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UNIVERSITÄT
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FACULTY OF
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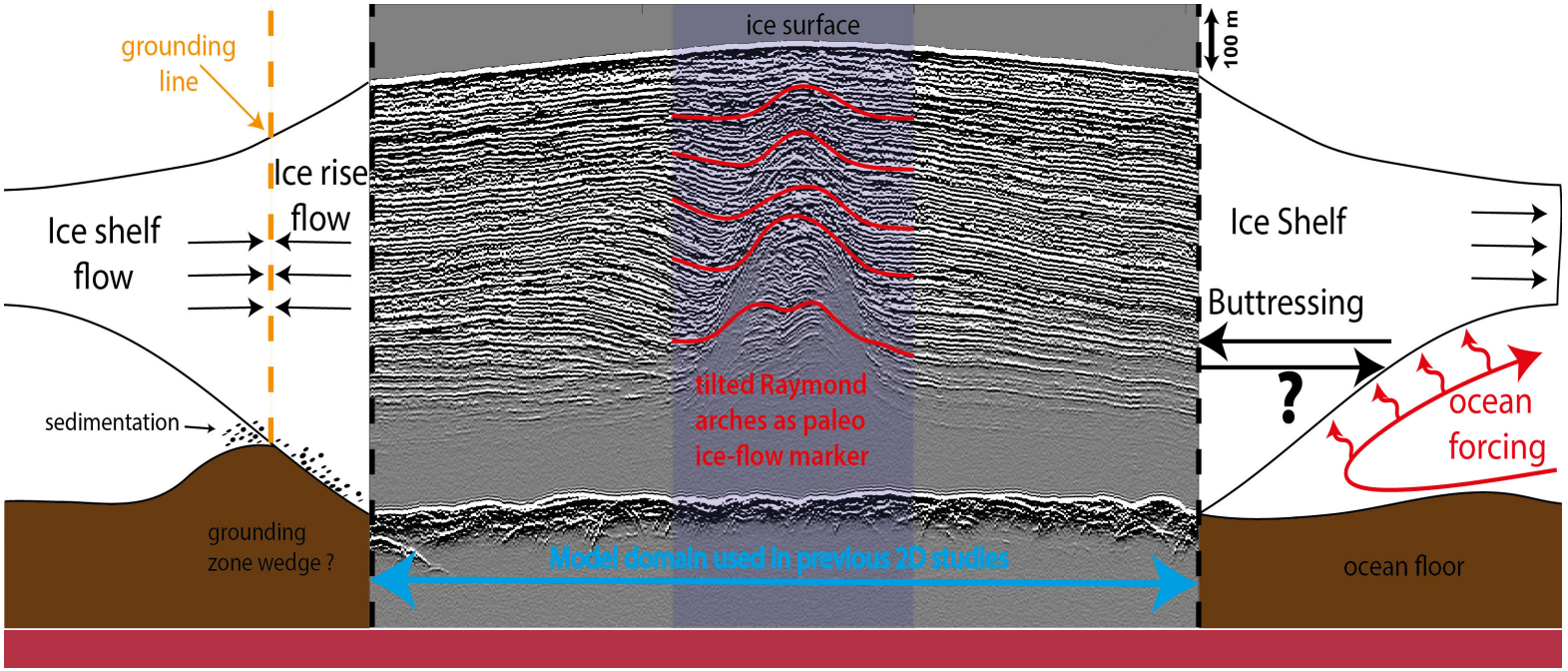
Institute of Geodynamics

ESD
Earth System
Dynamics Research Group



Modelling of ice rises in East Antarctica with Elmer/Ice

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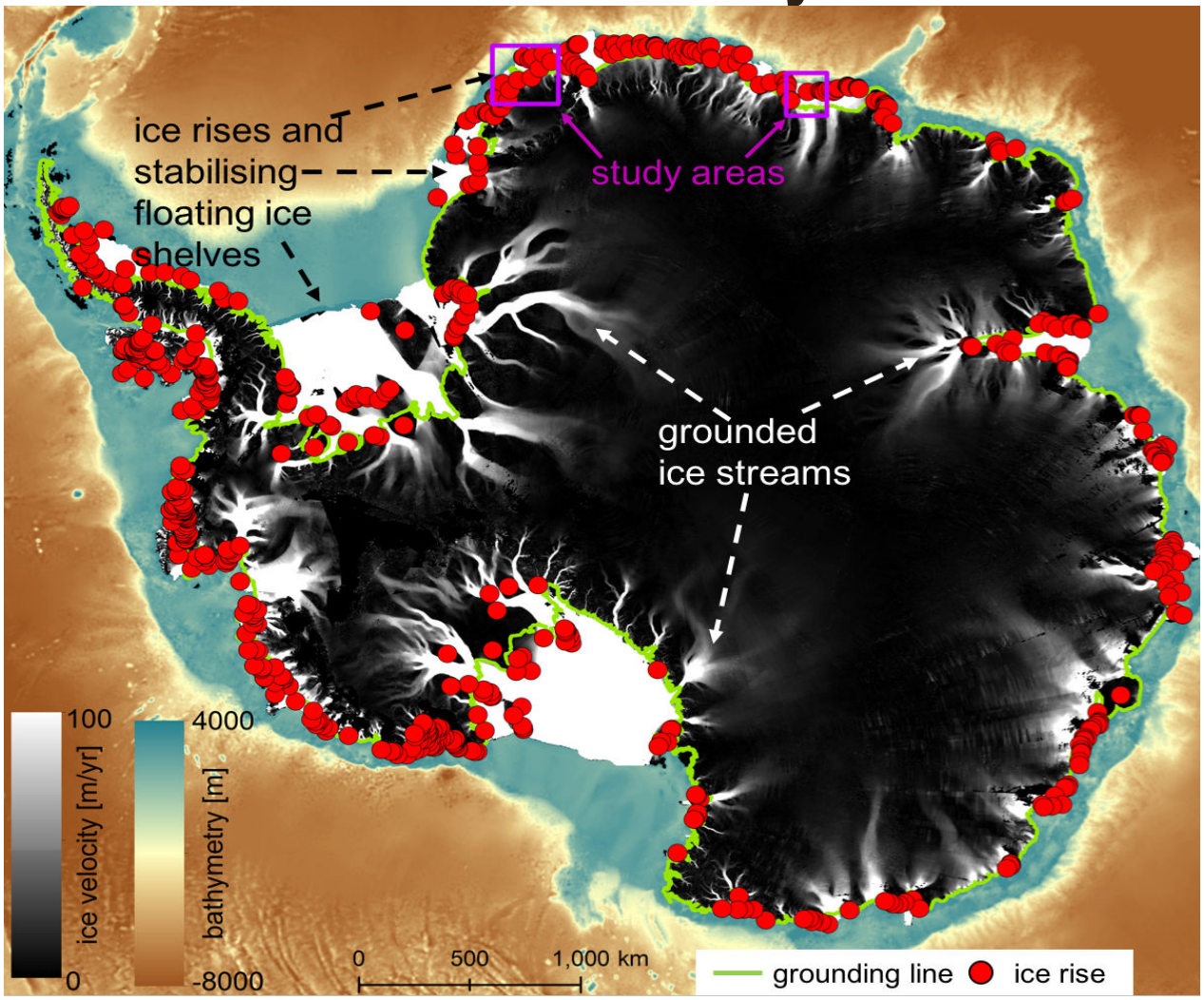
Earth System Research Group (Prof. Todd A. Ehlers)

