

Ice-shelf channels in observations and models

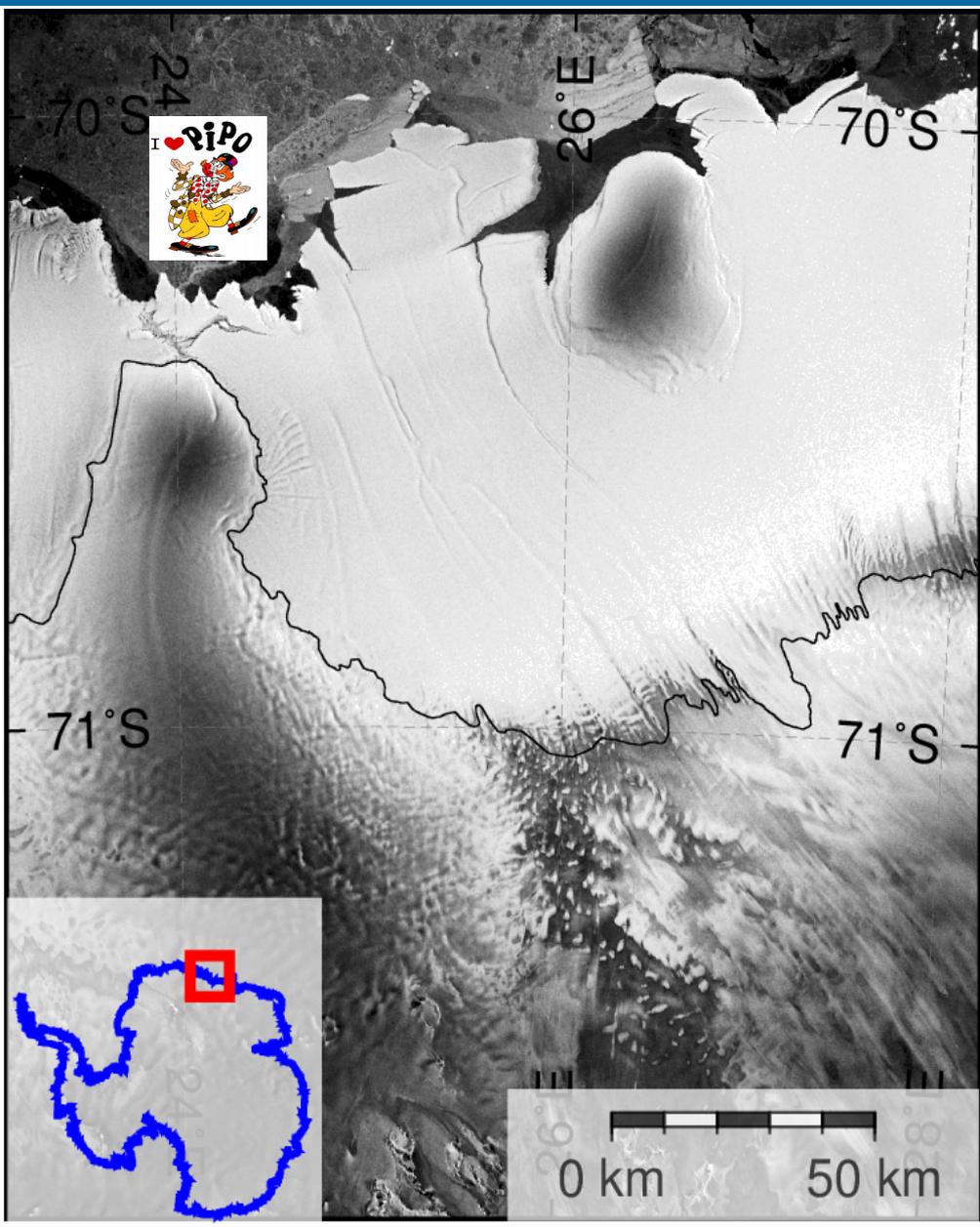
R. Drews, S. Berger, L. Favier, B. van Liefferinge,
V. Helm, K. Matsuoka, F. Pattyn

ULB

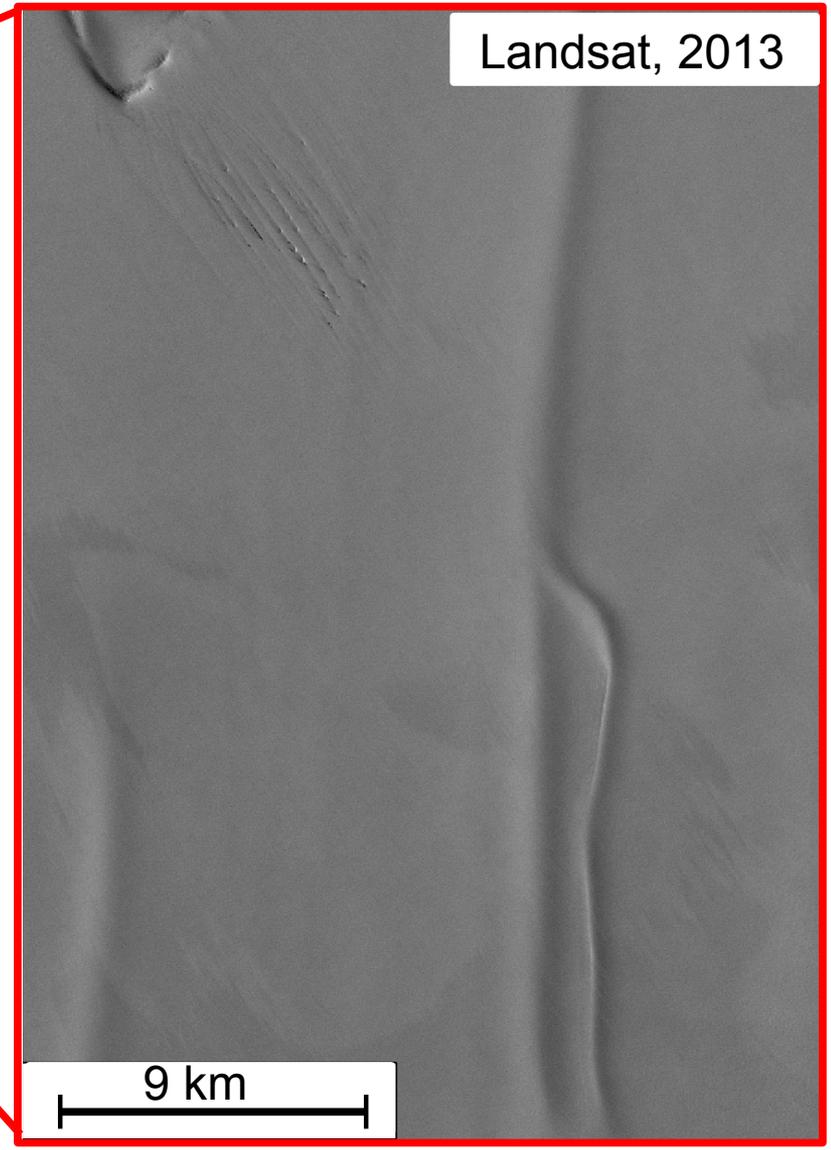
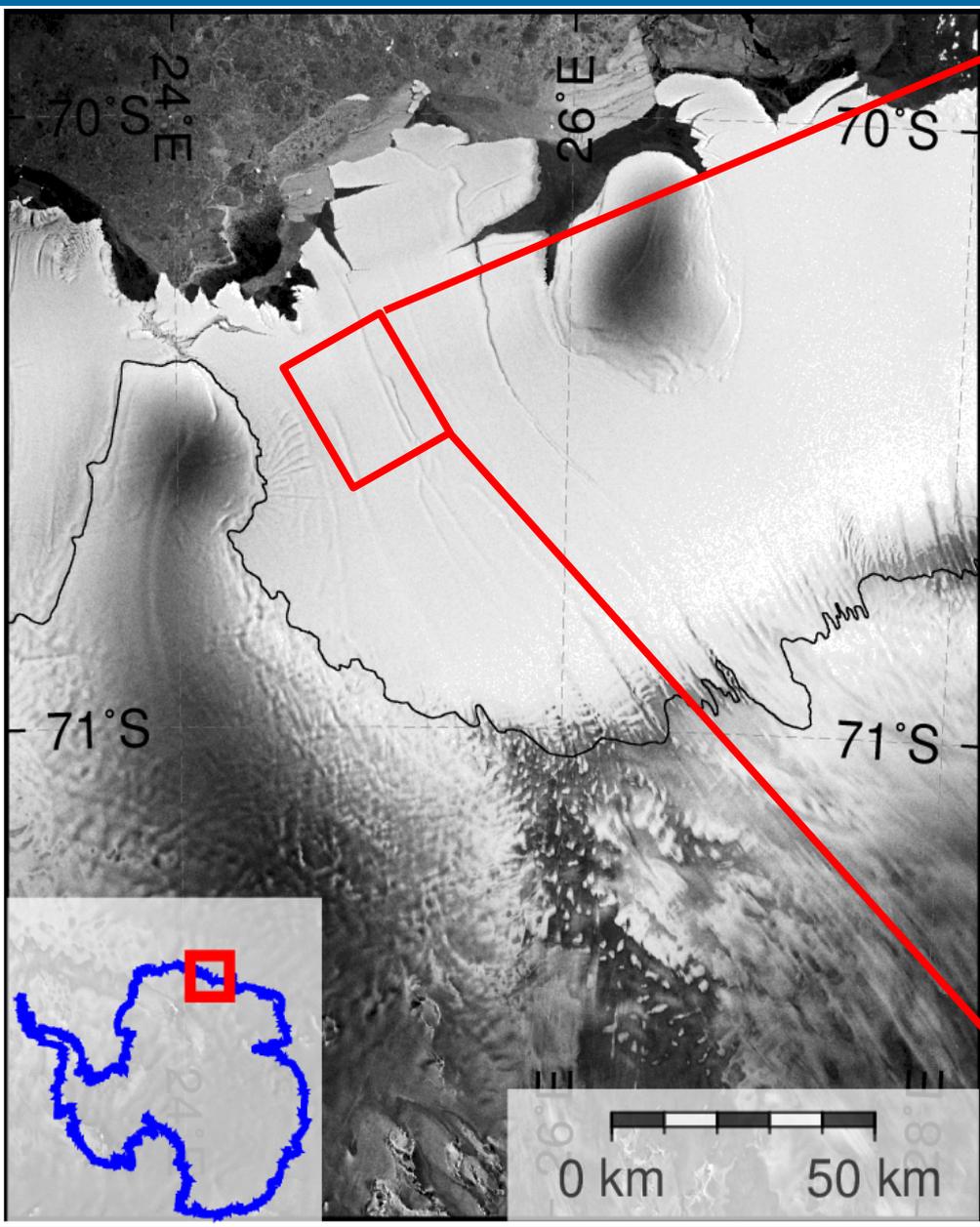
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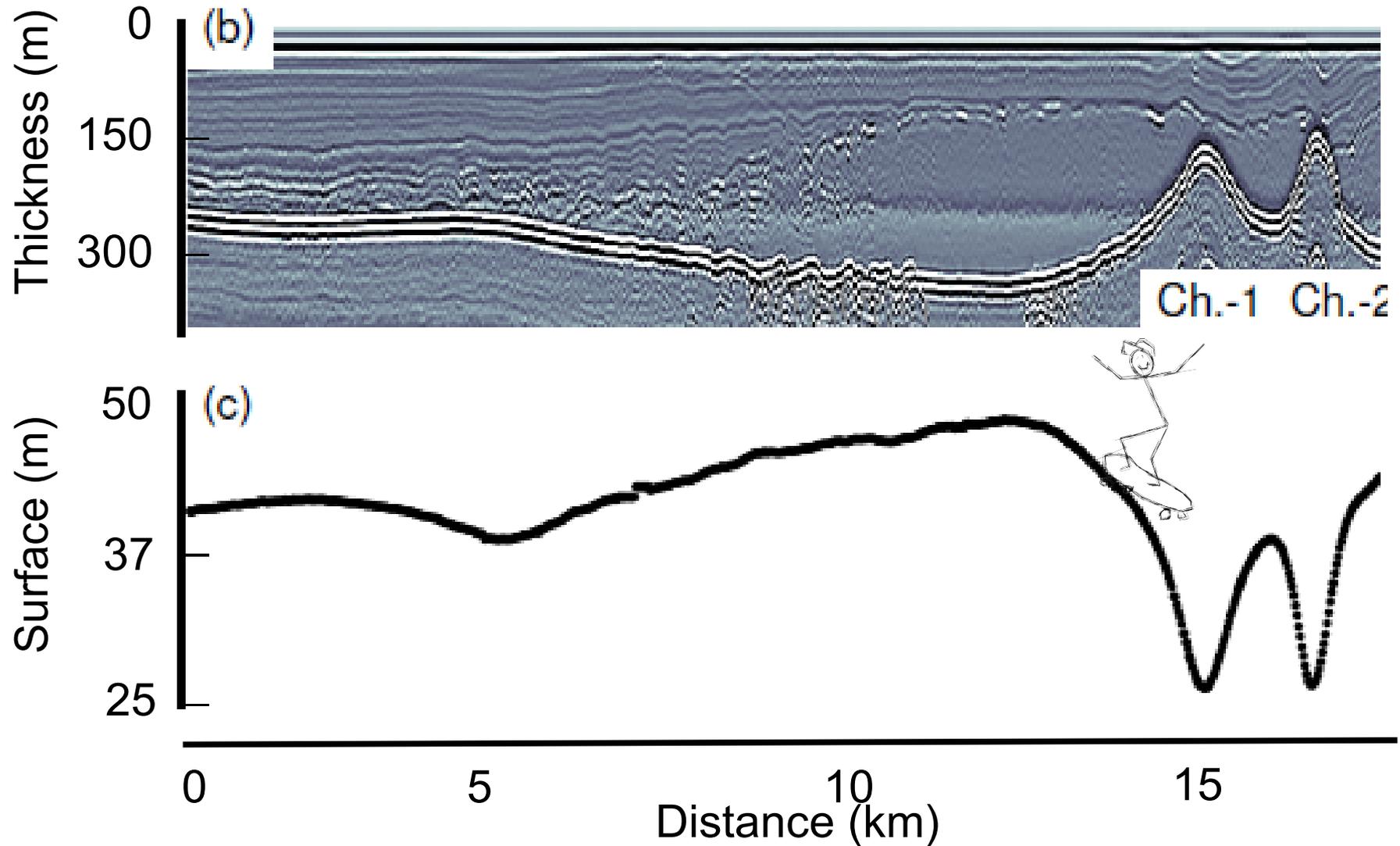




Roi Baudouin Ice Shelf: Channels



How channels look like



About ice-shelf channels

Where do channels come from ?

