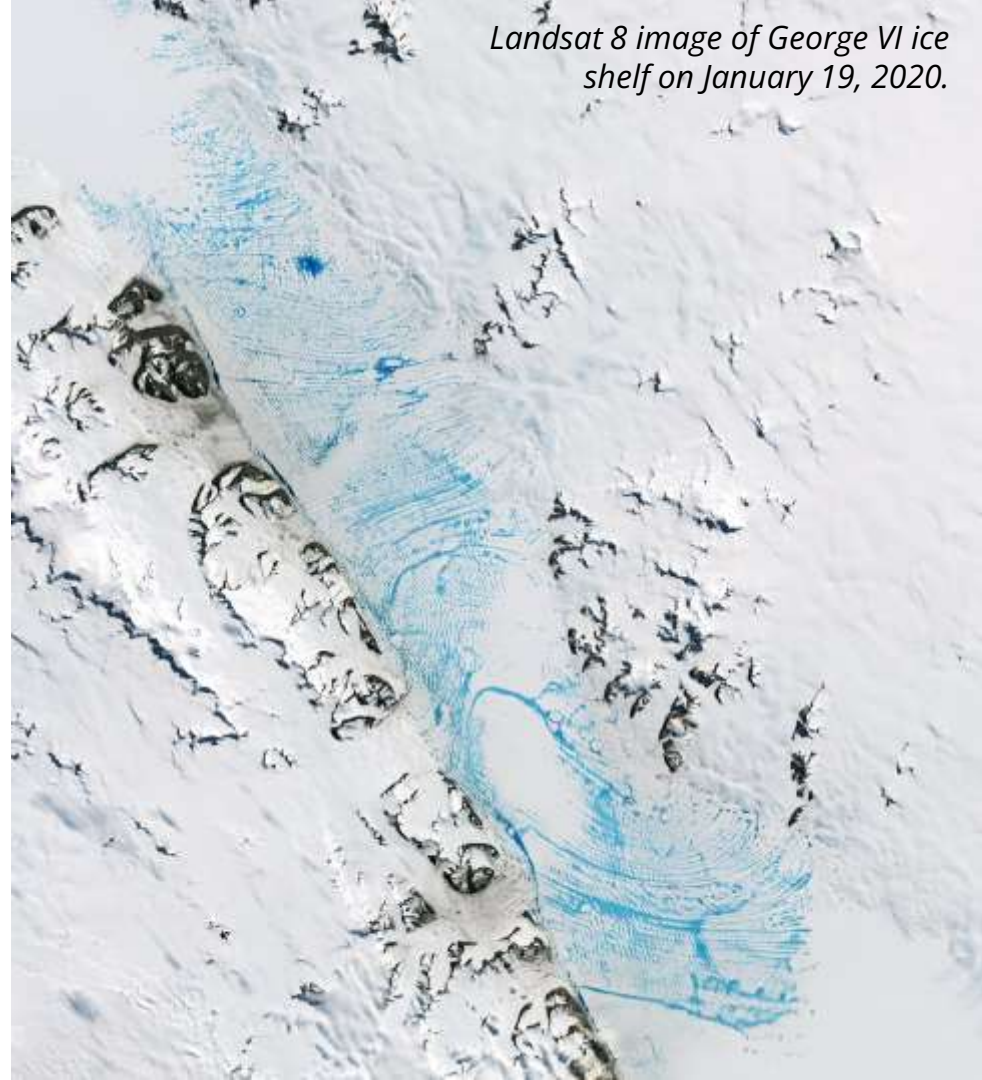


OCEAN:ICE Copenhagen, May 2023

Firn modelling to estimate Antarctic ice sheet freshwater fluxes



Landsat 8 image of George VI ice shelf on January 19, 2020.



