Delineation of grounding line for high latitude glaciers of the Antarctic Ice Sheet using TerraSAR-X and Sentinel-1

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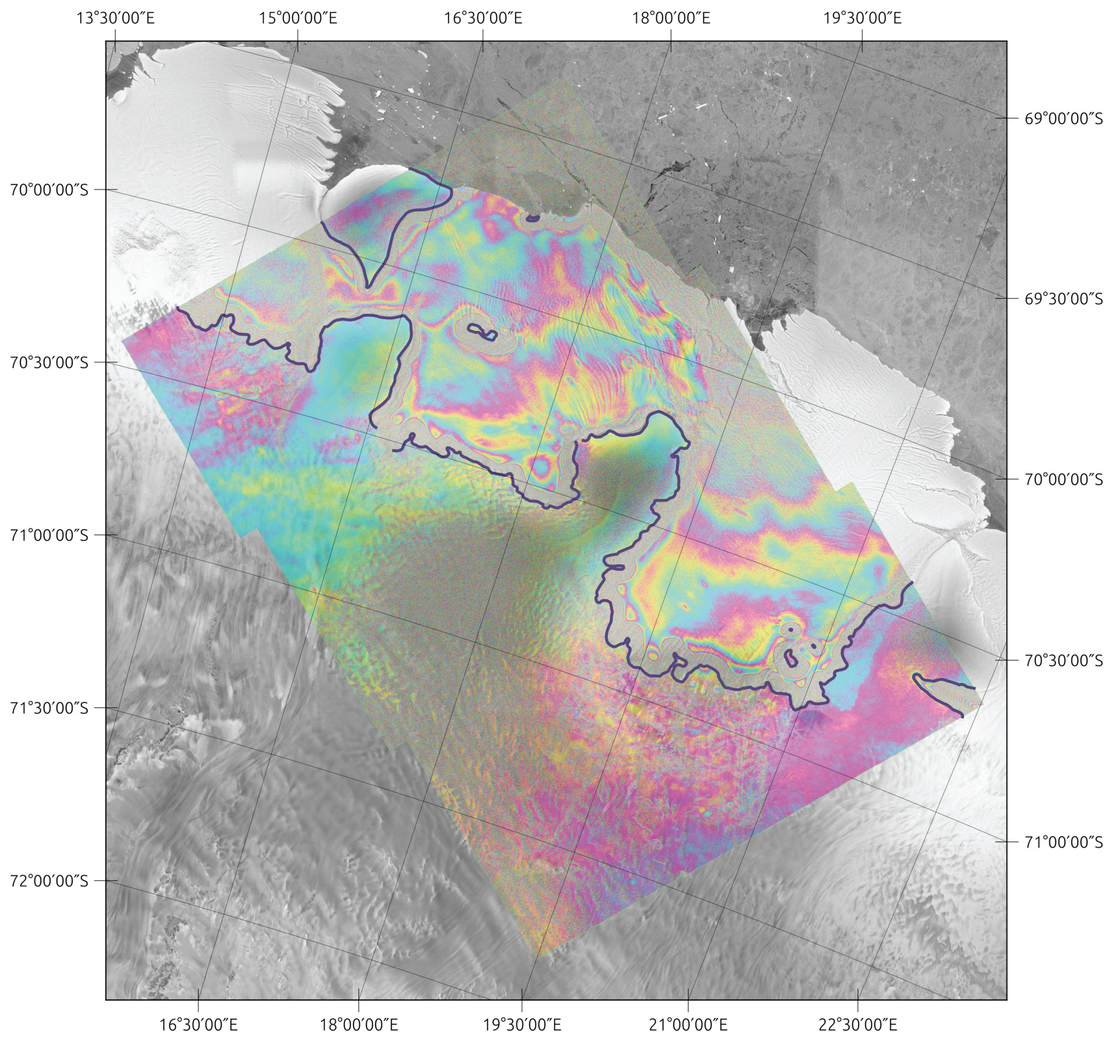

Figure 1: Sentinel-1 double difference interferogram and derived grounding line location (GLL) at the Lazarevisen Ice Shelf based on acquisitions from 2015/05/25, 2015/06/06 and 2015/06/18, descending pass direction, relative orbit number 49.

