

ECOLOGICAL MEASUREMENTS OF THE SURFACE CONCENTRATIONS OF O₃, NO₂, SO₂, DUST AND METEOROLOGICAL PARAMETERS IN CITY OF DEVIN, BULGARIA

I. IVANOV¹, V. GRIGORIEVA², M. MIHALEV², S. ARSOVA³

¹Firm "IVECOL", Ogneboretz 3, 1619 Sofia, Bulgaria

²Institute of Electronics, Bulgarian Academy of Sciences, 72 Tzarigradsko Chaussee, 1784 Sofia, Bulgaria

³Institute of Meteorology and Hydrology, Bulgarian Academy of Sciences, Plovdiv, Bulgaria

Abstract. Significant steps have been undertaken in recent years concerning the ecological control of air quality, provoked by the increasing environmental pollution. More information on pollutant sources and a better understanding of the mechanisms of pollutant extension under various meteorological conditions are necessary for solving local and regional air pollution problems and for protection the environment. In this paper we present the results of the estimation of the environmental state in Devin, Bulgaria. The dynamics of basic atmospheric pollutants — O₃, NO₂, SO₂ and dust is analyzed with respect to the meteorological conditions.

Keywords: air quality, environmental pollution

Introduction

The town of Devin (41° 45' N, 24° 24' E) is situated in Rhodope mountainous area, in southern Bulgaria. Typical for the site are the temperature inversions near the ground in the mornings and a great number of clear days including and wintry period. The measuring station was set in the center of the town, in a street of moderate urban transport. An analysis of the ambient air has been carried out from 17 to 29 of January 1993, twice in day - at 8.00h and 14.00h (Local Time). The measurements of the ozone content were made with a chemiluminescent O₃ analyzer, type 3—02P—1: the detection limit is about 2 µg/m³, the fast-response is of the order of 1 sec, the relative measuring error is *ca* 7%. The samples of ambient air for determination of NO₂, SO₂ and dust concentrations were taken in accordance with Bulgarian State Standard, as devices for taking of air samples were produced by "Himtest"- Sofia. The accuracy of the determination of NO₂, SO₂ and dust concentrations was comparable with that of O₃ measurements. On a parallel with the carrying out the air analysis, the meteorological parameters - atmospheric pressure, temperature, wind velocity, cloudiness have been measured.

Ecological measurements

The results of the performed investigations of the ecological state of the surface air in Devin are shown in Fig. 1. After calm and sunny days in the beginning of the experiment (18- 20 January), a period of unstable meteorological situation came - variable, cloudiness weather with wind velocity 1-3 m/s (Fig. 1a) and snowfall on 26 of January. The temperature variations with a sharp fall of the day temperature on 26th and the pressure variations (Fig.1b) illustrate meteorological situation during measuring period. The dust pollution in the air (Fig. 1c) has shown heightened values at stable meteorological conditions and has decreased several times reaching the standard value (average daily concentration) of 0.25 mg/m³ /1/ in conditions of atmospheric circulation during wind. The changes in the content of sulfur dioxide and nitrogen dioxide were of almost similar character (Figs. 1d and 1e). The NO₂ and SO₂ concentrations, detected in the period 18 - 26 January, have been caused mainly by vehicles and were enough low as compared with standard values — 100 µg/m³ and 150 µg/m³ /1/, respectively. On the average, the morning concentrations prevailed slightly over the day ones that may be related to the

morning temperature inversions near the ground typical for the site. The abrupt increase of the NO_2 and SO_2 content in the air on 27 of January, when their concentrations have reached values typical for strongly urbanized regions, was connected with the intensive use of heating systems by reason of the considerable fall in the day temperature on 26 of January. The burning of the fossil fuel also increased the dust pollution (Fig. 1c). The surface ozone variations are given in Fig. 1f. Although the concentration of ozone depends strongly on the character of the site and the height at which the measurements are made, the observed changes of the O_3 content (excluding 26 and 27 of January) - an increase of the day concentrations compared to the morning ones, is a rather typical phenomenon for continental countries with meteorological conditions without sharp fronts. The variations of the ozone near the ground are

discussed usually in terms of air mass transport and photochemical production. In winter the atmospheric conditions are not conducive to the photochemical O_3 formation. The surface ozone concentration remains low in the mornings until daybreak causes a breakup of the nocturnal inversion allowing the ozone-rich air downs from aloft. The recorded slight increase of the ozone morning concentrations on 21, 23 and 25 of January was connected with the presence of wind, which enhanced air mixing. The cold atmospheric front with snowfall was the that which defining the ozone behavior on 26 of January. The level of morning concentrations reached the day values, very likely, due to the snowfall which disrupted the stable atmospheric layer and made the vertical mixing operative. The registered surface ozone concentrations were not exceeded $100 \mu\text{g}/\text{m}^3$ - standard value for populated areas /1/.

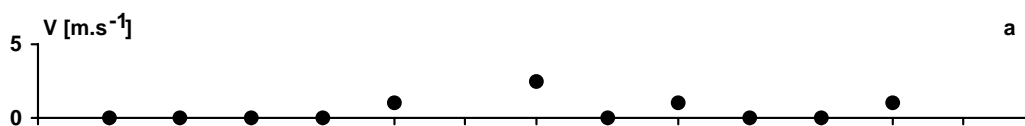


Figure 1.a.

