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Simulated mixing in the upper troposphere by small-scale turbulence

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Chemical composition in the upper troposphere/lower stratosphere (UTLS) plays an important role on the climate by affecting the radiation budget. Small-scale diabatic mixing like turbulence has a significant impact on the distribution of tracers which further affects the energy budget. Current models usually only have a higher resolution near the surface and a coarser resolution in the free atmosphere, which is too coarse to resolve the occurrence of small-scale turbulence in UTLS. In this work, we present enhanced vertical resolution (200 m in the UTLS) simulations focusing on the Scandinavian region using the state-of-the-art online coupled global/regional atmospheric chemistry model system MECO(n) (MESSy-fied ECHAM and COSMO models nested n times). We evaluated the basic meteorology (temperature and specific humidity) of the enhanced vertical resolution simulations with radiosonde data from the University of Wyoming and airborne in-situ measurements over northern Scandinavia. Additionally, we evaluated the ability of small-scale mixing in MECO(n) by comparing the model turbulence kinetic energy (TKE) with the calculated Ellrod Index and the impact of vertical diffusion in the COSMO instances in MECO(n) by releasing artificial passive tracer in the troposphere and stratosphere respectively. The results show that the enhanced vertical resolution simulations perform normally on basic meteorology. The simulations also show that the COSMO instances are able to resolve turbulence in UTLS with reasonable strength and the vertical diffusion in UTLS has a significant percentage impact on the tracer distribution.