Reliable data from low cost ozone sensors in a hierarchical network

Abstract

We demonstrate how a hierarchical network comprising a number of compliant reference stations and a much larger number of low-cost sensors can deliver reliable high temporal-resolution ozone data at neighbourhood scales. The framework, demonstrated originally for a smaller scale regional network deployed in the Lower Fraser Valley, BC was tested and refined using two much more extensive networks of gas-sensitive semiconductor-based (GSS) sensors deployed at neighbourhood scales in Los Angeles: one of ~20 and one of ~45 GSS ozone sensors. Of these, ten sensors were co-located with different regulatory measurement stations, allowing a rigorous test of the accuracy of the algorithms used for off-site calibration and adjustment of low cost sensors. The method is based on adjusting the gain and offset of the low-cost sensor to match the first two moments of the probability distribution of the sensor result to that of a proxy: a calibrated independent measurement (usually derived from regulatory monitors) whose probability distribution evaluated over a time that emphasizes diurnal variations is similar to that at the test location. The regulatory measurement station physically closest to the low-cost sensor was a good proxy for most sites. The algorithms developed were successful in detecting and correcting sensor drift, and in identifying locations where geographical features resulted in significantly different patterns of ozone variation due to the relative dominance of different dispersion, emission and chemical processes. The entire network results show very large variations in ozone concentration that take place on short time- and distance scales across the Los-Angeles region. Such patterns were not captured by the more sparsely distributed stations of the existing regulatory network and demonstrate the need for reliable data from dense networks of monitors.