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A comparison of stratosphere-troposphere transport in convection-permitting and convection-parameterizing simulations of three mesoscale convective systems

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The transport of stratospheric air into the troposphere within deep convection was investigated using the Met Office Unified Model (MetUM). Three cases were simulated in which convective systems formed over the UK in the summer of 2005. For each of these three cases, simulations were performed on a grid having 4 km horizontal grid spacing in which the convection was parameterized, and on a grid having 1 km horizontal grid spacing which permitted explicit representation of the largest energy containing scales of deep convection. Cross-tropopause transport was diagnosed using passive tracers that were initialized above the dynamically-defined tropopause (2 PVU surface) with a mixing ratio of one. Although the synoptic scale environment and triggering mechanisms varied between the cases, the total simulated transport was similar in all three cases. The total stratosphere-to-troposphere transport ranged from 25-100 kg/m2 across the simulated convective systems and resolutions, which corresponds to approximately 5-20 % of the total mass located within a stratospheric column extending 2 km above the tropopause. In all simulations, the transport into the lower troposphere (e.g., below 3.5 km elevation) accounted for $\sim$1% of the total transport across the tropopause. The largest difference between the simulations with different resolutions occurred in the one case of midlevel convection considered, in which the total transport in the 1 km grid spacing simulation with explicit convection was four times larger than that in the 4 km grid spacing simulation with parameterized convection.