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Data-driven super-parametrization using deep learning for large scale turbulent flow in weather/climate modeling ASHESH CHATTOPADHYAY, ADAM SUBEL, PEDRAM HASSANZADEH, KRISHNA PALEM, Rice University — Some of the physical processes that play key roles in turbulent systems such as weather/climate systems occur at such small spatial and fast time scales that trying to explicitly solve for them can lead to computationally intractable numerical models. These subgrid-scale processes (denoted by variable Y hereafter), are often parameterized using semi-empirical/physics-based schemes as a function of the large-scale/slow variables (X) that are explicitly solved. Multi-scale numerical models that explicitly solve for X and Y, but at different numerical resolutions, dubbed super-parameterization (SP), has been shown to improve simulations of large-scale turbulence in climate models, but at a large computational cost. More recently, several studies have shown promises of using deep neural networks, trained on data from high resolution climate models, for data-driven parameterization (DDP) of Y as a function of X. Here, we show that Gated Recurrent Units (GRU) can be used for data-driven super-parameterization (DDSP): To solve for X numerically at low resolution and emulate the evolution of Y with a GRU at higher numerical resolutions, at a much lower computational cost, and similar accuracy as that of SP on a multi-scale Lorenz 96 test bed.

Ashesh Chattopadhyay
Rice University

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