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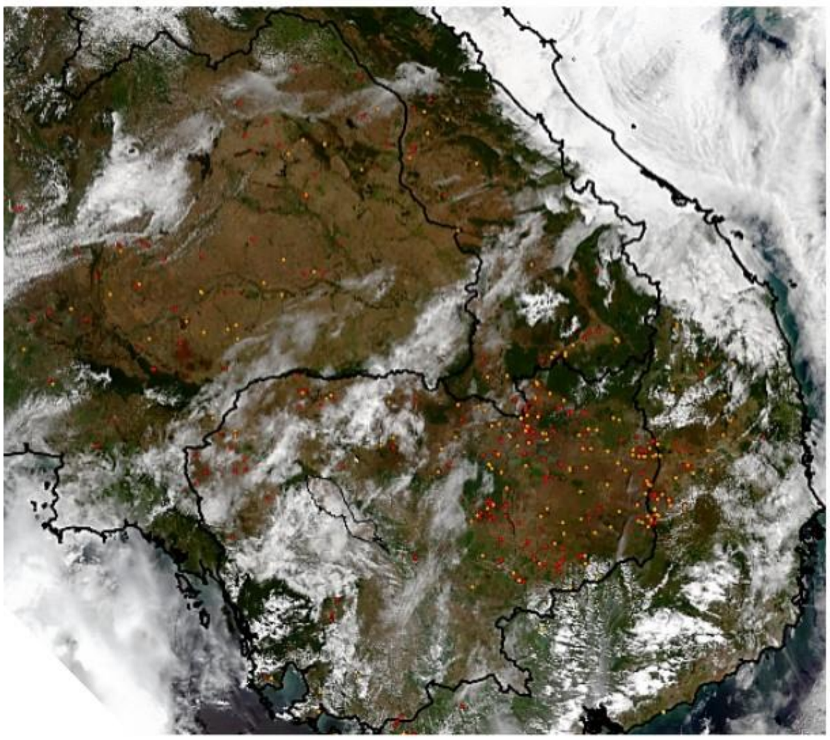

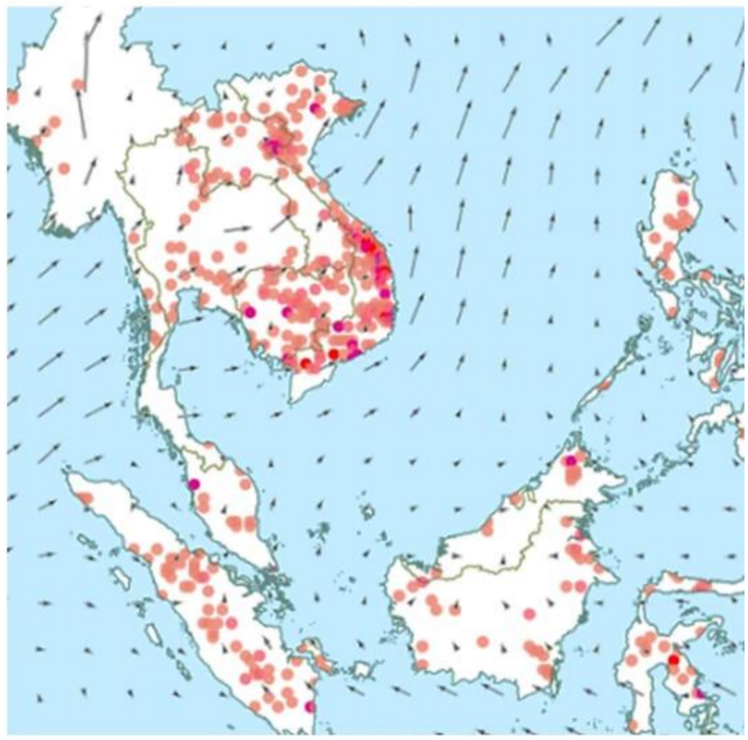

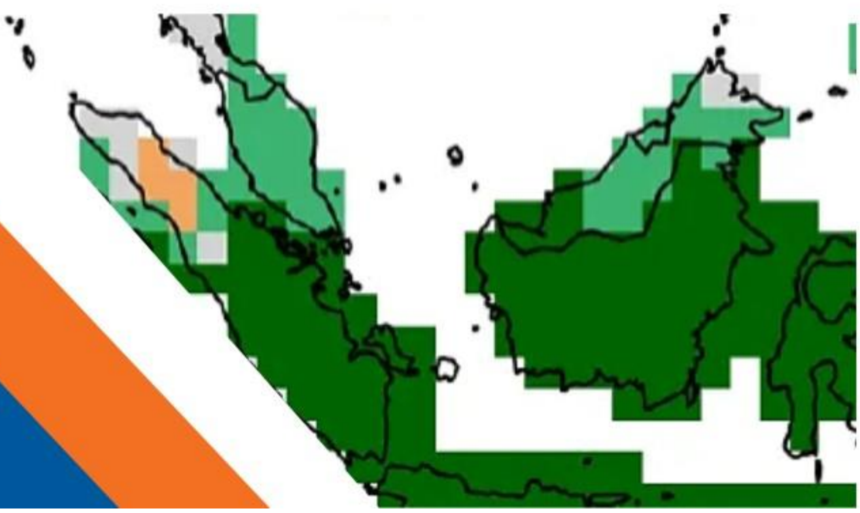

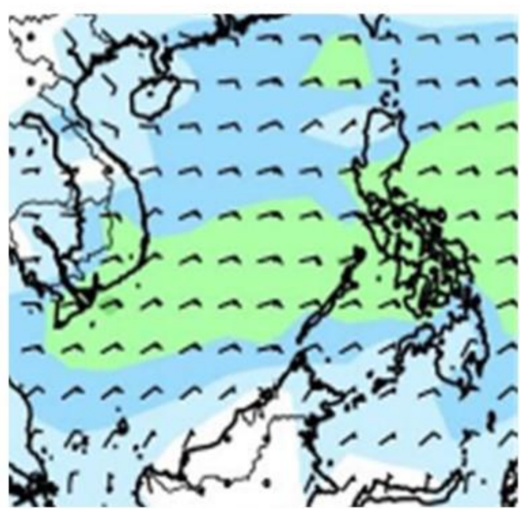

Content

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Published annually in March and September, the ASMC bulletin provides a review and outlook of weather and climate phenomena of importance to the region as well as their influence on the region's weather conditions. For feedback and enquiry, please email: **ASMC_Enquiries@nea.gov.sg**

Summary

In the first half of 2022,

- La Niña conditions were present throughout.
- Signs of a negative Indian Ocean Dipole (IOD) developing from May 2022.
- Wetter-than-normal weather was recorded over much of Southeast Asia.
- Persistent dry conditions and transboundary smoke haze were observed over Mekong sub-region.

For September 2022 till February 2023,

- La Niña is predicted to continue until end 2022 and return to neutral by January 2023.
- IOD is likely to persist in negative phase but to weaken towards end 2022.
- Models indicate an enhanced chance of above-normal rainfall (wetter) conditions over Southeast Asia.
- Wetter conditions for the southern ASEAN region are expected to set in from October 2022.
- Onset of Northeast Monsoon by end 2022 signals the start of dry season over Mekong sub-region.

Over Southeast Asia,

- Heavy rain fell over central Viet Nam during the traditional dry season (March – April 2022).
- Tropical cyclones in April and June over the Philippines showed influence by El Niño Southern Oscillation.
- A two-day spell of widespread rainfall caused floods at Brunei Darussalam in March 2022.
- Polar vortex brought below-normal temperature over Thailand in early April 2022.

ASMC Regional Capability-Building Programme (ACaP):

- 18th ASEAN Climate Outlook Forum (ASEANCOF-18) held in May 2022
- *Upcoming*: ASMC Hotspot and Haze Assessment (H2A) Workshop (February 2023)
- *Upcoming*: Weather Prediction by Numerical Methods – Module 3 (WPNM-M3) Workshop (February 2023)

CLIMATE REVIEW (JAN – JUN 2022)

La Niña event persisted in the first half of 2022

El Niño Southern Oscillation

La Niña conditions were present throughout the first half of 2022. Observed sea-surface temperature (SST) values over the Nino3.4 region of the Tropical Pacific started showing indications of La Niña conditions in the third quarter of 2021, which persisted through the first half of 2022 (Figure 1). Key atmospheric indicators of ENSO (e.g., trade wind strength and cloudiness) also showed La Niña conditions during this time.

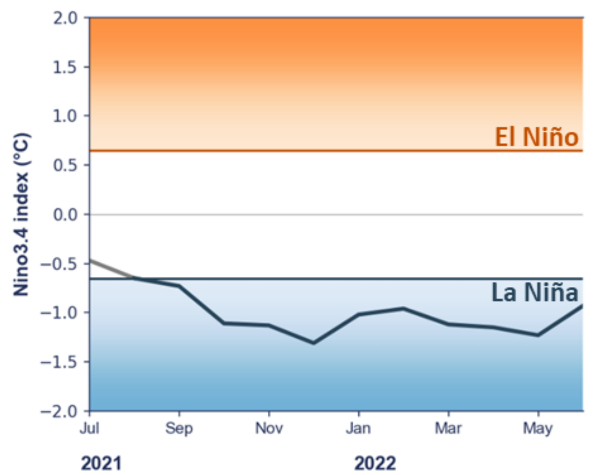


Figure 1. The Nino3.4 index (detrended) using the 1-month SST anomalies. Warm anomalies (⩾ +0.65; orange) correspond to El Niño conditions while cold anomalies (⩽ -0.65; blue) correspond to La Niña conditions, otherwise neutral (> -0.65 and < +0.65). *Reference methodology: Turkington, Timbal, & Rahmat, 2018*.

The observed La Niña conditions varied from model predictions at the start of 2022. Previous ENSO outlooks (ASMC bulletin Issue 9) predicted the negative (cool) Nino3.4 values to ease through March – May 2022. In February, models predicted that the La Niña event was at peak intensity, with most models showing a gradual decrease in intensity and return to neutral conditions by the middle of 2022 (Figure 2). However, the observed Nino3.4 values maintained in intensity until May, when they started to weaken, although still indicating La Niña conditions.

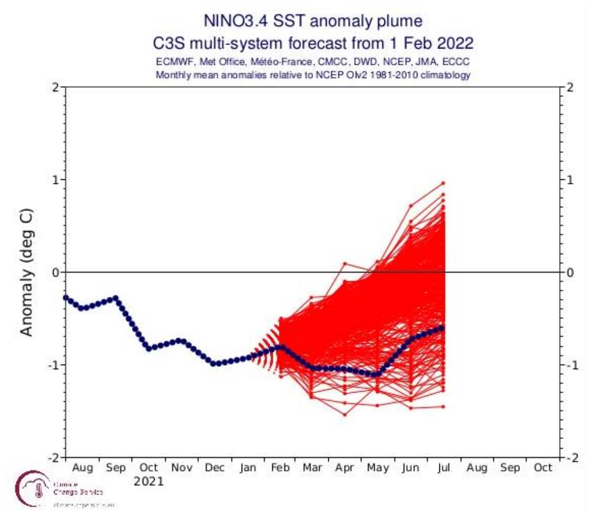


Figure 2. Prediction of Nino3.4 index's strength (red lines) from February 2022 from various seasonal prediction models of international climate centres. Observed values are in blue. *Credit: Copernicus C3S*.

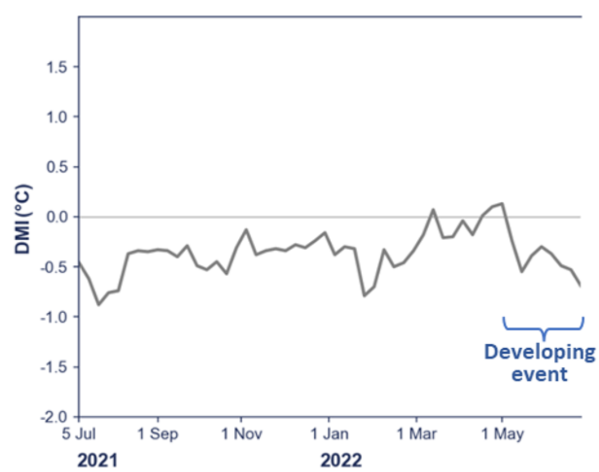


Figure 3. The Indian Ocean Dipole Mode Index (DMI) showing generally negative values between July 2021 and June 2022, including a developing negative Indian Ocean Dipole event from May. *Credit: Bureau of Meteorology, Australia*.

Indian Ocean Dipole

The Indian Ocean Dipole (IOD) index overall indicated neutral conditions for much of the first half of 2022, with signs of a negative IOD event developing from May 2022 (Figure 3). At the start of 2022, the IOD index was negative and increased in intensity briefly before weakening to near zero in March 2022. The IOD index remained near zero until May when it started to cool and show signs of negative IOD development.

