Impact of different retrieval methodologies and snow depths on altimetry-based estimations of: pan-Arctic sea ice thickness, and sea ice outflow and freshwater fluxes through Fram Strait

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Impact of different retrieval methodologies and snow depths on altimetry-based estimations of:

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In the climate system, heat is transferred between the poles and the equator through both atmospheric and oceanic circulation. One key component in transferring heat is through freshwater exchange in the Arctic, which is moderated by several elements, one of them being the outflow of freshwater from sea ice. Using Earth observation data, the volume of sea ice has been estimated using gridded sea ice thickness, sea ice concentration and ice drift velocity products. Furthermore, through designated flux gates, the outflow of sea ice and freshwater fluxes has been estimated. However, various sea ice thickness products exist with ranges of different methodologies and auxiliary products applied – all of this introduce differences in the estimated fluxes. This study investigates the impact of using different re-trackers and snow depth products in the sea ice thickness and outflow computation for the winter of 2014-2015.

3 Different re-trackers
TFMRA50, LARM, SAMOSA+

5 Different snow depth products
mW99, W99/AMSR2, SnowModel, NESOSIM, ASD

15 Monthly gridded products

Sea ice thickness and snow depth

Largest differences in radar freeboards occur in coastal regions and in the Fram Strait. Snow dephts experience largest differences in the marginal seas and Fram Strait (Figure 1). Since most export occurs in the Fram Strait and outflow studies primarily focus on this region, it is of interest to investigate how big this impact is on the fluxes.

- Atlantic Arctic Ocean experiences largest differences – re-trackers behaving differently across seasons
- Sea ice thickness varies in this region up to 63% or 1.9 m (53% or 1.79 m without ASD snow depth)

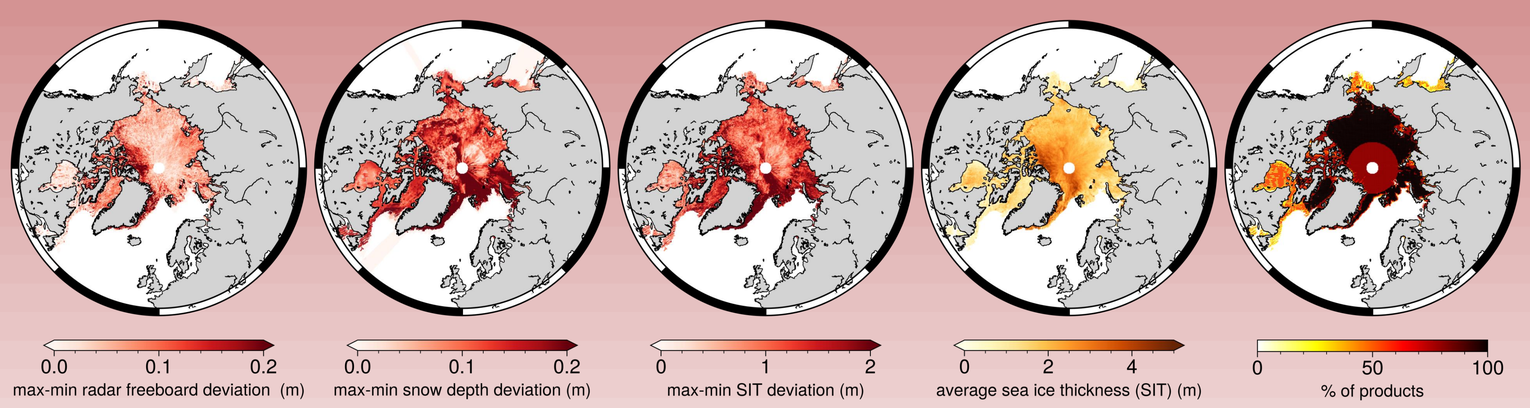

Figure 1. Deviation determined by maximum-minimum subtraction of radar freeboard, snow depth and sea ice thickness (SIT) determined using a combination of 3 re-trackers and 5 snow depths for the month of March 2015 (in total 15 products). Average sea ice thickness using all 15 products are shown along with the % coverage of the products.

