B05: Variability and trends of water vapor in the Arctic

J. Rückert[1], A. Walbröl[2], K. Ebell[2], G. Spreen[1]

[1]Institute of Environmental Physics, University of Bremen
[2]Institute for Geophysics and Meteorology, University of Cologne

e-mail: kebell@meteo.uni-koeln.de
e-mail: gunnar.spreen@uni-bremen.de

Water vapor is a crucial greenhouse gas and significant component of the hydrological cycle. However, monitoring the temporal and spatial variability of water vapor in the Arctic - which is important to understand its role in Arctic amplification - is hampered by the sparseness of in-situ measurements and the challenges for remote sensing retrievals. Crewell et al. [1] recently showed that monthly mean values of integrated water vapor (IWV) strongly differ (up to 30%) between different satellite products in the central Arctic. In the project B05, improved water vapor microwave radiometer (MWR) retrievals from both space and ground are thus developed as a first step and jointly analyzed with the comprehensive measurements of the MOSAiC campaign providing a full year of IWV reference measurements in the central Arctic.

Over the open ocean, retrieval of water vapor using space-borne radiometer are prevalent but over sea ice the retrievals have higher uncertainties and are more challenging due to variable and high sea-ice emissivity in the microwave domain. An optimal estimation method [2] is used to simultaneously retrieve six geophysical parameters from satellite radiometers, including IWV, sea ice concentration and liquid water path (LWP). We present a comparison of this IWV retrieval to in-situ measurements from the MOSAiC campaign. The temporal variability is captured but we observe a significant bias. We present a potential improvement of the retrieval by including snow in the forward model.

For the ground-based MWRs onboard Polarstern during the MOSAiC campaign, a quadratic regression (Neural Network approach) is performed to retrieve IWV, LWP, and humidity profiles from the standard low-frequency HATPRO (high-frequency MiRAC-P). In addition, temperature profiles are derived from HATPRO zenith and elevation scans. The radiometers are characterized by a complementary moisture sensitivity with MiRAC-P working best in extremely dry conditions. We present the performance of the retrieved products of HATPRO and MiRAC-P compared to Polarstern radiosondes and a two-channel MWR from the Atmospheric Radiation Measurement research facility.

In future, the derived data sets will also be set in context to other satellite and reanalysis products. With the upcoming HALO-$(\mathcal{AC})^3$ campaign, a focus will be set on the anomalous water vapor transport to the Arctic and the complex vertical structure of water vapor.

This work was supported by the DFG funded Transregio-project TR 172 "Arctic Amplification $(\mathcal{AC})^3$".

References

[1] S. Crewell, K. Ebell, P. Konjari, M. Mech, T. Nomokonova, A. Radovan, D. Strack, A. M. Triana-Gómez, S. Noël, R. Scarlat, G. Spreen, M. Maturilli, A. Rinke, I. Gorodetskaya, C. Viceto, T. August, and M. Schröder, *A systematic assessment of water vapor products in the Arctic: from instantaneous measurements to monthly means*, Atmos. Meas. Tech. **14** (2021), no. 7, 4829–4856, DOI 10.5194/amt-14-4829-2021.

[2] R.C. Scarlat, G. Heygster, and L. T. Pedersen, *Experiences With an Optimal Estimation Algorithm for Surface and Atmospheric Parameter Retrieval From Passive Microwave Data in the Arctic.* IEEE J-STARS **10** (2017).