Reply to Anonymous Referee #2

We would like to thank Anonymous Referee #2 for their helpful comments. Below are the original comments in regular with our responses in *italic* text.

Comments to the author:

The manuscript describes an algorithm to derive cloud optical thickness, particles effective radius, and cloud top effective temperature using EarthCARE's multi-spectral imager (MSI). Cloud water path is also derived using optical thickness and effective radius. The retrieval uses 7 channels of MSI. The retrieval is done though a forward model in an iterative way to minimize a const function. The const function is the sum of the difference of modeled radiances and observed radiances and retrieval cloud properties and their a priori estimates. The const function takes into account of measurement uncertainty based on signal-to-noise ratio and forward model errors. The forward model errors are assumed to be independent. The algorithm is tested with EarthCARE simulator HALIFAX scene and MODIS data. Also, M-CLD properties are validated within the framework of the CGMS internatonal cloud working group.

 The manuscript is well written and results are easy to understand. I only have minor comments or clarifications.

 Equation 1. Is this for all 0.67, 0.865, 1.65, and 2.21 channels?

Yes, principle yes, but for the LUT we calculate mainly the pair VIS/SWIR1. We added a sentence below the equation: The target is to find the pair of τ, r_e which gives the highest accordance, or better the optimal estimate for the set of equations above for the V IS/SW IR1 channels.

Line 141. What is theta_c?

 Thanks, that is a mistake it should be t_c (cloud transmission) has been corrected.

Line 242. S changes weights to sum up the elements to compute the cost function. How do you estimate diagonal term of Sa? Does this covariance matrix depend on region or cloud type? If variances are fixed, could you present the size of variances in a table? This is nice, in principle, if we know the covariance matrix. But in practice, we do not really know Sa. How sensitive the final solution is to the covariance matrix?

For the background covariance, Sa we started with a simple assumption, which should be improve further. So far, the variance of the state vector is used based on the minimum and maximum values. We added a table (Tab.4).

 Table 1. Change "cloud particle size" to "cloud particle radius".

Done.

Figures. Generally, axis labels and legends are too small. For example, Figure 2 (legend), Figures 3, 4, 5 and 6 (labels for the color bar).

We revised the figures.

Figure 7 and 8 do not mean very much to readers who are not a member of the cloud working group unless all title or legends are explained.

We think that it is important to show these figures in that level of detail, because the ICWG is a strong group with high expertise in cloud retrievals from passive satellite sensors and therefore it is a strong argument that the M-CLD retrieval can keep up with the other sophisticated retrievals in our opinion. The reference Hamann et al. 2014 provides much details about the retrievals and the intercomparison, which is out of the scope of the present manuscript, but it did not compare to M-CLD before. This was done just in a later step and never published. Therefore, we would like to include the results in our paper. We have added a sentence to the caption: Detailed information about the algorithms behind the acronyms in the titles are provided in table 4 of Hamann et al. 2014.

Figure 9. Could you provide mean difference and RMS difference between MODIS M-COP values in a table? It is even better If the authors have compared more scenes and provide robust statistics.

We agree that more statistics would certainly improve the significance of the comparison, but for the time being, we only have a few cases, for which statistical mean numbers should only be interpreted with care. However, once real data is available, there will be a comprehensive validation effort comparing to other sensors including the active instrument from EarthCARE. Fig. 9 (in the revised version now Fig. 10) shall give some qualitative indications about the agreement and maybe also weaknesses of the M-CLD retrieval, which should be further assessed with robust statistics in the future. We have slightly rephrased the text below the last figure: "The COT values between MODIS and MSI are in good agreement, while there is a slight overestimation of M-REF compared to MODIS for water clouds and underestimation for ice clouds. However, one should note that this is only a qualitative comparison for one case study and a comprehensive assessment of the quality of the M-CLD products will be perform once real MSI observations are available."