

**21st Session of
South Asian Climate Outlook Forum (SASCOF-21)
25 November 2021
(Held online due to CoVID-19 pandemic)**

**Consensus Statement on the Forecast for December 2021
to February 2022 Season Rainfall and Temperatures over
South Asia**

Summary

Above normal precipitation is likely during the winter season (December 2021 to February 2022) over many areas in the southern part of South Asia. Normal to below-normal precipitation is likely over many areas of the northwestern part of the region, some areas along the foothills of the Himalayas, and the northeastern part of South Asia.

During the season, above normal minimum temperatures are likely over many areas of the north, northwestern, northeast, southern parts of South Asia and along the plain of the Himalayas. However, below normal minimum temperatures are likely over some areas of central and northwest parts of the region. The rest of the region is likely to experience normal rainfall or have climatological probabilities.

Normal to Above normal maximum temperatures are most likely over north, northwest, northeast, along the Himalayas and southernmost parts of the region. Below normal maximum temperatures are likely over the remaining parts of the region.

This consensus climate outlook for December 2021 to February 2022 season over South Asia has been developed through an expert assessment of the prevailing global climate conditions influencing the South Asian climate and seasonal forecasts from different climate models around the world. Currently, La Niña conditions are prevailing in the tropical Pacific Ocean, and neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. These parameters, which are known to influence the climate variability over South Asia are likely to continue at their current level during the DJF 2021/22 season. Careful consideration is also given to other regional and global factors as well as the intraseasonal variability of the region that can affect the rainfall and temperature patterns over the region.

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

Introduction

During the winter season (December to January), Northern parts of South Asia receive a good amount of precipitation in the form of both snow and rain. The southern part of the region consisting of the southeastern part of India, Sri Lanka, and the Maldives also receive a good amount of rainfall during the season. Most of the remaining areas of the region generally receive very little precipitation during the season. It is recognized that the seasonal predictability of the region during the season is limited to some extent by the strong day-to-day atmospheric variability. The day-to-day atmospheric variability over the northern (southern) part of the region is caused by the passage of disturbances in the mid-latitude westerlies (tropical easterlies). The seasonal predictability over the southern part of the region is also limited by the eastward-moving Madden Julian Oscillation (MJO), which represents the major global scale intra-seasonal variability pattern.

The climate outlook for December 2021 to February 2022 (DJF 2021/22) season was finalized during the 21st session of the South Asian Climate Outlook Forum (SASCOF-21) held on 25th November 2021 via video conferencing in the backdrop of the current extraordinary circumstances of Covid-19 pandemic prevailing in the world. The session was attended by experts representing the National Meteorological and Hydrological Services (NMHSs) of all the nine South Asian countries as well as those representing several global and regional climate agencies including WMO Regional Climate Centre (RCC) Pune, Indian Institute of Tropical Meteorology (IITM), Met Office (UKMO) and Regional Integrated Multi-hazard Early-warning System (RIMES), etc. The online forum deliberated on various observed and emerging climate forcing that are known to influence the climate variability of the region such as the El Niño/Southern Oscillation (ENSO) conditions over the equatorial Pacific, Indian Ocean Dipole (IOD) conditions over the Indian Ocean, etc. The key features of these climate forcing are briefly discussed below.

ENSO conditions over the Pacific Ocean

The El Niño/Southern Oscillation (ENSO) is one of the global scale climate phenomena having a significant influence on the year-to-year variability of the winter precipitation as well as the surface temperatures over South Asia. The La Niña

conditions observed over the equatorial Pacific Ocean at the beginning of the year turned weak/borderline La Niña conditions during April 2021. However, in the month of May, the strength of cooler SST anomalies has reduced significantly and La Niña conditions turned into neutral (cool) ENSO conditions and continued in subsequent months. During August and September, the cooling trend of SSTs was seen to be continued. In October month, weak La Niña conditions were established over the Pacific. Currently, weak La Niña conditions are prevailing over the Pacific. Atmospheric conditions are also indicating La Niña conditions. The latest forecasts from global climate models indicate a strong probability for La Niña conditions likely to continue during the winter season (DJF).

IOD Conditions over the Indian Ocean

In addition to ENSO conditions over the Pacific, other factors such as Indian Ocean sea surface temperatures have some influence on the climate variability of the region. During May 2021, weak negative IOD conditions were observed over the Indian Ocean which enhanced slightly in the subsequent month of June and July and weakened slightly in the month of August. During September, weak negative IOD was weakened further and turned into neutral IOD conditions. In the month of October, Dipole Mode Index (DMI) is slightly negative side of its normal, however, within the neutral range. Currently, the SST conditions over the equatorial Indian Ocean suggest neutral Indian Ocean Dipole (IOD) conditions. Forecasts from global climate models indicate a strong probability of neutral IOD conditions to persist during the winter season (DJF).

