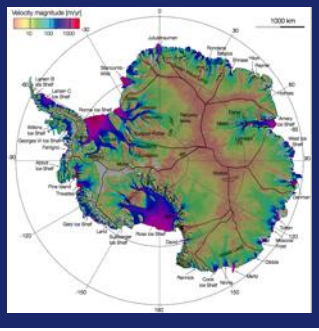

Antarctic Ice Velocity Mapped from Space: A Game Changing New Product

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Coordination of data acquisition by the IPY Space Task Group.

Goal & Objective

Goal:

Improve our knowledge of ice dynamics of the Great Ice Sheets to better understand their current and future impact on sea level change.

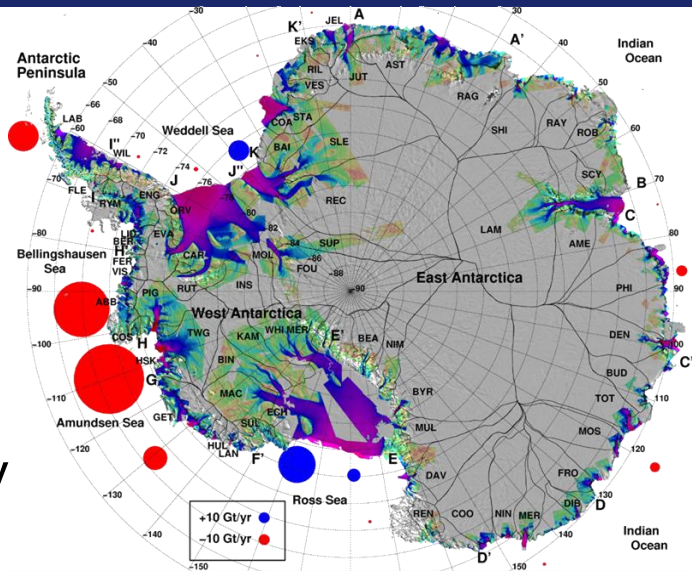
Objective:

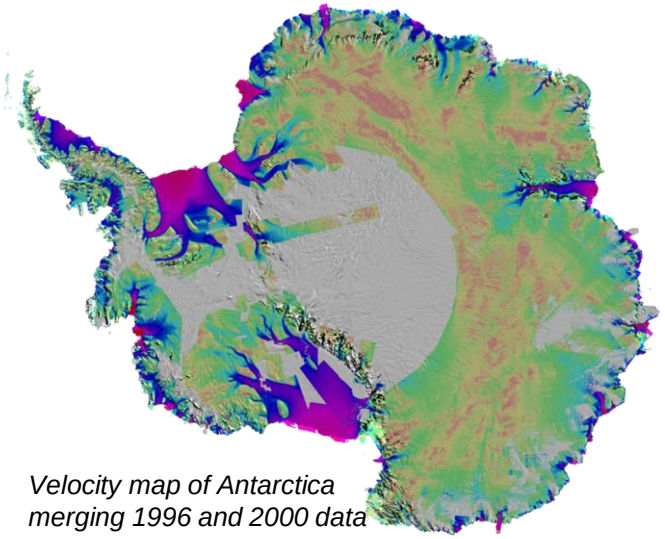
Generate and distribute a new Earth Science Data Record (ESDR): digital maps of ice velocity of the Antarctic continent from satellite data.

History of Data Availability:

1996 ERS Tandem mission (Coastal Antarctica).1997 AMM-1 limited left looking acquisitions
2000 AMM-2 first large scale coverage RAMP

→ NO complete coverage achieved. Data quality in the interior is not great (due to data limitations). Already had an impact on science





Velocity map of Antarctica merging 1996 and 2000 data

Opportunity

- IPY STG coordination of SAR acquisitions in Polar Regions
  - Coastal areas covered with C-band AND L-band data
    - ENVISAT ASAR (C-band) and ALOS PALSAR (L-band)
  - Multiple coverages of coastal areas
  - First ever complete coverage of central Antarctica (RADARSAT-2)
- Funding opportunity
  - NASA MEaSUREs Program

