Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2017-62-SC4, 2017

Ocean Science
Discussions
Open Access

Interactive comment on "Isoneutral control of effective diapycnal mixing in numerical ocean models with neutral rotated diffusion tensors" *by* Antoine Hochet et al.

T. McDougall

trevor.mcdougall@unsw.edu.au

Received and published: 22 December 2017

It is not true that potential temperature is equally good as Conservative Temperature in an ocean modelling context. This has been described in several papers that quantify the non-conservative production of both variables, and I note that section 5 of the quoted paper of Tailleux (2015) is incorrect in this regard. Here is another way of seeing this. Consider the ocean surface which is exchanging heat with the overlying atmosphere continuously. When integrating over say a minute, or an hour or a day or a week or a season, when using Conservative Temperature it is simple to calculate the ingest of Conservative Temperature over this period of time; it is simply the ingested

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amount of heat divided by a fixed value of heat capacity namely cp_0. But the ingested amount of potential temperature is impossible to calculate accurately when potential temperature is used as the model variable. This is because the ingested amount of potential temperature is equal to the time integral of the instantaneous air-sea heat flux divided by the specific heat capacity at zero pressure, cp(SA,T,0). This specific heat capacity varies each second and is different in the daytime versus at night time (because of the variations in temperature), and it varies with the sea surface salinity. These temporal variations of temperature and salinity are unknown to an ocean model at time scales less than the time step of the model. Hence it is impossible to accurately calculate the air-sea flux in terms of potential temperature. Similarly, in the interior of the ocean, due to unresolved temporal and spatial variations of the turbulent fluxes, it is not possible to accurately evaluate the non-conservative production terms. This is the reason why their magnitude should be made as small as possible, for example, by using Conservative Temperature rather than potential temperature as the model prognostic variable. Hence it is not true (as the present OSD paper and also Tailleux (2015) suggest) that potential temperature is equally good as Conservative Temperature as a choice for a prognostic variable for an ocean model.

Regarding the isotropic nature of small-scale turbulent mixing, both the Smith and Ferrari (2009) paper and the Scotti (2015) paper [Scotti, A., 2015: Biases in Thorpe-scale estimates of turbulence dissipation. Part II: Arguments and turbulence simulations. J. Phys. Oceanogr., 45, 2522-2543] support the isotropic nature of small-scale turbulent mixing. I agree that the correct treatment of small-scale mixing processes by allowing them to not only diffuse diapycnally but also epineutrally does cause only trivial changes to the amount of epineutral diffusion. Nevertheless, it is good to include these processes correctly so as to reduce confusion in the literature, and to use language correctly.

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