

SASCOF: Twentieth South Asian Seasonal Climate Outlook Forum (SASCOF-20) & Climate Services User Forum (CSUF)
EVENT: 27 - 30 SEPTEMBER 2021, Online Event
ISSUE DATE: 11 OCT 2021 – **NOT FOR OPERATIONAL USE - DRAFT**
VALIDITY: October to December (OND) 2021
FOR: Rainfall / Precipitation, Minimum (Min) and Maximum (Max) Temperature



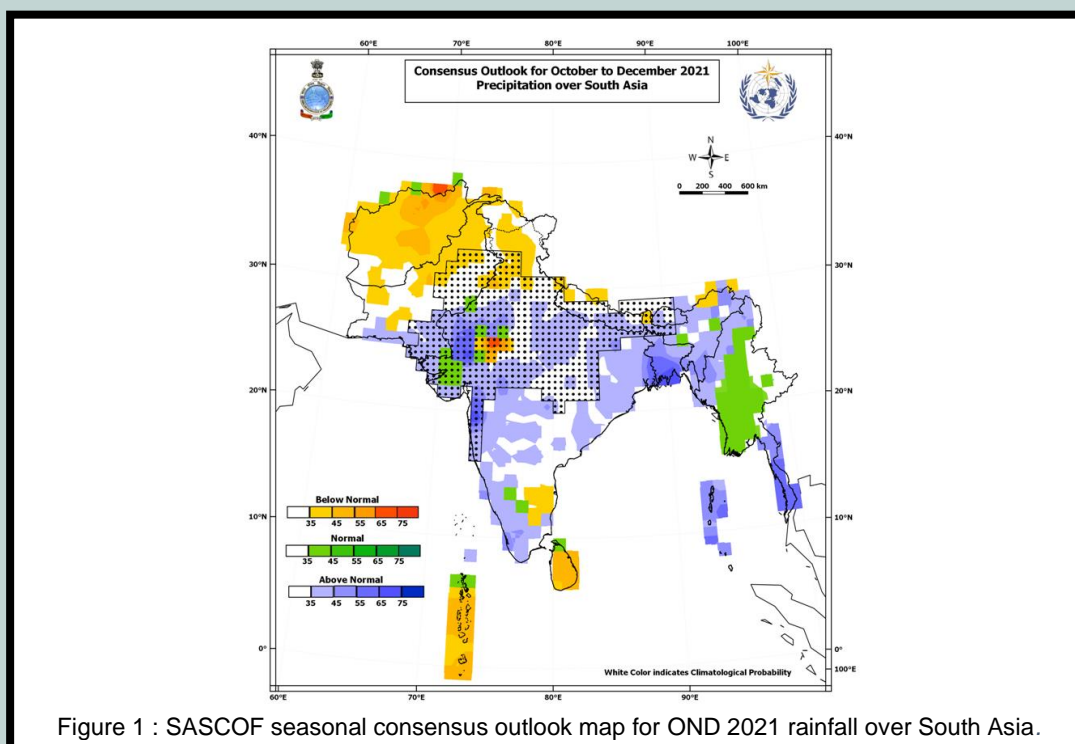
1.1: SUMMARY – REGIONAL RAINFALL



Below-normal rainfall is likely during the 2021 October – December (OND) season over the southern parts of the South Asia, including most parts of Sri Lanka, the Maldives and some parts of southeast India, where climatologically ample amounts of rainfall is received during the season. Below normal rainfall is also likely over the north-western and northern parts of South Asia, including some areas along the foothills of Himalayas. However, these areas climatologically receive very low rainfall during OND season. Above normal rainfall is likely over most parts of central, southeast and north-east regions of South Asia. Remaining parts of the region are likely to experience normal seasonal rainfall or climatological probabilities.

Figure 1 shows overall seasonal precipitation outlook for October to December (OND) 2021. This is for each 1°Latitude x 1°Longitude grid box in South Asia; based on the findings of the twentieth South Asian Seasonal Climate Outlook Forum (SASCOF-20).

This outlook map has been produced through expert assessment of the prevailing climate conditions and model forecasts from around the world. The respective tercile categories (below normal, near normal and above normal) and probabilities (%) were derived from an initial set of objective gridded model forecasts, then synthesised through collaborative assessment and scientific justification.



The colours on Figure 1 indicate the most likely of the three rainfall tercile categories for the forthcoming season, and the probability of these categories occurring.

- | | |
|---------------------|---|
| ABOVE NORMAL | - Rainfall above the upper tercile. |
| NEAR NORMAL | - Rainfall between the lower and upper tercile. |
| BELOW NORMAL | - Rainfall below the lower tercile. |

For more information on terciles, see the 3d: Frequently Asked Questions.

SASCOF: Twentieth South Asian Seasonal Climate Outlook Forum (SASCOF-20) & Climate Services User Forum (CSUF)
EVENT: 27 - 30 SEPTEMBER 2021, Online Event
ISSUE DATE: 11 OCT 2021 – **NOT FOR OPERATIONAL USE - DRAFT**
VALIDITY: October to December (OND) 2021
FOR: Rainfall / Precipitation, Minimum (Min) and Maximum (Max) Temperature



1.2: SUMMARY – REGIONAL MIN & MAX TEMPERATURE



During the season, minimum temperatures are likely to be above normal over most areas of north-eastern South Asia. The minimum temperatures are most likely to be below normal over central and north-western areas of the region. The seasonal minimum temperatures are likely to be normal or of climatological probabilities over remaining areas.

The maximum temperatures are likely to be above normal over northwest, northern and northeast areas of the region. The maximum temperatures are likely to be below normal over most of the central parts of South Asia. Maximum temperatures are likely to normal or of climatological probabilities over remaining parts of the region.

Figure 2 and Figure 3 show the overall seasonal minimum (left) and maximum (right) temperature outlook for October to December (OND) 2021. This is for each 1°Latitude x 1°Longitude grid box in South Asia; based on the findings of the twentieth South Asian Seasonal Climate Outlook Forum (SASCOF-20).

The temperature outlook maps have been produced through expert assessment of the prevailing climate conditions and model forecasts from around the world. The respective tercile categories (below normal, near normal and above normal) and probabilities (%) were derived from an initial set of objective gridded model forecasts, then synthesised through collaborative assessment and scientific justification.

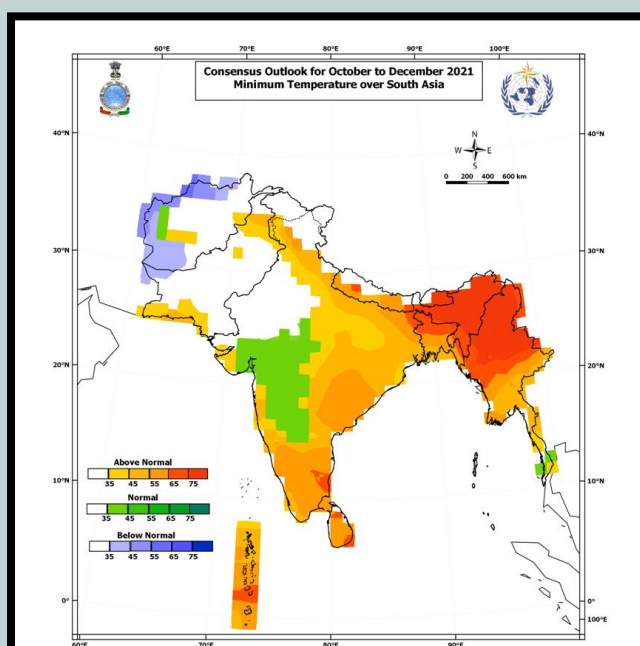


Figure 3: SASCOF seasonal consensus outlook map for OND 2021 Minimum temperature over South Asia.

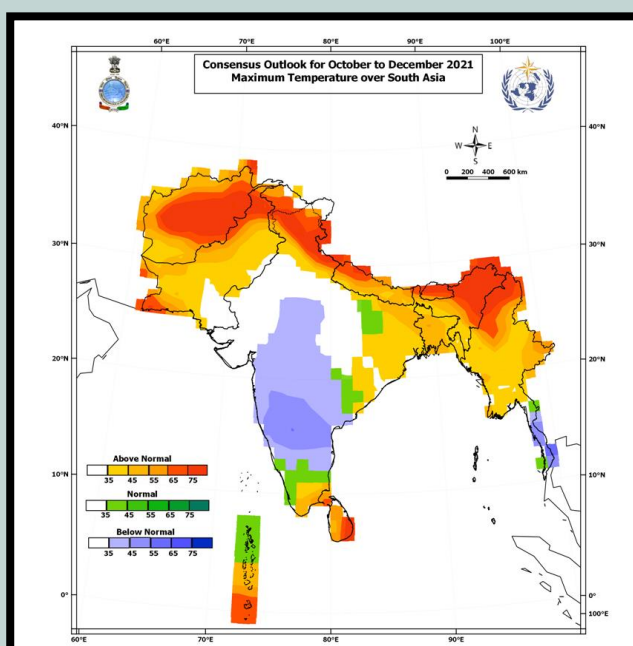


Figure 2: SASCOF seasonal consensus outlook map for OND 2021 Maximum temperature over South Asia.



