Data Collection for Mesoscale Model Validation: A Field Campaign

A contribution to subproject SATURN

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Introduction

The Great Lisbon Area (GLA), because of its industrial and urban importance, is an example of a region with high emission levels and photochemical air pollution problems. On the other hand, it is located on a coastal zone with a complex coastline associated with significant terrain features and sea/land breezes circulation, which result in a complex airflow circulation. Therefore, the knowledge and characterisation of mesoscale air flow patterns as well as its effect on the dispersion of atmospheric pollutants is fundamental. That is the reason why experimental fieldwork and the complementary application of numerical modelling are essential for this study.

Field campaign

In this context, two field campaigns (meteorology and air quality) were carried out in Lisbon region from 8th to 18th July, 1996 and 1997, searching for typical synoptic summer situations. The campaigns were structured in order to integrate all monitoring stations (public or private) located in the study domain. Mobile monitoring stations, whose location was based on numerical simulation, were also used. Generally, temperature, relative humidity, wind speed and direction were measured at every meteorological station. The ozone (O_3), carbon monoxide (CO), nitrogen oxides (NO_x) and sulfur dioxide (SO_2) concentration were measured at air quality stations (Fig. 1). Ground-based information, radiosondes and tether-balloon soundings have also been made. The tether-balloon sounding system includes both meteorological data acquisition and ozone sensors. In the summer campaign 1997, the vertical structure of the atmospheric boundary layer was also studied with aircraft measurements in the

Proceedings of EUROTRAC Symposium '98
Editors: P.M. Borrell and P. Borrell

scope of the STAAARTE programme (Scientific Training and Access to Aircraft for Atmospheric Research Throughout Europe). The flights performed with the instrumented aircraft had *in-situ* monitoring of atmospheric pollutants.

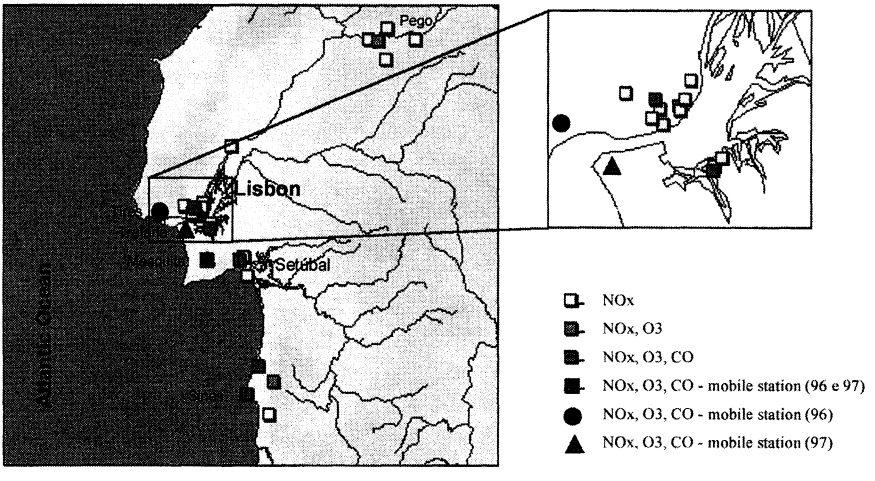

Fig. 1: Location of air quality stations and pollutants measured at GLA.

Mesoscale and photochemical dispersion simulation at GLA

To calculate the summer mesoscale circulations and the ozone field concentration over GLA, the MAR system (Barros, 1994; Barros *et al.*, 1995) has been applied, forced with the most frequent summer synoptic circulation type over the Iberian Peninsula and using a clean air approach. The emission data are based on a top-down scheme performed over the CORINAIR 90 emission inventory (see Emission inventory for simulation and validation of mesoscale models). The MAR system was applied at the LisbEx 96 domain (200 × 200 km, around Lisbon city) with a grid spacing of 4 kilometers. The output wind, temperature and ozone fields (Figs. 2 and 3) were compared with measured data recorded during day 3 (10th of July) of the LisbEx 96 campaign, which was considered one of the most representative days for summer conditions.

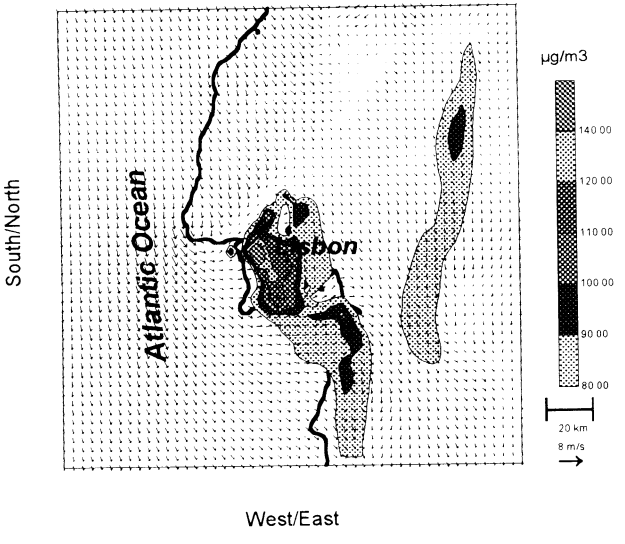

Fig. 2: Early afternoon (14:00 LST) wind field (10 m GLA) and ozone field concentration in $\mu g\ m^{-3}$.

