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Review of the Southwest Monsoon 2024 in Malaysia

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ASSESSMENT REPORT

REVIEW OF THE SOUTHWEST MONSOON 2024 IN MALAYSIA

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1.0 OVERVIEW

The southwest monsoon in Malaysia is part of the Asian Summer monsoon regime. Due to the prevailing southwesterly wind during this time of the year, it is known as the southwest monsoon by the locals. The season typically begins in mid-May and ends in mid-October, during which the monsoon trough is generally positioned to the north of the Malaysian region. During this period, winds will blow consistently from the southwest with lower air humidity and more stable atmospheric conditions. Large-scale climate drivers such as the El Niño–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) remained predominantly neutral during this season, indicating minimal large-scale modulation of regional rainfall variability. Hence, one would expect less rain to occur due to the absence of any large-scale weather systems. Intraseasonal variability during this season was mainly influenced by intermittent Madden–Julian Oscillation (MJO) activity. Nevertheless, rainfall can still occur, particularly during the break phase of the monsoon. The onset date of SWM 2024 over the Malaysian region based on official declaration by the Malaysian Meteorological Department (MET Malaysia) was declared on **17th May 2024**, while the **24th September 2024** was considered to be the withdrawal date of the SWM 2024. Overall, the 2024 Asian summer monsoon which lasted from May to September was close to climatological normal conditions.

This report summarizes the surface climate characteristics and atmospheric conditions associated with SWM 2024. The report also discusses analyses of the SWMI, ENSO conditions, IOD phase, MJO characteristics, monthly mean rainfall distribution amount and the occurrence of tropical cyclones over the western Pacific Ocean during SWM 2024.

2.0 ONSET AND WITHDRAWAL OF THE MONSOON IN MALAYSIA

2.1 The Southwest Monsoon Index (SWMI)

One criterion for the SWMI onset is for the meridional shear of zonal wind at the 850 hPa level, must be less than 0 m/s. The SWMI reanalysis data for Malaysia (Figure 1) revealed that the first-time continuous values of negative meridional shear (SWM) were calculated fell on the **17th May 2024**. During the withdrawal phase, the meridional shear of zonal wind at the 850 hPa level must be greater than 0 m/s. The reanalysis data (Figure 1) showed that the withdrawal date fell on the **4th October 2024**, when positive values of SWMI were observed. The SWMI-based reanalysis data indicates the onset date was consistent with the official declaration, while the withdrawal date differs from the official declaration which is on 24th September 2024.

