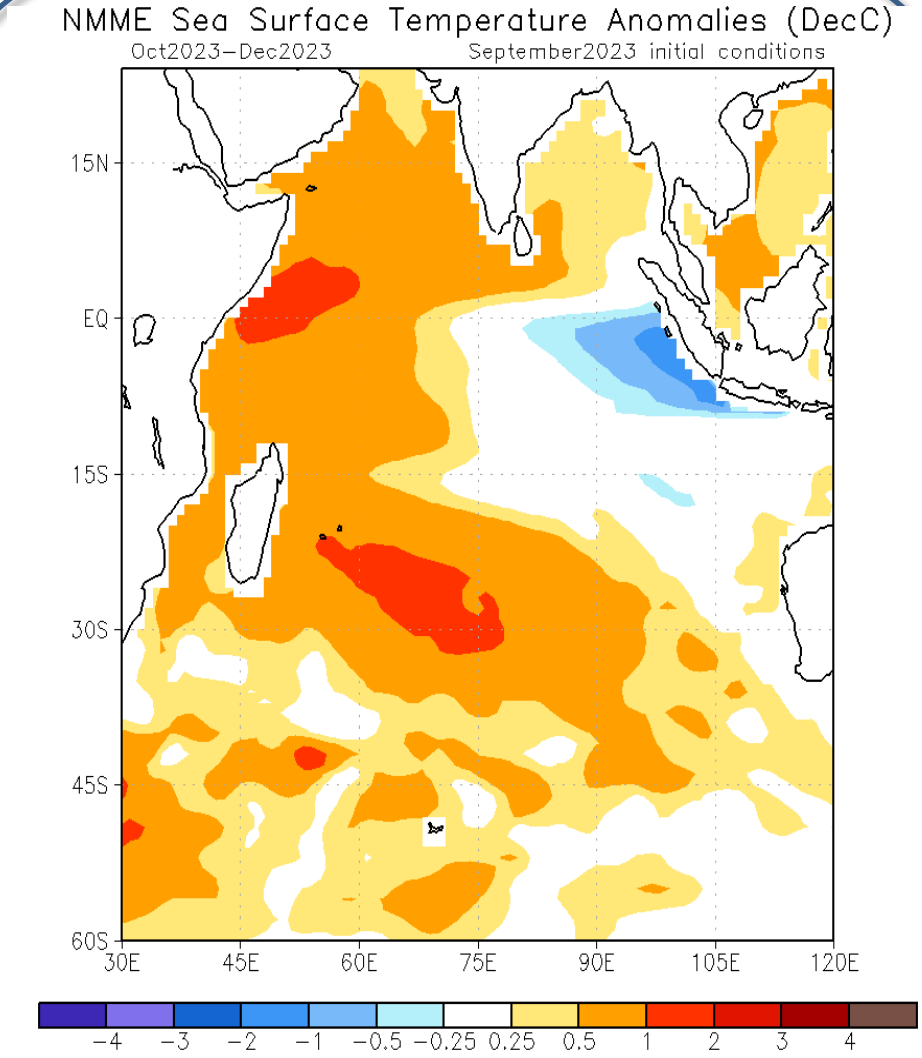
Oceanic ENSO Precursors: WWV & CTP



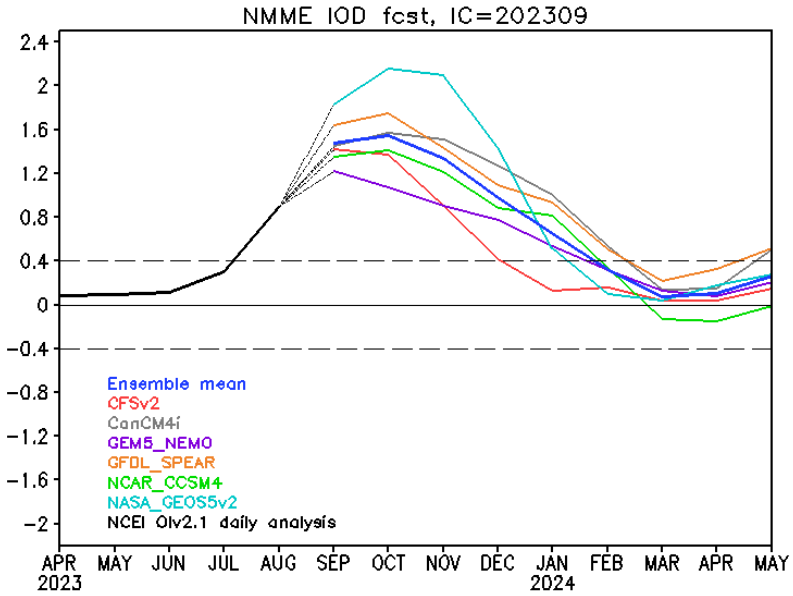


Warm water volume (WWV) is defined as an average of D20 anomaly across the equatorial Pacific (120° E – 80° W, 5° S-5° N) (Meinen and McPhaden 2000). Central tropical Pacific (CTP) index is calculated as the averaged D20 anomaly in the central tropical Pacific (160° W-110° W, 10° S-10° N) (Wen et al. 2014). The monthly D20 data is obtained from the Real-time Ocean Reanalysis Intercomparison Project(https://www.cpc.ncep.noaa.gov/products/GODAS/multiora93_body.html).

NMME Forecasts in the Indian Ocean

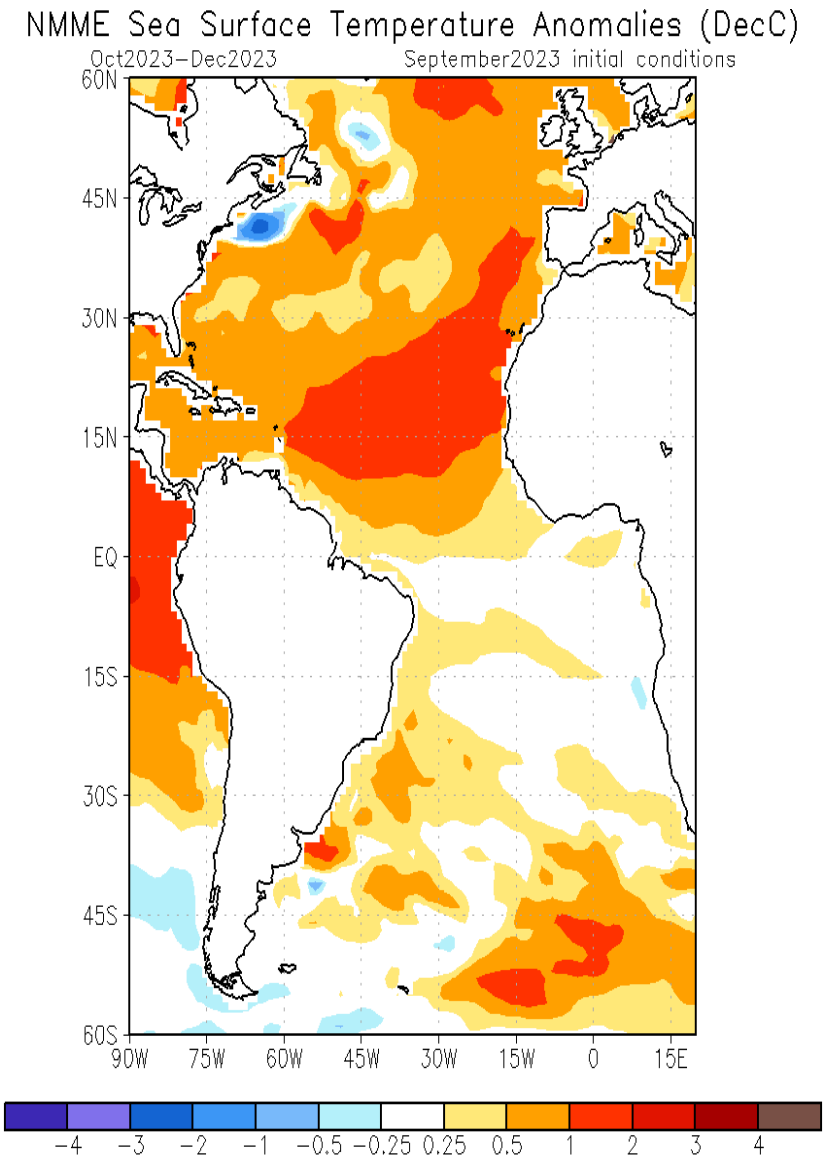


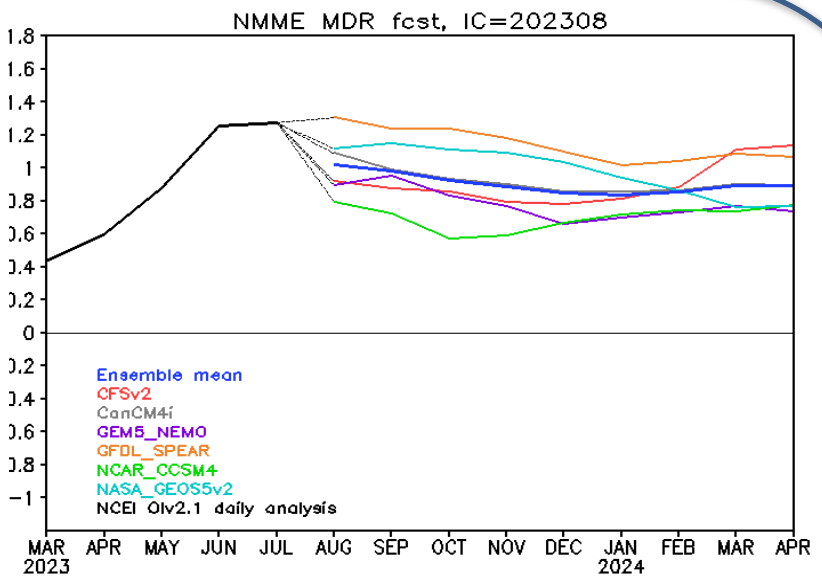
https://www.cpc.ncep.noaa.gov/products/international/ocean_monitoring/IO_monitoring_fcsts/io_index.shtml