- subglacial, hydrological water outlets
(A. Jenkins et al., J. Phys. Oceanogr. 2011;
A. LeBrocq et al., Nat. Geosc., 2013)
- transverse variations in ice thickness
(O. Sergienko, J. Geophys. Res., 2013)

What happens inside channels ?

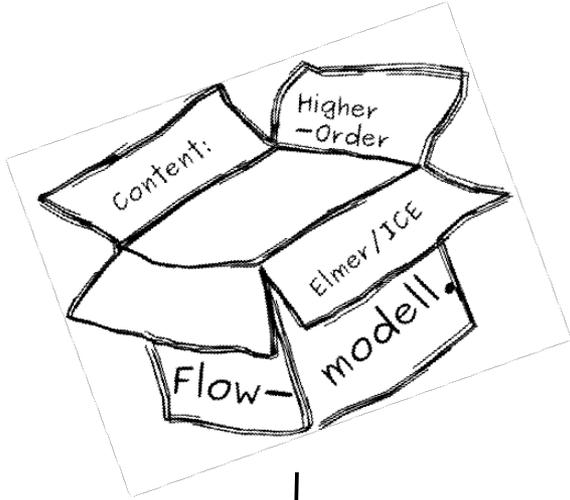
- channelized melting
(T. Stanton, Science, 2013; !O. Marsh at previous talk!)

Why would channels be important ?

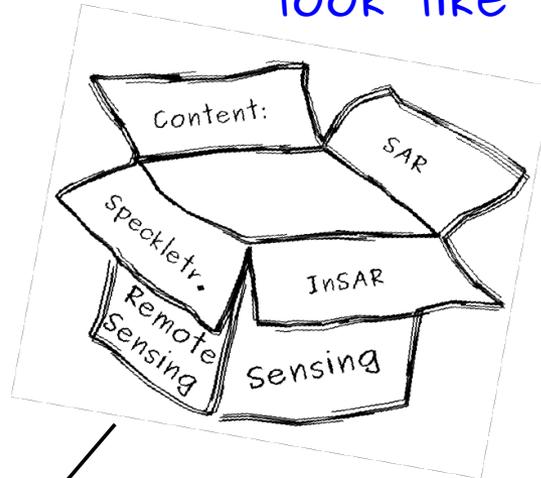
- destabilize ice shelves
(E. Rignot & K. Steffen, Geophys. Res. Lett., 2008;
D. Vaughan et al., J. Geophys. Res., 2012)
- stabilize ice shelves
(C. Gladish et al., J. Glaciol., 2012;
T. Milligate et al., J. Geophys. Res., 2013)

Channels in observations and models

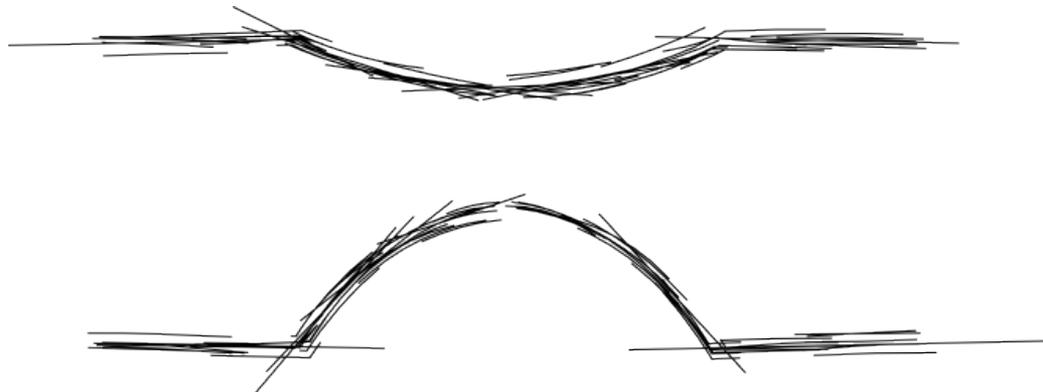
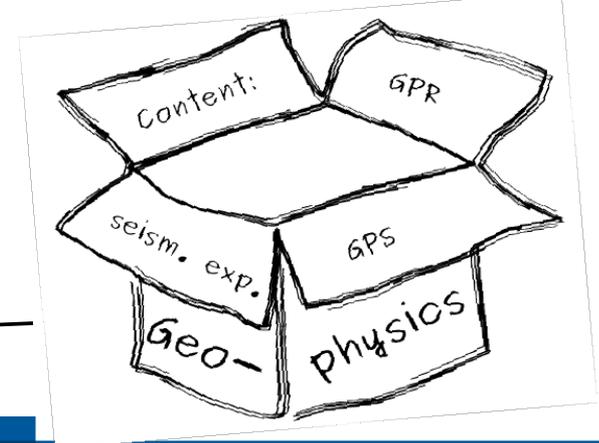
How do channels evolve in full Stokes models?



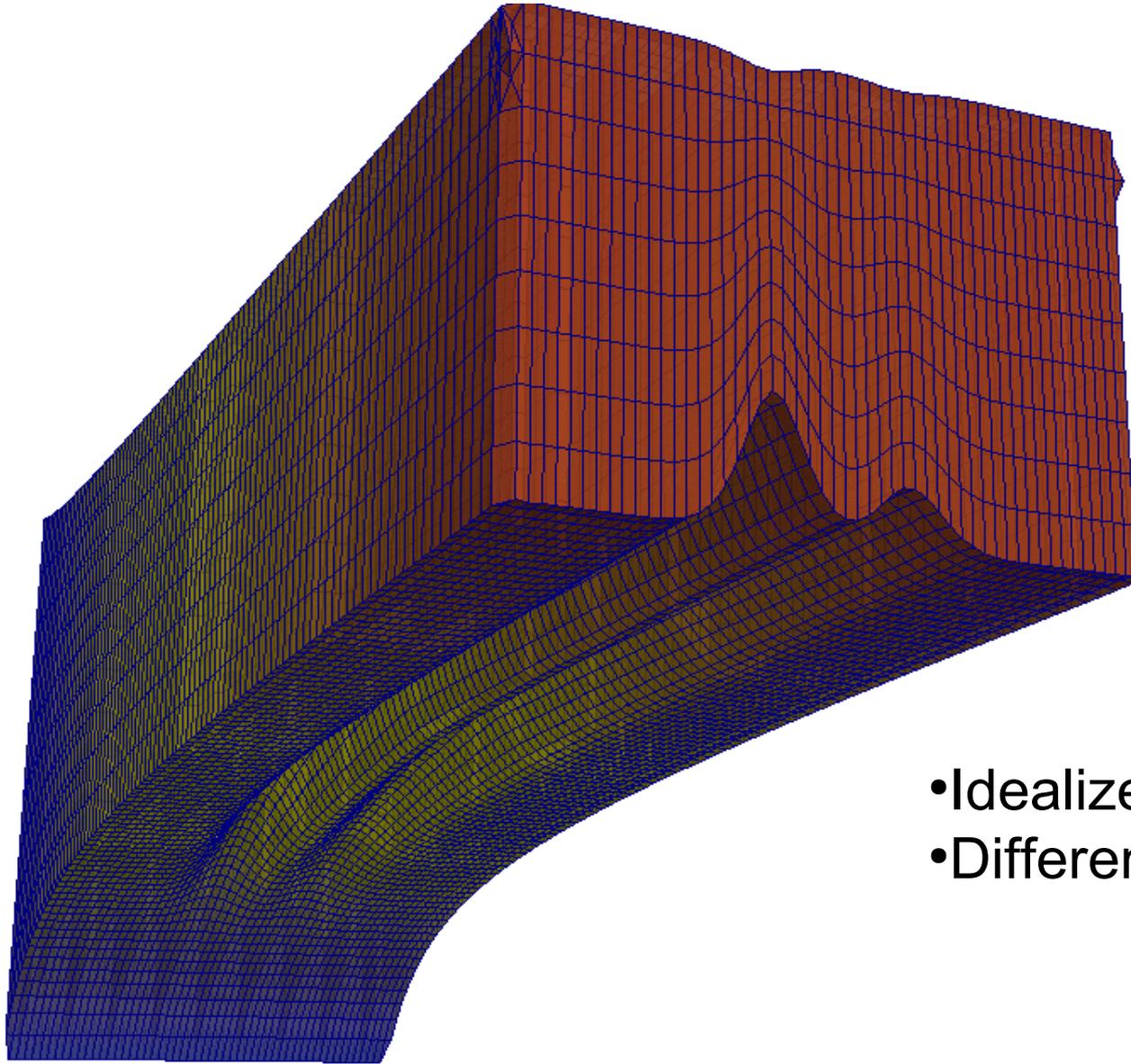
How do channels look like from space ?



How do channels look like in the field?



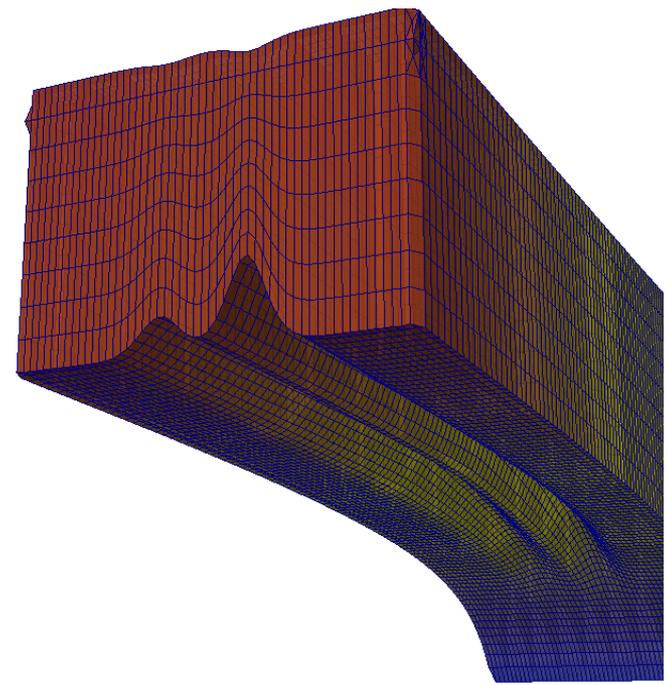
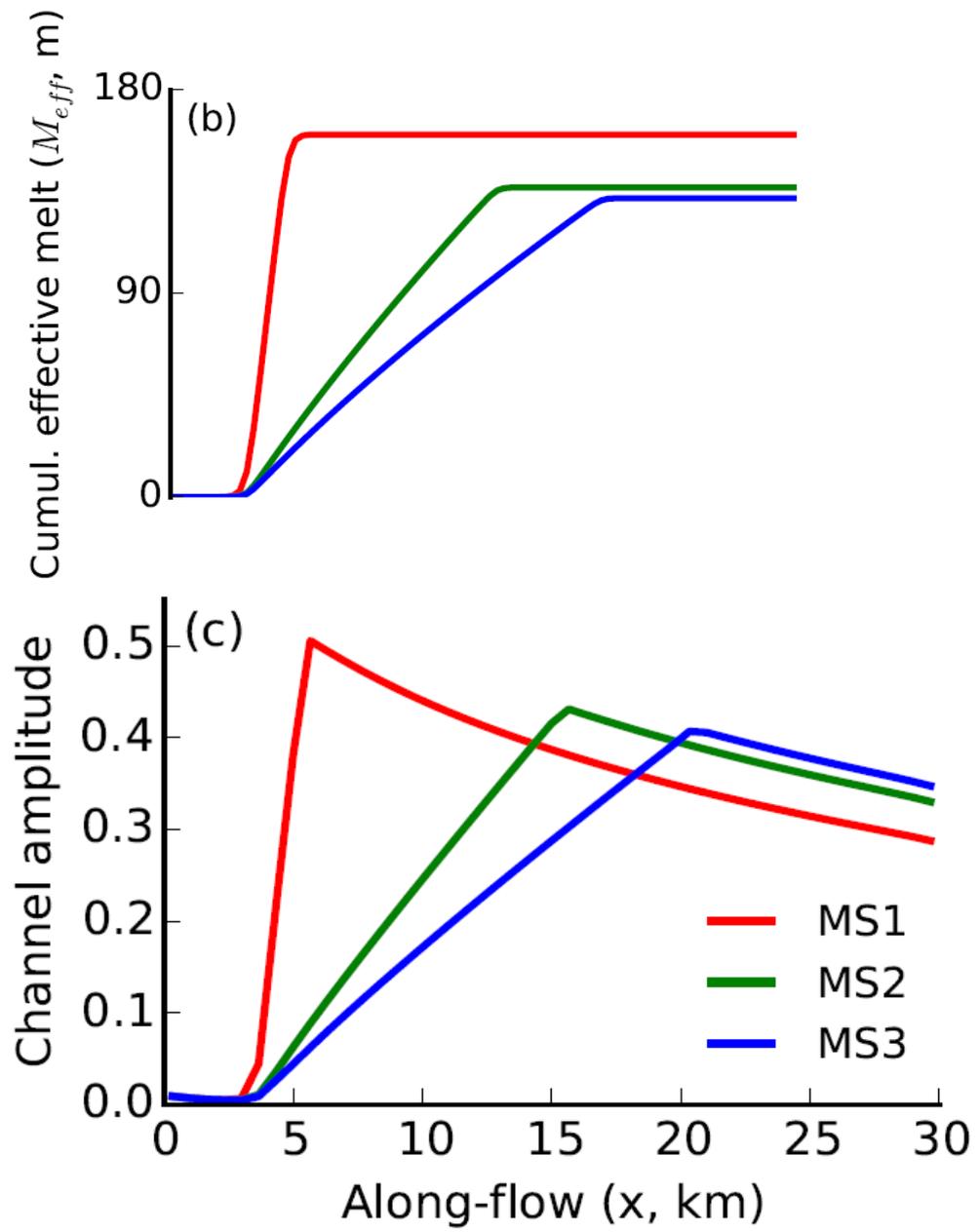
Elmer/Ice: channel evolution



