# Training on Seasonal Prediction to Operational Services in South Asia

## Workshop report and feedback

**22<sup>ND</sup> FEBRUARY TO 11<sup>TH</sup> MARCH 2021 - ONLINE REMOTE TRAINING**

**Asia Regional Resilience to a Changing Climate (ARRCC)**

**Work Package 2: Strengthening Climate Information Partnerships – South Asia (SCIPSA)**

# Document history

| Version | Purpose | Date |
|---------|---------|------|
| 0.1 | Draft | 19th March 2021 |
| 1.0 | Final version | 20th April 2021 |

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# Contents

# 1. Introduction

The Asia Regional Resilience to a Changing Climate (ARRCC) programme, with funding support from UK Aid is a four-year programme that aims to strengthen weather and climate services across South Asia. The regional programme started in September 2018 and aims to deliver new technologies and innovative approaches to help vulnerable communities use weather warning and forecast to better prepare for climate related shocks. The programme is regional, however with a focus on Afghanistan, Bangladesh, Nepal and Pakistan and recognising the important contributory role of India.

Under the ARRCC programme Work Package 2, Strengthening Climate Information Partnerships – South Asia (SCIPSA), focusses on the prediction and application of seasonal forecast information. SCIPSA is being implemented by the UK Met Office (UKMO) and is supported by regional partners RIMES (Regional Integrated Multi-Hazard Early Warning System for Africa and Asia).

The SCIPSA project has three key components:

1. Strengthening regional and national climate organisations through the regional and national climate outlook forums so that they become standard platforms for the provision of seasonal climate outlook information and interfacing with user sectors.
2. Engage with user departments in key priority sectors in the region through a series of planned co-development workshops to identify user needs and develop solutions to meet user needs including the use of optimized seasonal forecast systems using the latest models and scientific knowledge.
3. Capacity development of both users and generators of climate information through training workshop and co-development activities.

One of the key activities of SCIPSA is to build capacity within National Meteorological and Hydrological Services (NMHSs) to enable the generation of co-designed, user-oriented climate information and dissemination tools to support risk management decisions.

To aide in the capacity building of NMHSs in the four ARRCC focus countries, RIMES in collaboration with UKMO and Regional Climate Centre (RCC) - India Meteorological Department (IMD) Pune built upon the first foundation-level operational seasonal prediction training workshop held in February 2019. Jointly we facilitated online training on Seasonal Prediction to Operational Services in South Asia during 22nd February to 11th March 2021. The training workshop was part of continuing capacity development efforts for strengthening seasonal climate information and services in the South Asia region.

The workshop aims and overview is discussed in section 2, followed by participant feedback in section 3 and future recommendations in section 4.

## 2. Workshop aims and overview

This online training workshop on 'Seasonal Prediction to Operational Services' was part of continuing capacity development efforts for strengthening climate information and services in the South Asia region, under the SCIPSA project that sits within the Asia Regional Resilience to a Changing Climate (ARRCC) programme. A key focus of this work is to create and continue to develop capacities within National Meteorological and Hydrological Services (NMHSs) to enable them to generate user-oriented seasonal climate outlook information that could feed into co-designing of tools to support risk management decisions. This workshop builds upon learning and recommendations from the 'Foundation-Level Operational Seasonal Prediction in South Asia' workshop, held in February 2019.

The key recommendations based on participant feedback from the February 2019 workshop were as follows:

- If we plan to maintain the same quantity of material, in future the workshop should be carried out over 5 days instead of 4.
- Either an extended workshop or a follow-on workshop should include sessions focussed on the statistical methods underlying CPT.
- A follow-on workshop should also include guidance on comparing forecasts from different modelling centres, thereby creating a type of multi-model advisory.

Taking this feedback into account initially this workshop was planned to be hosted again at AIT Bangkok over a 2-week period in February 2020. The workshop planned to cover:

- The importance of domain choice of predictors (X-domain, model/forecast) and predictands (Y-domain, historical observations).
- Introduction to statistical techniques (CCA, EOFs, cross validation) to provide a background to the statistical techniques behind CPT.
- 'Weather within seasonal climate': Module on advanced use of CPT for predicting rainy day frequencies and thresholds, and a module on CPT to predict onset using a research-based method.
- Introduction to Model Selection to include in a Multi-Model Ensemble (MME).
- Introduction to the FOCUS tool for MME production.
- Introduction to creating Standard operating Procedures (SOPs) and for participants to create own SOPs for the SASCOF forecast production.

- User requirements in agriculture and water sector – instances in ARRCC project countries of Afghanistan, Bangladesh, Nepal, and Pakistan.

However, due to the COVID-19 pandemic it was agreed to postpone this face-to-face applied training workshop to a later date. The training workshop scope and agenda was modified to be delivered online during a 4-day week (Monday to Thursday) from Monday 22nd February to Thursday 11th March 2021. Taking into account that the training is applied in nature, regional time differences between the UK, SASCOF member countries and Thailand, allowing for any technical internet connectivity issues, and appreciating the risk of online training fatigue, 4-hour sessions were planned to be held during the morning (afternoon) UK (South Asia) time.

The 'Seasonal Prediction to Operational Services' online training workshop is the next step towards capacity building efforts under SCIPSA for NMHS officials from South Asian countries, with the aim that participants will develop an understanding and appreciation for the following topics:

1. Investigating 'weather within the seasonal climate' and advanced application of CPT to produce tailored output for use in downstream products and services:
    a. Predicting rainy day frequencies.
    b. Prediction onset - Review of South Asian monsoon onset definitions, Using R to create onset data from daily observations, based on an objective definition of monsoon onset.
2. Introduction to the FOCUS tool combining output from multiple seasonal forecasting systems to produce user-relevant messages to aide informed decision-making.

The feedback from this training event will guide the evolution of future training requirements during Pre-COF events and the SCIPSA regional training in February 2022. The full workshop agenda can be found in Annex 1.

## 2.1. Week 1 Training sessions

- **Day 1: Monday 22nd February 2021**

*Session 1: Recap of foundation level training*

The training workshop was officially opened by Climate Lead, Dr Srinivasan of RIMES, on behalf of the RIMES director gave a warm welcome as the co-host of the online training workshop. Dr Srinivasan introduced how he had hoped that the workshop was to be hosted at AIT Bangkok, Thailand but due to the ongoing restrictions with travel and health risks we have worked together to deliver this workshop remotely online. The workshop is furthering strengthening the foundation training delivered in February 2019. This was followed by

remarks from Dr Sreejith from RCC Pune a co-host of the event and wished success to all participants of this online training event. The ARRCC SCIPSA work package lead, Mr Francis Colledge, UKMO, as the host organisation introduced the training workshop aims and objectives. Francis made a special mention as to why and when seasonal forecasts are useful. As shown by Figure 1, they are useful if they allow users to adjust related management decisions according to the forecast, therefore we need to meet users requests when scientifically viable to produce direct and derived forecast products such as seasonal total rainfall, numbers of dry and wet days, onset and clarity on uncertainty. The aim of this training workshop is to begin exploring and investigating tools and techniques that can meet these needs.



Figure 1. How can seasonal forecasts be deemed useful?

Participants were then informally quizzed with 20-time limited questions using the online quiz platform 'Kahoot!'. As shown by Figure 2, each question was designed to gage how much knowledge was retained from February 2019 and to provide a refresher on the foundation-level training. The overall response level of understanding across the board was high and the answers were discussed between questions. The quiz was appreciated by the participants in terms of its content and delivery method noting its interactivity online.
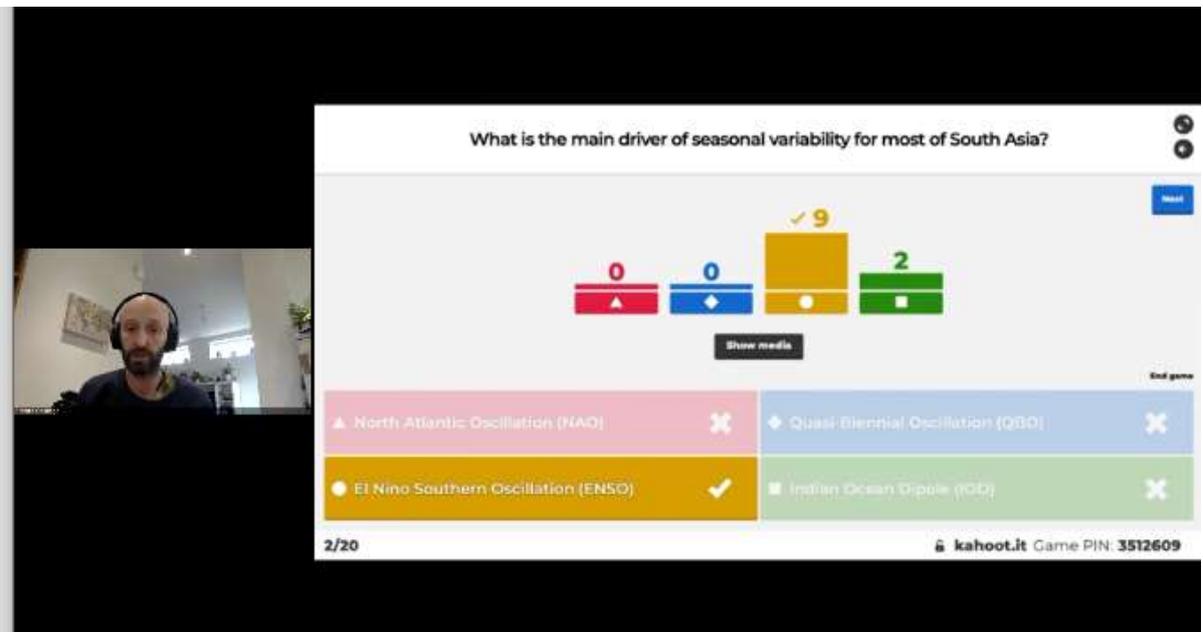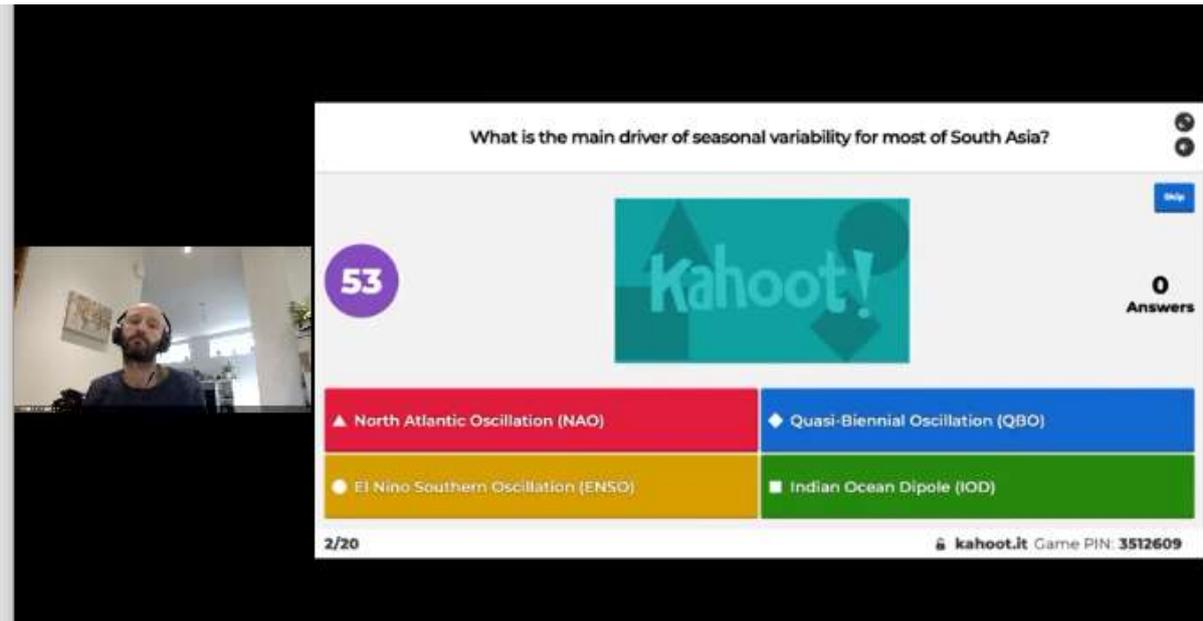
Figure 2. Kahoot quiz example question and results.

