Advancing Ice-Sheet Research with the Next Generation Landsat Sensor

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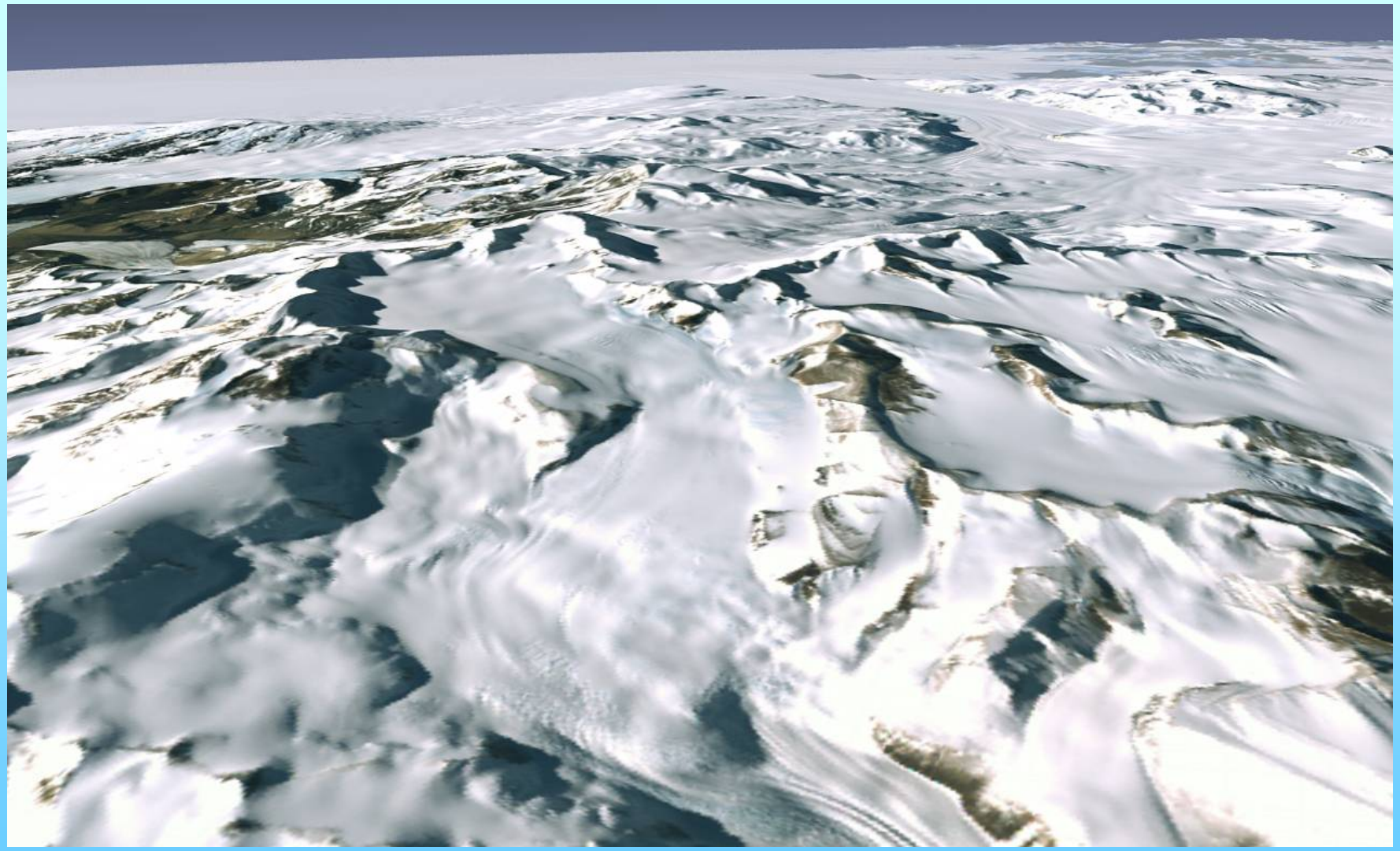
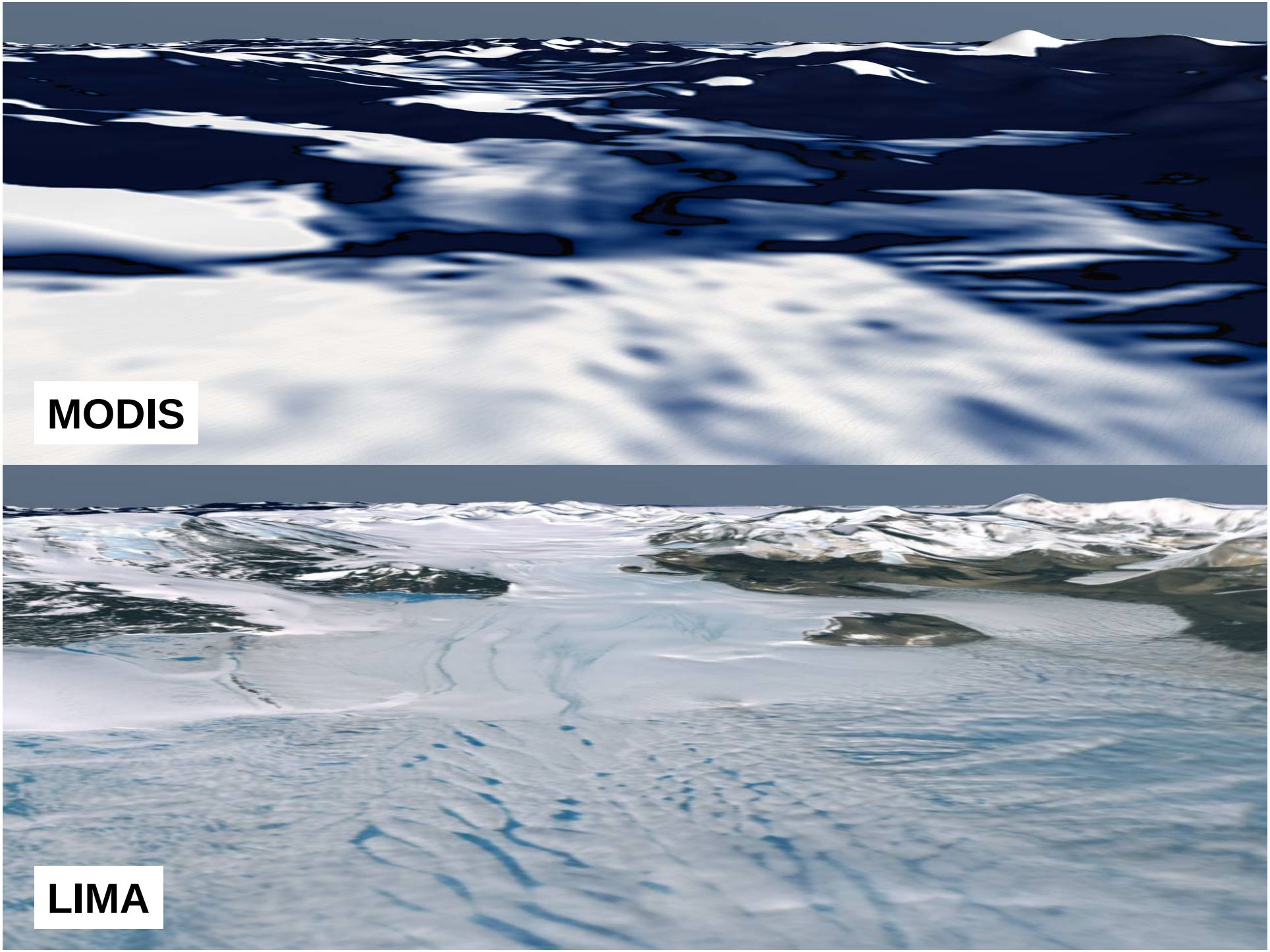
Topics

