

Validation of tropospheric NO₂ column density data observed by TROPOMI: Comparison with 4AZ-MAXDOAS

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TROPOspheric Monitoring Instrument (TROPOMI) aboard the Sentinel-5 Precursor satellite has an unprecedented fine horizontal resolution of 7 km×3.5 km (at nadir) for tropospheric nitrogen dioxide (NO₂) column observations and is expected to improve estimation of emissions, including localized kilometer-scale emissions. However, previous studies reported that underestimation could occur in tropospheric NO₂ column data from satellite observations, although its causes are still under discussion. The present study attempts to validate TROPOMI tropospheric NO₂ column data to confirm that the underestimation occurs and clarify the causes. For this purpose, we used ground-based 4-different-azimuth-viewing Multi-Axis Differential Optical Absorption Spectroscopy (4AZ-MAXDOAS) installed at Chiba, Japan (35.63°N, 140.10°E, 21 m asl). The 4AZ-MAXDOAS observed tropospheric NO₂ simultaneously in 4 different azimuth directions, enabling the evaluation of spatial inhomogeneity of NO₂, which has been considered to be the major cause of the underestimation. From 4AZ-MAXDOAS data, we found that differences in tropospheric NO₂ column data among 4 different azimuth directions reached up to 40%, indicating the existence of significant horizontal spatial inhomogeneity in NO₂ around the observation site. Then, we compared 4AZ-MAXDOAS data with coincident TROPOMI data. TROPOMI data showed an underestimation by up to about 50% compared to 4AZ-MAXDOAS data, confirming the underestimation in TROPOMI data. However, the correlation was not clear between the magnitude of the underestimation and the coefficient of variance in 4-azimuth data from 4AZ-MAXDOAS observations. This suggests that the observed underestimation cannot be explained only by the effect of the NO₂ spatial inhomogeneity. Instead, the underestimation should be attributed more significantly to the assumption made in the air mass factor calculation.

Keywords: Atmosphere, Satellite observation, Nitrogen dioxide