Consensus Outlook for December 2021 to February 2022 Season Rainfall and Temperature (Minimum & Maximum) over South Asia

A consensus outlook for December 2021 to February 2022 season rainfall over South Asia has been prepared based on the expert assessment of prevailing large-scale global climate indicators mentioned above and experimental as well as operational long-range forecasts based on statistical and dynamical models generated by various operational and research centers of the world.

During the season, the climate of the region is also generally get influenced by the strong day-to-day atmospheric variability. Therefore, it is recognized that there is large uncertainty in the prediction of winter precipitation over the region. It was also

recognized that SSTs over the Pacific (such as ENSO) are not the only factor that decides the performance of the winter season climate over the region. Other relevant climate drivers such as the state of the Indian Ocean Dipole (IOD), the Tropical Atlantic SST, etc. are also important. The relative impact of all these parameters needs to be considered to determine the expected state of the climate over the region during the season. There is a unanimity among the experts that the prevailing weak La Niña conditions in the equatorial Pacific Ocean are likely to be strengthened and Neutral Indian Ocean Dipole conditions over the Indian Ocean are likely to continue during the winter season. However, the impact of La Niña on the winter season precipitation over northern parts of South Asia is not very clear particularly due to strong day-to-day atmospheric variability over the region.

The outlook for the 2021/22 winter season precipitation and Temperature (Minimum & Maximum) over South Asia is shown in **Fig.1a-c**. The figure illustrates the most likely tercile category¹ as well as its probability for each of the 1° latitude x 1° longitude spatial grid boxes over the region. The box-wise tercile probabilities were derived using an objective approach from an initial set of gridded forecasts from multiple GCMs and consolidated through a consensus-building discussion among climate experts.

The outlook suggests that during the winter season December 2021 to February 2022 (DJF 2021/22) season, above-normal precipitation is likely during the winter season (December 2021 to February 2022) over many areas in the southern part of South Asia. Normal to below-normal precipitation is likely over many areas of the northwestern part of the region, some areas along the foothills of the Himalayas, and the northeastern part of South Asia.

