

Re-Processing of SAR data for derivation of glaciological parameters on the Antarctic Peninsula: First results of a study at Wordie Ice Shelf

P. Friedl¹, T. Seehaus², F. Weiser¹, R. Lorenz¹, M. Braun², K. Höppner¹

¹DLR - German Remote Sensing Data Center (DFD), Oberpfaffenhofen, Germany, ² Institute of Geography, Friedrich-Alexander Universität (FAU) Erlangen-Nürnberg, Erlangen, Germany

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(1) MOTIVATION & RESEARCH QUESTIONS

- Disintegration of Wordie Ice Shelf during the 1980s in a series of events
- No long-term studies which address the adaption process of all former tributary glaciers to the new boundary conditions
- How can multi-mission SAR data be used in order to derive long time series of datasets of glaciological parameters at Wordie Bay (e.g. glacier extents, grounding line positions, flow speeds, glacier mass flow, glacier elevation/volume changes and contributions to global sea level rise)?
- How did these parameters change after the disintegration of the ice shelf exactly over time and how long do these changes last?
- Are there differences in the behavior of the single glaciers?

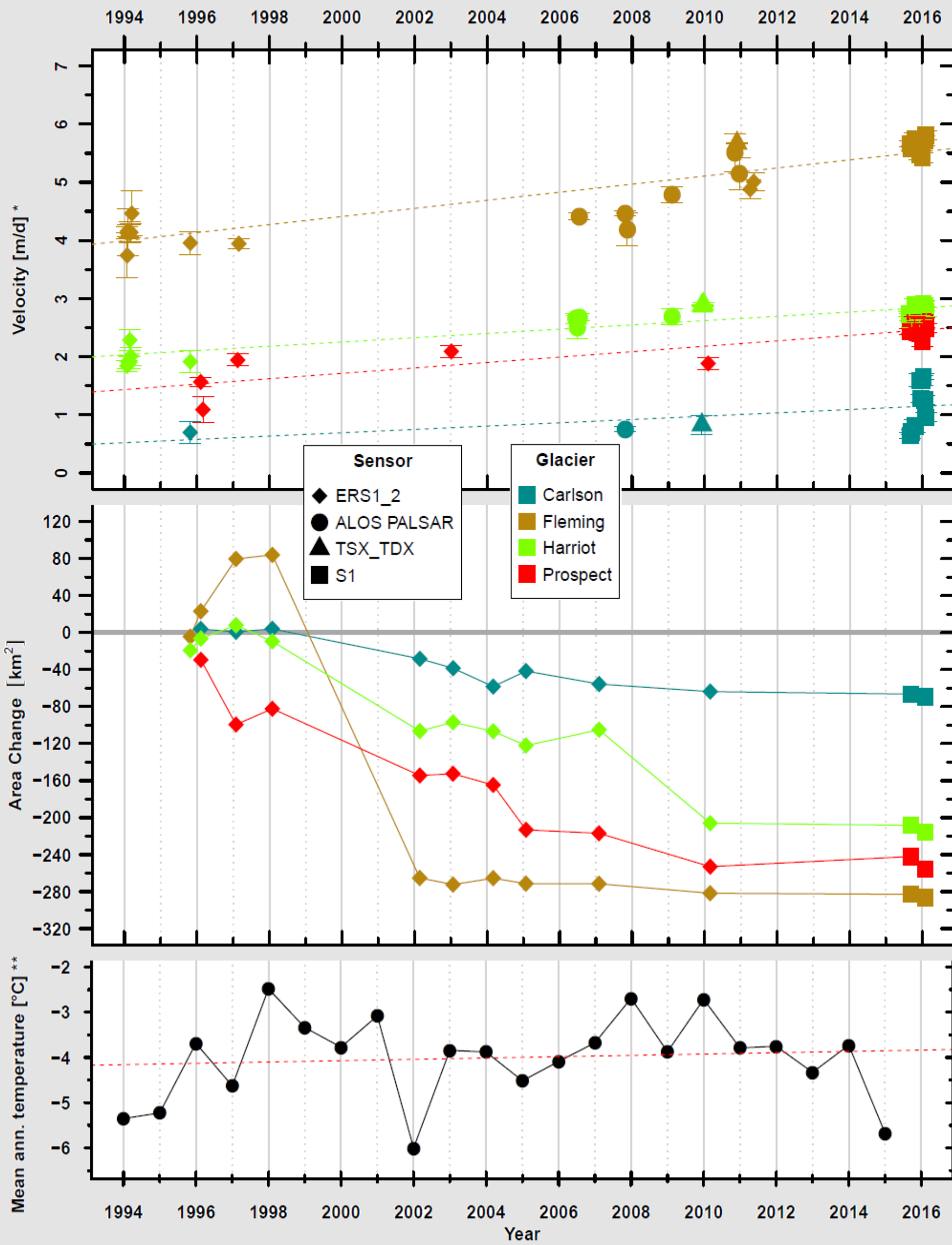
(3) DATASET OF PRESENTED RESULTS

Data	Data Type	Provider/Data Source
ERS 1/2 (1991 – 2011)	C-Band SAR Data	ESA Archive at DFD / DLR
TSX / TDX (since 2007)	X-Band SAR Data	DLR
ALOS PALSAR (2006 – 2011)	L-Band SAR Data	JAXA
Sentinel-1 (since 2014)	C-Band SAR Data	ESA
Landsat-8	Optical Data	USGS
ASTER GDEM V2	Height Data	NASA / METI / LP DAAC
Temp. (Rothera Station)	Temperature Record	BAS / READER Project
TPX08	Tide Model	Gary et al. (2002)
MEaSUREs Antarctic Grounding Line	Antarctic Grounding Lines 1994 – 2009	Rignot et al. (2011)

(4) METHODS OF PRESENTED RESULTS

Method	Input Data	Product / Parameter
Feature Tracking	<ul style="list-style-type: none">Multi-mission SAR DataASTER GDEM V2	<ul style="list-style-type: none">Orthorectified Surface Velocity Fields (range, az.)
Differential Range-Offset Tracking	<ul style="list-style-type: none">Orthorectified Velocity Fields (range, Sentinel-1)TPX08 Tide Model	<ul style="list-style-type: none">Differential Velocity Fields (range)Grounding Line
Manual Mapping	<ul style="list-style-type: none">Orthorectified & Calibrated Multi-mission SAR Intensity Images	<ul style="list-style-type: none">Glacier OutlinesArea Change

