Characterization of atmospheric aerosol in the urban area of Napoli (Italy).

INFM UdR Napoli

Consiglio Nazionale delle Ricerche

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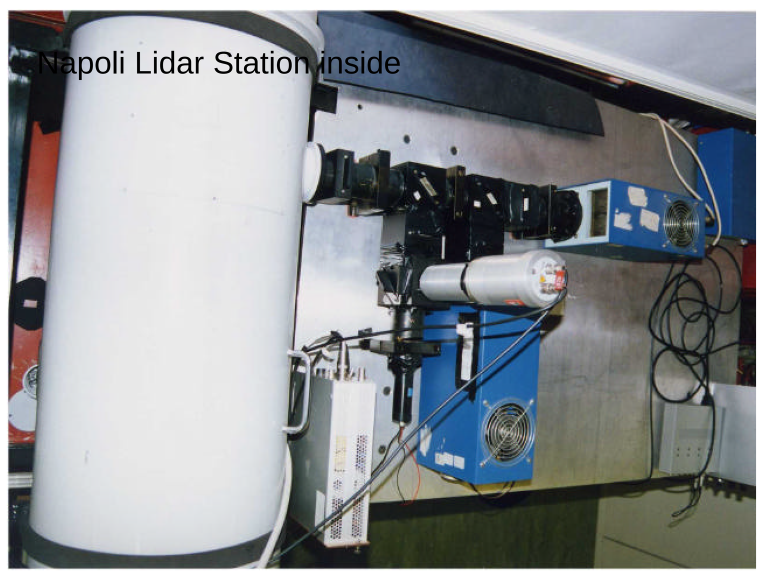
ABSTRACT

Systematic Lidar measurements of tropospheric aerosols optical properties have been carried out in the urban area of Naples (40 ° 50'N-14 ° 10'E, 118m a.s.l.), in the framework of EARLINET project and of a co-operation between the Naples municipality administration, the INFM (Istituto Nazionale per la Fisica della Materia) and the spin off company PROMETE.

Lidar data were taken during EARLINET project following a schedule of two measurements per week (climatological measurements); further measurements have been performed during Saharan Dust transport events and some detailed observation of complete diurnal cycle has been carried out.

A statistical analysis in terms of integrated backscattering (BI), optical depth (OD), extinction to backscattering ratio(LR), and Dust Layer height, obtained from measurements carried out over 30 mounts, has been realized.



INTRODUCTION

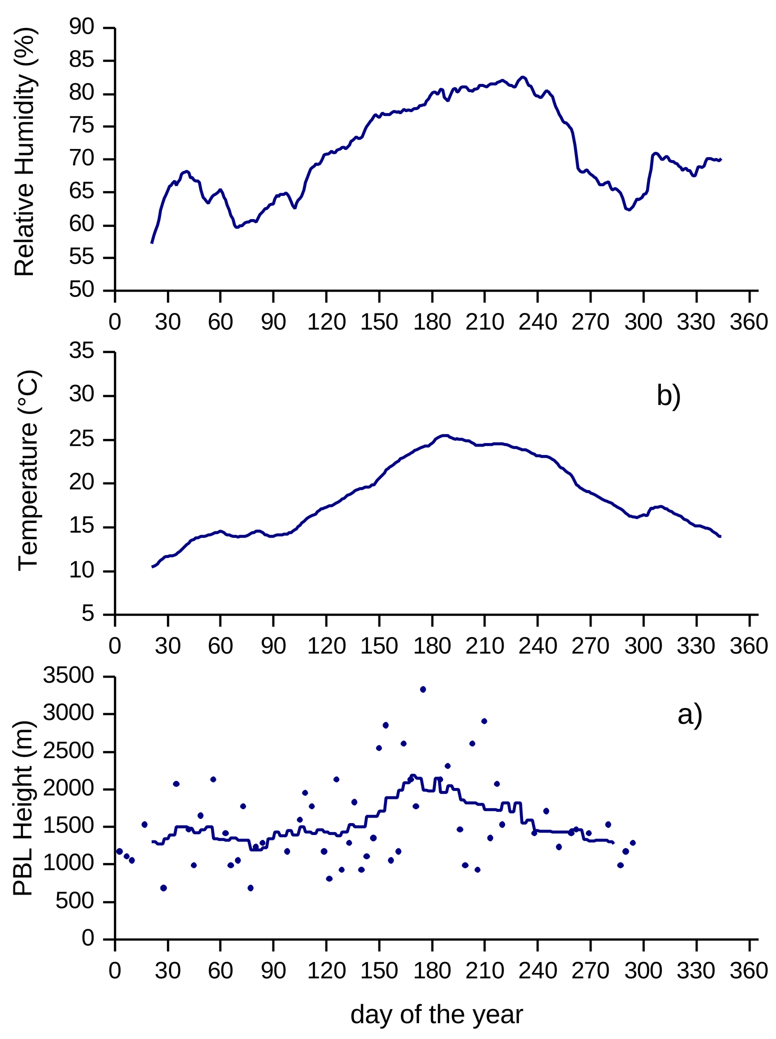
Lidar systematic measurements of aerosol backscattering and extinction profiles have been performed in the urban area of Napoli at laser wavelength of 351nm. The aerosol backscattering and extinction profiles were obtained from simultaneously measurements of elastic and N_2 Raman signals.

