# Investigating increases in atmospheric ethane from 2007 to 2020 via a Bayesian inversion of surface flask measurements

*J. Aljbour, C. Butenhoff*

**Undergraduate Researcher with Portland State Universities' Center for Climate and Aerosol Research**

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 a ~2-month lifetime reacting with tropospheric hydroxyl radical (**OH**), and has a 100-year indirect global warming potential (**GWP**) of ~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 a net reduction in fugitive emissions from natural gas venting and flaring. Yet observations from 2010 and onward show a positive trend, particularly across the Northern Hemisphere, and additionally have displayed a decoupling in co-emission of ethane and methane. These recent trends have yet to be adequately understood. In this work we investigate changes to the global ethane emissions between two time-periods, 2007-2008 and 2019-2020. In addition to the predominant ethane emission sources of fossil fuel, biofuels, and biomass burning—we also consider the minor emission sources of biogenic, geologic and oceanic. We use GEOS-Chem with the high-performance option (**GCHP**) (**v13.0.2**) at a horizontal grid resolution of $4^{o}$x$4.5^{o}$ and surface flask measurements of $C_2H_6$ from NOAA Global Monitoring Division (**GMD**). From the primary emission categories of: anthropogenic, biomass burning, biogenic, geologic, and oceanic—we optimize flux strengths for 35 source regions using an analytical Bayesian inversion model. By exploring more detailed emissions inventories we can better understand the recent trends in the global ethane budget, which may necessitate further re-evaluation of the contribution from key emission sources. As a more thorough understanding remains a critical precursor in improving the efficacy of policies to reverse ongoing trends in atmospheric ethane and related NMVOCs.

## Plain-Language Summary:

This work seeks to reconcile the discrepancies between atmospheric ethane observations and emission sources by the combination of including emissions from often-overlooked natural sources and optimization of key emission sources via an analytical inverse Bayesian model. By exploring more detailed emissions inventories we can better understand the recent trends in the global ethane budget, which may then necessitate further re-evaluation of the contribution from key emission sources. As a more thorough understanding remains a critical precursor in improving the efficacy of policies to reverse ongoing trends in atmospheric ethane and other related non-methane hydrocarbons.