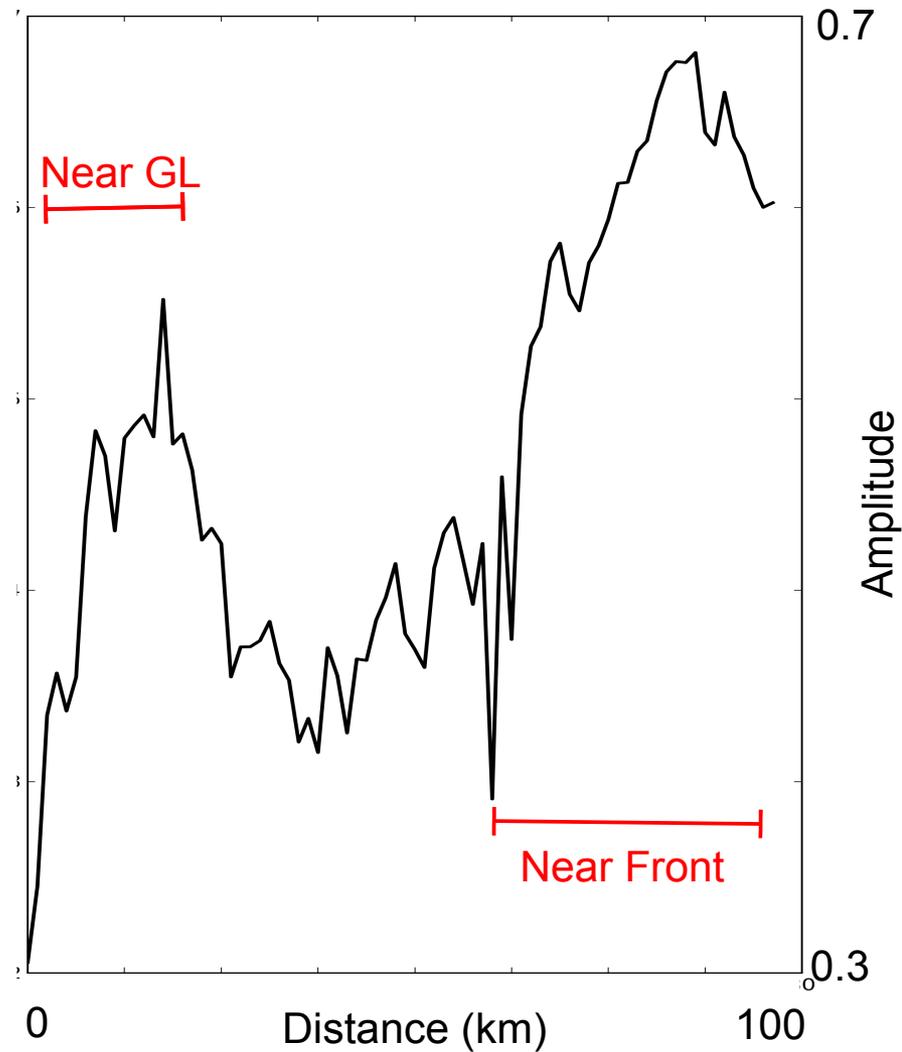
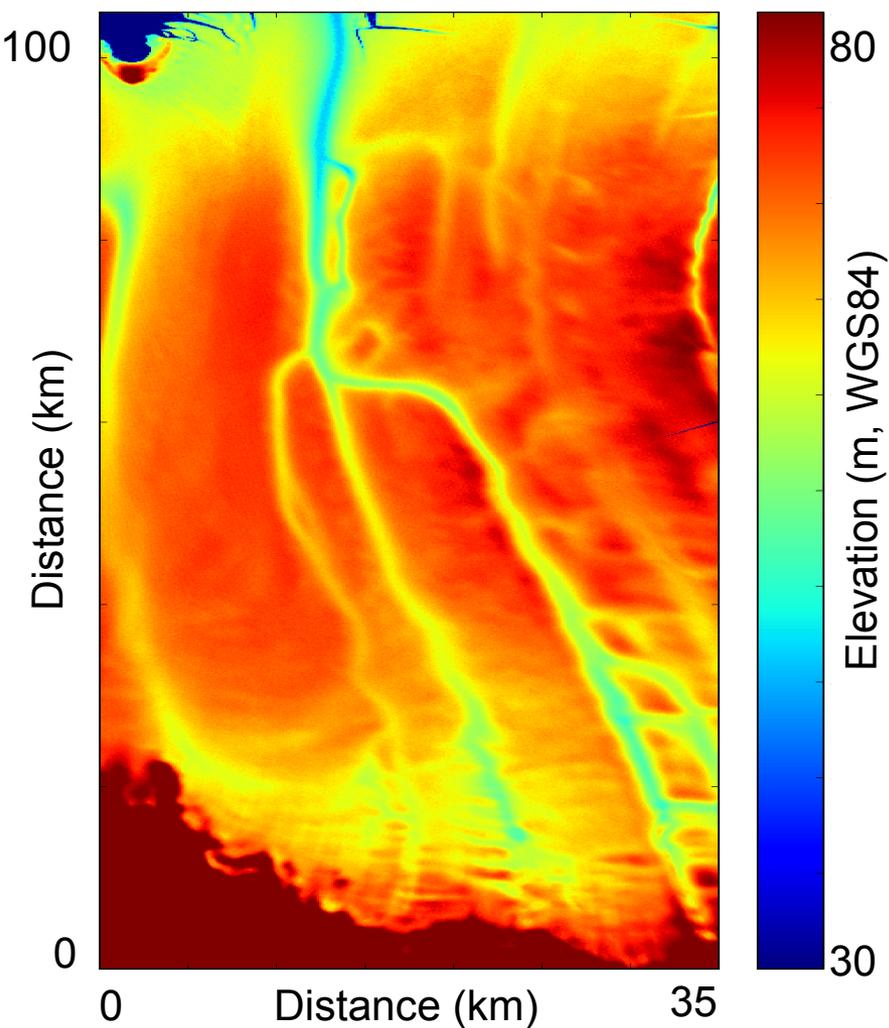
- Idealized Geometry
- Different Melt Scenarios



