

Antarctic ice rise formation, evolution and stability

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Current knowledge and questions to answer

- The formation and evolution of ice rises has never been investigated
- Their potential to hamper the retreat of ice sheets has hardly been quantified so far
- Understanding and quantifying their impact is crucial in future sea level rise predictions
- The Raymond effect tells us that they may exhibit millenium-scale stability
- How do they form ?
- How fast they form ? Are they stable ?
- How much do they buttress ice shelves and contribute to the ice sheet stability ?

About ice rise and Antarctica ?

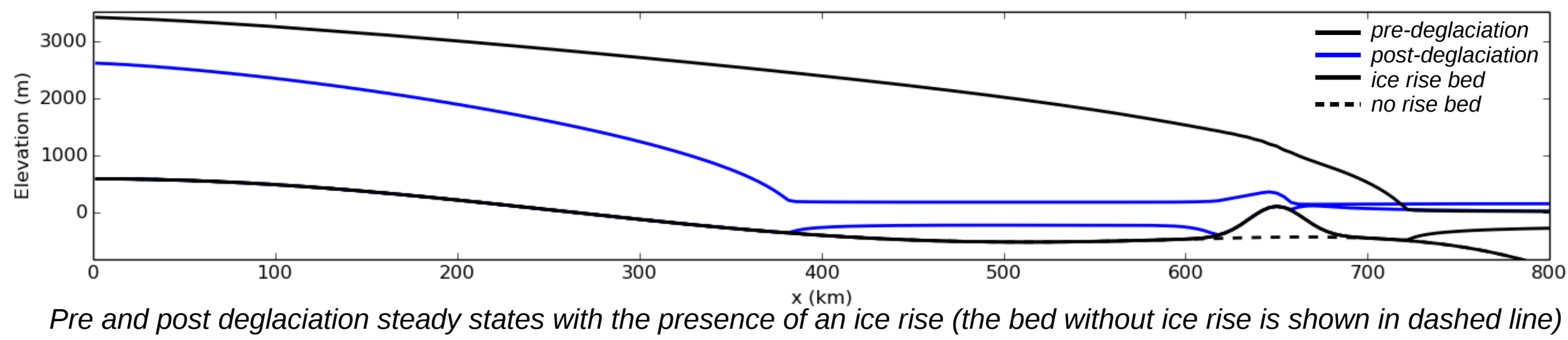
- In Antarctica, numerous topographic highs emerge from the edge of the continental shelf (see A box)
- Ice rises, or local dome protruding through the ice shelf, stem from the contact between those highs and the floating ice
- Ice rises are characterised by their local flow clearly disconnected from the much faster neighbouring ice shelf

