Eddy covariance observations of CH_4 and N_2O

Towards more accurate emission estimates

P. Kroon[1,2]

A. Hensen[1]

H. Jonker[2]

A. Schrier-Uijl[3]

M. Tummers[2]

F. Bosveld[4]

[1]ECN, the Netherlands; [2]TU Delft, the Netherlands;
[3]WU, the Netherlands; [4]KNMI, the Netherlands

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ECN
P.O. Box 1
NL 1755 ZG Petten
The Netherlands

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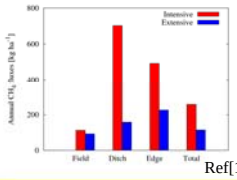
Authors: P. Kroon[1,2], A. Hensen[1], H. Jonker[2], A. Schrier-Uijl[3] and F. Bosveld[4]

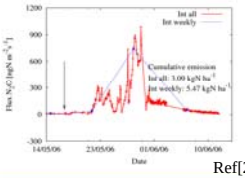
1. ECN, the Netherlands ; 2. TU Delft, the Netherlands ; 3. WU, the Netherlands; 4. KNMI, the Netherlands

Introduction

The uncertainty in annual estimates of CH_4 and N_2O over agricultural fields is almost always 50% or higher when chamber measurements are used due to a combination of spatial and temporal variation of the emissions.



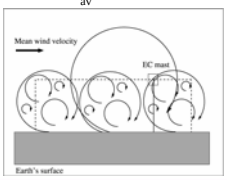
Ref[1]



Ref[2]

Eddy covariance method provides a good alternative to determine emission estimates on a hectare scale that also have continuous coverage in time.

$$\mathrm{EC}_{wc} = \frac{1}{T_{\mathrm{av}}}\int w'(t)C'(t)dt$$

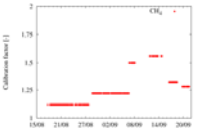


Systematic errors in EC flux measurements

$$\mathrm{EC}_{wc} \overset{?}{=} \mathrm{EC}_{wc}^{\mathrm{meas}}$$

$$\mathrm{EC}_{wc} = \chi_{\mathrm{cal}}\chi_{\mathrm{low}}\chi_{\mathrm{high}}\mathrm{EC}_{wc}^{\mathrm{meas}} + \chi_{\mathrm{cal}}\chi_{\mathrm{Webb}}$$

After corrections, the 30 min EC fluxes can increase by even more than 100%.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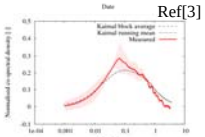


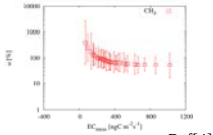
Ref[4]

Uncertainty in 30 min EC flux measurements

$u(\mathrm{EC}_{wc})$ can be much larger than 100% for a 30 min EC flux. This uncertainty is mainly caused by $u(\mathrm{EC}_{wc}^{\mathrm{meas}})$ which is assumed to be equal to the random one-point uncertainty.

$$u_{\mathrm{op}} = \sqrt{\frac{2}{M}}\sigma_{w'c'} = \sqrt{\frac{20z}{T_{\mathrm{av}}U}}\sqrt{\overline{(w'c')^2} - \overline{(w'c')}^2}$$

$$= a\mathrm{EC}_{wc}^{\mathrm{meas}}$$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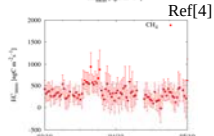
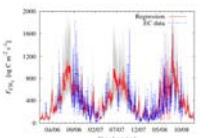

Ref[4]

Annual CH_4 and N_2O balance

The field emissions were derived by

$$F_{wc} = \underbrace{\int_0^h \frac{\partial \bar{c}}{\partial t}dz}_{\mathrm{St}_{wc}} + \underbrace{\overline{w'c'}|_{z=h}}_{\mathrm{EC}_{wc}}$$

and the average annual field CH_4 and N_2O emissions were 165 (±13%) kg CH_4 ha^{-1} yr^{-1} and 20 (±34%) kg N_2O ha^{-1} yr^{-1}. The total field greenhouse gas balance was estimated at 15 Mg ha^{-1} yr^{-1} CO_2-eq. with contributions of 33, 26 and 41% by CO_2, CH_4 and N_2O, respectively.



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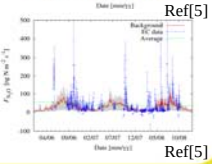

Ref[5]

Conclusions

- The annual emission estimates of peat areas are very uncertain.
- Corrections should be applied for systematic errors in EC flux measurements.
- The uncertainty in a 30 min EC flux is mainly caused by one-point uncertainty and can be larger than 100%.
- Assuming 100% data coverage, the uncertainty of a monthly EC flux average can be even smaller than 10%.

References: 1. Schrier-Uijl et al., BGD, 2008; 2. Kroon et al., Nutr. Cycl. Agorecosyst., 2008; 3. Kroon et al., BG, 2007; 4. Kroon et al., AFM, submitted; 5. Kroon et al., Eur. J. Soil Sci., submitted.

p.kroon@ecn.nl, tel: +31224-564062