SASCOF: **Twenty-second South Asian Seasonal Climate Outlook Forum (SASCOF-22) & Climate Services User Forum (CSUF)**
EVENT: 26 – 28 April 2022, Online Event
ISSUED: 03 May 2022
VALIDITY: June to September (JJAS) 2022
FOR: Rainfall / Precipitation.

1.1: SUMMARY – REGIONAL RAINFALL

Normal to above normal rainfall is most likely during the 2022 southwest monsoon season (June – September) over most parts of the South Asia. Geographically, above normal rainfall is most likely along the foothills of Himalayas, many areas of northwestern and central parts of the region, and some areas of east and southern parts of the region. However, below normal rainfall is most likely over some areas of extreme north, northwest, and south, and southeastern parts of the region. The seasonal rainfall is most likely to be normal or of climatological probabilities over the remaining areas of the region.

Figure 1 shows overall seasonal precipitation outlook for June to September (JJAS) 2022. This is for each 1°Latitude x 1°Longitude grid box in South Asia; based on the findings of the twenty-second South Asian Seasonal Climate Outlook Forum (SASCOF-22).

This outlook map has been produced through expert assessment of the prevailing climate conditions and model outlooks 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 outlooks, then synthesised through collaborative assessment and scientific justification.

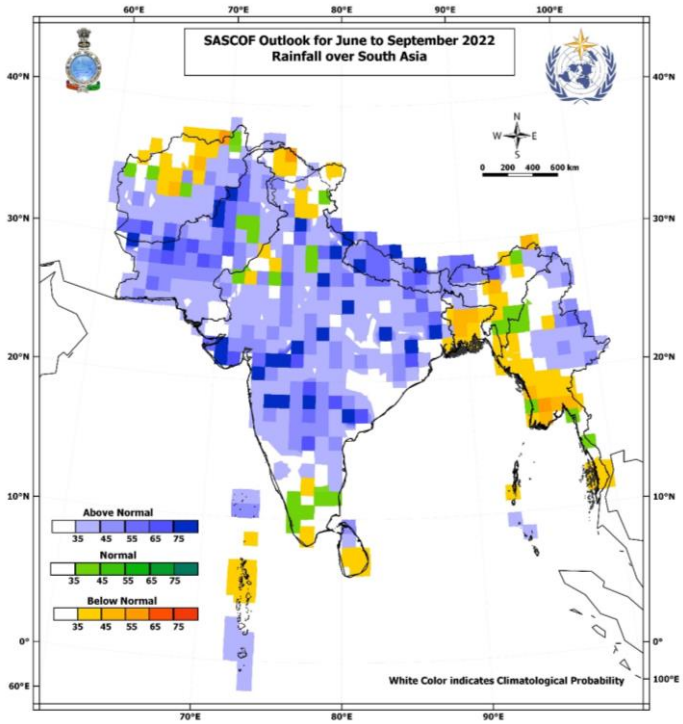


Figure 1 : SASCOF seasonal outlook map for JJAS 2022 rainfall over South Asia.

KEY

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: **Twenty-second South Asian Seasonal Climate Outlook Forum (SASCOF-22) & Climate Services User Forum (CSUF)**
EVENT: 26 – 28 April 2022, Online Event
ISSUED: 03 May 2022
VALIDITY: June to September (JJAS) 2022
FOR: Maximum (max) and Minimum (min) Temperature

1.2: SUMMARY – REGIONAL MAX & MIN TEMPERATURE

The seasonal maximum temperatures are most likely to be normal to below normal over most parts of the region, except over extreme northwest and some areas of northern and northeastern parts of the region. Maximum temperatures have climatological probabilities over remaining areas.

During the season, above normal minimum temperatures are likely over many areas along foothills of Himalayas, northern, northwestern and northeastern parts of the South Asia. Below normal to normal minimum temperatures are most likely over most areas of central, southern and southeastern part of South Asia. The seasonal minimum temperatures have climatological probabilities over remaining parts of the region.

Figure 3 and Figure 2 show the overall seasonal maximum (left) and minimum (right) temperature outlook for June to September (JJAS) 2022. This is 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-22).

The temperature outlook maps have been produced through expert assessment of the prevailing climate conditions and model outlooks 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 outlooks, then synthesised through collaborative assessment and scientific justification.

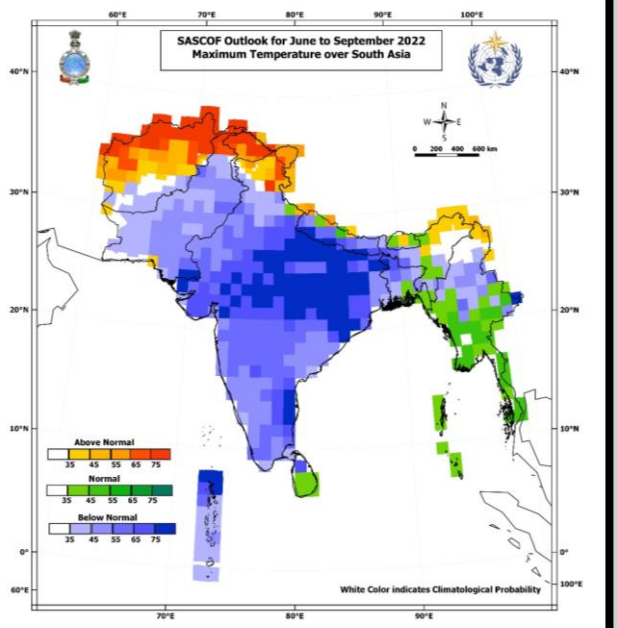


Figure 3: SASCOF seasonal outlook map for JJAS 2022 MAX temperature over South Asia.

