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Quantifying US Fossil Fuel CO₂ Emissions Using Precise Measurements of ¹⁴C in Atmospheric CO₂

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We report the first national scale estimates of CO₂ emissions from fossil fuel combustion and cement production in the US based directly on atmospheric observations, using a dual-tracer inverse modeling framework and CO₂ and Δ¹⁴CO₂ measurements obtained primarily from the North American portion of NOAA's Global Greenhouse Gas Reference Network. The derived US national total for 2010 is 1653±60 TgC/yr, with an uncertainty (2σ) that takes into account random errors associated with atmospheric transport, atmospheric measurements, and specified prior CO₂ and ¹⁴C fluxes. The atmosphere-derived estimate is significantly (>3σ) larger than US national emissions for 2010 from three global inventories widely-used for CO₂ accounting, even after adjustments for emissions that might be sensed by the atmospheric network but which are not included in inventory totals. In contrast, the atmosphere-derived estimate is within 1σ of a similarly adjusted 2010 annual total and 9 of 12 adjusted monthly totals aggregated from the latest release of the high-resolution, US-specific "Vulcan" emissions data product. Here we focus our presentation on determination and reduction of methodological uncertainties and future applications of the method for annual emissions detection and emissions trend detection at scales ranging from the US as a whole to contiguous groups of US states, such as those participating in the Regional Greenhouse Gas Initiative.