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# Measurements of atmospheric aerosol in the Salentum Peninsula and its correlation with local meteorology

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**Summary.** — In this paper the results of measurements of Total Suspended Particles (TSP), PM10 and PM2.5 and their correlation with meteorological parameters are presented. The samplings were carried out with a mobile laboratory in seven locations in the Salentum Peninsula located in the southeastern part of Italy in Puglia. Measurements were taken discontinuously during the period 2002-2005. Up to now no systematic analyses of aerosol concentrations in the Salentum Peninsula have been presented in the scientific literature. This study is therefore a useful basis for assessing the local situation and for planning future monitoring. Measurements have been performed, on a daily basis, using standard European inlet (CEN-EN12341, 1998) and successive gravimetric detection of aerosol deposited on filters. The measurement sites can be considered representative of urban background for all the cases investigated. An analysis of the random uncertainties (LOQ and LOD) for the different types of filters used is reported. Results show concentrations in good agreement with lognormal distributions, indicating that the PM10 fraction is about 66% of TSP and PM2.5 is about 67% of PM10, which allows us to evaluate that the fraction of PM2.5 is about 44% of TSP. Concentration levels were correlated with local meteorological parameters, especially with wind velocity and precipitations. Results indicate that during rainy days the average concentration is reduced of about 70% and the reduction is larger for TSP and PM10 with respect to PM2.5. There is, on average, a substantial decrease of concentration levels in high wind conditions. Results also suggest the possibility of a significant contribution of African dust to PM10 and TSP, especially in the spring and summer season, which could be responsible for some days with concentrations above the threshold imposed by the European legislation on PM10.

PACS `92.20.Bk` – Aerosols.
PACS `92.60.Mt` – Particles and aerosols.
PACS `92.60.Sz` – Air quality and air pollution.

## 1. – Introduction

The Salentum Peninsula is downwind of the Brindisi and Taranto industrial areas for most of the year. Brindisi is the site of a very large petroleum refinery and two oil combustion power plants, while Taranto hosts metallurgical industries with stainless-steel production. Both areas have been classified by WHO as risk areas both for the population and the environment [1]. Small industrial areas are present in the Salentum peninsula and they are distributed near some of the major towns. The meteorological conditions over Salentum are characterized by winds coming mainly from the N-NW sector and from the S-SE directions, which might expose it to industrial emissions situated to the NW (Taranto) and NNW (Brindisi). Such conditions and their implications for air quality are of great concern to the local administration (mainly the Provincial Government of Lecce). Moreover, a research study involving dispersion models [2] has shown the probability, in the north and middle part of the peninsula, of fallout of the pollution emitted by the power plants of Brindisi.

The local air quality control network consists of monitoring stations capable of measuring the standard gas indicators (as required by National and European legislations) and only the total suspended particulate (TSP) for the aerosol phase. In recent years, the provincial government of Lecce has been running, on its own, two monitoring stations also equipped with continuous PM10 and PM2.5 sensors, although the stations are still under calibration and maintenance conditions. As a general consequence, very little data on particulate matter (specifically PM10 and PM2.5) concentrations are available for the area. Several field campaigns have therefore been performed using a mobile laboratory, with the aim of monitoring the particulate matter concentration levels (TSP, PM10 and PM2.5). The present work refers to data obtained during the measurement campaigns carried out from January 2002 to December 2005 on urban background sites. Average values of TSP, PM10 and PM2.5 concentrations, together with their statistical distributions, will be presented. Correlation of aerosol concentration with wind velocity and direction, at different heights above the ground, will also be analyzed. Since there is a general lack in the scientific literature on aerosol concentration data in the Salentum Peninsula, the present work is a preliminary assessment of the aerosol concentration levels which could be useful for planning the strategies for future monitoring.

## 2. – Description of measurement sites and experimental techniques

The measurements were performed using the mobile laboratory shown in fig. 1. The laboratory is equipped with a BTX analyzer (Syntech Spectras GC855), a sequential PM10 sampler operating at the constant flow-rate of $2.3\,\mathrm{m}^3/\mathrm{h}$ (Thermo ESM Andersen FQ95SEQ) with the inlet at 2.5 m above the ground, capable of 16 days of continuous samplings, and a sequential TSP sampler (Zambelli, Explorer V53M) capable of 8 days of continuous monitoring when operated over 24 h averages. The mobile laboratory is also equipped with a telescopic mast (10 m high) that was sometimes used as a base for a micrometeorological station. In this way, it was possible to obtain detailed information on local meteorology, allowing the correlation of aerosol concentration levels with local meteorological conditions. During the field campaigns PM2.5 data were gathered by means of a manual sampling line according to the CEN TC 264/Working Group 15 indications. The line is equipped with a standard inlet (Zambelli) and is run by a vacuum pump (Tecora, Bravo H-Plus) operating at a constant flow-rate of $2.3\,\mathrm{m}^3/\mathrm{h}$.

