Studying High Ozine Levels in Bulgaria and Europe

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Abstract. The ozone pollution may cause damages on plants, animals and human beings when certain critical levels are exceeded. Therefore, it is important to study the actual ozone levels and the relationship between related emissions and the high levels of the ozone concentrations.
Two versions of the Danish Eulerian Model (DEM) are used in this study. The fine-grid version of DEM uses grid of 480×480 points (10 km resolution). The coarse-grid version of DEM is defined on a $96 \times 96 grid$ (50 km resolution). In the paper, an attempt is made as to answer the following three questions: (a) Where in Bulgaria and in Europe the highest levels of the ozone concentrations are located? (b) How big is the influence of the European emission sources on the pollution levels in the different parts of Bulgaria? (c) Is it possible to evaluate the changes of the pollution levels in Bulgaria and in Europe when the predicted for 2010 European emissions are used?

1 Introduction

High ozone concentrations can cause damages on plants, animals and human health. In fact, when the effects from high ozone levels are studied, one should look not at the ozone concentrations but on some related quantities. The following four quantities (high ozone level indicators) are important [1–3, 5]:

- **AOT40C** – Accumulated over threshold of 40 ppb hourly mean values of O_3 concentrations during the day-time period from May 1 to July 31 values. The crops are damaged when AOT40C exceeds 3000 ppb.hours.
- **AOT40F** – the same as AOT40C but accumulated during the period from April 1 to September 31. Forests are damaged when AOT40F exceeds 10000 ppb.hours.
- **NOD60** – Number of days in which the averaged over eight successive hours ozone concentration exceeds at least once the critical value of 60 ppb. If the limit of 60 ppb is exceeded at least in one 8-hour period during a given day, then the day is called "bad". People with asthmatic diseases have difficulties in "bad" days. It is desirable the "bad" days not to exceed 20 per year. It turns out that it is difficult to satisfy even this relaxed requirement. Removing all "bad" days is a too ambitious task.

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– **ADOM** – Averaged daily maxima of the ozone concentrations in the period from April 1 to September 30. This quantity is not directly related to some particular damaging effects. It is used to validate the model results. The model validation related to the other quantities is rather difficult as it can be seen later.

Three emission scenarios are run using the Danish Eulerian Model (DEM) discretized both on coarse (96×96) and fine (480×480) grid [6]:

– In the first scenario, called **Basic Scenario**, the emissions for 1997 from the EMEP inventories [4], are used.
– In the second scenario, called **Bulgarian Scenario**, the emissions for 1997 from the EMEP inventories are used, but the Bulgarian emissions are set to zero.
– The third scenario, **Scenario 2010**, is obtained by modifying the EMEP emissions for 1990 by the factors given in [1].

In **all** scenarios the meteorology for 1997 is used.

2 Validation of the Model Results

Comparisons of calculated by DEM quantities that are related to the high ozone concentrations with corresponding measurements taken at many EMEP stations located in different European countries are presented in this section. Only data from "representative" stations are utilized.

When AOT40C and AOT40F values are compared a station is considered representative if it measures at least 50% of the total number of hours in the respective period.

When NOD60 values are compared one requires that at least 50% of the 8-hour averages are available. This is a stronger requirement than in AOT40 cases because if one measurement is missing then eight 8-hour averages cannot be calculated.

When ADOM values are compared a station is considered representative if 50% of the daily maxima can be found. As to calculate the maximum for a given day, at least 20 hourly measurements must be available.

Note that the above criteria are different from the criteria used for representative stations in [6]. There, the daily mean values of the measurements are tested. In the present study the hourly mean values of the ozone concentrations are handled.

The results from the comparisons are summarized in Table 1.

It is clearly seen from the table, that the model overestimates AOT40 indicators. Calculations on the fine grid are somewhat closer to the measured values and the correlation coefficients are higher. This increase is substantially higher in case of ADOM indicator. But the real benefit from the enormous amount of calculations on the fine grid can be estimated when space distribution of various indexes is dealt with, especially for small areas.