

Chemical Feedback from Decreasing Carbon Monoxide Emissions

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About half of atmospheric carbon monoxide (CO) is from direct emissions that are due to incomplete combustion and are related to both natural (e.g., wildfires) and anthropogenic activities. The remainder of CO in the atmosphere is produced from the chemical oxidation from 1. methane (CH₄) and 2. Non-Methane Organic Compounds (NMVOC's), mainly from biogenic sources (i.e., Isoprene). Since most of the NMVOC's, CO, and CH₄ in the atmosphere are oxidized by the hydroxyl radical (OH), the associated chemical lifetimes of these species are strongly coupled with OH. Understanding changes in the burden and growth rate of atmospheric CH₄ has been the focus of recent studies but still lacks scientific consensus. We quantify the CH₄ loss rate by contrasting two model simulations for 2002-2013: 1) a Measurement of Pollution in the Troposphere (MOPITT) CO reanalysis, and 2) a Control Run without CO assimilation. These simulations are performed with the CESM/CAM-Chem fully-coupled chemistry climate model with prescribed CH₄ surface concentrations. Using the Data Assimilation Research Testbed (DART), the assimilation of MOPITT observations constrains the global CO burden, which significantly decreased over this period. We present a mechanism that link how the reduction of global CO abundance of about 20% results in higher CH₄ oxidation and shorter CH₄ lifetimes (by around 8%). As a direct feedback, there is an increase in the chemical production of CO. We will first present global and annual tropospheric integrated statistics (Figure 1), then, we will zoom in on the tropical region where most of the CH₄ oxidation occurs.

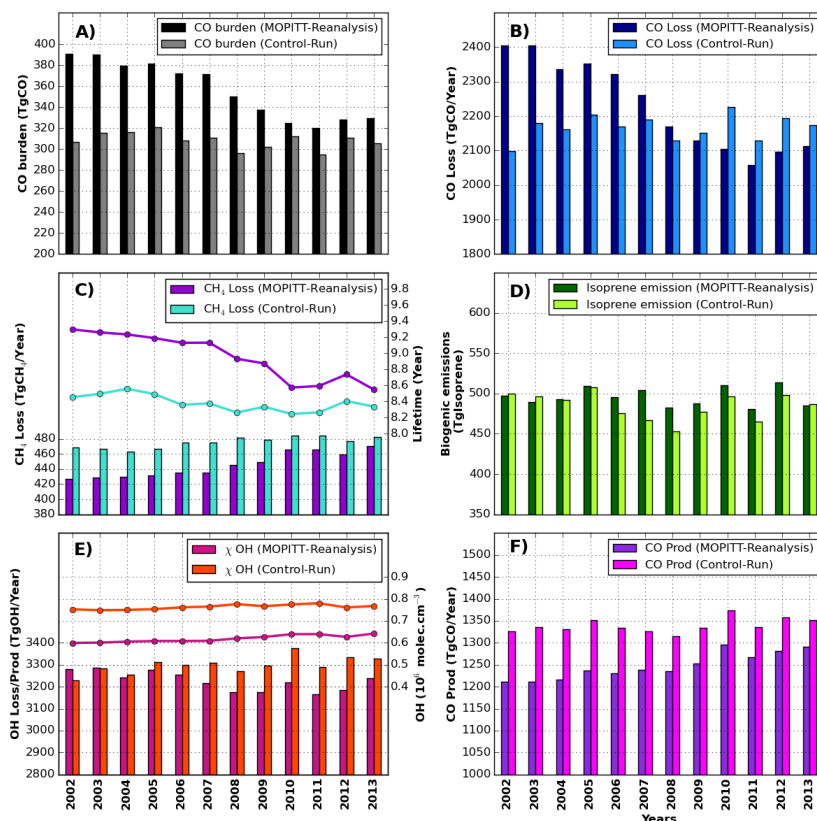


Figure 1. Global, annual and tropospheric integrated CO burden (a, TgCO), CO chemical loss (b, TgCO.yr⁻¹), CH₄ loss (c, TgCH₄.yr⁻¹), Isoprene emissions (d, TgIsoprene.yr⁻¹), OH chemical loss/Production (TgOH.yr⁻¹) and CO chemical production (TgCO.yr⁻¹). The CH₄ lifetime (with regards to OH) is shown on panel D and the airmass-weighted tropospheric mean OH is also plotted on panel E.