The sampling sites were the University of Lecce Campus, hereinafter referred to as Lecce (where the ISAC-CNR Research Institute is located), and the towns of Galatina, Maglie, Campi Salentina, Spongano, Galatone and Collemeto. The locations, indicated in fig. 2, are well distributed along the middle line of the peninsula. The measurement locations were chosen in order to be representative of the urban background, so that measurements were taken far away from the centre of the towns and far from roads with


Fig. 1. – (a) Mobile laboratory with telescopic mast for meteorological measurements. (b) Sequential PM10 sampler Thermo ESM Andersen FQ95SEQ. (c) Particular of the sampling inlets (PM10 and PM2.5) and of the rain gauge.

heavy traffic. The site of Maglie is located at the north periphery of the town of Maglie located about 35 km SSE of Lecce. Measurements have been taken inside the courtyard of a high school. The site is exposed to countryside in the north sector (from NW to E) and it has characteristics of an urban-background area; however, some of the buildings in the north directions placed at more than 500 m from the site are devoted to industrial activity. There is also a complex for treatment of olive husks with a small chimney (about


Fig. 2. – Map of the Salentum Peninsula indicating the measurement sites located in the administrative district of the main town of Lecce.

22 m high) and a waste incinerator with another chimney (40 m high) placed at roughly 800 m from the site. The chimneys were separated by about 10° when seen from the measurement site. In the south sector the situation is different, the inhabited town of Maglie having several packed one- and two-story buildings. Different kinds of filters were used to collect atmospheric aerosol. In particular cellulose nitrate filters with 0.8 $\mu$m porosity (Millipore), and, starting from the beginning of 2004, quartz fibers (Sartorius). Occasionally PVC (Omega Specialty Instruments co.) filters have been used in 2003. The gravimetric assessment was performed by means of an analytical balance with 10 $\mu$g sensitivity (both Sartorius and Scaltec balances were used). During each measurement campaign (two weeks long on the average) some blank filters were used to correct, when necessary, for systematic uncertainty and also to check measurement quality through the evaluation of random uncertainty. Experimental errors on gravimetric measurements of aerosol can arise from several independent sources, most notably moisture absorption, electrostatic effects, filter damage during handling and imprecision in weighing due to the balance used. A method of estimating the measurement accuracy is to use a statistical analysis of blank filters [3]. The procedure makes use of a certain number of blank filters which go through the same procedure as the exposed filters. In particular, blank filters follow the same conditioning, handling and weighing procedure as those employed for measurements, including expositions to the same environment and for the same time periods, the only difference being that the airflow through the blank filters is zero so that no particles are collected on them. The blank filters are weighed before and after exposition to the environment to determine the difference in mass $P$. In our experiments $P$ was determined, for each filter, as the average of three successive and independent measurements taken after two days of laboratory conditioning period. The variability of $P$ furnished information on the experimental systematic and random uncertainty. The systematic uncertainty is largely due to interference of the relative humidity of the environment (RH) and it could be corrected, if necessary, using a certain number $N_\mathrm{b}$ of blanks filters for a specific measurement campaign. After correction for the systematic part of the uncertainty, it is possible to estimate the random part using the standard deviation as

$$\hat{\sigma}_P = \sigma_P \left(1 + \frac{1}{N_\mathrm{b}}\right)^{1/2}, \qquad (1)$$

where $\sigma_P$ is the standard deviation of the mass difference $P$ of the blank filters [3]. We performed the analysis on the three kinds of substrate used. The first set of 32 blank filters collected over 5 measurement campaigns is referring to cellulose nitrate filters. The second set of 19 filters collected over 4 measurement campaigns is referring to quartz fibre filters and the last set of 8 filters collected in 2 measurement campaigns refers to PVC filters. The results indicate $\hat{\sigma}_P = 49\,\mu$g for cellulose nitrate filters; $\hat{\sigma}_P = 45.2\,\mu$g for quartz fibre filters and $\hat{\sigma}_P = 40.7\,\mu$g for PVC filters. The Limit Of Detection (LOD) is usually evaluated as 3 times $\hat{\sigma}_P$ and the Limit Of Quantification (LOQ) is generally defined as 10 times $\hat{\sigma}_P$. Therefore, in terms of concentration, the values are: LOD = $2.7\,\mu\mathrm{g/m^3}$ and LOQ = $8.9\,\mu\mathrm{g/m^3}$ for the cellulose nitrate filters; LOD = $2.5\,\mu\mathrm{g/m^3}$ and LOQ = $8.2\,\mu\mathrm{g/m^3}$ for the quartz filters and LOD = $2.2\,\mu\mathrm{g/m^3}$ and LOQ = $7.4\,\mu\mathrm{g/m^3}$ for PVC filters. Results indicate that the average values of the LOD are quite similar for the different kinds of filters, however the small differences are scaled according to the sensitivity of the substrate to RH: PVC filters are the least sensitive; quartz fibre filters have an intermediate sensitivity and nitrate of cellulose filters are the most sensitive. It

