The authors would like to thank the referee for the helpful comments and suggestions. Our point-to-point response the reviewer's comments is detailed below.

Response to Anonymous Referee #1

1) *My main concern has to do with the discussion and presentation of the dust event in the Mediterranean. About half the paper is devoted to this case study. The related sections are too long and the discussion of the study is not particularly convincing.*

The authors spend a great deal of time presenting each individual measurement (AERONET, MODIS, CALIOP) at length, while they could really only discuss CALIOP the lidar instrument as it is the most relevant to their paper, and only devote a couple of sentences and relevant references for the others. The same applies to the description of CHIMERE and WRF. These models are not the central part of the paper and their description could be shorter.

Furthermore, I am not convinced that including MODIS and AERONET is that relevant to the case study. The main purpose of the paper is to present the lidar signal simulation tool, so the emphasis should be on the comparison between CALIOP and CHIMERE. Moreover, the authors calculate the optical properties only at 532 nm (and 1064 nm), which are directly comparable for CALIOP. However, MODIS and AERONET are at other wavelengths (550 and 500 nm).

Our simulator allows the calculation of a series of optical properties that can be directly compared to observations (passive and active). Although the added value of OPTSIM is the simulation of L1 lidar parameters, we note that parameters observed by passive remote sensors, such as the aerosol optical thickness, are widely used for the validation of aerosol modeling by CTMs. Therefore we have decided to also present comparisons with AERONET and MODIS. Even if the comparisons are made at a different (but close) wavelength, the information obtained and the identified weaknesses of the model could not be explained by these differences.

However, we understand the reviewer's point and the sections dedicated to passive remote sensing and modeling have been rewritten in a more concise way (cf. section 4.1).

2) *I suggest that the authors apply their tool to other case studies, for example some case studies already published in the literature. Depending on the model simulations that they have access to, they could focus on pollution case studies over Europe, or dust transport from Africa to the Atlantic, or dust/pollution transport from Asia to the Pacific. The advantage of doing this would be to demonstrate the value of their tool instead of comparing directly the model output (aerosol extinction) to Level 2 CALIOP products. More generally I suggest that the authors include both Level 1 and Level 2 products in their comparisons. This will allow them to demonstrate the value of their tool, and maybe emphasize the shortcomings of the lidar retrieval of level 2 products.*

We agree that an application to several case studies already documented would be interesting. Since this manuscript for GMD was written primarily to describe the simulator and its capabilities, we have chosen to only illustrate this on one example. More in depth scientific analysis of the information available in the CALIOP L1 observations to evaluate simulated pollution transport based is ongoing but is beyond the scope of this paper.

Following the reviewer's suggestion, we have included L2 products (Fig.1) in our comparisons (cf. section 6.2.1).

The observed L2 extinction and backscatter coefficients, and the corresponding CHIMERE simulations for the 7-9 July event are shown in Fig. 13. An aerosol layer can be clearly seen in both figures across the orbit portion. The maximum for both coefficients is located above the continent around 35° N near the Blida station, while the plume is extending towards the sea. Vertically it is located between ~1.5 to ~4.5 km. In CHIMERE, an aerosol layer is simulated in the same area, but both coefficients are strongly underestimated. The extinction coefficient underestimation is notably larger. This could be explained by the aerosol type identification in the CALIPSO classification algorithm. Indeed a large fraction of the observed dust layer is identified as polluted dust. On the other hand, CHIMERE is simulating mainly dust in this area. The exact contribution of dust to the simulated lidar signal is discussed in the following section.

