ICE THICKNESS AND BED CONDITIONS OF THE NORTH EAST GREENLAND ICE STREAM

INTRODUCTION

The Greenland ice sheet is a key area for rapid ice mass changes and future implications for ice sheet mass balance and sea level contribution (Tapley and others, 2019; Masson-Delmotte and others, 2018; Kjart and others, 2013). A prominent feature of the Greenland ice sheet is the North East Greenland Ice Stream (NEGIS, Figure 1). This 600-km-long ice stream drains 12% of the Greenland ice mass via fast-flowing marine-terminating outlet glaciers (Larsen and others, 2018).

Here, we provide a high-resolution ice thickness data set derived from a radio echo sounding survey of a large part of NEGIS in the vicinity of EGRIP drill site (Figure 2). The computation of a detailed bedrock elevation model for the region allows us to study flow related features of the ice stream and link them to ice thickness and topography.

DATA

The data has been recorded in May 2018 with AWI’s ultra-wideband multi-channel radar installed on the AWI Polar6 Basler BT-67 aircraft (Figure 4).

- Number of channels: 8
- Mapped area: 2400 km² (8233 km of profiles)
- Grid spacing: 5–10 km
- ~ 130 km up- and downstream of EGRIP drill site

RESULTS

We derived the ice thickness and created a bedrock model nested into the bedrock topography of Marchington and others (2017) BedMachine v3 (BM-3).

- Ice thickness and Bedrock Elevation
- Ice thickness increases towards downstream from 2039-3029 m
- Variations dominated by topography which ranges from -293 to 606 m

Main Findings

1. Location of an elevation difference of up to 567 m
2. A hill that is not present in our data, but a hidden region with a strong internal reflection
3. A ridge in the central northern part of the survey area
4. Next to the ridge, we find a trough with steep slopes
5. Isolated bedrock undulations

Furthermore, surface elevation changes correlate with bedrock features in respect to ice flow direction and to the position of the shear margin (Figure 5).

DISCUSSION

The bedrock reflection is sometimes masked by internal reflections, representing basal entrainments and by steep dipping reflectors. Large surface elevation changes are correlated with the ice streaming over bedrock bumps and get more frequent in downstream (Figure 10). Moreover, we interpret off-nadir reflections as ridges extending in ice flow direction.

CONCLUSIONS

For future sea level projections it is important to understand the ice dynamics of ice streams like NEGIS. One important key feature is to understand ice flow properties and the effect of bedrock topography in this context.

Radar system

Since 2016 the German Alfred Wegener Institute (AWI) has been operating a multi-channel ultra-wideband (UWB) air-borne radar sounder and imager for sounding ice thickness, imaging internal layering and the ice-bed interface of polar ice sheets. The radar system is installed on the AWI Polar6 Basler BT-67 aircraft (Figure 4).

Eight power amplifiers enable a maximum transmit power of 1000 W peak power. A variable gain stage can be set for each analog receiver channel as well as an anti-aliasing band-pass filter (Hale and others, 2016). The radar system is also able to alternate between different pulse length stages and different receiver gains for each stage to increase the dynamic range.

METHODS

Our sketch of our workflow is represented in Figure 7. For our radar data processing we use the CrEIS Toolbox algorithms for all three domains in along-track (f-k migration), cross-track (array processing) and vertical component (pulse compression).

Radar data is recorded in the time domain and converted into depth. On behalf of our surface and bedrock detection, we calculate the thickness of the ice columns for every trace and derive the bedrock elevation. We also computed surface slopes on the basis of the Arctic DEM model (Porter and others, 2018) and compared major elevation changes with our bedrock.

REFERENCES