ON THE EFFECTS OF ICE DIVIDE MOTION ON RAYMOND BUMPS

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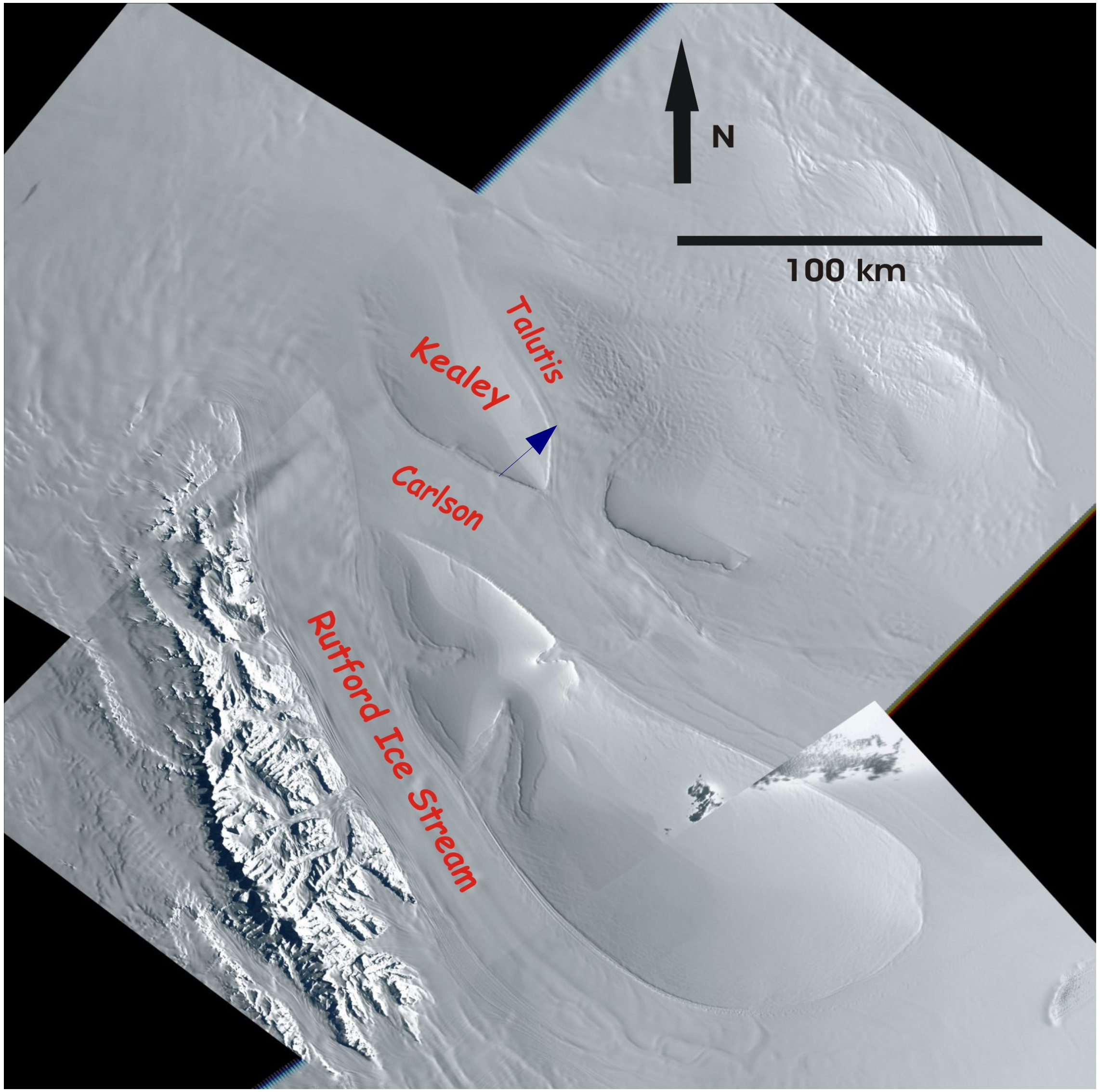
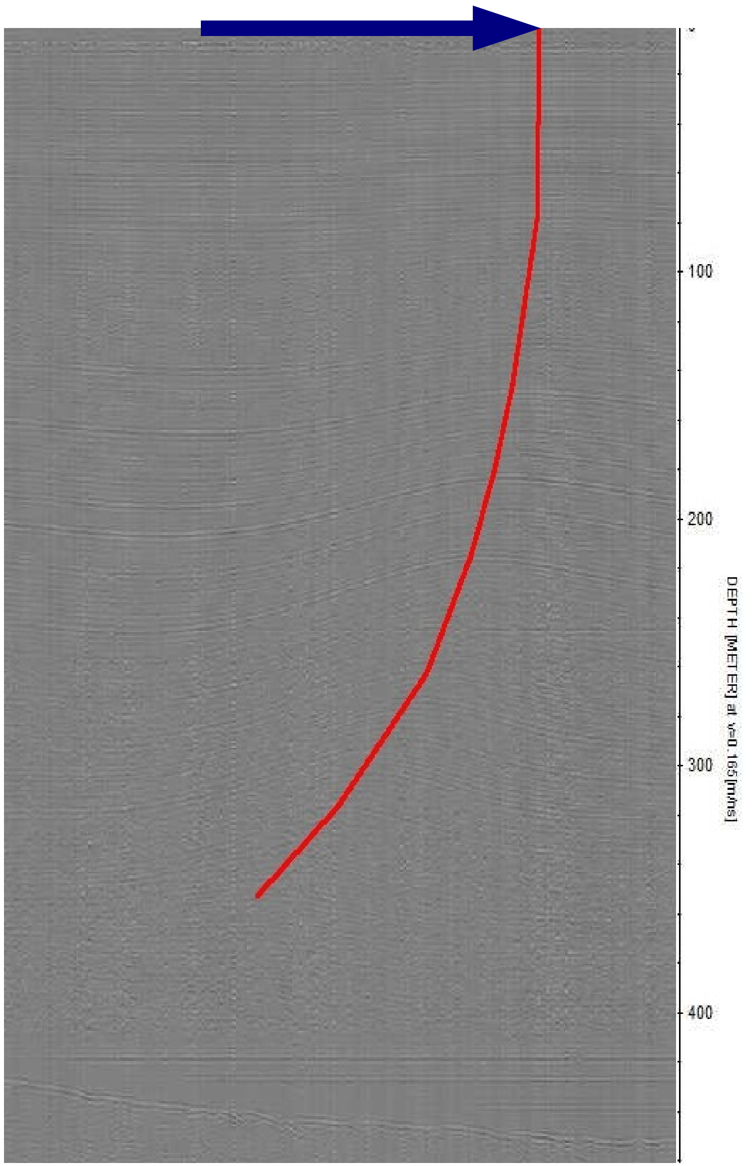
Outline