This was followed by an opportunity for the NMHS officials to present feedback in no more than 5 slides and taking no more than 10 minutes on how CPT based seasonal forecasting went in 2019/20 highlighting what worked well, what was most challenging and if they have tried anything new or learnt any new techniques. An example slide delivered by Bikash Nepal of Department for Hydrology and Meteorology (DHM) Nepal is shown in Figure 3. Presentations were delivered followed by feedback and questions from Andrew Colman of UKMO and Dr Sreejith of RCC Pune.
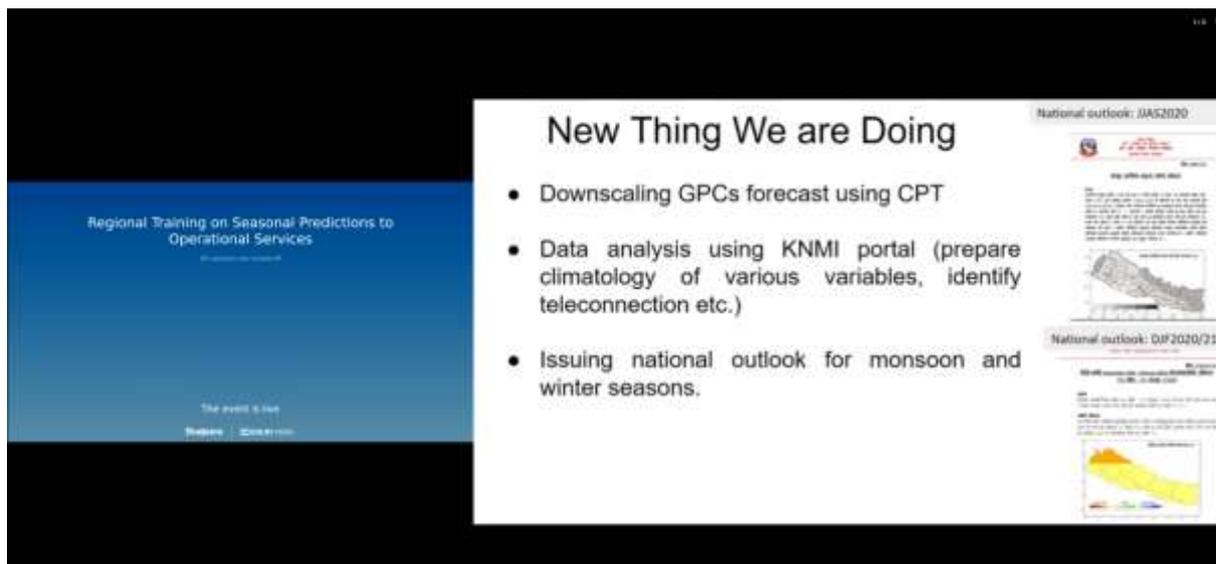
Figure 3. Example presentation delivered by Bikash Nepal of DHM Nepal.

The final session of day 1, session 2 on Advanced CPT – Predicting rainy day frequencies was delivered by Andrew Colman.  Andrew introduced the predicting number of rain days using CPT CCA models.  Sometimes users require different information from the seasonal mean/total, for example the number of days with rain or the number of days with rain greater than a threshold, for example > 10mm in a day.  CPT models can be developed to predict such variables by substituting mean/total as Y variables with datasets of rain days.  The first assignment for downloading the CHIRPS observation data and the seasonal forecast models for the chosen season of October to December (OND) or June to September (JJAS) and participants were required to note summaries of the data downloaded including first and last year of hindcast year, number of hindcast ensemble members, downloaded hindcast file size and the top left value in the file for CHIRPS and models.  An example is provided for JJAS in Figure 4, and this ensured that everyone was downloading the correct data to input into CPT.

| February forecasts for JJAS | First and last hindcast year | NUMBER OF HINDCAST ENSEMBLE MEMBERS | DOWNLOADED HINDCAST FILE SIZE (MB) | Top left value 40N 60E for CHIRPS 40N 0E for models |
|---|---|---|---|---|
| CHIRPS >0mm | 1981-2020 | N/A | 1.4 | 0.500 |
| CFS | 1982-2020 | 24 | 18 | 1.15 |
| GFDL-SPEAR | 1992-2020 | 15 | 12 | 0.915 |
| COLA-CCSM4 | 1982-2020 | 10 | 16 | 0.553 |
| CanCM4i | 1981-2018 | 10 | 16 | 0.45 |
| GEM-NEMO | 1981-2018 | 10 | 16 | 0.350 |
| NASA-GEOSS2S | 1981-2016 | 4 | 16 | 0.450 |

HINT: The number of ensemble members can be read from the _M 1 to ?? RANGE statement in expert mode (for CPT downloads) .

Figure 4. Assignemnet 1 resutls example.

- **Day 2: Tuesday 23rd February 2021**

Day 2 began with the rest of the NMHS officials' presentations delivered as part of session 1. Feedback was once again delivered by Andrew Colman and Dr Sreejith. This was then followed by a continuation of session 2 where further demonstrations were given by Andrew on downloading the data via CPT and the IRI climate data library and to respond to any outstanding issues and questions from participants. The results table as shown in Figure 4 was shared with the participants so that they could then check their results to ensure that they had downloaded the correct data.

This was followed by the introduction to assignment 2 where Andrew provided a demonstration on how to input the forecast data into X (Predictor) and the number of wet days into Y (Predictand) and setup CPT to produce precipitation maps plots for ROC below- and above-normal number of wet days greater than a daily rainfall threshold of 0 mm or 10 mm, and the probabilistic forecasts for season of choice (OND or JJAS) for 2020 and 2021. Participants were requested to produce the plots for each model in a pre-prepared Google slides presentation pack and provide conclusions on which model is best and how do they compare with other forecasts. An example slide that was presented to the participants is shown in Figure 5.
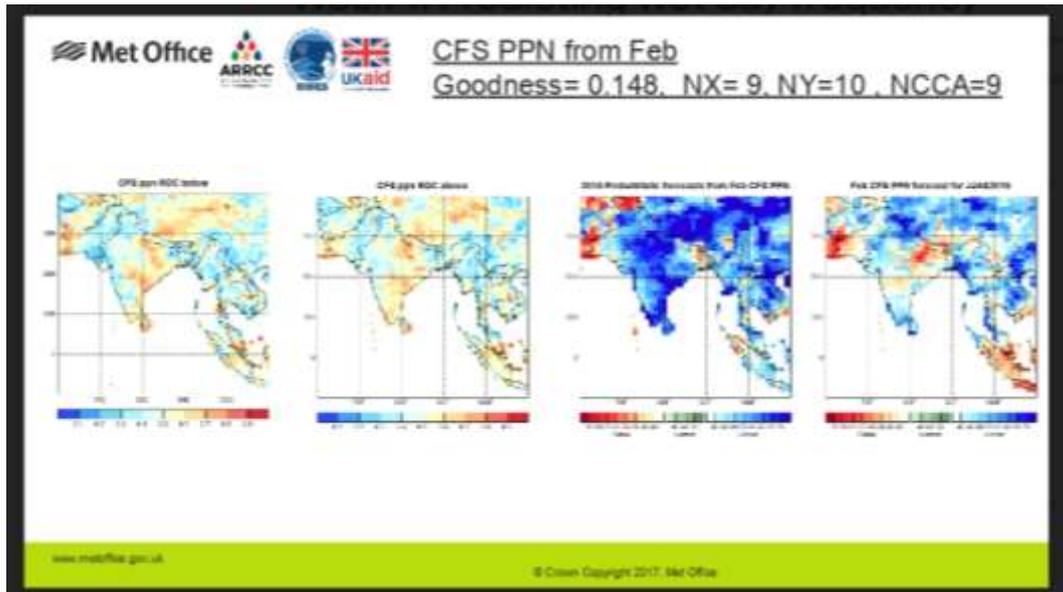
Figure 5. Example slide on how to present assignment 4 resutls.

