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Estimation of surface nitrogen dioxide mixing ratio using the OMI NO_2 tropospheric column data measured in Korea

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We, for the first time, estimated daily and monthly surface nitrogen dioxide (NO_2) volume mixing ratio (VMR) using three empirical models (Model-1, Model-2, and Model-3) with NO_2 tropospheric vertical column density (OMI-Trop NO_2 VCD) data obtained from Ozone Monitoring Instrument (OMI) in four metropolitan cities: Daejeon, Gwangju, Gyeonggi, and Seoul in South Korea for the period between 2006 and 2014. The performance of those empirical linear models was evaluated via comparison with the surface NO_2 VMR data obtained from in-situ measurements(in-situ NO_2 VMR) for the two years validation period. Model-1 is a linear regression equation between OMI-Trop NO_2 VCD and in-situ NO_2 VMR, whereas Model-2 is a linear regression equation which incorporate boundary layer height (BLH) obtained from Atmospheric Infrared Sounder (AIRS). Model-3 is a multiple linear regression equation. The monthly mean surface NO_2 VMRs estimated by Model-2 showed good agreements with those of in-situ measurements. We found that correlation coefficients (R) between the estimated monthly mean surface NO_2 VMRs from Model-2 and in-situ NO_2 VMRs range from 0.70 to 0.82. The best correlation (R = 0.82) was found in Gwangju, while the poorest correlation (R = 0.70) was found in the western part of Seoul. In terms of the daily NO_2 estimation, the highest correlations were found between the daily surface NO_2 VMRs estimated by Model-3 and in-situ NO_2 VMRs ($0.62 < R < 0.90$). The best correlation (R = 0.90) was found in the western part of Seoul, while the poorest correlation (R = 0.62) was found in Gwangju. We also discussed the performance of these empirical models for surface NO_2 VMR estimation with respect to other statistical data such as root mean square error, mean bias, mean absolute error, and percent difference. This present study shows a possibility of estimating surface NO_2 VMR using the satellite measurement.