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Measurements of in situ chemical ozone (oxidant) production rates

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Tropospheric ozone is a major air pollutant, harmful to human health, agricultural crops and vegetation, the main precursor to the atmospheric oxidants which initiate the degradation of most reactive gases emitted to the atmosphere, and an important greenhouse gas in its own right. The capacity to understand and predict tropospheric ozone levels is a key goal for atmospheric science – but one which is challenging, as ozone is formed in the atmosphere from the complex oxidation of VOCs in the presence of NO_x and sunlight, on a timescale such that in situ chemical processes, deposition and transport all affect ozone levels. Known uncertainties in emissions, chemistry, dynamics and deposition affect the accuracy of predictions of current and future ozone levels, and hinder development of optimal air quality policies to mitigate against ozone exposure.

Recently new approaches to directly measure the local chemical ozone production rate, bypassing the many uncertainties in emissions and chemical schemes, have been developed (Cazorla & Brune, AMT 2010). Here, we describe the development of an analogous Ozone Production Rate (OPR) approach: Air is sampled into parallel reactors, within which ozone formation either occurs as in the ambient atmosphere, or is suppressed. Comparisons of ozone levels exiting a pair of such reactors determines the net chemical oxidant production rate, after correction for perturbation of the NO_x-O_3 photochemical steady state, and when operated under conditions such that wall effects are minimised.

We report preliminary measurements of local chemical ozone production made during the UK NERC ClearfLo (Clean Air for London) campaign at an urban background location in London in January and July 2012. The OPR system was used to measure the local chemical oxidant formation rate, which is compared with observed trends in O_3 and NO_x and the prevailing meteorology, and with the predictions of a detailed zero-dimensional atmospheric chemistry model, constrained by observations of long-lived species.