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Stochastic modeling of the oceanic mesoscale eddies

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In this work, a stochastic representation [Bauer2020a, Bauer2020b] based on a physical transport principle is proposed to account for mesoscale eddy effects on the the large-scale oceanic circulation. This stochastic framework [Mémin2014] arises from a decomposition of the Lagrangian velocity into a time-smooth component and a highly oscillating noise term. One important characteristic of this random model is that it conserves the energy of any transported tracer. Such an energy-preserving representation has been successfully implemented in a well established multi-layered quasi-geostrophic dynamical core (http://www.q-gcm.org). The empirical spatial correlation of the small-scale noise is estimated from the eddy-resolving simulation data. In particular, a sub-grid correction drift has been introduced in the noise due to the bias ensuing from the coarse-grained procedure. This non intuitive term seems quite important in reproducing on a coarse mesh the meandering jet of the wind-driven double-gyre circulation. In addition, a new projection method has been proposed to constrain the noise living along the iso-surfaces of the vertical stratification. The resulting noise enables us to improve the intrinsic low-frequency variability of the large-scale current. From some statistical studies and energy transfers analysis, this improvement is well demonstrated.

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