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Development of a portable instrument to measure ozone production rates in the troposphere

Sofia Sklaveniti (1,2), Nadine Locoge (1), Philip Stevens (2), Vinod Kumar (3), Vinayak Sinha (3), Sébastien Dusanter (1,2)

(1) Mines Douai, Sciences de l'Atmosphère et Génie de l'Environnement, F-59508 Douai, France, (2) School of Public and Environmental Affairs, Indiana University, Bloomington, IN, US, (3) Department of Earth and Environmental Sciences, Indian Institute of Science Education and Research Mohali, Sector 81, S. A. S. Nagar, Manauli PO, Punjab 140306, India

Ground-level ozone is a key species related to air pollution, causing respiratory problems, damaging crops and forests, and affecting the climate. Our current understanding of the tropospheric ozone–forming chemistry indicates that net ozone production occurs via reactions of peroxy radicals (HO_2+RO_2) with NO producing NO_2, whose photolysis leads to O_3 formation. Production rates of tropospheric ozone, $P(O_3)$, depend on concentrations of oxides of nitrogen ($NO_x = NO + NO_2$) and Volatile Organic Compounds ($VOCs$), but also on production rates of RO_x radicals ($OH + HO_2 + RO_2$). The formation of ozone follows a complex nonlinear chemistry that makes strategies for reducing ozone difficult to implement. In this context, atmospheric chemistry models are used to develop emission regulations, but there are still uncertainties associated with the chemical mechanisms used in these models. Testing the ozone formation chemistry in atmospheric models is needed, in order to ensure the development of effective strategies for ozone reduction.

We will present the development of an instrument for direct measurements of ozone production rates (OPR) in ambient air. The OPR instrument is made of three components: (i) two quartz flow tubes to sample ambient air, one exposed to solar radiation and one covered by a UV filter, (ii) a NO_2-to-O_3 conversion unit, and (iii) an ozone analyzer. The total amount of ozone exiting each flow tube is conserved in the form of $O_x = NO_2 + O_3$. Ozone production rates $P(O_3)$ are derived from the difference in O_x concentration between the two flow tubes, divided by the exposure time of air inside the flow tubes. We will present studies that were carried out in the laboratory to characterize each part of the instrument and we will discuss the performances of the OPR instrument based on experiments carried out using synthetic air mixtures of known composition (NO_x and $VOCs$). Chemical modeling will also be presented to assess the reliability of ozone production rate measurements.