Sea Surface Temperature Conditions

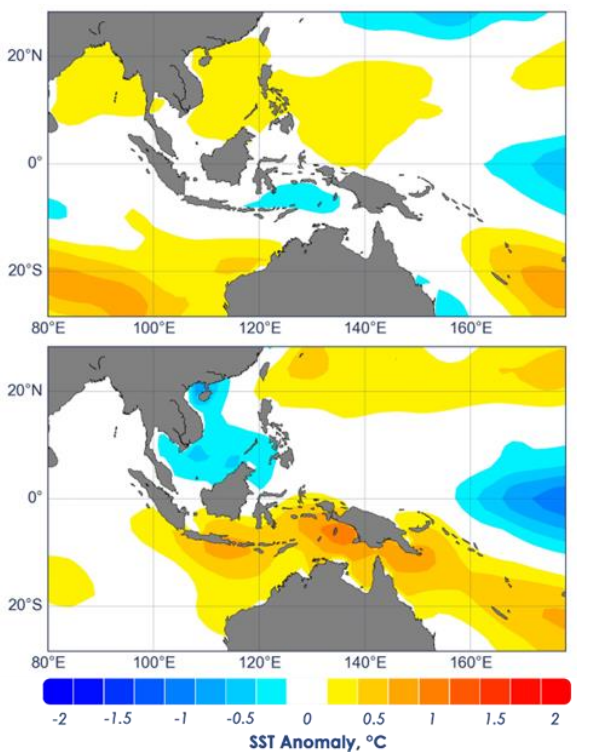


Figure 4. Average sea surface temperature (SST) anomalies for January – March 2022 were near average for much of the SEA region (upper). In comparison, the April – June 2022 values were above average for much of the southern parts of the region (lower). *Data:* *IRI Data Library*.

The SST anomalies in and around Southeast Asia showed a mix of below- to above-average temperatures in the first half of 2022. Between January and March, the SST anomalies were near- to slightly above-average for the northern ASEAN region and near-average for the southern ASEAN region (Figure 4; upper). Between April and June, warm anomalies developed south of the Equator, with cooling of SSTs in the South China Sea (Figure 4; lower). Positive anomalies over the southeast tropical Indian Ocean are in line with a negative IOD event developing (Figure 4; lower).

Madden-Julian Oscillation

For the first three months of 2022, the Madden-Julian Oscillation (MJO; Figure 5), a source of intra-seasonal variability, showed only intermittent activity. At the beginning of the year, the MJO was over the Western Pacific (Phase 7) shortly before transiting into the Western Hemisphere (Phase 8) and then decaying rapidly in the middle of January. Between the middle of January and the much of February, the MJO signal was mostly indiscernible based on the RMM index. An MJO signal developed over the Western Hemisphere (Phase 1) in the second week of March and propagated eastward through the Indian Ocean (Phases 2 and 3), before decaying over the Maritime Continent (Phase 4) in the last week of March.

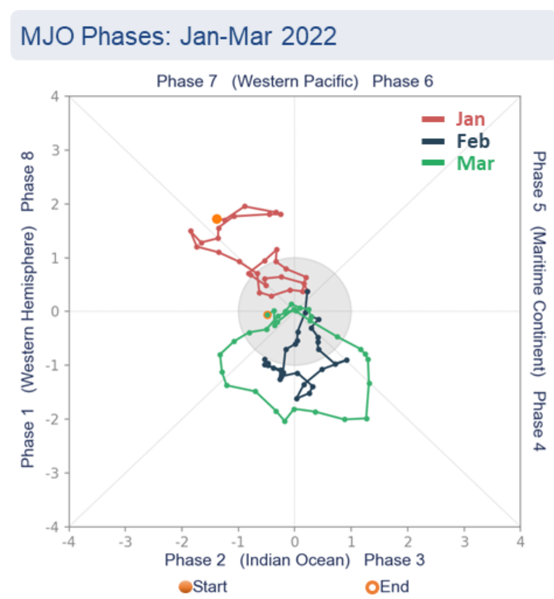


Figure 5. MJO strength and phases during January (red), February (blue), and March (green) 2022. The orange dots mark the start and end of the timeseries. *Data:* *Bureau of Meteorology, Australia*.

MJO activity was weak or indiscernible for much of April 2022, with coherent MJO signals in May and June 2022 (Figure 6). An MJO signal developed over the Indian Ocean (Phase 2) at the end of the first week of May and propagated quickly eastward through the Maritime Continent (Phases 4 and 5), the Western Pacific (Phases 6 and 7), before weakening in Phase 8 at the end of the third week of May. Another MJO signal emerged over the Western Pacific (Phase 6) at the end May and propagated eastward through the Western Hemisphere and to the Indian Ocean in June.

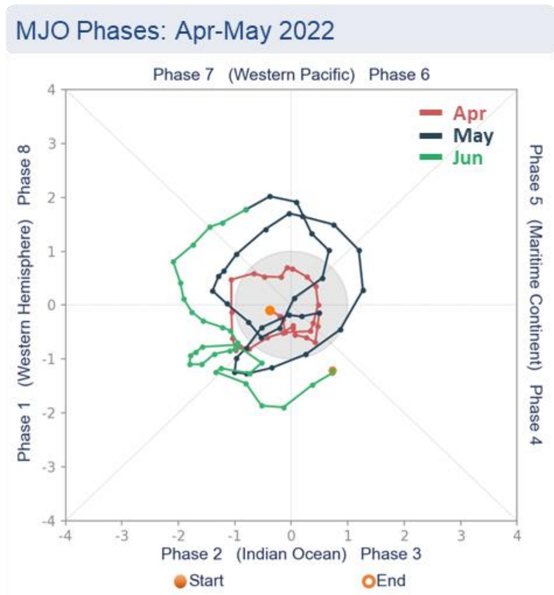


Figure 6. MJO strength and phases during April (red), May (blue), and June (green) 2021. The orange dots mark the start and end of the timeseries. *Data: Bureau of Meteorology, Australia*.

Temperature Conditions

Southeast Asia experienced a mix of below- to above-average temperatures in the first half of 2022 (Figure 7). No significant regional temperatures anomalies were recorded between January and March 2022, apart from above-average temperature over some parts of northwest Thailand, northern Philippines, and Indonesia (Figure 7; upper). In April to June 2022, below-average temperatures were recorded over parts of western and central Mainland Southeast Asia and above-average temperature was recorded over the southeastern Maritime Continent, with the rest of region recording near-average temperature.

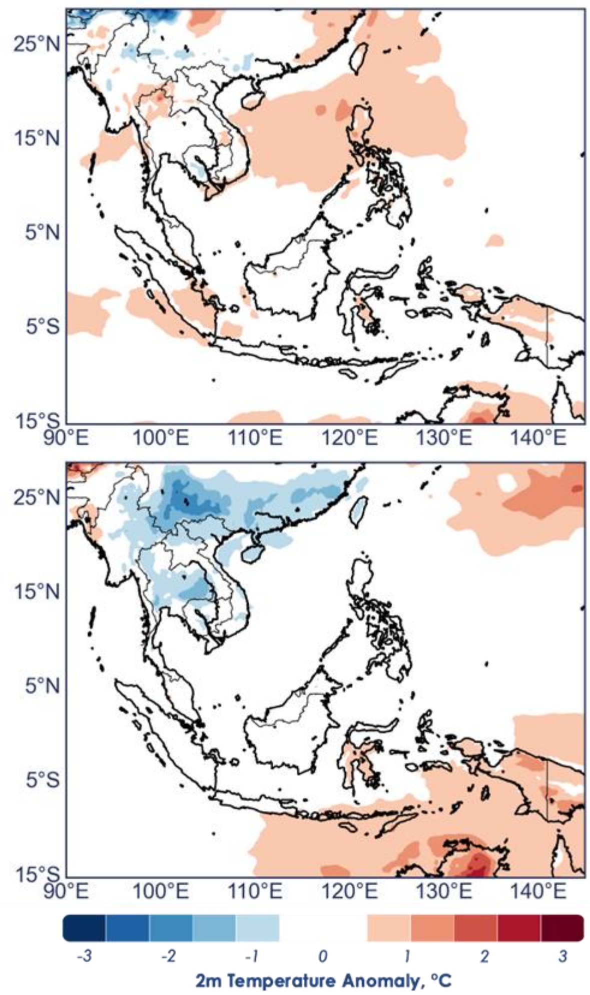


Figure 7. Average 2-metre temperature anomalies (˚C) against 1991 – 2020 climatology for January – March 2022 (upper) and April – June 2022 (lower) shows warmer conditions (red shades), near-average conditions (white), and cooler conditions (blue shades) for Southeast Asia in the first half of 2022. *Data: ECMWF*.

Rainfall Conditions

From January to March 2022, near- to above-average rainfall was recorded over Mainland Southeast Asia and the northern half of the Maritime Continent (Figure 8; upper), likely influenced by the La Niña conditions. Elsewhere, a mix of below- to above-average rainfall was recorded. Considering the influence of MJO, MJO activity in Phases 7 and 8 likely contributed to the drier conditions over the Maritime Continent in January (Review of Regional Weather for January 2022). The MJO activity in Phases 2 to 4 likely contributed to the wetter conditions in March (Review of Regional Weather for March 2022).

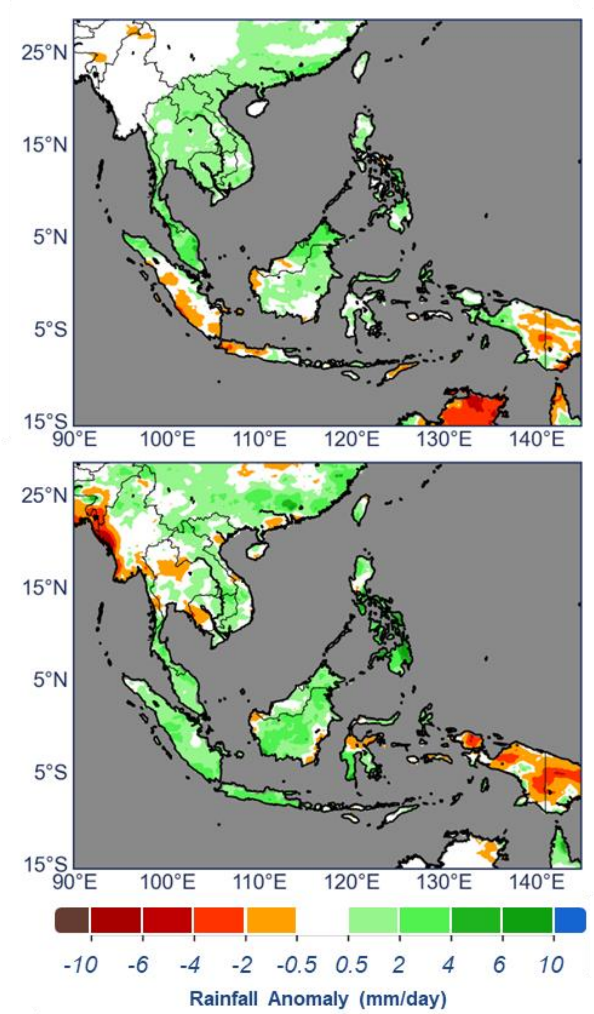


Figure 8. Rainfall anomaly (in mm/day) for January – March 2022 (upper) and April – June 2022 (lower) against 1991 – 2020 climatology from CHIRPS dataset. Areas in green experienced wetter than average conditions, while those in orange experienced drier than average conditions. *Data: IRI Data Library*.

Between April and June 2022, a mix of below- to above-average rainfall was recorded over Mainland Southeast Asia, with the largest negative anomalies (drier conditions) over western Myanmar, and the largest positive anomalies (wetter conditions) over southern Lao PDR and northeast Cambodia (Figure 8; lower). Above-average rainfall was recorded over much of the Maritime Continent in April to June 2022 with the largest positive anomalies (wetter conditions) over the Philippines. With the complete circumnavigation of the globe by the MJO pulse during April to June 2022, the La Niña conditions and developing IOD were the likely main drivers for the increased rainfall over Southeast Asia.

REGIONAL FIRE AND HAZE SITUATION (JAN – JUN 2022)

Persistent dry conditions and transboundary smoke haze over the Mekong sub-region

Overview

Despite La Niña conditions prevailing between January and June 2022, dry weather conditions were observed over the northern ASEAN region on most days during this period. This contributed to an escalation of hotspot and smoke haze activity in the Mekong sub-region between January and May 2022. Clusters of scattered hotspots with visible smoke plumes started developing in northern Cambodia in January 2022. The situation intensified in February and March as scattered hotspots and smoke haze was observed over parts of Myanmar, northern Thailand, and Lao PDR. The situation reached a peak in early April 2022 as widespread moderate to dense transboundary haze was observed stretching across Lao PDR into Thailand, Viet Nam, and Cambodia. The return of rainy weather conditions in May 2022 then helped to suppress the overall hotspot and smoke haze activity in region.

Hotspot Count

The hotspot counts in the Mekong sub-region for the period January to June 2022 were mostly lower compared to previous years, although more hotspots were detected in Lao PDR in 2022 compared to 2018 and 2021. Overall, the total hotspot count for the sub-region was around 24% lower in 2022 compared to 2021. Shower activities continued over the southern ASEAN region even during the dry phase of the northeast monsoon. As a result, hotspot and smoke haze activity remained subdued there, except for isolated hotspots and localised smoke plumes that were observed on some days during late March and early April 2022.

