ELSEVIER

Atmospheric Research 74 (2005) 403–433

ATMOSPHERIC RESEARCH

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Ground-based remote sensing observation of the complex behaviour of the Marseille boundary layer during ESCOMPTE

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Received 31 July 2003; received in revised form 28 February 2004; accepted 30 April 2004

Abstract

Ground-based remote sensing systems have been used during the ESCOMPTE campaign, to continuously characterize the boundary-layer behaviour through many atmospheric parameters (wind, extinction and ozone concentration distribution, reflectivity, turbulence). This analysis is focused on the comparison of the atmospheric stratification retrieved from a UV angular ozone lidar, an Ultra High Frequency wind profiler and a sodar, above the area of Marseille, on June 26th 2001 (Intensive Observation Period 2b). The atmospheric stratification is shown to be very complex including two superimposed sea breezes, with an important contribution of advection. The temporal and spatial evolution of the stratification observed by the UV lidar and by the UHF radar are in good agreement although the origin of the echoes of these systems is quite different. The complexity of the

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0169-8095/$ - see front matter
doi:10.1016/j.atmosres.2004.04.007

dynamic situation has only partially been retrieved by a non-hydrostatic mesoscale model used with a 3 km resolution.

Keywords: ESCOMPTE; Boundary layer; Sea breeze; Lidar; Wind profiler

1. Introduction

During June and July 2001, the regional ESCOMPTE program has completed many air pollution investigations, from the Marseille–Berre region, in order to validate air pollution models (Cros et al., 2004) and predict photochemical pollution episodes. During this campaign, a side project was also devoted to the characterisation of the Urban Boundary Layer (UBL) dynamics more specifically over the Marseille town (Mestayer et al., in press). Joined efforts gave the opportunity to deploy, over Marseille, several ground-based remote sensing instruments such as lidars, radars and sodars, for a quasi-continuous monitoring of the low troposphere during the four 3-day intensive observation periods with low wind and high insolation favourable to high ozone concentration episodes and sea breeze events. These measurements were also accompanied by several punctual radiosoundings and airborne measurements. The aim of this study is to analyse, mainly through the ground-based remote sensing instruments, the structure and the dynamics of the urban boundary layer on June 26th, corresponding to a high ozone level day at the end of a photochemically polluted Intensive Observation Period (IOP2b). The analysis of the atmospheric stratification will show that the dynamics of the atmosphere is complex and cannot be limited neither to a single urban boundary-layer dynamics nor to a single sea breeze dynamics. This work will also give the opportunity to highlight some interesting correlations between remote-sensed measurements such as clear air radar and ozone lidar data. Both measurements providing well-matched information with additional specificities that help for the understanding of the Atmospheric Boundary Layer (ABL) evolution.

The analysis will be compared to a simulation from the Mesoscale NonHydrostatic Chemistry (MesoNH-C) model (Cousin et al., 2004). Two-way grid nested simulations are performed with a 9 km resolution for the large domain between latitudes 40.8°N and 47°N and longitudes 1.06°E and 10.02°E. The embedded ESCOMPTE small domain (3 km resolution) centered on Marseille and Berre pond is located between latitudes 42.7°N and 44.3°N and longitudes 4.22°E and 6.42°E. There are 54 vertical levels, 40 of which lie between the surface and 2500 m in the boundary layer. The simulation was started on June 21st at 0:00 UTC, at the beginning of IOP2a.

2. Tools for analysis of the boundary-layer stratification and dynamics

The location of the experimental set-up presented in the following is shown in Fig. 1. The sites were devoted to the Marseille UBL study and were situated either inside the town