Arctic Atmospheric Rivers: New Perspectives on the Impact on the Surface Energy Budget

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Abstract

Atmospheric Rivers (ARs) play a critical role in the Arctic climate system, providing a large fraction of the water vapor transport into the Arctic, despite their rare occurrence. The potential of such events to impact especially the ice-covered regions of the Arctic have been explored in recent studies: ARs can trigger surface melt of the Greenland ice sheet, slow the seasonal recovery of the Arctic sea ice and play a critical role in snow depth variations. These studies of mostly individual cases of ARs highlight the warming effect of ARs. We provide a climatological analysis of the statistical impact of Arctic ARs on the atmospheric components of the surface energy budget (SEB). The analysis is based on the ERA5 reanalysis from 1979 to 2021 and investigates ARs detected by the Guan and Waliser algorithm. We confirm a statistical net energy gain of the surface related to the occurrence of ARs. We further provide two complementary metrics to quantify the climatological relevance of the SEB impact, showing that the most *extreme* impact occurs in winter over sea-ice covered areas, while the climatologically most *relevant* impact occurs in winter over the open ocean. Furthermore, we analyze the physical mechanisms behind the AR-related SEB anomalies, with a special focus on cloud radiative processes. The results quantify the variability of the impact of ARs on the SEB such as the seasonal changes and the dependence on the surface type.

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