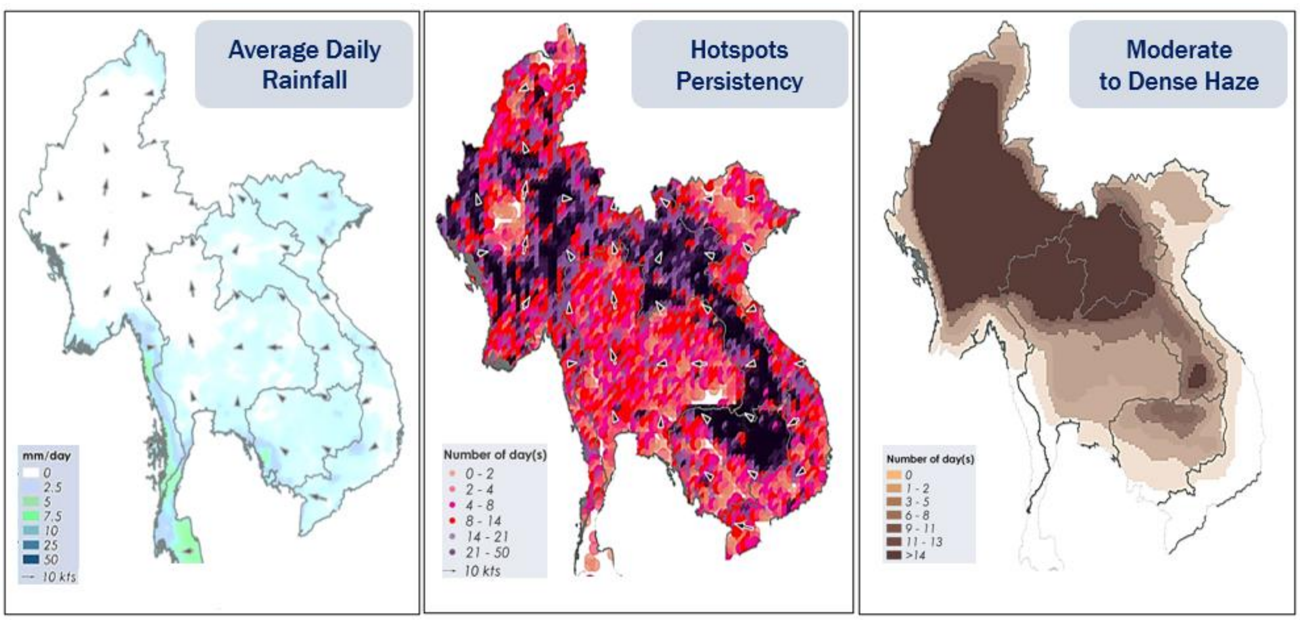


Figure 9. Average daily rainfall over the Mekong sub-region during January – May 2022 (left), hotspots persistency over the Mekong sub-region during the same period (middle), and areas where moderate to dense haze was observed during the same period (right).

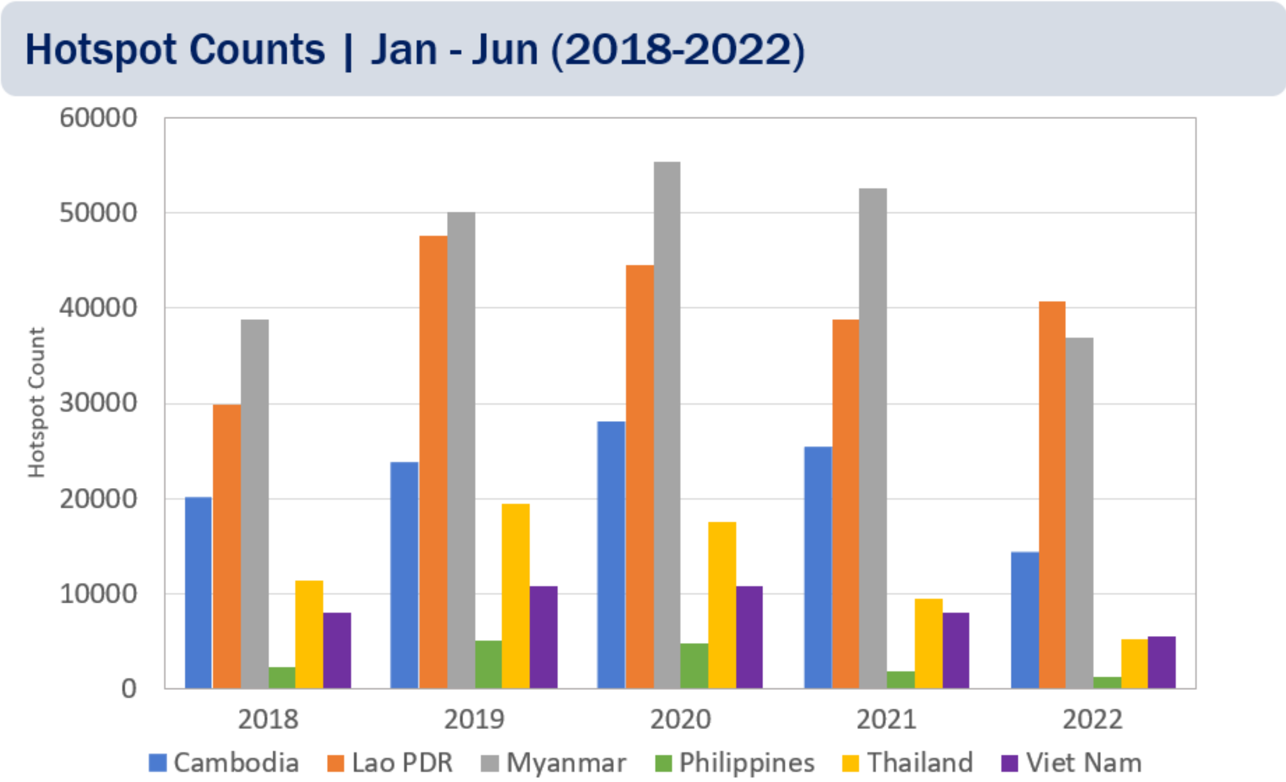


Figure 10. Hotspot counts for the northern ASEAN region during January – June (2018 – 2022). The hotspot counts from 2019 onwards are based on the NOAA-20 satellite, while those in 2018 are based on the Suomi-NPP satellite.

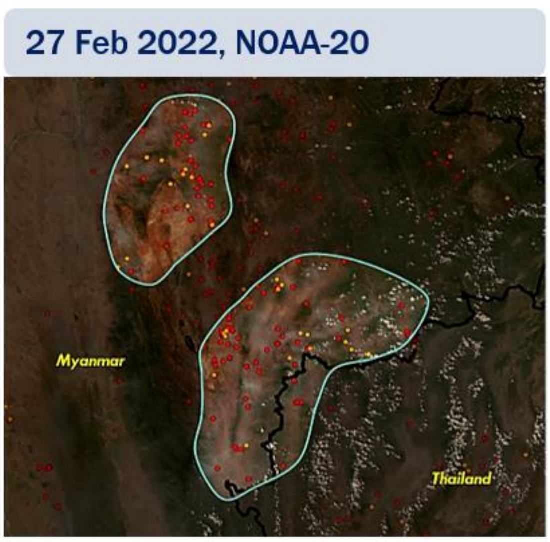


Figure 11. In February and March 2022, hotspots and smoke haze development were mostly concentrated in the border region between Myanmar and northern Thailand.

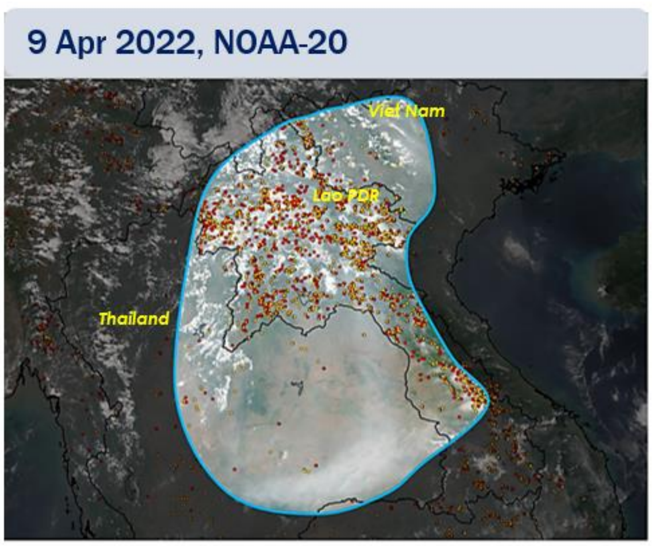


Figure 12. There was an escalation in hotspot and smoke haze activity in April 2022 as widespread transboundary haze was observed over Lao PDR and stretching into Thailand, Viet Nam, and Cambodia.

CLIMATE AND HAZE OUTLOOK (SEP 2022 – FEB 2023)

Negative IOD until November and La Niña likely to persist for the rest of this year

ENSO Outlook

ENSO conditions are currently La Niña with the SST anomalies over the Nino3.4 region remaining consistent with weak La Niña conditions. Most model outlooks from international centres (C3S Copernicus) indicate weak to moderate La Niña continuing for the rest of 2022 (Figure 13). However, a few predictions show further strengthening of the La Niña conditions from September, while a few others indicate a return to neutral by January 2023.

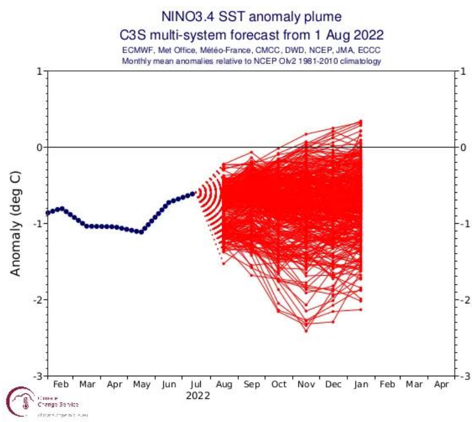


Figure 13. Nino3.4 SST anomaly predictions from C3S Copernicus models showing colder temperatures until end 2022. Most models predict La Niña conditions for the rest of this year. *Credit:* C3S Copernicus.

In line with the Nino3.4 predictions, the ensemble-mean predictions of SST anomalies show La Niña conditions during September – November (SON) 2022 (Figure 14). Under La Niña conditions, colder SST anomalies are observed in the central and eastern Tropical Pacific Ocean (blue shades) and warmer anomalies in the western Tropical Pacific waters (red shades). La Niña conditions further require the SST pattern to remain for several months, as well as to couple with the atmosphere through stronger easterly winds in the eastern Pacific Ocean and more rainfall than average in the central Indo-Pacific region.

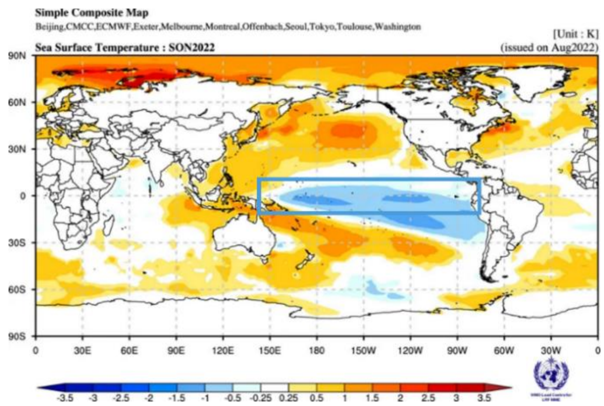


Figure 14. SST anomaly prediction for SON 2022 from WMO showing La Niña conditions in the Tropical Pacific Ocean (blue box). *Credit: WMO Lead Centre for Long-Range Forecasting (LRF)*.

IOD Outlook

The negative IOD is likely to persist for the next few months in its negative phase (Figure 15). Some models predict the negative IOD event to be strong. Most models predict the negative IOD to rapidly weaken towards the end of the year, coinciding with the onset of the Northeast Monsoon season (Figure 15). The shifting of monsoon trough southwards leads to the dissipation of any IOD events.

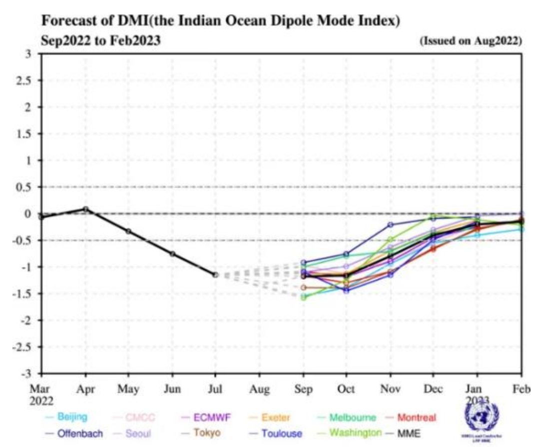


Figure 15. IOD index predictions, from models available on the WMO Lead Centre for Long-Range Forecasting, continue to be negative but will rapidly weaken towards the end of the year. *Credit: WMO Lead Centre for LRF*.

