POLAR SCIENCE FOR PLANET EARTH

Influence of subglacial conditions on ice stream dynamics: Seismic and potential field data from Pine Island Glacier

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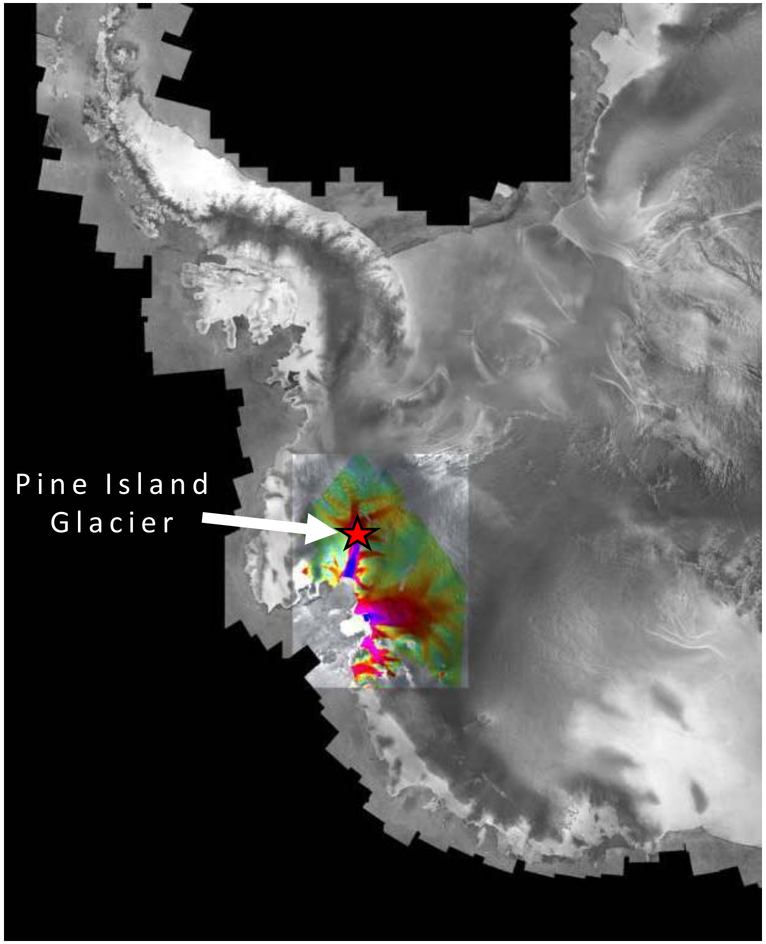
Pine Island Glacier

