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Boundary fitted low dissipation large-eddy simulation for complex terrain wind resource assessment

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Recent advances in LES within the HPC code Alya have allowed to obtain an unstructured grid low dissipation scheme. It combines the advantages of low dissipation structured grid approaches commonly used for flat terrain with the flexibility of unstructured grid techniques for complex terrain. For such cases wall modeling is mandatory and a novel implementation for finite element LES is used. Moreover, two approaches for the generation of the inflow boundary condition are tested. The first one uses synthetic inflow data while the second one uses a precursor type inlet. The influence of the inflow direction on the results is also analysed.

A finite element Galerkin approximation is used for the space discretization with a non-incremental fractional step method to stabilize pressure. This allows for the use of finite element pairs that do not satisfy the inf-sup condition, such as equal order interpolation for the velocity and pressure used in this work. The convective term is discretized using the EMAC discretisation that conserves kinetic energy, momentum and angular momentum. Temporal discretization is performed through an explicit third-order Runge- Kutta scheme. The formulation is closed by an appropriate expression for the subgrid-scale viscosity. In this work, the eddy-viscosity model proposed by Vreman 2004 is used.

Experimental data from the Bolund experiment [1] is used to validate the model. Obtained results are satisfactory and better than most available reference data proving the capability of the current model to reproduce the complex physics involved in the present application. The model is also tested against results from a recent benchmark [2].

Most of the simulations have been performed in the Marenostrum 4 Supercomputer composed of Intel Xeon Platinum 8160 chips but the performance has also been evaluated in a Xeon Phi machine with very positive results.

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