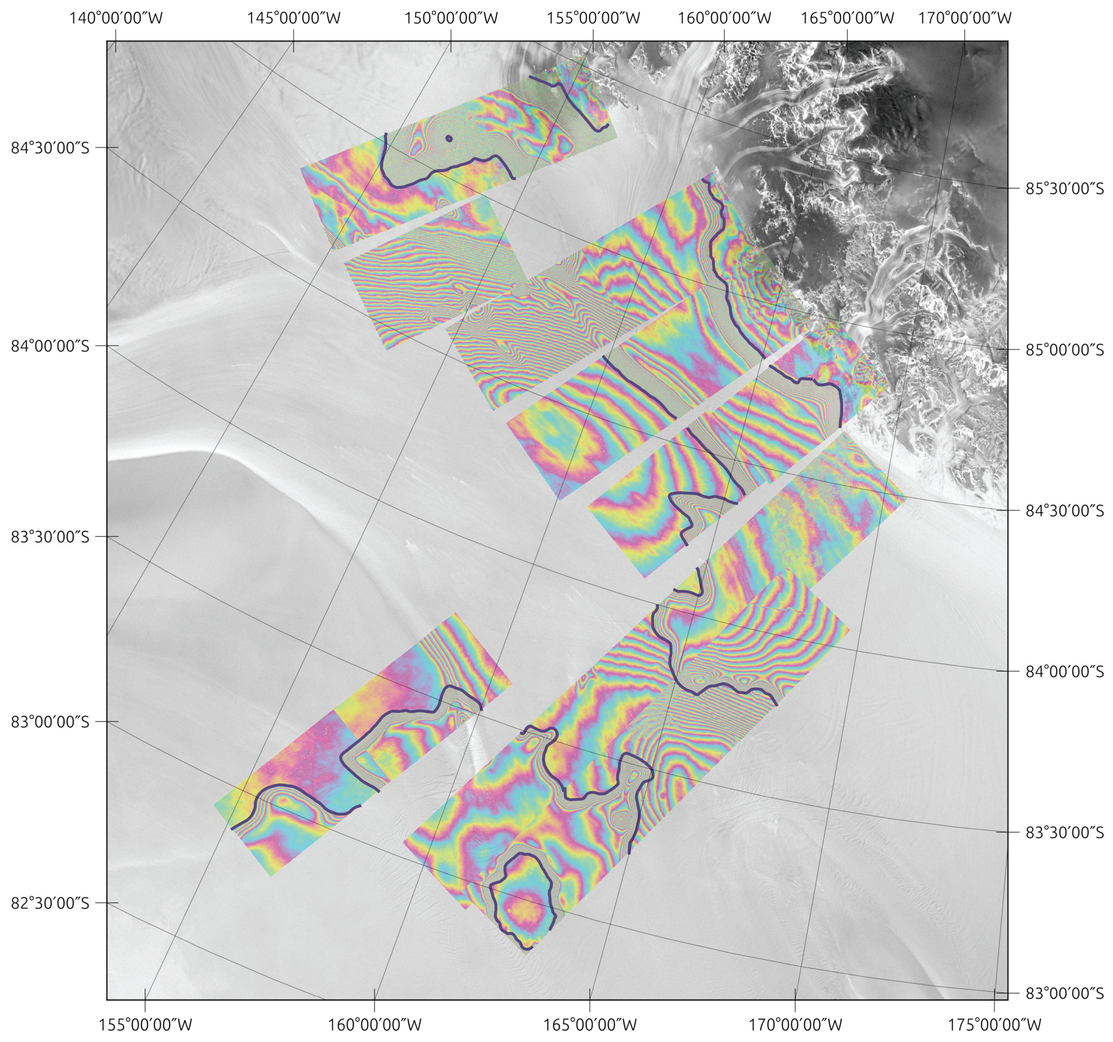

Figure 2: TerraSAR-X double difference interferograms and derived GLL at the Southern Ross Ice Shelf based on acquisitions from 2012/09/02 until 2013/11/26, descending pass directions, left looking from relative orbits 38, 53, 68, 83, 98, 114. These Southern latitudes cannot be imaged by Sentinel-1 nor by ERS-1/2.

