Surface and basal crevassing of the Larsen C Ice Shelf: Implications for ice shelf stability

Daniel McGrath[1], Konrad Steffen[1], Ted Scambos[2], Eric Rignot[3,4], Jose Luis Rodriguez[5], Waleed Abdalati[1,6]

[1] CIRES, University of Colorado at Boulder, Boulder, Colorado
[2] NSIDC, University of Colorado at Boulder, Boulder, Colorado
[3] University of California, Earth System Science, Irvine, California
[4] Jet Propulsion Laboratory, Pasadena, California
[5] CECS, Valdivia, Chile
[6] NASA Headquarters

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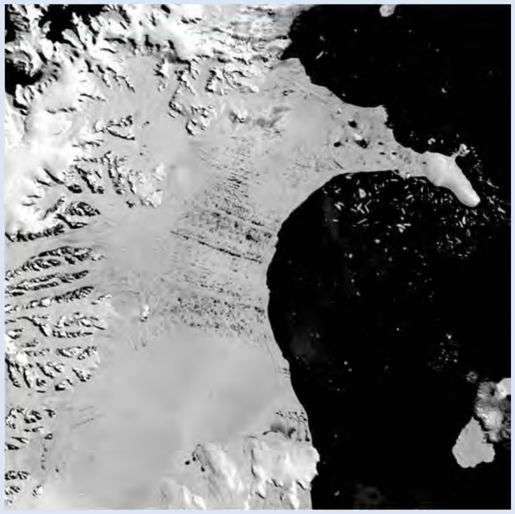
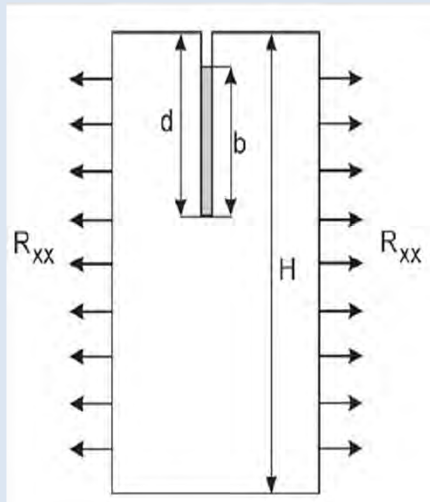
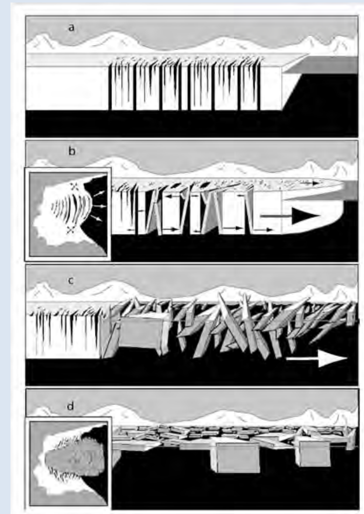
What have recent collapses told us about ice shelf processes? “climate induced mechanical instability”



Larsen B; pre-collapse



Van der Veen, 2007



MacAyeal and others, 2003

Larsen B; post-collapse

Pre-conditioning of the ice shelf:

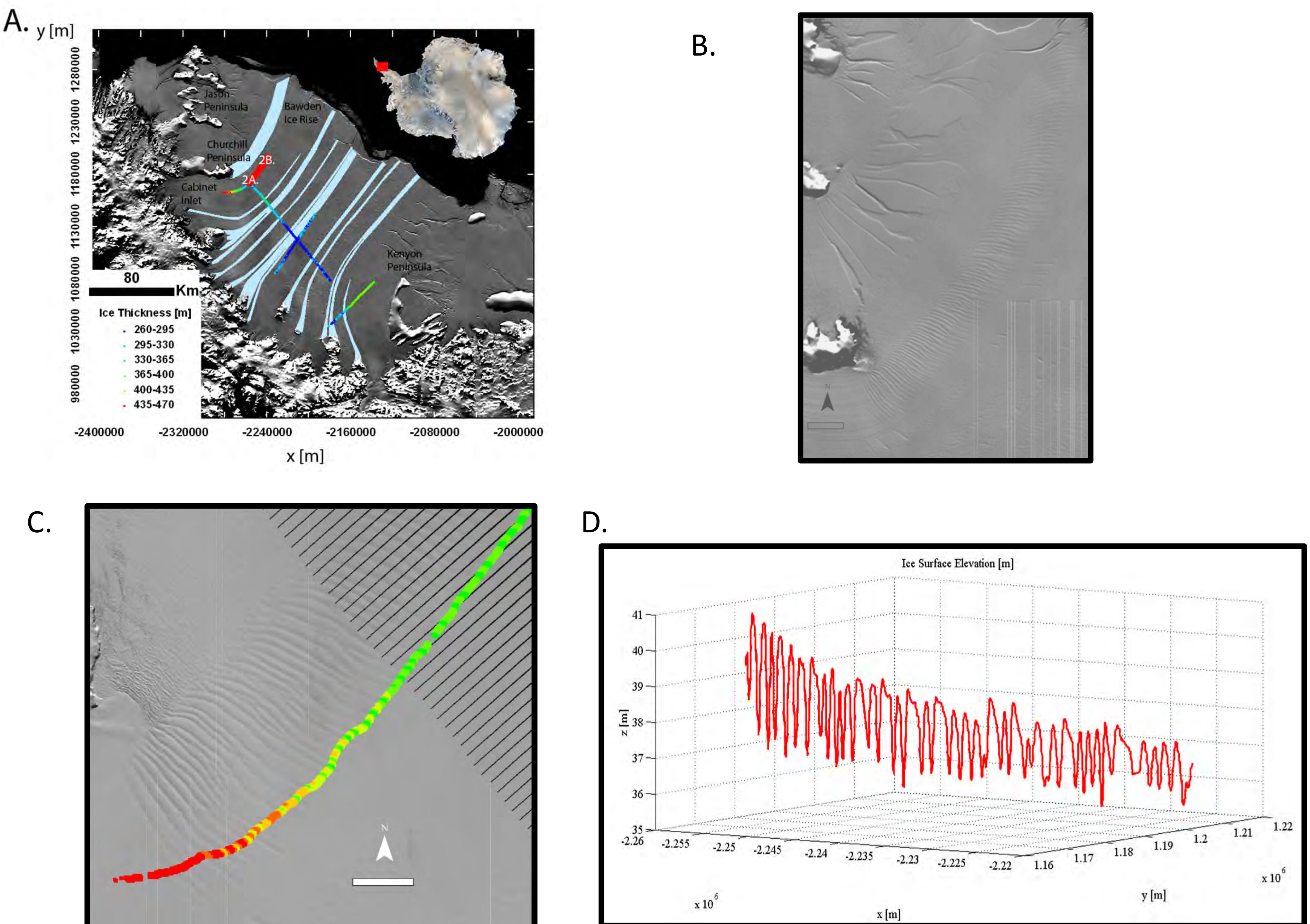
a) Thinning (firn densification, basal melt)

