ASMC Bulletin

ASEAN SPECIALISED METEOROLOGICAL CENTRE

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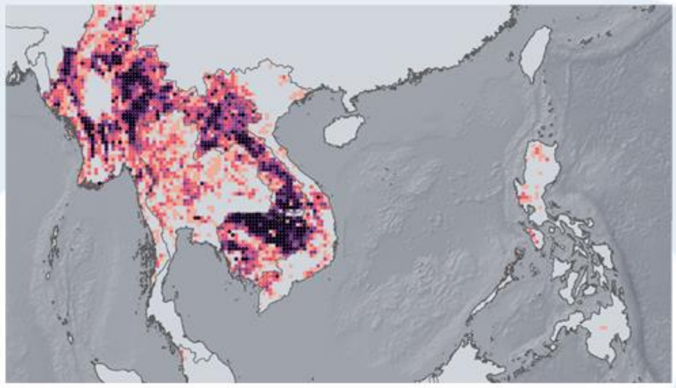

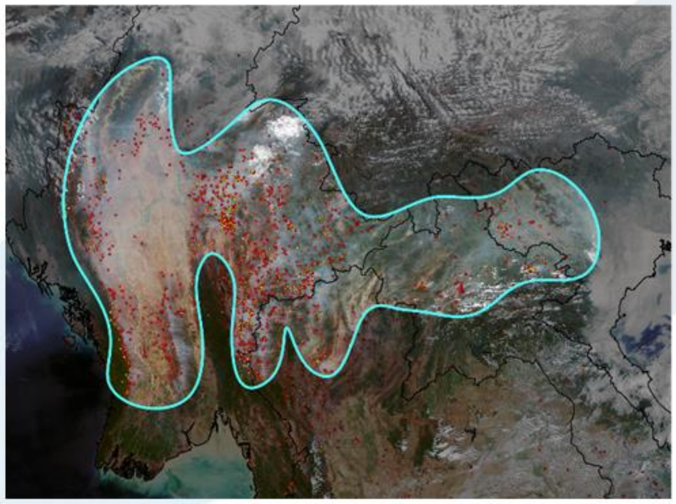

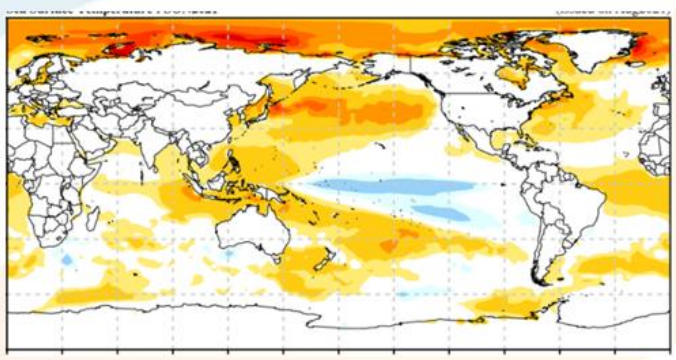

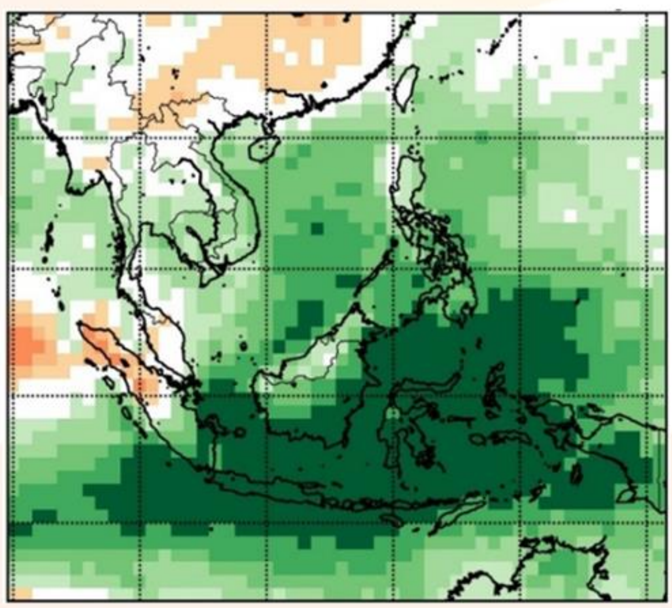

Issue No.8
September 2021

Published annually in March and September, the ASMC bulletin provides a review and outlook of weather and climate phenomena of importance to the region (e.g., ENSO, MJO, and monsoon) as well as their influence on the region's temperature and rainfall conditions.

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Summary

In the first half of 2021,

- The 2020 La Niña event ended while the Indian Ocean Dipole (IOD) remained generally neutral. A complete circumnavigation of the MJO pulse during the second quarter of 2021 contributed to the mix of below- to above-average rainfall over Southeast Asia.
- Moderate to dense smoke haze affected much of the Mekong sub-region in the first quarter of 2021. Hotspot counts were comparable to those in previous years for the same period.
- Hot and dry spells affected Viet Nam and Thailand during May-July 2021, an intense monsoon over the Bay of Bengal brought heavy rainfall to coastal areas of Myanmar in June 2021, while four tropical cyclones crossed within the Philippine Area of Responsibility (PAR).

For the period September 2021 to February 2022,

- A negative phase of the IOD developed and is expected to persist until October 2021.
- For the rest of the year, either ENSO neutral conditions or La Niña conditions could re-develop.
- Models predict wetter conditions over much of Southeast Asia, particularly over central and southern parts of the Maritime Continent.

ASMC continues its 5-year Regional Capability-Building Programme (ACaP):

- 3rd Workshop on ASEAN Regional Climate Data, Analysis and Projections (ARCDAP)
- 2nd Workshop on Weather Prediction by Numerical Methods (WPNM)
- 16th Session of the ASEAN Climate Outlook Forum (ASEANCOF)
- Webinar on Hotspot and Haze Assessment (H2A)

ASMC
ASEAN SPECIALISED METEOROLOGICAL CENTRE

CLIMATE REVIEW (JAN – JUN 2021)

End of La Niña event

El Niño Southern Oscillation

The first half of 2021 saw the end of the La Niña event that developed in the second half of 2020. Observed sea-surface temperature (SST) values over the Nino3.4 region of the Tropical Pacific transitioned from La Niña conditions to neutral conditions in the second quarter of the year (Figure 1). Key atmospheric indicators of ENSO (e.g., trade wind strength and cloudiness) also returned to more neutral conditions during this time.

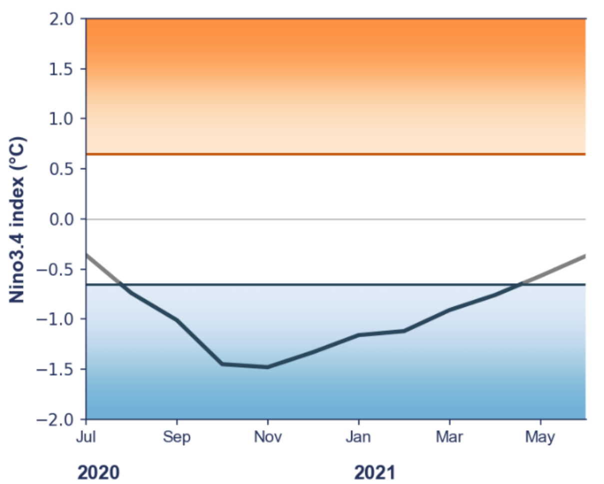

Figure 1. The Nino3.4 index (detrended) using the 1-month SST anomalies. Warm anomalies (⩾ +0.65; orange) correspond to El Niño conditions while cold anomalies (⩽ -0.65; blue) correspond to La Niña conditions, otherwise neutral (> -0.65 and < +0.65). *Reference methodology: Turkington, Timbal, & Rahmat,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

In December 2020, models from the Copernicus C3S multi-model system predicted that the La Niña event would have passed or neared the peak intensity, with a gradual return to neutral conditions by the first half of 2021 (Figure 2). Overall, the model predictions were close to the Nino3.4 index observed values.

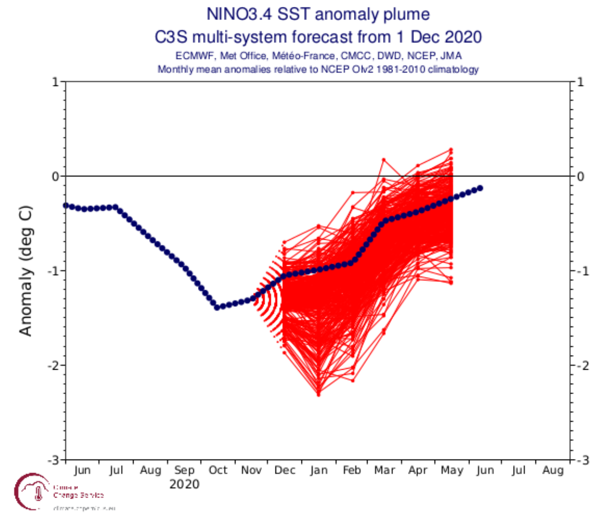

Figure 2. Forecasts of Nino3.4 index's strength (red lines) in December 2020 for the first half of 2021 from various seasonal prediction models of international climate centres. Observed values are in blue. *Credit: Copernicus C3S*.

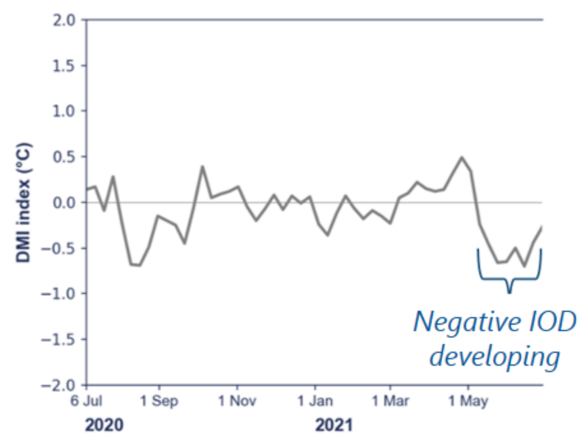

Figure 3. Indian Ocean Dipole (IOD) index showing generally neutral values between July 2020 and June 2021. *Credit: Bureau of Meteorology, Australia*.

Indian Ocean Dipole

The Indian Ocean Dipole (IOD) index was neutral for the first half of 2021, although there were signs of a negative IOD event developing from June onwards (Figure 3). At the start of 2021, the IOD index was close to zero. After a brief increase in April (although not long enough to declare a positive IOD event), the IOD has been negative. While there was a slight weakening at the end of June, overall, the ocean and atmospheric conditions over the Indian Ocean indicate that a negative IOD was developing towards the middle of 2021.

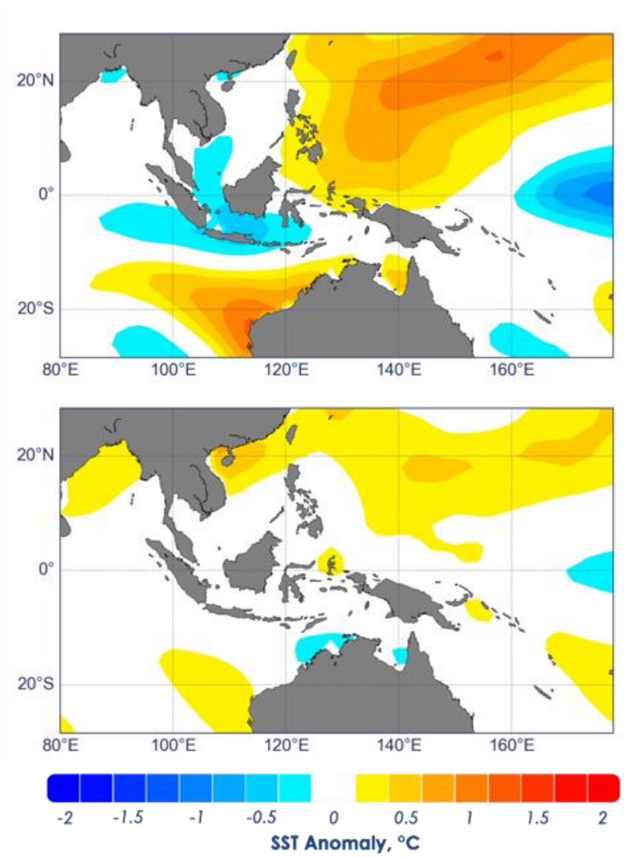

Figure 4. Average sea surface temperature anomalies for January – March 2021 were below- to near-average for much of the Southeast Asia region (upper). In comparison, the April – June 2021 values were closer to the average for much of the region (lower). *Data: IRI Data Library*.

