How to make the most of a highr resolution DEM (SPIRIT) over an Antarctic outlet glacier, test case of the Astrolabe Glacier, Terre Adélie sector, East Antarctica

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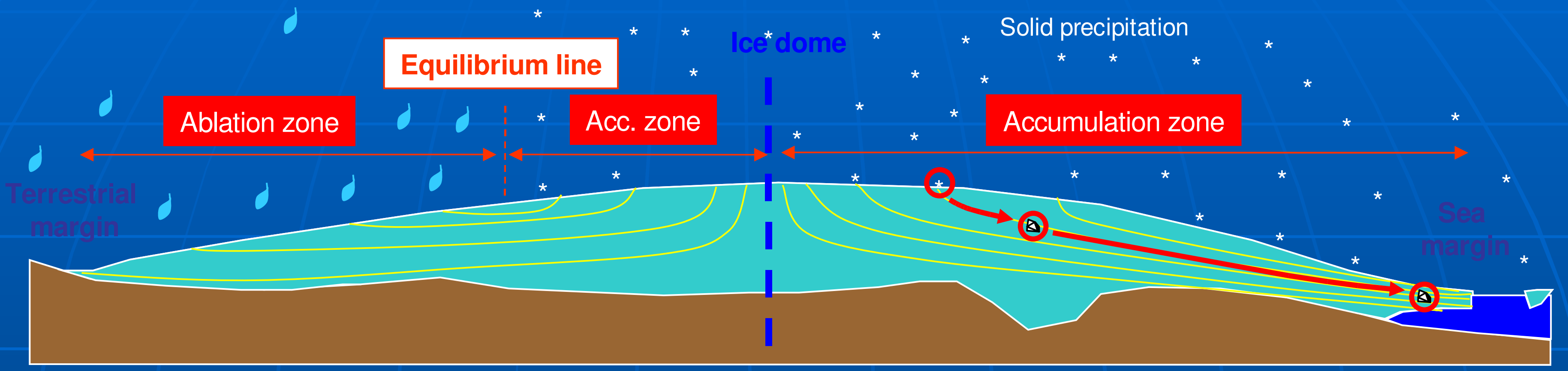
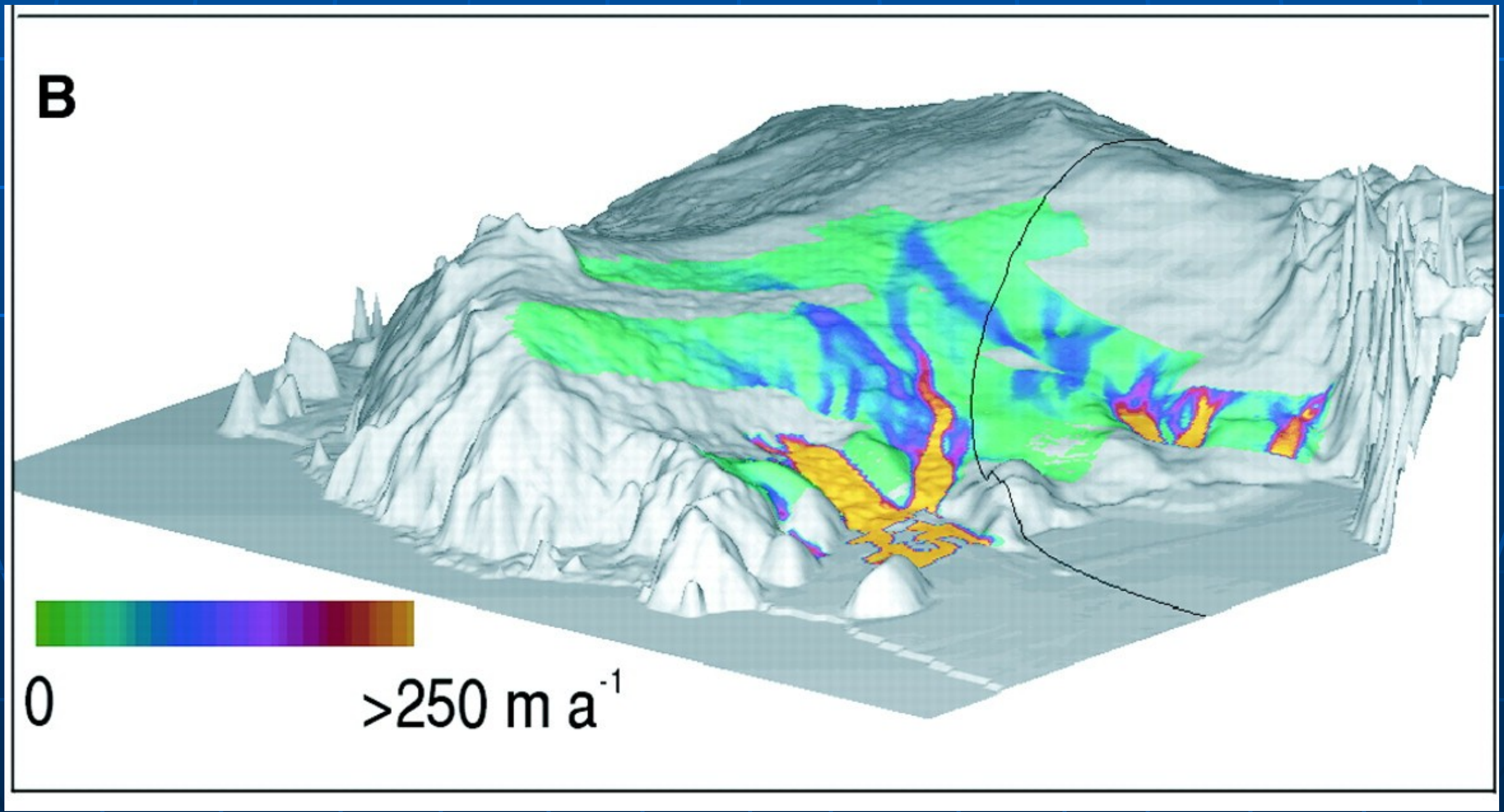
www-lgge.obs.ujf-grenoble.fr/axes/IPY/dacota

CONTEXT

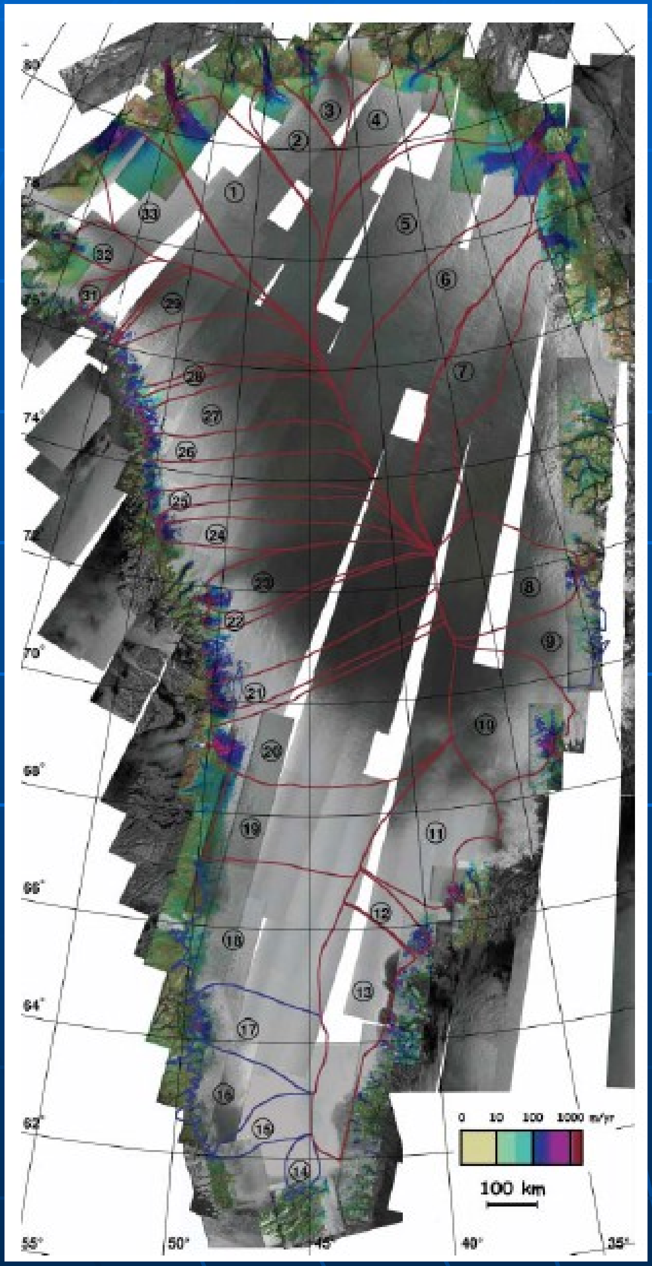
Ice fluxes within the ice-sheet

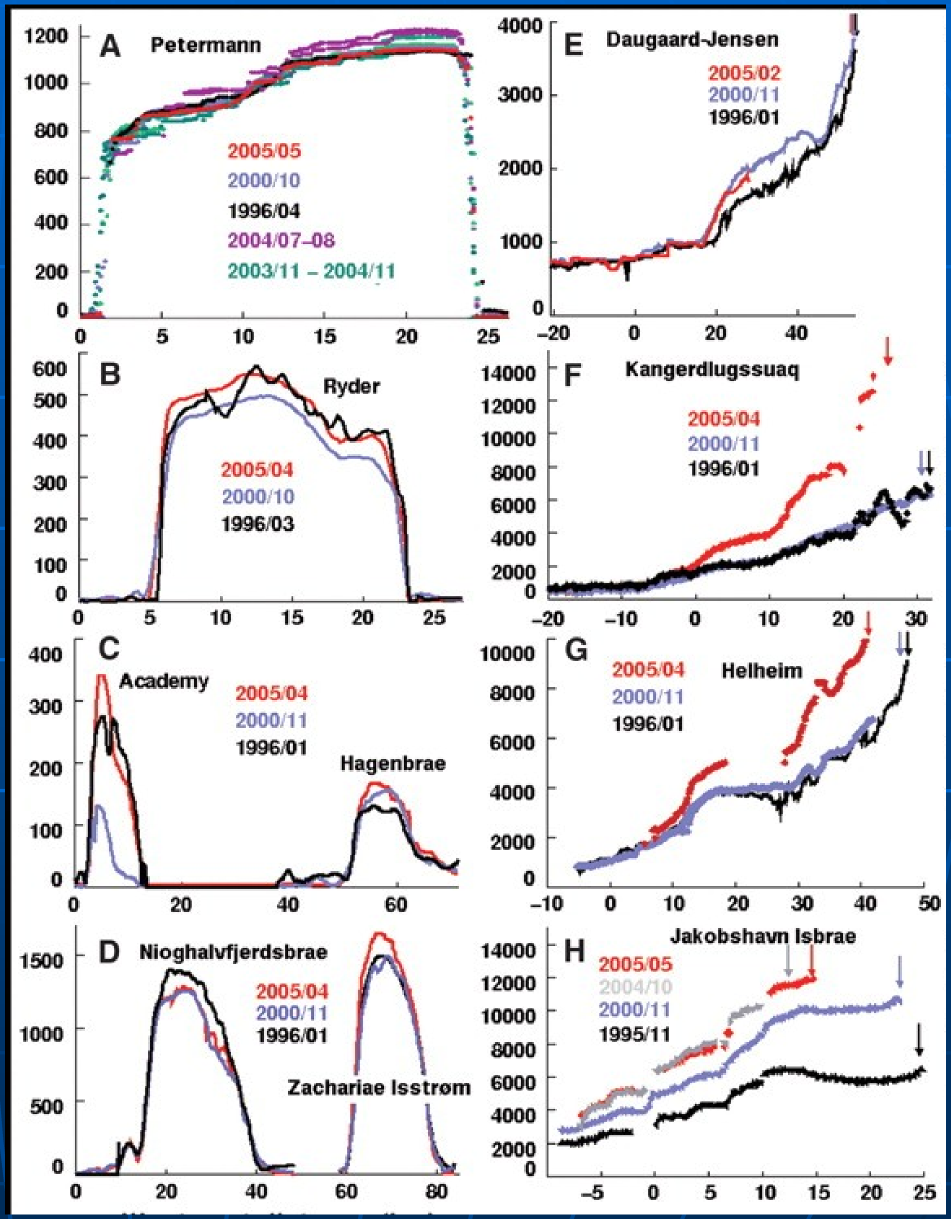




CONTEXT

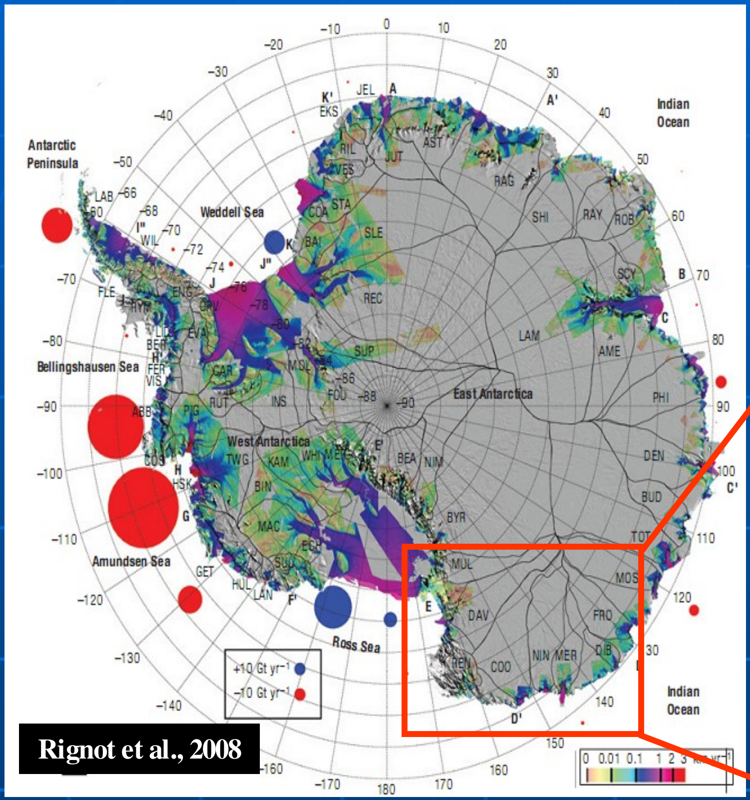
These fast-flowing glaciers are speeding up !

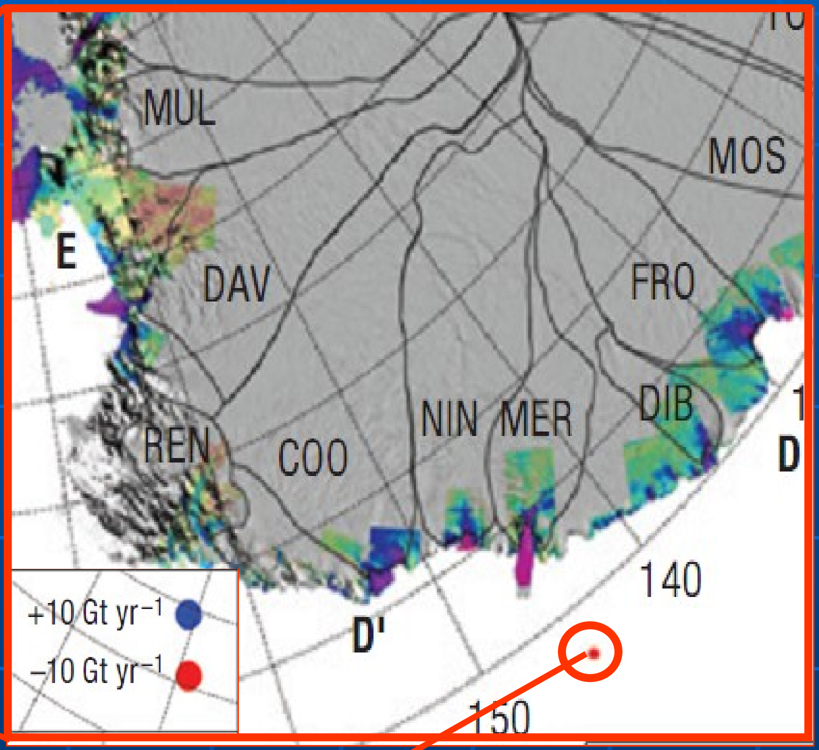




Rignot and Kanagaratman, 2006

CONTEXT





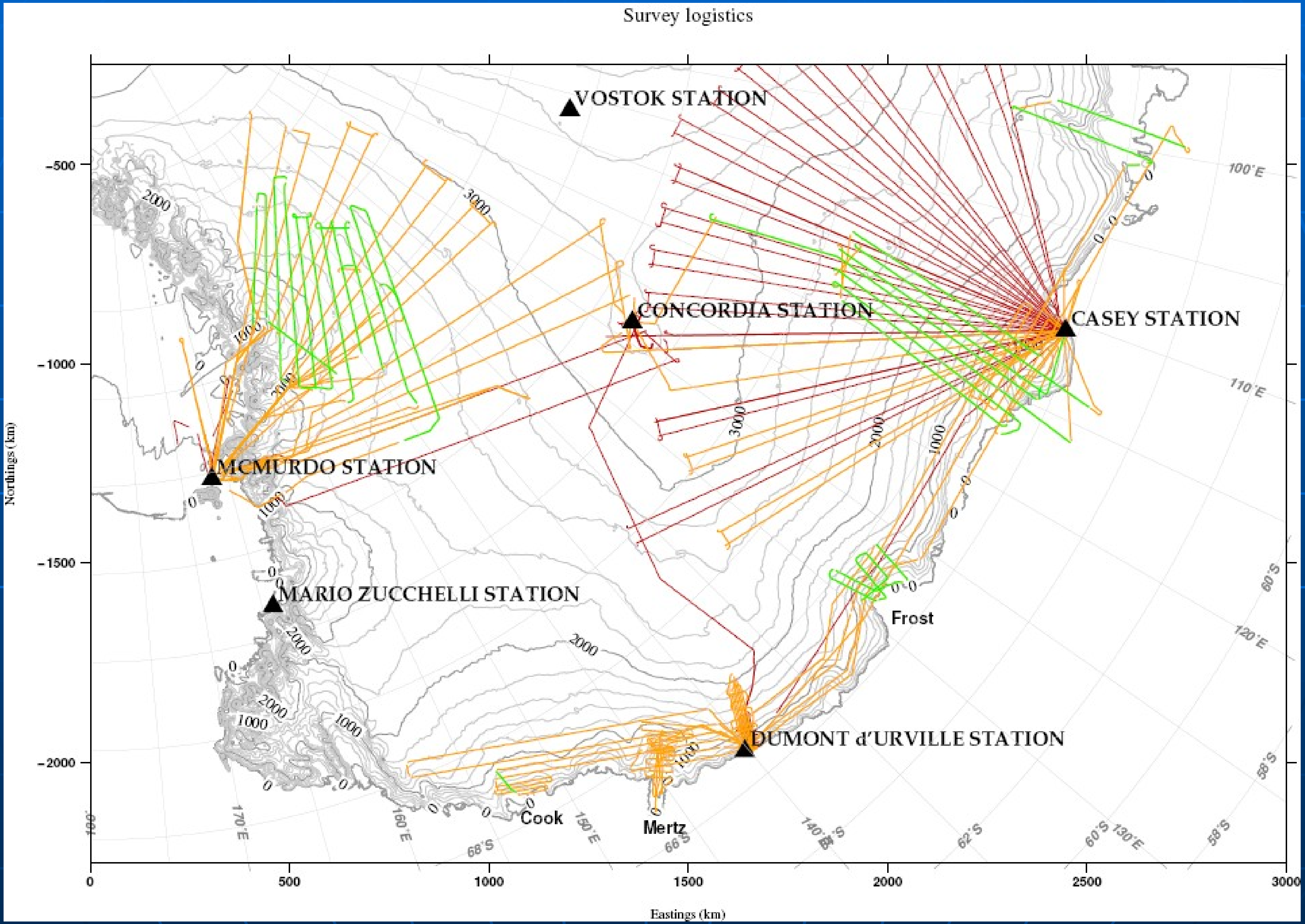
Large uncertainties in the overall mass balance of the East-Antarctic ice sheet (Wilkes sector)

