Near Real-Time Air Quality Mapping Using Data Fusion Techniques and Sentinel-5P Data

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Project SAMIRA

The presented work is a part of the SAMIRA (SAtellite based Monitoring Initiative for Regional Air quality) project – an ESA-funded project which aims at improving air quality monitoring in the regions of collaborating countries: Norway, Poland, Romania and the Czech Republic.

Data fusion in air quality mapping

The fusion of in-situ measurements, outputs from chemical transport models (CTM) and other supplementary data (altitude, population density, land use etc.) was already tested in previous research and is also used routinely[1]. Within the SAMIRA project, the added value of satellite data was examined. Here we present the preliminary results of near real-time hourly mapping.

Input data sources

The data fusion is run on a 1 x 1 km domain covering the Czech Republic, the period presented here is from 15/03/2019 to 01/04/2019.

- **in-situ measurements of NO_2**
  - CHMI air quality database - background stations. Up-to-date measurements every hour (lag ca. 1 hour).
- **satellite data**
  - Sentinel-5P/TROPOMI: NRTI L2 NO_2, daily overpass with original 7x3.5 km spatial resolution. Data with quality flag >=0.5 converted to L3 with the HARP[2] toolbox (0.05x0.05 deg). Latest available retrieval is used.
- **supplementary data**
  - altitude, population density

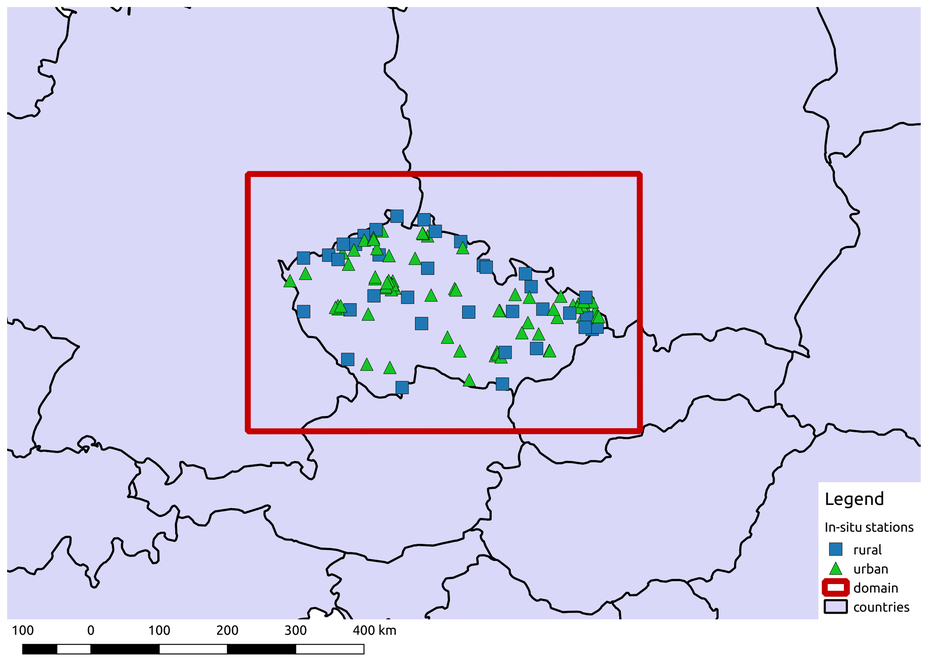


Figure 1: Computational domain and in-situ station locations.

Data fusion methodology

The data fusion is carried out using multiple linear regression and spatial interpolation of its residuals (residual kriging). Air quality maps are calculated separately for urban and rural background stations and then merged by population density. The results are verified by cross-validation (i.e. the interpolation calculated repeatedly, each time leaving out one station).