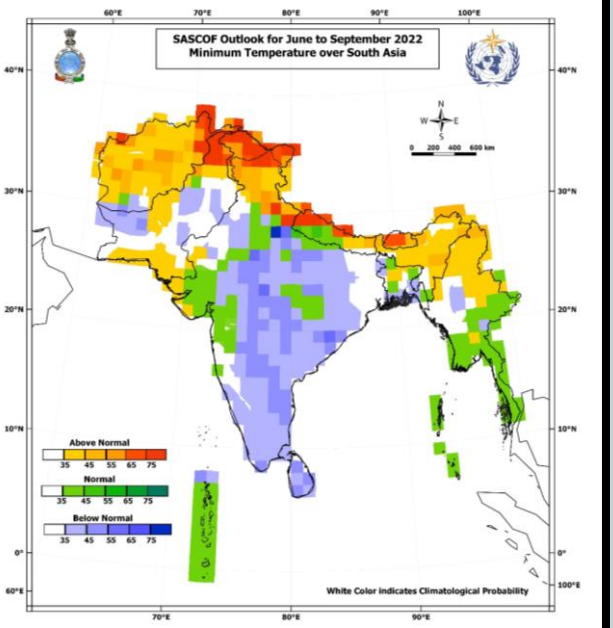


Figure 2: SASCOF seasonal outlook map for JJAS 2022 MIN temperature over South Asia.

KEY

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

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.

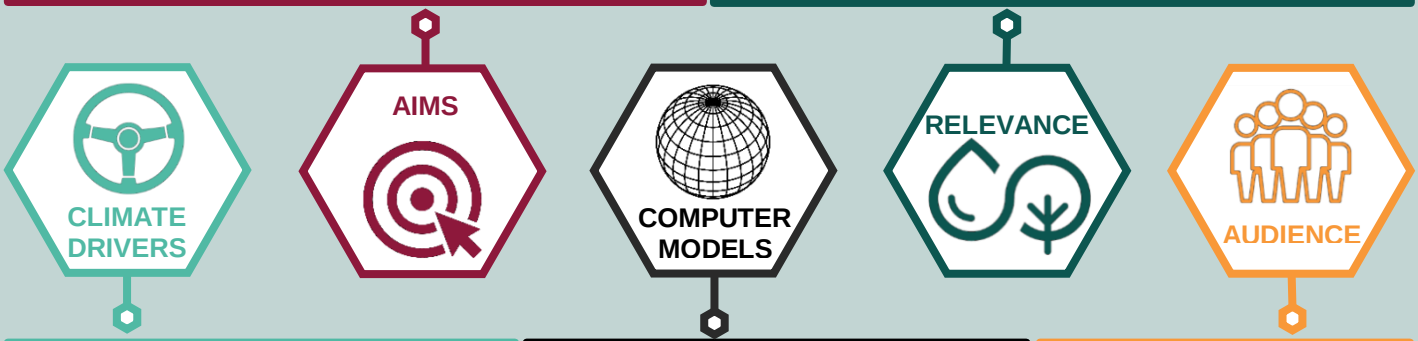
For more information on terciles, see the 3d: Frequently Asked Questions.

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.



Emerging large-scale climate drivers have been reviewed, e.g.
- The El Niño Southern Oscillation (ENSO)
- The Indian Ocean Dipole (IOD).

Model simulations from around the world have been assessed to …
- Establish the prevailing conditions.
- Produce this outlook.

The target audience is…
- The regions NMHSs.
- The NMHSs are available to guide climate service users.

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), who 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) and the Asia Regional Resilience to a Changing Climate (ARRCC) Programme.
- 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).
- 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) 2022 overall rainfall, maximum and minimum temperature outlook, for the SASCOF-22 member countries in South Asia has been provided in the table below.

