MODELLING THE OCEAN-ICE INTERACTIONS BENEATH ICE SHELVES IN A BROKEN STATE

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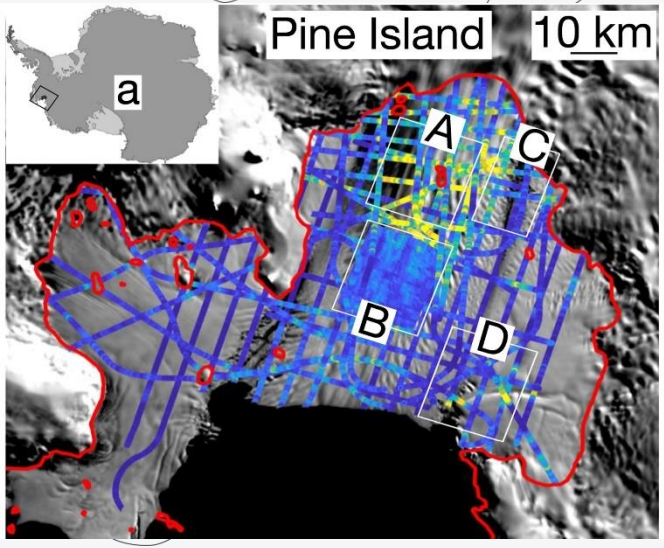
Not so smooth under an ice shelf

What are the feedbacks on melt and stability?



Watkins et al, 2021

- Topography at the base
  - Basal crevasses, melt channels, rifts, …
  - Roughness as a measure
- Impact on basal melt
  - Excavation of existing basal highs
  - Correlation between basal melt and roughness (Watkins et al, 2021)
- Impact on stability
  - Thins and weakens shelves
- Usually not included in models

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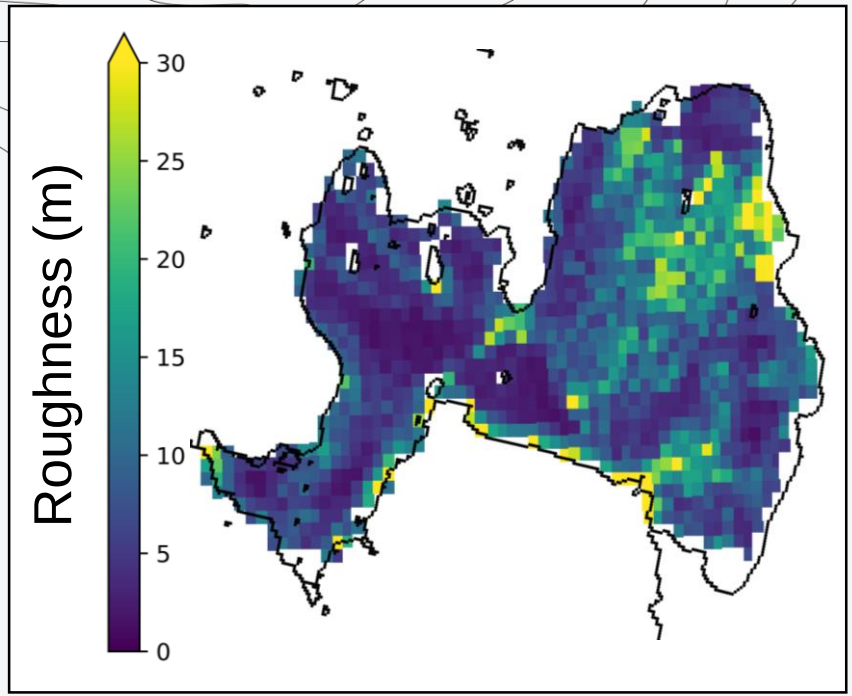
Basin-scale model

Spatial variation of roughness in ocean model



- Ocean model NEMO-4.2 at 1/12° (1-2 km)
  - Regional config at the Amundsen Sea
  - Basal melt implemented (Mathiot et al, 2017)
- Spatial change of drag at the ice/ocean interface
  - Roughness from Watkins et al, 2021
  - Drag coefficient C_d as a function of roughness interpolated on the ocean model grid

