We thank Reviewer #1 for his or her useful comments on our manuscript. All comments have been thoroughly considered so as to improve the manuscript. Hereafter Reviewers' comments are written in *black italics***, our responses in bold black fonts and the changes in the manuscript in blue bold.**

The manuscript consists of a case study of the vertical structure and optical properties of mineral dust observed during nine flights over the western Mediterranean from June 14th to July 4th 2013. The focus is on determining the refractive index, the spectral scattering coefficient, the particle number concentrations both sub-micronic and super-micronic and finally the Angstrom exponent. As the profiles provide vertically resolved information on these quantities, the respective roles of mineral dust and pollution aerosol in modulating these parameters can be analyzed and put intto the context of a late spring, early summer period over the region. The authors describe well the methods used, the uncertainties of the instruments and the significance of the different profiles they collected.

R1.1. The terminology 'intermediate layer' and 'elevated layer' are confusing as one expects a lower layer. I propose to the author to chance this terminology by defining a below-3km layer as one that encompasses the Marine Boundary Layer and the bottom of the free troposphere and the above-3km layer as the one that includes the free troposphere above 3km of the western Med.

« Intermediate dust layer » and « elevated dust layer » are replaced by « below-3km dust layer » and « above-3km dust layer », respectively, throughout the text.

R1.2. Here are two references really worthwhile citing as they constitute precursor work on the physical characteristics of dust over the Mediterranean and on the role of dust in heterogeneous chemistry respectively: Van Dingenen et al, 2005 and Bauer et al., 2004. In addition, it would be worth mentioning the work of Gian Paolo Gobbi and F. Barnaba who documented through LIDAR measurements the vertical structure of dust layers over the Mediterranean Sea with some very elevated extension above 10km.

There references are now added in the manuscript.

R1.3. The authors might not be aware of a debate among modelers on how absorbing dust really is. These measurements of the refractive index are very nice in that they could bring this debate towards a closure. Here are the 3 papers that to my knowledge incited to rethink the values of refractive indices that were originally published in the OPAC database:

Kaufman, Y. J., Tanré, D., Dubovik, D. O., Karnieli, A., and Remer, L. A.: Absorption of sunlight by dust as inferred from satellite and ground-based remote sensing, Geophys. Res. Lett., 28, 1479–1482, 2001.

Moulin, C., Gordon, H. R., Banzon, V. F., and Evans, R. H.: Assessment of Saharan dust absorption in the visible from Sea- WiFS imagery, J. Geophys. Res., 106(D16), 18 239–18 250, doi:10.1029/2000JD900812, 2001.

Balkanski, Y., Schulz, M., Claquin, T., and Guibert, S.: Reevaluation of Mineral aerosol radiative forcings suggests a better agreement with satellite and AERONET data, Atmos. Chem. Phys., 7, 81-95, doi:10.5194/acp-7-81-2007, 2007.

As the authors will see from looking at Figure 1, 2 and 4 from the paper Balkanski et al., 2007, dust is less absorbing that what most modeling groups are assuming, studies that are included in the discussions of latest IPCC report.

Thank you for this relevant comment. We agree with Reviewer #1 that the dust absorption as represented by the imaginary part of the refractive index in models should be reassessed. This is especially true when comparing the values observed for dust from our in-situ measurements (n_i between 0.000 – 0.005) with that published in the OPAC database (n_i = 0.006) that is widely used by the modelling and remote sensing communities. We add in the results and conclusion sections a comparison of our observations with the OPAC dataset.

Additional text P21632 L7: We compared our measurements on dust absorption properties with values published in the OPAC aerosol database that is widely used by modelling and remote sensing communities. The result of this comparison indicates an overestimation of dust absorption properties in the OPAC database. The n_i value achieved in the OPAC database (n_i=0.006) is high compared to values observed for Saharan mineral dust in source region and over the Mediterranean during ADRIMED (n_i between 0.000–0.005). This finding is in line with previous studies showing disagreements in dust absorption between satellite retrievals and modelling studies that has been solved by decreasing the imaginary part of the dust refractive index (Kaufman et al, 2001; Moulin et al, 2001; Balkanski et al., 2007; Mian Chin et al., 2009).

Additional text P21636 L20: A straightforward comparison of our results with values published in the OPAC aerosol database, which is widely used by the remote sensing communities, suggests that the OPAC database overestimate dust absorption.

R1.4. The discussion page 21629 of the manuscript, assumes that only dust will influence the single scattering albedo (SSA), the authors should be much more careful when they state this. Although dust represents more than 80% of the total aerosol load, only a few percent of the mass of rBC or 15% of SO_4 will change by 0.01 to 0.03 this SSA. They should reword this passage saying that if rBC is less than 1% of the total load, then they can do this inference, if not the SSA will decrease due to rBC and the value they measure/infer is a lower limit to the actual SSA of dust.

We do not understand the Reviewer's comment here since this paragraph aims at presenting the SSA for dust scenes in different air masses. The influence BC-laden air masses on the SSA of dust layers is presented.

<u>Minor points:</u>

R1.5. The assumptions for the computation of SSA in Table 5 that appears on the line ''w0 (chemistry)'' have not been well presented. If the authors took a simple weighted average, it is erroneous; it should be weighted by the product of the optical depth times the asymmetry factor of each aerosol component.