Firn observation and modelling team at UU



Peter Kuipers Munneke
Coordinator firn modelling



Sanne Veldhuijsen
Antarctic firn modelling



Max Brils
Greenland firn modelling



Valeria Dibiase
Firn aquifers from space



Willem Jan van de Berg
Regional climate modelling

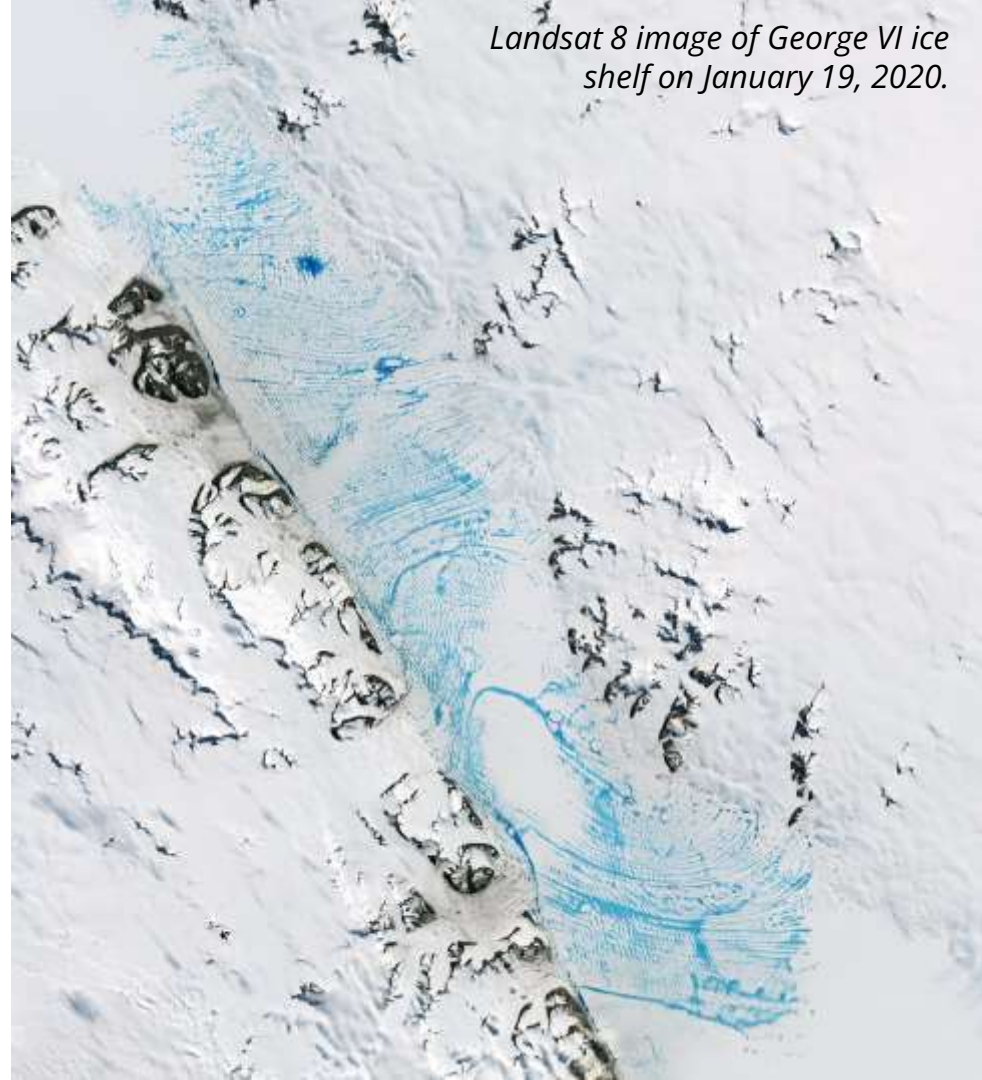


Melchior van Wessem
Antarctica SMB and firn modelling

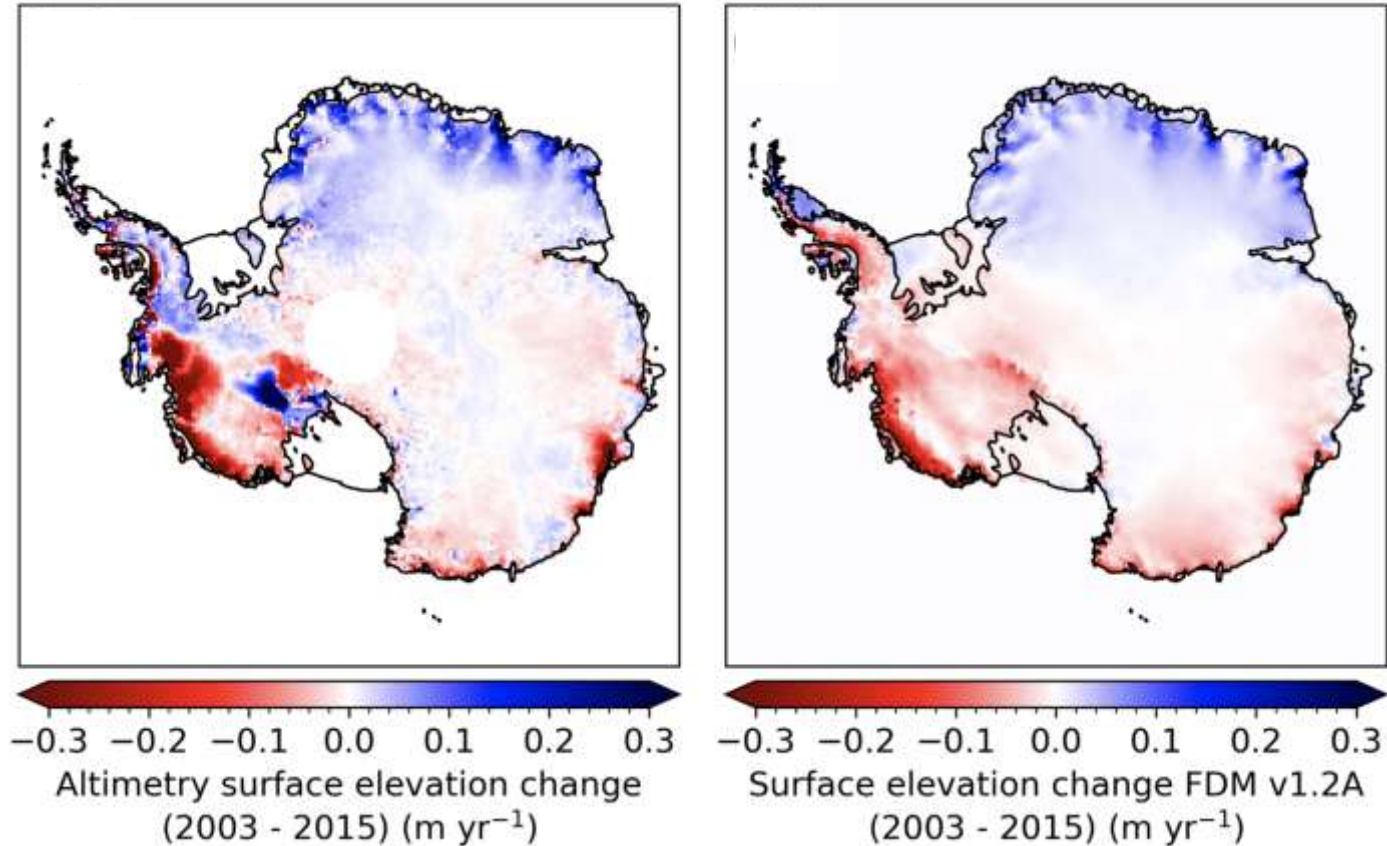


Main motivations

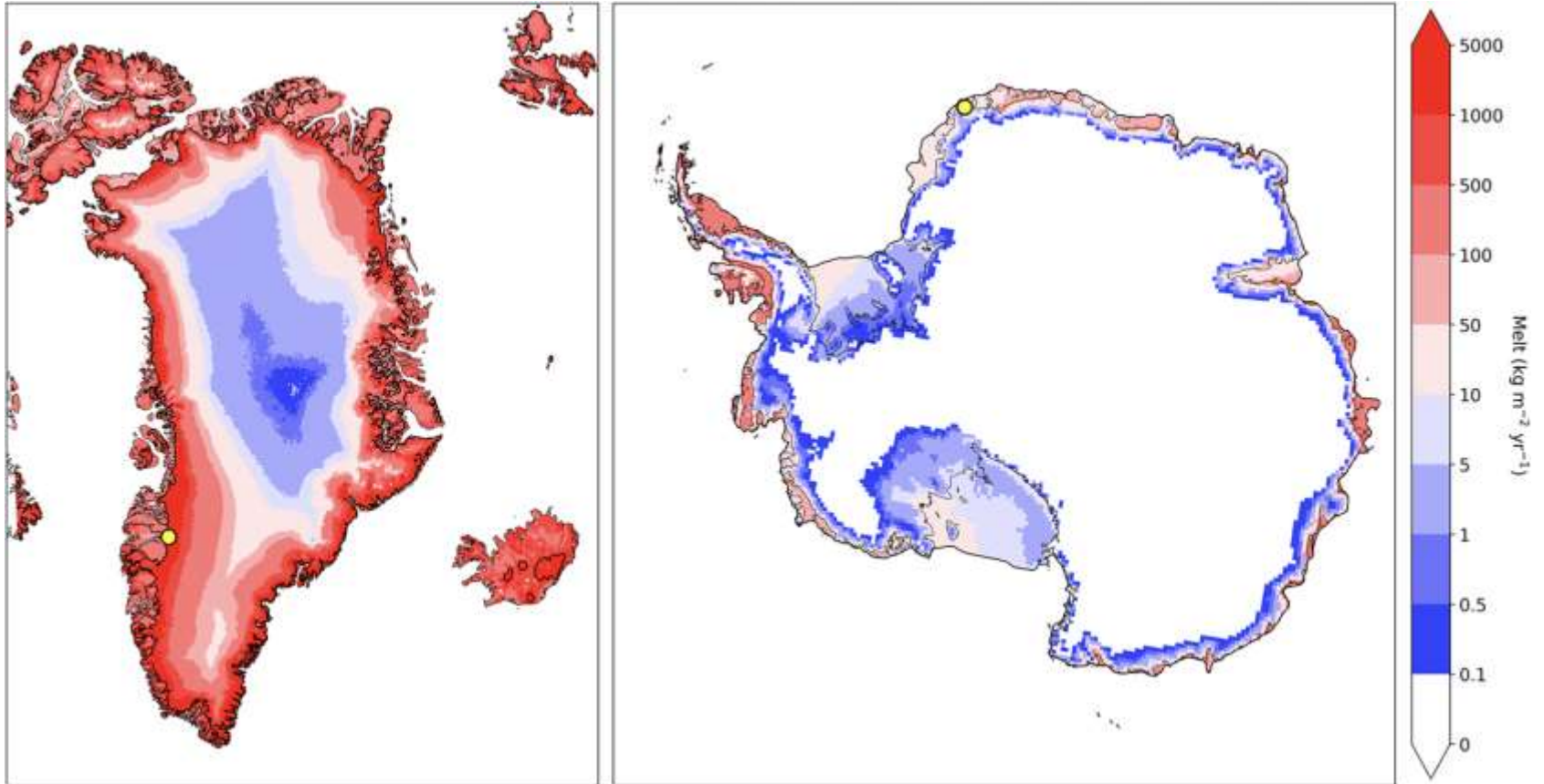
1. **EO needs firn models:** firn depth must be known in space and time to convert total thickness to ice thickness (for solid ice flux) and volume changes to mass changes
2. **Firn models need EO:** firn retains meltwater by ponding, refreezing, retention, aquifer storage, and superimposed ice formation
3. **Ice shelves hard:** floating (no GRACE, altimetry more sensitive)



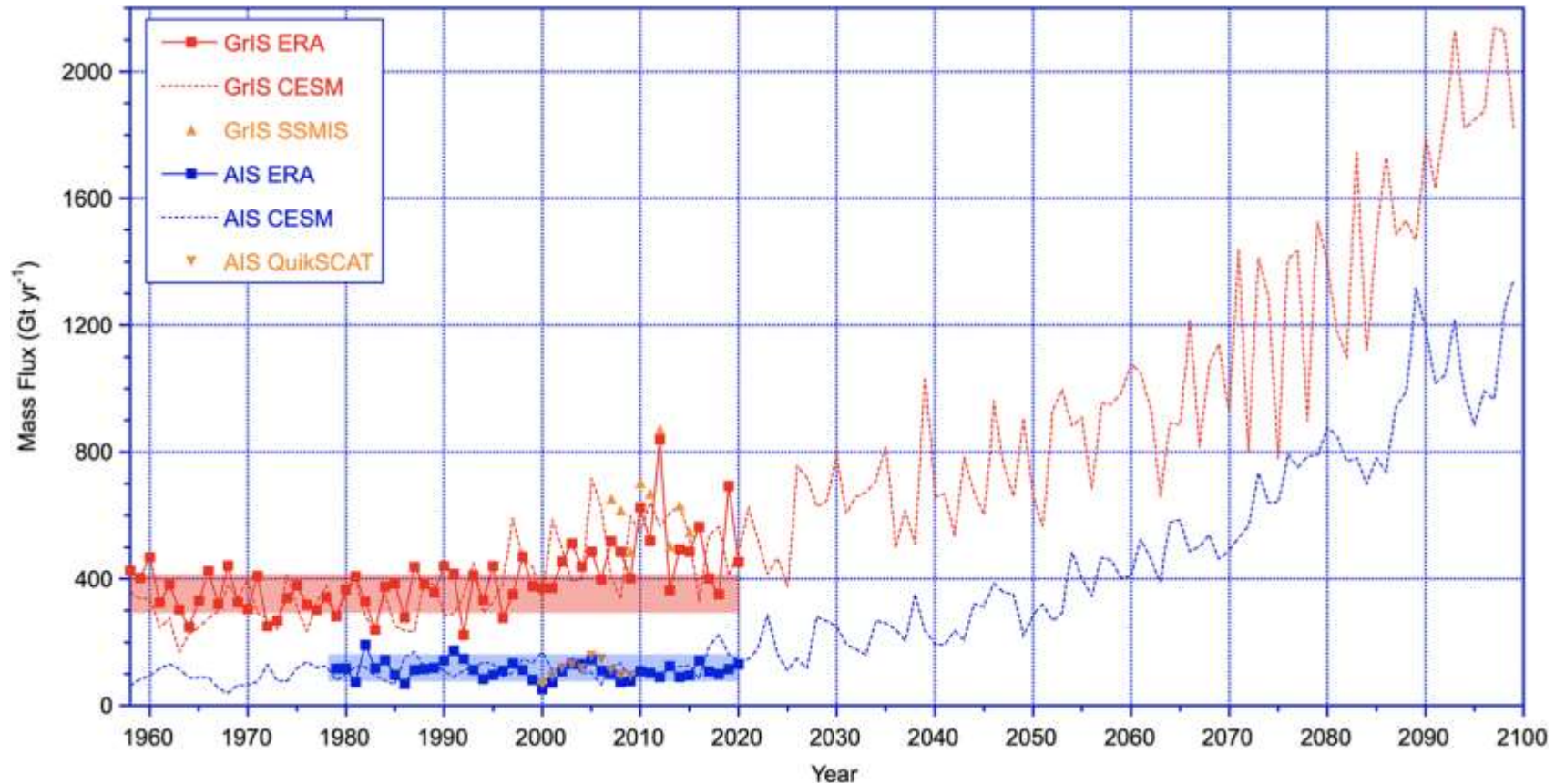
Elevation change from altimetry & firn depth modelling