Rainfall Outlook

For SON 2022, selected C3S models (SEA RCC-Network Long-range Forecasting Node) indicate an enhanced chance of above-normal (wetter) conditions over much of Southeast Asia, with the highest likelihood over central and eastern parts of the Maritime Continent (Figure 16). These areas of above-normal rainfall correspond to those that are typically wetter than average during a negative IOD or La Niña event. For the western Maritime Continent, model predictions indicate either no dominant or below-normal (drier) terciles. However, model skill is low at this time of year in this region.

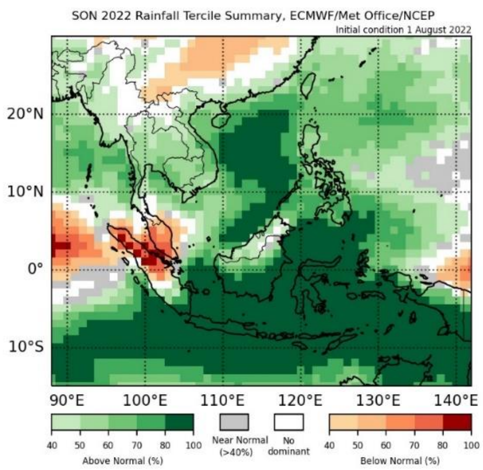


Figure 16. Rainfall tercile summary predictions from multi-model ensemble for SON 2022, showing regions with a higher likelihood of drier conditions (brown) and wetter conditions (green).

With the La Niña conditions to continue for the rest of this year, wetter conditions are also likely for much of eastern Maritime Continent for December 2022 - February 2023. Based on composites from previous La Niña events, wetter-than-average conditions occur over the Philippines, eastern Indonesia, Peninsular Malaysia, and northern Borneo during December to February period.

Temperature Outlook

For temperature, many parts of the ASEAN region are predicted to experience above-normal (warmer) conditions during SON 2022 (Figure 17). The exceptions are the central/eastern Mainland Southeast Asia, and parts of the equatorial region where the model predictions indicate either near-normal or below-normal (cooler) terciles.

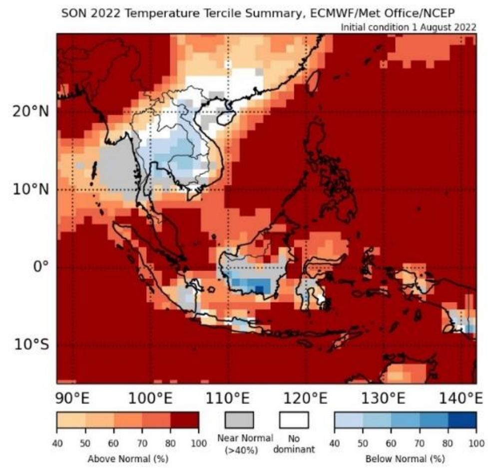


Figure 17. Temperature tercile summary predictions from multi-model ensemble for SON 2022, showing regions with a higher likelihood of warmer conditions (red) and cooler conditions (blue).

Haze Outlook

Going forward, with above-normal rainfall forecast for most parts of the southern ASEAN region for the rest of the year, the overall hotspot and smoke haze situation is likely to remain mostly subdued. Nonetheless, intermittent periods of drier weather can still be expected, and hotspot and smoke haze activities may escalate during these brief periods, contributing to an increased risk of transboundary haze. Typically, wetter conditions for the southern ASEAN region are likely to set in from October, which should help to suppress hotspot activity in the region. As the Northeast Monsoon develops towards the end of the year, the northern ASEAN region is expected to enter its traditional dry season, and this may contribute to increased hotspot activities there.

SIGNIFICANT WEATHER EVENTS IN SOUTHEAST ASIA

Heavy rain over central Viet Nam during dry season

Contributed by Mr Mai Van Khiem, Mr Nguyen Van Huong, Ms Tran Ngoc Van, Ms Hoang Thi Mai, Ms Nguyen Thanh Hoa, Ms Trinh Thuy Nguyen, and Mr Tran Quang Diep
National Centre for Hydro-Meteorological Forecasting (NCHMF), Viet Nam

Heavy rain events in Viet Nam can be contributed by various weather patterns and climate variability. For example, a combination of tropical disturbance and cold surge which typically occurs during the transition period between winter and spring over the central coast of Viet Nam. In recent years, in addition to quantitative rainfall forecasting, more focus has been put on impact forecasting to urge organisations and people to be more proactive in the prevention of natural disasters to minimise risk and damage to properties, facilities, and lives. This article provides an example of NCHMF's operational forecasting and provision of early warning on heavy rain events in the central provinces of Viet Nam.

Background

Climatologically, March and April are dry months for much of Viet Nam (Figure 18). However, from 31 March 2022 to 2 April 2022, widespread rainfall and strong wind conditions were observed over central Viet Nam, due to the influence of a tropical depression that moved from the middle of the Bien Dong Sea toward Viet Nam, as well as a cold surge which brought strong northeasterly winds. The heavy rain caused floods over hundreds to thousands of hectares of land for rice and crops in the low-lying areas. In the Thua Thien Hue province, flood water at 0.3 to 0.4 m high coupled with strong and gusty winds injured 4 people, damaged 27 houses and sank 7 boats. In the Quang Nam province, approximately 7,400 hectares of lands for rice and vegetables – one third of the total plantation areas – were damaged. In the Phu Yen province, 2 deaths, 180 sunk boats, and damage to 2,500 lobster cages were reported.

NCHMF issued a total of 70 bulletins on widespread heavy rain: (a) 35 official bulletins on heavy rain over the Central Coastal and Central Highlands regions, (b) 13 brief bulletins on warnings for flash floods, landslides, flooding, (c) 13 bulletins on cold surge causing strong winds, high waves, heavy rain, and (d) 9 bulletins on dangerous weather over the sea causing high waves and gusty winds. NCHMF also provided timely and comprehensive updates to stakeholders, including the National Committee for Search and Rescue, the Commanding Committee of Natural Disaster Prevention and Control for Ministries, news agencies, and media.

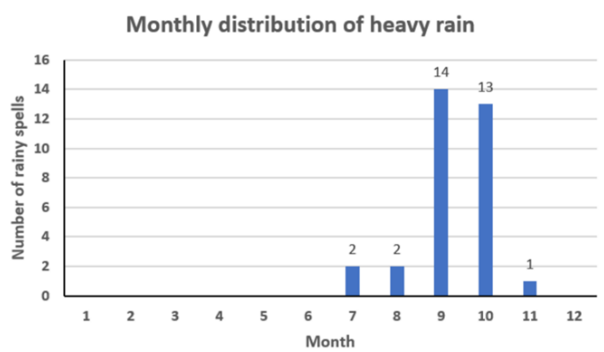
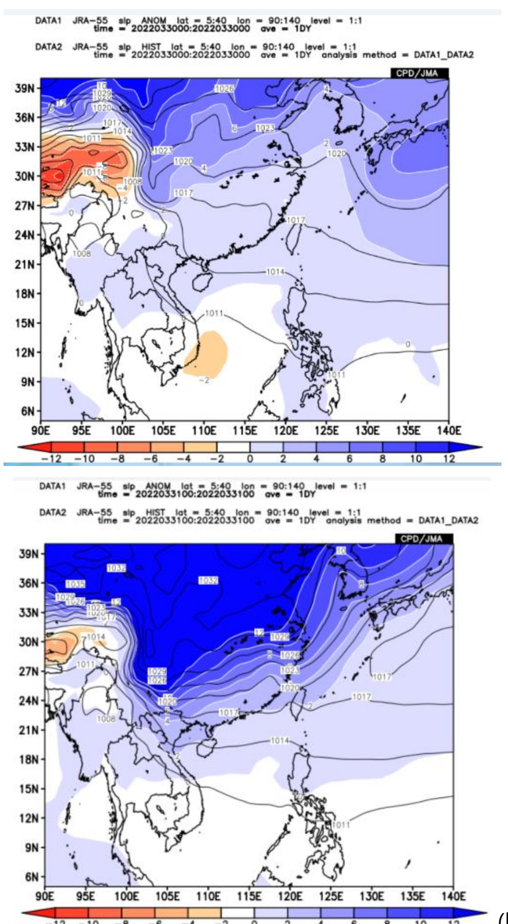


Figure 18: Monthly distribution of heavy rain over Central Viet Nam.

For April in the last 30 years, there had been 25 cold surges (including 3 consecutive cold surges on 4, 13, and 29 April 2003) that recorded wind speed of level-7 and above based on Beaufort scale. The latest event was the cold surge in April 2022. Historically, several tropical storms had occurred in March over the Bien Dong Sea (2002, 2005, 2006, and 2012) – most of them dissipated over the sea except for Typhoon Pakhar which made landfall over Viet Nam in March 2012.

Analysis

On 30 March 2022, a low-pressure system was observed to the east of the South Central Coast region of Viet Nam. From 31 March 2022, a cold air mass began to affect northern Viet Nam, which moved southwards to central and southern provinces of Viet Nam in early April 2022. During this period, the western Pacific subtropical high (WPSH) weakened gradually toward the east. On 2 April 2022, the convergence of jet stream at the 500 mb level had shifted to the east and a cold surge formed in the south (Figure 19). As a result, heavy rain fell over central Viet Nam. In particular, heavy to extreme rainfall was observed over the areas from Quang Binh to Binh Dinh while moderate to heavy rainfall was observed from Nghe An to Binh Thuan province and the Central Highlands.



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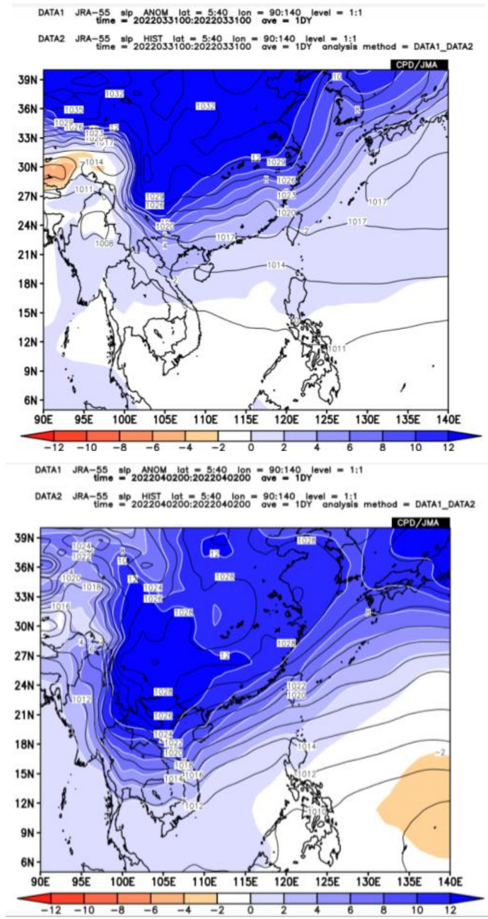


(c)

(d)

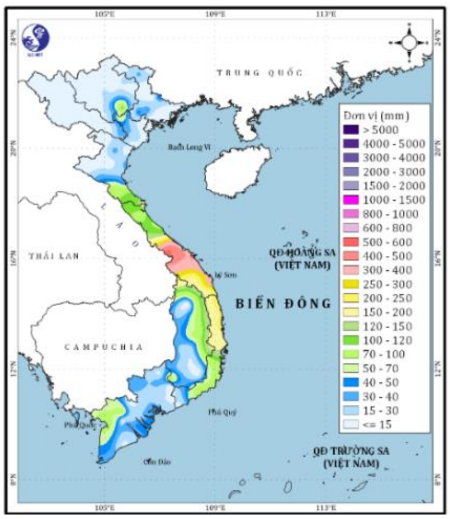
Figure 19: Mean Sea Level Pressure and anomaly during the period 30 March 2022 to 2 Apr 2022 (from a to d). *Credit: Tokyo Climate Center*.

Summary

During the period 31 March 2022 to 2 April 2022, heavy rain and strong winds were observed across central Viet Nam. A total rainfall of 200 – 450 mm and rainfall percentile of above 95th were recorded in many parts of central Viet Nam, from Ha Tinh to Phu Yen provinces (Figure 20). Significant and record-breaking daily rainfall was also reported by several stations (Table 1).

While March and April are traditionally dry months in Viet Nam, anomaly can still occur, such as when there are presence of a low-pressure system and a cold surge over the coastal areas of Viet Nam, as described in this article. The heavy rain was also considered rare as it set record high rainfall amount over many stations. While NCHMF had issued early warnings detailing the duration, intensity, and impact of the heavy rain to high-risk areas, there was still significant damage caused and reported.

Combination of cold surge and presence of tropical storm is the main factor for heavy rain during dry season in Viet Nam. In conclusion, the heavy rain event that occurred during dry season over central Viet Nam showed that in addition to the provision of accurate forecast and timely warnings, more awareness needs to be raised among people and organisations, in order to better mitigate and manage the impact from natural disasters.