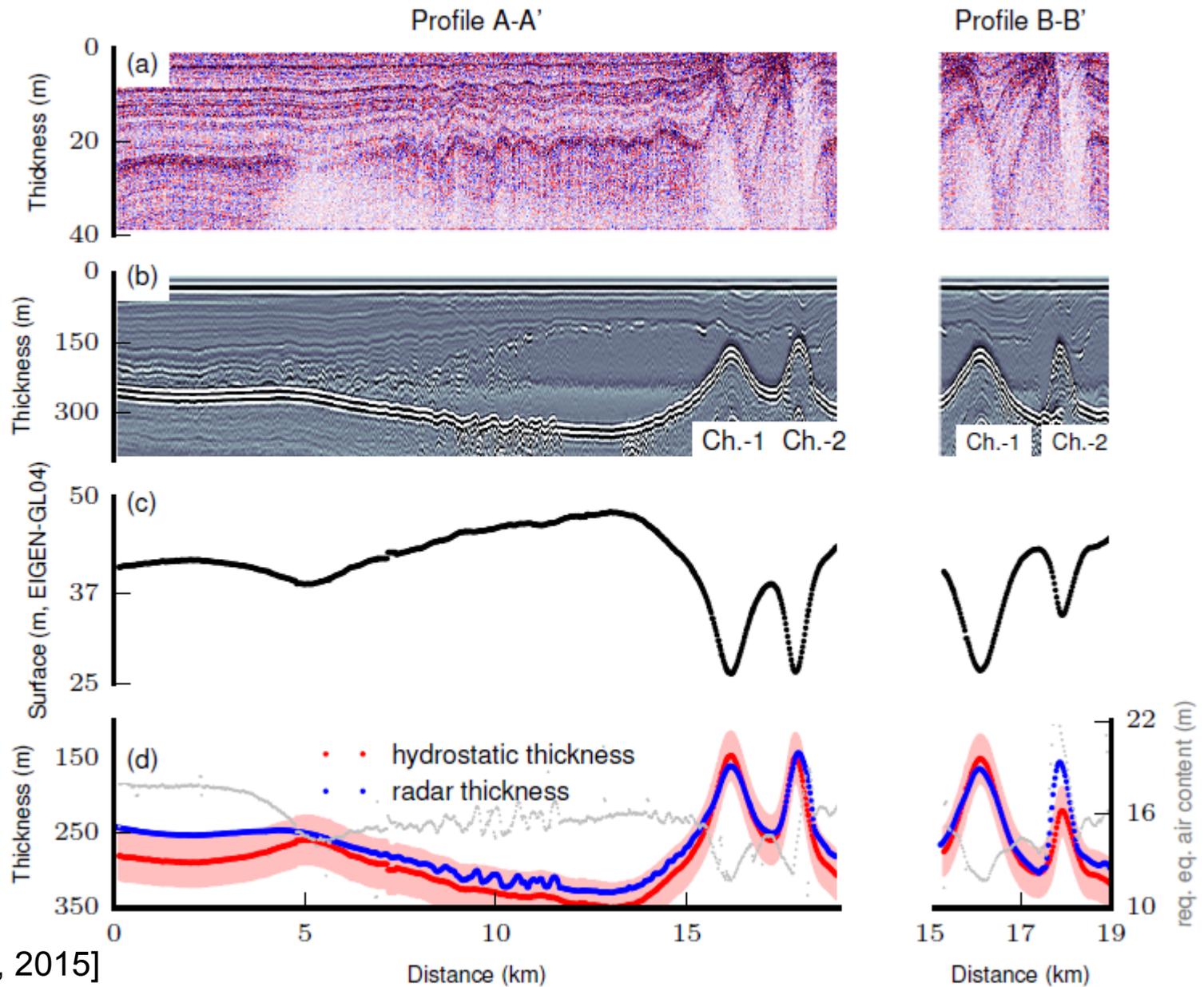
Channel Amplitudes as function of melt

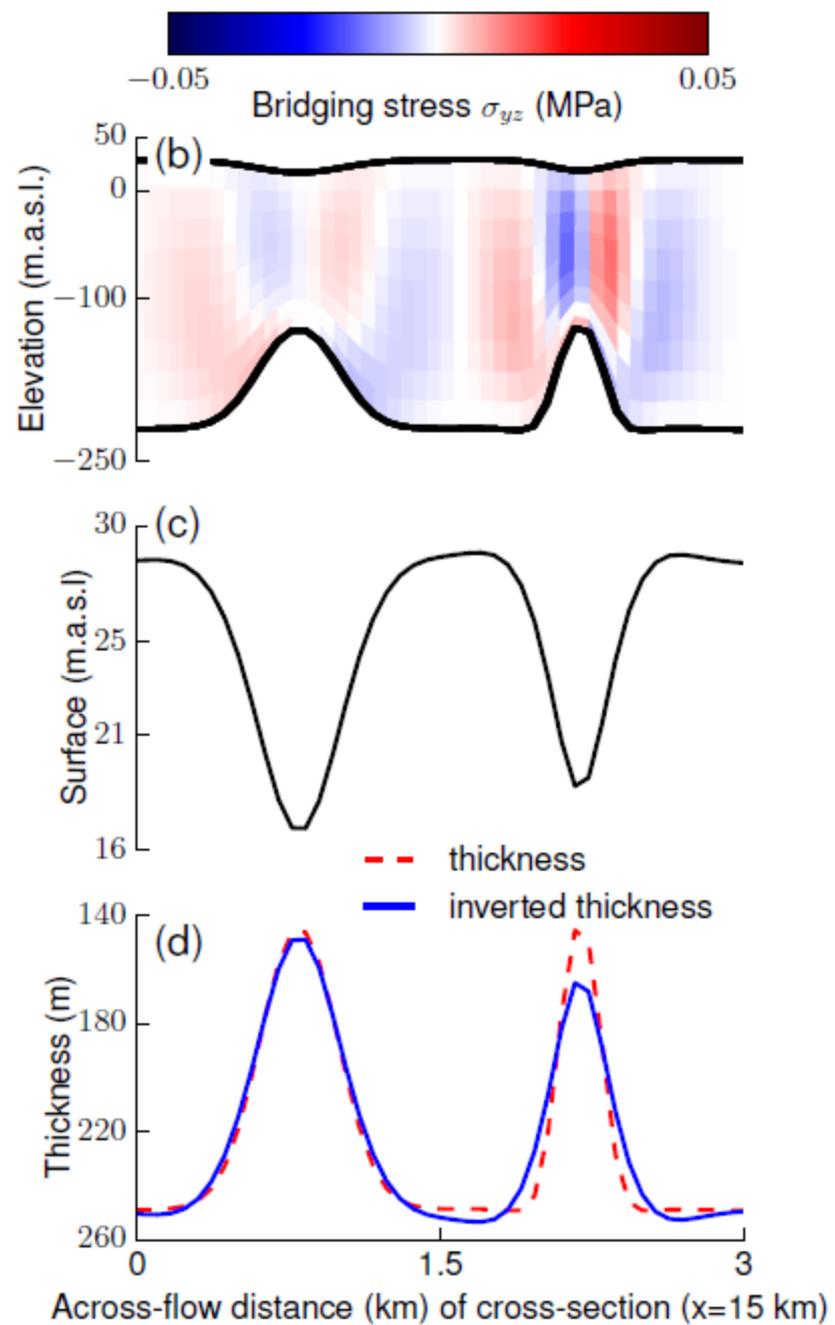
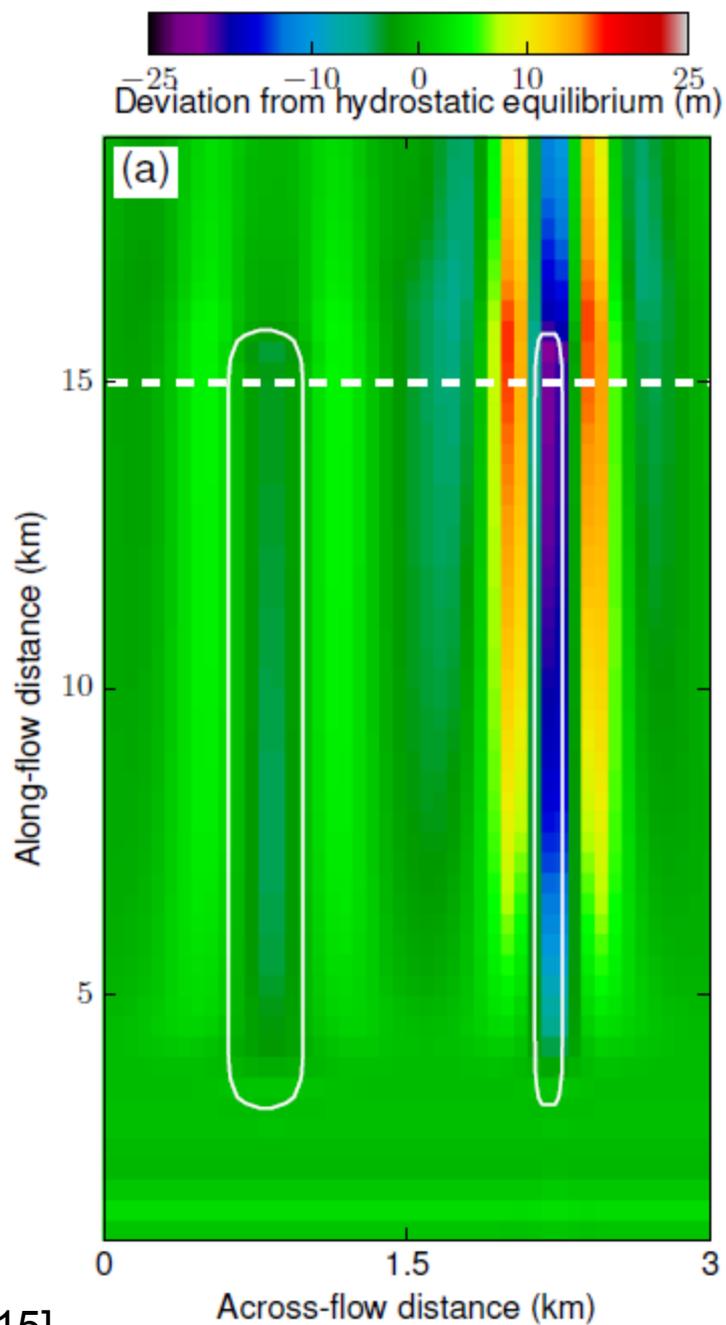


Amplitude from TerraSAR-X

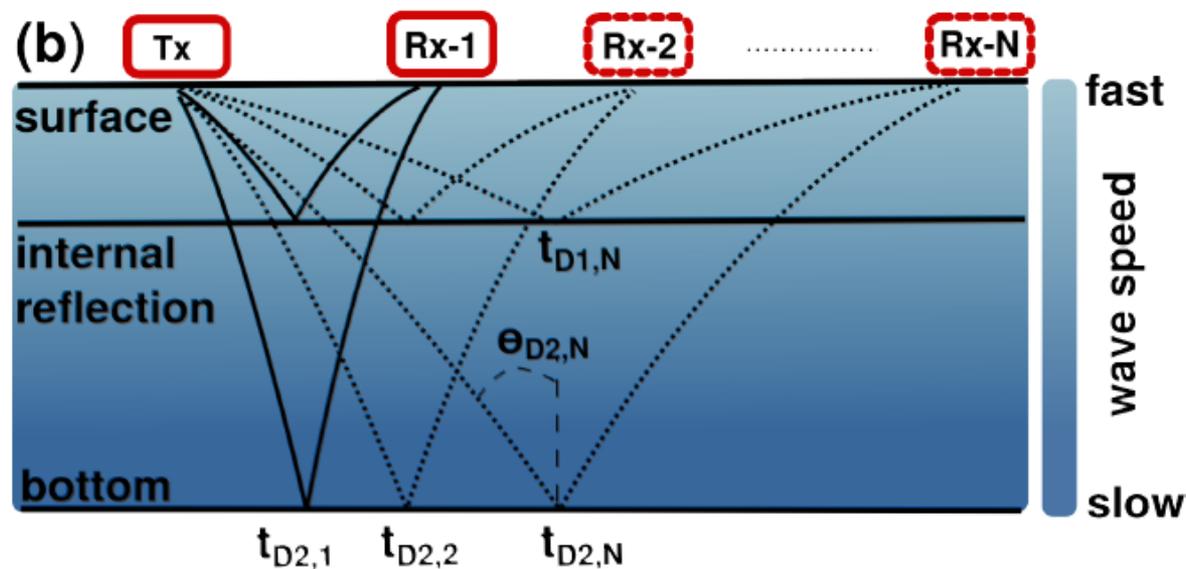
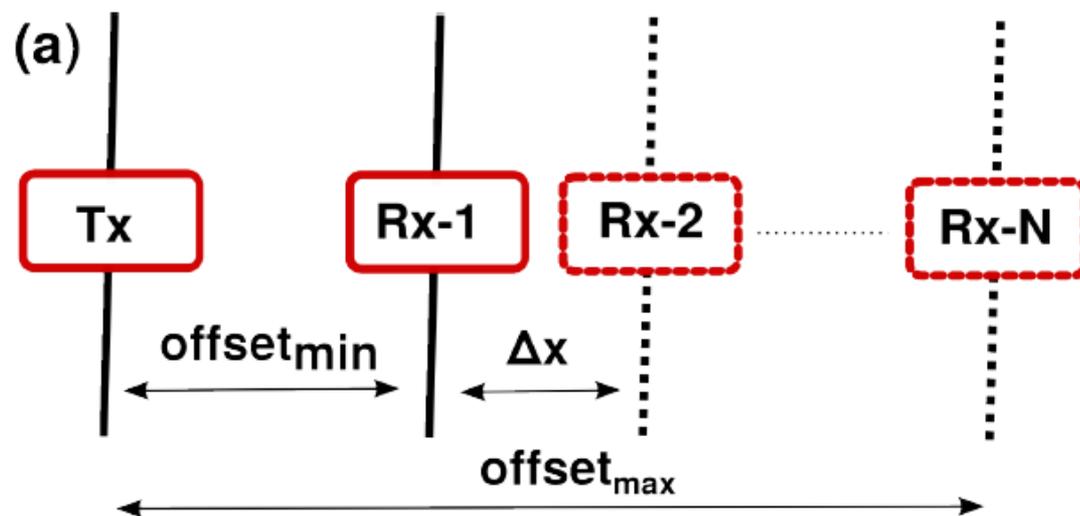


