Cryosphere Component of NASA MEaSUREs Progam

Craig Dobson, NASA HQ

IPY STG SAR Coordination Mtg. June 23, 2009

Making Earth Science Data Records for Use in Research (MEaSUREs)

- Focus on the creation of Earth System Data Records (ESDRs), including Climate Data Records.
- An ESDR is defined as a unified and coherent set of observations of a given parameter of the Earth system, which is optimized to meet specific requirements in addressing science questions.
- ESDRs are critical to understanding Earth System processes, to assessing variability, long-term trends, and change in the Earth System, and to provide input and validation means to modeling efforts.
- The MEaSUREs projects are focused on product generation, availability, and utility.
- NASA ROSES-2006 solicitation, 29 projects selected October 2007

MEaSUREs Cryosphere Projects

- Antarctic Ice Mapping
  Eric Rignot, Jet Propulsion Lab and Ted Scambos, NSIDC

- Arctic Sea Ice Kinematics
  Ron Kwok, JPL and Don Atwood, Univ. Alaska Fairbanks

- Freeze/Thaw ESDR
  John Kimball, Univ. of Montana and Kyle McDonald, Jet Propulsion Lab

- Greenland Ice Mapping
  Ian Joughin, Univ. of Washington

- N. Hemisphere Snow & Ice
  David Robinson, Rutgers Univ.

National Aeronautics and Space Administration
Science Mission Directorate - Division of Earth Science
Making Earth System data records for Use in Research Environments (MEaSUREs)

Ice Velocity Mapping of the Great Ice Sheets: Antarctica

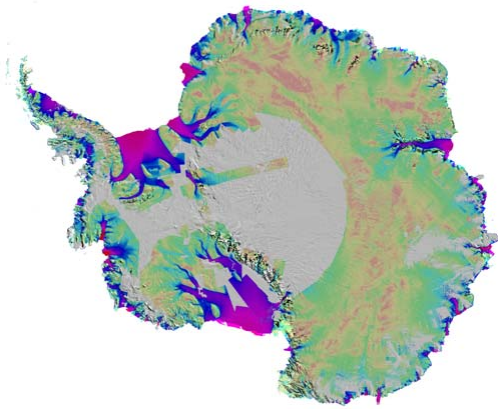
Eric Rignot, University of California Irvine, CA, Principal Investigator
Theodore Scambos, National Snow and Ice Data Center, Boulder, CO, Co-Investigator

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

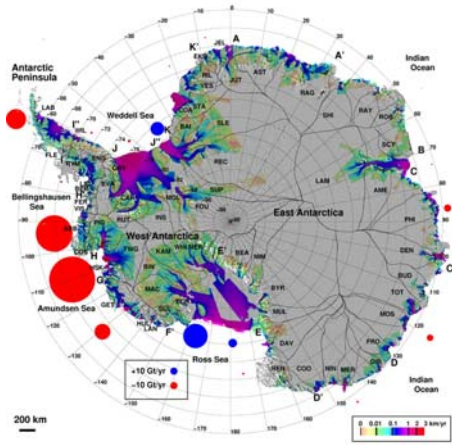
Objectives: Generate and distributed a new Earth Science Data Record (ESDR): digital maps of ice velocity of the Antarctic continent from satellite data.

Key Innovation: Continental-scale application of interferometric synthetic-aperture radar techniques using multiple satellite radar systems and multiple time periods.

Velocity map of Antarctica merging 1996 and 2000 data



Mass loss (red blobs) versus mass gain (blue blobs) caused by changes in ice dynamics.



NASA Relevance:

- NASA Earth science enterprise requires knowledge of the evolution of ice sheets to predict sea level change.
- This effort will enable a new generation of ice sheet numerical models capable of more realistic predictions.

Accomplishments to date:

- 1 paper submitted, 1 paper published, multiple conference and invited lecture presentations.

Schedule (5 year project started in late 2008):

- FY01: Data set compilation; implementation of a large-scale mapping processor.
- FY02: Production of ALOS PALSAR velocity and Envisat ASAR velocity for year 2007. Assembling of ERS-1/2 1996 velocity and Radarsat-1 2000 velocity.
- FY03: Posting of first velocity maps on NSIDC site.
- FY04 and FY05: Complete maps for years 1996/1997, 2000, 2006/2007 and 2009/2010.

