On modelling area averages (aggregation) of momentum and surface heat fluxes based on satellite observations of LAI, land cover, surface temperature and roughness.

Niels Otto Jensen and Charlotte B. Hasager

n.o.jensen@risoe.dk

Risø National Laboratory, Wind Energy Department, Roskilde, Denmark

Abstract:

A new concept for aggregation (area-averaging) the roughness lenghts for the momentum and sensible heat flux is described. The result are the so-called effective roughness values that are useful for the calculation of the surface energy balance and surface fluxes at larger scales e.g. in climate models, weather forecasts and hydrological modelling in heterogeneous landscapes. Typically a ratio between the momentum roughness, z_0, and temperature roughness, z_{0t}, of the order of 10 (the kB^{-1} factor) is assumed. In the current work the ratio between them is directly calculated based on a set of linearized atmospheric flow equations including a viscous sub-layer resistance (i.e. the local z_{0t}) of the different land cover types in the terrain. The equations are solved by Fast Fourier Transforms and iteratively solved in regard to stability (Monin-Obukhov), viscous sub-layer and water roughness (Charnock). The model is a microscale model, i.e. calculates the area-average of $\langle z_0 \rangle$ and $\langle z_{0t} \rangle$ for each large grid cell containing a number of local microscale patches of the size order of 30-1000 m. At this horizontal length scale the non-linear advective effects are highly significant. The model inputs are surface temperature maps, leaf area index maps and land cover maps based on high-resolution optical satellite or airborne scenes. The local roughness length for momentum is assigned per pixel based on land cover type and vegetation height. For bare soil, water and urban area there is a constant ratio between the local values of z_0 and z_{0t} but in vegetated areas the ratio is dependent on vegetation type and leaf area index. Therefore $\langle z_0 \rangle$ and $\langle z_{0t} \rangle$ are no longer proportional.