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THE CURRENT STATE OF THE PSEUDO DNS METHOD, FROM ITS ORIGINS TO ITS LATEST DEVELOPMENTS

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Abstract. The aim of this presentation is to show the evolution of a novel method developed by the authors to provide a reliable and engineering-feasible solution to one of humanity's greatest enigmas: turbulence. While the first theoretical foundations were laid in 1877, when Boussinesq formulated the turbulent viscosity hypothesis, it was not until 1963 that Smagorinsky proposed the first LES model for CFD applied to meteorology. More than six decades have passed, and the community is still searching for a feasible way to solve this enigma, despite the advantage offered by computational simulation. Assuming that the key lies in solving all the scales present in the Navier-Stokes equations, this has so far been impossible from an analytical point of view and, numerically, only in cases at limited Reynolds numbers. This technique of simulating all scales, called "DNS", from the largest, the integral, to the smallest, the Kolmogorov scale, requires, in the most important cases, grids so fine that they are impossible to process with the available resources. From the 1970s to the present, different methodologies have been presented, most of them focused on modeling certain scales to reduce this cost. Thus, today we have models from the Reynolds Averaged Navier-Stokes (RANS) family, models where part of the scales are simulated and part is modeled, the so-called Large Eddy Simulation (LES), hybrid methods that combine RANS with LES, and, more recently, with the advent of artificial intelligence, models based on Machine Learning. Our proposal aims to not use any model, simulate most scales, and rely on what the subgrid provides. However, instead of incorporating it into the simulation as DNS would do, we propose solving it offline and appropriately building a database (human genome-like) from which the information that the subgrid would provide can be extracted without any correlation, similar to a multiscale calculation. In this way, an accuracy similar to that of DNS is achieved at a cost comparable to RANS. In the presentation, we will show, on a timeline, the developments that have been made, the challenges overcome, and the results obtained, both at the academic level and in complex applications.

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