Bridging in Ice Shelf-Channels

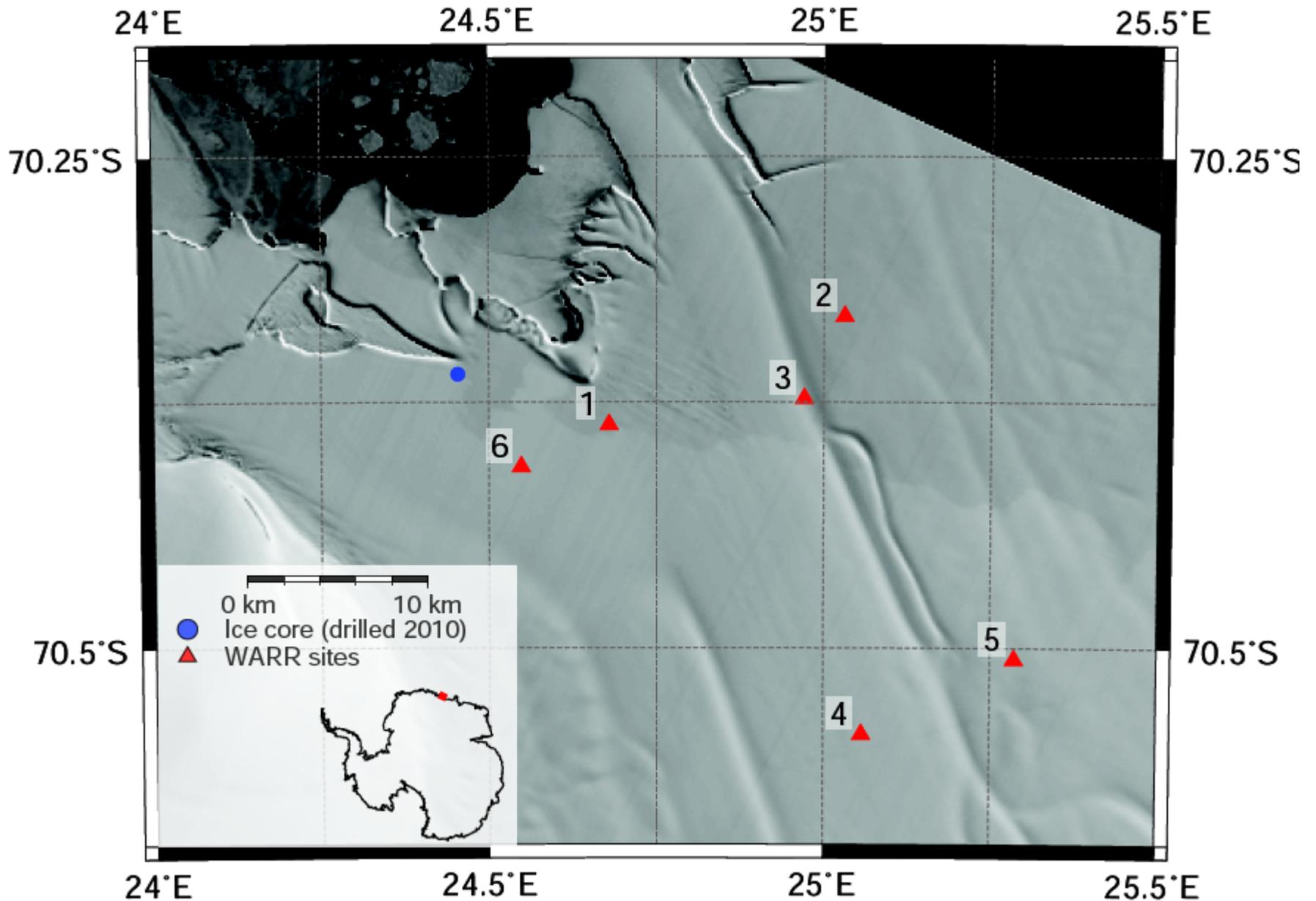


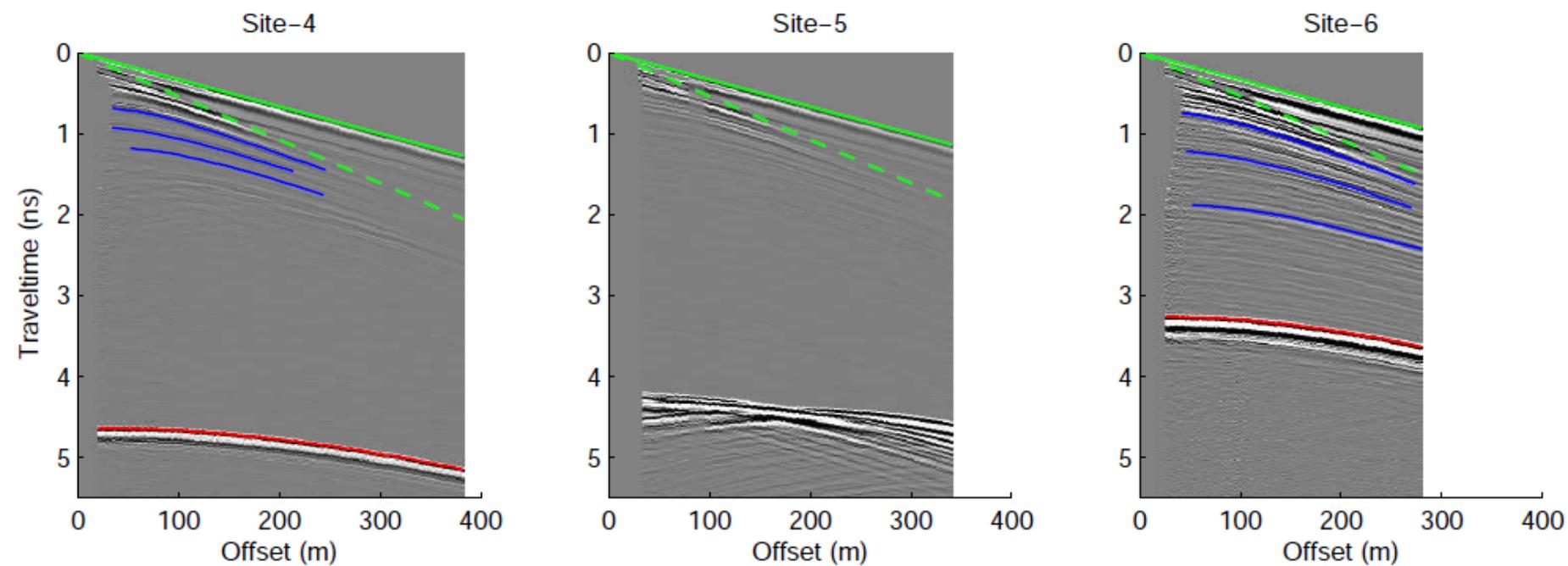
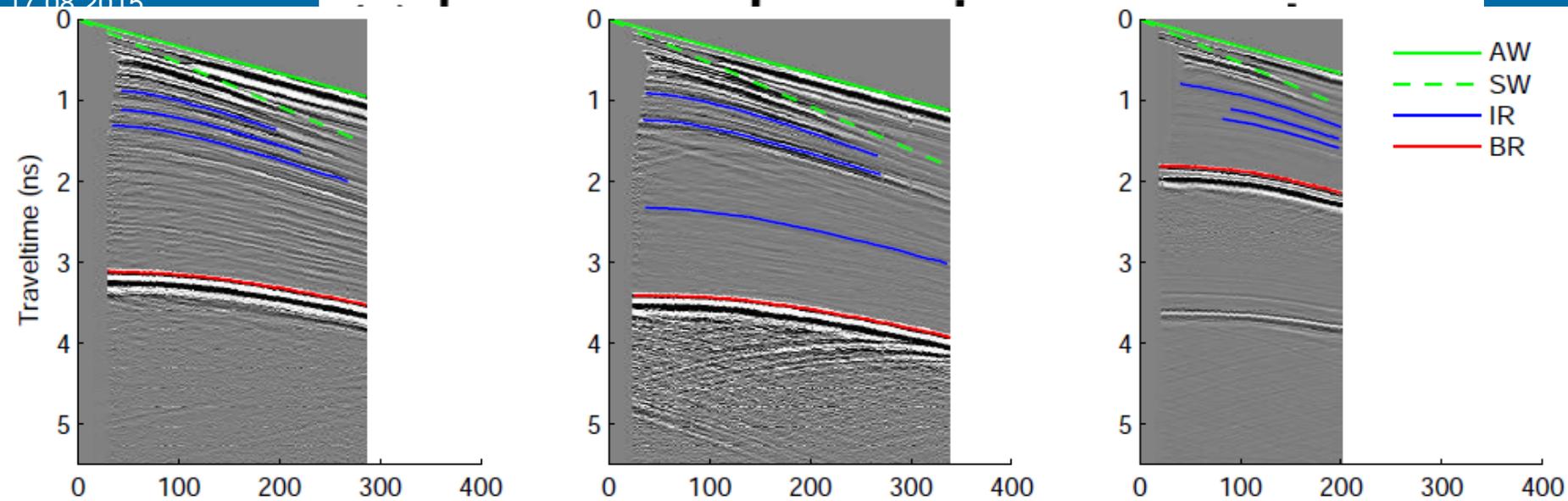


Density From Radar



Density in Channels



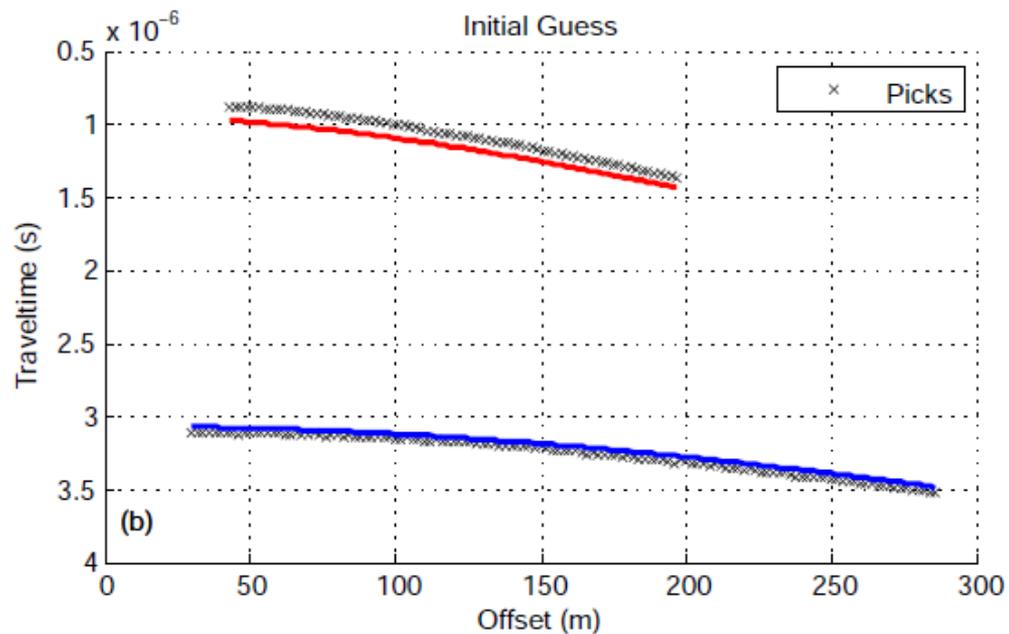
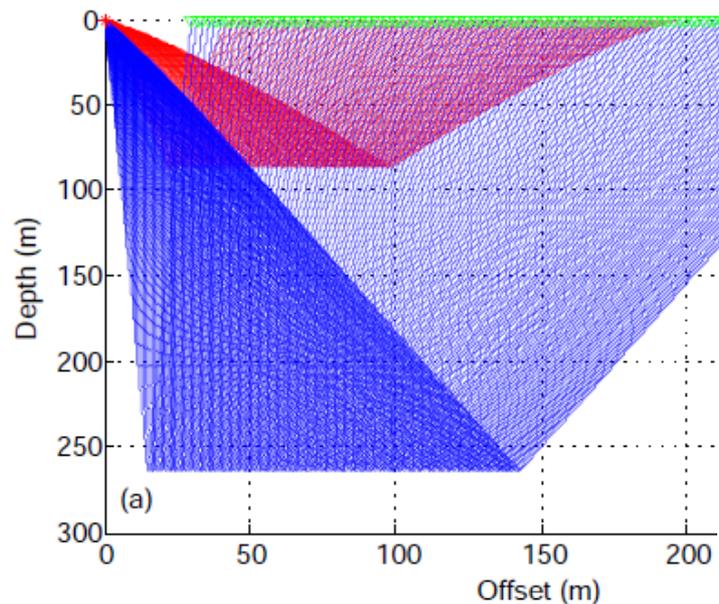


Density in Channels

Initial Guess

$$\rho = 910 - Ae^{-rz}$$

Raytracing



Density in Channels

Initial Guess

Raytracing

Parameter Update
(Non-linear Program.)

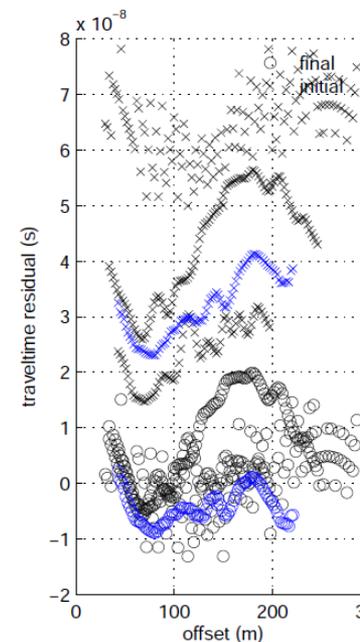
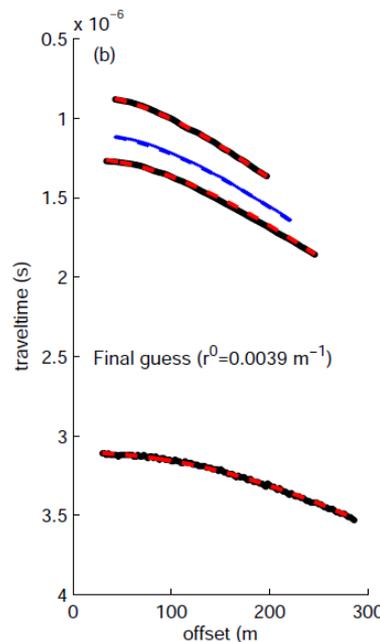
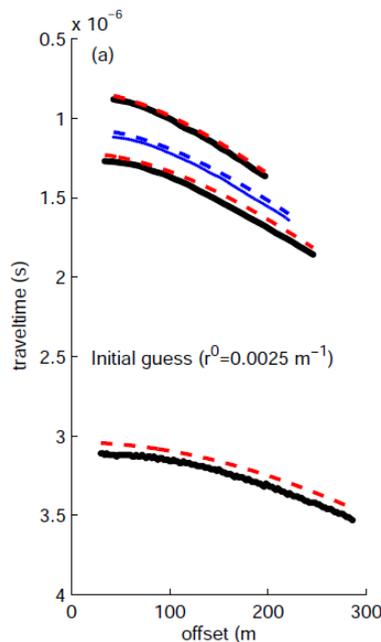
Optimal Parameters A, r