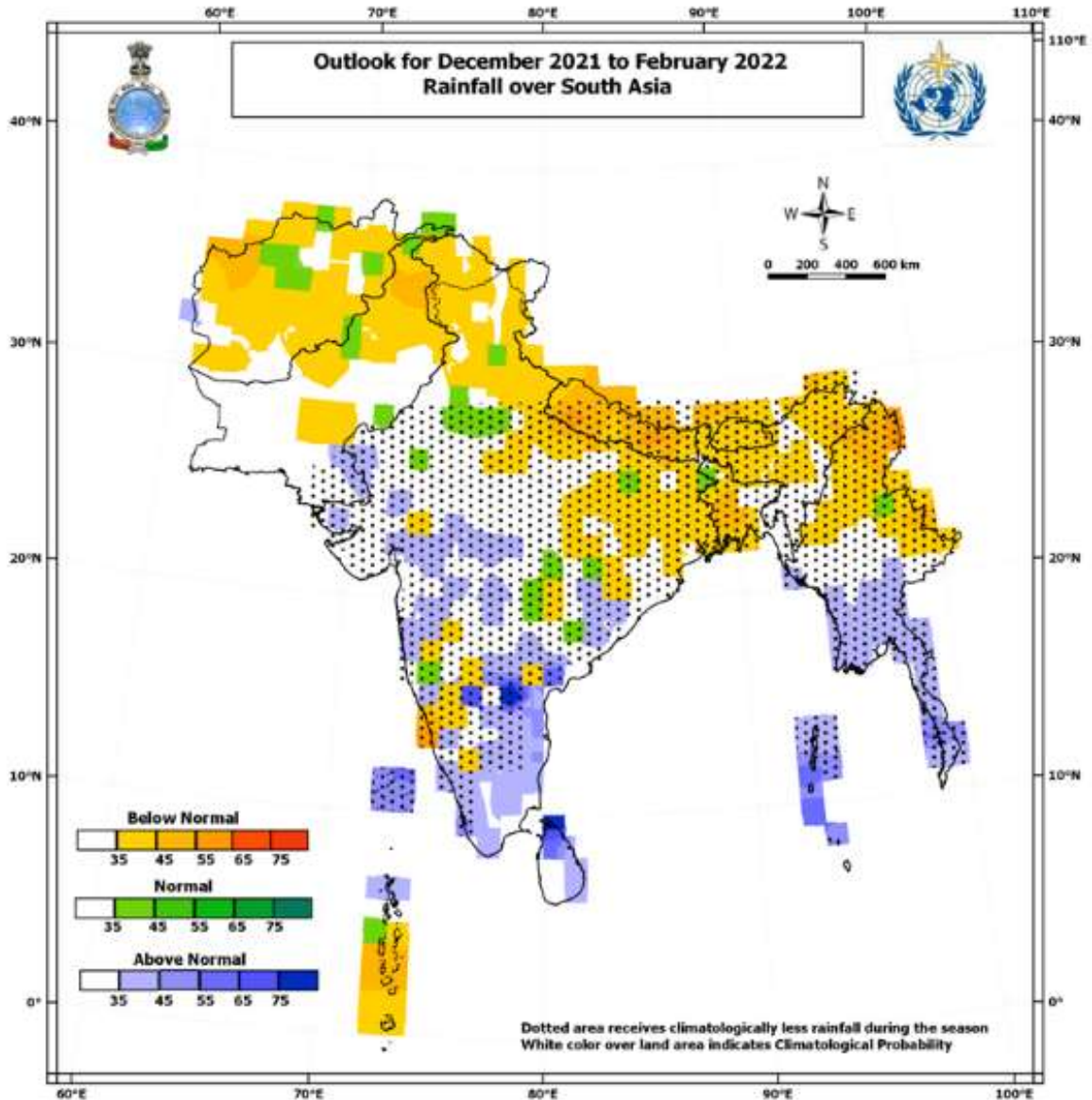


Fig.1a. Consensus outlook for the winter season (December 2021 to February 2022) precipitation over South Asia. The dotted area shown in the map climatologically receives very low rainfall and experience dry weather during DJF season.

