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Preindustrial-to-present-day radiative forcing by tropospheric ozone from improved simulations with the GISS chemistry-climate GCM

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Abstract. Improved estimates of the radiative forcing from tropospheric ozone increases since the preindustrial have been calculated with the tropospheric chemistry model used at the Goddard Institute for Space Studies (GISS) within the GISS general circulation model (GCM). The chemistry in this model has been expanded to include simplified representations of peroxyacetylnitrates and non-methane hydrocarbons in addition to background NO_x-HO_x-O_x-CO-CH_4 chemistry. The GCM has improved resolution and physics in the boundary layer, improved resolution near the tropopause, and now contains a full representation of stratospheric dynamics. Simulations of present-day conditions show that this coupled chemistry-climate model is better able to reproduce observed tropospheric ozone, especially in the tropopause region, which is critical to climate forcing. Comparison with preindustrial simulations gives a global annual average radiative forcing due to tropospheric ozone increases of 0.30 W/m^2 with standard assumptions for preindustrial emissions. Locally, the forcing reaches more than 0.8 W/m^2 in parts of the northern subtropics during spring and summer, and is more than 0.6 W/m^2 through nearly all the Northern subtropics and mid-latitudes during summer. An alternative preindustrial simulation with soil NO_x emissions reduced by two-thirds and emissions of isoprene, paraffins and alkenes from vegetation increased by 50% gives a forcing of 0.33 W/m^2. Given the large uncertainties in preindustrial ozone amounts, the true value may lie well outside this range.

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