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Micrometeorological observations of CH_4 and N_2O at a managed fen meadow in the Netherlands

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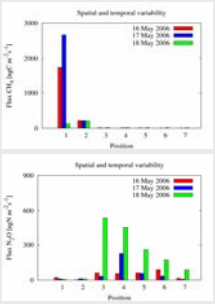
Introduction and aim

Global atmospheric concentrations of CO_2, CH_4 and N_2O have increased markedly as a result of human activities since 1750 (30%, 150% and 17% respectively). The increase of CH_4 is primarily due to agriculture (IPCC, 2007). Our research is part of the BSIK ME1 project that has its main focus on peat meadow ecosystems in the western part of the Netherlands. Since the 19th century these areas have been a strong net source of carbon dioxide as a result of increased peat oxidation caused by drainage. To understand the effect of natural changes and management on the GHG emission and uptake in the areas, an integral assessment of the GHG balance in these areas is required. In this part of the research, In this part of the research, high-frequency micrometeorological methods are used for estimating CH_4 and N_2O exchanges from a managed fen meadow in the Netherlands. High-frequency micrometeorological methods are a good option to obtain integrated emission estimates on a hectare scale that also has continuous coverage.

Example: Spatial and temporal variations measured by chamber



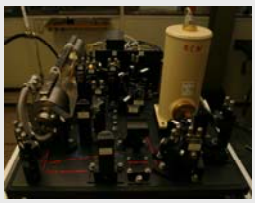
Site description and Methods

The Oukoop site is an intensively managed dairy farm near the town of Reeuwijk in the central part of the Netherlands (52º01'15" N, 4º01'17" E). The surrounding area of the measurement location has soil consisting of a clayey peat. Rye grass is the most dominate grass species with rough bluegrass often co-dominant. The climate is temperate and wet, with an average temperature of 10.3ºC and an average annual precipitation of 870mm in 2004 and 2005 (Veenendaal et al., 2007). Manure and fertilizing are applied from February to September. Manure and artificial fertilizing application were about 253kgNha^{-1}yr^{-1} and 84kgNha^{-1}yr^{-1} in 2006.

Eddy covariance measurements of CH_4 and N_2O had been performed continuously from August 17th to November 6th 2006. The measurement height was 3m and the mast was positioned in the middle of the field. Wind speed, air temperature, CH_4 and N_2O were measured using a system consisting of a sonic anemometer (model R3, Gill Instruments) and a quantum cascade laser spectrometer (model QCL-TILDAS-76, Aerodyne Research Inc.).

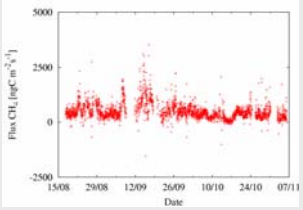
A sampling frequency of 10Hz and a precision of 2.6 and 0.3 ppb Hz$^{-1/2}$ was obtained for CH_4 and N_2O, respectively. Laser drift was removed using a 120s running mean.

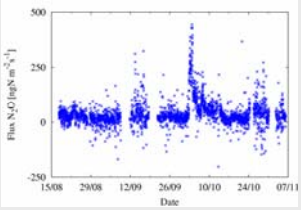
Sonic anemometer (left) and quantum cascade laser spectrometer (right)



Results

In general the measurements for both CH_4 and N_2O show a net emission. About 97% and 86% of all flux values are positive for CH_4 and N_2O, respectively. The high positive peaks were clearly related to cow manure application.





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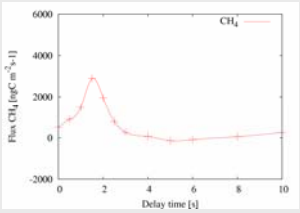
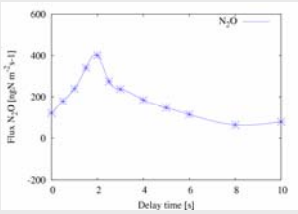
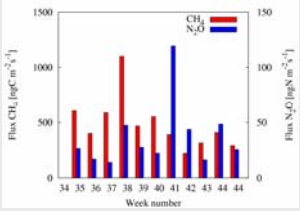
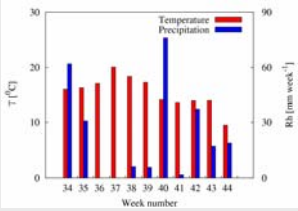




The reliability of the fluxes was checked using correlation versus delay time plots. These correlation plots suggested that these fluxes were well defined. The highest CH_4 week average occurred in the week, in which cow manure was applied. An amount of 55kgNha-1 cow manure was applied on 14 September 2006 (week 37). However, the highest N_2O week average took place in week 40 after a large amount of precipitation.





The average fluxes and their standard deviations were 0.48±0.38µgCm^{-2}s^{-1} (2.32±1.80mgm^{-2}hr^{-1}) and 0.04±0.06µgNm^{-2}s^{-1} (0.22±0.35mgm^{-2}hr^{-1}).

Conclusions

- The system was able to run continuously using an automatic liquid nitrogen filling system.
- The dairy farm site was a net source, however, also uptake seemed to occur in short events lasting a few hours.
- The N_2O peak, which was strongly correlated to precipitation, occurred about three weeks after fertilizing.
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Further reading: 'Suitability of quantum cascade laser spectrometry for CH_4 and N_2O eddy covariance measurements' (Kroon et al., submitted)