- **Day 3: Wednesday 24ᵗʰ February 2021**

Day 3 was a live drop-in session for individual work on assignments 1 & 2 with live support provided by Andrew Colman, Francis Colledge, and Dr Srinivasan.

The assignments were submitted at 12:00 UK time for assessment and feedback. Individual feedback on submitted assignments 1 & 2 was prepared and delivered via the google classroom platform by Andrew Colman and Francis Colledge.

- **Day 4: Thursday 25ᵗʰ February 2021**

On day 4 Andrew Colman and Francis Colledge delivered overall feedback on the assignments submitted. The presentation slide packs were to a high standard and in general the results participants produced were in line with those that Andrew had produced. Slight differences could be due to selecting different training periods, domains etc and these were discussed as a group. Each participant then had the opportunity to each present their results from assignment 2. The standard of presentations was excellent with regards to clear communication and effectively describing the results on each slide. Constructive feedback was delivered to each presentation and overall to ensure that:

1. It is below- or above-normal number of wet days above a threshold (> 0 mm/day or > 10 mm/day) and not seasonal rainfall totals.
2. Model ensemble member numbers etc
3. Ensure that slides are clearly annotated, and the conclusions are clear as if you the reader were interpreting for the first time without any previous instruction or guidance.

## 2.2.    Week 2 Training sessions

- **Day 5: Monday 1st Match 2021**

Day 5 introduced Session 3 on Advanced CPT and R tools for the prediction of onset.  The session began with a review of South Asian monsoon onset definitions where NMHS officials presented on how monsoon onset defined in country. How reliable is this definition? How it is currently communicated? If not, how could it be communicated to users? The identified definitions by NMHS officials are highlighted in Table 1. Dr Sreejith provided invaluable guidance on monsoon onset definitions and prediction and is described in **Box 1**.

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**Box 1.** Invaluable guidance and feedback on Monsoon Onset definitions and prediction as provided by Dr Sreejith.

- Monsoon onset is not strictly coming under the definition of seasonal prediction.  It is mainly a lot of variation on day-to-day weather. Onset definition is mostly on day-to-day weather. We can do better planning with extended range forecast. For example, in Kerala in India there has been a lot of research and well-defined criteria, IMD are now issuing PCR based forecast 2nd week of May.
- With dynamical models we could now start to provide up to 1 month ahead. It is very difficult to do at seasonal timescales and with limited skill.
- Sreejith commented on Nepal and high mountain region challenges - on how challenging it is for declaring monsoon onset. Pre-monsoon rainfall showers and westerly disturbances (March to May) makes it difficult to distinguish between monsoon flow or from these convective phenomena. The definition itself is very difficult to distinguish in this case.
- Longer term tropical cyclone guidance is delivered based upon using dynamical models, perhaps methods could be developed for monsoon onset prediction.
- Within this training we are investigating tools and techniques during this that could be further explored and researched by NMHS officials.

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After the presentations from NMHS officials, Andrew Colman provided an overview of the methodology to be used in assignments 3 & 4 for predicting summer monsoon onset using CPT and R tools.  Andrew introduced how we can describe the temporal evolution with rainfall accumulations. To discover the average time of onset we can define when onset has occurred when the percentage of season total rainfall reaches a pre-defined threshold, for example 20%. An example was provided for east Africa as shown by Figure 6 that visualises the observed mean evolution via the 20th isochrone, where the colours indicate time of local arrival of 20% of average season total rainfall. What we are trying to do with CPT is to predict these isochrones using terciles to define early, normal, or late onset.
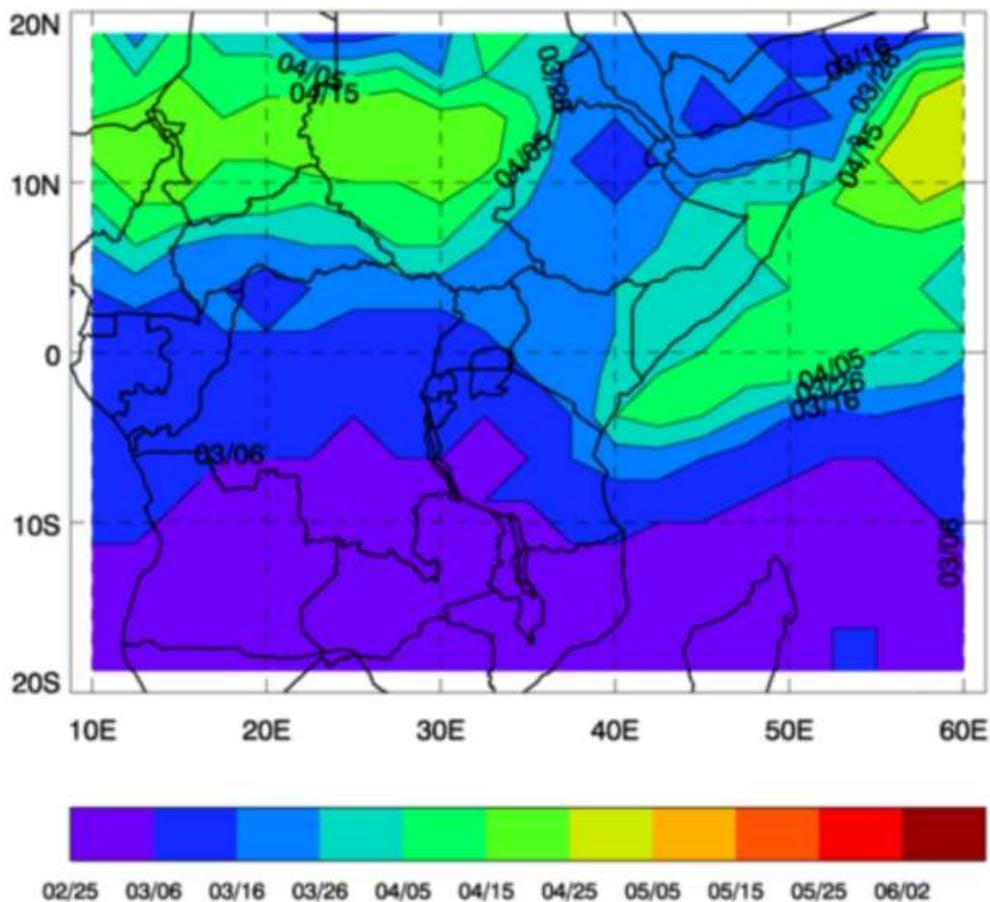
Figure 6. East Africa example that visualises the observed mean evolution via the 20th isochrone, where the colours indicate time of local arrival of 20% of average season total rainfall.

Following the introduction to the topic Andrew then provided a worked example and overview of assignment 3, 'Downloading for CPT Assignment 3'. In assignment 3 NHMS officials downloaded daily gridded CHIRPS observed rainfall data for a sub-region (could be country-specific, or a larger sub-region) of South Asia from the IRI data library. This was followed by using an R program to process the observed daily rainfall and create a file of gridded season onset dates in CPT format. Within this dataset onset timing at a grid point is defined as the number of days after a specified date by which X% of the long-term seasonal average has accumulated. This was followed by downloading a prescribed list of seasonal forecast models using the CPT download tool and as in assignment 1 were requested to provide summaries of the downloaded models in a table to check if the data is correct.

Table 1

| Country | How is monsoon onset defined? | How reliable is this definition? | How is it currently communicated? If not, how could it be communicated to users? |
|---|---|---|---|
| **Bangladesh** | Normal onset of Summer Monsoon as defined by Ahmed and Karmakar (1993)<br><br>Varies from year to year, onset is expected in late May or early June.<br><br>Climatological normal date in South eastern part of Bangladesh is June 2nd and moves north-westwards by June 15th. | Prediction of monsoon onset is a challenging job.<br><br>The last two monsoons onset has been late, for example in Cox's Bazar and Chattogram coast (8th and 10th June respectively). | |
| **Bhutan** | The criteria set is mainly based on the subjective definitions that are mainly used in India by the India Meteorological Department. Following criteria have to be met to declare the onset of monsoon in Bhutan.<br><br>(i)      If after 5th June, 60% of the 20 class A meteorological stations report rainfall of 1.5 mm or more for two consecutive days and widespread rainfall across the country<br>(ii)      Onset date of isochrones produced by IMD either passes through Bhutan or near bordering states of India, namely, Arunachal Pradesh, Assam, West Bengal and Sikkim.<br>(iii)      The orientation of cloudiness across the northern Bay of Bengal and over Bhutan from the satellite images, and forecast of rainfall by Weather Research and Forecasting model (WRF) for more than three consecutive days. | NCHM do not forecast the monsoon onset.<br><br>Monsoon onset information has been made available once the above mentioned criteria are fulfilled. | • NCOF (stakeholders engagement)<br>• Press release<br>• Made available in NCHM website and Media<br>• Television interviews<br>• Print media |
| **India** | 1.   Rainfall Criteria<br>• If after 10th May, 60% of the 14 stations (Minicoy, Amini, Thiruvananthpuram, Panalur, Kollam, Alapuxha, Kottayam, Kochi, Trissur, Kozikode, Talassery, Cannur, Kasargode and Mangalore) report rainfall of ≥ 2.5 mm for two consecutive days, the onset of monsoon over Kerala be declared on 2nd day provided the WIND FIELD and OLR criteria are also in | Definition is quite reliable – using Principal Component Regression (PCR) model for the forecasting date of Monsoon onset over Kerala. During the last 15 years (2005- | |

concurrence.

2. Wind Field Criteria

(i) For winds, the RSMC wind analysis / satellite derived wind data is to be used.

(ii) Westerlies up to 600 hPa level in the region bounded by latitudes Equator to 10ºN and longitudes 55ºE to 80ºE.

(iii) Zonal wind speed of the order of 15 to 20 Kts at 925 hPa level over the region bounded by latitudes 5ºN to 10ºN and longitudes 70ºE to 80ºE.

