

Interactive comment on “The impact of human activity on anthropogenic dust emission over global semi-arid regions” by X. Guan et al.

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We are grateful for the reviewers' useful advice and comments. They helped us greatly to improve this paper. Our point-by-point responses to the reviewers' comments are listed as follows.

General comments:

The authors aim to explore the relationship between population and anthropogenic dust in semi-arid regions, which has significant implications for local climate change—an important research topic facing the climate change research community. The study clearly reveals that the global semi-arid regions present in average the highest anthropogenic dust burden, and the dust emissions vary substantially across semi-arid regions with different population density and socioeconomic development levels. His

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paper has great potential for making an important contribution to scholarly discussions on the interactions between human intervention and climate systems at both global and local levels.

Part 1:

(1) Here are some comments and suggestions for the authors to consider in the revision. My main concern is that the human impacts on dust emission are not only determined by the number and growth rate of the population but also affected by the types in intensities of human activities. To choose the four semi-arid regions of different continents and at various socioeconomic development levels for the study of the relations between population density/change and anthropogenic dust burden is a good research design. However, the decision of excluding almost half of the semiarid areas with a population density below 10 persons km⁻² from the analysis unfortunately makes the research less robust.

Response: We appreciated the reviewer's insightful question and agreed that almost half of the semi-arid areas has a population density below 10 persons km⁻². The figures 1 and 2 are the revised figures include the population density below 10 persons km⁻². They are similar with the primary figures. The new figures in the revised manuscript and related description have been updated in the revised manuscript.

(2) The areas excluded are believably dominantly the less populated regions in North America and North Africa, which represents two regimes of human activities and seems to generate very different impacts on anthropogenic dust emissions. While the inclusion of these areas in the analysis of overall interacting patterns may lead to mixed results, one should consider analyzing the relationships in the four regions separately and exploring whether or not there is a common pattern in the relationship between population density and anthropogenic dust burden among all four regions. Even if the resulted relationship varies across regions, it could lead to further analysis of the reasons: why they differ? Is it due to the different levels of aridity, or different types and

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intensities of human activities?

Response: We agree and appreciate the reviewer's suggestion and comment. As the reviewer mentioned, the points with population densities less than 10 persons km⁻² are greatly located in North America and North Africa, since the semi-arid regions in East China and India have higher population densities. The differences of population densities in the four semi-arid regions seem to show very different impacts on anthropogenic dust emission. While the inclusion of these areas in the analysis of overall interacting patterns may lead to mixed results, we have added the description and discussion on the relationships in the four regions separately (Fig. 3) in the revised manuscript. The typical economic mode has great impact on the relationship between anthropogenic dust and population densities over different semi-arid regions. The comparison in East China, India, North America, and North Africa (Fig. 3) demonstrate the Indian semi-arid region with a traditional agriculture has a close relationship between population density and anthropogenic dust. Related with other semi-arid regions, India as a developing country, agriculture is its major industry, the relationship between human activities and population is more direct, and its agriculture is an industry that directly impacts the land that is easily leading to production of anthropogenic dust. It illustrated that anthropogenic dust has a close relationship with development level of agriculture.

(3) Would the pattern be clearer after controlling AI index, or/and economic level/activity?

Response: We think the pattern will be clearer after controlling the economic level. This part of description and discussion has been added in the revised manuscript. As shown in Fig. 3, we can find that different semi-arid regions have inconsistent relationships between population density and anthropogenic dust, which illustrates the role of economic level in relationship between anthropogenic dust and population.

Part 2:

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Other comments:

(1) In section 4.1, it would be preferable to use "mixed dust" instead of "combined dust" to avoid confusion, particularly when Figure 5 stacks (or combines) anthropogenic and natural dust burden from the "mixed" dust regions.

Response: Thanks for the suggestion. The "combined dust" has been replaced by "mixed dust," and we have checked the whole manuscript to ensure no similar problem exists in the revised manuscript.

(2) The sentence of Lines 28-29 on Page 6 can be moved to introduction section, and expressed as a key contribution of this research.

Response: Thanks for the suggestion. The sentence in lines 28-29 on Page 6 has been moved to the introduction section, as a key contribution of this research.

(3) While Figure 4 displays anthropogenic vs. combined (mixed) dust burden, the text on Page 6 talks about the natural vs. mixed dust burden. It should make them consistent.

