PROMICE NYHEDSBREV
Programme for Monitoring of the Greenland Ice Sheet Nr 11 • 2016

Monitoring the Arctic's largest remaining ice shelf

At the moment, the largest remaining ice shelf in the Arctic lies in Northeast Greenland and is part of Nioghalvfjerdsfjorden (79 Fjord) Glacier (Fig. 1). 79 Fjord Glacier and its neighbours to the south (Zachariae Isstrøm and Storstrømmen) are outlet glaciers of the Northeast Greenland Ice Stream, together draining 6.6% of the ice sheet (Rignot and Kanagaratnam, 2006). Understanding the dynamics of the ice stream and its outlets is therefore important for projections of future sea-level rise through ice loss.

In PROMICE we monitor glacier area change and glacier surface velocities using data from satellites. At the end of the 2016 melt season, we observed that an iceberg roughly the size of Manhattan (or Amager Island if you are a Dane) nearly has detached from the part of the glacier front flowing into Djimphna Sound (Fig. 1). The detachment has already been progressing for some years. We also noticed that the lower part of the glacier draining into the sound is suddenly flowing faster than the average of winter speeds from 1991/1992 to 2010/2011 (Fig. 2).

79 Fjord Glacier is 80 km long and 20 km wide. The upper part of the glacier is land based while the outer part (~60 km) is a floating ice shelf, where the majority of mass is lost by melting from below, not at the surface. The northern part of the glacier drains into Djimphna Sound, where the northern glacier front and the large, nearly detached iceberg are located. At the main glacier front, four islands block the glacier flow and divide the shelf into five separate tongues. The stability of these tongues is dependent on the semi-permanent sea ice which encloses them. When this "fast ice" breaks up every few decades, the ice tongues disintegrate through rapid calving. However, the ice margin in Djimphna Sound behaves differently; without a barrier of islands, the fjord ice there breaks up more often, resulting in more frequent calving events. There is no evidence of the entire ice shelf breaking up in 20th century. However, during the Holocene Climatic Optimum (7700-4500 years before present) when climate was warmer than at present, evidence shows that the fjord was ice free and the ice shelf was gone (Reeh *et al.*, 2006).

A recent study by Mouginot *et al.* (2015) documented changes at 79 Fjord Glacier and Zachariae Isstrøm in dynamics , extent and