1. Landsat Image Mosaic of Antarctica (LIMA)
2. Antarctic Surface Accumulation and Ice Discharge (ASAID)
3. ICESat-II Science Definition
4. Image Differencing

1. LIMA: What Antarctica really looks like!




MODIS
LIMA

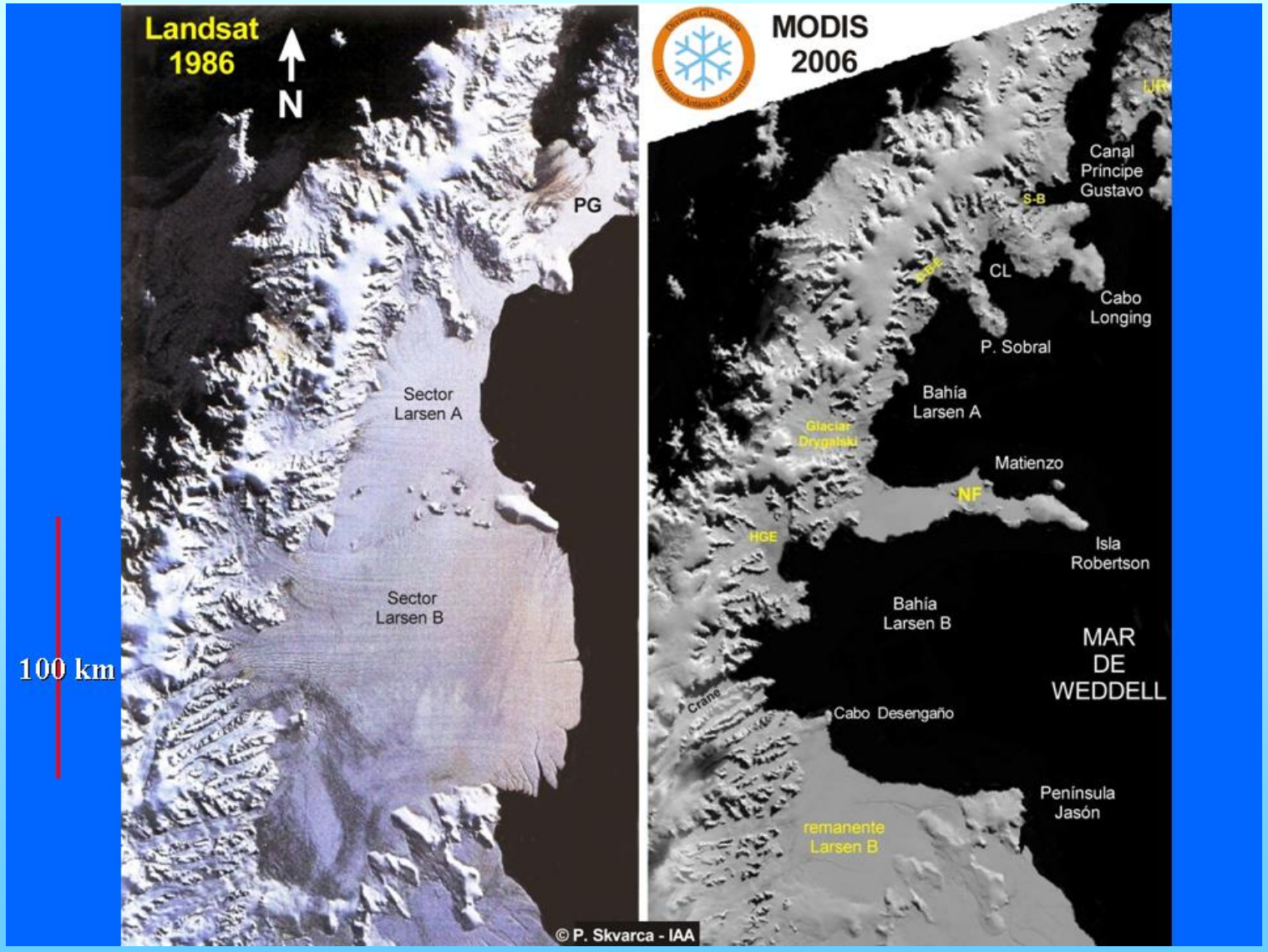
LIMA “firsts”

- First true- color mosaic of Antarctica
- First high-resolution mosaic of Antarctica
- First IPY benchmark data set
- First non-Photoshop continental-scale mosaic produced by USGS
  - not “just a pretty picture”
  - a rigorous scientific data product
    - Metadata capture numeric treatment of every pixel
  - lowers the bar to using satellite imagery
    - Scientists don’t need to touch single scenes

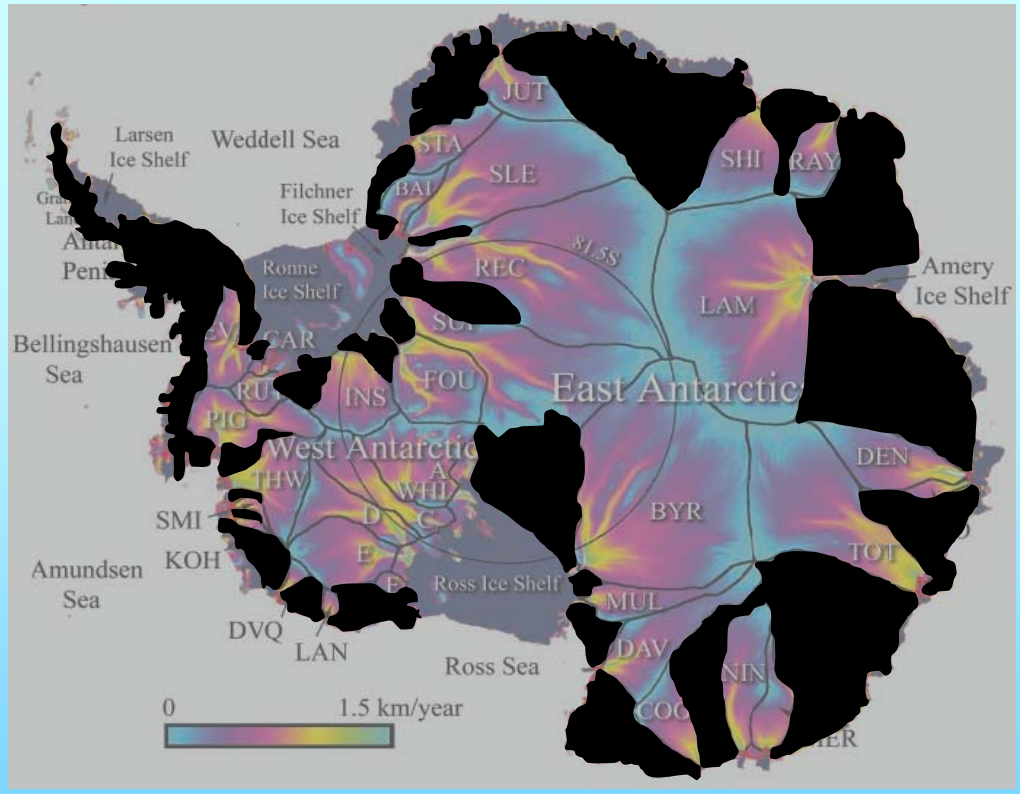
Beyond LIMA

- Not done yet
  - Final scenes for cloud clearing processed and awaiting mosaicing
  - http://lima.usgs.gov has to be improved
- LDCM will permit subsequent (and better) mosaics
- GLS or AGLS?

You want change?!