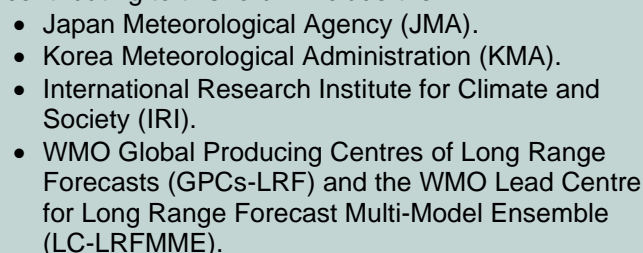
The colours on Figure 3 and Figure 2 indicate the most likely of the three minimum and maximum temperature tercile categories for the forthcoming season, and the probability of these categories occurring.

- | | |
|---------------------|--|
| ABOVE NORMAL | - Min/Max temperature above the upper tercile. |
| NEAR NORMAL | - Min/Max temperature between the lower and upper tercile. |
| BELOW NORMAL | - Min/Max temperature below the lower tercile. |

For more information on terciles, see the 3d: Frequently Asked Questions.

Factors that have been assessed to produce this outlook include:

- Inform decision making & risk management.
- Enable adaptation to future conditions
- Mitigate impacts.



SASCOF: Twentieth South Asian Seasonal Climate Outlook Forum (SASCOF-20) & Climate Services User Forum (CSUF)
EVENT: 27 - 30 SEPTEMBER 2021, Online Event
ISSUE DATE: 11 OCT 2021 – **NOT FOR OPERATIONAL USE - DRAFT**
VALIDITY: October to December (OND) 2021
FOR: Rainfall / Precipitation, Minimum (Min) and Maximum (Max) Temperature

1.4: SUMMARY - NATIONAL

A summary of the October to December (OND) 2021 overall rainfall, minimum and maximum temperature outlook, for the SASCOF member countries in South Asia has been provided below.

It remains essential that you consult your country's National Meteorological & Hydrological Service (NMHS) for the official & latest forecast for your country.

BANGLADESH

Normal to above normal rainfall is likely to experienced over most parts of the country.

Above normal minimum and maximum temperatures are likely over the most parts of the country.



INDIA

Normal to above normal rainfall is likely over most parts of the country, but below normal rainfall is likely over northern parts of the country.

Above normal minimum temperatures are likely over most parts of the country except for central and adjoining western parts. Normal to below normal maximum temperatures are likely over most parts of the country, except for North and NE India.



MYANMAR

Rainfall is likely above normal in the lower part of Myanmar and about normal in the remaining areas.

Maximum temperatures are likely above normal in Upper Myanmar, and Minimum temperature is likely above normal in the Lower Myanmar.



PAKISTAN

Above normal rainfall is likely over most parts of the country.

Mean temperature is likely to be above normal over most parts of the country.



SASCOF: SASCOF-20
ISSUE DATE: 11 OCT 2021
VALIDITY: OND 2021

AFGHANISTAN

Below normal precipitation is likely over most parts of the country.

Maximum temperatures are likely to be above normal over most parts of the country and minimum temperatures are likely to be below normal over the central and north western part.



BHUTAN

Normal to above normal precipitation is expected over the entire country for OND 2021.

Normal to slightly above normal maximum and minimum temperature are likely over the country for OND 2021.



MALDIVES

Below normal rainfall is expected to be receiving over most parts of the country with slight chances for normal rainfall over northern-most atolls.

Mean temperature is expected to be slightly above normal in all areas.



NEPAL

Above normal rainfall is likely over most of the central and eastern Nepal and normal rainfall is likely over north western Nepal.

Above normal minimum and maximum temperature are likely over most parts of the country for OND 2021.



SRI LANKA

Below normal rainfalls are likely over most parts of the island during OND 2021 season.

Both maximum and minimum temperatures are like to be above normal over most parts of the country for OND 2021.



1.5A: DISCLAIMER

- Please consult your country's national meteorological service for the official forecast for your country.
- No person should act based on the contents of this report without first obtaining additional professional advice, which is specific to one's requirements.
- Any geographical boundaries shown in this report do not necessarily correspond to political boundaries.

1.5B: POINTS OF CONTACT

For more information and further updates on the winter monsoon outlook on the national scale, the respective National Meteorological and Hydrological Services (NMHSs) may be consulted.

COUNTRY	ORGANISATION	POINT OF CONTACT	EMAIL
Afghanistan	AMD	Mr. Mousawi Sayed Reza	mousawi3190@gmail.com
Bangladesh	BMD	Dr. Md. Abdul Manan	mannan_u2003@yahoo.co.in
Bhutan	NCHM	Ms. Phuntsho Wangmo	pwangmo@nchm.gov.bt
India	IMD	Dr. O.P. Sreejith	sreejith.op@gmail.com
Maldives	MMS	Ms Azeema Ahmed	azymaahmed@gmail.com
Myanmar	DMH	Ms. Chaw Su Hlaing	chawsuhlaing.dmh@gmail.com
Nepal	DHM	Ms. Indira Kadel	ira_kadel@yahoo.com
Pakistan	PMD	Dr. Muhammad Afzaal	afzaalkarori@gmail.com
Sri Lanka	DOM	Ms Anusha Warnasooriya	rashanthie@yahoo.com

1.5C: THE NATIONAL CLIMATE OUTLOOK FORUM (NCOF) / MONSOON FORUM (NMF) DATES (AT TIME OF WRITING)

COUNTRY	ORGANISATION	DATE	DETAILS	LINK
Afghanistan	AMD	INFORMATION NOT AVAILABLE AT TIME OF WRITING.		
Bangladesh	BMD			
Bhutan	NCHM			
India	IMD			
Maldives	MMS			
Myanmar	DMH			
Nepal	DHM			
Pakistan	PMD			
Sri Lanka	DOM	05 OCT 2021	25 th National Seasonal Forum	Not Available

1.5D: SASCOF UPDATE SCHEDULE (AT TIME OF WRITING)

The operational SASCOF product is available at <http://rcc.imdpune.gov.in/Products.html> under 'Consensus Statement'. This non-operational SCOS will be made available at the same link, under 'Enhanced SASCOF Outlook'.

SASCOF	AREA / ORGANISATION	SEASON	RELEASE DATE
SASCOF-20	REGIONAL	OND 2021	Sep 2021
SASCOF-21	REGIONAL	DJF 2021/22	Nov 2021
SASCOF-22	REGIONAL	JJAS 2022	Apr 2022
SASCOF-22 Update	REGIONAL	JJAS 2022 (Update)	May 2022
SASCOF-23	REGIONAL	OND 2022	Sep 2022
SASCOF-24	REGIONAL	DJF 2022/23	Nov 2022
SASCOF-25	REGIONAL	JJAS 2023	Apr 2023

1.5E: REGIONAL CLIMATE CENTRE, PUNE

World Meteorological Organisation (WMO) Regional Climate Centres (RCCs) perform mandatory functions, covering the domains of long-range forecasting (LRF), climate monitoring, data services and training.

RCC (RA Region II) India Meteorological Department, Pune, fulfils this role in South Asia. Its website (<http://rcc.imdpune.gov.in/>) provides access to [operational long-range forecasting products](#), [operational climate monitoring products](#), the [SASCOF Products](#) and [SASCOF event information](#).

CONTENTS

1.1: SUMMARY – REGIONAL RAINFALL	1
1.2: SUMMARY – REGIONAL MIN & MAX TEMPERATURE	2
1.3: OUTLOOK CONSIDERATIONS SUMMARY	3
1.4: SUMMARY - NATIONAL.....	4
1.5a: Disclaimer.....	5
1.5b: Points of Contact.....	5
1.5c: The National Climate Outlook Forum (NCOF) / Monsoon Forum (NMF) Dates (at time of writing)	5
1.5d: SASCOF Update Schedule (at time of writing)	5
1.5e: Regional Climate Centre, Pune	5
PART 2 – SASCOF FORECAST FOR OND 2021	6
2a: SASCOF-20 Event Overview	6
2b: Current Conditions	7
2c: Status of the Climate Drivers.....	7
2d: Comparison – Last Years Observed Versus This Season's Outlook	7
2e: The Climate Models Considered.....	8
2f: Confidence & Skill	8
2g: Verification of Last Years Forecast - Rainfall.....	10
PART 3 – SUPPORTING DOCUMENT.....	11
3a: Climate Drivers - Background	11
3b: The SASCOF Process	12
3c: SASCOF & CSUF Background	13
3d: Frequently Asked Questions	14
3e: Find Out More / Useful Links:.....	16
3f: Acronyms	17

PART 2 – SASCOF FORECAST FOR OND 2021

2A: SASCOF-20 EVENT OVERVIEW

This regional seasonal rainfall, min and max temperature outlook for the 2021 October to December monsoon season (OND) over South Asia, has been collaboratively developed during:

Event:	The twentieth session of the South Asian Climate Outlook Forum (SASCOF-20) & associated Climate Service User Forum (CSUF).
Location:	Online event due to the COVID-19 pandemic.
Date:	27 – 30 September 2021.
Host:	RCC IMD Pune.
Participants:	National Meteorological & Hydrological Services (NMHS) experts: From 8 South Asian countries including... Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Pakistan & Sri Lanka. Sector Users: Representing government, water, agriculture, disaster risk reduction & health. Additional experts & facilitators: WMO, RCC Pune, IITM, UKMO, RIMES, JMA, KMA & IRI
Co-ordinated by:	The India Meteorological Department (IMD), which is also the WMO Regional Climate Centre (RCC) for South Asia, the Regional Integrated Multi-hazard Early-warning System (RIMES) & the UK Met Office (UKMO).
Sponsored by:	The Asia Regional Resilience to a Changing Climate (ARRCC) programme, with funding from UK Aid (Foreign, Commonwealth & Development Office).
Pre/Post COF:	Not applicable - due to COVID-19.
Find out More:	Go to '3b: The SASCOF Process' & '3c: SASCOF & CSUF Background' sections.

