Large scale circulation associated with monsoon rainfall patterns and oceanic features 2024

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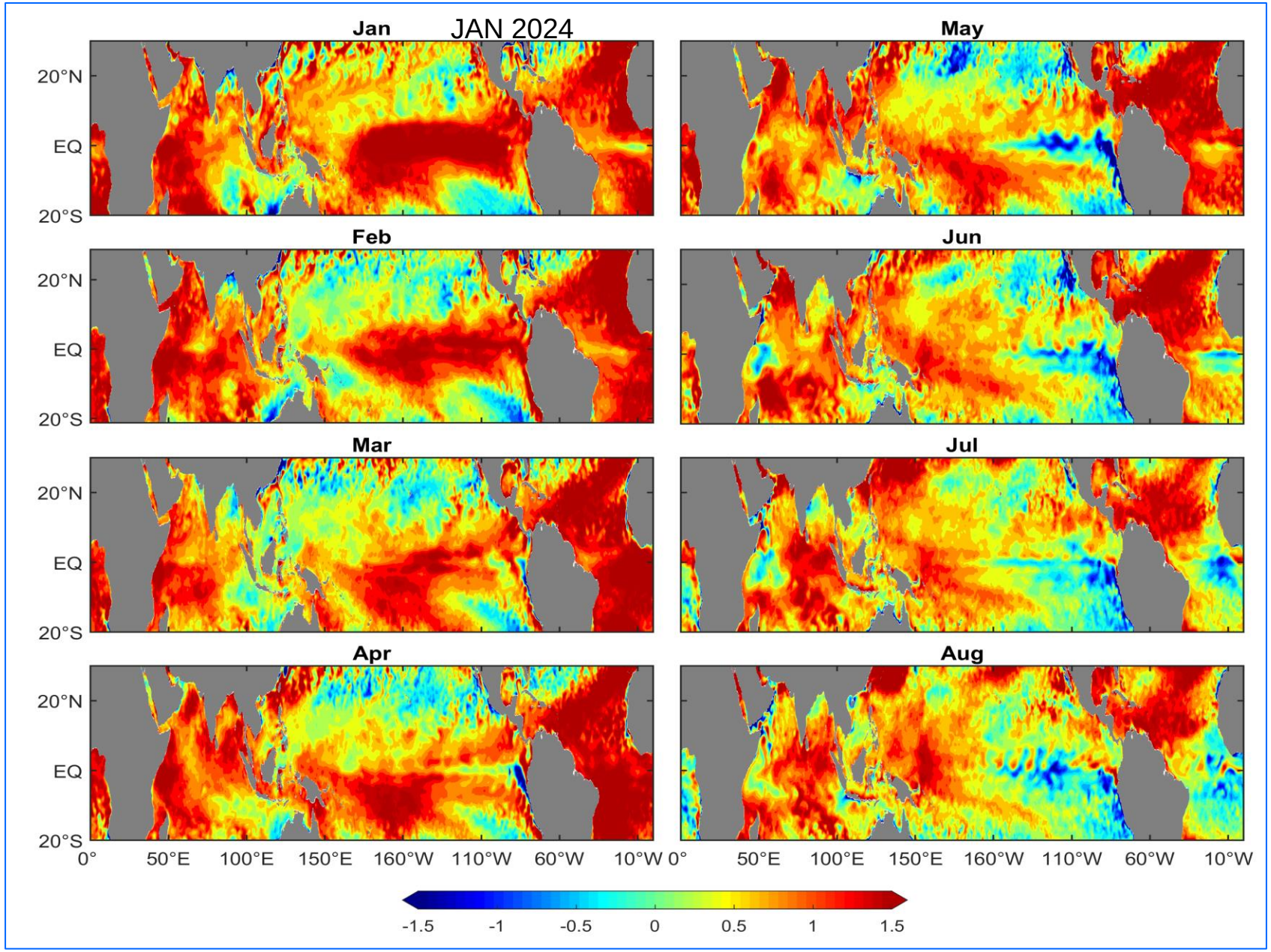
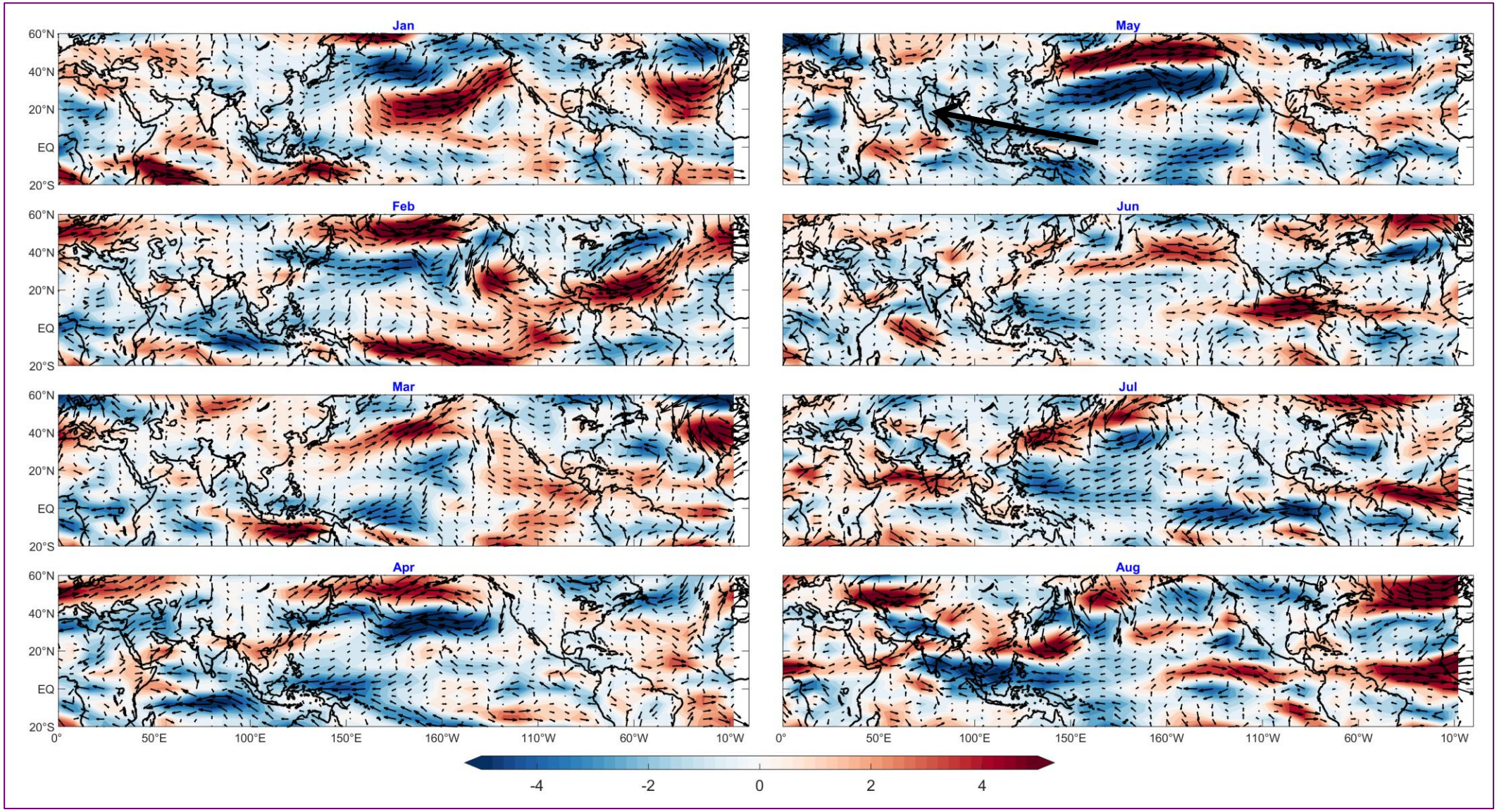
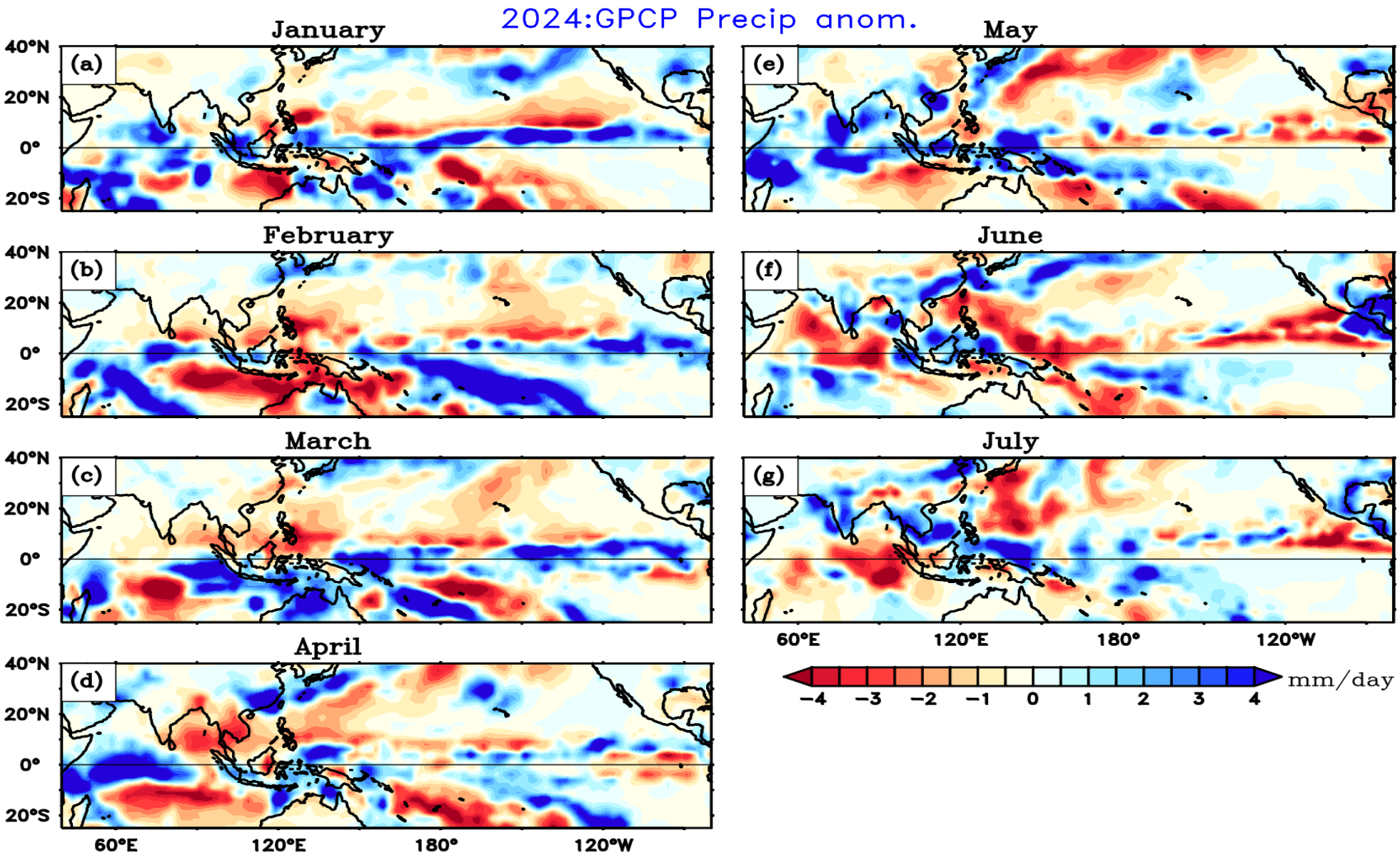
2023-2024 El Niño – NOAA SST anomalies



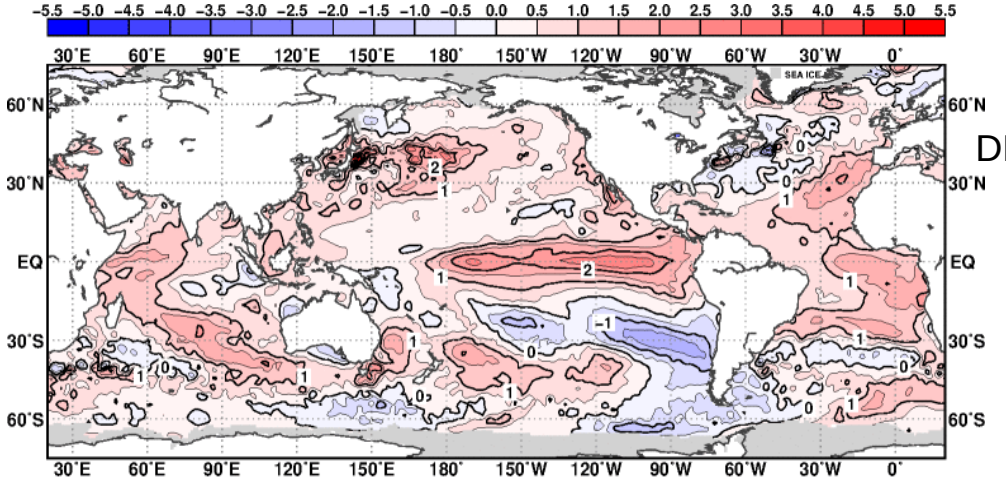
850 hPa wind anomalies from Jan to Aug 2024 (Aug 1 to 18 avg) - NCEP



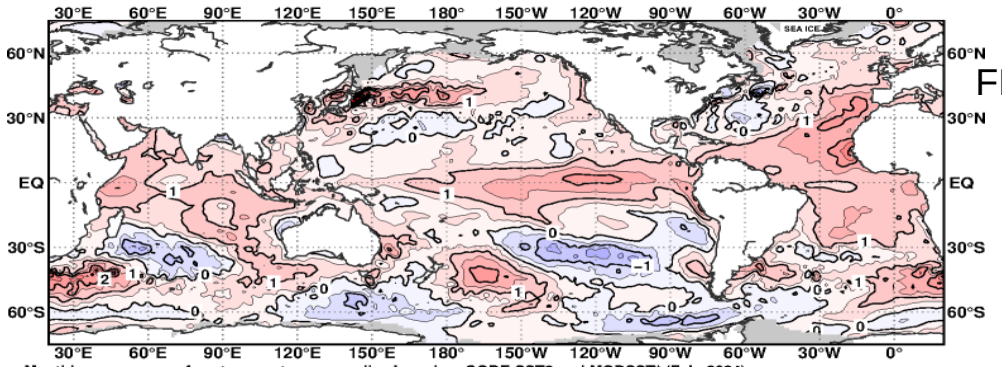
Rainfall anomalies



2023-2024 El Niño



DEC 2023



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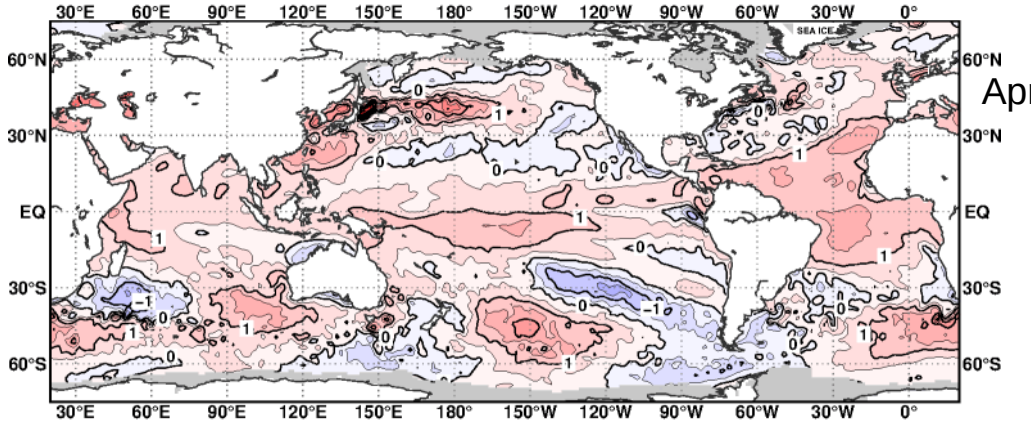
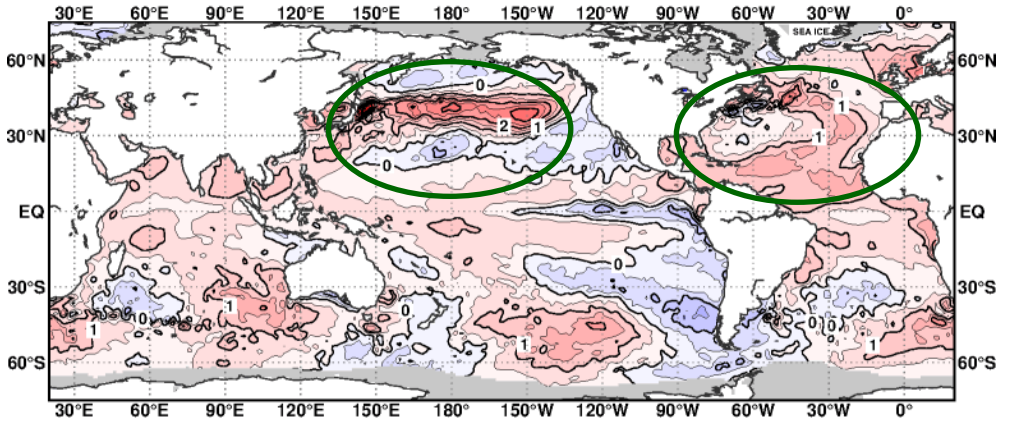
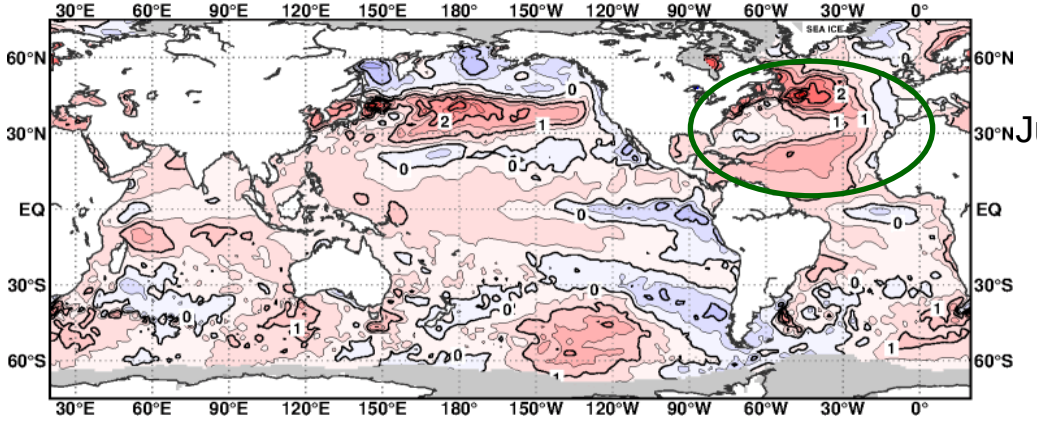


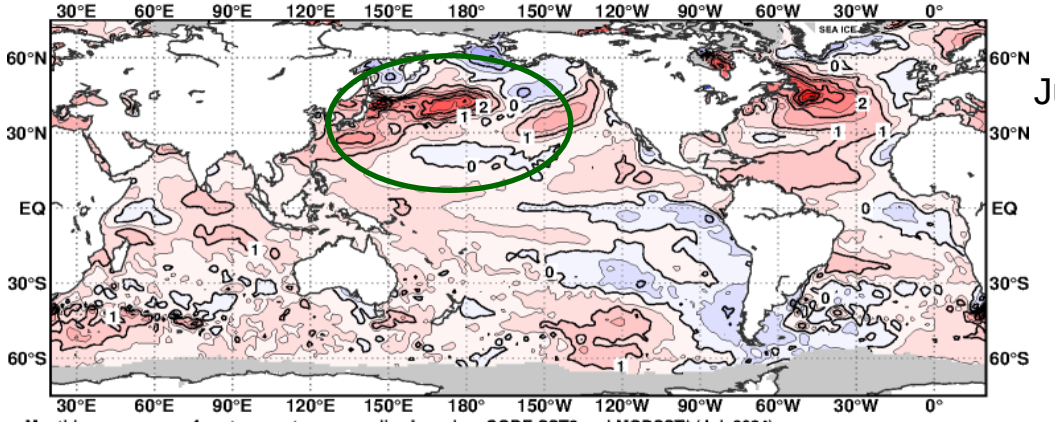
April 2024



May 2024



June 2024



July 2024

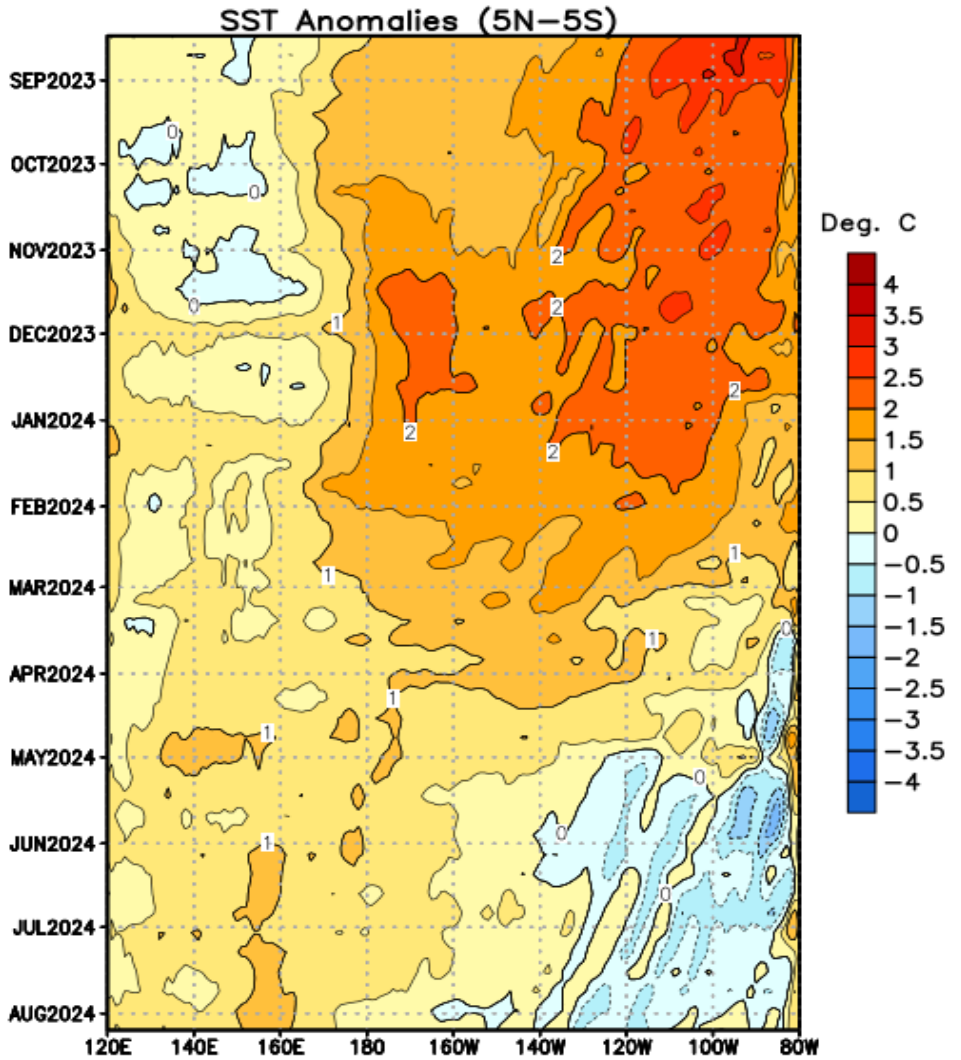
Recent Evolution of Equatorial Pacific SST Departures

