

General comments

The authors attempted to establish one or more threshold for distinguishing polluted dust from pure dust using their optical properties (i.e., total attenuated backscattering coefficient, depolarization ratio and color ratio) measured by a ground-based Lidar. They concluded that depolarization ratio threshold of 0.2 could be used to differentiate the polluted and pure dust. The authors presented a good literature review. However, the study does not give much new insight into the study topic. Generally, the manuscript was poorly written and exhibits some mistakes, which largely hampers its readability. Numerous adjoining sentences are repeated (see the specific comments). Moreover, I have some major concerns with the methods and explanations in the manuscript.

1. The ‘anthropogenic dust’ is defined in a confusing way.
The definition of the anthropogenic dust in the literatures (Tegen and Fung, 1995; Huang et al., 2015) is clear, that is the dust produced by human activities on disturbed soils. I cannot understand why the authors proposed a new definition for it (Lines 94-95). It seems that the anthropogenic dust in the manuscript means the dust (taking no account of its source) mixed with pollutants. Why not simplify it to “polluted dust”?
2. Can the subtype of dust aerosols be identified using the surface weather record and boundary layer height? I doubt.
Firstly, the PBL height derived from the Lidar may be in low accuracy during the dusty days owing to the impact of the dust layer.
Secondly, the PBL height shown in Figs.3 and 5 doesn’t have a diurnal variation, why?
Thirdly, according to figure.6, the authors claimed that the dust aerosols detected at SACOL originate from the Mongolia (Lines 292-293). Noting that the air parcels passed through Mongolia at an altitude of much more than 4500m, thus the dust is unlikely to originate from the Mongolia.
Fourthly, still according to figure.6, the authors concluded that the dust is mixed with anthropogenic pollution when passing through Baotou and Yulin city. Again, the air parcels passed through Baotou and Yulin at an altitude of more than 4500m, the dust is unlikely to be mixed with anthropogenic pollution.
Moreover, the dust may enter the atmosphere when the air parcels were in contact with the surface (starting at 00:00 UTC, 31 Mar 2010 in Fig.4, and 00:00 UTC, 30 Jul 2010 in Fig.6) or even prior to the start date of the back-trajectory simulations, doesn’t it? The results will be more reliable if both the pathway and the altitude of the air parcels were considered.
3. When was the first dust case detected? On 19 October 2009 (see line 253) or 31 March 2010 (see line 743)?

4. According to the manuscript, there were two types of pure dust: a) dust layer within the PBL and recorded by the weather stations; b) dust layer above the PBL and not recorded by the weather stations. It seems that the later one is more likely to be “pure dust”, is there any different between their optical properties?
5. With regard to Figs. 1 and 2, the discussions in the main text did not match the plots. Actually, the Fig.2 rather than Fig.1 shows the structure of the Lidar. The Fig. 1 was not discussed in the main text.
6. Color ratio is an indicator for particle size. A large value represents big particle and a small value represents small particle. Generally speaking, anthropogenic aerosols are mainly composed of fine mode particles, why it has a large color ratio (see line 219)?

Specific comments

1. Check the order of the subtitle of Fig 9. The right panel should be the results of pure dust.
2. Mistake in lines 309-310: ‘From the results above we can see the depolarization of pure dust is larger than that of anthropogenic dust which means the pure dust is more sphere.’
‘the pure dust is more sphere’ should be ‘the anthropogenic dust is more sphere’
3. Mistake in lines 426-427: ‘The mean value of pure dust is larger than that of anthropogenic dust, which means that the pure dust is more a spherical’
‘the pure dust is more a spherical’ should be ‘the anthropogenic dust’.
4. Lines 103-104: remove ‘mixed with the anthropogenic dust’.
5. Lines 143-147: there is no essential difference between ‘the environment of the mountain top is almost natural, and is rarely affected by human activity’ and ‘building at the top of the mountain, the influence of houses and human activity is escaped’, delete the later one.
6. Line 359, change ‘found’ to ‘used’.
7. Line 474-477, duplicate sentence. Remove ‘Results showed that the backscattering depolarization ratio was smaller for all particle sizes in polluted dust.’