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

Overview

- **Pacific Ocean**
  - La Niña condition persisted with negative subsurface temperature anomaly reemerging in the central-eastern Pacific Ocean.
  - The negative PDO strengthened in Jul 2022, with PDOI = -2.2 .
  - Marine Heat Waves (MHWs) developed in the North central Pacific and western Bering Sea.

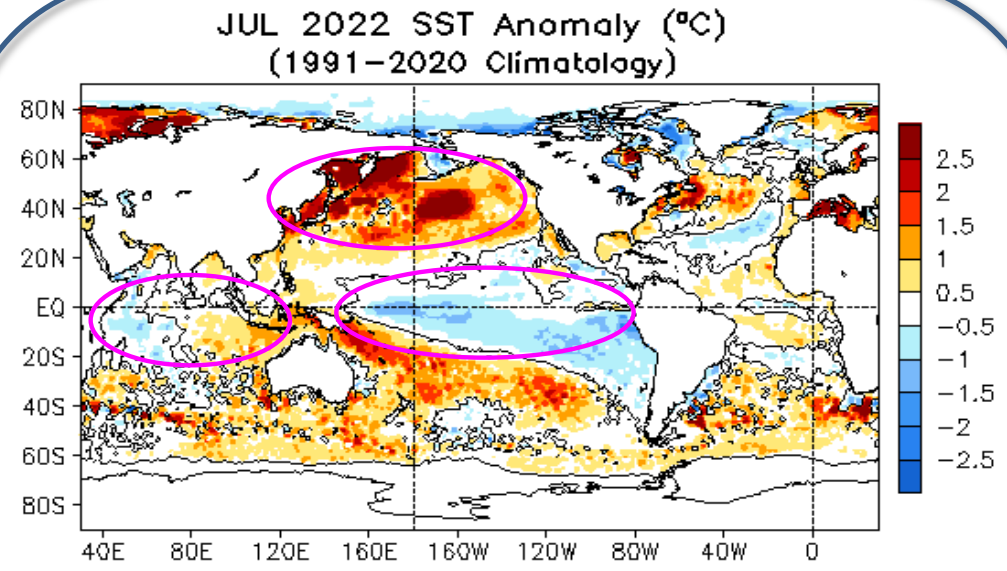
- **Arctic Ocean**
  - Averaged Arctic sea ice extent for July ranked the twelfth lowest in the satellite record.

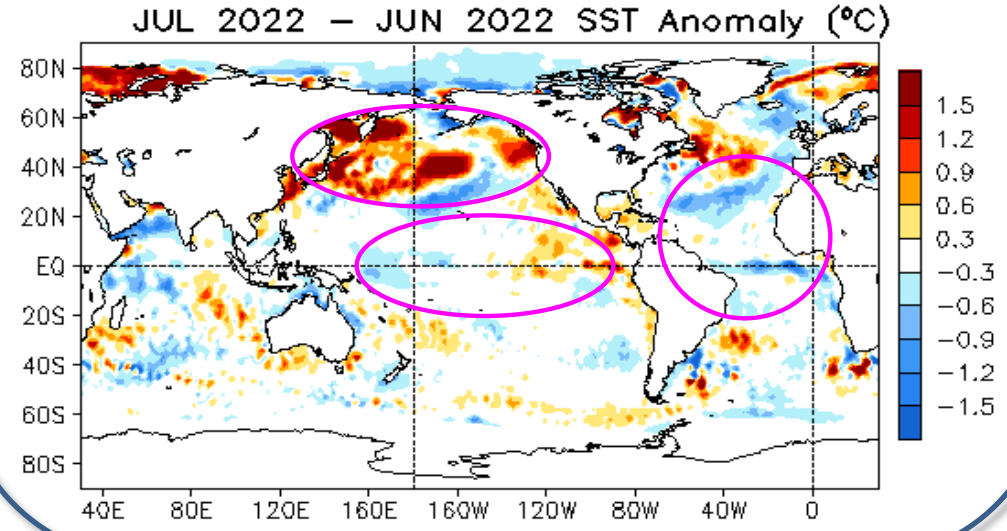
- **Indian Ocean**
  - Indian Dipole Mode Index increased substantially in Jul 2022 , with DMI = -0.9℃.
  - All NMME models favor a negative IOD event during the northern hemisphere summer-fall 2022.

- **Atlantic Ocean**
  - Atlantic hurricane activity was quiet in July.
  - NOAA updated Atlantic Season outlook on 4 Aug 2022 still expects above-normal Atlantic Hurricane Season.
  - A majority of NMME models predicted near normal SSTs to persist in the Hurricane main development region through the whole 2022 hurricane season.

Global Oceans

Global SST Anomaly (°C) and Anomaly Tendency



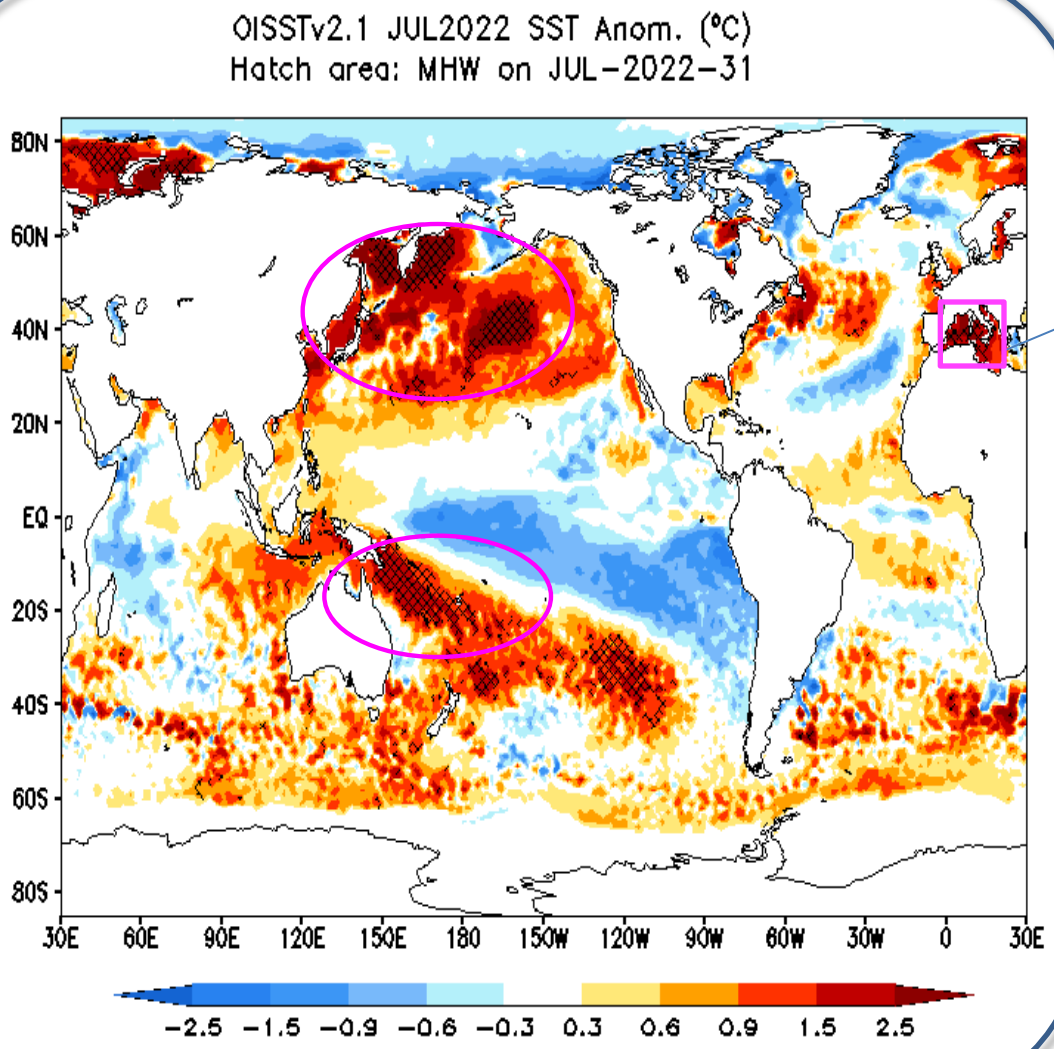


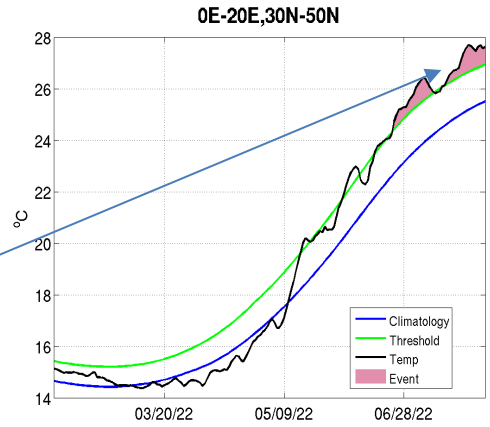
- SSTs were below average across most of the equatorial Pacific Ocean.
- Strong positive SSTAs dominated the North Pacific.
- Positive (negative) SSTA were present in the eastern (western) tropical Indian Ocean.

- Positive (negative) SSTA tendencies were observed in the eastern (western) equatorial Pacific.
- Both positive and negative SSTA tendencies were observed in the North Pacific.
- Negative SSTA tendencies were present in the equatorial and subtropical North 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

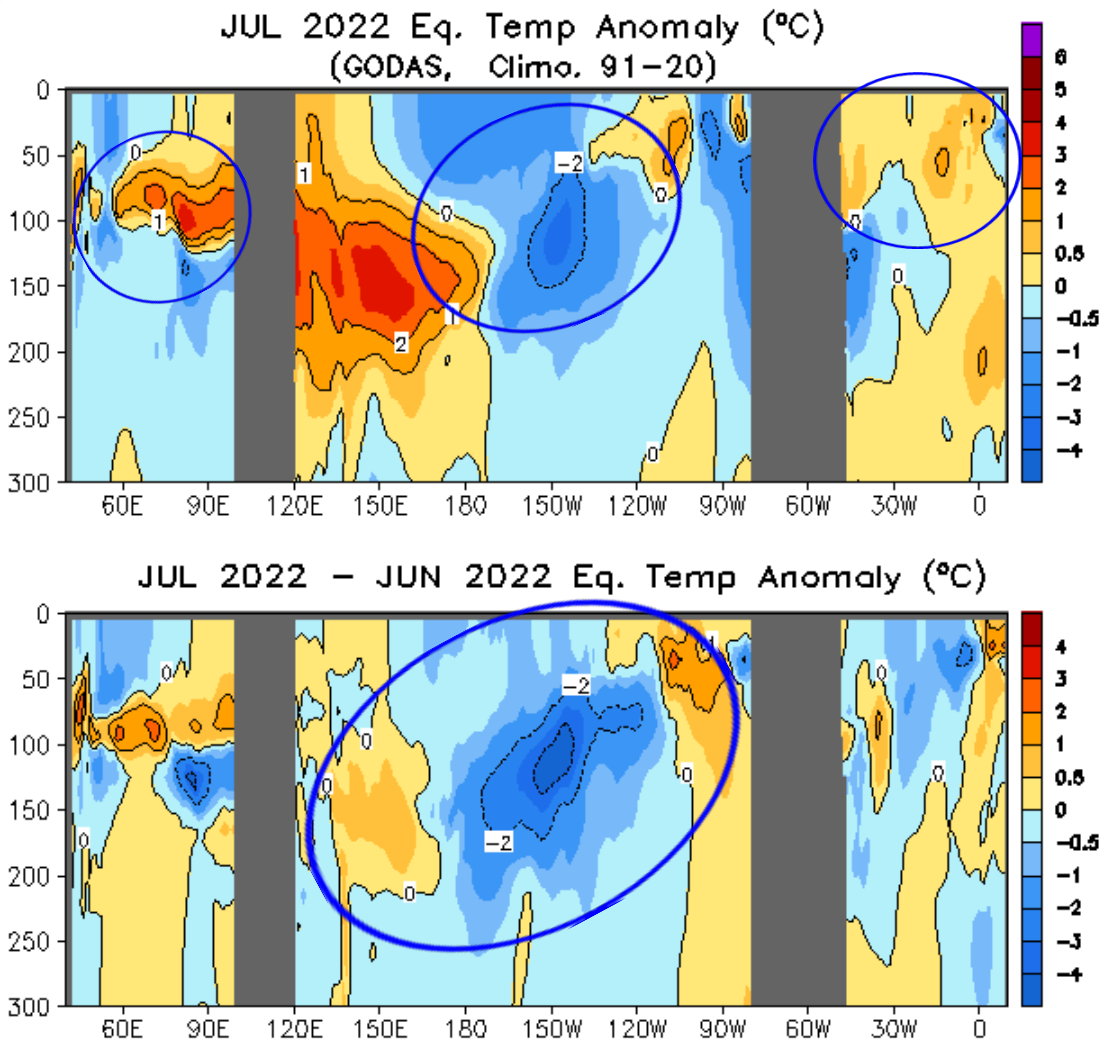




- MHWs were observed in the Mediterranean Sea , Sea of Okhotsk, west of Bering Sea, north central Pacific ocean, and the Coral Sea.

(Left panel) Monthly 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

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



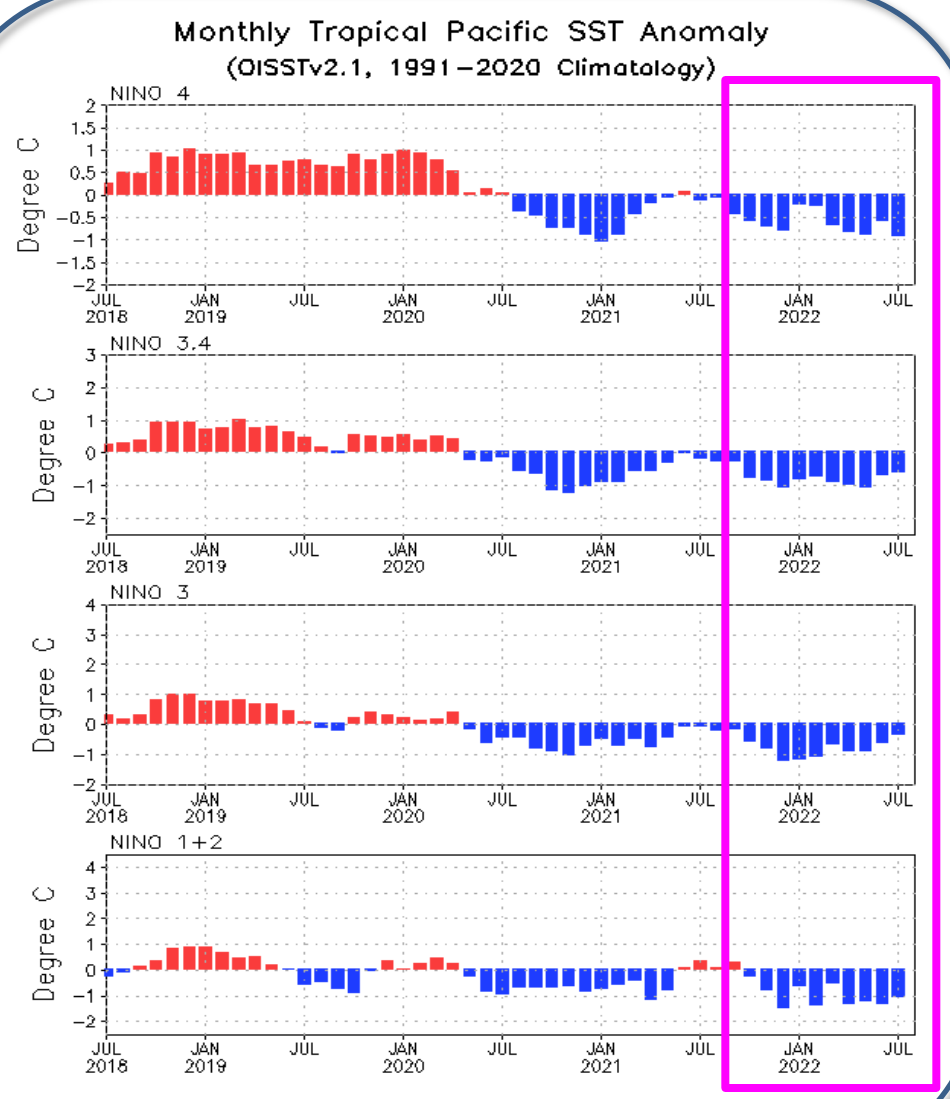
- Negative temperature anomalies reemerged along the thermocline in the central-eastern Pacific Ocean.
- Large positive temperature anomalies persisted in the eastern equatorial Indian Ocean.
- Positive temperature anomalies dominated the upper 100m of equatorial Atlantic Ocean.

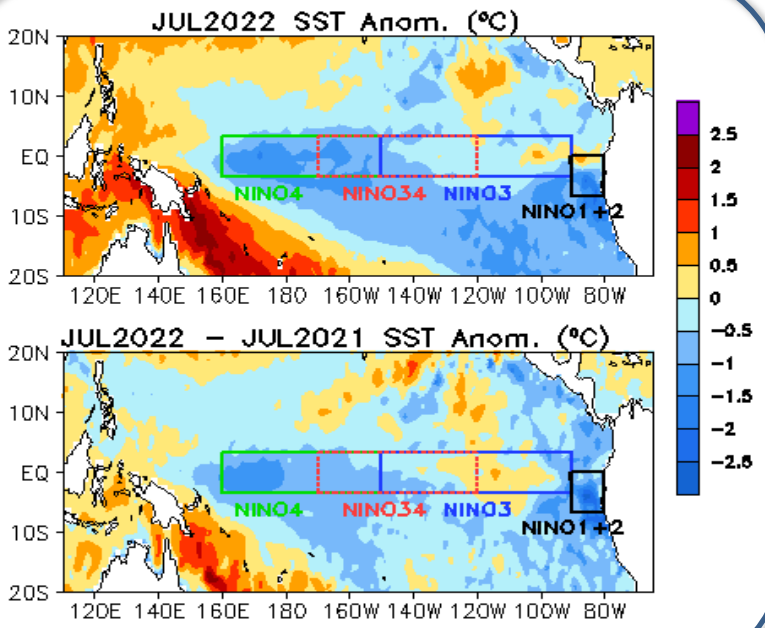
- Negative temperature anomaly tendency was observed along the central-eastern equatorial thermocline in the Pacific Ocean.

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 Niño 4, the other three Niño indices warmed up slightly in Jul 2022.

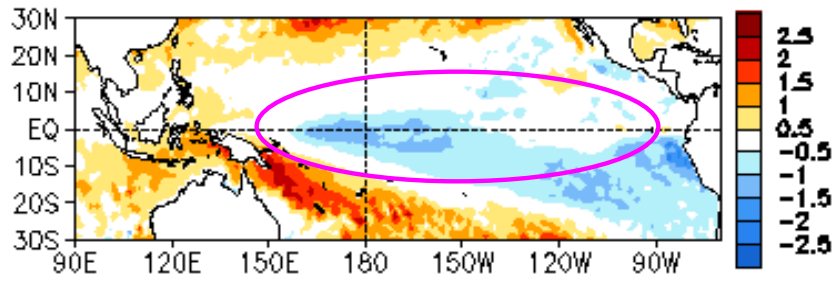
- Negative Niño3.4 weakened slightly in Jul, with Niño3.4 = -0.6C.

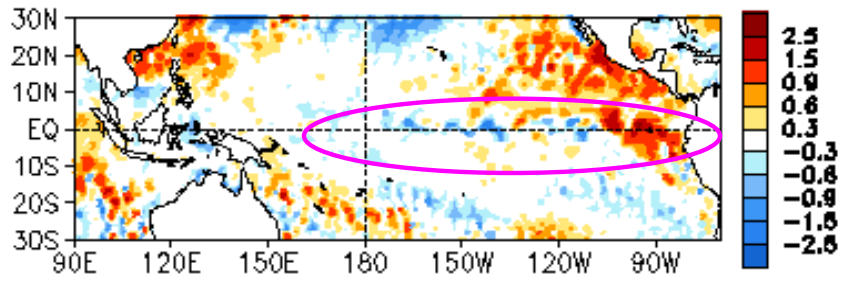
- Compared with Jul 2021, the western-central and southeastern tropical Pacific were cooler in Jul 2022.

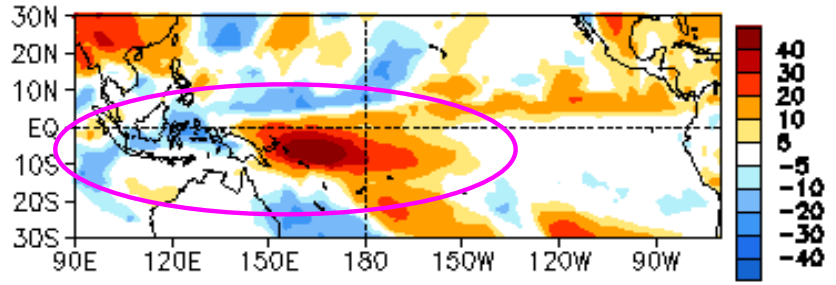
- The indices may have slight differences if based on different SST products.

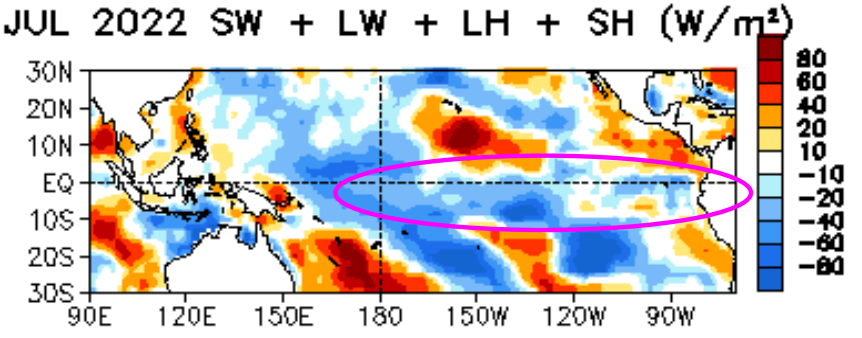
Niño region indices, calculated as the area-averaged monthly mean SSTAs (°C) for the specified region. Data are derived from the OISSTv2.1 SST analysis, and anomalies are departures from the 1991-2020 base period means.

