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Local circulations over complex terrain in the Northeast of Portugal - Modelling O3 transport

C. Gouveia (1) and M. L. R. Liberato (2)

(1) Escola Superior de Tecnologia de Setúbal (EST), Instituto Politécnico de Setúbal, Portugal (cgouveia@est.ips.pt) (2) University of Trás-os-Montes e Alto Douro, Physics Dept., Portugal.

In recent years awareness of the importance of evaluating the intensity and the impact of transport and transformation of atmospheric pollutants aroused and these processes, on regional to local air quality, in relation to climate and atmospheric composition change, became focus of exhaustive research.

Satellites allow studying global transportation as well as local phenomena, being these observations compared to ground measured data, substantiating the importance of regular measurements both in urban and background locations. Usually background automatic stations are installed in locations where concentration levels are considered constant so that background values may be considered as a reference.

Measurements of O3 (in addition to NO, NO2, SO2) concentrations have been made at a background automatic station located at Lamas de Olo, Vila Real, in the North of Portugal since February 2004. Surprisingly, the data for O3 concentrations obtained at this background automatic station revealed several days with extremely high concentration values, indicating a frequent violation of the EU health protection standards at this rural site. Whether these frequent exceedances result from stratospheric intrusions or from local scale air-pollution transport and transformation processes is still a question of debate and was the motivation for this study of local atmospheric circulation on a rural region characterized by complex terrain.

We begin by describing the rural surface O3-concentration measurements made at the mentioned background station and by performing its seasonal evolution evaluation. Results show that ozone exceedances occurred on more than 100 days within the

2004-2007 period. Seasonal evolution of ozone monthly mean values shows a clear broad spring-summer maximum, which peaks in April. Furthermore maximum values seasonal evolution makes evidence of exceedances occurring from April to October, with an increase of maximum values from April to July.

Afterwards prior to the air-pollution and dispersion study a first evaluating study of local atmospheric circulation simulation has been performed. This is particularly important for pollutants such as ozone which while arising from complex atmospheric chemical reactions is also subject to scale dependent transport and dispersion processes. Our first step was to evaluate how the available air-quality model simulates atmospheric circulation in the study region. The model used in this study is the Atmospheric Dispersion Modelling System (ADMS), which is a second-generation Gaussian dispersion model and one of the more traditional types of environmental impact "plume" models. Numerical simulation of atmospheric circulation is performed through the application of a 'met pre-processor', FLOWSTAR Model, also developed by CERC (Cambridge Environmental Research Consultants) to calculate airflow over complex terrain including the effects of stratification and variable surface roughness.

Our results show that FLOWSTAR Model generally captured the observed diurnal variations and magnitude of wind direction and speed, making evidence of its topographic character. Thus FLOWSTAR model revealed to be a tool that simulates adequately the airflow in the study region for the considered scenarios. Our results make evidence of the important effect of taking in consideration an acute surface roughness distribution in the performed simulations. Finally, the impact of complex terrain on air pollution over this region is analyzed with CERC's air dispersion model. Results for days of exceptional exceedances are discussed in detail.

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