Processing and analysis of dense ice velocity time series to reconstruct seasonal fluctuations of 3 greenlandic glaciers: Russell Gletscher, Upernavik Isstrom, Petermann Gletscher.

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Significant seasonal changes in ice flow have been reported for outlet glaciers in Greenland. Understanding the mechanisms that control these rapid intra-annual changes in dynamics could potentially help to clarify Greenland's long-term evolution and climate change response.

In this study, we investigate seasonal changes in ice flow velocity in order to better understand the processes controlling them. We focus on 3 Greenlandic glaciers of different types: Russell which is a land-terminating glacier with speed ranging from 50 to 350 m/yr, Upernavik Isstrom which is a marine-terminating tidewater glacier with speeds up to 4 km/yr, and Petermann Gletscher that has a large ice shelf and with speed at the order of 1 km/yr. Since 2014, the number of spaceborne observations over the ice sheet has increased dramatically with the launch of Landsat-8, Sentinel-1 and -2, providing almost continuous monitoring of glacier dynamics.

Here, we develop an automatic processing chain to derive dense time series of surface ice flow from radar sensors, Sentinel -1a/b, and optical sensors, Landsat-7/8 and Sentinel-2, using speckle or feature tracking algorithms. We construct a post-processing analysis based on local polynomial regression to filter our multi-sensor time series and create a velocity database with high temporal resolution and reduced noise. The database allows us to reconstruct the continuous evolution of surface ice velocity with frequency intervals ranging from monthly for the entire glacial basin to weekly for the downstream parts.

Using this methodology, we obtain velocity fields for 4 years between 2015 and 2019 of the entire basins of Russell, Upernavik and Petermann glaciers. Our results clearly show the seasonal variations in flow to which these glaciers are subjected. We analyze the average seasonal fluctuations during the 4 years, as well as particular behavior in different years. These results are then compared and discussed in relation to potential external forcings such as subglacial hydrology (change in basal friction), fluctuations in the ice front or grounding line positions (change in buttressing) and the presence of sea ice or ice melange in front of the glaciers.

Finally, we conclude on the benefits of our post-processing approach for the analysis of dense ice flow time series and provide first insights on the causes of seasonal variations observed on these 3 glaciers.