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DETERMINISTIC MODEL OF THE EDDY DYNAMICS FOR A MID-LATITUDE OCEAN MODEL

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Résumé

Mesoscale eddies, although being on the scales of O(20-100 km), have a disproportionate role in shaping the mean stratification, which varies on the scale of O(1000 km). With the increase in computational power, we are now able to partially resolve the eddies in basin-scale and global ocean simulations, a model resolution ($\Delta x \sim 10$ km) often referred to as mesoscale permitting. It is well-known, however, that due to grid-scale numerical viscosity, mesoscale-permitting simulations have less energetic eddies and consequently weaker eddy feedback onto the mean flow. For our study, the mean flow we focus on is wind-driven jets in mid-latitude oceans such as the Gulf Stream. The poorly resolved eddy feedback results in a weaker eastward extent of the jet into the gyre, hindering the accurate modeling of air-sea interaction and storm tracks in coupled climate simulations. A common remedy to improving the path of oceanic jets has been to implement eddy parametrizations which mimic the eddy feedback. However, conventional and well-established eddy parametrizations, such as the Gent-McWilliams' parametrization (hereon GM), are intended for non-eddying models ($\Delta x \sim 100$ km). When applied in mesoscale-permitting models, GM tends to damp out the partially resolved eddies, which actually further deteriorates the performance of the model.

I will present a first step towards designing a physically-consistent eddy parametrization targeting mesoscale-permitting models within the quasi-geostrophic (QG) framework. We run a QG model at mesoscale-resolving resolution in a double-gyre configuration and formulate a deterministic

closure for the eddy rectification term of potential vorticity (PV), namely, the eddy PV flux divergence. The eddy PV flux divergence encapsulates the net eddy feedback onto the mean flow. Our closure successfully reproduces the spatial patterns and magnitude of eddy kinetic and potential energy diagnosed from the mesoscale-resolving model. One novel point about our approach is that we account for non-local eddy feedbacks onto the mean flow by solving the 'sub-grid' eddy PV equation prognostically in addition to the resolved PV. Future steps towards a stochastic parametrization and connection to primitive equation models will be discussed.

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