Response: The text on Page 6 has been revised to be consistent with the figure caption.

(4) While Page 7 Line 19 says "both India and East China have higher population density (\geq 250 persons km⁻²) which is also displayed in Figure 6, the other parts of the paper uses 45 persons km⁻² for East China. Is the number in Figure 8 derived from the data of Figure 6? Please explain why.

Response: It is our poor English expression, and we have revised the text. In Line 19 on Page 7, we want to state that "For the four selected semi-arid regions, only India and East China have grids with population density greater than 250 persons km⁻², most of North Africa has the population density between 10 and 40 persons km⁻², and the population density in semi-arid region of North America is in the range of less than 10 persons km⁻²."

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(5) The last paragraph of Page 7 and Figure 7 is not really relevant and could be removed. There are some contradictions in texts of the first two paragraphs on Page 8. For instance, it says 8 percentages population increase in East China in the first paragraph but 6.16 percentages in the second; 30 percentages increase in N. Africa in the first paragraph, and 29.26 percentages in the second. While the paper is generally well written, the second half of the text needs to be improved.

Response: Thanks for the suggestion. We agree with reviewer. This paragraph has been rewritten. The contradiction in text has been revised.

(6) In particular, Section 4.2 and 4.3 are not always easy to follow. For instance, what does it mean “Most semiarid regions locate in the anthropogenic dust areas”(Page 8 Line 18)? What is “rear population” (Page 8 Line 23)?

Response: Sections 4.2 and 4.3 have been revised. (1) According to the distribution of anthropogenic dust (Huang et al., 2015), anthropogenic dust not only appears in the semi-arid regions, but also relatively concentrated in the semi-arid regions. The sentence of “Most semi-arid regions are located in the anthropogenic dust areas” has been removed, in order to avoid misunderstanding. (2) “[R]ear population” should be “rare population”. Similar problems no longer appear in the revised manuscript.

Reference:

Huang, J., Liu, J., Chen, B., and Nasiri, S. L.: Detection of anthropogenic dust using CALIPSO lidar measurements, *Atmos. Chem. Phys.*, 15, 11653–11655, doi:10.5194/acp-15-11653-2015, 2015.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, doi:10.5194/acp-2015-952, 2016.

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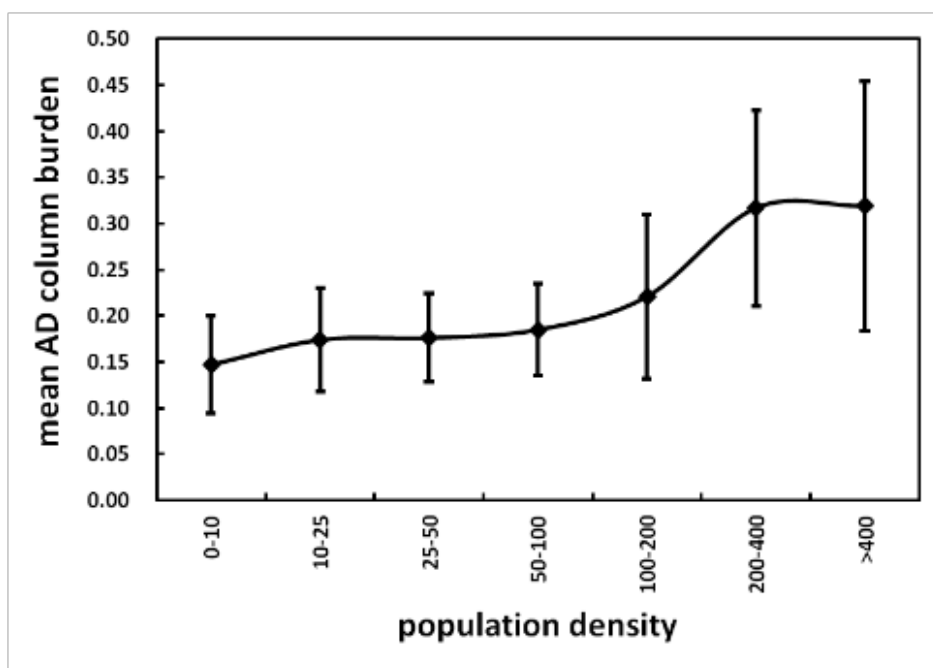


