

SASCOF: Twenty-Fifth South Asian Seasonal Climate Outlook Forum (SASCOF-25) & Climate Services User Forum (CSUF)
EVENT: 27 – 29 April 2023, Online Event
ISSUED: 5 June 2023
VALIDITY: June to September (JJAS) 2023
FOR: Rainfall / Precipitation.



1.1: SUMMARY – REGIONAL RAINFALL



Normal to below normal rainfall is likely during the 2023 southwest monsoon season (June – September) over most parts of South Asia. Geographically, above normal rainfall is likely over northern most parts and northwest of the region, as well as parts of eastern and southern regions of South Asia. However, below normal rainfall is likely over some areas in the northwest, central and north-eastern parts of the region. The remaining areas of the region are likely to receive seasonal rainfall within normal ranges or in line with climatological probabilities.

Figure 1 shows the overall seasonal precipitation outlook for June to September (JJAS) 2023 across south Asia. The map represents each 1°Latitude x 1°Longitude grid box in the region and is based on the findings of the twenty-second South Asian Seasonal Climate Outlook Forum (SASCOF-25).

This outlook map has been produced by expert assessment of the prevailing climate conditions and model outlooks from various sources worldwide. The tercile categories (below normal, near normal and above normal) and their respective probabilities (%) were derived from an initial set of objective gridded model outlooks. These findings were then synthesised through collaborative assessment and scientific justification.

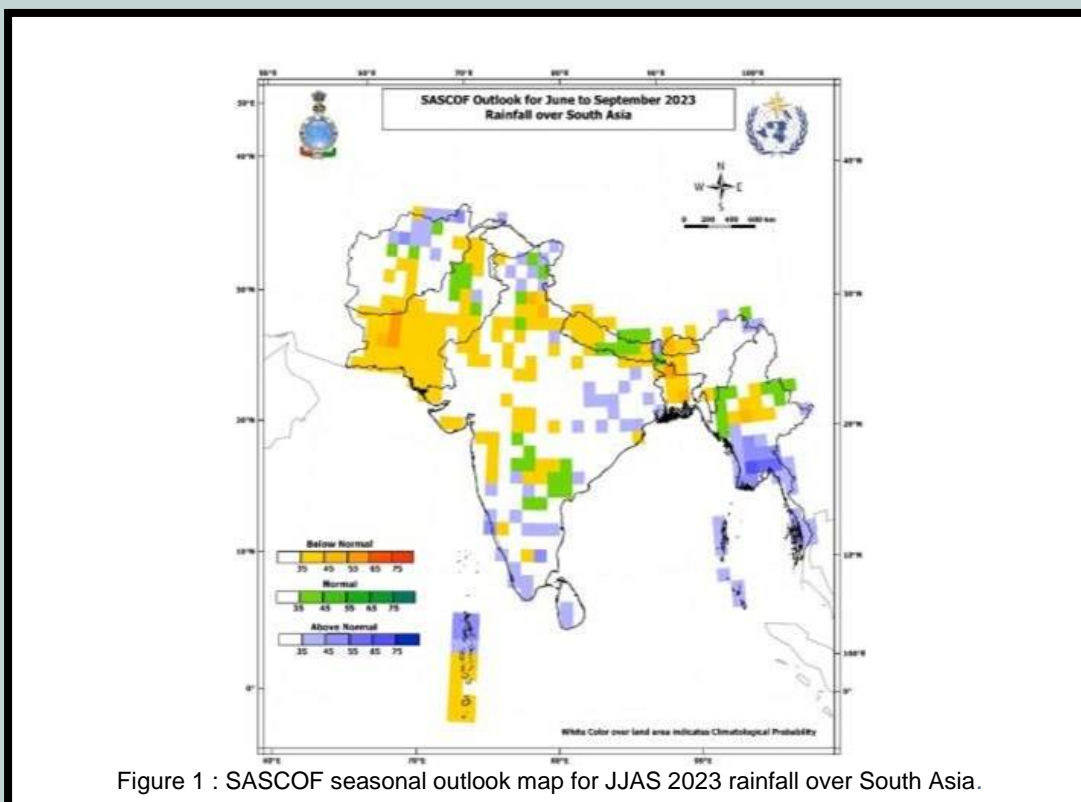


Figure 1 : SASCOF seasonal outlook map for JJAS 2023 rainfall over South Asia.



KEY

The colours in Figure 1 indicate the most likely rainfall tercile category for the upcoming season, along with the corresponding probability of occurrence.

- 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.

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FOR: Maximum (max) and Minimum (min) Temperature



1.2: SUMMARY – REGIONAL MAX & MIN TEMPERATURE



During the season, above normal minimum temperatures are likely over the majority of South Asia, excluding parts of the foothills of the Himalayas. The seasonal maximum temperatures are most likely to be above normal over most parts of the region, except central region and parts of the southern region of South Asia.

Figure 3 and Figure 2 show the overall seasonal outlook for maximum (left) and minimum (right) temperatures for June to September (JJAS) 2023. These outlooks are provided for each 1°Latitude x 1°Longitude grid box in South Asia, based on the findings of the twenty-first South Asian Seasonal Climate Outlook Forum (SASCOF-25).

The temperature outlook maps have been produced through expert assessment of the prevailing climate conditions and model outlooks from various sources worldwide. The tercile categories (below normal, near normal and above normal) and their corresponding probabilities (%) were derived from an initial set of objective gridded model outlooks. These findings were then synthesised through collaborative assessment and scientific justification.

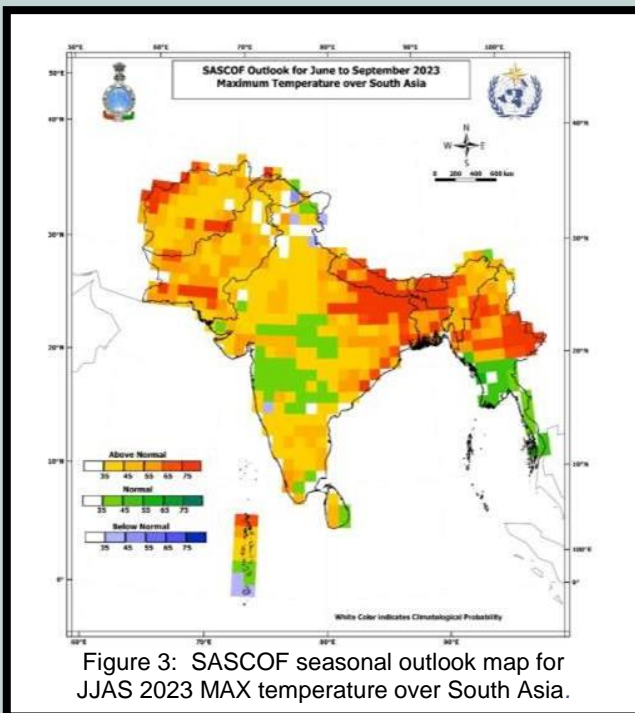


Figure 3: SASCOF seasonal outlook map for JJAS 2023 MAX temperature over South Asia.

