Interactive comment on "EARLINET evaluation of the CATS L2 aerosol backscatter coefficient product" by Emmanouil Proestakis et al.
Anonymous Referee #1
Received and published: 18 March 2019

General Comments: In this study the authors are presenting the coordinated effort of the European Aerosol Research Lidar Network (EARLINET), to evaluate the Level 2 aerosol backscatter coefficient product derived by the space borne backscatter lidar namely Cloud-Aerosol Transport System (CATS). The manuscript is well written and has a scientific merit. Therefore, in my opinion it worth being published under the special issue "EARLINET aerosol profiling: contributions to atmospheric and climate research" of the Atmospheric Chemistry and Physics journal. However, in order to help improving the manuscript, I would kindly suggest the authors to take into account the following specific comments.

The authors would like to thank the reviewer for the interesting and at the same time substantial comments and suggestions. We tried, and did our best, to incorporate the proposed changes and corrections in the revised manuscript, aiming at improving the presented paper. Following, you will find our responses, one by one to the comments addressed.
Kind regards,
Emmanouil Proestakis

Specific Comments:
1. Abstract: Page 2, line 1: "Independently of daytime/nighttime conditions.". Please consider revising this statement. At the end of this paragraph the authors are mentioning an underestimation of 22.3% during day and 6.1% during night time. So there is a significant difference in the comparison based on the sky light conditions something that has to be mentioned clearly in the abstract. Where you can attribute this difference? e.g. SNR issue, significance of your day-night statistical sample?

The authors agree with the statement of the reviewer. Therefore, the sentence was modified from:
"*In addition, CATS misclassification of aerosol layers as clouds, and vice versa, in cases of coexistent and/or adjacent aerosol and cloud features, may lead to non-representative, unrealistic and cloud contaminated aerosol profiles. The distributions of backscatter coefficient biases show the relatively good agreement between the CATS and EARLINET measurements, although on average underestimations are observed, 22.3 % during daytime and 6.1 % during nighttime.*"
To:
"*In addition, CATS misclassification of aerosol layers as clouds, and vice versa, in cases of coexistent and/or adjacent aerosol and cloud features, may lead to non-representative, unrealistic and cloud contaminated aerosol profiles. Regarding solar illumination conditions, low negative biases in CATS backscatter coefficient profiles, of the order of 6.1%, indicate the good nighttime performance of CATS. During daytime, reduced signal-to-noise ratio by solar background illumination prevents retrievals of weakly scattering atmospheric layers that would otherwise be detectable during nighttime, leading to higher negative biases, of the order of 22.3%, in CATS daytime performance.*"

Regarding the comment of the reviewer, where the authors attribute this difference, the effect of SNR is considered the most critical factor, because measurement noise by solar illumination background and layer detection are different during daytime and nighttime, with the effect propagating through the retrieval algorithms to atmospheric layer detection and classifications and eventually to Level 2 and Level 3 products. Example of the critical level of SNR effect is the Minimum Detectable Backscatter (MDB), as reported by McGill et al. (2007), for both CALIOP and CATS and for both daytime and nighttime conditions (Table 1). According to *Table 1* the detection sensitiveness of thin, weakly scattering atmospheric layers at CATS M7.2 1064 nm is two orders of magnitude higher during nighttime that during daytime (MDB two orders of magnitude lower during nighttime than during daytime). In the case of CALIOP, both for 532 and 1064 nm, MDB during nighttime is an order of magnitude lower during nighttime than during daytime.

Table 1: CATS and CALIPSO 532 and 1064 nm Minimum Detectable Backscatter (MDB) with Units in $Km^{-1}sr^{-1}$ (McGill et al., 2007).

	CATS 7.2	CALIPSO
532 nm night	$1.6x10^{-2} \pm 0.84x10^{-3}$	$1.6x10^{-4} \pm 0.84x10^{-4}$
1064 nm night	$5.0x10^{-5} \pm 0.77x10^{-5}$	$1.6x10^{-4} \pm 0.84x10^{-4}$
532 nm day	$3.8x10^{-2} \pm 1.05x10^{-3}$	$1.7x10^{-3} \pm 0.84x10^{-3}$
1064 nm day	$1.3x10^{-3} \pm 0.24x10^{-3}$	$1.0x10^{-3} \pm 0.30x10^{-3}$

2. Introduction: The Introduction is well written however I am missing the scientific question that this manuscript envisages to answer. Please try to make this clear in this section and consider mentioning the achievements and progress of the scientific community so far towards this topic. Are there any similar activities for CATS? The results presented here are having great difference with similar studies for other space borne lidars? The reader has to reach section 2.1 in order to find some answers on the aforementioned concerns.

The authors agree with the reviewer that the manuscript was characterized by a significant lack of mentioning similar achievements and activities, towards the assessment of CATS performance. The authors agree with the reviewer regarding the necessity of including the findings of the aforementioned studies and have adjusted the manuscript accordingly. To be more specific, the following paragraphs were added to the manuscript (Section 1 - Introduction):

"*CATS performance has been validated against ground-based AErosol RObotic NETwork (AERONET; Holben et al., 1998) measurements and evaluated against satellite-based Atmospheric Optical Depth (AOD) retrievals of Aqua and Terra Moderate Imaging Spectroradiometer (MODIS; Levy et al., 2013) and active CPL (McGill et al., 2002) and CALIPSO CALIOP (Winker et al., 2009) profiles of extinction coefficient and AOD at 1064 nm. Lee et al. (2018) compared daytime quality-assured CATS V2-01 vertically integrated extinction coefficient profiles (1064 nm) and AERONET AOD (1020 nm) values, spatially (within 0.4^o Longitude and Latitude) and temporally (±30 minutes) collocated, and found a reasonable agreement with a correlation of 0.64. A comparative analysis of CATS and MODIS C6.1 Dark Target (DT) AOD retrievals, through spectral interpolation between 0.87 and 1.24 μm channels, reported correlation of 0.75 and slope of 0.79, over ocean. In addition, Lee et al., (2019) evaluated AOD and extinction coefficient profiles from CATS through intercomparison with CALIOP. With regard to AOD, analysis a total of 2681 CATS and CALIOP collocated observation cases (within 0.4^o Longitude/Latitude and ±30 minutes ISS and CALIPSO overpass difference), showed correlation of 0.62 and 0.52 over land and ocean respectively during daytime (1342 cases), and 0.84 and 0.81 over land and ocean respectively during nighttime (1339 cases). Comparison of CATS and CALIOP collocated extinction coefficient profiles based on the closest Euclidian distance on the earth's surface, shows also good shape agreement, despite an apparent CALIOP underestimation in the lowest 2 km height. CATS and CALIOP observations were used by Rajapakshe et al. (2017) to study the seasonally transported aerosol layers over the SE Atlantic Ocean. The performed comparative analysis reported on similar geographical patterns regarding Above Cloud Aerosols (ACA), Cloud*

Fraction (CF) and ACA occurrence frequency (ACA_F) between CATS and CALIOP retrievals. However, the authors reported also on differences between CATS and CALIOP vertical aerosol distributions, with ACA bottom height identified by CATS lower than the respective of CALIOP. CATS retrievals were used to document the diurnal cycle and variations of clouds, with CALIOP complementarily used. Noel et al. (2018) showed that both CATS and CALIOP profiles of CF agree well on both the vertical patterns and values at 01:30 and 13:30 LT, over both land and ocean, with minor differences of the order of 2-7% throughout the entire profiles of cloud fraction. CATS depolarization measurements, which are critical in the processing algorithms of aerosol subtype classification, were investigated in the case of desert dust, smoke from biomass burning and cirrus clouds (Yorks et al., 2016), and were found consistent and in good agreement with depolarization measurements from previous studies and historical datasets implementing CPL (Yorks et al., 2011) and CALIOP (Liu et al., 2015)."

