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

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Introduction

Various processes contributing to Arctic amplification cause global warming to be effectively larger in the Arctic region. Here, we focus on observations at the AWIPEV research base in Ny-Ålesund (78.9°N, 11.9°E), Svalbard. The Ny-Ålesund surface observations reflect the recent warming in the North Atlantic Arctic, with the largest temperature increase occurring in the winter months.

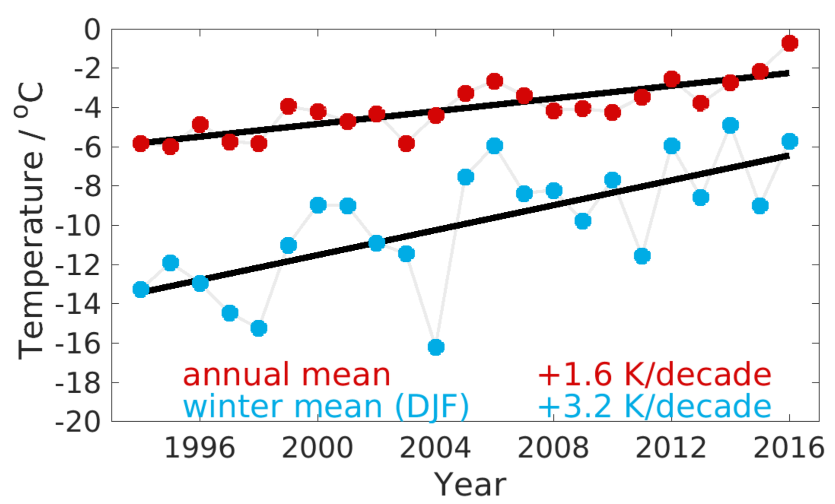

Fig.1: Air temperature (2m) in Ny-Ålesund [update of *Maturilli et al., 2015*].

How does the climate change signal emerge in the vertical column ?

Data

Radiosonde measurements obtained at the Arctic research base AWIPEV at Ny-Ålesund (78.9° N, 11.9° E), Svalbard, from 1993 to 2015 have been homogenized accounting for instrumentation discontinuities by correcting known errors in the manufacturer provided profiles.
The homogenized radiosonde data set is available at http://doi.pangaea.de/10.1594/PANGAEA.845373.