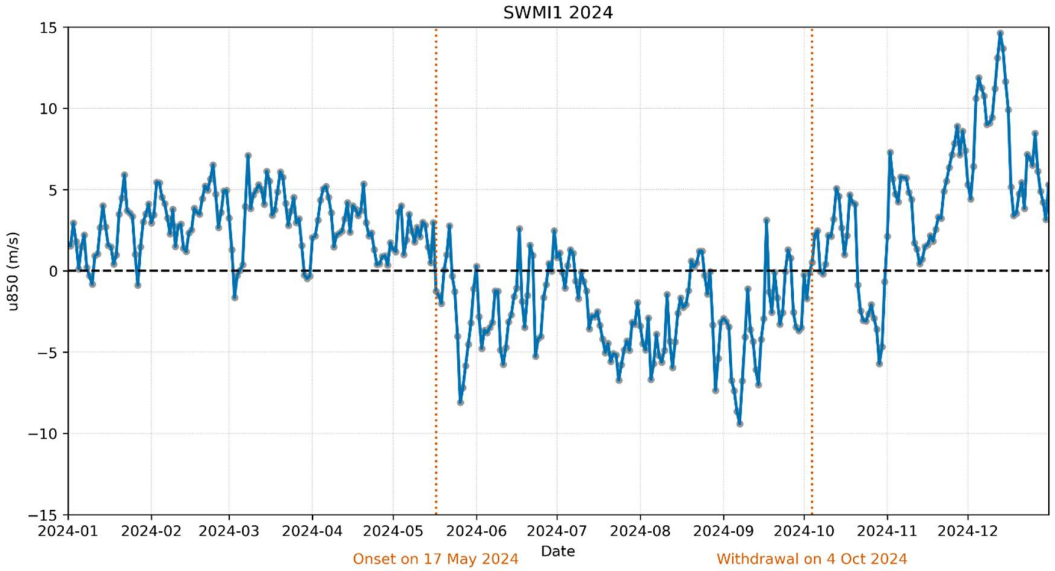

Figure 1. SWMI for Southwest Monsoon 2024

2.2 Synoptic Features

The provided panels (Figure 2), illustrate the monthly mean precipitation derived from Global Precipitation Measurement (GPM) and the low-level wind circulation at 850 hPa from ECMWF Reanalysis v5 (ERA5) for the period from May to September 2024, including the MJJAS (May-June-July-August-September) seasonal mean. The Southwest Monsoon (SWM) is generally characterized by drier conditions (less rainfall) compared to the Northeast Monsoon (NEM) and the inter-monsoon seasons, due to the stable atmospheric conditions associated with the prevailing southwesterly flow.

The wind arrows clearly show the transition and establishment of the SWM, which is defined by a consistent westerly/southwesterly wind flow across the region, particularly over the South China Sea (SCS) and Peninsular Malaysia. In May 2024, the winds over the SCS and Peninsular Malaysia are generally shifting, indicating the onset of the SWM, which typically begins in mid-May. The flow is becoming more westerly/southwesterly. From June to August 2024, the Southwest Monsoon circulation is well-established. Strong and persistent southwesterly winds prevail from the Bay of Bengal, across the Indochina Peninsula, and into the SCS. This flow pattern, particularly the stronger westerlies over the northern part of the domain, is characteristic of the SWM season. Meanwhile in September, the flow remains generally southwesterly, but there are signs of weakening and more variable directions over the southern SCS and Borneo, hinting at the approaching Monsoon Transition Phase. The seasonal mean (MJJAS Seasonal Mean) clearly shows the dominant southwesterly wind pattern across the entire domain, reflecting the seasonal average circulation characteristics during the season.

Rainfall over Peninsular Malaysia is generally lower throughout the period from May to September, consistent with the SWM being the relatively drier season. There is a persistent area of slightly higher rainfall along the west coast (May, June, July, August), likely associated with nocturnal and early morning Sumatra squall lines forming over the Straits of Malacca and moving eastward, as well as local convection.

Rainfall over Sarawak and Sabah appears more variable and localized compared to the Peninsular, but generally remains in the moderate range. From the figure, the highest precipitation is consistently located north and east of the Philippines

and over parts of Indochina and the Bay of Bengal. This enhanced convection is associated with the active monsoon trough and is the primary area for tropical cyclone (TC) formation during the boreal summer, which can indirectly influence Malaysian weather by steering the SWM flow.

