Surface topography and massflux of the Antarctic ice sheet in western Dronning Maud Land, derived by differential SAR interferometry

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GATEWAY ANTARCTICA

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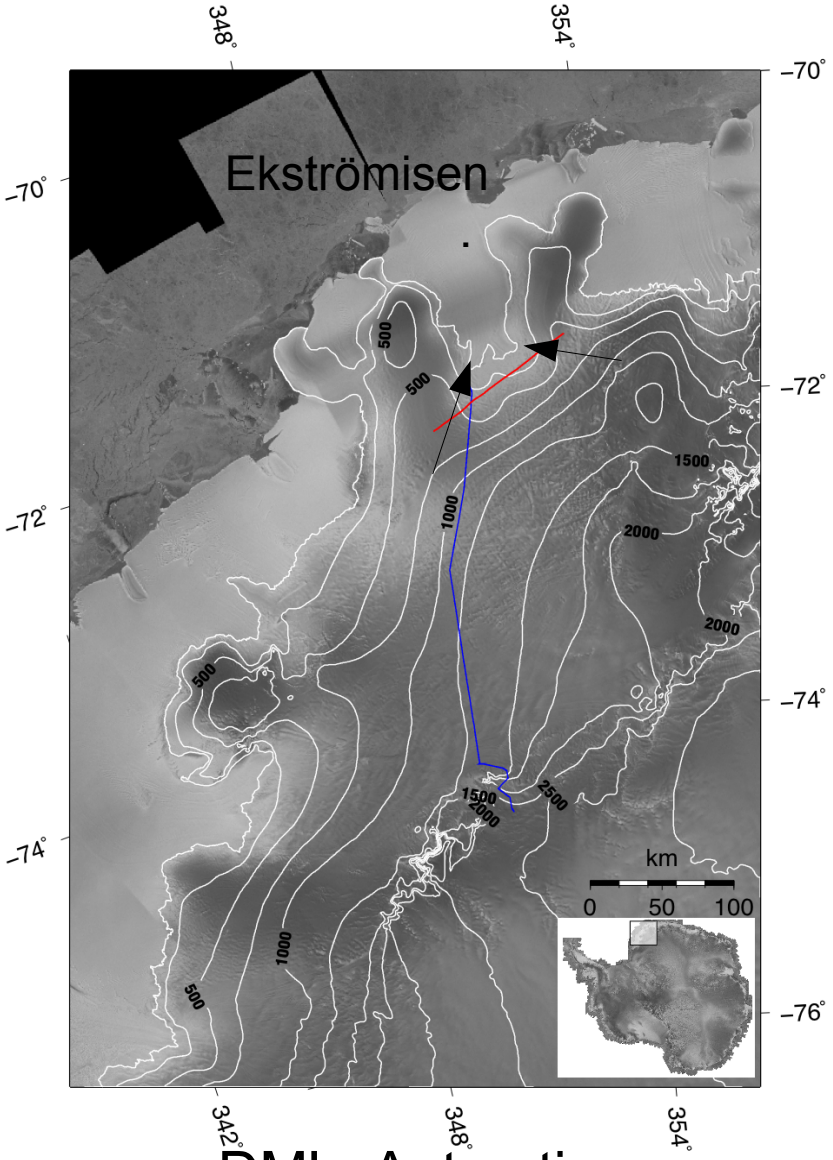
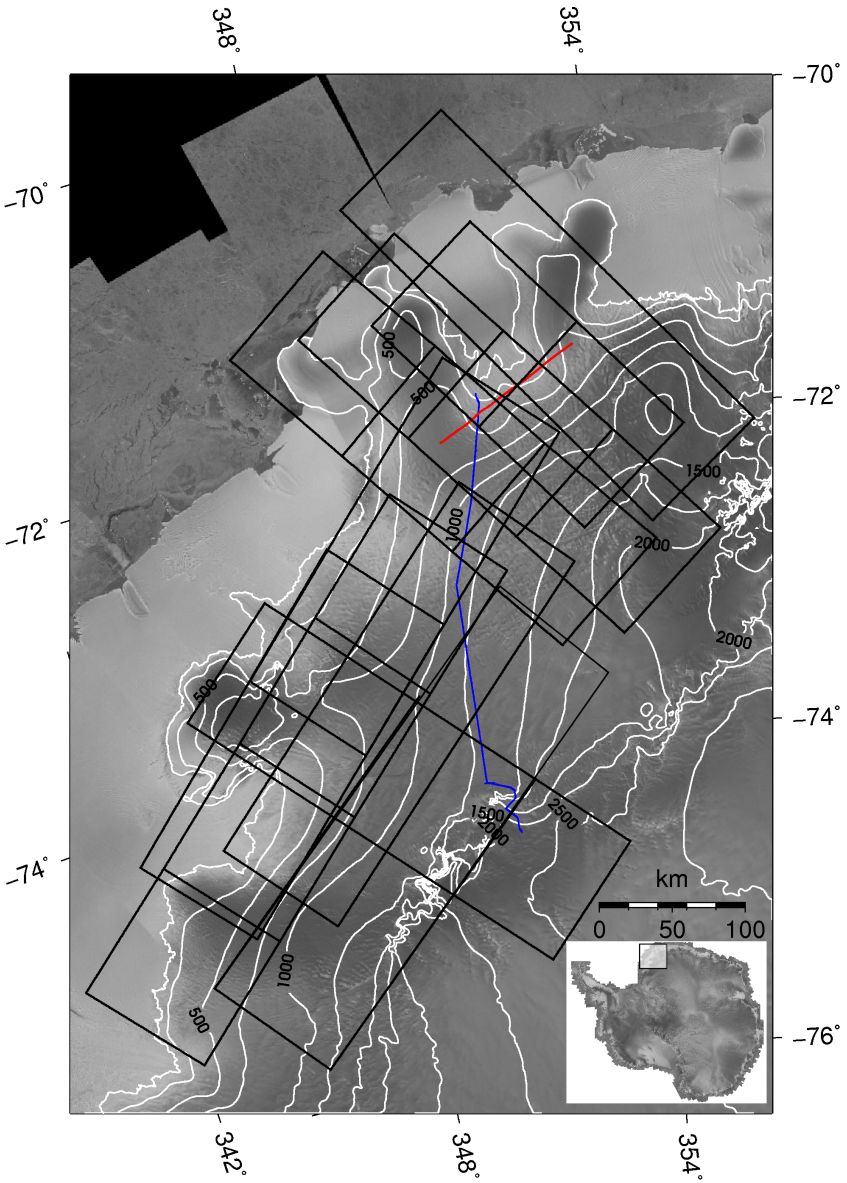
Objectives



DML, Antarctica

- Develop a new DEM via DinSAR
- Derive 3D – Flowfields
- Estimate Mass Flux into the Ekströmisen
- Map Accumulation

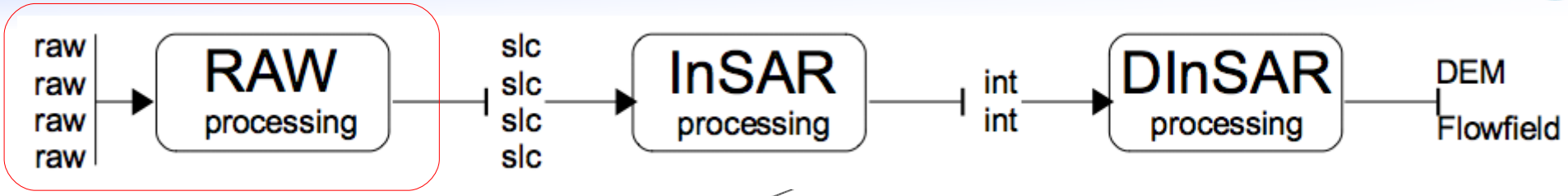
Data Set

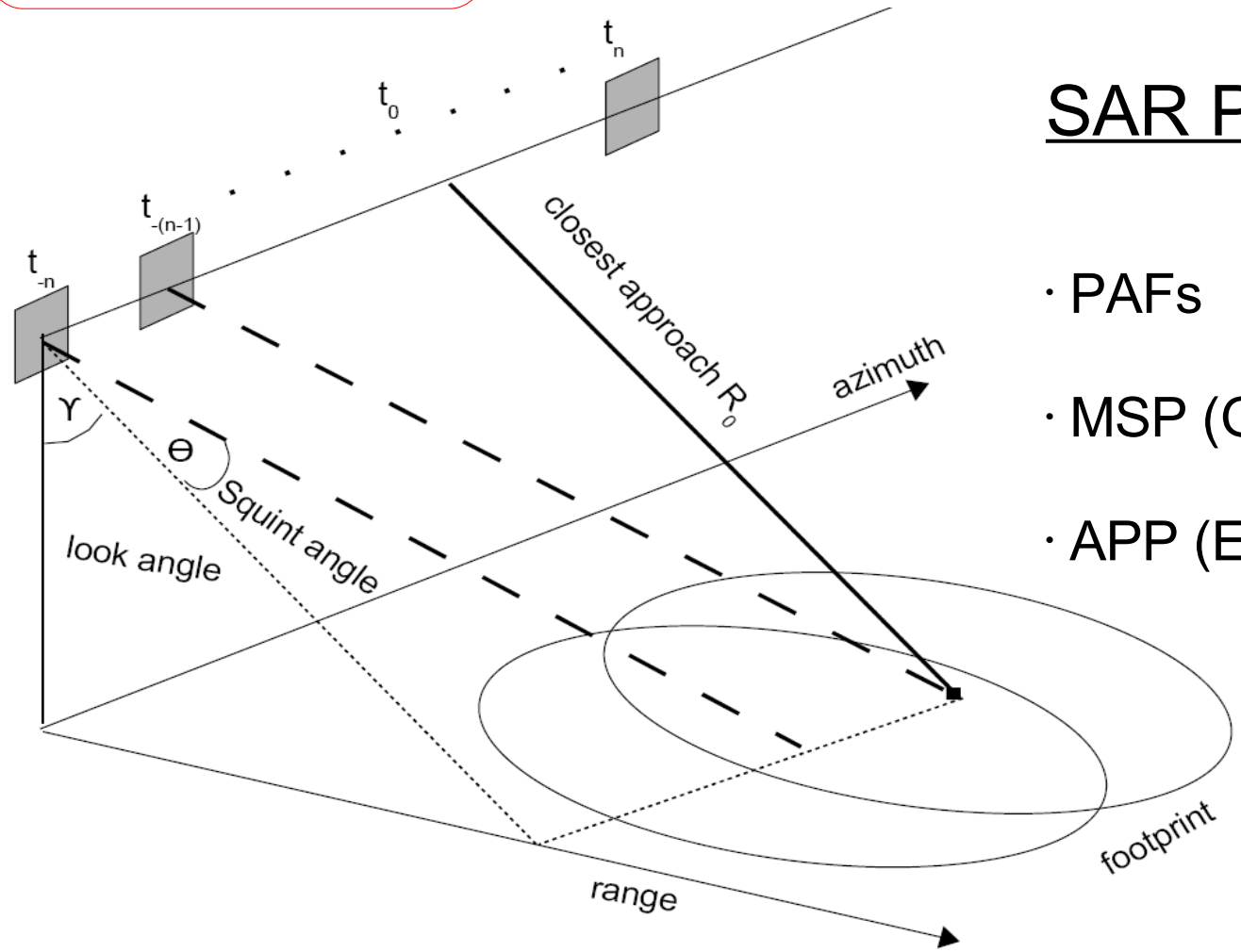


W - Dronning Maud Land, Antarctica

- 116 SAR scenes from ERS-1/ERS-2
- 19 digital elevation models
- area ~ 130 000 km²

