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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The role of mixing layer on changes of particle properties in lower troposphere" *by* L. Ferrero et al.

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To Referee1

REFEREE 1 GENERAL COMMENT:

The paper describes the chemical-physical properties of atmospheric aerosol from vertical profiles measured in Milan during three years field campaign. Number size distribution and chemical composition profiles are presented and discussed. Vertical profiles aerosol data are relevant because they form the link between aerosol ground-based observations and aerosol retrievals from spaceborne sensors. Despite the scientific significance of this topic, the present study fails in proving a significant contribution to knowledge's progress. The results presented are poor of novelty and their implications quite unclear. Further, paper is penalized by an inappropriate use of the English language which makes the reading of few sections quite difficult. The reviewer would advice the authors to revise the manuscript, especially the results and discussion section. Major efforts should be made to provide a more clear and concise presentation of the observations and to highlight the novelty and relevance of the findings.

ANSWER:

Thank you for your useful comments.

1) You say that "the present study fails in proving a significant contribution to knowledge's progress. The results presented are poor of novelty and their implications quite unclear" and "advice the authors to revise the manuscript, especially the results and discussion section. Major efforts should be made . . . to highlight the novelty and relevance of the findings".

In this respect the aim of this work is to describe, by a modelling approach, the typical particle size changes along height, within and above the mixing layer. These are shown under different meteorological situations (tab. 2) by a general law (eq. 6). This kind of knowledge is fundamental in remote sensing applications (Satellite, lidar, photometer. . .) to retrieve the main physical parameters of atmospheric particles (PM ground concentrations, optical properties and size distribution along height). Along the whole paper, the innovative points, not yet clearly resolved in literature as far as we know, are the following: 1. we find new relationships between Hmix and changes in particle size both for fine and coarse particles (fig. 5.b and 7) under stable conditions. This is a topic of interest because, as reported in the introduction (from pag. 16485, line 29, to page 16486, lines 1-6) the connection between the columnar aerosol size distribution and details of the vertical profiles is still under discussion. In this respect, as reported by Campanelli et al. (2003) and by Corrigan et al. (2008), the remote sensing (satellite and AERONET) approach need assumptions about aerosol physical,

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Interactive Comment

optical and chemical parameters, as well as homogeneity, which may not lead to valid results (Dubovik et al., 2000; Levy et al., 2004). A common basic assumption of all the above-mentioned algorithms is that the atmosphere is vertically homogeneous and that the aerosol optical characteristics are constant over the whole air column. Our results, collected in Milan, in the stagnant conditions of the Po Valley are totally new as regards the description of the relationship between aerosol size distribution and details of the vertical profiles under these meteorological conditions. This is also reported in the result and discussion section at page 16494 (lines 17-27), and in the conclusions. 2. coarse particles cannot be dispersed into the ML in the same way as finest ones especially during winter (fig. 5a; low wind speed conditions). This is a point of interest because Hmix is usually used in literature (Levy et al. 2007; Di Nicolantonio et al., 2007; Liu et al., 2005; Sarigiannis et al., 2004) to retrive PM concentrations at ground from satellites (i.e. MODIS on Terra and Aqua platforms) as a proxi of the aerosol effective scale height (Heff) introduced by Kaufman and Fraser in 1983. The use of Hmix instead of Heff requires, for example, that an homogeneous mixing is present into the mixing layer. Figure 5a in the paper gives a first answer to the accuracy of a such approximation. High stability conditions can make the two fractions differently dispersed; in these cases the use of Hmix in PM retrieval algorithms can induce an error. 3. the present study proposes a statistical model for assessing the size distribution changes of the fine fraction along height (section 3.2), which is a basic trait of the work done, that proposes a general tool for handling similar data sets. All vertical profiles together enter in a probabilistic model, after standardising vertical profiles with respect to the ML height (proposed in section 3.2). In this model parameters are estimated, in a statistical sense, in order to permit to find a general law, valid for similar meteorological situations (tab. 2). Moreover the results can be expressed via credibility bands and not only via point values: this is allowed by managing model and data uncertainty via probability tools. The prototypal model we propose can moreover be used in any previsive situation. The basic ideas are the following: a) If we assume that, at any heights, the basic information is the OPC size class relative contribution to the total count, it has to be treated with appropriate statistical tools (i.e. compositional data analysis), this approach is proposed for the first time. b) A statistical model has been estimated separately on each of four homogeneous groups of launches, characterized by different external conditions. In this way typical vertical profile behaviours have been identified (fig. 9): this is a novel result. c) The statistical model at the same time takes into account compositions, heights and launches of the same group and arrives at modelling counts within the OPC size class. 4. the model developed is able to predict particle properties along height starting from ground measurements (aerosol and meterological) and ML height. This is reported in the section 3.2 and in the conclusions. In this respect, we have been able to compute the model counterpart of several experimental evidences and to confirm experimental conjectures. In particular, Tables 6 and 7 report the model counterpart of the average relative contribution of each size class in homogeneous sub-groups. The 95% credibility intervals of Table 7 contain the empirical average relative size distribution. This shows how statistical modelling permits one to compute measures of uncertainty of estimated values that render results more thorough than descriptive syntheses of data. Among the outputs of the hierarchical statistical model, also appear the estimated MPD values corresponding to the empirical values. The MPD growth estimated via the model is 1.6$\pm$0.4% for group A; 2.2$\pm$0.5% for group B; $-$2.0$\pm$0.5% for group C and 6.1$\pm$1.2% for group D, in accordance with experimental evidences.

Finally we would remark that these results came from the collection of long-term data series (3 years, more than 300 profiles), using a thetered balloon approach, and thus avoiding the common limit of direct sampling along vertical profiles: the temporal significance of these measurements and their interpretations. Infact, in literature balloon size-distribution measurements where done mainly during short-peculiar sampling campaigns (Laakso et al., 2007; McKendry et al., 2004; Maletto et al., 2003; Stratmann et al., 2003).

2) You say that “Further, paper is penalized by an inappropriate use of the English

language which makes the reading of few sections quite difficult"

We submitted our paper to a native speaker before the ACP submission. However we submitted now our paper to another native speaker and we are going to simplify the sentences in the text to made the paper easy to read.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 16483, 2009.