Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07714, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07714
EGU General Assembly 2008

Impact of terrain heterogeneities on coherent structures properties in the surface layer: experimental and numerical approaches

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This study investigates experimentally and numerically the impact of terrain complexity on the coherent structures properties using large-eddy simulation (LES) performed with and without forest canopy and turbulence data collected by two sonic anemometers at 10 and 30m height on the 30-m tower of the SIRTA observatory (Palaiseau, France). Using an objective detection technique based on wavelet transforms of fluctuations time series of atmospheric variables (vertical wind component or temperature) measured by the SIRTA and simulated by LES, the study shows that whatever the upstream complexity of the terrain, the coherent structures display turbulence properties which are independent of the complex nature of the terrain. Indeed, the frequency of occurrence, time duration of the coherent structures, the time separation between two structures and their relative contribution to the total fluxes (momentum and heat) appear to be independent from the upstream roughness. These results are fundamental since these coherent structures contribute significantly to the energy and matter transport between the surface and the atmosphere, and their “universal” properties may probably facilitate their parameterization in the numerical models even in presence of surface heterogeneities.