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The Cryosphere Discussions

Interactive comment on "Satellite-observed sea ice area flux through Baffin Bay: 1988–2015" *by* Haibo Bi et al.

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Response to reviewer 1

This paper tries to monitor the sea ice flux (SIC) changes in Baffin Bay from 1988 to 2015 using the NSIDC sea ice concentration (SIC) and sea ice motion (SIM) datasets. The authors also try and link these changes in SIF to climate variables from the NCEP-NCARR dataset. Thought the datasets used for this study are very relevant and results can be very relevant to understanding the climate variability of sea ice conditions in Baffin Bay, after reading the paper, I do not think the authors understand the sea ice conditions in Baffin Bay and the drivers of the sea ice fluxes properly.

Response: Following the suggestion, a introduction of the sea ice conditions in Baffin

Bay is depicted in Section 3 in the revised manuscript. Section 3.1 gives a brief description of sea ice coverage. Section 3.2 make a introduction about the general sea ice drift pattern. Section 3.3 presents the trends in concentration and sea ice motion in Baffin Bay. These facts complement the understanding of the changes and the driving forcing of sea ice flux appropriately for different gates as seen in the discussion (Section 5).

My first concern is why the authors keep comparing the SIF of Baffin Bay with the SIF of Fram Strait. The ice regimes of those two regions are very different. The source of the SIF from Fram Strait comes directly from the Arctic Ocean and a large portion of the ice that flows there is comprised of multi-year ice all year round. In the case of Baffin Bay, the ice flows from Lancaster Sound and Nares strait in the summer months and is a mix of multi-year ice and first-year ice but in the winter, the ice mainly comes from first-year ice generated in polynyas of Lancaster Sound and the northern part of Baffin Bay. A major driver in Baffin Bay is the North Water Polynya (NOW) and nowhere do the authors mention this. Also, that polynya exists because of the ice bridge that is created in Nares Strait in the winter which blocks the inflow of thicker multi-year ice from the Arctic Ocean. Fram Strait and Baffin Bay are thus not comparable in terms of SIF.

Response: Thanks for the insightful suggestions. Recognizing that Fram Strait is a totally different areas for sea ice export, in the revised manuscript we remove the comparison with the flux in Baffin Bay. Considering the fact that North Water Polynya (NWP) is the primary ice source to the Bay during cold-freezing periods, we altered the positions of the North fluxgate (Figure 4) to further higher latitudes and quantify the sea ice inflow components originating from Lanscater Sound and NWP. The mitigating effects of sea ice flux though Nares Strait owing to the appearance of ice bridge (arch) during winter period are demonstrated in CIS maps (Figure S1) and reiterated in Section 2.1.3. Quantitatively, our ultimate estimates showing that 78%∼85% (Section 5.1.3) of the ice inflow through the North Gate consists of ice grown in NWP. This fact outlines

the recurring polynyas during cold seasons as a major contributor to ice area entering into the northern Baffin Bay.

Another issue is the separation between before and after the year 2000. The selection of the year 2000 seems arbitrary to me. Many climate change studies (including the IPCC report) state that there was a climate shift around 1998. Why did the authors not look at before and after 1998? Why don't there results show this climate regime shift (it should appear in the NCEP-NCARR dataset).

Response: In the revised manuscript, we focus on the issue of interannual variability and the long-term trends of sea ice area flux over the past nearly four decades and discuss the primary causes for the observed interannual variations and trends. As suggested by the reviewer, the inter-period changes, as previously separated by 2000, is not proper and excluded in the revision. Instead, we concentrate on the variability of the month-to-month ice transport of the past four decades (Figure 10) as well as the long-term trends (Figure 11). In particular, the climate changes associated with a warmer Northern Hemisphere over time, as shown in the NCEP-NCAR SAT data (Figure 16), are related to a thinner ice cover (Figure 15) and thus the increased area flux (Figure11). Also, some results can be explained by the sea ice conditions themselves. For example, the low SIM values on the Greenland coast in the winter months can be explained by the ice conditions. The sea ice along the coast is land fast, i.e. attached to the Greenland coast and does not move (note: the extent varies each year). I would strongly recommend that the authors visit the Canadian Ice Service website (https://www.canada.ca/en/environment-climate-change/services/iceforecasts-observations/latest-conditions.html) and specifically their 30-year ice atlas (https://www.canada.ca/en/environment-climate-change/services/ice-forecastsobservations/latest-conditions/climatology/30-year-climatic-atlases.html) to better interpret the SIF results.

Response: This piece of comment is vital to this study. Accordingly, we inspect the CIS maps for the ice conditions in Baffin Bay. Especially important is the knowledge of

spatial distribution of land-fast ice around the coasts of the bay, as provided in the CIS ice atlas. The land-fast ice extent benefits our study in that it helps to identify the zero flux grid cells which generally appears around the endpoints of one fluxgate adjacent to coasts. Secondly, it provides a thread to understand the slow ice motion, as introduced by reviewer, in the region attached to the Greenland coast (Figure 2, red arrows).

Overall, I would not reject this paper since it is very relevant to the studied field of climate change but I suggest major reviews after the authors better describe the region of interest and its different drivers. I would suggest to remove the comparison with Fram Strait as they don't have the same ice regimes. I would also study a bit more in detail the ice conditions which can be obtained on a weekly basis from the Canadian Ice Service in order to improve the interpretation of the results.

Response: As suggested by the reviewer, a major review is conducted by the authors. We remove the comparison with ice export through Fram Strait for its totally geophysical setting for sea ice. More information about the ice conditions in Baffin Bay is given (Section 3), such as the appearance and distribution of ice bridges in Nares Strait (Figure s1), the annual sea ice extent of the bay and coverage of NWP (Figure 6), the typical current circulation systems (Figure 1), and so on.

Specific comments: In the figure caption, I suggest adding more detailed descriptions of the figures. Specify what the a), b), c) and d) subfigures are etc. For Figure 7, what is the reference to generate the anomaly map? Usually it's a specific period that is used but it was not specified in the text. Also, what are the units if any for this anomaly map?

Response: Revised as suggested. To make it clear and direct to readers, we add captions to Figures with multiple subfigures (such as Figure 10). Figure 7 in the original submission has been removed in the new version of manuscript. Moreover, in the revision, we specify for each examined period or time interval anywhere mentioned in case of any ambiguity. For instance, we analyze the sea ice area flux for the

four different seasons including Winter (December-February), Spring (March-May), Summer (June-August), and Autumn (September-November). In some places , we refer the cold-period to include winter and spring or warm-period to cover summer and autumn seasons, if no particular annotation is given (See 5.3.2). Note that in the comparison of accumulated sea ice flux between our and previous studies (Figure 5), the cold period spans a time interval from Nov to May. Therefore, we try every effort to give an additional explanation about the time range to ensure that the alternatively used time period will not confuse the readers.

Please also note the supplement to this comment:
https://www.the-cryosphere-discuss.net/tc-2018-136/tc-2018-136-AC1-supplement.pdf

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