2. Antarctic Surface Accumulation and Ice Discharge (ASAID)

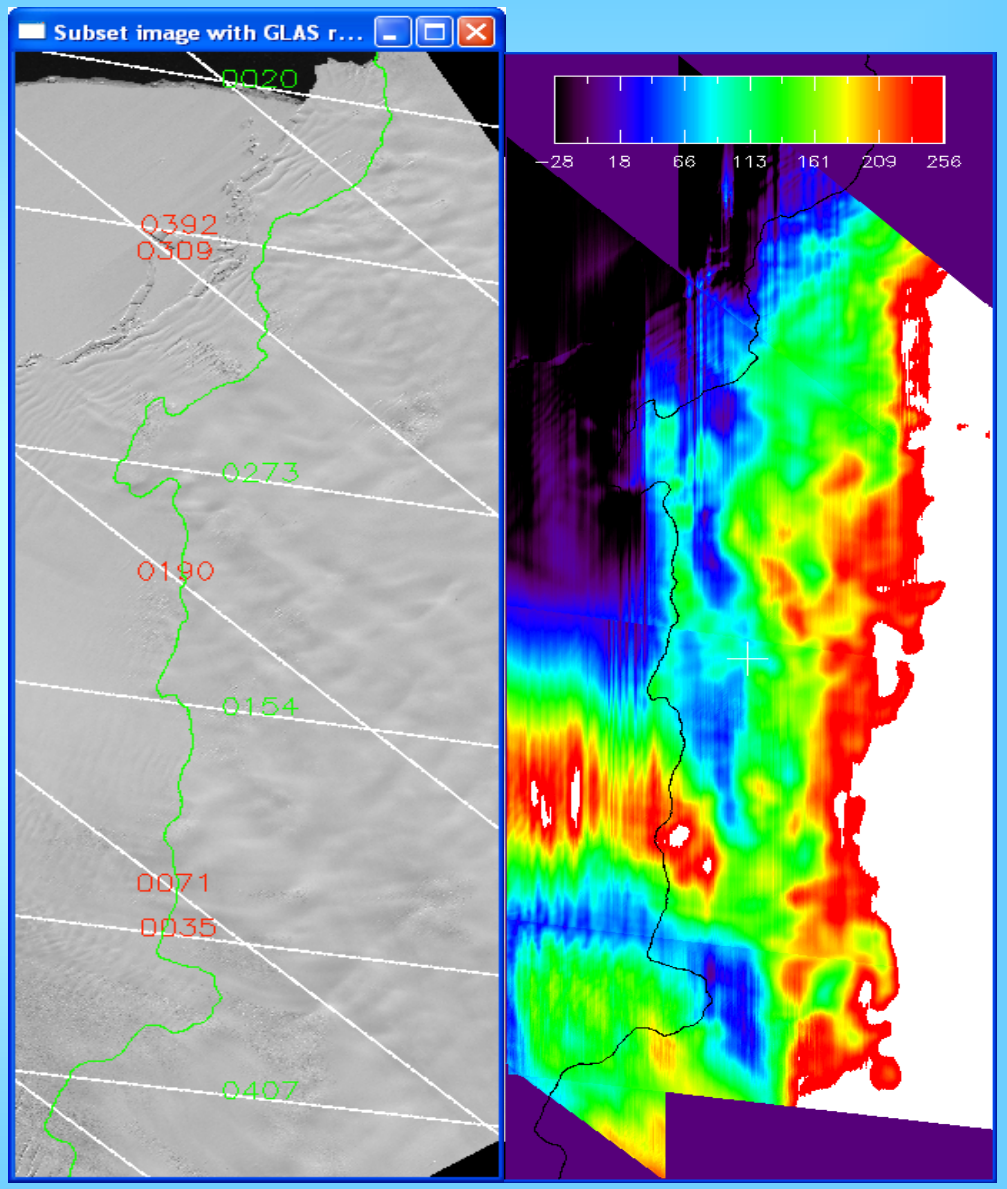


Focus on major outlet glaciers ignores nearly 50% of discharge flux

2. Antarctic ~~Surface Accumulation and~~ Ice Discharge (ASAID)

- Combines three data sources
  - Landsat
  - ICESat
  - SAR
- Products
  - Perimeter elevation fields
  - Grounding line position and ice thickness
  - Discharge velocity
  - Discharge flux

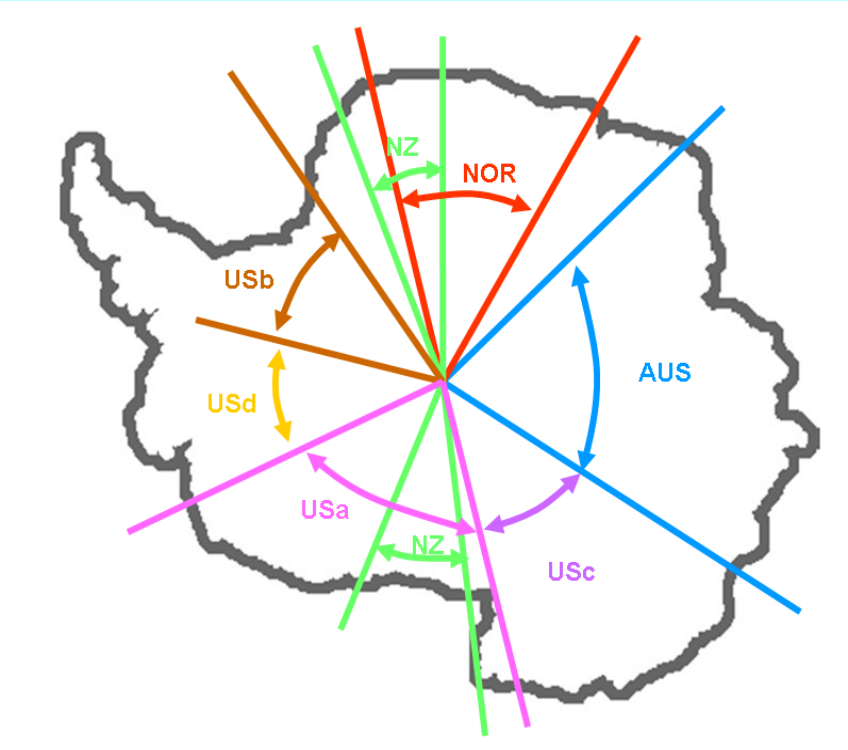
- Landsat DNs used to interpolate elevations between ICESat profiles
- Grounding line traced on Landsat image and checked with ICESat
- Elevations converted to ice thickness at grounding line (hydrostatic equilibrium)
- InSAR surface velocity used with ice thickness to calculate discharge flux



