

Current dynamics of Petermann Gletscher, Greenland Ice Sheet



Gourmelen N.⁽¹⁾, Park JW.⁽²⁾, Dehecq A.⁽³⁾, Shepherd A.⁽⁴⁾, Paden J.⁽⁵⁾

(1) University of Edinburgh, UK

(2) Yonsei University, KR

(3) Université de Savoie, FR

(4) University of Leeds, UK

(5) CRESIS, USA



THE UNIVERSITY
of EDINBURGH



UNIVERSITY OF LEEDS

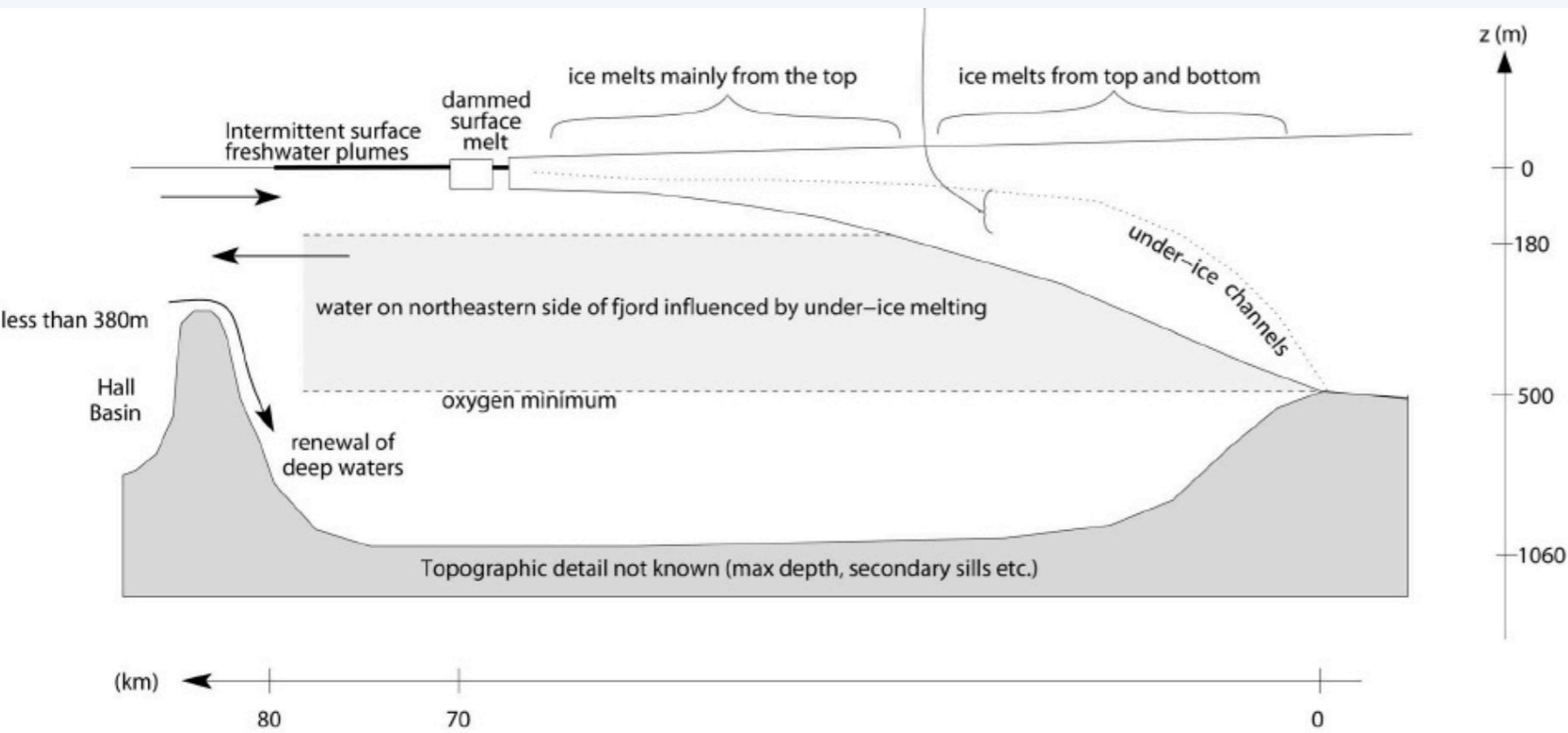


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Overview

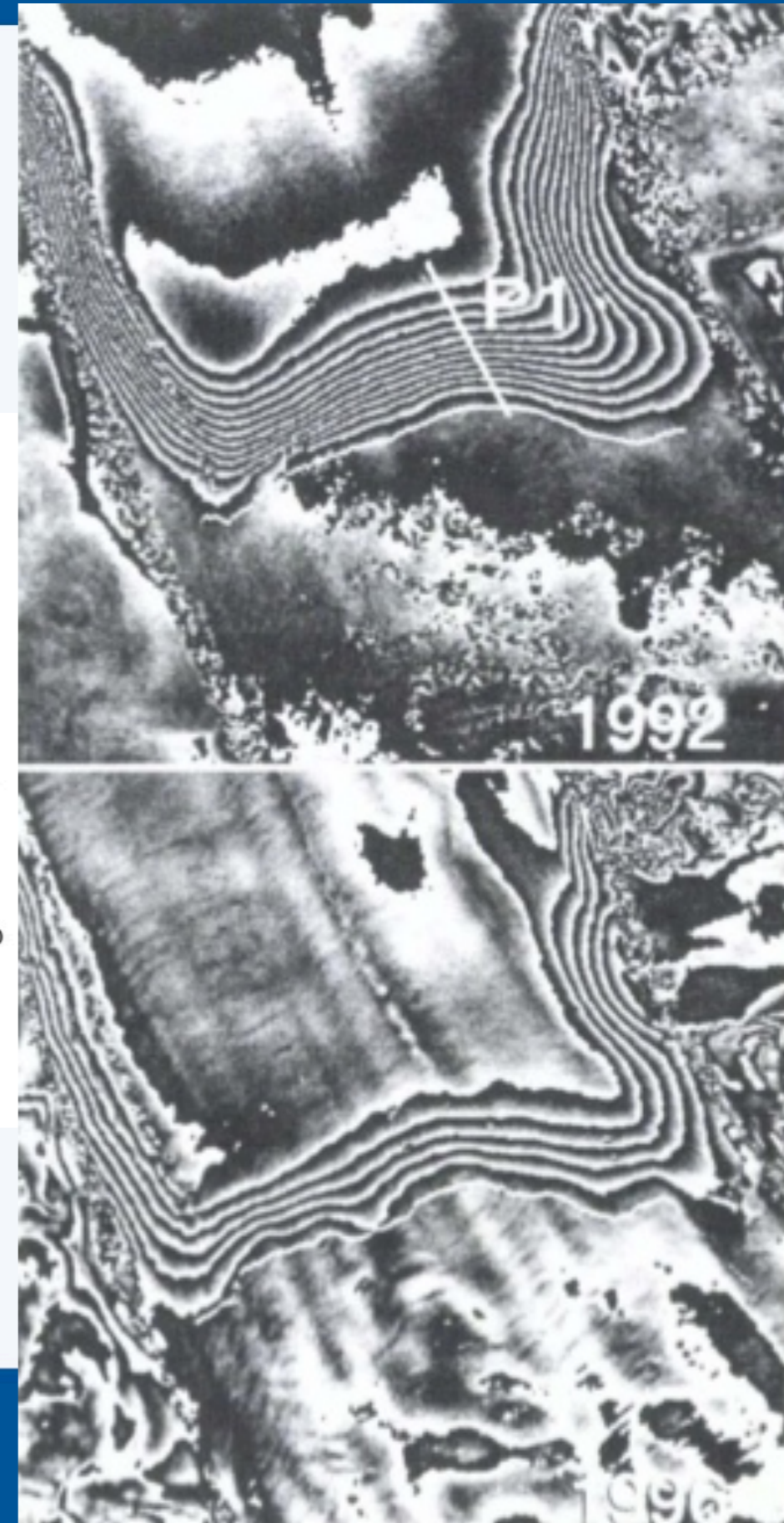
1. Current status of ECVs over Petermann
2. 20-years grounding line thinning
3. Surface elevation change

