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Optical flow velocimetry inside an entrained cavity

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ABSTRACT

A number of studies have referred to the existence of a vortex cell within an urban street canyon when ambient winds aloft are perpendicular to the street. The understanding of vortex dynamics or vorticity distribution in a such configuration is of great interest. Vortex structures play an important role in the dynamics of pollutant dispersion. This configuration was simulated by the interaction between a boundary layer and a cavity. Experimental characterisation of the vortex structures evolution was developed by flow velocity measurements inside and out of the cavity. Classical methods like hot wire and Laser Doppler Velocimetry (LDV) display only local measurements. Particle Image Velocimetry (PIV) method is based on the optical flow technique developed by G. Quénot (1992). Optical flow computation consists in extracting a dense velocity field from an image sequence assuming that the intensity is conserved during the displacement. Compared with the classical DPIV method, this technique has the following advantages: (i) it can be applied simultaneously to sequences of more than two images; (ii) it performs a global image match by enforcing continuity and regularity constrains on the flow field. This helps in ambiguous or low particle density regions; (iii) It provides dense velocity fields (neither holes nor border offsets); (v) local correlation is iteratively searched for in regions whose shape is modified by the flow, instead of being searched by fixed windows. This greatly improves the accuracy in regions with strong velocity gradients.

An approach Large Eddies Simulation was developed to characterise the flow vortex structures in the cavity . The experimental results obtained by PIV based on optical flow are used in order to valid the numerical model. This technique emphasis the vortex structures inside the cavity which present small scales as well as large scales related to the cavity geometry. Theses vortices are usually non-stationary.