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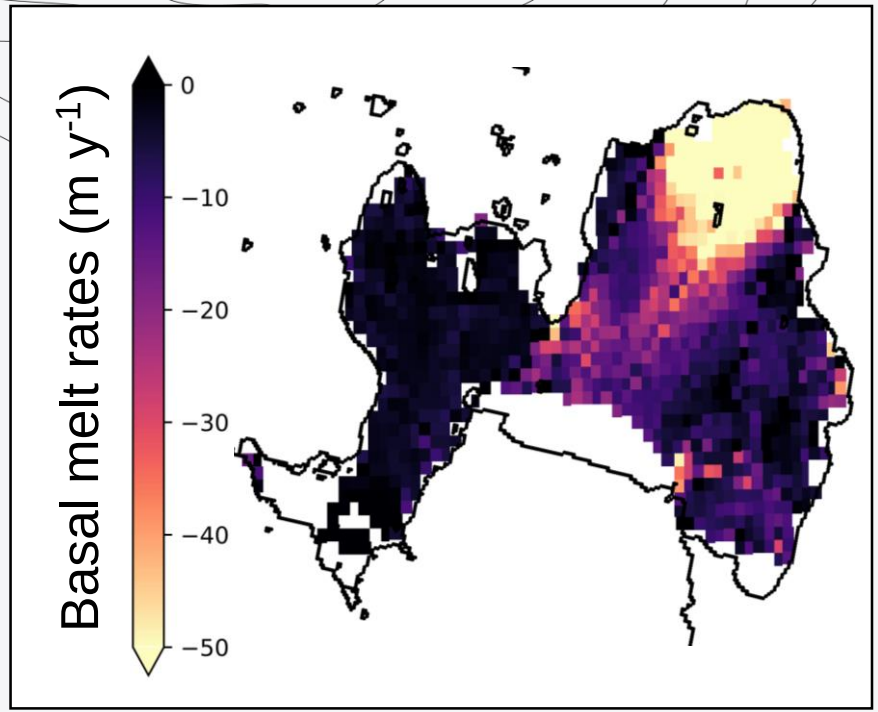
Basin-scale model

Basal melt affected by basal drag



- Basal melting depends on ocean circulation and heat amount in the boundary layer (BL)

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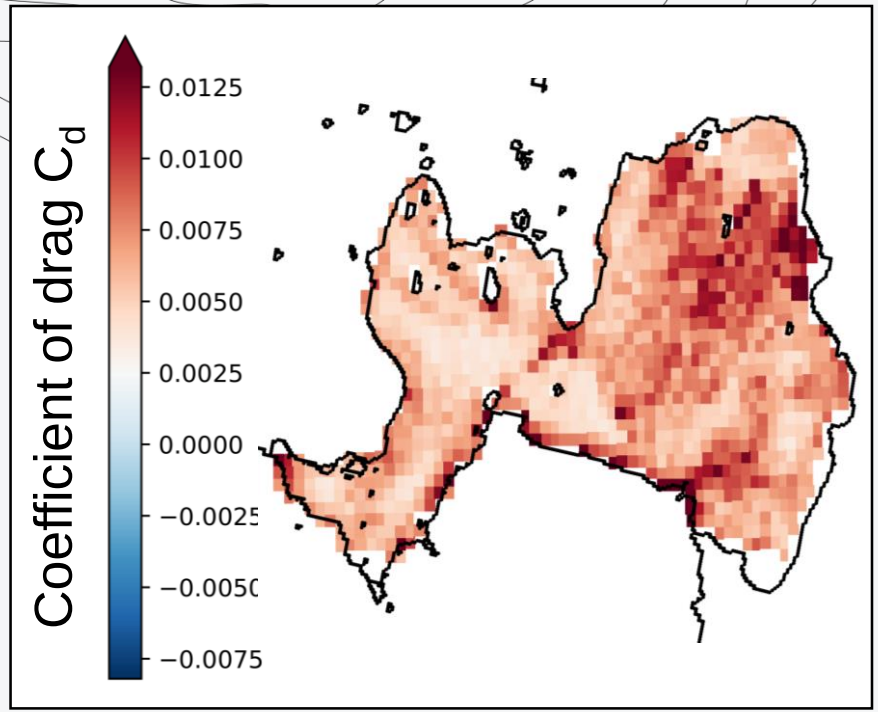
Basin-scale model

Basal melt affected by basal drag



- Basal melting depends on ocean circulation and heat amount in the boundary layer (BL)
- Basal drag controls turbulent exchange of heat, changes the shear profile and the thickness of the boundary layer

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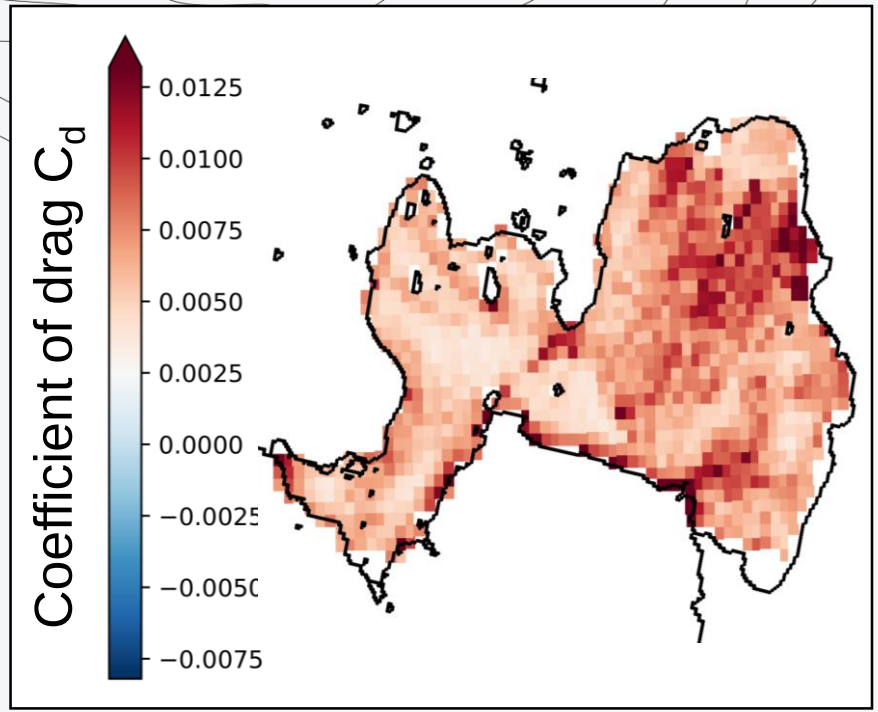
Basin-scale model

