Downscaling Mass Balance components with ICESat, GRACE, and SMB

Mike MacFerrin[1,2], William Colgan[2],
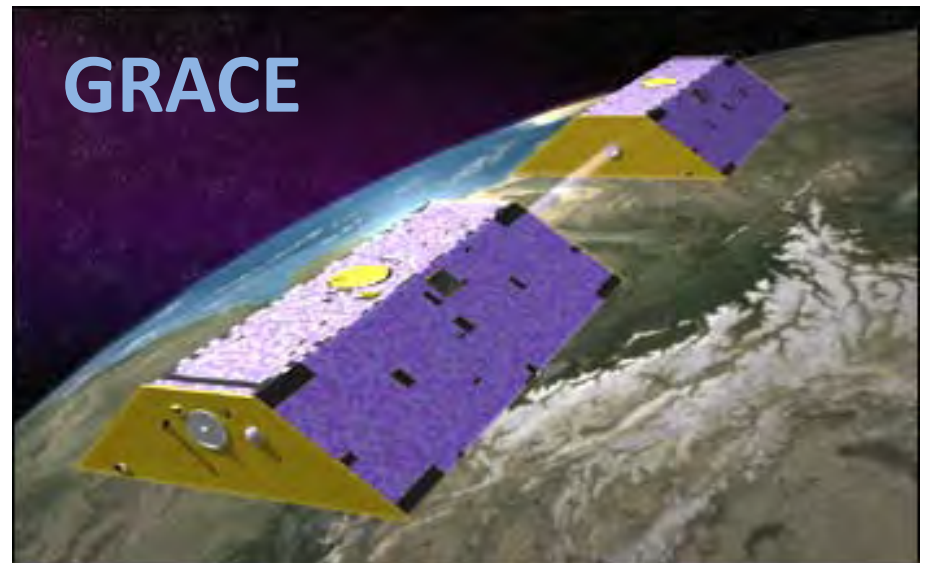Waleed Abdalati[1,2,3], Ted Scambos[4], Scott Luthcke[5]

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[4] National Snow & Ice Data Center (NSIDC)
[5] NASA Goddard Space Flight Center (GSFC)