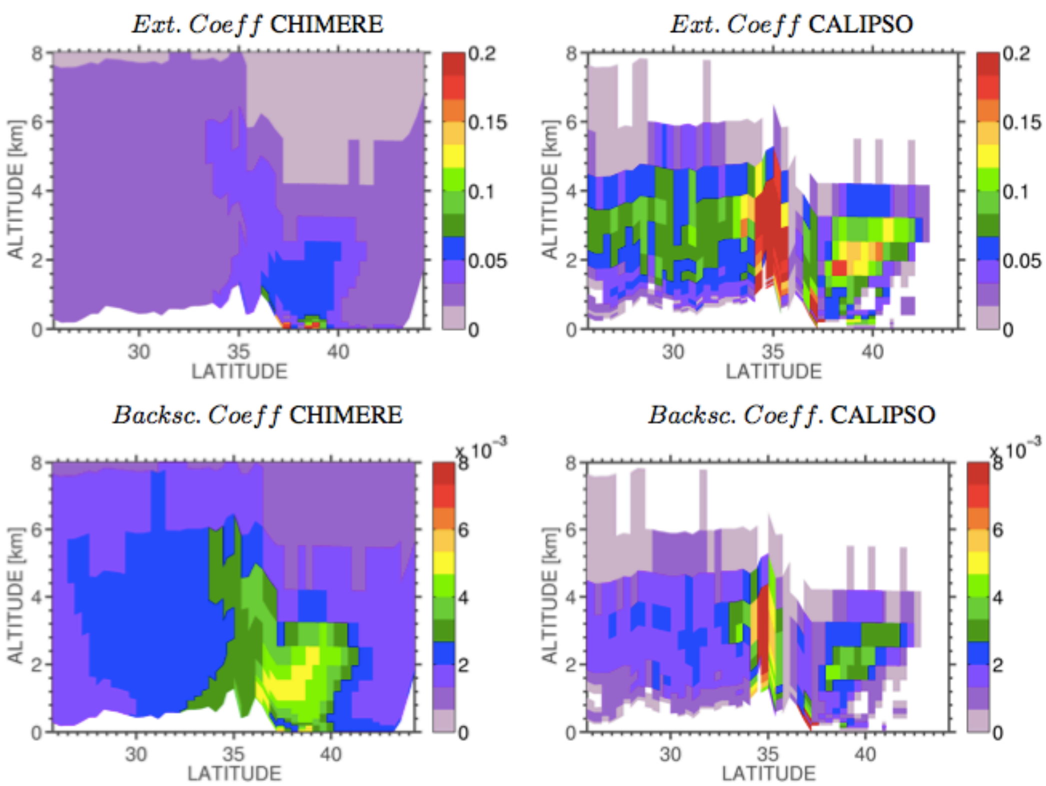

Fig. 1: Extinction (km^{-1}) and backscatter (km^{-1}sr^{-1}) coefficient by CHIMERE (left) and CALIOP (right) for the nighttime portion of the orbit of the 9 July 2007. The CALIOP data are averaged into the model's horizontal and vertical resolutions for comparison to the simulated profiles.

Moreover, the motivation for using L1 rather than L2 data is discussed in more detail in the introduction of revised version of the paper :

The reliability of L2 retrievals is constantly improving (V3 data products have considerably improved compared to the V2 release), and these data have proven to be very useful for analyzing aerosol-related pollution transport events. However it is a well-documented fact that they are prone to uncertainties (e.g. *Liu et al., 2009; Omar et al., 2010; Young and Vaughan, 2009; Winker et al., 2009*).

A key parameter that is used to derive L2 products (backscatter and extinction coefficients) from attenuated backscatter profiles (L1 data) is the extinction-to-backscatter ratio (lidar ratio). The mean values used are based on prescribed bi-modal size distributions and characteristic complex refractive indices according to the observed natural variability for each aerosol species. An erroneous estimation of the lidar ratio will, of course, result into a biased retrieval.

For example, although CALIPSO L2 dust observations are found to exhibit reasonable agreement with ground measurements, some considerable discrepancies still exist in lidar ratio values between CALIPSO and ground measurements (e.g. *Heintzenberg, 2009; Tesche et al., 2009; Kacenelenbogen et al., 2011*). These may result from a misclassification of the identified layer type (clouds or aerosols) or the identified aerosol type (e.g. dust misclassified as polluted dust). Moreover natural variability can be the cause of a wrong estimation of the lidar ratio. The range of different lidar ratio values in the CALIPSO Lidar Ratio selection algorithm is rather narrow compared to the values reported in the literature (e.g., *Mattis et al., 2002; Mona et al., 2006; Papayannis et al., 2008; Liu et al., 2008*).

Minor comments:

+ page 1707, Line 11. Should it be R'=1.2 instead of R?

Indeed, the correct symbol is R'. The sentence was corrected, following the reviewer's comment.

+ page 1705, line 22. What does "MD" refer to? Molecular Density? Please specify.

Indeed, MD stands for Molecular Density. The sentence was corrected, following the reviewer's comment.

+ page 1710, line 15. The authors vastly overstate the agreement with observations: "the agreement is good". Figure 7 shows rather poor agreement, with the model often being factors of 2-10 too low!+ Figure 10. What do points 1, 2, 3 refer to?

The "good" agreement is referring only to background levels of AOD. Indeed the model appears to be underestimating the observed AOD peaks. The sentence was rephrased for more clarity, according to the reviewer's comment, as follows:

The agreement for background AOD levels is satisfying and most events are captured in the Carpentras and Lecce sites (correlations of 63% and 56% respectively). However the magnitude of the observed AOD peaks is generally underestimated. These scores are in consistency with current air quality models performances (e.g. Stern et al., 2008).

The points 1, 2, 3 refer to the three individual R' profiles presented in

Fig.12: one corresponding to the maximum observed R' (35.19° N); the second located over the sea (39.23° N); the third (33.91° N) closer to the area of the dust emissions.

The sentence has been modified as follows:

Three individual R′ profiles are presented in Fig.14: one corresponding to the maximum observed R′ (35.19◦ N); the second located over the sea (39.23◦ N); the third (33.91◦ N) closer to the area of the dust emissions. They correspond to points 1, 2 and 3 in Fig. 12.