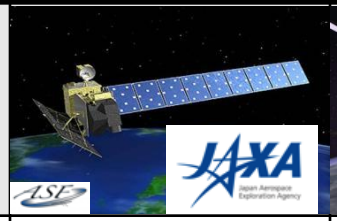
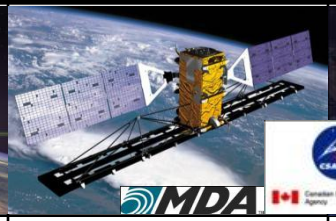
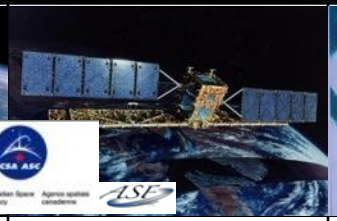
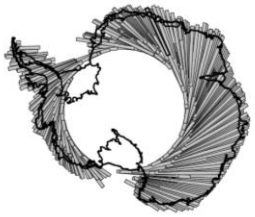
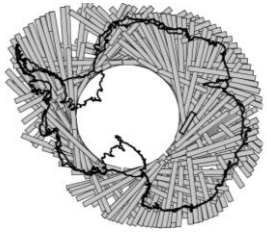
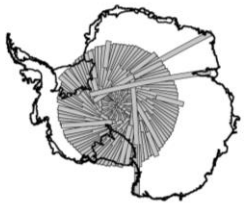
  (Making Earth System data records for Use in Research Environments)
- 15 years in house expertise in InSAR based glacier velocity measurements
- Other factors
  - Advances in computer hardware
  - Advances in Antarctic Research (Balance velocity, improved DEM)

Challenges

Continental-scale application of interferometric synthetic-aperture radar techniques

- Data from multiple sensors and different time periods
  - Full coverage also requires left AND right looking acquisitions
- Large data volume
  - Hundreds of tracks acquired for full coverage (>11TB SAR data/year)
- Acquisition strategy by data providers
  - Short tracks, few reaching coast to coast (ASAR, RADARSAT-2)
- Ionospheric perturbation (for L-band)
  - Significant challenge in the interior (perturbation larger than signal)

Data Sources

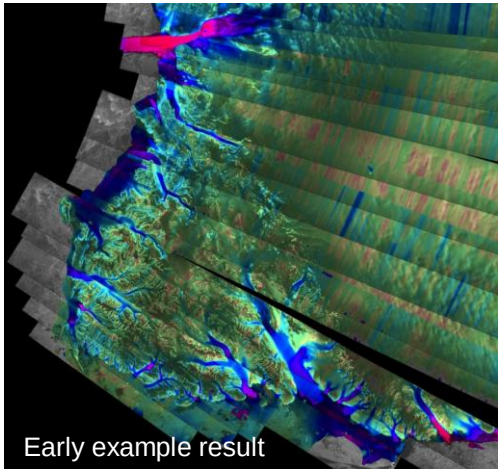
	ALOS PALSAR	ENVISAT ASAR	RADARSAT-2	RADARSAT-1	ERS-1/2
Sensor / Agency					
Band	L	C	C	C	C
Repeat	46 days	35 days	24 days	24 days	1day, 3days
Coverage	2006 - 2010	2007 - 2009	2009, 2011	1997,2000,2004	1992,1996
Look direction	right	right	left, (right)	right, (left)	right
Mosaic				Historic data (pre IPY campaign)	Historic data (pre IPY campaign)
Utilization	Best coverage in coastal areas	Best coverage of the interior	Only coverage of central Antarctica	Used for filling gaps	Used for filling gaps
Comment	Acquisitions coordinated by the Space Task Group (STG) for the International Polar Year			Selected tracks only – more data available	

Velocity Calibration

Need to convert offsets to absolute velocity.

