

THE CLIVAR SYMPOSIUM BRIDGING SCIENCE and Society in Southeast Asia and Beyond 2025

Poster Session 7 : Cascading and Compound Event inc. Climate Variability and Change , Wednesday, 24 September2025.

S7-P-01 : Unique Patterns of the Indian Ocean Dipole events since 2019

Salvienty Makarim⁽¹⁾, Yenni Tri Ayundawati⁽²⁾ , Triofarrah Evant ⁽³⁾, Agus Santoso⁽⁴⁾, Weidong Yu⁽⁵⁾, Albertus Sulaiman⁽⁶⁾, Widodo S Pranowo⁽⁶⁾

- 1) Center for Marine and Fisheries Training, The Agency for Marine Fisheries Extension and Human Resources Development, Ministry of Marine Affairs and Fisheries, Indonesia
2) University of Padjajaran, Indonesia
3) University of Sultan Ageng Tirtayasa, Indonesia
4) University of New South Wales (UNSW), Australia
5) School of Atmospheric Sciences, Sun Yat Sen University, China
6) Research Center for Climate and Atmosphere, National Research and Innovation Agency, Indonesia
Corresponding author: **Salvienty Makarim** (selvikarim05@gmail.com)

Abstract

The Indian Ocean Dipole (IOD) is a dominant climate driver in the Indian Ocean, altering ocean and atmospheric circulations over the Indian Ocean and beyond. Recent studies have suggested that modes of climate variability like the IOD may change under greenhouse forcing. As the planet continues to warm, it is necessary to observe and monitor the climate. Here, we analyze recent IOD events, finding some unique characteristics in negative IOD event in 2022 and positive IODs in 2019 and 2023 as reflected by their sea surface temperature, salinity, current, and rainfall patterns. Our analysis reveals that the 2022 negative IOD started earlier in May, and ended in October. The Indonesian Archipelago experienced an intensive rainfall from May to December 2022, induced sequentially by the Asian Monsoon, the negative IOD, the Australian Monsoon and the La Niña events.

During the 2019 positive IOD, cool SST and upwelling in the Eastern Indian Ocean were strong and the IOD ended in December 2019. However, the 2023 positive IOD was short lived from the end of August up to November, coinciding with an El Niño condition in the Pacific. The cooler SST off Sumatra during the 2023 IOD was stronger than off Java SST anomaly, leading to meridionally asymmetric rainfall pattern over Sumatra. The unique IOD characteristics in 2019, 2022 and 2023 appear to be linked to the warmer background Indo-Pacific SST. The IOD events involve changes to the Indonesian Throughflow through Indo-Pacific atmospheric teleconnection.

Keywords: IOD, Asian Monsoon, Australian Monsoon, La Niña, El Niño, Indonesian Throughflow

Fig 1. IOD Positive 2019

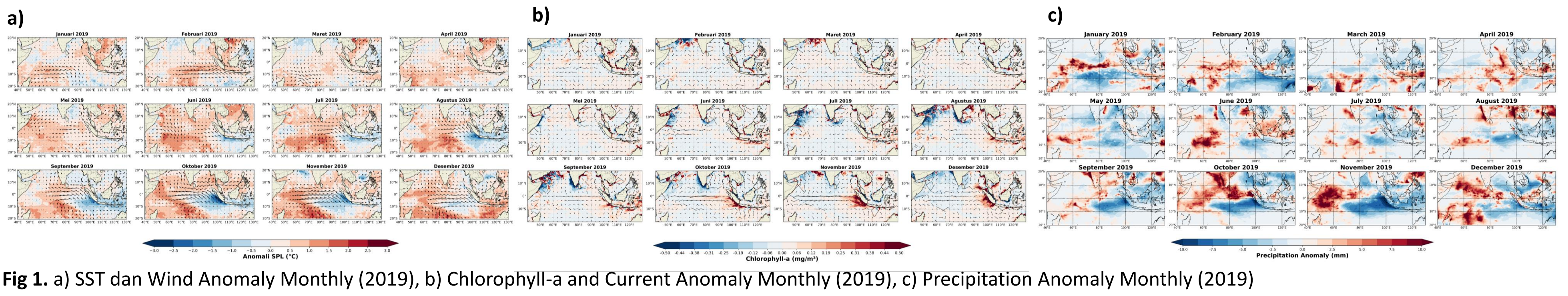


Fig 1. a) SST dan Wind Anomaly Monthly (2019), b) Chlorophyll-a and Current Anomaly Monthly (2019), c) Precipitation Anomaly Monthly (2019)

