Comparison of Simulated and Observed $^{13}CO_2$ at North American Sites

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

[1]Institute of Arctic and Alpine Research, 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

The rare stable carbon isotope, ^{13}C, has been used previously to partition CO_2 fluxes into land and ocean components. The major fluxes of this gas (fossil fuel, ocean, and land) impose distinctive and predictable fractionation patterns upon the stable isotope ratio, making it an excellent tool for distinguishing between them. Historically, isotope constrained inverse methods for calculating CO_2 surface fluxes (the "double deconvolution") have disagreed with bottom-up flux estimates. By using the double deconvolution technique, with independent estimates of time histories of ocean fluxes and atmospheric observations of CO_2 and $^{13}CO_2$, it is possible to derive the disequilibrium flux. We hypothesize that estimating disequilibrium flux in this way can not only reconcile previous disagreements between global scale atmospheric observations and bottom-up ocean flux estimates, but can also be a valuable tool for understanding variability in terrestrial biosphere exchange mechanisms, and the implications of these processes for carbon cycling. 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 C3 and C4 vegetation to net ecosystem exchange. Identification of the mechanisms driving variability in the terrestrial exchange of $^{13}CO_2$ necessitates higher spatial resolution of terrestrial disequilibrium flux variability. As a first step towards creating spatially resolved estimations of terrestrial disequilibrium flux and its drivers, we predict the CO_2 and $^{13}CO_2$ concentrations at several North American NOAA ESRL Global Monitoring Division tower sites, using a Lagrangian transport model, and compare our simulated values to those observed at the monitoring sites. Preliminary results will be presented.

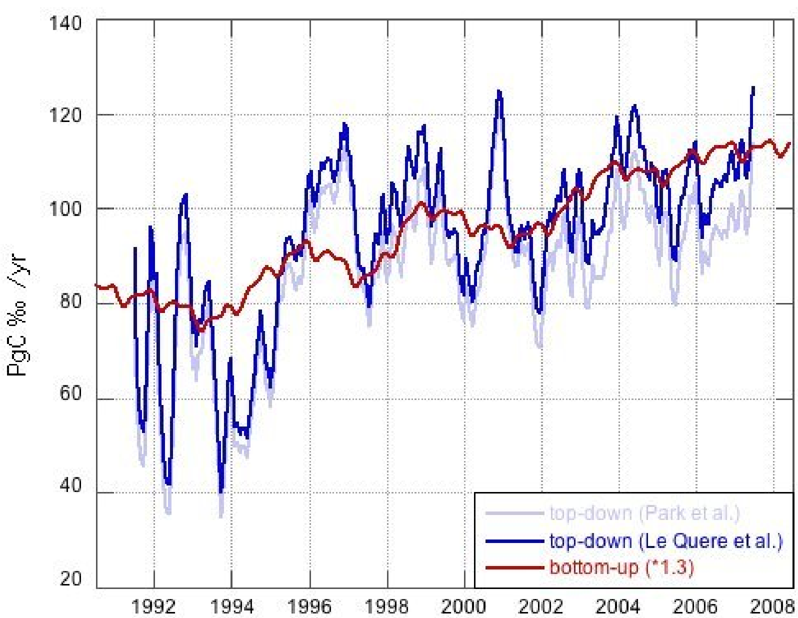

Figure 1. Global 12-month mean disequilibrium flux, calculated using the ocean fluxes of Park et al. (in prep.) (light blue) and Le Quéré et al. (2007) (dark blue). Red line is bottom-up global 12-month mean disequilibrium flux, scaled by 30%. The scaling factor was chosen because it produces land and ocean flux magnitudes similar to that of the single deconvolution approach, which eases comparison. The choice of 1.3 does not impact our conclusions, because we focus on the issue of interannual variability. Of note is the difference in interannual variability between the bottom-up and top-down global disequilibrium flux calculations.