Methodology





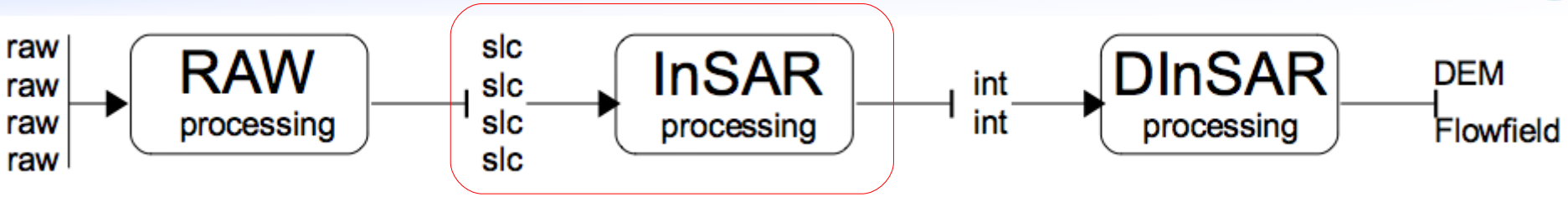
SAR Processors

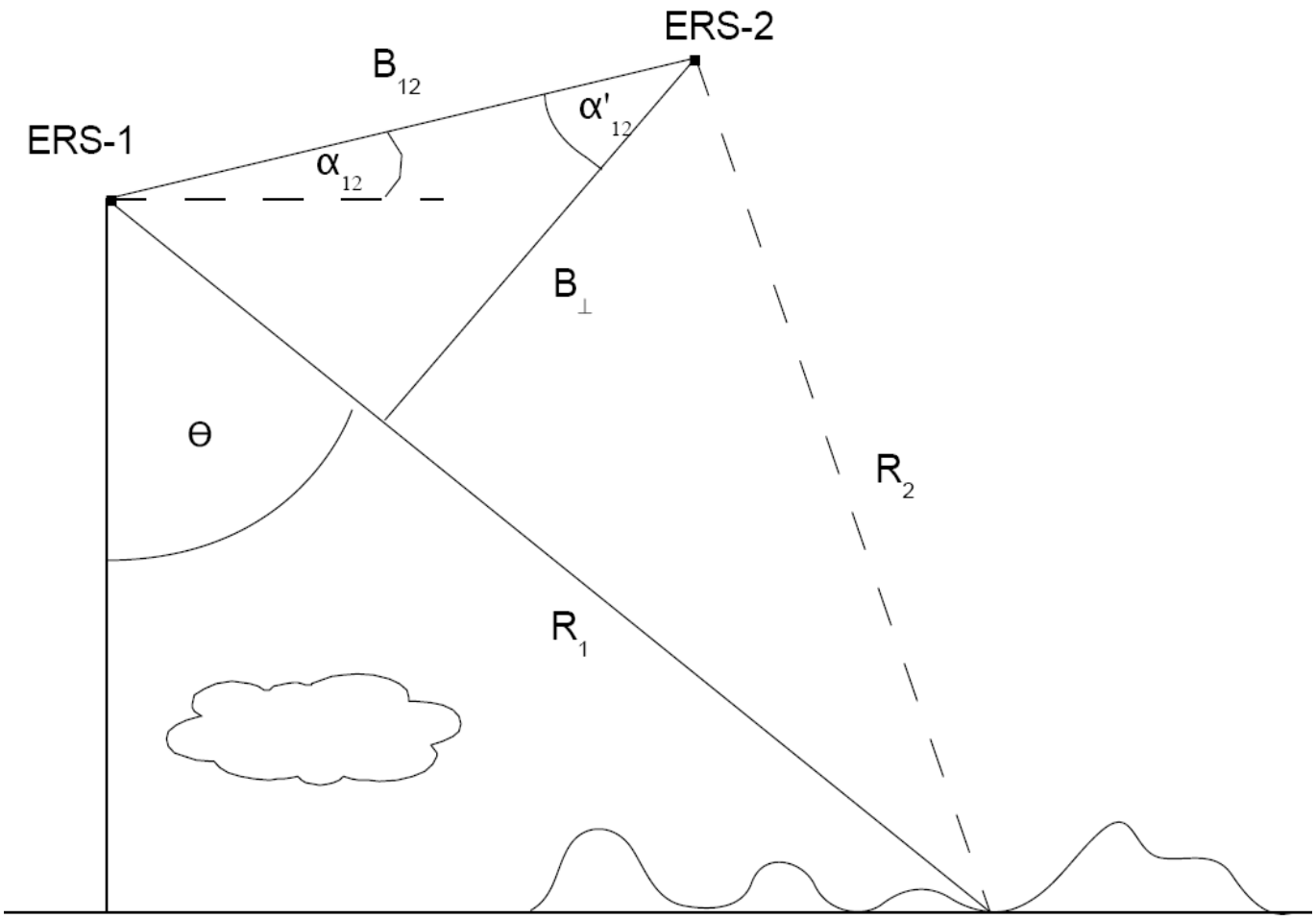
· PAFs

· MSP (Gamma Remote Sensing)

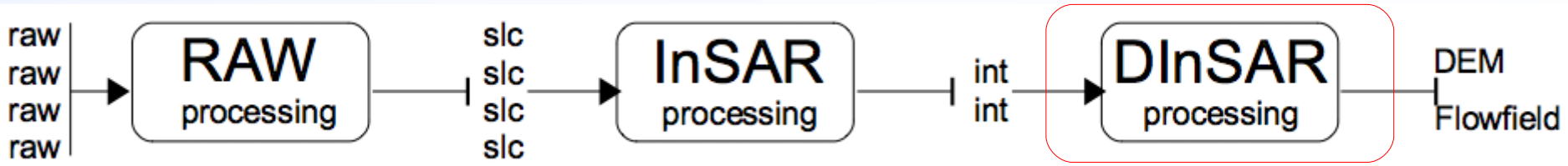
· APP (EarthView)