COUNTRY	RAINFALL	MAXIMUM TEMPERATURES	MINIMUM TEMPERATURES
AFGHANISTAN	Above normal precipitation in northeastern & south parts of country. East, central & some parts of north shows normal precipitation. North, northwest, west & some southwest parts shows below normal rainfall.	Above normal maximum temperatures are likely for this season.	-
BANGLADESH	Normal to below normal rainfall over Bangladesh.	Warmer than normal mean temperature during the season.	
BHUTAN	The country as a whole is expected to experience slightly above normal rainfall.	The country as a whole is expected to experience slightly below normal maximum temperature.	The country as a whole is expected to experience normal minimum temperature.
INDIA	Southwest monsoon seasonal (June to September) rainfall over the country as a whole is most likely to be normal to above normal.	Below normal over most parts of India, above normal over northernmost parts of India.	Below normal to normal over central & east India, normal over north & northeastern India.
MALDIVES	Rainfall is most likely to be above normal over southern atolls & part of central atolls. Below normal rainfall is expected over northern atolls & part of central atolls.	Maximum temperatures are likely to be below-normal over the country.	Minimum temperatures are likely to be below normal over northern-most atolls & normal over rest of the country.
MYANMAR	Slightly above normal rainfall is likely in the northeastern part of Myanmar & near normal rainfall in the remaining Regions & States.	Near normal maximum temperature is likely in the whole country.	Near normal minimum temperature is likely whole country.
NEPAL	Above normal precipitation is very likely during the JJAS 2022 over Nepal.	Normal to below normal maximum temperature is likely over Nepal.	Normal to above normal minimum temperature are likely over Nepal.
PAKISTAN	Above normal rainfall likely over most parts of the country with largely above normal over southern half of country & nearly normal over extreme north northeast.	Maximum temperatures are expected to be below normal across much of the country except extreme north region where it's expected to be above normal.	Minimum temperatures above normal in general with marked above-average over extreme north & northeast.
SRI LANKA	Above normal over northern part, near normal rainfall over SW slopes of the country, below normal rainfall over western & SW coastal areas & climatological probability for other parts of the country.	Maximum temperatures are likely to be below normal during JJAS 2022.	Above normal minimum temperatures are likely during JJAS 2022.
DETAILS	SASCOF: **SASCOF -22**	Issued: **03 May 2022**	Validity: **JJAS 2022**

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	-	www.amd.gov.af
Bangladesh	BMD	English & Bengali	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#reports
Myanmar	DMH	English & Myanmar	https://www.moezala.gov.mm/moonson-weather-forecast
Nepal	DHM	Nepali	http://www.dhm.gov.np/climate/
Pakistan	PMD	English & Urdu	www.pmd.gov.pk
Sri Lanka	DOM	Sinhala, Tamil & English	www.meteo.gov.lk

1.5C: NATIONAL POINTS OF CONTACT

COUNTRY	ORGANISATION	POINT OF CONTACT	EMAIL
Afghanistan	AMD	-	-
Bangladesh	BMD	Dr. Md. Abdul Mannan S M Quamrul Hassan	mannan_u2003@yahoo.co.in smquamrul77@yahoo.com
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	-	mwo@met.gov.mv
Myanmar	DMH	Ms. Chaw Su Hlaing Dr. May Khin Chaw	chawsuhlaing.dmh@gmail.com mkhinc@gmail.com
Nepal	DHM	Dr. Inidra Kadel	kadelindira@gmail.com
Pakistan	PMD	Dr. S. Sarfaraz Dr. Zaheer Ahmad Babar	sarfarazmet@hotmail.com zaheer_a_babar@hotmail.com
Sri Lanka	DOM	-	metdpa@meteo.gov.lk met.seasonalprediction@gmail.com

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-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. 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 2022

2A: SASCOF-22 EVENT OVERVIEW

This regional seasonal rainfall, maximum (max) and minimum (min) temperature outlook for June to September (JJAS) 2022 over South Asia, has been collaboratively developed during:

Event:	The twenty-second session of the South Asian Climate Outlook Forum (SASCOF-22) & associated Climate Service User Forum (CSUF).
Location:	Online event.
Date:	26-28 April 2022
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, 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:	Introduction to the IRI CPT – Lead by UKMO.
Find out More:	Go to '3b: The SASCOF Process' & '3c: SASCOF & CSUF Background' sections.

2B: CURRENT CONDITIONS

Observed rainfall for the month of March 2022 was well below normal over the north, central, southwest and north-western region. It was more than average over some parts of the east and southeast region. The rest of the region experienced average rainfall.

Observed mean temperatures for the month of March 2022 for South Asia were well above average over most parts of region, except for some parts of the central east region, where experienced average temperatures.

2C: STATUS OF THE CLIMATE DRIVERS

El Niño-Southern Oscillation (ENSO)

Currently, moderate La Niña conditions are prevailing over the Pacific. The latest global model outlooks indicate that the La Niña conditions are likely to continue during the upcoming monsoon season.

Indian Ocean Dipole (IOD)

Currently 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.

Snow Cover over the Northern Hemisphere

The snow-covered area over Northern Hemisphere as well as Eurasia was near normal (slightly towards positive side of the normal based on 1991-2020) during last few months (December 2021, January to March 2022). The northern hemisphere snow cover areas during February and March 2022 were 29th and 25th lowest ever during the respective months in the last 56 years. On the other hand, the Eurasian snow cover area 32th and 24th lowest ever during the respective months in the last 56 years. Winter and spring snow cover extent has a general inverse relationship with the subsequent Asian summer monsoon rainfall.

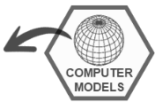
To find out more about the region's climate drivers, please see '3a: Climate Drivers - Background'.