3. OLR Criteria

• The INSAT derived Outgoing Long wave Radiation (OLR) value in the region bounded by latitude 5º N to 10º N and longitudes 70ºE to 78ºE should be less than 200 W / m².

20) the forecast issues for the date of monsoon onset over Kerala was within the forecast limits for all years except 2015. Model error = 4 days

New Dates of Normal Monsoon Onset/progress (based on 1961-2019) (Pai et al, 2020)

• Monsoon onset over Kerala remains the same, i.e., 1 June.

• However, new monsoon advance dates over the states like Maharashtra, Gujarat, Madhya Pradesh, Chattisgarh, Telegana, Andhra Pradesh, Odisha, Jharkhand, Bihar and parts of Uttar Pradesh are delayed by 3-7 days compared to existing normal dates.

• However, over extreme northwest India, the monsoon arrives now little earlier, on 8th July compared to the existing date of 15th July.

| Maldives | There are two distinct seasons annually, Northeast Monsoon (dry season) and Southwest Monsoon (wet season) Northeast Monsoon extends from January to March and Southwest Monsoon from May to December. | • The monsoon onset criteria is reliable and we have been following the | • Maldives Meteorological Service issues a news bulletin, when Monsoon onset declares over Maldives. |
|---|---|---|---|

Southwest monsoon sets in over southern area around 1st or 2nd week of May. It advances northwards, usually in surges, and covers the entire country before end of May.

Guidelines to be followed for declaring onset of Southwest Monsoon season:

a) Rainfall

If after 1st May, 60% of the following Meteorological stations over the southern atolls, S.Gan, Gdh. Kaadehdhoo, L.Kadhoo, and AWS at S.Hithadhoo, S.Hulhumeedhoo, Gn.Fuvahmulah, Ga. Gemanfushi, Ga. Kooddoo, report rainfall of 2.5 millimeters or more for 2 consecutive days, the onset over southern part of the country be declared, provided with other parameters are also in concurrence.

b) Winds field

The zonal wind direction of southwest or westerly winds should be observed in the southern area. The surface or 925hPa wind speed should be of the order of 10 Knots or more. The low level wind speed can be obtained from Radio-Sonde data at S.Gan and low level wind data from satellite maps.

c) Strength of Somali jet.

The Somali Jet over the Western Arabian Sea should be well established with wind speed of 25 knots or more over western Arabian Sea. The Somali jet can be determined by visual inspection of Satellite wind maps.

d) Strength of Monsoon low

Formation of surface low over Southwest Bay of Bengal.

Guidelines to be followed for declaring onset of Northeast Monsoon season:

a) Rainfall

- If after 1st December, 60% of the following Meteorological stations over the northern atolls, Hdh. Hanimaadhoo, and AWS at Ha. Kelaa, Hdh. Kulhudhufushi B. thulhaadhoo, B. Dharavandhoo report rainfall of 2.5 millimeters or more for 2 consecutive days, the onset over northern part of the country be declared, provided with other parameters are also in concurrence.

criteria for long period of time.
- Recently the criteria are amended, after installation of AWS at many islands
- The Meteorological conditions were observed prior to the onset in the region.

- Monsoon onset criteria were shared with our stakeholders. We also share this information to media and during awareness sessions.

| | | | |
|---|---|---|---|
| | b) Winds field<br><br>• The zonal wind direction of northeast or easterly winds should be maintained in the northern area. The surface or 925hPa wind speed should be of the order of 10 Knots or more over the northern area of the country. | | |
| **Myanmar** | Related Synoptic conditions with onset<br><br>• Movement of ITCZ – it is an indicator of the onset and withdrawal of Southwest Monsoon. Northward movement of ITCZ is one of the indicators of monsoon onset.<br>• Disappearance of sub-tropical westerly jet at 300hPa indicates onset of southwest monsoon.<br><br>The guidelines to be followed for declaring onset of southwest monsoon over southern parts and its further advance over the country are listed below:<br><br>(a) Rainfall – If after second or third dekad of May, 2mm or more for five consecutive days received in the southern part of Myanmar and check the appearance of stratus cloud.<br>(b) The significant include the development of a low-level cyclone circulation and upper level anticyclone in south Asia, as well as strong convection in the Bay of Bengal.<br>(c) Westerly Jet move to the North of Himalaya range at 200mb level.<br>(d) Check the Madagascar High and Somali Jet/cross equatorial flow<br>(e) Mumbai wind at 200mb refer in mid-April.<br>(f) China High pressure area move to the east (to check semi- permanent Low/High pressure areas)<br>(g) Compare with normal charts (surface, 850, 700, 500, 300 and 200 mb). | Well tested methodology | • Fax<br>• Website<br>• Radio, television and newspaper<br>• Monsoon Forum |
| **Nepal** | **Normal onset date:**<br><br>**10th June in south-eastern Nepal. We are updating it soon.**<br><br>**Major Criteria**<br><br>• Wind: | • We don't do of onset forecast.<br>• We declare the onset once we observe the mentioned criteria.<br>• It is reliable. | • Press Release<br>• Special Bulletin via website, email and social media (Facebook and Twitter)<br>• Communicated with National Disaster Risk Reduction |

| | | |
|---|---|---|
| | • Full development of South Easterly Wind over southeast Nepal at surface over eastern Nepal.<br><br>• Rainfall:<br>   • If 2-3 consecutive rainfall days is reported from observation stations in Eastern Nepal<br><br>• OLR<br>   • Reduced OLR over Nepal (~200wm2)<br><br>• Onset over the south and central India.<br>• Forecasters intuitive Knowledge based on his/her experience<br>• Forecast/Outlook from other agency (e.g. IMD)<br><br>Due to complex topography and intertwined weather system, sometimes, it is very difficult to distinguish the onset of the monsoon from the pre-monsoon rainfall activities. | Management Authority and other stakeholders like NARC.<br>• Different radio and television interviews. |
| **Sri Lanka** | SW Monsoon onset Criteria<br><br>1. At least 2.5 hPa pressure gradient (from Colombo to Trincomalee) in the South-westerly direction.<br>2. Extending of South-westerly winds from surface to at least 18000ft.<br>3. Occurrence of rain at least two consecutive days at Galle, Colombo, Ratnapura, and Nuwara-Eilya<br>4. Formation of surface low or low tropospheric vortices in the vicinity of the island or in the Southwest Bay of Bengal.<br>5. About 5-10 days after the first appearance of Tropical Easterly jet (over 40 kts) around Sri Lanka Latitudes. | Well tested methodology |

- **Day 6: Tuesday 2nd March 2021**

The session began with resolving any technical issues that NMHS officials faced in downloading the CHIRPS or seasonal forecast model data. Andrew then provided a worked example for assignment 4 of how to produce the ROC above (late onset) and ROC below (early onset) normal skill maps and the probabilistic forecast maps for the CFS model for the 2020 and 2021 summer monsoon season. Participants then had the time to continue working on the assignments with technical support on hand.

- **Day 7: Wednesday 3rd March 2021**

This was a live drop-in session on assignments 3 & 4 where NMHS officials could continue to work and ask for assistance. The assignments were submitted at 12:00 UK time for assessment and feedback. Individual feedback on submitted assignments 1 & 2 was prepared and delivered via the google classroom platform by Andrew Colman and Francis Colledge.

- **Day 8: Thursday 4th March 2021**

On day 8 Andrew Colman and Francis Colledge delivered overall feedback on the assignments submitted. The presentation slide packs were once again to a very high standard and in general the results participants produced were in line with those that Andrew had produced. Andrew noted that there were some slight differences in results however everyone was able to provide some sensible results of onset and skill results. Each participant then had the opportunity to each present their results from assignment 4. Once again, the standard of presentations was excellent with regards to clear communication and effectively describing the results on each slide.

## 2.3. Week 3 Training sessions

The RIMES team and RCC Pune conducted a FOCUS demonstration workshop from 8th to 11th of March 2021 in a virtual model. Participants from all eight South Asian countries participated in the 4-day long workshop. It was designed to provide an overview of the FOCUS tool, which is currently being developed for providing Multi-Model ensemble-based seasonal climate outlooks for the upcoming season.

- **Day 9: Monday 8th March 2021**

Session 4: Introduction to FOCUS

RIMES team discussed two of the major components of the tool: 1) the MME Seasonal Climate outlook generation and 2) the Model performance analysis. A brief theoretical background was provided, and the tool's components were demonstrated as a hands-on exercise. During the

preliminary exercise, the participants were provided access to the live online platforms. All users were able to:

- Access the system successfully
- Register themselves using the web interface of the tool, filling in the required information
- Log in to the system successfully and able to access the outlook generation page for their preferred region/country.
- Follow the instructions to generate a sample outlook choosing different parameter by filling in the required information.

Participants explored the tool during the rest of the first day's exercise. As the tool works and operates online, the local/client machine and browser, and internet played a crucial role. For some participants, it took more than the expected time.

- **Day 10: Tuesday 9th March 2021**

Session 5: FOCUS Exercise on outlook generation and Skill Assessment

During day 10, the participants were given six exercises to generate an outlook for their respective countries or the region of interest. The exercise was to ensure that the participants were able to perform all tasks independently. The exercises were as follows.:

- Exercise 1: Generate forecast for MAM-2021 (Pre-Monsoon season) with 1-month lead-time (February Initial conditions) with available GCMs models
- Exercise 2: Generate forecast for JJAS (Monsoon Season) 2020 with 3-month lead-time (March initial conditions), 2-month lead-time (April initial conditions), and 1-month lead-time (May initial conditions) with all available GCM Models
- Exercise 3: Generate Monthly forecast for June, July, August, and September 2020 with 1-month lead-time, 2-month lead-time, 3-month lead-time, and 4-month lead-time with all available GCM Models e.g., June with May initial conditions (1-month lead-time), July with May initial conditions (2-month lead-time), August with May IC (3-month lead-time) and September with May initial conditions (4-month lead-time) July with June initial conditions (1-month lead-time) etc.
- Exercise 4: Generate forecast for OND-2020 (Post Monsoon season) with 1-month lead-time (September Initial conditions) with all available GCM Models
- Exercise 5: Generate forecast for DJF2020-2021 (Winter season) with 1-month lead-time (November Initial conditions) with all available GCM Models
- Exercise 6: Generate forecast for JFM-2021 with 1-month lead-time (November Initial condition) with all available GCM Models.