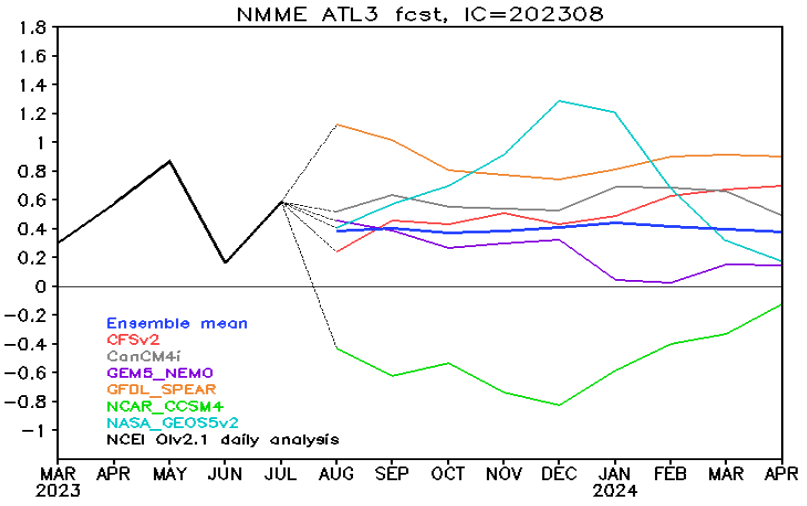


- All NMME members predict a positive IOD event will develop in fall 2023.

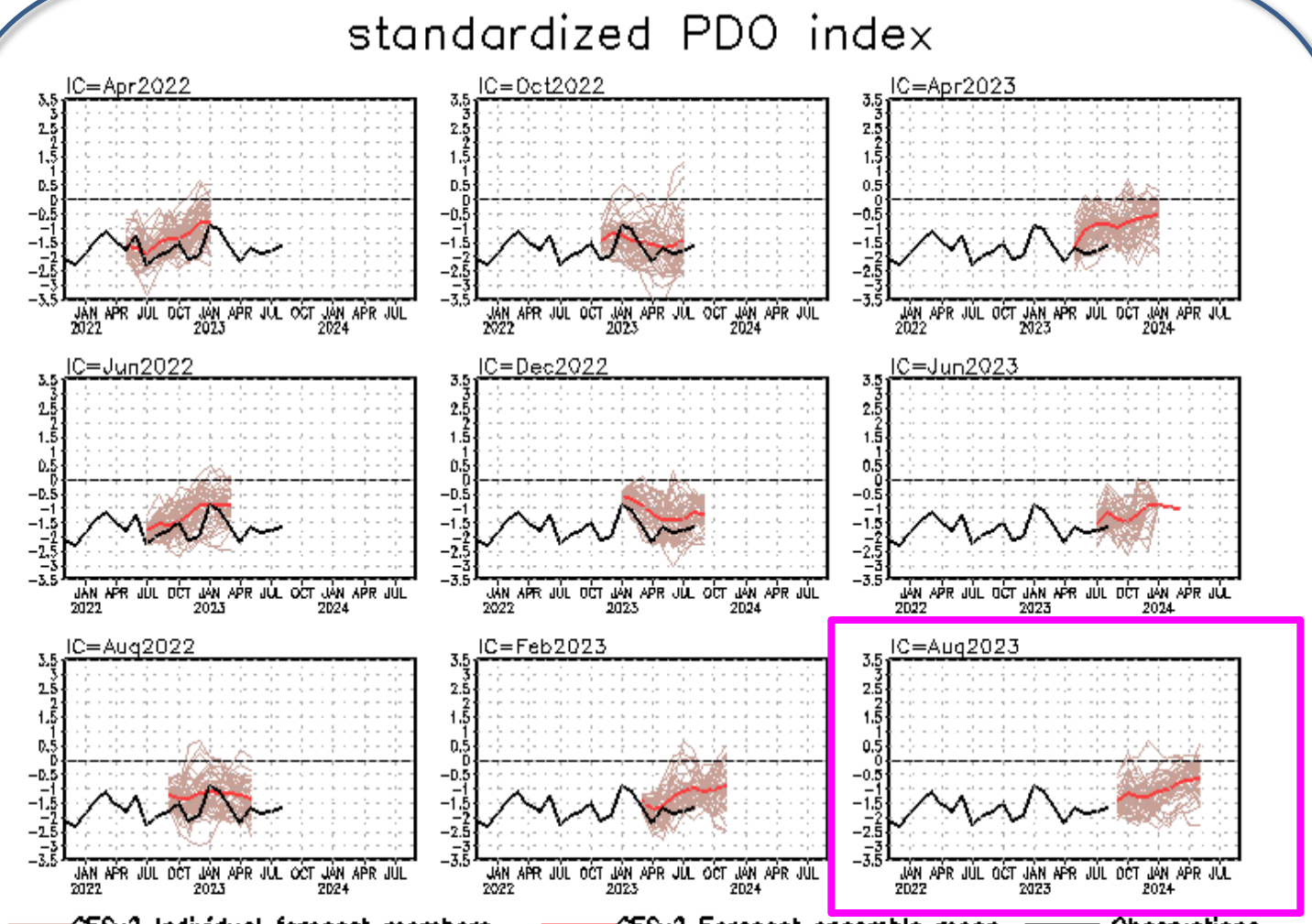
NMME Forecasts in the Atlantic Ocean







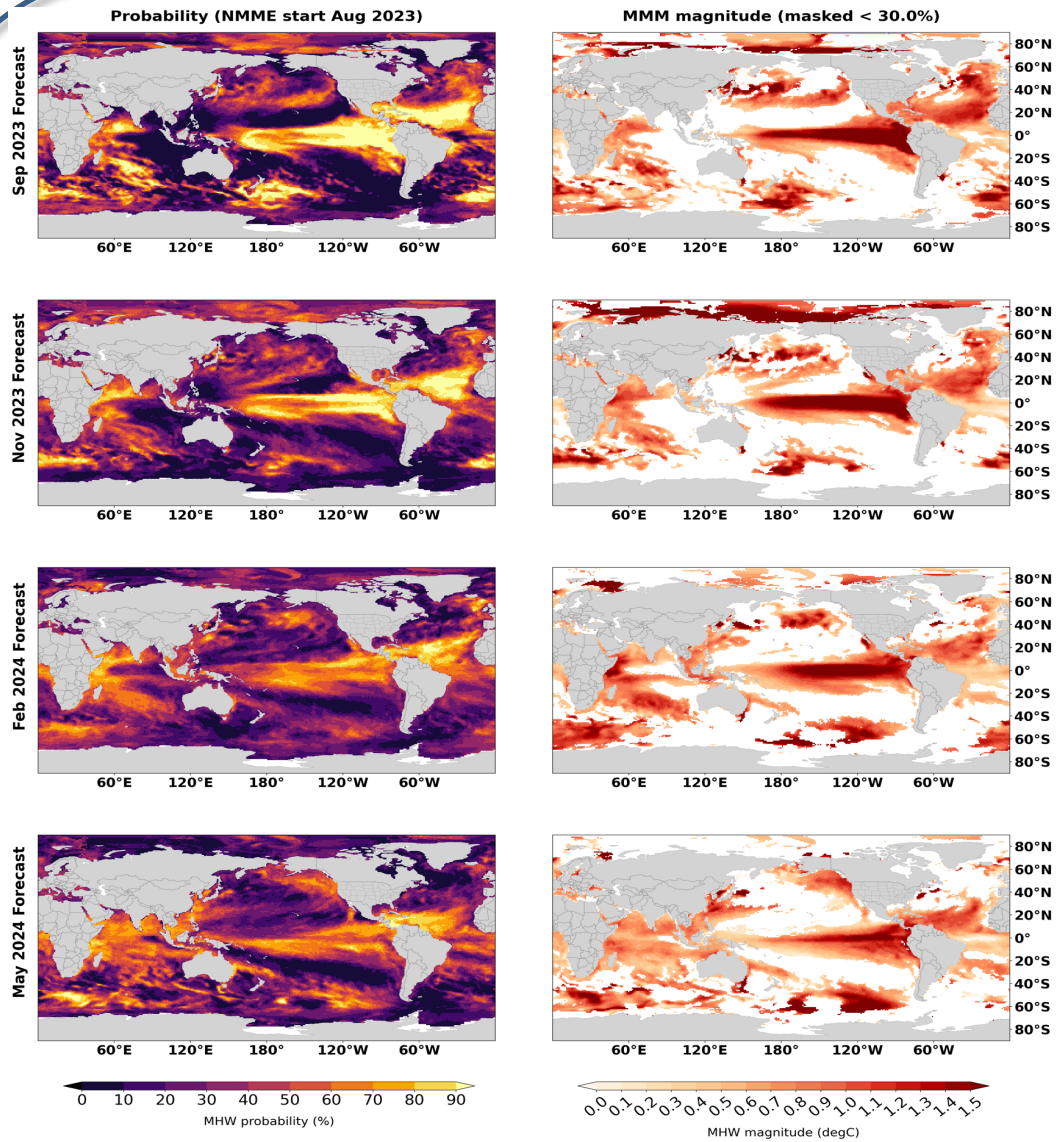
CFS Pacific Decadal Oscillation (PDO) Index Predictions from Different Initial Months



- CFSv2 predicts the negative phase of PDO will continue through spring 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.