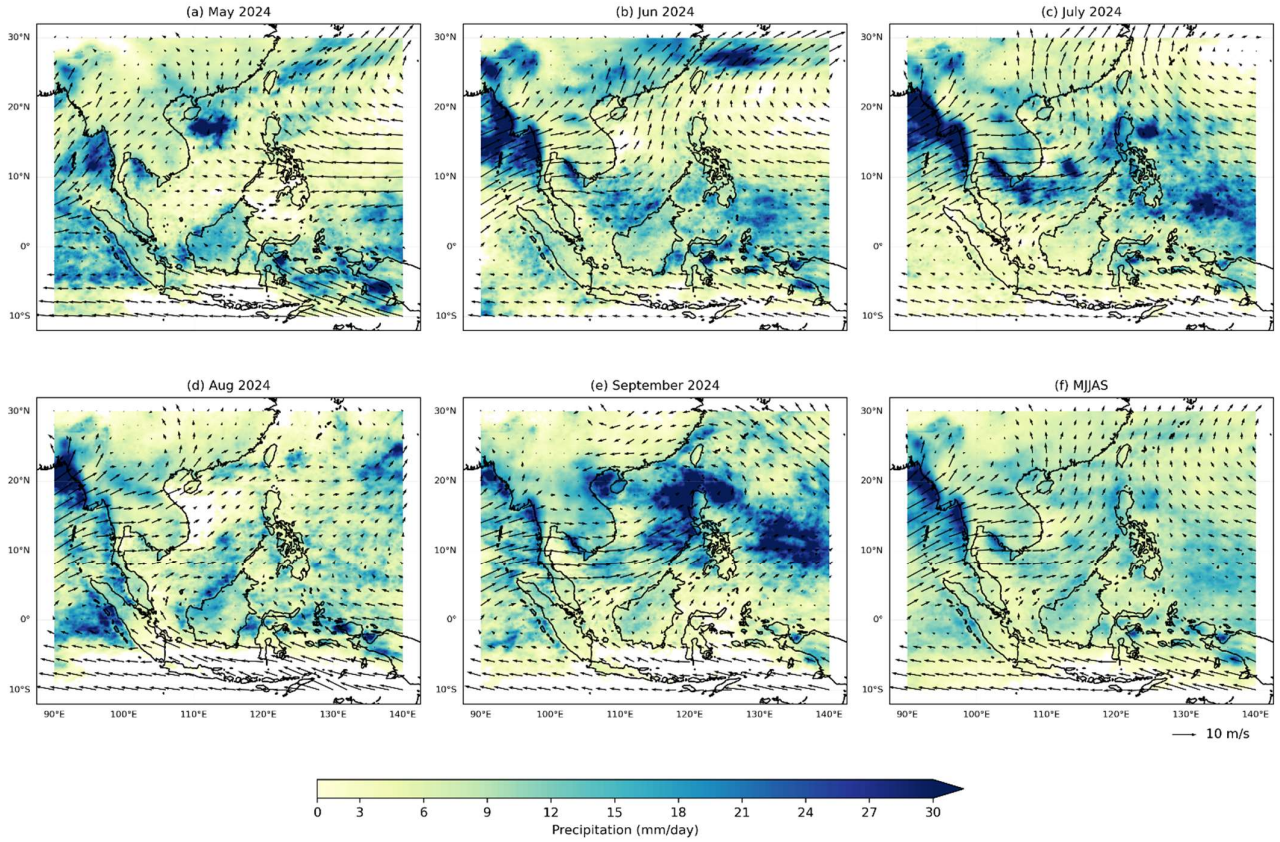

Figure 2. Wind and precipitation during Southwest Monsoon 2024

3.0 SEA SURFACE TEMPERATURE

3.1 El Niño-Southern Oscillation (ENSO) Condition

The ENSO state remained neutral during the preceding Southwest Monsoon season, indicating that the average Sea Surface Temperatures (SSTs) in the central equatorial Pacific Ocean fluctuated near the long-term mean (see Figure 3).

This suggests that large-scale global teleconnections typically driven by strong El Niño or La Niña events will be minimal or absent. Consequently, the Malaysia region experienced weather patterns (temperature and precipitation) that are more closely aligned with seasonal long-term averages. Figure 3 shows the Relative Niño3.4 index obtained from The Australian Bureau of Meteorology (BoM) website.