¹Tercile categories have equal climatological probabilities, of 33.33% each

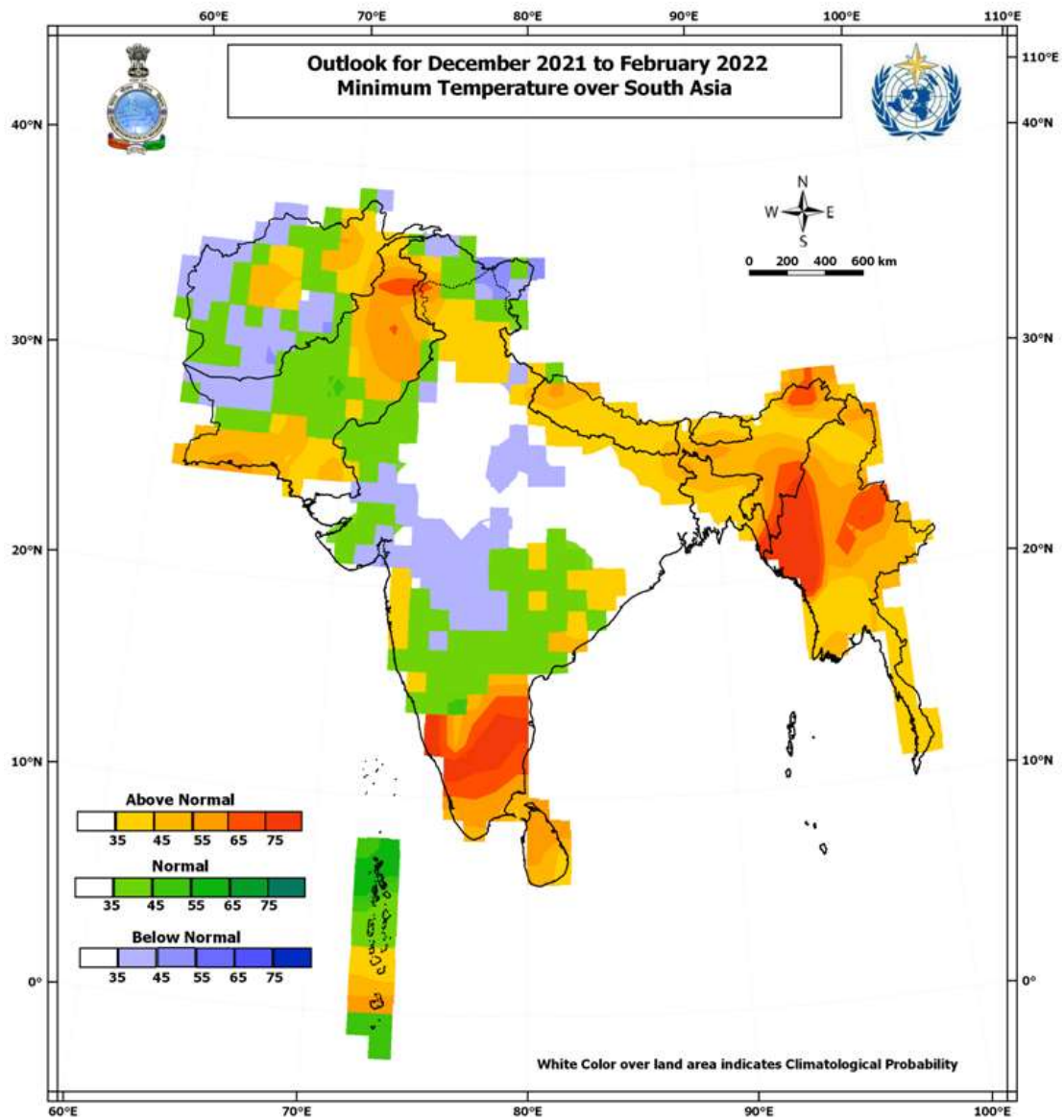


Fig.1b. The consensus outlook for the winter season (December 2021 to February 2022) Minimum Temperature over South Asia.