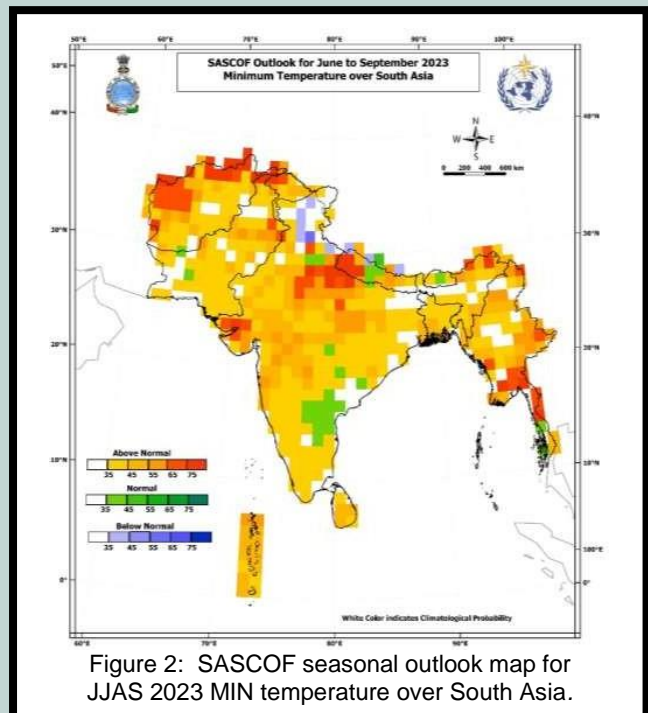


Figure 2: SASCOF seasonal outlook map for JJAS 2023 MIN temperature over South Asia.



The colours on *Figure 3* and *Figure 2* indicate the most likely tercile categories for maximum and minimum temperatures for the upcoming season, as well as the probability of occurrence for each category.

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

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

1.3: OUTLOOK CONSIDERATIONS SUMMARY

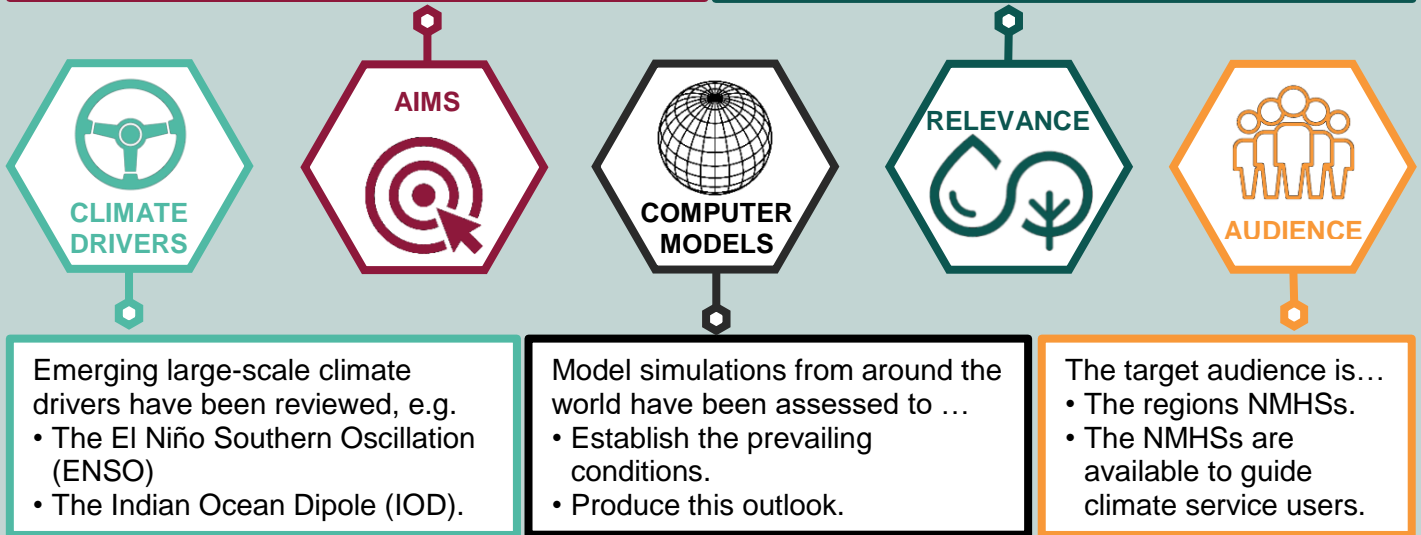
Factors that have been assessed to produce this outlook include:

This SCOS aims to ...

- Communicate the regional outlook for the upcoming seasons rainfall pattern in South Asia.
- Offer guidance to facilitate NMHSs preparations of national level seasonal outputs.

This is because weather, seasonal & climate predictions can be used to ...

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



Organisations Supporting & Contributing to the SASCOF Forum:



National Meteorological & Hydrological Services (NMHSs) and representatives from various sector users, work alongside the co-sponsors of this SASCOF forum including the ...










- India Meteorological Department (IMD), which is a WMO designated 1.5e: Regional Climate Centre, Pune, for Region II: Asia.
- Indian Institute of Tropical Meteorology (IITM).
- World Meteorological Organization (WMO).
- UK Met Office (UKMO)
- Regional Integrated Multi-hazard Early-warning System (RIMES).

Additional international and regional organisations contributing to this forum include the:

- Japan Meteorological Agency (JMA).
- Korea Meteorological Administration (KMA).
- International Research Institute for Climate and Society (IRI).
- United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
- International Water Management Institute (IWMI)
- WMO Global Producing Centres of Long Range Forecasts (GPCs-LRF) and the WMO Lead Centre for Long Range Forecast Multi-Model Ensemble (LC-LRFMME).

1.4: SUMMARY - NATIONAL

A summary of the June to September (JJAS) 2023 overall rainfall, maximum and minimum temperature outlook, for the SASCOF-25 member countries in South Asia has been provided in the table below.

COUNTRY	RAINFALL	MAXIMUM TEMPERATURES	MINIMUM TEMPERATURES
 AFGHANISTAN	Above normal precipitation in the north east, southeast and eastern part of Afghanistan and Below Normal Precipitation in some part of the southwest and western part of Afghanistan.	Temperature variation will likely to remain between 0.5 up to 2-degree Celcius in southwestern and north western parts of Afghanistan.	
 BANGLADESH	Rainfall is likely to be Normal to Below Normal over the country.	Maximum and Minimum Temperature over the country are likely to be above normal.	
 BHUTAN	The country as a whole is expected to experience normal precipitation.	The country as a whole is expected to experience normal to slightly above normal maximum temperature.	The country as a whole is expected to experience below normal minimum temperature.
 INDIA	Normal rainfall likely over many areas of Peninsular India and adjoining East Central India, East India, Northeast India and over some parts of Northwest India. Normal to below normal rainfall is likely over some areas of Northwest India and parts of west central India and some pockets of Northeast India.	Maximum temperature is likely to be above normal over many parts of the country during the season.	Minimum temperature is likely to be above normal over many parts of the country during the season.
 MALDIVES	Rainfall is expected to be above normal over northern and most parts of central atolls and below normal over rest of the country.	Temperatures are expected to be above normal over the most part of the country.	
 MYANMAR	Slightly below normal rainfall is likely in the Northern part of Myanmar and near normal to above normal rainfall in the remaining Regions and States.	Above normal maximum temperature is likely in the Upper Myanmar areas and about normal maximum temperature in the remaining areas.	Near normal minimum temperature is likely in the Western and Southern tip of Myanmar and above normal minimum temperature in the remaining areas.
 NEPAL	Below normal precipitation is expected over large parts of the country.	Above normal maximum temperature is likely during JJAS 2023 over Nepal.	Normal to above normal minimum temperature is likely during JJAS 2023 over Nepal.
 PAKISTAN	Nearly normal precipitation expected in southern half of the country, below-normal in centre-east & CP in extreme northeast of the country.	Overall warmer than average temperatures (both Tmin & Tmax) expected during JJAS 2023 across most parts of the country with southwestern and northeastern parts to experience largely warmer than averages.	
 SRI LANKA	Above normal rainfalls are likely over western, southern and Sabaragamuwa provinces and below normal over central province and climatological probability for remaining areas.	Above normal max and min temperatures are likely during JJAS 2023	
DETAILS	SASCOF: SASCOF-25	Issued: 5 June 2023	Validity: JJAS 2023