2B: CURRENT CONDITIONS

Observed rainfall for the month of September 2021 was well above normal over most parts of west, central and eastern parts of the region. It was less than average over some parts of north and north-eastern region. The rest of the region experienced average rainfall.

Observed maximum temperatures for the month of September 2021 for South Asia were near the average over most parts of region, except for some parts of the north-western region, which experienced above average maximum temperatures. Observed minimum temperatures for the month of September 2021 for South Asia were more than the average over most parts of region.

2C: STATUS OF THE CLIMATE DRIVERS



El Niño-Southern Oscillation (ENSO)

Currently cool neutral ENSO conditions are prevailing over equatorial Pacific region. The latest forecasts from many climate models indicate that La Niña conditions are likely to re-emerge during the October to December season.

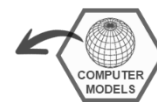
Indian Ocean Dipole (IOD)

Weak negative Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. Recent forecasts from majority of the coupled models suggest that the negative IOD conditions are likely to weaken during OND season.

To find out more about the region's climate drivers, please see '3a: Climate Drivers - Background'.

2D: COMPARISON – LAST YEARS OBSERVED VERSUS THIS SEASON'S OUTLOOK

	2020 Post Monsoon Season (OND)	2021 Post Monsoon Season (OND)
Climate drivers	<ul style="list-style-type: none"> During OND 2020, La Niña conditions prevailed over the Pacific Ocean. SSTs cooled further and La Niña conditions were established during September and continued in subsequent months of October to December 2020. Neutral IOD conditions were observed from August and continued into the subsequent months of September to December 2020. The DMI (Dipole Mode Index) remained within average values during OND season. 	<ul style="list-style-type: none"> Currently, cool neutral ENSO conditions are prevailing over the Pacific. Latest forecasts indicate that the La Niña conditions are likely to re-emerge during the OND season. At present negative IOD conditions are prevailing over Indian Ocean. Recent forecasts suggest that the negative IOD conditions are likely to weaken during OND season.
Rainfall	<ul style="list-style-type: none"> Above normal rainfall was observed over the north-western, north-eastern, southern and some parts of southeast South Asia. Below normal rainfall was observed over the northern most parts of South Asia and east South Asia. Most other parts of the region experienced normal to above normal rainfall. 	<p>There are differences in the detail when comparing the rainfall experienced during the 2020 post monsoon season to this 2021 OND outlook. These include:</p> <ul style="list-style-type: none"> Above normal rainfall is likely over most parts of central, southeast and north-east regions of South Asia. Below-normal rainfall is likely over southern parts of including most parts of Sri Lanka, Maldives and some parts of southeast India, where climatologically ample amounts of rainfall are received during OND. Below normal rainfall is also likely over the north western and northern parts of South Asia including some areas along the foothills of Himalayas. However, these areas climatologically receive very low rainfall during OND season. The remaining parts of the region are likely to experience normal seasonal rainfall or climatological probabilities.
Temperature	<ul style="list-style-type: none"> Above normal temperatures were observed over the central, north-eastern and south-eastern parts of extreme South Asia. Below normal temperatures were observed over north-western parts of South Asia. Most of the other parts of the region experienced normal to above normal mean temperatures. 	<ul style="list-style-type: none"> During the season, normal to above normal maximum temperatures are likely over most parts of the region, except central and peninsular India and also over the southern tip of Myanmar. Similarly, above normal minimum temperatures are likely over most parts of the region except over some parts of the central-west and the extreme northwest.



2E: THE CLIMATE MODELS CONSIDERED

Models selected for Multi Model Ensemble (MME):

Model Name	Hindcast Period for Rainfall	Hindcast Period for Temperature	Calibrated / Uncalibrated	Calibrated with (SST, PPN, etc) or N/A
RSMAS-NCAR-CCSM4	1982-2010	1993-2018	CALIBRATED	SST & PPN
NCEP-CFsV2	1982-2010	1993-2018	CALIBRATED	SST & PPN
CanCM4i	1982-2010	1993-2018	CALIBRATED	SST & PPN
NASA-GOES_S2S	1982-2010	1993-2018	CALIBRATED	SST & PPN
GEM-NEMO	1982-2010	1993-2018	CALIBRATED	SST & PPN
MMCFS	1982-2010	1993-2018	CALIBRATED	SST & PPN
ECMWF	1982-2010	1993-2018	CALIBRATED	SST & PPN
JMA	1982-2010	1993-2018	CALIBRATED	SST & PPN

2F: CONFIDENCE & SKILL

The figures below illustrate the distribution of skill when predicting the below and above average tercile categories over the South Asia region. Specifically, this is the ROC score of the multi-model average, where 100% (1.0 as shown on the scale) represents perfect skill and 50% (0.5 as shown on the scale) equals chance.

Confidence & Skill - Rainfall

Figure 4 shows that most of Pakistan, Afghanistan, some parts of north and west India, southern islands and eastern parts of the South Asian region are coloured violet to orange for below normal rainfall, indicating skill of approximately 60-80% for these regions. The central and peninsular parts of India and regions along the foothills of Himalayas are coloured grey, indicating less skill for these locations.

Figure 5 for above normal rainfall has similarities to the patterns shown in Figure 4. However, Figure 5 does have slightly less grey over some central-India, indicating better skill in these places.

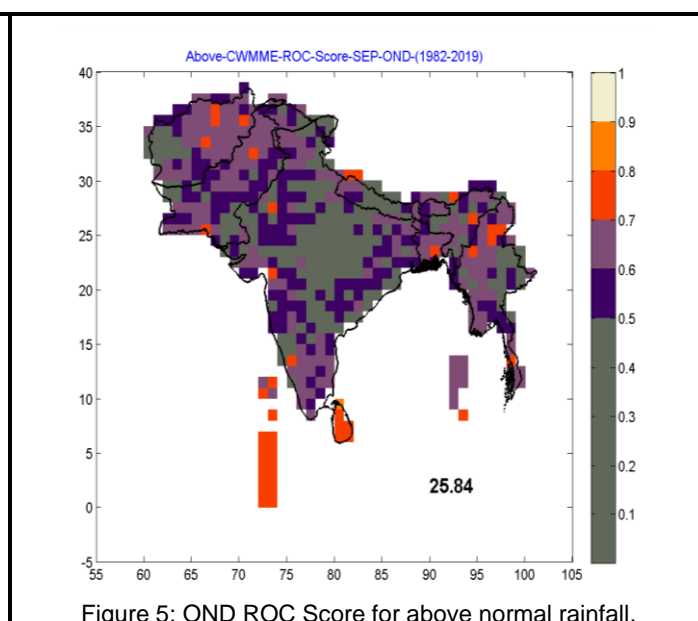
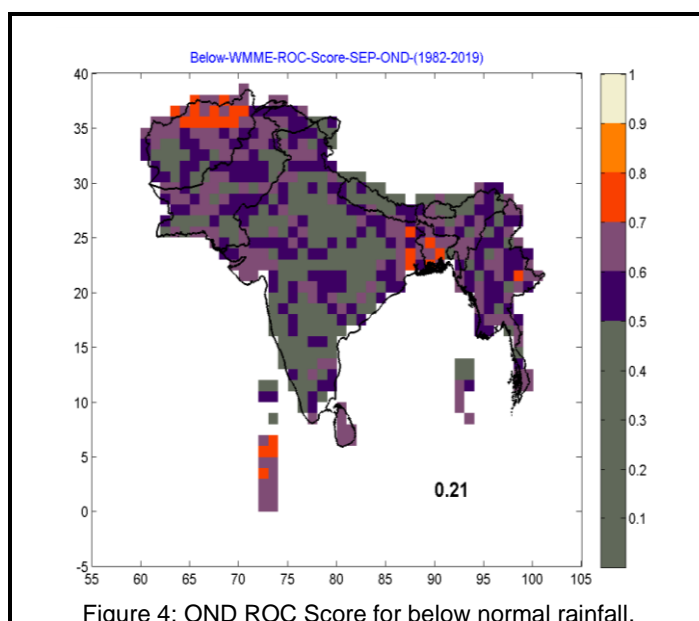


Figure 4: OND ROC Score for below normal rainfall.

Figure 5: OND ROC Score for above normal rainfall.

Confidence & Skill – Minimum and Maximum Temperature

Figure 6 (for below normal maximum temperatures) shows that most parts of the South Asian region are coloured violet to orange, indicating skill of approximately 60-80% for these regions. However, central and eastern India, Bangladesh, west Myanmar and parts of Afghanistan are coloured grey indicating less skill for these locations.

