AIR POLLUTION LEVEL DURING SNOWFALL DAYS OVER THRIASSIO PLAIN, GREECE

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EXTENDED ABSTRACT

At the beginning of January 2002 and between January the 20th and February the 20th, 2004 there was a series of days characterized by extremely low temperatures and continuous snowfall, especially over the Central and Southern parts of Greece. Those days were characterized by very strong cold invasions accompanied by heavy snowfall. For the industrial area of the Thriasio Plain this is a very rare phenomenon, therefore suitable of the examination of air pollution levels under such extreme circumstances. Hourly meteorological and air pollution data were obtained from the 6 station of the monitoring network operated by the local authorities. The data presented herein cover the continues days with subzero temperatures over the Thriassion Plain area The results of the analysis indicate a significant differentiation of the meteorological parameters inside the close basin of the Thriasio Plain. Air temperature, relative humidity and wind speed records, presents spatial variation between stations. Also despite the evidently unfavorable weather conditions, air pollution levels and especially O_3, are rather significant. The diurnal variation of NO_2 reveals its source, during non-working days the concentrations are flat low through the period, while during working days diurnal variation is easily observed. Ozone levels during all three periods are quite significant presenting the highest concentrations is that at Magoula followed in order by those of Elefsis, Mandra's labor buildings and Paralia Aspropyrgou.
The diurnal variation of the pollutants reveals their sources, and the independence of these sources from external factors, namely their industrial relation. Recording such high air pollution levels under these meteorological conditions is a strong testimony of the air quality problems of the area.

Key words: air pollution levels, snowfall days

1. INTRODUCTION

High air pollution concentrations and pollution episodes are usually recorded under meteorological conditions unfavorable for pollution dispersion. In this work we examine

the pollution levels during days characterized by very low temperatures and snowfall, over the industrial area of Thriassion Plain. These conditions caused problems with road transport, decreased industrial production because not attendance of workers and intensive use of central boilers. These conditions would be expected they cause differentiations in the usual air pollution records.

The weather over Greece, during January 2002 was distinctively cold. During 4-6 January 2002 the southern part of Greece was affected by severe bad weather. Snowfall commenced in the morning of January, 4th, when the existence of a deep barometric low over Southeastern Aegean, cause strong north –northeast winds over the Aegean, while very cold air masses were transported over the country. The northeastern winds and the cold air masses persisted for two more days resulting in continuous snowfall over Eastern central Greece and Evoia (Prezerakos 1984). Duration of the phenomenon was large and as a result the accumulated snow caused significant problems on surface transport, damages on the agricultural production and in general had an adverse effect on the social and economic life of the areas affected (Lagouvardos *et al.,* 2002). January 2004 was a cold and markedly wet month throughout the country. The last ten days set out with the passage of a very deep low pressure system. On the 21st-22nd of January, a meteorological «bomb» cause severe damages on many Aegean islands with winds reaching typhoon levels (> 12 on the Beaufort scale) along with significant snowfalls over the Cyclades and Crete. February 2004 was a rather dry month for most of the country's regions, yet the middle ten days were characterized by a very strong cold invasion accompanied by heavy snowfall over Central and Southern Greece. Since the morning of February the 12th this cold invasion cause a sharp temperature drop across and snowfall the country. During the next two days air temperature at the station of NOA at Pendeli reached –10 ºC while the minimum temperature at Thission was –5.1 ºC, the lowest value since 1934. All Greece was at subzero or near zero temperatures throughout February 13th. During that day snow cover was significant event at flat areas of Attika and Peloponnesos, caused problems with road transport. The extremely low temperatures prevailing till 16/02 resulted in damaged the agricultural production extensively (www.noa.gr).

