# THIRD SESSION OF ASEAN CLIMATE OUTLOOK FORUM (ASEANCOF-3)

17-19 NOVEMBER 2014, CENTRE FOR CLIMATE RESEARCH SINGAPORE,

METEOROLOGICAL SERVICE SINGAPORE

## *Consensus Statement and Meeting Report*


**Summary of Consensus Statement**

The consensus outlook takes guidance from the dynamical model outputs of the different WMO recognised Global Producing Centres (GPCs) and other institutions, in particular the multi-model ensemble (MME) forecasts from WMO Lead Centre for Long Range Forecast Multi-Model Ensemble (WMO LC-LRFMME) and APEC Climate Centre (APCC). It also considers the prediction skill and associated confidence that can be derived from the models, as well as the seasonal evolution of large-scale circulation features of importance to Southeast Asian climate, such as El Niño Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD). Another key component of the consensus outlook is the national-level forecasts for the different Southeast Asian countries provided by experts from the respective National Meteorological Services (NMSs).

Using the above as a basis, the seasonal outlook is as follows:

> *For the upcoming boreal winter monsoon (December-February, DJF) season, normal to below normal rainfall is favoured over most of the southern and eastern parts of the Maritime Continent. Elsewhere, generally normal to above normal rainfall is favoured.*
>
> *Above normal temperature conditions are generally favoured over the whole Southeast Asia region for boreal winter monsoon, with higher probabilities of above normal temperature over the central, tropical regions.*


## 1. Introduction

The Third ASEAN Regional Climate Outlook Forum (ASEANCOF-3) was held on 17-18 November 2014 in Singapore ahead of the December-February (DJF) winter monsoon season. The third day, 19

November 2014, was dedicated for training of ASEAN National Meteorological Services (NMSs) participants in ensemble seasonal prediction systems. ASEANCOF-3 was sponsored by the World Meteorological Organization (WMO) and United States Agency for International Development (USAID), and organised by the Meteorological Service Singapore (MSS) as host of the ASEAN Specialised Meteorological Centre (ASMC).

## 2. Regional and Global Participation

This Forum had a strong turnout of two representatives each from all ten ASEAN countries' National Meteorological Services (NMSs) of Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. Seasonal predictions experts from the WMO Global Producing Centres of Long Range Forecasts (GPCs) were also present, namely the China Meteorological Administration (CMA), Bureau of Meteorology (BoM, Australia), Japan Meteorological Agency (JMA), Climate Prediction Center (CPC, NOAA, US), and the Met Office Hadley Centre (MOHC, UK). Experts from the WMO Lead Centre for Long Range Forecast Multi-Model Ensemble (WMO LC-LRFMME) and APEC Climate Centre (APCC) also attended.

In consultation with WMO, ASEANCOF-3 focused on the application of long range forecasts in the water resources management sector. Thus, user representatives from this sector in the region were also invited. These included the Mekong River Commission (MRC), Hydrological Forecasting Division of the National Centre for Hydro-Meteorological Forecasting (NCHMF, Vietnam), Research Centre for Water Resources, Agency of R&D, Ministry of Public Works (RCWR, Indonesia) and Singapore's national water agency, PUB. In addition, two other potential regional users of seasonal outlooks were also invited, namely the ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management (AHA) and Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES).

## 3. Forum Sessions

Following opening formalities, the forum started with a session of presentations by the GPCs, who provided brief descriptions of the current status of their seasonal prediction models and modelling activities. Relevant to the needs of ASEAN NMSs, models' skill for Southeast Asia region was also presented for discussions. The institutions then provided an outlook for temperature and rainfall for the season DJF 2014-2015, including the seasonal evolution of large-scale circulation features of importance to Southeast Asian climate, such as the El Niño Southern Oscillation (ENSO).

The presentations from the GPCs were encouraging in terms of improvements in climate models, and the growth in climate model data availability. The latter issue has been greatly facilitated by the WMO GPCs through the Commission for Basic Systems (CBS) Expert Team on Extended and Long-range Forecasts.

The second session was lined-up with presentations from the individual ASEAN NMSs describing their seasonal prediction methodologies and end-user communication strategies. In line with the theme for this Forum, presenters also gave accounts of the working relationships and experiences with their respective water agencies and other end-users of their seasonal outlook. Presenters then concluded with the country-level seasonal outlook for DJF 2014-2015.

The third session was an opportunity for representatives from the user sectors to present their work and bring to the awareness of the GPCs and NMSs their requirements for seasonal outlooks to support decision-making. Presenters also shared some of the successful linkages with the NMSs in their respective countries.

The final session of the Forum involved the development of a consensus outlook for DJF drawing on the range of forecasts provided earlier. Following discussions from the outlooks of the GPCs and the NMSs, the 2-day Forum successfully concluded with the endorsement of the consensus outlook for the Southeast Asia region from all present.

## 4. Consensus Outlook for DJF 2014-2015

Evaluation of Current Climate Conditions and Indices (ENSO and IOD)

The El Niño Southern Oscillation (ENSO) has remained largely within neutral conditions in recent months (refer to Section 5 for further discussions on this). Correspondingly, other indicators of ENSO (large-scale clouds and wind patterns) have also remained mostly within modest (neutral) magnitudes of anomalies. For the coming seasons, based on model prediction and expert assessments, weak or borderline El Niño conditions are expected and these could be established in the next two months (Figure 1).

