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Air quality assessment for Portugal

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Abstract

According to the Air Quality Framework Directive, air pollutant concentration levels have to be assessed and reported annually by each European Union member state, taking into consideration European air quality standards. Plans and programmes should be implemented in zones and agglomerations where pollutant concentrations exceed the limit and target values. The main objective of this study is to perform a long-term air quality simulation for Portugal, using the CHIMERE chemistry-transport model, applied over Portugal, for the year 2001. The model performance was evaluated by comparing its results to air quality data from the regional monitoring networks and to data from a diffusive sampling experimental campaign. The results obtained show a modelling system able to reproduce the pollutant concentrations' temporal evolution and spatial distribution observed at the regional networks of air quality monitoring. As far as the fulfilment of the air quality targets is concerned, there are excessive values for nitrogen and sulfur dioxides, ozone also being a critical gaseous pollutant in what concerns hourly concentrations and AOT40 (Accumulated Over Threshold 40 ppb) values.

Keywords: Air quality; Numerical modelling; European legislation; Gas pollutants

1. Introduction

Air quality is one of the areas in which Europe has been most active in recent years. The European Commission (EC) defined an overall strategy through the setting of long-term air quality objectives. A series of directives has been introduced to control levels of certain pollutants and to monitor their concentrations in the air. In 1996, the Environment Council adopted the Framework Directive 96/62/EC (FWD) on ambient air quality assessment and management. This directive covers the revision of previously existing legislation and introduces new air quality standards for previously unregulated air pollutants, setting the timetable for the development of daughter directives for a range of pollutants. The list of atmospheric pollutants to be considered includes sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter, lead, ozone (O_3), and benzene, carbon monoxide (CO), polyaromatic hydrocarbons, and some heavy metals.

The FWD was followed by the daughter directives, which establish the numerical limit values, or, in the case of ozone, target values, for each of the identified pollutants. Besides setting air quality limit and alert thresholds, the objectives of the daughter directives are to harmonize monitoring strategies, measuring methods,

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calibration, and quality assessment methods to arrive at comparable measurements throughout the European Union (EU) and to provide good public information.

In terms of ambient air quality assessment, the FWD also introduces new guidelines, identifying modelling as an air quality management tool and defining that ambient air quality, throughout the territory of the member states, shall be assessed by a combination of measurements and modelling techniques to provide an adequate level of information on ambient air quality in respect to the relevant pollutants. In fact, measured concentrations available at given monitoring sites do not generally describe sufficiently the spatial distribution of air pollutants over wide areas, whereas this information is a crucial factor to evaluate the impact of air pollution on human health and natural ecosystems. Modelling systems can represent suitable tools for these purposes, allowing the study of air quality with an adequate spatial detail, the verification of the fulfilment of the limit targets and threshold values imposed by the EC directives, and also the assessment of appropriate emission reduction strategies.

Therefore, to assess the air quality at a regional level, verifying the fulfilment of the limit targets and threshold values imposed by the EC directives, and to understand the causes and origin of air pollution, numerical modelling exercises should be used. Recent works (Hogrefe et al., 2001) emphasize the importance of policy analysis on a "climatological" basis rather than of focusing on a single critical episode; this approach allows to better evaluate the model performances and to quantify policies effects with respect to long-term air quality standards. Several ozone modelling studies were already performed for Portugal, in β-mesoscale domains and during some specific and episode days (e.g., Barros et al., 2003; Borrego et al., 2000). Large-scale simulations including Portugal have also been done, but with a coarse grid resolution (Coutinho and Borrego, 1991). The present work represents an important and a pioneer scientific air pollution modelling study for Portugal, because it aims to assess the air quality over the whole continental region of Portugal for the most critical gaseous pollutants (SO_2, CO, NO_2 and O_3) and during the entire year of 2001, using a modelling system that was evaluated taking into account the EC Modelling Quality Objectives.

2. Methodology

CHIMERE is a 3D chemistry-transport model, based on the integration of the continuity equation for the concentrations of several chemical species in each cell of a given grid (Schmidt et al., 2001). CHIMERE has been used for several research applications, including sensitivity to anthropogenic or biogenic emissions (e.g., Beekmann and Derognat, 2003; Menut, 2003; Derognat et al., 2003), emission diagnostics (Vautard et al., 2003), or photo-oxidant forecasting over several regions of Europe (namely Italy and Belgium), being the official model for air quality forecasting over France and Paris region (Vautard et al., 2000). Results showed a reasonable skill for daily maximum forecasts of ozone with an averaged root mean square (RMS) error of about 10 ppb and 0.8 of correlation, which is in agreement with the ozone forecast model intercomparison experiment described in Tilmes et al. (2002). Besides this

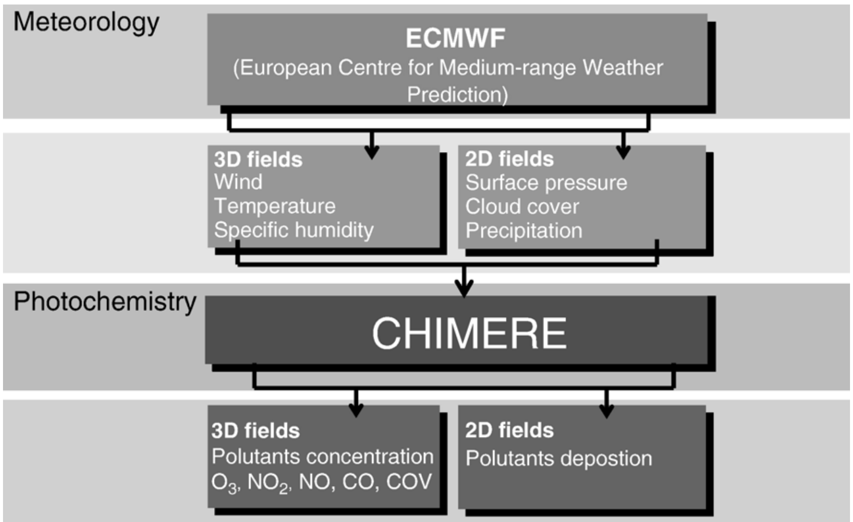

Fig. 1. Structure of the modelling system.