Importance – contribution to SL

- Fieldwork
- Data & results
- Implications & iSTAR Programme

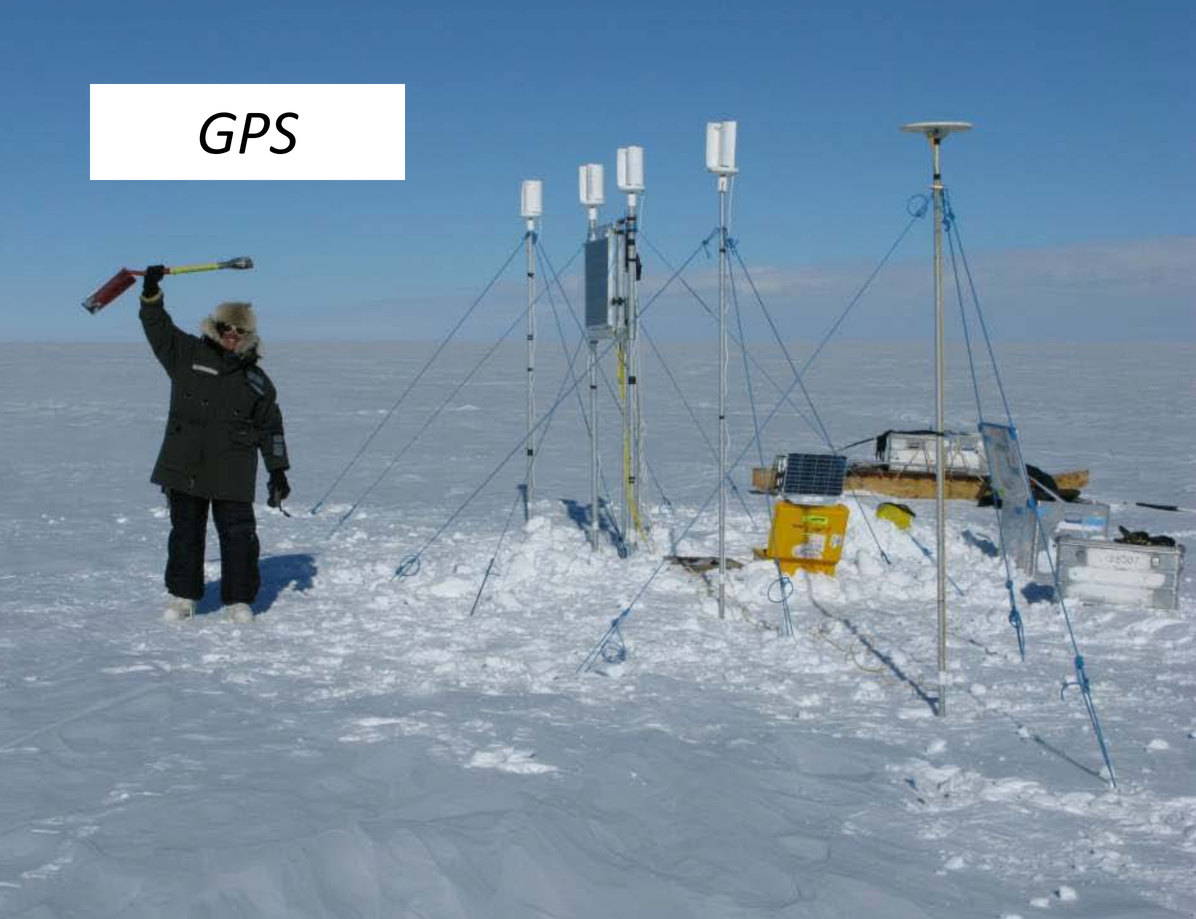


Wind

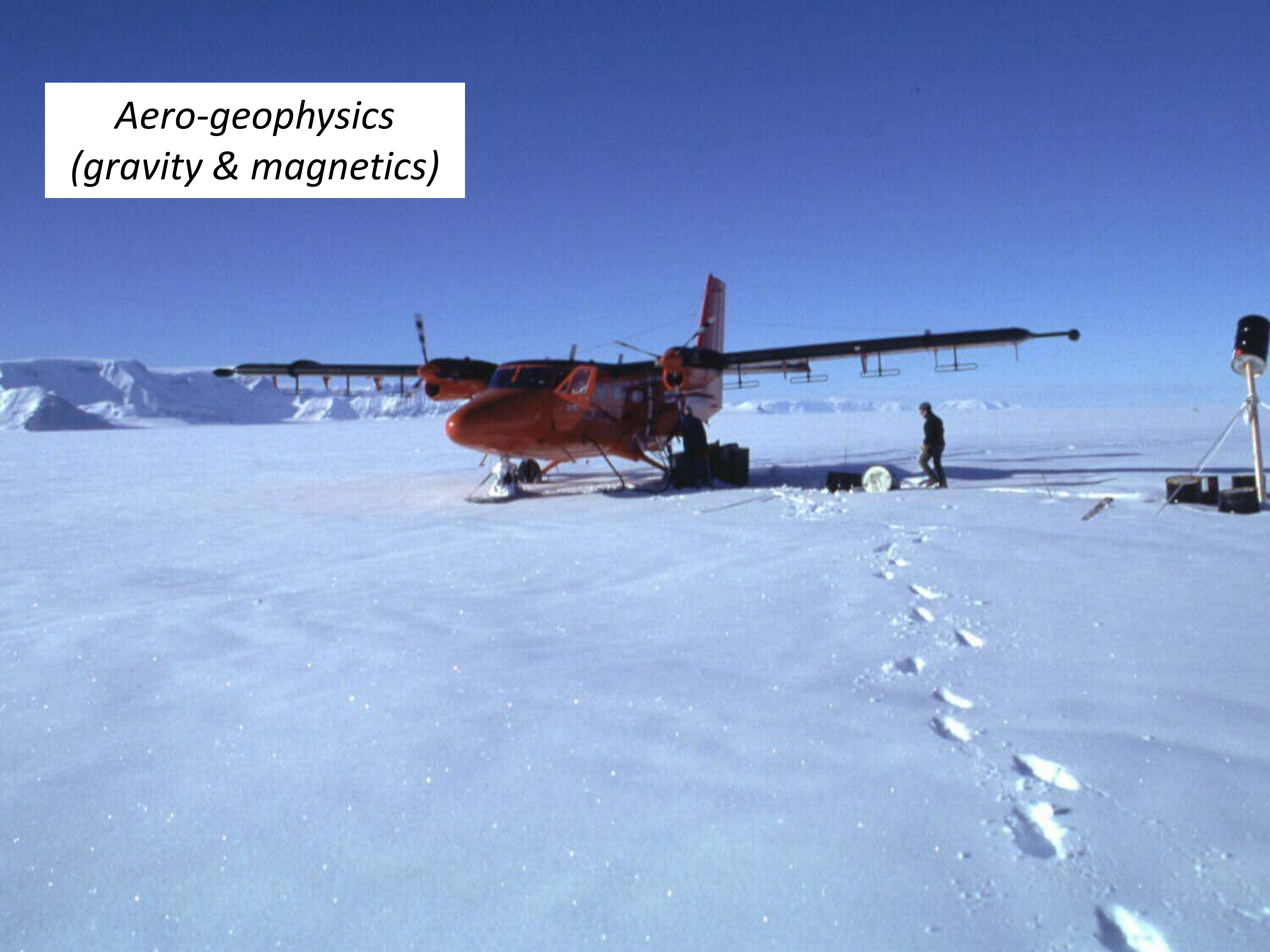
