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NO_x emission fluxes estimated from OMI-retrieved tropospheric NO_2 columns over East Asia

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In this study, we estimated top-down NO_x emissions over East Asia, using available information on the levels of NO_2 and NO_x, wind vectors, and geolocation from OMI observation and CAMQ/WRF simulations. For the high-resolved (i.e. 30 km$\times$30 km) top-down NO_x emissions, an algorithm was developed based on the mass balance equation. Two main parameters were incorporated in the algorithm. For the first, atmospheric NO_x molecules transported from/to the adjacent cells for considering the non-local sources were sophisticatedly calculated. For the second, effective NO_x lifetime for the nonlinearity between NO_2 columns and NO_x emissions was estimated from the mass balance equation. In the analysis, the NO_x transports from/to the neighborhood cells had significant impacts on the effective NO_x lifetime in both cold and warm seasons. Also, in the sensitivity test, we showed that the errors in the top-down NO_x estimations can be reduced by filtering the data whose NO_x lifetimes are smaller than 5 hours. The relative errors caused by the uncertain issues of NO_x lifetimes with interpolation of satellite data were $\sim$13% and $\sim$5% in January and July, 2014. Using the algorithm, the top-down NO_x emissions were estimated to be 1.04 and 1.18 Tg N/month over our entire domain for January and July, respectively. The values corresponded to decreases by $\sim$15% and $\sim$2%, compared with the bottom-up NO_x emissions in January and July, respectively. We also compared the CMAQ-estimated NO_2 columns with OMI-retrieved NO_2 columns to evaluate the bottom-up NO_x emission and investigate how much the top-down NO_x emissions estimated from our algorithm were improved.