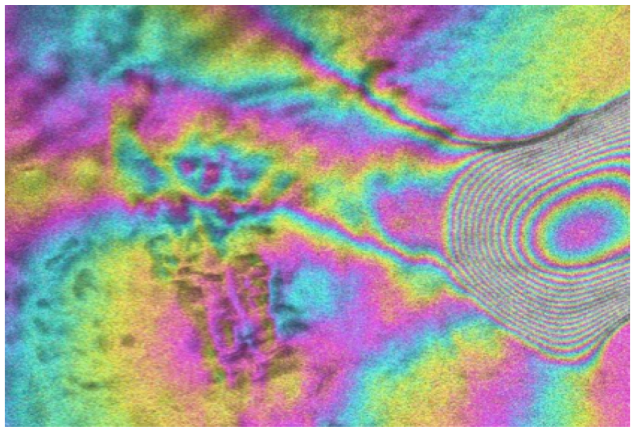
Interferometric SAR

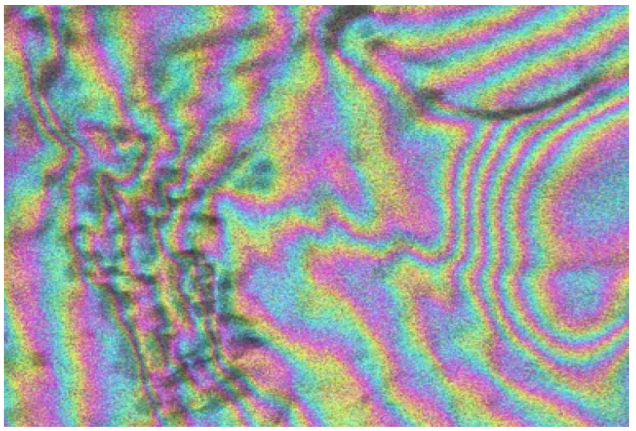


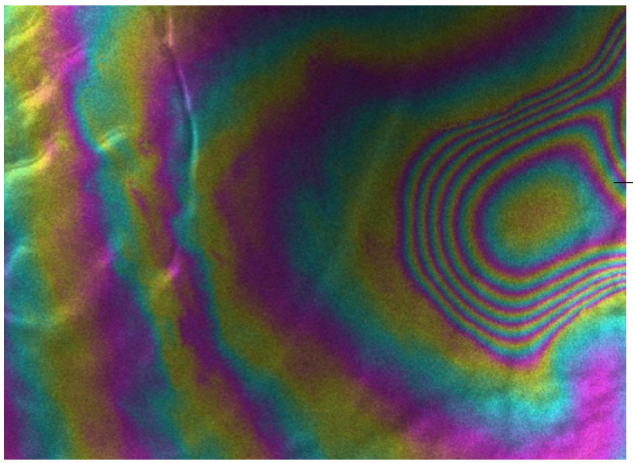


Differential SAR Interferometry









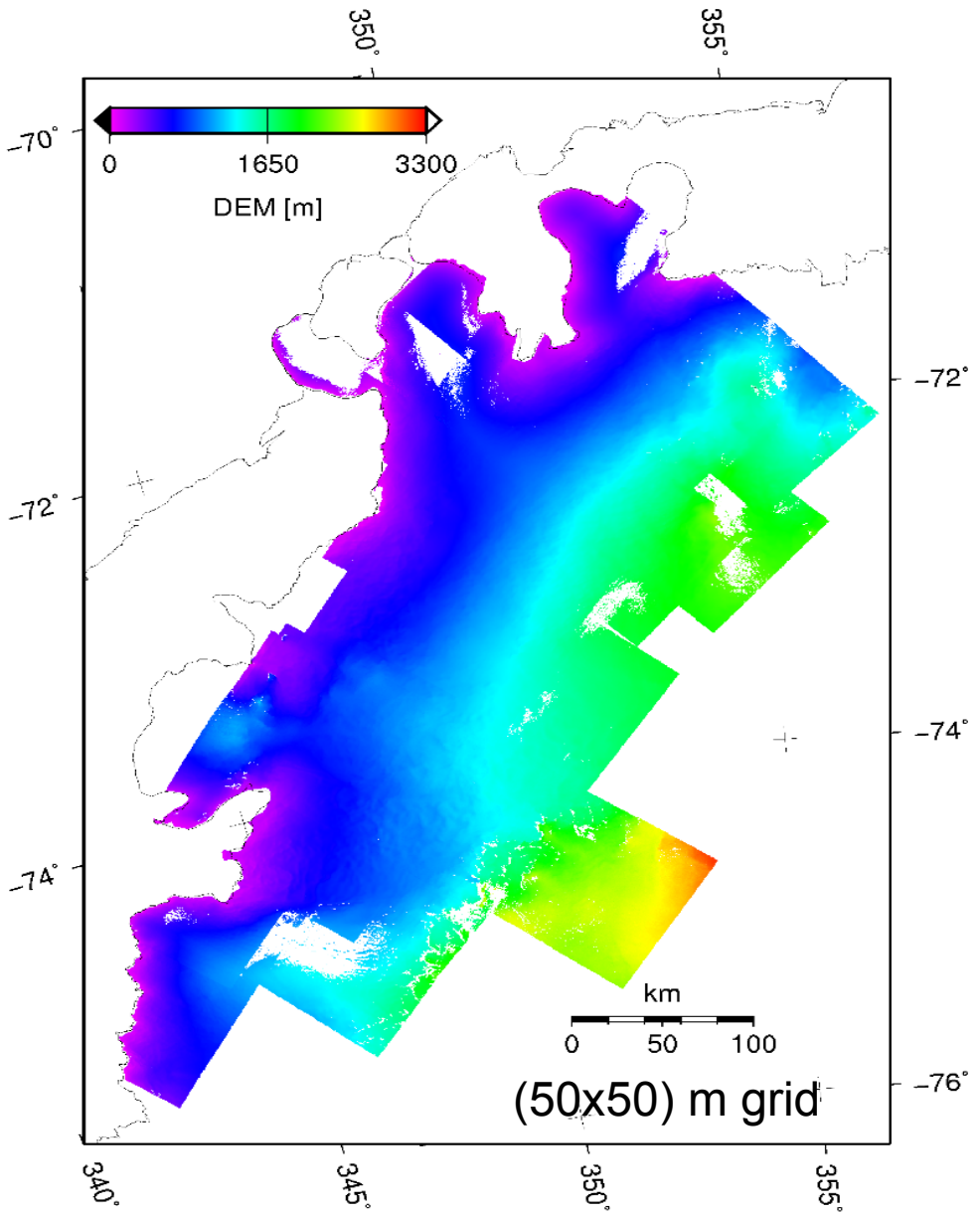
Icesat GCPs

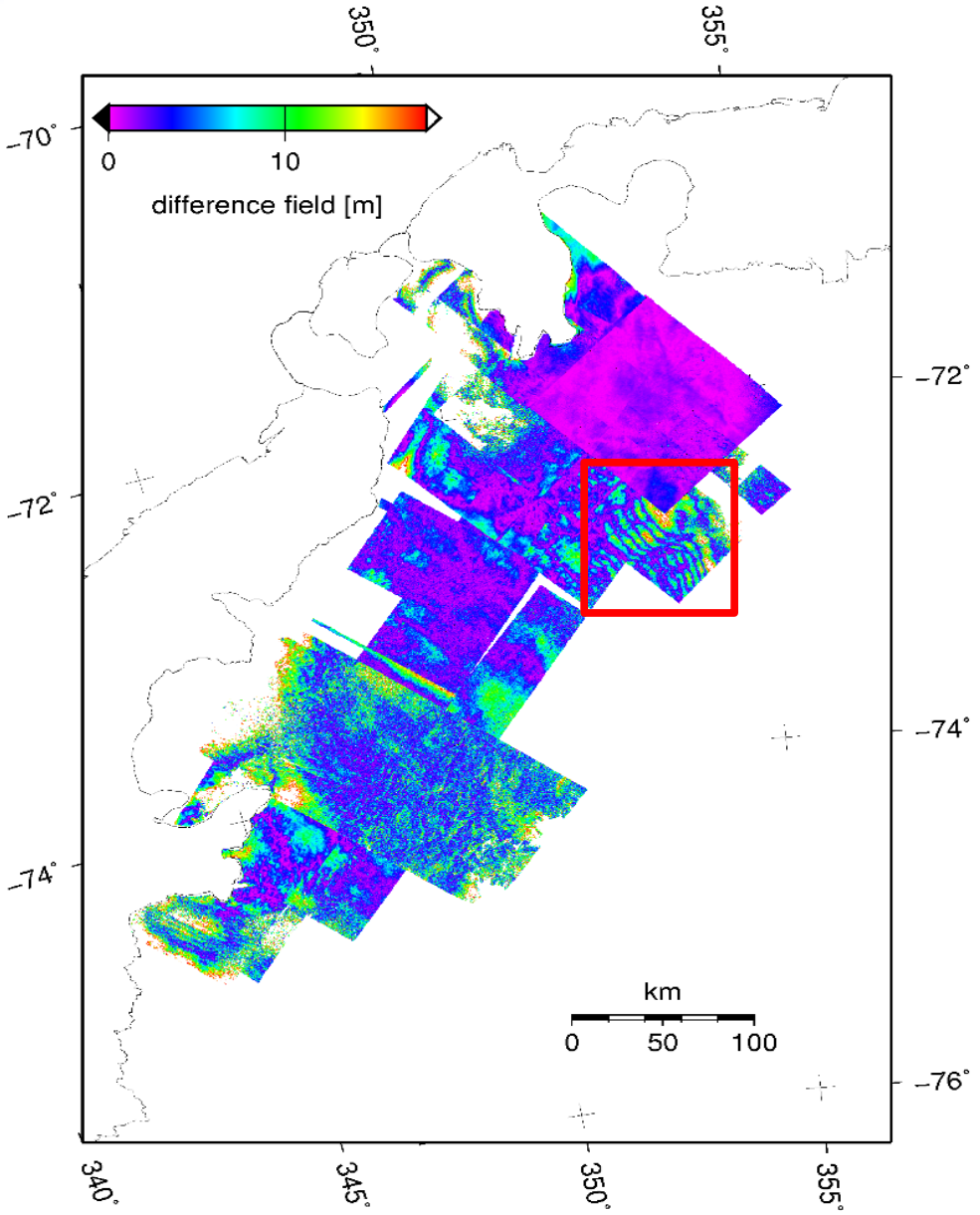
DEM

1D - Disp. → **3D - Disp.**

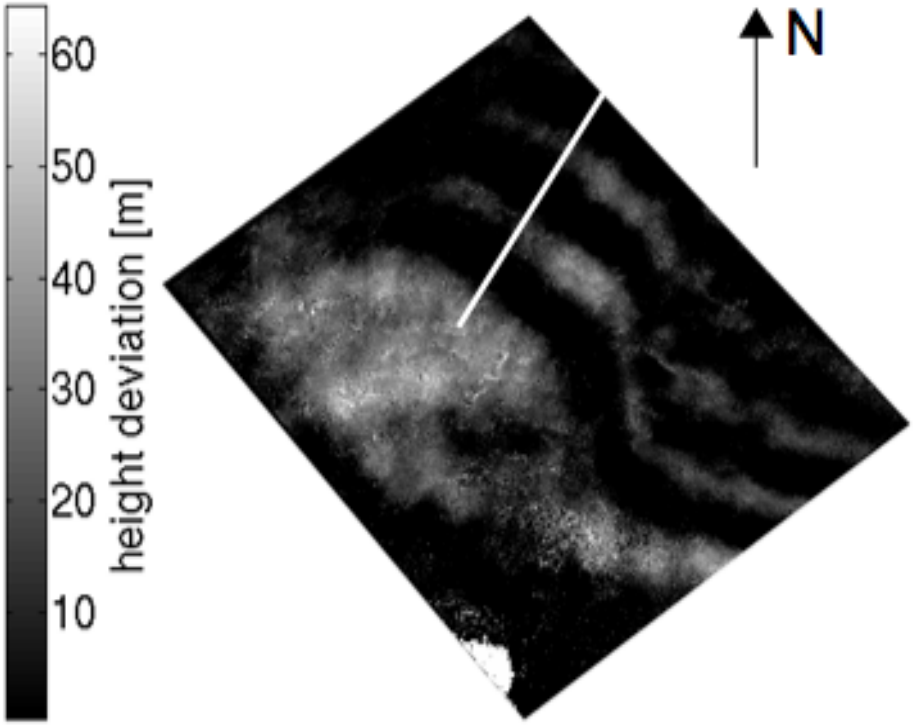
Int

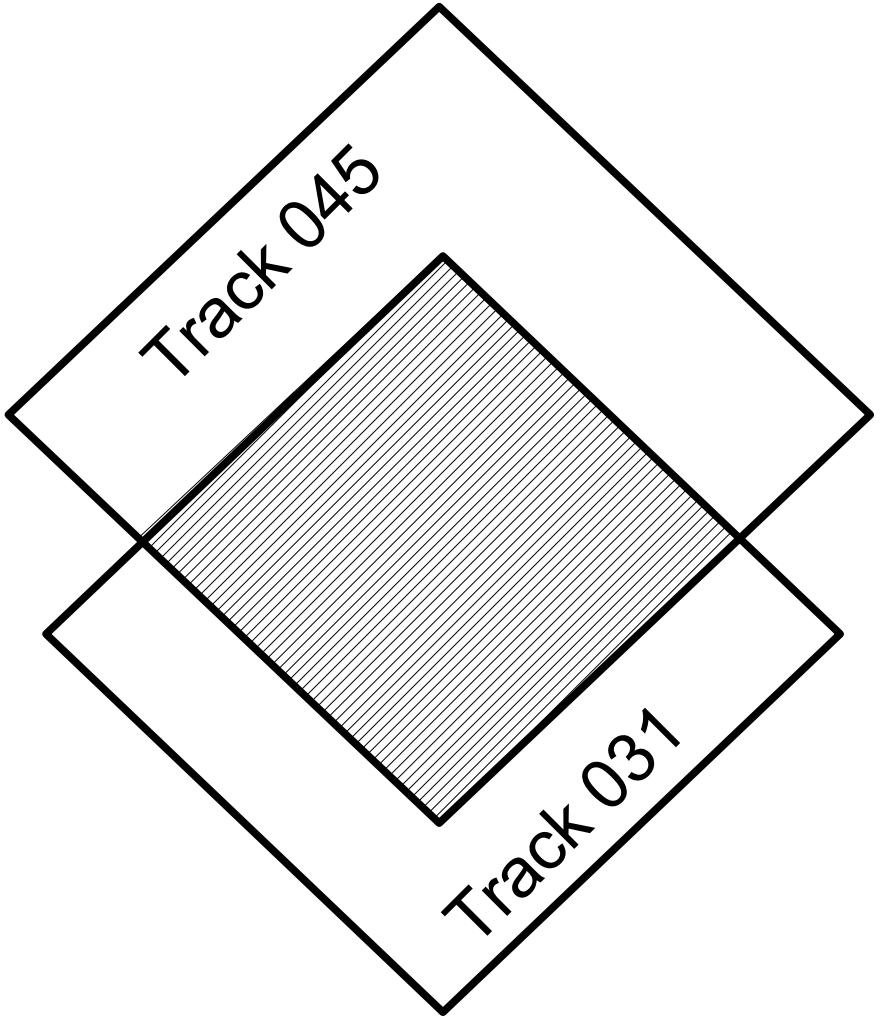
Mosaic


350°
355°
-70°
-72°
-74°
-76°
0
1650
3300
DEM [m]
km
0
50
100
(50x50) m grid
340°
345°
350°
355°

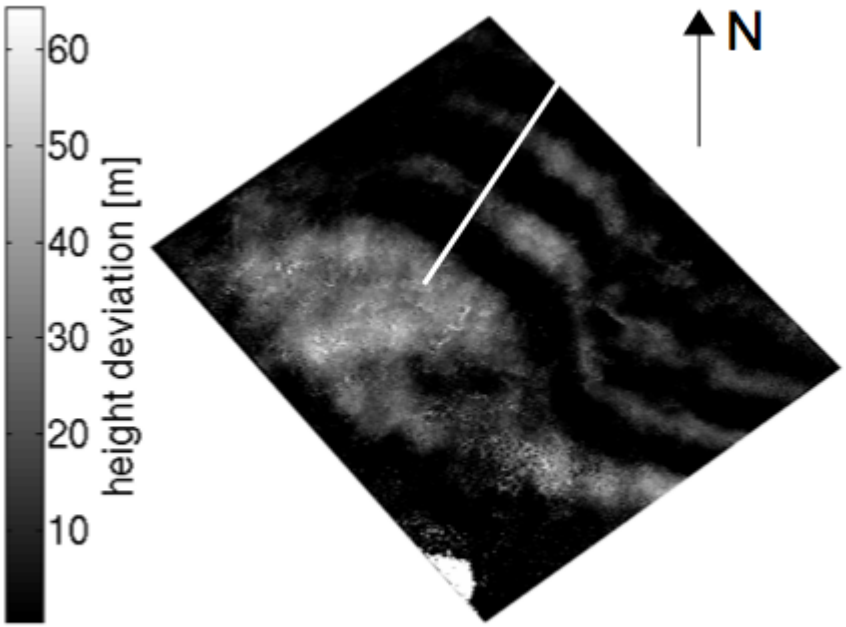

350°
355°
-70°
-72°
-74°
-76°
0
10
difference field [m]
km
0
50
100
340°
345°
350°
355°

