Major Achievements of the Ministry of Earth Sciences, Government of India in 2025: Technology-Driven Innovations in Climate, Earth, and Ocean Sciences- Reflections from the Patron

SYNOPSIS

The Ministry of Earth Sciences (MoES) of India has demonstrated remarkable progress in 2025, marking a transformative period for the country's weather forecasting, disaster risk reduction, renewable energy exploration, atmospheric monitoring, and oceanic research. This essay synthesizes the Ministry's major milestones, including the launch of the Bharat Forecasting System (BFS), the upgraded Winter Fog Experiment (WiFEX-II), a pioneering geothermal energy project in Arunachal Pradesh, advancements in rainfall monitoring in Goa, recognition at the global level for disaster preparedness, India's participation in the NASA–ISRO Synthetic Aperture Radar (NISAR) mission, and the development of new research vessels. By combining technological innovation with international collaboration, MoES has consolidated its role as a global leader in earth sciences. The achievements are not isolated but are rooted in sustained infrastructure investments from late 2023 and 2024. Collectively, these efforts highlight India's growing scientific leadership in weather, climate, and ocean research, with implications for national security, environmental sustainability, and socioeconomic resilience.

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I. INTRODUCTION

The Ministry of Earth Sciences (MoES) is a critical pillar of India's scientific and strategic infrastructure, entrusted with monitoring the atmosphere, ocean, and solid earth systems. In 2025, the Ministry has delivered several groundbreaking initiatives that underscore both its technological capabilities and global leadership. These achievements span forecasting systems, renewable energy exploration, disaster risk reduction, and polar as well as oceanic research. This paper discusses the major achievements of MoES in 2025, situating them within the broader context of India's scientific growth and international standing.

1.1 Bharat Forecasting System (BFS)

On May 26, 2025, the Indian Institute of Tropical Meteorology (IITM), under MoES, launched the Bharat Forecasting System (BFS), a high-resolution weather prediction framework operating on a 6 km grid (MoES, 2025a). BFS represents a significant leap in India's forecasting ability, particularly in medium- and short-range weather prediction. By improving spatial resolution, BFS provides actionable insights for agriculture, disaster management, and urban planning. Compared with earlier systems, BFS offers sharper predictions of monsoon rainfall, cyclones, and heatwaves, reducing uncertainties that traditionally challenged forecasters.

1.2 WiFEX-II Fog Forecasting Program

Fog remains a major hazard for aviation in northern India, often causing large-scale disruptions during winter. To address this, MoES rolled out the Winter Fog Experiment-II (WiFEX-II) in 2025, expanding its coverage to airports such as Jewar and Hisar (IITM, 2025). This upgraded system integrates advanced observational networks and high-resolution models capable of delivering runway-level forecasts with over 85% accuracy. The initiative is expected to improve air traffic management and passenger safety, while reducing economic losses from delays.

1.3 Geothermal Energy Breakthrough in the Northeast

A historic milestone was achieved in renewable energy with the successful drilling of Northeast India's first geothermal production well in Dirang, Arunachal Pradesh (CESHS, 2025). With reservoir temperatures estimated at ~115 °C, this development provides a foundation for eco-friendly power generation in the Himalayan region. Beyond energy production, geothermal systems in the Northeast can foster local community development through direct heating applications and sustainable livelihoods. This achievement positions India among the limited number of countries exploring geothermal resources at a production scale.

1.4 Advanced Rainfall Monitoring in Goa

Improving monsoon research remains a core focus of MoES. In 2025, the Ministry supported the installation of a Joss–Waldvogel Disdrometer (JWD) at the National Centre for Polar and Ocean Research (NCPOR), Goa (NCPOR, 2025). This state-of-the-art instrument provides real-time data on raindrop size distribution and intensity, enhancing understanding of monsoon microphysics. Such measurements are vital for refining climate models and forecasting heavy rainfall events that have significant societal impacts.

1.5 Recognition in Disaster Risk Reduction

India's global leadership in disaster preparedness was reaffirmed when Dr. Mrutyunjay Mohapatra, Director General of Meteorology, IMD, received the UN Sasakawa Award 2025 (UNDRR, 2025). This award recognized India's advancements in cyclone forecasting and the development of impact-based, sector-specific warning systems. The achievement reflects MoES's long-standing commitment to minimizing disaster-related fatalities and economic losses, while also reinforcing India's role in shaping global best practices.

1.6 India–US NISAR Satellite Mission

The NISAR mission, a joint venture between ISRO and NASA launched in 2025, has direct applications for MoES. The satellite is designed to monitor land surface changes, glacier dynamics, and coastal processes with unprecedented precision (ISRO, 2025). By leveraging NISAR data, MoES enhances its capacity for climate change studies, hazard mapping, and long-term sustainability planning. For India, NISAR represents both scientific advancement and international collaboration in earth observation.

1.7 Ocean Research Vessel Development

Oceanic and polar research form another cornerstone of MoES's work. In 2025, the Garden Reach Shipbuilders & Engineers (GRSE), in collaboration with Norwegian firm Kongsberg, finalized plans for India's first Polar Research Vessel (PRV) (GRSE, 2025). Additionally, contracts were signed to construct two Coastal Research Vessels (CRVs) for applications ranging from mineral exploration to environmental monitoring. These developments expand India's scientific presence in the Arctic, Antarctic, and coastal waters, thereby supporting both strategic and environmental objectives.

2. NEW CONTRACT WITH UNITED NATIONS INTERNATIONAL SEABED AUTHORITY (ISA)

India is set to ink a new contract with the United Nations International Seabed Authority (ISA) for exploration of critical minerals in the northwestern region of the Indian Ocean. These minerals are vital for advancing renewable energy technologies. This agreement comes in addition to the two exploration sites already allotted to India by the ISA.

Dr. M. Ravichandran, Secretary, Ministry of Earth Sciences (MoES), emphasized that this milestone, under the ambit of the Deep Ocean Mission, will strengthen India's capabilities in ocean science and technology, bolster mineral exploration, and foster international cooperation and collaboration in deep-sea research.

2.1 Foundations from 2023–2024

The accomplishments of 2025 were built upon earlier initiatives from 2023–24. These included enhanced severe weather forecasting, expansion of Doppler weather radars, establishment of impact-based forecasting models, and platforms such as the Air Quality Early Warning System (AQEWS), SAMUDRA mobile app for ocean advisories, and IndOBIS biodiversity portal (MoES, 2024). These foundations provided the infrastructure and technical expertise necessary for the breakthroughs seen in 2025.

3. CONCLUSION

The year 2025 stands as a landmark for the Ministry of Earth Sciences. From high-resolution weather forecasting through BFS and WiFEX-II to pioneering geothermal energy in the Northeast, from advanced rainfall monitoring in Goa to global recognition in disaster preparedness, the Ministry has achieved progress across multiple domains. The launch of NISAR and development of research vessels further extend India's scientific reach into global climate monitoring and oceanic exploration. These achievements, supported by prior groundwork, reinforce MoES's role in safeguarding India's future against environmental risks while also contributing to sustainable development. As India navigates the complexities of climate change and resource management, the strides made by MoES in 2025 offer both national resilience and international leadership.

Abbreviations

MoES – Ministry of Earth Sciences
CESHS - Centre for Earth Sciences and Himalayan Studies
GRSE – Garden Reach Shipbuilders and Engineers
NCPOR - National Centre for Polar and Ocean Research
IITM-Indian Institute of Technology, Madras
UNDRR- United Nations for Disaster Risk Reduction.
NISAR - NASA-ISRO Synthetic Aperture Radar
ISA- International Seabed Authority

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