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

Prepared by

Climate Prediction Center, NCEP/NOAA

October 11, 2022

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 Ocean
  - Indian Ocean
  - Atlantic Ocean
- **Global SSTA Predictions**

Overview

•Pacific Ocean

- La Niña condition continued in Sep 2022.
- Strong negative PDO persisted in Sep 2022, with PDOI = -1.8.
- Marine Heat Waves (MHWs) re-emerged in the west-central North Pacific, and persisted in the North-east Pacific and near the west coast of USA.

•Arctic Ocean

- Averaged Arctic sea ice extent for September ranked the eleventh lowest in the satellite record.

•Indian Ocean

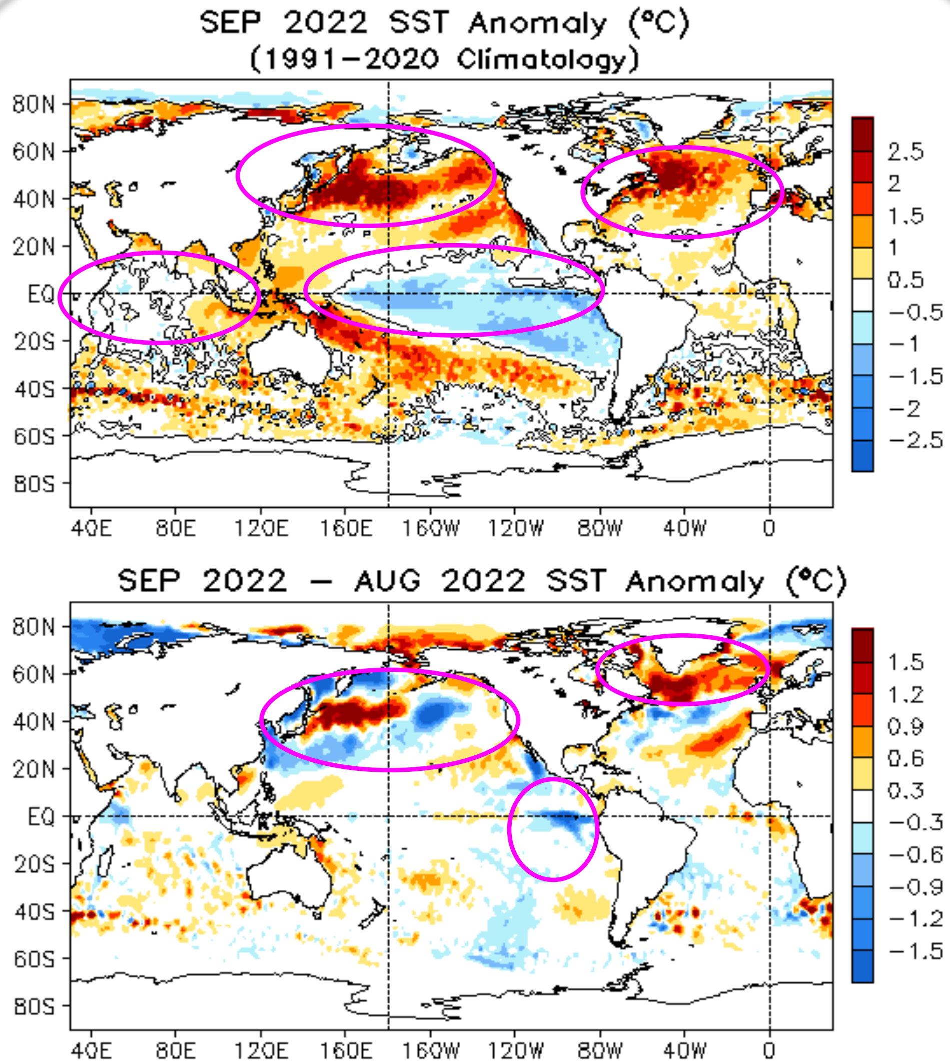
- The negative Indian dipole event continued to develop in Sep 2022.
- All NMME models predicted the negative IOD condition last through Nov 2022.

•Atlantic Ocean

- Four hurricanes formed in Sep 2022.
- A majority of NMME models predicted above or near normal SSTs to persist in the Hurricane main development region through the 2022 hurricane season.

Global Oceans

Global SST Anomaly (°C) and Anomaly Tendency

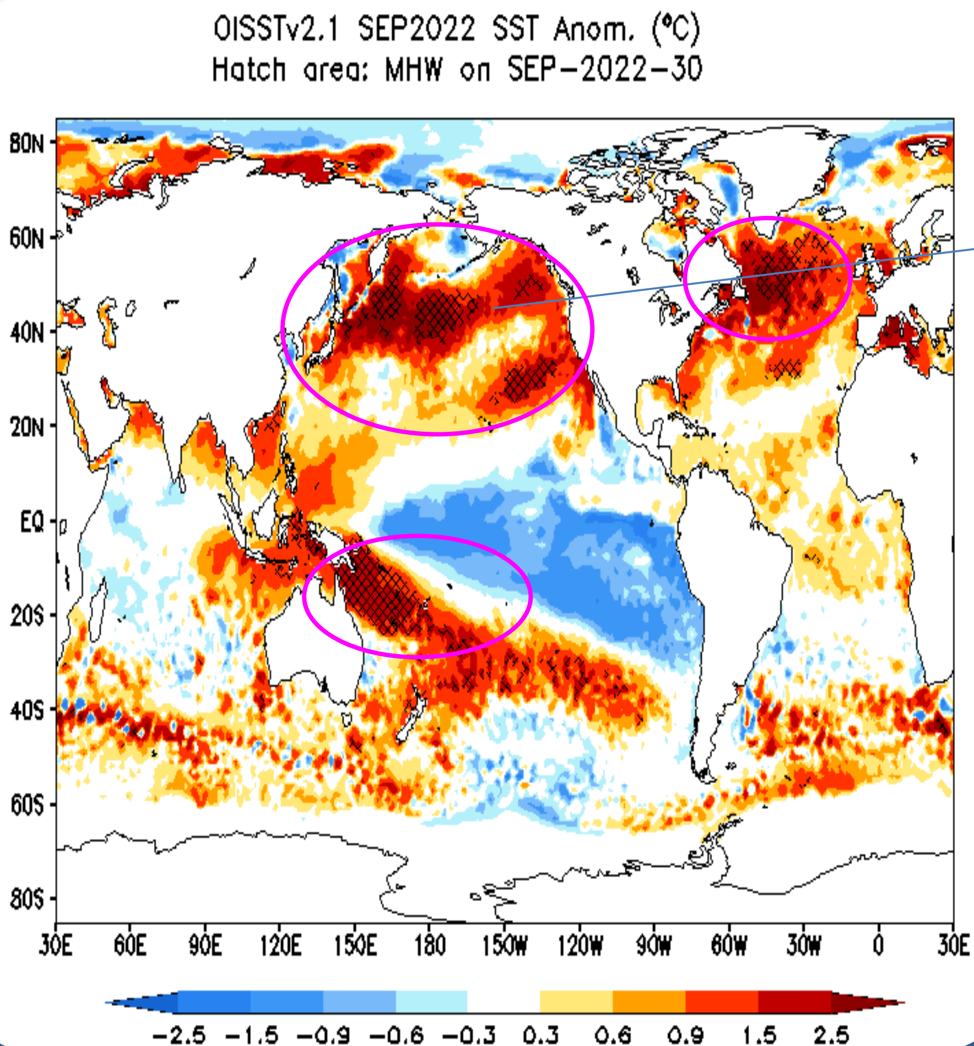


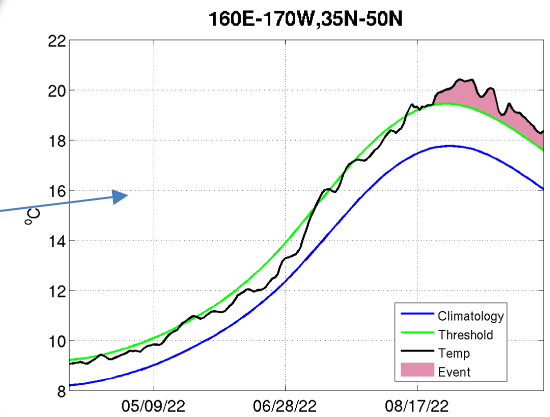
- SSTs were below average across most of the equatorial Pacific Ocean.
- Strong positive SSTAs were present in the North Pacific and the North Atlantic Oceans.
- Positive SSTA persisted in the eastern Indian Ocean.

- Negative SSTA tendencies were observed in the far eastern equatorial Pacific.
- Both positive and negative SSTA tendencies were observed in the North Pacific.
- Large positive SSTA tendencies were observed in the subpolar Atlantic Ocean.

SSTAs (top) and SSTA tendency (bottom). Data are derived from the OISSTv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

Global Monthly SST anomaly and Marine Heat Waves

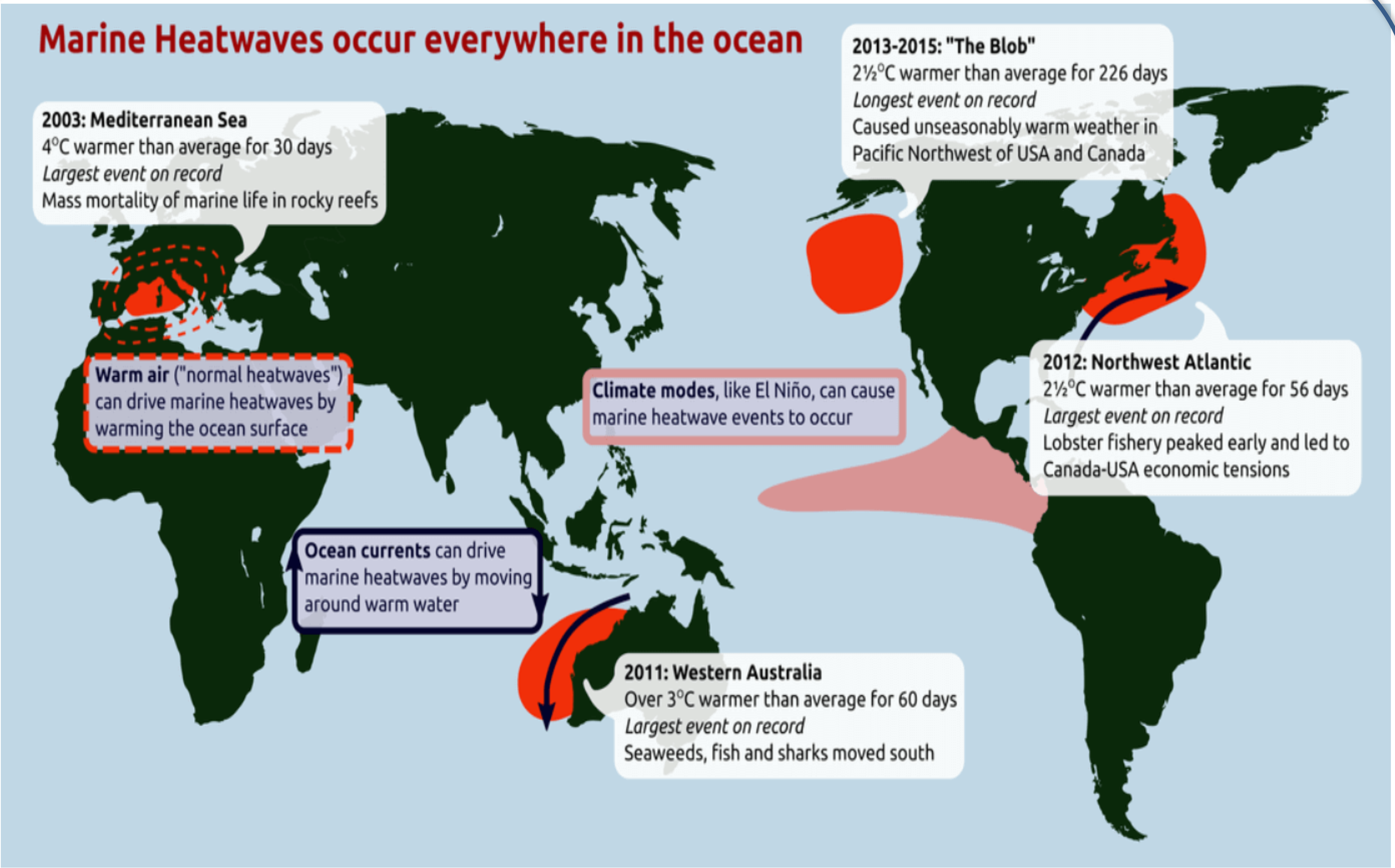




- MHWs were observed in the Northcentral, Northeast Pacific , Northwest Atlantic, and the Coral Sea.

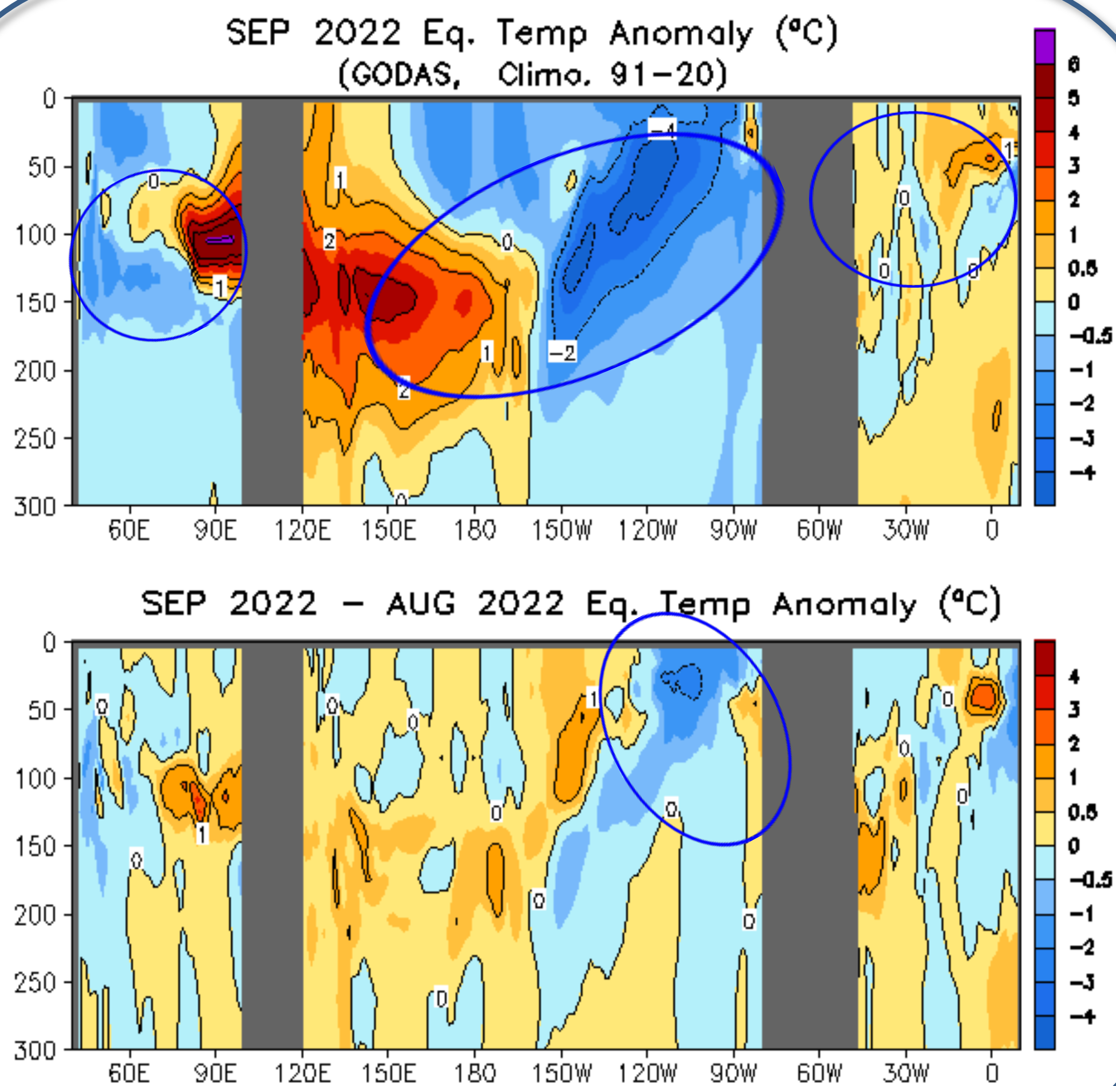
((Left panel) Monthly SST anomaly (shaded) and locations experiencing marine heat waves (hatched) by the end date labelled in the plot. (right panel) SST evolution at a specific location. Green line and blue line are the 90th percentile and daily climatology, respectively. Shaded area denotes the periods 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

Historical Marine Heat Wave events and impacts



https://www.severe-weather.eu/global-weather/north-pacific-ocean-anomaly-2022-usa-seasonal-influence-fa/

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



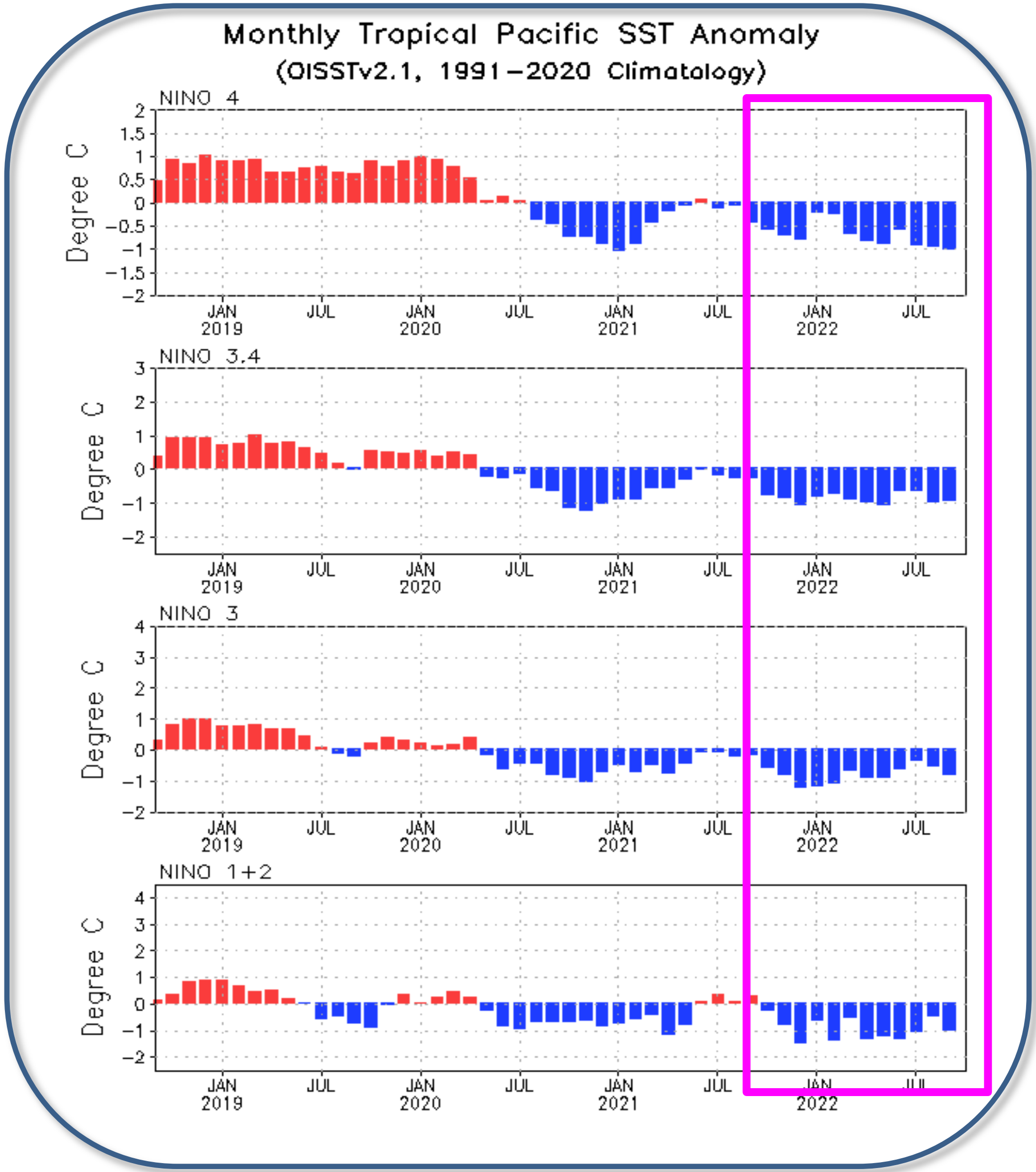
- Negative (positive) temperature anomalies persisted along the thermocline in the eastern (western) Pacific Ocean.
- Large positive temperature anomalies persisted in the eastern equatorial Indian Ocean.
- Positive temperature anomalies dominated the upper 100m of the equatorial Atlantic Ocean.

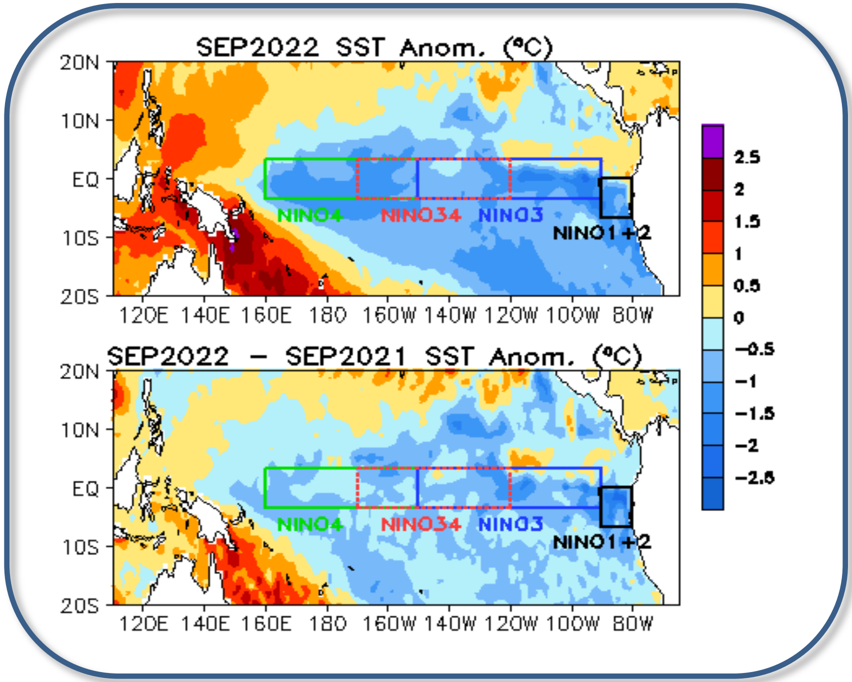
- Negative temperature anomaly tendency was observed along the eastern equatorial thermocline in the Pacific Ocean.

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

Evolution of Pacific Niño SST Indices





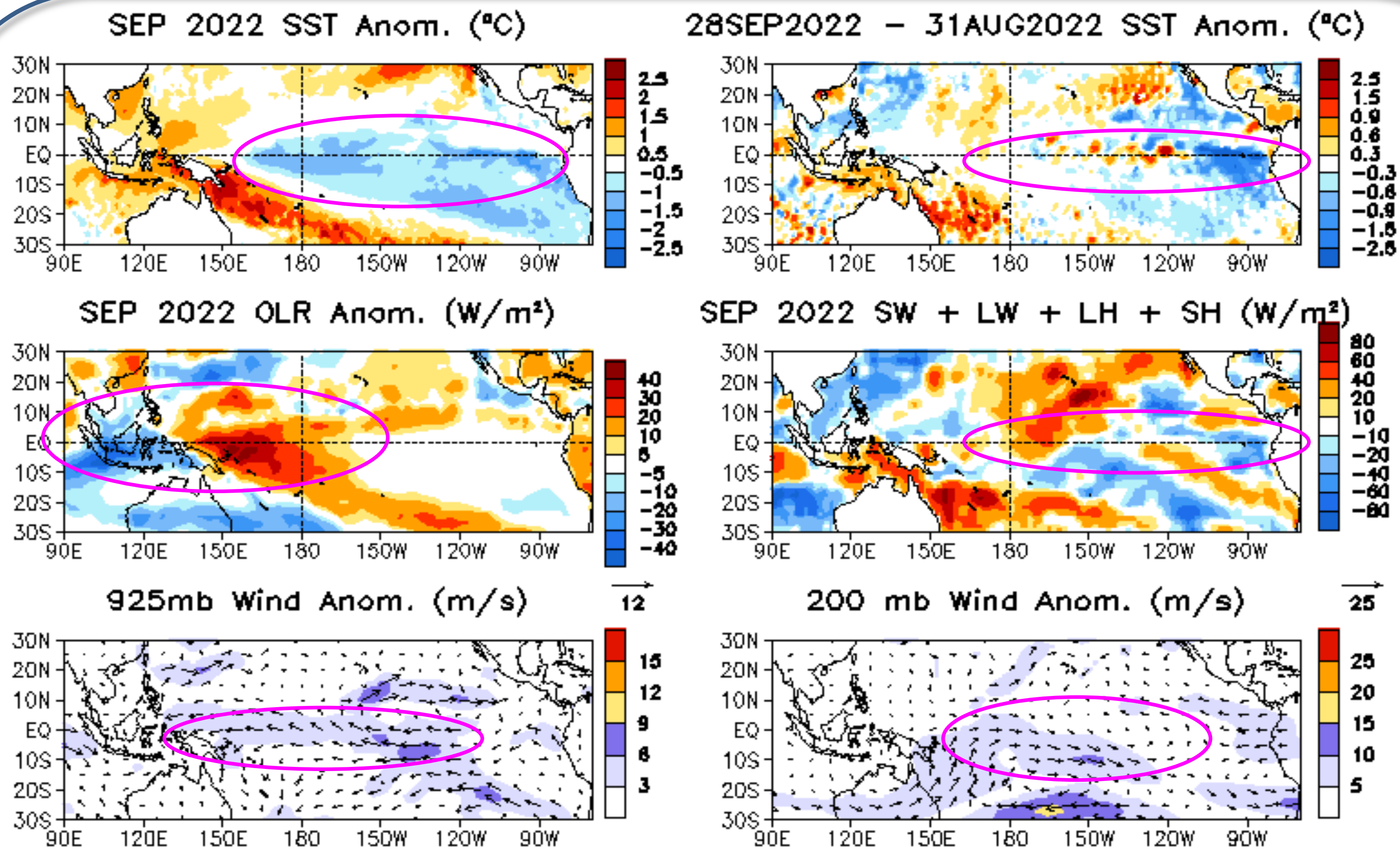
- Except for Niño3.4, other Niño indices cooled in Sep 2022.

