

Huawei's Pangu-Weather AI model published in Nature

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Text saved 18 Oct 2026 (the page as published).

SHA-256 of the saved text: fd076eae332e97cb64d6f471af444825457de71fc0b69e40c8b800e30f32fc63

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Prestigious science journal Nature publishes paper about Pangu Weather AI Model authored by HUAWEI CLOUD researchers

Meteorological model shows strong performance when compared with traditional prediction in speed and accuracy

[Shenzhen, China, July 6, 2023] HUAWEI CLOUD announced that a paper about its breakthrough Pangu Weather AI model has been published by Nature, one of the world's top scientific journals.

The publication marks the first time that employees of a Chinese technology company are the sole authors of a

Nature paper, according to Nature Index. The paper, describing how to develop a precise and accurate global AI weather forecast system based on deep learning using 43 years of data, appeared in the prestigious journal on July 5, 2023.

Pangu-Weather is the first AI prediction model to demonstrate higher precision than traditional numerical weather forecast methods. The model allows a 10,000x improvement in prediction speed, reducing global weather prediction time to just seconds. The paper, titled "Accurate medium-range global weather forecasting with 3D neural networks" provides independent verifications of these capabilities.

Pangu-Weather challenges the previously held assumptions that the accuracy of AI weather forecast is inferior to traditional numerical forecasts. The model, developed by the HUAWEI CLOUD team, is the first AI prediction model with higher precision than traditional numerical prediction methods.

With the rapid development of computing power over the past 30 years, the accuracy of numerical weather forecast has improved dramatically, providing extreme disaster warning and climate change predictions. But the method remains relatively time-consuming. To improve prediction speeds, researchers have been exploring how to using deep learning methods. Still, the precision of AI-based forecasting for medium and long-term forecasts has remained inferior to numerical forecasts. AI has been mostly unable to predict extreme and unusual weather such as typhoons.

Every year, there are around 80 typhoons worldwide. In 2022, in China alone, the direct economic loss caused by typhoons was 5.42 billion yuan, according to the figures from China Ministry of Emergency Management. The earlier that warnings can be sent out, the easier and better it is to make adequate preparations.

Because of their speed, AI weather forecast models have been attractive but have lacked precision for two reasons. First, the existing AI meteorological forecast models are based on 2D neural networks, which cannot process uneven 3D meteorological data well. Second, medium-range weather forecast can suffer from cumulative forecast errors when the model is called too many times.

How Pangu-Weather addresses these challenges

During scientific trials, Pangu-Weather model has demonstrated its higher precision compared to traditional numerical prediction methods for forecasts of 1 hour to 7 days, with a prediction speed gain of 10,000 times. The model can accurately predict in seconds fine-grained meteorological features including humidity, wind speed, temperature, and sea level pressure.

The model uses a 3D Earth-Specific Transformer (3DEST) architecture to process complex non-uniform 3D meteorological data. Using a hierarchical, temporal, aggregation strategy, the model was trained for different forecast intervals using 1 hour, 3-hour, 6- hour and 24-hour intervals. This resulted in a minimization of the quantity of iterations for predicting a meteorological condition at a specific time and a reduction in erroneous forecasts.

To train the model for specific time intervals, the researchers trained 100 epochs (cycles) using hourly samples of weather data from 1979-2021. Each of the sub-models that resulted required 16 days of training on 192 V100 graphics cards. Pangu-Weather Model can now complete 24-hour global weather forecasts in just 1.4 seconds on a V100 graphics card, a 10,000-time improvement compared with the traditional numerical prediction.

Explaining why the HUAWEI CLOUD AI team chose to focus on weather predictions, Dr. Tian Qi, Chief Scientist of HUAWEI CLOUD AI Field, an IEEE Fellow, and Academician of the International Eurasian Academy of Sciences, explained "Weather forecasting is one of the most important scenarios in the field of scientific computing because meteorological prediction is a very complex system, yet it is difficult to cover all aspects of mathematical and physical knowledge. We are therefore delighted that our research has been recognized by the Nature magazine. AI models can mine statistical laws of atmospheric evolution from massive data. At present, Pangu-Weather mainly completes the work of the forecast system, and its main ability is to predict the evolution of atmospheric states. Our ultimate goal is to build next-generation weather forecasting framework using AI technologies to strengthen the existing forecasting systems. "

Commenting on the significance and quality of the research by HUAWEI CLOUD, academic reviewers from Nature explained that not only is Pangu-Weather very easy to download and run, but that it executed quickly on even a desktop computer. "This means that anyone in the meteorological community can now run and test these models to their hearts' desire. What a great opportunity for the community to explore how well the model predicts

specific phenomena. That's going to help with progress in the field." Another reviewer noted that "the results themselves are a significant step beyond previous results. This work will, in my opinion, make people reevaluate what forecasting models might look like in the future".

In May 2023, Typhoon Mawar caught the world's attention as the strongest tropical cyclone of the year thus far. According to the China Meteorological Administration, Pangu-Weather accurately predicted the trajectory of Typhoon Mawar five days before it changed course in the eastern waters of the islands of Taiwan.

Pangu error is smaller in typhoon Mawa path prediction

In addition, in order to continuously advance leading AI weather forecast models, stable cloud environments, work suites, and corresponding O&M are also essential.

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