Recommendation for JAXA Regarding ALOS-2 Acquisitions Over Polar Ice Sheets

November 2015

Bernd Scheuchl
University of California, Irvine (bscheuch@uci.edu)
Ice Sheet Science Coordinator for the Polar Space Task Group

Motivation

Spaceborne SAR is a proven, invaluable tool researching the great ice sheets. Interferometric SAR data allow the measurement of ice surface velocity with unparalleled coverage and accuracy. Differential interferometric SAR data (3+ consecutive acquisitions) allow the delineation of the grounding line (i.e. the transition boundary where ice detaches from the bed to become afloat in the ocean). Knowledge of ice velocity as well as the exact location of the grounding line is crucial for ice sheet mass balance calculations.

ALOS PALSAR L-band SAR data have contributed in a unique way to the first continent-wide ice velocity map of Antarctica assembled as part of an International Polar Year effort. Specifically coastal areas that could not be mapped with C-band data (due to a lack of correlation) were mapped with ALOS PALSAR data. ALOS-2 PALSAR-2 shows significant potential to continue this data record of the world's ice sheets.

As PSTG Ice Sheet Science Coordinator, I prepared a requirements document that contains specific recommendations for ALOS-2: SAR Science Requirements for Ice Sheets
http://www.wmo.int/pages/prog/sat/meetings/documents/PSTG-3_Doc_08-02-02_SAR-Req-IS.pdf

Here, I provide a summary and update of recommendations to JAXA in light of the recent PSTG meeting (October 2015) and acquisition plans from other Space Agencies presented at this meeting.

Comments to the existing BOS

Thanks to JAXA's initiative, the current BOS already covers very important regions of Antarctica and Greenland in 10m FBD mode. This is the data of most interest to the ice sheet science community. Critical areas are even covered in ascending and descending mode. However, not all coverage is available as interferometric data yet. It would be important to attempt to reach InSAR coverage in all BOS regions.

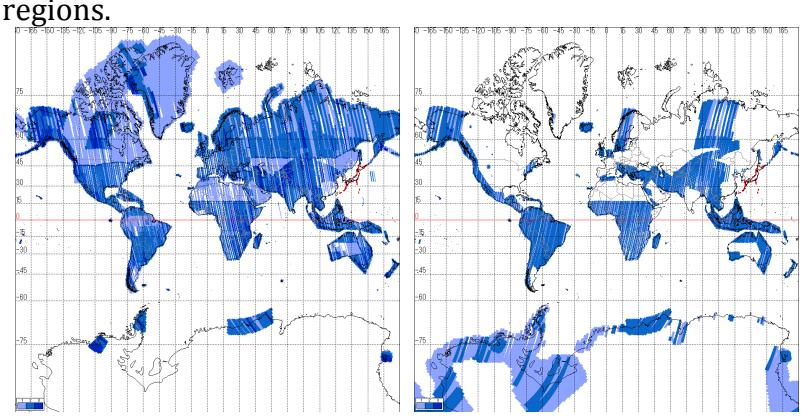

Figure 1: ascending coverage (left) and descending coverage (right), both PALSAR-2 FBD. Darker blue tones indicate multiple coverages (up to 3)

Specific Suggestions for Data Acquisition Strategies

The following recommendations were made with knowledge of the existing BOS as well as an assessment of data acquired (provided by JAXA) but without knowledge of available resources of ALOS-2 PALSAR-2. The recommendations below are prioritized (1: highest priority, lower priorities usually encompass higher priority items as well), to provide BOS planners flexibility:

Antarctica:

1. It would be important if the critical areas already covered (see existing ascending coverage) could have (at least 3) consecutive acquisitions once a year to allow differential interferometry for grounding line detection. A third acquisition will also improve the velocity measurement with two InSAR pairs available.
2. An extension of the critical areas to fast glaciers in East Antarctica would be considered an asset (Totten & Moscow University Glaciers, Denman Glacier, Cook Ice shelf). Please see the corresponding kmz files delivered together with this document.
   Attached file: Archive_01_East_Antarctica_Detail.zip
3. Selected Areas of Central Antarctica, that can only be monitored with left looking mode are the Transantarctic Mountains, Bird Glacier, Ice streams A, B, D, E, on Ross Ice Shelf as well as Slessor Glacier, Recovery Glacier, Foundation Glacier, Support Force, Institute IS and Rutford Glacier on Ronne Filchner Ice Shelf. InSAR coverage for these areas would be considered an asset.
   Attached files: Archive_02_Ross_Detail.zip, Archive_03_Ronne_Detail.zip
4. It would be an asset if the larger existing coverage (see descending coverage) would be available interferometrically (2 or more consecutive acquisitions). This would allow the generation of large area ice velocity maps (i.e. in West Antarctica as well as for Ross and Ronne Filchner Ice Shelves).