2. DATA USED

The data used in this study were obtained from GERPPE and GPDA. The network of the Bureau of Pollution Control and Environmental Quality (GERPPE) of the Development Association of Thriassion Plain had 4 air quality monitoring stations operating since 2000. The Environment Bureau of the Municipality of Aspropyrgos (GPDA) has two stations operating since 2002. All stations are measuring air pollution and basic meteorological parameters except from the one designated as GOR, providing 1 hourly data. The data presented herein cover the days with subzero temperatures over the Thriassion Plain area, during the periods of the cold invasions discussed in Introduction.

The air quality monitoring network used covers the urban areas of the 4 municipalities of the area. Position EL-1 is in Elefsis city center (1000m from the sea shore), inside the municipal parking area, away from large constructions. Station EKM is near the large housing complexes of Mandra (600m from the sea shore), neighboring the Industrial Zone of Elefsis to the south and the Industrial Zone of Mandra to the north-northeast, while the ground to the west presents intense relief. Station MAG lies in the centre of Magoula (3000m from the sea shore) while P.As in the center of Paralia Aspropyrgou, a part of the city of Aspropyrgos, surrounded from the south and east by a legislated industrial area of 3000 acres housing some large heavy industry units, 400m from the sea shore. Station Germanika (GER), is located on the eastern edge of the Aspropyrgos

500m east of the center of the city of Aspropyrgos (ASP) and 2000m from the sea shore. The Industrial Zone of Aspropyrgos, with an assigned area of 3500 acres, is 1500m northeast of Germanika. Station Goritsa Aspropyrgou (GOR), is located within the settlement with the same name, north of the airfield, in a distance of 3500m from the sea shore. North and northwest of station GOR there are 3 large quarries marked on the map presented in Figure 1, along with the center at Mandra (MAN).

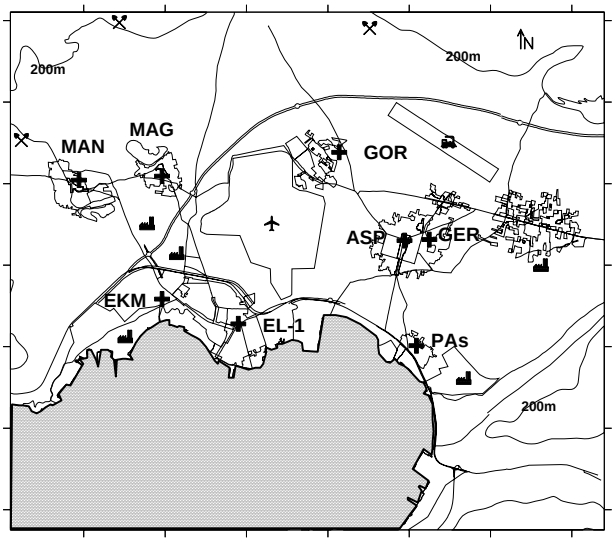

Figure 1: Map of Thriassion Plain, scale 1:5000, featuring the main urban areas, the designated industrial zones, the main road network, and the 200m contour level.

3. LOCAL METEOROLOGICAL CONDITIONS

Heavy and continuous snowfall and especially a series of days with very low temperatures is something rarely observed over the Thriassion Plain area therefore, such an incident would be a very good opportunity to investigate the air pollutants level over the area under such extreme conditions.

Figures 2a to 4b present the daily course of air temperature, relative humidity and wind speed. The period from the 4th to the 7th of January 2002, was the coldest of the three period considered. It was also the period with the longer lasting snowfall. Notable there is a large variation among the temperatures recorded at the various stations. More specifically station (EL-1) is the coldest of all, with a maximum deviation of 4 ^{o}C, with respect to (P.As), the warmest station situated very close to the sea shore, some major industrial complexes and the National Road. EKM station is the second coldest but the temperature differences between this station and the rest are small. Finally, the station at (GER) records temperatures quite similar to those of P.As. Air temperature remained below 4 ^{o}C, for 72 hours thus allowing for the retention of snow cover for some after the snowfall has ended. The other two periods examined, 21–26 January 2004 and 12–16 February 2004 are characterized by the abrupt temperature drop by 12 and 16 ^{o}C respectively.