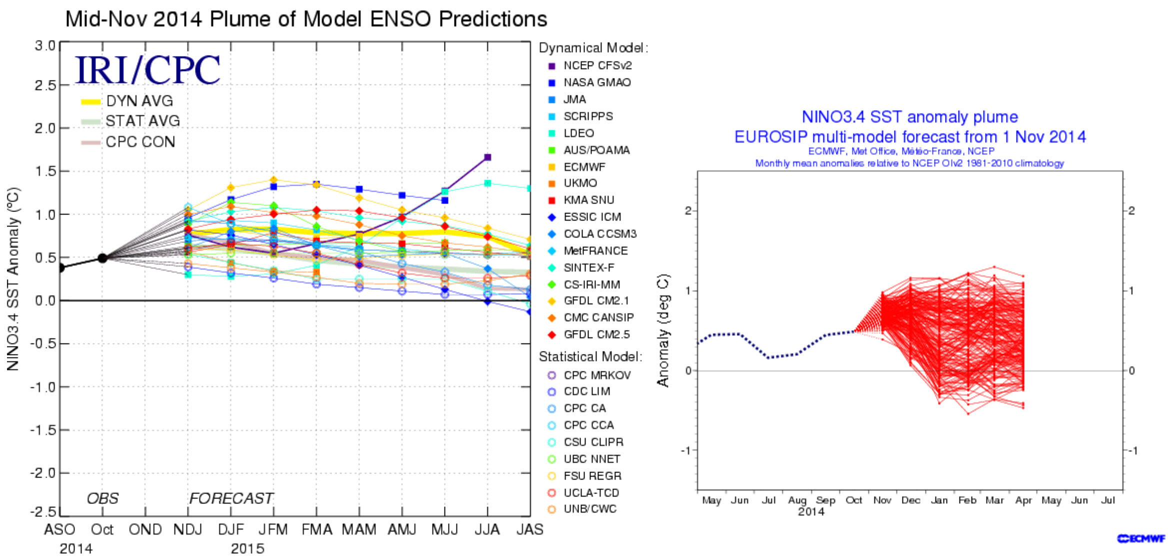


**Figure 1: (Left) Multi-model ensemble forecasts of Niño3.4 SST anomaly index indicating values of largely between 0.5 to 1.0, i.e. weak/borderline El Niño conditions from IRI/CPC which use the averages of individual ensemble members in each model (credit: IRI/CPC). (Right) A larger spread of the index is predicted from the EUROSIP multi-model forecasts which use individual ensemble members of the models considered (credit: EUROSIP).**

For the Indian Ocean Dipole (IOD), when it is in positive phase, the sea-surface temperatures (SST) are lower in the southeastern Indian Ocean relative to the west. In the negative phase, the opposite is true. IOD is known to have significant impact on the region's rainfall [1], for example, during positive IOD events in the past drought conditions have been reported in parts of the Maritime Continent [2].

The forecast of IOD is also expected to remain within neutral thresholds at least in the next three months (Figure 2). It is thus expected not to have any significant impact on regional rainfall during the upcoming DJF season. This is not unusual as the IOD tends to revert toward neutral during the Australian Monsoon season.

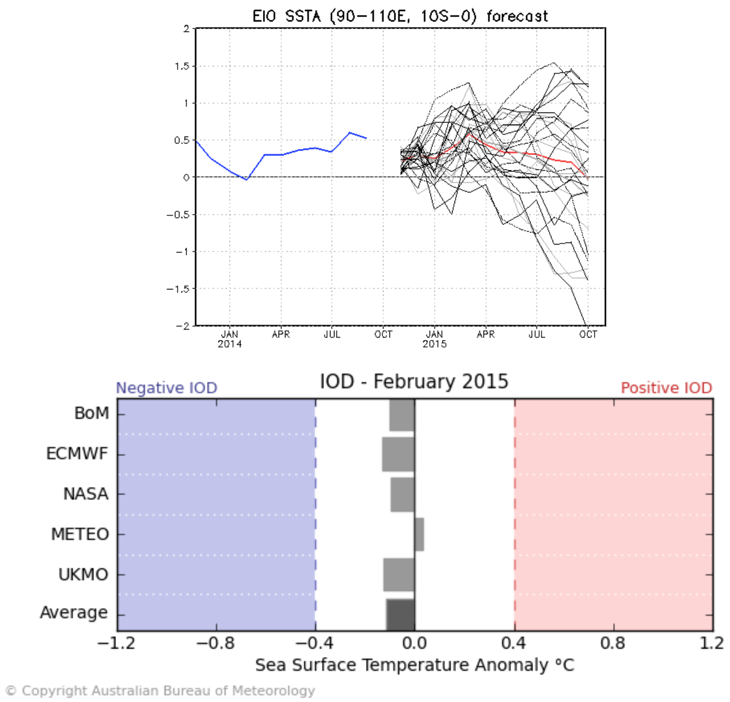


**Figure 2: IOD index forecast from JAMSTEC (top, credit: JAMSTEC) and selected multi-model ensemble forecast used by the Bureau of Meteorology, Australia (bottom, credit: BoM).**

The starting point in the formulation of the consensus outlook was the dynamical model outputs from GPCs and other institutions, in particular the multi-model ensemble (MME) forecasts from WMO LC-LRFMME and the APCC which combined the forecasts from the individual models. The outlook also took into consideration prediction skill and associated confidence derived from the different model hindcasts. Inputs from the models' seasonal evolution of large-scale circulation features of importance to Southeast Asian climate, such as El Niño and IOD were also considered. Another key aspect of the consensus outlook was the national-level forecasts for the different Southeast Asian countries provided by experts from the respective NMSs.