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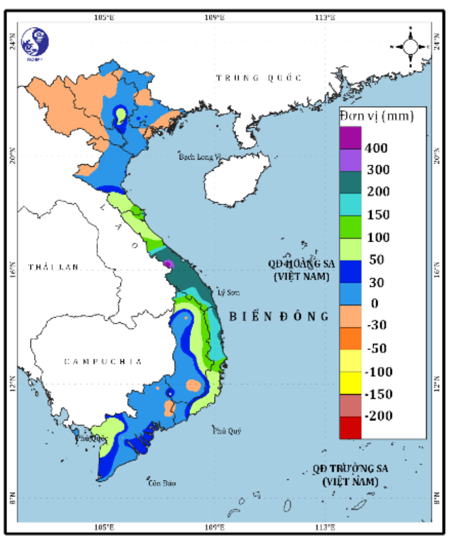

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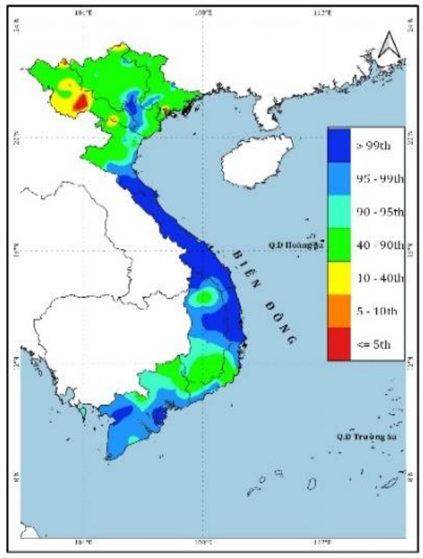

(c)

Figure 20: Total rainfall amount, anomaly, and percentile (from a to c) over Viet Nam during the period 31 March 2022 to 2 April 2022.

Station	Total daily rainfall (mm)	Historical max total daily rainfall (mm)^
A Luoi	255.8 (31/03/2022)	96.3 (2015)
	254.4 (01/04/2022)	93.2 (2015)
Nam Dong	157.1 (31/03/2022)	84.3 (2001)
Khe Sanh	147.7 (01/04/2022)	101.0 (2009)
Hue	162.8 (02/04/2002)	119.8 (2007)

Table 1: Significant and record-breaking total daily rainfall recorded during the heavy rain event from 31 March 2022 to 2 April 2022. ^*Note: Historical record for the period 1991 – 2020.*

Trend and variability of tropical cyclones in the Western North Pacific during April

Contributed by Dr Joseph Basconcillo
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Tropical cyclones in April 2022

There were two named tropical cyclones (TC) that formed in the Western North Pacific (WNP) basin in April 2022 – Tropical Storm (TS) Megi (202202; local name: Agaton) and Typhoon Malakas (202201; local name: Basyang). Both TCs entered the Philippine Area of Responsibility (PAR) earning their local names from the PAGASA. The mean TC frequency in April from 1981 to 2022 is 0.67 (±0.71 standard deviation), which means that the count of two TCs in April 2022 was more than thrice the mean value in April. Of the said TCs, only TS Megi (202202) made landfall in Guiuan, Philippines on 9 April 2022 (Figure 21a). It stayed in the PAR for 3 days and 18 hours and reached a maximum intensity of 40 knots (75 km/h). Meanwhile, Typhoon Malakas (202201) stayed in the PAR for only three hours on 12 April 2022 and remained in the Pacific Ocean for most of its lifetime over 9 days and 18 hours.

Because of its short-lived stay in the PAR and remote distance from the Philippine landmass, there was no considerable TC-associated rainfall with Typhoon Malakas (Figure 21c and 21d). Meanwhile, TS Megi brought considerable rainfall and damage during its passage. For example, three weather stations reached more than 200 mm of 24-hour rainfall namely Baybay (536.2 mm, 10 April 2022), Mambusao (338.8 mm, 11 April 2022), and Guiuan (207.8 mm, 9 April 2022). In addition, three weather stations recorded more than 400 mm of cumulative rainfall during 8 – 12 April 2022, which included Baybay (996.8 mm), Mambusao (453.8 mm), and Borongan (445.8 mm). The passage and landfall of TS Megi caused most stations in central Philippines to record above-normal rainfall in April (Figure 21b), which was primarily due to the stationary movement of TS Megi during its lifetime in the PAR.

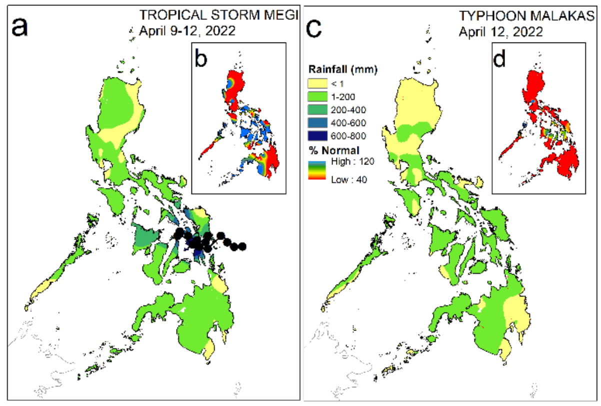

Figure 21: Accumulated TC-associated rainfall and percentage in April 2022 during the passage of Tropical Storm Megi (a and b) and Typhoon Malakas (c and d).

Trend and variability of TC frequency

The above-normal TC frequency in April 2022 raises questions whether there is a trend in increasing TC activity in the WNP and what possibly causes such a trend if it exists. The mean TC passage frequency in April is generally confined in the Pacific Ocean with two nodes – one is located around 150°E and the other node near 130°E (Figure 22a), which means that the TC passages in April tend to be non-landfalling. Here we show that the TC frequency in April is significantly increasing ($p=0.047$) albeit the marginal p-value (Figure 22b). The timeseries also shows that there is considerable variability in TC frequency with the most recent periodic increase since early 2010s.

The different TC metrics in April such as the Accumulated Cyclone Energy (ACE), mean intensity, landfalling distance, and translation speed were plotted to determine if such a trend also exists in their timeseries. For more details on the methods used in analysing the timeseries of TC metrics, refer to Basconcillo et al. (2021) and Basconcillo and Moon (2022). The ACE is an index based on the sum of the squared six-hourly maximum sustained winds and is used to quantify TC activity because it integrates TC frequency, duration, and intensity. Results show that there is no trend in ACE, mean TC intensity, TC landfalling distance, and storm speed (Figure 23a – 23d). However, there is a need to underscore that such statistical results should be taken in the context of the few TC occurrences in April where a low sample number can be possibly dilute and/or exaggerate statistical tests and their result. Further analysis is intended to be performed for these TC timeseries.

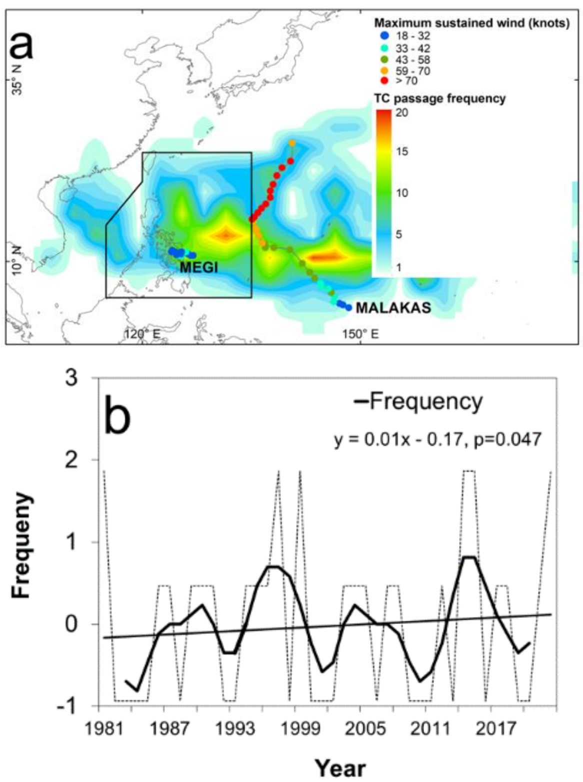

Figure 22: Climatology of TC passage frequency in April. *Top:* Mean TC passage frequency in the Western North Pacific (WNP) during April from 1981 to 2022. The dots indicate the TC track and intensity of Tropical Storm Megi and Typhoon Malakas. The black box indicates the location of the Philippine Area of Responsibility. *Bottom:* Timeseries of TC frequency in WNP. The black (dashed) line indicates the (original) 1-3-4-3-1 filtered timeseries.

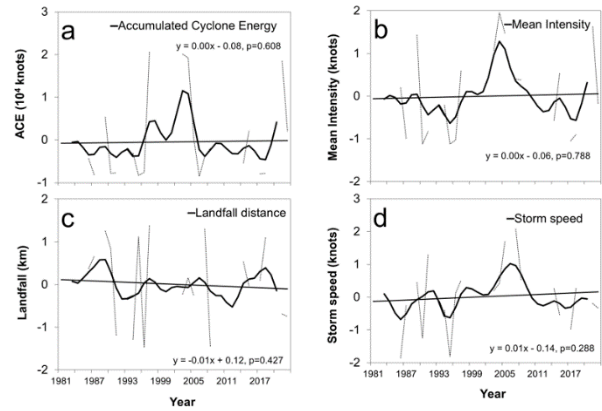

Figure 23: Climatology of selected TC metrics. *From (a) to (d):* Timeseries of Accumulated Cyclone Energy (ACE), mean TC intensity, TC landfall distance, and storm speed in April (1981 – 2022) over the Western North Pacific. The black (dashed) line indicates the (original) 1-3-4-3-1 filtered timeseries.

Influence of ENSO on TC frequency

As one of the dominant interannual modes of SST variability in the tropical Pacific, the El Niño Southern Oscillation (ENSO) tends to peak during December – February or the boreal winter. Past literature has demonstrated that the different TC metrics such as frequency, mean intensity, tracks, and lifetime maximum intensity are robustly linked with ENSO. However, most studies on the TC-ENSO linkage focused on the months with more TC occurrences thus the inadequate literature on such linkage in April is not surprising.

One of the classic flavours of ENSO (e.g., Niño 3.4, Niño 3) , the Niño 4 (also called Central Pacific ENSO) is correlated (anticorrelated) with SSTs in the Central (Western) Pacific in April (Figure 24a). This indicates that during La Niña (El Niño) the SST in the Western Pacific becomes warmer (cooler), which is a more (less) favourable environment for TC development and intensification. Due to the ongoing La Niña, the SSTs in the western Pacific are expectedly warm; this might have contributed to the above-normal TC frequency in April 2022. Based on Extended Reconstructed SST version 5, the SST anomaly in April 2022 in the Niño 4 region was -0.84. However,

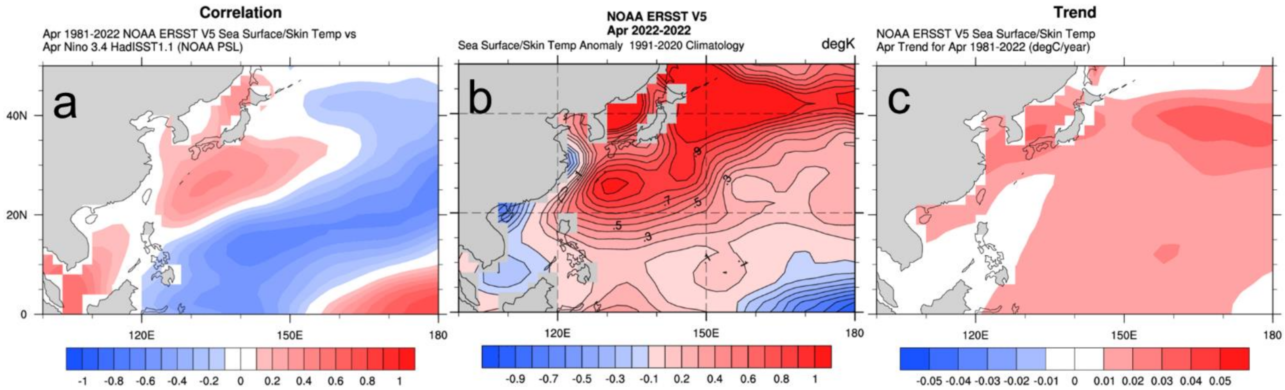

Figure 24: Relationship of sea surface temperature and large-scale environment: (a) spatial correlation of Nino 4 and sea surface temperature (SST) during April from 1981 to 2022, (b) SST anomalies in April 2022, and (c) trend from 1981 to 2022 in the Western North Pacific. *Credit: WRIT, 2022*.

there was no significant correlation between Niño 4 and TC frequency in April (r=0.24, p=0.151) but such weak correlation does not necessarily translate to the absence of relationship between the two. Such low correlation was perhaps due to the few TC occurrences in April.

