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A multi-model physics-informed neural network approach for solving the shallow-water equations on the sphere

We propose the use of physics-informed neural networks for solving the shallow-water equations on the sphere in the meteorological context. Physics-informed neural networks are trained to satisfy the differential equations along with the prescribed initial and boundary data, and thus can be seen as an alternative approach to solving differential equations compared to traditional numerical approaches such as finite difference, finite volume or spectral methods. We discuss the training difficulties of physics-informed neural networks for the shallow-water equations on the sphere and propose a simple multi-model approach to tackle test cases of comparatively long time intervals. Here we train a sequence of neural networks instead of a single neural network for the entire integration interval. We also avoid the use of a boundary value loss by encoding the boundary conditions in a custom neural network layer. We illustrate the abilities of the method by solving the most prominent test cases proposed by Williamson et al. [J. Comput. Phys. 102 (1992), 211-224]. This is joint work with Roman O. Popovych.