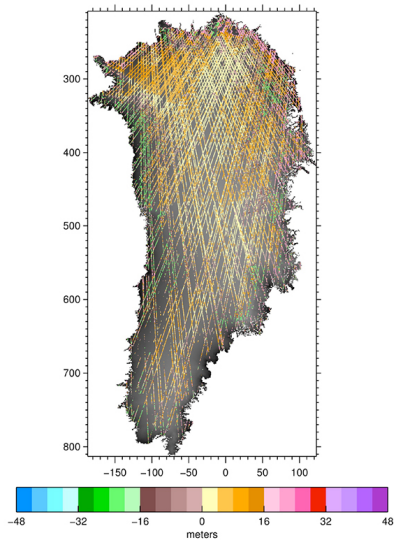
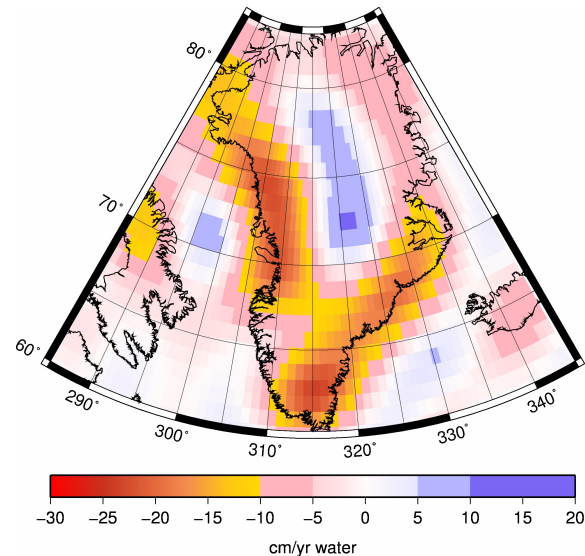
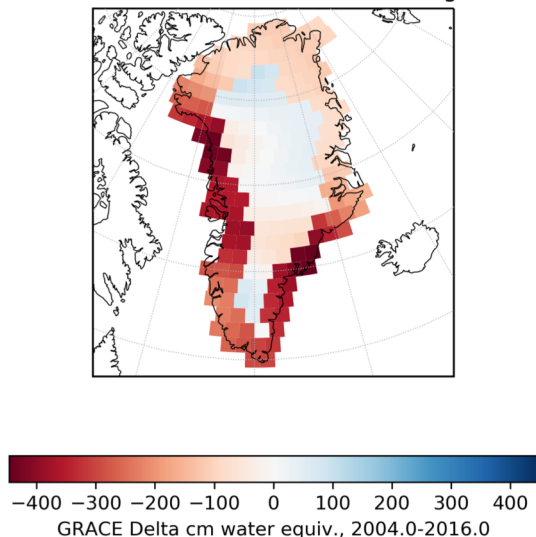


# The Cryosphere model Comparison tool (CmCt): The Ice Sheet Model Comparison Tool for Greenland and Antarctica using various Altimetry, and GRACE Satellite Data

Erika Simon<sup>1</sup>, Sophie Nowicki<sup>2</sup>, Lori Tyahla<sup>3</sup>, Jack Saba<sup>4</sup>, John Dimarzio<sup>3</sup>, Steven Price<sup>5</sup>, Jenni Bonin<sup>6</sup>, Craig Johnson<sup>1</sup>, Bryant Loomis<sup>2</sup>, Michael Croteau<sup>7</sup>



GRACE Mascon Total Mass Change



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# Outline

- ***Motivation***
- ***Concept***
- ***CmCt Website***
- ***Submission and Output***
- ***Moving Forward***



# Motivation

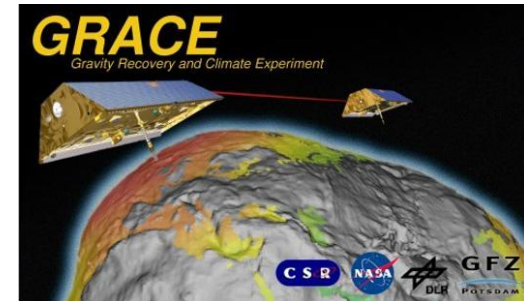
- There are currently over 2 decades of large-scale satellite observations over Greenland and Antarctica:

- ERS1/2: 1991 - 2003
- ICESat: 2003 - 2009
- GRACE: 2003 - 2016
- Envisat: 2002 - 2012



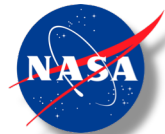
- Future missions will extend these observational time series:

- ICESat-2: 2018 – 20??
- GRACE Follow-On: 2018 – 20??
- GRACE2 2020's - ?



