EMS7/ECAM8 Abstracts,
Vol. 4, EMS2007-A-00659, 2007
7th EMS Annual Meeting / 8th ECAM

On the stability dependence of the roughness length for very rough natural surfaces

S. Zilitinkevich (1,3), **I. Mammarella** (1), A. Baklanov (2), S. M. Joffre (3)

(1) University of Helsinki, Finland, (2) Danish Meteorological Institute, Denmark, (3) Finnish Meteorological Institute, Finland

The concepts of the roughness length, z_{0u}, and displacement height, d_{0u}, has been introduces in engineering fluid mechanics to parameterize the effect of the flow interaction with the surface roughness elements in the wall law linking the surface stress (or friction velocity, u_*) with the mean flow velocity. It is recognised that z_{0u} depends on the typical height, h_0, and the shape of roughness elements and, over smooth surfaces, on u_* and the molecular viscosity v; d_{0u} is usually taken proportional to h_0. These concepts have been universally adopted in environmental fluid mechanics, although land surfaces are often complex and extremely rough. Roughness elements, e.g. for forest or urban canopies, could be as high as $h_0 \sim$20–50 m, which is quite comparable with the Monin-Obukhov length scale, L, characterising typical sizes of turbulent eddies. In these conditions it is only natural to expect that the surface resistance, and therefore the effective values of the roughness length, z_0, and displacement height, d_0, could depend on the static stability. To the best of our knowledge, the effect of stratification on z_0 and d_0 was never considered until present. We develop a theoretical model accounting for this mechanism and validate it against experimental data. It is disclosed that the stability dependence is especially strong in stable stratification. Recommended formulation is ready for use in modelling applications.