Reply to Reviewer 2
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The valuable comments by Reviewer 2 are greatly appreciated. Our replies to the Reviewer 2 comments are given below.

General comments: *This manuscript deals with the description and application of a novel cloud height detection algorithm for limb-scatter observations with the OMPS Limb Profiler. A sample data set was analyzed with this new algorithm and the results were compared to collocated cloud/aerosol observations with the CALIOP Lidar on the CALIPSO spacecraft, showing good overall agreement. The paper is in general well written and easy to follow. The manuscript should eventually be published in AMT in my opinion, but I ask the authors to consider the specific comments listed below.*

Reply to General comments: We thank the Reviewer 2 for these positive comments.

Comment 1: *Page 10161, line 8: 'Several techniques to retrieve cloud information from remote sensing measurements have been developed.' This statement is certainly correct. It's somewhat curious that almost all of the papers cited in the following sentences deal with cloud remote sensing based on nadir observations, not limb observations. Please also cite the relevant papers dealing with cloud detection in limb-scatter observations:*
Bourassa A. E., Degenstein, D. A., Llewellyn E. J.: Climatology of the subvisual cirrus clouds as seen by OSIRIS on Odin, Adv. Space Res., 36, 807 – 812, 2005.
von Savigny, C., Ulasi, E. P., Eichmann, K.-U., Bovensmann, H., and Burrows, J. P.: Detection and mapping of polar stratospheric clouds using limb scattering observations, Atmos. Chem. Phys., 5, 3071 – 3079, doi:10.5194/acp-5-3071-2005, 2005.
and perhaps:
Eichmann, K.-U., Lelli, L., von Savigny, C., Sembhi, H., and Burrows, J. P.: Global cloud top height retrieval using SCIAMACHY limb spectra: model studies and first results, Atmos. Meas. Tech. Discuss., 8, 8295-8352, doi:10.5194/amtd-8-8295-2015, 2015.

Reply: These three papers have been included in the revised manuscript. In fact, we had already cited two relevant papers (Kokhanovsky et al. 2005 and Rault et al. 2013) that deal with cloud detection in limb-scatter observations (please see Page 16101 and Page 16109 in the original manuscript).

Comment 2: *Page 10162, equation (2) and Figure 1: Your cloud detection method is based on the spectral dependence of the vertical gradient in limb radiance – or more precisely the natural logarithm of the limb radiance. Fig. 1 suggests that there is always a clear difference in the spectral dependencies between cloud free cases (Rayleigh only), aerosols and clouds. I'm not fully convinced this is actually correct and I suggest also plotting perhaps 2 cloud free cases for tangent heights between 10 – 15 and 20 –25 km. I'm thinking along the following lines: At 5 – 10 km the vertical gradients in limb radiance are quite small in the Rayleigh only case for the 500 – 900 nm spectral range (i.e. limb radiance does not vary that much with tangent height), because the atmosphere*

is not optically thin any more along the line of sight. If you take the 20 –25 km tangent height range instead, then the radiance profiles at longer wavelengths (around 90 km) will drop off already quite quickly, while this will not be the case for the shorter wavelengths (around 500 nm). Therefore, I would expect a larger spectral slope also for cloud-free cases if one looks at higher tangent heights.
I don't think this point is a major problem for your paper, because the results shown later demonstrate that the method works well. But it would be good to show the spectral dependence of the radiance gradient for cloud free cases also at higher tangentheights.

Reply: We agree that the radiance profiles *I* at longer wavelengths (around 900 nm) will drop off quite quickly for cloud-free cases at higher tangent heights. However, this is not the case for the vertical gradient *G* in equation (2) and Figure 1. We made the following two figures requested by Referee 2, using LP measurements at 28°N. For the purpose of comparison, the scales of the plots are the same as shown in Figure 1. The spectral dependence of the radiance gradient at 11.5-15.5 km, shown in Figure R2a, is very similar to the clear sky cases shown in Figure 1. The spectral dependence at 21.5-25.5 km is slightly greater, as shown in Figure R2b, but the magnitude of the slope α(z) only ranges between -0.00017 and -0.000072. These values are a factor of about 10 smaller than the cloud example presented in Figure 1 of the manuscript, and may represent the presence of small amounts of aerosols. This result supports our assertion that clouds have a distinctive spectral dependence using the radiance gradient approach.

