Atmos. Chem. Phys. Discuss., 9, S1399–S1403, 2009
www.atmos-chem-phys-discuss.net/9/S1399/2009/

Atmospheric Chemistry and Physics Discussions

ACPD

9, S1399–S1403, 2009

Interactive Comment

Interactive comment on "Taklimakan dust aerosol radiative heating derived from CALIPSO observations using the Fu-Liou radiation model with CERES constraints" *by* J. Huang et al.

J. Huang et al.

Received and published: 12 April 2009

We are very appreciative of the reviewer's thorough review of the paper. The comments and suggestions are very helpful in improving the paper. We have addressed the raised issues and considered their valuable suggestion/comments in the revisions. The following are our point-by-point responses.

1. Introduction: The manuscript misses a review of previous studies that have used radiative transfer models and CALIPSO/CERES observations to estimate aerosol forcing. Is this a new approach or a previously used approach?

Response: To our knowledge this approach is new. However, we have added references to recently published papers that study aerosol forcing by using either satellite data or radiative transfer models.

2. How accurate are the extinction coefficients of dust obtained from CALIPSO? This manuscript should either evaluate CALIPSO data in this work or cite previously studies that has done the evaluation.

Response: We evaluated the uncertainty of the dust aerosol extinction coefficients obtained from CALIPSO from the sensitivity test (see Page 15) which is mainly related to the assumed lidar ratio. The sensitivity test showed that the lidar ratio uncertainty of ś20% can lead to uncertainties of about ś6.8, ś7.6, ś14.4 Wm-2 in the net dust radiative forcing at the TOA, in the atmosphere, and at the surface, respectively (see Table 3).

3. In the calculation of radiative effects of dust, extinction coefficients were from CALIPSO, but single scattering albedo and asymmetry factor were from the work of Hess et al. [1998]. I think using parameters from Hess et al. is the weak part of this work. Why not calculating these two parameters based on measurements (e.g.,aerosol size from satellite or other method, if available)?

Response: The reviewer’s suggestion is good. However, there are no surface measurements covering the Taklimakan which can be used to estimate single scattering albedo and asymmetry factor. It is also very difficult to derive these two parameters from satellite measurements (there is no such product from existing satellite retrievals). This is the reason that we selected dust aerosol single-scattering albedo and asymmetry factors used over Taklimakan region from comparison of CERES TOA solar fluxes with Fu-Liou model simulations along with the CALIPSO.

4. Second paragraph of Page 5975: Dust aerosol single-scattering albedo and asymmetry factor used over Taklimakan region were determined by comparing the CERES TOA solar fluxes with Fu-Liou model simulations along the CALIPSO orbit, using 4 different dust aerosol types Hess et al. (1998). The authors found that the dust aerosol type that fits best is the transported mode. I have two concerns about this treatment: (1) The manuscript evaluated TOA radiative fluxes from the model by comparing them

ACPD

9, S1399–S1403, 2009

with CERES measurements. Based on this comparison, the authors claimed that the radiative transfer model constrained with the CERES observations can be used to reliably determine the variation of dust aerosol radiative heating rate with the input of vertical distributions of dust aerosols from CALIPSO measurements;. I think it is too early to draw such a conclusion. The evaluation of model should also be done for the atmosphere without dust (for example, for several days before the dust event), because the concentrations of absorbing gases, vertical profiles of meteorological variables, and assumptions of surface albedo can all influence TOA fluxes. The model is ready to estimate dust forcing and heating rate only when fluxes simulated both with and without dust have been evaluated. (2) Single scattering albedo and asymmetry factor of transported mode of dust were picked out and used in all the simulations. Because all four modes of dust coexist in the atmosphere in reality, how does this assumption influence your model results? Can you justify that contributions from other modes of dust are small?

Response: The reviewer has a good point in (1). It should be noted that the surface albedo we used was from the CERES standard product that was derived from CERES reflected solar radiation observations combined with the Fu-Liou radiation model in the clear sky conditions over the same region. Also, consistent with the CERES product, we used the atmospheric profiles such as temperature and H2O from the reanalysis and O3 from SMOBA although our calculations showed that the simulated reflected solar fluxes are not sensitive to the uncertainty of these profiles at all as expected. Thus by using the CERES-derived surface albedo, the Fu-Liou model is already evaluated under the condition without aerosols. Related to the reviewer's second point, the transported mode is a combination of other three modes but with more weighting in accumulation mode. Finally we have shown in the paper the impact of the uncertainties in the CERES-derived surface albedo and single scattering properties associated with the dust aerosol transported mode on the radiative forcings.

5. Table 2 shows that LW forcing values are positive at TOA, surface, and in the atmo-

ACPD

9, S1399–S1403, 2009

sphere. Explain in the text why LW heating rates show cooling in Figure 8?

Response: Although dust aerosols appear to have less effect on LW radiative heating rates, they do show a warming effect below the dust layers and cooling near the top of the layers. However, for the whole atmospheric column averaged LW radiative heating rates are positive (see Table 2b). A similar example is the cirrus radiative forcing in the LW which are positive in the atmosphere and surface. But if the cirrus is thick enough, there exists cooling at the cloud top.

6. Figure 1 is not necessary; Remove it. Just need to describe the dust event in the text.

Response: We have removed Figure 1 as suggested.

7. Surface albedo used in this work should be given explicitly in the manuscript.

Response: We have given the averaged albedo over the Taklimakan region used in this study.

8. Section 6: Describe clearly how uncertainties in forcing values were calculated.

Response: We have clarified the uncertainties in forcing values in the revised version.

9. It is stated in the conclusion section that However, our results suggest that the single scattering albedo of Taklimakan dust aerosols is about 0.89 at 0.67 μm which is about 6% less than Saharan dust;. What results showed that single scattering albedo of 0.89 is reasonable for Taklimakan dust?

Response: In the transported mode, the single scattering albedo is of about 0.89 at 0.67 um, best fits the comparison between Fu-Liou model simulated TOA flux and CERES TOA flux. So, we selected this mode and think it is reasonable.

10. Finally, heating rates or forcing values obtained in this work should be compared with previous estimates for dust events. Do the values from this work agree with those from previous studies or does this work have new findings?

ACPD

9, S1399–S1403, 2009

Interactive Comment

Response: We would like to compare our results with the previous studies. Although dust aerosol heating or forcing is an old topic, we find very few references documenting Taklimakan dust aerosol heating or forcing, especially for summer months.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 5967, 2009.

ACPD

9, S1399–S1403, 2009