-2 ± 19 Gt /yr

Need for a more accurate computation of the total ice flux to the sea through outlet glaciers

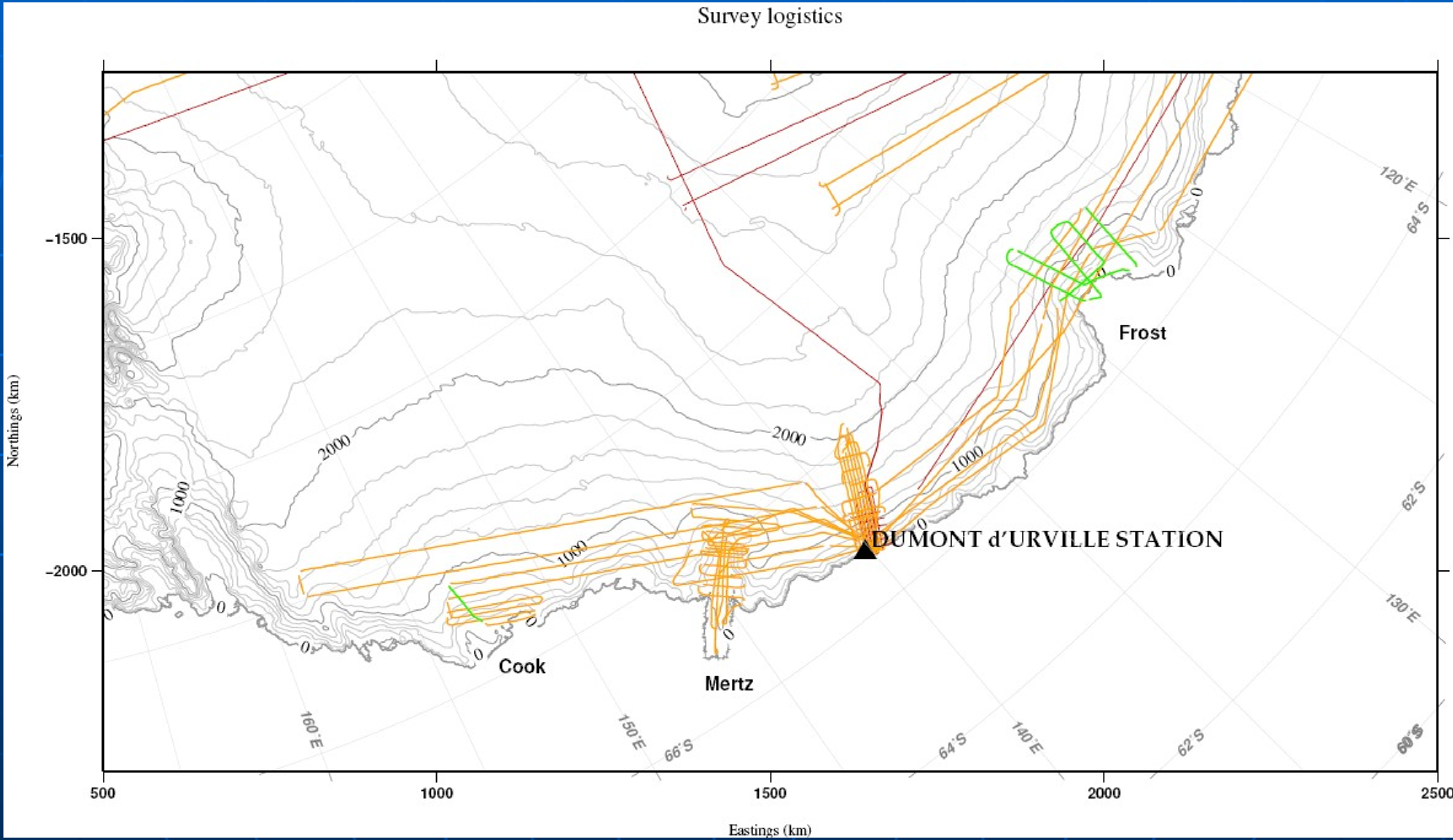
CONTEXT

Airborne radar and Lidar campaign (ICECAP project)



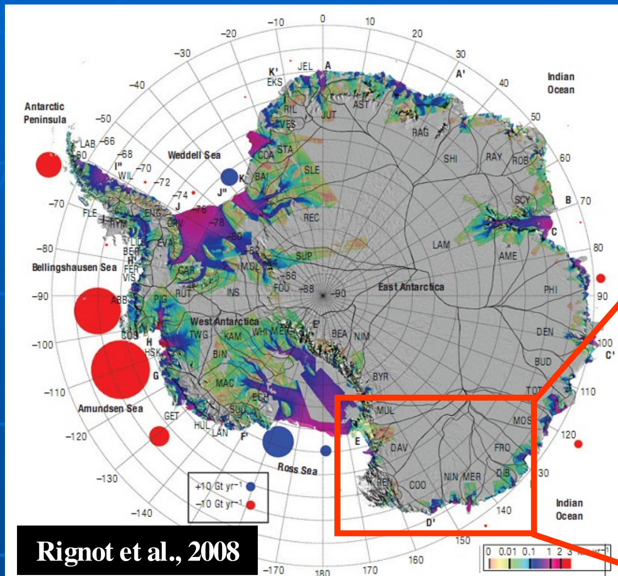
CONTEXT

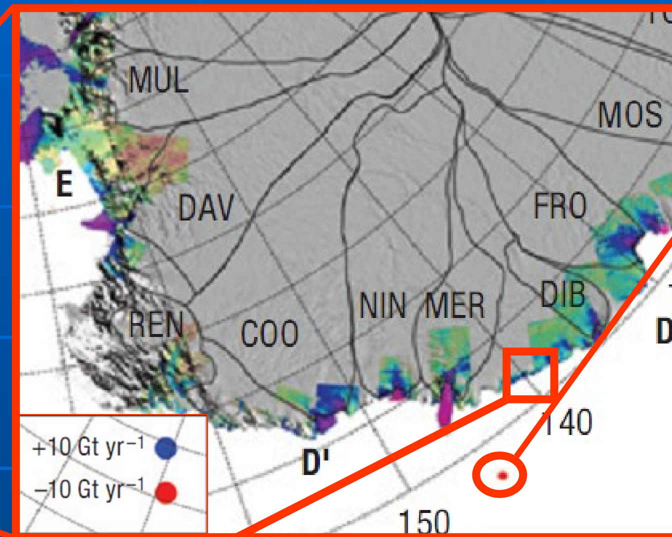
Focus on the Wilkes-Terre Adélie sector



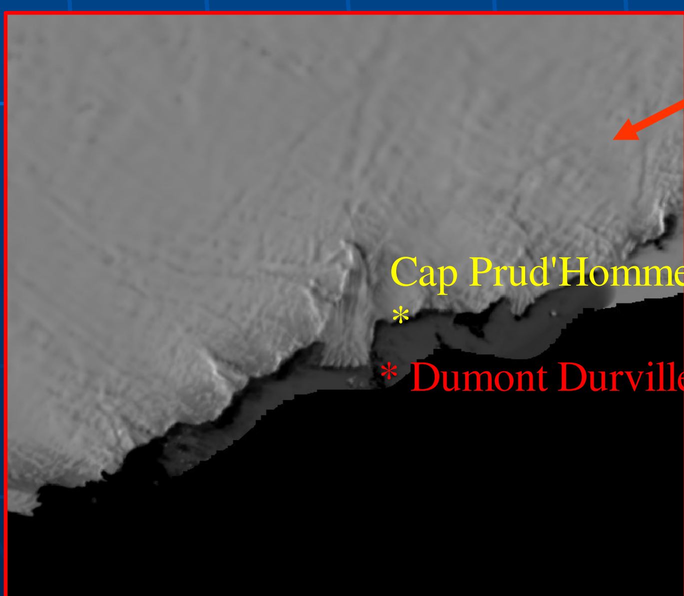
CONTEXT

The Astrolabe glacier as a test zone





-2 ± 19 Gt /yr



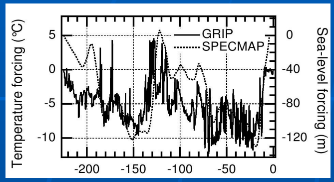

Logistical facilities (near the french bases of Dumont d'Urville and Cap Prud'Homme

CONTEXT

Ice flow modelling and necessary field data

Environmental forcing

Mass balance data



T

Sea level forcing

Core of the model

$$\nabla.\boldsymbol{\tau_i}+\rho g_i=0, \quad i=x,y,z$$

$$\frac{\partial H}{\partial t}=M-\nabla.\boldsymbol{q} \quad ; \quad \boldsymbol{q}=\bar{\boldsymbol{v}}_{\boldsymbol{H}}H=\int_h^{H+h}\boldsymbol{v_H}(z)dz$$

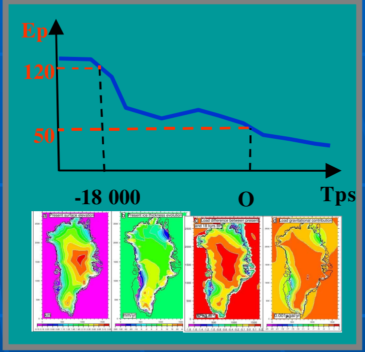
$$\frac{\partial T}{\partial t}=\frac{1}{\rho c_p}\nabla.(k\nabla T)-\boldsymbol{v}.\nabla T+\frac{W}{\rho c_p}$$

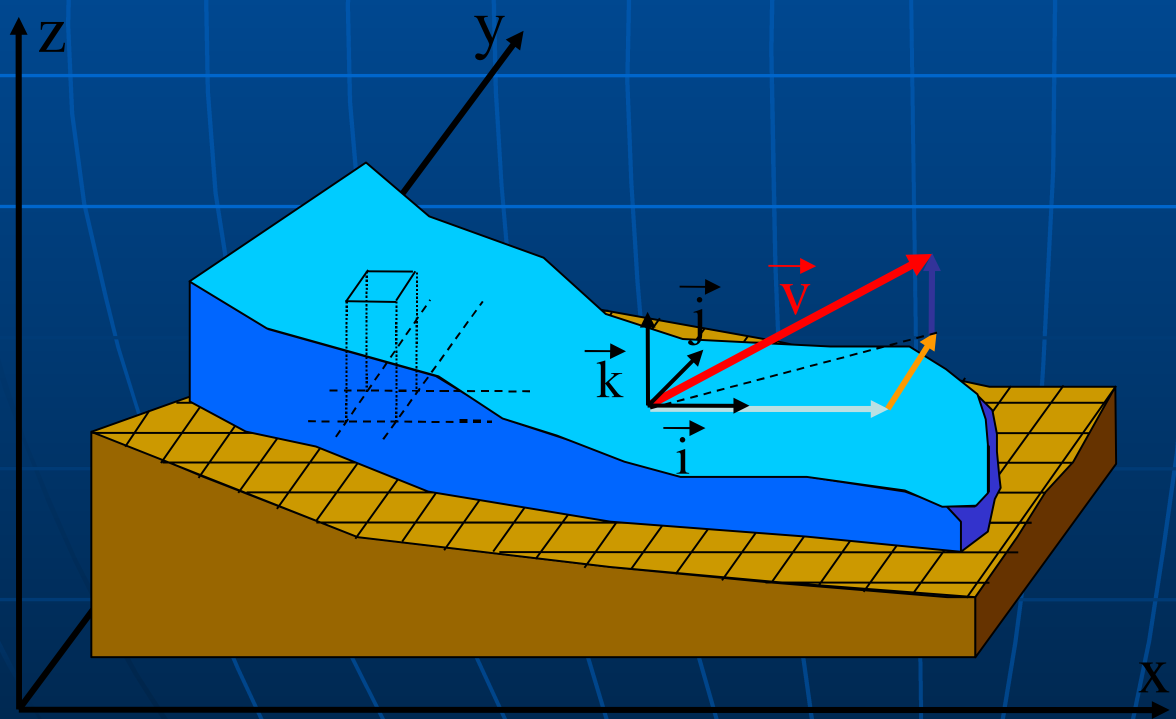
$$\dot{\epsilon}_{i,j}=A(T)\tau^{n-1}\tau'_{i,j}$$

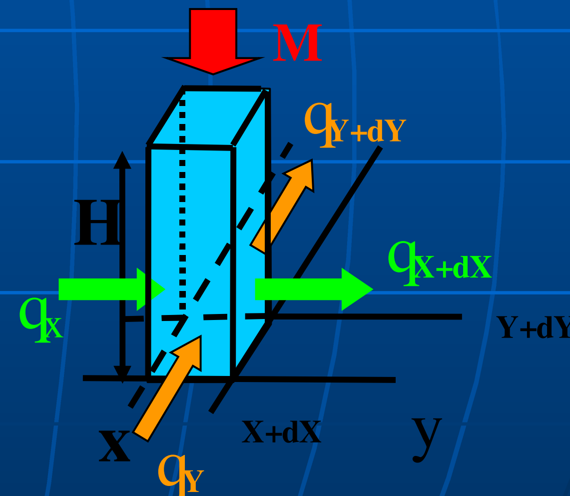
Sliding law

Grounding line dynamics

Model outputs

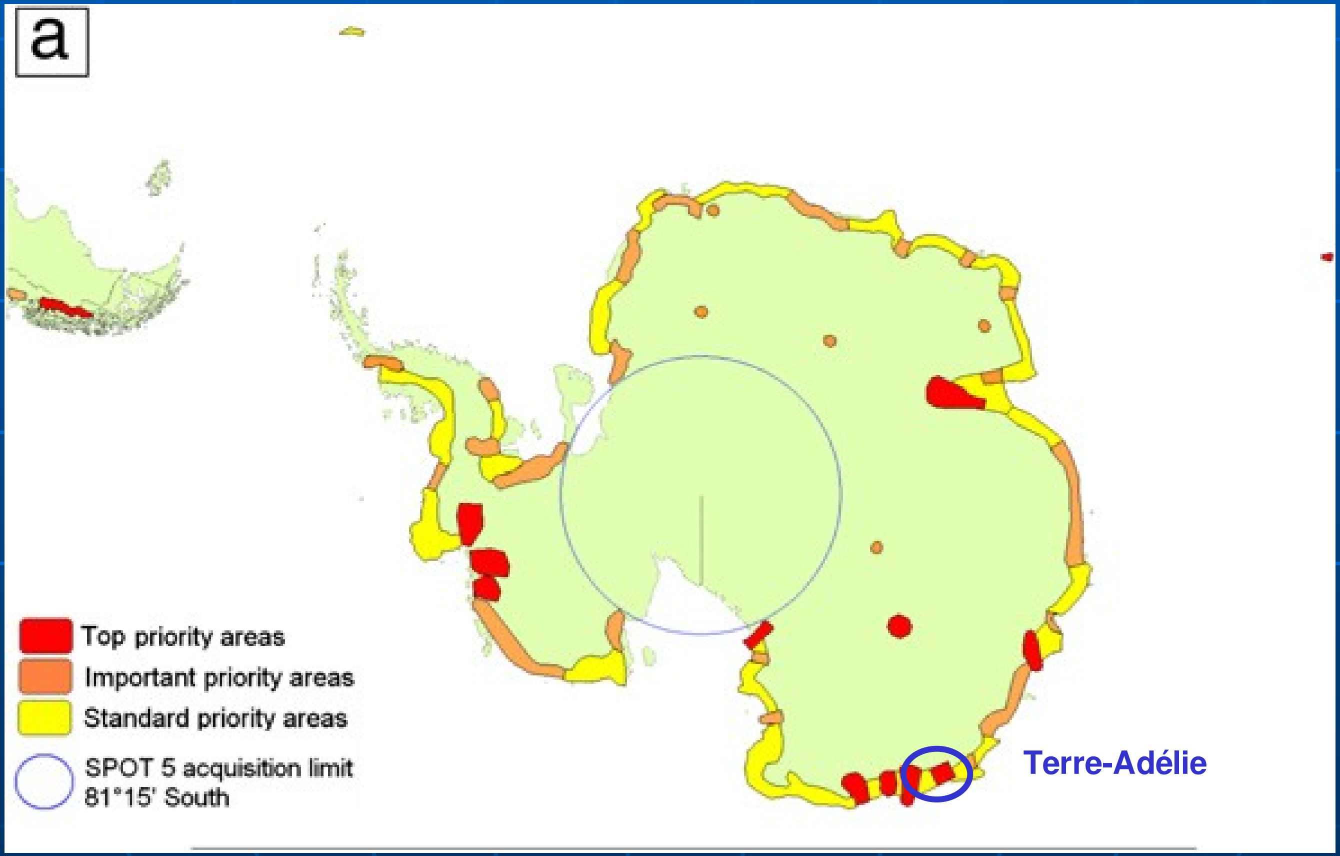






SPIRIT DATA SETS

Areas of interest for the SPIRIT project in the Southern Hemisphere.



