Geophysical Research Abstracts, Vol. 7, 06782, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06782

LES of neutral ABL flow over random roughness distributions with different scales of heterogeneity

E.Bou-Zeid (1), M.B. Parlange (1,2), and C. Meneveau (3)

(1) Department of Geography and Environmental Engineering and Center for Environmental and Applied Fluid Mechanics, Johns Hopkins University, Baltimore, Maryland, USA, (2) School of Architecture, Civil, and Environmental Engineering, Swiss Federal Institute of Technology at Lausanne (EPFL), Lausanne, Switzerland, (3) Department of Mechanical Engineering and Center for Environmental and Applied Fluid Mechanics, Johns Hopkins University, Baltimore, Maryland, USA

Large eddy simulation (LES) dynamically captures the effect of changes in land cover on atmospheric flow and hence is a very useful tool for modeling of the non-linear land-atmosphere interaction over heterogeneous terrain. However, to be faithful to the physics of atmospheric boundary layer (ABL) flow over heterogeneous and complex terrain, the LES needs a fully local subgrid-scale (SGS) model that does not require any directions of statistical homogeneity for averaging. We have implemented such an SGS model, the Lagrangian dynamic scale-dependent model, in LES and validated the code against classic results for flow over homogeneous terrain and against field experimental results (Bradley's 1968 experiment) for flow over an abrupt change in surface roughness.

Subsequently, we performed LES of ABL flow over random distributions of surface roughness and looked at the effect of roughness heights and heterogeneity distribution on land-atmosphere interaction. The 'effective surface roughness' and 'blending height' were computed to quantify momentum transfer at the earth surface. An 'integral length scale' was defined to characterize the spatial scale of surface heterogeneity, based on the structure function (variogram) of the surface roughness.

As one expects, for surfaces with low variation of the roughness heights, land-atmophere interaction is rather insensitive to the spatial distribution of the roughness and the effective surface roughness changes little with the scale of heterogeneity. On the other hand, for surfaces with significant variation of the roughness height, momen-

tum transfer at the earth surface is significantly enhanced as the heterogeneity scale is decreased. Furthermore, we show that the effective surface roughness for random patches can be well estimated using a parameterization we previously developed and tested for regular patches.