- Motivation
- Model description
- Ice divide Migration
  - -Fast (Instantaneous forcing)
  - -Slow (Linear forcing)
- Transient temperature response
- What’s wrong?
- Double-rooted bumps: anisotropy?
- Conclusions

Motivation: hints about the past





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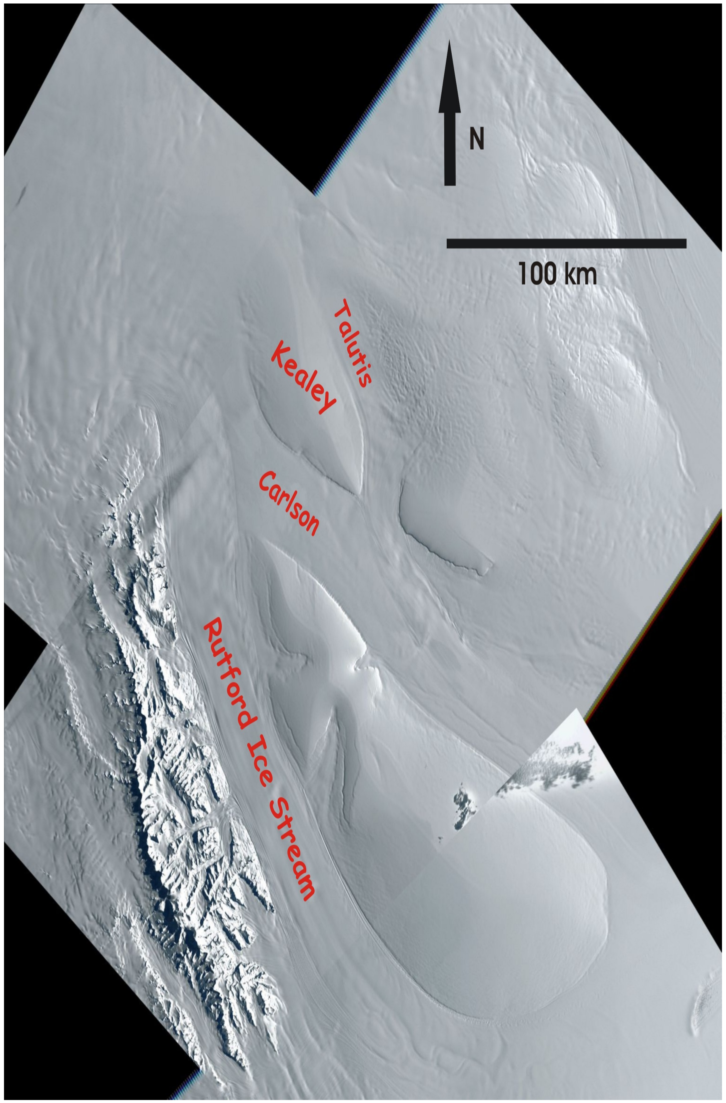
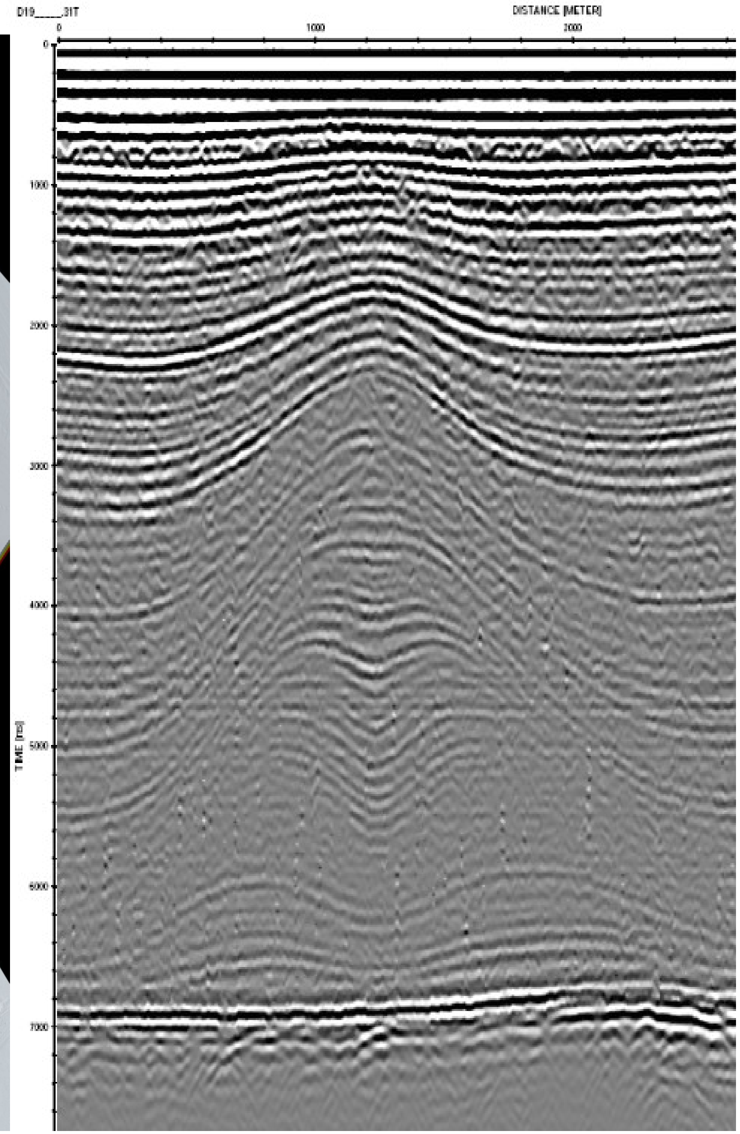
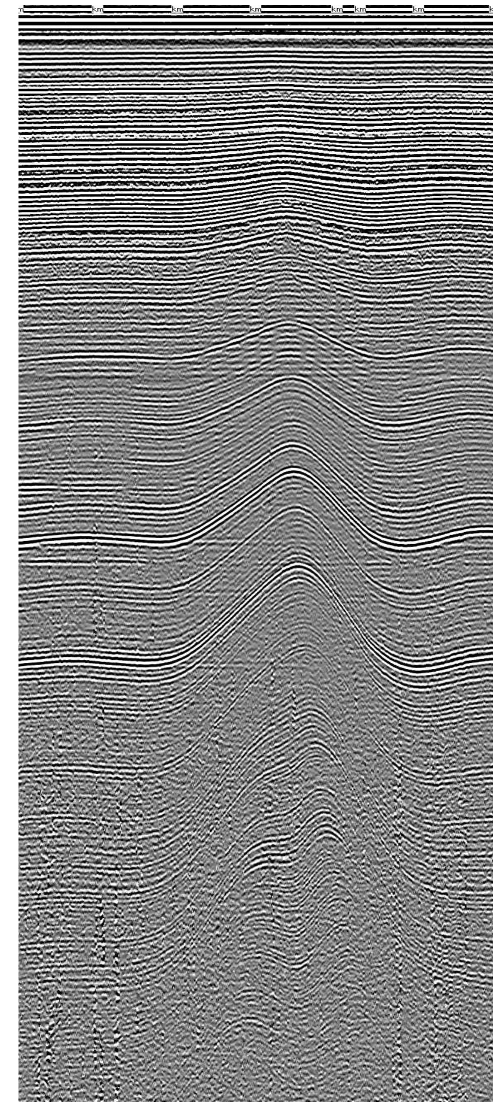
Motivation: hints about ice properties