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ALOS PALSAR:

Pros: most pro-efficient InSAR data set for ice sheet mapping due to high temporal coherence, fine spatial resolution and long repeat cycles.

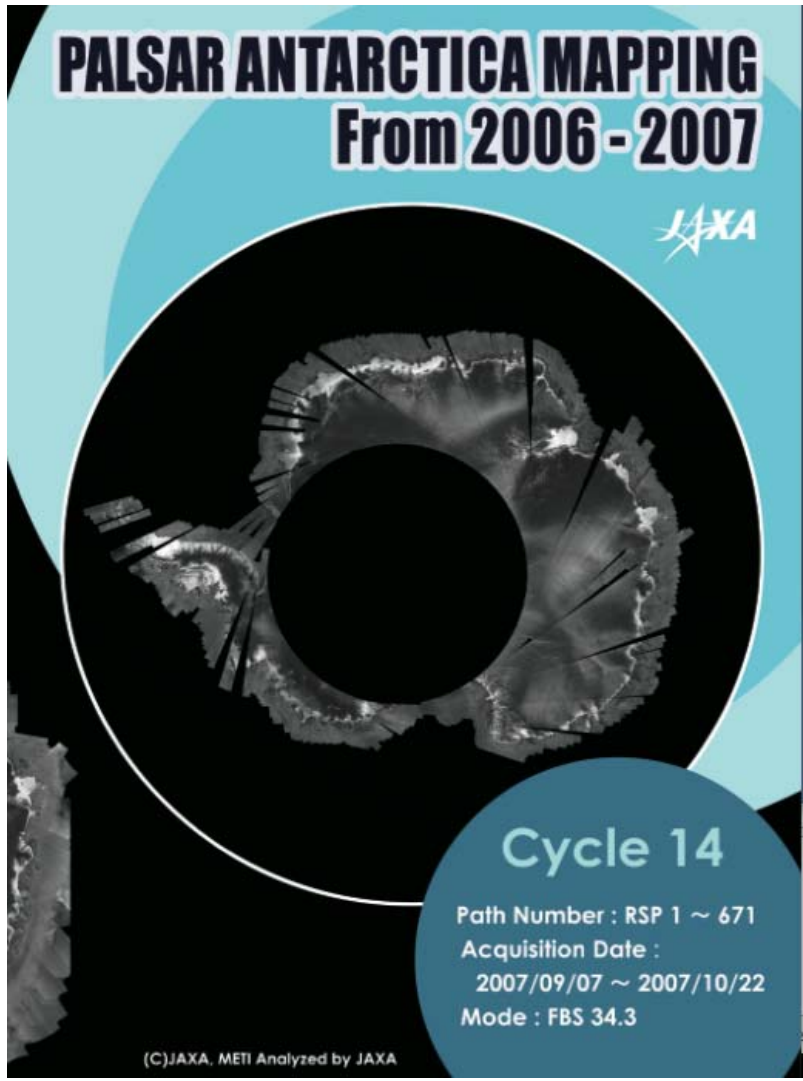
Cons: Ionospheric disturbances are a limiting factor in the interior, distribution of data is complicated by the frame structure of the data (as opposed to full orbits), and the long repeat offers limited possibility to map grounding lines.

Current status: Received 593 orbits from year 2007 and started the processing. Ordered half of 303 orbits for year 2008.