Conclusion

This article highlights the preliminary observational analysis of TC occurrences in April while providing new insights on the trend and variability of selected TC metrics that are not previously described in the literature because of few TC occurrences in April. Results show that there is a significantly increasing TC frequency in April during the period 1981 – 2022, which can be attributed to TC-ENSO linkage. Such results, therefore, merit future works especially on the establishment and thorough understanding of TC-ENSO linkage especially in months with few TC occurrences. Such a relationship is also expected to be established for the other climate modes in different spatiotemporal scales (e.g., decadal variability, Indian Ocean SST-based indices, and Atlantic Ocean SST-based indices).

Reference

Basconcillo, J., Cha, EJ. & Moon, IJ. Characterizing the highest tropical cyclone frequency in the Western North Pacific since 1984. Sci Rep 11, 14350 (2021). https://doi.org/10.1038/s41598-021-93824-2.

Basconcillo, J., Moon, IJ. Increasing activity of tropical cyclones in East Asia during the mature boreal autumn linked to long-term climate variability. npj Clim Atmos Sci 5, 4 (2022). https://doi.org/10.1038/s41612-021-00222-6.

PAGASA Daily Rainfall and Temperature Monitoring. https://www.pagasa.dost.gov.ph/climate/climate-monitoring#daily-rainfall-and-temperature.

Web-based Reanalyses Intercomparison Tools (WRIT). https://psl.noaa.gov/data/writ.

Decreasing tropical cyclone activity in the Western North Pacific during June

Contributed by Dr Joseph Basconcillo
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Tropical cyclones in June 2022

The tropical cyclone (TC) occurrences in June 2022 in the Western North Pacific (WNP) basin were quite unusual considering that its two named TCs were formed during the last few days of the said month. Both TCs entered the Philippine Area of Responsibility (PAR) albeit their short-lived stay earning their local names from the PAGASA (Figure 25a). These TCs are Typhoon Chaba (202203; local name: Caloy) and Tropical Storm (TS) Aere (202204; local name: Domeng). The mean TC frequency in June from 1981 to 2022 is 1.88 (± 1.33 standard deviation), which means that the TC count in June 2022 was below- to near-normal TC frequency. Both TCs did not make a landfall in the Philippine landmass. TS Aere remained in the Pacific Ocean (lifetime duration: 5 days and 12 hours) while Typhoon Chaba stayed in the South China Sea (lifetime duration: 5 days). Of the said two TCs, TS Aere stayed in the PAR longer (1 day and 20 hours) than Typhoon Chaba (1 day and 2 hours).

Because of their short-lived stay in the PAR and remote distance from the Philippine landmass, there was no considerable TC-associated rainfall from both Typhoon Chaba and TS Aere (Figure 25a and 25c). Typhoon Chaba remained a tropical depression while inside the PAR and reached a peak intensity of 70 knots (130 km/h) before its landfall in Southern China. Only two stations recorded greater than 100 mm of 24-hour rainfall namely Baler (135.3 mm, 28 June 2022) and Tayabas (116.5 mm, 28 June 2022). Meanwhile, three stations observed greater than 100 mm of cumulative rainfall while Typhoon Chaba was in the PAR, which include Baler (182.3 mm), Tayabas (119.0 mm), and Casiguran (100.8 mm). The track of TS Aere was quite distant from the Philippine landmass so only one station recorded greater than 100 mm of 24-hour rainfall and cumulative rainfall while TS Aere was in the PAR. Rainfall over Dipolog Station reached 100.0 mm on 1 July 2022 with the same amount as its cumulative rainfall. The percent of normal rainfall during the passages of the Typhoon Chaba and TS Aere did not considerably contribute to the monthly rainfall in June 2022 (Figure 25b and 25d).

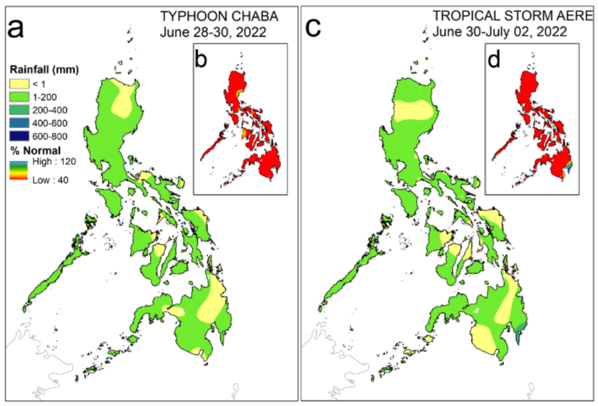


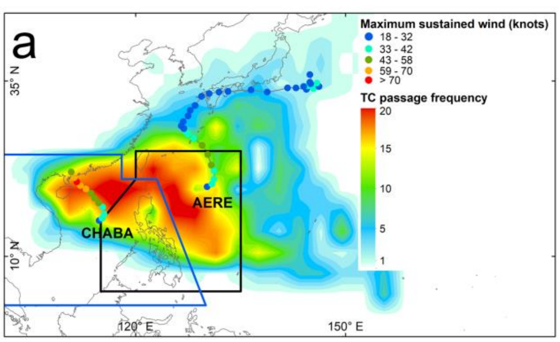
Figure 25: Accumulated TC-associated rainfall and percentage in June 2022 during the passage of Typhoon Chaba (a and b) and Tropical Storm Aere (c and d).

Trend and variability of TC frequency

The mean TC passage frequency during June from 1981 to 2022 has two nodes – one node is found in the Philippine Sea and the other node is located in the South China Sea (Figure 26a). The first node appears to spread northwards or enter the South China Sea via the Luzon Strait. The second node is most prominent along 115°E indicating that Southeast Asia is considerably affected by TC passages in June. Following the definition of Southeast Asia (SEA) domain used by Basconcillo and Moon (2022), the timeseries of TC frequency during June from 1981 to 2022 are plotted for the WNP and SEA, respectively. In June 2022, only Typhoon Chaba was located in the SEA. Results showed a significantly decreasing TC frequency in

SEA but the same signal could not be said to be true in the WNP. The difference in trend between SEA and WNP was perhaps due to the non-inclusion of the first node of TC passage frequency in the Philippines (Figure 25a) in the definition of SEA. Such omission is to ensure that the TC passages in SEA would result in direct impact rather than when the TCs track northward without making their landfall.

The different TC metrics in June such as the Accumulated Cyclone Energy (ACE), mean intensity, landfalling distance, and storm speed were plotted to determine if a similar trend also exists in their respective timeseries. For more details on the methods used in analysing the timeseries of TC metrics, refer to Basconcillo et al. (2021) and Basconcillo and Moon (2022). The ACE is an index based on the sum of the squared six-hourly maximum sustained winds and is used to quantify TC activity because it integrates TC frequency, duration, and intensity. Results show that there is no trend in ACE, mean TC intensity, and landfalling distance (Figure 27c – f) in the WNP but there is a significant trend for similar TC metrics in the SEA. These results indicate that the TC activity, including both TC frequency and intensity, are increasing in the SEA region. Meanwhile, the TC storm speed is also decreasing in the SEA; slower TCs tend to induce more rainfall along its path, which ultimately may lead to higher cost of damages. It should be noted, however, that there is a need to revisit these results in the context of spatial scaling (e.g., other definitions of SEA boundary) to verify their robustness.



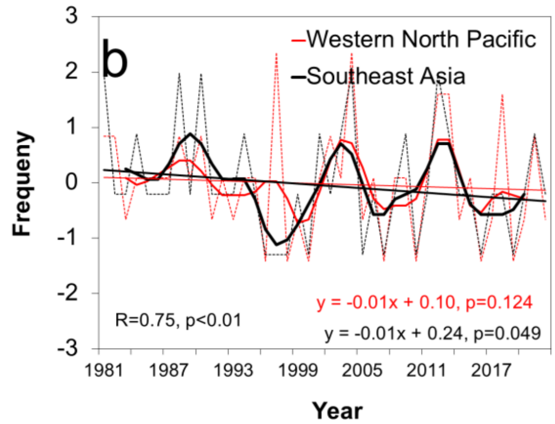


Figure 26: Climatology of TC passage frequency in June. *Top:* Mean TC passage frequency in the Western North Pacific (WNP) during June from 1981 to 2022. The dots indicate the TC track and intensity of Typhoon Chaba and Tropical Storm Aere. The black (blue) box indicates the location of the Philippine Area of Responsibility. *Bottom:* Timeseries of TC frequency in WNP (red line) and Southeast Asia (black line). The dashed (solid) line indicates the (original) 1-3-4-3-1 filtered timeseries.

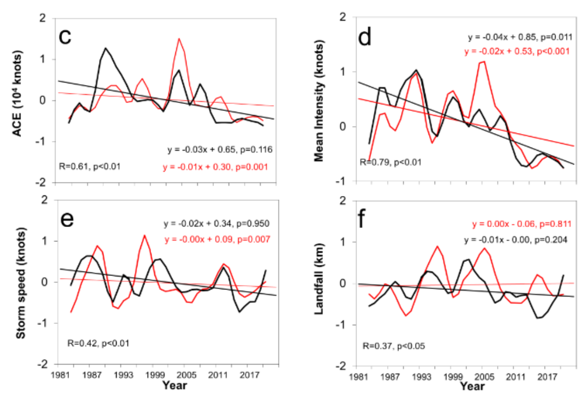


Figure 27: Climatology of selected TC metrics. *From (c) to (f):* Timeseries of 1-3-4-3-1 Accumulated Cyclone Energy (ACE), mean TC intensity, TC landfall distance, and storm speed in June (1981 – 2022) over the Western North Pacific (black line) and in Southeast Asia (red line), respectively.

Influence of ENSO on TC frequency

The El Niño Southern Oscillation (ENSO) tends to peak during December – February and declines during the boreal summer. Previous literature has shown that various TC metrics such as frequency, mean intensity, tracks and landfalling distance, and peak intensity are significantly correlated with ENSO.

However, most studies on the TC-ENSO linkage focused on the entire TC season (e.g., June – November) or a season by itself (e.g., June – August) with more TC occurrences thus the inadequate literature for a single month such as June is not surprising. The Niño 4 (also called Central Pacific ENSO) is correlated (anticorrelated) with SSTs in the central and western tropical Pacific in June (around 20°E in the central Pacific) (Figure 28a). This indicates that during La Niña in June 2022, the western Pacific tended to become relatively cooler than its previous months, which comparatively could have been less favourable for TC development and intensification. There was also significant correlation between Niño West and ACE in June (r= -0.63, p=0.000). Based on the Extended Reconstructed SST version 5, the SST anomaly in June 2022 in the Niño 4 region was -0.72. Thus, when compared with previous months, the La Niña conditions in June 2022 could have contributed to a relatively cooler SST, which then resulted in below- to near-normal TC frequency. Overall, La Niña may have different manifestation in the same location in different months.

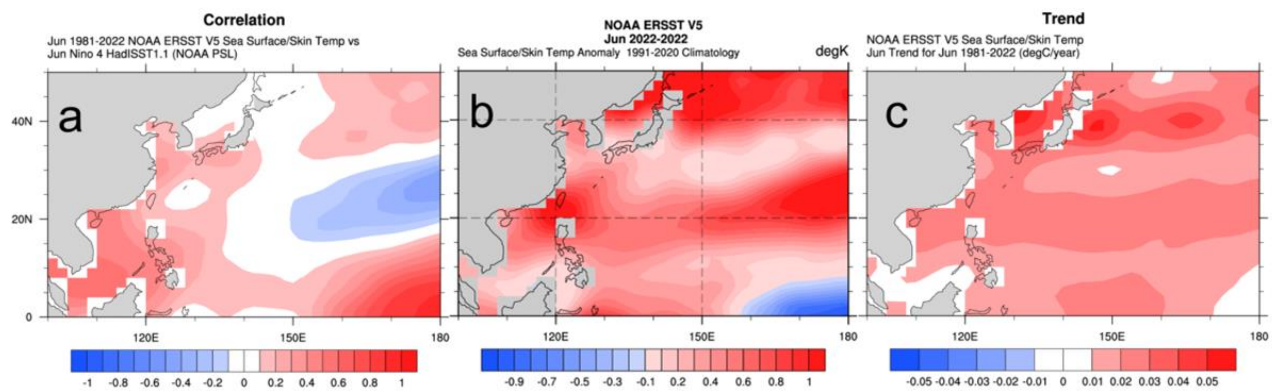


Figure 28: Relationship of SST and large-scale environment: (a) spatial correlation of Nino 4 and SST during June from 1981 to 2022, (b) SST anomalies in June 2022, and (c) trend from 1981 to 2022 in the Western North Pacific. *Credit: WRIT, 2022.*

Conclusion

This article highlights the preliminary observational analysis of TC occurrences in June while providing new insights on the trend and variability of selected TC metrics that are not previously described in the literature. Results show that there is a significantly increasing TC activity in June from 1981 to 2022, which can be attributed to TC-ENSO. Therefore, future works will closely focus on the establishment and thorough understanding of TC-ENSO and further analysis to be for the other climate modes in different spatiotemporal scales (e.g., decadal variability).