Project Objectives

- Partition components of ice sheet Mass Balance equation with combined satellite observations
  - **GRACE dM/dt**
  - ICESat dH/dt
  - Surface Compaction models
  - SMB models (van den Broeke, et al)
- Resample dM/dt to sub-GRACE resolutions given higher-resolution dh/dt and SMB inputs
  - Propagate errors in dataset resampling
  - Assimilate data in "backward" analysis of high-level results, then "forward" model the data in low-level GRACE iterations
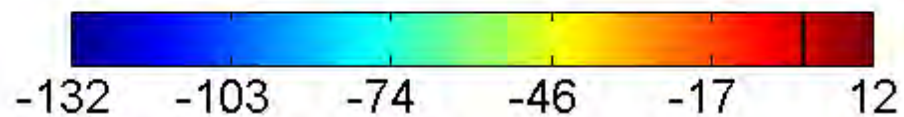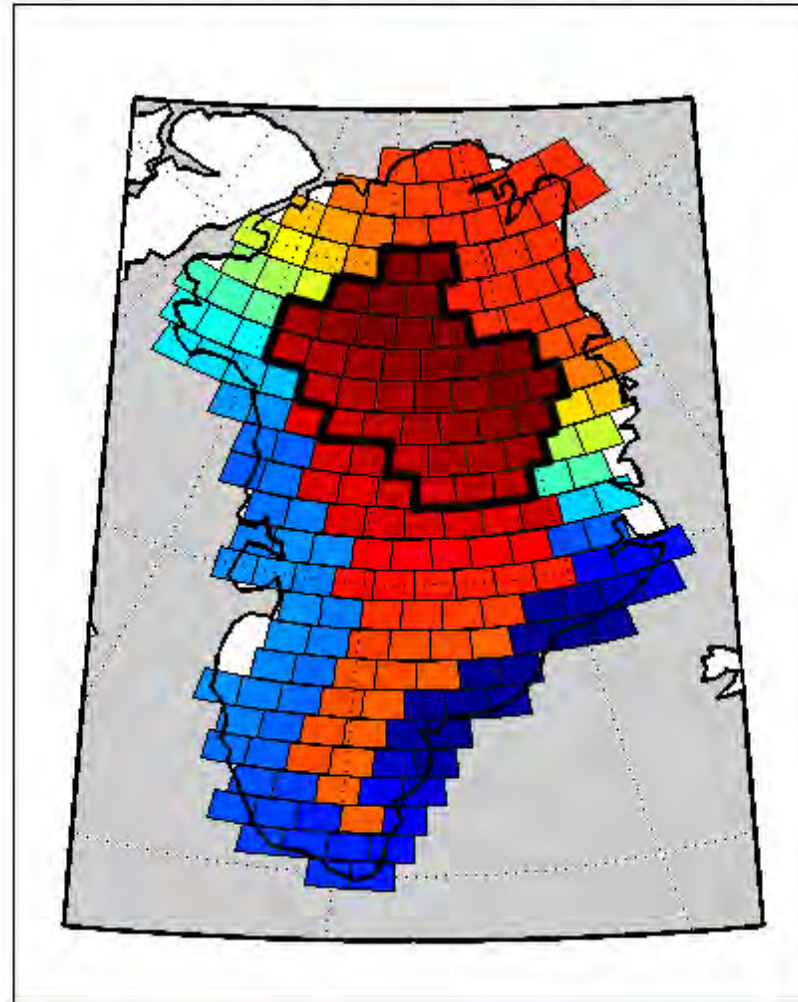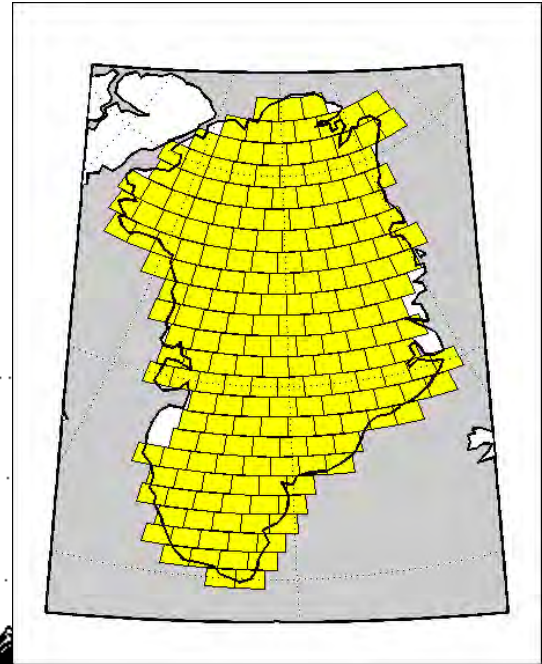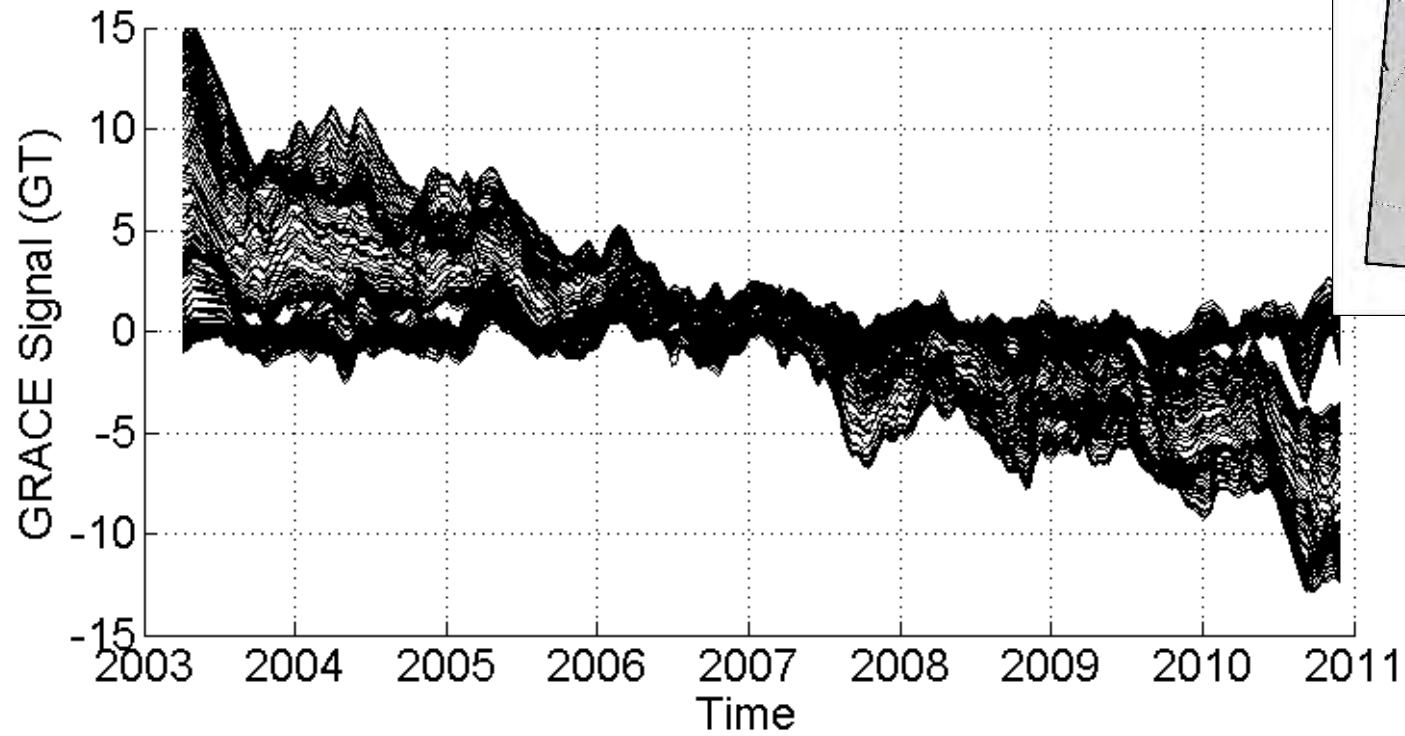
Luthcke GRACE data: De-trending individual mass change values
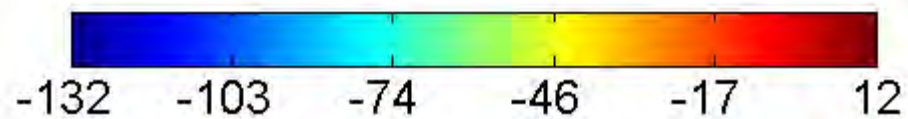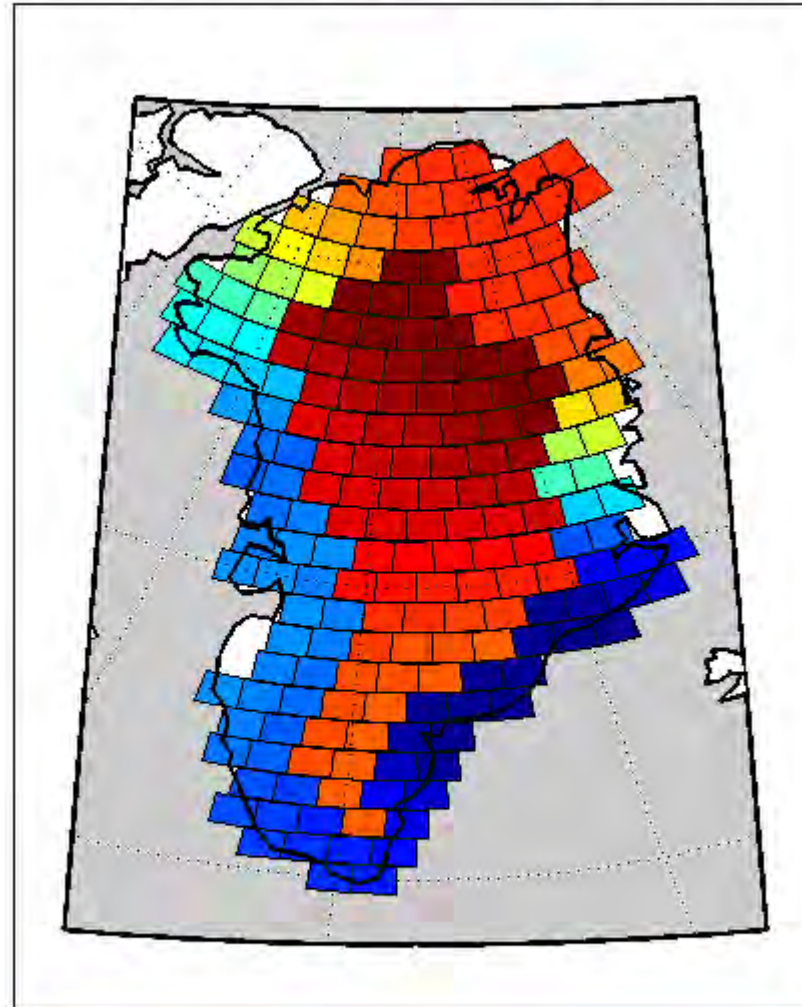
2004-2008 GRACE (kg/m^2/a)

