Preliminary intercomparison of the ESA Sentinel-5P NO_2 tropospheric column density product against the in-situ ground measurements

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INTRODUCTION

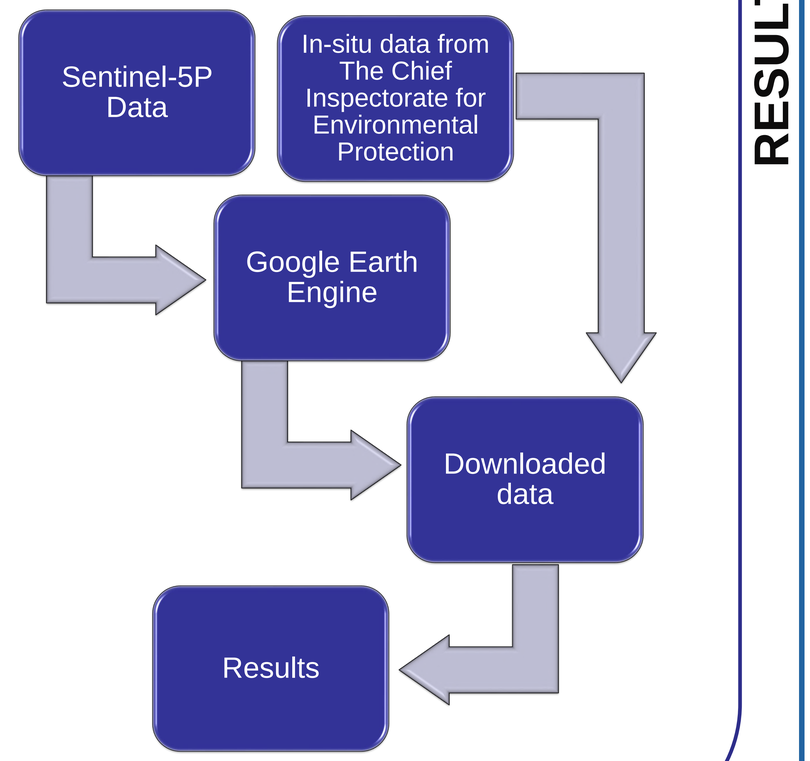
Air pollution in Poland is a severe threat to public health and it was proven to be the main source of many lethal diseases. Across Europe, air quality in Poland is one of the worst. Thus, there is a strong demand for air quality monitoring in Poland in order to raise public awareness and to develop policies that will mitigate this huge problem. The main objective of the research was to compare and determine limitations of the tropospheric NO2 column number density product generated from the Sentinel-5 Precursor (S-5P) satellite data provided by the European Space Agency. The validation analyses were performed for each month separately with and without the division between the urban, suburban and rural locations on the basis of 117 ground stations.

METHODS AND DATA

Data quality, availability and representativeness analysis

Validation of the Sentinel-5P products

Analysis of concentration of atmospheric pollutants in selected locations in Poland



RESULTS

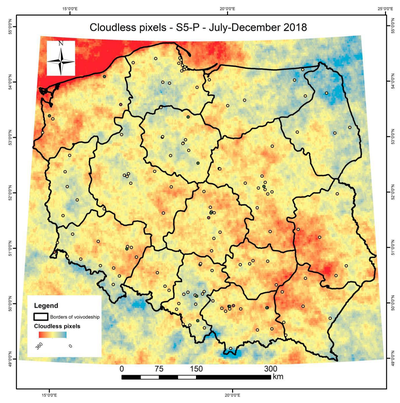


Fig. 1. Cloudless pixels – july-december 2018 – S5-P

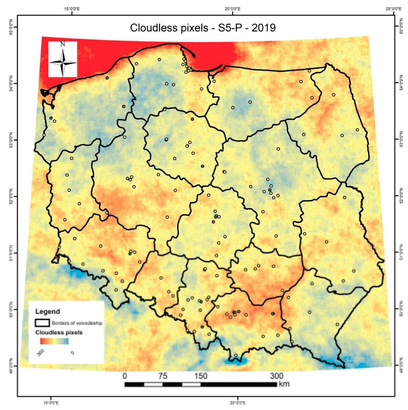


Fig. 2. Cloudless pixels – 2019– S5-P

The data quantity analysis revealed that up to two satellite images were available per day and in total there were 45-50 cloudless acquisitions in the 2018 year. The fewest (2-4) images were available in December as opposed to 25 images available in August.