Digging


Seismics

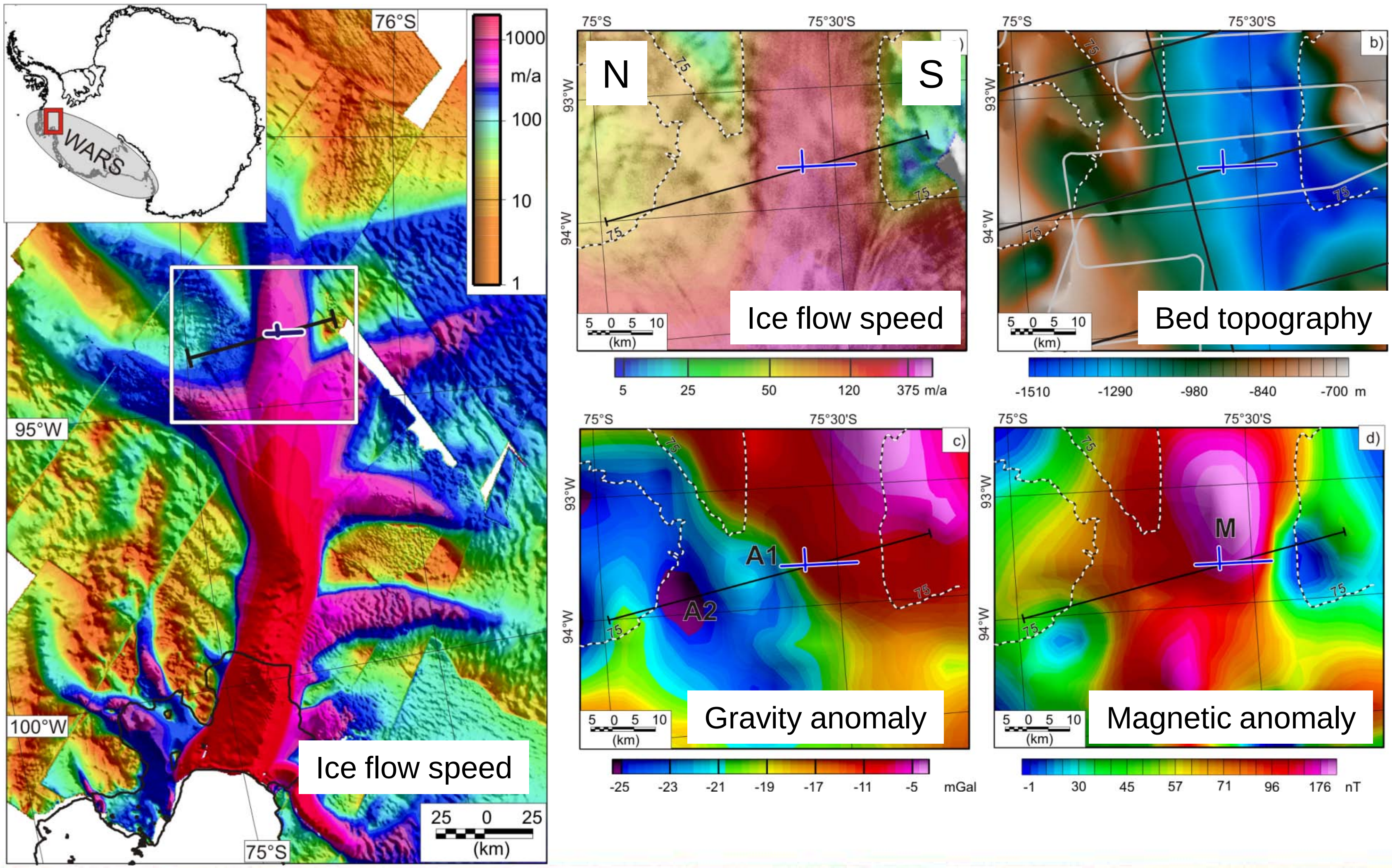
GPS



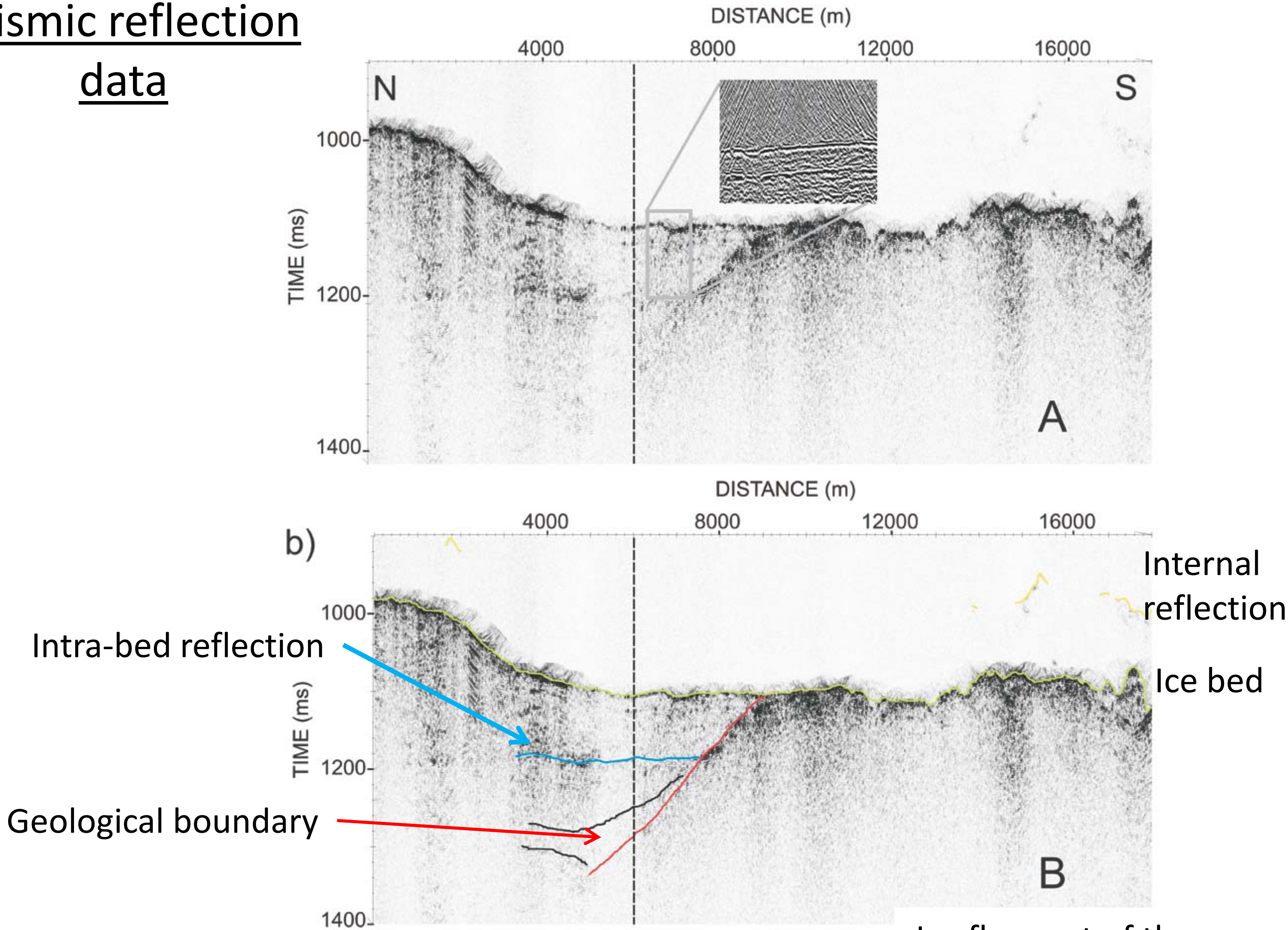
Aero-geophysics (gravity & magnetics)