The MME forecasts from the different institutions were largely in agreement for both temperature and rainfall. For temperature, the prediction is for the high likelihood of warmer-than-average temperatures over the tropical regions, and moderate likelihood of warmer-than-average conditions elsewhere. The combined influence of very high background global temperatures (in part due to global warming) and the impacts of a marginal El Niño event characterised by warm Pacific SSTs is the primary driver for this forecast. For rainfall, consistency is noted over the eastern Maritime

Continent where below normal rainfall is predicted. This is consistent with expectations over the region during years in DJF (Figure 3) in the presence of El Niño conditions. In the Sumatra, Malay Peninsula and western Sarawak/Kalimantan regions, where the correlation between rainfall and ENSO was found to be weak in previous studies [4], the skill of the dynamical models is very low for rainfall and the outlook was modified in this region on statistical basis and local experts' assessments.

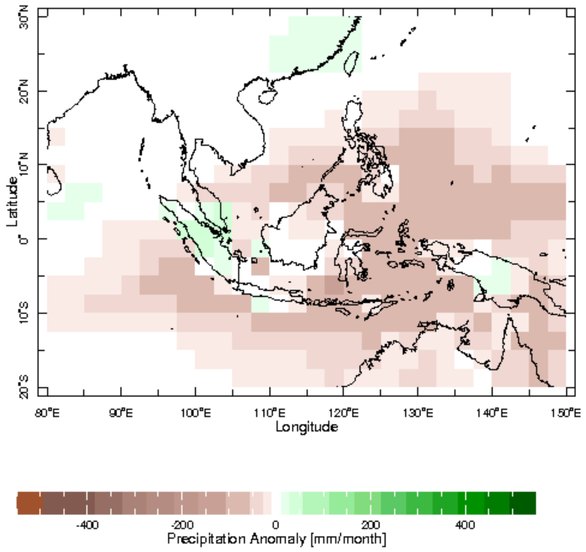


**Figure 3: Rainfall anomaly composite for El Niño years showing drier-than-normal conditions (brown shades) mostly in the southern and eastern parts of the Maritime Continent for the months December to February the following year (credit: NCEP CAMS_OPI/IRI).**

Using the above forecasts as a basis, and incorporating national-level outlooks, the draft forecasts were presented to the Forum, discussed and then finalised. The forecasts, with tercile probabilities assigned, are illustrated in Figure 4 and Figure 5 below and as a reference, the tercile climatology boundaries are provided in Appendix B.

<u>Outlook for DJF</u>

*For the upcoming boreal winter monsoon (DJF) season, normal to below normal rainfall is favoured over most of the southern and eastern parts of the Maritime Continent. Elsewhere, generally normal to above normal rainfall is favoured.*

*Above normal temperature conditions are generally favoured over the whole Southeast Asia region for boreal winter monsoon, with higher probabilities of above normal temperature over the central, tropical regions.*

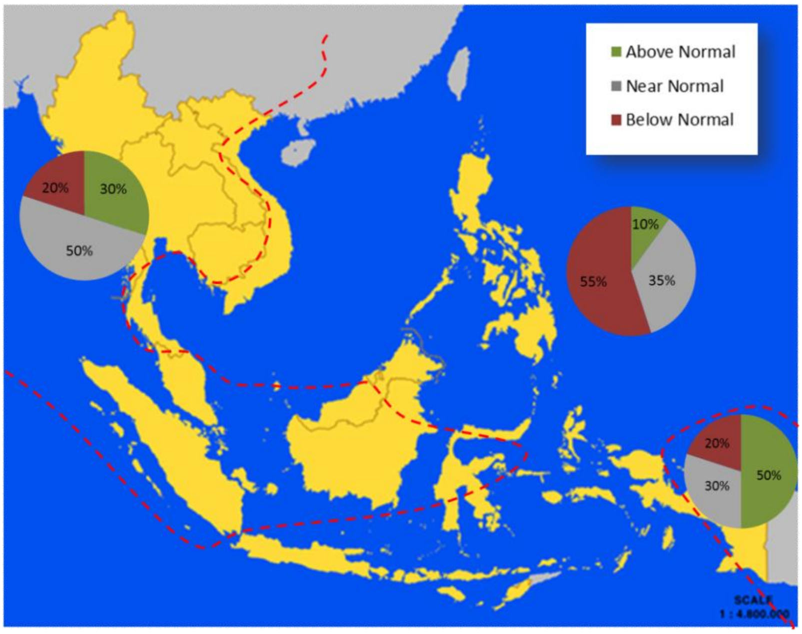


**Figure 4: Consensus rainfall outlook for December 2014 to February 2015 over Southeast Asia in terms of probabilities for tercile categories of Above Normal (upper 67th percentile, in green), Near Normal (between 33rd and 67th percentiles, in gray) and Below Normal (lower 33rd percentile, in brown). The regional demarcations (dotted, red line) are meant as a guide and not to be regarded as precise distinction of predictions between areas. Refer to individual countries' NMSs for national-level detail and updates.**

