Characterisation of methane net ecosystem exchange from a Scottish peatland.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

C. Helfter, J. Drewer, P. Levy, I. Leith, S. Leeson, R. McKenzie, M. Sutton, E. Nemitz and U. Skiba

Centre for Ecology and Hydrology, Edinburgh, UK.

Introduction

Continuous monitoring of net ecosystem exchange (NEE) of methane (CH_4) by the eddy-covariance (EC) technique began in August 2010 at Auchencorth Moss (55° 47' N, 3° 12‘ E), a low-lying, drained acid peatland 20 km South-West of Edinburgh, Scotland, UK.

The site is an open moorland with extensive uniform fetch of blanket bog to the south, west and north. The vegetation present within the flux measurement footprint comprises mixed grass species, heather and substantial areas of moss species (Sphagnum spp. and Polytrichum spp.).

Methods

Eddy-covariance (EC) derives the flux (F_g) of trace gas *g* from the covariance between the deviation from their respective means of the vertical wind velocity component *w* and of the trace gas concentration (χ_g).

$$F_g = \overline{w' \chi_g'} \qquad (1)$$

Measurements are taken atop a 2.5 m mast supporting a Gill Windmaster Pro ultrasonic anemometer operating at 20 Hz. Air is sampled ca. 15 cm below the anemometer’s sensor head using 0.95 cm (OD), ca. 20 m long Dekabon tubing and is analysed by a Los Gatos RMT-200 fast methane analyser operating at 10 Hz.

Results

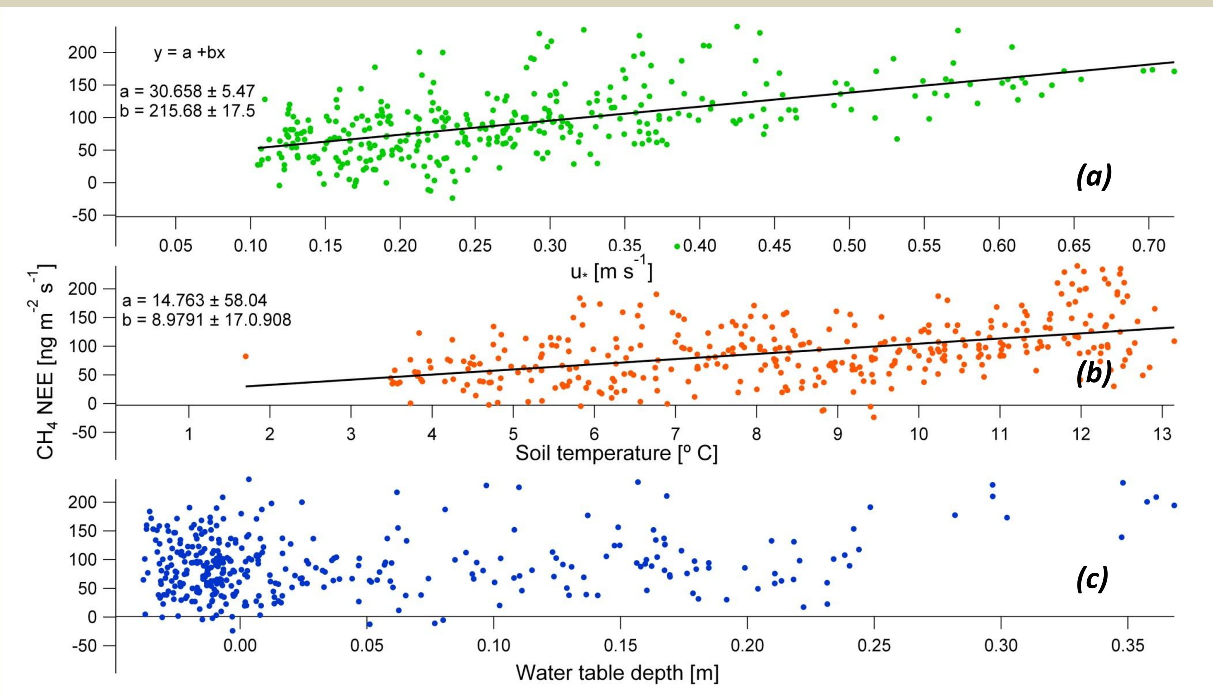

Fig. 1: CH_4 NEE as a function of (a) friction velocity, (b) soil temperature and (c) water table depth (negative values denote water levels above the sensor).

