Ecological Society of America Annual Meeting 2009 (Albuquerque, NM)

Title:
Constructing a complete carbon budget for a north temperate lake district

Authors:
Ishi Buffam, Monica G. Turner, Ankur R. Desai, Paul C. Hanson, Matthew C. Van de Bogert, James A. Rusak, Noah R. Lottig, Emily H. Stanley, Timothy K. Kratz and Stephen R. Carpenter

Affiliation:
University of Wisconsin-Madison

Background/Questions/Methods

The development of complete regional carbon budgets is an integral step in the effort to predict response and potential feedbacks to a changing climate regime. Considerable advances have been made in the understanding of forest C cycling across a wide range of regions, but wetland and lake contribution to the C cycle remains relatively uncertain in spite of recent research suggesting their importance may exceed expectations based on their areal coverage. Using a combination of field surveys and tower-based CO_2 flux measurements, modeling, and review of the literature, we constructed a complete C budget for the Northern Highlands Lake District (NHLD), a ~7000 km^2 lake and wetland rich region in northern Wisconsin/Michigan. The modeling includes explicit uncertainty analysis. This is one of the first regional C budgets to explicitly incorporate aquatic and terrestrial C cycling under the same framework. We divided the landscape into 3 major compartments (forests (60% of the area), wetlands (25%) and lakes(13%)) and quantified all major C fluxes into and out of those compartments, with a particular focus on exchange with the atmosphere but also including sedimentation in lakes and hydrologic export.

Results/Conclusions

Field surveys demonstrated that C storage on the landscape was dominated by peat-containing wetlands (fens and bogs), which make up only 20% of the landscape area but contain about half of the total fixed C pool in the NHLD (ca. 300 Tg). The largest gross land-atmosphere fluxes were forest production and respiration, averaging 940 and 650 g-C m^{-2} yr^{-1}, respectively. However, wetland net ecosystem exchange (NEE) and lake CO_2 efflux were also consequential. Direct hydrologic (riverine) export of C from the entire region was minor compared to land-atmosphere fluxes, but within-region hydrologic transport from uplands/wetlands to lakes was still an important vector of terrestrially-produced fixed C, subsidizing lake food webs and also contributing to C loss from the system, either as CO_2 evasion or sedimentation. Lakes and wetlands were important components of the C budget and both fluxes and pools for the region would be dramatically misrepresented without their inclusion. Construction of this budget opens opportunities for future research in developing scenarios to examine sensitivities of the major regional C fluxes to climate change and land use/land cover change.