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Arctic Warming, Moisture Increase and Circulation Changes Observed in the Ny-Ålesund Homogenized Radiosonde Record

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Compared to global warming, the feedback mechanisms of Arctic Amplification lead to an increase of surface temperature in the Arctic by a factor of two. Yet, the vertical structure of Arctic warming and its resulting radiative feedbacks are poorly understood. Here, we focus on the analysis of the atmospheric column above Ny-Ålesund (78.9° N, 11.9° E), Svalbard.

At Ny-Ålesund, radiosondes have been launched on a daily basis since 1993 in support of synoptic observations. The obtained radiosonde measurements 1993 to 2014 have been homogenized accounting for instrumentation discontinuities and known errors in the manufacturer provided profiles. From the homogenized data record, a first upper-air climatology of wind, humidity and temperature above Ny-Ålesund is presented, forming the background for the analysis of changes detected during the 22-year period. Particularly during the winter season, a strong increase in atmospheric humidity and temperature is observed, with a significant warming of the free troposphere in January and February of up to 3 K per decade. This winter warming is even more pronounced in the boundary layer below 1 km, presumably amplified by local conditions including e.g. orographic effects or the boundary layer capping inversion.

Also the largest contribution to the increasing atmospheric water vapour column originates from the lowermost 2 km of the atmosphere where specific humidity inversions are frequently observed. Yet, no increase in the water vapour contribution by humidity inversions is detected. Instead, we find an increase in the humidity content of the large scale background humidity profiles to be responsible for the observed increase in winter integrated water vapour.
The observed difference in the frequency occurrence of wind directions in the free troposphere between the first and second half of the 22-year period implies that the large scale synoptic flow over Svalbard has changed over the years. During the winter season, the tropospheric flow is found to occur less frequent from northerly directions and to the same amount more frequent from the South.

We conclude that changes in the atmospheric circulation lead to an enhanced advection of warm and moist air from lower latitudes to the Svalbard region in the winter season, causing the warming and moistening of the atmospheric column above Ny-Ålesund.