Near real time surface velocity measurements of North-East Greenland Ice Stream outlet glaciers from Sentinel-1A data

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Introduction

We have processed 691 Sentinel-1A image pairs for obtaining a 2015/2016 winter velocity field for the entire Greenland ice sheet. The data were processed by intensity offset tracking and subsequently filtered using an iterative approach based on local statistics. This method has been successful for nearly all outlet glaciers around Greenland, however in the south-eastern part data gaps are present. In order to study the seasonal behavior of the two major outlet glaciers of the North-East-Greeland ice stream (NEGIS), we have derived a time series of velocity fields using Sentinel-1A data. For assessing the quality of the Sentinel-1A velocity fields, we compare the data to velocity fields obtained with the same method using TerraSAR-X and Landsat-8 data acquired at nearly the same time period.

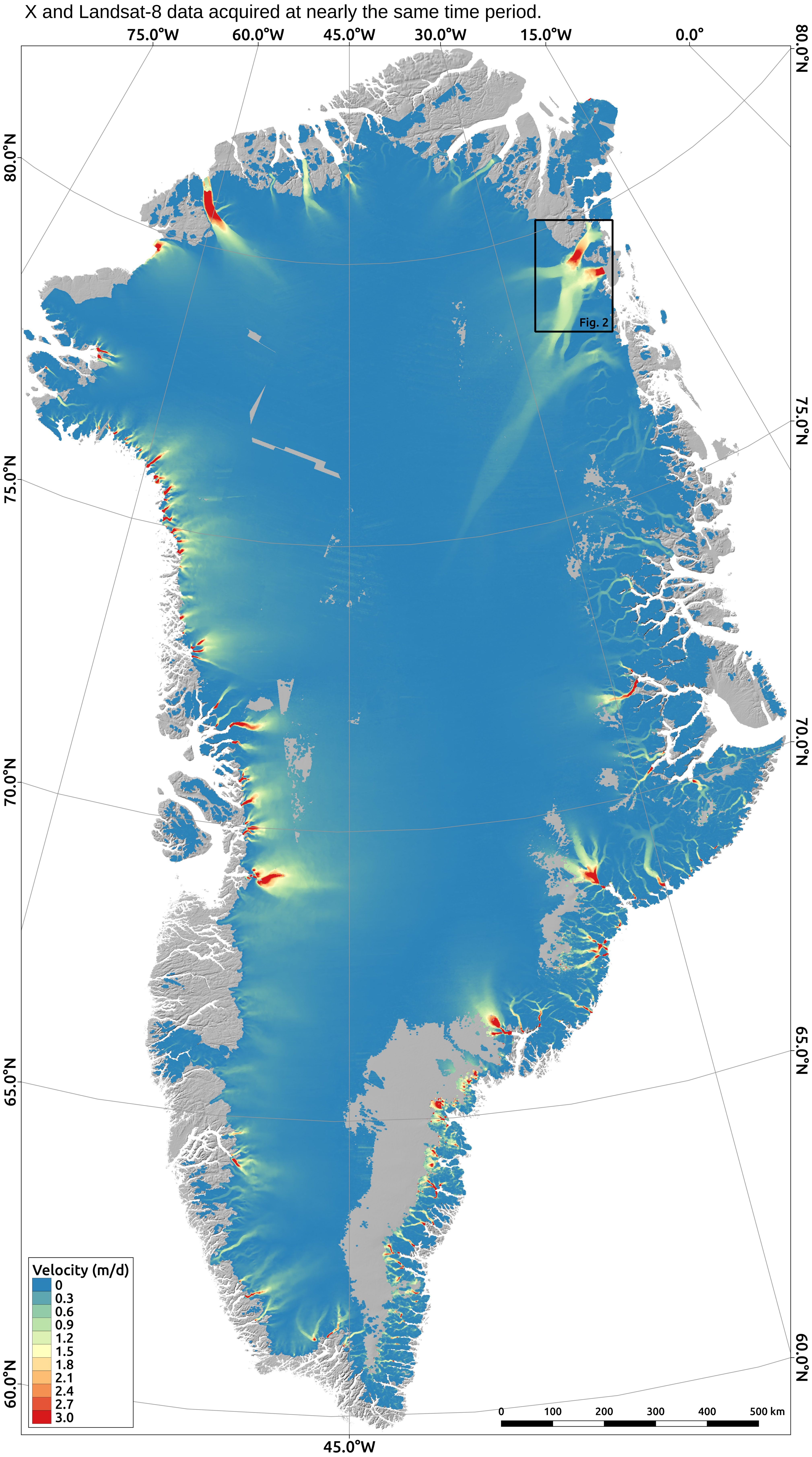

Figure 1: Sentinel-1A mosaic of 2015/2016 winter velocities. Data were acquired between December 01, 2015 and February 25, 2016. Here preference was given to 12-day repeat passes resulting in a total amount of 691 image pairs. In the background a hillshade of the GIMP DEM is shown (Howat et al. 2014).