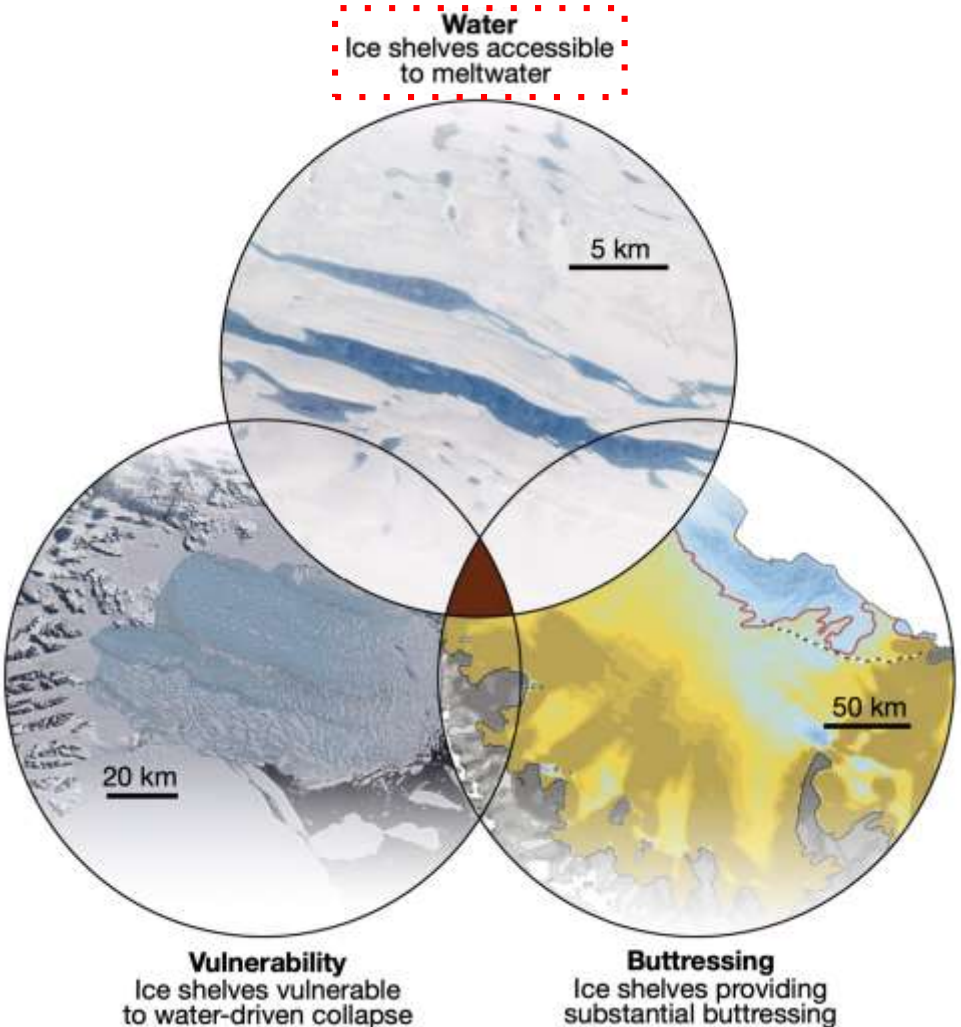
Runoff: Greenlandification of Antarctica?



Future melt (SSP5-8.5, RACMO and CESM)

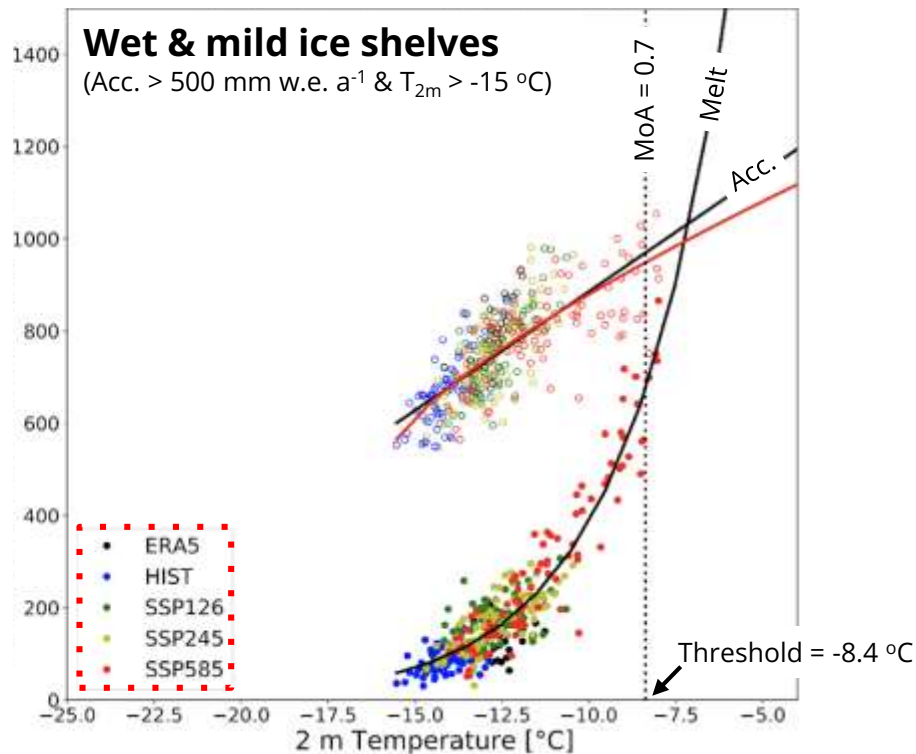
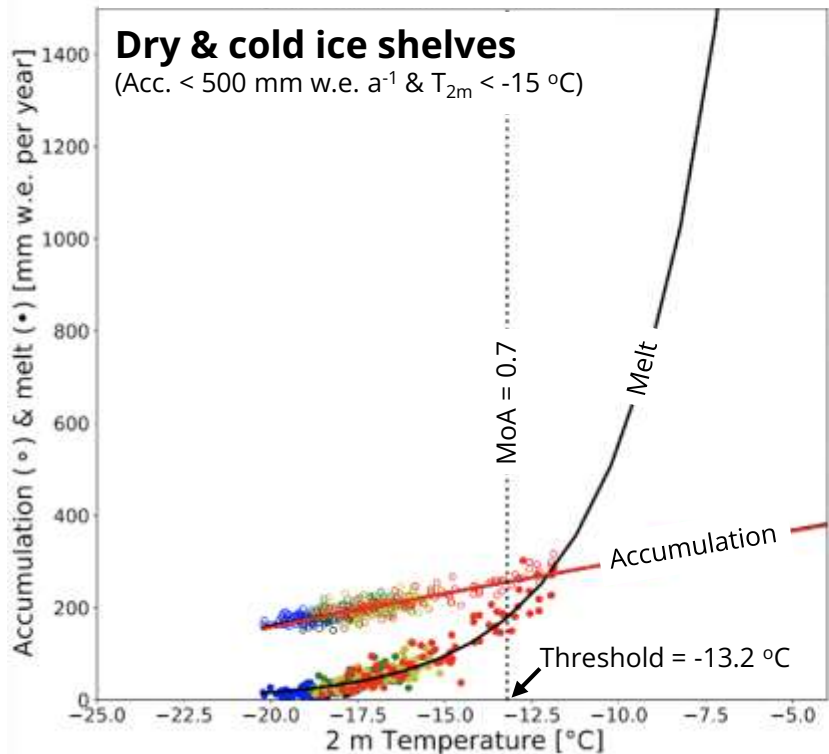