Temperature

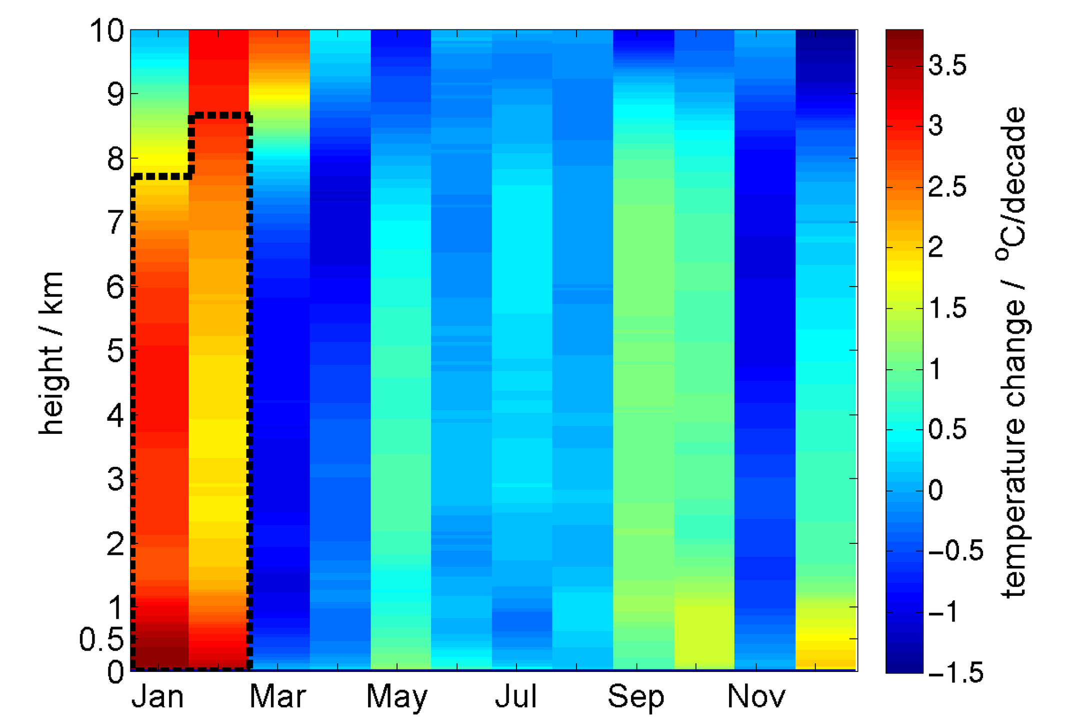

Fig.2: Change of upper-air temperature from radiosondes 1993-2014, significance indicated by dashed line.

- significant warming of the tropospheric column in January and February up to 3 K per decade
- winter warming is even more pronounced in the boundary layer below 1 km, presumably amplified by mesoscale processes including e.g. orographic effects or the boundary layer capping inversion

Humidity

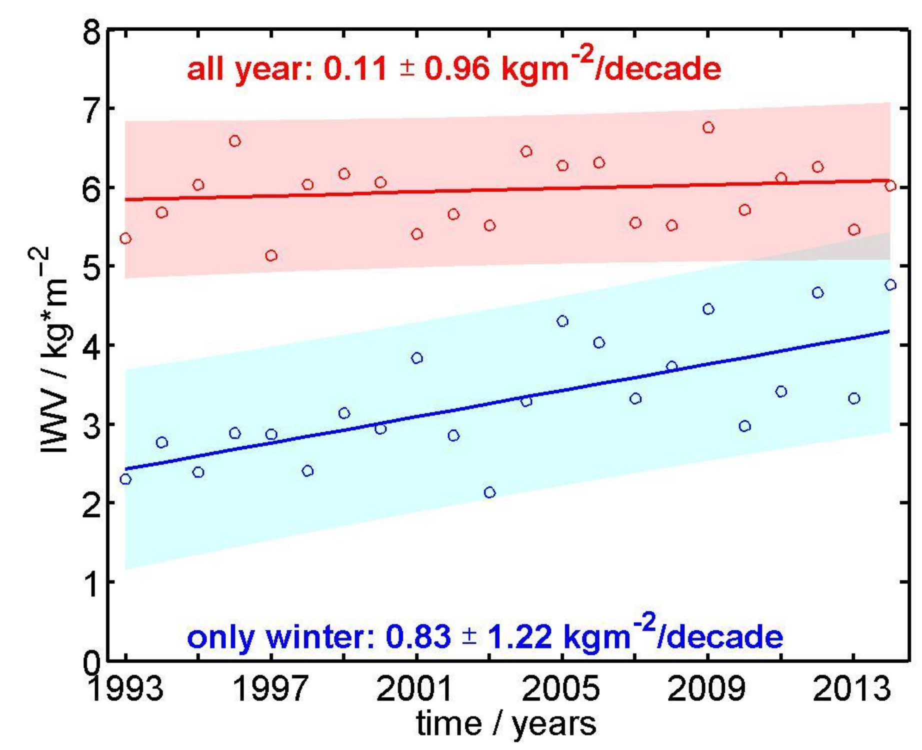

Fig.3: Integrated water vapour (IWV) from radiosonde measurements for the annual and the winter season mean (red and blue circles, respectively). The increase is given by the linear regression (lines) ± 1 standard deviation (colour shaded), respectively.

