

Continuous monitoring of urban air quality with a pulsed DOAS technique

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[Introduction]

NO₂ is emitted from anthropogenic sources and has a large influence on the production and extinction of the tropospheric ozone. Therefore, in the urban area, the observation of the NO₂ concentration is important to control air pollution. In this context, the purpose of this research is the observation of NO₂ in Tokyo urban area by pulsed Differential Optical Absorption Spectroscopy (PDOAS). In PDOAS technique, we can easily remove background light to use pulsed light source and observe the average density of NO₂ through long path length. We demonstrated this system in the trace gas observation campaign at Tokyo metropolitan area in summer 2008.

[Device outline]

The measurement system consists of a light source, a telescope, a small CCD spectrometer, and a lap top PC. In the campaign, two PDOAS systems were utilized simultaneously to retrieve NO₂ column densities along different directions. As the light sources, high-intensity flashing white obstruction lights available on the top of exhaust flues of incinerator plants were employed, in which one Xe lamp light source was located 6.3-km east and another was 7-km north from the observation site at the Hongo campus of Univ. of Tokyo. The both flash lights are focused by the telescopes and detected by the CCD spectrometers through optical fibers.

[Analytical technique]

The observed light spectra subtracted from the background lights is decayed by the absorption of NO₂ and the extinction of Rayleigh/Mie scattering in the range of 400-450 nm. In this range, there is no absorption of other trace gases except NO₂, so that we can easily retrieval NO₂ concentration. The observed spectra have two components, one varies rapidly with wavelength and another varies slowly. The differential absorption spectra are obtained by removing slowly changing part (smooth line) which is fitted to the observed spectra. The differential absorption cross-section is defined by considering the absolute cross-section as the sum of the spectrum, which varies rapidly with wavelength, and a slowly varying component. Then, in the slowly varying component of the observed spectra, there is the effect of the extinction of Rayleigh/Mie scattering and the slowly varying absorption cross-section, so that the resulting structure of the observed spectra is only caused by the rapidly varying NO₂ cross-section. Finally we obtain the NO₂ concentration by peak-to-peak spectrum matching of the differential absorption spectra and the differential absorption cross-section.

[Results and discussion]

We performed two PDOAS systems in daytime from 1st to 23rd August, 2008. Temporal variations of retrieved NO₂ column densities will be discussed in terms of spatially inhomogeneous distributions of NO₂. The NO₂ column densities were also compared with single-point data of NO_x measured by chemiluminescence analyzer.