The observations display clear intra-annual velocity variability. We can replicate this intra-annual velocity variation by seasonally perturbing the basal melt rates at identified sensitive regions.

Investigation of GNSS and satellite observed ice flow velocities using ice sheet modelling on the Ross Ice Shelf

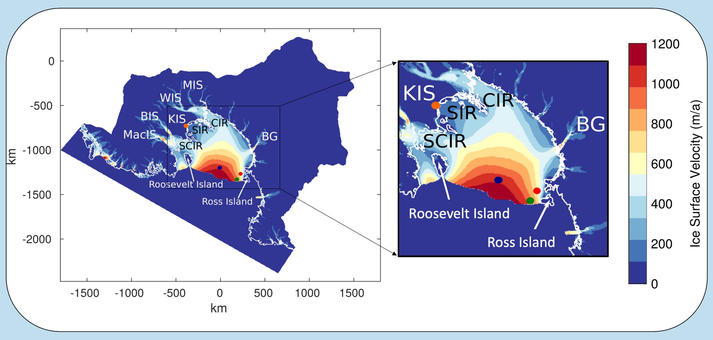
Francesca Baldacchino[1,4], Nicholas R. Golledge[1], Huw Horgan[1], Mathieu Morlighem[2], Alanna V. Alevropoulos-Borrill[1], Alena Malyarenko[1,3], Laurine van Haastrecht[1], Dan Lowry[1], and Alexandra Gossart[1]

Abstract

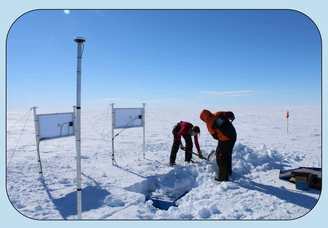
- The influence of seasonal basal melt rates on the Ross Ice Shelf (RIS) flow variability is not yet fully understood.
- This paper's aim is to explore whether **seasonal perturbations in basal melt rates** on the RIS can explain the observed intra-annual variations in ice flow at different sites across the ice shelf.

Introduction

- Ocean-forced basal melting drives the largest mass losses on the Antarctic Ice Sheet.
- The **Ross Ice Shelf** is Antarctica's largest ice shelf by area and is approximately in balance.
- Recently, high basal melt rates have been observed at the calving front.
- With predicted surface warming and declines in summer sea ice, these **elevated basal melt rates are projected to increase**.