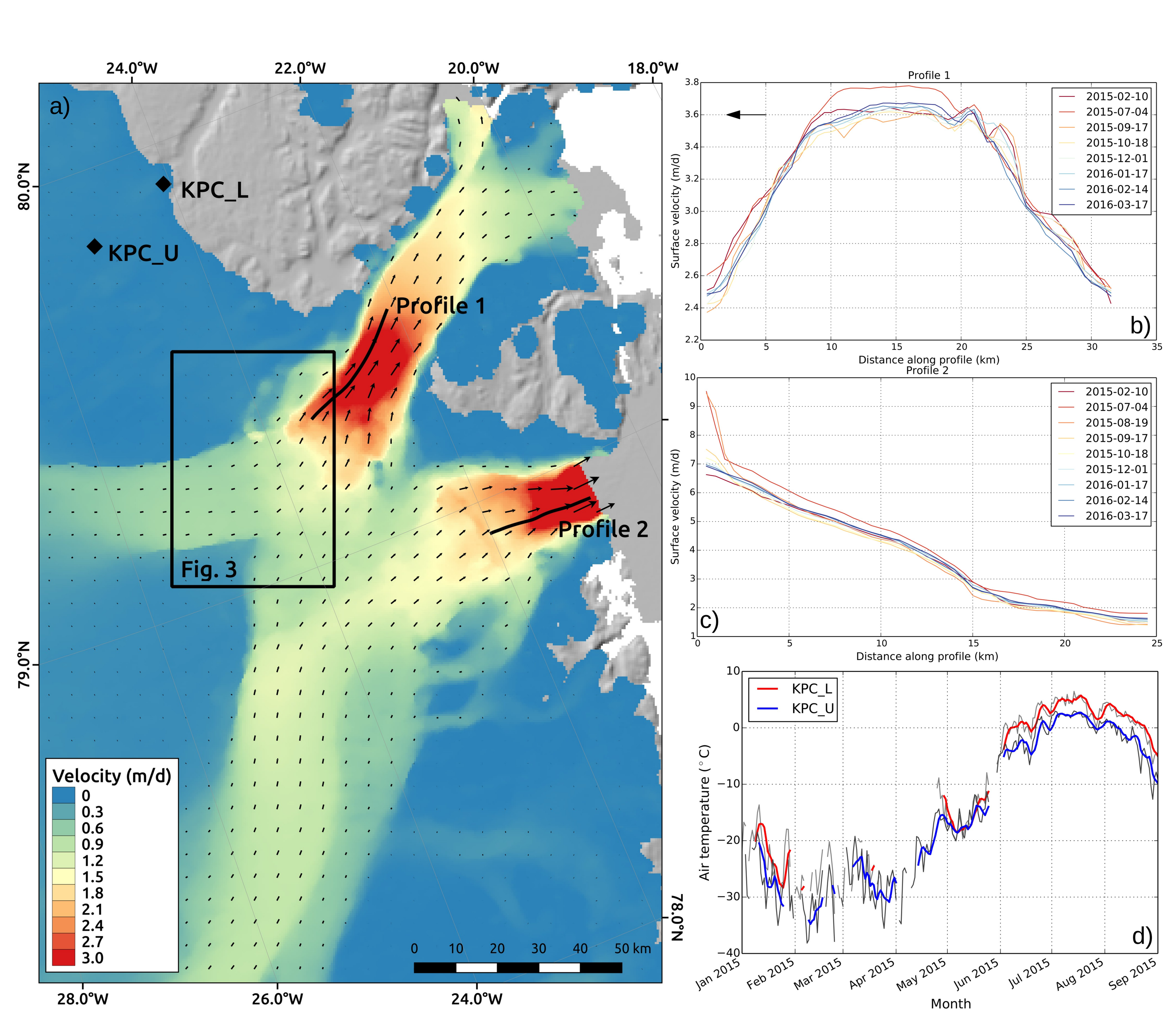

Figure 2: 2015/2016 winter velocities of the two major outlet glaciers Nioghalvfjerdsfjorden and Zachariæ Isstrøm are shown in a). Seasonal velocities along central flow lines (Profile 1 and Profile 2) are shown in b) and c). Flow direction is indicated by the black arrow. PROMICE temperature measurements at location KPC_U and KPC_L are shown in d) (Van As et al., 2011).

Results

The time series of Nioghalvfjerdsfjorden has been extracted along a central flow line of its northern branch crossing the grounding line area (Fig. 2, Profile 1). The glacier is accelerating considerably in July, which is in agreement with high surface temperatures captured by two nearby PROMICE weather stations (Van As et al., 2011, Fig. 2) and melt events seen by TerraSAR-X (see also Poster Humbert & Braun). At Zachariæ Isstrøm similar patterns are found, however, in contrast to Nioghalvfjerdsfjorden, Zachariæ Isstrøm also exhibits an detectable inter-annual speed-up, also found by Mouginot et al., 2015.