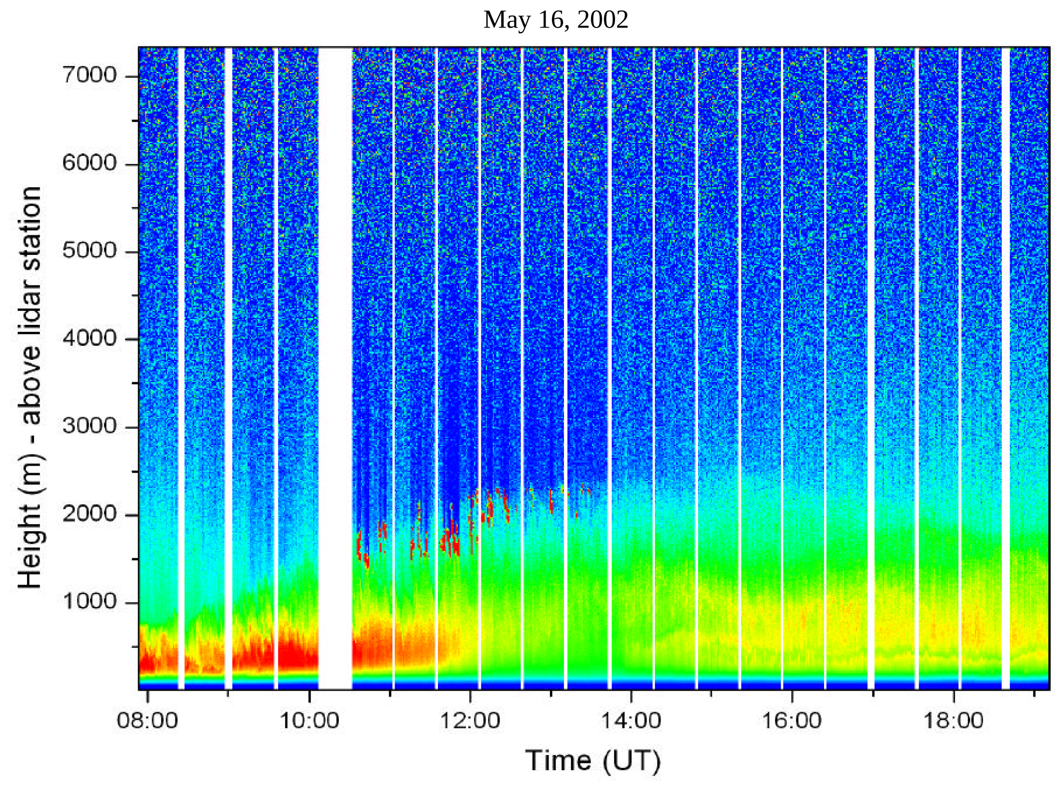
Measurements have been performed twice a week in clear sky conditions and a statistical analysis in terms of integrated backscattering (BI), optical depth (OD), extinction to backscattering ratio(LR), and Dust Layer height (DL), obtained from measurements carried out over 30 mounts, has been realized.