- Negative Niño3.4 persisted in Sep 2022 , with Niño3.4 = -0.9 C.

- Compared with Sep 2021, the western-central and southeastern tropical Pacific were cooler in Sep 2022.

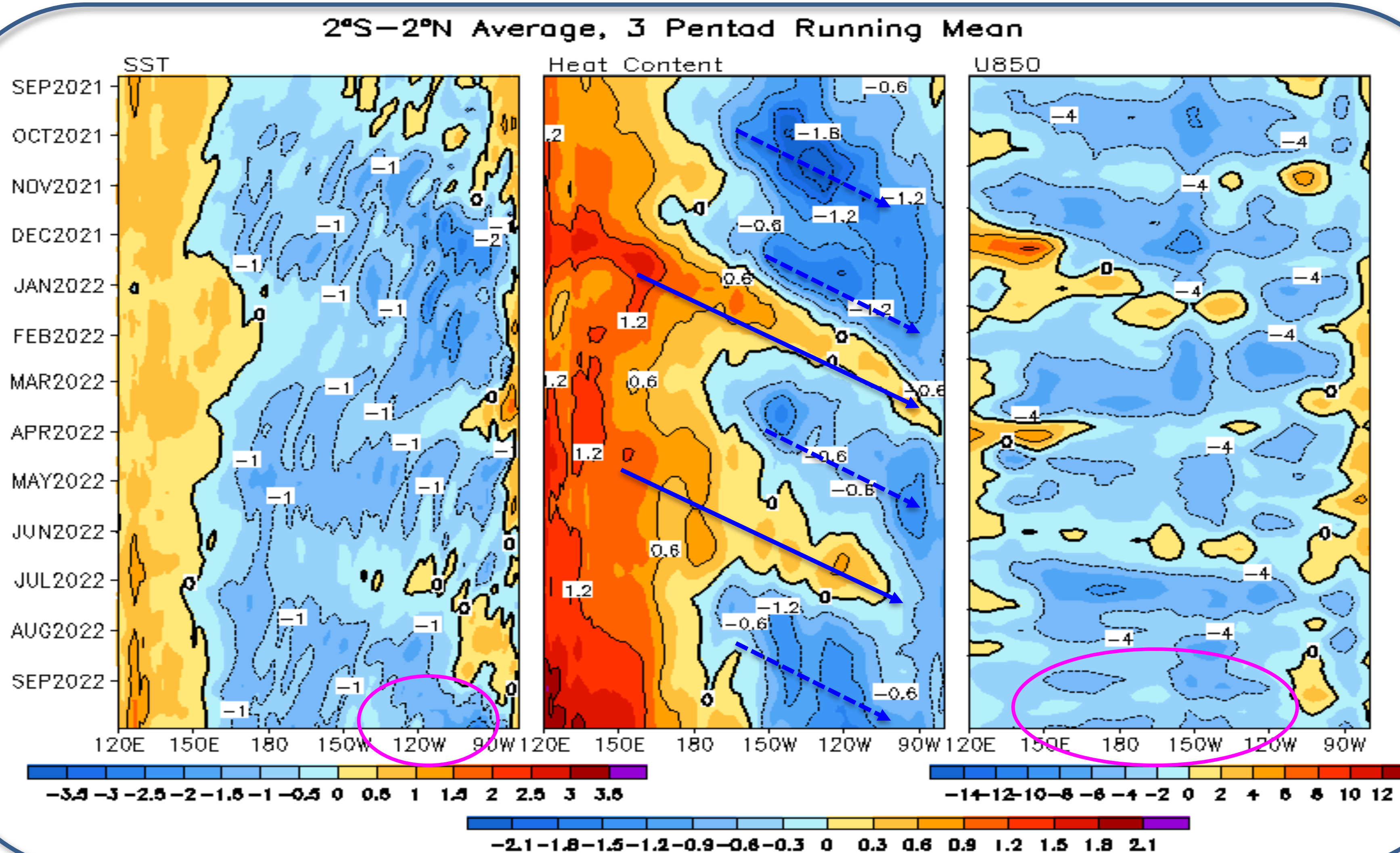
- The indices may have slight differences if based on different SST products.

Niño region indices, calculated as the area-averaged monthly mean SSTAs (°C) for the specified region. Data are derived from the OISSTv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.



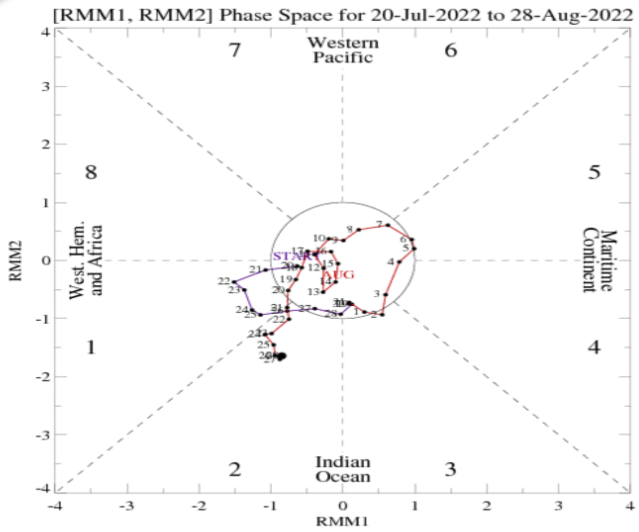
SSTAs (top-left), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right; positive means heat into the ocean), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the OISSTv2.1 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.

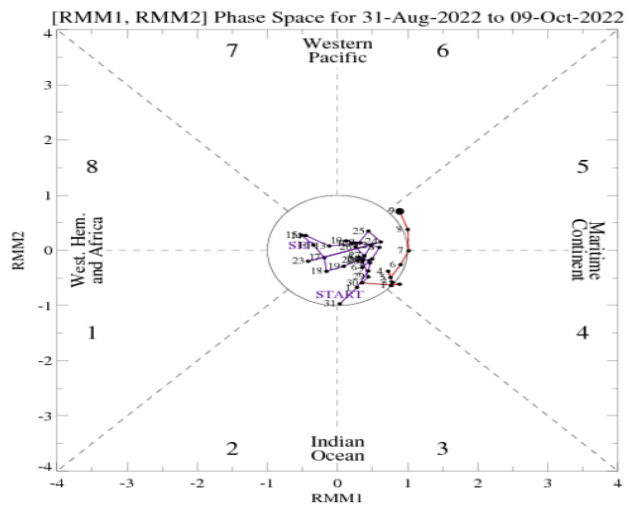
Equatorial Pacific SST (°C), HC300 (°C), u850 (m/s) Anomalies



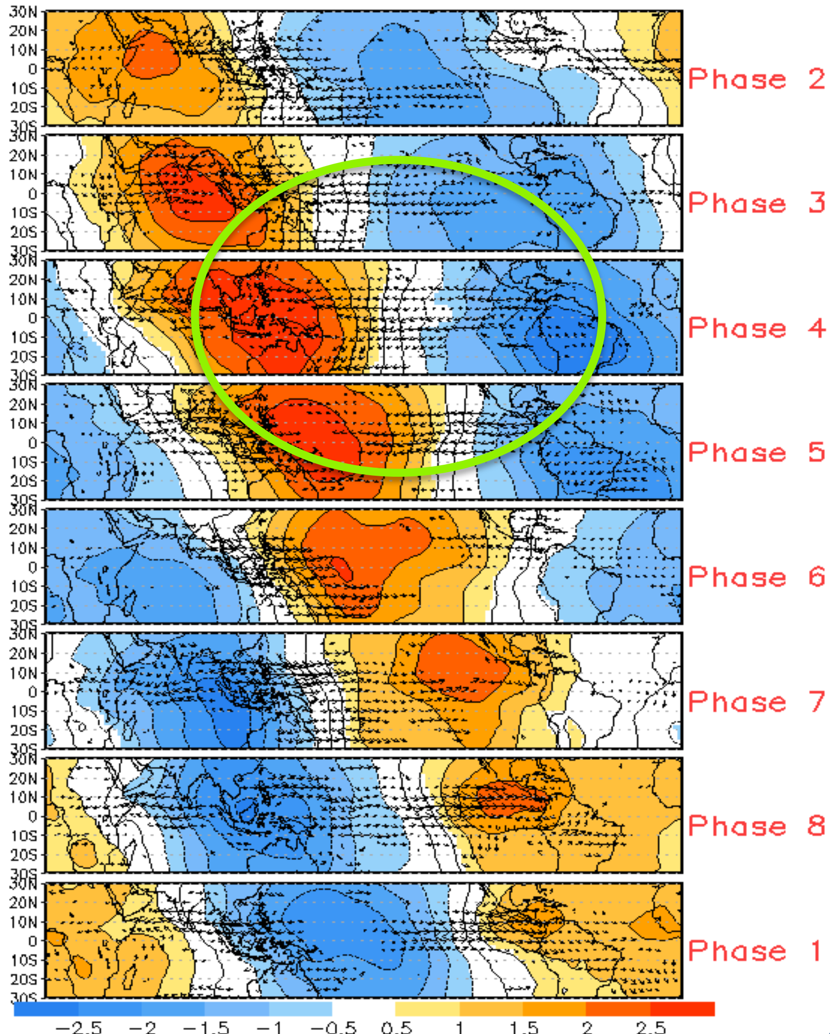
- Negative H300 anomaly continued in the eastern Pacific in Sep 2022, contributing to the enhanced SSTA in the eastern Pacific .
- In response to the strong easterly wind surges in early July, an upwelling ocean Kelvin wave was initiated in the central Pacific and propagated to the eastern Pacific by the end of Aug 2022.
- Easterly wind anomaly prevailed over the equatorial Pacific in Sep 2022.

MJO Activities

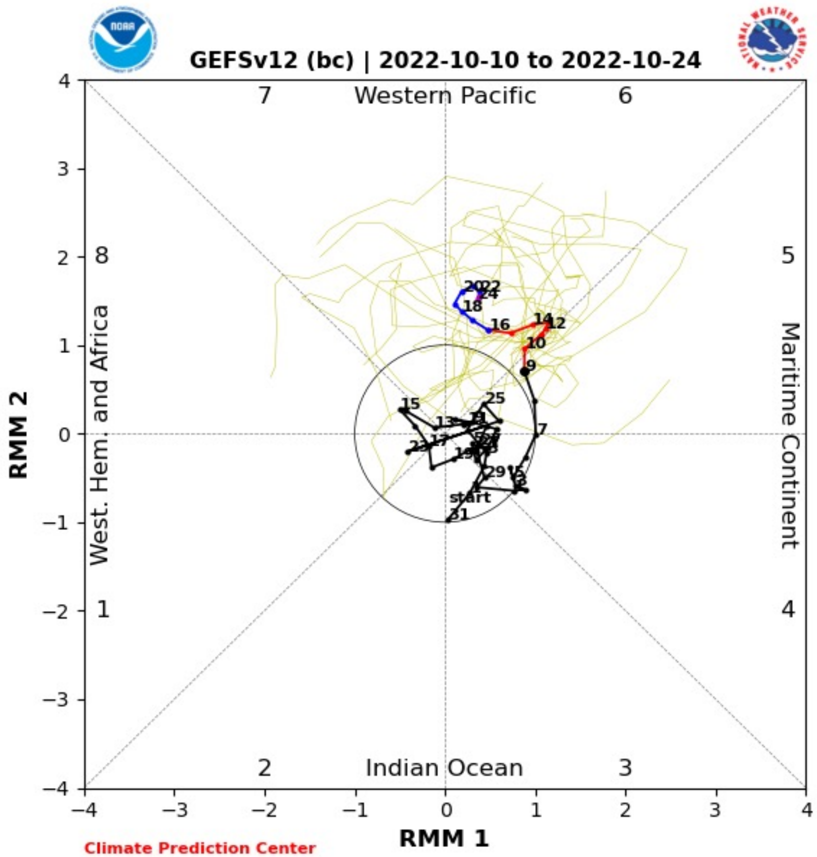


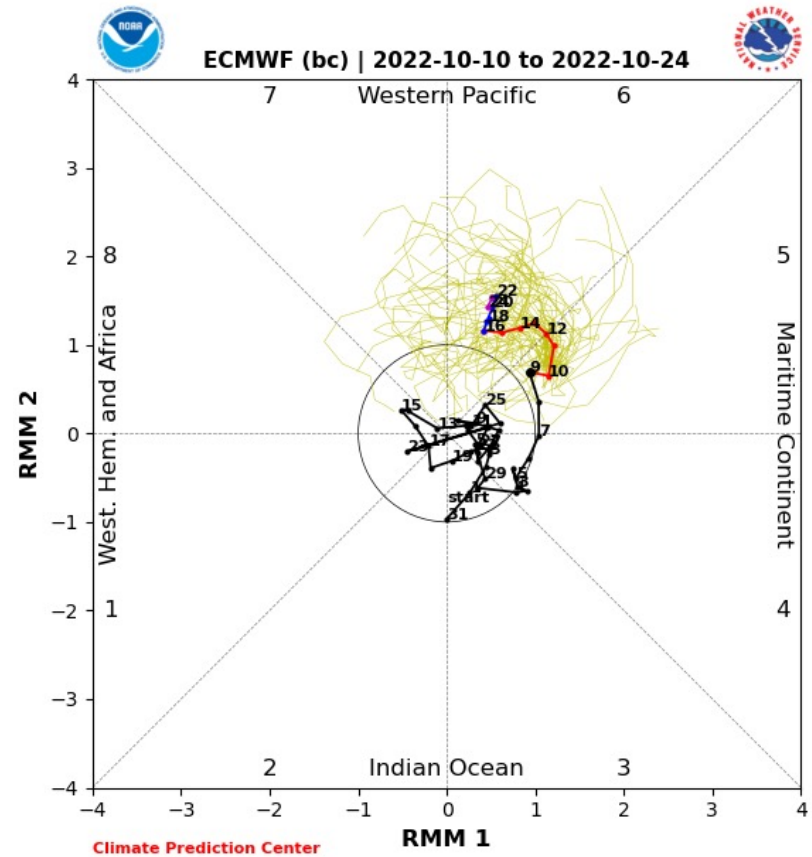


850-hPa Velocity Potential and Wind Anomalies



MJO Index: Forecasts



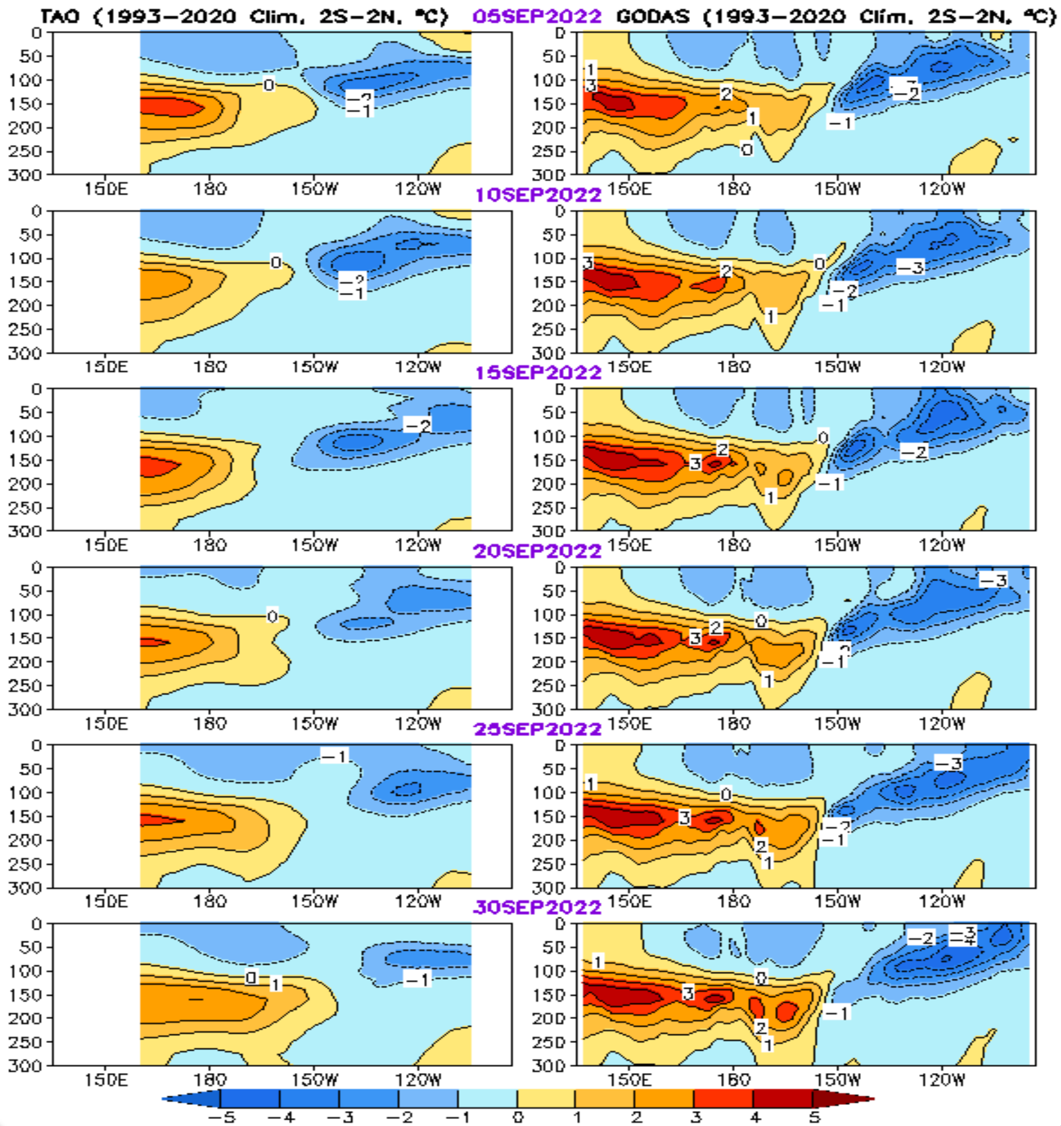


https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml#forecast

- Both GEFS and ECMWF ensembles support a renewed MJO event emerging across the Maritime Continent and propagating into the western Pacific during the next two weeks.

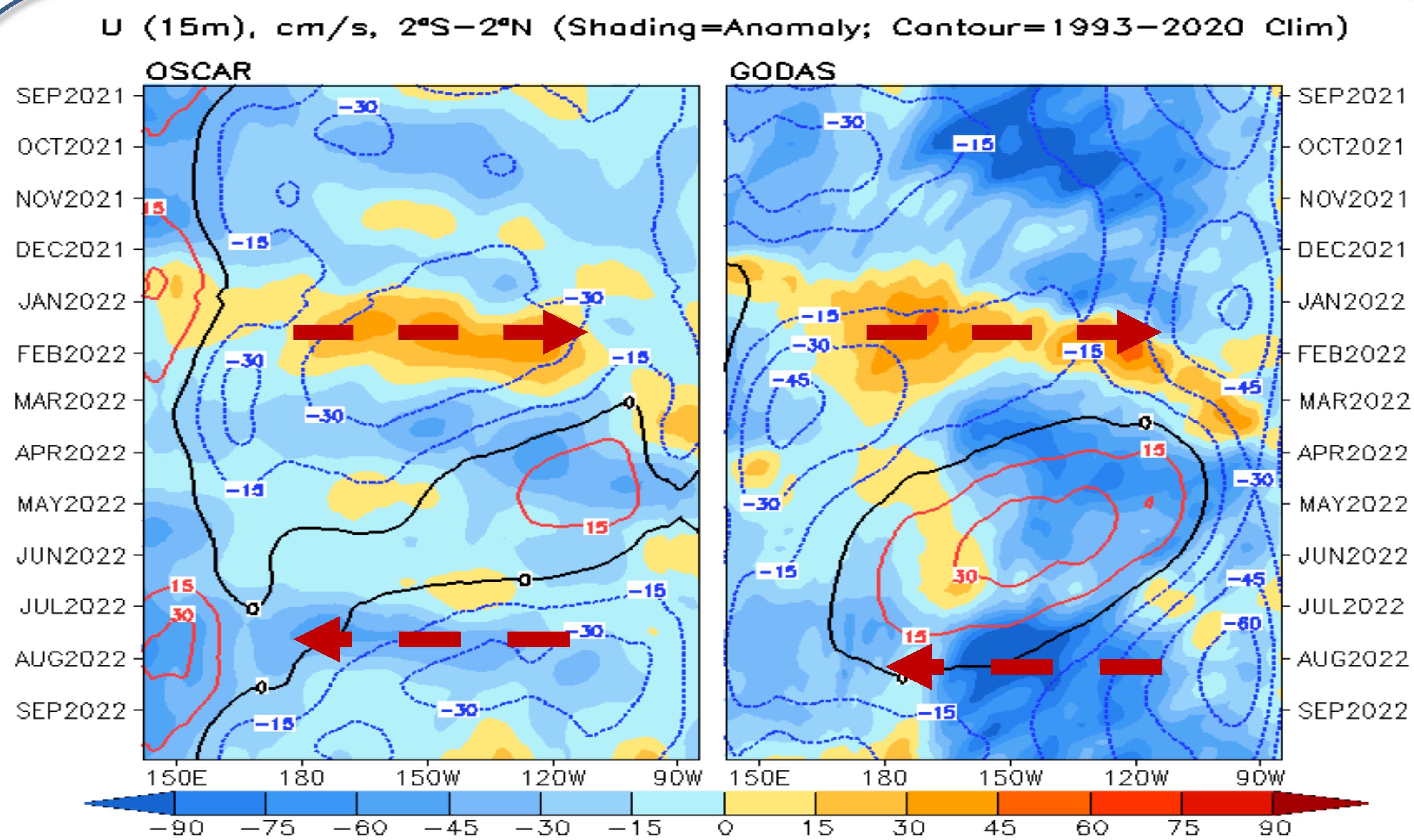
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

TAO GODAS



- Negative temperature anomaly in the eastern Pacific entered the mixed layer, favoring of further SST cooling in the eastern Pacific.
- West-east dipole pattern was stationary in the last six pentads.