NOAA PSL Marine Heat Wave Forecasts



- NMME forecasts suggest that MHW coverage will remain near 50% of the global oceans through Feb 2024.
- MHW conditions are expected to persist in the eastern tropical Pacific, central North Pacific, Northwest Pacific and tropical North Atlantic through the end of year.
-The MHW off the Oregon and Washington coasts are forecasted to weaken over the next 1-2 months.
- MHW condition will persist in the Caribbean Sea and southern Gulf of Mexico through October 2023.

https://psl.noaa.gov/marine-heatwaves/#report

Acknowledgement

- Drs. Arun Kumar, Zeng-Zhen Hu, Jieshun Zhu reviewed PPT, and provide insightful suggestions and comments
- Dr Gang Liu provided the slides of NOAA Coral Reef Watch.
- Dr. Pingping Xie provided the BASS/CMORPH/CFSR EVAP package
- Drs. Jieshun Zhu and Wanqiu Wang provided the upgraded sea ice forecasts

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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

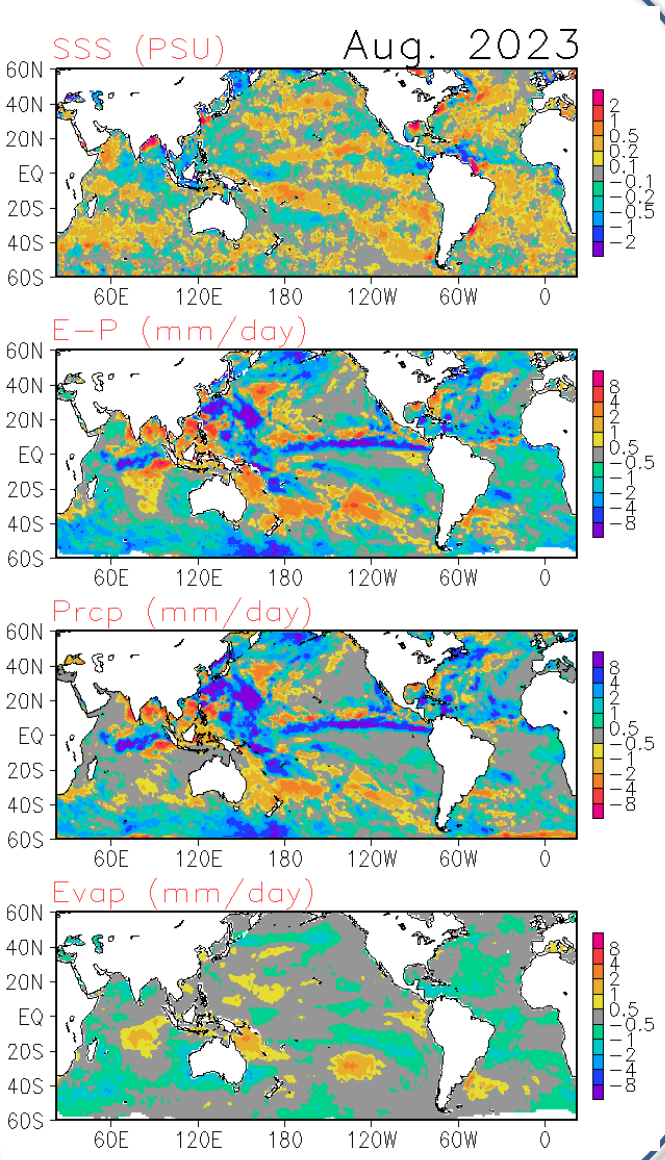
http://www.cpc.ncep.noaa.gov/products/GODAS/multiora93_body.html

Backup Slides

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

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

Enhanced convection (precipitation, E-P) is observed across the equatorial Pacific and Atlantic, positioned southward / northward of its climatological latitudes, respectively over the two oceans. Positive precipitation (E-P) is also enhanced / depressed over the equatorial Indian Ocean / Bay of Bengal. SSS anomalies over the above mentioned regions are largely a reflection of the E-P anomalies there. Freshened SSS anomalies over the Calabrian Sea and adjacent areas are mostly attributable to the active hurricanes / tropical storms over the region during August.



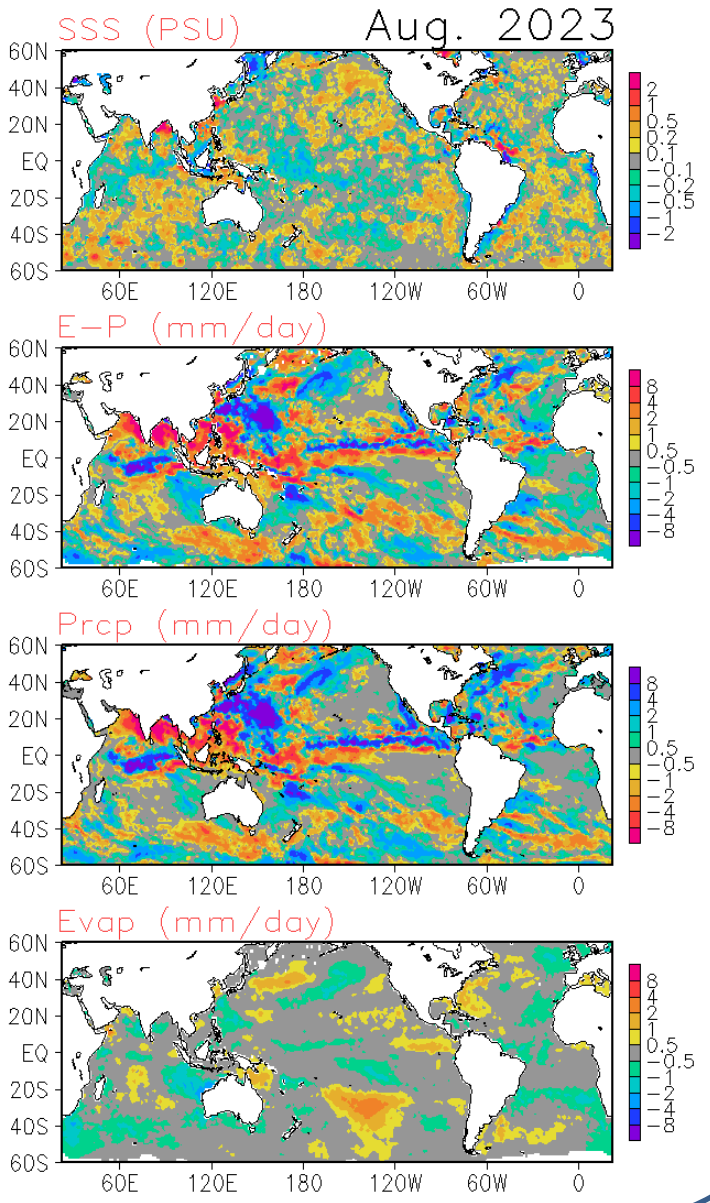
SSS : Blended Analysis of Surface Salinity (BASS) V0.Z
(a CPC-NESDIS/NODC-NESDIS/STAR joint effort)
ftp.cpc.ncep.noaa.gov/precip/BASS

Precipitation: CMORPH adjusted satellite precipitation estimates

Evaporation: Adjusted CFS Reanalysis

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

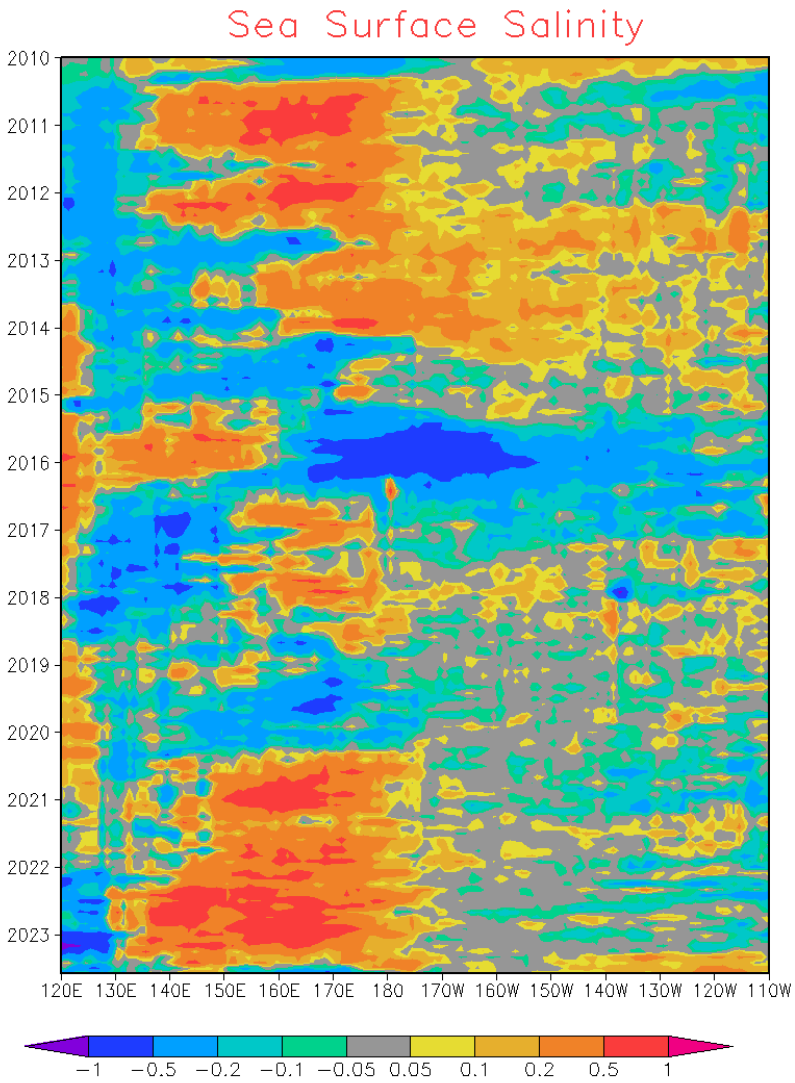
A pair of zonally oriented bands of enhanced / strengthened ITCZ precipitation anomaly tendencies present over the equatorial Pacific, causing SSS tendency of similar patterns (though much less organized). Dry precipitation / E-P tendencies also appear over the Bay of Bengal and Arabian Sea, contributing to the saltier SSS tendency there.



