^{14}C-based Emission Estimates for Halocarbons and Other Greenhouse Gases Across the U.S.

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The small radiocarbon fraction of atmospheric CO_2 (~1:10^{12} ^{14}C:C) has proven to be a valuable tracer for the fossil fuel derived component of observed CO_2 (C_{ff}) over large industrialized land areas. A growing number of $^{14}CO_2$ measurements are being made in air, sampled from a network of tall towers and airborne profiling sites around the U.S. alongside measurements of CO_2, CO, CH_4, N_2O, SF_6, and a large suite of halo- and hydro-carbons. C_{ff} observations paired with boundary-layer enhancements of more than 20 other anthropogenic gases measured in the same samples allow us to determine apparent emissions ratios for each gas with respect to C_{ff} (where apparent ratios refer to those at the time of observation rather than at the time of emission). Here we have convolved these apparent emission ratios with appropriate spatial footprints over which the emissions of fossil fuel derived CO_2 has been independently determined (e.g., the VULCAN C_{ff} inventory) to derive absolute emissions of the correlate gases on regional spatial scales. Coherent spatial and seasonal variations in apparent emissions ratios and absolute emissions are found at sites across the U.S. for a number of gases. The observed seasonal and spatial variability derived for some of these gases is qualitatively consistent with our understanding of how these chemicals are released to the atmosphere. The magnitude of the observed seasonal and spatial variations suggests that national emission magnitudes derived from top-down atmospheric studies performed over monthly to seasonal periods at only a few sampling locations may have substantial biases. We use our results to provide national-scale emission magnitude estimates for a wide range of ozone-depleting and non-CO2 greenhouse gases.

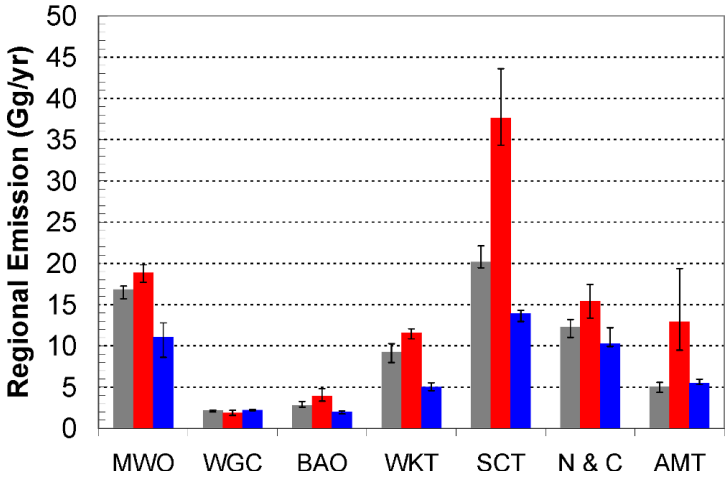

Figure 1. Regional emissions of the refrigerant HFC-134a derived from measured covariations with $^{14}CO_2$ during 2010 and consideration of the VULCAN fossil fuel emissions inventory. Summer (red), winter (blue), and annual (gray) emission rates are determined at 8 different locations: southern (MWO) and central (WGC) California, Colorado (BAO), Texas (WKT), South Carolina (SCT), Maryland and New Hampshire (N&C), and Argyle Maine (AMT).