GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
LOK SABHA
UNSTARRED QUESTION NO. 1902
TO BE ANSWERED ON WEDNESDAY, 11TH FEBRUARY, 2026

ACCURATE WEATHER FORECASTING

†1902. SHRI SANATAN PANDEY:

Will the Minister of EARTH SCIENCES be pleased to state:

(a)   the details of new techniques being used by the Government for accurate weather forecasting in view of the rapidly changing weather pattern and natural calamities during the last few years;
(b)   whether any new technology is under consideration to be used in future and if so, the details thereof; and
(c)   the details of types of technologies for which we are dependent on foreign institutions for weather forecasting?

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

(a)   In view of the occurrences of higher frequencies of natural calamities during the last few years, the Government has strengthened and modernized observational systems, developed and operationalized new weather and climate models to improve the prediction of various severe weather events at a more granular scale. Systematic modernisation activities undertaken through Monsoon Mission and Mission Mausam to increase High Performance Computing (HPC), data integration, and the application of new techniques and technologies, such as AI/ML-based systems, to the weather prediction methodology. Some of the major progress achieved till 2025, compared to 2014, is given in Annexure-1.

Under Monsoon Mission and Mission Mausam, two global forecast models, such as GFS 12 km and NCUM 12 km, have been operational in real time since 2018. The Bharat Forecasting System (BharatFS) has been operational since May 2025 at a very high resolution of 6 km to cater to block-levels and, further, to panchayat levels.

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 the implementation of the HPC Systems "Arunika" and "Arka", 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 in 2014.

To automate and integrate data and forecasts, IMD has developed an end-to-end GIS-based Decision Support System (DSS) that serves as the front end of the early warning systems for the timely detection and monitoring of all-weather hazards. It is supported by specific severe weather modules to provide timely, impact-based early warnings for extreme weather events such as cyclones, heavy rainfall, thunderstorms, lightning, fog, and heatwaves, which have devastating impacts on human lives, livelihoods, and infrastructure. 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 available every 15 minutes. It also uses Numerical Weather Prediction (NWP) products from a suite of models run in MoES. To provide impact-based forecasts and warnings, the DSS integrates exposure and hazard data.

(b)   Yes. To address further gap areas in the weather and climate services and to effectively use new technologies in the future, the Ministry of Earth Sciences has implemented Mission Mausam Scheme. Mission Mausam Scheme is a multi-faceted and transformative initiative to boost India's weather and climate-related science, research, and services. In addition, the integration of artificial intelligence (AI) and machine learning (ML) technologies is also improving the precision of predictions by enhancing model accuracy and prediction resolution.

(c)   MoES institutions rely on foreign institutions primarily for core modeling frameworks, advanced assimilation techniques, and high-end computing hardware related to numerical weather prediction.

Core Modeling Frameworks: Through MoES, NCMRWF (National Centre For Medium Range Weather Forecasting) is a core partner in the "Momentum" partnership with the UK, Australia, New Zealand, and Singapore. The aim of the Momentum Partnership is to provide a framework for all partners to effectively use and contribute to the development of a world-leading seamless modelling framework for NWP. The NCMRWF-NWP system is based on the Momentum Partnership's advanced Unified Model system. This modelling system used an advanced dynamical core (END Game) and representation of physical processes. The data assimilation system is Hybrid 4D-Var. The ensemble prediction system used the En-4DEnVar system. 4D-Var/Hybrid Data Assimilation: UKMO-sourced variational codes customized for NCUM, handling radar/satellite observations critical for monsoon/cyclone initialization.

Hardware and Software: Supercomputing Components: NVIDIA/AMD GPUs in Arunika supercomputer, plus CUDA libraries for AI/ML acceleration (GraphCast/Pangu downscaling).

Parameter/ System	December 2014	December 2025
Automatic Weather Station network	12	1008
Doppler Weather Radar	15	47
Rain Gauge Stations	3500	6700
Runway Visual Range Systems	20	186 (49 Drishti + 137 FSM RVR)
Current weather indicating systems at RWY	29 Airports out of 99 Airports	All airports are equipped with RWY instruments, including all new airports (137 Digital Current Weather Indicating System at 93 Airport out of 107 Airports)
Pressure measuring	Mercury Barometers	Digital Barometers
No of stations for City forecasts	300 cities	1601 cities
Nowcast stations	141	1211
High Performance Computing (HPC)	1.1 Peta flops Processing speed	28 Peta flops Processing speed
Upper air observations	43 RS/RW Stations 62 Pilot Balloon stations	56 RS/RW Stations. 62 Pilot Balloon stations
High Wind Speed Recorders	19	36 (Goa station decommissioned)
Early Warnings for Tropical Cyclones	No extended range outlook was issued. No pre-genesis forecast of track & intensity was issued. Early Warnings for Tropical Cyclones were issued 3 days in advance from	Since April, 2018, extended range outlook are being issued for cyclogenesis over entire North Indian Ocean for next two weeks every Thursday. Since April, 2022, pre-genesis forecast of track & intensity are being issued from low pressure stage itself. Early Warnings for Tropical Cyclones were issued 5 days in advance from deep depression stage since April, 2018.