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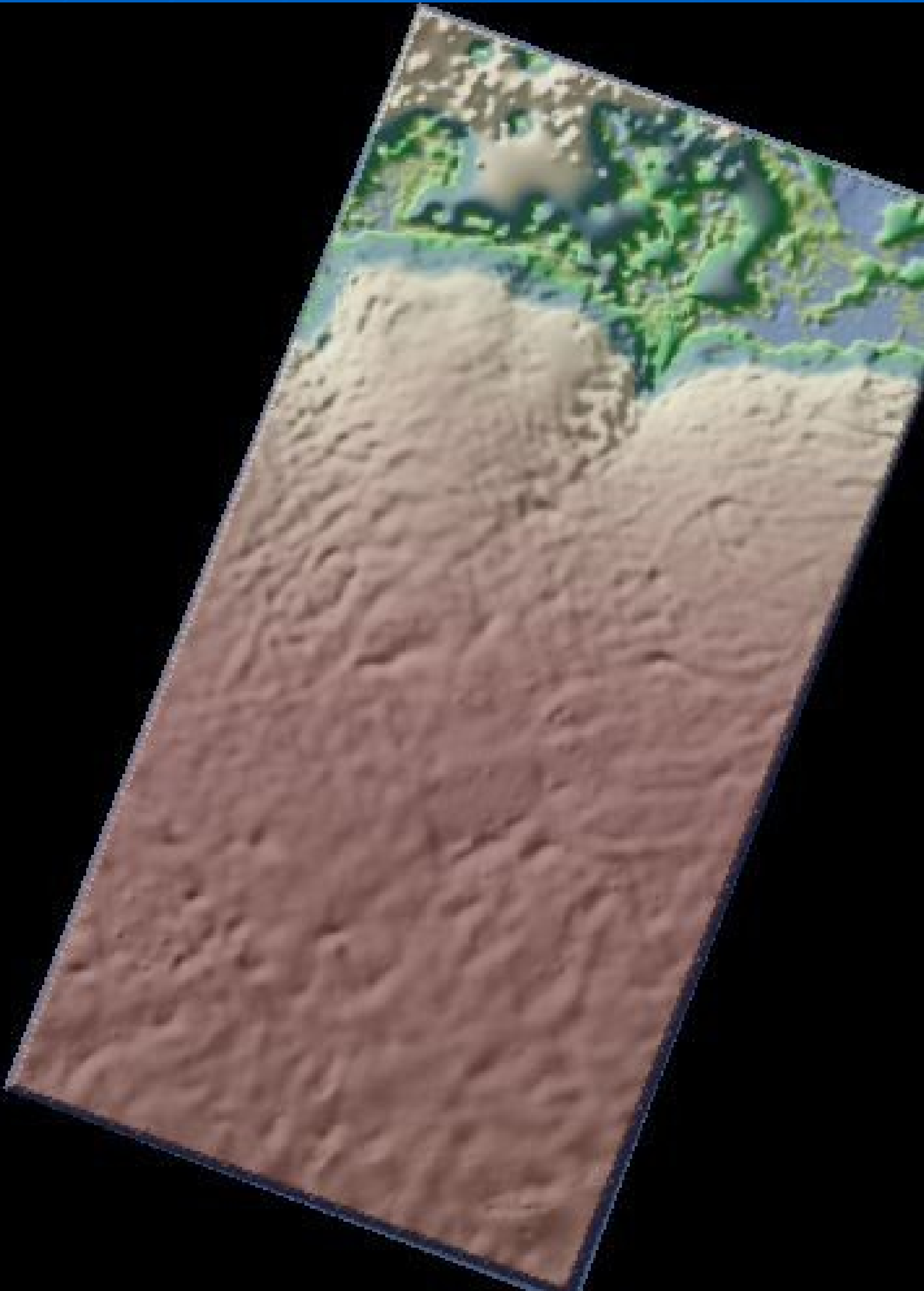
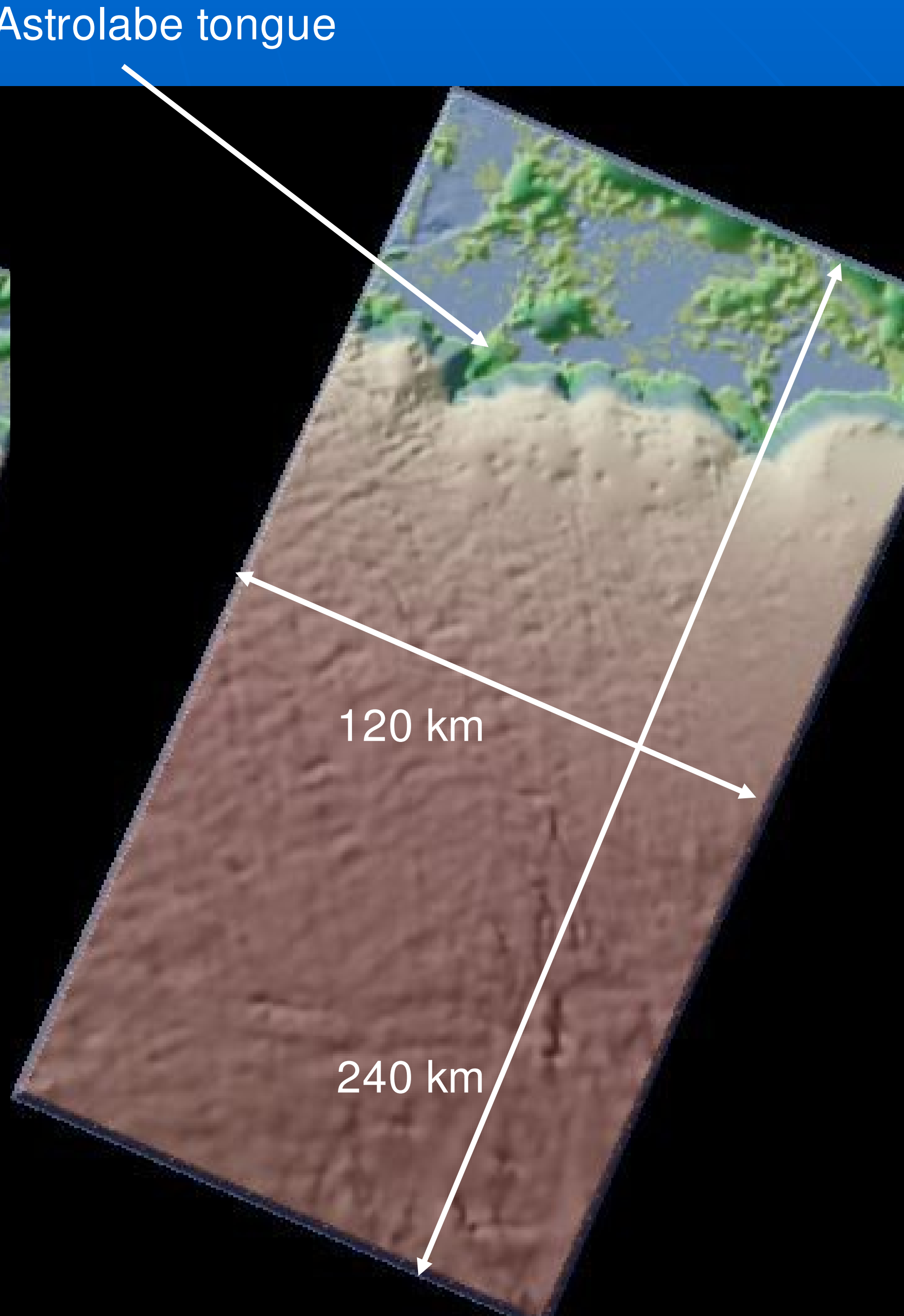
SPIRIT DATA SETS



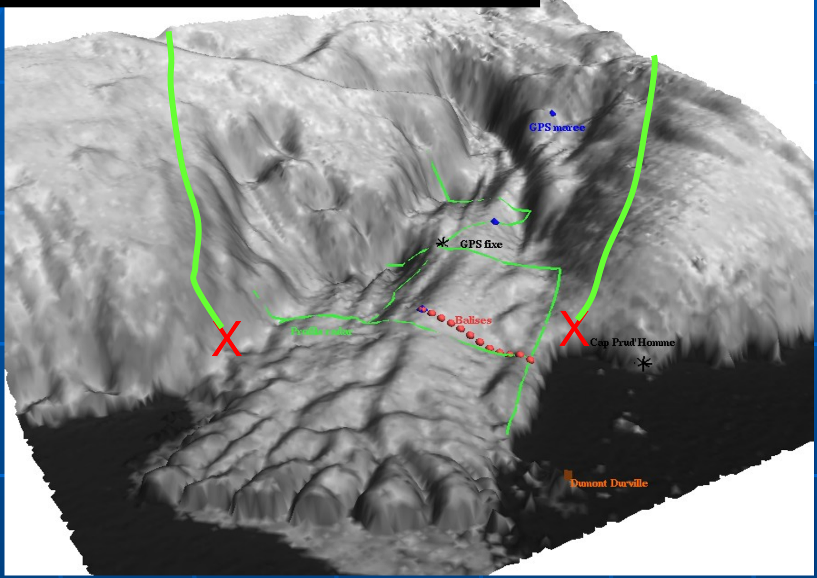


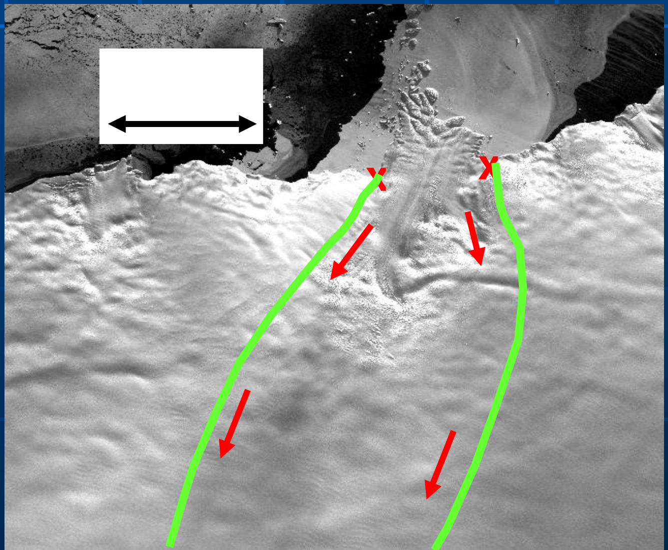
SPIRIT DATA SETS

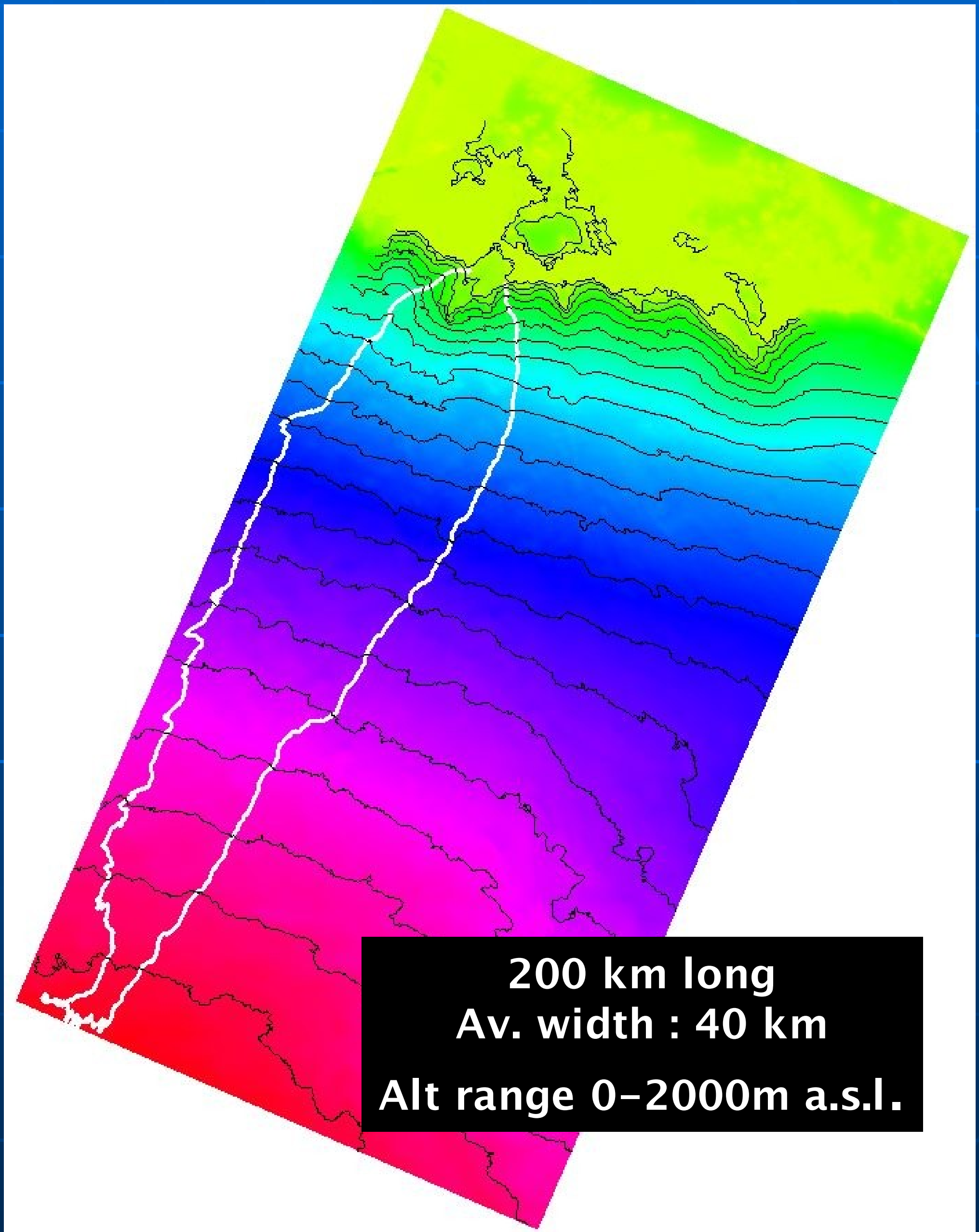
A dynamically consistent body : the drainage basin

SPOT HRS stereographic pair -> DEM

(Spirit project , SPOT Image, CNES)