ASAID in IPY

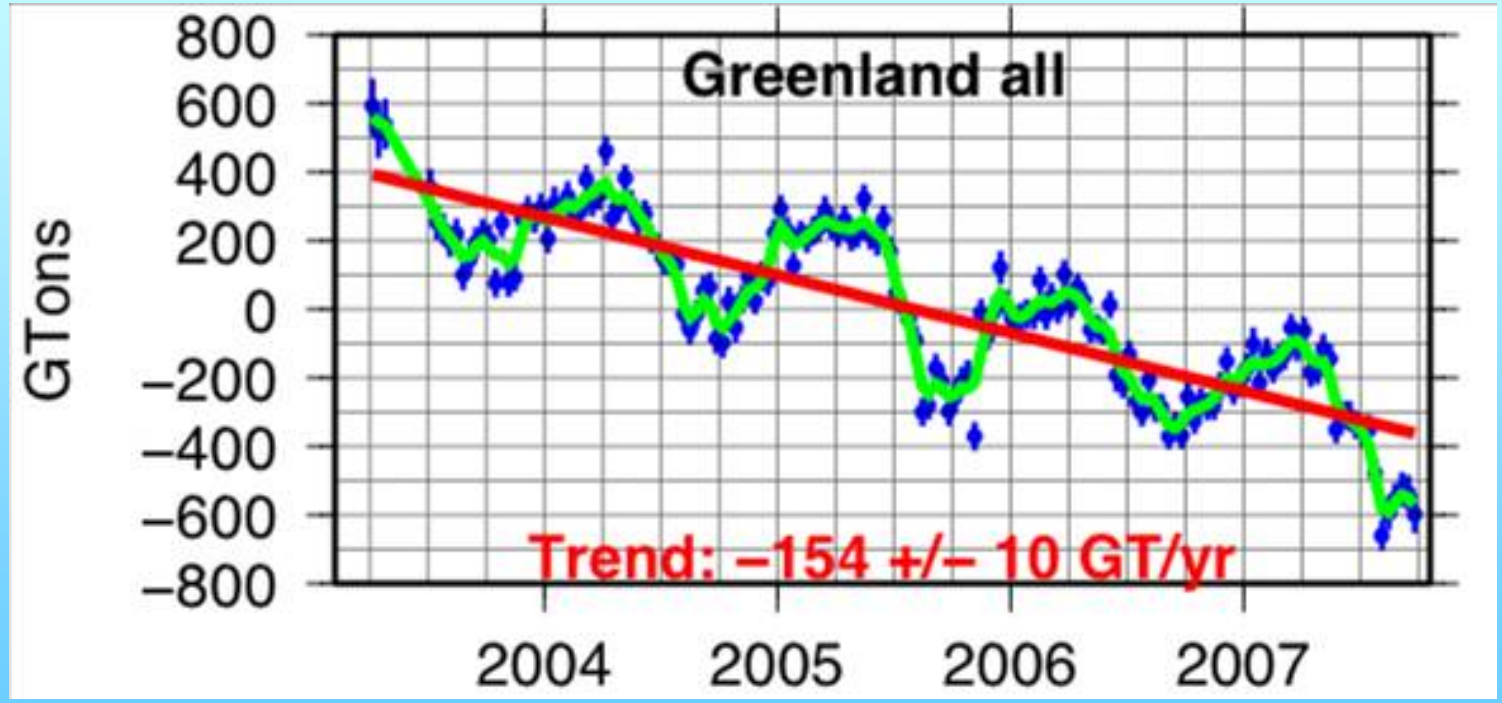
- International partnerships
- Training of young scientists
- Benchmark data set
- Projects beyond what could be done without IPY

- LDCM : improved radiometry will enable refined elevations



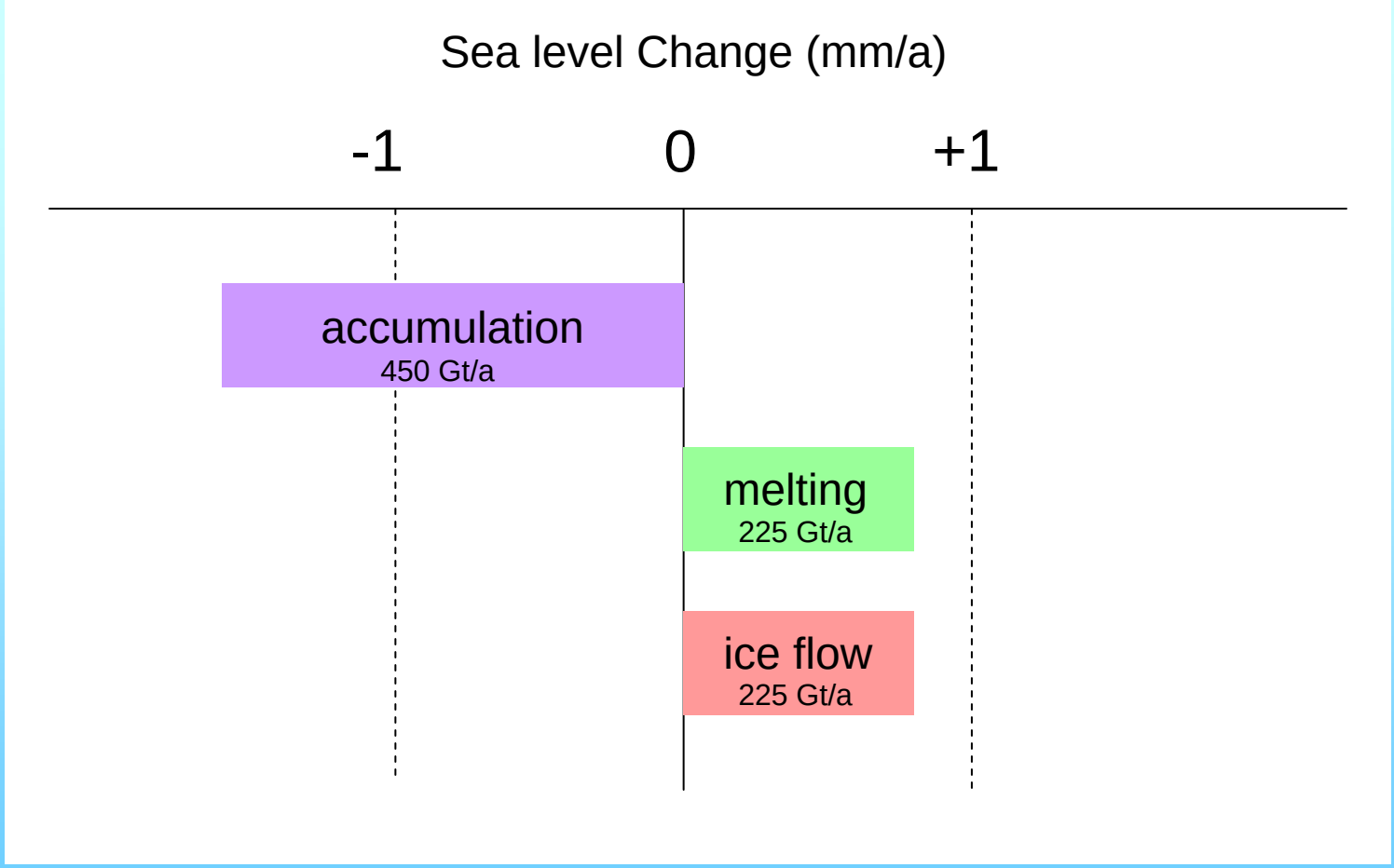
3. ICESat-II Science Definition

- Paradigm shift in ice sheet mass balance
  - Dynamics drives near-term ice mass changes



