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Stratospheric water vapour in the Arctic: measurements and analysis

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The stratospheric water vapour mixing ratio inside, outside, and at the edge of the polar vortex has been accurately measured by the balloon-borne FLASH-B Lyman-Alpha hygrometer during the LAUTLOS campaign in Sodankylä, Finland, in January and February 2004. The retrieved H_2O profiles reveal a detailed view on the Arctic lower stratospheric water vapour distribution, and provide a valuable dataset for the validation of model and satellite data. Analysing the measurements with the semi-lagrangian advection model MIMOSA, water vapour profiles typical for the polar vortex' interior and exterior have been identified, and laminae in the observed profiles have been correlated to filamentary structures in the potential vorticity field.

Applying the validated MIMOSA transport scheme to specific humidity fields based on ECMWF T106 analyses, large discrepancies from the observed water vapour profiles arise. The ECMWF analyses and MIMOSA 3-dimensional field reconstructions both reveal a dry bias of about 1 ppmv in the lower stratosphere above 400 K, accounting for a relative difference from the measurements in the order of 20 %. Although the MIMOSA transport scheme is able to reproduce weak water vapour filaments and to emend the vertical H_2O gradient, the dry bias induced by the initial H_2O field exceeds by far any improvement introduced by the better representation of the dynamical field.

The large dry bias in the models' representation of stratospheric water vapour in the Arctic implies the need for future regular measurements of water vapour in the polar stratosphere to allow the validation and improvement of climate models.