TCP Final Report: Measuring the Effects of Stand Age and Soil Drainage on Boreal Forest Net Ecosystem Production

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This was a 6-year research project in the Canadian boreal forest that focused on using field observations to understand how boreal forest carbon balance changes during recovery from catastrophic forest fire. The project began with two overarching goals: (1) to develop techniques that would all the year round operation of 7 eddy covariance sites in a harsh environment at a much lower cost than had previously been possible, and (2) to use these measurements to determine how carbon balance changes during secondary succession. The project ended in 2006, having accomplished its primary objectives.

Key contributions to DOE during the study

(1) Design, test, and demonstrate a lightweight, fully portable eddy flux system that exploits several economies of scale to allow AmeriFlux-quality measurements of CO_2 exchange at many sites for a large reduction in cost (Goulden et al. 2006).

(2) Added seven year-round sites to AmeriFlux, at a relatively low per site cost using the Eddy Covariance Mesonet approach (Goulden et al. 2006). These data are freely available on the AmeriFlux web site.

(3) Tested and rejected the conventional wisdom that forests lose large amounts of carbon during the first decade after disturbance, then accumulate large amounts of carbon for ~several decades, and then return to steady state in old age. Rather, we found that boreal forests recovers quickly from fire and begins to accumulate carbon within ~5 years after disturbance. Additionally, we found no evidence that carbon accumulation declines in old stands (Goulden et al. 2006, Goulden et al. in prep).

(4) Tested and rejected claims based on remote sensing observations (for example, Myneni et al 1996 using AVHRR) that regions of boreal forest have changed markedly in the last 20 years. Rather, we assembled a much richer data set than had been used in the past (eddy covariance observations, tree rings, biomass, NPP, AVHRR, and LandSat), which we used to establish that the forests in our study region have remained largely constant over the last 20 years after accounting for the effects of stand age and succession (McMillen et al. in review).

Papers delivered

Litvak M, Miller S, Wofsy SC, Goulden M. 2003. Effect of stand age on whole ecosystem CO2 exchange in the Canadian boreal forest. Journal of Geophysical Research-Atmospheres 108 (D3): Art. No. 8225.

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Bond-Lamberty B, Gower ST, Goulden ML, McMillan A. 2006. Simulation of boreal black spruce chronosequences: Comparison to field measurements and model evaluation. Journal of Geophysical Research, VOL. 111, G02014.

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A.L. Dunn, C.C. Barford, S.C. Wofsy, M.L. Goulden, B.C. Daube. 2007. A long-term record of carbon exchange in a boreal black spruce forest: means, responses to interannual variability, and decadal trends. Global Change Biology, 13 (3): 577-590

McMillan AMS and Goulden ML. Seasonal and age dependent variations in surface reflectance and ecosystem function in boreal forests. In review, Journal of Geophysical Research.

Data sets delivered

Our entire chronosequence data set (total of approx 22 site-years) is available through the AmeriFlux website.
http://public.ornl.gov/ameriflux/site-select.cfm
Canada -- BOREAS NSA - 1850 burn site, ~3 years data
Canada -- BOREAS NSA - 1930 burn site, ~4 years data
Canada -- BOREAS NSA - 1963 burn site, ~4 years data
Canada -- BOREAS NSA - 1981 burn site, ~4 years data
Canada -- BOREAS NSA - 1989 burn site, ~4 years data
Canada -- BOREAS NSA - 1998 burn site, ~3 years data

See also:
http://www.ess.uci.edu/%7Eboreal_canada/index.html