Grounding line retreat - early 90's



Johnson et al., 2011

Rignot, 1998

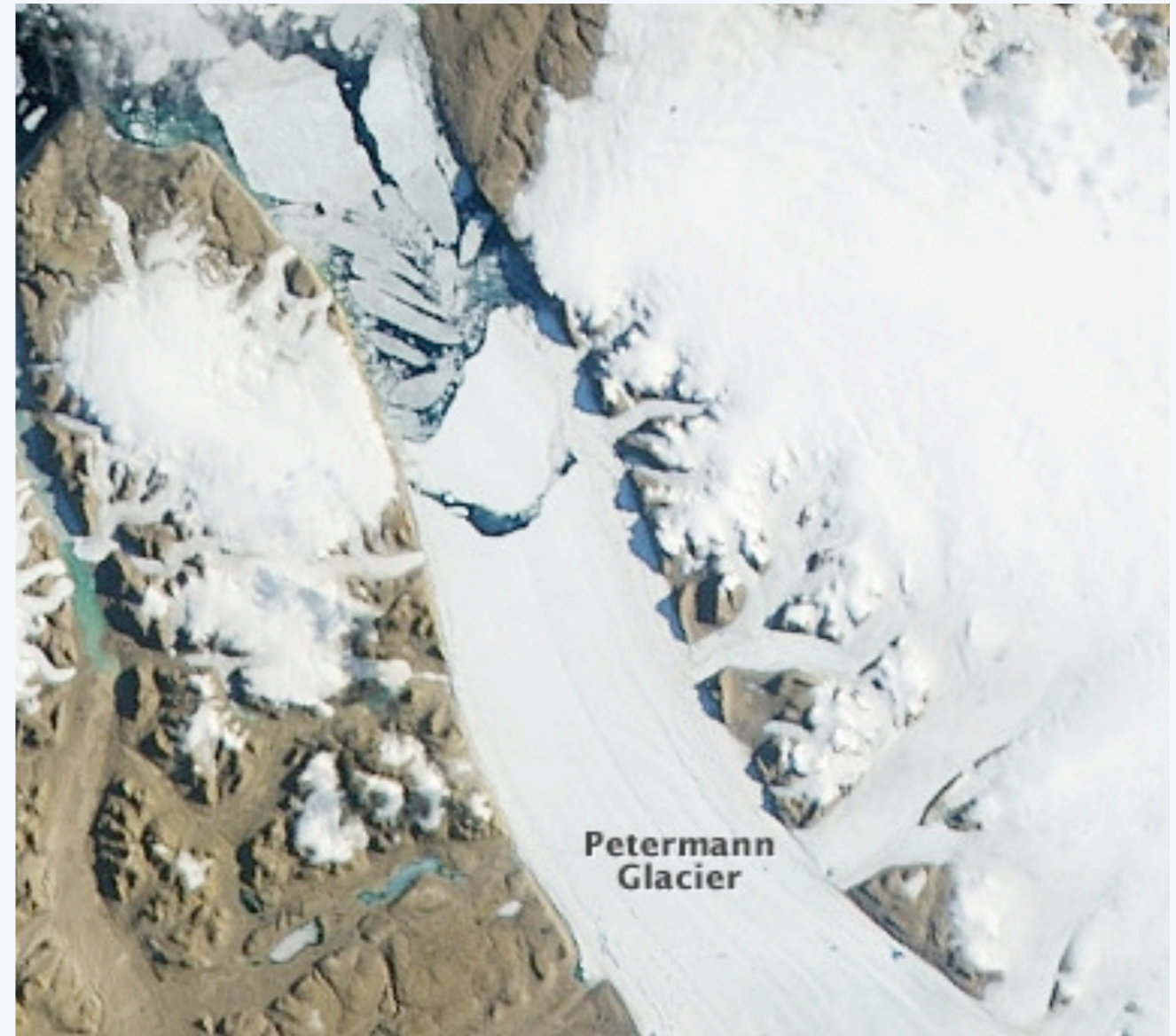


2010 calving event



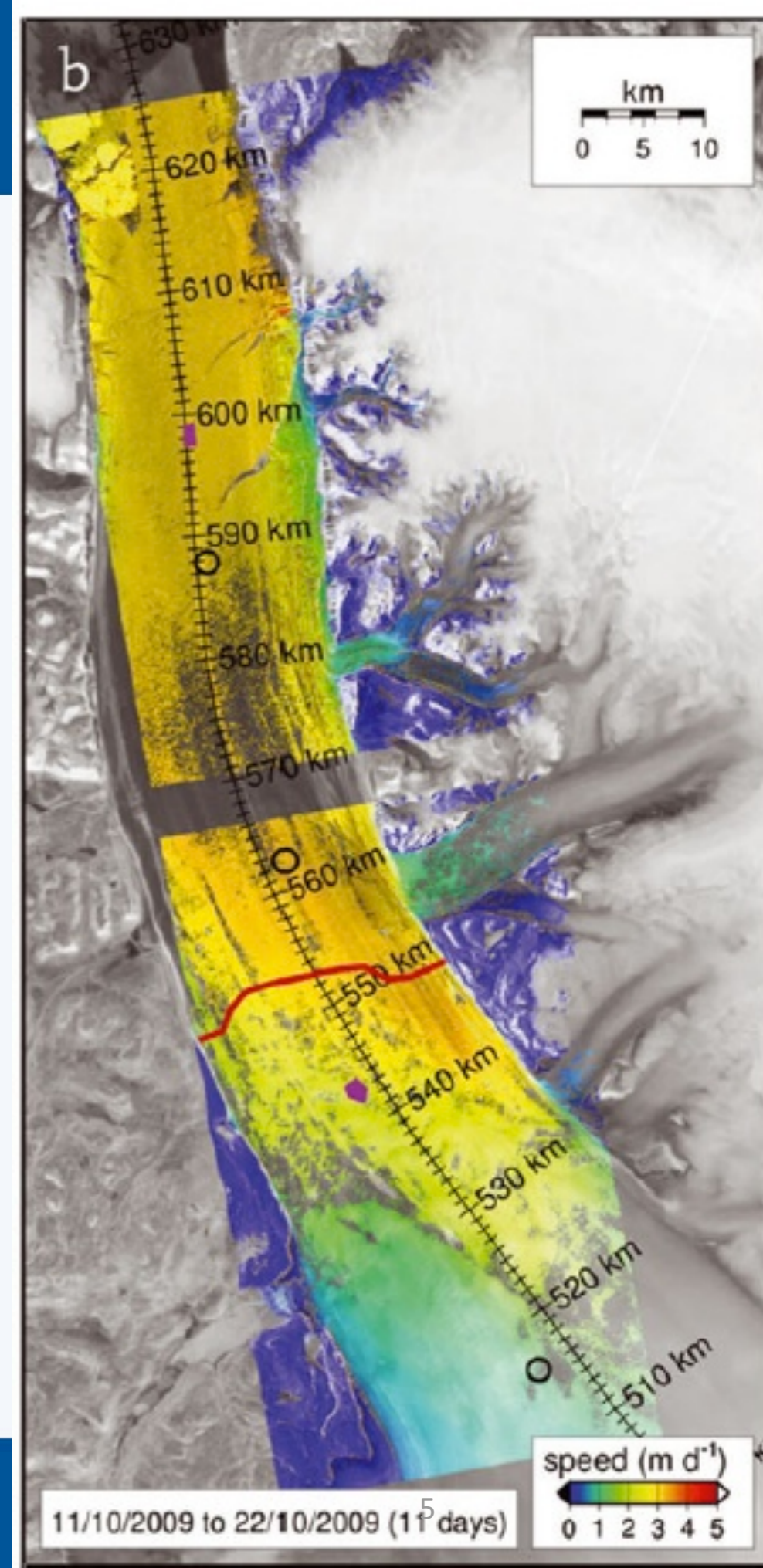
NASA

2012 calving event



Surface velocity change

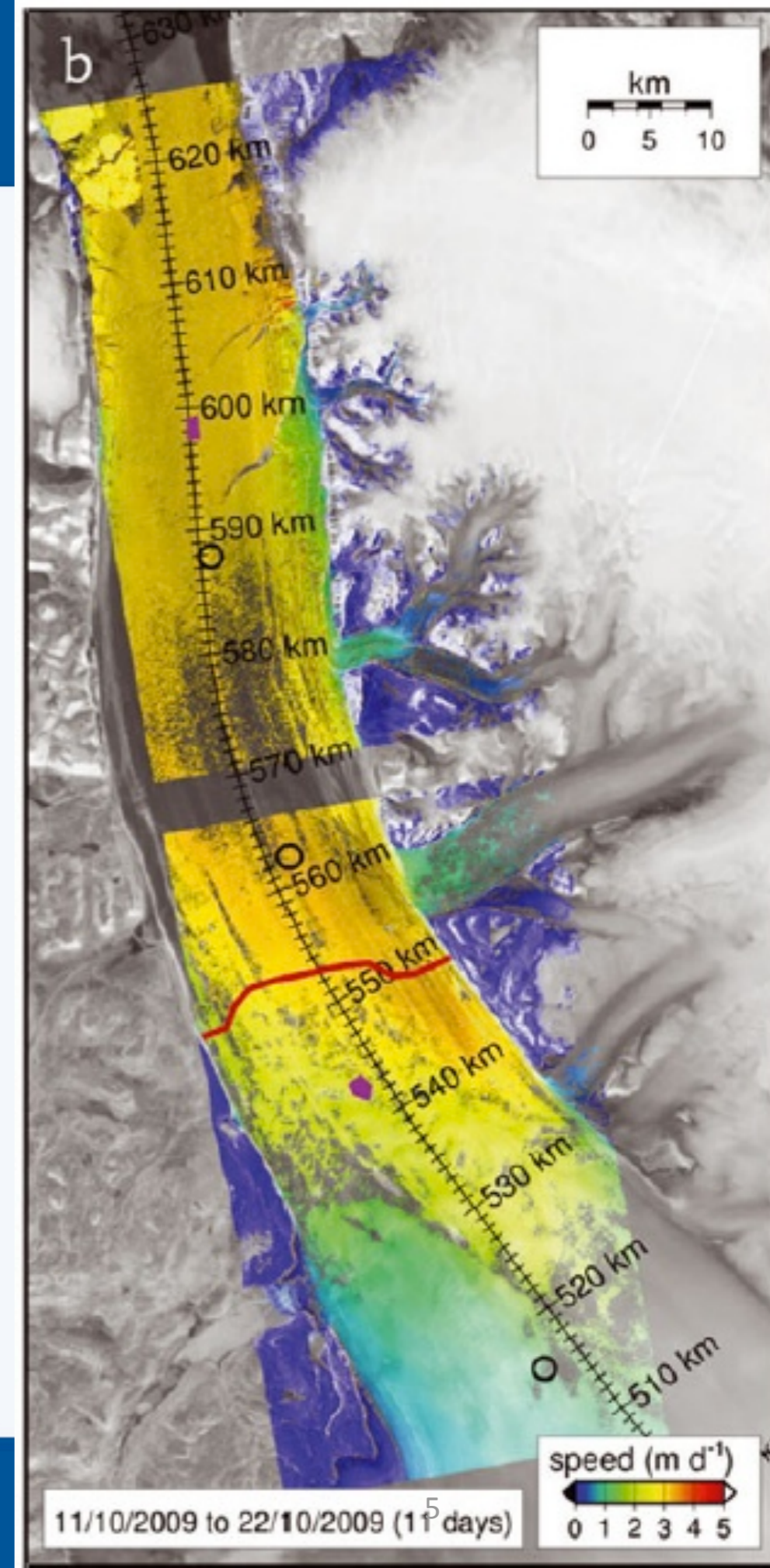
Nick et al., 2012



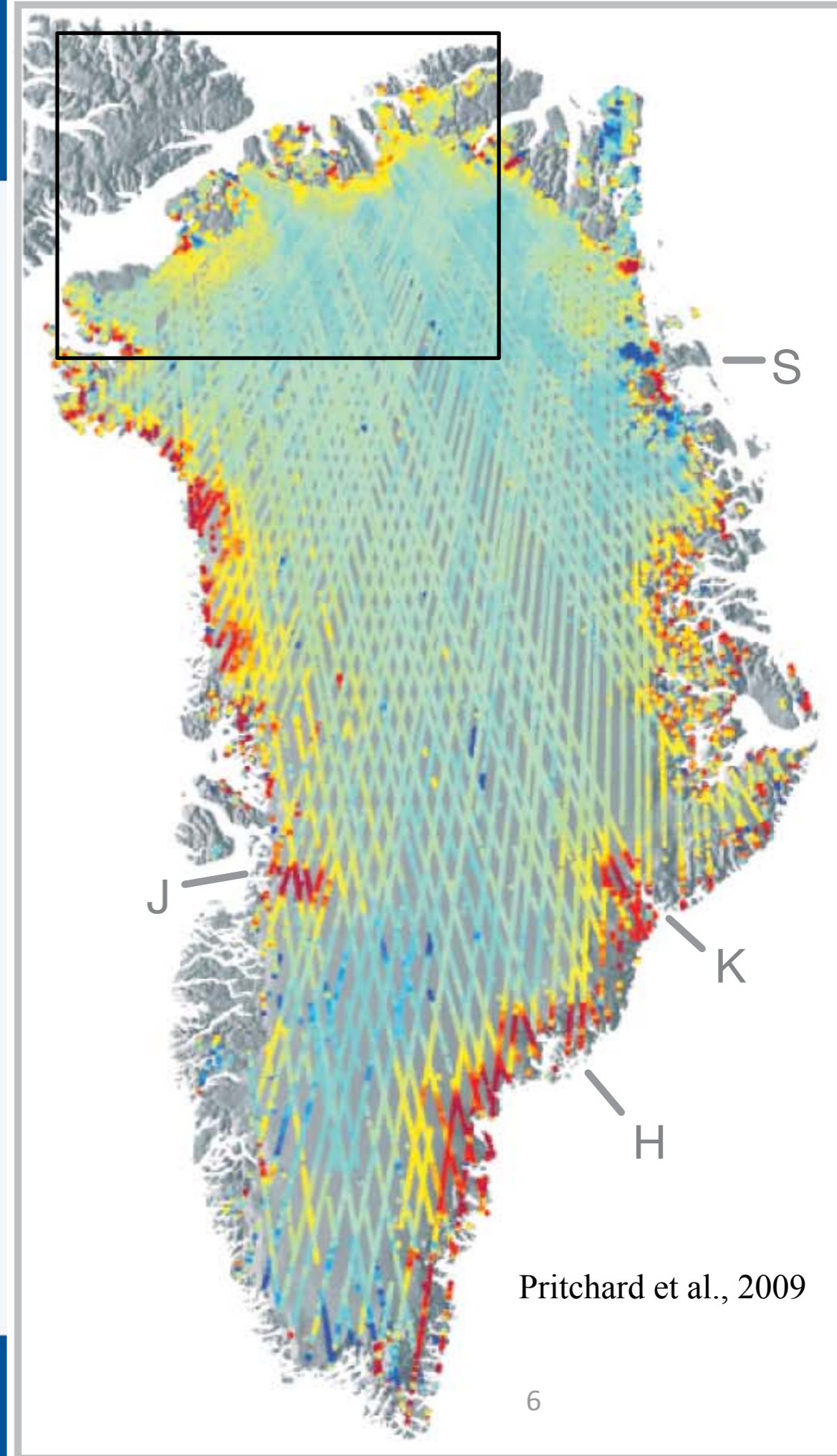
Surface velocity change

-> No change in ice discharge over the last 20 years at Petermann Gletscher

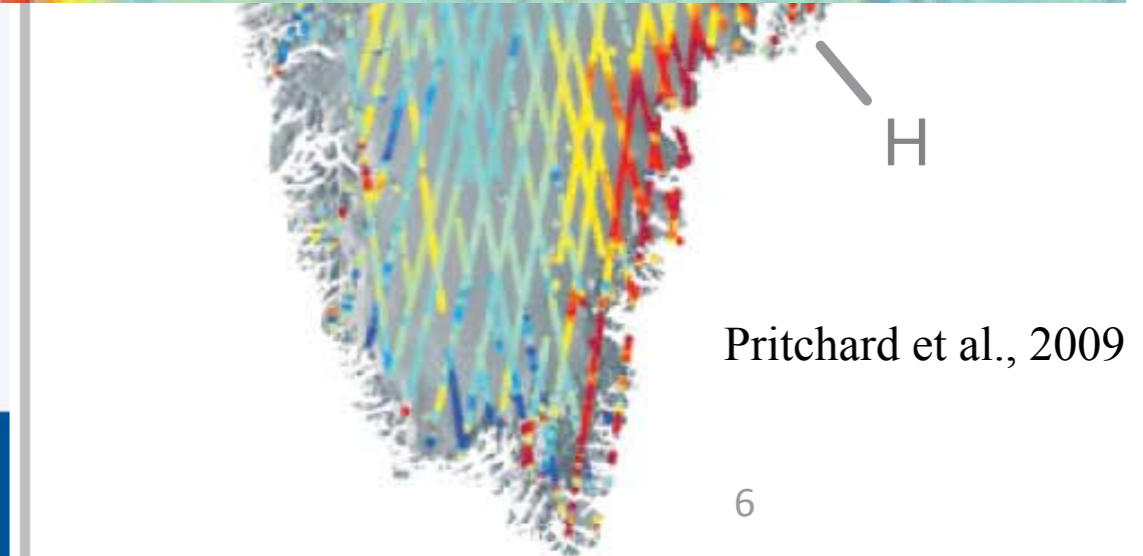
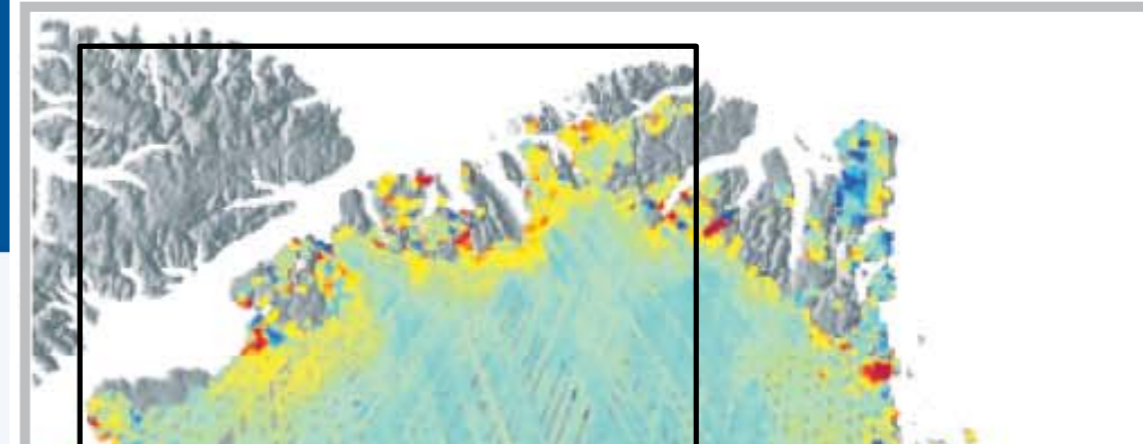
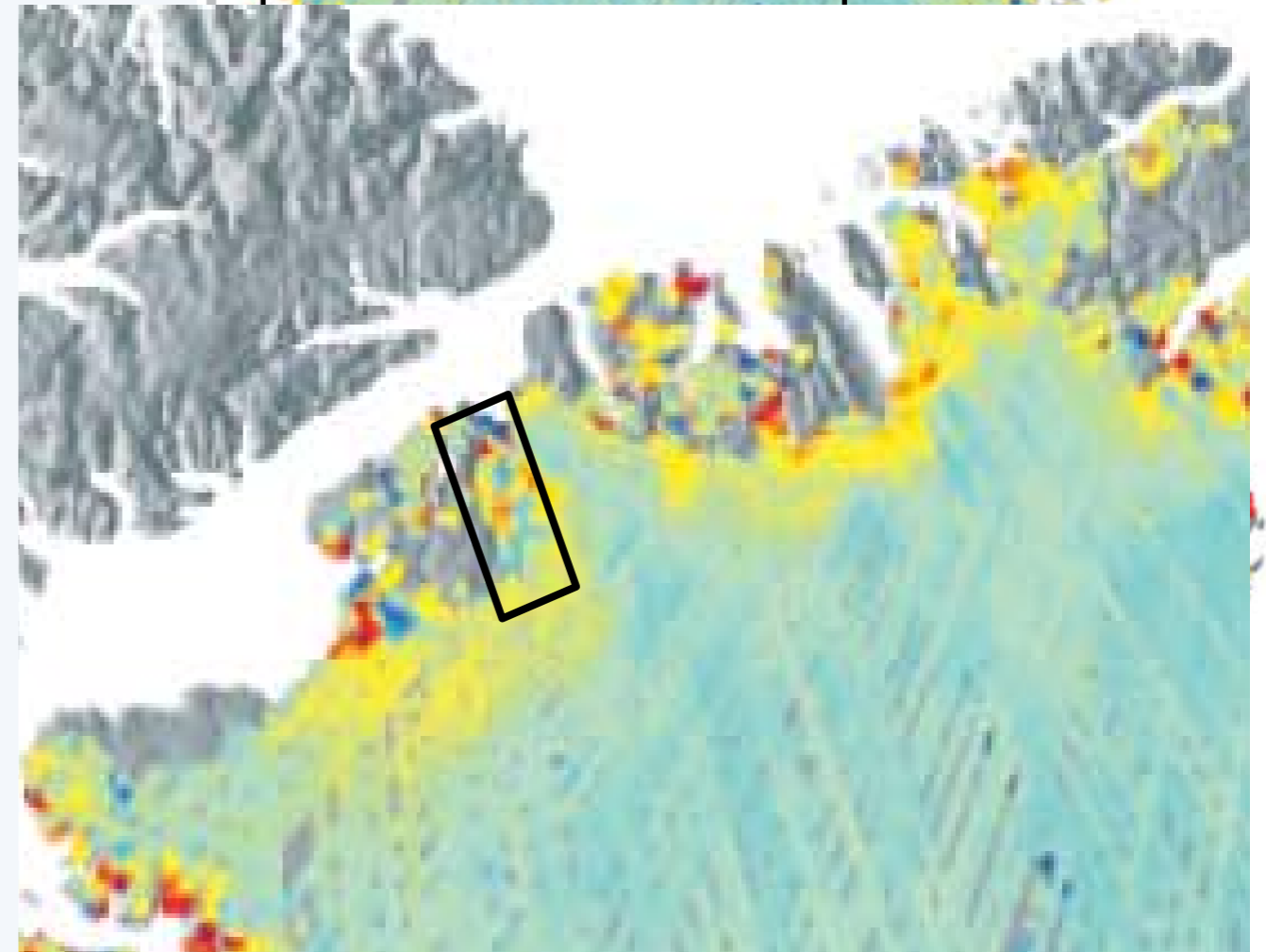
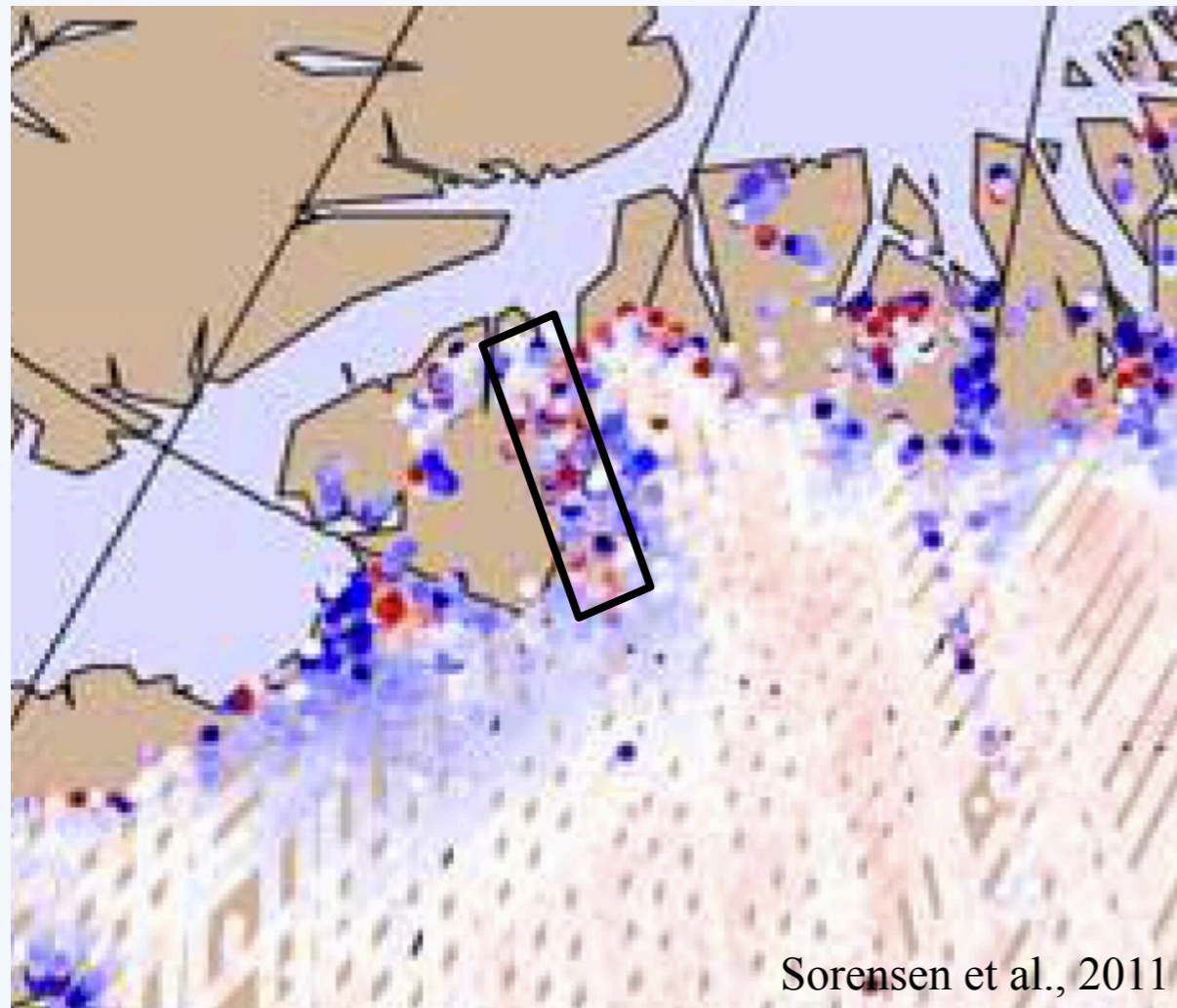
Nick et al., 2012



Surface elevation change



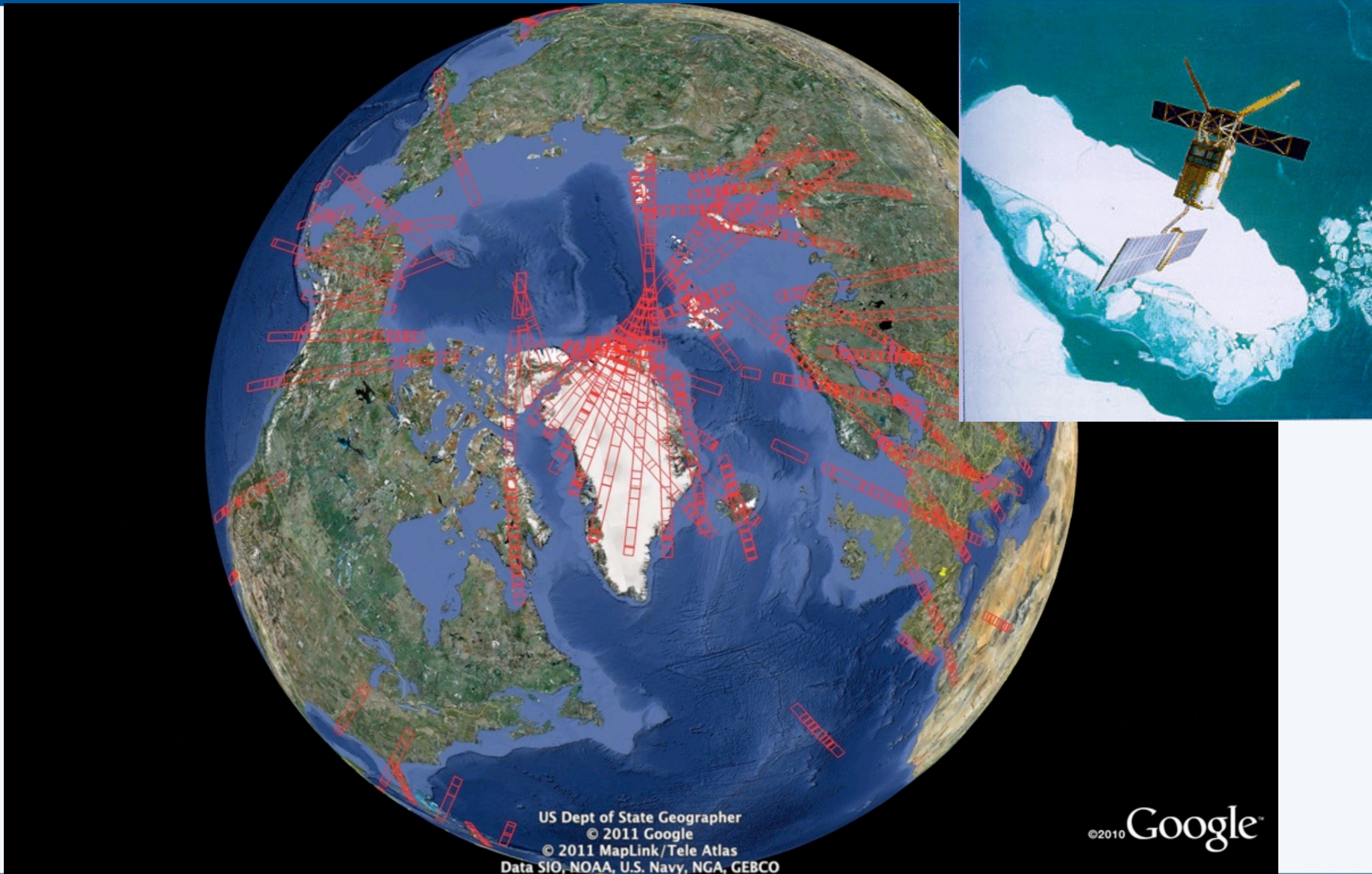
Surface elevation change



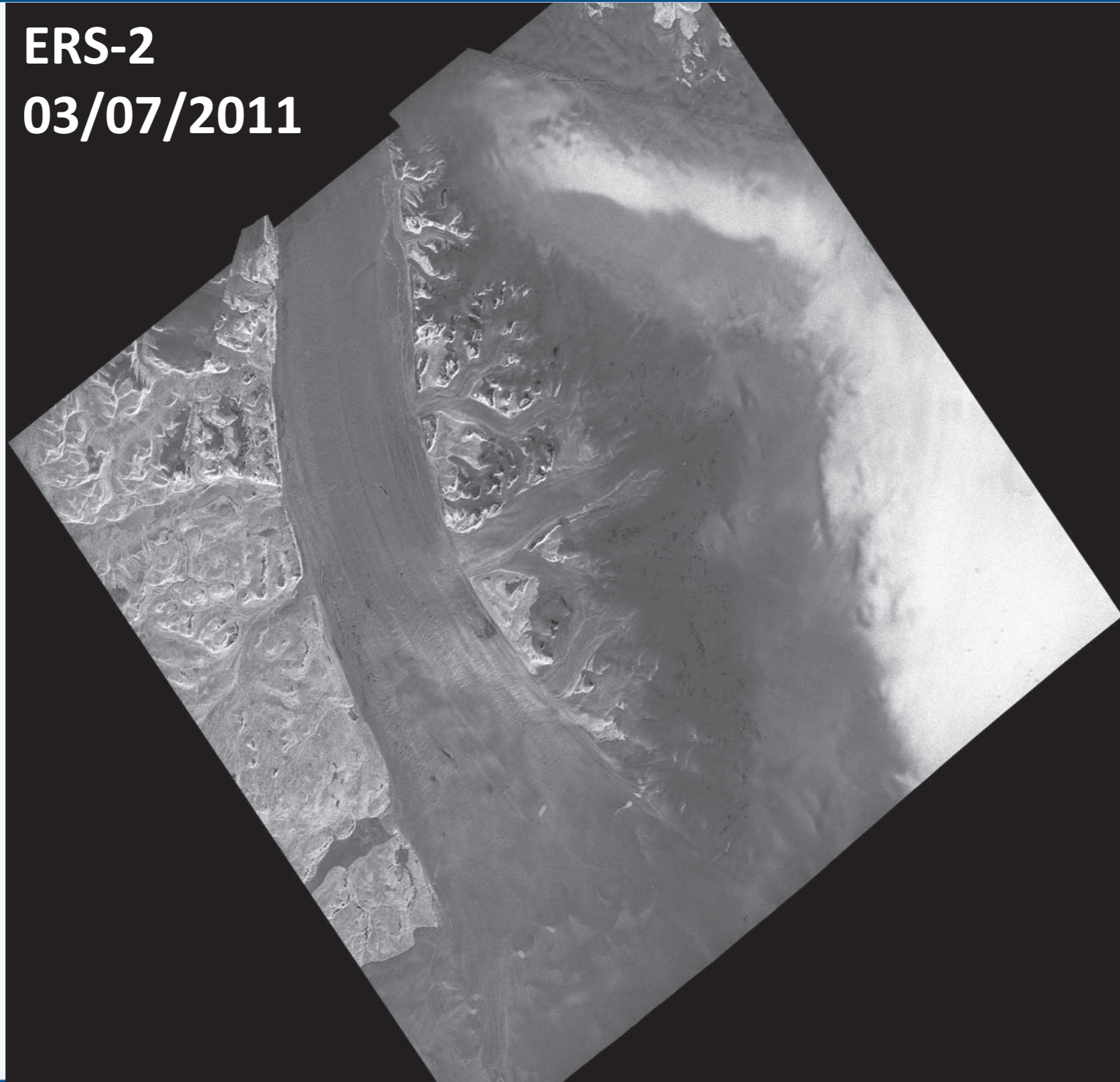
-> No consistent signal of elevation change over Petermann Gletscher

1. Motivation
2. 20-years grounding line thinning
3. Surface elevation change

ERS2, 2011 ice phase



ERS-2
03/07/2011

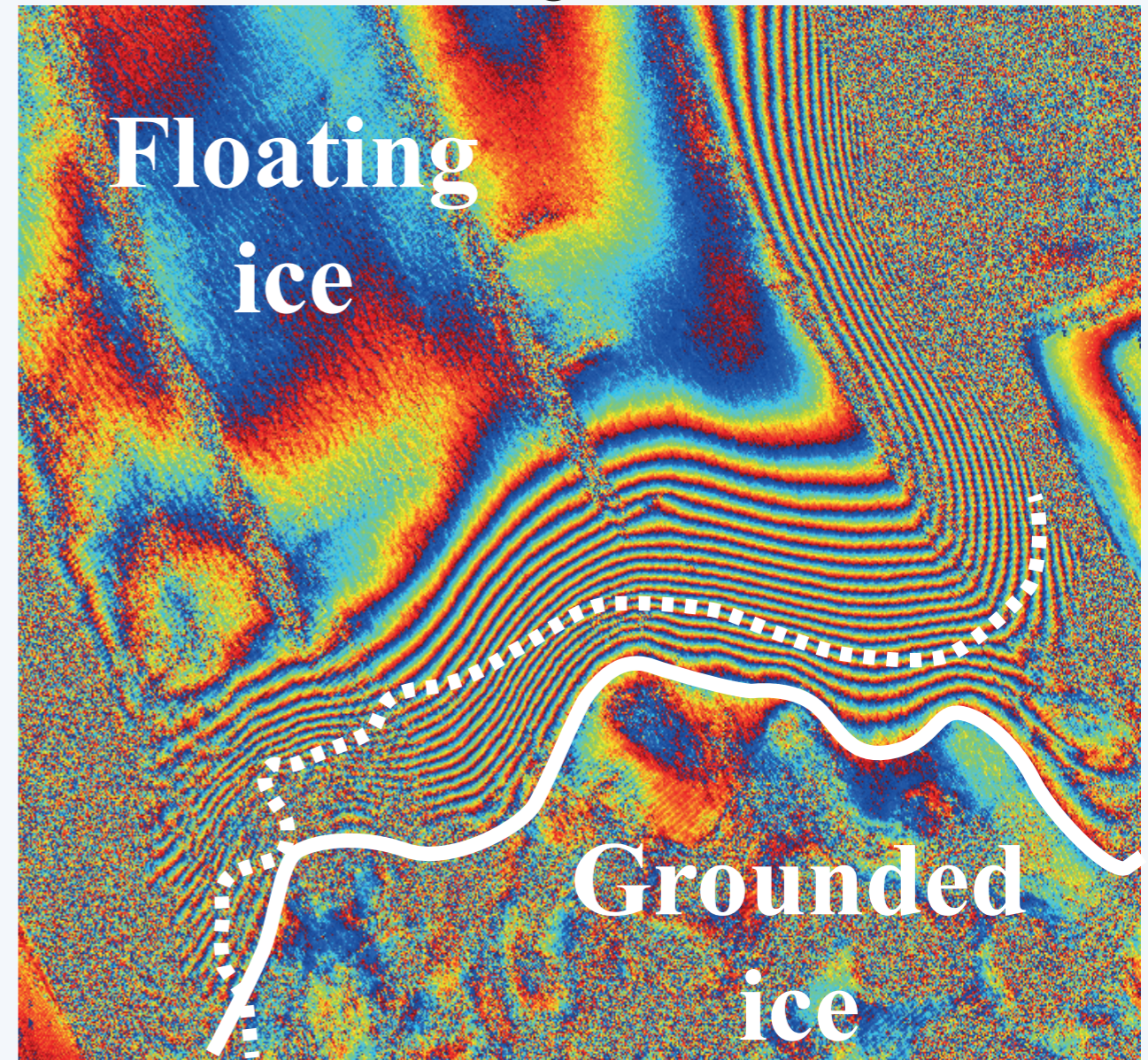
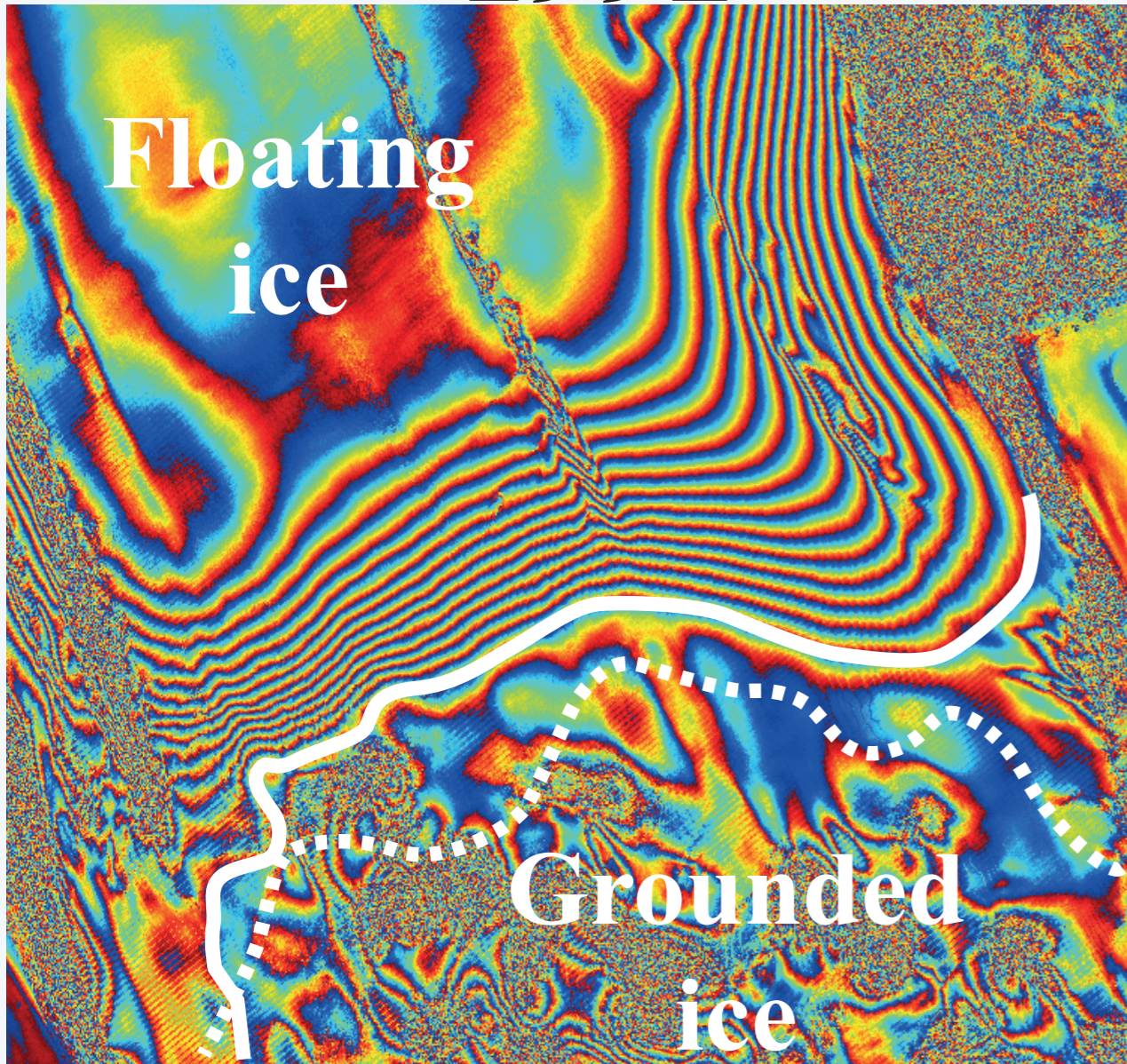


