

We thank the reviewer for the constructive comments and resulting improvements to the paper. We have responded to each comment in-line below, and will soon submit the updated manuscript including the changes described below. With the introduction of a flowchart figure (new Figure 2) all Figure numbers after Figure 1 have been moved up by 1.

More discussion is needed on how the FeatureMask works in situations where there is significant variation in profile-to-profile attenuation, e.g. when identifying lower-level features below an upper-level cloud that has gaps in it. Are the kernels in the median-filter approach adjusted, or does the method rely on pixel value adjustment only? Is this information propagated to subsequent smoothing algorithms somehow?

The text has been modified based on your, the other referee and the community comments by Mark Vaughan.

The verification section would be better served by calculating the contingency tables based on the signal fields (or attenuated backscatter coefficient) rather than the extinction field, since this provides a more direct comparison of the cumulative effect of atmospheric attenuation on feature detection. Verification before and after combination of the strong and weak feature masks would clearly show the additional benefit of the full FeatureMask algorithm.

This is an excellent idea. We have added an additional panel to the figure to visualize the information with respect to attenuated backscatter signal strength. As well as provided the percentages of detection by the different masking techniques. What is for instance nice to see in this additional panel is that the attenuated fields show similar signals strength as clear sky fields, and that a large number of detected extinction pixels have an attenuated backscatter within this clear sky distribution but are detected based on horizontal and vertical correlation of the signal field.

Lines 25-29: Here, it is stated that measurements from 4 sensors are combined, in order to be compared to measurements from 1 of them. Abstract states that measurements from 3 sensors are combined..

This part indeed read different from what was intended. The line has been rewritten to:

EarthCARE science is built around the synergistic use of these four advanced sensors (Eisinger et al., 2022), where ATLID, CPR and MSI data are combined in order to estimate the 3D atmospheric properties of clouds, aerosols and precipitation, including their optical and microphysical properties.

Lines 70: What do you mean by 'effects' here? I assume that you mean that is is not just the mask that is propagated, but also decisions made on smoothing. Using 'decisions made' would be clearer.

Followed the advice and updated text

Lines 95-96: Correlation of what data?

We were discussing the horizontal and vertical correlation of the attenuated backscatter data. Added this to the text.

Lines 115-117: It would be clearer to mention the ideal case here and then discuss the cross-talk, its correction and implications after line 141.

Thanks for the suggestion, I agree that this will make it more clear. The text has been reordered

Lines 348-351: Need to be more specific here. Is this procedure performed for each feature value separately? What is the order of precedence if the process finds overlapping features with different values? Features from which mask receive a penalty, and why do some receive a 2 point penalty?

One side effect of the hybrid median masking is the posterizing of the image (Rush 2007), where the pixel values are updated each iteration. This ensures that regions become more uniform and edges between regions become therefore more abrupt as the edge detection remains strong. By iterating the HM filter we only need to check after 5 iterations whether pixels have been removed or if gaps are filled. When they disappear we want to keep track of potential pixels which need to be evaluated after launch. Since 5 is a reserved number for pixels very close to the ground which are expected to contain aerosols. FM values which has a 6 require a penalty of two in order to skip the 5. However it is also sometimes 3 points (for those pixels where FM was originally 7). The following line has been added.

All features filled in due to the hybrid median filtering are added to CFM, all features disappearing, for FM between 5 and 7, receive a penalty of one to three points bringing them in the range between FM=[1,4] on their detection status.

Technical comments

Line 4: Replace 'state is estimated, which then are used' with 'state is estimated and then used'.

Updated text following your suggestion

Line 18 and elsewhere: Choose one format for displaying extinction and backscatter values throughout the manuscript.

Agreed, these were inconsistent.

Line 30: Replace 'have being developed' with either 'are being developed' or 'have been developed'.

Updated text using ' have been'

Line 35: Replace 'rations' with 'ratios'.

Thanks for noticing this, updated text

Line 38: Explain what Aeolus is here (a satellite wind lidar mission) as this is the first time it is mentioned in the main text.

Added a line referring the Aeolus mission.

Line 66: Replace 'aerosols regimes' with 'aerosol regimes'.

Removed the s

Line 67: Replace 'liquid clouds signals are not mixed with aerosol of' with 'liquid clouds are not mixed with aerosol or'.

Updated text

Line 79: Replace 'FeaturMask' with 'FeatureMask'. Suggest using 'regions' rather than 'areas' - 'areas' imply a 2-dimensional (horizontal) spatial extent, whereas the FeatureMask is of time-height dimensions.

Updated text

Line 89: Replace 'to to' with 'to'.

Removed to

Line 91: Replace 'the the' with 'the'.

Updated text to: *In Section 4 the results for two simulated tests scenes and one Aeolus-CALIOP collocated orbit are presented.*

Line 118: Replace 'correction' with 'corrections'.

Updated text

Line 125: Replace 'depend both' with 'both depend'.

Updated text

Line 172: Replace 'area's' with 'areas'.

Updated text

Line 176: Do you mean 'quantitative' here?

Rephrased the sentence: *The meaning and explanation of the values should be interpreted loosely.*

Lines 206-207: Is the vertical cross-talk pixel-to-pixel only? Or does it extend beyond neighbouring pixels?

Added an extensive description of the lidar signals and cross-talk

Line 240: Should mention here how the standard deviation of the signal is calculated.

Added a description: *A number of error estimates, i.e. total, proportionality, systematic and random errors, are defined in the L1 file, it is assumed that the random errors used within this processor represent} the signal standard deviations.*

Lines 244-246: Do you mean single pixel elements in both the vertical and spatial sense? Not sure that you need to specify 'Cumulus' here as such 'single pixel elements' could also arise from liquid clouds or other features which may be narrow in one dimension (along track) but extensive in the other spatial dimension (perpendicular to the track).

You are correct that it reads to constraining this way. Rephrased the text.

Line 265: For 'Those pixels' do you mean 'Co-polar Mie pixels'?

Both the Co-polar Mie and Co-polar Rayleigh pixels. The line has been rewritten to:

The resulting Mie image is used for the detection of strong features, i.e. those pixels with a value above a user defined threshold (within this paper a value of 34% is adopted) are set as a strong feature return using FM values of 7, 8 or 9 depending on the absolute hybrid median pixel value. The resulting co-Polar Rayleigh image is used for the detection of attenuated regions, i.e. Rayleigh pixels with a hybrid-median-value < 40% are set to be fully attenuated [FM=-1]

Lines 268-269: Paragraph needs fixing.

The paragraph has been reformulated

Line 278: What is 'features in 1' referring to?

The word Figure has been added

Lines 290-291: Replace 'detects' with 'detect'. What do you mean by 'cutting corners'? It might be safer to write 'artificially rounding the corners of 2-dimensional features'.

This was indeed what was meant. I think I was cutting corners when writing it down. This paragraph has been removed from this part of the text.

Line 414: Replace 'ot' with 'it'.

Updated text

Figures: Some figures will require their colour scales to be modified in order to meet the journal publication requirements.

The color schemes have been updated

Figure 5: Replace 'cut of' with 'cut off'.

Added f

Figure 7: Replace 'verticals scale' with 'vertical scale'.

The line was removed when the top panel was also plotted between 0 and 20 km.