

Interactive comment on “Composition, size distribution, optical properties and radiative effects of re-suspended local mineral dust of Rome area by individual-particle microanalysis and radiative transfer modelling” by A. Pietrodangelo et al.

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Anonymous Referee #1 At first I want to apologize for the delay of my review. The paper by Pietrodangelo et al. analyses the composition, size distribution, optical properties and radiative effects of local resuspended dust particles in the area of Rome. The paper is well written and all the laboratory analyses are performed with following a rigorous approach. The results indicate several differences in the chemical com-

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position/size distribution of the resuspended dust which is discussed to play a role in modulating the particle optical properties and radiative effects in the area of Rome.

The authors are grateful to the Anonymous referee #1 for helpful suggestions and remarks concerning the Manuscript acp-2015-259, which allowed to improve consistently the scientific quality of this study. All suggestions from the Referee have been followed, and remarks have been discussed extensively, as follows.

The paper has potentially the interest for publication on ACP, however I have several major concerns, which are listed below: 1. Concerning the introduction/context: I have some problems in identifying the importance of the study in link to the mean aerosol composition/optical depth in the area of Rome. Which is the fraction of PM₁₀ that can be associated to resuspended dust in the area of Rome? Which is the frequency of occurrence of these episodes and their impact on the visible optical depth?

The reviewer addresses an interesting question about the role of local mineral dust of Rome area on the PM₁₀ and on the impact of this contribution on the visible optical depth. On the basis of this query, the following considerations can be made.

1. Some comments, on the frequency and the influence on the mass concentration, of local crustal dust resuspension to the ambient PM₁₀ in the Rome area have now been added in the Introduction, and two figures (Figures 2S and 3S) have been added to the Supplementary materials (Supplementary materials_revised), to support the discussion on this item. To summarize briefly, a long period has been analysed (2005 – 2011 and 2005 – 2015, depending on the site), for which data are available at two different background sites in Rome area (as showed in Figures 2S and 3S). The goal was to evaluate the number of days and the entity of the crustal contribution, on days of desert dust intrusion at-ground (DD-days) and on days showing a large crustal contribution (above 50% of total PM₁₀ mass) without occurrence of desert dust at-ground, indicating a crustal contribution from local sources (LD-days). Interestingly, among the above described days, the mass concentration of the crustal matter on LD-days is in

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many cases comparable with that observed on DD-days.

2. The local mineral dust samples of this study have to be considered as emitted at source, as discussed in the following points. The visible optical depth due to these samples is thus negligible with respect to the columnar AOD. In fact, the AOD of these components is not directly comparable to the column integrated AOD measured during the local dust events, the reason of which is discussed in the reply to question #2. To this aim, the authors have been analysed the AOD downloaded from the Rome Tor Vergata AERONET station nearest to the recognized sources. The AOD@532nm is generally between 0.2-0.3 with Angstrom coefficient larger than one, fine mode aerosols dominate the atmospheric column. As example, the Figure shows the AOD@532nm and the Angstrom coefficient for two events of local and Saharan dust, respectively.

Local Dust (see figure in the supplement pdf file attached to plain text)

Saharan Dust (see figure in the supplement pdf file attached to plain text)

Therefore, following the reviewer's suggestions, to evaluate the radiative efficiency of the local dust, the radiative impact of the principal components of the chemical mixture, travertine and volcanic, independently from their loading has been evaluated introducing the efficiency radiative forcing. This allows us to achieve manuscript purposes with results not related to the influence of these components to the total visible optical depth. Furthermore, the PM10 samples of this work are obtained from topsoil/outcropped rocks materials collected at the source, while the available radiative measurements are not close to these sites. Under this aspect, the AERONET data cannot be considered as representative of the local dust spread on the Rome area and, therefore, cannot be compared with the dust samples of this work.

2. Concerning the representativeness of the considered samples: how the size distribution of the analysed samples is representative of airborne particles? And for the mineralogy?