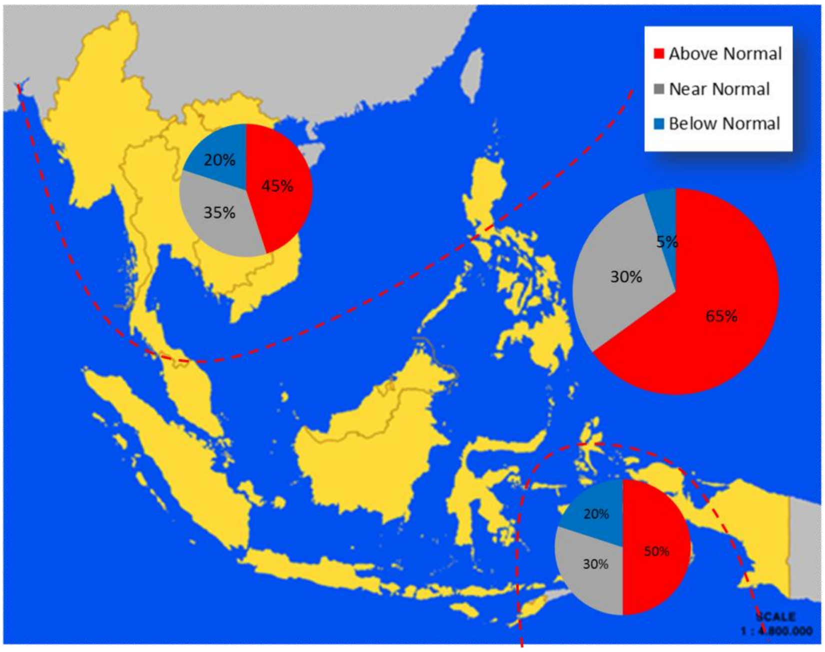


**Figure 5: Consensus temperature outlook for December 2014 to February 2015 over Southeast Asia in terms of probabilities for tercile categories of Above Normal (upper 67th percentile, in red), Near Normal (between 33rd and 67th percentiles, in gray) and Below Normal (lower 33rd percentile, in blue). The regional demarcations (dotted, red line) are meant as a guide and not to be regarded as precise distinction of predictions between areas. Refer to individual countries' NMSs for national-level detail and updates.**

For more information on the boreal winter monsoon outlook and further updates on the national scale, the relevant NMSs should be consulted.

## 5. Review of Climate Conditions and Outlook for JJA 2014

Recent El Niño and Indian Ocean Dipole Developments

From the middle of 2014, a number of models and expert assessment have pointed to the possibility of El Niño development starting from boreal summer/fall 2014 (Figure 6). Since then, the sea-surface temperatures (SST) over the tropical Pacific Ocean have been showing signs of the warming as anticipated (Figure 7 and Figure 8). The current situation represents borderline or marginal El Niño conditions and there is significant potential for this event to become established over DJF (see Section 4).

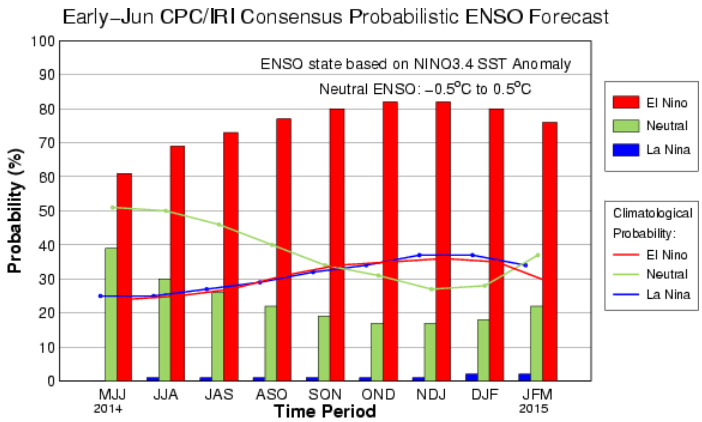


**Figure 6: Consensus probabilistic forecast from CPC/IRI from earlier in June 2014, where it estimated about 70% chance of El Niño occurring during the June-September (JJAS) 2014 season (credit: CPC/IRI).**

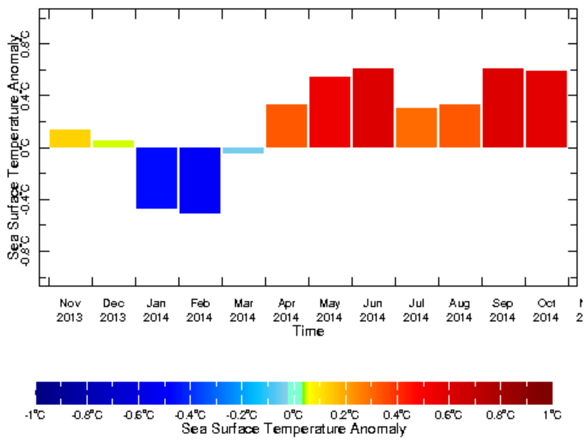


**Figure 7: Monthly sea-surface temperature anomaly (SST) over the Niño3.4 region of the Pacific Ocean from November 2013 to October 2014. Warm anomalies have been observed from April to October, but with momentary slowing down of the warming trend during July and August (credit: NCEP Reyn_SmithOIv2 monthly SST anomaly/IRI).**