Fletcher Promontory



Kealey ice rise

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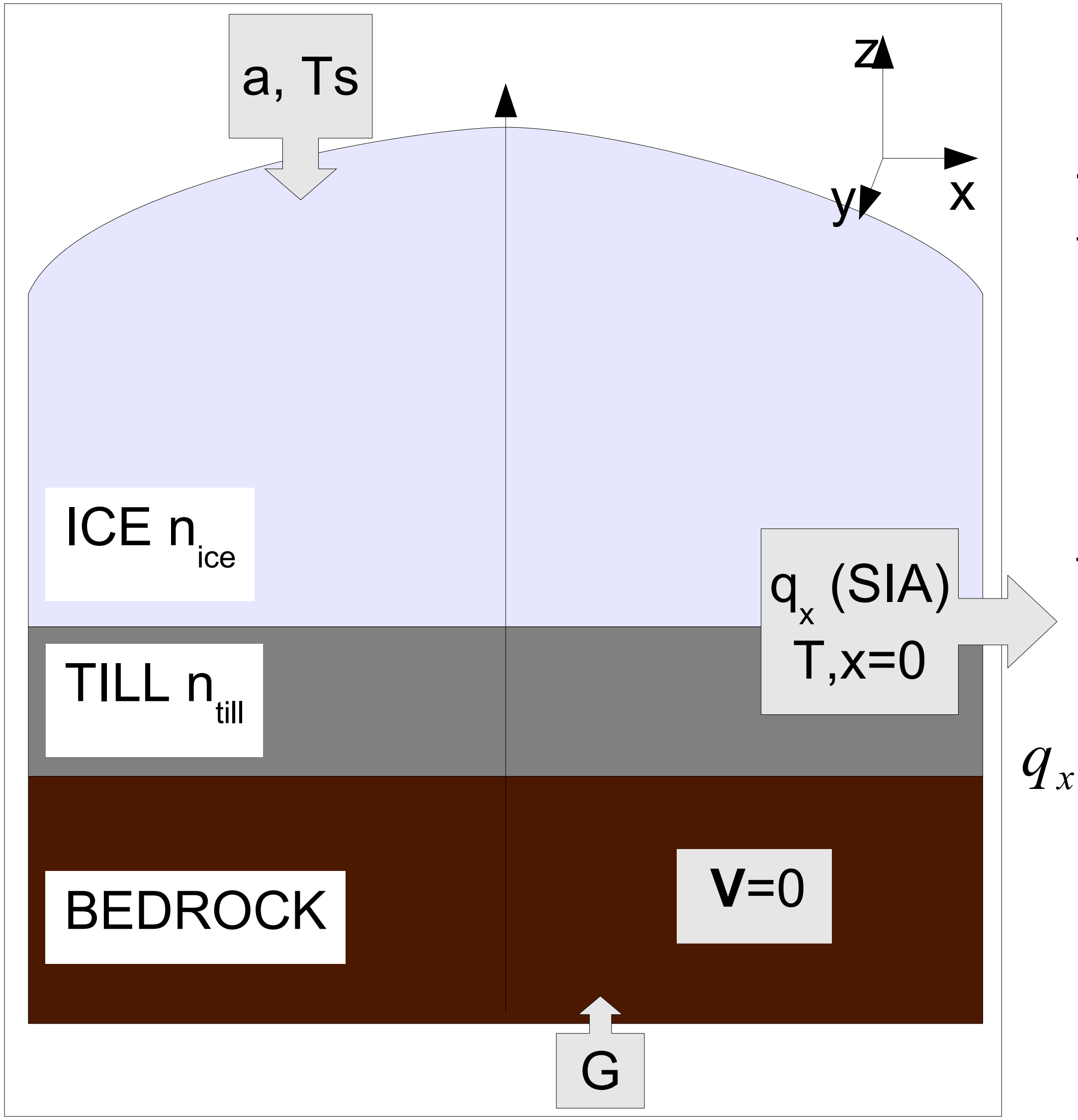
Model description