- **Recent Evolution of Equatorial Pacific SST Departures (oC)**

- **ENSO-neutral conditions are present.* Equatorial sea surface temperatures (SSTs) are above average in the western Pacific, near average in the east-central Pacific, and below average in the eastern Pacific Ocean.**

- **Positive sea surface temperature (SST) anomalies persisted across most of the eastern and central Pacific Ocean from the beginning of the period until April 2024.**

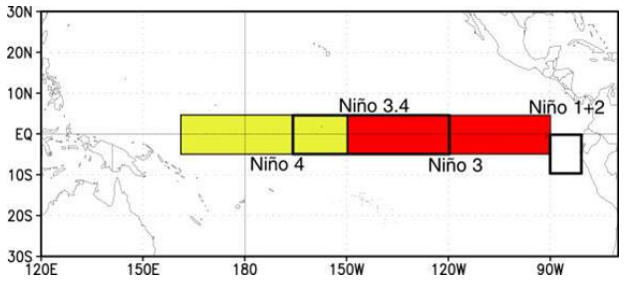
- **Since mid March 2024, below-average SSTs have emerged in the eastern Pacific and expanded westward.**

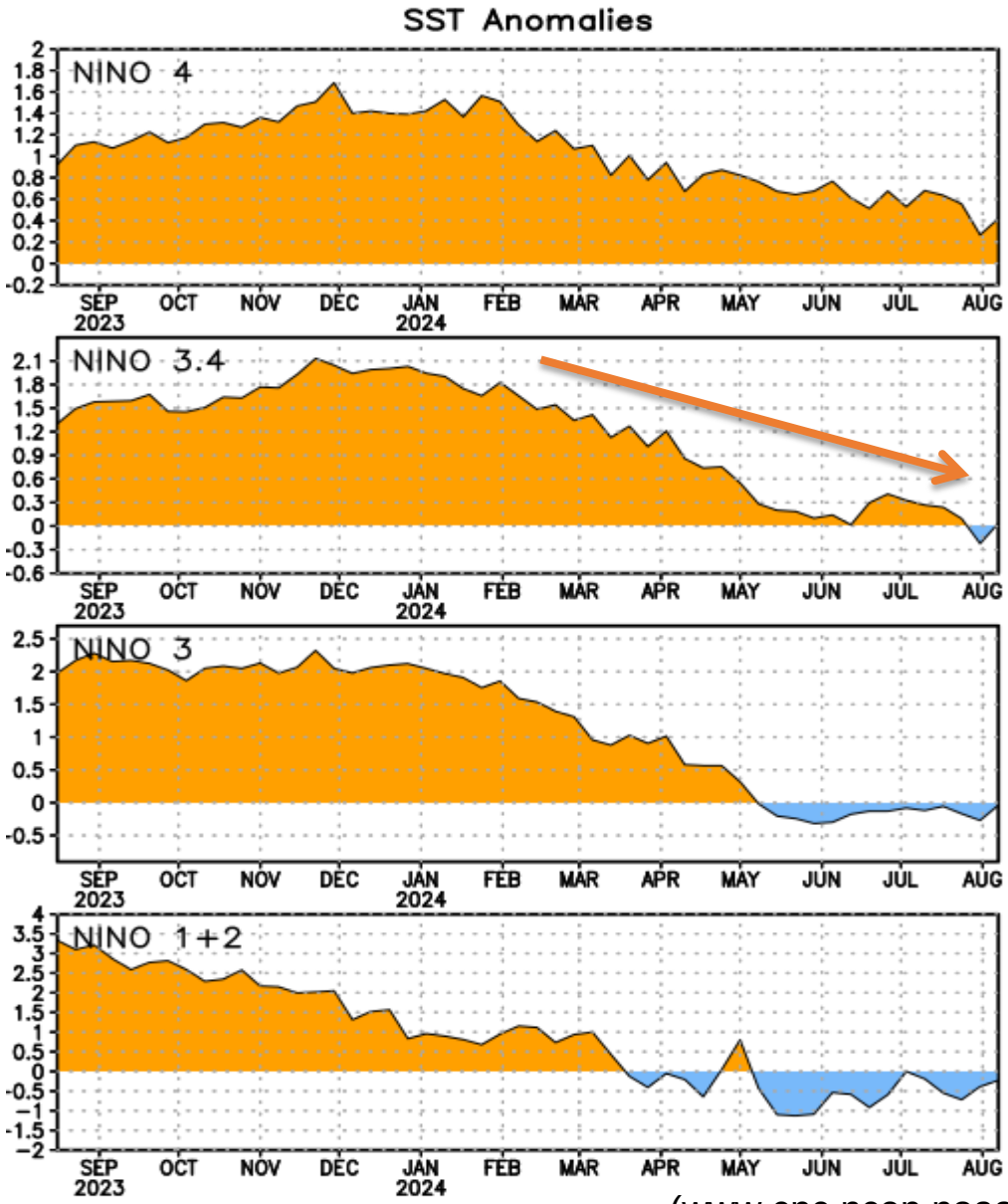


(www.cpc.ncep.noaa.gov)

Niño Region SST Departures (oC) Recent Evolution

- The east and central equatorial Pacific SST warming reduced from Jan 2024 to Augurs 2024.
- Nino 3.4 shows decay of El Nino related SST anomalies (decay phase El Nino).
- Western equatorial Pacific SSTs warmer than the eastern part.

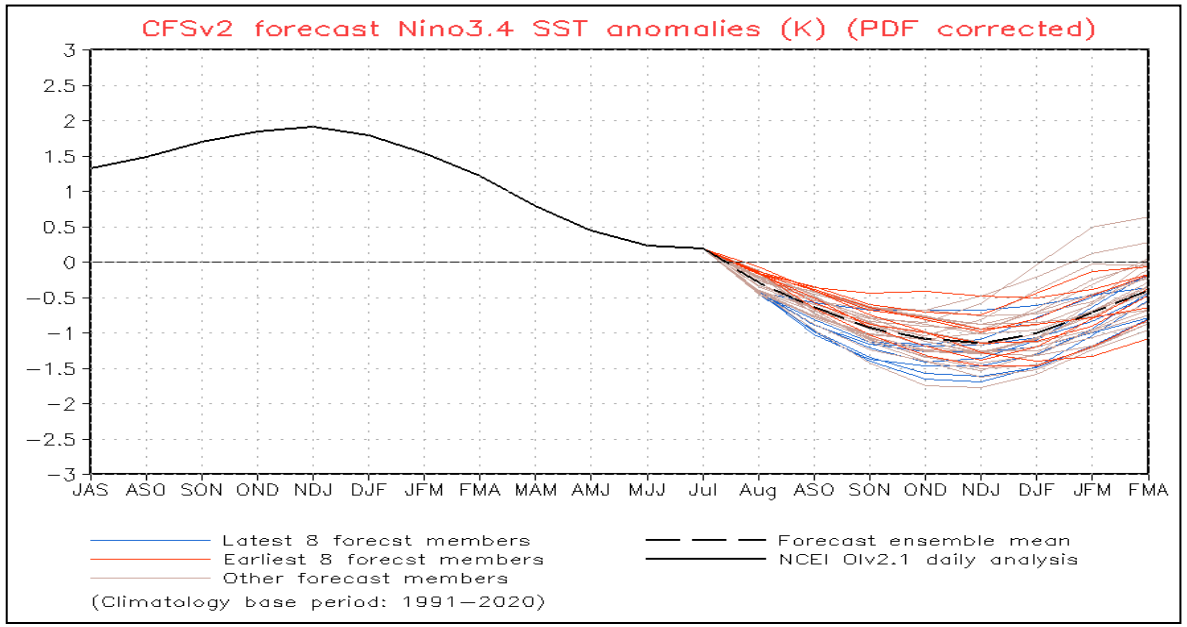




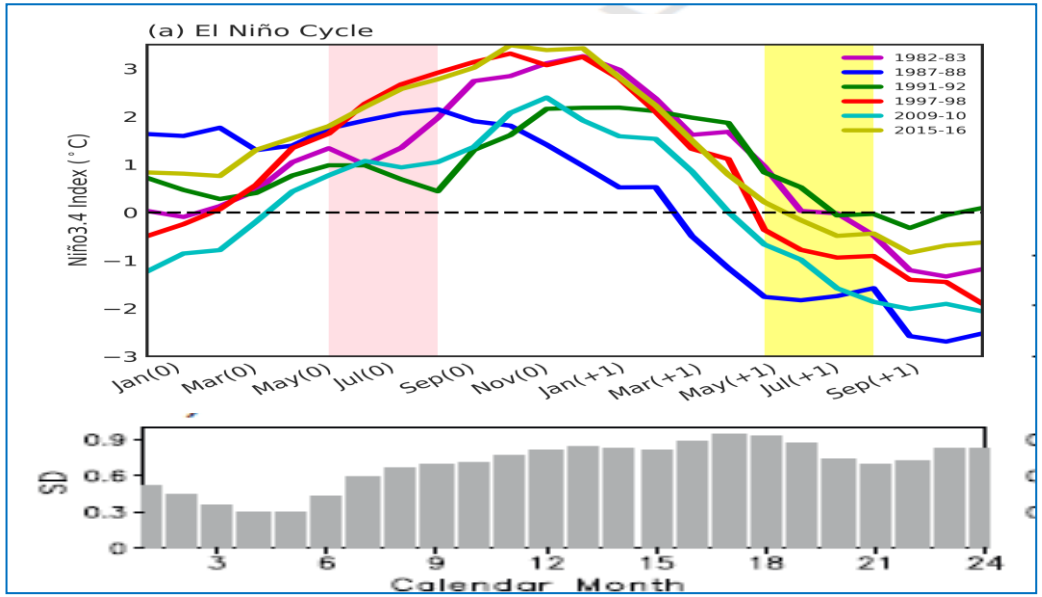
(www.cpc.ncep.noaa.gov)

El Niño Decay phase

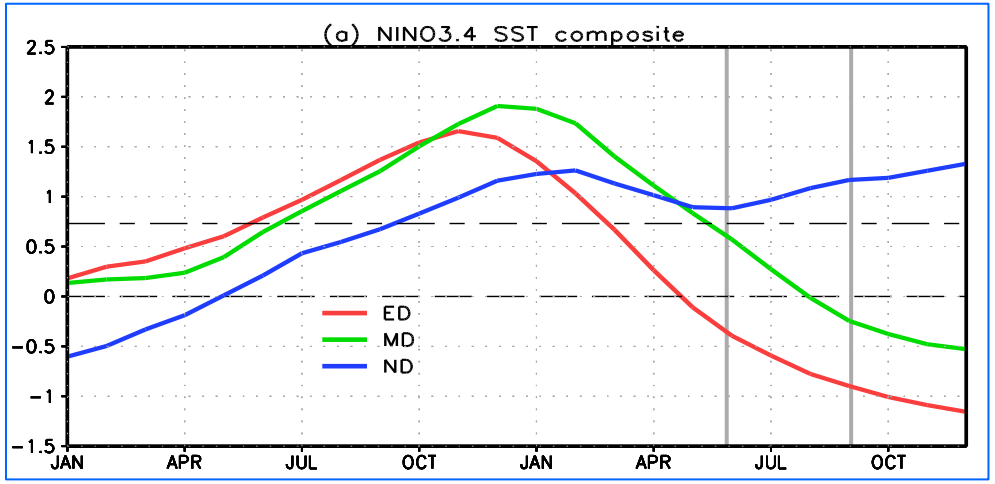
SST Outlook: NCEP CFS.v2 Forecast (PDF corrected)
Issued: 12 August 2024



The CFS.v2 ensemble mean (black dashed line) indicates a transition to La Niña around August-October 2024.



El Niño annual cycle (Niño-3 SST anomalies °C) for individual events and their composite for observations and (b) the model. Standard deviation among El Niño events in observations for each month and (d) same as (c) but for the model SST anomalies. Chowdary et al. 2024..

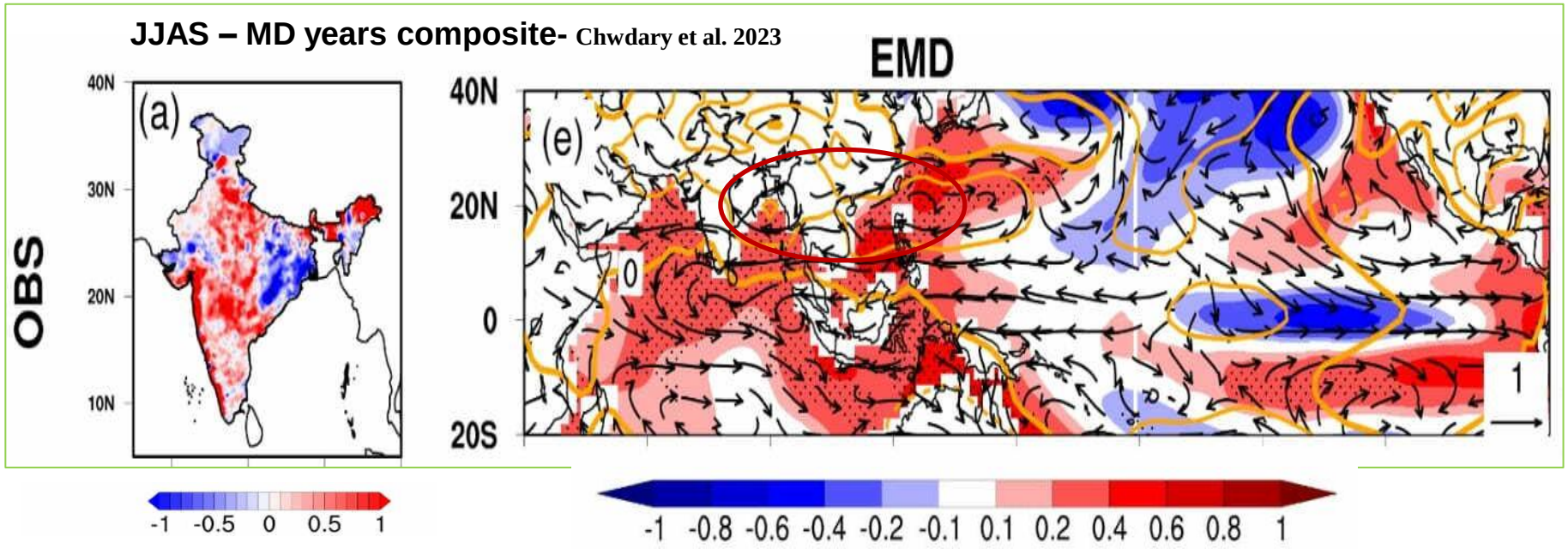


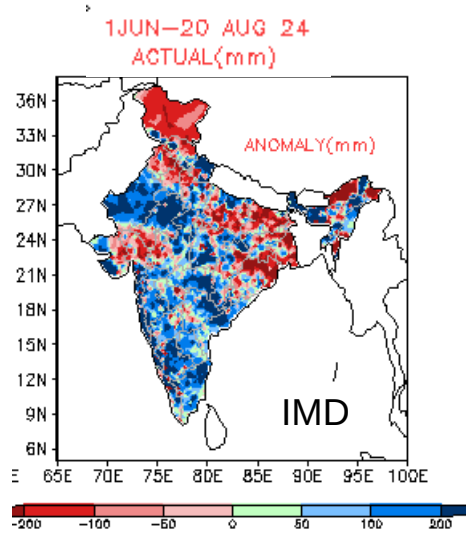
Composite of observed normalized Niño 3.4 SST (°C) anomalies for early decay (ED) years, mid-summer decay (MD) years, no decay (ND) years. Dashed line represents standard deviation.

Differences in Decay phase of El Nino

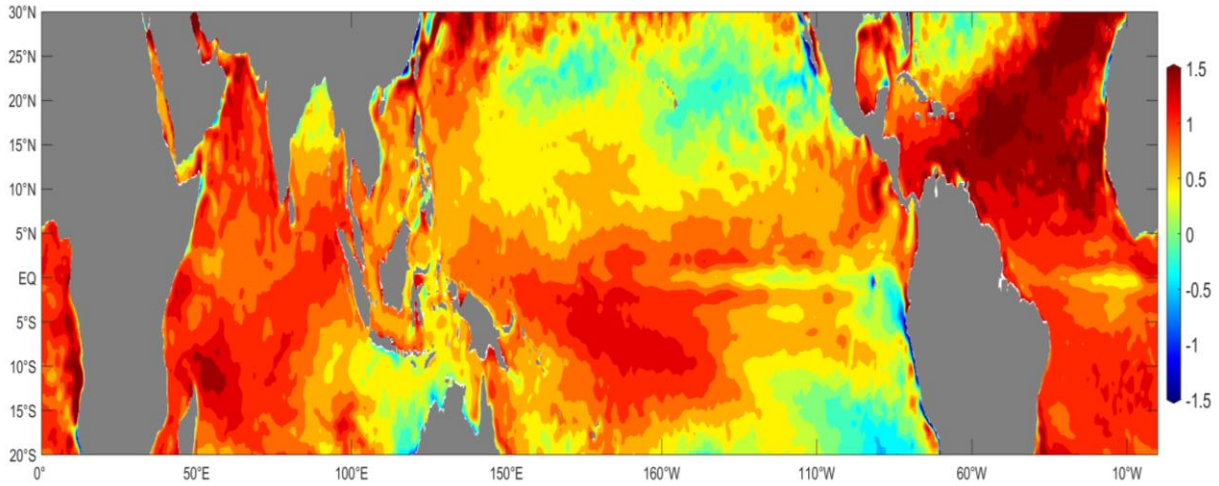
June 1st to August 24th: JJA rainfall anomalies

JJAS – MD years composite- Chwdary et al. 2023

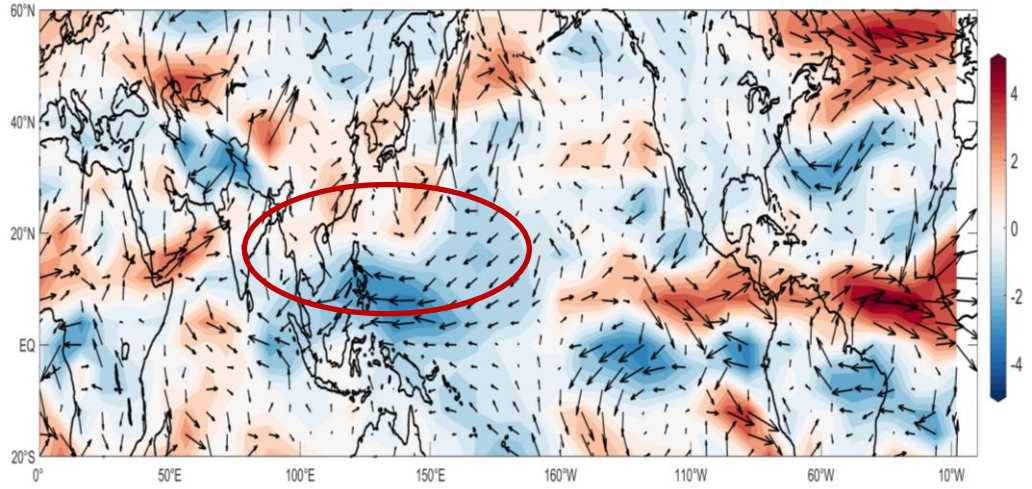




JJA 2024 NOAA – SST anom.