Figure 7 (for above normal maximum temperatures) shows that parts of Pakistan, most of Afghanistan, India (except for central and the north peninsular region), Bhutan, Sri Lanka, Maldives, northern parts of Myanmar are coloured violet to orange, indicating skill of approximately 60-80% for these regions. However, the areas over eastern India, south Myanmar and parts of Nepal are coloured grey indicating less skill for these locations.

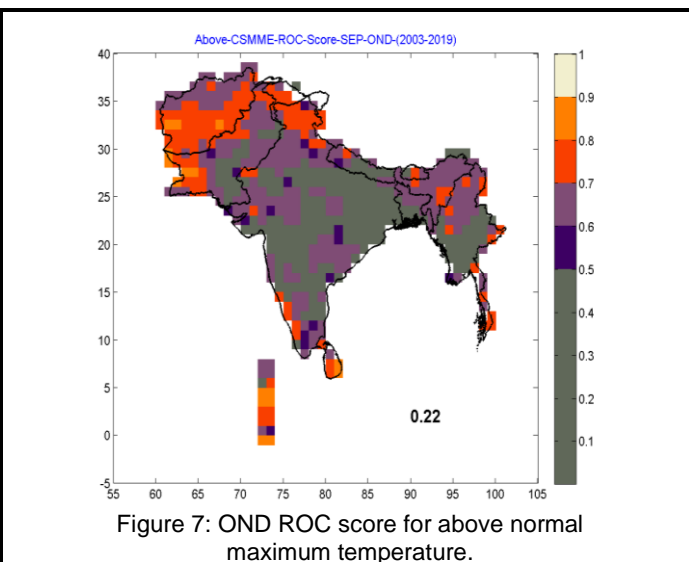
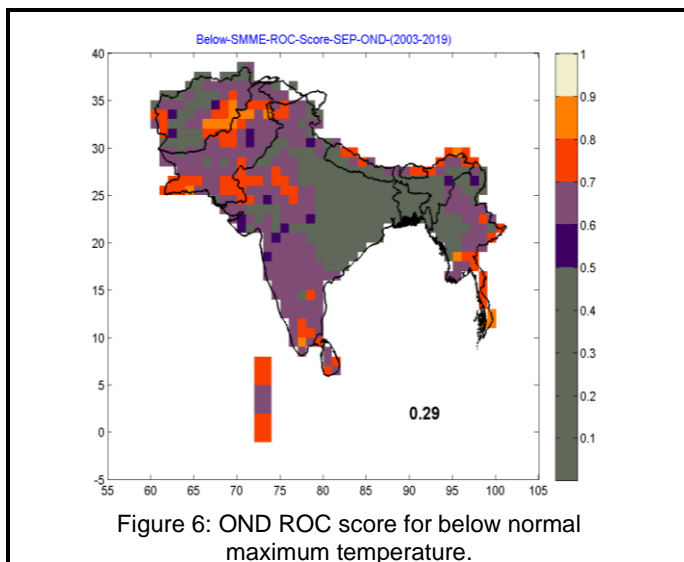
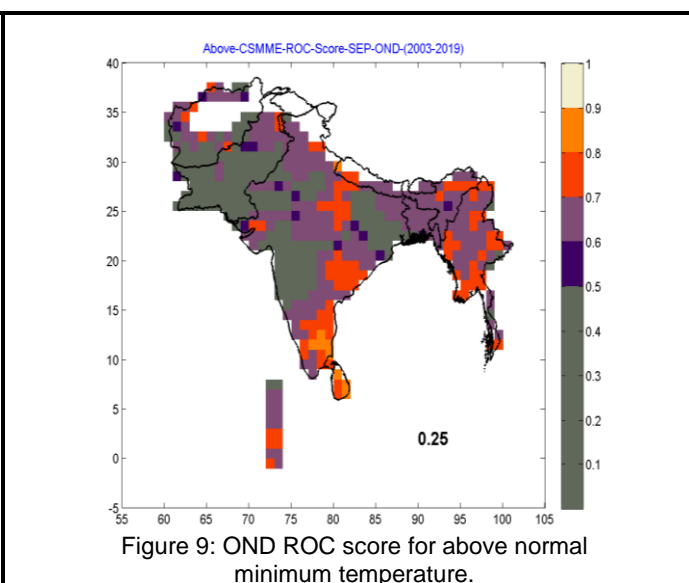
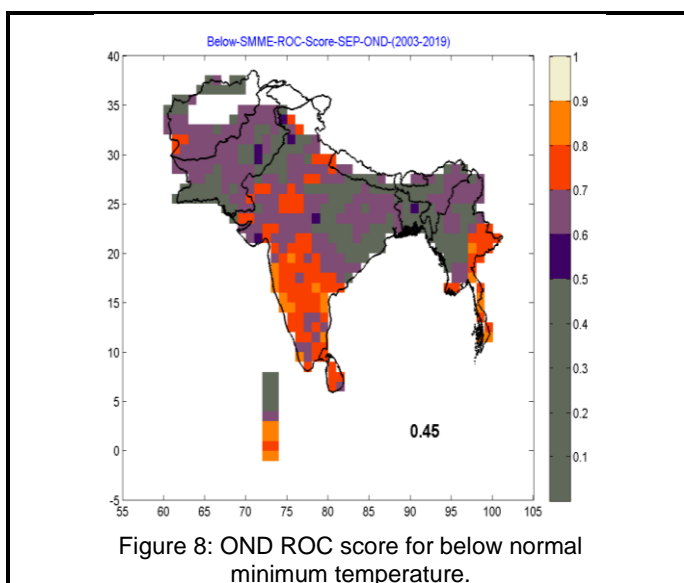


Figure 8 (for below normal minimum temperatures) shows that that most of India, Myanmar, Sri Lanka, Maldives, eastern Bhutan and some parts of northern Pakistan are coloured violet to orange, indicating skill of approximately 60-80% for these regions. However, there is grey over the eastern parts of India indicating lower skill.

Figure 9 (for above normal minimum temperatures) has similarities to the patterns shown in Figure 8. However, Figure 9 does have slightly more orange colour over central and eastern India indicating higher skills in these places. That said, some parts of west India, southern parts of Pakistan and Afghanistan are coloured grey indicating less skill for these locations.



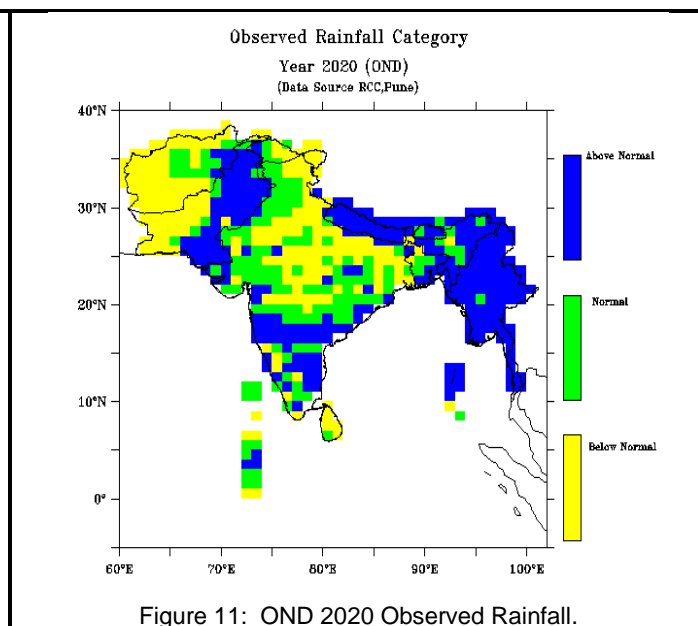
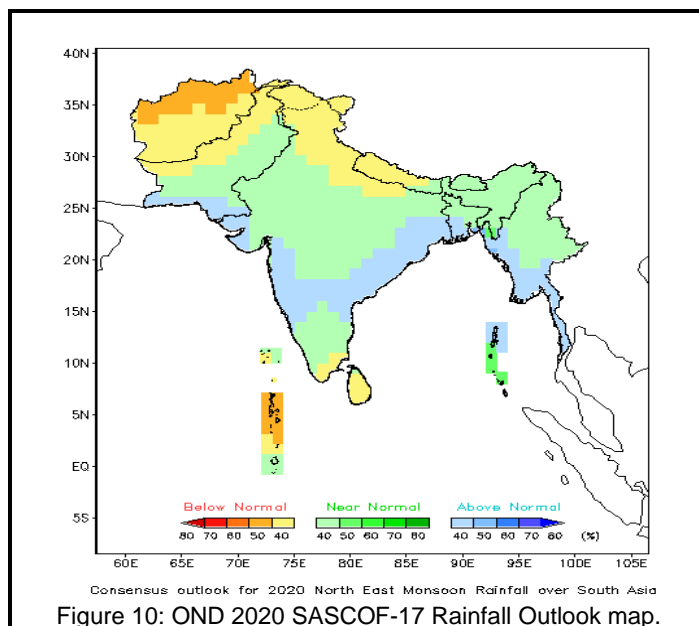
2G: VERIFICATION OF LAST YEARS FORECAST - RAINFALL

Observed versus the SASCOF Forecast

Figure 10 shows the SASCOF outlook map for the OND 2020 summer monsoon season. This outlook suggested:

- Normal rainfall was forecast over most parts of South Asia.
- Above-normal rainfall was forecast to be most likely over the land areas around north and the central Bay of Bengal, most parts of north and central peninsular India and southern parts of Myanmar.
- Below-normal rainfall was forecast for the southern parts of South Asia, including some parts of extreme south-eastern India, most parts of Sri Lanka and the Maldives, and also over the north western and northern parts of the region including some areas along the foothills of Himalayas.

