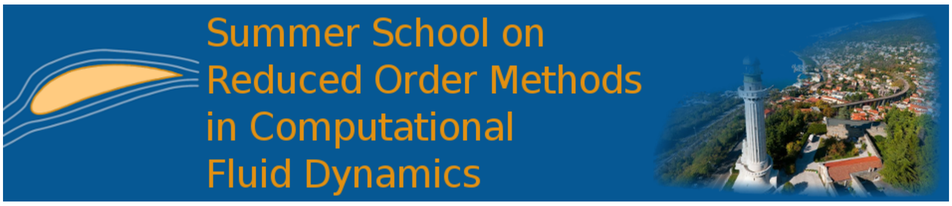

Contribution ID: **93** Type: **Poster**

ROM for Large-scale Modelling of Urban Air Pollution

Urban air pollution is a major global challenge that is responsible for damage to climate, ecosystems, and health. Recent research conducted by the World Health Organization (WHO) has shown that 9 out of 10 people breathe polluted air and this indirectly translates into a human life cost (over 3 million deaths per year) and an economic cost (estimated at 5 trillion dollars per year). For these reasons, air quality management is listed as one of the UN Sustainable Growth Goals, and a directive by the EU Commission has prescribed to assess air quality through monitoring stations that can be supported by appropriate mathematical modeling tools. In particular, a framework that can combine direct measurements and computational modeling techniques is an important analytical tool, able to extract various insights from the collected statistics and open new strategies for decision support and scenario forecasting at different scales.

Since at the urban level, pollutant dispersion depends on daily weather conditions, CFD models with low time scales, repeated evaluation, and fine mesh discretization must be used. The former requirements translate into huge memory requirements, making it essential to use HPC facilities to get results in reasonable time frames. However, the problem is suitable for the employment of Reduced Order Models (ROMs) to achieve fast converged solutions with limited loss of accuracy.
For this reason, the present work consists of the exploration of a Proper Orthogonal Decomposition (POD) coupled with the Galerkin projection approach for the acceleration of external environmental flow problems.

The evolution of the pollutant is described through the transport equation, where the convective field is given by the solution of the Navier-Stokes equation, while the source term consists of an empirical time series.
We studied two different options for the reduced order model, namely extracting a POD basis onto which the FOM field is projected, or using the DEIM as a hyper-reduction strategy. Both these approaches are proven to be effective, even when the basis for the source term is extracted on a subset of the time series, and then used for future state prediction.
We then tackled the parametrized convective field case, by changing the direction and intensity of the inlet velocity. This modeling choice is in agreement with the aforementioned assumption of coupling the use of our model to experimental measurements. Here we propose a data-driven approach based on a POD-NN reconstruction of the flux field, which is used to recover in a non-intrusive fashion the reduced-order operators required for the online evaluation.
Our framework is validated using as computational domain the main campus of the University of Bologna, modeled using a mesh with about 40k cells.

Primary authors: ROZZA, Gianluigi (SISSA); Dr STABILE, Giovanni (Sissa); KHAMLICH, Moaad (SISSA); Dr KÖRNYEI, László (Széchenyi István University); Prof. HORVÁTH, Zoltán (Széchenyi István University)

Presenter: KHAMLICH, Moaad (SISSA)

Session Classification: Poster blitz