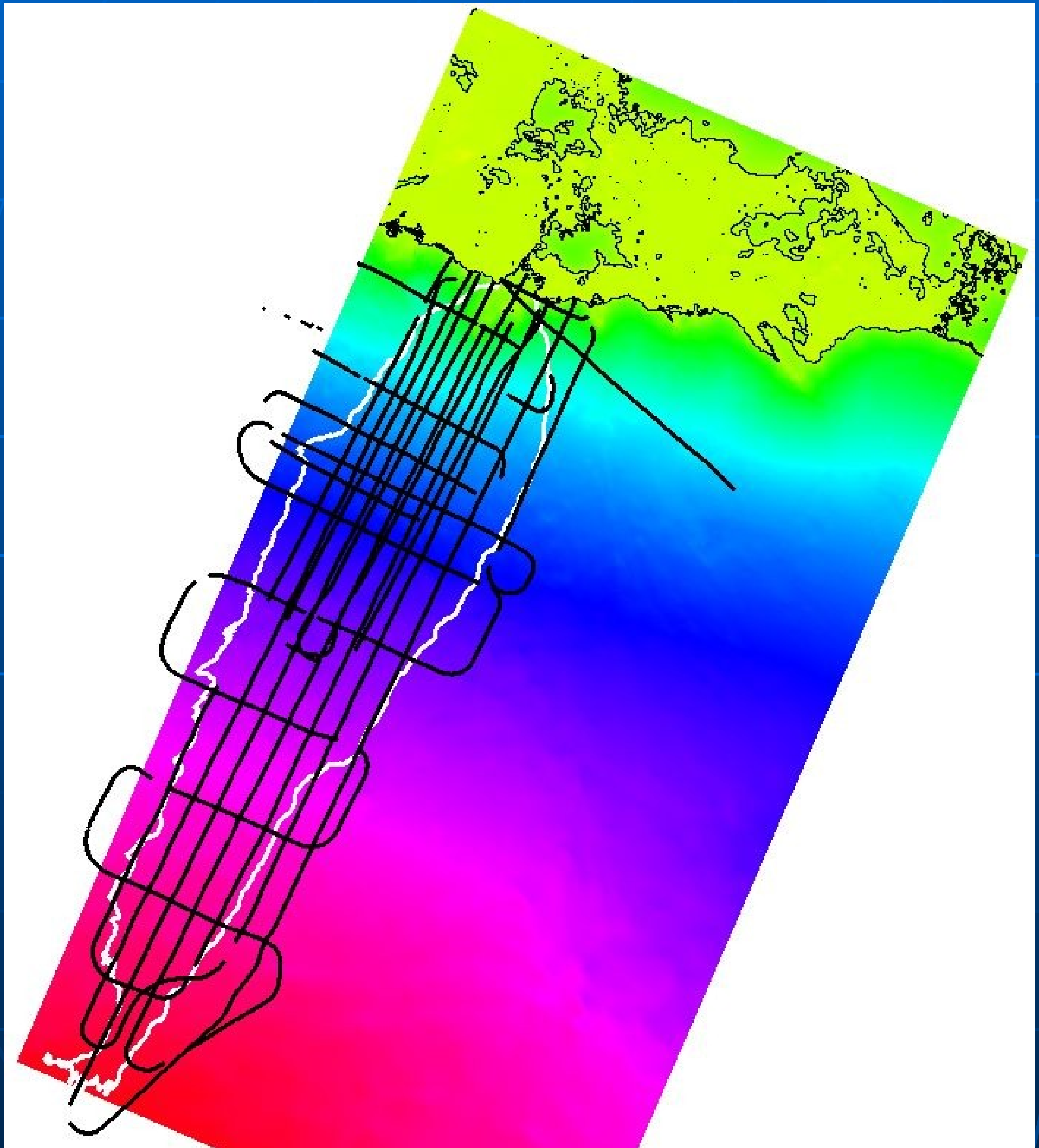






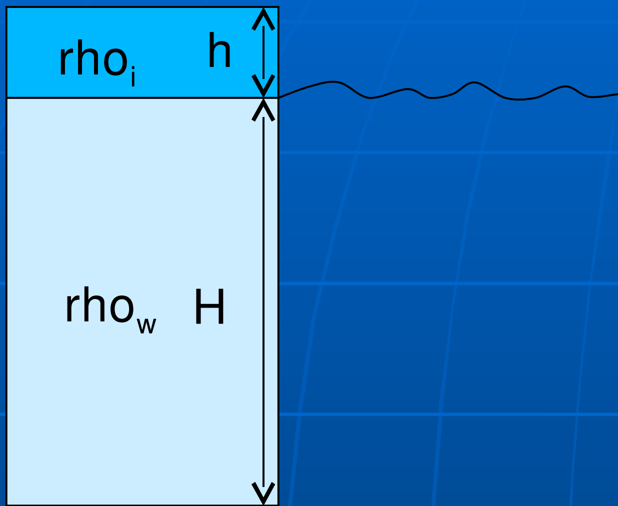
SPIRIT DATA SETS

Flight lines for the airborne geophysical survey

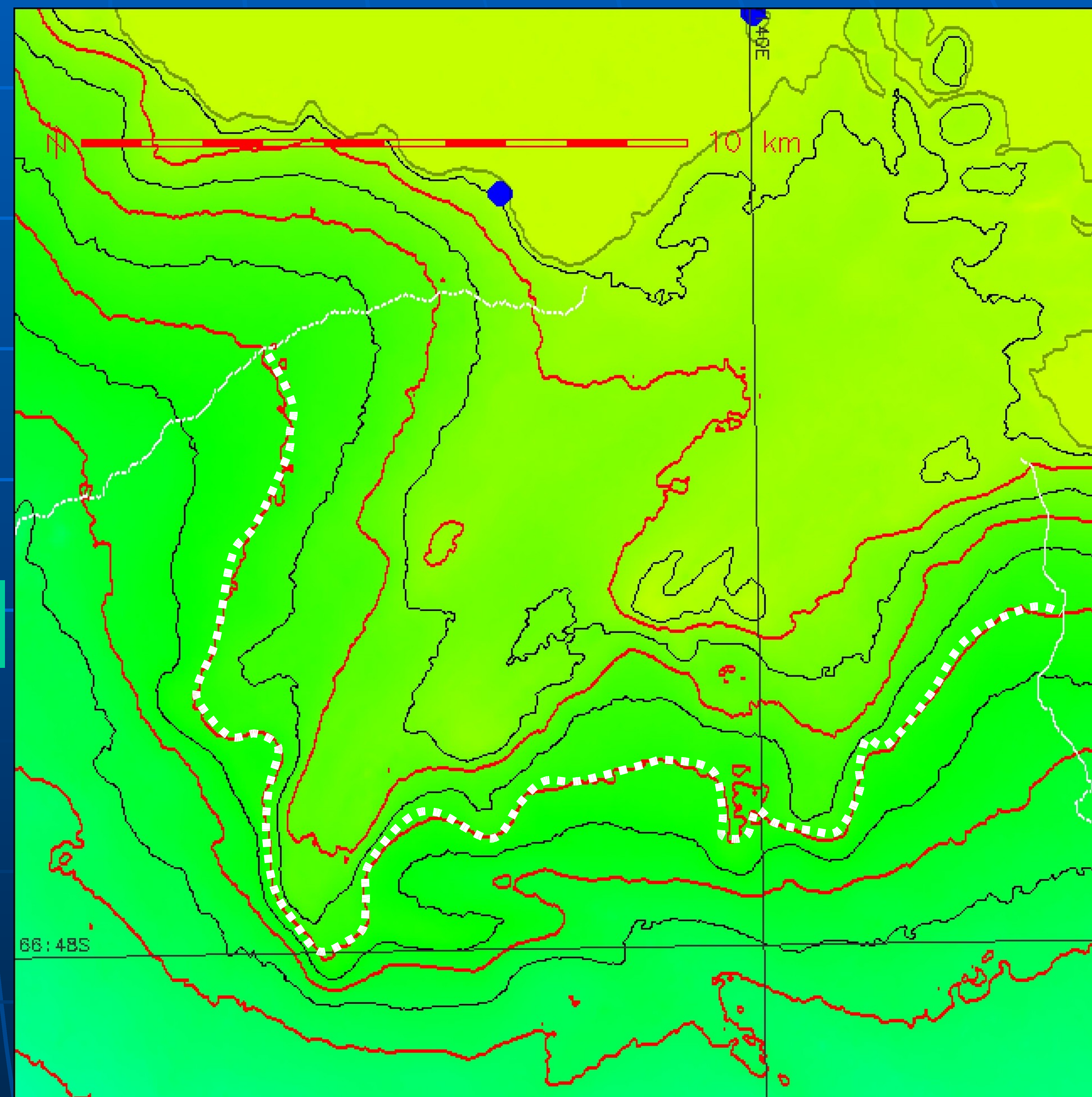


JPL 2.5MHz radar (red grid)

Location of the Grounding line



On Topographic grounds…..



Flotation criterion :

$H = h * rho_i / (rho_w - rho_i)$

$rho_w = 1023\ kg.m^{-3}$	$rho_i = 875\ kg.m^{-3}$

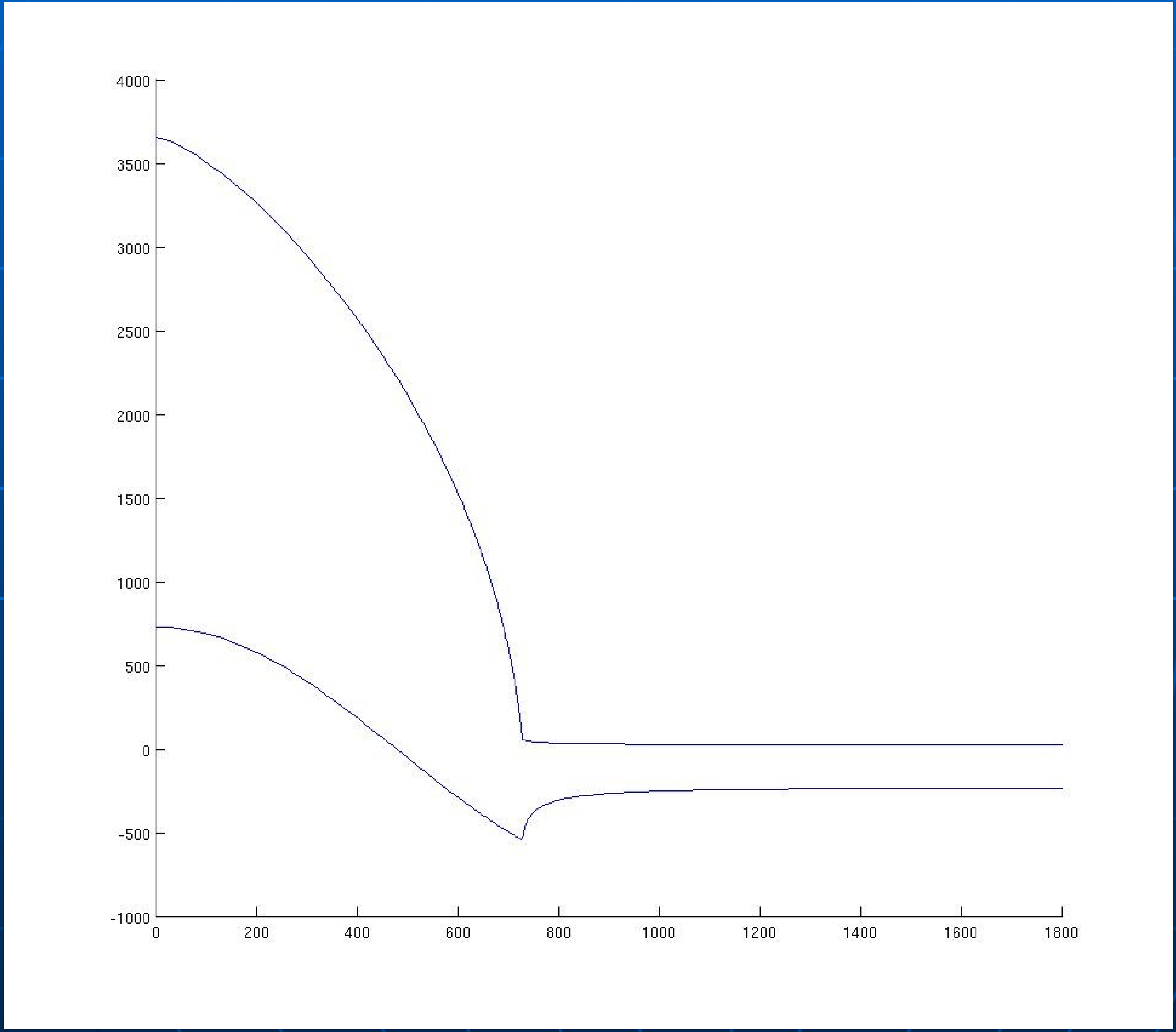
$H = 6 * h$

H_{max} : 1800-2000 m

Maximum floating height of about 300m

Marine ice-sheet – Model profile

Grounding line position from modelling



Marine ice-sheet – Model profile

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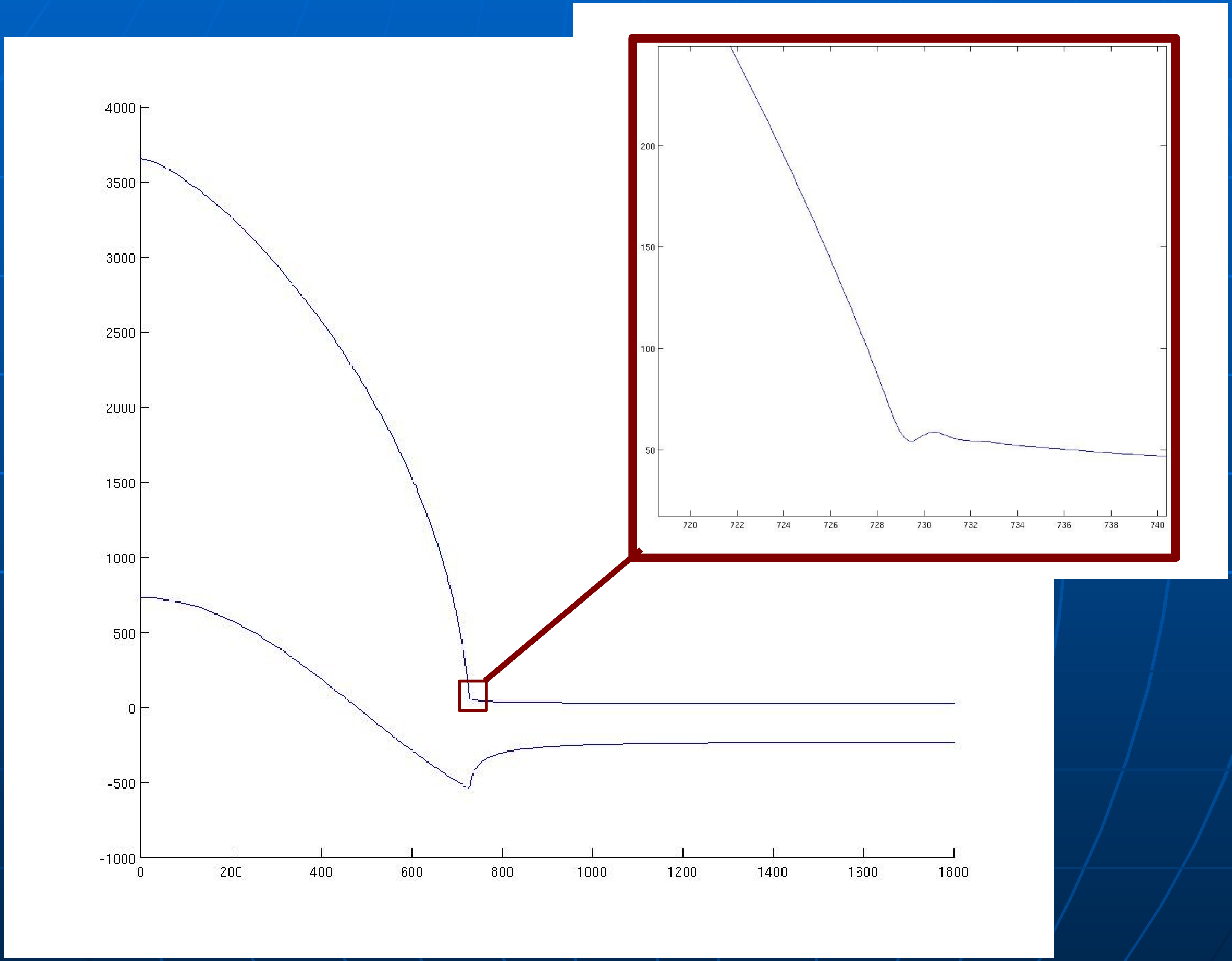
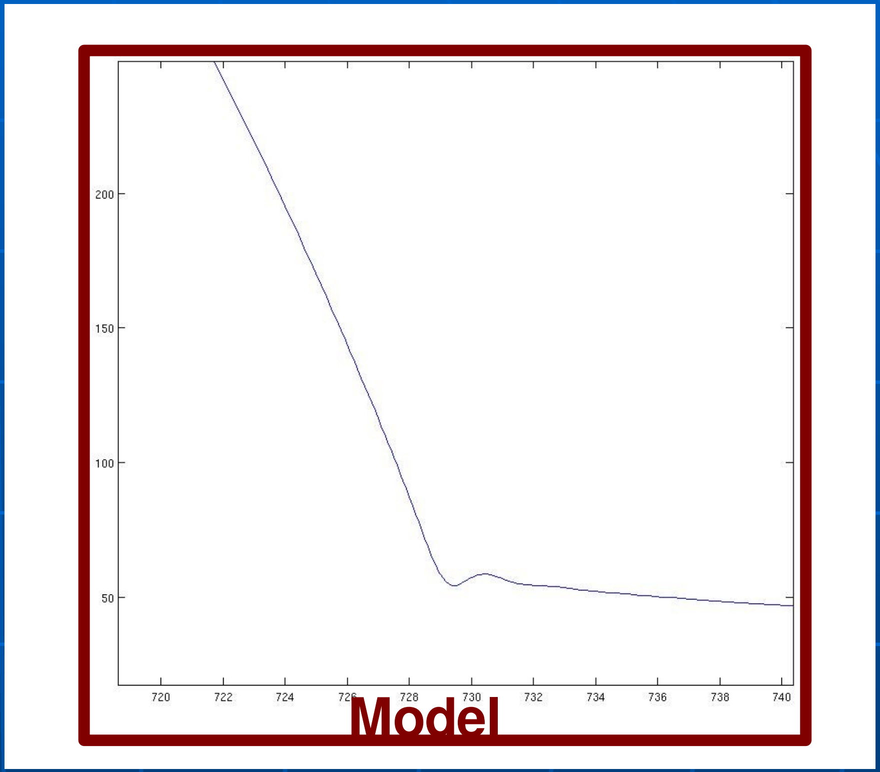


