Oxygen-18 of Atmospheric CO_2: Decadal Trends and Climate Variability

E.J. Zakem and J.W.C. White

Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, CO 80309;
734-751-4037, E-mail: Emily.Zakem@colorado.edu

The stable oxygen isotope ^{18}O is unique to isotope ecology in that it links the hydrosphere to the carbon cycle. The two gross land biosphere fluxes, photosynthesis and ecosystem respiration, are the dominant influences on the $\delta^{18}O$ of atmospheric CO_2 on decadal timescales. Since these fluxes also dominate the interannual variability of atmospheric CO_2 itself, analysis of atmospheric $\delta^{18}O$ trends could provide useful insight into the terrestrial carbon cycle. The reasons for the interannual variability of atmospheric $\delta^{18}O$ remain unclear, particularly because the mechanisms of the interannual variability of the terrestrial biosphere carbon flux are not fully understood. Data from numerous global sites shows a global decadal oscillation in $\delta^{18}O$, suggesting a climatological forcing. We compare trends in $\delta^{18}O$ with climate records, examining correlations and proposing associated mechanisms. Significant correlation is found with the Niño indices. Significant anti-correlation is found with tropical precipitation and tropical humidity. Possible mechanisms include strong effects on $\delta^{18}O$ by relative humidity, the ^{18}O of precipitation, and the magnitudes of global photosynthesis and ecosystem respiration. Simple modeling of the $\delta^{18}O$ in atmospheric CO_2 supports the plausibility of these mechanisms, but does not result in the pattern observed in the data. Results suggest errors in the methods used to calculate isotopic values of the terrestrial biosphere CO_2 fluxes, since data trends show the likelihood of global climate influence on $\delta^{18}O$ communicated through the terrestrial carbon cycle.

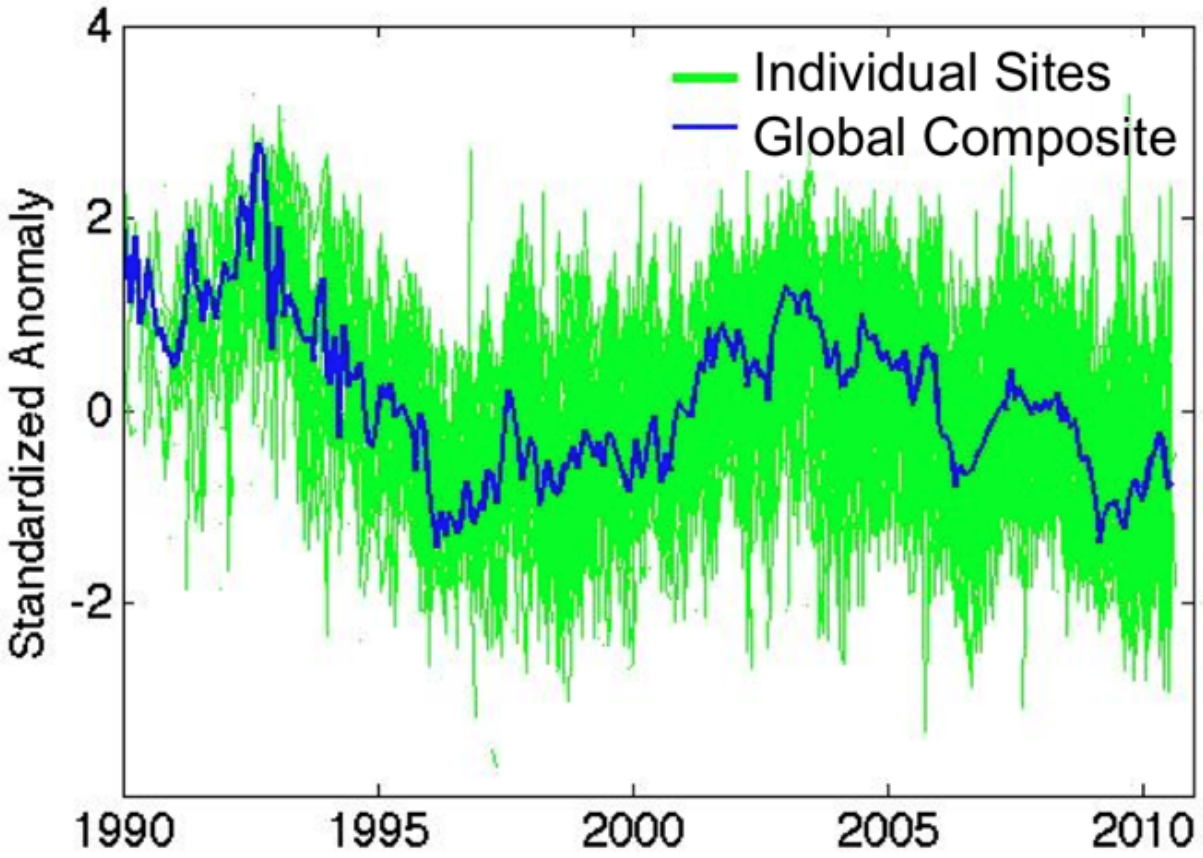

Figure 1. Standardized $\delta^{18}O$ of atmospheric CO_2 data from multiple sites and the resulting assimilation-weighted global composite.