Measurements of flow over an urban canyon model using HWA and PIV techniques

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Resumo

Neste artigo são apresentados resultados preliminares de medidas em túnel de vento utilizando as técnicas de anemo-metria de fio-quente e velocimetria por imageamento de partícula sobre um modelo físico tipo cânion urbano.

1. Introduction

The preliminary results presented herein are the starting point of a series of wind tunnel simulations to be carried out along the next two years in connection with a larger project (Fisch, 2008). In the present stage we tested instrumentation and data processing. We present results for a model of an urban canyon type, for which vertical profile were studied by means of the hot-wire anemometry technique (HWA) and the velocity fields were obtained using particle image velocimetry (PIV).

In the next stage, we will apply those techniques to study wind flow over the area of the Alcântara Launch Center (ALC) as it was done by Pires et al. (2010) in a preliminary analysis. The main goal is to characterize the mean flow and the turbulence across the ALC, from the ocean, passing by a cliff and reaching the launch pad. Scaled experiments will then be tested against field observations. Thus, wind characteristics obtained in wind tunnel can be used to assess structure stresses over rockets and launch tower as well as input data to dispersion models, a current environmental concern.

2. Results

We deployed a close circuit wind tunnel with an open section test. Experimental setup for HWA and PIV are similar to those used by Avelar et al. (2008) and Pires et al. (2010). The simulations results show non-dimensional speed and turbulence are very little dependent on the canyon width or on free flow speed (Fig. 1 shows an example). Three common dimensionless positions in these two configurations were chosen to compare the results: (1/4, 2/4, 3/4)h/d for the canyon 4h and (2/8, 4/8, 6/8)h/d for the canyon 8h. For example, speed profiles keep grouped above the canyon height for each nominal speed, 2, 5, and 10 m/s. Results of PIV simulations show that a recirculation pattern is displaced with respect to the canyon center according to the flow speed.

3. Further comments

We presented an overview of a set of experiments using the HWA and the PIV techniques. In this paper we intended mainly to show the technique potential to study atmospheric flows. Besides urban canyon studies, the techniques can be applied to the flow over a cliff as it occurs in the Alcântara Launch Center area and to the study of the impact of clearings on tropical rain forests. Usually, in the Amazonian forest, the meteorological stations are installed by cutting trees and making an open space. That study will help to understand how the circulation inside this clearing is related to the flow above forest.

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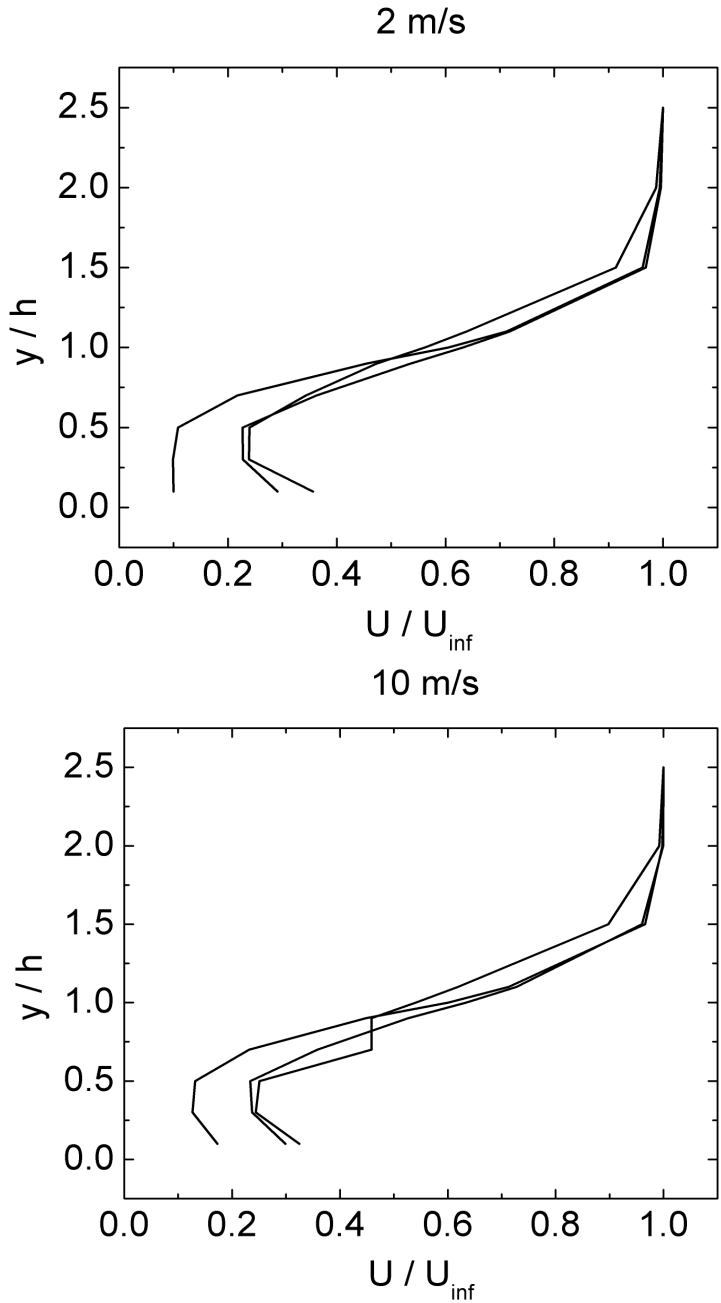

Figure 1. Example of wind profiles for a canyon of width $d = 4h$. After normalization they approximately match each other, unless for the position $x = h$, where the flow is about 1 m/s below the canyon height.

References

Avelar A.C., Banhara J.R., Fico Jr. N.R., Andrade C.R., Zaparoli E.L., 2009: Experimental and numerical investigation of roughness and three-dimensional effects on the flow over shallow cavities, in 39th AIAA Fluid Dynamics Conference 22 - 25 June 2009, San Antonio, Texas.

Fisch G., 2008: PROJETO ECLICLA – Estudo da Camada Limite Interna na região do Centro de Lançamento de Alcântara. In: XV Congresso Brasileiro de Meteorologia, 2008, São Paulo.

Pires L.B.M. Roballo S.T., Fisch G., A.C. Avelar, Girardi R.M., Gielow R., 2010: Atmospheric flow measurements using the PIV and HWA techniques, **J. Aerosp.Technol. Manag**., **2**, 127-136.