Relative humidity presents little spatial variation between stations with the lowest values recorded at EKM station and the highest at P.As station located close to the sea.

Wind (Figures 2b, 3b, 4b), is stronger at EL-1 and, EKM and weaker at P.As. Deviations between stations are considerable. During January, 6th wind speed at EL-1 is twice that at EKM and triple that at P.As. Similar behavior was observed in all three cases considered.

High wind speeds persisted for a longer time during January 2002 while the highest wind speed was recorded during 22 January 2004 (17,5m/sec at EL-1). All station registered northern winds during all examined periods.

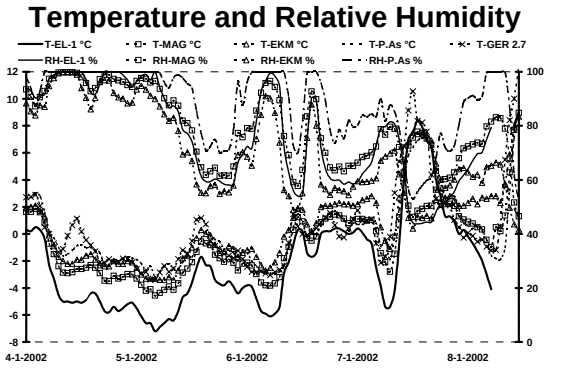

Figure 2a: 4 – 7 January 2002

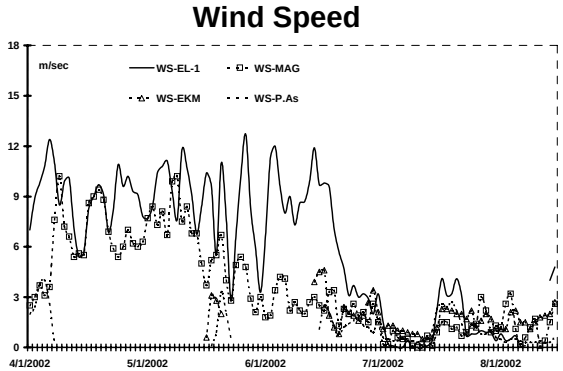

Figure 2b: 4 – 7 January 2002

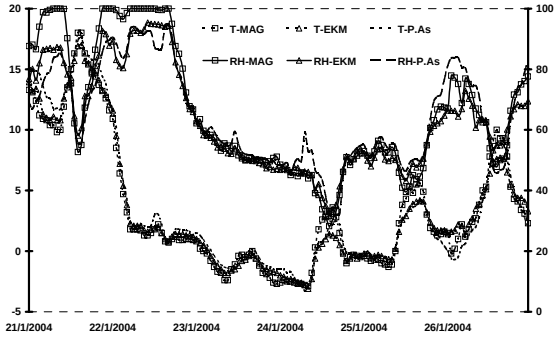

Figure 3a: 21 – 26 January 2004

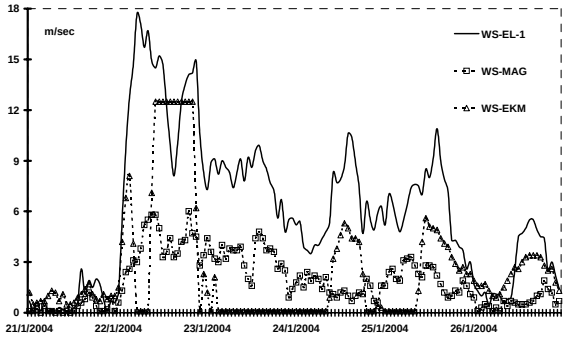

Figure 3b: 21 – 26 January 2004

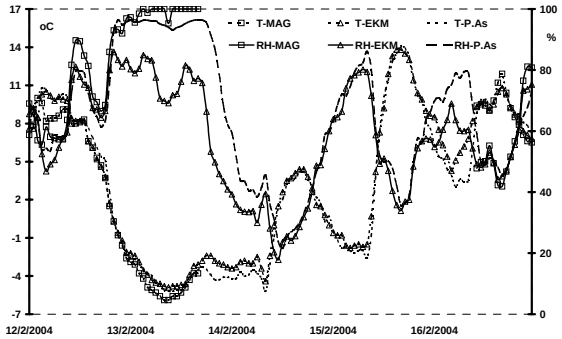

