

# Examination of Two Pandora Observation Modes for the Validation of the TROPOMI Tropospheric NO<sub>2</sub> Vertical Column Density

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## Abstract

Satellite observations provide crucial information on the spatial distributions and variations of nitrogen dioxide (NO<sub>2</sub>), and thereby on NO<sub>x</sub> emission sources. For example, the Tropospheric Monitoring Instrument (TROPOMI) on the Copernicus Sentinel-5 Precursor satellite provides the NO<sub>2</sub> tropospheric vertical column density (NO<sub>2</sub> tropVCD) at a high spatial resolution on a daily basis across the globe. To ensure the accuracy and long-term stability, these satellite data need extensive validations by a reference method. The Pandora instruments, ground-based remote-sensors, are now widely used as a reliable source for the satellite validation of NO<sub>2</sub> and some other species. In this study, we investigated the performance of two observation modes of the Pandora instruments, which are the Direct-sun and the Multi Axis Differential Optical Absorption Spectroscopy (MAXDOAS) modes. Data from these observations at four stations located in Japan were examined. The comparisons to TROPOMI showed a strong correlation in NO<sub>2</sub> tropVCD for both of the Direct-sun mode ( $r^2 = 0.85 - 0.87$ , slope = 0.66 – 0.81) and the MAXDOAS mode ( $r^2 = 0.68 - 0.81$ , slope = 0.66 – 0.92), indicating a high level of accuracy. Additionally, we also determined the effective distance when comparing TROPOMI with the two Pandora observation modes. For the Direct-sun mode, we should consider TROPOMI pixels which are within 5 km from the Pandora station and are arranged in the Pandora viewing direction. Whereas, for TROPOMI and the Pandora MAXDOAS comparisons, we found that it is better to use the maximum horizontal distance for NO<sub>2</sub> as the effective distance. After correcting for horizontal representativeness in the Pandora observations, the correlation significantly improved for the MAXDOAS mode ( $r^2 = 0.85 - 0.87$ , slope = 0.66 – 0.99).

## Early Career Scientist

YES, I am an early career scientist.

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