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Investigating lightning-driven interannual variability in the oxidative capacity of the troposphere

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The lightning source of nitrogen oxides ($NO_x \equiv NO + NO_2$) is a major driver of the oxidizing power of the troposphere through production of ozone and OH. Parameterization of this source in chemical transport models (CTMs) is difficult because of uncertainty in lightning generation processes and the ability to describe them on a global scale. Long-term satellite observations of lightning flashes from the Optical Transient Detector (OTD) and the Lightning Imaging Sensor (LIS) since 1995 offer important constraints. We explore here how to exploit these constraints in a way that maintains the coupling between deep convective transport and lightning production in the CTM (essential for non-linear chemistry) and enables simulation of lightning-driven interannual variability in ozone and OH. We present the results from a series of nine-year simulations of the GEOS-Chem 3D global CTM of $O_3 - NO_x - CO - VOC - aerosol$ composition, varying the manner in which we constrain the lightning source to the spatial, seasonal and interannual heterogeneity seen in the satellite observations. We compare against long term observations of tropospheric ozone profiles from aircraft (MOZAIC) and sonde networks aggregated by the World Ozone and Ultraviolet Radiation Data Centre (e.g., SHADOZ, NOAA/CMDL), as well as the total tropospheric columns observed by the EPTOMS satellite. We find interannual variability in the global source of NO_x from lightning to be on par with that of biomass burning emissions, but with a disproportionately higher influence on variability in the oxidative capacity of the troposphere.