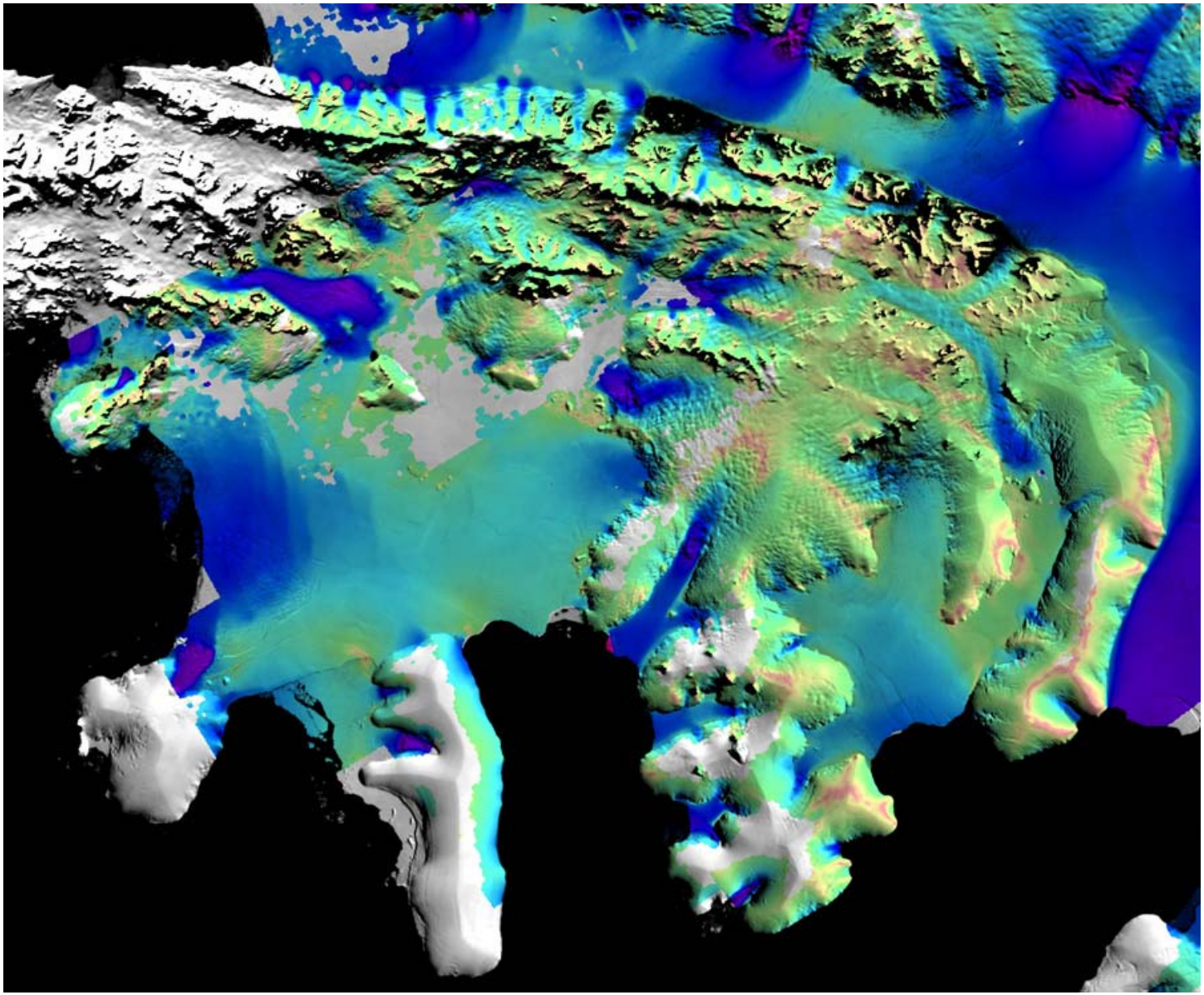
Future data needs: Would like to order 550 full orbits per year for 2009-2011.

Expected results: Most complete mapping of coastal velocities made to date and temporal changes for 2006-2011.

Greatest challenges: Please make sure JAXA acquires the data and that ASF has the processing capability to order, process and distribute them to us in a timely fashion. Second order priority: fill in acquisition gaps not covered in previous years (2006 and 2007).



Wilkins Ice Shelf viewed by ALOS PALSAR



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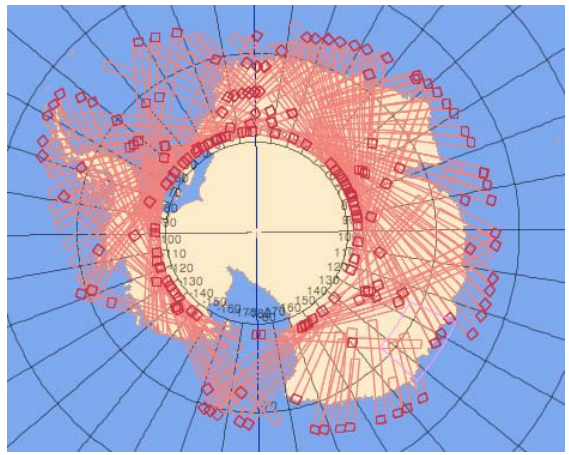
ENVISAT ASAR:



Pros: most pro-efficient InSAR data set for interior ice sheet mapping: long orbits, wide swath, long repeat, coverage farther south than ALOS, HH pol. adopted by ESA maintains high coherence.

