EMS Annual Meeting Abstracts,
Vol. 6, EMS2009-42, 2009
9th EMS / 9th ECAM

9th European Conference on Applications of Meteorology
9th EMS Annual Meeting
High resolution meteorology - applications and services

Up-scaling methods of greenhouse gas fluxes between the soil and the atmosphere using a measuring tunnel as well as open-path measurement techniques for the flux-gradient method

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For up-scaling the emissions of N2O, CO2 and CH4 (GHG) from arable field soils a measuring tunnel for controlled enrichment of released gases was installed at the soil surface covering an area of 495 or 306 m2. The concentrations of GHG and humidity were measured by the path-averaging, multi-component Fourier Transform Infrared (FTIR) absorption spectrometry at an open path of 100 m length across the whole measuring tunnel. During a 2-years-time frame the N2O fluxes between the soil and the atmosphere at the agricultural field varied between 1.0 and 21 μg N2O-N m-2 h-1. These results were compared with N2O emission rates that were simultaneously measured with a conventional closed chamber technique. The resulting N2O fluxes between the soil and the atmosphere of both methods had the same order of magnitude. However, we found an extreme spatial variability of N2O fluxes at the scale of the closed chambers. The hypothesis that an enlargement of the measured soil surface area is an appropriate measure to avoid the problems of up-scaling results of small scale chamber measurements was confirmed by the results obtained with the measuring tunnel.

Currently, a non-intrusive emission and flux measurement method at a scale from 100 m up to. 27.000 m2 on the basis of the flux-gradient method (0.50 and 2.70 m height above surface) is developed and tested by means of open-path multi-component measurement methods (FTIR, GHG) and area averaging meteorological measurements (determination of horizontal winds, friction velocity using acoustic tomography). Two campaigns in October 2007 and June 2008 were performed with this new methodology when wind speeds were low. Due to the very low wind speeds and insufficient turbulence for the application of the usual flux-gradient method a new concept introducing the viscosity instead of stability corrections was developed. It requires a direct measurement of the friction velocity and the vertical gradient of the horizontal wind speeds by ultra-sonic anemometers. The mean results of this measurement method during both campaigns and the measuring tunnel results differ by about 25 % to the mean measuring tunnel results. The calculated single values on the basis of 10-minutes-mean data varied from 2 up to 42 μg N2O-N m-2 h-1.