- Linear correlation of CH_4 fluxes (F_{CH4}) with friction velocity (u_*) and soil temperature (T_{soil}) (Fig. 1 a&b).
- Weak dependence on water table depth (d_{WT}) (Fig. 1 c).
- Uniform distribution of F_{CH4} (u_*) with respect to wind direction (Fig. 2).

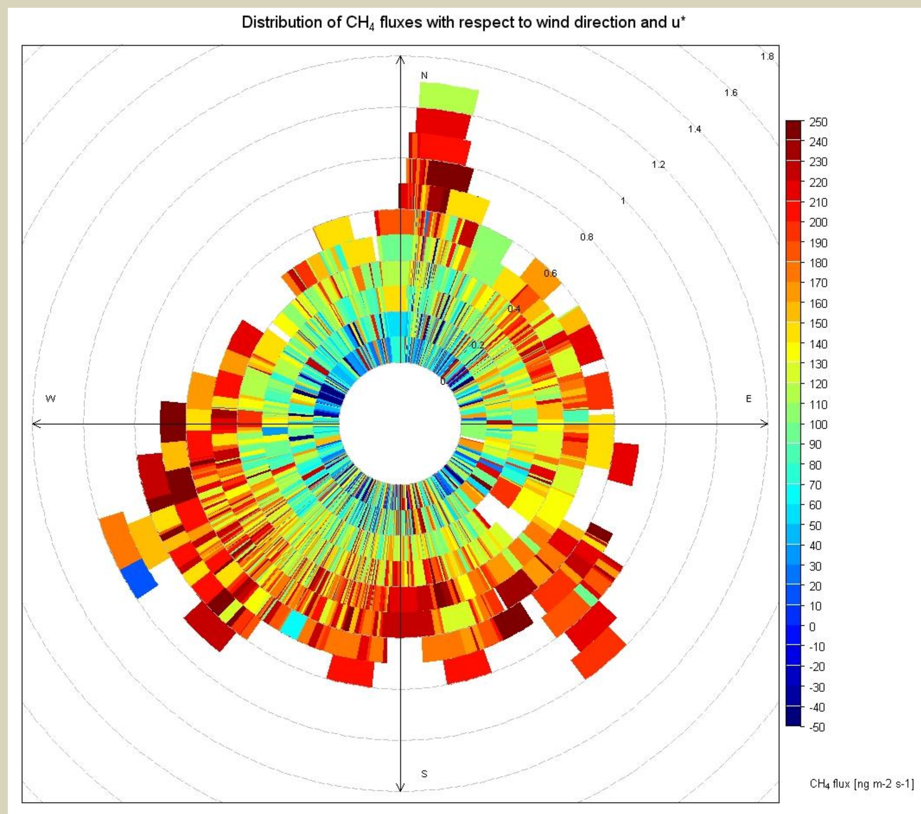

Fig. 2 †: Bi-variate distribution of CH_4 fluxes with respect to friction velocity and wind direction.

- CH_4 NEE is well-characterised throughout the year by a multi-variate linear function of u_* (strongest dependence), T_{soil} and d_{WT} *(Fig. 3)*.
- The site is a net source of CH_4 (emission of 23 kg CH_4 ha^{-1} between August 2010 and July 2011).
- Net emissions were observed even during a period of complete snow cover.
- No quantitative correlation with fluxes obtained from chambers measurements.

