AIR CHEMISTRY MEETS BIOLOGY - AIRBORNE MEASUREMENTS OF CO_2 AND H_2O FLUXES OVER A HETEROGENOUES LAND SURFACE

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We present results from an airborne experiment designed to investigate the regional carbon dioxide budget and an attempt of relating local fluxes to underlying biological surface structures and anthropogenic emission sources.

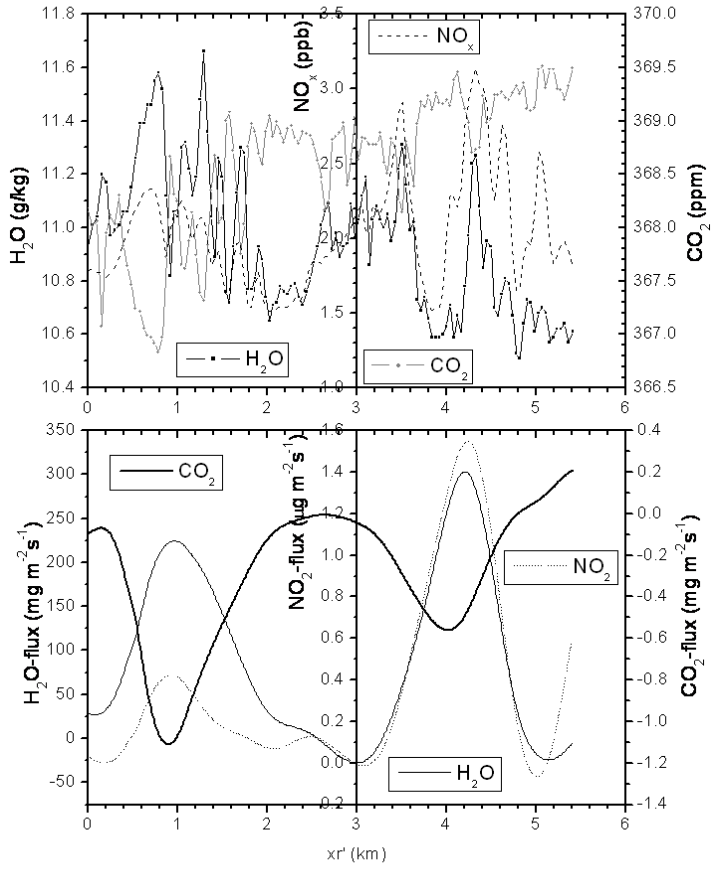

Fig.1 concentrations (a) and fluxes (b) of CO_2 , H_2O and NO_2 100 m above ground along a 6 km long flight track over the Jülicher Börde. Fluxes are filtered with a cutoff distance of 400 m.

We investigated the impact of local surface inhomogeneities on the spatial and temporal distribution of trace gases in the near surface boundary layer during an airborne observation campaign in August 2004. Atmospheric concentrations of H_2O and CO_2 as well as several meteorological parameters were recorded with high spatial and temporal resolution over the heterogeneous, intensively managed farmland of the Jülicher Börde. A hyperspectral sensor and a high speed video camera were deployed in downward-looking mode in order to quantify coverage and biological activity of the vegetation below the aircraft. Additionally trace gases (CO, NO, NO_2, NO_y, PAN, O_3) as well as aerosols have been measured in parallel.

CO_2 and H_2O show pronounced small scale structures, both in the mixing ratios and in the fluxes (Fig. 1). The anti correlation between CO_2 and H_2O fluxes suggest that the fluxes are due to biological activity, i.e., photosynthesis and transpiration. The results suggest too that vegetation structures with a size of 500 meters can be identified in their contributions to the local CO_2 and H_2O budget. The highest CO_2 flux along the flight path are produced by a small natural preserve area with a poplar stand, whereas the areas covered by sugar beats seem to have substantially smaller CO_2 and H_2O fluxes (Fig.2). This will be further

investigated from simultaneous surface measurements of the CO_2 uptake and water vapour conductance.

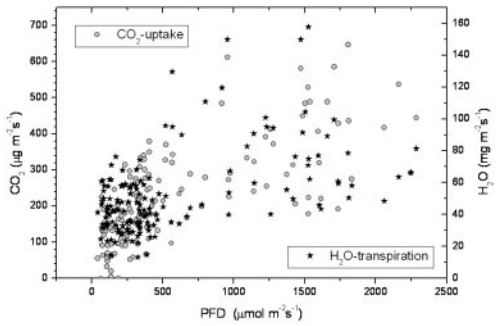

Fig.2 Photosynthetic uptake of CO_2 and transpiration by sugar beat leafs underneath the flight tracks (a LAI of 4 has been assumed)

The airborne measurements of CO and NO_x proved extremely valuable for eliminating structures imposed on the CO_2 field by anthropogenic emission sources. The influence of traffic emissions from a business district and a motorway south of the area was clearly identified by the pronounced positive NO_x fluxes in the southern part of the experimental area (Fig. 1). Using the NO_x/CO_2 emission ratios taken from emission inventories for the experimental area the contribution to the overall CO_2 budget can be quantified. Road traffic represents about 95% of the total NO_x emissions in this area according to the emission inventory.
The large coal-fired power plant Weisweiler, located upwind of the measuring area, was intercepted several times during the campaign causing strong enhancements in CO_2, CO and NO_x. From the slope of the correlation of data collected in the plume (see Fig. 3), the average CO/CO_2 emission ratio is estimated to 0.65 ppb/ppm, which is in good agreement with the ratio of 0.6 ppb/ppm calculated from the reported emissions of the power plant. Other industrial sources were detected occasionally, but their influence on the measured concentrations was generally small

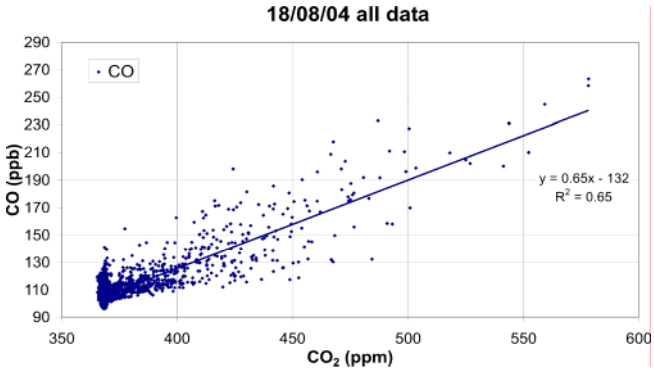

Fig. 3: Relation of CO to CO_2 in the plume of the power plant Weisweiler

The combination of airborne flux measurements and high resolution emission inventory will provide information on the contributions of different anthropogenic sources to the CO_2 budget and will hence allow a better assessment of the exchange fluxes with the biosphere.