Figure 11 shows the observed rainfall distribution anomaly during the OND 2020 monsoon season over South Asia. This is expressed as the grid-point rainfall tercile categories¹. In general, the consensus outlook for the 2020 October to December season rainfall was accurate in most areas, particularly those where climatologically ample rain is received during the season. In many areas of the region where climatologically ample amount of rainfall is received during the season like south India, Maldives and south Myanmar, both the forecast and realised rainfall categories were same. In addition, the below-normal rainfall forecasted over the north and north western parts of the region and over Sri Lanka matched very well with the observed category. However, there were some differences between the observed and forecasted rainfall patterns. The rain received over the Nepal region was above normal, where the forecast was for mostly below normal rainfall. The table below captures the possible causes of these differences.



Challenges	Description
Production process	<ul style="list-style-type: none"> • There are a variety of different forecast methods applied to build a forecast, including dynamical model output from global climate models, calibrated global model output, and statistical methods. The skill of the method also varies across the region. • One-way SASCOF is acting to improve this is by adopting an Objective Forecast methodology.
Modelling	<ul style="list-style-type: none"> • Seasonal forecasts of large-scale features like ENSO may have exhibited limited skill during April due to the spring barrier. This reduces the reliability of the SST seasonal forecasts. • The tele-connections between the South Asian rainfall and climate drivers like ENSO and IOD are not fully captured by climate models yet. • Rainfall over the South Asian region is highly influenced by the intra-seasonal variabilities like Madden Julian Oscillation (MJO), Monsoon Intra-seasonal Oscillation (MISO) etc, which are outside of the predictability limits of the seasonal forecast. • The regional rainfall over the monsoon season depends on synoptic scale systems like monsoon depressions and low-pressure areas. These contribute substantially to rainfall totals and local variations, which cannot be forecasted on a seasonal scale well in advance. This can make a major difference in the forecast and observed rainfall at a local level.

¹ Based on a merged dataset created using various gridded data sets like CHIRPS, IMD, BMD, etc; with a base period of 1982-2010.

PART 3 – SUPPORTING DOCUMENT

3A: CLIMATE DRIVERS - BACKGROUND



South Asia has a diverse climate which is dominated by a monsoon system. To determine the expected state of the monsoon over the South Asian region for the coming months, the SASCOF forum deliberates the relative influence of various observed and emerging climatic features. This is because slowly evolving climate drivers provide a source of predictability on seasonal timescales.

Climate drivers such as the El Niño-Southern Oscillation (ENSO) and the associated tropical Pacific sea surface temperatures (SST) over the equatorial Pacific, the Indian Ocean Dipole (IOD), winter and spring snow cover area over Eurasia and land surface temperature anomalies can all have an influence on the conditions during the monsoon season. While, variability also exists within the season, driven by intra-seasonal oscillations such as the Madden-Julian Oscillation; the influence of the monsoon climate drivers have been outlined below.

El Niño/Southern Oscillation (ENSO)

ENSO is a coupled atmosphere-ocean phenomenon that occurs in the tropical Pacific Ocean. ENSO is one of the global scale climate phenomena that have significant influence on the year-to-year variability of the monsoon over South Asia. Figure 12² illustrates the typical atmospheric and oceanic characteristics of El Niño (left), normal (centre) and La Niña (right) conditions over the Pacific Ocean.

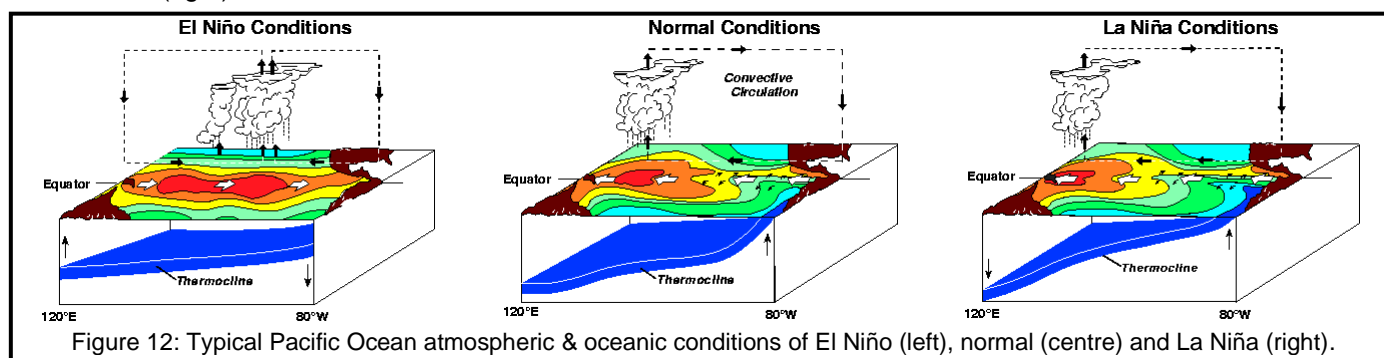


Figure 12: Typical Pacific Ocean atmospheric & oceanic conditions of El Niño (left), normal (centre) and La Niña (right).

El Niño (La Niña) conditions are known to typically weaken (strengthen) the South Asian southwest monsoon circulation and reduce (enhance) the rainfall over much of the region. However, it is recognised that there is large uncertainty in the evolution of ENSO conditions and its impact on the regional rainfall distribution from one year to another. It has also been shown that during northeast monsoonal rainfall over Sri Lanka, rainfall is generally enhanced (suppressed) during El Niño (La Niña) years. During El Niño events a reduction in tropical cyclone activity can occur over the Bay of Bengal between May and November.

Indian Ocean Dipole (IOD)

IOD is an irregular oscillation of sea-surface temperatures in the tropical Indian Ocean, in which the western part becomes alternately warmer (positive phase) or colder (negative phase) than the eastern part. Figure 13³ shows the influence of the positive and negative IOD modes on the region. In general, negative IOD is associated with a weaker than normal monsoon over South Asia. Conversely, positive IOD is associated with a stronger than normal monsoon.

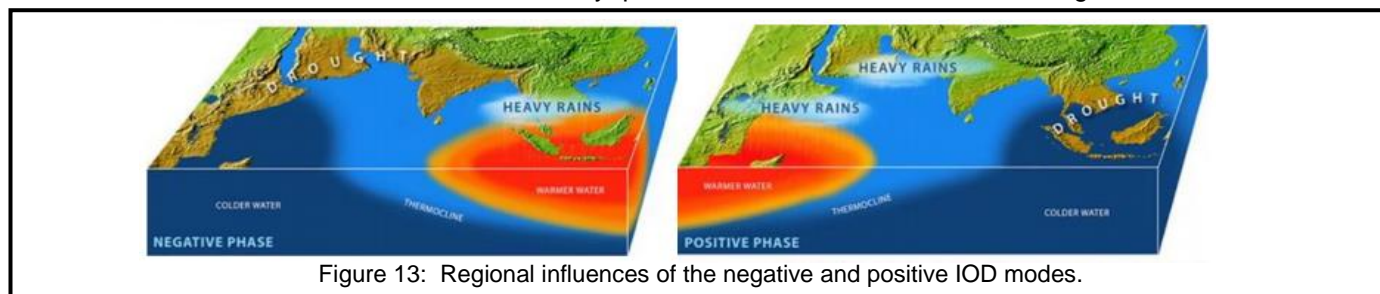


Figure 13: Regional influences of the negative and positive IOD modes.

Eurasia Snow

In general, the Eurasian snow cover area during winter and spring has an inverse relationship with the subsequent South Asian summer monsoon rainfall. i.e. Winters with extensive (little) snow cover over Eurasia, tend to be followed by summers with less (more) monsoonal rainfall.

² Source: NOAA Pacific Marine Environmental Laboratory (<https://www.pmel.noaa.gov/elnino/schematic-diagrams>)

³ Source: illustration by E. Paul Oberlander, ©Woods Hole Oceanographic Institution.

3B: THE SASCOF PROCESS

Preparing the SASCOF Outlook

This seasonal outlook statement for South Asia was prepared based on:

- The expert assessment of prevailing large-scale global climate drivers.
- Operational and experimental long-range forecasts based on dynamical and statistical models generated by various operational and research centres of the world.
- Experimental models developed during capacity-building workshops conducted for the South Asian countries in association with previous and the current SASCOF sessions.

The WMO pilot for objective seasonal forecast methods

Following recommendations from the Regional Climate Outlook Forum (RCOF) review in 2017, the WMO has developed guidance on 'Operational Practices for Objective Seasonal Forecasting'. This proposes the adoption of an objective (and replicable) methodology when producing seasonal climate outlooks, to underpin products and services at the regional and national level. An example of an objective seasonal forecast process is illustrated in Figure 14.

