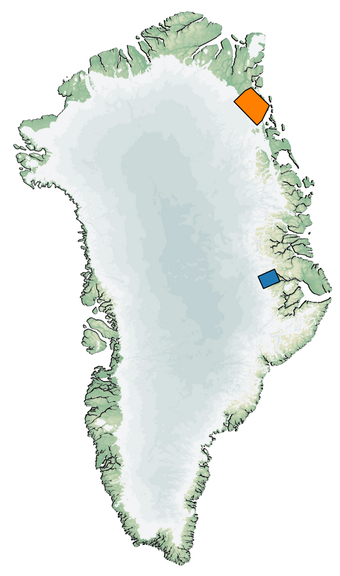
Northeast Greenland outlet glacier velocities and high resolution elevation from TerraSAR-X and TanDEM-X data.

Lukas Krieger[1*], **Dana Floricioiu**[1] and **Thomas Nagler**[2]

[1]German Aerospace Center (DLR), Germany; [2]ENVEO IT GmbH, Austria

*Author for correspondence : lukas.krieger@dlr.de

1. Introduction



During the last few decades, the Greenland ice sheet has experienced strong environmental changes. The most harsh and rapid of these have occurred particularly in the west and southeast of Greenland and have been well reported. The northeast of Greenland is yet to experience this transformation, which provides an excellent opportunity to observe the development of the ice sheet. Therefore, the project *Northeast Greenland Ice Sheet* aims at observing the evolution of outlet glaciers of this area with SAR data from the past and present. Two consequences of regional climate warming, surface melting and speed-up of the outlet glaciers, are investigated with TanDEM-X (TDM) and TerraSAR-X (TSX)

TanDEM-X elevations

TerraSAR-X velocities

2. TanDEM-X elevations

In order to create surface elevation time series of Zachariae Isstrøm and Nioghalvfjersfjorden, multiple DEMs from bistatic TDM acquisitions were processed to cover the glacier area until around 150km inland. The DEMs are processed with the Integrated TDM Processor developed at DLR. For adjusting the absolute elevation of the TDM DEMs, these are co-registered to IceBridge ATM elevations acquired over flat, ice free terrain in 2009 and 2012. Alternatively, previously corrected TDM DEMs can be used for this adjustment. The TDM DEMs from the years 2010-2012 were mosaicked, giving higher priorities to more recent elevations. Afterwards, GIMP elevations [1, 2], with a nominal date of 2007, were subtracted from the TDM mosaic to visualise surface elevation changes.