DATA COMPARISON AND FLUXES

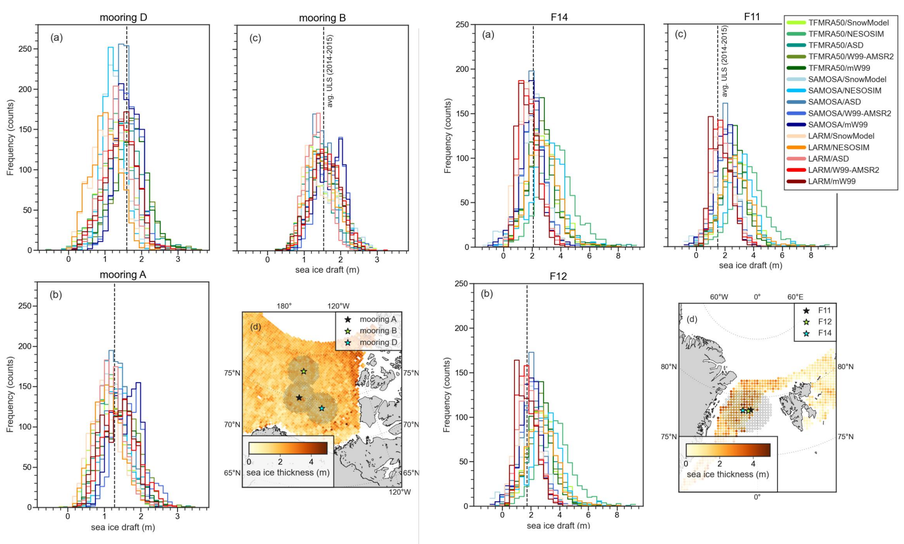

Figure 2. Comparison between moorings in the Beaufort Sea and the Fram Strait during winter 2014/2015 using gridpoints wihtin 200 km of the moorings. Note the normal distribution in the Beaufort Sea compared to the Fram Strait.

Sea ice and freshwater fluxes

Fluxes are determined through a fluxgate at 79N in the Fram Strait using high-resolution SAR-derived sea ice drift along with passive-microwave-derived sea ice concentration and the 15 sea ice thickness products (Figure 3).

- Fram Strait is a highly dynamic area with a mix of sea ice types, large drift speeds and is close to the ice margin and coast of Greenland – difficult for altimeters
- Fram Strait remains main source of export and it is therefore important to understand the impact here

Comparison with mooring data

To evaluate the 15 sea ice thickness products, we compute the sea ice draft and compare with draft observations from moorings in the Beaufort Sea and Fram Strait (Figure 2).

- Skewed distributions in Fram Strait – coincident with large discrepancies observed here
- Better correlations in Beaufort Sea

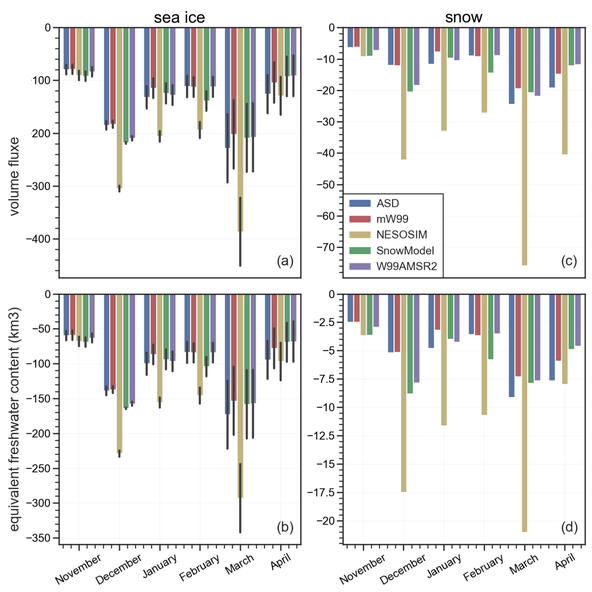

Figure 3. Sea ice (and snow) volume fluxes and freshwater fluxes through fluxgate at 79N. Errorbars denote variability due to re-trackers.