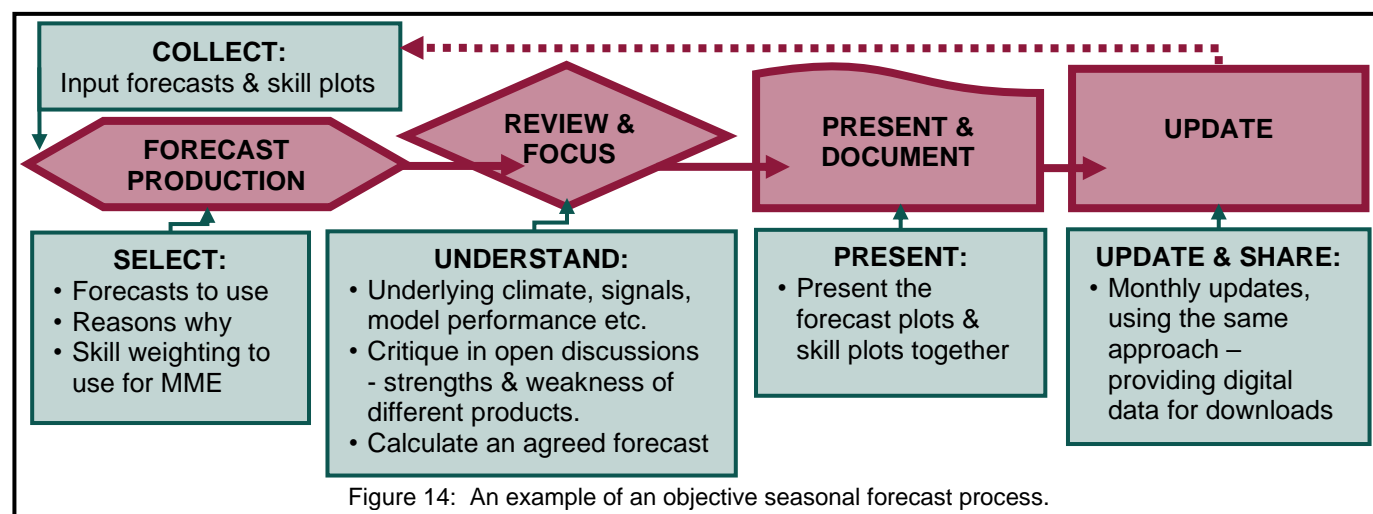


Figure 14: An example of an objective seasonal forecast process.

Alongside four other RCOFs, SASCOF has been selected as a pilot to demonstrate best practice based on the WMO guidance and its ten principles for Operational Seasonal Forecasting. During the pre-COF event at SASCOF-14, an objective approach (recognising that some subjectivity will still exist) for a seasonal outlook was developed and a programme of work is ongoing, including the...

1. Identification of skilful seasonal forecast methodologies for South Asia region.
2. Identifying the necessary resources for developing and operationalising such methodologies, and
3. Assembling and coordinating the cooperation among the institutions that could be involved in further developing and operationalising skilful seasonal forecast systems.

SASCOF Relation to NCOF / NMF

The National Climate Outlook Forum/National Monsoon Forum (NCOF/NMF) platforms aim to strengthen the flow of climate information from the regional scale to the national-level, alongside two-way feedback between NMHSs and sector users (see Figure 15). These forums have been able to establish the global-regional-national connection of standard seasonal climate information. So, the emphasis now is on the creation of strong national level “pull” to strengthen flows of all relevant inputs to generate nationally appropriate products and services.

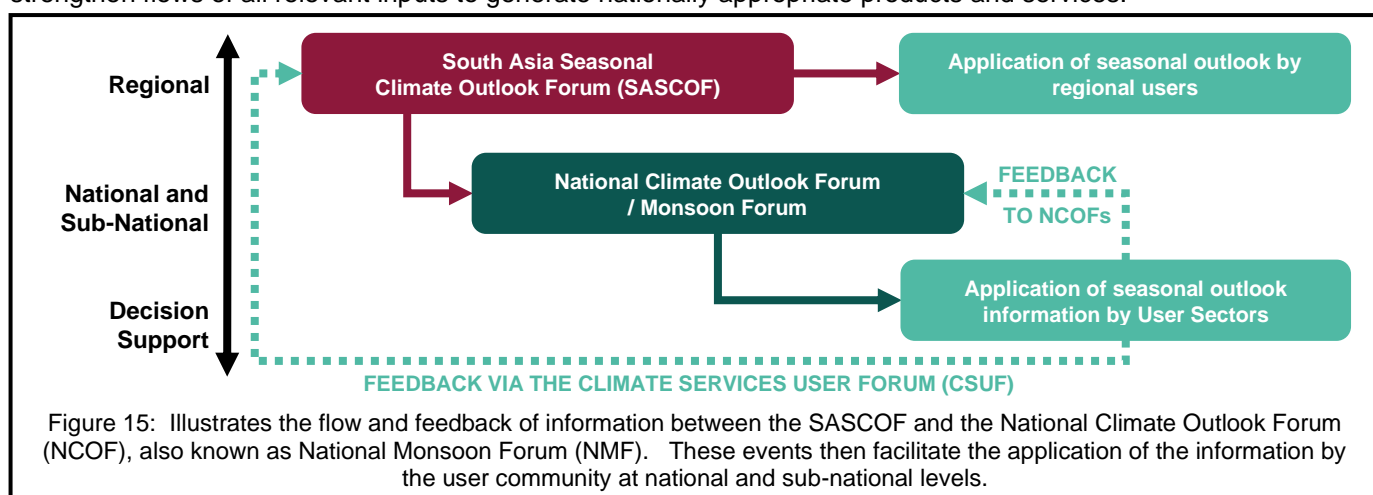


Figure 15: Illustrates the flow and feedback of information between the SASCOF and the National Climate Outlook Forum (NCOF), also known as National Monsoon Forum (NMF). These events then facilitate the application of the information by the user community at national and sub-national levels.

3C: SASCOF & CSUF BACKGROUND

History of SASCOF

Asia has large differences in climatology on sub-regional scales. Thus, the WMOs Forum on Regional Climate Monitoring, Assessment and Prediction for Regional Association II' (FOCRA II) recommended sub-regional RCOFs, devoted to the specific needs of countries with common climatological characteristics.

The South Asian Climate Outlook Forum (SASCOF) was therefore implemented in 2010, to focus on the climate information needs of nations affected by the Asian monsoon climate. Since then, the SASCOF has developed to include a Climate Service User Forum (CSUF) and this combined event is now held twice a year (typically in April and September).

The history of the SASCOF is summarised below. More detail regarding the SASCOF events and products can be found at <http://rcc.imdpune.gov.in/Sascof.html>.

SASCOF EVENT	DATE	LOCATION	SEASON	CSUF SECTOR	ASSOCIATED TRAINING / PRE-COFs
SASCOF-20	27-28 & 30 SEP 2021	Online event	OND	Water, Agriculture, DRR & Health.	
SASCOF-19 Update	10 JUN 2021	Online event	JJAS	-	-
SASCOF-19	26-28 APR 2021	Online event	JJAS	Water, Agriculture, Disaster Risk Reduction (DRR) & Health	Pre-COF training conducted online during 19-20 April 2021. Online training conducted on Seasonal Prediction to Operational services in South Asia- 22 FEB to 11 Mar2021
SASCOF-18	23 NOV 2020	Online event	DJF	-	-
SASCOF-17	23/24/28 SEP 2020	Online Event	OND	Water & Agriculture	-
SASCOF-16 update	08 JUN 2020	Online event	JAS	-	-
SASCOF-16	20-22 APR 2020	Online Event	JJAS	Water & Agriculture	Cancelled due to COVID-19.
SASCOF-15	23-25 SEP 2019	Thiruvananthapura, India	OND	Water & Agriculture	Distillation workshop - Enhancing communication & tailoring seasonal outlooks. 26-27 SEP 2019 at Thiruvananthapuram, India.
SASCOF-14	18-23 APR 2019	Kathmandu, Nepal	JJAS	Water & Agriculture	Seasonal Prediction Foundation-Level Operational Seasonal Prediction training workshop. 25-28 FEB 2019 at AIT, Bangkok.
SASCOF-13	26-28 SEP 2018	Colombo, Sri Lanka	OND	Water	
SASCOF-12	19-20 APR 2018	Pune, India		Agriculture, Health, Energy & Water	Climate Data Base Management & seasonal prediction. 13-18 APR 2018.
SASCOF-11	25-27 SEP 2017	Male, Maldives	OND	Agriculture, Fishery & Defence	
SASCOF-10	24-26 APR 2017	Thimphu, Bhutan	JJAS	Water & Agriculture	9 th International Training Workshop on Climate Variability and Prediction (9ITWCVP) at Pune, India 13-21 APR 2017.
SASCOF-9	27-29 SEP 2016	Nay Pyi Taw, Myanmar	OND	Agriculture	
SASCOF-8	25-26 APR 2016	Colombo, Sri Lanka		Water & Health	Capacity Building Training Workshop on Seasonal Prediction 19-23 APR 2016.
SASCOF-7	14-15 OCT 2015	Chennai, India	OND	Agriculture	
SASCOF-6	21-22 APR 2015	Dhaka, Bangladesh	JJAS	Water	Seasonal prediction 19-20 April
SASCOF-5	22-23 APR 2014	Pune, India	JJAS	Water	Seasonal prediction 14-21 April
SASCOF-4	18-19 APR 2013	Kathmandu, Nepal	JJAS		Seasonal prediction 15-17 April
SASCOF-3	19-20 APR 2012	Pune, India	JJAS		Seasonal prediction 16-18 April
SASCOF-2	13-15 APR 2011	Pune, India	JJAS		Seasonal prediction 8-12 April
SASCOF-1	13-15 APR 2010	Pune, India	JJAS		



Aims of SASCOF

The South Asian Seasonal Climate Outlook Forum (SASCOF) is a World Meteorological Organisation (WMO) Regional Climate Outlook Forum (RCOF). It is tasked with producing a “user-relevant climate outlook products in real time, in order to reduce climate-related risks and support sustainable development for the coming season, in sectors of critical socioeconomic significance for the region⁴”.