1992 - 2011 Grounding line retreat



1992

2011

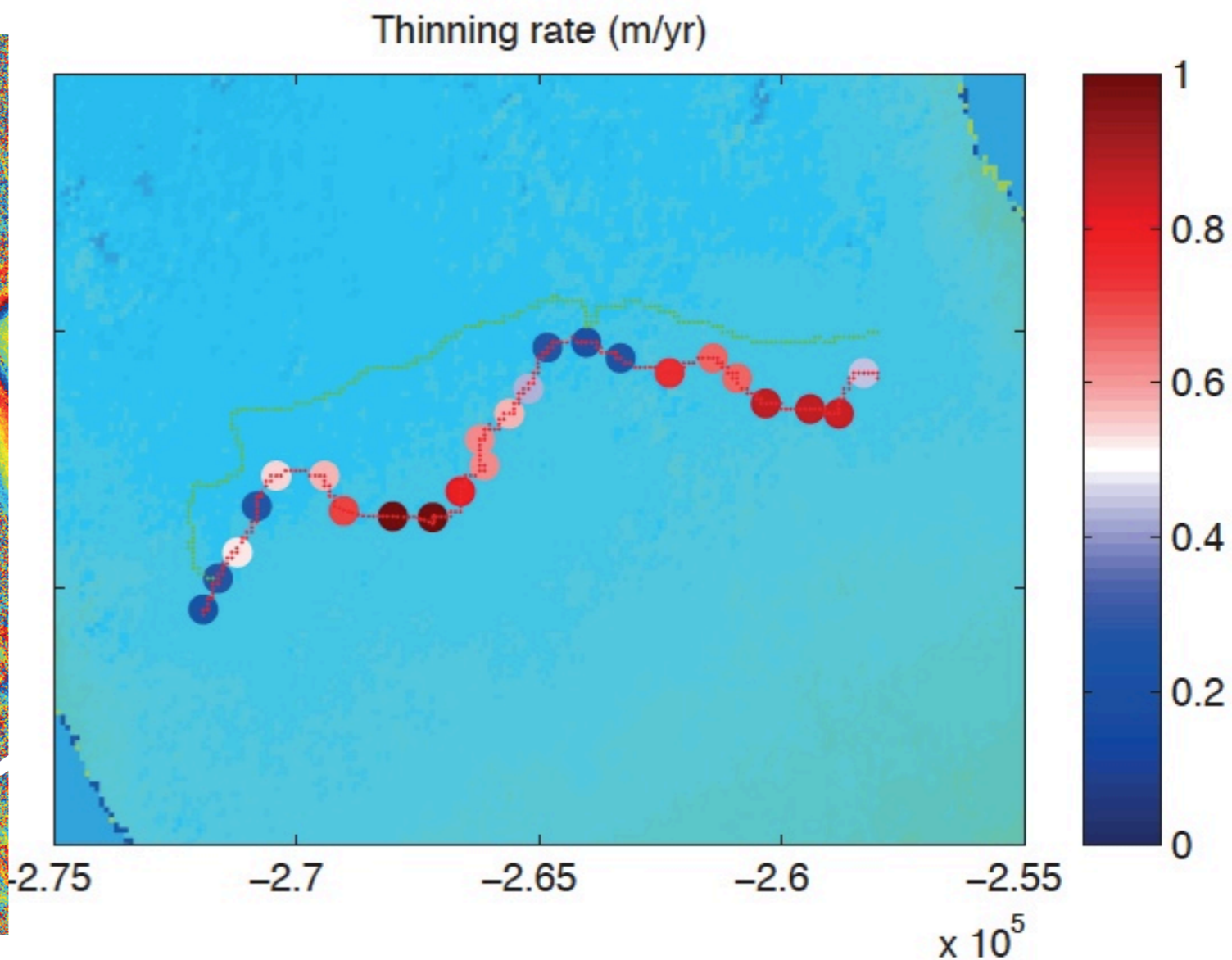
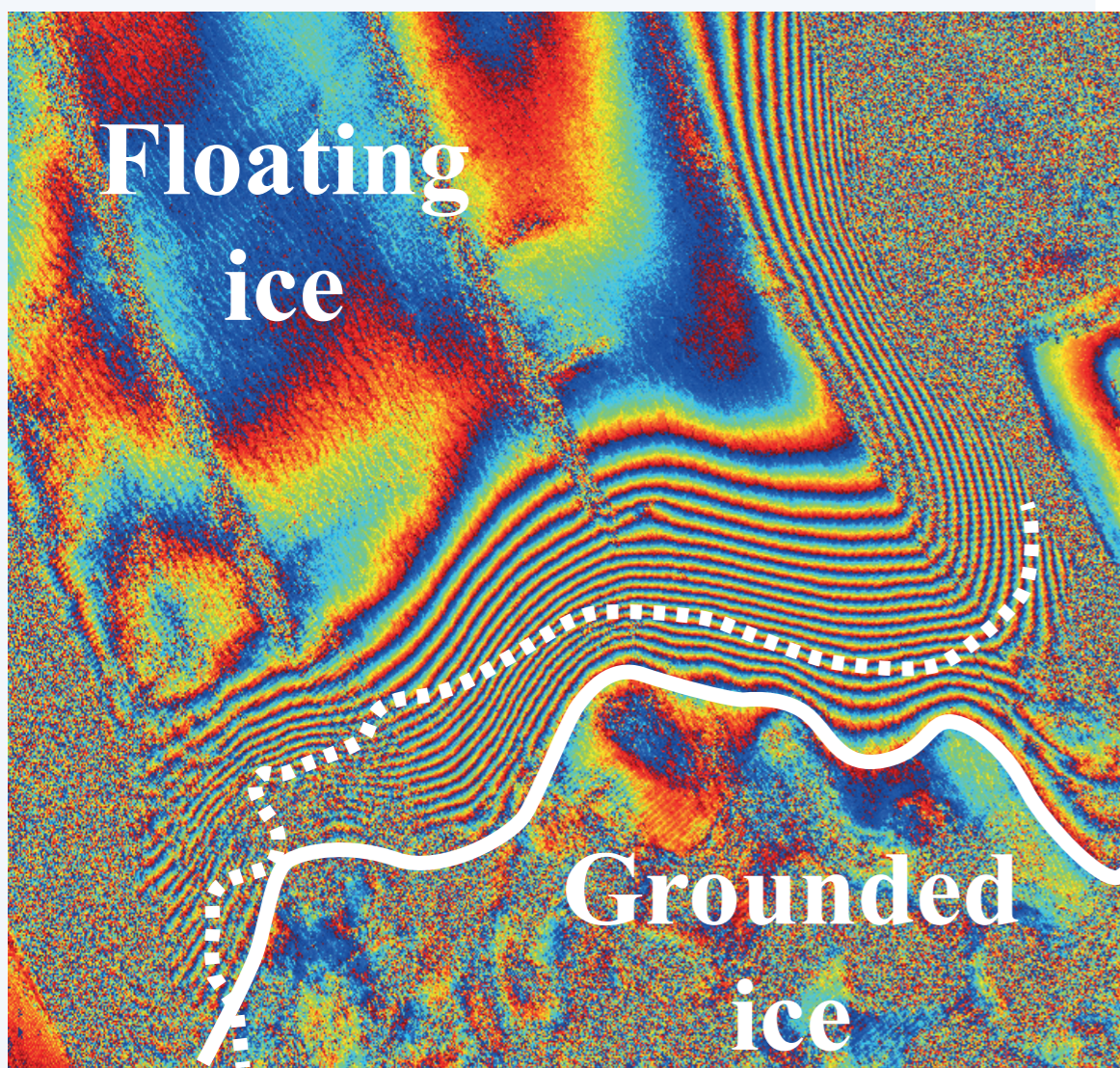


..... 2011 Grounding Line position

2 km

..... 1992 Grounding Line position

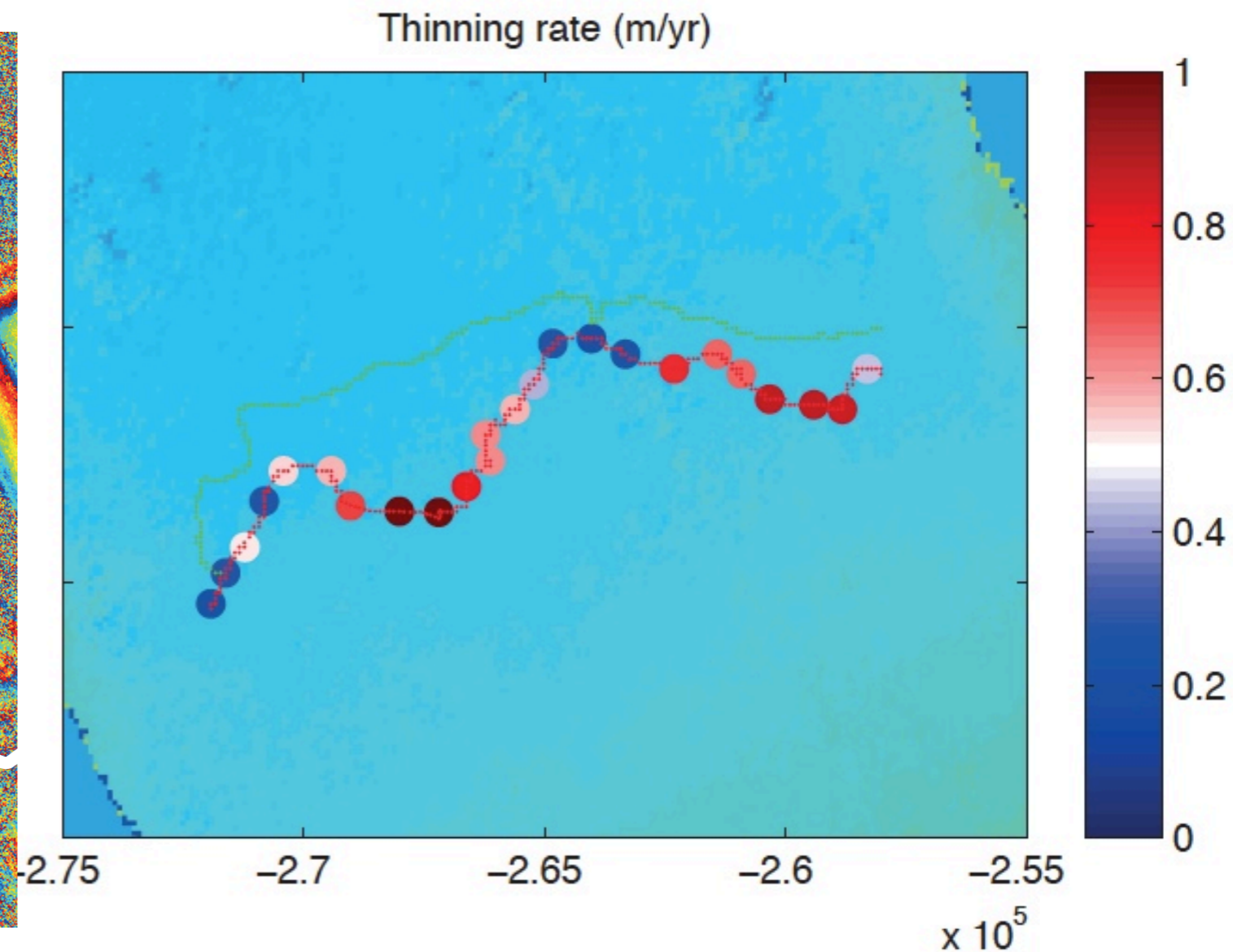
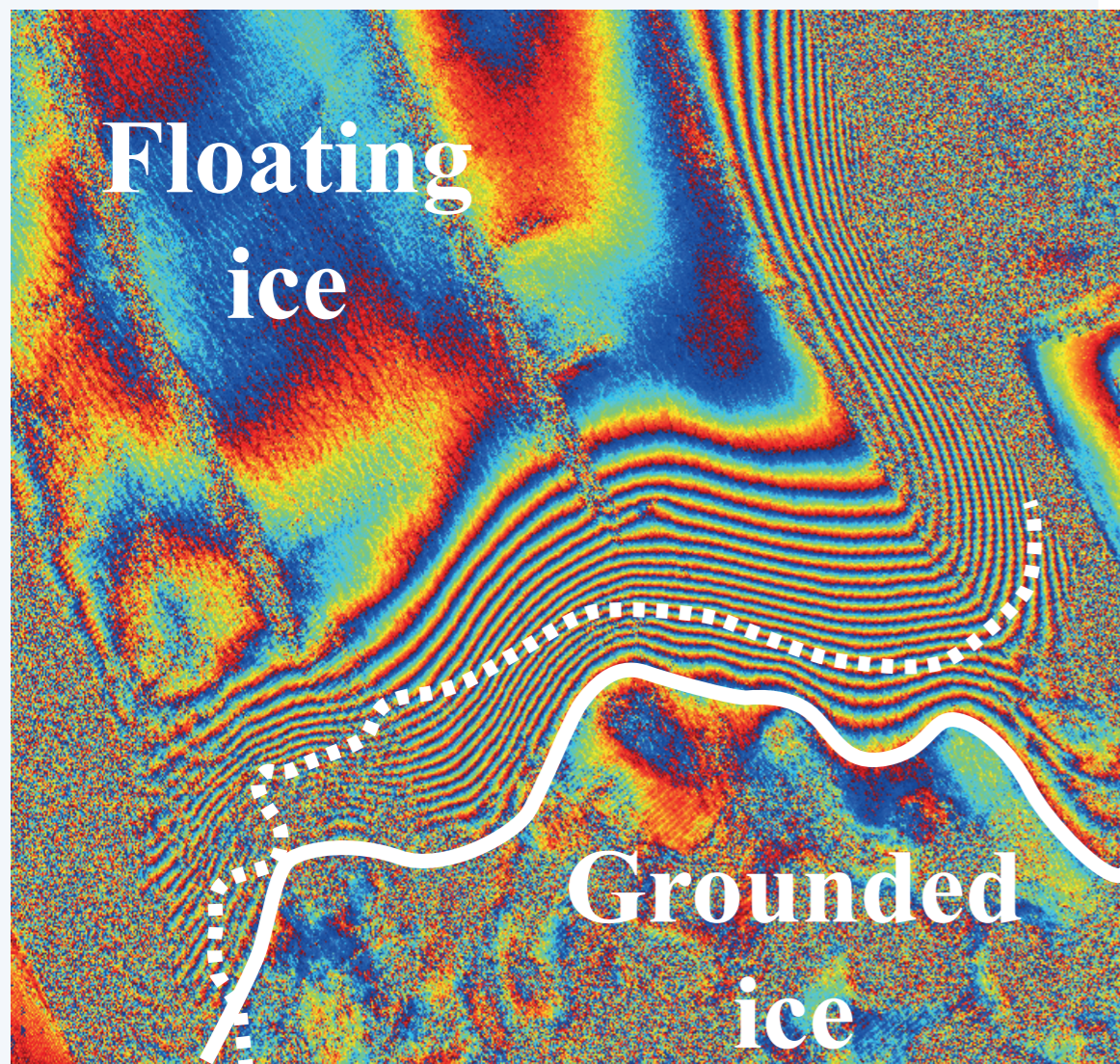
1992 - 2011 Thinning at the grounding line



1992 - 2011 Thinning at the grounding line

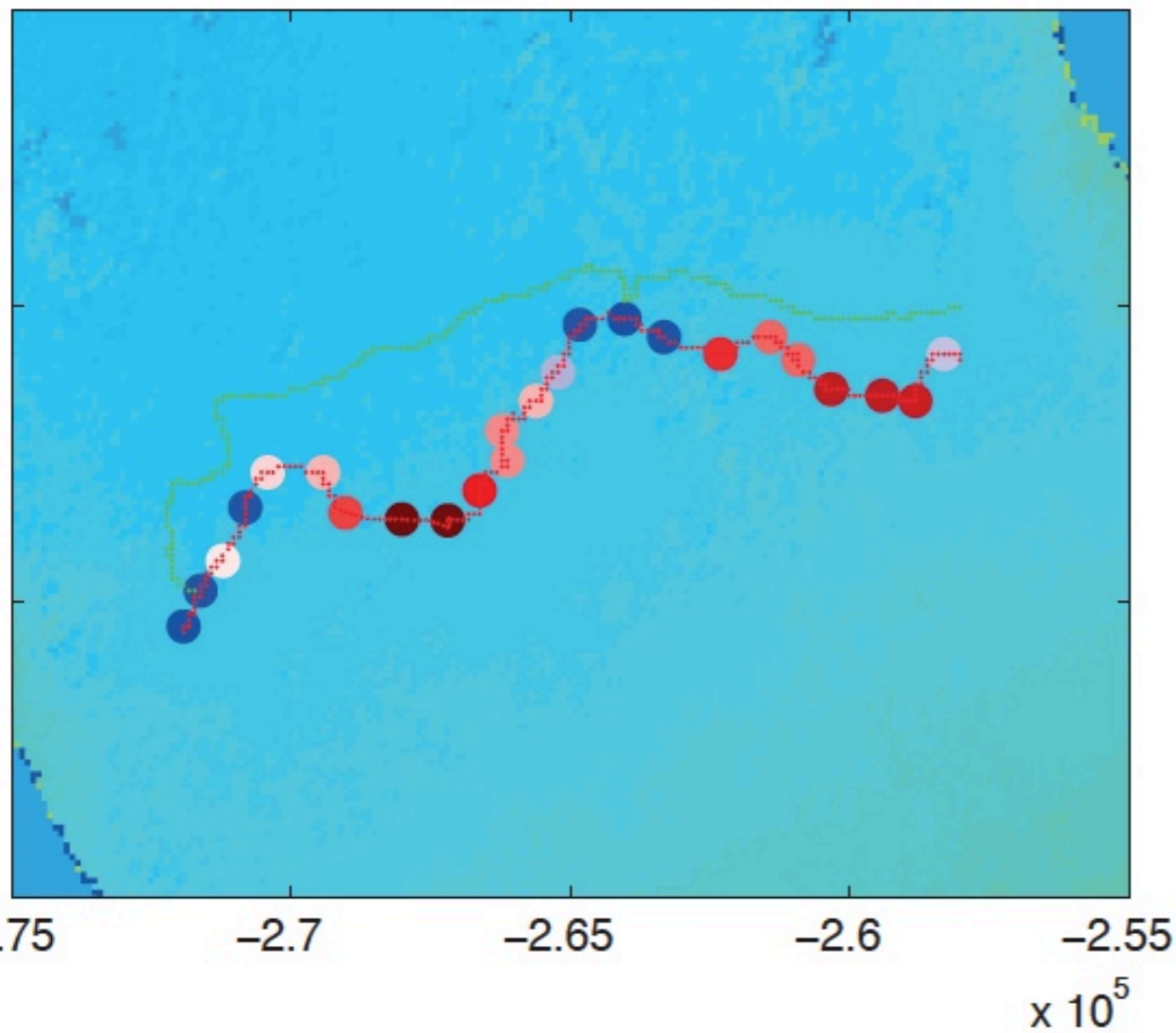


- 1992-2011 thinning rate of 0.5 to 1 m/yr, similar to 1992-1996 period [Rignot, 1998]

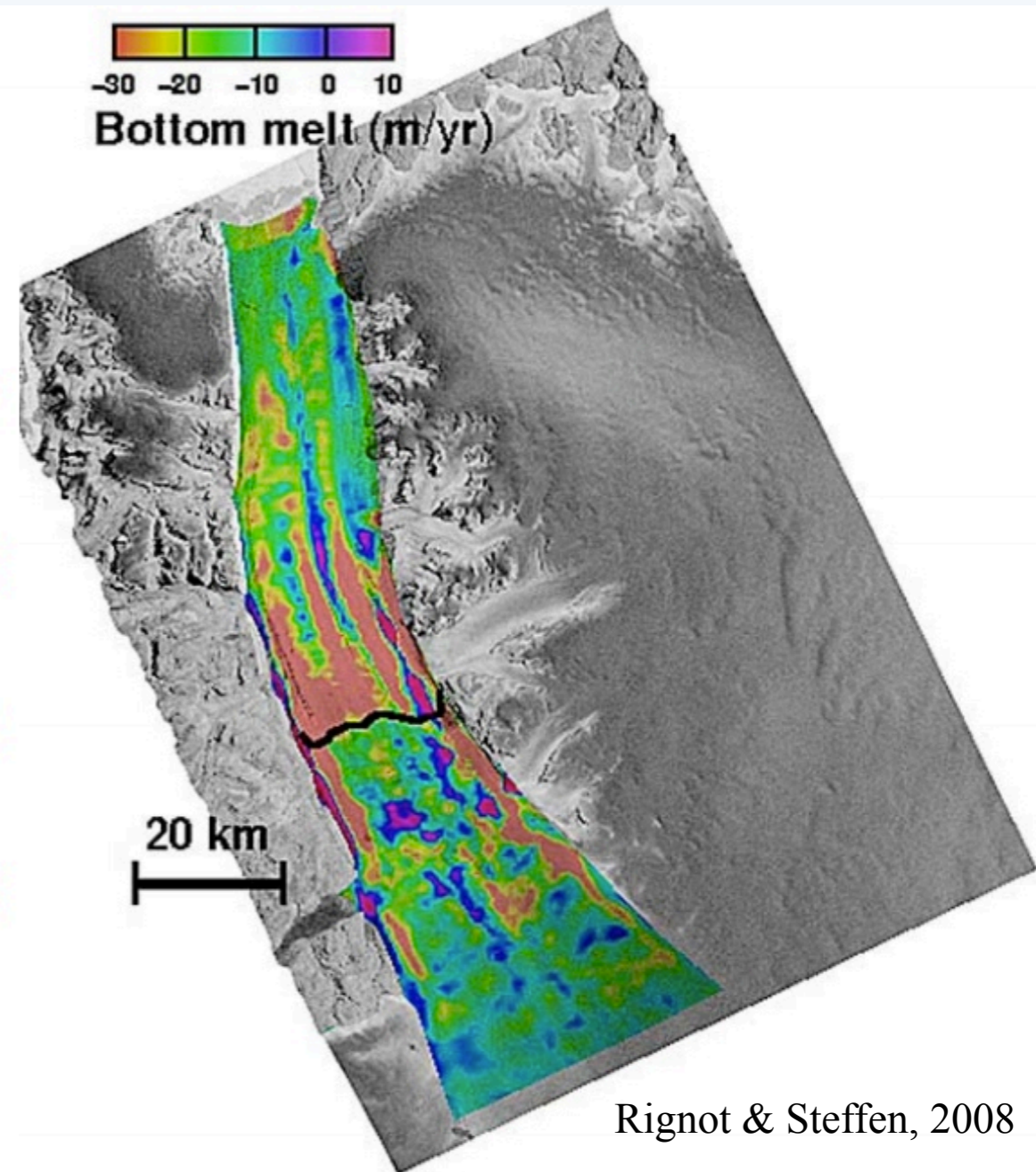


Steady state melting

Thinning rate (m/yr)