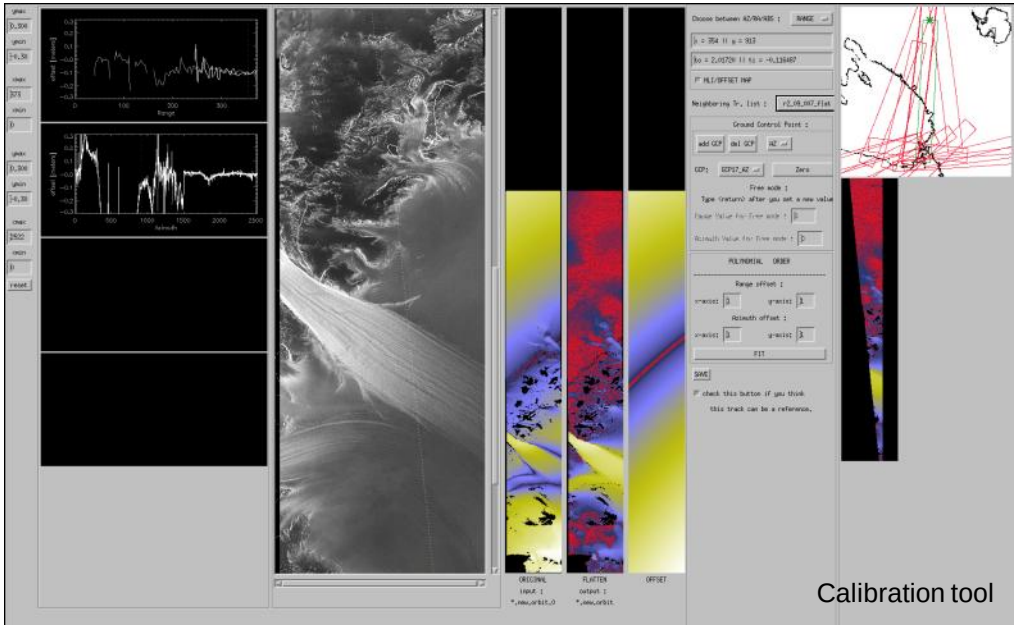
Initial strategy: find ground control points with zero velocity

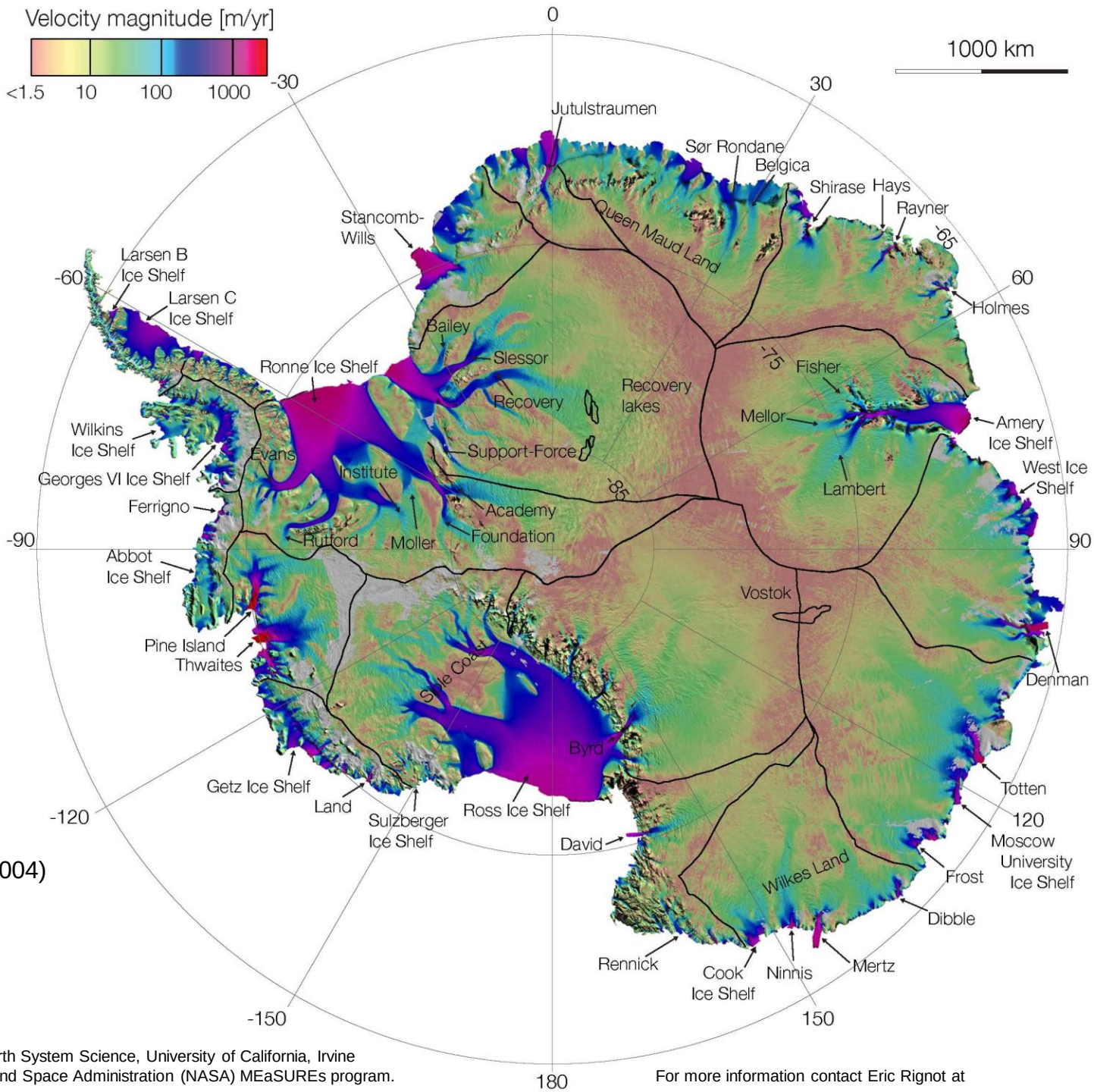
Issue:
Data acquisition strategies do not support this approach on a continental scale