SASCOF also provides a platform for:

- The collaborative assessment of the available prediction information and the co-development of the outlook.
- The regional networking of the climate service providers (NMHSs).
- Two-way feedback and engagement between the NMHSs and user sector representatives.
- An opportunity to promote the use of the SASCOF products and services. This is achieved through the joint SASCOF Climate Services User Forum (CSUF), which has representatives from the climate sensitive user sectors in attendance.

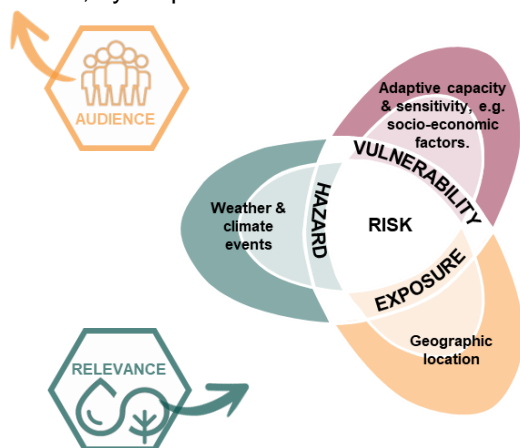
3D: FREQUENTLY ASKED QUESTIONS



What are the aims of the SCOS?

This Seasonal Climate Outlook Statement (SCOS) aims to:

- Produce a joint assessment of the regions upcoming monsoon season over South Asia.
 - Offer guidance to the regions NMHSs, to facilitate preparations of national level seasonal outlooks.
 - To communicate and disseminate a regional overview, to complement the NMHSs national level seasonal outlook.
- Together, these can facilitate individuals, businesses, governments and other users in their planning, decision-making and communications, with various sector applications like water management, agriculture & food security, health, media, hydro power etc.



How does this outlook relate to decision making?

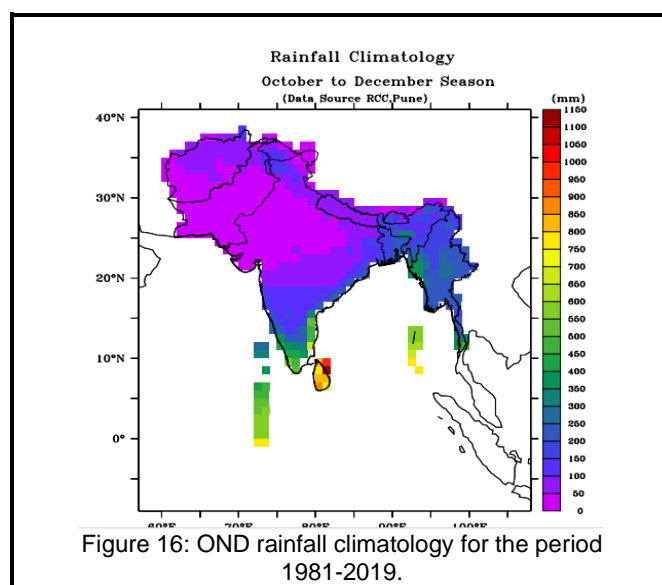
The impact of a changing climate depends on three key factors - the hazard itself, exposure levels and vulnerability. This outlook aims to provide information on the future hazard, which can be used in conjunction with local knowledge of the exposure and vulnerability to better understand the risk.

What is normal?

In the scientific sense, normal is defined as the average climatology. For convenience the historical record or climatology period is usually about 30 years in length.

What is the rainfall climatology in South Asia?

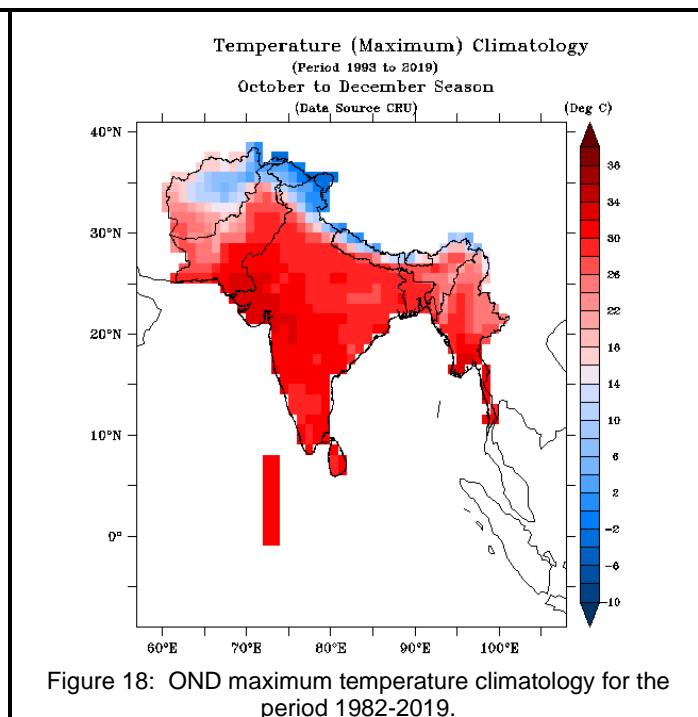
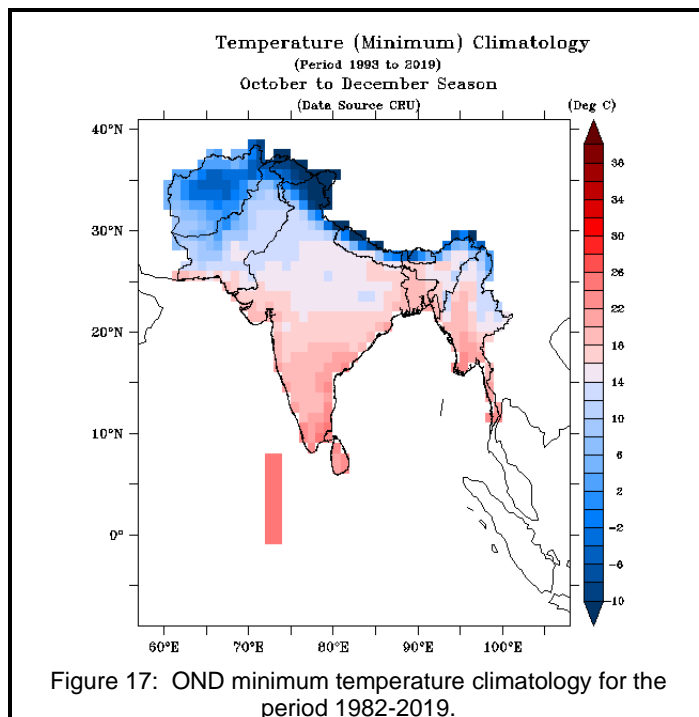
The regions ‘normal’ rainfall is characterised by remarkable spatial variability. Figure 16 shows the long-term historical patterns of the post monsoon (Oct to Dec) rainfall over South Asia. This information is sourced from the merged rainfall data over South Asia of RCC Pune, thus illustrating an example of the background climatology for rainfall anomalies in South Asia.