Regarding the question the manuscript envisages to answer, the author have modified/included the following paragraphs to the manuscript (Section 1 - Introduction):

"*Overall, CATS retrievals have been evaluated and found in reasonable agreement with ground-based AERONET, airborne CPL and satellite-based MODIS and CALIOP measurements. However, for the quality assessment of CATS backscatter coefficient profiles, a large-scale and dense network of ground-based lidar systems is needed, in order to facilitate high-quality collocated and concurrent measurements. This necessity is largely related to the ISS orbital characteristics, the CATS near-nadir viewing (0.5^o off nadir), the lidar narrow footprint (14.38 m diameter), and the limited number of ISS overpasses. The European Aerosol Research Lidar Network (EARLINET) consists of a unique infrastructure for assessing the validation needs for spaceborne lidar missions.*".

3. Section 2.3.1: I think it would be beneficial for the manuscript to include a flowchart showing the methodology of the comparison followed by the authors. The entire process can be summarized there along with the methodology requirements followed by the authors. e.g. the spatial - temporal constraints, cloud screening requirements, etc. The information exists in the manuscript but I feel like it is scattered among the sections.

The authors agree with the reviewer that is would be beneficial to summarize the key parameters and the associated thresholds implemented in the framework of the study. For this reason the following table was included in the manuscript:

Table: List of CATS quality assurance thresholds applied in the EARLINET comparison.

Mode	7.2
Level	2
Parameter	Backscatter Coefficient
Wavelength	1064nm
Distance	≤ 50km radius from the EARLINET stations
Feature Type Score	≤ -2
Sky Condition	0 – clean skies *and* 1 – clear skies (no clouds)
Backscatter Coefficient	$0 \leq b_{1064nm} \leq 2$ [$Mm^{-1}sr^{-1}$]
Vertical range window	≤ 10 km (a.s.l.)

Regarding EARLINET, the authors implement the Single Calculus Chain (SCC) is used D'Amico et al, 2015; D'Amico et al, 2016; Mattis et al., 2016), for the homogenization of the lidar data in a standardized output format. SCC facilitates an automatic algorithm developed to further address the quality assurance of the lidar measurements. The EARLINET implementation is described in "*Section 3.2.3*".

4. Page 7, lines 18-19: "::: is less than 30%, ::: requirements of EARLINET". The authors are kindly requested to provide a reference for this statement.

The text is modified according to the reviewer's recommendation, and the following references were included:

"*The comparison showed that by using only the signal from the elastic channels, the mean relative deviation in the calculation of the aerosol backscatter coefficient at 1064 nm is less than 30 % (Althausen et al., 2009; Baars et al., 2012; Engelmann et al., 2016; Hänel et al., 2012), thus meeting the quality assurance requirements of EARLINET.*"

with the following references:

- *Althausen, D., Engelmann, R., Baars, H., Heese, B., Ansmann, A., Müller, D., and Komppula, M.: Portable Raman Lidar PollyXT for Automated Profiling of Aerosol Backscatter, Extinction, and Depolarization, J. Atmos. Ocean. Technol., 26, 2366–2378, 2009.*
- *Baars, H., Ansmann, A., Althausen, D., Engelmann, R., Heese, B., Müller, D., Artaxo, P., Paixao, M., Pauliquevis, T., and Souza, R.: Aerosol profiling with lidar in Amazon Basin during the wet and dry season, J. Geophys. Res., 117, D21201, 2012.*
- *Engelmann, R., Kanitz, T., Baars, H., Heese, B., Althausen, D., Skupin, A., Wandinger, U., Komppula, M., Stachlewska, I. S., Amiridis, V., Marinou, E., Mattis, I., Linne, H. and Ansmann, A.: The automated multiwavelength Raman polarization and water-vapor lidar Polly(XT): the neXT generation, Atmos. Meas. Tech., 9(4), 1767–1784, doi:10.5194/amt-9-1767-2016, 2016.*
- *Hänel, A., Baars, H., Althausen, D., Ansmann, A., Engelmann, R., and Sun, Y. J.: One-year aerosol profiling with EUCAARI Raman lidar at Shangdianzi GAW station: Beijing plume and seasonal variation, J. Geophys. Res., 117, D13201, 2012.*

5. Page 8, line 8: "scattering respectively"-> "backscattering respectively".

The text is modified according to the reviewer's recommendation.

6. Section 2.3.3: This section is important for following up the manuscript and has to be highlighted. Therefore, I would kindly suggest to the authors to list it as 2.4.

The text is modified according to the reviewer's recommendation.

7. Page 9, line 6: "The discussed constraints:::": How much these constrains affect the final dataset (in terms of number of measurements and overall evaluation)?

Regarding the question of the reviewer on the discussed constrains on the dataset, Figures 1-4 show quantitatively the effects of (i) distance between the EARLINET station and the closest profile of the CATS-ISS overpass for each correlative case, (ii) CATS Feature Type, (iii) number of CATS Level 2 (L2) Aerosol Profiles (APro) used in the CATS horizontal average, and the effect of (iv) topography of EARLINET stations. The comparison exercise examines the effect of one discussed constrain at a time, while keeping all the other parameters in the methodology constant, and considers various evaluation metrics, as discussed in the following sections.

(i) Effect of distance between the EARLINET station and the closest profile of the CATS-ISS overpass

Figure 1 shows the effect of distance between the closest CATS L2 APro and the respective EARLINET station matchup, for different upper Euclidean distance thresholds (i.e.: 5n km, $n \in N=\{1,10\}$). To be more specific, the Mean Bias (MB; [$Mm^{-1}sr^{-1}$]) - (Fig.1a), Root Mean Square Error (RMSE; [$Mm^{-1}sr^{-1}$]) - (Fig.1b), Correlation Coefficient (Fig.1c), and the number of

CATS-EARLINET correlative cases per each upper distance threshold are considered. For each upper distance threshold, all the available CATS-EARLINET cases of Euclidean distance lower or equal to the respective upper limit are considered in the computation of the aforementioned evaluation metrics. This cumulative approach is selected due to the limited number of CATS-EARLINET correlative cases, and is applied separately for daytime and nighttime ISS overpasses, due to the different CATS measurement conditions.

Based on the analysis, during nighttime (daytime), the CATS-EARLINET MB is increasing (decreasing) starting from the 5 km upper distance threshold, to reach -0.0300 (-0.123) $Mm^{-1}sr^{-1}$, for the radius threshold of 50km shown in the study. The computed RMSE values are in the range between 0.447 and 0.343 $Mm^{-1}sr^{-1}$ for nighttime and between 0.357 and 0.448 $Mm^{-1}sr^{-1}$ for daytime, for the distance thresholds of 5km and 50km respectively. The minimum RMSE values are observed when considering ISS overpass cases of closer than 40 km distance to the EARLINET stations during nighttime, corresponding to MB of 0.018 $Mm^{-1}sr^{-1}$. The Correlation Coefficient is decreasing with increasing distance between the ISS overpass and the EARLINET stations. Notably, the Correlation Coefficient is not changing considerably for thresholds between 15 and 40 km for nighttime (~0.8) and between 15 and 30 km for daytime (~ 0.7). Sharp decreases in the Correlation Coefficient are observed during daytime (0.547), for distances closer to the EARLINET stations than during nighttime (0.693), for 35 and 40 km distance respectively.

The observed tendencies can be explained in terms of the distance thresholds and number of available cases, since the distance thresholds define the number of cases that are used in the analysis and the number of case is critical to assess the performance of CATS. Consequently, the MB, RMSE and Correlation Coefficient are all subject to both the number and the characteristics of the CATS-EARLINET cases used. In the study the authors use the maximum number of available EARLINET cases, to avoid any possible selection effect resulting from a poor sample of correlative cases, when strict collocation filters are applied. Using the maximum number of available correlative cases, i.e. twenty six (26) and twenty one (21) for nighttime and daytime respectively, for ISS overpasses within 50km radius from the EARLINET stations, the authors envisage to quantitatively address the question of CATS performance and the representativeness of the aerosol backscatter coefficient profiles, over various atmospheric, illumination and ISS overpass conditions.