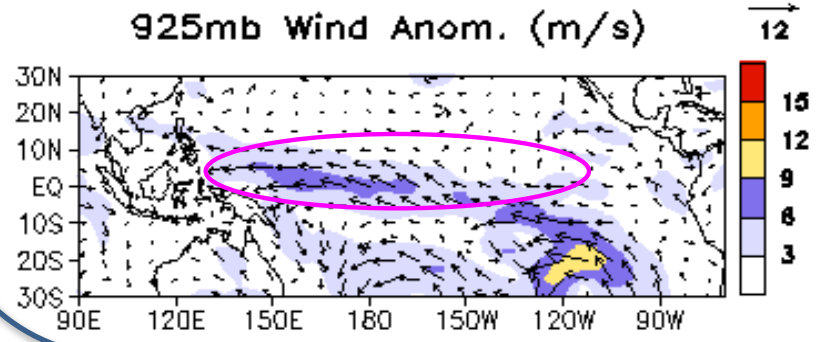
Tropical Pacific: SSTA, SSTA Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Winds

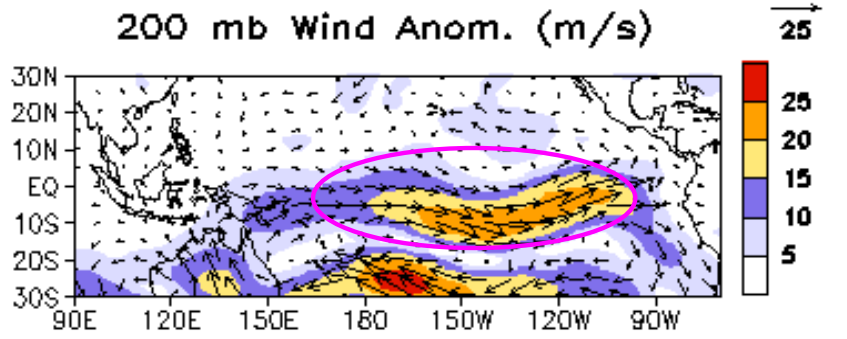






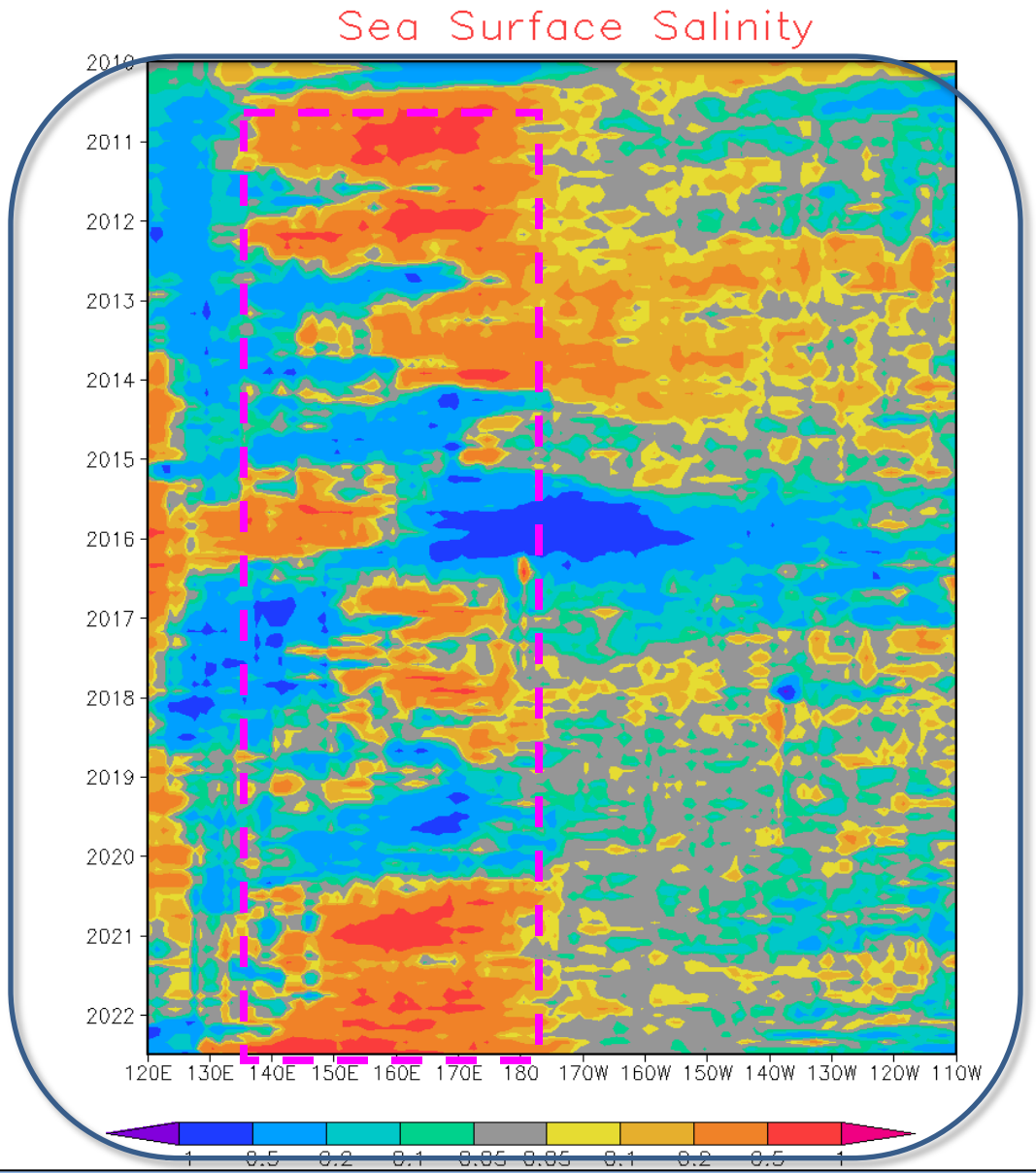






SSTAs (top-left), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right; positive means heat into the ocean), 925-mb wind anomaly vector and its amplitude (bottom-left),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

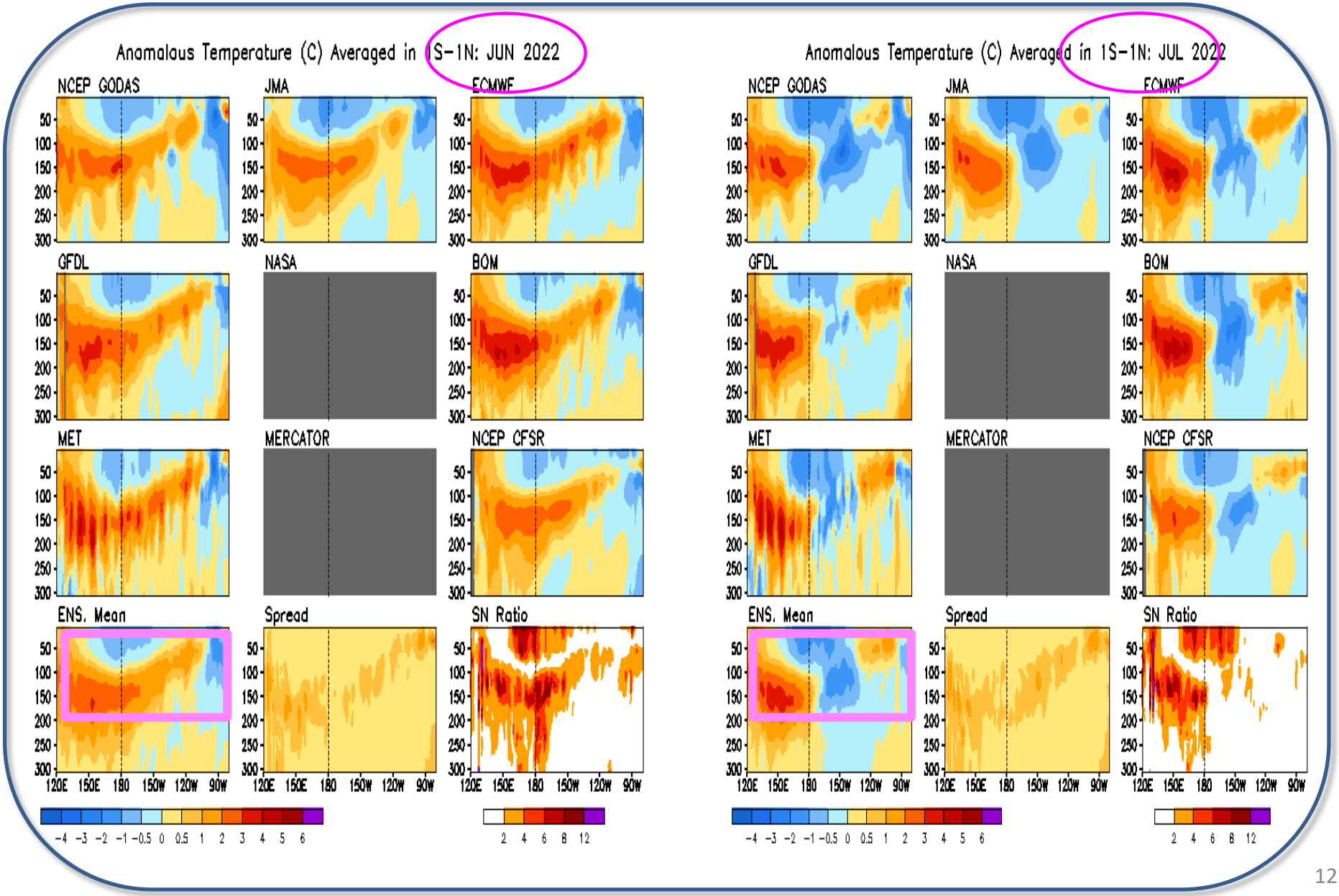


- Positive (negative) SSS anomaly presented east (west) of 140E during 2010, 2011, 2016,2017, 2020, 2021 La Nina events.

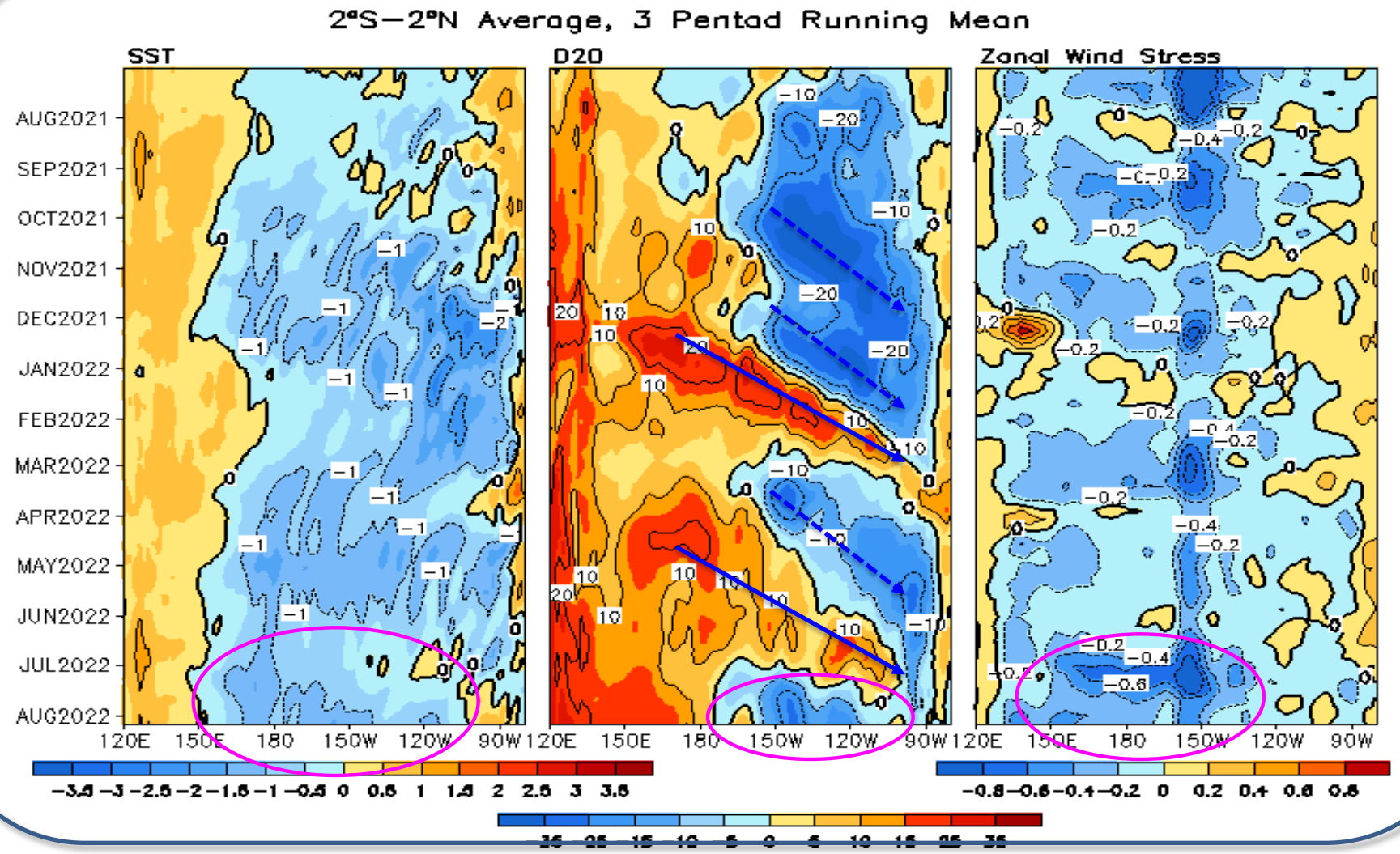
- Positive SSS anomaly continued and enhanced slightly in the western-central equatorial Pacific

Sea surface salinity (SSS) anomalies are derived from Blended Analysis of Surface Salinity (BASS) V0.Z (Xie et al. 2014). 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. Data is available at ftp.cpc.ncep.noaa.gov/precip/BAS.

Multiple Ocean Reanalysis: Temperature anomaly at Equator

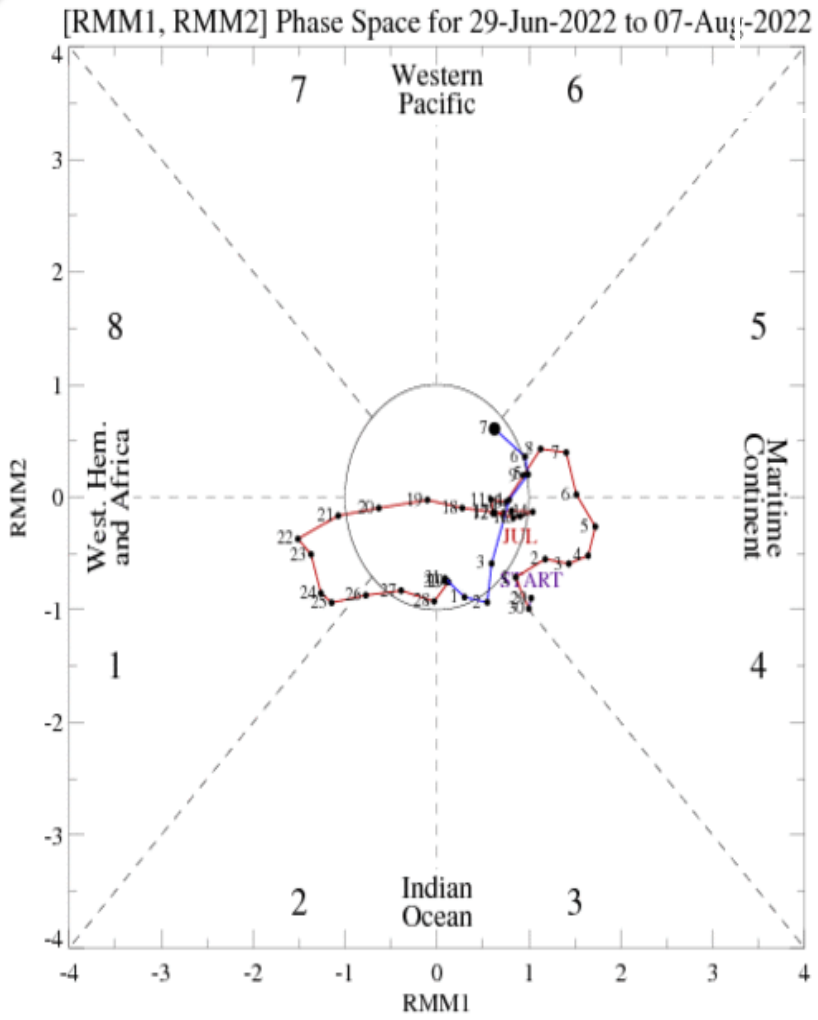


Equatorial Pacific SST (°C), D20 (m) and TAUX (dyne/cm ^{2}) Anomalies

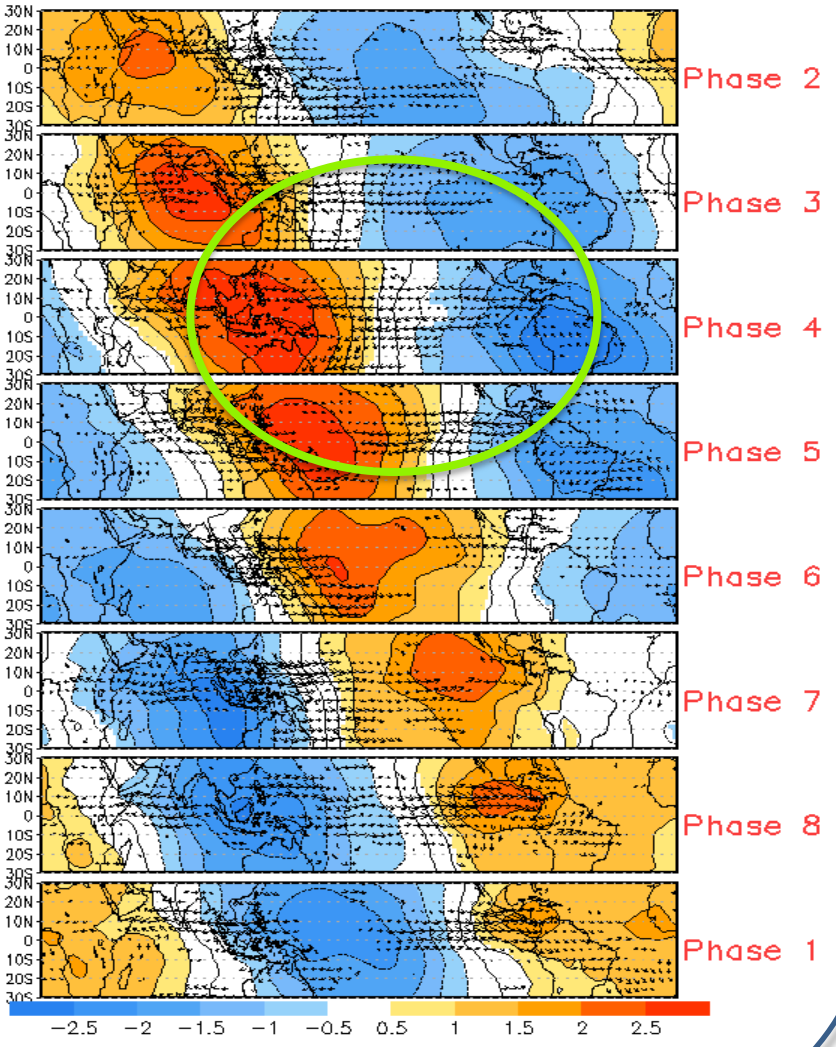


- Negative SSTA weakened in the eastern Pacific , while enhanced in the western-central Pacific in Jul 2022.
- Strong easterly surface wind prevailed over the western-central Pacific in July, consistent with the re-emergence of negative D20 anomaly in the eastern Pacific Ocean.

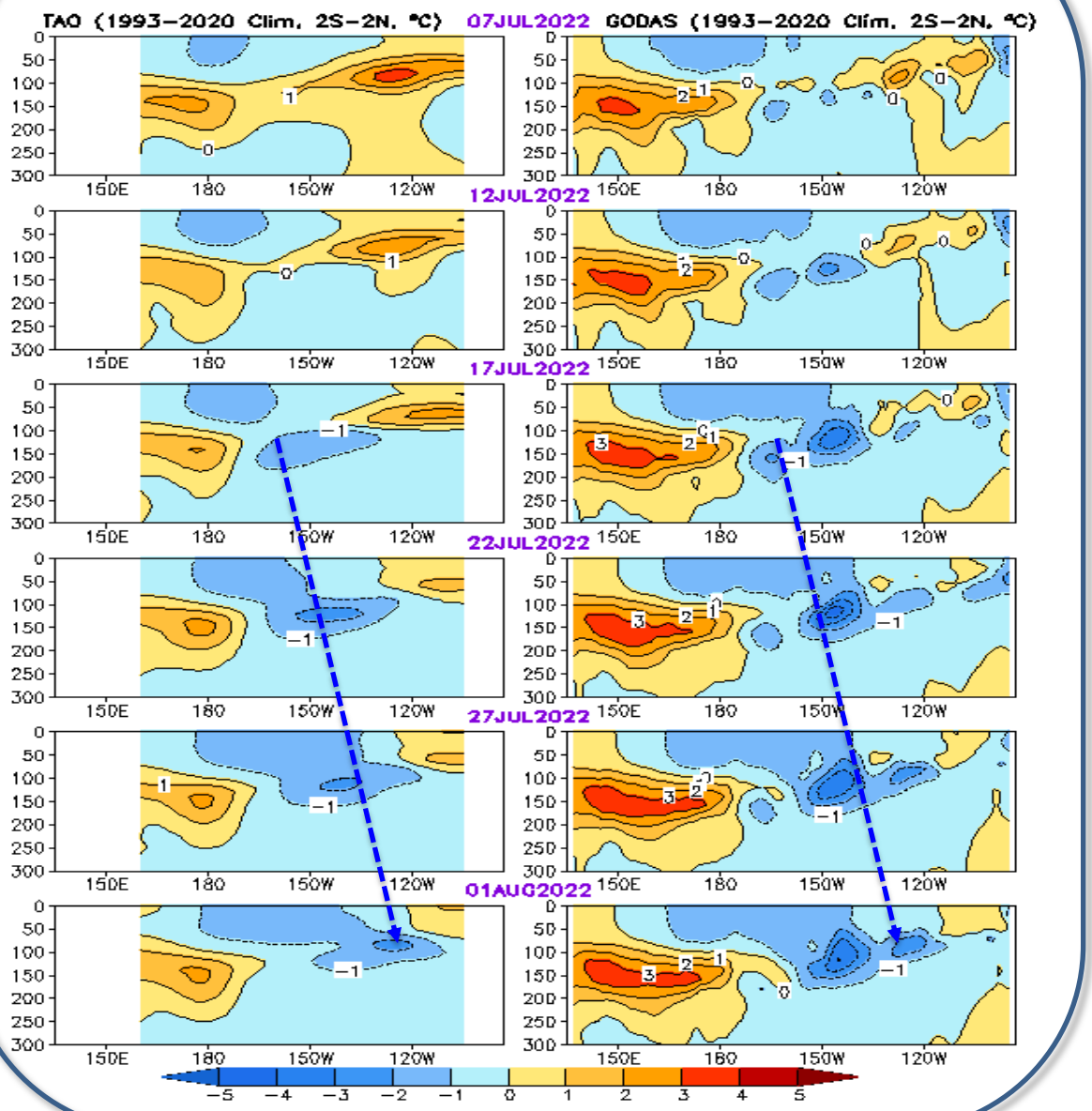
MJO Activities



850-hPa Velocity Potential and Wind Anomalies

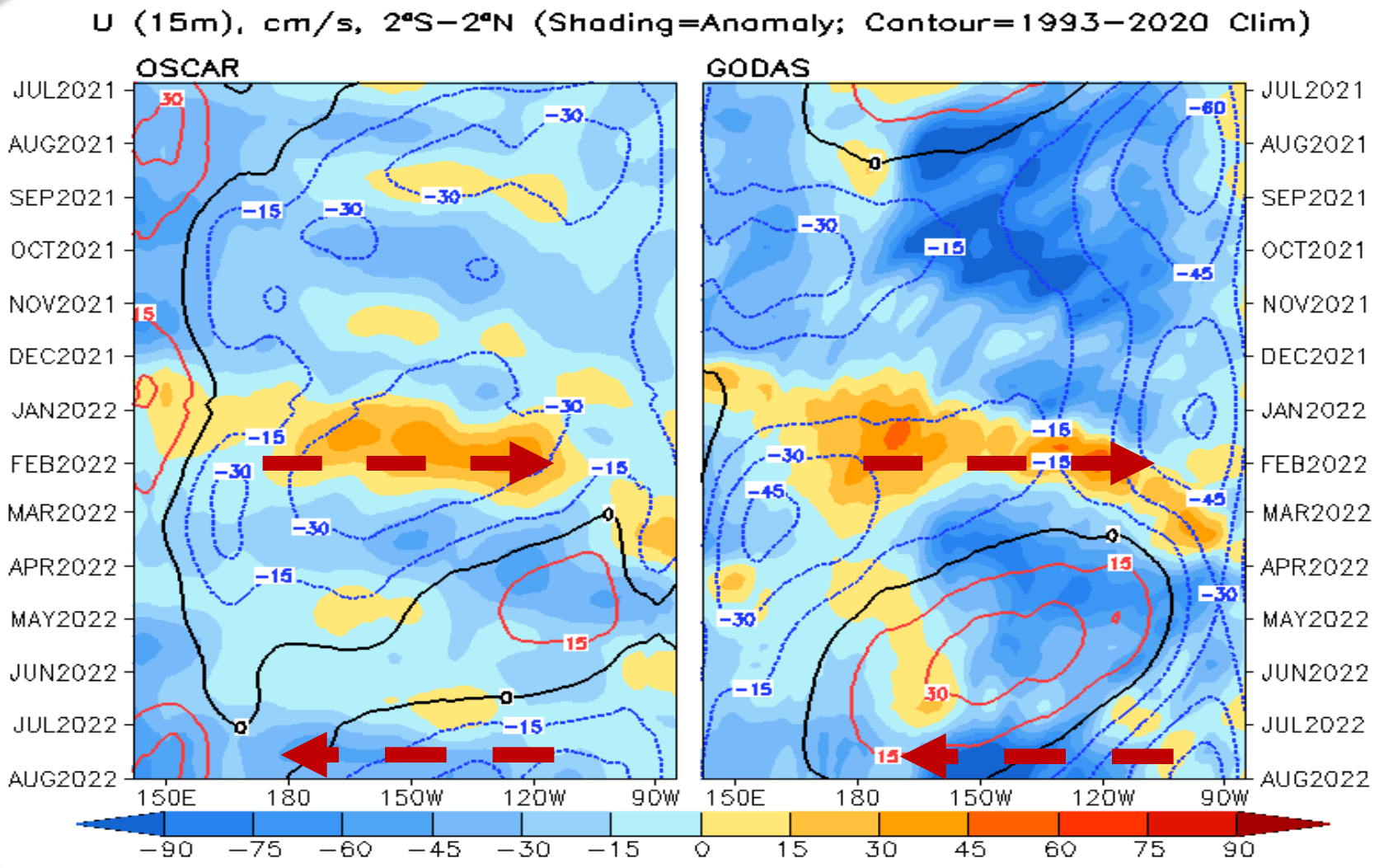


Equatorial Pacific Ocean Temperature Pentad Mean Anomaly



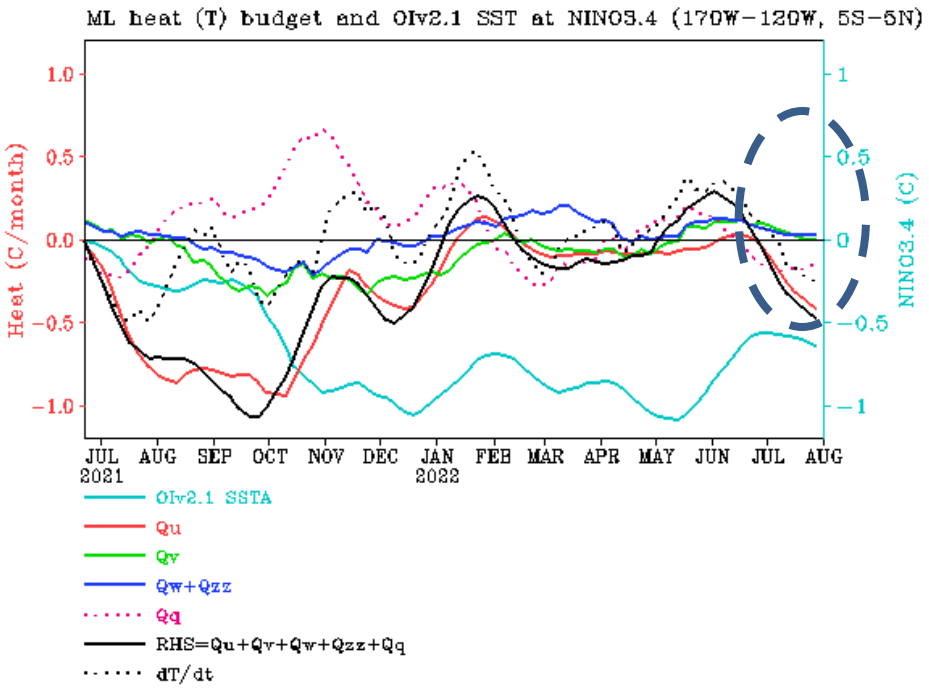
- Weak negative temperature anomaly appeared near the central Pacific thermocline (160º E-140ºW) in the middle of Jul, and then propagated eastward.
- Positive anomaly in the eastern Pacific deceased gradually in the last six pentads.
- Subsurface cooling in GODAS was stronger than that in TAO.

