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Retrieval of total water vapour over polar regions from spacebourne microwave radiometer data

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The polar regions belong to the regions of which the least information is available about the current and predicted states of surface and atmosphere.

We present advances in a method to determine the total (column) water vapour of the polar atmosphere from spacebourne microwave radiometer data, in particular data from the sensor AMSU-B (Advanced Microwave Sounding Unit B) on the new generation polar orbiting satellites of NOAA (National Oceanic and Atmospheric Administration), NOAA-15, NOAA-16, and NOAA-17; likewise, data from the the sensor SSM/T2 (Special Sensor Microwave) on the DMSP (Defense Meteorological Satellite Program) satellites can be used.

While AMSU-B is designed and operationally used for humidity sounding, this fails over polar regions since there, (1) the total water vapour content of the atmosphere is so low that the contribution caused by surface emission is substantial and (2) the surface emission is poorly known and highly variable because of variable ice cover of the seas.

Our method which retrieves total water vapour is complementary in that it works exactly where the atmosphere is dry enough for the ground to be "seen" by the sensor, and it is independent of the surface emissivity. The basic idea is to use three channels where the surface emissivity is similar but the water vapour absorption is different (such as the three AMSU-B channels centred around the 183 GHz water vapour line). Using these three channels and the window channel at 150 GHz, the method works up to total water vapour contents of about 6 kg/m2. An extension to higher water vapour values by also using the window channel at 89 GHz and information about the correlation between the surface emissivities at the various frequencies will be presented.

Maps of the polar total water vapour derived by our method show details that are missed by, e.g., model or reanalysis data because of the sparsity of observations. The possibility to assimilate total water vapour derived in such a way into numerical weather prediction models is being explored at present within the EU project IOMASA (Integrated Observing and Modelling of the Arctic Sea Ice and Atmosphere). The total water vapour data might also be used together with regional models for water cycle investigations.