Fig 2. IOD Positive 2023

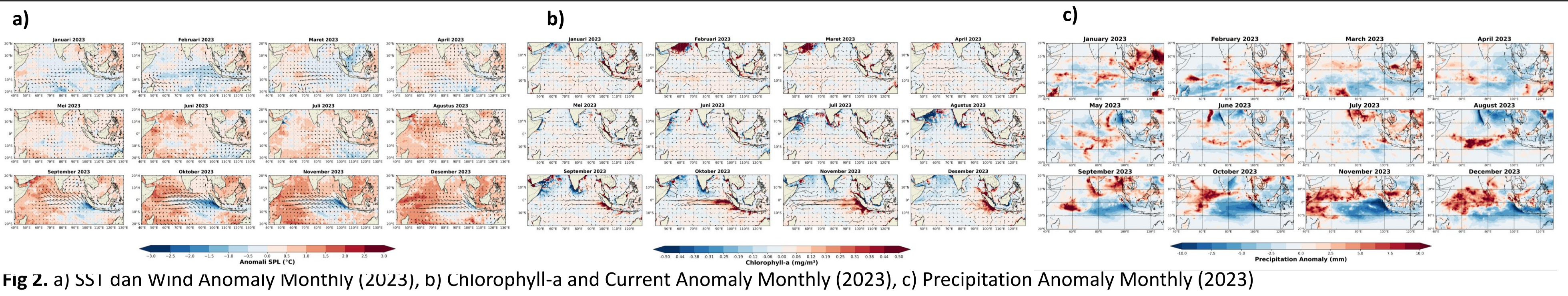


Fig 2. a) SST dan Wind Anomaly Monthly (2023), b) Chlorophyll-a and Current Anomaly Monthly (2023), c) Precipitation Anomaly Monthly (2023)

Table 1. IOD Positive (1980-2024)

NO	Year	Intensity
1	1982	Moderate
2	1991	Weak
3	1994	High
4	1997	High
5	2006	Moderate
6	2008	Weak
7	2012	Weak
8	2015	Weak
9	2017	Weak
10	2019	High
11	2023	High