Early example result

Solution:

- New calibration tool
- Use overlapping tracks or reference solution
- Careful selection of the order the tracks are processed in
- Iterative approach
- Use data stacking


Calibration tool



Ice Velocity Map

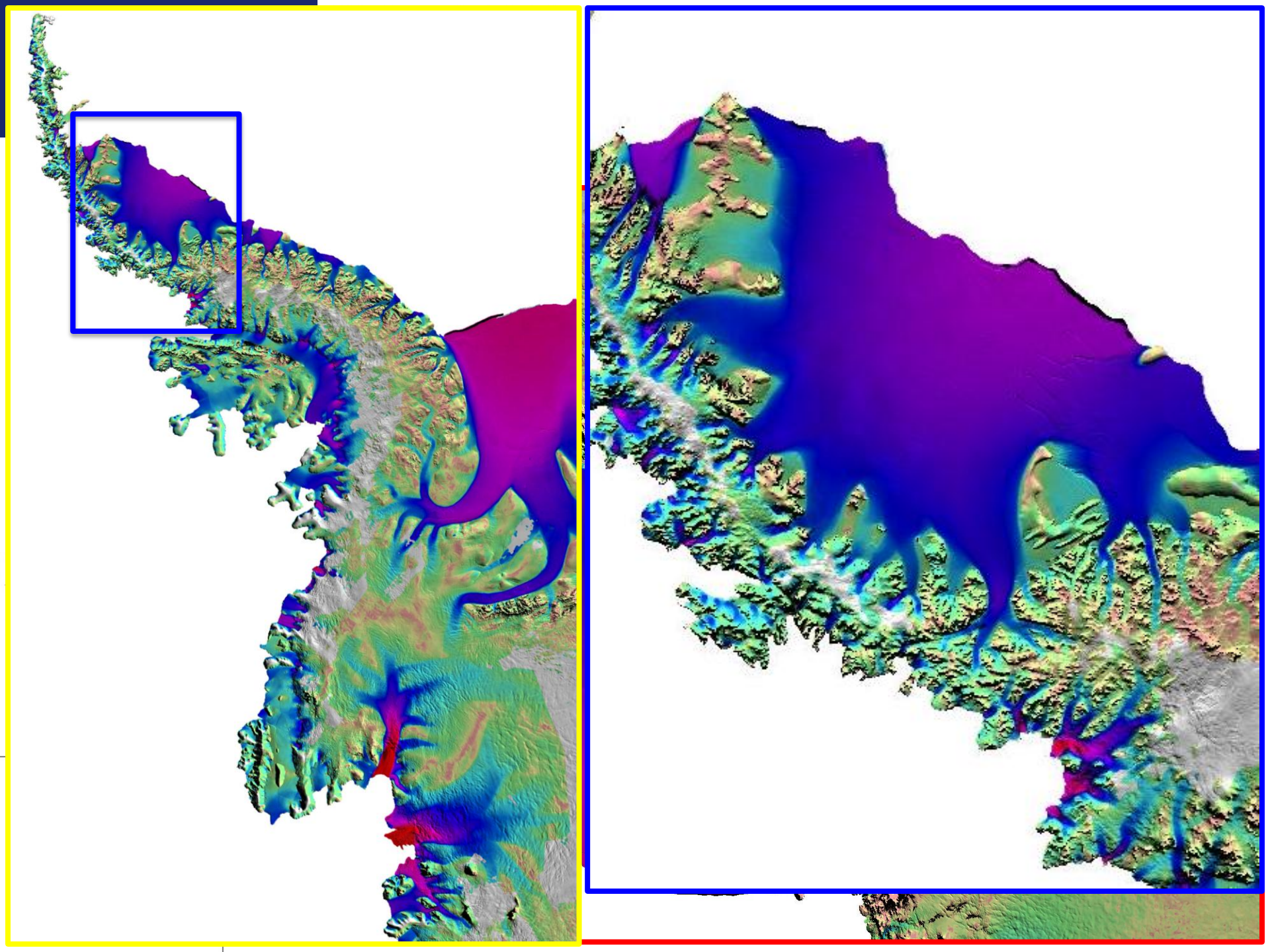
ALOS PALSAR (2006-2008)
ENVISAT ASAR (2007-2009)
RADARSAT-2 (2009)

