Carbon Science Investigations: LTER cross-site study advancing application of optical properties of organic matter in soil and water

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The transport of carbon from terrestrial to aquatic ecosystems is a critical component of ecosystem C accounting. Cycling of carbon is an important aspect of the function of terrestrial and aquatic ecosystems across the LTER network. The chemical properties of the major pools of detrital organic carbon dissolved in water and stored in soils can play a key role in determining fluxes from the landscape and the key biogeochemical processes controlling carbon cycling. However, finding tools to characterize functional pools of DOC that relate to its movement and lability has proven elusive. "Optical properties" refers to the ways in which this organic matter absorbs light across the UV and visible spectrum and then fluoresces (emits light at a higher wavelengths). Recent research has suggested that specific optical properties can indicate the initial sources of organic matter and the transformations that have occurred. They can also be readily measured, and the literature in which optical properties of organic matter have been applied has been rapidly in diverse fields of environmental science and engineering.

On May 2nd and 3rd, 2013 a LNO sponsored workshop, *Linking Aquatic and Soil Organic Matter across Ecosystems,* was held at the Institute of Arctic and Alpine Research at the University of Colorado at Boulder. The members of the workshop steering committee were Diane McKnight (MCM & NWT), Rudolf Jaffe (FCE), Kate Lajtha (HJA), and Hiliary Hartnett (CAP). Jessica Ebert (MCM) and Kaelin Cawley (FCE) helped organize the workshop, including the pre-workshop submission of optical data by participants. The workshop's goals were to advance the application of optical properties in studies of SOM/DOM linkages between terrestrial and aquatic ecosystems, develop a synthesis of studies of soil interstitial water, soluble SOM, and DOM across diverse LTER sites, and develop approaches for incorporating optical data from LTER monitoring programs in the LTER Network Information Systems (NIS). The workshop had 26 attendees, including university professors, research scientists, post docs, and PhD students from 15 different institutions and 13 separate LTER sites.

In association with the workshop, Jessica Ebert (MCM) received a LNO graduate student fellowship and conducted a 2-day pre-workshop training session. This session focused on hands-on training for obtaining 3-D fluorescence spectra, referred to as excitation and emission matrices or EEMs, and statistical analysis of EEMs through Parallel Factor Analysis (PARAFAC). The participants learned how to analyze EEMs using existing PARAFAC models which are based on analysis of EEMs from surface and ground waters from several LTER sites. The training session had 17 attendees, which included 14 masters or PhD students, 2 post docs, and a research assistant. Many of the attendees also participated in the subsequent workshop. Jessica has continued to lead the post- workshop analysis of existing spectral data and new soil and water samples contributed by participants.

During the LNO workshop the following research questions were discussed:
-Can we see similarities between optical properties of DOC on land and in water?
-Can we use optical properties of soil DOC extracts to predict DOC flux to streams?
-What is the connectivity between (dissolved and potentially dissolved) organic matter pools in the environment?
-What are the environmental drivers of both quantity and quality of the organic matter?
-How is that affected by disturbance events (land use change, climate, storm events, pine beetle kill, natural and anthropogenic, impoundments)?
-Does short term temporal variation matter over long time scales?
-What is the time-scale of the variability?
-Where is convergence of organic matter characteristics along the hydrologic flow path within catchments?
-What are the similarities in and differences in where this convergence is happening between various sites?

On the morning of the second day of the workshop, the post-docs and graduate students took over the leadership of the workshop. This group developed a plan to collect surface water, surface soil, and lysimeter data when available from the various LTER sites with the intention of developing an All LTER PARAFAC model. This new model will be able to characterize optical properties of soil and water samples across LTER sites. The plan was presented to the steering committee members, who had held a separate breakout meeting at a local coffee shop. All the participants then developed a detailed plan of action which is now underway. The plan was also further discussed at a subsequent GRC meeting and new participants were brought in.

Emails were sent to all sites and 10 sampling kits have been sent out. Water and soil samples have been returned back from 3 sites and 1 other site is expected in the next several days. When more kits have been received another round of kits will then be sent out to the remaining sites that have agreed to participate.