- **Day 11: Wednesday 10th March 2021**

Session 6: Skill Assessment

During Day 11, the model skill was demonstrated to users, and different indicators were discussed, and users were again provided a hands-on demonstration on the Forecast skill generation process and interpretation methods. Once the users were familiar with the steps in generating the model skills specific to their region, they were provided a series of exercises quite similar to the first set of exercises, but this time the outlook generation will be done after comparing the results against the model skill. The final forecast shall be based on the models with better skill only.

- **Exercise 1:** Generate forecast for MAM-2021 (Pre-Monsoon season) with 1-month lead-time (February initial conditions) with GCMs models whose skills are good for your domain and forecast month/season.

- **Exercise 2:** Generate forecast for JJAS (Monsoon Season) 2020 with 3-month lead-time (March initial conditions), 2-month lead-time (April initial conditions), and 1-month lead-time (May initial conditions) with GCMs models whose skills are good for your domain and forecast month/season.

- **Exercise 3:** Generate Monthly forecast for June, July, August, and September 2020 with 1, 2, 3 and 4-month lead-times with GCMs models whose skills are good for your domain and forecast month/season (e.g., June with May initial conditions (1-month lead-time), July with May initial conditions (2-month lead-time), August with May initial conditions (3-month lead-time) and September with May initial conditions (4-month lead-time) July with June initial conditions (1-month lead-time) etc.

- **Exercise 4:** Generate forecast for OND-2020 (Post Monsoon season) with 1-month lead-time (September initial conditions) with GCMs models whose skills are good for your domain and forecast month/season.

- **Exercise 5:** Generate forecast for DJF2020-2021 (Winter season) with 1-month lead-time (November initial conditions) with GCMs models whose skills are good for your domain and forecast month/season.

- **Exercise 6:** Generate forecast for JFM-2021 with 1-month lead-time (December initial conditions) with GCMs models whose skills are good for your domain and forecast month/season.

- **Day 12: Thursday 11th March 2021**

Session 7: Presentations by participants and Feedback

On day 12, the participants compiled their final results generated from the two days of exercise. The participants were asked to present the results and interpret the reason for choosing a certain outlook. This section presents some sample results of national level analysis and commentary carried out by participants.

***Bangladesh***

The model does not have signal in the central regions however it shows better performance on the south east coastal region. Skilled weighted average method has better performance compared to other two.    However, further skill assessment is needed to evaluate the model for all seasons.
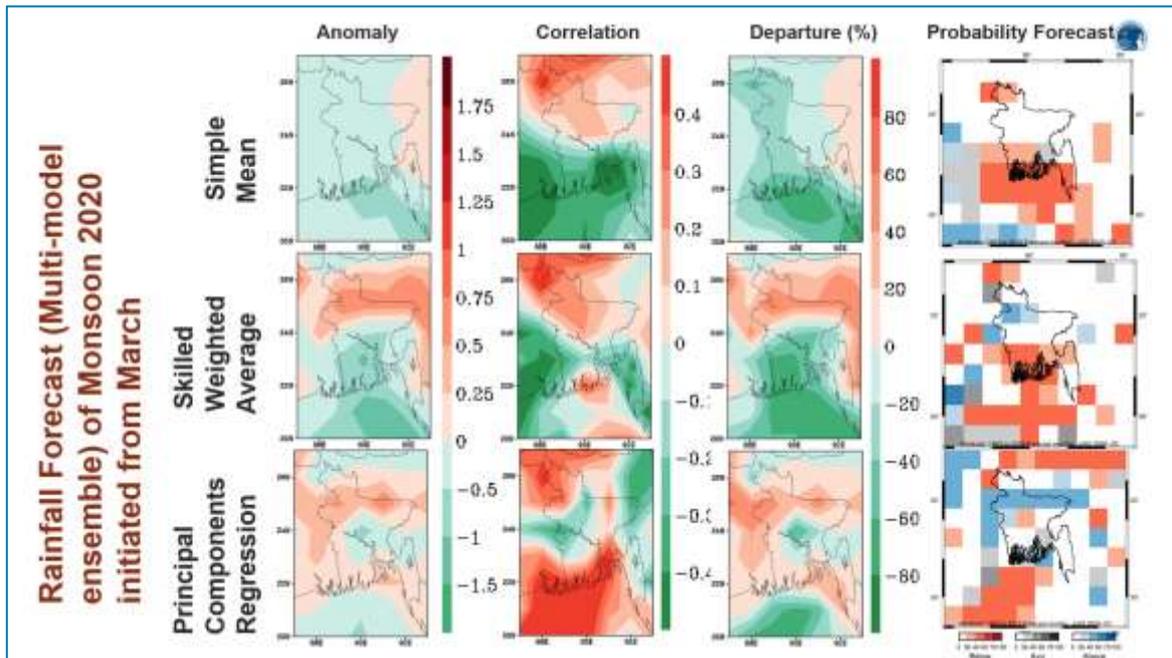


**Figure 7.** Monsoon (JJAS)-2020 forecast with March IC (3-lead)
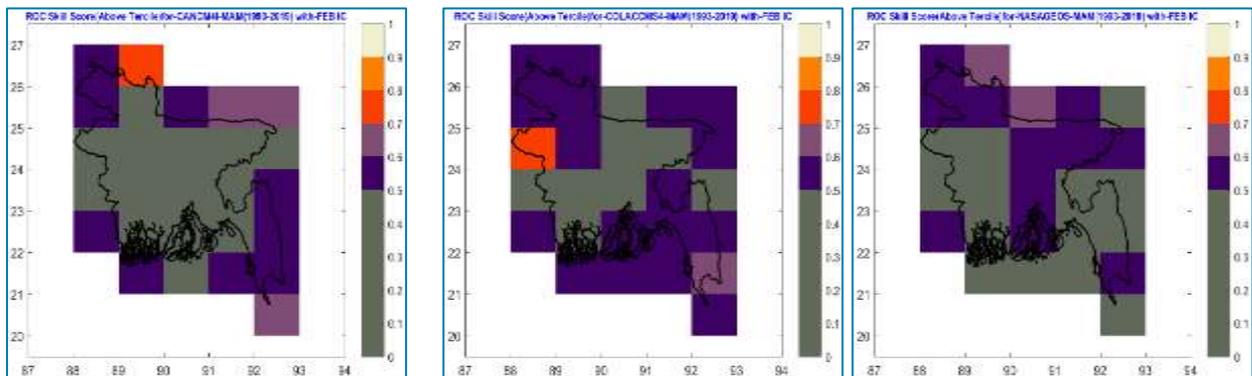


**Figure 8.** Skill (MAM)-1993-2019 forecast with Feb-IC (1-lead)

### *Bhutan*

The skill of the Climate models are poor in the Bhutan region. In some cases, the entire region indicates climatological probability. Sometimes if different MME method like the Weighted and PCR shows different forecast and it is challenging to choose one for the final forecast.
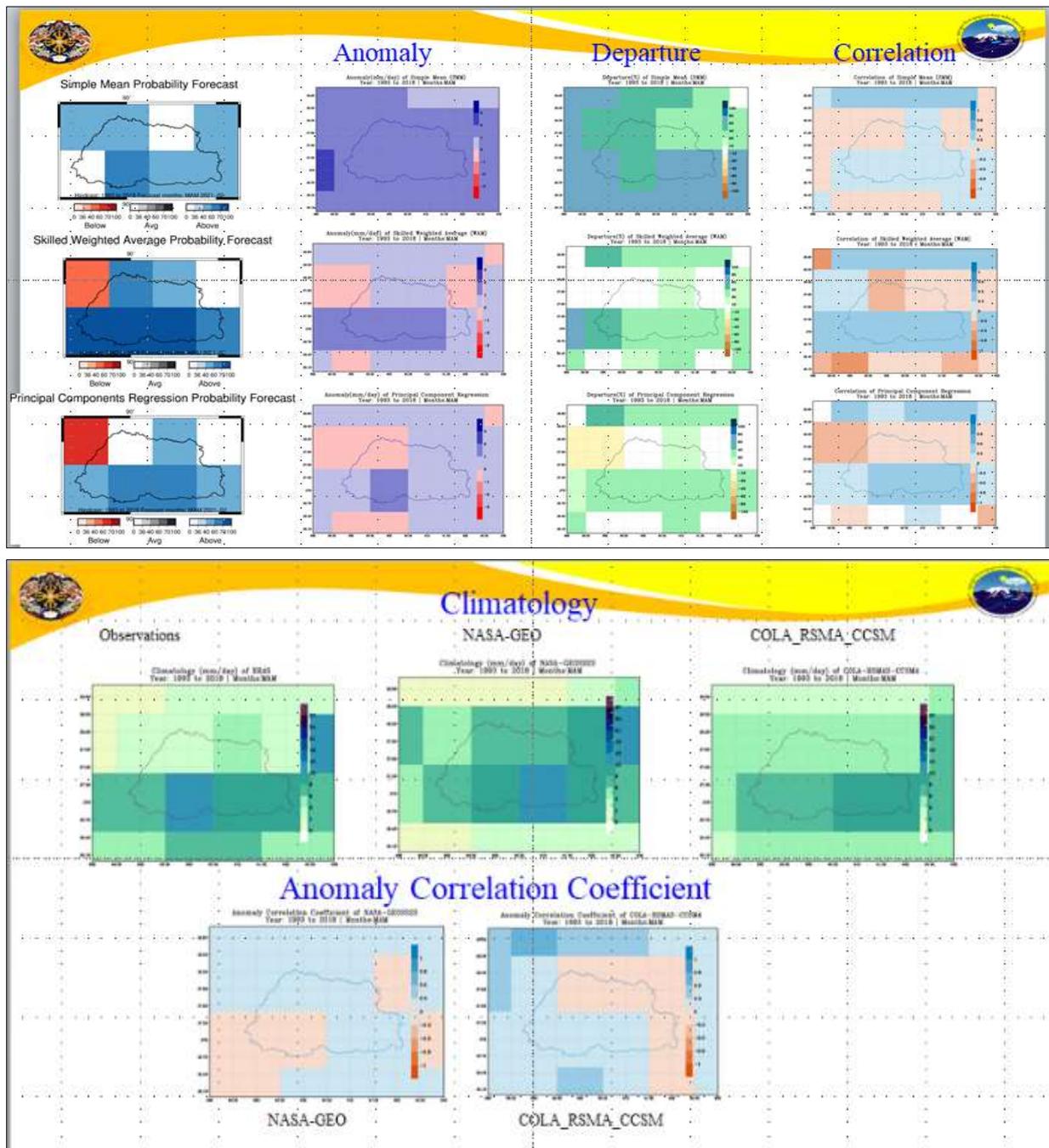