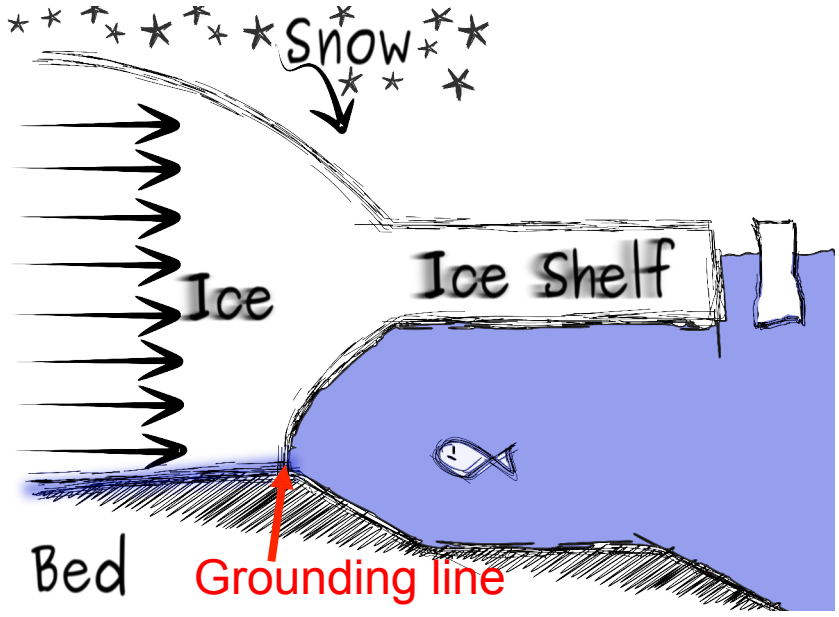
Outline

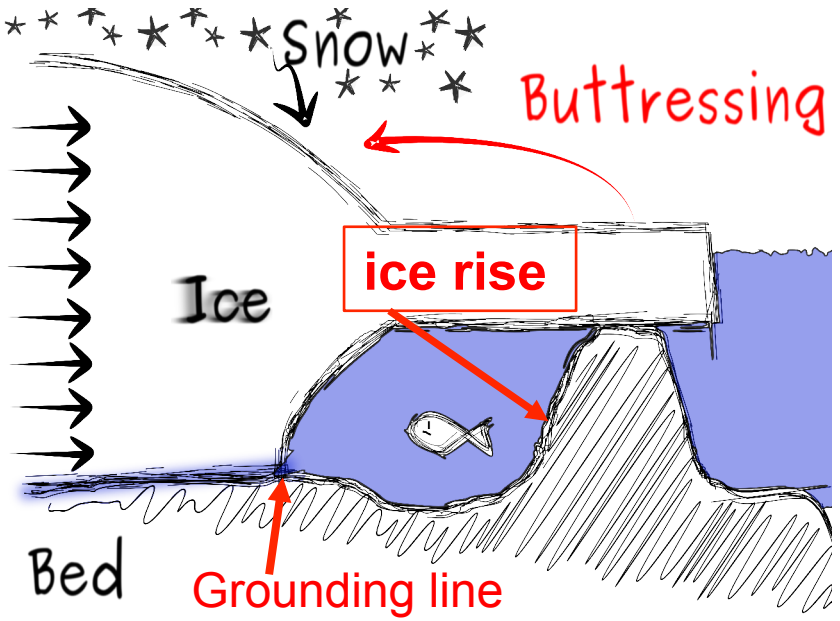
1. Introduction
2. 3D Elmer/Ice modelling
   Halvfaryggen Ice Rise
3. 3D Elmer/Ice synthetic geometry