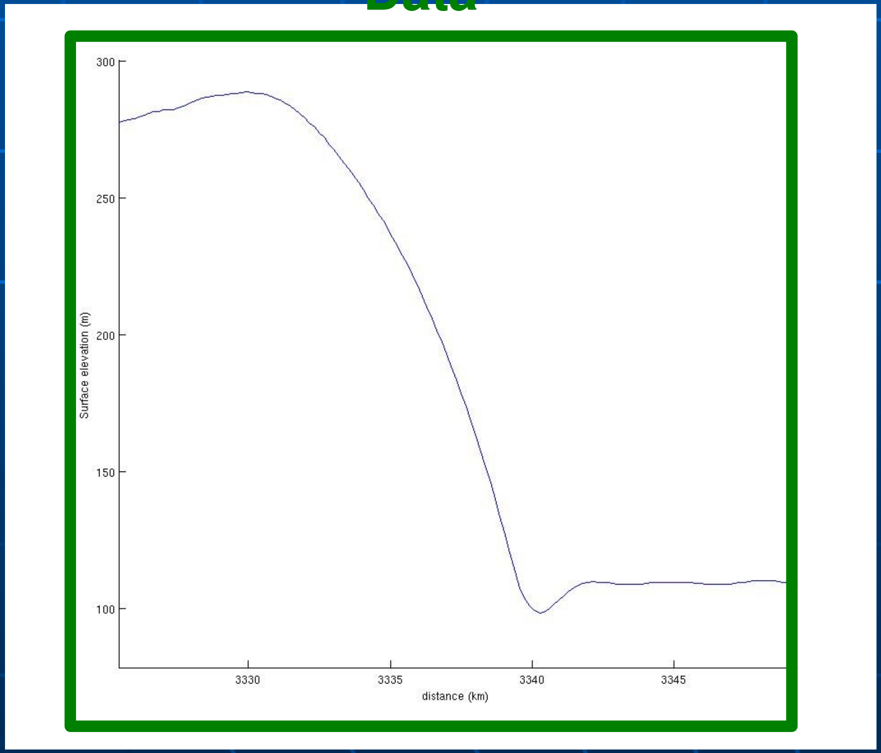
Grounding line position from modelling

Surface elevation around the grounding line : model versus data



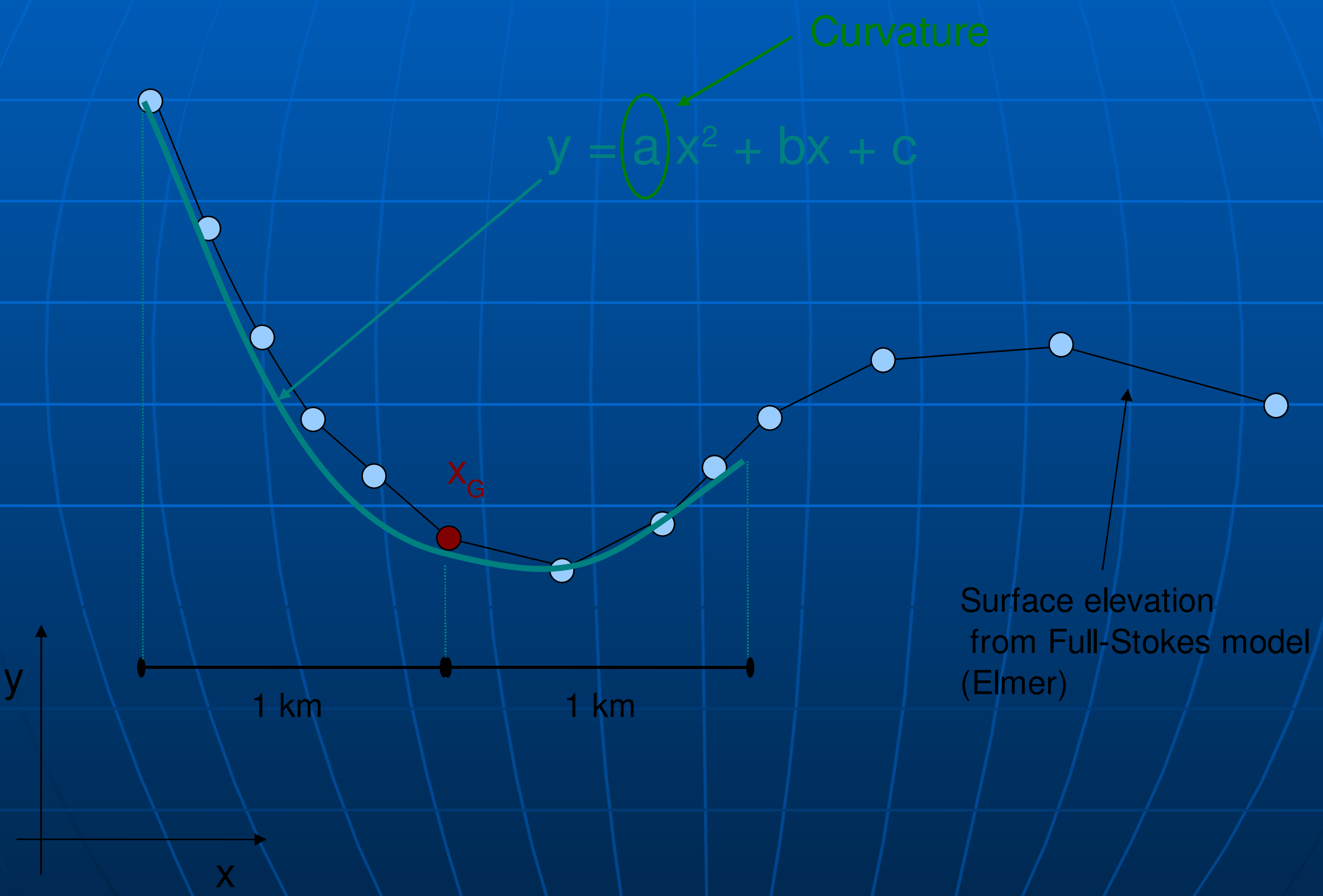
Model

Data



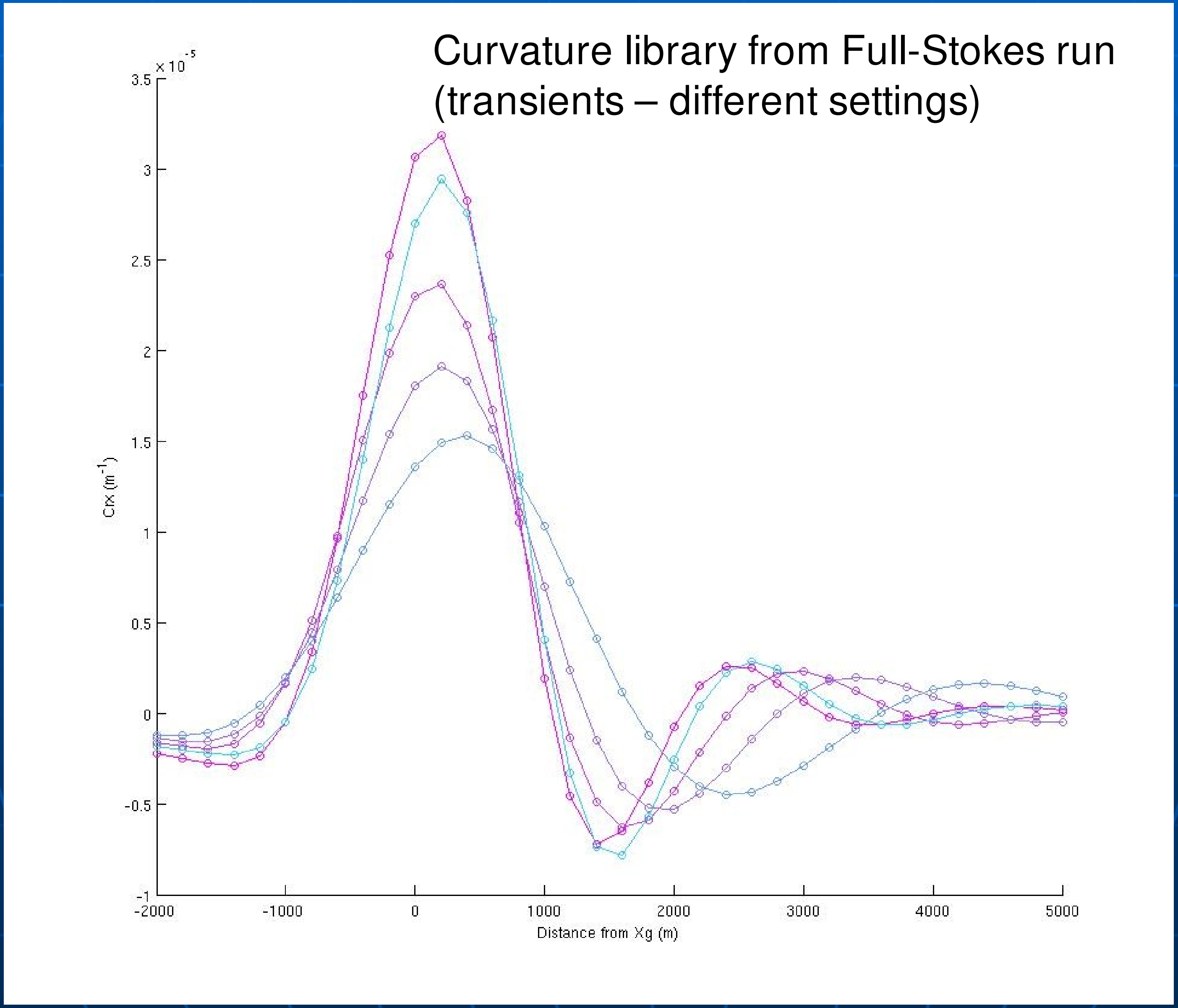
Quadratic curvature fitting around the grounding line (along a flow line)