**Figure 9.** MAM-2021 forecast with Feb IC (1-lead)

### Nepal

The model performance was better and MAM skill for the MME models were found to be good. The Skilled weighted average method has better performance compared to the other two Multi model ensemble method.
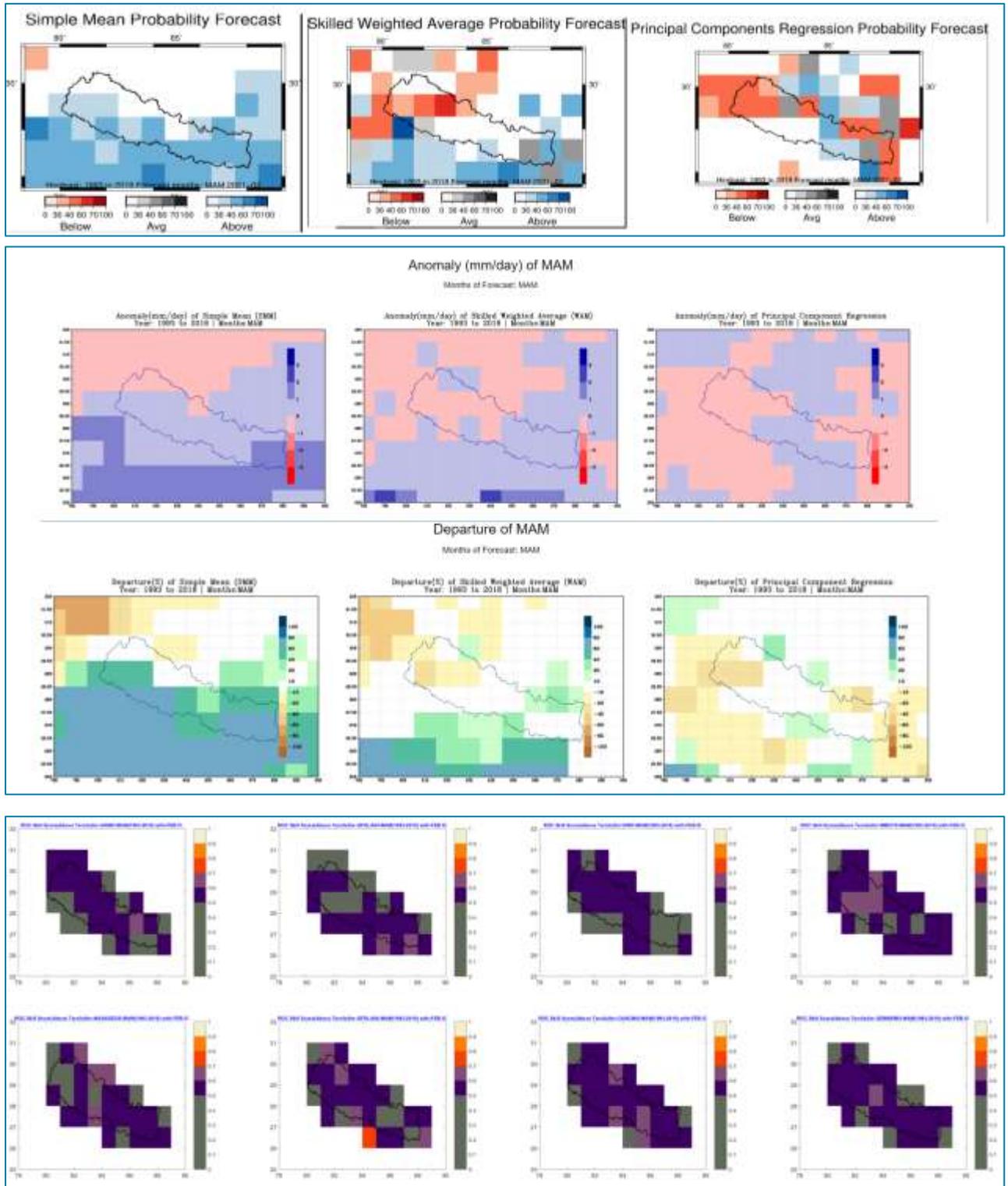


**Figure 10.** MAM-2021 forecast and Skill with Feb IC (1-lead)

Session 8: Final review session and next steps

- Recommendations for FOCUS

All participants appreciated the efforts to put together the FOCUS tool. The ease of use of the tool was the highlight. They also appreciated the flexibility the tool brings in the generation of outlooks with user-defined lead time and period. One of the other major points from the exercise was to put some guidance documentation on usage of the different MME products, especially if there are differences between them, which one should be chosen over the other (Skill assessment of the MME method is one way consider).

The users also recommended to consider:

- An offline version of the tool
  - For faster processing
  - Allows the user to generate forecasts even if they are not online.
- Allow user to use country observation data
  - Process and generate gridded data
- Fix all issue so that FOCUS can be used for the coming season
- Improvement to the visualization; mainly selecting the colour and scale of a different variable may help fix the issue.

# 3. Participant Feedback

At the end of the workshop, participants were given the opportunity to feedback on their experiences through Microsoft Forms. The feedback form gathered information with regards to Technology and resources, Google classroom assignments, Live introduction, teaching and review sessions and Overall, which asked participants to rank various aspects of the workshop on a spectrum and any additional supporting comments. A detailed summary of the workshop feedback can be found in Annex 2 of this document.

**Technology and resources**

Overall, the feedback on the use of the Google Classroom and the quality and variety of the online training material and resources was rated excellent. The majority of participants found that the online lessons worked well with regards BlueJeans events platform and were able to submit and partake in work without any issues. One participant noted issues with internet connectivity. Additional feedback was provided:

- *'Virtual workshop/training/meeting is the best alternative in special situation like this COVID-19 pandemic. We, the organizer and participants tried our best to make the*

*event successful in spite of poor internet connection and power supply in the developing countries. To me training on CPT was very good, and the tools and technical issues of FOCUS need to be improved.'*

- *'Software/tools must be tested well in advance to save the time during training sessions. There were several issues i.e. server was not responding, several options of software not working, there was no error/warning msg.'*

**Google classroom assignments**

The majority of participants took between 4-5 hours on average to complete the assignments each week, and the rest taking 2-3 hours.  In general, it was found that the time commitment required to complete the lessons was acceptable but equally split between 'about what you were expecting' and 'more than you were expecting'.

General feedback was also gathered with regards to how useful participants found the assignments and how the assignments will support their activities moving forward. If it wasn't useful, they were asked to state why this was the case. Here are some examples of feedback responses:

- *'Yes, all the assignments were very useful for refreshing the knowledge acquired earlier on CPT tools. In addition to CPT, FOCUS tool-related exercises were very useful to get familiarize with the tool. It will support in my activities in the office during the preparation of the seasonal forecast.'*

- *The Training on Seasonal Prediction to Operational Services was a platform where I could get more updates on the applications of CPT, onset prediction and FOCUS tool. This training gave a more learning experience on various applications which can be used for seasonal forecasting. All the assignment are related to the operational work so, it gives an additional details on enhancing the existing information and it can be used as a reference while generating seasonal prediction.'*

- *'It was useful but if the training will be face to face and physically, more useful and success use from "our" side'* NMHS name removed for anonymity.

**Live introduction, teaching and review sessions**

Overall, for each training week the live introductions and teaching were rated very good to excellent.  The end of week review and discussion sessions (including presentations) were rated very good overall.  Further comments suggested that the live sessions were interactive and useful.

**Overall**

The participants thought that overall the training was very enjoyable and overall feedback with regards to usefulness, relevance, structure and methods, and teaching materials is shown in Figure 11.



Figure 11. Overall feedback on training with regards to its usefulness, relevance, structure and Methods, and Teachning materials.

In general, it was agreed that joint training and review sessions between NMHS officials were useful, with some example comments below:

- *'The review session is useful and learned from others'*
- *'This collaborative work is very useful to get wider knowledge of seasonal variability over the different countries of South Asia. Such knowledge together with the familiarization with the operational system in seasonal forecasting of those countries is always helpful.'*
- *'The two-way communication is effective as it gives an opportunity to learn new things and clear the misconception. The joint session is must for future as well for encouraging effective flow of communications and grabbing the additional knowledge.'*

The majority of participants said they are guaranteed to use the information of knowledge gained during the 3-week training workshop in their normal area of work. Some additional comments highlighted below:

- *'Being in the operational agency working in the field of meteorology will use the information and knowledge from this training in producing seasonal forecasts for my country.'*
- *'The CPT and FOCUS tools are very user friendly and convenient tools for making seasonal outlook at the national level. We use these tools for making seasonal forecasting. Also, I am planning to teach about these tools to my staffs.'*

- *'The knowledge gained from this training will be used for the prediction of wet days spell, dry day spell etc. FOCUS tool will be utilized for the seasonal prediction using MME'*

However, there are also areas for growth as shown by the comment below. FOCUS is a tool in development and all feedback gathered in this workshop be taken to help shape its enhancement for MME forecast production.

