Aerosols and Clouds data processing and optical properties retrieval algorithms for the spaceborne ACDL/DQ-1

by Guangyao Dai et al.

The paper discusses the data and retrieval results of the Aerosol and Carbon Detection Lidar (ACDL) on board the new Chinese DQ-1 satellite launched in April 2022. The ACDL is the first HSRL lidar using an iodine filter in space and measures in 3 wavelengths (532nm, 1064nm and 1572 nm. This work focuses on the retrievals from the first 2 wavelengths.

These exciting first results show some extremely nice images of the different retrieval products (extinction, depolarization, lidar ratio & color-ratio) and promises a great continuation, as well as providing a bridge function, for the current lidar data series starting with CALIPSO & Aeolus missions and the future EarthCARE, AOS and Aeolus-2 missions towards a lidar climate series. To enable the ACDL to take this international role it is important that the L1 data and its retrievals will become available to the general scientific community. We understand that this is not up to the authors, but we do urge that at least the L1 data and L2 products as shown in Figure 8 (June 27 2022; 00:45-01:11 and 09:49-10:15) are provided as part of the 'Data availability' .

There are a number of minor and more important revisions (both technical and textual) which will have to be made before the paper can be accepted for publication. The issues are specified by page and line numbers following the online PDF.

Revisions:

In a number of cases too few details are provided when discussing the details of the retrieval algorithms used. I have separated these from the minor textual issues as these require additions to the current text.

Background noise subtraction (Section 2.3):

In line 155 it is described that the minimum value of the segmented-averaged signals in the channels is used for subtracting background noise. First to be sure, when you use segment here is it the vertical segment as suggested in Lines 223-229 or do you refer to segments like in Section 5: 'two segments for subsequent data processing'. From the text it is vertical but it is unclear to me how you segment this vertically and if it is the minimum after performing a convolution with a vertical smoothing kernel or it is really the minimum value of any point. Please provide more information on the procedure followed, in case of the first the width of the Kernel, in the second on why this would not provide a very noise behavior

Auxiliary datasets & denoising

Line 176: do you have a reference for the C & K system parameters, or is there no additional information available.

In lines 114-116 it states : transmittance of iodine filter for aerosol scattering and molecular scattering are denoted by fa and fm, which are function of height due to its dependence on atmospheric temperature and pressure. Later you describe the use of ERA54 which has a relatively low resolution in space and time. Can you provide a discussion of what the errors

are on the retrievals due to the use of the data with respect to higher resolution NWP forecast data or reanalysis. Or is the filter position not that depending on the exact P & T profiles.

In section 4.1.2 (see also Fig. 6) the DNR is an important parameter for quality control. However in the end we only see the profiles in Signal (W [without units]). It would be nice, especially for the molecular channel to also see the corresponding profile of DNR^M with on top the lines you use as threshold for QC.

Minor revisions:

There are a number of textual changes to be made and a few issues with the figures. If sentence starts with → a word or ',' should be added

Line 14 add , after 2022

Line 17 → The methods have been

Line 18 → ACDL system and are

Line 21 → ACDL/DQ-1,

Line 24 analysed, which demonstrated → analyzed, demonstrating

Line 29 and absorbing thermal → and absorbing & emitting thermal radiation

Line 33 → active remote sensing tool, lidars can provide aerosol and cloud profile

Line 36 → payload of the Cloud

Line 39-42 → with CALIOP as the Mie scattering and Rayleigh scattering are combined in the backscatter signal (Sayer et al. 2012). The CALIOP team has developed the Hybrid Extinction Retrieval Algorithm (HERA) which retrieves both the particulate backscatter and extinction profiles from attenuated backscatter profile by including the scene classification () as a-priori.

Line 43 previous studies : do you point here to both the Young paper or even more, a bit unclear

Line 46 different spectral → difference in spectral

Line 48 → coefficients can be obtained simultaneously

Line 50 → The Aeolus satellite, which carries a Fabry-Pérot interferometer based wind lidar (ALADIN), was successfully

Line 52 measure → measuring

Line 53 And Aeolus → Additionally Aeolus optimizes the … by using a maximum

Line 56 Add also newer EarthCARE references from the new AMT special issue

Line 61 → DQ-1 is equipped with five sensors,

Line 64 One is → The first is ; and another is → and the second is

Line 84 → pulses down

Line 88 by the energy → by energy

Line 89 → , which is called dual-pulse

Line 90 → Because of the dual-pulse design,

Line 94 Lidar specialists will know but add something like narrow peak with Mie scattering and broader molecular Rayleigh scattering for the non specialists

Line 150 that only → than only

Line 152 could be higher → can be higher

Line 157 → noise in the high

Line 157-170 Can you give some reference to the values used, e.g. is 1,5 V cross-polar as much as ice clouds would give, or do you only loose dust-aersols?? In Figure 4 the daytime shows consistently peaks at the same place for all 532nm channels. Please provide some context for the reader, i.e. type of clouds at different area's resulting in these noise patterns. It is ofcourse also related to the request above in the revisions requested on the background noise subtraction.

Line 175 Can you provide a reference for the C and K parameters?

Line 186 → raw data in each

Line 187 → scales, a vertical

Line 194 What do you mean with considering the systematic parameters?

Line 200 disorderly noise. Is there something specific you want to say here? Do you mean random noise with respect to bias?

Line 212 Please rephrase first sentences upto distinctly. I don't understand exactly what you want to say

Line 214 reserve → preserve

Line 219 → different thresholds are chosen.

How is this chosen, are they fixed, do they depend on SNR and are therefore dynamic. Please elaborate on this more.

Line 228 → 2-D median filter, and subsequently a vertical sliding

Please discuss the size of the 2D filter in #profiles and # vertical bins and the size of the vertical sliding window you use for this.

Line 256. On the multiple scattering you refer to Hu & Garnier. But which of the solutions did you pick exactly for ice-clouds and water clouds. And just to be sure, you do neglect multiple scattering by large aerosol particles?

Line 280 → Thus indicating

Line 281 → satellite passed

Line 284 low-altitude clouds that existed in the range of 6 km and 16km. These are generally not considered low-altitude. Please rephrase

Line 286 in the absence of HSRL. The sentence feels a bit off, maybe add 'HSRLcapabilities' or 'in the case of a backscatter lidar'.

Line 292-295 Move the discussion of area V to the description above describing nighttime

Line 290 Please rephrase sentence 'The superposition …..daytime', it is hard to read and rename echo to backscatter.

Line 296 What do you mean by reusability in this context

Line 297 Can you provide an estimate of the current processing rate with the statement. Every orbit of yy minutes takes zz minutes to process up to this product.

Line 300 → Most clouds are removed

Line 302 → different heights can also

Line 303 → of the layer averaged AOD

Line 314. Please rephrase sentence 'And the …night scenes'.

Line 325 which require additional improvements

Figures:

Figure 2: In the lower box : Average strategy → Averaging strategy

Figure 3: y-axis label Signal/ (V)→ Signal (V) , similar for the x-axis label

Figure 4: You have 3e4 profiles can you provide in the caption how much this is in total time (just to get some reference).

Figure 5: The images look really nice but have a too low resolution (zooming in the label blurs). Can you make the font size slightly larger as well?

Figure 6: Please add units to Signal ^& km in brackets and see comment above on additional plot

Figure 8: The images look really nice but have a too low resolution (zooming in the label blurs). Can you make the font size slightly larger as well? In the caption remove the aerosol 3x in the last sentence. You retrieve both cloud and aerosol properties.

Figure 9: remove whole layer, AOD is the entire range unless specified as layer integrated. Nice way to show the layers btw!!