N_2O fluxes from the city of Edinburgh

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Introduction

Nitrous oxide (N_2O) is the third largest greenhouse gas contributor to overall global warming, behind carbon dioxide and methane. Agricultural activities contribute to the 65% of the production of human-related nitrous oxide, whereas lower levels of emissions arise from industrial processes, combustion processes in the power generation sector and from road transport. Direct measurements of nitrous oxide emissions from urban environments are required to provide better estimates for the N_2O emission factors databases (e.g. NAEI).

Site, materials and methods

Fig.1 Arrangement of the inlet lines close to the ultrasonic anemometer (PTFE for the gases: N_2O, CO_2, H_2O, VOCs, copper tube for aerosols).

A fast response ultrasonic anemometer (Fig.1) was mounted on a 2.5-m mast fixed to the upwind edge (for the preferred westerly airflow) on top of the external wall of Nelson Monument (Fig.2), situated on Calton Hill, approximately 65 m above the street level near the Edinburgh city centre during November 2005. The measurements were taken in parallel to other gases (O_3, VOCs, CO_2, CO, NH_3) and aerosol and particles in November 2005.

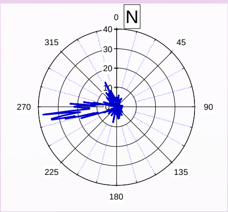


Fig.2 Above:The Nelson monument, on Calton hill in Edinburgh.

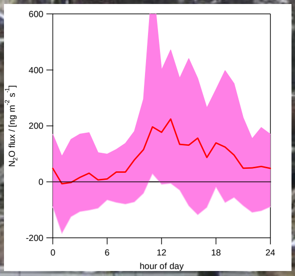
Left: The wind rose from the top of the tower, showing westerly airflow being the dominant flow.

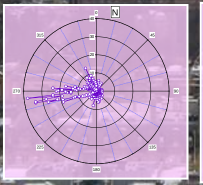
The N_2O concentration was measured by a TDL (Tunable Diode Laser Absorption Spectrometer, Aerodyne Research Inc., see picture above): the system was operated at a frequency of 5 to 7 Hz, and the air sample was pulled through an inlet line to the sonic anemometer.

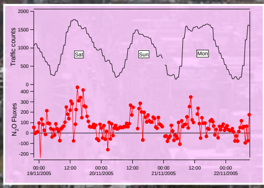
The fluxes were measured by the ***eddy covariance*** method, according to which the flux of a scalar *C* can be written as:

$$F_C = \overline{C'w'}$$

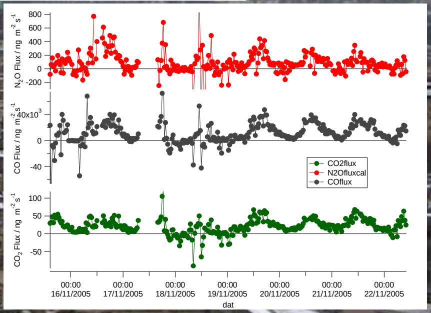
N_2O related to CO and CO_2 emissions and traffic







	N_2O Flux [ng m^{-2} s^{-1}]	N_2O Conc [ppbV]
MEAN	91.7	359.90
STD DEV	116.20	18.04
MIN	-241.70	306.50
MAX	438.80	455.70

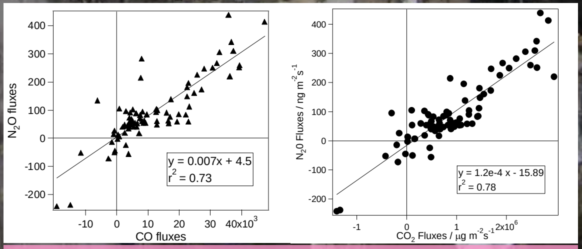


The fluxes show a daily cycle of emission for N_2O, with a peak in the early afternoon, following the dynamics of the boundary layer mixing, as in the case of CO and CO_2. From the statistics shown in the table above, it is evident the concentration level is 40ppbV circa above the background level, and the fluxes are comparable to N_2O emission following fertiliser application on agricultural land.

Discussion

Eddy covariance measurements of N_2O fluxes above the city of Edinburgh were conducted in parallel to other gaseous species and aerosol flux measurements during autumn '05. The data show good agreement between the fluxes of N_2O with respect to CO and CO_2. These measurements allow to assess the impact of combustion in terms of transport and heating at the urban scale.

Further work is required to complete the flux spectral analysis and with regard to stationarity, and to explore further possible relations with the other investigated chemical compounds.



The UK National Atmospheric Emissions Inventory (NAEI) implied relative emission ratios: the average values compare well with the relative emission factors from the scatter plots of N_2O with CO and CO_2.

	N_2O/CO_2	CO/CO_2	N_2O/CO
Petrol Catalytic Urban	$2.2\ 10^{-4}$	0.0062	0.035484
Diesel cars Urban	$1.7\ 10^{-4}$	0.0012	0.141667
Petrol non catalytic Urban	$2.7\ 10^{-5}$	0.054	0.005
Diesel HGV Urban	$2.4\ 10^{-5}$	0.0021	0.011429

References

E. Nemitz, K.J. Hargreaves, A. G. McDonald, J. Dorsey and D. Fowler, 2002, "Micrometeorological measurements of the urban heat budget and CO_2 emissions on a city scale" Environ. Sci. Technol., 36, 3139-3146.

Acknowledgments

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