Fri. Mar. 30, 2018

- Finish "Part 1" of Digital Image Processing
  using slides from Wednesday

- Additional Lidar Examples
  - Glacial Features and Landslides under forest canopy,
- Satellite Gravity Measurements (GRACE, GRAIL)
- On Monday:
  - Map Projections
  - Linear Unmixing

For Wednesday of next week read:

- Reading: Chapter 9 ("Environmental" Remote Sensing")
  - Once again -- Satellites old but principles still apply

Digital Image Processing Part 1.
Use slides posted for Wednesday

LIDAR Examples

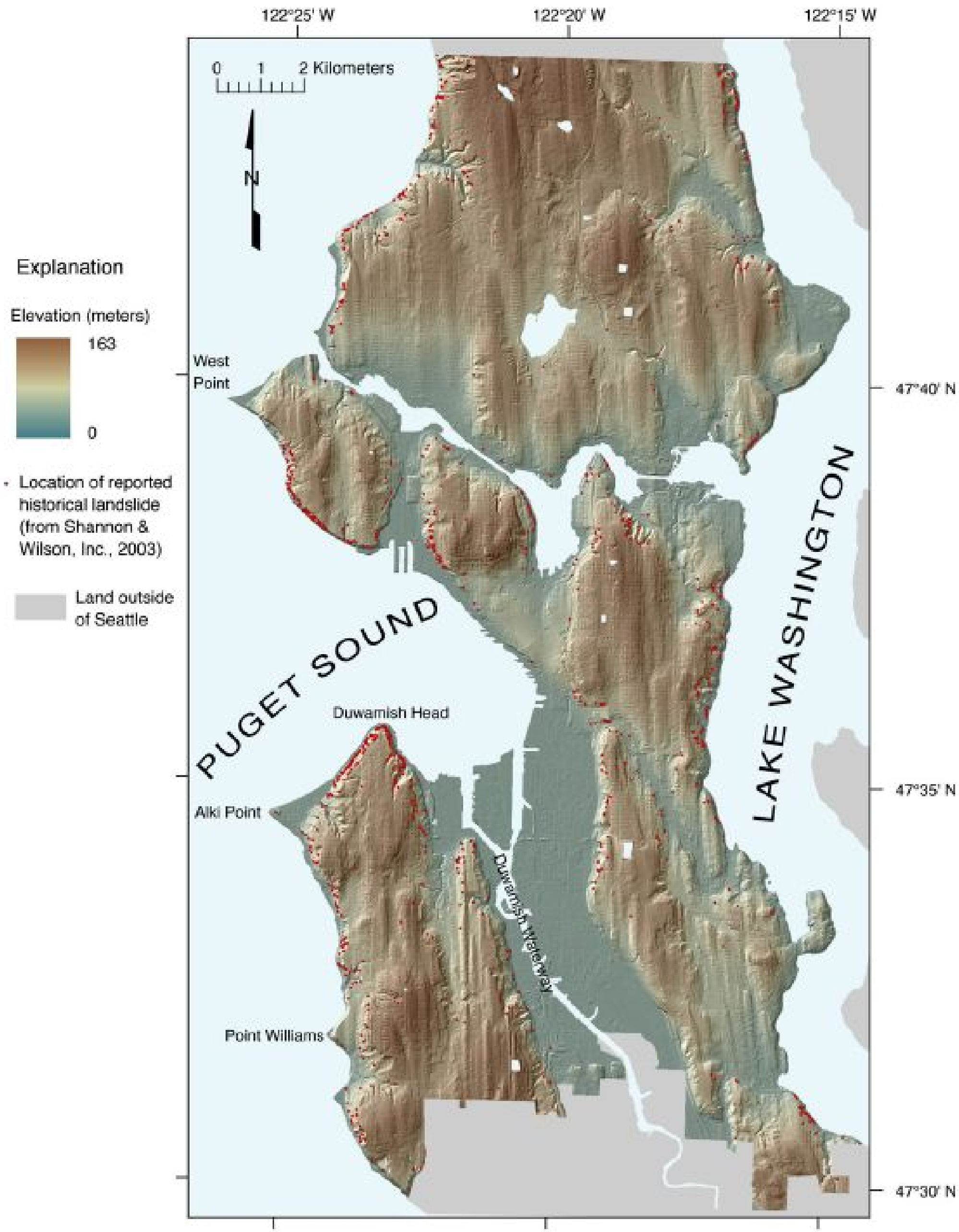


Fig. 3. Shaded relief map created from the LIDAR-derived, bare-earth digital elevation model (DEM) of Seattle showing land-surface elevations and locations of historical landslides (locations modified from Shannon and Wilson, Inc., 2003).