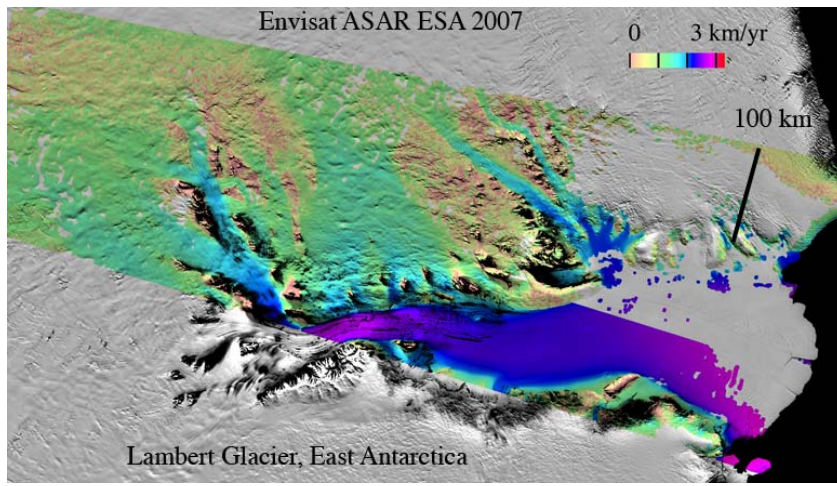
Cons: Coherence is lower than at L-band, some areas systematically fail to correlate (Wilkes Land and West Antarctica), and the long repeat offers limited possibility to map grounding lines.

Current status: Received 362 orbits from year 2007 from ESA thanks to Help Desk and Henri Laur, Mission Manager. ESA framed three complete mosaics for IPY: 2007, 2008 and 2009. Ordered 362 orbits for 2008.

Future data needs: Would like to maintain 362 orbits per year for 2009-2011.

Expected results: Most complete interior mapping of velocities.

Greatest challenges: Please make sure ESA acquires the data and continues distributing them to us as efficiently and generously as they did with the 2007 data.



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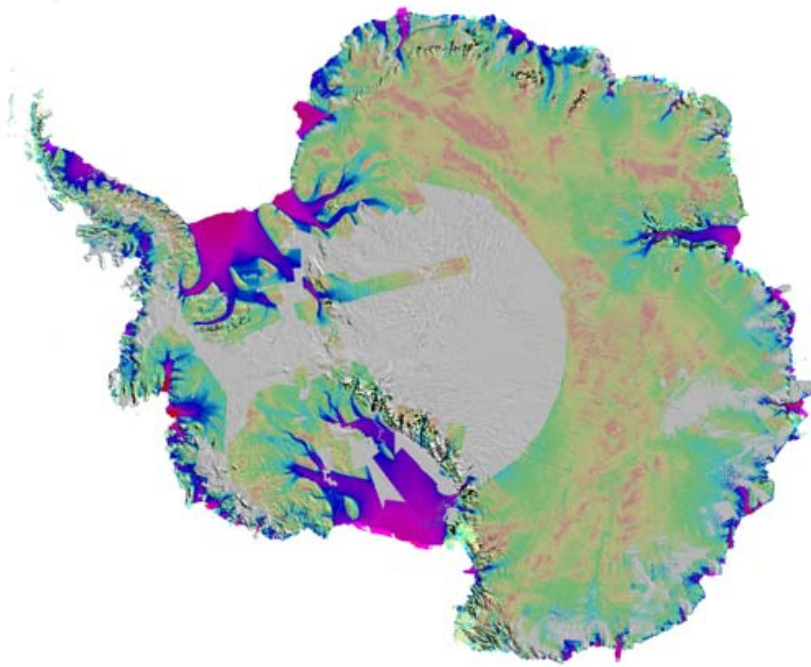
OTHER ISSUES:

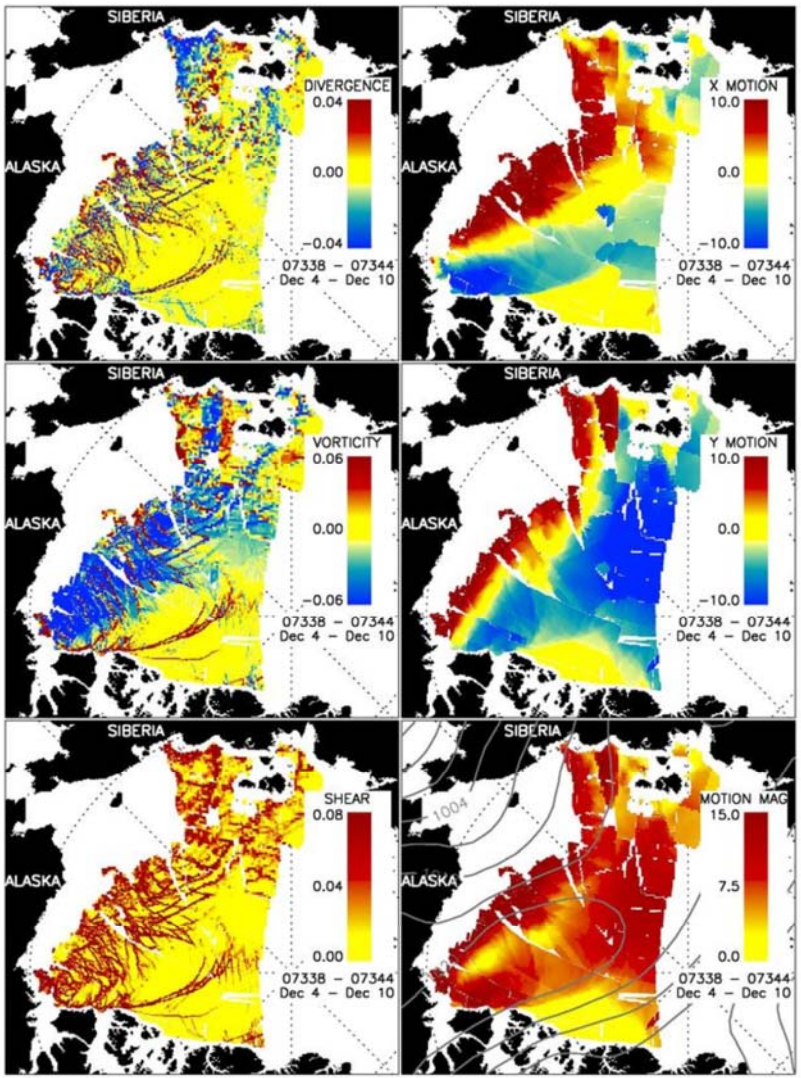
We absolutely need the help of our Canadian partners to get **Radarsat-2 coverage of the regions** south of 81 degree south. These were only partially covered in 1997 by Radarsat-1. We need a complete coverage. No other sensor can do it. Includes key glaciers e.g. Byrd Glacier.

Future sensors (Sentinel-1, ALOS PALSAR-2, DesdynI) should consider **shorter revisit cycles** in order to map grounding line positions (requires three consecutive passes at short (a few days up to one week) revisit. Grounding line positions are essential to know for ice sheet numerical modeling, monitoring of ice sheet evolution and for acccurate calculation of ice sheet losses. Currently, only ERS-1/2 has been able to map all grounding lines in Antarctica. Radarsat-1 and ALOS PALSAR only work on relatively slow moving glaciers.



ESDR (Earth Science Data Record) of Small-Scale Kinematics of Arctic Ocean sea ice