Monthly SSS Anomaly Evolution over Equatorial Pacific

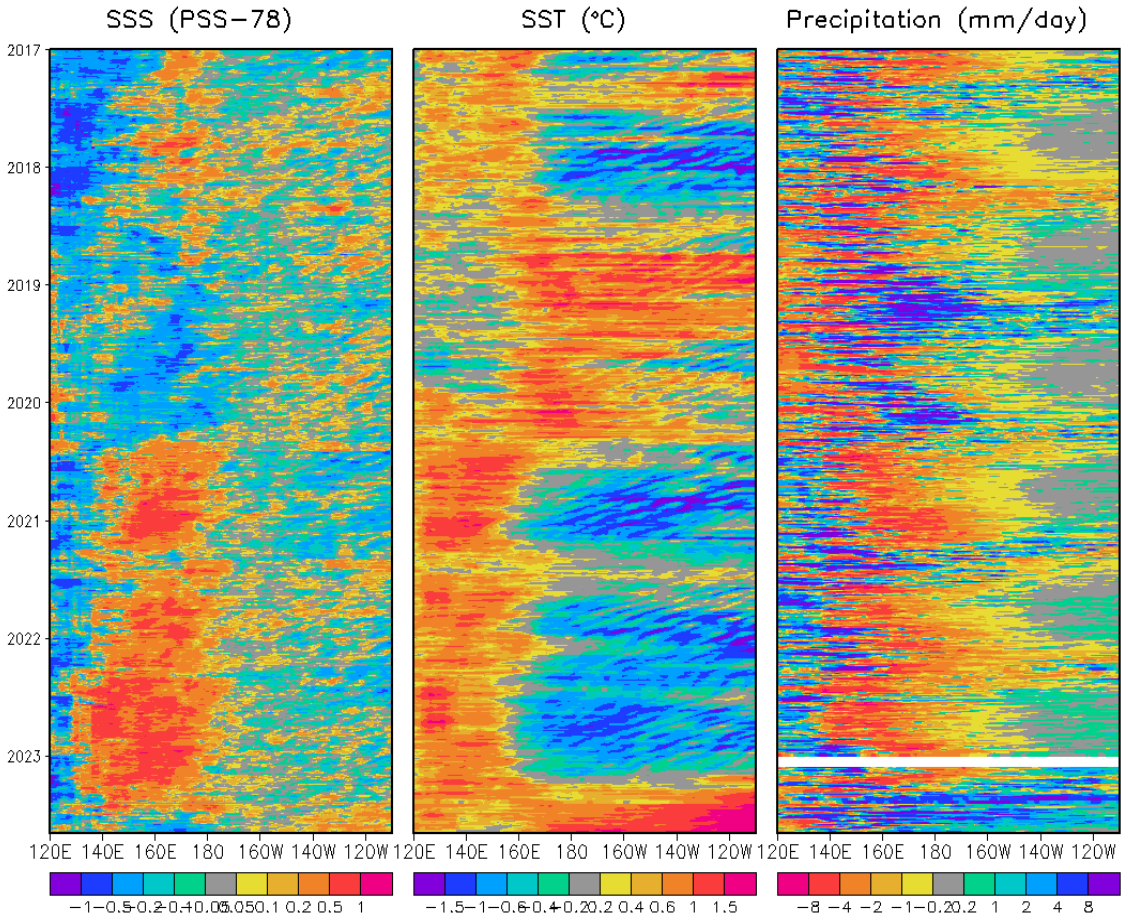
NOTE: Since June 2015, the BASS SSS is from in situ, SMOS and SMAP; before June 2015,The BASS SSS is from in situ, SMOS and Aquarius.

- Hovermoller diagram for equatorial SSS anomaly **(5˚S-5˚N);**
- SSS anomalies over the western and central equatorial Pacific (130ºE-180º) now turn into negative (freshened), after a multi-year continued saltier SSS. SSS anomalies over the eastern equatorial are less directly influenced by E-P in general and exhibit slightly positive (saltier) recently.

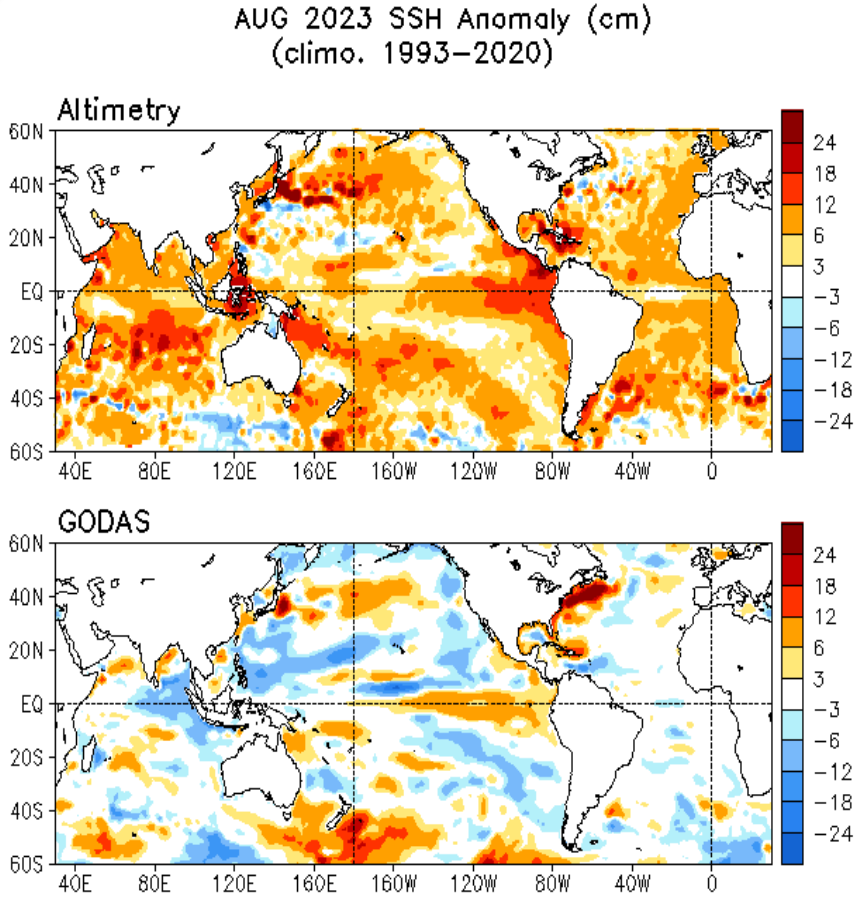


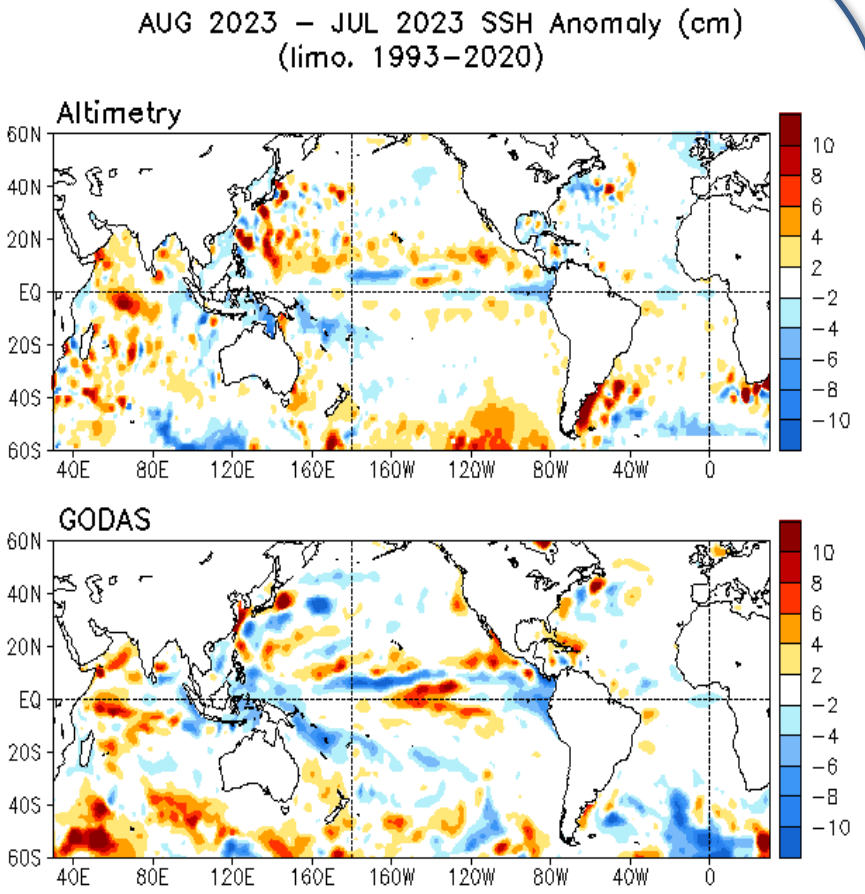
Pentad SSS Anomaly Evolution over Equatorial Pacific

Figure caption: Hovermoller 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.



