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**Seasonal Outlook for Winter Temperatures and
Rainfall Forecast for December 2021**

Highlights

- a) **Temperature** - During the upcoming winter season (December 2021 to February 2022), normal to above normal minimum temperatures are most likely over many parts of northwest India, most parts of south and northeast India, and some areas along the foothills of the Himalayas. Below normal minimum temperatures are most likely over some parts of north interior peninsula. Below normal maximum temperatures are likely over most parts of the country except over some parts of northwest India and most parts of northeast India, where normal to above normal maximum temperatures are most likely.
- b) **Rainfall** - Monthly rainfall for December 2021 over the south Peninsular India consisting of five meteorological subdivisions of Tamil Nadu, Puducherry & Karaikkal , Coastal Andhra Pradesh & Yanam, Rayalaseema, Kerala & Mahe and South Interior Karnataka is most likely to be above normal (>132% of Long Period Average (LPA)).
- c) **SST Conditions** - Currently, weak La Niña conditions are prevailing over equatorial Pacific region. The latest Monsoon Mission Coupled Forecasting System (MMCFS) forecast indicates that La Niña conditions are likely to strengthen and peak to moderate conditions during the upcoming winter season. At present, neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean and the latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue during the forecast period.

As the changes in the Sea Surface Temperature (SST) conditions over the Pacific and the Indian Oceans are known to influence the Indian climate, IMD is carefully monitoring the evolution of sea surface conditions over these Ocean basins.

Seasonal Outlook for the Temperatures during December 2021 to February 2022 and Rainfall Forecast for December 2021

1. Background

Since 2016, the India Meteorological Department (IMD), Ministry of Earth Sciences (MoES) has been issuing seasonal forecast outlooks for subdivision scale temperatures over the country for both hot and cold weather seasons. These predictions were based on the Monsoon Mission Coupled Forecasting System (MMCFs) Model developed under MoES's monsoon mission project. This year, IMD has adopted a new strategy for issuing monthly and seasonal outlooks of rainfall and temperature over the country. The new strategy is based on the newly developed Multi-Model Ensemble (MME) based forecasting system. The MME approach uses the coupled global climate models (CGCMs) from different global climate prediction and research centers including IMD/MoES MMCFs model. IMD has now prepared seasonal outlook for temperatures over the country for the upcoming winter season (December 2021 to February 2022) and the same is presented in section 2.

The south Peninsular India consisting of five meteorological subdivisions (Tamil Nadu & Puducherry & Karaikkal, Coastal Andhra Pradesh & Yanam, Rayalaseema, Kerala & Mahe and South Interior Karnataka) receives significant amount of rainfall during the month of December due to northeast monsoon. Utilising the new strategy of the MME based forecasting system as discussed above, IMD had issued rainfall forecasts for the 2021 northeast monsoon season (October to December (OND)) and for the months of October and November. Now, IMD has prepared the following monthly rainfall forecast outlook for December 2021 and presented in section 3.

- i. Probabilistic forecast for the rainfall averaged over the south Peninsular India.
- ii. Probabilistic forecast for the spatial distribution of rainfall over the country.

2 Seasonal Temperature Forecast for December 2021 to February 2022

Fig.1 and Fig.2 show forecasted probabilities of the minimum and maximum temperatures respectively for December 2021 to February 2022 (DJF) season. The probability forecast for the minimum temperatures (Fig.1) indicates that during the upcoming winter season (December 2021 to February 2022), normal to above normal minimum temperatures are most likely over many parts of northwest India, most parts of south and northeast India, and some areas along the foothills of the Himalayas. Below normal minimum temperatures are most likely over some parts of north interior peninsula.

The probability forecast for the maximum temperatures (Fig.2) indicates that Below normal maximum temperatures are likely over most parts of the country except over some parts of northwest India and most parts of northeast India, where normal to above normal maximum temperatures are most likely.

3. Probabilistic Forecast for the Monthly Rainfall during December 2021

The 2021 December rainfall averaged over the south Peninsular India is most likely to be above normal (>132% of LPA). The LPA of rainfall over south Peninsular India during December based on the data of 1961-2010 is about 44.54 mm.

The probabilistic forecast for the spatial distribution of tercile rainfall categories (above normal, normal and below normal) over the country for the month of December is shown in Fig.3. The forecast suggests that normal to above normal rainfall is most likely over most parts of south peninsular India except over northwestern areas of the region and in a few small pockets of the region, where below normal rainfall is most likely. The forecast also suggests that below normal rainfall is most likely over most areas of northwest India and some parts of central and northeast India. Normal rainfall is most likely over remaining parts of the country. The dotted areas in the map climatologically receive very less rainfall during December and the white shaded areas within the land areas represent climatological probabilities.

4. SST conditions in the Pacific and the Indian Oceans

Currently, the Sea Surface Temperatures (SSTs) and the atmospheric conditions over the equatorial Pacific Ocean indicate weak La Niña conditions. The latest forecasts from MMCFS and other global models suggest that La Niña conditions are likely to strengthen and peak to moderate conditions during the upcoming winter season.

In addition to El Niño- Southern Oscillation (ENSO) conditions over the Pacific, other factors such as the Indian Ocean SSTs also influence on Indian climate. At present, neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean and the latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue during the forecast period.