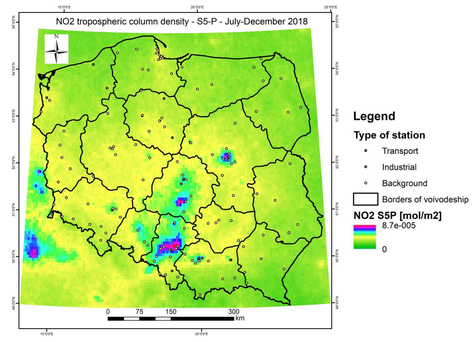


Fig. 3. NO_2 tropspheric column density – july-decemebr 2018 – S5-P

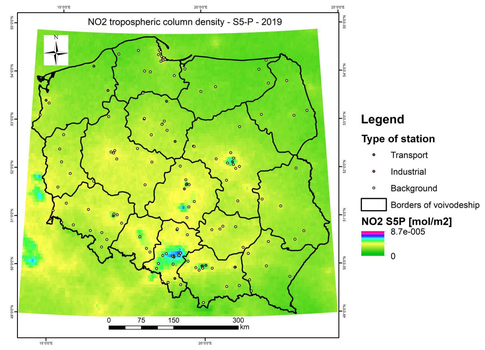


Fig. 4. NO_2 tropspheric column density – 2019 – S5-P

The study revealed distinct geographical pattern with the highest NO2 concentrations (6,80E-05 [mol/m2] - 9,80E-05 [mol/m2]) in Warsaw, Cracow, and Lodz agglomerations as well as in the Upper Silesia Metropolis. Relatively high NO2 emissions were also detected around Wroclaw and Opole cities. Contrarily, the lowest level of NO2 (1,40E-05 [mol/m2] - 2,00E-05 [mol/m2]) was revealed in the Pomerania and Warmia and Masuria regions (Northern Poland).