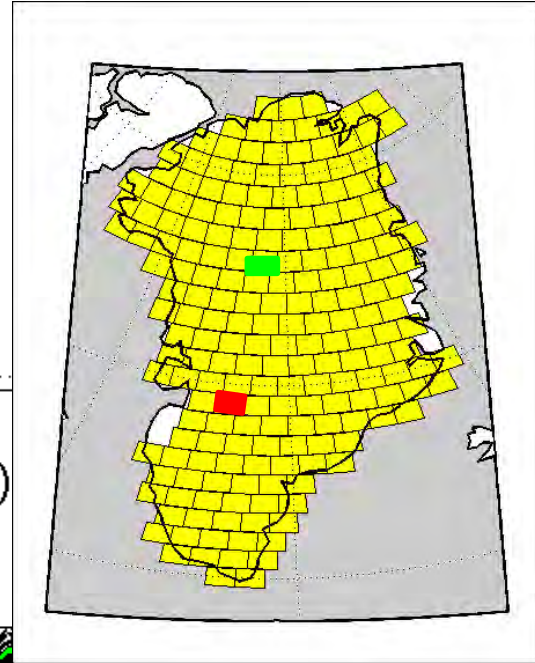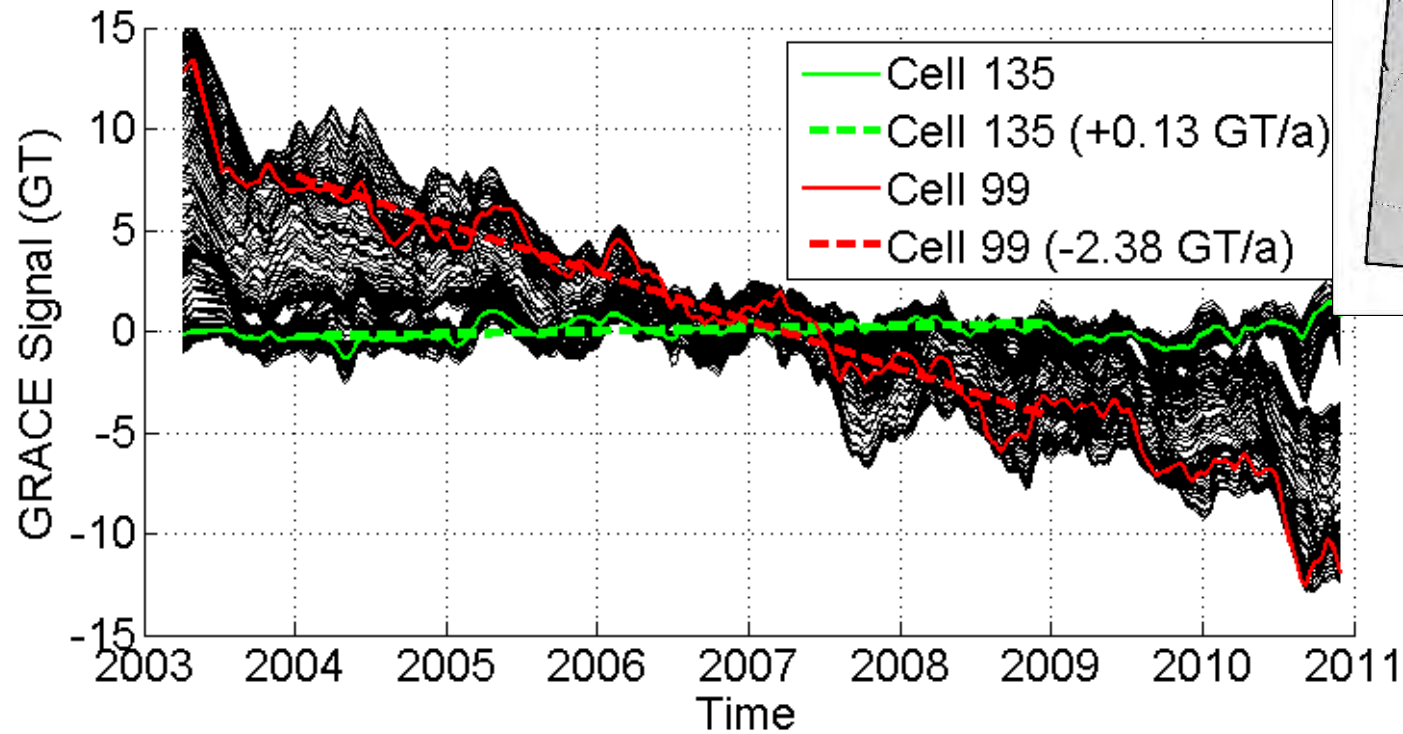# Luthcke GRACE data: De-trending individual mass change values
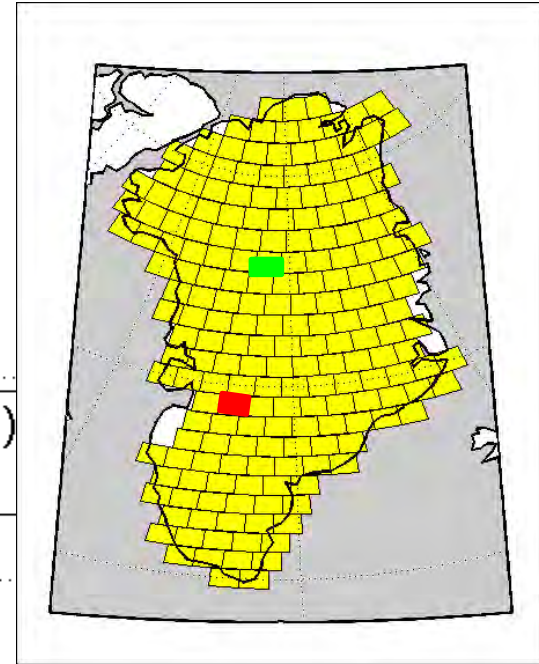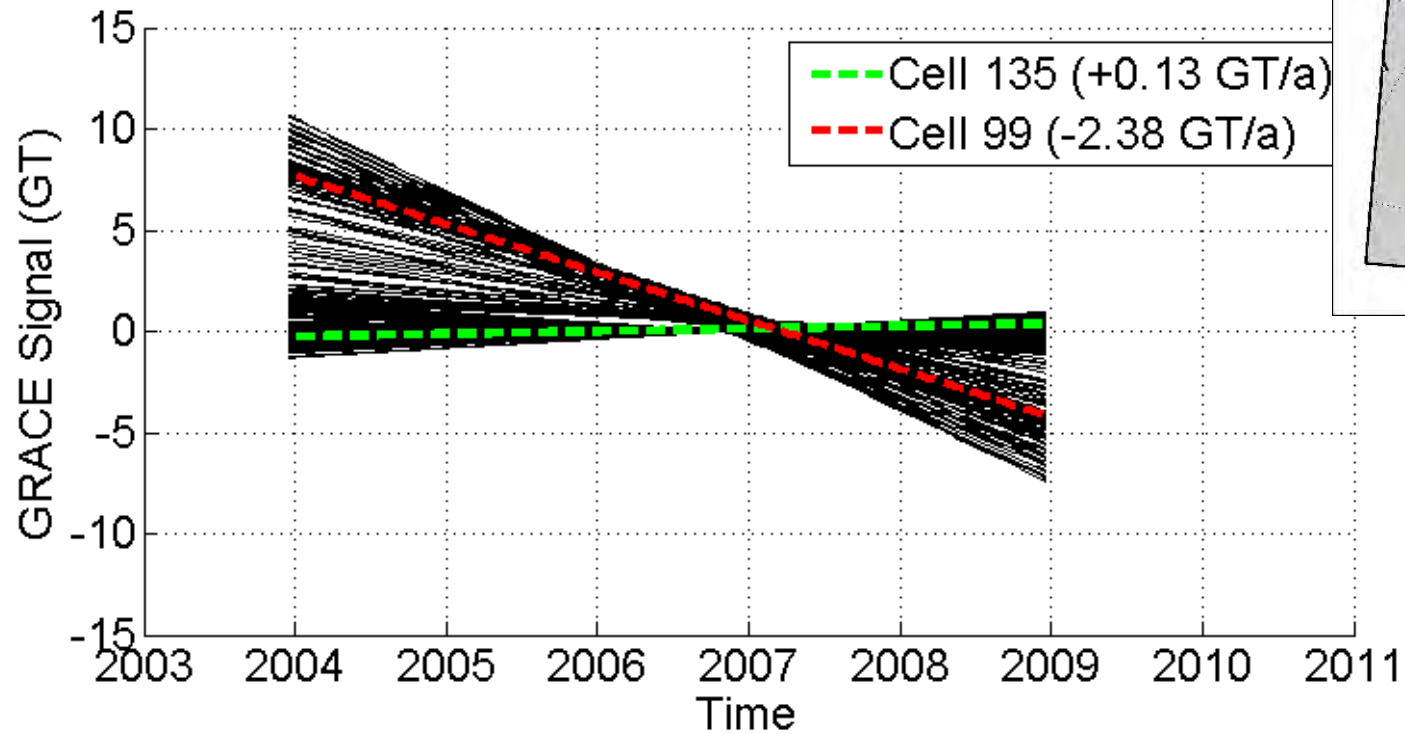

