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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Sensitivity of atmospheric aerosol scavenging to precipitation intensity and frequency in the context of global climate change" *by* Pei Hou et al.

Anonymous Referee #2

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This is a potentially interesting paper on changes in wet deposition due to precipitation intensity and amount changes. However, there are several issues that need to be addressed before the paper can be accepted: 1. The methods is not complete, and more details on the experiments and a better descirption of the cases (in a table) need to completed. More details below. 2. The trend in the precipitation using either the TRIMM or the reanalyses is unlikely to be robust or good enough for this analysis. The Renalysis are well know to have trouble with the moisture budget, while the TRIMM time series is too short.

I wonder if the authors don't want to just do a correlation between the annual average

precipitation in different regions and the wet deposition lifetime in that region, and see if there isn't a robust signal in that. Then you can still make some statements about how different regions are likely to move, based on climate projections or longer term precipitation trends. I would bet, if your results are robust, that you will get a good relationship just with annual averages (or seasonal), and then you can more safely extrapolate into the future.

More details:

"Our study, based on the GEOS-Chem model simulation, shows that the removal efficiency and hence the atmospheric lifetime of aerosols have significantly higher sensitivities to precipitation frequencies than to precipitation intensities, indicating that the same amount of precipitation may lead to different removal efficiencies of atmospheric aerosols." Please make it clear that this is dependent on the way that you have included wet deposition, but that we don't really know the right answer.

"We first analyze changes in the precipitations between two 7-yr periods (2008-2014 vs. 2001-2007)" This is a very short time scale to talk about: is this going to be interpretable? Please go into the details of statistical significance and interannual variability and what your goal is with such short time scale differences.

61:"model does not simulate meteorology;": it does simulate meteorology, but it does not do this prognostically, it just forces it from data.

67: Change:"in details by" to in detail by

68: "The efficiency of wet scavenging is very sensitive to the hydrophilicity of BC." Please make clear that this is a result from your study.

96: f0.5i2: I appreciate that you tried to make your case names make sense, but they are still unintelligible, so you probably want a table describing all your cases, and try to NOT use your case name, but rather use English whenever possible.

"Our result also agrees with the lifetime of 5.8 $\pm$ 1.8 days simulated by the GEOS-

Chem model [Park et al., 2005] and the 5.4 days result simulated by the ECHAM5-HAM model [Stier et al., 2005]." How does it compare to other models in AEROCOM? Why just compare to two previous studies?

140:" The efficiency of wet scavenging can be affected by model parameterization. We first examine the impacts on our results from the parameterization on the hygroscopicity of aerosols. We compare the changes in the BC lifetime between two scenarios (f1i1 vs. f0.75i1.33) with alternative parameterization schemes." How did you change the hygroscopicity? Please add to the methods section.

150: "We also evaluate the impacts on wet scavenging from aerosol size with sensitivity simulations. If we assume the aerosols to be in coarse mode, we find that would lead to more efficient scavenging and 150 consequently much shorter lifetime (compared to the default setting in GEOS-Chem that all BC aerosols are in accumulation mode)." Plesae describe your fine and coarse mode depencies in the model so that we understand why this occurred. Overall in the methods you need to repeat a full description of your wet deposition algorithm, as your results could be completely sensitive to how you have parameterized this.

"We find that during these 14 years, the average precipitation intensity has increased over most regions, but the average precipitation 180 frequency has decreased over more than one third of the total regions including western North America (nwNA and swNA), southern South America (sSA), western Europe (wEU), southern Africa (sAF), and southwestern Asia (swAS)." This is a very short time period to argue for increases or decreases: this could just be interannual variability. Do you really want to argue for increases or decrsease? If so, show a statistically significant difference, etc. I would argue a better way to do it, is just use annual averages, which will allow you to use more data (as described above).

"By combining these precipitation changes for various regions as shown in Fig. 4 with the relationship between precipitation characteristic and the BC lifetime as illustrated

in Fig. 2, we can analyze the long-term changes in the atmospheric aerosol lifetimes driven by precipitation changes." Because I don't believe you have a long enough time series, I don't believe you can extend it, unfortunately. Please think about doing this analysis in a much more robust manner (with error bars showing the trends are important enough, believeable, etc) or just pull this section out of the paper.

"Since the TRMM data only cover a relatively short period, we make similar analyses with three reanalysis datasets (NCEP, NCEP2, and MERRA) to cover a longer time period (2001-2010 vs. 1981-1990) (Fig. 5). We find that, similar to the TRMM data, all the 195 three reanalysis datasets show increasing trends for precipitation intensity over most regions but more divergent trends for precipitation frequency in the past decades." Here you might have enough data to talk about this, but still very short time period. Again, show the standard deviations, show that they are signficiant, suppor tiwth other studies that try to show trends across such very short time periods in such a highly variable value (precipitation).

Also, there are significant problems with the moisture budgets in the reanalyses: are you sure you even want to do this? Might be better to just use climate model output because of the problems with inconsistencies in the data (please see all the papers by Kevin Trenberth showing the very large warts in the moisture budgets for all the reanalyses; not just one paper).

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