Pre-read: The promise of AI weather forecasting

Weather and climate variability pose significant challenges to agriculture and food security, particularly in low- and middle-income countries (LMICs). Timely, actionable, and localized weather forecasts are critical for effective climate adaptation, especially for farmers and rural communities.

Forecasting capabilities in many LMICs remain limited due to a combination of technological constraints, limited data access, and shortages in human resources. While traditional numerical weather prediction (NWP) models are powerful, they require substantial computational resources, which are often out of reach. Emerging AI-based forecasting approaches offer promising tools to bridge these gaps—enabling more timely and accurate predictions at significantly lower computational cost. These models can be adopted by national meteorological and hydrological services (NMHS) to generate their own forecasts and tailor them using local data and in-country meteorological expertise.

Data-driven deep-learning models offer several advantages for weather forecasting. Compared to NWP, they require significantly less computational power (Schultz et al., 2021; Balaji, 2021; Irrgang et al., 2021; Reichstein et al., 2019; Pathak et al., 2022; Bi et al., 2023; Lam et al., 2023).These models can also help address known biases in NWP models and generate large forecast ensembles at low computational cost for probabilistic forecasting and data assimilation (Schultz et al., 2021; Balaji, 2021). Once trained, deep learning models deliver forecasts far more quickly than NWP systems, enabling the generation of extensive ensemble forecasts (Chattopadhyay et al., 2021; Weyn et al., 2021; Chen et al., 2023; Lang et al., 2024; Kotchkov et al., 2024; Price et al., 2025).

AI-based models, for example, can generate 1 to 10-day forecasts at fine spatial and temporal scales much more cheaply and quickly than physics-based models. FourCastNet, which marked the beginning of the AI-driven revolution in weather forecasting, is an example of a weather forecasting model that provides accurate short to medium-range global predictions (Pathak et al., 2022). More recent models, such as Pangu-Weather (Bi et al., 2023) and GraphCast (Lam et al., 2023), have not only matched but often surpassed the performance of state-of-the-art NWP models.

These large ensembles have been shown to improve subseasonal-to-seasonal (S2S) forecasts and enhance the detection of extreme weather events across various timespans. Research is also underway to generate probabilistic AI forecasts at longer scales, such as S2S forecasts (Chen et al., 2023; Price et al., 2025). Recent developments have tested the ability to model fine-scale physical information that can capture the formation and dynamics of high-impact

extreme events such as extratropical cyclones (Baño-Medina et al., 2025; Carlton-Perez et al., 2024).

With AI models now operationally viable for 1 to 10-day lead times—and ongoing advances in modeling extreme events and S2S timescales—NMHSs have a powerful new set of tools at their disposal. These models allow NMHSs to generate their own forecasts and quickly tailor them to user needs by leveraging local data and national expertise. This represents a major breakthrough: enabling faster, more affordable, and more accurate forecasting, while also expanding the range of applications beyond what was possible with traditional NWP systems.

AI weather forecasting in the news:

- What's next in the AI revolution
- AI breakthrough is 'revolution' in weather forecasting
- AI will soon eclipse traditional weather forecasting, says expert
- AI-driven weather prediction breakthrough reported
- A.I. Is Quietly Powering a Revolution in Weather Prediction
- Fully AI driven weather prediction system could start revolution in forecasting
- Google Introduces A.I. Agent That Aces 15-Day Weather Forecasts
- New AI Weather Forecasting Model Improves Accuracy Up To 20%
- Weatherwatch: How AI could offer faster, affordable weather forecasting
- AI can forecast the weather in seconds without needing supercomputers