

## ***Interactive comment on “Fram Strait sea ice export variability and September Arctic sea ice extent over the last 80 years” by L. H. Smedsrud et al.***

**J. Hutchings (Editor)**

[jhutchings@coas.oregonstate.edu](mailto:jhutchings@coas.oregonstate.edu)

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Dear Lars and co-authors,

As you have learnt, all the reviews and comments are in for your paper "Fram Strait sea ice export variability and September Arctic sea ice extent over the last 80 years". At this stage I would like you to provide a response to reviewer 1 and outline changes you will make to the paper in response to all comments of all reviewers. Thank you for the response to reviewer 2.

Both reviewers express concerns about the presentation of uncertainty in your manuscript. In response to reviewer 2 could you please discuss how the uncertainty

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in ice drift estimate impacts the area flux estimate. Yes, I agree the variance is not the same as the error estimate, however it is very hard from your current text and figures to gauge the signal to noise ratio. In the context of the trends and whether you can identify periods of variability that are longer than the interannual variability this variance does impact the length of time series you need to draw conclusions. Your manuscript could be clarified in this respect, which would of course make the paper more readable and accessible. For example, you discuss in detail the difference in trends between various different analyses, but do not put this into the context of if these differences are statistically insignificant. You do discuss the point that the last 30 years is impacted by several high export years at the end of the time series, and I think you can do a better job of putting this into context. The fact that your SLP based export estimate differs from previous work needs to be considered in the context of no particular record being the truth and all having errors that are not well defined.

There are several previous works linking the Fram Strait export or the Arctic sea ice pack state and ice motion to the Dipole Anomaly. Please consider the work of Jia Wang's group for example.

Wu, B., Wang, J., & Walsh, J. E. (2006). Dipole anomaly in the winter Arctic atmosphere and its association with sea ice motion. *Journal of Climate*, 19(2), 210-225.

Watanabe, E., Wang, J., Sumi, A., & Hasumi, H. (2006). Arctic dipole anomaly and its contribution to sea ice export from the Arctic Ocean in the 20th century. *Geophysical research letters*, 33(23).

Wang, J., Zhang, J., Watanabe, E., Ikeda, M., Mizobata, K., Walsh, J. E., ... & Wu, B. (2009). Is the Dipole Anomaly a major driver to record lows in Arctic summer sea ice extent?. *Geophysical Research Letters*, 36(5).

Your choice of calling March to August Spring is a little unusual in my mind.

I understand that you choose this time period based on the assumption all ice that

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grows in open water created by the export between these times will melt out in summer. This is a highly simplified model and does not account for ridging, but then again the albedo feedback will amplify the melt so you are not really looking at export from March-August as a linear indicator of open water in summer. Did you choose to split the time series periods in March as this is the 6 month split that gives you the best fit of the export to end of summer ice extent? I am having trouble wrapping my head around how the over 80% variance in ice export explained by cross strait pressure gradient and assumed seasonal cycle on ocean currents(at a time when the time series is also experiencing larger export), and the 22-55% covariance of the export proxy and following September sea ice extent allow you to make strong statements about causality. While the proxy record is defensible, I am not sure what contribution export has to ice extent based on the correlations. Does the proxy perform as well earlier in the time series, how much of the reduction in correlation is due to decreased covariance of the three station pressure with ice drift? In fact, the shorter time period is influenced by specific high export years, and you show that the last 7 years of the record are where this happens and influences trends. If you were to chose a similar short time series bracketing the years identified by for example Son Nghiem et al. (2007) as high transpolar ice drift and export (e.g. 2005-2007) would you get increased correlation based on this particular event? It does not look so from my quick scan of your figures, and the ice export at Fram Strait lagged (by a year) the transpolar drift event that the 2007 minimum was related to. It appears to me that the only time when the export explained a significant portion of the September ice extent has been in recent years (2011-2014). Is this the case?

I agree with reviewer 1 that you should tightening your manuscript to not overstate results.

### Specific Points

Abstract line 18 and 20: Missing squared from your area dimensions. Also at page 12, lines 20 and 21. Check throughout please.

line 32 "FShas" -> "FS has"

line 25-26 "should be considerably more accurate than 10%". Did you not actually estimate this? I think you just need to reconsider your grammar here.

page 5 line 16-19 You have noted an increased ice drift in winter. Echoing reviewer 1, there is increased open water in summer and potentially changes to surface roughness of the ice. This will impact stress transfer between the wind and ocean, and increased wind stress transfer to the ocean might also lead to increased currents. This is an example of speculative discussion where you could strengthen the manuscript by focussing on your key result (the time series) and a more rounded acknowledgement of its limitations.

page 16 line 25: There is a missing word

Please check all your references are listed. I could not find Krumpen et al. (2016) for example.

Looking forward to your response, Jenny

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Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-79, 2016.

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