# Concept

- Run ice sheet model over some specified time period for which remote sensing (e.g. ICESat and / or GRACE) observations exist
- Process model output for comparison to these observations
- Process observations for comparison to model output
- Evaluate model performance relative to observations (e.g):
  - ICESat, ERS-1, ERS-2, Envisat : ice sheet surface elevation
  - GRACE : mass trends
- Calculate various qualitative and quantitative metrics to evaluate model performance





## Cryosphere Model Comparison Tool (CmCt)

Home

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▶ Data Sets

▶ Publications

Feedback

Log out

### Submit Comparison

Required fields are denoted by an asterisk (\*)

#### Reference information

Your title for this  
comparison run\*

#### Model information

Model name\*

Filename\*  no file selected

Model file format\*

Grid spacing (km)\*

Comments

Mission\*

Region\*

#### Comparison 1

Model time index\*

Variable\*

ICESat-GLAS  
year\*

ICESat Data sets\*

Add another comparison

# CmCt Website

- The Cryosphere model Comparison tool (CmCt) is a web-based data validation tool that has been developed in order to facilitate ice sheet model analysis.
- Available at <https://gsgshpcc.sgt-inc.com/cmct/>
- **ICESat** laser altimetry data and **ERS-1, ERS-2, Envisat** radar altimetry for ice sheet *surface elevation*
- **GRACE SH and Mascon solution** for *mass trend estimation*
- Evaluate model performance





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Model name\*

Filename:\*  no file selected

Model file format\*

Grid spacing (km)\*

Comments

Mission\*

Region\*

#### Comparison 1

Model time index\*

Variable\*

ICESat-GLAS year\*

ICESat Data sets\*

Add another comparison

✓ Please select  
ICESat-GLAS (2003-2009)  
GRACE (2003-2012)  
ERS1 (1991-1996)  
ERS2 (1995-2003)  
Envisat (2002-2012)

Region\*

✓ Please select  
Antarctica  
Greenland

ICESat-GLAS year\*

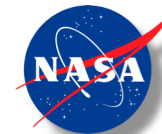
✓ Select year

2003  
2004  
2005  
2006  
2007  
2008  
2009

ICESat Data sets\*

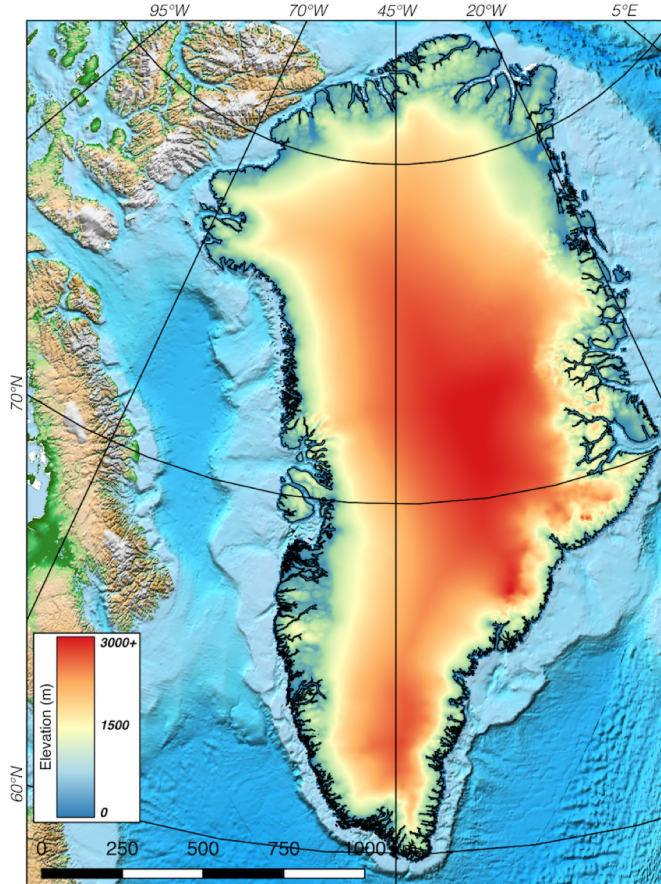
Add another comparison

✓ Please select  
WGS84 elevation - Greenland  
EGM08 Mean Tide elevation - Greenland  
EGM08 Tide-Free elevation - Greenland

