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Investigating spatial and temporal variability of Arctic water vapor from passive microwave radiometry and Arctic system reanalysis (ASR)

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The Arctic, a region where near-surface temperature increase is more than twice the global, is extremely vulnerable to climate change. While many feedback mechanisms such as water vapor, ice-albedo or lapse rate as well as atmospheric transport from lower latitudes have been suggested, their relative contribution is still unclear as few measurements to test hypothesis are available in this region. Since water vapour alters the greenhouse effect it is of vital importance to study and to understand mechanism which controls its distribution and circulation through the atmosphere. The main redistribution pattern that water vapour follows is temperature because it controls the water vapour partial pressure.

In this study we put our focus on spatial and temporal variability of water vapor by using a novel approach. Instead of using water vapor products retrieved from microwave satellite we avoid the many assumptions involved in the retrieval process by directly looking at brightness temperatures (BTs) observed in water vapor sensitive channels.

We can make use of the long term Fundamental Climate Data Record (FCDR) data set from two passive microwave radiometers, namely Advanced Microwave Humidity Sounder (AMSU-B) and Microwave Humidity Sounder (MHS) to check for spatial and temporal variability of BT. Providing a good coverage (approximately 10 times per day over polar regions), vertical (5 channels) and horizontal resolution (15 km at nadir) makes these satellites well suited for this investigation. Moreover, the Arctic System Reanalysis (ASR) version 2 (2000 - 2016) data set that has good horizontal (15 km) and vertical (34 levels) resolution is used to check the suitability of our approach.

In order to link ASRv2 to satellite measurements we use the model to observations method by employing the Passive and Active Microwave Radiative Transfer Model (PAMTRA) simulator. First studies show that synthetic BTs simulated from ASRv2 check realistically and represent features, such as mesocyclone signatures well by showing strong BT depression of mesocyclone convective cores due to strong snow scattering effects.

Generally, a difference between observations and simulations of few selected cases is of few degrees K with better agreement over ocean raising confidence for our approach.