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

	2021 Summer Monsoon Season (JJAS)	2022 Summer Monsoon Season (JJAS)
Climate drivers	• Neutral (cool) ENSO conditions were observed during May - July 2021. The (cool) ENSO conditions started strengthening during August & weak La Niña conditions were established by September 2021. • During May 2021, weak negative IOD conditions were observed over the Indian Ocean, which enhanced slightly in the subsequent month of June & July & weakened slightly in the month of August. During September, the negative IOD was weakened further & turned into neutral IOD conditions.	• Currently, moderate La Niña conditions are prevailing over the Pacific. The latest global models indicate that the La Niña conditions are likely to continue during the upcoming 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	• Above normal rainfall was observed over the parts of north-western & central South Asia & foothills of Himalaya. • Below normal rainfall observed over north, extreme northwest, & central-east parts of South Asia.	• Normal to above normal rainfall is most likely during the 2022 southwest monsoon season (Jun – Sep) over most parts of the South Asia. • Geographically, above-normal rainfall is most likely along the foothills of Himalayas, many northwestern & central parts, & some areas of east & southern parts of the region. • Below normal rainfall is most likely over some areas of extreme north, northwest, south, & southeastern parts of the region. • The seasonal rainfall is most likely to be normal or of climatological probabilities over the remaining areas of the region.

	2021 Summer Monsoon Season (JJAS)	2022 Summer Monsoon Season (JJAS)
Temperature	• Observed mean temperatures for the season were above normal over northwest, central & northeast regions of South Asia. • Below normal mean temperature was observed over north & southeast regions of South Asia.	• The seasonal maximum temperatures are most likely to be normal to below normal over most parts of the region except over extreme northwest & some areas of northern & northeastern parts of the region. Maximum temperatures have climatological probabilities over remaining parts of the region. • During the season, above normal minimum temperatures are likely over many areas along foothills of Himalayas, northern, northwestern & northeastern parts of the South Asia. Below normal to normal minimum temperatures are most likely over most areas of central, southern & southeastern part of South Asia. The seasonal minimum temperatures have climatological probabilities over remaining parts of the region.

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.

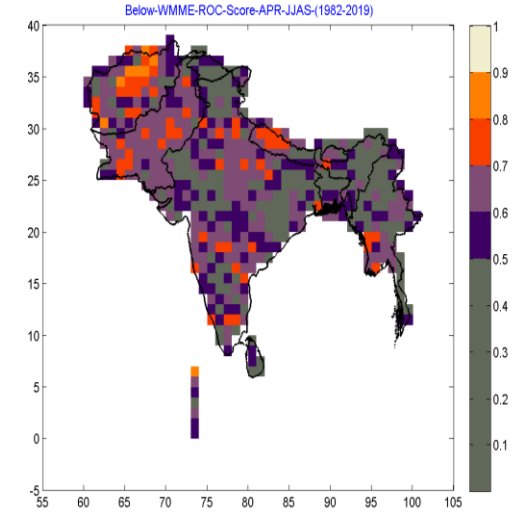


Figure 4: JJAS ROC Score for below normal rainfall.

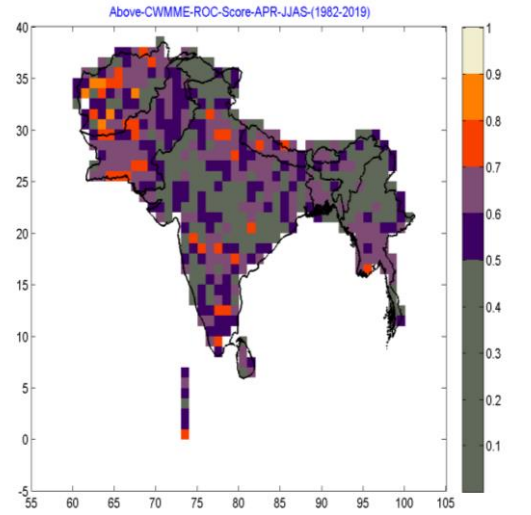


Figure 5: JJAS ROC Score for above normal rainfall.

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 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.

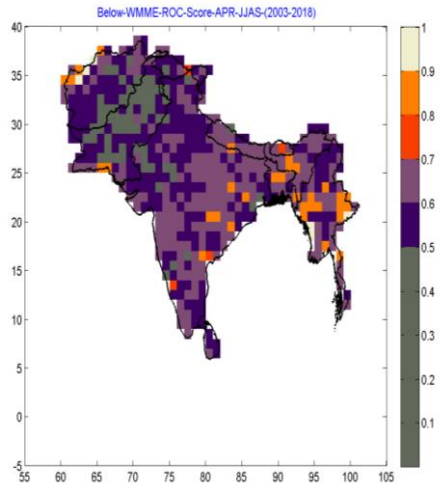


Figure 6: JJAS ROC score for below normal maximum temperature.

