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Comparison of tropospheric NO_2 observations by GOME and ground stations over Tokyo, Japan

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Nitrogen oxides (NO_x = NO + NO_2) are anthropogenically emitted as a form of NO in the high-temperature burning processes of fossil fuels mainly in energy generations and vehicles. Because NO_x is a precursor of ozone, which is composed of a so-called photochemical smog, and is a health-hazard matter, the monitoring of NO_2 is important to control air quality. The satellite observation is one of the most suitable methods for the monitoring of air pollution because satellite observations can obtain a global distribution of the pollutants. However, the observation of tropospheric gases by satellites still includes technically challenging problems, and the field is developing.

To test whether satellite observations could successfully detect the behavior of tropospheric NO_2, we compared satellite and ground-based observations of tropospheric NO_2 over the Tokyo region. The satellite data were tropospheric NO_2 vertical column density (VCD) derived from Global Ozone Monitoring Experiment (GOME) spectrometer measurements (hereafter GOME-NO_2) [Richter et al., 2005], and the ground-based data were surface NO_2 volume mixing ratio (VMR) observed by the network of air-quality monitoring stations in Tokyo. The analysis was performed for the data from January 1996 to June 2003.

We found a strong correlation between GOME-NO_2 and the surface VMR. They showed a similar seasonal variation with a maximum in winter and a minimum in summer. The result suggested that GOME was observing the behavior of NO_2 near the surface in the Tokyo region. A more rigorous comparison was conducted by scaling the surface NO_2 VMR to the tropospheric VCD with vertical NO_2 VMR profiles. The NO_2 profiles were calculated by using the chemical transport model CMAQ/REAS [Uno et al., 2007; Ohara et al., 2007]. This second comparison indicated that the GOME observations represent the behavior of NO_2 more closely at the relatively unpolluted ground stations than at the highly polluted ground stations of the air-quality monitoring. This tendency could be attributed to the horizontal heterogeneity within a GOME footprint (320kmX40km). Comparison with a previous study in northern Italy [Ordonez et al., 2006] showed that the GOME-NO_2 measurements tended to be smaller over Tokyo than over northern Italy. There would be two reasons for such a difference. First, areas of ocean intruding into the GOME pixels could lower the observed GOME-NO_2 because Tokyo is located in a coastal land region with a gulf. Second, the pollution in Tokyo is so spatially concentrated that the rural regions contaminating GOME pixels could also reduce the observed NO_2 concentration from its true spatially resolved value.