Basal melt affected by basal drag



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$$F_d = \rho C_d U_m^2 = \rho u^*$$

C_d coefficient of drag
U_m mean flow in BL
u^* friction velocity

- Coefficient of drag as a function of roughness z_0

$$C_d = \left(\frac{K}{\log(z/z_0)} \right)^2$$

$K = 0.4$ von Karman constant
z half thickness of 1st ocean level beneath the ice

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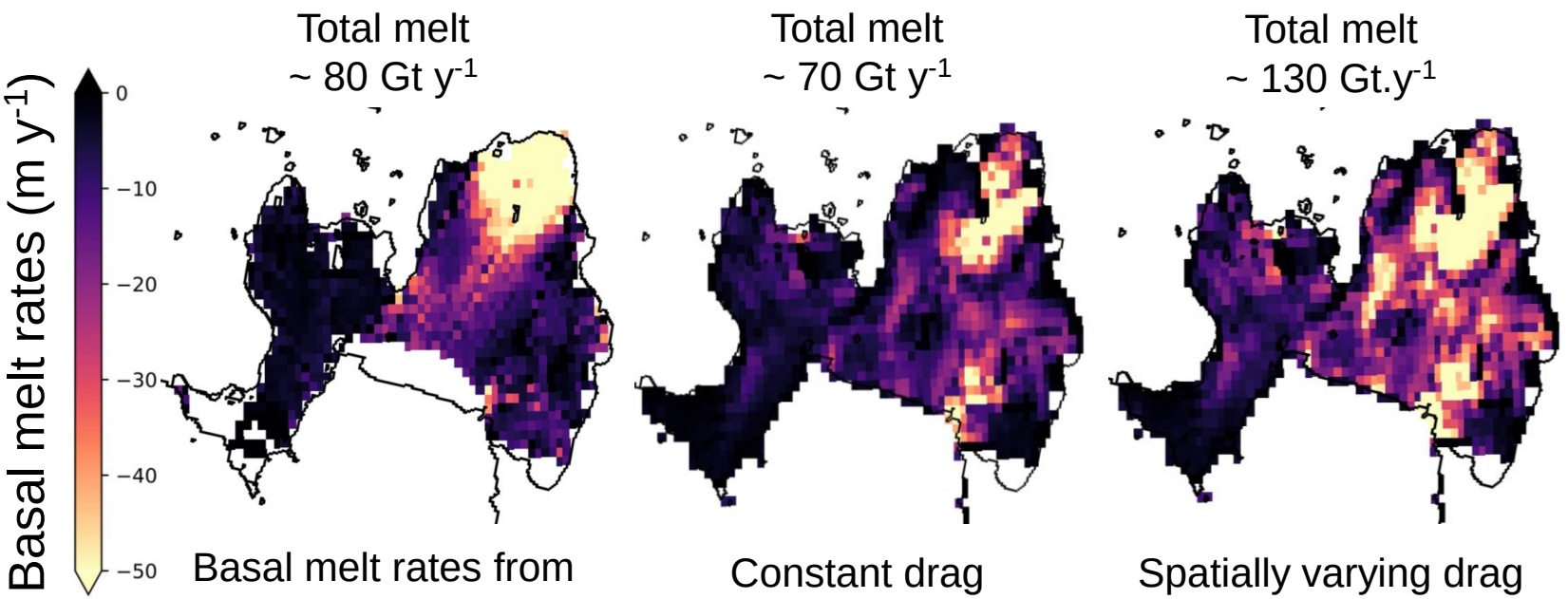
Basin-scale model

Pine Island Ice Shelf basal melt rates (2008 - 2015)



Next steps…

- Basin-scale model
  - More experiments
  - Finer resolution of the ocean model
  - Apply it to other ice shelves
- Crevasse-scale model
  - Examine the balance between ocean melt and deformation of a crevasse
  - 3 high resolution models

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Thanks!

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