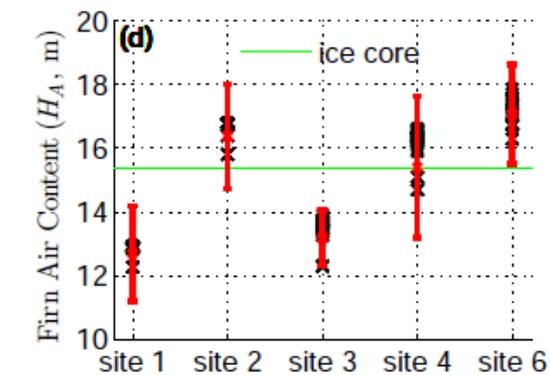
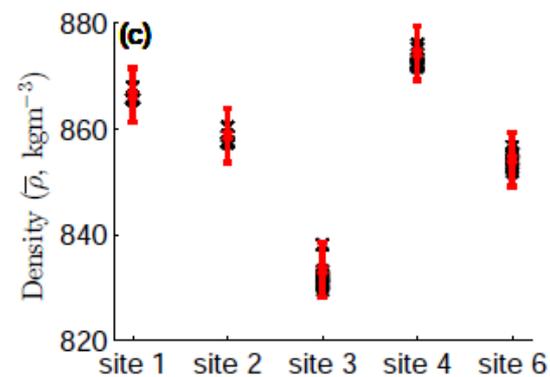
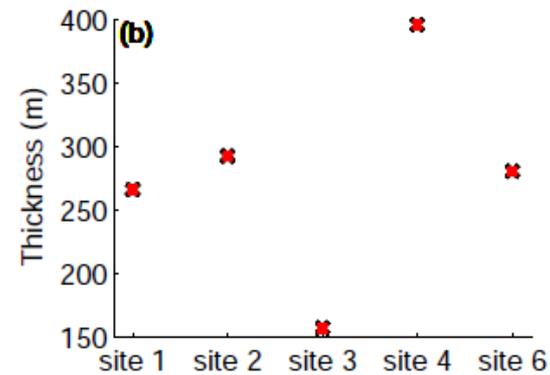
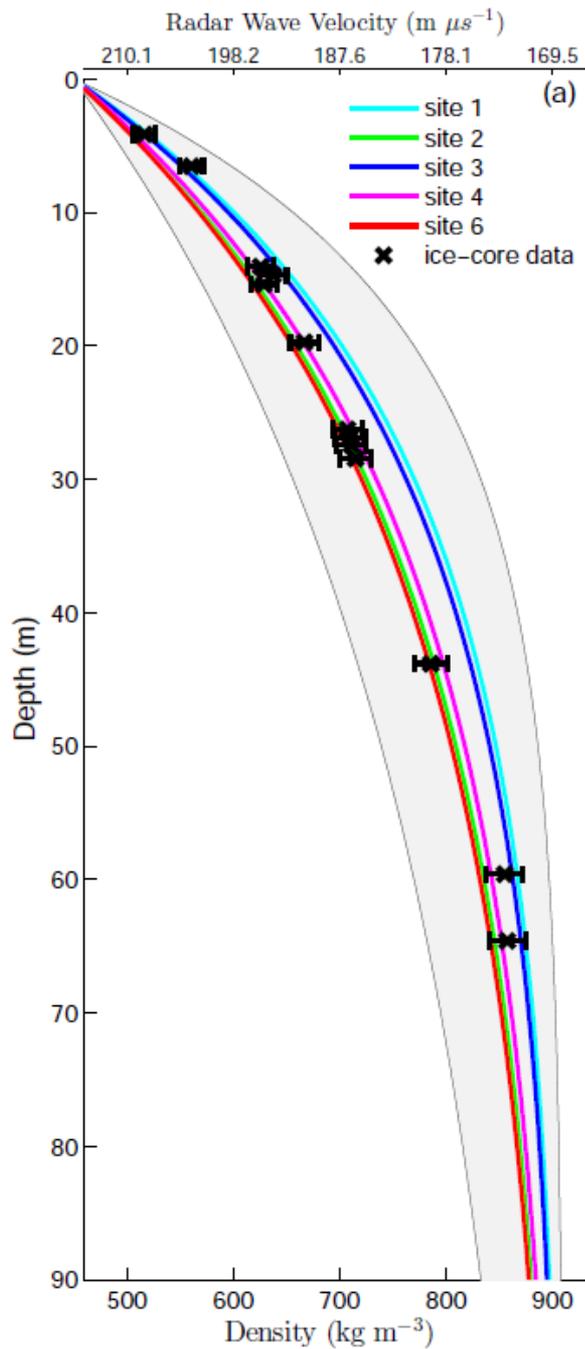
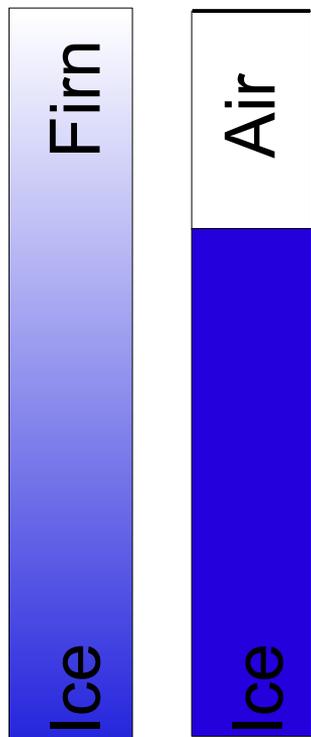
$$\rho = 910 - Ae^{-rz}$$



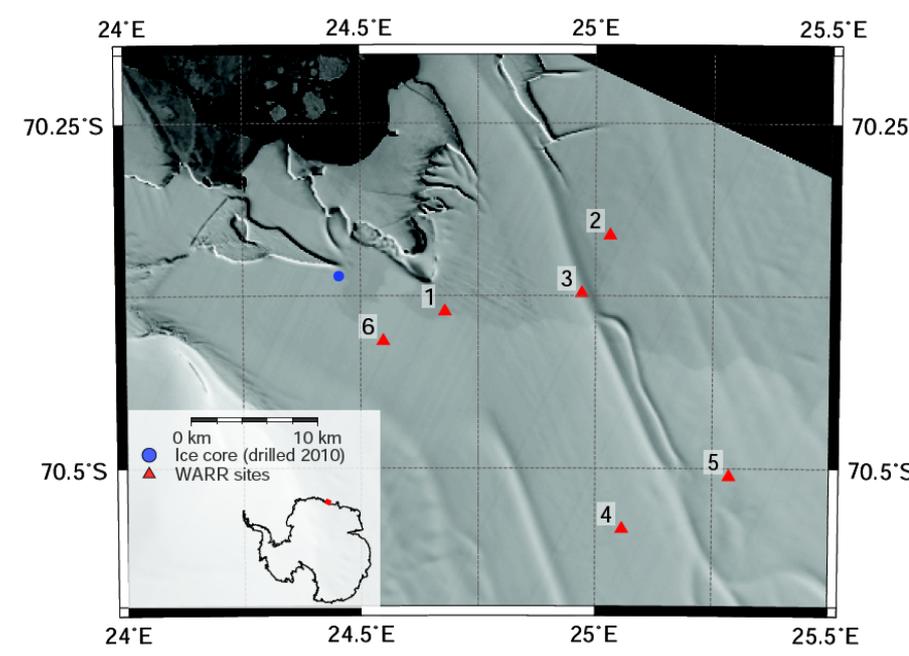
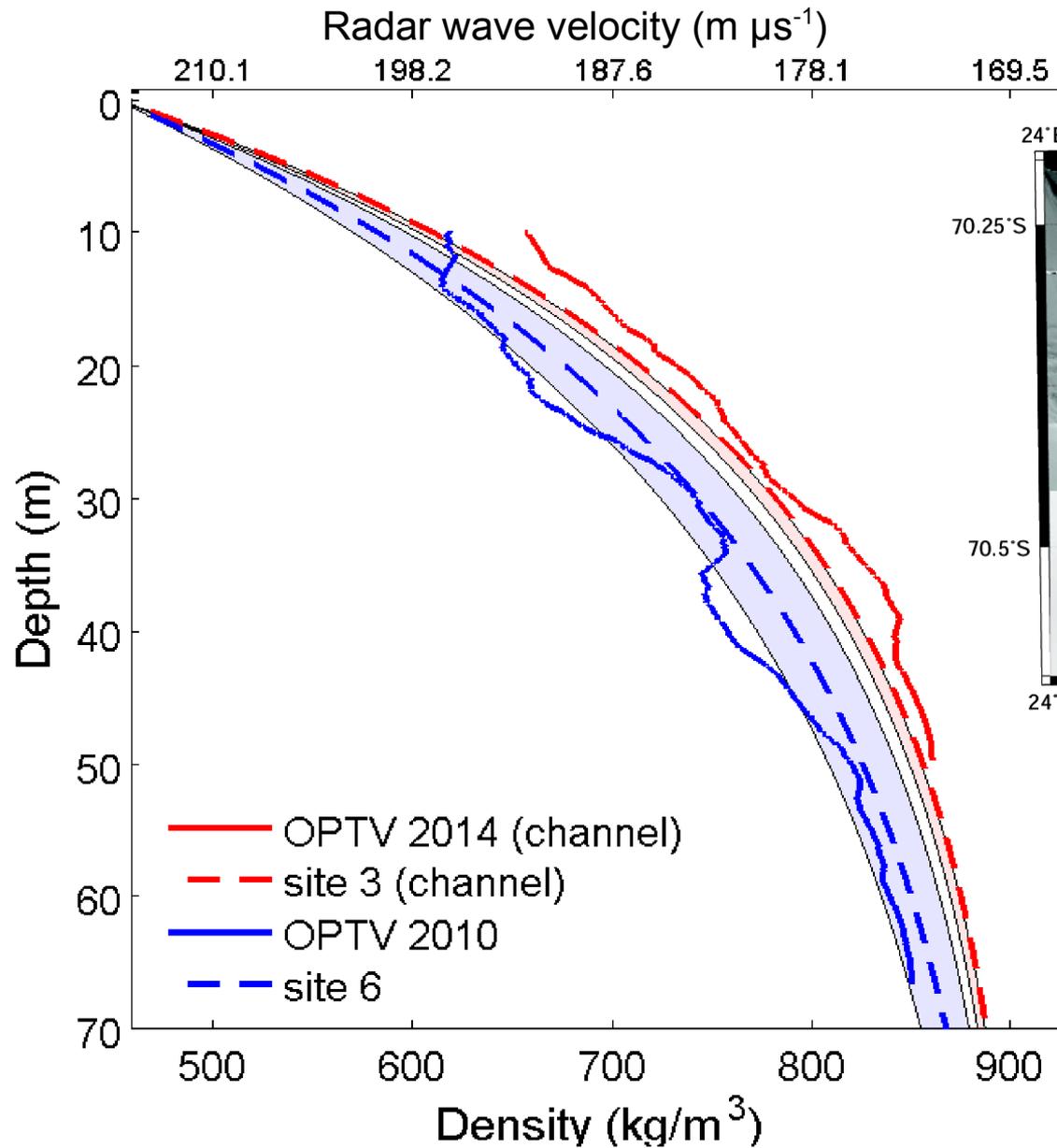
Radar Speed

$$J = \frac{1}{2} \|\mathbf{t}_{\text{mod.}} - \mathbf{t}_{\text{obs.}}\|^2 + \frac{\lambda}{2} \|\mathbf{m}\|^2$$