Temperature Conditions

Overall, the SST anomalies in and around Southeast Asia returned to near average in the first half of 2021. Between January and March 2021, in much of the Southeast Asia region, the SST anomalies were below- to near-average, while above-average SST anomalies were present across and to the east of the Philippine Sea (Figure 4; upper). These warm anomalies in the Western Pacific are a common feature of La Niña events. Between April and June 2021, these warm anomalies weakened in line with the weakening La Niña event along with near-average SST conditions for the rest of the region (Figure 4; lower). The developing negative IOD is not discernible from Figure 4 (lower), although this is not surprising given that these conditions only develop towards the end of the review period.

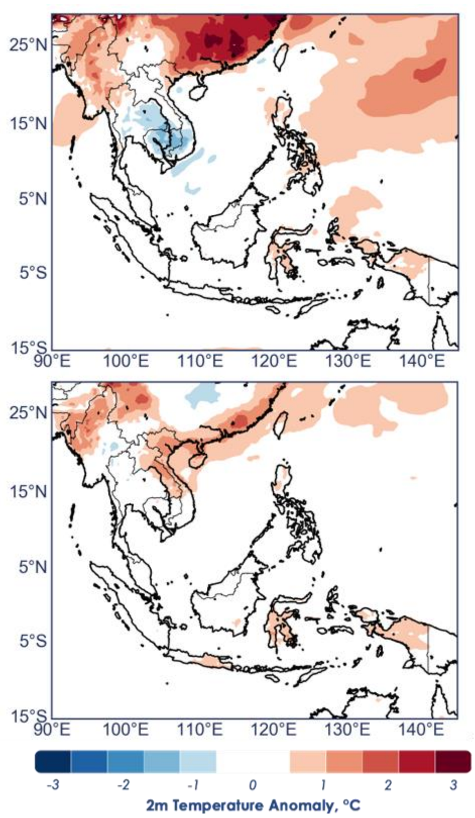

Figure 5. Average 2-metre temperature anomalies (˚C) against 1991-2020 climatology for January – March (upper) and April – June (lower) show warmer conditions (red shades), near-average conditions (white), and cooler conditions (blue shades) for Southeast Asia in the first half of 2021. *Data: ECMWF*.

Overall, Southeast Asia experienced a mix of below- to above-average temperatures in the first half of 2021 (Figure 5). For Mainland Southeast Asia between January and March 2021, below-average temperatures were recorded over Cambodia and parts of Thailand and Viet Nam, while above-average temperatures were recorded over Myanmar (Figure 5; upper). The below-average temperatures returned to near-average in April to May 2021, with the rest of Mainland Southeast Asia recording near- to above-average temperatures. The Maritime Continent experienced a mix of near- to above-average temperatures throughout the first half of 2021.

Rainfall Conditions

For rainfall, no significant anomalies were recorded over Mainland Southeast Asia between January and March 2021, noting that this also corresponds to the dry season for the region. Between April and June 2021, a mix of below- to above-average rainfall was recorded, with the largest negative anomalies (drier conditions) over parts of Myanmar and Viet Nam, and the largest positive anomalies (wetter conditions) over southern Cambodia and Viet Nam, as well as northern Lao PDR.

Considering rainfall over the Maritime Continent, most of the region, recorded above-average rainfall for the January – March 2021 period (Figure 6; upper), which was likely influenced by La Niña conditions still present in the Pacific Ocean during this time. However, there was a mix of below- to above-average rainfall from April to June 2021 (Figure 6; lower), corresponding to the end of La Niña event. With two of the main climate drivers in neutral state during the second quarter of 2021 (IOD and ENSO), intra-seasonal variability may have played a larger role in the observed rainfall anomalies.

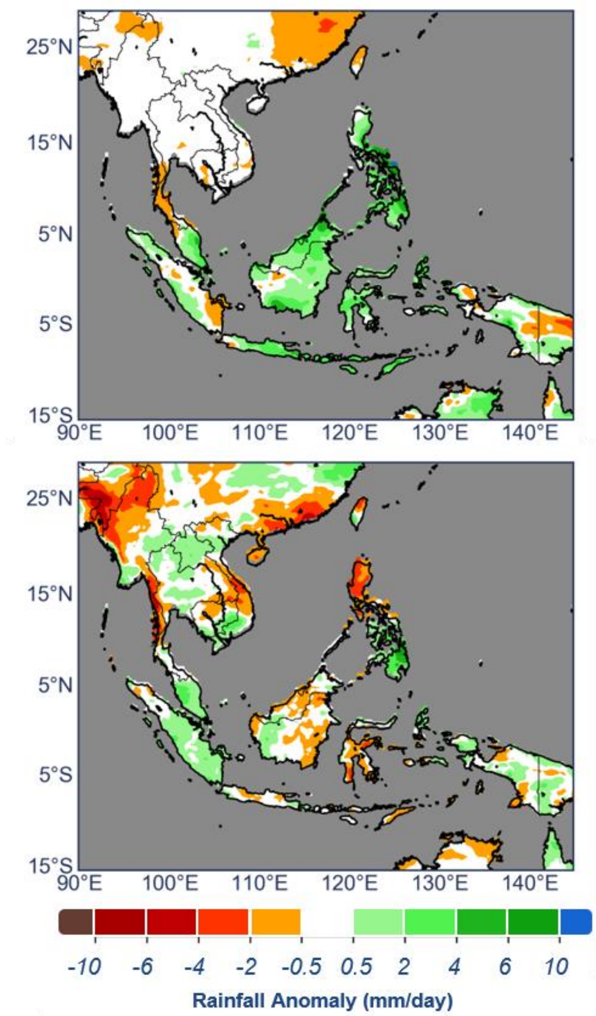

Figure 6. Rainfall anomaly (in mm/day) for January – March 2021 (upper) and April – June 2021 (lower) against 1991-2020 climatology from CHIRPS dataset. Areas in green were wetter than average, while those in orange were drier than average. *Data: IRI Data Library*.

Madden-Julian Oscillation

At the sub-seasonal timescale from January to March 2021, the Madden-Julian Oscillation (MJO) pulses were not as strong or as coherent as in previous years (Figure 7). Between the ends of January and February, the RMM index suggested that an MJO pulse was present in the Western Pacific. However, there was little eastward propagation of the signal, apart from the first two weeks of February. During this time of the year, Phase 6 typically brings wetter conditions to the eastern-most part of the Maritime Continent. Phase 7, on the other hand, brings drier conditions to the western half of the Maritime Continent, which is consistent with weaker positive rainfall anomalies in the western Maritime Continent in Figure 6 (upper). In the second half of March, an MJO pulse was present in the Western Hemisphere (Phases 8 and 1), which then propagated eastward to the Maritime Continent (Phase 4). This MJO pulse would have increased the rainfall over the Maritime Continent, particularly when it was in Phases 3 and 4, although the signal was not particularly strong. Overall, the presence of the La Niña conditions as well as other high-frequency waves may have contributed to the less coherent MJO pulses in January to March 2021 compared to this period in previous years.

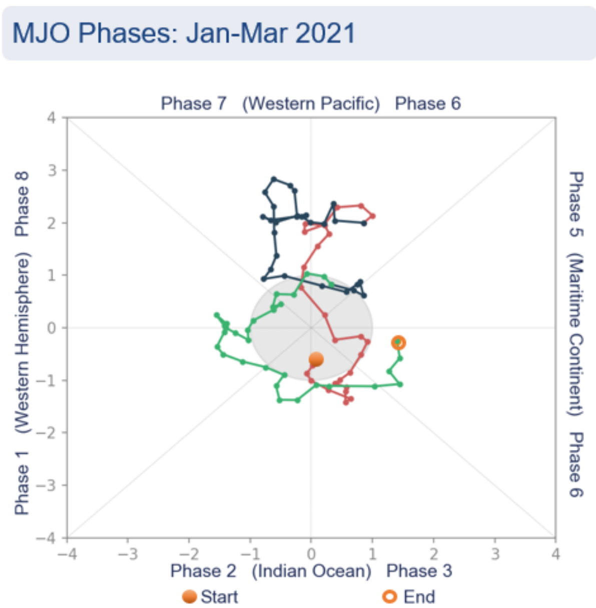

Figure 7. MJO strength and phases during January (red), February (blue) and March (green) 2021. The orange dots mark the start and end of the timeseries. *Data: Bureau of Meteorology, Australia*.

The MJO pulse from the end of March continued propagating eastward, becoming stronger and more coherent in April and May 2021, followed by no coherent MJO signal in June 2021 (Figure 8). Starting from the Maritime Continent (Phases 4 and 5) in the beginning of April 2021, the MJO pulse propagated eastwards, strengthening when it reached the Western Hemisphere (Phase 8). This pulse continued propagating eastward in May 2021, although it became less coherent for a time as it passed through the Indian Ocean (Phases 2 and 3) around the middle of the month. Towards the end of May 2021, the MJO pulse reached the Maritime Continent (Phase 4) again, before weakening in Phase 5. This complete circumnavigation of the globe by the MJO pulse may also explain the mix of below- to above-average rainfall over Southeast Asia from April to June 2021 (Figure 6; lower), as MJO pulses bring both wetter and drier conditions to the region, depending on the phase.

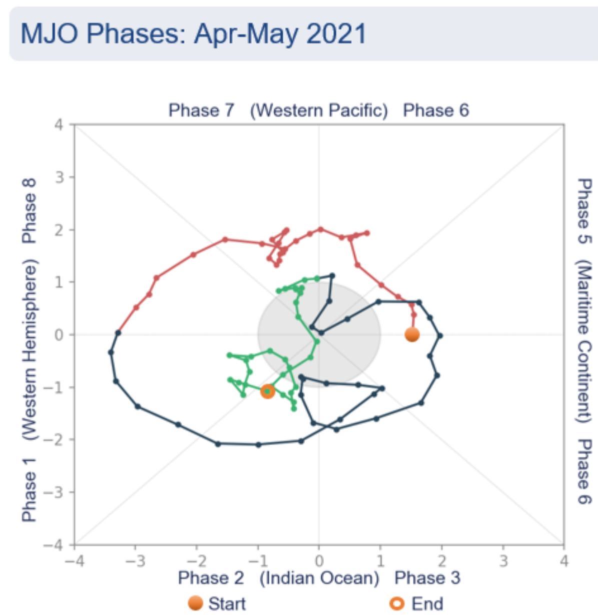

Figure 8. MJO strength and phases during April (red), May (blue) and June (green) 2021. The orange dots mark the start and end of the timeseries. *Data: Bureau of Meteorology, Australia*.

REGIONAL FIRE AND HAZE SITUATION (JAN – JUN 2021)

Transboundary smoke haze over the Mekong sub-region

In January 2021, persistent dry conditions in parts of the Mekong sub-region led to the development of clusters of hotspots mainly in northern and eastern Cambodia. Moderate to dense smoke haze from these clusters was also observed on several days, at times drifting westwards into Thailand. With dry conditions (Figure 9) extending into February and March 2021, the hotspot and haze situation over the Mekong sub-region deteriorated and more intense clusters of hotspots were detected, particularly in Cambodia and the northern parts of the Mekong sub-region (Figures 10 and 11).

Moderate to dense smoke haze — some of which were transboundary — was observed emanating from these hotspot clusters and affected most parts of the Mekong sub-region (examples in Figures 12 and 13). Stations across the eastern and central parts of the sub-region reported air quality reaching "Very Unhealthy" levels on a few days.

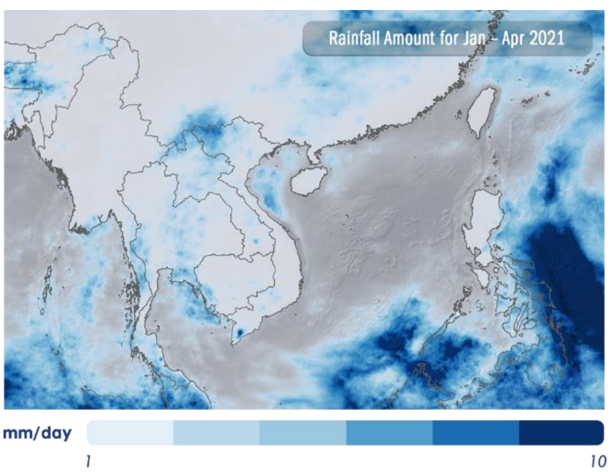

Figure 9. Average daily rainfall over the northern ASEAN region during January – April 2021. *Data: Global Precipitation Measurement (GPM).*

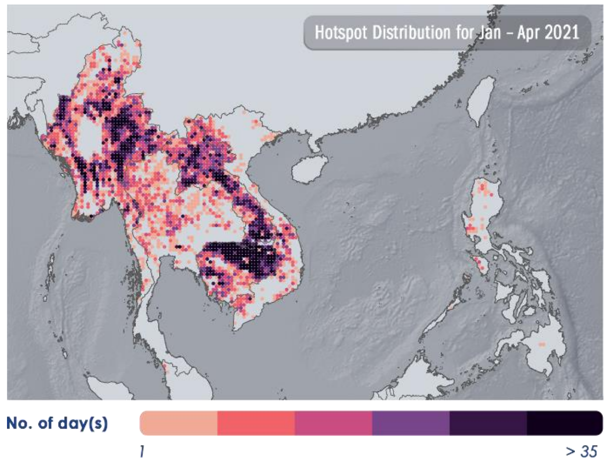

Figure 10. Distribution of NOAA-20 hotspots for January – April 2021. Persistent clusters of hotspots were detected particularly in Cambodia and the northern parts of the Mekong sub-region.

