Impact of mesoscale turbulence on oceanic predictability in an optimal dissimilation framework

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Abstract

Mesoscale oceanic turbulence clearly impacts large-scale oceanic features, but many underlying mechanisms remain elusive and the quantitative assessment of the resultant limits of oceanic predictability is challenging. Comprehensive experimental analysis of these aspects of ocean predictability, however, can be facilitated by suitable experimental frameworks. As an enabling tool for such an approach we have developed an iterative variational method for the optimal dissimilation of aspects of the ocean state, here applied to decorrelate mesoscale turbulence in an eddy-permitting ocean general circulation model on a time scale of 60 days: the method computes initial-condition perturbations that gradually reduce the similarity between the perturbed and the baseline variant of a proxy for mesoscale eddies in regions of strong eddy activity; at the same time the magnitude of the perturbation increments are sought to be minimal. A comparison between resulting optimally perturbed simulations and a non-optimally perturbed simulation ensemble provides a framework for statistical exploration of the temporal evolution of the optimally perturbed ensemble and subsequent discussion of implications for ocean predictability. Using such an analysis, we demonstrate the widespread unpredictability of mesoscale variability on a time scale of two months in regions with strong mesoscale activity and discuss examples of the examination of the impact of mesoscale uncertainty on the predictability of large-scale oceanic diagnostics.

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