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SPATIAL DISTRIBUTION OF BELGRADE AIR POLLUTION

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Abstract

Belgrade air pollution has been monitored by two monitoring networks for more than a decade now, but no overall characterization of the pollution based on those results has been published so far. We give here seasonal spatial distributions of SO_2, NO_2, and BS (black smoke) over the city area, and discuss the characteristics in terms of likely sources and their seasonal contributions.

Introduction

Air pollution in a developing urban area usually initially increases, passes through a maximum and then decreases, when pollution abatement becomes effective [1]. Cities in the industrialized western world are in some respects at the last stage of this development. In transition economies many cities are in the stabilization stage. In developing countries the pollution levels are still rising.

Belgrade is a hilly city with an average elevation of 116.75 m, and lies at the southern rim of the large Pannonian Plane.

There are 20 air pollution monitoring stations in the Belgrade city area, belonging to the network of the Institute of Public Health, IPH, (17 stations) or the Hydrometeorology Service of the Republic of Serbia, HSRS, (3 stations) [2]. They monitor various pollutants, but SO_2, NO_2, and BS (black smoke) are common to all. All 3 of the HSRS stations are equipped for automatic monitoring (except for BS), and only 3 out of 17 stations belonging to IPH are such.

Results and Discussion

After a critical analysis [3] the results of all 6 automatic monitoring stations of the two existing networks were selected to form the main input of a surfer-type software that plots spatial distributions of the concentrations. The results of only a few other "manual" stations were deemed reliable and included in the input. The plots of SO_2, NO_2, and BS concentrations are plotted in Figures 1, 2, and 3, respectively.

The plots of SO_2 (Fig. 1) indicate that the maximum in winter months is concentrated around the area with several poorly filtered large heating systems near the centre of the city. In summer, the maximum is shifted more to the industrial area near the Danube riverbank. This is a strong indication of extensive use of classical fossil fuels (coal and oil) for heating.

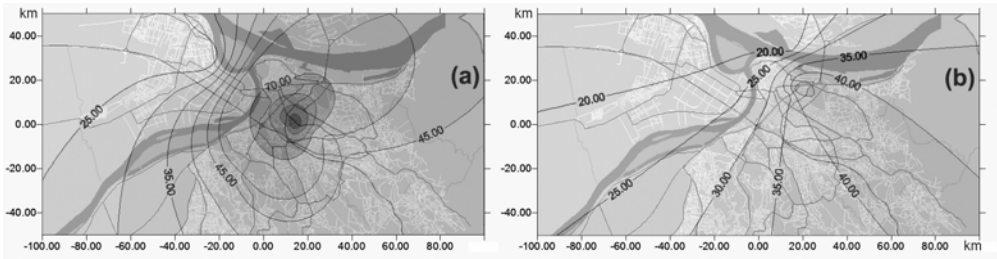

Fig. 1. Spatial distribution of SO_2 in (a) winter and (b) summer.

The plots of NO_2 (Fig. 2) feature open iso-concentration curves in some parts, which may be an artefact due to lack of data in those parts, but the winter superposition (Fig. 2a) indicates the contribution of the district heating plants located more prevalently in the western parts of the city. This contribution is absent in summer (Fig. 2b), and the summer plot basically reflects the traffic density distribution. However, overall NO_2 concentrations are moderate, indicating a moderate traffic load.

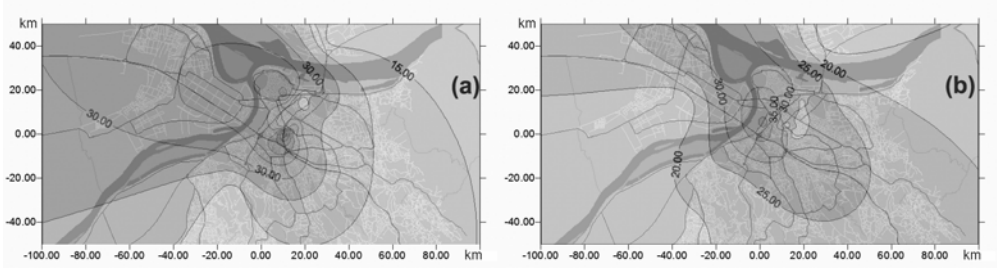

Fig. 2. Spatial distribution of NO_2 in (a) winter and (b) summer.

Both the winter and the summer plots of BS (Fig. 3) show a clear "island" of "clean" air around the monitoring station Košutnjak, which is expected, as it is an elevated urban background point. Generally, high BS concentrations seem to be confined to lower parts of the city, where particulate matter naturally accumulates. That indicates natural and traffic sources of this pollution. High summer BS concentrations to the north from the main city area also indicate a strong natural source of this parameter - natural dust, which is quite present in the north, towards the Pannonian Plain. In winter, there is an "island" of high BS pollution around the city centre, where most of the individual and poorly filtered heating sources are situated (Fig. 12a). In that period, district heating plants in the western parts of the area apparently add the seasonal contribution as well [4].

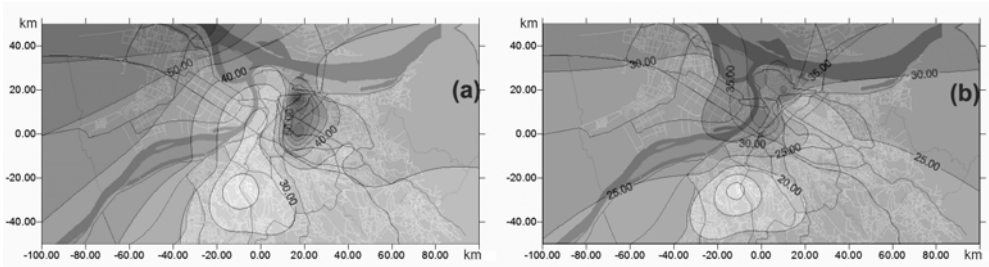

Fig. 3. Spatial distribution of black smoke in (a) winter and (b) summer.

Conclusion

The most significant characteristics of air-pollution in Belgrade are: high SO_2 and elevated BS pollution in the cold season mainly caused by domestic heating, NO_2 pollution that follows the temporal and spatial variations of traffic emissions and indications of significant natural contributions to BS.

In most respects, air pollution in Belgrade has characteristics of most East-European cities in the past decade, of countries in transition in which economic conditions have a strong effect on the atmospheric environment (the quality of the car fleet and types of environmental protection related installations at the stationary sources, as well as the type of home heating) [5].

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