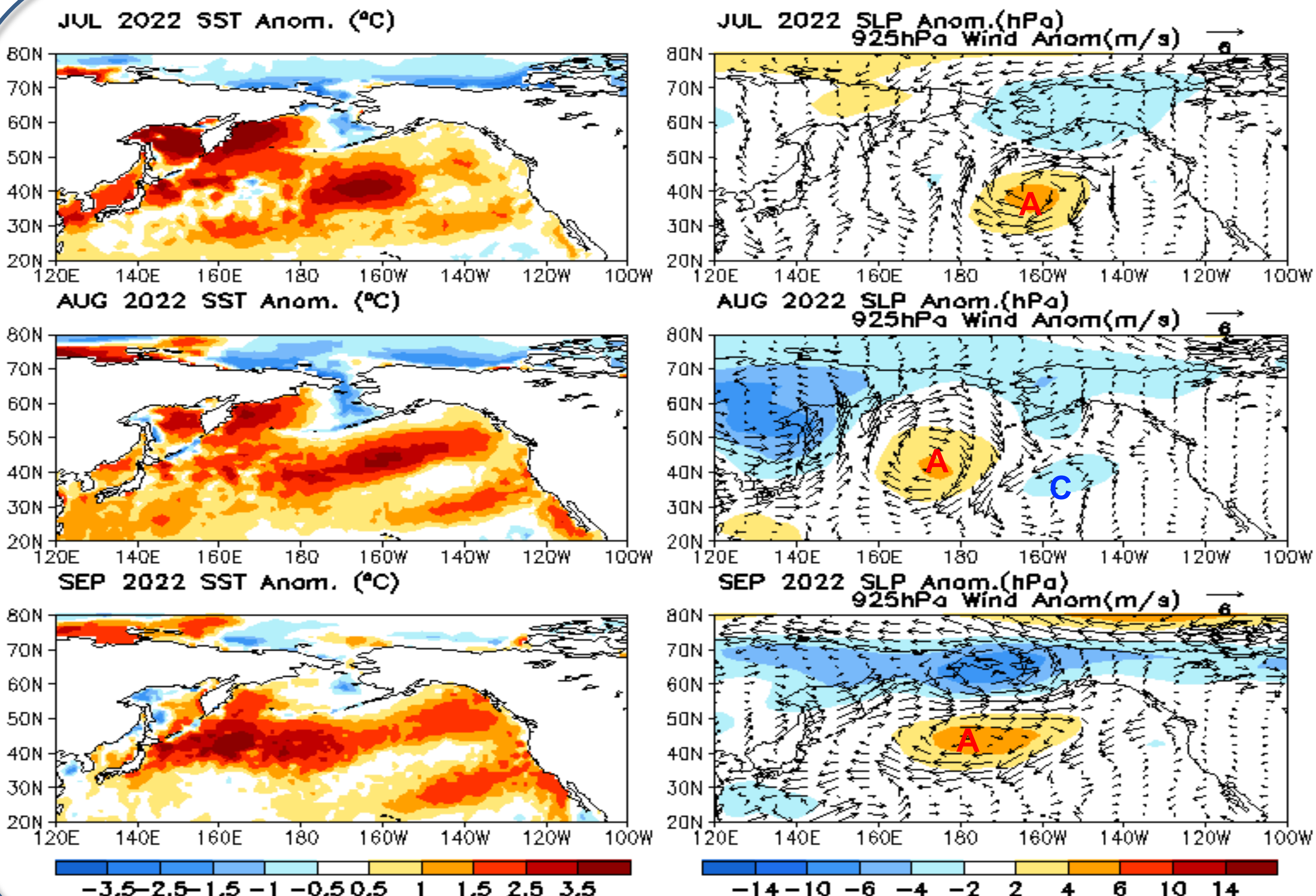
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



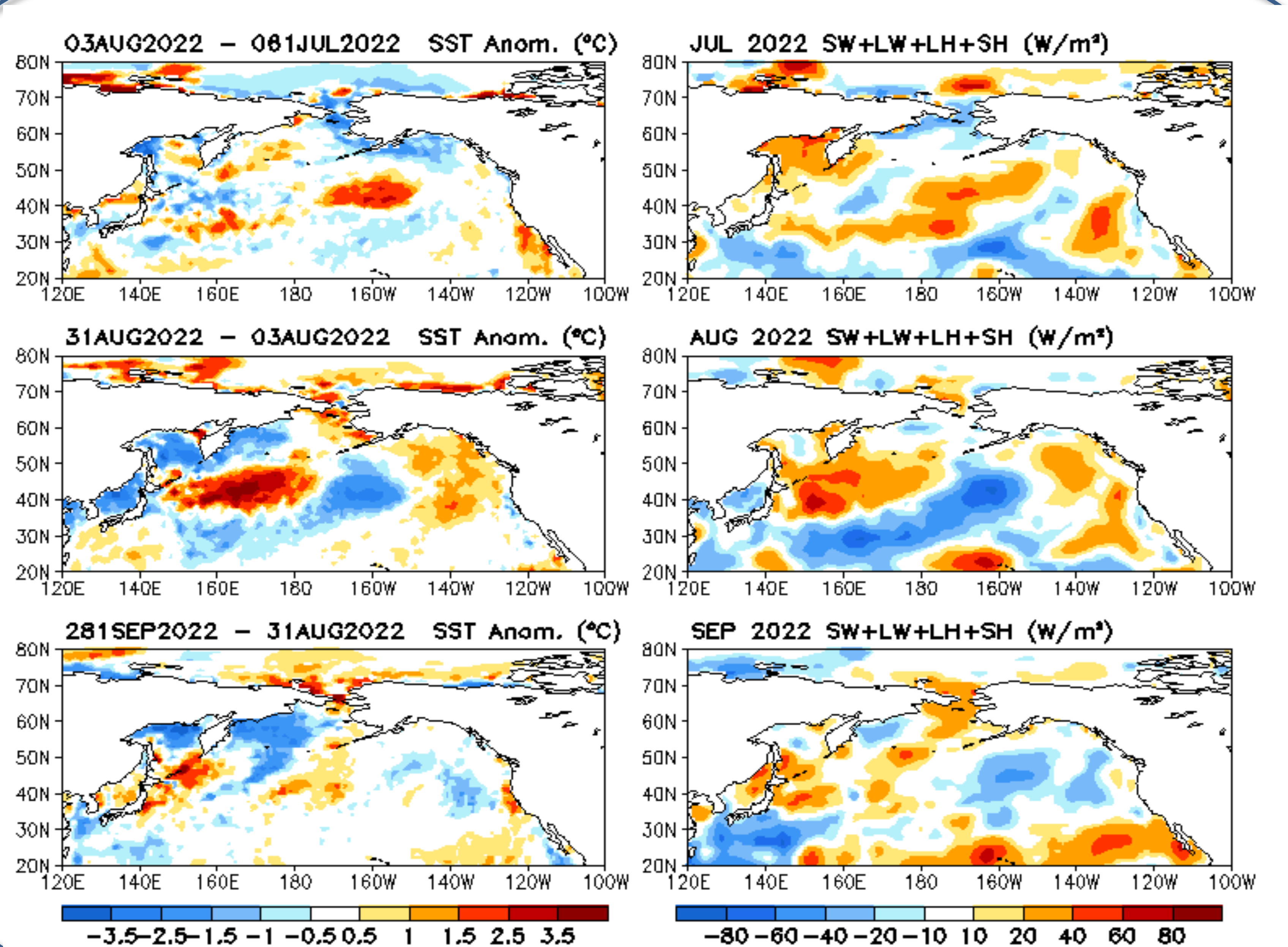
- Distribution of zonal current anomaly in Sep 2022 was different between OSCAR and GODAS.

North Pacific & Arctic Oceans

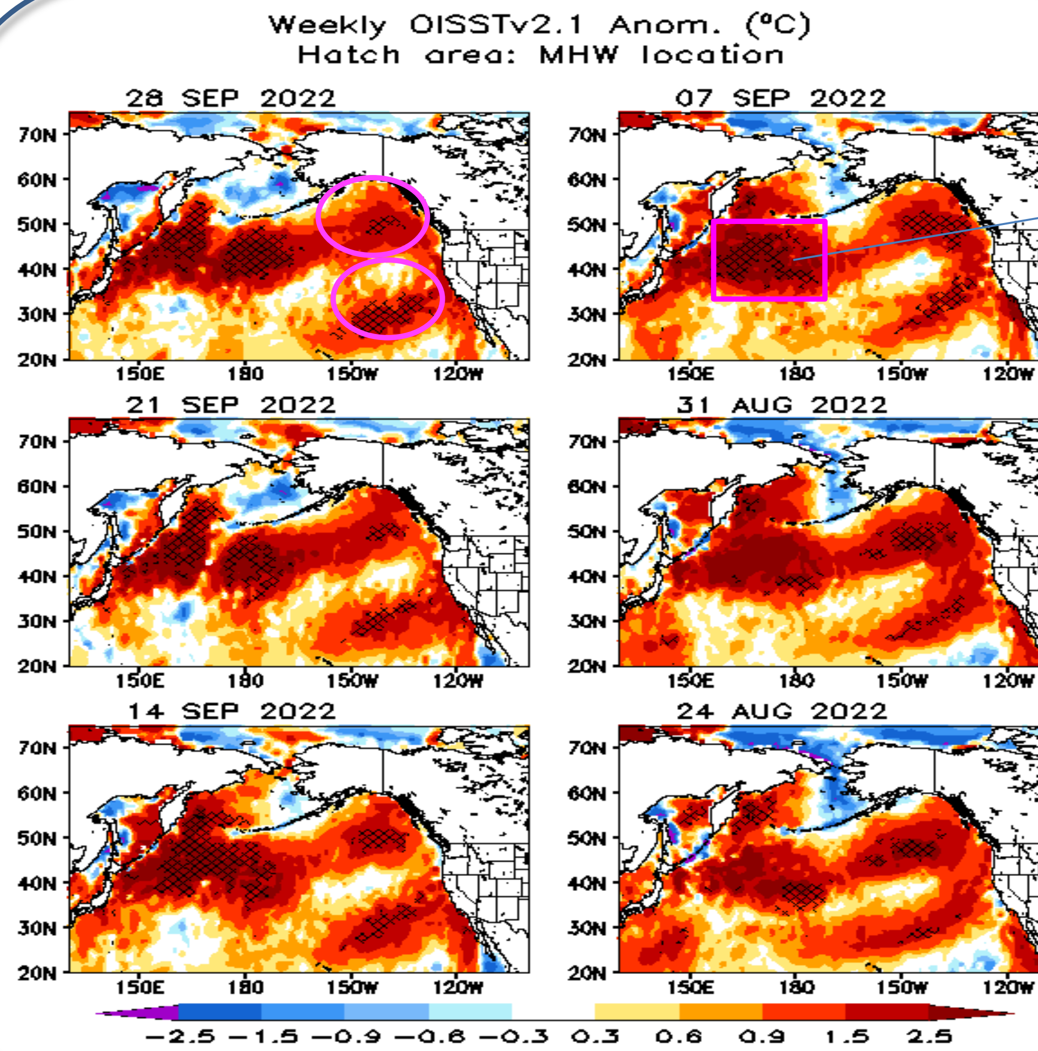
Last 3- month North Pacific SST, SLP, and uv925 anomalies

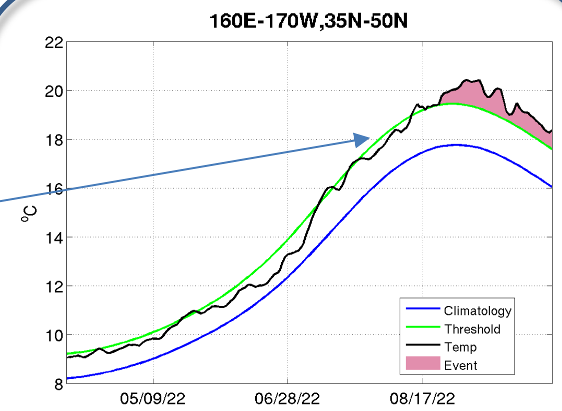


Last 3- month North Pacific SST tendency and Surface Heat Flux anomalies



Weekly SST anomaly and MHWs in the North Pacific

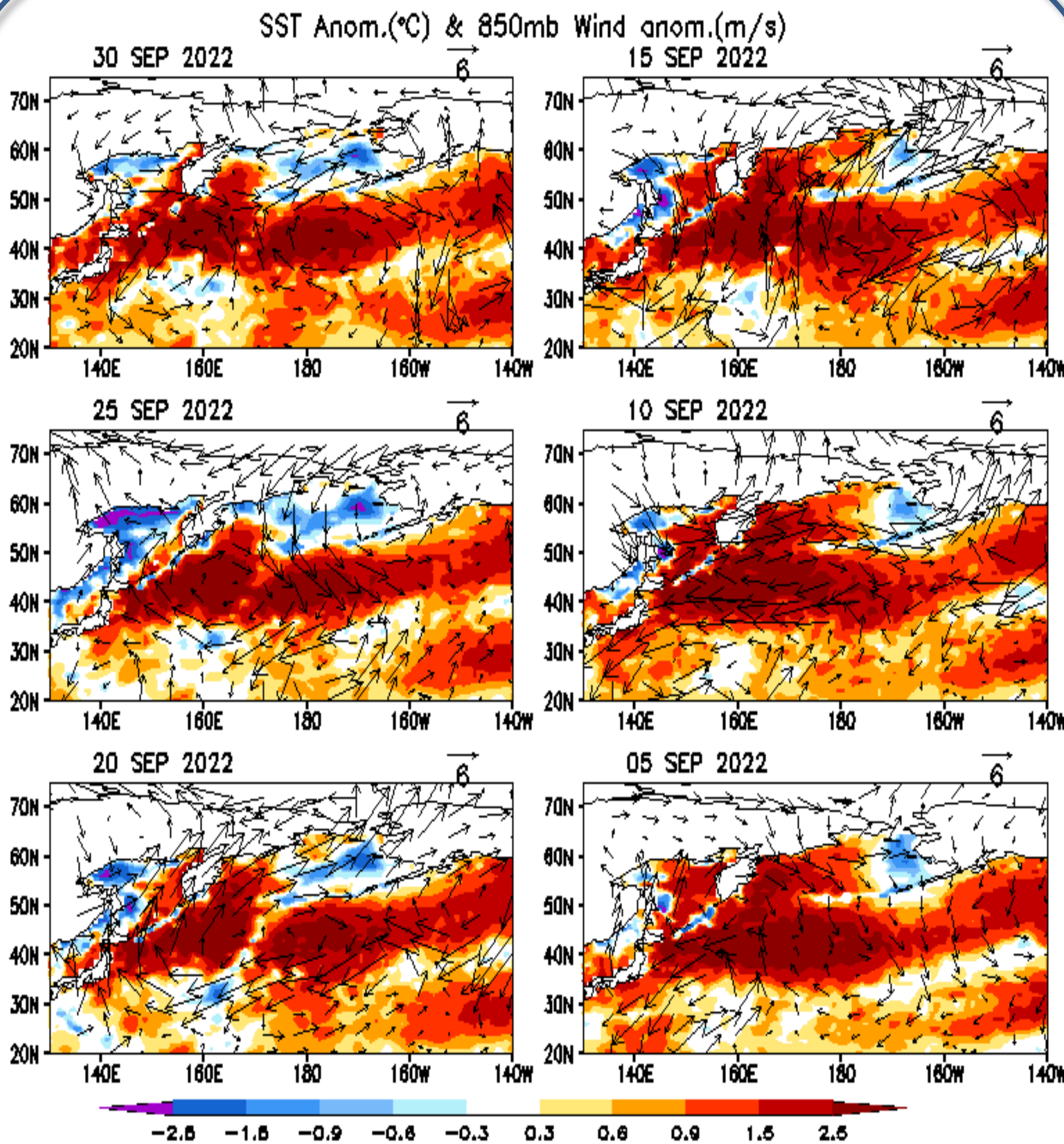


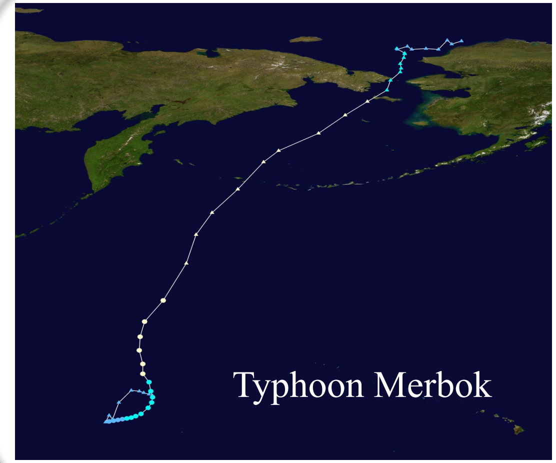


- MHWs reemerged in the western-central Pacific in Sep 2022.
- MHWs persisted in the northeast Pacific (Pacific Blob) and near the west coast of USA.

(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

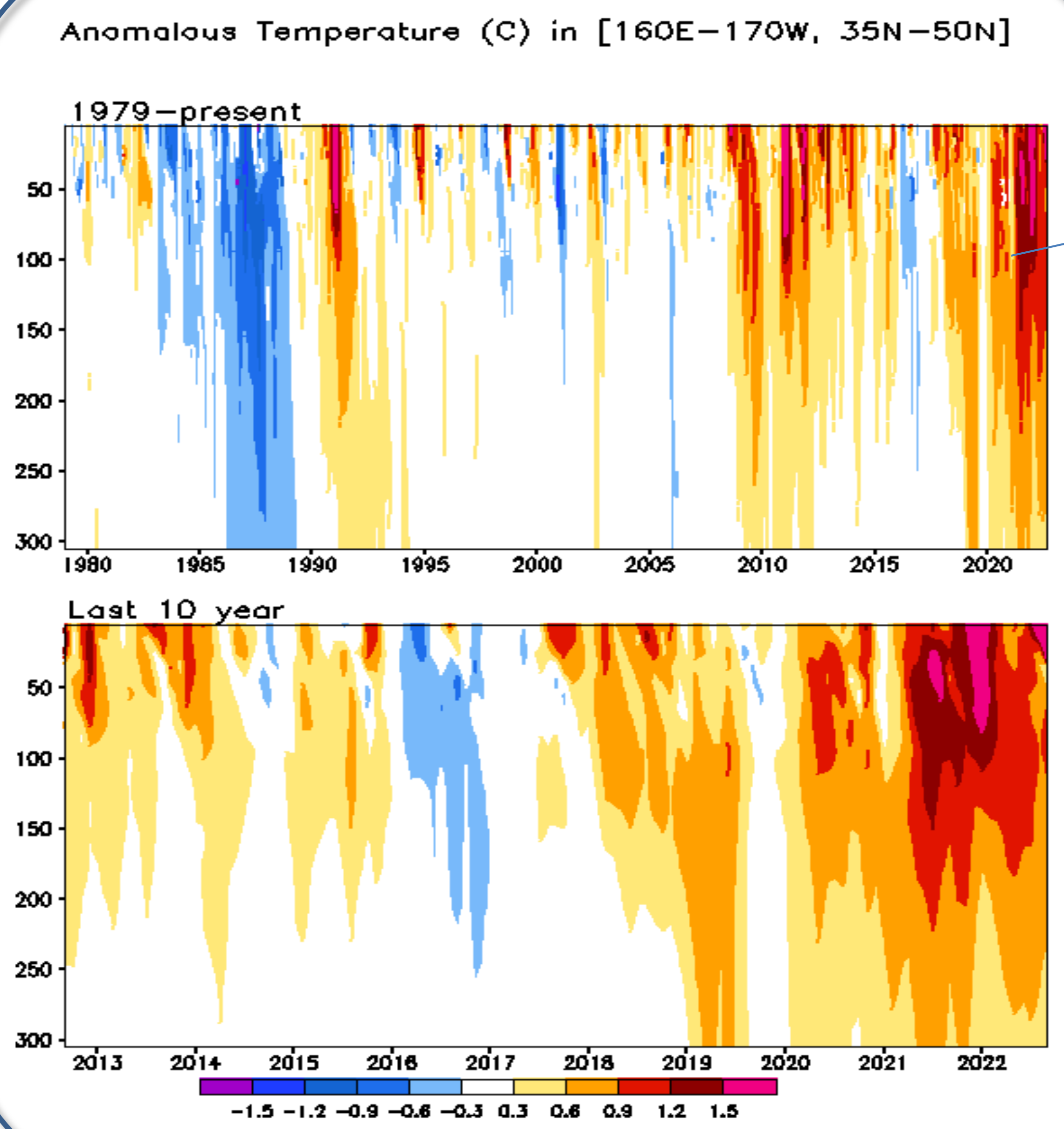
Pentad SST and 850UV anomalies in the North Pacific

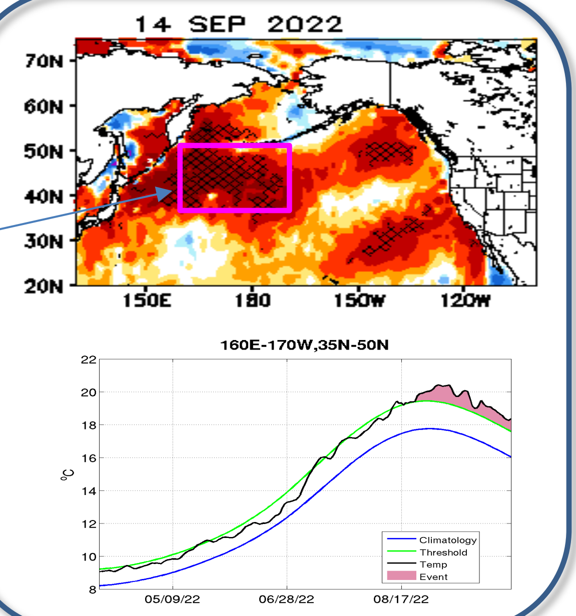




- Typhoon Merbok formed in the North central Pacific, where historically few typhoons form.
- Typhoon Merbok morphed into a powerful northern Pacific storm, influencing western Alaska on Sep 17-18 with hurricane-force winds, and with over 50-foot seas and coastal flooding no seen in decades.
- The extremely warm water in the northcentral Pacific helped to enhance the lifecycle and strength of the northern cyclones.

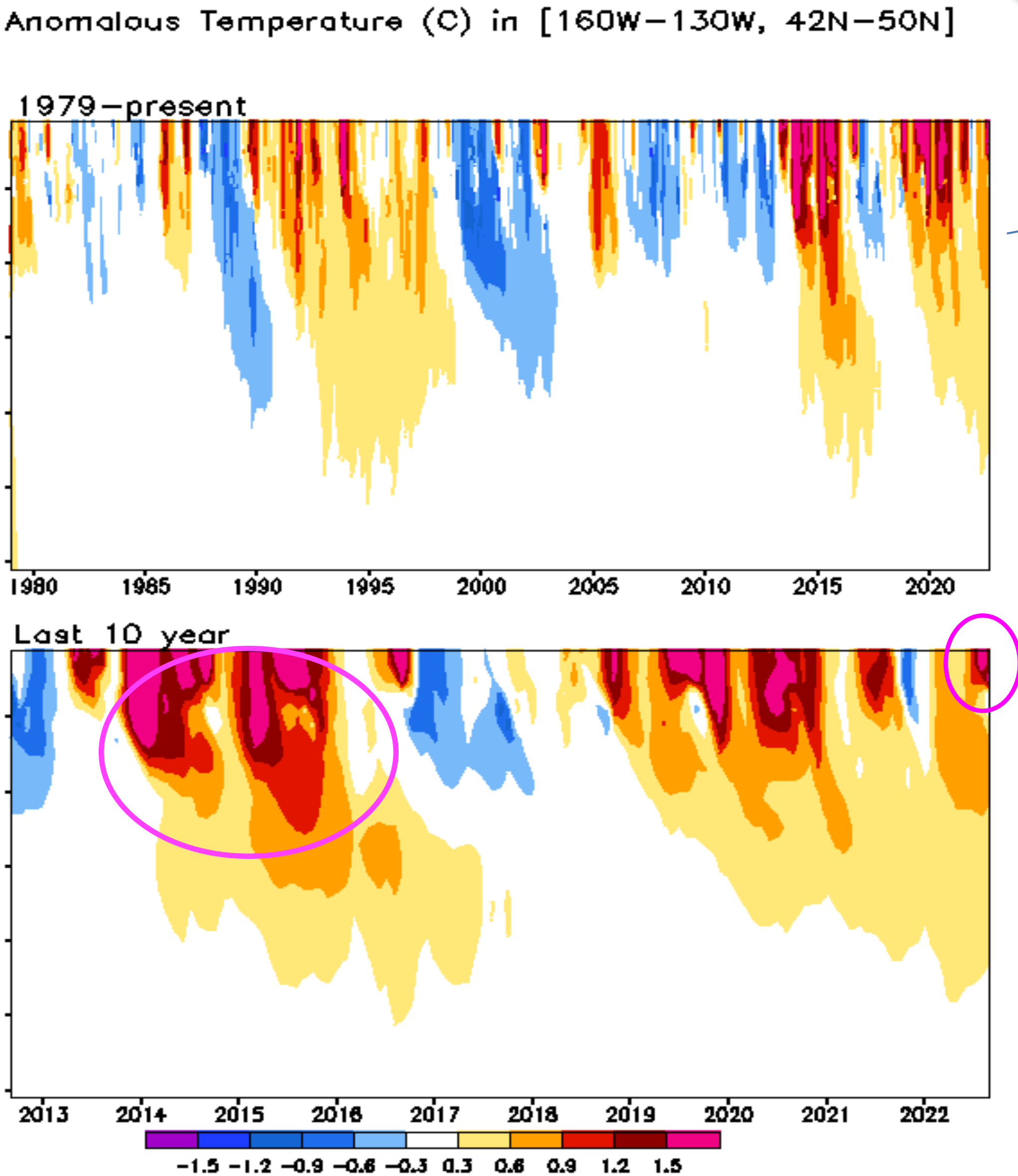
Subsurface Temperature Anomaly in the Northcentral Pacific

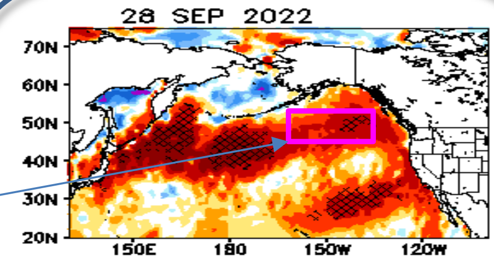


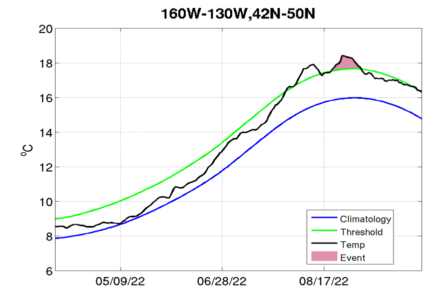


- Positive subsurface temperature anomaly in the North central Pacific has persisted since 2020.
- Subsurface warming in the last couple of years is the strongest event since 1979.
- Positive temperature anomaly (>0.9ºC) penetrated to 200m in recent months.

