Journal of Environmental Protection and Ecology 1, No 1, 17–21 (2000)

ON THE AIR POLLUTION IN WEST MACEDONIA REGION, GREECE

A.G. TRIANTAFYLLOU[a*], F. VOSNIAKOS[b], G. CHARALABIDIS[a], N. PAPADAKIS[c]

[a]*Environmental Physics Laboratory, Mining Engineering Department, TEI of Kozani, Greece*
[b]*Applied Physics Laboratory, TEI of Thessaloniki, Greece*
[c]*Hygiene Laboratory, Aristotle University of Thessaloniki, Greece*

Abstract. In this study some main characteristics of the air quality as well as the pollutants dispersion in West Macedonia region are presented. Specifically continuous concentration measurements of total particulate matter (TSP) and particulate matter of less than 10 μm aerodynamic diameter (PM10) are analyzed. These measurements have been carried out in the most polluted area of West Macedonia, Ptolemais–Kozani industrial area. Based on the data analysis, an attempt is made to provide useful information on the air quality levels considering the air quality standards. Moreover, some results from a combined use of a mesoscale atmospheric model with a Lagrangian Particle Dispersion Model are presented. The simulation results give useful information concerning the pollutants transport emitted from some point sources in West Macedonia area.
Keywords: air pollution, concentration, dispersion, West Macedonia.

AIMS AND BACKGROUND

West Macedonia lies in the north part of Greece. In this area, and especially in the Florina–Ptolemais–Kozani axis (see Fig. 1), is produced the larger amount of the electric power produced in Greece[1]. Four lignite power stations (PS) are operating in the region, while another power station (Meliti PS) is under construction.

The used lignite by these power stations is mined in the nearby open-pit mines and transported to the power stations by trucks rail and also via conveyor belt. The emissions arising from the combustion of lignite and from mining of the lignite coal as well transport of lignite ash are mainly particles (flyash, fugitive dust) and SO_2.

Another power station (PS5, Fig. 1) aggravating the area, operates in FYROM country and is located near the border with Greece and consequently to this area. As it is indicated there is the possibility of pollutants transport from the station to the West Macedonia area under specific atmospheric condition prevailing.

The variability of the physiographic characteristics and the terrain complexity of the area may lead to the formation of local atmospheric circulation, of various types, which affect pollutant transport and dispersion[2].

* For correspondence.

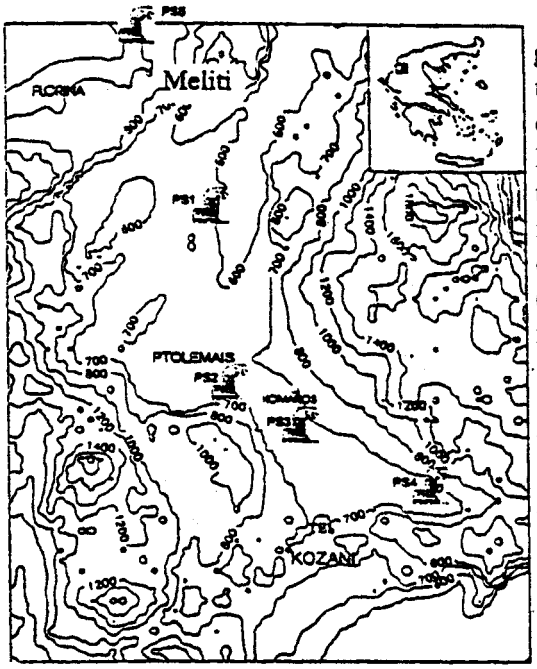

Fig. 1. Location of Florina – Ptolemais – Kozani axis

In Greece, the standard promulgated by EU (Ref. 3) is followed, and the measure used has been the concentration of total suspended particulates matter (TSP), which are taken to refer to all particles in suspension in the atmosphere. Considering that only particles with diameter <10 μm (PM10) are likely to be responsible for most of the adverse health effects due to their ability to reach the lower regions of the human respiratory tract, in the USA an air quality standard for PM10 (recently this was reduced to PM2.5) was introduced[4] (annual mean less than 50 $\mu g/m^3$).

In this study continuous concentration measurements of TSP and particulate matter of less than 10 μm aerodynamic diameter (PM10) are analyzed. Based on the data analysis, an attempt is made to provide useful information on the air quality levels considering the air quality standards.

Moreover, some first results of a combined use of a mesoscale atmospheric model with a Lagrangian Particle Dispersion Model (LPDM) are given in order to be investigated the special and temporal pollutants distribution in the atmosphere.