Antarctica surrounded by ice rises

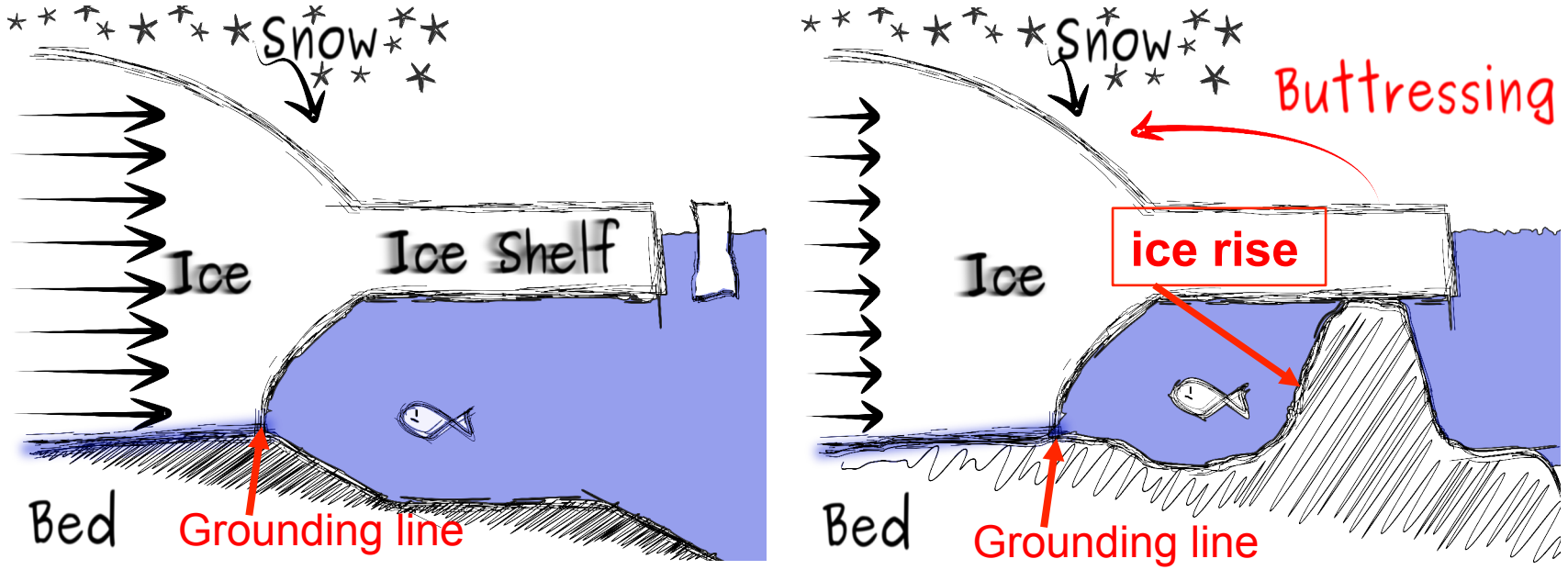


Ice shelf buttressed through ice rise



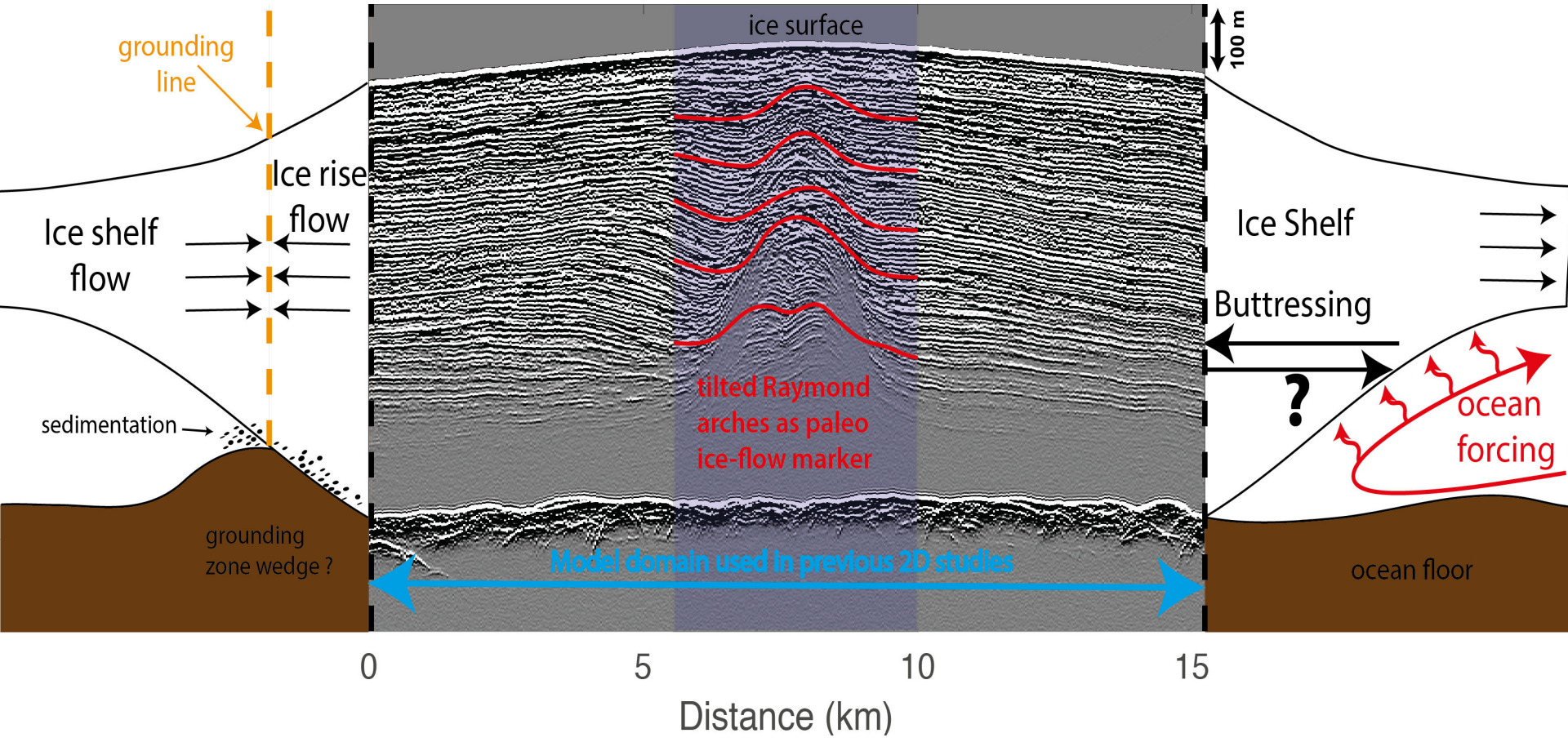


Ice shelf buttressed through ice rise



- **Ice rises** usually **omitted** in **continental scale simulations**

Previous modelling approach

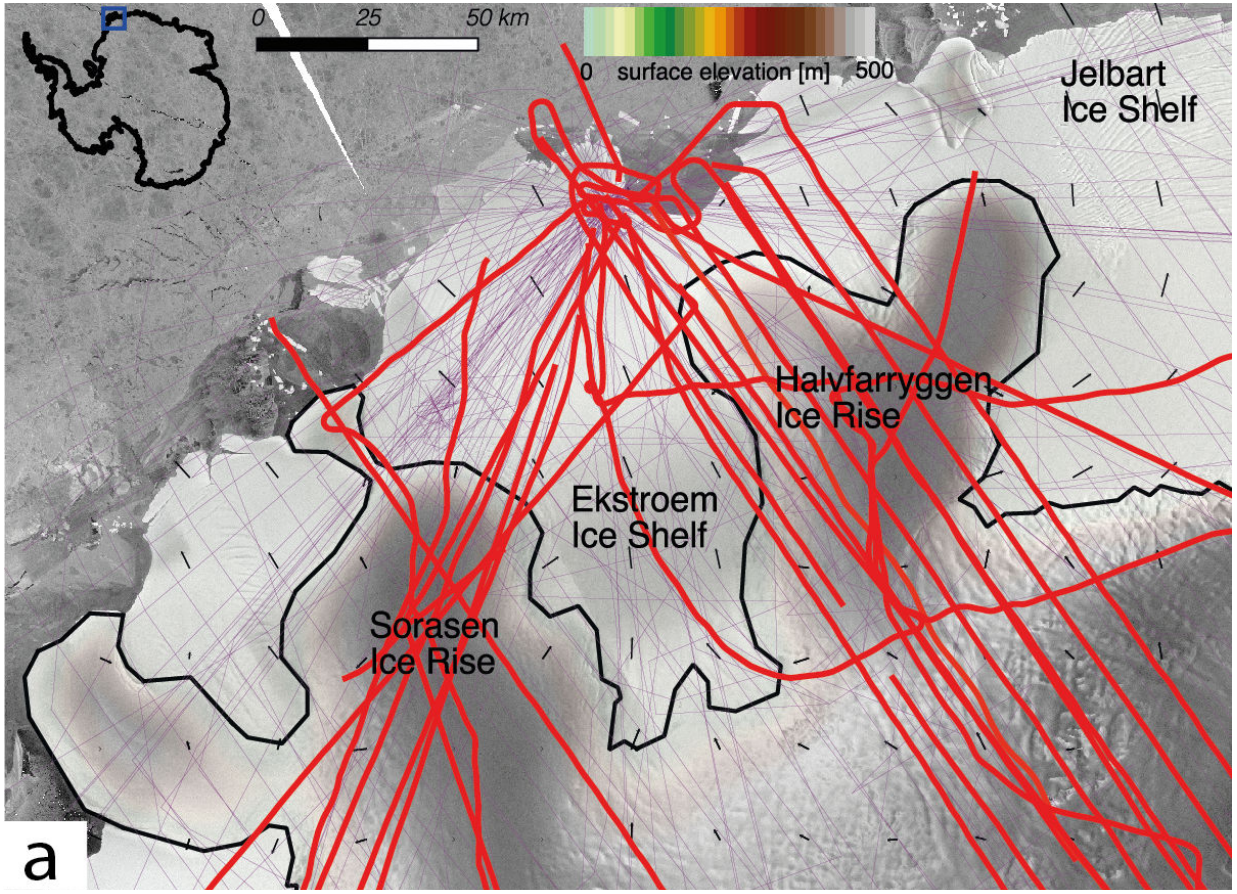


Hypotheses tested

1. Ice rises are paramount for the stability of the Antarctic ice sheet

