General comments

This paper reports important results from the high spectral resolution lidar flying on the DQ-1 satellite. These are the first HSRL aerosol retrievals from space, so the paper is quite significant. The paper presents initial retrieval results and comparisons with other observations but requires additional details and explanation before it is publishable.

To better understand the retrieval algorithm and the nature of the data products, more detailed description of the instrument and the signal processing steps applied are necessary. Several figures require more explanation. Since the paper has a focus on validation, methods use to calibrate the instrument and calibration accuracy should be explained, as well as the expected retrieval accuracy. Expressing ratios in dB is confusing. While common in the radar community, in the lidar community ratios are nearly always expressed as linear ratios rather than in dB. I strongly recommend that linear ratios be used rather than dB.

When validating instrument retrievals, one would like to compare with data which is more accurate, or equally accurate. This is a problem for DQ-1 because there may not be any suitable profile data available for comparisons. Discussion of comparisons with MPLnet and CALIPSO in Section 3 should acknowledge that aerosol extinction retrievals from the MPLnet and CALIPSO elastic backscatter lidars have significant uncertainties, which may be larger than the uncertainties of the DQ-1 retrievals. Thus the discrepancies between MPLnet and DQ1 could be entirely due to uncertainties in the MPLnet retrieval and it could be difficult to say what the accuracy of the DQ1 retrieval is. Comparisons of column AOD from AERONET, on the other hand, represent a true validation as AERONET AOD is quite accurate.

Detailed comments

Lines 49-51: What instrument was used to conduct the "observational experiments"? Was this the "airborne scaling system for ACDL" mentioned later? Please clarify. Does "multi-source data" refer to ground-based instruments? What type of instruments provided data?

Line 65: CALIPSO was "retired" in fall 2023 but not because of fuel consumption. CALIPSO science operations were terminated in August 2023 because the satellite's solar arrays could no longer generate enough electrical power to operate the CALIOP lidar.

Lines 72-74: Plans for AOS no longer include an HSRL instrument. AOS information on the vertical motion of clouds will come from Doppler radar.

Line 79: EarthCARE is anticipated to be launched in spring 2024.

Line 85: Is the "airborne scaling system for ACDL" an airborne simulator of the DQ-1 HSRL?

Line 95: "to ensure the accuracy" – HSRL retrievals should be more accurate than elastic backscatter lidars such as CALIOP and MPLNET. Intercomparisons are useful but elastic

backscatter lidars have significant retrieval errors and are not suited to validate HSRL accuracy. The comparison of DQ-1 AOD with Aeronet is more helpful.

Section 2. Instrumentation and Method

Very little has been published in English on this instrument. Additional description is necessary to understand the nature of the signals to which these retrievals are applied.

Line 118: Is the suppression of the aerosol signal only 25 dB? Using an iodine filter, the suppression of the aerosol signal can be much greater than 25 dB. Can the authors discuss?

Lines 121-122: Some discussion of the pre-processing steps is required. What is meant by "signal to noise ratio control" and what type of moving average and pulse averaging is applied?

Table 1 gives laser energy as "> 150 mJ" but the manuscript says laser pulses A and B have different energies. What is the energy of each pulse, A and B, and how they are averaged together? What is the time delay between these two 532 nm pulses? What does it mean they can be "categorized and adjusted during the retrieval process" (Line 110) The operations described in lines 125-127 are not clear. What is meant by "48 sets".

How is "measurement accuracy" in Table 1 defined? Is this the random error of the parallel channel signal or does it include calibration errors? Measurement accuracy depends on many factors, including background lighting, altitude, and averaging. Under what conditions is the measurement accuracy of 15% achieved? Is this before or after noise reduction is applied?

Important parameters are missing from Table 1. The manuscript mentions "energy differences" between CALIOP and DQ-1 several times but does not explain what the difference is. Lidar sensitivity depends on more than laser pulse energy. To gain more understanding of data quality and to better interpret intercomparisons, parameters such as receiver field of view, laser linewidth, bandwidth of the Fabry-Perot etalon, detector type (PMT, APD?, other?), detection scheme (analog or photon counting), and dynamic range of the detection system should be given. What is the view angle of the lidar - pointed at nadir or off-nadir?

Line 124 says "L2A data have been calibrated during production" How is calibration of the three signals accomplished? What is the accuracy of this calibration? What is the accuracy of the ratio of the parallel channel to molecular channel and of the volume depolarization ratio.