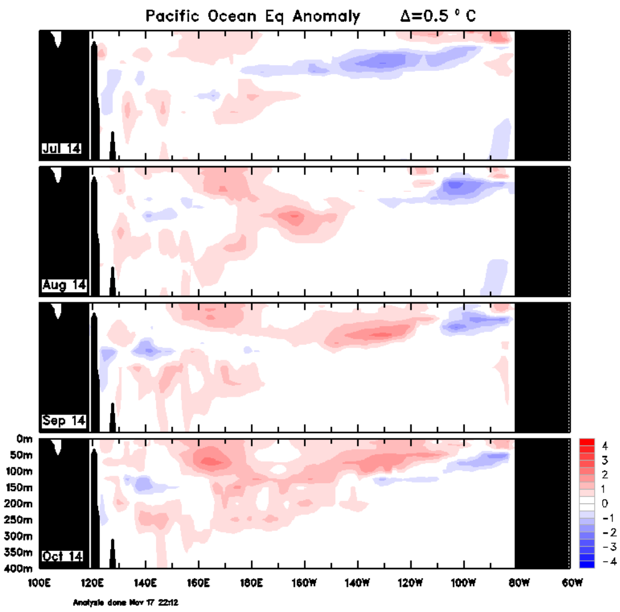


**Figure 8: Sub-surface temperature anomalies of the equatorial Pacific Ocean, where warmer than average waters have re-emerged in recent months following the brief slowdown in July 2014 (credit: BoM).**

However, the warming patterns observed over recent months were not limited to only the Niño3.4 region but covered large expanse of the Pacific Ocean, including the Western Pacific region. This could have resulted in the atmosphere not responding through the Walker Circulation and not impacting the weather patterns over Southeast Asia during the Southwest Monsoon season (June-September, JJAS) as expected (Figure 9). For example, over:

- The southern and eastern Maritime Continent where El Niño tends to cause drier-than-normal rainfall patterns.
- The Philippines, where El Niño tends to cause wetter-than-normal conditions.
- Mainland Southeast Asia, where El Niño generally causes drier-than-normal conditions.

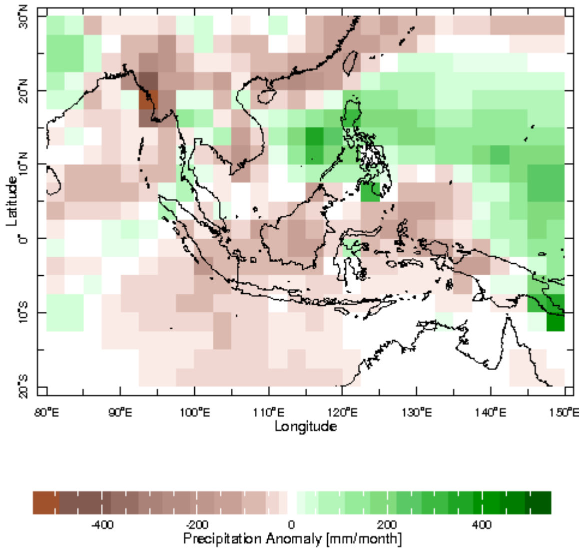


**Figure 9: Rainfall anomaly composite for El Niño years showing drier-than-normal conditions (brown shades) mostly in the southern half of the region for the months June to September (credit: NCEP CAMS_OPI/IRI).**

The IOD on the other hand was briefly negative during July-August but has otherwise remained largely within the neutral range (Figure 10). Thus, it would have not influenced the regional weather for that season.

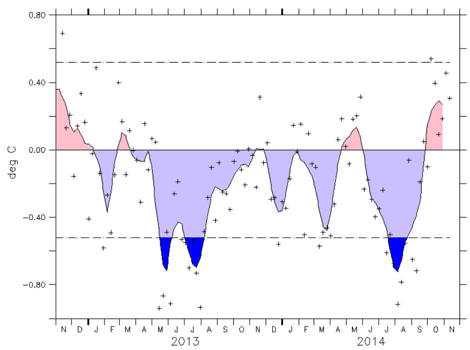


**Figure 10: The IOD index calculated using Reynolds OIv2 SST analysis data from IRI, showing values largely within neutral thresholds except for July-August 2014 when it is significantly negative (credit: NOAA/IRI).**

<u>Review of Outlook for JJA 2014</u>

Following was the consensus outlook for JJA 2014:

> *For the upcoming Southwest Summer Monsoon (June-August, JJA) season, normal to below normal rainfall is expected over most of the southern parts of Southeast Asia as well as the central and eastern parts of Mainland Southeast Asia. Elsewhere, generally normal to above normal rainfall can be expected (Figure 11**Error! Reference source not found.**).*

*Above normal temperature conditions are generally expected over the whole Southeast Asia region for summer monsoon, with higher probabilities of above normal temperature over the southern parts of the region (Figure 12**Error! Reference source not found.**).*