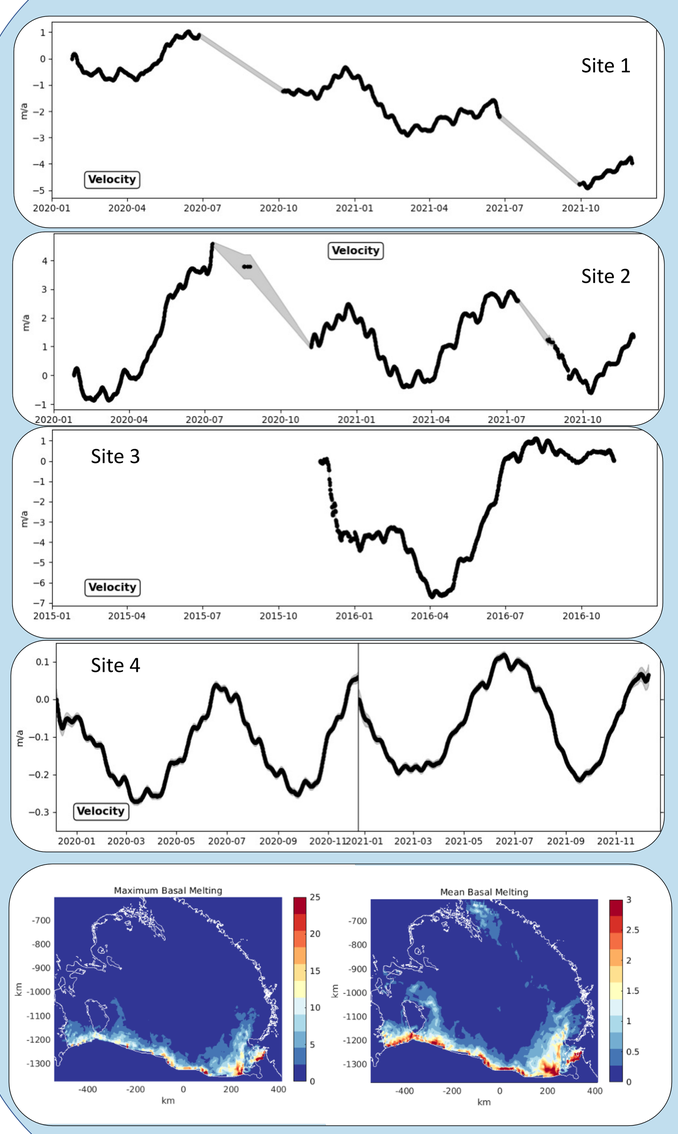


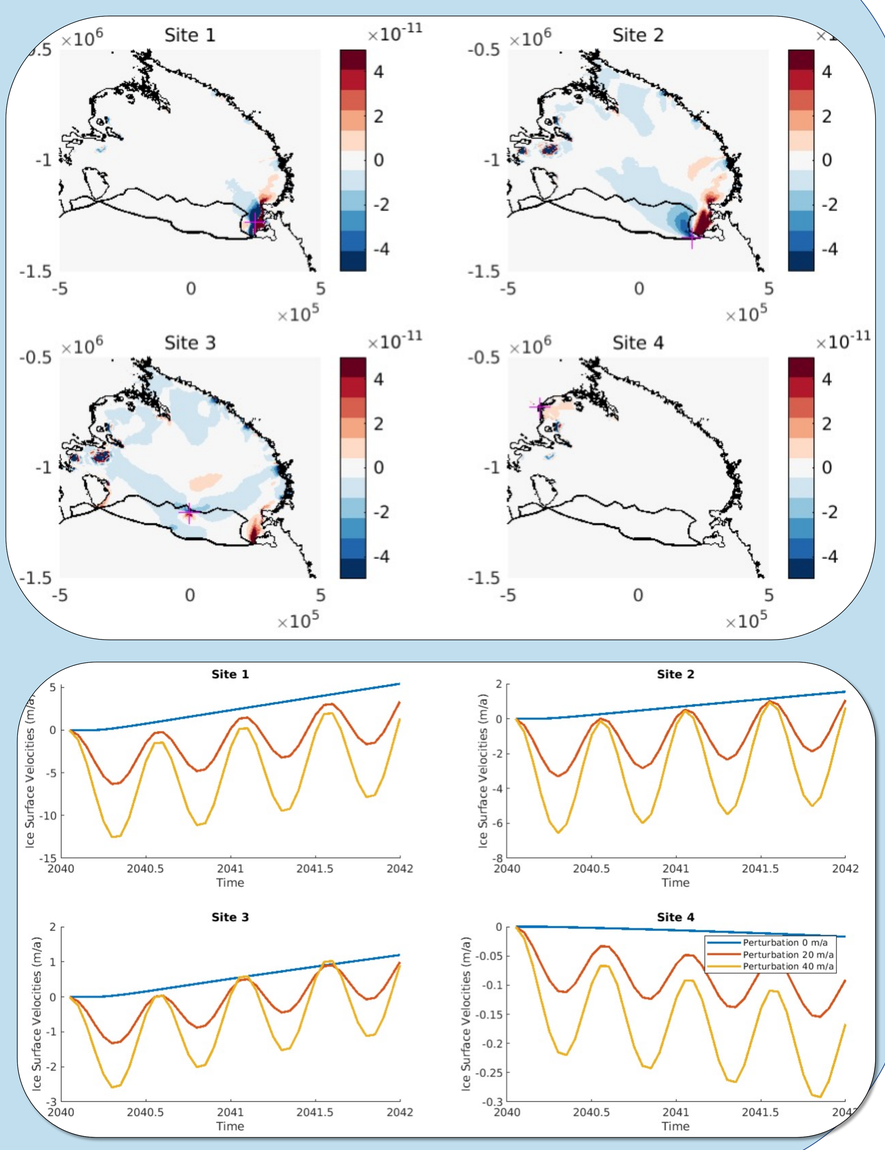
Methods



- This paper presents three new long-duration **Global Navigation Satellite Systems** (GNSS) measurements.
- And **Sentinel-1** ice velocity measurements at the GNSS sites.
- Automatic differentiation in the **Ice Sheet and Sea-level System Model** to identify sensitive regions of the RIS, **where changes in basal melt affect ice velocities at the GNSS sites.**
- We seasonally perturb **Massachusetts Institute of Technology general circulation basal melt rates.**

Results





Discussion

- There is a **clear seasonal signal** for all GNSS sites with two distinct velocity peaks: one in January (austral summer) and one in June (austral winter).
- Our modelled perturbations highlight that there is a **delay of 2-3 months** between the peak basal melt rates and velocities.
- We found that by perturbing basal melt rates at identified sensitive regions on the ice shelf we **were able to reproduce** the GNSS intra-annual velocity variability.
- We suggest that **seasonal changes in basal melt can explain the observed intra-annual velocity variability at Sites 1 and 2.**
- Our sensitivity maps highlight where **increases in basal melt rates will influence ice velocity** today and in the future.

[1] Antarctic Research Centre, Victoria University of Wellington, New Zealand
[2] Department of Earth Sciences, Dartmouth College, Hanover, NH 03755, USA
[3] National Institute of Water and Atmosphere Research, Wellington, New Zealand
[4] Institute of Geodesy, Technology University of Graz, Austria

Correspondence: francesca.baldacchino@tugraz.at

VICTORIA UNIVERSITY OF WELLINGTON TE HERENGA WAKA
Antarctic Science Platform
Antarctica New Zealand