Line 127: The DQ-1 L2A dataset is an input to the algorithm. Explain what the L2A dataset is and what processing steps are used to produce the L2A.

Line 131: Explain how SNR is used to control data quality. Explain what kind of signal smoothing was applied to the pre-processed data. How is this different from the averaging applied as a pre-processing step?

The authors should discuss the magnitude of T_m and T_a in equation 2.3 and refer to Fig 1. From Fig 1 it looks like T_a is about 0.002 and T_m is perhaps 40-50%. Since this is a validation paper,

the authors should address how T_m and T_a vary on-orbit and whether this variation is a source of retrieval uncertainty.

Line 159: Is the extinction profile really computed from a simple derivative as described in Eq 2.9? This method is extremely sensitive to signal noise.

Line 169-171: These two sentences are not correct. In the last few years, the CALIOP laser was producing an increasing number of laser pulses with near zero energy. As explained above, science operations were terminated in August 2023 because the orbit had precessed to the east and the satellite's solar arrays could no longer generate enough electrical power to operate the lidar.

Section 3. Validation

Additional detail is needed on how CALIPSO data is used in the intercomparison with DQ-1. "Energy attenuation of the CALIPSO laser" is mentioned a number of times and pointed to as the source of various discrepancies. It is not clear what is meant by "laser energy attenuation". This term needs to be explained.

Line 207: There are no stratocumulus clouds at 15 km altitude. There are clouds at 15 km at about 15N which attenuate the lidar signal and look like dense cirrus.

Line 218: The method used to estimate SNR needs to be described in more detail. Variability of the signal due to noise must be separated from variability of the atmosphere.

Line 221: What is the "aerosol signal SNR" and how is it computed? For a backscatter lidar, the SNR of the component of the return signal due only to aerosol scattering doesn't make much sense.

Line 243-244: Please explain why the difference in depolarization is attributed to CALIPSO and not to DQ-1? What is meant by "the depolarization ratio retrieved by the laser energy attenuation in CALIPSO."

Line 245: CALIPSO lidar ratios are estimated, not retrieved, so they do not themselves provide validation of lidar ratios retrieved from DQ-1.

Line 253: Comparisons with MPLnet set a bound on the accuracy of DQ-1 retrievals but do not "ensure the accuracy of aerosol optical property retrieval using DQ-1" because DQ-1 retrievals should be more accurate than those from MPLnet.

Line 333: Please describe how the data was 'corrected for energy variations'. If the attenuated backscatter profiles are properly calibrated, further correction for energy variations should not be necessary.

Line 353 states that DQ-1 yields more reliable depolarization ratios than CALIOP. This statement needs more discussion and needs to be supported by analysis. How was it established that DQ-1 is "more reliable", does this mean more accurate?

Comments on figures

There is a problem in the way the CALIOP profile has been plotted in Fig 4e. Does "raw signal" refer to the Level 1 attenuated backscatter profiles? Inspection of CALIOP browse images shows the mean 532 nm attenuated backscatter at 20 km is roughly 1E-4 /km/sr whereas Fig 4e indicates the attenuated backscatter is already below 1E-4 /km/sr at 10 km altitude. Please explain how the CALIOP profile in Fig 4e was computed.

Figure 8 shows a significant high bias in many of the AOD retrievals from DQ1. The authors attribute this high bias to cloud contamination. Have the authors demonstrated this? Improved removal of clouds should improve the agreement or might reveal other sources of bias.

In Section 4.1 it is stated that the backscatter coefficient and volume depolarization of Sahara dust decreased during transport across the Atlantic, while the dust lidar ratio remained constant. This is difficult to tell from Figure 9. It would be helpful to add additional plots which show these trends (or lack of trend) more clearly.

What do the data curtains in Figure 10 represent? Is each curtain a single orbit (at what longitude?) on the first day of the month, or the average of several orbits (over what range of longitudes) averaged over a month of data?

Minor issues and technical corrections

Line 56: "This global information values …" should be "This global information is valuable …"

Line 64: Does Chiang et al. 2011 describe a retrieval algorithm? It looks like a validation paper.

Line 67: I don't understand what "has filtered the Mie scattering at different echoes" means. Please clarify

Line 68: "avoids" would be better than "exempts"

Line 75: the reference for Cornut et al. 2023 is missing

Equations 2.6 and 2.8 appear to be the same