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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "The sensitivity of global climate to the episodicity of fire aerosol emissions" *by* S. K. Clark et al.

Anonymous Referee #3

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Review of "The sensitivity of global climate to the episodicity of fire aerosol emissions," by Clark et al.

This paper addresses the question about the use of monthly mean fire emissions in studies investigating the effects of biomass burning aerosols on climate. Fires tend to be episodic. By implementing a steady, slowly varying source of primary aerosols from fires, climate models may not properly capture the nonlinear interactions between aerosols and clouds that occur in the real world. The authors therefore want to test the application of more episodic emissions, and examine the consequences for radiative forcing and climate. They apply 4 kinds of emissions, all with the same 5-year total emissions: daily, once-per-month, once-per-year, and once-in-5-years. Daily emissions are the default in many climate models, calculated by distributing the monthly

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Interactive Discussion

Discussion Paper

mean emissions into smoothly varying, daily increments. The authors find that application of daily biomass burning emissions may overestimate the net cooling effect of fire aerosols by about 1 Wm-2.

Main criticisms. 1. The paper does not go far enough to examine the model mechanisms that change when varying the episodicity of biomass burning emissions. For example, what explains the spatial pattern of the difference in the aerosol indirect effect when comparing the daily and the once-per-month cases (Figure 4)? What exactly causes the southward shift in the Intertropical Convergence Zone (ITCZ) in the monthly case? See detailed comments for pages 9-11.

2. The utility of two of the simulations is not clear. These are the simulations with the once-per-year fires and those with the once-in-5-years fires. Are these pulses realistic? Why is it instructive to examine such clearly unrealistic scenarios? This reader is puzzled.

3. Eight-day average emissions from GFED have been available at least since 2010. A daily GFED emission inventory has also been derived using observations of active fires from the Geostationary Operational Environmental Satellite (GOES; Mu et al., 2011). It would have been useful to the community to test these emissions.

Detailed criticisms. Page 2. Run-on sentence: "In the long term, we find that an increase . . ." Please be more clear about the net forcing effect of applying daily fire emissions. It appears the authors wish to say that applying daily emissions may overestimate the net cooling effects of biomass burning aerosols by ~1 Wm-2. If this is correct, please say so. Be more quantitative about results regarding change in ITCZ and precipitation rates.

Page 3. Provide more examples of climate studies calculating the radiative forcing from fires. Please supply more quantitative information about the observed episodicity of fires. Is there a spatial dependence to the episodicity? Be more quantitative in describing the Chen results.

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Page 7. State location of gridbox in Central Africa for which the emissions are shown in Figure 1.

Page 8. There is no reference to Figure 3. Also please provide a table of net forcing for the 4 cases.

Page 9. Provide global mean annually averaged cloud droplet number, not just the percent difference between two cases. Typo: “diminises” Explain why the monthly case results in large reductions in the indirect effects off the west coasts of South America and Central Africa and over Siberia.

Page 10. Please diagnose the model response to the indirect effect in the monthly case. Also provide more information about previous studies looking at the climate effects of the vertical structure of clouds and black carbon. What are the uncertainties of this effect? See Koch and Del Genio (2010) and later papers. Does Figure 5 show the same information as Figure 4 but this time as differences between the daily case and the other cases? Please convince the reader that the largest differences in the aerosol indirect effect occur where “substantial fire emissions and sensitive cloud regimes coincide.” Consider plotting the zonally averaged fire emissions or cloud sensitivity. In any event, how exactly is cloud sensitivity defined? Why are the clouds in some regions more sensitive than others?

Page 11. What exactly causes the southward shift of the ITCZ in the monthly case? What is the time period of the observed precipitation rates of Xie and Arkin (1997)? The reader assumes that these rates are from the 1990s, but the GFED emissions are from 1997 to 2006. Why not compare precipitation rates during years contemporary with the GFED emissions? How is improvement defined? What does a negative percent improvement mean? What explains the pattern of “improvement” seen in Figure 9?

Tables. Please define acronyms in footnote or caption to the tables.

Table 2. The usual practice is to put statistically significant results in bold. Please

provide units for lifetime.

Figures. For the difference plots, please make clear in the captions what difference is being shown.

Figure 1. Say where the gridbox is.

Figure 2. “In each case” should be “in all cases.”

Figure 5. Over what time period are the forcings calculated?

Figure 6. Consider making multi-panel plots – e.g., combine Figures 5 and 6.

Figure 7. What do white areas signify?

Figure 8. Explain both in the caption and the text what percent improvement means and what years of observations were examined.

References.

Koch, D., and A.D. Del Genio (2010), Black carbon semi-direct effects on cloud cover: review and synthesis, Atmos. Chem. Phys., 10, 7685–7696. Mu, M., et al. (2011), Daily and 3-hourly variability in global fire emissions and consequences for atmospheric model predictions of carbon monoxide, J. Geophys. Res., 116, D24303, doi:10.1029/2011JD016245.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 23691, 2013.

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