Measuring the surface-atmosphere exchange budgets of CO_2 and CH_4 from peatlands using micro-meteorological flux measurements.

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Background:

Peatlands are an important part of the global carbon cycle. Photosynthetic uptake of carbon dioxide (CO_2) from wetland vegetation, and emissions of methane (CH_4) formed under anoxic conditions by bacteria (methanogens) contribute largely to the net carbon balance of a peatland. With micrometeorological flux measurements we are able to monitor the surface-atmosphere exchange of these greenhouse gases (GHG) in-situ in a non-intrusive way. Thus, flux measurement techniques such as the eddy covariance method have become essential tools for global carbon cycle studies.

Established Research:

Eddy flux measurements of CO_2 together with CH_4 have been carried out at the Marcell Experimental Forest "Bog Lake Fen (BLF)" site since 2009. These measurements survey a large and mostly tree free hummock-hollow-patterned bog system, approx. 1.6 miles west of SPRUCE. Together with ancillary measurements of basic meteorology and hydrology, this long-term data set yields a valuable tool to study the C-balance of a natural peatland. Despite differences in hydrology and vegetation cover, both measurement sites (BLF and SPRUCE) yield large potential for comparison studies.

Connectivity to SPRUCE / Proposed future research:

Concurrent to Bog Lake Fen, flux measurements of CO_2 and CH_4 are also being carried out at SPRUCE, in one of the "control" plots. Both flux set-ups use similar instrumentation, however instruments deployed at SPRUCE are newer generation sensors. Especially in the case of the Li-7500 CO_2/H_2O gas analyzer, the older models are believed to suffer from a bias in measurements due to an internal heat source from the instrument's electronic components. We have found evidence for this measurement artifact in our dataset, and thus, concurrent measurements from SPRUCE could help in developing correction methods. Additionally automated soil-flux chambers at SPRUCE also measure the CO_2 exchange with the atmosphere. Results from chamber incubations may yield further potential in identifying measurement bias.

In the near future, we will deploy an automated CO2, N_2O and CH_4 flux chamber system at BLF. We're aiming to monitor fluxes across a hydrological gradient, e.g. deploy chambers in hollows versus hummocks etc. This dataset will be complimentary to already established soil-flux chamber measurements at SPRUCE. We anticipate developing strategies for future study sites and collaborative experiments, e.g. linking surface-atmosphere fluxes to below-ground processes.

Finally, we propose an inter-comparison study of CH_4, CO_2 and energy flux measurements between both sites using both measurement techniques, namely eddy covariance and flux chamber incubations. Our proposed collaboration is intended to validate flux measurements at either site, to study GHG fluxes and the energy balance across a hydrological gradient and ecosystem transitional zone, i.e. along changing hydrology and vegetation between BLF and SPRUCE, and to produce meaningful and usable flux data products for future research and synthesis studies.