Partitioning of Terrestrial Carbon Sources Using $^{14}$CO$_2$: Observations and Modeling


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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 retrievals in CarbonTracker

Figure 1. Model representations of a) $\Delta^{14}$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 $\Delta^{14}$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)).