EGU23-3558, updated on 21 Jan 2024
https://doi.org/10.5194/egusphere-egu23-3558
EGU General Assembly 2023

Temporal activity of subglacial channels around the grounding line of Roi Baudouin Ice Shelf, from ice-penetrating radar

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The existence of ice-shelf basal channels has a significant impact on both buttressing ability and basal melting of ice shelves in Antarctica. Although they can provide a unique perspective of processes for the mass transfer from grounded ice sheet to floating ice shelf, their origination and evolution are still not fully understood.

Here we used airborne and ground-based radar to investigate the subglacial channel features at the grounding line (GL). We determined the geometry of five channels (two of which are characterized for the first time) in a set of flow-perpendicular radar profiles, also perpendicular to the channels. We found that the evolution from grounded subglacial channels to the ice-shelf basal channels mainly goes through three stages: (1) The grounded subglacial channels appear 4 to 5 km upstream of the GL and their incision into the ice sheet increases while approaching the GL; (2) as the subglacial channels extend into the grounding zone (1 to 2 km downstream of GL), their inner walls started melting, also they keep their roof-top features; (3) on the shelf interaction with the ocean, surface accumulation and ice dynamics further lead to flattening and widening, progressively turning them into generally known ice-shelf basal channels.

Additionally to radar observations, we investigated the role of subglacial hydrology with two modelling approach (subglacial water flux with CUAS-MPI and water routing with CiDRE). A comparison shows that most channel locations in the radar profiles match with areas of higher subglacial water presence, consequently implying that subglacial water flux could mainly be responsible for maintaining the presence of subglacial channels.

Based on the already earlier proposed relation that the presence of a sub-ice shelf basal channel is linked to a corresponding channel at the GL, we identify one now active channel at the GL to be related to one which was earlier until 59 years ago. This indicates that basal channels and consequently basal water flux across the GL can change at least on the scale of centuries. Our observed reactivation of a subglacial channel confirms the suitability of basal channels in ice shelves to be used as proxies of past subglacial hydrological activities and other potentially larger

events.