Subsurface Temperature Anomaly in the Northeast Pacific (Pacific Blob)

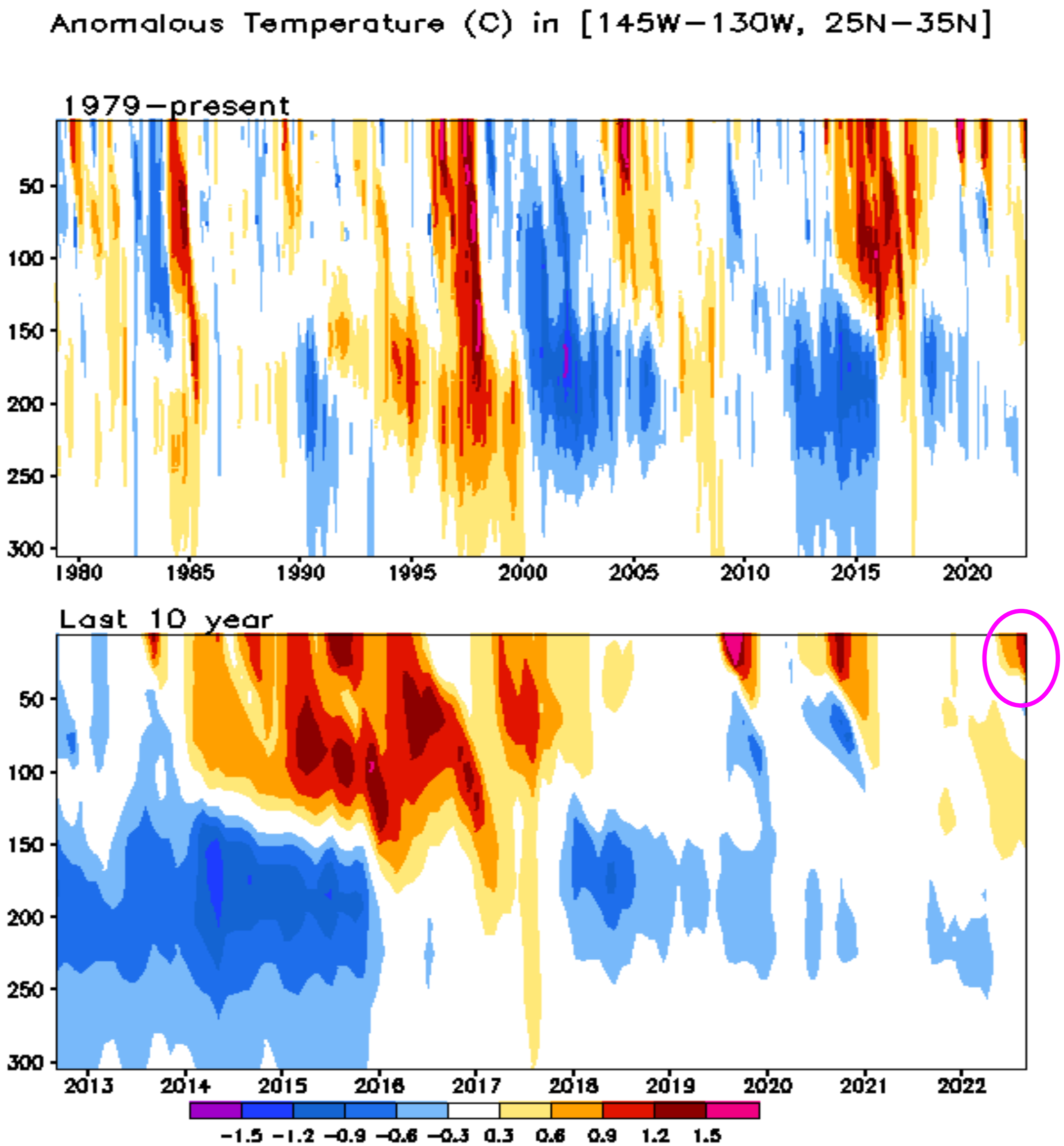


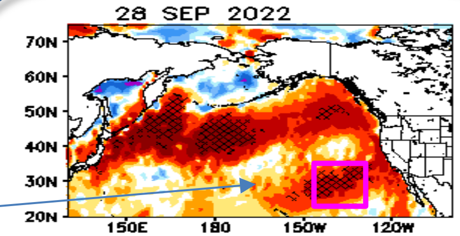


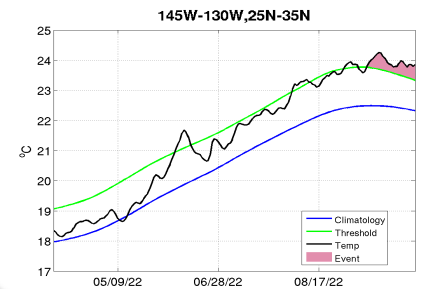


- Positive subsurface temperature anomaly (>0.9ºC) was confined in the upper 50m in Sep 2022.
- Subsurface warming was strongest during 2014-2016 (Pacific Blob).

Subsurface Temperature Anomaly near the west coast of USA



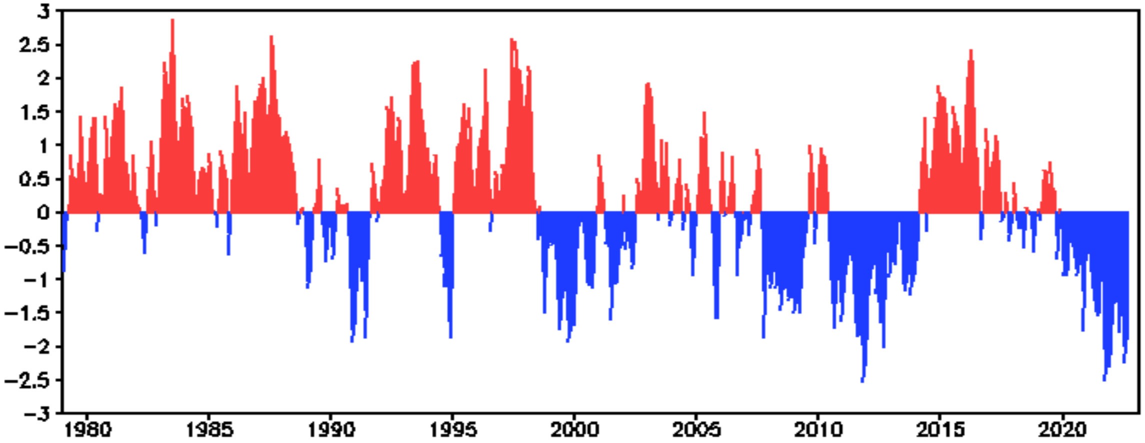




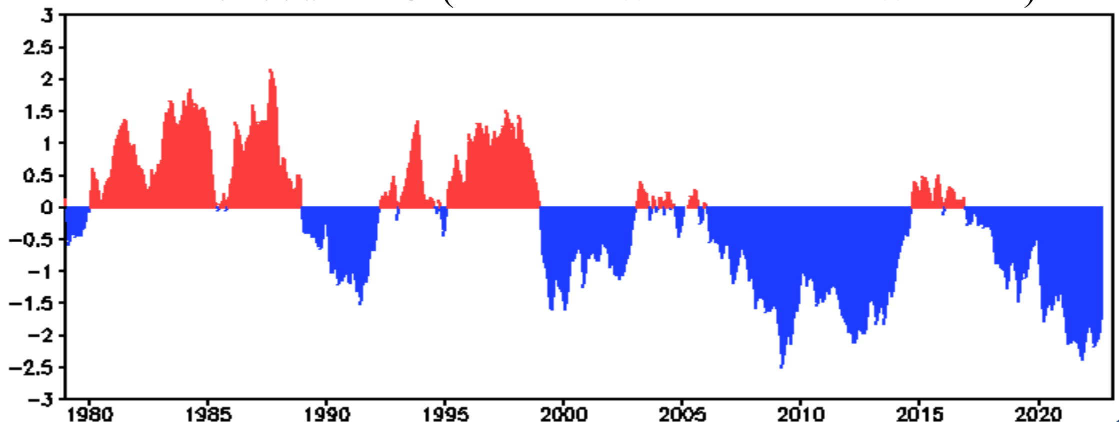
- Positive subsurface temperature anomaly (>0.9ºC) was confined in the upper 50m in Sep 2022.

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 = -1.8. in Sep 2022.

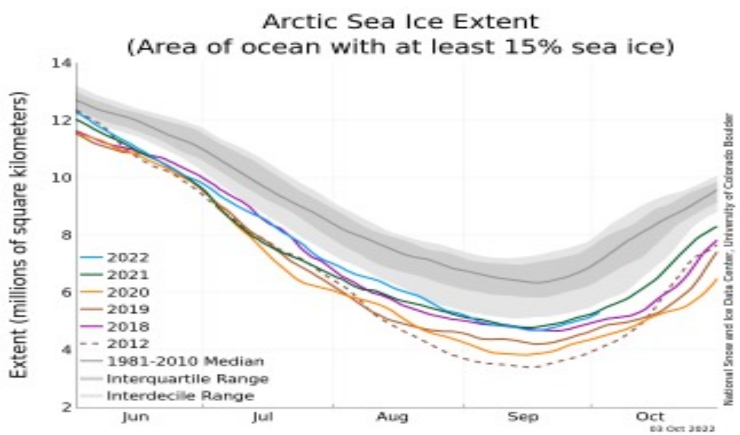
- Negative H300-based PDO index has persisted 71 months since Nov 2016, with HPDO = - 1.63 in Sep 2022.

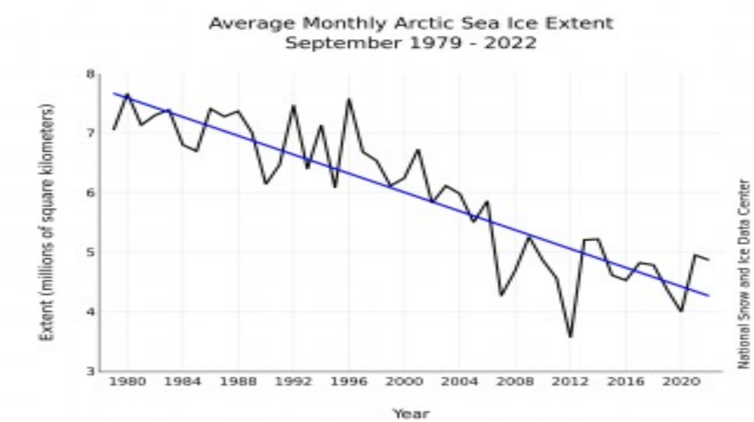
- SST-based PDO index has considerable variability both on seasonal and decadal time scales.

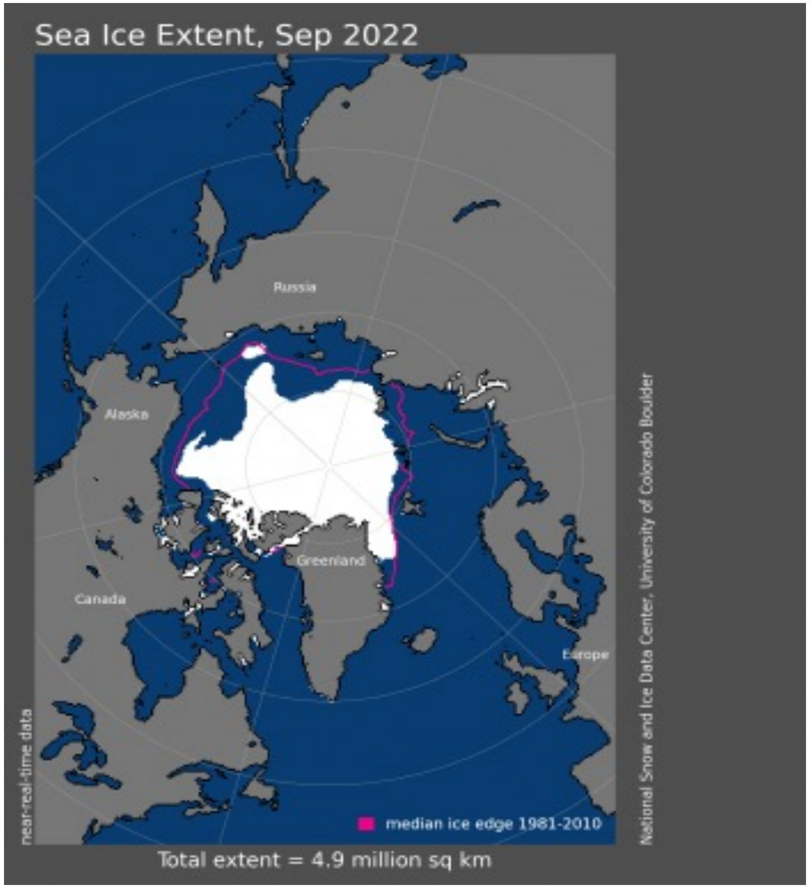
- H300-based PDO index highlights the slower variability and encapsulates an integrated view of temperature variability in the upper ocean.

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.

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

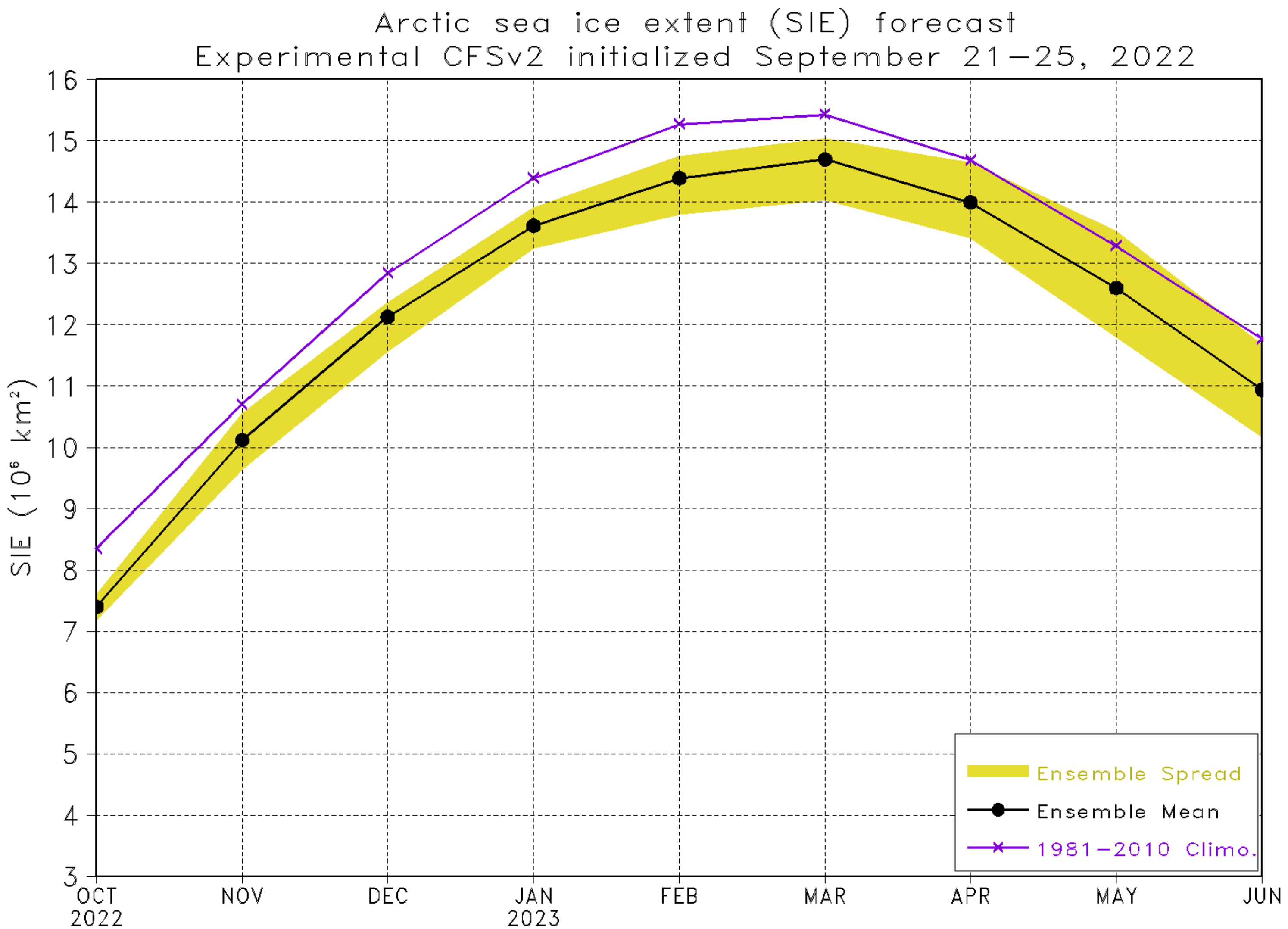






- Average Arctic sea ice extent for September 2022 was 4.87 million square kilometers, tying with 2010 for eleventh lowest in the satellite record.

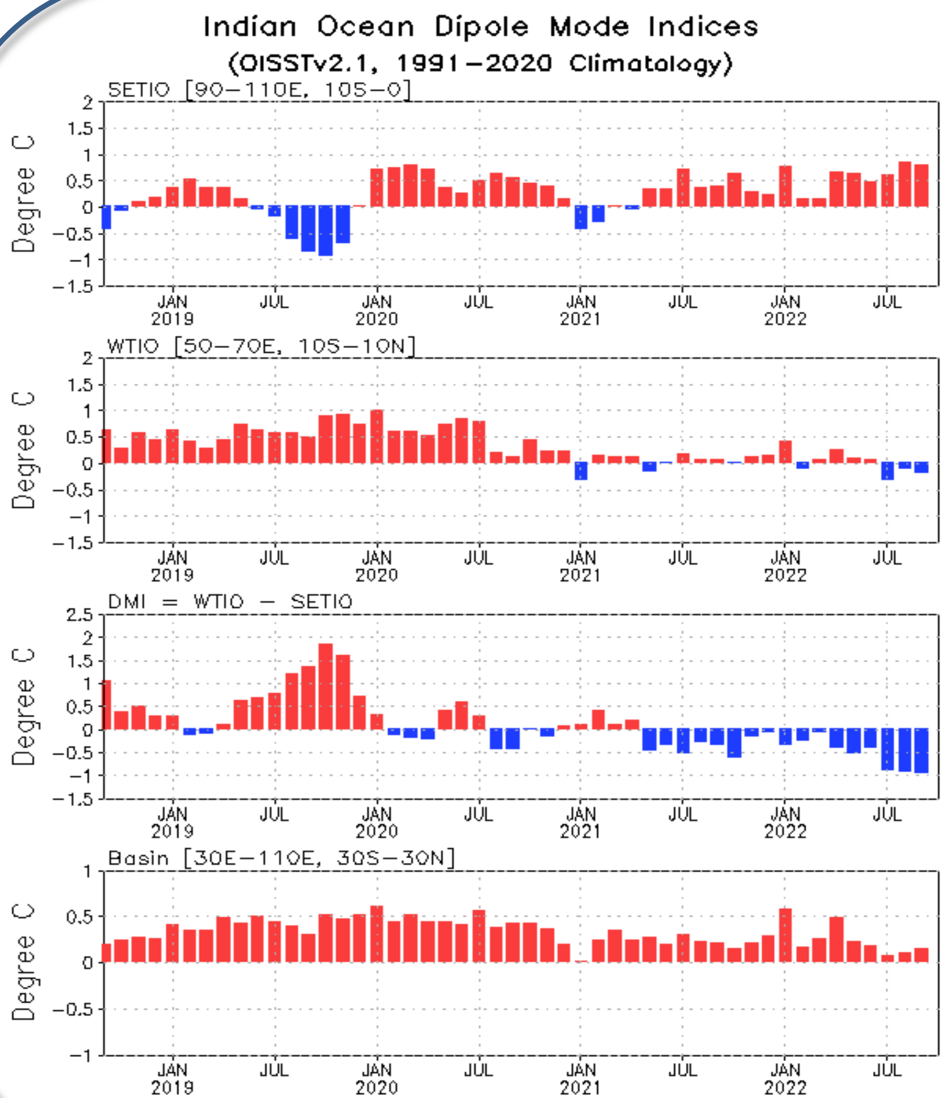
NCEP/CPC Arctic Sea Ice Extent Forecast

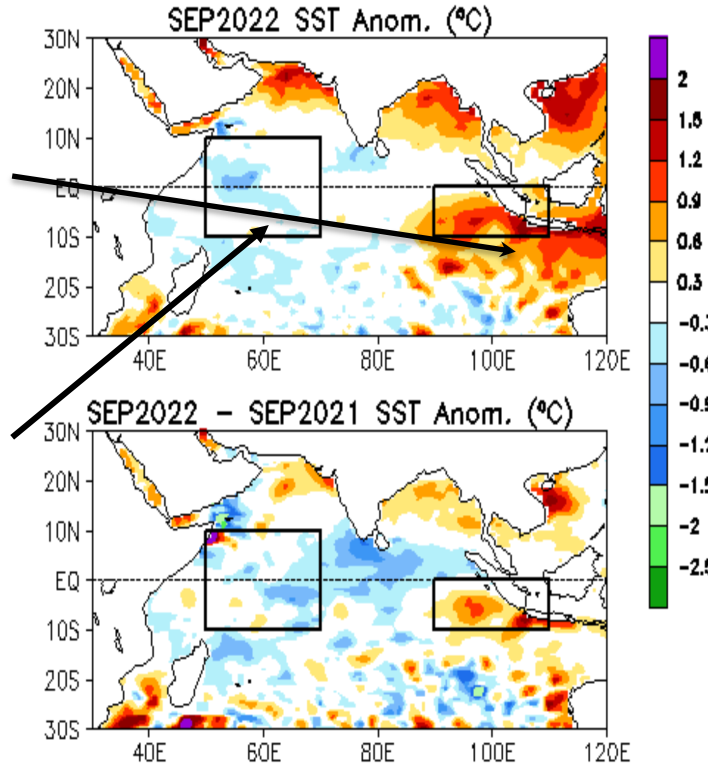


https://www.cpc.ncep.noaa.gov/products/people/wwang/seaice_seasonal/index.html

Indian Ocean

Evolution of Indian Ocean SST Indices

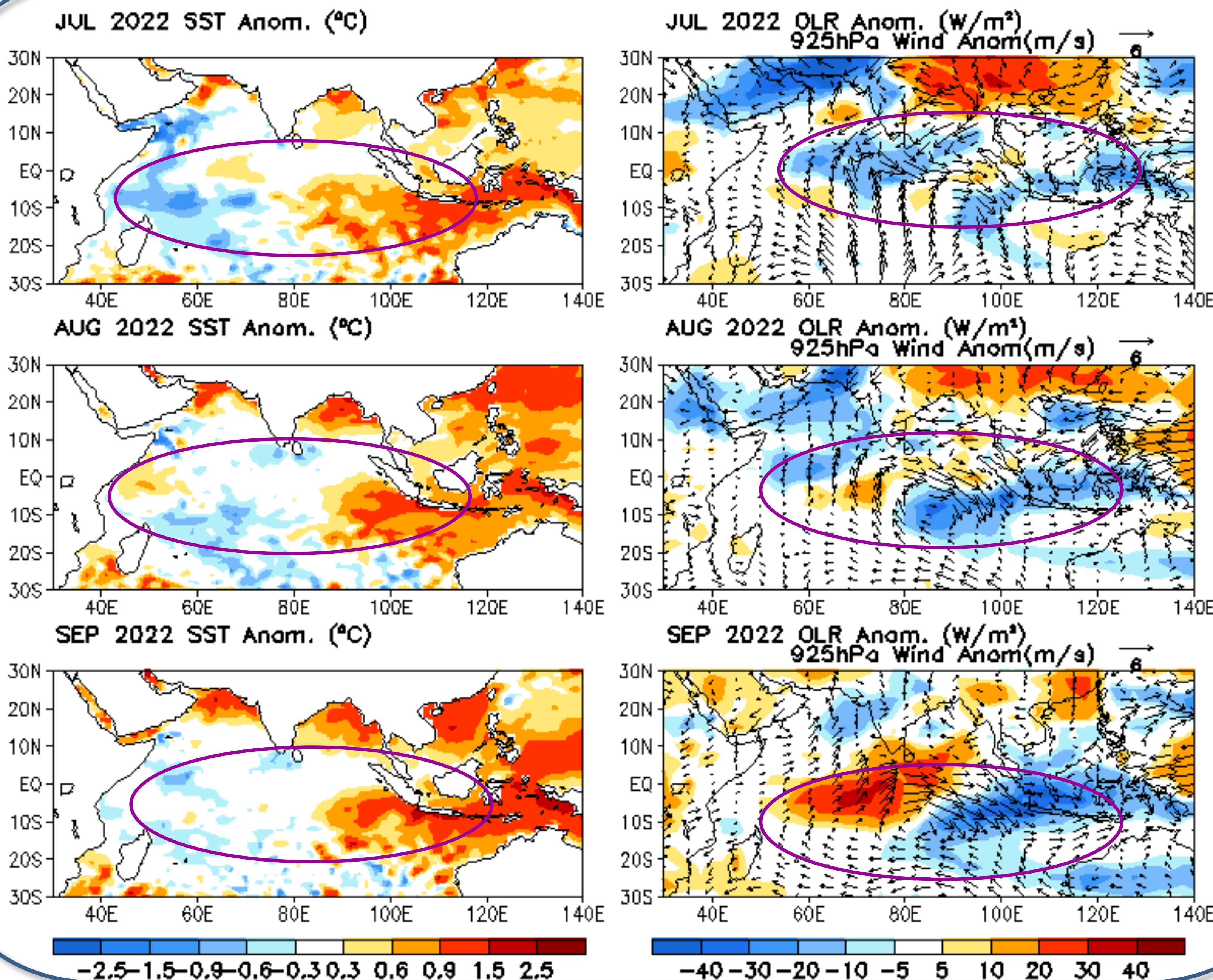




- Negative Indian Ocean Dipole event continued to develop in Sep 2022.