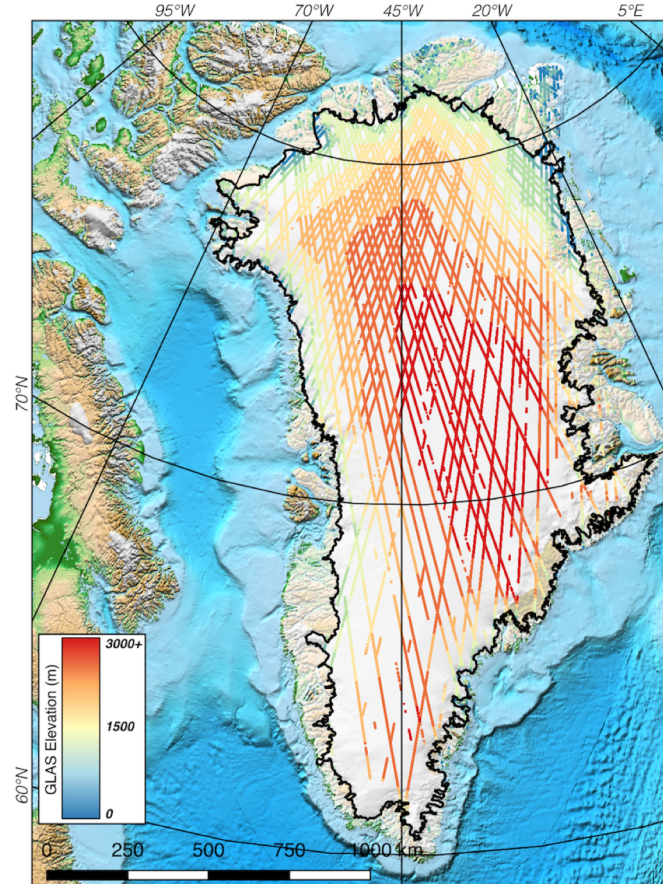


# CmCt ICESat Comparison

Input 5km model of elevations



ICESat elevations from L2D campaign



# CmCt ICESat Comparison

NASA National Aeronautics and Space Administration Goddard Space Flight Center

Search: [ ] GO  
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### Files for egsgimon?

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<input type="checkbox"/> CMCT_egsgimon7_20170705T134251.tar.gz	Jul 05, 2017 17:42
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Download

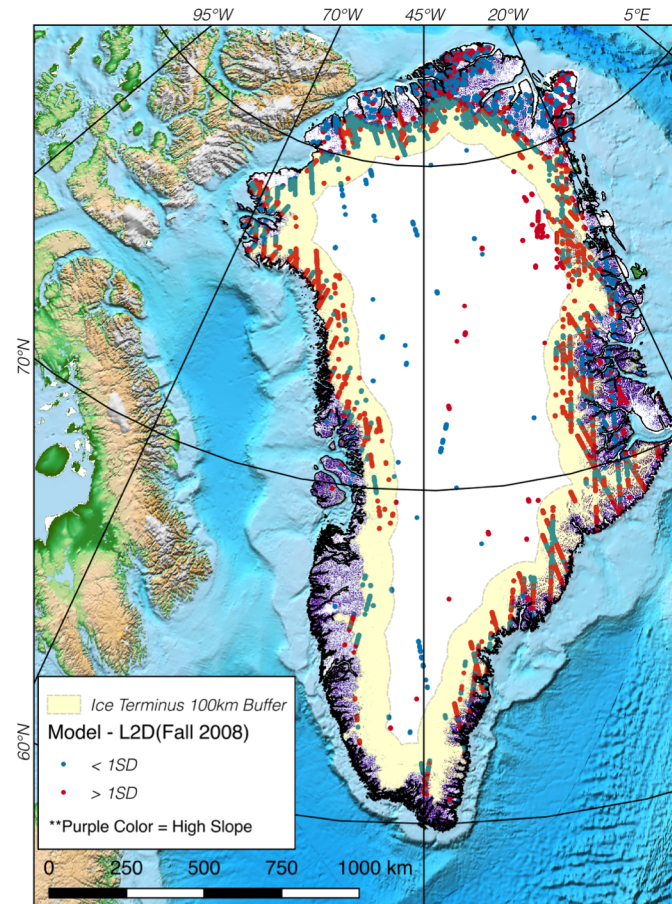
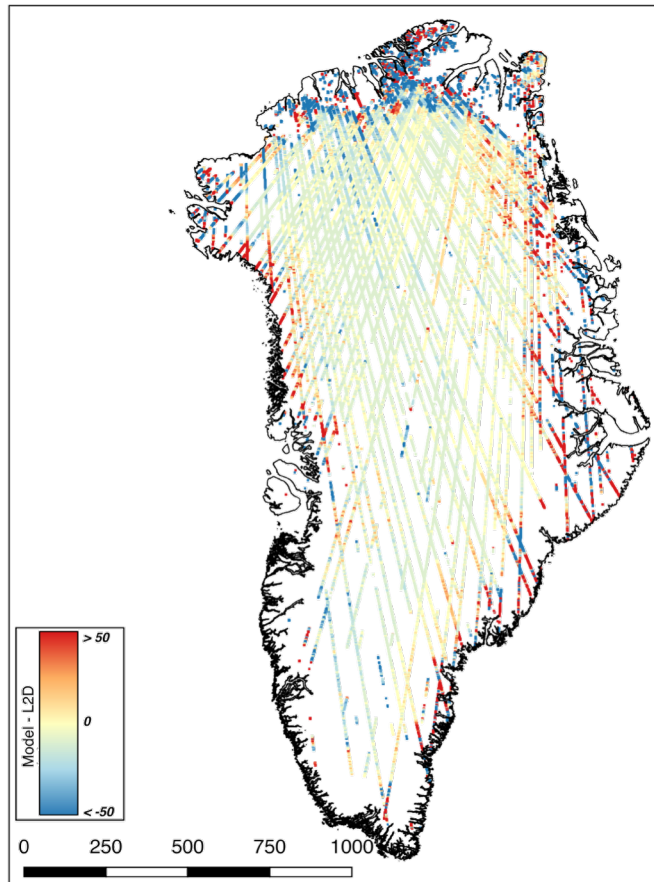
After submission, user will receive an email with a link to download the data as a zipped tar file. It will contain:

