

Eddy covariance measurements of CH_4 and N_2O using quantum cascade laser spectrometry

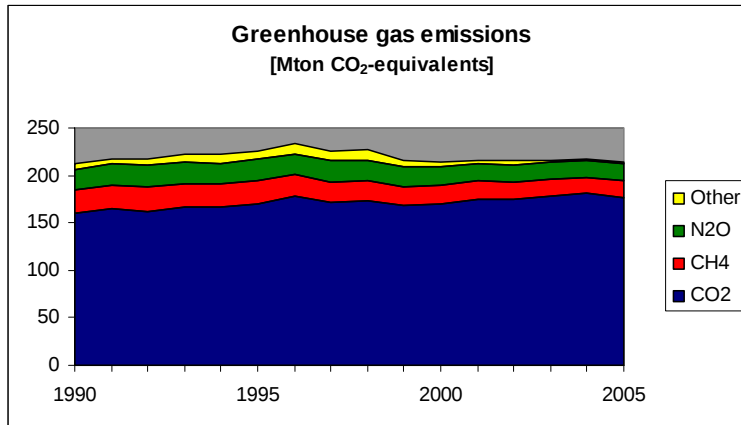
Petra Kroon



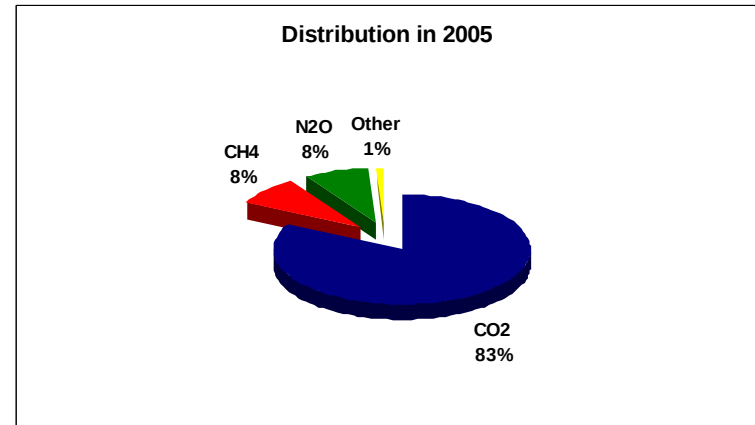
Outline

- Problem description
- Possible solutions
- Actual state
- Future focus

Problem description (1)