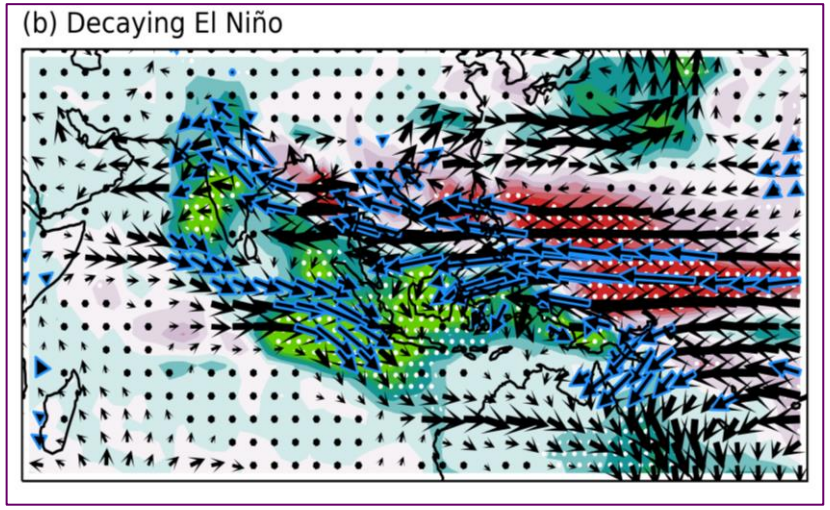


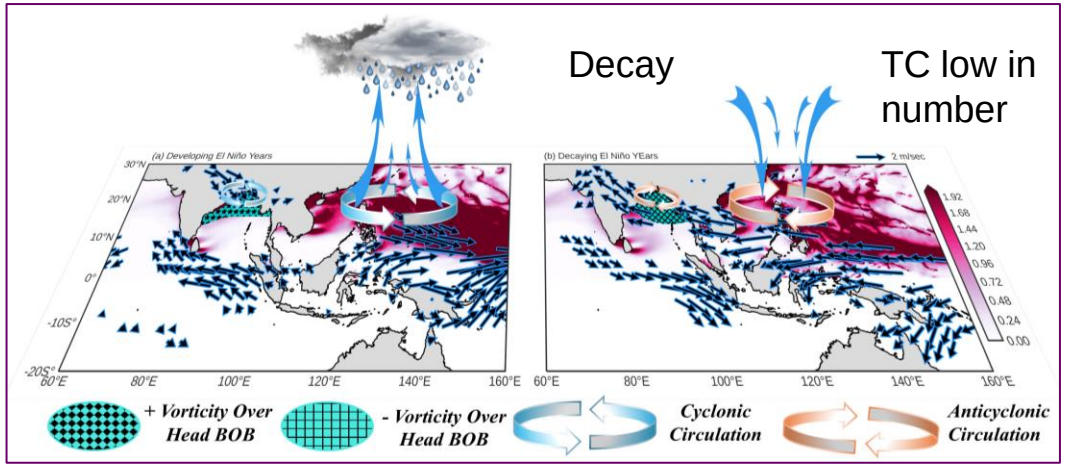
JJA 2024 NCEP – 850 hPa anom.

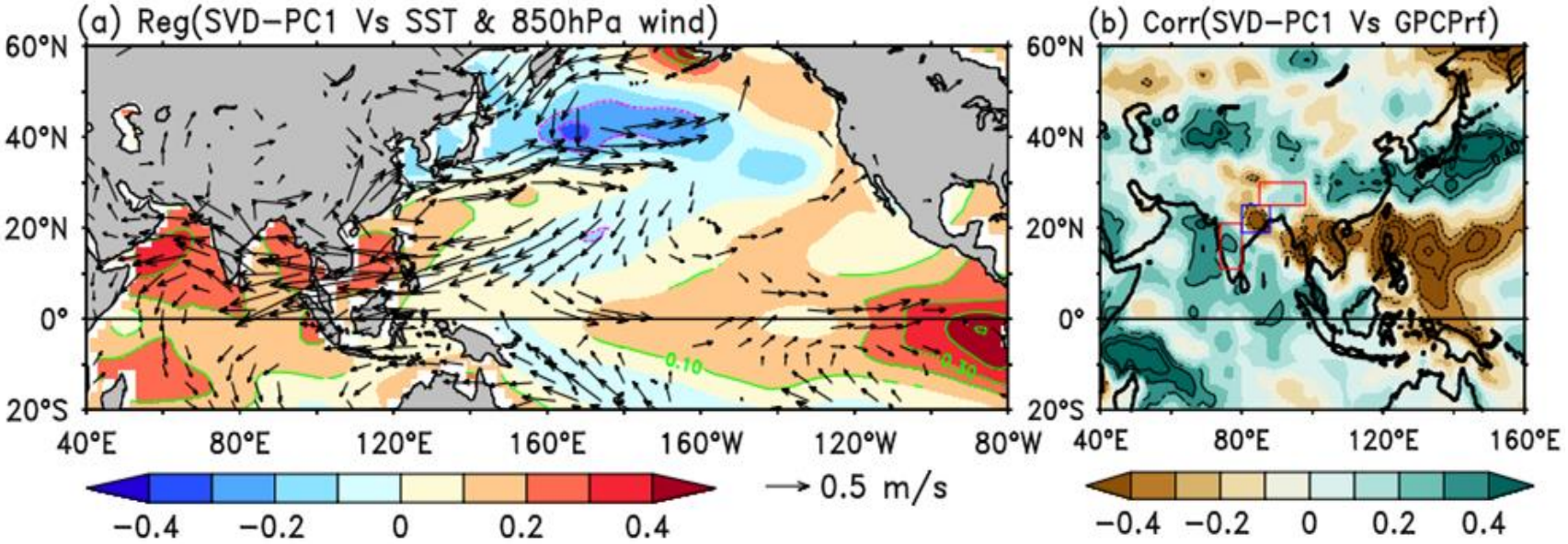


IPOC mode and its influence on ISM rainfall on Interannual timescale

Obs







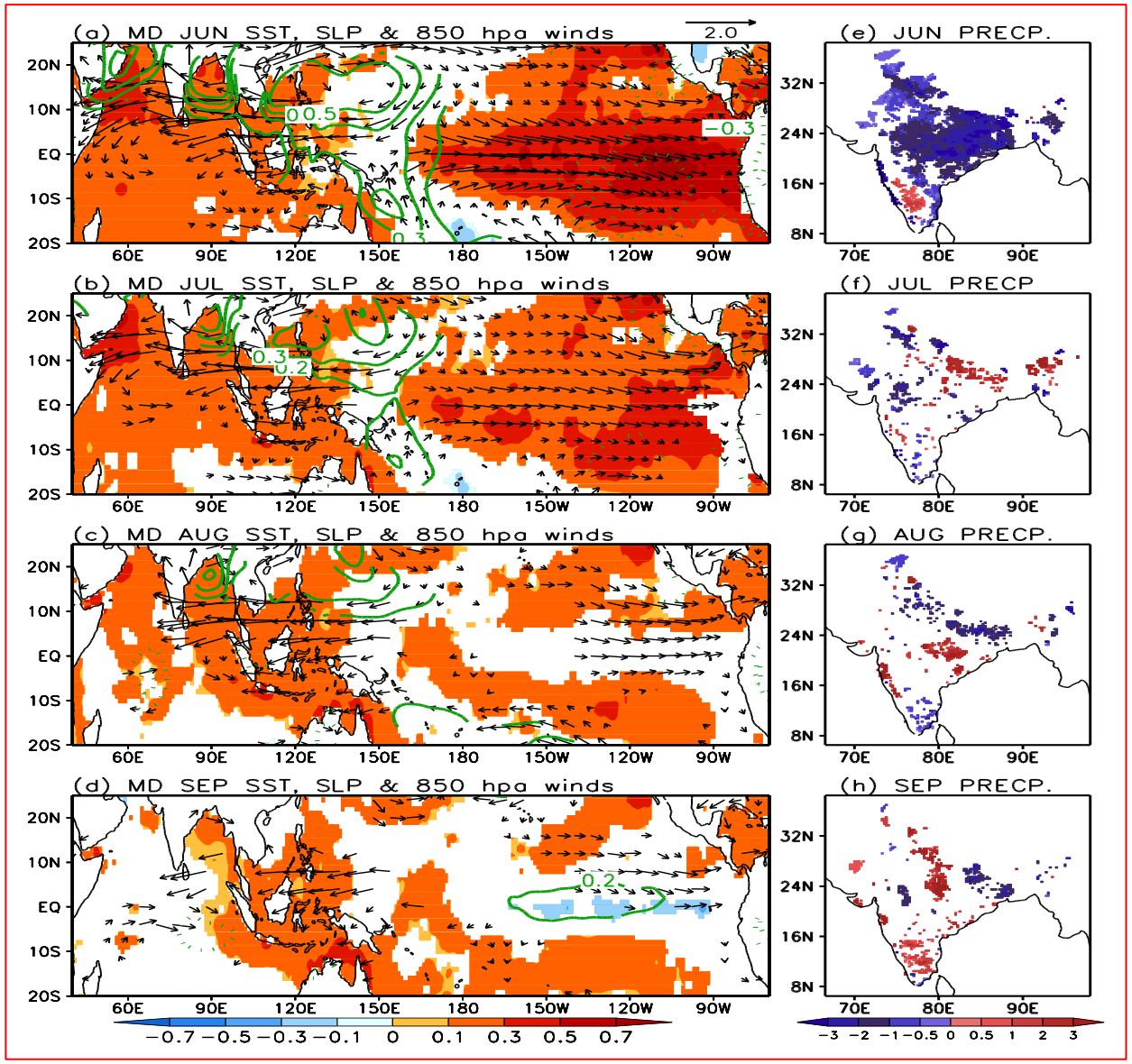
(a) Regression of JJA SVD-PC1 upon SST, 850hPa wind anom. (b) Correlation between SVD-PC1 and GPCP rainfall (contours and vectors are significant at 90% confidence level)

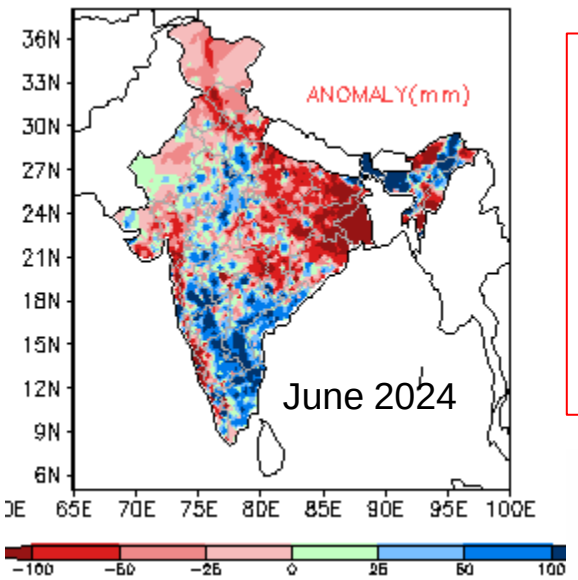
- **IPOC mode determined by SVD analysis between TIO (40°-120°E, 20°S-25°N) SST and WNP (100°-160°E, 0°-60°N) 850 hPa vorticity anomalies during JJA over 1979-2020**
- **SVD mode1 %variance = 62%**

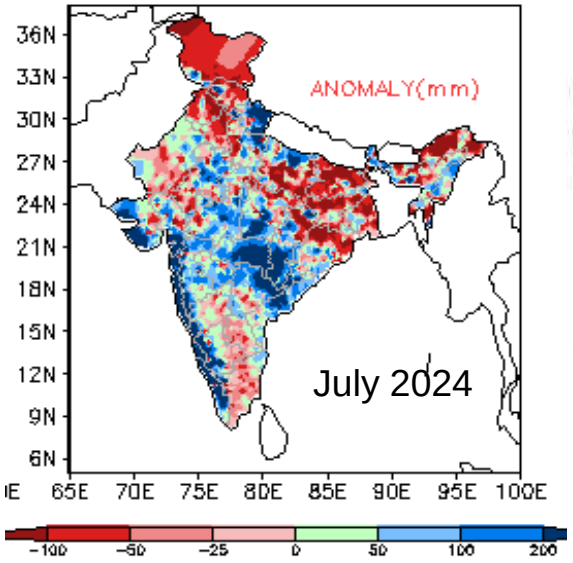
It is clear that the regional rainfall patterns are strongly influenced by IPOC mode

Chowdary et al (2019, 2024); Gnanaseelan and Chowdary et al. (2020); Darshana et al (2020)

Mid-Summer-Decay



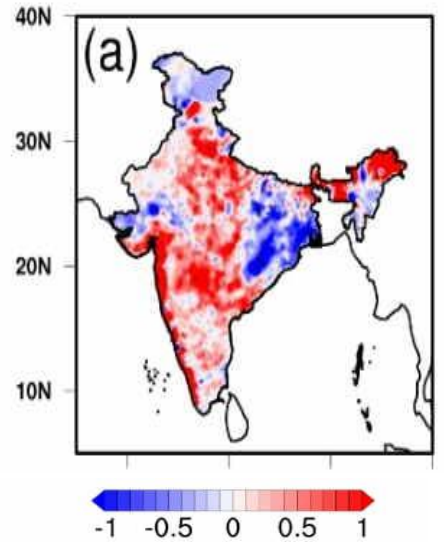


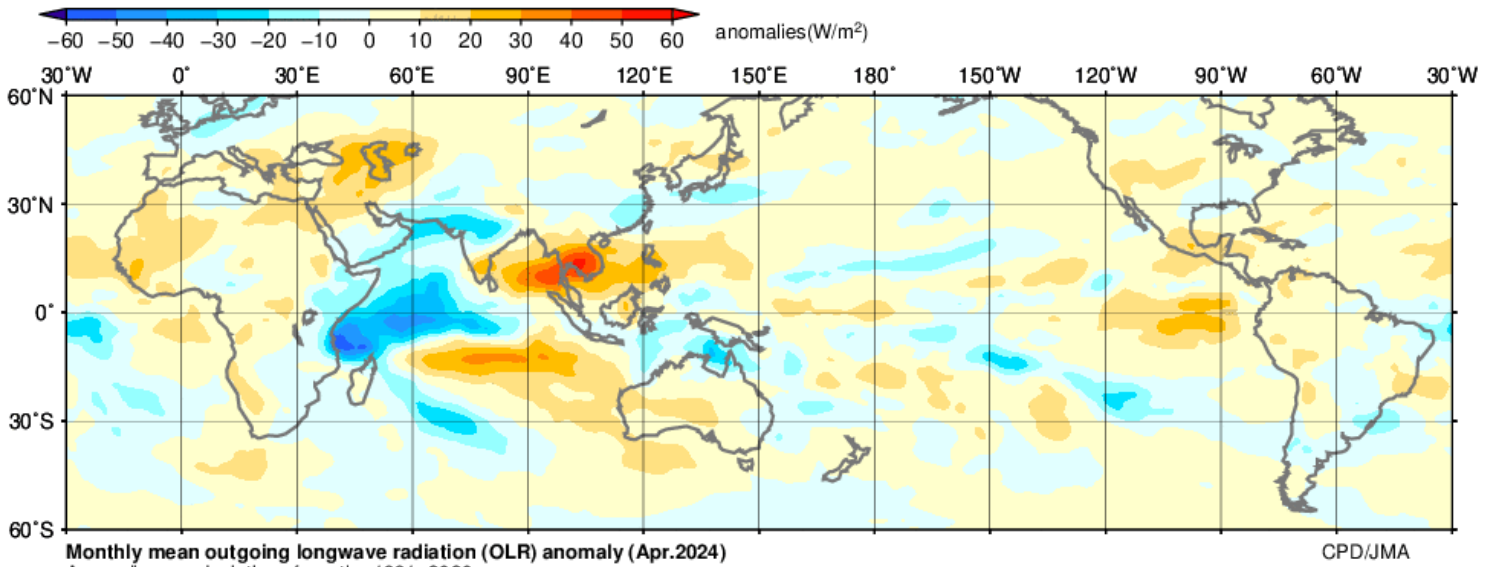


Composite of SST (°C, shaded), SLP (hPa, contours) and 850hPa wind (ms^{-1}, vectors) anomalies for MD years during (a) June, (b) July, (c) August, and (d) September. (e) to (h) are same as in (a) to (d) IMD rainfall (mm/day). Chowdary et al .2017.

JJAS – MD years

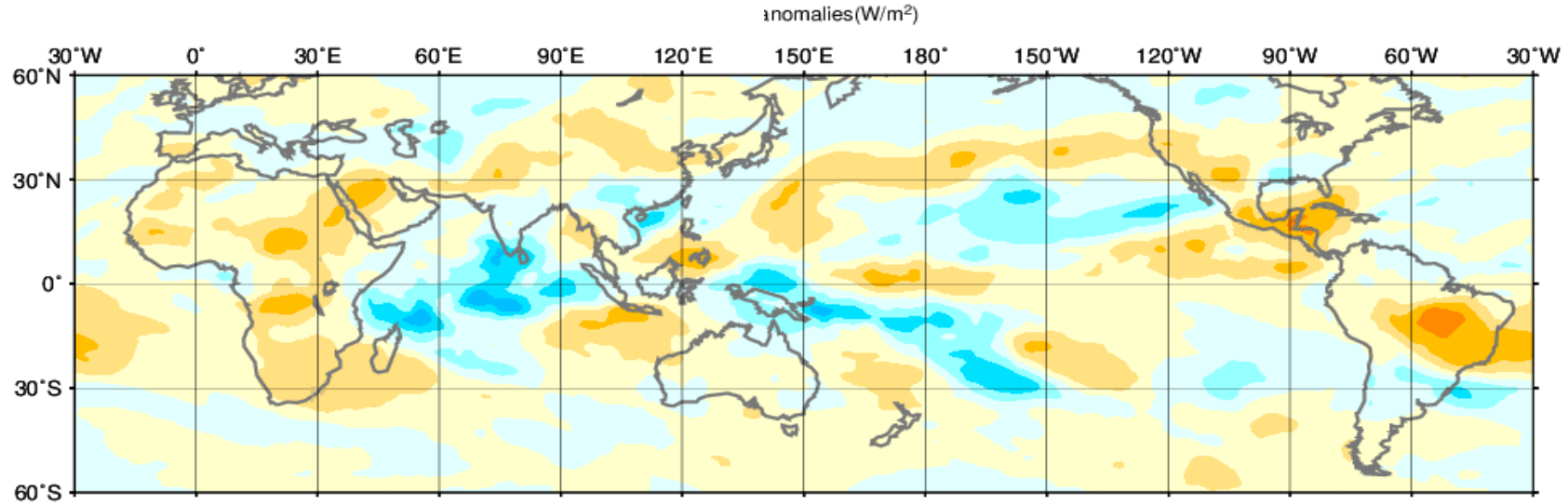
OBS





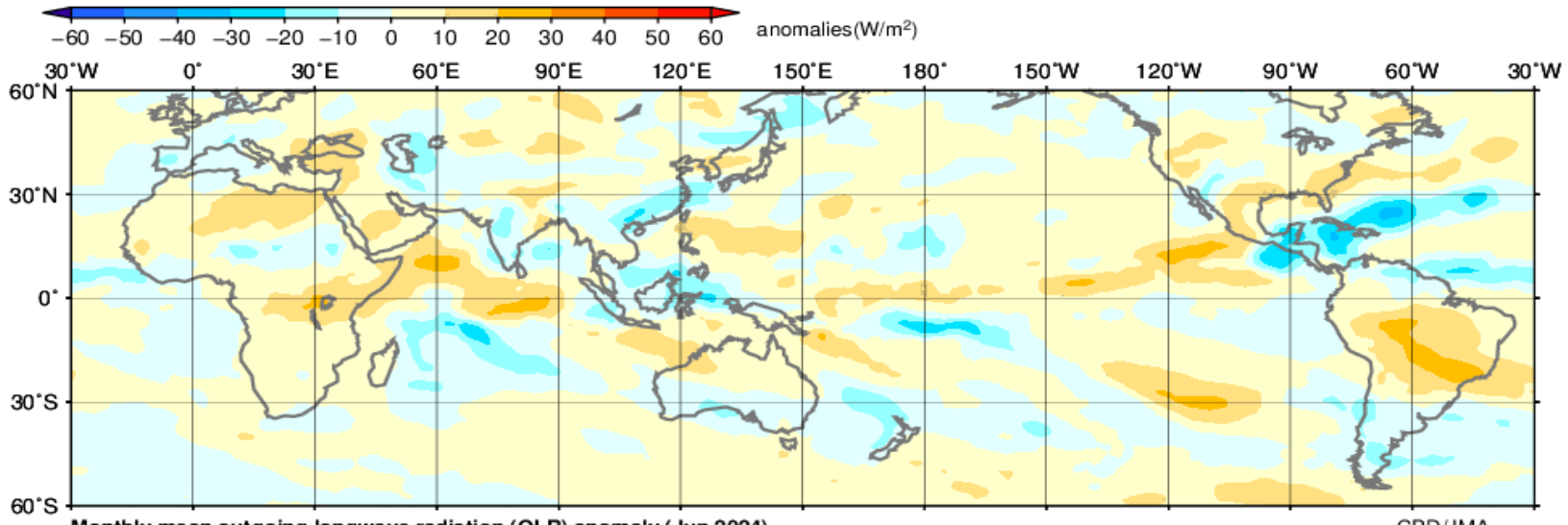
Monthly mean outgoing longwave radiation (OLR) anomaly (Apr.2024)
Anomalies are deviations from the 1991–2020 average.
Original data (CPC Blended OLR) provided by NOAA.

