# Antarctic ice rise formation, evolution and stability

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Please !!!!

## Current knowledge and questions to answer

→The formation and evolution of ice rises has never been simulated
→Their potential to hamper the retreat of ice sheets has hardly been quantified so far
→Understanding and quantifying their impact is crucial for future sea level rise predictions
→According to the Raymond effect, they may exhibit millenium-scale stability
→How and when did they form ?
→How fast do they form ? Are they stable ?
→How do they contribute to ice shelf buttressing and consequent ice sheet stability ?

## About ice rises in Antarctica ?

- In Antarctica, numerous topographic highs emerge from the edge of the continental shelf (see Dronning Maud Land in A box)

- Ice rises, *i.e.*, local domes protruding through ice shelves, stem from the contact between highs and the floating ice above

- Ice rises are characterised by local flow, clearly disconnected from the much faster ice of the neighbouring ice shelf

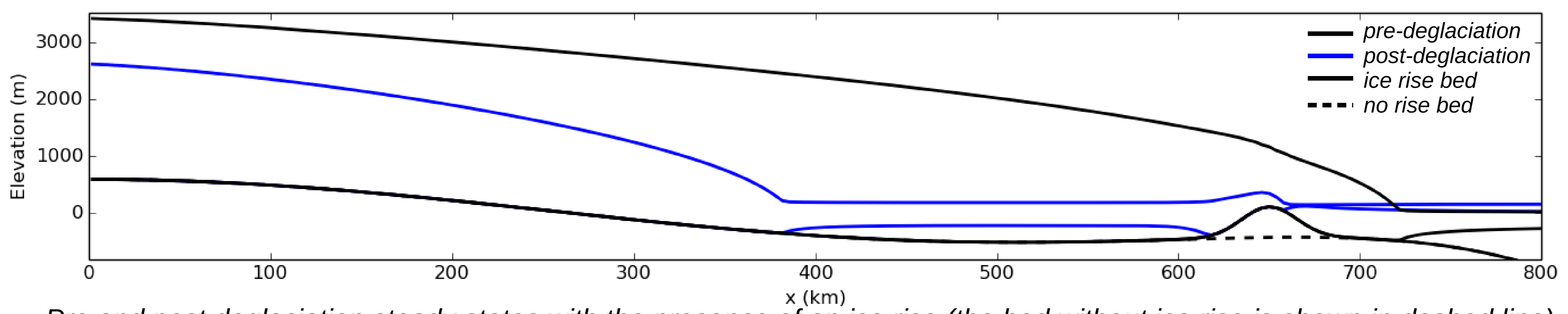
## Take home message

→We show that ice rises can result from the deglaciation of an ice sheet
→A number of field-observable features related to ice rises showed up in the modelling
→Buttressing induced by ice rises is much more effective during the transient retreat of the ice sheet, compared to steady states before and after deglaciation
→Formation of an ice rise is rather quick compared to the time scale of the deglaciation

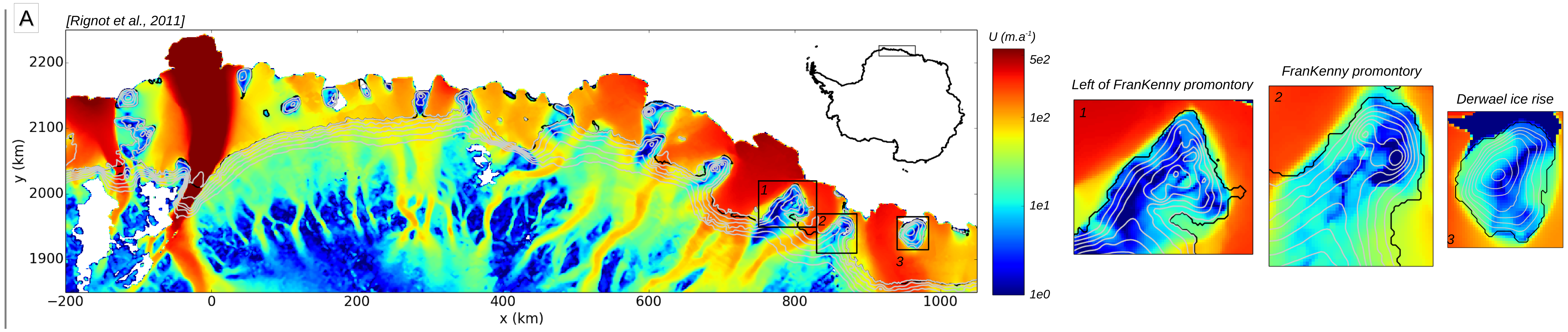
→This study seriously affects timing sea level changes, such as Meltwater Pulse 1A events since the last glacial maximum, but also affects understanding and quantification of future sea level rise from the Antarctic ice sheet

