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Low-cost Sensor Networks for Improving Understanding of Urban Air Pollution

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High-frequency measurements of nitrogen monoxide (NO), nitrogen dioxide (NO_2) and carbon monoxide (CO) were made using a dense network of electrochemical sensors at urban sites in Cambridge from March – June 2011, with the aim to improve understanding of the behaviour of these species on fine spatial and temporal scales.

E.U. legislation has set target levels for gases thought to have adverse impacts on human health, and consequently led to a need for a more informed air pollution control policy. With many sites in the U.K. and in the rest of the E.U. still failing to meet annual targets for NO_2, a need to better understand pollutant sources and behaviour has arisen. Whilst traditional chemiluminescence techniques used by local authorities to measure NO_x provide great accuracy, the instrumentation is expensive and difficult to deploy on a dense spatial scale.

The ability of low-cost, portable devices, incorporating electrochemical sensors to measure gases such as CO, NO and NO_2 at ambient concentrations, with GPS and GPRS facilities for positioning and data transmission, has been demonstrated by deployments in urban areas including London, Valencia, Kuala Lumpur and Lagos. Tests in the laboratory against gas standards at parts-per-billion levels have shown high sensitivity of the sensors to their respective target gases. Moreover, co-locations in the field with chemiluminescence and spectroscopic instruments have demonstrated good agreement. The degree of variability in concentrations of the pollutants, on both spatial and temporal scales, has been highlighted in the various mobile sensor campaigns, exposing the limitations of a sparsely populated static network in an urban centre.

The technology described was extended to establish a dense urban network of autonomous static units, capable of capturing data with high temporal resolution for several months. Preliminary results highlight the importance of meteorology, traffic and street architecture on the levels of pollutants observed. Bivariate polar plots are one type of tool being used to analyse the data, with the potential to distinguish local and long-range sources from each other, and to indicate where street canyon recirculation may be occurring.

Future work will include use of the same static units for an intensive three month collaboration in London, leading to comparison of data with model results and thus indicating the effectiveness of part-pedestrianisation of a busy street on mitigating the poor air quality. Installation of a network of sensors in the grounds of a major international airport for up to a year will enable source attribution studies to be carried out on a finer spatial and temporal scale than has been possible before, and allow future air quality modelling to be carried out more accurately. Furthermore, improved understanding of the atmospheric science in the vicinity of the airport will mean that more informed planning decisions can be made in order to ensure that future airport operations are conducted whilst conforming to acceptable environmental standards.