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Evaluation of TROPOMI/Sentinel-5 Precursor NO2 product against ground-based observations in Helsinki and first applications to Finnish society

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We evaluate the satellite-based TROPOMI (TROPOspheric Monitoring Instrument) NO2 products against ground-based observations in Helsinki (Finland). TROPOMI NO2 total (summed) columns are compared with the measurements performed by the Pandora spectrometer during April–September 2018. The mean relative and absolute bias between the TROPOMI and Pandora NO2 total columns is about 10% and 0.12 × 10^{15} molec. cm^{-2} respectively.

We find high correlation (r = 0.68) between satellite- and ground-based data, but also that TROPOMI total columns underestimate ground-based observations for relatively large Pandora NO2 total columns, corresponding to episodes of relatively elevated pollution. This is expected because of the relatively large size of the TROPOMI ground pixel (3.5 × 7 km) and the a priori used in the retrieval compared to the relatively small field-of-view of the Pandora instrument. On the other hand, TROPOMI slightly overestimates relatively small NO2 total columns. Replacing the coarse a priori NO2 profiles with high-resolution profiles from the CAMS chemical transport model improves the agreement between TROPOMI and Pandora total columns for episodes of NO2 enhancement, but the overall bias remains the same (within the uncertainties).

In order to evaluate the capability of TROPOMI observations for monitoring urban air quality, we also analyse the consistency between satellite-based data and NO2 surface concentrations from the Kumpula air quality station in Helsinki. We find similar day-to-day variability between TROPOMI and in situ measurements, with NO2 enhancements observed during the same days. Both satellite- and ground-based data show a similar weekly cycle, with lower NO2 levels during the weekend compared to the weekdays as a result of reduced emissions from traffic and industrial activities (as expected in urban sites).

Several applications have been already carried on to support informed decision making and Finnish society in general. We developed a simple web platform to inform environmental authorities at municipal level about the use of satellite observations for air quality monitoring. We assisted the Finnish authorities during the first period of the COVID-19 pandemic in assessing the

effect of the lockdown on air quality. We supported the Finnish Ministry of Environment in compiling the periodic national air pollution assessment report to the EU. We participated in several international cooperation projects for assessing the major air pollution sources and the available air quality monitoring systems over several developing countries and for providing recommendations on strengthening air quality monitoring. We collaborated with the department of Social Science at the Univ. of Helsinki for the assessment of the environmental impacts of the energy and extracting sector in Yakutia (Russia).

Reference: Ialongo, I., Virta, H., Eskes, H., Hovila, J., and Douros, J.: Comparison of TROPOMI/Sentinel-5 Precursor NO_2 observations with ground-based measurements in Helsinki, Atmos. Meas. Tech., 13, 205–218, https://doi.org/10.5194/amt-13-205-2020, 2020.