b) Ability to support surface melt ponds

c) Reduced backstress from shear margins

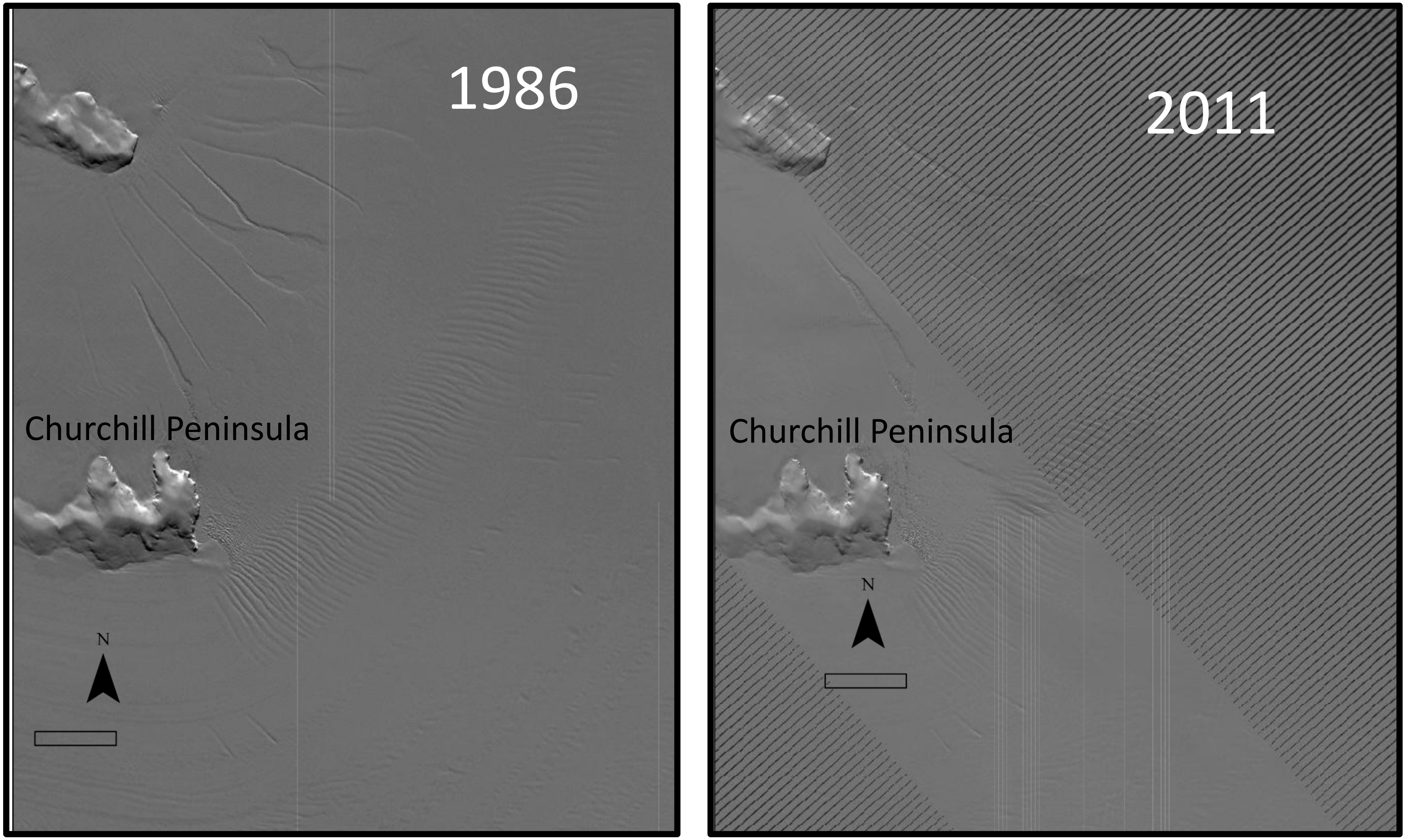
d) Surface and/or basal crevassing and rifting

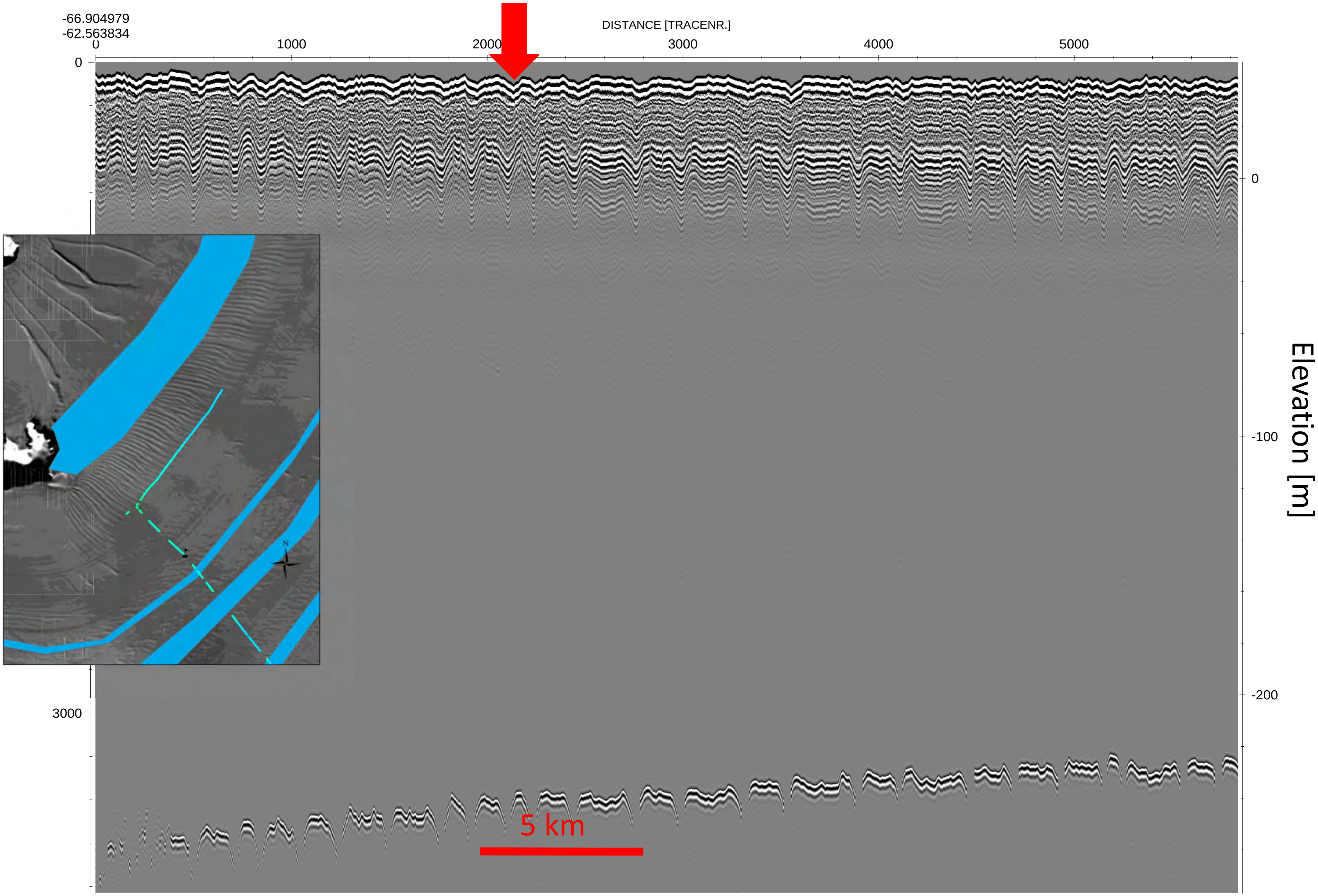
e) Reduced marine ice accretion/weakened suture zones



