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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Rainfall feedback via persistent effects on bioaerosols" *by* E. K. Bigg et al.

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This work presents is a very interesting crossed analysis which combines an exceptional historical dataset of decade rainfall measurements, associated with atmospheric ice nuclei (IN) concentration measurements at several sites in Australia. The main conclusion is that a positive feedback between rainfall and IN exists. The manuscript is nicely constructed and written, data manipulation and the source of the data are clearly explained and referenced when necessary, the figures are clear and illustrative, and the text is well referenced. The dataset is apparently consequent and has been deeply exploited, and then put into context. In the first part of the manuscript, it is question of the evolution of IN concentrations on the days following a key day compared to the days

before it, at some selected sites and dates (for which IN concentration were available, I assume). Then, similar analysis of rainfall quantity and frequency is presented. Long-term analysis in rainfall patterns revealed trends linked with landscape modifications, like industrialization and the development of urban areas. Rainfall characteristics and IN concentration profiles around key days behave similarly, which strongly suggests that a link between these 2 parameters exists. The fact that this link could actually be a positive feedback, which implies reciprocal influence, is supported by a demonstration with arguments or observations from the literature: rain causes the aerosolization and promotes at the same time the growth of biological IN, and these can act as IN in supercooled clouds and induce rain. I found this work very innovative by its rather uncommon approach, and the dataset used. The feedback suggested here constitutes undoubtedly a great advance in the understanding of climate and the distribution of rain over the globe.

Specific comments: - Abstract: indicate that you are referring to "atmospheric" IN concentrations - Introduction: Page 25506, line 19: 0.3% of what? (vapor supersaturation?) - Page 25506, line 23: Not clear what "much more influence" compares to. Is it compared to CCN? If so, how could IN and GCCN, that are "usually at least four orders of magnitude fewer" could have "more influence". Also not clear what the word "fewer" refers to (do you mean fewer IN and GCCN in marine than in continental situation? or fewer IN and GCCN than CCN for both situations?) - Section 2.1: I had some difficulties to follow the calculations that have exactly been done, and giving generic equations would probably help. Showing the different steps of data manipulation (raw data, difference, cumulative difference and correction for seasonality) on an example in SM would also be helpful. The reference Soubeyrand et al (2014) actually presents it nicely, but it would be interesting to have an example here also as this is quite original manipulation. - Information on raw data is really missing (exact number or observations and dates, ranges of IN concentrations, rainfall frequency and intensity, means, quartiles or any statistical parameter that could summarize the whole raw datasets or periods of them). - Overall the manuscript it is question of biological IN, which I would

agree are certainly good candidates for the trends observed, but there is absolutely no evidence for it. Even though authors have taken care of using the conditional tense and mitigate their conclusions when necessary, the fact that bioaerosols could be involved appears quite speculative as it derives from literature results showing (already) that bioIN concentration in the air is increased after rain elsewhere on the planet (e.g. Huffman et al. 2013), and that the oscillations observed in some cases can only be due to biological systems. The IN measurements were led at -15°C and -20°C, so well below the warmest temperature generally accepted for minerals (i.e. -10°C). The reason why authors hypothesized IN to be biological is because "There are no known phenomena by which mineral or inert CCN, GCCN or IN could be enhanced in this way" (p25505). This seems to represent a dangerous shortcut. I do still think that this work is very valuable and needs to be communicated largely, and that this is a nicely constructed demonstration, but statements should probably be more careful when talking about the nature of the INs. For example, having the term "bioaerosol" mentioned in the title appears too conclusive regarding the data presented. - There is no reference to another important positive feedback observed between desert dust and drought that has been described previously (Rosenfeld et al., 2001). It would be relevant to cite and discuss this reference, which actually also supports the conclusions drawn here, but shows at the same time that also minerals can be involved in feedbacks. - How did you build the cause-consequence relationship between rainfall and IN concentrations? If the phenomenon observed corresponds to a real feedback, there should be some delay between the responses of IN concentration and rainfall, rather than an overlap (the respective peaks should alternate, basically). What is the delay between the 2 profiles? If no delay, why does this constitute a feedback and not simply an indirect correlation to another parameter? It would be interesting to have wind speed or temperature (or...?) data for example, and verify their behavior when manipulated as for IN and rain. - If the evolution of CD (IN concentration) and Fv (rainfall frequency) are linked, there should logically be a correlation (not necessary linear), between these 2 parameters. However, no such relationship is shown or mentioned directly in the paper.

It would be interesting here to show a plot of IN concentration against rainfall frequency, either on raw or on modified data, if necessary, or to explain why one cannot detect this correlation so simply. - Figures: Indicate in the legends the absolute concentrations of IN before (or after) the key day, as already done for Figure 2. This helps figuring out the absolute concentrations.

References:

Rosenfeld, D., Rudich, Y. and Lahav, R.: Desert dust suppressing precipitation: A possible desertification feedback loop, PNAS, 98(11), 5975–5980, doi:10.1073/pnas.101122798, 2001.

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