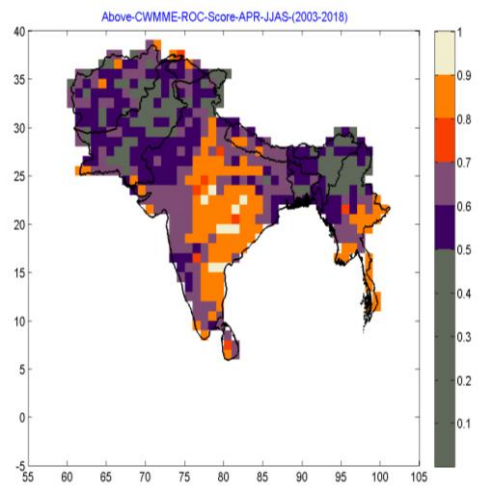


Figure 7: JJAS ROC score for above normal maximum temperature.

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.

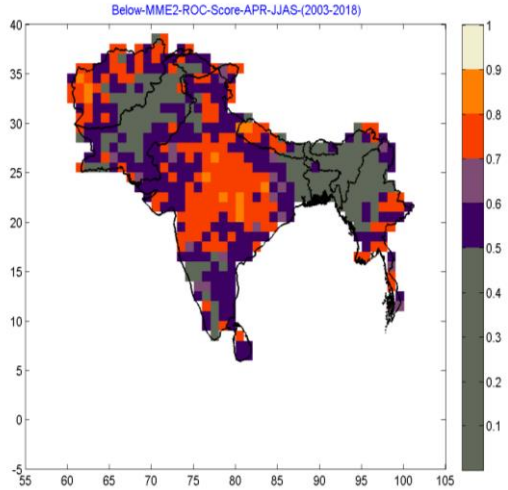


Figure 8: JJAS ROC score for below normal minimum temperature.

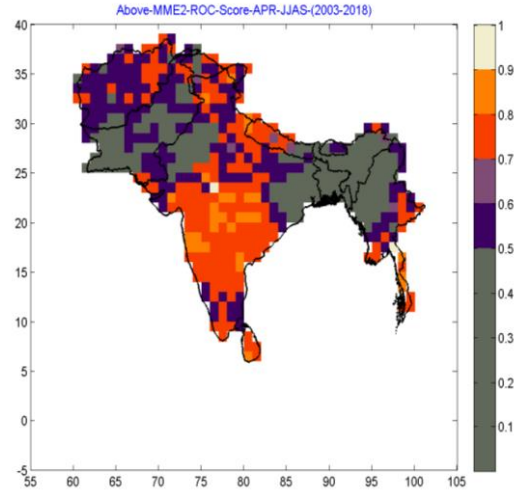


Figure 9: JJAS ROC score for above normal minimum temperature.

Uncertainty

While there is confidence in the SASCOF-22 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 continuing La Niña conditions during upcoming seasons. Furthermore, there is the possible development of negative IOD conditions during 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 2021 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. 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 2021 monsoon season over South Asia. This is expressed as the grid-point rainfall tercile categories[1]. It was seen that above normal rainfall was observed over the parts of north-western and central South Asia and foothills of Himalaya matched well with forecast. The below normal rainfall observed over north, 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 northeast regions of South Asia, where above normal rainfall was forecasted.

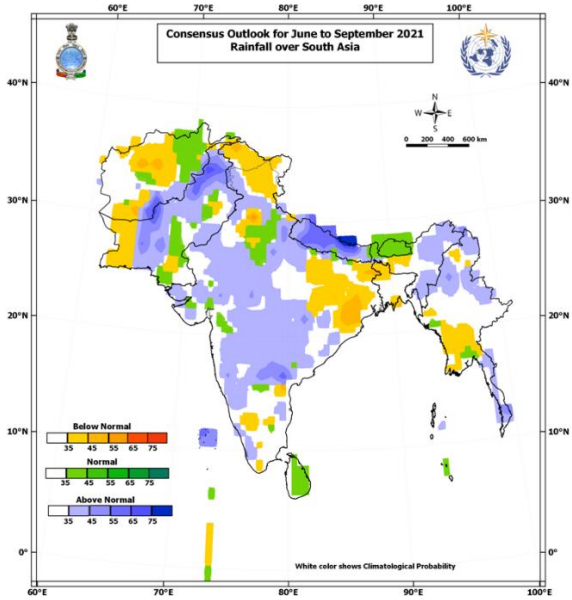


Figure 10: JJAS 2021 Rainfall Outlook Map.

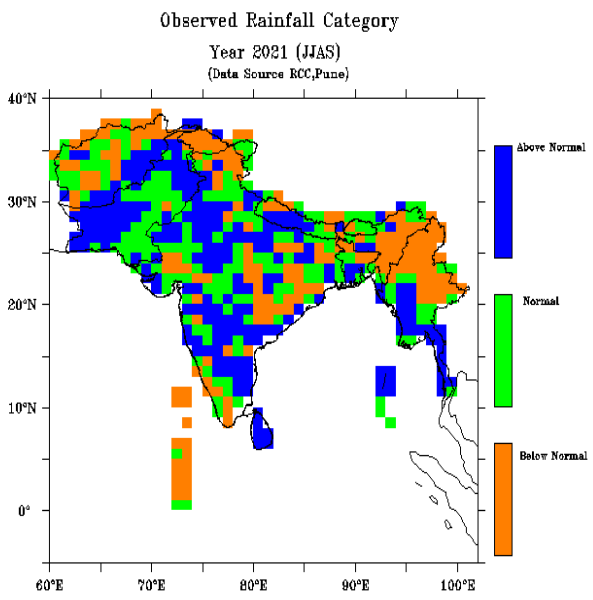


Figure 11: JJAS 2021 Observed Rainfall Map.