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



- Anomalous westward currents dominated in the equatorial Pacific both in OSCAR and GODAS since Feb 2022.
- Anomalous westward currents enhanced rapidly in Jul 2022.

NINO3.4 Heat Budget



Qu: Zonal advection; Qv: Meridional advection;

Qw: Vertical entrainment; Qzz: Vertical diffusion

Qq: (Qnet - Qpen + Qcorr)/ρcph;

Qnet = SW + LW + LH +SH;

Qpen: SW penetration;

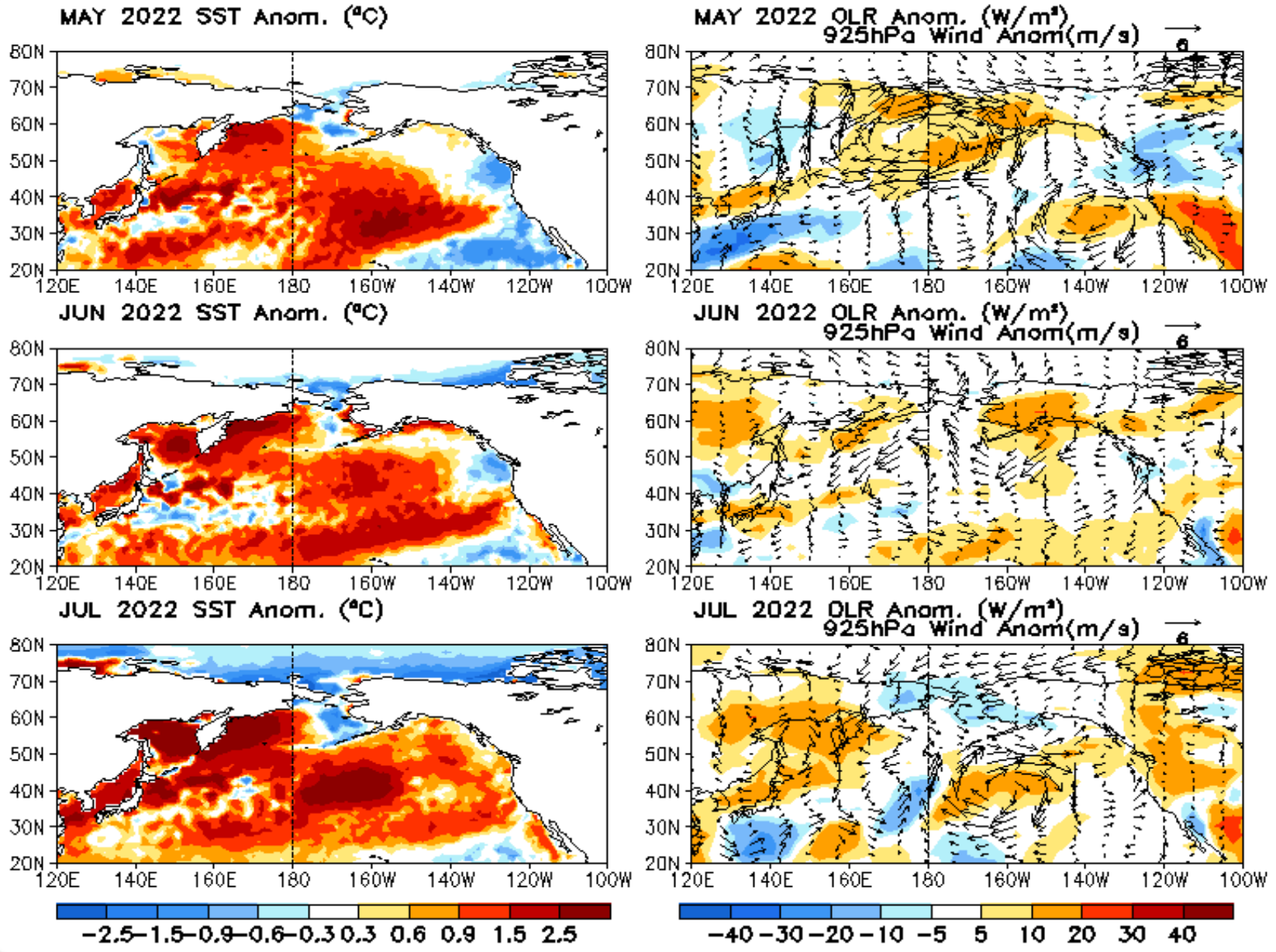
Qcorr: Flux correction due to relaxation to OI SST

- Observed SSTA tendency (dT/dt) in Nino3.4 region (dotted black line) switched to a negative phase in Jul 2022.
- Zonal advection (Qu, reg line) term is the primary dynamical processes contributing to the negative tendency.

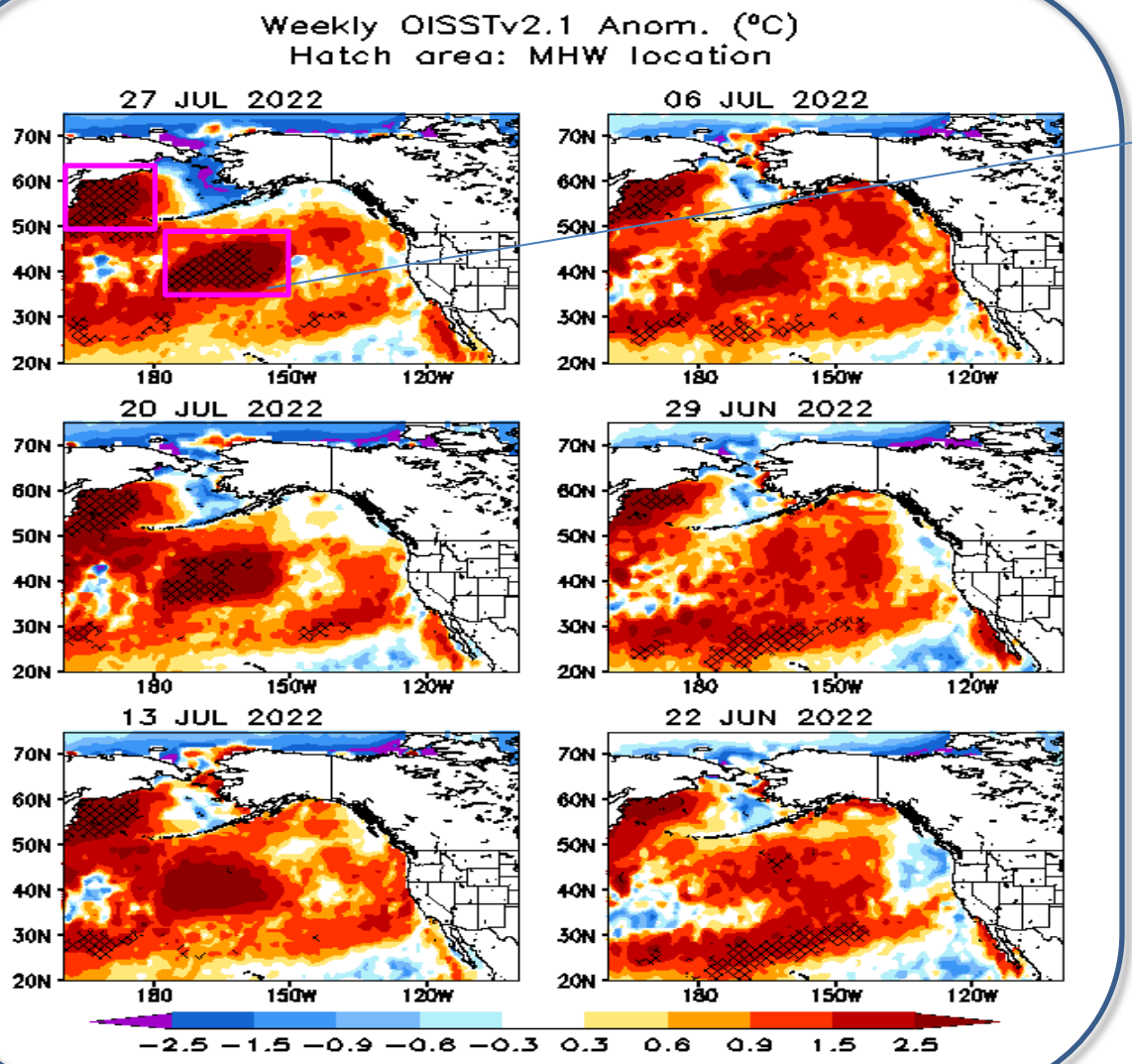
Huang, B., Y. Xue, X. Zhang, A. Kumar, and M. J. McPhaden, 2010 : The NCEP GODAS ocean analysis of the tropical Pacific mixed layer heat budget on seasonal to interannual time scales, J. Climate., 23, 4901-4925.

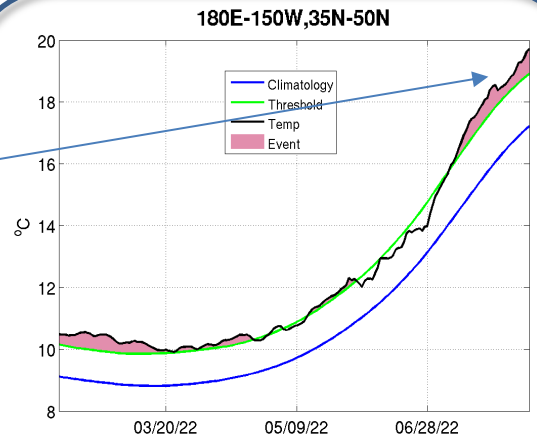
North Pacific & Arctic Oceans

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



Weekly SST anomaly and MHWs in the North Pacific

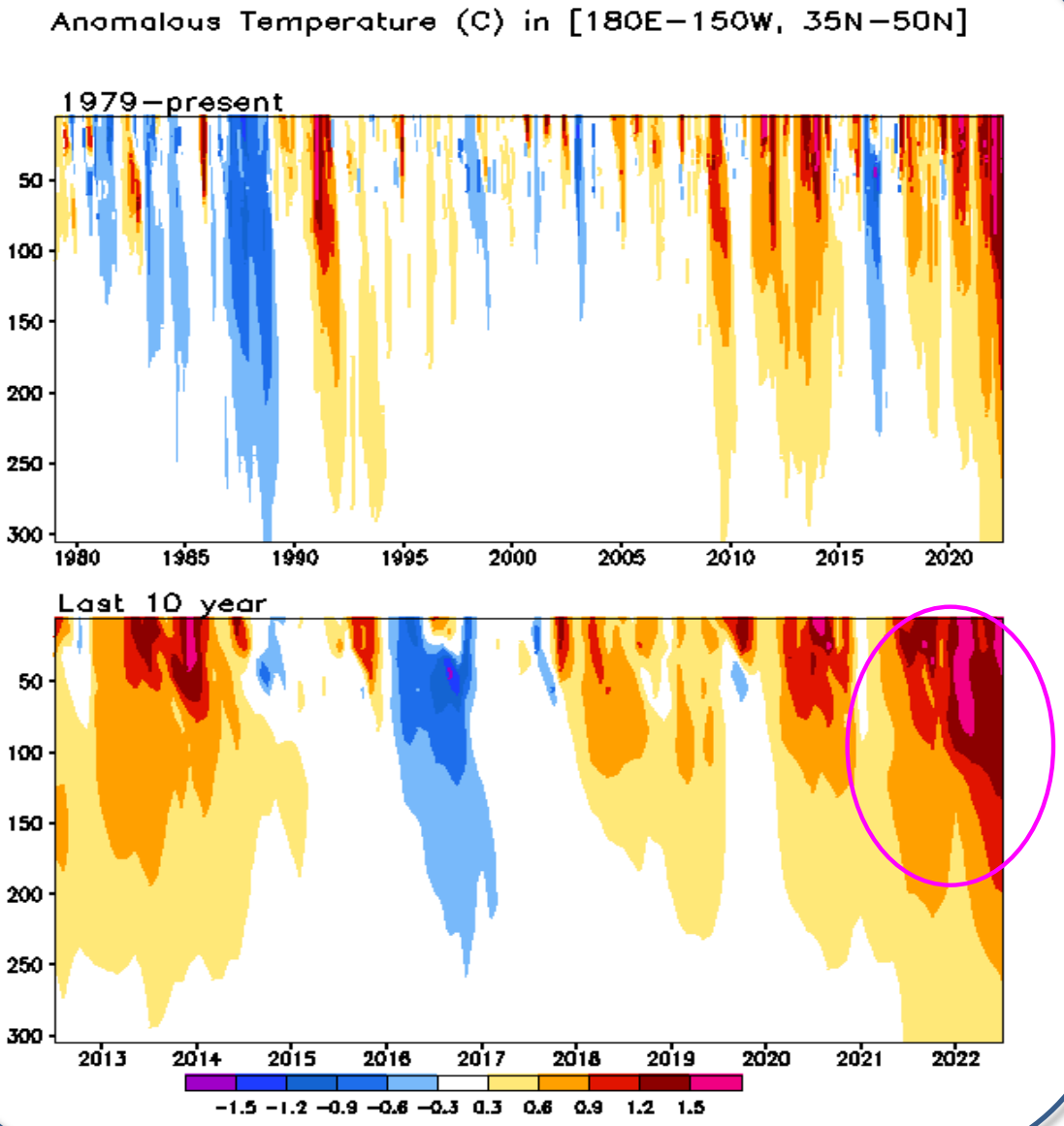


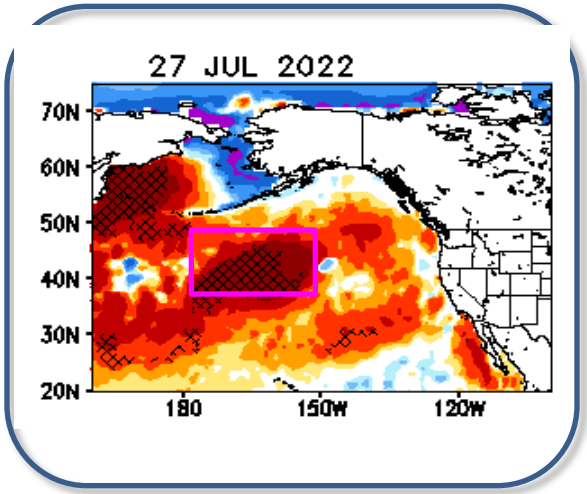


- MHWs developed in the north central Pacific and the west of Bering Sea in the late July.
- Considerable amount of anomalously warm waters persisted near the coast of California.

(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 North-Central Pacific

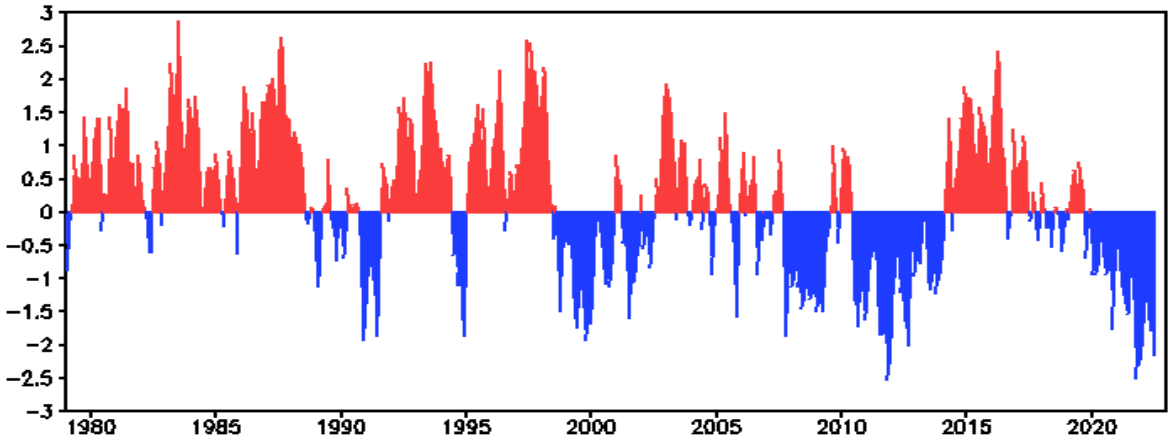




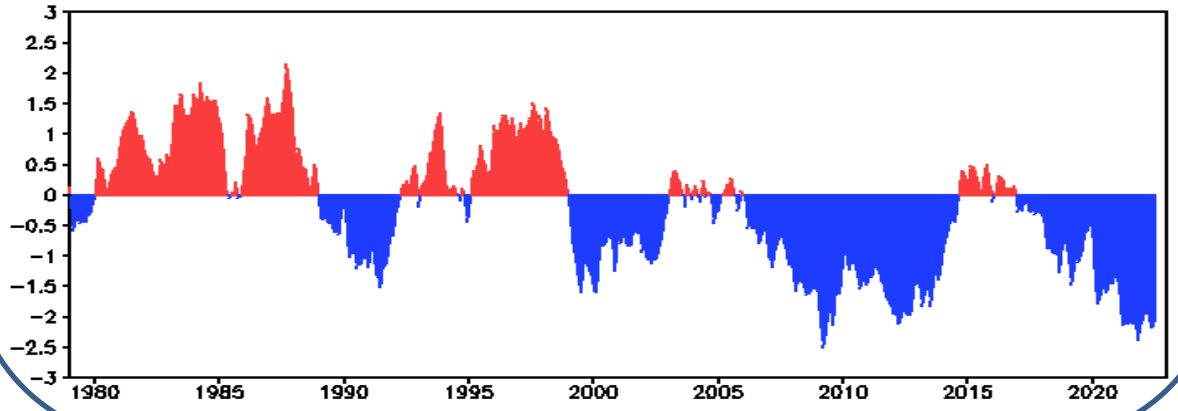
- Positive subsurface temperature anomaly in the North central Pacific has persisted since 2018.
- Subsurface warming in recent months is the strongest event since 1979.

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 = -2.2 in Jul 2022.

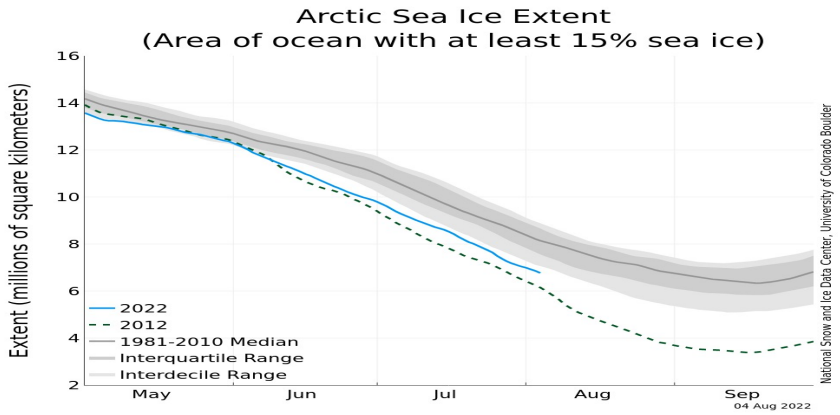
- Negative H300-based PDO index has persisted 69 months since Nov 2016, with HPDO = - 2.1 in Jul 2022.

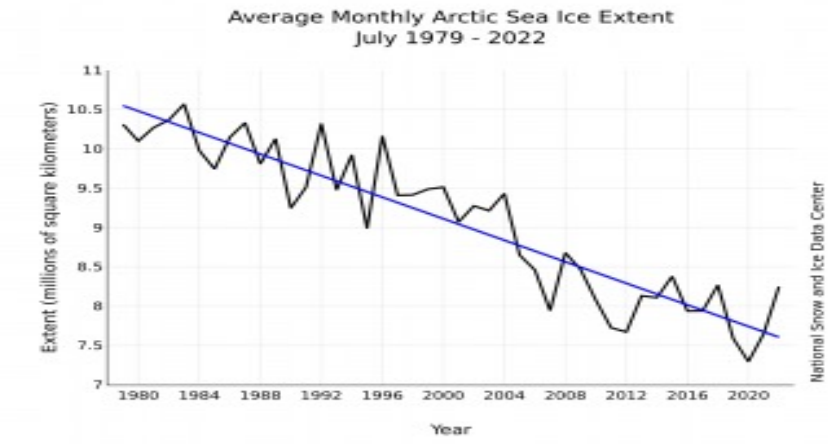
- SST-based PDO index has considerable variability both on seasonal and decadal time scales.

- 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.

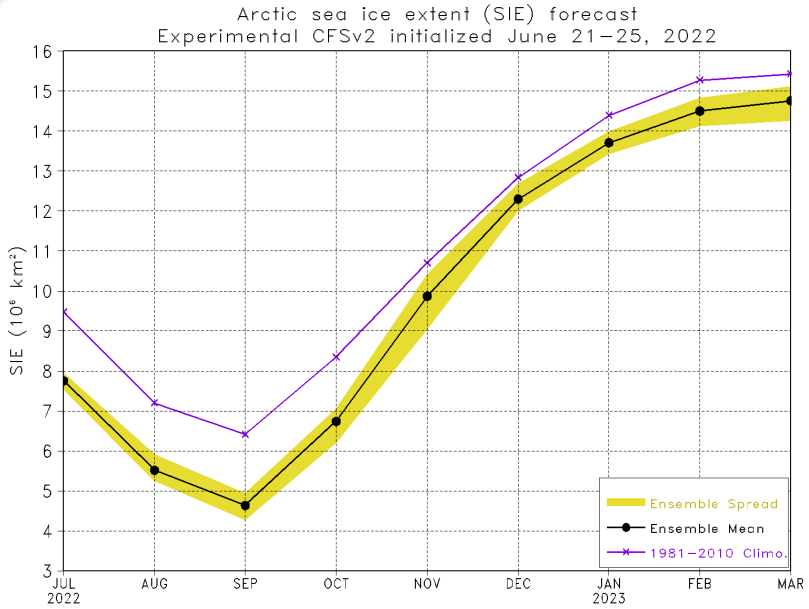
Arctic Sea Ice; NSIDC (http://nsidc.org/arcticseaicenews/index.html)

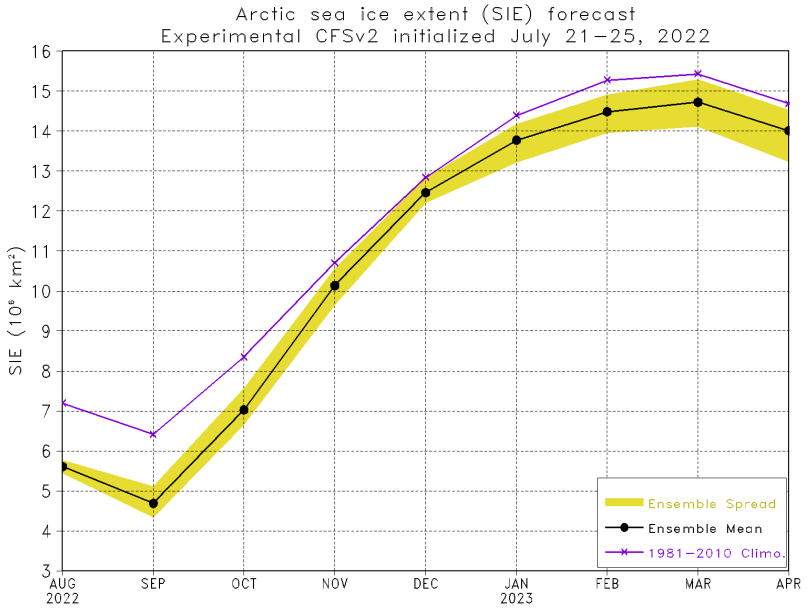




- Average Arctic sea ice extent for July 2022 was 8.25 million square kilometers, ranking twelfth lowest in the satellite record.

