Project 2: Quantification of aerodynamic roughness for weather models through CFD simulations of idealized microscale flows

Student Project Proposal

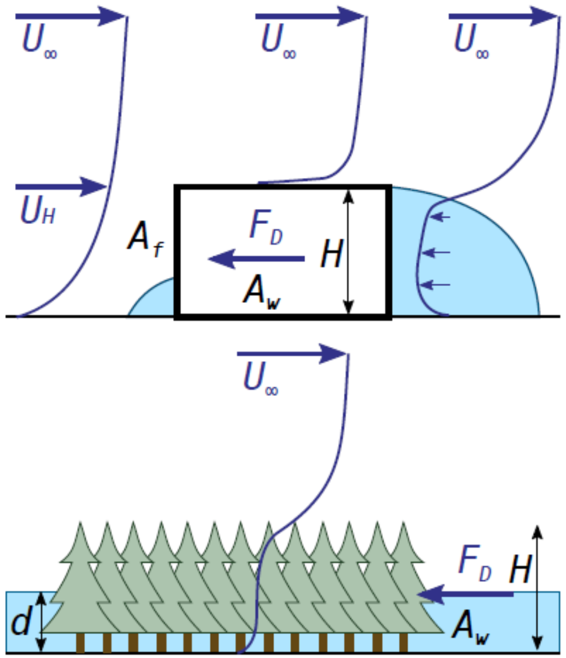
APPLY

Contact person:
Carlos Rodrigues

E-mail:
calvr@vestas.com

Background

The aerodynamic roughness in atmospheric flows is usually an heuristic quantity, as its measurement is difficult or even unfeasible for heterogeneous roughness elements. Mesoscale weather models require such data to parameterize surface drag, as their grid resolution is too coarse to resolve the flow around protruding roughness elements. Equivalent surface-roughness parameters could be fit using idealized microscale flow solvers, by resolving the aerodynamic drag over a simplified geometry describing the topography.



Scope

The student would investigate the use of OpenFOAM computational fluid dynamics (CFD) solver to characterize aerodynamic roughness, performing simulations under idealized microscale conditions. Depending on the density of the roughness elements, these will be modelled by objects or a porous media, the latter characterized by a frontal-area density. The work will also focus on the applicability of analytical models such as Macdonald et al. (1998) for urban fabric or Thom (1971) for forest canopies. Additionally, flow simulations over arrays of wall mounted prisms or cylinders will be considered to investigate roughness sheltering and Reynolds number dependency on those drag laws.

Keywords: Atmospheric boundary layer, microscale flows, surface roughness, aerodynamic drag

Thom AS (1971). Momentum absorption by vegetation. Q. J. Royal Meteorol. Soc. doi:10.1002/qj.49709741404
Macdonald RW, Griffiths RF, Hall DJ (1998). An improved method for the estimation of surface roughness of obstacle arrays. Atmos. Env. doi:10.1016/S1352-2310(97)00403-2