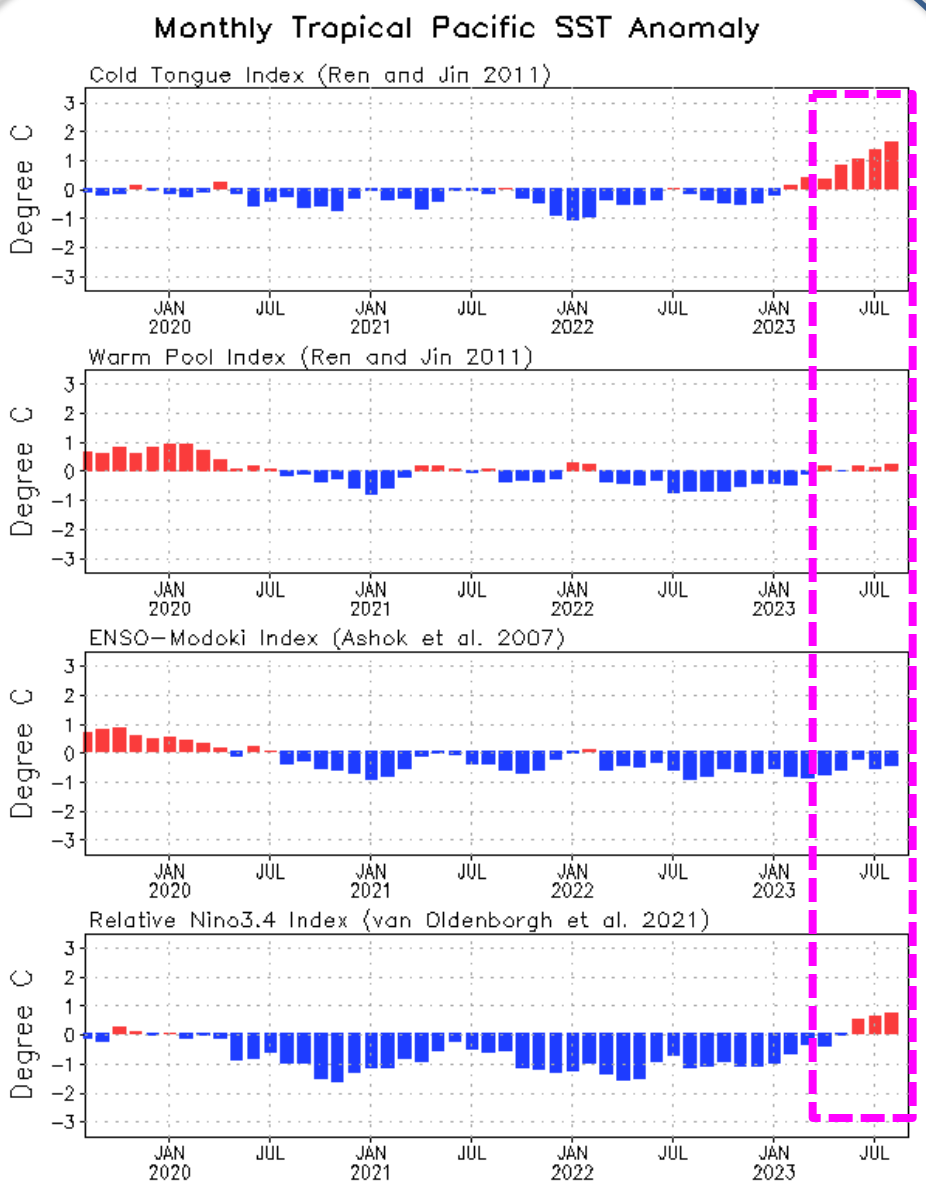
AVISO & GODAS SSH Anomaly (cm) and Anomaly Tendency

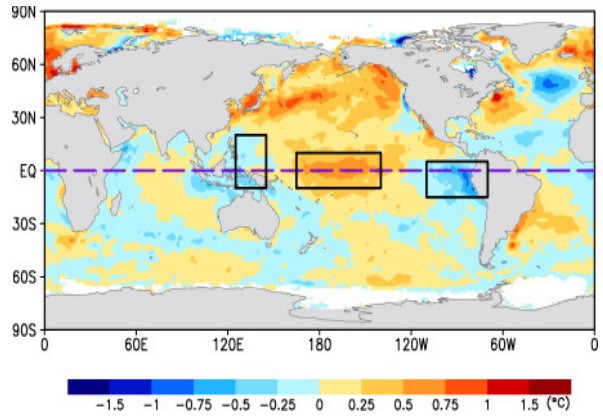




- SSHs were above normal in the equatorial Pacific in GODAS & AVISO.
- The tendencies indicated an increase (decrease) of SSH in the eastern (western) tropical Pacific.

Evolution of Pacific Niño SST Indices



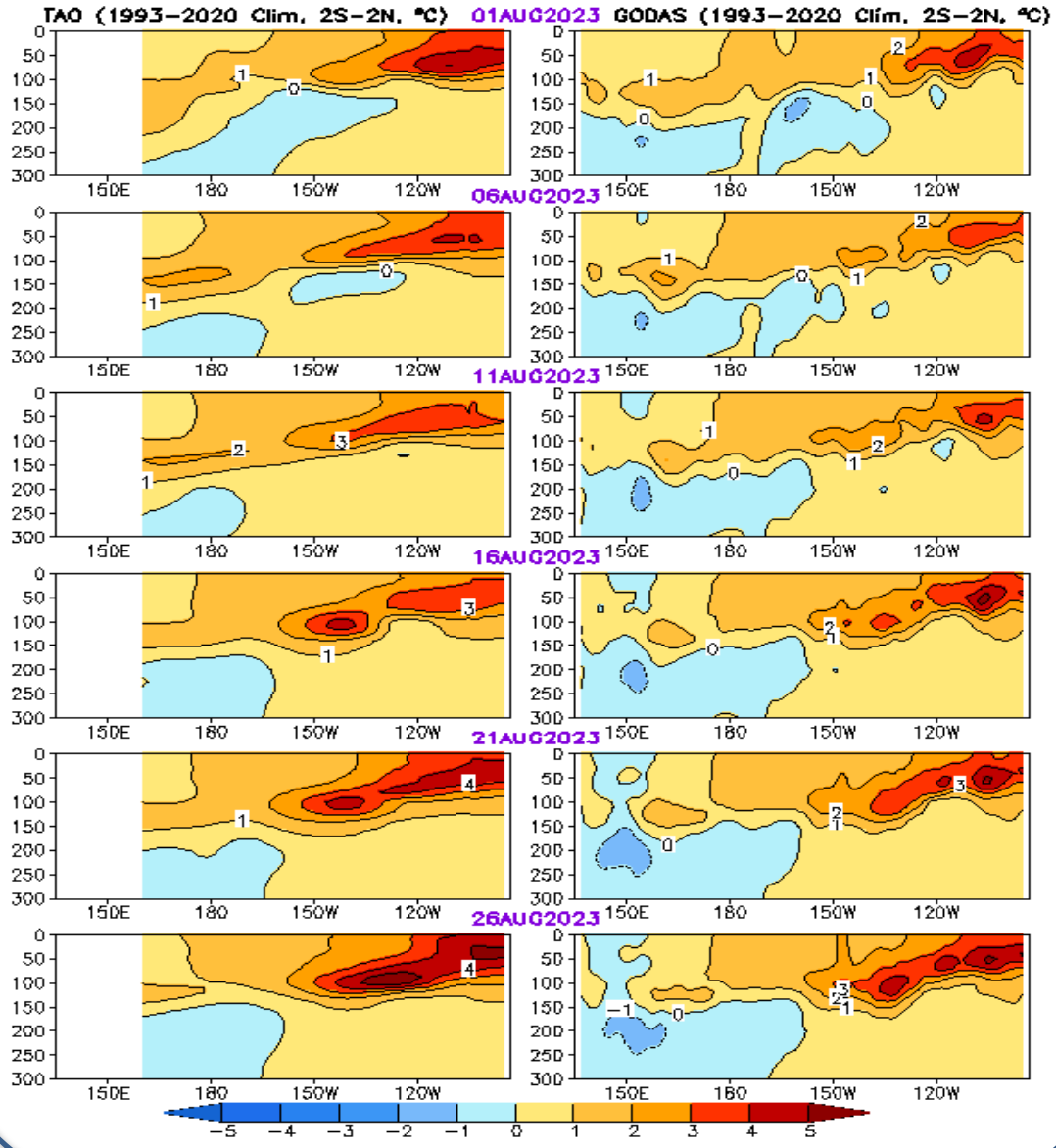


- Relative Niño3.4 index is now included in ENSO monitoring, which is defined as the conventional Niño3.4 index minus the SSTA averaged in the whole tropics (0º-360º, 20ºS-20ºN), in order to remove the global warming signal. Also, to have the same variability as the conventional Niño3.4 index, the relative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

Relative Niño3.4 data updated monthly at:

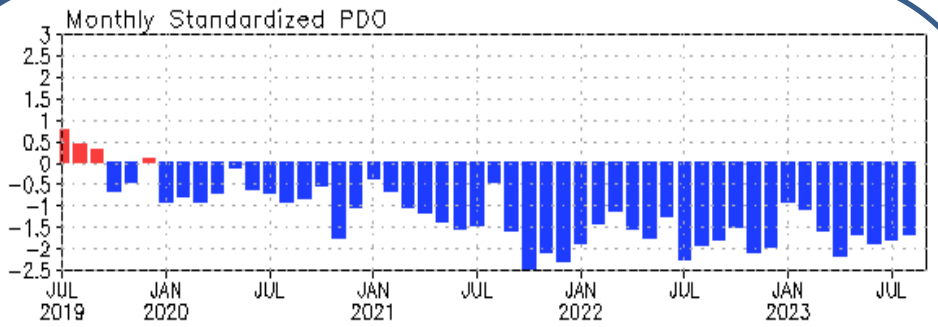
https://www.cpc.ncep.noaa.gov/data/indices/RONI.ascii.txt

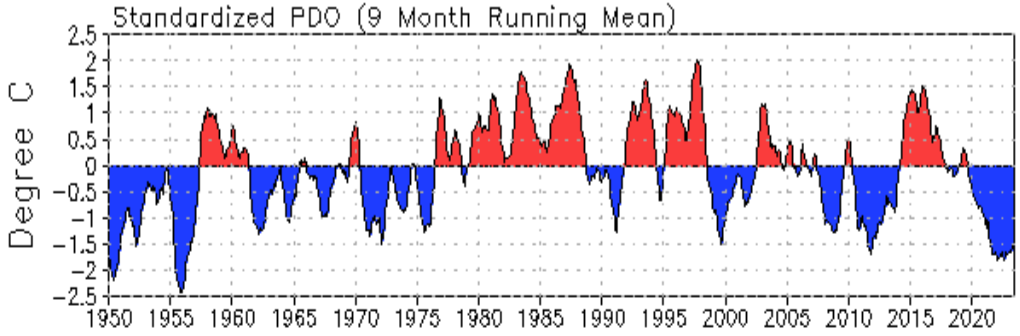
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