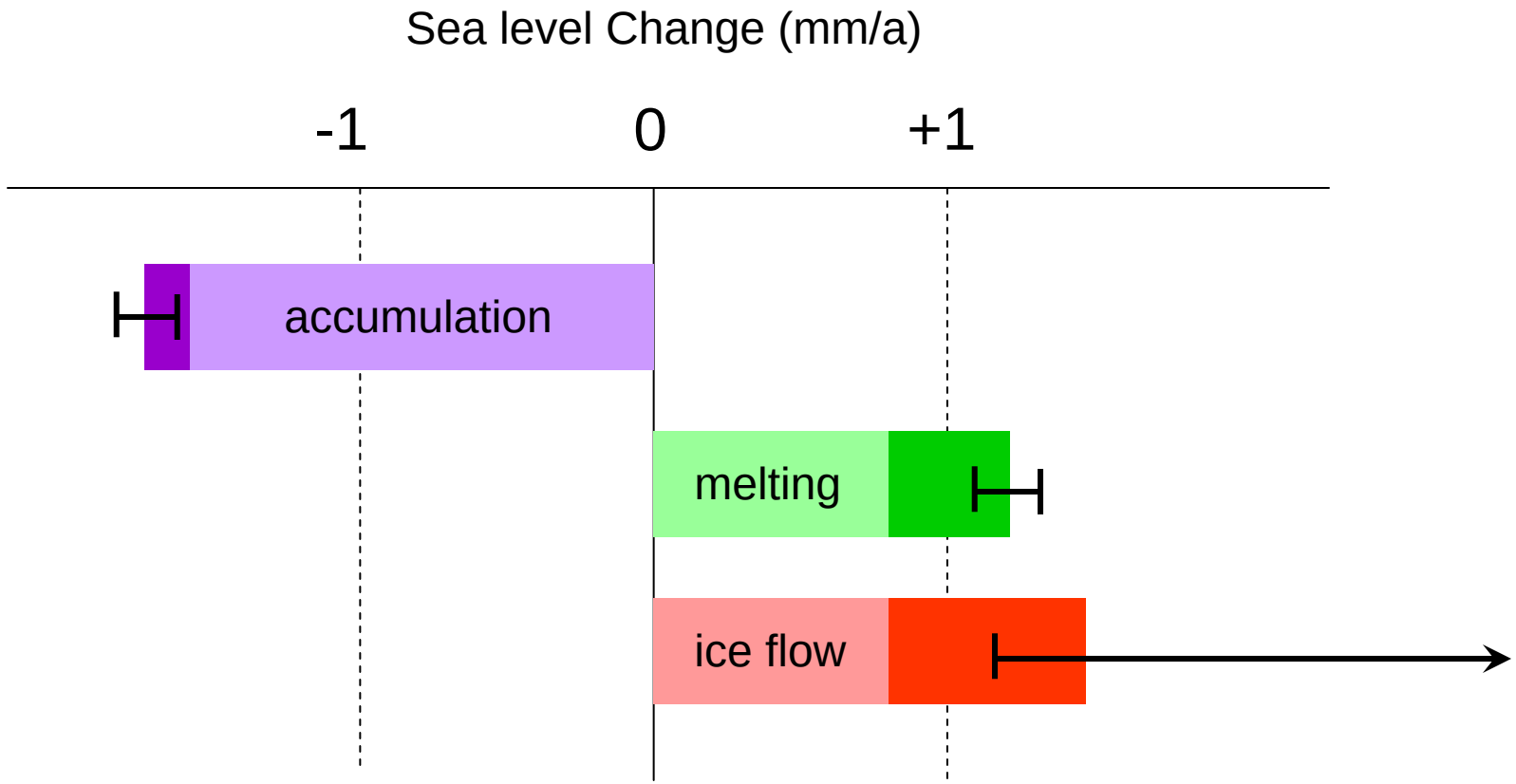
(GRACE data analysis by S, Luthcke et al.)

“Old” Greenland Ice Sheet



Approximately in “mass balance”

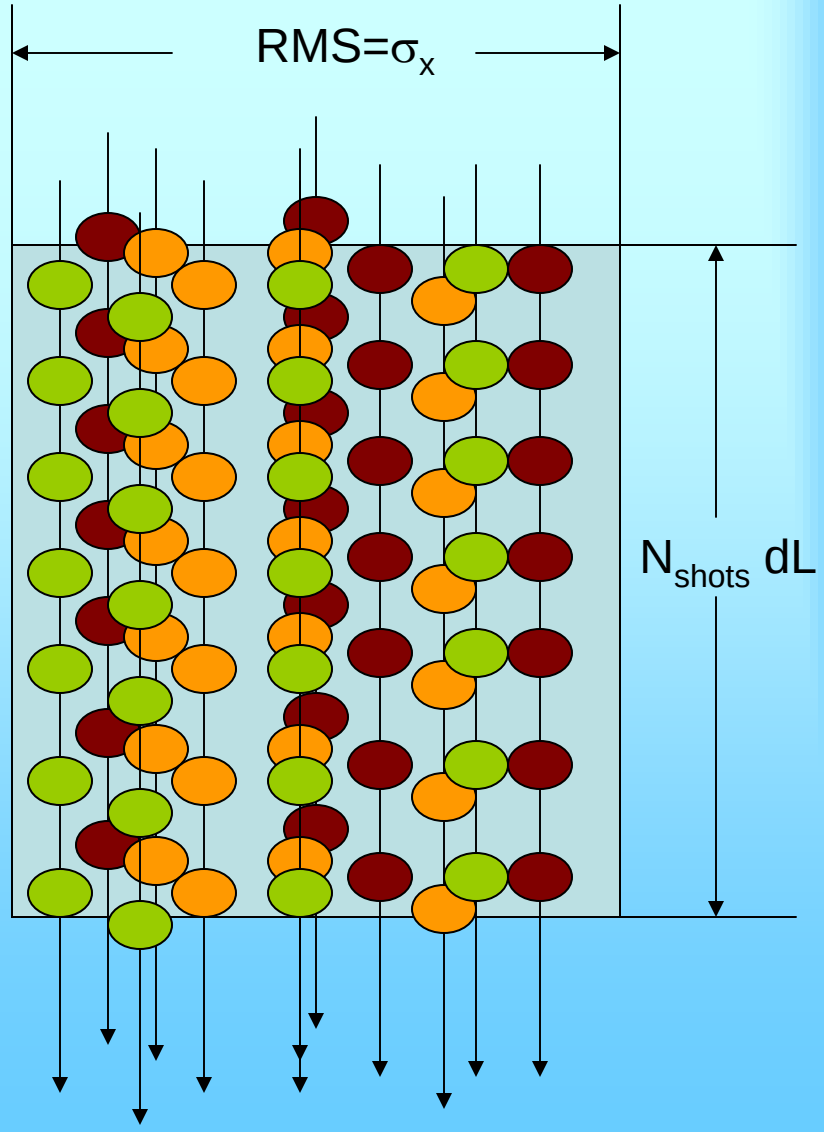
Tomorrow's Greenland Ice Sheet



Things could get a little better or a lot worse
Increased ice flow will dominate the future rate of change

Using “true” Hi-Res DEMs

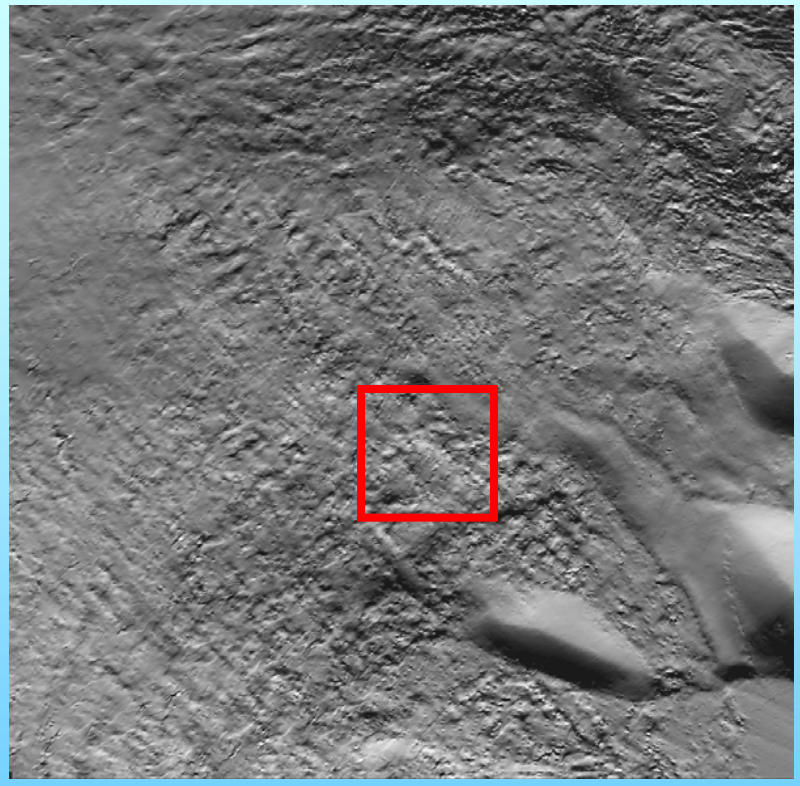
- Addressing sensor design issues
  - Footprint size
  - Footprint spacing
  - Multiple beams
  - Pointing