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The approach of laboratory resuspension of dust by mechanical ventilation along an adequate time and by simultaneous sampling in the controlled environment of the chamber, is widely employed in the research field of the mineralogical and micro-physical characterization of airborne crustal dust (e.g. Gill et al., 2006 and references therein; Feng et al., 2011; Aymar et al., 2012; Dobrzhinsky et al, 2012). By this approach, indeed, it is possible to reproduce with good approximation the conditions of the field sampling at a dust source, and the size distribution of the resuspended particles is negligibly affected, with respect to the original distribution in the source material. This is extensively treated by Gill et al. (2006). Moreover, it should be taken into account that the PM10 samples of this work are obtained by a PM10 sampling head compliant with EN12341 standard (as reported in the paper by Pietrodangelo et al., 2013, cited in Section 2.1 of the Manuscript). Therefore particles in the samples of this work have aerodynamic diameter below $10\mu\text{m}$ and can be considered, with sufficient approximation, as if they were collected at the dust source. To better clarify this point, some comments have been added in Section 2.1 of the revised Manuscript (p.5, lines 23 – 31). Under the above arguments, the mineralogy of the PM10 particles collected by chamber resuspension in this study can be considered representative of the mineralogy of the same particles in the geological source materials. The approximation by which this assumption is made depends strictly on the confidence on the ability of this approach in reproducing the conditions of field sampling at a dust source, as above discussed, at least with respect to the interference of the PM10 sampler on the dust source itself. Considering that about 95% of mineral particle included in this study show physical size below, or equal to, $5\mu\text{m}$, our results are also in line with arguments reported by Mahowald et al. (2014): "Accurate representation of the dust particle size distribution (PSD) in the atmosphere begins with a parameterization of the dust PSD at emission. Note that the different measurements of the size distributions at emission are all in rough agreement for dust aerosols smaller than $5\mu\text{m}$ in diameter . . . This is quite remarkable, considering that these measurements were taken over different soils, in different source regions, and using different techniques. For larger particles

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(> 5 μm), the size distributions do differ substantially, a possible cause of which is discussed in the next section. In order to parameterize the dust PSD at emission in models, the dependence on wind speed and soil properties, such as soil PSD, needs to be understood. A number of studies have reported measurements of the dust PSD at different values of the wind friction speed. Most of these measurements show no dependence of the dust PSD on the wind speed at emission On balance, the measurements indicate that the dust PSD is independent of the wind speed at emission. This conclusion is supported by the observation of Reid et al. (2008) that the PSD of dust advected from individual source regions appeared invariant to the wind speed at emission.”

3. What about the obtained mineralogical composition in comparison with that of similar sources? It is possible to have a comparison with other studies?

The availability in literature of dust sources similar to those investigated in this study is small, due to the peculiar geological setting of the Latium region, and in particular of Rome area, as widely discussed in the paper by Pietrodangelo et al. (2013), which is cited in Section 2.1 (p.6, line 2 of the revised Manuscript) concerning this point. Moreover, given the great effort of experimental work required to determine quantitatively the mineralogical composition of the airborne PM, few studies concern this aspect (as reported at p.4, lines 3-7, of the revised Manuscript). Nevertheless, we can add to the already cited references the mineralogical profiles of PM10 from mineral dust sources located in North Africa and Saudi Arabia (Ganor et al., 2009). We discussed this reference adding some text in Section 3.4.1.

4. Concerning the calculation of the optical properties, I do not agree with the fact that calcite is not absorbing; conversely, in the shortwave, calcite is one of the most absorbing minerals. I think you have to reconsider the choices of the refractive indices for your minerals/samples. Moreover, considering that you have measured the mineralogy, why not calculating the complex refractive index based on the mineralogical composition using either an internal mixing or external mixing rule?

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Calcite is absorbing significantly above 5000 nm. The imaginary part of the refractive index (r.i.) is, in the wavelength range considered by our study, below 0.01 (Sokolik & Toon 1999, Di Biagio et al. 2014). Moreover, the calculation of the complex r.i. (e.g., as performed by Kandler et al., (2007) at 550 nm only) is out of the aims of our study, since the radiative transfer code 6SV requires, among other inputs, the spectral trend of the real and of the imaginary parts of the r.i. in the range 350 – 3750 nm. Concerning the volcanics sample, it was not possible to build the real and imaginary parts of r.i. on the basis of the mineralogical composition determined, e.g. introducing a complex mixing model, due to the lack of numerical data, in literature, in the wavelength range required for simulations by the 6SV code. Indeed, the availability of the spectral trend of the imaginary part of r.i. is limited to 2500 nm for most minerals. Moreover, available spectral data of the r.i. account only for ab. 70% of the mineralogical composition of the volcanic sample; the uncertainty which would be introduced by not considering mineral phases, such as plagioclase and pyroxene, for which appropriate data are not available in literature, would be thus too large to apply a complex mixing modelling to estimate the r.i.. Therefore, the choice of assuming the r.i. spectral trend of the “water-insoluble” aerosol component provided by the 6S radiative model, which is rich in silicate minerals similarly to the volcanics dust of this study, was considered more suitable. The authors are anyway grateful to the Reviewer for the suggestion of introducing a complex mixing model, and aim at developing this issue in future studies.

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/15/C8755/2015/acpd-15-C8755-2015-supplement.pdf>

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 13347, 2015.

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