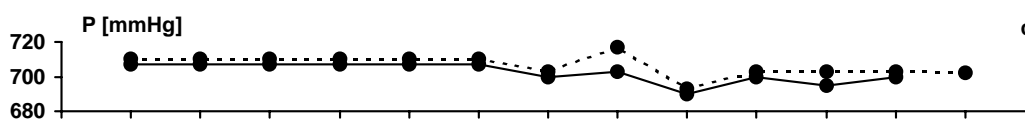


Figure 1.b.

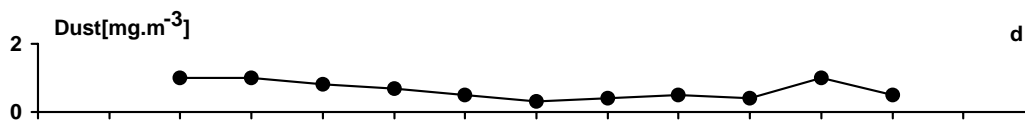


Figure 1.c.

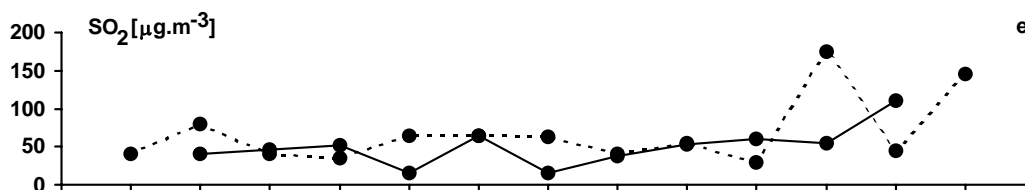


Figure 1.d.

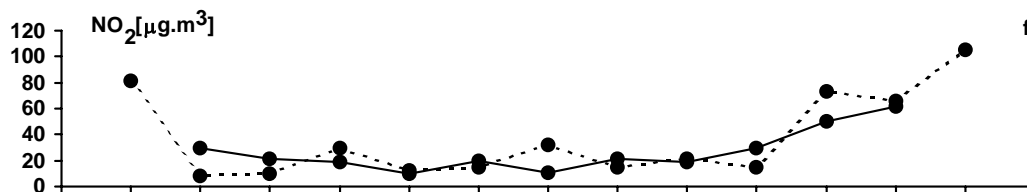


Figure 1.e.

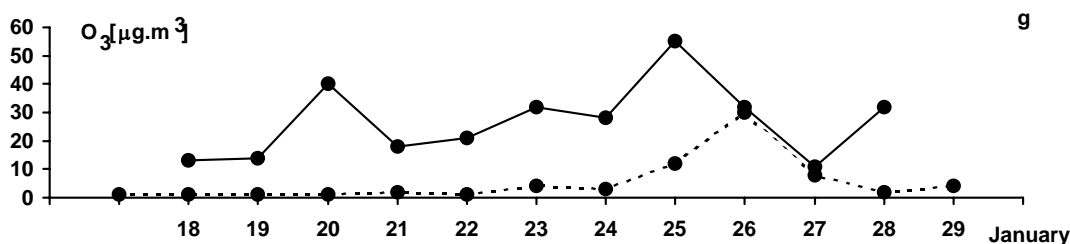


Figure 1.f.

Figure 1. Time series of wind velocity (a), atmospheric pressure (b), dust concentration (c), SO₂ concentration (d), NO₂ concentration (e) and O₃ concentrations temperature (f). The measurements carried out at 08.00h and 14.00h are presented by dotted and solid lines respectively.

Conclusions

The results of the two-week complex ecological investigations of the ambient air quality in Devin, Bulgaria show, that high dust pollution levels, exceeded 4 to 5 times the standard value, occurred, when a stable synoptic situation takes place. The fossil fuel burn up products, thrown into the atmosphere during heating period increased NO₂ and SO₂ pollutant concentrations 2 to 3 times, but retained them under National Standard values. The surface ozone concentrations fully defined by local climate conditions and the weather situation and did not exceed National Standard. The observations showed that surface ozone concentration is sensitive to all processes (wind, thermal turbulence, snowfall) which enhance the air mass vertical mixing. So ozone is a good indicator of the stability of atmospheric surface layers.

References

- [1] Ministerstvo na Narodното Zdrave. Dershaven Vestnik, N 43, 1994, 12-14.
- Krapivin, V.F. (1968) *On the survivability of complex systems in conflict situations*. Proc. 5th Int. Congress on Cybernetics, Sept. 11-15th 1967, Namur (Belgique), pp. 863-880.
- [2] Krapivin, V.F. (1996). *The estimation of the Peruvian current ecosystem by mathematical model of the biosphere*. Ecological Modelling, 91: 1-14.
- [3] Krapivin, V.F., and A.M. Shutko, (1989) *Observation and prognosis of the state of environmental resources, ecological and meteorological situations by means of geological informational monitoring system*. Proc. 4th Int. Symposium on Okhotsk sea and Sea Ice, 5-7 Feb. 1989, Mombetsu, Japan, pp1-5.