



## Direct injection of water vapor into the lower stratosphere through extreme convection: A case study for the summer 2019 in the mid latitudes

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Water vapor is one of the strongest greenhouse gases of the atmosphere. Its driving role in the upper troposphere / lower stratosphere region (UTLS) for the radiation budget was shown by e.g. Riese et al., (2012). Despite its low abundance of 4 - 6 ppmv in the stratosphere, even small changes in its mixing ratio can lead to a positive feedback to global warming. To better understand changes and variability of water vapor in the lower stratosphere, we focus here on exchange processes from the moist troposphere to the dry stratosphere in the mid latitudes. These processes are caused by extreme vertical convection, which is expected to increase in intensity and frequency with progressive global climate change.

Within the MOSES (Modular Observation Solutions for Earth Systems) campaign in the summer of 2019, two extreme vertical convection events could be captured with balloon borne humidity sensors over the eastern part of Germany. The comparison of measurements before and after both events reveal distinct water vapor enhancements in the lower stratosphere and show that even in mid-latitudes over shooting convection can impact the water vapor mixing ratio in the UTLS. The measurements are compared with the Microwave Limb Sounder (MLS) data as well as ECMWF reanalysis data.

We will show a deeper analysis of both events by using visible and infrared weather satellite images in combination with meteorological fields of ECMWF. Backward trajectories of the air masses with the enriched water vapor mixing ratios calculated with the CLAMS model and combined with the satellite images can confirm the convective origin. Additionally, we show the further development of this distinct water vapor filaments within the lower stratosphere in order to trace the transport and mixing process, based on an analysis of forward trajectories.