

An exploration of the discrepancy between observations and atmospheric ethane emission inventories: underestimations in key source emission categories

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Ethane (C_2H_6) is one of the most abundant non-methane hydrocarbons within the atmosphere and is co-emitted with methane (CH_4) in key source categories. It has an approximate 2-month lifetime relative to its eventual oxidation via reacting with tropospheric hydroxyl radical (OH), and has a 100-year indirect global warming potential (**GWP**) of approximately 5.5. Ethane has anthropogenic, pyrogenic, biogenic, oceanic, and geologic emission sources with a budgetary composition relative to the order listed. Observations in atmospheric ethane concentrations show a negative trend of ethane mixing ratios from 1984 to 2010 over several regions globally, which has been associated with an overall reduction in fugitive emissions from natural gas venting and flaring. Yet observations in atmospheric ethane concentrations from 2010 and onward show a positive trend, particularly across the Northern Hemisphere, and additionally have displayed a decoupling in co-emission between ethane and methane. These recent trends in the atmospheric concentration, atmospheric distribution, emission sources, and decoupling from methane have yet to be adequately understood. Thus, given the present gap in understanding, we explored the discrepancy between current observational data and composite emission inventories for the global ethane budget. Our primary inquiry posits that the existing discrepancy can be attributed to underestimations in key source emission categories coupled with the exclusion of geologic and oceanic emission sources. Here we use recreated emission scenarios using varied composite emission inventories within GEOS-Chem GCHP (**v13.0.2**) at a horizontal grid resolution of $2^\circ \times 2.5^\circ$ and NOAA Global Monitoring Division (**GMD**) C_2H_6 observational measurements. Where in which emission scenario 1, Optimized Fossil Fuel (**OFF**), is composed of the baseline CEDS CMIP6 emission inventory with scaled anthropogenic fossil fuel emissions, the addition of geologic emissions, and oceanic emissions (**RETRO**). While emission scenario 2, Optimized Biomass Burning (**OB**), is composed of the EDGAR (**v4.3.2**) emission inventory, GFED4 emission inventory with biomass burning emissions scaled up by a factor relative to the total burned area and C_2H_6 emission factor, the addition of geologic emissions, and oceanic emissions (**RETRO**). The implications relate to a more adequate understanding of the current global ethane budget, which may necessitate further re-evaluation of the contribution from key emission sources. For by exploring more detailed emissions inventories we can better understand the recent trends in atmospheric ethane, as this more thorough understanding remains a critical precursor in improving the efficacy of policies to reverse ongoing trends in atmospheric ethane and related NMVOCs.