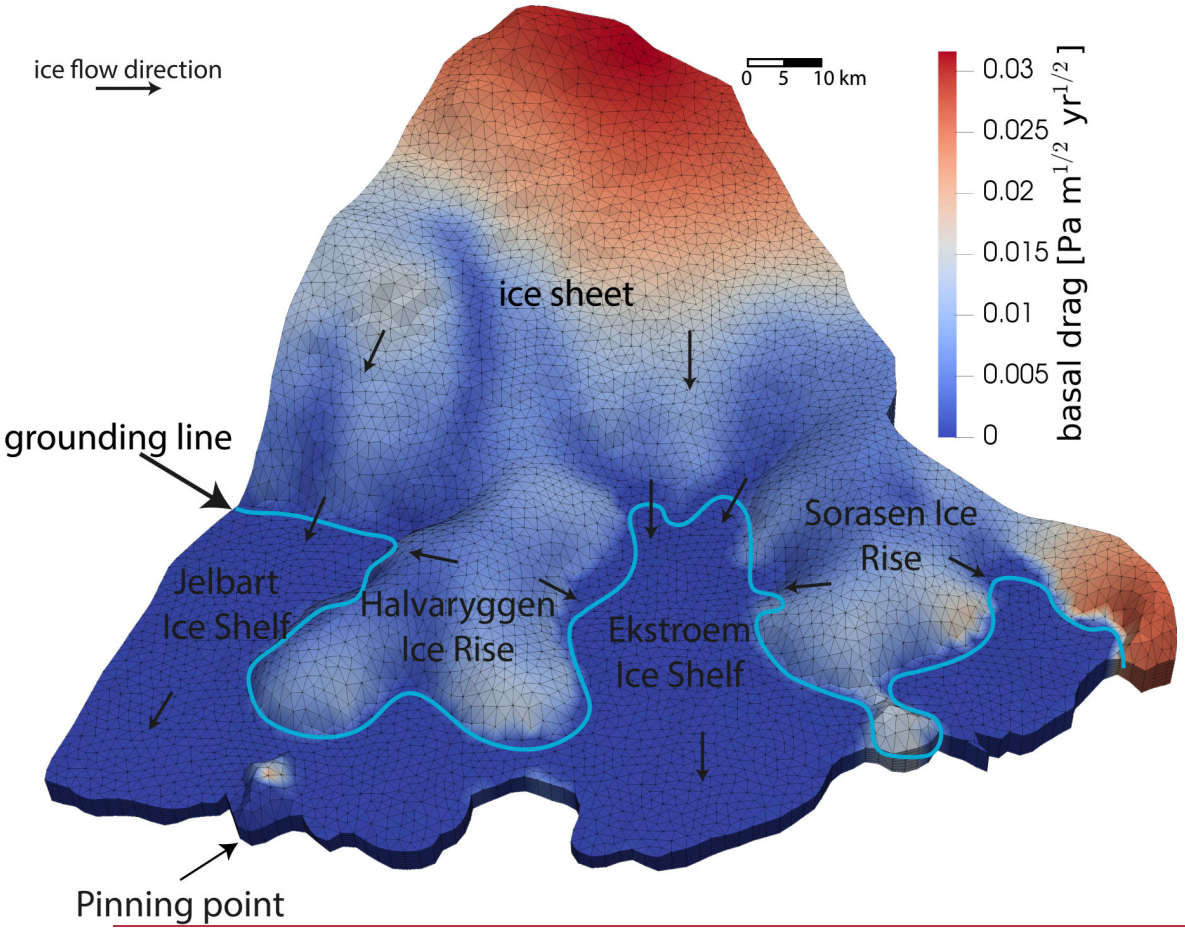
2. Ice rises are an untapped archive for past ice thickness and grounding-line positions

Study site: Ekstroem Ice Shelf



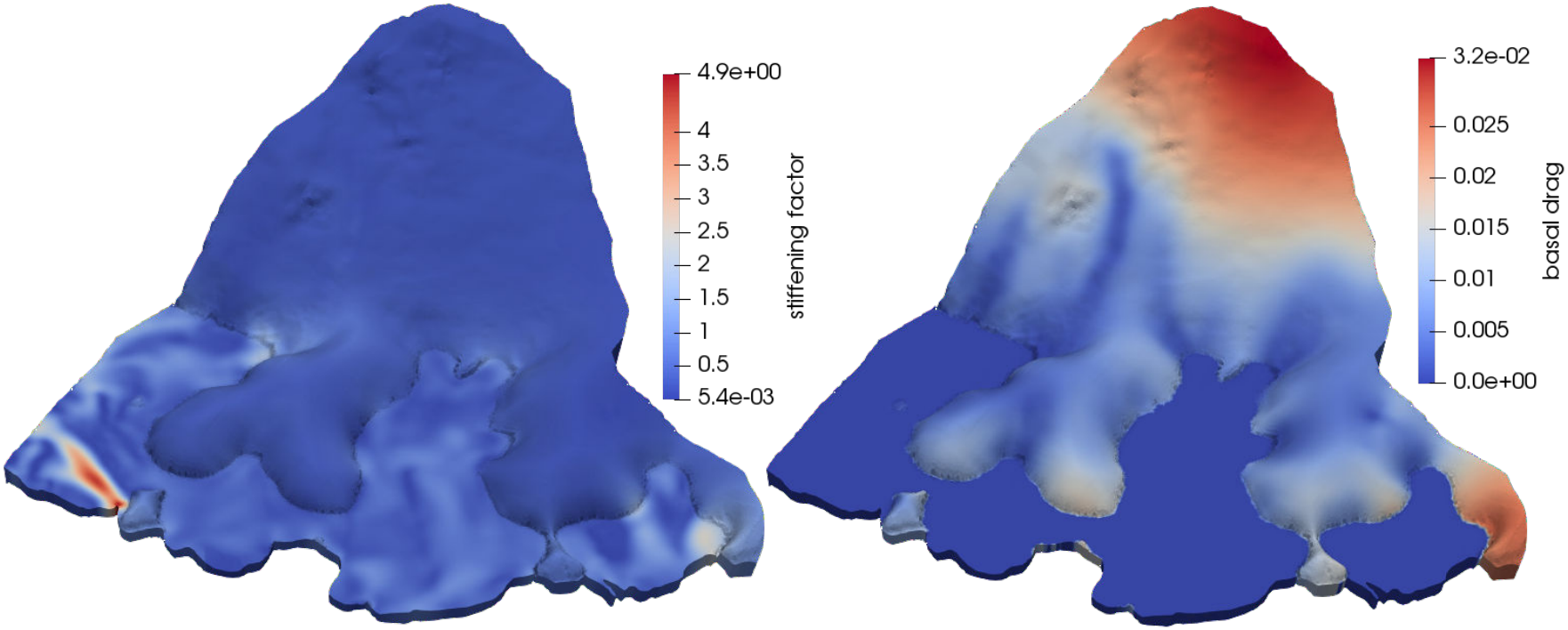
- **Dense network of boundary input datasets** (e.g. bedrock and surface topography)

Model domain



- **Dense network of boundary input datasets** (e.g. bedrock and surface topography)
- Multiple **ice rises and pinning points**