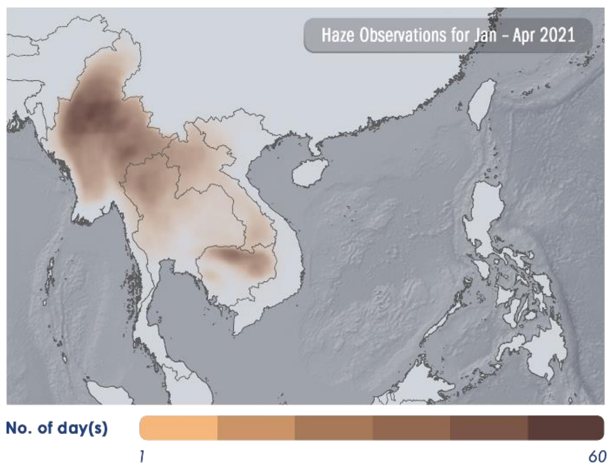

Figure 11. Haze areas for January – April 2021. Smoke haze from clusters of hotspots were observed particularly in Cambodia and the northern parts of the Mekong sub-region.

Through April 2021, a gradual increase in shower activities helped to subdue the hotspot and haze situation in the first fortnight over the southern, eastern, and central parts of the Mekong sub-region, and subsequently over the rest of the sub-region.

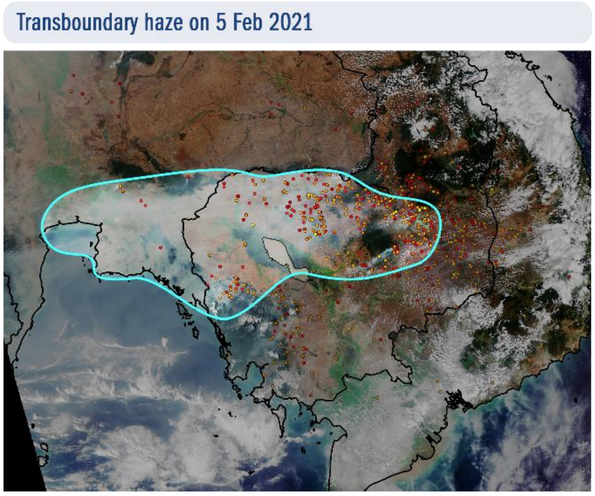

Figure 12. On 5 February 2021, smoke haze from hotspot clusters detected in the northern parts of Cambodia was observed drifting westwards into Thailand.

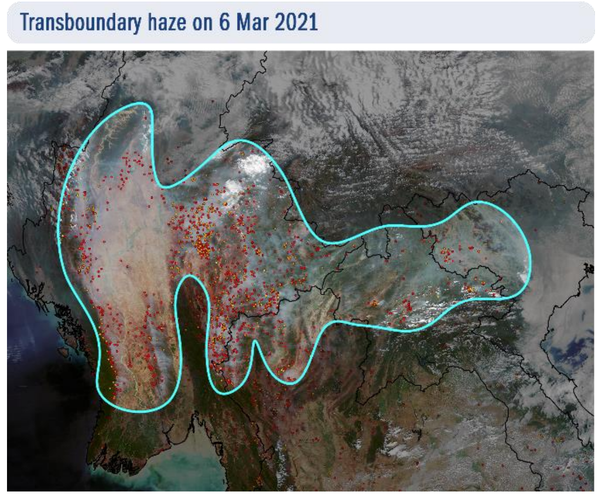

Figure 13. On 6 March 2021, moderate to dense smoke haze was observed over the northern and western parts of the Mekong sub-region. Smoke haze from hotspots in the eastern parts of Myanmar and the northern parts of Lao PDR were observed drifting eastwards into the northern parts of Lao PDR and Viet Nam respectively.

Overall, the hotspot counts in the Mekong sub-region were comparable to, or lower than, those in previous years for the same period (Figure 14). The total hotspot counts for the sub-region in 2021 were about 14% lower than those in 2020. In the southern ASEAN region, drier conditions during the dry phase of the Northeast Monsoon in February–early March 2021 contributed to isolated hotspot activities with localised smoke plumes in parts of Peninsular Malaysia, central and northern Sumatra, and West Kalimantan. Hotspot activities were generally subdued from April 2021 as shower activities increased with the onset of inter-monsoon conditions.

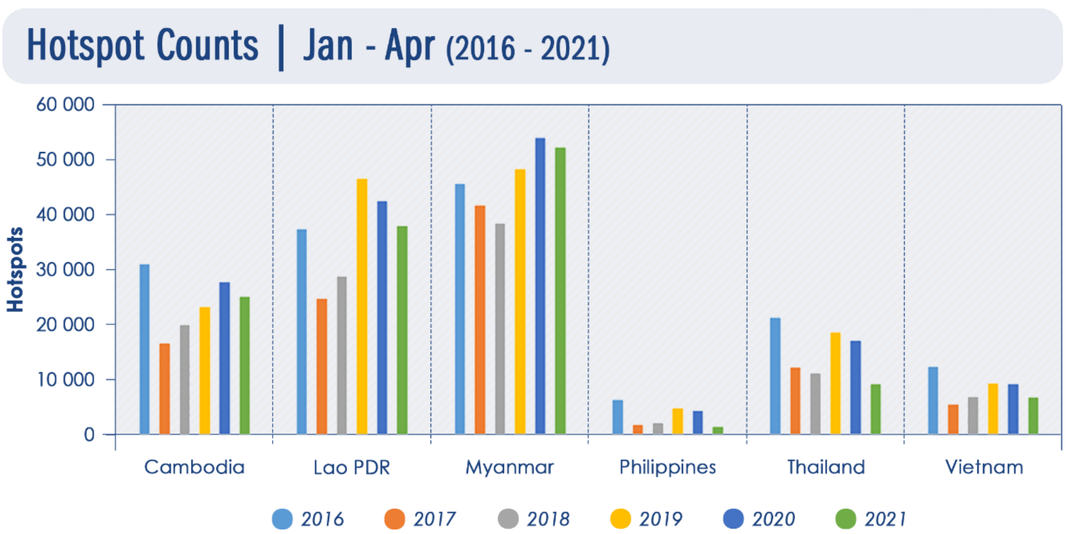

Figure 14. Hotspot counts for the northern ASEAN region during January – April (2016 – 2021).
[Note: The hotspot counts from 2019 onwards are based on the NOAA-20 satellite, while those from 2016 – 2018 are based on the Suomi-NPP satellite.]

CLIMATE AND HAZE OUTLOOK (SEP 2021 – FEB 2022)

Negative phase of IOD to persist until October and signs of possible La Niña developing near the end of the year

ENSO Outlook

ENSO conditions are currently neutral and the SST anomalies over the Nino3.4 region are negative, but within the neutral range. Model outlooks from international centres (C3S Copernicus) indicate *neutral or negative anomalies to continue* until the end of 2021 (Figure 15). From October onwards, most models predict La Niña conditions of varying strength based on the Nino3.4 index.

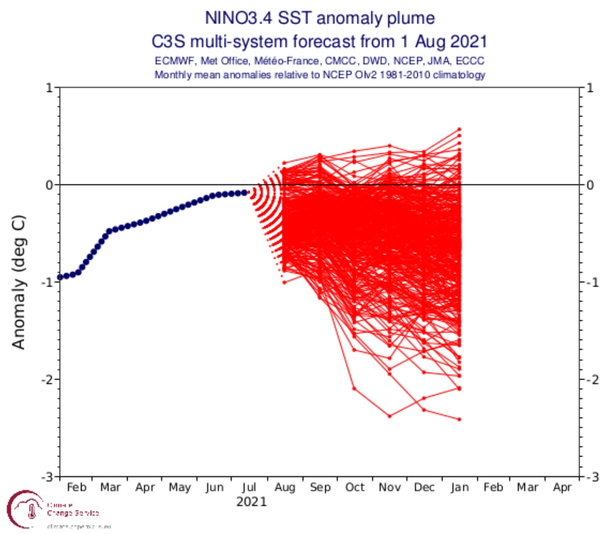

Figure 15. Nino3.4 SST anomaly predictions from C3S Copernicus models showing neutral or colder temperatures until the end of the year. Accounting for background warming, most models predict La Niña conditions from October onwards. *Credit: C3S Copernicus*.

In line with the Nino3.4 predictions, the ensemble-mean predictions of SST anomalies show La Niña-like conditions during September – November (SON) 2021 (Figure 16). Under La Niña conditions, colder SST anomalies are observed in the eastern and central Tropical Pacific Ocean (blue shades) and warmer anomalies in the western Tropical Pacific (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 western Pacific Ocean.

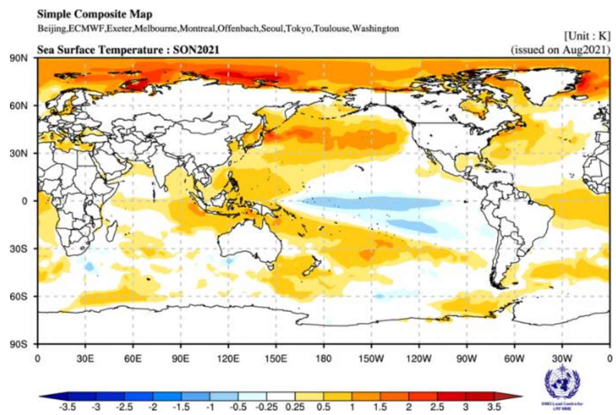

Figure 16. SST anomaly prediction for September - November (SON) 2021 from WMO showing La Niña like conditions in the Tropical Pacific Ocean (blue box). *Credit: WMO Lead Centre for Long-Range Forecasting*.

IOD Outlook

The IOD is likely to persist until October 2021 in its negative phase (Figure 17). 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 17). The shifting of monsoon trough southwards leads to the dissipation of any IOD events.

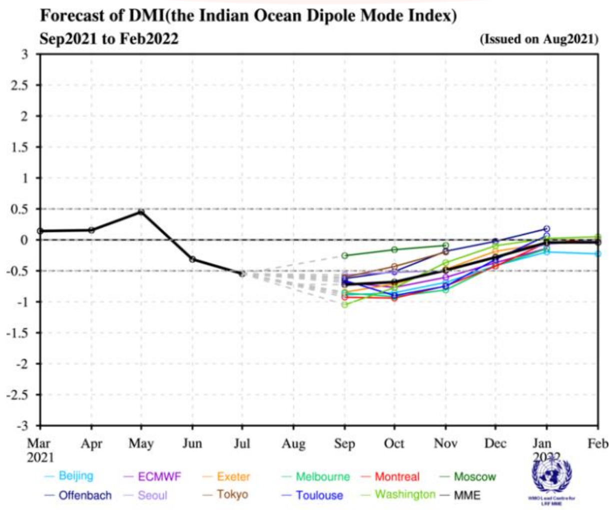

Figure 17. IOD index predictions, from models available on the WMO Lead Centre for Long-Range Forecasting, continue to be negative but will rapidly weaken towards the end of the year. *Credit: WMO Lead Centre for Long-Range Forecasting*.

Rainfall Outlook

In the upcoming September – November 2021 period, model predictions from 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 southern parts of the Maritime Continent (Figure 18). These areas of above-normal rainfall correspond to those that are typically wetter than average during a negative IOD event. For some parts of Mainland Southeast Asia, Peninsular Malaysia, and Sumatra, the model predictions indicate either no dominant or below-normal (drier) terciles. These regions also correspond to areas where the model skill is low at this time of year.

If La Niña conditions develop, wetter conditions are also likely for much of Southeast Asia for December 2021 - February 2022 (not shown). Based on composites from previous La Niña events, wetter-than-average conditions occur over the Philippines, eastern Indonesia, northern Borneo, and Peninsular Malaysia during December to February period.