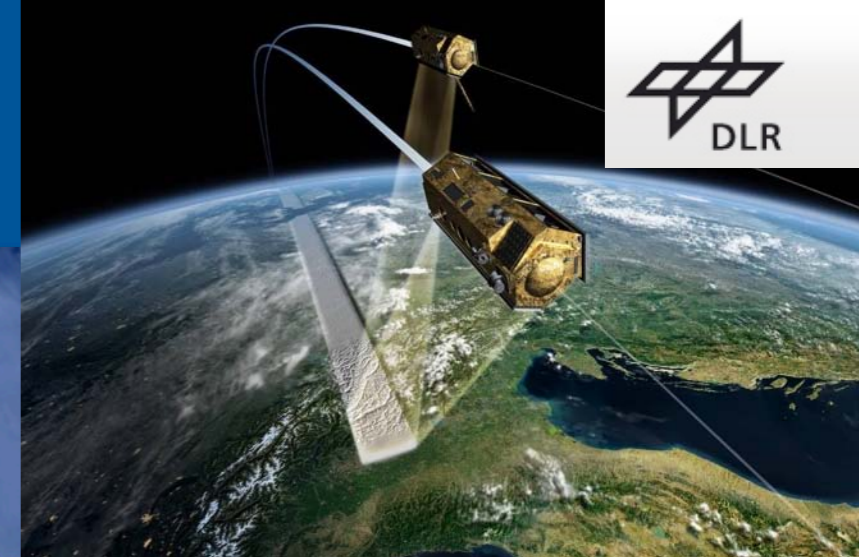
Bottom melt (m/yr)



Rignot & Steffen, 2008

1. Motivation
2. 20-years grounding line thinning
3. Surface elevation change
 - TanDem-X
 - CryoSat-2

TanDem-X



TanDem-X

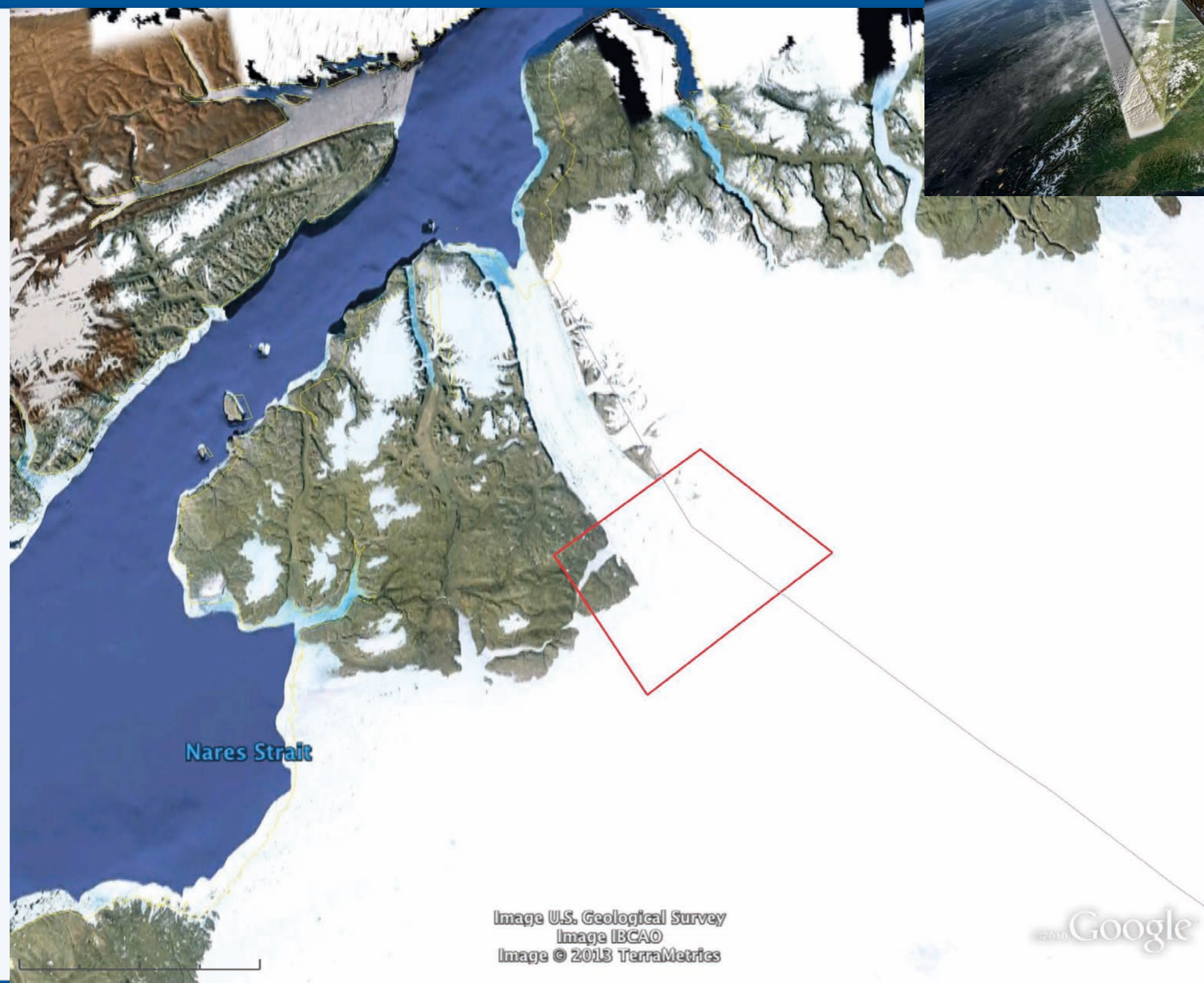
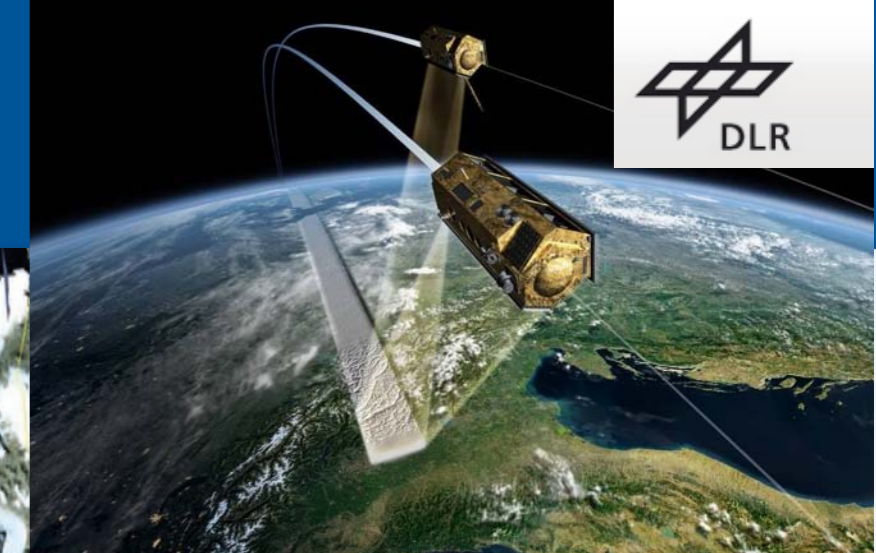
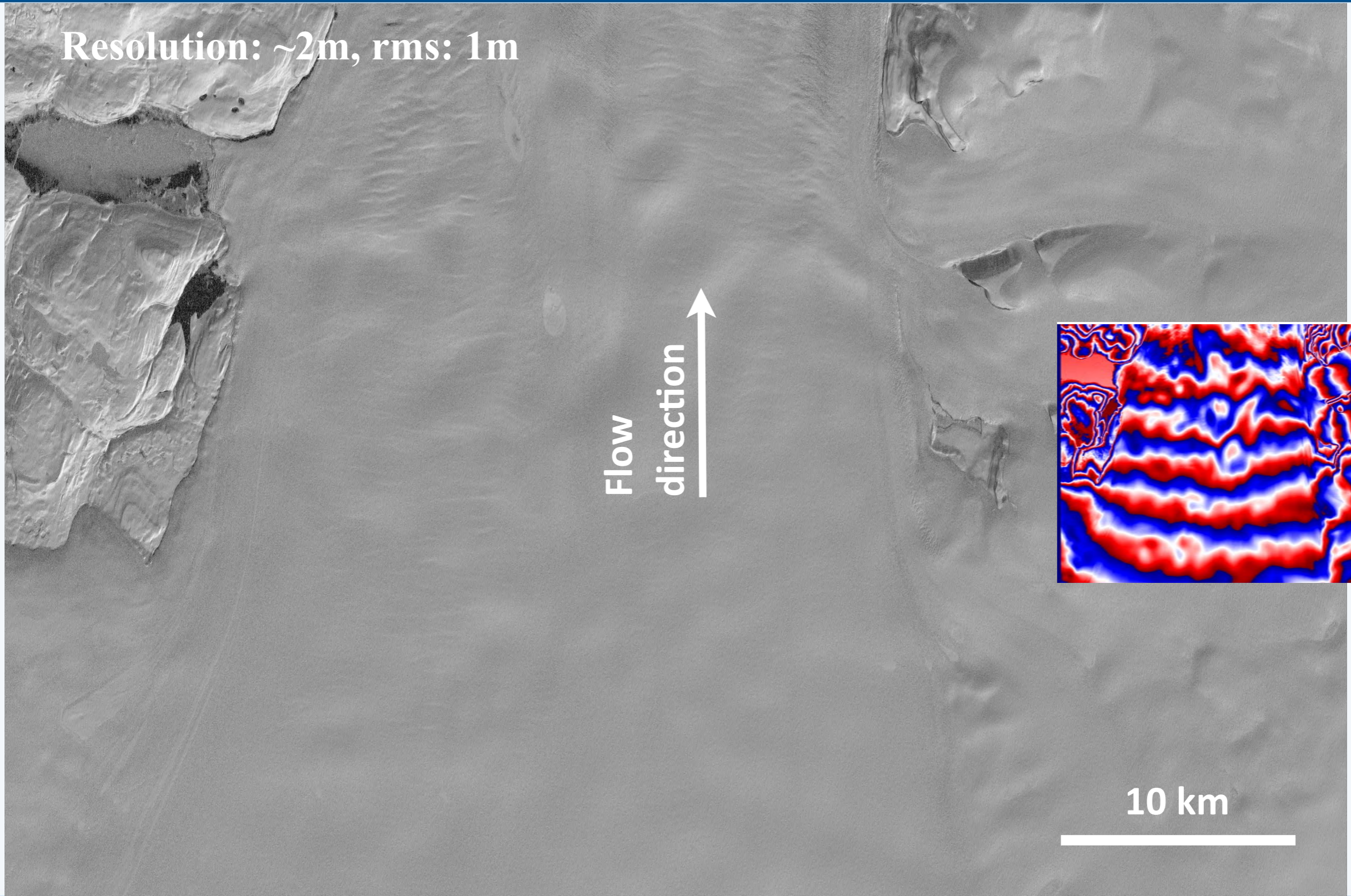
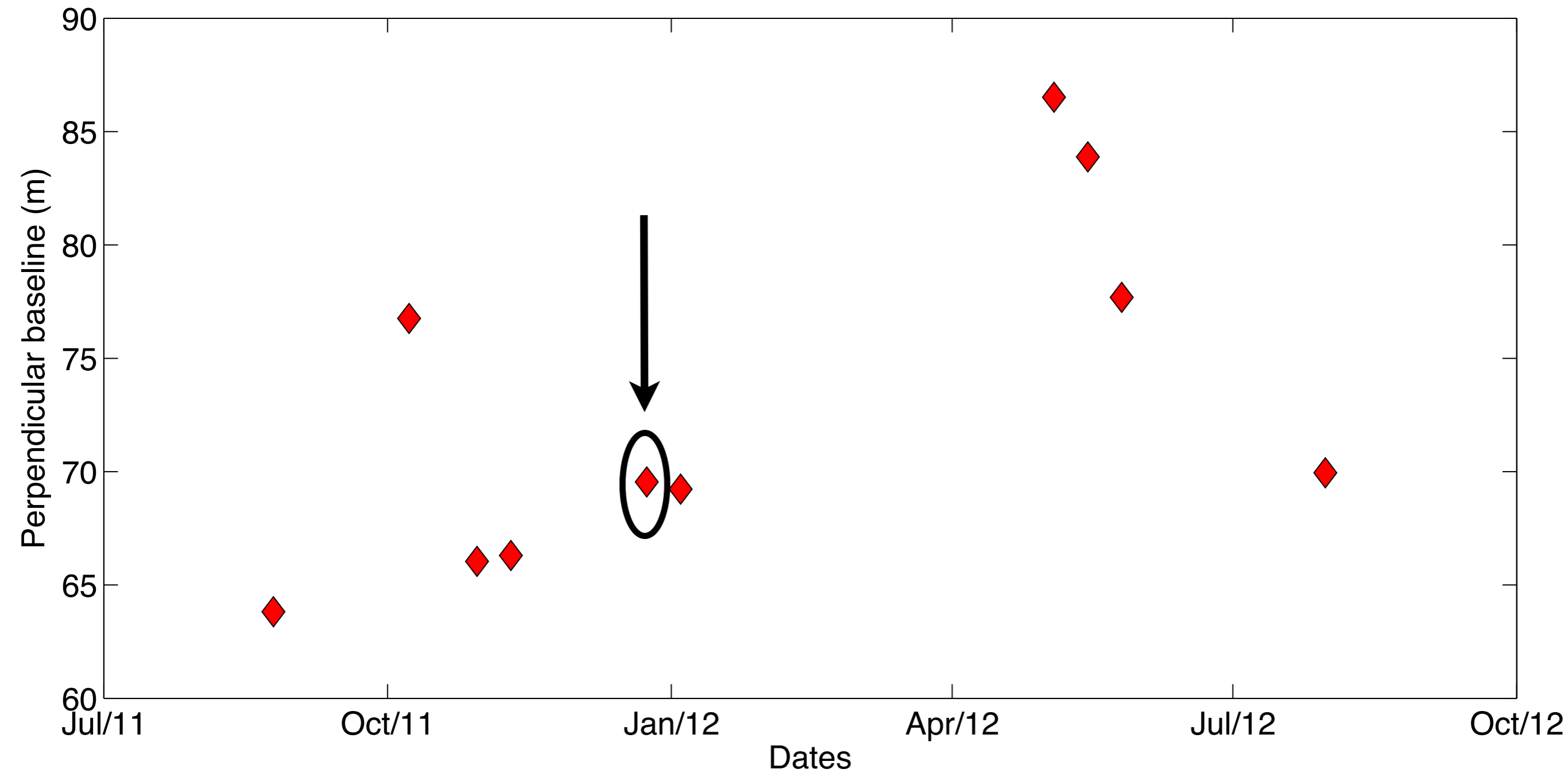


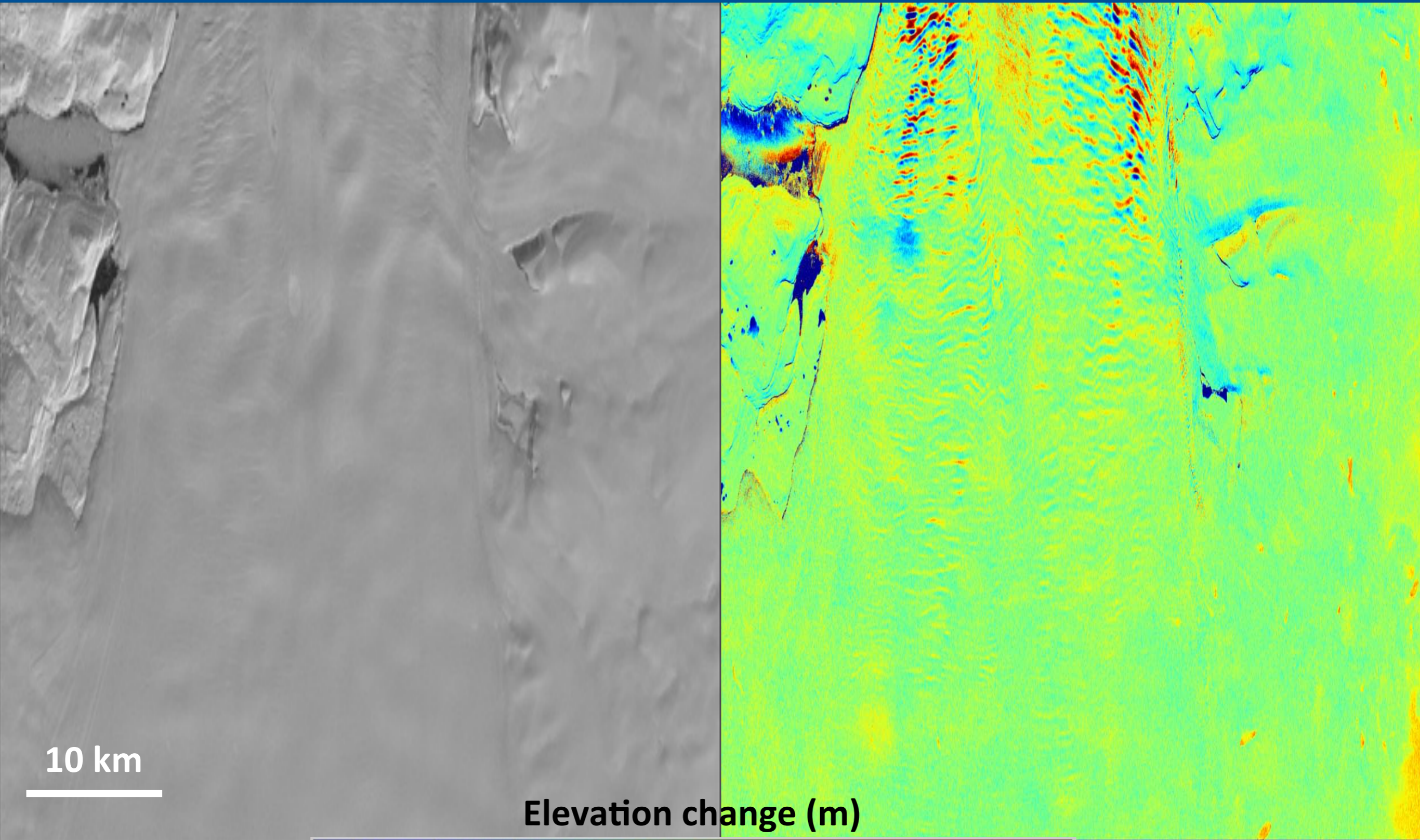
Image U.S. Geological Survey
Image IBCAO
Image © 2013 TerraMetrics

TanDem-X DEM over Petermann





Height variation: 25/08/2011 vs 24/12/2011



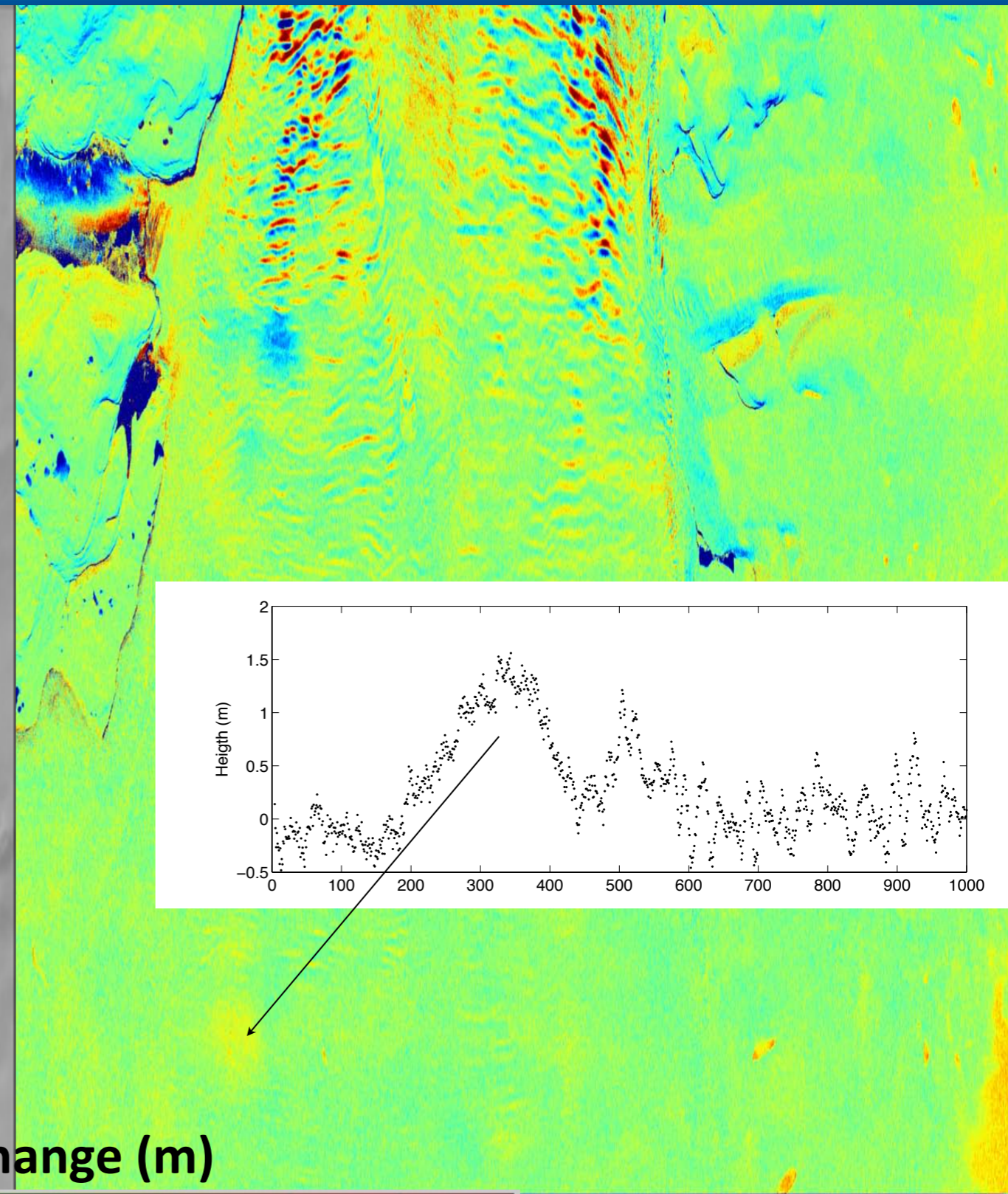
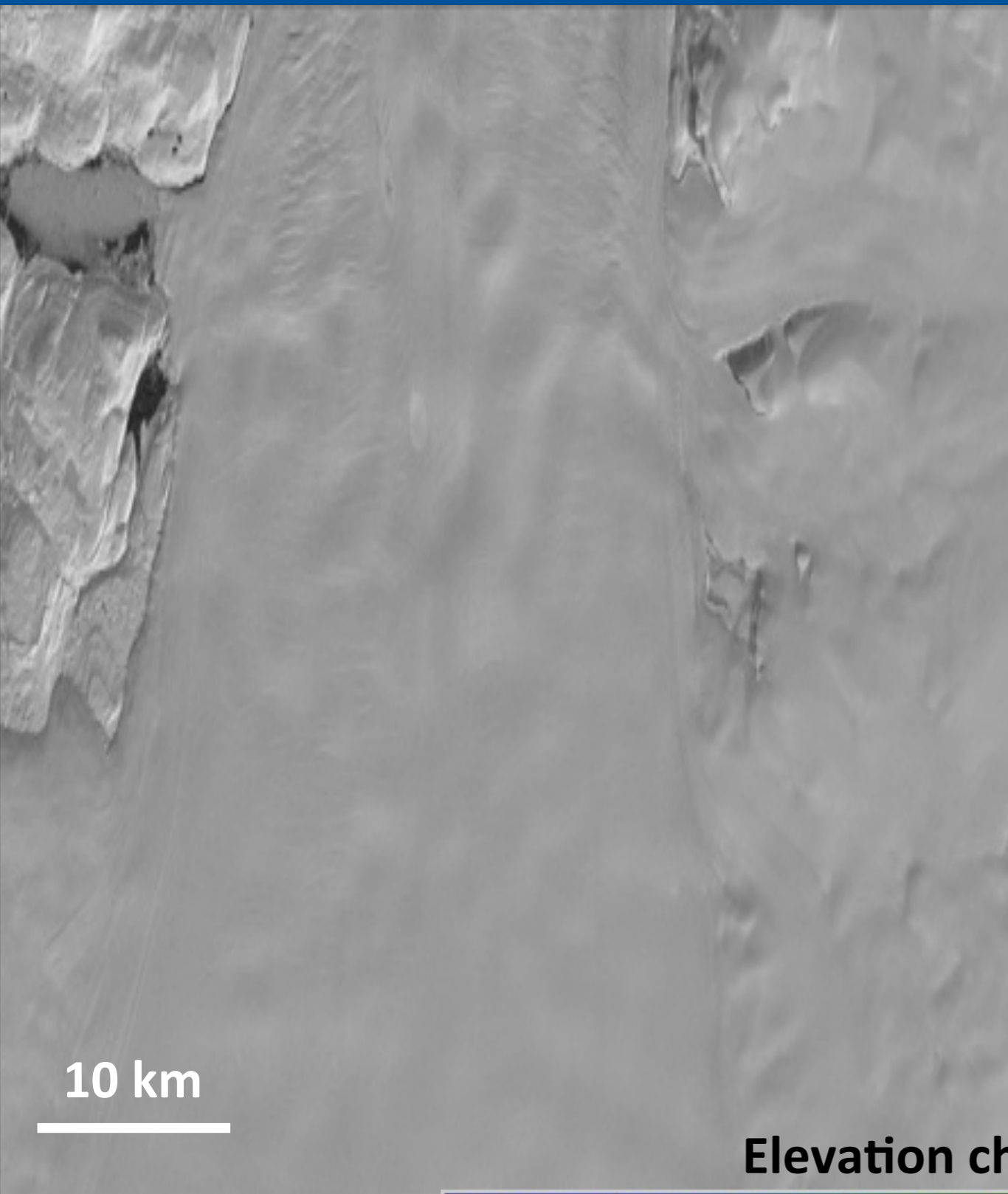
10 km

