Inverting $^{13}CO_2$ for Terrestrial Carbon Fractionation in North America

C. Alden[1], J.B. Miller[2] and J.W.C. White[1]

[1]Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, CO 80309; 719-930-5281, E-mail: caroline.alden@colorado.edu
[2]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309

A variety of methods exist for constraining chemical fluxes at the earth's surface. Inverse modeling is often used to estimate regional-scale fluxes of the greenhouse gas carbon dioxide (CO_2), by using atmospheric observations and particle transport models to optimize prior flux estimates. Fluxes of the rare stable carbon isotope in CO_2, ^{13}C, have not traditionally been calculated with inverse models. Historically, ^{13}C has been used to partition CO_2 fluxes into land and ocean components, because major fluxes of this gas (fossil fuel, ocean, and land) impose distinctive and predictable fractionation patterns upon the stable isotope ratio. As measurement density improves, ^{13}C has the potential for an important new role in carbon cycle research: to illuminate mechanisms driving terrestrial biosphere exchange variability. Calculated time series of the global land flux, disequilibrium flux, and terrestrial discrimination from 1991 through 2008 that are consistent with bottom up net ocean fluxes suggest high interannual variability in terrestrial disequilibrium flux. The primary contributors to this variability likely include discrimination due to plant stomatal opening and the relative contributions of C_3 and C_4 vegetation to net ecosystem exchange. Discerning $^{13}CO_2$ flux magnitude and variability on smaller space and time scales could therefore inform our understanding of the dynamics that exist between carbon cycling and environmental/climatic variability, as well as the impacts of biofuels on the ^{13}C budget. We determine "optimal" estimates of CO_2 and $^{13}CO_2$ surface fluxes across the region encompassing 10-80°N and 145-25°W. We use the Lagrangian particle dispersion model FLEXPART to generate partial derivative matrices or "influence functions", which relate fluxes in each 1x1 degree grid cell in the region of interest to concentrations at several North American NOAA ESRL Global Monitoring Division tower sites. By comparing modeled with observed $^{13}CO_2$ concentrations at tower sites, we can then optimize our prior flux estimates. We will present comparisons between our simulated values and those observed at the monitoring sites, and we will present the preliminary results of our inversion.

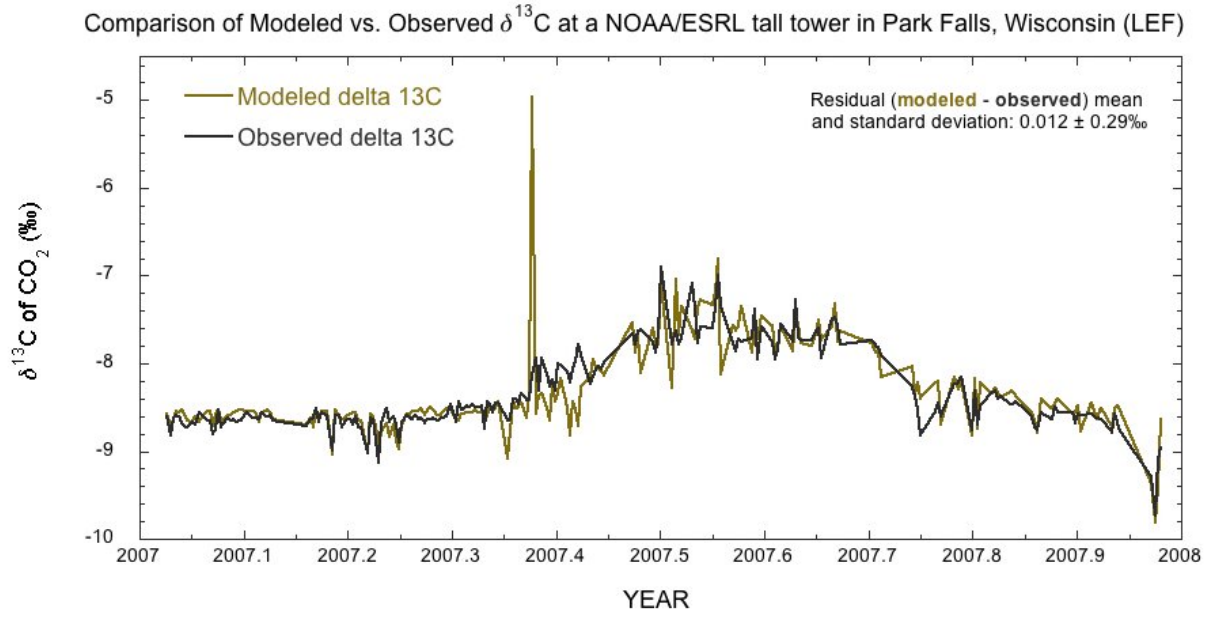

Figure 1. Comparison of Modeled vs Observed ^{13}C at a NOAA ESRL tall tower in Park Falls, WI.