OIB Bathymetry from Gravity

Kirsty Tinto, Jim Cochran, Robin Bell, Alex Boghosian, Dave Porter

Acknowledgements to Sander Geophysics Ltd, Beth Burton and OIB teams

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

OIB Bathymetry Level 4

Greenland

- 18 glaciers in NW and N Greenland (August 2013)
- 44 glaciers from all regions
  - 67 profiles (January 2014)
- Grid in NW Greenland (January 2014)

Antarctica

- Thwaites (2011)
- Larsen (2011)
- Abbot (2014)

In process

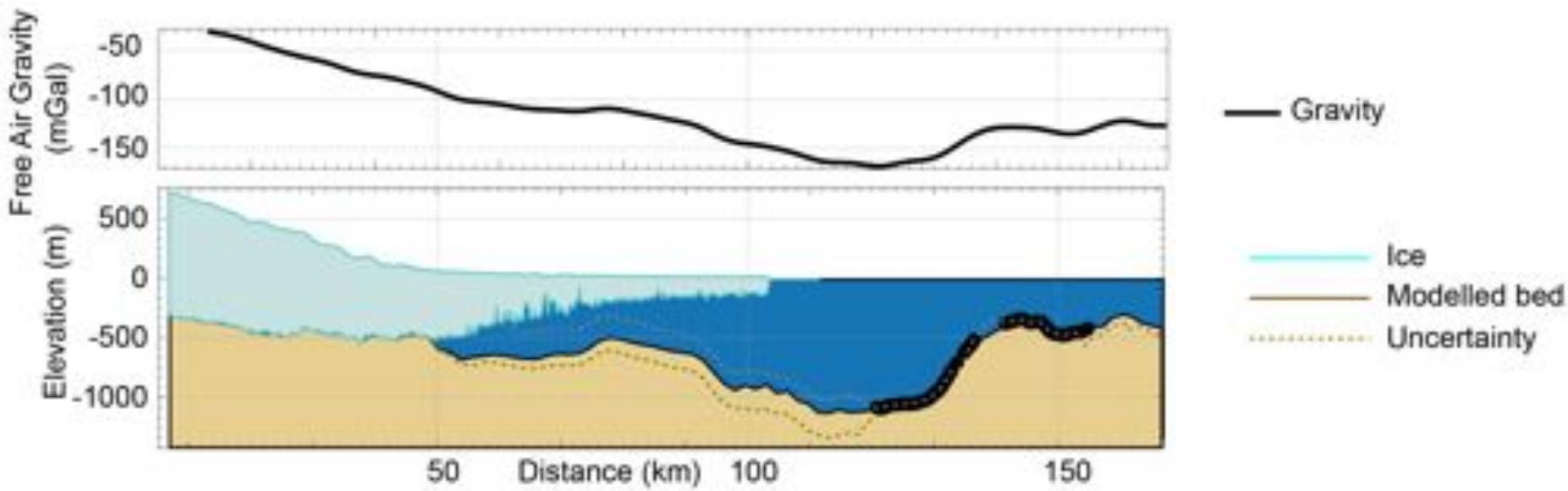
- Integrated Amundsen Sea
- Getz ice shelf
- NE Greenland

http://nsidc.org/data/igbth3.html

Modelling bathymetry from gravity

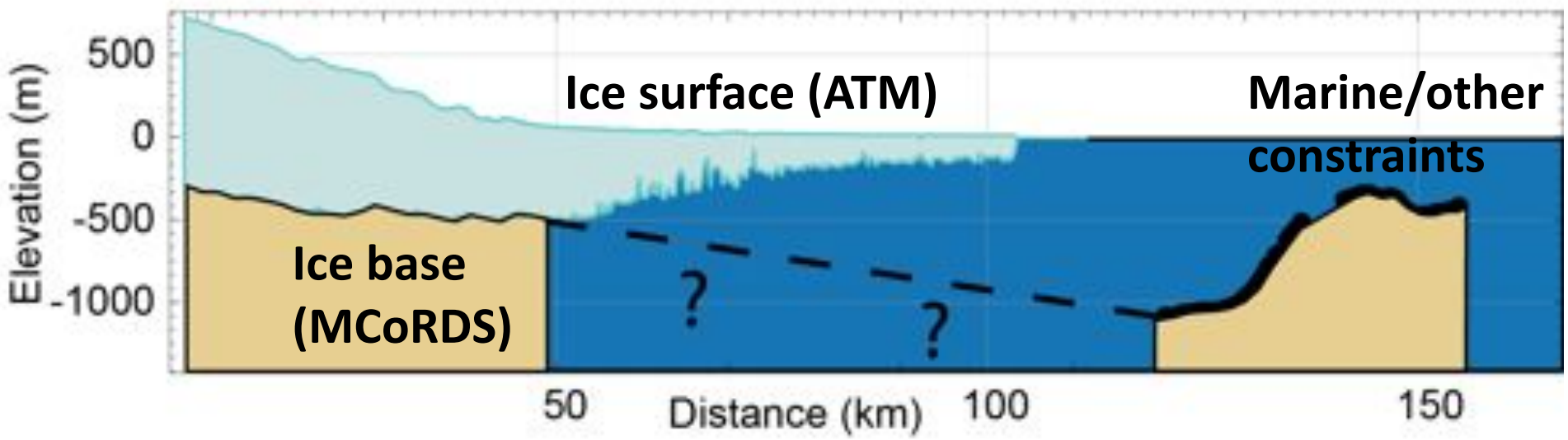
Profile inversions

- STEP 1: Construct model
- STEP 2: Establish geology
- STEP 3: Invert gravity for bathymetry



Profile inversions

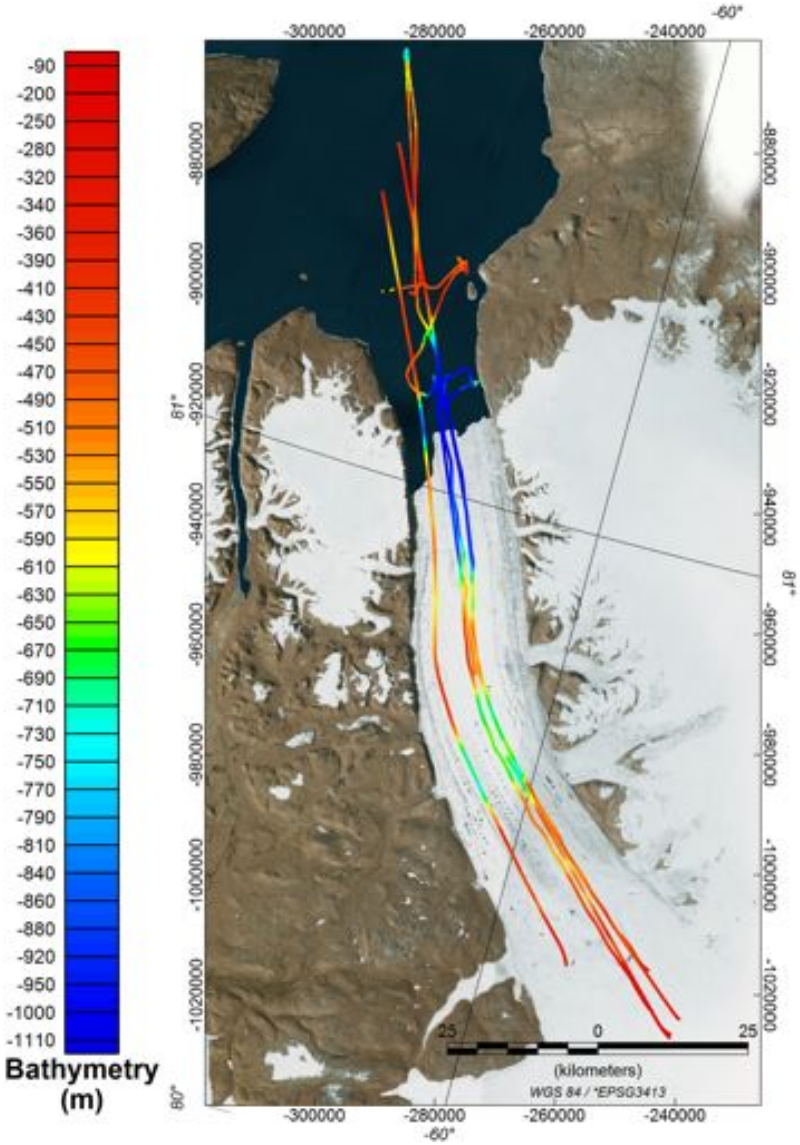
- STEP 1: Construct model
  - combine data from OIB and other sensors