2004-2008 GRACE (kg/m^2/a)

Luthcke GRACE data: De-trending individual mass change values

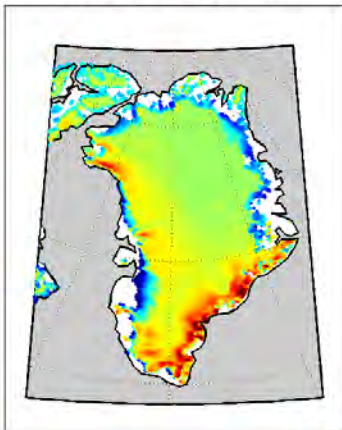# Luthcke GRACE data: De-trending individual mass change values

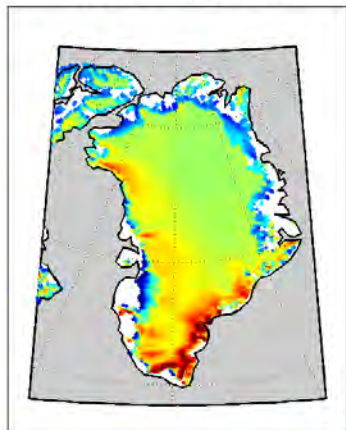# Luthcke GRACE data: De-trending individual mass change values

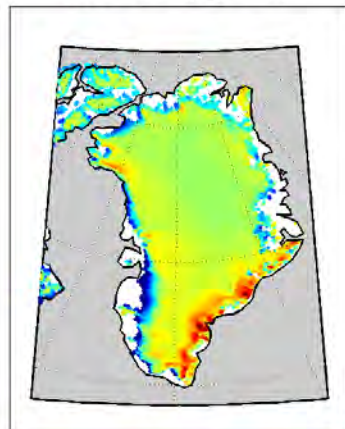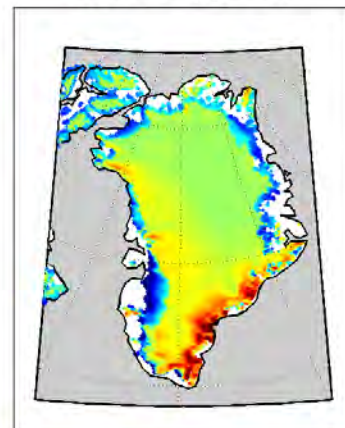# Van den Broeke SMB data: Interpolate to GRACE resolution