TABLE I. – *Average concentrations and standard deviations of TSP, PM10 and PM2.5 for the different years. The last row is the combination of all data.*

| Year | TSP | | | PM10 | | | PM2.5 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | n. | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | n. | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | n. |
| 2002 | 52.3 | 24.6 | 31 | 41.0 | 18.1 | 7 | — | — | — |
| 2003 | 43.6 | 15.9 | 37 | 24.2 | 13.4 | 48 | — | — | — |
| 2004 | 39.7 | 16.4 | 24 | 26.6 | 8.5 | 43 | 21.7 | 7.8 | 24 |
| 2005 | — | — | — | 32.7 | 11.7 | 35 | 16.2 | 6.1 | 25 |
| Avg. | 45.5 | 19.8 | 92 | 28.1 | 12.6 | 133 | 18.9 | 7.5 | 49 |

has to be put in evidence that what actually changes relevantly from one kind of filter to the other and also from one measurement campaign to the other is the correction of systematic uncertainty (*i.e.* the average value of $P$). The largest corrections are needed for cellulose nitrate filters, instead very small negligible corrections are usually needed for quartz fibre and PVC filters.

## 3. – Results and discussion

**3·1.** *Average concentration.* – All the measurements sites can be considered representative of urban background even if the site of Maglie is influenced by an industrial area nearby in the N direction as described in the previous section. This allows to use all measured daily concentrations in evaluating average concentrations values of atmospheric aerosol. This means that 92 measurement days are available for TSP, 133 days for PM10 and 49 days for PM2.5. Measurements of PM2.5 are concentrated in the years 2004 and 2005. Table I shows the arithmetic means and the standard deviations of TSP, PM10 and PM2.5 measurements. The results indicate an average value of TSP equal to 45.5 $\mu$g/m$^3$, an average of PM10 equal to 28.1 $\mu$g/m$^3$, and an average concentration of PM2.5 equal to 18.9 $\mu$g/m$^3$. Table I also shows the averages disaggregated by years (from 2002 to

TABLE II. – *Average concentrations and standard deviations of TSP, PM10 and PM2.5 for the different measurements sites (town).*

| Meas. Site | TSP | | PM10 | | PM2.5 | |
|---|---|---|---|---|---|---|
| | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) |
| Campi Sal. | 42.1 | 16.9 | — | — | — | — |
| Spongano | 39.8 | 7.9 | — | — | — | — |
| Lecce | 49.1 | 22.2 | 25.2 | 14.9 | 16.8 | 6.4 |
| Maglie | 40.6 | 15.9 | 26.9 | 8.1 | 22.7 | 9.0 |
| Galatina | — | — | 31.2 | 8.2 | — | — |
| Galatone | — | — | 26.2 | 11.6 | 13.4 | 4.0 |
| Collemeto | — | — | 38.2 | 8.8 | 21.4 | 5.4 |

TABLE III. – *Average concentrations and standard deviations of TSP, PM10 and PM2.5 for the different seasons.*

| Season | TSP | | | PM10 | | | PM2.5 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | n. | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | n. | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | n. |
| Cold (Oct.-March) | 44.1 | 21.6 | 45 | 26.2 | 11.5 | 76 | 21.7 | 7.8 | 23 |
| Hot (April-Sept.) | 46.9 | 18.2 | 47 | 30.7 | 13.5 | 57 | 16.4 | 6.3 | 26 |

