

Interactive comment on “Recent wind driven high sea ice export in the Fram Strait contributes to Arctic sea ice decline” by L. H. Smedsrud et al.

Anonymous Referee #2

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Ice export is one of two main processes that govern the overall sea ice balance in the Arctic Ocean. The recent strong decline in Arctic sea ice area and sea ice volume pose the question whether an increase in export could have contributed. The main conduit for sea ice export is Fram Strait. Consequently, the authors combine Envisat ASAR estimates of sea ice velocity in Fram Strait with SSM/I and AMSR sea ice concentration data to estimate recent sea ice area export through Fram Strait. A statistical relationship between the geostrophic meridional wind component and sea ice drift as well as sea ice area export is put forward. For the period of available satellite data there is a good linear fit between sea ice area export and the geostrophic wind. This relationship is used to reconstruct sea ice area export for the period of available atmospheric re-analysis data. According to this reconstruction, sea ice area export through Fram Strait has increased by 25% compared to the 1960s.

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The manuscript is a contribution to the question of overall sea ice mass balance in the Arctic and the possible causes for the recent dramatic decline. This topic is highly relevant and fitting for TCD. There are a few recommendations that I can suggest and which might improve the manuscript.

It should be realized that with the data considered here, only the ice area export from the Arctic can be estimated. The title of the manuscript is thus clearly too ambitious and must be changed. Neither is the ice export (implying volume or mass export of sea ice) from the Arctic considered nor can the data really be used to establish a contribution to the sea ice volume balance in the Arctic Ocean. At all places where “sea ice export” is used in the text, it should be replaced by “sea ice area export”.

Detailed comments:

Page 1312, line 2: Arctic sea ice area decline does hardly continue at a steady rate. The rate of sea ice area change is itself changing considerably interannually and on longer time scales.

Page 1312, line 7: The name of the “underlying current” should be mentioned. The statement that it drives 33% of the ice export is a little bit too concise to be understandable. Does it refer to the trend, the variability, or is this referring to the long-term mean sea ice area export?

Page 1313, line 7: Statement unclear: Are year 2000 conditions and vanishing summer sea ice in 2080 extreme cases for the end of the century according to the climate projections? The term “prediction” should be avoided in this context.

Page 1313, line 16: There is a tendency in the literature on Arctic sea ice to only mention positive feedbacks. One wonders how Arctic sea ice can exist in the first place. It should be noted that open water favors new sea ice production, a negative feedback associated with declining sea ice cover.

Page 1313, line 23: Trends in sea ice area export have not previously been found

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in Fram Strait. Have there been attempts to estimate these trends? Please provide references.

Page 1313, line 26: The statement on increasing sea ice drift in Fram Strait since 1979 needs a reference.

Page 1314, line 4: It is not true that a conclusion regarding the effect of changes in sea ice area export on the thinning of Arctic sea ice will be given in section 5. I only find one statement there that such a relationship is likely. Anyway, without knowledge of the ice volume export changes in Fram Strait, we cannot arrive at conclusions about the sea ice mass balance in the Arctic.

Page 1317, line 13: It remains unclear how eq.(1) could be used to estimate the mean speed of the East Greenland Current in Fram Strait, as eq.(1) is for ice drift.

Page 1317, line 23: “our pressure dependency” and “our constant term” are awkward expressions and should be replaced.

Page 1318, line 10: “AMSR derived drift vectors” – I believe that you only consider the meridional velocity component (or rather the drift component perpendicular to the line connecting the two points between which the atmospheric pressure gradient is taken).

Page 1319, line 13: Discussing the ice area export using changes in annual mean sea ice drift and concentration is misleading. Since both the drift and the concentration vary seasonally and with higher frequency, the correlation of fluctuations cannot be neglected in the total annual mean transport.

Page 1321, line 11: Trends might be statistically significant and robust according to formal statistical criteria. However, it would still be interesting to see the impact of single extreme export years on the trend estimate. This could easily be done by recalculating the trends with certain anomalies (e.g. 1995 or 2000) taken out. From Fig.7, I suspect that the result would actually be quite different.

Page 1322, section 4.3: A time series plot showing all three estimates (AMSR, SAR,

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and NCEP) for sea ice area export would be helpful.

Page 1324, line 8: Where does the information about the intensification of cyclones over the Nordic Seas come from? Please provide a reference.

Page 1324, line 13: Statement (GCMs -> additional forcing necessary) is unclear.

Fig.2: How are the values binned? It would be good to have an explanation in the caption without need to refer to the main text.

Fig.3: What exactly is meant by “changes in seasonal monthly ice export”? Changes compared to what baseline?

Fig.5: What is the cause for the conspicuous vanishing SAR-based velocities where AMSR ice drift is non-zero? Fig.7: Values from Kwok (2009) are given as red dash-dotted line?

Interactive comment on The Cryosphere Discuss., 5, 1311, 2011.

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