- Log file.
- Record list file.
- Netcdf grid.
- Histogram file.





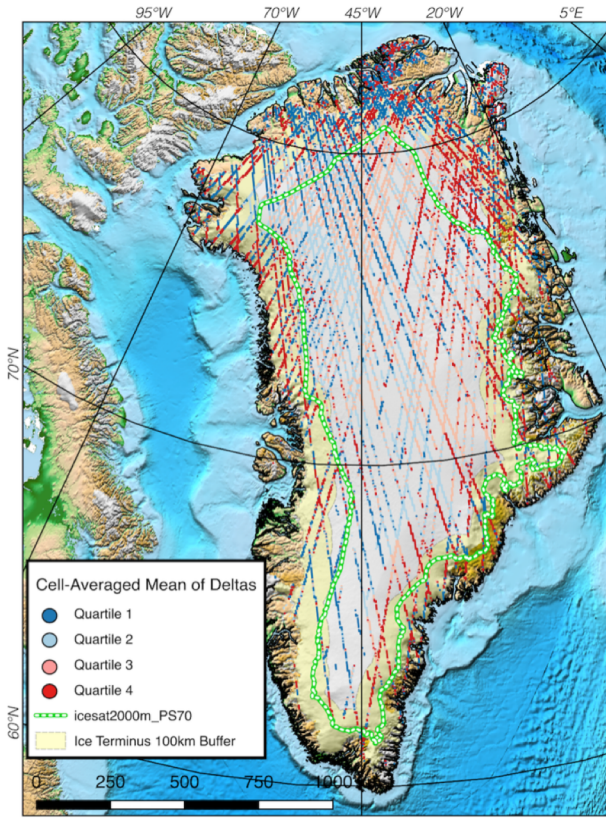
# CmCt ICESat Comparison



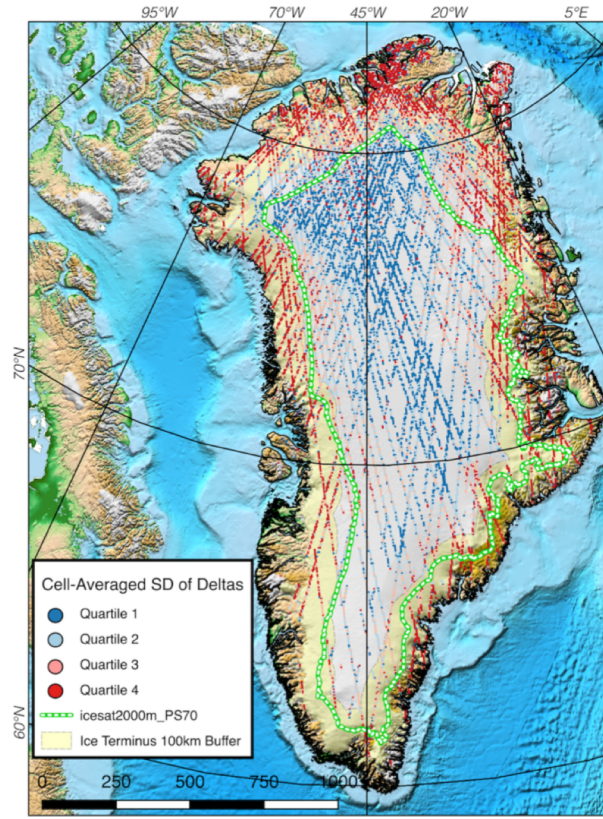
- Log file.
- **Record list file**
- Netcdf grid.
- Histogram file.