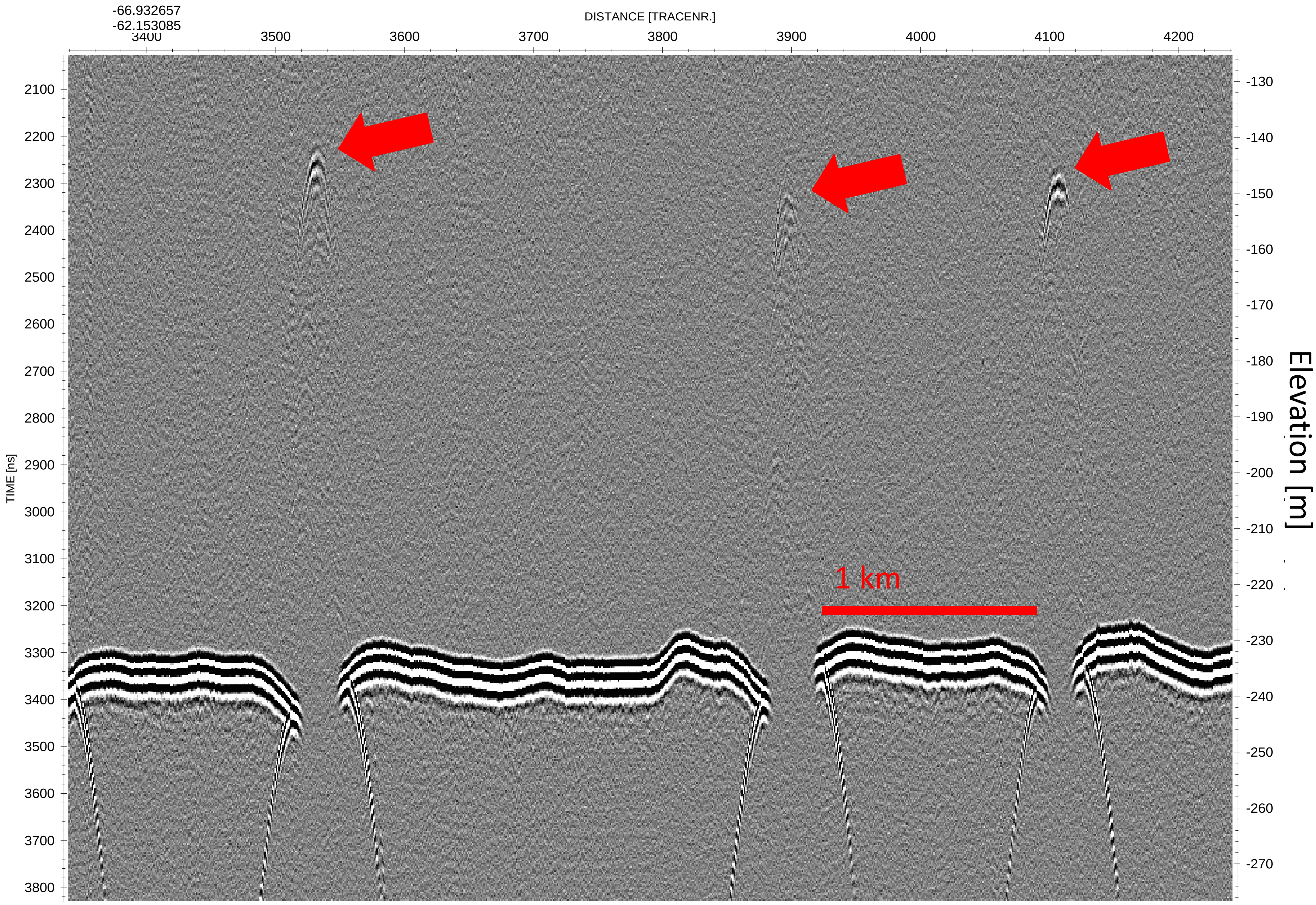
NASA IceBridge ATM surface elevation (2009)

Stable surface features of Larsen C

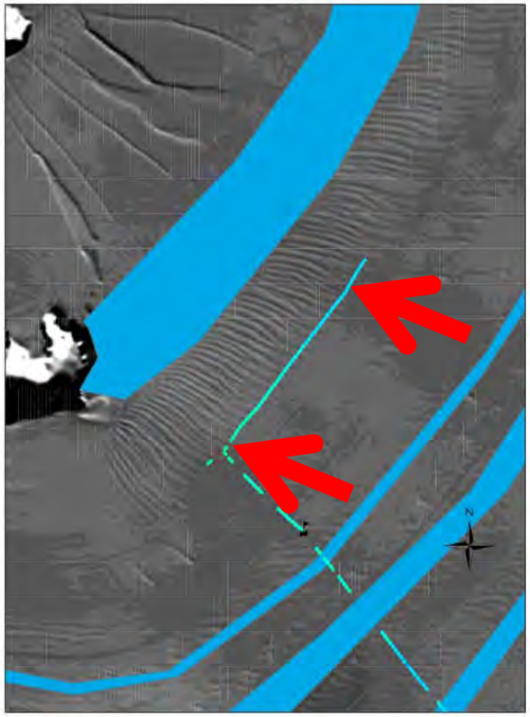


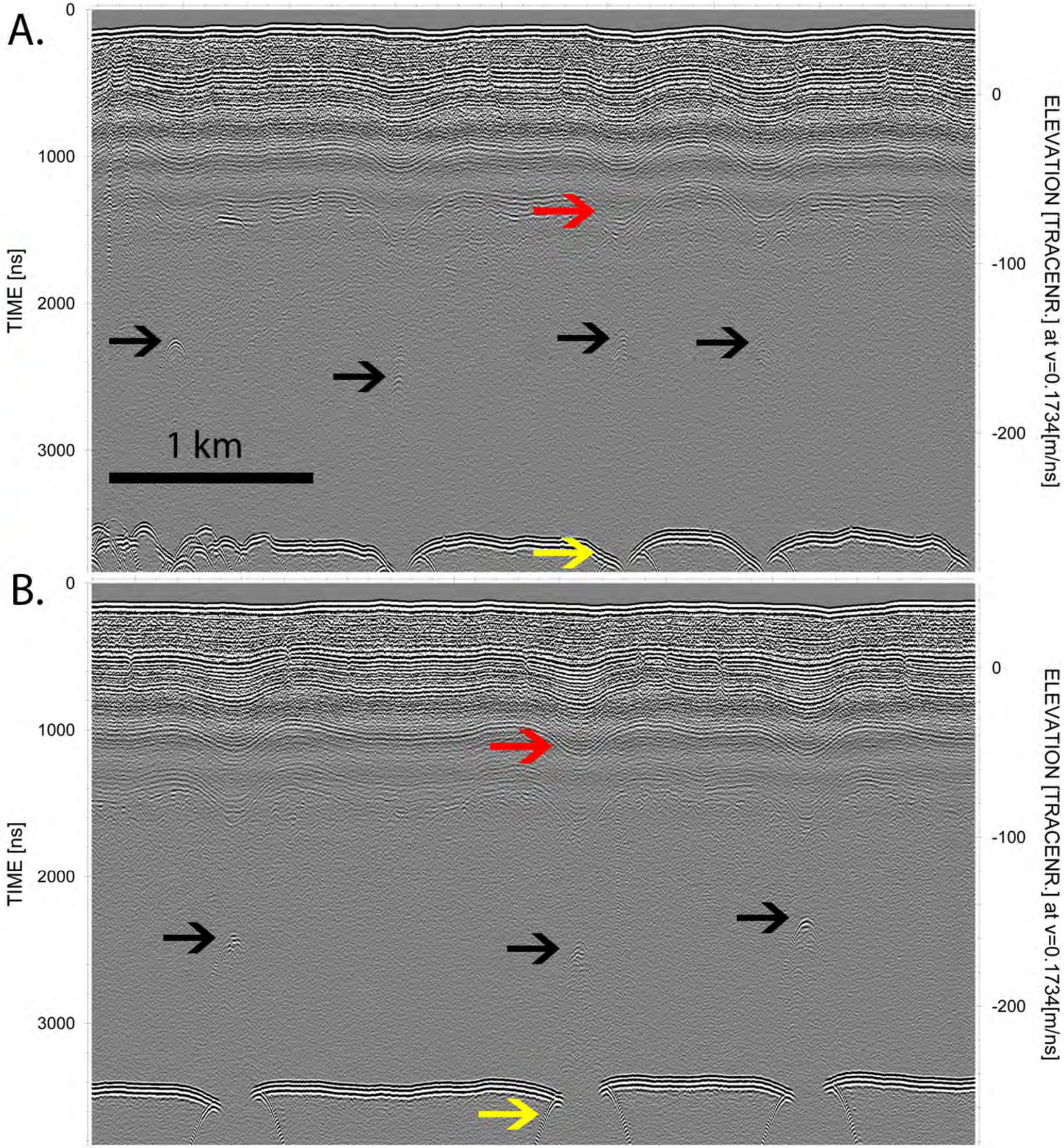


-66.904979
-62.563834
DISTANCE [TRACENR.]
0
1000
2000
3000
4000
5000
0
3000
0
-100
-200
Elevation [m]
5 km
N



-66.932657
-62.153085
DISTANCE [TRACENR.]
3400
3500
3600
3700
3800
3900
4000
4100
4200
TIME [ns]
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
3600
3700
3800
Elevation [m]
-130
-140
-150
-160
-170
-180
-190
-200
-210
-220
-230
-240
-250
-260
-270
1 km