- Ice: 0.915 g/cc, ATM surface, MCoRDS base
- Rock: 2.67 g/cc, MCoRDS surface, invert unknown
- Water: 1.028 g/cc

Marine constraints

- Valuable complement to aerogravity
- Improve bathymetry model, inform geology
- Acquired by PI request
  - Need to have available in public database

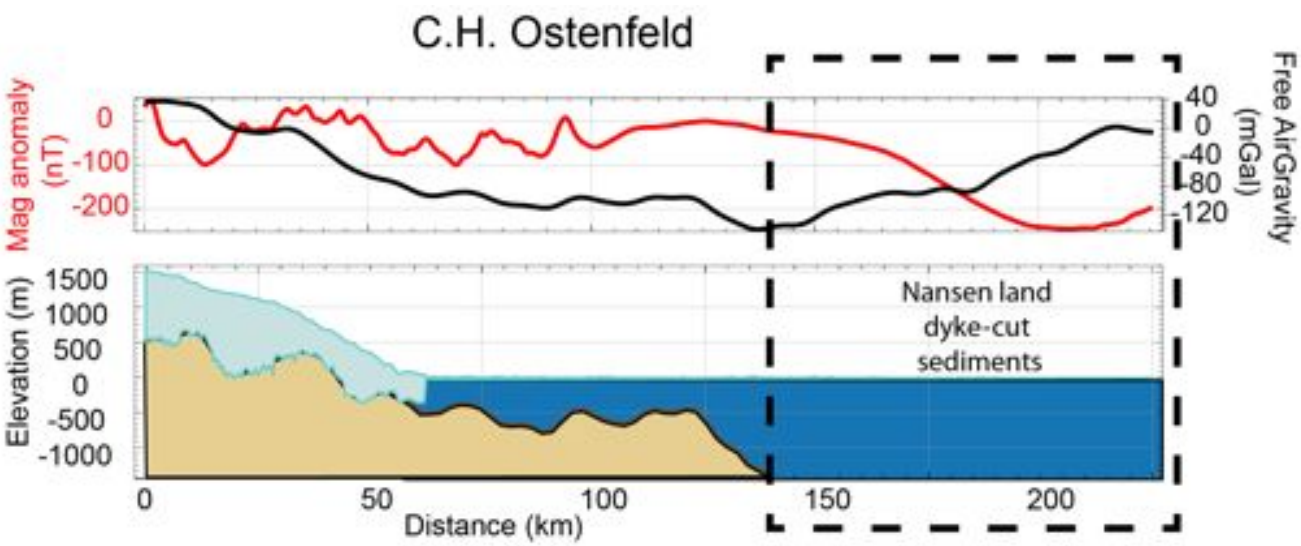


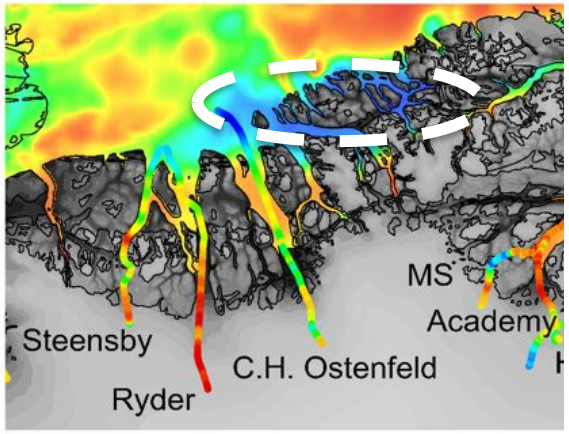
MGDS
MARINE GEOSCIENCE DATA SYSTEM

http://www.marine-geo.org/index.php

Profile inversions

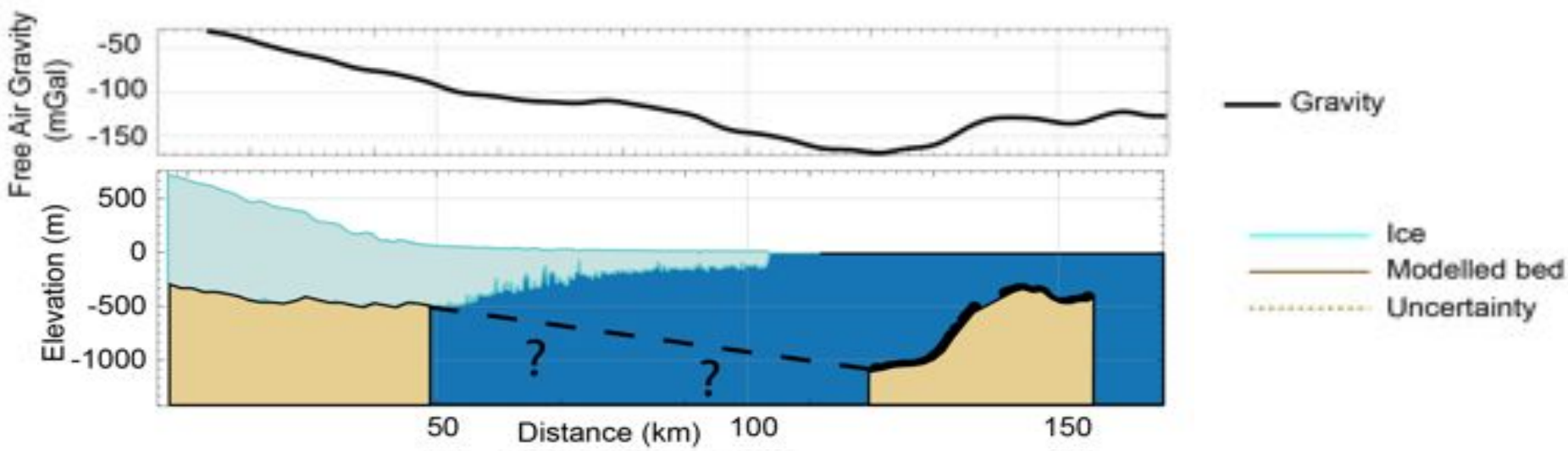
- STEP 2: Establish geology
  - Magnetometer to identify changes in geophysical character