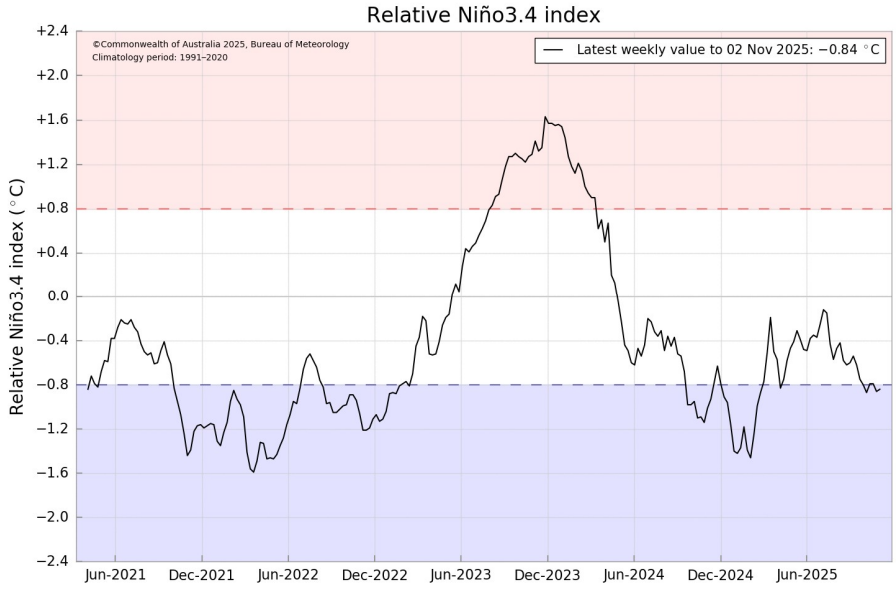

Figure 3. Relative Niño3.4 Index
(Source: https://www.bom.gov.au/climate/enso/)

3.2 The Indian Ocean Dipole (IOD)

The Indian Ocean Dipole (IOD) indicated a neutral IOD throughout the period although the index values had generally been above zero in May 2024 (see Figure 4). During the neutral IOD phase, there was no significant warming or cooling in the western or eastern Indian Ocean. With the absence of strong sea surface temperature anomalies, the IOD did not exert a strong influence on regional weather patterns, resulting in relatively minimal changes to the atmospheric circulation. Consequently, the Walker circulation and equatorial westerly wind anomalies typically associated with positive or negative IOD phases were largely absent. The prevailing atmospheric patterns across Southeast Asia therefore reflected seasonal monsoon dynamics, rather than basin-scale ocean–atmosphere interactions tied to the IOD.

As a result, the sea surface temperatures in the tropical Indian Ocean remained close to normal. Under such conditions, the climate over the Maritime Continent is primarily governed by monsoonal evolution and local convective processes.

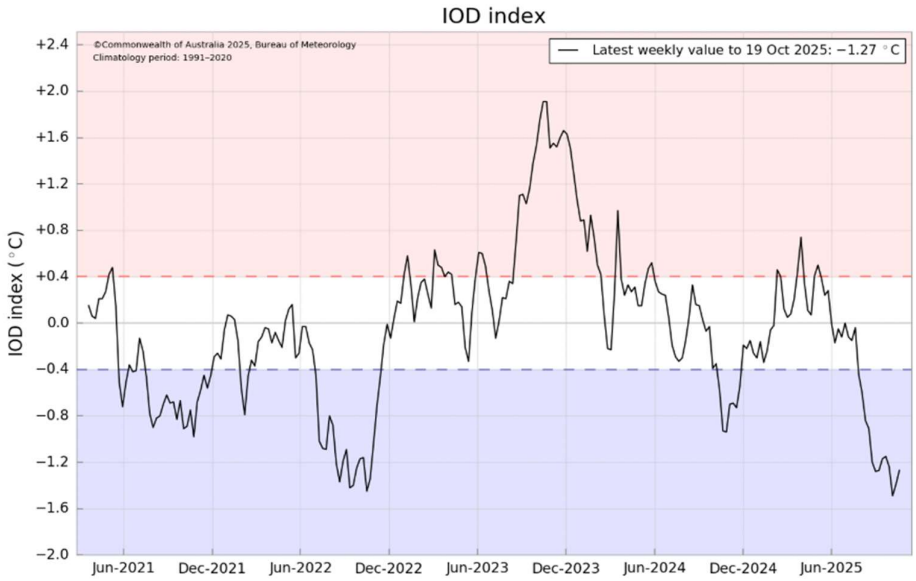

Figure 4. IOD index (Source:https://www.bom.gov.au/climate/enso/)

4.0 THE MADDEN–JULIAN OSCILLATION (MJO)

The Malaysia's weather patterns were influenced by fluctuations in the Madden–Julian Oscillation (MJO), especially during periods when the signal became active over the Maritime Continent. The impacts varied month by month depending on the strength and phase of the MJO. MJO is an eastward-moving disturbance of clouds, rainfall, winds and pressure that circles the globe in the tropics every 30-60 days. The horizontal axis represents RMM1 and the vertical axis represents RMM2. The distance from the center (the black circle) indicates the MJO strength; points inside the circle suggest a weak or undetectable MJO, while points outside signify an active MJO signal.