Inversion for basal drag and ice stiffening

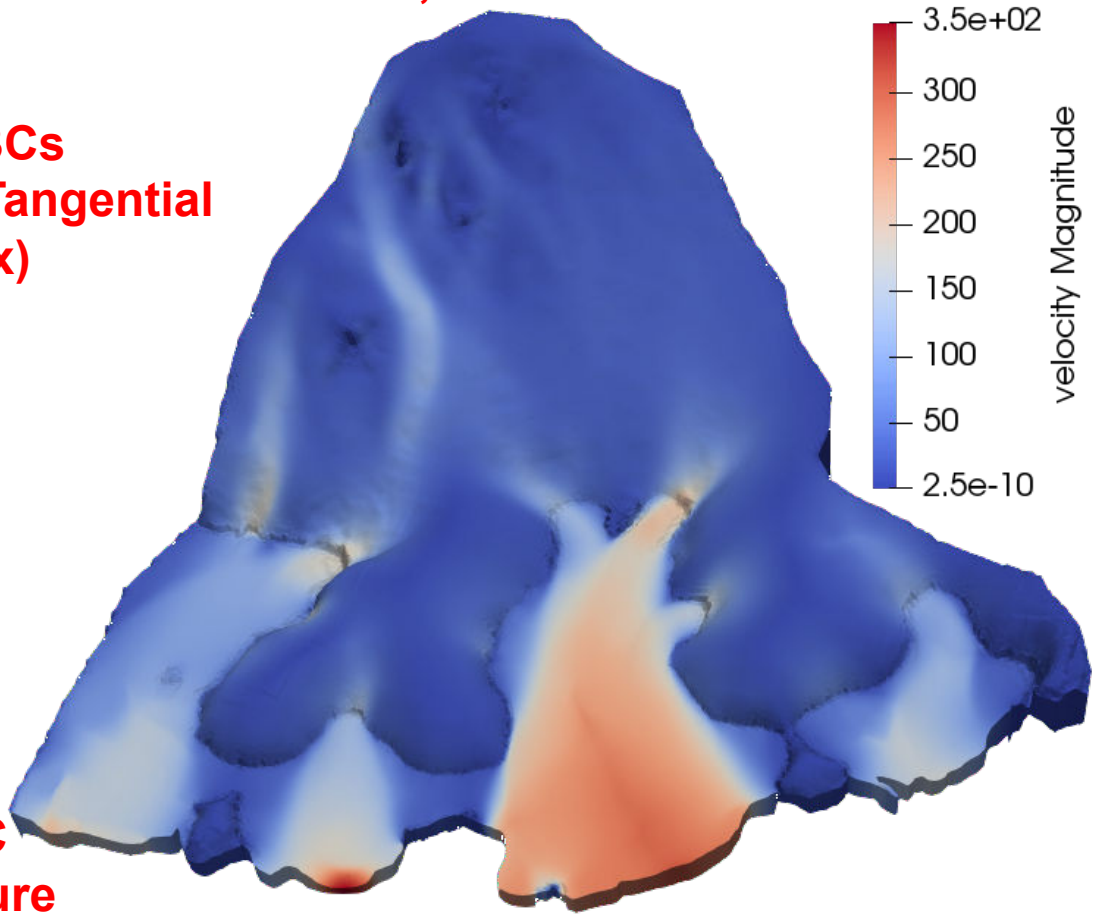


- **Ice stiffening** factor inferred from inverse method **at 1km horizontal resolution**
- **Basal drag coefficient** inferred from inverse method **at 1km horizontal resolution (linear Weertman)**

Model Setup Relaxation Simulation

Back BC Normal Tangential
Vel 1 = 0; Vel 2 = 0

Lateral BCs
Normal Tangential
(no influx)
Vel 1 = 0



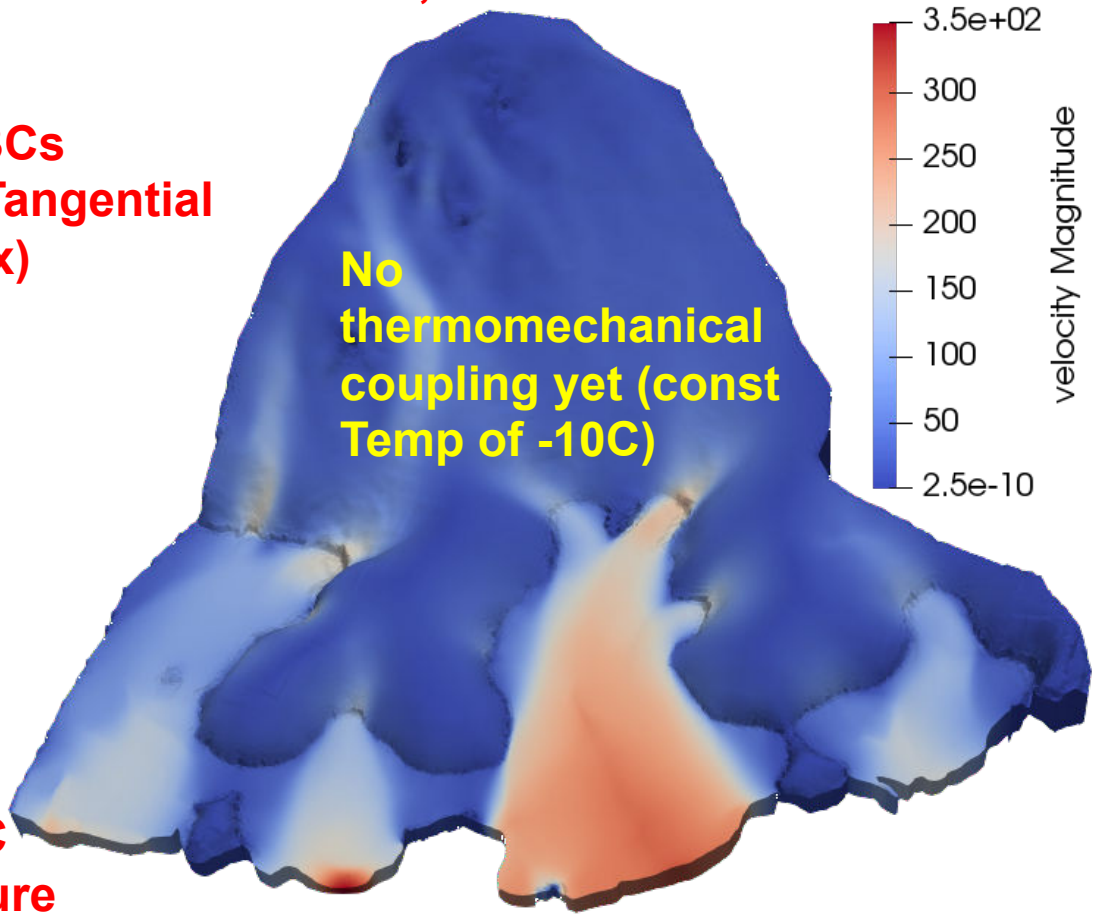
Basal BC
Linear Sliding

Front
Calving BC
Sea Pressure

Model Setup Relaxation Simulation

Back BC Normal Tangential
Vel 1 = 0; Vel 2 = 1e10

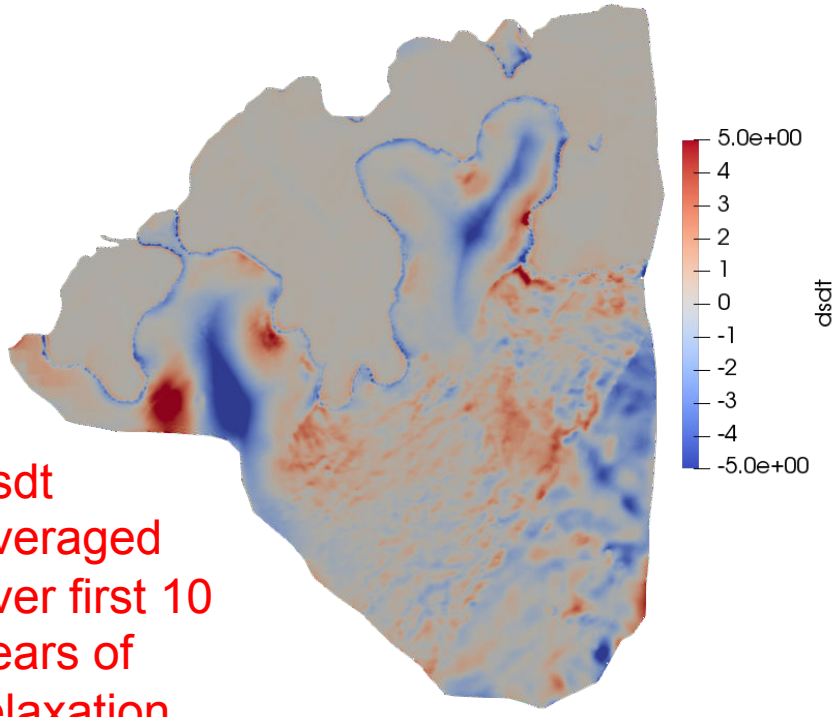
Lateral BCs
Normal Tangential
(no influx)
Vel 1 = 0