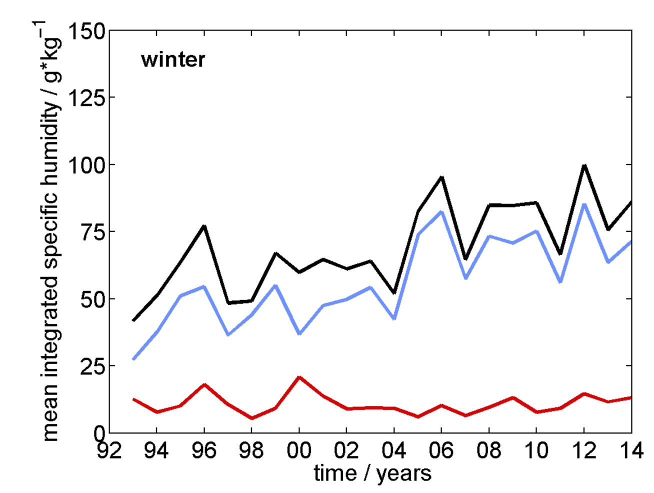

Fig.4: Integrated specific humidity of the total profiles (black), the background humidity profiles (blue), and the inversion layers (red).

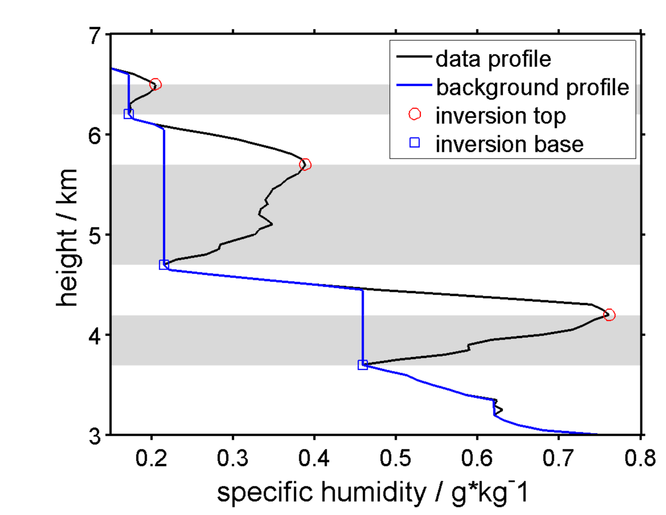

Fig.5: Specific humidity profile (black line), considering several humidity inversion layers (grey shading), and a background humidity profile (blue line).

- increase in water vapour column in winter
- no increase in the contribution by specific humidity inversions
- increase in the humidity content of the large scale background humidity profiles