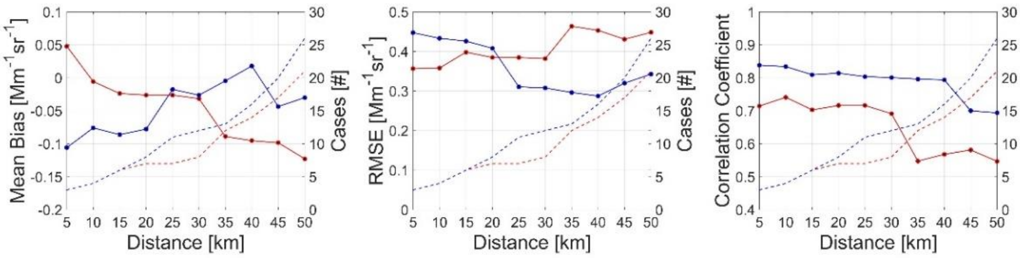

Figure 1: CATS backscatter coefficient at 1064nm with respect to EARLINET ground-based measurements, as a function of distance (km) between the closest CATS Level 2 Aerosol Profile and the respective "collocated" EARLINET station, for daytime (red line) and nighttime (blue line) ISS overpasses. Left: Mean Bias [$Mm^{-1}sr^{-1}$], center: RMSE [$Mm^{-1}sr^{-1}$] and right: Correlation Coefficient. Dashed lines correspond to the number of CATS-EARLINET correlative cases considered per each upper distance threshold between the CATS footprint and the locations of EARLINET stations.

(ii) Effect of Feature Type Score

The main objective of the CATS Cloud Aerosol Discrimination (CAD) score, or Feature Type Score, is to provide to the Feature Type classification a level of confidence. In the case of CATS, the Feature Type score is an integer number ranging between -10 and 10. The values of CATS Feature Type score correspond to classified aerosol atmospheric layers (negative values) and

cloud atmospheric layers (positive values), while the magnitude of the Feature Type score corresponds to the confidence level of the classification. A value of -10 indicates complete confidence that the layer is an aerosol layer, while Feature Type score equal to 0, indicates an atmospherics layer with equal probability to be cloud or aerosol.
Figure 2 shows the effect of Feature Type Score, for different values, between -8 and 0 (i.e. for atmospheric layers classified as aerosol layers). The Mean Bias (MB; [$Mm^{-1}sr^{-1}$]) - (Fig.2a), Root Mean Square Error (RMSE; [$Mm^{-1}sr^{-1}$]) - (Fig.2b) and Correlation Coefficient (Fig.2c) are shown per each Feature Type Score. For each Feature Type score, cases of lower classification confidence level are not considered in the assessment of CATS performance and representativity, indicating the effect of the selected Feature Type thresholds.
Based on the MB, RMSE and Correlation Coefficient, a similar tendency is observed for different Feature Type Scores. To be more specific, not considerable changes are observed for different Feature Type Scores, regardless of the selected Feature Type threshold. This effect is due to the atmospheric characteristics of the CATS-EARLINET cases considered in the analysis. In the framework of the study, to account for contamination effects of multiple-scattering and specular reflection in the intercomparison process, only cloud-free atmospheric scenes are used. Furthermore, cases with detected cirrus, either at the EARLINET Range-Corrected-Signal quicklooks or at the ISS-CATS backscatter coefficient profiles or the feature type profiles, are not considered in the study. Initially, the presence of clouds was investigated through the implementation of CATS backscatter coefficient and depolarization time-height images and EARLINET range-corrected-signal. Cases for which the retrieval of EARLINET temporally-averaged profile was not feasible due to the presence of clouds, and/or CATS cases that the presence of clouds propagated into the CATS spatial-averaged profile were discarded from the analysis. Consequently, the lack of dependence shown in Figure 2 (a-c) is the result from the a priory selection of cloud free conditions selected in the analysis. However, a notably characteristic is the nighttime performance of CATS, which as shown from the lower absolute MB and lower RMSE, but in addition from the higher Correlation Coefficient values, due to higher SNR, is more representative than the corresponding daytime performance.

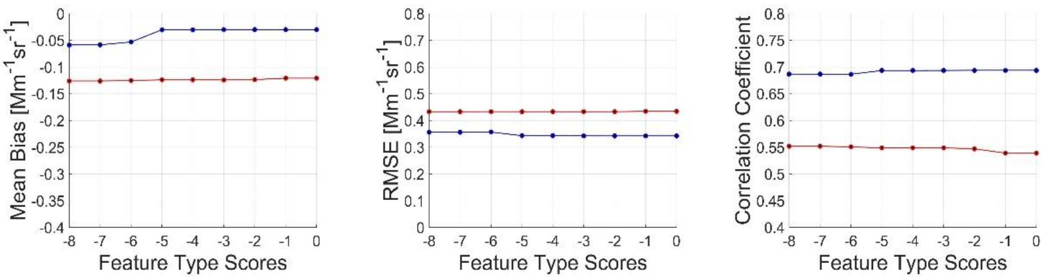

Figure 2: CATS backscatter coefficient at 1064nm with respect to EARLINET ground-based measurements, as a function of Feature Type score, for daytime (red line) and nighttime (blue line) ISS overpasses. Left: Mean Bias [$Mm^{-1}sr^{-1}$], center: RMSE [$Mm^{-1}sr^{-1}$] and right: Correlation Coefficient.

(iii) Effect of number of CATS-ISS L2 aerosol profiles used in the spatial averaging

Similarly to the analysis presented and discussed above, Figure 3 shows the effect of different number of aerosol profiles used when spatially averaging to retrieve the CATS aerosol profiles used in the framework of the study. In Figure 3, the acronym "CPro" corresponds to the closest CATS profiles to the corresponding EARLINET station. Accordingly, the Mean Bias (MB; [$Mm^{-1}sr^{-1}$]) - (Fig.3a), Root Mean Square Error (RMSE; [$Mm^{-1}sr^{-1}$]) - (Fig.3b), Correlation Coefficient (Fig.3c), are computed for different number of profiles used (i.e. CPro±1Profile, CPro±2Profiles, …).

Based on the MB, RMSE and Correlation Coefficient, the representativeness of CATS spatial profile is increasing with increasing number of aerosol profiles used in the horizontal averaging. To be more specific nighttime MB is almost constant, showing a low dependence on the number of profiles used, while for daytime CATS cases the opposite effect is observed, with improvement of CATS performance though increasing number of profiles used. Regarding RMSE no significant changes are observed, though a slight decreasing tendency in the RMSE is observed for both daytime and nighttime cases. Regarding the Correlation Coefficient, increasing in the values is also observed, with increasing number of profiles used, both for daytime and nighttime cases, denoting the improvement of the representativeness with increasing number of CATS profiles used in the spatial averaging.

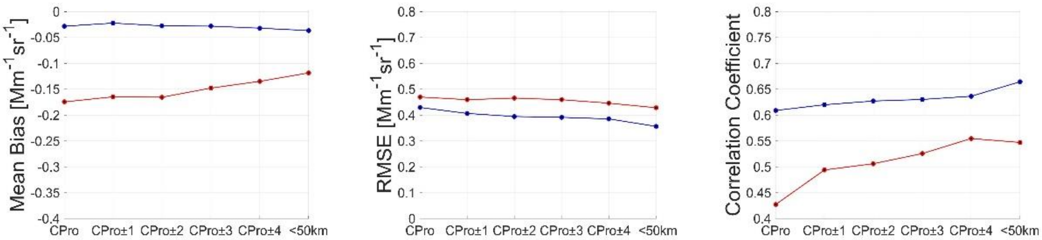

Figure 3: CATS backscatter coefficient at 1064nm with respect to EARLINET ground-based measurements, as a function of the number of L2 Aerosol Profiles used in the CATS spatial averaging, for daytime (red line) and nighttime (blue line) ISS overpasses. Left: Mean Bias [$Mm^{-1}sr^{-1}$], center: RMSE [$Mm^{-1}sr^{-1}$] and right: Correlation Coefficient. "CPro" corresponds to the closest CATS profile to the EARLINET station.