CPD/JMA



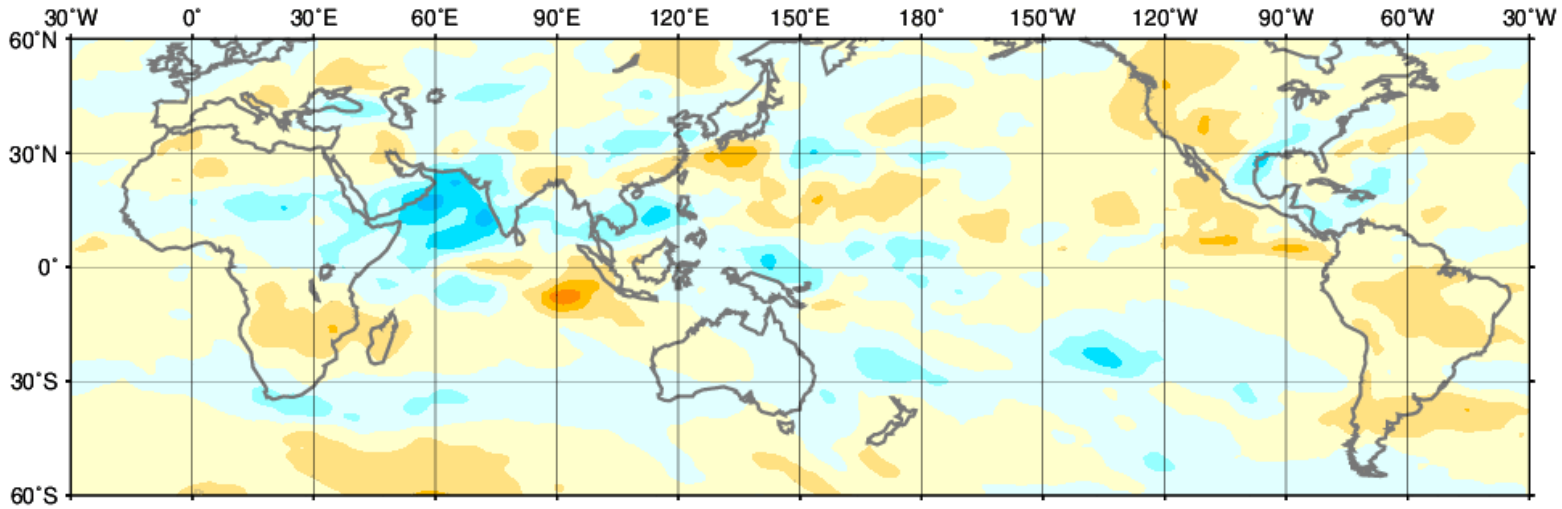
Monthly mean outgoing longwave radiation (OLR) anomaly (May2024)
Anomalies are deviations from the 1991–2020 average.
Original data (CPC Blended OLR) provided by NOAA.

CPD/JMA



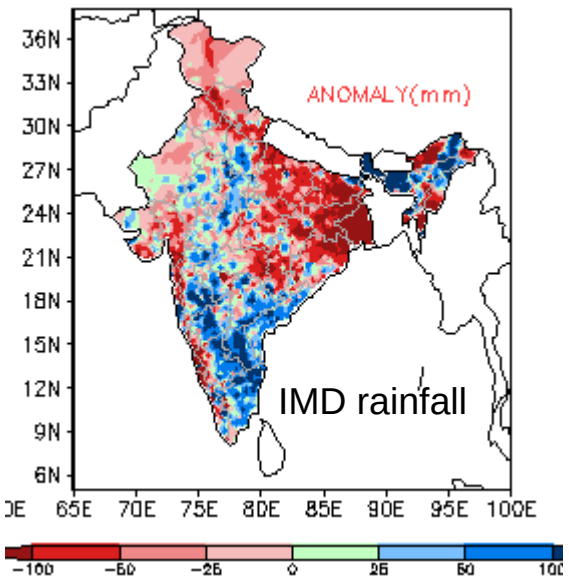
Monthly mean outgoing longwave radiation (OLR) anomaly (Jun.2024)
Anomalies are deviations from the 1991–2020 average.
Original data (CPC Blended OLR) provided by NOAA.

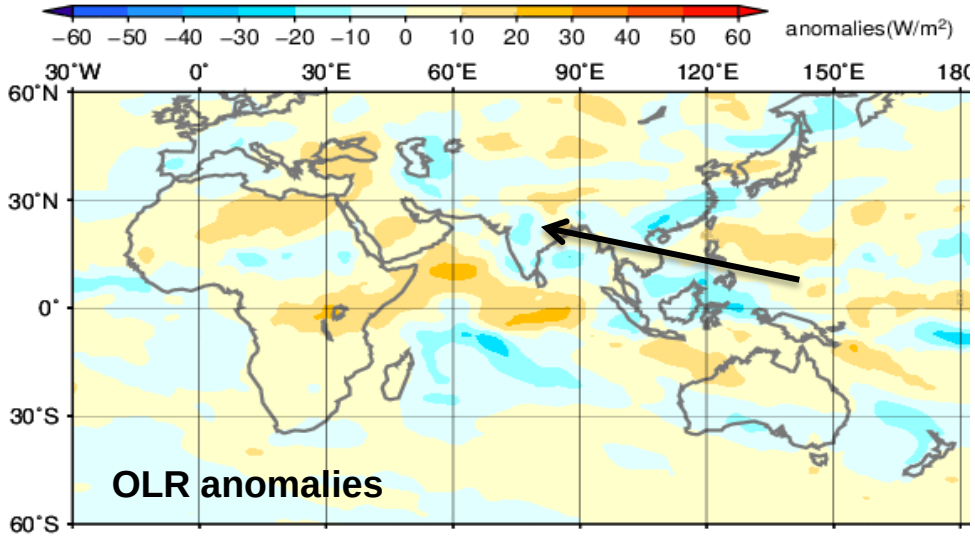
CPD/JMA



Monthly mean outgoing longwave radiation (OLR) anomaly (Jul.2024)
Anomalies are deviations from the 1991–2020 average.
Original data (CPC Blended OLR) provided by NOAA.

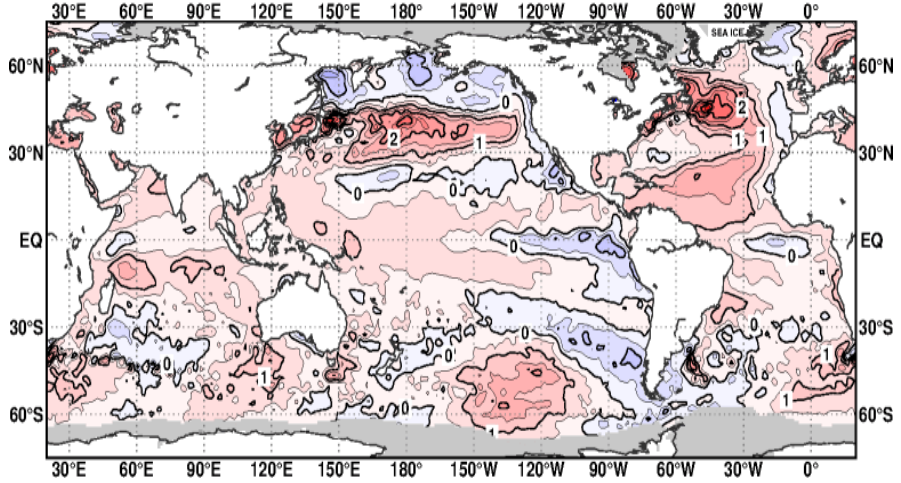
CPD/JMA



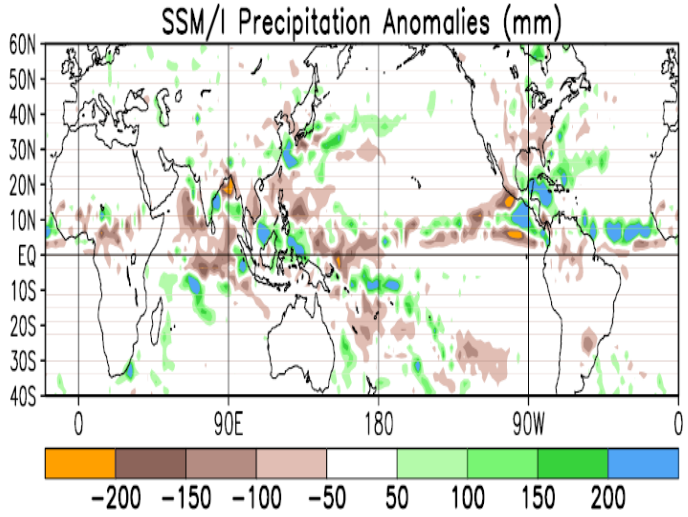


Monthly mean outgoing longwave radiation (OLR) anomaly (Jun.2024)
Anomalies are deviations from the 1991–2020 average.
Original data (CPC Blended OLR) provided by NOAA.

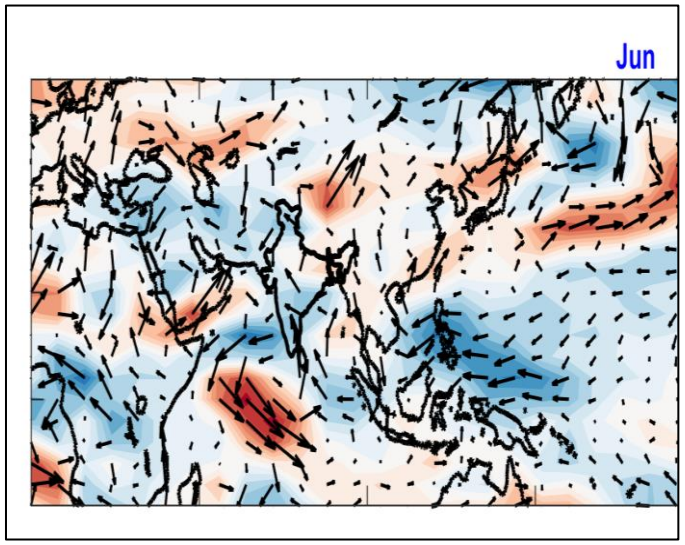
SST anomalies (JRA)



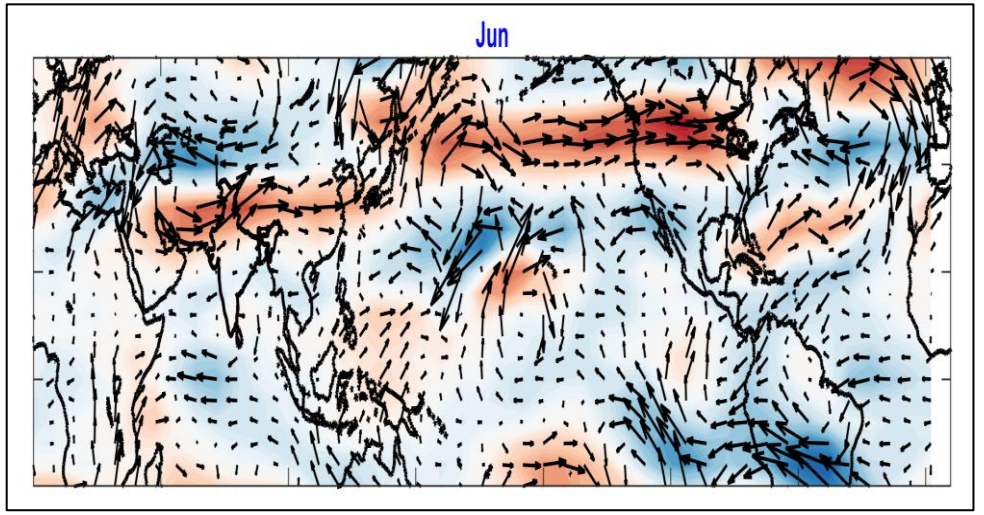
GPCP rainfall anomalies



850 hPa wind anomalies

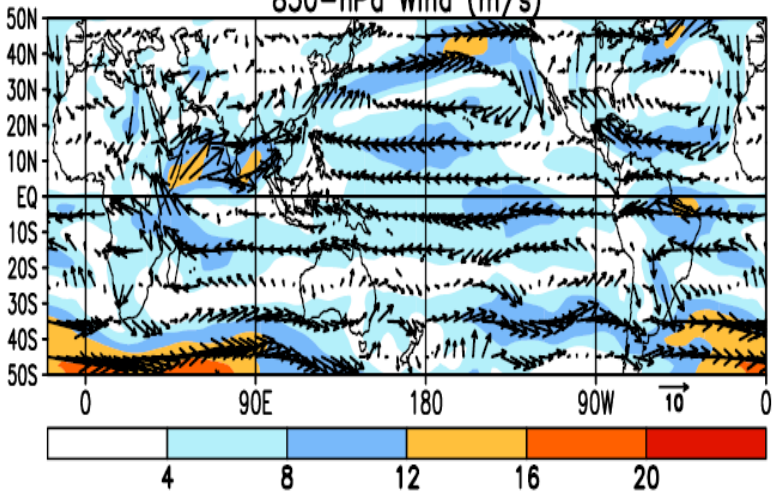


200 hPa wind anomalies



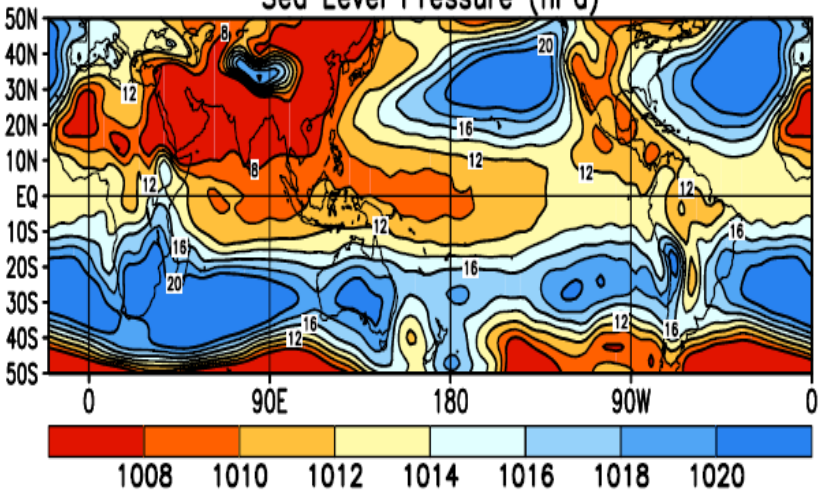
June 2024

850-hPa Wind (m/s)



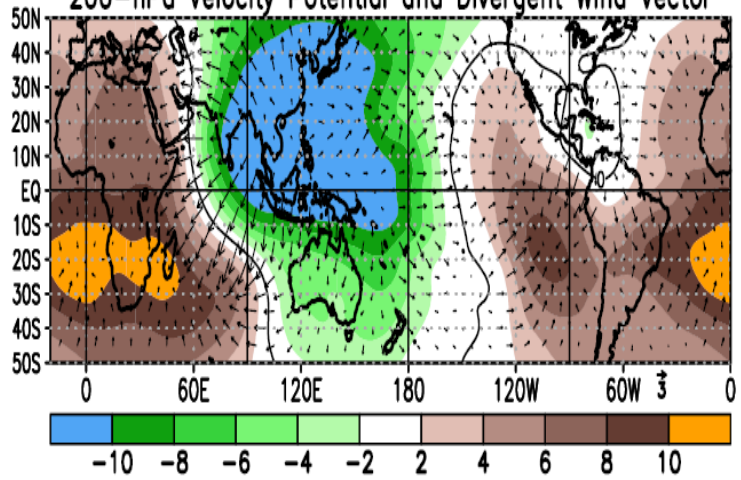
June 2024

Sea Level Pressure (hPa)

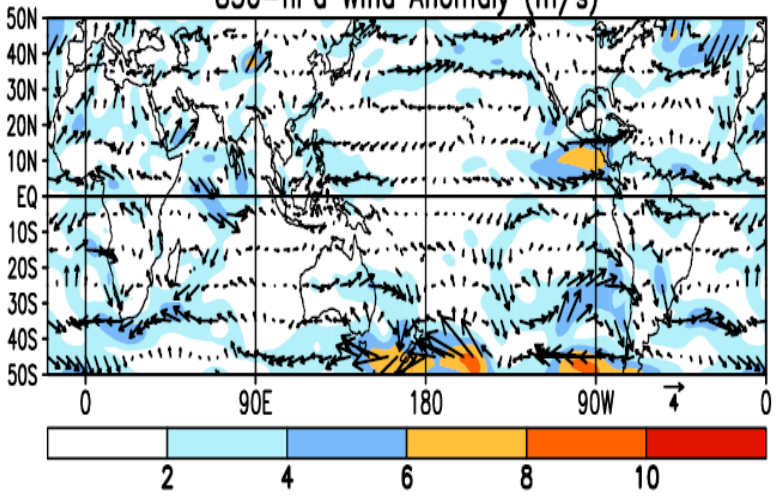


June 2024

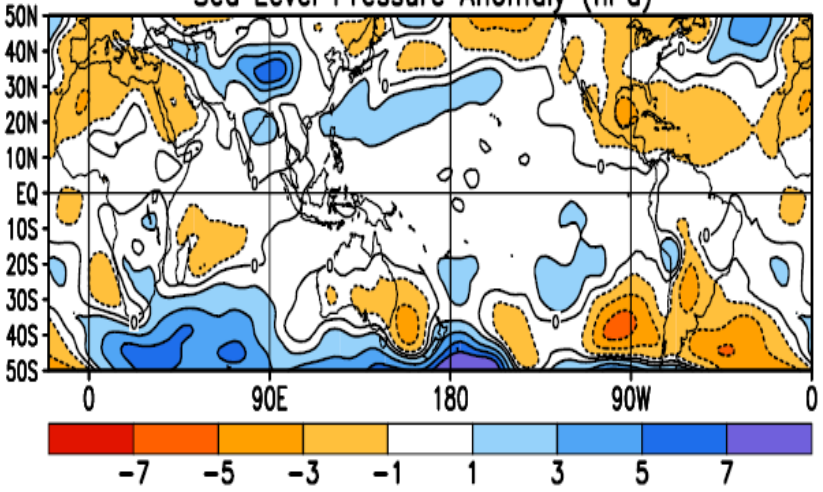
200-hPa Velocity Potential and Divergent Wind Vector



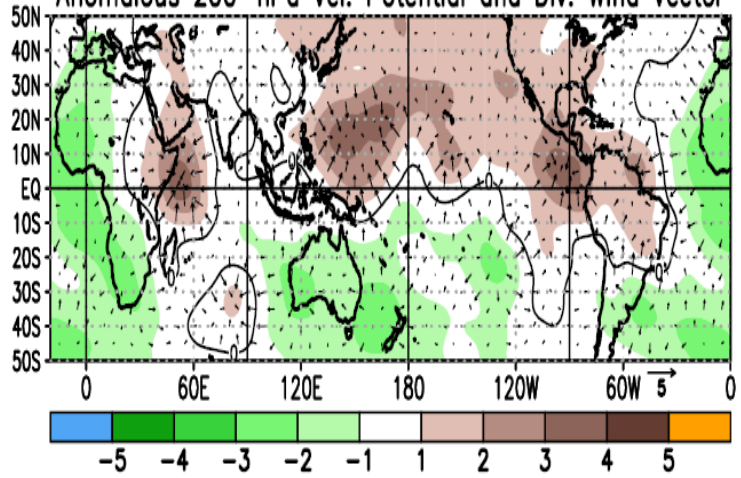
850-hPa Wind Anomaly (m/s)



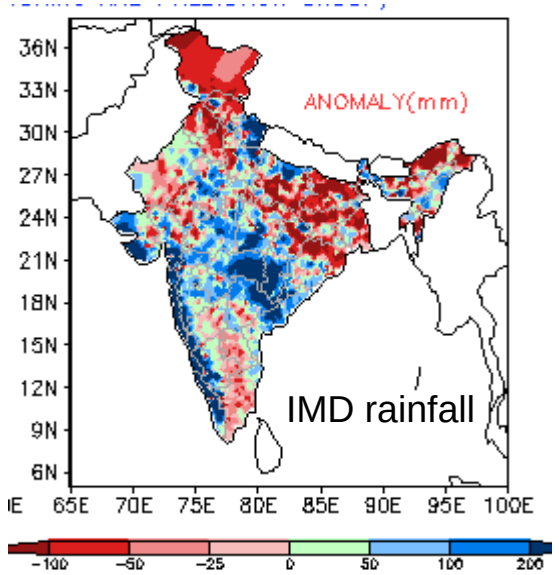
Sea Level Pressure Anomaly (hPa)

