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Interannual variabilities in tropospheric constituents during 2000-2013 simulated in a chemistry-aerosol coupled climate

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Global distributions and abundances of tropospheric constituents (O_3, CH_4, NOy, CO, VOCs, NHx, SOx and aerosols) interannually change under the influences of meteorology (transport, temperature, water vapor, clouds, rain, etc.) and emissions from anthropogenic/natural sources and biomass burning. In this study, we investigate interannual variability of tropospheric constituents during the years 2000 to 2013 in a chemistry-aerosol coupled climate model. The base chemical model used in this study is CHASER (Sudo et al., 2002, 2007) coupled with the aerosol model SPRINTARS (Takemura et al., 2006). The CHASER model, also developed in the framework of the MIROC earth system model (MIROC-ESM-CHEM), simulates detailed chemistry in the troposphere and stratosphere with an on-line aerosol simulation including production of particulate nitrate and SOA. We use the NCEP reanalysis data (FNL) for constraining the model's meteorology.Anthropogenic and biomass burning emissions are specified using the HTAP2 and MAC inventories, respectively. For biogenic VOCs emissions, we employ calculation by the land ecosystem/trace gas emission model VISIT (Ito et al., 2008). Our results show that temporal variability (anomaly) in surface and lower tropospheric ozone very clearly correlates with that in CO especially in NH, indicating principal importance of biomass burning emission in determining near-surface O3 variability; surface PM ($PM_{2.5}$) in NH also coincides with CO. Changes in middle to upper tropospheric O3, on the other hand, basically respond to variability in transport from the stratosphere and lightning NOx production. It is also demonstrated that temporal variability in tropospheric mean OH is largely controlled by tropospheric abundances of O_3, CO, and water vapor.

Keywords: tropospheric ozone, aerosol, PM2.5, methane, oxidation capacity, chemistry climate model