Challenges	Description
Production process	• 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	• 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 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 12[2] illustrates the typical atmospheric and oceanic characteristics of El Niño (left), normal (centre) and La Niña (right) conditions over the Pacific Ocean.

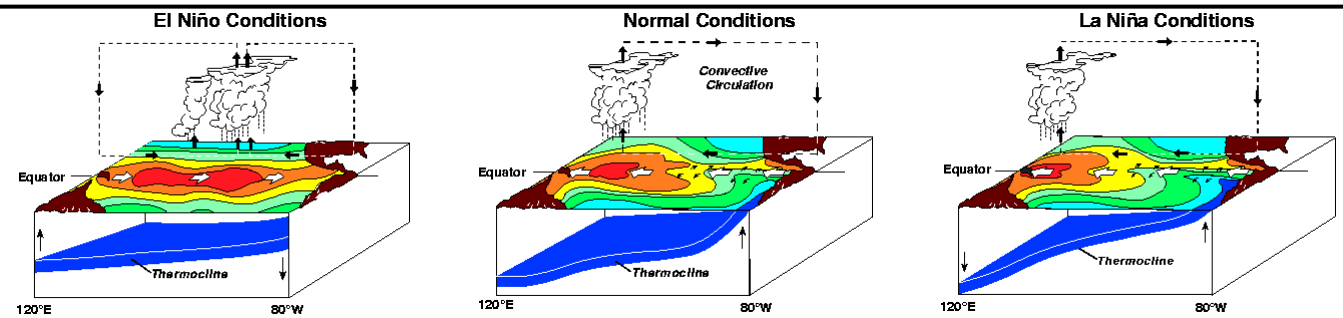


Figure 12: Typical Pacific Ocean atmospheric & oceanic conditions of El Niño (left), normal (centre) and La Niña (right).

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 13[3] 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.

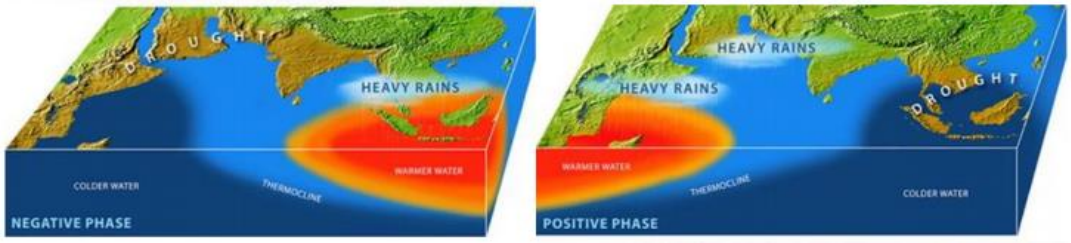


Figure 13: Regional influences of the negative and positive IOD modes.

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.

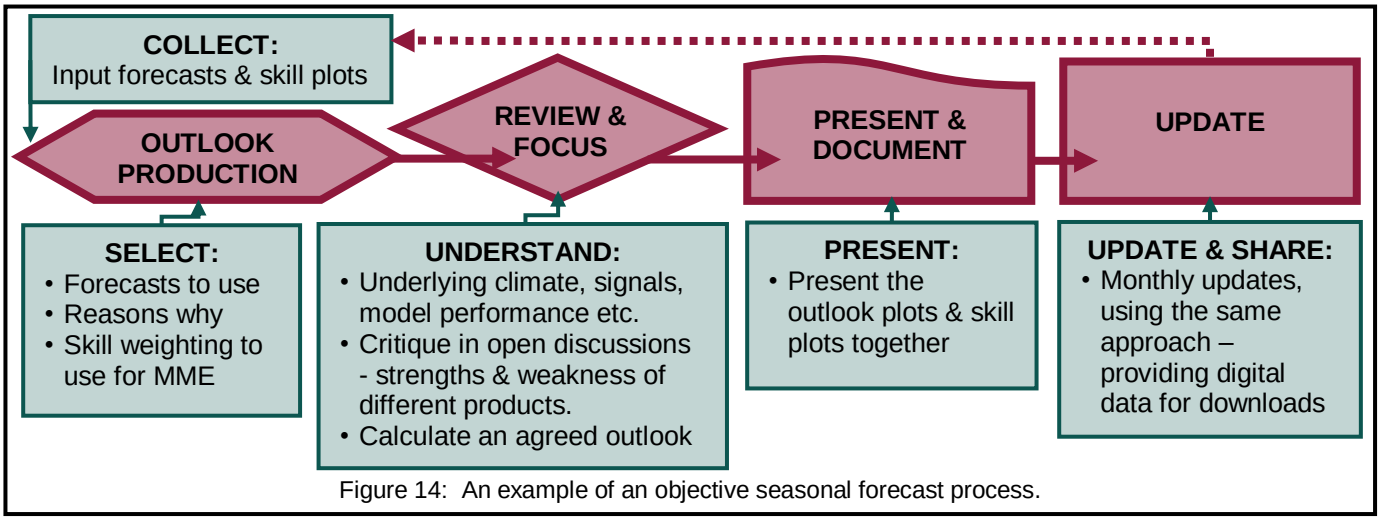


Figure 14: An example of an objective seasonal forecast process.