Ponding and ice shelf hydrofracturing

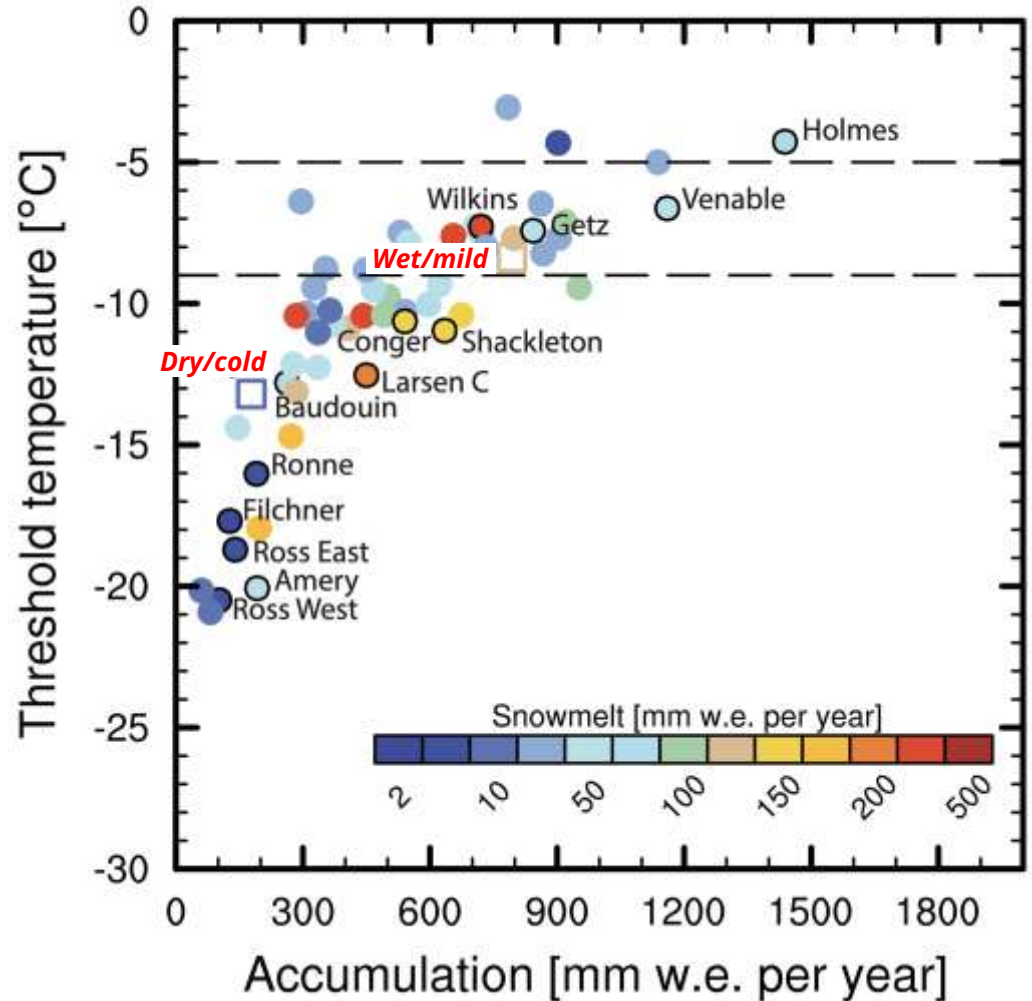


Lai and others, 2020

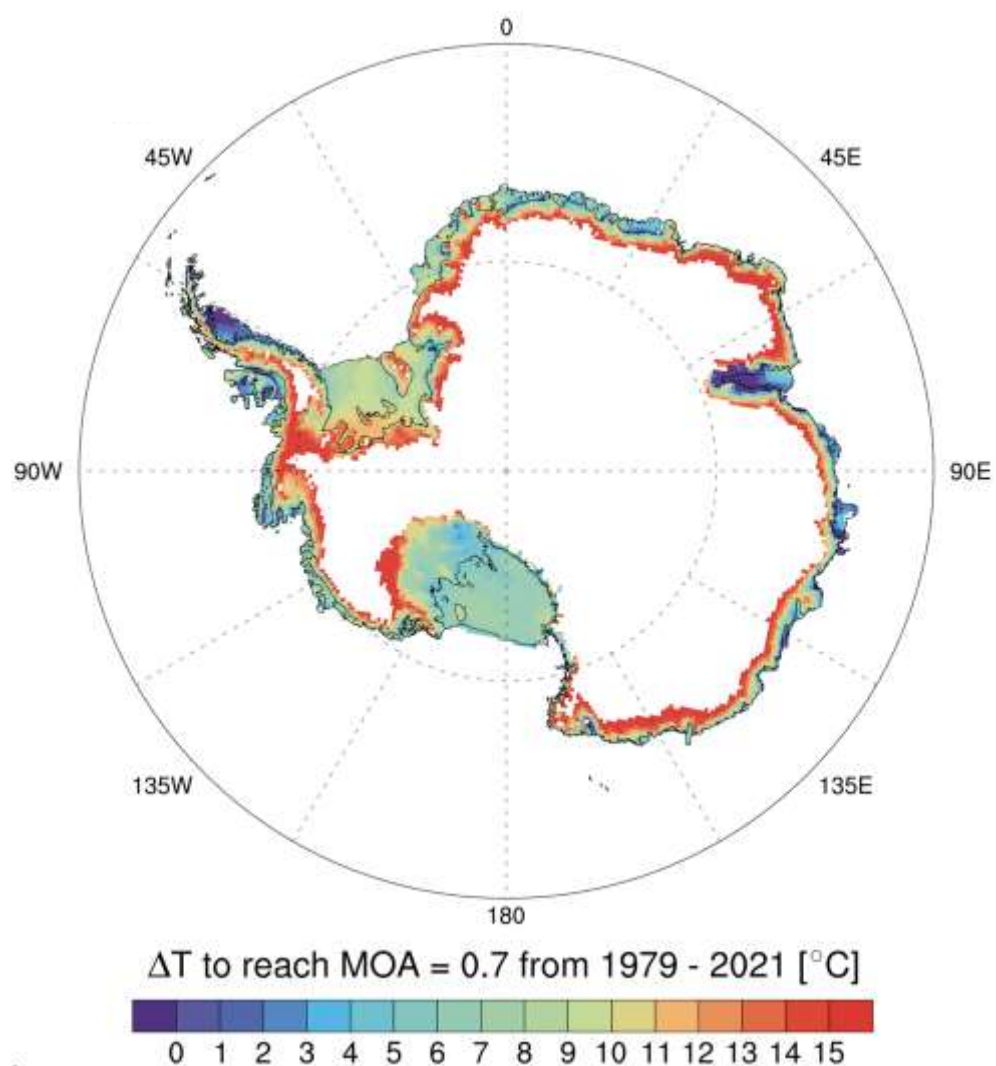
No firn modelling but simple climate threshold



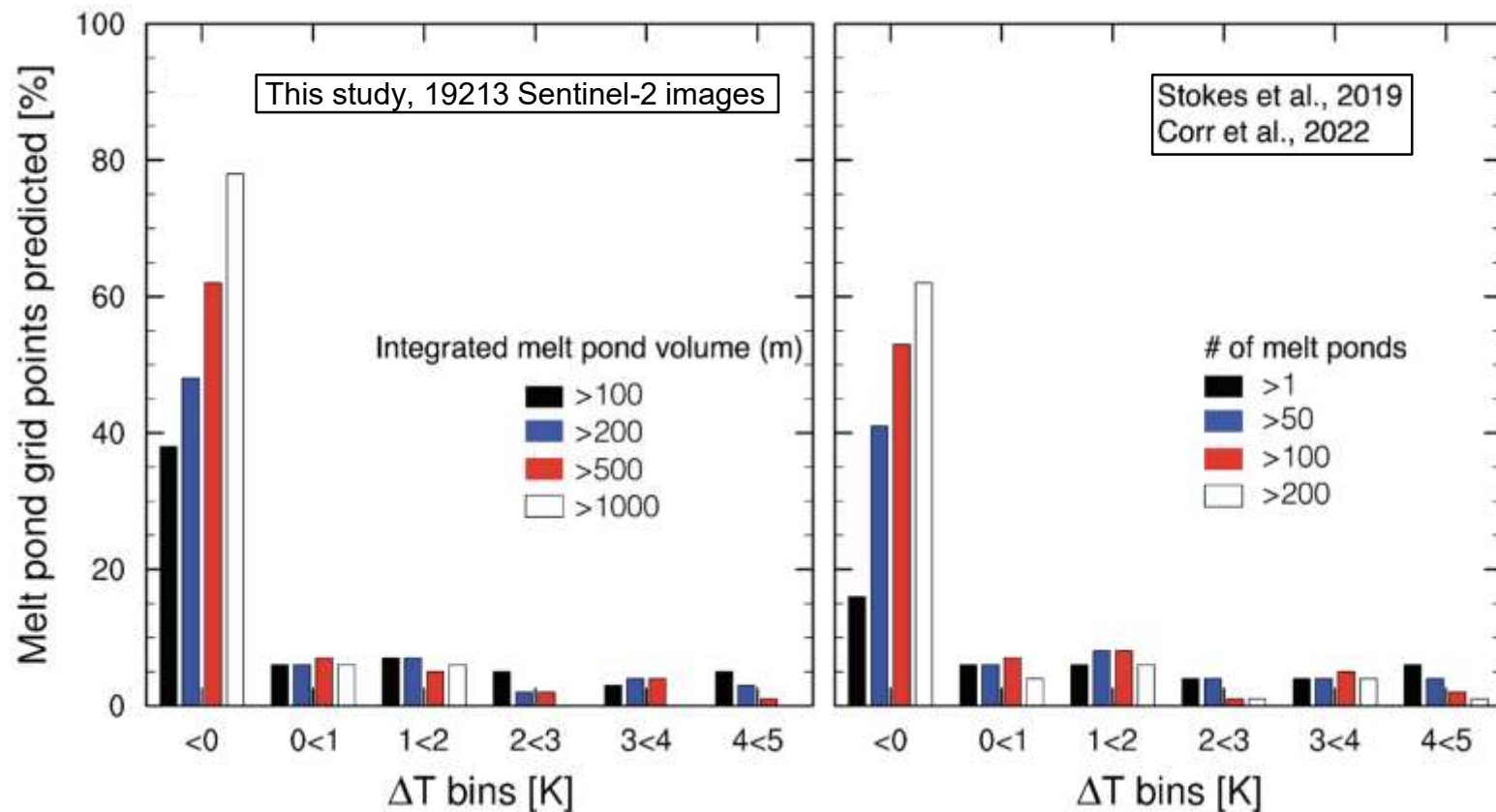
Snow accumulation controls ponding threshold temperature