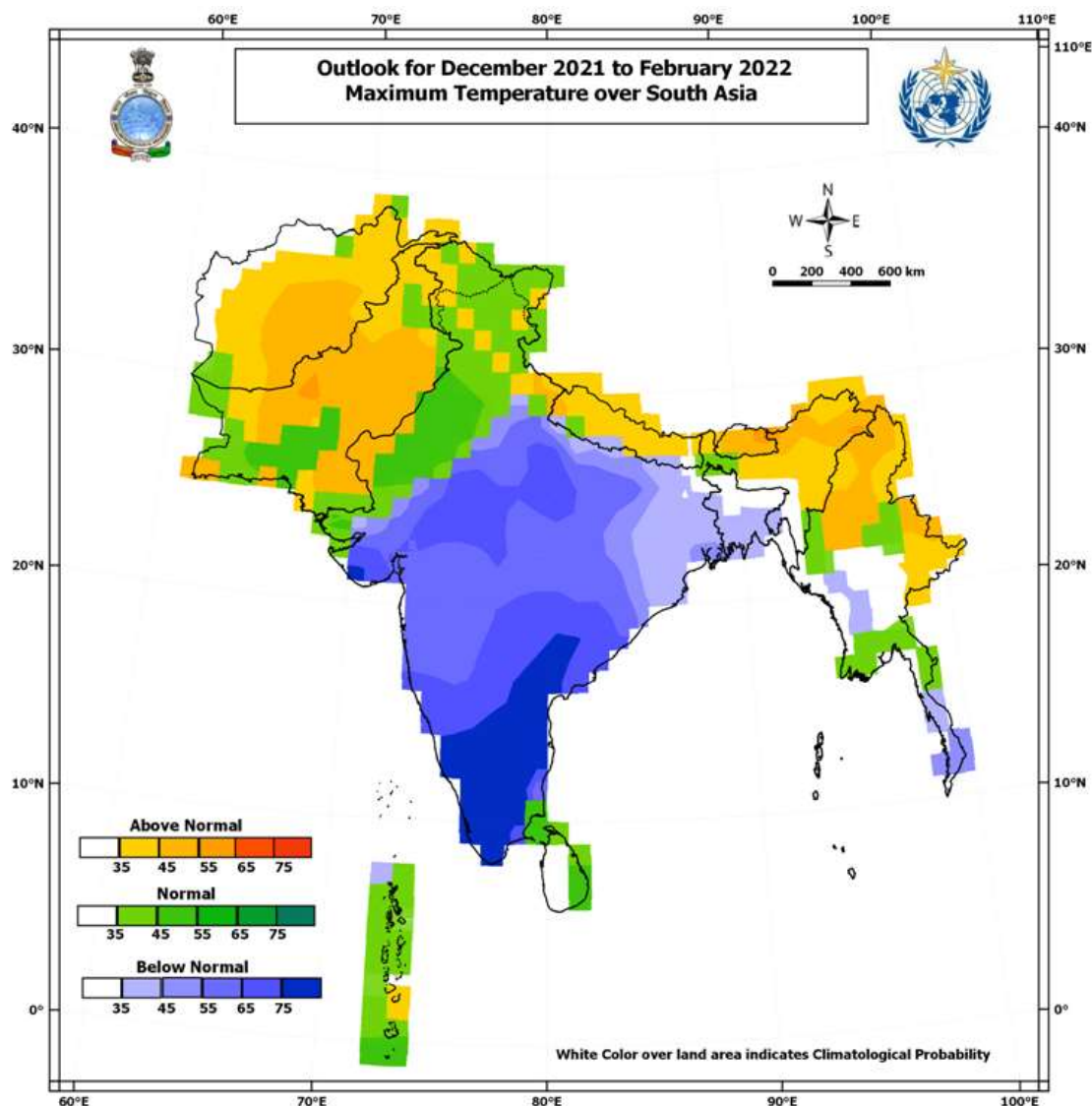


Fig.1c. Consensus outlook for the winter season (December 2021 to February 2022) Maximum Temperature over South Asia.

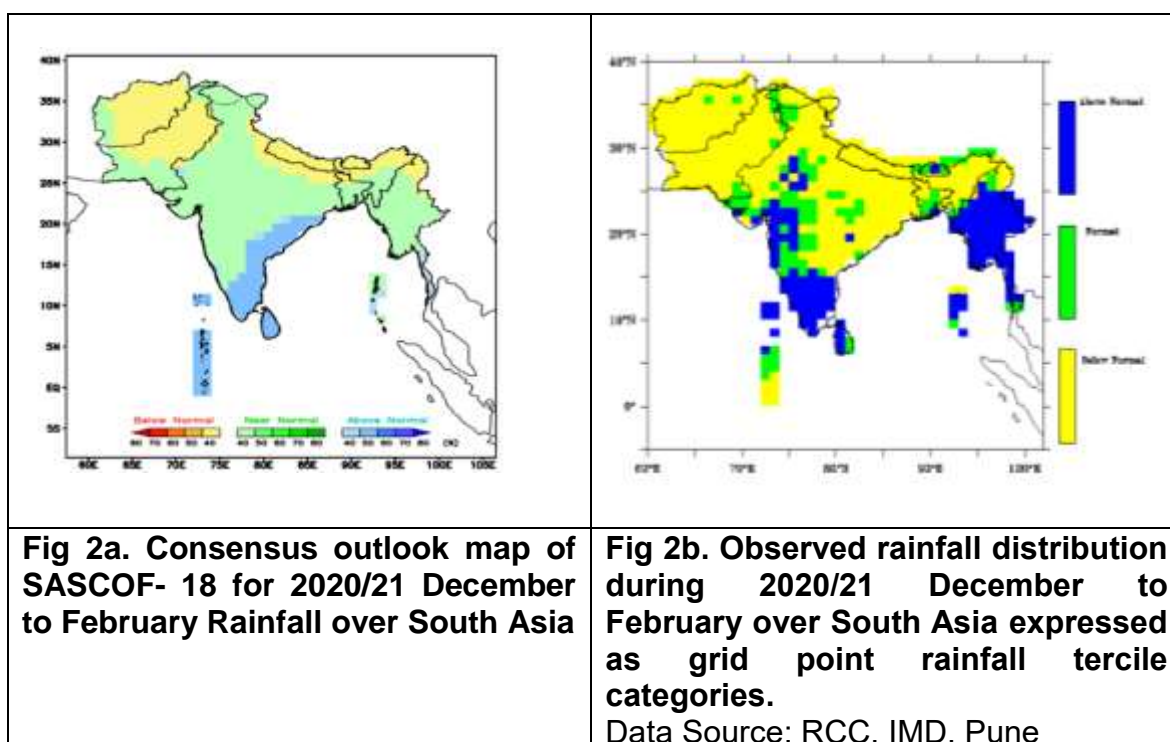
Consensus outlook on minimum temperatures for December 2021 to February 2022 season indicate that above normal minimum temperatures are likely over many areas of the north, northwestern, northeast, southern parts of South Asia and along the plain of Himalayas. However, below normal minimum temperatures are likely over some areas of central and northwest parts of the region. Rest of the region is likely to experience normal rainfall or have climatological probabilities.

¹Tercile categories have equal climatological probabilities, of 33.33% each.

The consensus outlook on maximum temperatures for December 2021 to February 2022 season suggests that Normal to Above normal maximum temperatures are most likely over north, northwest, northeast, along the Himalayas and southernmost parts of the region. Below normal maximum temperatures are likely over the remaining parts of the region.

