Long-term Decline of Global Atmospheric Ethane Concentrations and Implications for Methane

I.J. Simpson[1], M.P.S. Andersen[2], S. Meinardi[1], L. Bruhwiler[3], N.J. Blake[1], D. Helmig[4] and D.R. Blake[1]

[1]University of California at Irvine, Department of Chemistry, Irvine, CA 92697; 510-642-5882, E-mail: isimpson@uci.edu
[2]University of California at Irvine and Jet Propulsion Laboratory, Department of Chemistry, Irvine, CA 92697
[3]NOAA Earth System Research Laboratory, Boulder, CO 80305
[4]Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, CO 80309

Methane (CH_4) and ethane (C_2H_6) are the most abundant hydrocarbons in the remote atmosphere. Both are precursors to tropospheric ozone and CH_4 is a potent greenhouse gas. This work presents the longest continual record of global atmospheric CH_4 and C_2H_6 levels. Their global trends have shown a remarkably strong correlation over the past 25 years, both in terms of long-term trends and short-term anomalies (Figure 1). The global CH_4 growth rate has slowed considerably, from strong growth of ~1% yr^{-1} in the late 1970s and early 1980s to near-zero growth by the 2000s, with renewed growth of up to 0.4% yr^{-1} beginning in 2006. The global C_2H_6 concentration declined by 21% over a similar period, from 791 ± 19 pptv in 1986 to 625 ± 12 pptv in 2010. Based on simulations using the TM5 atmospheric tracer transport model, ethane's long-term global decline is attributed to decreasing fugitive emissions from ethane's fossil fuel source — most likely reduced venting and flaring of natural gas in oil fields. Because ethane's fossil fuel source is shared with CH_4, and because CH_4 and C_2H_6 are emitted from fossil fuel sources in characteristic emission ratios, we used our long-term C_2H_6 record to quantitatively investigate methane's slowing growth rate. Reduced fugitive fossil fuel emissions of CH_4 were found to account for at least 10 ■ 21 Tg yr^{-1} (30 ■ 70%) of the decrease in methane's global emissions, significantly contributing to methane's slowing growth rate since the mid-1980s. This research helps to clarify conflicting findings from recent studies (Aydin et al., 2011; Kai et al., 2011), which have disagreed on whether reduced fossil fuel or microbial emissions caused methane's global growth rate to slow.

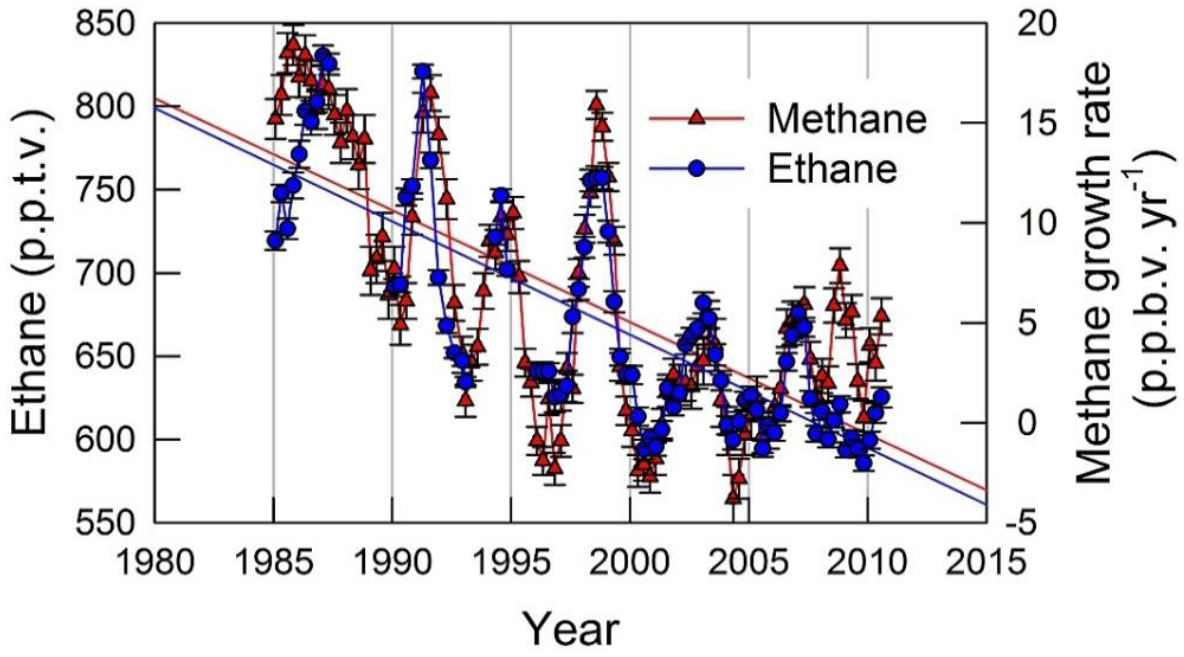

Figure 1. Running global averages of ethane mixing ratios (blue circles) and methane growth rate (red triangles) from the University of California, Irvine global monitoring network. Solid lines are linear fits to the ethane (blue) and methane (red) data using a least squares regression.