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Interactive comment on "Mesoscale cascades and the "conundrum" of energy transfer from large to dissipation scales in an adiabatic ocean" *by* Mikhail S. Dubovikov

Anonymous Referee #2

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The manuscript "Mesoscale cascades and the conundrum of energy transfer from large to dissipation scales in an adiabatic ocean" by M. Dubovikov tries the resolve the dilemma of missing processes for the dissipation of balanced flow. The manuscript is reasonably well written such that it is possible to follow, although the details of the key argument are as usual buried in many other papers by the author. The proposed solution to the dilemma appears to be simple: while kinetic energy cascades upscale, potential energy cascades downscales and takes up the upscale kinetic energy towards dissipation at small scales.

Key in the argumentation is that the conversion of EPE to EKE depends on the scale.

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Discussion paper

It is argued that when the spectral Rossby number (Ro) is small, there is no conversion from EPE to EKE (in fact it is shown to be directed from EKE to EPE). This is assumed to be the case at the Rossby radius where most of the eddy energy is produced by baroclinic instability. Instead, the EPE then cascades downscale until the spectral Ro increases such that conversion EPE to EKE can take place. Then the EKE cascades upscale until it is converted to EPE at large scales and small Ro again.

It is demonstrated that from the turbulence closure approach by Canuto, Dubovikov et al it follows that there is indeed conversion from EKE to EPE at scales like the Rossby radius. For the dominant conversion from EPE to EKE at smaller scales with large Ro no strong arguments are given as far as I can see. The directions of the energy cascades are apparently assumed but in agreement with common believe. I haven't followed the derivation of the key result Eq. 5.7 in detail, but it seems correct.

This is a nice idea of the meso-scale energy cycle. The inverse energy cascade would just be a closed loop within a larger scope with a cascade of total energy towards small scale. However, it must be wrong since it is against all believes, observational and in particular modelling results that energy conversion by baroclinic instability is directed from EKE to EKE at the scale of the Rossby radius. In fact in all studies I know of, it is directed from EPE to EKE at all scales. The only conclusion for me is that this prediction of the turbulence closure approach by Canuto, Dubovikov et al given by Eq. 5.7 is wrong. That does not mean that all predictions and the whole closure is wrong, but it shows that one has to be careful with implications of simple closures like that.

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