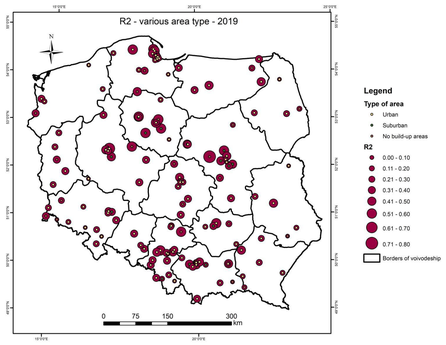


Fig. 5. R^2 – satelitę data and in-situ data – various area type - 2019

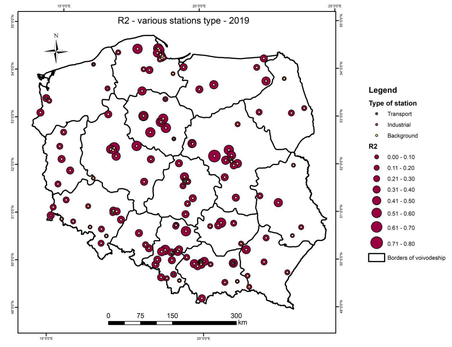


Fig. 6. R^2 – satelitę data and in-situ data – various station type - 2019

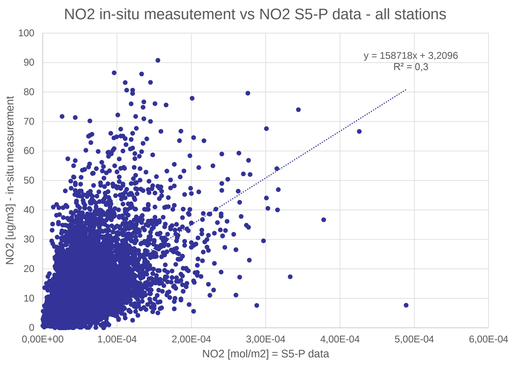


Fig. 7. NO_2 in-situ measurements vs NO_2 S5-P data – all stations

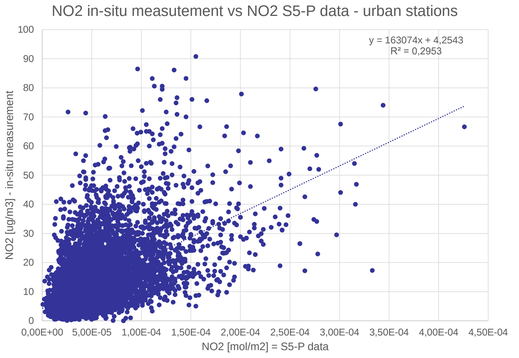


Fig. 8. NO_2 in-situ measurements vs NO_2 S5-P data – urban stations

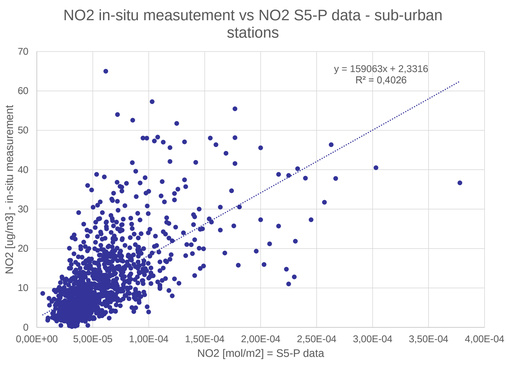


Fig. 9. NO_2 in-situ measurements vs NO_2 S5-P data – sub-urban stations

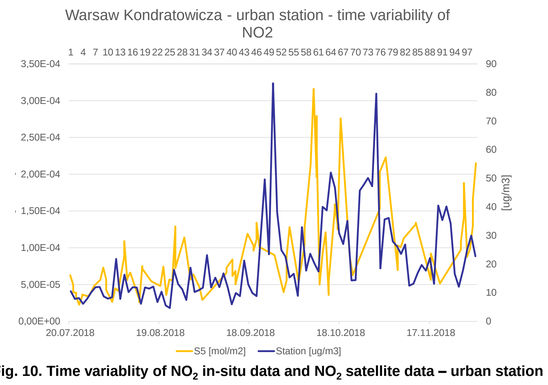


Fig. 10. Time variablity of NO_2 in-situ data and NO_2 satellite data – urban station

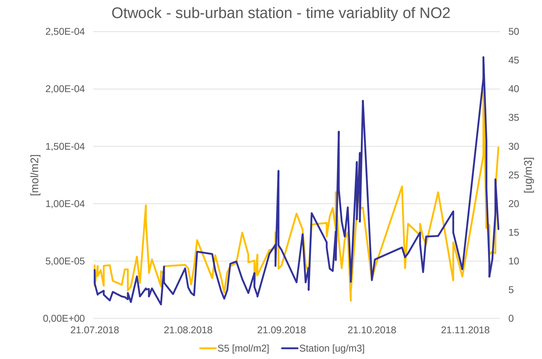


Fig. 11. Time variablity of NO_2 in-situ data and NO_2 satellite data – sub-urban station

CONCLUSIONS

The validation analysis of the S-5P tropospheric NO2 product against in-situ ground measurements revealed the following Pearson correlation coefficients: for all stations R=0.55, for urban stations R=0.55, for suburban stations R=0.63, and for rural stations R=0.55. However, it has to be emphasized that the analysis was performed only for the 2018 year due to the lack of in-situ measurements for the 2019 year that have not been published yet. Figure 11 depicts close agreement between the in-situ measurements and S-5P NO2 product from the perspective of temporal variability. However, at a national scale this agreement is moderate (Fig. 7) but locally a significant correlation can be achieved (Fig. 5 and Fig. 6).

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