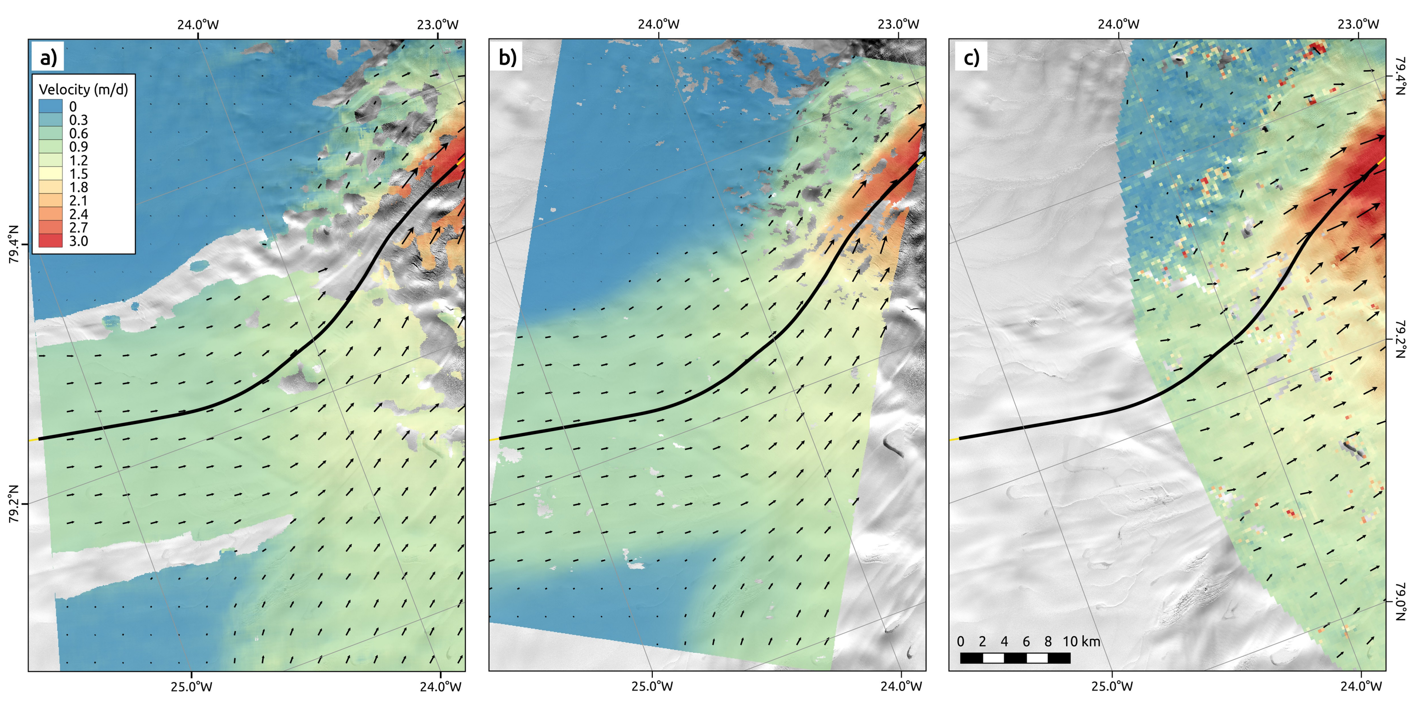

Figure 3: glacier surface velocities in the confluence area of Nioghalvfjerdsfjorden glacier (location is shown in Fig. 2). Velocities were derived by means of intensity offset tracking on Sentinel-1 data (a) and TerraSAR-X data (b) and feature tracking on Landsat-8 data (c). The time of data acquisition is almost equal. Sentinel-1 data were acquired on September 06/18, 2015. TerraSAR-X data were acquired on September 06/17, 2015 and Landsat-8 data were acquired on September 04/20, 2015. Velocities along the black central flow line are shown in Fig. 4.

Comparing TerraSAR-X, Landsat-8 and Sentinel-1A velocity fields, we find that they are in general agreement, also indicated by the quality and match of the flow direction. In slow moving areas Landsat-8 results are potentially biased by the short time interval between