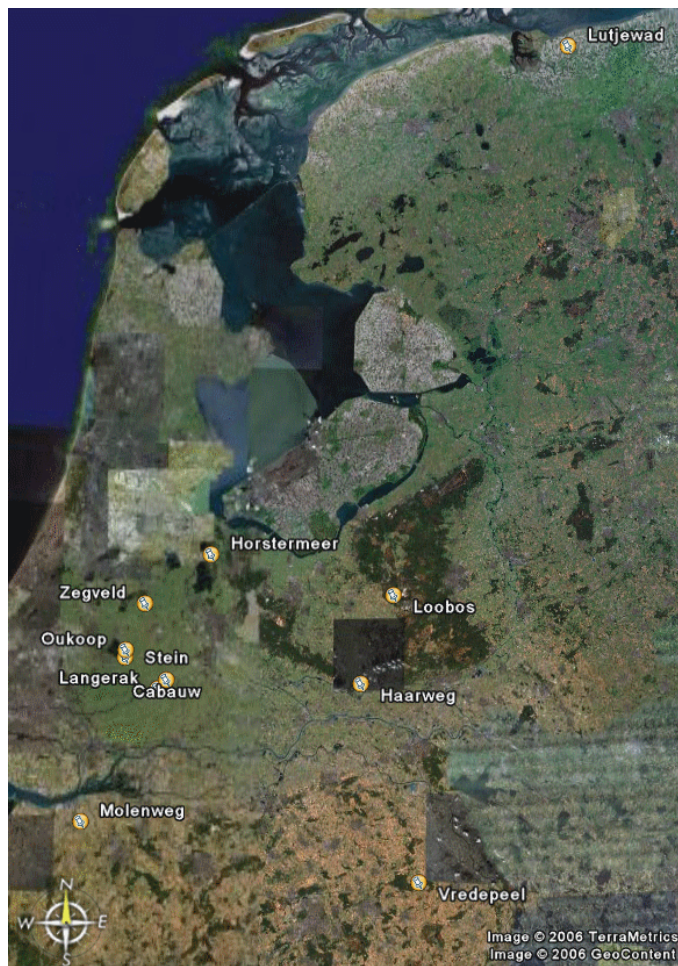
Emission registration Netherlands, 2006



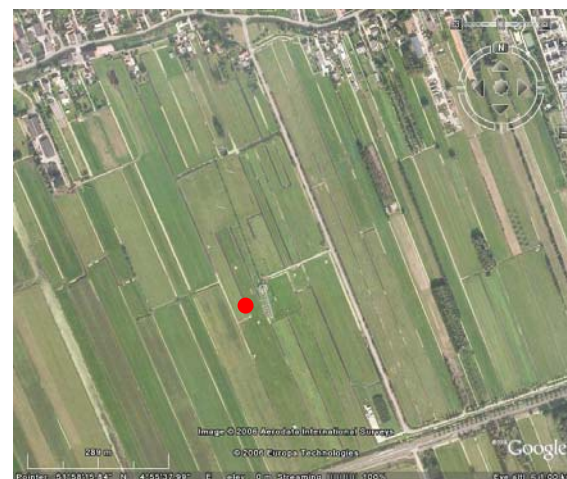
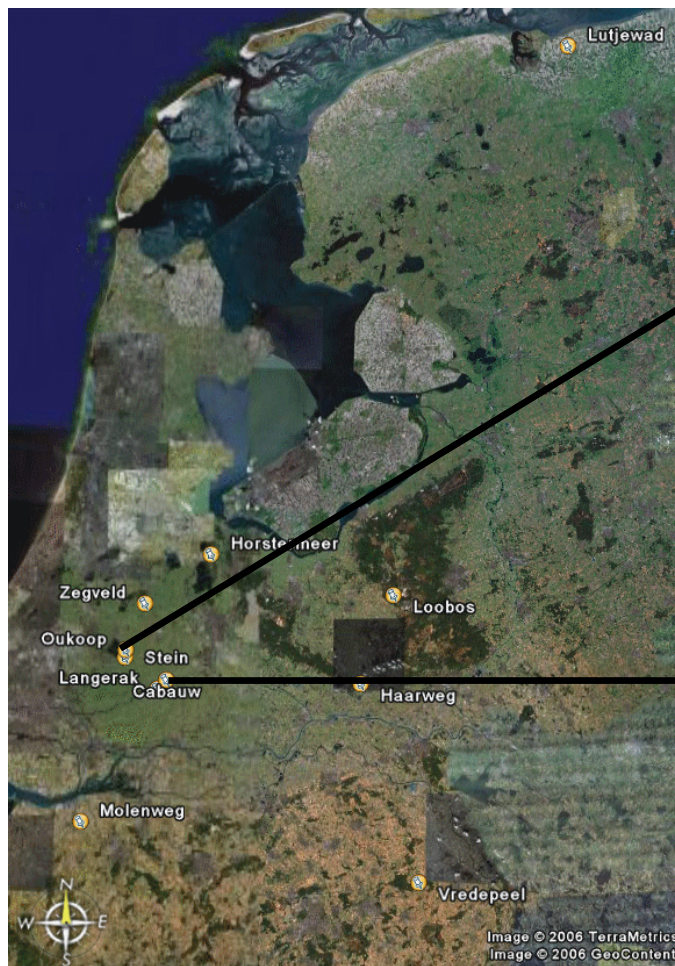
Focus on CH₄ and N₂O emissions from agriculture because of:

- 100% uncertainty
- Global Warming Potential CH₄ and N₂O higher than CO₂
24 and 310 times, respectively
- Agriculture highest contribution to CH₄ and N₂O emissions

Problem description (2)

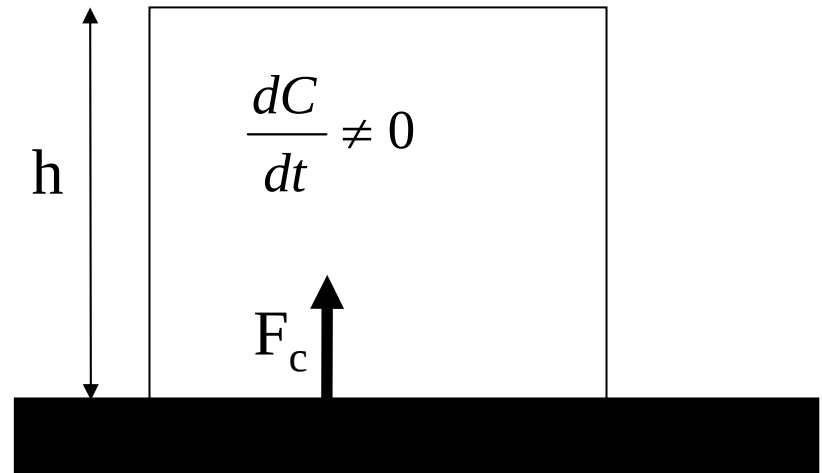


Problem description (3)