NCEP/CPC Arctic Sea Ice Extent Forecast

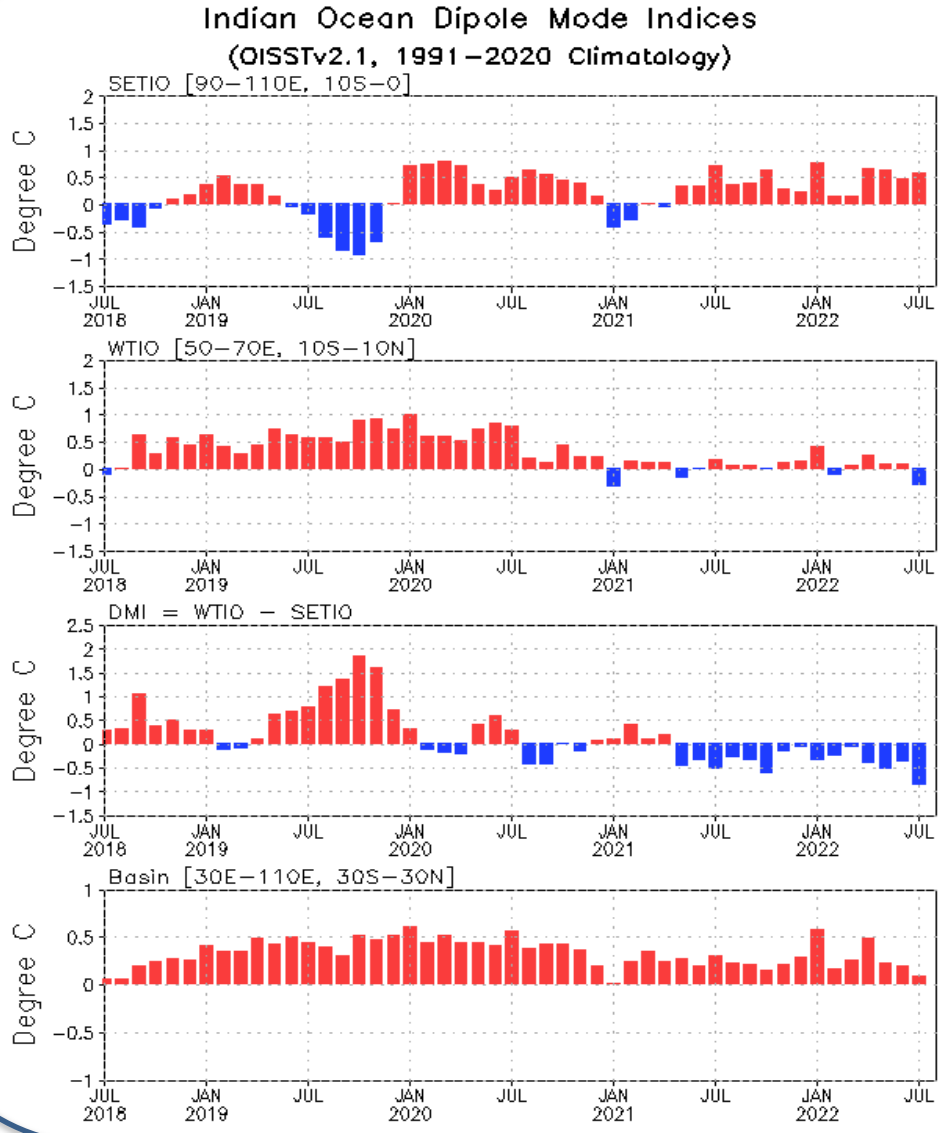


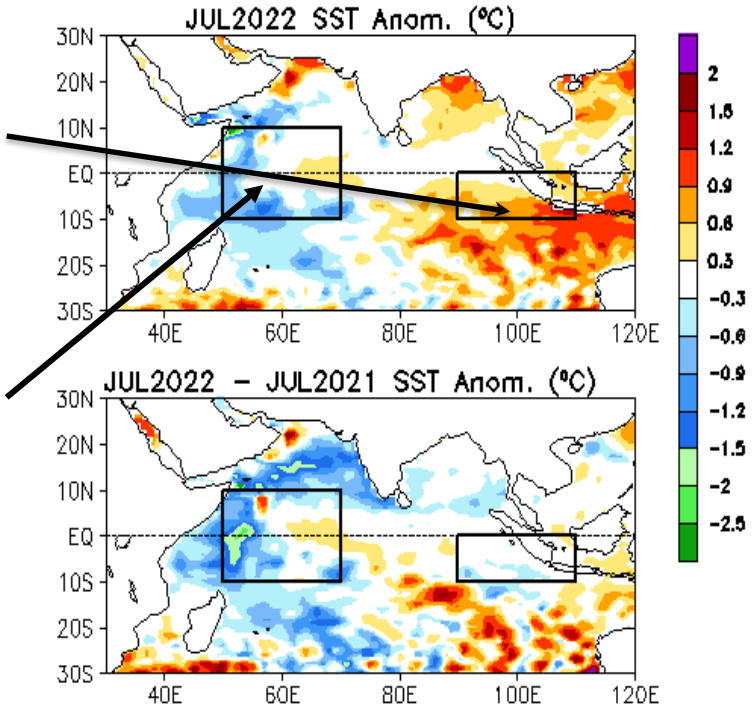


https://www.cpc.ncep.noaa.gov/products/people/wwang/seaice_seasonal/index.html

Indian Ocean

Evolution of Indian Ocean SST Indices

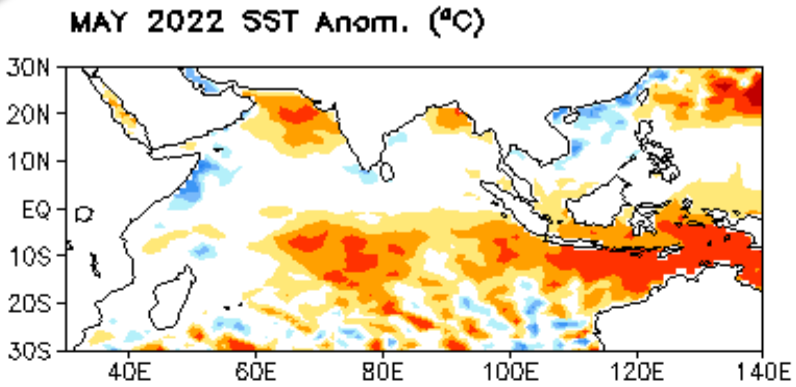


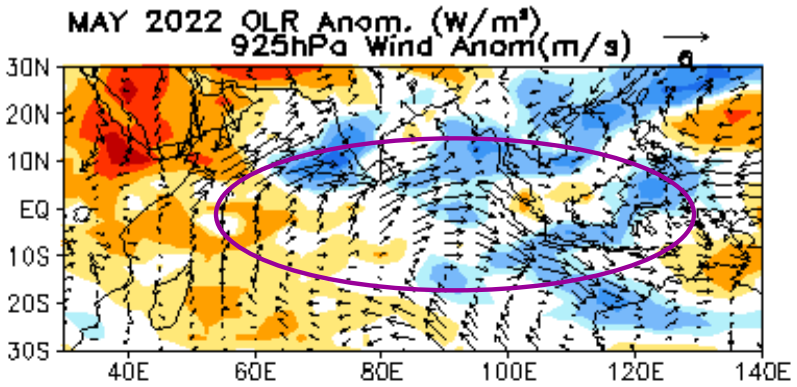


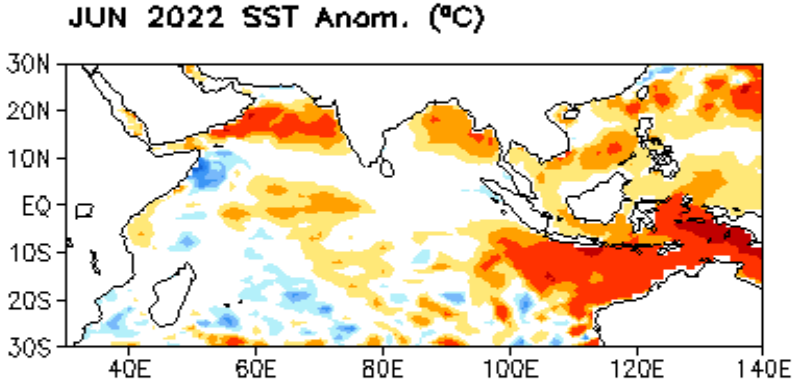
- Negative Indian Ocean Dipole Mode index (DMI) enhanced substantially in Jul 2022 , with DMI = -0.9°C.

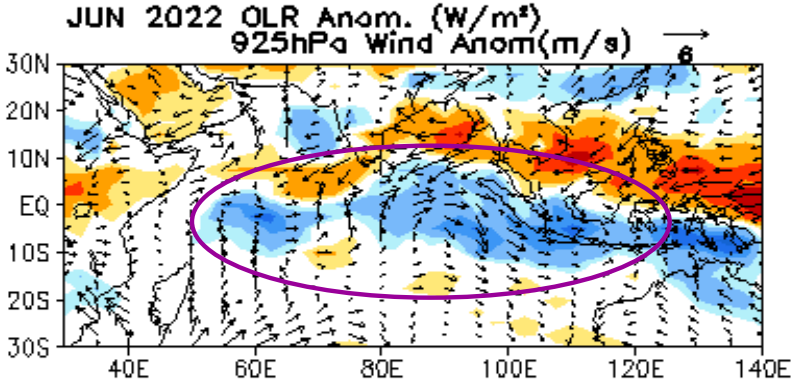
Indian Ocean region indices, calculated as the area-averaged monthly mean SSTA (OC) for the SETIO [90ºE-110ºE, 10ºS-0] and WTIO [50ºE-70ºE, 10ºS-10ºN] regions, and Dipole Mode Index, defined as differences between WTIO and SETIO. Data are derived from the OIv2.1 SST analysis, and anomalies are departures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

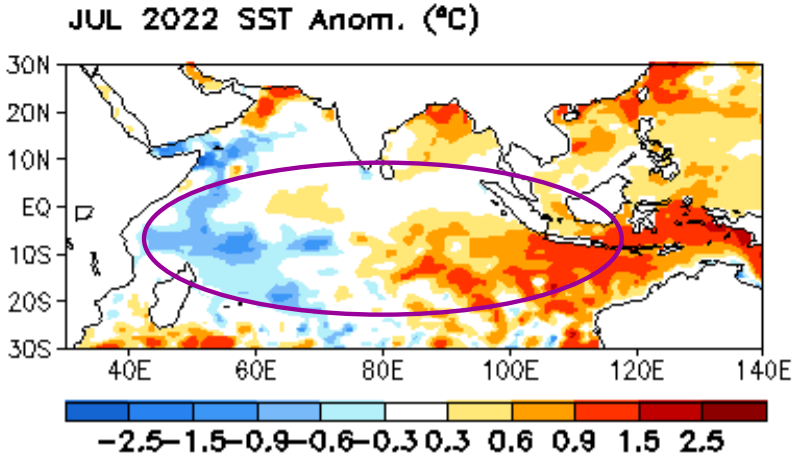
Last 3-month Tropical Indian SST , OLR & uv925 anomalies

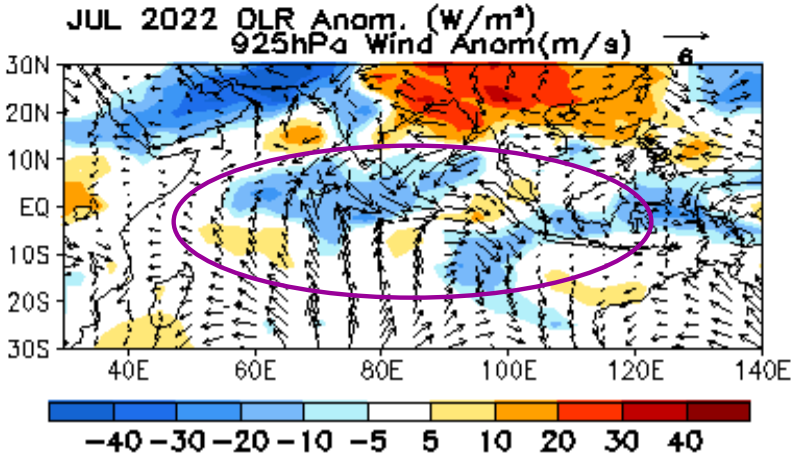






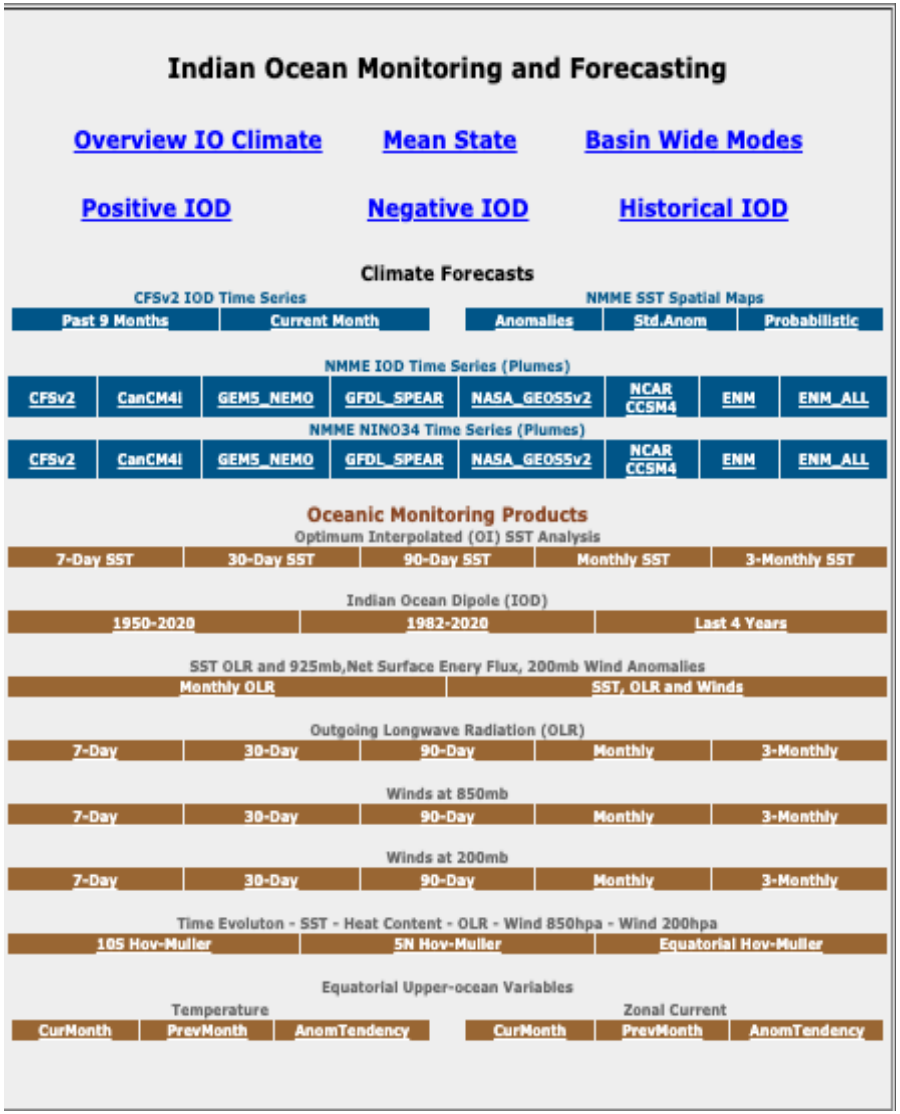






CPC Indian Ocean Monitoring and Forecasting Website

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

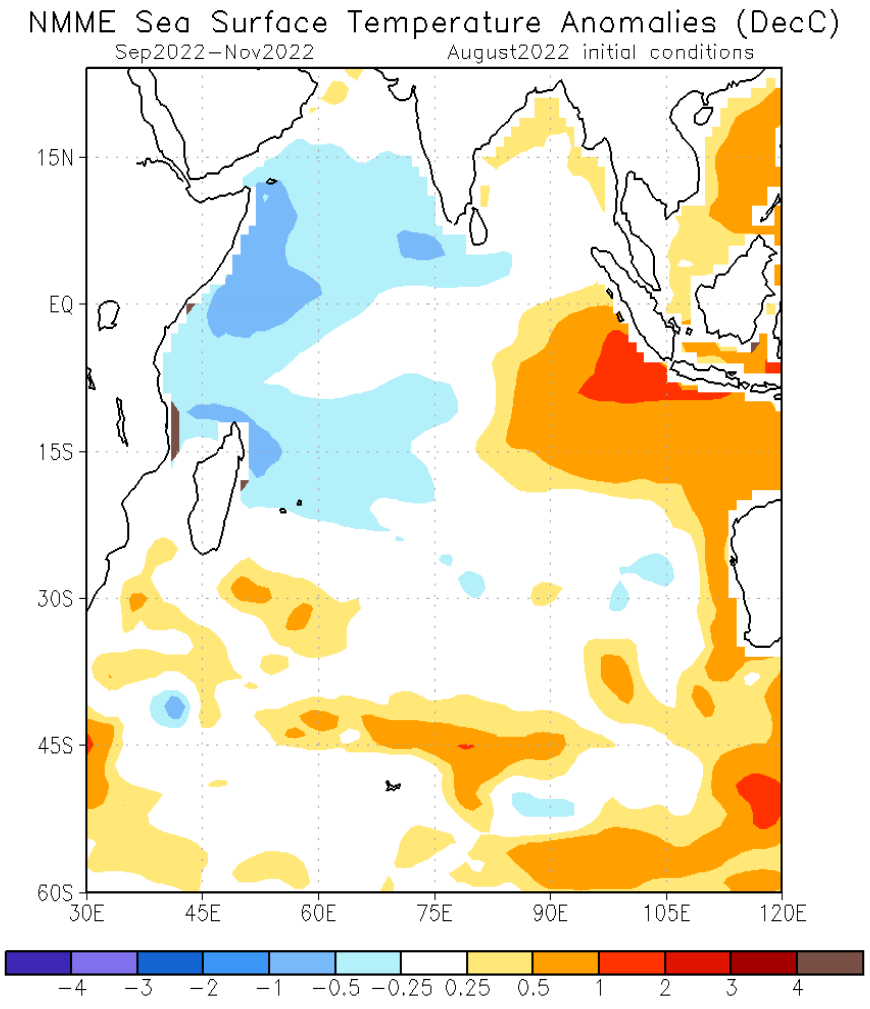


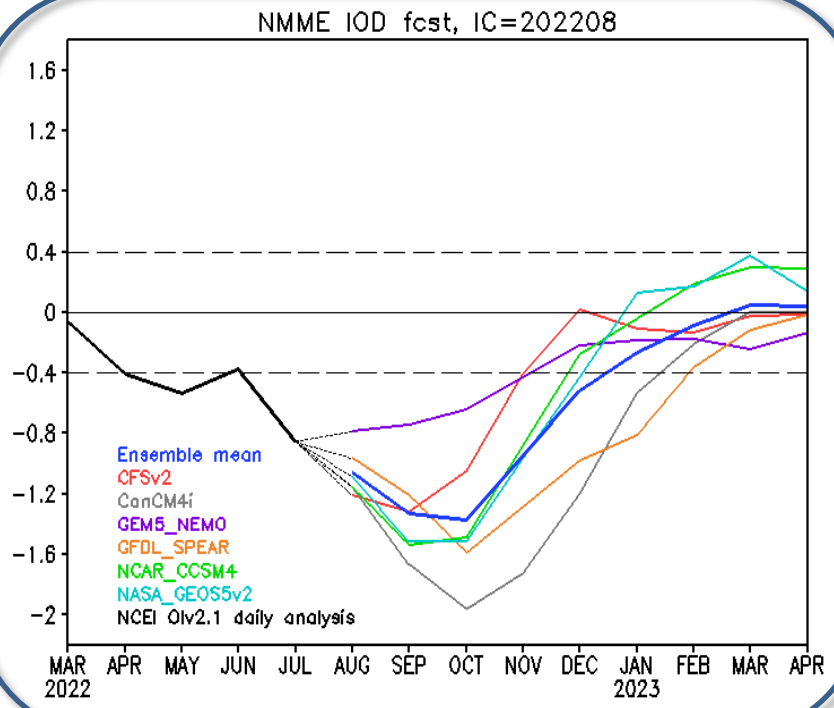
- Real time updates for
  - Climate Forecast including NMME SST spatial maps and IOD time series.
  - Ocean Monitoring Products
  - Atmospheric variables, including OLR, winds at 850mb and 200mb.