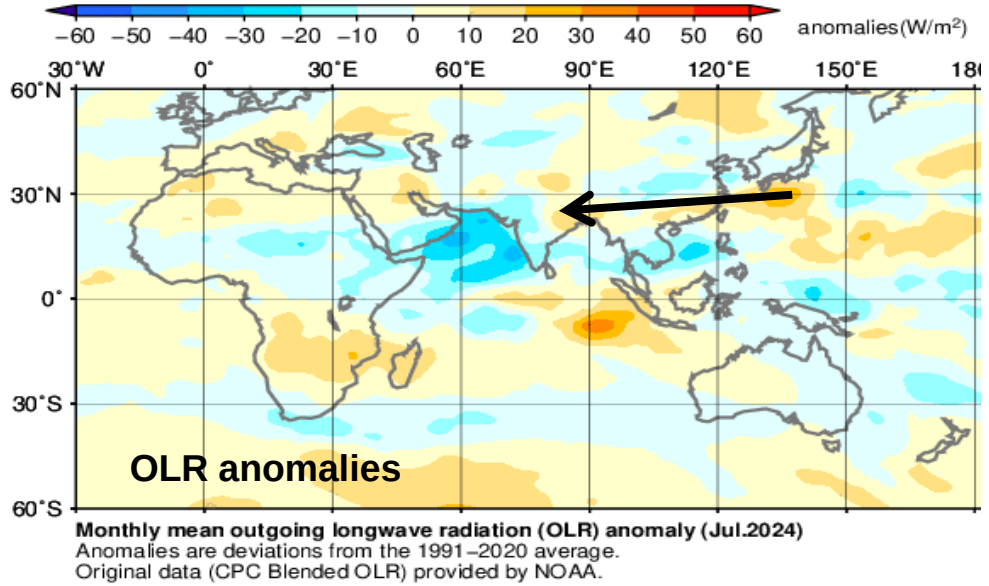


Anomalous 200-hPa Vel. Potential and Div. Wind Vector

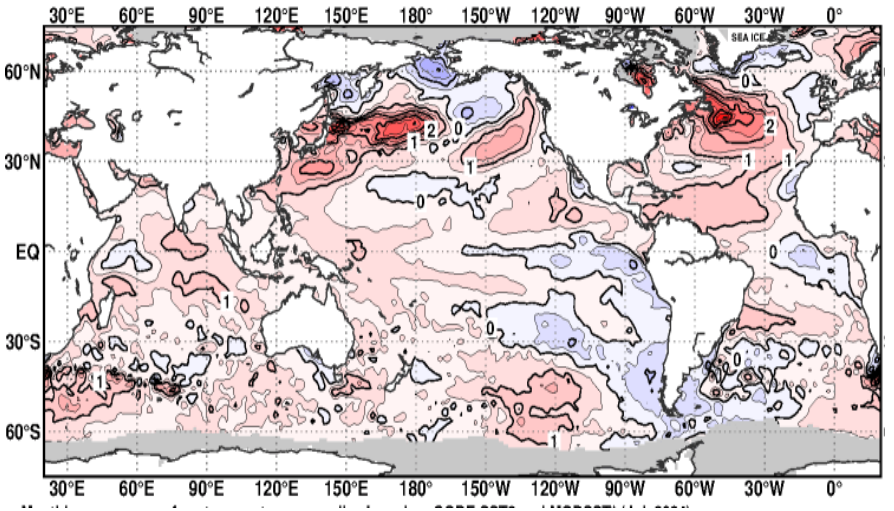


July 2024

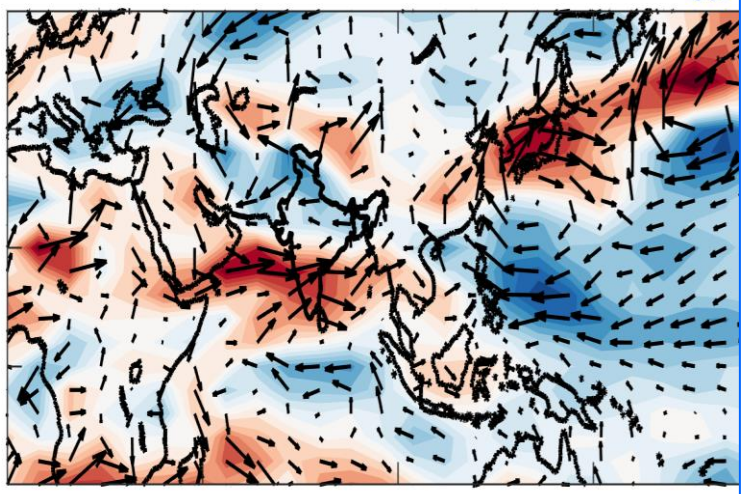




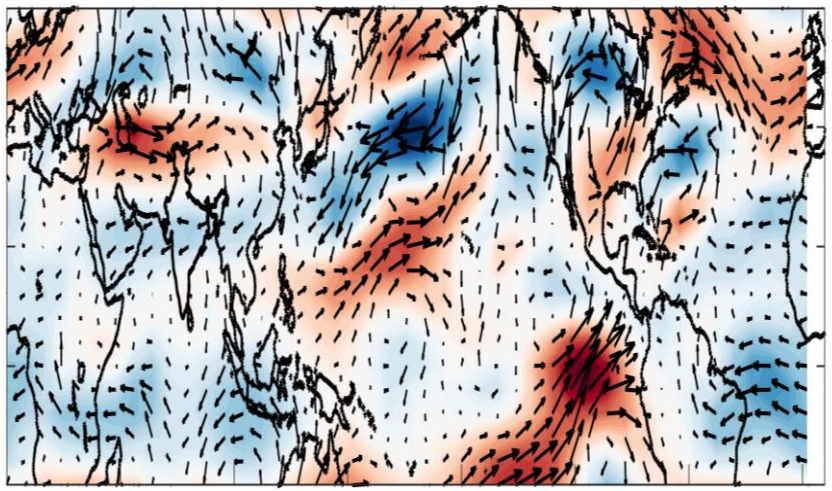
July 2024 JRA

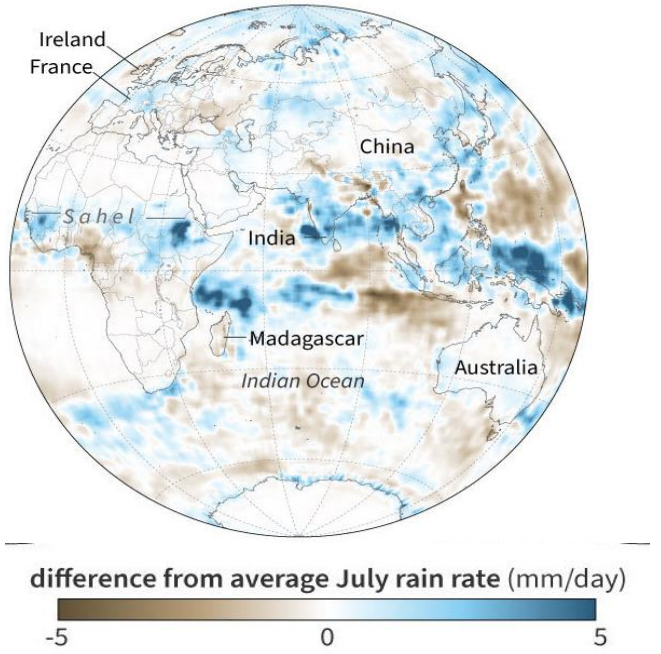


850 hPa wind anomalies



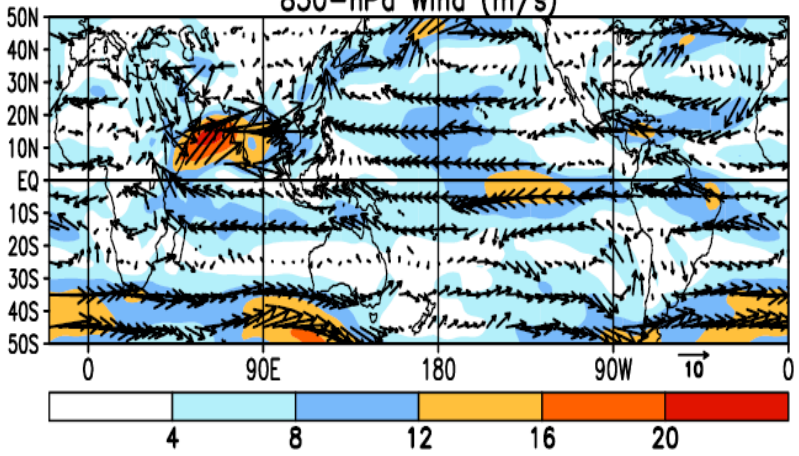
200 hPa wind anomalies





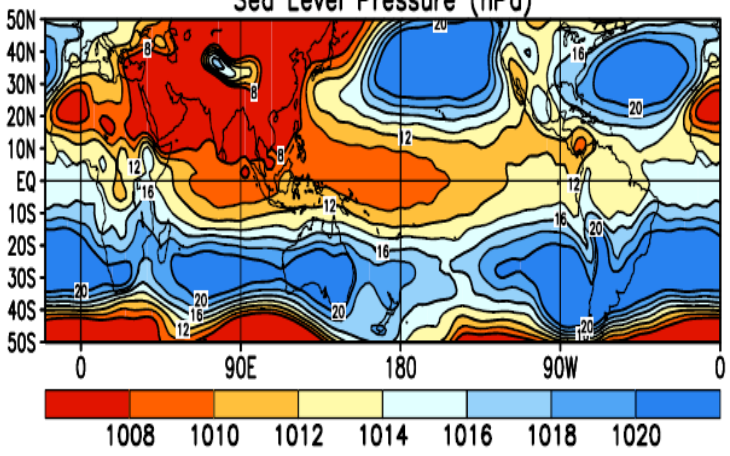
July 2024

850-hPa Wind (m/s)



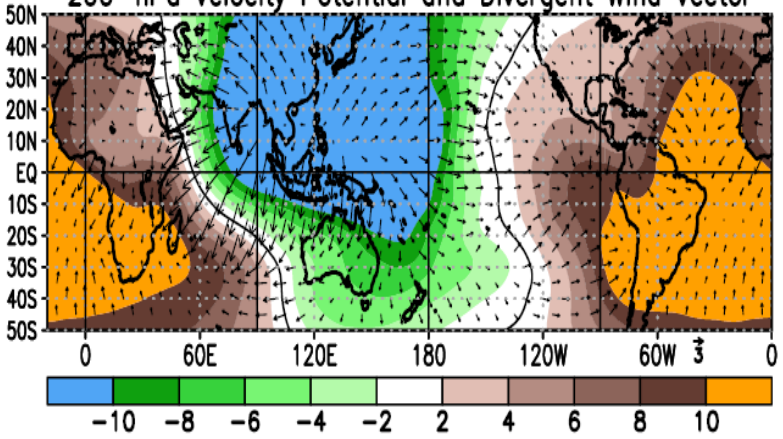
July 2024

Sea Level Pressure (hPa)

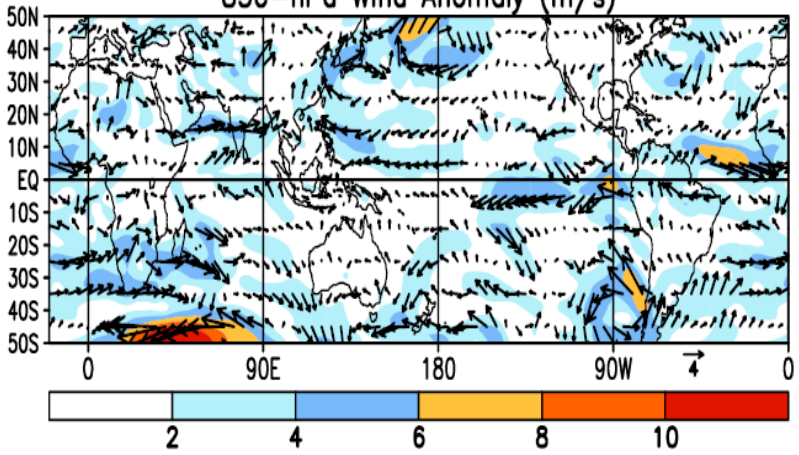


July 2024

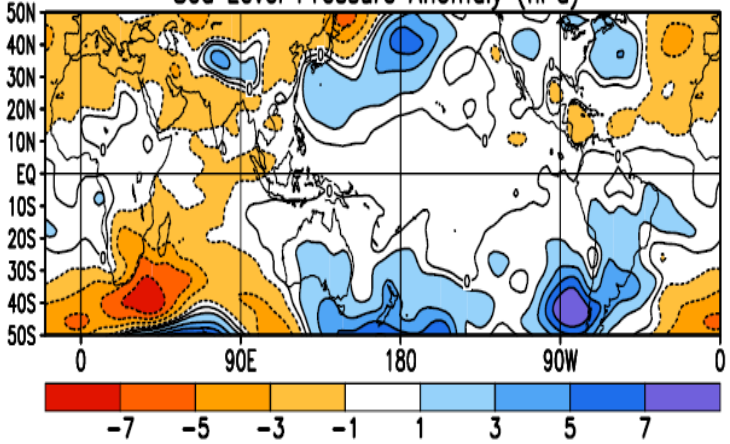
200-hPa Velocity Potential and Divergent Wind Vector



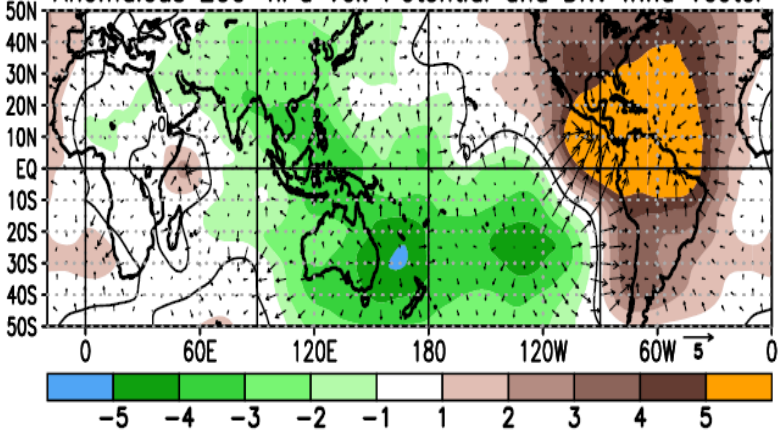
850-hPa Wind Anomaly (m/s)

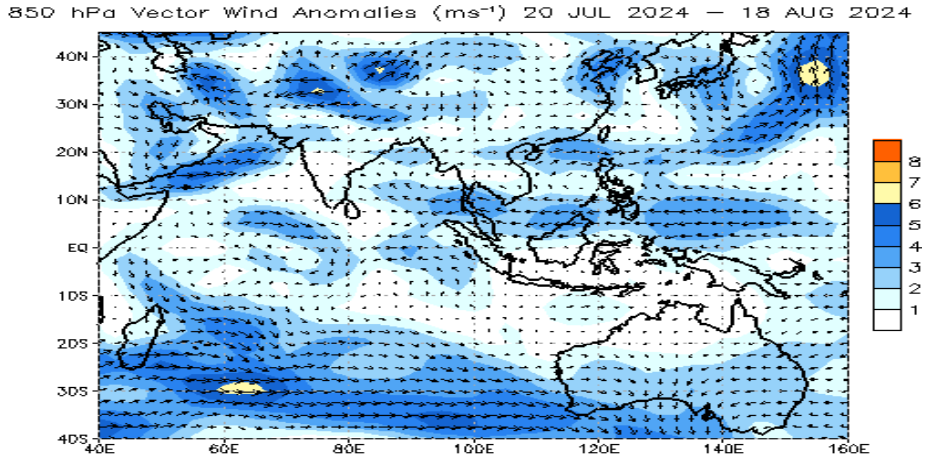


Sea Level Pressure Anomaly (hPa)

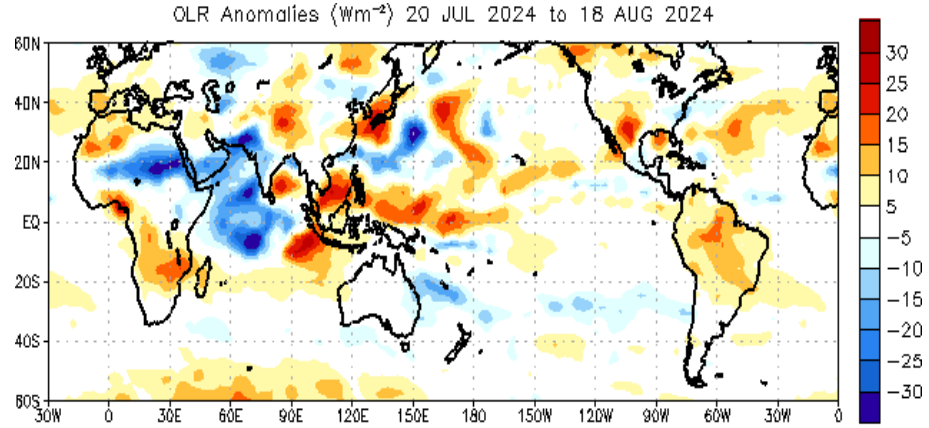


Anomalous 200-hPa Vel. Potential and Div. Wind Vector

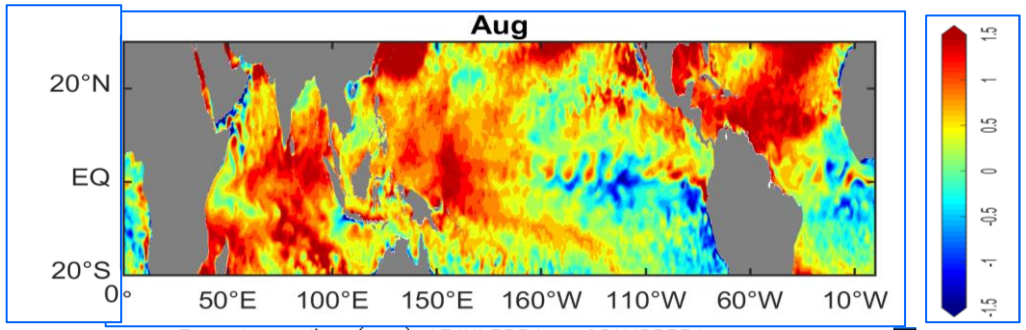


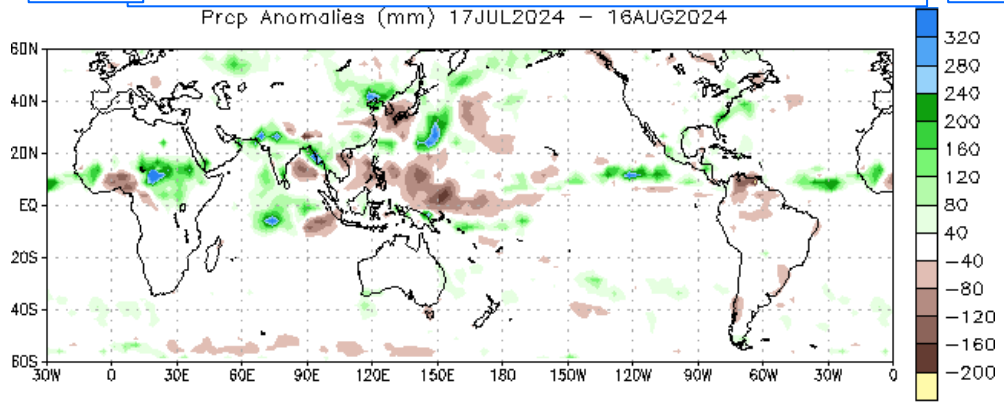


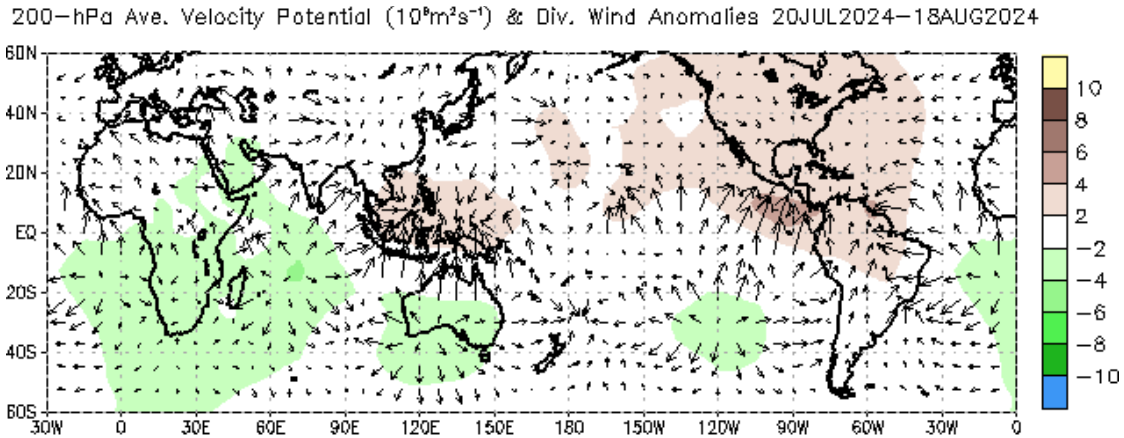
Data Source: NCEP/CDAS – Climatology (1991–2020)
(Wind speed > 1 ms⁻¹ shaded)



Data Source: NCEP/CPC Blended OLR
Climatology (1991–2020)