2005), together with their standard deviations and the number of available samples. It has to be put in evidence that 2002 statistics for PM10 is limited, plausibly explaining the relatively large average value. In table II average concentrations are disaggregated by sampling sites. Similar values are observed for the average concentration levels in the different sites, with the exception of Collemeto that presents a larger average concentration. Table III shows the average concentration levels in the two main seasons of the year: the cold season, considered from October to March, and the hot one from April to September. The comparisons show a slightly higher TSP and PM10 concentrations during hot months with respect to the cold ones but PM2.5 shows an opposite trend. The increase of concentration in the hot season is the opposite of what occurs in the north of Italy, where meteorological conditions and domestic heating systems combine with traffic emissions to give rise to generally higher particulate concentration in winter months [4]. In our data taken in urban background sites the influence of domestic heating as well as difference in the traffic load during the year is limited. What is more in the south of Italy, apart from the aforesaid difference, the opposite trend might be explained by the contribution of intrusion of African dust to aerosol concentration. These intrusions, actually more probable during spring and summer, could be identified through the analysis of the air circulation at the upper levels [5] and they are prevalently composed, at least in the South of Italy, by particles in the coarse fraction that may explain the different trend in the PM2.5 concentrations. There is no, up to now, PM10 data available in the scientific literature measured in the Salentum Peninsula, however an analysis of atmospheric aerosol was reported [6] for Bari, which is the largest city in the Puglia region, located about 150 km from Lecce. In a residential area with light traffic PM10 concentrations are found to range from 15 $\mu$g/m$^3$ to 60 $\mu$g/m$^3$. The ratio between concentration levels in the different aerosol fractions is usually a parameter more suitable for comparison among the data obtained at different measurement sites. The average values reported in table I should not be used to evaluate the different ratios, because some of the measurements are not simultaneous. Considering only the 46 simultaneous measurements of daily concentrations of PM10 and TSP, the PM10/TSP ratio was found to be 0.66 ($\pm$0.23 Std. Dev.). The average PM2.5/PM10 ratio, calculated using 22 simultaneous samples, was 0.67 ($\pm$0.2 Std. Dev.). This allows to infer the PM2.5/TSP ratio to be equal to 0.44. The value of PM10/TSP is in good agreement with the values reported in [7], for the city of Barcelona, for which a ratio of 0.65 is reported. For the town of Bologna, the PM10/TSP ratio is about 0.80 [8]. The PM2.5/PM10 ratio evaluated with our results is very similar to the values reported for Milan [4,9] where an average of 0.7 was reported. Therefore, it

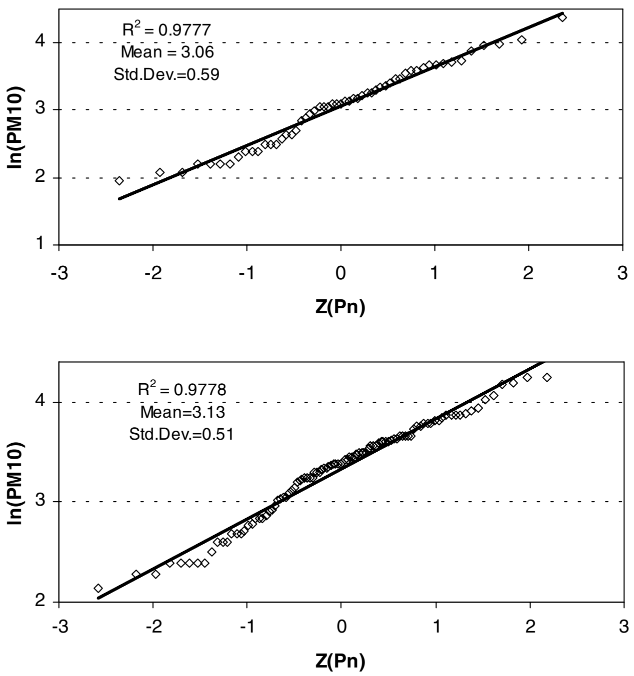


Fig. 3. – Comparison of measured concentrations (marks) with lognormal distribution (continuous line). (a) Only PM10 data taken in Lecce. (b) Only PM10 data taken in sites with similar average (Lecce, Maglie and Galatone).

should be noted that seasonal differences in PM2.5/PM10 values are found [4,9], ranging from 0.63 in summer to 0.73 in winter. The PM10/TSP ratio is also influenced by local meteorology, and could change at high wind speed [4,9]. Values of PM2.5/PM10 ranging from 0.6 to 0.85 are reported [7], with an average around 0.7. In the highly populated Mexico City values of the average PM2.5/PM10 ratio were found to vary from 0.44 to 0.60, according to different measurement locations [10]. Our results indicate that the ratio PM2.5/PM10 is larger in Maglie with respect to the other sites and this could be due to the presence of the industrial area near the measurement site.

Measurements of six different rain gauges distributed in the Salentum Peninsula have been used in order to obtain daily precipitations in the area were the mobile laboratory was operating. This allows to evaluate statistically the effect of rain on average concentration levels for the different fraction of aerosol. Periods of simultaneous TSP and PM10 sampling as well as periods of simultaneous PM2.5 and PM10 measurements have been divided in rainy days: defined as days in which there has been a total precipitation of at least 0.8 mm $H_2O$ (*i.e.* four times the minimum threshold of detection of the rain gauges) and non-rainy days in which the total precipitation is less than 0.8 mm $H_2O$. Results indicate that during rainy days the average concentration of the different fractions of aerosol decreases. In particular TSP decreases of about 32%, PM10 of about 29% and PM2.5 of about 17%. Basically the reduction is stronger for TSP, it is at intermediate values for PM10 and it is lower for PM2.5 reflecting the dynamics of wet removal process that is more efficient for coarse particles.