Greenland:

1. As a minimal requirement we recommend to extend the interferometric coverage (currently NW Greenland) also the Southern Greenland coast. Here, C-band data suffer from decorrelation, whereas L-band data would provide correlation and therefore allow ice velocity measurements.
2. A full interferometric coverage (at least 3 consecutive acquisitions) of coastal Greenland would serve the science goals even better. Such coverage could be achieved through a combination of ascending and descending acquisitions along the coastline (Ascending in NW Greenland as shown in BOS; Descending in SE Greenland (currently not available)), to reduce the number of tracks required for coverage of the entire coast.
3. It would be considered an asset if the larger coverage (Greenland-wide, see ascending coverage) would be available interferometrically with 2 or more (ideally 3) consecutive acquisitions.

The appendix is for your information only and contains ice velocity maps for Antarctica and Greenland as well as maps highlighting areas where the ice velocity is greater than 20 m/year. In principle, coverage of all fast areas ($v > 20$ m/year) with ALOS-2 PALSAR-2 data would be desirable, however, given the sensor load, the above suggestions provide a set of prioritized recommendations that will serve the science community.

Appendix A: Antarctica

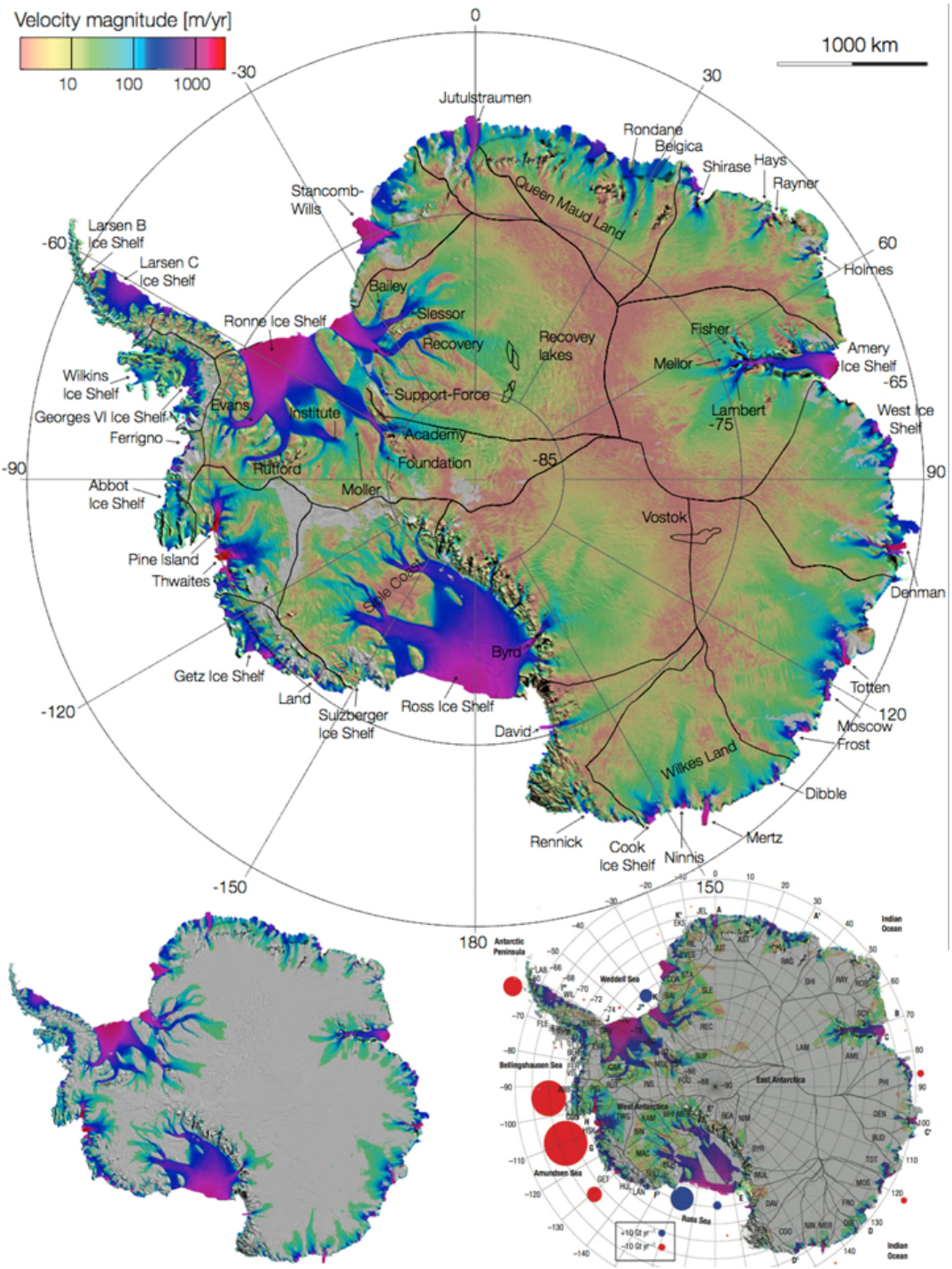

Figure 2: top) Ice velocity of Antarctica, full map; bottom left) high speed areas, v>20 m/yr; bottom right) Mass balance analysis with areas of biggest mass change indicated with red (mass loss) and blue (mass gain) dots.