As the rainfall and temperature during the winter season depict strong intra-seasonal variability, it is advised to watch the extended range forecasts along with updated seasonal forecasts for better decision-making. The extended range forecasts for rainfall, temperature, cyclone genesis, MJO, etc. over the region can be obtained from RCC, Pune website (<http://rcc.imdpune.gov.in/exrange.html>). These forecasts are updated every week.

Verification of consensus outlook (SASCOF- 18) for December 2020 to February 2021 season



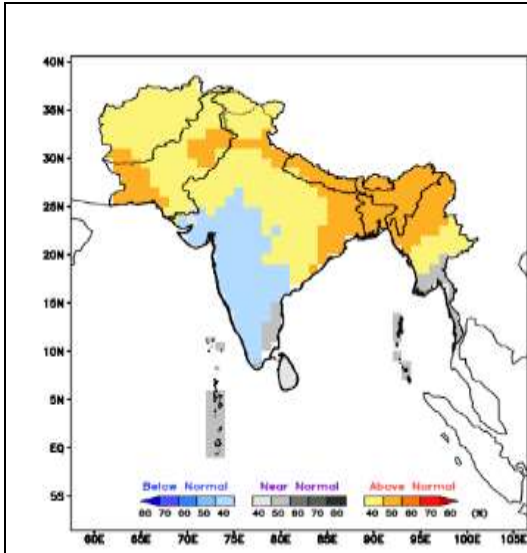


Fig 3a. Consensus outlook map of SASCOF- 18 for 2020/21 December to February Maximum Temperature over South Asia

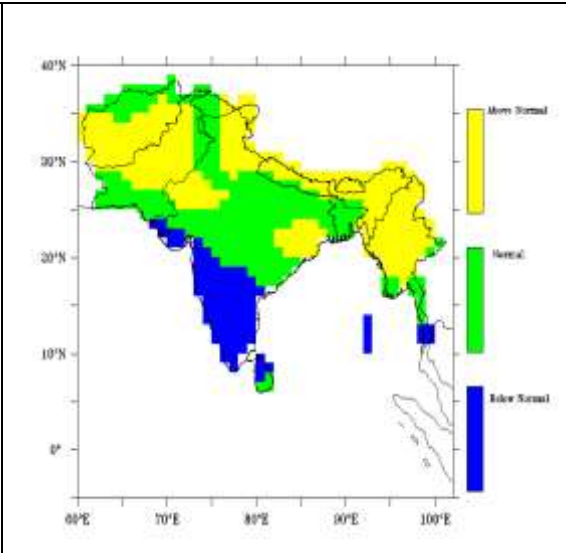


Fig 3b. Observed Maximum Temperature distribution during 2020/21 December to February over South Asia expressed as grid point minimum temperature tercile categories

Data Source: <http://berkeleyearth.org/>

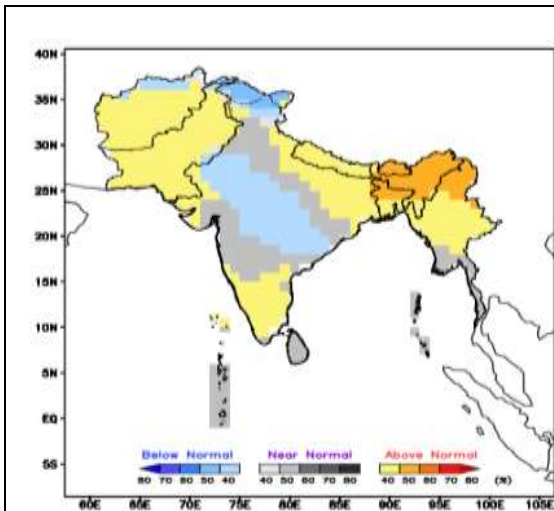


Fig 3c. Consensus outlook map of SASCOF- 18 for 2020/21 December to February Minimum Temperature over South Asia

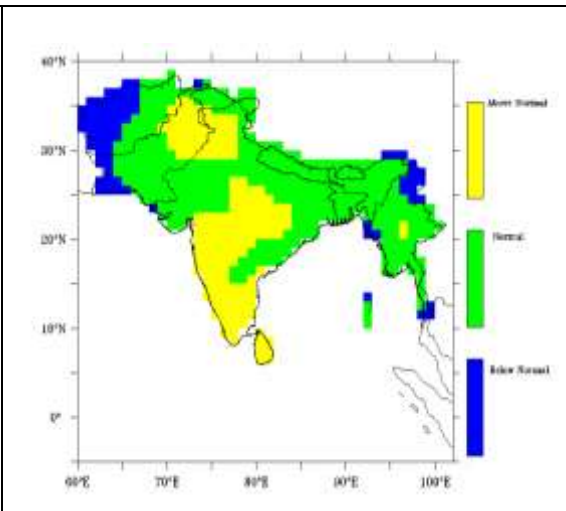


Fig 3d. Observed Minimum Temperature distribution during 2020/21 December to February over South Asia expressed as grid point minimum temperature tercile categories.