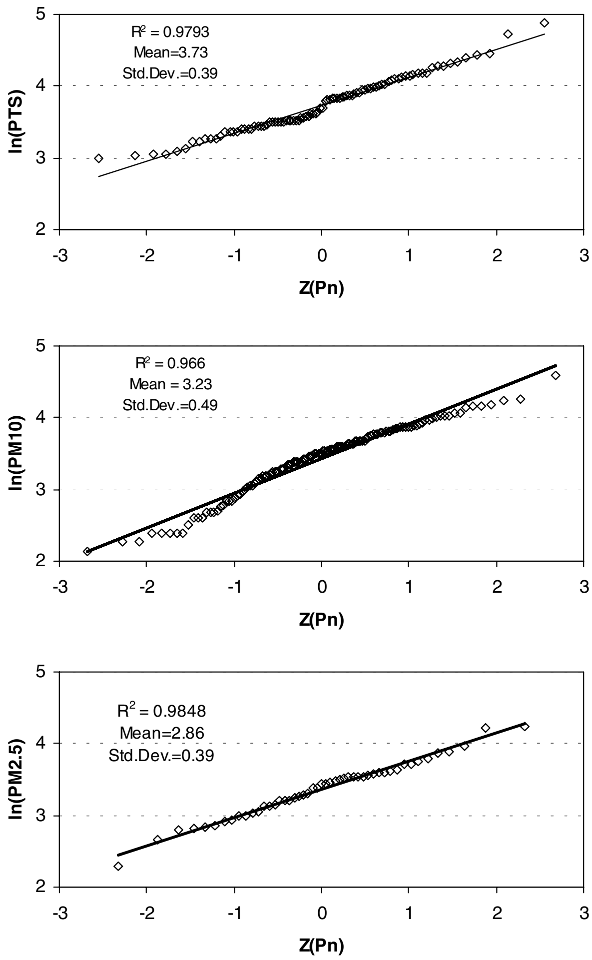


Fig. 4. – Comparison of measured concentrations (marks) with lognormal distribution (continuous line). (a) All TSP data. (b) All PM10 data. (c) All PM2.5 data.

**3**˙2. *Statistical distribution of daily concentrations.* – We compared the distributions of daily measured concentrations with normal and lognormal distributions. The method followed was the same as the one described in [11] for $SO_2$ concentrations. Results indicate that the lognormal distribution is a better description of measured data as is expected in general for pollutant concentrations [12]. Figure 3(a) reports the distributions of PM10 measured in the site of Lecce (marks), together with the estimated lognormal distribution (continuous line). The abscissa is constructed from the order statistic medians or normal score, $Z(p)$, calculated from the inverse of the cumulative distribution function of the standard normal distribution. The results reported in fig. 3(b) refer to all measurements of PM10 taken in site with similar average (Lecce, Maglie and Galatone) considering all the data as coming out from a single population. In both cases the determination coefficient $R^2$ is quite good. In fig. 4 the analysis has been performed on all data of TSP, PM10 and PM2.5 as coming out from a single population. In this case the agreement of measured distribution of PM10 with respect to theoretical distribution becomes smaller.

This is a likely consequence of putting together data coming out from sites with significant differences in average concentration values as well as standard deviations. The lognormal distribution seems to give a good description of measured data. However there are some differences in the tail, especially at very low or very high concentrations [13].

Using the parameters of the obtained lognormal distribution it is possible to estimate the probability of a PM10 concentration above the legislation threshold of $50\,\mu g/m^3$. If the calculated probability is referred to a complete year (365 days of data), it is estimated that there would be 27 days with values above this limit. This must be compared with the PM10 standards in the legislation, which imposes $50\,\mu g/m^3$ as a limit not to be exceeded for more than 35 days per year. Such results are valid for measurement locations similar to those investigated in this work, *i.e.* urban background sites, although the scenario could be different for hotspots situated in major areas of urban traffic.

**3**·3. *Correlation with meteorological data.* – Measured concentrations at the different sites have been correlated with meteorological parameters (wind velocity and direction) taken at different height. Radiosoundings at the level of 958 hPa (corresponding roughly to 500 m) and at the level of 790 hPa (corresponding roughly to 2000 m) have been taken in Brindisi located at about 35 km NW of Lecce. The correlation has been studied in order to individuate eventual long-range transport from Taranto and Brindisi. Also measurements taken at 10 m height using the mobile laboratory are available for a limited number of measurement campaigns. Correlations with wind at 958 hPa level are reported in fig. 5 for TSP, PM10 and PM2.5 measured at the different sites. Basically there is not a clear pattern indicating preferential direction for long-range transport and a similar result is obtained using correlations at the level of 790 hPa (not shown). The peak at about $80\,\mu g/m^3$ in PM10 around 180° and one of the peak (at about $113\,\mu g/m^3$) present in the TSP are a single case of intrusion of African dust over the south of Puglia. Results indicate an accumulation of data in the sector between SW and SE and in the sector between NW and N. These are the most probable wind directions given the local meteorology of the Salentum Peninsula. Figure 6 shows the correlation between TSP, PM10 and PM2.5 concentrations and wind velocity, considered as the arithmetic means of wind intensities over the sampling period, for local data taken at about 10 m height in two different sites. There is a correlation with the wind intensity, which might be explained by an increase in the dilution due to a more effective mixing at high wind velocities. In particular, a clear correlation can be seen for the data taken in Lecce (especially for PM10), for the ones in Maglie the correlation is less evident. At the latter sites, transport from local industrial sources could explain the difference in the pattern. As a matter of fact, if there are industrial plumes at relatively low altitudes, the ground level concentrations could increase at high wind speed when the plumes are advected directly towards the measuring instruments.