Figure 5 shows the active MJO in Phase 5 during May 2024 likely enhanced convection over the Maritime Continent, supporting heavy rainfall episodes. Similarly, the active MJO in Phases 4 and 5 during early to mid-September 2024 likely enhanced convection over the Maritime Continent. From June to August 2024, the MJO signal weakened significantly, becoming inactive or incoherent. During these months, the MJO contributed minimally to regional rainfall variability.

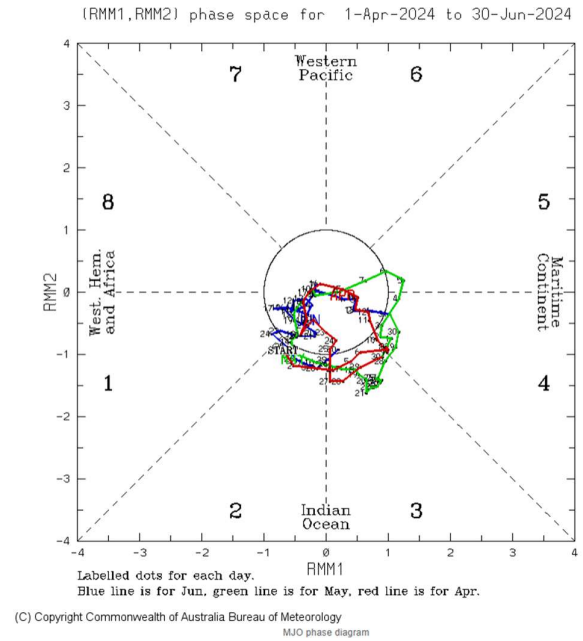

Figure 5. MJO phases from April to Jun 2024. The red line represents April, the green line represents May and the blue line represents Jun.

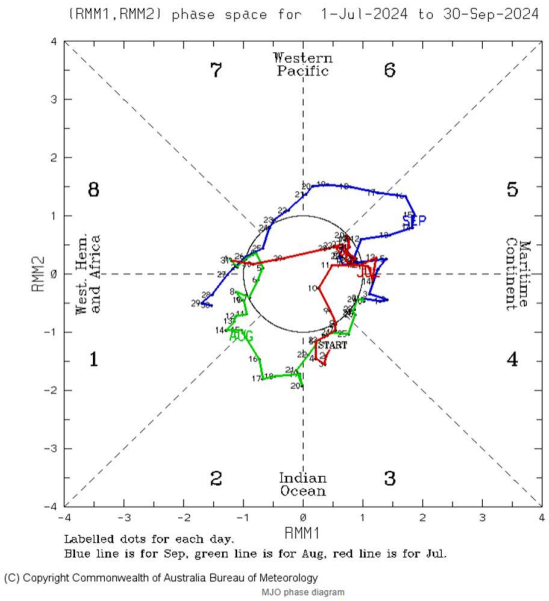

Figure 6. MJO phases from July to September 2024. The red line represents July, the green line represents August and the blue line represents September.

5.0 PRECIPITATION

Figure 7 illustrates the monthly mean rainfall in Peninsular Malaysia and Borneo from the 42 principal stations distribution from May to September 2024. The climatological mean rainfall was calculated based on a 30-year reference period (1991–2020) using long-term monthly averages derived from the same dataset. From the figure, the rainfall analysis indicates that the monthly mean rainfall for May, June, August and September exceeded the respective climatological means for Peninsular. Meanwhile for Borneo, the monthly mean rainfall in May, June, and August was above the climatological mean, with August showing the highest positive deviation. July was the only month that experienced significantly below-normal rainfall, with the monthly mean below the climatological average for Peninsular. While in Borneo, July and September recorded significantly below climatological mean. Overall, the rainfall analysis for Peninsular Malaysia and Borneo from May to September 2024 shows a generally wetter-than-normal period, with July being the main exception in both regions.