Take home message

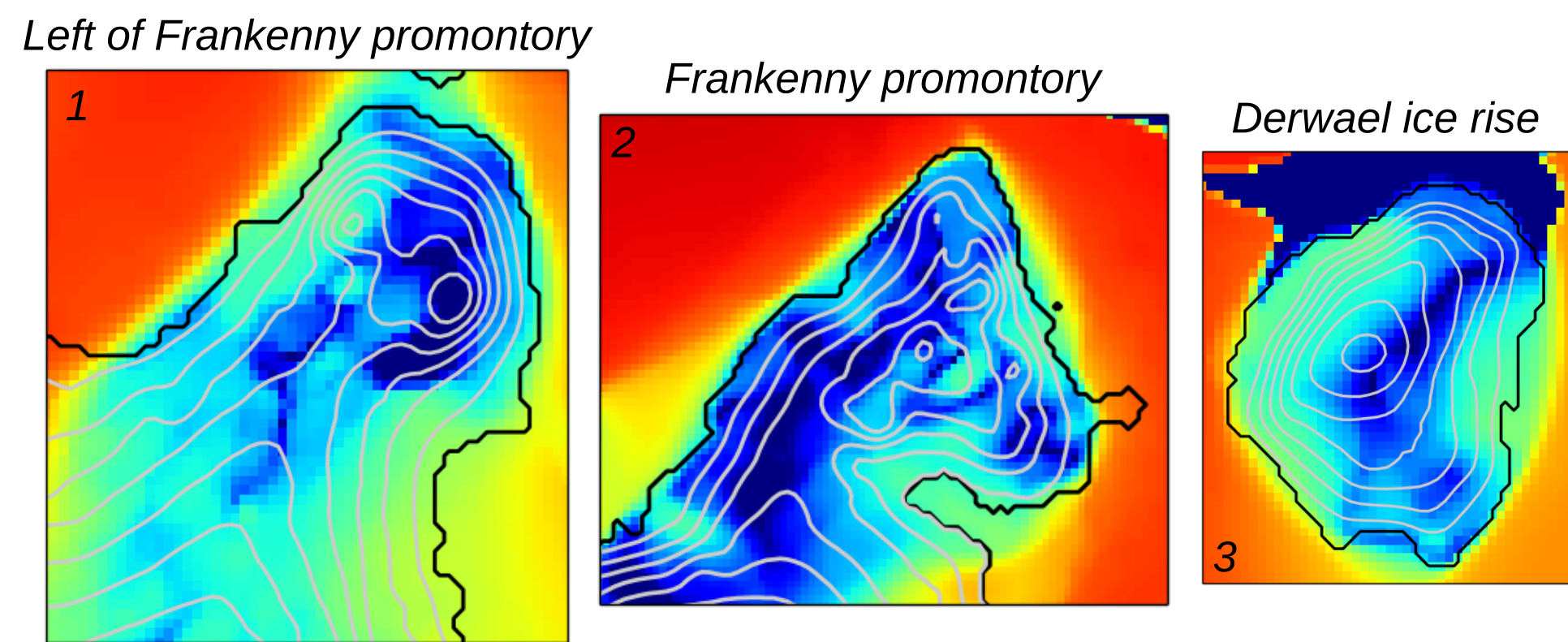
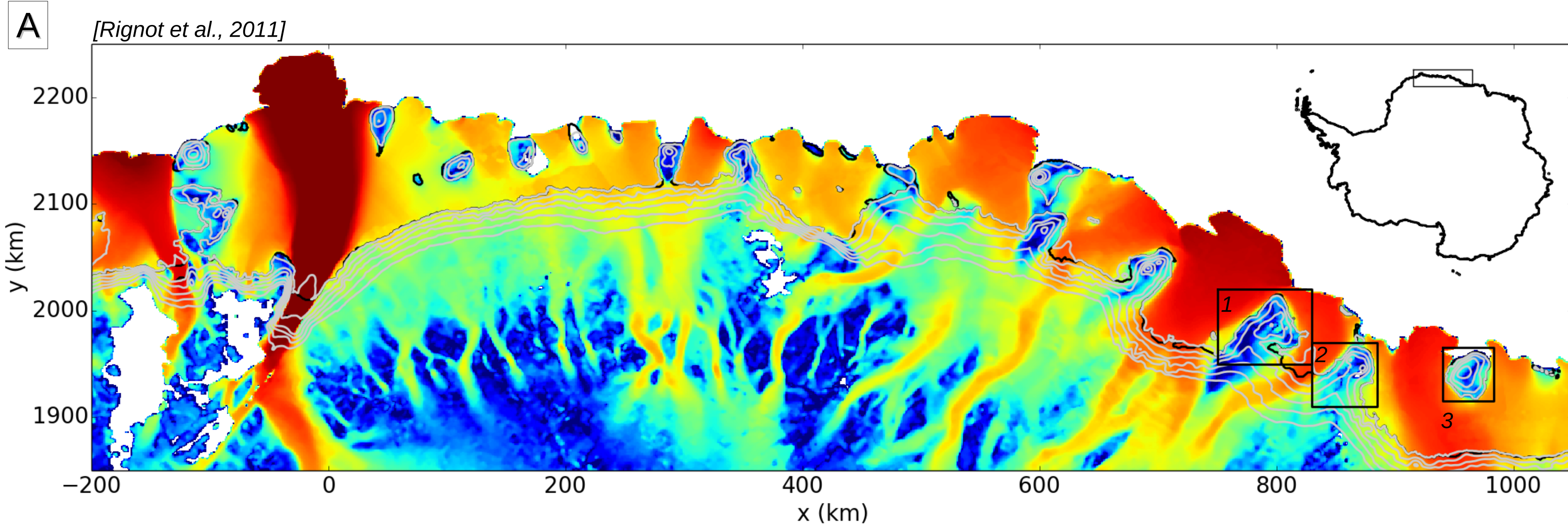
- We show that an ice rise is the result of the deglaciation of an ice sheet
- A number of field-observable features related to ice rises showed up in the modelling
- The buttressing effect induced by an ice rise is much more effective during the transient retreat of the ice sheet, compared to steady states before and after deglaciation
- The formation of the ice rise is rather quick compared to the time scale of the deglaciation
- This study seriously affects timing sea level changes, such as Meltwater Pulse 1A events since the last glacial maximum, but also affects understanding and quantification of future sea level rise from the Antarctic ice sheet