# CmCt ICESat Comparison



Mean of the model/observation deltas



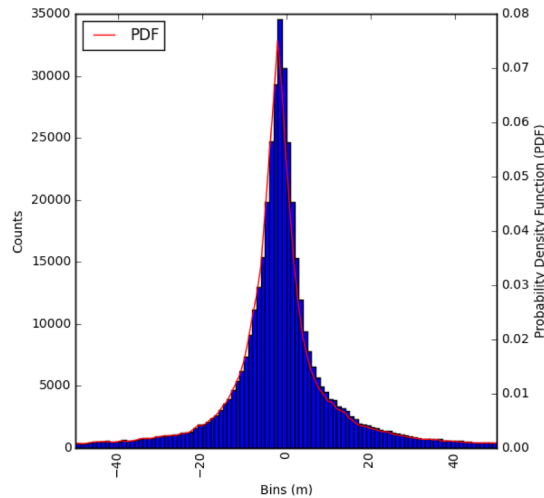
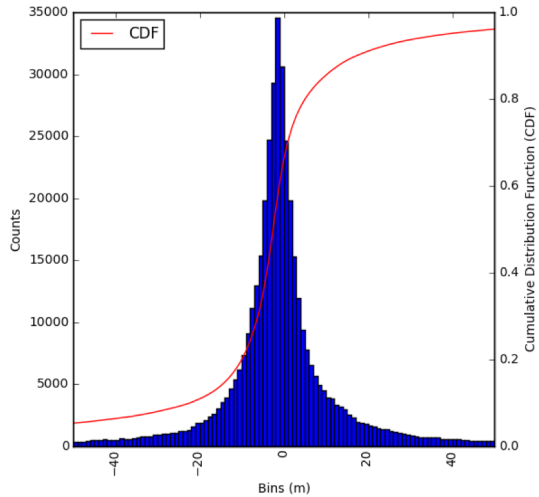
Standard deviation of the model/observation deltas.

NetCDF with mean and standard deviations of Deltas per cell.

- Log file.
- Record list file.
- **Netcdf grid.**
- Histogram file.



# CmCt ICESat Comparison



Histogram text file with 1 meter bins.

- Log file.
- Record list file.
- Netcdf grid.
- **Histogram file.**

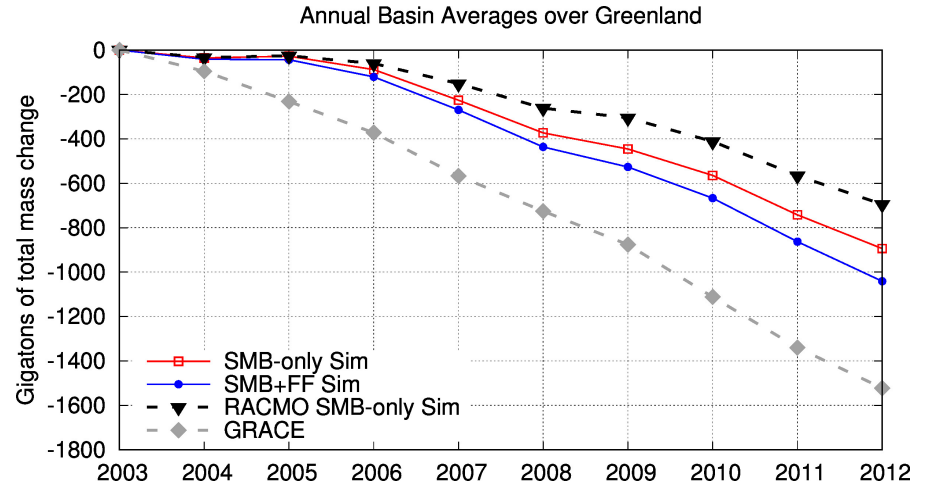
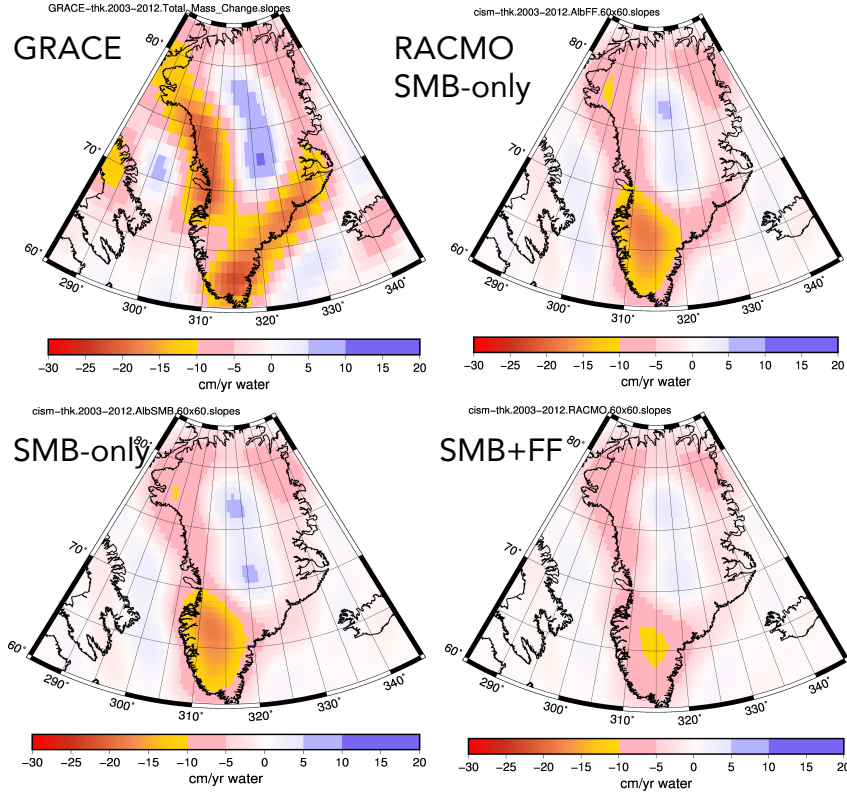