Ice flow: full Stokes (Hvidverg, 96)

Temperature: Solved in bedrock, consider temperature evolution

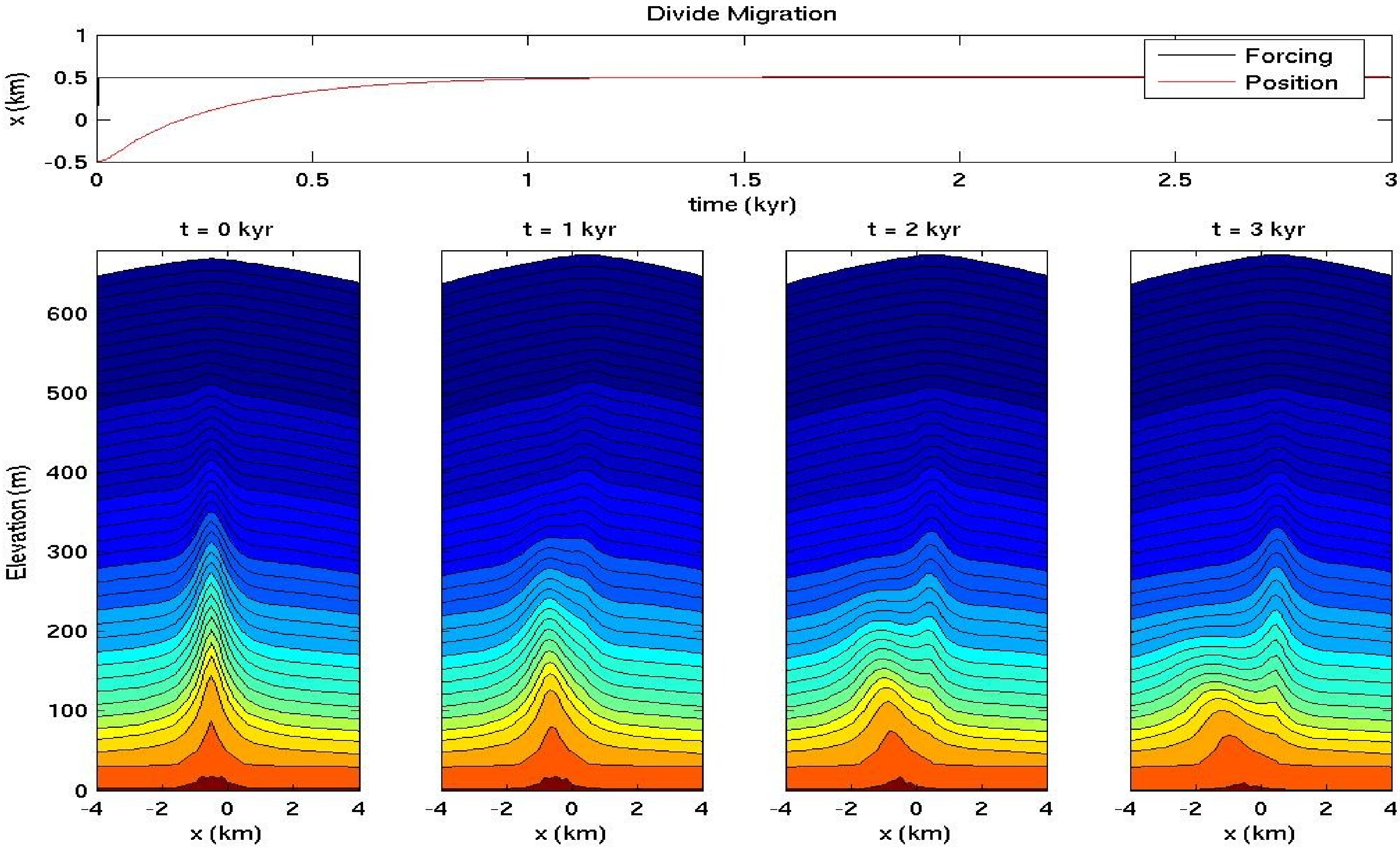
Sliding is considered using a viscous till layer (Pettit, 03)