Wind

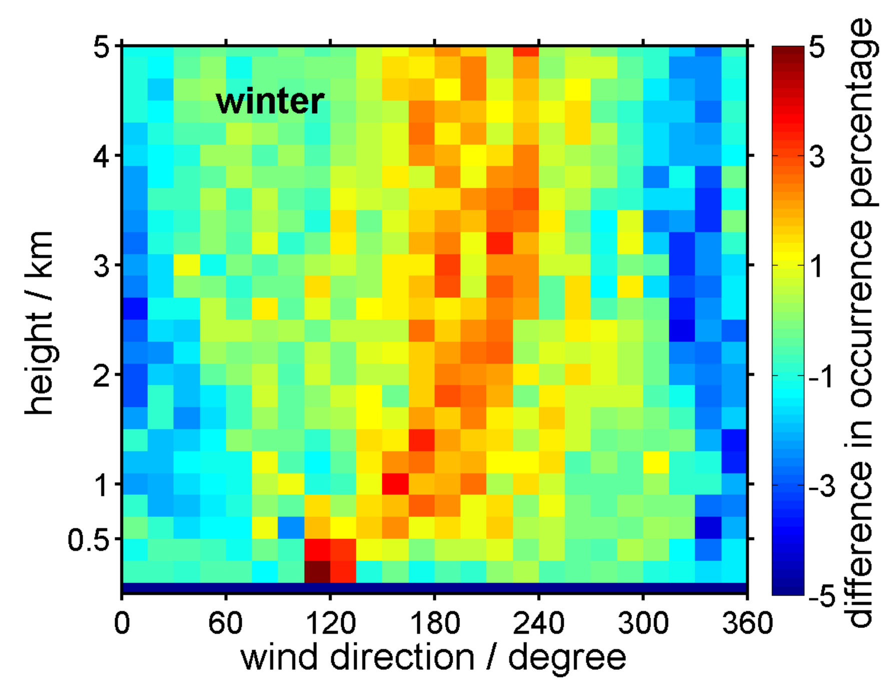

Fig.6: Difference in relative occurrence frequency of wind directions in winter season (DJF), subtracting period [1993 to 2003] from period [2004 to 2014].

- tropospheric flow in winter occurs less frequent from northerly directions and to the same amount more frequent from the South

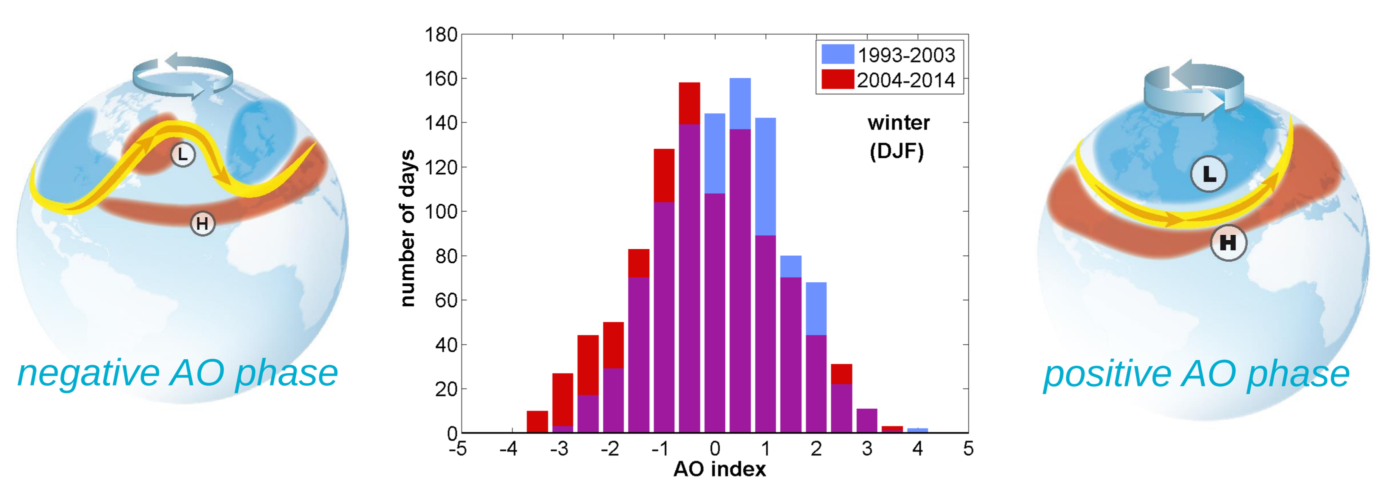

Fig.7: Daily Arctic Oscillation (AO) indices for the winter months (DJF), divided into the early period 1993–2003 (blue) and the late period 2004–2014 (red) from ERA-interim. Left and right: schematic of the jet stream position and the more meridional (zonal) flow under negative (positive) AO conditions, respectively.

Conclusion

- changes in winter atmospheric circulation
- enhanced advection of warm and moist air from lower latitudes to the Svalbard region
- warming and moistening of the atmospheric column above Ny-Ålesund

Maturilli et al. (2015): Surface radiation climatology for NyÅlesund, Svalbard (78.9° N),basic observations for trend detection. Theor. Appl. Climatol., 120: 331-339. doi:10.1007/s00704-014-1173-4.

Maturilli and Kayser (2016): Arctic warming, moisture increase and circulation changes observed in the Ny-Ålesund homogenized radiosonde record. Theor. Appl. Climatol., doi:10.1007/s00704-016-1864-0

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