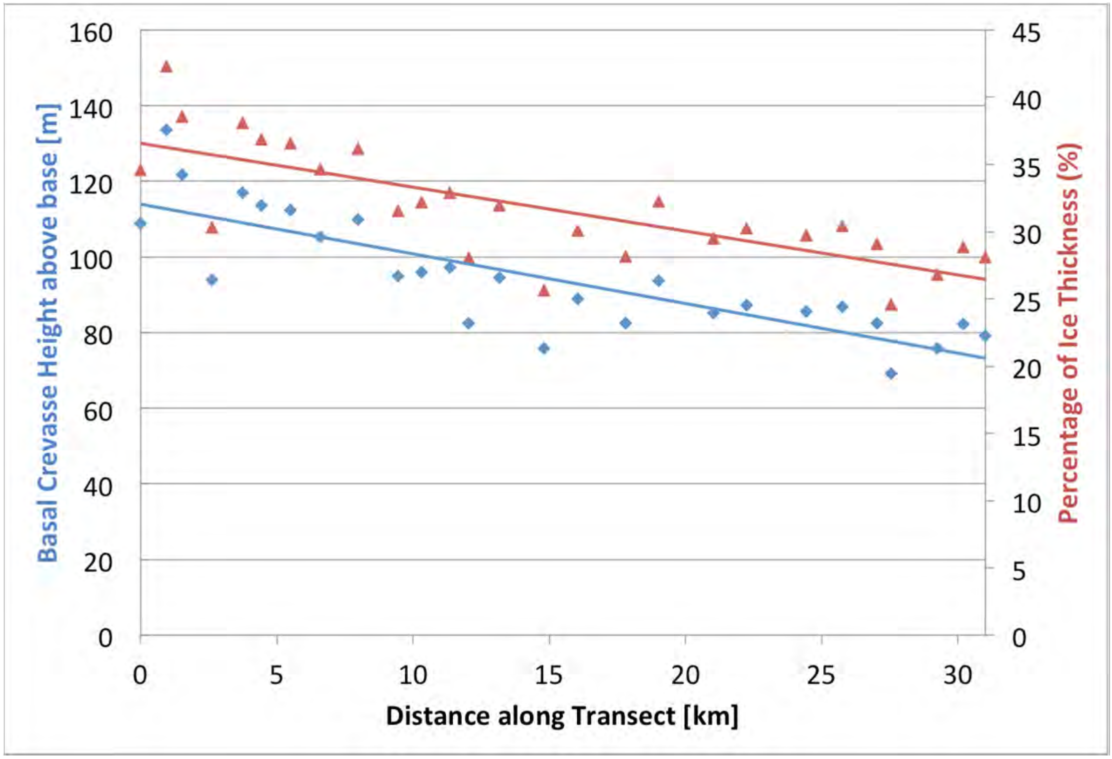


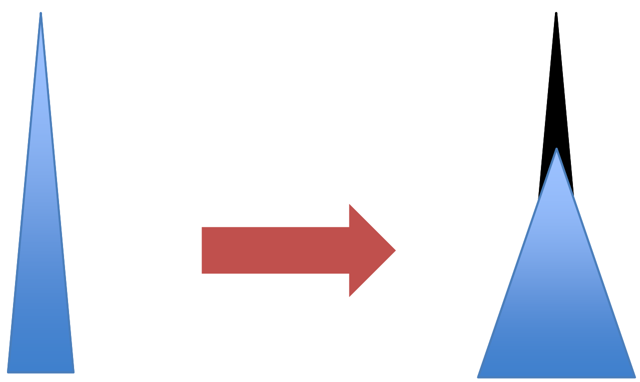


Spacing: 0.54 to 2.04 km, mean of 1.2 km

Height: 69 to 130 m, 24 to 43% of ice thickness

Width: ~120 m at end of transect





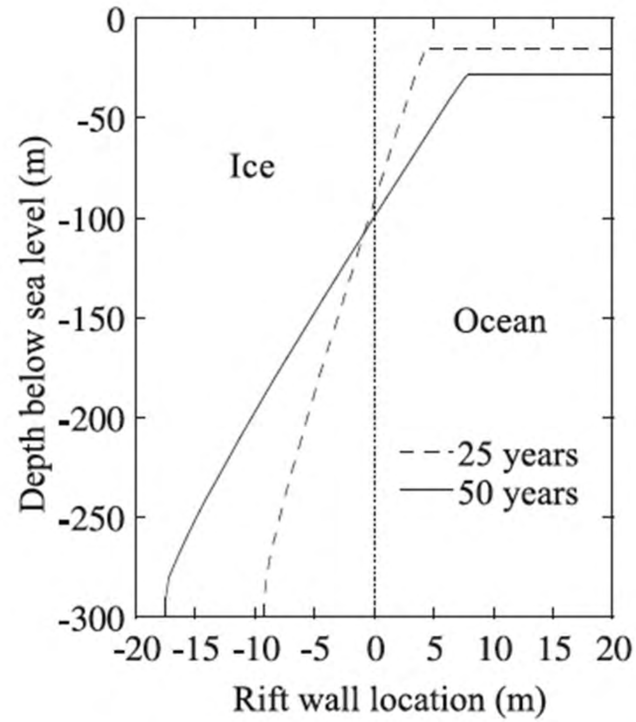
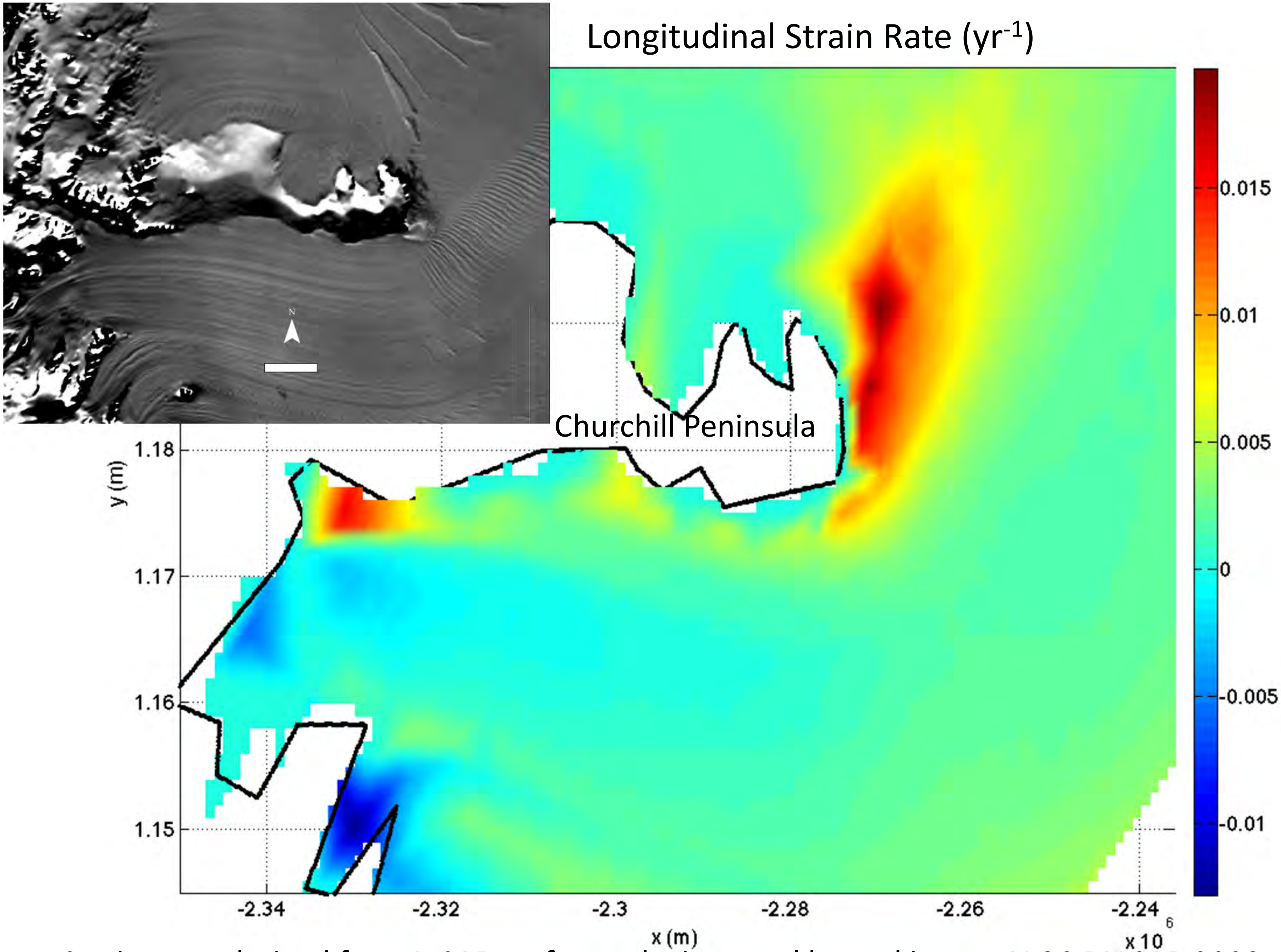