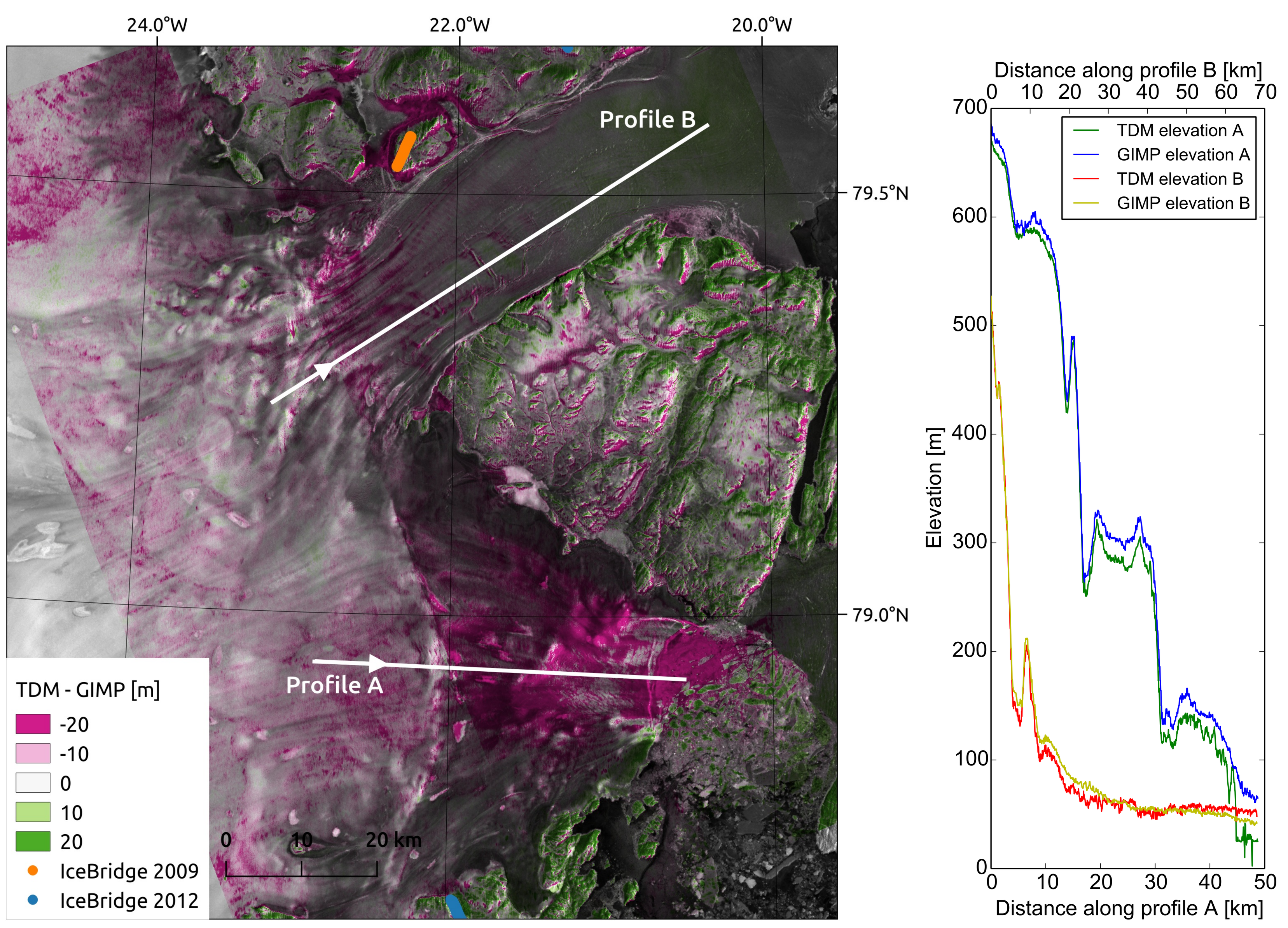


Figure 1: The difference of mosaicked TDM (2010-2012) and GIMP (2007) elevations for Zachariae Isstrøm (east flowing) and Nioghalvfjersfjorden (north flowing). TDM elevations have been registered to IceBridge ATM data over flat, ice free terrain. In the background a RADARSAT-1 SAR amplitude mosaic from 2012-2013.

The residual mean of IceBridge ATM elevations to TDM DEMs at the locations marked in Figure 1 is 0.37 m with a standard deviation of 3.24 m. However, a clear thinning of the glacier can be observed from the TDM-GIMP DEM difference over most of the glaciated area of Zachariae Isstrøm. Nioghalvfjersfjorden does not show such a pronounced surface elevation change. The large differences in the mountainous terrain can be attributed to radar shadow and the higher resolution of the TDM DEMs.

3. Ice velocities from TerraSAR-X

Ice velocity maps were derived from repeat pass TSX data by using normalised cross-correlation to track glacier features. The processing works with TSX SSC products as input. Estimated shifts in range and azimuth direction between the single matching windows are projected on the earth's surface, where they represent displacements in north and east direction. The resulting velocity magnitudes are compared to almost coincident measurements from Sentinel-1A (S1) data in the period January to March 2015 [3, 4]. Figure 2 shows TSX and S1 ice velocity maps over Daugaard Jensen Glacier georeferenced with GIMP elevations.