(iv) Effect of EARLINET stations topography

In order to study the effect of topography on the CATS profiles the authors separated the participating EARLINET stations into 3 clusters: Continental (Case I – Belsk, Bucharest, Leipzig, and Warsaw), Coastal (Case II – NOA, Athens NTUA, Barcelona, Cabauw, Thessaloniki and Lecce) and Mountainous (Case III – Dushanbe, Evora, Observatory Hohenpeissenberg, Potenza). The three clusters and the characteristics of the stations are given in Table 2. In addition, Figure 4 shows the locations of the participating stations; green circles denote Continental stations, blue circles denote Coastal stations and brown circles denote Mountainous stations. Figure 4 shows, additionally to the geographical distribution of the active EARLINET stations, the daytime/nighttime overpasses of ISS within the evaluation period, between 02/2015 and 09/2016, encompassing the first twenty months of CATS operation. Due to the limited available dataset of CATS-EARLINET cases, the daytime/nighttime approach was not followed in the case of the analysis regarding the effect of topography.

Table 2: Clustering of EARLINET stations with respect to topographical features.

Case I - Continental				
EARLINET Station	Identification Code	Latitude (°N)	Longitude (°E)	Altitude a.s.l. (m)
Belsk	be	51.83	20.78	180
Bucharest	bu	44.35	26.03	93
Leipzig	le	51.35	12.43	90
Warsaw	wa	52.21	20.98	112

Case II - Coastal				
EARLINET Station	Identification Code	Latitude (°N)	Longitude (°E)	Altitude a.s.l. (m)
Athens-NOA	no	37.97	23.72	86
Athens-NTUA	at	37.96	23.78	212
Barcelona	ba	41.39	2.12	115
Cabauw	ca	51.97	4.93	0
Thessaloniki	th	40.63	22.95	50
Lecce	lc	40.33	18.10	30

Case III - Mountainous				
EARLINET Station	Identification Code	Latitude (°N)	Longitude (°E)	Altitude a.s.l. (m)
Dushanbe	du	38.56	68.86	864
Évora	ev	38.57	-7.91	293
Observatory Hohenpeissenberg	oh	47.8	11.01	974
Potenza	po	40.60	15.72	760

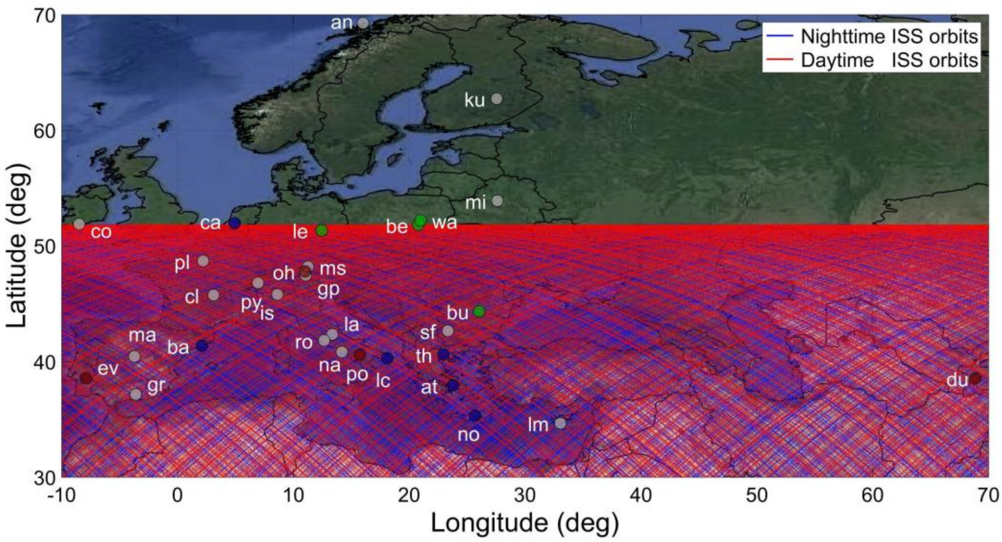

Figure 4: Distribution of EARLINET lidar stations over Europe and West Asia. Green dots: Continental stations used in the inter-comparison. Blue dots: Coastal stations used in the inter-comparison. Brown dots: Mountainous stations used in the inter-comparison. ISS orbits between 02/2015 and 09/2016 are overlaid in red for daytime and in blue for nighttime overpasses.

Figure 5 shows the effect of Topography, for three different clusters of station characteristics, as introduced above (Case I: Continental, Case II: Coastal and Case III: Mountainous). In Figure 5a, the Box and Whisker plot on the $CATS_i$-$EARLINET_i$ residuals is shown, including the lower and upper whiskers which indicate the 10th and 90th percentiles respectively, and the 25th and the 75th quantiles indicated by the lower and upper box boundaries respectively. The horizontal line and the red dot indicate the statistical mean and median values respectively while outliers are indicated by red crosses. According to the results, it is evident that the correlative measurements between the Mountainous EARLINET stations and the ISS overpasses are characterized by higher variability, more extreme differences, higher absolute mean and median biases and higher RMSE than in the Continental and Maritime cases. Complex topography, in terms of geographical characteristics, erroneous mean backscatter coefficient profiles due to the high variability of aerosol load in the Planetary Boundary Layer, the horizontal distance between the CATS lidar footprint and the ground-based lidar stations and surface returns enhance the discrepancies, especially in the lowermost part of the profiles, resulting in higher differences between the EARLINET profiles and CATS profiles. Due to the lack of the aforementioned effects arising from complex topography, CATS representativeness and performance is higher over the Continental cases, while CATS performance over the Coastal stations is characterized by slightly lower absolute value of mean bias and at the same time by lower Correlation Coefficient than in the case of Continental cases. However, it has to be taken into consideration the important factor related to the presented results that is the number of CATS-EARLIENT correlative cases used in the analysis, 23 for Case I - Continental, 10 for Case II - Coastal and 14 for Case III - Mountainous. Analytical evaluation metrics on the effect of topography are given in Table 3.

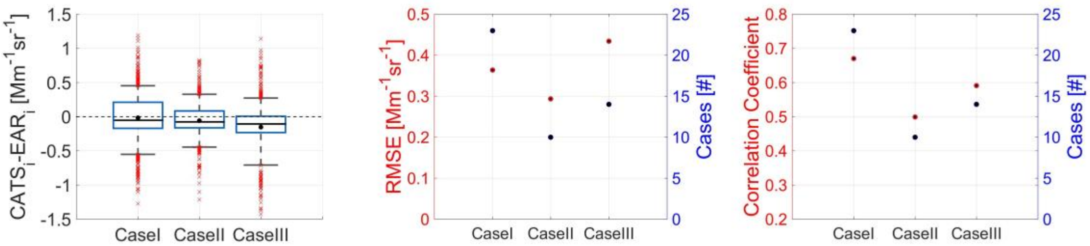

Figure 5: CATS backscatter coefficient at 1064nm with respect to EARLINET ground-based measurements, as a function of different topography of EARLINET stations for three different clusters of station topographical characteristics (Case I: Continental, Case II: Coastal and Case III: Mountainous). In Fig.5a, the Box and Whisker plot on the CATS$_i$-EARLINET$_i$ residuals is shown, including the lower and upper whiskers which indicate the 10th and 90th percentiles respectively, and the 25th and the 75th quantiles indicated by the lower and upper box boundaries respectively. The horizontal line and the red dot indicate the statistical mean and median values respectively while outliers are indicated by red crosses. Fig.5b and Fig.5c show the RMSE and Correlation Coefficient as a function of the different clusters, including the number of available cases per cluster.