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. 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.

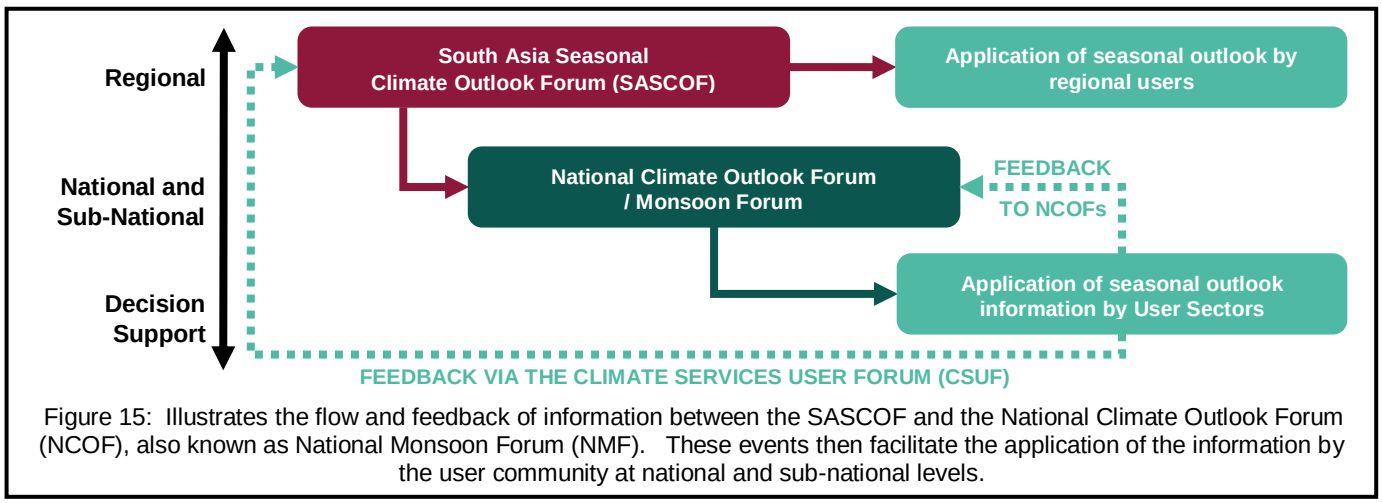


Figure 15: Illustrates the flow and feedback of information between the SASCOF and the National Climate Outlook Forum (NCOF), also known as National Monsoon Forum (NMF). These events then facilitate the application of the information by the user community at national and sub-national levels.

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-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	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	9th 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	25-26APR 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 region[4]".

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.

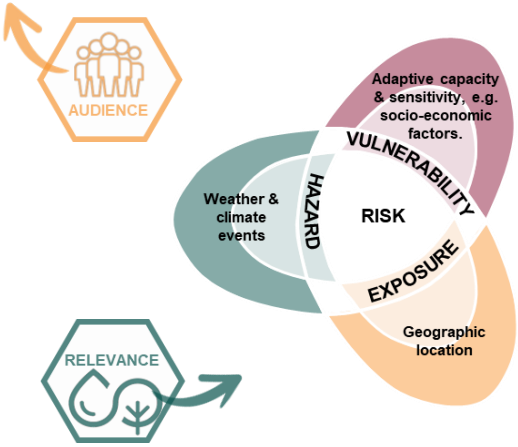
3D: FREQUENTLY ASKED QUESTIONS

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.



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 rainfall patterns over South Asia for June to September. 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.

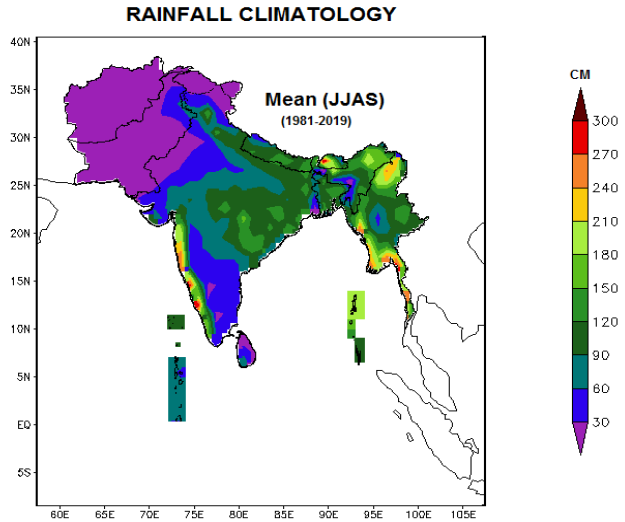


Figure 16: JJAS rainfall climatology for the period 1981-2019.

