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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Dust Radiative Effects on Atmospheric Thermodynamics and Tropical Cyclogenesis over the Atlantic Ocean Using WRF/Chem Coupled with an AOD Data Assimilation System" *by* Dan Chen et al.

Anonymous Referee #1

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This paper discusses the direct radiative effects of dust on atmospheric thermodynamics and tropical cyclogenesis during a Saharan dust outbreak in the summer 2006 in two different regions over the Atlantic Ocean in a modeling study using the WRF/Chem model coupled with a data assimilation system of aerosol optical depth. This study is interesting and novel in design. It addresses an important question of how dust interacts with tropical cyclones because that is still a matter of debate. Dust is one factor that is not taken into account in the seasonal TC forecasts and on hindsight has been made responsible for the rather inactive 2006 Atlantic TC season. The topic of the paper is appropriate for ACP.

The authors first analyzed all 4-day forecasts from Jul 8 to Sept 18, 2006 once with the radiative effects of dust switched on and once switched off. More specifically they looked at the hourly results of simulated dust in the eastern vs. western main cyclogenesis region (MCR) and further divided the simulated results into elevated dust and deep-layer dusts. They find that deep-layer dust that is located at low altitudes inhibits convection because it increases convective inhibition through radiative heating of dust immediately above the boundary layer. They found the opposite for elevated dust. I am not sure that I agree with their findings because the paper is rather cumbersome to read. The results between the radiative effects of dust on (RE_ON) and dust off (RE_OFF) are rather ambiguous, sometimes not supported or poorly explained and some of their results may be overinterpreted. Instead of just showing time series of the differences between RE_ON and RE_OFF, a statistical analysis would be needed in order to convince the readers that their results are statistically significant and not within the noise. If this aspect and the detailed comments listed below are addressed, I recommend the paper for publication in ACP.

Detailed comments:

p.2, l. 24/25: The sentence seems wrong, what is meant by "as in semi-direct effect", as consistent with the semi-direct effect?

p.3, l.29: radiatively active

p.6, l. 6: why didn't you also diagnose AOD at 483.5 nm from the model?

p.7, l. 13: how did you come up with the definition of "deep layer of dust".? Is there a reference or justification for this? If this definition of dust gives you only 8.5-10.7% of the cases, and the rest of the cases are elevated dust, then you have 10 times as many cases of elevated dust. That doesn't seem to be appropriate. Or maybe you need to specify better what you mean by total sampling ratios.

p.7, l. 33: I disagree, the positive RH anomaly goes along with a negative T anomaly

just above the PBL, not a positive one. Higher up both anomalies have the same sign, how do you explain that?

p.7, l.36: I disagree: how can there be reduced radiation below the dust layer if the SW radiation anomalies are positive?

p.8, l. 1: How would ice clouds play a role? Explain.

p.8, l.9: Why is the warming of the dust stronger if elevated? Explain.

p.8, l.30: There is no decrease in the net heating rate below 900 hPa at least no significant one. If you refer to the LW heating that seems to be too small to matter. Please correct.

p.8, l.31: Why do ice clouds change? Explain.

p.8, l.36: What about changes in adiabatic expansion and cooling? If you show heating rates, it would be great if you looked at all the contributions, i.e. add heating rates from phase changes, vertical diffusion and advection in order to understand your results.

p.9, l.8/9: No statistics are presented, just differences of time series. For statistics it would be necessary that you calculated the significance of the changes in RE_ON - RE_OFF as compared to natural variability or something like this.

p.9, l.30: ...air is relatively dry.... For what?

p.9, l.32: decreases

p.11, line 2: Figure 13d is so patchy that I don't agree that there is a significant warming effect at cloud top. That is not convincing.

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