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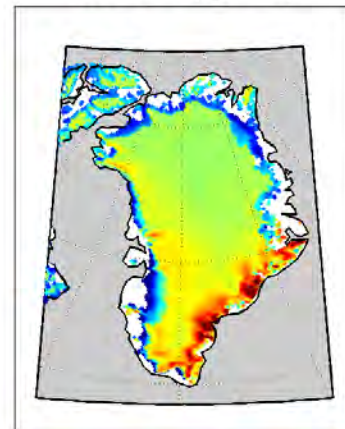
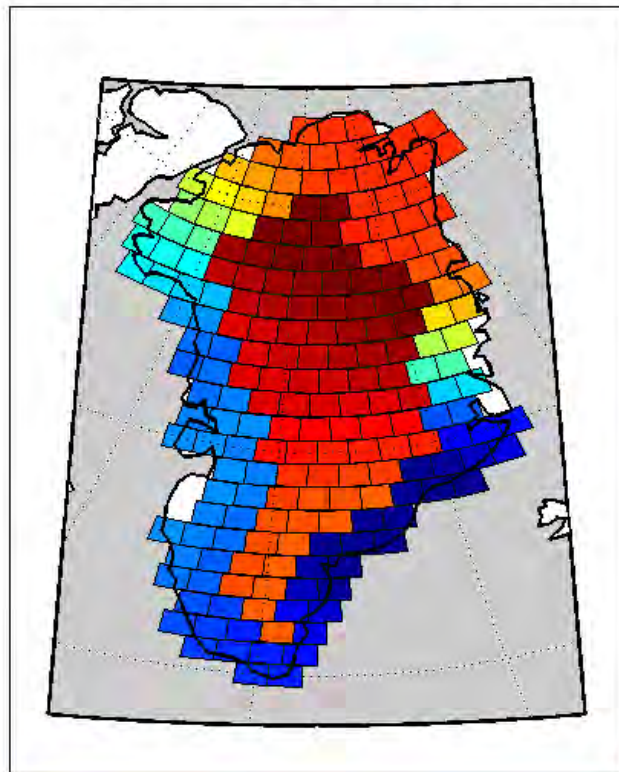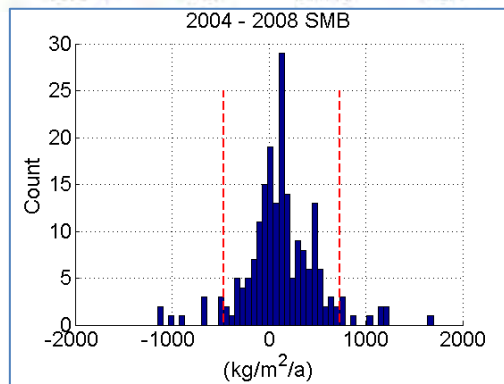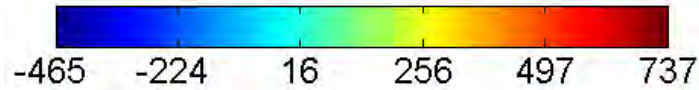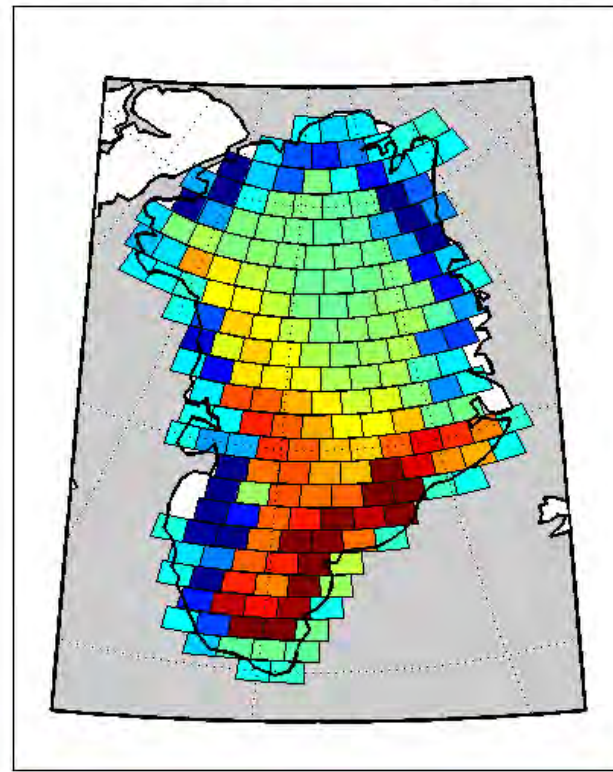