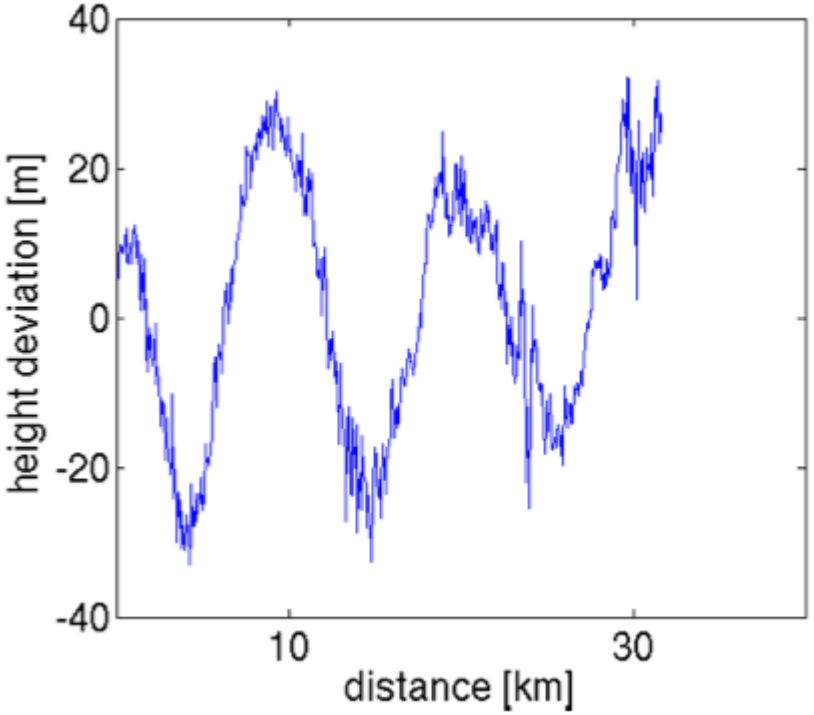
Mosaic



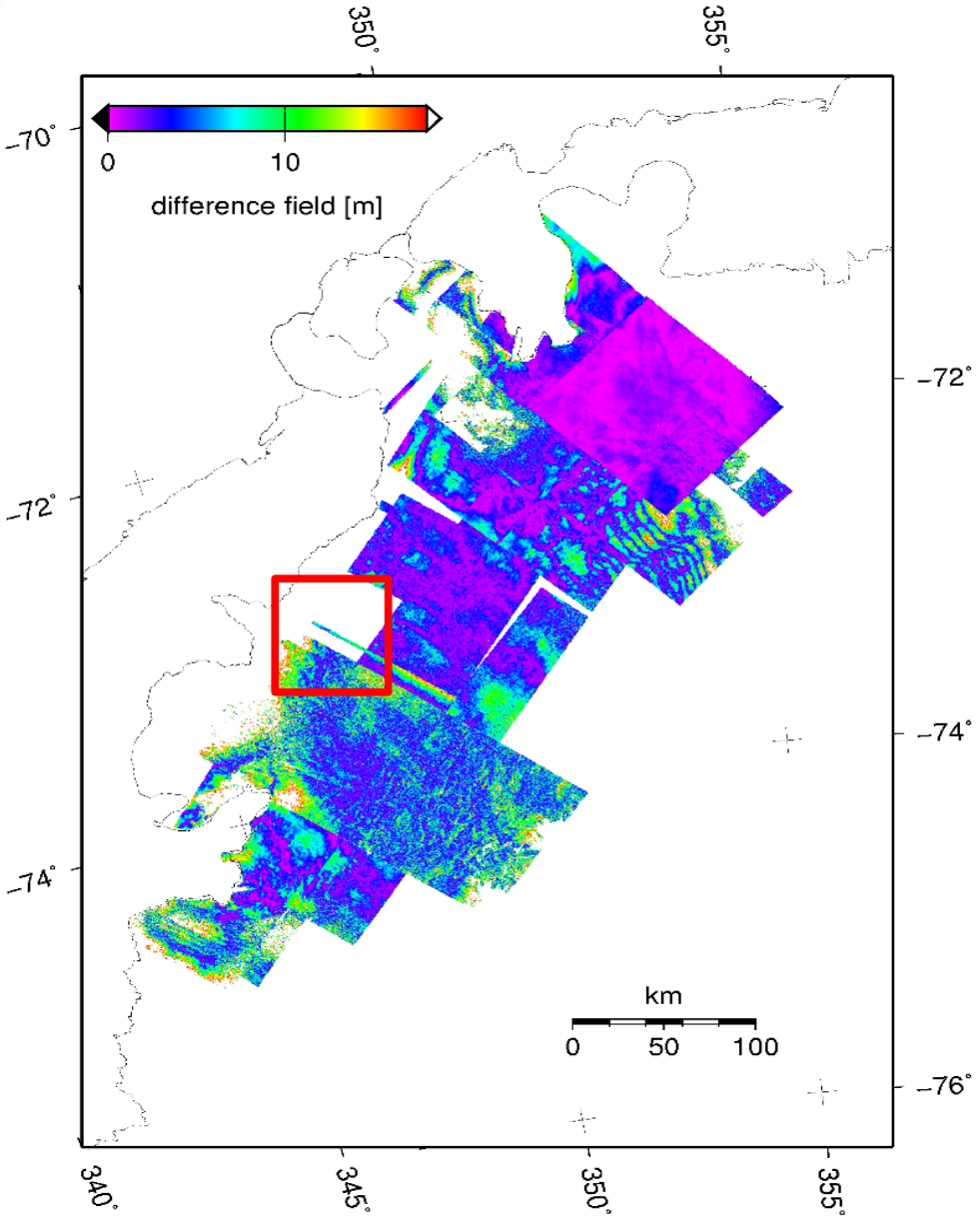


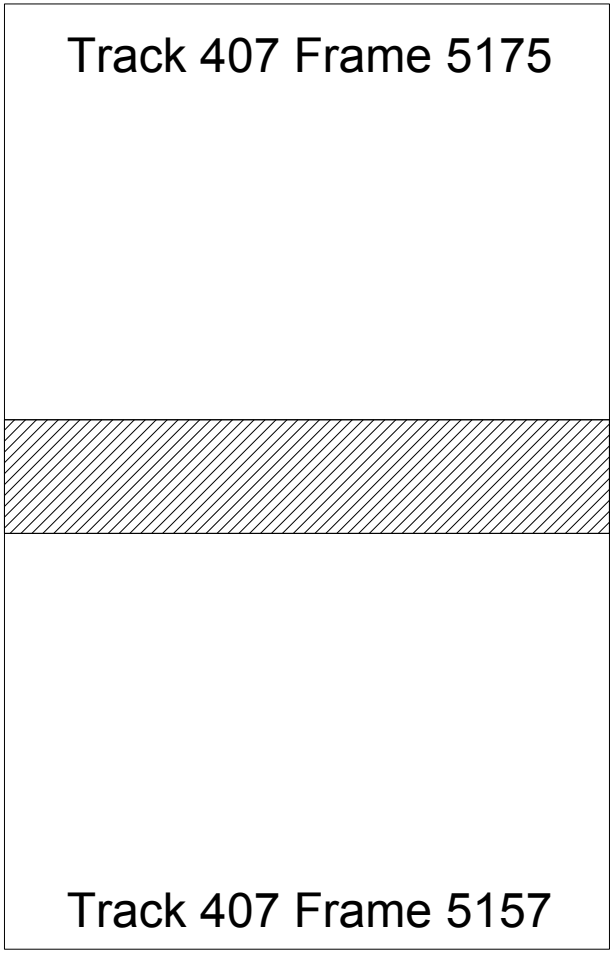
Mosaic


60
50
40
30
20
10
height deviation [m]
N

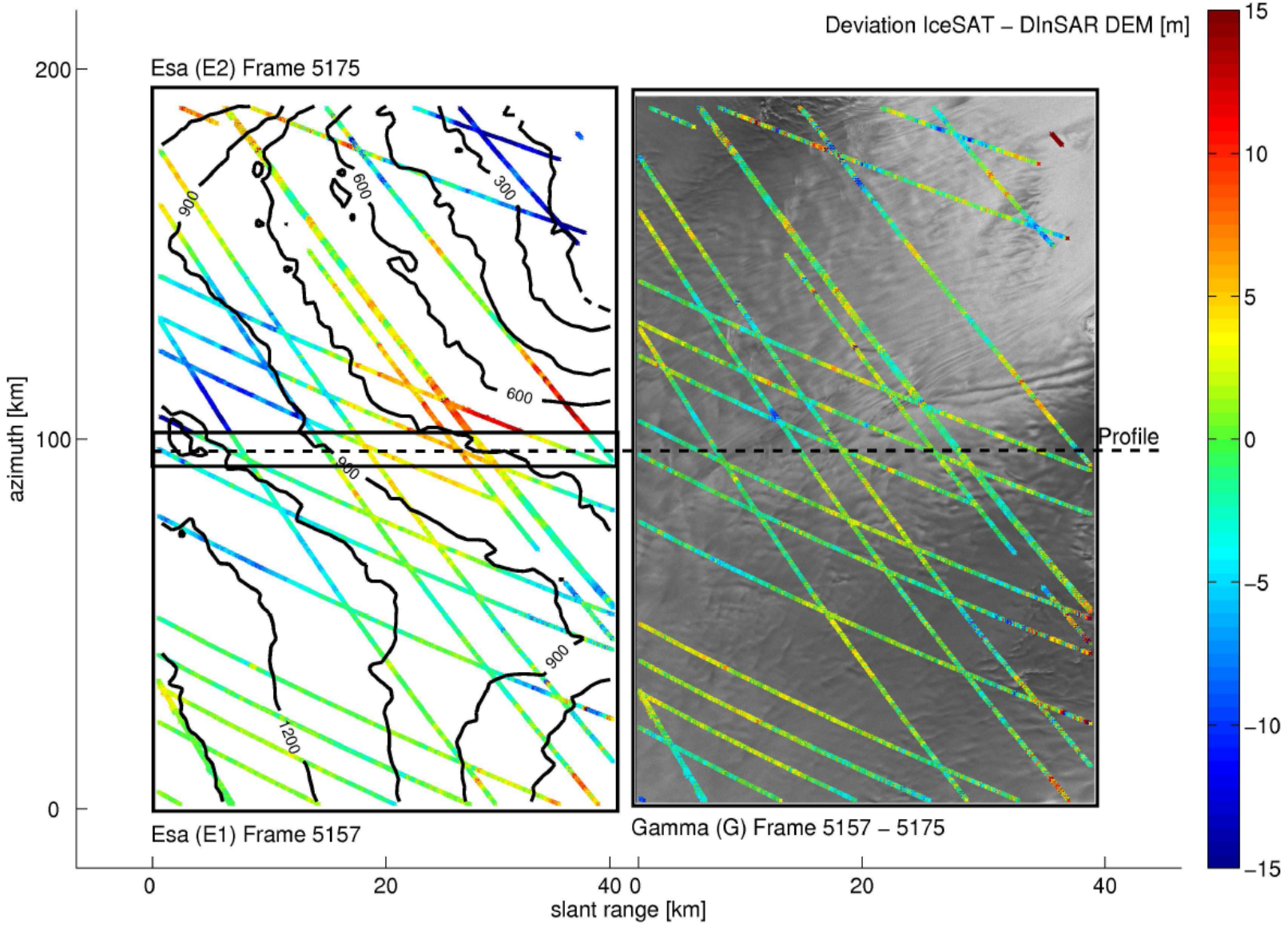

40
20
0
-20
-40
height deviation [m]
10
30
distance [km]

Mosaic

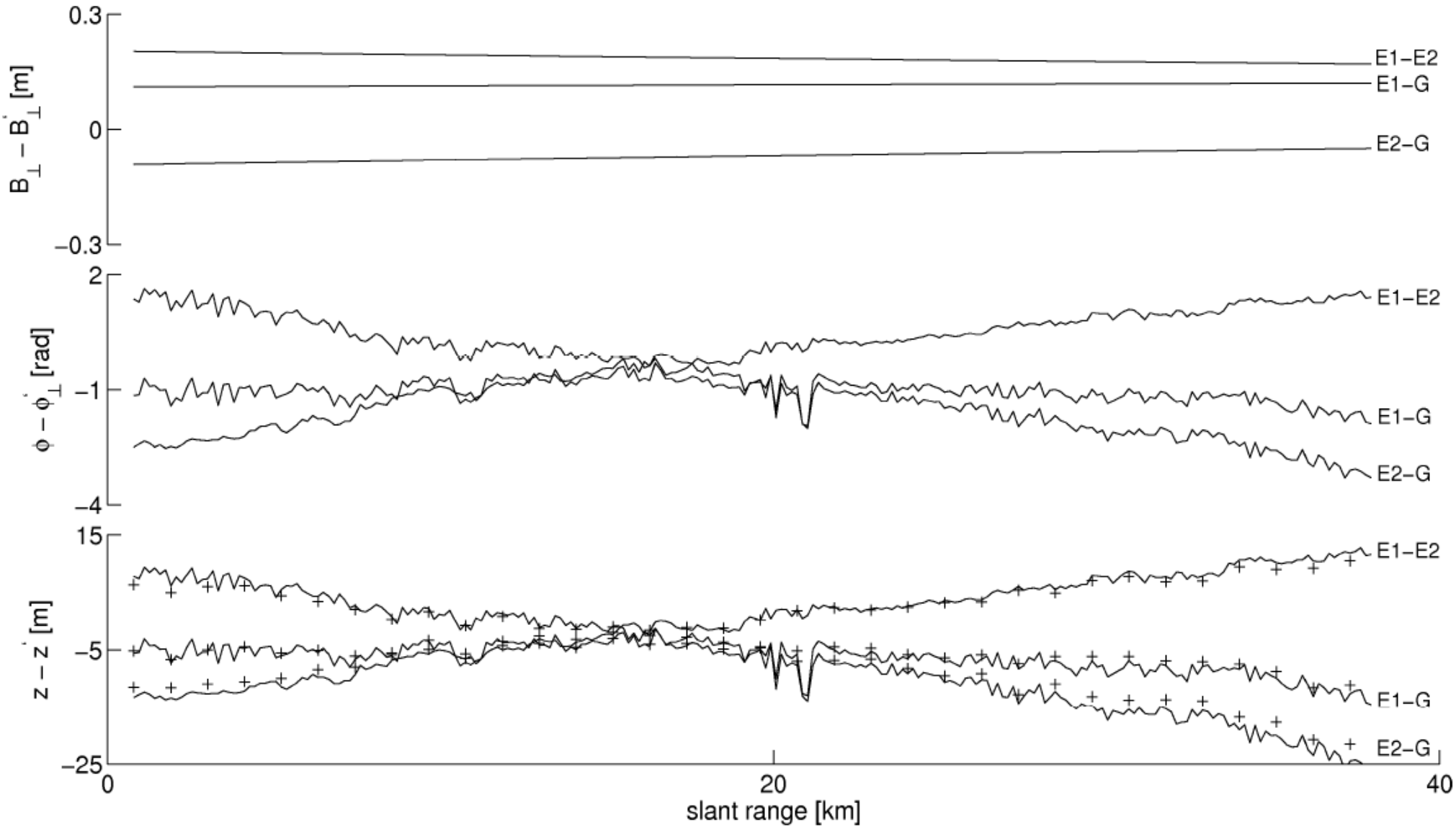

350°
355°
-70°
-72°
-74°
-76°
0
10
difference field [m]
km
0
50
100
340°
345°
350°
355°


