Comment on essd-2021-194

Anonymous Referee #3

The manuscript is well written and presents relevant results and discussions. Thank you for dedicating time to publish a detailed discussion and analysis of this dataset. However, a more detailed discussion on a few topics would greatly benefit the manuscript.

Thank you for reading the paper and the comments.
The manuscript is modified to address the issues raised, please see below for details.

Main comments:

How does the multiscale data assimilation implemented here compare to previous work, such as Li et al (2015) and Tissier et al (2019)? I understand more details should be available in Chamberlain et al (2021a). But since this is not yet published, it would be good to have some more details in the present manuscript.

The magnitude of improvements found with the multiscale data assimilation in BRAN were comparable to those reported in regional and basin scale models by Li et al. and Tissier et al. 2019; this is now added to the introduction. In essence, similar ideas are being applied, albeit with different implementations due to different data assimilation (DA) systems (e.g. 'standard' 3D-VAR and EnOI). Other differences are the domains and time scale, here we apply multiscale DA to a long global-scale ocean reanalysis.
The Chamberlain et al. (2021a, doi:10.1016/j.ocemod.2021.101849) manuscript is accepted and available.
A brief description of the multiscale data assimilation is now a subsection of the 'Ocean data assimilation system.'

The model has the Southern Ocean as one of its regions of interest. The absence of a coupled ice model can have significant impacts on the circulation and water column structure in this part of the world, with potential repercussions to the global deep ocean. Could you please explain the impacts on the model results and how potential problems are minimized?

A paragraph has been added to the introduction to give a better context to the work done.
The development of BRAN is in support of operational ocean forecasting around Australia and has found many other applications across this broad region, now listed in the introduction as well. As such, BRAN has not focused on dynamics close to Antarctica under the influence of processes associated with sea ice at this stage. The Bluelink Project intends to include sea ice in future versions of BRAN to expand the utility of the product.

I am a bit confused about the definition of innovation. To my best knowledge it is defined as the difference between the observations and the model maped to the obs locations. However, all the values presented in Fig. 2 are positive. Does this mean there are model BIASES for all the fields? Or are the innovation and increment defined in a different way?

This definition of innovation is fine, the values plotted in Fig. 2 are the "mean absolute values" which is why they are all positive. There is now a separate paragraph discussing the values of mean biases that may help clarify.
Figure 2 is showing trends in global averages of the absolute innovation values; global averages of mean innovations (~ biases) typically average out close to zero, obscuring significant regional variability, discussed and shown in Chamberlain et al 2021a.

A few minor comments:

Lines 64-65. It looks there is a typo. Please review it.

This sentence has been rewritten to clarify.

Line 97. Typo: "of" should be "on".

Fixed.

Lines 190-191: Comparing the daily average fields to observations excludes a lot of high frequency processes that will be smoothed out. I imagine the observations were also averaged for the comparisons.

Yes and yes.
Rapid, small scale dynamics will be averaged out, there are not enough observations to constrain these features over the global domain at this time.

All available observations from each day are used for these comparisons. Text is modified to help clarify, "we compare daily-averaged reanalysed fields … with daily observations."

Line 215. Could you please explain how the multiscale assimilation eliminated the biases?

In the extra paragraph added discussing biases (Section 3.1), there is a brief explanation of why the multiscale is effective.
"The fine scale corrects mesoscale features (like done in BRAN2016), and the extra coarse step uses an ensemble containing longer length scales and larger localisation (see Appendix), which are more effective at correcting large-scale biases."

Line 216. How to avoid the over-fitting in the EnOI scheme?

We suggest modifying the observation errors assigned, for AVHRR in particular (as described later in this section), which reduces the weighting used to fit to the observations within the DA system when calculating the corrections to the ocean state.