Fig 4. Composite IOD Positive for the Period 1980-2024

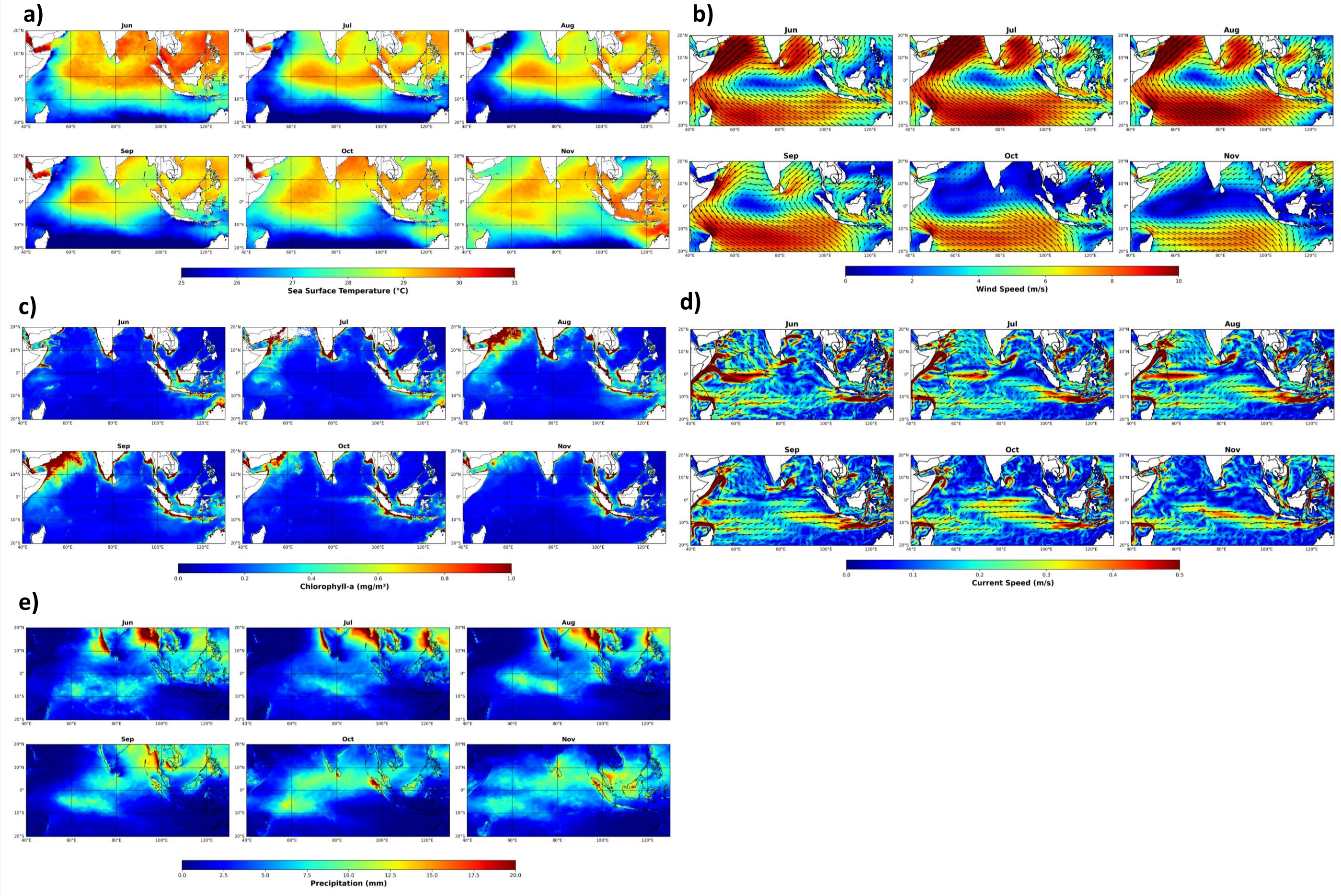


Fig 4. a) SST Monthly (June-November), b) Wind Speed and Direction Monthly (June-November), c) Chlorophyll-a Monthly (June-November), d) Current Speed and Direction Monthly (June-November), e) Precipitation Monthly (June-November)

Table 2. IOD Negative (1980-2024)

NO	Tahun	Itensitas
1	1981	Weak
2	1983	Moderate
3	1988	Weak
4	1998	Moderate
5	2002	Weak
6	2005	Weak
7	2010	Moderate
8	2014	Weak
9	2016	Moderate
10	2022	High