RADARSAT-1 (1999, 2000, 2004)
ERS-1, ERS-2 (1992,1996)

Rignot, E., J. Mouginot, and B. Scheuchl (2011), Ice Flow of the Antarctic Ice Sheet. Science

This work is carried out at the Department of Earth System Science, University of California, Irvine under a contract with the National Aeronautics and Space Administration (NASA) MEaSUREs program.

For more information contact Eric Rignot at



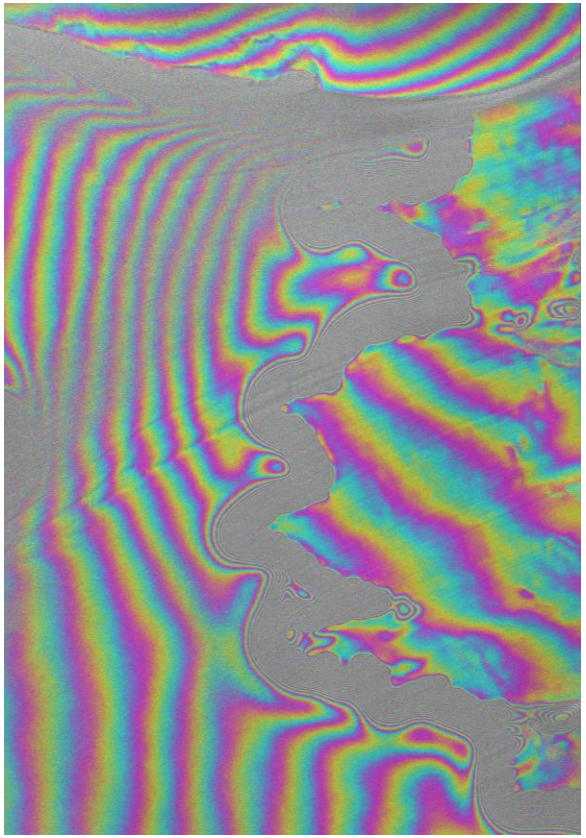
Grounding Line

The **Grounding line** (GL) is the **boundary** between **grounded** and **floating** ice.

Ice reaches the ocean at over 28,600 km of the coastline, or 76% of Antarctica, of which 22,600 km experiences tidal flexure.

