**Ocean Science
Discussions**

Interactive
Comment

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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General Comments

Our knowledge of sea ice is fraught with errors and missing information. This is one reason it is tempting to use models with data assimilation to fill in the gaps. However, data assimilation is not straightforward because it tampers with the basic conservation properties and feedbacks of the system. This study attempts to examine these difficulties with an idealized model and experimental framework.

The authors use a model to construct the "true state" of the Arctic sea ice and then assimilate this true state into a perturbed model. This method permits assimilation of perfect information and control over model errors. This clever study gives new insight

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into the developing field of data assimilation.

Specific Comments

How is it known that the agreement of the model control and observations is acceptable to make a reliable study (Re p276)? I don't object to using an idealized model. But I expect the results from assimilation to be somewhat model dependent. For example, the model has no deformation from shear, so it is missing a major source of interaction between dynamics and thermodynamics. This doesn't diminish the value of performing this kind of study. The strength here is that the model results can be understood more fully. It would be helpful to have a succinct discussion about what aspects of the idealized model are representative of principal processes in sea ice and what is lacking.

It would be helpful to identify the results that are most likely to be general. I think the authors have done a nice job writing conclusions that are very general. They would be wise to say that they have taken care in this way. A brief discussion of caveats with regard to the model would be helpful in the summary or conclusions as well.

I think assimilation should be considered as defeating a feedback rather than being part of some special "error feedback" (as stated on p282). Regarding the top of page 277, I think it is helpful to say that data assimilation defeats one of the model's innate negative feedback processes involving thickness and deformation. Thorndike et al 1975 say that dynamics seek the mean and thermodynamics the extremes. When you perturb the temperature, your thermodyamics seek an anomalous extreme in thickness. The model's ice dynamics act to reduce this anomaly, but data assimilation defeats this process.

Assimilating ice information has the potential to improve ice-ocean coupling during climate model spinups. It would be interesting to include information about the freshwater and heat exchanged between ice and ocean as a metric of model performance with an idealized model. Perhaps these are best left for future work though.

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Technical Corrections

p268 I don't think the strength of ice-ocean models is necessarily a matter of scale. I think Rothrock and Zhang showed that the Arctic-wide trends did not agree well across models. Instead, I think their value is in allowing for hypothesis testing.

p272 "this correction is too steep" doesn't 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.

p272 "Un" is a typo

eq 5 When is A_i set equal to A_{ass}?

p277 "weaker" should be "smaller" and "stronger" should be "greater"

p277 what is "the good reason"?

p277 "ice thickness distribution" should be reserved in sea ice studies to refer to the probability density function g(h). Use ice thickness spatial distribution or pattern instead.

p280 "To be total" change to "In total"

p280 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." However, if the authors agree with my point 2 above, then the text needs more substantial revision at p 280.

p281 "in function" change to "as a function"

Fig 6. I just can't see any improvement in Fig 6 d over c. Fig 6 is pretty hard to see after all.

Fig 8 caption him should have subscripts

S50

Interactive comment on Ocean Sci. Discuss., 4, 265, 2007.

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