6-day deformation fields of the Arctic Ocean ice cover



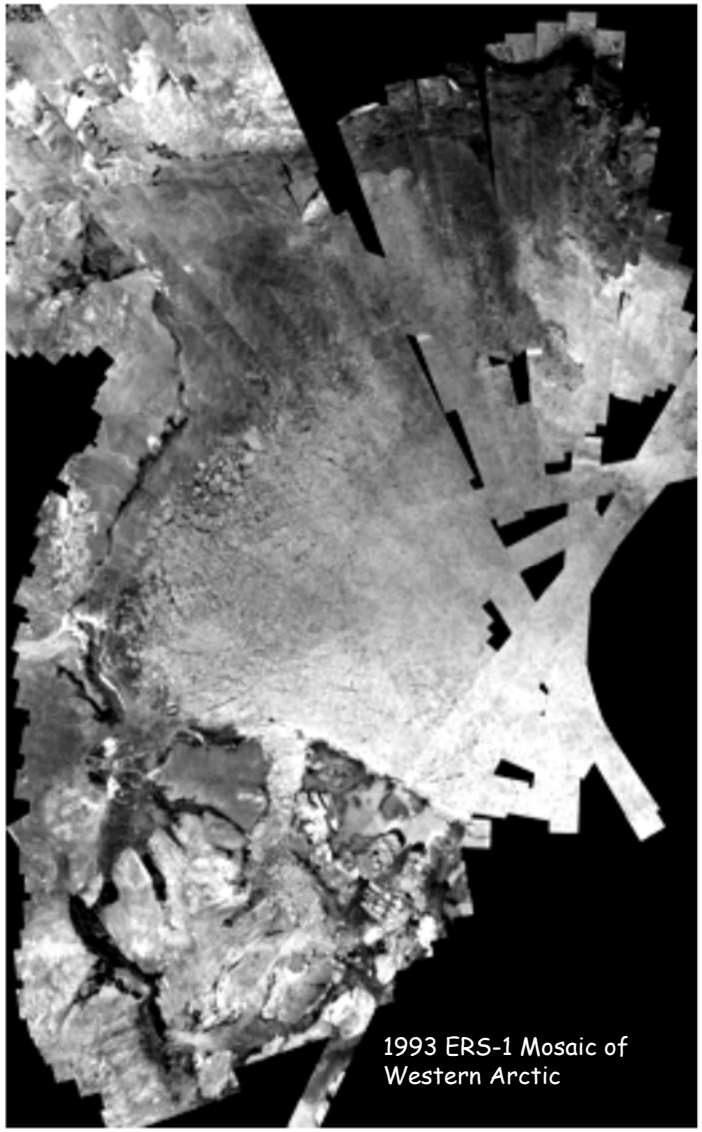
Ron Kwok, Jet Propulsion Laboratory

Don Atwood, Alaska Satellite Facility

Description and Objectives

- To produce fine-scale sea ice motion ESDRs for the years 2004 through 2008. These products will add to the 7-year record of RADARSAT-1 data.
- To produce 3-day ice motion ESDRs of the northern Bering Sea from 1997-2008.
- To produce a record of bi-weekly high-resolution (100 m) image mosaics of the Arctic Ocean from 1991-2008 using available ERS-1, ERS-2, and RADARSAT-1 SAR imagery.
- To distribute, archive, and provide user services to promote and support the wide-spread use of these ESDRs.

ESDR (Earth Science Data Record) of Small-Scale Kinematics of Arctic Ocean sea ice



Data Sources

- 1992-1997: ERS-1 and ERS-2 Imagery
- 2004-2007: RADARSAT-1 ScanSAR
- 2007-present: Envisat ScanSAR, ALOS

Data Products/Services

- Sea ice trajectories
- Time-varying deformation (strain rates) of ice parcels at length scales of ~5 km
- Backscatter distribution and Multiyear Ice Classification with these ice parcels
- Gridded 3-day products of motion and deformation
- Monthly high-resolution image mosaics of the Arctic Ocean during winter
- Web-based distribution of data products from ASF DAAC