Figure 4a: 12 – 16 February 2004

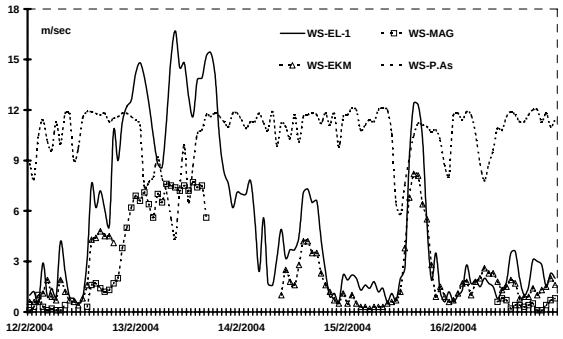

Figure 4b: 12 – 16 February 2004

4. AIR POLLUTION LEVELS

Air pollution levels during the examined period are high for all pollutants except sulphur dioxide. The diurnal variation of NO_2 (Figures 5a, 6a) reveals its source, since during the period 4 – 7 January 2002 (non-working days) the concentrations are flat low through the period, while during the other two cases a diurnal variation is easily observed.

Ozone levels during all three periods are quite significant (Figures 5b and 6b). Even though the meteorological conditions can be considered as unfavorable for pollution buildup, with wind speed remaining over 4m/s, ozone concentrations cannot be characterized as low, ranging from 30 μgr/m3 up to 100 μgr/m3, in all stations and periods. The spatial pattern observed is similar to that already observed (www.thriasiopedio.gr). The station presenting the highest concentrations is that at (MAG) followed in order by those of, EMK and P.As.

