Mapping Urban Air Quality Using a Network of Low-Cost Sensors: A Data Assimilation Approach

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Recent advances in sensor technology have enabled the construction of small and low-cost platforms for measuring various parameters related to air quality. These platforms are ideally suited to be used within a crowdsourcing or citizen science framework. Due to their small size and lower cost, such devices can be deployed throughout the urban environment at much higher density than what is feasible with traditional air quality monitoring stations equipped with reference instruments. A large network of such low-cost sensors is thus capable of providing significantly more detail regarding the spatial distribution of air pollutants in the environment. However, despite the increased deployment density, such sensor networks continue to require additional information for producing spatially exhaustive maps of air quality throughout the urban environment.

We present here our recent work on mapping real-time urban air quality by combining crowdsourced observations from the recent generation of low-cost air quality sensors with time-invariant data from local-scale dispersion model. The approach is based on data assimilation, which allows for combining observations with model data in a mathematically objective way and therefore provides 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.

The results indicate that using a network of low-cost microsensors in conjunction with model information is able to provide realistic high-resolution maps of urban air quality. Such detailed urban air quality maps can then further be used for providing personalized information about air quality to 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.