COMPARISON TO OTHER STUDIES

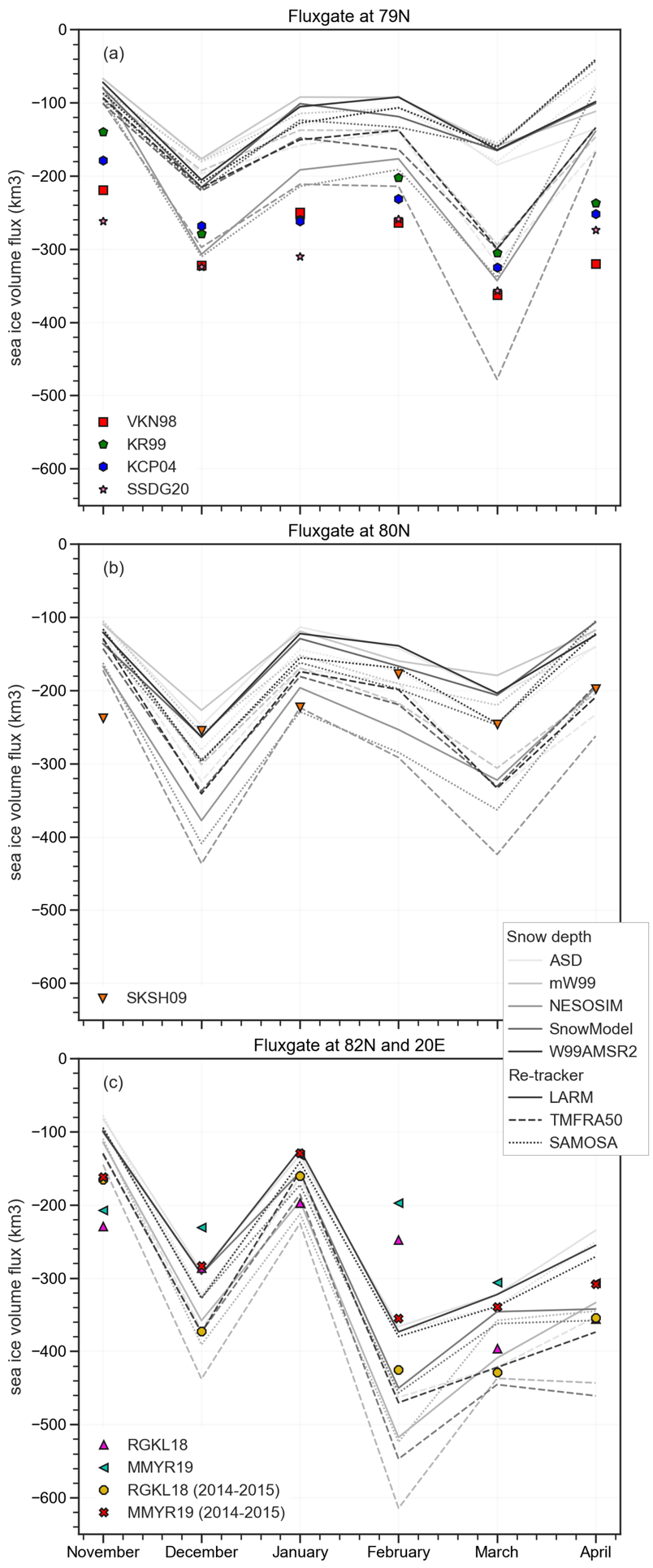

Figure 4. Comparison with former sea ice volume fluxes studies at various fluxgate locations in the Fram Strait. Note the temporal coverage of the studies.

Investigating the cause of the changes in outflow utilising different sources of auxiliary data as well as position of fluxgates will allow us to better understand the discrepancies between different sea ice outflow studies (Figure 4) in the same region. Similarly, it will provide an idea of the impact it will have when using different choices of fluxgate positions, sea ice drifts and sea ice thickness products.

Next steps

- Compare fluxes when using different drift products
- Extract parameters along fluxgate to understand discrepancies

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