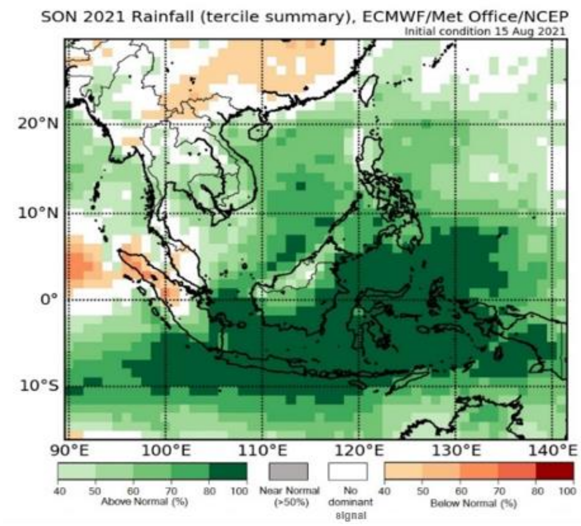

Figure 18. Rainfall tercile summary predictions of multi-model ensemble model for September-November (SON) 2021. Brown shades show regions with a higher likelihood of drier conditions, while green shades show regions with a higher likelihood of wetter conditions (contains modified Copernicus C3S information).

Temperature Outlook

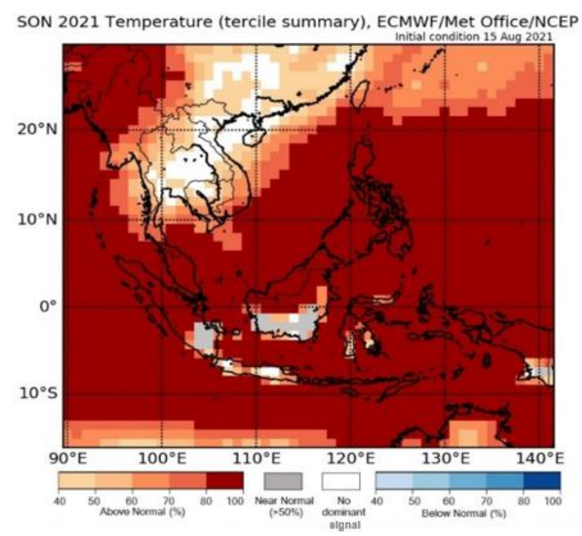

Figure 19. Temperature tercile summary predictions of multi-model ensemble model for September-November (SON) 2021. Red shades show regions with a higher likelihood of warmer conditions, while blue shades show regions with a higher likelihood of cooler conditions (contains modified Copernicus C3S information).

For temperature, most parts of the ASEAN region are predicted to experience above-normal (warmer) conditions during September – November (SON) 2021 (Figure 19). The exceptions are eastern

Thailand, Lao PDR, and northern Viet Nam, where each of the terciles is equally likely based on model predictions.

Haze Outlook

For the southern ASEAN region, the traditional dry season is expected to persist till October 2021. While higher-than-normal rainfall is forecast for the rest of 2021 dry season, periods of dry weather can still contribute to an increase in hotspot and smoke haze activities. Subsequently, as inter-monsoon followed by Northeast Monsoon conditions set in, an increase in rainfall is likely for the southern ASEAN region in November and December 2021, helping to keep the hotspot and smoke haze activity subdued. Climatologically, drier conditions are expected in the southern ASEAN region in January and February 2022 which may contribute to an increase in isolated hotspots and localised smoke plumes.

The Mekong sub-region is likely to experience rainy conditions for the rest of the year before the traditional dry season for the region sets in around December 2021/early January 2022. During the traditional dry season, prolonged drier conditions, can contribute to an escalation of hotspot and smoke haze activities in the sub-region.

SIGNIFICANT WEATHER EVENTS IN SOUTHEAST ASIA

Hot spells in northern and central Viet Nam in June 2021

Contributed by Ms Van Ngoc Tran (Forecaster) and Ms Mai Hoang Thi (Forecaster)
Climate Prediction Division, National Centre for Hydro-Meteorological Forecasting (NCHMF), Viet Nam

In June 2021, a hot spell occurred continuously for 12-17 days in the northern provinces and for 18-24 days in the central provinces of Viet Nam. During this heat wave, the highest daily temperature recorded ranged from 36°C to 39°C and peaked over 40°C at some areas in the central mountainous region. The June 2021 hot spell brought significant impact on people’s lives, affected flora and fauna, and increased the occurrences of forest fires in several provinces, including Quang Binh and Thua Thien Hue in the central region of Viet Nam. An early warning was issued to the provinces to alert and to make necessary preparations, which helped to reduce the impact.

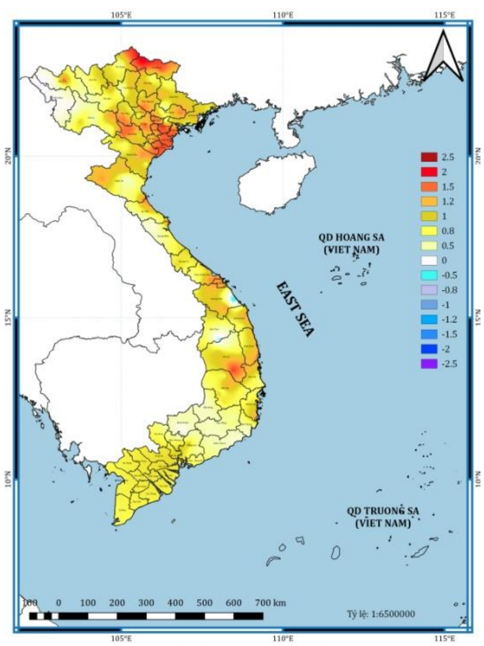

Figure 20. Temperature anomaly over Viet Nam in June 2021.

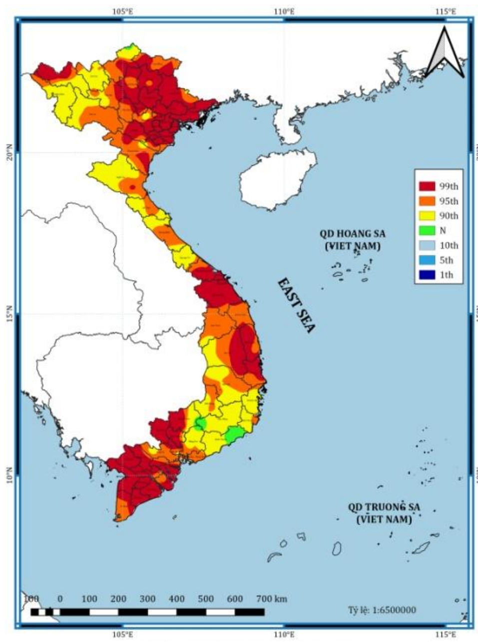

Figure 21. Temperature anomaly percentile over Viet Nam in June 2021.

In June 2021, the average temperature recorded was about 0.5-1.5°C higher than the climatological average. In some places in eastern north Viet Nam, the anomaly was 2°C above average (Figure 20). Figure 21 shows the anomaly percentile throughout Viet Nam – the anomalies recorded in the eastern north and in the south were in the 99th percentile.

The temperature recorded by observation stations were compared to the climatological records in Table 1. It could be seen that the highest temperature in June 2021 was 4-7°C higher than the climatological average, and 0.2-0.7°C higher than the highest ever recorded temperature since records began in 1961.

Station	Climatological Average (1991 – 2020) for Maximum Temperature (°C)	June 2021 (°C)	Historical High (°C) and Year
Van Chan	32.9	40.3	39.7 (1997)
Hai Duong	33.3	40.6	40.2 (2007)
Hung Yen	33.6	40.5	40.3 (2017)
Tam Ky	34.9	40.9	40.2 (2014)
Ba To	35.1	40.2	39.5 (1998)
Cao Lanh	32.4	36.0	35.6 (2020)

Table 1. Maximum temperature recorded by observation stations in June 2021, compared to the climatological average for maximum temperature from 1991 to 2020, and the historical records.

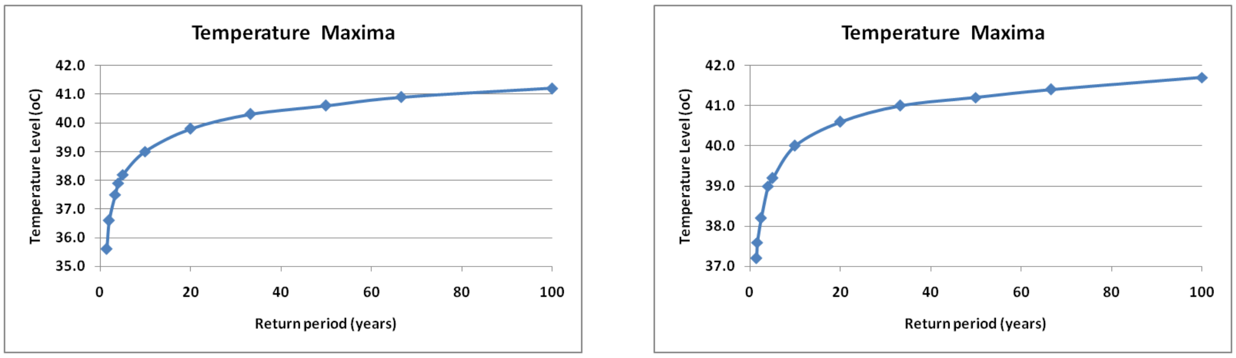

Figure 22. Return period of maximum temperature at Hai Duong station (left) and Tam Ky station (right).

The return period of the highest temperature at Hai Duong station (40.6°C) is about 45 years, and about 30 years at the Tam Ky triangulation station (40.9°C) (Figure 22).

The main cause of the hot spell in June 2021 could be attributed to the influence of the significant low-pressure system located over the Tibetan Plateau area, combined with the southwesterly winds resulting from the strong Foehn effect. The Foehn phenomenon happens when the southwesterly winds are blown over the Truong Son mountain range and causes dry heat – often characterised as a hot, dry southwesterly wind. The Foehn effect results in prolonged heat and low humidity during the daytime and indirectly increases fire risk.

During the period 17-21 June 2021, the significant low-pressure system located in the Tibetan Plateau area was found to be more active than normal (Figure 23a). In the northern and north-central regions, the outgoing longwave radiation (OLR) standard deviation was positive and contributed to suppressed convection and less cloud cover (Figure 23b). At the 850mb level, the southwesterly wind field was relatively strong over Viet Nam (Figure 23c). At the upper layer of the atmosphere, the subtropical high-pressure system spread towards the west and over the northern and central regions, where downflow was enhanced (Figure 23d) and the heat wave occurred more intensely.

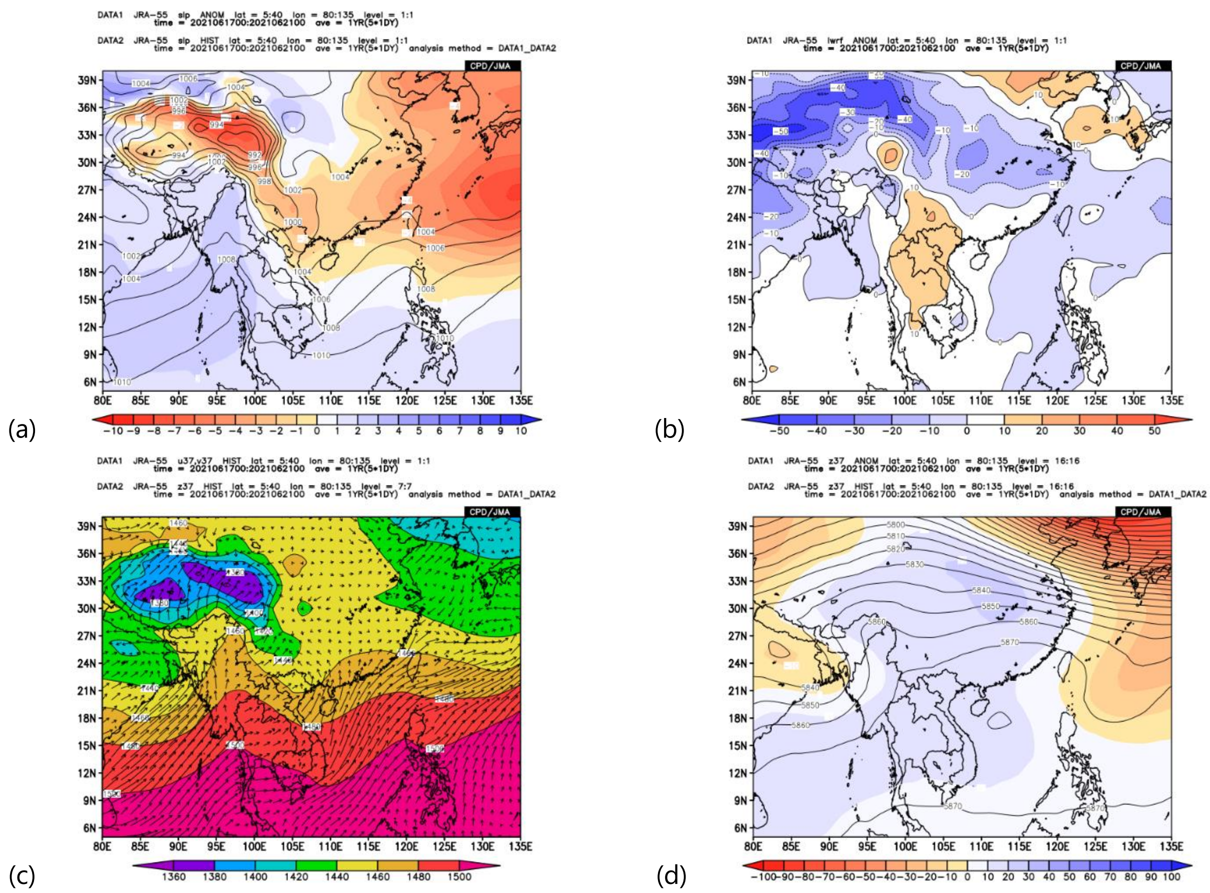

Figure 23. (a) Average standard deviation map of mean sea level pressure (mb), (b) OLR anomalies (W/m^2), (c) Average geopotential height (gpm) and wind at 850 mb, (d) standard deviation map of geopotential height at 500 mb from 17-21 June 2021. *Credit: Japan Meteorological Agency*.

