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Quasi-geostrophic coupled model under location uncertainty

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In this work, we aim to describe atmosphere-ocean coupling through a physically-based stochastic formulation. We adopt the framework of modelling under Location Uncertainty (LU) [Bauer2020a], which is based on a temporal-scale separation and a stochastic transport principle. One important characteristic of such random model is that it conserves the total energy of the resolved flow. This representation has been successfully tested for ocean-only models, such as the barotropic quasi-geostrophic (QG) model [Bauer2020b], the multi-layered QG model [Li2021], as well as the rotating shallow-water model [Brecht2021]. Here, we consider the ocean-atmosphere coupled QG model [Hogg2003]. The LU scheme has been tested for coarse-grid simulations, in which the spatial structure of ocean uncertainty is calibrated from eddy-resolving simulation data while the atmosphere component is parameterized from the ongoing simulation. In other words, the ocean dynamics has a data-driven stochastic component whereas the large-scale atmosphere dynamics is fully parameterized. Two major benefits of the resulting random model are provided on the coarse mesh: it enables us to reproduce the ocean eastward jet and its adjacent recirculation zones; it improves the prediction of intrinsic variability for both ocean and atmosphere components. These capabilities of the proposed stochastic coupled QG model are demonstrated through several statistical criteria and an energy transfers analysis.

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