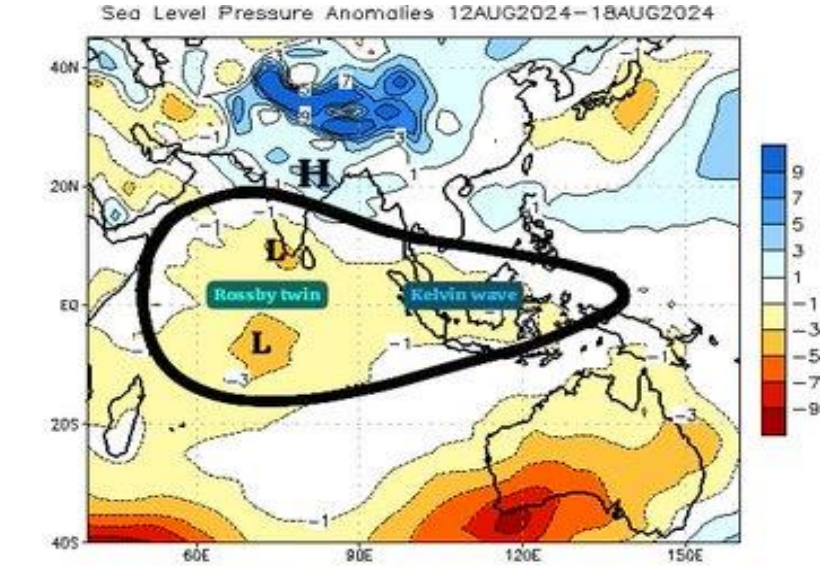




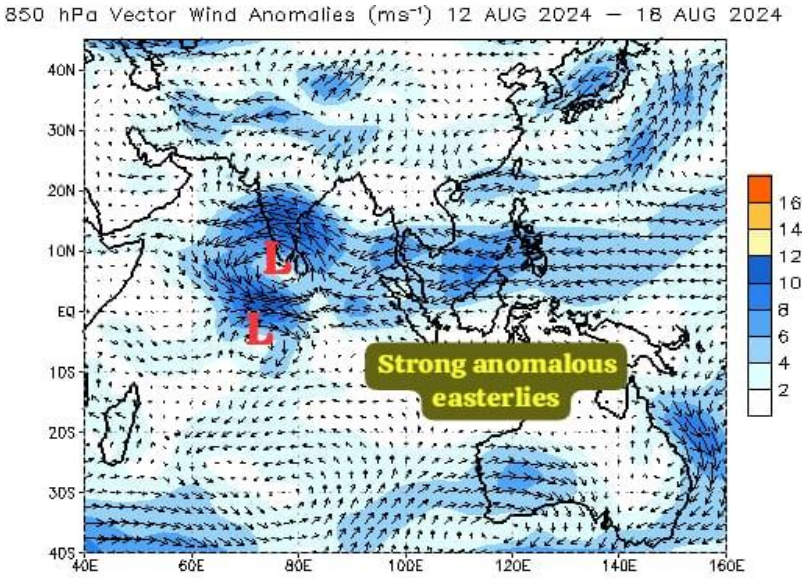


Data Source: NCEP CDAS
Climatology (1991–2020)

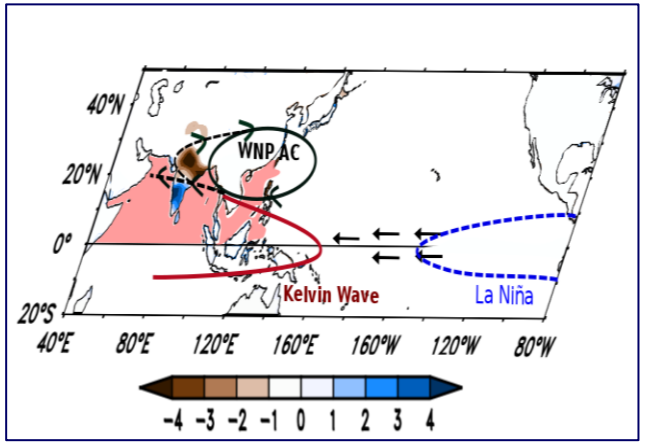
12 to 18th August - NCEP/CDAS



Data Source: NCEP/CDAS – Climatology (1991–2020)

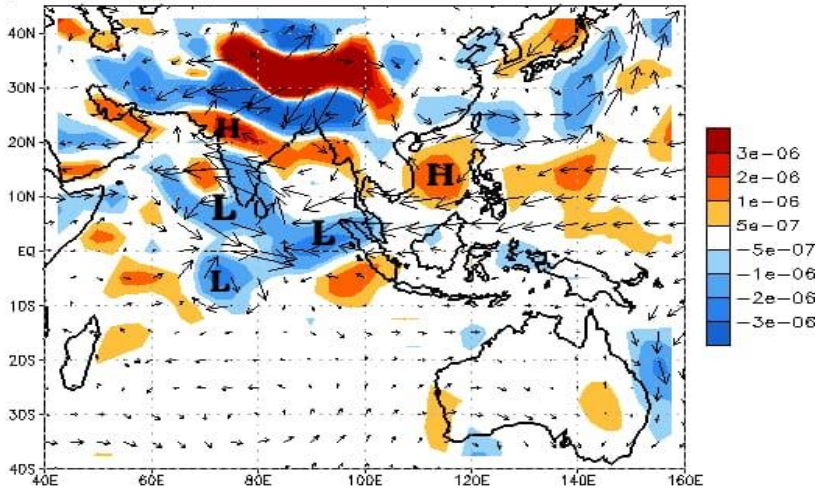


Data Source: NCEP/CDAS – Climatology (1991–2020)
(Wind speed > 2 ms⁻¹ shaded)

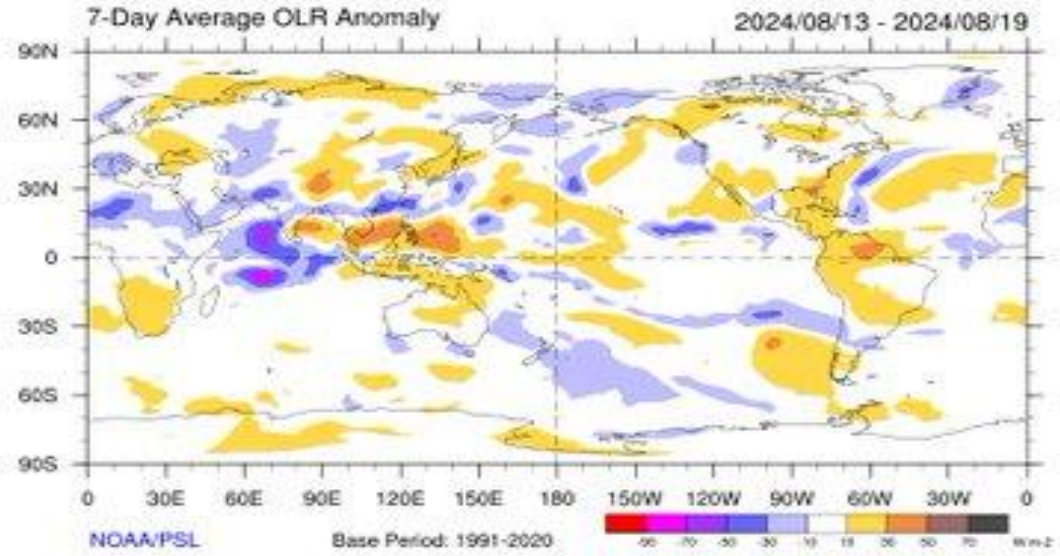


Light red color in the Indian Ocean represents basin-wide warming. Brown and Blue color over India shows negative and positive precipitation anomalies: For the month of July 2020 (Darshana et al. 2024)

Divergence of Water Vapor Flux Anomalies 12 AUG 2024 – 18 AUG 2024

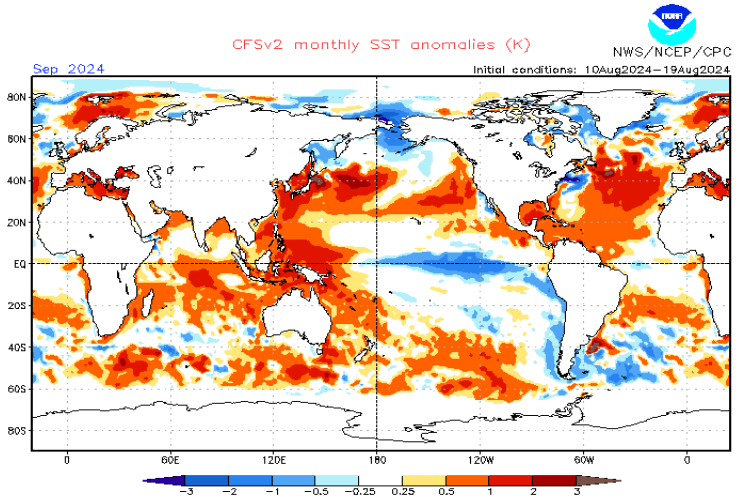


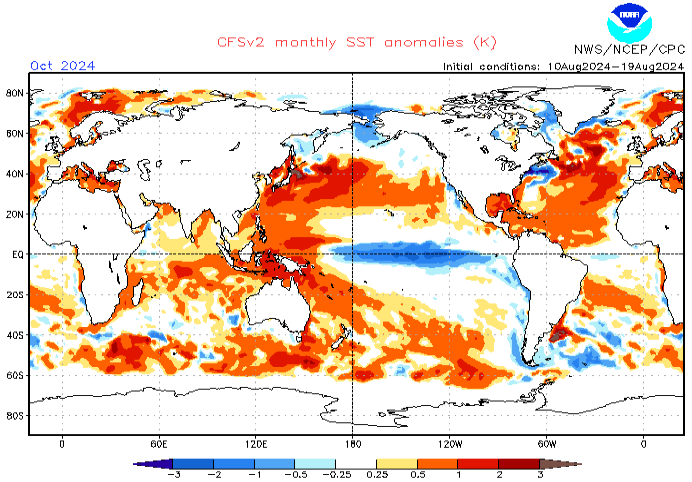
Data Source: NCEP/CDAS – Climatology (1991–2020)

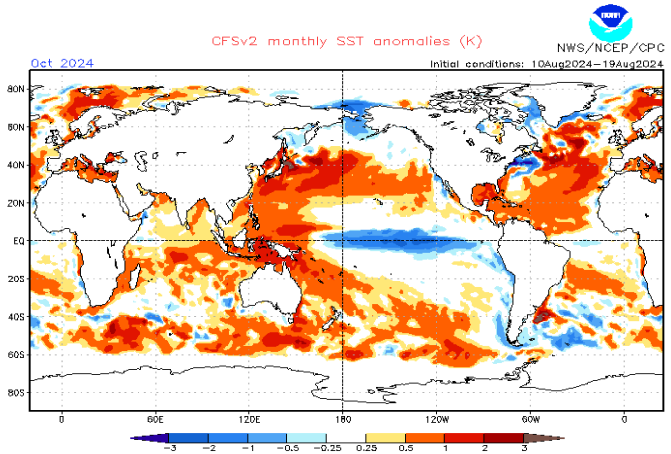


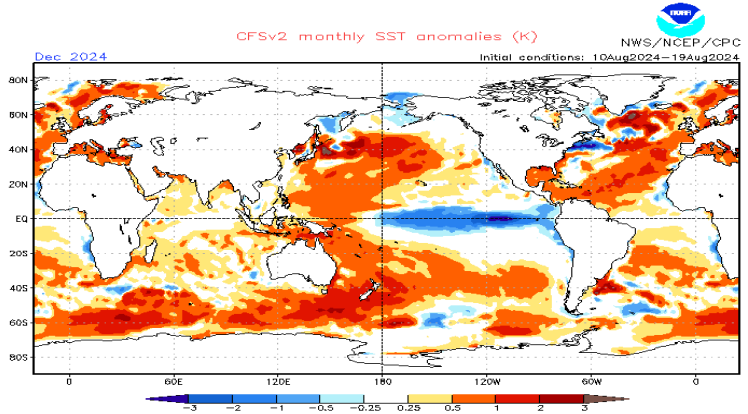
Gokul. T

CFSv2 forecast monthly SST anomalies ICs: 20240810 – 20240819 CPC







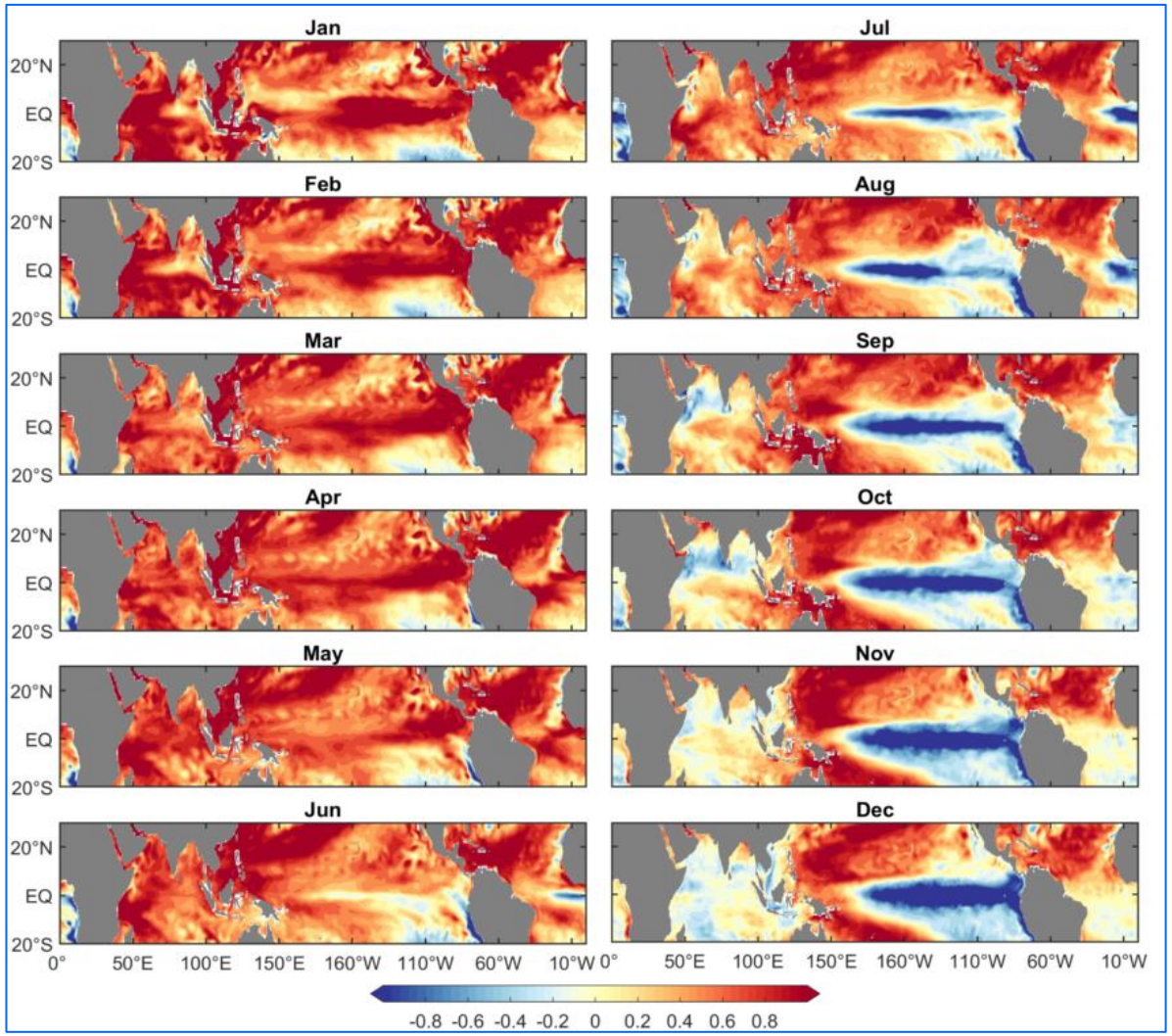


ENSO-neutral is expected to continue for the next several months, with La Niña favored to emerge during September-November (66% chance) and persist through the Northern Hemisphere winter 2024-25 (74% chance during November-January).*

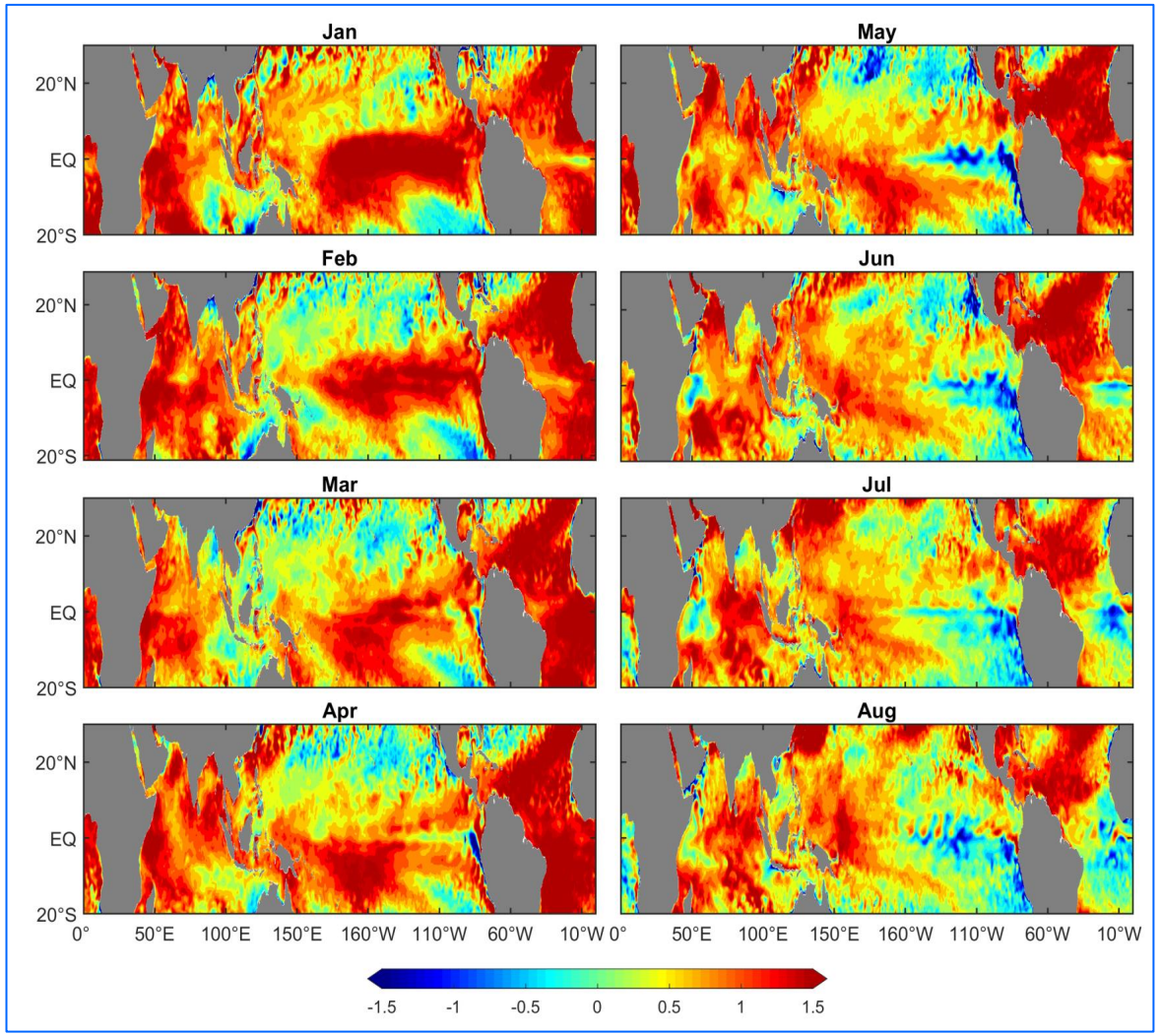
IITM Decadal Climate Prediction System (IITM-DCPS)

SST anomalies: Prediction from Nov 2023 ICs – IITM Decadal Climate Prediction System

IITM-DCPS: Nov 2023 ICs



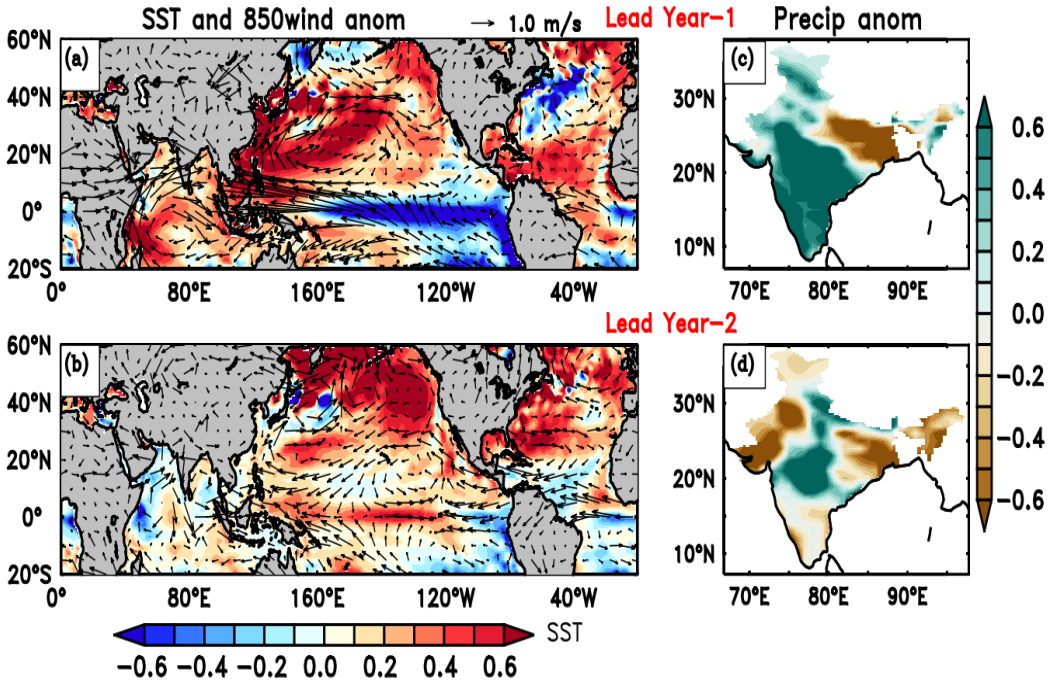
Observations

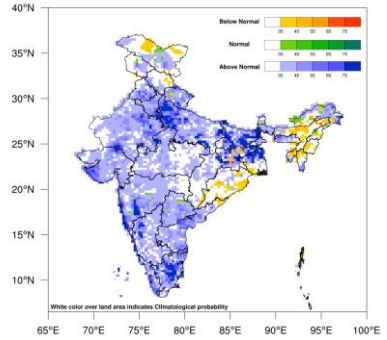


IITM Decadal Climate Prediction System (IITM-DCPS)