Fig 5. Composite IOD Negative for the Period 1980-2024

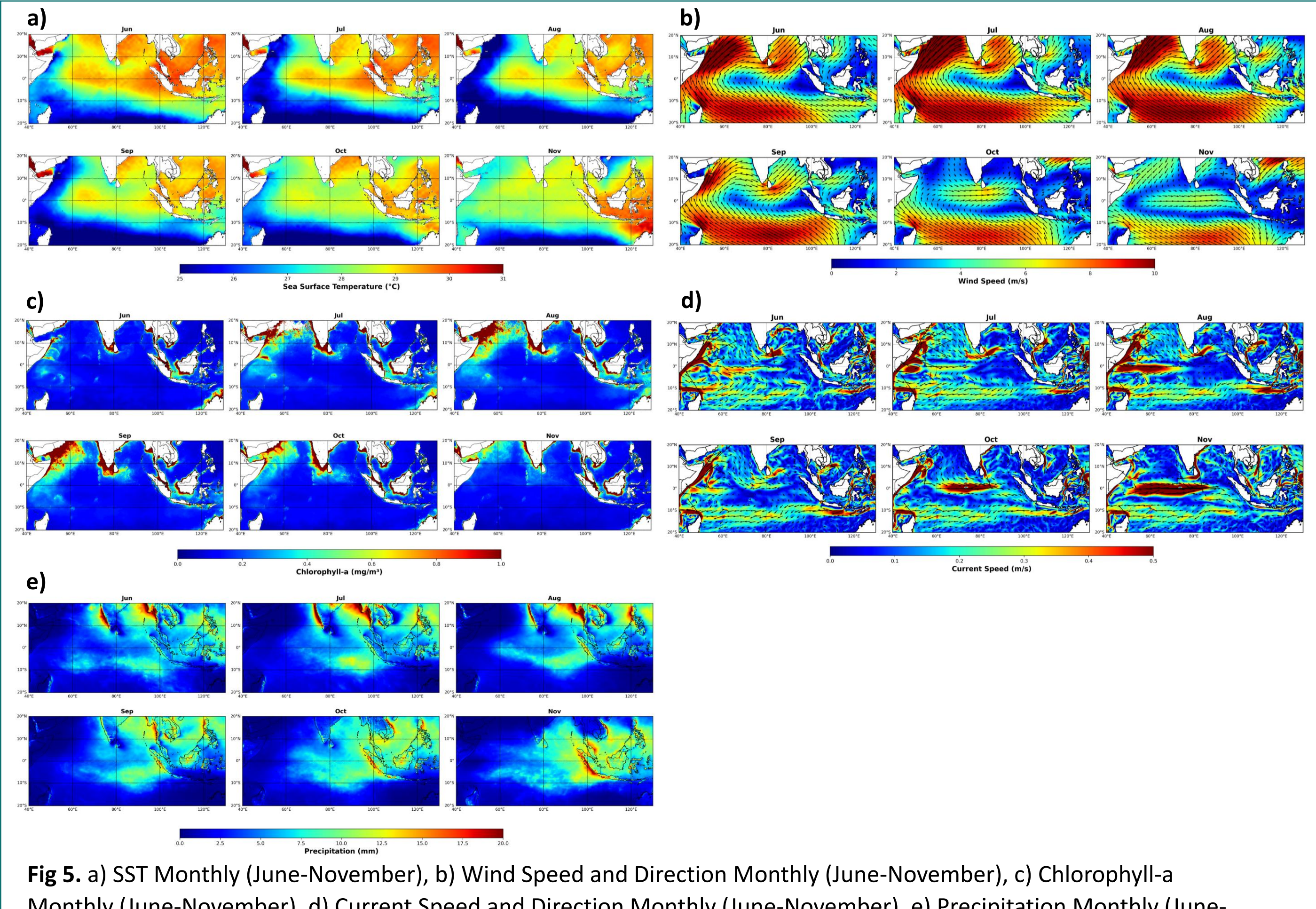


Fig 5. a) SST Monthly (June-November), b) Wind Speed and Direction Monthly (June-November), c) Chlorophyll-a Monthly (June-November), d) Current Speed and Direction Monthly (June-November), e) Precipitation Monthly (June-November)