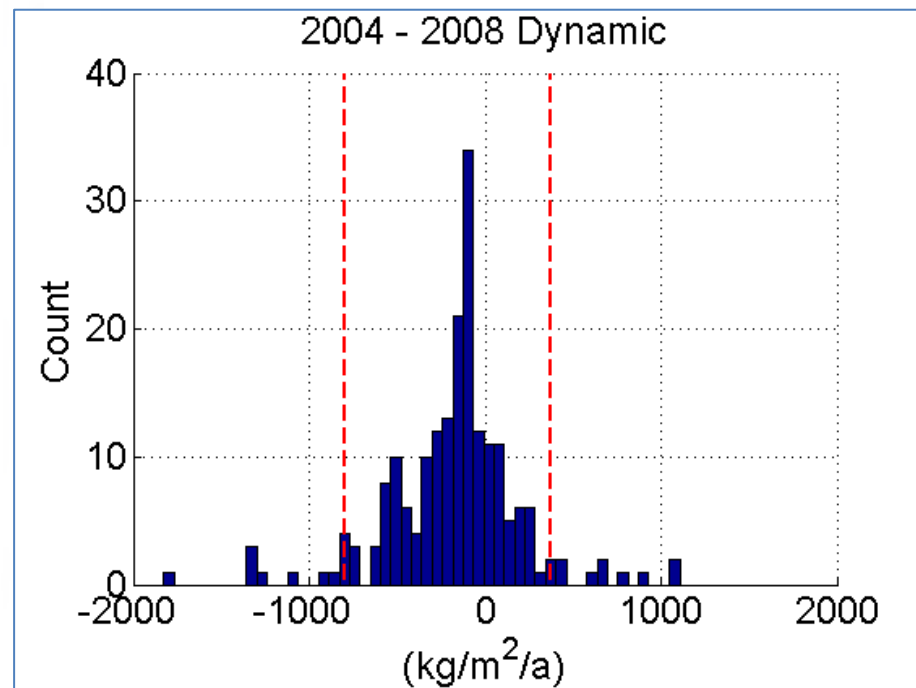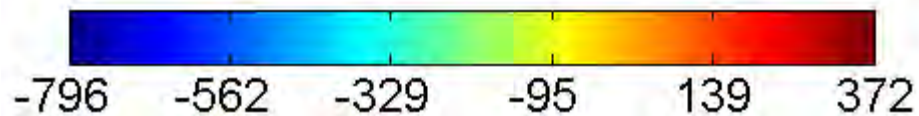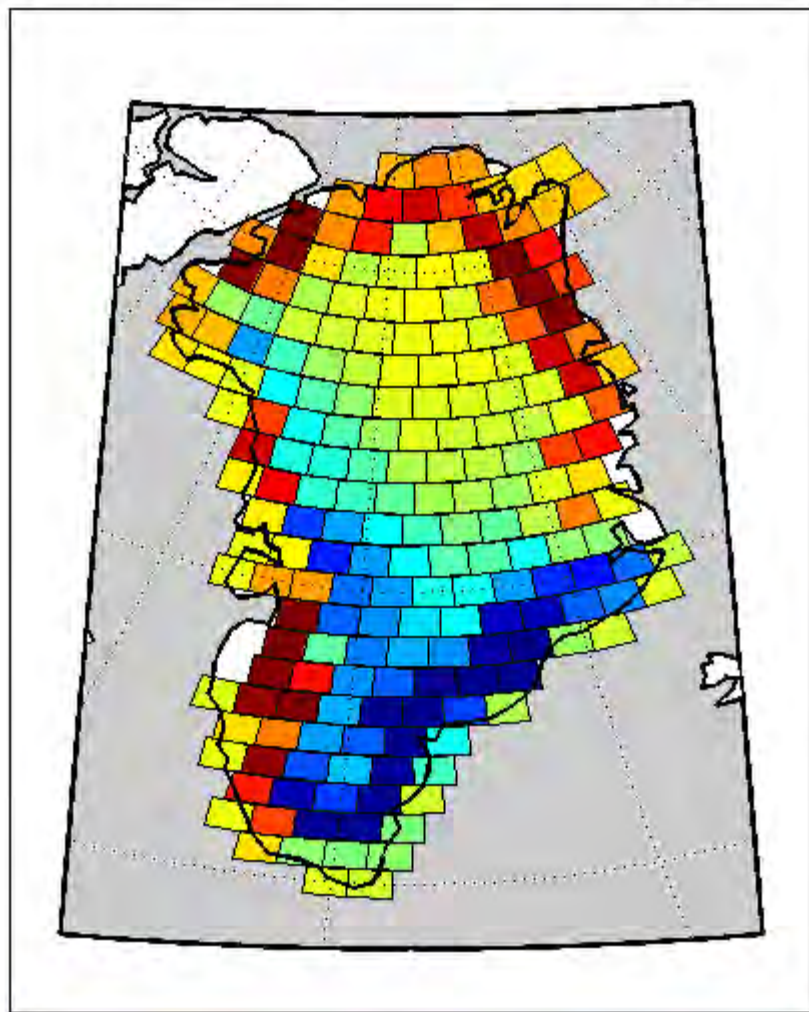# Differencing SMB mass change from GRACE mass change
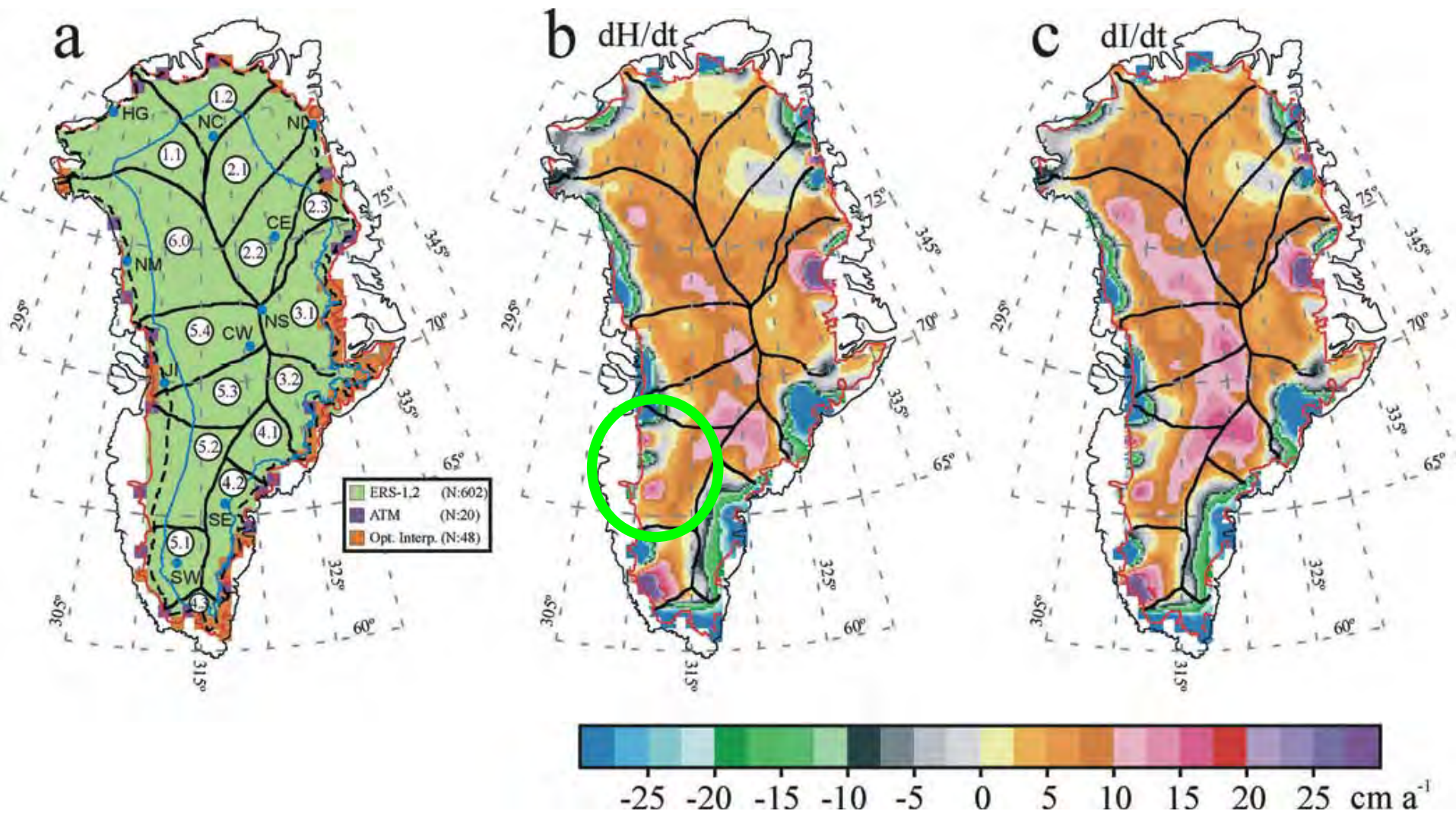