- Plots are available at
  - 7-day
  - 30-day
  - 90-day
  - Monthly
  - 3-monthly

Contact Wassila Thiaw wassila.thiaw@noaa.gov

NMME Forecasts in the Indian Ocean

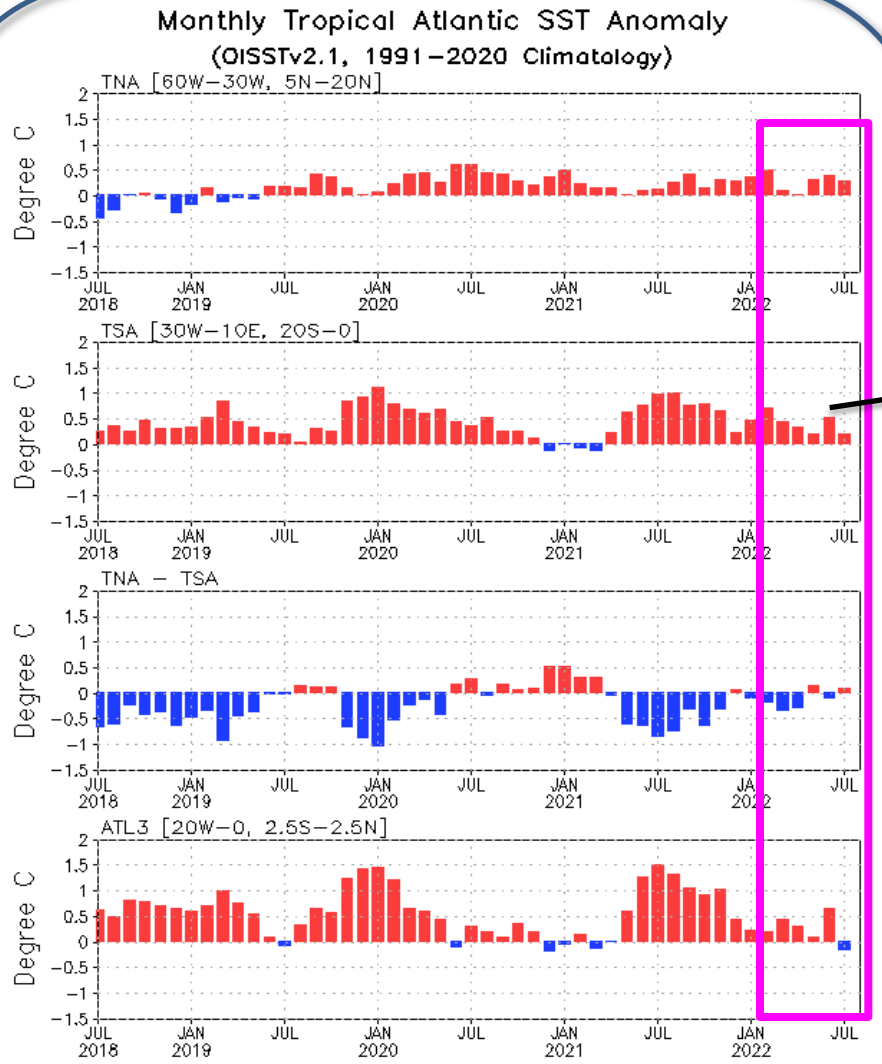


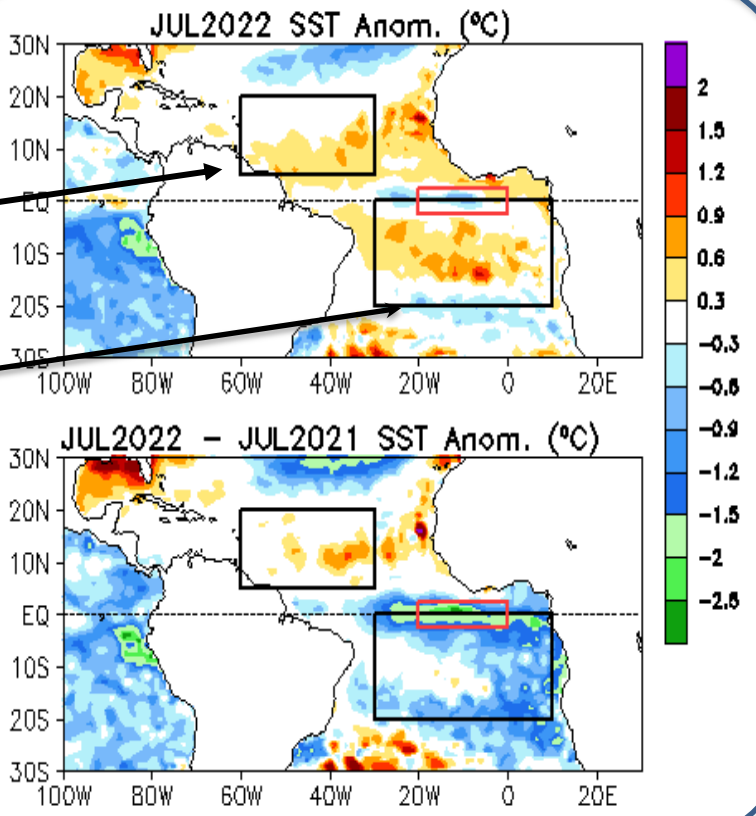


- All NMME models favor a negative IOD event during the northern hemisphere summer-fall 2022.

Tropical and North Atlantic Ocean

Evolution of Tropical Atlantic SST Indices

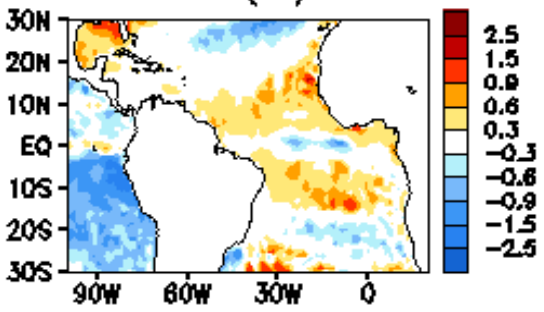


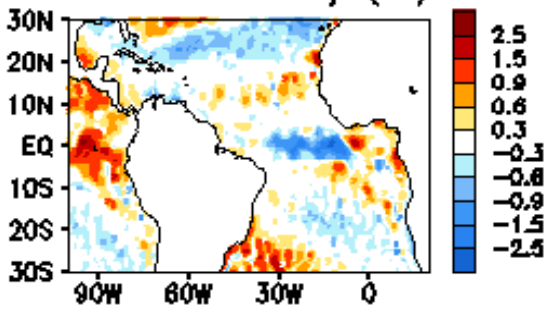


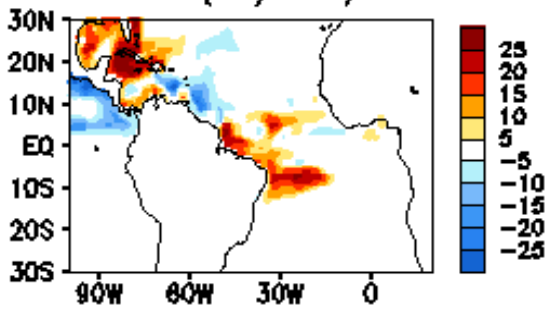
- Both TNA and TSA indices cooled down in Jul 2022.
- Positive ATL3 index switched to a negative phase in Jul 2022, with ATL3 = - 0.2°C.

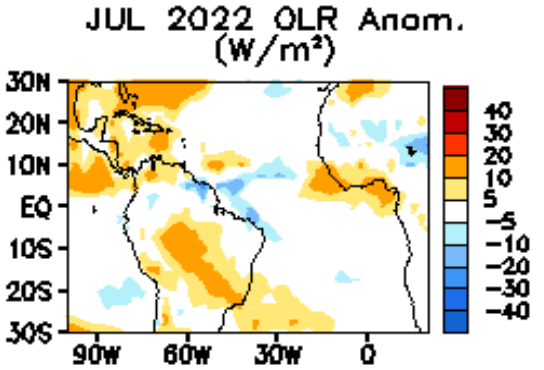
Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean SSTAs (°C) for the TNA [60°W-30°W, 5ºN-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the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

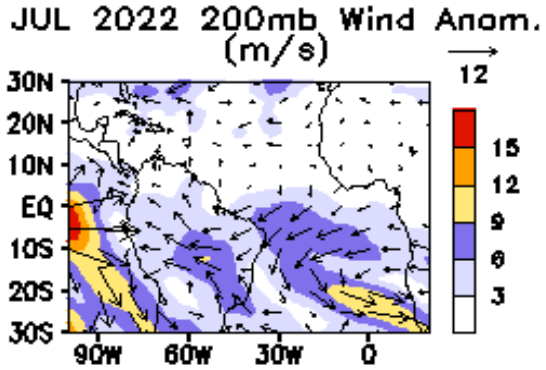
Tropical Atlantic Ocean: SSTA, SSTA Trend, TCHP,OLR,UV200,UV200-UV850, Heat Flux and RH Anomalies

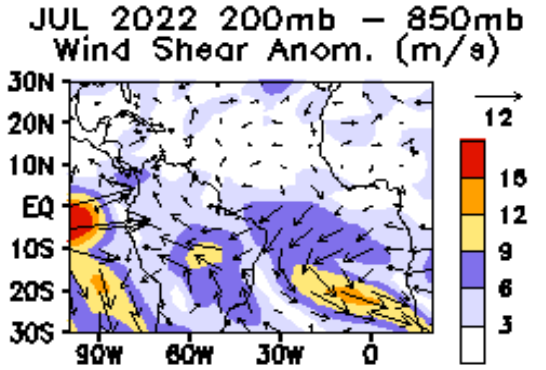


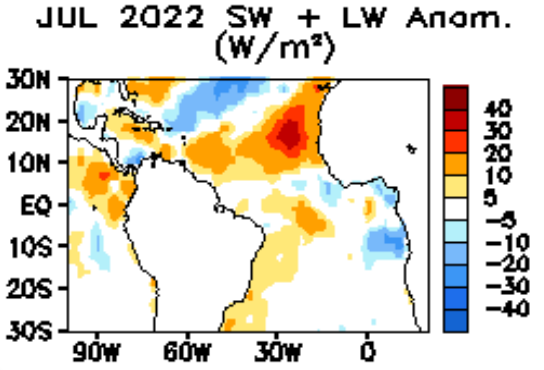


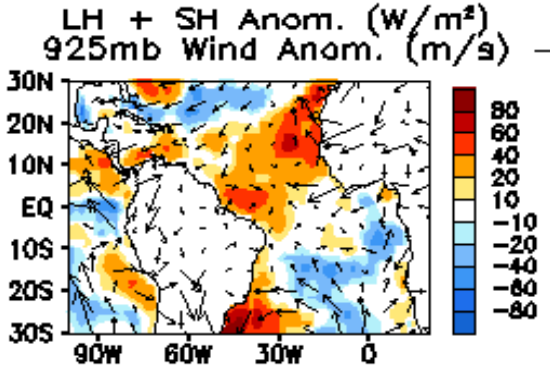


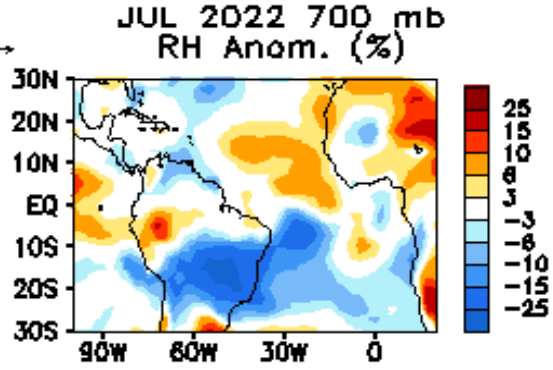




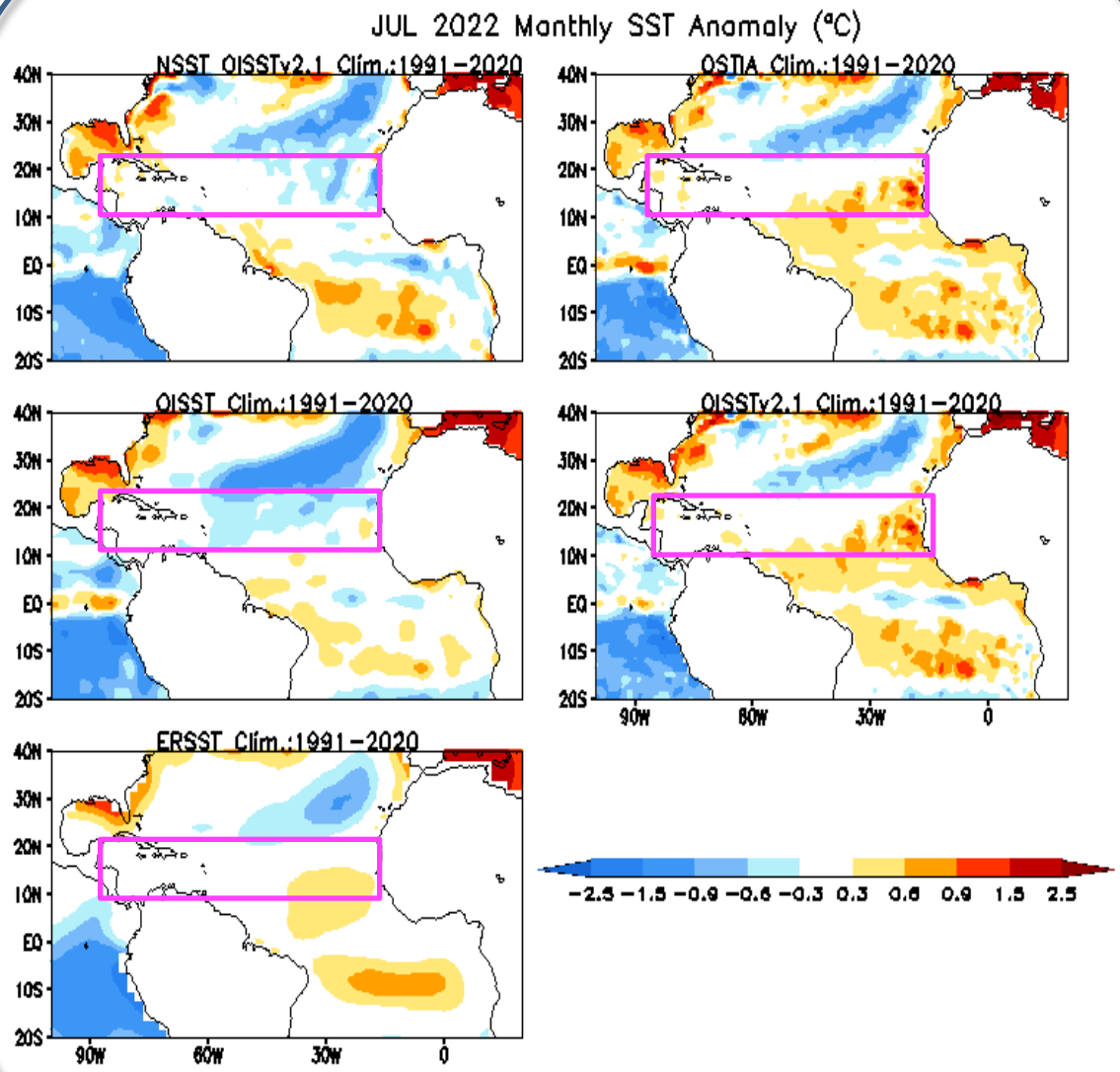








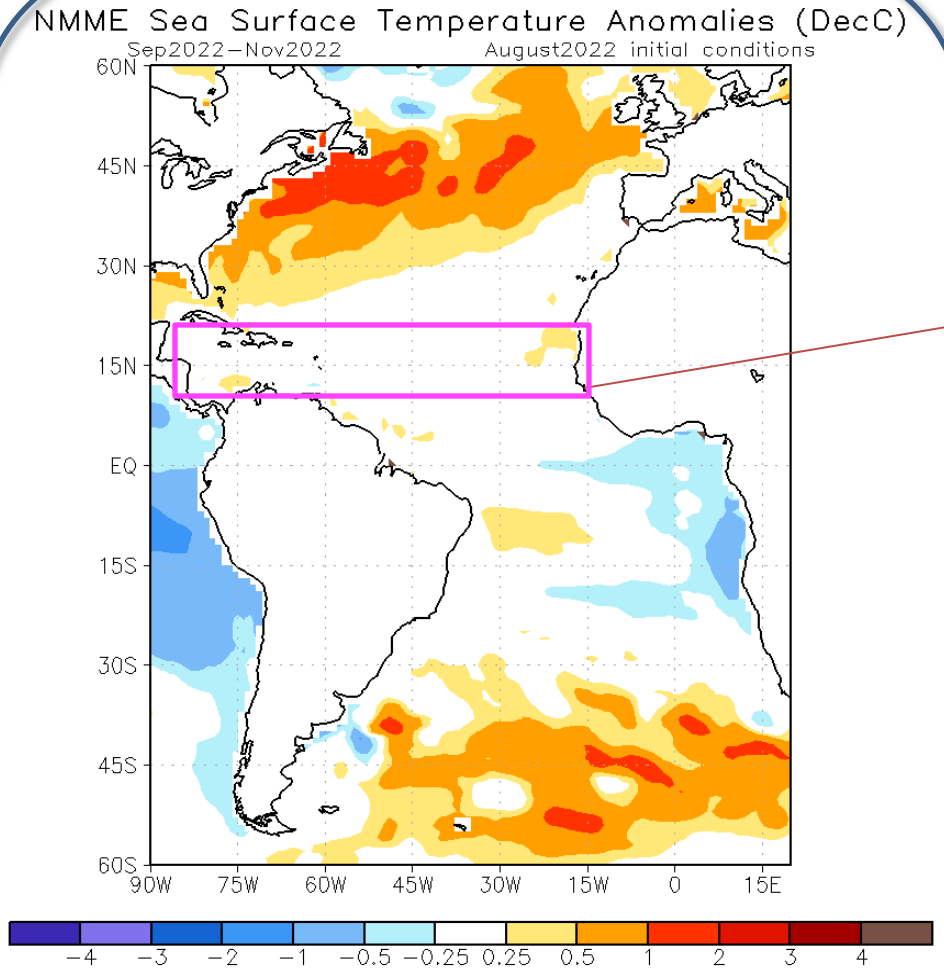
Monthly SST Anomaly in the Atlantic Ocean



- Different SST datasets display anomalies of different sign in the MDR.

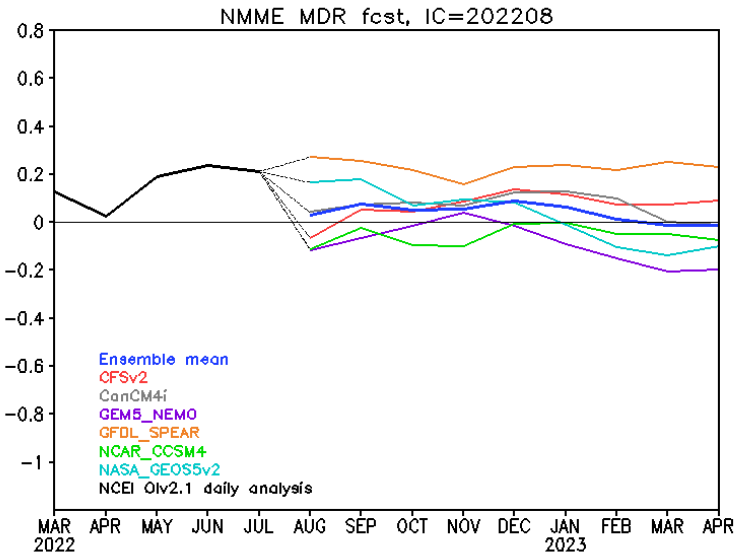
-NSST was cooler than OISST v2.1 in the northern tropical Atlantic Ocean.

NMME Forecasts in the Atlantic Ocean



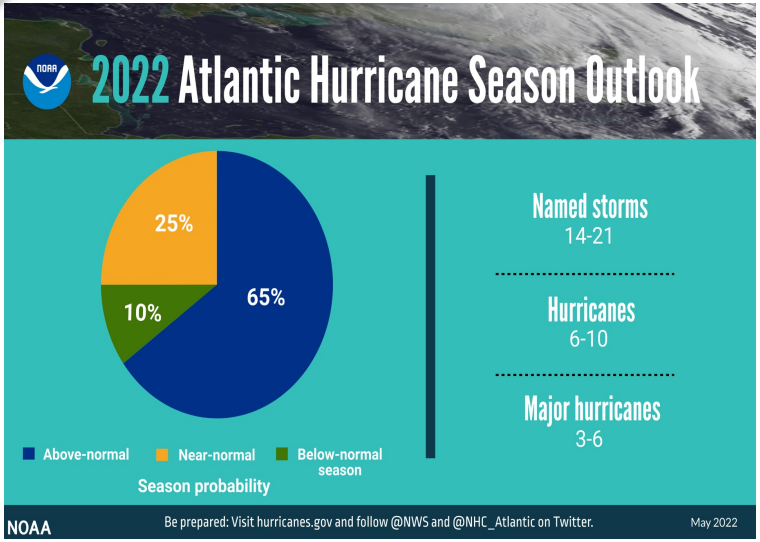
https://www.cpc.ncep.noaa.gov/products/international/index.shtml

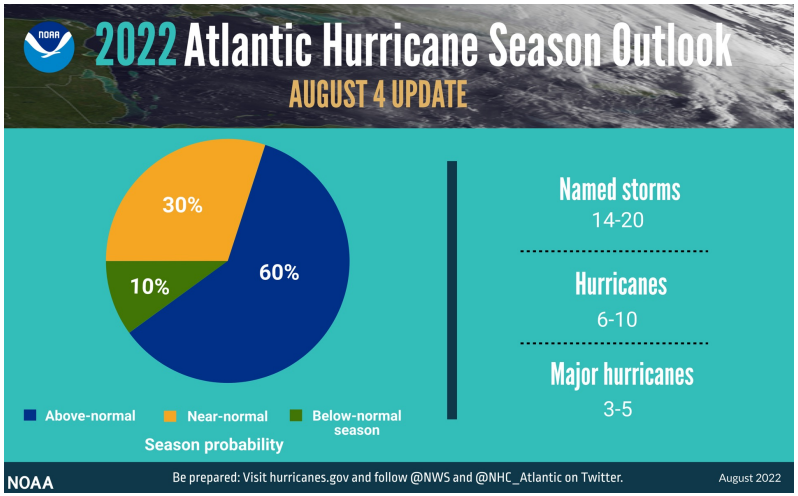
Hurricane Main Development Region
(90ºW-12ºW, 9ºN-21.5ºN)



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

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.

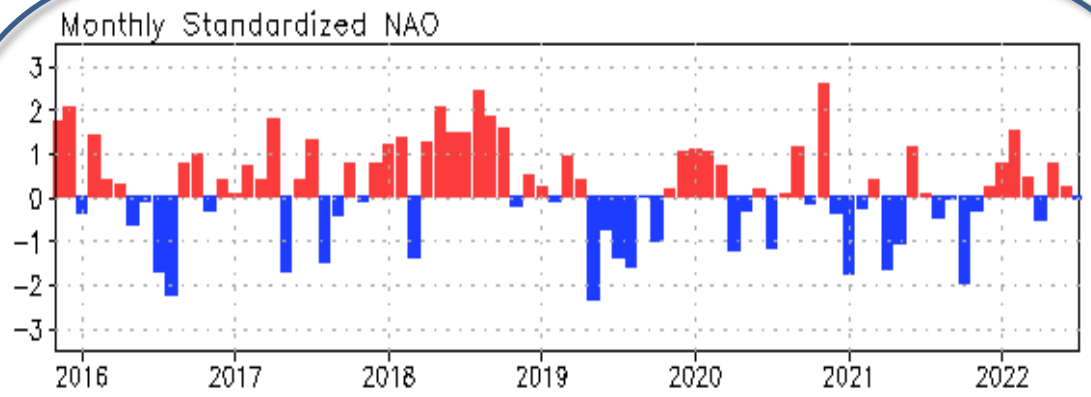
2022 Atlantic Hurricane Season Activities

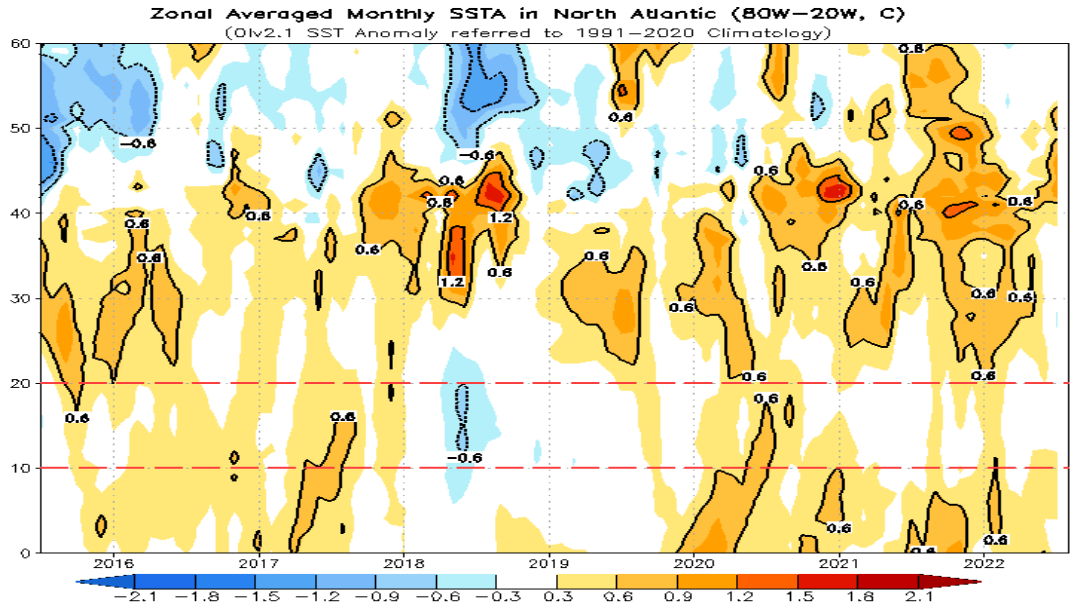
https://en.wikipedia.org/wiki/2022_Atlantic_hurricane_season

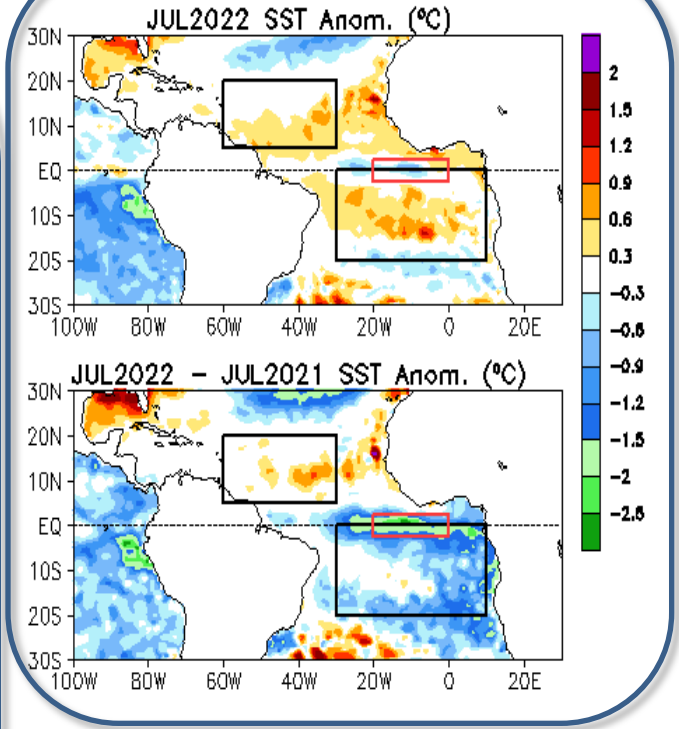
- No tropical storms developed since July 3.