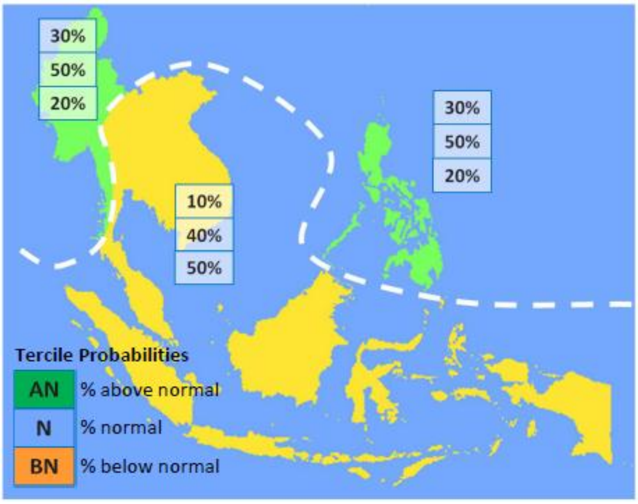


**Figure 11: Consensus rainfall outlook for June 2014 to August 2014 over Southeast Asia.**

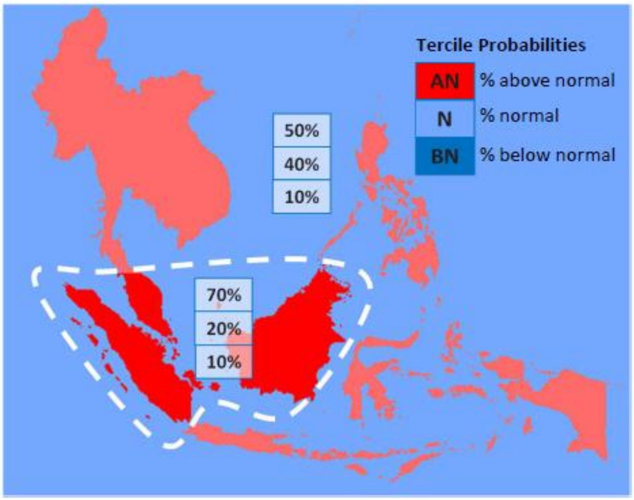


**Figure 12: Consensus surface temperature outlook for June 2014 to August 2014 over Southeast Asia.**

Based on temperature observations from NOAA's NCDC (GHCN-M) and CAMS datasets, observed temperature anomalies were above the upper tercile for JJA 2014 season (Figure 13) and this is consistent with the category predicted most likely by the outlook. The warming observed is consistent with the general global warming trend, which is increasing the odds of above average seasonal temperature conditions which have been observed for much of 2014 [3].

For rainfall (Figure 14), largely normal conditions were observed over the western Mainland Southeast Asia (around Myanmar) and the eastern Maritime Continent (around Philippines) as were predicted in the outlook. Elsewhere over the region, normal to below normal rainfall conditions were observed as predicted in the outlook, except for the southern Maritime continent (Java and

Sulawesi islands), where the rainfall observed was above normal. Overall, a satisfactory outlook was provided for JJA 2014.

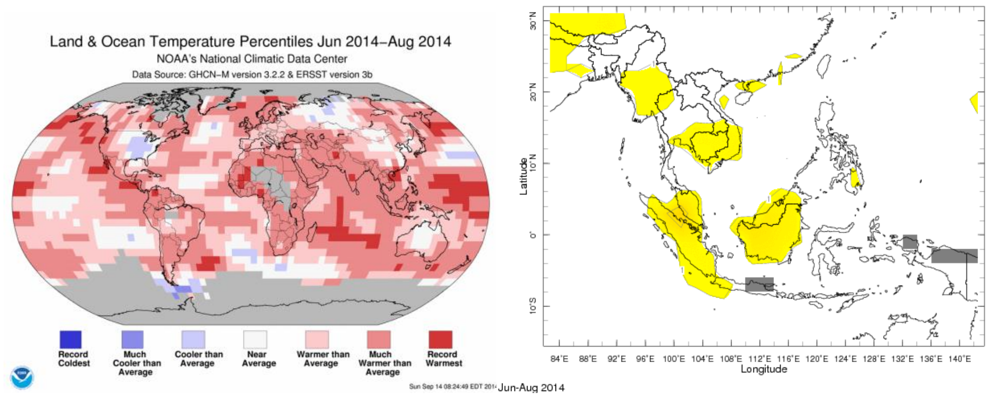


**Figure 13: (Left) Global land and ocean temperature percentiles from NOAA NCDC (credit: NOAA) and seasonal anomalies – yellow indicates positive anomalies – from Climate Anomaly Monitoring System, CPC (credit: NOAA, CAMS) for June - August 2014.**

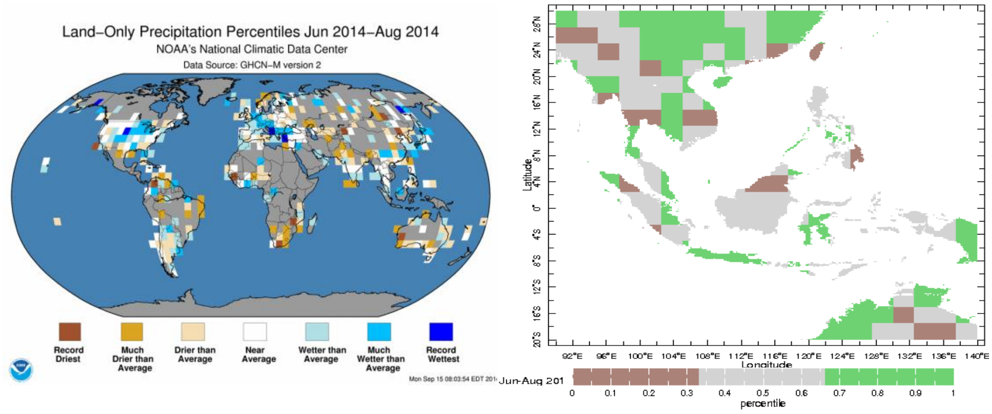


**Figure 14: (Left) Global land rainfall percentiles from NOAA NCDC (credit: NOAA) and (right) from Climate Anomaly Monitoring System, CPC (credit: NOAA, CAMS) for June - August 2014.**