Methodology

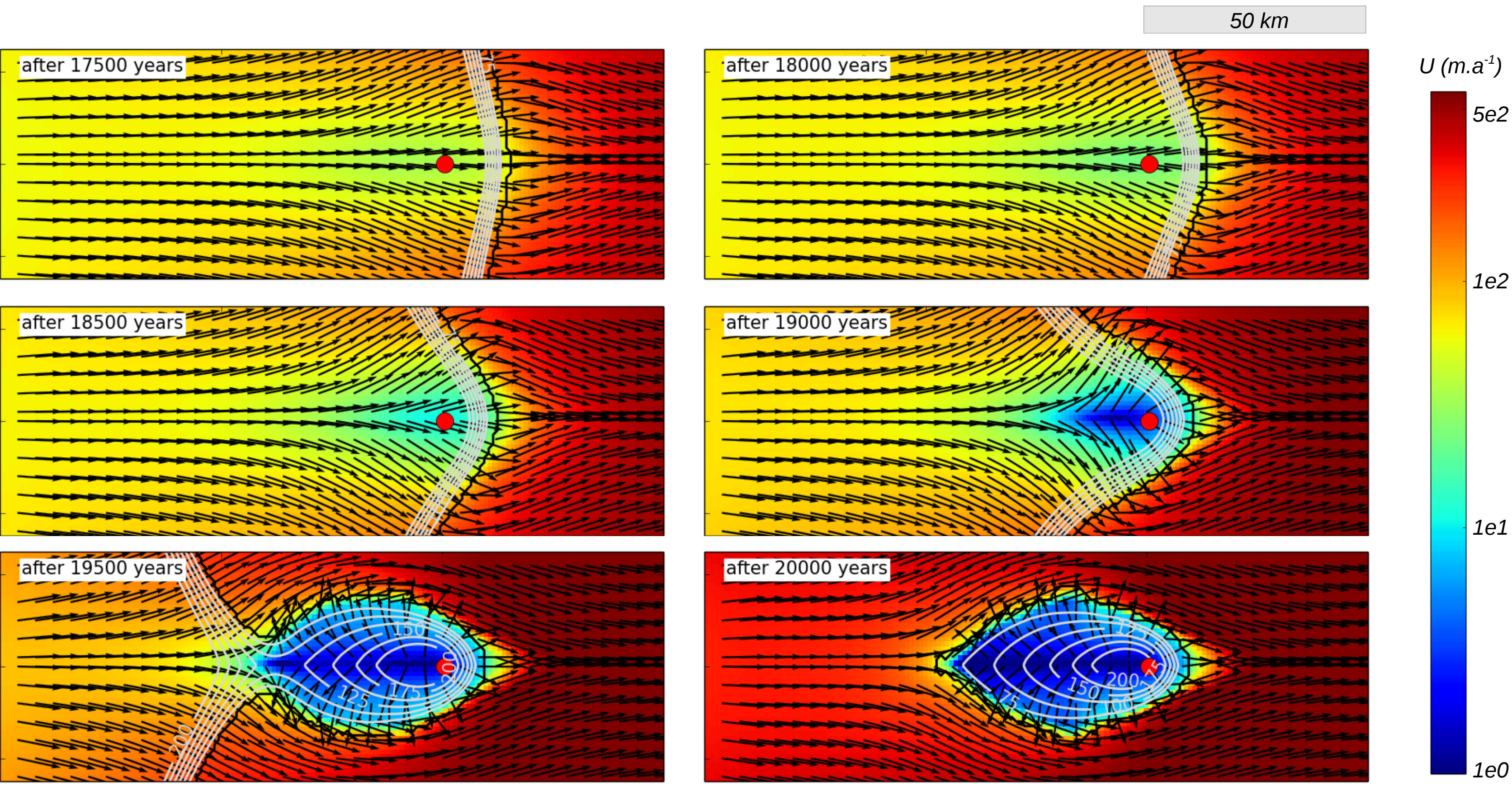
- We use the up-to-date ice-sheet model BISICLES [Cornford et al., 2013] with a resolution of 500 m at the grounding line
- 2 deglaciation experiments are done with or without an ice rise
- 3 steps : (i) pre-deglaciation steady state (5 ka), (ii) deglaciation (1 cm per year sea level rise during 15 ka) and (iii) post-deglaciation steady state (30 ka)