2004-2008 GRACE (kg/m^2/a)
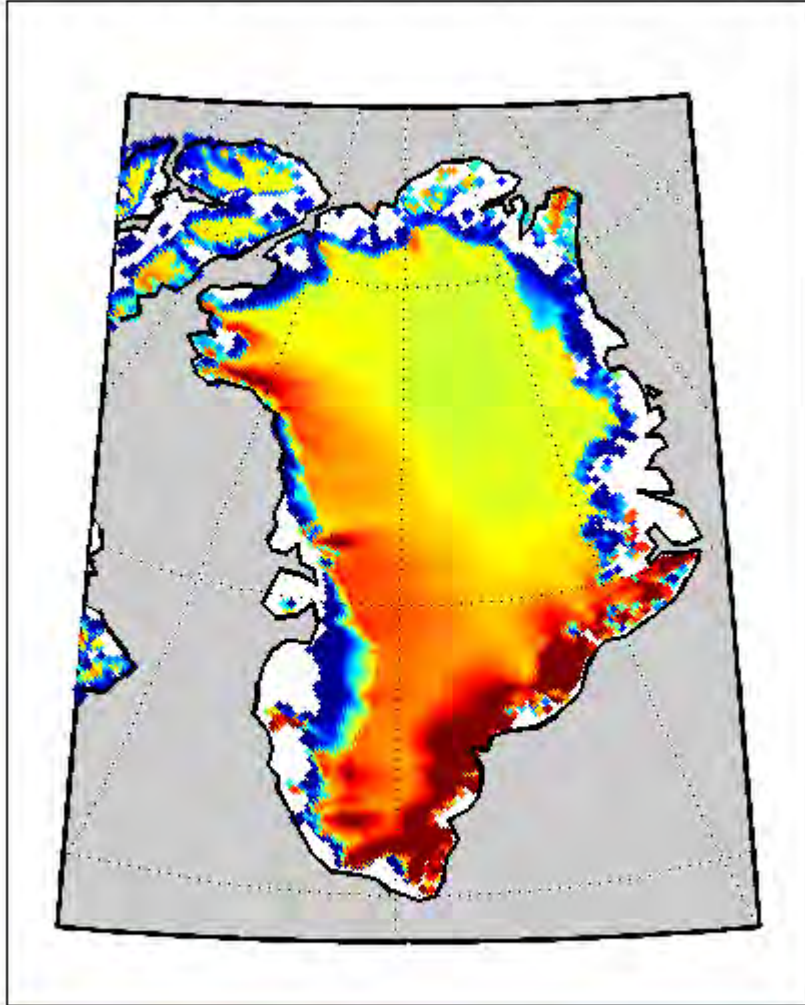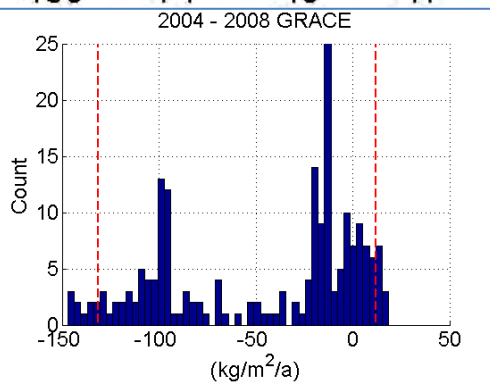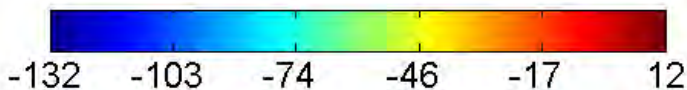
2004-2008 SMB (kg/m^2/a)

