EGU22-2764, updated on 31 May 2022
https://doi.org/10.5194/egusphere-egu22-2764
EGU General Assembly 2022

Towards interpretation of the radio-stratigraphy of Antarctic ice shelves from modeling and observations: A case study for the Roi Baudouin Ice Shelf, East Antarctica

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Ice shelves surrounding the Antarctic perimeter buttress ice flow from the continent towards the ocean, and their disintegration leads to an increase in ice discharge and sea level rise. The evolution and integrity of ice shelves is governed by surface accumulation, basal melting, and ice dynamics. We find history of these processes imprinted in the ice-shelf stratigraphy, which is mapped using isochrones imaged with radar. As an observational archive, the radar obtained stratigraphy combined with ice flow modeling has high potential to assist model calibration and reduce uncertainties in projections for the ice-sheet evolution. In this study we use a simplistic and observationally driven ice-dynamic forward model to predict the ice-shelf stratigraphy. We validate this approach with the full Stokes ice-flow model Elmer/Ice, and present a test-case for the Roi Baudouin Ice Shelf (East Antarctica) - where our model predictions agree well with radar obtained observations. The presented method enables us to investigate whether ice shelves are in steady-state, as well as to map spatial variations of how much of the ice-shelf volume is determined by its local surface mass balance. In the case of Roi Baudouin, we find the ice-shelf volume in the western part to be dominated by ice inflowing from the ice sheet, while the eastern part of the ice shelf is dominated by ice locally accumulated on the shelf. Such analysis serves as a metric for the susceptibility of ice shelves to climate change. We further apply our approach to other ice shelves in Antarctica.