# GRACE Spherical Harmonics Comparison

- Convert the model data to a more “GRACE-like” resolution.
- GRACE sees only mass anomalies.
- Calculate the mass change in each individual year and change trend over the 2003-2012 period.
- The resolution of the processed model output is further reduced. The uniform grid is being converted to spatial harmonics at degree-and-order 60.
- Calculate various qualitative and quantitative metrics to evaluate model performance



# GRACE SH Comparison Total Mass Change

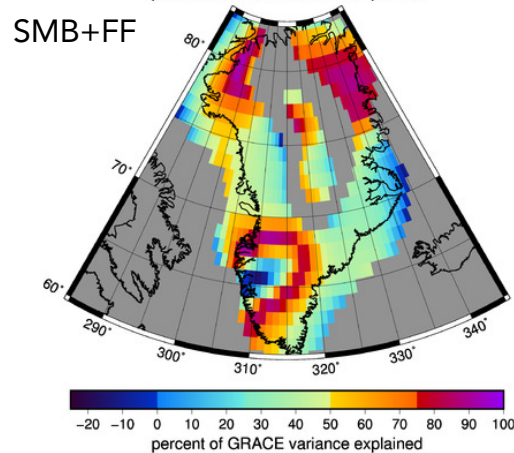
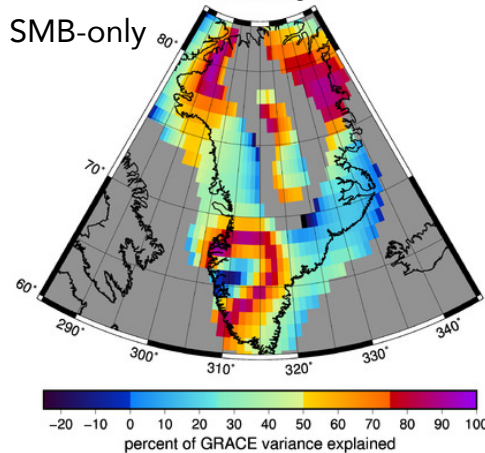
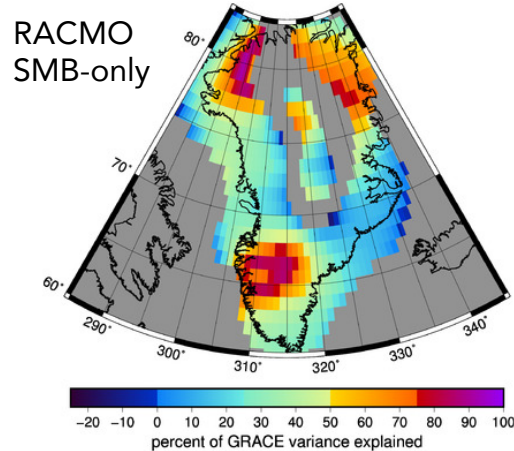
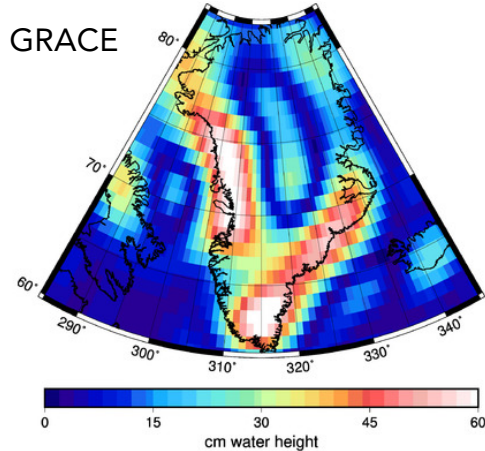