Fig. 1. Mean anthropogenic dust column burden changes as a function of population density

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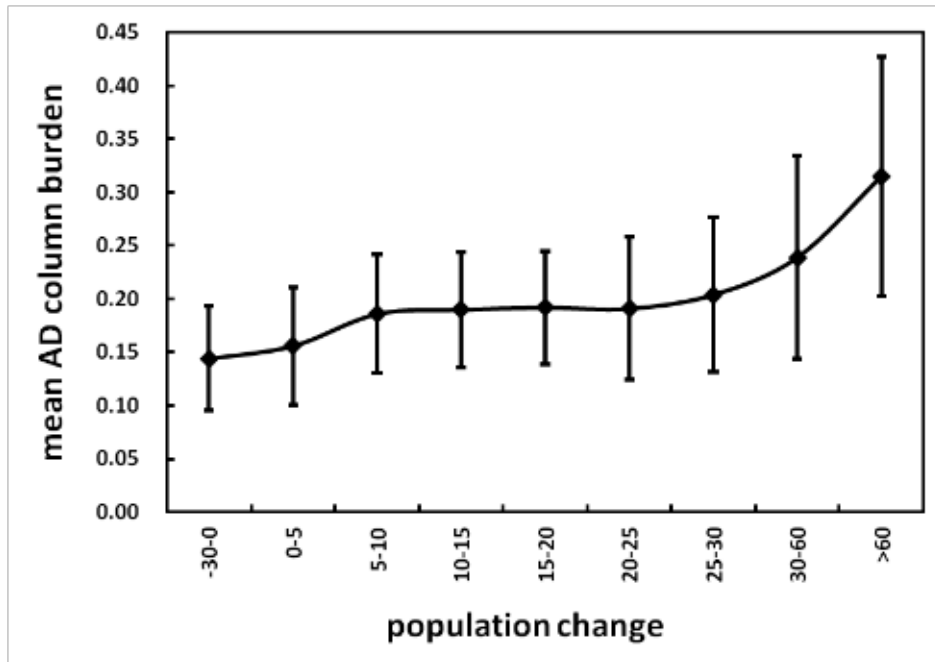


Fig. 2. Mean anthropogenic dust column burden changes as a function of population change

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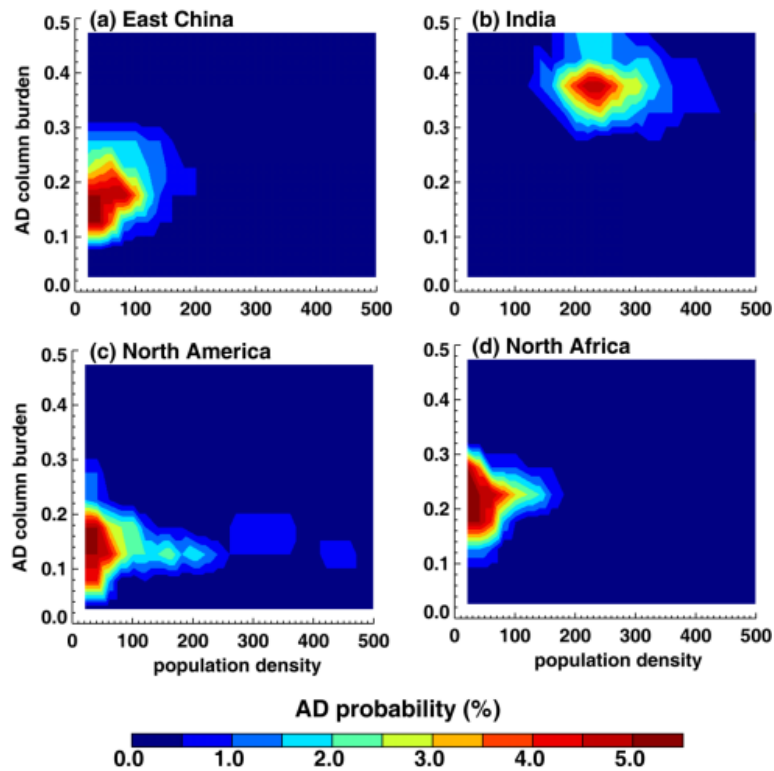


Fig. 3. Anthropogenic dust probability density distributions of semi-arid regions in (a) East China, (b) India, (c) North America, (d) North Africa

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