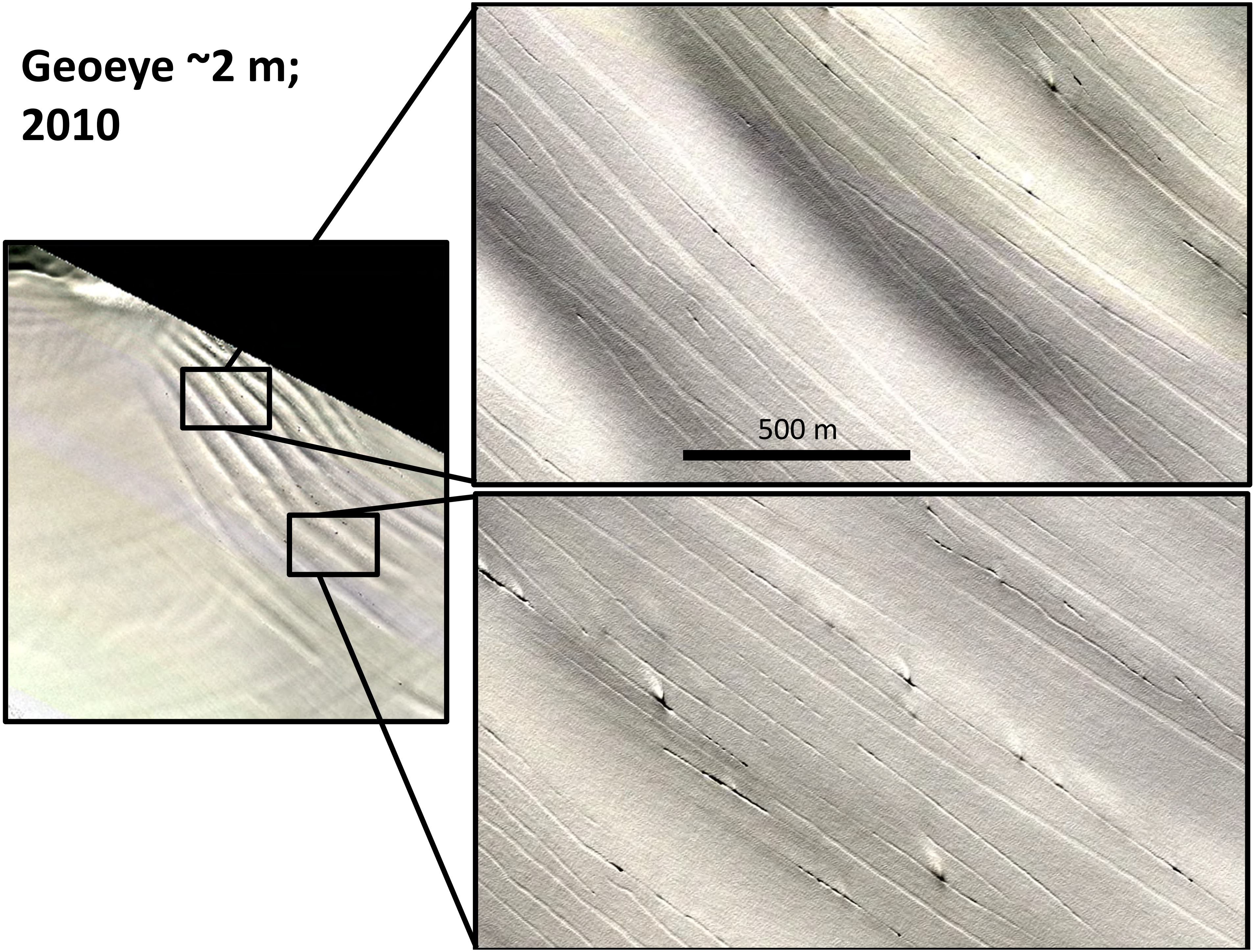
Figure 5. The profile of the rift's wall after a 25-year integration and at the end of a 50-year standard experiment compared with the initial wall location (which is represented by the vertical dotted line at the middle of the horizontal axis). The horizontal extensions of the two curves at the top indicate the interface between the accumulated ice and the water at the corresponding times. Notice that the horizontal distance scale is exaggerated relative to the vertical one.