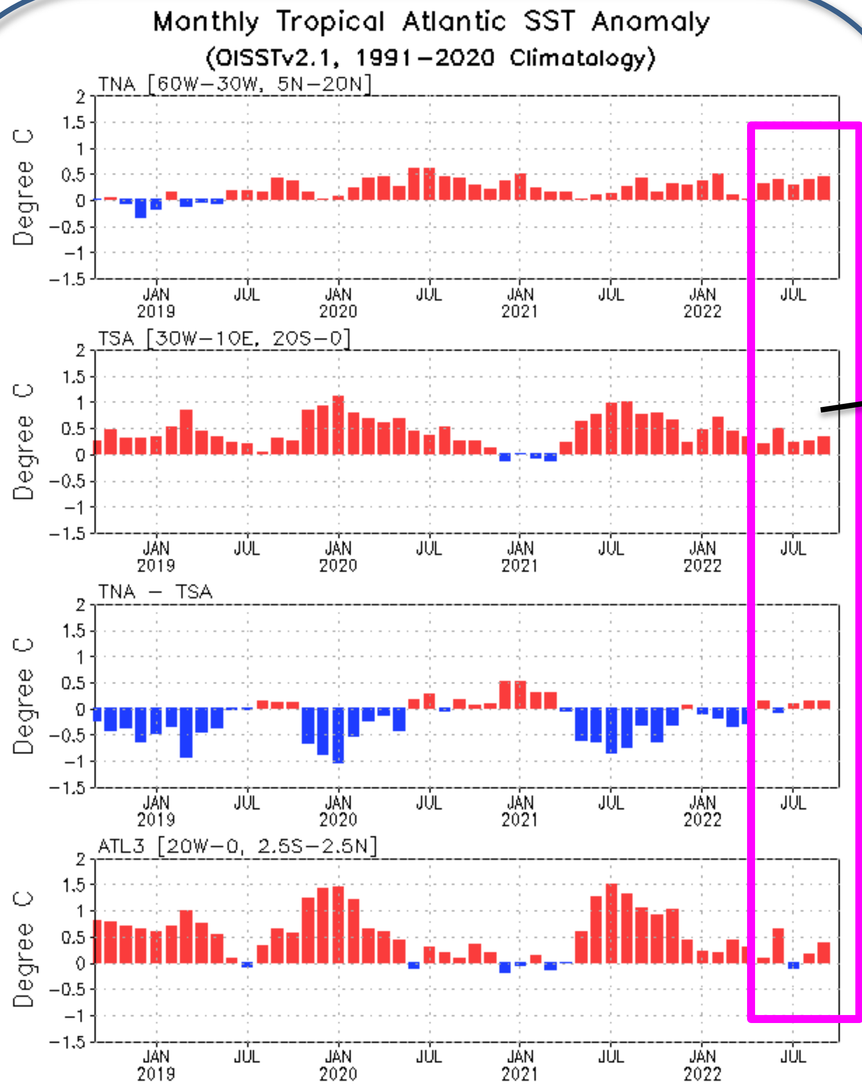
Indian Ocean region indices, calculated as the area-averaged monthly mean SSTA (OC) for the SETIO [90ºE-110ºE, 10ºS-0] and WTIO [50ºE-70ºE, 10ºS-10ºN] regions, and Dipole Mode Index, defined as differences between WTIO and SETIO. Data are derived from the OIv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

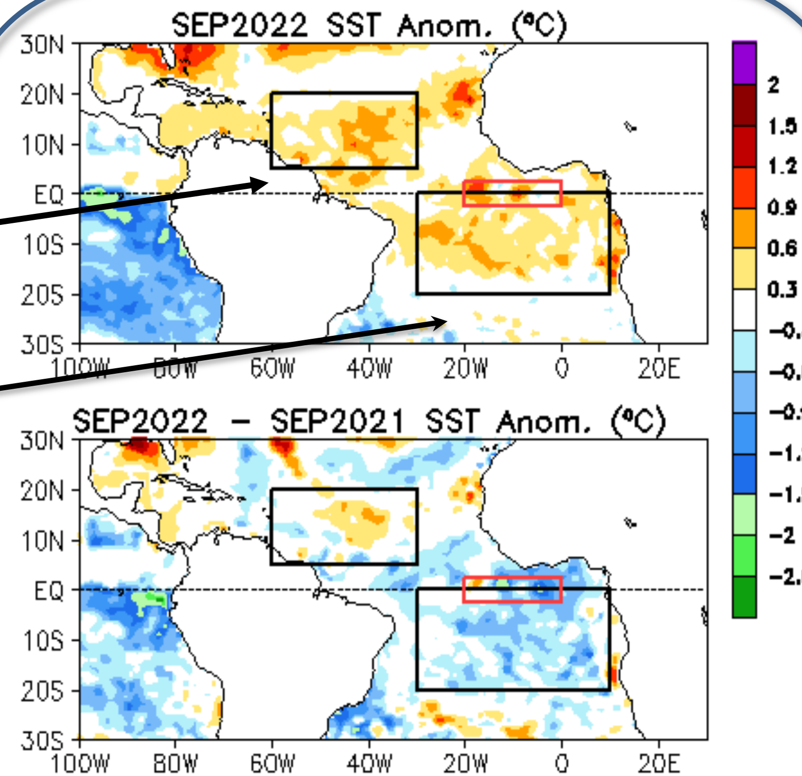
Last 3-month Tropical Indian SST , OLR & uv925 anomalies



Tropical and North Atlantic Ocean

Evolution of Tropical Atlantic SST Indices

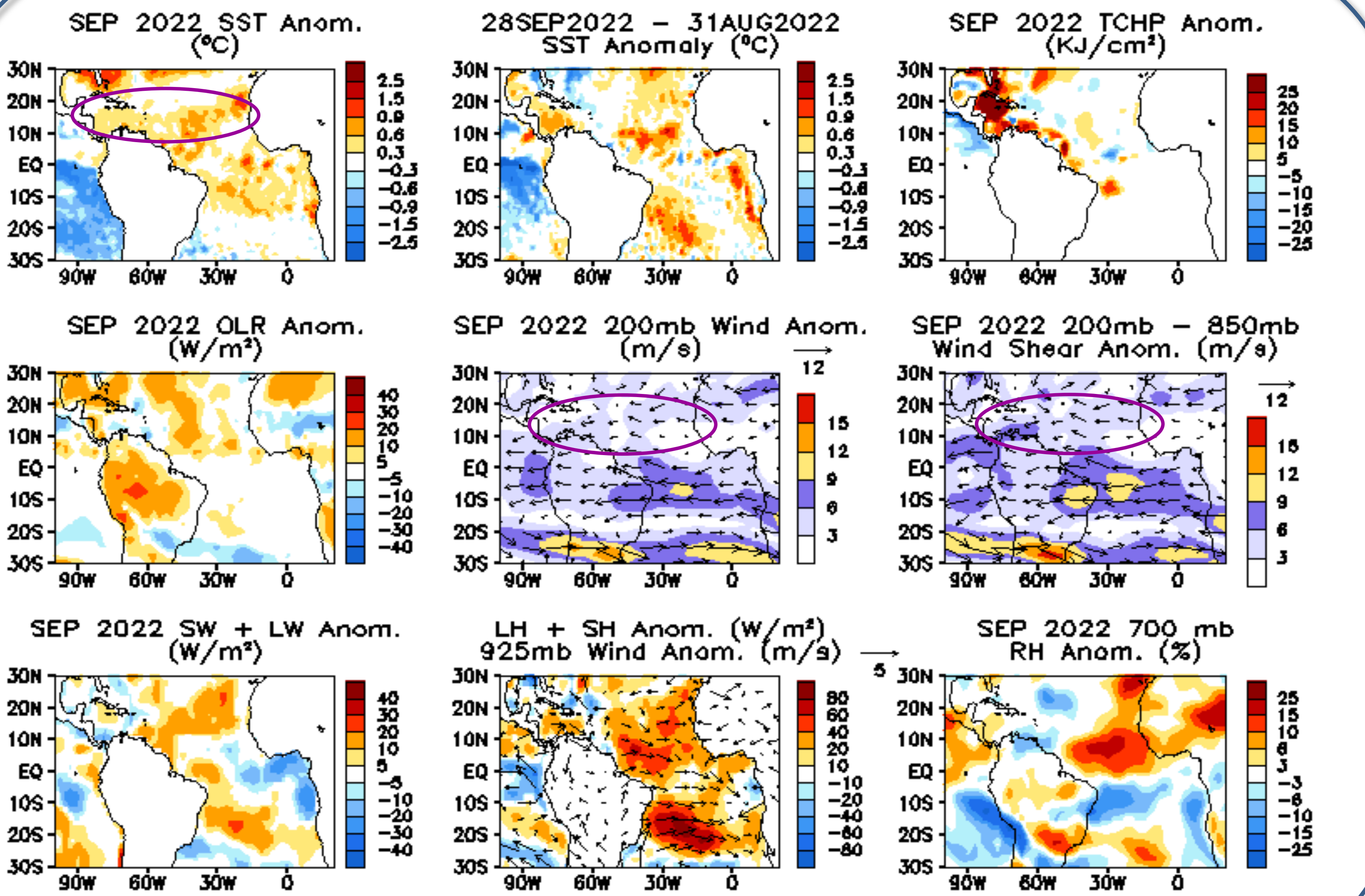




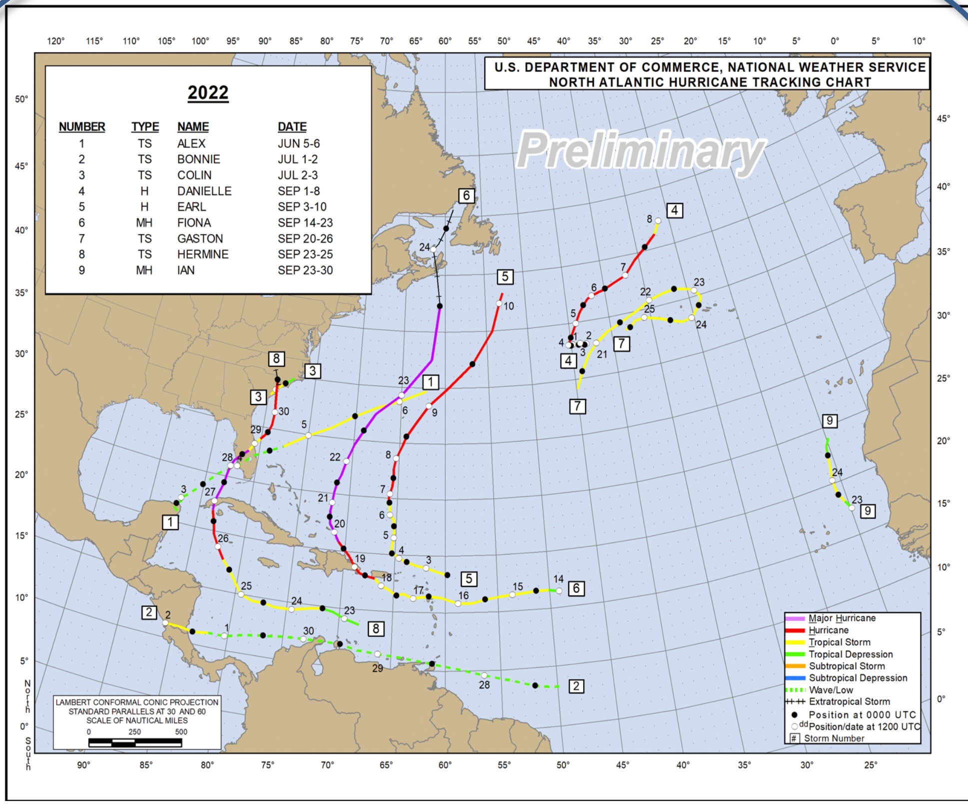
-TNA, TSA and Atl3 indices warmed up in Sep 2022.

Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean SSTAs (°C) for the TNA [60°W-30°W, 5ºN-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the OISSTv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

Tropical Atlantic Ocean: SSTA, SSTA Trend, TCHP,OLR,UV200,UV200-UV850, Heat Flux and RH Anomalies



2022 Atlantic Hurricane Season Activities



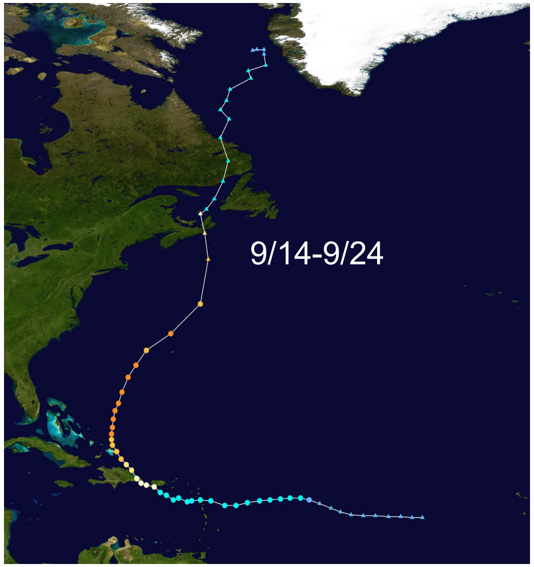
https://www.nhc.noaa.gov/data/tcr/

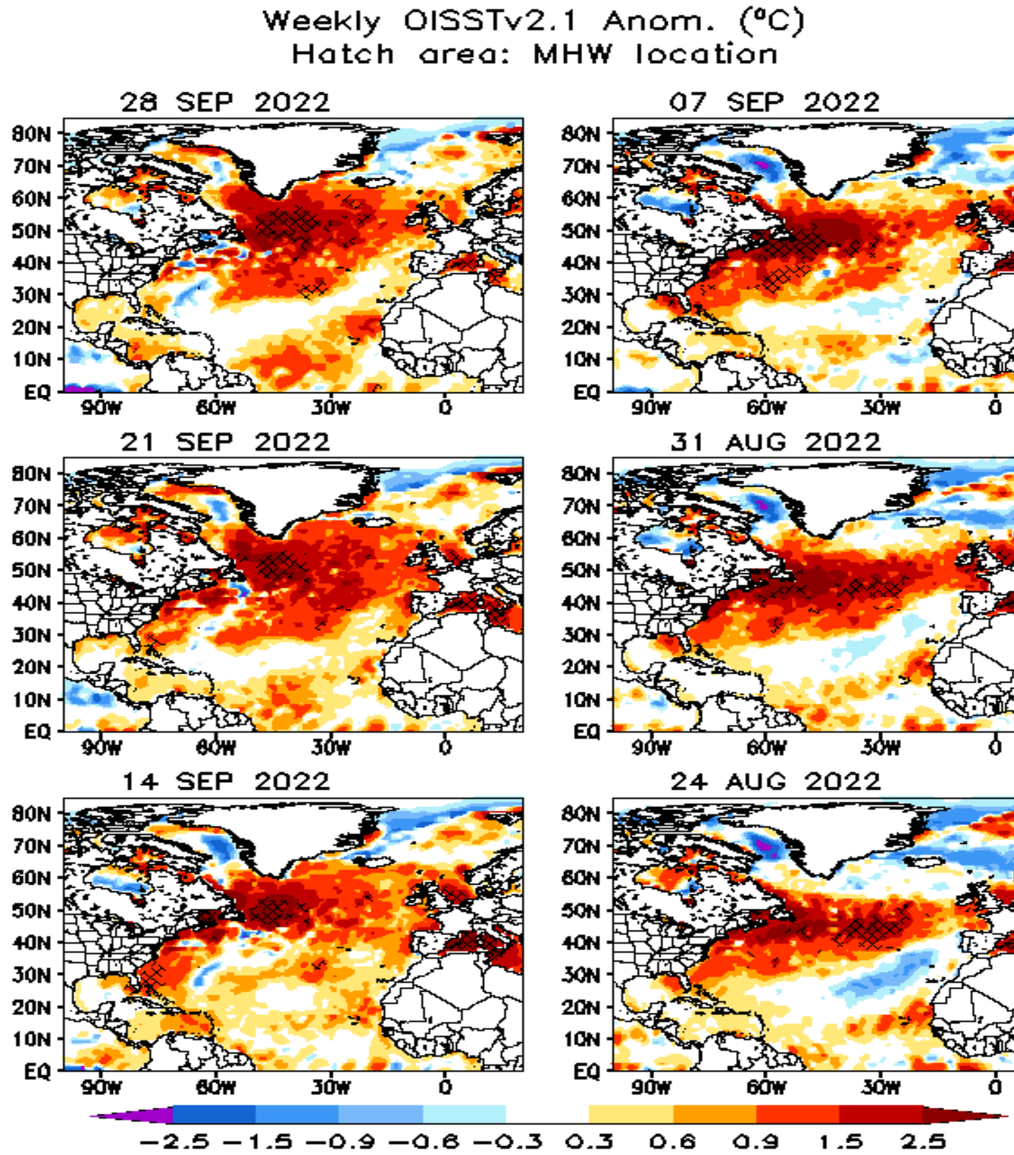
- Four hurricanes formed in Sep 2022.

- By Oct 7 2022, nine tropical storms formed, with four developing to hurricanes, and two developing to major hurricanes.

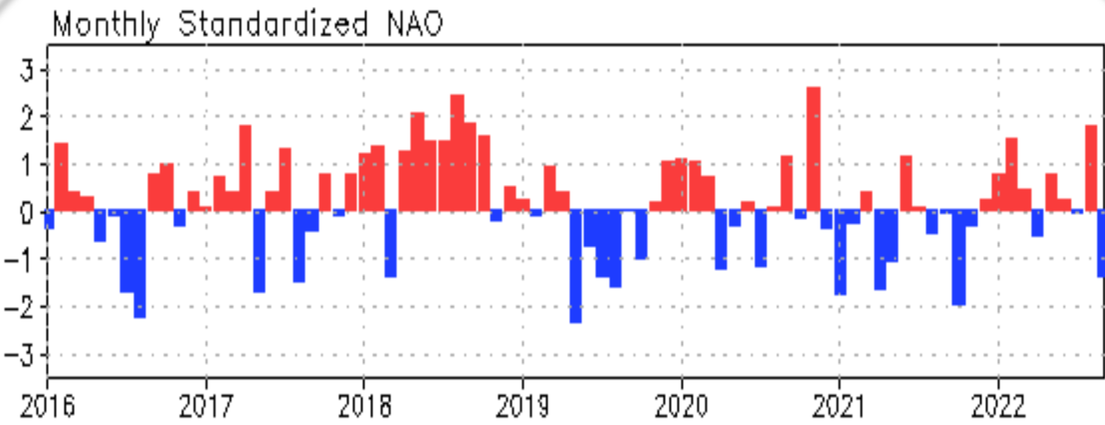
Atlantic	Observations (By Oct 7)	Updated Outlook (Aug) 60% above-normal	Outlook (May) 65% above-normal	(1991-2020)
Total storms	9	14-20	14-21	14
Hurricanes	4	6-10	6-10	7
Major hurricanes	2	3-5	3-6	3

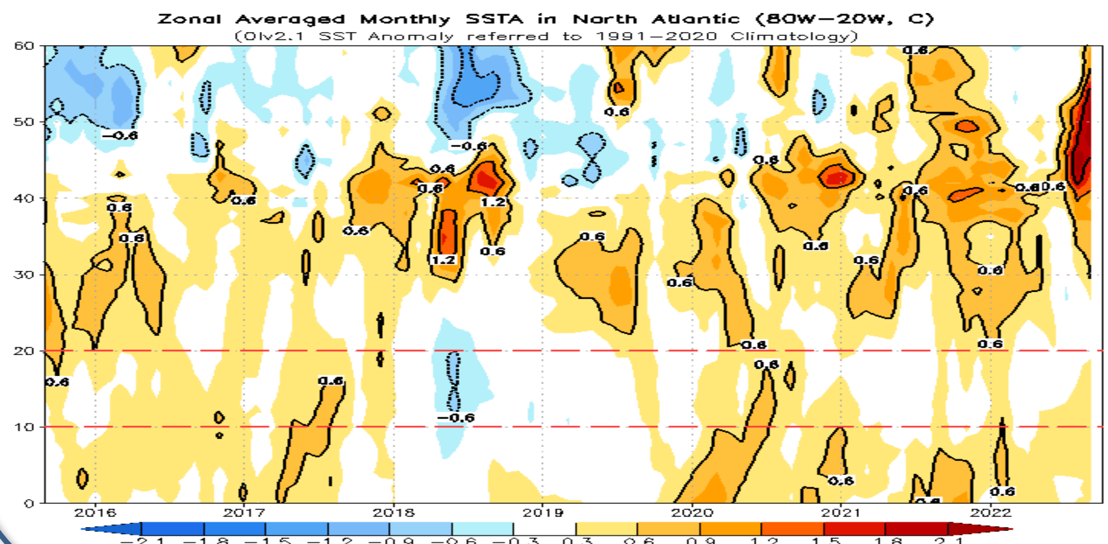
Hurricane Fiona

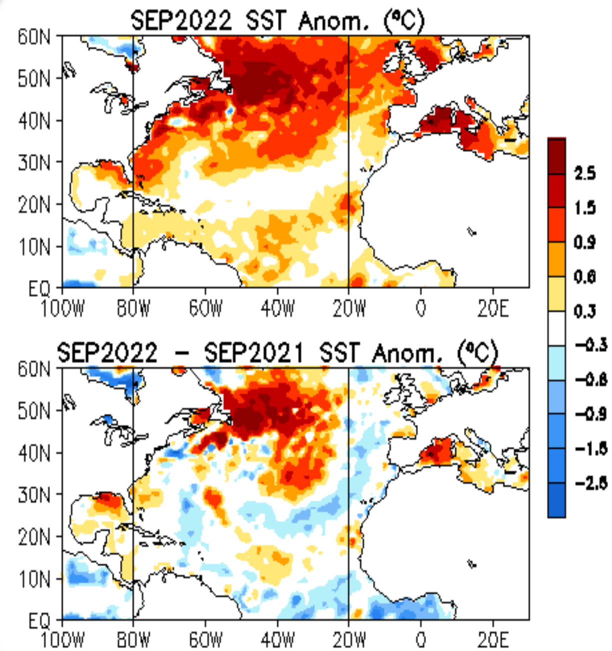




NAO and SST Anomaly in North Atlantic







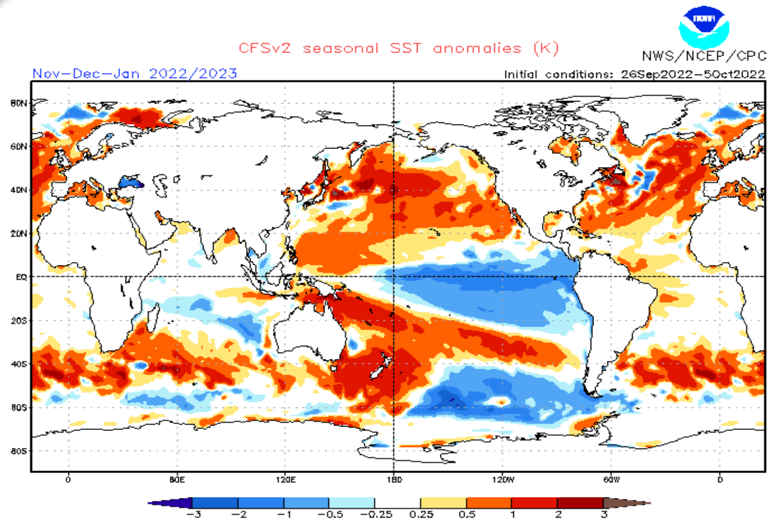
- NAO switched to a negative phase in Sep 2022, with NAO = -1.4.
- The positive SSTAs in the mid-high latitudes of the North Atlantic Ocean were evident since 2021.

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 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.