Data Source: <http://berkeleyearth.org/>

The consensus forecast outlook map (Fig.2a) for the 2020 December to 2021 February season suggested above normal Precipitation over some areas of the southern part of the region including the eastern part of the peninsular Indian subcontinent, the southeastern part of the region, and islands. Below normal precipitation is observed over some areas of the northwestern part of the region, some areas along the foothills of the Himalayas, and the northeastern-most part of South Asia. Fig. 2b shows the observed rainfall distribution during the 2020 December to 2021 February season expressed in terms of tercile categories. It is seen that above below normal rainfall was received over most parts of north-west south Asia including Pakistan Afghanistan, northern parts of region along the foothills of Himalayas. Above normal rainfall was received over most of the areas of the southern region including islands, some parts of west-central peninsular India, and also over eastern parts of the region.

From the above Figures 2a & 2b, it is visible that many areas of the region where climatologically good amounts of rainfall are received during the season like south India and Sri Lanka both the forecasted and realized rainfall categories were the same. In addition, the below-normal rainfall forecasted over the north and northwestern parts of the region and also over the foothills of the Himalayas were matching very well with the observed category. However, the observed above normal rainfall over Bhutan was forecasted as below normal rainfall. Overall, it can be concluded that the consensus outlook for the 2020 December to 2021 February season rainfall was accurate in most of the areas.

The consensus forecast outlook map for maximum temperature (Fig.3a) for December 2020 to February 2021 season suggested that below normal maximum temperatures over the western half of Peninsular India and neighboring west-central parts of the region. Normal maximum temperatures over southern parts of the region including some areas of southeast India, south Myanmar, Sri Lanka, and islands. Above Normal Maximum Temperature over remaining parts of the region. Fig. 3b shows the observed maximum temperature distribution during the December 2020 to February 2021 season expressed in terms of tercile categories. It is seen that above normal to normal maximum temperature was received over most parts of north-west South Asia including Pakistan and Afghanistan, northern parts of region along the foothills of the Himalayas and some parts of central India and eastern part of the region including Bhutan, Nepal, and Bangladesh. Below normal maximum

temperature was received over most of the areas of southern peninsular India and the northern part of Sri Lanka.

The consensus forecast outlook map for minimum temperature (Fig.3c) for December 2020 to February 2021 season suggested that above normal minimum temperatures over most parts of the region. Below normal minimum temperatures were forecasted over some areas of northernmost and central parts of the region and Normal minimum temperatures over southern parts of South Asia. Fig. 3d shows the observed minimum temperature distribution during the 2020 December to 2021 February season expressed in terms of tercile categories. It is seen that above normal minimum temperature was received over most parts of peninsular India and the northwestern part of the region including Pakistan. The normal minimum temperature was observed over the foothills of the Himalayas, the east coast of India, the eastern part of the region including Bhutan, Nepal, and Myanmar, and some northwest parts of the region. Below normal minimum temperature was received over the extreme northwestern part of the region that includes parts of Afghanistan and Pakistan.

It is clear that above normal to normal maximum temperature received over the most parts of north-west south Asia including Pakistan and Afghanistan, northern parts of region along the foothills of the Himalayas and some parts of central India and eastern part of the region including Bhutan, Nepal, and Bangladesh are well forecasted. The below normal maximum temperature received over southern peninsular India was also correctly forecasted.

The above normal minimum temperature received over the southern part of peninsular Indian is reasonably forecasted. The normal minimum temperature observed over the foothills of the Himalayas, the eastern part of the region including Bhutan, Nepal, and Myanmar, and some northwest parts of the region are forecasted as the above normal minimum temperature. The below normal minimum temperature received over the extreme northwestern part of the region also failed to forecast. The above normal minimum temperature over the northern part of southern peninsular India is forecasted as below normal. However, the normal minimum temperature over the east coast of India was correctly forecasted. In short, it can be concluded that the consensus outlook for December 2020 to February 2021 season maximum temperature was accurate in almost all areas. However, the consensus outlook for December 2020 to February 2021 season minimum temperature failed in some areas.

