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Organic trace gases collected using the Whole Air Sampler over North America (summer 2021, 2022), in the UTLS region, targeting deep convective regions

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Whole Air Samples (WAS) were collected as part of the Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) field campaign in the Upper Troposphere-Lower Stratosphere (UTLS) region during Summer 2021 and 2022. Grid-Rad and satellite imagery were used to identify regions of overshooting convection, and areas with outflow from the overshooting were targeted by the DCOTSS aircraft using trajectory models and in-situ measurements. Because a wide range of trace gases with different atmospheric lifetimes and sources are measured, WAS can provide insight into the processes that influence trace gas composition of the UTLS over North America. We investigate the tropospheric tracer relationships within and around these deep convective regions to determine the extent of penetration of tropospheric gases into the lower stratosphere (LS). Compounds such as ethane and ethyne with short (< 6 months) tropospheric lifetimes do not reach the LS without rapid transport from deep convection, and we observe cases where these gases are elevated above stratospheric background, typically well correlated with other tropospheric tracers (e.g. CO). However, the relationship between enhanced water vapor from overshooting convection and tropospheric tracers is more complex. Further, we show that ratios between different trace gas species can help identify and distinguish air mass types (e.g., biomass burning, oil and gas production, urban influence, etc.). Finally, we determine the Cl- and Br-halogen budgets for 2021 and 2022 stratosphere over N. America and the contribution of very-short-lived organic halogen species.