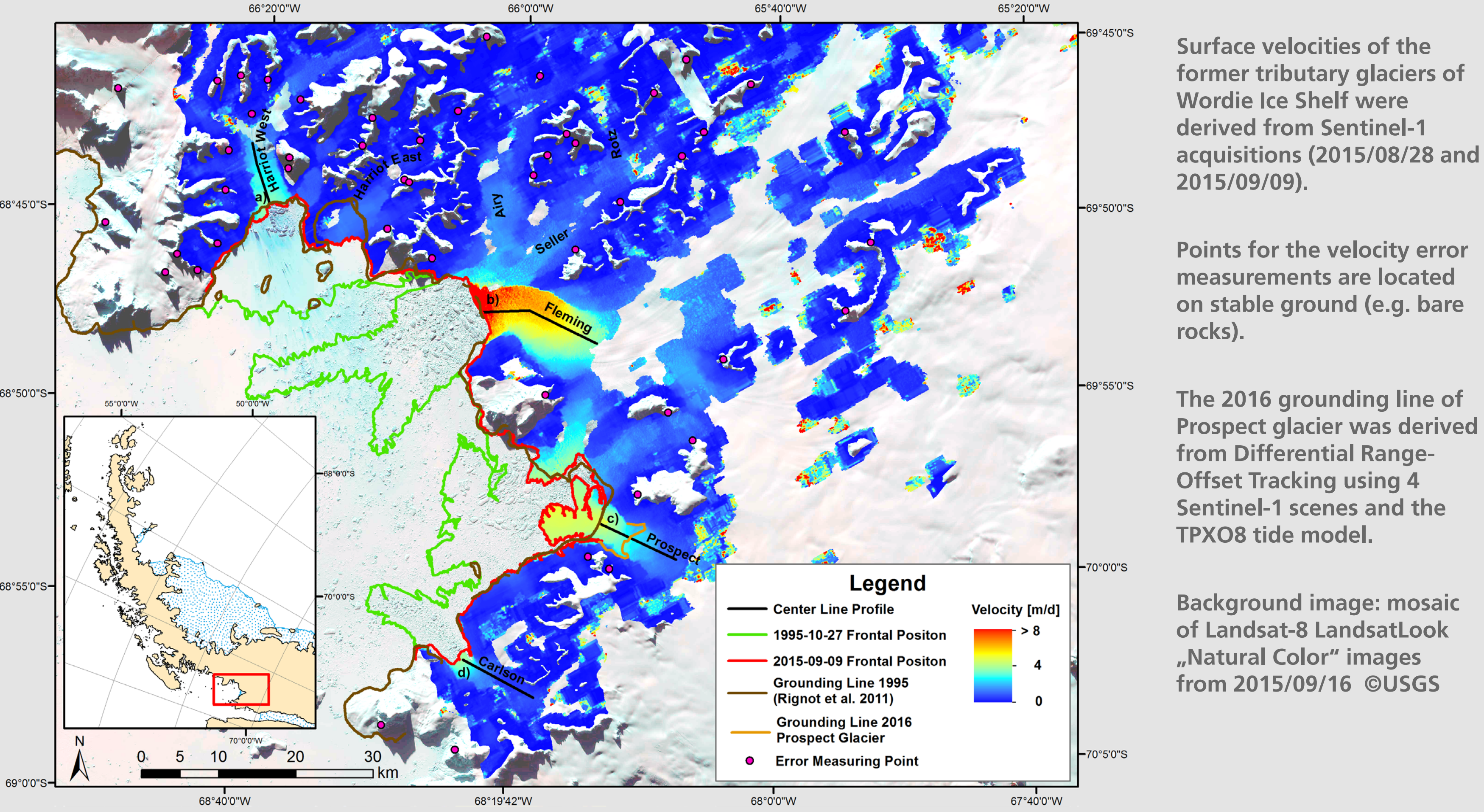
(5) ICE DYNAMICS



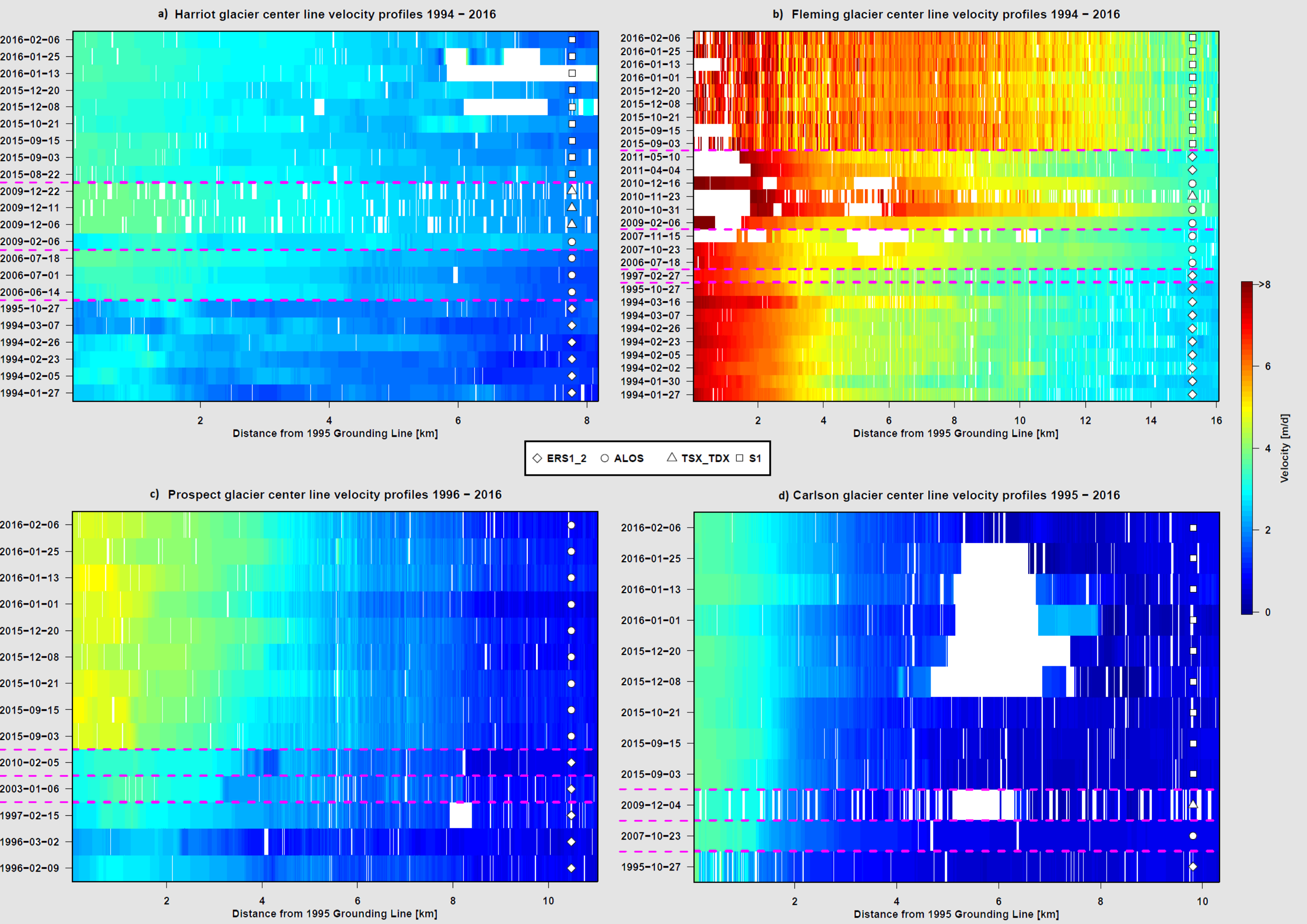
* Median velocities along center line profiles, see (2)
Median velocity errors were calculated from velocities at points over stable ground, see (2)