Fig 3. IOD Negative 2022

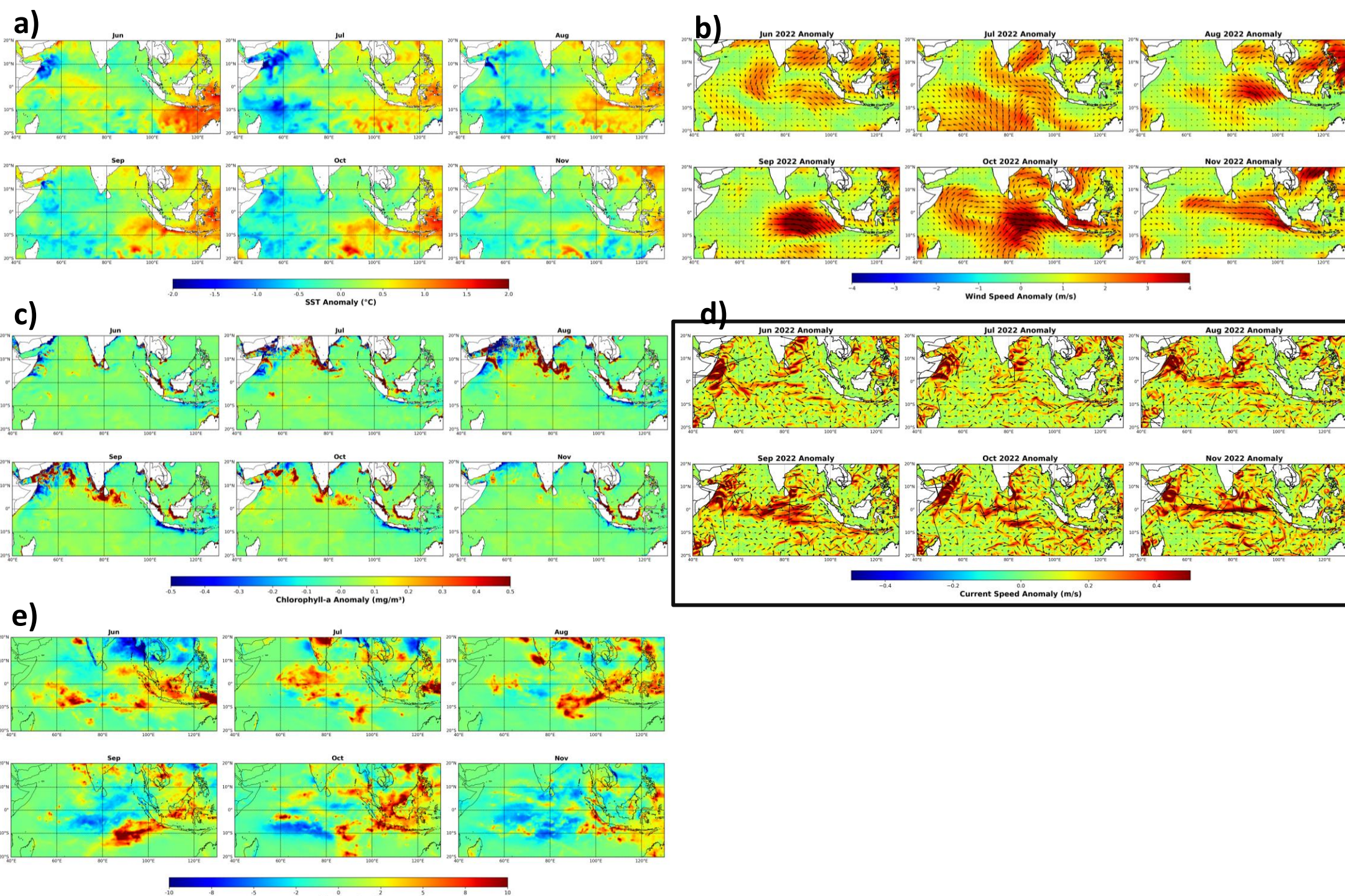


Fig 3. a) SST Anomaly Monthly (June-November), b) Wind Speed and Direction Anomaly Monthly (June-November), c) Chlorophyll-a Anomaly Monthly (June-November), d) Current Speed and Direction Anomaly Monthly (June-November), e) Precipitation Anomaly Monthly (June-November)

