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Applications of Deep Learning to Ocean Data Inference and Sub-Grid Parameterization

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Data from observations and ocean models lack information at small- and fast-scales. Here we use machine learning to leverage observations and/or model data by predicting unresolved turbulent processes and sub-surface flow fields. We use synthetic data generated from numerical simulations and train convolutional neural networks on this data. We demonstrate that convolutional neural networks successfully replicate the spatiotemporal variability of the sub-grid eddy momentum forcing, are capable of generalizing to a range of dynamical behaviors, and can be forced to respect global momentum conservation. We also show that the sub-surface flow field can be predicted using only information at the surface (e.g., using only satellite altimetry data). Our study indicates that data-driven approaches can be exploited to predict both sub-grid and large-scale processes, and present ways forward to implement eddy sub-grid parameterization.