The Influence of Hydrological Changes on the ^{18}O Content of Atmospheric CO_2

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Observations show no long-term trend in the ^{18}O content of atmospheric CO_2 (denoted as δCa), though stations around the world observe similar interannual variations in δCa values. Modeling studies have shown evidence that the seasonal cycle and spatial structure of δCa values result from land ecosystem fluxes. This study evaluates the δCa budget to identify meteorological variables that could potentially cause the observed variations. It is found that observed δCa values negatively correlate with relative humidity in certain regions of the tropics and mid to high latitudes, and it is estimated that the variations in relative humidity would drive a 0.25‰ decrease in δCa values during the 1990s. It is also shown that there are similar variations in precipitation totals within the tropics that would suggest positive correlations between δWP and δCa values consistent with an amount effect (δWP values typically decreasing as precipitation amounts increase). The decrease in δWP values would act to decrease δCa values by as much as 0.56‰. A global model is constructed to simulate the atmospheric concentrations of both CO_2 and $CO^{18}O$. Model results agree well with observations in the global mean and zonal mean (Figure 1). Sensitivity experiments were conducted with the model, and the results confirm that δCa values respond to changes in relative humidity and δWP values. This study suggests that interannual δCa variations are driven primarily by isotope hydrology and relative humidity. In contrast to previous work, we find little evidence of changes to photosynthesis or respiration driving the observed δCa variations.

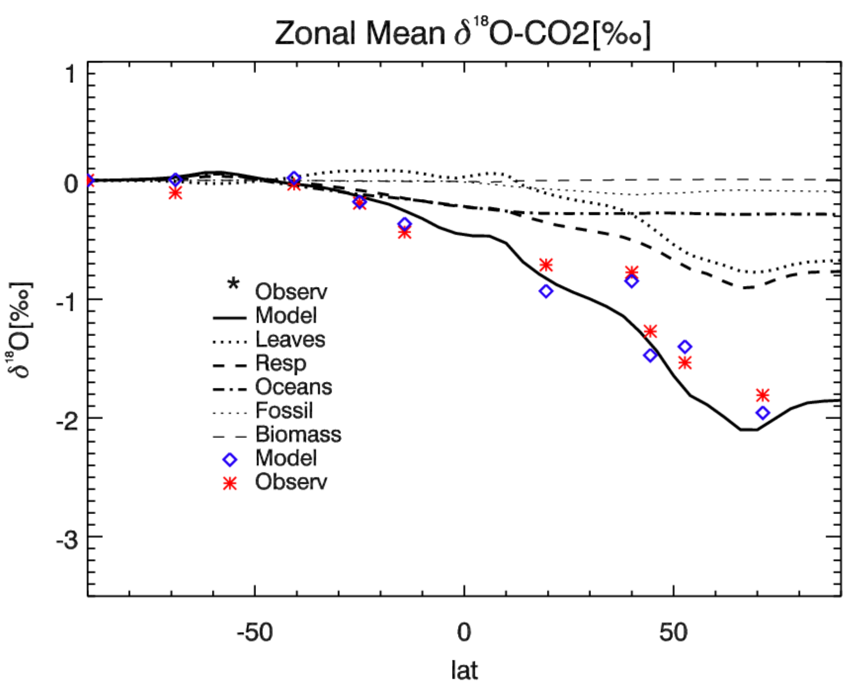

Figure 1. Simulated north-south gradient in δCa values (‰) (solid line) and the contributions from leaves (dark dotted), respiration (dark dashed), oceans (dash-dot), fossil fuel consumption (light dotted), and biomass burning (light dashed). Asterisks are values from an observed mean value, and the squares are from the closest grid-cell to each observation.