Khazendar and Jenkins, 2003

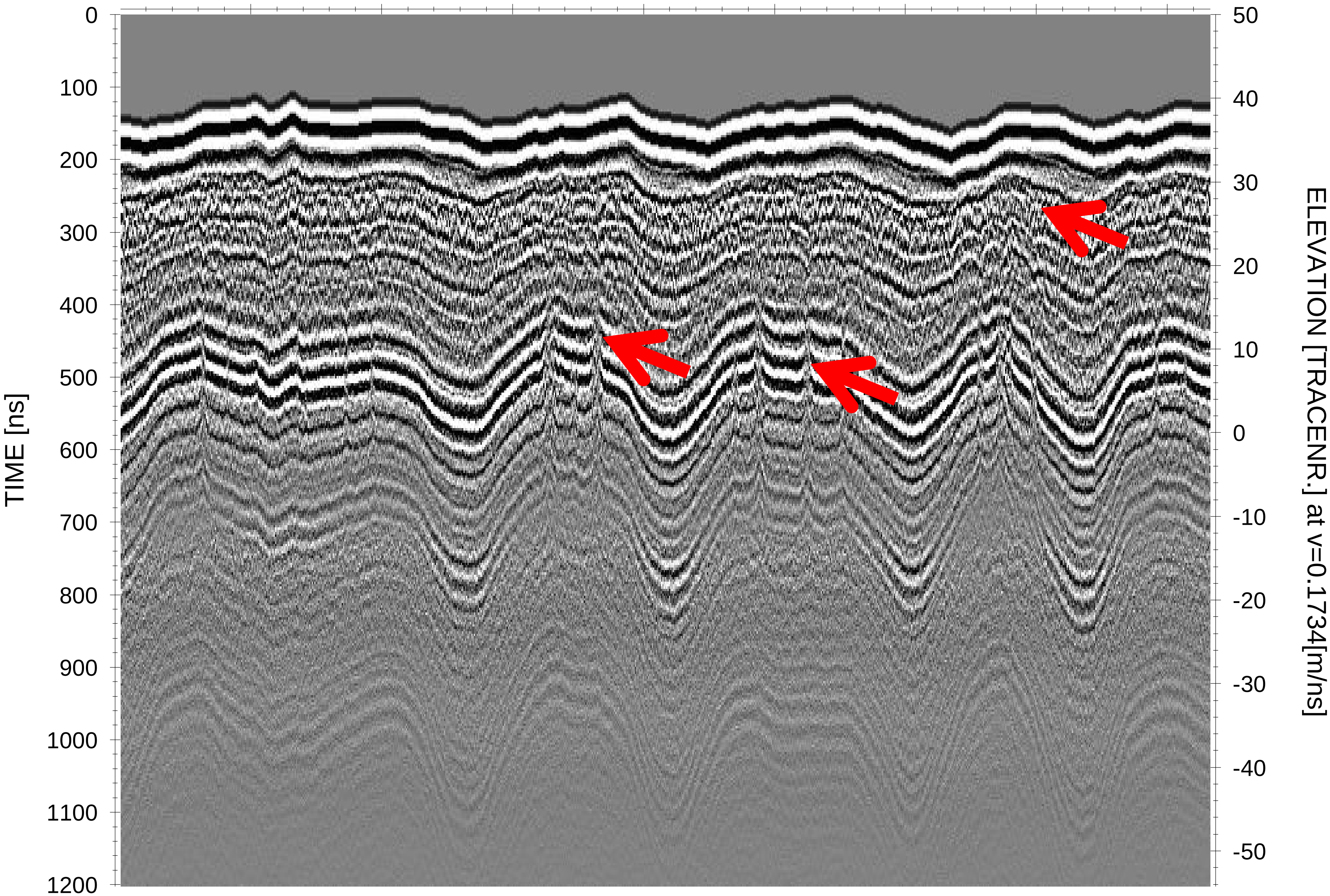


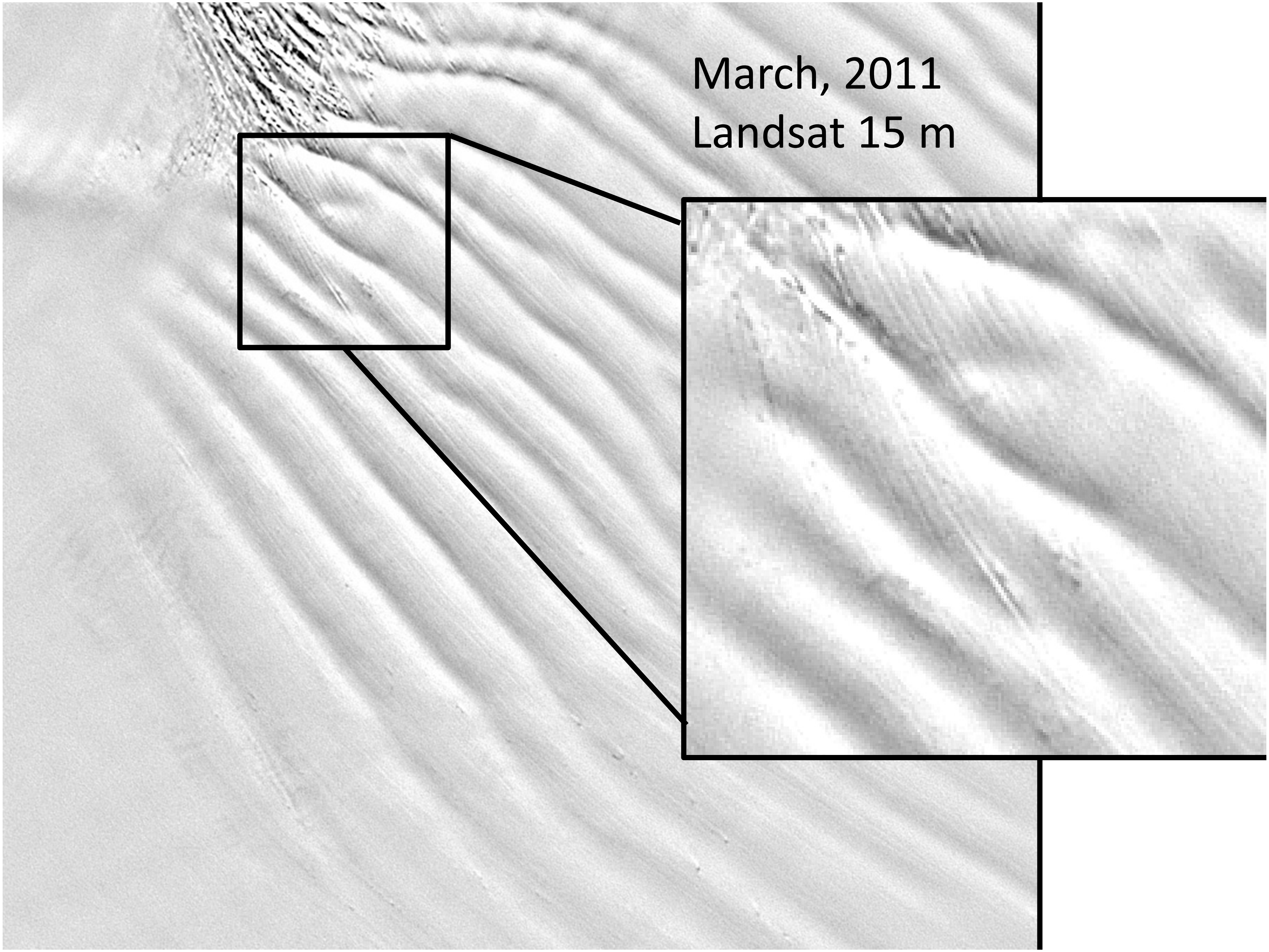
Strain rates derived from InSAR surface velocity, speckle tracking on ALOS PALSAR 2008 data. E. Rignot, 2011

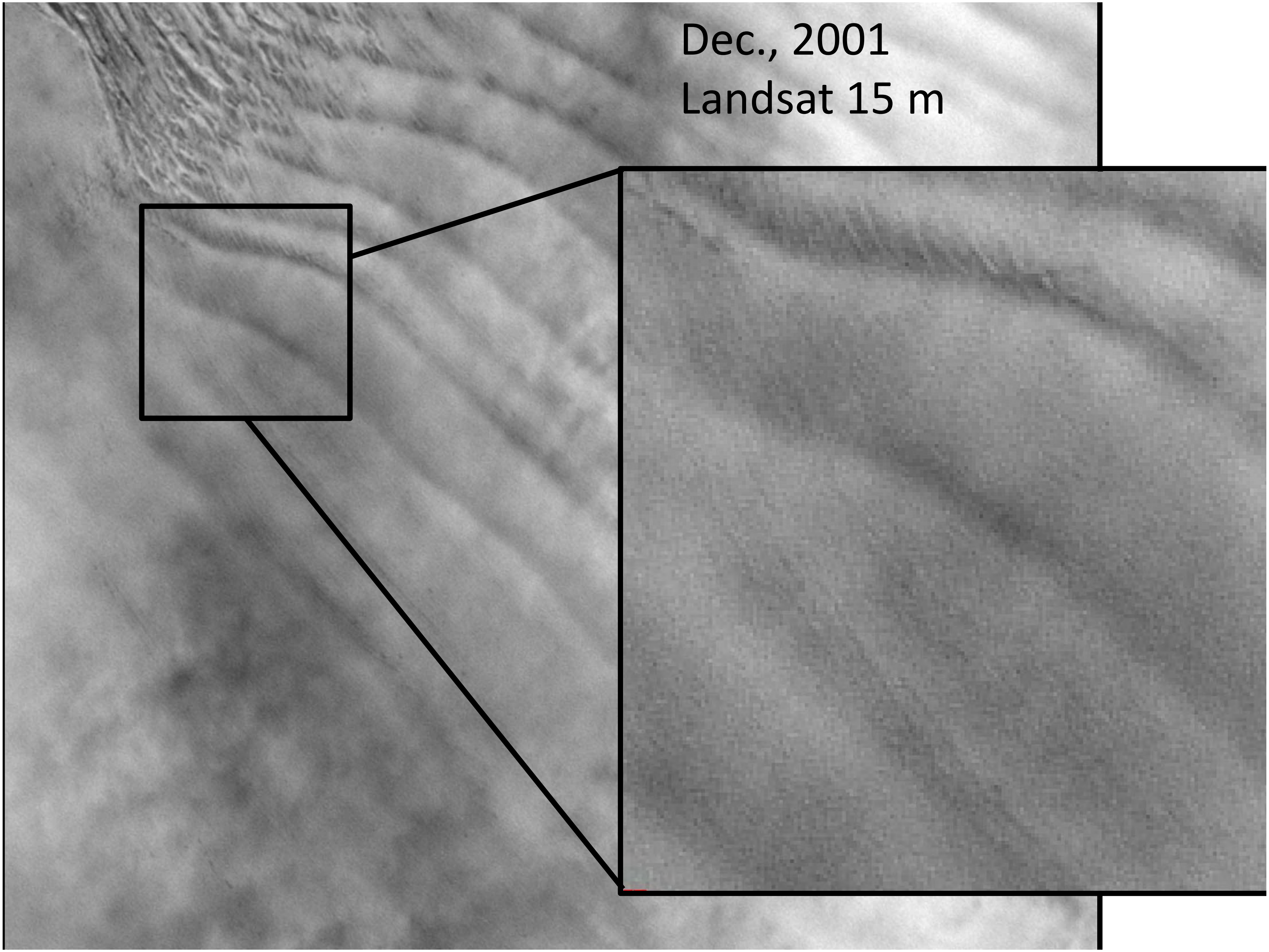

Why basal crevasses but no surface crevasses?