-By 10 Aug 2022, three tropical storms formed.

NAO and SST Anomaly in North Atlantic







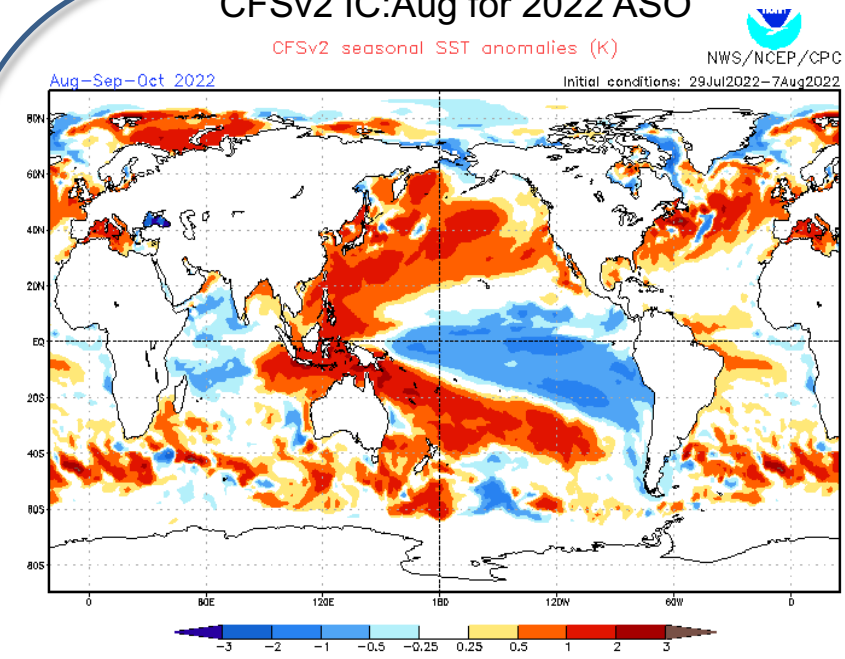
- NAO was near-normal in Jul 2022.
- The positive SSTAs in the mid-high latitudes of the North Atlantic Ocean were evident since 2021.

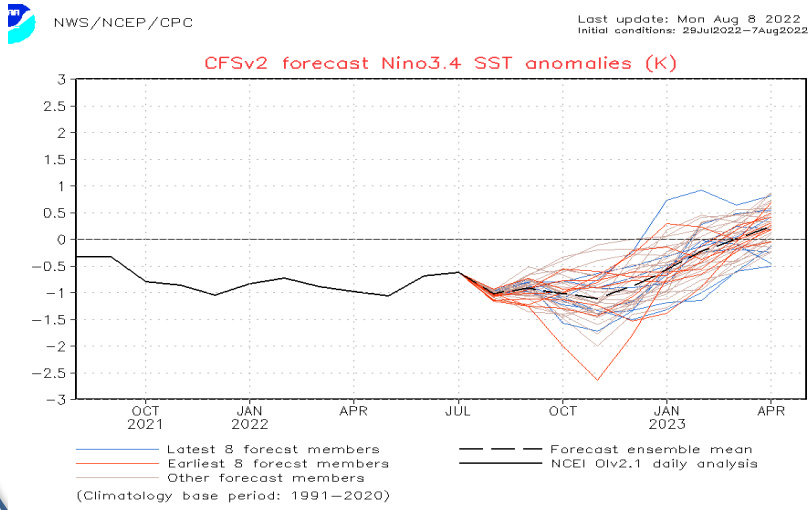
Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20°N-90°N. Time-latitude section of SSTAs averaged between 80ºW and 20ºW (bottom). SST are derived from the OIv2.1 SST analysis, and anomalies are departures from the 1991-2020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

ENSO and Global SST Predictions

CFSv2 and NMME SST predictions

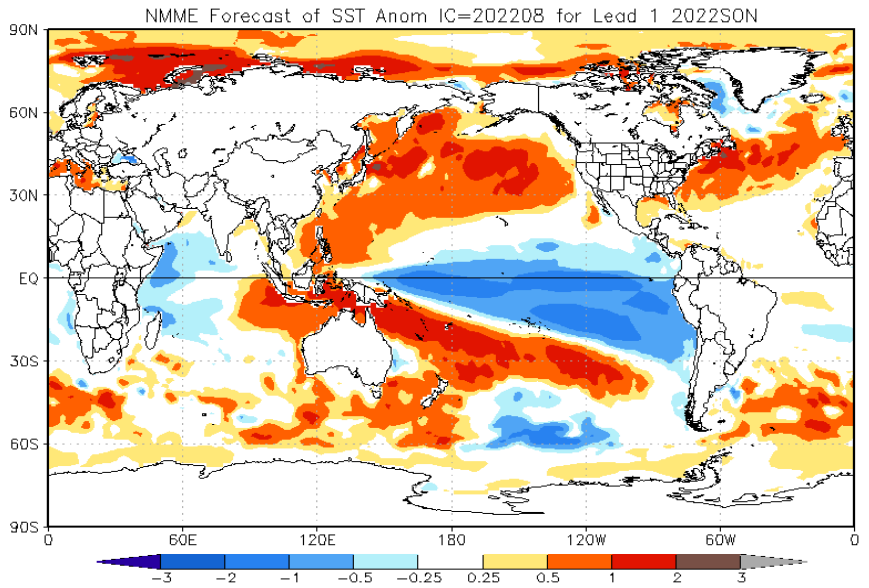
CFSv2 IC:Aug for 2022 ASO

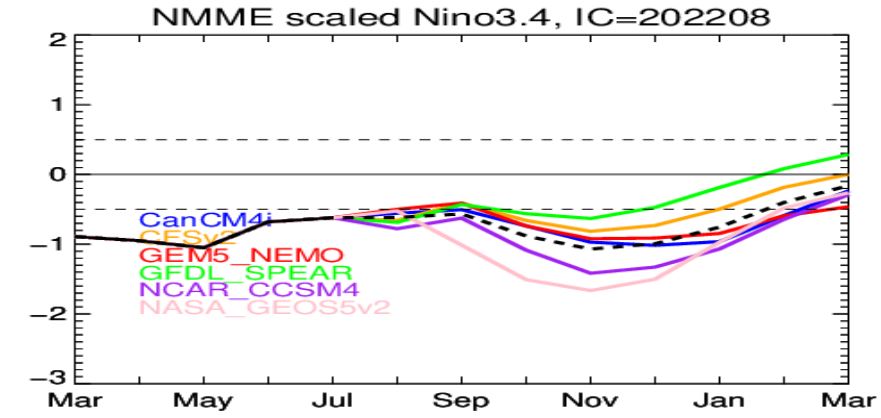




https://www.cpc.ncep.noaa.gov/products/CFSv2/CFSv2seasonal.shtml

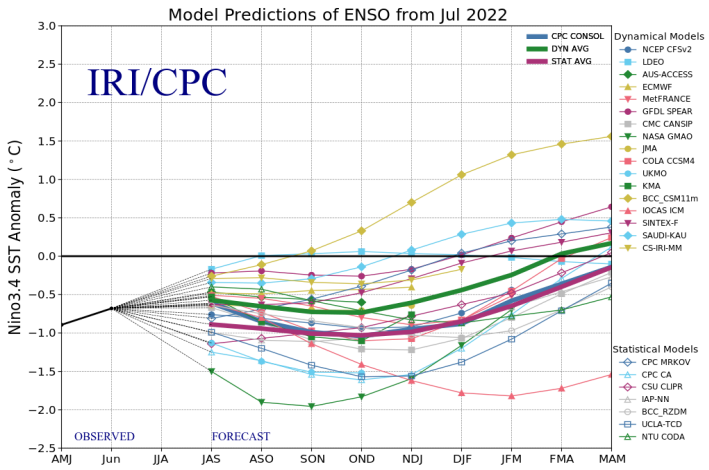
NMME IC:Aug for 2022 ASO

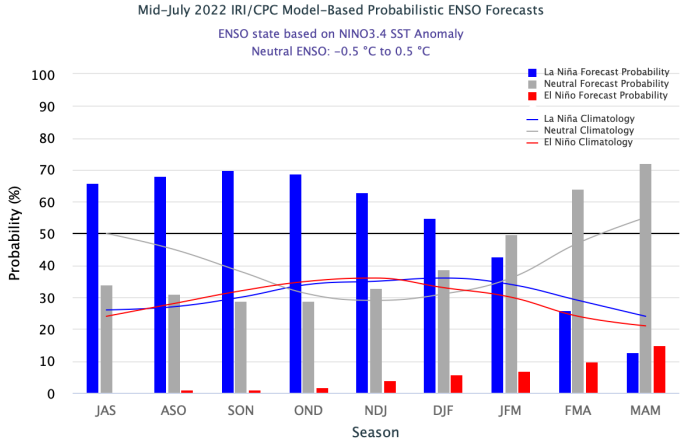




https://www.cpc.ncep.noaa.gov/products/NMME/

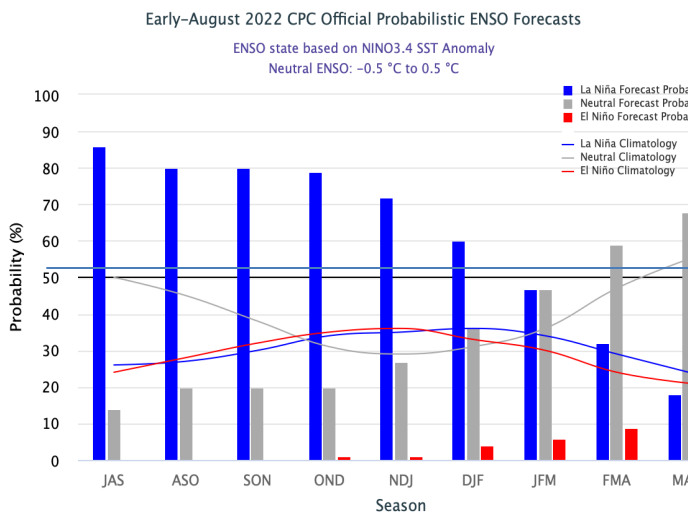
IRI/CPC Niño3.4 Forecast : July 2022





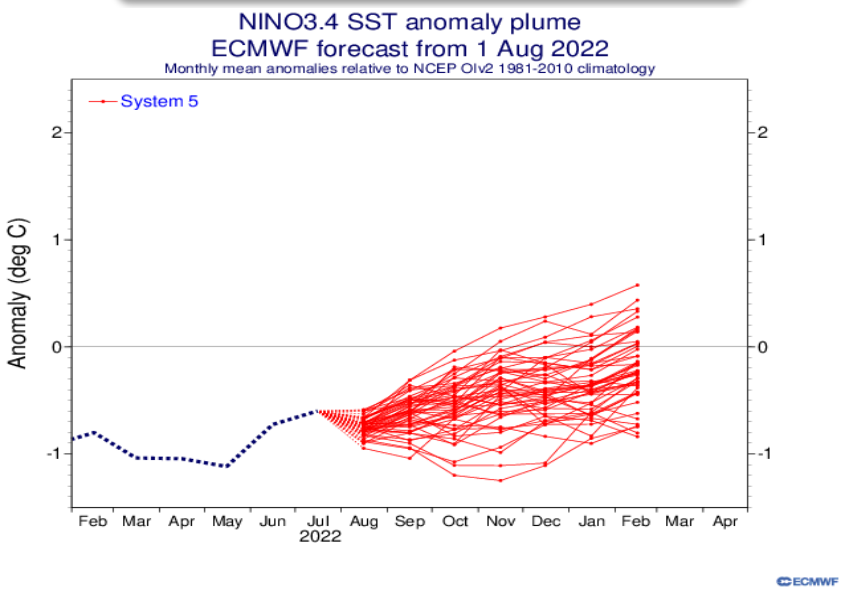
- A majority of models predict SSTs to remain below-normal at the level of a weak La Niña until early winter (Nov-Jan) with 63% likelihood.

- NOAA “ENSO Diagnostics Discussion” on 11 August stated that “La Niña is expected to continue, with chances for La Niña gradually decreasing from 86% in the coming season to 60% during December-February 2022-23 ”.