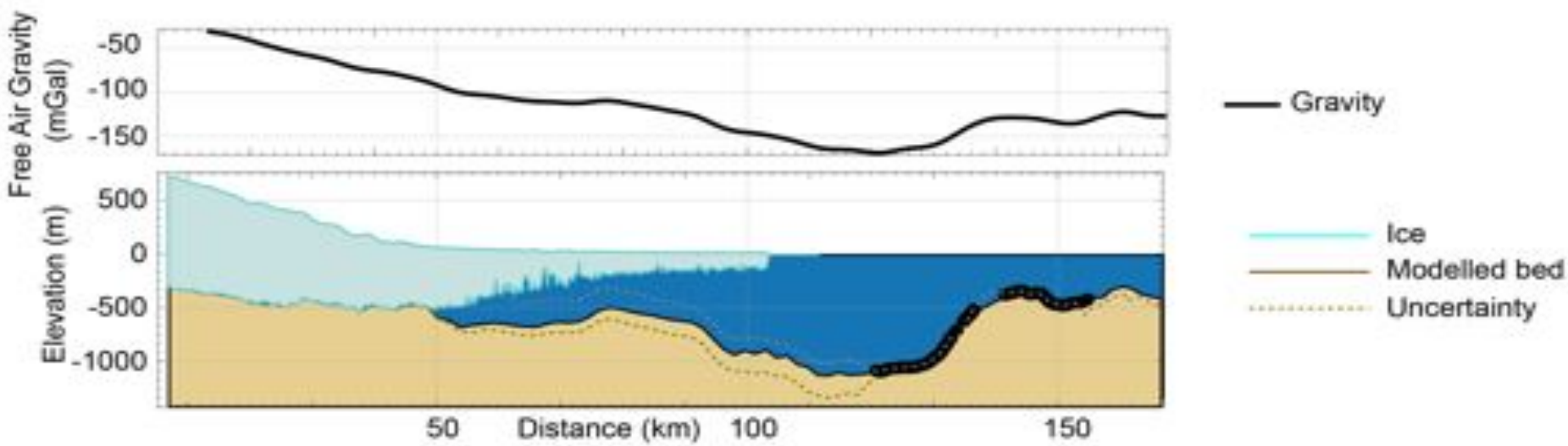
Profile inversions

- STEP 3: Invert gravity for bathymetry
  - GMSys, based on Talwani, 1959



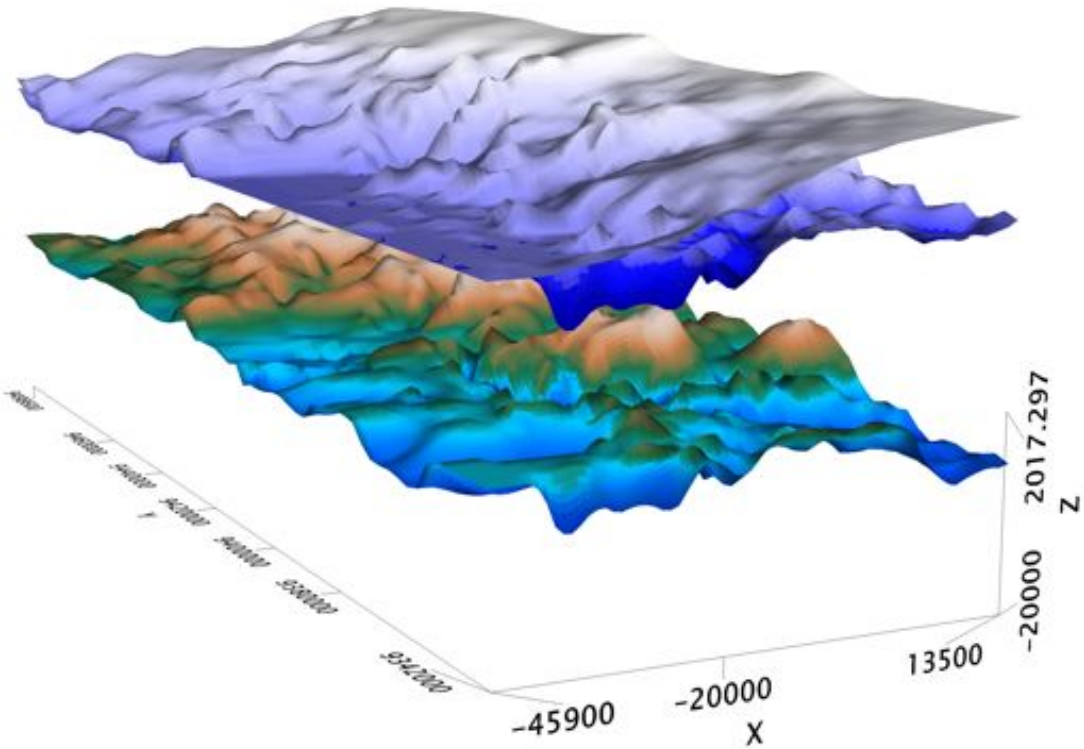
Profile inversions

- STEP 3: Invert gravity for bathymetry
  - GMSys, based on Talwani, 1959
  - Model most reliable near constraints



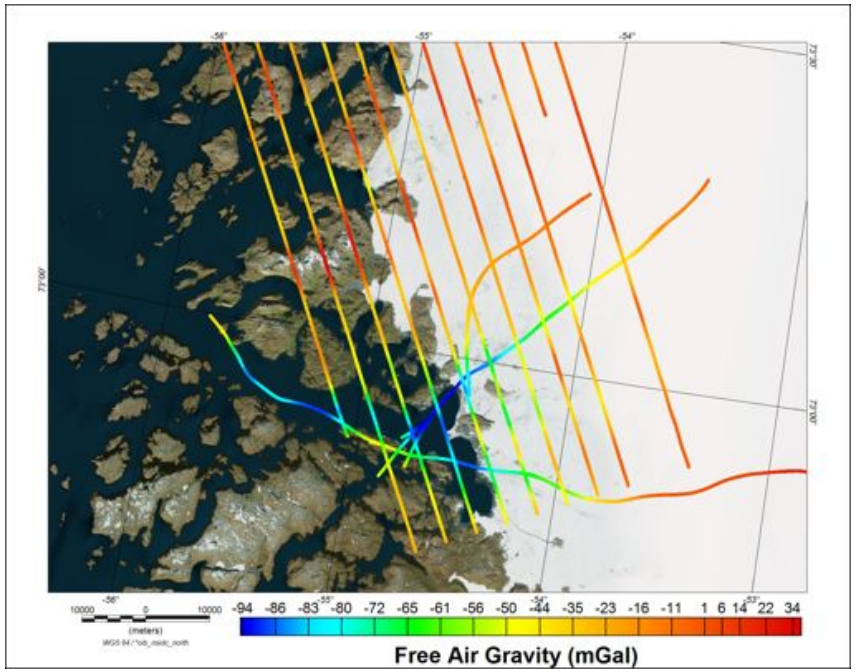
Uncertainty: ± 50 – 200 m 5 km wavelength

Grid inversion



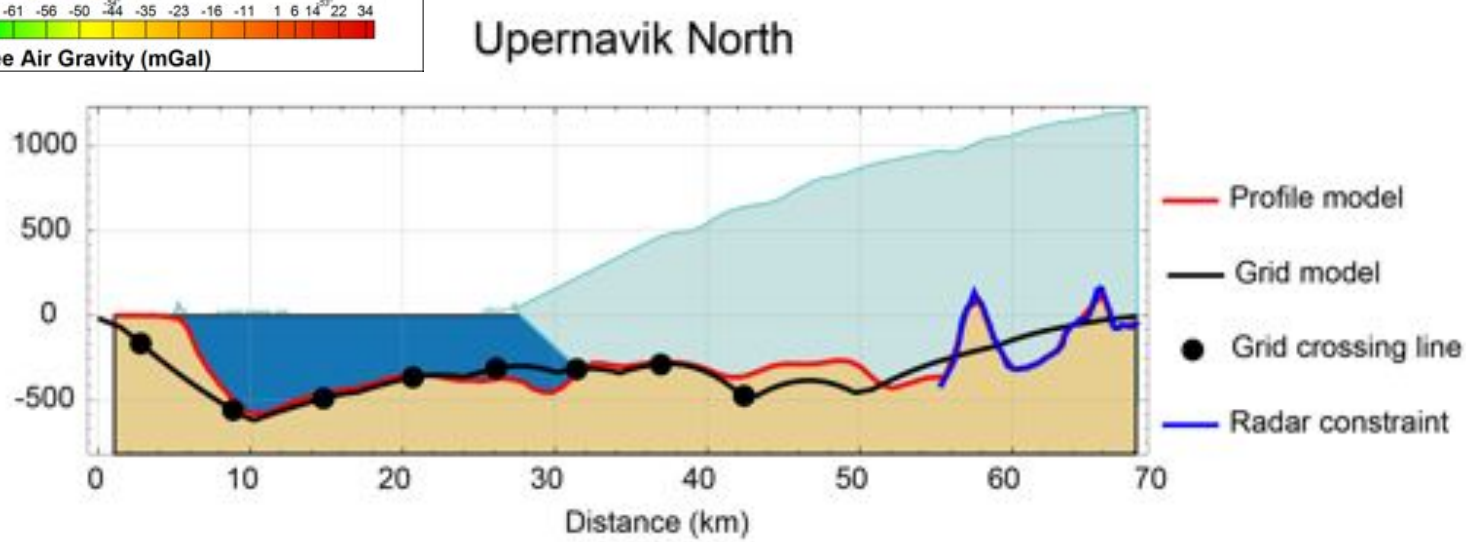
- STEP1: Construct model
  - Grid datasets
  - Upward continue gravity grid to constant survey elevation
- STEP2: Establish geology
  - Use magnetometer to define boundaries
- STEP3: Invert gravity for bathymetry
  - GMSys3D, Parker (1972)

