Modelling Ice Sheet Changes in the Wilkes Subglacial Basin before 2500: How Sensitive Are Our Predictions?

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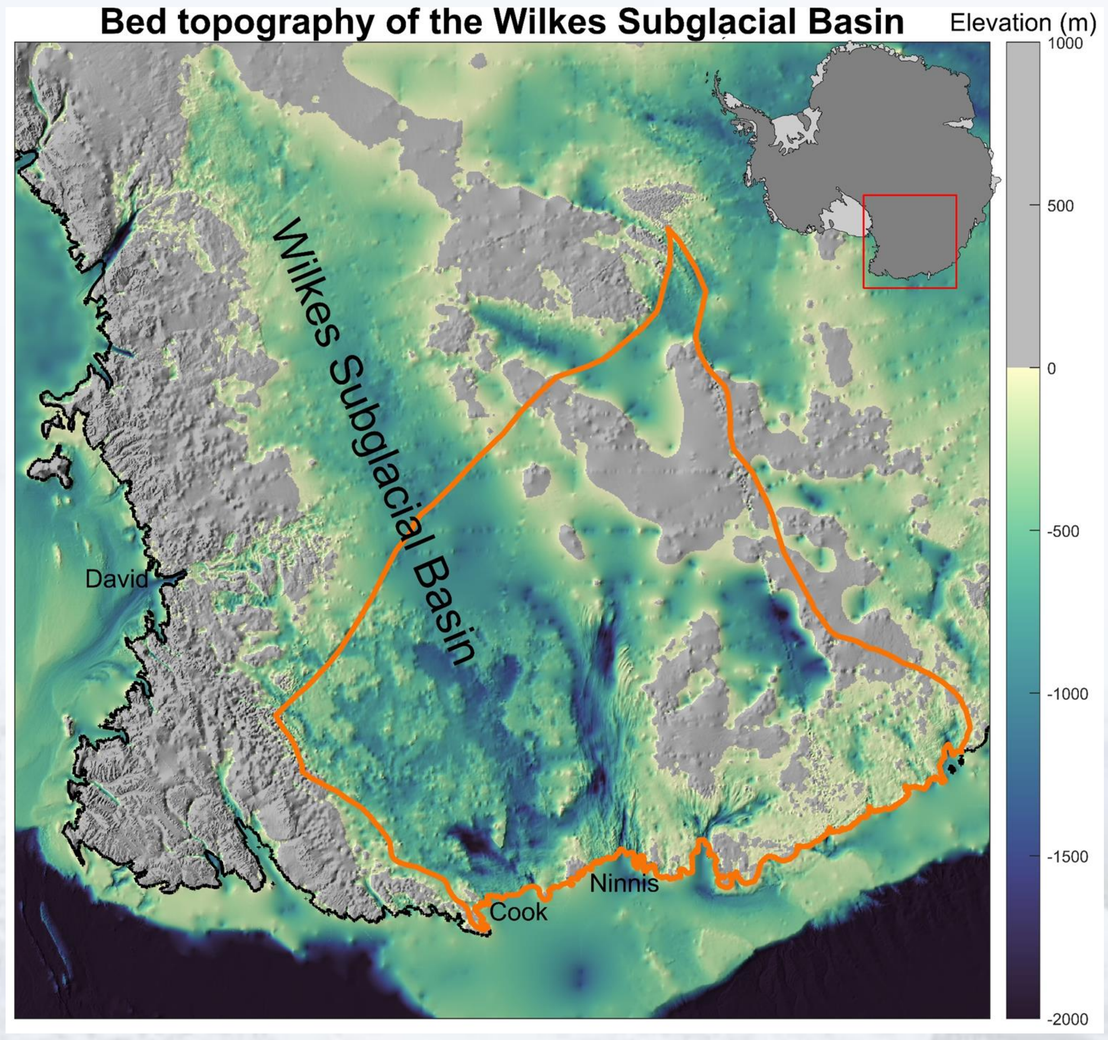
INTRODUCTION

Wilkes Subglacial basin (WSB)

- A vast basin covering ~400,000 km^2, with an ice volume equivalent to 3~4 m of global sea level rise.
- Highly susceptible to Marine Ice Sheet Instability (MISI).
- Largely unexplored: No field survey data and very few targeted model predictions.