Differencing SMB mass change from GRACE mass change
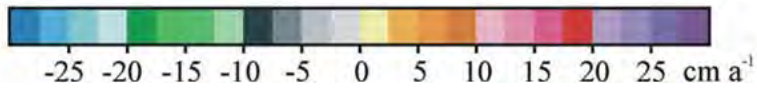

Dynamic = GRACE - SMB $(kg/m^2/a)$

Zwally dH/dt

ICESat/GRACE assimilation

2004-2008 GRACE (kg/m^2/a)

-132 -103 -74 -46 -17 12

-25 -20 -15 -10 -5 0 5 10 15 20 25 cm a^{-1}
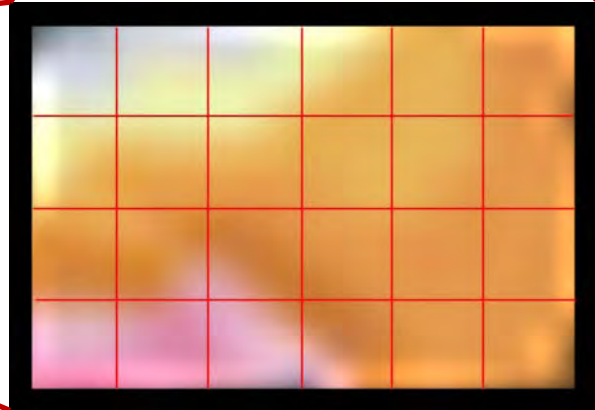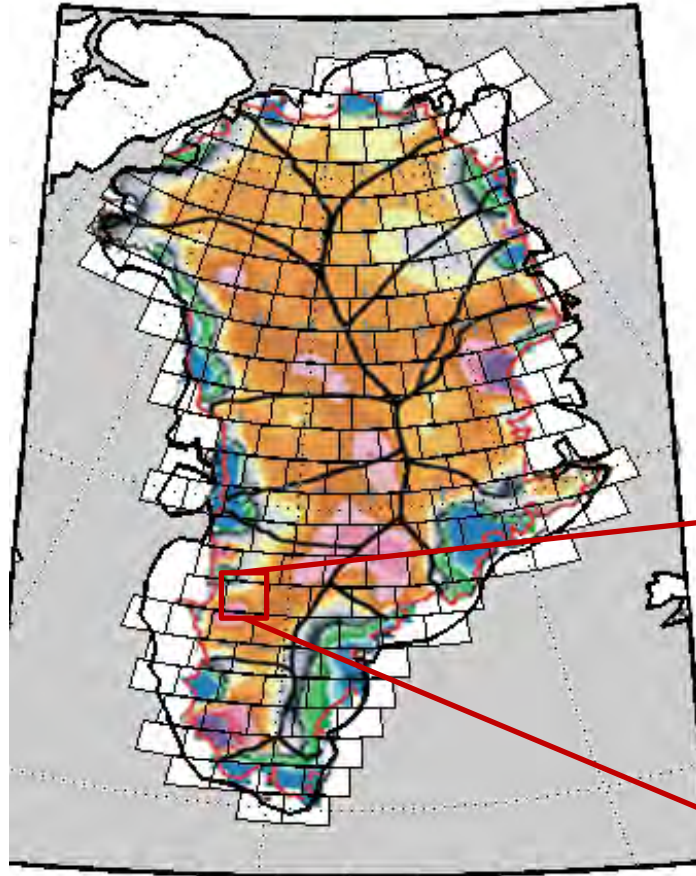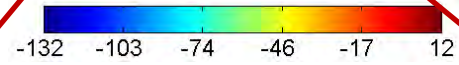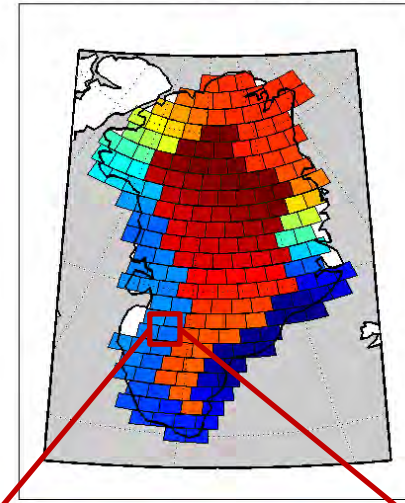
Future Work

- Complete "backward" data assimilation in Greenland

- "Forward"-model dh/dt and SMB with low-level GRACE data, compare results with "backward" model

- Extend analysis to Antarctica (Patagonia, SE Alaska?)

- Prepare algorithms for future ICESat-2 (2016) and
  GRACE-2 (20XX) missions

S.B. Luthcke et al., NASA GSFC, code 698