"Bare Earth" overview of region near Pugent Sound

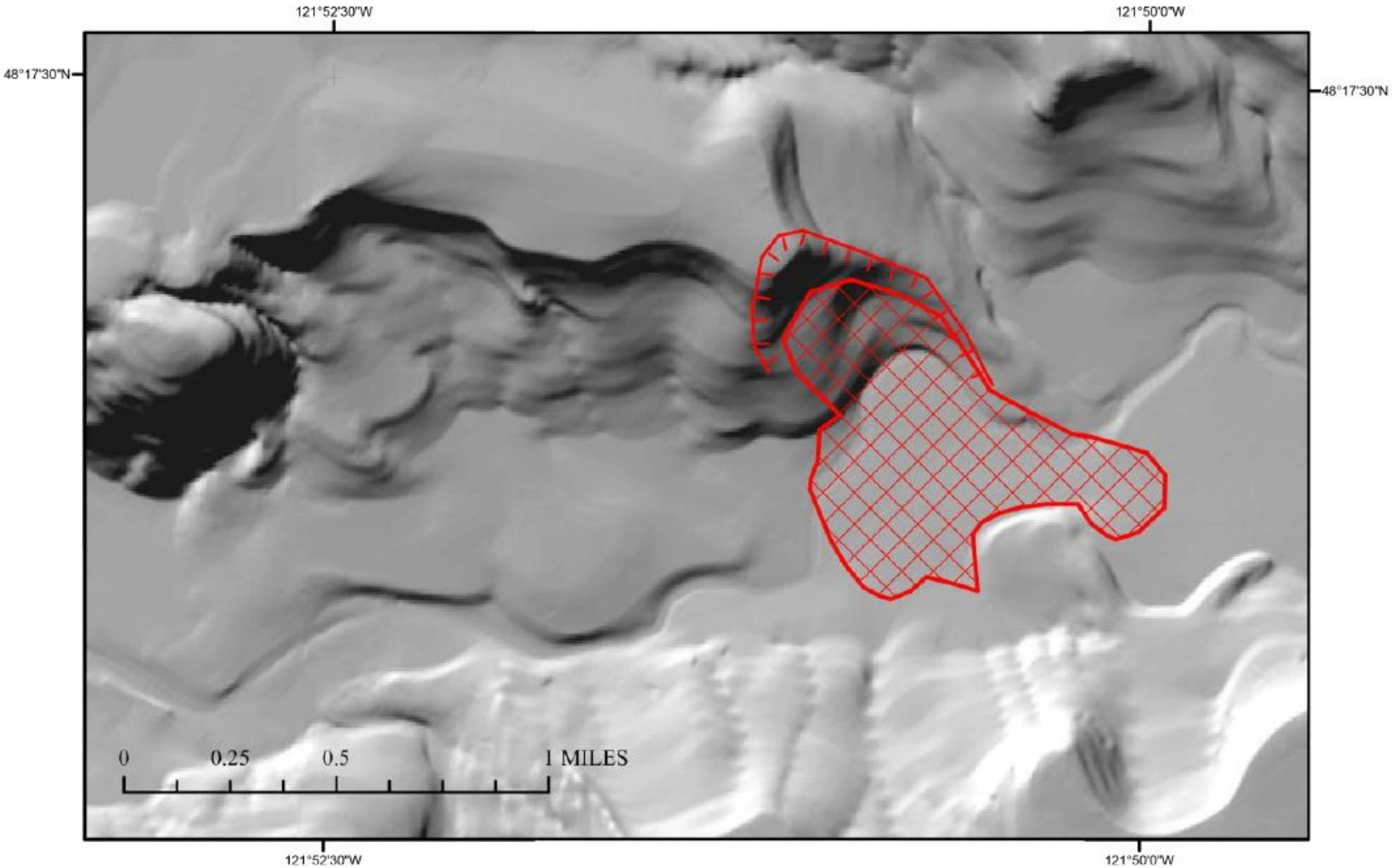
Note glacial striations

Oso Landslide

- Oso, Washington landslide on Mar. 22, 2014 killed 43 people and engulfed 49 homes and other structures.

Image by Spc. Samantha Ciaramitaro - http://www.dvidshub.net/image/1209676/oso-mudslide, Public Domain, https://commons.wikimedia.org/w/index.php?curid=31937393

Oso Landslide Contour Map



Oso, Washington landslide on Mar. 22, 2014 killed 43 people and engulfed 49 homes and other structures.

Figure 1. Shaded-relief image of elevation model derived from 1:24,000-scale contours on published U.S. Geological Survey (USGS) topographic maps. The red cross-hatched area marks the approximate extent of deposits from the March 22, 2014, landslide.