EXPERIMENTAL

TSP data was obtained by a station installed in Komanos (Fig.1), a village in the middle of the basin. The TSP measurements were obtained as daily mean values using a Hi-volume sampler by Greek Public Power Corporation.

The PM10 data was obtained by a station located on the roof (750 m ASL) of the Technological Education Institute (TEI) which is located about 1km northern to Kozani and about 8 km south of PS3 (Fig.1). The PM10 data were recorded as mean hourly values. The PM10 measurements have been made using a beta-absorption (FAG FH 62 I-N) monitor with the specific sampling head for particles with aerodynamic diameter smaller than or equal to 10 μm (PM10). This monitor is based on the principle of beta-ray-absorption by particles, sampled through the instrument and collected on a fiber-glass filter tape. Automatic zero is provided for each measurement cycle. For span check a sequenced calibration foil of known absorption is used. The instrument was calibrated at intervals of 2 to 3 months.

RESULTS AND DISCUSSION

3.1. TSP and PM10 concentrations. Figure 2 gives the mean annual concentration of TSP in Komanos station for thirteen years. The mean annual concentrations are equals or higher from the EC yearly standard which is 150 μg/m^4.

Figure 3 gives mean annual concentrations for PM10 in TEI station, for a four-year period (1991–1994). The mean annually concentrations which are given in this figure resulted from the 24 h average. As it can be seen in the figure the annual average is about the same during the year 1991 and 1992. The next year a reduction is observed, which is more intensive, in 1994. The annual values during the years 1991–1993 exceed the USEPA air quality standard (50 μg/m^4). During the next year this value is about equal to the above air quality standard. The above mentioned concentration reduction during 1993 and especially during 1994 may be due to the installation of the new electrostatic precipitators in the PS2 and PS3, which started operating from July 1993 and December 1993, respectively. However, the above measurements are not enough to give a safety conclusion.

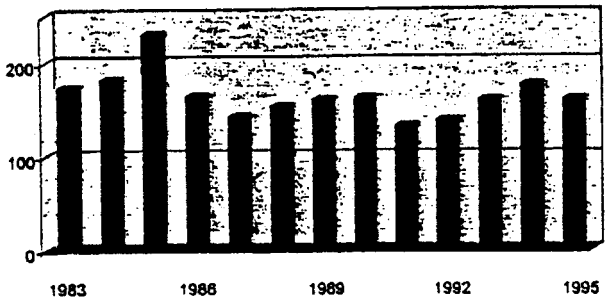

Fig. 2. Mean annual concentrations of TSP in Komanos, West Macedonia, Greece

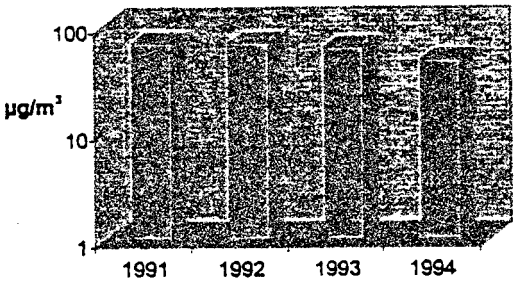

Fig. 3. Mean annual concentrations of PM10 in the vicinity of Kozani, West Macedonia, Greece

3.2. Simulations. It is obvious that the measurement stations gives the results of the contribution from the whole sources in the area. In order to be investigated the contribution of each source into the different places as well as the dispersion conditions of the pollutants released in the basin, a simulation is attempted by a combined use of a mesoscale atmospheric model with the LPDM.

Specifically the Colorado State University Mesoscale Model (CSUMM) was used to predict the meteorological fields over this area. The predicted fields by this model are used as input to the LPDM. The procedure used in the LPDM is to continuously release particles from the stacks whose subsequent positions are determined from the synoptic, mesoscale and microscale components. More detailed description of this technique is presented in Refs 5-9, while the above models modification for this area is described by Triantafyllou[10].