Profiles and grids: Upernavik



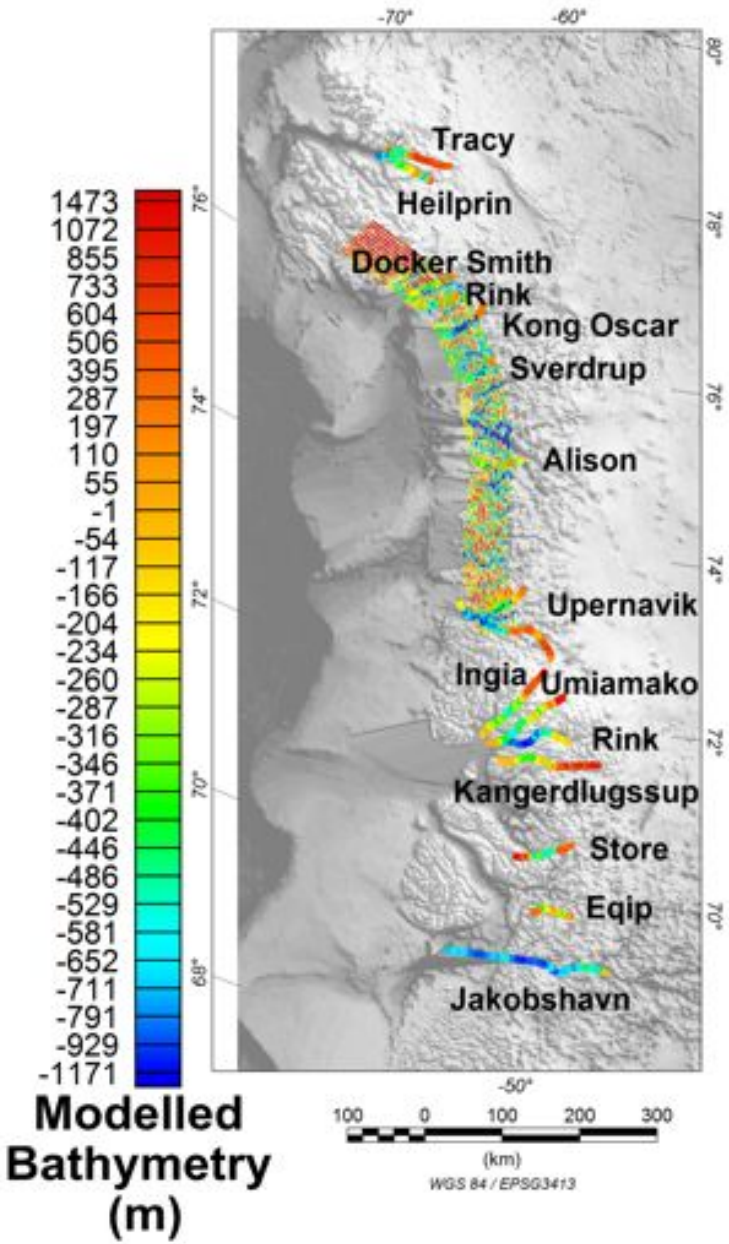
- **Profiles:** identify sills and are tuned to local constraints
- **Grids:** identify pathways and are consistent between lines.
- **Models:** may have mismatches – grid may underestimate full amplitude

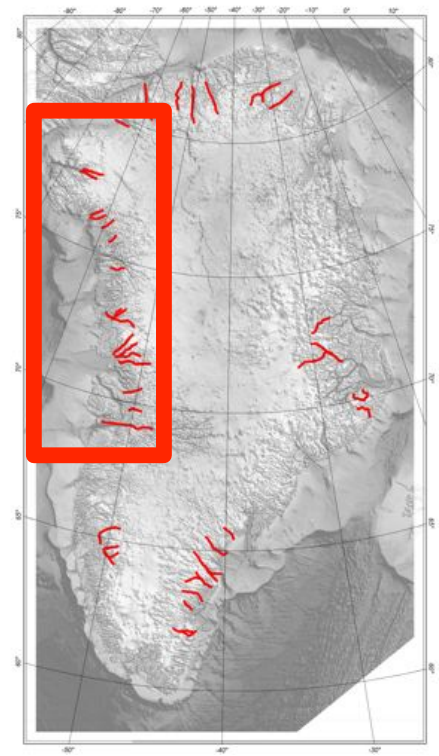
- Ongoing efforts to integrate models



RMS 2D-3D = 110 m

Northwest

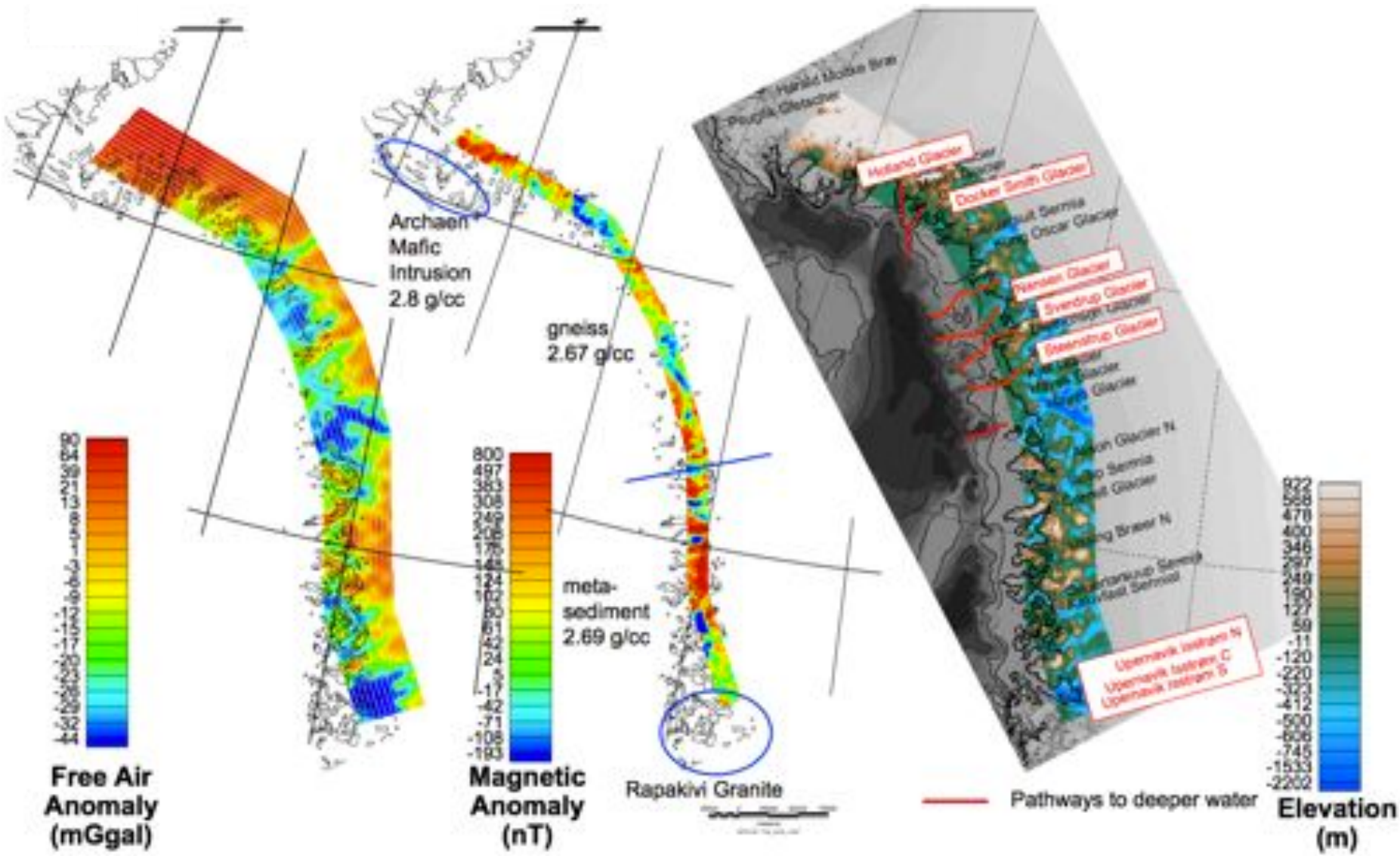




- 15 Glaciers
- 8 with sills
- Pathways across the continental shelf – from grids
(2 more flights would close the gap)