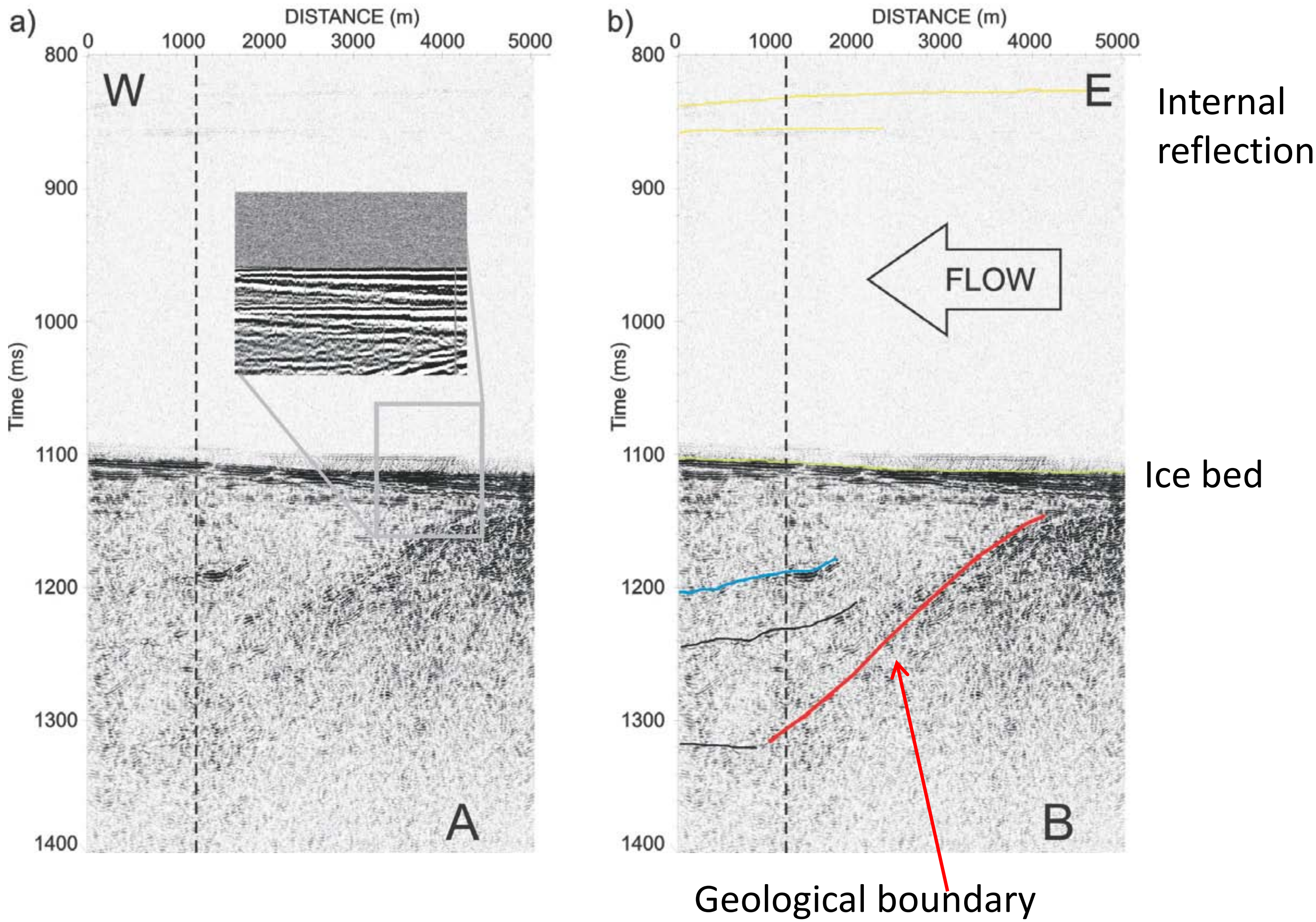
Subglacial conditions and ice flow



Seismic reflection data

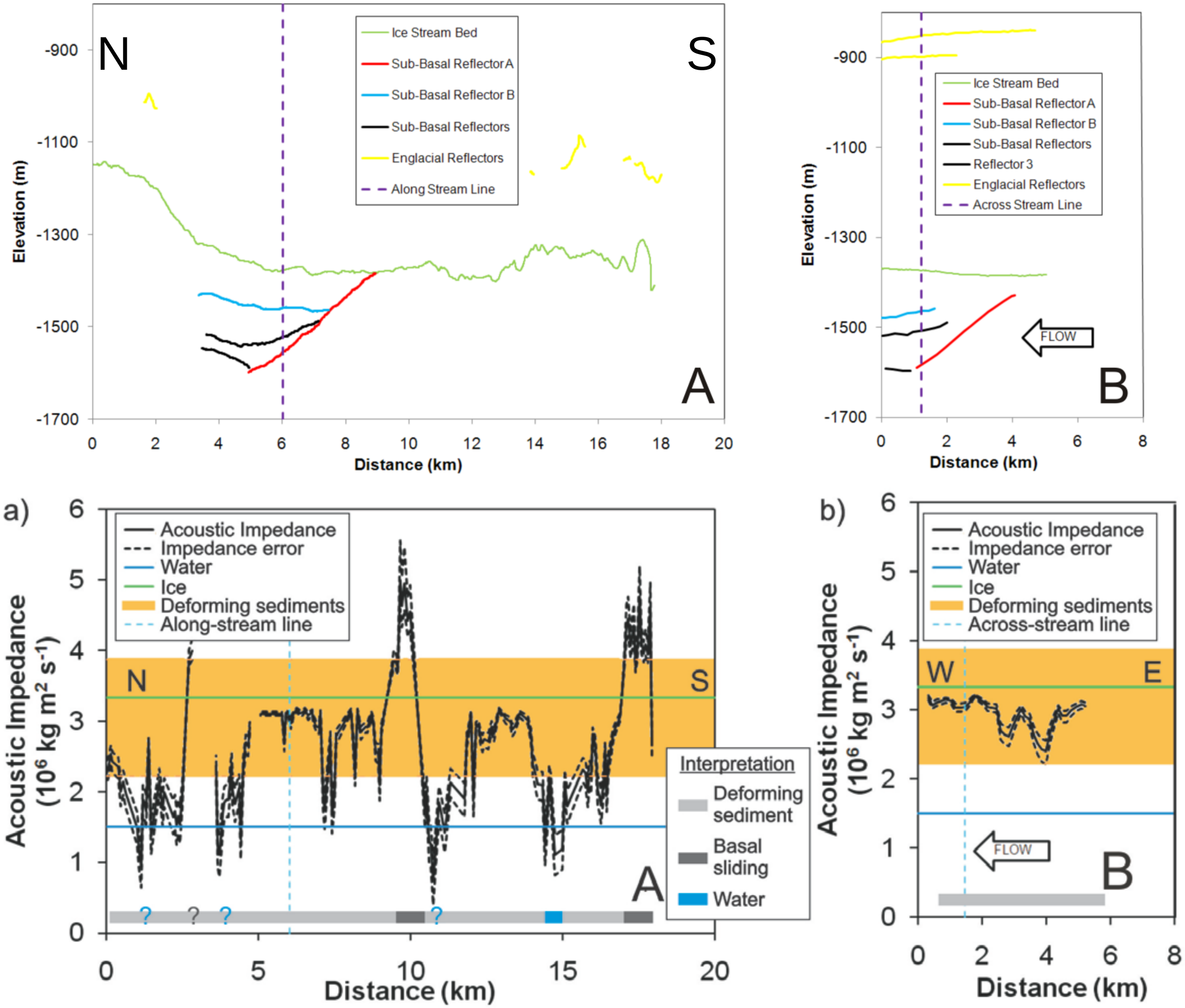


Ice flow out of the screen

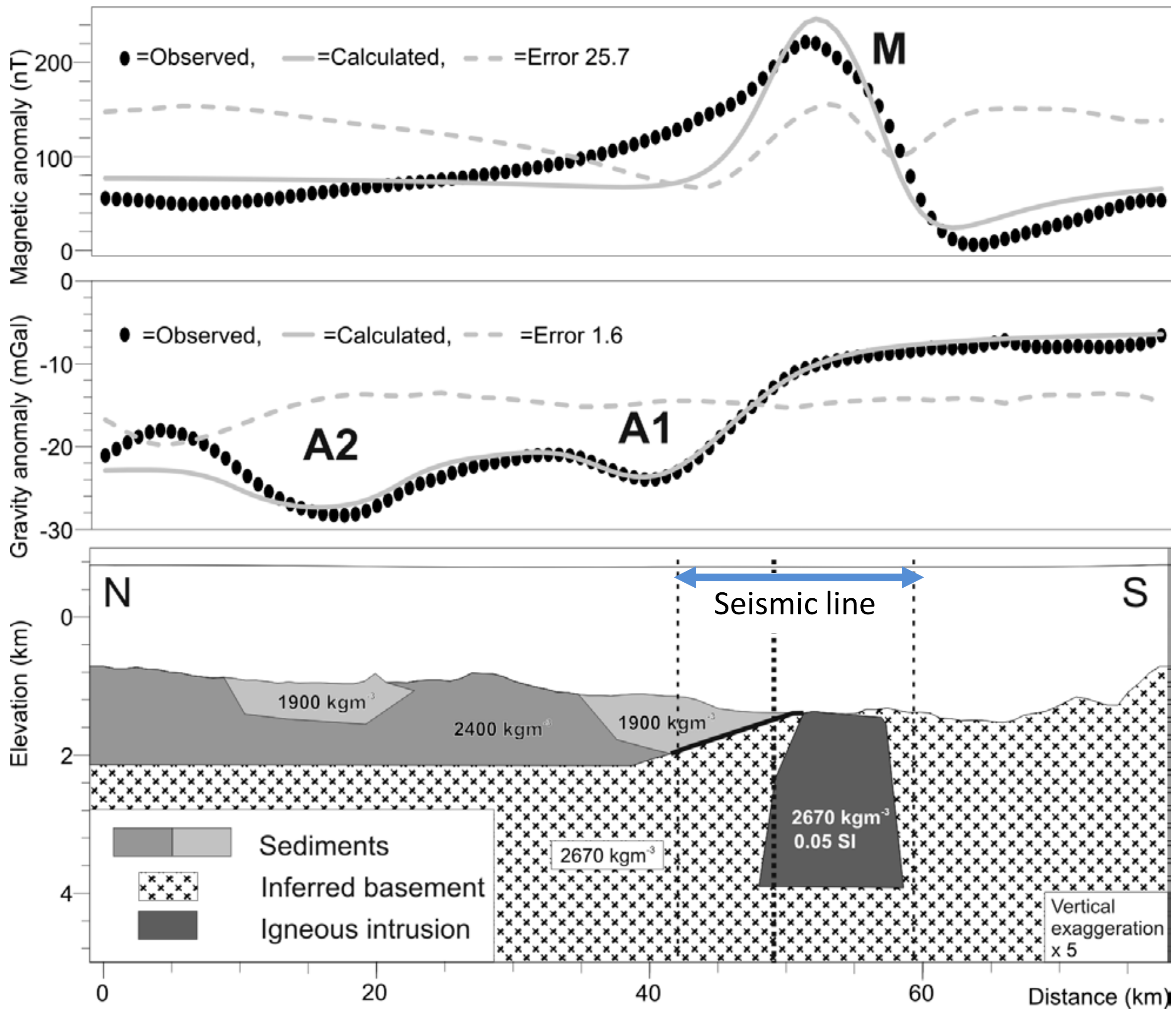


a)
DISTANCE (m)
0
1000
2000
3000
4000
5000
800
900
1000
1100
1200
1300
1400
Time (ms)
W
A
b)
DISTANCE (m)
0
1000
2000
3000
4000
5000
800
900
1000
1100
1200
1300
1400
Time (ms)
E
FLOW
B
Internal reflection
Ice bed
Geological boundary