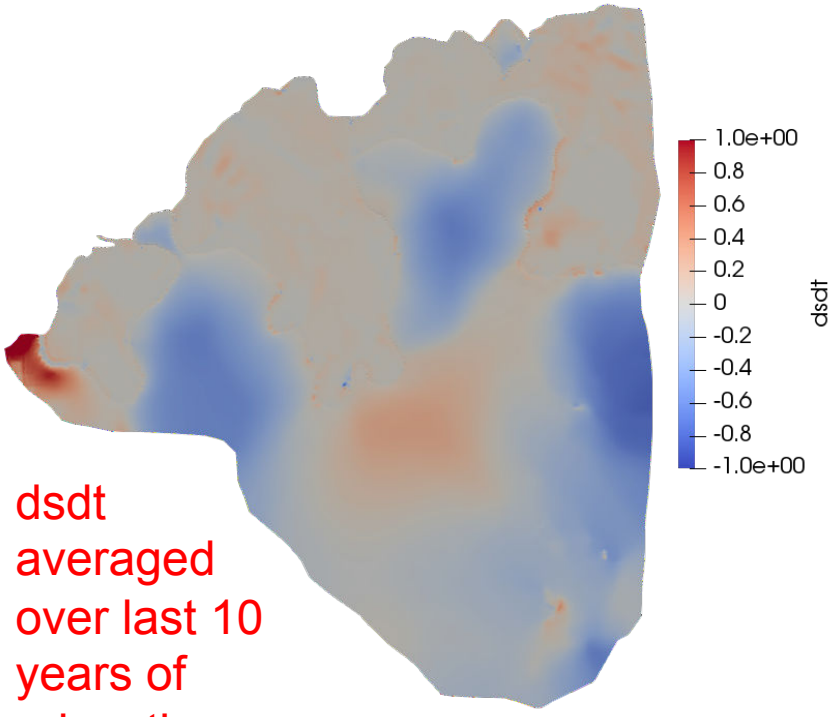
Basal BC
Linear Sliding

Front
Calving BC
Sea Pressure

Ice loss at ice divides



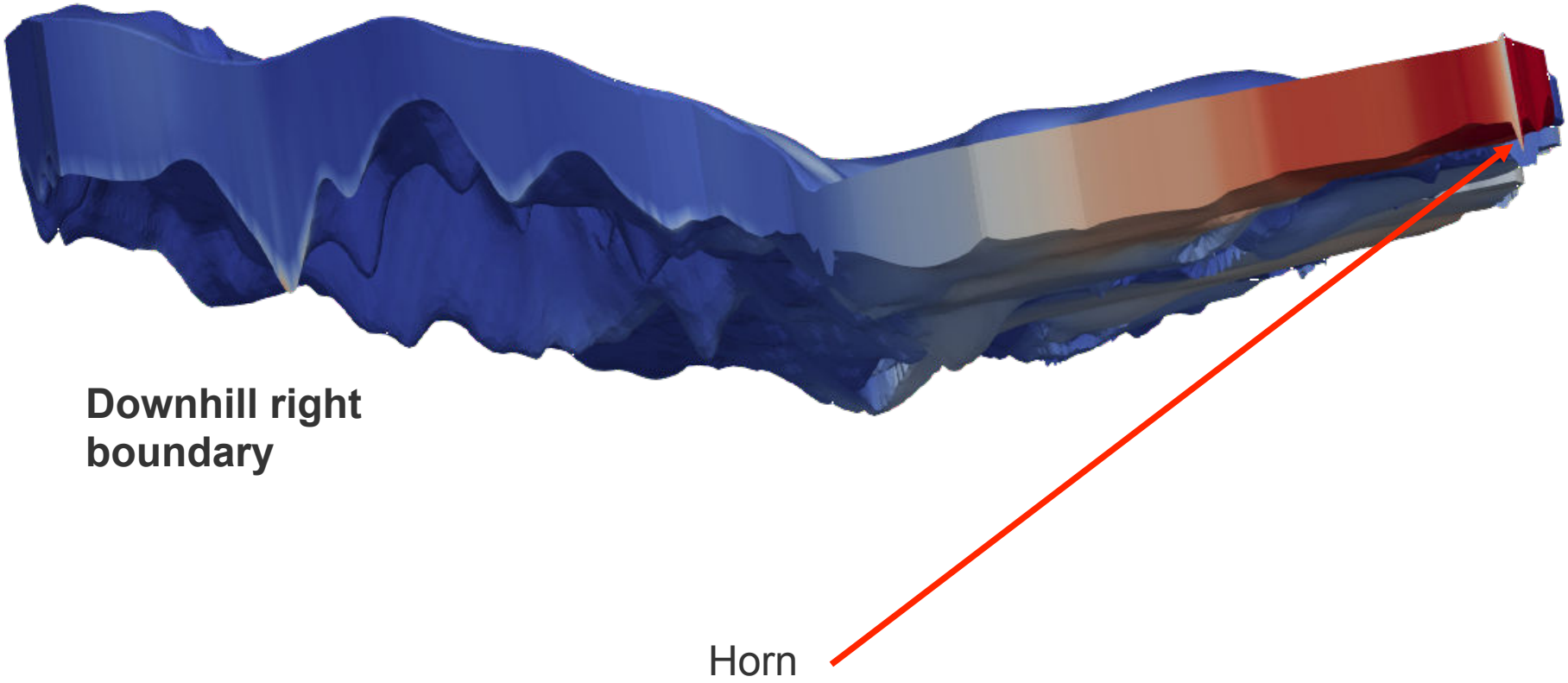
dsdt averaged over first 10 years of relaxation