19

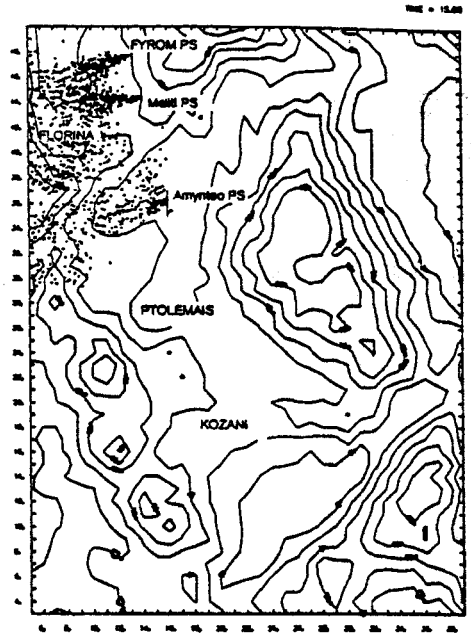

Fig. 4. Plan view of particle plume at 15:00 l.s.t. Summer case

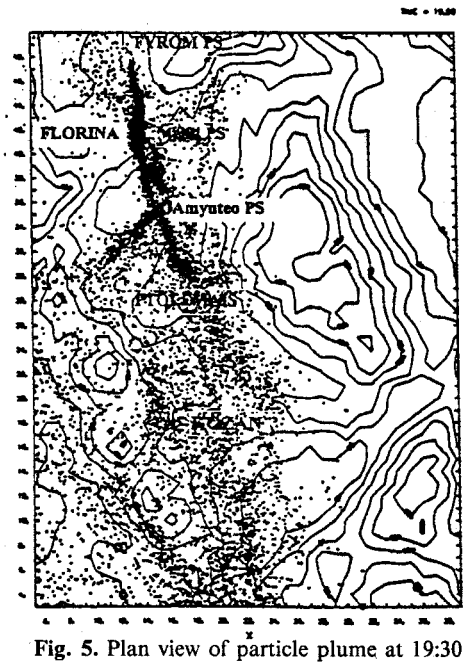

Fig. 5. Plan view of particle plume at 19:30 l.s.t. Winter case

The LPDM was used to simulate the movement of particles released at the stacks of FYROM, Meliti, Amynteo PS. Figure 4 gives the simulation for a summer typical case[10]. The release of particles started at 5:00 l.s.t. This figure shows the positions at 15:00 l.s.t. Particles are moving toward SW. Florina city is effected by FYROM and Meliti PS.

Figure 5 gives the simulation for a winter typical case[10]. The release of particles started at 5:30 l.s.t. This figure shows the positions at 19:30 l.s.t.

The atmosphere is stable and the released particles are moving toward south in a narrow strip. The particles in the south part of the area are from release during previous hours. As it can be seen in this figure, under such atmospheric condition prevailing pollutants transport are observed towards south greater area. However, the above approximation is under more investigation.

Acknowledgements. The authors would like to thank the Greek Public Power Corporation for providing with Komanos TSP data.

20

REFERENCES

1. Proceedings of the 1st Conference for the Development of the Western Makedonia Region. Western Makedonia Region, 1989.
2. A. G. TRIANTAFYLLOU, C. G. HELMIS, D. N. ASIMAKOPOULOS, A.T. SOILEMES: Boundary Layer Evolution over a Large and Broad Mountain Basin. Theor. Appl. Climatol., **52**, 19 (1995).
3. Air Quality Guidelines for Europe. World Health Organization, 1987.
4. Federal Register, Vol.5, No 126, 40CFR Part 53, 24726-7, July 1, 1987.
5. G. KALLOS: The Use of Mesoscale Models on Air Pollution Studies in Industrial Installations. Environmental Software, **4**, 117 (1989).
6. G. KALLOS: Mesoscale Flow – Fields and Dispersion in the Coastle Terrain of Eastern Korinthian Gulf in Greece during Summer. In: Air pollution Modelling and Its Application, VIII (Eds H. van Dop, D.G. Steyn). Plenum Press, New York, 1991.
7. R. T. MCNIDER, M. MORAN, R. A. PIELKE: Influence of Diurnal and Inertial Boundary Layer Oscillations on Long Range Dispersion. Atmos. Environ., **22** (11), 2445 (1989).
8. W. L. PHYSICK, D.J. ABBS, R.A. PIELKE: Formation of the Thermal Internal Boundary Layer in a Mesoscale Model. Boundary Layer Meteor., **49**, 99 (1989).
9. R. A. PIELKE, R.W. ARRITT, M. SEGAL, M.D. MORAN, R.T. MCNIDER: Mesoscale Numerical Modelling of Pollutant Transport in Complex Terrain. Boundary Layer Meteor., **41**, 59 (1987).
10. A. G. TRIANTAFYLLOU: Experimental and Theoretical Study of the Dispersion Conditions of Air Pollutants in West Macedonia. PhD. Dissertation, University of Athens, 1994. 355 p.

Received 21 November 1998
Revised 4 January 2000