Warming (ΔT) required to reach threshold temperature



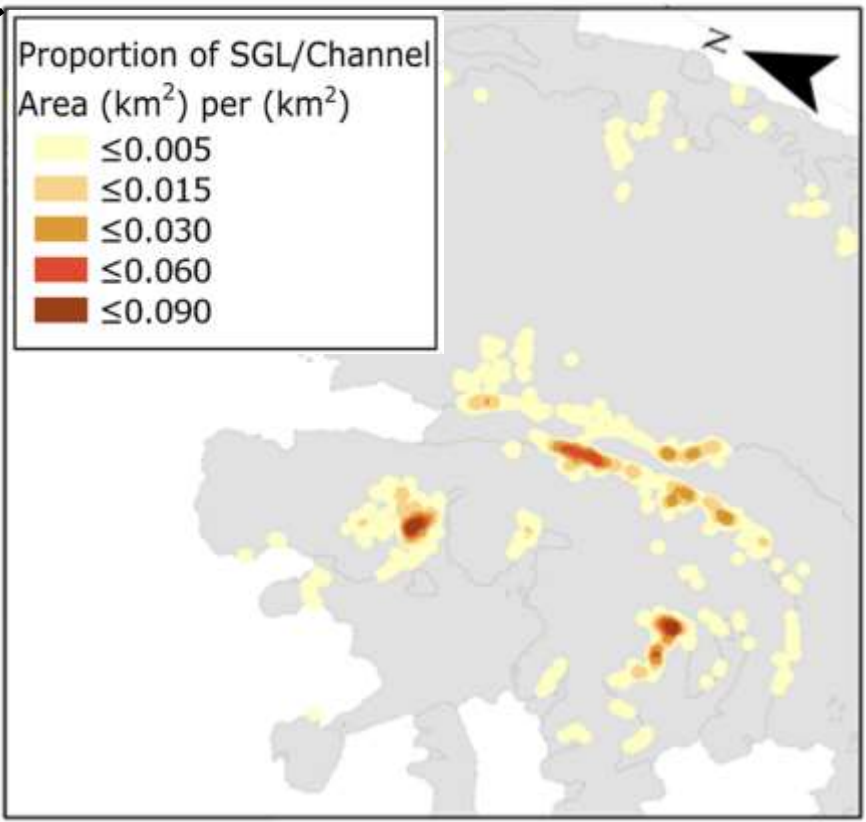
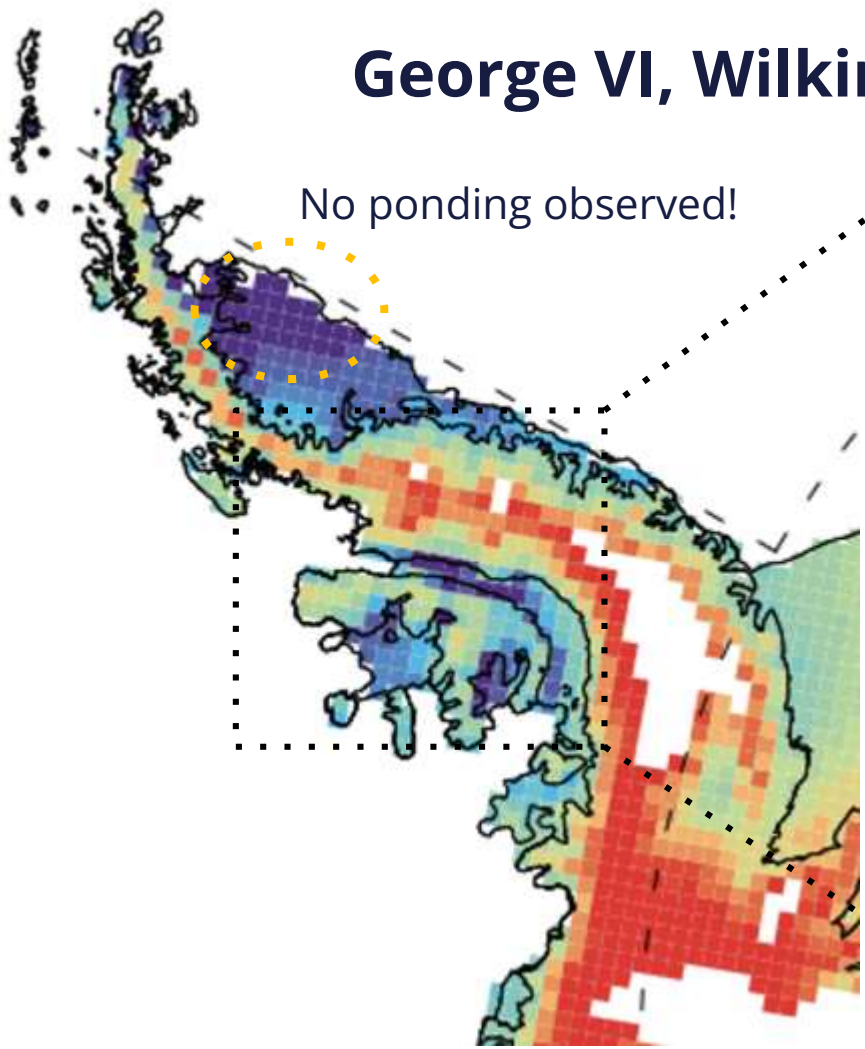
Evaluation: predicted ($\Delta T < 0$) vs. observed melt ponds



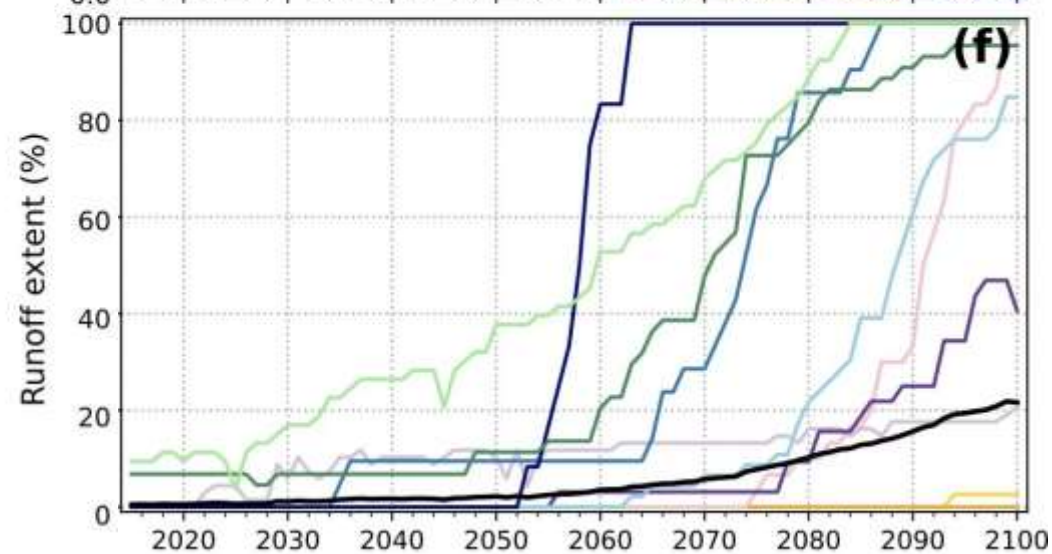
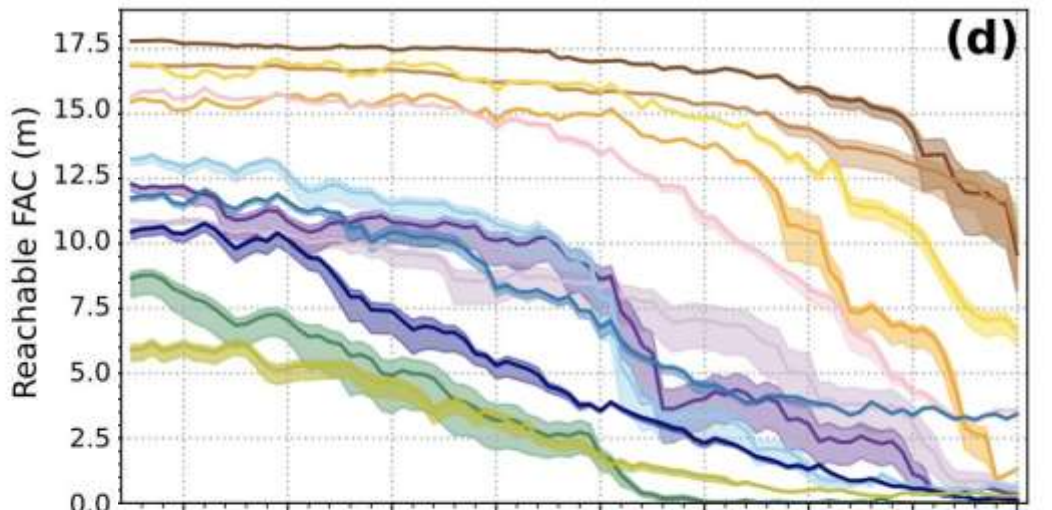
Resolution effect (grid cells larger than typical ponds): skill improves when requiring increased #ponds in a grid cell.

George VI, Wilkins and Bach ice shelves

No ponding observed!