1.5A: DISCLAIMER

- It remains essential that you consult your country's National Meteorological & Hydrological Service (NMHS) for the official & latest outlook 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: NATIONAL SEASONAL OUTLOOK INFORMATION

For more information and further updates on the outlook for the national scale, the respective National Meteorological and Hydrological Services (NMHSs) may be consulted. Further information can be found at:

COUNTRY	ORGANISATION	LANGUAGES	LINK(S)
Afghanistan	AMD	English, Dari and Pashto	http://www.amd.gov.af/seasonal-forecast/
Bangladesh	BMD	English	www.bmd.gov.bd
Bhutan	NCHM	English	https://www.nchm.gov.bt/home/pageMenu/776
India	IMD	English & Hindi	https://imdpune.gov.in/ http://rcc.imdpune.gov.in/Products.html
Maldives	MMS	English & Dhivehi	https://www.meteorology.gov.mv/downloads
Myanmar	DMH	English & Myanmar	https://www.moezala.gov.mm
Nepal	DHM	Nepali	https://www.dhm.gov.np/climate-services/long-range-forecast
Pakistan	PMD	English & Urdu	https://www.pmd.gov.pk/en/assets/seasonal-outlooks/JAS_2023_outlook.pdf
Sri Lanka	DOM	Sinhala, Tamil & English	www.meteo.gov.lk

1.5C: NATIONAL POINTS OF CONTACT

COUNTRY	ORGANISATION	POINT OF CONTACT	EMAIL
Afghanistan	AMD	Soma Popalzai	popalzaisoma@yahoo.com
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Bhutan	NCHM	Ms. Phuntsho Wangmo Monju Subba	pwangmo@nchm.gov.bt msubba@nchm.gov.bt
India	IMD	Dr. O.P. Sreejith	sreejith.op@gmail.com
Maldives	MMS	Ahmed Rasheed	ahmed.rasheed@met.gov.mv
Myanmar	DMH	Dr. Kyaw Moe Oo	dg.dmh1@gmail.com , kyawmoeoo39@gmail.com
Nepal	DHM	Dr. Inidra Kadel	ira_kadel@yahoo.com kadelindira@gmail.com
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1.5D: SASCOF UPDATE SCHEDULE (AT TIME OF WRITING)

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

SASCOF	AREA / ORGANISATION	SEASON	RELEASE DATE
SASCOF-25	REGIONAL	JJAS 2023	Apr 2023
SASCOF-25 Update	REGIONAL	JJAS 2023 (Update)	May 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. It's 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](#).

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PART 2 – SASCOF OUTLOOK FOR JJAS 2023

2A: SASCOF-25 EVENT OVERVIEW

This regional seasonal rainfall, maximum (max) and minimum (min) temperature outlook for June to September (JJAS) 2023 over South Asia, has been collaboratively developed during:

Event:	The twenty-second session of the South Asian Climate Outlook Forum (SASCOF-25) & associated Climate Service User Forum (CSUF).
Location:	Online event
Date:	27-29 April 2023
Host:	RCC IMD Pune (Online)
Participants:	National Meteorological & Hydrological Services (NMHS) experts, from 9 countries including Afghanistan, 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, and the Regional Integrated Multi-hazard Early-warning System (RIMES)
Sponsored by:	
Pre/Post COF:	
Find out More:	Go to ‘3b: The SASCOF Process’ & ‘3c: SASCOF & CSUF Background’ sections.

2B: CURRENT CONDITIONS

Observed rainfall for the month of March 2023 for South Asia was above normal in the central region, while it was below normal in the north-eastern region. The rest of the region experienced average rainfall.

Observed mean temperatures for the month of March 2023 for South Asia were well below average over most parts of North-west, central and South-east region whereas the rest of region experienced average temperatures.

2C: STATUS OF THE CLIMATE DRIVERS



El Niño-Southern Oscillation (ENSO)

La Niña conditions are currently present in the equatorial Pacific region, but their strength has been reduced over the past few months. The latest MMCFS forecast indicates that ENSO-neutral conditions are expected to start from the next season, with the possibility of El Niño developing during the second half of the southwest monsoon season.

Indian Ocean Dipole (IOD)

Currently, neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. The latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue during the upcoming season, but a positive IOD is likely to develop towards the end of the southwest monsoon season.

Snow Cover over the Northern Hemisphere

The snow-covered area over the Northern Hemisphere and Eurasia was below normal (towards negative side of the normal based on 1991-2020) during last few months (December 2022, January to March 2023). The northern hemisphere snow cover areas during February and March 2023 were 26th and 15th lowest ever during the respective months in the last 57 years. On the other hand, the Eurasian snow cover were 21st and 6th lowest ever during the respective months in the last 57 years. Winter and spring snow cover extent has a general inverse relationship with the subsequent Asian summer monsoon rainfall.

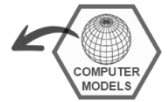
To find out more about the region’s climate drivers, please see ‘3a: Climate Drivers - Background’.

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

	2022 Summer Monsoon Season (JJAS)	2023 Summer Monsoon Season (JJAS)
Climate drivers	<ul style="list-style-type: none"> Weak La Niña conditions were observed during June - July 2022. The (cool) ENSO conditions started strengthening during August & strong La Niña conditions were established by September 2022. Since May 2022, neutral IOD conditions were observed over the Indian Ocean, which continued up to the month of July. During August, the negative IOD was established and continued up to September 2022. 	<ul style="list-style-type: none"> The La Niña conditions are prevailing over the equatorial Pacific region, but the strength of the La Niña continue to weaken for the past few months. The latest MMCFS forecast indicates that the ENSO-neutral conditions are expected to start from the next season and the El Niño is likely to develop during the second half of the southwest monsoon season. At present, neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. The recent outlooks from coupled global models suggest that the negative IOD conditions are likely to develop during the monsoon season.
Rainfall	<ul style="list-style-type: none"> Above normal rainfall was observed over the parts of north-western, west-central and south-west parts of South Asia. Below normal rainfall observed over foothills of Himalaya and northeast parts of South Asia. 	<ul style="list-style-type: none"> Normal to below normal rainfall is likely during the 2023 southwest monsoon season (June – September) over most parts of the South Asia. Geographically, above normal rainfall is likely over northern most parts and northwest of the region as well as parts of eastern and southern regions of South Asia. However, below normal rainfall is likely over some areas northwest, central and north-eastern parts of the region. The seasonal rainfall is likely to be normal or of climatological probabilities over the remaining areas of the region.

