To,
The Referees,
Comparison of the simulated upper-ocean vertical structure using 1-dimensional mixed-layer models,
doi:10.5194/os-2016-45

Subject: Plan for the revision of manuscript

Dear Referees,

The authors thank you for your comments on the manuscript. In this letter, we briefly outline our intended major revisions and the associated modifications we plan to make to answer both your concerns. In addition, we will also be submitting point by point formal responses to your reviews. Aside from minor points, we have merged your major concerns into three main points. These are listed below.

1. **Continuous and dis-continuous near-inertial shear band in SWAPP**

   A major difference between the models, which had been mentioned but not explained adequately, is the formation of a continuous near-inertial (NI) shear band in the simulation CA ($k-\epsilon$) compared to discontinuous shear bands below the mixed layer (ML) in those with the KPP and PWP models. The shear bands in the PWP and KPP simulations appear discontinuous because the log of the shear spectrum in the regions of discontinuity is less than the range shown in the plots (figure 3), so the shear is indeed weaker in PWP and KPP at these intermediate depths. In contrast, the shear spectrum in the simulation CA is within this specified range at all depths. This is because for the CA simulation, local mixing below the ML smears out the shear profile, reducing the maxima and enhancing the minima. This phenomenon does not happen in the PWP and KPP simulations since in this version they do not have any background mixing below the ML. The revised manuscript will discuss this in detail.

2. **Variability of SST with mixed-layer depth**

   For the MLML comparison we have shown that the diurnal variability of the SST depends on the surface fluxes and the local mixing near the surface. Referee 1 has commented that the diurnal SST variability could simply depend on the mixed-layer depth (MLD), and that shallower MLD in PWP results in a larger increment of SST at the end of each diurnal cycle. In the revision, we illustrate that the SST variability for PWP depends on the trapping depth and not on the MLD, whereas for the other two simulations it also depends on the local eddy diffusivity near the surface. We define the trapping depth as the depth of the portion of the water column that absorbs the net heat flux, and this depth can often be deeper than the mixed layer depth. Our revised plots of the MLD and the trapping depth show that despite shallower ML, the PWP simulation has a deeper trapping depth compared to KPP and CA. Even though a deeper trapping depth explains a shorter diurnal amplitude in the SST in the PWP simulation, it does not explain why the SST is cooler for CA and KPP at the end of the diurnal cycle than for the PWP simulations. This smaller net SST increment in CA and KPP for the diurnal cycle is because of the formation of a near-surface negative nighttime temperature gradient mixed by the resulting local eddy mixing. In contrast, the near-surface negative temperature gradients are mixed instantaneously in PWP by convective adjustment, implying a more vigorous mixing which does not reduce the SST as much. The revised manuscript will discuss this in detail.

3. **Comparison of model results with observations**

   In the revised manuscript, we provide additional discussion on how the model results compare with the observed datasets, and the implications of these comparisons. Even though the warming in the PWP simulation is similar to the observations during the $2\frac{1}{2}$ month R phase, the SST warming in

> the MLML dataset was partly a consequence of advective warming near the surface (Plueddemann et al, 1995), which is not present in any of the simulations. We have confirmed the presence of this advective warming from depth-integrated heat content plots from the MLML dataset which we plan to show in our revision. In the MLML dataset, the advective warming positively biases the depth-integrated heat content, and consequently the SST. The PWP simulation, in spite of the absence of advective warming, yields a similar SST variability during the R phase. Hence, the agreement of the PWP simulation with observations in this instance is not an evidence of superior model performance. The revised manuscript will discuss this in detail.

We are thankful to reviewer 1 for pointing out other minor concerns, which will also be addressed in the revised version.

The objective of this study is to bring to light inter-comparisons between model predictions of upper-ocean characteristics that have not been investigated before. We have done this using two widely used upper-ocean datasets. While this manuscript does not recommend specific improvements to existing mixing parameterizations, we believe that this analysis will provide a useful guideline for future studies undertaking such a task.

Thank you.

Sincerely,
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