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Oso Landslide Lidar Map

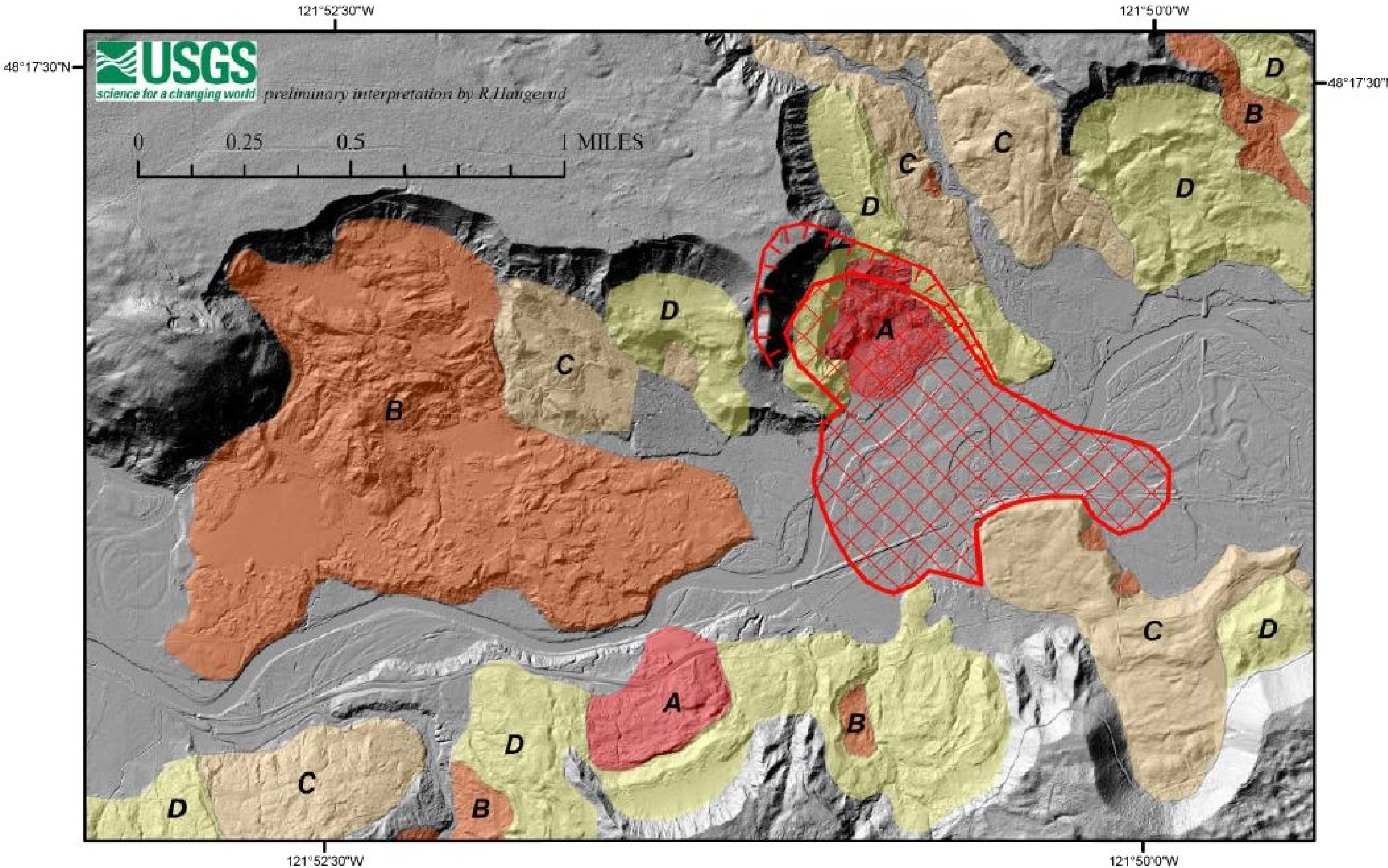

Figure 2. Shaded-relief image calculated from the 2013 lidar survey. Colored areas show older landslide deposits, distinguished by their relative