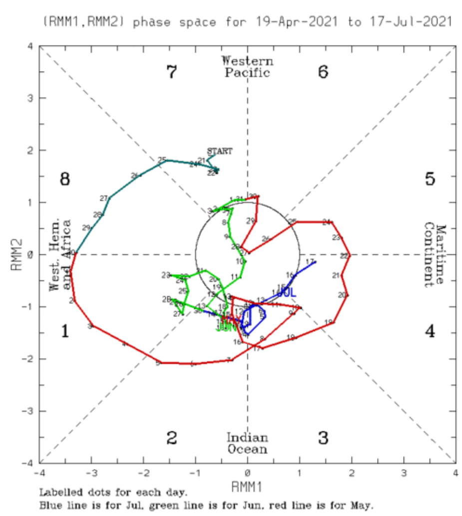

Figure 24. MJO monitoring from 19 April 2021 to 17 July 2021 (green line represented June 2021). *Credit: Bureau of Meteorology, Australia*.

During the first 20 days of June 2021, the MJO was inactive from Phases 8 to 1, where the weather is usually associated with drier conditions. Over the region, the temperature was also warmer and thereby enhanced the overall temperature anomalies. In summary, southwesterly winds from the low-pressure system over the Tibetan Plateau, and the downflow of subtropical high pressure at the 500 mb, brought drier conditions to the northern and central regions of Viet Nam in June 2021. The inactive MJO had also contributed to the hot spell during this period.

Severe weather event over the Rakhine Coast of Myanmar

Contributed by Ms Sabai Lwin (Assistant Director)
Agro-Meteorological Division, Department of Meteorology and Hydrology (DMH), Myanmar

Myanmar experienced a severe weather event on 16 June 2021, with heavy rainfall, strong winds and floods causing damage to Thandwe Airport in the Thandwe District in Myanmar (Figure 25). The event was due to the intense monsoon over the Bay of Bengal and resulted in damages to small airport vehicles, floods at the airport and several flight cancellations.

Synoptic Situation

At the time of the event, Myanmar was in the early-monsoon season (after the transition period), where intense Southwest Monsoon conditions were observed over the Rakhine Coast of Myanmar. Analysis from the surface synoptic weather chart at 0000 UTC, 16 June 2021 (Figure 26) showed converging isobar lines which were conducive for strong winds and heavy rainfall over the Rakhine Coast of Myanmar. The imagery from the Himawari-8 satellite at 0920 UTC, 16 June 2021 (Figure 27) also illustrated thunderstorm clouds and heavy rainfall over the Rakhine Coast of Myanmar.

Figure 25. Severe weather affected the Rakhine Coast, including the Thandwe Airport in the Thandwe District of Myanmar. *Credit: Eleven Media Group*.

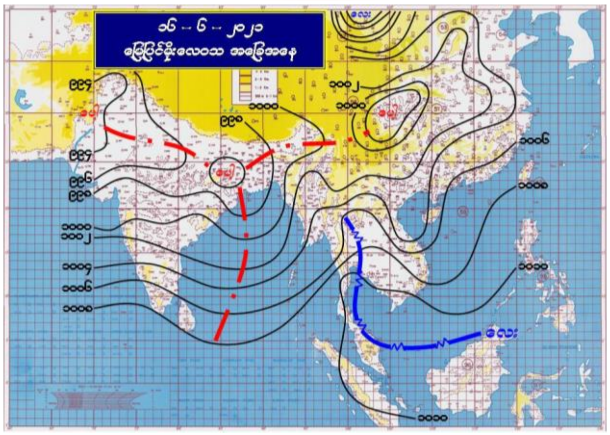

Figure 26. Surface weather chart by DMH at 0000 UTC, 16 June 2021.

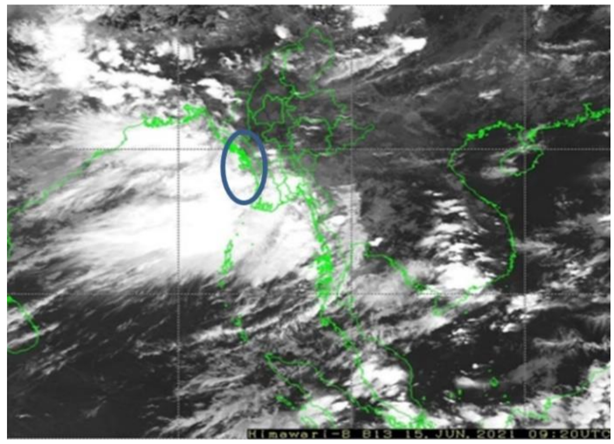

Figure 27. Himawari-8 satellite image at 0920 UTC, 16 June 2021 shows rain clouds over the Rakhine Coast of Myanmar (blue circle). *Credit: Japan Meteorological Agency*.

Forecasting the Event

At DMH, meteorological forecasters use the daily rainfall and wind forecast products from the Global Forecast System (GFS) model developed by the US National Centers for Environmental Prediction (NCEP). The GFS model output predicted the heavy rain over the Rakhine Coast of Myanmar to take place on 16 June 2021 (Figure 28).

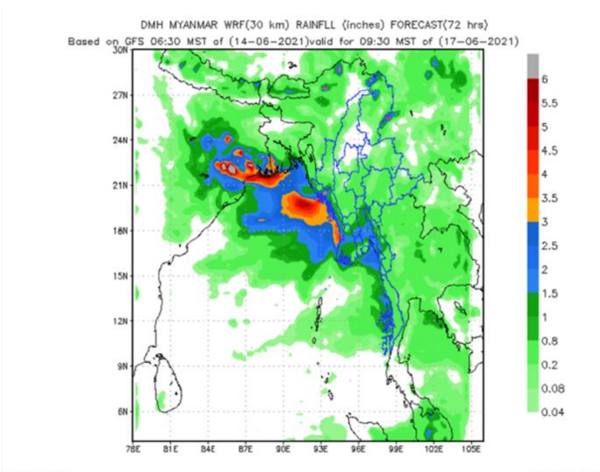

Figure 28. Rainfall Forecast from GFS on 16 June 2021 based on the model run on 14 June 2021, showing heavy rain over the western coast of Myanmar.

Observations

The total daily rainfall recorded at the Thandwe station was 169 mm and 143 mm on 16 June 2021 and 17 June 2021 respectively – both rainfall amount was considered as heavy rain (the daily climatological average for Thandwe station is 40 mm for 16 June, and 68 mm for 17 June). The heavy downpour could be attributed to the intense monsoon conditions over the Bay of Bengal.

Issuance of Warning

During the period 15-17 June 2021, weather monitoring by DMH was prioritised over the Bay of Bengal, where the adverse weather from the intense monsoon could potentially affect the Rakhine Coast of Myanmar and the Rakhine State. For precaution and early preparation, the DMH issued on that day, weather forecasts five times a day, on top of the routine daily forecast.

Dry spells in Thailand in May-Jul 2021 – a seasonal variability during a rainy monsoon

Contributed by Mr Chalump Oonariya (Meteorologist) and Ms Krittika Suebsak (Meteorologist)
Climate Center, Thai Meteorological Department (TMD), Thailand

Seasonal cycle shifts and variability are climate drivers that have direct impact on the weather and climate events in the tropical region, and essentially on monsoon activities. Monsoon characteristics, including its onset and withdrawal, are typically influenced by large-scale atmospheric systems (e.g., Walker or Hadley cell). The Indo-Pacific region located in the tropical zone, is an area associated with the Indian Monsoon and the Southeast Asian Monsoon. The tropical zone is important as it is surrounded by the largest warm pool of the earth and contains the most complicated ocean-land-atmosphere interactions.

Seasonal variation of surface and upper air features can be established from the mean winds. These variations are on a global scale, but its influence and effects are more pronounced over the continental land masses. At the upper troposphere in the subtropics, it is common to observe a distinct Hadley cell converging towards the equator in the form of low-level trade winds. Along with convection of air and heat, these form the Intertropical Convergence Zone (ITCZ), which is also an area with near-zero absolute vorticity. The ITCZ influences the global precipitation, and its variability has a big impact to rainfall anomalies in the tropical area, further affecting agriculture and water resources. Therefore, the monsoon occurs in a seasonal cycle and is part of the global circulation system. It is essential to understand the changes and variability of the ITCZ, including its position, oscillation, and intensity, as these form the ingredients to seasonal variability.

In this article, we would like to address the dry spells that occurred during the rainy monsoon season in 2021. Figure 29 shows the mean daily rainfall (from climatological records between 1979-2005 and from observations) over Thailand from 16 March 2021 to 25 July 2021. Two strong dry spells between 18 June 2021 and 5 July 2021 as illustrated in Figure 29, where the rainfall fell well below the climatological mean. The first dry spell occurred from 27 May 2021 to 6 June 2021 while the second spell was longer, from 18 June 2021 to 5 July 2021. These events caused severe damage to agricultural areas and water resources, which extended from central to northern and northeastern Thailand.

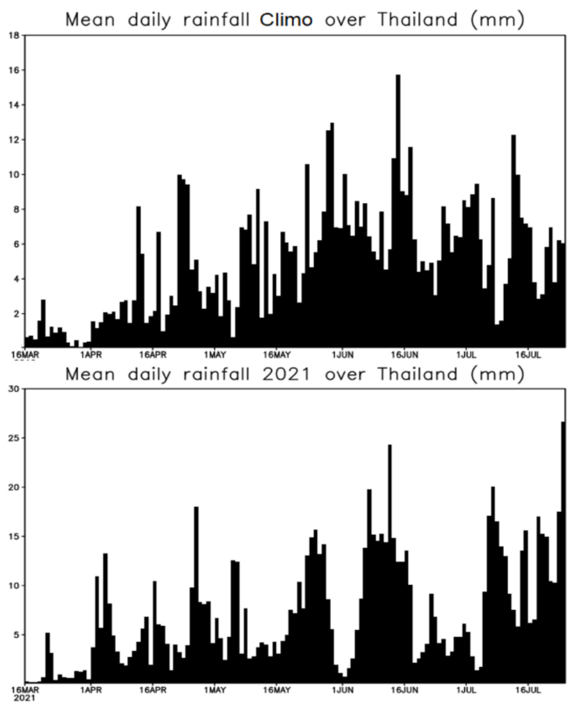

Figure 29. Climatological mean daily rainfall (mm/day) over Thailand from 16 March to 25 July averaged over 1979-2005 (upper) and mean daily rainfall for the same period in 2021 recorded from TMD weather stations (lower).

The rainy monsoon seasons in Thailand are normally characterised by consecutive rain days and influenced by the position of the ITCZ. During the rainy monsoon in 2021 (May-July), the subtropical high-pressure zones over the Pacific Ocean influenced the extension of a strong cross-equatorial pressure gradient (CEPG), as shown in Figure 30. The magnitude of the CEPG is important in determining the location of the ITCZ, which is a narrow zone in parallel with the equator. The ITCZ is also described as an area of low atmospheric pressures with the convergence of trade winds, and often produces cloud convection and precipitation. It is related to the cyclonic relative vorticity in the lower troposphere.

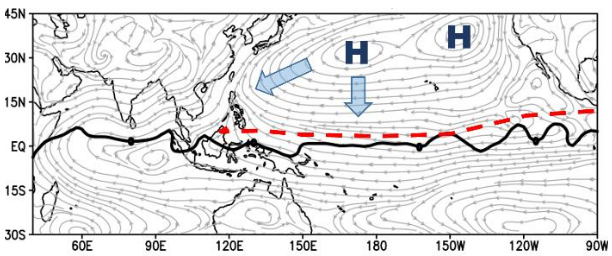

Figure 30. Low-level winds at 850 hPa (grey streamlines) and the subtropical high (H) associated with the subsidence of the Hadley cell located over the Pacific Ocean and the absolute vorticity at 925 hPa (solid black line). The ITCZ was positioned near equator (dashed red line). *Credit: NCEP/CPC CDAS.*

The ITCZ may undergo interannual fluctuations in its position and intensity, and further influence the seasonal variations. Figure 31 compares the ITCZ-induced mean daily precipitation during the dry spell in Thailand (18 June 2021 to 5 July 2021) with climatological mean (June-July, 1979-1995). Climatologically, the ITCZ lies close to Mainland Southeast Asia. However, during the dry spell, the influence of the ITCZ was weak over the Indochina Peninsula due to its position and intensity. The position and characteristics of the ITCZ could also be associated with the meridional gradient variation (i.e., CEPG).

