EdiSol

A system to measure surface fluxes by eddy covariance

EdiSol

in Boreal and Temperate Forests

Modelling studies using the global flask network for atmospheric carbon dioxide (and its isotope ^{13}C in CO_2) suggest that a major sink for carbon may be in the boreal forests of northern latitudes. Much of the boreal forests in Scandinavia, Russia and Canada is undisturbed, some is exploited on a more or less sustainable basis and natural fires are a regular occurrence. A number of major international experiments have taken place and are continuing in these areas and *EdiSol* is a system ideally suited to be used for monitoring carbon and water balances over extended periods. The first flux network to use eddy covariance makes use of *EdiSol* and similar systems to monitor Europe's forests. The network is called EuroFlux and has been in operation since 1996. Surface flux experiments made on a campaign basis have been popular over the past decade or so and one such is BOREAS. The **BOR**eal **E**cosystem **A**tmosphere **S**tudy took place in mid-Saskatchewan and northern Manitoba in 1994 and 1996 with one aim to improve our understanding of the exchange of water and carbon fluxes between the boreal forest and the atmosphere. Eddy covariance is the optimal micrometeorological method to obtain continuous surface flux measurements and a number of tower flux sites were established across the boreal forest.

Two *EdiSol* systems were deployed in a stand of Black spruce (*Picea mariana*) in the southern study area in Saskatchewan. In 1996, experiments began before snow melt in spring and were made continuously until snow fall in the early winter. It is necessary to make such long-term measurements covering the non-growing season given that soil carbon decomposition occurs all year round, even under snow, *EdiSol's* proven design and its ability to operate remotely in extreme conditions meant that data recovery rates exceeded 95% of the available time. The range of temperature in 1996 over which *EdiSol* operated was from -25 to + 30 °C

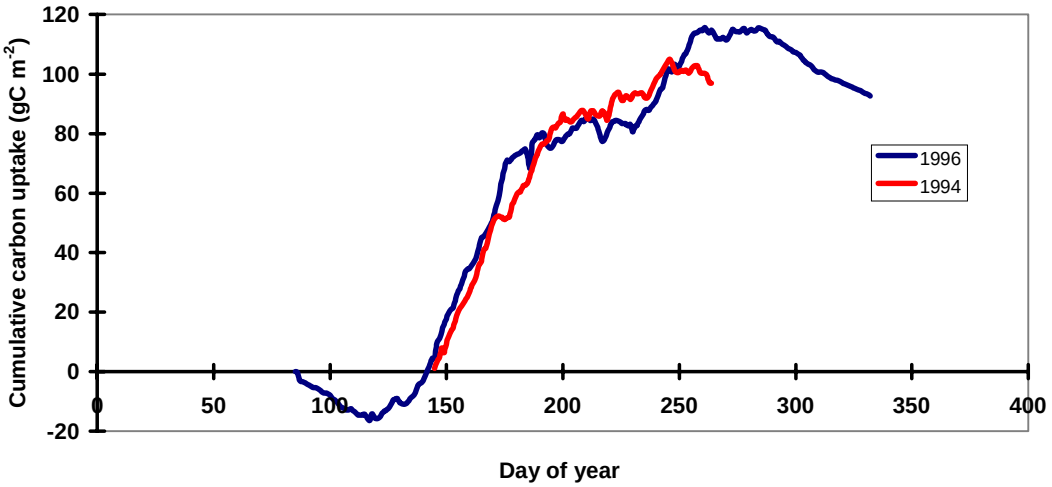

Figure 1. Cumulative carbon uptake as measured by an *EdiSol* system above Black Spruce at the Southern Study Area during BOREAS 1994 and 1996.

In 1994 with 120 days of continuous data (as dictated by the length of the fixed experimental period), there was a net gain of 95 gC m^{-2} in relation to evapo-transpiration of about 225 mm of water. The sink strength for carbon equates to about 1 tC ha^{-1}. In 1996, the net sink/source terms could be measured directly throughout nearly the whole of the annual period and equate to a sink strength of about 75 gC m^{-2}. (in the figure above, positive values indicate net carbon gain by the system).

Hardware and Software issues in an *EdiSol* system can be found in:

- Moncrieff, J.B., Massheder J.M., de Bruin, H., Elbers, J., Friborg, T., Heusinkveld, B., Kabat, P., Scott, S, Sogaard, H. and Verhoef, A. (1997) A system to measure surface fluxes of momentum, sensible heat, water vapour and carbon dioxide. *Journal of Hydrology* **182**.
- Jarvis, P.G., Massheder, J.M., Hale, S.H., Moncrieff, J.B., Rayment, M. and Scott, S.L. (1997) Seasonal variation of carbon dioxide, water vapour and energy exchanges of a boreal Black Spruce forest. *Journal of Geophysical Research* (in press).

Background information on BOREAS is available from:

- Sellers, P. et al (1995) The Boreal Ecosystem-Atmosphere Study (BOREAS): an overview and early results from the 1994 field year. *Bulletin of the American Meteorological Society* **76**, 1549-1577.
- http://boreas.gsfc.nasa.gov

EdiSol is a system for measuring the surface fluxes of momentum, heat CO_2 and H_2O by eddy covariance. *EdiSol* uses commercially-available instrumentation: a 3-axis sonic anemometer (Gill A1012R) and an infra-red gas analyser (LI-COR 6262). Air to be sampled is brought to the optical bench by being ducted down a sampling tube from a point near the sonic anemometer. The system is controlled by specially-written software which calculates the surface fluxes of momentum, sensible and latent heat and carbon dioxide and displays them in real time on a PC screen. The IRGA, PC and associated plumbing and flow control systems are housed in an environmentally sealed enclosure.

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