ICESat DEM looks good at large scale

Shaded Relief
View of DEM

ICESat DEM

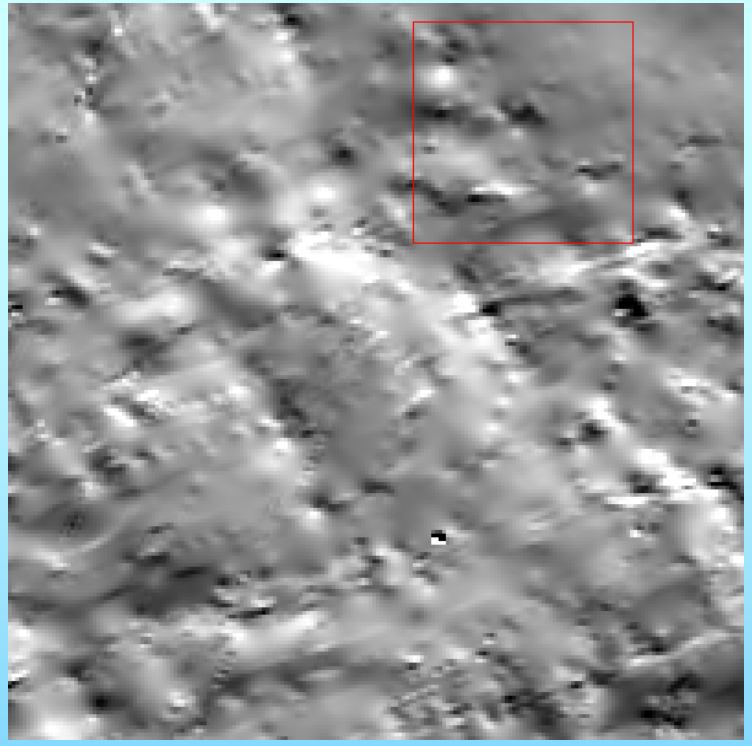


600 km

but…

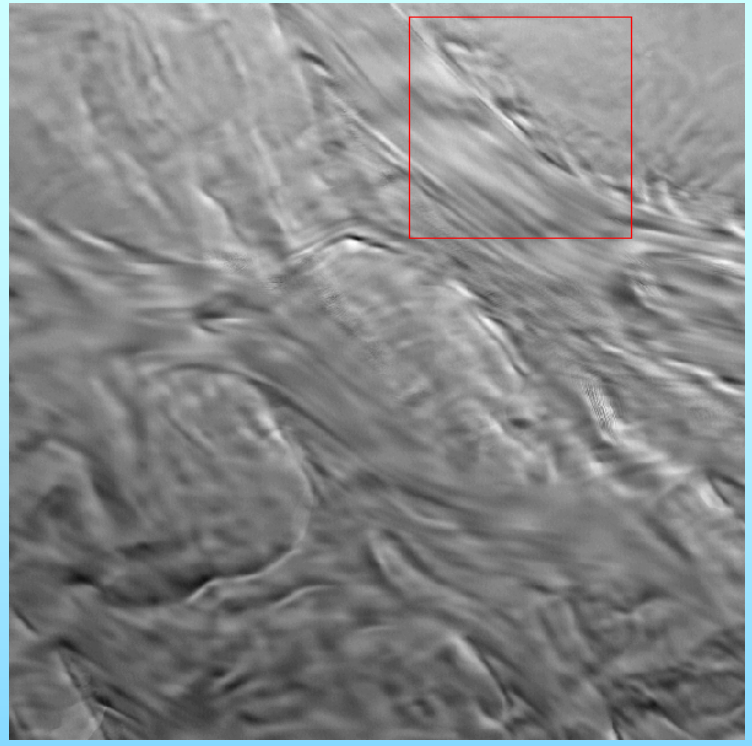
Cross-track elevations are very poor

ICESat DEM



100 km

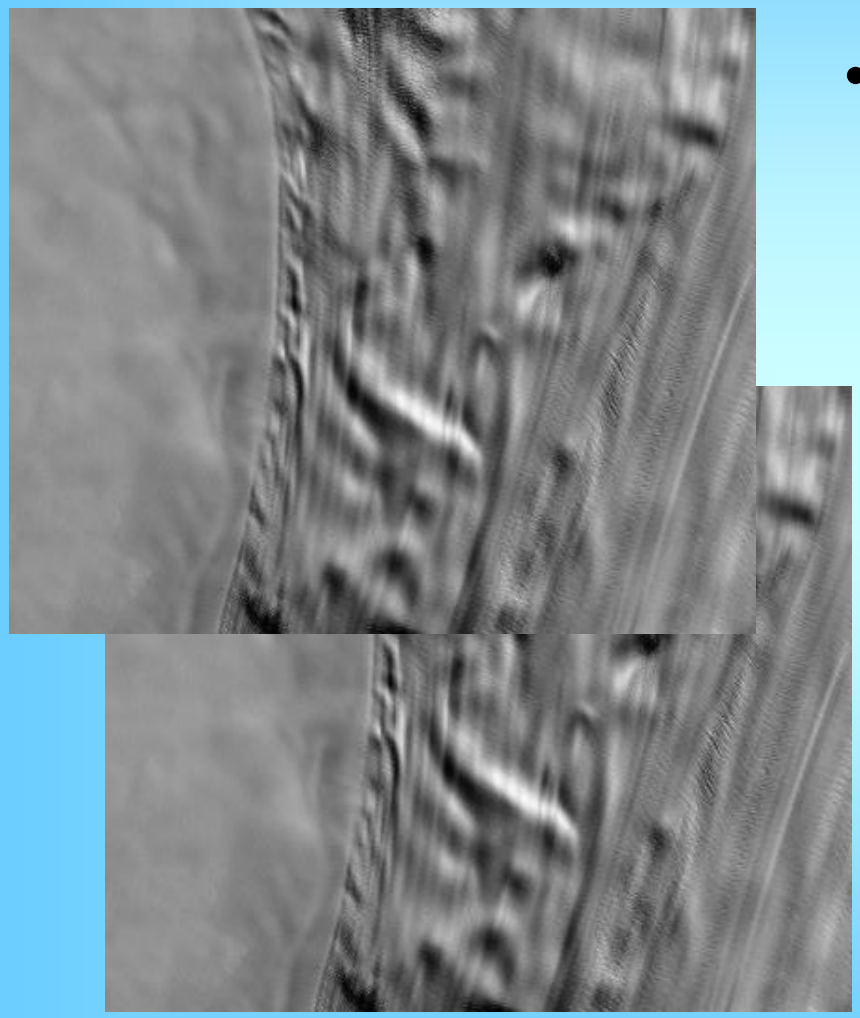
Landsat



100 km

LDCM: better radiometry will improve ability to interpolate elevations

4. Image Differencing



Original images

- New detection technique
  - Subglacial water movement
  - Rift propagation
  - Grounding line migration