Appendix B: Greenland

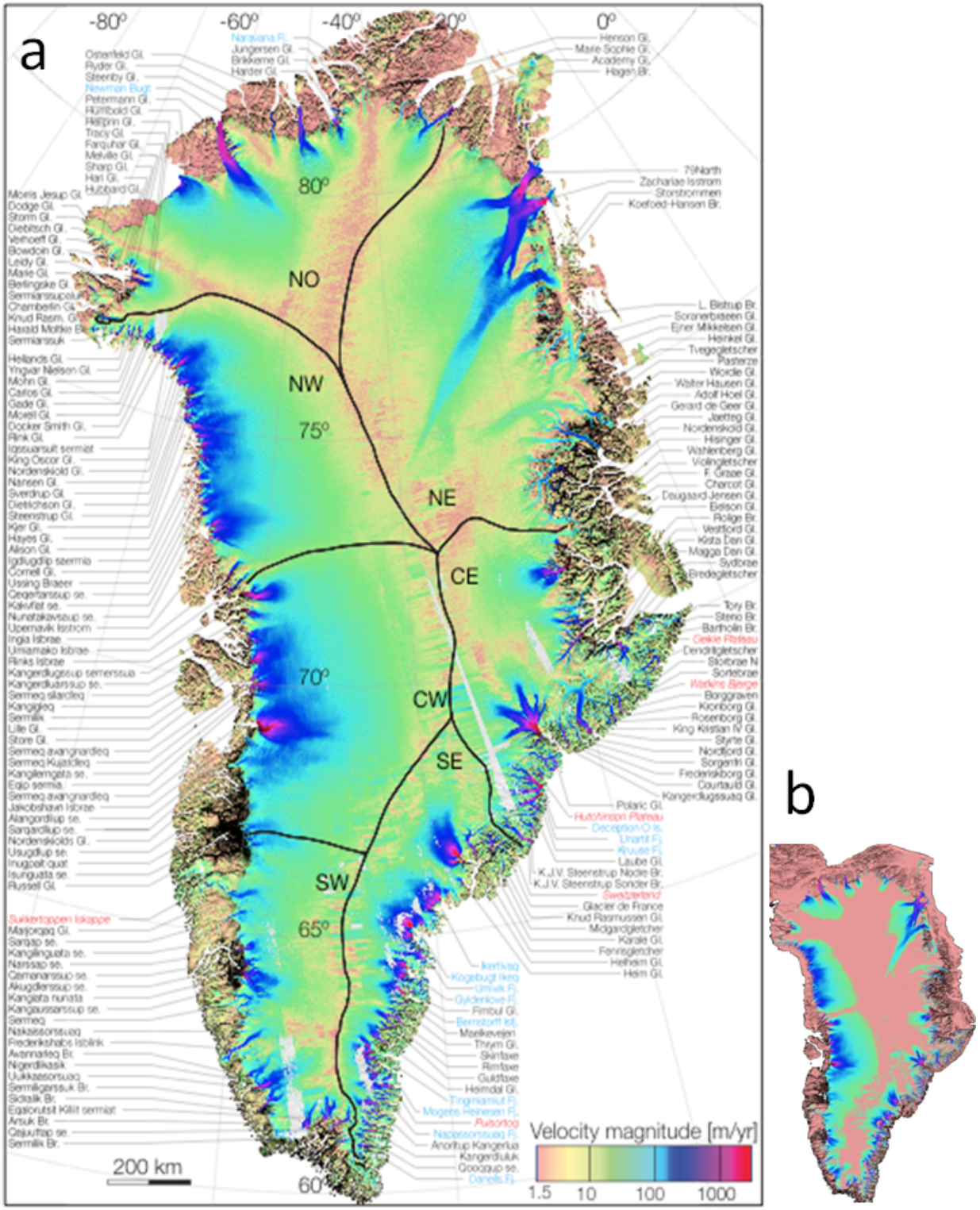

Figure 3: Ice velocity of Greenland. a) full map; b) v>20 m/yr. Critical regions include the South East Coast (SE) and the Central West and North West Coast (CW, NW). Frequent coverage of all fast areas would be an asset.