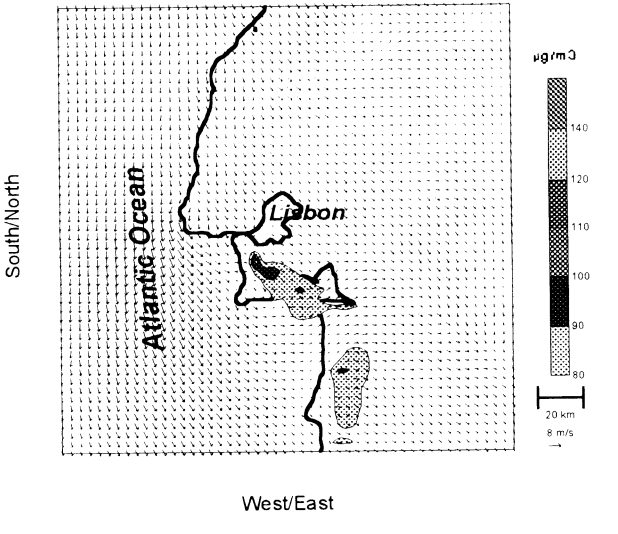

Fig. 3: Early evening (18:00 LST) wind field (10 m GLA) and ozone field concentration in $\mu g\ m^{-3}$.

Meteorological scenario

The lower troposphere pressure field for the 10th July, 1996 was characterised by the presence of the Azores anticyclone extended in a ridge over the northern

part of the Iberian Peninsula, promoting a continental dry and very hot circulation over Portugal. Strong insulation allows the formation of mesoscale circulations and photochemical production.

Wind and temperature field evaluation

For the wind direction, the MAR system gave a good agreement with the measured data for Lisbon, predicting the time of the breeze wind rotation. As for wind velocity, it has some difficulties after the sunset but before the sunrise and during the day, the system gave a sufficient performance. For temperature, the system tends to over predict during the night and under predict during the day.

Ozone field evaluation

To compare the ozone predictions with observations, a quantitative error analysis has been utilised (Keyser and Anthes, 1977). Results found for Mvelho station (nearby Sines), Século station (Lisbon, centre city) and Tires (near by Tejo river mouth) for the LisbEx 96 day 3 are presented in Table 1. RMSE (root mean square error) can be considerable reduced if a constant bias is removed. This bias could be the result of uncertainties verified during the specification of the initial and lateral boundary conditions. Skill is demonstrated when: $S \approx S_{obs}$, $E < S_{obs}$, and $E_{ub} < S_{obs}$. For the Século station, skill can not be demonstrated because of its centre city placement, very close to pollutant sources and, thereby, strongly affected by local emissions. All emission data base errors might be considerably amplified which would effect the system predictions.

Table 1: Error analysis of system predicted ozone for the Mvelho, Século and Tires stations.

Stations	E	E_{ub}	S	S_{obs}	S/S_{obs}	E/S_{obs}	E_{ub}/S_{obs}
Mvelho	43.7	10.1	14.4	14.4	1.0	3.0	0.7
Século	37.1	28.3	30.6	5.6	5.5	6.6	5.1
Tires	50.9	26.7	22.0	38.9	0.6	1.3	0.7

E : root mean square error (RMSE) S : standard deviations of predicted data
E_{ub}: RMSE after a constant bias is removed S_{obs}: standard deviations of observed data

Conclusions

The field experiment, LisbEx 96, is a fundamental tool for future work on GLA in order to understand better the photochemical phenomena of a coastal city like Lisbon and contribute for the numerical model validation under complex mesoscale circulations. The preliminary evaluation work shows that the MAR system can perform an adequate mesoscale and photochemical prediction for the

GLA but still there is work to be done related with emission database. The data analysis and the numeric simulations for photochemical production and advection under mesoscale circulation influence had shown the strong influence of this type of circulation in Portugal, particularly, in the Lisbon region and the influence over Sines region.

Acknowledegments

The authors would like to thank to PRAXIS XXI Programme for the support to the Projects AMAZOC (PRAXIS/3/3.2/AMB/38/94) and IGLO (PRAXIS/3/3.2/EMG/1949/95). This work was also supported by DGA (PEAM/P/AMA/603/95).

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