[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 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.

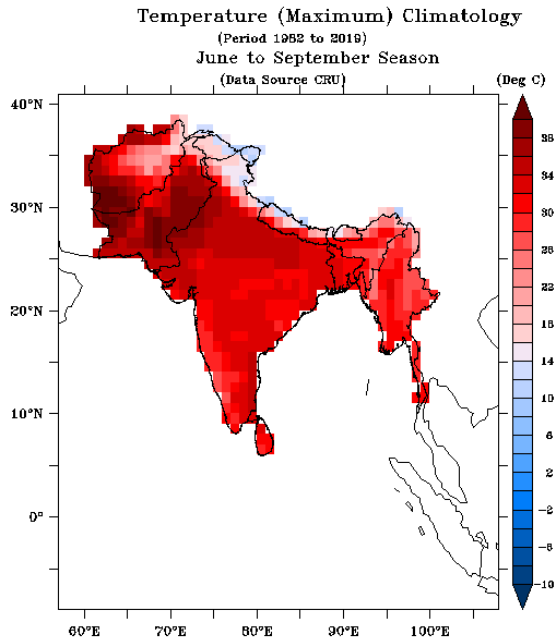


Figure 17: JJAS maximum temperature climatology for the period 1982-2019.

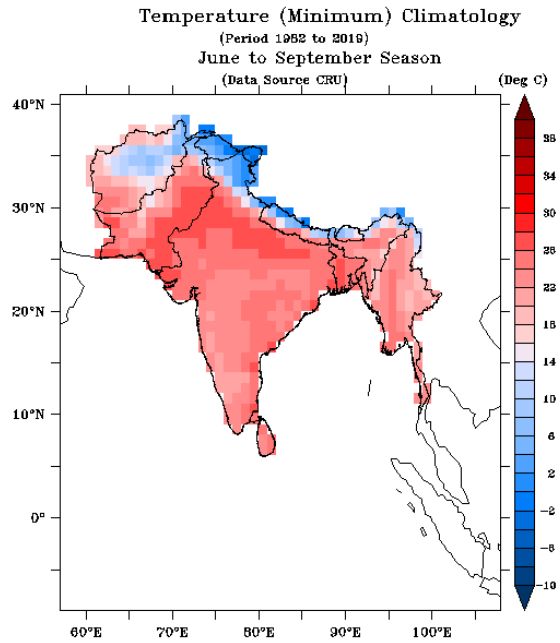


Figure 18: JJAS minimum temperature climatology for the period 1982-2019.

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).

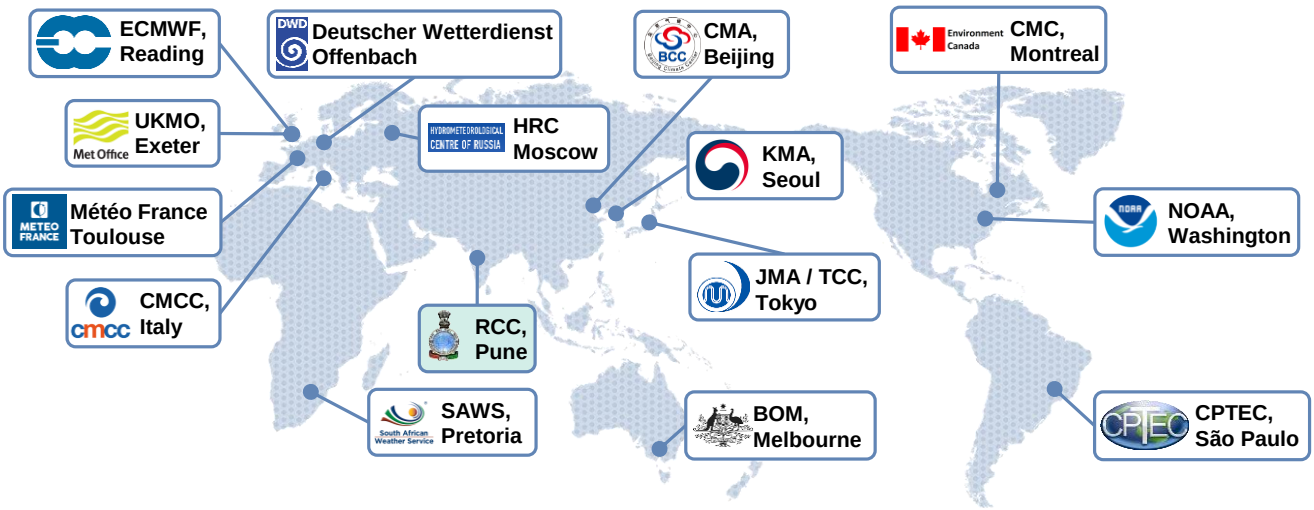


Figure 19: The centres whose forecast products were consulted during the SCOS process.

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.

3F: ACRONYMS[5]

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
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)

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