**3**·4. *Intrusion of African dust.* – Aeolian dust coming from Africa has been measured for several years at different European stations, including the Monte Cimone CNR station [14] and the Jungfraujoch site (see for example [15]). Frequent cases of Saharan dust have also been identified in the area of Lecce [16]. Such episodes may have an important impact on detected aerosol concentration levels. For example, a recent research in Spain has indicated the potential effect of such dust in the difficulties of meeting the new standards concerning PM10 in Europe [17]. In Italy too, Saharan dust might have an important potential impact, at least in the southern and central regions of the country, especially at rural or urban background stations. In this paper we analyzed the meteo-

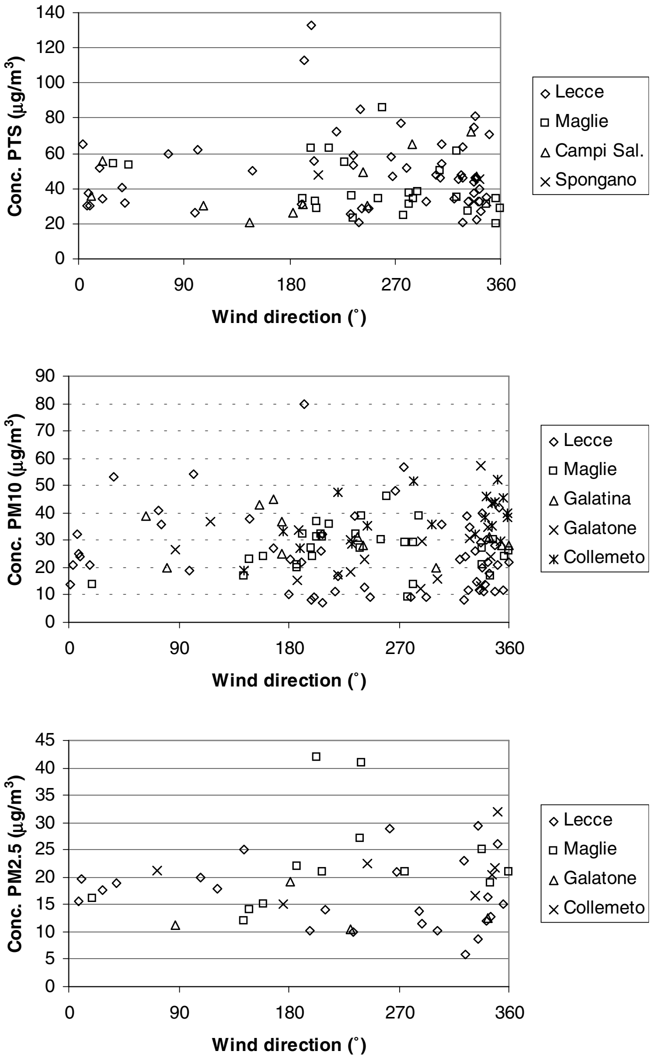


Fig. 5. – TSP, PM10 and PM2.5 concentrations against average wind direction. Meteorological data are measured at 500 m (958 hPa) above the ground.

TABLE IV. – *Average concentrations of TSP, PM10 and PM2.5 in days in which is present an intrusion of African dust (SD cases) and in days in which the intrusion is not present (NSD cases).*

| Classification | TSP | | | PM10 | | | PM2.5 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | n. | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | n. | Conc. ($\mu$g/m$^3$) | Std. Dev. ($\mu$g/m$^3$) | n. |
| SD | 57.5 | 23.3 | 19 | 33.1 | 18.0 | 26 | 18.2 | 4.9 | 8 |
| NSD | 42.4 | 17.7 | 73 | 26.9 | 10.6 | 107 | 19.0 | 7.9 | 41 |