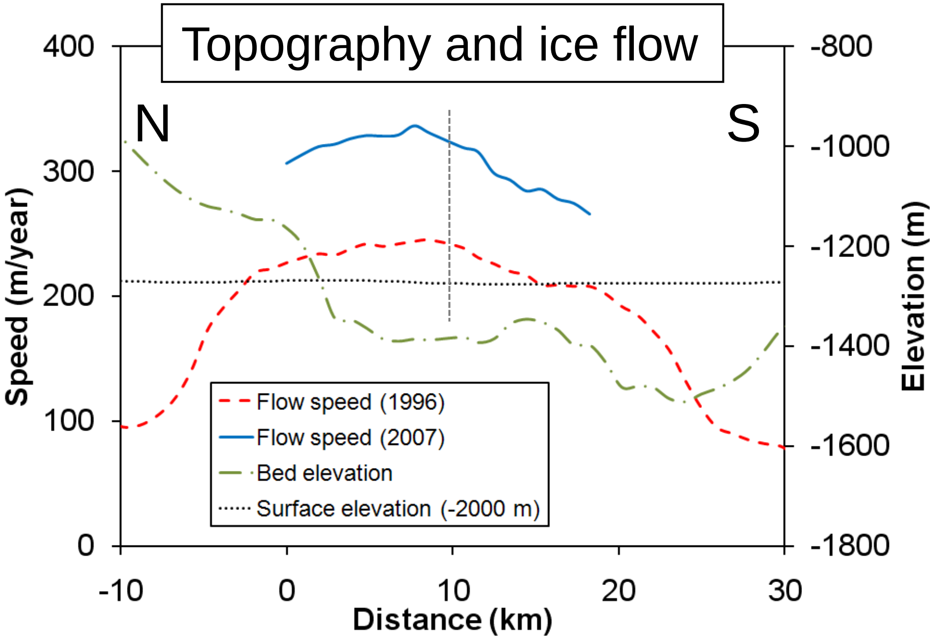
Structure and properties

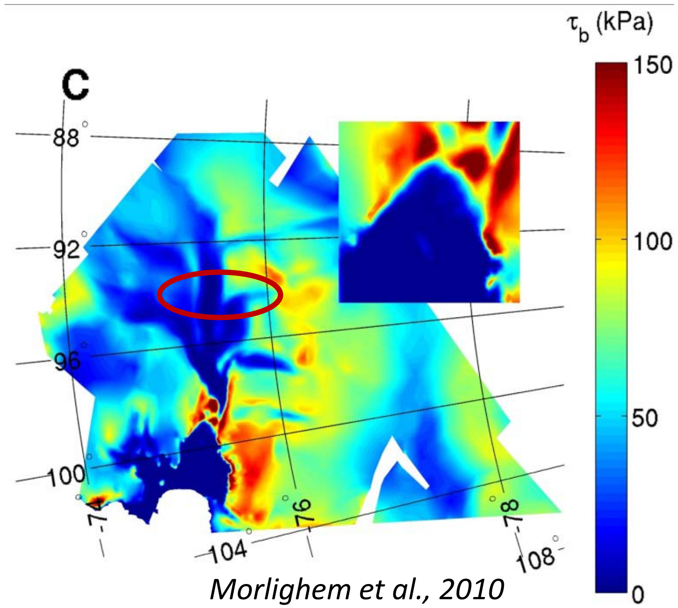


Airborne potential field data



Glaciological data

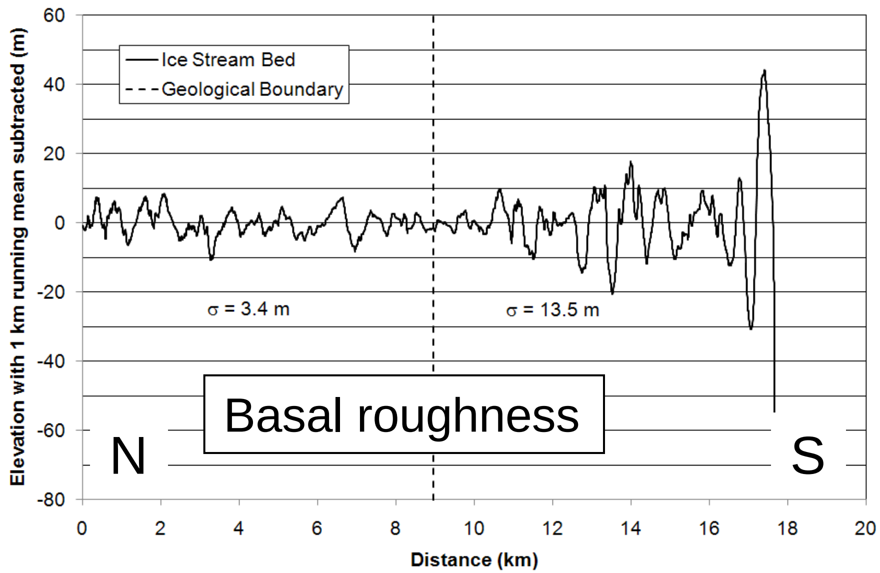




Morlighem et al., 2010

Basal drag

Ice flow, out of the screen



Summary:

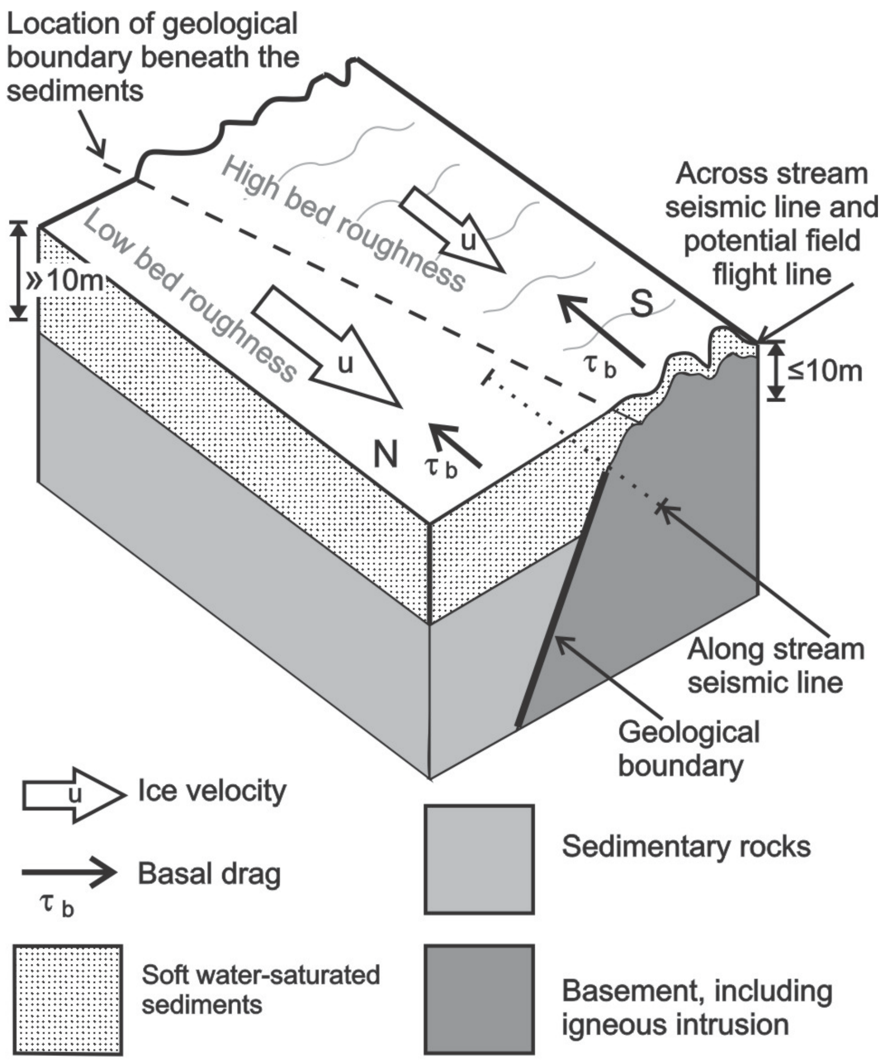
Changes in measured parameters crossing the geological boundary

Measured parameter	**Change across geological boundary (N to S)**	**Quantify change**
Ice velocity	Decrease	325 to 290 ma^{-1}
Basal drag	Increase	3.4 to 7.8 kPa
Bed roughness	Increase	σ = 3.4 m to σ = 13.5 m
Sediment acoustic impedance	No significant change	No change (mean = 2.9 x10^6 kg m^2 s^{-1})
Sediment thickness	Decrease	>>10 m to ≤10 m
Potential field (gravity & magnetic)	Yes	Sedimentary basin to Basement rocks

Interpretation

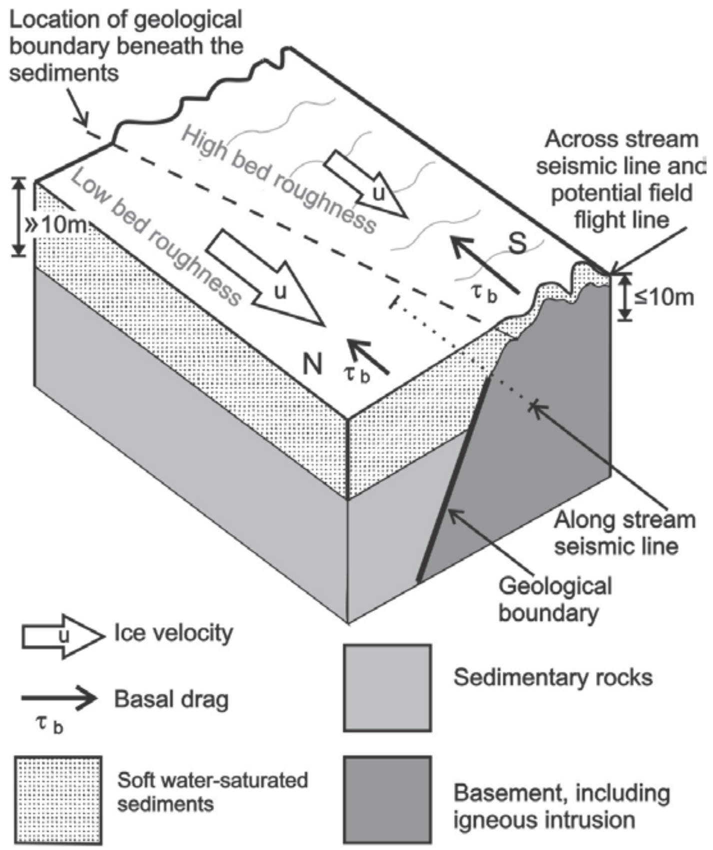
CHANGES:
- **Ice velocity**
- **Basal drag**
- **Bed roughness**
- **Deeper geology**

