Second International Conference Math 2 Product (M2P 2025)
Emerging Technologies in Computational Science
for Industry, Sustainability and Innovation
June 4th -6yh, 2025, Valencia, Spain

DATA-DRIVEN FLUID MECHANICS: FROM FUNDAMENTALS TO APPLICATIONS FOR THE ENERGY TRANSITION

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ABSTRACT

Data-driven techniques, facilitated by machine learning, are becoming increasingly prevalent in fluid mechanics. The fluid mechanics community is one of the original "big data" communities, that has long been using data-driven techniques to study and model flows. In recent years, modern machine learning techniques have been adopted, with further hybrid developments fusing physics-based approaches with purely data-driven machine learning or by applying such methods to complex flows.

This session will present these latest developments both from a fundamental point of view, and in the context of applications to sustainable engineering flows. We gather presentations from three different European consortia (CYPHER, MODELAIR and ENCODING) which aim to develop hybrid physics-augmented machine learning for various flow applications. Specifically, this session will present the latest results of these consortia in developing novel machine learning techniques dedicated to:

- Physically consistent data-driven turbulence/combustion modelling
- Predictive flow reduced-order modelling
- Flow control
- Chemical kinetics reduction
- Acceleration of flow simulations
- Data assimilation

These advancements will be demonstrated on fundamental problems, but also on engineering-relevant flow applications that support the conversion of our society to a sustainable energy model, such as air pollution mitigation in the urban environment, flow modelling and combustion optimization for power generation, renewable synthetic fuel characterization, etc. This session will bridge the gap between fundamentals in machine learning for fluid mechanics and engineering applications driving our sustainable energy conversion.