Track 407 Frame 5175
Track 407 Frame 5157

Processing Uncertainties

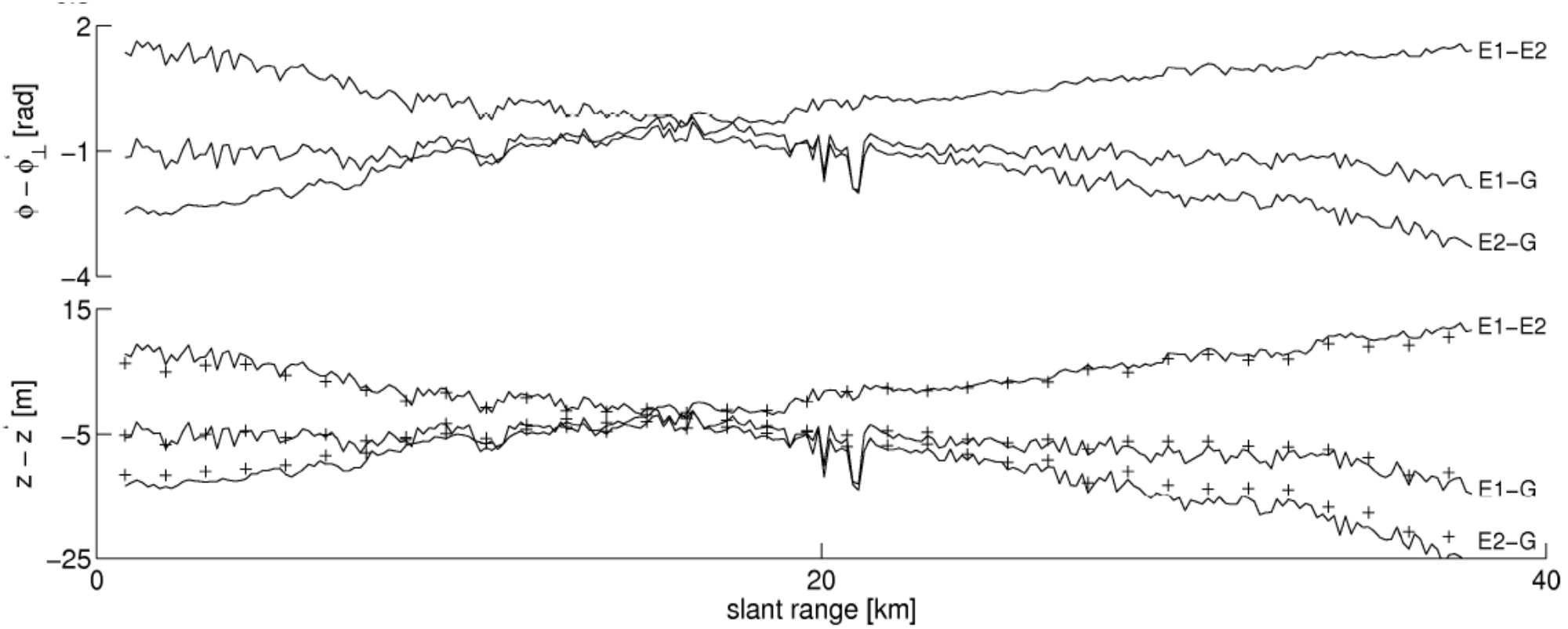


Processing Uncertainties

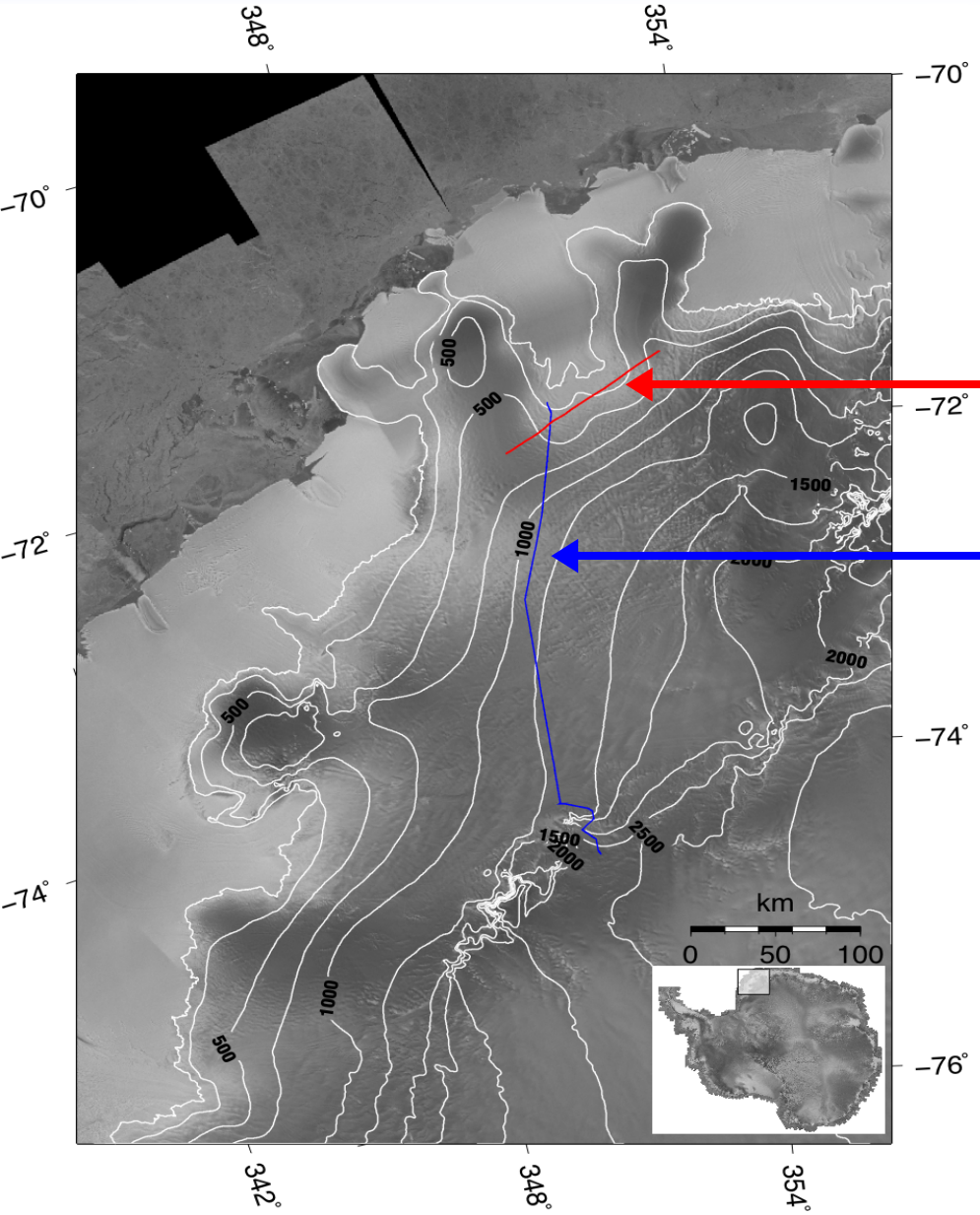


Processing Uncertainties

$$z - z' = \frac{\lambda r_0 \sin \Theta_0}{4\pi} \cdot \left(\frac{\Delta\phi_f B'_{\perp,0} - \Delta\phi'_f B_{\perp,0}}{B'_{\perp,0} B_{\perp,0}} \right)$$