Table 3: Clusters of EARLINET stations and CATS evaluation metrics.

	Continental stations	Coastal stations	Mountainous stations
Median	-0.053 [Mm^{-1}sr^{-1}]	-0.076 [Mm^{-1}sr^{-1}]	-0.106 [Mm^{-1}sr^{-1}]
Mean	-0.016 [Mm^{-1}sr^{-1}]	-0.058 [Mm^{-1}sr^{-1}]	-0.151[Mm^{-1}sr^{-1}]
RMSE	0.367 [Mm^{-1}sr^{-1}]	0.293 [Mm^{-1}sr^{-1}]	0.434 [Mm^{-1}sr^{-1}]
Correlation Coefficient	0.673	0.499	0.591
Number of cases	23	10	14

8. Page 9, line 18: "here considered"-> "considered here".

The text is modified according to the reviewer's recommendation.

9. Page 9, lines 32-33: I cannot understand this conclusive statement. How "the absence of significant biases, both daytime and nighttime" is obvious from figure 3c.

The reviewer is right, that Figure 3c corresponds to a nighttime atmospheric scene, therefore the statement, referring not only to nighttime but also to daytime conclusions, may be confusing for the reader. The authors, have inspected of all available cases one-by-one, and wanted to provide the information through this section, that when the atmospheric scene is homogeneous and the scattering characteristics of the aerosol layers are above the MDB thresholds of CATS sensor (i.e. sufficient SNR for detection and classification), the overall CATS performance under such homogeneous conditions is good, with absence of significant biases. This conclusion holds both for daytime and nighttime. For this reason the "*representative case*" was used.
However, since the authors agree with the reviewer that the sentence may be confusing, the sentence was reformulated from:
"The intercomparison presented in Figure 3c is a representative case, indicating the overall high performance of CATS and the absence of significant biases, during both daytime and nighttime, under relative homogeneous and cloud free conditions."
to:
"Although the case presented and discussed in Figure 3 corresponds to a nighttime ISS overpass, the case is representative for cloud free and relative homogeneous atmospheric scenes in terms of aerosols, for both daytime and nighttime solar background illumination, demonstrating the overall high performance of CATS under such conditions."

10. Page 10, lines 9-10: "due to the different SNR:::": I think that indeed this is the case. But this contradicts to the author statement of no significant bias between day and night conditions stated earlier (page 9, lines 32-33).

The reviewer is right on the high importance and effect of SNR is CATS retrievals and algorithms. Statement of page 9, lines 32-33 has been reformulated to avoid possible confusions, according to the reviewer's comment.

11. Page 10, lines 24-29: I have the feeling that this information should be moved to section 2.2 where the description of CATS data level product is already given. At that section, the authors can present a detailed description of their methodology followed for could screening.

According to reviewer's recommendation the suggested part of the manuscript was moved (and slightly modified to fit better to the paragraph), to Section 2.1 (former Section 2.2 in the ACPD discussion version).
To be more specific, the suggested part was modified from:
"In addition to the backscatter coefficient, CATS Level 2 data provide the feature classification of the detected layers (namely: clear air, cloud, aerosol and totally attenuated) and the numerical confidence level of the classification, similar to the CALIOP Cloud-Aerosol-Discrimination (CAD) algorithm (Liu et al., 2004; Liu et al., 2009). CATS Feature Type Score is a multidimensional probability density function (PDF) developed based on multiyear CPL observations, that discriminates cloud and aerosol features, assigning an integer between -10 and 10 for each detected atmospheric layer."
to:
"In addition to CATS Level 2 Feature Type (namely: clear air, cloud, aerosol and totally attenuated), the algorithm provides the confidence level of the Feature Type classification, similar to the CALIOP Cloud-Aerosol-Discrimination (CAD) algorithm (Liu et al., 2004; Liu et al.,

2009). CATS Feature Type Score is a multidimensional probability density function (PDF) developed based on multiyear CPL observations, that discriminates cloud and aerosol features, assigning an integer between -10 and 10 for each detected atmospheric layer."

12. Page 11, line 23: "end of 2018:::" -> Maybe "end of 2019" ?

The manuscript was modified to:
"*Based on this analysis and comparisons with CALIPSO, the CATS cloud-aerosol discrimination algorithm was updated for the V3-00 Level 2 data products (released in the end of 2018) to improve the accuracy of the Feature Type and Feature Type Score, especially during daytime.*"

13. Section 3.2: I wonder why the authors constrained their study only to the comparison of aerosol backscatter and they did not proceed with comparison of other aerosol related properties as well (e.g. physical and not properties such as integrated backscatter, AOD, lidar ratio, layer center of mass-thickness). I have the feeling that by taking into account more properties in their comparison will improve the manuscript and will enhance the arguments (i.e. argument of tenuous layer, argument of lidar ratio assumption) for the discrepancies shown here. In addition to that the information provided by each station individually is lost in the analysis demonstrated here. For example, a figure showing the differences between CATS-EARLINET for day and night time conditions per station along with the mean value may explain some of the discrepancies shown in this section (e.g. the argument of topography) or it may reveal other discrepancy patterns if any (i.e. latitudinal).

CATS products and processing algorithms are provided in different levels of processing. CATS Level 1B (L1B) data include vertical profiles of total and perpendicular attenuated backscatter signals, range-corrected, calibrated and annotated with ancillary meteorological parameters (McGill et al., 2007; Powell et al., 2009; Vaughan et al., 2010). CATS Level 2 (L2) products provide the vertical distribution of aerosol and cloud properties (depolarization ratio, backscatter and extinction coefficient profiles at 1064 nm – FFOV), with a horizontal and vertical resolution of 5 km and 60 m respectively. In addition, L2 data include geophysical parameters of the identified atmospheric layers (vertical feature mask - feature type, aerosol subtype), the required horizontal averaging and information on the feature type classification confidence (Yorks et al., 2019).
Regarding CATS L1B, the validation is a study led by NASA GSFC Team, and more specific by Dr. Rebecca Pauly (Science Systems and Applications Inc., Lanham, 20706, United States Science Systems and Applications Inc., Lanham, 20706, United States), member of the CATS Team. The study is already submitted on AMT journal:
"*Pauly, R. M., Yorks, J. E., Hlavka, D. L., McGill, M. J., Amiridis, V., Palm, S. P., Rodier, S. D., Vaughan, M. A., Selmer, P. A., Kupchock, A. W., Baars, H., and Gialitaki, A.: Cloud Aerosol Transport System (CATS) 1064 nm Calibration and Validation, Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2019-172, in review, 2019*".
In this study, the EARLINET authors in collaboration with the CATS Team evaluate CATS Level 2 Mode 7.2 v2.01 backscatter profiles at 1064nm (Palm et al., 2016). The reason of focusing to the evaluation of backscatter coefficient is the operation wavelength of CATS, i.e. the 1064nm wavelength. Since EARLINET lidar systems do not provide depolarization ratio measurements at 1064nm the particulate depolarization ratio parameter could not be evaluated, included in the analyssis. In addition, since CATS is a satellite-based elastic backscatter lidar (McGill et al., 2015), in order to provide vertically resolved extinction coefficient profiles (km^{-1}) of aerosols and clouds in the Earth's atmosphere, the computation algorithm implements a number of intermediate parameters (i.e. lidar ratio, feature type classification, aerosol subtype classification, among others). Due to the reason that the

profiles of extinction coefficient are a computed product and not included in the direct measurements, extinction coefficient profiles were also not included in the analysis. The authors have focused on particulate backscatter coefficients ($km^{-1}sr^{-1}$), since this is the product directly derived from measurements, the sum of the parallel and perpendicular backscatter measurements (i.e., $\beta_{1064nm\_total} = \beta_{1064nm\_parallel} + \beta_{1064\_perpendicular}$). Future study will include high collocated analysis on the CATS performance and representativeness, including the issues mentioned by the reviewer, based on high temporally and spatially collocated measurements between airborne FAAM Bae-146 research aircraft and ISS measurements, performed in the framework of the AER-D/ICE-Dcampaign, over Cape-Verde (Santiago island), on August 6-25, 2015, as introduced by Marenco et al. (2018) – Figure 5.

