Comments by Reviewer #3

> General comments The main objective of this paper, entitled \Fu-Liou Gu radiative transfer model used as proxy to evaluate he impact of data processing and different lidar measurement techniques in view of next and current lidar space missions" is to quantify inconsistences in aerosol (one case in this study : dense dust aerosol event) and cloud (one case in this study : thin cirrus) radiative forcing at Top Of the Atmosphere and at surface due to two different ground lidar techniques (elastic and Raman lidar, i.e. the Multi-wavelengh System for Aerosols (MUSA) Lidar (Madonna et al., 2011)) and/or data processing (i.e. effect lidar measurement with different vertical resolution together with smoothing techniques). Vertical profiles of aerosols and cloud optical properties (i.e. extinction) are retrieved with classical algorithm (lidar ratio is set to 45 Sr for the aerosol event and to 25 Sr for the cirrus) and with the more accurate Raman lidar techniques. Then radiative forcing is computed with the help of Fu-Liou Gu radiative transfer. Sensitivity of radiative forcing to input parameters (extinction) is evaluated applying a Monte Carlo technique. Aerosol type is the number 17 in the radiative transfer model, and effective diameter of cirrus crystals is computed from Heymsfield et al. (2014) parametrisation. Finally, on the basis of this two study cases, authors conclude that radiative forcing is affected by the measurement and retrieval techniques as well as on the data processing constrainst/assumptions from 0.5% percent to 35% This paper address relevant scientific topics within the scope of AMT. Scientific methodologies and assumptions are valid but not always clearly outlined (see my specific comments). Description of experiments and calculations are rather complete. The overall presentation is rather structured and clear.

We thank the reviewer for the positive comments

> Nevertheless, I have two problems when I review this paper. Firstly, even if scientific methodology and calculation are interesting, scientific contribution of this work is not very novel. This paper is rather a sensitivity study of radiative forcing to vertical profiles of extinction retrieved by two different lidar techniques (classic and Raman lidar) but for only two specific two cases (an aerosol event and a thin cirrus). It is also obvious that vertical resolution of lidar measurement (and smoothing techniques) affects computed radiative forcing. I don't understand why these only two cases are representative of the numerous atmospheric conditions. I have the feeling that this paper presents early results and do not reach the scientific level of AMT. Maybe authors could go further in their investigations by, for example, analysing typical atmospheric conditions and/or more extreme atmospheric conditions (cirrus with large optical depth, with different effective radius, altitude, different aerosols, etc. . .).

We agree that it is already known that different lidar techniques and data processing produce different results, but in literature a discussion on the uncertainty/impact due to the use of different lidar techniques to validate the radative forcing inferred from satellite platform or modeling measurements is indeed missing. As metric we used the Fu-Liou-Gu radiative transfer model net radiative effect at the Top of the Atmosphere (for satellite based measurements) and at surface (for ground based measurements). Even if in literature many studies are based on case studies, we agree that the presented case are not enough. For this reason we added two more cases: one including a biomass burning event and another a thick cirrus cloud.

> Secondly, there is no coherency between the work and results presented in this paper and the title that do not reflect the contents of this paper. Fist off all, the title talk about \next and current lidar space missions". When I read this title and introduction, I expected that authors investigate also the sensitivity of radiative forcing due to the difficulty (spatial and temporal averaging scale) of retrievals of extinctions with CALIOP/CALIPSO or with CATS or with EarthCARE. However, authors refer this fact in the introduction but not in their computations and analyses. Moreover, EarthCARE lidar is a high spectral resolution lidar, witch is not exactly the same technique as the Raman technique. Next, I do not understand why authors make emphasis on the Fu- Liou Gu radiative transfer model. Certainly, this model is a good model. But why this model is considered by the authors as a proxy? Why it is stressed in the title like that?

We agree that the title can generate confusion and the manuscript lacks of clarity in this sense. For this reason we specified it in the title and changed the text accordingly. The rationale behind the title is that we would like to raise awareness on how much the different lidar techniques/data processing affect the retrieval of the optical and geometrical properties of the aerosol and cloud layers, bearing in mind that also several space missions are going on and other are ready to be launched using these techniques/data processing. We changed completely the title into:"Impact of the different lidar measurement techniques and data processing on evaluating cirrus cloud and aerosol direct radiative effects."

> Specific comments Page 1, line 17 (and further in the text) : Please give the mathematic definition of the net radiative forcing. In general we talk about radiative forcing defined as the change in the net (down minus up) irradiance.