	2022 Summer Monsoon Season (JJAS)	2023 Summer Monsoon Season (JJAS)
Temperature	<ul style="list-style-type: none"> Observed mean temperatures for the season were below normal over northwest and west-central regions of South Asia. Average mean temperature were observed over rest of the regions of South Asia. 	<ul style="list-style-type: none"> During the season, above normal minimum temperatures are likely over most parts of South Asia except parts of the foothills of Himalaya. The seasonal maximum temperatures are most likely to be above normal over most parts of the region except central and parts of the southern region of South Asia.
	•	•

2E: THE CLIMATE MODELS CONSIDERED



Models selected for Multi Model Ensemble (MME):

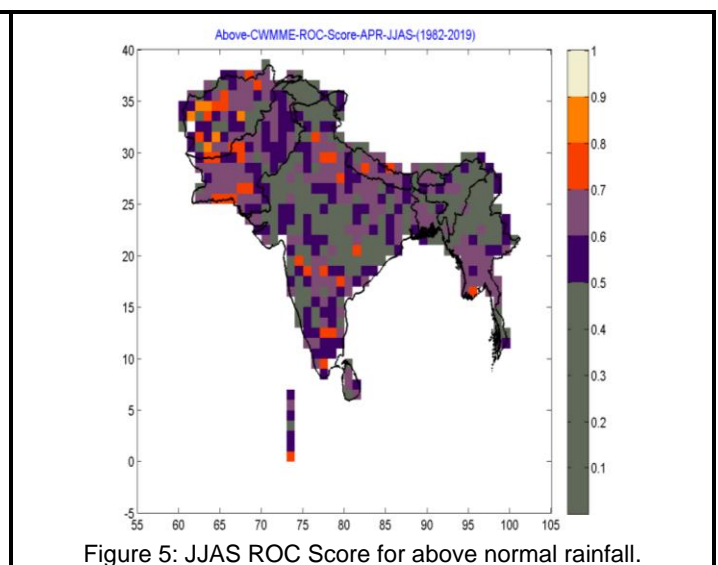
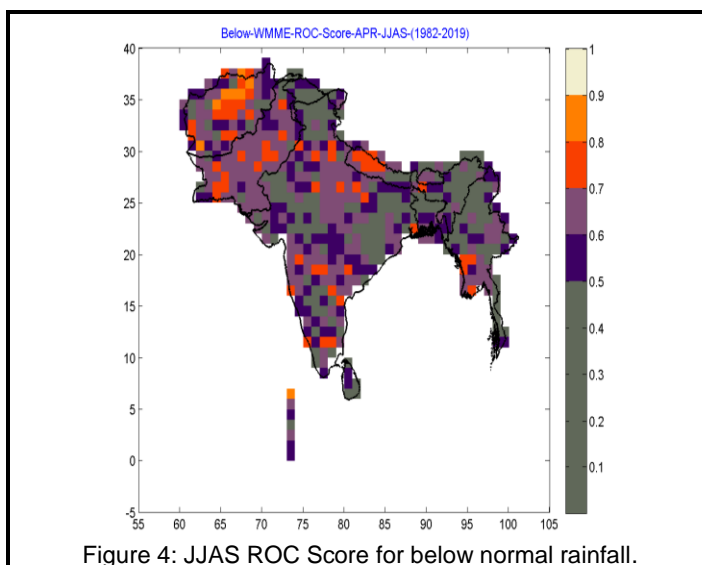
Model Name	Hindcast Period for Rainfall	Hindcast Period for Temperature	Calibrated / Uncalibrated	Calibrated with (SST, PPN, etc) or N/A
RSMAS-NCAR-CCSM4	1982-2010	1993-2018	CALIBRATED	SST & PPN
NCEP-CFsV2	1982-2010	1993-2018	CALIBRATED	SST & PPN
CanCM4i	1982-2010	1993-2018	CALIBRATED	SST & PPN
NASA-GEOS_S2S	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 & UNCERTAINTY

The next figures 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 (for below normal rainfall) shows that most of India, Pakistan and western Nepal are coloured violet to orange, indicating skill of approximately 60-80% for these regions. The far north and south of India and many other regions are coloured grey indicating a less skill for these locations. Figure 5 (for above normal rainfall), has similarities to the patterns shown in Figure 4. However, Figure 5 has slightly more grey over central-India indicating lower skill in these places.



Confidence & Skill – Maximum and Minimum Temperature

Figure 6 (for below normal maximum temperatures) shows that that most parts of the South Asian region are coloured violet to orange for below normal maximum temperature, indicating skill of approximately 60-80% for these regions. However, the areas over north-western part especially over the central and north parts of Pakistan and some parts of Afghanistan are coloured grey indicating a less skill for these locations.

