GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
RAJYA SABHA
UNSTARRED QUESTION No. 2131
ANSWERED ON 06/08/2026

ACCURACY OF FORECASTING

2131. # SHRI MAYANKKUMAR NAYAK:
SMT. SEEMA DWIVEDI:
SHRI KESRIDEVSINH JHALA:
SHRI BABUBHAI JESANGBHAI DESAI:
DR. SANDEEP KUMAR PATHAK:

Will the Minister of **EARTH SCIENCES** be pleased to state:

(a) the developmental achievements recorded under Mission Mausam;
(b) the technical specifications of High-Performance Computing (HPC) infrastructure established to support the Mission, including its total processing capacity;
(c) the improvements in accuracy of forecasting cyclonic disturbances and high-impact weather events following the operationalisation of Mission Mausam; and
(d) the estimated socio-economic transformation and benefits likely to accrue from the enhanced accuracy of weather forecasting services under this framework?

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

(a) Mission Mausam was launched on January 14, 2025, with the core objective of making India a "Weather-ready and Climate-smart" nation by exponentially enhancing the country's earth system observations, modeling, and forecasting capabilities. The major milestones recorded since its approval and implementation include:

- Operationalization of Next-Generation Forecast Frameworks:
    - The Mithuna Forecast System (MFS), a coupled atmosphere–land–ocean–sea ice system integrating internal data assimilation and ensemble predictions became operational at NCMRWF on the Arunika HPC in November 2025. The Mithuna-Regional configuration assimilates Indian Doppler Weather Radar (DWR) observations to provide enhanced high-resolution weather forecasts over the Indian landmass.
    - The Bharat Forecast System (BharatFS) has been successfully operationalized for short-range and extended-range forecasting, utilizing a very high resolution of 6 km to deliver localized updates down to the block and panchayat levels.

- Establishment of Specialized Observational & Research Testbeds:
    - Urban testbeds and meso-networks have been deployed in Delhi (comprising 3 capital observatories and 185 automatic weather stations) and are actively in progress in Chennai (comprising coastal/urban center observatories and 26 automatic weather stations).
    - A dedicated Coastal Research testbed has been set up at Visakhapatnam.
    - Specialized laboratories have been developed in Pune, including an Aerosol Laboratory, a fog dispersion chamber, and systems for 3D-printed Automatic Weather Station (AWS) development and ice nucleation parameterization for monsoon clouds.
- Global Transition Systems and Outreach:
    - Implementation of the WMO Information System 2.0 (WIS2.0) on a standalone server to manage the global transition from the legacy Global Telecommunication System (GTS), optimizing the reception and distribution of global observational data.
    - Two Direct Broadcast Network (DBNet) stations are undergoing implementation at Delhi/NCR and Chennai to improve real-time Low Earth Orbiting (LEO) satellite data processing.
    - Approval and rollout of the tender for the Earth System Visualization Using Science on Sphere (EViSoS) platform to synthesize operational forecasts and climate reanalysis for research, education, and outreach.

(b) Technical specifications of the High-Performance Computing (HPC) infrastructure established to support the Mission, including its total processing capacity: To meet the high computational demands of localized mesoscale models, the Ministry of Earth Sciences has boosted its aggregate processing capability to 28 Peta FLOPS in 2025, marking a significant upgrade from the 6.8 Peta FLOPS available in 2014. This total incorporates a combined core processing capacity of 22 Peta FLOPS provided by the twin supercomputing systems, supplemented by a standalone 1.9 Peta FLOPS system specifically designated for Artificial Intelligence and Machine Learning (AI/ML) applications. The detailed system architecture and storage metrics for the core computing platforms are outlined in Table below:

Table: Technical Specifications of the High-Performance Computing (HPC) Infrastructure at the Ministry of Earth Sciences

Component / Parameter	**ARKA HPC (IITM, Pune)**	**ARUNIKA HPC (NCMRWF, Noida)**
Total System Capacity	11.77 Peta FLOPS	8.24 Peta FLOPS
CPU Specifications	2,115 CPUs (Rpeak: 10.70 PF)	3,021 CPUs (Rpeak: 7.49 PF)

