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Nonlinear Processes in Geophysics
Discussions

Interactive comment on "Theoretical comparison of subgrid turbulence in the atmosphere and ocean" *by* V. Kitsios et al.

Anonymous Referee #1

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General Comments:

In this paper Kitsios, Frederiksen, and Zidikheri examine subgrid-scale parameterizations with relevance to both atmospheric models and eddy-permitting ocean models. Their work is performed in the context of two-layer quasigeostrophic dynamics on a sphere, where the "atmospheric" regime has a large deformation radius and an imposed westerly jet in both hemispheres, and the "oceanic" regime has a smaller deformation radius and a single westerly jet in the southern hemisphere. The authors use high resolution direct numerical simulations (DNS) to diagnose the parameters of both stochastic and deterministic subgrid models based on the framework of Frederiksen & Kepert (2006, cited in the manuscript), for a range of different coarse-model resolutions. The authors determine scaling laws for the various parameters so that the

subgrid models can be used in situations where a high-resolution DNS is not available. Finally, these scaling laws are used to test a range of subgrid models of varying degrees of complexity in coarse-model simulations; the results are very impressive. My primary concern is that the majority of these results seem to be present in the authors' previous works, namely Kitsios et al. 2012 and 2013 (cited in the manuscript). The 2012 paper examines a very similar "atmospheric" regime, while the 2013 paper examines a very similar "oceanic" regime. It's not clear to me if anything in the present paper adds to these previous two, beyond the observation that the scaling laws for the two regimes are very similar.

Specific Comments:

- In the abstract and intro (p1676 l11 & p1677 l8) you say that 'an increase in resolution will not necessarily improve the accuracy.' This seems like a secondary consideration; isn't the primary concern that at low (fixed) resolution the accuracy may be poor?
- It might help to note that alpha, D0, and kappa in equation (1) are not constants but operators.
- It's not clear to me why you would ever have j not equal to k in equations 6 and 7. Why not use the version from the Kitsios et al 2012 paper (eqns 8 and 9)?
- In the discussion between equations 11 and 12, and in equation 12 I suspect that there are some places where a subscript 0 is missing on t.
- p1689 l20: The fact that the drain is negative in this regime is very interesting; it might be worth mentioning the recent related work by Jansen & Held (Parameterizing subgrid-scale eddy effects using energetically consistent backscatter, Ocean Modelling, 2014) who have proposed a parameterization in the oceanic regime using negative viscosity.

- p1690 l9 "as more eddies are being explicitly resolved, less enstrophy is transferred to fewer subgrid eddies" This statement seems to conflict with the fact that the enstrophy flux is approximately constant through this range of wavenumbers?
- Although the energy spectra of the LES show excellent agreement with the DNS, this is only one measure of accuracy. One might also check things like meridional heat flux or large-scale EOFs.

Interactive comment on Nonlin. Processes Geophys. Discuss., 2, 1675, 2015.