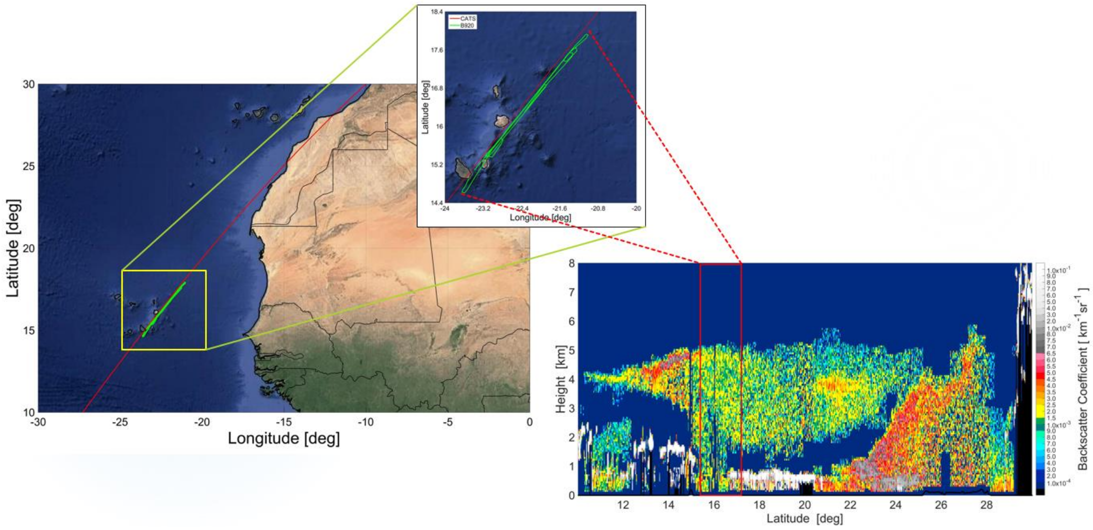

Figure 5: B920 flight on August 7th, 2015 over Cape Verde, high collocated with ISS-CATS overpass. Left: B920 flight and ISS footprint (left), and CATS backscatter coefficient 1064nm scene (right).

Regarding the comment of the reviewer of explicitly addressing the differences between CATS-EARLINET for day and night time conditions per station, along with the mean value to explain some of the discrepancies, it has to be noted that the sample of collocated profiles in many stations does not permit an analysis with strong “per-station” conclusions. For instance, we mention here that Barcelona (ba), Athens_NTUA (at), and Bucharest (bu) stations are participating with only one available case of CATS-EARLINET collocated measurements. In addition, certain number of station happens to contribute with either only nighttime or daytime correlative cases, i.e. Athens_NOA (no) and Lecce (le) with only nighttime cases (three and two cases respectively) and Evora (ev) with only daytime cases (two cases), not allowing to follow the per-station approach.

The undervalue of EARLINET is relying to the approach of the participating community treats EARLINET as a single entity, with the main objective to obtain an extended, coordinated and of continental scale network of sophisticated ground-based Raman lidars and eventually, to foster a quantitative, comprehensive, and statistically significant database of the distribution of aerosol on a continental scale (Bösenberg et al., 2003; Pappalardo et al., 2014). The quality assurance and improvement of the performance of the EARLINET systems is tested through the intercomparison of both the infrastructure (Wandinger et al., 2015) and the optical products (Böckmann et al., 2004; Pappalardo et al., 2004). In addition, the homogenization of the lidar data in a standardized output format is facilitated and an automatic algorithm is developed to further address the quality assurance of the lidar measurements (the Single Calculus Chain (SCC), D’Amico et al, 2015; D’Amico et al, 2016; Mattis et al., 2016).

In order to clarify and demonstrate the sample issue, not allowing to follow a per-station approach, the authors have included here (but also in the manuscript) the following “Table 4”, where the cases used in the intercomparison are given.

Table 4: ISS-CATS and EARLINET cases considered in the evaluation process of CATS backscatter coefficient profiles at 1064 nm.

Day-Night Flag	Date yyyy/mm/dd	Time hh:mm:ss (UTC)	EARLINET station	min Distance (km)	EARLINET Date (yyyy/mm/dd) | measuring time cloud-free window (UTC)
N	2015/11/25	03:44:09	Athens	40.42	2015/11/25 | 03:30:00 – 04:30:00
N	2016/01/29	01:46:08	Athens	46.84	2016/01/29 | 01:00:00 – 02:30:00
N	2016/02/01	17:23:36	Athens	23.29	2016/02/01 | 17:45:00 – 19:30:00
N	2016/02/01	17:23:39	Athens_NTUA	18.58	2016/02/01 | 18:20:51 – 19:57:41
D	2016/05/03	06:45:15	Barcelona	45.93	2016/05/03 | 08:59:00 – 09:59:00
D	2015/08/13	17:29:18	Belsk	2.39	2015/08/13 | 18:02:10 – 18:45:40
N	2016/08/08	17:34:50	Belsk	6.56	2016/08/08 | 17:31:08 – 18:12:05
N	2016/07/28	19:15:24	Bucharest	45.35	2016/07/28 | 17:41:22 – 18:41:22
N	2016/09/14	04:21:09	Cabauw	21.01	2016/09/14 | 05:27:25 – 06:00:03
N	2015/08/03	21:40:39	Dushanbe	42.64	2015/08/03 | 20:00:00 – 22:00:00
N	2016/08/14	15:39:07	Dushanbe	22.08	2016/08/14 | 15:57:00 – 17:19:00
D	2015/06/20	08:38:33	Dushanbe	13.33	2015/06/20 | 08:54:00 – 09:07:00
D	2015/07/12	06:47:07	Dushanbe	33.46	2015/07/12 | 06:25:00 – 07:10:00
D	2016/05/02	07:35:38	Evora	47.27	2016/05/02 | 07:58:50 – 08:00:21
D	2016/05/31	19:43:41	Evora	39.42	2016/05/31 | 19:29:56 – 19:59:35
N	2016/01/30	00:50:16	Hohenpeissenberg	13.36	2016/01/30 | 00:20:00 – 01:20:00
N	2016/03/17	02:12:09	Hohenpeissenberg	43.40	2016/03/17 | 01:42:00 – 02:42:00
D	2015/10/31	12:56:05	Hohenpeissenberg	34.41	2015/10/31 | 12:26:00 – 13:26:00
D	2016/04/12	15:29:18	Hohenpeissenberg	12.77	2016/04/12 | 14:55:00 – 16:05:00
D	2016/08/07	16:49:29	Hohenpeissenberg	31.81	2016/08/07 | 16:19:30 – 17:19:30
D	2016/08/23	10:42:43	Hohenpeissenberg	36.11	2016/08/23 | 10:12:30 – 11:12:30
D	2016/09/14	05:58:59	Hohenpeissenberg	28.37	2016/09/14 | 04:59:00 – 05:59:00
N	2015/07/27	21:14:35	Lecce	34.69	2015/07/27 | 20:42:00 – 21:09:00
N	2016/08/04	22:44:06	Lecce	4.72	2016/08/04 | 20:50:00 – 21:20:00
N	2015/07/30	00:18:19	Leipzig	41.16	2015/07/30 | 00:34:00 – 01:04:00
N	2015/08/03	21:29:44	Leipzig	15.81	2015/08/03 | 21:31:00 – 22:00:00
N	2015/09/24	01:13:34	Leipzig	25.05	2015/09/24 | 01:01:00 – 01:30:00
N	2015/09/29	00:05:33	Leipzig	36.49	2015/09/28 | 22:42:00 – 23:12:00
N	2015/09/29	23:13:24	Leipzig	48.46	2015/09/28 | 22:55:00 – 23:24:00
N	2015/09/30	22:21:13	Leipzig	12.89	2015/09/30 | 21:25:00 – 21:34:00
N	2016/06/05	20:14:01	Leipzig	36.93	2016/06/05 | 20:02:00 – 20:31:00
N	2016/09/13	03:37:49	Leipzig	3.79	2016/06/05 | 00:00:00 – 02:30:00
N	2016/09/12	04:29:46	Leipzig	45.08	2016/09/12 | 00:00:00 – 02:30:00
N	2016/09/15	03:30:25	Leipzig	48.36	2016/09/15 | 00:00:00 – 02:30:00
D	2015/04/21	14:54:35	Leipzig	6.73	2015/04/21 | 16:04:00 – 16:33:00
D	2015/04/21	16:31:00	Leipzig	31.28	2015/04/21 | 16:34:00 – 17:04:00
D	2015/04/24	15:25:13	Leipzig	47.83	2015/04/24 | 14:03:00 – 14:32:00
D	2015/08/13	17:27:54	Leipzig	1.36	2015/08/13 | 19:01:00 – 19:30:00
D	2016/08/24	11:26:39	Leipzig	3.46	2016/08/24 | 10:00:00 – 12:00:00
D	2016/08/24	13:03:12	Leipzig	48.97	2016/08/24 | 10:00:00 – 12:00:00
N	2015/07/21	00:13:26	Potenza	2.01	2015/07/21 | 00:00:00 – 02:52:19
D	2015/11/06	10:54:52	Thessaloniki	19.46	2015/11/06 | 11:57:03 – 12:27:20
N	2016/01/28	19:17:11	Thessaloniki	39.54	2016/01/28 | 20:08:40 – 20:38:57
D	2015/08/13	17:29:20	Warsaw	42.95	2015/08/13 | 17:00:00 – 17:22:00
D	2015/08/19	15:22:30	Warsaw	44.47	2015/08/19 | 15:25:00 – 15:47:00
D	2016/06/07	18:29:46	Warsaw	41.22	2016/06/07 | 18:15:00 – 18:43:00
N	2016/08/08	17:34:53	Warsaw	46.99	2016/08/08 | 17:00:00 – 17:23:00

