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Speciated VOC to CO Ratios in Global Megacities: towards a model emission inventory parameterization

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As of 2007 over half of the world's population live in urban areas. Urban air pollution is an issue in most megacities, which are loosely defined as urban areas with populations of 10 million or more. A recent modelling study showed that while megacities in Asia are concentrated into approximately 2% of the land area, they emit 10-15% of total anthropogenic emissions in Asia and contain 30% of the Asian population, therefore exerting a disproportionate impact on human health. The largest source of emissions in most megacities and urban conglomerations is vehicular-related emissions.
Anthropogenic volatile organic compounds (VOCs), carbon monoxide (CO), and nitrogen oxides (NOx) are important precursor compounds to ozone and secondary organic aerosol formation and are emitted largely from vehicles in urban areas. Elevated levels of ozone, which are harmful to human health, have been observed in many urban areas and megacities. Quantifying ozone precursors and being able to model them accurately to derive the impact of emissions changes is important for policy-makers and the improvement of air quality. Certain VOCs are very reactive in the atmosphere (e.g., xylenes and benzene compounds) and therefore have very high potential for ozone and SOA formation; accurate modelling of the individual VOCs will lead to better predictions of SOA formation and ozone levels.
Using speciated volatile organic compound (VOC) and carbon monoxide (CO) measurements from the Marylebone Road, a kerbside site in central London from 1998 to 2009 a number of statistical analyses have been undertaken to investigate the long-term trends in the data and the VOC to CO ratios. Long-term trends show decreases by a factor of four for the VOCs and a factor of three for the CO over the measurement period. Although significant decreases in concentration were observed the fractional contribution of the individual VOCs to the total remained similar. Over the same period VOC to CO ratios for London remained steady an indication that emissions reduction measures affected all the measured compounds equally. A comparison of VOC to CO ratios was undertaken for London and other global megacities. Remarkably similar ratios were found for all cities in developed countries. Since megacity emissions are typically dominated by vehicular emissions, the dominant source of VOCs and CO in most urban areas, it is suggested that given the similarity of VOC to CO ratios in these cities, the ratios could be used to constrain and thereby improve VOC representation in regional/global models for urban areas.