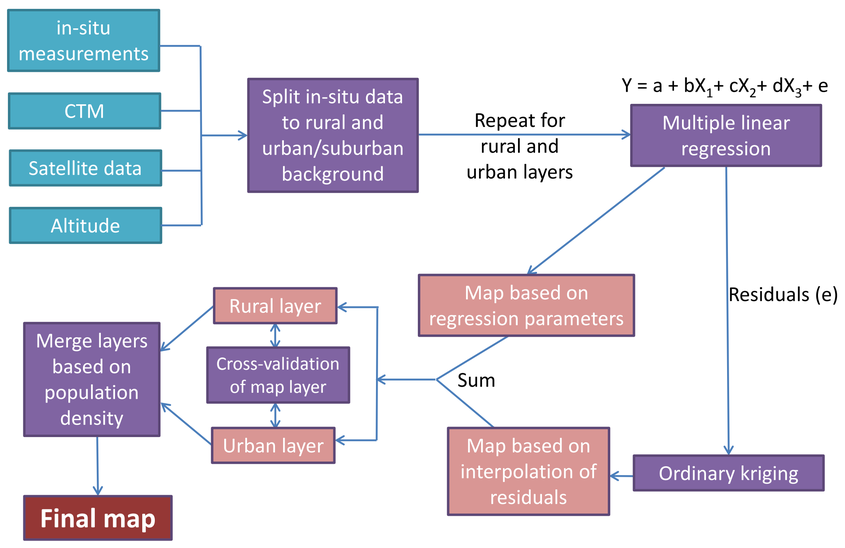
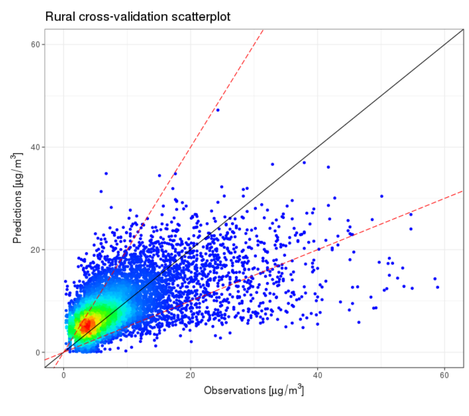
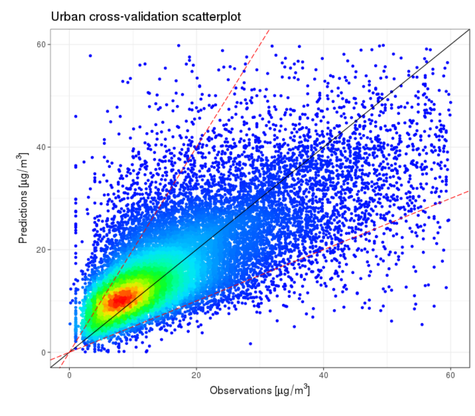


Figure 2: Data fusion process: regression - interpolation - merging mapping.

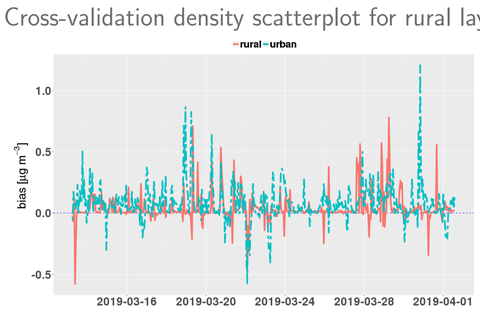
Results



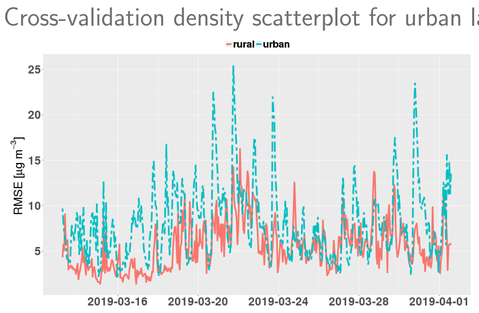
(a) Cross-validation density scatterplot for rural layers.



(b) Cross-validation density scatterplot for urban layers.



(c) Time series - cross-validation bias.



(d) Time series - cross-validation RMSE.

Figure 3: Cross-validation plots for rural and urban layers.

Rural			
RMSE average	RMSE median	bias average	bias median
5.50	5.15	0.04	0.01
Urban			
RMSE average	RMSE median	bias average	bias median
7.94	7.14	0.08	0.05

Table 1: Comparison of average and median RMSE and bias.

