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Equivariance-preserving Deep Spatial Transformers for Autoregressive Data-driven Forecasting of Geophysical Turbulence. ASHESH CHATTOPADHYAY, Rice Univ, MUSTAFA MUSTAFA, Lawrence Berkeley National Laboratory, PEDRAM HASSANZADEH, Rice University, KARTHIK KASHINATH, Lawrence Berkeley National Laboratory, ENVIRONMENTAL FLUID DYNAMICS GROUP COLLABORATION, DATA AND ANALYTICS SERVICES COLLABORATION — A deep spatial transformer based encoder-decoder model has been developed to autoregressively predict the time evolution of the upper layer's stream function of a two-layered fully turbulent quasi-geostrophic (QG) system without any information about the lower layer's stream function. The spatio-temporal complexity of QG flow is comparable to the complexity of the observed atmospheric flow dynamics. The ability to predict autoregressively, the turbulent dynamics of QG is the first step towards building data-driven surrogates for more complex climate models. We show that the equivariance preserving properties of modern spatial transformers incorporated within a convolutional encoder-decoder module can predict up to 9 days in a QG system (outperforming a baseline persistence model and a standard convolutional encoder decoder with a custom loss function). The proposed data-driven model remains stable for multiple time steps thus promising us of stable and physical data-driven long-term statistics.

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