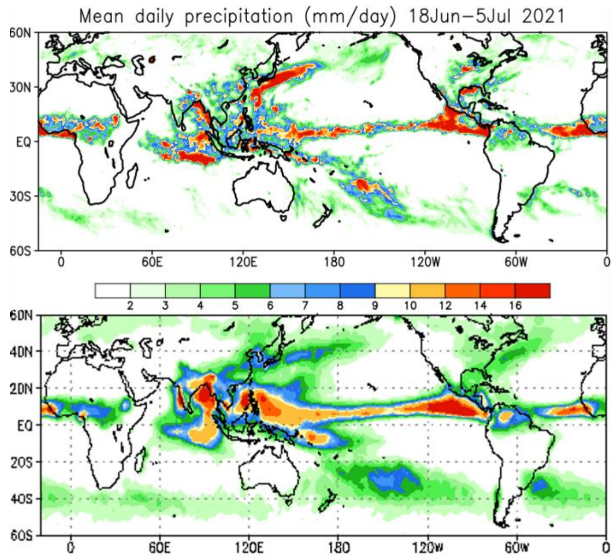

Figure 31. Mean daily precipitation (mm/day) and corresponding ITCZ (18 June 2021 – 5 July 2021). Observation data (upper) and climatological records (June-July, 1979-1995) (lower). *Credit: NCEP/CPC CMORPH and CDAS.*

The relationship between ITCZ (of its position and intensity) and CEPG shows complicated patterns and causes seasonal variability, especially over Mainland Southeast Asia and the Maritime Continent. Observation data has also shown the impact of the seasonal variability on rainfall anomalies during the rainy monsoon season in 2021 in Thailand. As an outcome, this seasonal variability resulted in rainfall anomalies, evident from the dry spells experienced in Thailand and other parts of Mainland Southeast Asia. During the rainy monsoon season in 2021, the longest dry spell in Thailand lasted for more than two weeks from 18 June 2021 to 5 July 2021 and affected various agricultural areas and water resources management.

Northwest Pacific tropical cyclone (TC) season synopsis (Jan-Jun 2021)

Contributed by Mr Junie Ruiz, Ms Ana Liza Solis, Ms Rusy Abastillas
The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), The Philippines

Six low-pressure vortices in the Northwestern Pacific basin had developed into tropical cyclones (TCs) from January to June 2021. Four of these were formed in or had entered the Philippine Area of Responsibility (PAR) (Figure 32). These TCs are categorised and named as (i) Severe Tropical Storm Dujuan (locally named Auring), (ii) Typhoon Surigae (locally named Bising), (iii) Tropical Storm Crising, and (iv) Tropical Storm Choi-Wan (locally named Dante).

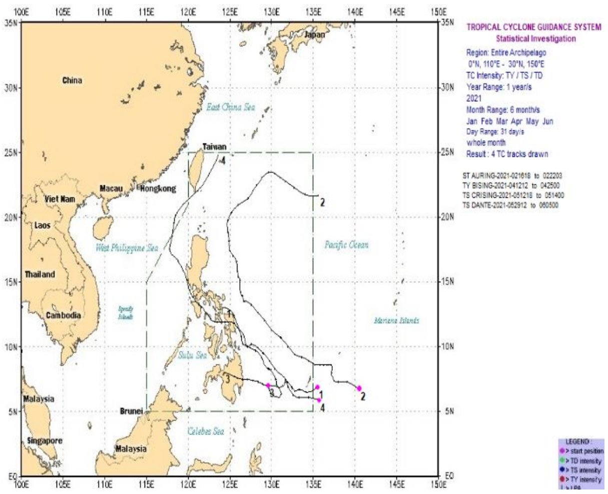

Figure 32. Tracks of TCs that affected the PAR from January to June 2021.

The number of TCs during this period was considered near-average statistically. Figure 33 shows the track of Typhoon Surigae (or Bising) from 16-24 April 2021. It did not make landfall but brought moderate to heavy rains that caused floods and landslides in some areas in the eastern Philippines. Figure 34 shows the track of Tropical Storm Choi-Wan (or Dante) from 30 May to 5 June 2021, which made landfall in the central Philippines and moved northwestward. It brought widespread rainfall over the southern and western parts of the country. The rainfall was also induced by the prevailing Southwest Monsoon. The event also triggered the onset of the rainy season over the western part of the Philippines.

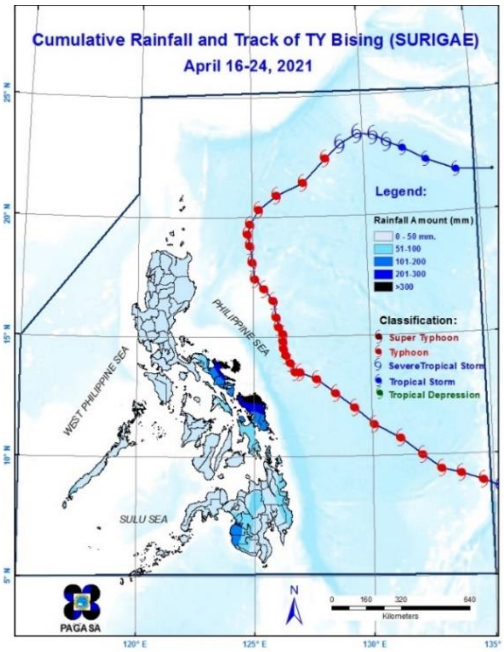

Figure 33. Track of Typhoon Surigae.

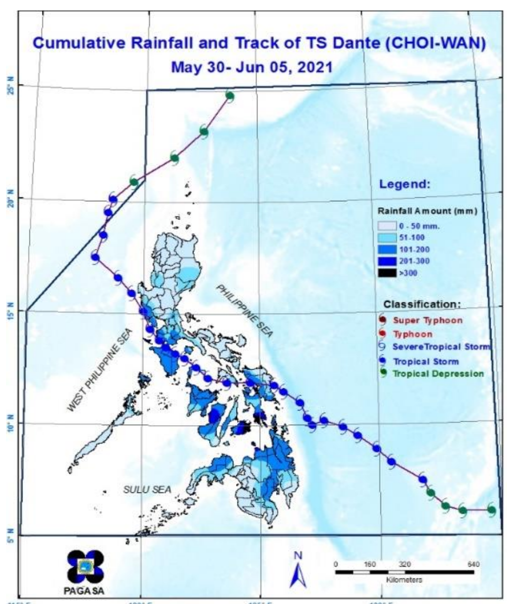

Figure 34. Track of Tropical Storm Choi-Wan.

In addition to the TC events, La Niña conditions also enhanced the precipitation. As a result, most areas in the central and southern parts of the Philippines experienced more than 20-40% increase in rainfall for more than three consecutive months. These led to flooding and landslides in the affected areas.

PAGASA's post-event assessment showed that the increase in rainfall over most parts of the Philippines from October 2020 to March 2021 had significantly affected agricultural activities and the infrastructure. The rainfall caused floods over rice and corn fields, and the above-normal soil moisture had reduced crop yields. The prolonged rains also damaged infrastructure and delayed the construction of new roads and buildings. In summary, the prolonged rains had impacted socio-economic growth.

In its response to minimise the damage and casualties during these events, the PAGASA, specifically its Regional Services Division (PRSD), coordinated closely with various stakeholders from the government, private and non-government organisations, especially agencies managing agricultural activities and disaster risk reduction. PAGASA also timely issued Climate and Weather Advisories for the affected areas to prepare and mitigate the impact brought by the TCs.

REGIONAL ACTIVITIES AND ASMC EVENTS

Using subseasonal outlooks for disaster management in ASEAN: AHA Centre

Contributed by Mr Keith Paolo C. Landicho (Disaster Monitoring and Analysis (DMA) Officer – DMA Unit)
The ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre)

The ASEAN region has a population of over 667 million people as of 2020. The region has the world's third largest labour force and is foreseen to rank as the fourth-largest economy in the world by 2050. It is common knowledge that the ASEAN region is the most disaster-prone region in the world due to natural hazards. The region accounts for 7.59% of the global disaster mortalities during the period 2015-2020, with a total economic loss estimated at US$11.1 Billion.

The ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre) aims to reduce the humanitarian impacts of disasters by translating into actions the spirit of "One ASEAN, One Response" through risk identification, early warning, and monitoring, among others. The AHA Centre closely works with the National Disaster Management Organisations, relevant hazard monitoring and forecasting agencies of all ASEAN Member States, as well as international and regional organisations like the ASEAN Specialised Meteorological Centre (ASMC). The AHA Centre believes that regular monitoring and accurate information shared in a timely manner to appropriate decision-makers, can help save lives during critical situations. This is made largely possible by the gatekeepers of the organisation, the Disaster Monitoring and Analysis (DMA) Unit, which mainly operationalises hazard and disaster monitoring activities.

The operational tools that the DMA primarily use to fulfil its mandate are the ASEAN Disaster Monitoring and Response System (DMRS) and the ASEAN Disaster Information Network (ADINet). These tools are the most comprehensive and active systems capturing, monitoring, and recording hazards and disasters in the ASEAN region, with almost 700 disasters recorded since January 2021. From the start of 2021 up until 16 August, the DMA has produced 32 weekly disaster updates, six monthly disaster reviews and seasonal outlooks, 30 flash updates, and more than 650 flash alerts.

Aside from the core mandates of hazard and disaster monitoring and information management and dissemination, the DMA is also in charge of projects relevant to concretising the spirit of "One ASEAN, One Response".

1. **The ASEAN Risk Monitor and Disaster Management Review (ARMOR)**, a publication that consolidates knowledge on disaster risk management in the region, is now on its 3rd edition with the theme, "When disasters and pandemic collide - what does it mean to us (or ASEAN), now and into the future?". The 3rd edition has been successfully registered to the International Standard Serial Number (ISSN) and is planned to be officially launched during the AHA Centre 10th Anniversary celebration in November 2021.

2. **The AHA Centre Information Management Network (AIMNet)** aims to strengthen the Emergency Operations Centres (EOC) of the ASEAN Member States through improved data availability, quality and accessibility, and advance risk assessment and information management capacities.

3. **Risk and Vulnerability Assessment** continuation through the regional

implementation of the National Disaster Preparedness Baseline Assessment (NDPBA) to further enrich the ASEAN DMRS as well as enhance regional analyses done in close coordination with the Pacific Disaster Center (PDC-Global).

4. The **ASEAN Disaster Information Network (ADINet 2.0)**, the AHA Centre's disaster information database was improved to be more intuitive, informative, and integrable. It was also developed to include the **ASEAN Science-based Disaster Management Platform (ASDMP)**. With this, ADINet aims to be the regional standard for a comprehensive system on Hazard and Disaster Monitoring, Disaster Information Management, Big Data Visualisation and Analysis that: (1) is easily integrable (through API), (2) is modular (for future development) and (3) will also function as a knowledge hub/repository for relevant disaster risk reduction and management knowledge (Figure 35).