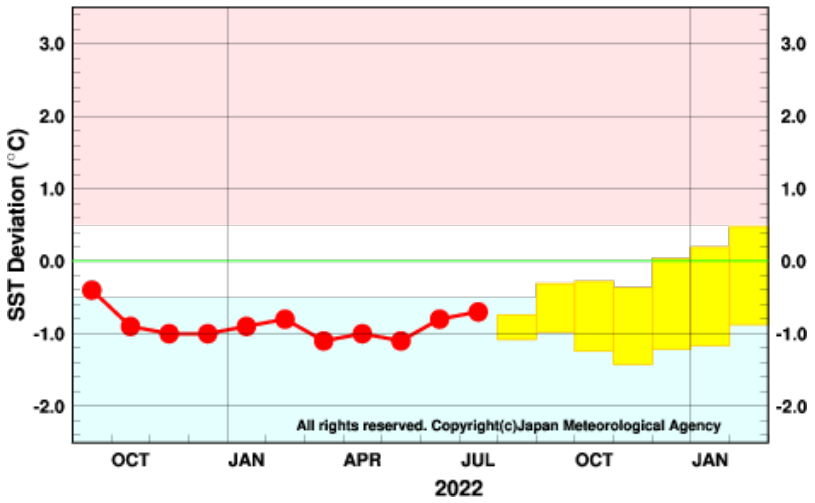


Individual Model Forecasts: ENSO neutral or borderline La Nina

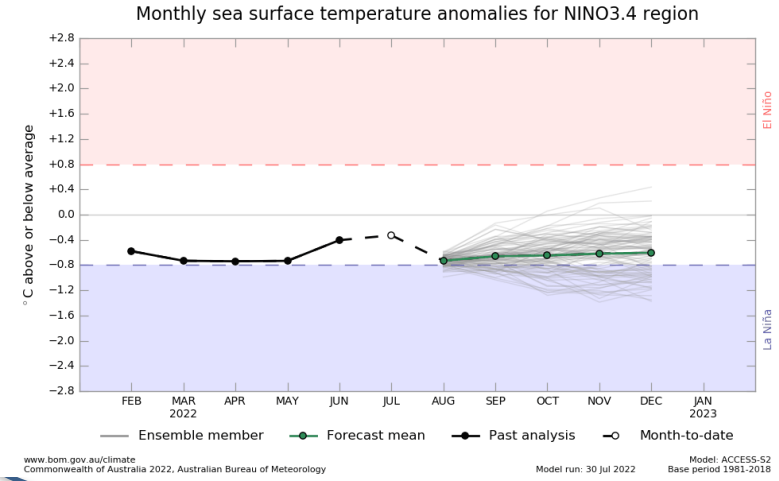
EC: IC= 1 Aug 2022



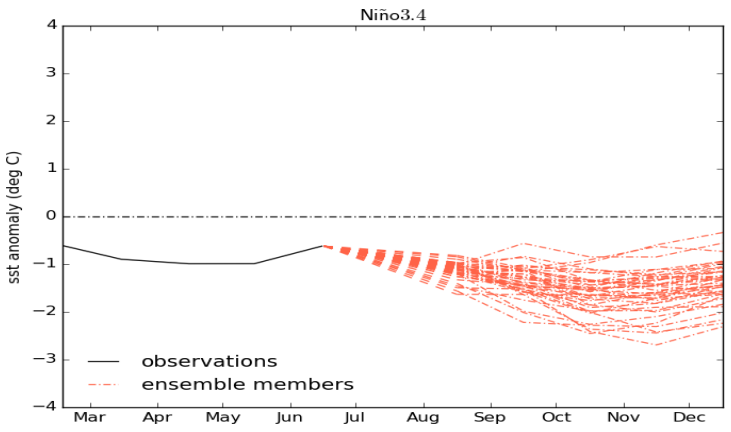
JMA: Updated 10 Aug 2022



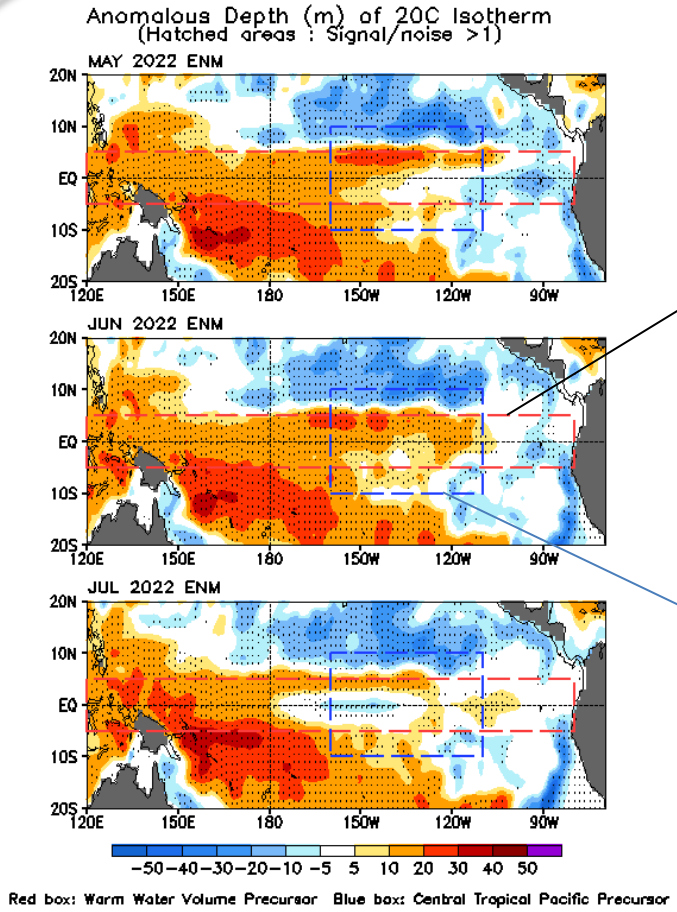
Australian BOM: Updated 30 Jul 2022

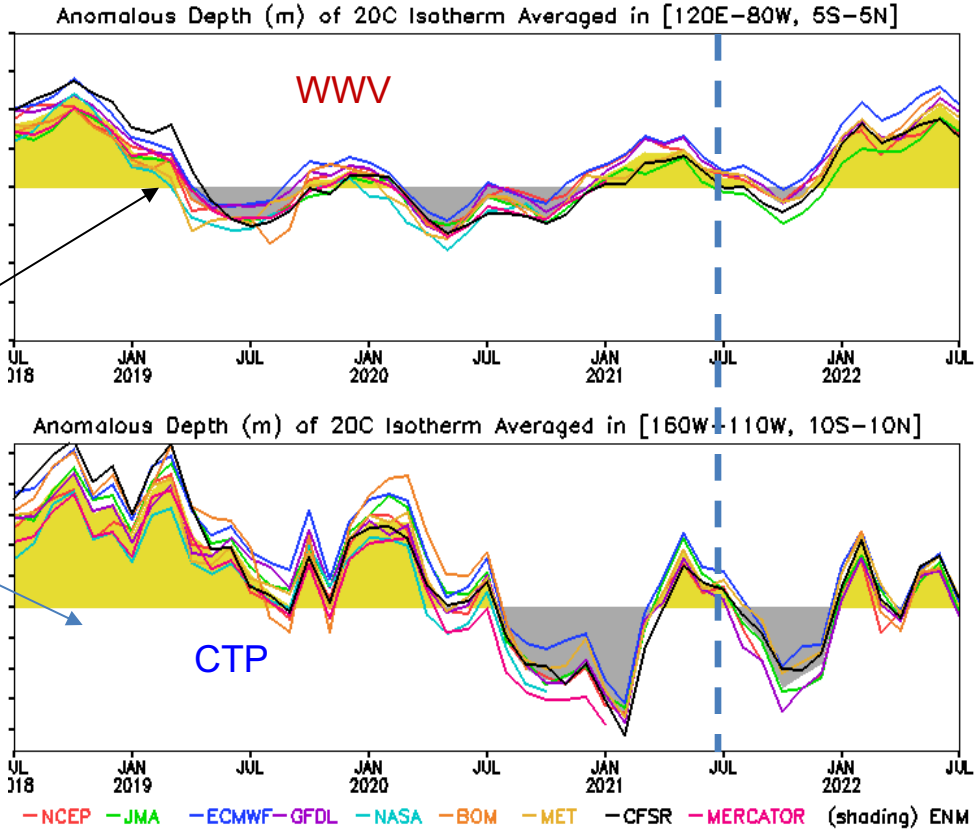


UKMO: Updated 11 Jun 2022



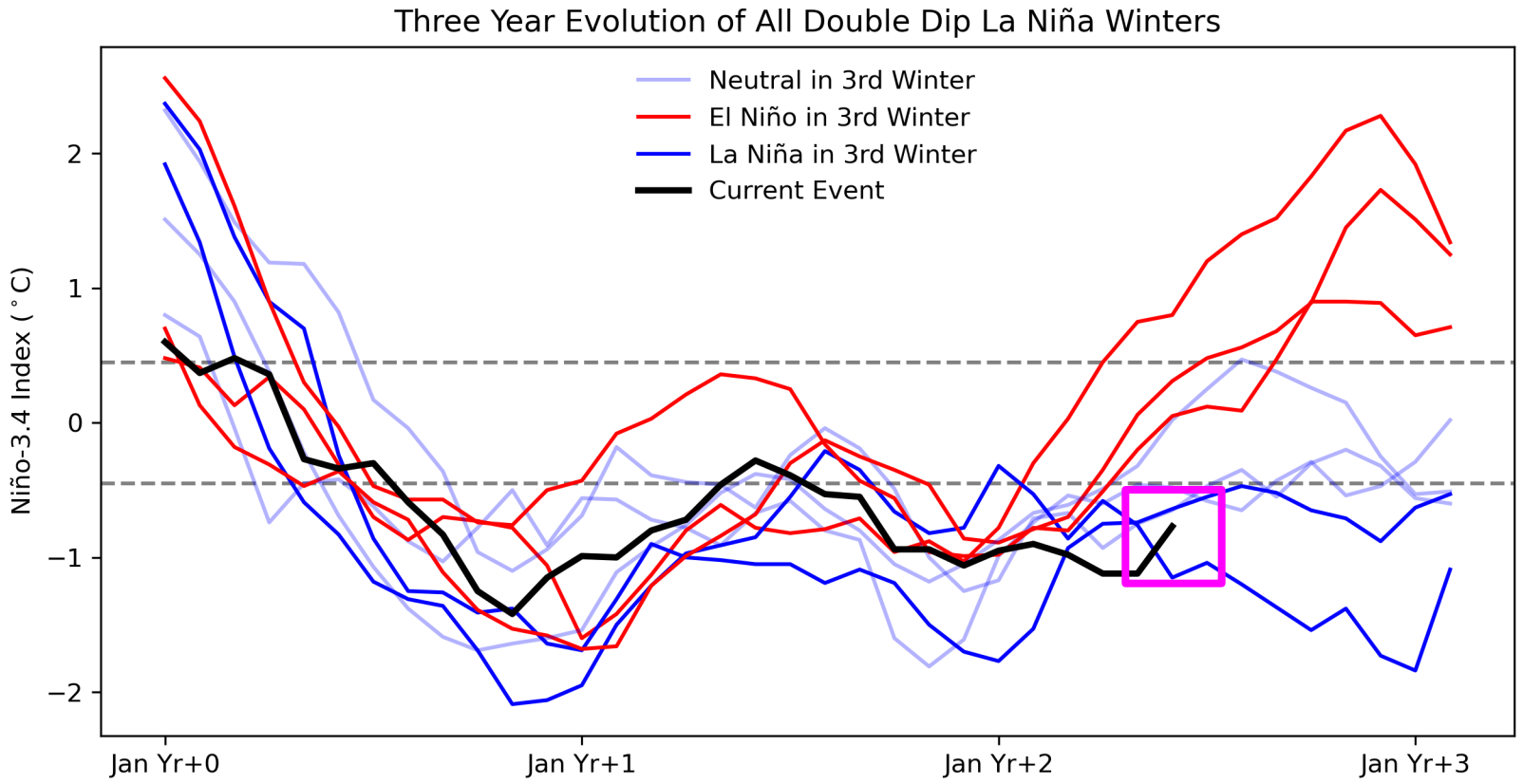
Oceanic ENSO Presursors: WWV & CTP





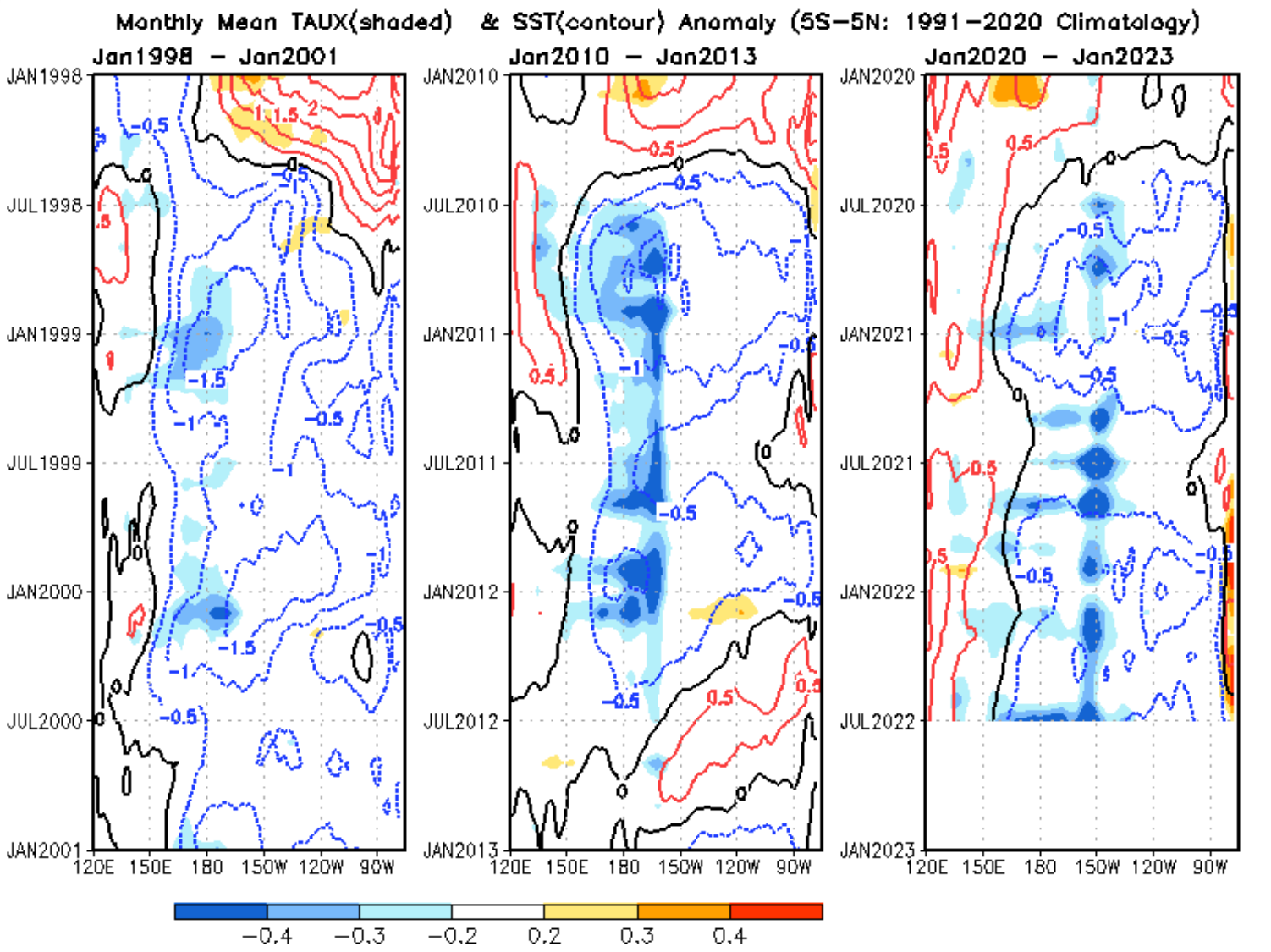
Warm water volume (WWV) is defined as an average of D20 anomaly across the equatorial Pacific (120° E – 80° W, 5° S-5° N) (Meinen and McPhaden 2000). Central tropical Pacific (CTP) index is calculated as the averaged D20 anomaly in the central tropical Pacific (160° W-110° W, 10° S-10° N) (Wen et al. 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).

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



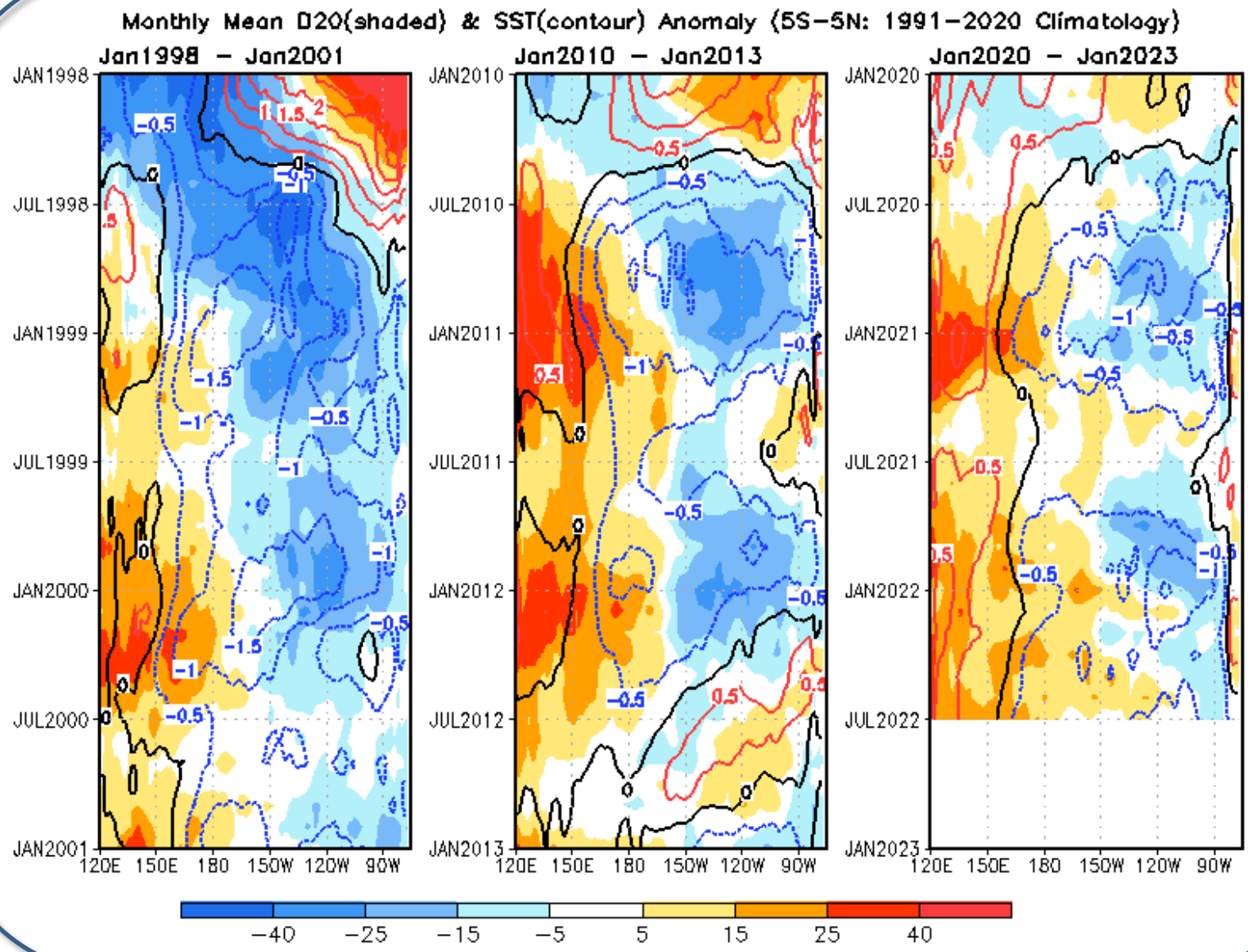
Three-year history of sea surface temperatures in the Niño-3.4 region of the tropical Pacific for 8 previous double-dip La Niña events. The color of the line indicates the state of ENSO for the third winter (red: El Niño, darker blue: La Niña, lighter blue: neutral). The black line shows the current event. Monthly Niño-3.4 index is from CPC using ERSSTv5.

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



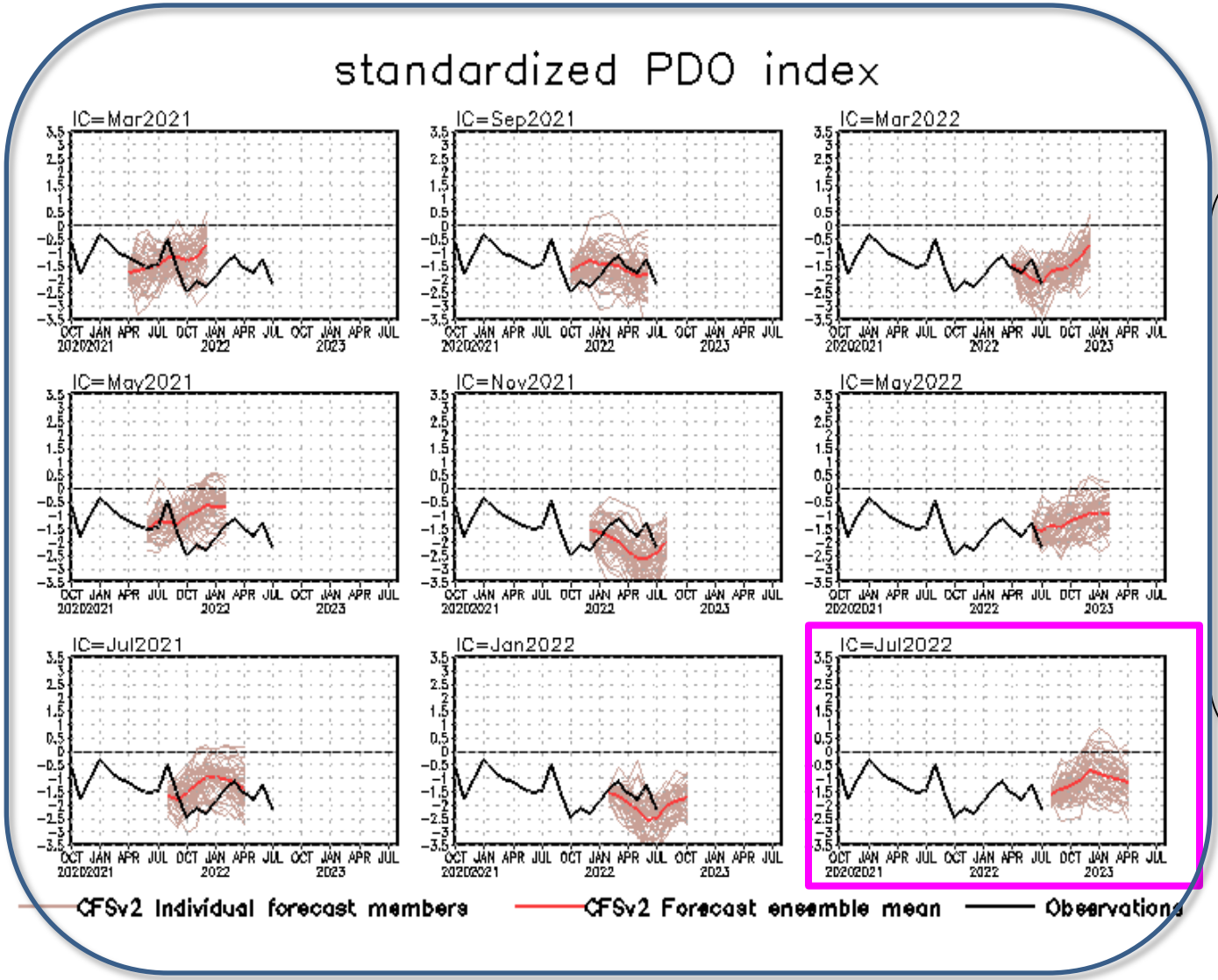
Data source: NCEP R2 reanalysis

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



Data source: NCEP R2 reanalysis

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



- Latest CFSv2 predicts the negative phase of PDO will continue through northern hemisphere Spring 2023.

CFS Pacific Decadal Oscillation (PDO) index predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1991-2020 base period means. PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [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.

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

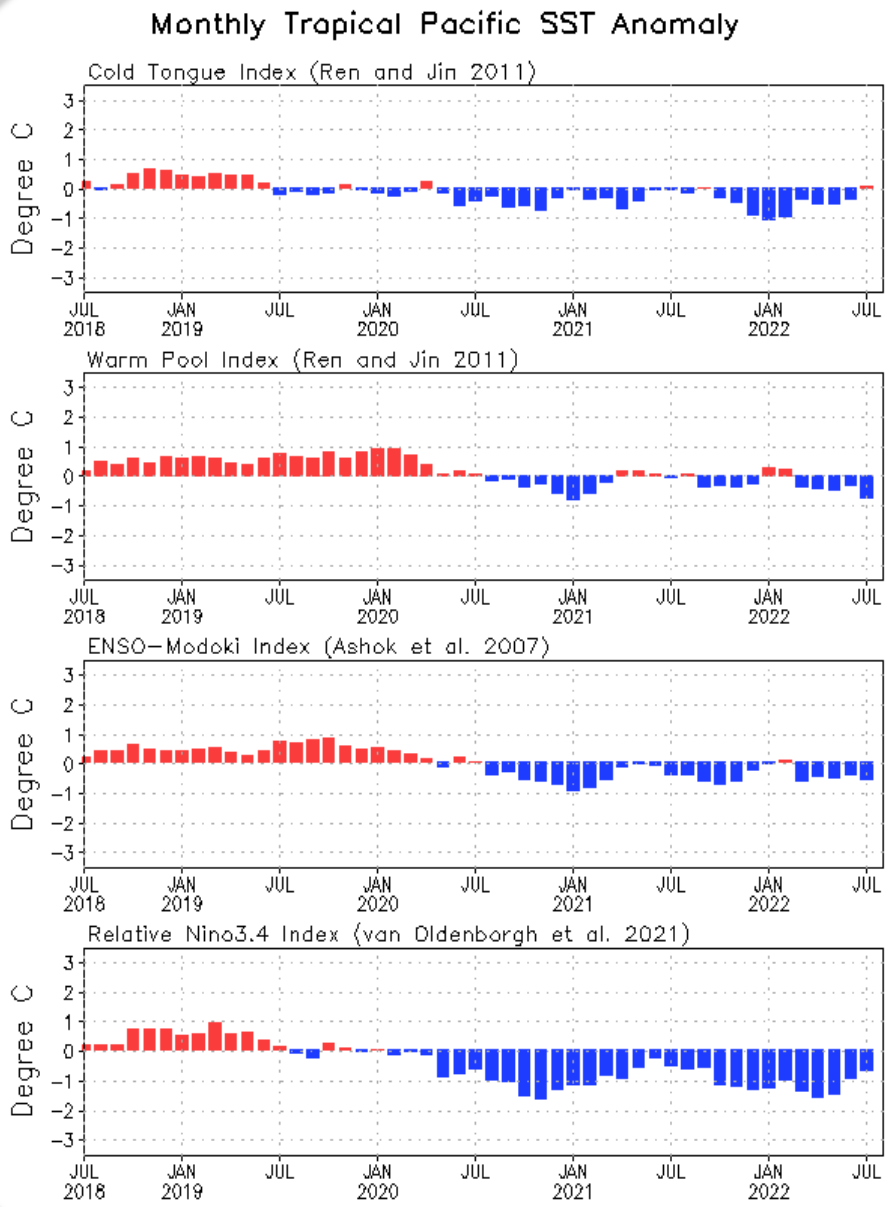
- Drs. Arun Kumar, Zeng-Zhen Hu and Jieshun Zhu : reviewed PPT, and provide insightful suggestions and comments
- Dr. Pingping Xie provided the BASS/CMORPH/CFSR EVAP package
- Dr. Wanqiu Wang provides the sea ice forecasts and maintains the CFSv2 forecast archive

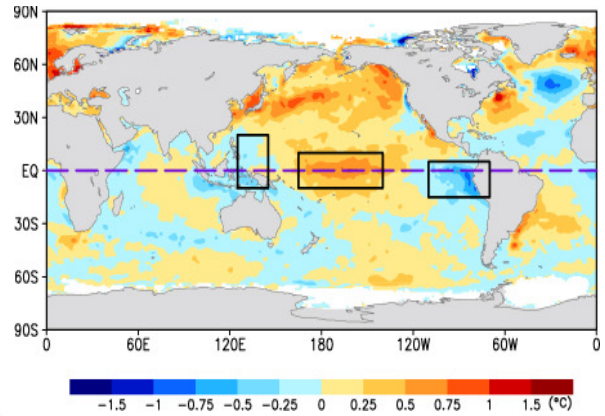
Please send your comments and suggestions to:

Arun.Kumar@noaa.gov
Jieshun.Zhu@noaa.gov
Caihong.Wen@noaa.gov
Zeng-Zhen.Hu@noaa.gov

Backup Slides

Evolution of Pacific Niño SST Indices



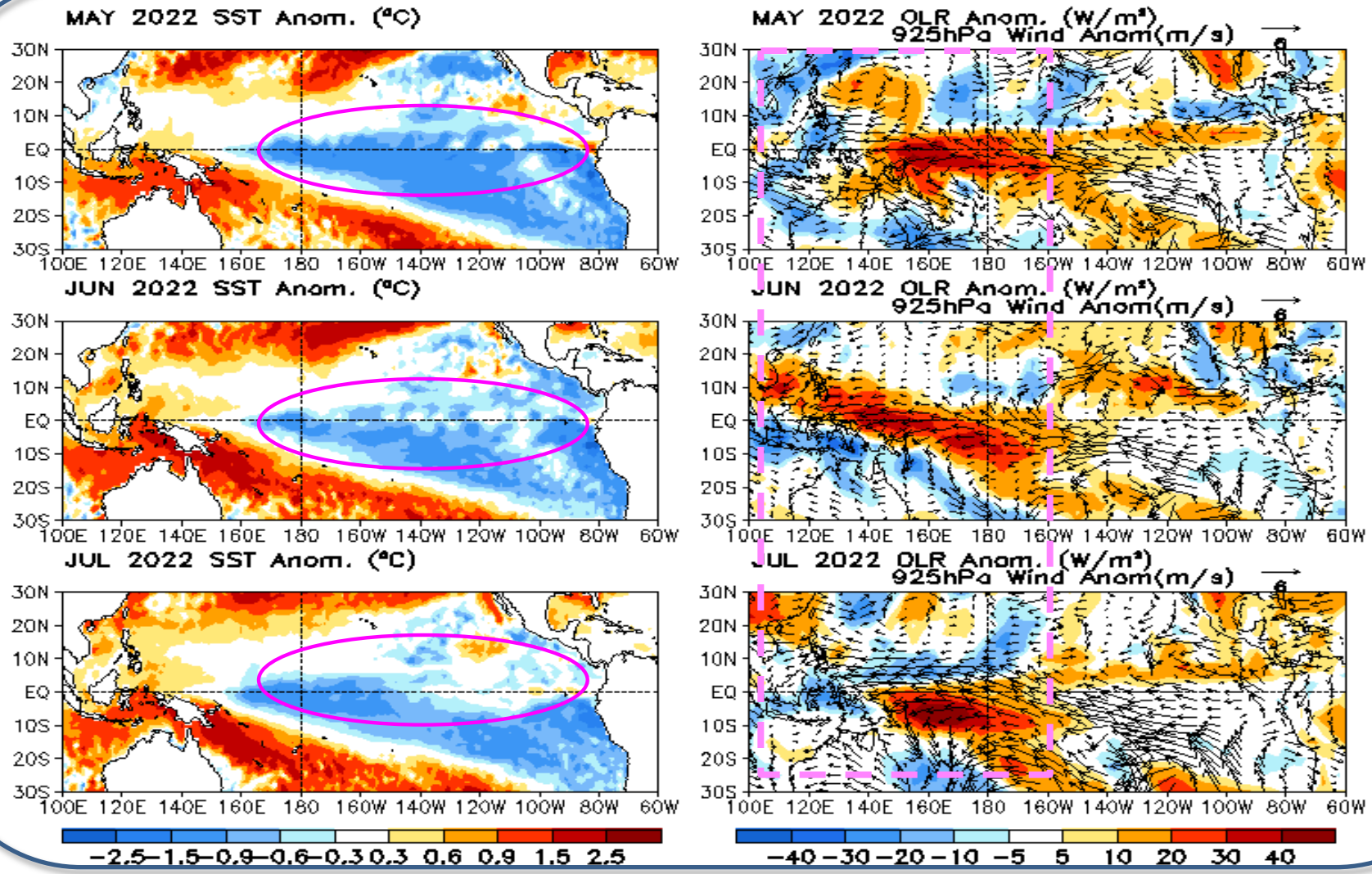


- Relative Niño3.4 index is defined as the conventional Niño3.4 index minus the SSTA averaged in the whole tropics (0º-360º, 20ºS-20ºN), in order to remove the global warming signal. Also, to have the same variability as the conventional Niño3.4 index, the relative Niño3.4 index is renormalized (van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

Relative Niño3.4 data updated monthly at:

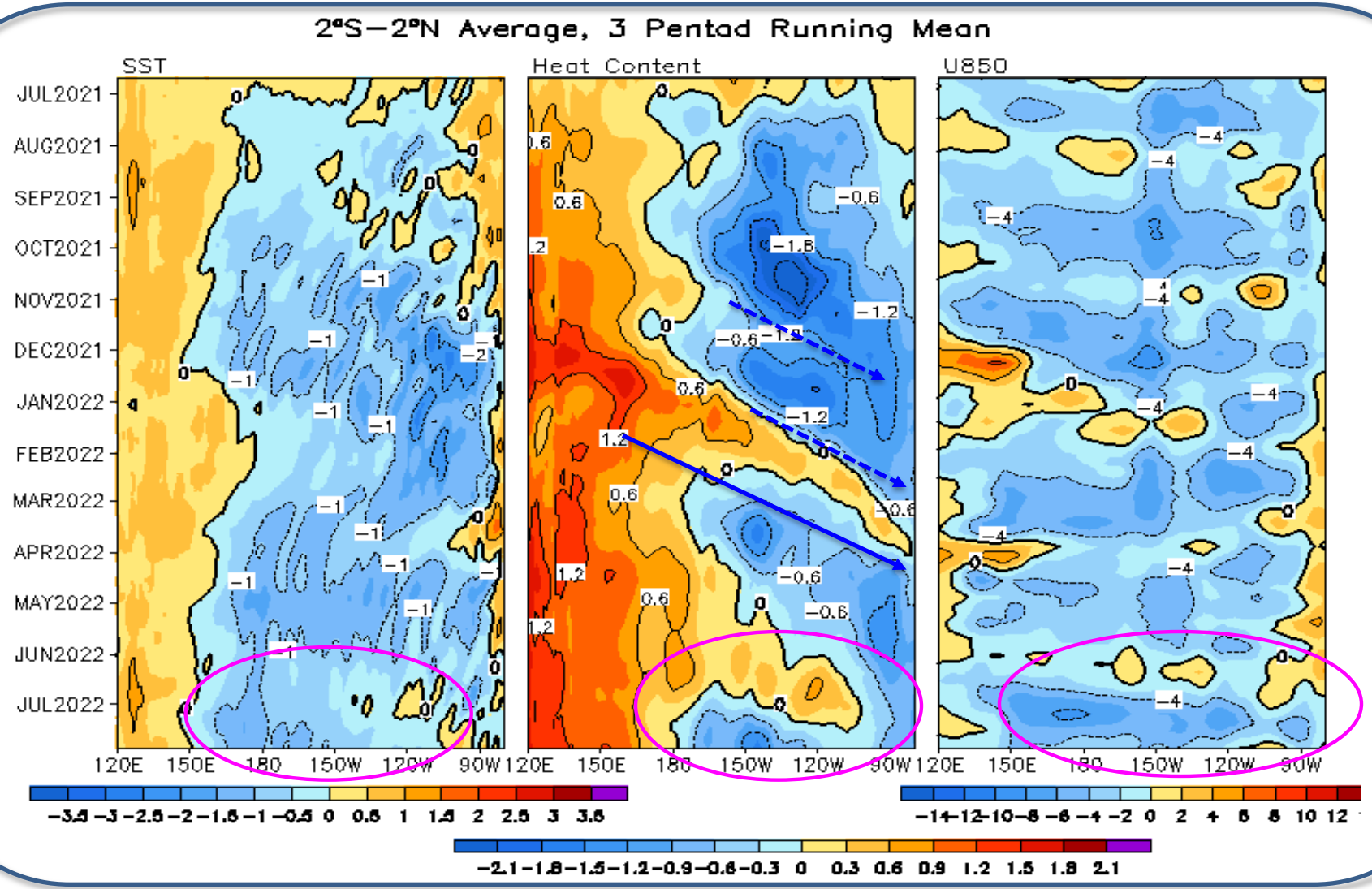
https://www.cpc.ncep.noaa.gov/data/indices/RONI.ascii.txt

