Analysis of the functional form of aerosol size distribution

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Keywords: particle size distribution, probability distribution,
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High suspended aerosol concentration in low atmosphere causes short-term health effects and increases the possibility of contracting serious acute or chronic respiratory and cardio circulatory diseases (Pope, 2000). The reduction of visibility (Schwartz, 1996) and the modification of the global climate through the alteration of Earth's radiation balance (Finlayson Pitts and Pitts, 2000) are two additional environmental issues related to this phenomenon. For these reasons the importance of aerosol particle size distribution has been increasingly recognized since the last century.

In this study, aerosol particle number concentration measurements in seven urban and rural sites, located in Lombardy region, northern Italy (Table 1) are considered.

Table 1. List of the measurement sites with indication of the period of observation.

Sites (Province)	From	To
Alpe San Colombano 1 (SO) *	27/01/2005	06/03/2005
Alpe San Colombano 2 (SO)	21/07/2011	15/09/2011
Bosco Fontana 1 (MN) *	02/07/2004	29/07/2004
Bosco Fontana 2 (MN) *	27/12/2004	20/01/2005
Broni (PV)	09/05/2007	13/06/2007
Casargo (LC)	07/08/2008	11/09/2008
Culmine San Pietro (LC)	06/06/2009	10/06/2009
Milano (MI)	15/07/2011	27/12/2012
San Lorenzo di Parabiago (MI)	05/03/2009	01/04/2009

The aerosol data represent size distributions within the particle diameter size range 0.25-30 µm subdivided in 30 size bins or 0.3-20 µm subdivided in 15 size bins (sites with *), measured with an Optical Particle Counter (OPC-Grimm Model 107). The data have been studied in term of particle size distribution considering 1-minute time interval, the temporal resolution of the OPC. The very different nature of the measurement sites is reflected by the average particle number, and aerosol dynamics, which greatly vary depending on the site. For example, in the urban background site of Milan, the number of particles per minute can exceed 10^6 pp/l especially during the cold season and in correspondence of rush hours. Conversely, the mountain site of San Colombano, located at 2250 m a.s.l., is characterized by an average number of particles per minute of about $5 \cdot 10^4$ pp/l (one order of magnitude less than Milan) and it does not show any particular trend.

In general, it does not exist a priori a function to be chosen to represent particle size distribution, due to the different characteristics phenomena producing aerosol particles. An envelope of log normal distributions have been widely used to fit the PM data.

The focus of this study is to investigate a method to found a general functional form, which is able to better describe the particle size distribution in all the investigated sites, which are characterized by these different behaviors. In order to do this, a technique based on the statistical relation between the third and the fourth moments, has been adopted. The results show that a general functional form is possible, and its parameters can be estimated with the Maximum Likelihood method. These parameters are site dependent and influenced by meteorological conditions. The founded new distributions have been compared with the classical approaches.

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