Divide migration is forced by ice flux at the flanks

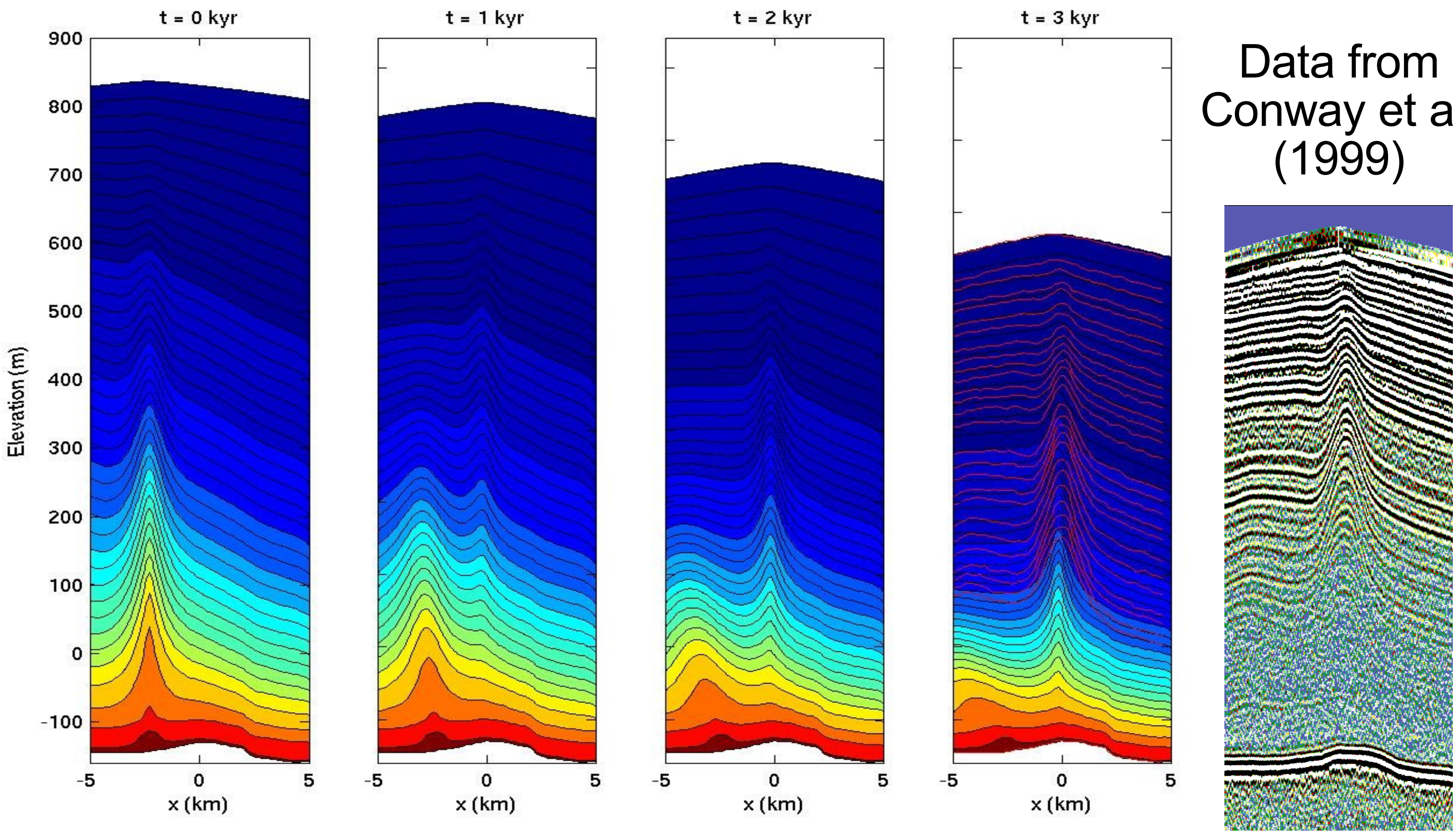
$$q_x(x_{flank}, t) = \int_{x_d(t)}^{x_{flank}} \left(a - \frac{\partial h}{\partial t}\right)(x', t)\, dx'$$

Numerics: Finite element and semi Lagrangian methods.

Fast migration: Instantaneous forcing



Migration: Roosevelt an example of fast migration?



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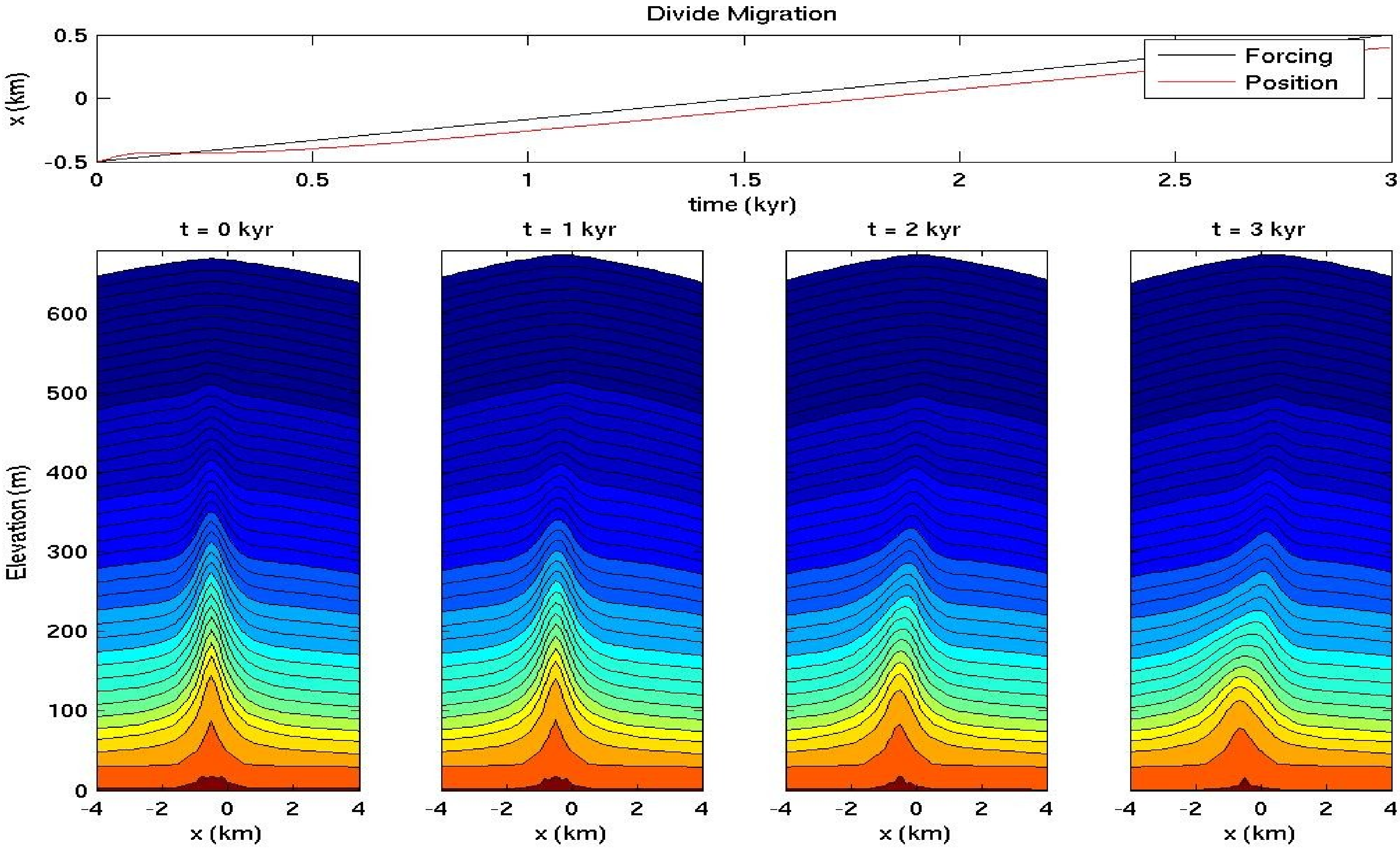
Slow migration: linear forcing