Last three months SST, OLR and uv925 anomalies



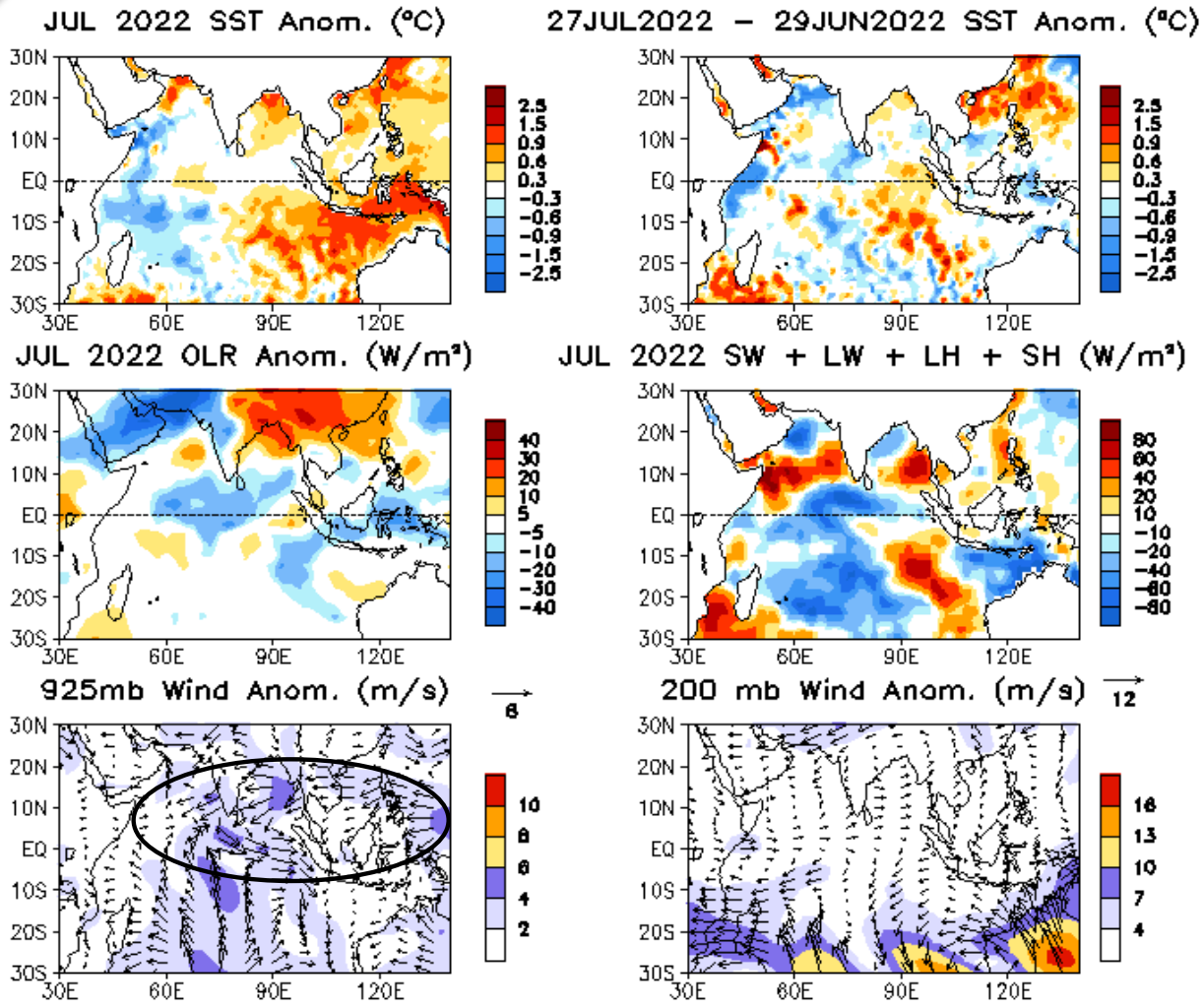
SSTAs (top-left), SSTA tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right; positive means heat into the ocean), 925-mb wind anomaly vector and its amplitude (bottom-left),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

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



- Negative SSTA weakened in the eastern Pacific , while enhanced in the western-central Pacific in Jul 2022.
- Strong easterly surface wind prevailed in the western-central Pacific in July, consistent with the negative H300 anomaly re-emergence in the central-eastern Pacific Ocean.

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

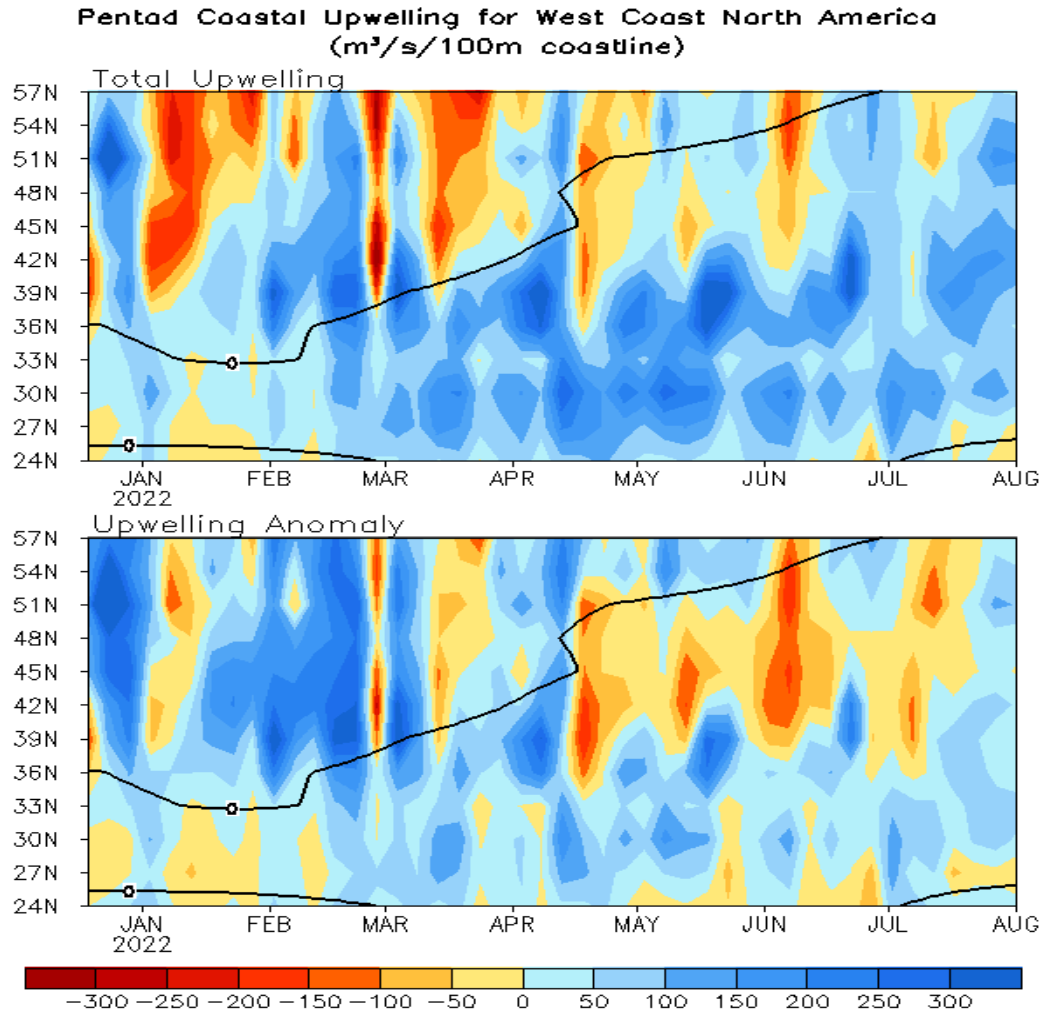


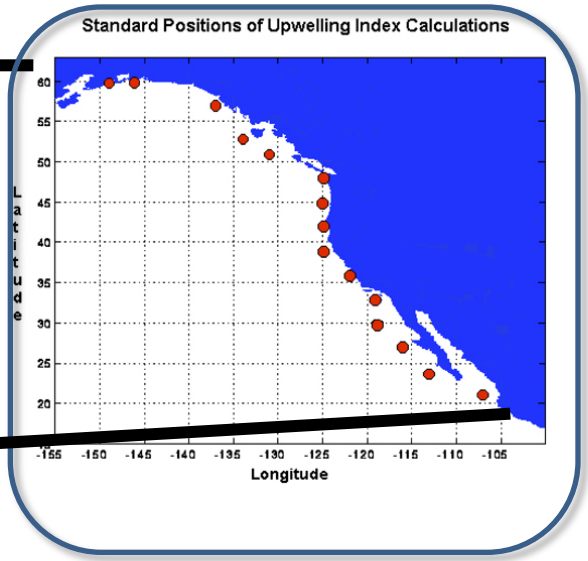
- Westerly wind anomaly prevailed over the eastern Indian Ocean, favoring further warming in the southeastern Indian Ocean.

- 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.

North America Western Coastal Upwelling

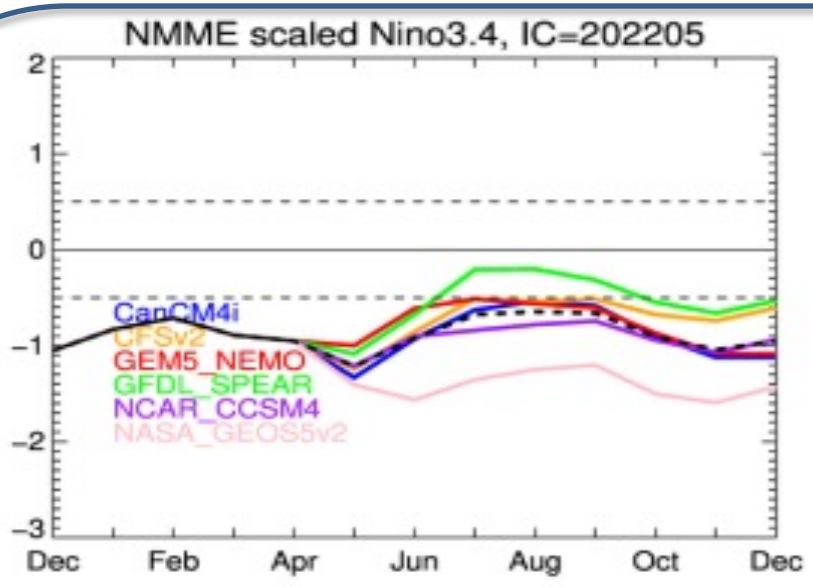


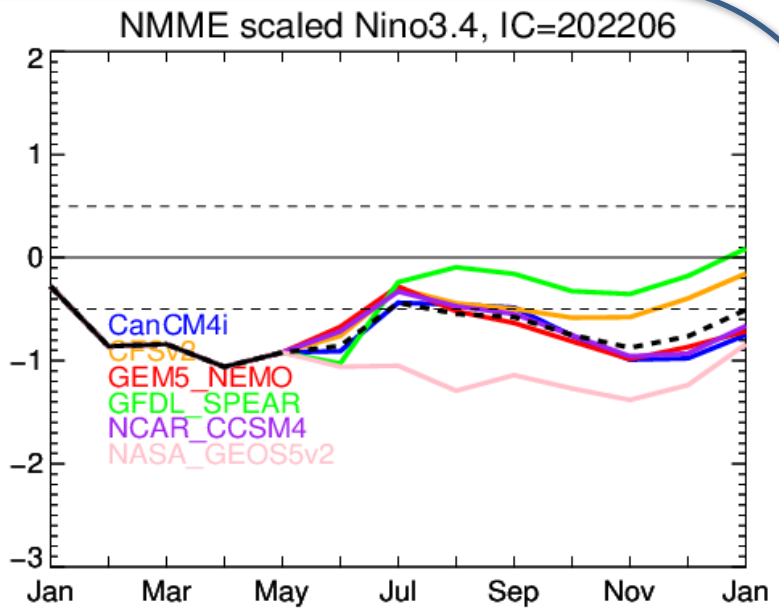


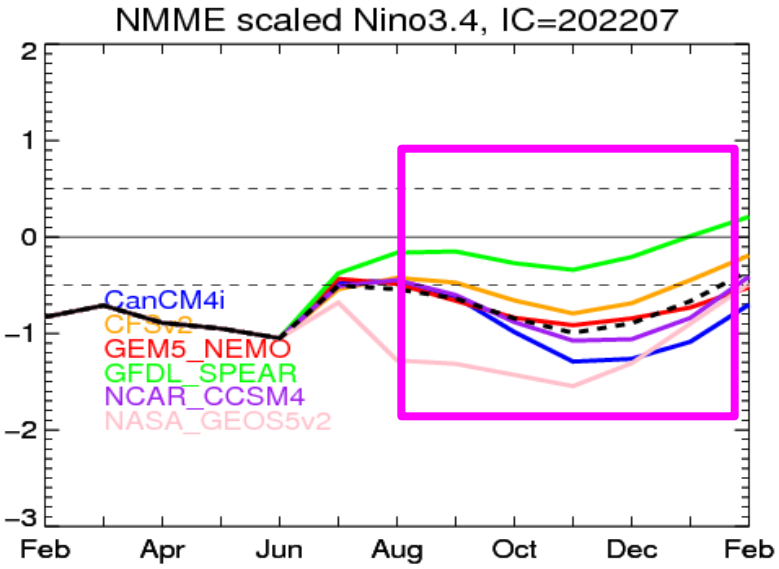
- Both anomalous coastal downwelling and upwelling were observed since mid-Apr 2022.

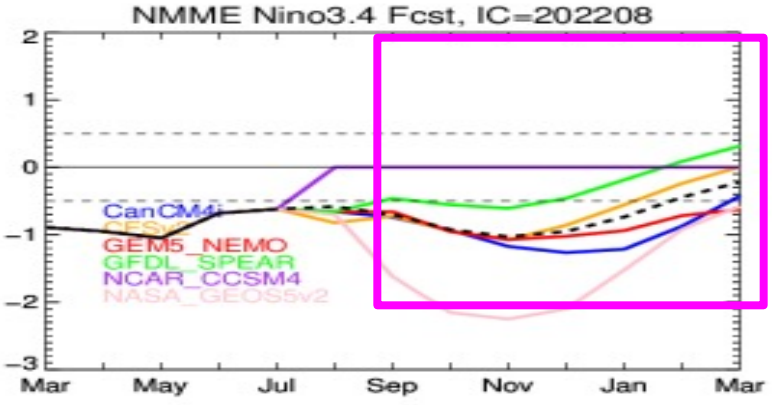
(top) Total and (bottom) anomalous upwelling indices at the 15 standard locations for the western coast of North America. Derived from the vertical velocity of the NCEP's GODAS and are calculated as integrated vertical volume transport at 50-meter depth from each location to its nearest coast point ($m^3/s/100m$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

NMME forecasts from different initial conditions





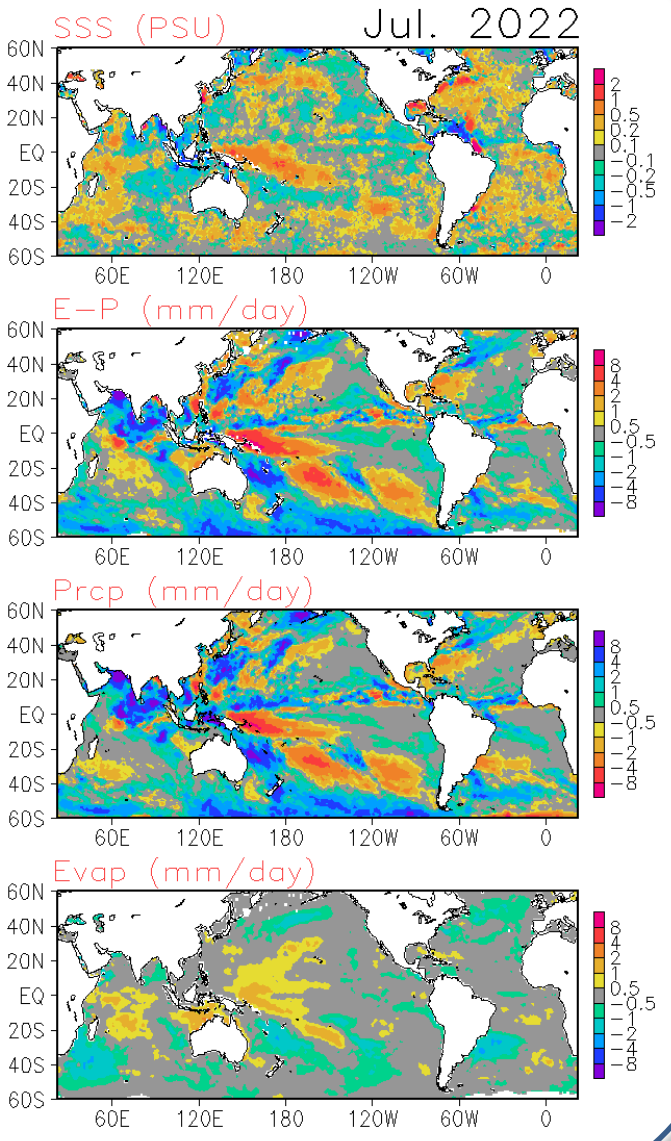




Global Sea Surface Salinity (SSS): Anomaly for July 2022

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

Large-scale SSS anomaly patterns remains similar to those of the previous month. Positive SSS anomaly over the equatorial Pacific is intensified compared to that during the previous month. Freshen SSS anomaly over the Caribbean sea and the central Atlantic is enhanced, while the saltier anomaly over the western Indian ocean off the east Africa coasts and over the northwestern Pacific also becomes stronger, all of which largely attributable to the fresh water flux anomalies over the regions.



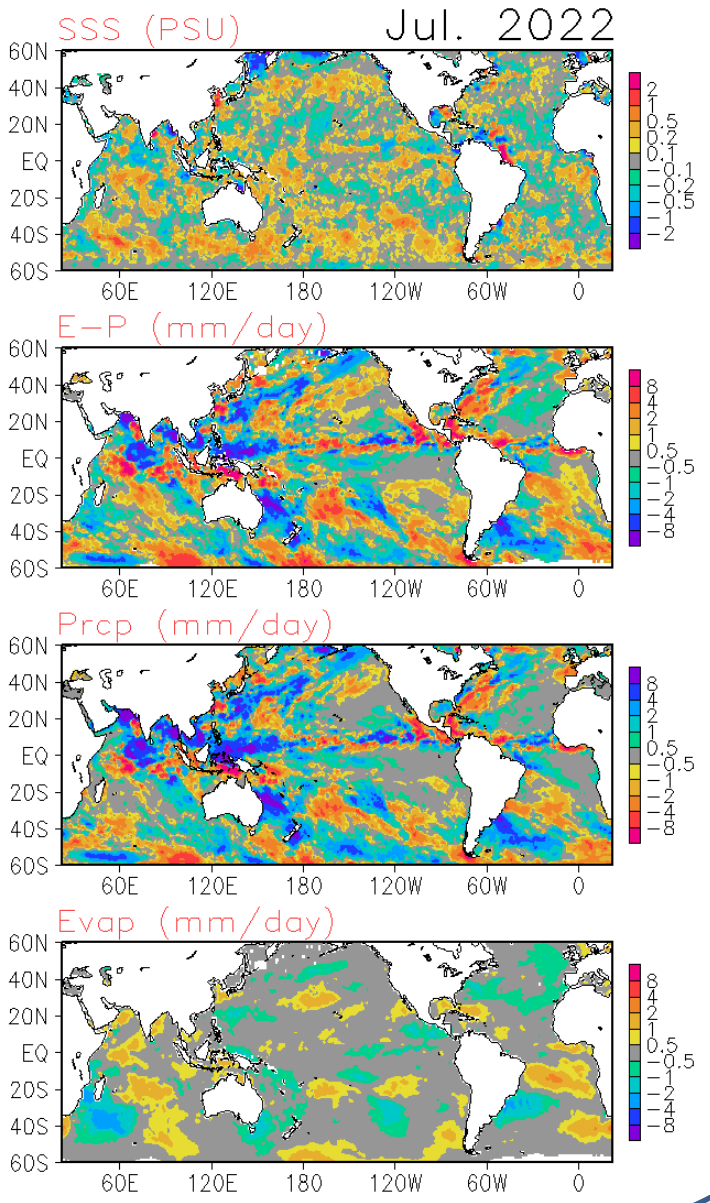
SSS : Blended Analysis of Surface Salinity (BASS) V0.Z
(a CPC-NESDIS/NODC-NESDIS/STAR joint effort)
ftp.cpc.ncep.noaa.gov/precip/BASS

Precipitation: CMORPH adjusted satellite precipitation estimates

Evaporation: Adjusted CFS Reanalysis

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

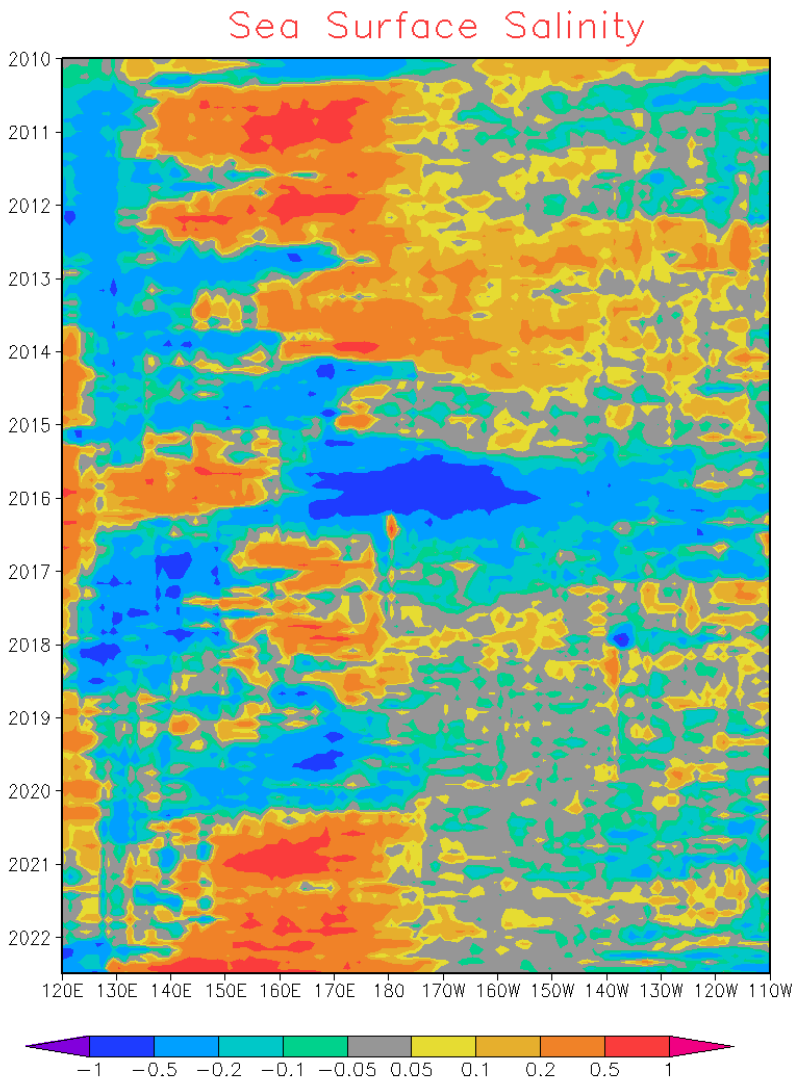
Despite the enhanced fresh water flux anomaly tendency over the equatorial western Pacific and the SW Pacific ocean off the east coasts of Australia, soldier SSS anomaly is enhanced slightly over the month. Zonally-oriented negative / positive SSS belts are observed over the equatorial central and eastern Pacific, a reflection of the northward shift of a slightly enhanced ITCZ.



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 and enhanced slightly over the central / western equatorial Pacific between 140°E and 170°W. Negative SSS anomaly 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.