data acquisition (16 days). TerraSAR-X data is leading to the best quality of the velocity field due to the high spatial resolution, nevertheless for large area mapping Sentinel-1A and Landsat-8 are preferable due to their large footprint.

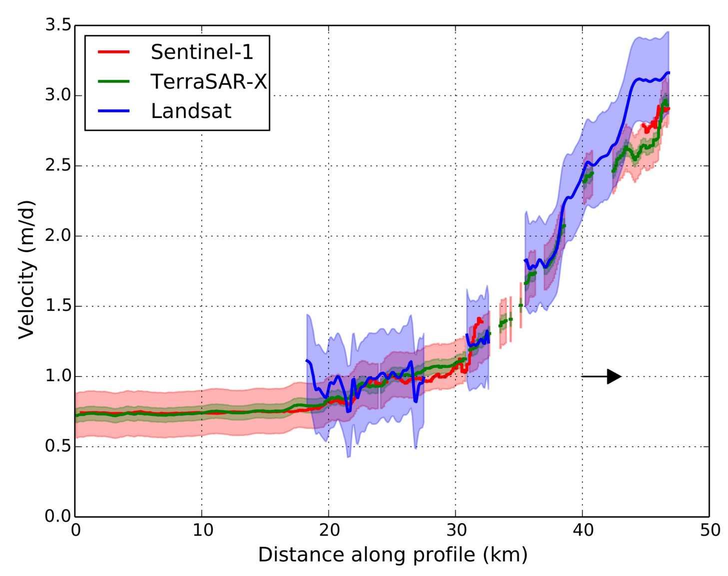

Figure 4: Sentinel-1, TerraSAR-X and Landsat velocities are shown along the central flow line shown in Fig. 3. Flow direction is indicated by the black arrow.

Conclusion

- Sentinel-1A data allows to map ice sheet wide velocity fields at reasonable processing costs, allowing near real time velocity mapping.
- multi-sensor comparison proofs a good agreement between the individual velocity fields.
- Nioghalvfjerdsfjorden is experiencing summer speed-up, while Zachariæ Isstrøm undergoes both, seasonal and inter-annual acceleration.

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