Review on a manuscript by Radhi et al. entitled "Optical, physical and chemical characteristics of Australian desert dust aerosols: results from a field experiment"

This manuscript reports new data on size-resolved chemical and ionic composition of four dust aerosol samples that were collected in November 2006 at a desert site Birdsville in SW Queensland, Australia. A 12 stage MOUDI impactor was used for sample collection. Subsequently, the MOUDI substrates were analyzed for chemical composition using the PIXE and PIGE techniques and for soluble ions using ion chromatography. These new data will be of interest to the broad scientific community working in the field of mineral dust aerosol. Below I provide some specific suggestions to help to improve this part.

The second part of the manuscript presents an analysis of three-year data from the AERONET site, which is also located in Birdsville. The analysis includes aerosol optical depth (AOD), Angstrom exponent, and size distribution. This part mainly focuses on the mixture of aerosol types occurring at the observational site and their seasonal variability with not much connection (if any) to the dust composition part. The only direct linkage I see is through comparison of size distributions retrieved from AERONET and measured at the surface with the MOUDI impactor. However, actual comparison (Fig.7c) is done for a single case (for one 24-hour sample collected on Nov.1). Furthermore, four reported MOUDI size distributions show various differences among themselves as well as differ from the AERONET size distribution. It is unclear why the authors "*consider the agreement to be excellent*…" (see p.25095:lines 15-16). I also found the statements on the dominance of dust coarse mode fraction somewhat confusing (see Abstract, Sections 4 and 7). Table 2 clearly shows that for all four samples PM2.5/PM10 is larger than 50% (57%-65%), implying the strong presence of fine size mode in dust-laden conditions. This also seems to be in disagreement with the AERONET size distribution presented in Fig.7c.

Because of seemingly little connection between AERONET data analysis and dust composition data, it seems like these two parts belong to two different manuscripts, unless the author will find a better way to present these results in a more unified fashion, addressing the existing inconsistencies and conflicting statements mentioned above.

Some specific comments:

1) P.25086: The Abstract does not summarize well the results presented in the manuscript, especially on chemical composition.

"The aerosol optical depth data showed a weak seasonal cycle… The Angstrom coefficient showed a stronger cycle, indicating the influence of the winter-spring burning season in Australia's north"

Both AOD (Fig.2) and Angstrom parameter (Fig.3) show some seasonal cycles. It is unclear why one is considered to be weak while another is deemed to be strong. Another concern is that reported AOD are very low which might introduce some biases in AERONET retrieved properties.

"Size distribution inversions showed a bimodal character, with the coarse mode assumed to be mineral dust, and the fine mode a mixture of biomass burning and marine biogenic material"

All AERONET size distributions are bimodal because the AERONET retrieval algorithms assume the presence of two size modes. This is in conflict with Table 2 results and with the statement (line 24, p.25094) "…*The mass size distribution during this period was multi-modal, but without a definable structure…"*

(Also see my comments on fine/coarse dust modes above).

2). Introduction describes well the importance of mineral dust, in general, but does not provide any information on past studies of mineral dust conducted in Australia. A brief review of studies related to the subject of the manuscript will be very helpful, especially past studies on chemical and mineralogical composition of Australian dust. At least some comparison to dust in other important regions will be of interest also.

3).Section 2.3: pp.25089-25090: It is unclear from the text whether or not aerodynamics diameters in MOUDI data were corrected for density and particle nonsphericity. This correction is required in the case of mineral dust.

Lines15-20: The dust samples were suspended in the water solution. This might affect the measurements of soluble ions. Addressing this issue will be helpful to better understanding the results.

Assessments of errors in presented data on chemical and ionic composition are needed (e.g., in Tables 3 and 4, Fig.8, 11).

4) p.25094: I would suggest adding a new column in Table 1 to briefly summarize environmental/atmospheric conditions specific to each sample.

5) pp.25094-25095: See my comments above on the MOUDI and AERONET size distributions. Additional comment is that the MOUDI size distribution has different sources of errors that need to be addressed in comparing to the AERONET.

6) Analysis of soluble ions. Section 6.2 states that high percentage of Ca2+ was nssCa2+, implying that it comes from dust. But in Section 7 the authors state that mineral dust Ca is presumed to be non-soluble. This needs further clarification. More general discussion on the nature of soluble species occurring in dust is also needed.

7) Formation on nitrates on dust particles (section 6.3). There is no evidence that nitrates were formed through reactions on dust particles collected during the field experiment. I would suggest that the relevant text be revised to show clearly that this is a hypothesis and not a finding.

8) There were no biomass burning events during the collection of dust samples. Nevertheless, section 6.4 states that K+ "…*has contribution from a number of sources, including biomass burning, crustal and sea spray*". This discussion of the sources on K+ will need to be corrected, and the nature of K+ in crustal material will need to be addressed.

9) Authors might want to re-consider the title since the majority of presented results (especially AERONET data) are relevant to the Australian continental aerosols containing not only dust but also biomass burning and biogenic and marine aerosols.