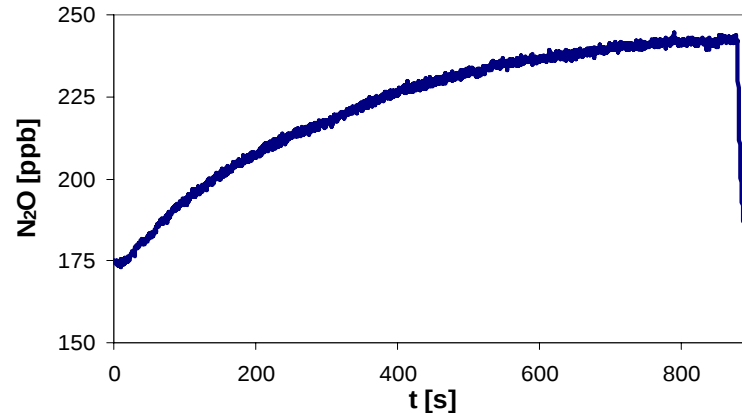


Problem description (4)

Manual box measurements



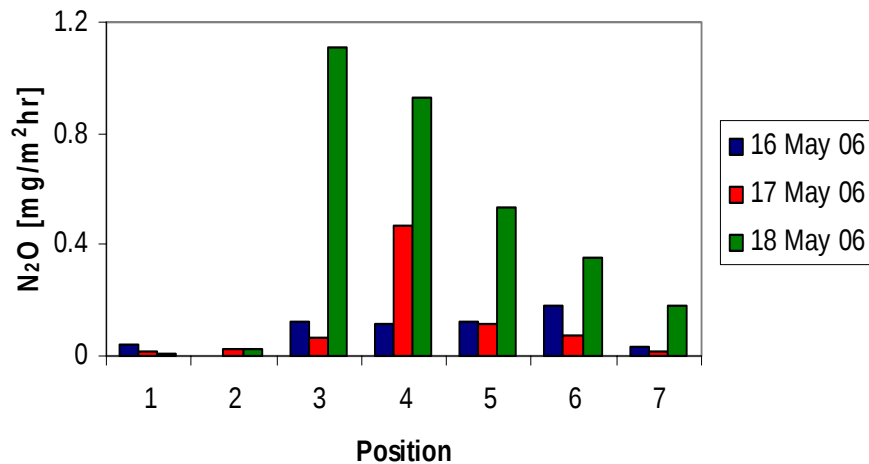
N_2O profile



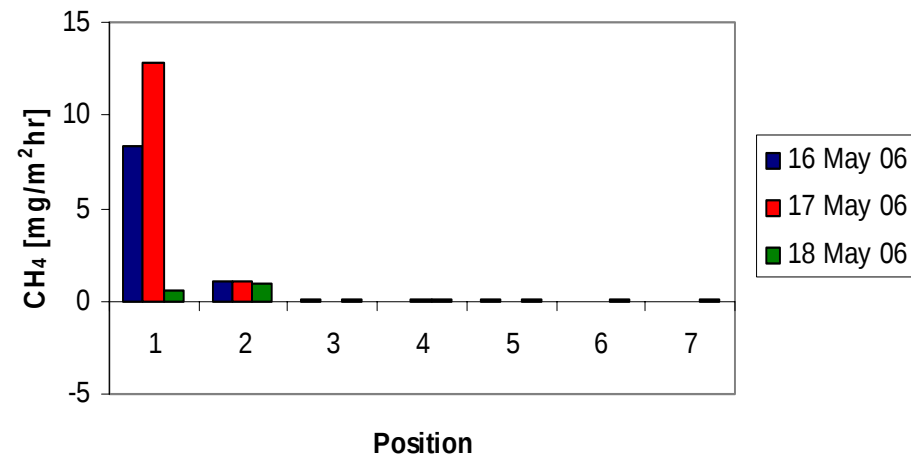
$$F_c = h \frac{dC}{dt}$$

Problem description (5)

