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Modelling perennial firn aquifers in the Antarctic Peninsula

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We predict the location of perennial firn aquifers (PFAs) in the Antarctic Peninsula using the updated regional atmospheric climate model RACMO2.3p2, that is specifically adapted for use over the polar regions. With RACMO2 output we force two sophisticated firn models, IMAU-FDM and SNOWPACK, with surface mass fluxes and surface energy fluxes, respectively. These firn models explicitly calculate processes in the snowpack, such as densification, meltwater penetration, refreezing, retention and runoff.

In this presentation, we focus on the Antarctic Peninsula (AP), where conditions are favorable for the formation of PFAs: there is both sufficient meltwater production and snowfall to store the meltwater in the firn during winter without refreezing, as the fresh snow insulates the meltwater from the winter cold wave. These conditions are similar to those locations where PFAs were discovered in Greenland and Svalbard.

While slightly different in behavior, both firn models calculate PFAs on Wilkins ice shelf and the northwestern AP mountain range, but also near the grounding lines of unstable or disintegrated ice shelves such as Prince Gustav, Larsen B and Wordie. The PFAs exist in different forms, e.g. long-lasting, shallow, deep or multi-layer, and are sensitive to the magnitude and timing of atmospheric forcing conditions. We carefully explore processes controlling their formation and/or longevity, discuss their implications for ice shelf stability, and their potential to exist elsewhere in Antarctica.