Elevation change (m)

-10

10

Height variation: 25/08/2011 vs 24/12/2011

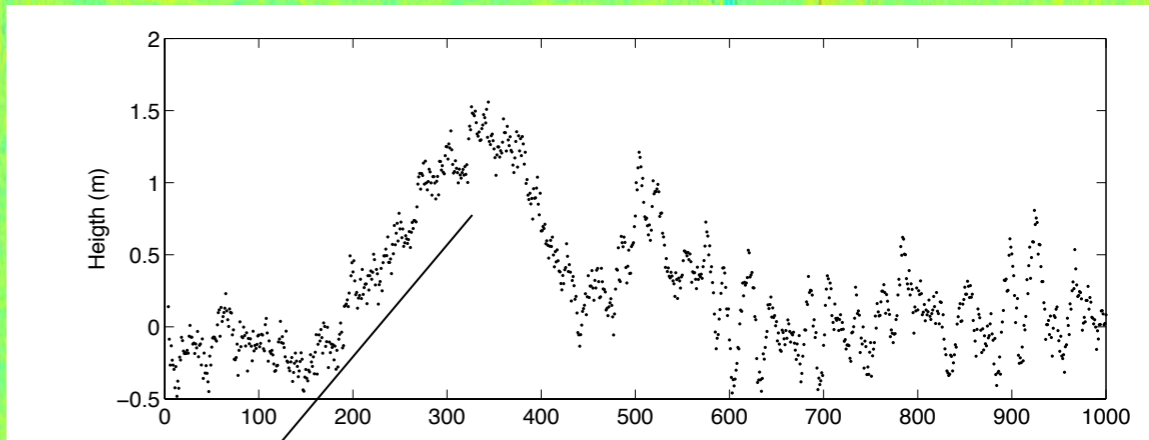
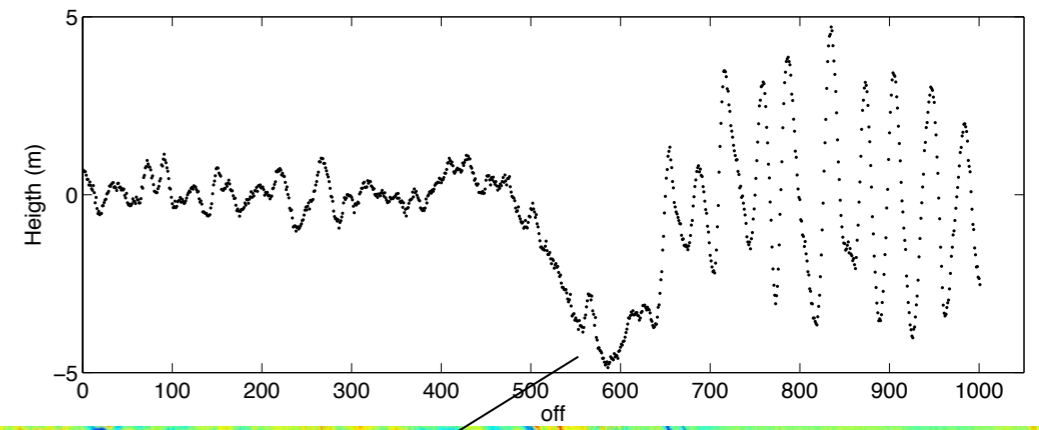
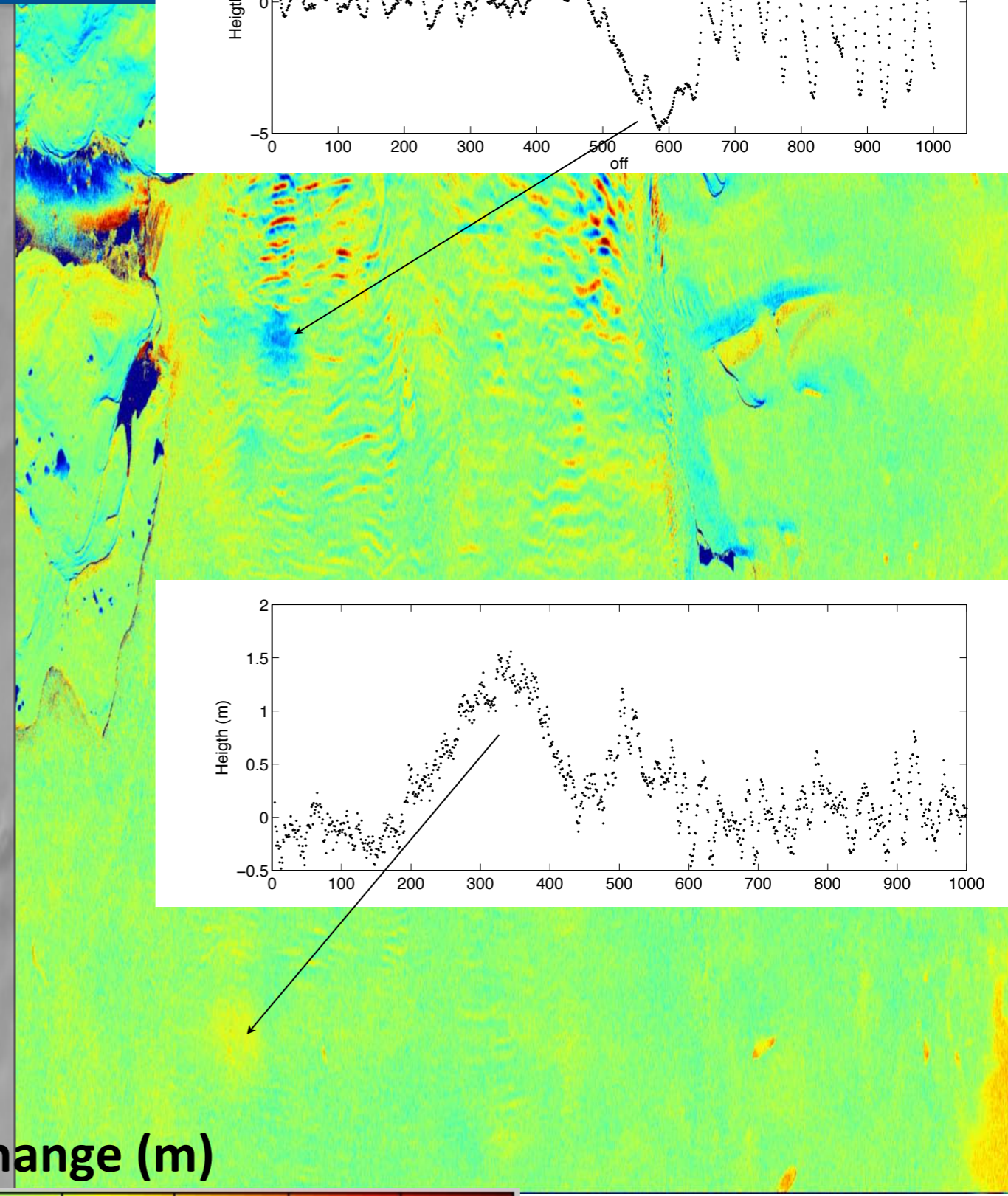
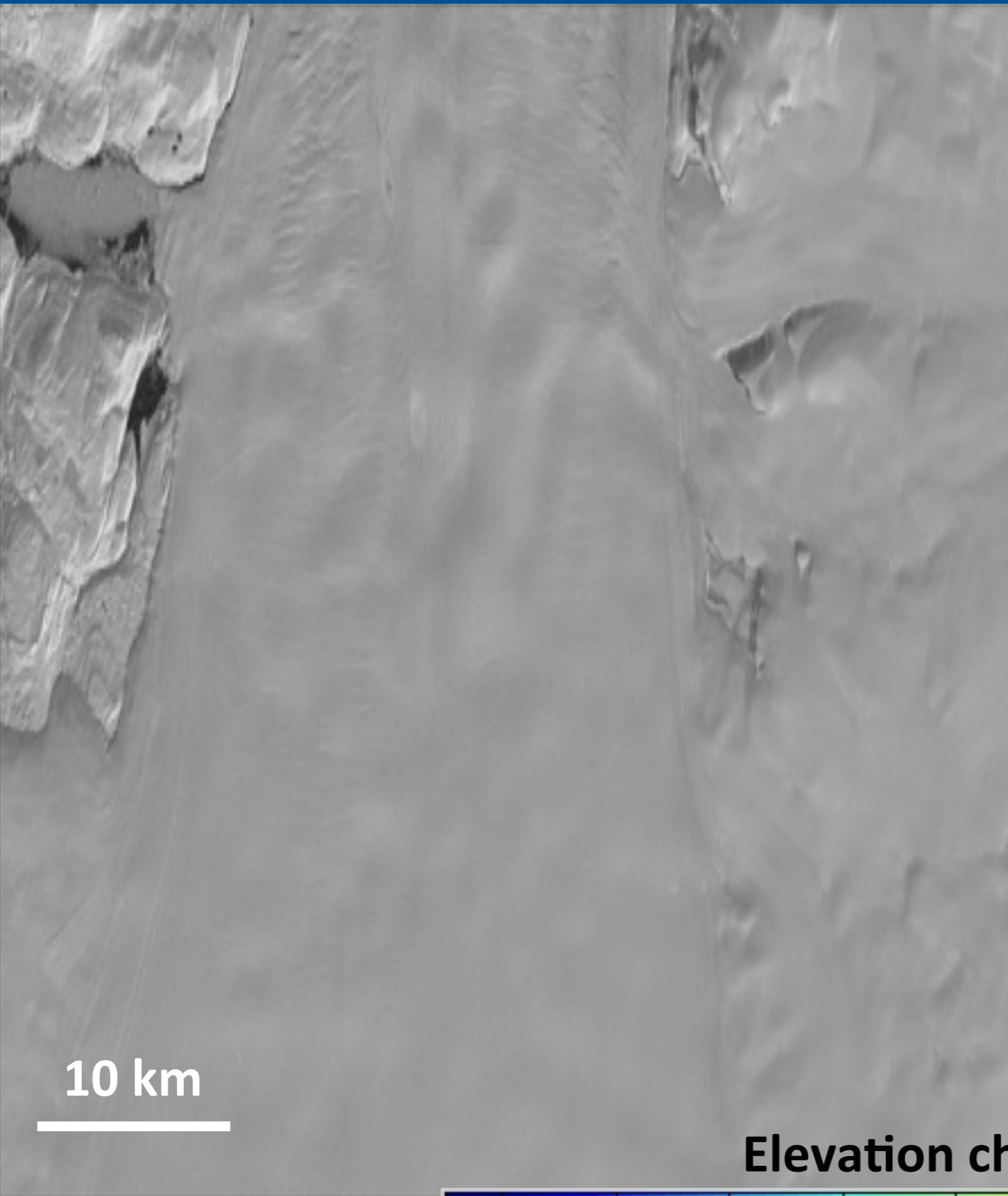


Elevation change (m)

-10

10

Height variation: 25/08/2011 vs

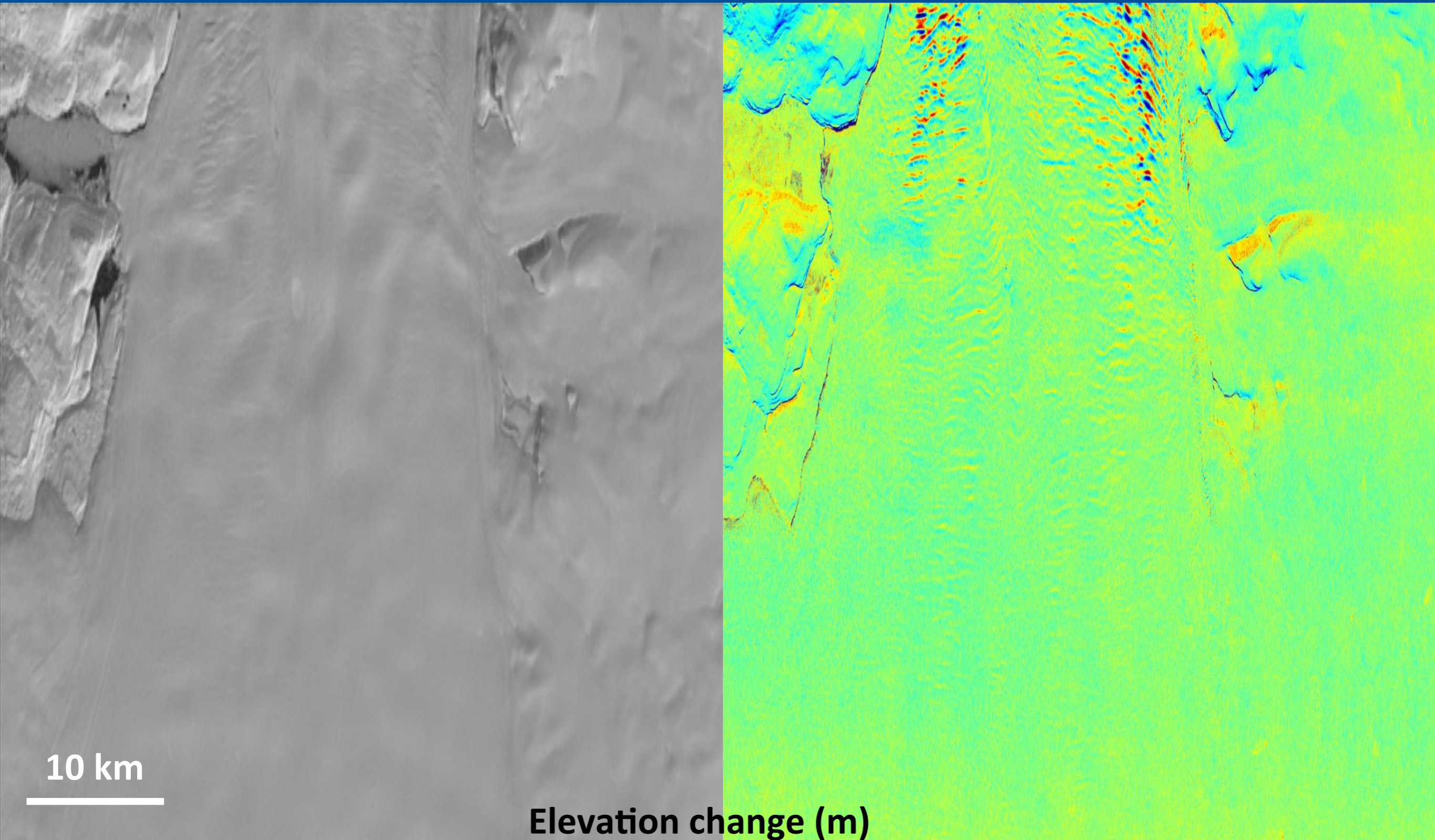


Elevation change (m)

-10

10

Height variation: 08/10/2011 vs 24/12/2011



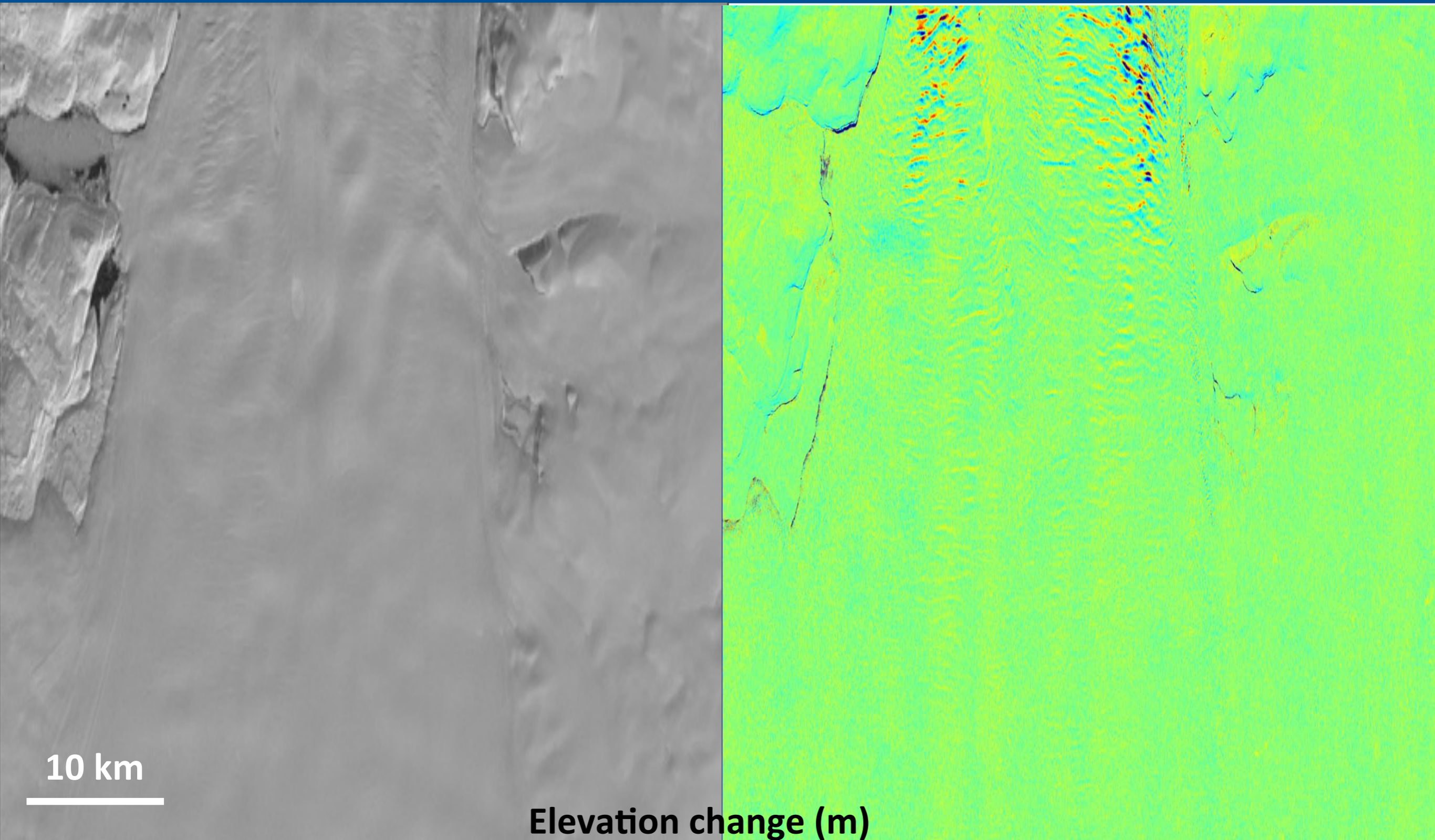
10 km

Elevation change (m)

