A case study on the impact of severe convective storms on the water vapor mixing ratio in the lower mid-latitude stratosphere

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Extreme convective events in the troposphere have not only immediate destructive impact on the surface, but can also influence the dynamic and composition of the lower stratosphere (LS). One of the impacts is the moistening of the LS. This effect plays a crucial role in climate feedback as water vapor in the UTLS (Upper Troposphere/Lower Stratosphere) has a major impact on the radiation budget of the atmosphere.

In this case study we investigate water vapor injection into the LS by convective events in mid-latitudes. In the framework of the MOSES (Modular Observation Solutions for Earth Systems) measurement campaign during the early summer of 2019, balloon borne measurements were performed to capture the water vapor injected into the stratosphere by convective events. On two consecutive days the balloon profiles showed clear evidence of water vapor transported above the tropopause by convection. The magnitude of the water vapor enhancement is comparable to other studies which show measurements above North America. At the altitude of the measured injection a sharp cut-off in a local ozone enhancement peak verifies the tropospheric origin of the water vapor injection. Back trajectories of the measured air masses reveal that the moistening took place multiple hours before the balloon launch and correlate well with ERA5 data showing a strong change in the structure of isotherms and a sudden and short lived increase in potential vorticity at the altitude of the trajectory. A comparison with MLS data shows that this process can barely be recognized by satellite measurements due to the low vertical and horizontal resolution.

It is hence desirable to increase the number of in-situ measurements focusing on the impacts of convective events on the lower stratosphere over Europe and to assess its impact on UTLS water vapor.