Ice Velocity Measurement from SAR: Comparison of Sentinel-1A and RADARSAT-2

Mapping the velocity fields of the continental ice sheets and their outlet glaciers is important in order to monitor and model the response of the cryosphere to global climate change. Since the mid-1990s, space-based SAR data have enabled measurement of ice velocities on a continental scale. Compared to interferometry, Offset Tracking techniques excel in terms of robustness and ease of automation. With the launch of Sentinel-1A in 2014 and Sentinel-1B in 2016, the potential coverage and revisit frequency have greatly improved, allowing monitoring of temporal changes in the ice sheet velocity fields.

Two Greenland-wide RADARSAT-2 campaigns were carried out during January-March 2014, and a smaller one in December 2014-February 2015. Ice velocity maps from both campaigns will be presented. A preliminary ice velocity map from the former campaign is attached with this abstract, while the latter awaits processing. The first Sentinel-1A Greenland-wide observation campaign was carried out in January-March 2015, and ice velocity fields with nearly complete coverage has already been demonstrated [1]. A preliminary IV map using the DTU IPP processor (not all pairs processed) is attached with this abstract.

The overlapping temporal coverage of the second RADARSAT-2 campaign and the first Sentinel-1 campaign allows a comparison of the two sensors in terms of:

- Impact of differing imaging modes (stripmap vs TOPS). The better coverage of Sentinel-1 is at the cost of a reduced azimuth resolution, however with a better range-resolution than RADARSAT-2 in standard beam mode. (RS2: 13.5m x 7.7m versus S1: 3m x 21m). Especially on the fast-flowing outlet glaciers, where the offset-tracking relies on the presence of features like glacier crevasses, a high resolution is important. Over the central Greenland ice sheet, where the backscatter is more homogeneous, offset-tracking relies instead on speckle tracking, reducing the need for high resolution. With more than one revisit, Sentinel-1 can generate 24-day baselines, and this allows a comparison of the two sensor modes without the influence of the temporal baseline.

- The impact of temporal baseline, 24 days vs 12 days (6 when S1B is commissioned). The smaller temporal baseline of Sentinel-1 eases feature-tracking on fast-moving glaciers, and improves coherence (and thus speckle tracking) over more homogeneous regions. On the other hand, noise and ionospheric scintillations introduce errors on the ice velocity estimate inversely proportional with the temporal baseline.

- Data quality (coverage, noise, geometric calibration).

DTU Space has implemented an operational interferometric post processing facility, IPP, which has been upgraded with a highly automated offset tracking capability in the frame of ESA’s Climate Change Initiative. The IPP processor ingests RADARSAT-2 SLC data, Sentinel-1 Interferometric Wideswath (IW) bursted SLC product, and several other past and current sensors (ERS/ENVISAT/ALOS/CosmoSkyMed/TerraSAR-X). Using the same processor ensures that observed differences lies in the data products/sensors rather than being due to different processing techniques.


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