The statistics are based on the regular and some special measurements carried out on years 2000, 2001 and 2002, except for some special aerosol events, e.g. Saharan dust, volcanic eruption and forest fire etc..

We have analyzed 261 lidar measurements corresponding to 176 days of measurement. 261 elastic lidar signals and 137 N_2 Raman lidar signals, measured after sunset and in clear sky conditions, have been selected and used to derive the aerosol backscattering and the extinction profiles independently.

RESULTS AND DISCUSSION

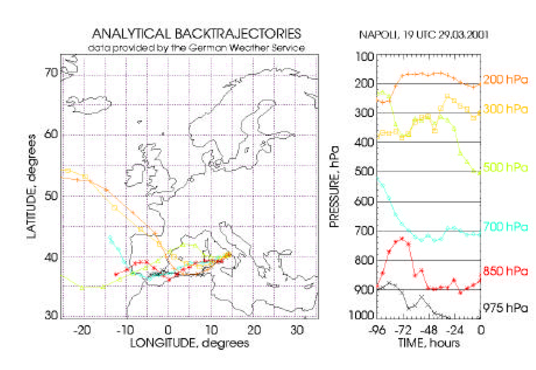




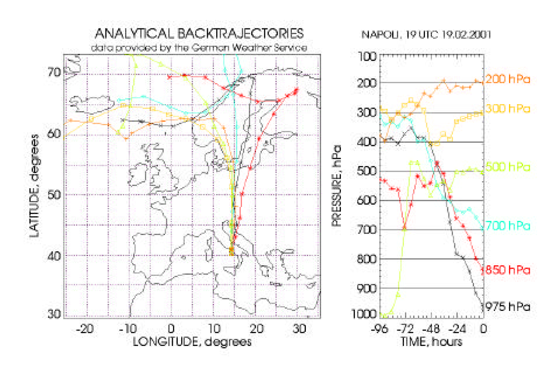
Preliminary analysis of the air mass origin as been made using back-trajectories calculated by the German Weather Service. This analysis has been restricted to measurements performed from June 2000 to June 2001 and referred to two different class of origin: sea and land.

This analysis, although it is preliminary, showed lowest LR values in connection with sea origin of the air mass transported to the measurement site, and typical of maritime aerosol. In a different way air mass coming from land are related to higher values of the LR, typical of urban aerosol.

The table shows also the values of the integrated backscatter and the optical depth as was calculated below the Dust Layer.



SEA



LAND

Air mass origin	BI below DL ($x10^{-3}sr^{-1}$)	OD below DL ($x10^{-2}$)	<LR> below DL (sr)
SEA	12.9?4.6	14.8?3.6	33?5
LAND	5.8?1.0	26.5?4.3	57?8