14. The pair of observation "i" refer to the vertical height of each case study or to each case study individually? This a general comment related to the comparison methodology followed by the authors: I speculate that the initial vertical resolution of the two profiles is not the same. For example, the L1 data products obtained by CATS are within 60 m vertical resolution (Yorks et al., 2011). On the other hand, the data products obtained by EARLINET (especially the Raman retrievals) are processed (application of low-pass filter on the signal) leading to range-resolution loss. A concept of effective resolution is already discussed in the literature (e.g. Iarlori et al., 2015). Therefore, it is not so clear to the reader how the authors managed to compare values obtained from different atmospheric heights? Did they interpolate their values or they used mean values in specific vertical height windows? In any case the authors are kindly suggested to comment their approach on this. (Iarlori, M., Madonna, F., Rizi, V., Trickl, T., Amodeo, A., Effective resolution concepts for lidar observations, Atmos. Meas. Tech., 8, 5157–5176, 2015 www.atmos-meas-tech.net/8/5157/2015/ doi:10.5194/amt-8-5157-2015).

The authors agree with the reviewer regarding not properly commenting on the respective aspect. Regarding CATS L2 profiles, the product provides the vertical distribution of aerosol and cloud properties (depolarization ratio, backscatter and extinction coefficient profiles at 1064 nm – FFOV), with a horizontal and vertical resolution of 5km and 60m respectively. On the contrary, EARLINET profiles were provided by the EARLINET community with higher vertical resolution. Towards the assessment of CATS performance, for the comparison of CATS against EARLINET, we implemented the $CATS_i$-$EARLINET_i$ residuals for each pair of observations "i", as a statistical indicator of CATS average overestimation or underestimation of the aerosol load, in terms of backscatter coefficient values. Since the vertical resolution of the two profiles was not the same and in order to compute the $CATS_i$-$EARLINET_i$ residuals, the EARLINET profiles were reduced in resolution to obtain 1-1 datasets, characterized by the same vertical resolution. This was achieved by computing the EARLINET mean backscatter coefficient value from all EARLINET bins within each CATS 60m backscatter coefficient range. Thus, indeed the speculation of the reviewer on the methodology, through computing mean values in specific vertical height windows, is right.
The aforementioned approach indeed led to loss of vertical resolution in the EARLINET profiles (Iarlori et al., 2015). For this reason, the authors (in the initial steps of the study) performed an exercise, to investigate the magnitude of the effect of the selected approach and the significance of loss of resolution in the EARLINET profiles, since the opposite approach (i.e. to increase the resolution of CATS profiles to match the EARLINET resolution), was not feasible.
Figure 6 shows an example of the exercise, corresponding to a nighttime ISS orbit, on September 30, 2015 (blue line), at a minimum distance of 12.9km from the EARLINET Leipzig – Germany PollyXT lidar system (indicated by a white dot), at 22:21 UTC (Fig. 3a). CATS particulate backscatter coefficient cross section at 1064 nm (Fig.6-right) shows the presence of aerosols up to 2.2 km (a.s.l.). CATS spatial-averaged and Leipzig temporal-averaged profiles were derived from CATS profiles within horizontal distance below of 50 km, between the Leipzig station and the ISS footprint.

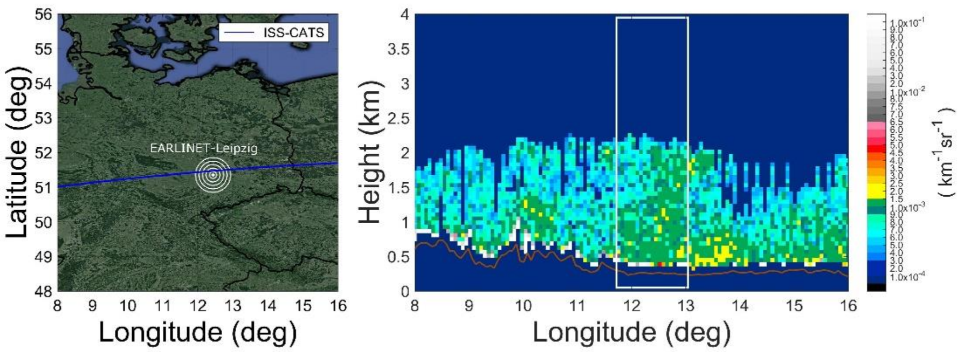

Figure 6: (left) Nighttime ISS orbit over EARLINET Leipzig station on the 30th of September 2015 (blue line). The white dot denotes the location of Leipzig lidar system, (b) CATS Backscatter Coefficient at 1064 nm.

Figure 7 shows the direct comparison between the backscatter coefficient profiles, measured from the EARLINET Leipzig station (red line) and CATS (blue line), along with their standard deviations (horizontal error bars). The profiles indicate the presence of aerosol up to 2.6 km height (a.s.l.). The intercompared profiles between ISS-CATS and EARLINET-Leipzig station are characterized by adequate agreement, although significant discrepancies were also present, especially to the lowermost part of the profiles, as discussed in the manuscript.