5. Extended Range Forecast and short to medium range forecasting services

IMD also provides extended range forecasts (7 –day averaged forecasts for the next four weeks) of rainfall and maximum & minimum temperatures over the country updated every week on Thursday. This is based on the Multi-model ensemble dynamical Extended Range Forecasting System currently operational at IMD. The forecasts are available through the IMD website (https://mausam.imd.gov.in/imd_latest/contents/extendedrangeforecast.php). The extended range forecast is followed by short to medium range forecast issued daily by IMD.

Minimum Temperature Outlook for December 2021 to February 2022

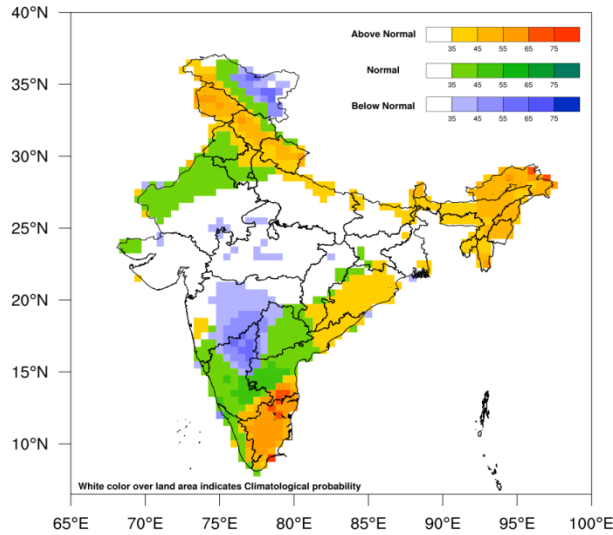


Fig1. Probability forecast of Minimum Temperature for December 2021 to February 2022.

Maximum Temperature Outlook for December 2021 to February 2022

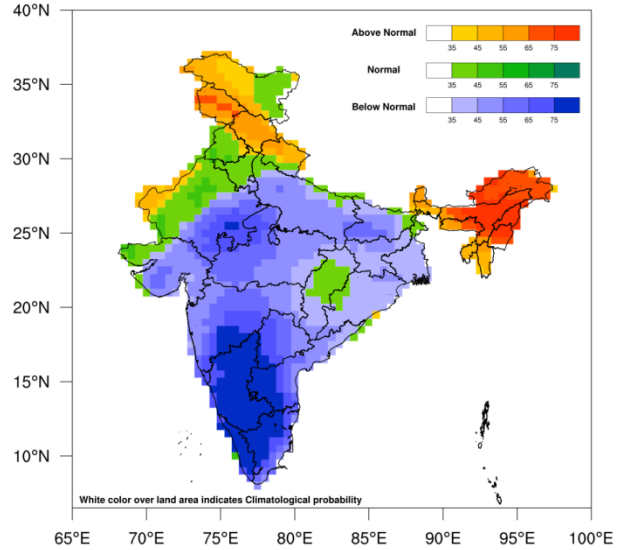


Fig2. Probability forecast of Maximum Temperature for December 2021 to February 2022.

probability rainfall forecast for 2021 DEC

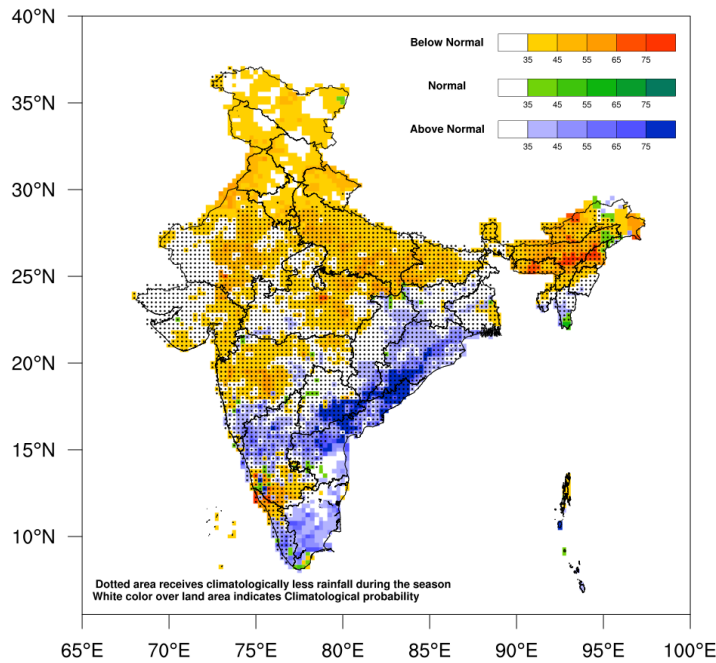


Fig.3. Probability forecast of tercile categories* (below normal, normal and above normal) for the rainfall over India during December 2021. The figure illustrates the most likely categories as well as their probabilities. The dotted area showed in the map climatologically receives very less rainfall during December month and the white shaded areas within the land areas represent climatological probabilities. The probabilities were derived using the MME forecast prepared from a group of coupled climate models. (*Tercile categories have equal climatological probabilities, of 33.33% each).