Geoeye ~2 m;
2010
500 m

Surface crevassing at crests of surface undulations



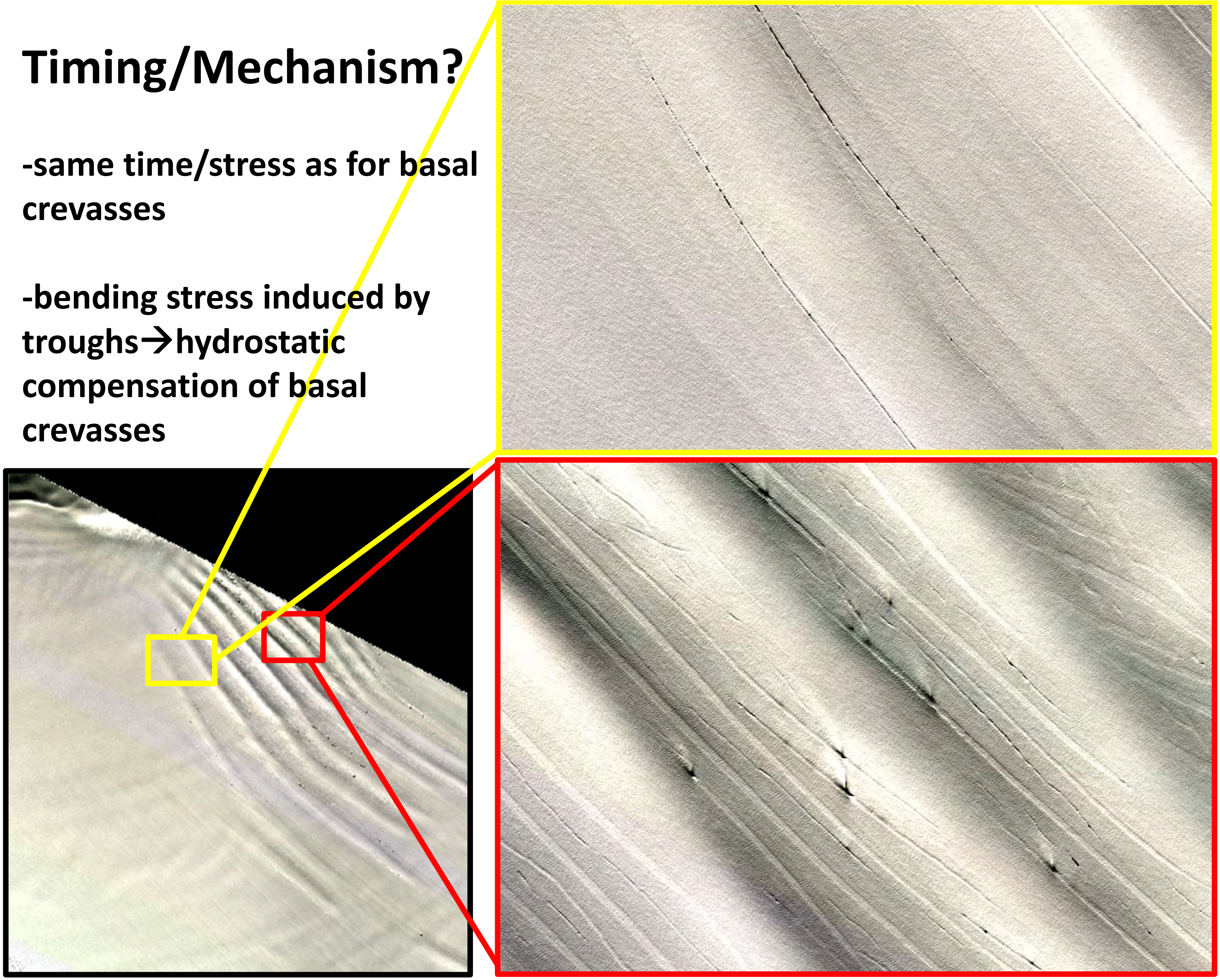

March, 2011
Landsat 15 m


Dec., 2001
Landsat 15 m

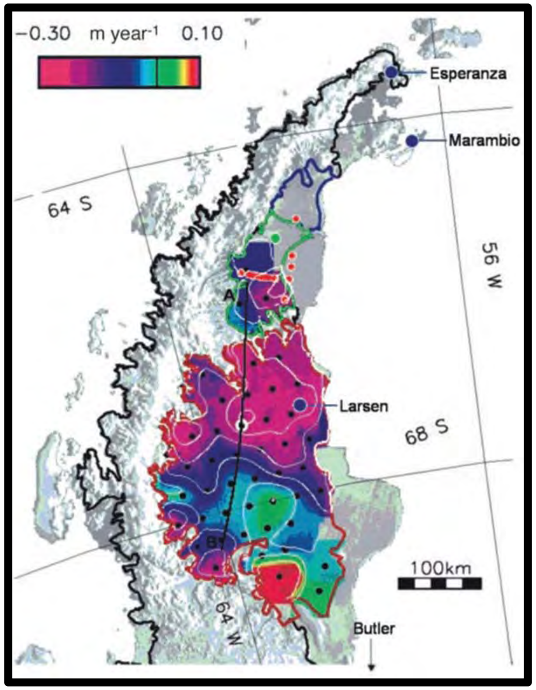
Timing/Mechanism?

-same time/stress as for basal crevasses

-bending stress induced by troughs→hydrostatic compensation of basal crevasses

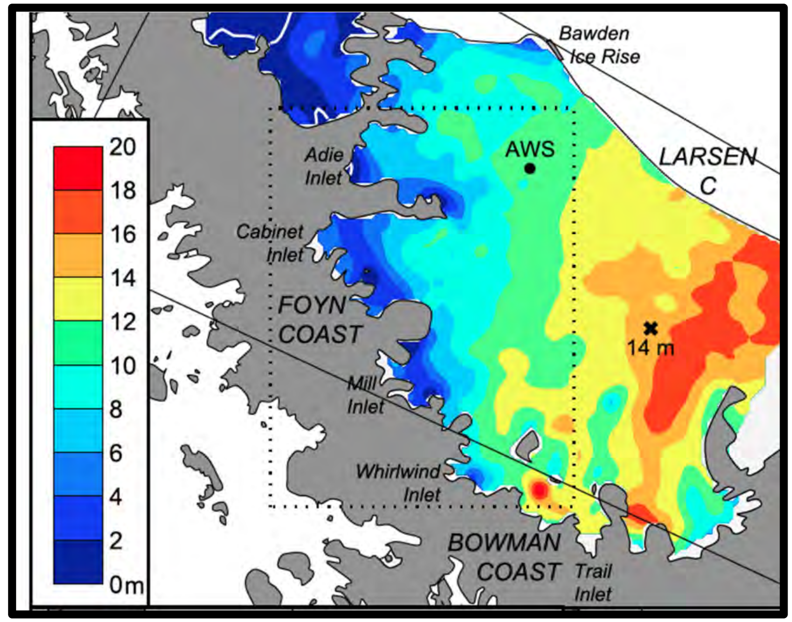


A.



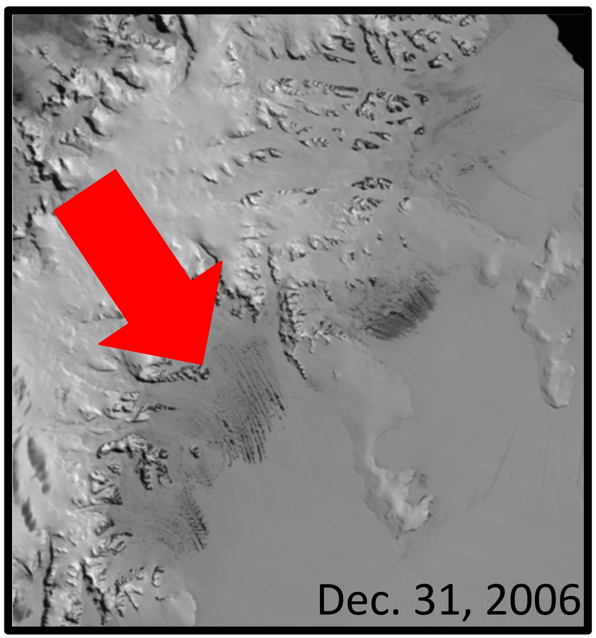
Shepherd and others, 2003

B.