Example maps

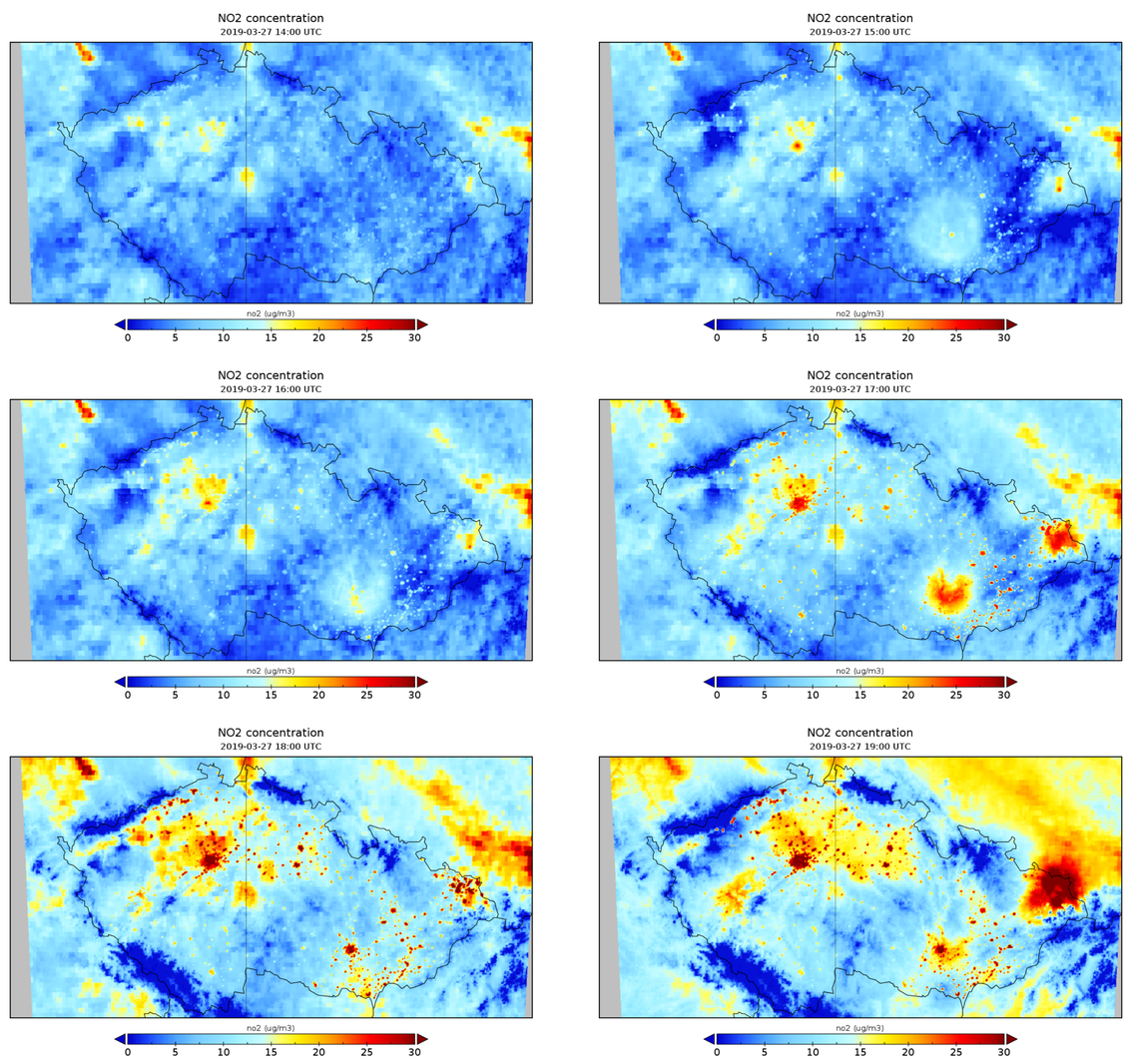


Figure 4: Examples of air quality maps.

Future work

- Add outputs from a chemical transport model
- Test other supplementary data that could help explain variations at an hourly temporal scale (meteorology...)
- Produce maps on an extended domain covering a major part of Europe
- Produce maps for more pollutants: SO_2, PM_{10}, $PM_{2.5}$
- Online presentation of maps
- Paper in preparation

References

[1] Horálek J., de Smet P., de Leeuw F., Kurfürst P., Benešová N. (2017). European air quality maps for 2014. ETC/ACM Technical paper 2016/6.

[2] Basic Envisat Atmospheric Toolbox (BEAT), HARP tool: http://www.stcorp.nl/beat/