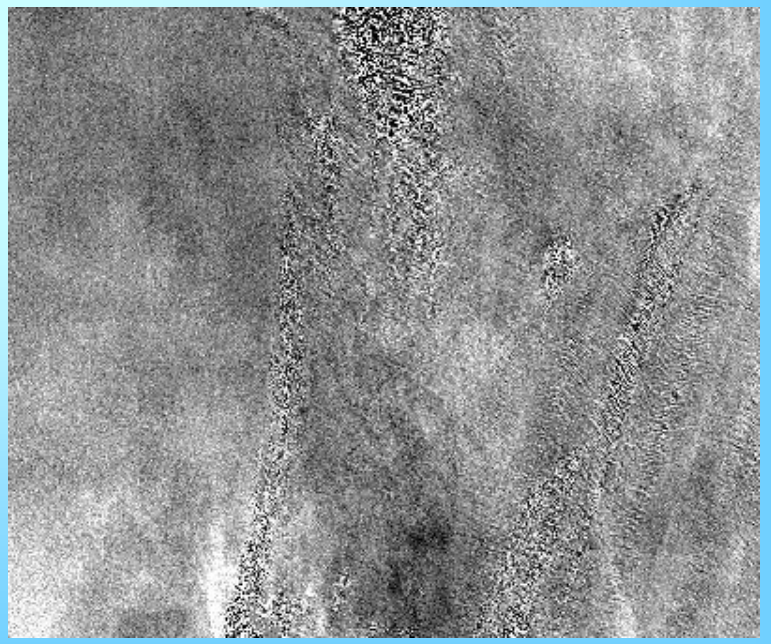
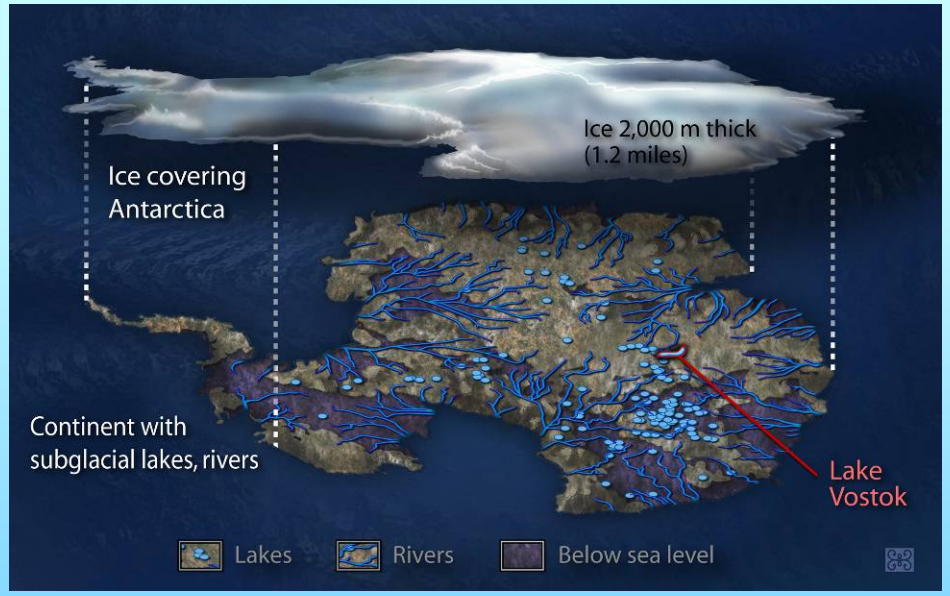
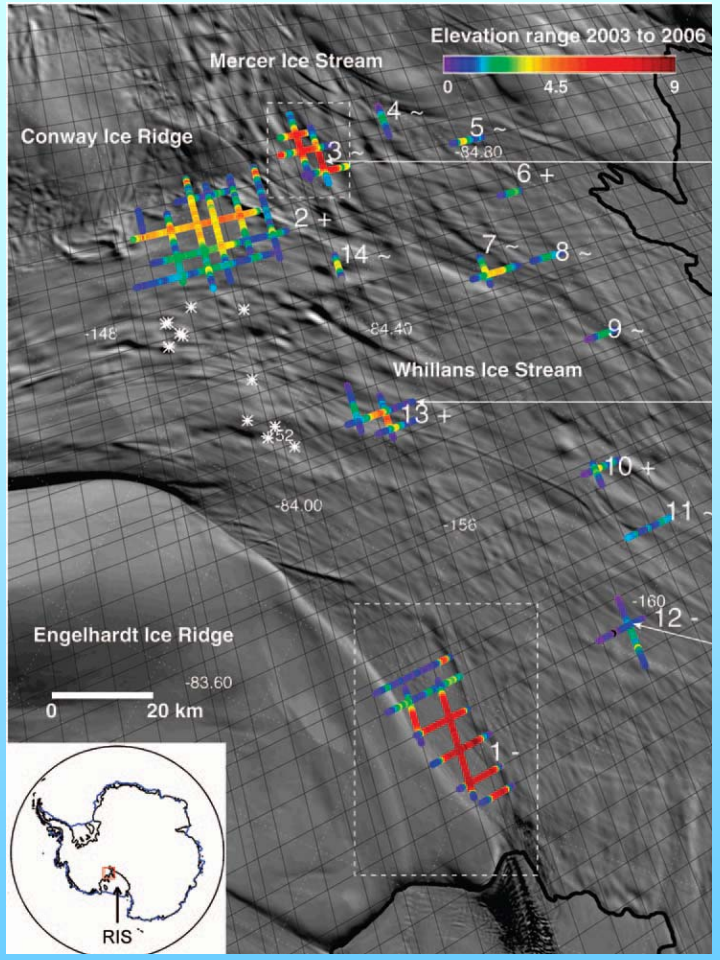