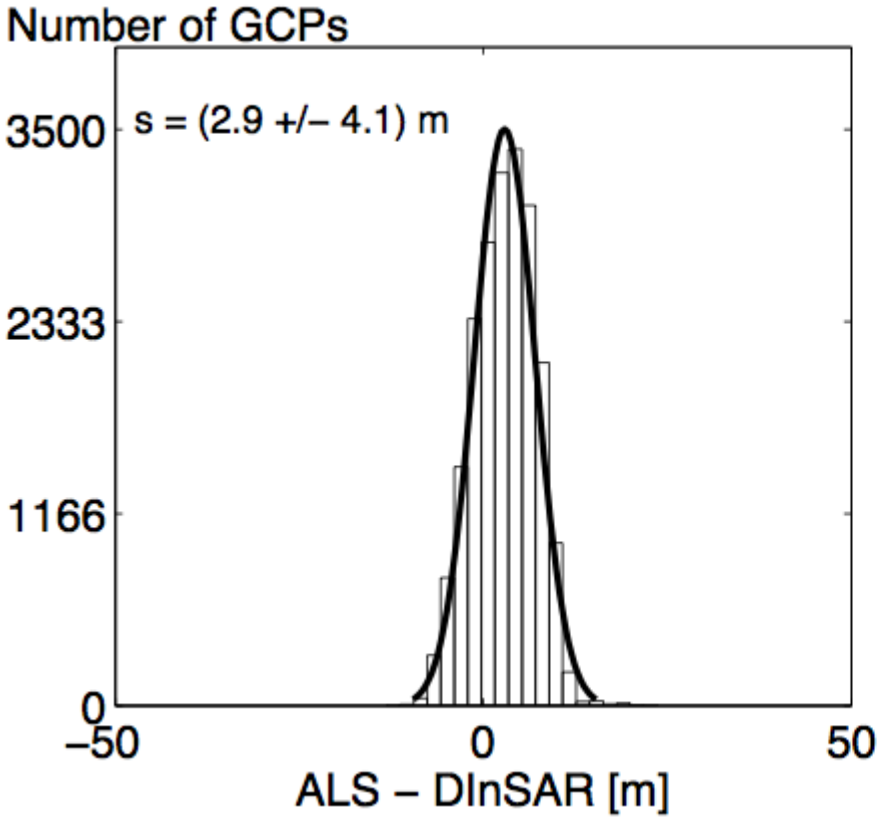
Comparison with GCPs

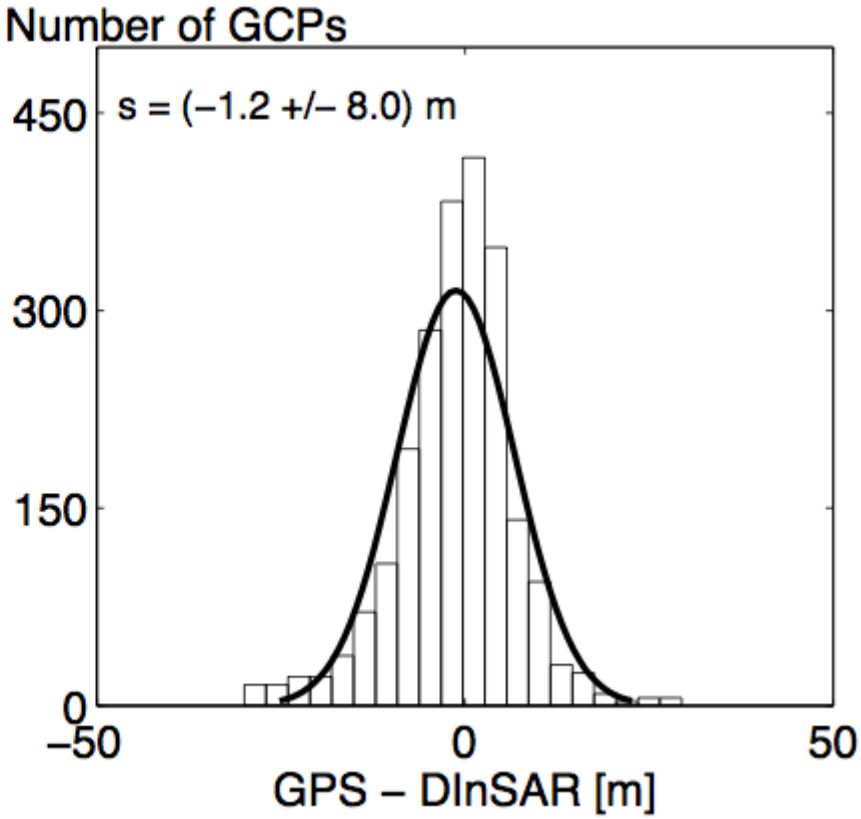


· Airborne Laser Altimetry

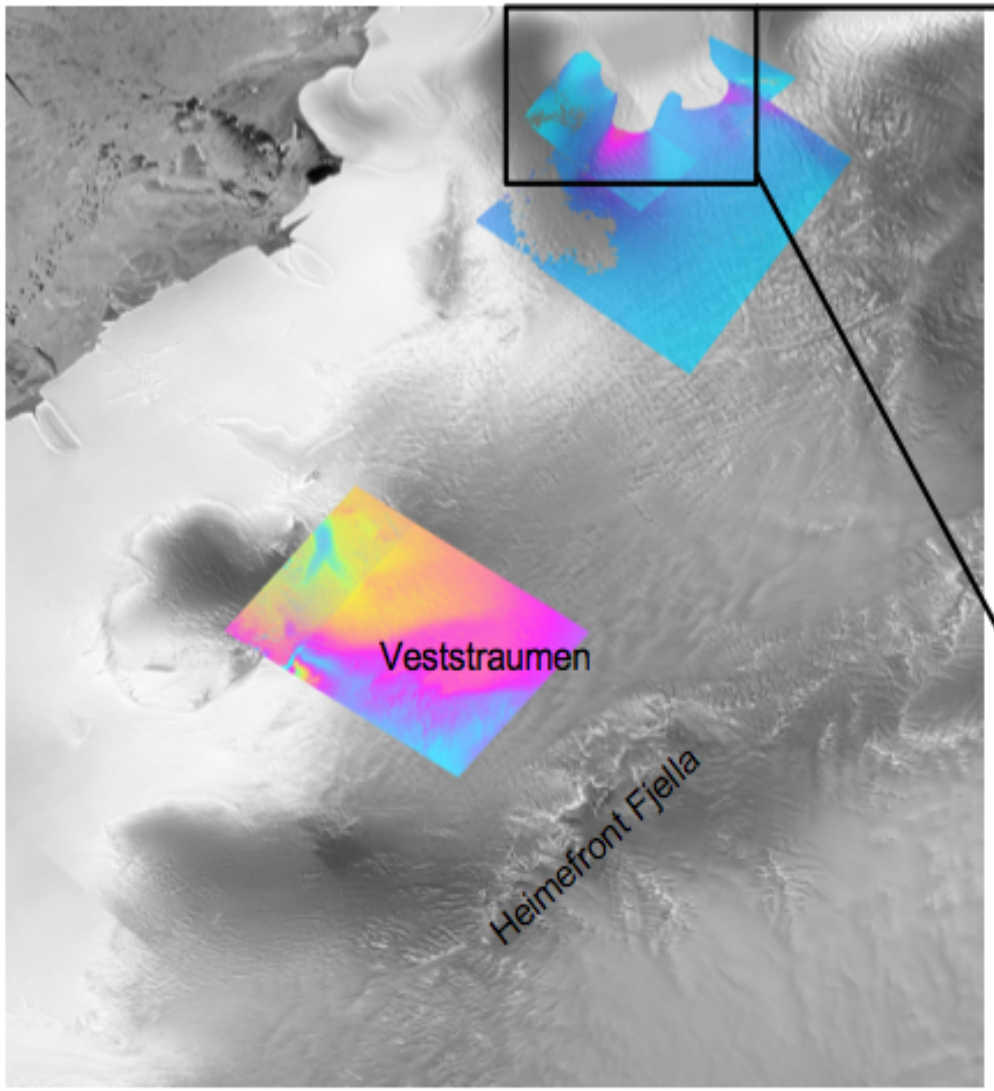
· Kinematic GPS

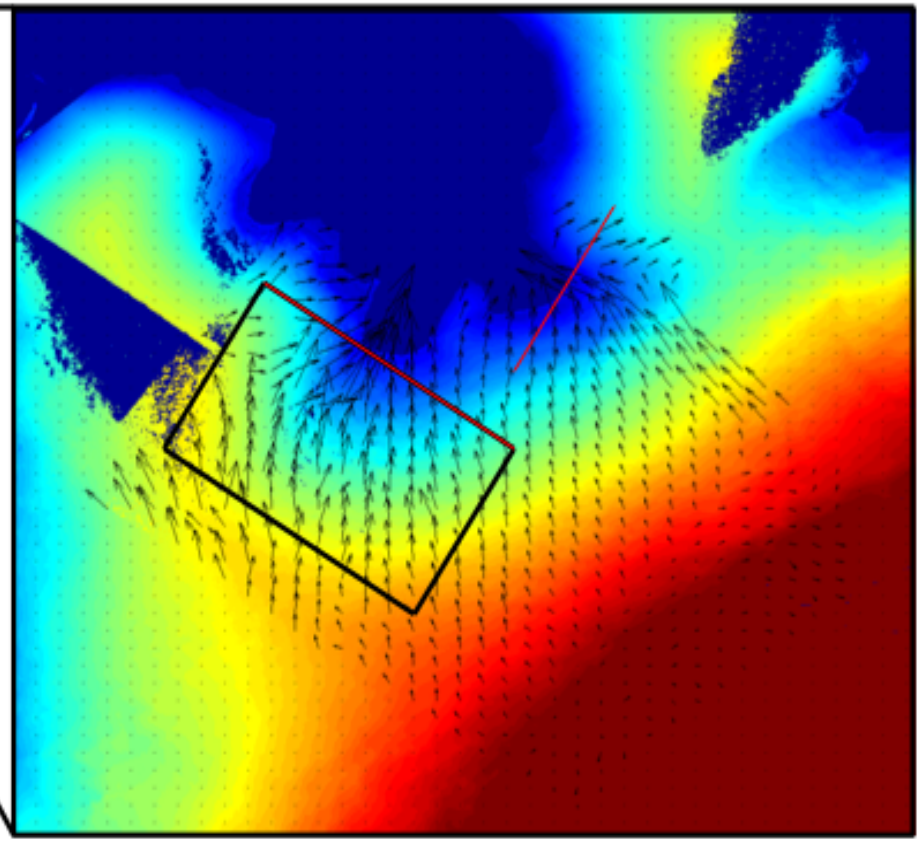
Comparison with GCPs





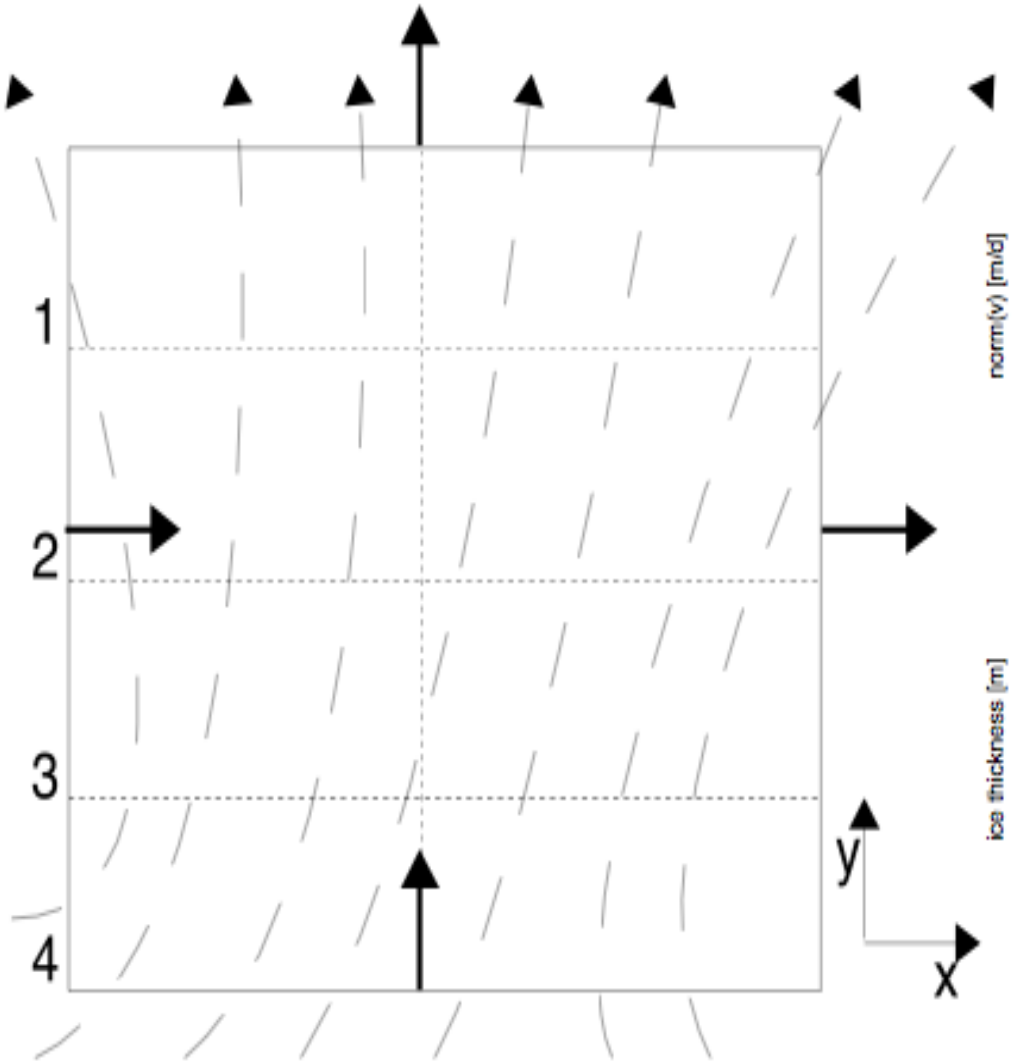
3 D - Flowfields

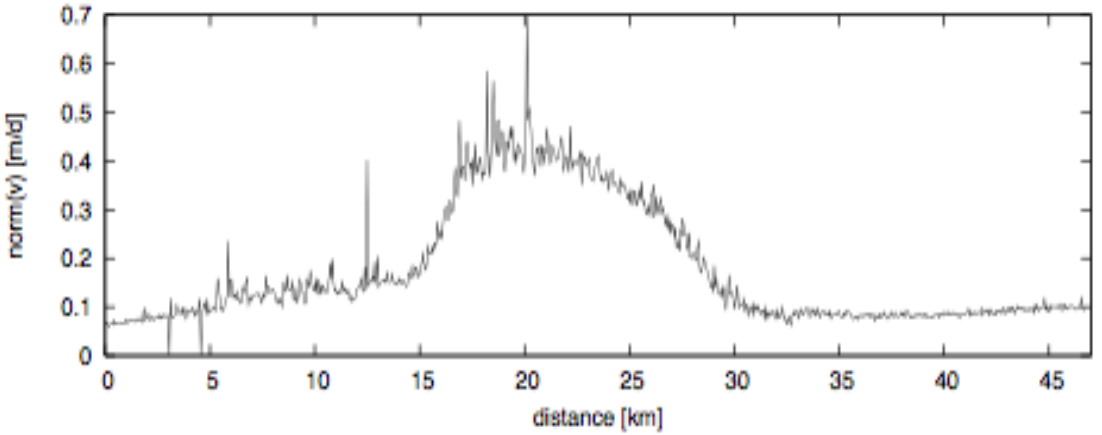


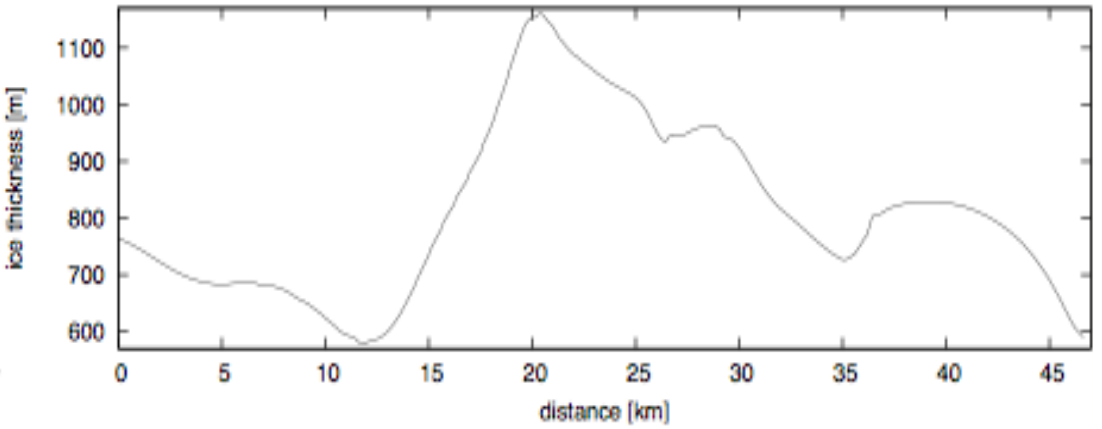


Mass flux: $3.45 \cdot 10^3$ Gt/a

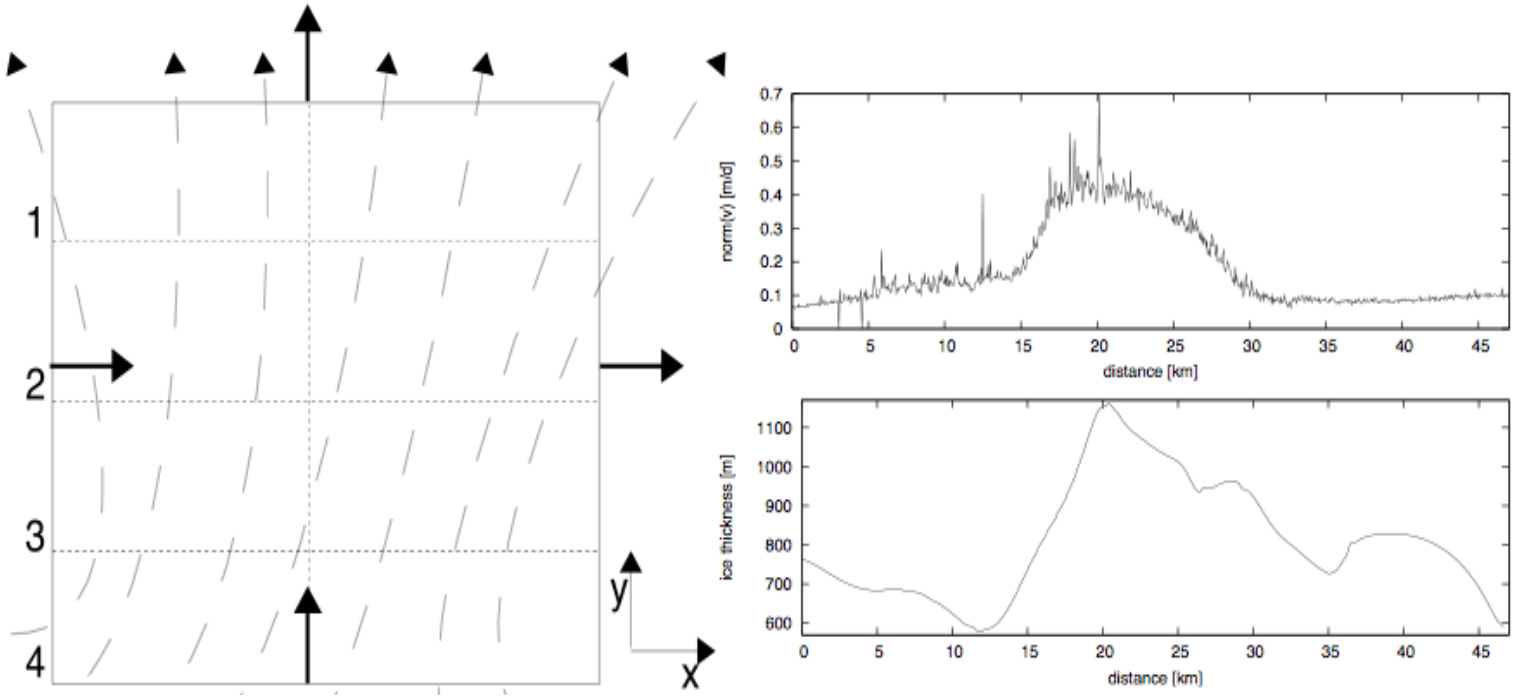
Boxmodel


1
2
3
4
y
x


norm(v) [m/d]
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
25
30
35
40
45
distance [km]