age: A, youngest to D, oldest. The red cross-hatched area marks the approximate extent of deposits from the March 22, 2014, landslide.

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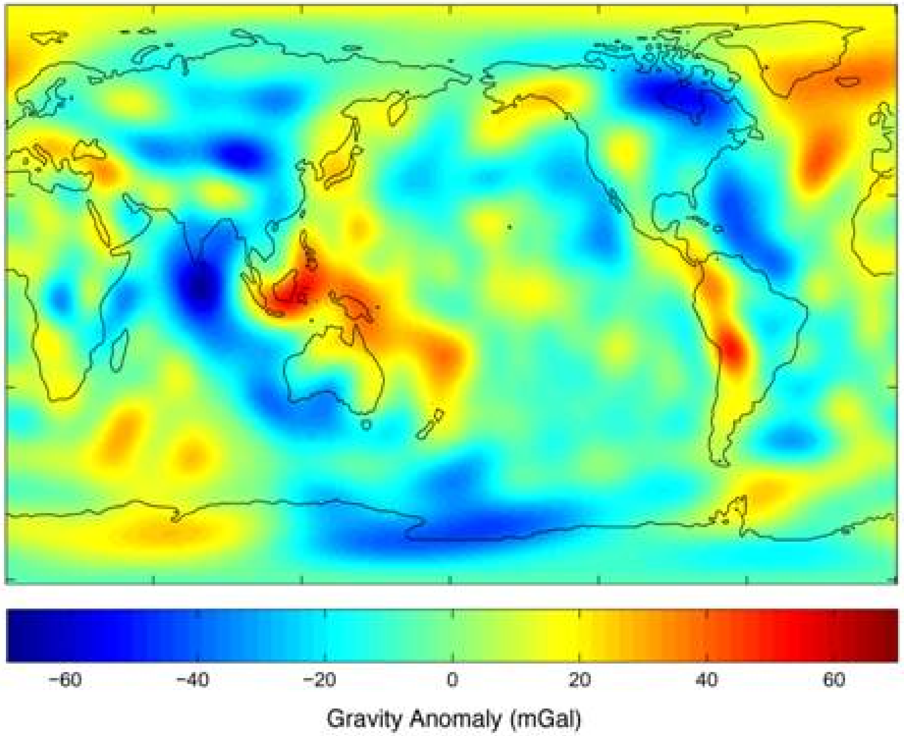
GRACE and GRAIL Satellites

