PARLIAMENT QUESTION: MONITORING AND PREDICTION OF CLIMATE CHANGE

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The Ministry of Earth Sciences (MoES) has a very good weather observation network consisting of Manual observatories, Automatic Weather Stations (AWSs), upper-air observatories, and Remote sensing tools such as Doppler Weather Radars (DWRs) and Satellites to observe and monitor climate change and extreme weather events across the country. The details are given below:-

- A state-of-the-art climate model with improved representation of Earth system processes is being developed at the Indian Institute of Tropical Meteorology (IITM, Pune) to improve the prediction of climate change. As part of model development, increased horizontal resolution, Indian Land-use land-cover data from the National Remote Sensing Centre, and glacier components are integrated into the Earth System Model. In addition, an improved cloud microphysics scheme and hybrid (Physics-informed Neural Network) parameterizations (use of AI/ML) for improving the physics and reducing the model biases are also being implemented at IITM.
- AI/ML is used for detection and attribution of climate change and downscaling climate projections, identifying climate fingerprints in heatwaves, heavy rain, cyclones, and estimating anthropogenic contributions.
- Mission Mausam is also launched by the Government of India, under the Ministry of Earth Sciences, to strengthen the country's climate preparedness. Under Mission Mausam, initiatives have been taking place to increase the observational network for monitoring climate change. Climate reference stations are being established across India for continuous monitoring of climate parameters.
- For the forecasting of extreme weather events, two global models forecast systems, such as GFS 12 km and NCUM 12 km, have been operational since 2018. In addition, the New Bharat Forecasting System (BharatFS) was made operational in May 2025 with a very high resolution of 6 km to cater to generate forecast as very high resolution.
- To provide computational support for such high-resolution models and to enable regular real-time operation, the computing facilities have also been substantially increased in computational power to integrate voluminous data and run mesoscale, regional, and global models at higher resolution.
- Recently, with "Arunika" and "Arka" systems, the Ministry of Earth Sciences has enhanced its total computing power to 28 Peta FLOPS in 2025, a substantial increase from the previous capacity of 6.8 Peta FLOPS, which was in 2014. For automation and integration of data and forecasts.

- IMD has also developed an end-to-end GIS-based Decision Support System (DSS), which has been working as the front end of the early warning systems for the timely detection and monitoring of all-weather hazards.
- This system uses all historical data, their extremes, as well as real-time surface and upper-air meteorological observations available to it for the Indian region and neighbourhood. It also includes radar observations available every 10-minutes and satellite products every 15 minutes. It also uses Numerical Weather Prediction (NWP) products from a suite of models run in MoES. For providing impact-based forecasts and warnings, the DSS integrates exposure data with hazard data in the system.

IMD continues to expand and upgrade its observational systems, such as Doppler Weather Radars (DWRs), Automatic Weather Stations, Automatic Rain Gauges, and upper-air systems. Numerical weather prediction systems have been improved with higher-resolution models, better data assimilation, and the use of the Multi-Model Ensemble (MME) approach.

The current DWR network of 48 DWRs covers about 92% of the country's total area. Further 6726 rain gauge stations, 1008 AWS, 186 runway visual range systems, 56 RS/RW stations, and 36 High wind speed recorders have been installed and are operational. To date 104 lightning location networks are also available across the India. Impact-Based Forecasting services and early warning dissemination have been strengthened through mobile applications, web portals, SMS alerts, and closer coordination with disaster management authorities.

The India Meteorological Department has developed advanced techniques for generating high-resolution gridded datasets of rainfall and temperature over India. These datasets are produced by integrating observations from a large network of meteorological stations and applying rigorous quality control and spatial interpolation techniques. These datasets are made available to research institutions, government agencies, and other stakeholders to support evidence-based planning, policy formulation, and scientific research.

These initiatives contribute to strengthening environmental policy and disaster management by enhancing early warning systems and supporting evidence-based decision-making and planning. In addition, the development of Earth System models through the incorporation of new Earth System components and AI/ML-based hybrid parameterization supports more reliable regional climate projections.

The India Meteorological Department has taken significant steps to enhance training, strengthen international cooperation, and expand awareness activities for improved climate and weather services. IMD actively collaborates with global and regional agencies—including WMO, WHO, UKMO, RIMES, UNESCAP, and all South Asian countries—to advance climate services in India and contribute to the regional climate services framework. IMD experts participate in several high-level international committees such as the WMO Task Team on the National Framework for Climate Services (TT-NFCS), the Climate Services Working Group of the South Asian Hydromet Forum (SAHF), and CLIVAR scientific panels, ensuring India's strong presence in global climate service development and international cooperation. Capacity building is further strengthened through numerous international training programmes conducted by IMD’s Meteorological Training Institute (MTI), which regularly hosts participants from developing and neighbouring countries. These combined efforts are substantially contributing to more robust climate services, improved early warning capabilities, and better-informed decision-making across sectors in India.

The initiatives of the India Meteorological Department, including improved forecasting systems and impact-based advisories, provide reliable scientific data and real-time information to governments and stakeholders. Tools such as the Bharat Forecast System, which offers high-resolution forecasts at around 6 km spatial scale, allow authorities to understand localized weather patterns and climate risks more accurately. These advancements have enhanced evidence-based environmental policymaking by enabling policymakers to integrate climate data into planning for sectors such as agriculture, water management, urban infrastructure, and public health. Accurate forecasts and climate outlooks support informed decisions related to crop planning, heat-action plans, flood management, and climate adaptation strategies.

Furthermore, IMD's impact-based forecasts, heavy rainfall warnings, flash-flood guidance, and urban flood advisories have strengthened disaster preparedness and early warning systems. State Governments and disaster management agencies can now take timely preventive measures, such as evacuations, resource mobilization, and infrastructure protection, which help reduce loss of life and property during extreme weather events.

Overall, these proactive measures have played an important role in building climate resilience and promoting sustainable development across rural and urban areas by improving risk awareness, enabling adaptive planning, and strengthening institutional response mechanisms to climate-related hazards.

This information was submitted by Union Minister of State (Independent Charge) for Earth Sciences and Science & Technology, Dr. Jitendra Singh in Rajya Sabha on 19 March 2026.

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