GPU Specifications	18 GPUs (Rpeak: 1.07 PF)	26 GPUs (Rpeak: 0.75 PF)
Compute Node Setup	2 x AMD Milan 7643, 48c, 2.3GHz	2 x AMD Milan 7643, 48c, 2.3GHz
Node Memory (Compute / GPU)	256 GB / 512 GB DDR4	256 GB / 512 GB DDR4
Accelerator Card per Node	4 x Nvidia A100 GPU 80GB SMX	4 x Nvidia A100 GPU 80GB SMX
Total Distributed Storage	33 Petabytes (29PB Home / 4PB Scratch)	23.1 Petabytes (20.3PB Home / 2.8PB Scratch)
Throughput (Home / Scratch)	304.5 Gbps / 1280 Gbps	435 Gbps / 1640 Gbps

(c) Improvements in the accuracy of forecasting cyclonic disturbances and high-impact weather events after the operationalisation of Mission Mausam: Enhanced numerical prediction configurations and model physics under Mission Mausam have yielded major improvements in short-to-medium range early warning capabilities:

- Cyclone Forecasting Errors and Accuracy:
  - Real-time track guidance provided by the NCMRWF Ensemble Prediction System to the India Meteorological Department (IMD) has reduced the mean direct position track error over the three seasons from 2023 to 2025 across all lead times.
  - At Day 1 lead time, track position error decreased from 78 km to 56 km (a 28% reduction).
  - At Day 3 lead time, track position error decreased from 154 km to 114 km (a 26% reduction).
  - At Day 5 lead time, track position error saw the largest decline, dropping from 251 km to 149 km (a 41% reduction), expanding early evacuation windows.
  - Overall cyclone track prediction accuracy has risen by 10–15% up to 72 hours and by 25–30% for 96–120 hours. Landfall point forecasting accuracy has improved by 64–72% up to 96 hours and by 90% at 108 hours.

- High-Impact Severe Weather Events:
  - Heavy Rainfall (>6.5 cm): Forecasting skill over the past 5 years improved by 27% at Day 1 and 17% at Day 3. The warning lead period for heavy rainfall has extended by 4 days compared to baseline trends before 2020, paired with up to a 45% increase in the Probability of Detection (POD).
  - Monsoon Rainfall & Extremes: Extended-range monsoon rainfall prediction skill increased by 15% for Week 1 and 18% for Week 3.

- Heatwaves and Cold-waves: Heatwave 5-day lead forecast accuracy during 2021–2025 matched the accuracy level of previous 3-day forecasts. Cold-wave forecasting accuracy for a 4-to-5 day lead time registered an improvement of 65% over earlier tracking periods.
- Thunderstorms: 24-hour thunderstorm forecast accuracy improved by 30% relative to the 2016–2020 period.

(d) Estimated socio-economic transformation and benefits likely to accrue from the enhanced accuracy of weather forecasting services under this framework: The precision achieved under Mission Mausam is delivering quantifiable benefits across multiple public and economic sectors:

- Drastic Reduction in Loss of Human Life and Public Property: Advanced, impact-based meteorological warnings have dramatically minimized extreme weather mortality rates. National cyclone fatalities have decreased from historical highs of over 10,000 in 1999 to double-digit figures in the recent decade. Heatwave deaths dropped from 2,040 in 2015 to fewer than 100 by 2022. Flash flood fatalities have been substantially curbed, directly saving the government exchequer from massive financial expenditure towards ex-gratia payments, rapid emergency evacuations, and long-term rehabilitation schemes.
- Grassroots Agricultural Empowerment: In tandem with the Ministry of Panchayati Raj, IMD has operationalized Panchayat-Level Weather Forecasts (GPLWF) covering nearly all Gram Panchayats across the nation. Accessible via digital portals like *e-Gramswaraj* and *Mausamgram*, this system equips farmers with precise localized metrics (temperature, humidity, and cloud conditions) that enable data-driven decisions on sowing, irrigation, and harvesting.
- Public Health and Environmental Management: High-performance systems have successfully enhanced air quality forecasting, providing exact early projections of severe pollution episodes over regions like Delhi-NCR. This forms the direct scientific core for activating the Graded Response Action Plan (GRAP) in advance, lowering public exposure to hazardous elements, cutting healthcare operational burdens, and improving local environmental governance.

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