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Application of Relaxed Eddy Accumulation (REA) method to estimate CO_2 and CH_4 surface fluxes in the city of Krakow, southern Poland.

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There is a growing interest in the recent years in studies aimed at quantifying carbon cycling in urban centres. Worldwide migration of human population from rural to urban areas and corresponding growth of extensive urban agglomerations and megacities leads to intensification of anthropogenic emissions of carbon and strong disruption of natural carbon cycle on these areas. Therefore, a deeper understanding of the carbon "metabolism" of such regions is required. Apart of better quantification of surface carbon fluxes, also a thorough understanding of the functioning of biosphere under strong anthropogenic influence is needed.

Nowadays, covariance methods are widely applied for studying gas exchange between the atmosphere and the Earth's surface. Relaxed Eddy Accumulation method (REA), combined with the CO_2 and CH_4 CRDS analyser allows simultaneous measurements of surface fluxes of carbon dioxide and methane within the chosen footprint of the detection system, thus making possible thorough characterisation of the overall exchange of those gases between the atmosphere and the urban surface across diverse spatial and temporal scales.

Here we present preliminary results of the study aimed at quantifying surface fluxes of CO_2 and CH_4 in Krakow, southern Poland. The REA system for CO_2 and CH_4 flux measurements has been installed on top of a 20m high tower mounted on the roof of the faculty building, close to the city centre of Krakow. The sensors were installed ca 42 m above the local ground. Gill Windmaster-Pro sonic anemometer was coupled with self-made system, designed by the Poznan University of Life Sciences, Poland, for collecting air samples in two pairs of 10-liter Tedlar bags, and with Picarro G2101-i CRDS analyser. The air was collected in 30-min intervals. The CO_2 and CH_4 mixing ratios in these cumulative downdraft and updraft air samples were determined by the CRDS analyser after each sampling interval. Based on the measured mixing ratios difference and the vertical wind component, the variability of the mean surface fluxes of CO_2 and CH_4 was quantified. In case of CO_2 flux, a typical diurnal pattern with the maximum values of around 30 mmol m^{-2} h^{-1} occurring during night hours and the minimum values, around -40 mmol m^{-2} h^{-1}, occurring early afternoon was observed during sunny days ("plus" and "minus" signs mark upward and downward fluxes, respectively). In addition, some events with much higher fluxes (up to 100 mmol m^{-2} h^{-1}) were observed, mainly during rush hours. Temporal variability of methane flux turned out to be much higher than that observed for CO_2. During summer, it varied from approximately -100 to +500 μmol m^{-2} h^{-1}, with the mean value of around +100 μmol m^{-2} h^{-1} and maximum values occurring predominantly during daytime. In addition to flux measurements, an attempt was made to characterize also the isotopic signature of carbon in the CO_2 flux components measured with the aid of REA method. The results showed that the precision of $\delta^{13}CO_2$ measurements performed with Picarro analyser was not sufficient to differentiate the isotopic signatures of upward and downward CO_2 fluxes.

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