(23-220414-B) **Advancing Understanding of Plant-Drought Responses in North American Ecosystems using Carbon Isotopic Discrimination in the Simple Biosphere Model**

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The terrestrial biosphere modulates increasing atmospheric carbon dioxide (CO_2) via ecosystem photosynthetic uptake and respiratory release, but our understanding of these processes and how present (and future) climate affect them is poor. Atmospheric CO_2 measurements trace net ecosystem exchange, but cannot provide process information. On the other hand, the isotopic ratio of carbon-13 to carbon-12 (expressed as a "$d^{13}C$" value relative to a reference ratio) is strongly related to isotopic fractionation (i.e. preferential uptake of carbon-12 over carbon-13) during photosynthesis, which is related to stomatal conductance and water use efficiency. By implementing photosynthetic fractionation and a parallel carbon-13 pool system in the Simple Biosphere Model (SiB, v. 4.2), we are able to trace isotopic signatures through a fully prognostic land carbon model to diagnose plant responses. Here we present results analyzing interactions of drought and carbon cycle changes from 2000-2020 across the CONUS region. Drought events were identified using county-level data from the University of Nebraska Lincoln Drought Monitor (UNL DM). We first examined anomalies in plant uptake against anomalies in soil moisture and vapor pressure deficit (VPD), binned by drought severity class as identified by the UNL DM's Drought Severity Coverage Index. Preliminary analysis indicates uptake and moisture anomalies become more negative during droughts, as expected. We then examined isotopic discrimination in response to drought stress across different ecosystems. Modeled positive $d^{13}C$ anomalies indicate plant stress and less ability to discriminate. Forward simulations with an atmospheric transport model will be used to compare SiB4 isotope fluxes to atmospheric $d^{13}C$ measurements from the Global Greenhouse Gas Reference Network. Finally, we test different stomatal conductance formulations in SiB4 to improve the predictability of drought. This is particularly relevant at sites where soil-moisture-VPD interactions show that increased VPD can offset decreased stomatal conductance which tries to limit water loss, implying that atmospheric water demand can outcompete a plant's ability to conserve water.

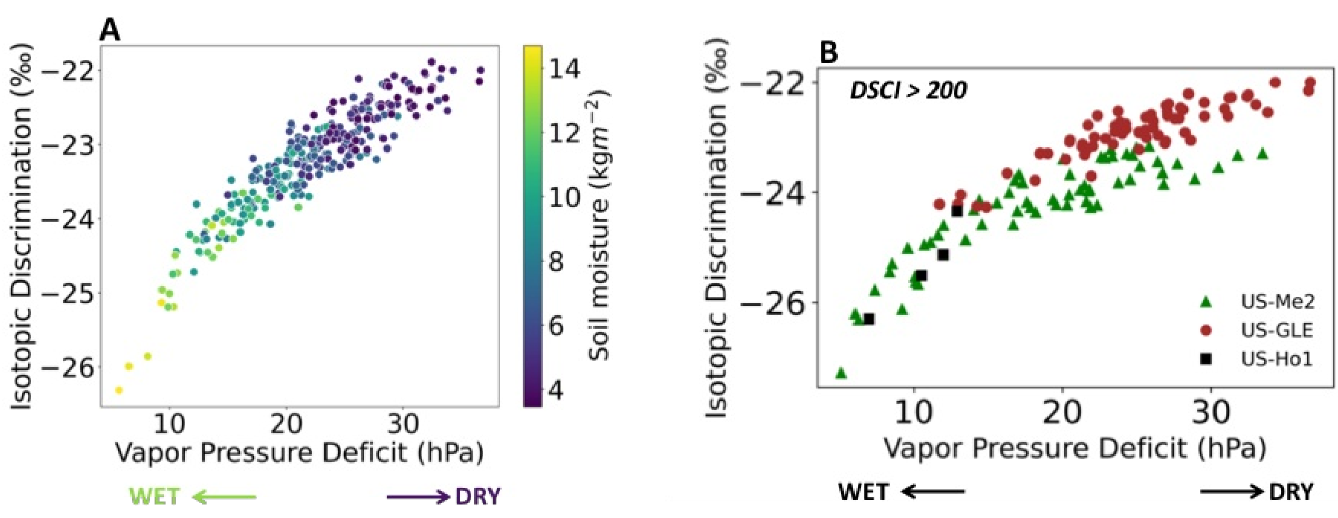

Figure 1. (A) Isotopic discrimination as a function of modeled soil moisture at an evergreen needleleaf site in Wyoming shows plant stress is reflected in isotope signatures. (B) Isotopic discrimination also captures differences in drought stress response for the same forest type across different sites in the CONUS region (Metolius Forest in Oregon, GLEES site in Wyoming, Howland Forest in Maine).