Response to Referee #3

We are very appreciative of the reviewer's thorough review of the paper. The suggestions and comments are very helpful for improving the paper. Our point-by-point responses are as follows:

General comments

This paper describes aerosol radiative properties and their relation with radiation budget in an arid area, Lanzhou, China. Radiative properties of aerosol were retrieved from measurements of direct and scattered solar radiation at several wavelengths by using sky-radiometer. The original data are valuable and analyzed results in this paper are considered to be reliable. However, the contents of this paper are just the description of observation and data analysis. Comparison and discussion with similar studies are needed for a scientific paper in academic journals. The similar studies had already been carried out in the past, for example, Aeolian Dust Experiment on Climate Impact (ADEC, Mikami et al., 2006). As part of ADEC, skyradiometer measurements were carried out in the desert area of China, and radiative properties were retrieved (Uchiyama et al., 2005). Evaluation of effects of dust aerosol on the radiation budget was also carried out by Shi et al. (2005). Simulations of the aerosol direct effect have been carried out for the past decades (e.g., IPCC, 2007). In this paper, just two days (21 March and 8 April) are selected as dusting days, so that it is too rough to discuss and conclude the radiative effect of dust aerosols. The author should refer to the past studies related to this topic and should clearly indicate the originality and new findings of this paper.

Response:

By following reviewer's suggestion, we have referenced all the above-mentioned papers. For comparing with the previous studies, this paper is first time to show the sky-radiometer measurements over Loess Plateau. These results should be interest to the communities of climate and aerosol since Loess Plateau being a special semi-arid land surface, part of dust aerosol source region and close to the desert

Specific comments

1. Page 23887, line 1: “the annual mean evaporation is about 1528.5mm (Huang et al., 2008b).” 1528.5mm is too large. Please check this evaporation value.

Response:

We checked again from Huang et al., 2008b and other reference, the annual mean evaporation is about 1528.5 mm at SACOL. However, the annual precipitation at SACOL is only about 300 mm, the situation of evaporation and precipitation makes the regional climate semi-arid climate.

2. Page 23887, line 15: “Improved Langley plot method” should be described; at least some references should be shown.

Response：

By following reviewer’s suggestion, the reference has been added.

3. Page 23887, line 28: “the Raleigh scattering” > “the Rayleigh scattering”

Response：

By following reviewer’s suggestion, “the Raleigh scattering” was changed to “the Rayleigh scattering”.

4. Page 23888, lines 25-26: Why only two days (21 March and 8 April) are selected to be dust days? Large AOD is found on the other days, for example, 28 and 30 March, so the author should describe the reason why these two days are dusting days with weather report, Angstrom exponent or aerosol size distribution. The criterion of background aerosol should also be indicated as well as dust aerosol.

Response:

We do select dust cases by combining with meteorological report and Angstrom wavelength exponent. According to meteorological report, 21 March was a strong dust day and 8 April was a floating dust day. Combing Angstrom wavelength exponent analysis, we found the dust days are 19 March, 21 March, 23 March, 25

March, 29 March, 31 March, and 8 April. During these days, almost all the Angstrom exponents are less than 0.5. The daily mean values of Angstrom exponent on 19 March, 21 March, 23 March, 25 March, 29 March, 31 March, and 8 April are 0.47, 0.10, 0.32, 0.25, 0.40, 0.27, and 0.56 respectively.

5. Page 23890, line 7: "SBDART model" should be described; at least some references should be shown.

Response:

By following reviewer's suggestion, the reference was added. According to the average humidity profile derived from microwave radiometer, we choose atmospheric profile as sub-arctic winter atmosphere (water vapor is 0.418 g/cm2) in SBDART model simulation. Additionally, we choose LOWTRAN_7 solar spectrum and set spectral variation of aerosol optical properties from 0.305 to 2.8.

6. Page 23890, lines 10-12: How is the surface albedo derived from pyranometer measurement? Diffuse radiation data are used?

Response:

We mainly considered the ability of the surface to reflect shortwave radiation and ignored the contribution of the longwave radiation to surface albedo. We calculate albedo by using the downward and upward shortwave radiation data from pyranometer. If $SW^{\downarrow}$ and $SW^{\uparrow}$ are downward and upward shortwave radiation, respectively, we can calculated the albedo (α) as follows:

$$\alpha = SW^{\uparrow} / SW^{\downarrow}$$

During the recalculation at 0.78 atm, we adjusted surface albedo to 0.2 for MAM.

7. Page 23890, lines 18-19: SSA value retrieved from diffuse flux is coupled with surface albedo. As mentioned above, surface albedo appears to be determined by using pyranometer measurement, and it is a constant value 0.25 independent of wavelength. How do you think about the effect of surface albedo uncertainty on the SSA retrieval?

Response: According to the result of Uchiyama et al. (2005), we considered that the effect of surface albedo error on the aerosol optical property is small and assumed surface albedo to be a constant for all wavelengths.

8. Page 23890, line 21 and Figure 4: vertical axis of Figure 4 should be shown as difference among “Observed”, “Result1”, and “Result2”.

Response: In this figure, we have not shown the difference between “Observed”, “Result1”, and “Result2” and but compared them each other, the title of this figure has been changed to: Comparison of observed and calculated broadband (a) total, (b) direct and (c) diffuse radiative flux at the surface on a clean sky (7 April 2009).

9. Page 23891, lines 12_15: Since the sky-radiometer can derive aerosol size distribution, it is better to discuss SSA and ASY with aerosol size distribution.

Response: The averaged ASY during dust period is much larger than that of background aerosols, which is reflected by large coarse and large fine mode volume in size distribution during dust day and background aerosols, respectively.

10. Page 23892, ARF: How did you treat the spectral properties of aerosols and surface albedo? These properties are quite important to integrate the wavelength range of solar radiation. At least the author should mention on this matter.

Response: We considered the effect of surface albedo error on the aerosol optical property is small and set surface albedo as constant for all wavelengths.

11. Page 23893, line 18 and Figure 9: Figure 8 covers Figure 9 and the contents of Table 3 covers Figure 9, so that Figure 9 is not necessary.

Response: Figure 9 was deleted.

12. Page 23894, line 20: In the acknowledgements, a name Pradeep Khatri is shown, but he is one of co-authors.

Response: Acknowledgements were modified.