-10

10

Height variation: 30/10/2011 vs 24/12/2011



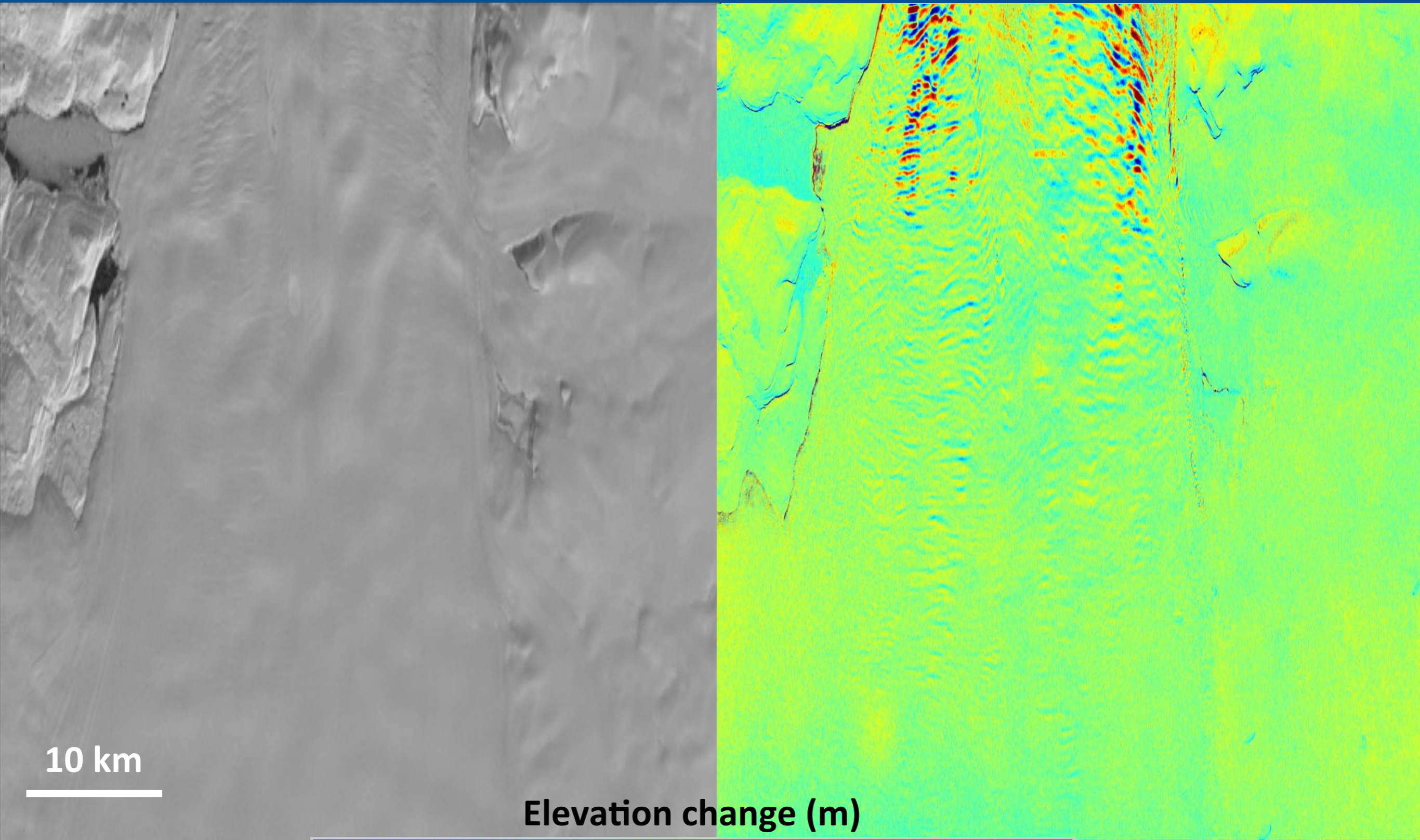
10 km

Elevation change (m)

-10

10

Height variation: 04/05/2012 vs 24/12/2011



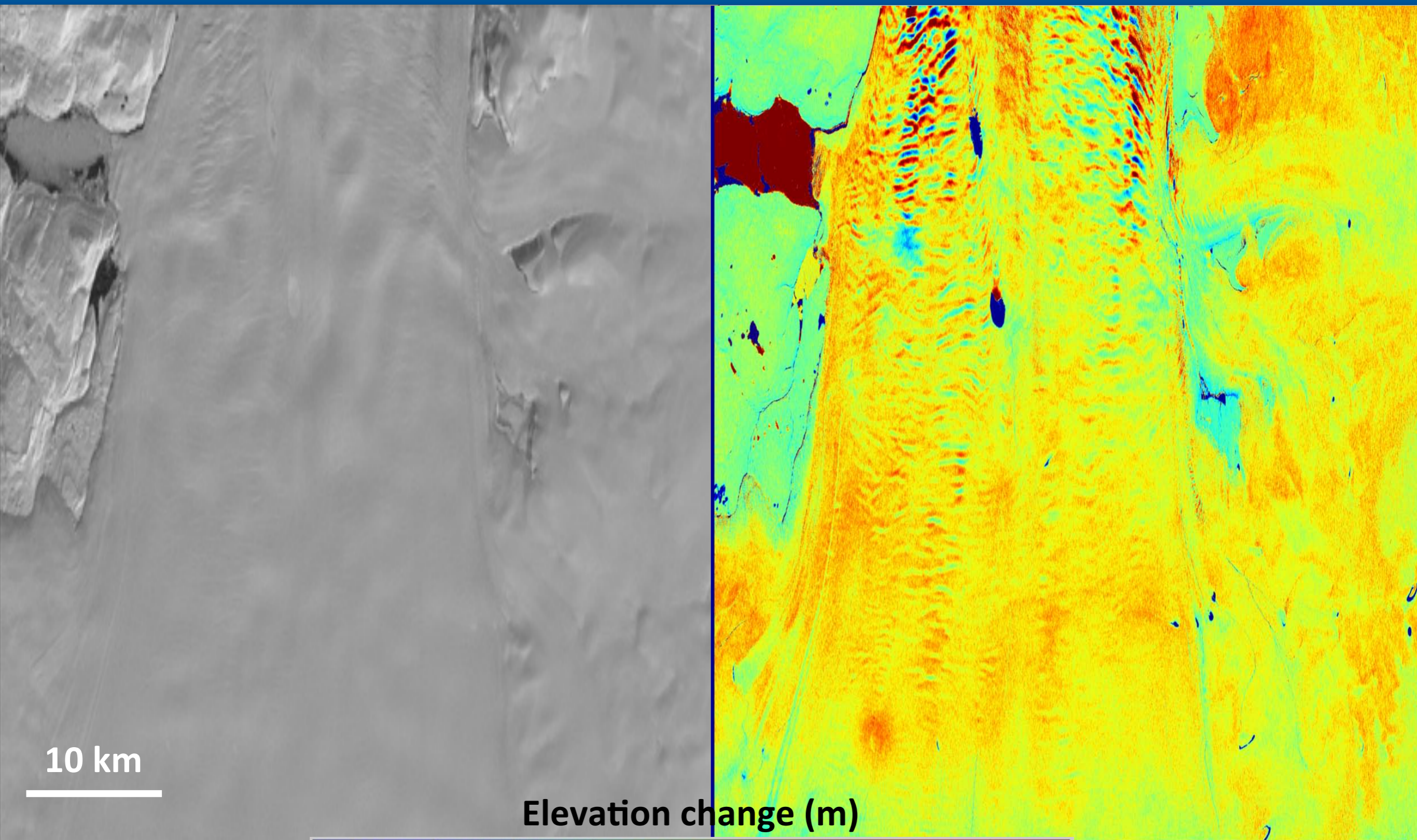
10 km

Elevation change (m)

-10

10

Height variation: 31/07/2012 vs 24/12/2011



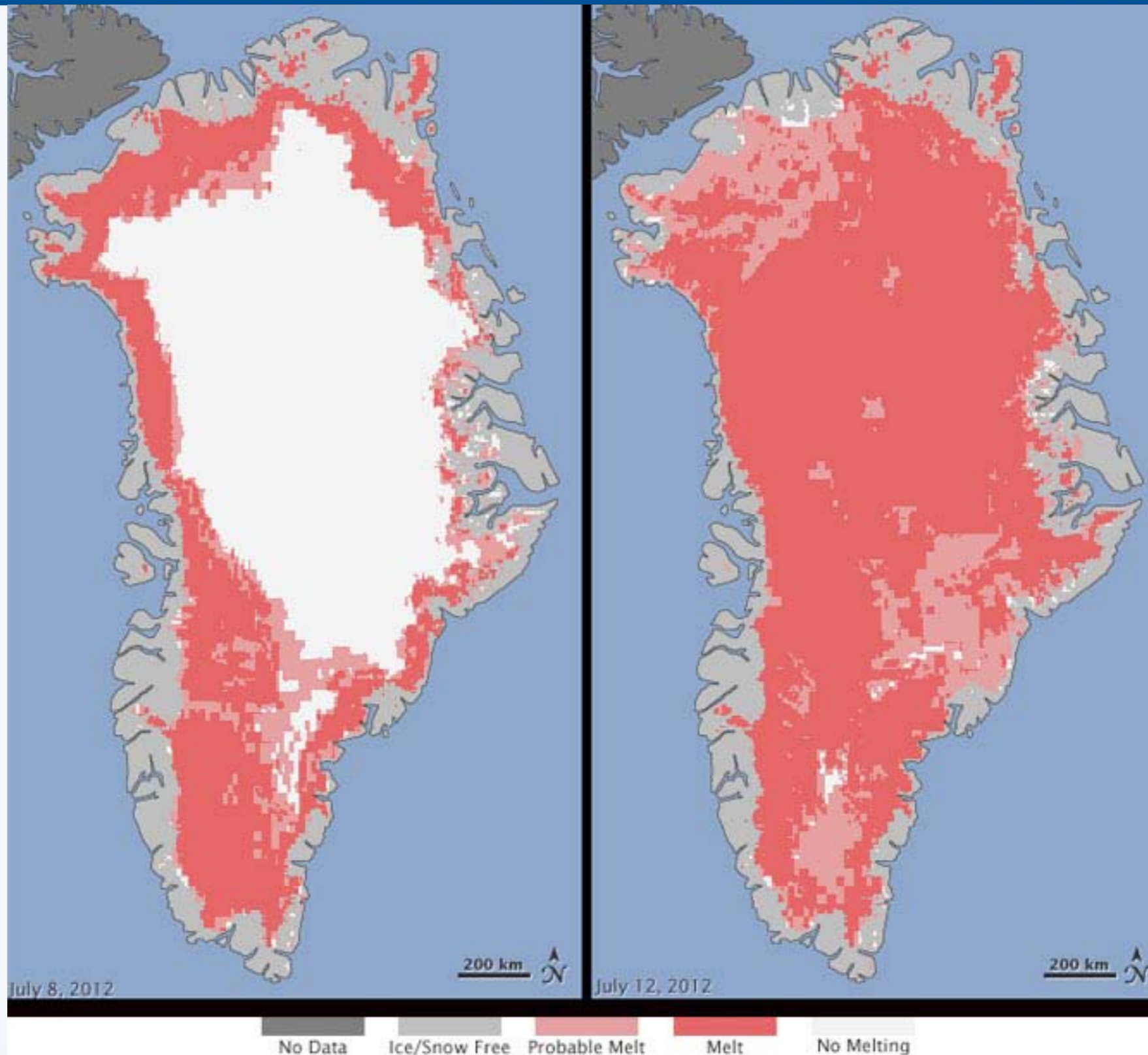
10 km

Elevation change (m)

-10

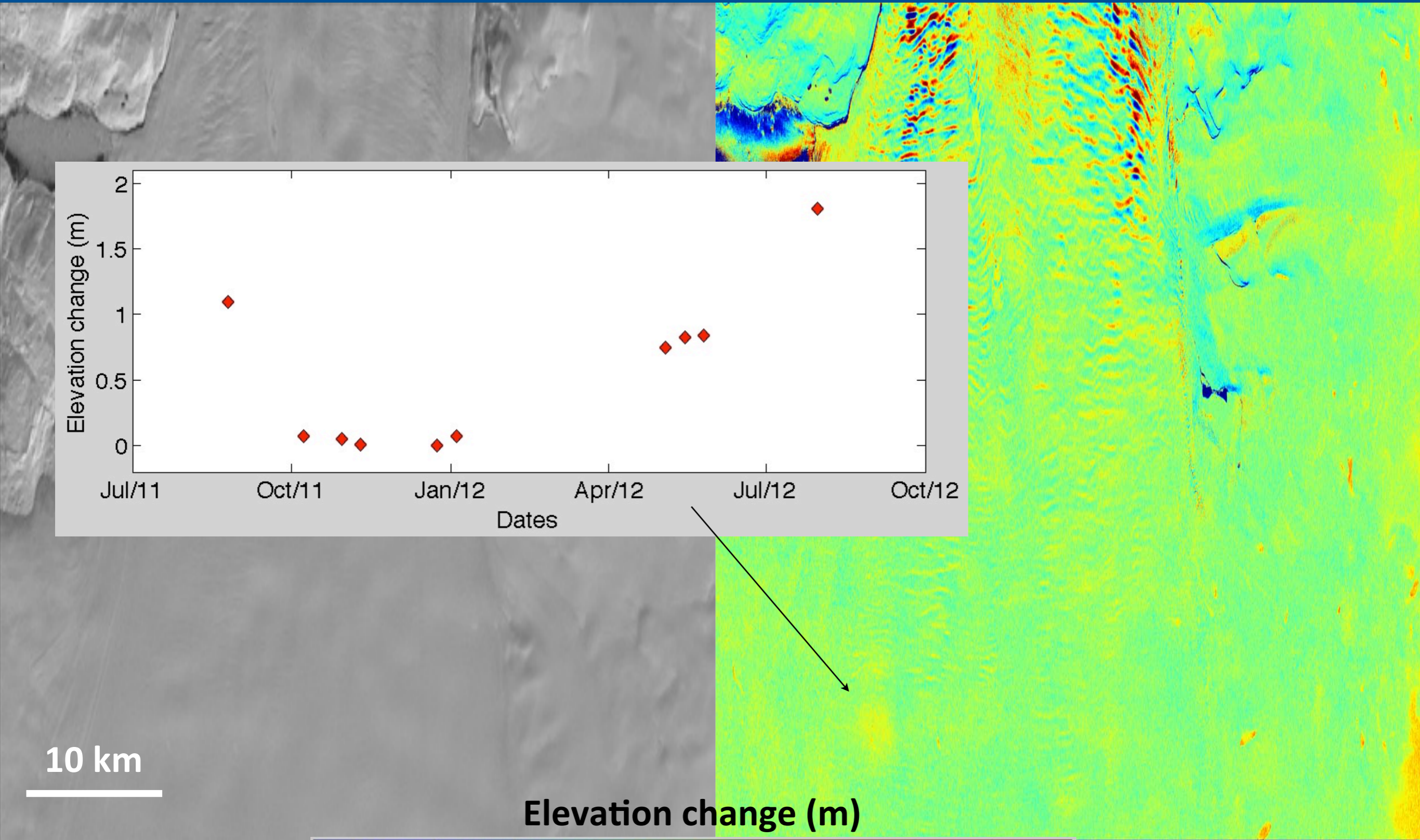
10

2012 Greenland surface melt



*N. E. DiGirolamo,
SSAI/NASA GSFC,
J. Allen, NASA
Earth*

Time evolution of local uplift



10 km

Elevation change (m)

-10

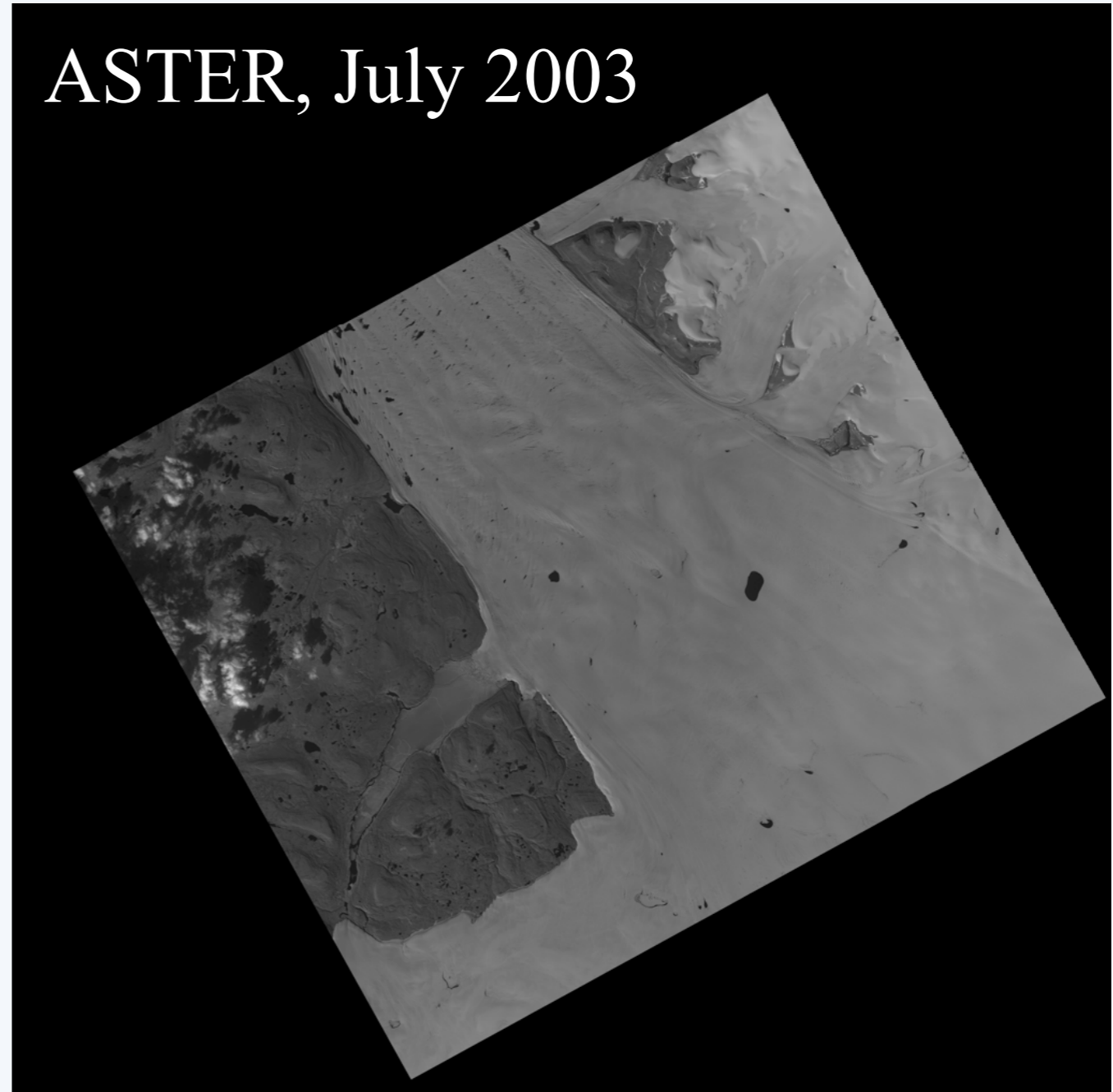
10

TanDEM-X (2012)

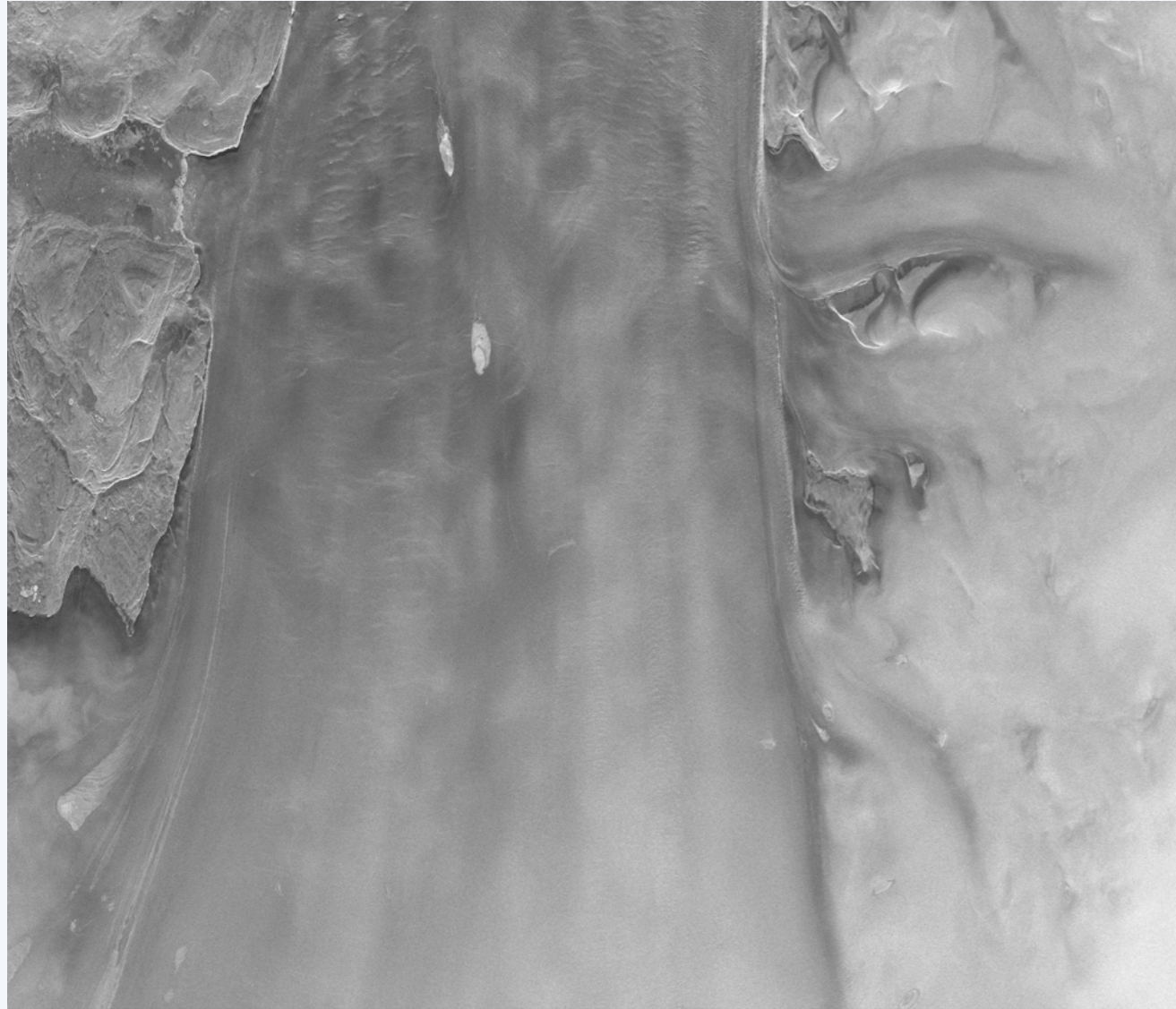
minus

ASTER dem (2003)