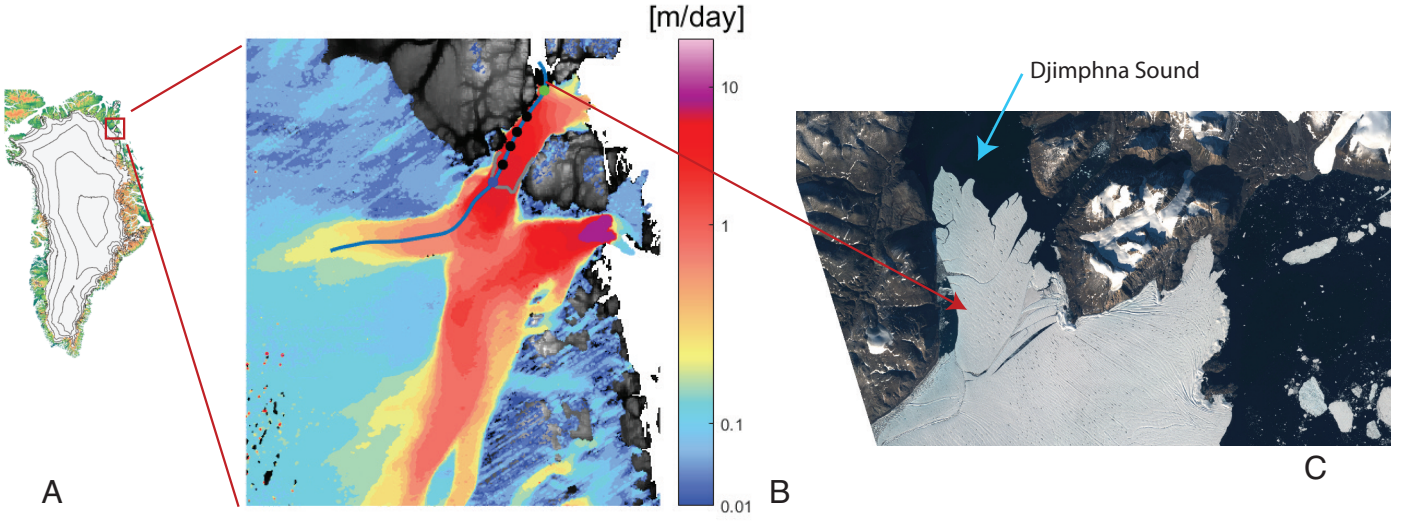

Figure 1: **A***: Nioghalvfjerdsfjorden Glacier is located in Northeast Greenland as marked by the red rectangle (Map data from GIMP-DEM V2.1 (Howat et al., 2014)).* **B***: Map showing January 2016 surface velocities of the outer part of the Northeast Greenland Ice Stream, produced from ESA Sentinel-1 data processed by PROMICE. "79" and "ZI" mark the locations of Nioghalvfjerdsfjorden Glacier and Zachariae Isstrøm, respectively.* **C***: ESA Sentinel-2 image from 9 September 2016 this year showing the large iceberg in Djimphna Sound about to break off.*