Fig 6. Quarterly for the Period 2019-2024

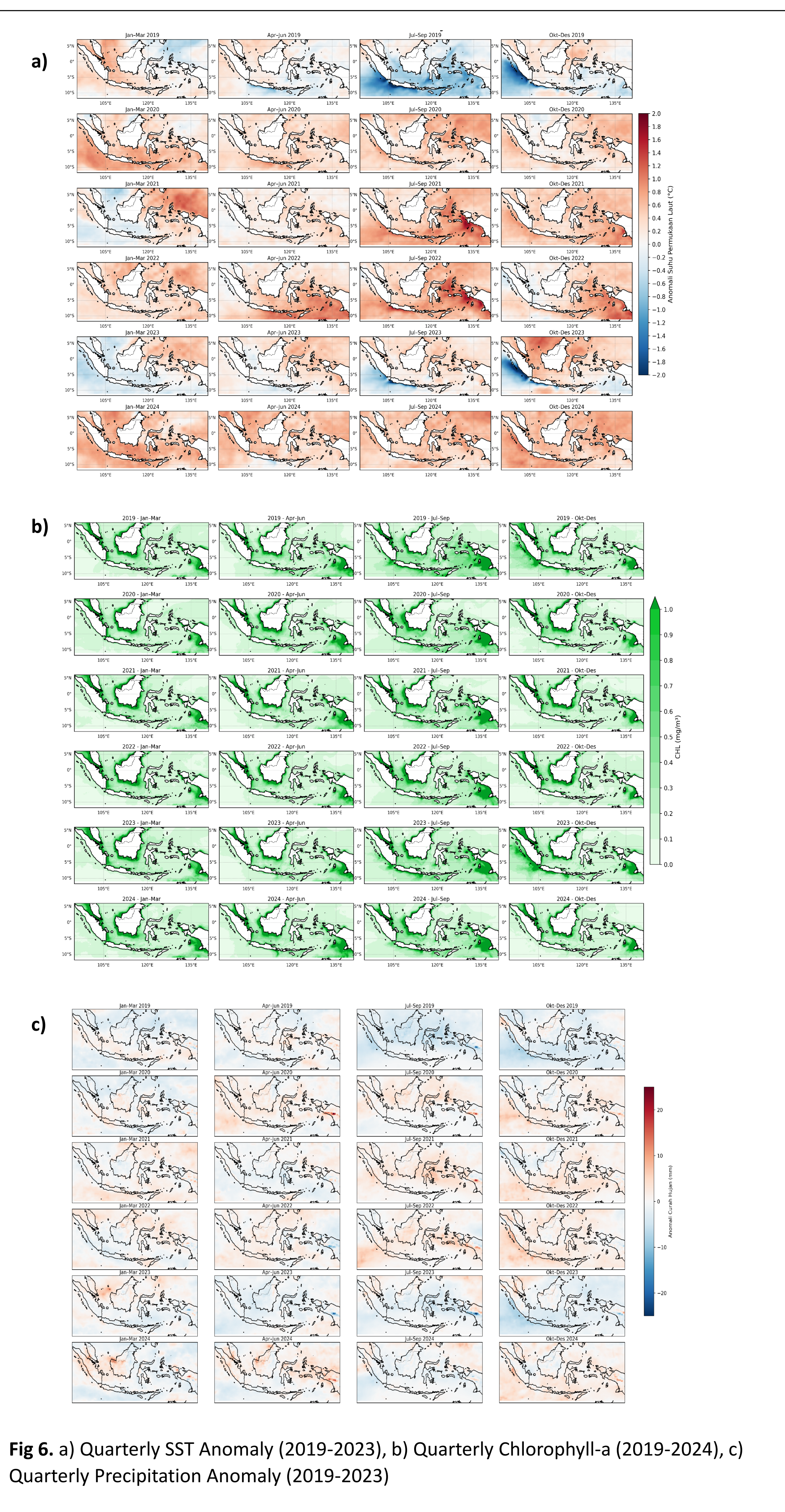


Fig 6. a) Quarterly SST Anomaly (2019-2023), b) Quarterly Chlorophyll-a (2019-2024), c) Quarterly Precipitation Anomaly (2019-2023)

Conclusion

The positive IOD positive 2019 and 2023 and The Negative IOD 2022 have unique patterns since the Indo-Pacific SST warmer and broader since 2019. The rainfall occurred during IOD positive IOD 2019 and 2023 in North Sumatra and Kalimantan when the upwelling and surface ocean current were also stronger. Meanwhile during The Negative IOD 2022 the higher rainfall precipitation occurred and the surface current from Karimata Strait appeared significantly. Seems the ITF water and ITF water exchanged responded intensively during the IOD events and a coupled IOD and ENSO contributes to the rainfall patterns in the maritime continent since 2019.