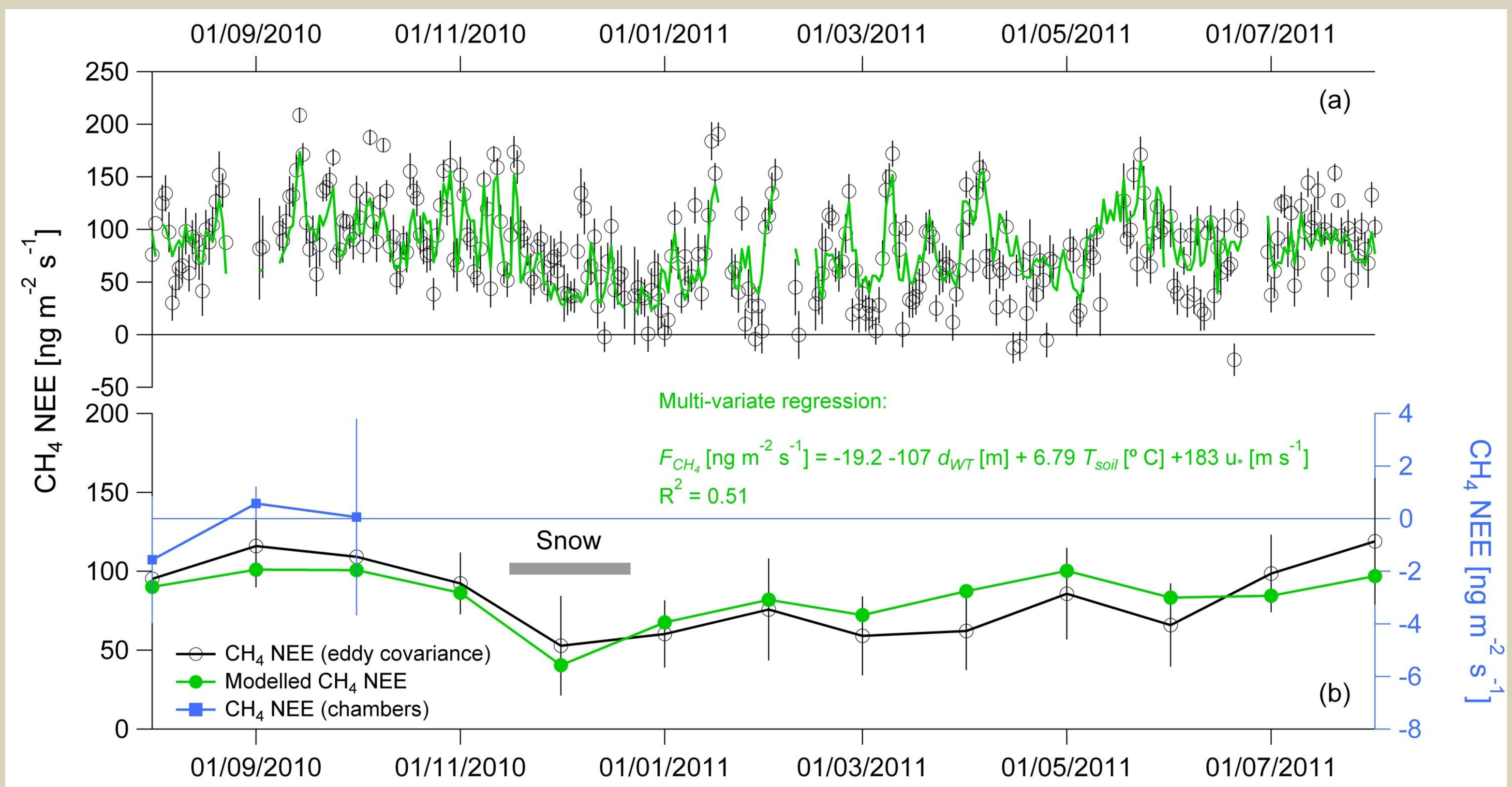

Fig. 3: Daily (a) and monthly (b) averages of F_{CH4} measured by eddy-covariance and modelled values obtained from multi-variate regression of F_{CH4} with respect to u_*, T_{soil} and d_{WT}. Three monthly estimates obtained from 9 spatially-segregated static chamber measurements are given in (b). Error bars denote the standard error of the mean (SEM).

Conclusions

CH_4 fluxes are largely turbulence-driven (deposition for $u_* < 0.1$ m s^{-1}) suggesting storage within the undergrowth, which, along with spatial heterogeneity, could explain the discrepancies between chambers and EC measurements.

Due to storage, eddy-covariance might reflect the site’s net exchange of methane but not necessarily capture its low-level source/ sink dynamics. Methane emissions have a global warming potential of 58 g CO_2-eq m^{-2} y^{-1}, approximately half the measured net sequestration of CO_2 at the site.

† *Plot created using the R openair package.*

Carslaw, D.C. and Ropkins, K. (2010). Open-source tools for analysing air pollution data. Environmental Research Group, King’s College London.

enquiries@ceh.ac.uk
www.ceh.ac.uk