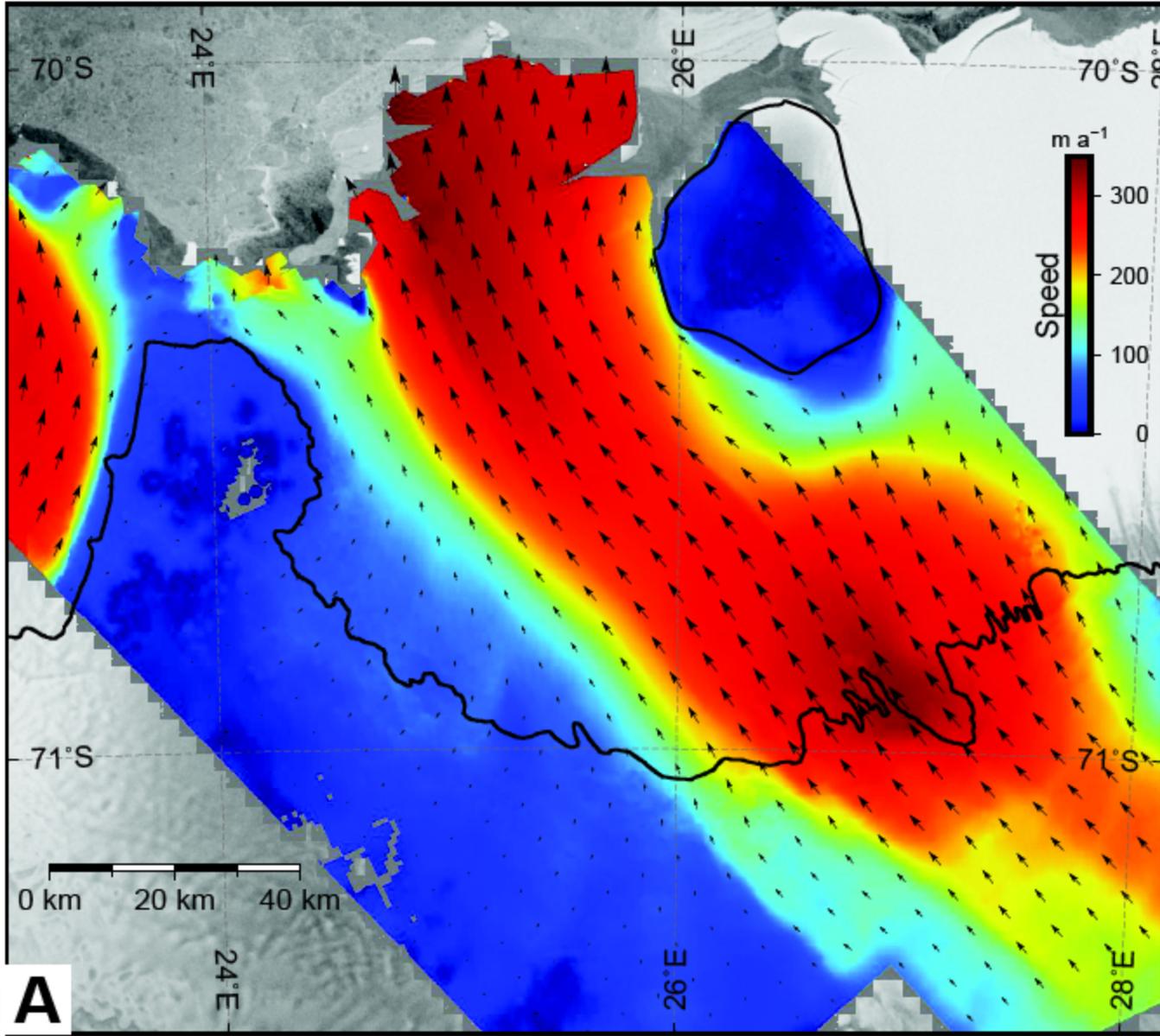




Comparison to OPTV



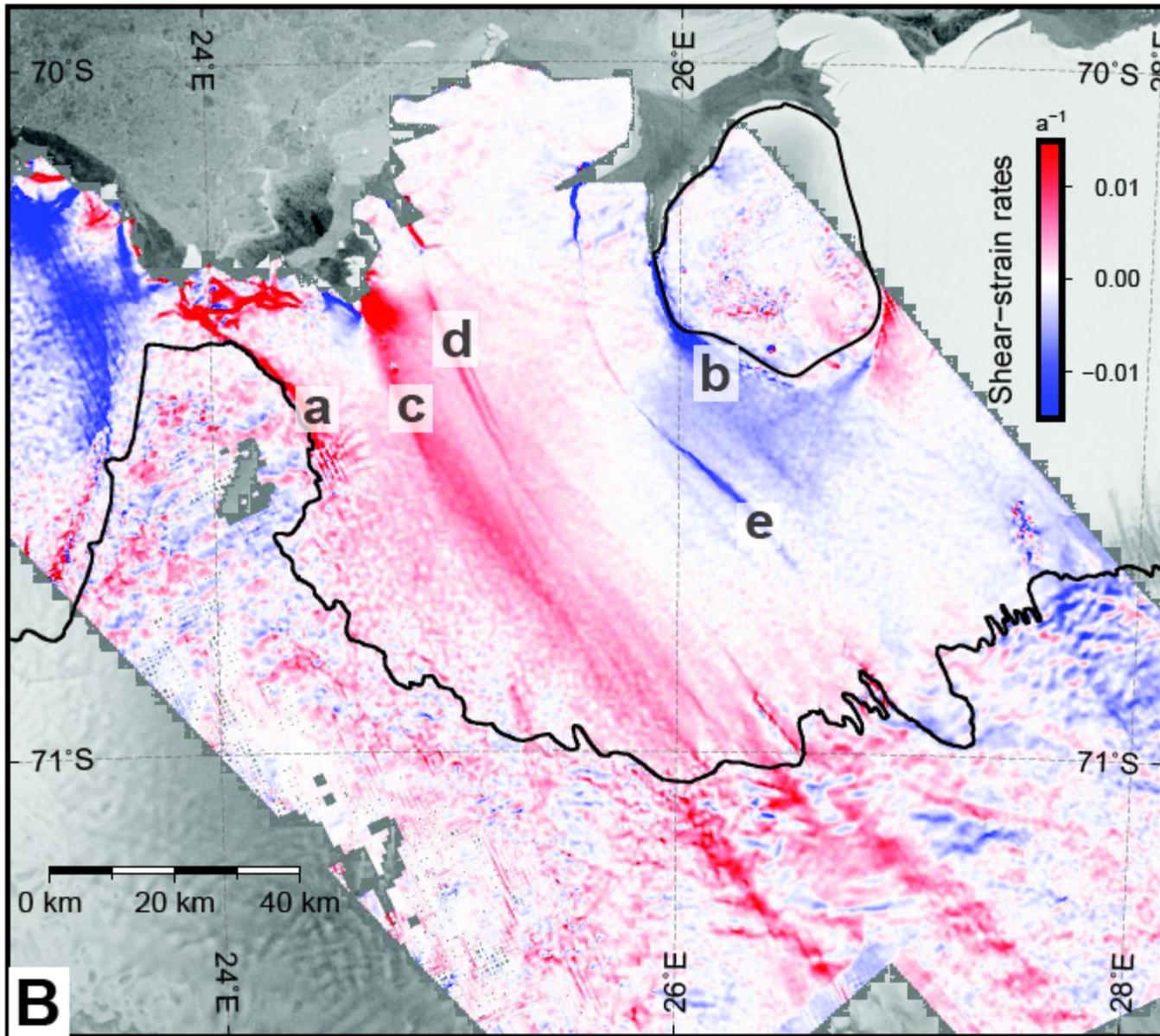
Roi Baudouin Ice Shelf: Channels



S. Berger
[sub. J. Glac.]

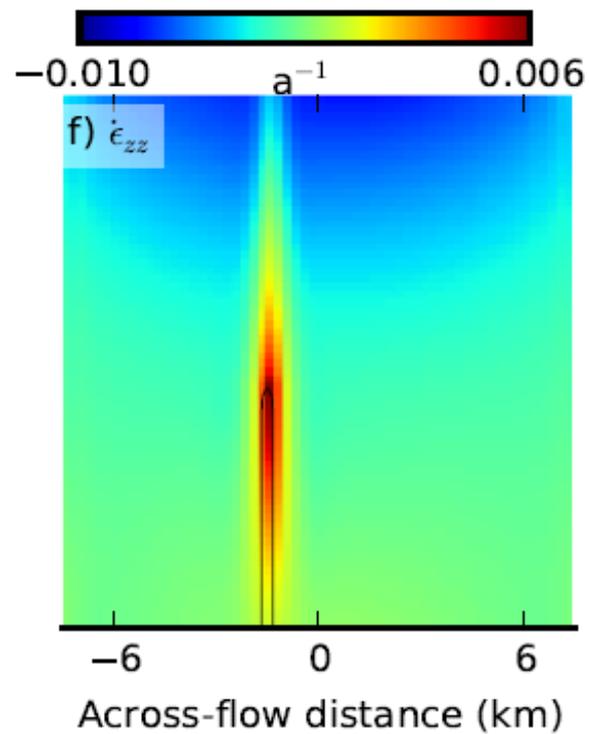
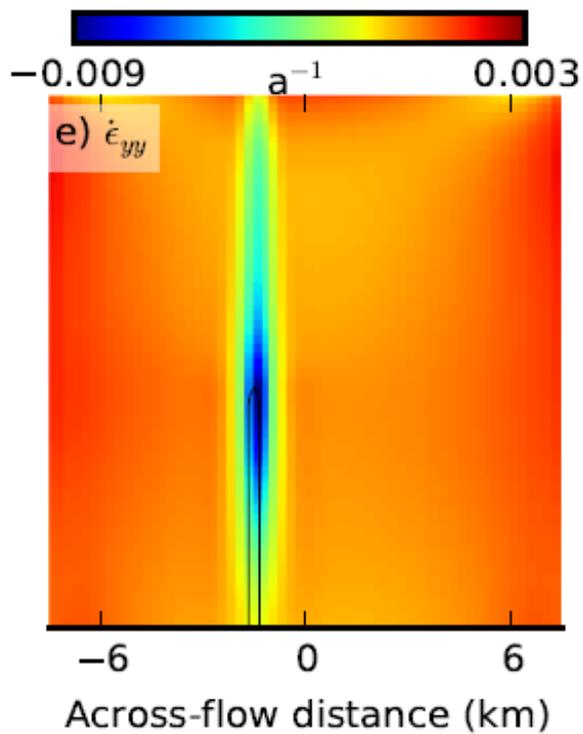
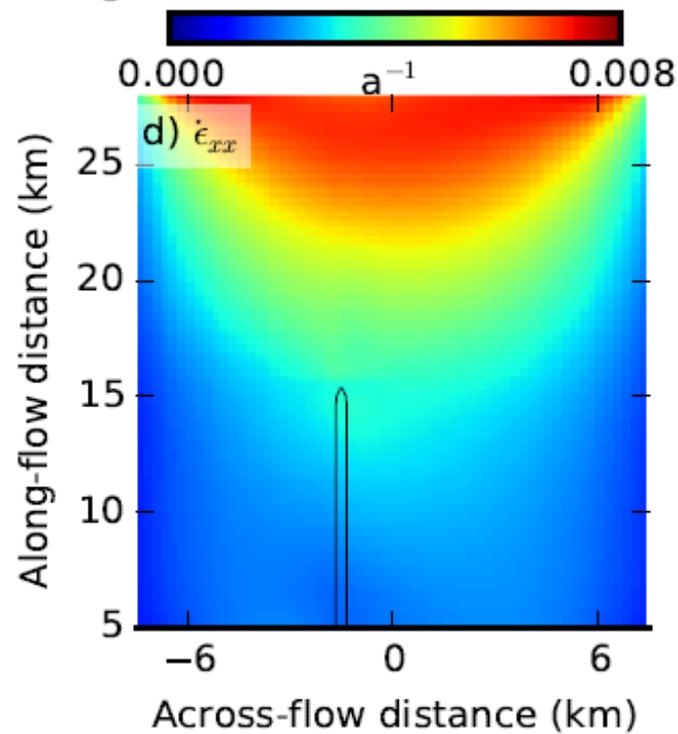
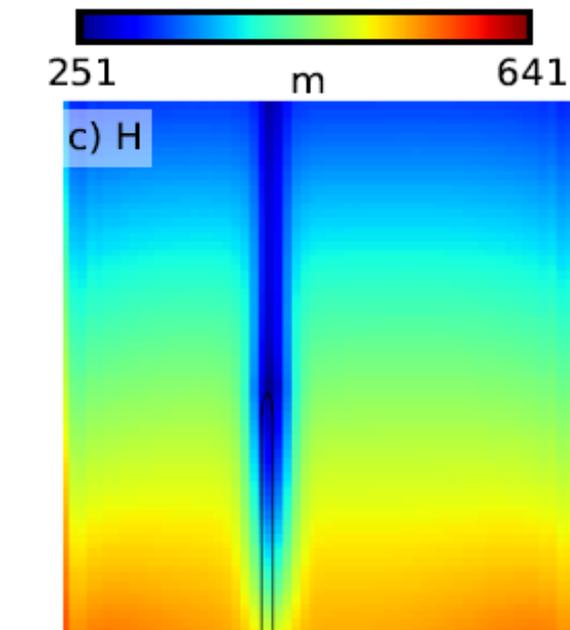
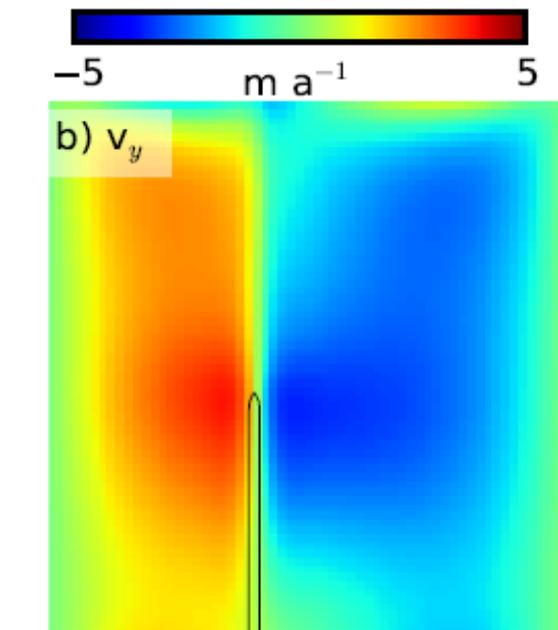
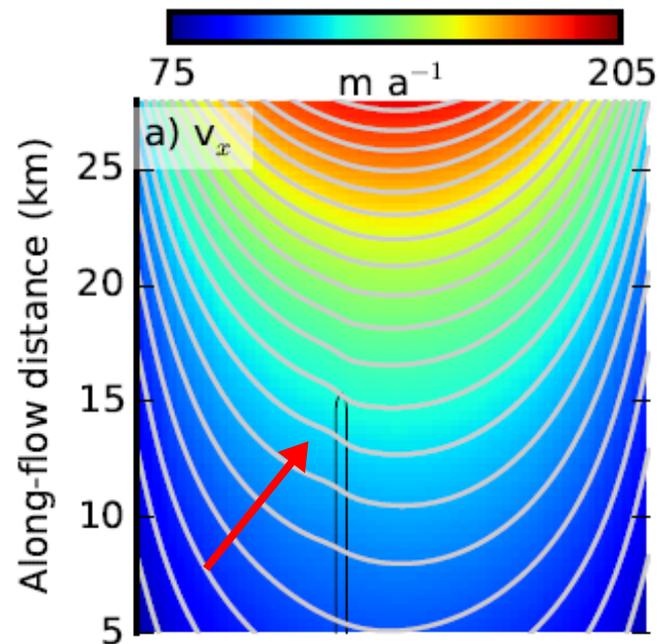
A