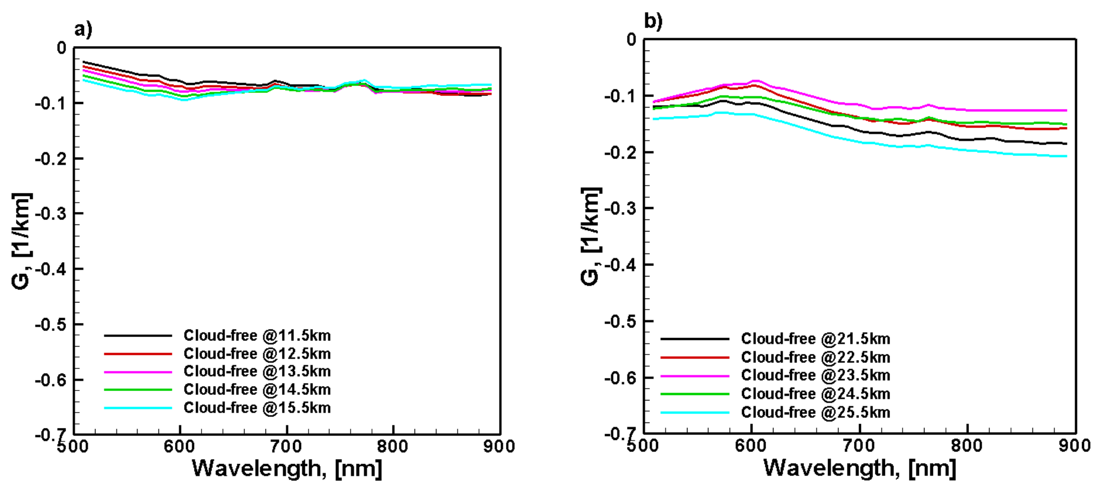

Figure R2. Variations in the radiance gradient $G(\lambda,z)$ from OMPS LP data at 28N during orbit 16754 on 21 January 2015 for cloud-free cases at tangent heights between 11.5 – 15.5km (a) and 21.5 – 25.5 km (b).

Comment 3: *Page 10163, line 12: 'consistent with the spectrally independent gradient expected for clear sky' Again, I don't think that cloud-free cases are necessarily associated with a spectrally independent gradient (see previous point), but I expect that for cloud free cases the spectral dependence will also depend on tangent height.*

Reply: You may be right, but this dependence is very small. Please see Reply to Comment 2 above for further discussion of this point.

Comment 4: *Page 10164, equation (5): I don't fully understand how the approach described in section 3.2 allows you to separate between clouds and aerosols – without any further assumptions or tests. The ASI will certainly indicate the presence of aerosols, but it will also respond to the presence of clouds, right? It seems one has to make further assumptions, e.g. thresholds, to distinguish between radiance enhancements due to aerosols and clouds. Moreover, as far as I can tell, the ASI concept is not used further in this study, e.g. for the comparison with the CALIOP observations. If this is the case, then the necessity of section 3.2 can be questioned. If ASI is used for the comparisons with CALIOP, then this should be explicitly discussed and sufficient details provided, in my opinion.*

Reply: The reviewer is correct that the ASI values alone are not sufficient to distinguish between aerosols and clouds. We introduce this quantity in Section 3.2 to help confirm the presence of aerosols at higher altitudes (20-23 km) for a specific event. This allows us to further demonstrate that while clouds and aerosols both change the radiance gradient for a single wavelength, our radiance ratio approach can correctly identify a cloud by choosing an appropriate detection threshold. We have also added material in response to other reviews that discusses the dependence of ASI and radiance ratio values on scattering angle.

Comment 5: *Fig. 2, top right panel: It's very difficult – if not impossible for a hardcopy version of the paper – to read the abscissa & ordinate labels. They should be increased significantly. Please also increase the size of the axis labels of the bottom right panel.*

Reply: The panels in Fig 2 have been enlarged and the size of the axis labels of the panels has been increased.

Comment 6: *Fig. 3 b): Same comment as for Fig. 2*

Reply: The size of the axis labels of the panels have been increased.

Comment 7: *Fig. 4, top panel: I suggest plotting vertical lines showing the latitudes of the measurements A and B. This would make it easier for the reader to interpret the Figure.*

Reply: Done.