# Evaluating water vapour products of state-of-the-art models and satellite products in the Arctic Ocean

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Water vapour is a critical component of the surface radiation budget in the Arctic Ocean due to the strong direct and indirect (clouds) greenhouse effect. The amplified warming of the Arctic and changes in the atmospheric circulation led to positive trends in water vapour. However, due to the sparsity of ground stations and challenges in satellite remote sensing, water vapour estimates and trends are uncertain in the Arctic Ocean. To analyze the quality of state-of-the-art water vapour products from models (reanalyses ERA5 and MERRA-2; forecast systems ICON and CAFS) and satellites (IASI combined sounding product), we use reference observations from the Multidisciplinary drifting Observatory for Study of the Arctic Climate (MOSAiC) expedition. The MOSAiC expedition took place in the Arctic Ocean, where the German icebreaker Polarstern drifted along with the sea ice for almost an entire year (October 2019 – September 2020). Radiosonde observations during the MOSAiC expedition provide detailed humidity profiles with a coarse temporal resolution. Water vapour profiles and integrated water vapour (IWV) derived from the combination of two microwave radiometers with different moisture sensitivities (HATPRO, 22 – 58 GHz and MiRAC-P, 175 – 340 GHz) complement the radiosonde observations due to their high temporal resolution. We use the high quality IWV product from the microwave radiometers and the humidity profiles from the radiosondes as reference for the evaluation.

The IWV comparison revealed a strong negative bias (15 %) for the satellite product in moist conditions and a negative bias of 10 % for MERRA-2 in dry conditions. In the cold seasons, most models underestimated the specific humidity in the lowest 2 km, except for a shallow surface layer. Further, we analyze the representation of the frequently observed humidity inversions, which affect the downwelling longwave radiation and the formation and maintenance of clouds, in all data sets in comparison to radiosondes. The presence of surface inversions is generally well detected by the models but underestimated by the microwave radiometers and satellite product. All data sets miss 10 – 30 % of the elevated inversions, especially in summer. Inversions tend to be smoother (overestimated depth, underestimated strength) in the models and remote sensing observations than in the radiosondes due to the differences in vertical resolution.