Can We Use $\delta^{13}C$ of CO_2 to Understand the Links Between the Water and Carbon Cycles and Climate?

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The fate of the Earth's climate is intricately linked to that of the global carbon cycle. Much uncertainty remains about those links and the potential responses of both systems to recent and ongoing human perturbations. Different attributes of atmospheric CO_2 (e.g. spatial gradients and relative abundances of its isotopologues) provide evidence of the mechanisms that link climate and the carbon cycle. The stable carbon isotope, ^{13}C, is a useful tracer for understanding terrestrial biosphere to atmosphere CO_2 exchange (as well as for partitioning land and ocean CO_2 fluxes) because photosynthesis discriminates strongly against heavy CO_2 (and ocean exchange does not). The degree to which photosynthesis fractionates against ^{13}C depends upon: 1) plant functional type distributions, because C_3 and C_4 plants have very different discrimination, and 2) weather and climate conditions, because stomatal conductance is closely related to C_3 plant isotopic discrimination.

To investigate these processes, we use a two-step Bayesian inversion model to optimize 1x1 degree and 3-hourly (interpreted at the monthly scale) fields of $\delta^{13}C$ of the biosphere over North America for the year 2010.

We also examine correlations between atmosphere $\delta^{18}O$ of CO_2 and climate records. This tracer offers complementary insights into biosphere atmosphere CO_2 exchange because of the close relationships between $\delta^{18}O$ and relative humidity and precipitation.

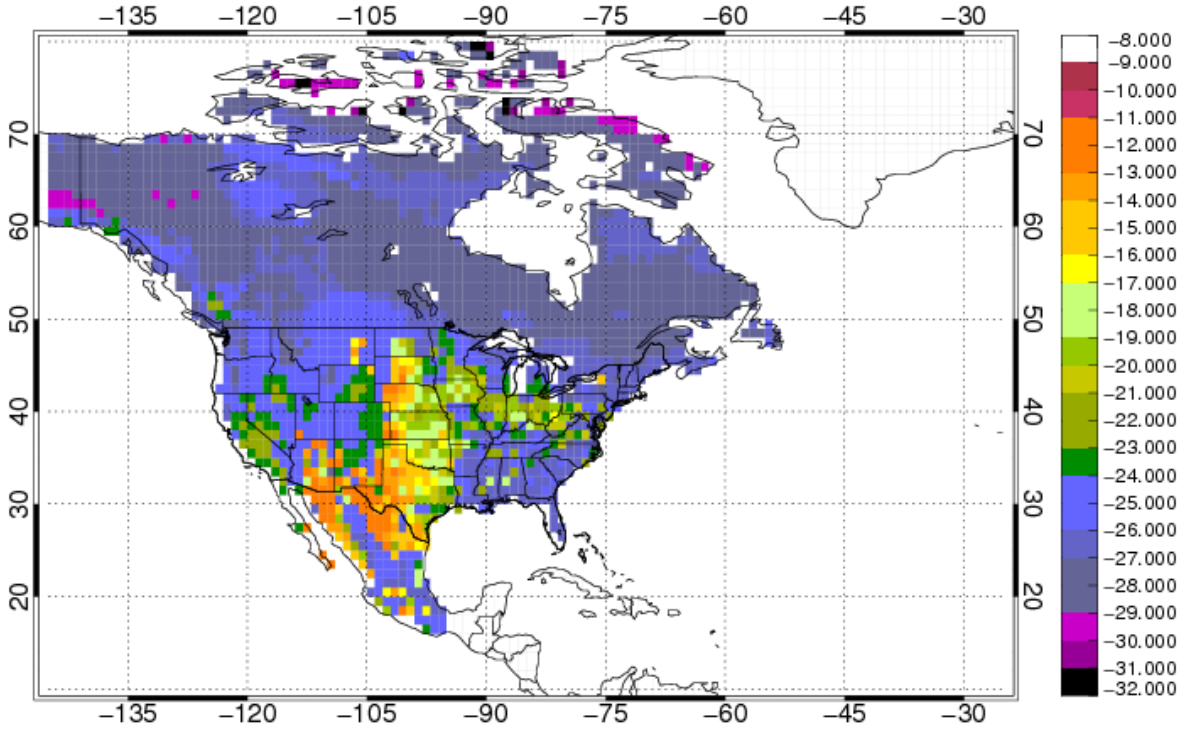

Figure 1. July 2010 SiB2 $\delta^{13}C$ of the biosphere.