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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Improved estimate of global dust radiative forcing using a coupled chemical transport-radiative transfer model" *by* L. Zhang et al.

Anonymous Referee #2

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General comments: This study addresses the uncertainty in model-predicted estimates of dust radiative forcing due to uncertainties in the vertical distribution of Saharan and Asian mineral dust. Dust transport, direct radiative forcing, and heating rates are computed for the period April 2006 with the global chemistry-transport model GEOS-Chem. In a sensitivity study, the changes in irradiances due to the presence of dust particles are calculated once with the modeled vertical structure of dust and once with a light extinction profile, which is derived from the dust optical depth using an exponential weighting function. The latter is an approach that is widely found in models using aerosol climatologies to include the average effect of aerosol particles on radiation.

The interesting but predictable results of this study show what climate researchers have been aware for long that the radiative forcing of dust is highly sensitive to its vertical profile, and that the climatological and the actual (modeled) dust distribution can differ dramatically. Most of the current general circulation models with an online computation of radiative effects of mineral dust and other aerosol types use the modeled horizontal AND vertical aerosol distribution.

In this regard, the title of the study is somehow misleading, as there is no general improvement in the estimate of the global direct radiative forcing of mineral dust. Also, the duration of the study period is too short to satisfy that demand. In addition, at least some comparisons to observations, e.g., from the European and Asian lidar networks, and from the CALIPSO satellite, should be presented, in order to evaluate the modeled dust distribution.

There is a general issue with the usage of the term “Aerosol Optical Depth (AOD)”, which is commonly defined as the vertically integrated extinction coefficient over a vertical column of unit cross section. Ignoring the fact that the AOD is a column integral, the authors speak of the vertical distribution or structure of the dust AOD. Here, “vertically-resolved AOD per grid level” or “vertical profile of extinction (coefficient)” should be used instead.

Specific comments: Introduction, Page 2419, Line 3-4: Sections 5 and 6 are missing in the outline of the paper structure.

Section 3, Page 2423/2424: The meteorological mechanisms, which cause dust emission, transport, and the formation of characteristic dust layers in the specific regions are not described thoroughly enough. A detailed description should include fundamental structures and terminology (e.g., the Saharan Air Layer for Africa).

Section 6: The Summary and Conclusion section ends abruptly and lacks of some outlook and implications that the results have.

Figures, In all line plots and cross sections, the axis and/or color bar labels are missing.

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