ice thickness [m]
1100
1000
900
800
700
600
0
5
10
15
20
25
30
35
40
45
distance [km]

Boxmodel



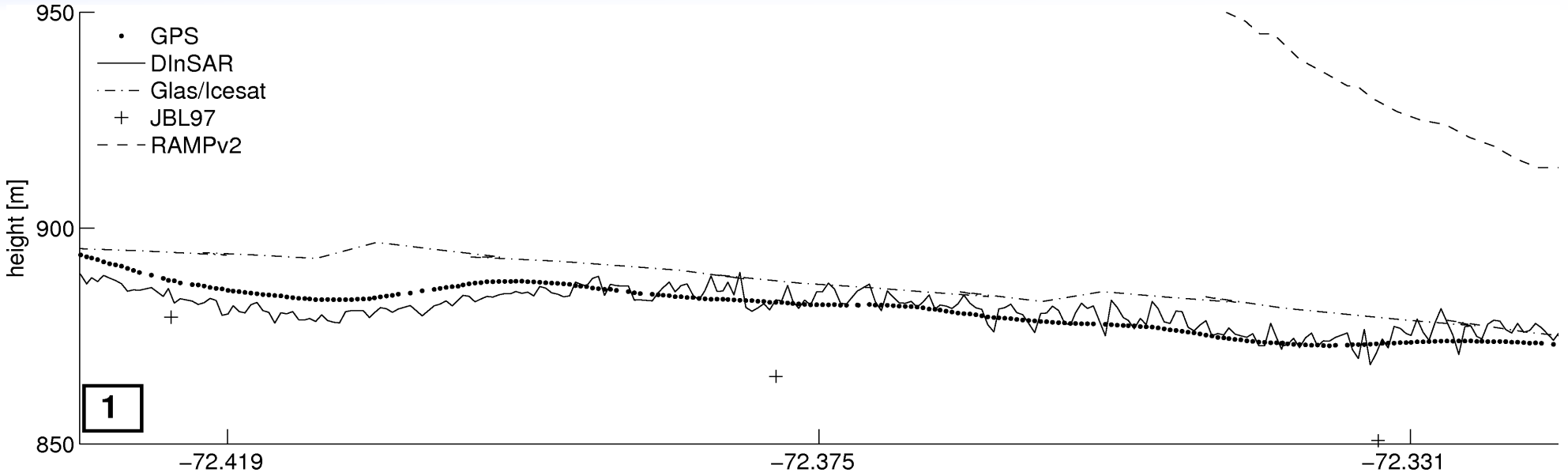
$$m_{f,res} = (2.128 - 2.214 - 0.077 - 0.047)\frac{km^3}{a} = -0.211\frac{km^3}{a}$$

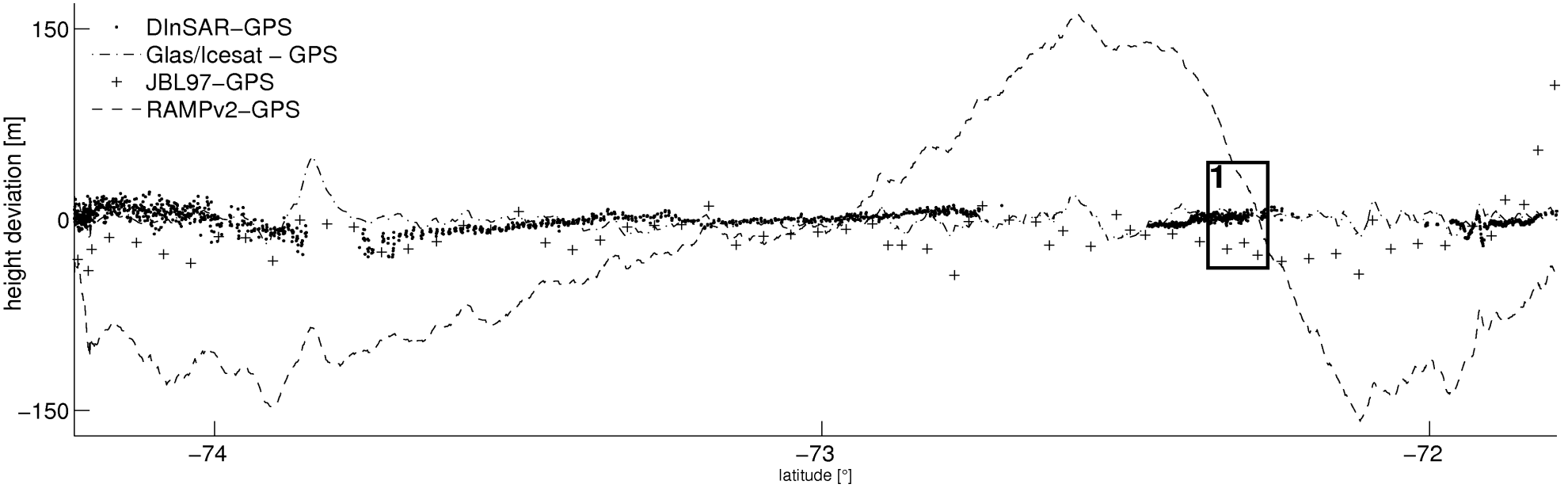
$$\dot{a} = \rho\frac{m_{f,res}}{A} = 248\frac{kg}{am^2}$$

Summary

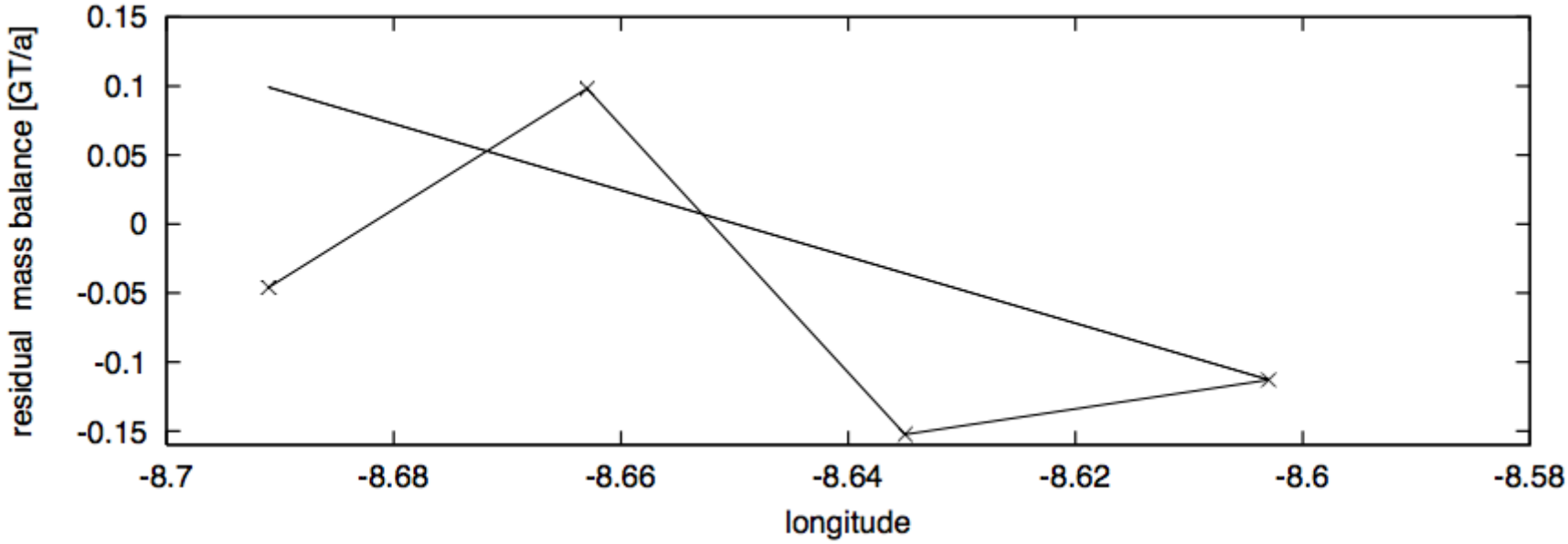
- Generation of high resolution DEM for Interferometry
- Difference field reveals processing and other external errors
- Displacement maps have been used for mass flux estimates
- Mapping of accumulation with satisfactory prelim. results

