Geophysical Research Abstracts
Vol. 18, EGU2016-8112, 2016
EGU General Assembly 2016

Allometric scaling of UK urban emissions: interpretation and implications for air quality management

Rob MacKenzie (1), Matt Barnes (2), Duncan Whyatt (2), and Nick Hewitt (2)

(1) Birmingham Institute of Forest Research, Earth Sciences Building, University of Birmingham, Birmingham B15 2TT, UK, (2) Lancaster Environment Centre, Lancaster University, Lancaster LA1 4YQ, UK

Allometry uncovers structures and patterns by relating the characteristics of complex systems to a measure of scale. We present an allometric analysis of air quality for UK urban settlements, beginning with emissions and moving on to consider air concentrations. We consider both airshed-average 'urban background' concentrations (cf. those derived from satellites for NO_2) and local pollution 'hotspots'.

We show that there is a strong and robust scaling (with respect to population) of the non-point-source emissions of the greenhouse gases carbon dioxide and methane, as well as the toxic pollutants nitrogen dioxide, PM2.5, and 1,3-butadiene. The scaling of traffic-related emissions is not simply a reflection of road length, but rather results from the socio-economic patterning of road-use. The recent controversy regarding diesel vehicle emissions is germane to our study but does not affect our overall conclusions.

We next develop an hypothesis for the population-scaling of airshed-average air concentrations, with which we demonstrate that, although average air quality is expected to be worse in large urban centres compared to small urban centres, the overall effect is an economy of scale (i.e. large cities reduce the overall burden of emissions compared to the same population spread over many smaller urban settlements). Our hypothesis explains satellite-derived observations of airshed-average urban NO_2 concentrations.

The theory derived also explains which properties of nature-based solutions (urban greening) can make a significant contribution at city scale, and points to a hitherto unforeseen opportunity to make large cities cleaner than smaller cities in absolute terms with respect to their airshed-average pollutant concentration.