Image Difference

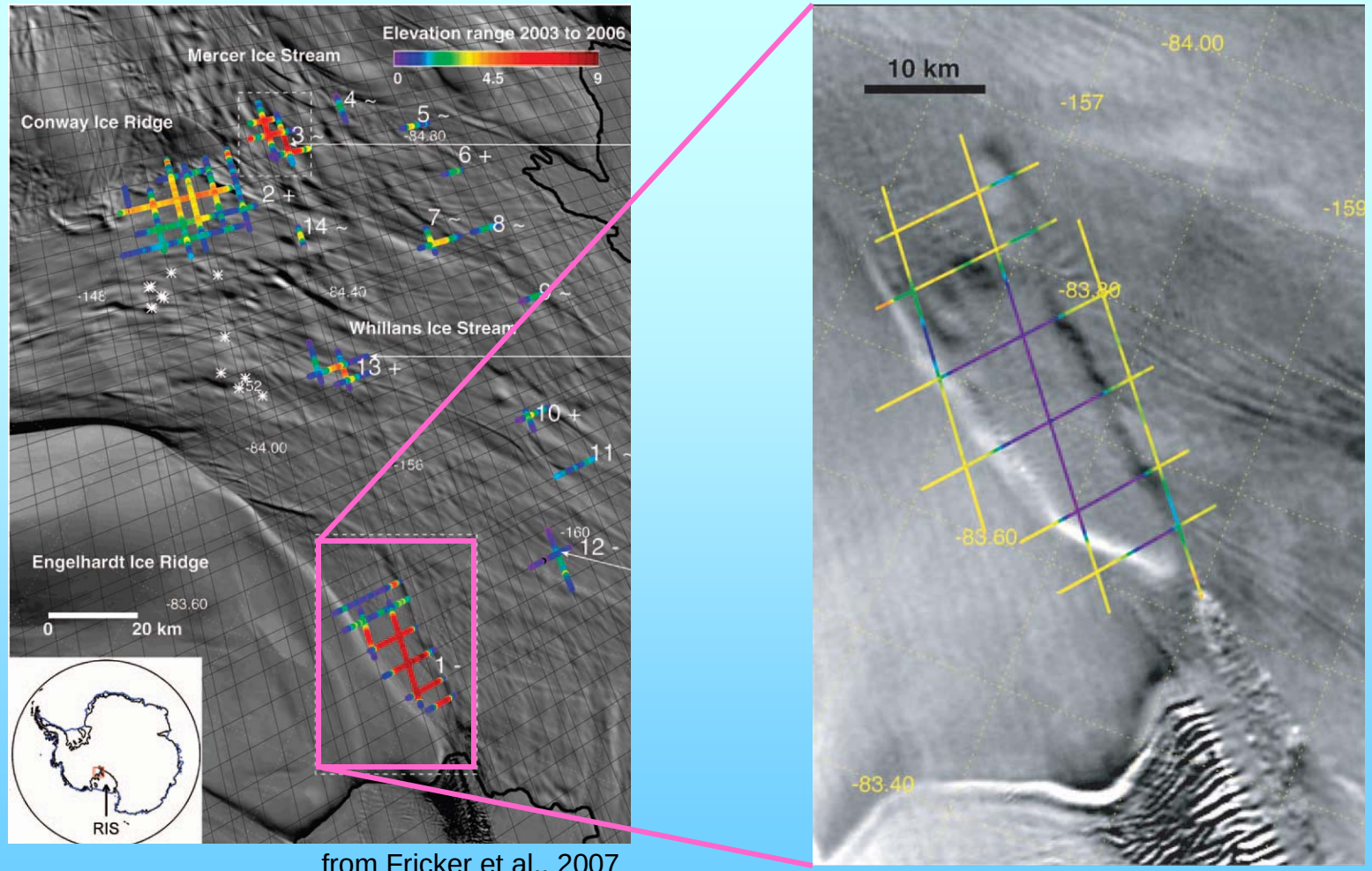
Subglacial Lakes and Water Movement





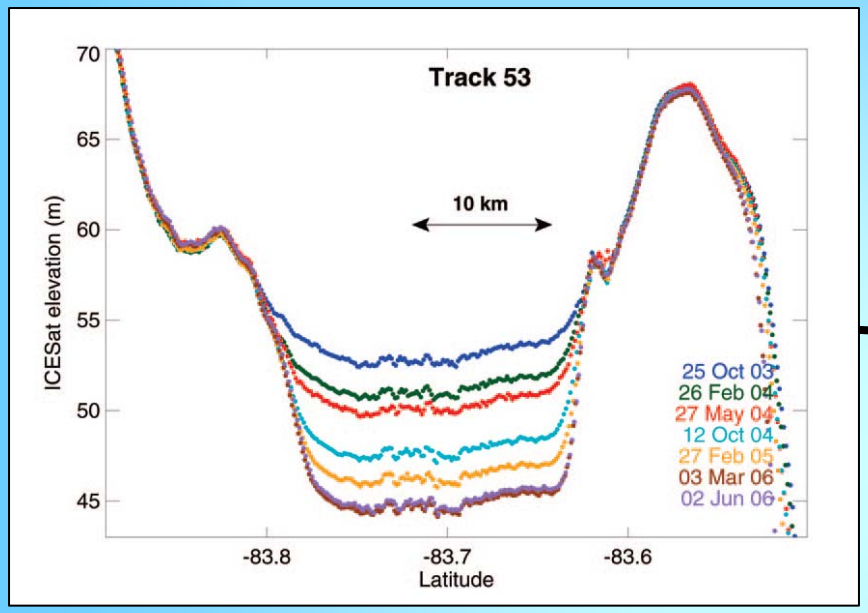
from Fricker et al., 2007

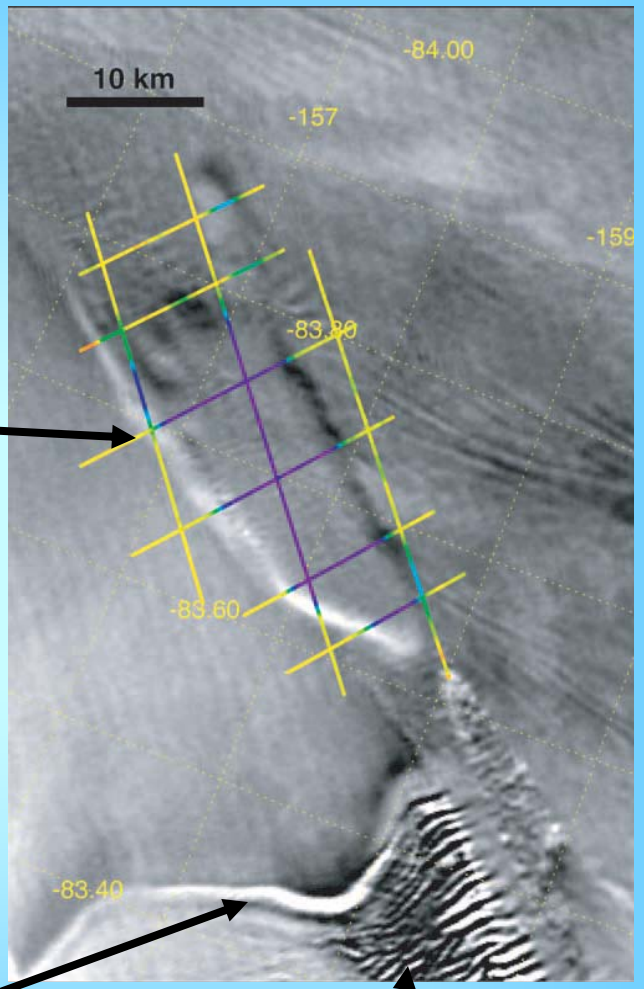
Success with MODIS



from Fricker et al., 2007

a. Lake drainage

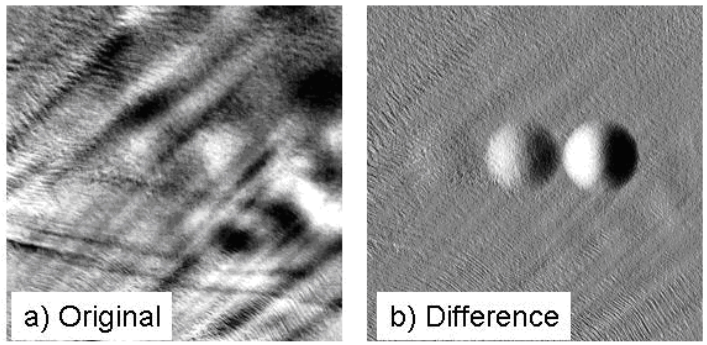


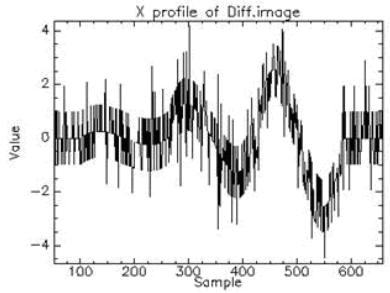


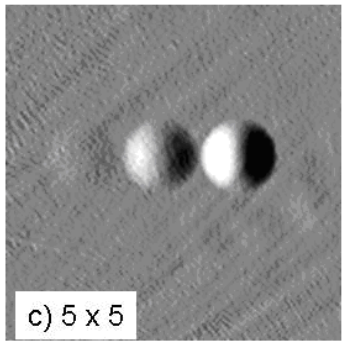
b. Grounding line migration

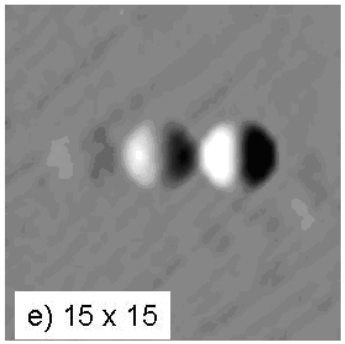
c. Rift motion

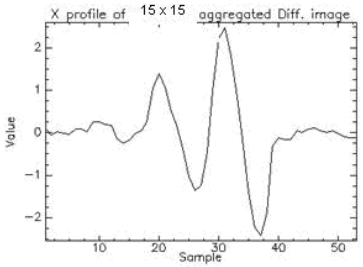
Theoretical Study











- LDCM : better radiometry improves detection threshold

Summary

- Landsat data have numerous uses in ice sheet studies
- Ice is changing FAST, don’t ignore it!
- LDCM’s improved radiometry will increase utility of Landsat in glaciology and in support of other satellite sensors