



## Multiscale plant wakes, turbulence and non linear scaling flexible effects

Teresa Vila (1), Jose M. Redondo (1), and David Velasco (2)

(1) Universidad Politecnica de Catalunya, Dept. Fisica Aplicada, Applied Physics, Barcelona, Spain (teresa@fa.upc.es, +34 93 4016090), (2) Universidad Politecnica de Catalunya, Dept. Eng. Hidraulica, Barcelona, Spain

We present velocity ADV measurements and flow visualization of the turbulent wakes behind plant arrays, as these are often fractal in nature, we compare the multifractal spectra and the turbulence structure behind the wakes. Both statistical measures allowing to calculate integral lengthscales and their profiles modified by the plant canopies [1,2] as well as intermittency and spectral behaviour

are also measured [3,4]. We distinguish several momentum transfer mechanisms between the canopy and the flow, an internal one where lateral turbulent tensions are dominant, and another one just above the plant average height dominated by vertical Reynolds stresses. Visualization of flow over individual plant models show the role of coherent vortices triggered by plant elasticity. The deformation rate of the plants and their Youngs modulus may be correlated with overal plant drag and geometry. This is modified strongly in fractal canopies. Large turbulent integral scales are linked to rugosity and the scaling of the waves.[5,6] Pearlescence experiments where local shear is visualized and numerical simulations of Fractal grids are compared following [7].

- [1] Nepf,H.M. Drag, turbulence and diffusion in flow through emergent vegetation. Water Resources Res. 35(2)(1999)
- [2] Ben Mahjoub,O., Redondo J.M. and Babiano A. Jour.Structure functions in complex flows. Flow Turbulence and Combustion 59, 299-313.
- [3] El-Hakim, O. Salama, M. Velocity distribution inside and above branched flexible roughness. ASCE Journal of Irrigation and Drainage Engineering, Vol. 118, No 6, (November/December 1992) 914-927.
- [4] Finnigan,J. Turbulence in plant canopies. Annu. Rev. Fluid Mech. 2000 , Vol. 32: 519-571.
- [5] Ikeda, S., Kanazawa, M. Three- dimensional organized vortices above flexible water plants. ASCE Journal of Hydraulic Engineering, Vol. 122, No 11, (1996) 634-640.
- [6] Velasco, D.,Bateman A.,Redondo J.M and Medina V. An open channel flow experimental and theorical study of resistance and turbulent characterization over flexible vegetated linnings. Flow, Turbulence and Combustion. 70, 69-88.
- [7] Layzet S. Vassilicos C. Vila T and Redondo J.M. I.O.P Fractal grids and wakes, Proceedings on Earth sciences (2009)