

## Laboratory and field experiments to assess the potential of low cost gas sensors for atmospheric chemistry research and monitoring.

Katie Smith,<sup>1</sup> Pete Edwards,<sup>1</sup> and Alastair C Lewis<sup>1</sup>

<sup>1</sup> Wolfson Atmospheric Chemistry Laboratories, Department of Chemistry, University of York, York, UK

The public are becoming increasingly aware of the health risks associated with air pollution and this is putting pressure on local authorities to provide monitoring data that more directly relates to personal exposure. This requires an economically viable method for monitoring local air quality at a much higher spatial density than current monitoring networks. Such a technology would also provide researchers with an insightful tool to examine our understanding of atmospheric processes and effects of policy interventions on air quality. The extreme complexity of the atmosphere, and low ambient concentrations of the target molecules, places constraints on the observational techniques that can be used. Low-cost sensors have been proposed as a potential solution to this and there are many examples where sensors have already been commercialized and sold to the public. However, within the realm of atmospheric science little has been done to understand the sensitivity, selectivity and overall performance of these devices.

Metal oxide (MO) sensors are one type of very low-cost gas sensor (<£10) capable of detecting gaseous compounds that adsorb to their active MO surface, causing a change in the resistivity of this surface. These sensors exhibit a fast-response to changing concentrations of common atmospheric pollutants, however the sensitivity and selectivity of the sensors is not well understood. Problems such as long term degradation and cross-interference with other prevalent atmospheric gases make selectivity and quantification of compounds difficult. We present data from extensive laboratory and field experiments that take a methodical approach to calibrating these sensors for individual and multicomponent atmospheric mixtures to establish the true capabilities of these sensors. These experiments show significant cross sensitivities which would impact their use as ambient pollution monitors. We also find that a single deployed sensor gives highly variable measurements, but the use of multiple co-located sensors significantly improves the quality and reproducibility of observations. Complex statistical analysis on the sensor data, combined with a supervised machine learning approach shows promise in determining the relationships between interference gases and extracting more accurately individual pollutant concentrations.