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Climatic effects of mesoscale ocean–atmosphere interaction in an idealized coupled model

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Evidence is mounting that vigorous intrinsic variability associated with mesoscale oceanic features (with spatial scales on the order of 10–100 km) contributes significantly to large-scale low-frequency climate variability, with fundamental implications for near-term (∼decadal) climate prediction. As of yet, extensive simulation of these decadal effects using high-resolution state-of-the-art coupled climate models has been computationally prohibitive, as it may require mesoscale-resolving atmospheric components. In this work, we study the effects of mesoscale air–sea coupling on large-scale low-frequency (interannual-to-decadal+) climate variability using the Quasi-Geostrophic Coupled Model (Q-GCM), in which the dynamical (QG) oceanic and atmospheric modules are coupled via interactive ageostrophic oceanic and atmospheric mixed layers. The key feature of this ageostrophic air–sea coupling is a temperature-dependent wind-stress, which permits effective transmission of the ocean induced sea-surface temperature anomalies to the free atmosphere. We perform multi-century Q-GCM simulations over a range of atmospheric and oceanic resolutions to identify parameter regimes of enhanced multi-scale ocean–atmosphere interaction and analyze their dynamics. This work was supported by the University of Wisconsin-Milwaukee Reseach Growth Initiative (UWM RGI 2018), as well as by the Russian Ministry of Education and Science (project 14.W03.31.0006).