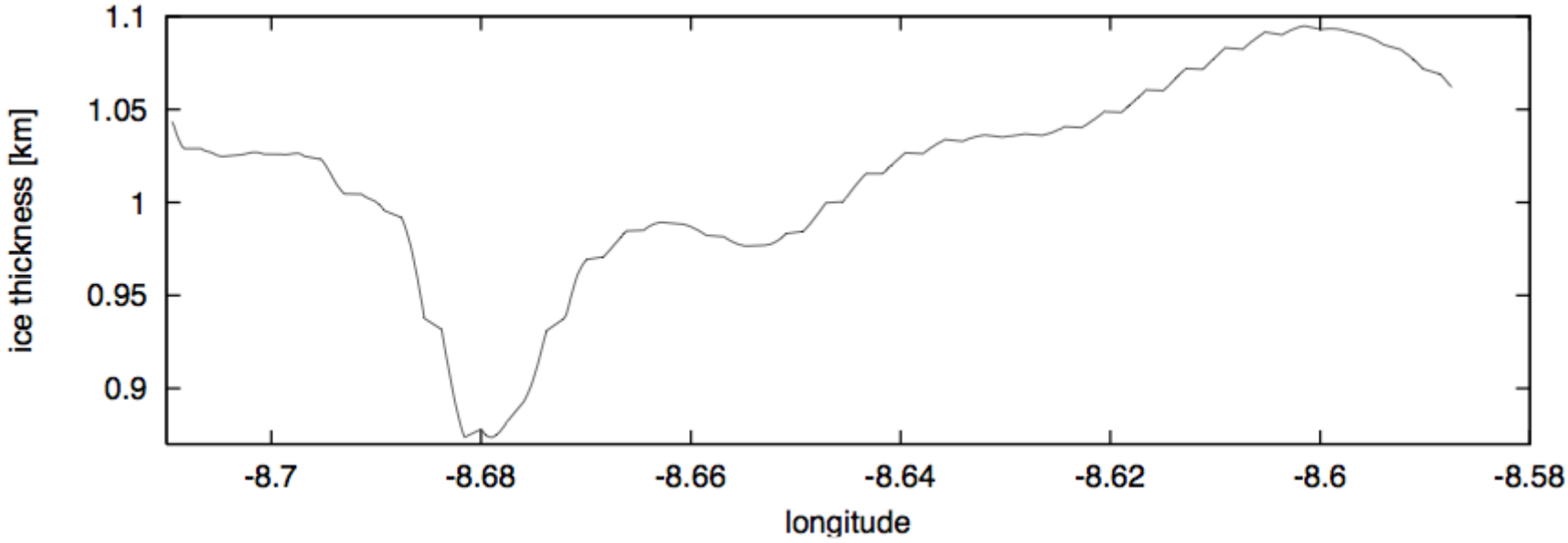
Comparison GPS





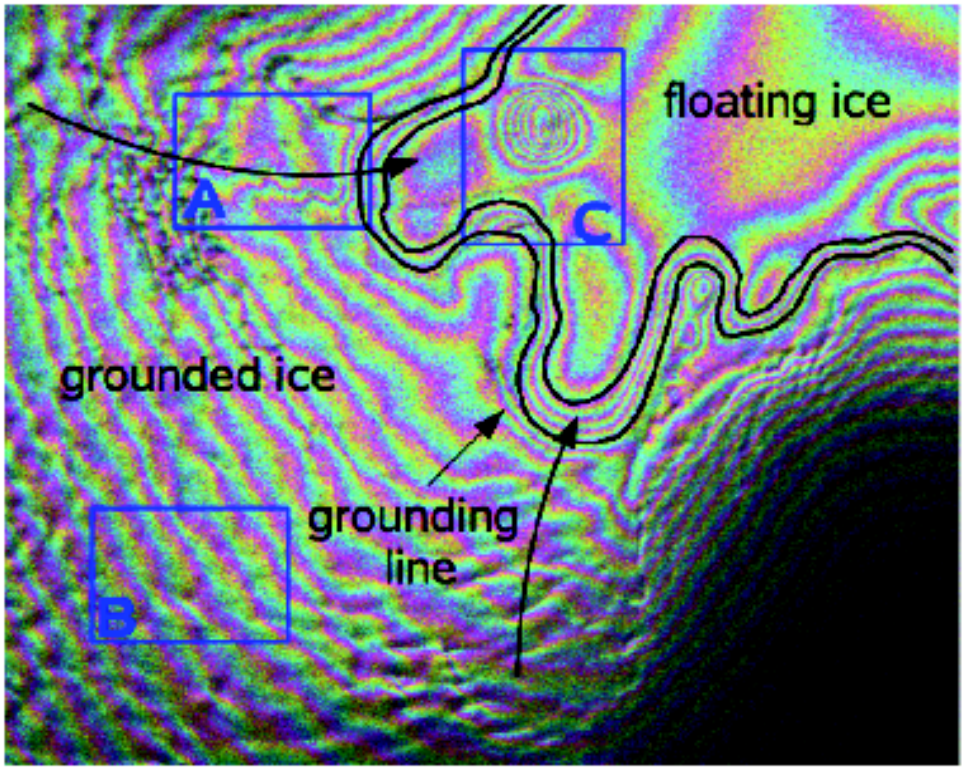
Boxmodell

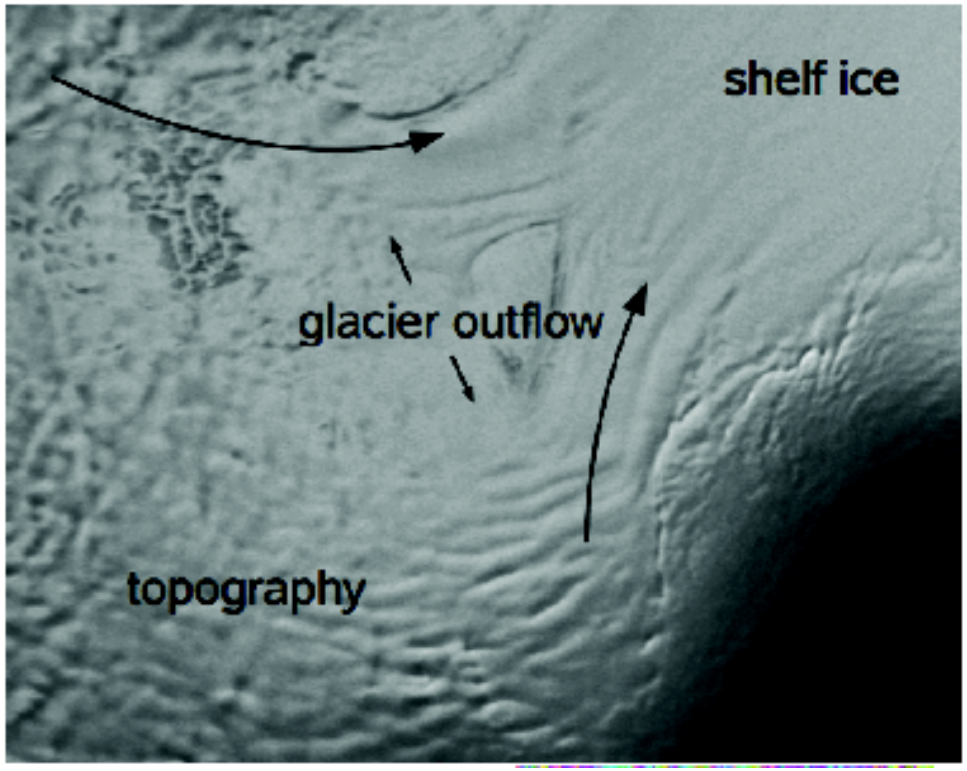

residual mass balance [GT/a]
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-8.7
-8.68
-8.66
-8.64
-8.62
-8.6
-8.58
longitude


ice thickness [km]
1.1
1.05
1
0.95
0.9
-8.7
-8.68
-8.66
-8.64
-8.62
-8.6
-8.58
longitude

SAR Interferometry

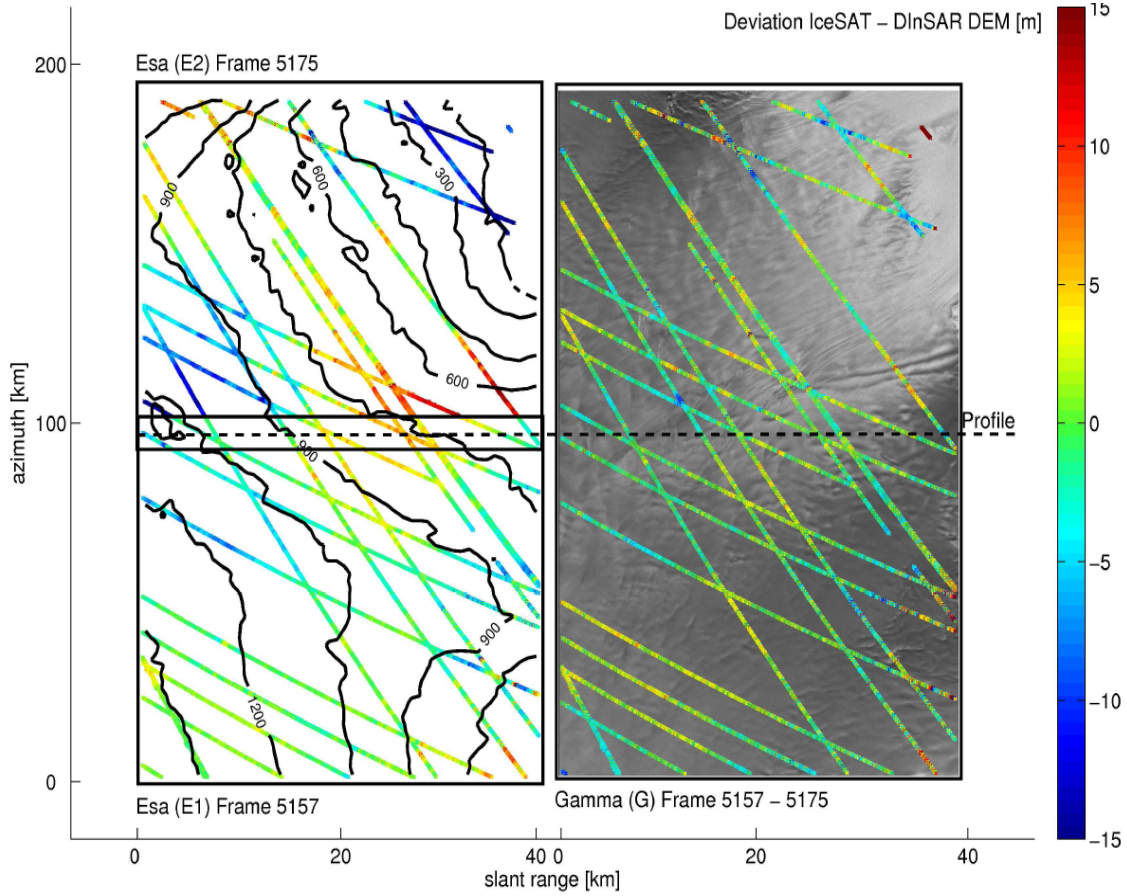
Mixed interferogramm with topography and displacement



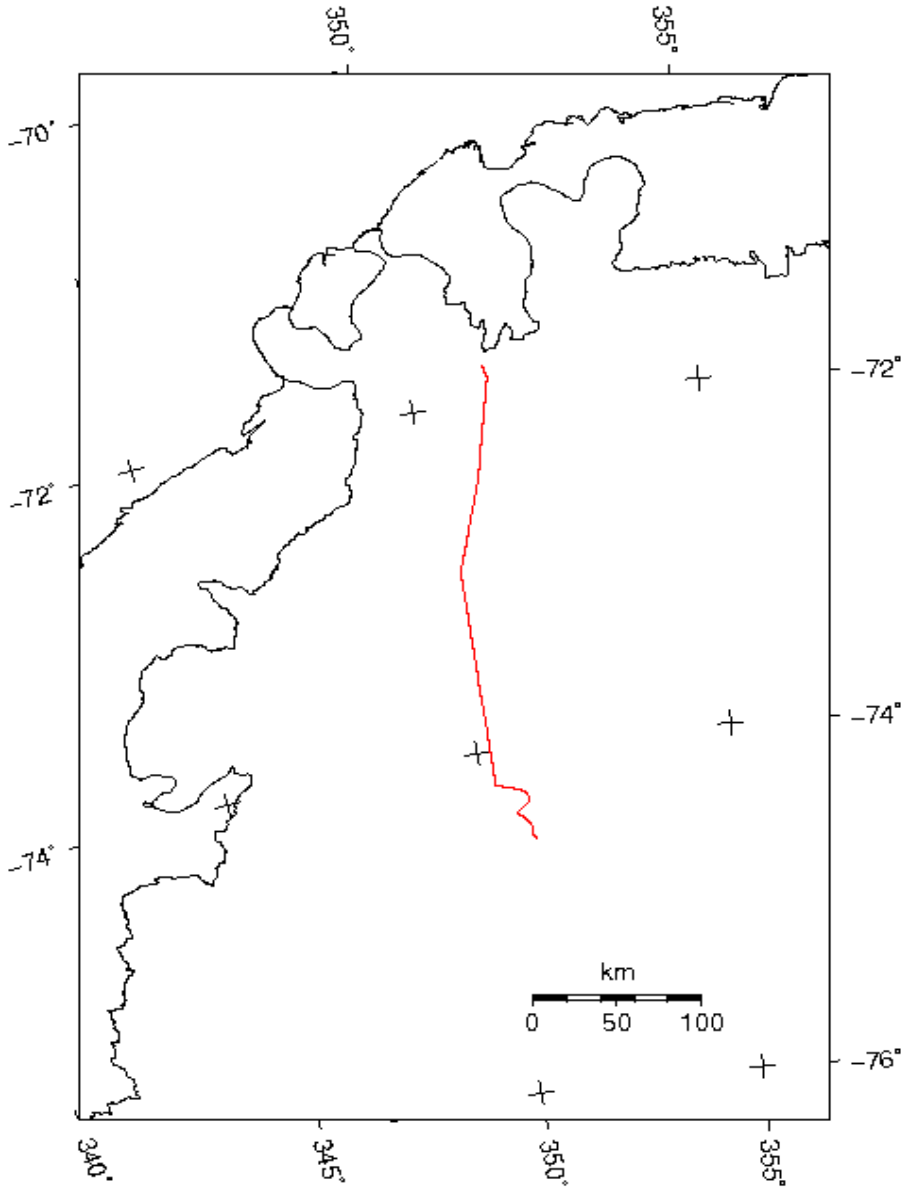


Processing Uncertainties

$$z - z' = \frac{\lambda r_0 \sin \Theta_0}{4\pi} \cdot \left(\frac{\Delta\phi_f B'_{\perp,0} - \Delta\phi'_f B_{\perp,0}}{B'_{\perp,0} B_{\perp,0}} \right)$$



Comparison with GPS



kinematic GPS

- traverse from Neumayer to Kohnen
- vertical accuracy < 1 m
- along track spacing ~ 3 m