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Interactive comment on “A combined approach of remote sensing and airborne electromagnetics to determine the volume of polynya sea ice in the Laptev Sea” by L. Rabenstein et al.

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Received and published: 8 February 2013

Summary

This manuscript presents a novel analysis of ice production in Laptev Sea polynyas by combining estimates of ice area production from SAR analysis with ice thickness data from an airborne EM campaign. Through manual examination of a series of Envisat ASAR images, the authors were able to identify regions of ice created during four distinct opening events during a 116-day period in the winter of 2007-08. By tracking these regions over time, the authors assigned age classes to discrete polygons comprising the ice cover. These age classes were then used as a means of extrapolating

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Interactive Discussion

Discussion Paper



Interactive
Comment

the airborne EM thickness data over a broader area and thus arrive at an estimate of total ice volume production of $94 \pm 27 \text{ km}^2$. To validate their methodology and allow the results to be cast into an Arctic-wide context, the authors compared their ice thickness maps and total volume production estimate with results from a high-resolution coupled ice-ocean model forced by NCEP 6-hourly surface data and observed landfast ice edge location. The modeled total ice production of 112.2 km^2 is within the range derived from observations and, according to the model, this accounted for 6.2% of the total Laptev Sea ice volume and 0.4% of the entire ice volume. The authors also investigate the relationship with age and thickness, which compares well with results from a 1-D freezing-degree day model for level ice. Overall, this is a well-written paper that describes a novel data-integration method applied to the study of ice production in a coastal polynya. I recommend this manuscript be published following minor changes, which are described in comments below.

General comments

I enjoyed reading and reviewing this manuscript and look forward to seeing it published, but I have two general comments and a number of minor corrections I would like to see addressed. The first of these pertains to the authors' use of observed reduction in ice area (convergence) to explain unexpectedly thick ice in a region identified as being only 16 days old (p 448, lines 19-24). It seems to me that the authors have the necessary data to test whether the amount of area change explains the increased ice thickness along sections 16c and 16f. Demonstration of conservation of ice volume would not only strengthen the assertion that dynamics can explain the observed ice thicknesses, but it would add another level of validation to the combined SAR-EM data product. My second general comment concerns the stated quality of the agreement between observed and modeled ice thicknesses. On page 451, lines 16-20, the authors state "... the distribution of ice thicknesses in Fig. 8a and 8b are generally similar, with most of the thickest ice in the middle and northern regions and some of the thinnest ice near the southern and eastern margins of the maps. Knowing that the Naosim

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model output is in good agreement with our sea-ice volume . . .". However, from Figure 8, it seems to me that there are significant differences in the spatial distribution of ice volume that are being overlooked. In particular, much of the thickest ice in the model results coincides with the areas of thinnest ice from observations (along the southern edge of the polynya). Whereas I might believe this could be the result of inadequate representation of landfast ice in the model, I would prefer to this discrepancy addressed explicitly before the local results are expanded to address regional and basin-scale values.

Specific comments

P443, line 2: "Landfast" is typically used as a single word. Also, the manuscript uses both "land fast" and "fast" and I would recommend using just one of these consistently throughout.

P443, line 2: Given that the polynyas can be expansive, I recommend replacing "locations" with "shoreward edges"

P443, line 5: Replace "are" with "is"

P446, lines 4-12: I recommend using the present tense here, unless the Bird in question is no longer configured in the same way. If so, the past tense should be used in line 3.

P446, line 22: I recommend avoid the use of "anyway", which sounds somewhat colloquial. Instead, the authors could begin this sentence with "However,"

P446 lines 26-29: Is it reasonable / feasible to assume a uniform spatial gradient of surface water conductivity?

P449, lines 15-18. I feel the meaning of this sentence needs to be clarified. Do the authors mean that if ice dynamics are excluded from consideration, then such differences have to be accounted for by variations in ocean heat flux, snow depth, etc?

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Interactive Discussion

Discussion Paper



Interactive
Comment

P450, line 6 Delete “a” before “several” P 451, line 8: I recommend replacing “land fastened” with “landfast”

P 451, lines 11-13: This sentence could be reworded to better explain the two different ways of calculating area. The first case is referring to the total area encompassed by the polygon, whereas the second case is the integration of ice concentration over this area. This is analogous to the difference between ice extent and ice area.

P 453, line 17: Replace “ist” with “is” in both cases (for consistency of language!)

Figure 1,3 and 5 It would help readers unfamiliar with the study area if the region shown in Figure 5 was the same as that shown in Figure 3 and the extent of this region was illustrated on Figure 1. I also recommend adding coastlines to Figures 3 and 5.

Interactive comment on The Cryosphere Discuss., 7, 441, 2013.

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