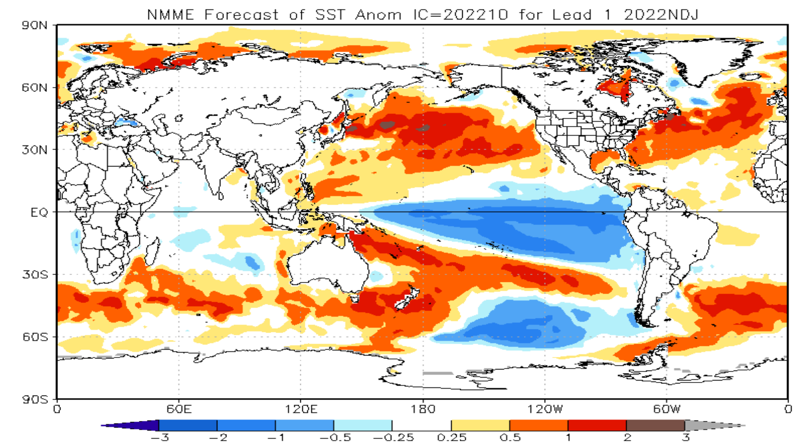
ENSO and Global SST Predictions

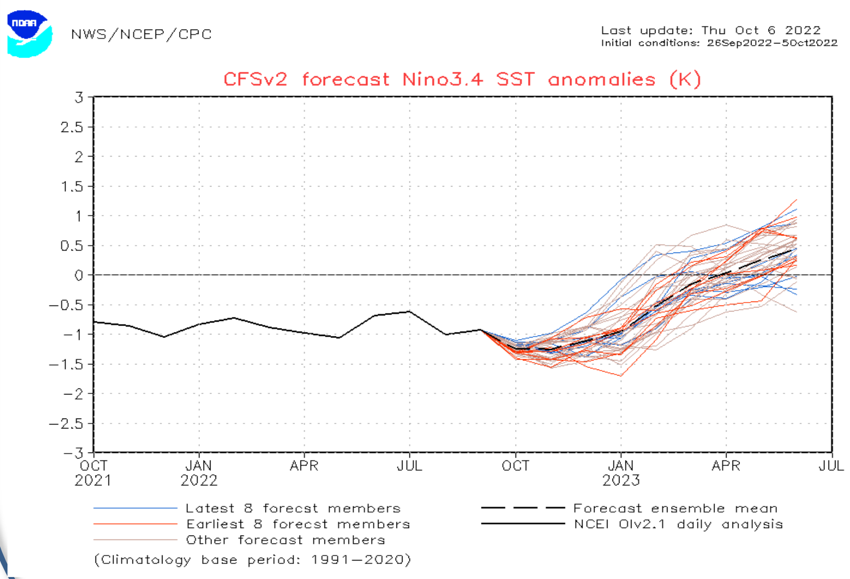
CFSv2 and NMME SST predictions

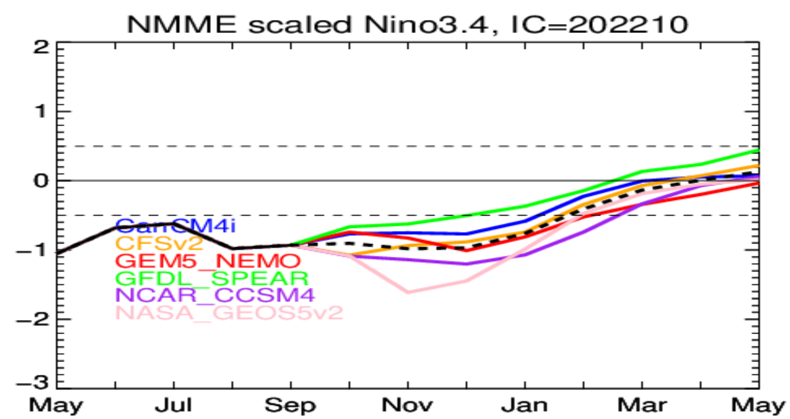
CFSv2 IC:Oct for 2022 NDJ



NMME IC:Oct for 2022 NDJ



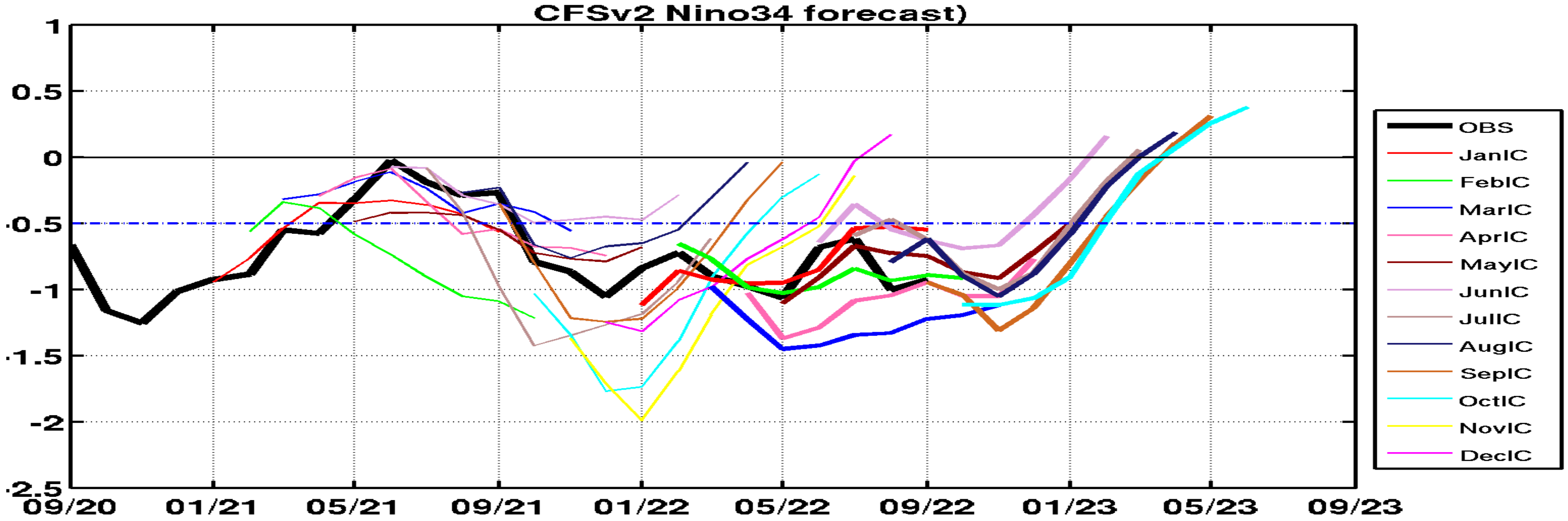


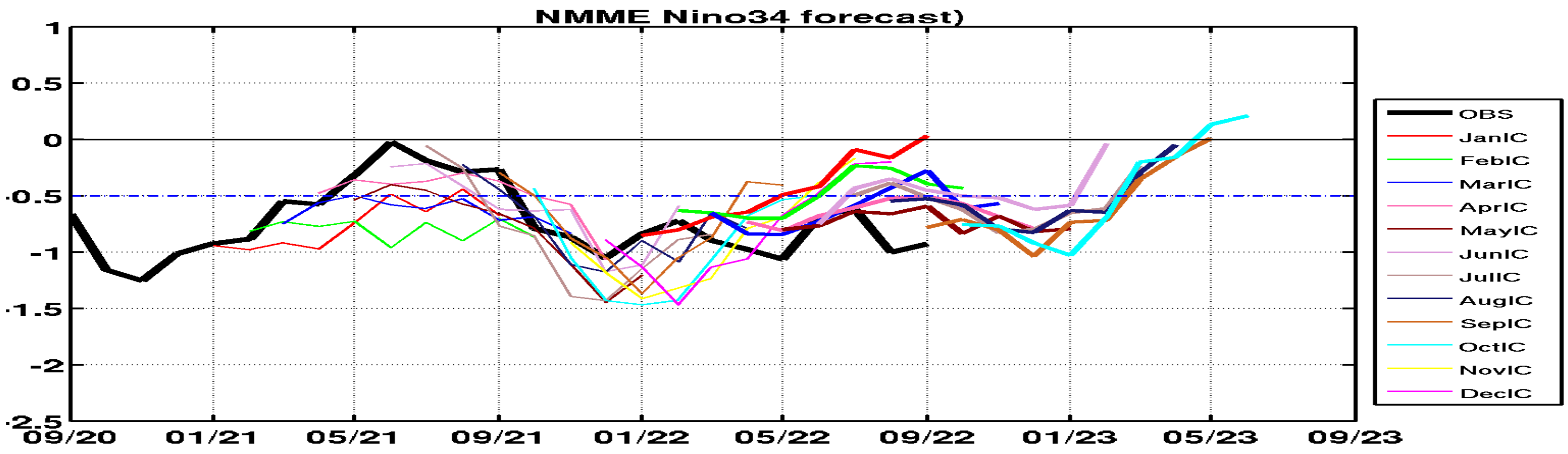


https://www.cpc.ncep.noaa.gov/products/CFSv2/CFSv2seasonal.shtml

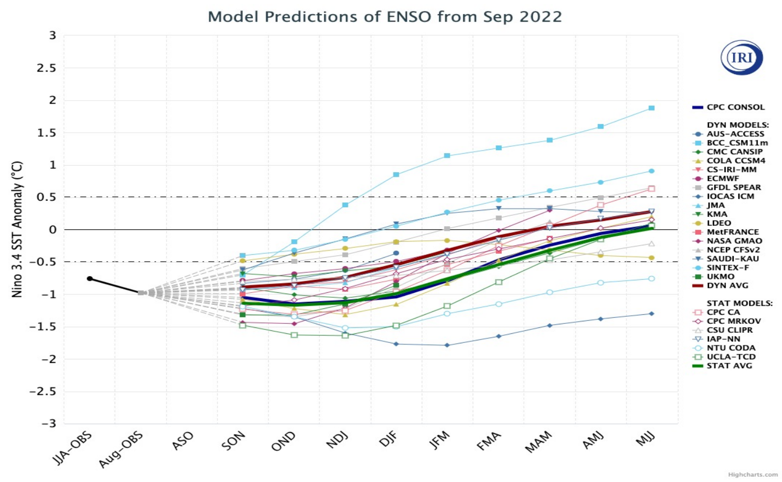
https://www.cpc.ncep.noaa.gov/products/NMME/

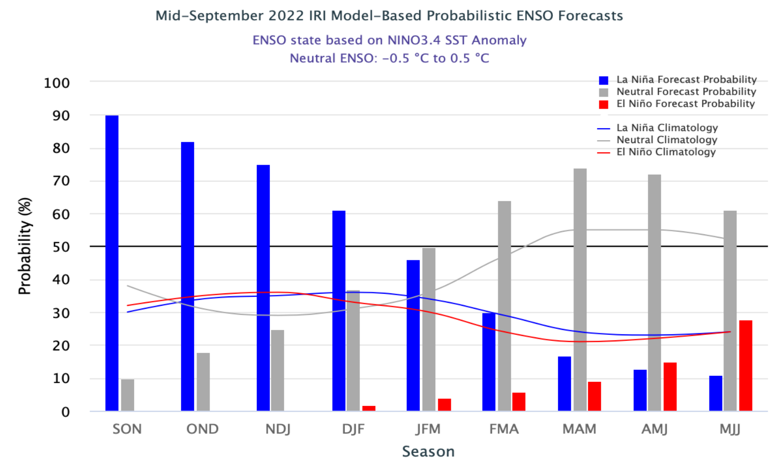
CFSv2 and NMME Nino34 predictions





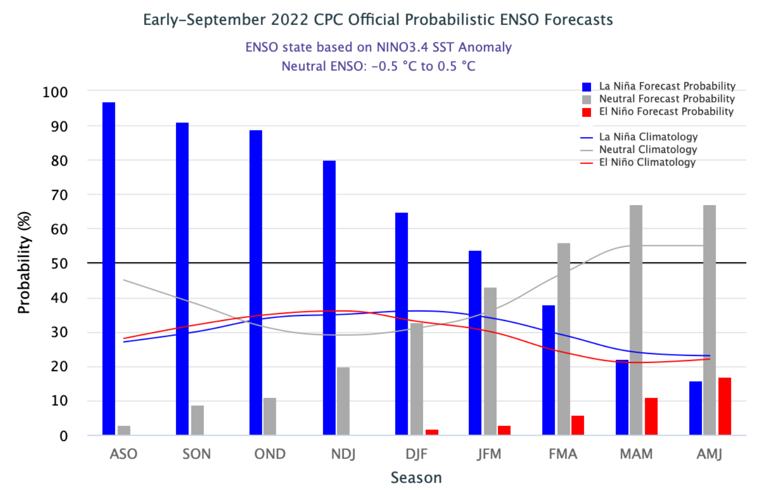
IRI/CPC Niño3.4 Forecast : September 2022



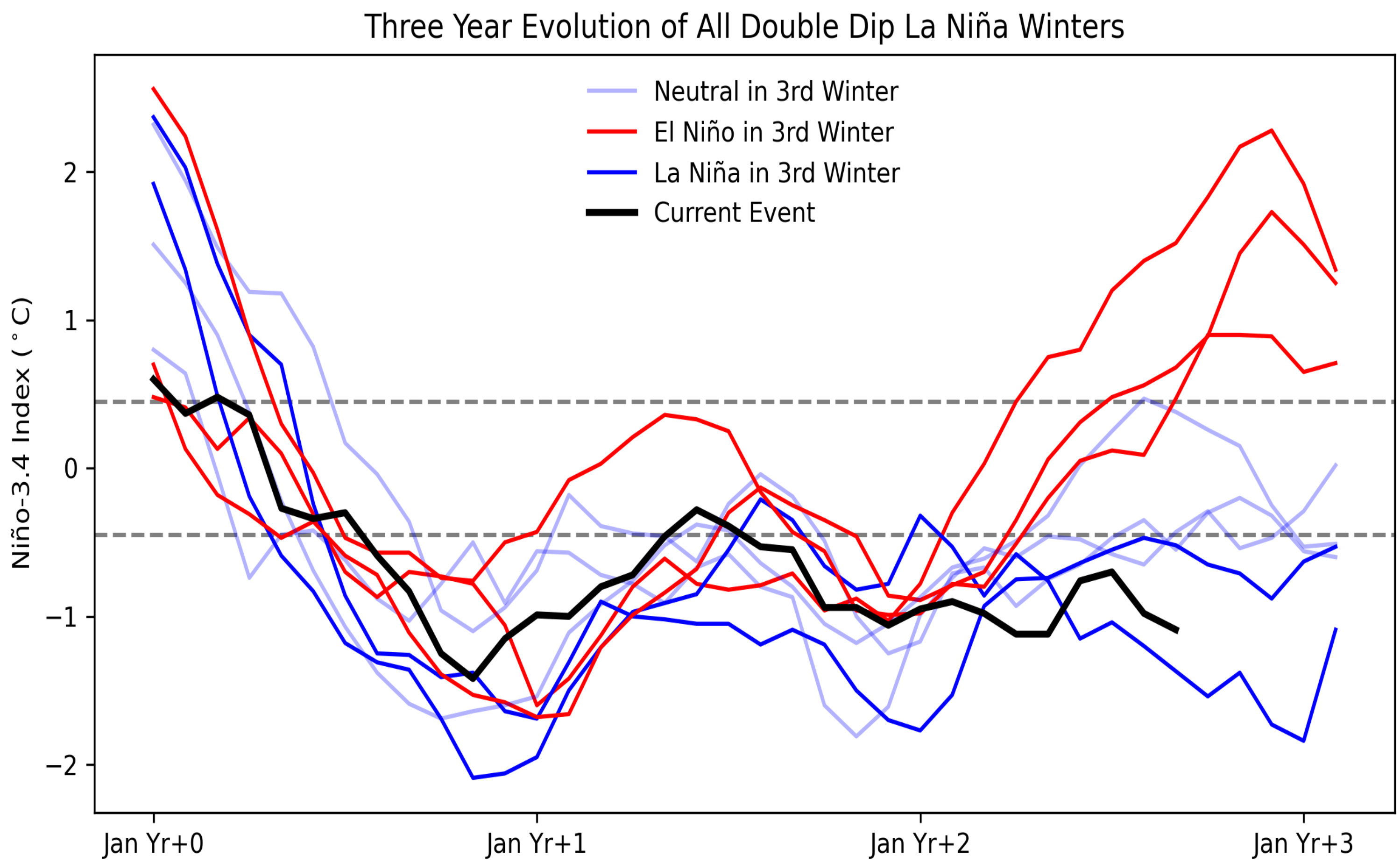


- A majority of models predict SSTs to remain below-normal at the level of a La Niña until Dec-Feb 2023 and return to ENSO-neutral thereafter.

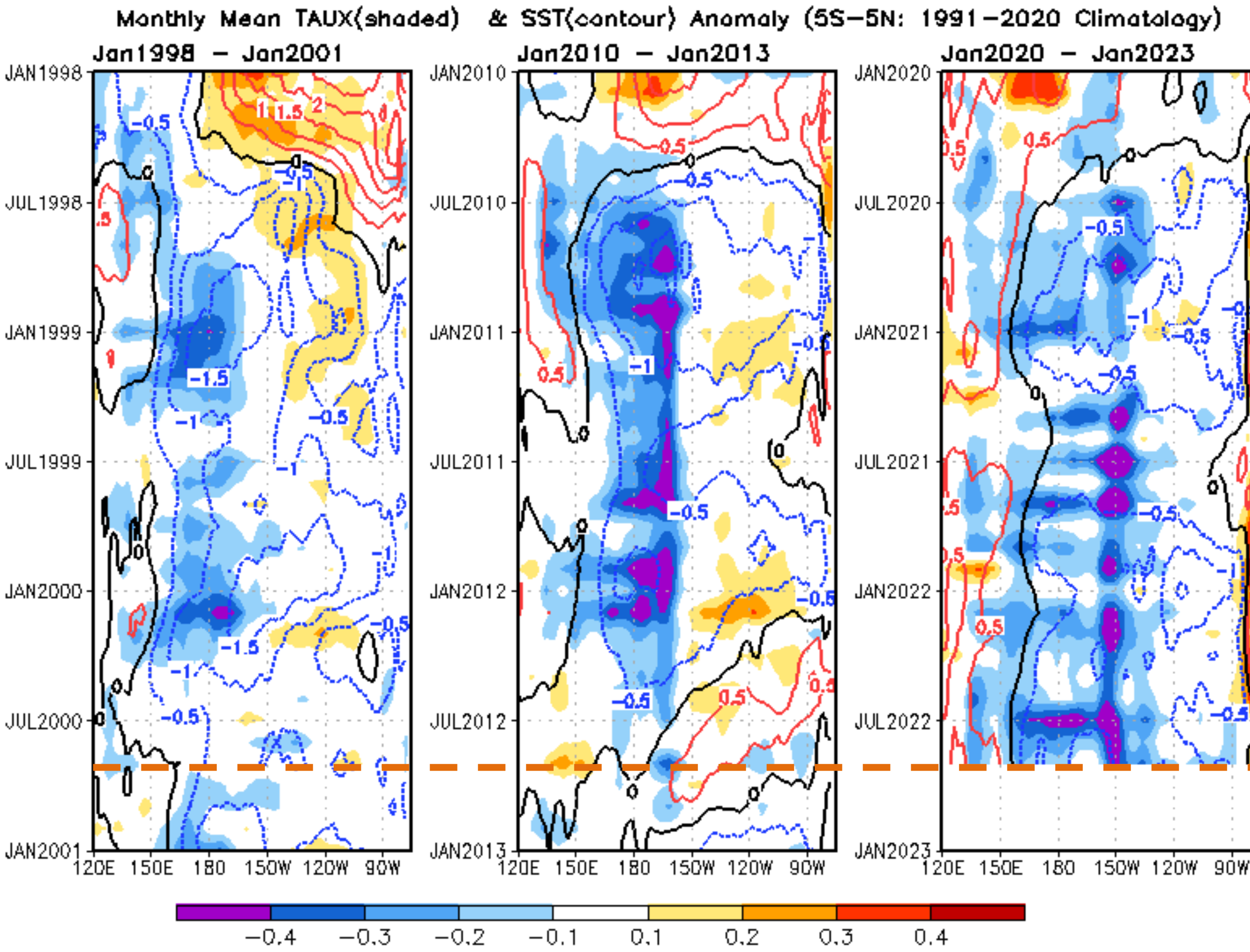
- NOAA "ENSO Diagnostics Discussion" on 8 September stated that "La Niña is favored to continue through Northern Hemisphere winter 2022-23, with a 91% chance in Sep-Nov and decreasing to a 54% chance in Jan-Mar 2023.



Nino3.4 Index Evolution in two-year La Ninas since 1950 (MICHELLE L'HEUREUX)



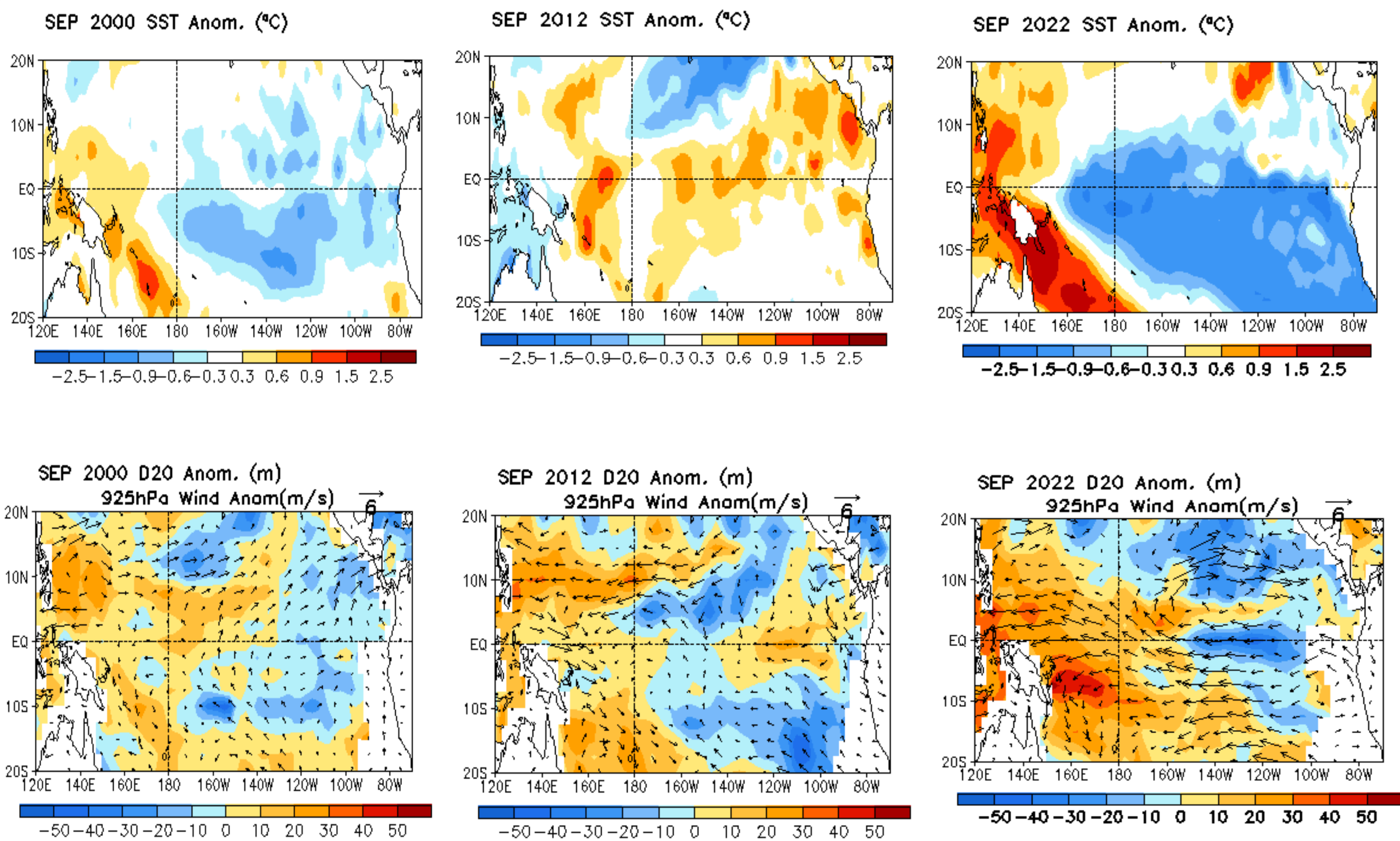
Evolution of Monthly Mean TAUX & SST Anomaly across [5S-5N]



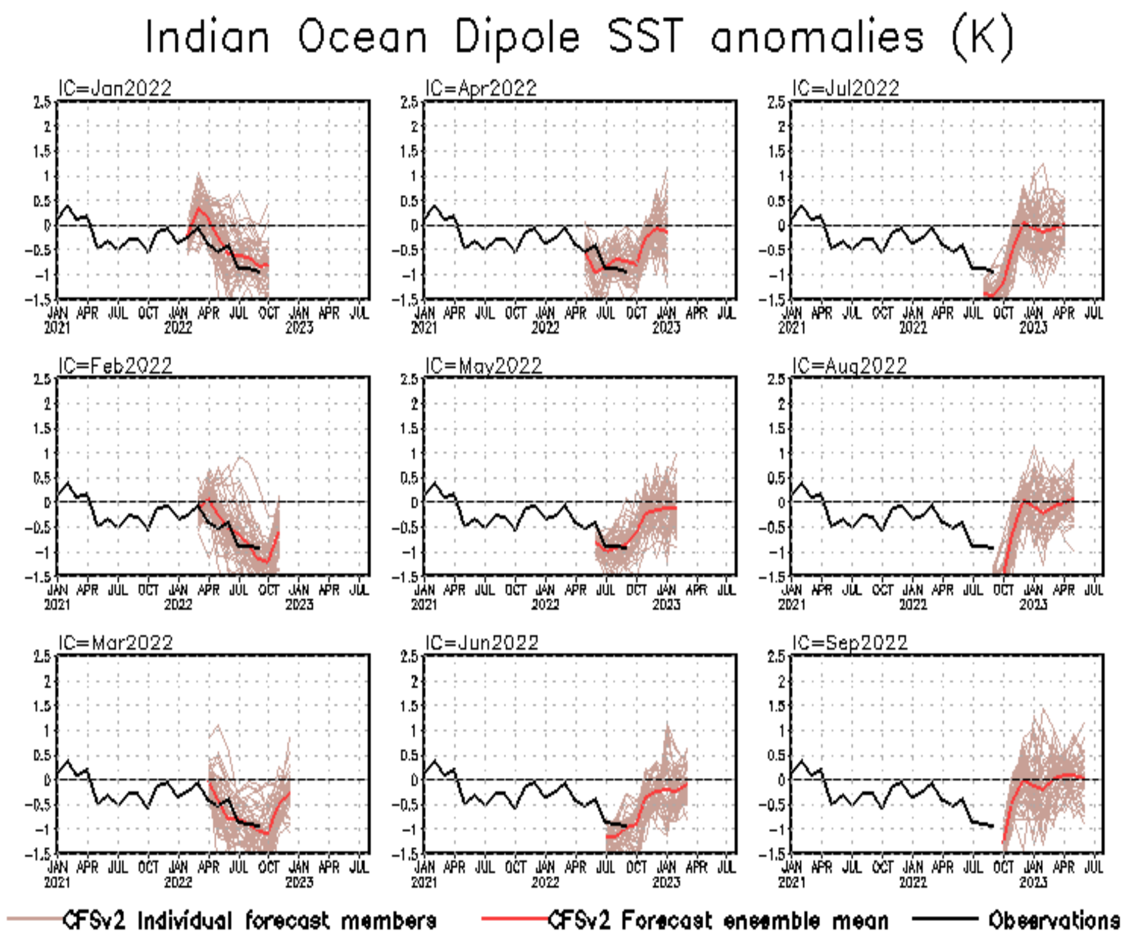
Data source: NCEP R2 reanalysis

SST, D20 and 925hpa Wind anomalies in September

Sep 2000 | Sep 2012 | Sep 2022



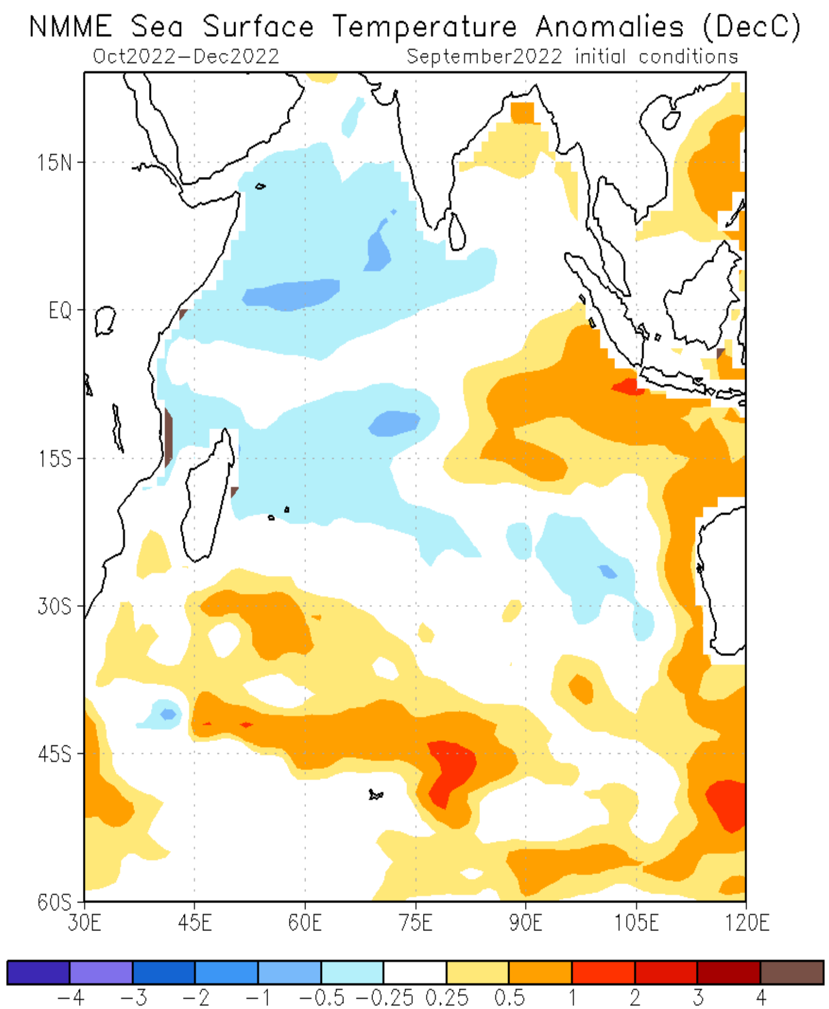
CFSv2 DMI SST Predictions

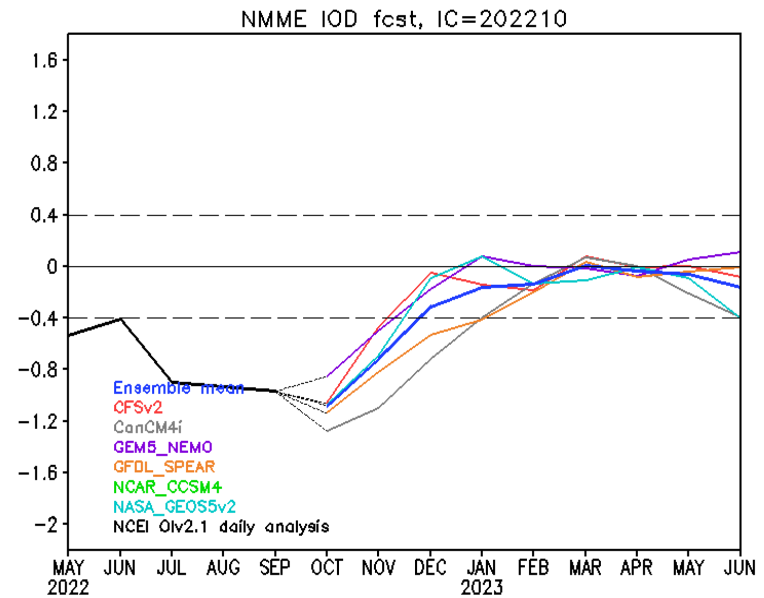


- CFSv2 did a good job in prediction the IOD evolution with IC Jan-May 2022.
- Latest CFSv2 forecasts favored a negative IOD conditions through fall 2022.