JJA – 2024- prediction

Summer Climate Prediction for 2024 in IITM-DCPS: JJA





IMD long range forecast for 2024 sw monsoon:

- Early monsoon: weakening of El Niño condition
- Second half of monsoon: La Niña conditions & Positive IOD
- Monsoon will be above normal with 106% of LPA

Other climate agencies also predict summertime La Nina conditions and dipole rainfall pattern over ISM region

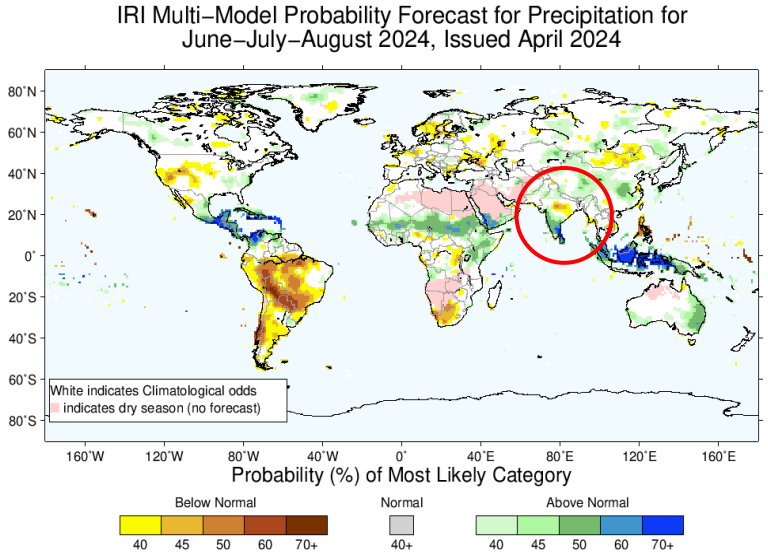
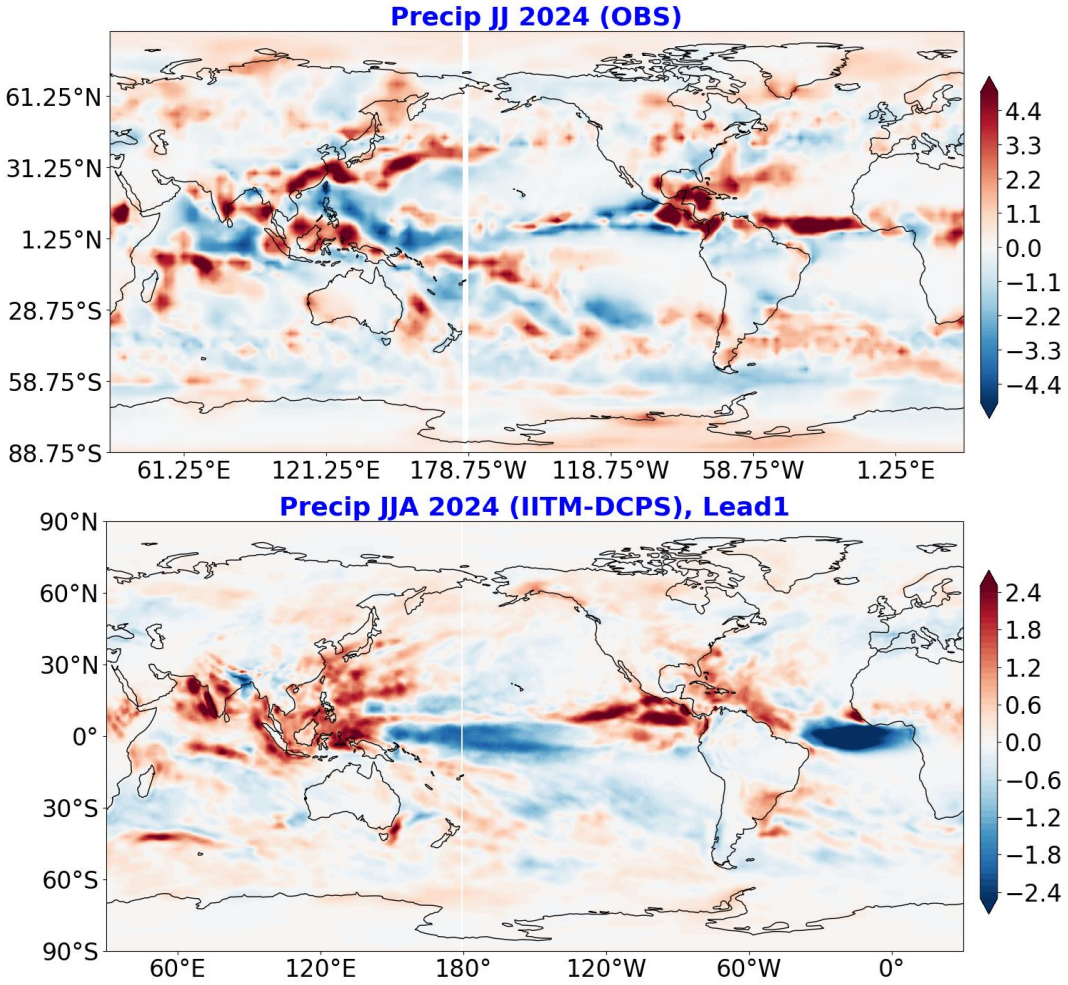


Fig. 2024 Summer (a-b) SST and 850 hPa wind anomaly for JJA (c-d) ISMR (JJA) anomaly in Model-Hindcast Lead Year-1 (Nov 2023 ICs) and Lead Year-2 (Nov 2022 ICs).

- IITM-DCPS Model LY1 Predicts La Nina-like cooling in eastern equ. Pacific, TIO warming and WNP anticyclonic circulation and Dipole-like precipitation structure over Indian land region
- Thus Year 2024 is the special case of positive IPOC mode (related to Decay of El Nino).

IITM Decadal Climate Prediction System (IITM-DCPS)

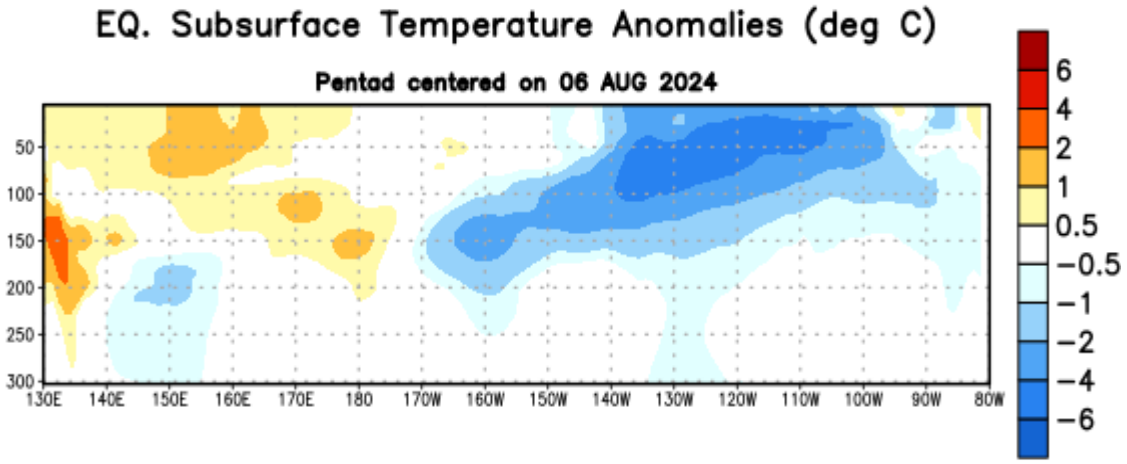


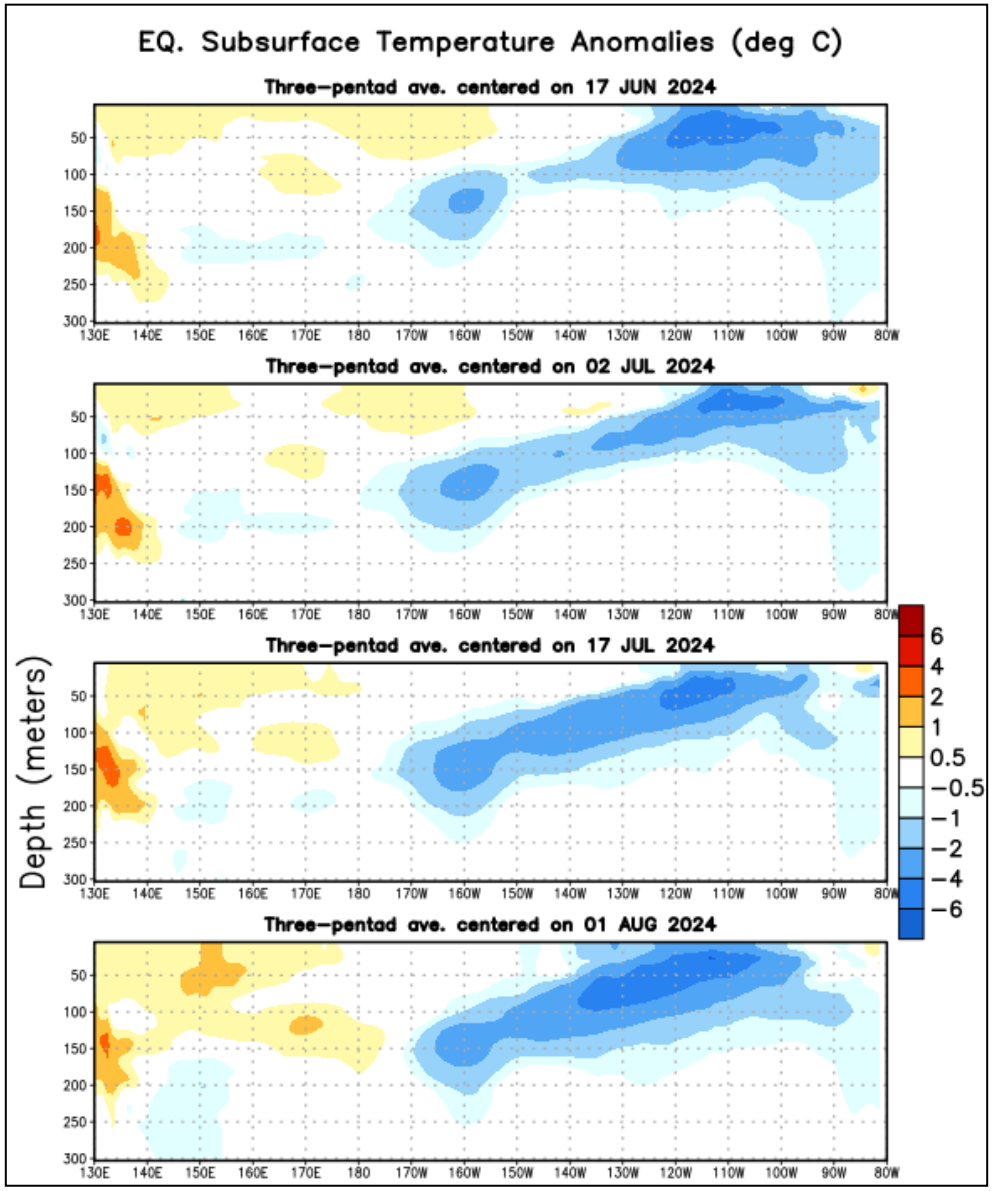
Spatial extent of above normal rainfall predicted by IITM-DCPS for year 2024.

Sub-Surface Temperature Departures in the Equatorial Pacific

- For two months, negative subsurface temperature anomalies have persisted in the eastern equatorial Pacific Ocean and extended to the surface.

- Below-average temperatures remain at depth in the central Pacific Ocean, with slightly above-average temperatures near the surface in the western Pacific Ocean.

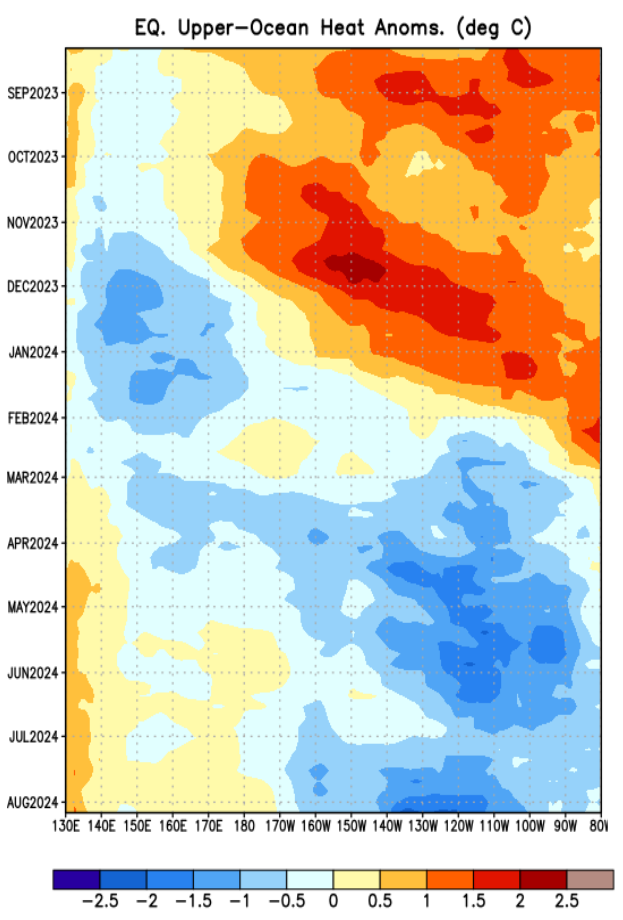


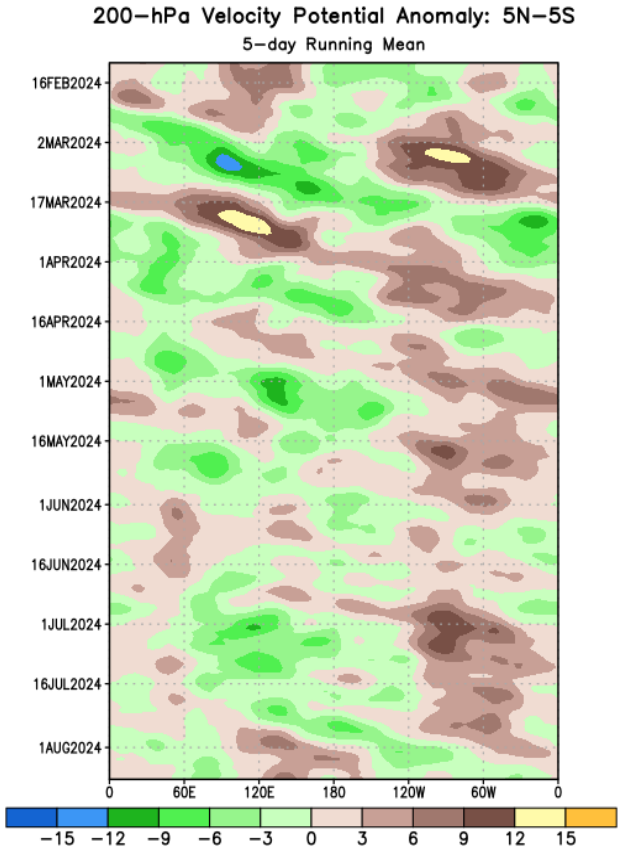


Climate Prediction Center / NCEP
12 August 2024

Weekly Heat Content Evolution in the Equatorial Pacific

- **Significant equatorial oceanic Kelvin wave activity (dashed and dotted lines) has been present throughout the period shown.**
- **Through January 2024, above-average subsurface temperatures persisted across most of the Pacific Ocean.**
- **Upwelling Kelvin waves were observed during December 2023, May 2024, and July 2024.**
- **Since March 2024, below-average subsurface temperatures were evident in the east-central and eastern Pacific. Equatorial oceanic Kelvin waves have alternating warm and cold phases.**



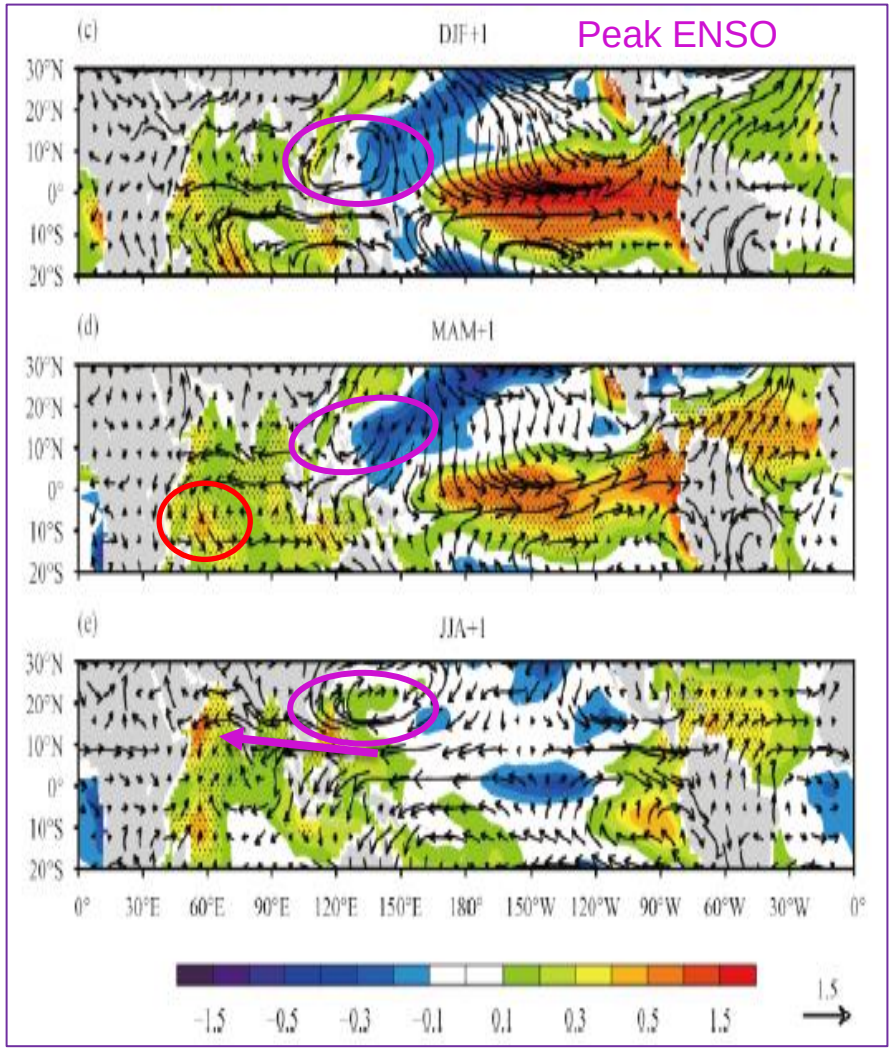


Climate Prediction Center / NCEP
12 August 2024

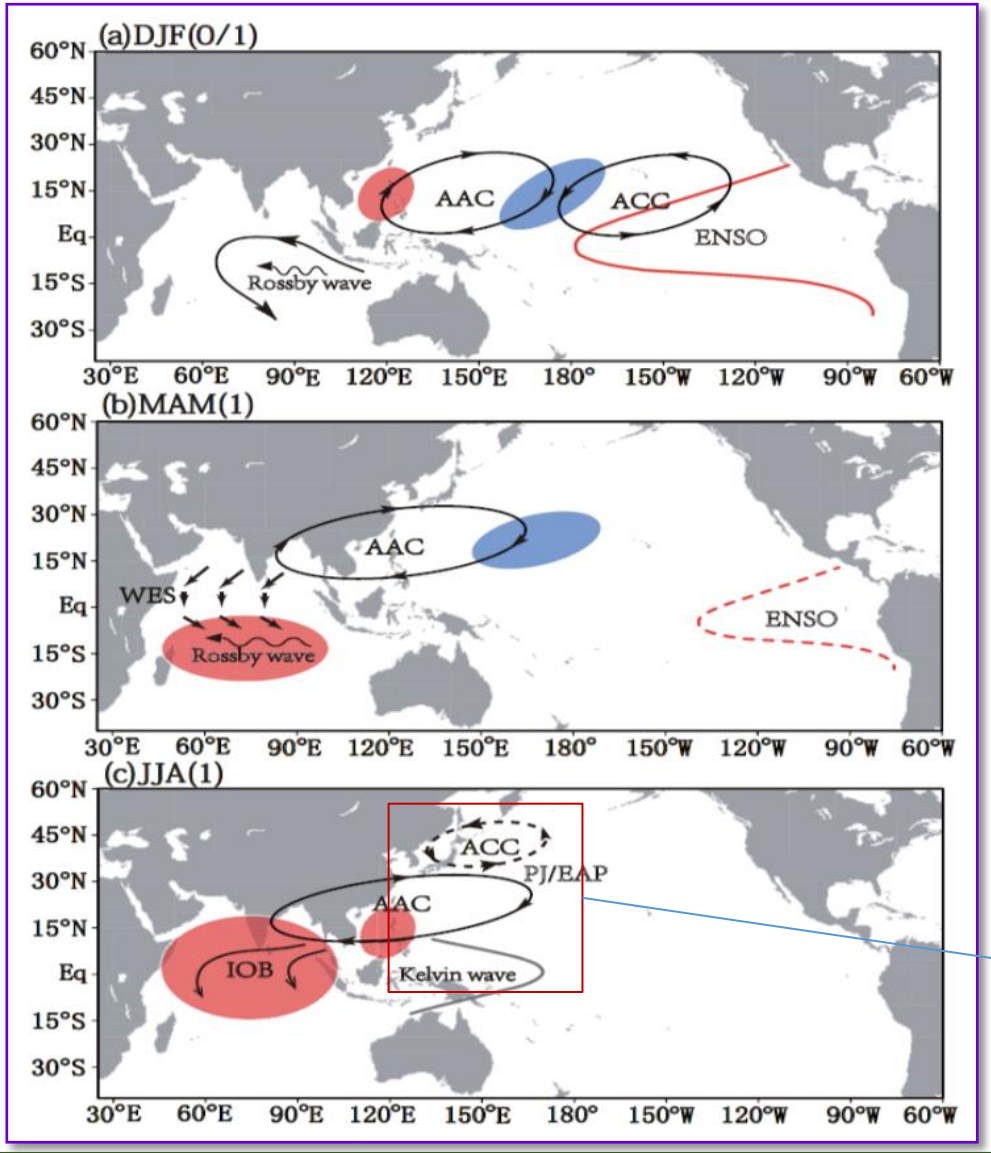
Thanks to – Gokul T, Dr. Gopinadh K, Dr. Darshana P, Dr. Vineet Singh, Dr. B Sudarsan Patro , Sc-D AWS Lab Pashan, Amol vibhute V, Dr. Gnanaseelan, Dr. Anant Parekh