## 6. Discussions and Follow up

Two discussion sessions were conducted following Session 2 and Session 3 presentations. Issues around the limited availability of hindcasts, forecasts and verification model data were discussed, and participants were advised on the platforms available where these could be obtained from. Participants also requested that they were informed of any significant model changes so that the necessary re-calibration of statistical techniques can be done, which was noted by the GPCs. There were also discussions around communicating uncertainty from model output to end-users and some ideas were shared on the 'best practices' adopted in some countries. Challenges and ideas on downscaling or calibration of model predictions to water catchment areas were also shared during discussions.

In order to improve the presentation and information provided with the seasonal outlooks, representatives from the NMSs were encouraged to gather feedback from their end-users on the regional consensus information (including the related country-level information each NMS provides). Such feedback should be shared during future ASEANCOFs for continuous improvements.

The next ASEANCOF is planned for May 2015 for the JJA Southwest Monsoon season.

## 7. Training

In collaboration with MSS, a training session was conducted on the third day of the meeting by a seasonal prediction expert, Dr. Richard Graham from the Met Office Hadley Centre, UK. For this training, ASEAN NMS participants were trained through hands on exercises and lectures in the concepts of ensemble model forecasting systems of the GPCs. Participants were shown the various data sources from which model predictions can be derived and used. The training also included robust techniques for model verification, so that participants are in a better position to assess models' skill for their respective regions of interest.

Dr. Wassila Thiaw from the Climate Prediction Center (CPC, NOAA) was also invited to share with the participants on the use of the platform on which the North American Multi-Model Ensemble (NMME) resides. The NMME consists of operational models participating in the WMO LC-LRFMME including the NCEP CFSv2, and two versions of the Canadian model. Additional models are from other U.S. centers including NOAA Geophysical Fluid Dynamical Laboratory NASA, and NCAR. Dr. Thiaw showed the participants how this dataset, which is available by the $10^{th}$ of each month can be utilized to enhance forecasts.

Overall, the training session was well-received by participants and they were keen to have similar training sessions conducted during future ASEANCOFs.

## Appendix A: Potential for Seasonal Forecasting in Southeast Asia during Winter Monsoon

Southeast Asia may be divided geographically into Mainland Southeast Asia and the Maritime Continent, with the two sub-regions overlapping the Malay Peninsula. The wet season in Mainland Southeast Asia starts in May, which actually marks the earliest onset of the Asian summer monsoon. As the season progresses into summer, monsoon rainfall covers the entire Mainland Southeast Asia and also western and southern Philippines. This is followed by a gradual transition with the monsoon convection marching southeastward to the Maritime Continent, where rainfall reaches annual maximum during the boreal winter. The spring transition is much more abrupt. The two sub-regions may therefore be identified with the summer and winter monsoon regimes, respectively, with the demarcation at the equator [5]. However, the two rainfall regimes are not symmetric, with the winter regime intruding into the summer regime on the windward side of coastlines and mountains, where winter monsoon surges produce heavy rainfall. Therefore, high interest in seasonal winter forecast is shared by all countries in the region.

A significant part of the skill in seasonal forecasts in climate models is rooted in ENSO [6], with the largest area of skillful forecast in the Maritime Continent where the effects of ENSO through anomalous Walker circulation and atmosphere-ocean feedback are well known. Thus, the prospect of useful operational seasonal forecasts is more promising in this region than in many other regions around the globe.

The complex terrain of islands of different sizes and mountains interspersed among the surrounding seas creates significant local-scale variations of weather and climate and their relationships with ENSO. The variations are due to the interactions between the seasonal-reversing winds and the local terrain, which are the primary mechanism for convective rainfall in both summer and winter monsoons [5]. The complexity of these variations is largest during the winter monsoon, when the relationship between rainfall and ENSO is weakest [7, 8, 9]. The situation is further complicated by the baroclinic systems in mid-latitude Asia, which drive the winter monsoon winds and surges that interact with synoptic scale disturbances and Madden-Julian Oscillations (MJO) [4]. These factors make the winter monsoon seasonal forecast both challenging and scientifically interesting.

(Excerpts from ASEANCOF-1 Report)

## Appendix B: Rainfall and Temperature Tercile Climatologies

The following figures are rainfall and temperature tercile boundary climatologies to reference against the consensus outlook. Only a single source of data for each variable is provided. For more representative climatologies, reference should be made also against observational datasets known to better characterise local patterns (e.g. quality-controlled station data).