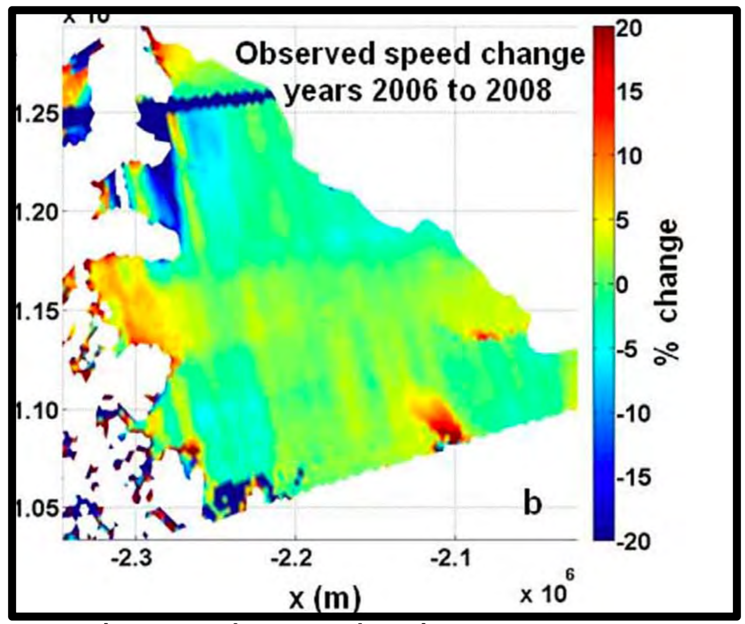


Holland and others, 2011

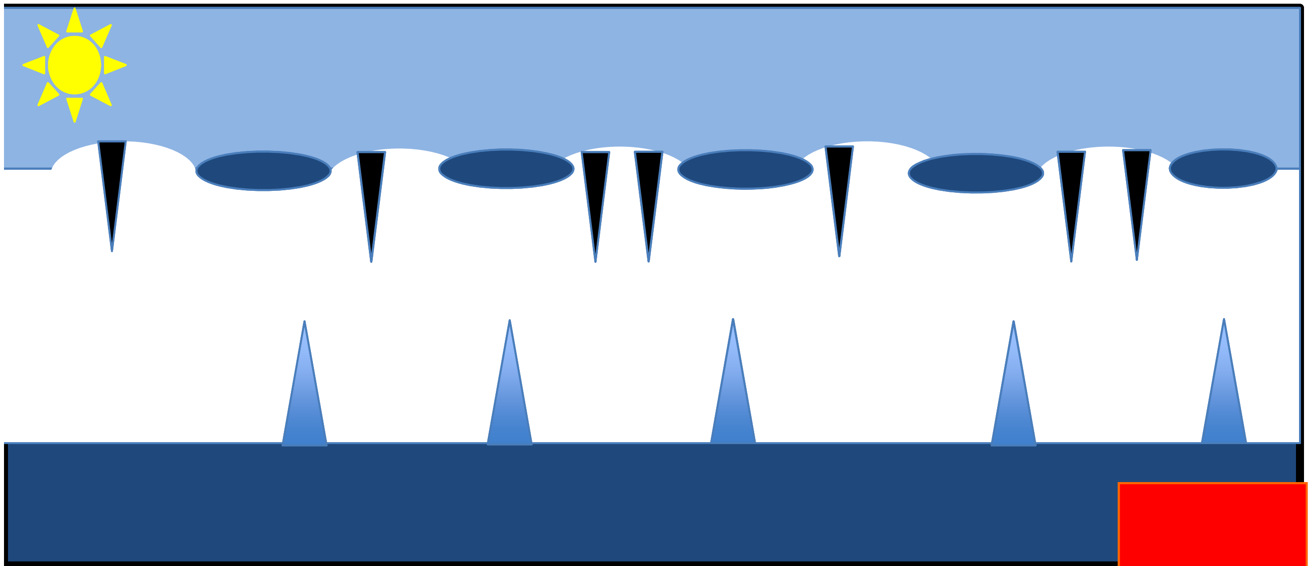
C.

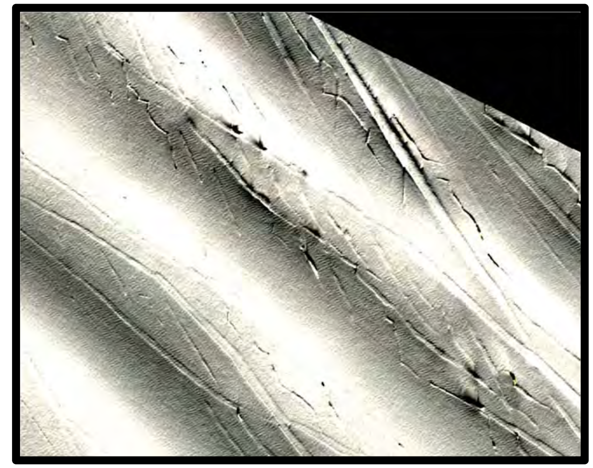


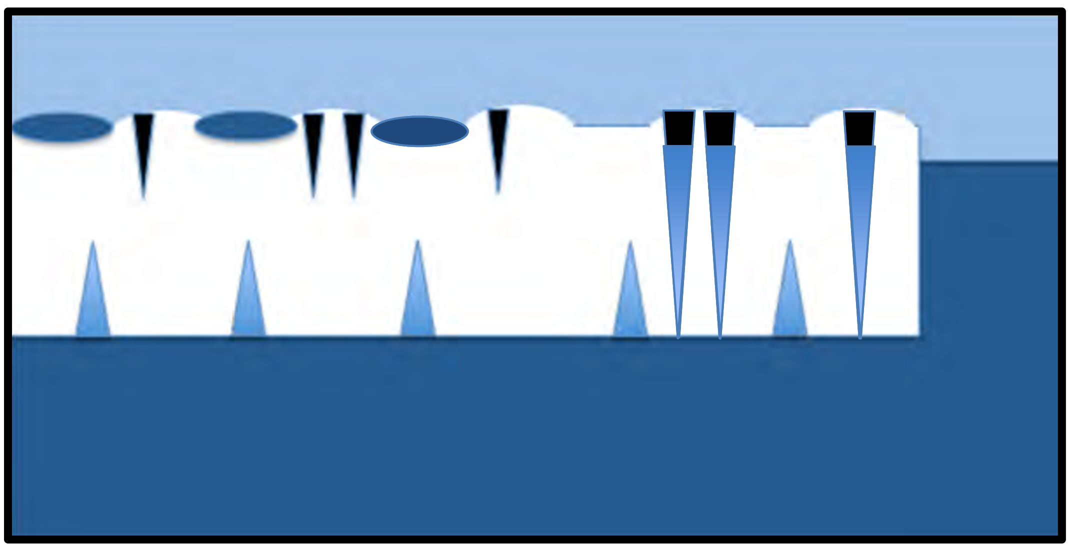
D.

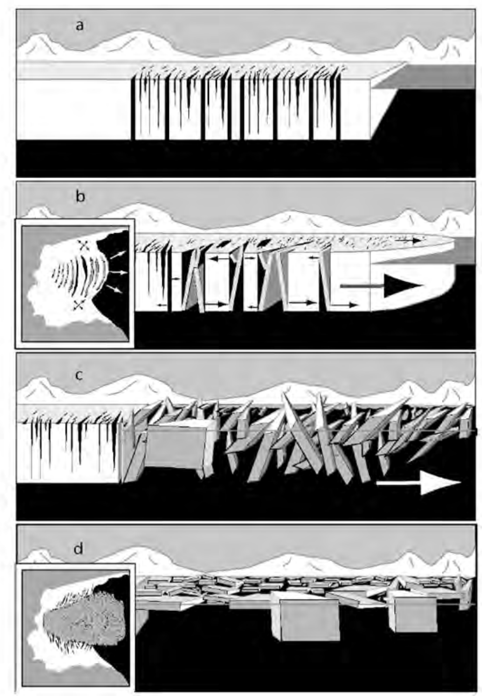


Khazendar and others, 2011









MacAyeal and others, 2003

Crevassing of the Larsen C ice shelf: Implications for ice shelf stability

Thanks to British Antarctic Survey for excellent field support; P. Morin and PGC for high resolution imagery; L. Padman for providing CATS2008a tide model; P. Holland for providing marine ice bands; W. Krabill and IceBridge/NSIDC for ATM data

Questions? Comments.

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