



Microphysical properties and trace gas signatures of a convective overshoot observed over Sweden during the TPex campaign

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Convective overshoot can result in irreversible mixing of air from the troposphere into the stratosphere, thereby influencing the radiation balance of this climate-sensitive region by altering greenhouse gas concentrations, particularly water vapor, and inducing ice and aerosol particles into the stratosphere. This study examines the cloud microphysical properties and trace gas signatures associated with a convective overshoot event observed during the TPex (Tropopause composition gradients and mixing Experiment) campaign in June 2024 over southern Sweden. While recent investigations have predominantly focused on convective overshoots related to air masses of (sub)tropical origin, this particular event took place during a cold air outbreak characterized by low tropopause altitudes (9 km; with temperatures around -55°C).

For the study, microphysical data collected in-situ during TPex aboard a Learjet by NIXE-CAPS (New Ice eXperiment - Cloud and Aerosol Particle Spectrometer) and trace gas measurements, including water vapor and ozone, were utilized. The findings reveal that ice particles were transported into the lower stratosphere, up to 1.5 km above the tropopause. At this altitude, a pronounced stratospheric ozone concentration of approximately 800 ppbv and a notable tropospheric water vapor concentration (~40 ppmv) were recorded, the latter being twice as high as background levels at the same height. This substantial injection of tropospheric air was linked to gravity wave breaking, and subsequently irreversible mixing near the overshooting top.

To gain deeper insight into the development of the overshoot, a forward trajectory analysis was conducted, and the evolution of cloud ice microphysical properties along the trajectories was simulated using the CLaMS (Chemical Lagrangian Model of the Stratosphere) model.