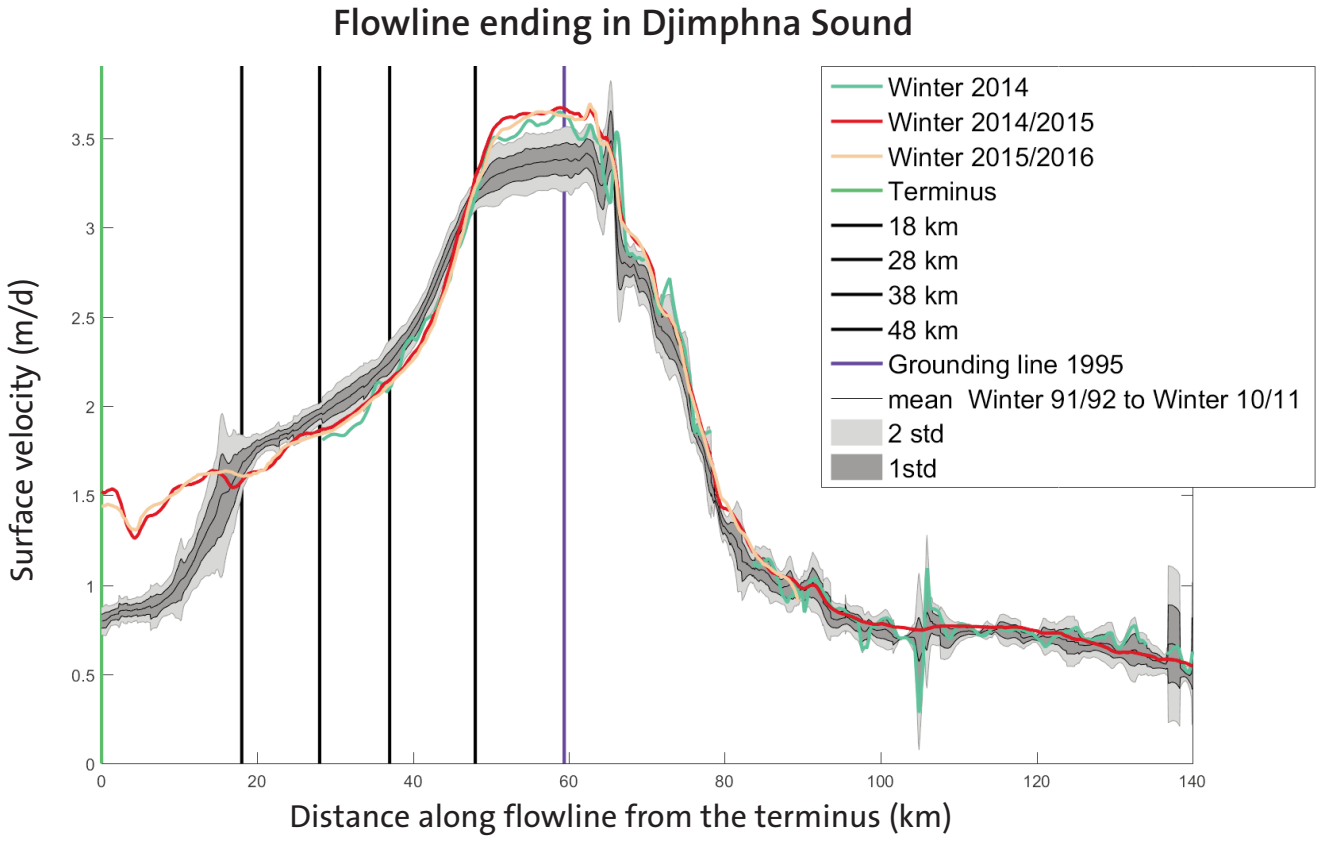

Figure 2: Surface velocity along the flowline in Fig 1B produced from Radarsat and ESA Sentinel-1, ERS and Envisat data (available from the ESA Greenland Ice Sheet CCI website: http://www.esa-icesheets-greenland-cci.org/). The vertical green line to the left indicates the glacier terminus while the blue vertical line is the location of the 1995 grounding line. The vertical lines are at the locations of the dots in Fig. 1B. The gray colors mark the 1 and 2 standard deviations from the mean surface velocity (1991/1992 to 2010/2011 from ERS and Envisat radar data). During the last two years (at least), the outer 17 km was flowing significantly faster.

Isstrøm also terminated in a large floating ice shelf, but in 2002-2003 it started retreating, triggering a speed-up of 50% from 2000 to 2014. By 2013-2014 Zachariae Isstrøm had retreated all the way back to its *grounding line* where a glacier detaches from the bed and begins floating. During the same period, 79 Fjord Glacier has also been speeding up at grounding line, bottom melting has increased and the floating tongue has thinned.

All observations point in one direction: the largest ice shelf in the Arctic may lose its title in the coming years. Exactly when 79 Fjord Glacier starts to break up like Zachariae Isstrøm is impossible to predict, but we are keeping an eye on it –from space.

Howat, I.M., Negrete, A. and Smith, B.E. 2014: The Greenland Ice Mapping Project (GIMP) land classification and surface elevation datasets, The Cryosphere, 8, 1509-1518

Mouginot, J., Rignot, E., Scheuchl, B., Fenty, I., Khazendar, A., Morlighem, M., Buzzi, A., Paden, J. 2015: Fast retreat of Zachariae Isstrøm, northeast Greenland, Science Vol 350

Reeh, N., Thomsen, H.H., Higgins, A.K., Weidick, A. 2001: Sea ice and the stability of north and northeast Greenland floating glaciers, Annals of Glaciology 33

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ESA Greenland Ice Sheet CCI ice velocity product: http://www.esa-icesheets-greenland-cci.org/

Further information

http://www.promice.dk

PROMICE

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- The purpose of PROMICE is to monitor the mass loss of the Greenland ice sheet, both the melting on the surface and the volume of icebergs discharged into the sea
- PROMICE is headed in Denmark by GEUS in cooperation with DTU Space and Asiaq in Greenland. Furthermore the programme collaborates with the Danish Meteorological Institute and foreign universities and authorities.
- Read more about PROMICE on promice.org, where you can find photos and videos, get direct access to measuring data from the ice sheet and the PROMICE outreach material. On the website you can also subscribe to our newsletter.
- Information can also be found on porlarportal.org a new website where Danish research institutions display the results of their monitoring of the Greenland ice sheet and the sea ice in the Arctic.

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