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Exploiting crowdsourced observations: High-resolution mapping of real-time urban air quality throughout Europe

Philipp Schneider (1), Nuria Castell (1), Islen Vallejo (1), Joris van den Bossche (2), William Lahoz (1), Alena Bartonova (1), and the CITI-SENSE Consortium Team

(1) NILU - Norwegian Institute for Air Research, Kjeller, Norway (ps@nilu.no), (2) VITO - Flemish Institute for Technological Research, 2400 Mol, Belgium

With the technology of air quality sensors improving rapidly in recent years and with an increasing number of initiatives for collecting air quality information being established worldwide, there is a rapidly increasing amount of information on air quality. Such datasets can provide unprecedented spatial detail and thus exhibit a significant potential for allowing to create observation-based high-resolution maps of air quality in the urban environment. However, most datasets of observations made within a citizen science or crowdsourcing framework tend to have highly variable characteristics in terms of quantity, accuracy, measured parameters, and representativeness, and many more. It is therefore currently unknown how to best exploit this information for mapping purposes.

In order to address this challenge we present a novel approach for combining crowdsourced observations of urban air quality with model information, allowing us to produce near-real-time, high-resolution maps of air quality in the urban environment. The approach is based on data fusion techniques, which allow for combining observations with model data in a mathematically objective way and therefore provide a means of adding value to both the observations and the model. The observations are improved by filling spatio-temporal gaps in the data and the model is improved by constraining it with observations. The model further provides detailed spatial patterns in areas where no observations are available. As such, data fusion of observations from high-density low-cost sensor networks together with air quality models can contribute to significantly improving urban-scale air quality mapping.

The system has been implemented to run in an automated fashion in near real-time (once every hour) for several cities in Europe. Evaluation of the methodology is being carried out using the leave-one-out cross validation technique and simulated datasets. We present case studies demonstrating the methodology for several cities throughout Europe, including Oslo, Barcelona, Ljubljana, Belgrade, Haifa, and Ostrava.

Detailed urban air quality maps such as those derived from data fusion techniques can then further be used for providing personalized information about air quality to the citizens. We present examples of how this kind of real-time data allows end users to find the currently least polluted route through a city or to track their individual personal exposure to air pollutants while moving through the urban environment.