EGU2020-20370, updated on 07 Jul 2022
https://doi.org/10.5194/egusphere-egu2020-20370
EGU General Assembly 2020

Impact of coastal East Antarctic ice rises on surface mass balance: insights from observations and modelling

Thore Kausch[1], Stef Lhermitte[1], Jan T.M. Lenaerts[2], Nander Wever[2], Mana Inoue[3], Frank Pattyn[3], Sainan Sun[3], Sarah Wauthy[3], Jean-Louis Tison[3], and Willem Jan van de Berg[4]

[1]Delft University of Technology, Geoscience and Remote Sensing, Delft, The Netherlands (t.kausch@tudelft.nl)
[2]University of Colorado Boulder, Department of Atmospheric and Oceanic Sciences, Boulder, The United States of America
[3]Université Libre de Bruxelles, Laboratoire de Glaciologie, Brussels, Belgium
[4]Utrecht University, Marine and Atmospheric Research, Utrecht, The Netherlands

About 20% of all snow accumulation in Antarctica occurs on the ice shelfs and ice rises, locations within the ice shelf where the ice is locally grounded on topography. These ice rises largely control the spatial surface mass balance (SMB) distribution by inducing snowfall variability due to orographic uplift and by inducing wind erosion due altering the wind conditions. Moreover these ice rises buttress the ice flow and represent an ideal drilling locations for ice cores.

In this study we assess the connection between snowfall variability and wind erosion to provide a better understanding of how ice rises impact SMB variability, how well this is captured in the regional atmospheric climate model RACMO, and the implications of this SMB variability for ice rises as an ice core drilling side. By combining ground penetrating radar profiles from two ice rises in Dronning Maud Land with ice core dating we reconstruct spatial and temporal SMB variations across both ice rises from 1982 to 2017. Subsequently, the observed SMB is compared with output from RACMO, SnowModel to quantify the contribution of the different processes that control the spatial SMB variability across the ice rises. Finally, the observed SMB is compared with Sentinel-1 backscatter data to extrapolate spatial SMB trends over larger areas.

Our results show snowfall-driven differences of up to ~ 0.24 m w.e./yr between the windward and the leeward side of both ice rises as well as a local erosion driven minimum at the peak of the ice rises. RACMO captures the snowfall-driven differences, but overestimates their magnitude, whereas the erosion on the peak can be reproduced by SnowModel with RACMO forcing. Observed temporal variability of the average SMBs calculated for 4 time intervals in the 1982-2017 range are low at the peak of the easternmost ice rise (~ 0.03 m w.e./yr), while being three times higher (~ 0.1 m w.e./yr) on the windward side of the ice rise. This implicates that at the peak of the ice rise, higher snowfall, driven by regional processes, such as orographic uplift, is balanced out by local erosion. Comparison of the observed SMB gradients with Sentinel-1 data finally shows the potential of SAR satellite observations to represent spatial variability in SMB across ice shelves and ice rises.