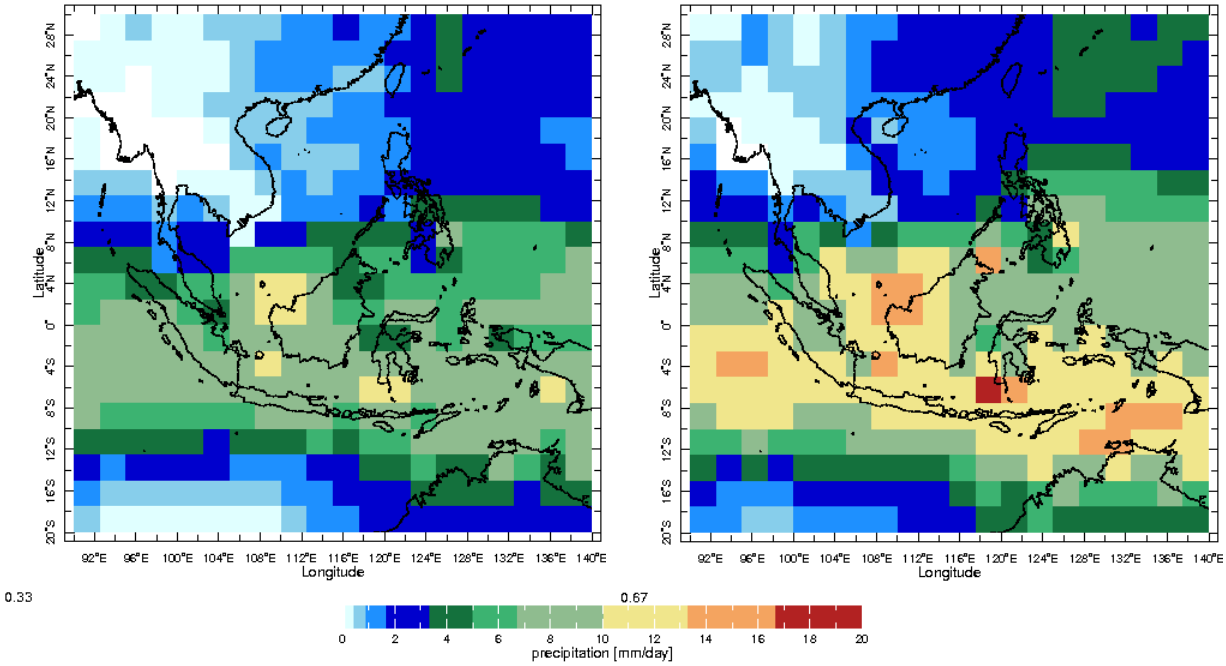


**Figure 15: Rainfall climatologies of the lower tercile boundary (left) and the upper tercile boundary (right) for DJF from 1981-2014 from CAMS_OPI dataset (NOAA, CPC)**

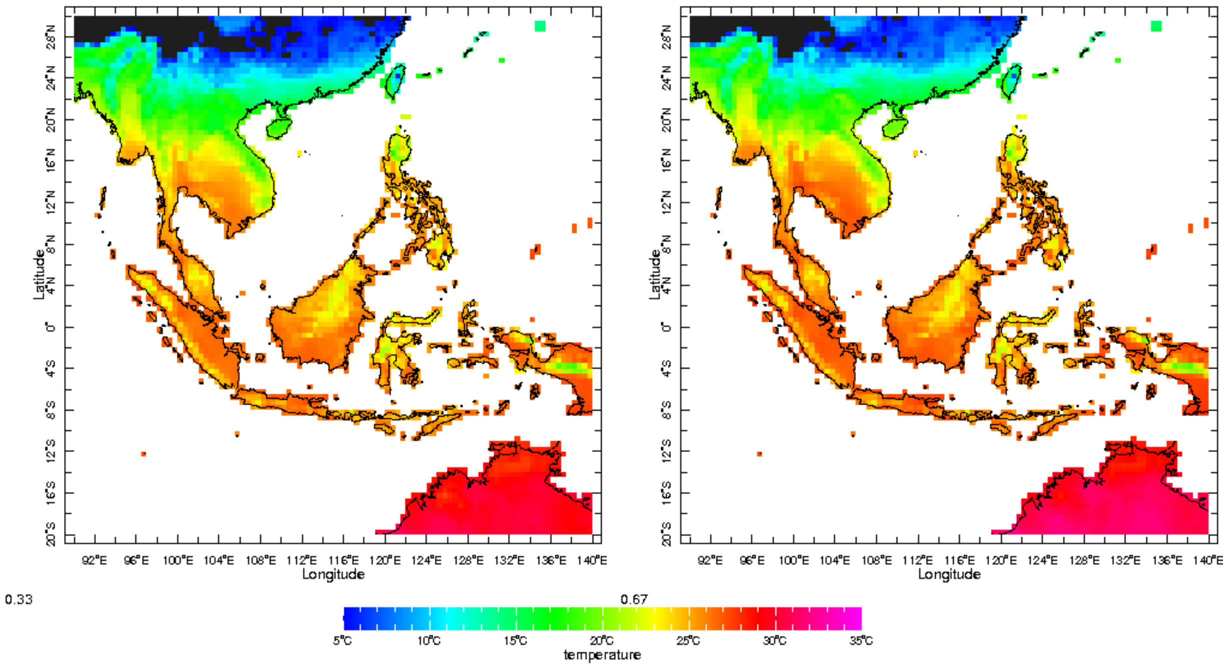


**Figure 16: Temperature climatologies of the lower tercile boundary (left) and the upper tercile boundary (right) for DJF from 1971-2000 from TS2p1 (CRU, UEA)**

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