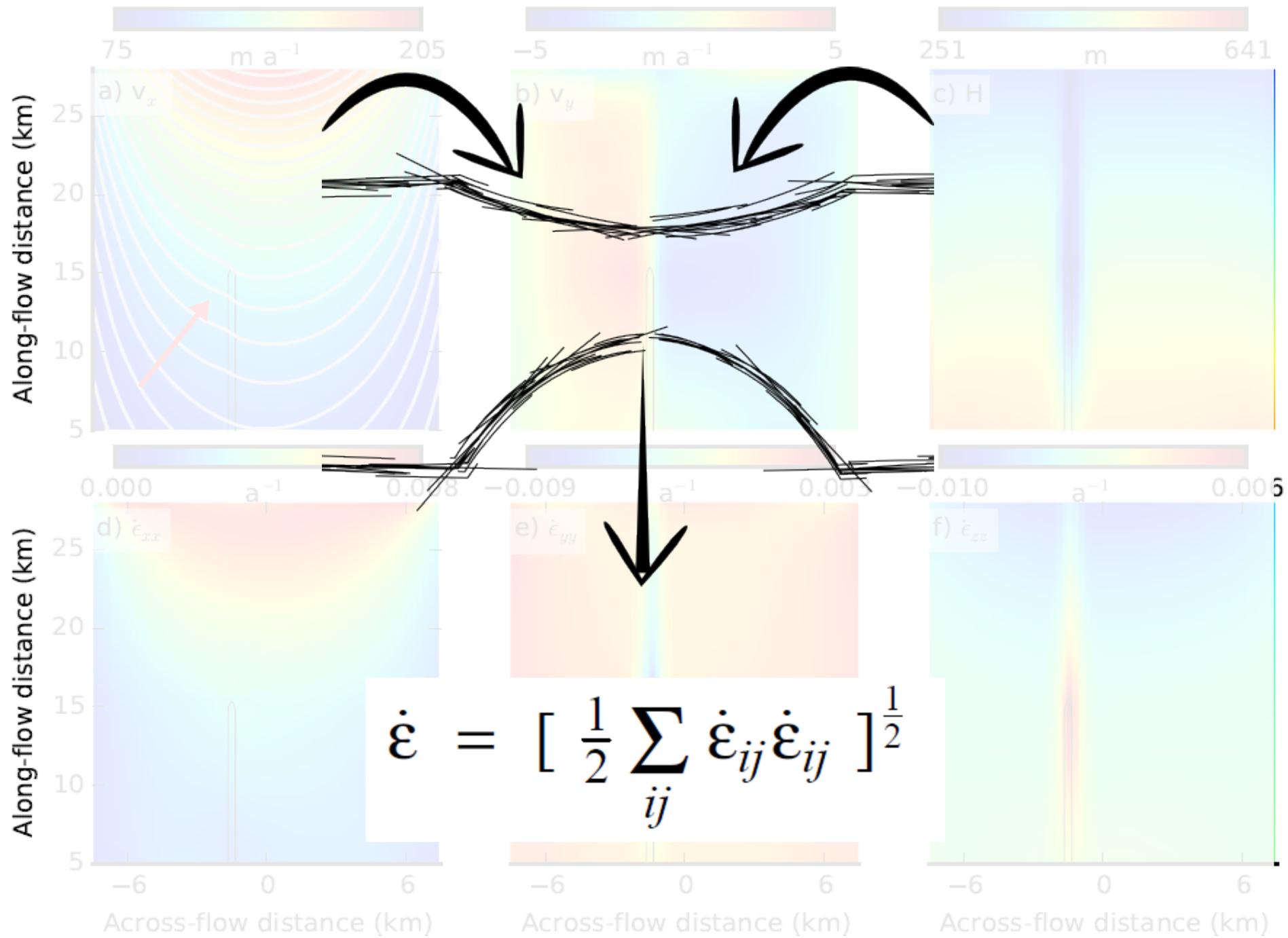
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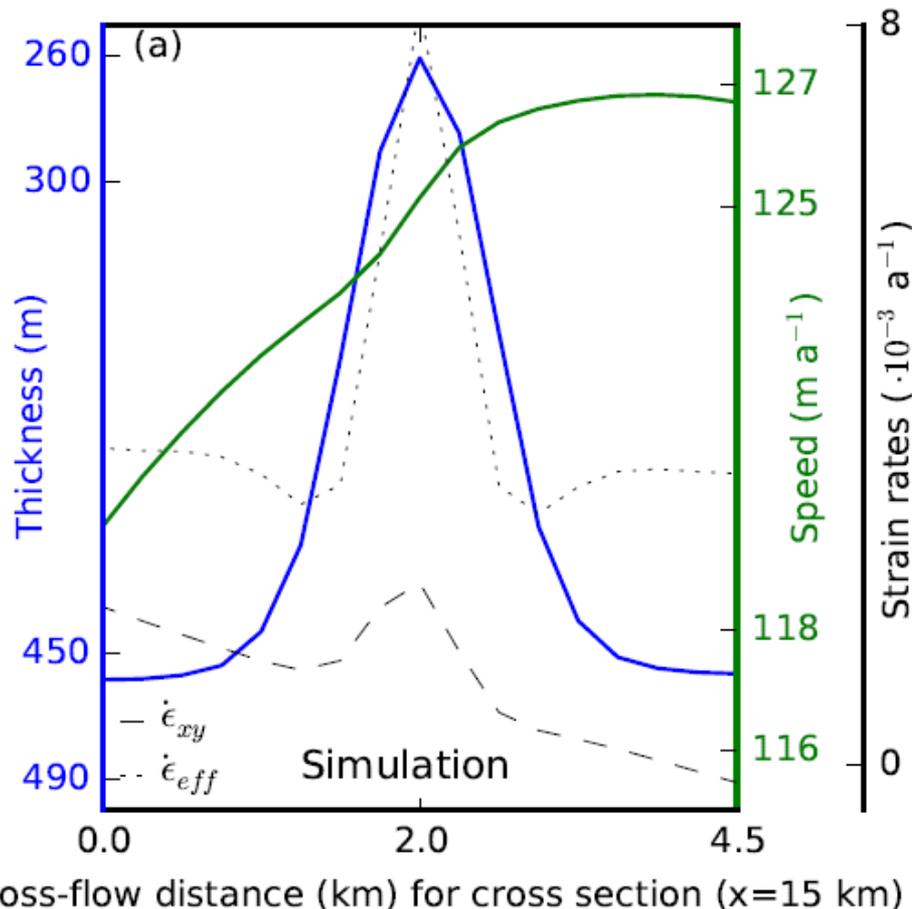
B



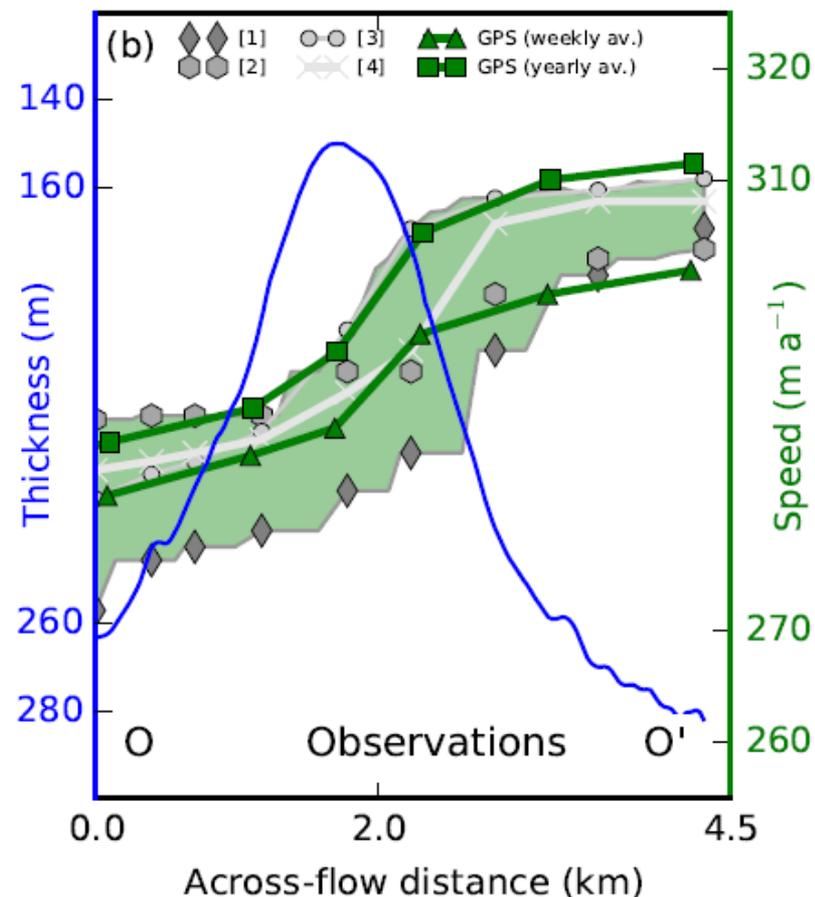


Increased shearing across channels

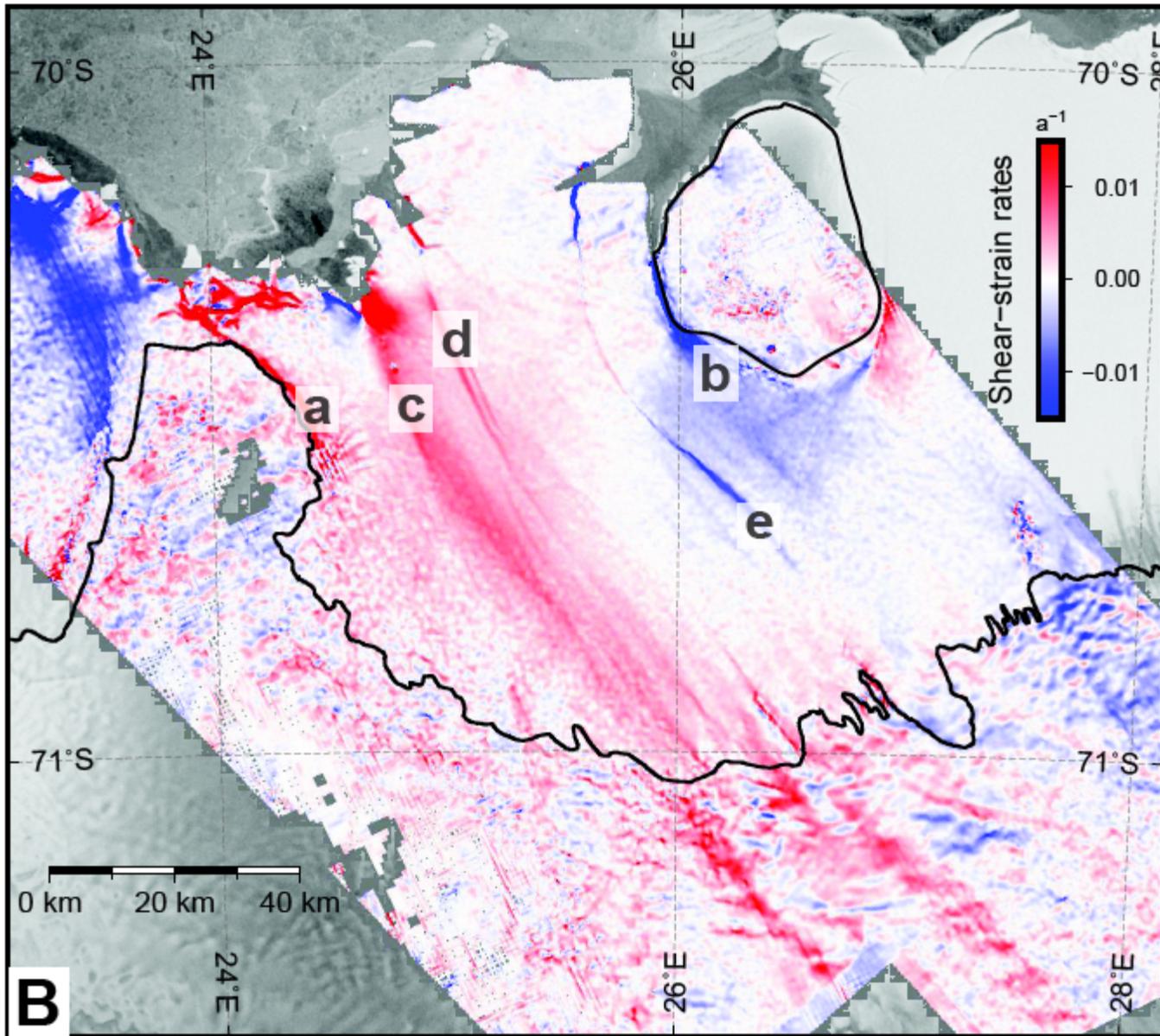
Model



Observations



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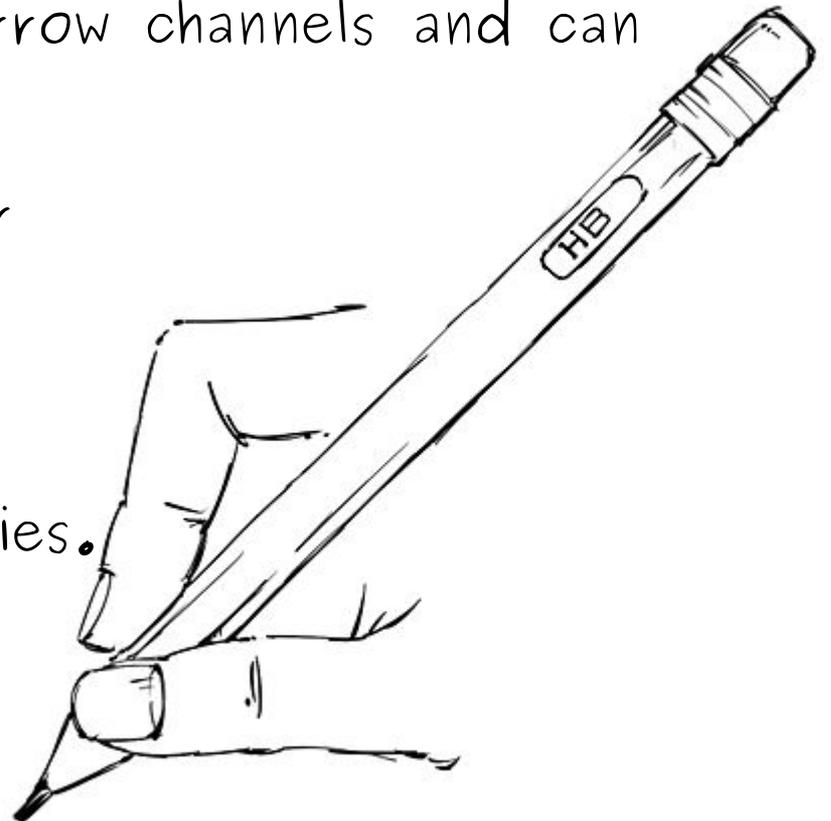


S. Berger
[sub. J. Glac.]

B

Summary

- (1) Channels grow with and decay without basal melting
- (2) Channel amplitudes at RBIS (derived from TanDEM-X) grow fastest near the GL and at the ice-shelf front
- (3) Bridging is important in narrow channels and can hinder hydrostatic inversion
- (4) Density (at RBIS) is denser inside ice-shelf channels compared to outside
- (4) Channelized melting leaves signature in surface velocities. Comparable patterns are detected at RBIS.



Map channelized melting from space ?