Aims

- Explore ice sheet evolution in the WSB over the next 500 years under potential future climate scenarios.
- Assess the sensitivity of predictions to various model configurations.
- Develop a coupled model system comprising ice sheet (Elmer/Ice), subglacial hydrology (GlaDS), and ocean (ROMS).



MODEL

We employ **Elmer/Ice** with **Shallow-Shelf Approximation** (SSA) throughout our simulations.

Mesh generation and refinement (250m, 500m, 1km, 2km)

↓

Inversions for ice viscosity and basal friction (1km)

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1995–2015 Historical run (250m, 500m, 1km, 2km)

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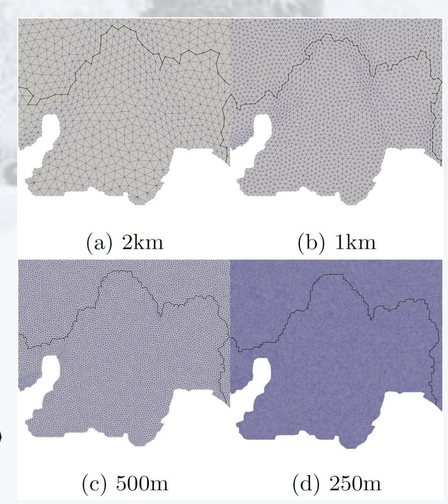
2015–2500 Future run (250m, 500m, 1km, 2km)



EXPERIMENTS – Sensitivity tests for a series of variables

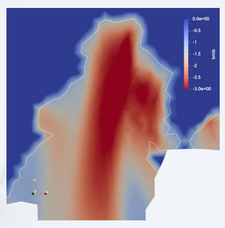
2 Thermal forcings
High emission (SSP5-8.5)
Low emission (SSP1-2.6)

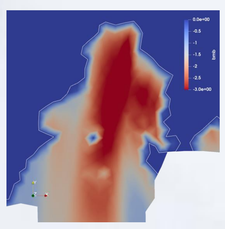
2 Melt rate parameterization
Default scheme from ISMIP6
Modified version with water column scaling

