

Dear Editor,

To begin with, we wish to thank the last critics from the Anonymous Referee #2, which we considered in revising the manuscript. For the sake of clarity, we reproduce the comments from the referee and then we present our answers. We indicate the lines of the paper where changes listed below took place, when relevant, using as reference the revised manuscript without the tracked changes.

All implemented changes may be tracked down in the attached files with the revised manuscript.

Reviewer comments and our answers

This is the second review of the manuscript that demonstrates the value of boundary conditions that includes dynamics. The manuscript has improved however I still request some minor changes. One is the missing conclusion.

Answer: A Conclusion was added to the manuscript (lines 484-496).

Abstract line 29. I assume that the improvement is due to the use of A4 oceanic boundary conditions rather than the nested area. If this the case it should be mentioned here.

Answer: Mentioned as suggested (line 30).

Line 51 and 52

“Also, knowledge about the possibility of ice in an area might be more important for applications than the specific details of the sea ice cover.”

I am sure what is referred to here. Is it that the results are used as statistics of a hindcast for planning or is it that an approximate sea ice cover is good enough for some application? Please clarify

Answer: The main idea here is that when it comes to operational forecast applications, such as navigation, it may be more important to be sure about the presence/absence of sea ice in a given area that to have an accurate prognostic of sea ice properties. We added a small sentence to specify “navigation” (line 53) as an example of an application, hoping this will make the sentence clearer.

Line 68: CICE do include two packages from v6 and onwards, however you models are version 5.1.2 and something close to v6.0.0 (I assume). I am not sure whether it add value to mention it or if it confuses more that you mention it.

Answer: We hope the sentence is clear enough since we write: “It includes two independent packages: CICE and Icepack. Sea ice dynamics ... **Previous versions did not have such a separation, but the code evolved over the last years towards a clear distinction between processes which are mainly horizontal and those that are mainly vertical/columnar (since CICE6)**” (lines 70-73).

Line 77 primary model for forecasting **of** sea ice conditions....

Answer: Done as suggested (line 100).

Line 82 should this refer to section 2.2?

Answer: Yes. Corrected in the revised manuscript (line 105). However, due to other suggestion (below) we moved the section describing the coupling and now it is section 2.2.1.

Line 86 could you add a reference to Arome-Arctic

Answer: We added a link to the web page of the The Norwegian Meteorological Institute where the model is referenced, a citation (lines 109-110) and the respective reference (lines 606-608).

Line 105 Here you could reference the cice 6.0.0alpha [CICE Release Table · CICE-Consortium/CICE Wiki · GitHub](#) as the code you got is likely close to this

Answer: We understand the importance of referencing a documented version. However, we believe that the version we use is a bit older than the one suggested by the referee. Therefore, we described it using the same words we used in a previous paper co-authored by Elizabeth Hunke and following her advice (that is one of the reasons why we have the impression that the version we used does not match exactly one of those versions listed in the Wiki):

Duarte, P., et al. (2017), Sea ice thermohaline dynamics and biogeochemistry in the Arctic Ocean: Empirical and model results, *J. Geophys. Res. Biogeosci.*, 122, 1632–1654, doi:10.1002/2016JG003660

However, we added a few words and now the sentence reads as:

“CICE [with a “column package” for thermodynamics and biogeochemical processes developed as part of the Accelerated Climate Model for Energy (ACME) project, close to CICE6.0.0 alpha (<https://github.com/CICE-Consortium/CICE/wiki/CICE-Release-Table>)]”

However, and as we emphasize in the last paragraph of the Discussion: “the compatibility of the changes described in this study with the most recent versions of the 474 Los Alamos Sea Ice Model (CICE + ICEPACK, <https://github.com/CICE-Consortium>), since the files changed and listed in 475 Table 1 are similar to those of the most recent versions.”

Section 2.2 I think that it is more natural to describe the coupling after section 2.1 and before the individual model setups (move 2.2 before section 2.1.1 and 2.1.2)

Answer: Thanks for the suggestion. Done as suggested. Now the coupling is described in 2.1.1 and former sections 2.1.1 and 2.1.2 became 2.1.2 and 2.1.3, respectively. We also corrected references in the text to the various sections.

Line 125. Do you use CICE_Finalmod.F90?

Answer: Yes. This was now added to the manuscript. The sentence became: “ROMS is the controlling software acting through the CICE drivers CICE_InitMod.F90, CICE_RunMod.F90 and CICE_FinalMod.F90 to initialize, run and finalize CICE” (line 82).

Line 230 I think that ice sheet is normally used for glaciers. I would rephrase to ice cover

Answer: Corrected as suggested. The sentence now is: “This means that the entire sea ice covered area inside the domain of the model...” (line 233).

Line 330 I would replace roughly one month with the date it was reinitialized.

Answer: Done as suggested (lines 335-336).

Line 376 reference figure 1 and the trajectories

Answer: Since here we write about the observations used to evaluate model results, we have chosen to refer instead 2.3.2 (line 382) section where all details regarding these observations are given, both those from the N-ICE2015 expedition (referencing Figure 1) and those from satellite data. Please note that the reallocation of the description of model coupling implied changes in the numbering of several sections.

Figure 4a I miss an explanation why the RMS error increases in wintertime.

Answer: This was already answered in our previous response. We reproduce here what we wrote then: “We suspect that the increase in RMSE towards wintertime is related to Barents-2.5 km known cold sea surface temperature bias manifesting itself more in the winter.”

Section 3.2.1/ Figure 5

I am not sure whether this adds value when figure 6 is included. The ocean is not in focus but the balance between 3 large figures and ~10 lines of text seems a bit off

Answer: We would rather keep this figure to illustrate vertical details about ocean model biases that show that, at least in comparison with TOPAZ4 results, the S4K ocean component is doing relatively well. We agree that the text associated with these figures is rather small, but it synthesizes the main messages about them.

Section 3.2.2

Please check references. I think that there are some, which do not match after removing a figure.

Answer: These references to the various figures were corrected, mostly by removing the wrong references to Fig. 10.

Line 394 – 398 some more details about the distribution would be nice.

Answer: Done as suggested – more details added (lines 400-406).

Line 446 – 451 Comment There is a contradiction in running nested models. You would like to resolve the physics better and based on this get a different result. On the other hand, you also want the model to be similar on the boundary in order not to create strange behaviors there.

Answer: Yes, we fully agree.

Line 449 I would remove matching

Answer: Removed as suggested.

Line 460 and 462 hallo -> halo

Answer: Corrected as suggested.

13 May 2022, Pedro Duarte (on behalf of all co-authors)