

Geosci. Model Dev. Discuss., referee comment RC6
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Reply on RC5

Remi Tailleux (Referee)

Referee comment on "The interpretation of temperature and salinity variables in numerical ocean model output, and the calculation of heat fluxes and heat content" by Trevor J. McDougall et al., Geosci. Model Dev. Discuss.,
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For the record, I made no comments on Prof. Fox-Kemper's intention or rationale so not sure how I may have mis-interpreted him. This being said, I find it hard to reconcile what he says about this paper and what I understand of it. Just to be sure that I understand him correctly, could Prof. Fox-Kemper clarify that by supporting this paper, he actually approves its main recommendation, namely that in future comparisons between EOS80- and TEOS10- based models, it will be acceptable from now on to compare (among other things) the monthly-averaged potential temperature computed with an EOS80 model with the monthly-averaged Conservative Temperature computed with a TEOS-10 model? (As opposed to compare the EOS80 monthly-averaged potential temperature with the TEOS10 monthly-averaged potential temperature inferred from the Conservative Temperature, as is currently recommended).

I think that what is at stakes here is whether it is needed for TEOS-10 models to archive both Conservative Temperature and the potential temperature inferred from it, which is the current recommendation of Griffies et al. (2016). The current need to save both fields represents a significant burden for TEOS-10 models, which in some sense are doubly-penalised compared to EOS80 models. Indeed, the switch to TEOS-10 and Conservative Temperature generally entails some additional computational cost, as the equation of state is more costly to estimate, and some additional operations are required to convert Conservative Temperature to potential temperature at the surface for correctly estimating radiative and sensible fluxes. The further need to calculate potential temperature at each time step in order to compute monthly means or snapshots represent a significant added computational and storage cost. Presumably, ocean modelling groups must have realised that while they agree that it would be beneficial to switch to TEOS-10, the significant increase in computational and storage costs that this currently entails is a strong disincentive to do so. Presumably, I imagine that this is the real motivation for this paper, which in some sense provides a way out for TEOS-10 models by telling them they can just archive Conservative Temperature, their argument that EOS80 potential temperature can actually be re-interpreted as Conservative Temperature if one wants providing a rationale saving them the need for diagnosing and archiving potential temperature, thus considerably reducing their computational and storage burden and making the switch to TEOS10 considerably less painful.

This is really the key issue to be debated here, which Prof. Fox-Kemper hasn't really commented upon yet. This is quite a big deal, because if TEOS-10 models stop diagnosing and archiving potential temperature, it will become quite hard in the future to disentangle when comparing potential temperature with Conservative Temperature, what are the differences that are due to the inherent differences between the two variables from those that are due to actual physical reasons.