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Comment on "Short-cut transport path for Asian dust directly to the Arctic: a case Study" by Huang et al. (2015) in Environ. Res. Lett.

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Abstract. The suggestion of Huang et al. (2015) on the climatological-scale transport of Asian dust to the Arctic appears to be an important and worthwhile assertion. It is unfortunate that the authors undermined, to a certain degree, the quality of that assertion by a misinterpretation of the critical 24 March 2010 Arctic event (which was chosen by the authors to illustrate their generalized, climatological-scale Arctic transport claim). They attempted to characterize that key event using AERONET/AEROCAN retrievals taken a day later and misinterpreted those largely cloud-dominated retrievals as being representative of Asian dust while apparently not recognizing that the coarse-mode aerosol optical depth retrievals on the previous day were actually coherent with their Arctic transport hypothesis.

1 Introduction

We recently came upon an interpretation in Huang et al. (2015) of Eureka AERONET/AEROCAN retrievals from the PEARL (Polar Environment Atmospheric Research Laboratory, actually Ridge Lab) instrument and from the Arctic High Spectral Resolution Lidar (AHSRL) for data acquired in March of 2010 at the high-Arctic PEARL complex. We note that the authors of this comment are the mentors of the AERONET (PEARL) instrument and long-time users of the AHSRL.

The suggestion of Huang et al. (2015) on the climatological-scale transport of Asian dust to the Arctic over a multi-year period appears to be an important and worthwhile assertion. It is unfortunate that they undermined the quality of that assertion by a misinterpretation of the critical 24 March 2010 Arctic event (which was chosen by the authors to illustrate their generalized, multi-year Arctic transport claim). They attempted to characterize that key event using AERONET/AEROCAN retrievals taken a day later and misinterpreted those retrievals while apparently not recognizing that the optically weak plume and the coarse-mode aerosol optical depth (AOD) retrievals observed on the previous day were actually coherent with their HYSPLIT Arctic transport evidence.

2 Dust and cloud events of 24 and 25 March 2010

We maintain that the event on the second day (25 March 2010) consisted of a complex but weak coarse-mode AOD plume structure which was dominated by what was very likely a cloud intrusion after ∼ 18:30 UT (cf. the neighbourhood of the 25 March dashed vertical line in Fig. 1). We can fairly confidently declare a cloud intrusion because of (i) the corresponding high AHSRL depolarization ratio seen in Fig. 1 and (ii) the strong variation of the coarse-mode AOD which is much more typical of spatially inhomogeneous (high-frequency) cloud than the low-frequency variation due to dust transported over large distances (see O'Neill et al., 2016, for a similar interpretation of spatially inhomogeneous and homogeneous clouds