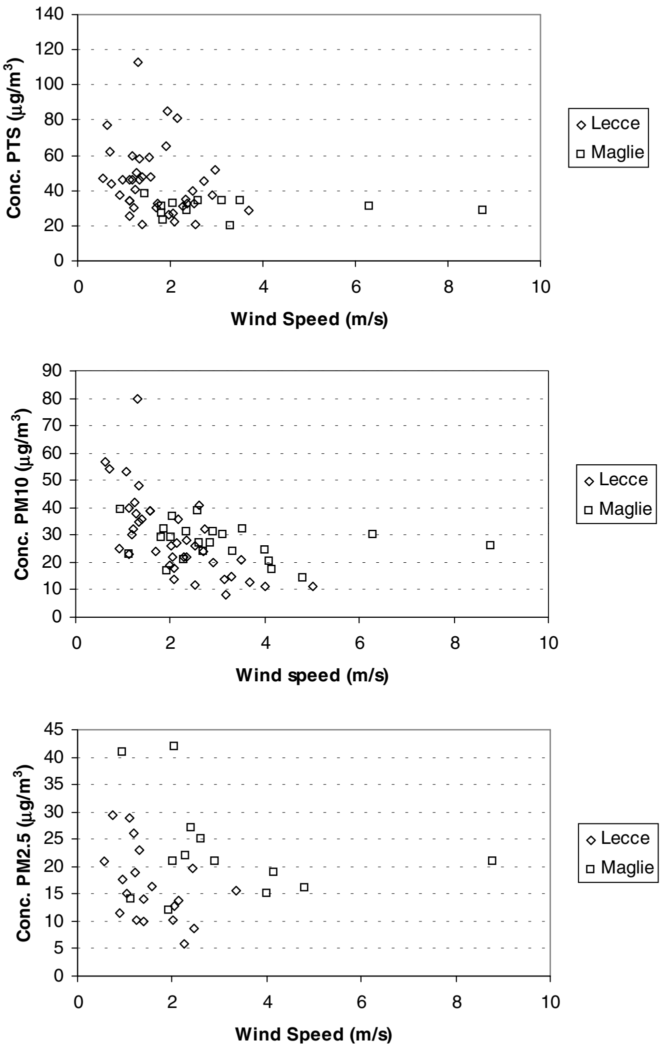


Fig. 6. – TSP, PM10 and PM2.5 concentrations against average wind velocity. Meteorological data are measured at 10 m above the ground.

rology of each measurement day in order to individuate the cases in which an intrusion of African dust in the south of Puglia is likely present. These cases have been classified by using different sources of information and in particular: the Aerosol Index maps provided by the Earth Probe TOMS (Nasa), and the seven-days back-trajectories centered on Lecce as well as the Aerosol Optical Thickness provided by the AERONET group. The dust loading and wind at 3000 m as well as the dry dust deposition calculated with the Dust Regional Atmospheric Model (DREAM) developed by the Euro-Mediterranean Centre on Insular Dynamics (ICoD) have also been used. Support from the lidar station operating at the Lecce University [18] was also used in the classification. Our results indicate that about 19.6% of the measurements have been taken during intrusion of African dust. About 12.5% of the measurements taken in the cold season and about

TABLE V. – *Daily average concentrations of TSP and PM10 during days with PM10 concentration above the limit of* $50\,\mu g/m^3$. *It is also reported the PM10/TSP ratio and the classification as Sahara Dust event (SD) and Non Sahara Dust event (NSD).*

| Date | PM10 ($\mu$g/m$^3$) | TSP ($\mu$g/m$^3$) | PM10/TSP | Classification |
|---|---|---|---|---|
| 24/07/2002 | 80 | 113 | 0.70 | SD |
| 07/05/2003 | 53 | — | — | NSD |
| 09/05/2003 | 57 | 77 | 0.74 | SD |
| 10/05/2003 | 54 | 62 | 0.87 | SD |
| 20/05/2005 | 57 | — | — | SD |
| 30/10/2005 | 52 | — | — | NSD |
| 31/10/2005 | 52 | — | — | NSD |

