WEEKLY OBSERVATIONS OF STABLE ISOTOPE COMPOSITION OF ECOSYSTEM-ATMOSPHERE CO_2 EXCHANGE - MEASUREMENTS IN AMERIFLUX SITES FROM 2001 - 2005

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ABSTRACT
The stable isotope composition of atmospheric CO_2 is being monitored in five AmeriFlux sites (four forests and one grassland) by collecting air samples inside and above canopies at weekly intervals. Measurements of concentration, $\delta^{13}C$ and $\delta^{18}O$ of atmospheric CO_2 have continuously been made from 100-ml flask samples since 2001. These measurements, in concert with eddy covariance flux measurements, provide mechanistic insights relating observed isotope changes and the controls over carbon sequestration and loss on seasonal and interannual bases. Data and a brief project description are available via the Internet at: http://ecophys.biology.utah.edu/Research/DOE_TCP/index.html.

The value of combining stable isotope and flux measurements has been exploited in several aspects of the carbon cycle: 1) interactions between carbon and water cycling in terrestrial ecosystems [*Lai et al.*, 2005], 2) quantification of canopy-scale estimates of photosynthetic discrimination against ^{13}C (Δ_A) [*Lai et al.*, 2004, 2005], 3) partitioning of net ecosystem exchange (NEE) flux into photosynthesis and respiration [*Lai et al.*, 2003], 4) relative influences of biotic and fossil fuel emissions on CO_2 concentration measured in terrestrial ecosystems [*Lai et al.*, 2004], and 5) effects of water stress on the interannual variation of carbon ($\delta^{13}C_R$) and oxygen ($\delta^{18}O_R$) isotope ratios of ecosystem-respired CO_2 [*Lai et al.*, *Journal of Geophysical Research-Atmosphere*, in review].

CO_2 measurements in terrestrial stations are subject to considerable localized gas exchange activities and fossil fuel effects relative to those from a remote marine site. A continental CO_2 gradient can be clearly identified when CO_2 concentration and $\delta^{13}C$ values measured in the canopy boundary layer are compared to tropospheric CO_2 values. Fig. 1 shows midday CO_2 concentration and $\delta^{13}C$ values in above-canopy air measured in two AmeriFlux sites (Wind River, WA, 45°49' N, 121°58' W and Rannells Flint Hills Prairie, KS, 39°12′N, 96°35′W). These samples collected in the mid-afternoon are more likely to represent relatively larger spatial areas because of the convective mixing. Above-canopy CO_2 shows significant seasonal cycles both in the forest and the prairie sites. Rannells prairie appears to have greater interannual variations in the above-canopy CO_2 and $\delta^{13}C$ values than the old forest. These site differences mainly reflect impacts of environmental variables, for instance precipitation, on the gas exchange activities between the ecosystems and the atmosphere.

For comparison, Fig. 1 also shows marine boundary layer (MBL) values derived from the NOAA/CMDL flask network. There are remarkable differences in the CO_2 and $\delta^{13}C$ values measured in the canopy air and in the MBL. This characteristic from terrestrial production potentially provides an opportunity for estimating net regional CO_2 flux based on flask measurements, which can then be independently compared with flux estimates from eddy covariance towers [*Helliker et al.*, 2004; *Bakwin et al.*, 2004]. In this paper, we investigate strategies to represent seasonal courses of CO_2 concentration measurements in terrestrial ecosystems using air samples collected on weekly intervals, which is relatively sparse compared to in-situ CO_2 measurements (usually hourly). When averaged over longer time scales (i.e. monthly or longer), differences between terrestrial signals and those in the MBL (Fig. 1), combining information regarding atmospheric transport (e.g., NCEP/NCAR reanalysis data), allows an estimation of regional CO_2 fluxes. The advantage of using a flask-based dataset is that a regional estimate of the $\delta^{13}CO_2$ flux can also be calculated, which should provide additional constrains to global inverse models. Results from a preliminary analysis will be compared to tower flux measurements and causes of potential errors will be discussed.

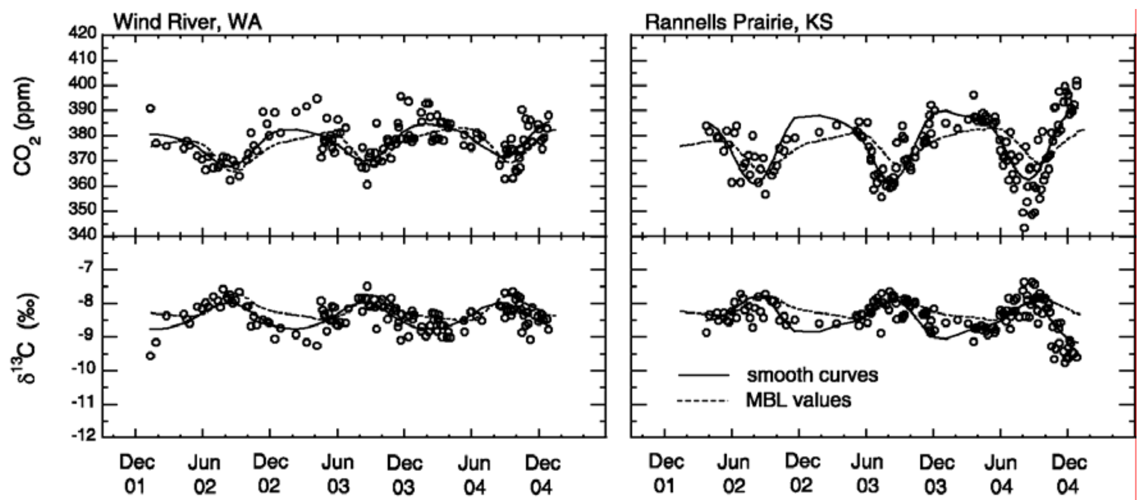

Fig. 1. Concentration and $\delta^{13}C$ of CO_2 in canopy air measured in the mid-afternoon. Open circles represent samples collected 2m above the canopy. Background troposphere, represented by MBL surface values derived from measurements within NOAA/CMDL network, were also shown for comparison.

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