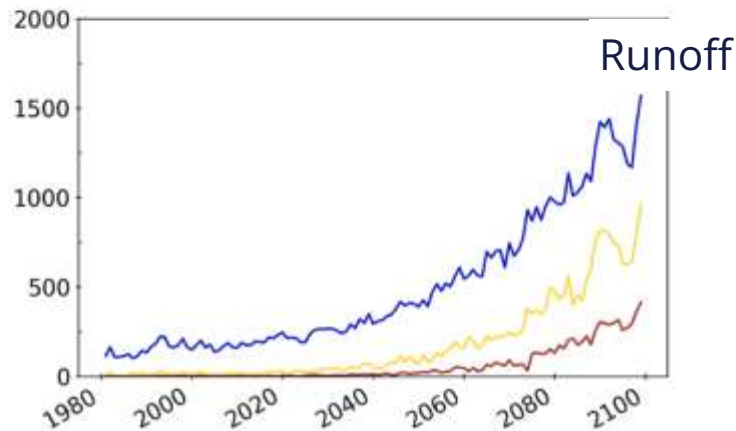
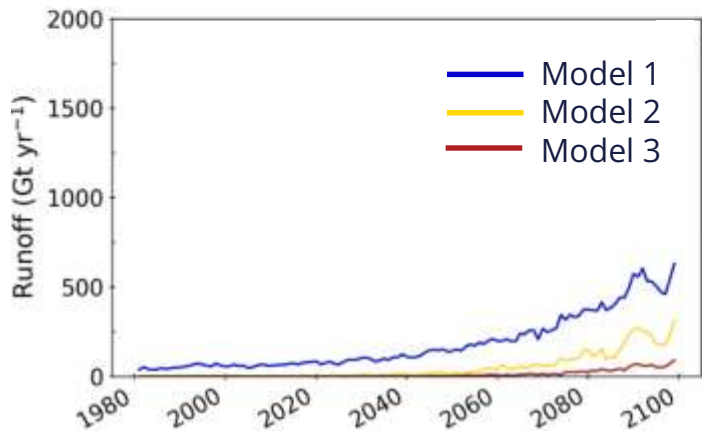
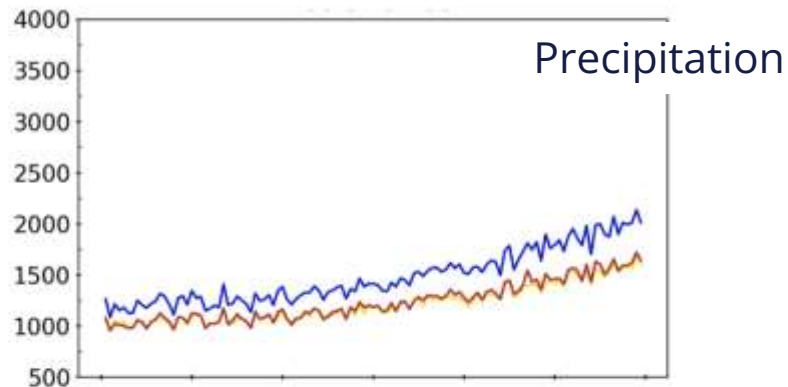
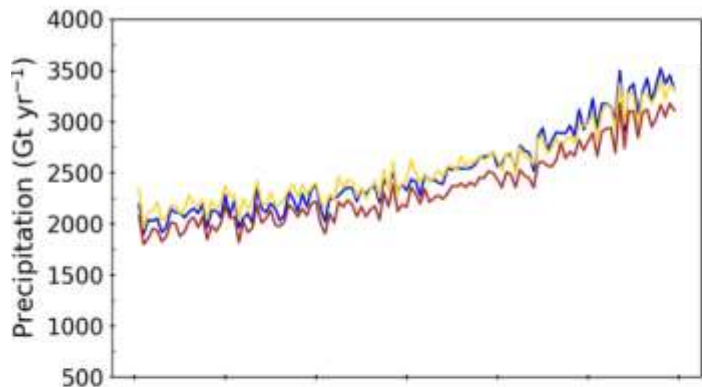


Predicted runoff from Antarctic ice shelves



- Ronne-Filchner
- Ross
- Getz
- Pine Island
- Abbot
- Amery
- Shackleton
- Fimbul
- George VI
- Wilkins
- Roi Baudouin
- Larsen C

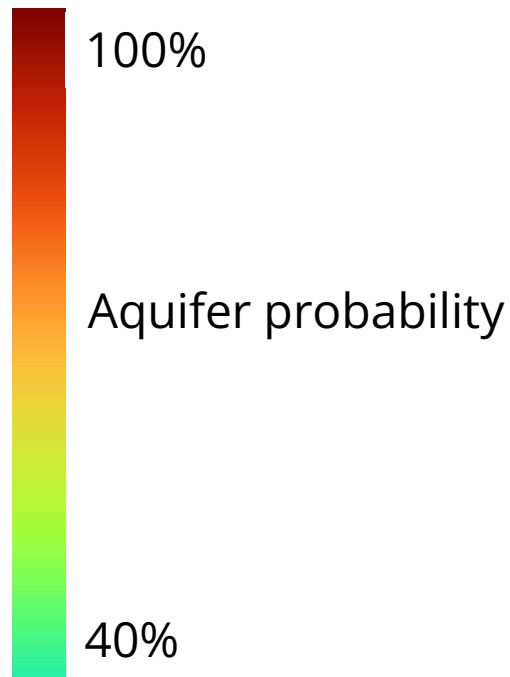
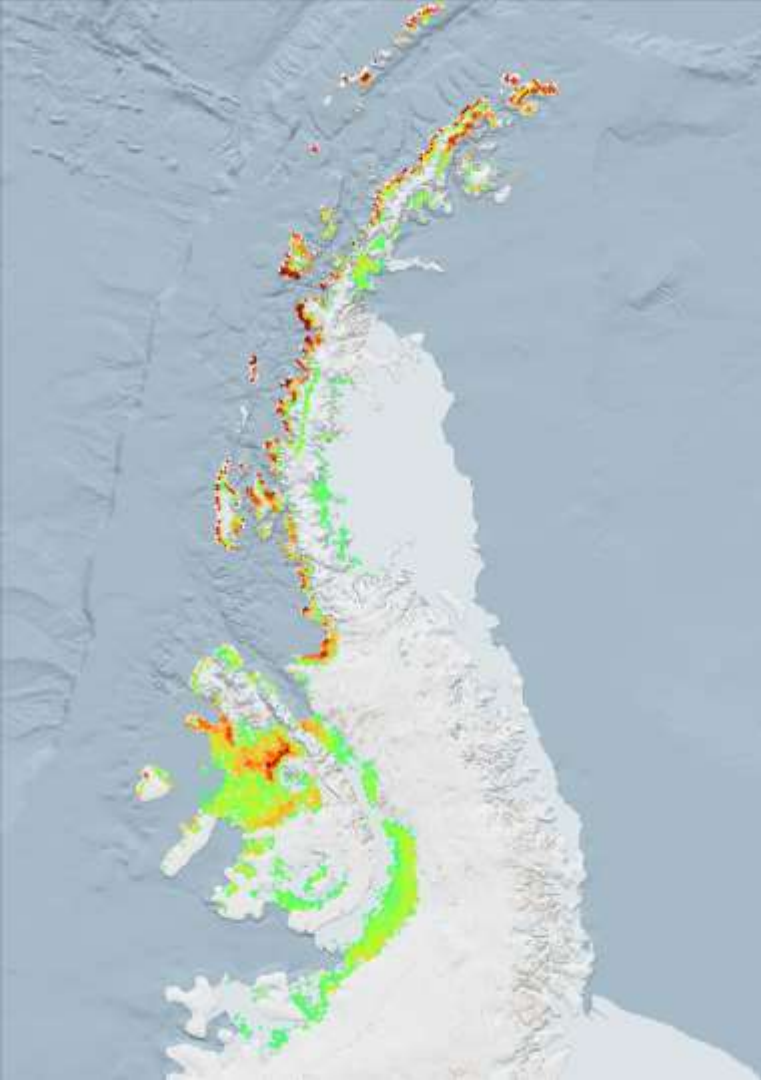
Future runoff from Antarctica: three polar RCMs



