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# Improved Climate Simulations through a Stochastic Parameterization of Ocean Eddies

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In climate simulations, the impacts of the subgrid scales on the resolved scales are conventionally represented using deterministic closure schemes, which assume that the impacts are uniquely determined by the resolved scales. Stochastic parameterization relaxes this assumption, by sampling the subgrid variability in a computationally inexpensive manner.

This study shows that the simulated climatological state of the ocean is improved in many respects by implementing a simple stochastic parameterization of ocean eddies into a coupled atmosphere–ocean general circulation model. Simulations from a high-resolution, eddy-permitting ocean model are used to calculate the eddy statistics needed to inject realistic stochastic noise into a low-resolution, non-eddy-permitting version of the same model. A suite of four stochastic experiments is then run to test the sensitivity of the simulated climate to the noise definition by varying the noise amplitude and decorrelation time within reasonable limits.

The addition of zero-mean noise to the ocean temperature tendency is found to have a nonzero effect on the mean climate. Specifically, in terms of the ocean temperature and salinity fields both at the surface and at depth, the noise reduces many of the biases in the low-resolution model and causes it to more closely resemble the high-resolution model. The variability of the strength of the global ocean thermohaline circulation is also improved. It is concluded that stochastic ocean perturbations can yield reductions in climate model error that are comparable to those obtained by refining the resolution, but without the increased computational cost. Therefore, stochastic parameterizations of ocean eddies have the potential to significantly improve climate simulations.

**Reference**

Williams PD, Howe NJ, Gregory JM, Smith RS, and Joshi MM (2016) Improved Climate Simulations through a Stochastic Parameterization of Ocean Eddies. *Journal of Climate*, **29**, 8763–8781. http://dx.doi.org/10.1175/JCLI-D-15-0746.1