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Transient temperature response to ice divide migration

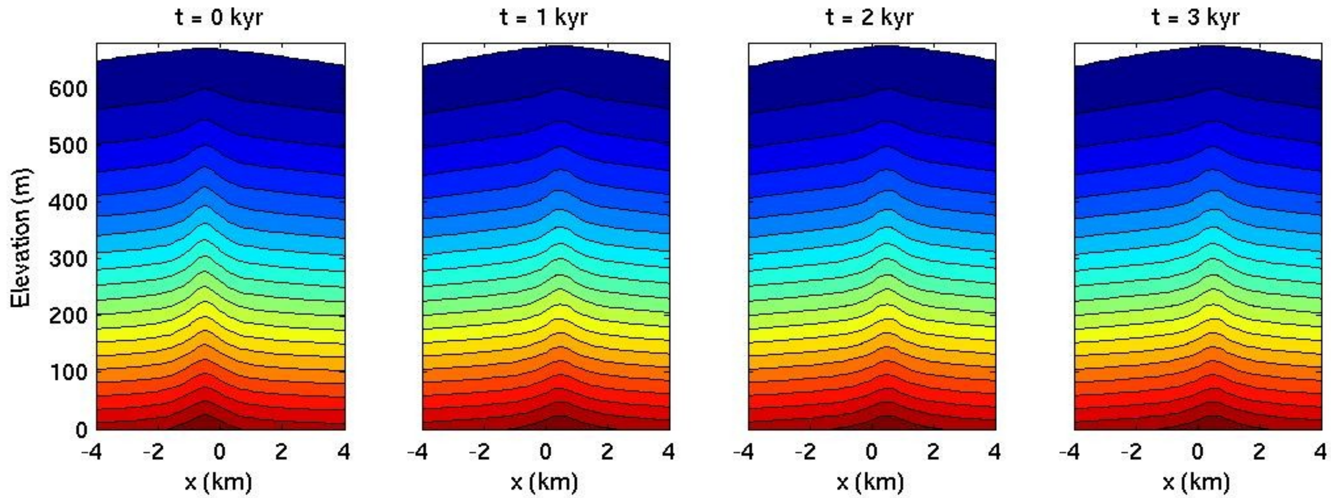
$$\tau = \frac{H_d}{a}$$

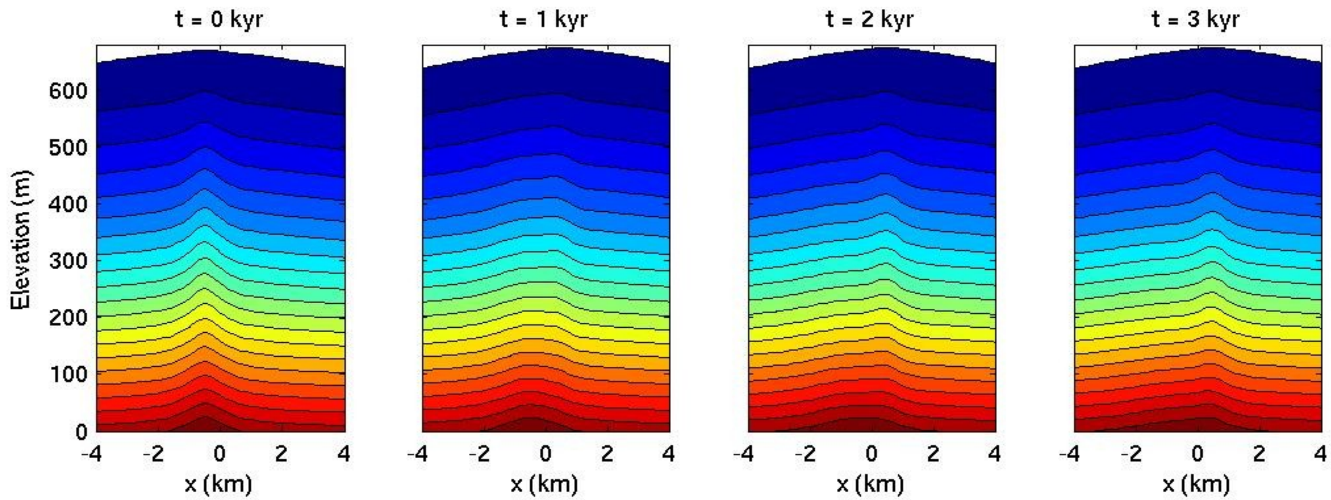
$$\tau_v \ll \tau$$

$$\tau_h \approx (\tau / 16)^*$$

$$\tau_h < \tau_T < \tau$$

