Assessment of consistent two-equation closure for forest flows

Andrey Sogachev (1), Dalibor Cavar (1), Andreas Bechmann (1), Hans Ejsing Jørgensen (1)

(1) Wind Energy Department, Technical University of Denmark, Roskilde, Denmark

Two-equation closure is a pragmatic compromise between simple first-order and more complex higher-order closure schemes for modelling atmospheric flows with CFD. However, the problem of treating plant drag has seriously limited the use of such closures in many applications. Recently a consistent closure implementing those effects was developed through consideration of the behaviour of the supplementary equation for the length-scale-determining variable in different turbulent flows (Sogachev et al., 2012: Boundary Layer Meteor., 145, 307-327). Being consistent with the canonical flow regimes of grid turbulence and wall-bounded flow, the closure suggested is also valid for homogeneous shear flows commonly observed inside tall vegetative canopies.

The present work assess the plant drag closure by comparing results of two different CFD models against observations derived over the forested area of Østerild in Denmark. Part of the forest was cut in 2011, and this provided a unique opportunity for testing models allowing two scenarios for land use and corresponding observation datasets (2008 – 2013). The numerical experiments show that the treatment of plant drag in the closure has universality and can be applied for any two-equation closure. Results derived by different CFD models with k-epsilon and k-omega closure are similar and in good comparison with observations. Overall, numerical results show that the closure performs well, opening new possibilities for application to tasks related to the atmospheric boundary layer—where it is important to adequately account for the influences of vegetation.