

Constraining Fossil Fuel CO₂ Emissions with Joint Assimilation of Atmospheric CO₂ and ¹⁴CO₂ Measurements

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Atmospheric source-sink inversions can be used to estimate surface fluxes of a trace gas (such as CO₂ or CH₄) from observed atmospheric gradients. Present day inversion products reporting surface fluxes of CO₂, such as NOAA's CarbonTracker (<http://www.esrl.noaa.gov/gmd/ccgg/carbontracker/>), solve for natural fluxes of CO₂ assuming that the fossil fuel flux of CO₂ is perfectly known. Since the CO₂ observing network is primarily sensitive to the sum of the natural and fossil fuel fluxes, any error made in calculating the 'fixed' fossil fuel CO₂ flux will lead directly to bias in the retrieved natural CO₂ flux. This is especially important at the regional scale. While the global total fossil fuel CO₂ flux is known to about 5% accuracy, regional estimates can be far less accurate. Over the past decade, the Carbon Cycle Greenhouse Gases Group at the Global Monitoring Division, in collaboration with the Institute of Arctic and Alpine Research (INSTAAR) at the University of Colorado (Boulder), have been measuring atmospheric ¹⁴CO₂/¹²CO₂ at selected sites, mostly over North America. Fossil fuel carbon, which is millions of years old, is devoid of this radioisotope, which has a half life of 5730 years. As a result, fossil fuel CO₂ emissions have a very different isotopic signature than all other sources. Here, we present the first results from a joint inversion of atmospheric CO₂ and ¹⁴CO₂ measurements, in order to estimate the natural and fossil fuel fluxes of CO₂, as well as so-called "disequilibrium fluxes", which also influence atmospheric radiocarbon gradients.

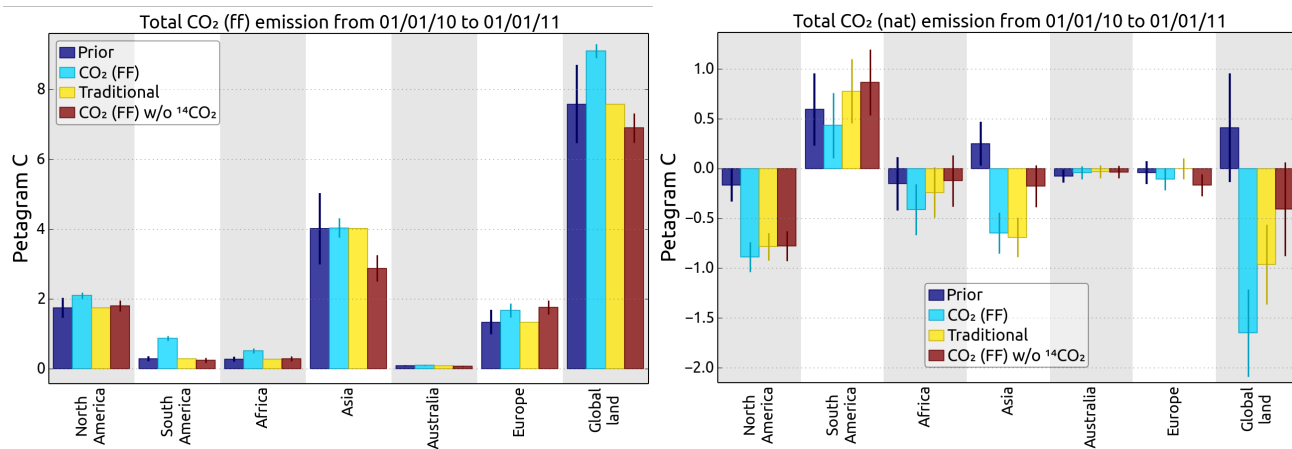


Figure 1. Optimized surface fluxes from three different source-sink inversions, and the first guess ("Prior"). The "Traditional" inversion uses fixed fossil-fuel fluxes, and adjusts natural CO₂ fluxes to fit atmospheric CO₂ measurements. The "CO₂ (FF) w/o ¹⁴CO₂" adjusts both natural and fossil fuel sources of CO₂, again using only CO₂ measurements. The "CO₂ (FF)" adjusts both natural and fossil fuel fluxes of CO₂ by assimilating both atmospheric CO₂ and ¹⁴CO₂ measurements.