⁴<https://public.wmo.int/en/our-mandate/climate/regional-climate-outlook-products>

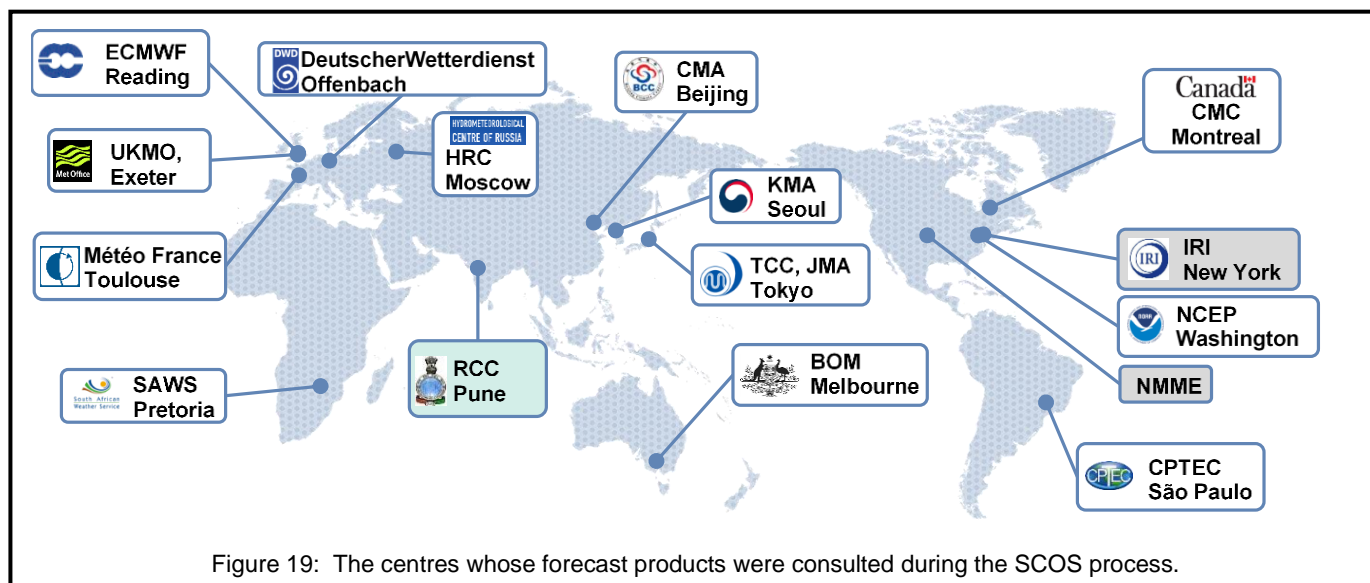
What is the temperature climatology in South Asia?

The regions 'normal' temperature is characterised by spatial variability. Figure 17 and 18 shows the long-term historical patterns of minimum and maximum temperature respectively, during the October to December season over South Asia. This information is sourced from the Climatic Research Unit (CRU) dataset and illustrates an example of the background climatology for temperature anomalies in South Asia.



Where does the seasonal forecast come from?

The WMO has designated 13 Global Producing Centres (GPCs) for seasonal prediction, who are part of the Global Framework for Climate Services (GFCS). The operational long-range dynamical climate models and forecast products from the centres in Figure 19, are reviewed during the preparations of a seasonal forecasts (with GPCs coloured in white, RCCs in blue and others in grey). This is in addition to statistical models generated by the regions NMHSs.



What is an objective forecast?

An objective forecast is a forecast created from a set of precursor data in a pre-defined way. It can therefore be reproduced exactly by others following the same pre-defined method. In contrast, subjective forecasts are a human estimate, based on the personal assessment and experience from one or more contributing forecasters.

What are (statistical / dynamical) seasonal forecast models?

A seasonal forecast model is either a statistical model or a dynamical model of the atmosphere and ocean, designed to predict the weather and climate for a forthcoming season. Statistical models use historical relationships between the previously observed climate (e.g. El Niño indices) and the season being predicted. Whereas dynamical models attempt to replicate the physics of the ocean and atmosphere to predict what future seasons will be like.

What are terciles?

A tercile is a way of categorising data by dividing it into three equally likely categories. To evaluate terciles, data are ordered from highest to lowest and subdivided into equal sized thirds.

In this case, historical precipitation (temperature) totals for a 30-year period are ordered from wettest to driest (hottest to coldest). The 10 wettest (hottest) years are divided from the remaining 20 years by a threshold called the “upper tercile”, forming the “above normal” tercile category. Similarly, the 10 driest (coldest) years are divided from the remaining 20 years by the “lower tercile” to form the “below normal” tercile category. The remaining third of years have precipitation (temperature) totals between the 2 terciles and these form the “near normal” tercile category. Figure 1, Figure 2 and Figure 3 shows the outlook for the forthcoming season. Here, the outlook data is compared to the historical data (the baseline) and categorised according to which tercile category it falls within.

What are ROC Scores?

Relative operating characteristic (ROC) are used for the verification of probability forecasts. In this instance it is a measure of the skill in predicting the below and above average tercile category. With ROC scores

- Perfect skill = 1.0 or 100%
- Chance = 0.5 or 50%

What is CPT calibration?

Calibration is the correction of seasonal forecasts to account for forecast errors as measured by comparing a set of trial forecasts, also known as hindcasts, with corresponding observations.

Calibration is sometimes referred to as MOS (Model Output Statistics), where the Climate Prediction Tool (CPT) is used as a tool for calibration. For more information see <https://iri.columbia.edu/our-expertise/climate/tools/cpt/>

What is verification and cross validation?

Verification is when a forecast or outlook is compared against a corresponding set of observations. The performance can be measured using several skill measures.

Cross validation is an efficient way of measuring the performance and skill of a forecast system. Skill measures created this way are used to reflect independent skill. This is done by removing each year one by one from a forecast system, then predicting each year using the forecast model created from the remaining years data.

3E: FIND OUT MORE / USEFUL LINKS:

- Regional Climate Centre, IMD, Pune - <http://rcc.imdpune.gov.in/>
- Forecasts from the 13 GPCs - www.wmolc.org
- Seasonal Forecasts Explained: Videos x5 – <https://www.youtube.com/playlist?list=PLyLeQN0tRck2unpUh-zo8RIRiGMrbxks8>
- Relative Operating Characteristic (ROC) Explained – <https://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/user-guide/interpret-roc>
- Seasonal Forecasting in South Asia: A Review of the Current Status (ARRCC, Sept 2019) - https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/business/international/scipsa_review_seasonal_forecasting_south_asia_final.pdf
- A Practical Guide to Seasonal Forecasts - https://www.climatecentre.org/downloads/files/A%20practical%20guide%20for%20seasonal%20forecasts_SHEAR.pdf

SEASONAL CLIMATE OUTLOOK STATEMENT (SCOS) SOUTH ASIA - OCT TO DEC 2021

3F: ACRONYMS⁵

ACRONYM	LONG TITLE
AGROMET	Agricultural Meteorology
AMD	Afghanistan Meteorological Department
ARRCC	Asia - Regional Resilience to a Changing Climate
BMD	Bangladesh Meteorological Department
BOM	Bureau of Meteorology, Australia
CARISSA	Climate Analysis for Risk Information & Services in South Asia (Work Package 3 of ARRCC)
CCA	Canonical Correlation Analysis
CFS	Climate Forecast System
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
CMA	China Meteorological Administration, Beijing
CMC	Canadian Meteorological Centre
COLA	Center for Ocean-Land Atmospheric Studies, USA.
CPT	Climate Prediction Tool
CPTEC	Center for Weather Forecasting & Climate Studies, Brazil.
CRU	Climatic Research Unit
CSUF	Climate Services User Forum
DFID	Department for International Development, UK
DHM	Department Hydrology & Meteorology, Nepal
DMH	Department of Meteorology & Hydrology, Myanmar
DMI	Dipole Mode Index
DOM	Department of Meteorology, Sri Lanka
ECMWF	European Centre for Medium-Range Weather Forecasting
ENSO	El Niño Southern Oscillation
GFCFS	Global Framework for Climate Services
GFDL	Geophysical Fluid Dynamics Laboratory, USA.
GLOSEA	Global Seasonal Forecasting System, UK Met Office
GPC	Global Producing Centre
GPC-LRF	Global Producing Centres of Long-Range Forecasts (WMO)
HRC	Hydrometeorological Research Centre, Russia
IBF	Impact Based Forecasting (Work Package 1 of ARRCC)
IITM	Indian Institute of Tropical Meteorology
IMD	India Meteorological Department
IOD	Indian Ocean Dipole
IRI	International Research Institute for Climate & Society, USA
ITCZ	Inter-Tropical Convergence Zone
JJAS	June, July, August, September
JMA	Japan Meteorological Agency
KMA	Korea Meteorological Administration
LRF-MME	Long Range Forecasting - Multi-Model Ensemble (WMO)
MEL	Monitoring, Evaluation & Learning.
MISO	Monsoon Intra-seasonal Oscillation

ACRONYM	LONG TITLE
MJO	Madden Julian Oscillation
MMS	Maldives Meteorological Service
MOS	Model Output Statistics
NCEP	National Centres for Environmental Prediction
NCHM	National Center for Hydrology & Meteorology, Bhutan
NCOF	National Climate Outlook Forum
NMF	National Monsoon Forum
NMHS	National Meteorological & Hydrological Service
NMME	North American Multi-Model Ensemble
NOAA	National Oceanic & Atmospheric Administration, USA
OND	October, November, December
PMD	Pakistan Meteorological Department
RCC	Regional Climate Centre e.g., IMD
RCOF	Regional Climate Outlook Forum
RIMES	Regional Integrated Multi-Hazard Early Warning System
ROC	Receiver Operating Characteristic
SASCOF	South Asian Seasonal Climate Outlook Forum
SAWS	South African Weather Service
SCIPSA	Strengthening Climate Information Partnerships – South Asia (Work Package 2 of ARRCC)
SCOS	Seasonal Climate Outlook Statement
SST	Sea Surface Temperature
TCC	Tokyo Climate Center, Japan
Tmax	Maximum Temperature
Tmin	Minimum Temperature
UKMO	Met Office, UK
UN	United Nations
WMO (LC)	World Meteorological Organization (Lead Centre)

⁵This table may contain acronyms, not specifically mentioned in this document but are considered to still be of relevance.