NCAR | CLIMATE & GLOBAL DYNAMICS

CGD Seminar Series

Enabling intelligent parameterizations through distributed, online inference with SmartSim: A case study simulating ocean eddy kinetic energy in MOM6

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Time: 11am – 12pm

For Zoom information, please contact Tracy Baker tbaker@ucar.edu

For live stream information, visit the CGD Seminar Webpage

ABSTRACT

Machine learning (ML) is emerging as a powerful tool for a variety of applications in the climate sciences, but its potential remains relatively unexplored in oceanography. ML opens up especially interesting opportunities for parameterizations of eddy effects, but challenges arise from the need to maintain numerical stability and provide physically-reasonable predictions. Modelers must choose carefully how and where to apply ML, via the choice of variable(s) to model, training data to supply, and by considering its potential impacts on the numerical simulation. In this talk we discuss the application of ML to the prognosis of mesoscale eddy kinetic energy (EKE), a project resulting from close collaboration between oceanographers at NCAR and the University of Victoria and Artificial Intelligence engineers at Hewlett-Packard Enterprise (HPE). EKE is chosen for this application because of its special role as a “master variable” containing information about the eddy diffusivity, energy dissipation, and scale-to-scale transfers.

Here we show the results of machine-learning based estimates of EKE using output from an eddy-permitting global ocean simulation as predicted by a neural network trained on coarsened output from an eddy-resolving simulation. We further demonstrate a global, proof-of-concept simulation that replaces the existing EKE parameterization with this ML surrogate. To achieve this, we use a version of MOM6 that takes advantage of two new HPE software solutions: SmartSim and SILC. SmartSim hosts ML models (Pytorch, TensorFlow, Tensorflow-Lite, and ONNX) inside of a distributed, in-memory store running alongside the simulation. SILC, the SmartSim client library, allows simulations written in Fortran, C, C++, and Python to call stored models remotely and obtain the results of inference in the native language of the simulation. Our results provide some of the first examples of enhancing a global, oceanic numerical simulation with ML techniques in a scalable software framework