- Gravity Recovery and Climate Experiment
  - Gravity measurements
    - (not electromagnetic waves like most other remote sensing in this class)
- Launched in March 2002, mission ended Oct. 2017
  - GRACE-FO (Follow-On) expected to launch in May 2018
- Pair of satellites ~220 km apart
  - K band radio system monitors separation as they orbit

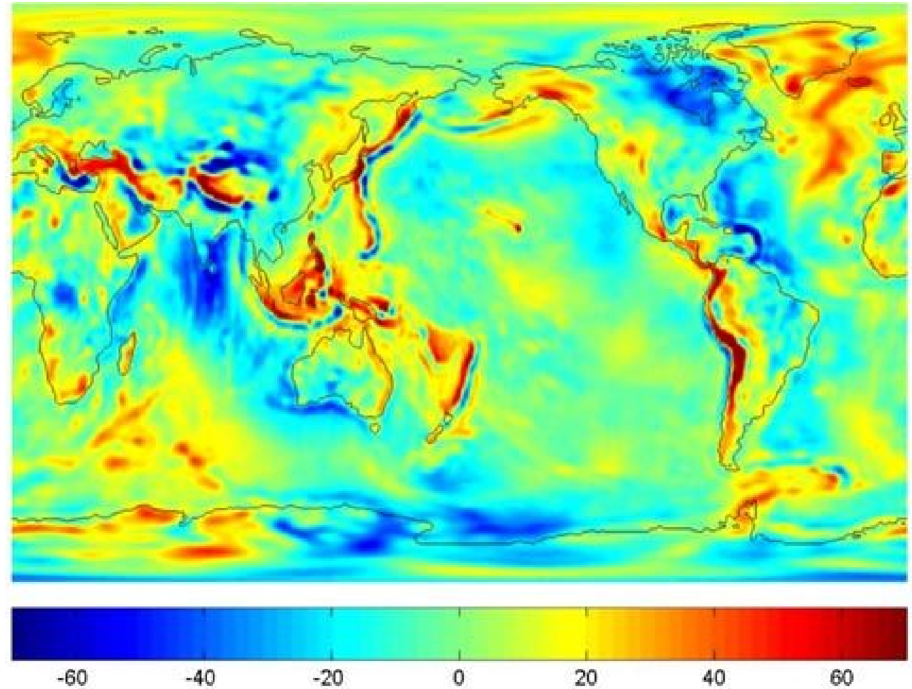
    Draw diagram on board
  - GPS, Laser Retroreflectors, Accelerometers also used
    - As they fly over mass concentration
      - As Lead satellite approaches mass it speeds up, increasing separation
      - As Lead satellite passes mass it slows down, while trailing satellite now approaching mass speeds up, decreasing separation
      - After both satellites have passes mass, separation should be back to original value
  - Dual satellite system lets them correct for atmospheric drag and other effects

- GRAIL: Gravity Recovery and Interior Laboratory (Ebb and Flow)
  - Launched Sept. 10, 2011
  - Entererd Lunar Orbit Dec. 31, 2011 / Jan. , 2012
  - Lunar Mapping Mission: March 6, 2012 till end of 2012