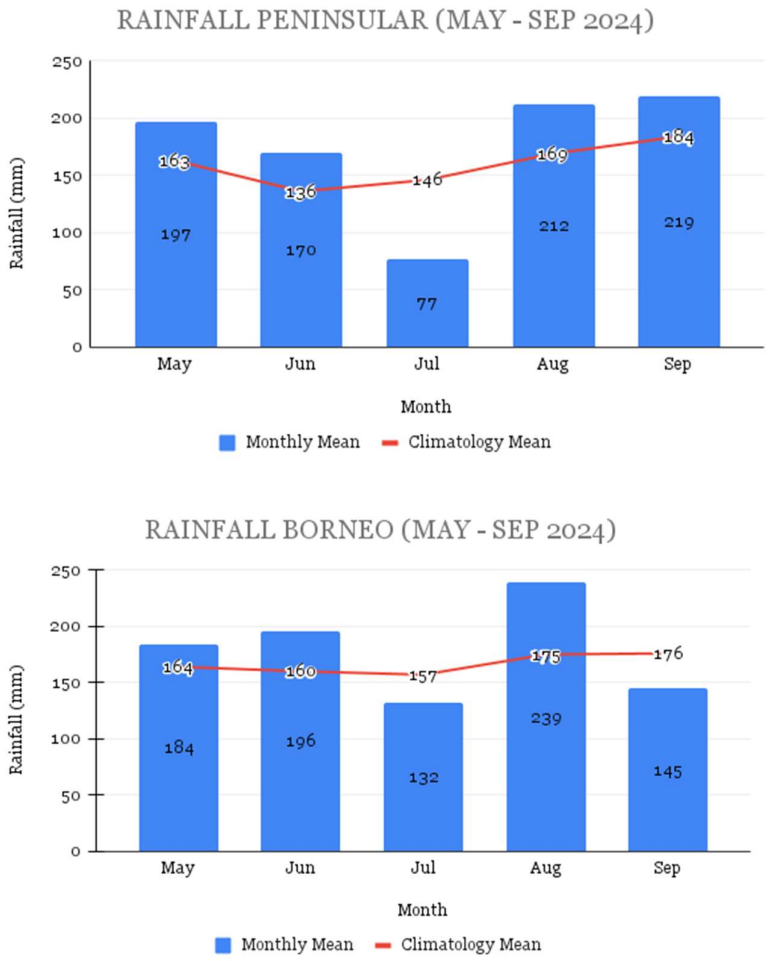

Figure 7. Monthly mean rainfall and the climatological mean rainfall for Peninsular Malaysia and Borneo

6.0 TYPHOON (TY) / TROPICAL CYCLONES (TC) OCCURRENCE

Table 1 shows the number of tropical disturbances in 2024 during Southwest Monsoon obtained from The Regional Specialized Meteorological Center (RSMC) Tokyo website. There was a total of 18 named tropical cyclones (TCs) over the western North Pacific and the South China Sea by the end of September 2024.

Table 1: List of tropical cyclones (TCs) from May to September 2024

Name	Date	Category	Maximum Wind (kt)
Ewiniar	25May - 30May	TY	75
Maliksi	31May - 31May	TS	35
Gaemi	20Jul - 26Jul	TY	90
Prapiroon	21Jul - 23Jul	STS	55
Maria	7Aug - 12Aug	STS	55
Son-Tinh	11Aug - 13Aug	TS	35
Ampil	12Aug - 18Aug	TY	85
Wukong	13Aug - 15Aug	TS	35
Jongdari	18Aug - 20Aug	TS	40
ShanShan	21Aug - 1Sep	TY	95
Yagi	1Sep - 8Sep	TY	105
Leepi	5Sep - 6Sep	TS	35
Bebinca	10Sep - 16Sep	TY	75
Pulasan	15Sep - 21Sep	TS	45
Soulik	19Sep - 19Sep	TS	35
Cimaron	25Sep - 26Sep	TS	35
Jebi	27Sep - 2Oct	STS	60
Krathon	28Sep - 3Oct	TY	105

Table 2 compares the 2024 May to September monthly number of tropical disturbances to the climatological (1991-2020).