The intercomparison presented in Figure 7 is shown to provide to the reviewer a quantitative response to the specific comment. Figure 7 shows the CATS averaged backscatter coefficient profile in blue color, while with respect to EARLINET both the initial (high resolution) and final (reduced in resolution to match the CATS profile resolution) are provided in black and red colors. As was observed the necessary loss resolution in the EARLINET profiles for achieving vertical match between the two datasets is very low, with final EARLINET profile following with high accuracy the characterizes and tendencies, both qualitative and quantitative, of the initial EARLINET profiles.

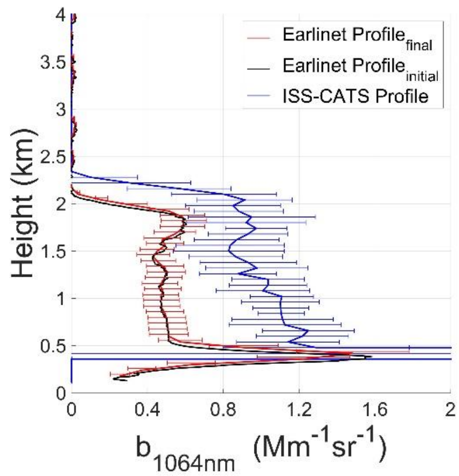

Figure 7: CATS and EARLINET-Leipzig backscatter coefficient profiles (1064 nm) for the nighttime ISS orbit over EARLINET Leipzig station on the 30th of September 2015. CATS backscatter coefficient profile at 1064nm is shown in blue line. EARLINET-Leipzig initial and final profiles, are shown is black and red respectively.

However, the authors agree with the reviewer on the absence of properly addressing the vertical match between the two datasets. For this reason, the following part was added on "*Section 2.3.2 - Particle backscatter coefficient retrievals from ground based lidars at 1064 nm*":

"*Finally, in order to perform the intercomparison between CATS and EARLINET profiles, the high resolution of EARLINET profiles was lowered to match the vertical resolution of CATS profiles (i.e. 60m). The objective of obtaining profiles of similar vertical resolution was addressed through computing the EARLINET mean backscatter coefficient value from all EARLINET bins within each CATS 60m backscatter coefficient height range. The computed EARLINET profiles of similar vertical resolution with CATS followed with high accuracy the characterizes and tendencies, both qualitative and quantitative, of the initial EARLINET profiles, despite the loss of vertical resolution (Iarlori et al., 2015).* ".

15. Page 13, line 30: "CALIOP" -> Maybe "CATS" instead of CALIOP?

CATS calibration is performed by normalizing the NRB signal in the altitude regime between 23 and 27 km. Although the region is used to normalize the NRB signal to the molecular backscatter, the region between 23 and 27 km is not aerosol free. According to the ATBD, the scattering ratios (e.g. total backscatter to molecular backscatter) at 532 nm are estimated based on CALIPSO CALIOP V4 L1 data. The 532 nm scattering ratios are used to estimate the 1064 nm scattering ratios and accordingly to the calibration of CATS. Consequently, a source of systematic errors in the CATS calibration is related to errors in the stratospheric scattering ratios provided by CALIPSO (ΔR). The scattering ratio values in CATS calibration are determined as outlined in section 3.3.4. of the CATS ATBD (https://cats.gsfc.nasa.gov/media/docs/CATS_ATBD.pdf; last visit: 29/05/2019).

16. Page 15, line 18, lines 24-25: "slight underestimations of the total AOD in climatic studies." "results in large AOD biases and unrealistic AOD values." I agree with these statements. However, in the current state of the manuscript there is no straight forward comparison of AOD but only backscatter coefficient. See also my previous specific comment No. 14.

The authors agree with the reviewer. Although not a CATS extinction coefficient 1064nm and AOD 1064 nm analysis were not included, the authors in order to provide a more detailed overview of CATS capabilities and representativeness have included literature review on studies investigating the performance of CATS. To be more specific, the following paragraph was added to the manuscript (Section 1 - Introduction), in line to the comment of the reviewer and in order to justify the statement mentioned ny the reviewer:

"*CATS performance has been validated against ground-based AErosol RObotic NETwork (AERONET; Holben et al., 1998) measurements and evaluated against satellite-based Atmospheric Optical Depth (AOD) retrievals of Aqua and Terra Moderate Imaging Spectroradiometer (MODIS; Levy et al., 2013) and active CPL (McGill et al., 2002) and CALIPSO CALIOP (Winker et al., 2009) profiles of extinction coefficient and AOD at 1064 nm. Lee et al. (2018) compared daytime quality-assured CATS V2-01 vertically integrated extinction coefficient profiles (1064 nm) and AERONET AOD (1020 nm) values, spatially (within 0.4^o Longitude and Latitude) and temporally (±30 minutes) collocated, and found a reasonable agreement with a correlation of 0.64. A comparative analysis of CATS and MODIS C6.1 Dark Target (DT) AOD retrievals, through spectral interpolation between 0.87 and 1.24 μm channels, reported correlation of 0.75 and slope of 0.79, over ocean. In addition, Lee et al., (2019) evaluated AOD and extinction coefficient profiles from CATS through intercomparison with CALIOP. With regard to AOD, analysis a total of 2681 CATS and CALIOP collocated observation cases (within 0.4^o Longitude/Latitude and ±30 minutes ISS and CALIPSO overpass difference), showed correlation of 0.62 and 0.52 over land and ocean respectively during daytime (1342 cases), and 0.84 and 0.81 over land and ocean respectively during nighttime (1339 cases). Comparison of CATS and CALIOP collocated extinction coefficient profiles based on the closest Euclidian distance on the earth's surface, shows also good shape* *agreement, despite an apparent CALIOP underestimation in the lowest 2 km height. CATS and CALIOP observations were used by Rajapakshe et al. (2017) to study the seasonally transported aerosol layers over the SE Atlantic Ocean. The performed comparative analysis reported on similar geographical patterns regarding Above Cloud Aerosols (ACA), Cloud Fraction (CF) and ACA occurrence frequency (ACA_F) between CATS and CALIOP retrievals. However, the authors reported also on differences between CATS and CALIOP vertical aerosol distributions, with ACA bottom height identified by CATS lower than the respective of CALIOP. CATS retrievals were used to document the diurnal cycle and variations of clouds, with CALIOP complementarily used. Noel et al. (2018) showed that both CATS and CALIOP profiles of CF agree well on both the vertical patterns and values at 01:30 and 13:30 LT, over both land and ocean, with minor differences of the order of 2-7% throughout the entire profiles of cloud fraction. CATS depolarization measurements, which are critical in the processing algorithms of aerosol subtype classification, were investigated in the case of desert dust, smoke from biomass burning and cirrus clouds (Yorks et al., 2016), and were found consistent and in good agreement with depolarization measurements from previous studies and historical datasets implementing CPL (Yorks et al., 2011) and CALIOP (Liu et al., 2015).*

17. Page 29, line 13: "The white circle" -> "The white dot denotes the location". The white circle refers to points at various distances from the lidar station as stated by the authors in Figure 2. Please consider correcting this minor typo in figures 3, 4, and 5.

The text is modified according to the reviewer's recommendation.

18. Figure 7: For the night time mean profiles the discrepancies are negligible but for the day time and specifically for the height region from 1-2 km large differences are observed. What is the main reason behind this? The significant influence of the topography? In that case why this difference is not shown also in the nigh-time profiles, considering this as a bias from one or more stations. The low daytime CATS SNR? In that case I would expect to see higher discrepancies than sown inside the PBL (longer atmospheric path), compared to 1-2 km. The calibration region of CATS? In any case, I think that a solid and quantitative explanation on this is missing.

The effect of signal-to-noise ratio (SNR) and the associated Minimum Detection Backscatter (MDB) are the critical factors determining the performance of CATS. However along with the technical capabilities of CATS there are different factors with effect on the final CATS profiles (i.e. topography, as mentioned by the reviewer). Regarding the quantitative and qualitative explanation exercises under different cases are presented and discussed in the reviewer's question #7.