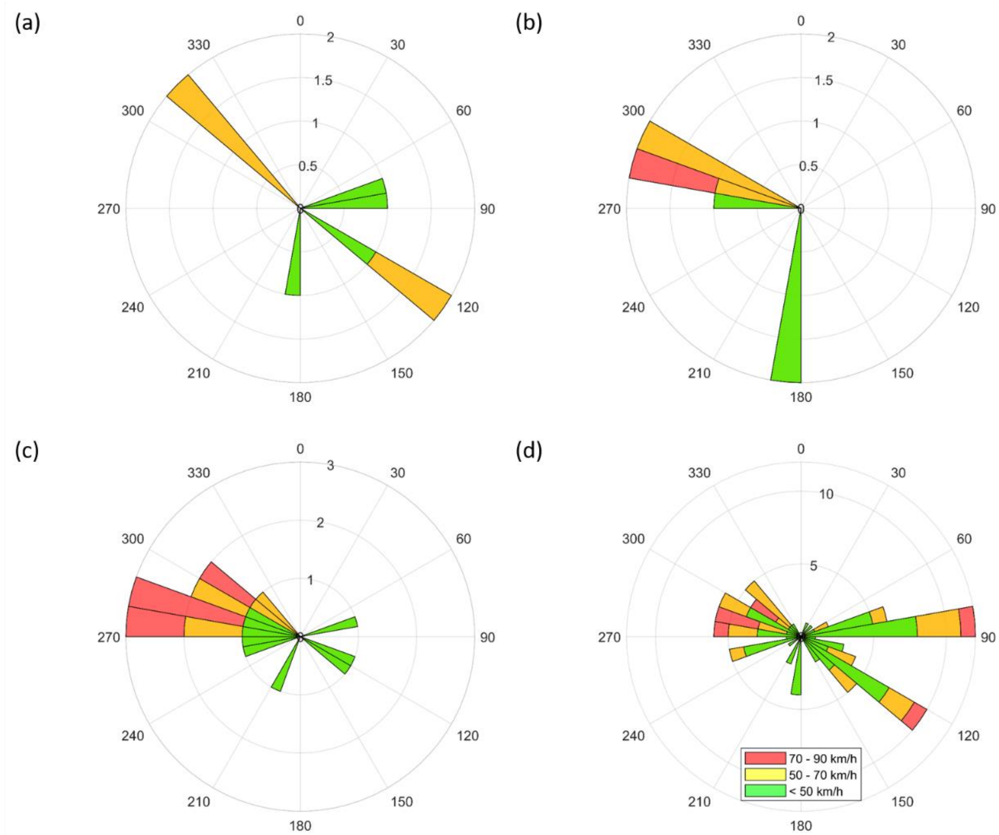
Responses to RC1

The author mentions drift, wind and ocean currents as a possible reasoning for landfast ice displacement, but very little evidence is presented to back up this claim other than reference to ice sheet break-up shown in Figure 3. Perhaps a wind rose, or a paragraph of winds statistics for the study time period may help to highlight this point.

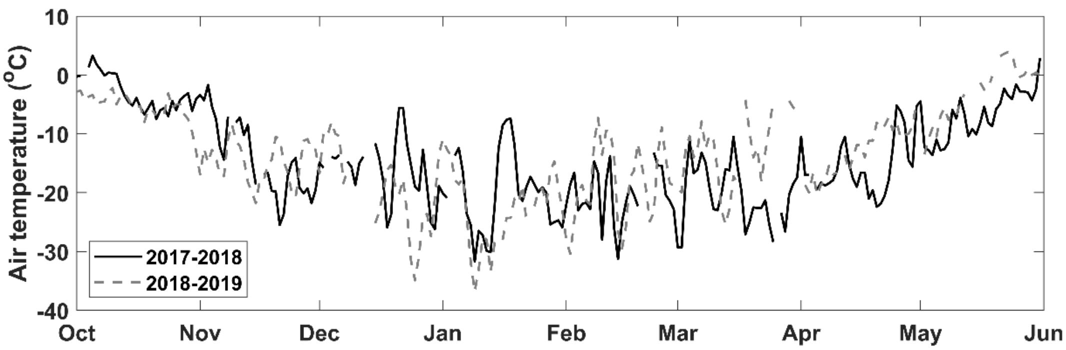
Agreed. An additional figure of wind rose graphs was produced to show the wind statistics during the 2017-2018 period (Figure S1). We confirmed the horizontal displacements are largely affected also by wind, not only by ocean currents. In particular, the distinct northwest displacements are considered to be due to the strong SE wind from the Mackenzie Delta. Also, the horizontal displacements during 20180125-20180206 (Figure 5b) and 20180206-20180302 (Figure 5c) were affected by the strong W and WNW winds. This new figure will be added after Figure 5 and explained in the revised manuscript.