Grounding line position from modelling

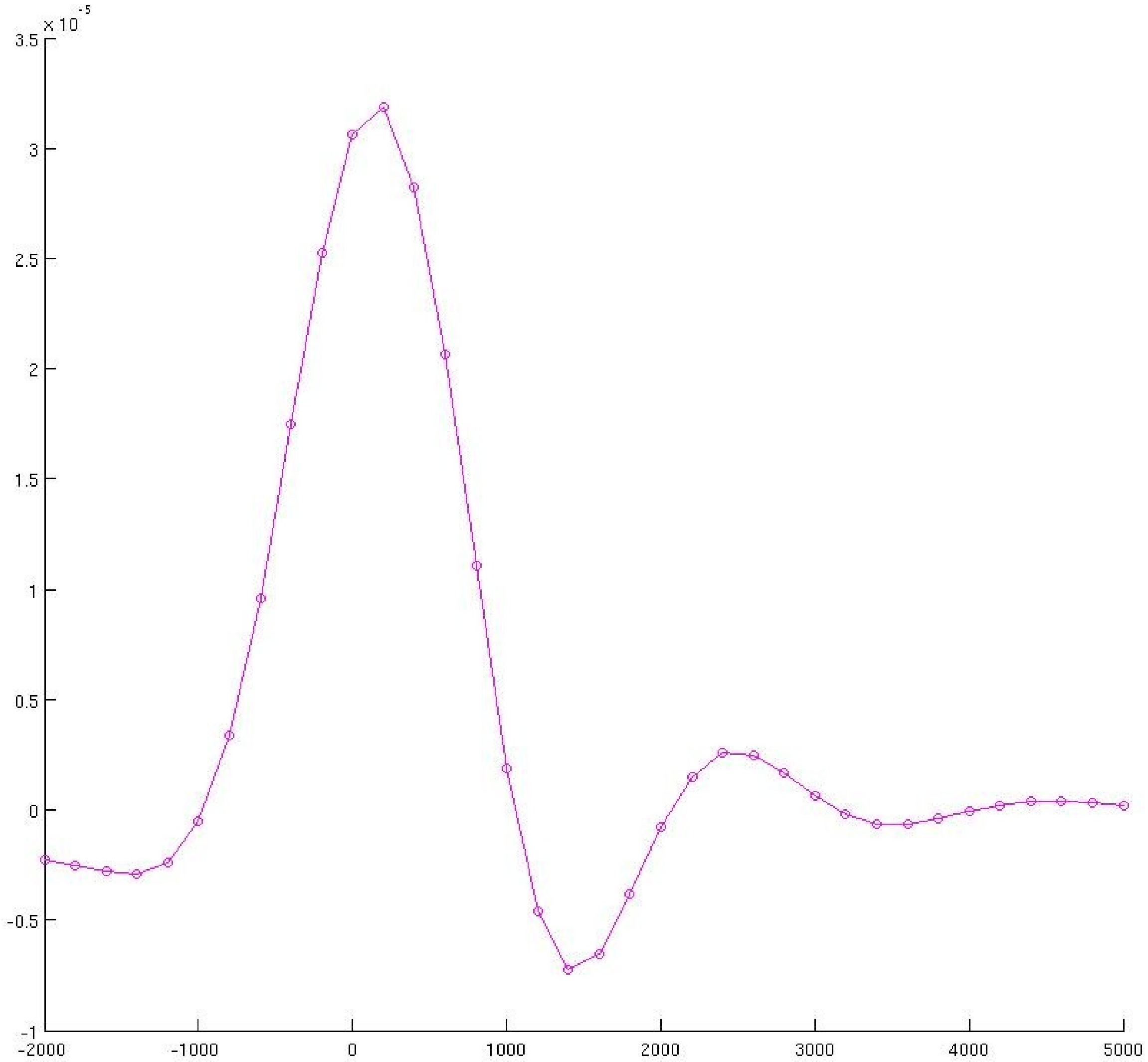


Runs under various conditions -> library of fitting curves

Grounding line position from modelling

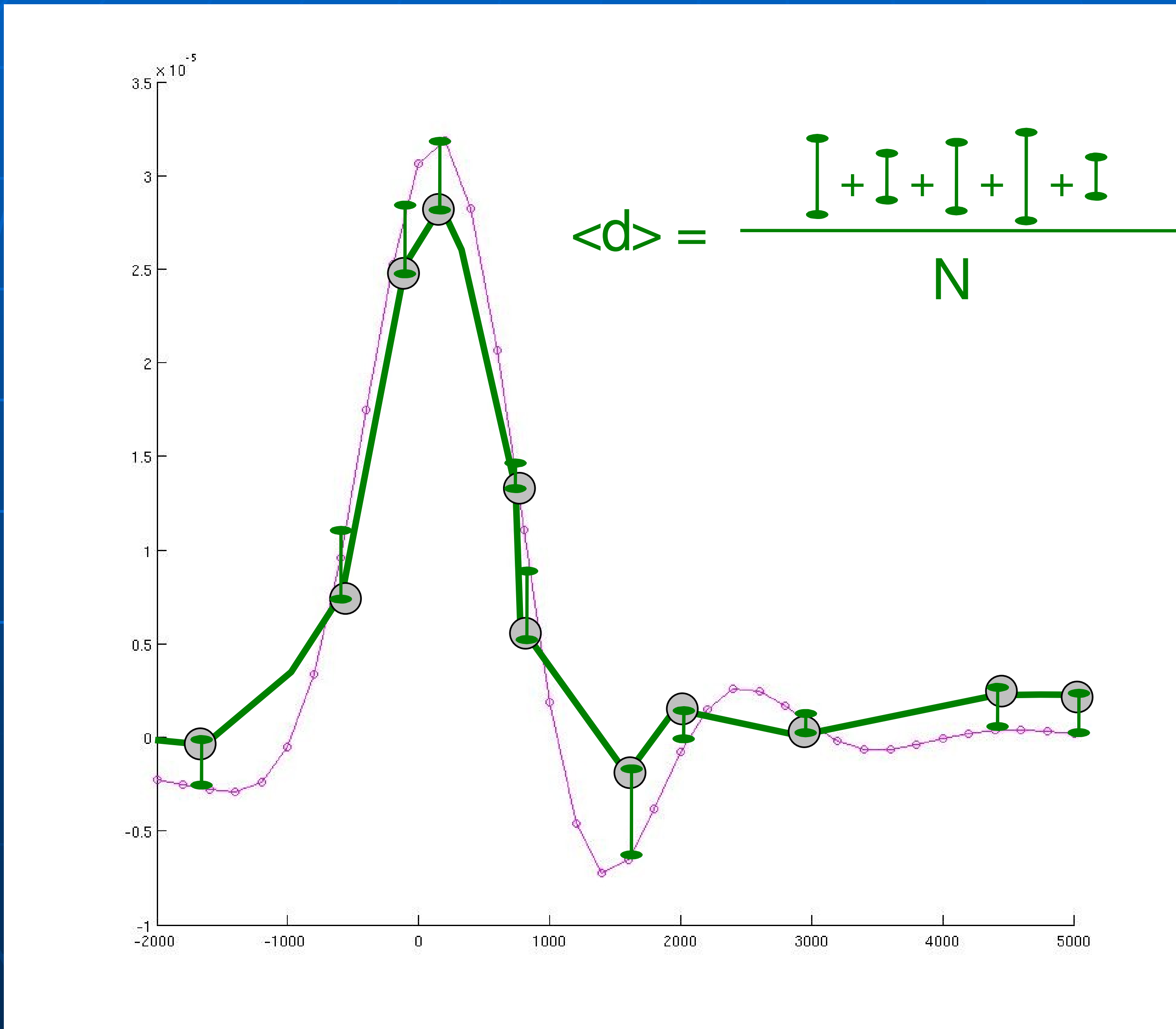


Grounding line position from modelling

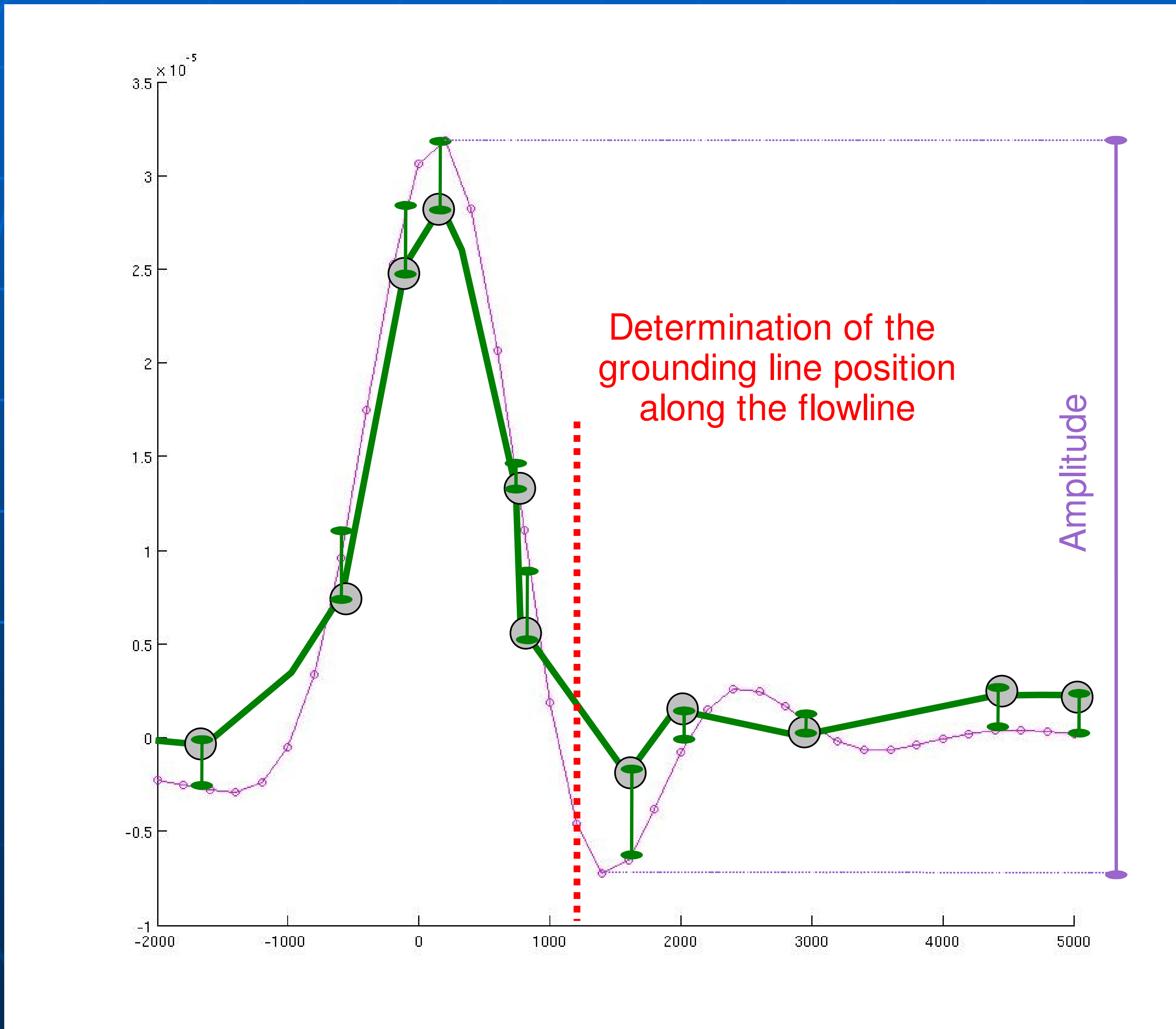


Grounding line position from modelling

Minimizing the misfit –> selection of the most appropriate curve



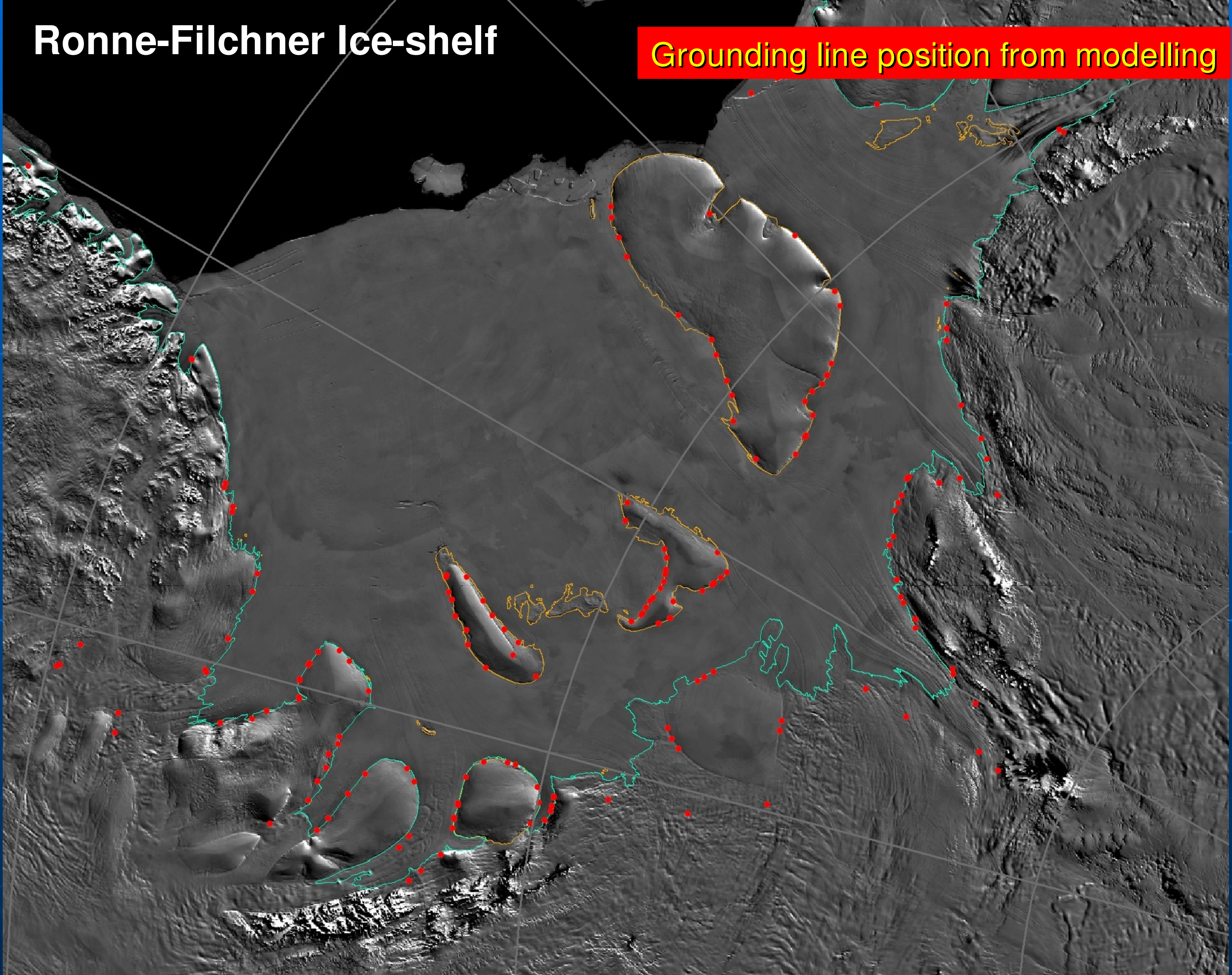
Grounding line position from modelling



$$\frac{\langle d \rangle}{\text{Amplitude}} < 0.2$$

Ronne-Filchner Ice-shelf

Grounding line position from modelling



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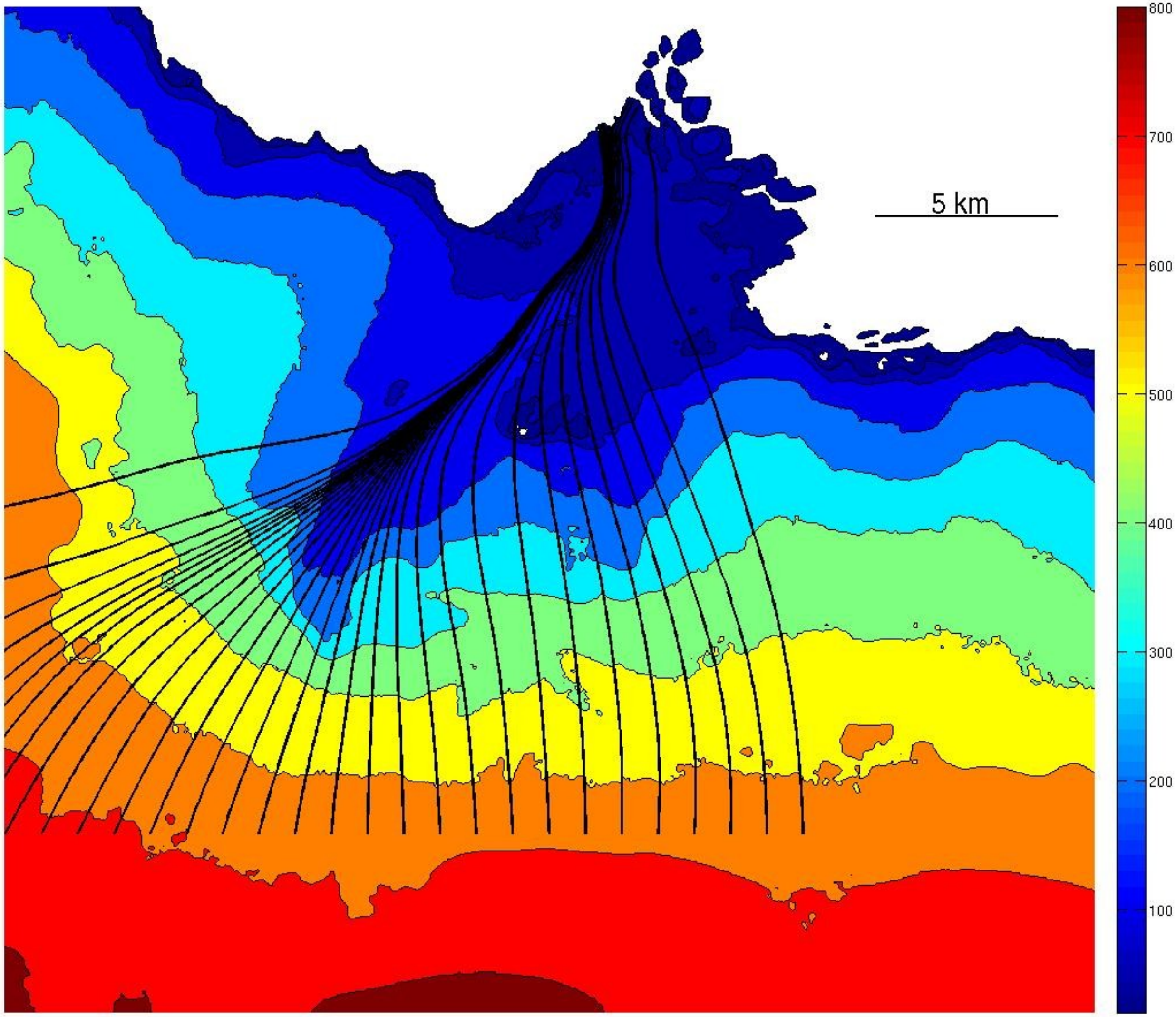

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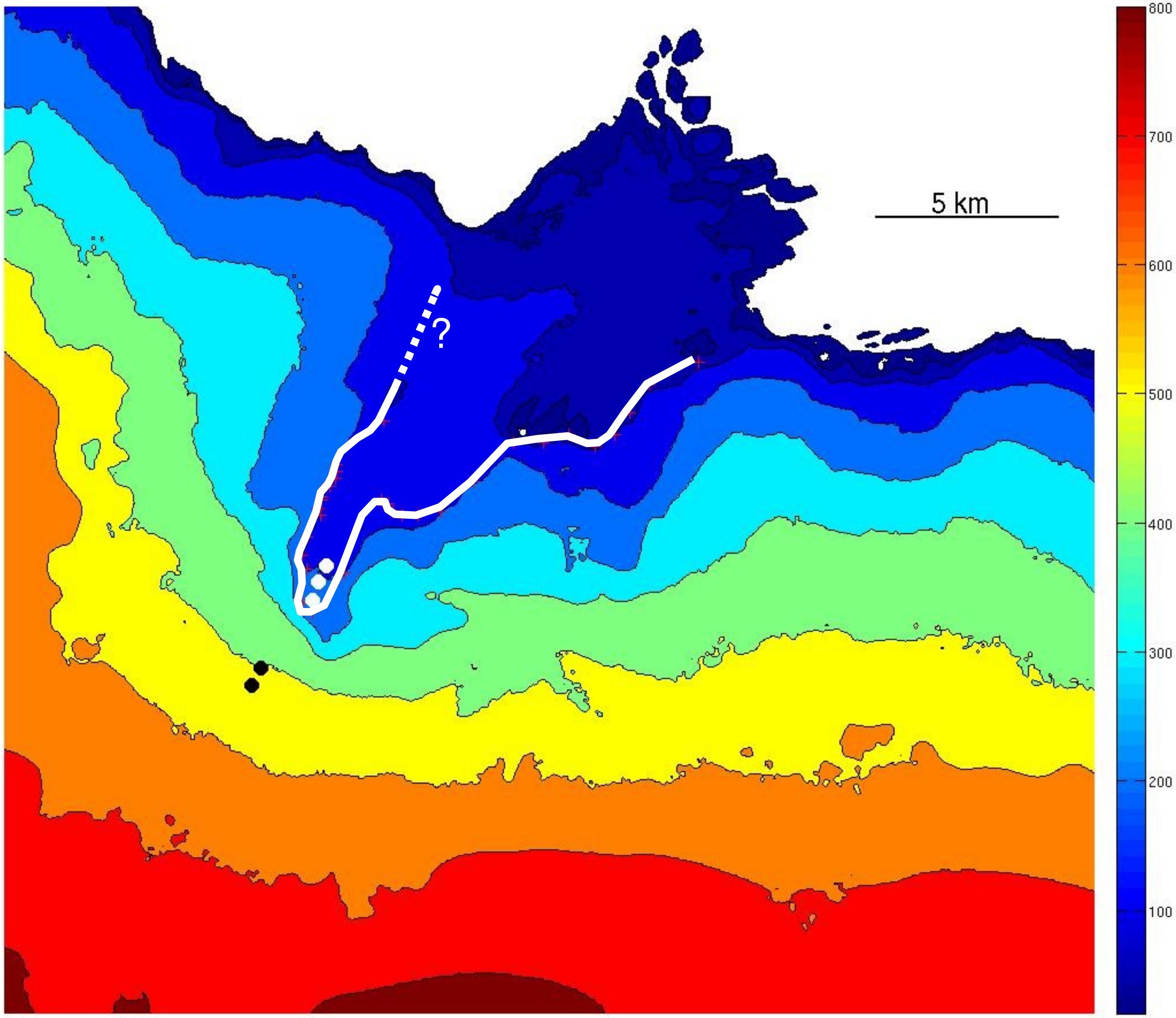