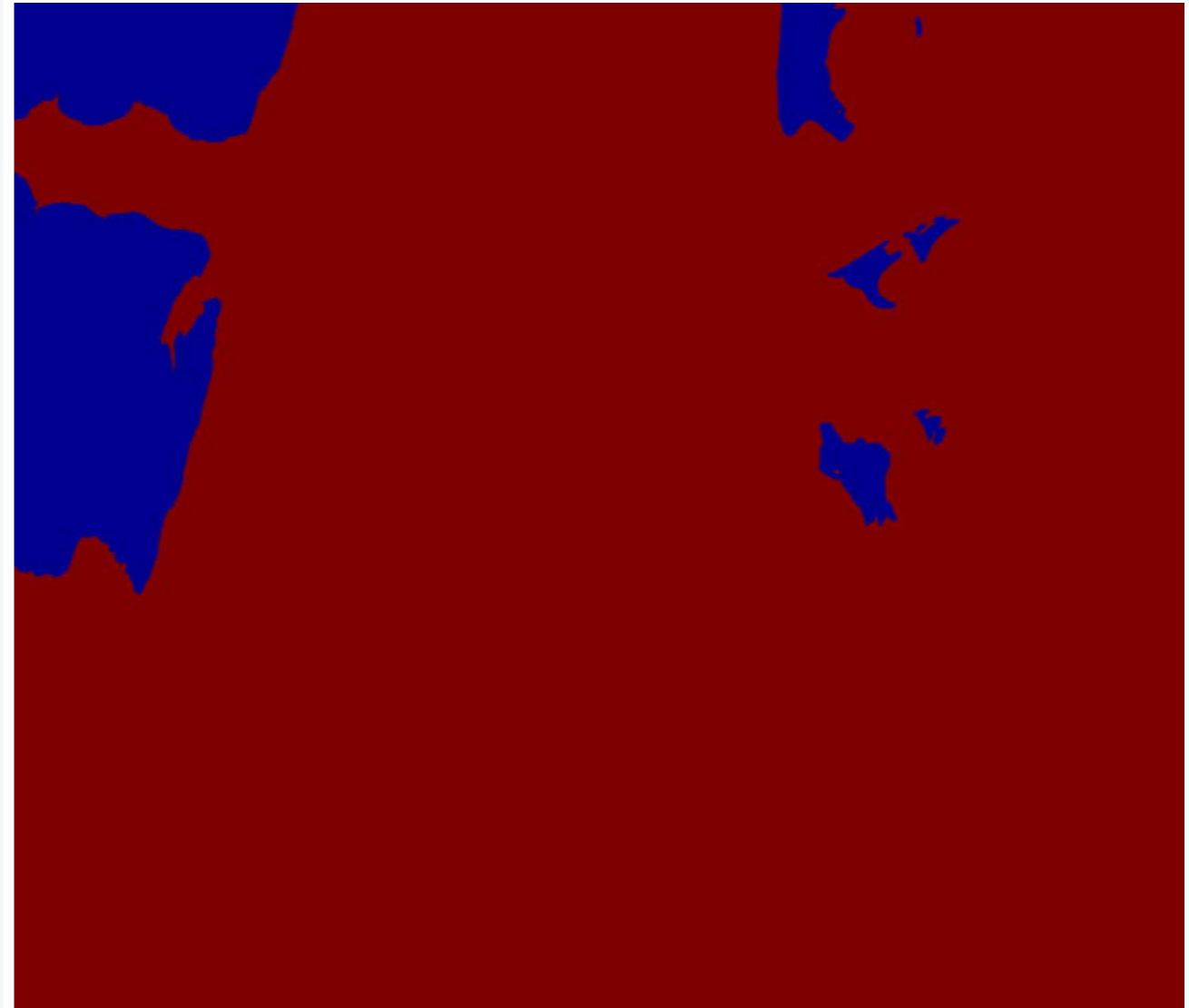
ASTER, July 2003



Backscatter

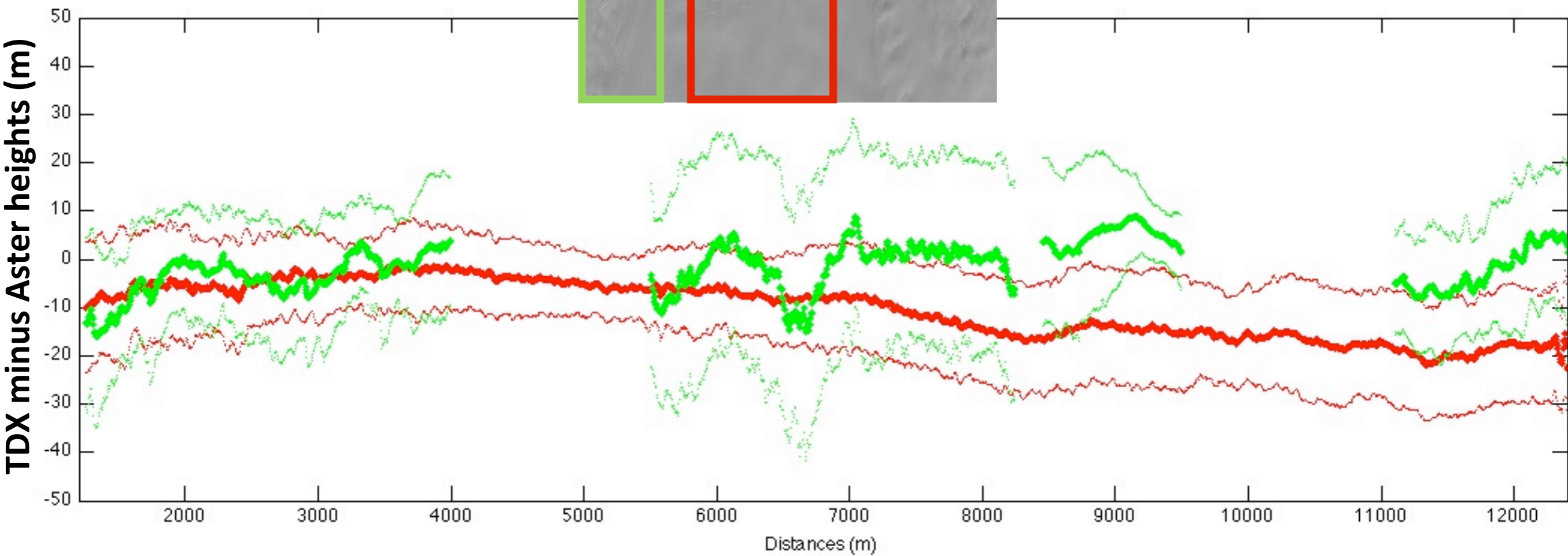
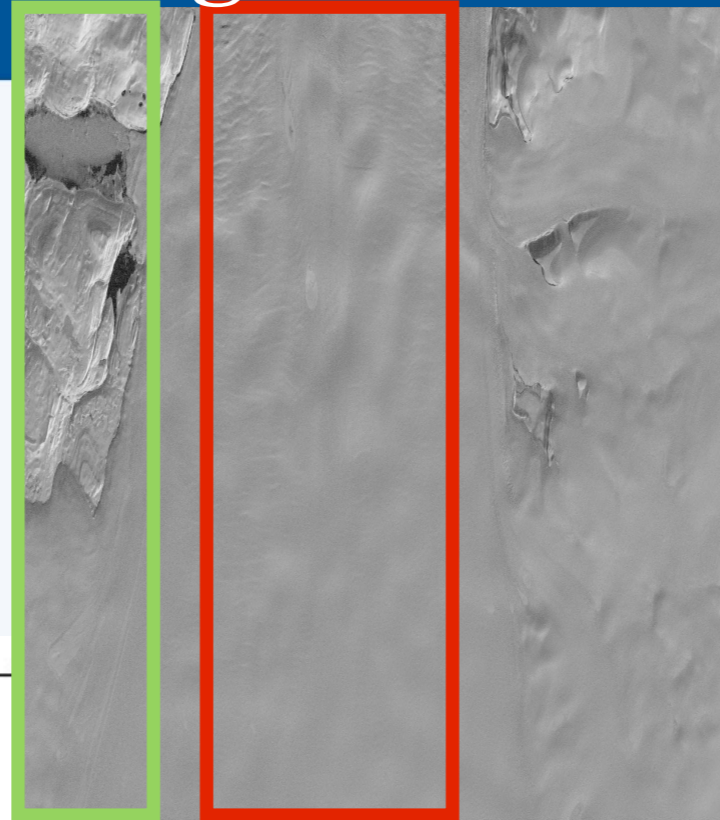


Land (blue) - ice (red) mask

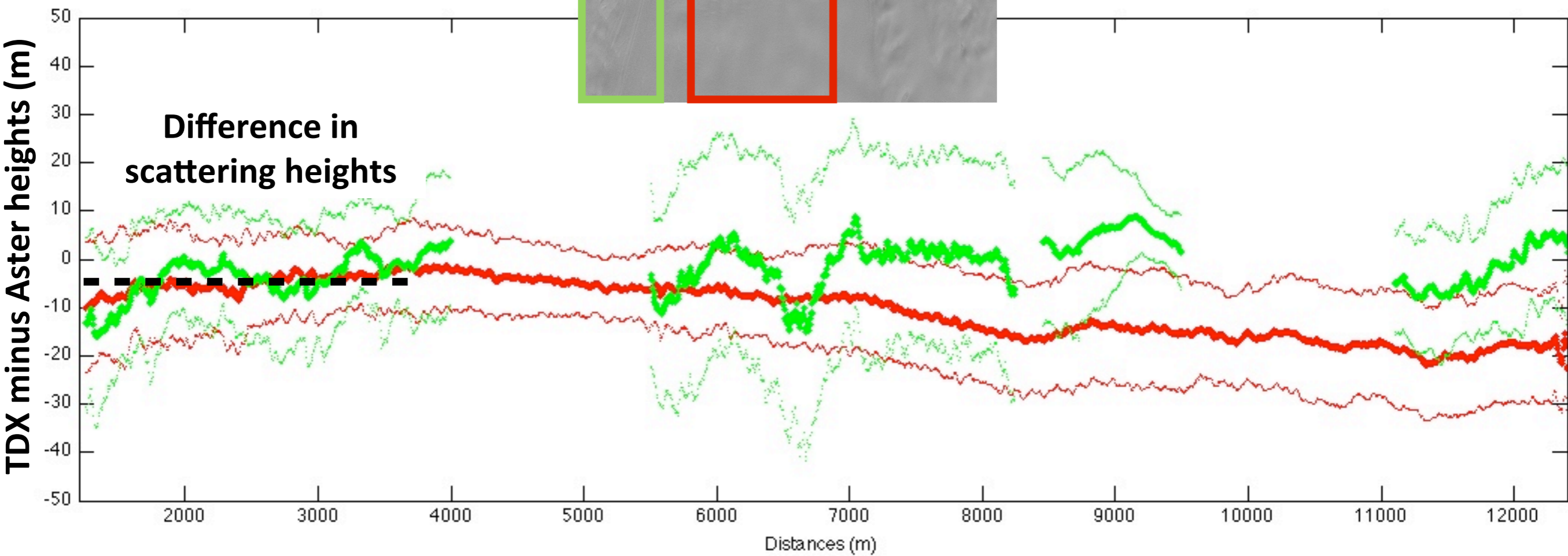
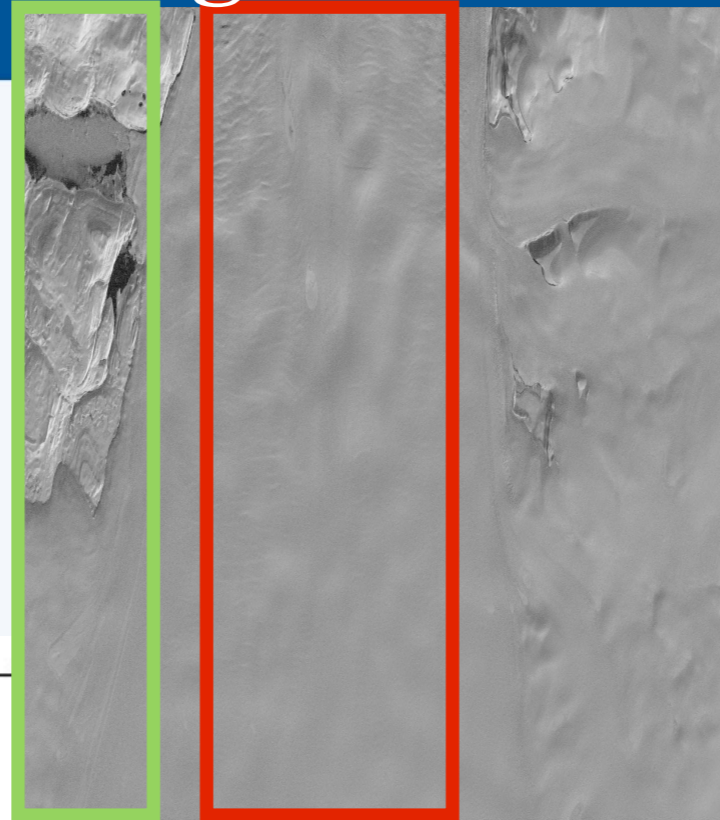


Howat I.M and A. Negrete, 2013

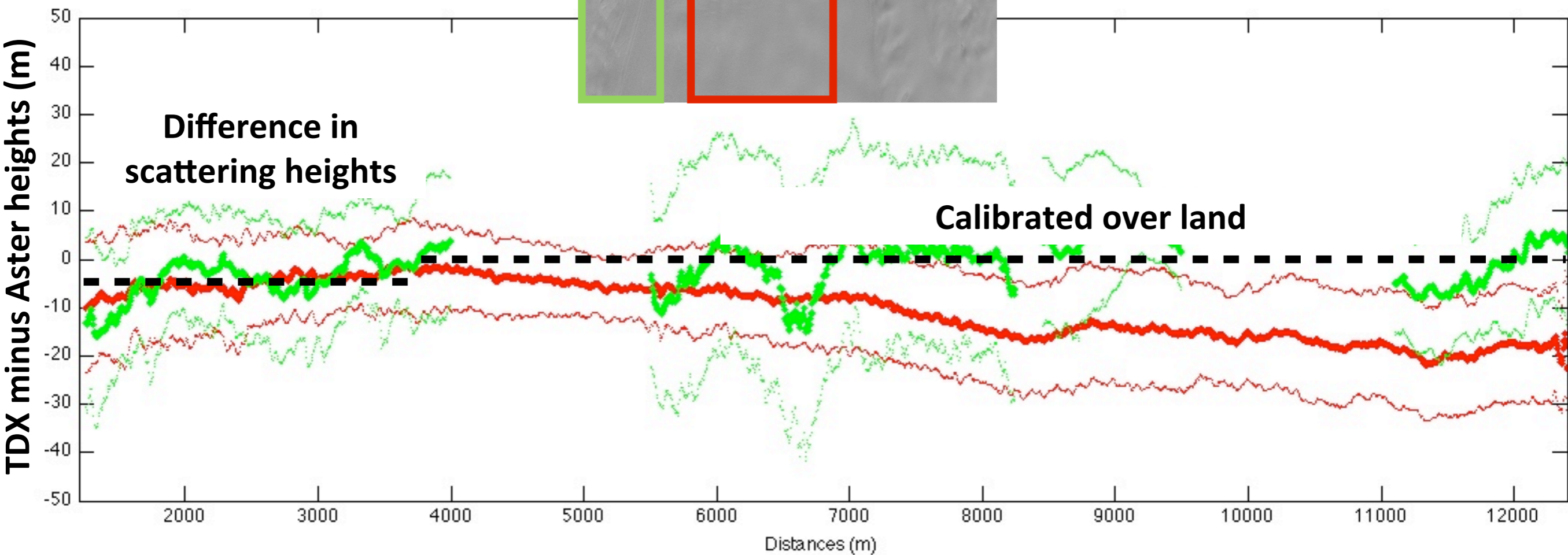
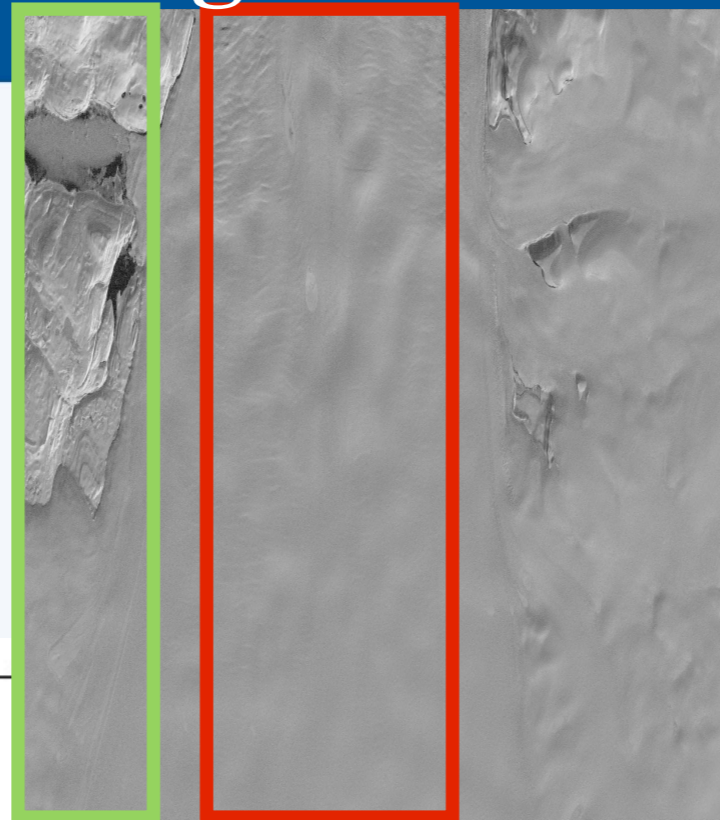
Long-term height change



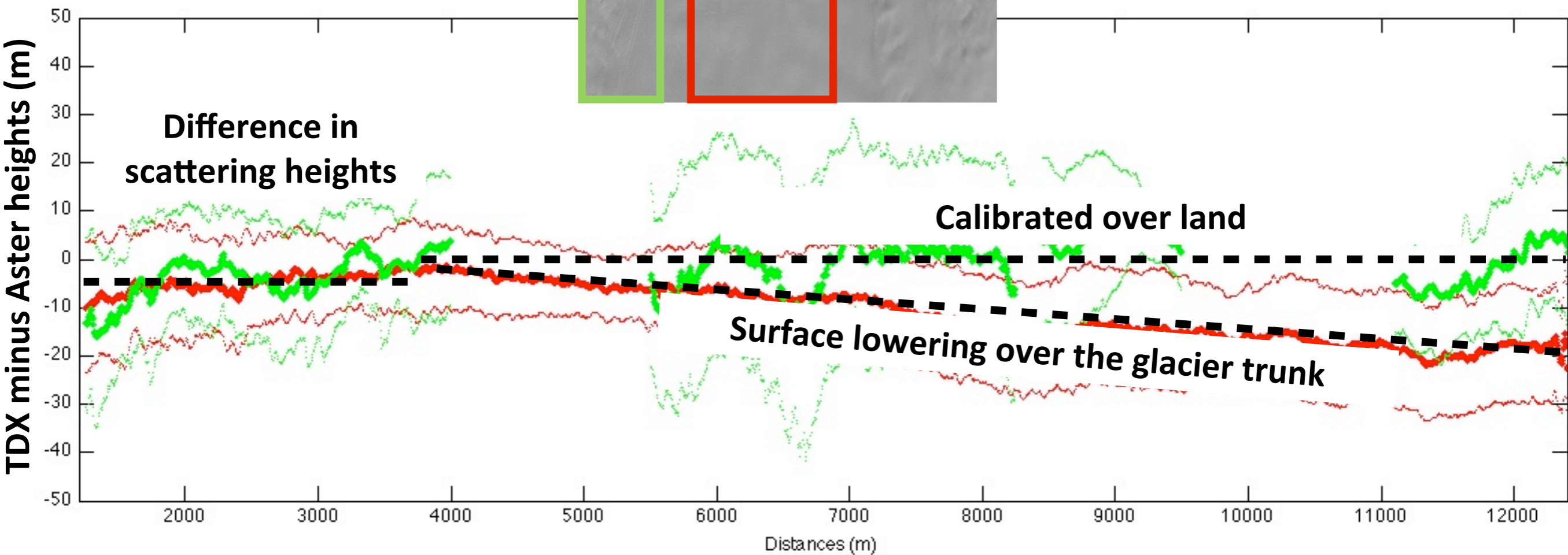
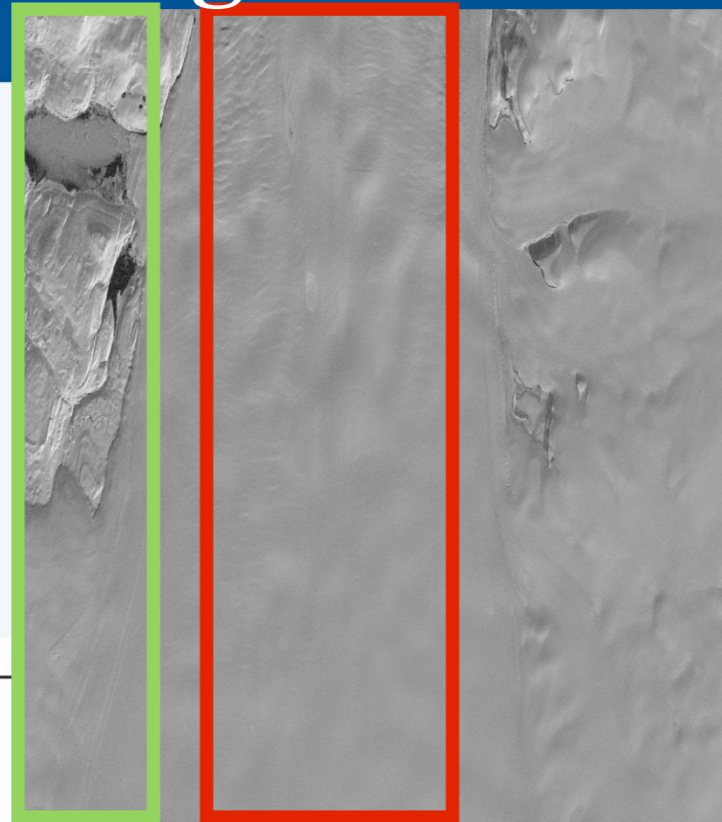
Long-term height change