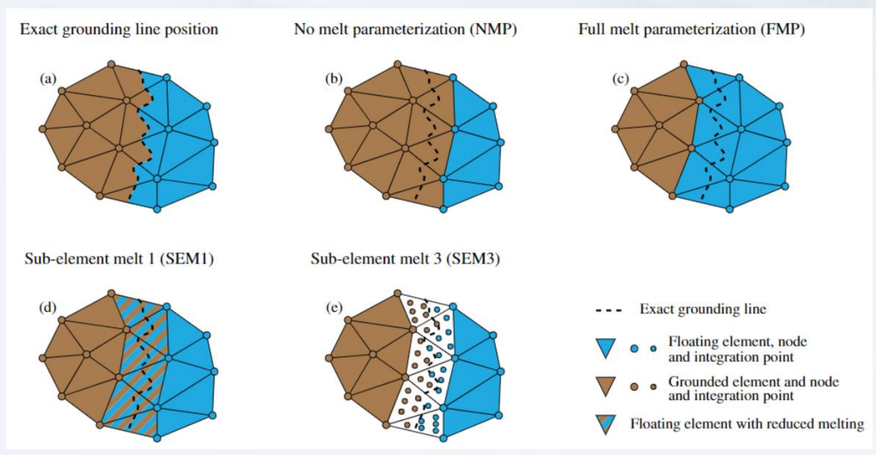
4 Mesh resolutions

2 Basal sliding laws
linear Weertman
regularized Coulomb

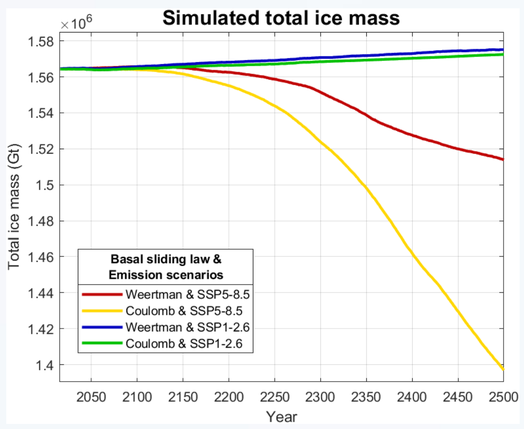
4 Melting schemes at the grounding line

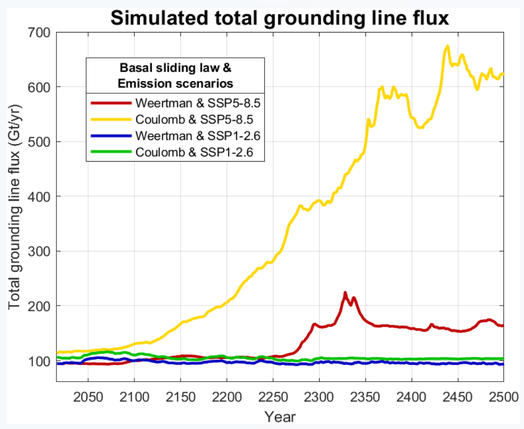




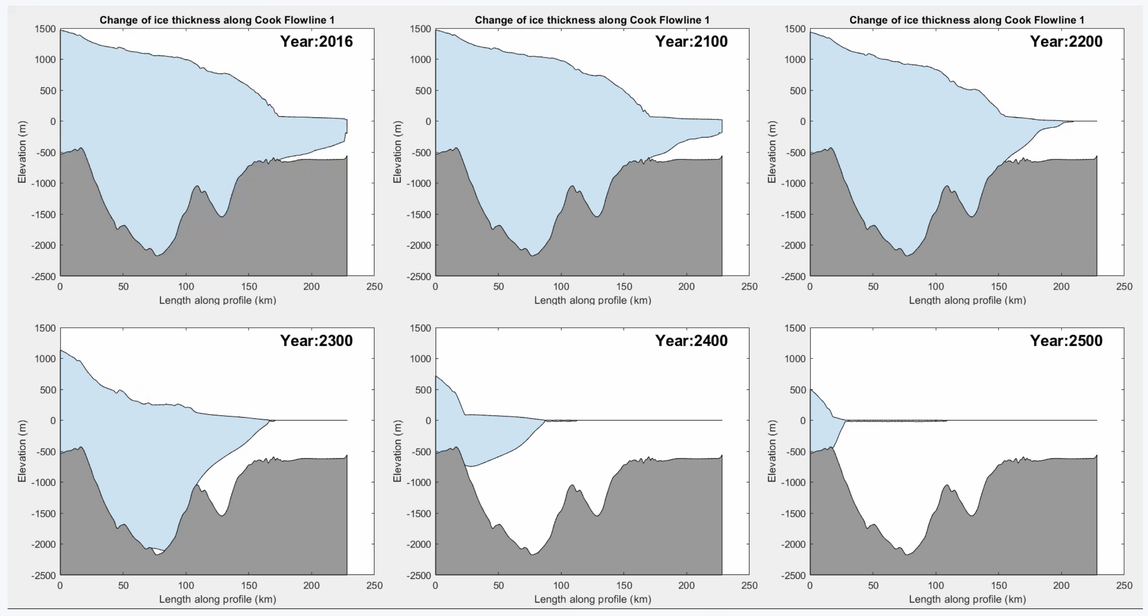


RESULTS

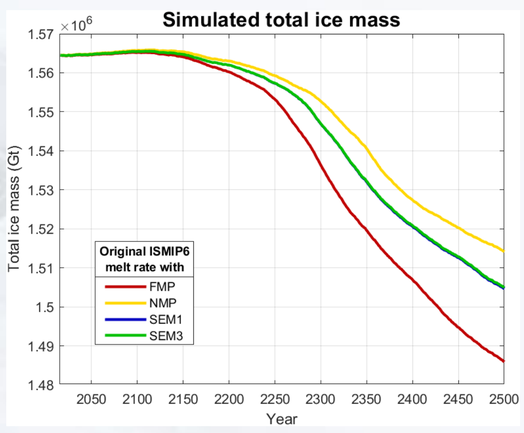


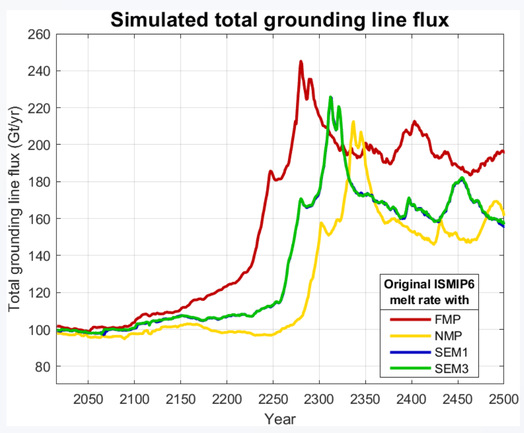


Under the high emission scenario, Marine Ice Sheet Instability is triggered by ongoing thinning, dominated by basal melt beneath the ice shelf.
Under the low emission scenario, the system approaches a steady state and gradually gains mass.

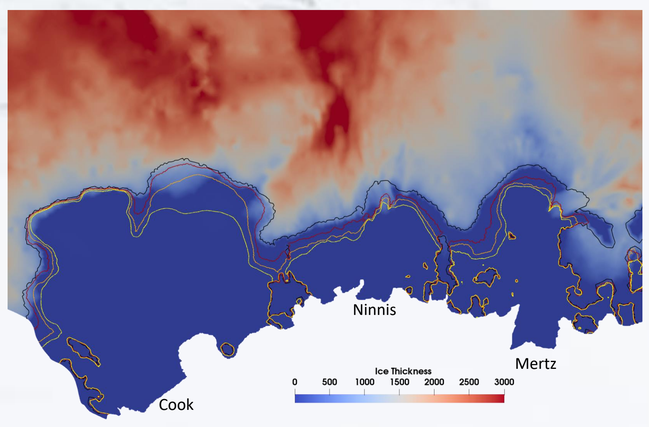


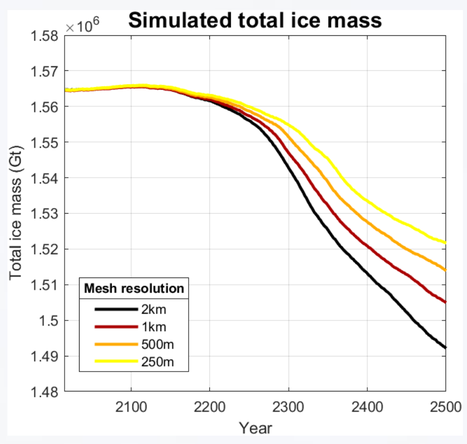
The tipping point is reached around **2200**!





Different melting schemes at the grounding line significantly affect the **timing** of the tipping point and the overall **magnitude** of the ice mass loss.





In our model, **coarse** resolution **overestimates** the grounding line retreat and ice mass loss.

CONCLUSION

- The WSB is relatively stable at least before **2100**, but if the grounding line retreated into the deep troughs the ice mass loss might be catastrophic.
- The ice sheet model is sensitive to various settings. Each of them can potentially change the story, especially the **melt parameterizations around the grounding line**.
- We recommend future ice sheet modelling study employ the "**Coulomb**" type of sliding law with **sub-element melt** parameterizations at the grounding line.

ACKNOWLEDGEMENTS

Yu Wang, Chen Zhao and Ben Galton-Fenzi received grant funding from the Australian Government as part of the Antarctic Science Collaboration Initiative program (ASCI000002). This research/project was undertaken with the assistance of resources and services from the National Computational Infrastructure (NCI), which is supported by the Australian Government. Rupert Gladstone and Thomas Zwinger were supported by Academy of Finland grant nos. 322430 and 286587, and wish to acknowledge CSC – IT Centre for Science, Finland, for computational resources

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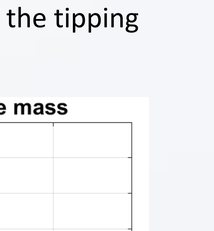

The Australian Antarctic Program Partnership is led by the University of Tasmania, and includes the following partner agencies

The Australian Antarctic Program Partnership is funded by the Australian Government Department of Industry, Science, Energy and Resources through the Antarctic Science Collaboration Initiative.