## Confronting models with regional $CO_2$ observations to improve interpretation of drought stress and emissions (anthropogenic and fire)

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This project focuses on the consequences of drought and emissions (fire and urban) for atmospheric trace gas concentration and stable isotope composition (carbon dioxide, carbon monoxide, methane). We expand on a well accepted atmospheric model (STILT-WRF) as a tool to evaluate stable isotope fluxes in CLM/CESM-related models through existing, long-term data sets from six long-term observatories as well as from field campaigns where high-precision trace gas concentration and isotope measurements can be made along the 750-km transect from western Utah through central Colorado.

Spatial Variation in Microbial Processes Controlling Carbon Mineralization within Soils and Sediments

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Approximately 3300 Pg of carbon (C) are stored in soils as organic matter, which is three-times the amount stored in the atmosphere. An important control on soil organic matter (SOM) storage is the mineralization (oxidation) rate, which is affected by climatic factors (particularly temperature and rainfall) influencing microbial metabolic rates as well as SOM chemistry, mineral-organic associations, and physical protection. What remains elusive is to what extent constraints on microbial metabolism induced by the respiratory pathway, and specifically the electron acceptor in respiration, control overall rates of carbon mineralization in soils. The complex physical structure of soils and sediments results in an abundance of redox environments even within seemingly aerobic systems. Therefore, factors limiting oxygen diffusion and availability such as soil texture and aggregate size (soil structure) may be central controls on microbial C mineralization rates. Here, we are combining laboratory studies with manipulations of field samples and in-field measurements to examine if soil structure and carbon availability interact to impose respiratory constraints on organic matter mineralization rates and thus storage.

We have developed a novel diffusion reactor coupled with an optical imaging system that allows visualizing spatial and temporal redox dynamics at the soil aggregate-scale. Combining these in-situ measurements with analysis of carbon chemistry, electron acceptor profiles and reactive transport modeling, we are determining the micro-scale distribution of operative microbial metabolisms and their cumulative impact on SOM mineralization rates. Our field studies comprise two sites: an upland temperate site that takes advantage of a series of soils with systematic variations in soil texture and structure, and a second site within an active tropical floodplain situated within one of the mega-deltas of Asia. Within the upland site, we are testing whether oxygen availability and redox state are good predictors of total carbon contents and chemistry across pedon-, horizon- and aggregate-scales. Within the tropic delta, we are comparing the abundance and chemical state of SOM at three locations having varying degrees of saturation (uncultivated seasonal wetlands, cultivated wetlands, and permanent lakes) by measuring total carbon content and chemistry, the latter deduced principally with C (1s) near-edge x-ray absorption fine structure (NEXAFS) spectroscopy. Collectively, our results quantitatively place the importance of aggregate-based heterogeneity in microbial redox processes on the rate of carbon mineralization.