## Methodology

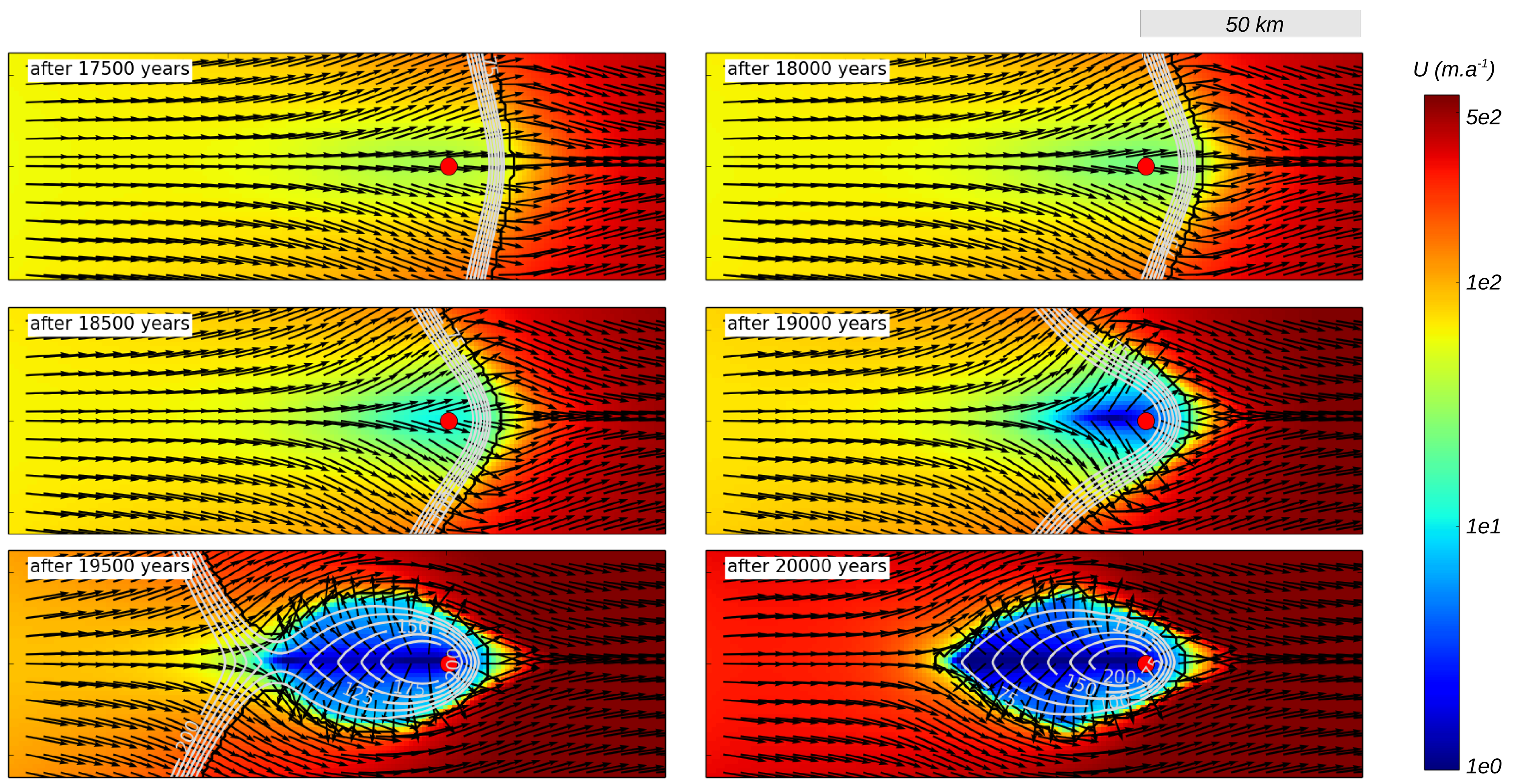
- We use the state-of-the-art ice-sheet model BISICLES *[Cornford et al., 2013]* with a resolution of 500 m at the grounding line
- 2 deglaciation experiments are done with or without an ice rise
- 3 steps : (i) pre-deglaciation steady state (5 ka), (ii) deglaciation (1 cm per year sea level rise during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



