Geophysical Research Abstracts
Vol. 18, EGU2016-12826, 2016
EGU General Assembly 2016

Continuous monitoring of Greenland and Antarctic ice sheet velocities using Sentinel-1 SAR

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The Sentinel-1 mission has opened up new opportunities for regular monitoring of glacier and ice sheet velocities at high spatial and temporal resolution. From January to March 2015 the first ice sheet wide campaign on Greenland was completed resulting in a nearly complete ice velocity map. Later that year the first Antarctic campaign commenced covering most of the continent outside the polar gap. Besides ice sheet wide campaigns the Sentinel-1 acquisition plan allows for nearly continuous monitoring of the Greenland ice sheet margin and several key regions in Antarctica at 12-day intervals. This offers the unique capability of operational monitoring of short-term and seasonal velocity fluctuations as well as year-to-year variations for large regions. The quantity of data thus becoming available is unprecedented and requires new approaches for efficient processing and data analysis.

Sentinel-1 carries a C-band synthetic aperture radar instrument providing high-resolution SAR images. Data is acquired across 250 km swaths at a spatial resolution of about 5 m x 20 m. We use repeat pass SLC images of Sentinel-1 acquired in Greenland and Antarctica to obtain ice flow velocity. We apply an iterative offset tracking approach, permitting to acquire the full range of velocities in a single swath while keeping the matching window at a minimum.

We present the first ice sheet wide velocity maps of Greenland and Antarctica derived from Sentinel-1 SAR data acquired in 2015. Results are compared with ice flow velocity fields derived from other sensors, including ALOS PALSAR and the TerraSAR-X mission. Additionally we present velocity time series with 12-day intervals of major outlet glaciers of the ice sheets spanning well over a year. Velocity time-series production has been automated using a set of newly developed tools allowing for fast generation of (near real-time) center-line and gate velocity profiles that are stored in a database. Other functionalities include discharge calculation using available ice thickness data for which examples are shown.