NO CHANGE:
- **Immediate sub-ice geology**



Conclusions

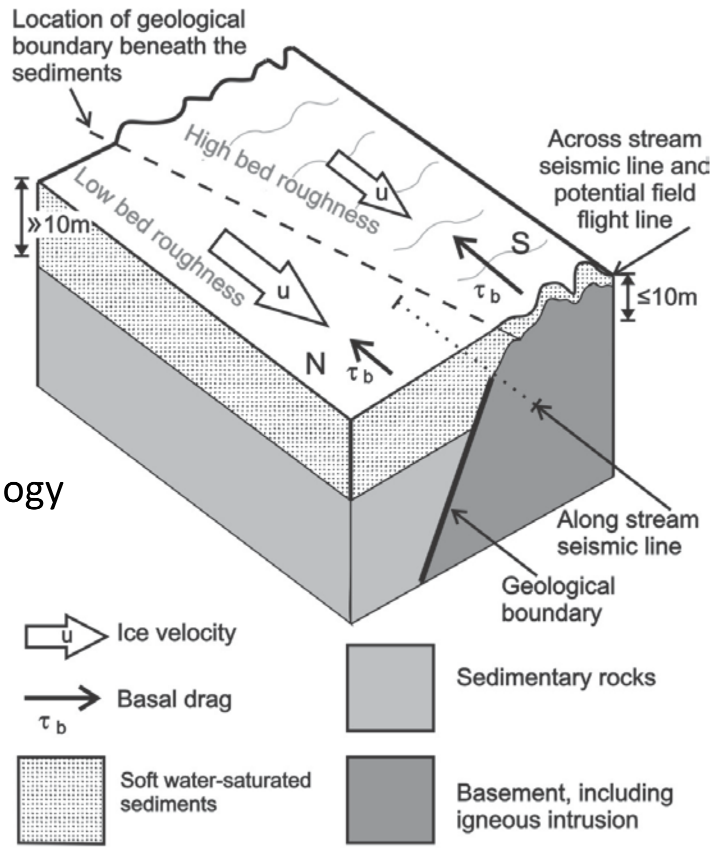
- Shallow basement beneath sediments on the South side increases drag & roughness, slowing ice flow
- Deeper geology exerting control on ice flow through the sediments
- Combined seismic & potential field interpretation essential
- Important?



Implications for basal processes?

- OPTION 1:
  Erosion could remove remaining sediments on South side, bring ice & basement into contact, further reduce ice flow?

- OPTION 2:
  Sediment supply maintained?



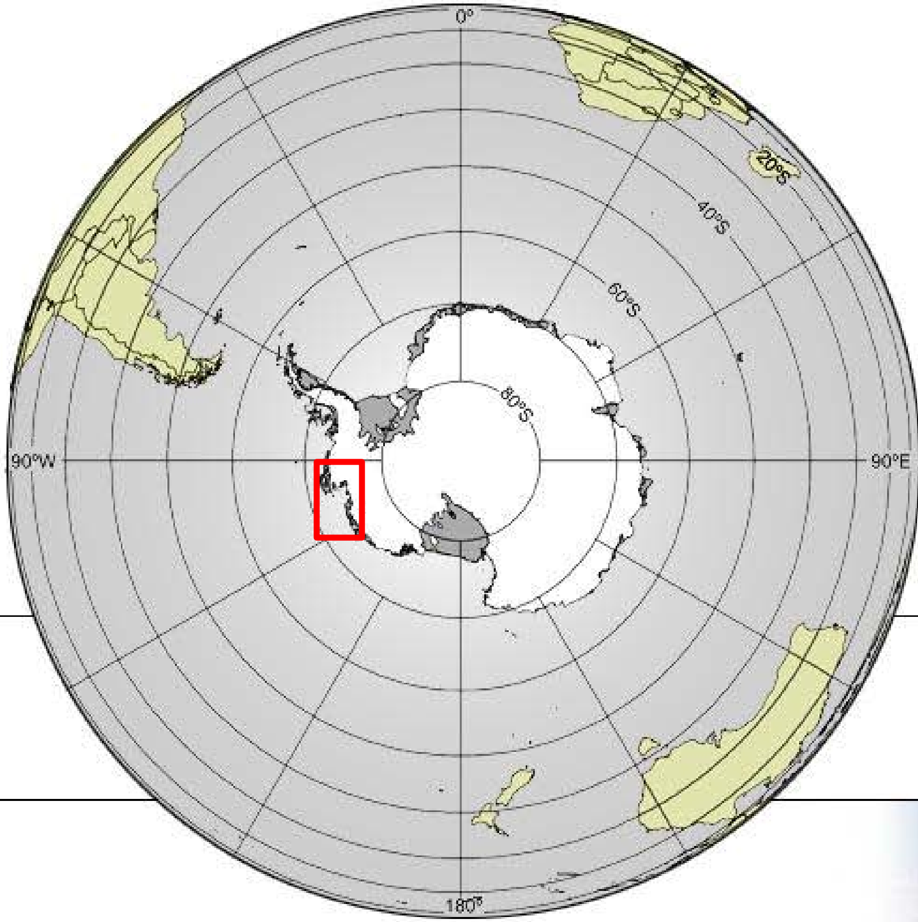
- Latter means - no change in ice flow
- Former means - flow changes controlled by subglacial geology

- Know erosion rates of ~1 m/a possible

- Pine Island Glacier – change within ~10 years?

Repeat surveys?