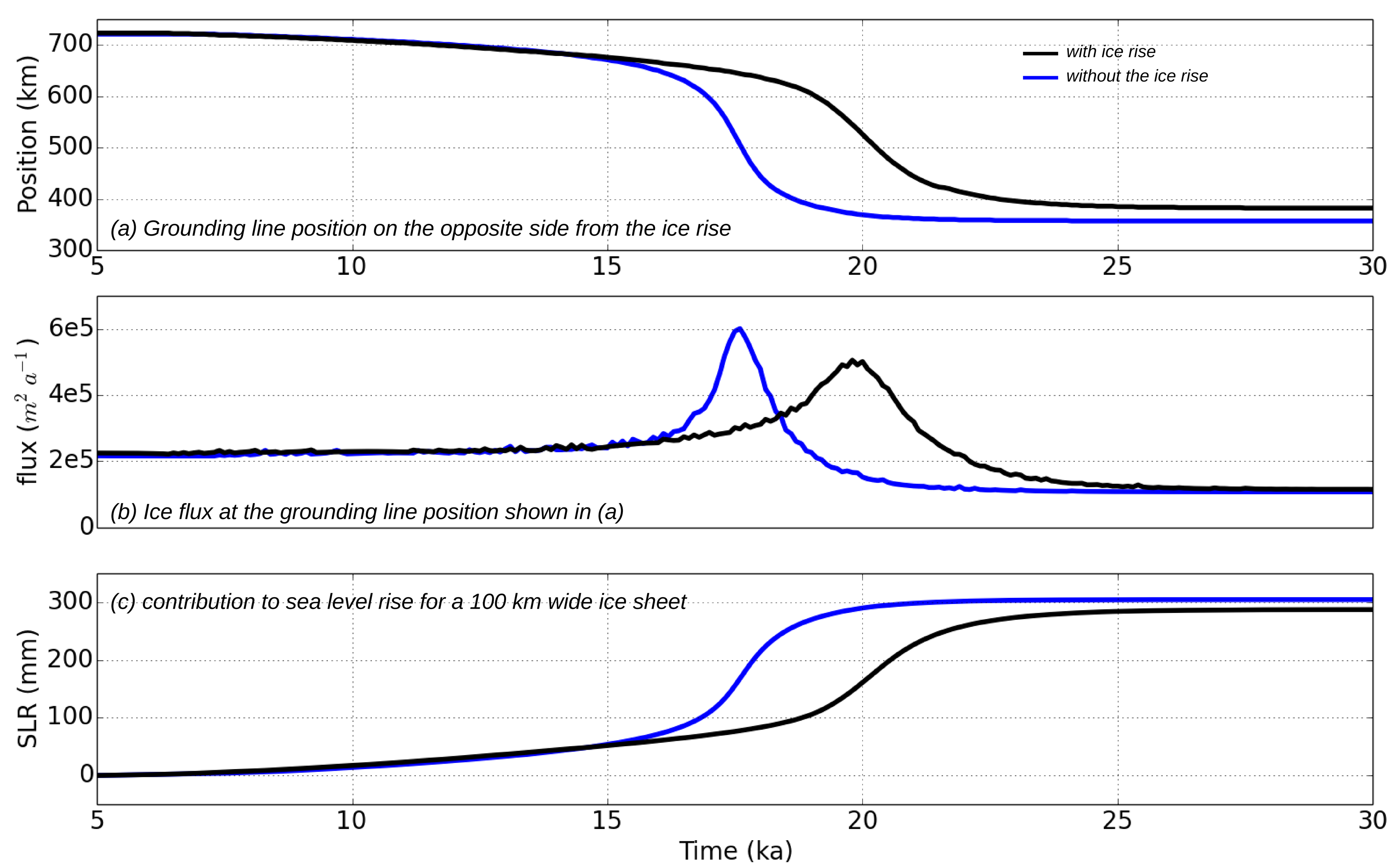

## Stability and rapid formation of the ice rise




*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*

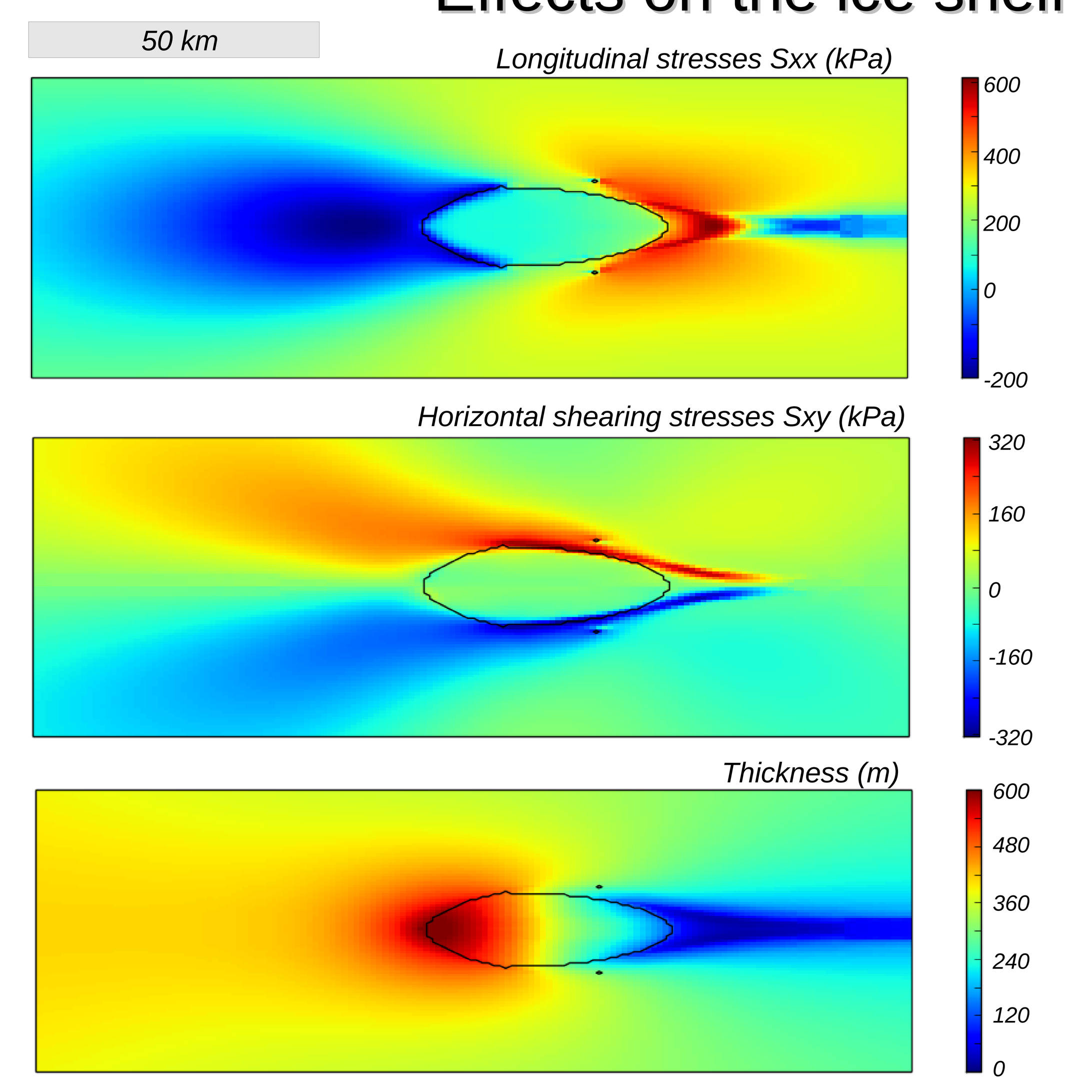
→ Formation of the ice-rise local flow lasts a few hundreds years
→ Ice-rise geometry and dynamics are then stable until final steady state is reached

## Buttressing induced by an ice rise




→ Steady states with or without the ice rise effect are close (they differ by up to 25 km)
→ 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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