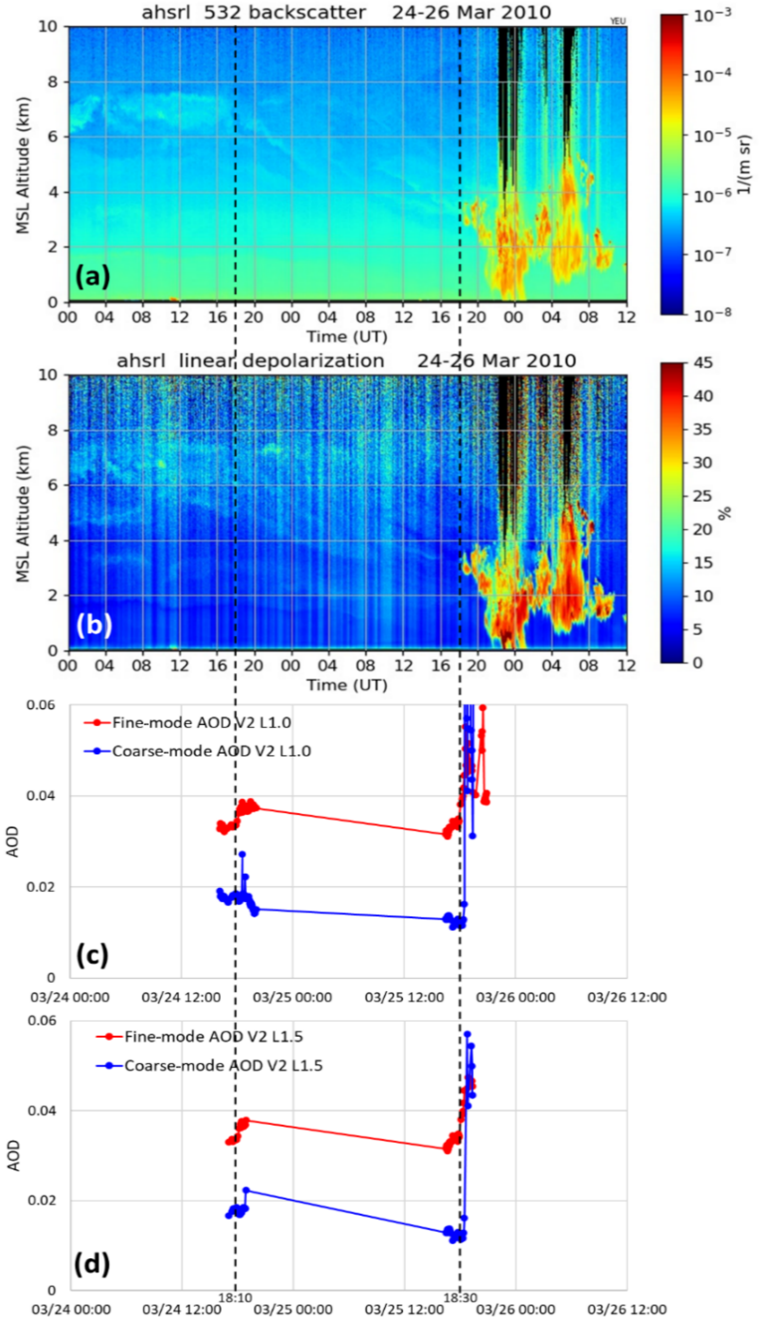

Figure 1. **(a)** AHSRL backscatter coefficient (β) profile. **(b)** AHSRL linear depolarization (δ) profile. **(c)** Level-1.0 (non-cloud-screened) fine-mode and coarse-mode AODs. **(d)** Level-1.5 (cloud-screened) fine-mode and coarse-mode AODs (a standard AERONET product). All times are UT. The 24 March, 18:10 dashed vertical line indicates the beginning of the decrease in thickness of the coarse-mode plume seen in the weak β profile and the moderate δ profile with an attendant weak decrease in the coarse-mode AOD (decrease $\sim$ 0.005 from approximately 0.02 to 0.015 for the Version 2 Level-1.0 coarse-mode AOD retrievals). The same decrease (but for different individual magnitudes of $\sim$ 0.01 to 0.005) are obtained using Version 3 Level-1.0 retrievals (which were unavailable when the authors wrote their paper). The 25 March, 18:30 dashed vertical line indicates the beginning of the rapid increase in the coarse-mode AOD due to what is very likely cloud associated with the sharp increases in the β and δ profiles (cloud presence is typically associated with high-frequency (rapid) coarse-mode AOD increases). It should be emphasized that the V2 Level-1.5 (cloud-screened) retrievals did not succeed in eliminating certain high-frequency coarse-mode AOD variations near the rapid rise at 18:30. V3 Level-1.5 retrievals did eliminate the coarse-mode AOD in the region of that rapid rise (but failed to eliminate some thinner cloud of relatively low coarse-mode AOD a few hours later).

and/or low-altitude crystals over the nearby 0PAL site). The coarse-mode AOD is a standard AERONET product which was available to Huang et al. It is an output of the Spectral Deconvolution Algorithm (SDA) of O'Neill et al. (2003): an illustrative comparison of coarse-mode and fine-mode AODs acquired at PEARL with analogous AHSRL-derived AODs can be found, for example, in Saha et al. (2010).

The criticism of confusing dust and clouds is not unrelated to the fact that the authors neglected to consider potential problems associated with the quality of the cloud screening algorithm. Their utilization of a significant 25 March drop in the value of the Angström exponent (AE) as an essentially qualitative indicator of the presence of coarse-mode dust (an argument made in reference to their Fig. 3) severely overestimated the optical depth of Asian dust (they also neglected to exploit the benefit provided by an analysis of the corresponding AHSRL profile).

They should have limited their analysis to the 24 March, HYSPLIT-synchronized time period when the coarse-mode AOD decreases slightly by ~ 0.005 for Version 2 Level-1.0 coarse-mode AOD retrievals ("decreases slightly" to the value characteristic of the thinner descending plume beyond the stronger and broader 7 km backscatter plume noted by the authors; see Fig. 1 for details). The backscatter coefficient profile of their Fig. 2d (supported by their HYSPLIT-generated transport pathway of Fig. 2i) suggests a dust plume arriving at Eureka on 24 August at an altitude close to the 7 km altitude of the AHSRL plume in Fig. 1 (a higher spatial- and colour-resolution version of their Fig. 2d profile): that 7 km plume is typical of the optically weak dust plumes observed over Eureka. The weak (~ 0.005) decrease in coarse-mode AOD is the type of springtime variation that one expects for Asian dust (AboEl-Fetouh et al., 2020), not the 25 March, cloud-enhanced increase of ~ 0.05 (i.e. ~ 10 times the 24 March decrease).

This lack of optical coherence at the event level undermines their climatological-scale claims of a preferred transport pathway of Asian dust into the Arctic. Their "probability-density-function (PDF)" computations of a preferred pathway to the Arctic are ostensibly convincing from a meteorological standpoint: however, the rigour of such affirmations can be called into question if their chosen illustrations of dust events are suspect (if the synchronicity of coarse-mode AOD and lidar profile variations is not investigated in detail and if the impact of potential cloud-screening problems is not properly examined).

Code availability. Processing codes are available upon request.

Data availability. AERONET data are available at https://aeronet.gsfc.nasa.gov/ (NASA, 2022). AHSRL data and profiles are available at http://hsrl.ssec.wisc.edu/ (University of Wisconsin Lidar Group, 2022).

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