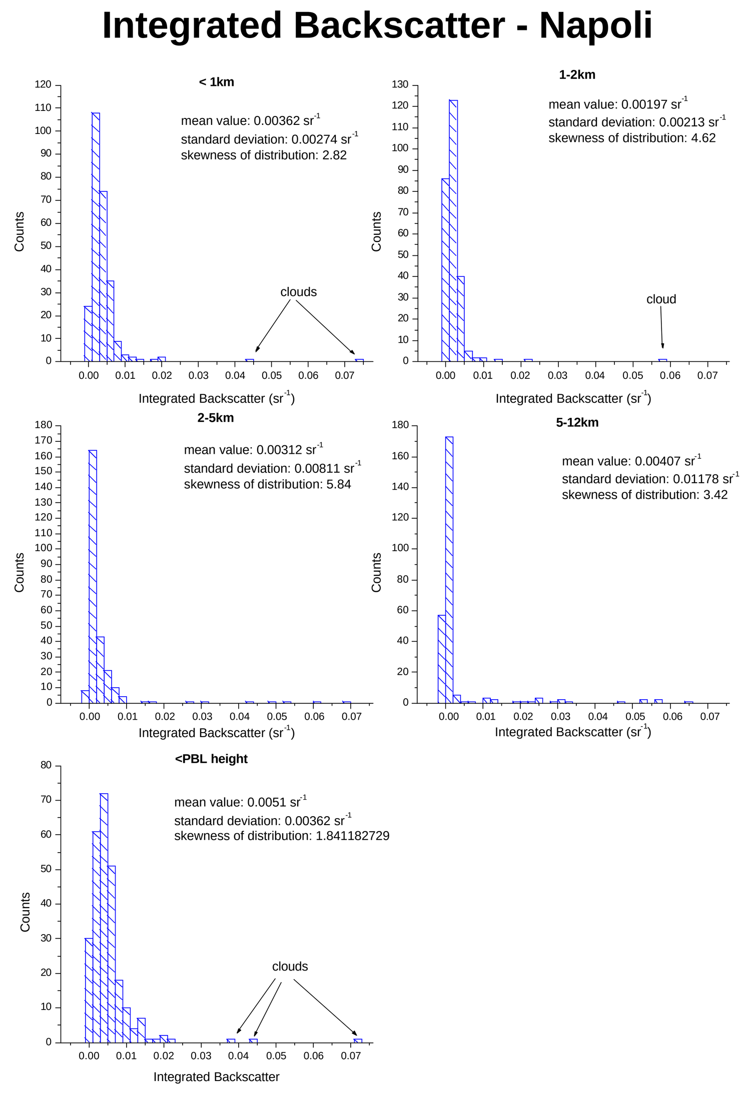
In fig.1 a) the annual cycle of the PBL height over the days corresponding to clear sky conditions is presented. The figure shows PBL height as derived from the measurements carried out in the year 2002. It is clear the trend to increase from January to June, whose maximum height is about 2000m, and the following decrease typical of winter months, in which the values are around 1400m. That is consistent with higher temperature (fig. 1b) registered in the summer because of the greater radiant flux on the ground. The warm air flows of the summer months produces the increase of the PBL structure, while in the winter the PBL decreases.

In the successive map the daily variation of the Range Corrected Signal, as they was observed on 2 May 16 2002, is reported. As it appears from this figure the top of the observed aerosol layer rises from 700m of height at 08.00 Universal Time (UT) to a maximum height of 2000m around 16:00 UT and decreases later through the afternoon.