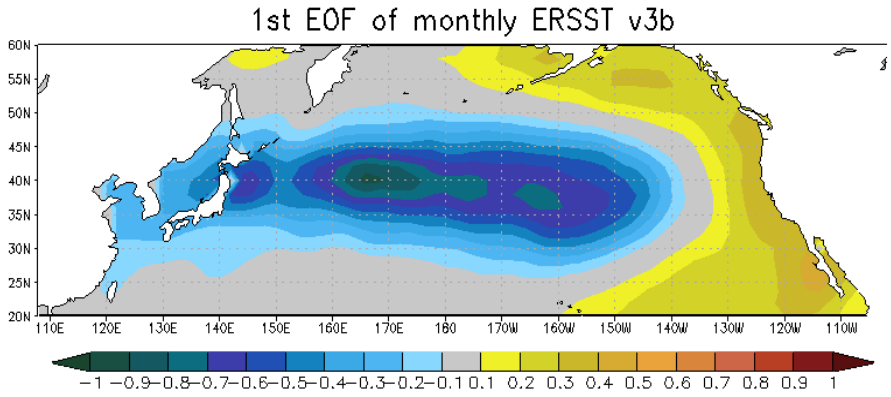


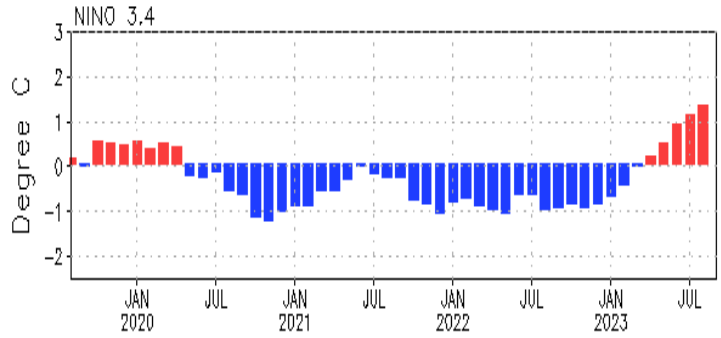
- Subsurface temperatures were warmer than average in the upper 150m.
- Subsurface warm anomalies have strengthened across the central and eastern equatorial Pacific.
- The features of the ocean temperature anomalies were similar between GODAS (model based) and TAO (objective) analysis.

Pacific Decadal Oscillation (PDO) Index







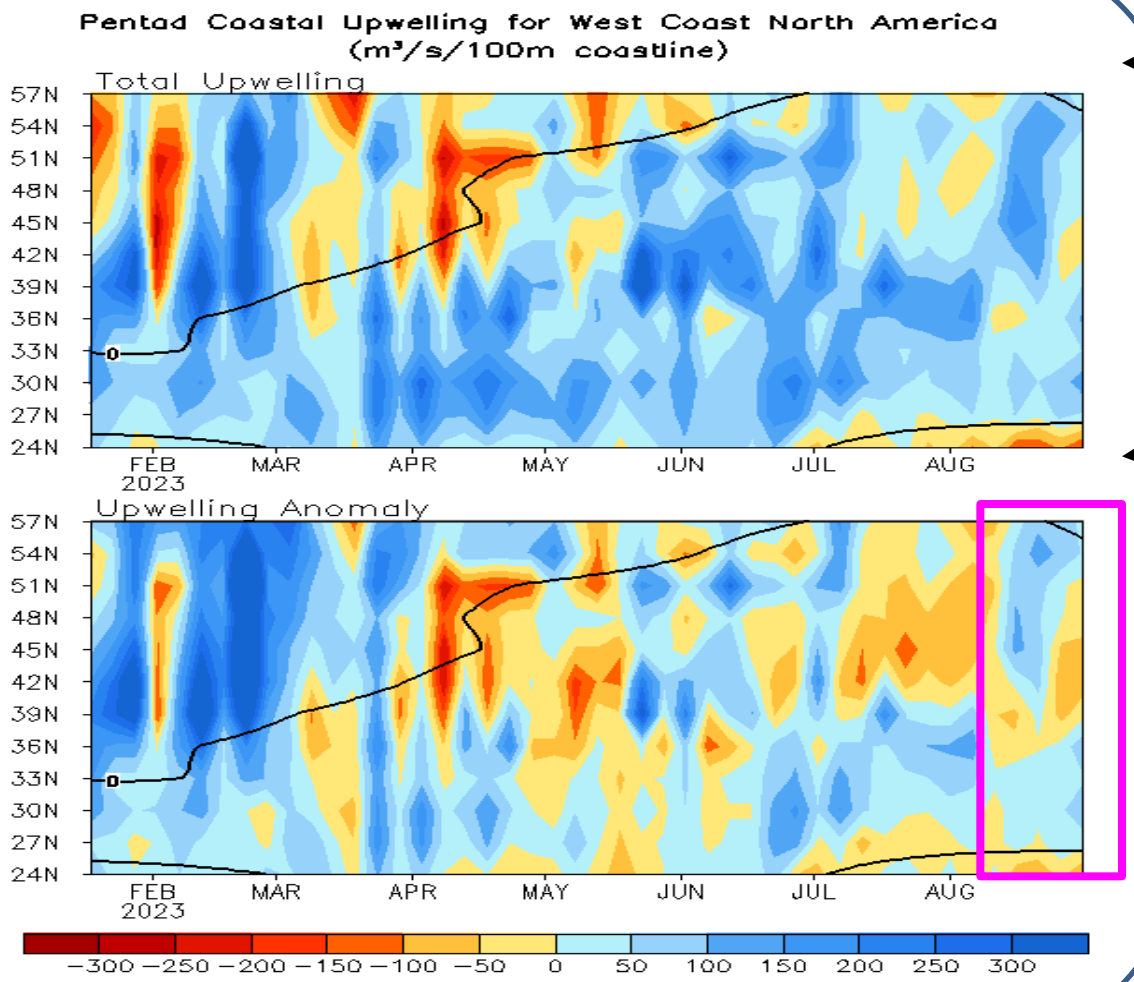


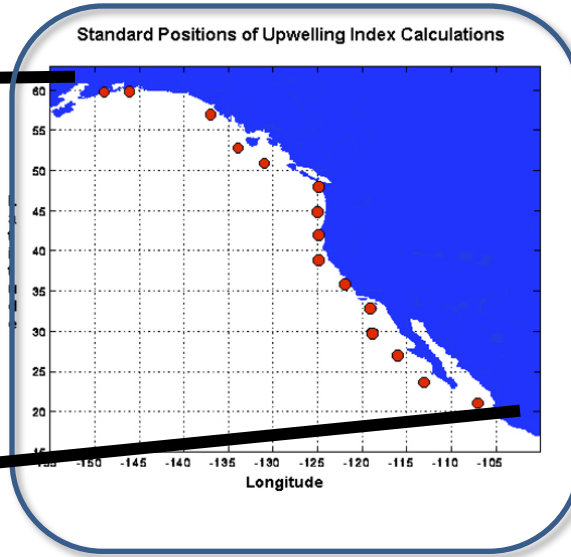
- The PDO has been in a negative phase since Jan 2020 with PDOI = -1.9 in Jul 2023.

- 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

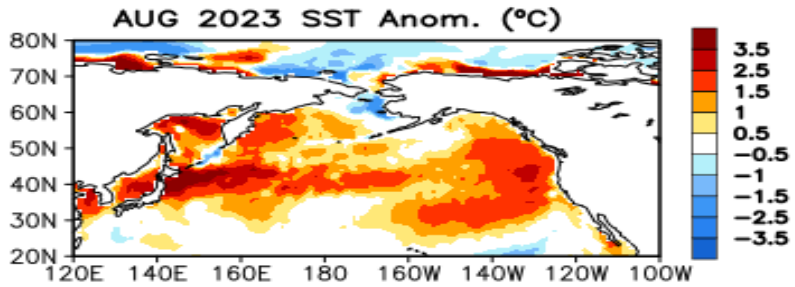


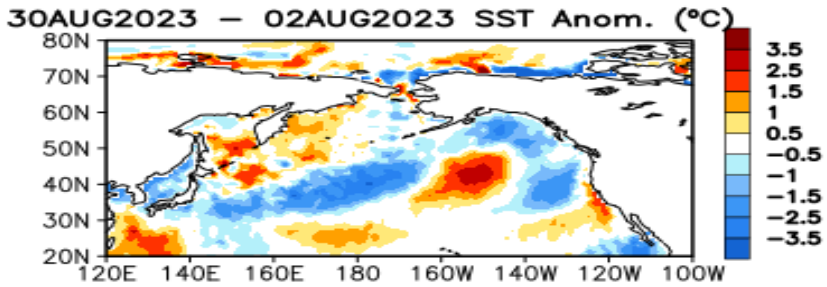


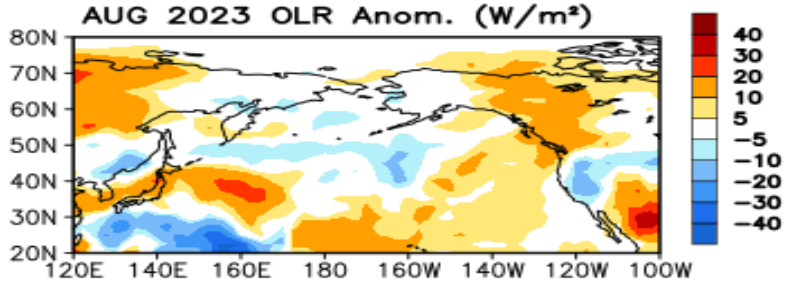
- Coastal (39º-54ºN) anomalous upwelling and downwelling were observed in Aug 2023.