Thank you

Evolution of 1) TIO basin wide warming 2) The Western-North Pacific AC - Indo-western Pacific **Ocean capacitor Mode**



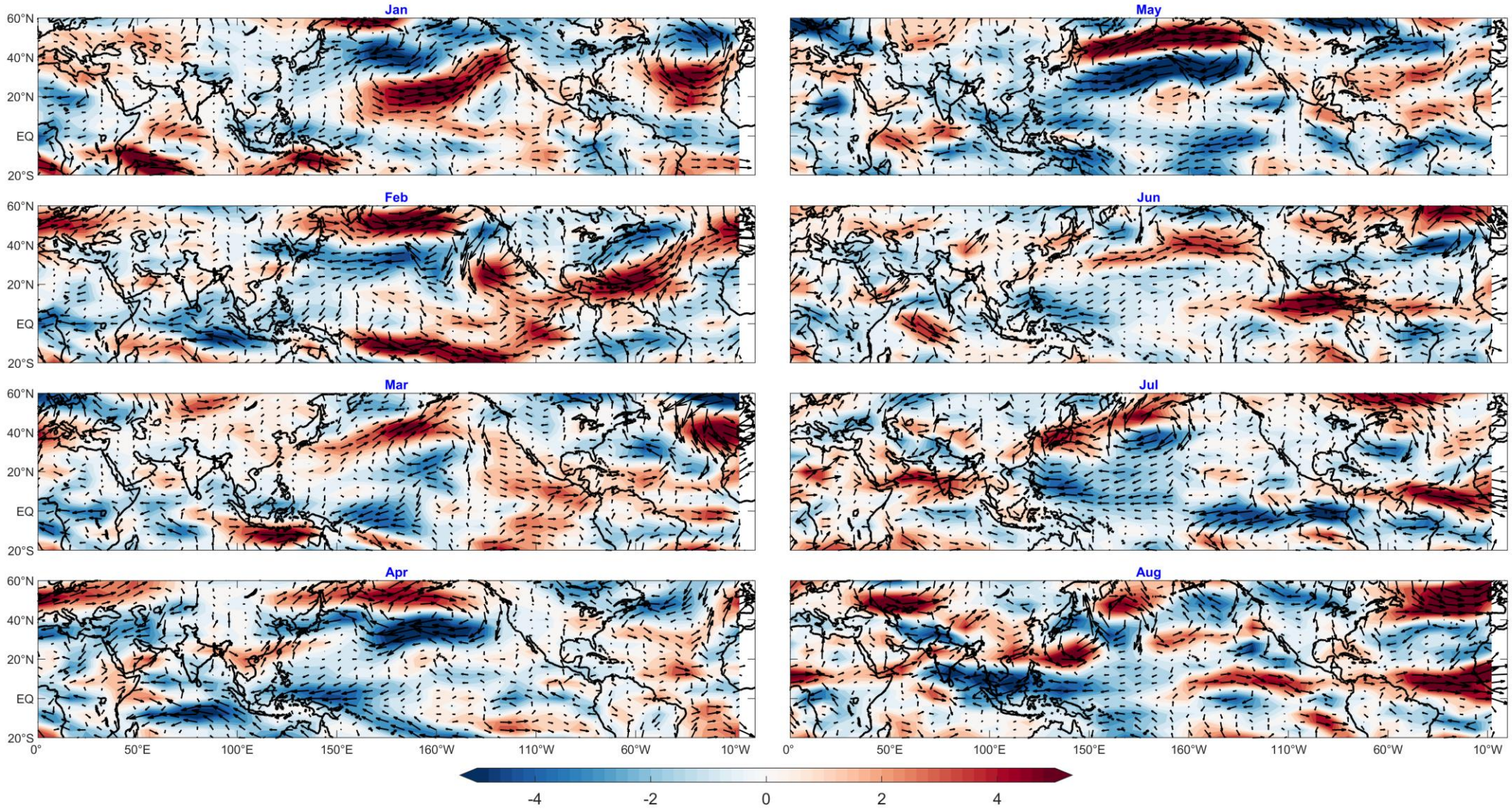
Anomalous SST (shaded, °C) and 850-hPa wind (m s–1) fields regressed against the Niño 3.4 index for (a) JJS0, (b) SON0, (c) DJF+1, (d) MAM+1, and (e) JJA+1 of 1980–2015 (Li et al. 2017).



The Pacific Japan pattern (Nitta 1987)

- **In decay phase of El Niño (JJA1), WNP AC keeps IO warm. In response, TIO SST feeds back and reinforces the AC via a tropospheric Kelvin wave. IPOC mode.**

Xie, S.P., Kosaka, Y., Du, Y., Hu, K., **Chowdary, J.S**. and Huang, G., 2016. Indo-western Pacific Ocean capacitor and coherent climate anomalies in post-ENSO summer: A review. *Advances in Atmospheric Sciences*, *33*(4), pp.411-432.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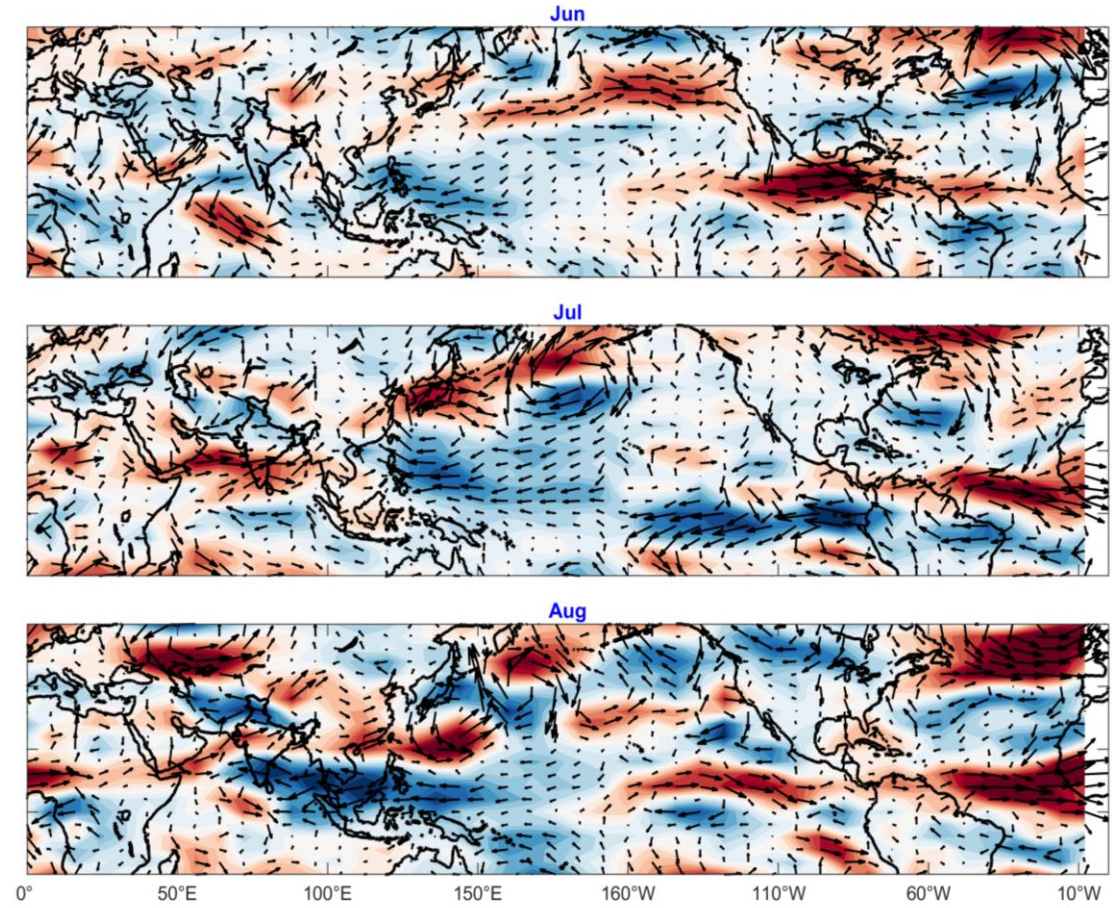
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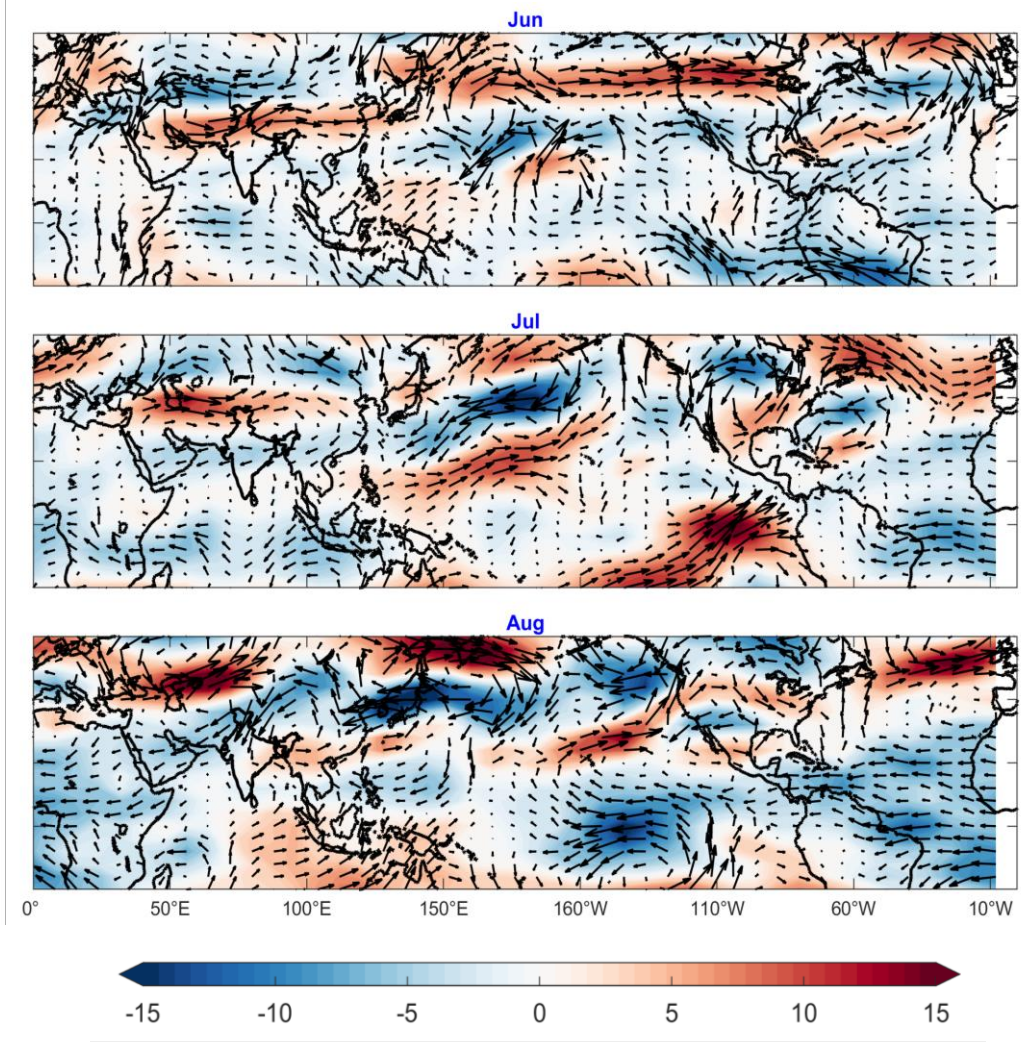
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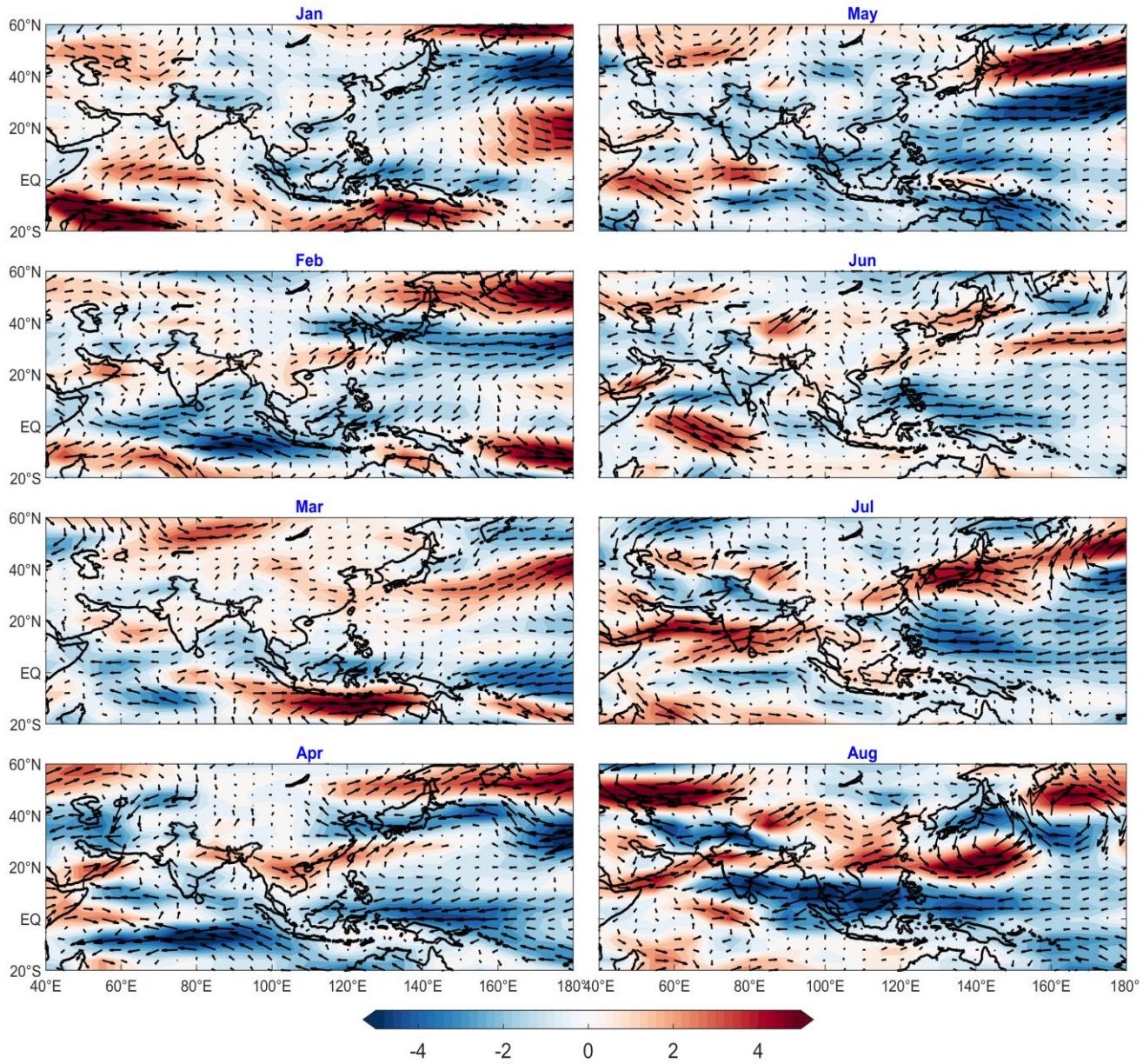
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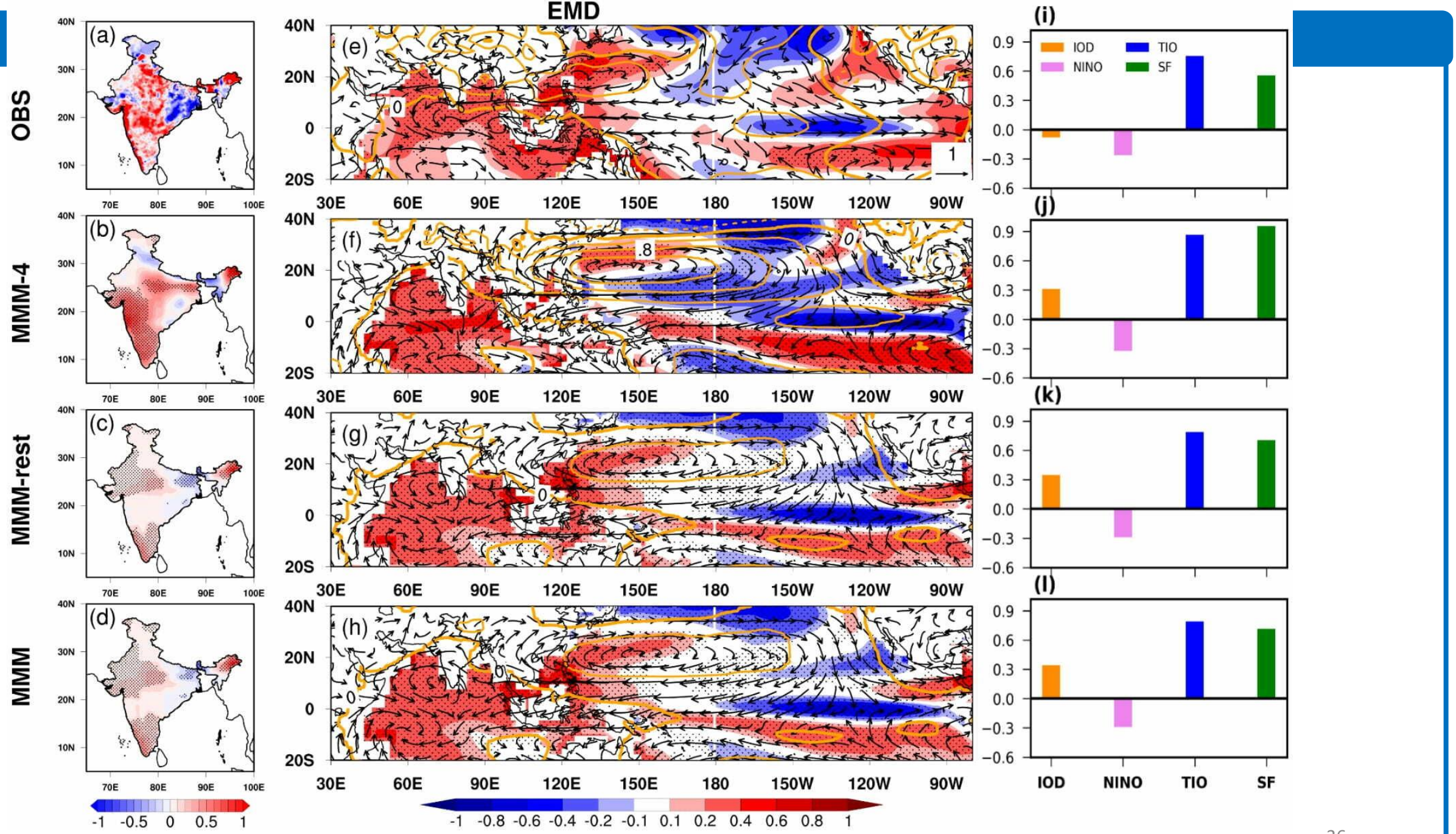
EMD
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