GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
RAJYA SABHA
UNSTARRED QUESTION NO. 3717
ANSWERED ON 03/04/2025

MONSOON FORECAST AND CLIMATE RESILIENCE

3717. SMT. RANJEET RANJAN:
SHRI NEERAJ DANGI:
SHRI AKHILESH PRASAD SINGH:

Will the Minister of EARTH SCIENCES be pleased to state:

(a) the measure taken to improve the accuracy of monsoon forecasting models used by the India Meteorological Department (IMD) in 2024 and the improvements planned for 2025;
(b) the steps taken to strengthen climate resilience in monsoon-dependant agricultural areas; and
(c) the role of satellite-based monitoring in improving weather forecasting and disaster preparedness?

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

(a) The India Meteorological Department (IMD) has adopted a new strategy for issuing monthly and seasonal operational forecasts for the southwest monsoon rainfall over the country based on both the statistical forecasting system and 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's Monsoon Mission Climate Forecasting System (MMCFS) model. The MMCFS and MME forecasts are updated every month. This was to satisfy the demands from different users and Government authorities for the forecasts of the spatial distribution of monthly and seasonal rainfall along with the regionally averaged rainfall forecasts for better regional planning of activities.

Since introducing the Statistical Ensemble Forecasting System (SEFS) in 2007 and implementing the MME approach in 2021 for seasonal forecasting, IMD operational forecast for the monsoon rainfall has shown noticeable improvement. For example, the average absolute forecast error in the forecasting of all India's seasonal rainfall has reduced by about 21% during the recent 18 years (2007-2024) compared to the same number of previous years (1989-2006), which indicates a highly successful forecast in recent years compared to previous years. The anomaly correlation between the observed and forecast ISMR during 2007-2023 was 0.55 compared to -0.21 during 1989-2006. It may be noted that IMD was able to correctly forecast the twin deficient monsoon years of 2014-2015, as well as the below-normal rainfall in 2023 and above-normal rainfall in 2024. These clearly indicate improvement made in the operational forecast system in the recent 18 years period compared to the earlier 18 years period. For 2025, the MME approach will continue to be used as this method introduced in 2021 has shown good skill in forecasting both the area-averaged rainfall at various geographical regions and spatial distribution of rainfall across the country at monthly as well as seasonal scales.

(b) To strengthen weather and climate services for the agriculture sector, the MoES has launched the Mission Mausam, which is envisaged to be a multi-faceted and transformative initiative to boost India's weather and climate-related science, research, and services. The Mission is launched to make Bharat a weather-ready and climate-smart nation with the aim that no weather will go undetected and early warning for all. It will help monsoon-dependent agricultural regions, citizens, and last-mile users to tackle extreme weather events and the impacts of climate change in a better way.

Further, the Mission's focus includes improving the observations by augmenting various observational networks throughout the country to provide highly accurate and timely weather and climate information across temporal and spatial scales, capacity building, and awareness generation. Apart from physics-based numerical models, the Ministry is developing new methods based on artificial intelligence (AI) and machine learning (ML) technologies for weather, climate, and ocean forecasting systems. And the formulation of collaborative research projects with academic institutions to share knowledge and develop innovative solutions for weather forecasting and climate modeling capabilities. Local user communities such as farmers/agricultural authorities, aviation authorities, power generation & distribution agencies, industries, health agencies, etc., are constantly involved/engaged, and periodic familiarization is imparted through user meet/stakeholder meet awareness programs, etc. The feedback is taken from the communities for the improvement of all-weather & climate services. Extensive use of local languages in forecast dissemination and regularly organizing workshops and awareness programs for community outreach is being undertaken.

By strengthening the observational network will also help to observe the changes in long-term weather patterns compared to past years to assess the changes in the climate and take measures towards climate resilience.

(c) The India Meteorological Department (IMD) has been using satellite technology extensively for weather monitoring and forecasting. This started with the use of photographs from Television Infrared Observation Satellites (TIROS-1) launched by the United States of America (USA) in April 1960. These photographs provided new information on cloud systems, including spiral formations associated with large storms, immediately proving their value to operational meteorologists. Over the years, IMD has embraced new developments in satellites and their applications, boosted through global coordination and support, such as geostationary satellites in 1974 and polar-orbiting satellites. With the advent of Indian National Satellites (INSAT) developed by the Space Research Organisation (ISRO) satellites in 1982, IMD has augmented satellite applications utilizing image and data products in collaboration with the ISRO. Currently, IMD is utilizing available international satellites, including European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and INSAT-3DR/3DS, as well as polar-orbiting satellites, including Oceansat-3 and Metop-B/C. The utilization of satellite data and products has improved nowcasting and severe weather along with timely detection of large-scale systems like monsoon circulation, cyclones, western disturbances, thunderstorms, etc. Above 90% of the data in the numerical models run by the Ministry of Earth Sciences (MoES) is satellite-based. The assimilation of satellite data in the models has improved the accuracy in short to medium range forecasting by about 20% to 30%. Algorithms/tools developed by IMD/ISRO and other international institutes, such as EUMETSAT, like nowcast tools, RAPID, Dvorak technique, etc., have improved decision-making and forecasting. These data and products are proven to be useful for disaster preparedness. However, there are still gaps in detecting small-scale weather events, such as cloudbursts, thunderstorms, localized heavy rainfall, squalls, hail storms, etc., due to a lack of high-resolution data, products, and satellite-based tools. Considering this, IMD and ISRO are working together for the development of the INSAT-4 series with better sensors and resolution.

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