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Horizontal moisture transport shapes the regional moistening patterns in the Arctic

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The Arctic has experienced regionally and seasonally variable moistening of the atmosphere during the recent decades. Compared to the accompanying amplified warming and dramatic sea ice decline, the moistening has so far remained less studied.

We address the regional and seasonal trends in the horizontal moisture transport in the Arctic during the last four decades, in 1979–2018, based on data of ERA5 reanalysis of European Centre for Medium-Range Weather Forecasts. We show that regional trends in moisture transport are large and mainly driven by changes in atmospheric circulation. We demonstrate that the regional moistening patterns in the Arctic during the last four decades have dominantly been shaped by these strong trends in horizontal moisture transport. Changes in local evaporation in the Arctic have only had a minor role in shaping the moistening patterns. We show that increasing trends in evaporation have been restricted to the vicinity of sea-ice margin over a limited period during the local sea-ice decline, and this step-wise increase has been followed by negative trends in evaporation in open sea, due to suppressing effect of horizontal moisture transport.

Both evaporation and the horizontal moisture transport have been affected by the diminishing sea-ice cover during the cold seasons from autumn to spring, and their trends have been dependent on the flow direction. We summarize the current understanding and the new results of flow-dependency of the trends in moisture transport and evaporation near the sea-ice margin, and the cloud response to those.

For the first time, we provide a detailed picture of both the drastic regional changes in the moisture transport within the Arctic and changes in local evaporation, and demonstrate large impacts of these changes on the climate of the Arctic. We suggest that also in the future, moisture and cloud distributions in the Arctic are expected to respond to changes in atmospheric pressure patterns; circulation and moisture transport will also control where and when efficient surface evaporation can occur.