Re-Processing of ERS-1/-2 SAR data for derivation of glaciological parameters on the Antarctic Peninsula

Peter Friedl[1], Kathrin Höppner[1], Matthias Braun[2] , Rainer Lorenz[1] and Erhard Diedrich[1]

[1] DLR - 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) Background

With a documented surface temperature rise of up to +0.53° C (decade^{-1}) from 1951-2006*, the Antarctic Peninsula (Fig. 1) is one of the world`s most affected regions by Climate Change.

Long term spaceborn synthetic aperture radar (SAR) data plays a central role for characterization of the resulting glaciological changes in this sensitive region.

One of the tasks of a newly established Junior Research Group at the German Remote Sensing Data Center (DFD) at the German Aerospace Center (DLR) is the application of European Remote Sensing Satellite (ERS-1 and ERS-2) SAR data for glaciological investigations on the Antarctic Peninsula.

Some of the results presented here are part of a master theses written at the Friedrich Alexander Universität Erlangen-Nürnberg (FAU) and the DFD (DLR) with the goal of conducting first parameter adjustments for automatized ERS-SAR data processing.

2) Data

For setting up and testing an automated processing chain (Fig. 2) 24 ERS-SAR scenes in single look complex format (SLC), recorded in 1994, 1995, 1996 and 2011, during periods when the satellites orbited in short repeat cycles (1 day and 3 days), were used.

The scenes cover parts of the Scar Inlet (Larsen B Ice Shelf) and the northern Larsen C Ice Shelf as well as parts of the former Wordie Ice Shelf (Fig. 1).

All SAR data which had been acquired over the 20 years` life span of ERS-1/-2 (1991 – 2011) for the Antarctic Peninsula, had been received at DLR's Antarctic station GARS O'Higgins (Fig. 1) and is archived at the DFD in Oberpfaffenhofen on behalf of the European Space Agency (ESA) .

Reference

*Turner, J.; Bindschadler, R.; Convey, P.; Di Prisco, G.; Fahrbach, E.; Gutt, J. et al. (2009): Antarctic climate change and the environment. A contribution to the International Polar Year 2007 - 2008. Cambridge: Scientific Committee on Antarctic Research.

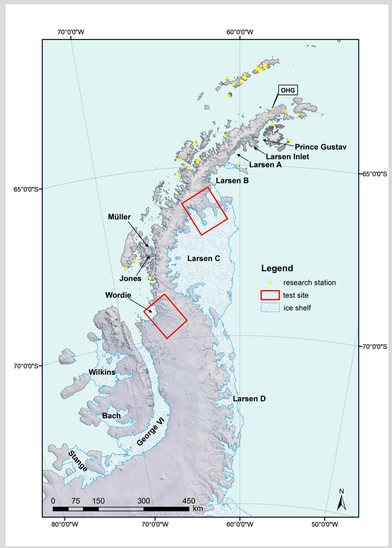

Fig. 1: Overview of the Antarctic Peninsula, it`s ice shelfs and the test sites. DLR's GARS O'Higgins station is labeled with "OHG".

Sources: Landsat Image Mosaic of Antarctica (LIMA) (U.S Geological Survey 2007) , RAMP-DEM (Liu et al. 2001), Shapefiles from the SCAR Antarctic Digital Database, Version 6.

Datum: WGS 84, Projection: polar stereographic

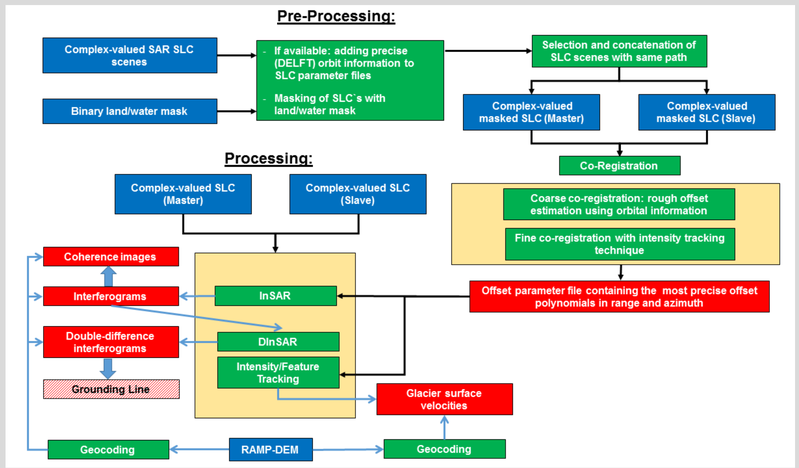

Fig. 2: Automated processing chain for ERS-1/-2 SAR data

3) Methods

Interferometric synthetic radar (InSAR) and differential interferometric synthetic radar (DInSAR) methods as well as the intensity tracking technique were applied to create four different value-added glaciological SAR-products, such as coherence maps, interferograms, double-difference interferograms and glacier velocity maps (Fig. 3).

