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Vertical structure of atmospheric moisture in the Arctic and its linkages to the clouds

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Much of the moisture in the Arctic is transported from the lower latitudes as evaporation is typically small over snow and ice-covered surfaces. There has been a large uncertainty on the altitude at which the moisture transport peaks in the Arctic, although the peak altitude of moisture transport has presumably a remarkable importance for the cloud climatology and properties as well on the clear-sky radiation. Here we present results on the vertical structure of the atmospheric moisture and its transport to the Arctic, including seasonal and spatial differences, based on ERA-Interim and JRA-55 reanalysis data as well as on radiosoundings from 36 stations in the circumpolar Arctic. The study period is from 2000 to 2014.

We investigate the vertical structure of horizontal moisture transport to the Arctic by dividing the atmosphere into several vertical layers and calculating moisture flux in each of them separately. Based on the variability of results between the data sets (two different reanalyses and radiosoundings), level of uncertainty in moisture transport estimates is also defined. We also present climatology and characteristics of humidity inversions, i.e. layers where specific humidity increases with height, in the Arctic, including their relationship with cloud cover.

Vertically uneven moisture advection is probably a significant generator of very common humidity inversion layers observed in the Arctic lower troposphere. These humidity inversions have in recent studies been demonstrated to offer a potential moisture source aloft for cloud formation and maintenance. Considering the commonness of the elevated humidity inversions in the Arctic troposphere, there is a strong reason to believe that humidity inversions have a high importance for clouds in wide spatial and temporal scales, and they possibly largely contribute to the spatially extensive cloud cover in the Arctic. The results encourage for further studies on interactions between humidity inversions and clouds, which may offer significant advances to currently poorly-modelled Arctic clouds.