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The PBDW: a reduced order data assimilation method for real-time monitoring of urban flows

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As the population increases, cities must constantly reassess their urban planning. However, this must be done in such a way to preserve the quality of life of its inhabitants. Energy saving, sustainable water and air quality are some of the important challenges associated with growing cities. In this context, the monitoring of the different urban flows (pollution, heat) is very important. For instance data assimilation approach can be used in monitoring. These methods incorporate available measurement data and mathematical model to provide improved approximations of the physical state. The effectiveness of modeling and simulation tools is essential. Advanced physically based models could provide spatially rich small-scale solution, however the use of such models is challenging due to explosive computational times in real-world applications. Beyond computational costs, physical models are often constrained by available knowledge on the physical system. To overcome these difficulties, we resort the Parameterized-Background Data-Weak (PBDW) method introduced in [1]. The PBDW formulation combines a set of solutions (a reduced basis [2]) from the physically based model, and the experimental observations, in order to provide a real-time and in-situ state estimate. The reduced basis is used to diminish the cost of using a high-resolution model by exploiting the parametric structure of the governing equations. In addition, variational data-assimilation techniques are used to correct the model error.

In this work we extend the PBDW method to the monitoring of urban flows as an important use case but also as an example of the very generic approach that proves well suited to Online monitoring over large scales. In case studies presented here, the method allows to correct for unmodeled physics and treat cases of unknown parameter values, all while significantly reducing online computational time.

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