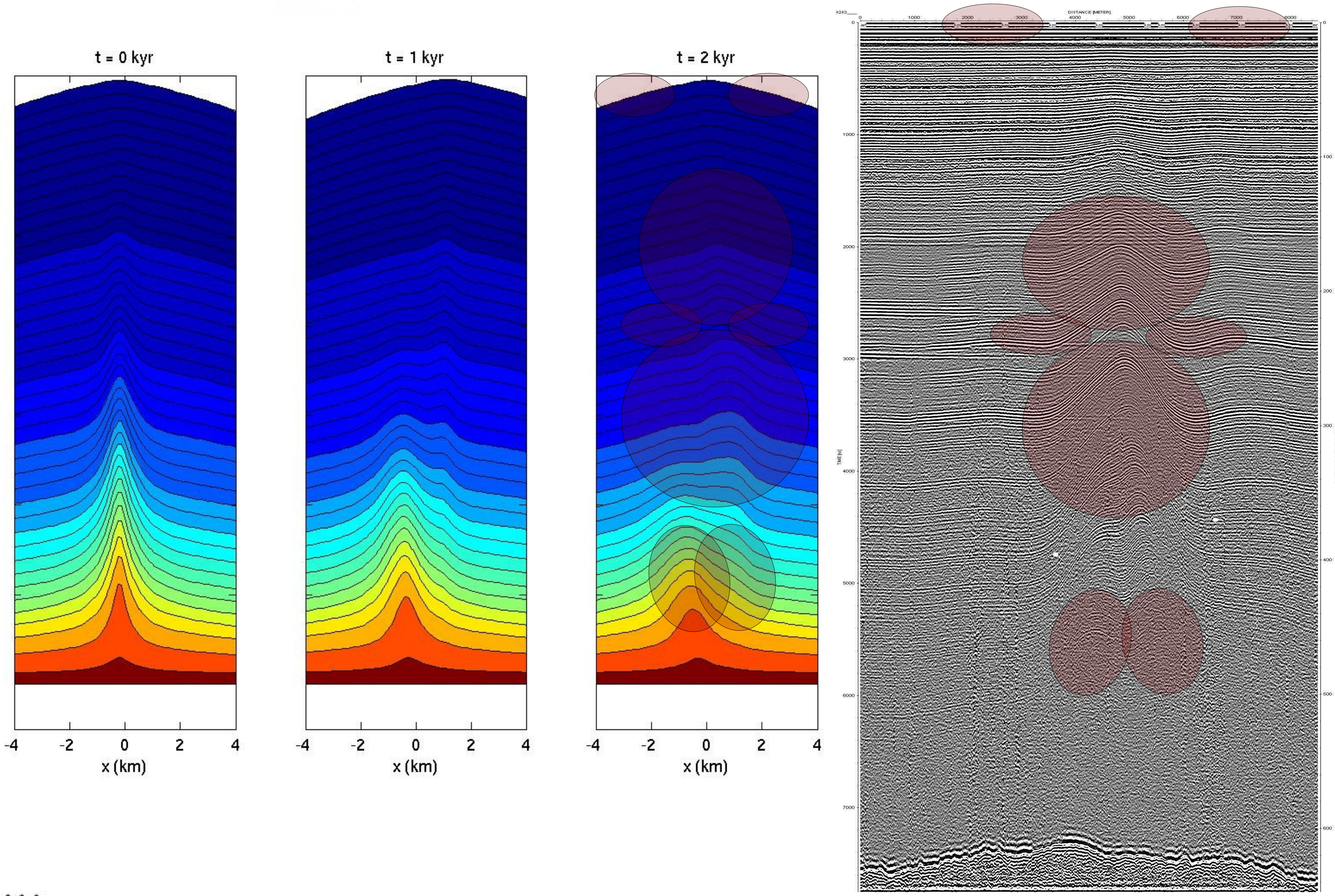
* (Hindmarsh, 96)





$$\frac{\partial T}{\partial t}$$

What’s wrong? Spot the differences



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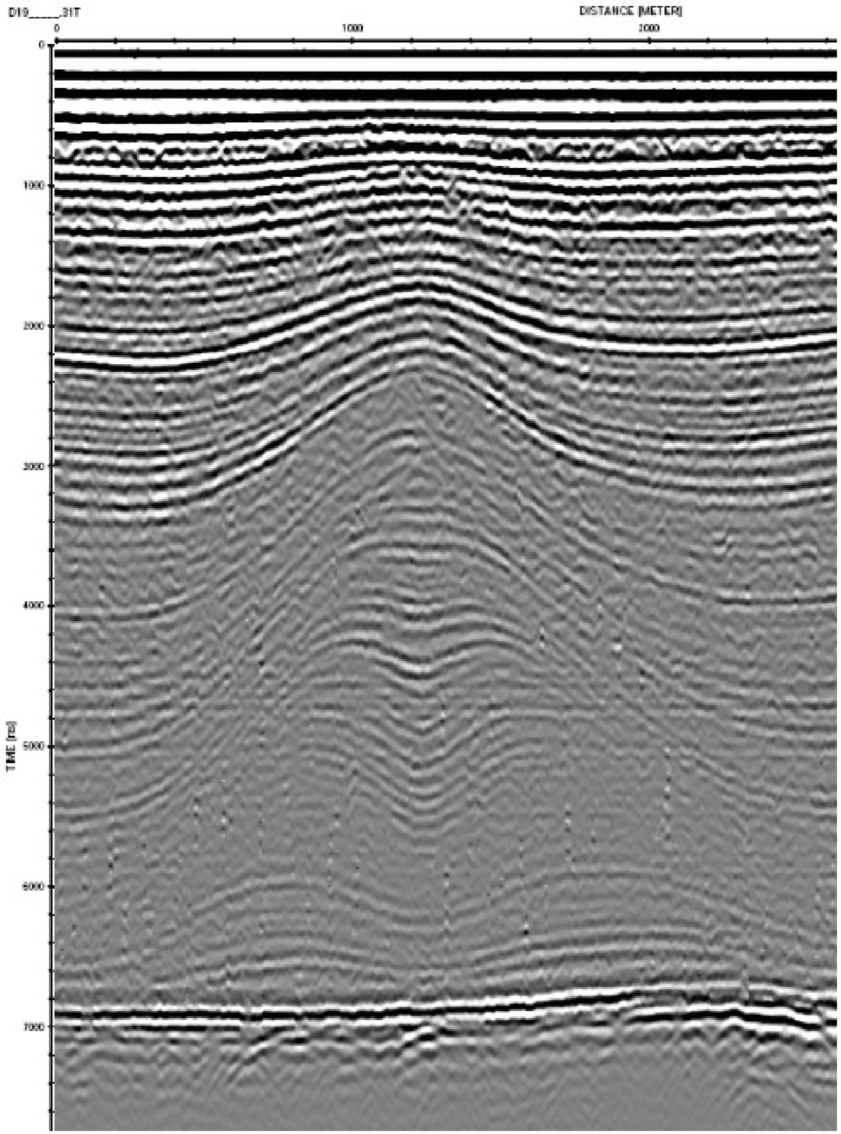
Double-rooted bumps: *ad hoc* explanation