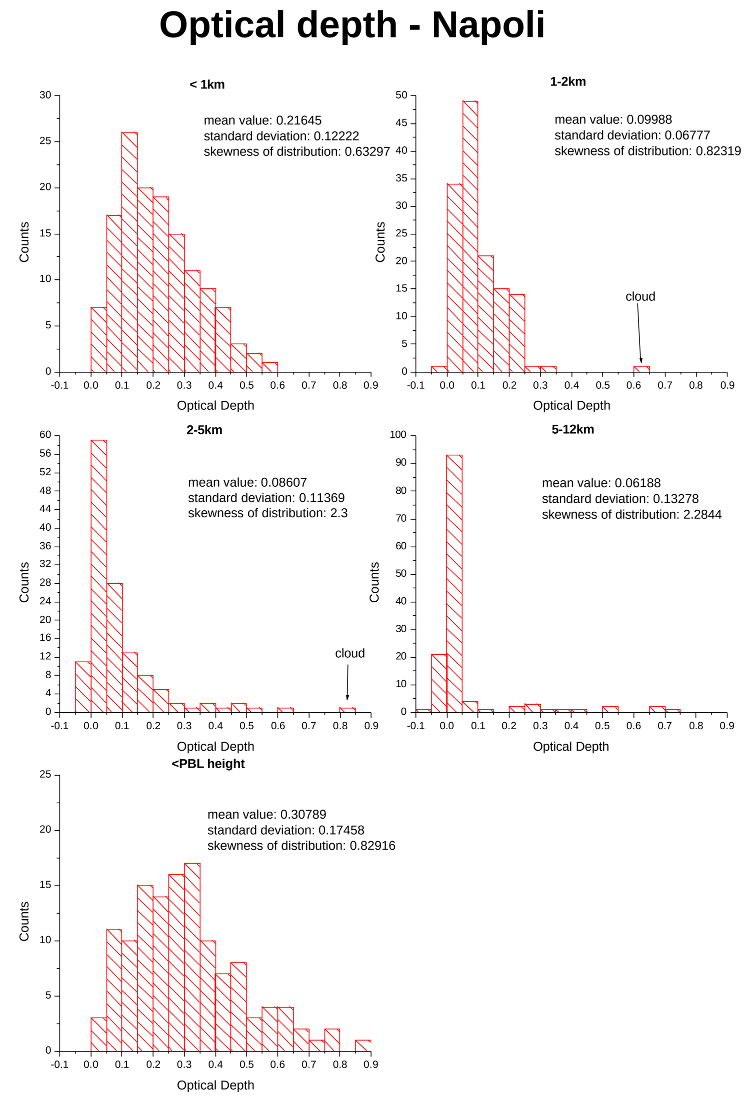
Statistical Analysis Results of Measurement in Napoli in 2000-2002

	DL Height (m)	< Backscatter >	Integrated Backscatter			Optical Depth			Lidar Ratio (sr)		
		Below DL ($x10^{-6} m^{-1} sr^{-1}$)	Below 2 km ($x10^{-3}sr^{-1}$)	2-4 km ($x10^{-3} sr^{-1}$)	Below DL ($x10^{-3} sr^{-1}$)	Below 2 km ($x10^{-2}$)	2-4 km ($x10^{-2}$)	Below DL ($x10^{-2}$)	Below 2 km	2-4 km	Below DL
Spring	1644?76	3.8?0.3	5.1?0.3	2.4?0.5	4.9?0.3	30.8?2.6	9.4?1.3	30.7?2.8	71?6	52?6	70?8
Summer	1653?82	4.2?0.3	6.2?0.4	2.3?0.2	6.1?0.5	39.0?3.1	13.5?2.1	39.7?3.6	77?8	54?5	79?7
Autumn	1350?58	3.2?0.2	4.8?0.5	0.8?0.1	3.9?0.3	28.9?2.4	3.8?0.5	28.4?2,8	85?9	40?5	83?8
Winter	1441?73	3.5?0.4	5.3?0.6	0.9?0.2	5.0?0.7	25.5?2.4	5.6?1.8	23.3?2.1	91?8	72?10	93?9