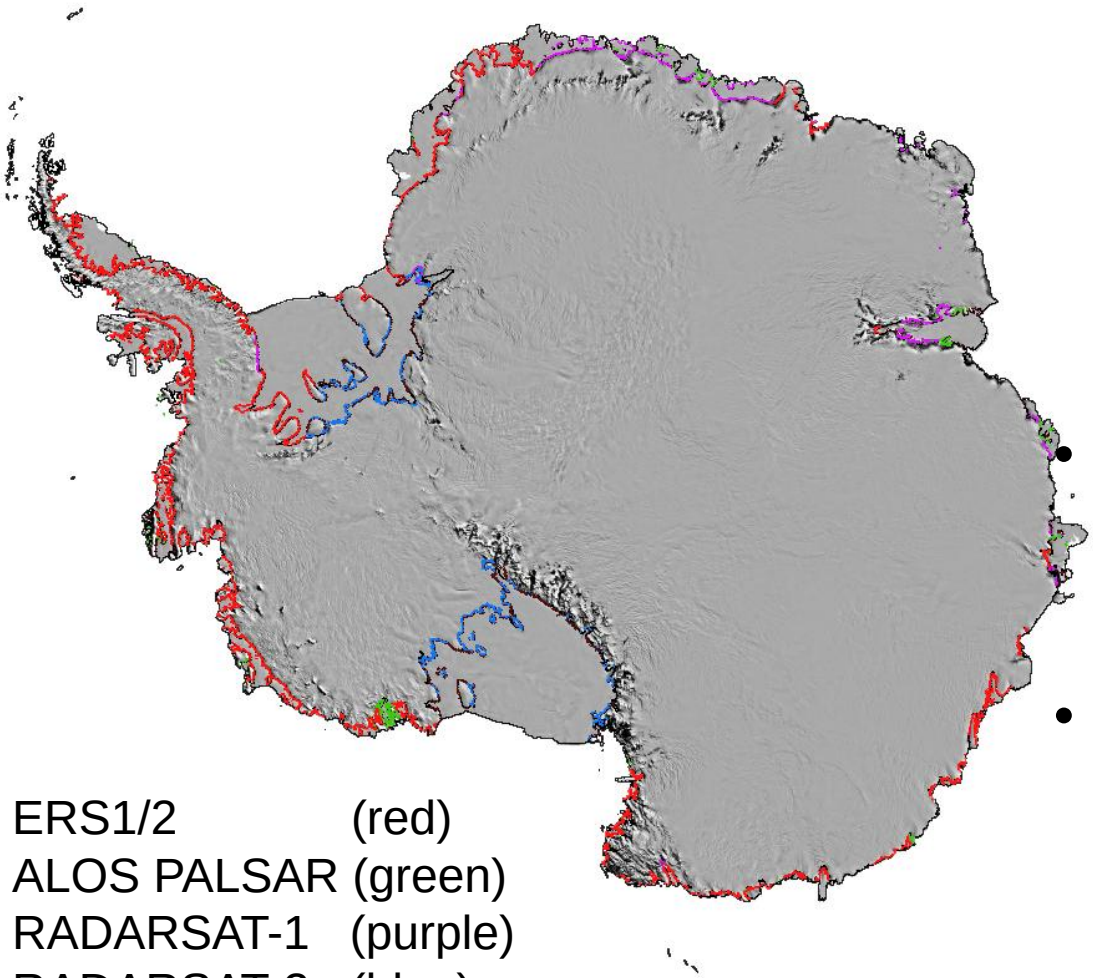
InSAR is a unique tool to measure the grounding line (GL). The grounding line is a critical boundary

- for ice fluxes into the ocean
- to monitor for ice dynamics and modeling
- to monitor over time as a sensitive indicator of glacier changes.



Example: RADARSAT-2 double difference interferogram showing a typical fringe pattern used to extract the GL. (Siple Coast)

Grounding Line



ERS1/2 (red)
ALOS PALSAR (green)
RADARSAT-1 (purple)
RADARSAT-2 (blue)

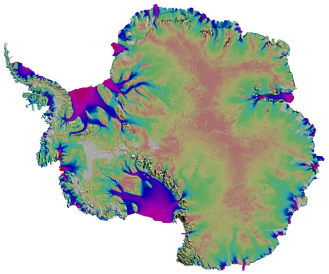
- We mapped **1.4 million** grounding line points experiencing tidal flexure based on double difference interferograms
- Good agreement with ICESat but with less noise
- Currently working with NSIDC to make this dataset available.

Rignot, E., J. Mouginot, and B. Scheuchl (2011), Antarctic grounding line mapping from differential satellite radar interferometry, Geophys. Res. Lett., 38, L10504,doi:10.1029/2011GL047109.

Conclusion

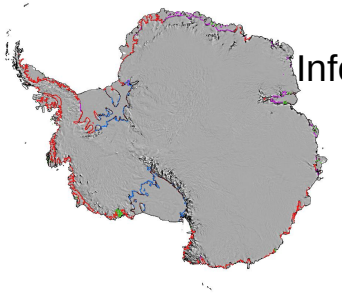
Two new products will soon be available for the scientific community

Ice velocity Map of Antarctica



Information: Ice velocity (v_x,v_y)
Posting: 900 m
Projection: Polar Stereographic
Precision: better than 20 m/year

DInSAR based Grounding Line



Information: Text file containing Latitude, Longitude, and sensor information

We are currently working with NSIDC on the release of these products

The way forward…

Product improvements (particularly for the ice velocity map)

- Fill remaining gaps (using historic data and new data collects)
- Reduction in measurement uncertainties (more data to be processed)
- Additional products (tbd)

Thank You

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NASA/Goddard Space Flight Center Scientific Visualization Studio