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Long-term MAX-DOAS network observations of NO2 in Russia and Asia: comparisons with OMI satellite observations

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We conducted long-term network observations using standardized Multi-Axis Differential optical absorption spectroscopy (MAX-DOAS) instruments in Russia and ASia (MADRAS) from 2007 onwards. At seven locations (Cape Hedo, Fukue, and Yokosuka in Japan, Hefei in China, Gwangju in Korea, and Tomsk and Zvenigorod in Russia) with different levels of pollution, we obtained 80,927 retrievals of tropospheric NO2 vertical column density (TropoNO2VCD) and aerosol optical depth (AOD). This large data set was used to analyze NO2 climatology systematically, including temporal variations from the seasonal to the diurnal scale. The results were compared with Ozone Monitoring Instrument (OMI) satellite observations and global model simulations. Two NO2 retrievals of OMI satellite data (NASA ver. 2.1 and Dutch OMI NO2 (DOMINO) ver. 2.0) generally showed close correlations with those derived from MAX-DOAS observations, but had low biases of ˜50%. The bias was distinct when NO2 was abundantly present near the surface and when the AOD was high, suggesting that the aerosol shielding effect could be important, especially for clean sites where the difference could not be attributed to the spatial inhomogeneity. Except for constant biases, the satellite observations showed nearly perfect seasonal agreement with MAX-DOAS observations, suggesting that the analysis of seasonal features of the satellite data were robust. A global chemical transport model, MIROC-ESM-CHEM, was validated for the first time with respect to background NO2 column densities during summer at Cape Hedo and Fukue in the clean marine atmosphere.

Keywords: Nitrogen dioxide, MAX-DOAS, Satellite data validation, temporal variation