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

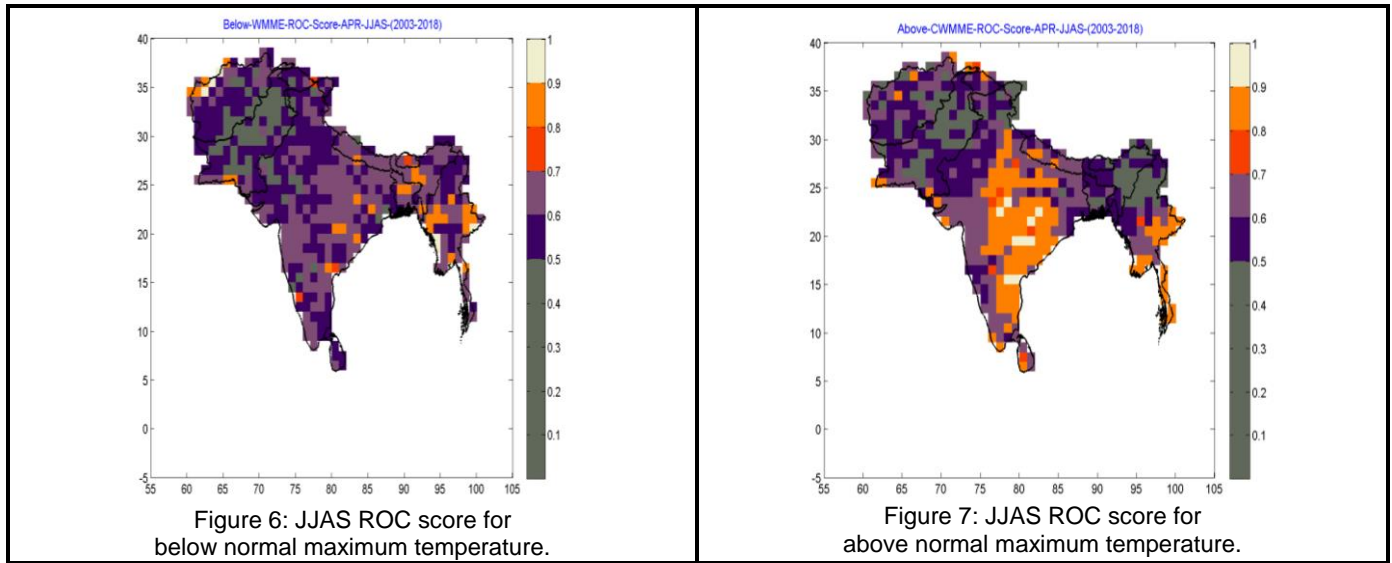
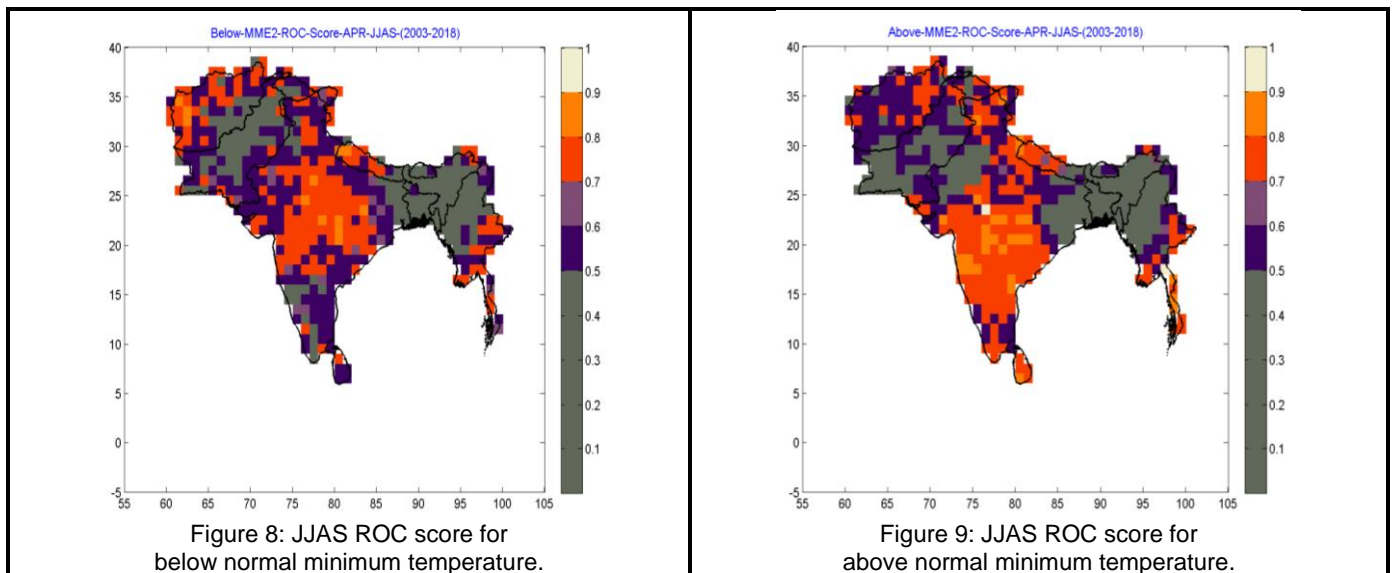


Figure 8 (for below normal minimum temperatures) shows that most of Afghanistan, Sri Lanka, western Nepal, eastern Bhutan, some parts of eastern Pakistan and most parts of central, north & north-west India are coloured violet to orange for below normal minimum temperature, indicating skill of approximately 60-80% for these regions. The far south and north-east of India, northern Myanmar and north-western Pakistan are coloured grey indicating less skill for these locations.

Figure 9 (for above normal minimum temperatures) has similarities to the patterns shown in Figure 8. However, Figure 9 does have slightly more grey over some east, northwest, and north-east India indicating lower skill in these places.



Uncertainty

While there is confidence in the SASCOF-25 outlook, it is recognised that the global climate models ENSO predictions prior to, and during, the spring season generally have noticeable uncertainty due to the spring barrier. It is also acknowledged that a most of the global models are indicating neutral ENSO conditions during upcoming seasons. Furthermore, there is the possible development of positive IOD conditions during end of the monsoon season.

2G: VERIFICATION OF LAST YEARS OUTLOOKS

Observed rainfall versus the SASCOF outlook

Figure 10 shows the SASCOF rainfall outlook map for the JJAS 2022 summer monsoon season. This suggested:

- Above-normal rainfall over some areas of the northwest South Asia, along the foot hills of Himalayas and northeast parts of the region, and many areas of central part of the region.
- Below normal was forecasted over many areas over extreme northwest, north and some areas over north-eastern parts of the region. Normal rainfall was forecasted for the remaining areas of the region.

Figure 11 shows the observed rainfall distribution anomaly during the JJAS 2022 monsoon season over South Asia. This is expressed as the grid-point rainfall tercile categories¹. It was seen that above normal rainfall was observed over the parts of north-western and central South Asia matched well with forecast. The below normal rainfall observed over extreme northwest, and central-east parts of South Asia also matched well with the forecast. However, there were differences between the observed and forecasted rainfall patterns over the foothills of Himalayas and some parts of northeast regions of South Asia, where above normal rainfall was forecasted.

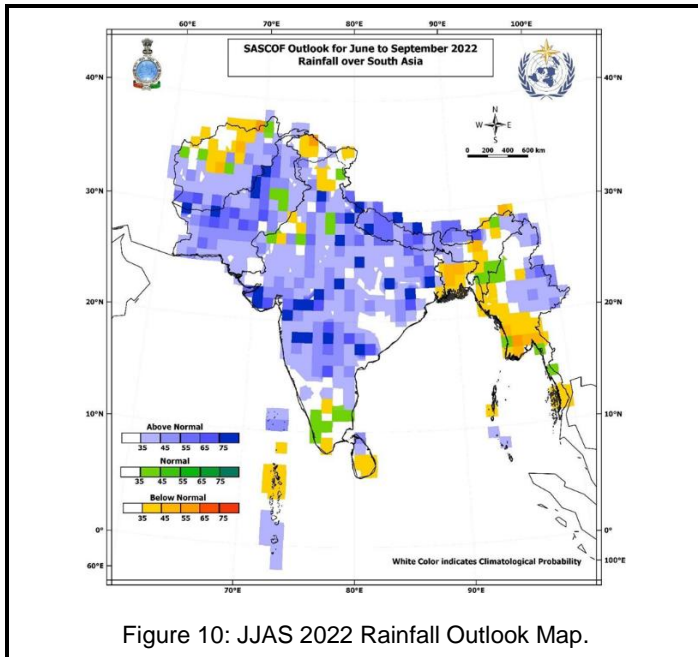


Figure 10: JJAS 2022 Rainfall Outlook Map.