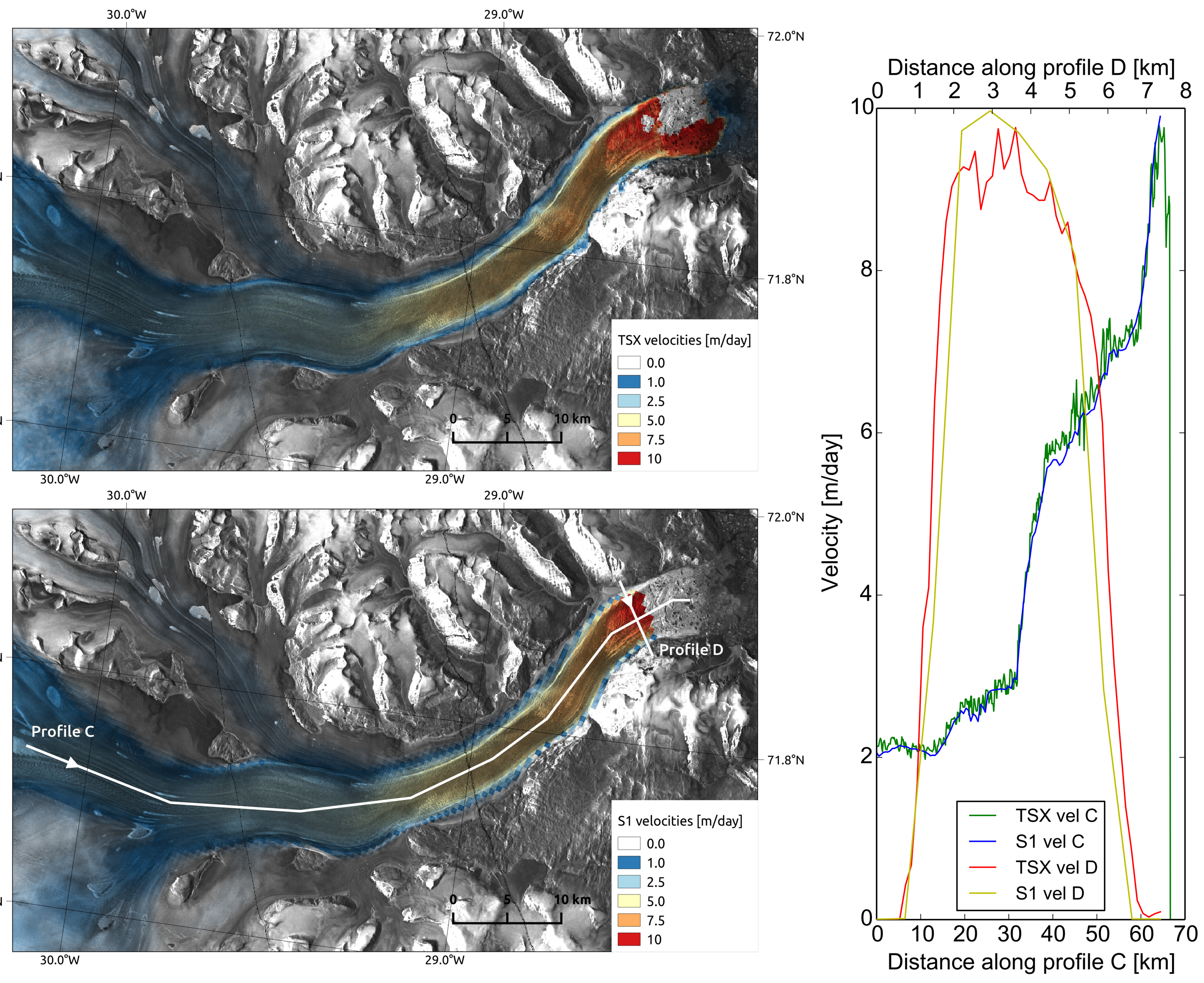


Figure 2: Ice velocities for Daugaard Jensen glacier derived from TSX data (February 2015) and corresponding S1 velocities (January - March 2015) overlaid on TSX backscatter amplitude images.

The comparison is done along the central flow line of the glacier and a transverse profile close to the glacier terminus. The velocity difference (TSX - S1) along the longitudinal profile is characterised by a mean of 0.076 m/day and the standard deviation of 0.158 m/day.

References

1. Howat, I. M., Negrete, A. & Smith, B. E. The Greenland Ice Mapping Project (GIMP) land classification and surface elevation data sets. *The Cryosphere* **8,** 1509–1518. ISSN: 1994-0424 (Aug. 2014).
2. Howat, I. M., Negrete, A. & Smith, B. E. *MEaSUREs Greenland Ice Sheet Mapping Project (GIMP) Digital Elevation Model* 2015. doi:`http://dx.doi.org/10.5067/NV34YUIXLP9W`.
3. Nagler, T., Rott, H., Hetzenecker, M., Wuite, J. & Potin, P. The Sentinel-1 Mission: New Opportunities for Ice Sheet Observations. *Remote Sensing* **7,** 9371–9389. ISSN: 2072-4292 (July 2015).
4. Nagler, T., Rott, H., Hetzenecker, M., Wuite, J. & Potin, P. *Greenland Ice velocity Map 2015 v. 1* 2015. <`http://products.esa-icesheets-cci.org`>.

Living Planet Symposium 2016, Prague, Czech Republic

Acknowledgements:
Research supported by the German Research Foundation (DFG) project *Northeast Greenland Ice Sheet*