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Carbon dioxide and methane emission dynamics in central London (UK)

Carole Helfter (1), Eiko Nemitz (1), Janet F. Barlow (2), and Curtis R. Wood (3)

(1) Centre for Ecology and Hydrology, Penicuik, United Kingdom , (2) Department of Meteorology, University of Reading, Reading, United Kingdom , (3) Finnish Meteorological Institute, Helsinki, Finland

London, with a population of 8.2 million, is the largest city in Europe. It is heavily built-up (typically 8% vegetation cover within the central boroughs) and boasts some of the busiest arteries in Europe despite efforts to reduce traffic in the city centre with the introduction of a congestion charging scheme in 2007. We report on two substantial pollution monitoring efforts in the heart of London between October 2006 and present.
Fluxes of carbon dioxide (CO_2) and water (H_2O) were measured continuously by eddy-covariance in central London from October 2006 until May 2008 from a 190 m telecommunication tower (BT tower; 51º 31' 17.4" N 0º 8' 20.04" W). The eddy-covariance system consisted of a Gill R3-50 ultrasonic anemometer operated at 20 Hz and a LI-COR 6262 infrared gas analyser. Air was sampled 0.3 m below the sensor head of the ultrasonic anemometer - which was itself mounted on a 3 m mast to the top of a 15 m lattice tower situated on the roof of the tower (instrument head at 190 m above street level) - and pulled down 45 m of 12.7 mm OD Teflon tubing. In addition, meteorological variables (temperature, relative humidity, pressure, precipitation, wind speed and direction) were also measured with a multi-sensor (Weather Transmitter WXT510, Vaisala). Eddy-covariance measurements at the BT tower location were reinstated in July 2011 and include methane (CH4), CO_2 and H_2O concentrations measured by a Picarro fast methane analyser (G2301-f).
CO_2 emissions were found to be mainly controlled by fossil fuel combustion (e.g. traffic, commercial and domestic heating). Diurnal averages of CO_2 fluxes were found to be highly correlated to traffic. However changes in heating-related natural gas consumption and, to a lesser extent, photosynthetic activity in two large city centre green spaces (Hyde Park and Regent's Park) explained the seasonal variability. Annual estimates of net exchange of CO_2 obtained by eddy-covariance agreed well with up-scaled data from the UK National Atmospheric Emissions Inventory (NAEI) for the flux footprint estimated using a simple Kormann-Meixner model. Methane emissions from central London exhibit diurnal trends both for concentrations and fluxes. The former is consistent with cycles of growth and shrinkage of the urban boundary layer. Methane fluxes are strongly correlated with those of carbon dioxide. Work is ongoing to establish to what extent the diurnal cycles reflect dynamic changes in ground sources (emissions from road traffic, commercial/ domestic heating, variations in flux footprint) and to what extent they are affected by transport efficiency between street level and the top of the tower and storage in between, given the high measurement height.