Long-term height change



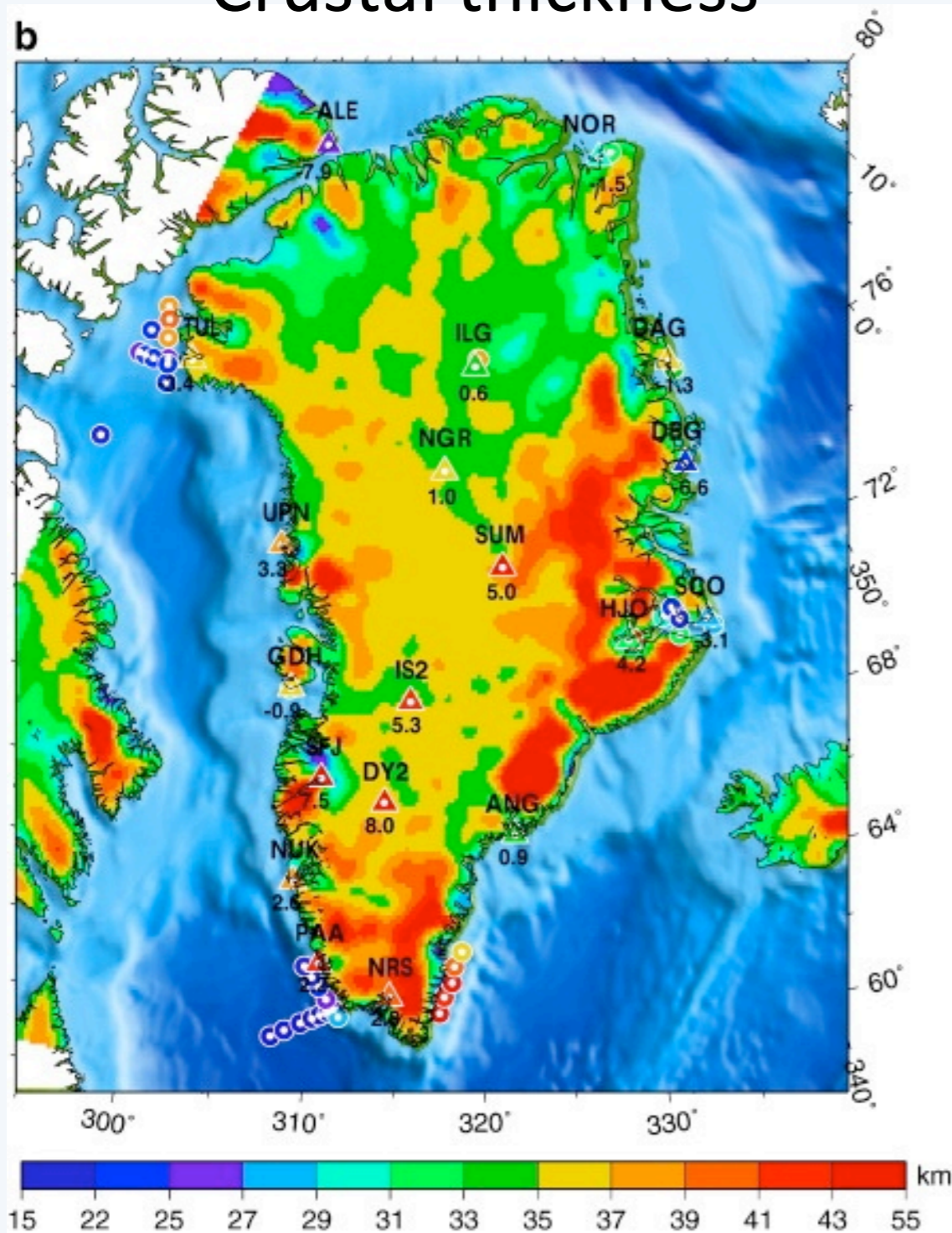
Long-term height change



Conclusions and Perspectives

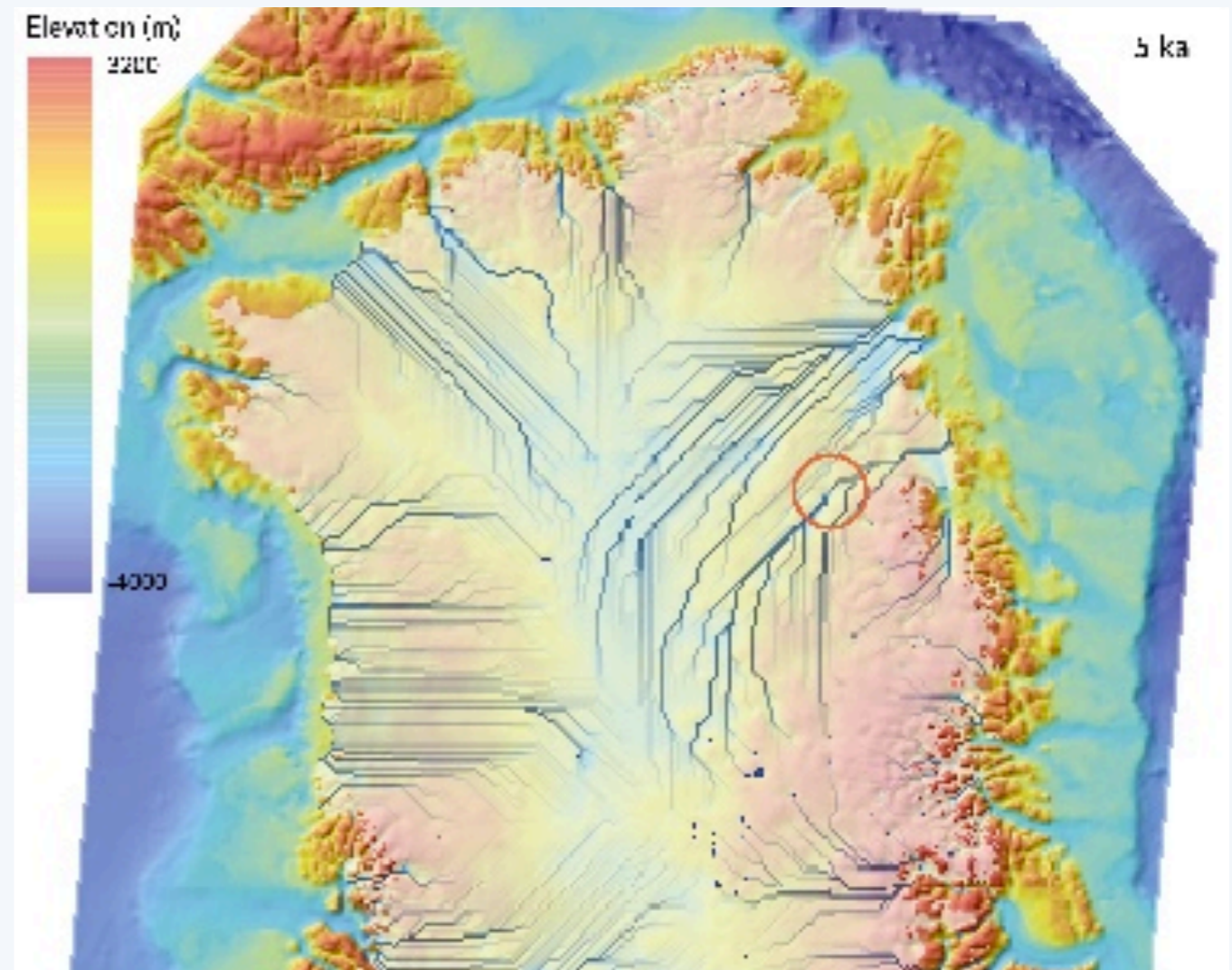
1. Steady retreat and thinning at the Petermann grounding line
2. Thinning is heterogeneous along the grounding line
3. High resolution topography shows activity of plumbing system
4. Apparent long-term thinning along the glacier

Crustal thickness



Braun et al., 2007

Drainage pathways

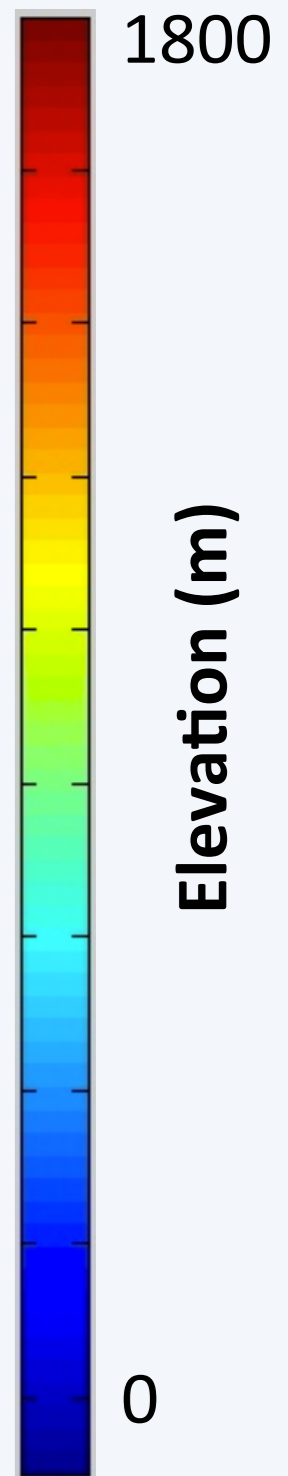
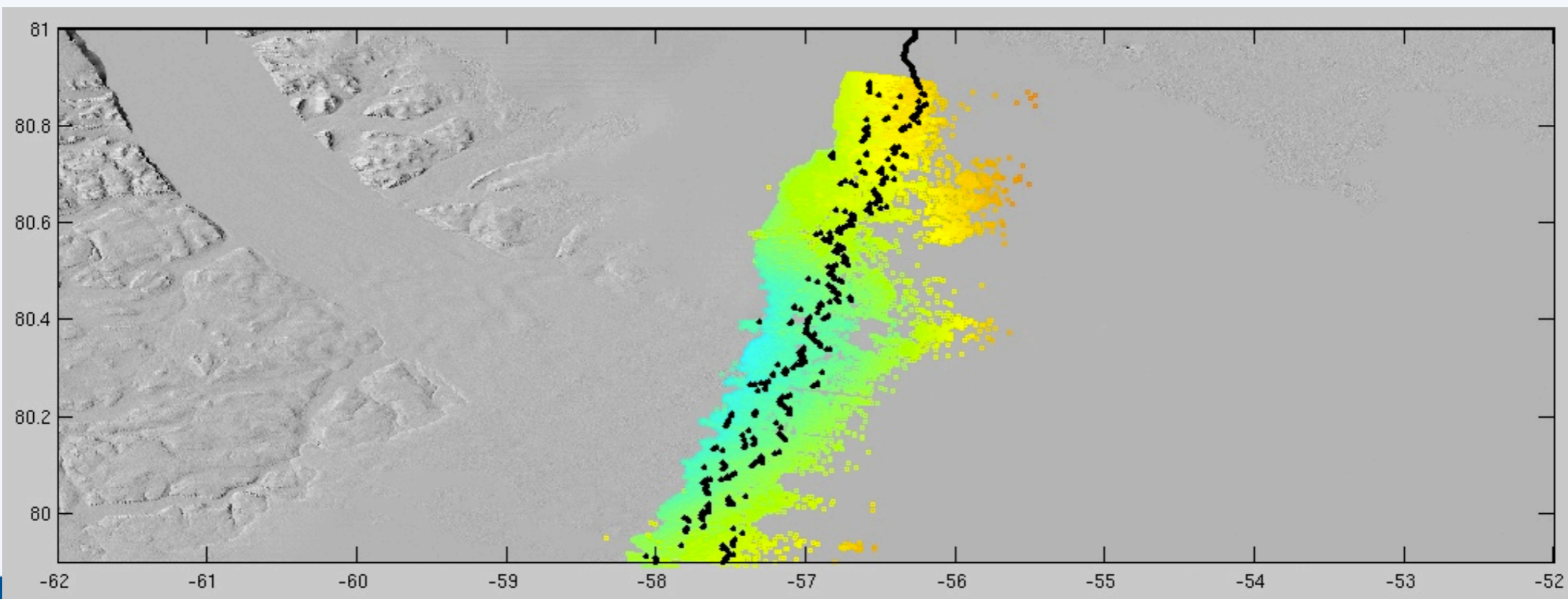
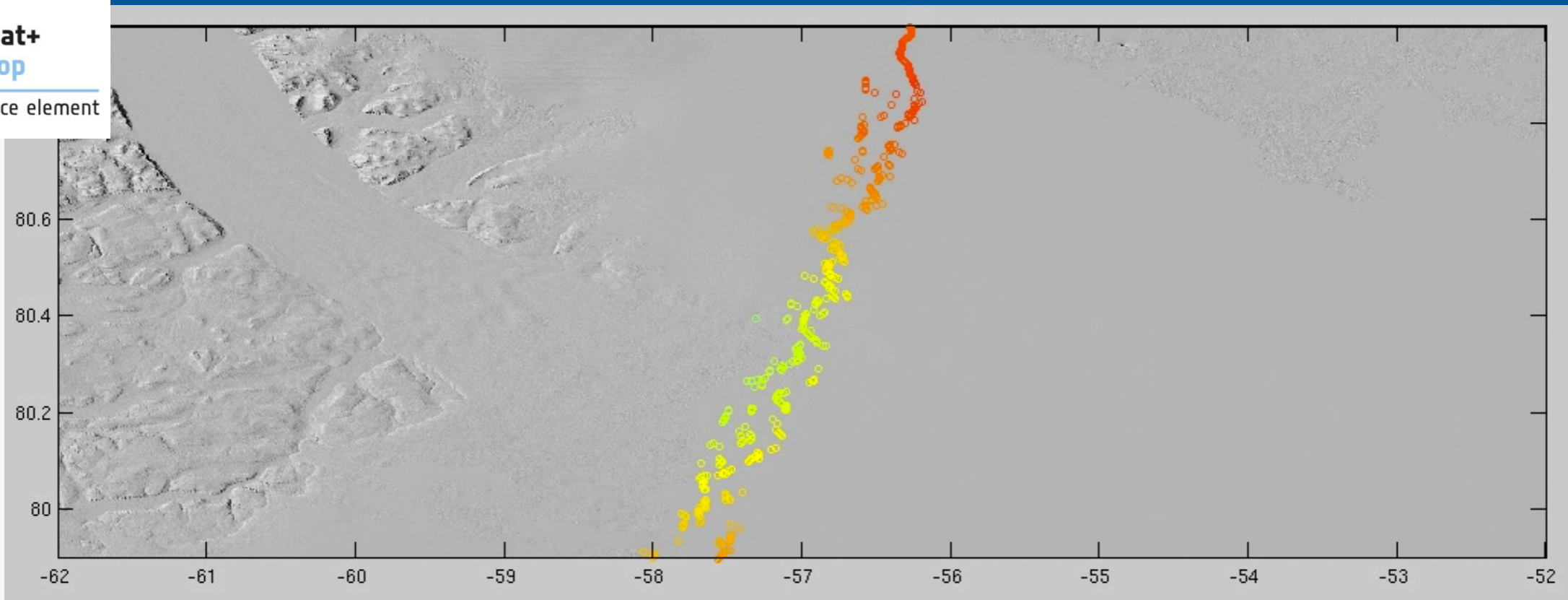


Livingstone et al., 2013

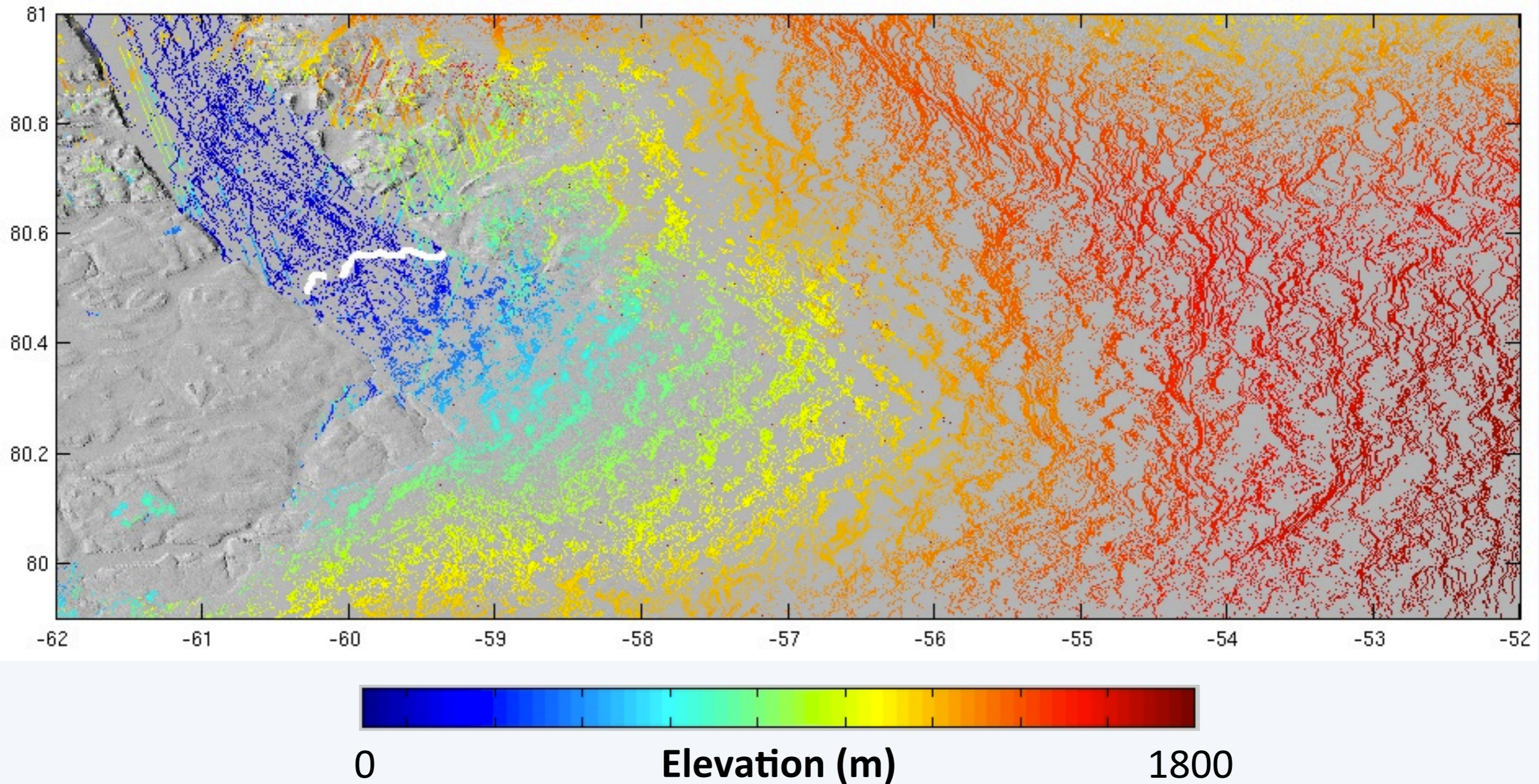
Conclusions and Perspectives

1. Steady retreat and thinning at the Petermann grounding line
2. Thinning is heterogeneous along the grounding line
3. High resolution topography shows we need to understand better its origin and how this impact flow and grounding line position
4. Apparent long-term thinning along the glacier

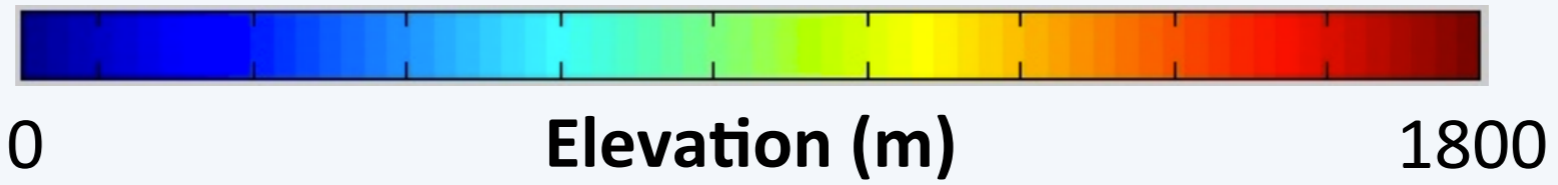
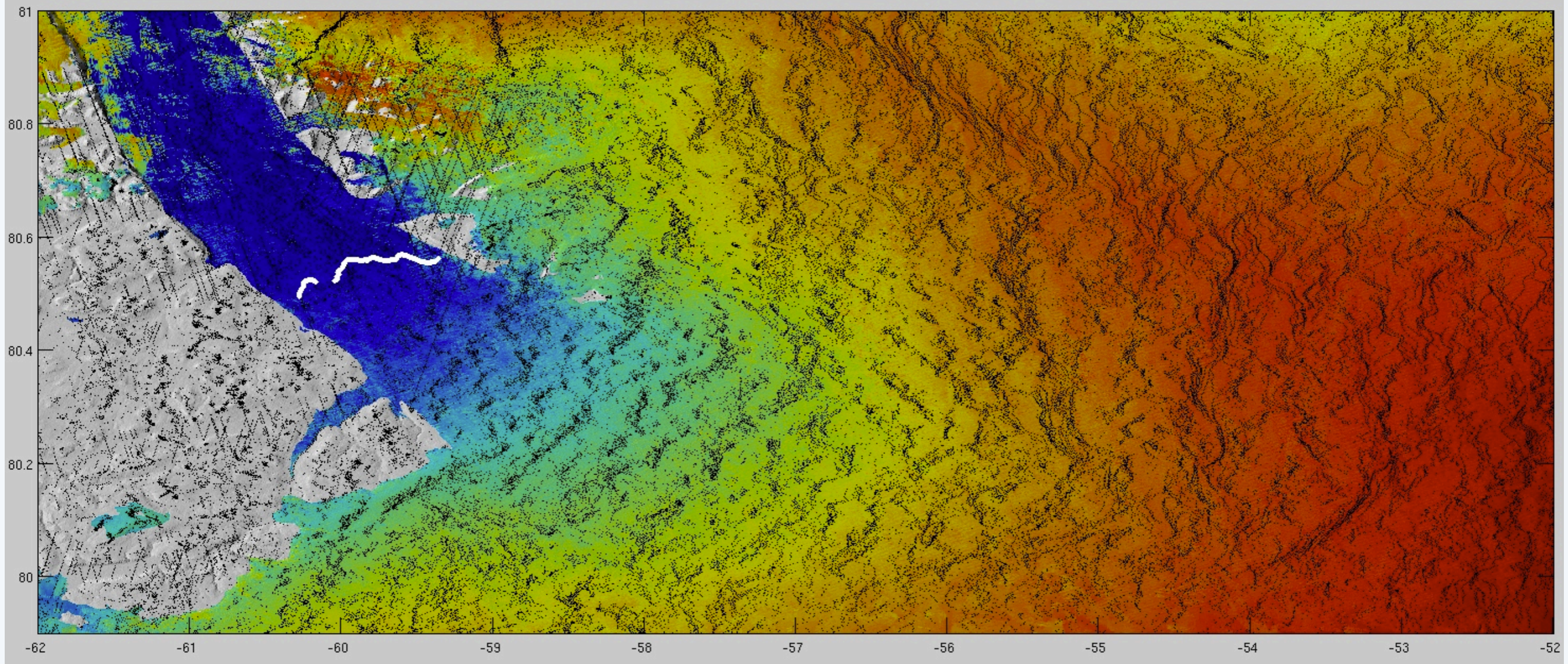
CryoTop - CryoSat Swath processing



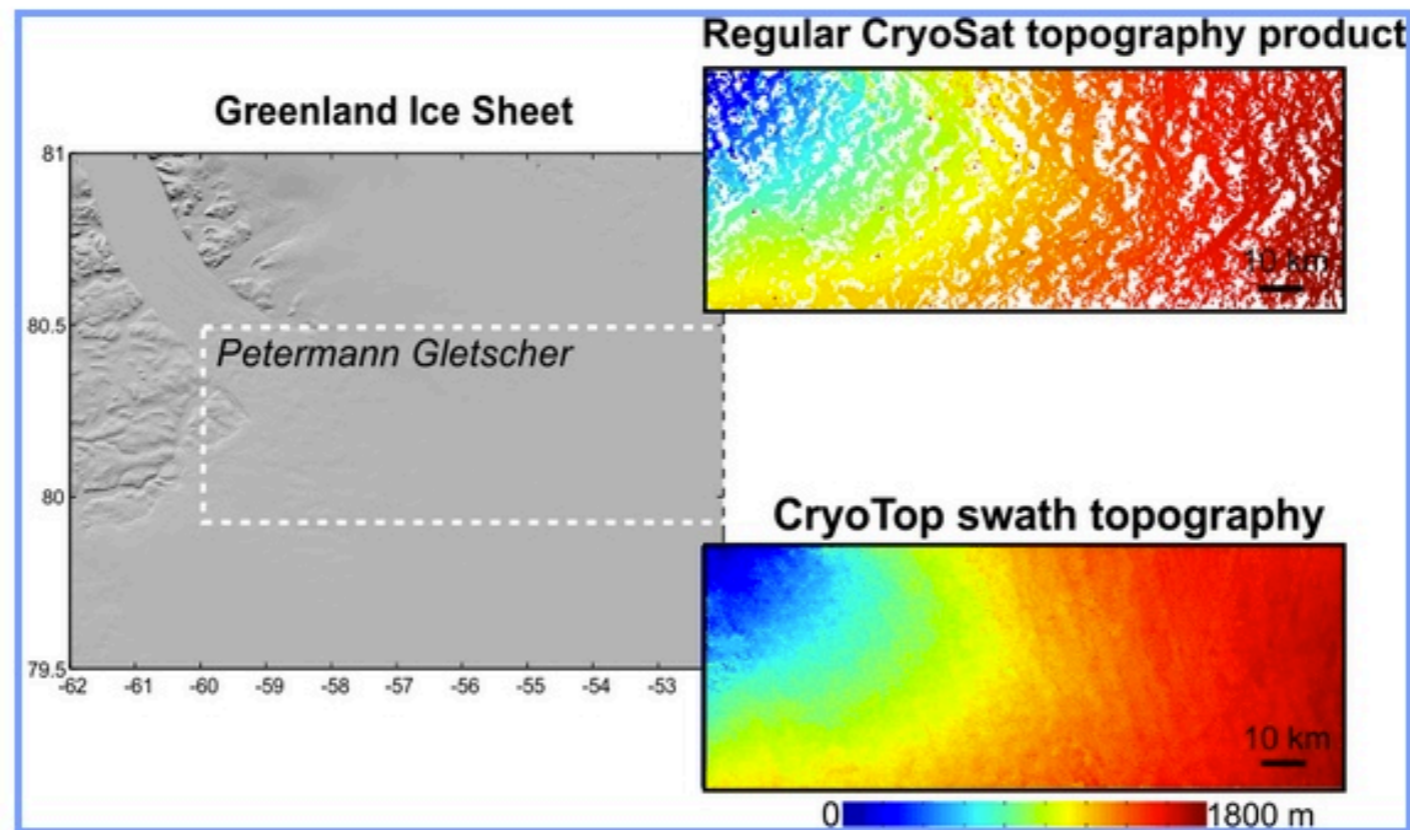
CryoTop - CryoSat standard height product



CryoTop - CryoSat Swath processing



<http://www.stse-cryotop.org/>



Swath processing of 2012/2013 CryoSat data (lower right) increases by a hundredfold the resolution of ice topography compared to standard CryoSat height products

Contact details

Noel Gourmelen, The University of Edinburgh, School of GeoSciences, Drummond Street, EH8 9XP, Edinburgh.
Email: noel.gourmelen@ed.ac.uk

