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A feasibility study for the monitoring of diurnal variations of the tropospheric NO_2 over Tokyo from a geostationary satellite

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We have conducted a feasibility study for the monitoring of diurnal variations of anthropogenic nitrogen dioxide (NO_2) in the lower troposphere over Tokyo, Japan, assuming a geostationary satellite's measurement. First we simulated Earth's atmospheric spectra by using a radiative transfer model, SCIATRAN, in the visible wavelength domain. In the simulation, we implemented the diurnal variations of the vertical profiles of NO_2 for summer and winter based on results from the CMAQ model. Using the synthesized spectra, we performed a Differential Optical Absorption Spectroscopy (DOAS) analysis to retrieve NO_2 slant column densities (SCDs) and also estimated the precision of the retrieved SCDs. Before the DOAS analysis, we added pseudo-noise components to the synthesized spectra to take into account sensor specification as currently discussed for geostationary instruments.

The retrieval simulation showed that the total NO_2 SCD (4.0-6.0$\times 10^{16}$ molecules/cm^2, depending on local time and season) could be measured with the precision of 20% at signal-to-noise ratio (SNR) =$\sim$100 and 2% at SNR=$\sim$1000, respectively. In our estimation, the precision of SCD did not much depend on local time (LT05-18 in summer and LT07-16 in winter) or season (summer and winter). We found that the diurnal variation of total NO_2 SCD from the morning to the evening (about 2.0$\times 10^{16}$ molecules/cm^2) could be well detected by the sensor with SNR>100. We also discuss the effect of uncertainties in surface reflectivity on the retrieval.