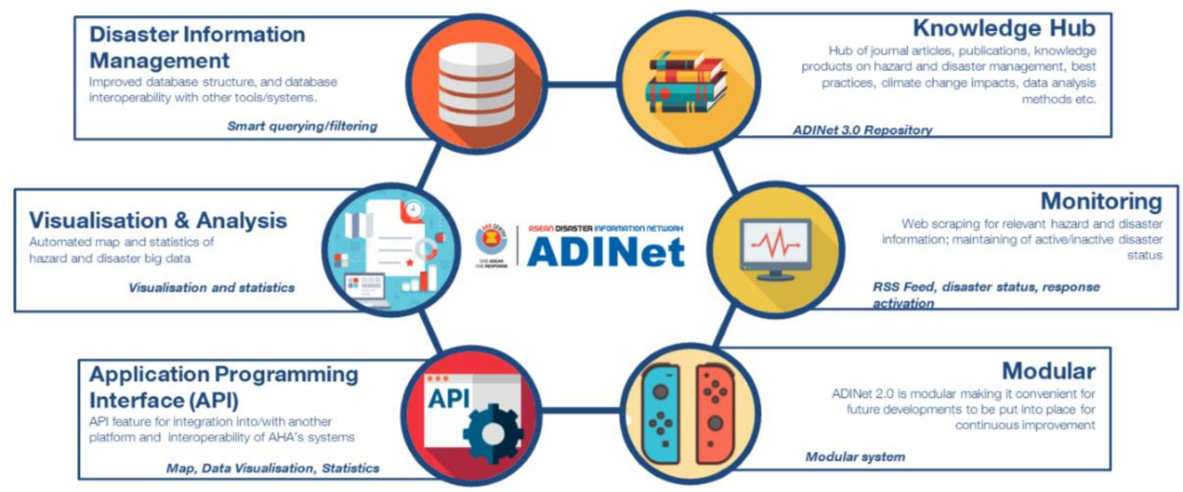

Figure 35. A diagram of the functionalities of the improved ASEAN Disaster Information Network (ADINet). (*Hyperlink: https://adinet.ahacentre.org/*)

The S2S-SEA (Capability Building Programme in Subseasonal to Seasonal Prediction for Southeast Asia) Pilot Project, under the World Meteorological Organization's S2S Real-Time Pilot Project, and the ASMC fortnightly outlooks have been very instrumental to the work of DMA and the AHA Centre. These also helped to make monitoring in the region more efficient and effective. The fortnightly outlook of wetter/drier conditions and cooler/warmer temperatures as well as the regional assessment of extremes under the S2S-SEA Pilot Project, direct monitoring efforts to points of interest. As a matter of fact, the timing of the forecast issuance (every two weeks) is sufficient and fits the requirements for the publication of the AHA Centre's information products. Subseasonal outlook information is embedded in the information products disseminated in a timely manner and on a need's basis (flash updates) to the AHA Centre's directory. This comprises the National Disaster Management Organisations, partner international and regional organisations, dialogue partners – to consolidate early action, synergise response efforts, and guide general decision-making. The products are also instrumental during Emergency Response Operations of the AHA Centre as it helps guide the actions of the Preparedness and Response team. This partnership between ASMC and the AHA Centre serves as a model of how collective action can help reduce the humanitarian impacts of disasters, particularly from hydrometeorological hazards, in the region.

Third Workshop on ASEAN Regional Climate Data, Analysis and Projections (ARCDAP-3) (Online: 15-18 March 2021)

The Third Workshop on ASEAN Regional Climate Data, Analysis and Projections (ARCDAP-3) was conducted with support from the World Meteorological Organization (WMO) from 15 – 18 March 2021 on the Zoom platform, as part of ASMC's 5-year Regional Capability-Building Programme (ACaP). The workshop was led by scientists from the Centre for Climate Research Singapore (CCRS) and attended by representatives from 10 ASEAN National Meteorological and Hydrological Services (NMHSs) and relevant agencies, representatives from both WMO's headquarters and its Regional Office for Asia and the South-West Pacific (RAP), as well as experts from regional and international institutes.

Figure 36. Participants of the ARCDAP-3 Workshop.

It was recommended at ARCDAP-2 held in March 2019, that ARCDAP-3 turn its focus to the newly available and growing database from the Coupled Model Intercomparison Project Phase 6 (CMIP6) which will support the anticipated Intergovernmental Panel on Climate Change (IPCC)'s Sixth Assessment Report. The workshop was split into five overarching themes: (1) introduction to the overall CMIP initiative and CMIP6, (2) introductory presentations by ASEAN representatives, (3) applications of CMIP6 for studying regional climate processes, (4) CMIP for producing climate change projections, and (5) regional downscaling and future work.

Dr Simon Marsland (Principal Research Scientist, Commonwealth Scientific and Industrial Research Organisation (CSIRO)), a member of the World Climate Research Programme (WCRP) Working Group on Coupled Modelling (WGCM), began with an introductory presentation on the WCRP and CMIP. This was followed with a sharing on the technological advancements from CMIP6 by Francois Delage (Data Scientist, Bureau of Meteorology, Australia (BOM)) and Claire Trenham (Experimental Scientist, CSIRO), in particular the higher equilibrium climate sensitivities (ECS) observed by a number of CMIP6 Global Climate Models (GCMs) and streamlined data tools such as Synda and Pangeo.

The workshop continued with the next session, where ASEAN representatives shared their experiences from previous national-level climate change studies and the use of climate model data. While most countries presented work that used derived data from CMIP5, they all expressed an interest in incorporating CMIP6 in their work in the future. The third theme followed, with presentations by academic experts on several applications of CMIP6 for the study of important regional climate features such as the representation of precipitation and processes such as the El Niño Southern Oscillation (ENSO). At this juncture, Dr Wilfran Moufouma-Okia (Head, WMO Climate Prediction Services Division) gave a seminar on enhancing climate services for resilient development.

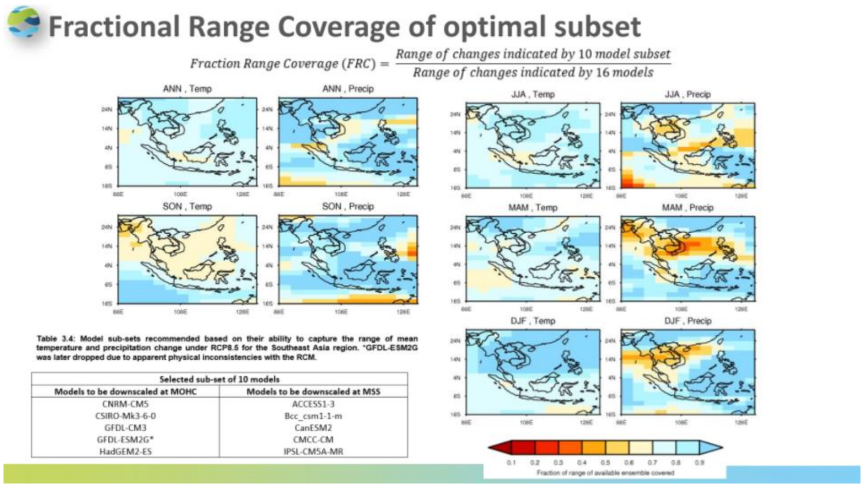

Figure 37. The fractional range coverage method used to sub-select CMIP5 GCMs for Singapore's Second National Climate Change Study (V2).

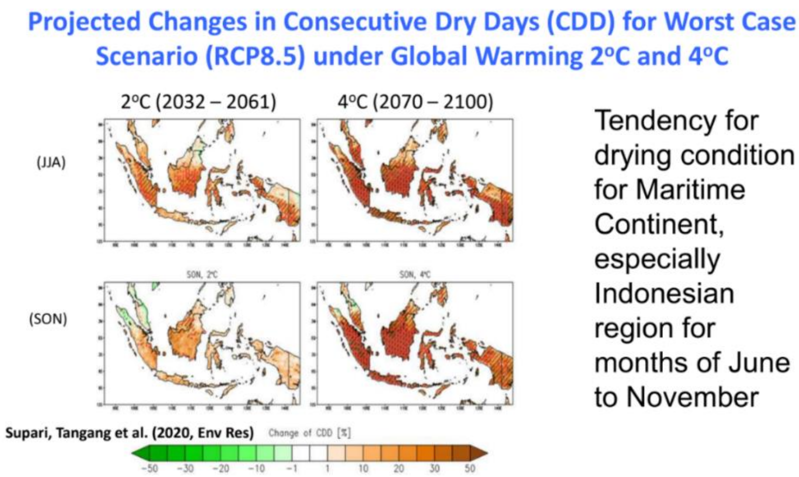

Figure 38. Some findings from CORDEX-SEA's first phase which downscaled CMIP5 GCMs.

The penultimate session of the workshop focused on how CMIP data has been used to produce national climate change projections, with experiences shared by representatives from the BOM, CSIRO, the Viet Nam Institute of Meteorology, Hydrology and Climate Change (IMHEN), and CCRS. The final theme of the workshop saw Prof Fredolin Tangang (Lead, CORDEX-Southeast Asia (SEA)), present an update and results from CORDEX-SEA's first phase, while some downscaling results from Singapore's ongoing Third National Climate Change Study (V3) were also shared by CCRS.

Aside from presentations and dedicated time for questions, participants were also engaged throughout the four days. There were three roundtable discussions and a breakout session that sought participants' inputs towards developing regionally shared best practices for producing robust climate change projections. While participants understood the decision to not conduct an extensive hands-on session due to the limitations in a virtual setting, many looked forward to having one involving CMIP6 data in the follow-up workshop, which will hopefully take place physically. This opinion was shared by the organising team as well. Further recommended topics included bias-correction, application of extreme indices for impacts assessment and regional model data analysis.

Weather Prediction by Numerical Methods – Module 2 (WPNM-M2) (Online: 3-5 May 2021)

Weather Prediction by Numerical Methods (WPNM) is a series of workshops conceptualised as part of ASMC's 5-year Regional Capability-Building Programme (ACaP). The workshops, jointly organised by ASMC and the Centre for Climate Research Singapore (CCRS), aim to raise member states' knowledge of the: (1) governing equations and numerical methods, (2) physical parameterisations, (3) data assimilation, and (4) predictability of numerical weather prediction (NWP) models.

The second of four planned workshops, WPNM-M2 covered the second topic on physical parameterisations. The aim was to equip participants with knowledge of how radiative, land surface, boundary layer, cloud and convective parameterisations are used in weather and climate models. All ASEAN National Meteorological and Hydrological Services (NMHSs) were formally invited and most of the WPNM-M2's 18 participants had prior experience using NWP or climate models and had also attended the WPNM's first module (WPNM-M1).

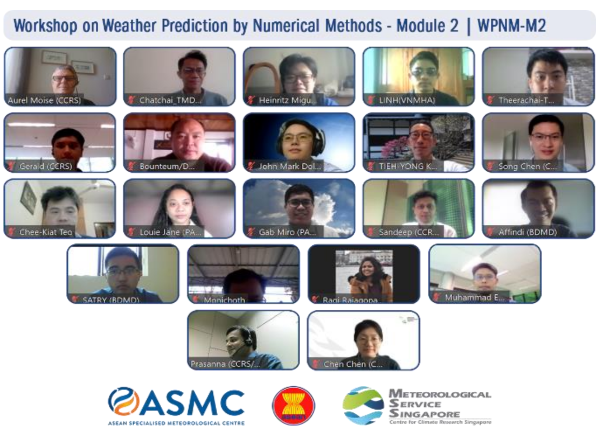

Figure 39. Participants from the first day of WPNM-M2.

Prof Koh Tieh Yong (Associate Professor, Singapore University of Social Science) kicked off the workshop with a lecture on the theory of radiative transfer (shortwave and longwave radiative transfer, and the role of clouds in radiative transfer) and its implementation in the weather and climate prediction models. Prof Koh started with basic concepts like the atmospheric structure, and then he explained the details of blackbody radiation, atmospheric absorption, theory of radiative transfer and atmospheric scattering. He ended the lecture by giving several examples of radiation calculations used in the weather and climate prediction models.

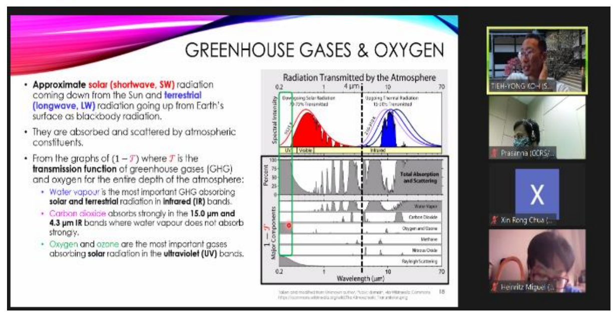

Figure 40. Prof Koh Tieh Yong introduces radiative transfer theory.

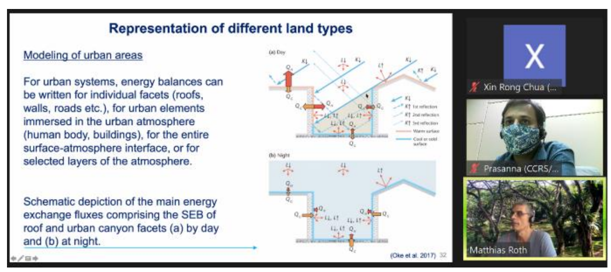

Figure 41. Prof Matthias Roth describes how different land types can be represented in NWP schemes.

Prof Matthias Roth (Professor, National University of Singapore) gave a lecture on surface fluxes and energy balance in NWP, and how to represent these for different land types. Prof Roth began by introducing participants to the concepts behind the energy balance framework before providing an overview of the fundamental equations underpinning the framework. The last lecture of the first day was delivered by Dr Song Chen (Research Scientist, CCRS) on urban canopy models, particularly regarding how rapid urbanisation has resulted in a growing need to understand urban impacts on weather forecasting and regional climate modelling.

