6.011 Enabling the use of low cost air quality sensors for atmospheric chemistry research.

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Abstract:

Low cost air quality sensors have been widely publicized, in principle offering increased information on the spatial and temporal variability of important chemical species and potentially a paradigm shift in air pollution monitoring. Despite multiple ‘citizen science' applications of air quality sensors, uptake of these technologies by the ‘academic’ atmospheric science community has been slow due to concerns over selectivity, sensitivity, accuracy, precision and temporal response. We report a range of laboratory and field studies of commonly-used sensors. In the laboratory we undertook a multicomponent calibration, exposing sensors to a mixture of gases at concentrations typical of an urban environment. We show a number of cross-interferences between the stated sensor analyte and the other species in the calibration mix, several of which would dominate sensor signals under typical city conditions. In field tests we ran twenty identical commercial sensor packages alongside standard regulatory instruments in a suburban environment over a period of three weeks. This experiment highlighted significant issues with sensor-to-sensor variability, as well as with signal response to target molecules for certain sensors.

We conclude that there are significant hurdles to be over come if the current generation of low-cost air quality sensors are to be used for research or regulatory purposes. However, our results also indicate that there may be routes forward. We show that for some sensors, the median signal from an ensemble of sensors provides a significantly better estimate of the target pollutant concentration than any sensor. We also show that although not necessarily orthogonal, different sensors measure different properties of the atmosphere. Thus an instrument composed of an ensemble of multiple different sensors coupled to an appropriate calibration methodology and statistical model may allow the creation of low cost sensor systems for measuring the concentration of some atmospheric pollutants.