EGU21-8002
https://doi.org/10.5194/egusphere-egu21-8002
EGU General Assembly 2021

The contribution of föhn winds to northeast Greenland summer melt and their relationship with atmospheric rivers

Kyle Mattingly[1], Jenny Turton[2], Jonathan Wille[3], Xavier Fettweis[4], and Brice Noël[5]
[1]Institute of Earth, Ocean, and Atmospheric Sciences, Rutgers, the State University of New Jersey, New Brunswick, NJ, United States of America (km1348@scarletmail.rutgers.edu)
[2]Institut für Geographie, Friedrich-Alexander Universität Erlangen-Nürnberg, Erlangen, Germany (jenny.turton@fau.de)
[3]Institut des Géosciences de l'Environnement, Université Grenoble Alpes, Saint-Martin-d'Hères, France (jonathan.wille@univ-grenoble-alpes.fr)
[4]Department of Geography, University of Liège, Liège, Belgium (xavier.fettweis@uliege.be)
[5]Institute for Marine and Atmospheric Research, Utrecht University, Utrecht, The Netherlands (b.p.y.noel@uu.nl)

Atmospheric Rivers (ARs), narrow filaments of concentrated water vapor transport, have direct impacts on the surface mass balance (SMB) of the western Greenland Ice Sheet through increased summer melting in the ablation area and increased snowfall in higher altitudes. Here, we show that an additional effect of ARs on SMB comes from the development of föhn winds, whereby the air is adiabatically warmed as it descends. As ARs pass over the ice sheet and deposit precipitation in northwest Greenland, the air subsequently flows down the leeward slope and the warm, dry conditions contribute to increased melting in the northeast, and more specifically on the Nioghalvfjerdsfjorden (or 79N) Glacier.

We identify föhn conditions using an automated detection algorithm applied to MAR and RACMO2 regional climate model output. These data are paired with an AR detection algorithm and self-organizing map (SOM) classification applied to MERRA-2 and ERA5 reanalyses, in order to investigate connections between regional circulation patterns, ARs, föhn winds, and ice sheet SMB. We find that föhn conditions and associated surface melt are increased for periods of 1–3 days after anomalous southerly and southwesterly water vapor transport by ARs through Baffin Bay and the Nares Strait. Approximately 70% of the ARs which make landfall in the northwest sector of Greenland lead to the development of föhn winds on the northeast coast. The frequency of AR-induced föhn conditions in the northeast has increased in the last 40 years, in line with an increase in the strongest ARs in the northwest. We also find that anomalous northerly moisture transport from the Lincoln Sea generates enhanced melt in the lowest (0–500m) elevations of northeast Greenland, while below-average surface melt occurs during all other identified moisture transport regimes.