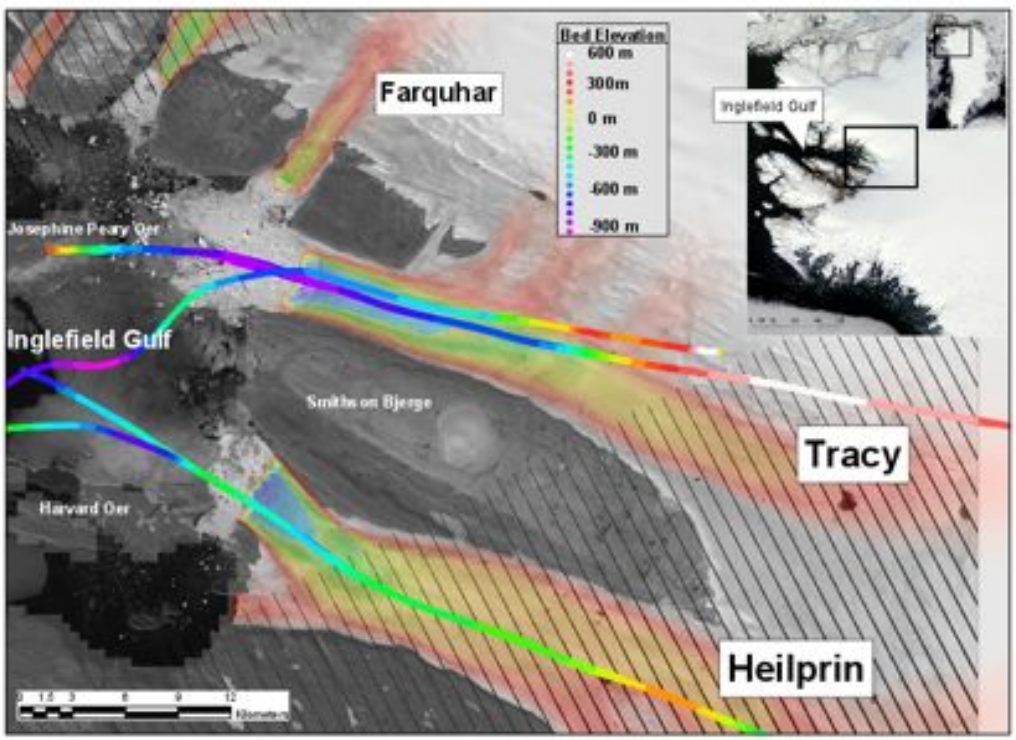
- Grounding line depth v. mass balance

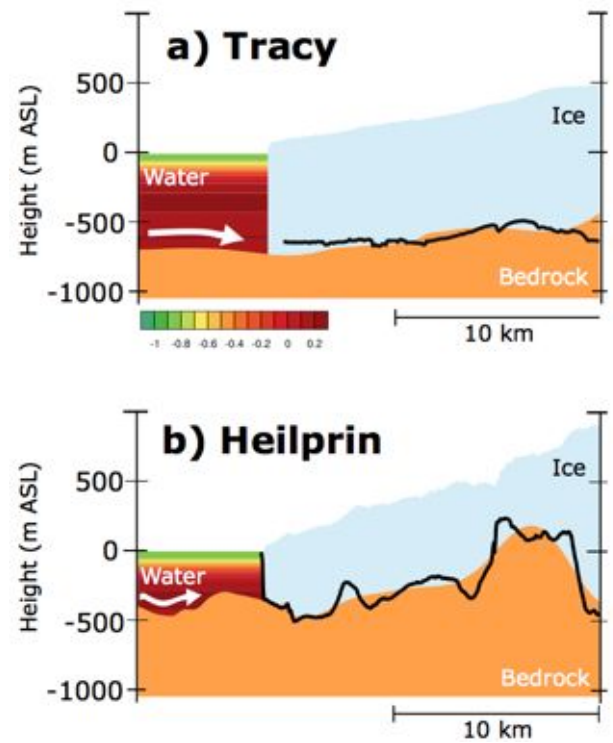
Pathways – from grids



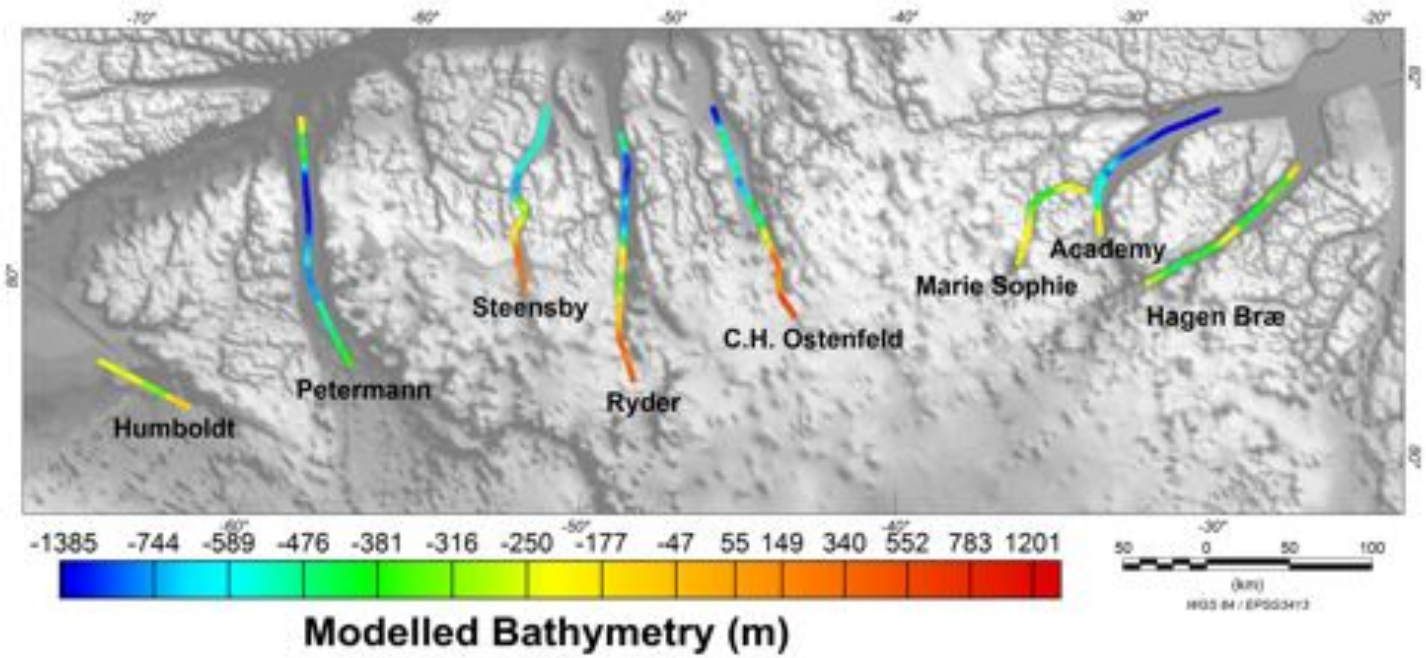
Grounding line depths – from profiles

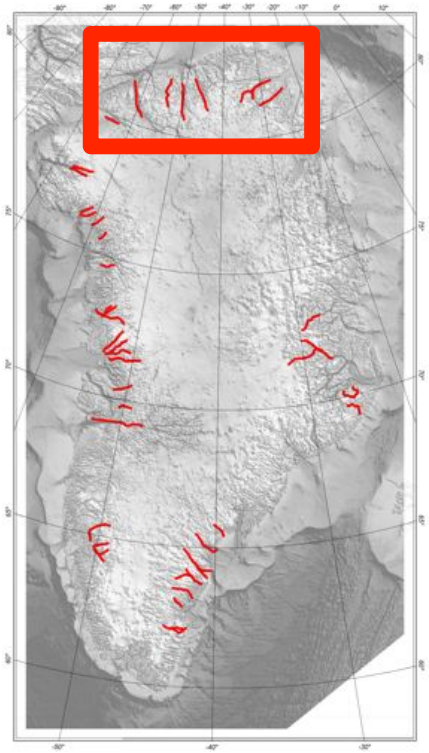
- Porter et al.
  - Tracy v. Heilprin
  - 39 grounding line depths modelled