Grounded ice sheet

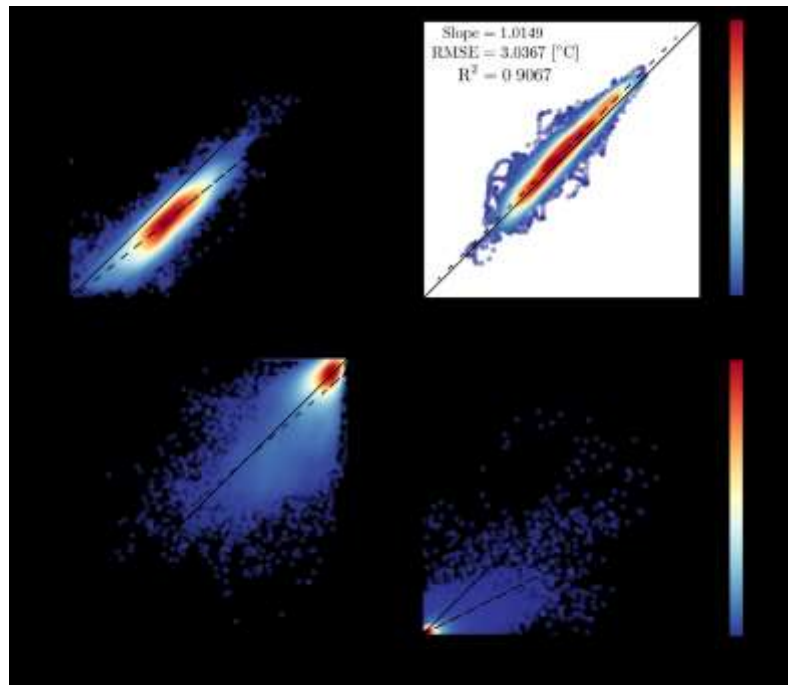
Ice shelves

Heat map of firn aquifer probability in the Antarctic Peninsula

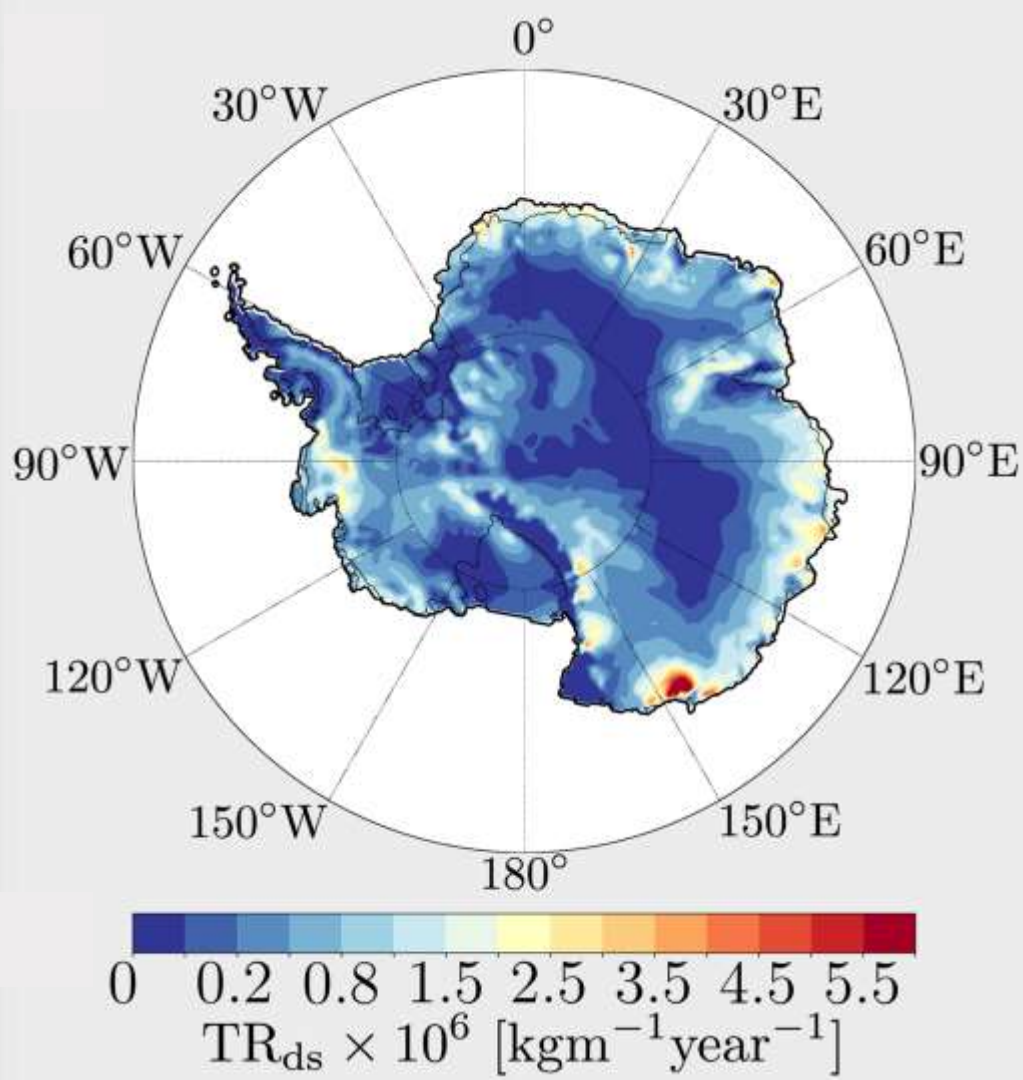


Dibiase and others, in preparation

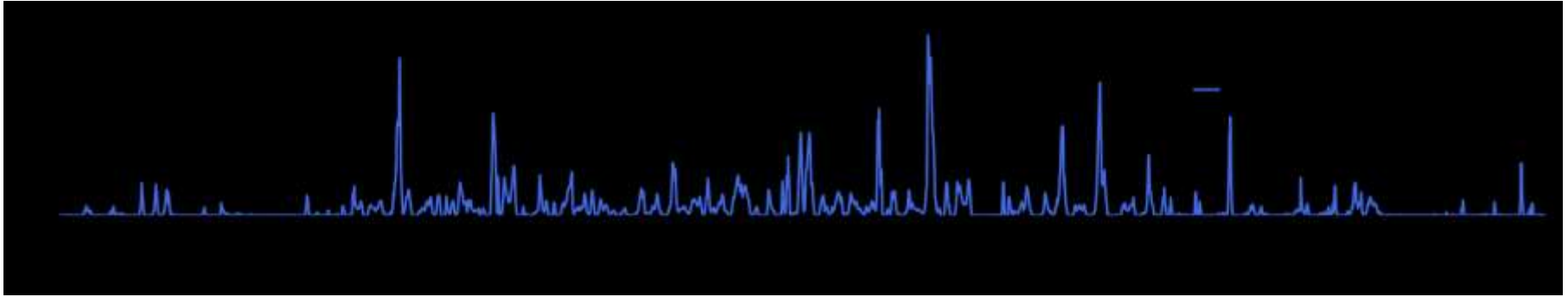
Drifting snow flux: is it significant?



Srinidhi Nagarada Gadde (in preparation)



Drifting snow flux: model evaluation at D47 ($\text{kg m}^{-1} \text{s}^{-1}$)



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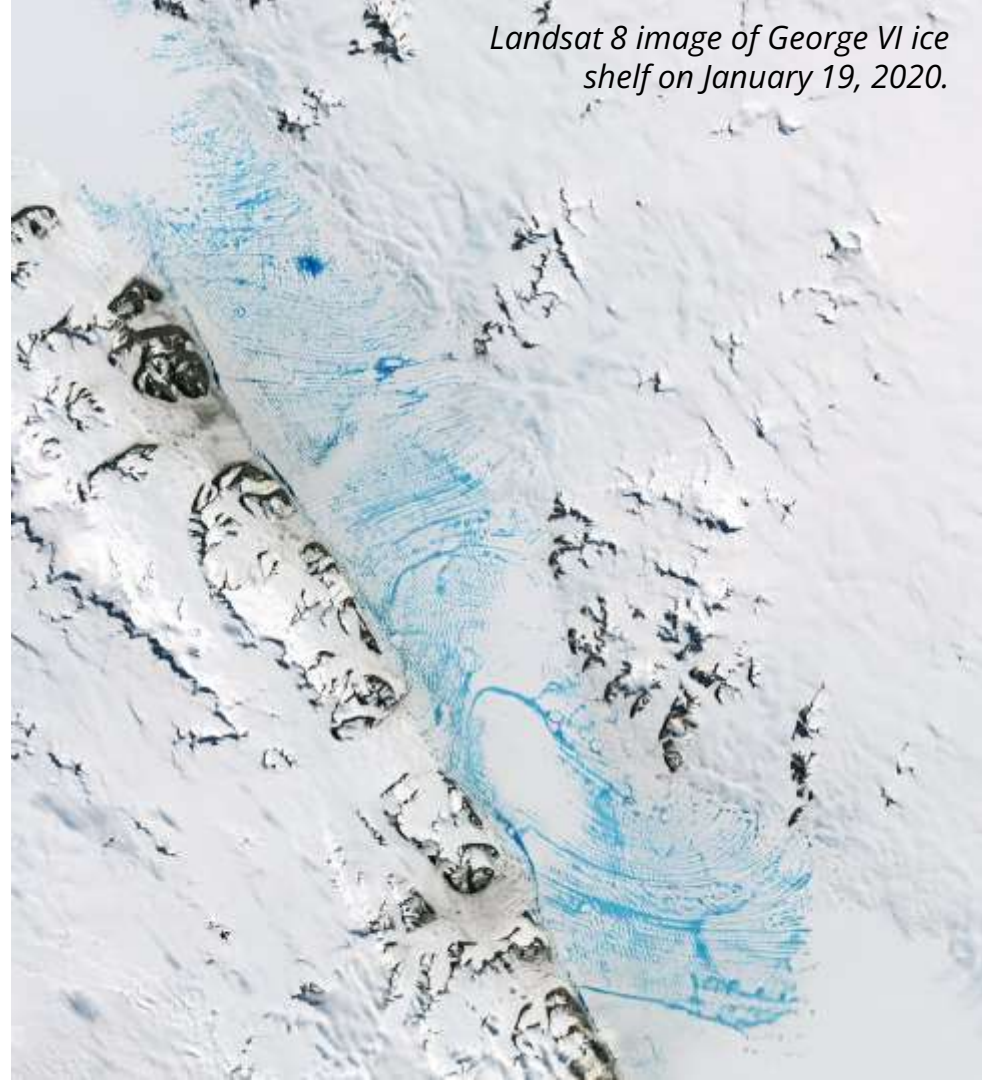


Willem Jan van de Berg
Regional climate modelling

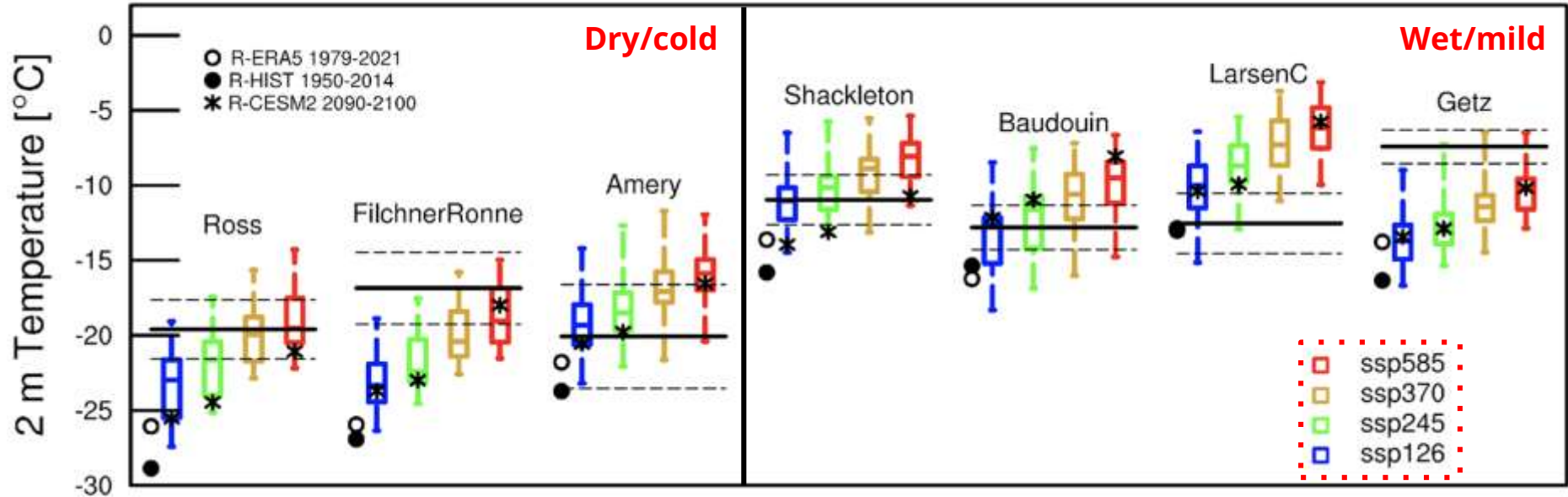


Thank you!