Reference

Basconcillo, J., Cha, EJ. & Moon, IJ. Characterizing the highest tropical cyclone frequency in the Western North Pacific since 1984. Sci Rep 11, 14350 (2021). https://doi.org/10.1038/s41598-021-93824-2.

Basconcillo, J., Moon, IJ. Increasing activity of tropical cyclones in East Asia during the mature boreal autumn linked to long-term climate variability. npj Clim Atmos Sci 5, 4 (2022). https://doi.org/10.1038/s41612-021-00222-6.

PAGASA Daily Rainfall and Temperature Monitoring. https://www.pagasa.dost.gov.ph/climate/climate-monitoring#daily-rainfall-and-temperature.

Web-based Reanalyses Intercomparison Tools (WRIT). https://psl.noaa.gov/data/writ.

Heavy rainfall over Brunei Darussalam in March 2022

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Overview

On 11 and 12 March 2022, wet weather conditions prevailed over Brunei Darussalam, particularly over the inland areas and resulted in floods over several rural areas. Due to flooding over the main roads, access to smaller villages in the inland Temburong District was cut off temporarily.

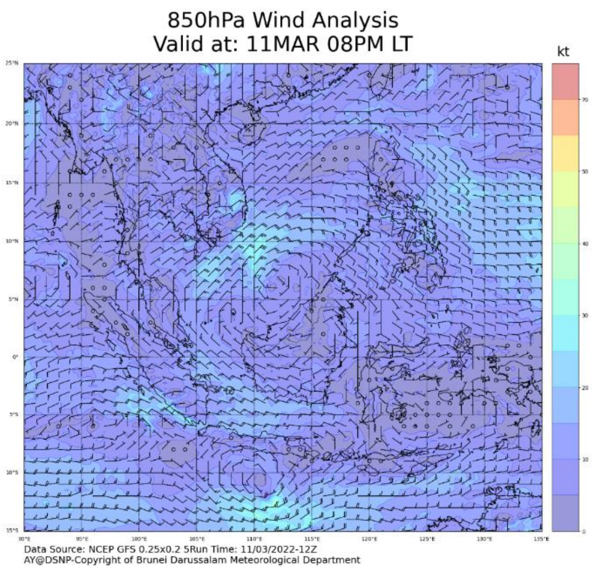


Figure 29: GFS wind analysis at 850 hPa on 11 March 2022, 12 UTC. *Credit: NCEP GFS.*

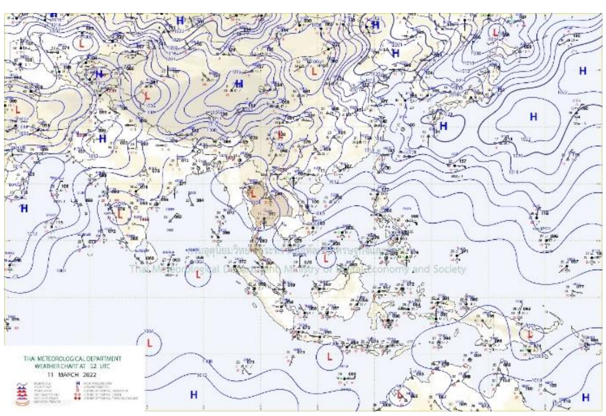
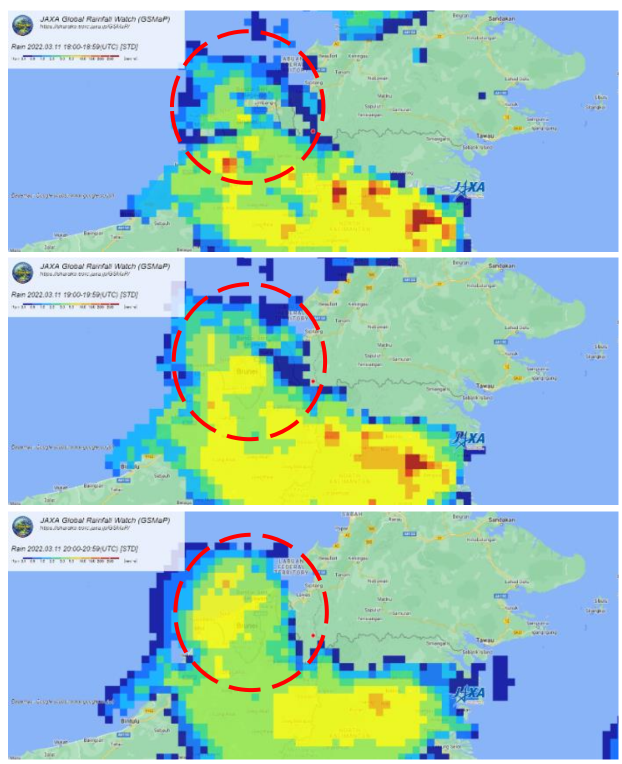


Figure 30: Surface weather chart on 11 March 2022, 12 UTC. *Credit: Thai Meteorological Department (TMD).*

Synoptic analysis

Based on the GFS wind analysis at 850 hPa on 11 March 2022, 12 UTC (Figure 29), a moderately strong cyclonic vortex could be seen over northwest of Brunei Darussalam. The vortex collected most of the moisture and energy from the surrounding and concentrated them close to Borneo's coastal region. This system also brought about southwesterly flow along the coastline of Brunei Darussalam. At the same time, strong easterly winds were blowing from the Northwest Pacific Ocean, likely due to the persisting La Nina conditions. These easterly winds penetrated through the Philippines to northeastern parts of Borneo. The combination of the two opposing winds caused a convergence of winds over Brunei Darussalam and consequently resulted in the heavy rainfall event. This analysis is also coherent with the surface low-pressure observed in the surface weather chart (Figure 30).



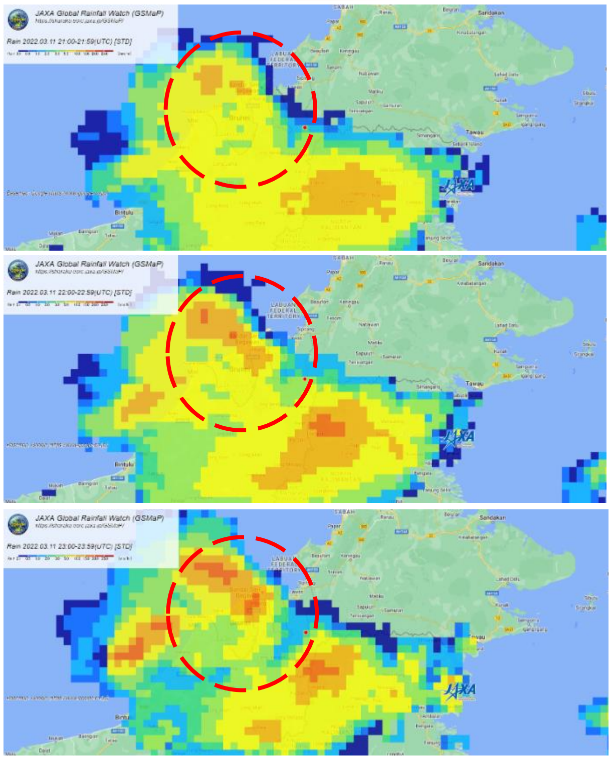


Figure 31: Hourly rainfall over Brunei Darussalam between 18 and 24 UTC on 11 March 2022. *Credit: JAXA Global Rainfall Watch (GSMaP).*

Figure 32: Floods occurred over the main road into the inland Temburong District on 12 March 2022. *Credit: Brunei Fire and Rescue Department.*

Observations

The estimated hourly rainfall based on JAXA GSMaP (Figure 31) shows that throughout the 6-hour period from 18 to 24 UTC on 11 March 2022, Brunei Darussalam experienced widespread rain with more intense thunderstorms observed over the inland areas. These corresponded well with the reports from the Fire and Rescue Department, where floods were reported by the rural communities in the Temburong District. Meanwhile, Brunei International Airport's weather station recorded 139.9 mm of rainfall over the 2-day wet spell.

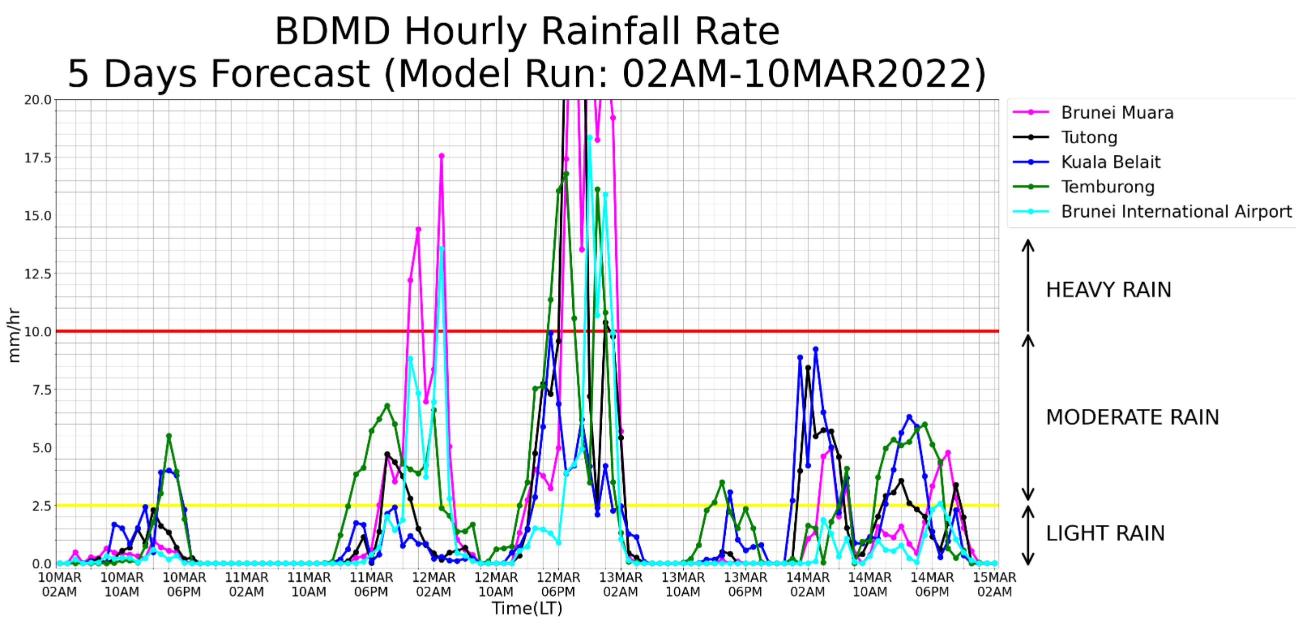


Figure 33: Heavy rainfall was predicted by the NCEP GFS model for the period 11 – 13 March 2022. *Credit: NCEP GFS.*

Forecasting the event

This particular heavy rain event was difficult to forecast, as the indications of severe weather were only observed and analysed approximately one day before it took place. The main reference NWP model and product were from NCEP GFS (Figure 33). In comparison, there were little indication from other NWP models such as ECMWF and WRF 5-km.

Issuance of early warning

Over the course of the event, Brunei Darussalam Meteorological Department (BDMD) had issued 1 yellow-stage and 1 amber-stage weather warnings, which helped the public and relevant government agencies in early preparation ahead of the heavy rain and severe weather conditions. The warnings were issued in a timely manner and made available to the public via various channels, including radio, television, social media, as well as real-time notification in the Brunei Weather mobile application. With the issuance of early warning and cooperative preparation from stakeholders, no lives were lost during the heavy rain event.

Figure 34: Weather warnings issued by Brunei Darussalam Meteorological Department (BDMD): yellow-stage on 11 March 2022 (*top*) and amber-stage on 12 March 2022 (*bottom*). *Credit: BDMD Forecast Office.*

Teleconnection between polar vortex and below-normal temperature in Thailand

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Large-scale atmospheric circulation plays an important role on climate variability and affects weather patterns and circulations that may occur in various time scale from a few days to decades.

Background

Teleconnection patterns are a naturally occurring aspect of a chaotic atmospheric system and can arise as a reflection of internal atmospheric dynamics. Temperature, rainfall, and intensity of the jet stream are all influenced by teleconnection patterns, which show large-scale changes in the atmospheric wave.

Teleconnection patterns may also refer to a recurring and persistent, large-scale pattern of pressure and circulation anomalies that span across vast geographical areas. These patterns typically last from several weeks to several months; they can sometimes be prominent for several consecutive years, thus reflecting an important part of both the interannual and interdecadal variability of the atmospheric circulation. Many of the teleconnection patterns are also planetary scale in nature and span across entire ocean basins and continents.

Polar vortex is a swirling vortex that is usually centred over the top of globe and hovers over the north pole. When the polar vortex is strong and spinning quickly, it has the potential to cause extremely unpredictable weather conditions. Figure 35 and Figure 36 show how the polar vortex can produce extremely volatile weather, where cold air transport from the polar regions toward the US and Europe regions. Figure 35 also shows the strengthening of the trough which intensified the cold weather. Over Thailand, there was a drop of temperature (10 °C below normal) for about a week from 24 March 2011 to 2 April 2011.