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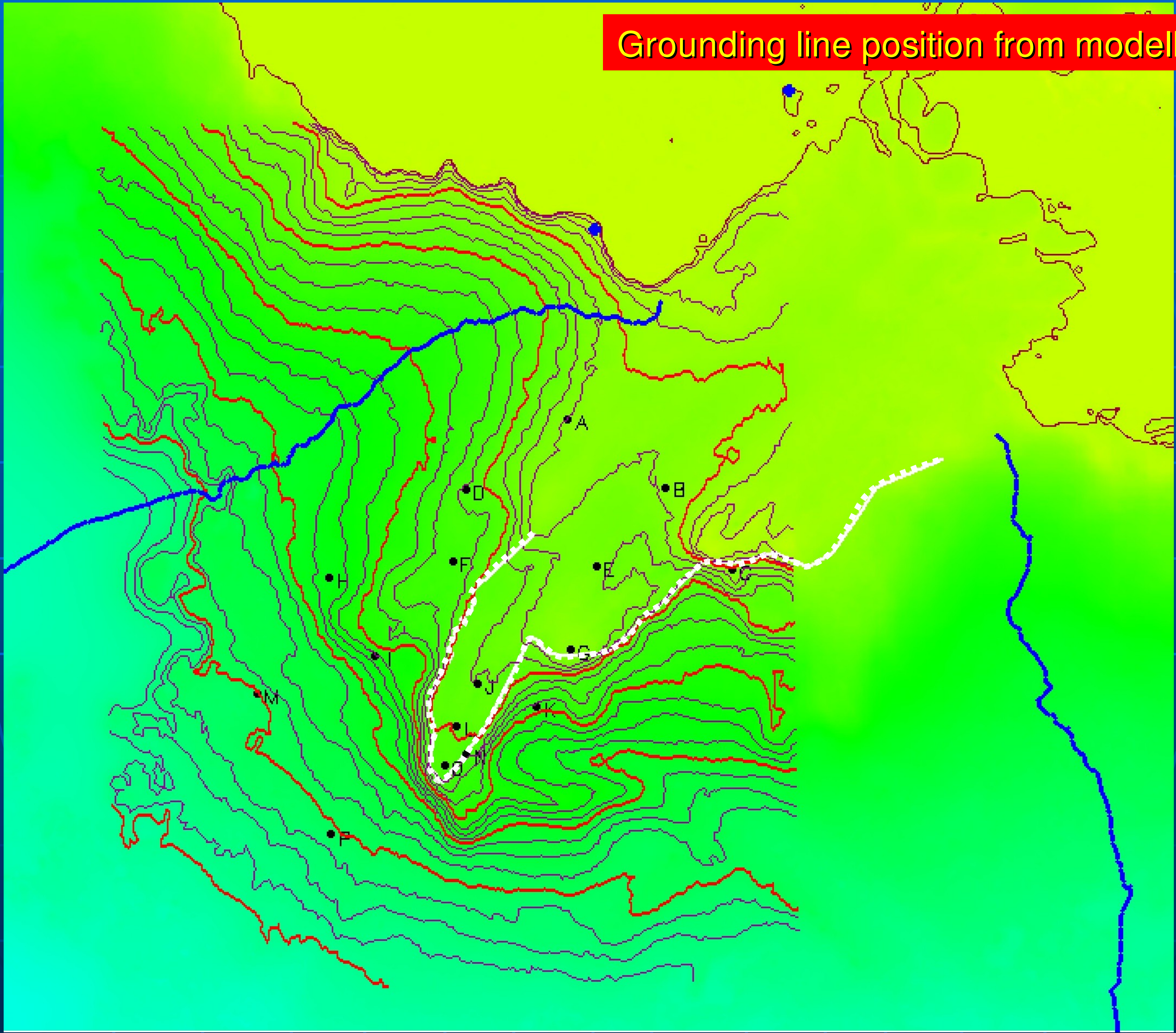
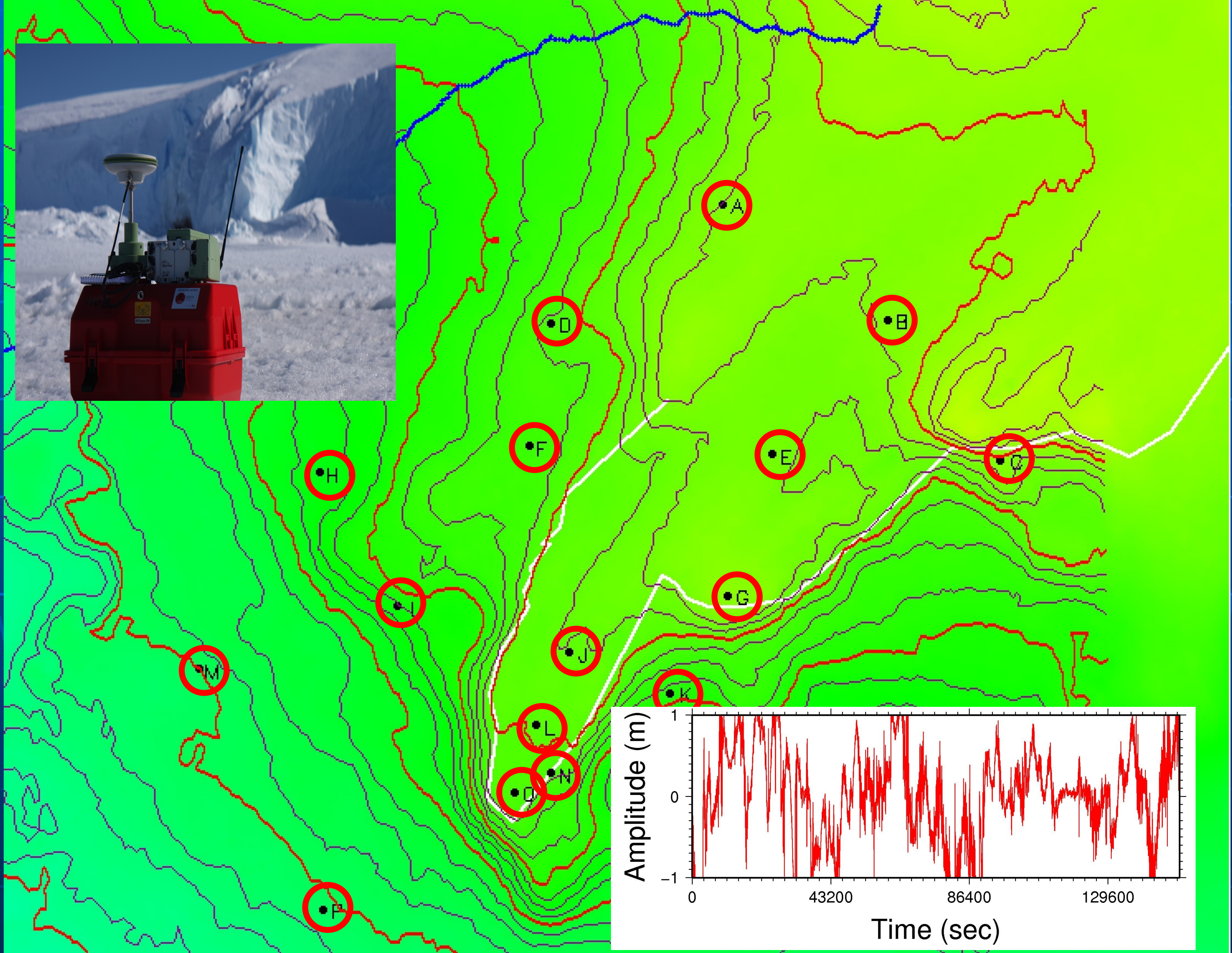
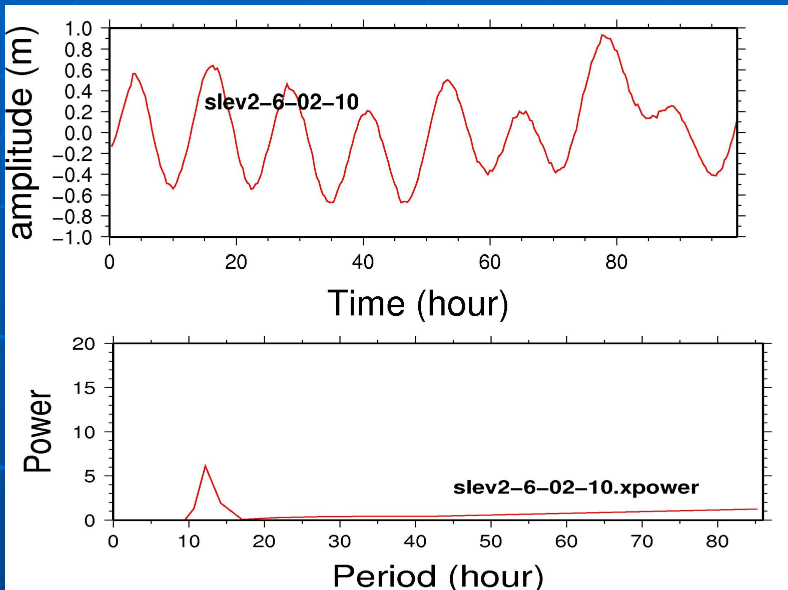
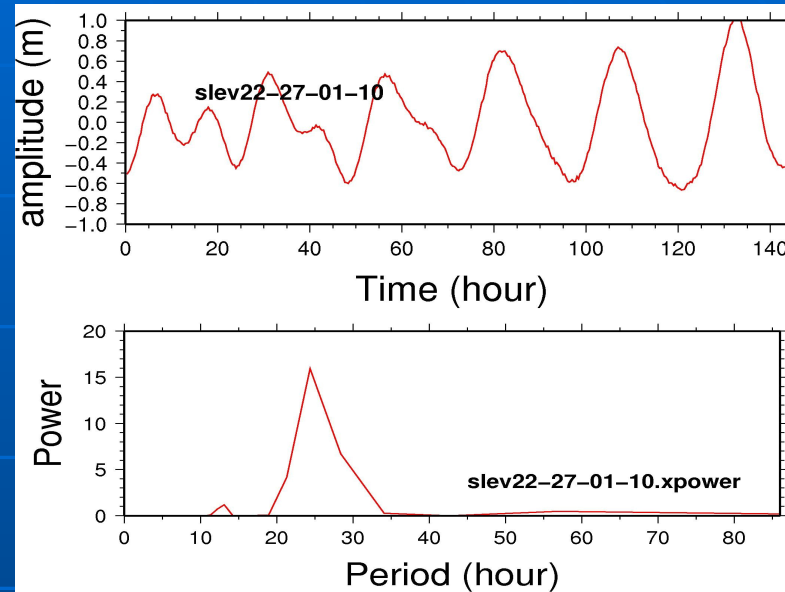


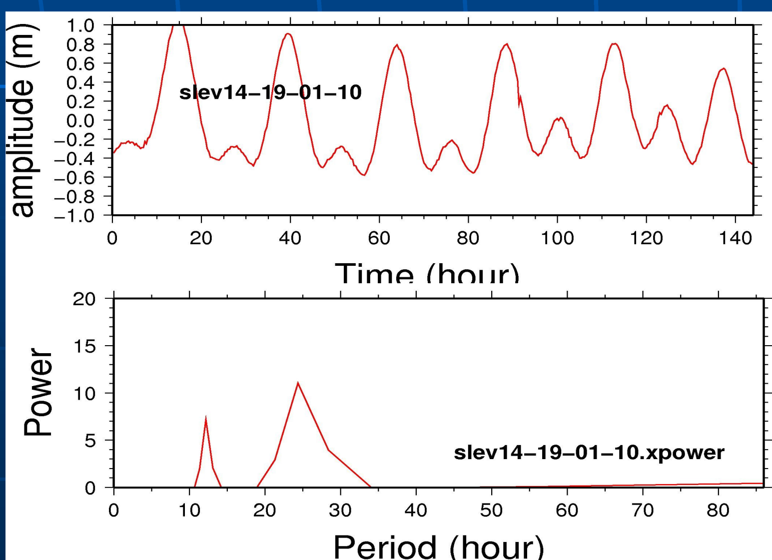
Grounding line position from GPS data

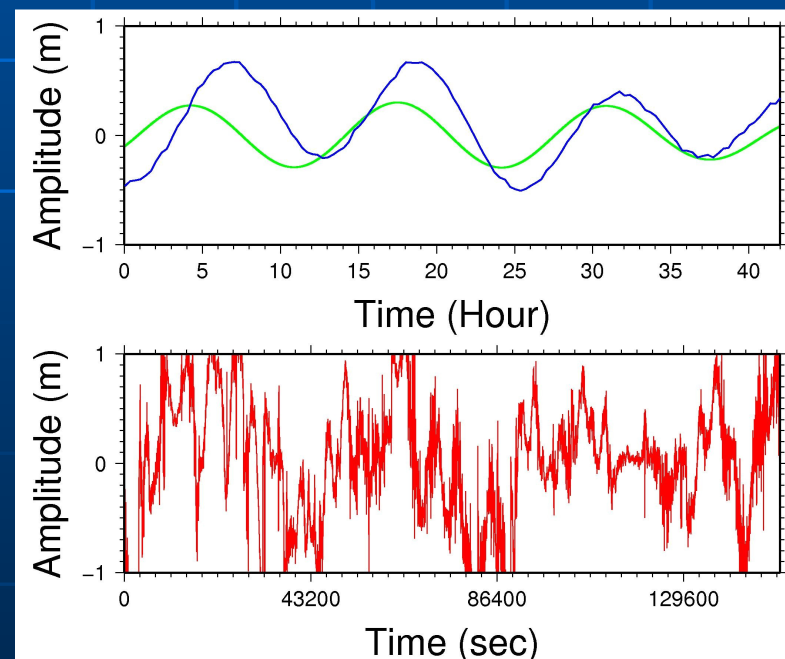


Grounding line position from GPS data









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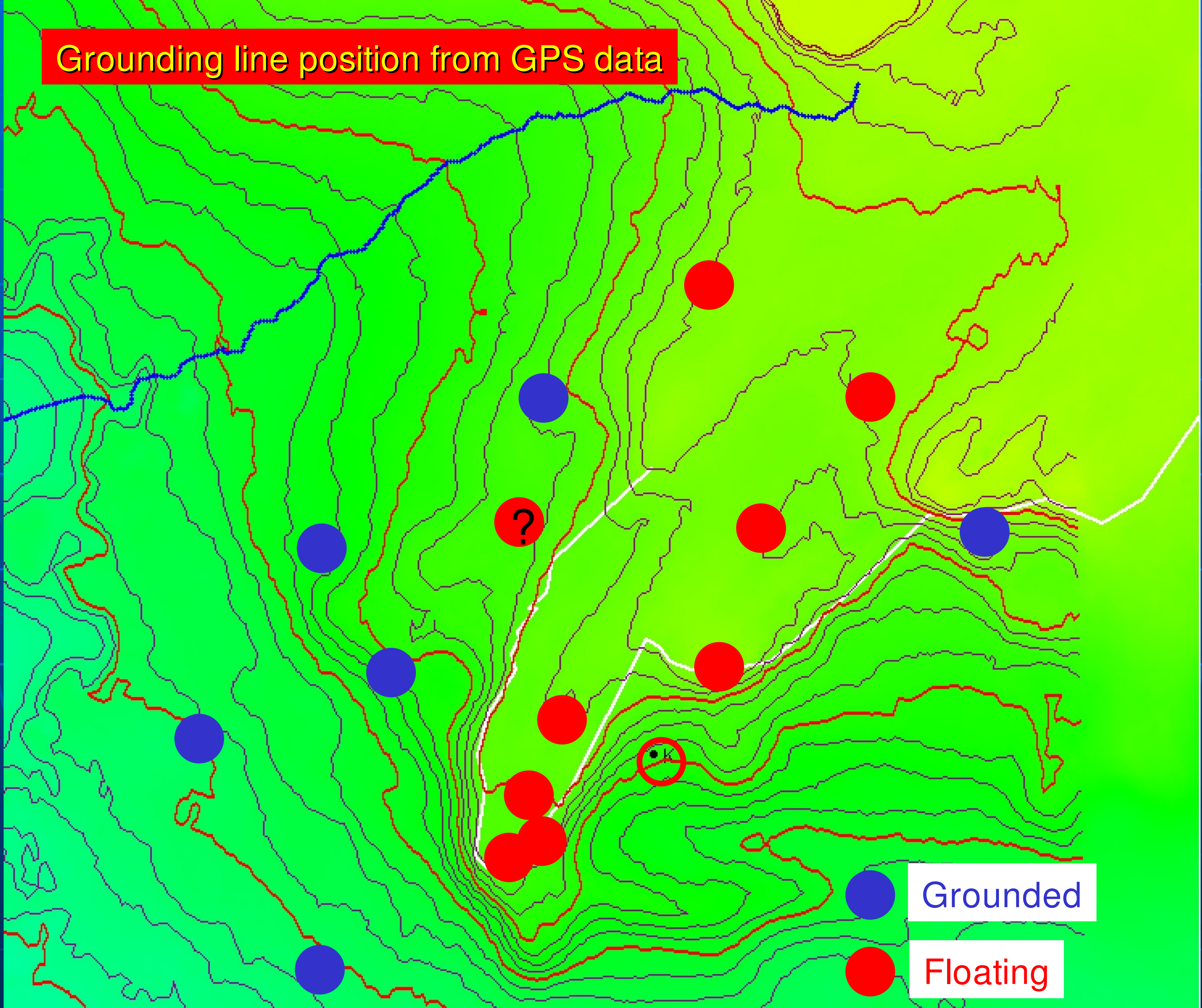
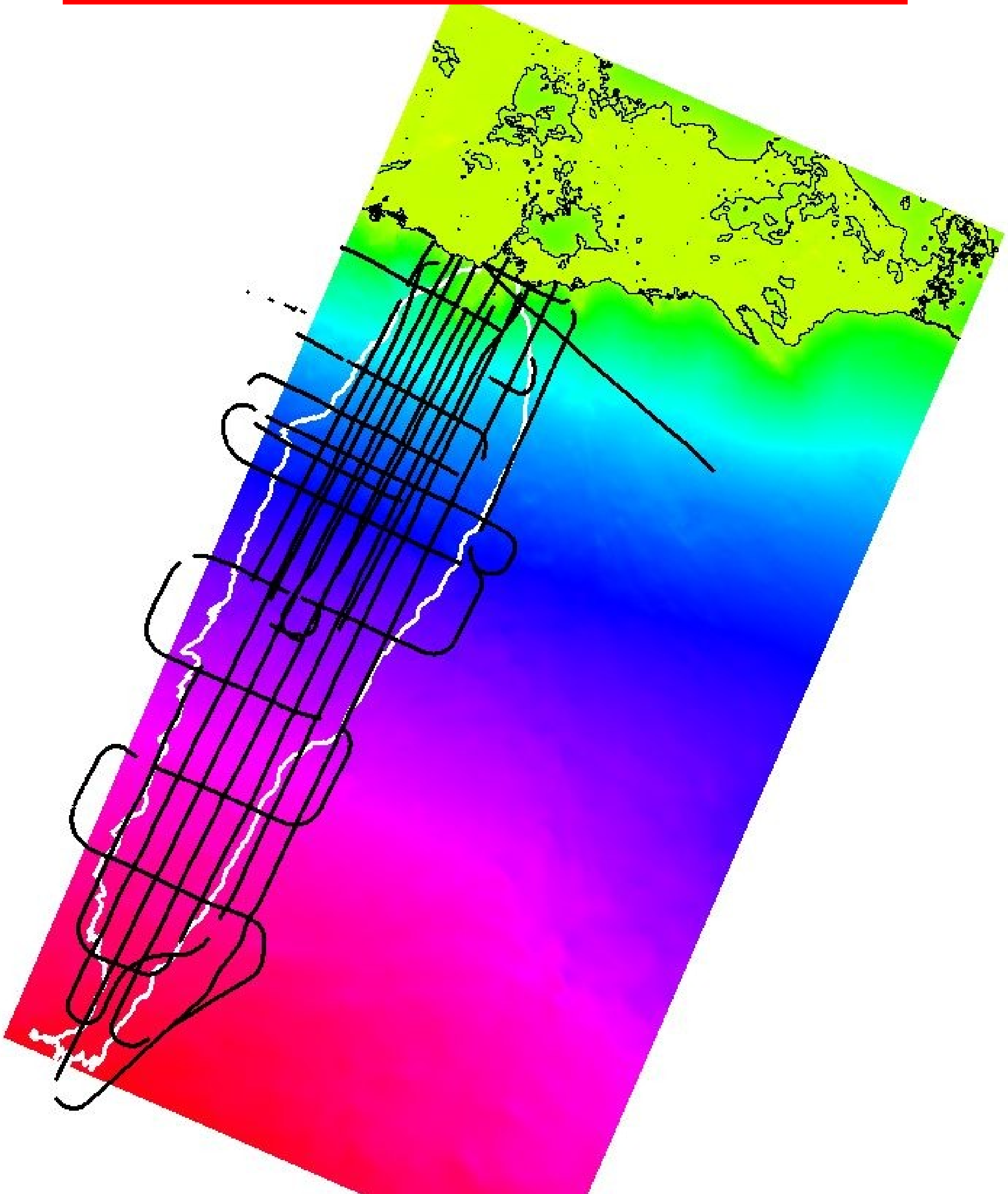


Geophysical airborne campaign (UT-JPL)