North

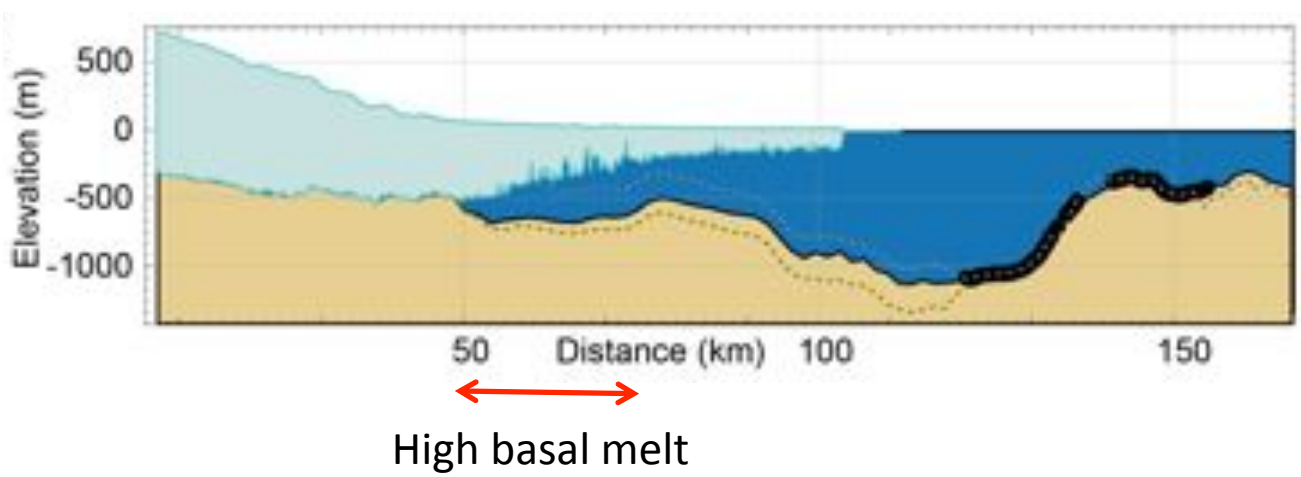


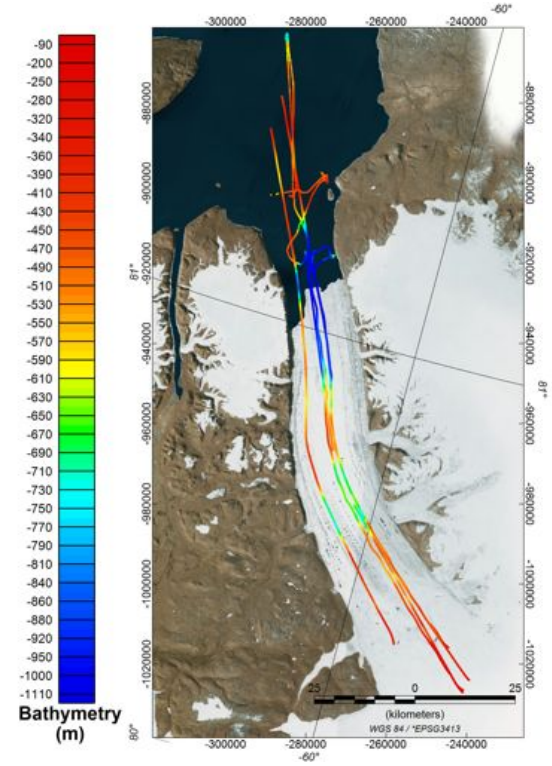


- 8 Glaciers
- Long, deep fjords (Petermann, Ryder, Academy)
- Identification of sills

Sill presence – fjord axis profiles

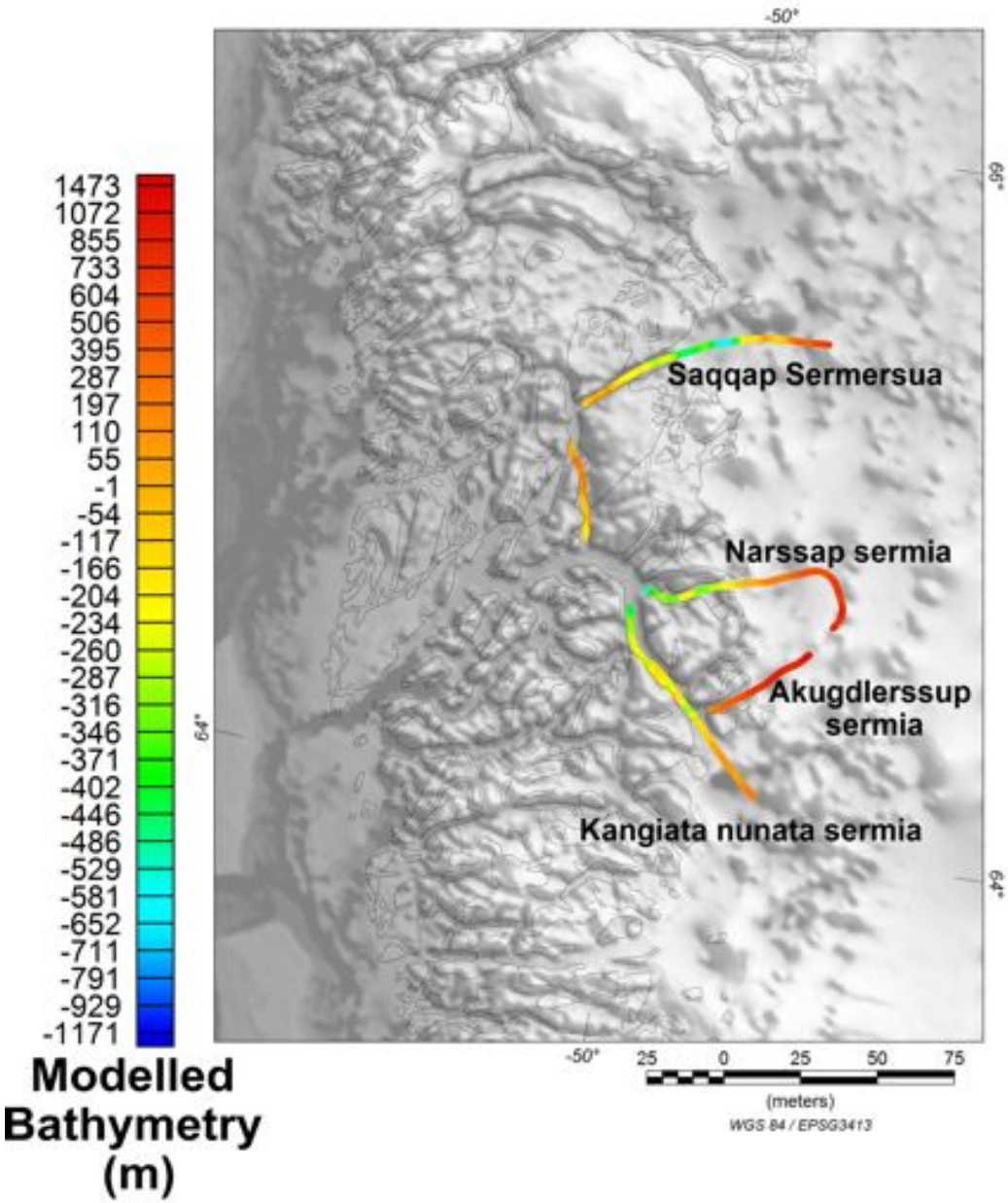
Petermann Glacier

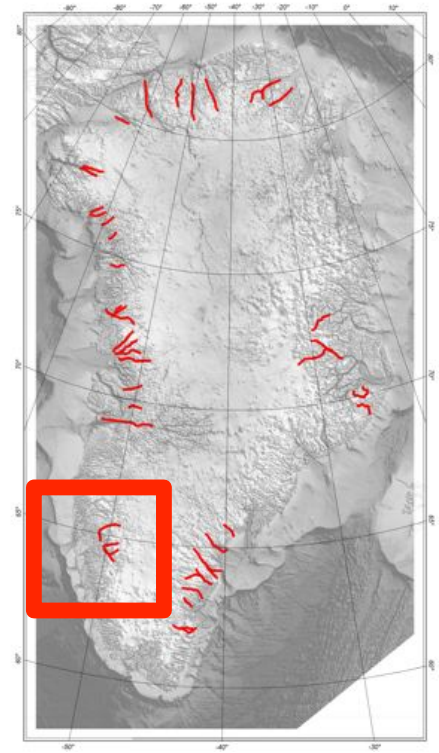




- Sills in the outer and inner fjord
- Geological control on their position (faults and formation boundaries)

