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Pseudo-2D RANS model for computationally-efficient simulations of wind farm flows STEFANO LETIZIA, GIACOMO VALERIO IUNGO, University of Texas at Dallas — Performance nowcasting, monitoring and layout optimization of wind farms can be greatly improved by embedding an accurate numerical tool simulating the wind flow and estimating power capture and wake losses. Such tool needs to be computationally efficient to run in real time or operate within an optimization loop. We propose an adaptation of the shallow-water model for the simulation of the 3D flow in a wind farm over a 2D domain. This approach, originally conceived for the investigation of tides and oceanic flow, permits to drop the vertical momentum balance from the set of the Navier-Stokes equations by performing a depth-average. The main hypothesis is that vertical velocities and gradients are negligible compares to the horizontal components. To adapt the shallow-water model to the wind farm case, it is necessary to introduce appropriate corrections near the turbines where vertical velocity magnitude and variability are significant. The corrections leverage the axial symmetry of the near wake to estimate vertical fluxes and dispersive stresses. The tool is validated versus high-fidelity LES simulations.

Stefano Letizia
University of Texas at Dallas

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