Duration of Project

- March 2008- March 2012

An Earth System Data Record for Land Surface Freeze/Thaw State

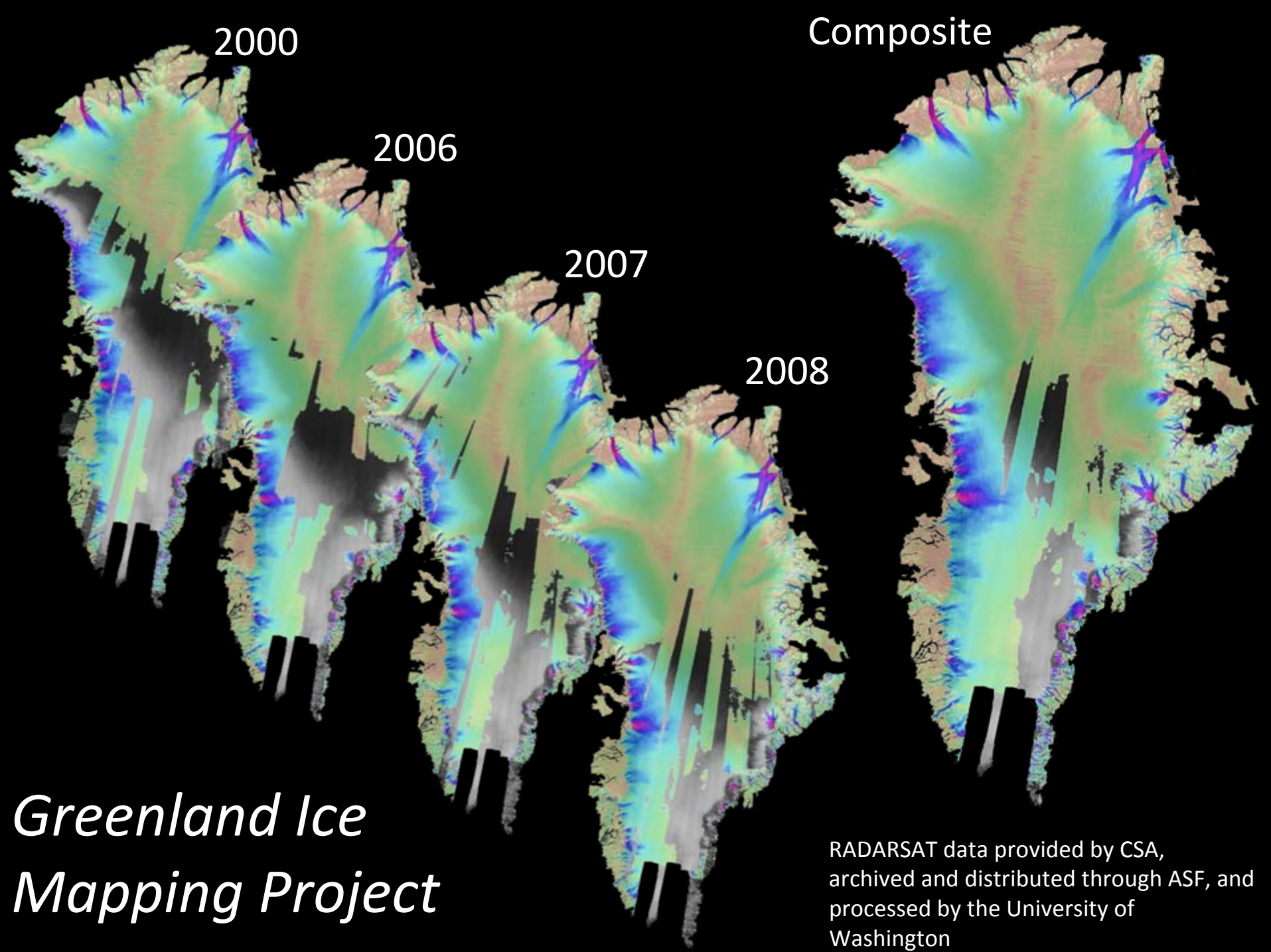
John Kimball[1] and Kyle McDonald[2]

[1]Flathead Lake Biological Station, Division of Biological Sciences, The University of Montana, Missoula MT; johnk@ntsg.umt.edu

