GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
LOK SABHA
UNSTARRED QUESTION NO. 2970
TO BE ANSWERED ON WEDNESDAY, 5TH AUGUST, 2026

ADVANCING MONSOON SCIENCE, CLIMATE RESEARCH AND WEATHER FORECASTING

2970. THIRU D M KATHIR ANAND:

Will the Minister of EARTH SCIENCES be pleased to state:

(a) the present status of scientific studies examining long-term changes in monsoon cloud characteristics including their height, intensity, spatial distribution and rainfall-producing capacity and the implications of these changes for climate variability across the country;
(b) the details of framework developed for strengthening climate modelling, satellite observations, atmospheric research and numerical weather prediction to improve understanding of changing monsoon patterns and associated extreme weather events;
(c) the details of assistance provided for expanding observational networks, Doppler Weather Radars and high-resolution climate research programmes;
(d) the coordination with the India Meteorological Department (IMD), academic institutions and international research organisations for advancing monsoon science and climate resilience; and
(e) the details of future plans for improving seasonal forecasts, disaster preparedness and climate adaptation in sectors dependent on the South-West monsoon?

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

(a) Recent studies have shown an increase in the frequency of deep convective clouds and in more intense, short-duration extreme rainfall. A recent study using satellite data showed a significant increase in the cloud top height of deep convective clouds as well as increases in the frequency of occurrence of deep convective clouds over the Indian subcontinent and adjacent oceanic regions (https://doi.org/10.1029/2024GL111394). A significant rising trend in the frequency and the magnitude of extreme rain events, and a significant decreasing trend in the frequency of moderate events over central India have also been studied (https://doi.org/10.1126/science.1132027). The long-term changes in low cloud across the country have also been assessed by IMD (https://doi.org/10.54302/mausam.v68i2.627). The impact of human-induced global climate change on the regional climate and monsoons of the Indian subcontinent, adjoining Indian Ocean and the Himalayas has been studied in detail by the MoES scientists (https://link.springer.com/book/10.1007/978-981-15-4327-2).

(b) The Mission Mausam was envisaged with the sole purpose of creating an integrated framework for strengthening climate modelling, satellite observations, atmospheric research and numerical weather prediction to improve understanding of changing monsoon patterns and associated extreme weather events, including:

(i) Adoption of advanced Multi-Model Ensemble (MME) and coupled dynamical climate models for operational long-range forecasting at monthly and seasonal scale for every month and season.
(ii) Continuous upgradation of Numerical Weather Prediction (NWP) models through improved model physics, higher spatial resolution, advanced data assimilation techniques and enhanced computational capabilities.
(iii) Strengthening of the national meteorological observation network through the installation of additional Doppler Weather Radars (DWRs), lightning network, Automatic Weather Stations (AWSs), Automatic Rain Gauges (ARGs), upper-air observing systems, wind profilers and other observing platforms.
(iv) Expansion of satellite-based observations through indigenous meteorological satellites and assimilation of satellite, radar and in-situ observations for improving forecast accuracy. National Centre For Medium Range Weather Forecasting (NCMRWF) under the Ministry of Earth Sciences (MoES) routinely receives near-real-time satellite observations from major global satellite data providers, including NASA/NOAA, ESA/EUMETCast, CMA, KMA, and JMA, in addition to data from the national agencies ISRO and IMD. The Centre has established the necessary infrastructure to receive and assimilate newly operational international satellite observations designated as WMO Core Data, ensuring their timely utilization in operational numerical weather prediction (NWP) data assimilation systems.
(v) Development of indigenous, technology-driven, and citizen-centric weather forecasting systems that strengthen disaster preparedness and improve public safety across India. IMD's in-house developed Decision Support System (DSS) is a major step in the direction of promoting self-reliance under the "Atmanirbhar Bharat" initiative.
(vi) 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.
(vii) In collaboration with the Ministry of Panchayati Raj, IMD has developed the Panchayat Mausam Seva Portal, providing Panchayat-level weather forecasts through e-GramSwaraj (https://egramswaraj.gov.in), Meri Panchayat App, e-Manchitra and Mausamgram (https://mausamgram.imd.gov.in). The mobile numbers of Panchayat Members, Ward Members and Panchayat Secretaries have been integrated with the Panchayat Mausam Seva Portal, enabling timely dissemination of weather forecasts and agrometeorological advisories through WhatsApp for further dissemination at the Gram Panchayat level. IMD also leverages the Krishi Sakhis and Pashu Sakhis network of the Ministry of Rural Development for last-mile dissemination of weather forecasts and agrometeorological advisories.

(viii) NCMRWF has developed two state-of-the-art climate reanalysis datasets: a global reanalysis covering 1992–2018 at 25 km horizontal resolution (NGFS) and a regional reanalysis covering 1979–2020 at 12 km horizontal resolution (IMDAA). These long-term, high-resolution datasets provide a valuable foundation for climate diagnostics, variability studies, and the development of AI/ML based climate applications at both national and international levels. The bias-corrected reanalysis products play a crucial role in the robust assessment of climate variability and extremes, including heatwaves, cold waves, cyclones, and heavy rainfall events. Building on these achievements.

(c) The Mission Mausam Program of the Ministry of Earth Sciences (MoES) is assisting implementation of Higher-resolution atmospheric observations, Next-generation radars, High-Performance Computers (HPC), developing improved earth system models and data-driven methods (use of AI/ML), developing a state-of-the-art Decision Support System (DSS) and dissemination system for last-mile connectivity.

(d) Under Mission Mausam, extra-mural projects are awarded to academic and research institutes across India and abroad for advancing monsoon research and prediction. IMD coordinates with national and international institutions to strengthen monsoon science, improve weather and climate prediction, and enhance climate resilience. The major collaborative initiatives include:

(i) Collaboration with academic and research institutions, including the Indian Institutes of Technology (IITs), universities and other national research organizations, for research on monsoon dynamics, climate variability, numerical weather prediction and extreme weather events.
(ii) Active participation in programmes of the World Meteorological Organization (WMO) and collaboration with international meteorological and climate research organizations for exchange of scientific knowledge, observational data, modelling techniques and best practices.
(iii) Cooperation with national agencies engaged in Earth system science for strengthening weather and climate services through improved observations, modelling, forecasting and impact-based early warning systems.
(iv) Joint research, capacity building, training programmes, workshops and scientific exchanges with national and international institutions to advance understanding of monsoon processes and improve forecasting capabilities.
(v) Continuous engagement with Central and State Government agencies, research institutions and disaster management authorities to translate scientific advances into improved climate resilience and weather-related risk reduction.

(e) Indian Institute of Tropical Meteorology (IITM) is using the latest version of the Monsoon Mission forecast system now. The plan is to improve the seasonal prediction model with in-house developed oceanic fluxes, inclusion of a new land surface model, river routing, etc as modified components of the seasonal prediction system. This is supposed to improve the skill of the model not only in predicting the all-India rainfall, but also its usefulness for applications such as extreme weather predictions during the monsoon period.

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