	deep depression stage.	
	24 Hours forecast error was 125 km during 2006-13.	24 Hours forecast error was reduced to 16.2 km during 2020-24.
	72 Hours forecast error was 268 km during 2006-13.	72 Hours forecast error was reduced to 69.5 km during 2020-24. In particular, accuracy of cyclone track, intensity and landfall point forecasts increased by 35-40%, 15-30% and 45-65% up to 48 hrs in advance. All these improvements have led to significant improvement in forecast accuracy of severe weather events and also significant reduction in death toll e.g., due to cyclones, around 7000 people lost their lives in 1999 Odisha Super Cyclone while it has been reduced to less than 100 over entire region from impact of tropical cyclones during recent years. Accurate forecast of 1 cyclone saves around 1100 crore rupees in terms of expenditure towards payment of ex-gratia to kins of dead, cost towards evacuation and savings to various sectors e.g., Power, Marine, Aviation, Railways etc. sector.
Agro-Meteorological Advisories	Agro-Meteorological Advisories were reaching to about 70 lakh farmers.	Agro-Meteorological Advisories are now reaching to about 276.7 lakh farmers.
District Agro-Met Units **Agro AWSs**	There was no District Agro-Met Unit (DAMU). 125 Agro-Automatic Weather Stations (Agro-AWS) were established.	199 District Agro-Met Units (DAMUs) were established and are functioning. A total number of 200 Agro-Automatic Weather Stations (Agro-AWS) are functioning and installed at KVKs under DAMU project. Earlier installed 125 Agro AWS during 2009-2012 is under upgradation under 330 Agro AWS Project 2025-2026. All 130 AMFUs is under upgraded with Agro AWS with four depth soil sensors and sunshine duration and global radiation measurement under 330 Agro AWS Project 2025-2026

Coverage of Agro-Meteorological Advisories	Resolution persisted up to district level.	District level Agro advisory services are Provided to all districts of India.
Medium Range Forecast Global Forecasting System	25 km resolution with 2 Models (GFS, NCUM)	6 km Bharat Forecasting System: Government has launched indigenously built BFS, a state of art numerical weather prediction model, since 27 May 2025. It promises finer and accurate rain forecasts down to the panchayat/cluster of panchayats level. 2 other models: 12 km resolution with 2 Models (GFS, NCUM)
Heat wave forecast accuracy at meteorological sub-division levels	68 % for 24 hr lead period 50 % for 48 hr lead period 27 % for 72 hr lead period	100 % for 24 hr lead period 95% for 48 hr lead period 90 % for 72 hr lead period
Heavy Rainfall forecast accuracy	Probability of Detection (POD) for south west monsoon heavy rainfall warning is 50 – for day 1 48 - for day 2 and 37 - for day3	Probability of Detection (POD) for south west monsoon heavy rainfall warning is 85 – for day 1 73 - for day 2 and 67 - for day3
Thunderstorm and lightning warning	3 days in advance up to Meteorological Sub-divisions level only.	Thunderstorm and lightning warnings are issued twice a day 5 days in advance upto District level. The Probability of detection for 24 hourly thunderstorm forecast is 0.89 in 2025 as compared to 0.31 in the year 2016. Similarly, the Probability of detection for 3 hourly thunderstorm nowcast is 0.93 in 2025 as compared to 0.61 in the year 2014.
Quantitative Precipitation Forecast (QPF)	It had a 2-day validity with a 3-day outlook in 2014.	By 2024, the validity period has increased to 7-days and accuracy has improved by over 10-15% since 2016

Establishment of Meso-network of Automatic Rain Gauges (ARG) and Doppler Weather Radars(DWRs) over Mumbai Metropolitan Region	2 ARG established by MoES	57 ARGs were installed by MoES 60 ARGs were installed by BMC C-Band Doppler Weather Radar at Veravali made operational in January 2022. 4 X-band Doppler Weather Radars were installed under the project of IITM, Pune. Dissemination of real-time rainfall information through mobile apps (Mumbai Weather Live) and web based data portal (Monsoon Online) http://mumbairain.tropmet.res.in/
Data assimilation in NWP models	50 GB per day	500 GB per day

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