Climatological Information of Rainfall and Temperature (Maximum & Minimum) over South Asia during December to February Season.

The long-term historical patterns of the rainfall over South Asia during the December to February Season (Fig.4 a & b), characterized by remarkable spatial variability, provide the general reference points at the respective locations for the rainfall anomalies indicated in the outlook. The long-term historical patterns of the Temperature (Minimum and Maximum) over South Asia during the December to February Season (Fig.5 a & b), characterized by large spatial variability, provide the general reference points at the respective locations for the temperature anomalies indicated in the outlook.

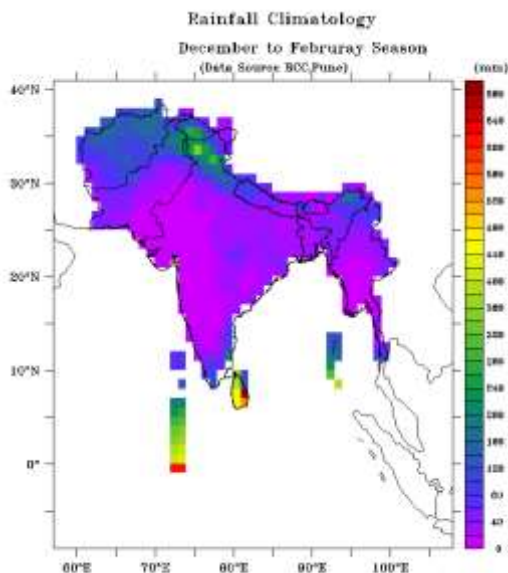


Fig.4 (a) Rainfall climatology for the period 1982-2019 for December to February Season over South Asia

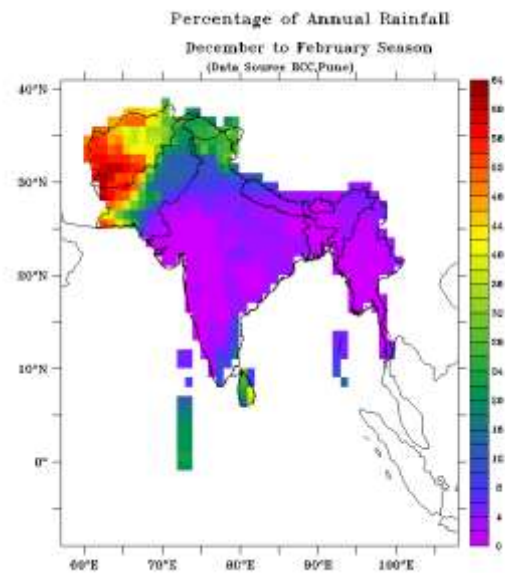


Fig.4 (b) Percentage of annual rainfall for December to February Season over South Asia.

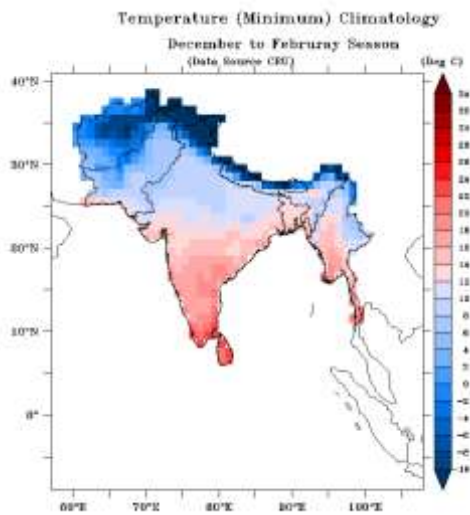


Fig.5 (a) Minimum Temperature climatology for the period 1982-2019 for December to February Season over South Asia

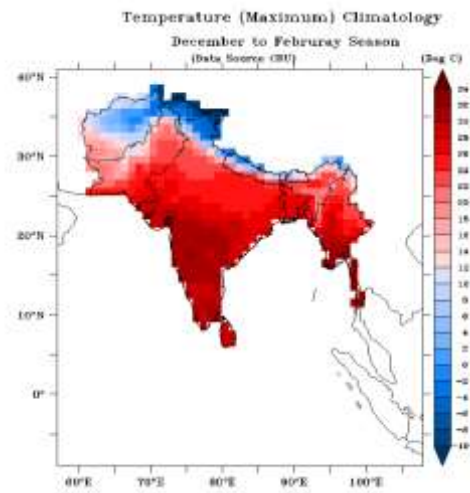


Fig.5 (b) Maximum Temperature climatology for the period 1982-2019 for December to February Season over South Asia