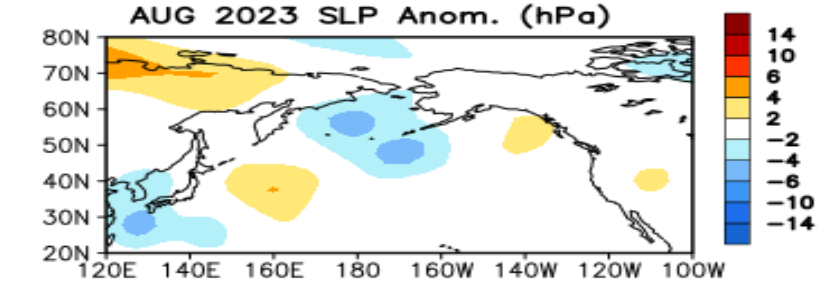
(top) Total and (bottom) anomalous upwelling indices at the 15 standard locations for the western coast of North America. Derived from the vertical velocity of the NCEP's GODAS and are calculated as integrated vertical volume transport at 50-meter depth from each location to its nearest coast point ($m^3/s/100m$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

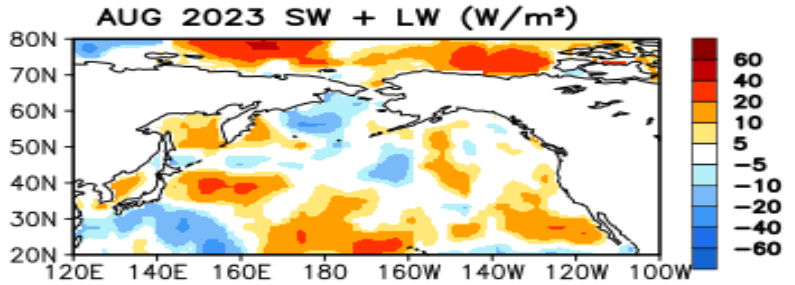
North Pacific & Arctic Ocean: SSTA, SSTA Tend., OLR, SLP, Sfc Rad, Sfc Flx Anomalies

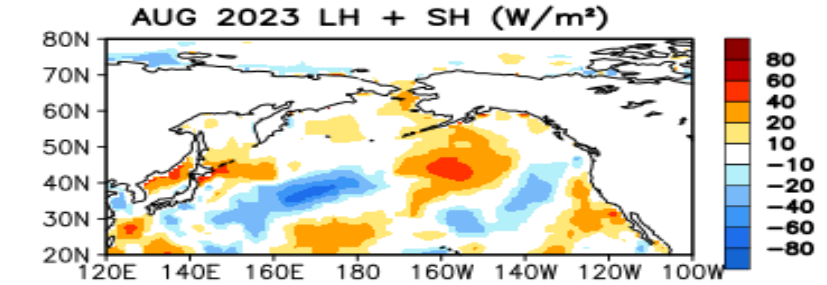






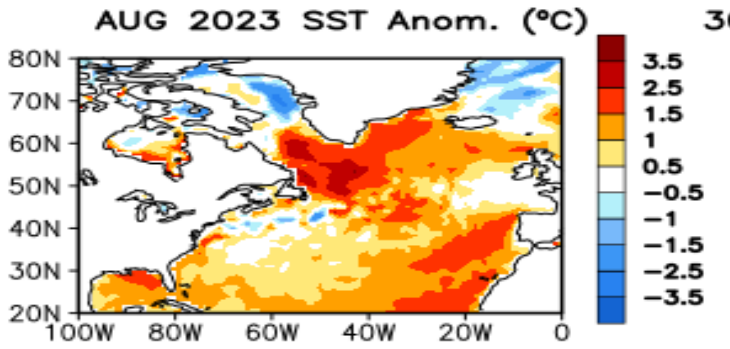


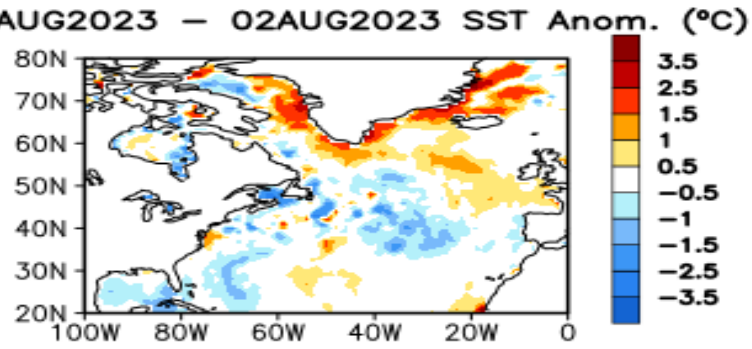


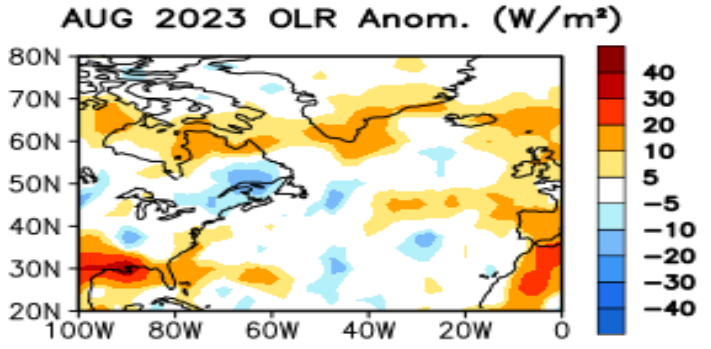


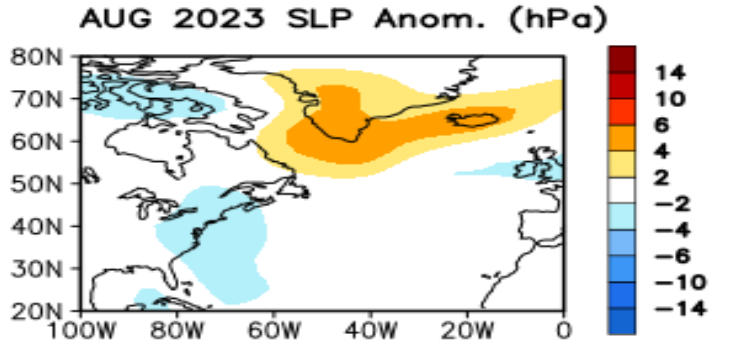
SSTA (top-left; OIv2.1 SST Analysis), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) (middle-left; NOAA 18 AVHRR IR), sea surface pressure (middle-right; NCEP CDAS), sum of net surface short- and long-wave radiation (bottom-left; positive means heat into the ocean; NCEP CDAS), sum of latent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

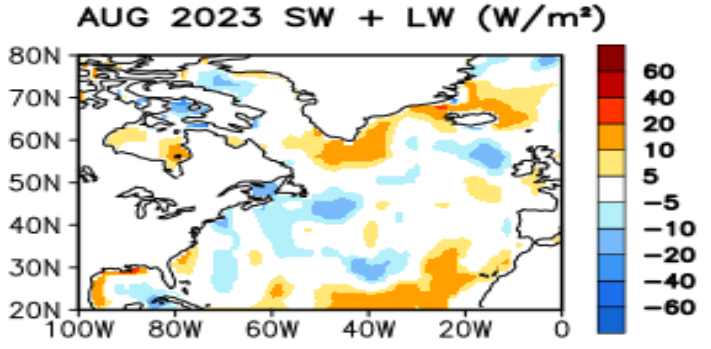
N. Atlantic: SST, SST tend., OLR, SLP, & heat flex anom.