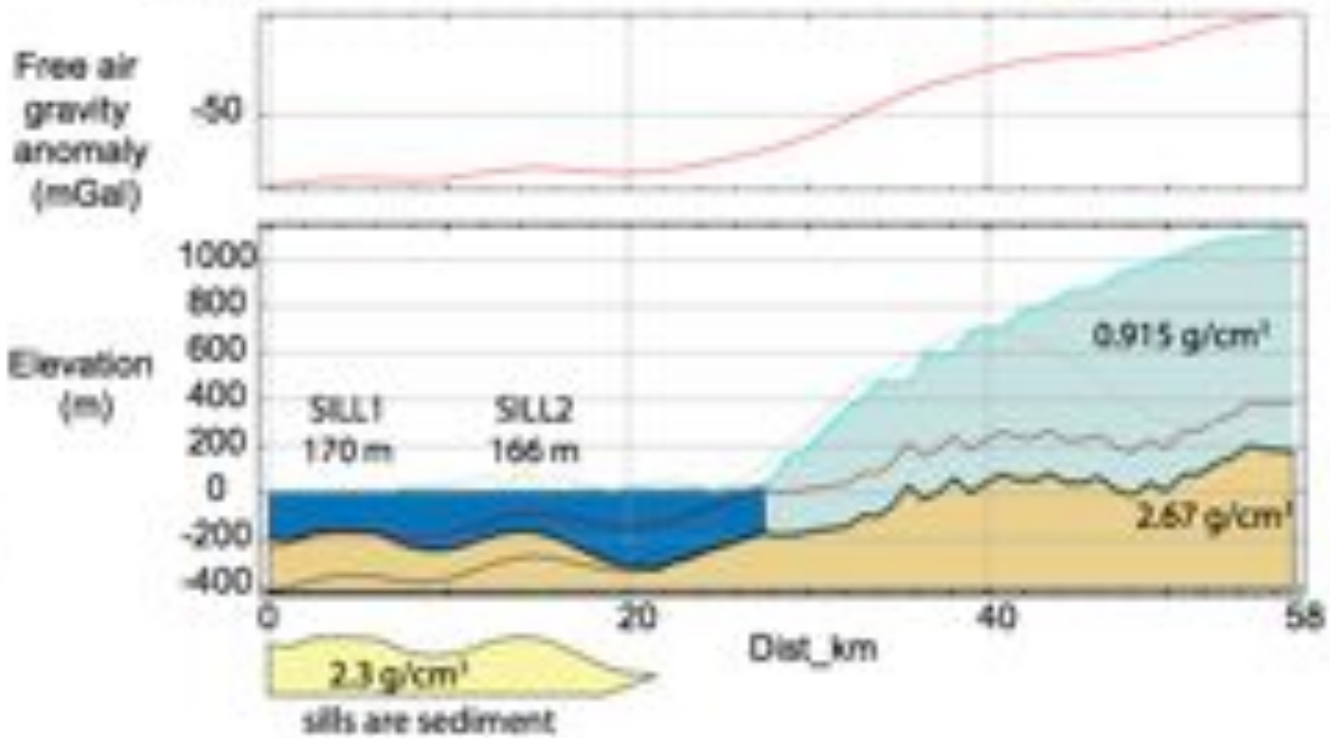
Southwest

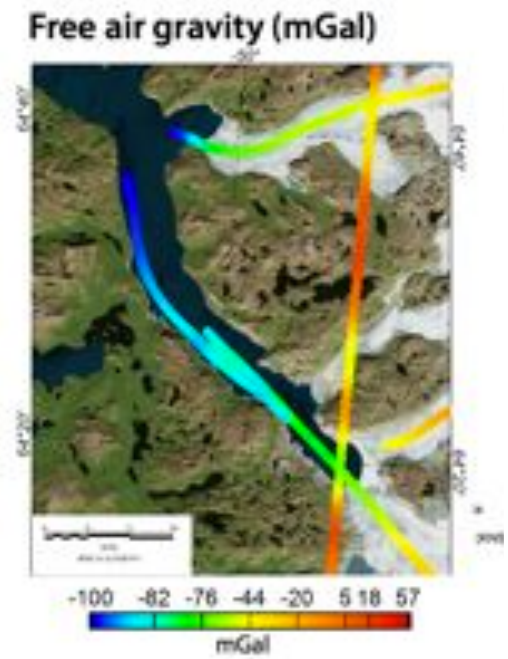




- 4 Glaciers
- Identify bed under grounded ice (difficult radar target)
- Mapping in fjord suggests sediment sills

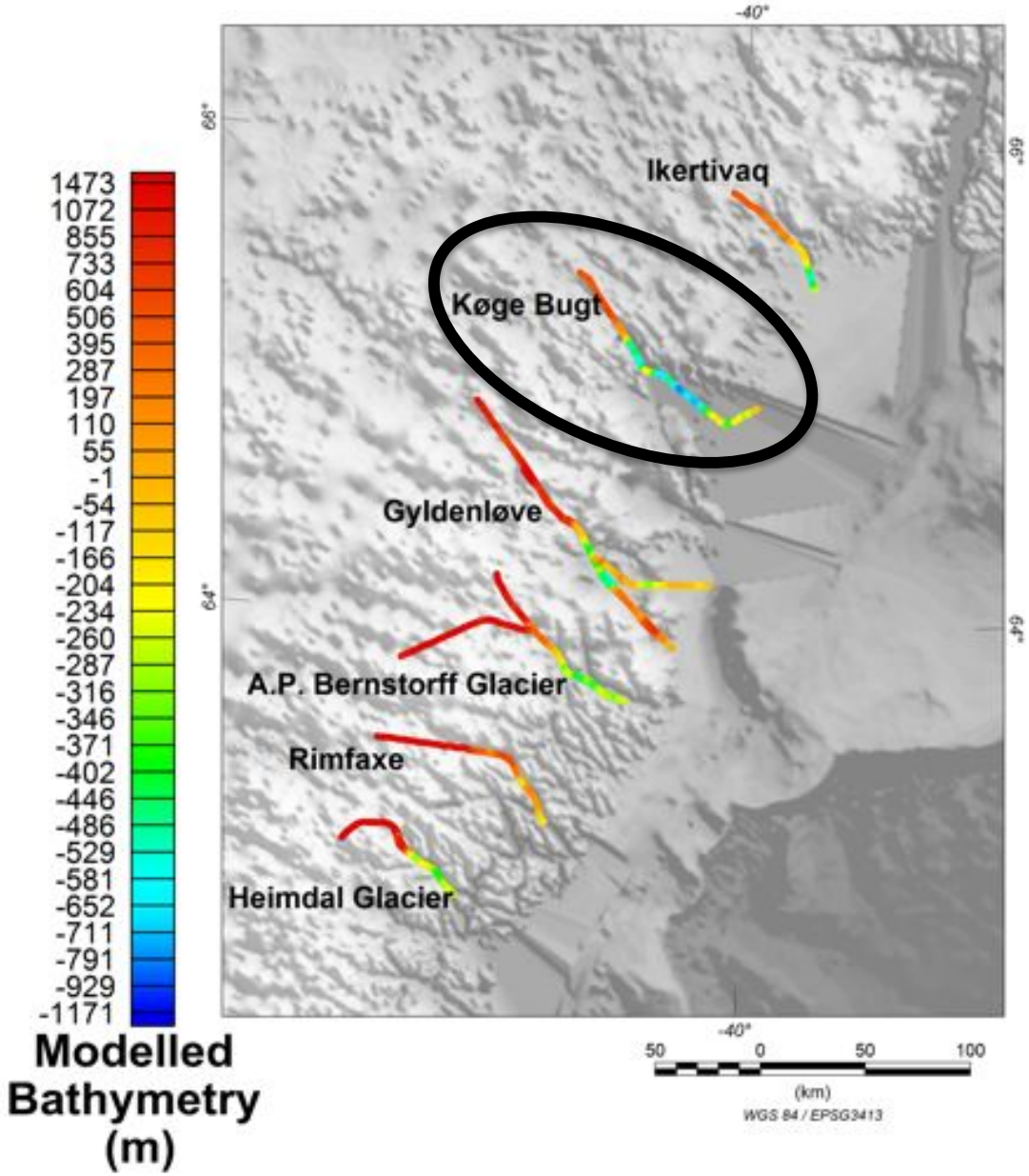
Sediment sills



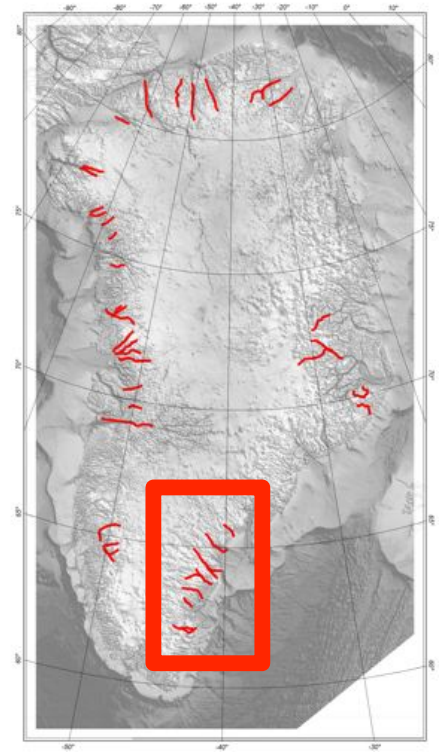


- Two sills resolved by gravity
- Elevations known (Mortensen, 2013)
- Sediment wedge required to meet constraints