Pre and post deglaciation steady states with the presence of an ice rise (the bed without ice rise is shown in dashed line)



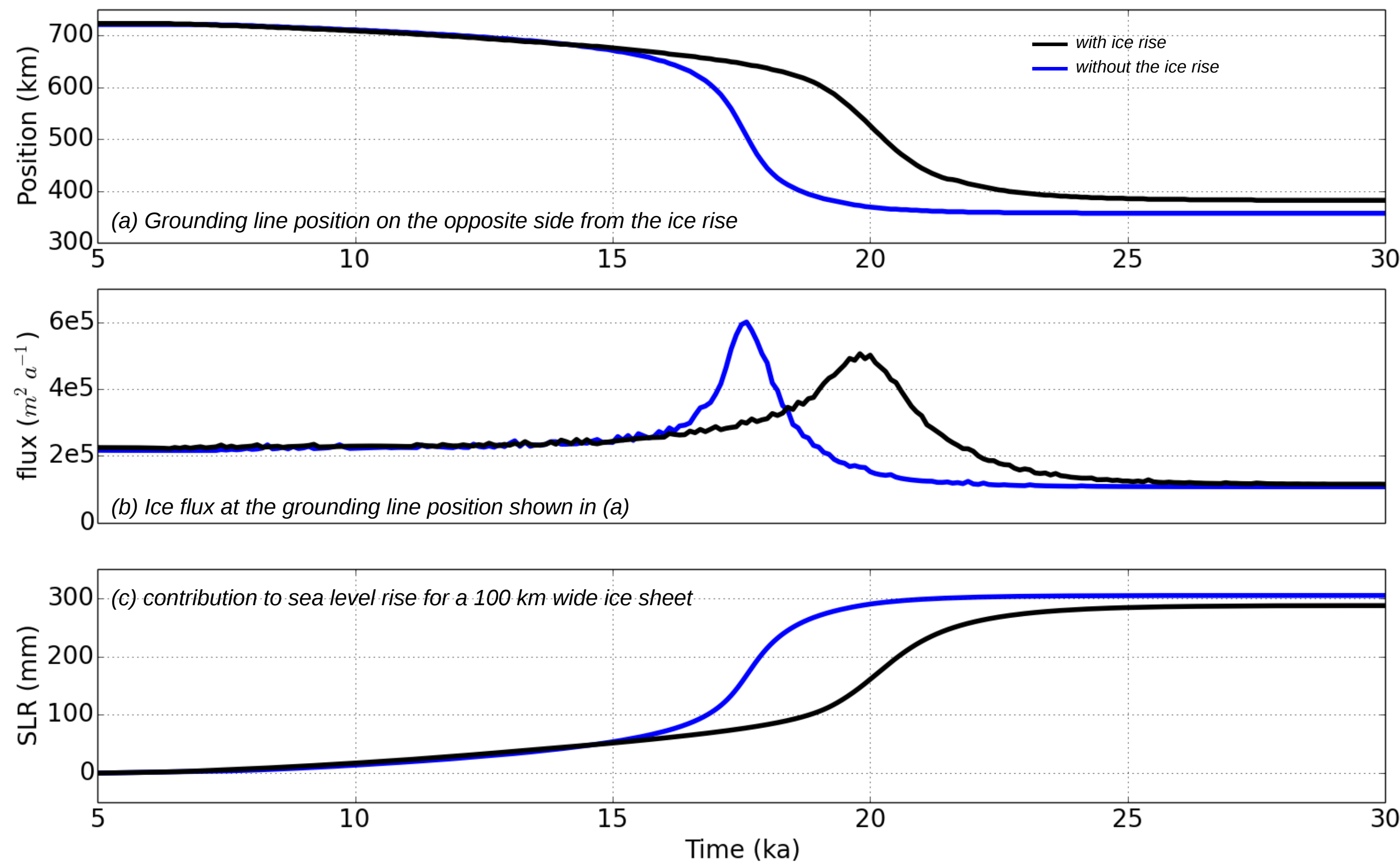
Stability and quick formation of the ice rise



Plan-view snapshots during the ice rise formation. Grounding line in black, height contour lines in gray (every 25 m), topographic high peak is the red dot, direction of flow is shown by the arrows, the speed by the colorbar