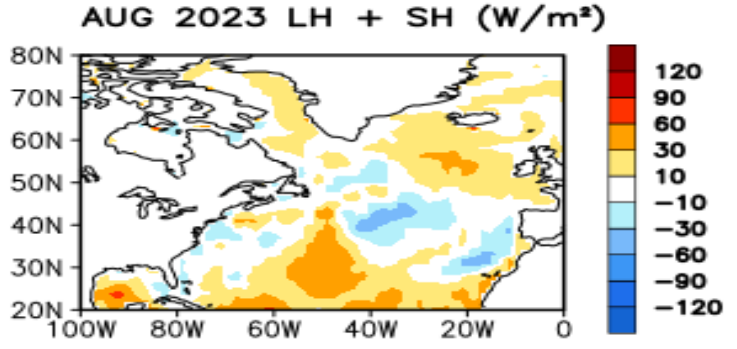




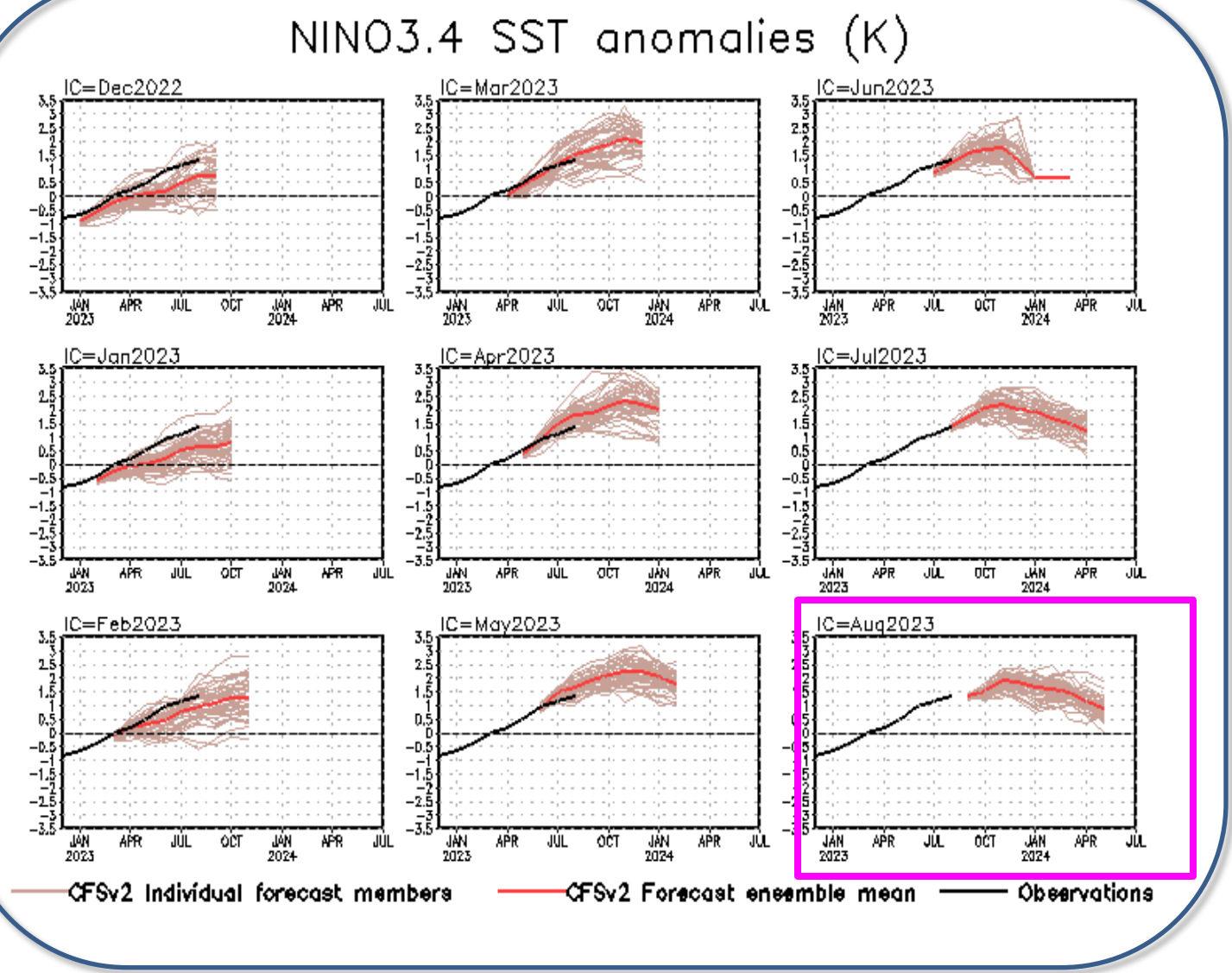








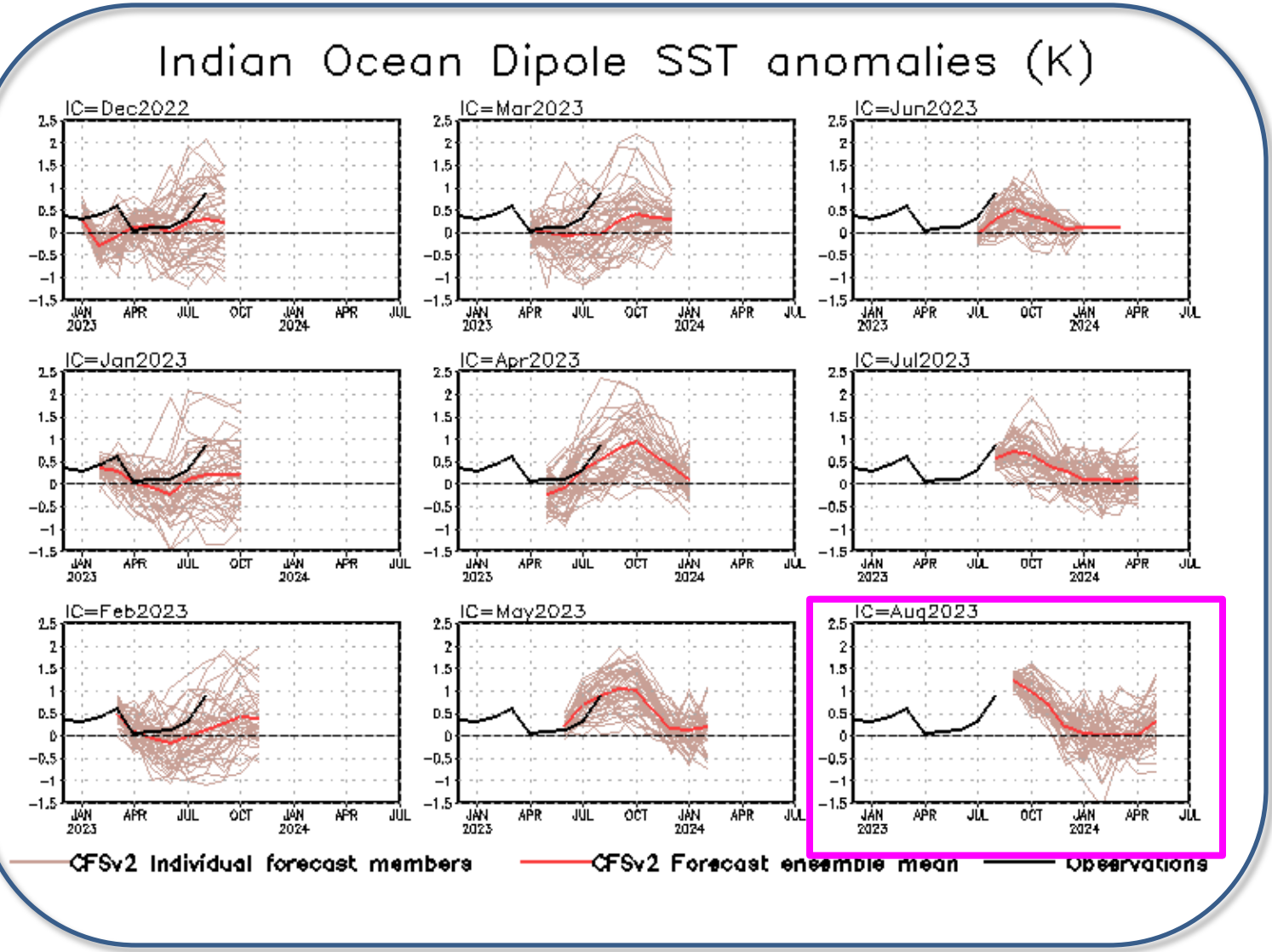
CFS Niño3.4 SST Predictions from Different Initial Months



- The latest CFSv2 forecasts call for 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.

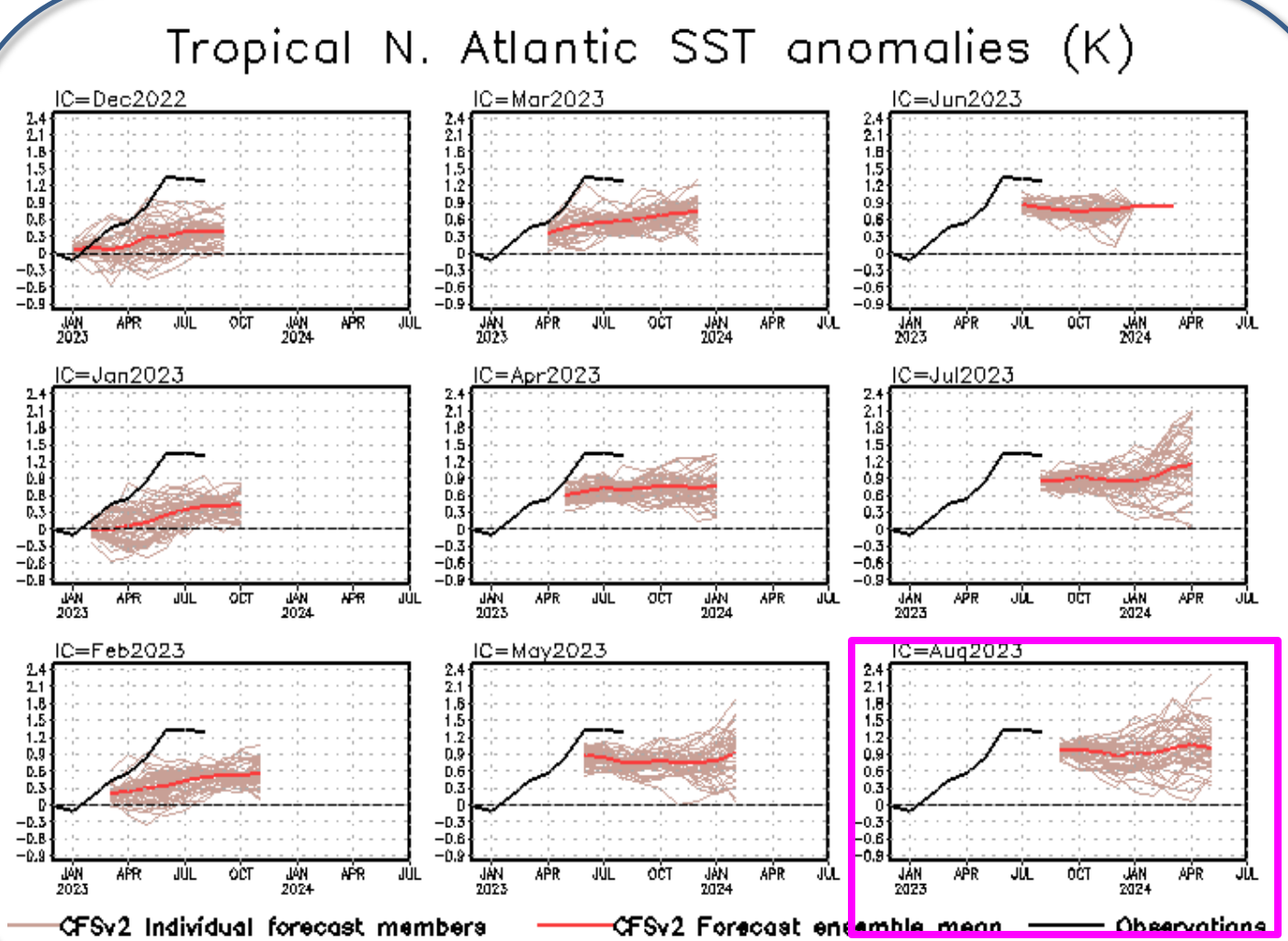
NCEP CFS DMI SST Predictions from Different Initial Months



- CFSv2 predicts a positive phase of IOD in the 2nd half of 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].