A Limited-Area Data-Driven Weather Model for High-temporal Predictions

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Abstract

Recently, several AI global data-driven weather prediction (DWP) models have been developed, presenting a promising approach for accurate weather prediction. Most of these DWP models provide forecasts at a 6-hour interval; thus, it is essential to explore whether these models are feasible for limited-area weather forecasting with high temporal resolution, particularly in regions affected by hazardous weather. Here, we introduce the data-driven limited-area model (DLAM), a regional weather prediction model with 1-hour temporal resolution covering East Asia and the western North Pacific. Our DLAM model is trained on 3 years of ECMWF ERA5 reanalysis data and is capable of predicting hourly weather variables at 0.25° resolution. As the lateral boundary information is crucial for regional weather prediction, we test both ERA5 reanalysis and global DWP predictions for boundary replacement during model inference. With boundary replacement, the DLAM forecast results are significantly improved for severe weather events such as tropical cyclones (TCs) and cold fronts. Compared to the baseline DWP model, Pangu-Weather FM1 (the only data-driven model capable of generating 1-hour predictions in the region of interest), our model shows better RMSEs and TC forecasts at lead times of about 3 to 4 days, especially for lower atmosphere variables. Additionally, the DLAM model demonstrates a strong ability to capture atmospheric physical properties such as vorticity, geostrophic balance, and kinetic energy spectra. This presentation will also cover how to design and modify deep neural networks based on process-based evaluations. Limitations of the current study and ongoing plans for further improving the DLAM model will also be discussed.

Key words : machine learning, deep learning, data-driven weather prediction, regional weather prediction