Table 2: The comparison of the tropical cyclones (TCs) during SWM 2024 and the Climatology of TCs from 1991-2020

Month	2024	Average (1991-2020)
May	2	1.0
Jun	0	1.7
Jul	2	3.7
Aug	6	5.7
Sep	8	5.0
Total	**18**	**17.1**

The number of tropical disturbances over the western Pacific Ocean in 2024 was near average.

7.0 SUMMARY

The Southwest Monsoon (SWM) in Malaysia for 2024 officially began on 17 May, as indicated by the Southwest Monsoon Index (SWMI), when the meridional shear of zonal wind at 850 hPa first became continuously negative. This onset was consistent with the typical mid-May timing observed in climatology. The monsoon withdrawal occurred on 4 October, later than the official withdrawal date of 24 September, when positive values of SWMI were recorded, indicating the return of northeasterly-dominated conditions.

Synoptic analysis based on ERA5 reanalysis and GPM precipitation data revealed the gradual establishment of southwesterly winds across the South China Sea and Peninsular Malaysia. During May, the flow was still transitioning, with winds gradually shifting to a dominant westerly/southwesterly pattern. From June through August, the SWM circulation was fully established, with persistent southwesterly winds extending from the Bay of Bengal, across the Indochina Peninsula, and into the South China Sea. This period was characterized by generally stable atmospheric conditions, leading to drier weather compared to the Northeast Monsoon and inter-monsoon seasons. However, localized convection and nocturnal squall lines from Sumatra produced higher rainfall along the west coast of Peninsular Malaysia. Rainfall over Sarawak and Sabah was more variable but mostly moderate. In September, the southwesterly flow weakened and became more variable, indicating the approaching monsoon transition phase.

Large-scale oceanic drivers remained neutral during the Southwest Monsoon period. ENSO conditions were neutral, with sea surface temperatures in the central equatorial Pacific close to long-term means, minimizing teleconnection influences on Malaysian weather. Similarly, the Indian Ocean Dipole (IOD) remained neutral, with no significant warming or cooling in the eastern or western Indian Ocean. Consequently, monsoonal rainfall and temperature patterns were largely governed by seasonal dynamics rather than basin-scale anomalies.

The Madden–Julian Oscillation (MJO) contributed to rainfall variability during the monsoon. An active MJO in Phase 5 in May likely enhanced convection over the Maritime Continent, supporting episodic heavy rainfall events. From June to August, the MJO weakened considerably and had little impact on rainfall variability. In early to

mid-September, MJO Phases 4 and 5 again enhanced convection, coinciding with localized rainfall peaks.

Rainfall analysis from 42 principal meteorological stations showed generally wetter-than-normal conditions in both Peninsular Malaysia and Borneo from May to September, except in July when rainfall was significantly below climatological averages. In Peninsular Malaysia, May, June, August, and September saw monthly rainfall exceeding the long-term mean, whereas July was notably drier. For Borneo, May, June, and August were wetter than normal, while July and September experienced deficits. The seasonal rainfall pattern indicates that while the SWM is typically the drier monsoon, localized convection and MJO activity contributed to wetter-than-average conditions during certain months.

A total of 18 named tropical cyclones developed over the western North Pacific and South China Sea during the Southwest Monsoon period, close to the climatological average of 17.1. These cyclones indirectly influenced Malaysian weather by modulating regional circulation patterns, particularly the southwesterly flow.

Overall, the Southwest Monsoon 2024 in Malaysia was characterized by a typical southwesterly circulation with generally drier conditions over Peninsular Malaysia, occasional rainfall enhancements along the west coast, and moderate rainfall over Borneo. Neutral ENSO and IOD conditions meant that large-scale anomalies had minimal influence, while the MJO contributed episodically to rainfall variability. Rainfall anomalies were generally above climatology except in July, and tropical cyclone activity remained near average, consistent with long-term SWM characteristics.

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