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Neural Partial Differential Equations for Atmospheric Dynamics

Maximilian Gelbrecht[1,2] and Niklas Boers[1,2]
[1]TUM School of Engineering and Design, Technical University Munich, Munich, Germany (gelbrecht@pik-potsdam.de)
[2]Potsdam Institute for Climate Impact Research, Research Domain IV, Potsdam, Germany

When predicting complex systems such as parts of the Earth system, one typically relies on differential equations which can often be incomplete, missing unknown influences or higher order effects. Using the universal differential equations framework, we can augment the equations with artificial neural networks that can compensate these deficiencies. We show that this can be used to predict the dynamics of high-dimensional spatiotemporally chaotic partial differential equations, such as the ones describing atmospheric dynamics. In a first step towards a hybrid atmospheric model, we investigate the Marshall Molteni Quasigeostrophic Model in the form of a Neural Partial Differential Equation. We use it in synthetic examples where parts of the governing equations are replaced with artificial neural networks (ANNs) and demonstrate how the ANNs can recover those terms.