All products were geocoded from range-Doppler imaging geometry to map coordinates (terrain corrected) with the help of the Radarsat Antarctic Mapping Project Digital Elevation Model (RAMP-DEM) Version 2 with 200 m spatial resolution (Liu et al. 2001).

The products are suitable for glaciological applications, such as determinations of glacier extend, grounding line position (Fig. 4), glacier and ice-stream velocities (Fig. 5) and glacier mass balance calculations with the flux-gate approach.

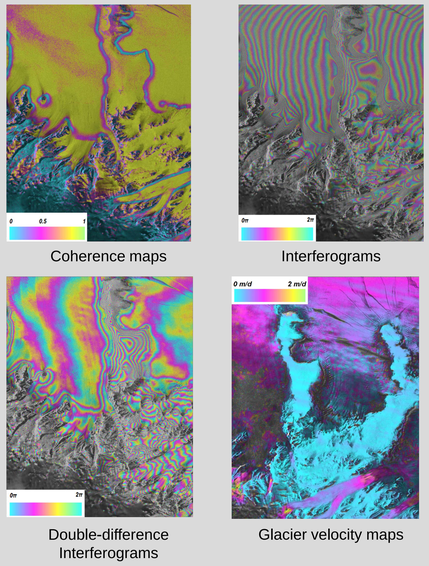

Fig. 3: Examples for value added products in range-Doppler geometry

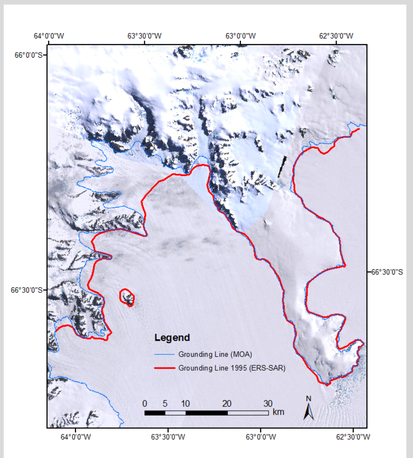

Fig. 4: Comparison of the delineated grounding line in the surrounding of Churchill Peninsula (northern Larsen C Ice Shelf) based on MOA and ERS-SAR data.

Sources: Landsat Image Mosaic of Antarctica (LIMA) (U.S Geological Survey 2007) , MODIS-based Mosaic of Antarctica (MOA) Grounding Line (Scambos et al. 2007)

Datum: WGS 84, Projection: polar stereographic

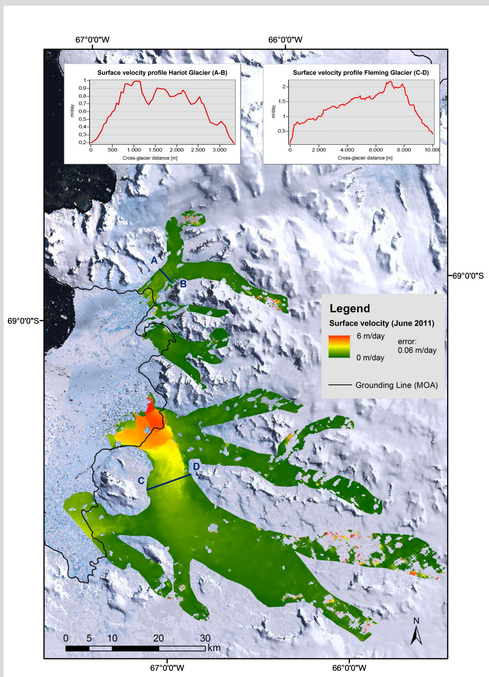

Fig. 5 Surface velocities of the tributary glaciers of the former Wordie Ice Shelf in June 2011 derived from feature/speckle tracking.

Sources: Landsat Image Mosaic of Antarctica (LIMA) (U.S Geological Survey 2007) , MODIS-based Mosaic of Antarctica (MOA) Grounding Line (Scambos et al. 2007)

Datum: WGS 84, Projection: polar stereographic

4) Future plans

Re-Processing of the existing archive of ERS-SAR data at the DFD in Oberpfaffenhofen for the entire Antarctic Peninsula is planned (data with short Temporal Baselines is preferred).

In combination with data from modern polar-orbiting sensors (e.g. TerraSAR-X, TanDEM-X, Sentinel 1) a great potential of the processed ERS data for long-term glaciological studies is expected.

Hence it is intended to carry out further glaciological investigations at different locations on the Antarctic Peninsula, taking account of re-processed ERS-SAR data as well as data from other SAR Sensors.

DLR Deutsches Zentrum für Luft- und Raumfahrt

FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

Deutsches Zentrum
für Luft- und Raumfahrt e.V. (DLR)
German Remote Sensing Data Center (DFD)
Department „International Ground Segment"
Münchner Straße 20
D-82234 Wessling

Peter Friedl
Tel: +49 8153 28 3104
Fax: +49 8153 28-1443
peter.friedl@dlr.de
www.DLR.de