Landsat 8 image of George VI ice shelf on January 19, 2020.

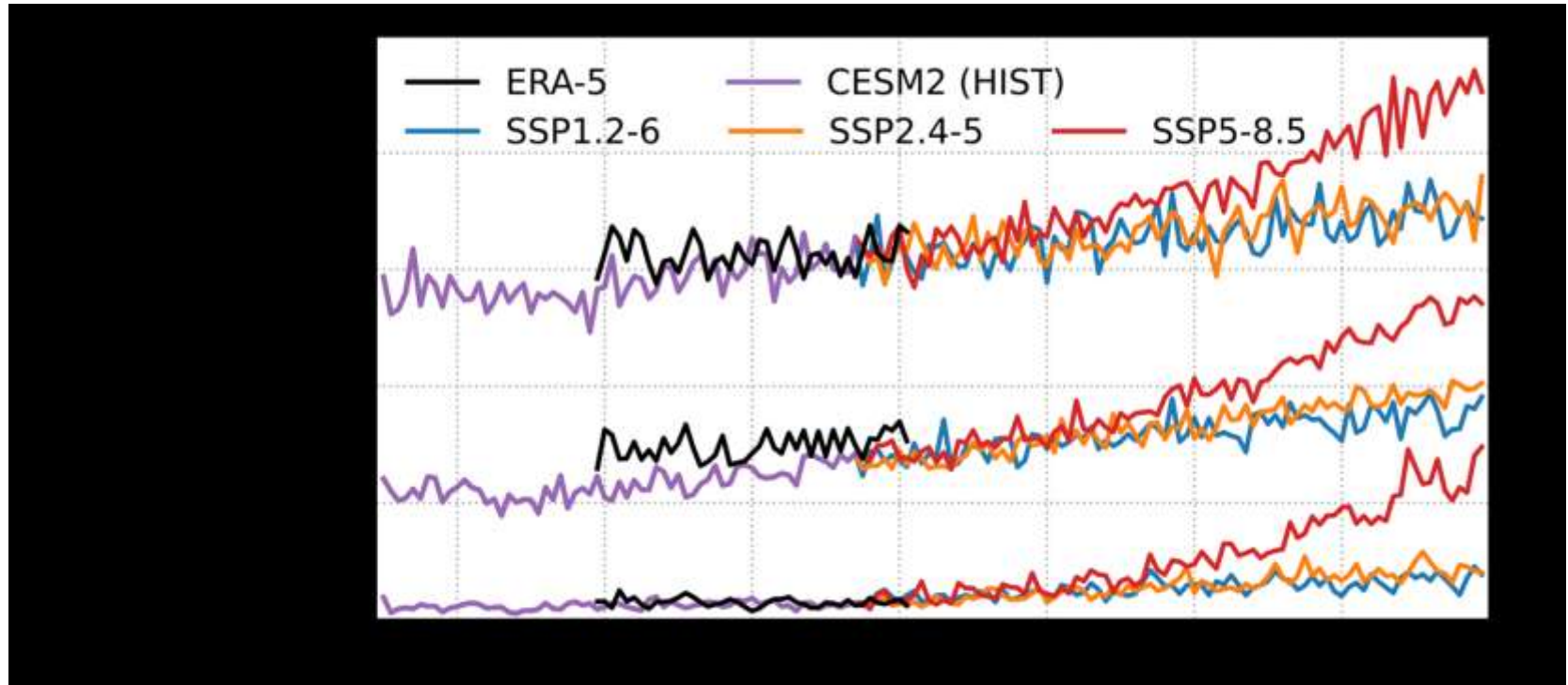


End-of-century (2090-2100), all CMIP6 models



— Threshold temperature with spatial standard deviation

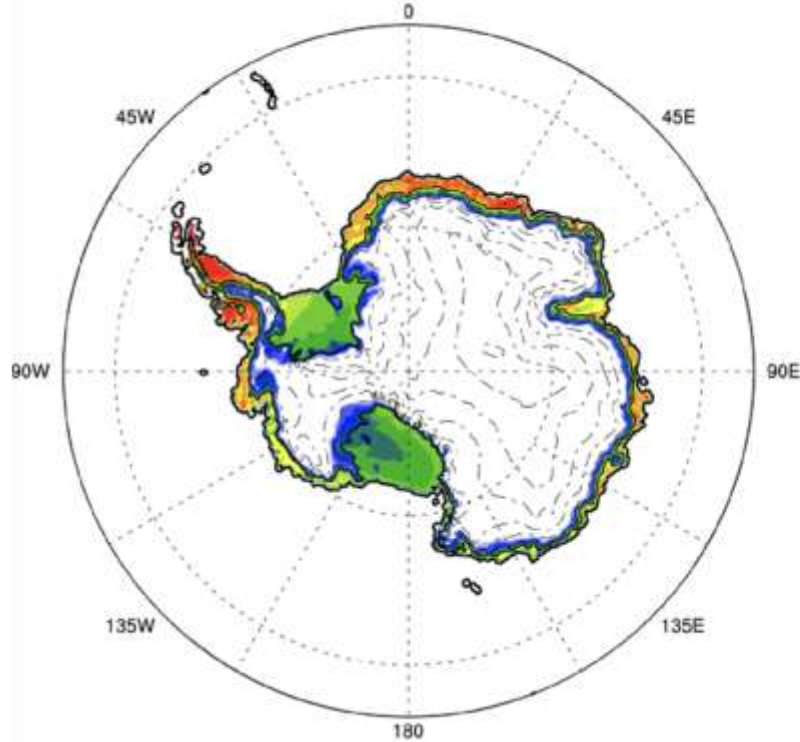
Future Antarctic surface climate and SMB (RACMO and CESM)



Future melt: how much will run off into the ocean?

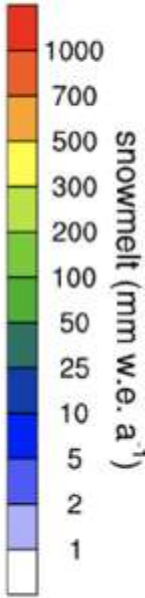
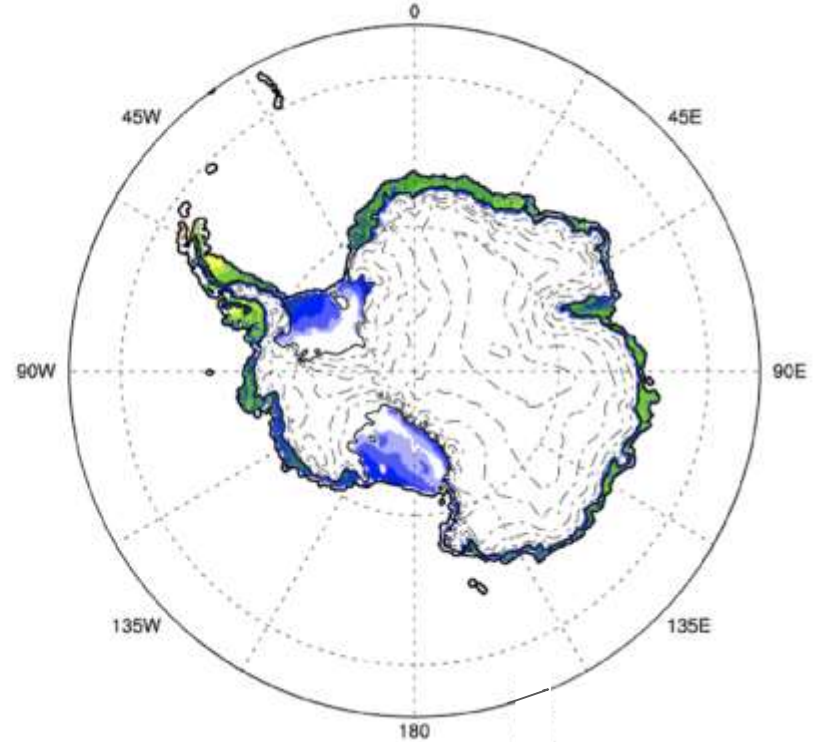
RACMO2.3p2

2069-2099





CESM2_RACMO2.3p2

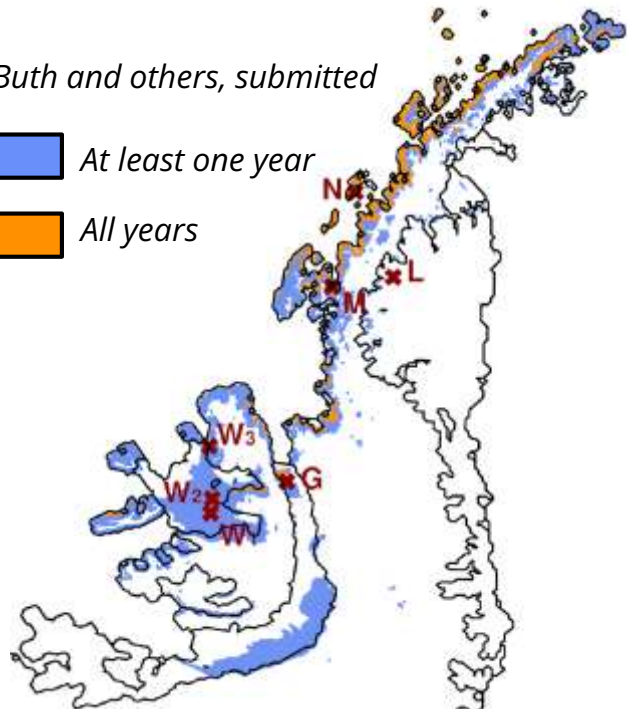
1950-1980



Buth and others, submitted

-  At least one year
-  All years

Sentinel-1 confirms perennial firn aquifers in the Antarctic Peninsula



Sentinel-1 perennial firn aquifer detection (2017-2020)

