Boulder Fluid and Thermal Sciences Seminar Series

Friday, November 10, 2017
10:00am-11:00am (refreshments at 9:45pm)
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Minimising the computational cost of large-scale wind farm simulations

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Driven by the worldwide growing demand for clean and sustainable energy, many large wind farms have been built and others are being planned in both offshore and onshore areas with abundant wind resources. In most cases, the wind turbines are clustered in arrays, often due to the limited available space, which makes them dependent on the effects of the multiple upstream wakes impacting on them. Indeed, a wind turbine operating within the wake of another upstream turbines will experience a significant reduction in its power production as well as an increase in its long-term dynamic fatigue loads. Accurate predictions of the wake-wake and turbine-wake interactions is therefore a complex problem that has attracted the interest of the research community focusing both on onshore and offshore wind farms. To better understand the interactions, we first consider the problem in the context of large-eddy simulation (LES). In LES the SFS turbulent flux of both momentum and heat is typically modelled using eddy-viscosity/diffusivity (Smagorinsky-type) models for which the model coefficients need to be specified a priori and are constant over the whole domain. Other models make use of scale-dependent Lagrangian dynamic procedures which optimise the local values for SFS, yet they require additional calculations to be made, increasing the computational cost. In a deviation from the previous models, we make use of a spectral vanishing viscosity (SVV)-like approach which regularises the Navier-Stokes equations to the grid size and does not require additional effort to compute the SFS flux. The second approach to minimise the overall computational cost of a large-scale wind farm simulation employs mesh optimisation techniques. Mesh-adaptivity is used within the framework of the unsteady Reynolds-averaged Navier Stokes equations and is shown to drive down the computational cost by a factor of two.

Biography: Mr. Georgios Deskos is a PhD student in the Applied Modelling and Computational Group in the Department of Earth Science and Engineering at Imperial College London (ICL). He holds an MSc in Civil Engineering from Virginia Polytechnic Institute and State University (Virginia Tech) in the USA and an MEng in Civil Engineering from National Technical University of Athens in Greece. Prior to starting his PhD, he worked as a Research Assistant in the Department of Civil Engineering at Imperial College London, working on wave-structure interaction problems. As part of his PhD research, G. Deskos has developed and validated a turbine parametrisation model (actuator line model) within the high-order numerical code Incompact3d and the mesh-adaptive finite-element solver fluidity, and uses both tools to simulate large-scale offshore and onshore wind turbine wakes under neutrally stable atmospheric boundary layer (ABL) conditions.