LES of convective PBL over a heterogeneous surface

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Resumo

Neste trabalho o modelo LES é utilizado para estudar as influências de diferentes comprimentos de rugosidade na estrutura turbulenta da camada limite convectiva. O aumento de temperatura está relacionado ao aumento no comprimento de rugosidade na área central.

1. Introduction

The Planetary Boundary Layer is an inherently non-linear and heterogeneous system, under permanent transition and enforced by a variety of internal and external physical process (Stull, 1988). The knowledge of the structure and dynamics of the PBL is therefore essential to the understanding of many fields, including dispersion of pollutants, cloud formation, local and mesoscale meteorology.

A numerical model widely used and currently appropriated to the study of the dynamics of the PBL is the Large-Eddy Simulation (LES). In this model, the large eddies are explicitly simulated and the small ones are parameterized (Deardorff, 1972; Moeng, 1984).

The aim of the present work is to give a contribution on the study of the impact of surface heterogeneities on the boundary layer dynamics. An improved version of a LES model, that accounts for the evolution of the moisture field and the presence of the heterogeneous surface, is used.

2. Experimental setup and statistical method

The surface is characterized in three patches with different roughness length.The central patch presents a roughness length $z_0 = 1$ m, while lateral patches are characterized by $z_0 = 0.1$ m. These values can represent those typical of urban and rural areas, respectively (Grimmond et al., 1998; Stull, 1988).

The LES model was initialized with zero mean wind. The simulations were performed with a domain size of 20 km x 10 km x 2 km and 256 x 128 x 128 grid points in x, y and z directions, respectively. The statistical analysis was performed following a method based on phase averaging (Hussain and Reynolds, 1970).

3. Results and discussion

Figure 1 shows horizontal cross-sections of the virtual potential temperature (θ_v) at two different levels. Very close to the surface (Fig. 1a), θ_v is larger over the patch with higher roughness length. This effect becomes weaker with height (Fig. 1b).

When a turbulent flow encounters a change in surface roughness, the mean flow accelerates or decelerates depending on whether the fluid flows from a rough onto a smooth surface, or vice versa (Claussen, 1987).

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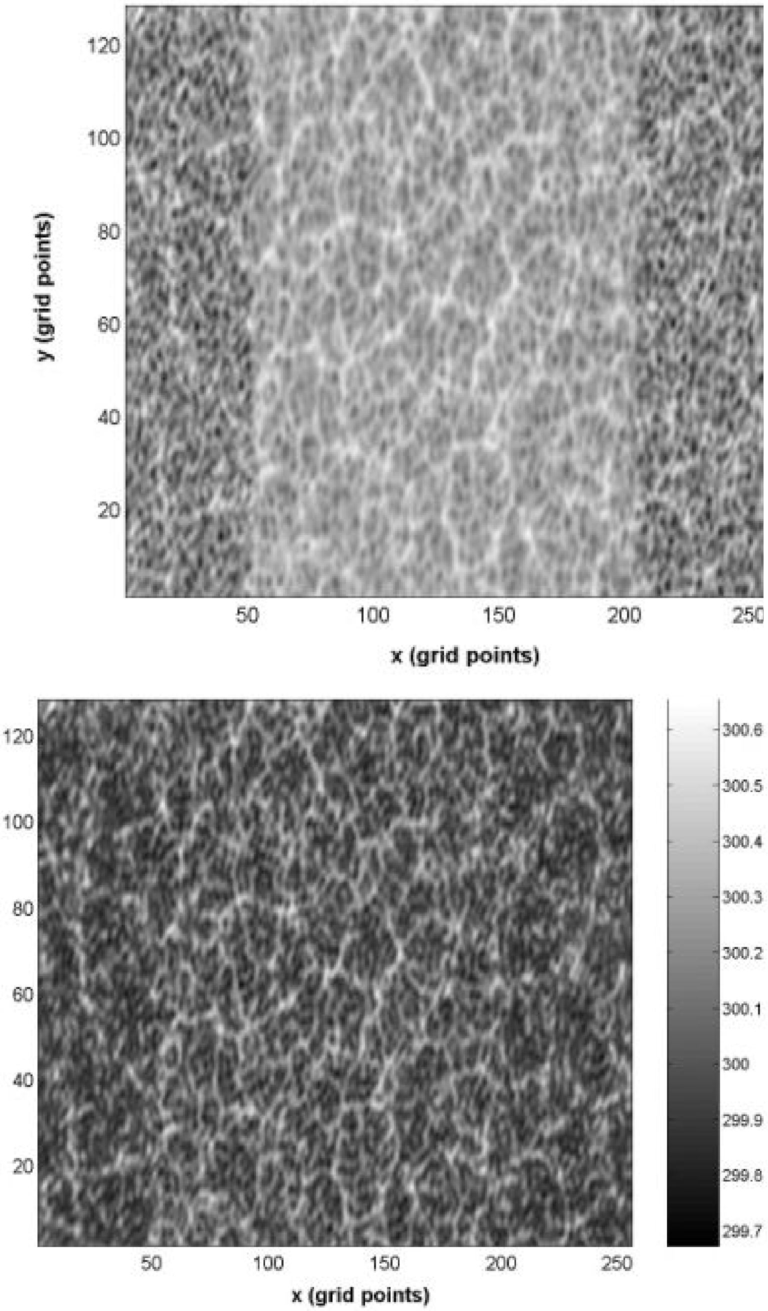

Figure 1. Horizontal cross-sections of virtual potential temperature at two different levels: (a - first) $z/z_i = 0{,}2$; (b - second) $z/z_i = 0{,}5$.

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