Improvement in Satellite Gravity Models

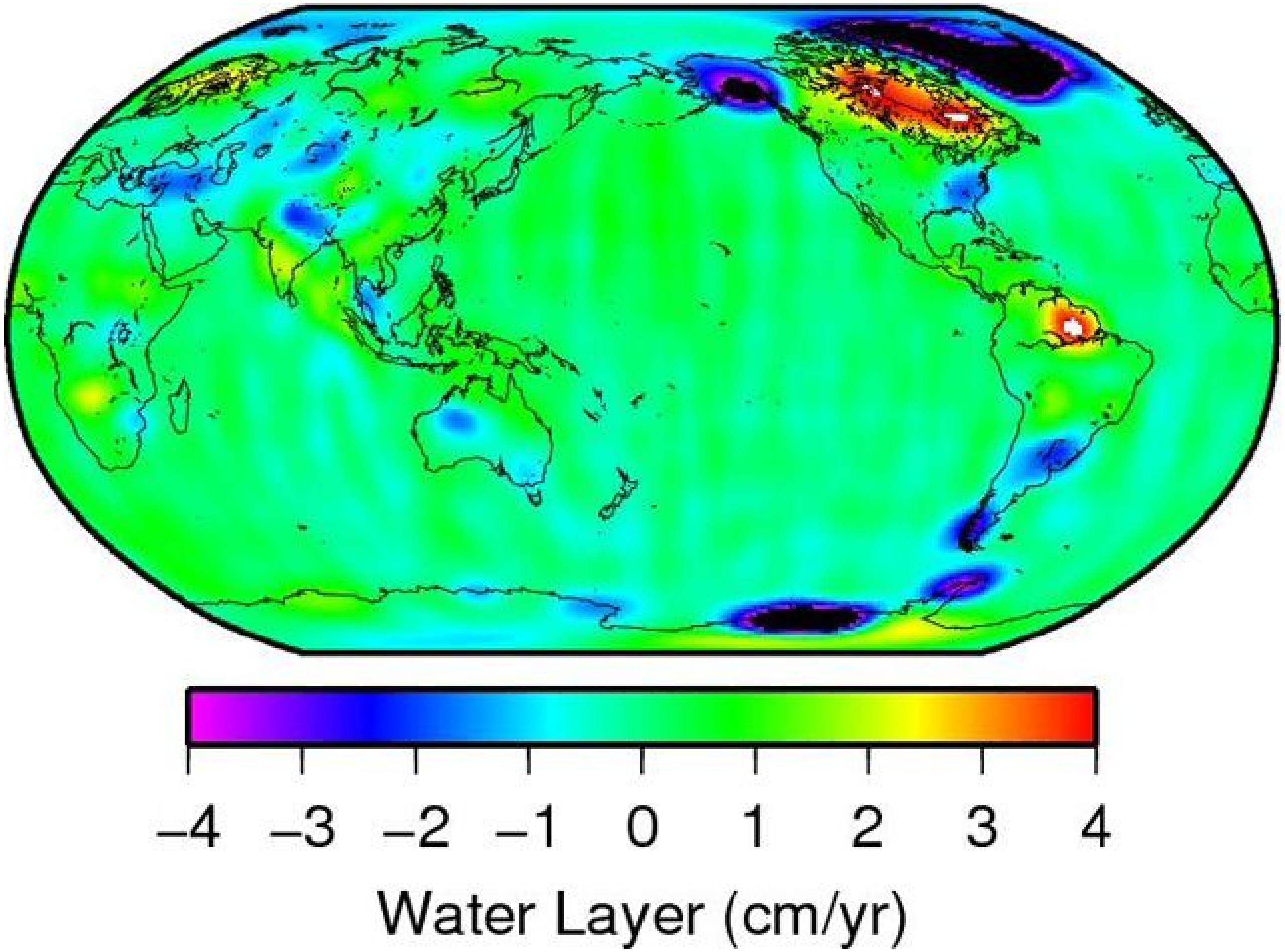


Pre-Grace Satellite Gravity Model



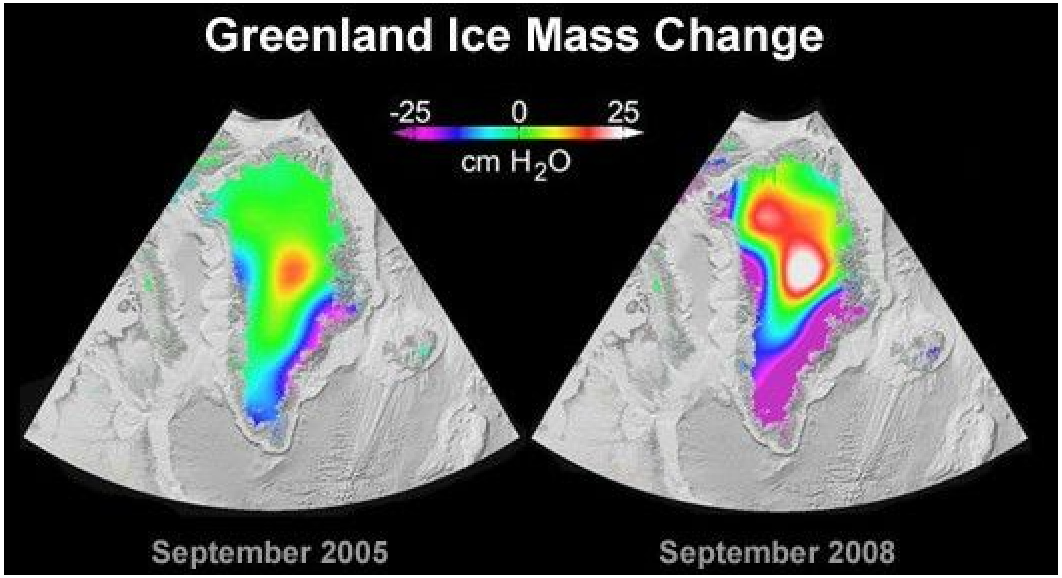
Grace Gravity Model after 1 year

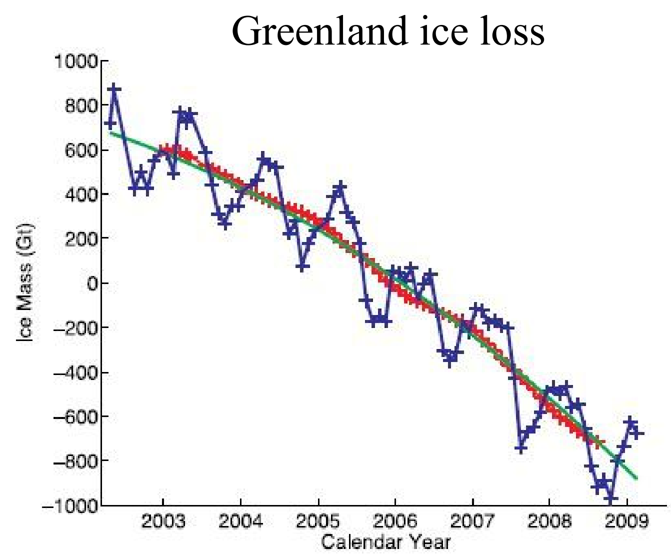
Global Mass Changes: 2003 to 2009

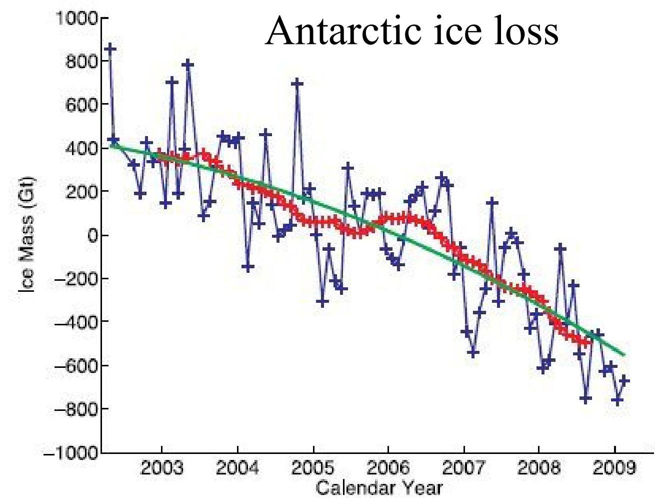


Mass change expressed as equivalent water depth per year

Ice Sheet Mass Changes







Graphs from Velicogna 2009 Geophys. Res. Lett. 36: L19503
Maps from NASA website

Other Gravity Effects

- Gravity + Ocean Height can be used to measure currents

- Convective motions in outer core may be (barely) detectable
  Dumberry (2010) Geophys. J. Int. 180: pp. 635-650

Grace Groundwater Changes in India

- Changing groundwater ⇒changing gravity