Evaluation of a methodology for ozone production rate quantification in ambient air

GOUFRANE ABICHOU[1], AHMAD LAHIB[1], MARINA JAMAR[1], WEIDONG CHEN[2], HENDRIK FUCHS[3], ANNA NOVELLI[3], MICHELLE FÄRBER[3], ALEXANDRE TOMAS[1] AND SÉBASTIEN DUSANTER[1]

[1]IMT Nord Europe
[2]Université du Littoral Côte d'Opale
[3]Institute of Energy and Climate Research, Forschungszentrum Jülich GmbH

Presenting Author: ghoufrane.abichou@imt-nord-europe.fr

Ozone (O_3) is a major secondary air pollutant, produced by a complex series of photochemical reactions from primary precursors, including nitrogen oxides ($NO_x = NO + NO_2$) and volatile organic compounds (VOCs). In the troposphere, ozone affects both global climate change and air quality, O_3 being the third most important greenhouse gas whose exposition to leads to detrimental effects for various life forms. Although long-term measurements of ozone are crucial to investigate future trends in air quality and climate change, the dependence of ozone on local chemistry, long-distance transport, vertical mixing and deposition processes poses certain limits to test atmospheric models, and ultimately to inform policy makers. Measuring ozone production rates, $P(O_3)$, and ozone concentrations simultaneously allows a detailed analysis of the above-mentioned O_3-driving processes and allow a critical evaluation of the chemical production process. Indeed, contrasting $P(O_3)$ values measured under different VOC/NO_x conditions can help in the identification of the ozone formation regime at a monitoring site, i.e. distinguishing between NOx-limited and NOx-saturated regimes, which in turn can help in the design of ozone control strategies.

The $P(O_3)$ quantification methodology tested in this work requires measurements of both peroxy radicals and nitrogen monoxide (NO) at the monitoring site. The gross ozone production rate is computed as the reaction rate between peroxy radicals and NO. In the present work, we report the quantification of $P(O_3)$ from the coupling of a chemical amplifier capable of measuring peroxy radicals and a NO_x trace analyzer to simulation chambers. Ozone production experiments were performed using different mixing ratios of VOCs and NO_x to contrast $P(O_3)$ values inferred from peroxy radical and NO measurements to values derived from observed O_x (O_3+NO_2) changes in the chamber. In this presentation, we discuss how ozone production changes with the nature of VOC and the quantity of NO added in the chamber, focusing on evaluating the accuracy of this methodology. The ability to infer the ozone production regime is also discussed.