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.

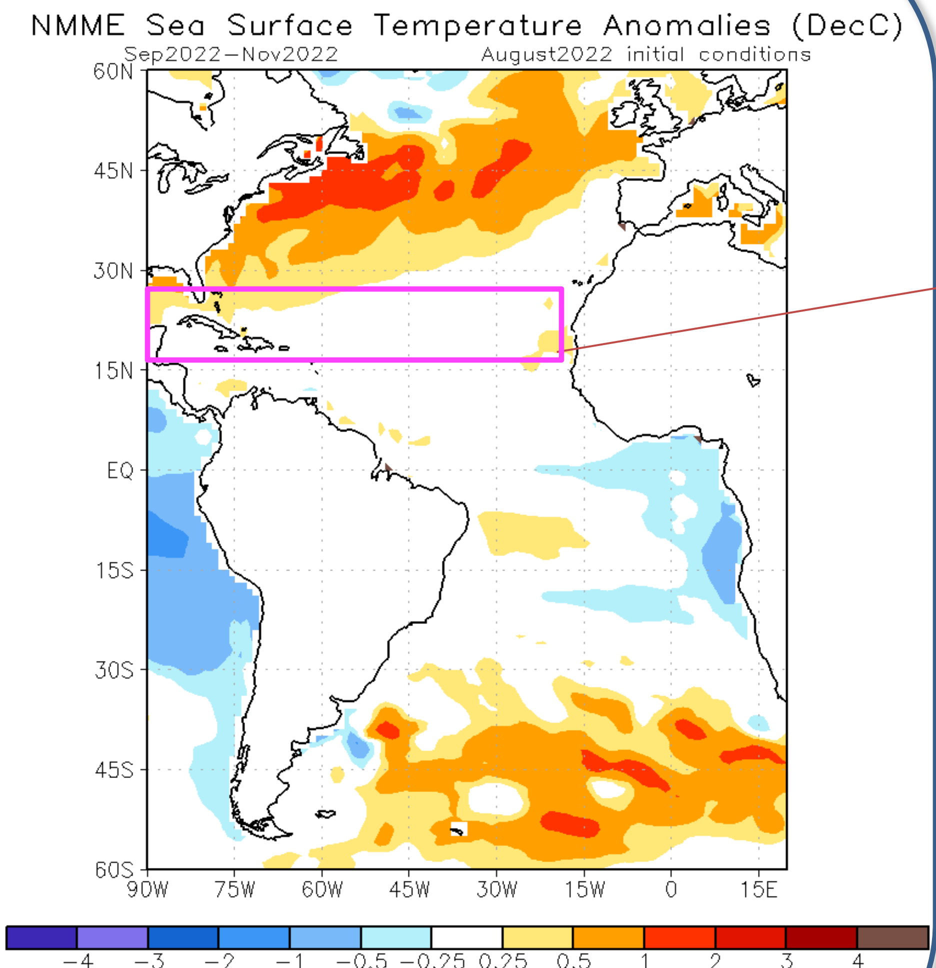
NMME Forecasts in the Indian Ocean





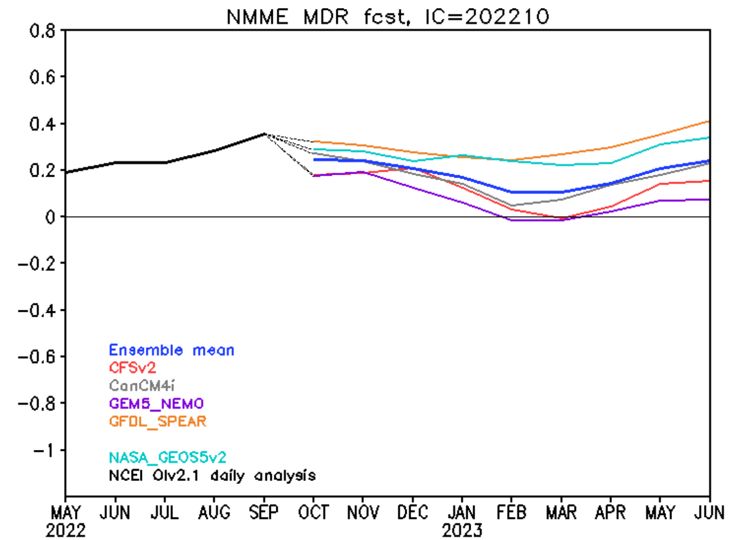
- All NMME models predict the negative IOD condition will last through Nov 2022.

NMME Forecasts in the Atlantic Ocean



https://www.cpc.ncep.noaa.gov/products/international/index.shtml

Hurricane Main Development Region (90ºW-12ºW, 9ºN-21.5ºN)



- A majority of NMME models predicted above or near normal SSTs to persist in the Hurricane main development region through the whole 2022 hurricane season.

Data Sources (climatology is for 1991-2020)

- **NCEP Weekly Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002, historical Monthly Ocean Briefing achieves ,Ocean briefing and GODAS web pages prior July 2022)**
- **Staring July 2022, NCEI Daily OISSTv2.1(Huang et al. 2021) replaced NCEP Weekly OISST data in the Monthly Ocean Briefing PPT , Ocean Briefing and GODAS web pages)**
- **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)**
- **NCDP/DOE Reanalysis II (R2) winds and heat fluxes (Kanamitsu et al. 2002)**
- **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

Acknowledgement

- Drs. Arun Kumar, Zeng-Zhen Hu and Jieshun Zhu : reviewed PPT, and provide insightful suggestions and comments

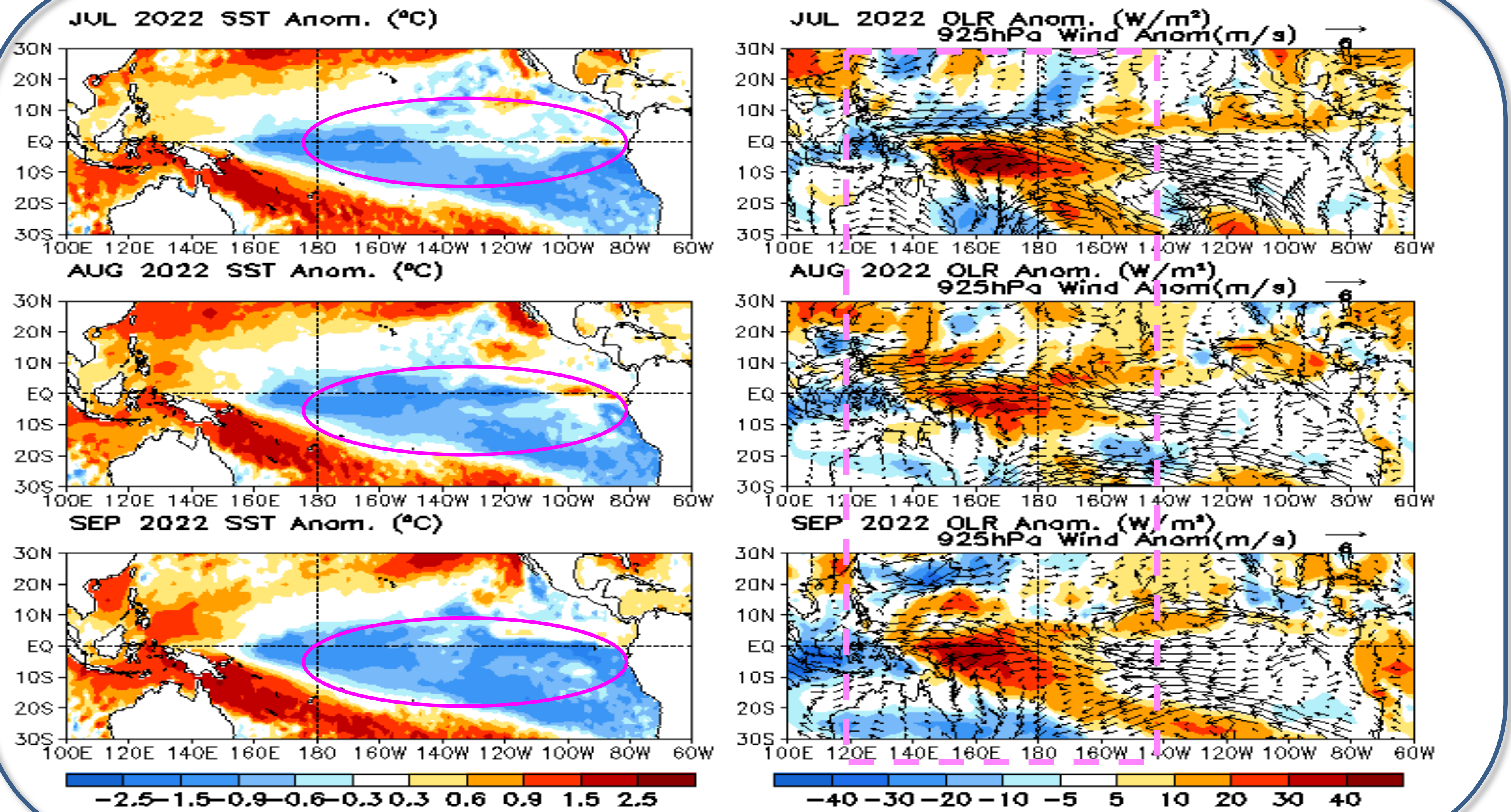
- Dr. Pingping Xie provided the BASS/CMORPH/CFSR EVAP package

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

Please send your comments and suggestions to:
Arun.Kumar@noaa.gov
Jieshun.Zhu@noaa.gov
Caihong.Wen@noaa.gov
Zeng-Zhen.Hu@noaa.gov

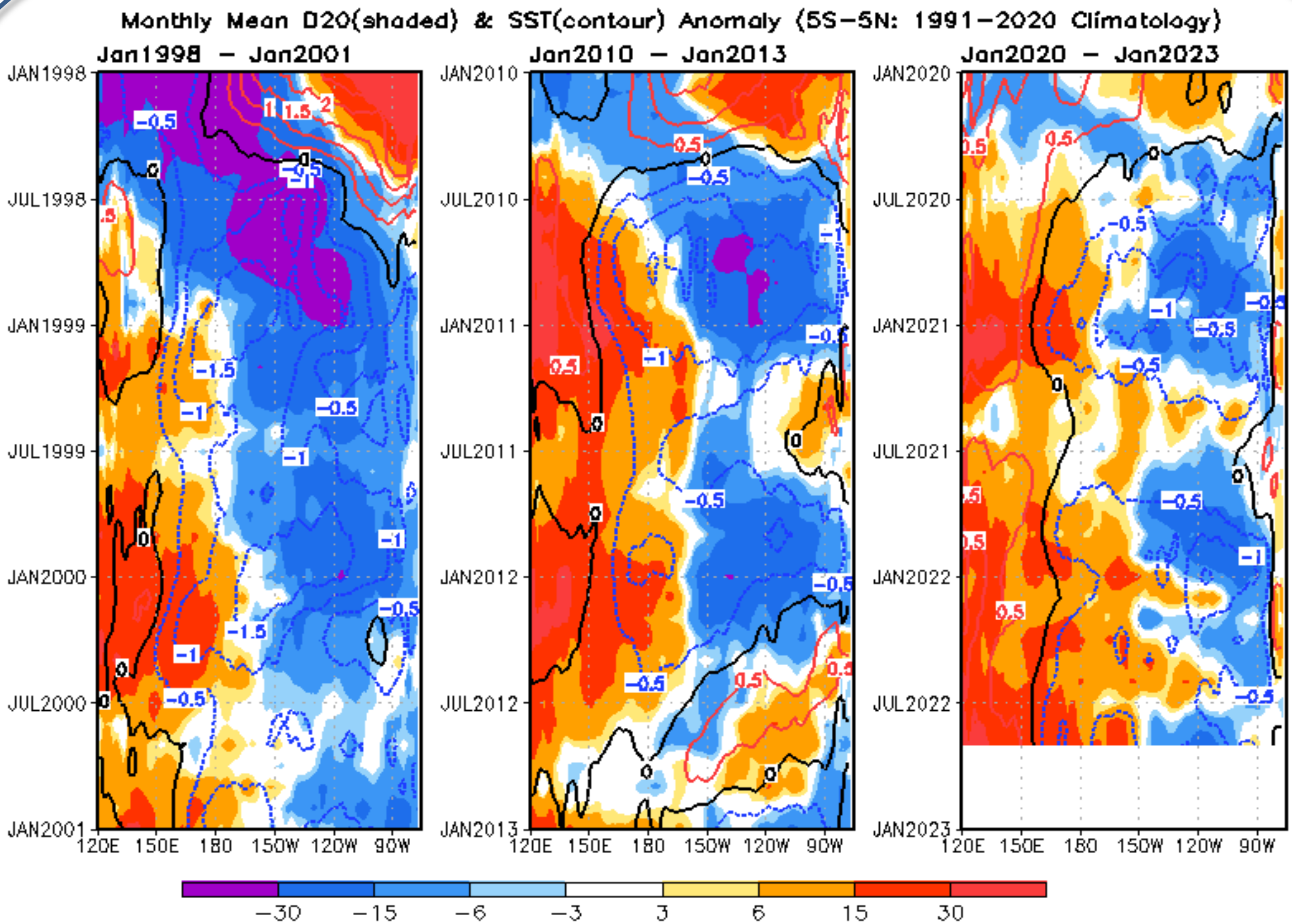
Backup Slides

Last three months SST, OLR and uv925 anomalies



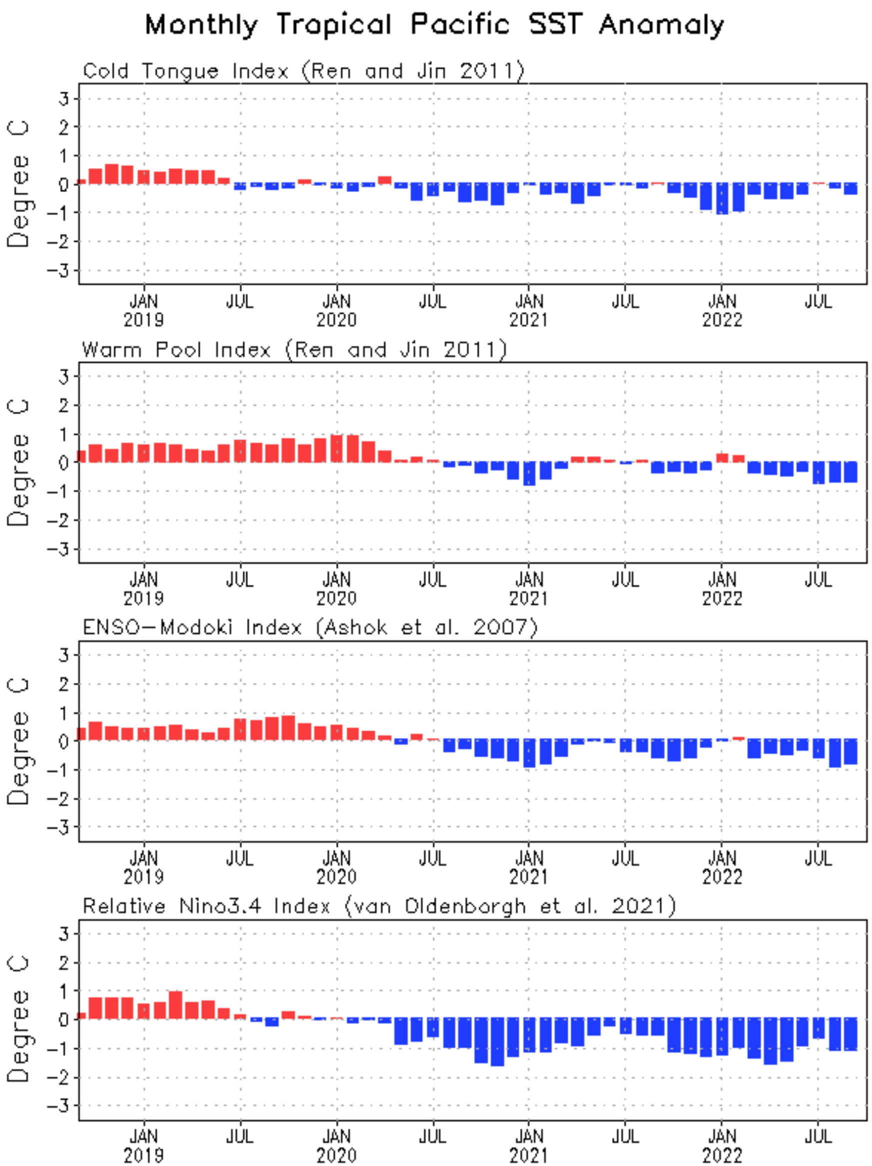
SSTAs (top-left), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right; positive means heat into the ocean), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the OISSTv2.1 SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1991-2020 base period means.

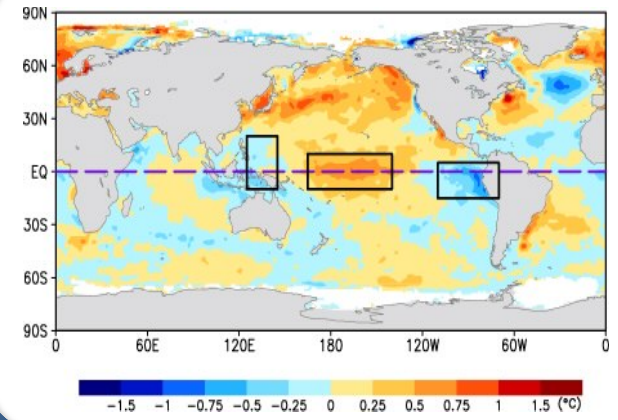
Evolution of Monthly Mean D20 & SST Anomaly across [5S-5N]



Data source: NCEP R2 reanalysis

Evolution of Pacific Niño SST Indices



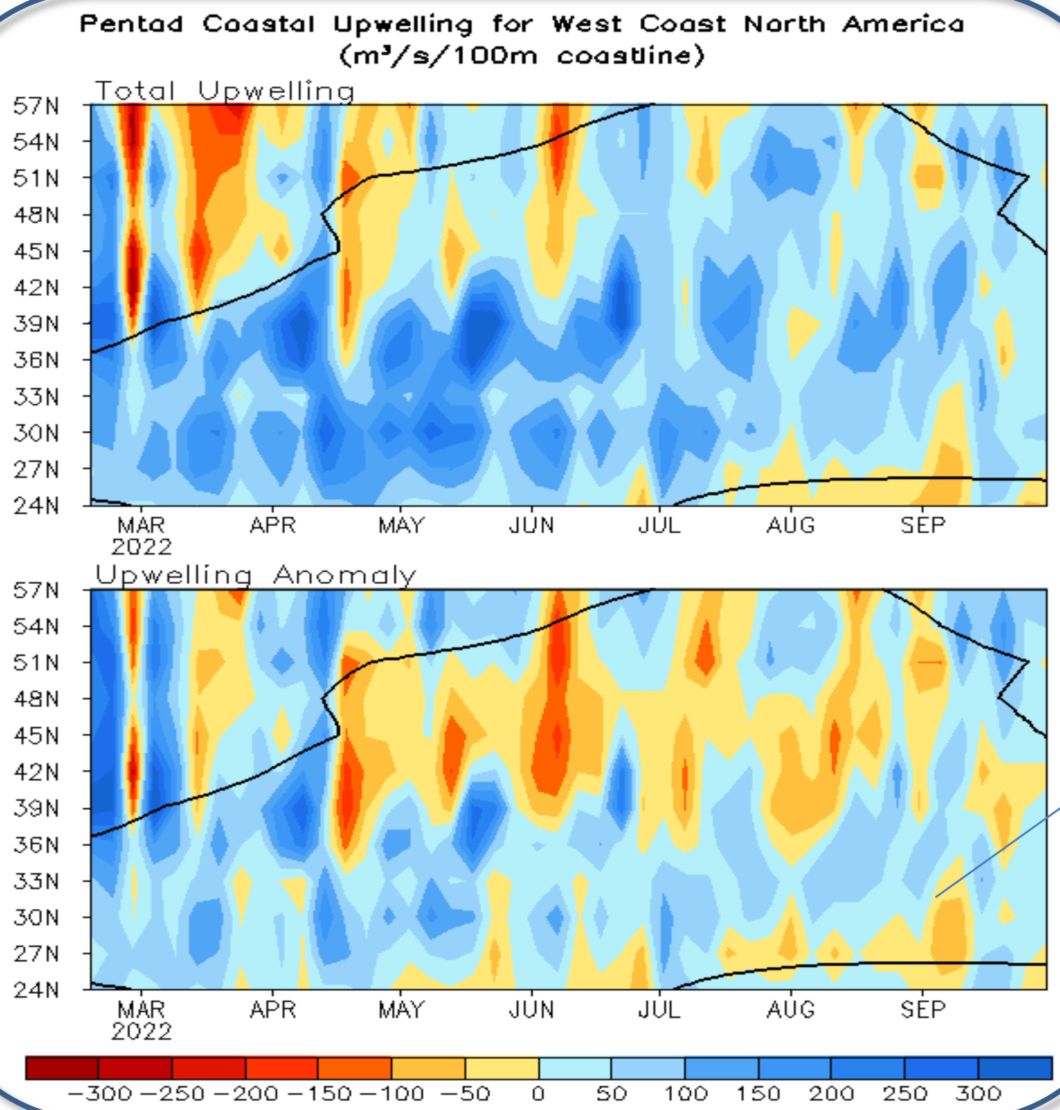


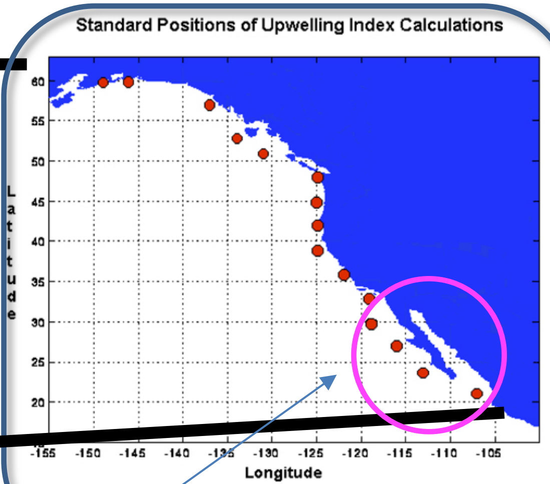
- Relative Niño3.4 index is defined as the conventional Niño3.4 index minus the SSTA averaged in the whole tropics (0º-360º, 20ºS-20ºN), in order to remove the global warming signal. Also, to have the same variability as the conventional Niño3.4 index, the relative Niño3.4 index is renormalized (van 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

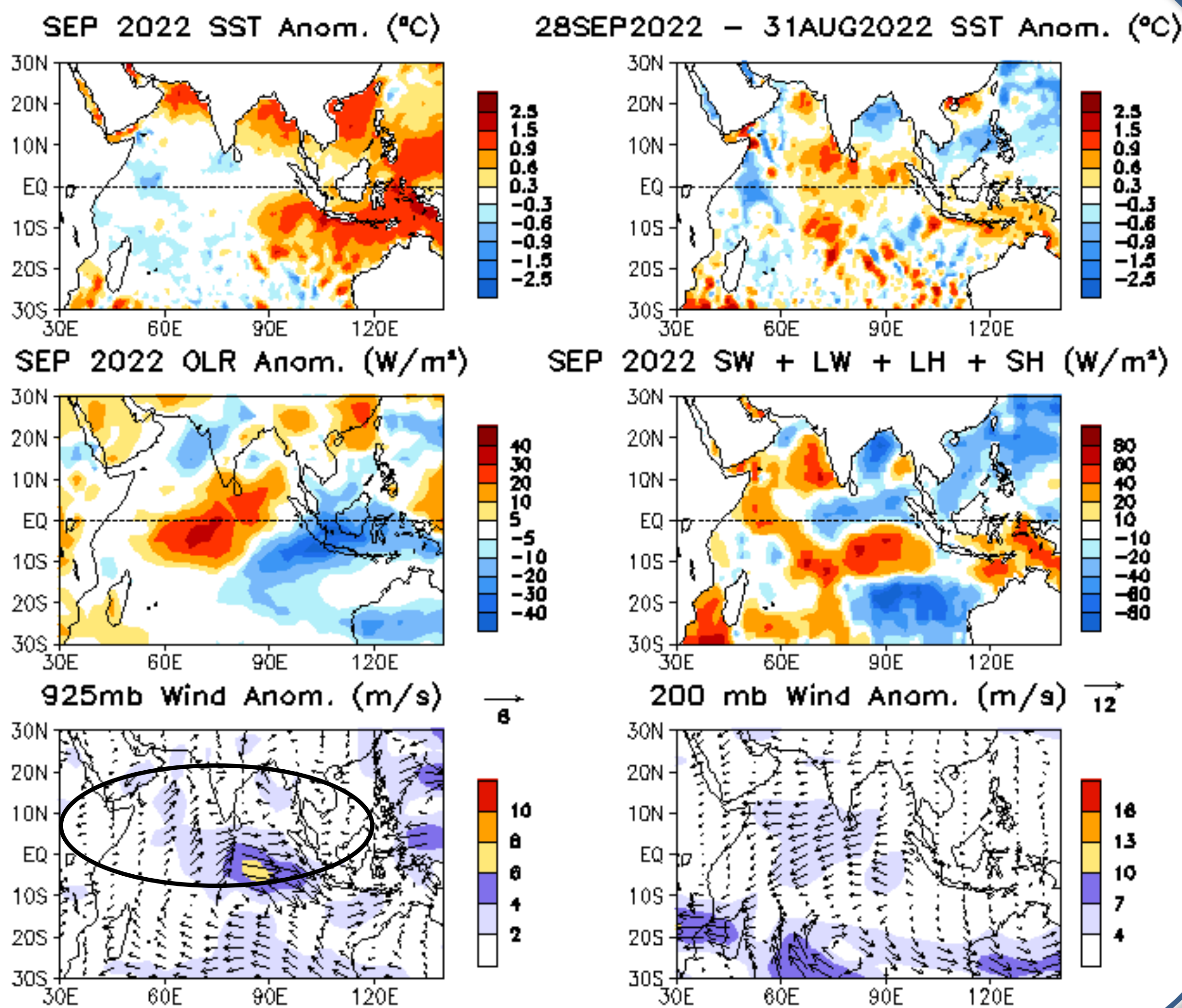
North America Western Coastal Upwelling





- Anomalous downwelling was observed south of 33ºN.
- Both anomalous coastal downwelling and upwelling were observed since mid-Apr 2022.

