

ECMWF puts its machine-learning weather model AIFS into operational use

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ECMWF's AI forecasts become operational

25 February 2025

ECMWF has taken the Artificial Intelligence Forecasting System (AIFS) into operations today, 25 February 2025, to run side by side with its traditional physics-based Integrated Forecasting System (IFS) to advance numerical weather prediction.

The AIFS outperforms state-of-the-art physics-based models for many measures, including tropical cyclone tracks, with gains of up to 20%.

This high-accuracy model complements the portfolio of our physics-based models by leveraging the opportunities made available by machine learning (ML) and artificial intelligence (AI). These include increased speed and a reduction of approximately 1,000 times in energy use for making a forecast.

First operational open AI model

The AIFS is the first fully operational weather prediction open model using machine learning with the widest range of parameters. It includes vital fields for users, such as wind and temperature, and details on precipitation types from snow to rain. The AIFS has a grid spacing of currently 28 km.

The AIFS has been designed holistically with all users in mind. For example, in the renewable energy sector it will help with predictions of quantities such as surface solar radiation levels or wind speeds at turbine levels, so that operations can be maximised.

The availability of the AIFS in conjunction with our other services will positively impact how national weather services in our 35 Member and Co-operating States and beyond will be able to make their predictions.

It could potentially help industries where forecasts for the medium range can affect decision-making, such as the energy sector for pricing forecasts, as well as the insurance, security and shipping sectors.

ECMWF's Director-General, Florence Rabier, said: "This milestone will transform weather science and predictions. It showcases our dedication to delivering a machine learning forecasting model that pushes the boundaries of efficiency and accuracy, and it underscores our commitment to harnessing the power of machine learning for the weather forecasting community. It is not only us who are innovating as it is important to remember that, with ECMWF, 35 nations are working together to advance weather science to improve global predictions. This is to help national meteorological agencies in their work to contribute to a safe and thriving society."

How does the model work?

The AIFS uses the same initial conditions for its forecasts as the IFS. These are based on the combination of a previous short-term forecast with around 60 million quality-controlled observations from satellites as well as many other streams, including from planes, boats, sea buoys and many other Earth-based measurement stations.

Every six hours, these initial conditions feed into the AIFS. The machine learning model, trained on how the weather has evolved in the past, assesses how the initial conditions will influence the weather for the coming days.

By contrast, the IFS uses physics-based capabilities to arrive at a forecast with a grid-spacing of 9 km over the globe, integrating the laws of physics in its computer code.

The first operational version is called AIFS Single. It runs a single forecast at a time, known as a deterministic

forecast. However, ECMWF is pushing this model to create a collection of 50 different forecasts with slight variations at any given time to provide the full range of possible scenarios. This is known as ensemble modelling, a technique developed and implemented by ECMWF more than thirty years ago.

Future plans

The launch of AIFS Single as an operational service is only the beginning. The next steps will be making ensemble forecasts available and introducing experimental data-driven sub-seasonal (extended-range) forecasting . The potential to hybridise data-driven and physics-based forecasts will also be a field of research over the coming years.

ECMWF's Director of Forecasts and Services, Florian Pappenberger, added: "We see the AIFS and IFS as complementary, and part of providing a range of products to our user community, who decide what best suits their needs. ECMWF's AIFS was an experimental model for some months whilst we enhanced its capabilities by interacting with our Member States and users to refine it. Making such a system operational means that it is openly available and has 24/7 support for our meteorological community. As always, we have to ramp up this service to full maturity, and we look forward to engaging directly with our users to ensure all needs are covered where possible."

Further information

More information on the implementation of the AIFS operational model is available, and the model has also been presented in a webinar . In addition, a series of AIFS blog posts can be accessed on our website, and AIFS Single forecast charts are available on our charts page .