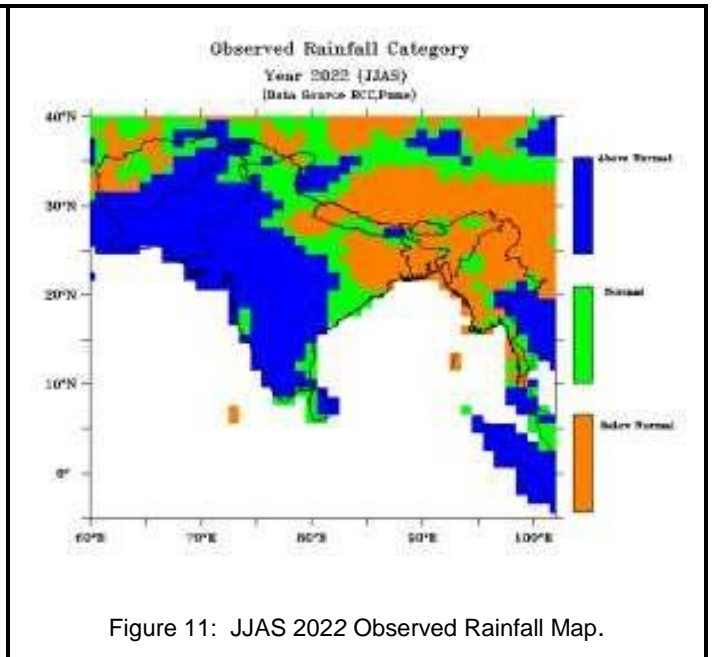


Figure 11: JJAS 2022 Observed Rainfall Map.

Challenges	Description
Production process	<ul style="list-style-type: none"> • There are a variety of different methods applied to build a seasonal outlook, 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"> • The tele-connections between the South Asian rainfall/temperature and climate drivers like ENSO and IOD are not fully captured by climate models yet. • Rainfall and temperature over the South Asian region are 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 outlook.

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 that is primarily influenced by the monsoon system. In order to predict the expected state of the monsoon over the region in the coming months, the SASCOF (South Asian Climate Outlook Forum) considers the relative influence of various observed and emerging climatic features. This is because slowly evolving climate drivers offer a source of predictability on seasonal timescales.

Climate drivers, such as the El Niño-Southern Oscillation (ENSO) and its 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 exert an influence on conditions during the monsoon season. Additionally, variability within the monsoon season is driven by intra-seasonal oscillations, such as the Madden-Julian Oscillation. The influence of these monsoon climate drivers is outlined below.

El Niño/Southern Oscillation (ENSO)

ENSO is a coupled atmosphere-ocean phenomenon that occurs in the tropical Pacific Ocean. It is one of the global scale climate phenomena that exert 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.

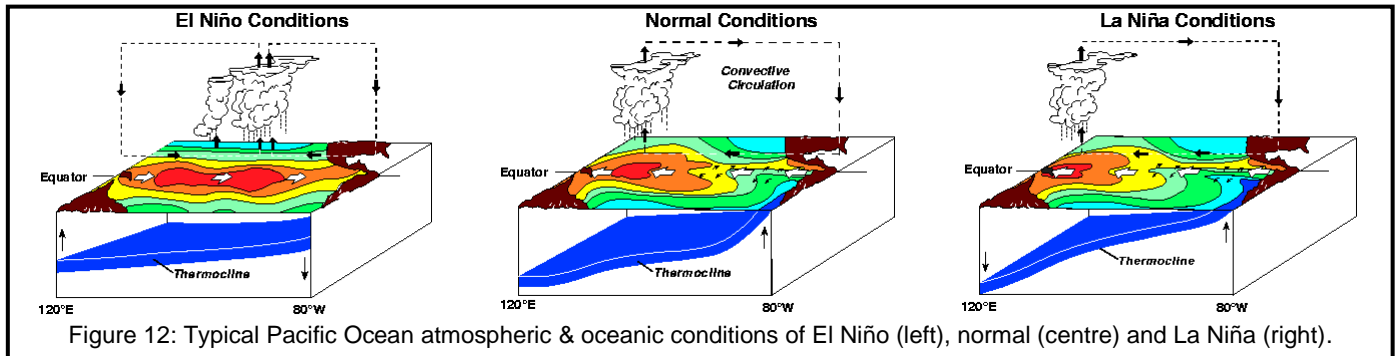


Figure 12: Typical Pacific Ocean atmospheric & oceanic conditions of El Niño (left), normal (centre) and La Niña (right).

El Niño (La Niña) conditions are generally known to weaken (strengthen) the South Asian southwest monsoon circulation and reduce (enhance) rainfall over much of the region. However, it is recognised that there is large uncertainty in the evolution of ENSO conditions and their 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. Furthermore, El Niño events have been associated with a reduction in tropical cyclone activity 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, characterized by alternating warmer (positive phase) and colder (negative phase) conditions in the western and eastern parts, respectively. Figure 13 illustrates the influence of the positive and negative IOD modes on the region. In general, a negative IOD is associated with a weaker-than-normal monsoon over South Asia. On the other hand, a positive IOD is associated with a stronger-than-normal monsoon.

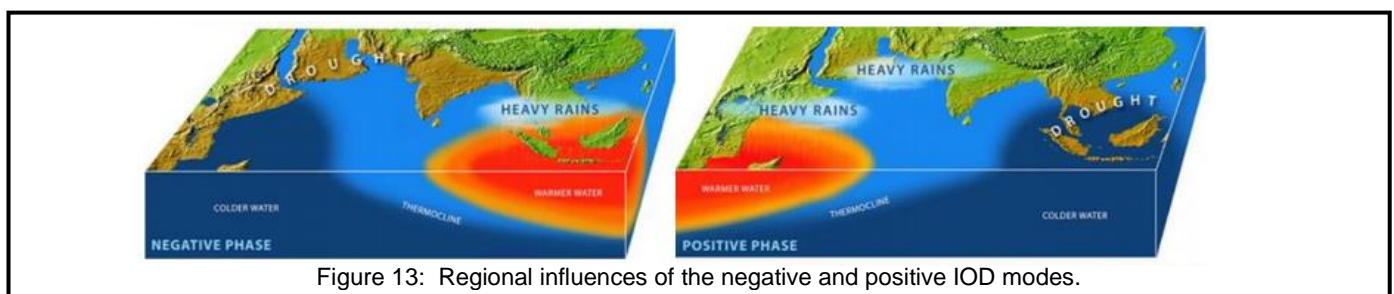


Figure 13: Regional influences of the negative and positive IOD modes.

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

Eurasia Snow

In general, there is an inverse relationship between the Eurasian snow cover area during winter and spring and the subsequent South Asian summer monsoon rainfall. This means that winters with extensive snow cover over Eurasia tend to be followed by summers with less monsoonal rainfall, while winters with little snow cover are often followed by summers with more monsoonal rainfall.

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.

