Emissions of Tetrafluoromethane and Hexafluoroethane: Balancing Anthropogenic Budgets from Atmospheric Measurements

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The perfluorocarbons, tetrafluoromethane (CF_4, PFC-14), and hexafluoroethane (C_2F_6, PFC-116) are powerful, long-lived greenhouse gases emitted mainly from aluminum production and semiconductor manufacture. While both industries report significant reductions in PFC emissions during the past two decades, more than half of the recent emissions derived from atmospheric PFC observations ("top-down" emissions) remain unaccounted-for in the emissions reported by industry ("bottom-up" emissions, based on statistical analysis/emission factors). Here we present industry-specific top-down emissions, based on industry-specific emission "signatures" derived from *in situ* measurements of the Advanced Global Atmospheric Gases Experiment program. We also performed regional inversions for East Asia, where both of the major emitting industries are heavily concentrated, using two independent inversion schemes.

Our results from the analysis of historical emissions show that about 75% of the unaccounted-for accumulated emissions of CF_4 during 1990-2009 can be attributed to the semiconductor industry, representing the major source of underestimation in previous studies. Most of the underestimated emissions in the aluminum industry occur after 2001 and are centered in China, where the emissions from this fast-growing sector remain poorly quantified. These results are supported by our regional emission inversion results for East Asia, where China's top-down emissions (3.9 ± 0.7 Gg/yr, for 2007-2010) significantly exceed bottom-up estimates (e.g. 1.3 Gg/yr for 2009).

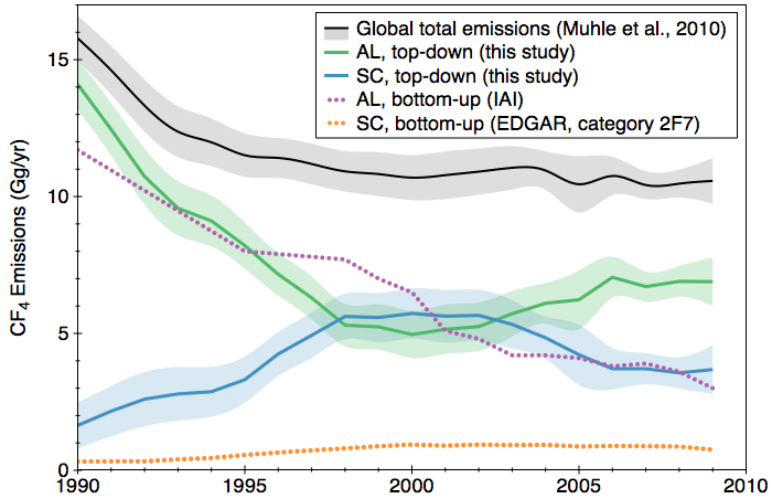

Figure 1. Top-down aluminum (AL) and semiconductor (SC) emissions of CF_4 derived in this study, compared with the bottom-up AL emissions from the International Aluminum Institute (IAI), and the SC emissions from the Emissions Database for Global Atmospheric Research (EDGAR), within context of the global total top-down emissions.