- *'We only attended FOCUS training. The tool still has certain limitations and need a lot of improvement. We definitively would like to use it in future when issues are fixed.'*

The majority of participants found the overall topics covered within the three-week online training workshop to be as expected or more than expected. Comments were provided with regards to what can we improve to make this better in the future, and some are highlighted below:

- *'More training and sharing new tools and techniques. I would like to suggest to include map generation tool like GIS or other platform. I also want learn PyCPT as well. Usefulness of more hands-on training has experienced in this workshop, since many participants learned well. So, in future workshops, please include more hands-on training in future workshops, More practical sessions.'*
- *'Assign specific tasks to individual participants. Time allocation can be made according to the work. Like this time FOCUS tool assignment had a lot of work but time allocated was not enough. Before closing every session, make sure everyone is clear and understand of how to carry out the assignment.'*
- *'In the future, I am expecting training on producing seasonal forecasts for temperature, as well as data pre-processing-related training for producing seasonal forecasts using the CPT tool.'*
- *'I was happy and satisfied with the experience. Being online, and not being relieved from the office made it demanding. Next time, we might probably be coming together for it. Thank you so much.'*
- *'Incorporating the multi-variate predictors and multi-model ensemble option in CPT tools helps a lot rather than developing a separate tool for making ensemble.'*
- *'In general I suggest to share the proposed training agenda well in advance with participants to get their feedback and learn if it really suffice their needs or they want some components to be included or excluded.'*

# 4. Future Recommendations

Based on the participant feedback described above, key recommendations can be identified for improving the quality and effectiveness of this workshop in the future.

## 4.1. Key Recommendations

- To ensure the proposed training agenda is shared well in advance with participants we must ensure that we share the invitations and agenda with the correct focal point contacts at the NMHS.
- Ensure that all software/tools are tested well in advance to save time during training sessions. It must be noted that technical issues are difficult to overcome sometimes during live online sessions, internet connectivity issues, and some tools are in development, but this will be clearly communicated in future to ensure everyone is clear about capabilities and what issues we may face.
- To look to build upon the regional sharing and knowledge sharing between NMHS officials.
- Albeit online training and the tools we have used has worked well for this training, face-to-face training is still preferred for this type of applied training.
- A follow-on workshop that explores temperature and further exploration of 'weather within seasonal climate'.

SCIPSA will take these recommendations into account when planning future capacity building activities of this nature under the ARRCC programme.  The next of which being the Pre-COF training activities scheduled for mid-April 2021, and the final SCIPSA regional training workshop in February 2022 hopefully to be hosted at AIT Bangkok.

# 5. References

Ahmed, R. and Karmakar, S. (1993), Arrival and withdrawal dates of the summer monsoon in Bangladesh. Int. J. Climatol., 13: 727-740. https://doi.org/10.1002/joc.3370130703

D.S.Pai, Arti Bandgar, Sunitha Devi, Madhuri Musale, M. R. Badwaik, A. P. Kundale, Sulochana Gadgil, M. Mohapatra, M. Rajeevan (2020) New Normal Dates of Onset/Progress and Withdrawal of Southwest Monsoon over India. Available online: https://internal.imd.gov.in/press_release/20200515_pr_804.pdf (Accessed: 18/03/2021)

# ANNEX 1 – Training workshop agenda

| Week 1 | Program | Responsibility |
|---|---|---|
| **Day 1: Monday, 22ⁿᵈ February 2021** | | |
| **08:00 – 08:30** | **Opening Session** <br><br> Workshop Aims and Objectives | Francis / Srini |
| **08:30 – 09:00** <br><br> **09:00 – 10:15** | **Session 1: Recap of foundation level training** <br> • Quick recap of foundation-level training <br> • Participants to present feedback on how useful forecasts have been to date | Francis <br><br> Francis |
| **10:15 – 10:30** | **Break** | |
| **10:30 – 12:00** | **Session 2: Advanced CPT – Predicting rainy day frequencies** <br><br> • Introduce Assignment 1: Downloading for wet days forecasts | Andrew / Francis |
| **Day 2: Tuesday, 23ʳᵈ February 2021** | | |
| **Morning local time** | **Individual working on Assignment 1** | |
| **08:00 to 10:15** | **Session 1 Continued** <br><br> • Participants to present feedback on how useful forecasts have been to date <br> • Q&A session on feedback | Francis |
| **10:15 to 10:30** | **Break** | |
| **10:30 to 12:00** | **Session 2 Continued** <br><br> • Introduce assignment 2: Predicting wet days using CPT | Andrew / Francis |
| **Day 3: Wednesday, 24ᵗʰ February 2021** | | |
| **Morning local time** | **Individual working on Assignment 1 and 2** | |

| 08:00 to 10:15 | **Live drop-in session** | Andrew / Francis |
| | • Individual work on Assignment 1 & 2 with live support. | |
| 10:15 to 10:30 | **Break** | |
| 10:30 to 12:00 | **Continued** | |
| 12:00 | • Submission of assignment for individual feedback at 12:00 UK time | |

| **Day 4: Thursday, 25th February 2021** | | |
| --- | --- | --- |
| **Morning local time** | **No training or assignment** | |
| 08:00 to 10:15 | **Review and feedback for session 2** | Francis / Andrew |
| | • Students present back findings | |
| 10:15 to 10:30 | **Break** | |
| 10:30 to 11:30 | Continued presentations | |
| | • Group Q&A session | |

| **Friday, 26th February 2021** | | |
| --- | --- | --- |
| | **No training or assignment** | |

| Week 2 | Program | Responsibility |
| --- | --- | --- |
| **Day 5: Monday, 1st March 2021** | | |
| **Morning local time** | **No training or assignment** | |
| 08:00 to 10:00 | **Session 3: Advanced CPT/R – Prediction onset** | |
| | • Review of South Asian monsoon onset definitions<br>• Discussion on key themes identified | |

| | | |
|---|---|---|
| 10:00 to 10:15 | Break | Francis / Sreejith |
| 10:15 to 12:00 | • Introduction to R program - Using R to create onset data from daily observations, based on one objective definition of monsoon onset<br>• Introduce Assignment 3 on downloading daily data and using r to create onset data | Andrew / Francis |

| Day 6: Tuesday, 2nd March 2021 | | |
|---|---|---|
| **Morning local time** | **Individual working on Assignment 3** | |
| 08:00 to 09:00 | • Introduce assignment 4 on forecasting onset using CPT | Andrew / Francis |
| 09:00 to 10:30 | **Break** | |
| 10:30 to 12:00 | • Individual working on Assignment 3 & 4 with live support | |

| Day 7: Wednesday, 3rd March 2021 | | |
|---|---|---|
| **Morning local time** | **Individual working on Assignment 3 & 4** | |
| 08:00 to 10:00 | • Live drop-in session on assignments | |
| 12:00 | • Submission of Session 4 assignment for individual feedback at 12:00 UK time | |

| Day 8: Thursday, 4th March 2021 | | |
|---|---|---|
| **Morning local time** | **No training or assignment** | |

| 08:00 to 10:15 | **Review and feedback for session 3** | Francis / Andrew |
| | • Students present back findings | |
| 10:15 to 10:30 | **Break** | |
| | Continued presentations | |
| 10:30 to 11:30 | • Group Q&A session | |

**Friday, 5th March 2021**

| | | |
| --- | --- | --- |
| | **No training or assignment** | |

| Week 3 | Program | Responsibility |
| --- | --- | --- |
| **Day 9: Monday, 8th March 2021** | | |
| 08:00 to 09:00 | **Session 4: Introduction to FOCUS**<br><br>• Presentation on methods and skill measurement<br>• (Review of methods used in FOCUS) | Itesh |
| 09:00 to 10:15 | • Functionality and Demonstration of Focus – Hands on | Jay |
| 10:15 to 10:30 | **Break** | |
| 10:30 to 12:00 | • Functionality and Demonstration of Focus – Hands on (Continued) | Jay |
| **Day 12: Tuesday, 9th March 2021** | | |
| | **Session 5: FOCUS Exercise on outlook generation and Skill Assessment** | |

| | | |
|---|---|---|
| **08:00 to 10:00** | • Seasonal Forecast generation, for a specific domain (for their respective countries) for the upcoming season.<br><br>**Step 1:** Assess the model for the domain and identify the best models.<br><br>**Step 2:** Use different models/methods to generate the forecast | Jay/Itesh/Raj |
| **10:00 to 10:15** | **Break** | |
| **10:15 to 12:00** | **Step 3: Compare**<br><br>• Models forecast vs the selected models forecast.<br>• MME methods<br>• Compare with CPT and other products | All |

| **Day 13: Wednesday, 10ᵗʰ March 2021** |
|---|

| | | |
|---|---|---|
| | **Session 6: Skill Assessment** | |
| **08:00 to 10:00** | **Step 4:** Assess the skill of the previous monsoon season. ROC, RMSE, CC, ACC etc<br><br>i)      Steps in skill assessment etc<br><br>ii)      Interpretation of the skill scores | Raj |
| **10:00 to 10:15** | **Break** | |
| **10:15 to 12:00** | **Step 5:** Assessing the skill of the model for the region for the current season. ROC, RMSE, CC, ACC etc | Raj |

| **Day 14: Thursday, 11ᵗʰ March 2021** |
|---|

| | | |
|---|---|---|
| **08:00 to 10:30** | **Session 7: Presentations by participants and Feedback**<br><br>• Interpretation of the outlook and presentation | Participants presentations |
| **10:30 to 10:45** | **Break** | |
| **10:15 to 12:00** | **Session 8: Final review session and next steps**<br><br>• Recommendations for FOCUS<br>• Feedback on the workshop and discussion | All |

# ANNEX 2 – Detailed Survey Feedback Results

Feedback was gathered using Microsoft Forms.