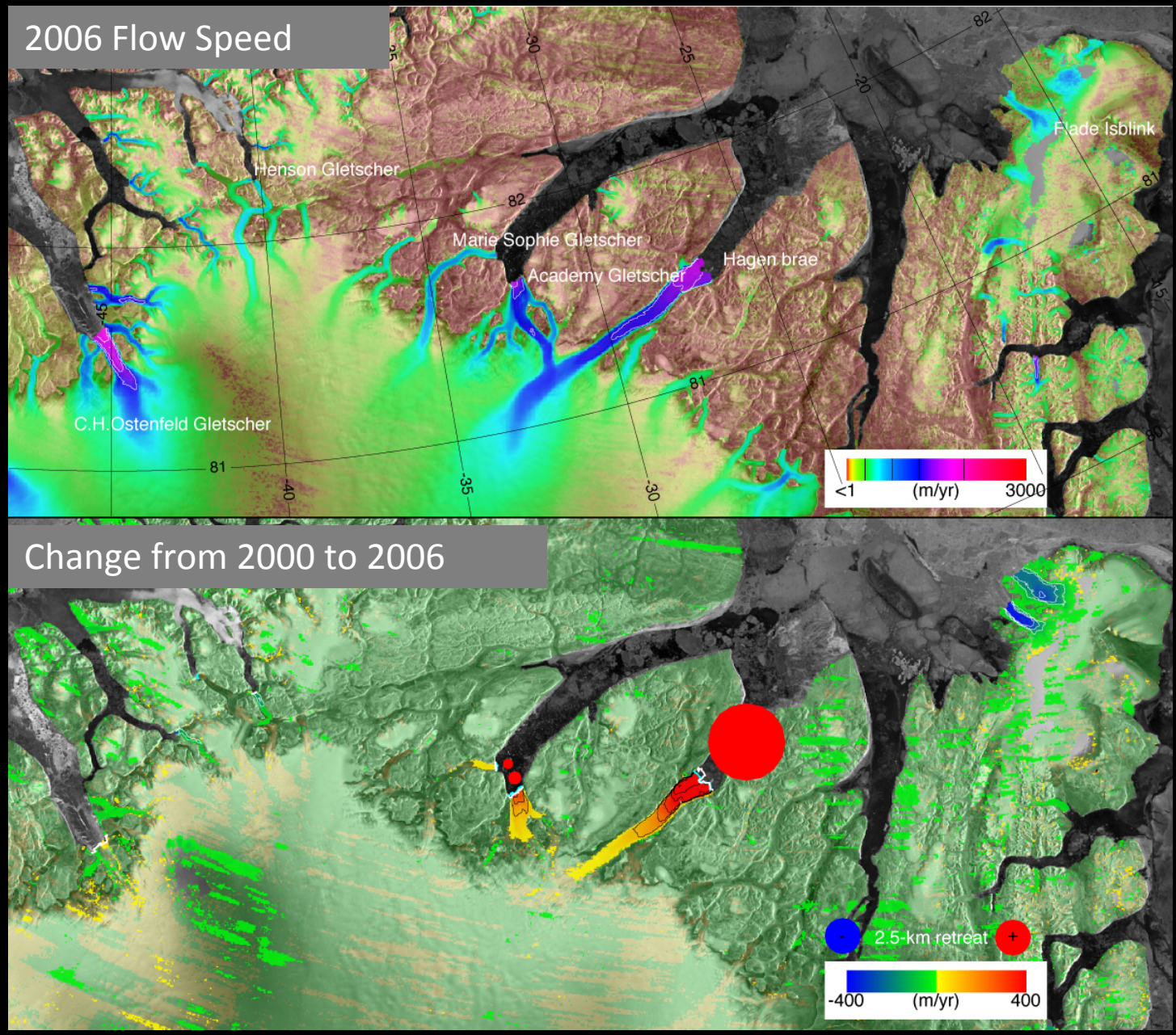
[2]Jet Propulsion Laboratory, Cal-Tech, Pasadena CA.

- **Goal: Construct a long-term (20+ yr) global earth system data record of terrestrial freeze/thaw (F/T) state dynamics;**
- **Approach: Temporal change classification of satellite multi-frequency active/passive microwave remote sensing records including SMMR, SSM/I, AMSR-E & SeaWinds;**
- **Accuracy documentation using global weather stations with dynamic QC & metadata;**
- **Potential Applications: Climate change assessment; water, energy & carbon cycle impacts;**
- **Planned data releases: 2009, 2011 & 2012;**
- **Product formats: polar and global EASE-grid projections; 25-km resolution postings; EOSDIS-HDF formatting.**
- **Data distribution through project website (http://freezethaw.ntsg.umt.edu) & NSIDC DAAC.**

NASA MEaSUREs


2000
2006
2007
2008
Composite
Greenland Ice Mapping Project
RADARSAT data provided by CSA, archived and distributed through ASF, and processed by the University of Washington

Northern Greenland Glacier Speed Change – 2000 to 2006



Other Relevant Items for IPY STG

- ALOS-TDRSS – NASA/JAXA LOA on operational use of TDRSS to downlink ALOS data. Operations expected early 2010. Simulations show that provision of a second 240Mbps downlink has significant impact on potential acquisition plan.

- Operation IceBridge – airborne campaigns to Arctic and Antarctic to bridge ICESat-1 observations to ICESat-2. Plan is for twice per year, both poles. Prime emphasis is on LiDAR, but other instruments are to be manifested. 1st campaign to Greenland April 2009.

- Decadal Survey Tier 1 Mission Status
  1. ICESat-2, LiDAR follow-on to ICESat-1
     - in formulation,
     - Science Definition Team Selected,
  2. DESDynI, L-band InSAR and multibeam LiDAR
     - in pre-phase A,
     - LiDAR & InSAR on separate spacecraft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