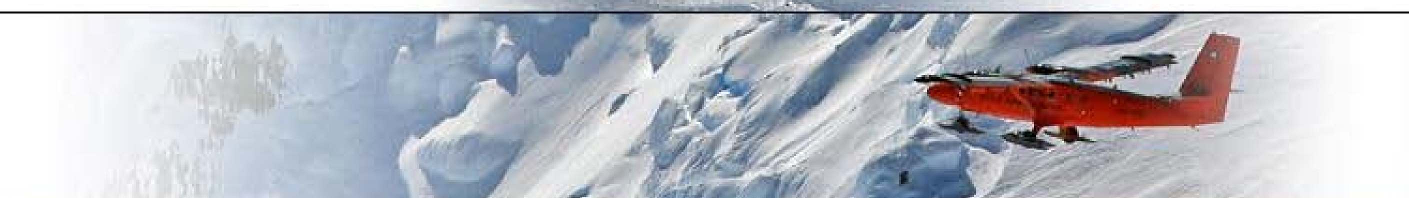
The iSTAR Programme



iSTAR

"Investigating the stability of the West Antarctic Ice Sheet"

- NERC funded
- 11 UK Universities, BAS & others (NSF)
- Ocean – Glacier – Basin



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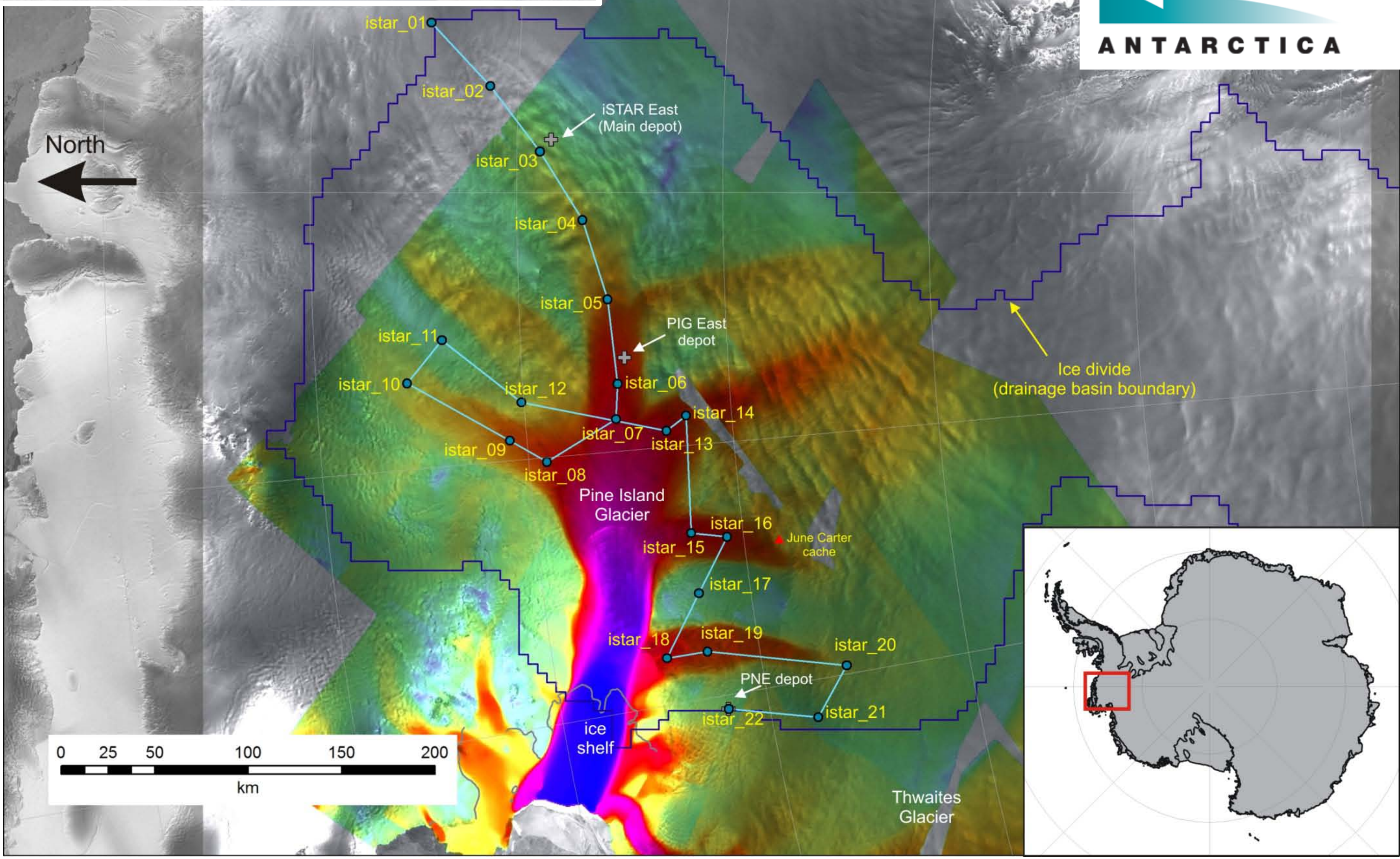

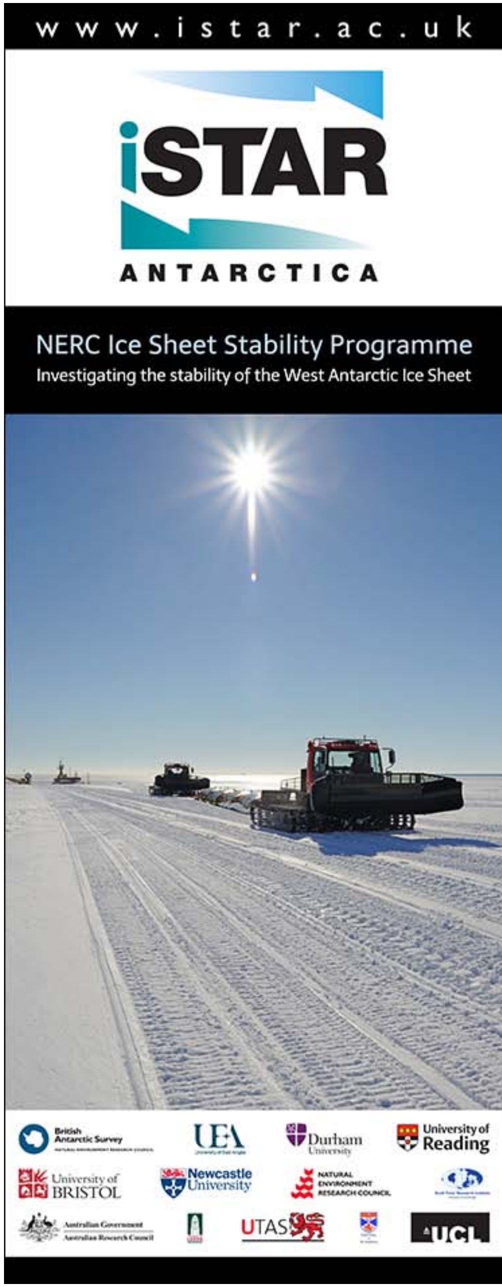
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