The next day started with lectures by Dr Teo Chee Kiat (Senior Research Scientist, CCRS) and Dr Anurag Dipankar (Senior Research Scientist, CCRS). These lectures reviewed how the dynamics of the boundary layer necessitates a parameterisation of unresolved turbulent fluxes, the applicability of different boundary layer schemes at varying model grid resolutions, and the simulation of large eddies in the boundary layer. The representation of cloud cover in weather and climate models was then covered by Dr Muhammad Eeqmal Hassim (Senior Research Scientist, CCRS) who explained that clouds are an essential variable in the numerical models due to their interaction with longwave and shortwave atmospheric radiation. Dr Sandeep Sahany (Head, Climate Modeling and Prediction Branch, CCRS) then carried on with a lecture on the importance of cloud and convective parameterisation in numerical weather prediction models. He explained that parameterisations can be thought of as a way to model the effects of a process rather than the process itself. Finally, Dr Dipankar returned with a lecture which used the Unified Model to demonstrate the complex coupling between dynamics and physics in NWP models.

In addition to lectures, Dr Prasanna Venkatraman (Senior Research Scientist, CCRS) and Dr Chua Xin Rong (Research Scientist, CCRS) also conducted hands-on training using an online version of the MIT single-column model. After introducing the concepts behind radiative-convective equilibria (RCE), participants used the MIT single-column model for experimentation and to explore theoretical concepts. Ultimately, the participants had an appreciation that — while the MIT single-column model is simple compared to complex real-world processes — a single-dimensional model could be used to understand how the Earth system's RCE would respond to a given forcing.

Overall, WPNM-M2 was a success, the basic concepts and theories learned from lectures were very useful to the participants in understanding the complex codes when configuring the numerical models. Dr Aurel Moise (Deputy Director, CCRS) thanked the workshop's organisers and participants, and introduced the potential topic for the next module of WPNM on data assimilation.

Sixteenth Session of the ASEAN Climate Outlook Forum (ASEANCOF-16) (Online: 20 and 24 May 2021)

The Sixteenth Session of the ASEAN Climate Outlook Forum (ASEANCOF-16), coordinated by ASMC, took place online on 20 and 24 May 2021. The forum was attended by over 30 participants from the ASEAN National Meteorological and Hydrological Services (NMHSs), World Meteorological Organization (WMO), ASEAN Secretariat and Regional Integrated Multi-Hazard Early Warning System (RIMES). While ASEANCOF sessions for the June–August period are usually held online over a single afternoon to discuss the consensus for the upcoming season, increased familiarity with virtual meetings allowed for an additional sharing session to be added to the ASEANCOF-16 programme.

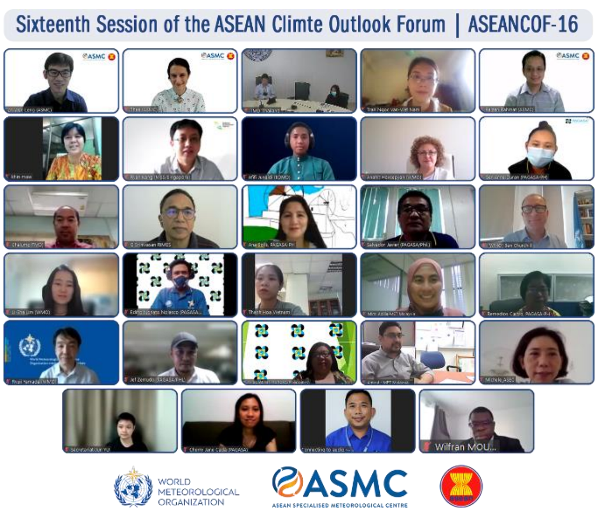

Figure 42. Participants of the ASEANCOF-16 (only those that shared their video were shown).

The first day of ASEANCOF-16 (20 May) covered a review of the previous outlook and a sharing session on the calibration and downscaling techniques used by ASEAN NMHSs for seasonal outlooks. The review of recent climate events and the previous outlook (Dec 2020 – Feb 2021) were based on national-level assessments by the NMHSs as well as a regional assessment by ASMC and the Node on Climate Monitoring of the South-East Asia Regional Climate Centre-Network (SEA RCC-Network). The remainder of the day focused on the implementation of objective seasonal outlooks.

After an introductory presentation by Dr Govindarajalu Srinivasan (Chief Scientist, RIMES), representatives of the NHMSs from the Philippines, Singapore, Thailand, and Viet Nam shared techniques that were currently being researched or used operationally in their NHMS. Of these, the Climate Predictability Tool (CPT) by the International Research Institute for Climate and Society (IRI), Columbia University, was currently being used by some of the presenting NMHSs to improve the skill of their seasonal outlooks. Presenters from Singapore and Viet Nam also focused on the calibration of temperature outlooks, which appeared more straightforward to calibrate as compared to rainfall outlooks.

Dr Thea Turkington (Senior Research Scientist, ASMC) then shared the progress and plans for ASEANCOF's shift towards objective seasonal outlooks, which included forming of the ASEANCOF Working Group. When asked where the priority should be placed for ASEANCOF's shift towards objective seasonal outlooks, just over half (57%) of respondents thought this should be 'calibration and downscaling techniques', followed by 'developing and disseminating standard operating procedures and guidelines' (29%). Many participants also responded positively to the statement that 'ASEANCOF would be a good platform for experts to share the latest advances in seasonal outlooks.

The focus of the second day (24 May) was reaching a regional consensus on the region's climate drivers, and the June–August 2021 rainfall and temperature outlooks. Prior to the forum, NMHSs filled out a detailed questionnaire on the upcoming season. Answers to this questionnaire were then used as the basis for the discussion on climate drivers while a gridded multi-model ensemble (dynamical seasonal models from ECMWF, UKMO, NCEP, JMA and ECCC global-producing centres) was used as the basis for the rainfall and temperature outlooks.

Ending off ASEANCOF-16 were updates from the nodes of the SEA RCC-Network. The Node on Climate Monitoring (led by PAGASA, Philippines) presented the contents of the climate monitoring website: Southeast Asia Climate Monitoring. The Node on Long-Range Forecasting (led by MSS, Singapore) presented the newly added ENSO outlook page and a potential Standardized Precipitation Index (SPI) forecast product. Via a poll, the NMHSs voted that they preferred to have both a single-month SPI (SPI-1) and a three-month SPI (SPI-3), with the latter being a combination of one observation and two forecast months.

Overall, ASEANCOF-16 showcased calibration and downscaling techniques currently being used by ASEAN NMHSs as part of the transition to objective seasonal outlooks for ASEANCOF. Future ASEANCOF sessions will continue working towards implementing objective outlooks for the region.

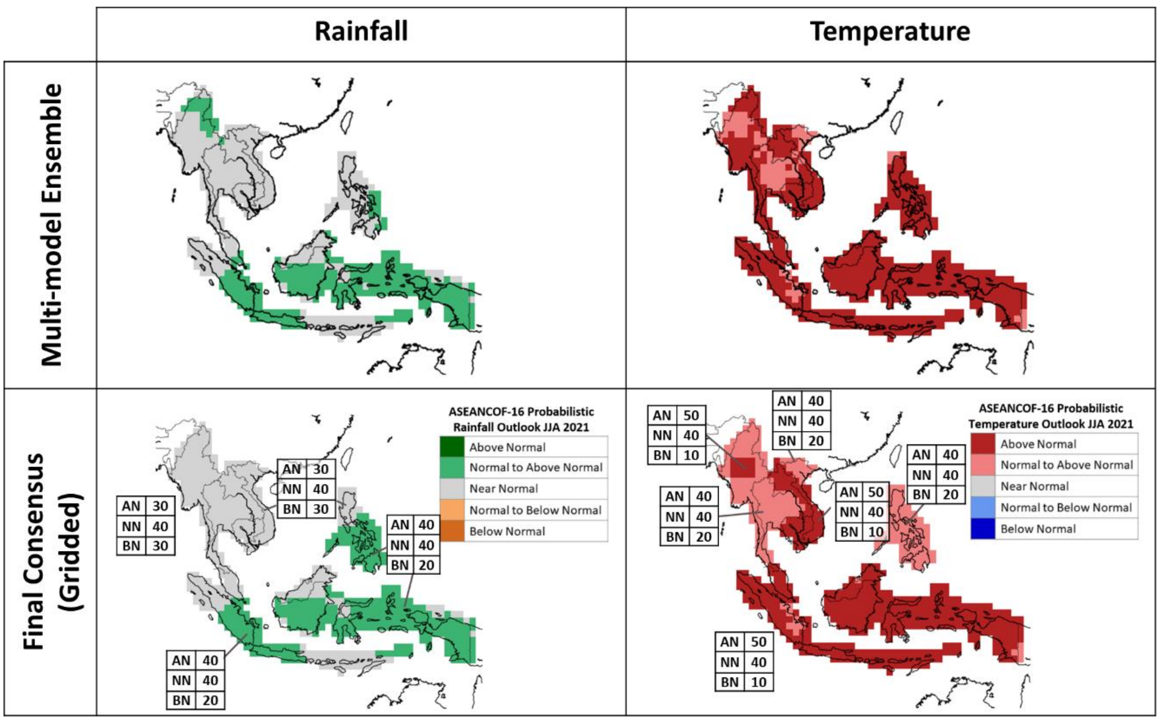

Figure 43. Multi-model ensemble (top) was used as a basis for the final consensus outlook for June – August 2021 (bottom).

Webinar on Hotspot and Haze Assessment (H2A) for the southern ASEAN Region (Online: 1-2 July 2021)

The ASMC conducted a Webinar on Hotspot and Haze Assessment (H2A) for the southern ASEAN region over two days from 1 to 2 July 2021. The Webinar was conducted under the ASMC's 5-year Regional Capability-Building Programme (ACaP) which was launched in 2018 to address the priority training needs of the ASEAN region.

The Webinar welcomed 14 regional participants from the environmental policy, air quality monitoring, fire and rescue services and meteorological sectors. The participants shared actively on their countries' monitoring of fire and haze activities and were keen to learn from ASMC on the use of satellites for hotspot and haze monitoring and detection. The workshop included lectures on dispersion modelling, seasonal and sub-seasonal climate prediction products, as well as the latest information on new satellites and satellite products for hotspots and haze monitoring available on the ASMC website.

Figure 44. Participants with the ASMC meteorologists and research scientists in a group photo.

Ms Razatul Aini Binti Razlan from the Department of Environment in Malaysia shared that the lectures were relevant and useful, and she would recommend the programme to her country officers. She hoped similar training workshops in the future would be opened to more participants and emphasise on the interpretation of satellite images.

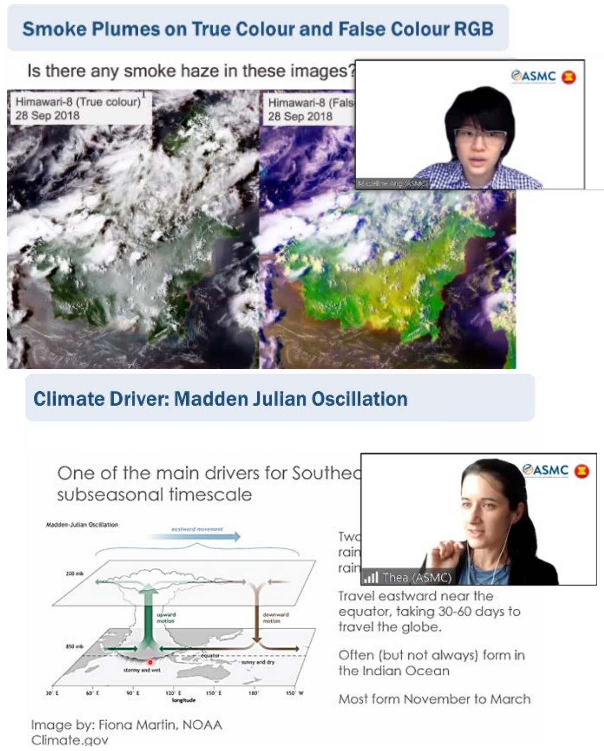

Figure 45. Screenshots of the lectures conducted by ASMC's meteorologists and research scientists.

In the wake of restrictions brought about by the COVID-19 pandemic, all of ASMC's workshops under the 5-year Regional Capability-Building Programme including workshops on Numerical Weather Prediction (NWP), ASEAN Climate Data, Analysis and Projections (ARCDAP) and the ASEAN Climate Outlook Forum (ASEANCOF) have moved to an online platform to continuously engage and raise regional capabilities in weather forecasting, subseasonal to seasonal prediction, climate change projections and haze monitoring.

Upcoming ASMC Events

Seventeenth Session of the ASEAN Climate Outlook Forum (ASEANCOF-17), Online, November 2021

The upcoming 17th Session of the ASEANCOF will be coordinated by ASMC and conducted online. ASEANCOF-17 aims to generate consensus rainfall and temperature outlooks for the December 2021 - February 2022 boreal winter monsoon season. The consensus will be provided alongside related information on weather and climate drivers in the Southeast Asia region such as the El Niño/La Niña, Indian Ocean Dipole, and monsoon circulations.

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