EGU General Assembly 2022

EGU22-6859, updated on 04 Dec 2022
https://doi.org/10.5194/egusphere-egu22-6859
EGU General Assembly 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Towards physics-informed stochastic parametrizations of subgrid physics in ocean models

Dmitri Kondrashov
University of California, Los Angeles, Department of Atmospheric and Oceanic Sciences, Los Angeles, United States of America (dkondras@atmos.ucla.edu)

All oceanic general circulation models (GCMs) include parametrizations of the unresolved subgrid-scale (eddy) effects on the large-scale motions, even at the (so-called) eddy-permitting resolutions. Among the many problems associated with the development of accurate and efficient eddy parametrizations, one problem is a reliable decomposition of a turbulent flow into resolved and unresolved (subgrid) scale components. Finding an objective way to separate eddies is a fundamental, critically important and unresolved problem.
Here a statistically consistent correlation-based flow decomposition method (CBD) that employs the Gaussian filtering kernel with geographically varying topology – consistent with the observed local spatial correlations – achieves the desired scale separation. CBD is demonstrated for an eddy-resolving solution of the classical midlatitude double-gyre quasigeostrophic (QG) circulation, that possess two asymmetric gyres of opposite circulations and a strong meandering eastward jet, such as the Gulf Stream in the North Atlantic and Kuroshio in the North Pacific. CBD facilitates a comprehensive analysis of the feedbacks of eddies on the large-scale flow via the transient part of the eddy forcing. A `product integral' based on time-lagged correlation between the diagnosed eddy forcing and the evolving large-scale flow, uncovers robust `eddy backscatter' mechanism. Data-driven augmentation of non-eddy-resolving ocean model by stochastically-emulated eddy fields allows to restore the missing eddy-driven features, such as the merging western boundary currents, their eastward extension and low-frequency variabilities of gyres.

- N. Argawal, Ryzhov, E.A., Kondrashov, D., and P.S. Berloff, 2021: Correlation-based flow decomposition and statistical analysis of the eddy forcing, Journal of Fluid Mechanics, 924, A5. doi:10.1017/jfm.2021.604

- N. Argawal, Kondrashov, D., Dueben, P., Ryzhov, E.A., and P.S. Berloff, 2021: A comparison of data-driven approaches to build low-dimensional ocean models, Journal of Advances in Modelling Earth Systems, doi:10.1029/2021MS002537