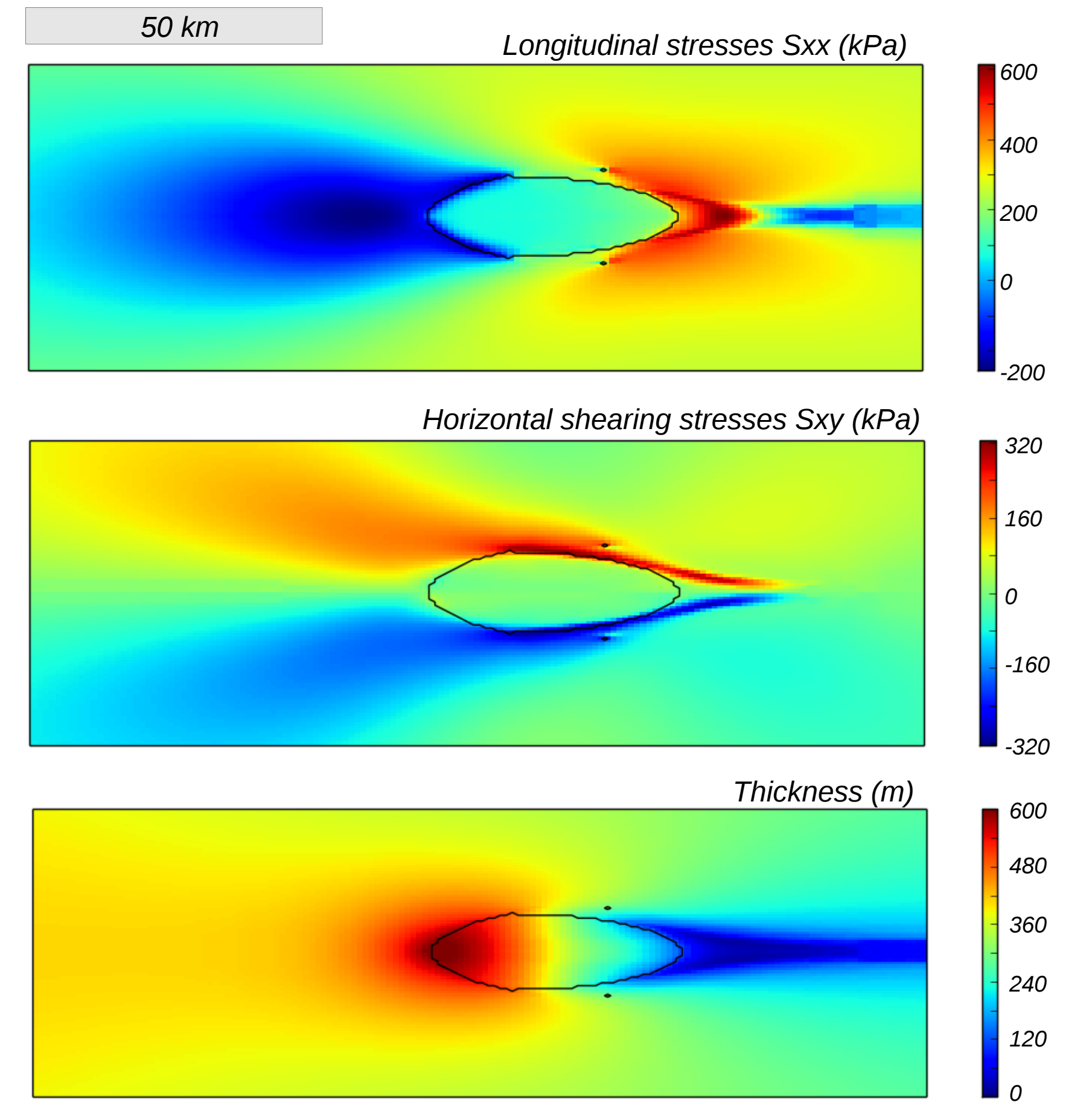
- The formation of the ice rise local flow last a few hundreds years
- The ice rise geometry and dynamics are then stable during the retreat of the ice sheet

Buttressing induced by an ice rise



- Steady states with or without the ice rise effect are close (they differ by up to 25 km)
- The ice sheet retreat is delayed by about 2 000 years with the ice rise effect

Effects on the ice shelf



- Upstream and downstream of the ice rise, there is compression and extension, respectively
- Very low ice thickness downstream of the ice rise, that explains the formation of rifts, ice-shelf breakup and open water in similar areas in Antarctica

References

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