Observed and modelled, cumulative, whole-ice-sheet mass trends

Total mass change trend over the 2003-2012 period



# GRACE SH Comparison Percent Variance

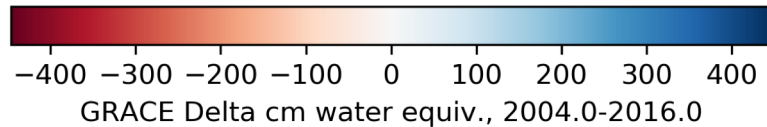
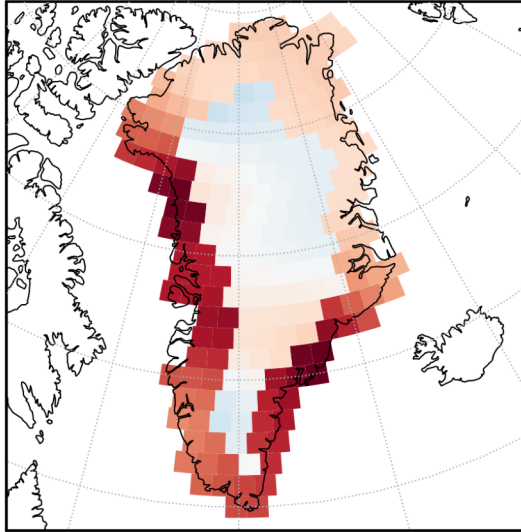


Grace percent variance plot and percent variance explained by the various models.

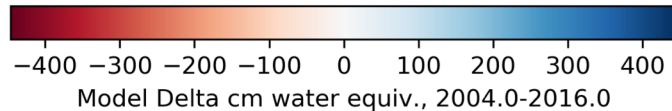
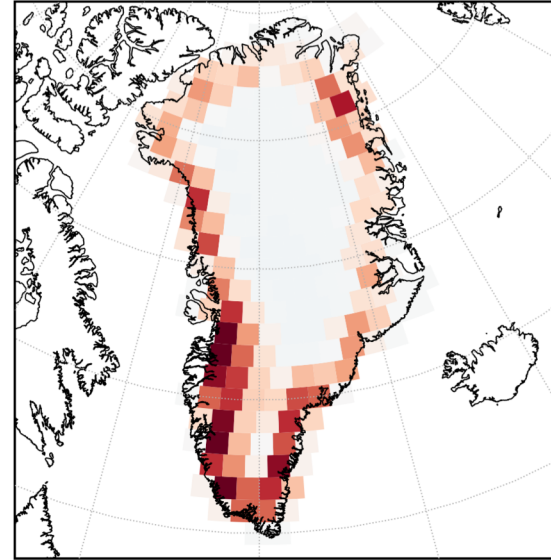


# GRACE MASCON Comparison

GRACE Mascon Total Mass Change

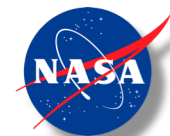
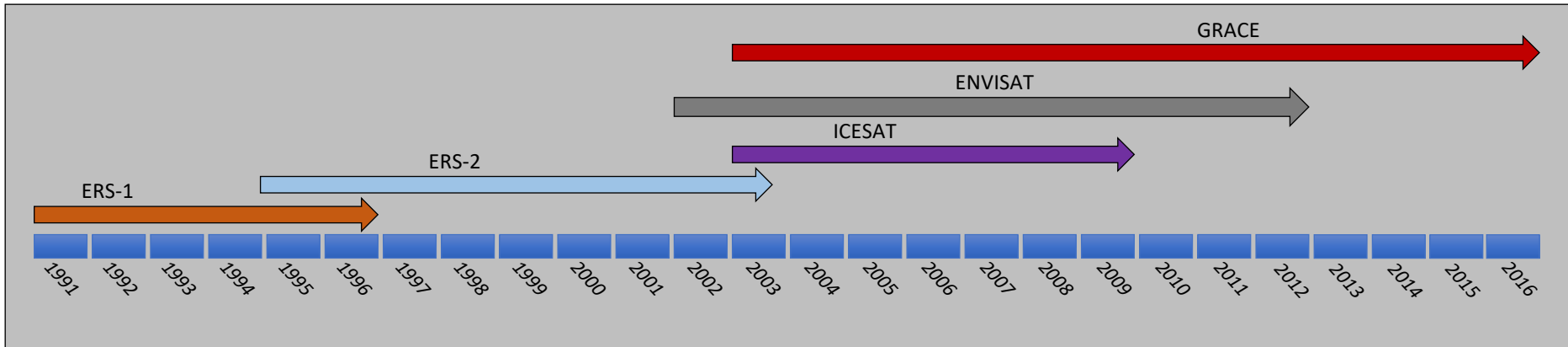