dsdt averaged over last 10 years of relaxation

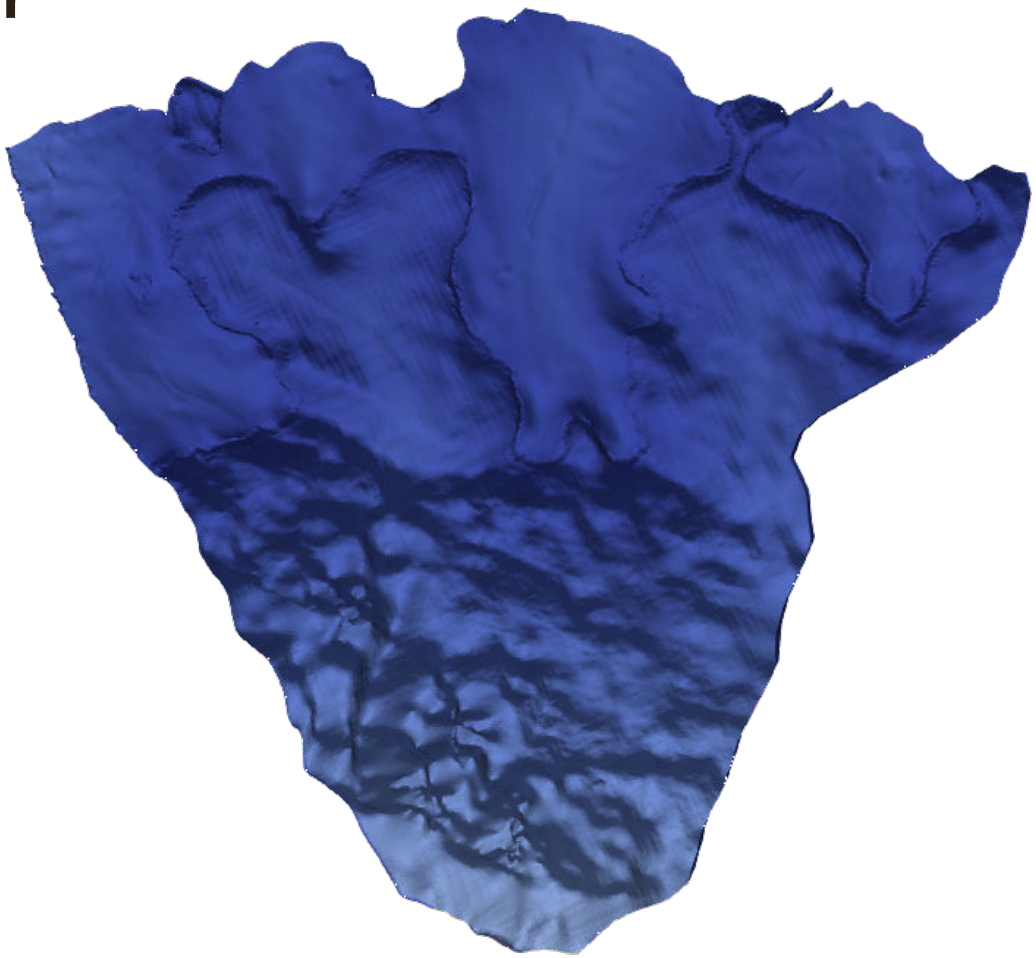
- Total ice loss of ~200 m at divides over 100 year relaxation simulation

Horns at ice shelf boundary

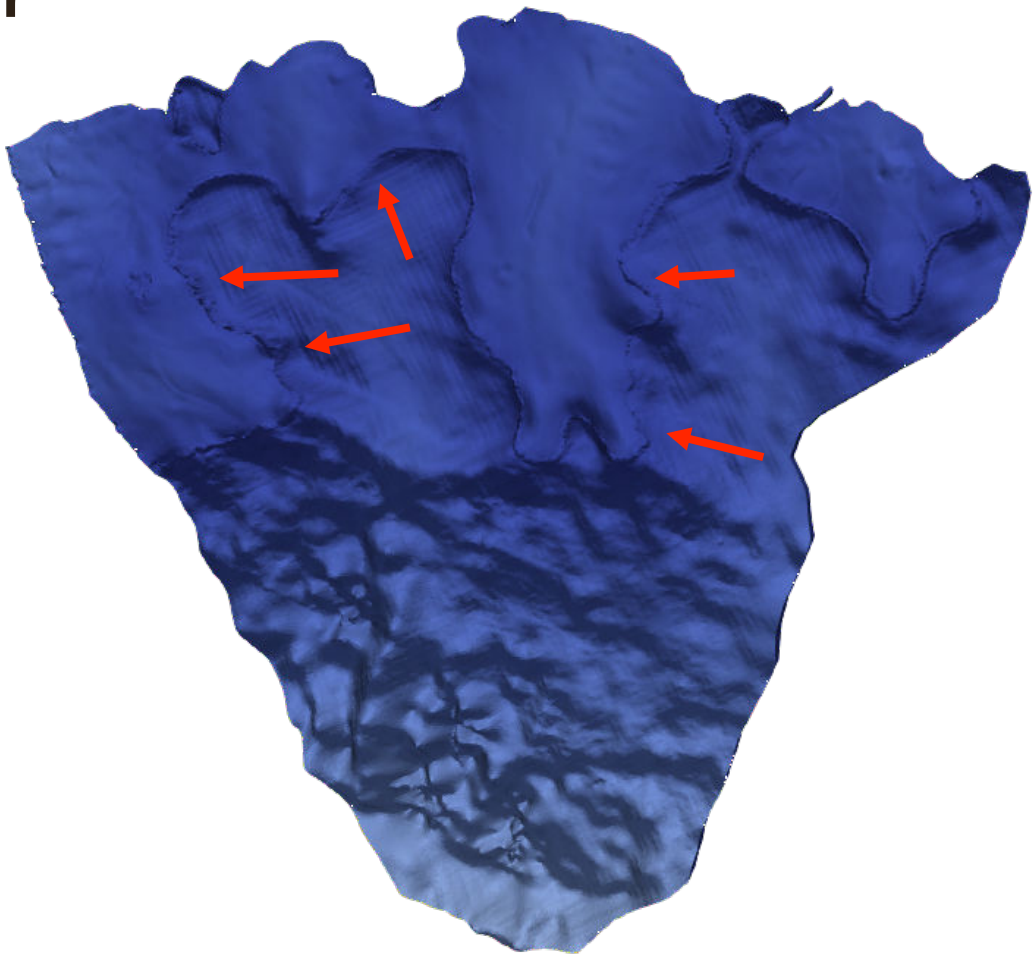


Reading relaxed geometry back in with Structured Mesh Mapper

Underside of the ice sheet



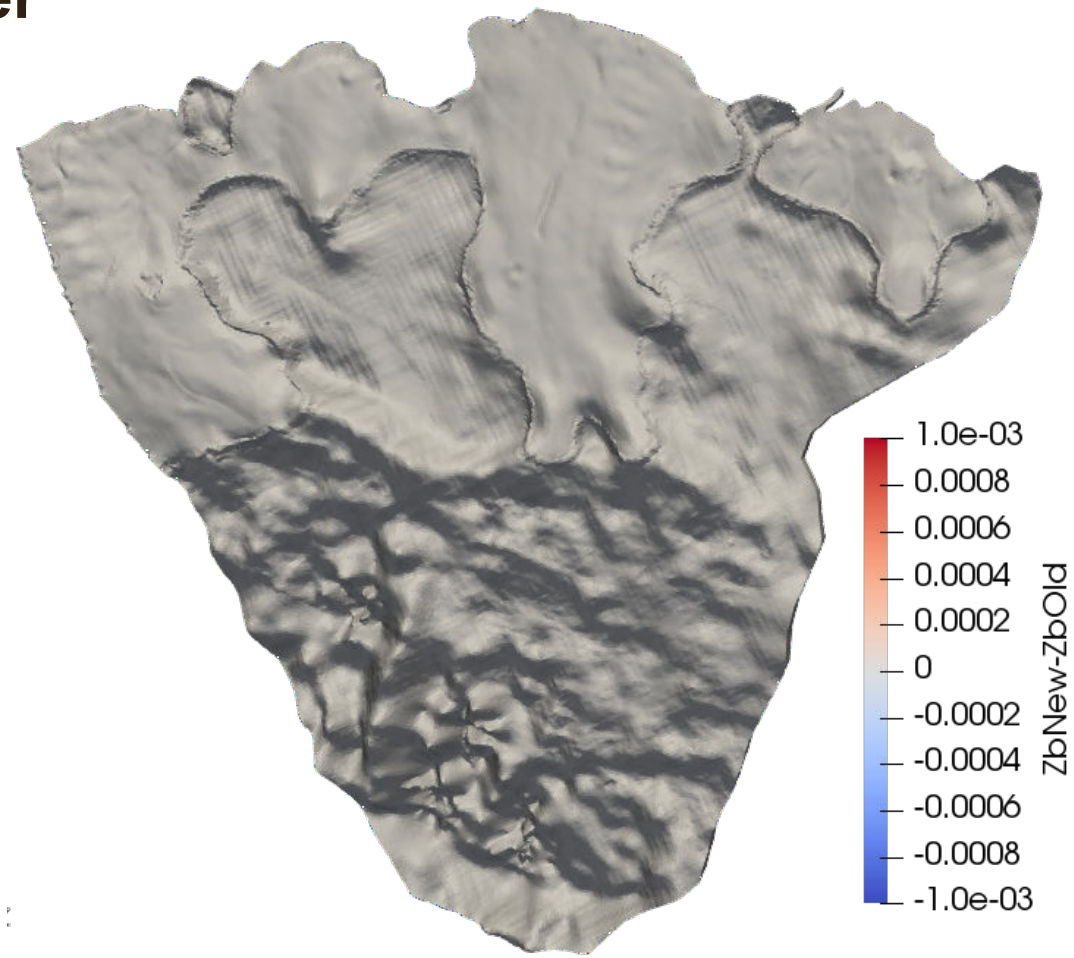
Reading relaxed geometry back in with Structured Mesh Mapper