.Figure S1. Wind statistics (Pelly Island station). (a) 20180113-20180125. (b) 20180125-20180206. (c) 20180206-20180302. (d) 20171126-20180407. North is 0°

Air temperature is an important component of the methodology towards the sea thickness model but the author failed to mention what the trend was during the study period. It would be good to know how this compares with the information presented in the discussion. Is there a threshold of growth once a maximum temperature is reached? Is that why maximum growth takes place between November to January and not after.

Here we present the air temperature data used for ice thickness models. The lowest temperatures are observed in January. This can explain why the significant growth was occurred between November to January. The air temperature data will be added if needed for a better explanation. Based on the ice thickness models, it is reached to the maximum in late May or early June, and then rapidly decreased. However, the proposed SPO technique is not applicable to the late stage of rapid changes and melting (i.e., surface melt and water over ice prevent radar penetration deeper). This was explained in lines 194-195. A follow-up study on the radar backscattering responses on the ice thickness growth and decay is ongoing, but it will be not included in this manuscript.



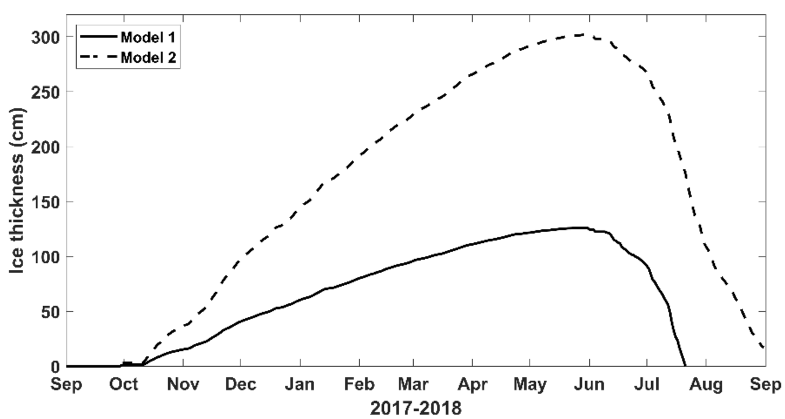


Figure S2. Air temperature during 2017-2018 and 2018-2019 cycles (upper, from the Pelly Island station) and sea ice thickness models (lower).

Did the authors look at the growth and displacement of bottomfast ice during the study period; does it show comparable growth patterns between the years?

Bottomfast ice is very stable compared to floating ice. While floating ice shows very strong backscattering from the ice-water interface, bottomfast ice appears very dark as radar signals penetrating into grounded ice are mostly absorbed into ground (Figure 3c). These are explained in lines 113-117. Thus, we could not detect any vertical offsets from bottomfast ice.

<u>Technical Corrections</u>

The figures were well done and helped to explain the results. A few edits below:

Figure 1 A – elevation model on land appears to be discontinuous with the abrupt break in the elevation at the latitude line. I am also confused on the colour, do they represent a range? (ie. 0-10, 10-50, 50-100). I think the map would look more realistic if you tighten the range of elevations at the lower levels (ie. 0-2, 2-5, 5-10, 10-50, etc) Bathymetry estimates seem believable.

It will be replaced with the following figure.