Background

- Grounding Line Location (GLL) is the position of the transition between grounded and floating ice
- It is a key boundary condition where ice models for floating/grounded ice need to be coupled
- Location varies, affected by subglacial topography, ice thickness, ocean tide level, air pressure etc.
- Ice thickness changes are very likely to cause horizontal shifts of the GLL
- Such changes serve as indicator for the ice sheet response to climatic changes
- Upper limit of flexure (ice deformation due to ocean tides) is representative for the actual GLL
- Differential InSAR is a well established technique to detect and map the upper limit of flexure

Problem

- GLLs need to be compared in order to reveal GLL retreats caused by ice thinning
- However, none of the currently existing GLL databases provide additional information such as ocean tide level, air pressure or timing information
- A comparison can be performed but a proper interpretation of the observed shift is difficult
- Within one tidal cycle the GLL can shift horizontally up to 10 km, the anticipated accuracy of the GLL however is a few hundred meters; thus ocean tides need to be considered

Motivation

- The goal within the Antarctic Ice Sheet (AIS) Climate Change Initiative (CCI) project is to derive GLLs and time series of GLL from ERS-1/2, TerraSAR-X and Sentinel-1a/b utilizing DInSAR
- The generated products which will be freely available are annotated with additional meta data
- The meta data allow more precise comparisons, conclusions and interpretations

Sample Data Sets

- Within the first year of AIS_CCI project four sample datasets were generated for:
  - Princess Astrid Coast (Nivlisen/Lazarevisen Ice Shelf) from ERS-1/2 and Sentinel-1 (Figure 1)
  - Southern Ronne Ice Shelf (Slessor/Recovery Glacier) from TerraSAR-X (Figure 2)
  - Riiser-Larsen and Brunt Ice Shelf (Stancomb Wills/ Heimefrontfjella Glacier) from ERS-1/2
  - Southern Ross Ice Shelf (Transantarctic Mountains) from TerraSAR-X
- Within the first project year GLLs were delineated manually from interferograms and gradient images
- A semi–automatic approach which is based on gradient thresholds is in development and should further improve data quality with newly released products
- GLL products are provided for user convenience in three popular formats:
  - ESRI shapefile (.shp) for GIS user and further analyses
  - ASCII file (.csv) in well known text (wkt) structure
  - Google Earth (kml) for GIS independent quick visualization
- All formats include geometry and the full metadata information (Figure 3)
- Each polyline (separately derived grounding line segment) has its own metadata record which describes its origin and generation
- Products can be downloaded at ENVEO's Cryoportal (Figure 4) and will be updated as the project proceeds http://cryoportal.enveo.at/antarctica.html#tab2
- User feedback would be welcome, please contact: dana.floricioiu@dlr.de, michael.baessler@dlr.de

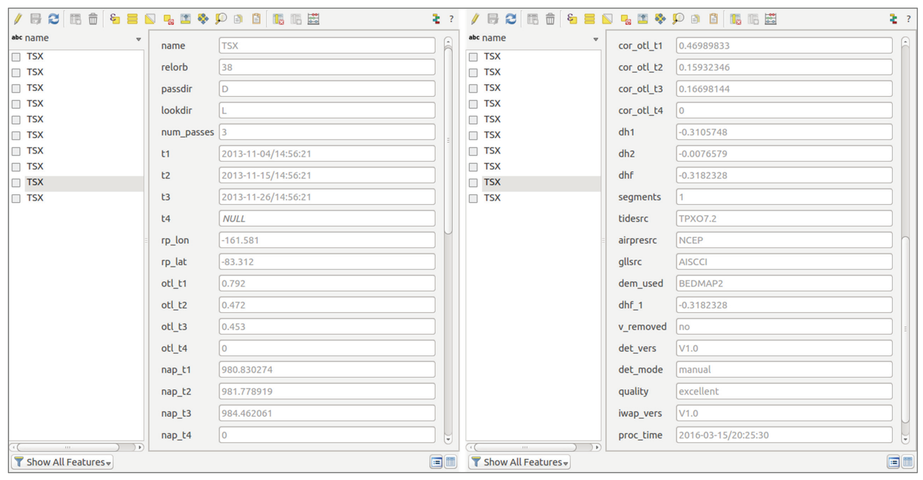

Figure 3: Sample GLL product metadata record which will be delivered with each polyline (grounding line segment). Contained information is e.g.: sensor, orbit, pass- and look direction, number of passes used, acquisition dates/time, reference point for ocean tide prediction, ocean tide predictions, respective air pressure values, corrected ocean tide levels and resulting height differences as well as names of the models (ocean tide, air pressure, digital elevation model), quality flag and some other values.

Figure 4: Screenshot of ENVEO's data portal. GLL products are currently sorted out by region. The download provides a ZIP file which contains all three formats (shp, csv, kml). A product user guide explaining the data formats and parameters is also available for download.