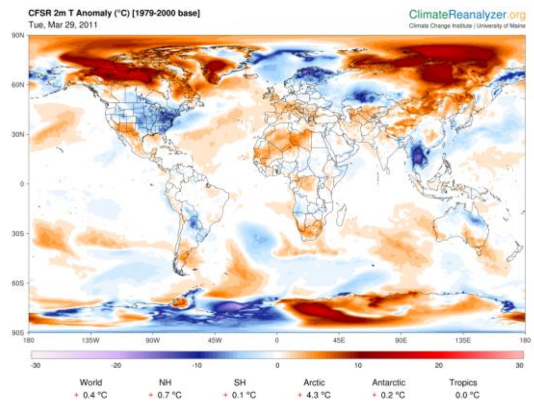

Figure 35: Surface temperature forecast from the CFSv2 model on 29 March 2011 which shows the impact of the wavy polar vortex and atmospheric patterns. *Credit: NCEP CFSv2 and CFS Reanalysis (CFSR) models.*

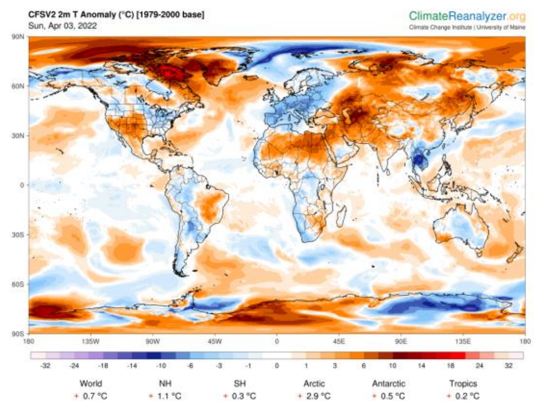

Figure 36: Surface temperature forecast from the CFSv2 model on 3 April 2022 which shows the impact of the weak polar vortex and atmospheric patterns. *Credit: NCEP CFSv2 and CFS Reanalysis (CFSR) models.*

Impact over Thailand

A recurrence of similar weather events took place in early April 2022 over the Mekong sub-region (Figure 35 and 36). The high-pressure system from China firstly reached the northeastern regions of Thailand, and then to central Thailand. Figure 37 shows a spatial pattern of the mean minimum temperature as an impact of the polar vortex. Figure 38 shows the time series of the anomaly of minimum temperature in various parts of Thailand.

Summary

TMD Climate Center continuously monitors the weather and climate events in the past and investigates the mechanism of teleconnection between atmospheric phenomena and extreme weather and climate events. The centre is also involved in various research and studies to better understand the regional and global climate system.

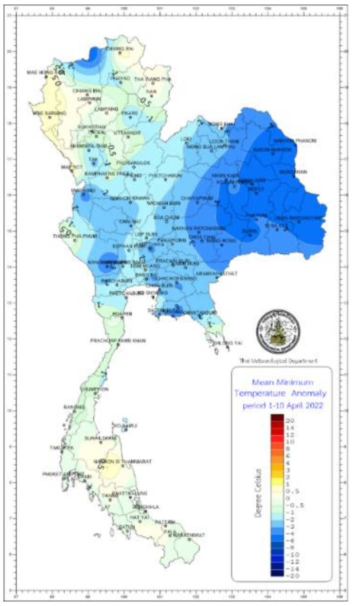

Figure 37: Mean minimum temperature anomaly on 1 – 10 April 2022 shows polar vortex causing below-normal temperature (climatological period of 1991 – 2020).

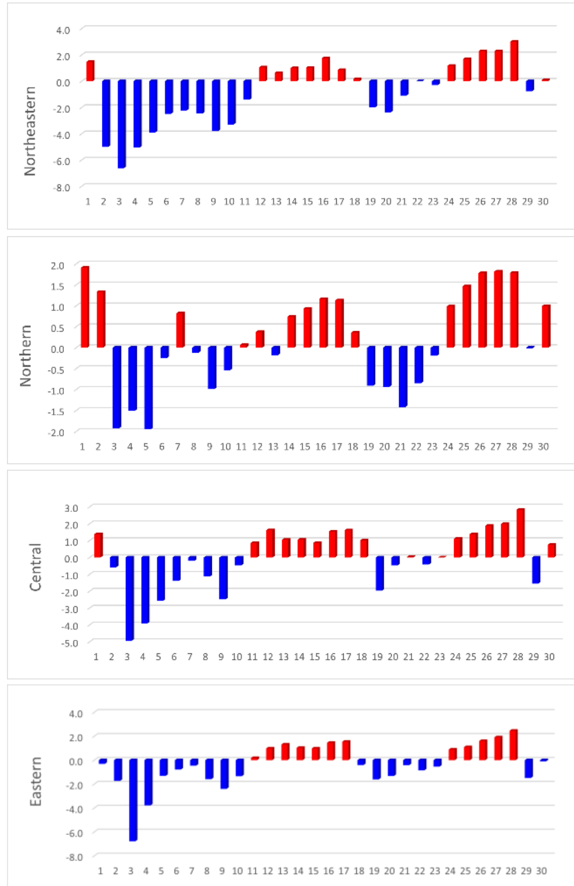

Figure 38: Time series of the anomaly of minimum temperature during 1 – 30 April 2022 across various parts of Thailand (climatological period of 1991 – 2020). *Credi:. TMD weather stations.*

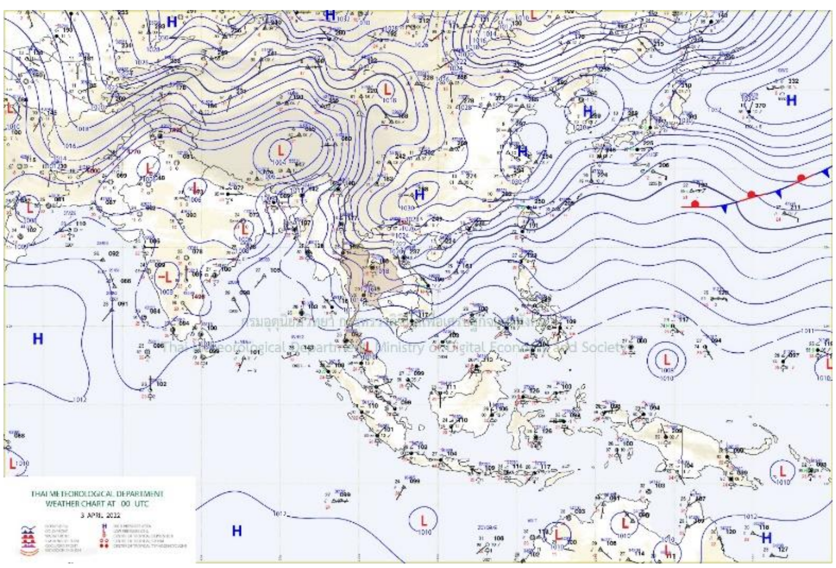

Figure 39. Weather chart at 00 UTC on 3 April 2022 shows the atmospheric waves in the northern hemisphere, Europe, and central Asia which experienced reverberations while high-pressure areas shifted downward to southern China and Mekong sub-region; temperature fell below average by 10 – 12°C, over provinces in northern and northeastern Thailand. *Credit: TMD.*

ASMC EVENTS

Eighteenth Session of the ASEAN Climate Outlook Forum (ASEANCOF-18) (Online: 24 and 26 May 2022)

The Eighteenth Session of the ASEAN Climate Outlook Forum (ASEANCOF-18) was organised by the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) in collaboration with the ASEAN Specialised Meteorological Centre (ASMC) and the ASEANCOF Working Group. Participants from the NMHSs of ASEAN Member States created a consensus forecast for the boreal summer monsoon 2022 in the ASEAN region.

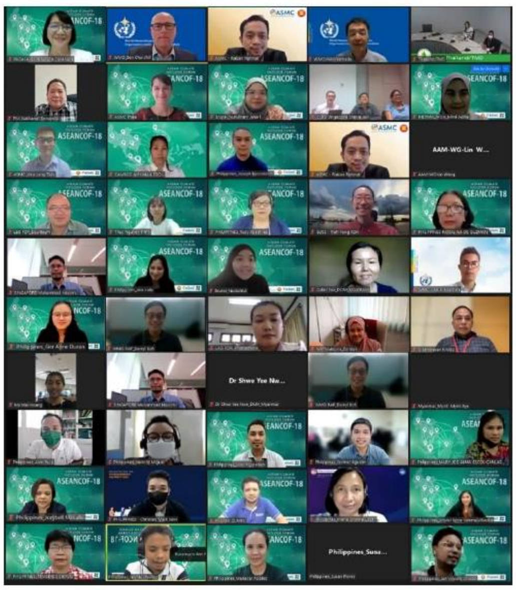

Figure 40: Participants from NMHSs, WMO-RAP, AAM-WG, ASMC, and the ASEANCOF Working Group during the first day of ASEANCOF-18.

The consensus for June-July-August (JJA) 2022 outlook (Figure 41) was achieved through an online session, which included presentations from different NMHSs, questionnaires, and discussions regarding the current climate conditions and predictions in the Southeast Asia region. In particular, ASEANCOF considered the influence of the El Niño Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) on the climate system over Southeast Asia.

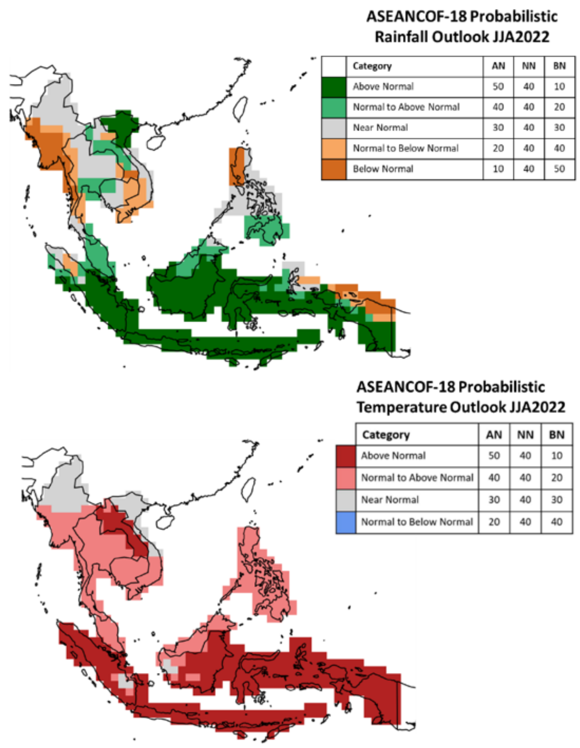

Figure 41: Consensus maps for probabilistic outlook on rainfall and temperature for JJA 2022.

ASEANCOF-18 agreed that for the upcoming boreal (Northern Hemisphere) summer season (JJA 2022), near- to above-normal rainfall is predicted over much of the southern ASEAN region. Near- to above-normal rainfall is predicted over Brunei Darussalam and many parts of Malaysia, with above-normal rainfall predicted most elsewhere. The exceptions include parts of the western and eastern Maritime Continent, where near- to below-normal rainfall is predicted. Over much of the northern ASEAN region, a mix of below- to above-normal rainfall is predicted. Near- to below-normal rainfall is predicted over the western and southeast portion of Mainland Southeast Asia, and northwest Philippines. Near- to above-normal rainfall is predicted over portions of northeast and southern Mainland Southeast Asia, and southern Philippines. Elsewhere in the northern ASEAN region, near-normal rainfall is predicted.

On temperature, ASEANCOF-18 agreed that near- to above-normal temperature is predicted over the ASEAN region. The highest likelihood of above-normal temperature is over the southern Maritime Continent and Lao PDR, while near-normal temperature is predicted over northern Myanmar, northern and central Viet Nam, and parts of the western Maritime Continent. An equal chance of near- to above-normal temperature is predicted over southern Myanmar, Thailand, Cambodia, southern Viet Nam, the Philippines, Malaysia, and Brunei Darussalam.

The theme of ASEANCOF-18 was understanding monsoons. The NMHSs' participants shared how they defined the monsoon in their country, including the importance of monitoring various components of the monsoon, such as onset, duration, strength, and variability. There was also a presentation from the Working Group for Asian Australian Monsoon (AAM-WG), who are working towards a regional monsoon index for Southeast Asia. Updates from this work will be presented at subsequent ASEANCOFs.

Moreover, the WMO-RAP emphasized the notion of "Early Warning and early action", where NMHSs have the essential role for the safety and wellbeing of the society particularly in ASEAN region.

Overall, it was a successful ASEANCOF-18. Participants expressed that they had a wonderful time and truly acquired valuable information that will be useful in NMHS's quest to help reduce the impacts of regional scale extreme climate events and work towards objective seasonal outlooks.

Some participants also expressed their interests in the discussion on the proposed formulation of a regional monsoon index, since currently, there are projects being implemented where one of its objectives is to develop a summer monsoon index over the maritime continent both during summer and winter season.

DOST-PAGASA as the ASEANCOF-18 host, is committed to support, and shall continue to participate actively in the succeeding ASEANCOFs.

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