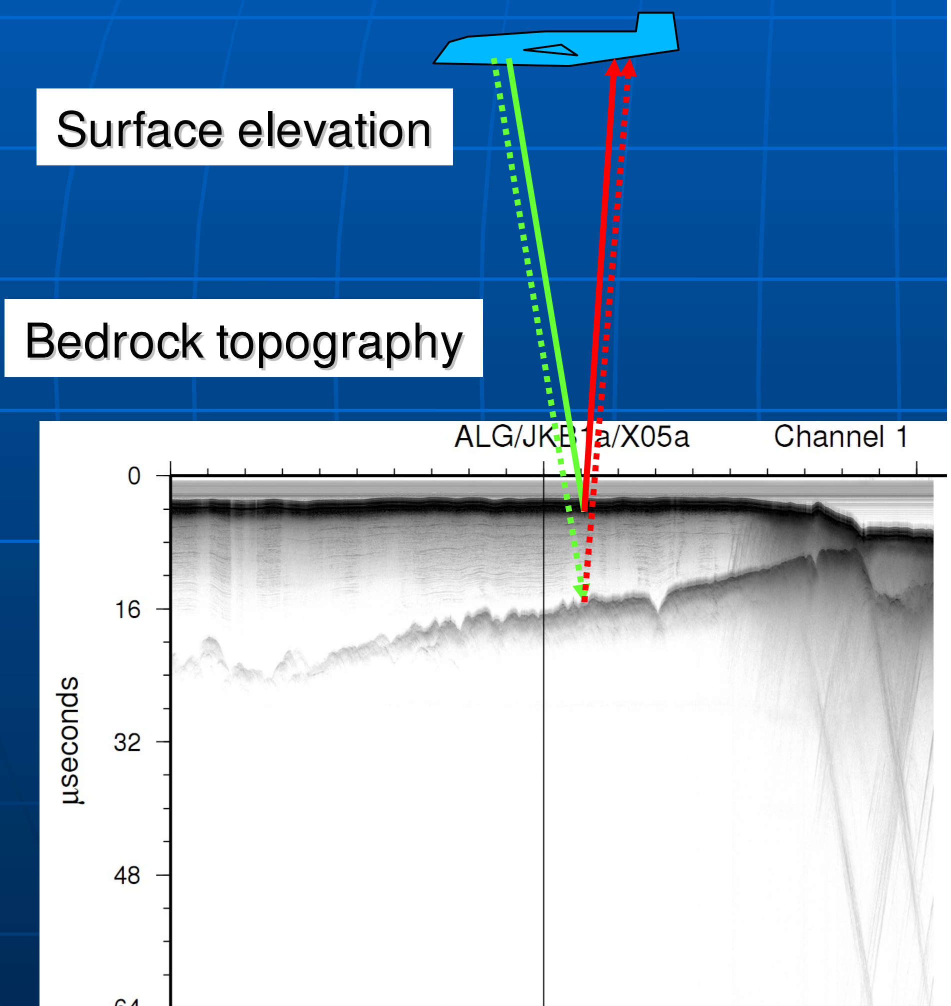


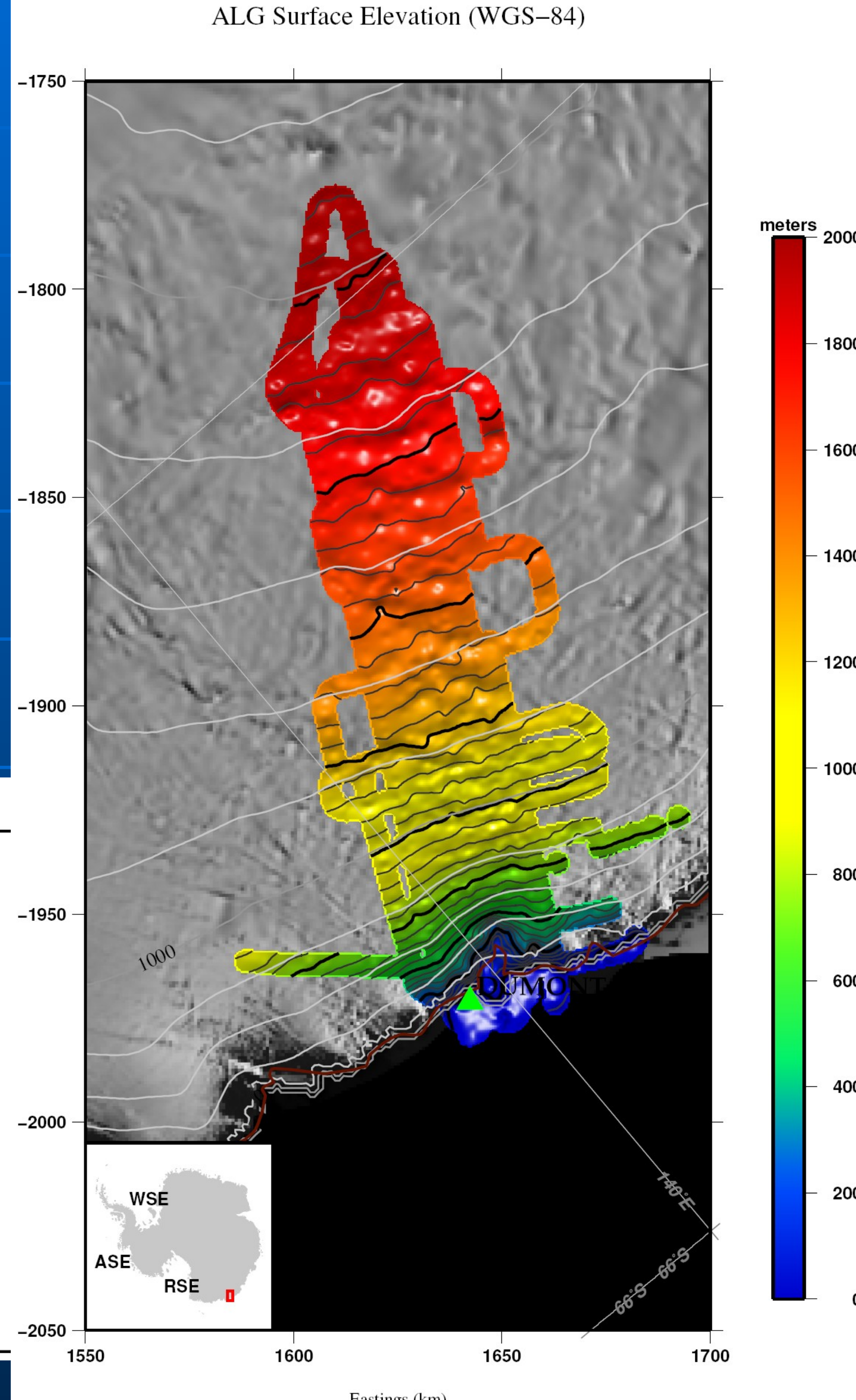
JPL 2.5MHz radar (red grid)

Geophysical airborne campaign (UT-JPL)

Aircraft GPS positioning

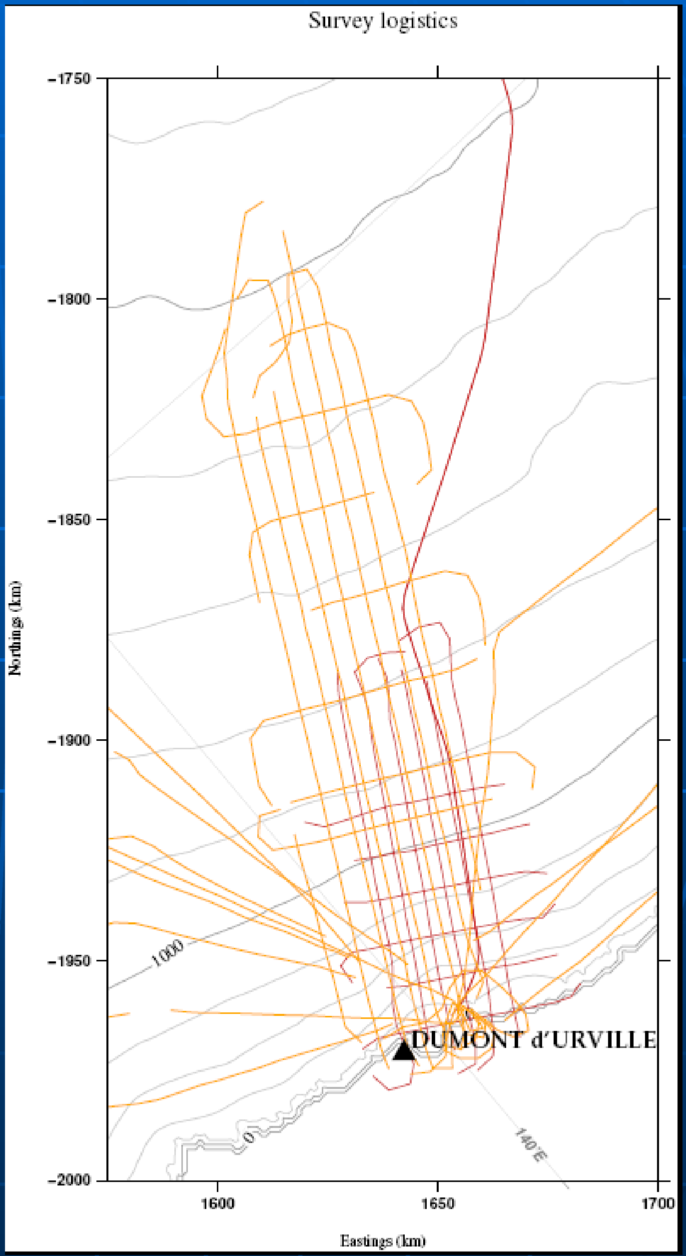
+ Double travel time of radar wave in the air



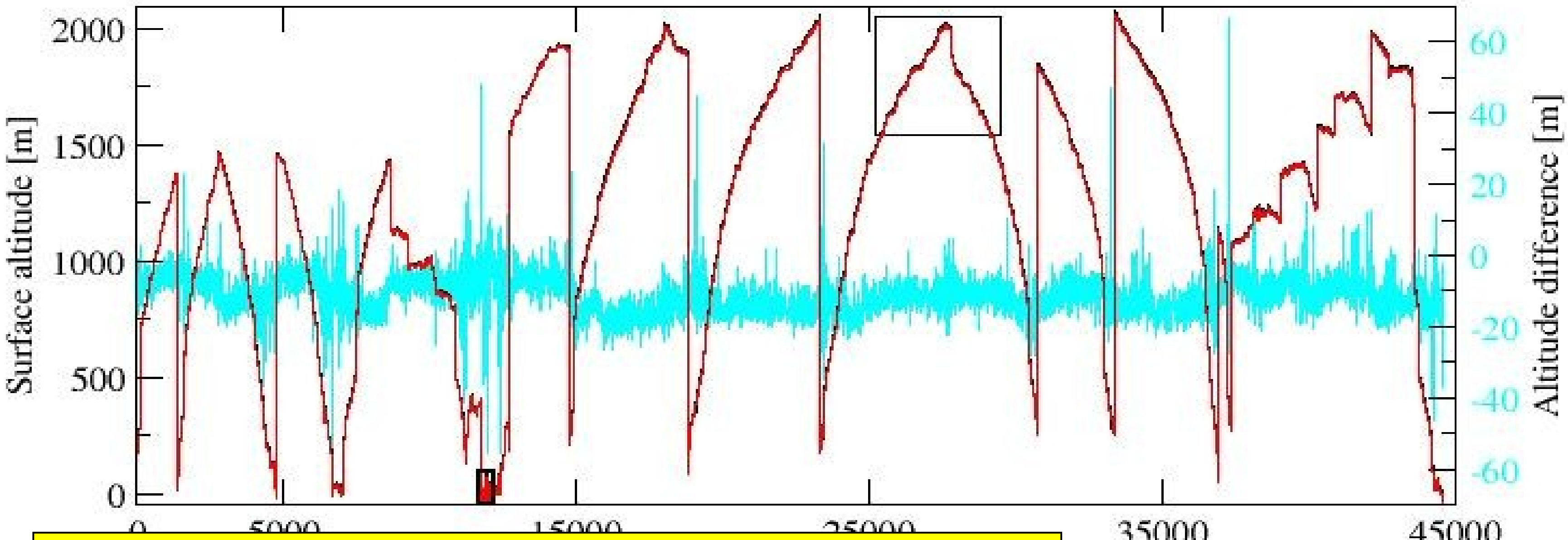


SPIRIT DEM compared with the ICECAP surface data set

42 000 radar points
-> nearest SPIRIT grid point

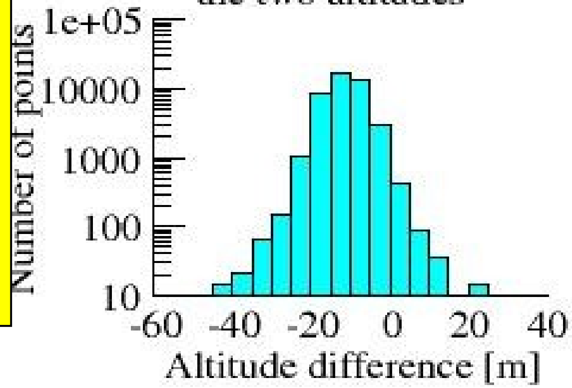


SPIRIT DEM compared with the ICECAP surface data set



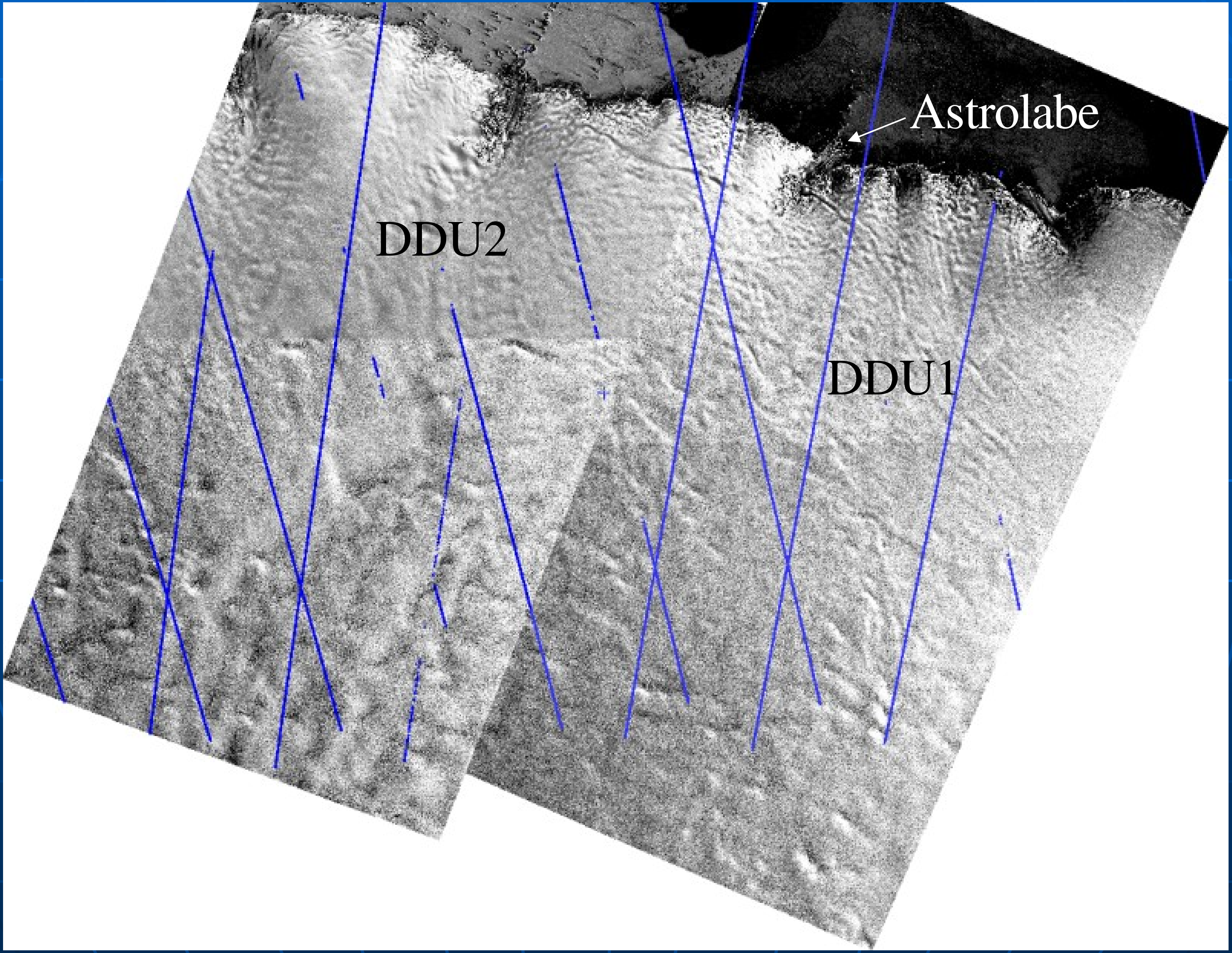
SPIRIT – ICECAP : 5.8 m RMS difference

Aircraft positionning : no carrier phase yet
Carrier phase -> increased accuracy



SPIRIT-ICESAT

DDU



DDU 2 : compa HRS - ICESAT

		HRS DEM v1	HRS DEM v2	HRS DEM v3
With interpolated pixels (=all data)	mean	**0.43**	**15.15**	**15.31**
	stddev	18.65	79.29	74.11
	Nb data	*4946*	*4946*	*4946*
Without interpolated pixels	mean	**-1.44**	**-1.46**	**-1.62**
	stddev	3.73	2.78	2.82
	Nb data	*1399*	*1419*	*545*
% of interpolated pixels		***56***	***53***	***71***

DDU 1: compa HRS - ICESAT

			HRS DEM v1	HRS DEM v2	HRS DEM v3
With interpolated pixels (=all data)		mean	**6.25**	**4.60**	**3.35**
		stddev	27.05	21.88	14.97
		Nb data	*4520*	*4520*	*4520*
Without interpolated pixels		mean	**-0.29**	**-0.30**	**-0.34**
		stddev	2.86	2.24	2.36
		Nb data	*2329*	*2175*	*957*
% of interpolated pixels			***33***	***33***	***54***


Thank you !