Beneath the ice divide ice should be stiffer

Double-rooted bumps can be explained with:

-n>10

-n>5 small deviatoric stresses (~10 kPa)

-Considering ice as a Bingham fluid.

-High anisotropy

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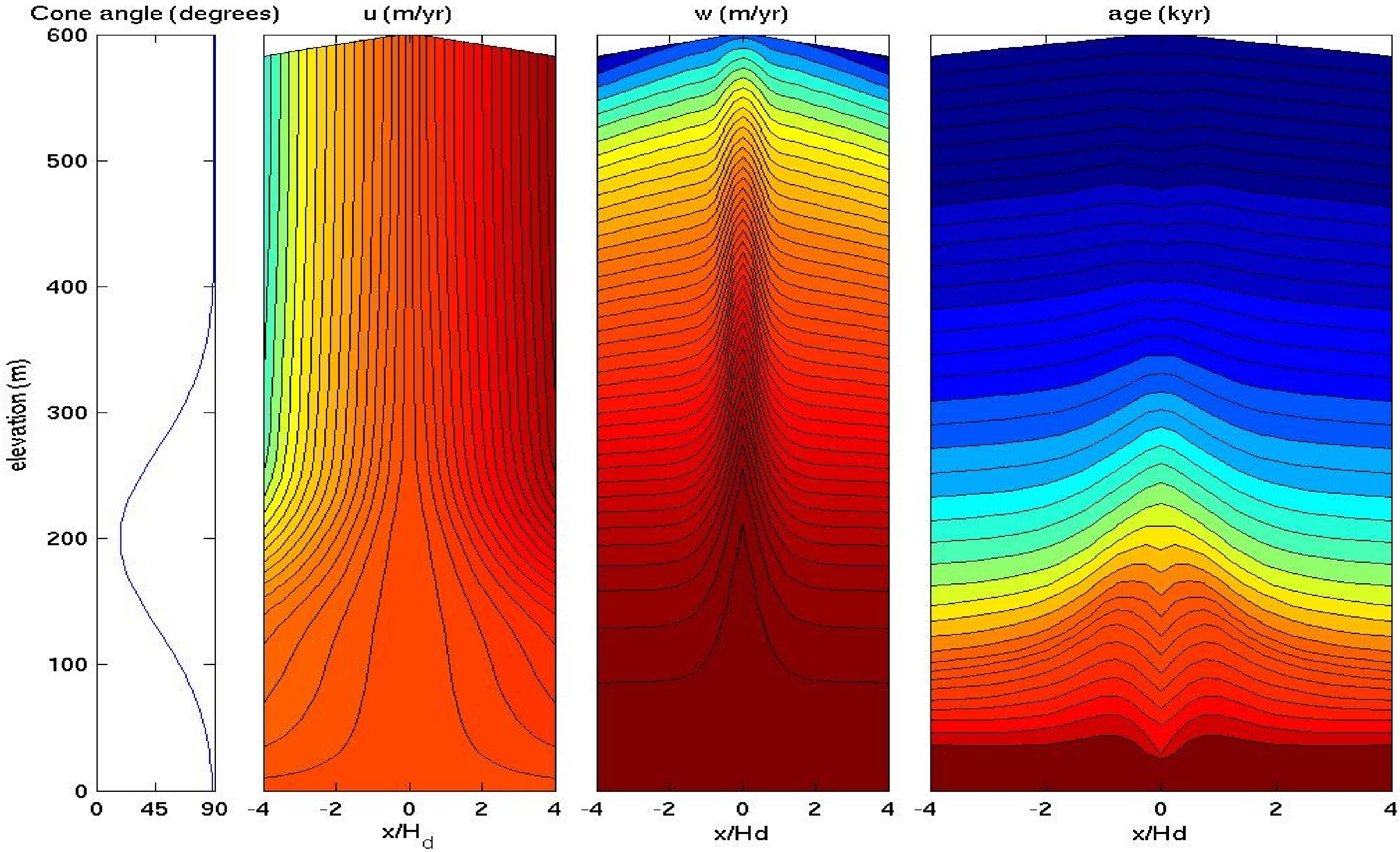
Double-rooted bumps: anisotropy?

Anisotropy as in Pettit 2003, Thorsteinsson 2001



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Conclusions

Ice divide migration

-There are traces of past ice divide migration in the radar layers geometry

Fast migration leaves Raymond bumps in a flank position which are advected with the flow while new ones develop in the new stationary position (e.g., Roosevelt Island).

Slow migration produce a tilt in the axis of the crests of the arches (e.g. Siple Dome, Kealey ice rise).

-Transient temperature effects are important when the time scale is comparable to the surface relaxation time ($\tau_h \approx (\tau/16)^*$)

Ice divide properties

-Considering a standard rheology (n~3) and isotropy there are features that can not be explained: bump amplitude and width, surface shoulders, radar layer dips... Double-rooted bumps.

-Anisotropy?