Abstract

[Research Title]

Re-Consideration of Ozone Formation Mechanism and Proposal of Scientific Basis for Oxidant Control Based on Regional Characteristics

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[Abstract]

To elucidate the mechanism of ozone formation based on a complete direct measurement of the HOx cycle, laboratory experiments, simulated chamber experiments, and atmospheric observations were conducted using highly advanced laser spectroscopic technique, which was developed to measure HOx reactivity. Intensive summer observations were conducted in Tsukuba City, Ibaraki Prefecture and Koto-ku, Tokyo in 2022 and 2023 to determine the ozone production regime by considering OH and HO_2 reactivity. It is proposed that model calculations may potentially overestimate ozone production at locations far from the source, such as urban suburbs. Since the unknown OH reactivity in the early stages of the reaction was found to correlate well with HCHO, and the relationship between unknown OH reactivity and HCHO concentrations from chamber experiments was well reproduced in the 2017 Tsukuba City observations, we proposed that the reproducibility of HCHO could be used as an indicator of the reliability of the air chemistry model. Chamber experiments revealed that the maximum potential ozone concentration decreased with increasing aerosol concentration under NOx-limited conditions. The measured results were confirmed by a detailed chemical reaction mechanism introducing HO2 uptake processes. In the case of the simulated atmosphere adjusted to be VOC-rate, the regime judging device also judged the atmosphere to be VOC-rate. On the other hand, in the case of the simulated atmosphere adjusted to NOx-rate, the regime determiner changed from VOC-rate to NOx-rate. These results can be explained by the detailed reaction model, confirming that the regime analyzer can accurately determine the ozone production regime. In order to simplify the direct determination of the ozone production regime, a portable regime determination device was constructed by downsizing the existing device. Intercomparison of the original and portable regime determination devices was conducted during intensive atmospheric observations in Koto-ku, Tokyo. We updated the existing regional chemical transport model (ADMER-PRO) anthropogenic emissions data and conducted simulations for the Kanto and Kinki regions to clarify regional and temporal characteristics of ozone production regimes and reduction efficiencies. Maps of ozone concentration reduction efficiencies weighted by population distribution and crop yield (human exposure concentration reduction efficiency and rice exposure concentration reduction efficiency,

respectively) were created for the Kanto and Kinki regions to quantitatively show the ozone exposure concentration reduction effect of precursor reduction by source-specific precursor reduction.

[References]

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