We provided in the text the definition of direct radiative effect accordingly. For this study we used the difference between the total sky (when cloud and/or aerosols are present) and the pristine sky (clear atmosphere)

> Page2, line 2-3 : references are not appropriate.

The provided references investigate how the sign in net radiative effect of cirrus clouds can change daytime. Then, the net forcing is still uncertain.

> Page2, line 3 : Cloud and aerosols have been also studied with POLDER/PARASOL.

References were added

> Page2, line 21 : Please give other references on the retrievals of aerosol and cloud properties with Raman lidar. By the way, what are the effects of multiple scattering with Raman lidar ? References ?

References were added. Multiple scattering is of course playing an important role mostly for clouds. However, investigating multiple scattering is beyond the scope of the manuscript as we start our analysis using the available products. As the answer given for another reviewer, we try to quantify only the technique/data processing discrepancy, not other effects. For the purpose of the manuscript, also synthetic signals can be used.

> Page2, line 26, eq 1 : This equation is not well written (exp)

Changed accordingly

> Page 3, line 2 : Please give other references.

Additional references are provided

> Page 4, line3 : Reference of Campbell et al., 2016 is not provided.

The reference is now provided

> Page 4, line 7 : You talk about CATS and EarthCARE. What about the high spectral resolution technique compared to Raman technique?

That's an interesting point. Unfortunately, in this first study we don't have co-located HSRL measurements to compare.

> Page 4 , line 18 : Heymsfield et al. (2014) is not appropriate.

Fixed

> `Page 4, line 24 : Why aerosol type number 17. What are optical properties of this aerosol?`

This type of aerosol is labeled as transported dust. However, we are interested in relative discrepancies, as we use for all the cases this aerosol type. We agree that the absolute value may be incorrect.

> `Page 5, line 3 : MUSA seem a great lidar, with polarization measurement. Why do not use polarization information in this study ?`

Actually all the information obtained from MUSA lidar observations, i.e. the geometrical and optical properties of aerosols and clouds at different wavelengths together with depolarization and ancillary information (e. g. back-trajectories) were used to identify aerosol type and cloud phase. While only the aerosol/cloud extinction profile is used as input for the FLG radiative transfer model.

> `Page 5, line 2 : What is the crystal shape of the cirrus ? What is the effect of changing effective diameter on the computed radiative forcing ?`

We use Heymsfield et al., 2014 empirical parameterization. Again, as we are interested in relative values of the net radiative effect, the parameterization is not fundamental for our analysis because it is the same for the considered lidar techniques/data processing.

> `Page 6, line 8 : This cirrus is very optically thin. What is the vertically optical depth ? Why do you choose such a small optical thickness? What is append if optical depth is large (1.5 to 3) ? What about the effect of multiple scattering? Do the retrieval algorithms (classic and Raman) take account of multiple scattering? For space mission lidar data, multiple scattering effects can be not negligible.`

We added a case with an optically thicker cirrus cloud. For sure, the multiple scattering affects mainly the cirrus cloud net radiative effect calculations, as the multiple scattering is modifying the cloud atmospheric extinction profile. However, in this first study, the different techniques and data processing profiles are not corrected by multiple scattering effects, as we are interested in quantifying the relative differences. For the scope it can be used a synthetic cloud signal where multiple scattering effects are not present.

Comments by Reviewer #4

> This work deals with the use of different lidar techniques and configurations for studying radiative forcing of aerosol and clouds. In particular, authors analyze the use of backscatter and Raman lidar signals.Backscattering lidar needs the assumption of a constant extinction-to backscatter lidar ratio for the entire profile while combination of backscattering and Raman signals allow independent retrievals of aerosol and clouds extinction and backscattering profiles. Authors show that different lidar techniques and different data processing produce different results, and in this research advance in showing quantitatively how much are those discrepancies. The novelty of this work is then in quantifying the impact of each technique on radiative forcing calculations at TOA and SFC. Due to the large number of backscattering lidar, e.g. MPLNET network uses such systems and very few EARLINET instruments do have Raman lidar during daytime, the results of this analysis are of great interest for the scientific community and valuable for its publication in Atmospheric Measurement Techniques. Nevertheless, I agree with other reviewers that major revisions are needed as the publication suffers from hasty writing and more cases should be considered. Other concerns should be addressed before publication: 1.- I think that a single case thin cirrus cloud is not exhaustive for the analysis. I would rather extend the research at least for three cases: thin cirrus clouds (as already studied) with COD<0.03, Opaque cirrus clouds,with a COD in between 0.03 and 0.3 and thick cirrus cloud case, with a COD>0.3

Thanks for the meaningful comment. We added a thicker cirrus cloud in the analysis.