Southeast



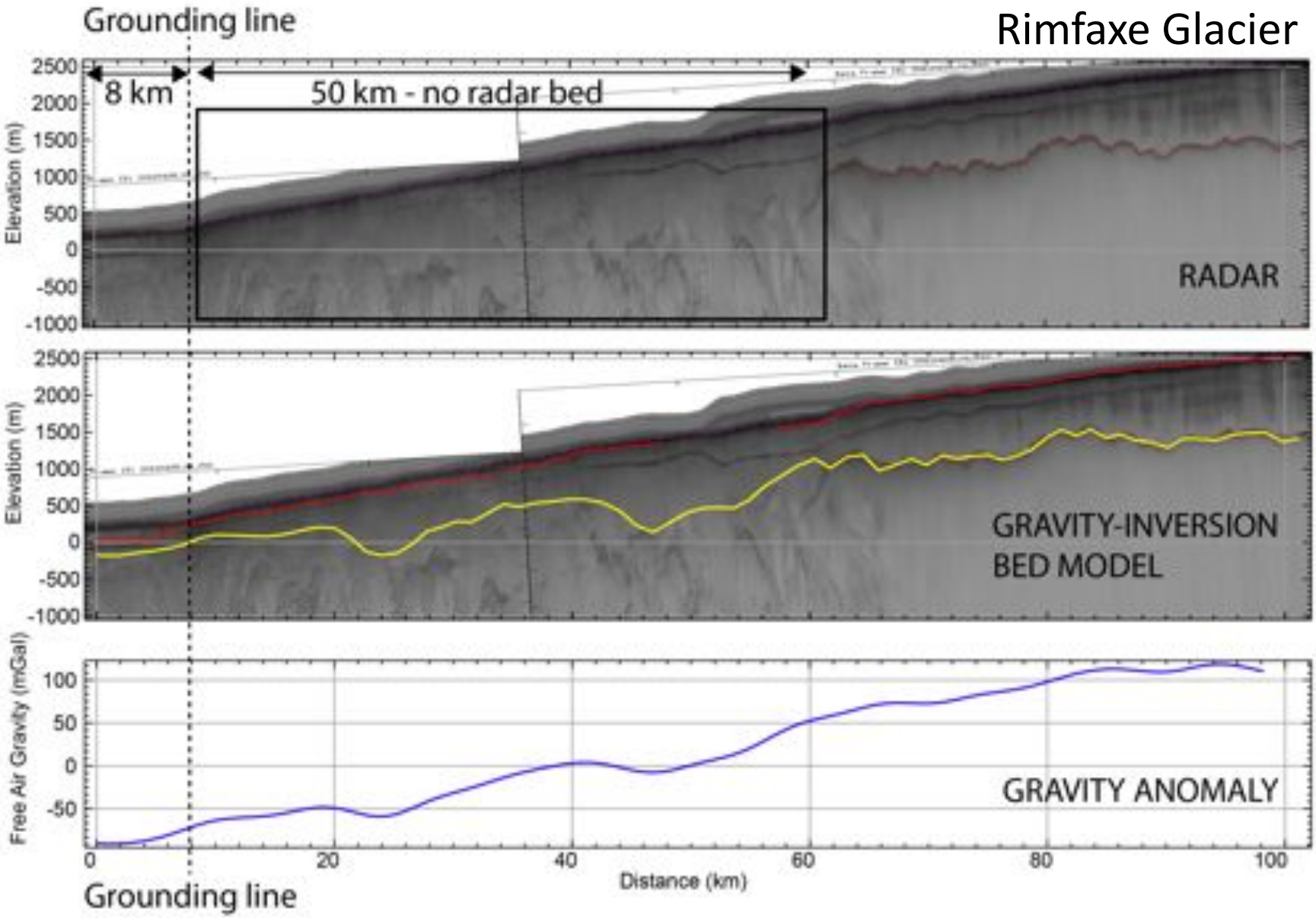
Koge Bugt
800 m max depth

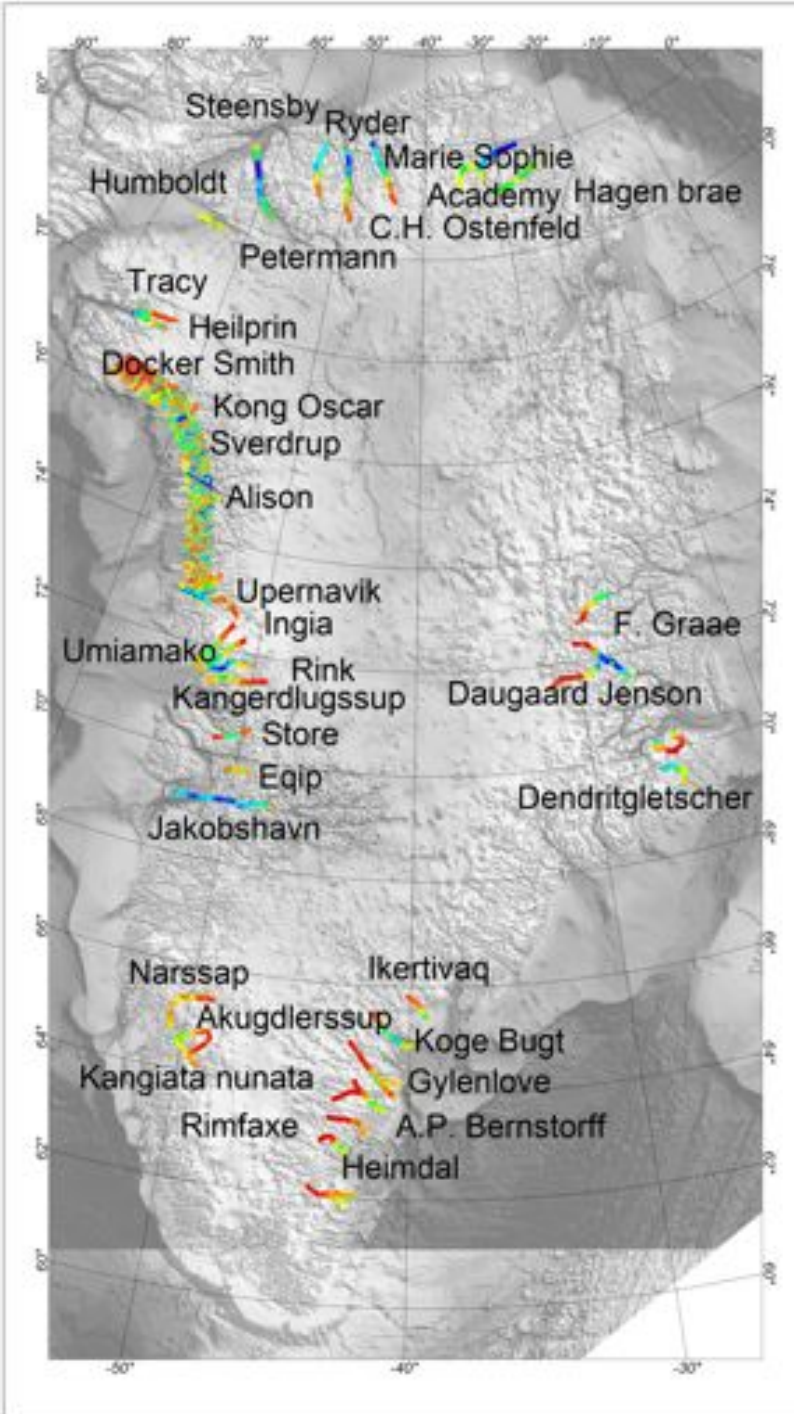


- 6 Glaciers
- Identify bed under grounded ice (difficult radar target)
- Offshore marine constraints would extend model

Grounded ice depths

Rimfaxe Glacier





OIB Bathymetry Level 4

Greenland

- 44 glaciers from all regions (January 2014)
- 67 profiles
- Grid in NW Greenland (January 2014)

- Models improved with marine constraints
- NE underway
- Gap on shelf in NW
- Missing bed in SE

http://nsidc.org/data/igbth3.html