26.2% of the ones taken in the hot season are concomitant to intrusion of African dust over Puglia. This is in agreement with observations that indicate spring and summer as the most probable periods for African dust intrusions in Puglia [16]. It has to be put in evidence that these are all cases found in our measurements but the effective contribution to the concentration levels could be different from one case to the other according to the strength of the local sources as well as to the effective rate of deposition of African dust. In table IV the average values of the concentrations of the different fraction of aerosol are reported selecting both SD cases (in which an intrusion of African dust is present) and NSD cases (in which the intrusion is not present). Results refer to all cases measured, therefore it has to be put in evidence that measurements of the different aerosol fractions are not necessarily simultaneous and they include measurements from several sites. However table IV shows that there is a substantial increase in the average TSP and PM10 concentrations as well as in the standard deviation of the concentrations, being more relevant the increase in TSP, during SD events. The concentration of PM2.5 does not show this pattern being the average concentration substantially similar in SD and NSD cases, even if this result has been obtained with a more limited statistics. Our data highlight seven cases where PM10 concentrations exceed the legislation limit ($50\,\mu g/m^3$ daily average), details of which are reported in table V, classified as either Sahara Dust events (SD) or Non Sahara Dust events (NSD). Basically 4 cases out of 7 above $50\,\mu g/m^3$ are identified as SD events. This means that, at least for urban-background and rural sites the intrusion of African dust could actually generate several cases of PM10 over the legislation limit. It has to be mentioned that in sites strongly influenced by local emissions (traffic, industrial emissions, domestic heating) the effect of intrusion of African dust could be more limited. The SD cases of 9/5/2003 and 10/5/2003 are a single episode of long-range transport of African dust over the south of Italy. The episode is mainly a transport of aerosol in the central part of Italy that extends down as far as the Salentum Peninsula. Our analysis shows that several SD cases actually last for many successive days and they are not necessarily associated to wind direction coming from the SE-S-SW sectors because large air circulations are often present over the Mediterranean sea. Therefore, according to our data, it is also possible to have SD cases associated to wind direction from the NW-W sector and also from the E sector. The results indicate that the PM10/TSP ratio during SD events is not strongly influenced; however during the SD event in July 2002, the monitoring station of the town of Lecce was operating, and the PM2.5/TSP ratio decreased to 0.24. This result and the ones reported in table IV allow arguing that most of the particles contained in Saharan dust are larger than 2.5 $\mu$m (coarse fraction). Therefore a simultaneous measurement of PM10 and PM2.5 could give discrimination between anthropogenic particulate and natural sources. Such behavior is in agreement with the analysis reported in [16], which shows how SD events in 2002 in Lecce are characterized by aerosol with a number distribution peaked at about 2 $\mu$m. This means that the mass-distribution is peaked to diameters larger than 2 $\mu$m. Measurements taken in Spain have also indicated that the PM2.5/PM10 ratio decreases during SD events [7].

## 4. – Conclusions

The present work reports an analysis of concentration levels of TSP, PM10 and PM2.5 measured in different sites in the Salentum Peninsula. Measurements were carried out discontinuously in the years from 2002 to 2005 with gravimetric detection of aerosol deposited on filters over 24 hours. Due to the general lack of data in the scientific literature relating to aerosol concentrations in this area of the southeastern Italy, this work constitutes a preliminary assessment of the situation, which could be a basis for planning future monitoring and investigations. All measurements sites were representative of the urban background and in one of them (Maglie) there is an industrial area nearby.

An analysis of different kinds of field blank filters has been carried out in order to investigate LOD and LOQ of concentration measurements. Results indicate an average LOD = 2.7 $\mu$g/m$^3$ for cellulose nitrate filters, an average LOD = 2.5 $\mu$g/m$^3$ for quartz fiber filters and an average LOD = 2.2 $\mu$g/m$^3$ for PVC filters.

Results indicate that the average value of PM2.5 is 18.9 $\mu$g/m$^3$, average PM10 is 28.1 $\mu$g/m$^3$ and average TSP is 45.5 $\mu$g/m$^3$. Concentration levels show difference between one site and the other and a seasonal pattern is present in which TSP and PM10 are larger during the hot season (April to September) and lower in the cold season (October to March). This pattern is not followed by PM2.5 even if this last fraction was evaluated with a more limited statistics. This seasonal change in concentration is essentially opposite to what is usually observed in the north of Italy and it could be partly due to the influence of intrusion of African dust that is more probable in spring and summer. Daily concentrations of TSP, PM10 and PM2.5 follow distributions in good agreement with lognormal statistical distributions.

Our results indicate that on rainy days TSP average concentration is reduced by about 32%, PM10 average concentration decreases of about 29%, and PM2.5 average concentration decreases of about 17%.

Daily concentrations are usually related to wind speed, with concentrations decreasing at high wind speed, with the exception of the measurements sites near local industrial sources that presents plumes which could arrive at the sensors more concentrated at high wind speed. However no particular correlation between concentrations and wind directions has been observed.

Our analysis shows that there are frequent cases of intrusion of African dust over the south of Puglia, in particular 19.6% of the measurements days are concomitant with intrusion of African dust. The distribution of SD is not uniform through the year being more probable in the spring and summer periods. During SD cases TSP and PM10 average concentrations are substantially increased, instead PM2.5 average concentrations are similar for SD and NSD cases. The results indicate, although with limited statistics, that during these episodes of African dust intrusion the PM10/TSP ratio does not change markedly, while the PM2.5/TSP ratio seems to decrease (although only one day of comparison was available from the monitoring network for PM2.5/TSP ratio). Such results could be explained in terms of the deposition of particles mainly in the coarse fraction between 2.5 $\mu$m and 10 $\mu$m, due to their settling velocities. This is compatible with the data obtained in the Salentum Peninsula during other research studies [16]. During the research period, 7 days occurred on which the daily concentration of PM10 was above the legislation limit of 50 $\mu$g/m$^3$. Our analysis shows that 4 of these 7 cases are concomitant with long-range transport of aerosol from Africa.

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