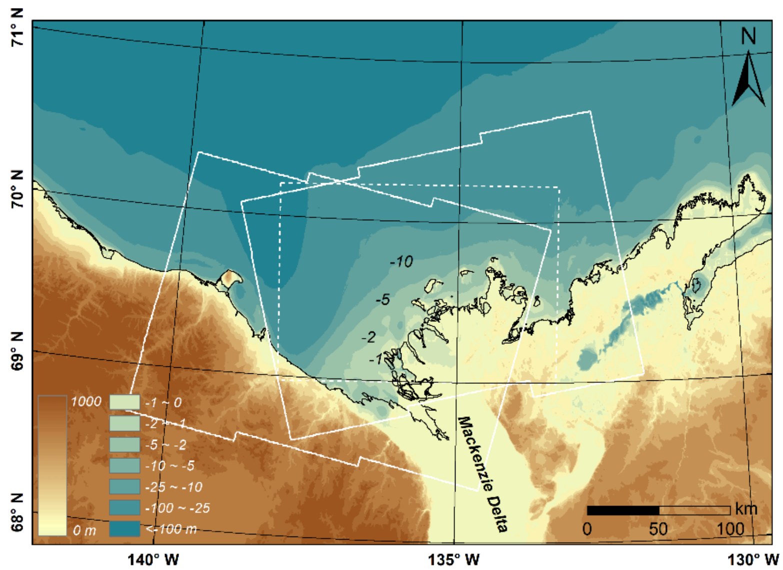


Figure S3.

Figure 1: (caption): missing bracket after b, adjust other brackets in caption to equal out.

To be checked as per the journal format.

Figure 5b: Please explain the large offset arrow coming from the Yukon coast in the Shingle Point area.

It is considered to be a significant horizontal displacement of floating ice off from the coast caused by the strong winds from east and south during 20180125-20180206.

Figure 5d: The red circles are hard to see

The colors will be adjusted for better visualization

Figure 6: Perhaps the land value can be black which is instantly distinguishable and matches the circle in Figure 5.

The green color was chosen to match with the vertical motions of the land represented in green in Fig. 5.

Line 35: Does bathymetry play a role in the distribution of landfast ice – perhaps it should be mentioned here. The shallow water depth of the Mackenzie Estuary definitely plays a role in the distribution of bottomfast ice and subsequent water discharge through these regions defined by the bottomfast ice barrier.

Agreed. The recurrent pattern of landfast ice is controlled by the shallow bathymetry (Nghiem et al., 2014). An explanation for the bathymetry effect will be added here.

Line 129: Please explain what an orbital phase ramp is?

It is 'a residual phase induced by orbital differences or errors'. To be added.

Line 158: Please add reference

'Source from the Mackenzie River Middle channel (10MC008) available at http://wateroffice.ec.gc.ca' will be added.

Line 160: I think it would be good to insert some stats on prevenient wind direction from the Pelly station.
Line 168: Yes agree, tidal fluctuations are nil but wind driven storm surge (even in the winter) have been known to cause over ice flooding. It would be good to know what the wind pattern was during the study period.

As explained above, Figure S1 will be added in the revised manuscript to explain the wind effects

Line 171: Chris Stevens (University of Calgary 2006-2011) conducted an MSc and PhD looking at the this area through GPR, perhaps his subsequent publication would provide some validation. May I also suggest the GSC online expedition database ED at Sea for further validation? https://ed.gdr.nrcan.gc.ca/index_e.php search cruise 2007301, Solomon describes a series of ice measurements with thickness and bottomfast ice

Thanks for your great suggestion. We used his paper and PhD thesis (Stevens et al. 2009; Stevens, 2011) on GPR ice thickness measurements and very low salinity measurements near the Mackenzie offshore in the reference list. The GPR measurements of the floating ice correspond to our estimations between 1.5 to 2 m though they were measured in 2005 and 2006. Unfortunately, we only found very brief descriptions on the 2007301 expedition from the GSC database.

<u>References</u>

Nghiem, S. V., Hall, D. K., Rigor, I. G., Li, P., and Neumann, G.: Effects of Mackenzie River discharge and bathymetry on sea ice in the Beaufort Sea. Geophysical Research Letters, 41(3), 873–879. https://doi.org/10.1002/2013GL058956, 2014.

Stevens, C. W.: Controls on Seasonal Ground Freezing and Permafrost in the Near-shore Zone of the Mackenzie Delta, NWT, Canada. PhD thesis, University of Calgary, https://doi.org/10.11575/PRISM/15339, 2011.

Stevens, C. W., Moorman, B. J., Solomon, S. M., and Hugenholtz, C. H.: Mapping subsurface conditions within the near-shore zone of an Arctic delta using ground penetrating radar. Cold regions science and technology, 56(1), 30-38, https://doi.org/10.1016/j.coldregions.2008.09.005, 2009.