EGU2020-12989
https://doi.org/10.5194/egusphere-egu2020-12989
EGU General Assembly 2020

Poleward moisture transport and its influence on precipitation in the Arctic: From case studies to long-term statistics

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There are many factors which could contribute to the Arctic warming: feedback processes like the lapse rate and ice-albedo feedback, the increasing downward longwave radiation caused by clouds and water vapour, and the reduction of sea ice in summer that leads to absorption of solar radiation and increase in local evaporation and more clouds. But also the atmospheric moisture transport from the lower latitudes can contribute to the surface warming in high-latitudes. This poleward moisture transport is mostly accomplished by extra-tropical cyclones, with especially strong contribution by the Atmospheric Rivers (ARs). ARs are long, narrow bands of enhanced water vapour transport which are responsible for over 90% of the poleward water vapour transport in and across mid-latitudes. Furthermore, they are responsible for producing significant levels of rain and snow. In addition, the greenhouse effect of water vapour and the formation of clouds increase the downward longwave radiation which can cause a thinning and melting of Arctic sea ice and snow.

In this study, we investigate the contribution of ARs to Arctic precipitation. Firstly, we look into different case studies for which observational data from the campaigns within the Collaborative Research Center “Arctic Amplification: Climate Relevant Atmospheric and Surface Processes, and Feedback Mechanisms (AC)^3” exist. The data include enhanced observations at/around Svalbard performed during the ACLOUD and the AFLUX campaigns.

Previous studies have shown that ARs reaching into the Arctic have different origins, including the Atlantic and the Pacific pathways and also Siberia. Here we examine which pathway is more common and which one transports more moisture into the Arctic for these case studies by using existing AR catalogues from global and polar-specific algorithms. Furthermore, the variability of precipitation influences the surface mass and energy balance of polar sea ice and ice sheets. Therefore, we will analyse the influence of ARs on precipitation in terms of frequency, intensity, and type of precipitation (rain or snow) for the different case studies. For this purpose, we will use reanalyses and observational data for the water vapour transport, total precipitation, rain and snow profiles.The occurrence of ARs and its influence on precipitation will be extended from case

studies to the long-term statistics (for at least 10 years).