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## ***Interactive comment on* “Multi-decadal variations of atmospheric aerosols from 1980 to 2009: sources and regional trends” by Mian Chin et al.**

### **Anonymous Referee #3**

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Comment on the paper “Multi-decadal variations of atmospheric aerosols from 1980 to 2009: sources and regional trends” by M. Chin et al. submitted to ACP.

This paper examines the variations of aerosols during the last 3 decades using results mainly from the GOCART model and observations either from several satellite instruments or from ground-based networks. The paper is rather lengthy and it is not always easy to follow the authors. I think a more condensed version of section 4 with focus on regions presenting significant variations during the last 3 decades will demonstrate the work done by the authors making the paper easier to follow. I suggest the publication of the paper once the following comments are addressed.

Major comments: 1) In Section 4, a table similar to Table 4 is needed, presenting

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the AOD values for the satellite instruments. This table will clearly show the regions where there is agreement about the trends/variations among the satellite instruments and the model, in addition to Figures 5 and 6, but providing more quantitative results. These comparisons will permit to authors to concentrate to regions with significant trends/variations, rather than presenting all of them in details. Given the uncertainties and the contradictory results (in some regions) between the different datasets, I hardly see the utility in doing so.

2) Although, the validation of the model (and the satellite data) against ground-based observations is very useful, by showing just results for some stations is not enough to corroborate or reveal any contradictions presented in the previous sections about the trends/variations from the model and the satellites. Especially, by presenting only global results, as in the case of AERONET or island stations, the authors contradict themselves (see the last sentence of the abstract about regional changes), because the capability of the model to reproduce the observations is not the same in all regions nor in all times. I understand that this is a difficult task due to gaps in the time series, but the authors can use the stations with the more complete data sets, especially within regions where the majority of stations indicate similar trends/variations. Also, they could add some columns in Table 3 to indicate the temporal evolution of the aerosols concentrations/AOD in the specific regions (similar to what they have done for the model in Table 4).

Minor comments: 1) Page 19753, line 23: Add also terrestrial radiation to the solar radiation, already mentioned.

2) I propose to put the majority of section 2.2 in the appendix as to me provides technical details, except from the last paragraph.

3) I think it will be useful for the discussion to provide the accuracy for the model and the observation datasets in Sections 2 and 3, as already done for AERONET.

4) The scale of the different regions/stations in Figures 4, 5, 6 (for AVHRR-CDR), 7,

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8, 9 and 10 changes. Provide a note. I believe that you should use the same scale (Figure 4) or homogenize as possible (e.g. same scale in the rows of Figure 5 etc.).

5) Page 19775, line 6: There is no obvious decrease from TOMS above Russia and Europe due to little coverage (see also your comment below, line 21-22).

6) Pages 19781-19782, Over the Arctic: Why present the two stations Barrow and Spitsbergen from the moment that their dataset is smaller? What is the additional information to the other two stations?

7) The Polar regions are not indicated in Table 1 and Figure 1, although appear in Table 4 and in Section 5.3. Also, you are using the surface measurements of Arctic sites (Section 4.4.1), but these are located over other regions (CAN and EUR). Please clarify/modify appropriately.

Technical comments: 1) Page 19762, line 24: Change 2012 to 2013 for the paper of Zhao et al.

2) Page 19779, line 14: The reference of Pan et al. is missing.

3) Page 19800, line 3: The paper of Kalashnikova et al., is now published in AMT.

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