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Towards a Copernicus Service for Monitoring Polar Ice Sheet Velocity and Discharge using Sentinel-1A and 1B SAR

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The enhanced imaging capabilities of Sentinel-1A and 1B and the systematic acquisition planning of polar regions by ESA form the basis for the development and implementation of an operational system for monitoring ice dynamics and discharge of Antarctica, Greenland and other polar ice caps. Within the framework of the ESA CCI and the Austrian ASAP/FFG programs we implemented an automatic system for generation of ice velocity maps from repeat pass Sentinel-1 Terrain Observation by Progressive Scans (TOPS) mode data applying iterative offset tracking using both coherent and incoherent image cross-correlation. Greenland's margins are monitored by 6 tracks continuously since mid of 2015 with 12 days repeat observations using Sentinel-1A. With the twin satellite Sentinel-1B, launched in April 2016, the repeat acquisition period is reduced to only 6 days allowing frequent velocity retrievals - even in regions with high accumulation rates and very fast flow - and providing insight for studying short-term variations of ice flow and discharge.
The Sentinel-1 ice velocity products continue the sparse coverage in time and space of previous velocity mapping efforts. The annual Greenland wide winter acquisition campaigns of 4 to 6 repeat track observations, acquired within a few weeks, provide nearly gapless and seamless ice sheet wide flow velocity maps on a yearly basis which are important for ice sheet modelling purposes and accurate mass balance assessments. An Antarctic ice sheet wide ice velocity map (with polar gap) was generated from Sentinel-1A data, acquired within 8 months, providing an important benchmark for gauging future changes in ice dynamics. For regions with significant warming continuous monitoring of ice streams with 6 to 12-day repeat intervals, exploiting both satellites, is ongoing to detect changes of ice flow as indicators of climate change.
We present annual ice sheet wide velocity maps of Greenland from 2014/15 to 2016/17 and Antarctica from 2015/16 as well as dense time series of short-term velocity changes of outlet glaciers since 2014. We will highlight the improvements of the dual satellite constellation of Sentinel-1A and 1B, in particular for fast moving glaciers and regions with high accumulation rates. Derived surface velocities are combined with ice thickness from airborne Radio Echo Sounding data to compute ice discharge and its short-term variation across flux gates of major outlet glaciers in Greenland and Antarctica. Ice velocity maps, including dense time series for outlet glaciers, and ice discharge products are made available to registered users through our webtool at cryoportal.enveo.at.