Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2017-55-RC2, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Direct radiative effects of dust aerosols emitted from the Tibetan Plateau on the East Asian summer monsoon – a regional climate model simulation" *by* Hui Sun et al.

Anonymous Referee #2

Received and published: 28 March 2017

General comments:

The authors use an RCM in order to investigate the effect of Tibetan Plateau dust sources on the East Asian Summer Monsoon (EASM). They find that removing the desert cells in Tibet reduces precipitation and generally weakens the EASM. The subject of the study is interesting and original, the presentation is clear (but a little lacking in depth) and the flow is smooth. There are a few major points that need to be clarified or otherwise addressed before the paper is accepted.

Specific comments in order of appearance :

p.1, l.24: "dust ... accounts for about half of all the aerosols". By mass? This is not

supported from Table 1 of the Chin et al. 2002 reference.

p.5, l.10: The alleged supremacy of MISR over MODIS is justified based on only one paper which itself is based on only one AERONET station. The better agreement of MISR AOD with the specific station cannot be considered representative, see for example Bibi et al., 2015 (http://dx.doi.org/10.1016/j.atmosenv.2015.04.013) who show that MISR compares better with AERONET at two stations, and MODIS at the other two stations of the Indo-Gangetic plains. I wouldn't exclude MODIS from the analysis.

p.6, l.20: It would be nice to include some statistics (correlation coefficient, bias, etc) in Figs. 4 and 5

p.7, l.13 and Fig.8: The widespread aerosol-induced cooling is quite impressive, but also raises questions. In much of the literature the direct radiative effect of dust is predominantly positive (warming) over land areas and becomes negative in specific situations like a large zenith angle (e.g. Quijano et al., 2000, J. Geophys. Res, 105(D10), 12207-12219). Specifically over Tibet, Chen et al. (2006) (reference in manuscript) show net aerosol warming. I would suggest that the authors explore more their derived aerosol cooling and provide information on the reasons behind this behaviour. For example, is the LW cooling from dust particles so much larger than the SW warming? How much less absorbing in SW is Tibetan dust compared to dust from other locations? What are the optical properties of the dust emitted by Tibet?

p.7, l.18: It would be interesting to see why the dust generates this downward motion.

Fig.9: How does the Tibetan dust cause cooling over central India only during the light dust years? I'm afraid that using heavy and light dust years introduces aerosol-unrelated interannual variability that complicates the picture. It would be much better if it were possible to tweak the dust productivity directly (please see below).

p.7, l.27 and Fig 10: As mentioned also by referee #1, the anticyclonic activity might be better visualized through geopotential heights.

p.8, l.15 and Fig.12: If I understand correctly, this difference in the EASM onset is rather marginal and probably circumstantial. For example if the value 5.5 were selected instead of 6, then the CON experiment shows earlier onset. The aerosol-induced delay of the EASM does not seem like a robust result.

Section 3.4.3: I think it would be interesting to show the change in precipitation with a Figure similar to Figs. 9 and 10. Also, there is no mention of precipitation changes in the north monsoon region.

A general remark: The authors focus on heavy and light dust years in order to evaluate the EASM sensitivity to aerosol emissions. Relying only on the heavy/light year classification, the problem retains the interannual variability from irrelevant factors such as the meteorological fields. Instead of (or maybe complementary to) the heavy/light year experiment, I would try reducing or increasing by specific percentages (e.g. 10%-100% in steps) the dust emission from the surface of Tibet, through modifications in the dust module. Then I would try to present the "climatological" 20-yr average change. I am not experienced with RegCM and do not know if these modifications are easy, so this is more suggestion than a requirement. This suggestion touches also on the valid problem (already pointed out by referee #1) of removing dust by substituting desert cells by vegetated ones. Except the aforementioned albedo changes, there could be other unwanted interferences to the aerodynamic resistances and land-air interactions. I would think that the tweaking of dust emission through modifications of e.g. Eqs. 2, 3 in the dust module would be a much better technique.

Technical corrections:

My rather trivial corrections are listed below

p.1, l.20: Please use "stationary" instead of "stationery"

p.1, l.26: Here "dust emission" is slightly better than "dust load".

p.1, l.29: Please use "drivers of" instead of "drivers on".

p.2, l.24: Please use "Gurbantunggut" instead of "Gubantunggut".

p.2, l.27: Please use "elevated" instead of "elevate"

p.4, Eq.4: χ and v are never defined

p.6, l.27: Please correct "respevtively" to "respectively"

p.9, l.22: Please use "spatiotemporal" instead of "spatiotemporal spatial"

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