GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
LOK SABHA
UNSTARRED QUESTION NO. 1839
TO BE ANSWERED ON WEDNESDAY, 29TH JULY, 2026

LONG RANGE FORECAST SYSTEM

1839. SHRI VISHWESHWAR HEGDE KAGERI:

Will the Minister of EARTH SCIENCES be pleased to state:

(a) the details of accuracy levels achieved by the India Meteorological Department's Long Range Forecast system during each of the last ten years, year-wise;
(b) the details of forecast errors recorded during the said period and the number of years in which forecast errors exceeded ten per cent of the Long Period Average;
(c) the extent of improvement achieved following adoption of the Multi-Model Ensemble forecasting system; and
(d) the measures taken by the Government to further improve long-range monsoon forecasting and prediction of extreme weather events in the country and if so, the details thereof, State-wise?

ANSWER
THE MINISTER OF STATE (INDEPENDENT CHARGE) FOR
MINISTRY OF SCIENCE AND TECHNOLOGY
AND EARTH SCIENCES
(DR. JITENDRA SINGH)

(a) Since 2021, the India Meteorological Department (IMD), under the Ministry of Earth Sciences (MoES), has adopted an advanced Multi-Model Ensemble (MME) approach for long-range forecasting. This has significantly improved the accuracy of long-range forecasts, with all forecasts issued since then remaining within the error limits. For example, operational monsoon forecasts since 2021 have been within the forecast error limits, with an average absolute error of 2.2% of the Long Period Average (LPA) over the five years (2021-2025). The year-wise details of the accuracy achieved by the IMD's Long-Range Forecast system during the last ten years are provided in the table below:

All India Monsoon Rainfall			
Year	Actual Rainfall (% of LPA)	First stage Forecast issued in April (Model error ± 5% of LPA)	Second stage Forecast issued in May (Model error ± 4% of LPA)
2015	86	93	88
2016	97	106	106
2017	95	96	98
2018	91	97	97
2019	110	96	96

2020	109	100	102
2021	99	98	101
2022	106	99	103
2023	95	96	96
2024	108	106	106
2025	108	105	106

(b) During the last ten years, the forecast error exceeded 10% of the LPA only once, in 2019, when the absolute forecast error was 14% of the LPA. Since the adoption of the MME strategy in 2021, the India Meteorological Department has significantly improved the accuracy of its long-range forecasts, achieving a mean absolute forecast error of only 2.2% of the LPA.

(c) The India Meteorological Department, under the Ministry, has progressively upgraded its LRF system by adopting an advanced MME forecasting approach based on coupled dynamical climate models. The MME system combines forecasts from multiple climate models, thereby reducing uncertainties associated with individual models and improving the reliability and skill of seasonal forecasts. The adoption of the MME forecasting system has led to a significant improvement in the reliability of seasonal monsoon forecasts. During the period 2021–2025, the average absolute error of the first-stage forecast was 3.1% of the LPA, while the average absolute error of the second-stage forecast further reduced to 2.2% of the LPA. In comparison, the average absolute error during 2016–2020 was 7.8% of the LPA. Thus, the average absolute error has reduced from 7.8% to 2.2% of the LPA, indicating a substantial enhancement in the reliability and skill of the seasonal prediction system following the adoption and operational refinement of the MME forecasting system. The MME system has also enhanced the consistency of forecasts by improving the representation of large-scale climate drivers such as the El Nino–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD), leading to more reliable seasonal monsoon predictions.

(d) Yes. The Government has taken several measures to further improve long-range monsoon forecasting and prediction of extreme weather events in the country. These include:

- Adoption of an advanced Multi-Model Ensemble and coupled dynamical climate models for operational long-range forecasting.
- Continuous upgradation of numerical weather prediction models through improved model physics, higher spatial resolution, advanced data assimilation techniques, and enhanced computational capabilities.
- Capacity enhancement under the Mission Mausam focuses on the modernization of meteorological observation systems through the expansion of the national observation network with additional Doppler Weather Radars (DWRs), Automatic Weather Stations (AWSs), Automatic Rain Gauges (ARGs), upper-air observing systems, wind profilers, and other observing platforms, along with the use of high-performance computing infrastructure and artificial intelligence/machine learning-based forecasting tools.

- Expansion of satellite-based observations through indigenous meteorological satellites and the assimilation of satellite, radar, and in-situ observations into numerical models to improve forecast accuracy.
- Dissemination of weather forecasts and warnings through multiple communication platforms, including mobile applications, APIs, web portals, SMS, television, radio, and social media, in coordination with Central and State Government agencies.

The above measures are being implemented uniformly across the country for the benefit of all States and Union Territories. Therefore, no State-wise allocation or distribution of these measures is maintained.

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