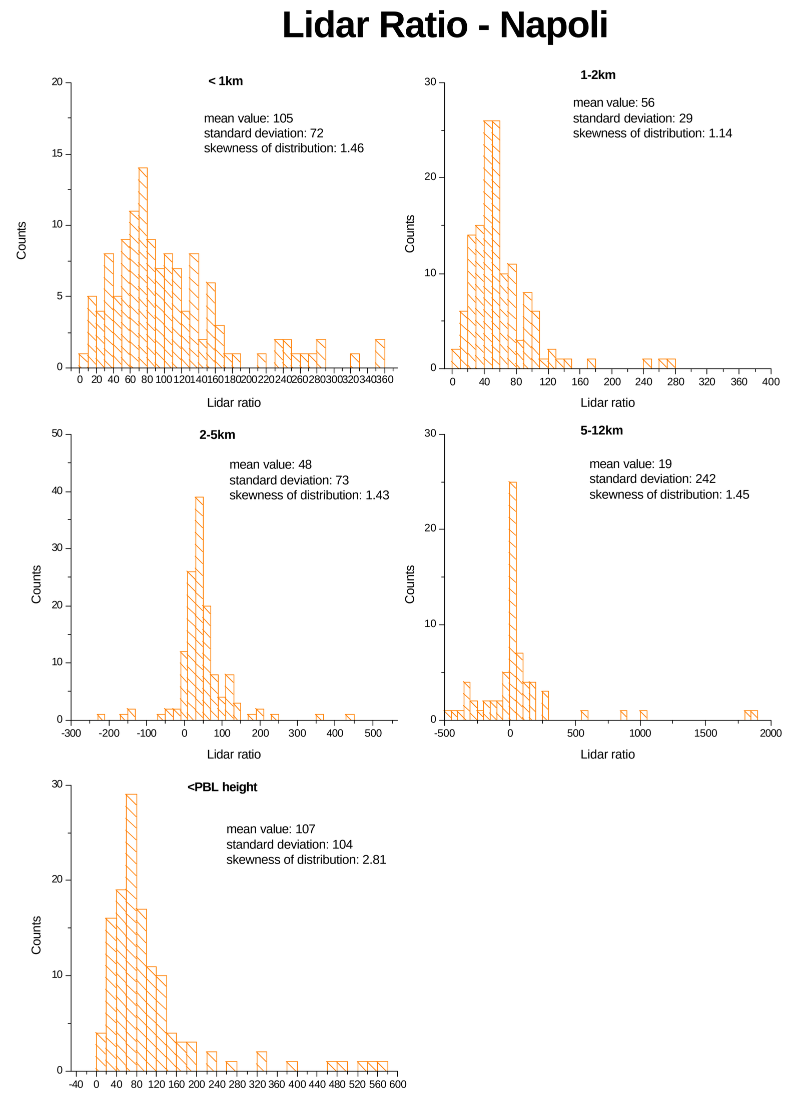
Integrated Backscatter - Napoli



Optical depth - Napoli



Lidar Ratio - Napoli



To perform the statistical analysis we have considered, for every day of measurement, the values integrated up to DL height, and the values integrated over two different atmospheric layers, two kilometers high. The aim is to trace out the seasonal variation of the aerosol load over the city of Naples and its vertical distribution in the lower troposphere

In the table we report the results obtained from statistical analysis applied to data concerning OD and BI. Maximum values, for clear sky conditions, are found during summer days, while minimum values are observed in winter. The table clearly evidence that the aerosol load is located essentially in the layer below 2 Km, and its content up to Dust Layer represents almost the 75% of the total aerosol load observed in the first 4 Km in the spring, summer and winter, and the 85%in the autumn months.

It is also shown the seasonal variation of the PBL height, as it was obtained by the first order derivative method applied to the logarithm of the Range Corrected Signal. The averaged PBL change from 1350?58 meters, as it was observed in the autumn months, to 1653?82 meters as it was observed in the summer months. It is evident the correlation with the warm air flows of the spring/summer months which produces the increase of the averaged PBL structure respect to the same observed in the autumn/winter months.

LR values, as was derived from the ratio between the extinction and the backscatter coefficients, are also reported. We can observe that the LR values obtained are larger in winter than in summer; this is related to a smaller pollution particles derived from local sources as combustion product, industrial activities, vehicular traffic, domestic heating. Moreover the values obtained are convincing with urban aerosol, while those obtained in summer are lower and related to higher values of the relative humidity registered in summer than in winter.

For the DL height, the OD and the BI values, obtained from June 2000 to October 2002, the statistical distributions have been derived. The mean value, standard deviation and skewness of the distribution are also reported in the figure.

ACKNOWLEDGEMENT

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