Ice Sheet Model Mascon Total Mass Change



# Other Available Datasets

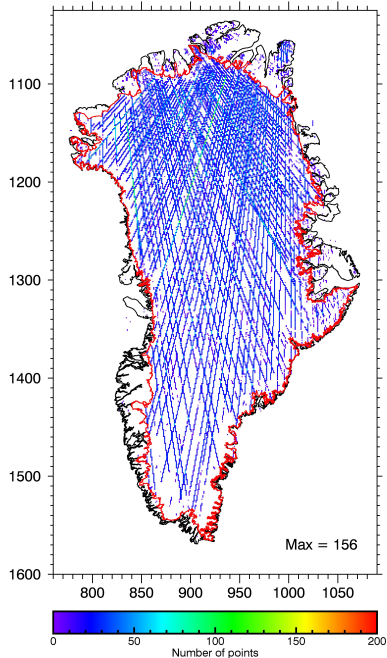
- Datasets from the ERS-1, ERS-2, and ENVISAT are also available for comparison.
- ERS and ENVISAT had a lower pulse rate and shorter repeat period, so data is sparser than ICESAT.
- However, they operated continuously to get monthly repeats over a long time span.



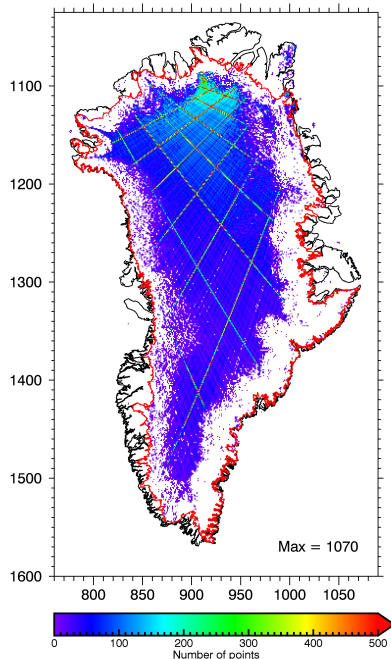


# Available Radar Altimetry Datasets

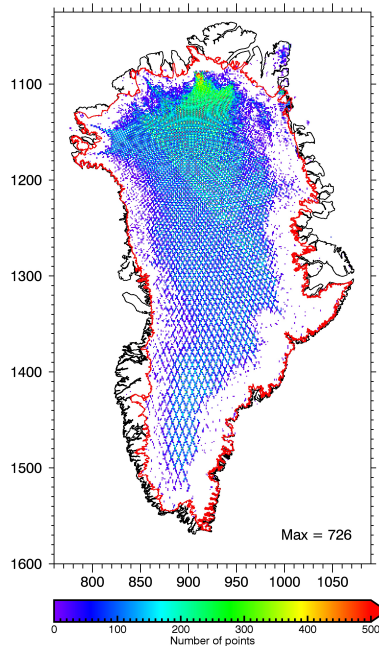
GLAS (L3C, 2005-05-20 to 2005-06-23)  
Number of points per tile, 5 km grid



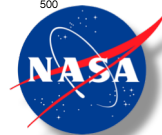
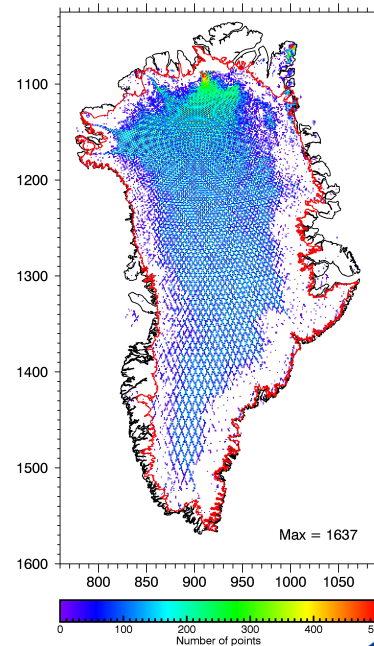
ERS1, 1994  
Number of points per tile, 5 km grid



ERS2, 1998  
Number of points per tile, 5 km grid



Envisat, 2007  
Number of points per tile, 5 km grid



# Moving Forward

- Adding other datasets (Ice velocity, Hi-Res Airborne Altimetry from IceBridge, Follow-on missions, SMB and Velocity comparisons)
- Quality Control capabilities:
  - Quick QC of data before submission
  - Check for ISMIP6 requirements (names, units, etc.)
  - Regridding to ISMIP6 requirements
- Multiple model submission and model to model comparison tools (Taylor diagram, etc.)
- Batch upload
- Plotting and interactive plotting capabilities
- Regional Comparisons
- More flexibility in the space and time intercomparing
- What is of interest to the community?