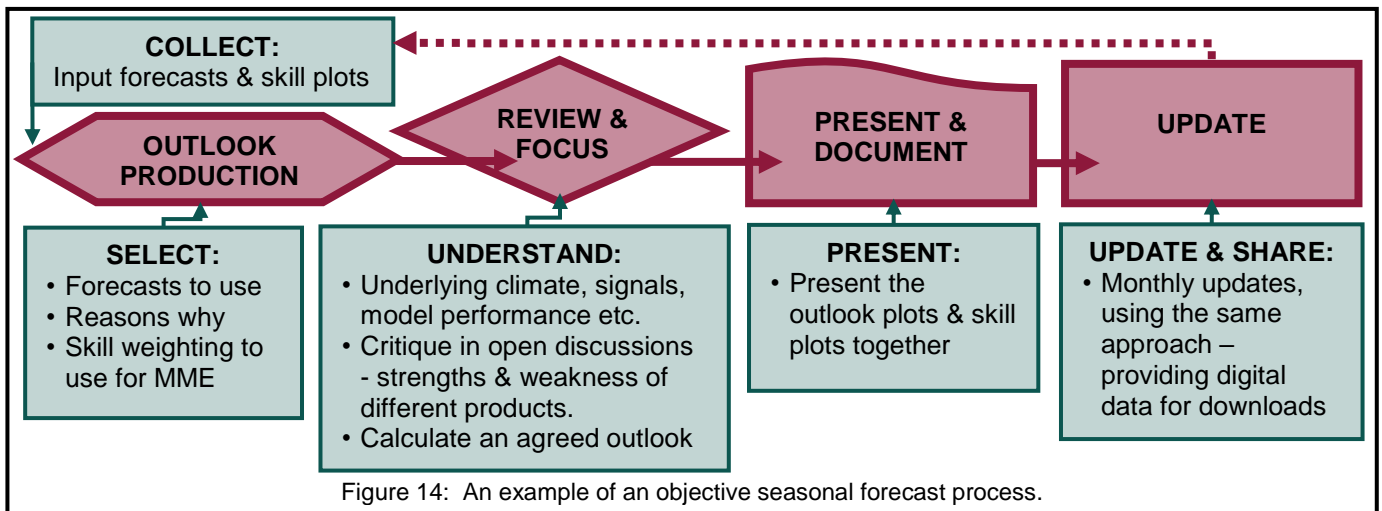


Figure 14: An example of an objective seasonal forecast process.

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. An objective approach (recognising that some subjectivity will still exist) for seasonal outlooks has been developed and a programme of work is ongoing, including...

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 outlook 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.

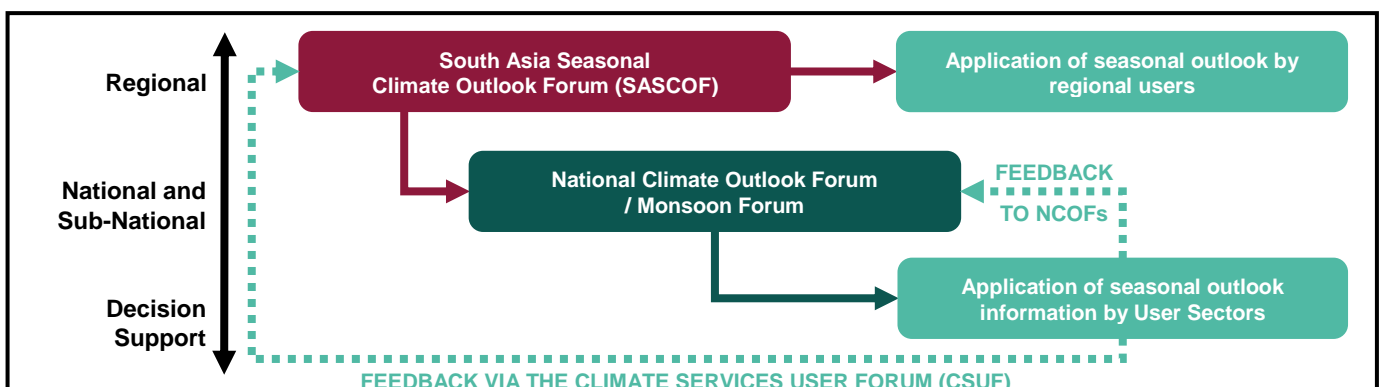


Figure 15: Illustrates the flow and feedback of information between the SASCOF and the National Climate Outlook Forum (NCOF), also known as National Monsoon Forum (NMF). These events then facilitate the application of the information by the user community at national and sub-national levels.

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-25	27-29 APR 2023	Online event	JJAS	Water, Agriculture, DRR & Health.	-
SASCOF-24	24 NOV 2022	Online event	DJF	-	-
SASCOF-23	26-29 SEP 2022	Online event	OND	Water, Agriculture, DRR & Health.	-
SASCOF-22 Update	14 June 2022	Online event	JJAS	-	-
SASCOF-22	26-28 APR 2022	Online event	JJAS	Water, Agriculture, DRR & Health.	Introduction to the IRI CPT
SASCOF-21	25 NOV 2021	Online event	DJF	-	-
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-11 Mar 2021
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	Thiruvananthapuram, 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 region³”.

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.

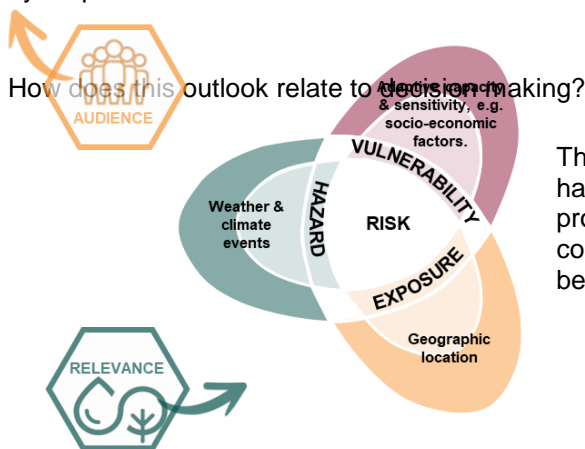
3D: FREQUENTLY ASKED QUESTIONS



What are the aims of this 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.



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.

³<https://public.wmo.int/en/our-mandate/climate/regional-climate-outlook-products>

What is normal?

In the scientific context, normal is defined as the average climatology. Typically, 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 rainfall patterns in South Asia from June to September. This information is obtained 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.

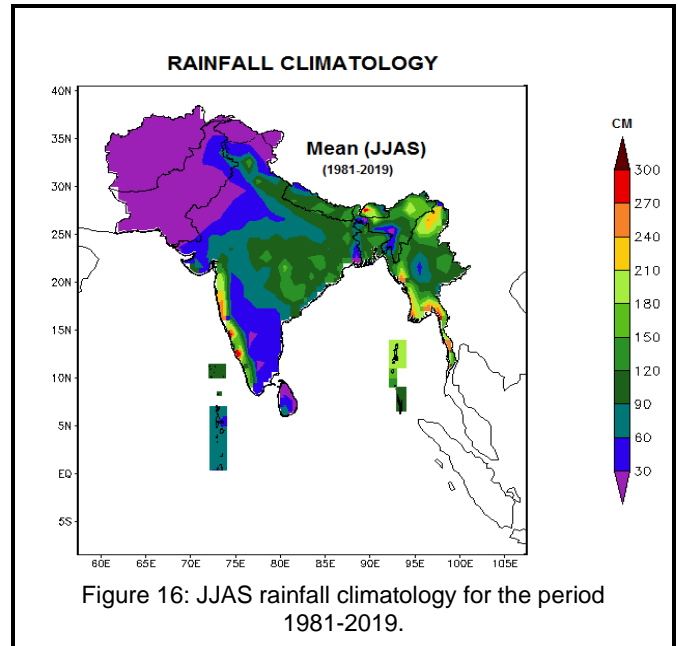


Figure 16: JJAS rainfall climatology for the period 1981-2019.

What is the temperature climatology in South Asia?

