3.1 THE UBL/CLU-ESCOMPTE EXPERIMENT : DESCRIPTION AND FIRST RESULTS

Patrice G. Mestayer [1] * and Pierre Durand [2]
[1] Laboratoire de Mécanique des Fluides, CNRS - Ecole Centrale de Nantes, France
[2] Centre National de Recherche Météorologique, CNRS - Météo-France, Toulouse, France

1. INTRODUCTION

The UBL/CLU-Escompte experiment aimed at documenting the four-dimensional structure of the urban boundary layer in connection with the urban canopy thermodynamics during a summer period of low wind and breeze conditions, from June 5 to July 15, 2001. The objective was mainly to construct a data base allowing to test urban energy exchange schemes and high resolution meteorological and chemistry-transport models.

The project took advantage of the large experimental set-up of the campaign ESCOMPTE (http://medias.obs-mip.fr/escompte) over the Berre-Marseille area, especially as concerns remote sensing from ground, airborne measurements, and the intense documentation of the regional meteorology. UBL/CLU appeared thus as an “associated project” of ESCOMPTE, with an additional experimental set-up to document the fine scale dynamics and thermodynamics of the urban atmosphere over the Marseille area, situated at Mediterranean coast, and involving more than one million of inhabitants.

While the ESCOMPTE campaign is described by the poster [P4.2], several participations in UBL/CLU are presented at this conference, and referred in this paper by their communication number between square brackets

2. THE EXPERIMENTAL SET-UP

The instrumentation was mainly deployed at 5 sites along the North-South axis of the city, roughly parallel to the shoreline.

* Corresponding author address: Patrice G. Mestayer, Laboratoire de Mécanique des Fluides, UMR CNRS 6598, Ecole Centrale de Nantes, BP 92101, 44321 NANTES cedex 03, France; e-mail: patrice.Mestayer@ec-nantes.fr

Four urban sites were equipped with micro-meteorological masts raising some 12 to 20 m above the urban canopy level [3.2, 14.6], where all the turbulent and radiation fluxes necessary to monitor the canopy surface energy budget were continuously measured. The turbulent fluxes were measured at 2 levels, except at the Observatoire site at only one level at 12 m above ground.

The central site (CAA) was located in the rather uniform, 19th Century, dense part of the city center [3.2]. It was also equipped with an array of up to 19 IR radio-thermometers, either fixed to monitor the surface temperature of selected elementary surfaces, or hand-held to evaluate surface temperature distributions during some periods of intense observation [9.4]. In this urban fragment thermometers also monitored the heat exchanges between building inside and outside during some periods.

Two IR radio-thermometers were also operated at the North site located in a suburban area of mixed constructions to monitor the composite surface temperatures of the ensembles immediately North and South of the site.
The two sub-urban sites (GLM and St Jerome) were equipped with mini-SODARs sounding the atmospheric surface layer [14.6] while the fourth urban site (Observatoire), close to the city center was equipped with a wind profiler UHF radar and a tethered balloon occasionally measuring thermodynamic and ozone profiles from 20 to 300 m.

Two scintillometers were set to measure the integrated heat flux over the city center, with 2.5 km optical paths oriented N-S and E-W [14.8 and 14.9].

At the hilly northern border of the city, the site Vallon Dol hosted a 10 m high mast with a sonic anemometer, a RASS-SODAR vertical sounder, and two 3-D scanning LIDARS measuring O3 concentration, particle concentration, and wind, over a range of about 10 km. They were operated in parallel to generate tomographic observations of the urban boundary layer.

The permanent set-up also included an array of 20 T-RH continuous recorders at a 6 m height over the ground [3.4], while transect T-RH measurements were occasionally made from the “T-RH Clio” car.

3. THE SET OF DATA OBTAINED

Most measurements were recorded continuously during the 6 weeks of the campaign, with the exception of the SODAR which were either shut up or operated at reduced power during nights and week-ends.

Two types of intensive observation periods (IOP) were more densely documented :
- the 5 ESCOMPTE IOPs (for a total of 15 days), generally during breeze situations. During these periods several airplanes measuring the atmospheric composition, turbulence within or at the top of the boundary layer, or wind field transects flew over Marseille to document the urban boundary layer;
- the 4 InfraRed days (or POI CLU in French), when an airplane equipped with a thermal infrared mapping camera scanned the urban canopy at different times in the day. The influence of spatial resolution and sensor orientation on the surface temperature measurement were documented by flying in 8 different directions with respect to the sun over the same 3 typical city quarters, especially the city center around the CAA site monitored by the array of IR radio-thermometers ; air temperature at 2 m level was also monitored with the “T-RH Clio” driven under the flight path.

The data base also includes a set of satellite images :
- about 170 images from the NOAA-AVHRR (4 images per day from June 4 to July 16) obtained from the HRPT (Modene, Italy) ;
- 2 ASTER high resolution VNIR, SWIR and TIR images covering Marseille (19 June, 5 July) and one the Marignane area (5 June), from the NASA Jet Propulsion Laboratory [3.3] ;
- the multi-spectral and panchromatic SPOT images of 17 June.

Finally the data set includes the maps that are being obtained from the specific analysis of the data base BDTopo of the IGN (French national geographic institute) which includes such urban objects as buildings, constructions, vegetation, etc. These high resolution maps include urban land uses, roughness parameters, etc. [4.4] .

All these data are being included within the ESCOMPTE data base [P4.2].

3. THE COOPERATIVE DATA ANALYSIS

While 11 groups participated in the field experiment, more than 17 groups participate in the data analyses, within seven main axes of cooperative studies :

- testing and validating the thermodynamic urban soil models and surface-atmosphere flux parameterized schemes [3.4], [9.4], [11.3] ;

- developing the algorithms to retrieve surface albedo, surface temperature, and heat flux in urban areas from satellite visible and IR channels [3.3] ;

- testing the models computing at a high spatial resolution the urban cover modes and roughness parameters [4.4] ;

- documenting the 4-D structure of the dynamic fields in the urban boundary-layer, including its depth, mainly in land-sea breeze conditions ;

- analyzing the spatial variability of urban micro-climatology and its relation with the structure of the urban fabrics ;

- testing the ability of high spatial resolution meteorological models to reproduce the details of the urban boundary layer dynamics ;

- providing reference dynamic fields for numerical simulation of urban air quality with high resolution models.

ACKNOWLEDGEMENTS

The project UBL/CLU-Escompte is funded by the CNRS programs for remote sensing from space (PNTS) and atmospheric dynamics (PATOM). As an ESCOMPTE associated project it also benefited from the ESCOMPTE funding (see P4.2).