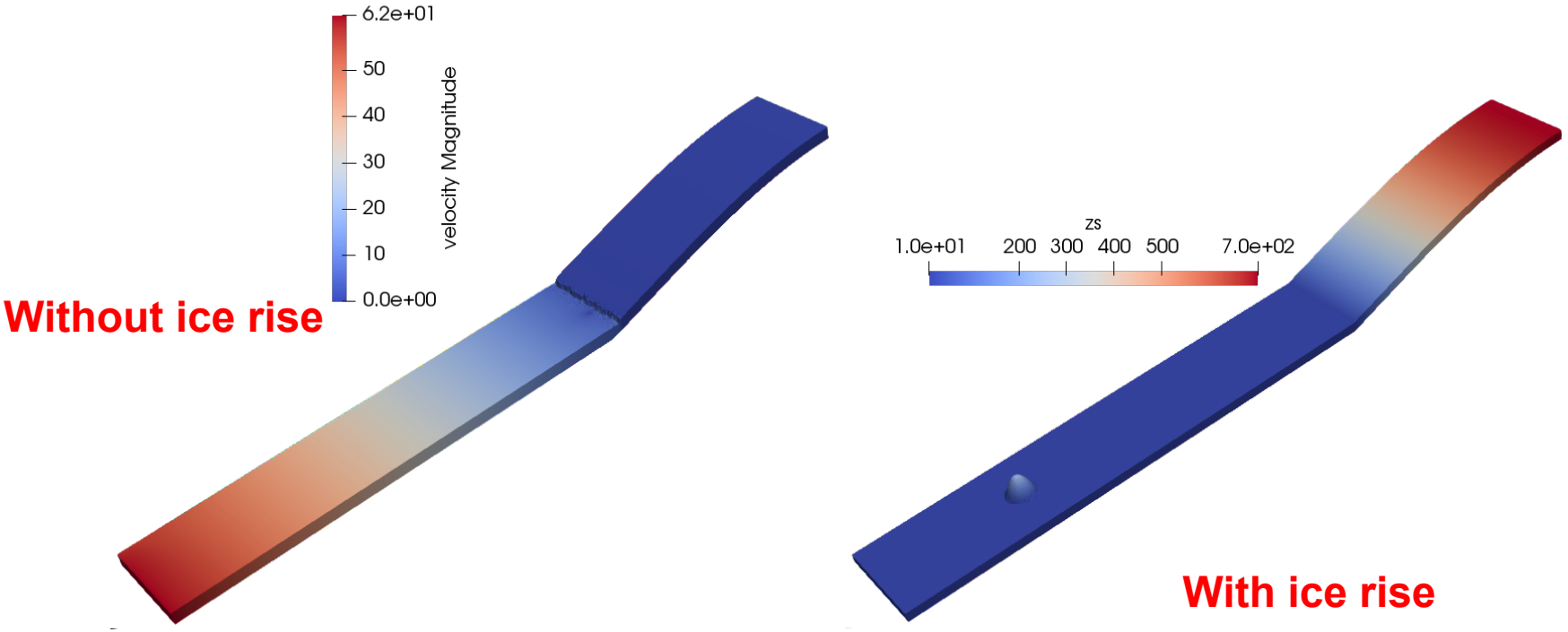
Underside of the ice sheet

Reading relaxed geometry back in with Structured Mesh Mapper

Underside of the ice sheet

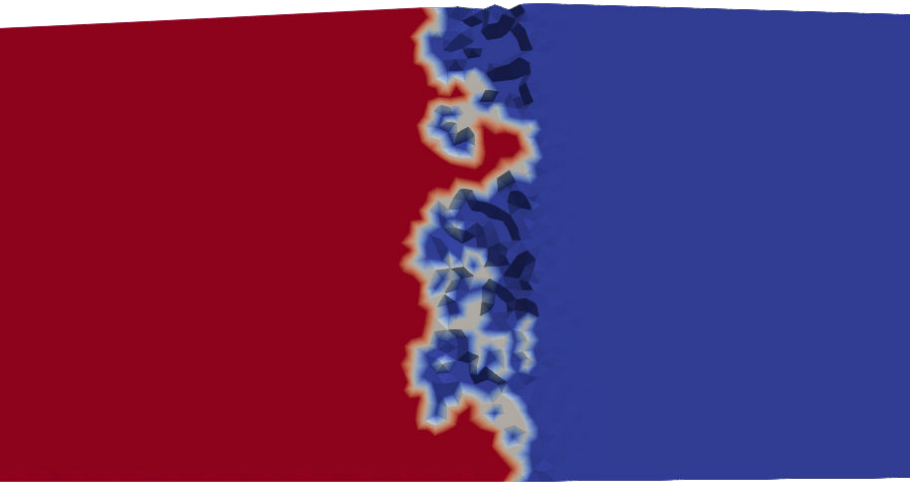


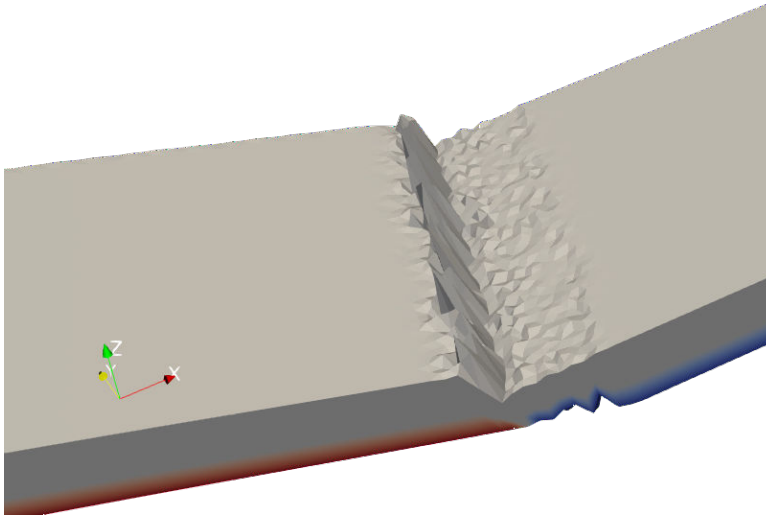
Synthetic 3D experiment



- Geometry from Favier 2015
- Run to steady state; force retreat by increase in sea-level

Synthetic 3D experiment





Future Work

- Age solver in shelf (semi-lagrangian solver together with Carlos Martin)
- L-Curve analysis, Convergence study
- Forcing experiments (e.g. ocean melting, divide migration)
- Coupling to landscape evolution model

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Thank you.

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