Towards machine learning-based Earth system models

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Large scale machine learning is currently revolutionizing Earth system modeling and the next generation of models will likely be machine learning-based or contain substantial machine learning components. The lack of a complete equation-based description of the Earth system as well as the availability of a plethora of high-quality data make this a tantalizing possibility to obtain models with unprecedented capabilities. In the first part of the talk, we will discuss grand challenges for building machine learning-based Earth system models and what milestones have already been achieved in the last years. We will also examine cases where machine learning models already surpass state-of-the-art equation-based models, e.g. for medium range weather forecasting. In the second half of the talk, we will introduce the WeatherGenerator project that aims to build a next generation, machine learning-based Earth system model. Led by leading European modeling centers but open-source from day-1, the project will train on a wide range of datasets to build a seamless prediction model that can faithfully represent Earth system dynamics from sub-km scale, short term processes to multi-decadal projects. The project will also consider selected applications to ensure the real-world applicability of the developed model.