The equation used to calculate w_0(chemistry) is added in section 4.2.

Additional text: Calculations of ω_0 were performed as follows:

$$\omega_0 = \frac{\sum_i (k_{ext,i} - k_{abs,i}).C_{m,i}}{\sum_i k_{ext,i}.C_{m,i}} \qquad (9)$$

R1.6. Page 21618: the authors make the assumption of the sphericity of dust particles but do not give the proper references to indicate that this assumption is reliable. Please indicate the work that have studied and quantified the effect of dust non-sphericity.

Mineral dust particles are certainly irregular, not spherical particles. The a-sphericity affects the angular distribution of the scattered light, mostly in the backward region at scattering angles larger than 80% (Mishchenko, 2009). Neglecting the particle a-sphericity induce a large uncertainty in the retrieved aerosol optical thickness from the satellite reflectance measurements. However, Mischenko et al. (1995) showed that the sphere model could be a suitable approximation for nonspherical dust in radiative flux simulation, because the optical depth, the single scattering albedo and the asymmetry factor are similar in the two cases. Because we only investigate angular-integrated properties, and for sake of comparison with the large majority of field data published so far, in this paper we only perform calculations in the spherical approximation.

R1.7. Page 21622; lines 21-22: Change "Relatively frequent dust episodes could be observed as it is typical for the season (Moulin et al., 1998). Âz with ''Moulin et al. (1998) have documented the frequency of dust episodes across the Mediteranean Sea, summer occurrences are quite frequent. ''

This is corrected.

R1.8. Page 21623, lines 10 to 13: please clarify the following sentence: '' Values obtained during ADRIMED are consistent with those obtained near dust source regions within 1.5 days after emission (Formenti et al., 2011b; Weinzierl et al., 2011; Ryder et al., 2013b), but, for a comparable transport time, higher than after long-range transport over the Atlantic ocean (Maring et al., 2003; Weinzierl et al., 2011)."

The sentence has been rewritten.

Updated text: "During ADRIMED, $D_{eff,c}$ values obtained in dust layers having spent less than 1.5 days in the atmosphere are consistent with those obtained near dust source regions (Formenti et al, 2011b; Weinzierl et al., 2011). Conversely, dust layers having spent more than 1.5 days in the atmosphere present higher $D_{eff,c}$ than previously observed over the Atlantic ocean (Maring et al., 2003; Weinzierl et al., 2011)."

R1.9. Page 21634 lines 16 to 20 : Change : '' Dust particles originating from Algeria, Tunisia and Morocco were sampled in the western Mediterranean basin after being trans ported 1–5 days of transport." To '' Dust particles originating from Algeria, Tunisia and Morocco were sampled in the western Mediterranean basin after 1 to 5 days of transport from the source regions."

This is corrected.

R1.10. Page 21635 lines 3 and 4 Change : '' Mineral dust carried higher concentration of pollution particles at intermediate altitude (1–3 km a.s.l.)..." to '' Measurements showed the presence of mineral dust together with higher concentration of pollution particles at intermediate altitude (1–3 km a.s.l.)..."

This is corrected.

References:
Formenti, P., Schütz, L., Balkanski, Y., Desboeufs, K., Ebert, M., Kandler, K., Petzold, A., Scheuvens, D., Weinbruch, S., and Zhang, D.: Recent progress in understanding physical and chemical properties of African and Asian mineral dust, Atmos. Chem. Phys., 11, 8231-8256, 10.5194/acp-11-8231-2011, 2011b.
Maring, H., Savoie, D. L., Izaguirre, M. A., Custals, L., and Reid, J. S.: Mineral dust aerosol size distribution change during atmospheric transport, J. Geophys. Res.-Atmos., 108, 10.1029/2002jd002536, 2003.
Mian Chin, Diehl, T., Dubovick, O., Eck, T. F, Holben, B. N, Sinyiuk, A., and Streets, D. G.: Light absorption by pollution, dust, and biomass burning aerosols: a global model study and evaluation with AERONET measurements, Ann. Geophys., 27, 3439-3464, doi:10.5194/angeo-27-3439-2009, 2009.
Mishchenko, M. I., Lacis, A. A., Carlson, B. E., and Travis, L. D. : Nonsphericity of dust-like tropospheric aerosols : implications for aerosol remote sensing and climate modelling, Geophys. Res. Lett., 22(9), 1077-1080, 1995.
Mishchenko, M. I., Electromagnetic scattering by nonspherical particles: A tutorial review, Journal of Quantitative Spectroscopy and Radiative Transfer, 11, 808-832, 10.1016/j.jqsrt.2008.12.005, 2009.
Weinzierl, B., Sauer, D., Esselborn, M., Petzold, A., Veira, A., Rose, M., Mund, S., Wirth, M., Ansmann, A., Tesche, M., Gross, S., and Freudenthaler, V.: Microphysical and optical properties of dust and tropical biomass burning aerosol layers in the Cape Verde region-an overview of the airborne in situ and lidar measurements during SAMUM-2, Tellus B, 63, 589-618, 10.1111/j.1600-0889.2011.00566.x, 2011.