**Technology and resources**

1.  Please rate the following from 1-5, where 1 is poor and 5 is excellent; Ease of navigation of Google Classroom.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 0 | 0 | 25% | 42% | 33% |

2.  Please rate the following from 1-5, where 1 is poor and 5 is excellent; Quality and variety of the online training material and resources.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 0 | 0 | 25% | 33% | 42% |

3.  Did all elements of the online lessons work technically (e.g. videos played, forms opened and able to submit, exercised worked)? Yes, No, Other_____.

|  | Response |
|---|---|
| Yes | 84% |
| No | 8% |
| Other | 8%, 'Online Session has its Problem' |

4.  Did the platform BlueJeans Events work nice and clearly for the live sessions?

|  | Response |
|---|---|
| Yes | 84% |
| No | 16% |

5.  Any additional comments on the technology, teaching materials (videos) and quizzes.

*'Teaching materials excellent',*

*'no comments. they are excellent',*

*'Virtual workshop/training/meeting is the best alternative in special situation like this COVID-19 pandemic. We, the organizer and participants tried our best to make the event successful in spite of poor internet connection and power supply in the developing countries. To me training on CPT was very good, and the tools and technical issues of FOCUS need to be*

*improved.'*

*'Software/tools must be tested well in advance to save the time during training sessions. There were several issues i.e. server was not responding, several options of software not working, there was no error/warning msg.'*

*'This training was very important for my job and training technology was excellent.'*

**Google classroom assignments**

6. On average how long (estimate) did it take you to complete each assignment (week 1: Assignment 1 & 2, Week 2: Assignment 3 & 4, Week 3: FOCUS tool Assignments)?

| How long | Result (%) |
|---|---|
| < 1 hour | 8 |
| 1-2 hours | 0 |
| 2-3 hours | 42 |
| 4-5 hours | 50 |
| > 5 hours | 0 |

7. Was the time commitment required to complete the lessons?

| | Result (%) |
|---|---|
| Less than you were expecting | 8 |
| About what you were expecting, acceptable | 42 |
| About what you were expecting, but not manageable | 8 |
| More than you were expecting, but acceptable | 42 |
| More than you were expecting, and not manageable | 0 |

8. How specifically did you find the assignments useful? How will they support your activities moving forwards? If it wasn't useful training please state why.

*'The assignments are useful and learned many new things like onset, and no of wet days. FOCUS TOOL is very useful and user friendly. What we have learned from this training, i will apply in my operational work and improve our work.'*

*'Assignments were very useful. They enhanced my knowledge and increased the confidence level in routing activities. It can be new chapter to move forward.'*

*'Yes, all the assignments were very useful for refreshing the knowledge acquired earlier on CPT tools. In addition to CPT, FOCUS tool-related exercises were very useful to get familiarize with the tool. It will support in my activities in the office during the preparation of the seasonal*

*forecast.'*

*'It was useful but if the training will be face to face and physically, more useful and success use from AMD side'*

*'I think, training will be helpful to make seasonal outlook at national level.'*

*'I think it will be useful to give good fc. But FOCUS is new to me.'*

*'CPT is used for seasonal forecasting. I learned it was be used for forecasting raining days and monsoon onset. I plan to use it and verify in the coming season.'*

*'The Training on Seasonal Prediction to Operational Services was a platform where I could get more updates on the applications of CPT, onset prediction and FOCUS tool. This training gave a more learning experience on various applications which can be used for seasonal forecasting. All the assignment are related to the operational work so, it gives an additional details on enhancing the existing information and it can be used as a reference while generating seasonal prediction.'*

*'All assignments are useful for us.'*

*'It was good to come together and test new tools i.e. FOCUS and assess its capabilities. It was also helpful to learn its performance in different parts of the region.'*

*'Very useful.'*

*'It was very useful for day to day operational activities of our section. Yes it will definitely help to improve the ongoing works related to seasonal prediction.'*

**Live introduction, teaching and review sessions**

9. Please rate the following from 1-5, where 1 is poor and 5 is excellent; Week 1 CPT experimentation on 'no. of wet days' live sessions.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 8%* | 0 | 8% | 42% | 42% |

*NMHS service not in attendance

10. Please rate the following from 1-5, where 1 is poor and 5 is excellent; Week 2 CPT 'monsoon onset' live sessions.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 8%* | 0 | 8% | 42% | 42% |

*NMHS service not in attendance

11. Please rate the following from 1-5, where 1 is poor and 5 is excellent; End of week review and discussion sessions (including presentations).

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 0 | 0 | 25% | 50% | 25% |

12. Any additional comments on live sessions

*'Live sessions are helpful. Few technical issues encountered'*

*'FOCUS is new to me so I think more practice and some upgrade is needed'*

*'The live session were interactive'*

**Overall**

13. How enjoyable did you find this training? Where 1 is not at all and 5 is extremely enjoyable.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 0 | 0 | 8% | 58% | 34% |

14. How would you rate the overall content of the training in the following areas.
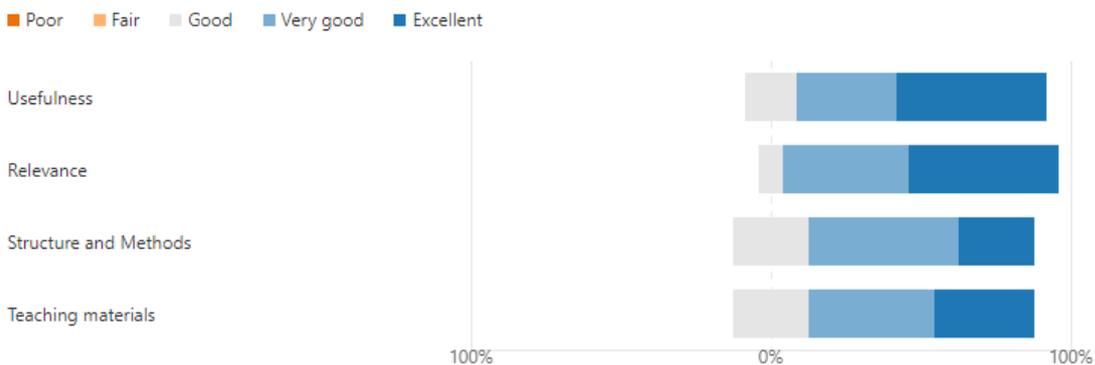


15. Was the joint training and review sessions between NMHSs useful? If so how will this collaborative work help you in future?

*'The review session is useful and learned from others'*

*'It will definitely help'*

*'This collaborative work is very useful to get wider knowledge of seasonal variability over the different countries of South Asia. Such knowledge together with the familiarization with the operational system in seasonal forecasting of those countries is always helpful.'*

*'Yes it was useful'*

*'Yes. We came to know how others are doing and how others are understanding which also help us to think differently.'*

*'It help to learn the practical uses'*

*'Yes'*

*'The two way communication is effective as it gives an opportunity to learn new things and*

*clear the misconception. The joint session is must for future as well for encouraging effective flow of communications and grabbing the additional knowledge.'*

*'The joint training and review sessions between NMHSs was useful for our seasonal forecast.'*

*'It was excellent to work together and definitely it will be very helpful to improve our capacity in regional forecast'*

*'This training sessions were useful for weather and climate prediction'*

16. How likely are you to use the information or knowledge you gained in the 3-week training workshop in your normal area of work? (1 = Never; 5 = Guaranteed)

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 0 | 0 | 8% | 25% | 67% |

17. How specifically will you use the information or knowledge gained? What actions will you take? If you won't use the information or knowledge from the training, please state why.

*'I will definitely use the knowledge in operational work'*

*'I use this knowledge in daily tasks in preparing weather reports as well as monthly outlook.'*

*'Being in the operational agency working in the field of meteorology will use the information and knowledge from this training in producing seasonal forecasts for my country.'*

*'The CPT and FOUCS tools are very user friendly and convenient tools for making seasonal outlook at the national level. We use these tools for making seasonal forecasting. Also, I am planning to teach about these tools to my staffs.'*

*'It help me to give better forecast for the end user.'*

*'For SASCOF and NCOF. For monsoon onset.'*

*'The information and knowledge gained from the training will be used while generating seasonal prediction for the country and will be used frequently.'*

*'I will use the information and knowledge for our seasonal forecast'*

*'We only attended FOCUS training. The tool still has certain limitations and need a lot of improvement. We definitively would like to use it in future when issues are fixed.'*

*'For seasonal prediction, this training is very useful.'*

*'The knowledge gained from this training will be used for the prediction of wet days spell, dry day spell etc. FOCUS tool will be utilized for the seasonal prediction using MME'*

18. Thinking about the overall topics covered within the three-week online training workshop, how much have you learned?

|  | Result (%) |
|---|---|
| Much less than expected | 0 |
| Less than expected | 25 |
| As expected | 17 |
| More than expected | 50 |
| Much more than expected | 8 |

19. What can we improve to make this better in the future?

*'More training and sharing new tools and techniques. I would like to suggest to include map generation tool like GIS or other platform. I also want learn PyCPT as well. Usefulness of more hands-on training has experienced in this workshop, since many participants learned well. So, in future workshops, please include more hands on training in future workshops, More practical sessions.'*

*'Assign specific tasks to individual participants. Time allocation can be made according to the work. Like this time FOCUS tool assignment had a lot of work but but time allocated was not enough. Before closing every session, make sure everyone is clear and understand of how to carry out the assignment.'*

*'In the future, I am expecting training on producing seasonal forecasts for temperature, as well as data pre-processing-related training for producing seasonal forecasts using the CPT tool.'*

*'The training should be physically'*

*'Incorporating the multi-variate predictors and multi-model ensemble option in CPT tools helps a lot rather than developing a separate tool for making ensemble.'*

*'More practice and upgrade of FOCUS is needed to improve in future.'*

*'I was happy and satisfied with the experience. Being online, and not being relived from the office made it demanding. Next time, we might probably be coming together for it. Thank you so much.'*

*'Overall, the mode of training (engagement, training materials, assignment, live discussions) were well organized.'*

*'We can improve the seasonal forecast to make this better in the future.'*

*'In general I suggest to share the proposed training agenda well in advance with participants to get their feedback and learn if it really suffice their needs or they want some components to be included or excluded.'*

*'Arrange this type of training physically.'*

*'Focus tool was working relatively slow speed. the server can be improved'*

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