(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.

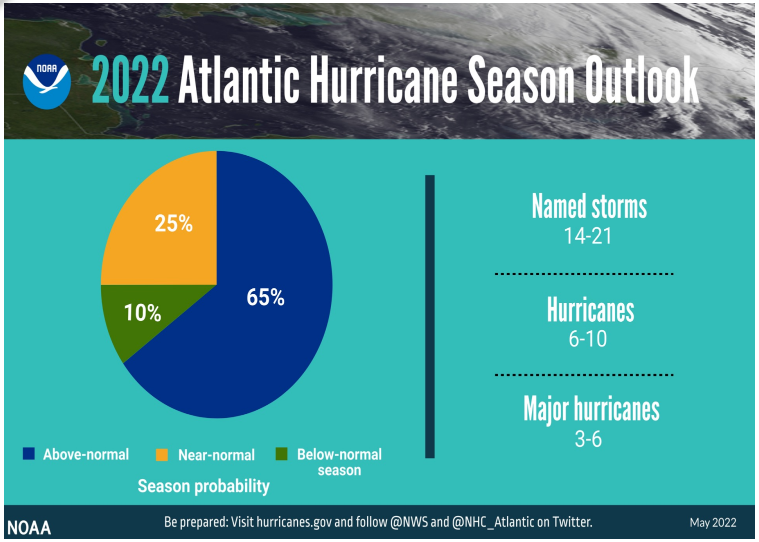


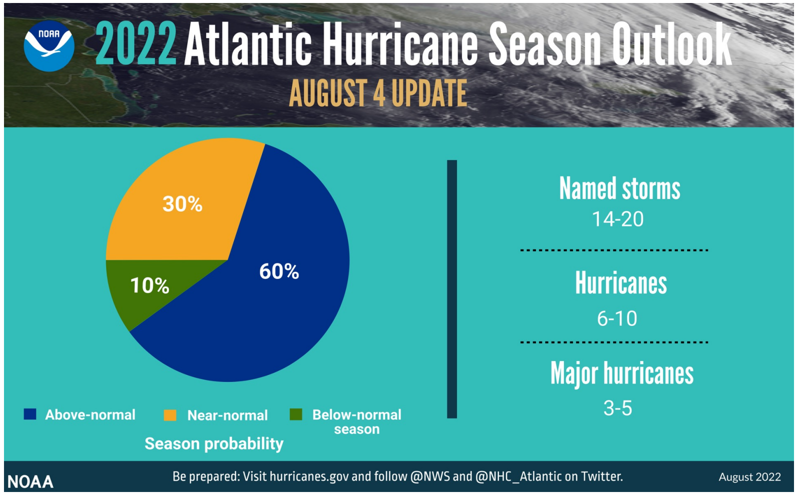
-Westerly wind anomaly prevailed over the eastern Indian Ocean, favoring further warming in the southeastern Indian Ocean.

- SSTA tendencies were generally consistent with the net heat flux anomalies.

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 OISSTv2.1 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.

Updated 2022 Atlantic Hurricane Season Outlook (4 Aug 2022)

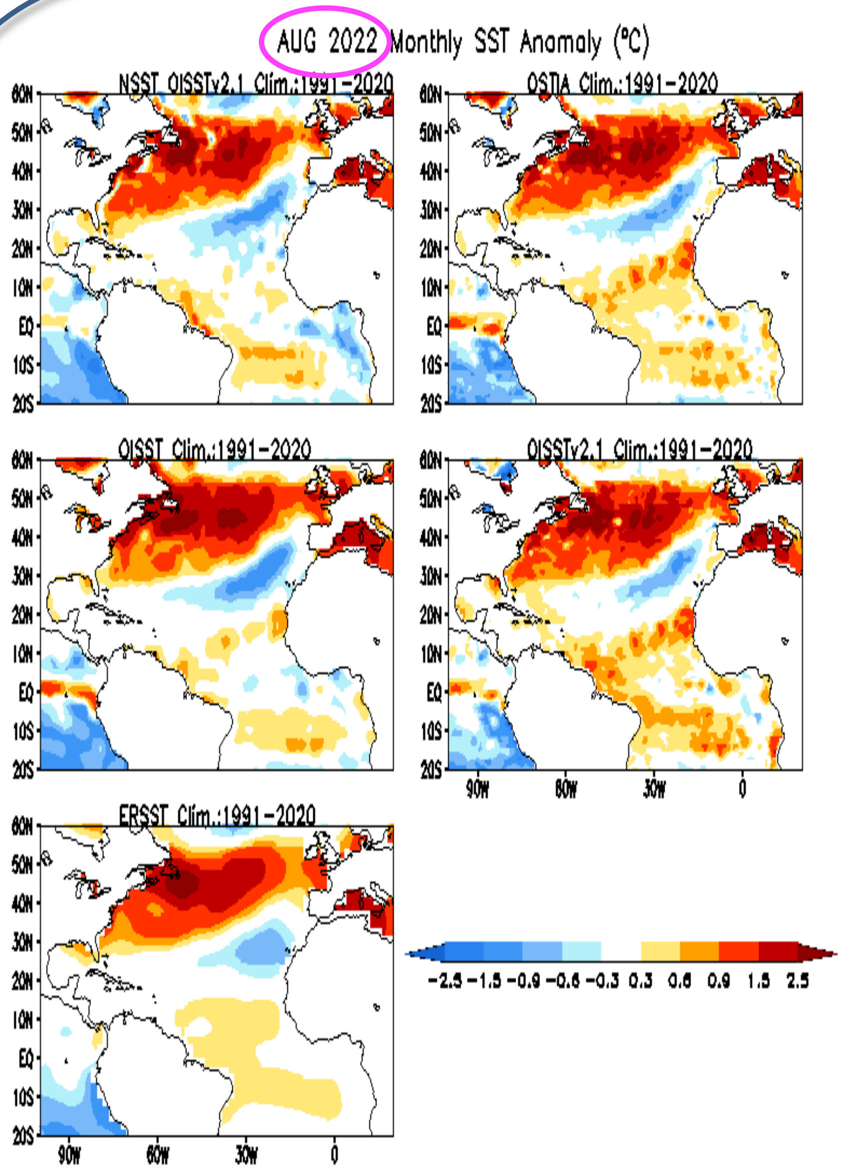


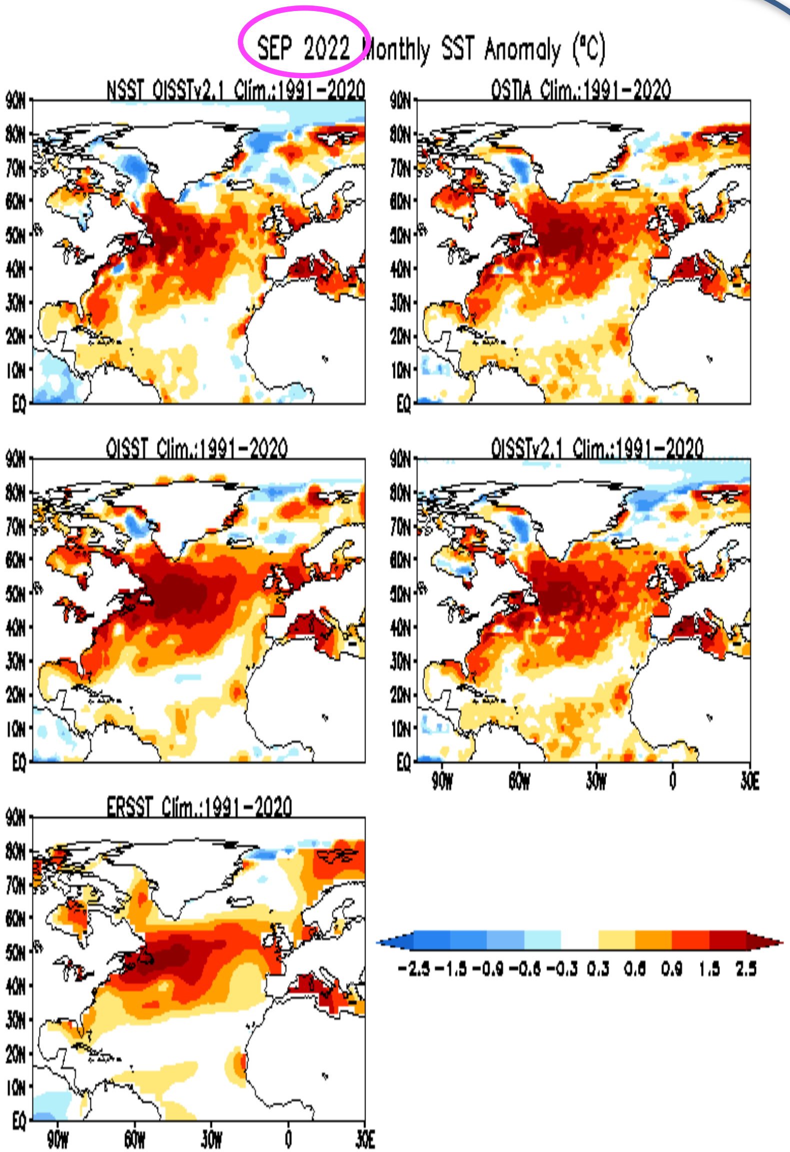


https://www.noaa.gov/news-release/noaa-still-expects-above-normal-atlantic-hurricane-season

- NOAA updated Atlantic hurricane season outlook slightly decreased the likelihood of an above-normal Atlantic hurricane season to 60%.
- Several atmospheric and oceanic conditions still favor an active hurricane season, including La Nina conditions, weaker tropical Atlantic trade winds, an active west African Monsoon, and likely above-normal SSTs.
- Uncertainty factor: SSTs have been varying on both sides of normal in hurricane main development region during the past 2 months.

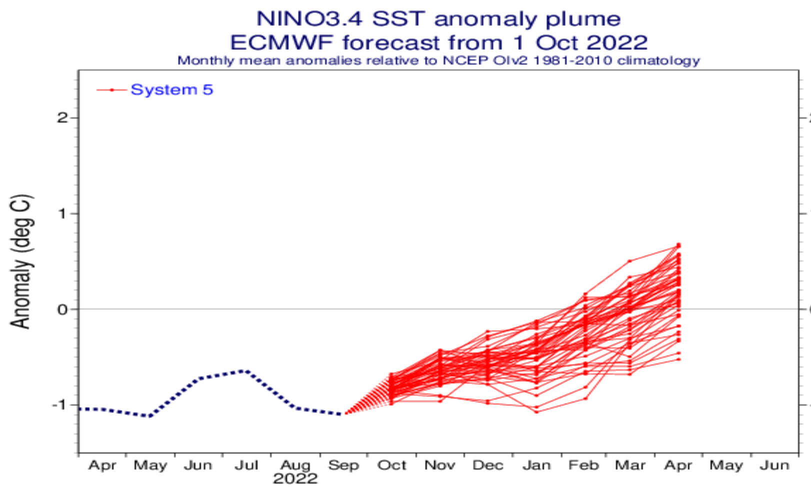
Monthly SST Anomaly in the Atlantic Ocean



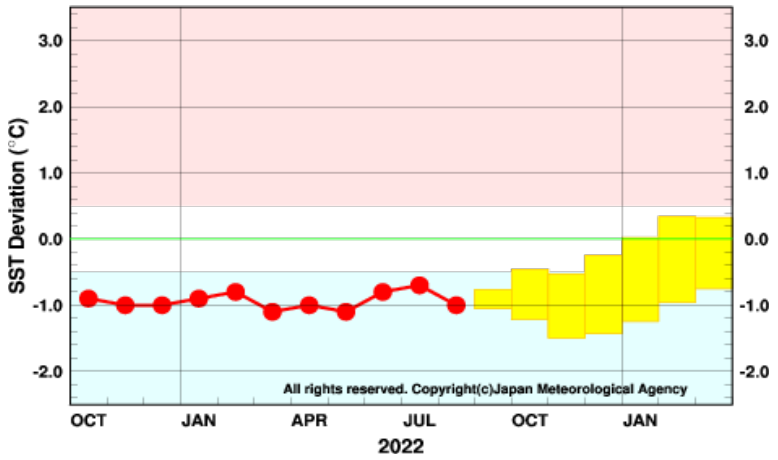


Individual Model Forecasts: ENSO neutral or borderline La Nina

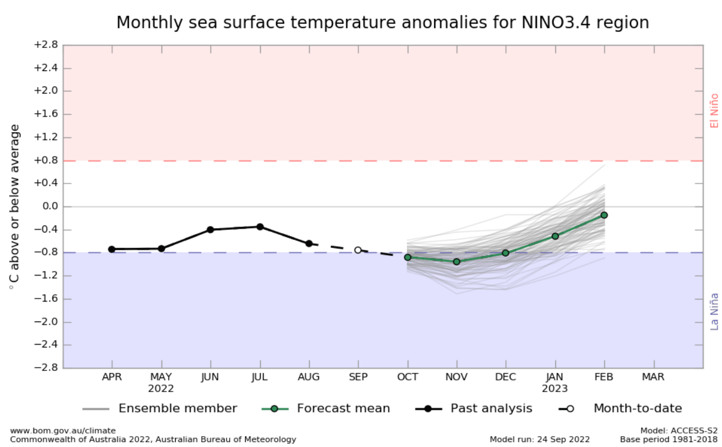
EC: IC= 1 Oct 2022



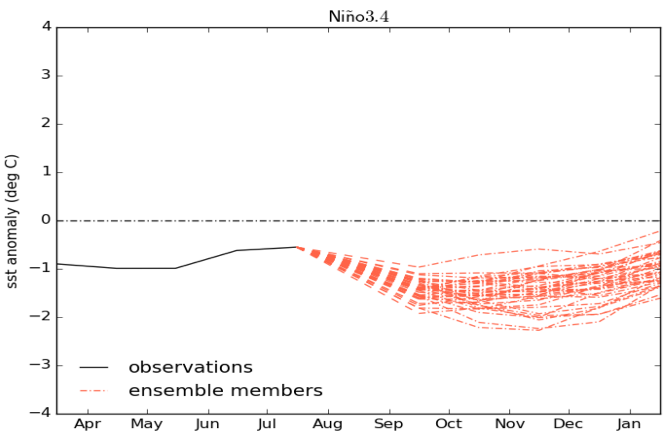
JMA: Updated 09 Se 2022



Australian BOM: Updated 24 Sep 2022



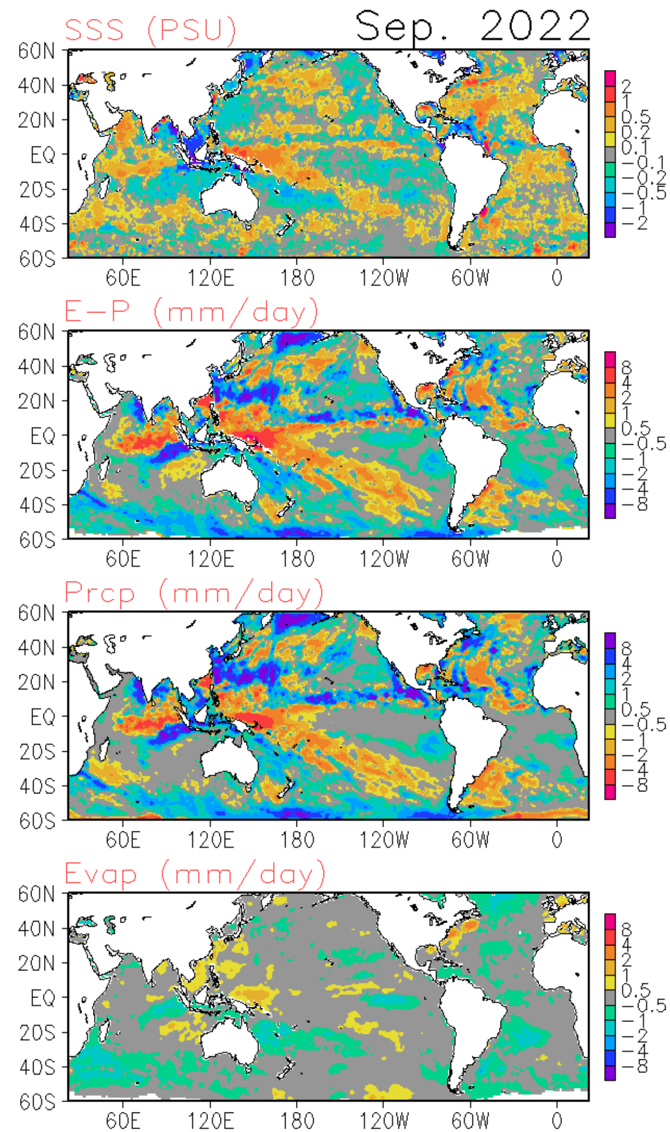
UKMO: Updated 11 Aug 2022



Global Sea Surface Salinity (SSS): Anomaly for September 2022

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

SSS anomaly patterns over the tropical and sub-tropical oceans are largely a reflection of the fresh water flux (E-P) which in turn is dominated by the precipitation anomalies. Over the astern and central Pacific, the ITCZ is shifted northward and slightly stronger than normal, causing a pair of zonally oriented bands of freshened and saltier SSS anomaly there. The saltier SSS anomalies observed last month over the mouths of the Yangtze and Ganges disappeared, turned into negative during this month. Positive SSS anomaly, however, is still visible over the mouth of the Amazon river.



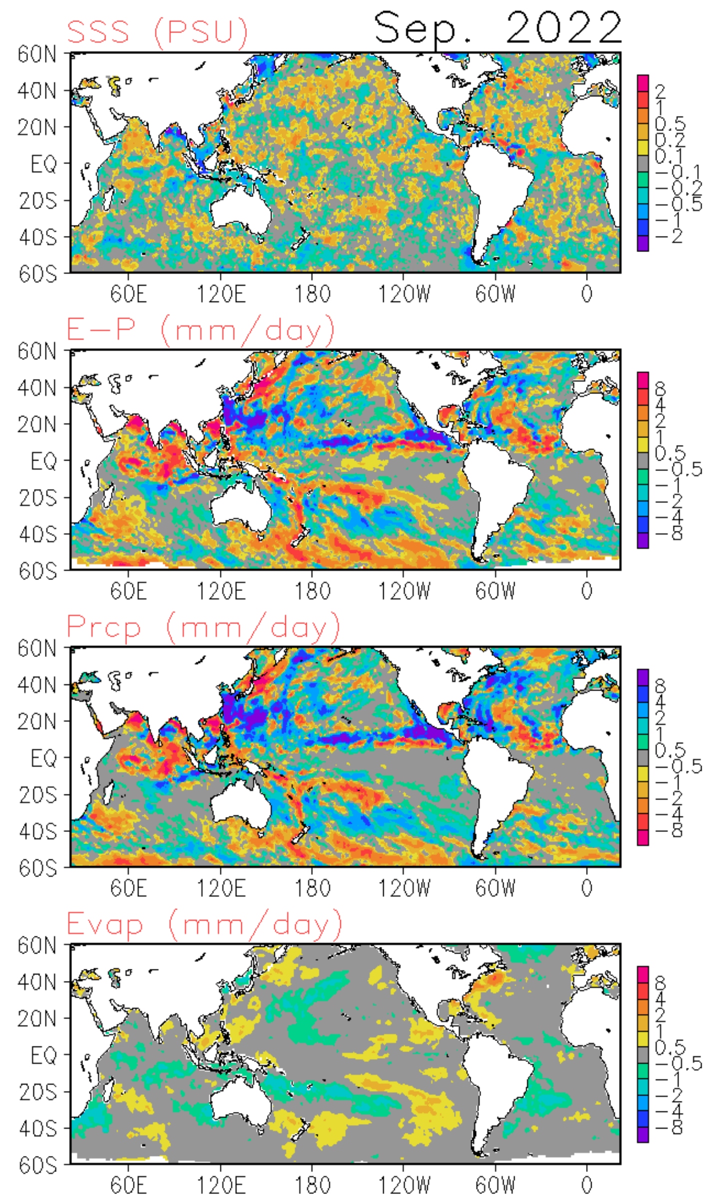
SSS : Blended Analysis of Surface Salinity (BASS) V0.Z
(a CPC-NESDIS/NODC-NESDIS/STAR joint effort)
ftp.cpc.ncep.noaa.gov/precip/BASS

Precipitation: CMORPH adjusted satellite precipitation estimates

Evaporation: Adjusted CFS Reanalysis

Global Sea Surface Salinity (SSS): Tendency for September 2022

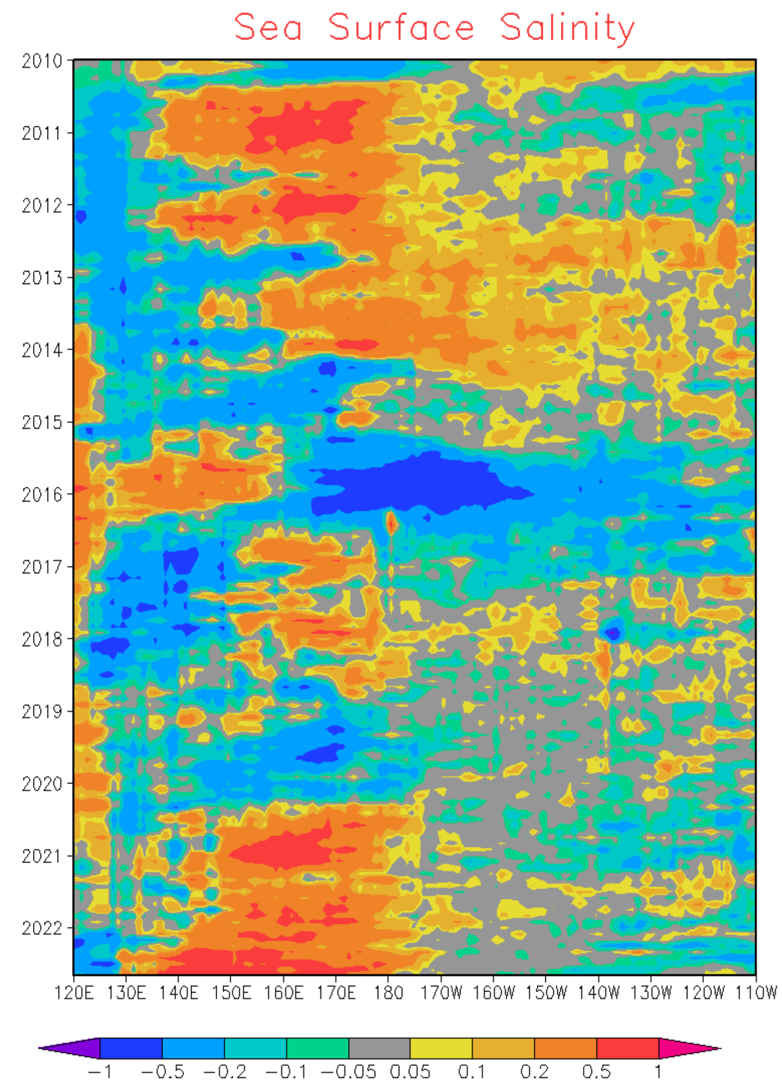
Overall, SSS tendency is not well organized as that of the monthly anomaly. Freshening SSS tendency is observed over the mouths of the Yangtze and Ganges rivers. Despite the enhanced tropical storm / hurricane activities (and therefore enhanced precipitation) over the Caribbean Sea and eastern portion of the Gulf of Mexico, a mixed pattern of positive and negative SSS tendency is observed there, suggesting contributions of multiple oceanic and air-sea interaction processes.



Monthly SSS Anomaly Evolution over Equatorial Pacific

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

- Hovemoller diagram for equatorial SSS anomaly **(5˚S-5˚N);**
- Positive SSS anomaly continues over the central / western equatorial Pacific between 140°E and 170°W. Weak negative SSS anomalies over the eastern Pacific continues.



Pentad SSS Anomaly Evolution over Equatorial Pacific

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