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Estimating source-receptor relationships of tropospheric ozone: On the importance of model horizontal resolution

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Ozone (O_3) near the surface is harmful to human health and to vegetation including crops. It is recognized that intercontinental transport of air pollutants affects air quality over a region. Task Force on Hemispheric Transport of Air Pollutants (TF HTAP) coordinated a multi-model inter-comparison of 21 chemical transport models (CTMs) for assessing source-receptor relationships (i.e., the change in pollutants over a receptor region produced by change in emissions in a source region). Typical horizontal resolution of HTAP models was about 300 km. A coarse-resolution model tends to overpredict ozone chemical production (e.g., Wild and Prather, 2006). However, it is unclear how model horizontal resolution affects source-receptor relationships of tropospheric ozone. We estimated source-receptor relationships of tropospheric ozone using the CHASER global CTM (Sudo et al., 2002) with medium-resolution (T42; 2.8 deg. x 2.8 deg.) and high-resolution (T106; 1.1 deg. x 1.1 deg.). The CHASER model is also developed as an atmospheric chemistry component of the MIROC-ESM-CHEM earth system model, and simulates detailed chemistry in the troposphere and the stratosphere with aerosols simultaneously. We conducted a 2010 control simulation and a sensitivity simulation with 20% reduced emissions in East Asia to estimate source-receptor relationships. The model results show that 20% East Asian emission reductions decrease surface O_3 by 0.94 ppbv and by 0.75 ppbv over East Asia in spring respectively in the medium-resolution and high-resolution models. The East Asian emission perturbations also reduced surface O_3 by 0.27 ppbv and by 0.24 ppbv in spring over North America respectively in the medium-resolution and the high-resolution models. Our results suggest that the high-resolution model tends to predict smaller decreases in surface O_3 over East Asia and North America in response to the East Asian emission reductions.

Reference
Wild and Prather (2006), J. Geophys. Res., 111, D11305, doi:10.1029/2005JD006605.
Sudo et al. (2002), J. Geophys. Res., 107, 10.1029/2001JD001113.

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