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Ocean Science Discussions

Interactive comment on "On the assimilation of ice velocity and concentration data into large-scale sea ice models" *by* V. Dulière and T. Fichefet

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Dear Cecilia,

Thank you very much for your constructive review of our manuscript. Here is a detailed answer.

Specifics Comments

CB : How it is know that the agreement of the model control and observations is acceptable to make a reliable study ...

AC : This was added at the end of the "Model formulation and forcing" Section (p273 l16):

Results of data assimilation are assumed to be somewhat model dependent. Hence, it would be appropriate to introduce physical processes, like among other things, deformation from shear, brine pocket release or ocean feedbacks in the model. However, for a more complete understanding of model results, for CPU time reasons and because we plan to later test data assimilation with NEMOLIM (a more comprehensive global ice-ocean model), we decided to run experiments with the model described above.

The following was added at the end of the Section "Assimilation of ice concentration data" in the "Thermodynamic perturbation" Section (p280 l16):

This solution is very model-dependent and may not be suitable for any other case-study. However, this solution is here appropriate and therefore retained in the experiments discussed in the following section.

And this to the "Conclusion" (p284 l6):

Likewise, the data assimilation results are assumed to be model dependent and the model used here is simplified (no shear deformation, no ocean feedbacks, ...).

CB : I think assimilation should be considered as defeating a feedback rather

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than being part of some special "error feedback", ...

AC : You are right. We mainly changed this part of the second paragraph of the Section "Assimilation of ice velocity data" in the main Section "Thermodynamic perturbation" into (p277 l6):

According to Thorndike et al. (1975), the dynamics seek the mean and the thermodynamics the extremes. When the thermodynamic perturbation is applied to the model, thermodynamics seek an anomalous extreme in ice thickness. The model's ice dynamics act to reduce this anomaly, but data assimilation defeats this process. For instance, if the ice is too thick in a region because of too low an air temperature, convergence will weaken in this area via the Kreyscher et al. (2000) correction. When higher ice velocities are assimilated, convergence becomes larger and ice thickens, thus defeating to lower the ice thickness error.

CB : Assimilation ice information has the potential to improve ice-ocean coupling during climate model spinup. It would be interesting to include information about the freshwater and heat exchanged between ice and ocean...

AC : Actually, we are now studying the freshwater and heat exchanged between ice and ocean while concentration or velocity data are assimilated into NEMOLIM, a more comprehensive ice-ocean model. Hence, we are not working with an idealized model anymore, however we are still runing twin experiments.

Technical corrections

CB : P268 l6: I don't think the strength of ice-ocean models is necessarily a matter of scale...

AC : We changed "These models provide very useful information regarding the large-scale behavior of the ice pack at the decadal time scale." to "These models provide very useful information regarding the behavior of the ice pack."

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CB : P272 l7: "this correction is too steep" does not make sense. Instead say this corrections causes a velocity gradient that is too steep. Also add "as a function of h" to the end of the paragraph.

AC : done

CB : P272 "Un" is a typo

AC : done

CB : p275 l2: eq 5, When is A_i equal to A_{ass}?

AC : This was added in the "Assimilation scheme" Section:

While the ice velocity is updated at the end of the model velocity computation (before ice transport), the ice concentration update is done at the end of the model iteration.

CB : P277 l3: "weaker" should be "smaller" and "stronger" should be "greater"

AC : done

CB : P277 l17: What is the good reason?

AC : The good reason would be that the ice thickness bias is improved because there is an improvement of the ice transport. For this specific case, h_i is globally too thick. Smoothing the advection when velocity data are assimilated leads to an ice thickness decrease and therefore to an ice thickness enhancement. In other experiments not discussed in the manuscript, h_i was globally too thin and the advection smoothing led to an ice thickness deterioration.

P277 l 17: but not for the good reason has been changed into *but not due to the enhancement of the ice transport*

CB : P277 "Ice thickness distribution" change to "ice thickness spatial distribution" or "pattern"

AC : done

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CB : P280 l13: "To be total" change to "In total"

AC : Changed to *To be complete*

CB : P280 l15: I think the discussion of feedback could be better by saying something like "... and they influence the next physical mechanism errors, which in turn effect the thickness."

AC : done

CB : P281 l8: "in function" change to "as a function"

AC : done

CB : I just can't see any improvement in Fig. 6 d over c.

AC : Figures are now with colours. We hope this is clearer.

CB : Fig 8 caption him should have subscripts

AC : done

We hope to have answered your comments in a satisfying way. Do not hesitate to contact us if you have any question.

Best Regards,

Valérie Dulière and Thierry Fichefet.

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