The WeatherGenerator: a foundation model for weather and climate

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The WeatherGenerator project aims to build a European foundation model for weather and climate. It will be trained on a wide range of reanalysis, simulation and observational datasets to learn a comprehensive latent Earth system state that allows for predictions from minutes to decades. The WeatherGenerator will support a wide range of applications, e.g. local and global weather forecasting, decadal climate projections, and impact models, such as for wind energy, agriculture and hydrology.

In the talk, we will present the key scientific concepts of the WeatherGenerator with training and fine-tuning of a moderate-sized model on ERA5, CERRA, METEOSAT-SEVIRI, IMERG, OPERA, and SYNOP stations. We will show the benefit of pretraining with masked token modeling and then fine-tuning towards forecasting, compared to directly training towards forecasting. We will also detail how our novel multi-scale network architecture (Fig. 1) can effectively represent processes at different spatiotemporal scales, e.g. mesoscale convective processes in the SEVIRI data but also synoptic and planetary-scale processes in ERA5. We will also demonstrate that we can learn a very rich latent Earth system state by training decoders for quantities that were not part of the pre-training. Finally, we will show how fine-tuning using SYNOP stations and local, high-resolution RADAR data can calibrate the model output, effectively providing a bias correction to the pre-training datasets. For evaluation, we will consider global forecast scores but also use local evaluation over the domain of the local datasets and present case studies.

The WeatherGenerator is open source and all results will be available through https://github.com/ecmwf/WeatherGenerator.

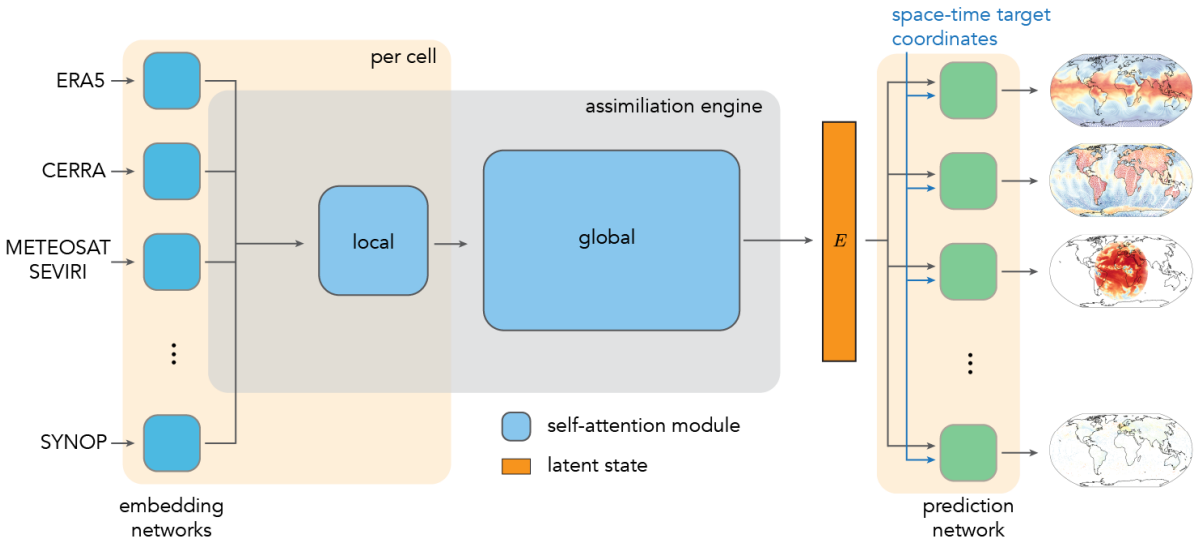

Fig. 1: Structure of the WeatherGenerator neural network architecture without the module to perform roll-out by advancing the Earth system state E from one temporal window to the next. The predictions on the right are real-world model output, demonstrating that our model is capable of skillful predictions.

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