** Temperatures at Rothera Research Station (67°35'8"S, 68°7'59"W), approx. 170 km north from Wordie Bay

(2) OVERVIEW OF THE STUDY AREA



(6) CENTER LINE VELOCITY PROFILE TIME SERIES 1995 – 2016



(7) RESULTS & CONCLUSIONS

- The median velocity of all tributary glaciers along their center line profiles increased during the observation period from 1994 - 2016. The yearly trend of the median velocity for the period 1994 - 2016 positively depends on the size of the glacier: (Fleming ≈ 7 cm/day, Prospect ≈ 5 cm/day, Harriot ≈ 4 cm/day, Carlson ≈ 3 cm/day)
- Whereas Fleming Glacier experienced a rapid area loss of approx. 349 km² between 1998 - 2000 after a short period of extension in the years 1995 - 1998, the other glaciers showed a more constant retreat between 1996 - 2010. Even though the glacier extents seem to be more stable at least since 2010, all glaciers still loose area every year.
- The grounding line of Prospect glacier retreated by approx. 4.5 km between 1995 - 2016
- For all glaciers the main acceleration took place in the lower parts of the glaciers and decreased with a bigger distance to the glacier front.
- Whereas the acceleration of Carlson glacier was moderate in its lower parts, a significant acceleration within the first 4 km of the profile could be observed for Prospect and Harriot glaciers between 2010 - 2015 and 1995 - 2006 respectively. Fleming glacier however, shows a significant upstream extension of high velocities between 2010 - 2015 and a much stronger variation of the velocities in 2015 and 2016.
- The presented changes show that the glaciers at Wordie Bay are still far away from a stable state. However, more data has to be processed to get a full picture of the glacier dynamics.

(8) OUTLOOK

- Fully automated monitoring of the present ice velocities at Wordie Bay with Sentinel-1 will be continued.
- Radarsat-1 and Envisat data will be processed in order to complete the velocity time series.
- TerraSAR-X future acquisitions of Fleming glacier will be processed in order to verify its current velocity pattern.
- Ice thickness, altimeter, bathymetry and surface mass balance data will be integrated in order to calculate mass fluxes and mass balances with the fluxgate approach.
- Elevation change and geodetic mass balances will be derived from TanDEM-X differential interferometry.

