Partitioning of Terrestrial Carbon Sources Using $^{14}CO_2$: Observations and Modeling

S. Lehman[1], J.B. Miller[2], P.P. Tans[2], C. Sweeney[2], A.E. Andrews[2], J. Southon[3], B.W. LaFranchi[4], T.P. Guilderson[4] and J.C. Turnbull[5]

[1]University of Colorado, Boulder, CO 80309; 303 492 8980, E-mail: Scott.Lehman@colorado.edu
[2]NOAA Earth System Research Laboratory, Boulder, CO 80305
[3]University of California at Irvine, Irvine, CA 92697
[4]Lawrence Livermore National Laboratory, Livermore, CA 94550
[5]Rafter Radiocarbon Laboratory, Lower Hutt, New Zealand

The small radiocarbon fraction of total CO_2 (~1:10^{12} ^{14}C:C) has proven to be an ideal tracer for its fossil fuel derived component. Unlike all other significant contributions to the atmospheric CO_2 budget, the fossil fuel component is devoid of radiocarbon, so that temporal and spatial gradients in recently added fossil fuel CO_2 can be readily identified as radiocarbon gradients provided there is adequate precision in the measurements. Over large industrialized land areas such as Eurasia and North America, the use of ^{14}C to isolate the recently added fossil fuel contribution also quantifies (by difference) the change in atmospheric CO_2 due to uptake and release by the terrestrial biosphere. Simple mass balance considerations suggest that in order to apportion fossil fuel and biological components in the continental CO_2 observations to ±1 ppm, a $^{14}CO_2$ measurement repeatability of ~2 per mil (1-sigma ppt deviation from standard) is needed. Here we will report on i) our efforts to maintain the necessary measurement precision in a growing number of air craft and tall tower sampling sites around the U.S., and on ii) the ability of the TM5 transport model (as currently implemented for CO_2 and $^{14}CO_2$) to represent the $\Delta^{14}CO_2$ observations. The latter is an important step towards using $^{14}CO_2$ as an additional constraint on regional fossil fuel emissions and Net Ecosystem Exchange flux retreivals in CarbonTracker

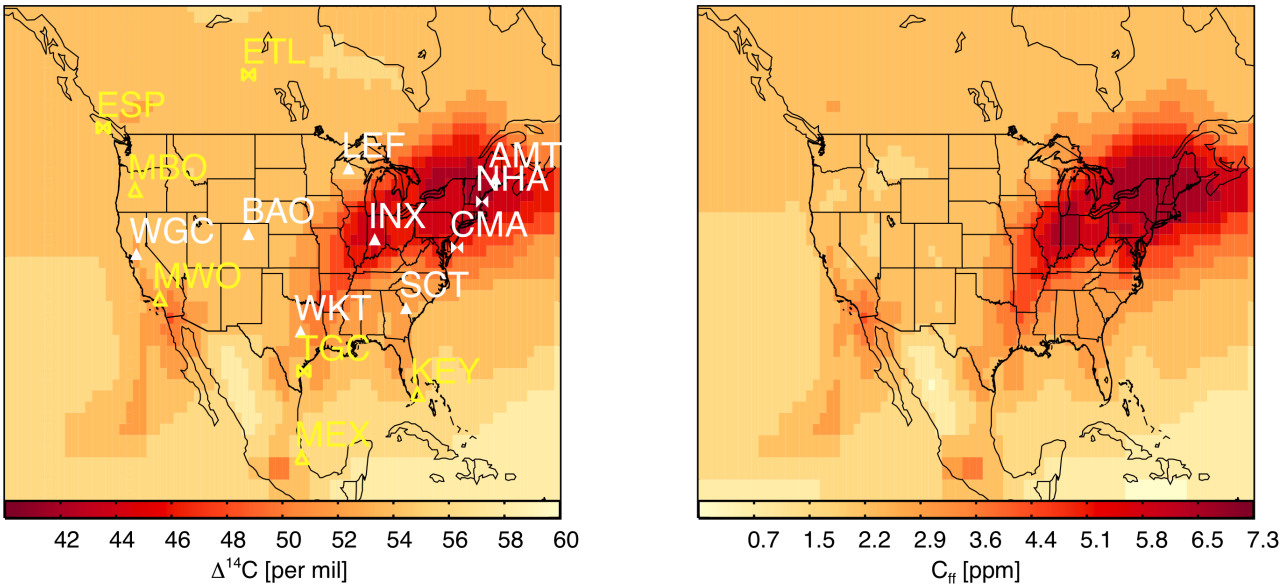

Figure 1. Model representations of a) Δ^{14}C (left panel) and b) the fossil fuel component of total CO_2 (C_{ff}; right panel) in the atmosphere near the surface over North America for a week in January of 2006. The color scales correspond to the expected mass balance relationship between Δ^{14}C and C_{ff} of -2.7 ‰/ppm. The sites labeled in white are existing ^{14}C sampling sites, as are Mount Wilson Observatory (MWO) and Niwot Ridge (NWR) (which underlays Boulder Atmospheric Observatory (BAO)).