Poster #96

Hot Spots and Hot Moments: Investigating the Relationship Between Soil Redox Dynamics and Greenhouse Gas Fluxes in a Wet Tropical Forest

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Background/Question/Methods
Hot spots and hot moments of greenhouse gas (GHG) fluxes occur in ways that are difficult to predict or model. Soil oxygen and redox dynamics can be key predictors of these fluxes. We report on a research effort to determine to what extent soil redox dynamics are a driver of soil GHG fluxes from a lower montane wet tropical forest. We installed and sampled a sensor field across a topographic gradient in the Luquillo Experimental Forest, Puerto Rico. The sensor field included galvanic oxygen (O_2) sensors, temperature probes and time-domain reflectometry for moisture along topographic gradients. Seven sensors of each type were installed at 12 cm depth along a ridge to valley catena; the entire catena transect was replicated five times for a total of 105 sensors. Within the sensor field we also installed nine automated gas flux chambers randomly located in each topographic zone (ridge, slope and valley). A Cavity Ring-Down Spectroscopy (CRDS) gas analyzer was used to measure pseudo-continuous fluxes of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). The experimental design produced a dataset with high temporal resolution of GHG fluxes, with nearly 10,000 measured fluxes. We also match those fluxes to soil O_2 concentrations, moisture and temperature at equally high temporal resolution.

Results/Conclusions
We found that 5%, 3% and 7% of CO_2, N_2O and CH_4 fluxes respectively were statistical outliers, large fluxes (either negative or positive) produced by hot spots in space or hot moments in time. Those outlier fluxes increased the mean flux of CO_2 by 25% (from 2.16 to 2.69 umol/m2/s), the mean flux of N_2O by 10% (from 0.10 to 0.11 nmol/m2/s), and the mean flux of CH_4 by 77% (from 2.07 to 3.66 nmol/m2/s). Soil moisture and O_2 availability followed distinct and robust topographic patterns, with significantly drier and more aerated soils in the upper topographic zones than in the valleys and lower topographic positions. Soil O_2 concentrations also experienced oscillations over hours, days and months. Soil O_2 concentrations were correlated positively with CO_2 fluxes (pearson's coefficient = 0.25) and negatively with N_2O and CH_4 fluxes (pearson's coefficients of -0.13 and -0.20 respectively). Finally, we further explore the potential for time series analysis and probabilistic statistical techniques to constrain predictions of GHG fluxes from soils.