The regions 'normal' temperature is characterised by spatial variability. Figure 17 and Figure 18 shows the long-term historical patterns of maximum and minimum temperature respectively, during the June to September 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.

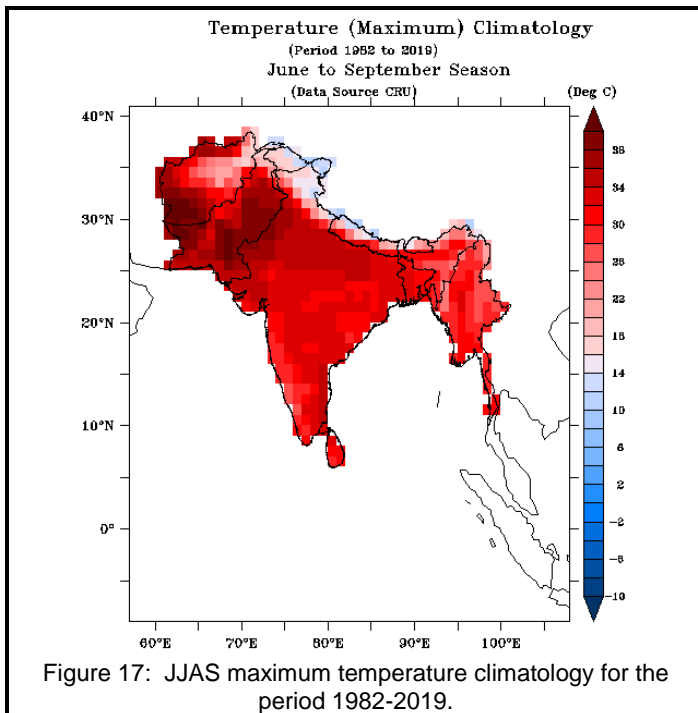


Figure 17: JJAS maximum temperature climatology for the period 1982-2019.

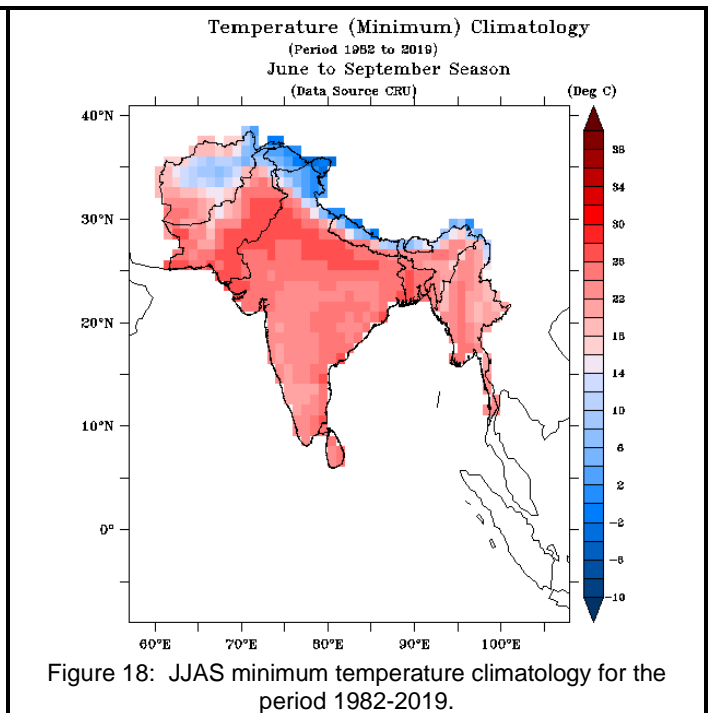


Figure 18: JJAS minimum temperature climatology for the period 1982-2019.

Where does the seasonal outlook come from?

The WMO has designated 14 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 products from the centres in Figure 19, are reviewed during the preparations of a seasonal outlook. This is in addition to statistical models generated by the regions NMHSs. The GPCs are coloured in white & RCC Pune in blue).

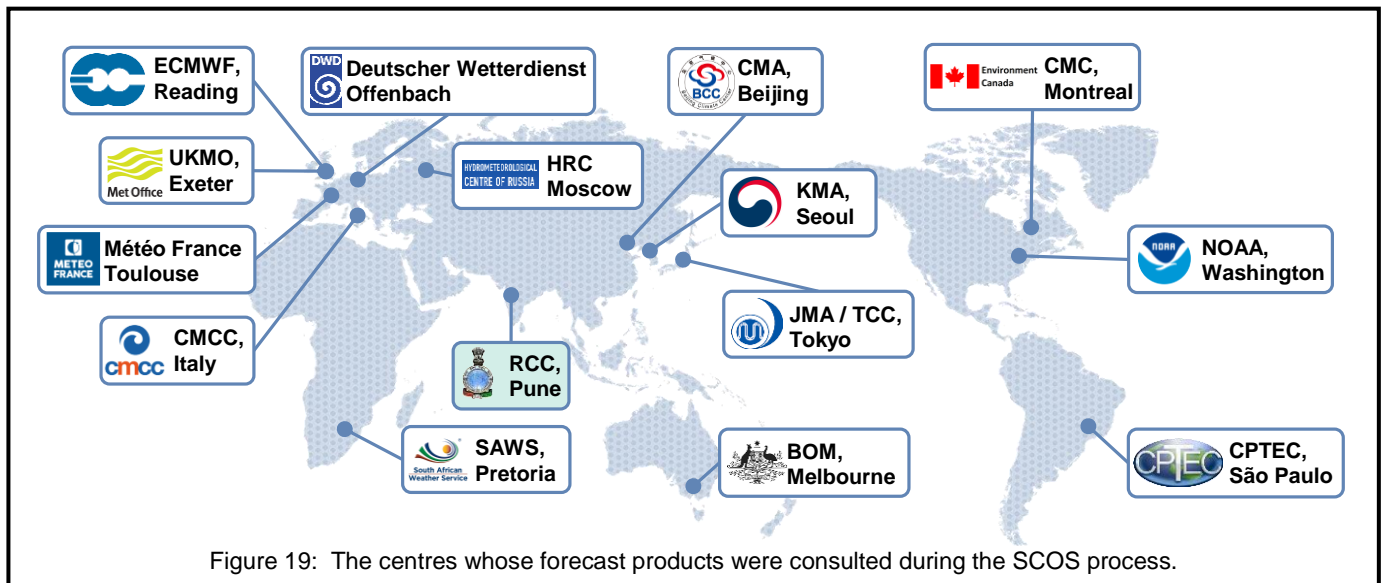


Figure 19: The centres whose forecast products were consulted during the SCOS process.

What is an objective forecast?

An objective forecast is an outlook 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 methods 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 – JUNE TO SEPTEMBER 2023**

3F: ACRONYMS⁴

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
DJF	December, January, February
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
GFCS	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

ACRONYM	LONG TITLE
LRF-MME	Long Range Forecasting - Multi-Model Ensemble (WMO)
MEL	Monitoring, Evaluation & Learning.
MISO	Monsoon Intra-seasonal Oscillation
MJO	Madden Julian Oscillation
MMS	Maldives Meteorological Service
MOS	Model Output Statistics
N/A	Not Applicable.
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
TBC	To Be Confirmed
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)

⁴This table may contain acronyms, not specifically mentioned in this document but are considered to still be of relevance.