**Title: Closure Models for Reduced Order Methods in Turbulent Flows using a Deep Learning Approach**

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**Abstract:** When taking into account CFD shape optimization problems, the resolution of many parameterized geometries is required. Thus the computational cost becomes unaffordable in case an efficient technique is not selected for this scope [Stabile G., Zancanaro M., Rozza G., Efficient Geometrical Parametrization for Finite-Volume based Reduced Order Methods, 2019, International Journal for Numerical Methods in Engineering].

In order to resolve turbulent flow problems a large variety of turbulence models is nowadays available. Although the direct projection of the additional set of equations describing the turbulence model is possible, such an approach would produce a ROM which depends on the specific turbulence model employed. In this talk we present instead a more generic approach were the contribution due to the turbulence model is approximated by data-driven approaches [Hijazi S, Stabile G., Mola. A., Rozza G., Data-driven POD-Galerkin reduced order model for turbulent flows, 2020, Journal of Computational Physics].

Specifically, we combined classical projection-based techniques applied to Navier-Stokes equations with deep learning methods for turbulence treatment. This choice allows us to develop one single procedure for turbulent flows, not depending on the selection of the turbulence model anymore. Joint work with M. Zancanaro, G. Stabile, A. Mola.