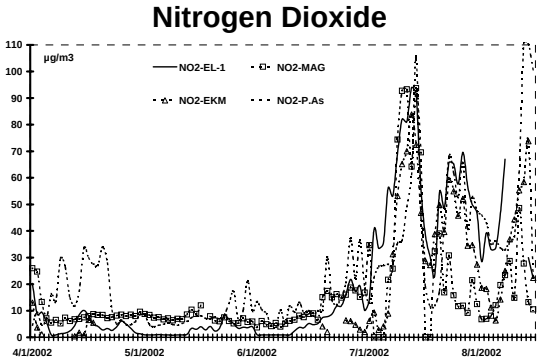

Figure 5a: 4 – 7 January 2002

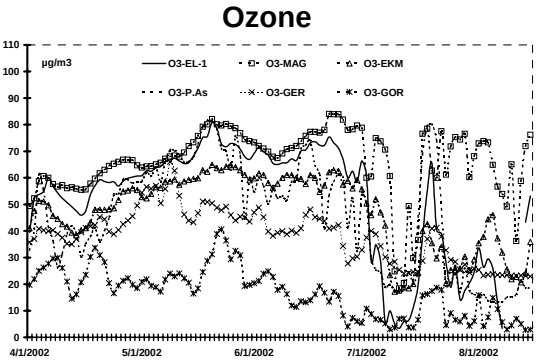

Figure 5b: 4 – 7 January 2002

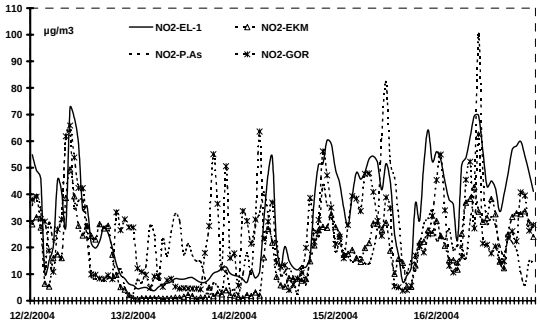

Figure 6a 12 – 14 February 2004

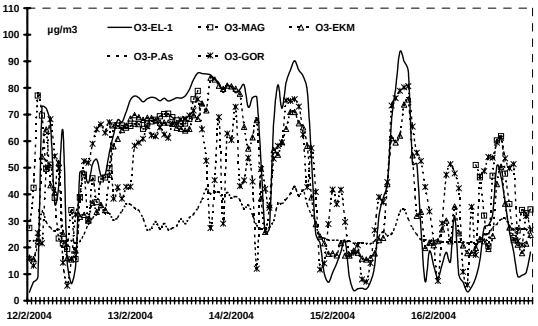

Figure 6b: 12 – 14 February 2004

Figures 7 and 8 present the daily courses of THC and PM10 respectively. Hydrocarbons in P.As exhibit outbursts in a manner consistent with that observed through the year (www.thriasiopedio.gr) Suspended particulate matter also present a clear diurnal cycle. In all three periods the respective levels are high indicating that the source of this pollutant remains unchanged.

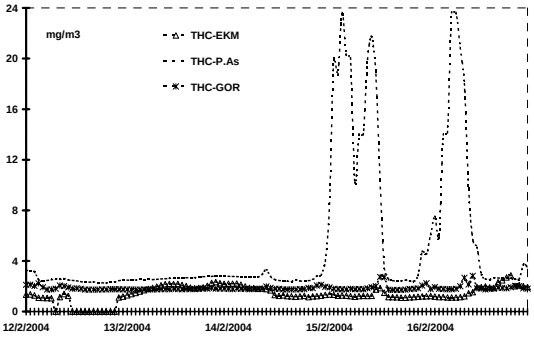

Figure 7: Diurnal variation of THC [mg/m^3], for 12-16 February 2004

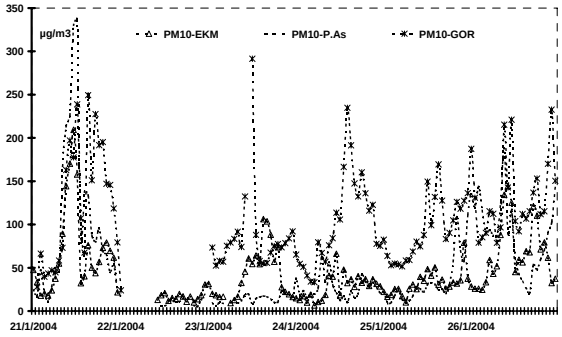

Figure 8: Diurnal variation of PM10 [µg/m^3], for 21-26 January 2004

The pollution levels recorded reveal the relevant pollution sources, namely the intense and unaffected by external factors, industrial activity inside the, surrounded by high relief, Thriassion Plain, in agreement to previous observations (Mavrakis etal, 2004).

5. CONCLUSIONS

Summarizing the conclusions about the evolution of the meteorological parameters over the Thriassion Plain are as follows:

1. There is significant differentiation of air temperature and relative humidity between the stations, with a maximum temperature difference of 4 ^{o}C. There is also significant

spatial variation of wind speed. EL-1 station registers the highest wind speeds and the lowest temperatures.
2. Air pollution levels are high despite the prevailing unfavorable meteorological conditions.
3. The diurnal variation of the pollutants reveals their sources, and the independence of these sources from external factors, namely their industrial relation.
4. The existence of high levels for all the pollutants examined, and especially ozone, under meteorological conditions adverse in that respect, is one more proof of the environmental problem of the Thriassion Plain area.

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