Space and temporal variability



Space and temporal variability



Disadvantage manual box measurements:

- Inaccuracy due to space and temporal variations
- Very labour intensive

Possible solutions (1)

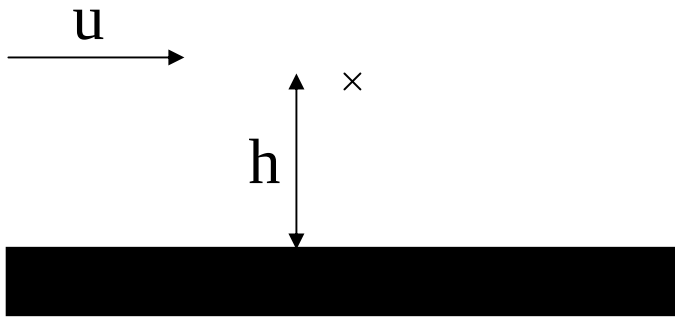
Automatic box measurements:

- Continuous flux values every 30 minutes
- Still no spatial variations included



Possible solutions (2)

Eddy covariance measurements

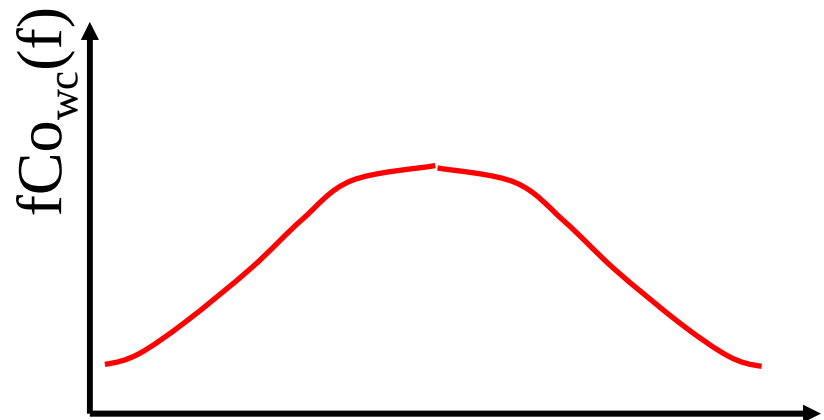


$$w(t) = \bar{w} + w'(t)$$

$$C(t) = \bar{C} + C'(t)$$

$$F_c = \frac{1}{T_a} \int w'(t)C'(t)dt$$

Co-spectrum (semi-log scale)



Possible solutions (3)

Requirements eddy covariance measurements:

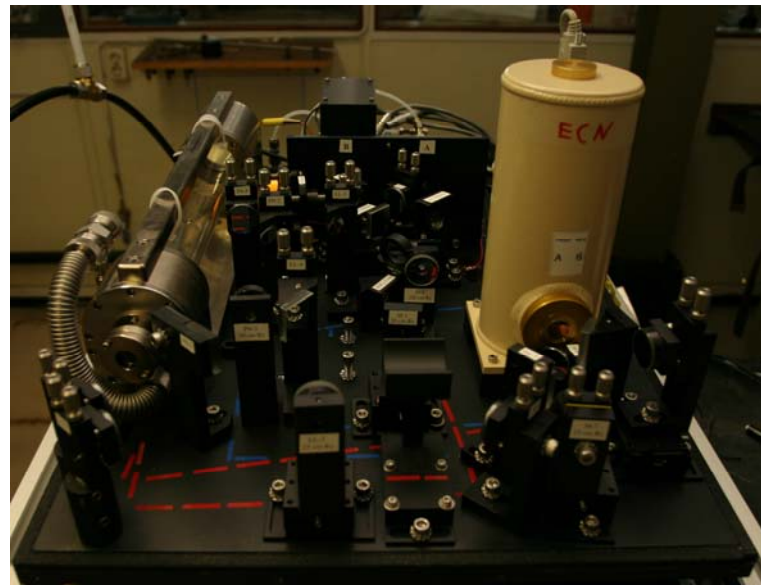
- Sampling frequency at least 10 Hz
- Stationair at least over 30 min
- Continuously running
- Sensitivity of 0.3 ppb and 1 ppb for N₂O (average 310 ppb) and CH₄ (average 1800 ppb)

Possible solutions (4)

Requirements eddy covariance measurements:

- Sampling frequency at least 10 Hz
- Stationair at least over 30 min
- Continuously running
- Sensitivity of 0.3 ppb and 1 ppb for N_2O (average 310 ppb) and CH_4 (average 1800 ppb)

Quantum cascade laser



Actual state (1)

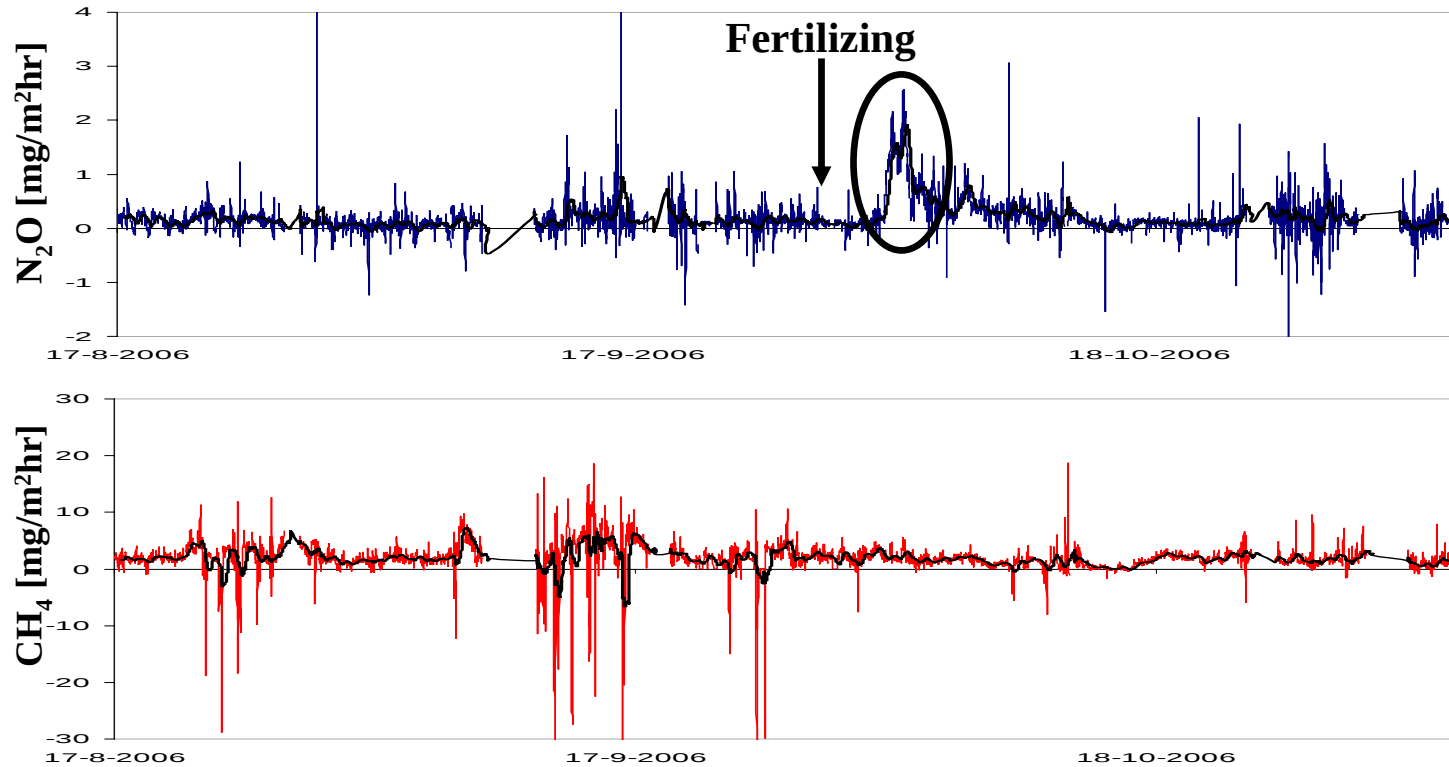
- Continuous automatic box measurements in Cabauw since June 2005 (coverage 61%)



- Continuous EC-measurements in Oukoop since August 2006 (coverage 87%)



Actual state (2)



Average emissions:

- $\text{N}_2\text{O} \rightarrow 0.20 \pm 0.36 \text{ mg/m}^2\text{hr}$
- $\text{CH}_4 \rightarrow 1.89 \pm 3.72 \text{ mg/m}^2\text{hr}$

Future focus

Quality of EC-measurements:

- Hot spots and bursts
- Instrumental drift
- Storage
- Coupling with box measurements

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