Atmos. Chem. Phys. Discuss., 14, C9850–C9854, 2014
www.atmos-chem-phys-discuss.net/14/C9850/2014/

Atmospheric Chemistry and Physics Discussions
Open Access

Interactive comment on "A multi-model evaluation of aerosols over South Asia: Common problems and possible causes" *by* X. Pan et al.

Anonymous Referee #2

Received and published: 8 December 2014

Manuscript review

Title: A multi-model evaluation of aerosols over South Asia: Common problems and possible causes

Authors: X. Pan et al.

Reviewer: Patrick Chuang, UC Santa Cruz

Reviewer's note: Although it was available, I did not look at the other review prior to writing this review.

This manuscript compares observations with modeled aerosol properties in South Asia (primarily India), with a focus on the Indo-Gangetic Plain (IGP), from 7 global models.

There are a number of strengths of this manuscript. The first is that it addresses a region of clear low bias in the models and seeks to better understand the source of the bias. That this region is home for a large population makes the study even more compelling. The second is that it brings a variety of observations (satellite and ground-based remote-sensing, as well as in situ) to compare with model products. A third is the use of a range of global models, which permits comparing different models with different capabilities (e.g. those that include nitrate aerosol versus those that do not), makes the results more robust than if only a single model were used.

That said, there are a number of ways that the manuscript could and should be improved. Broadly, two main issues are (1) improving comparisons of model output and observations and (2) quantifying the various explanations for the model low biases.

1. Use of observations

(a) The authors accurately state (p. 13, 20-22) “It should be noted that it is difficult for a global model with a coarse spatial resolution to reproduce pollutant concentrations measured in an urban environment...”, which I agree with. However, recognition of this is not, I believe, sufficient. Given this known scale issue, what would constitute "agreement" between model and the point observation? Presumably if the model output exactly matched the point observation, that would not imply a perfect model. So without some clear idea of what a perfect model would do, how do you know there is a "low bias" in the model? It’s possible that the entire mismatch is due to scaling, right? I don’t think that this is the case, but it seems that quantifying this issue is required. What if, say, CALIPSO or some other satellite data were used to try to get some sense of the spatial distribution in this particular grid box?

(b) All observations have their uncertainties and, most importantly for this study, biases. To conclude that the model biases are large, one should probably quantitatively evaluate the observational biases. How much of the model/observation discrepancies might be a result of the observations?

ACPD
14, C9850–C9854, 2014

For example, my understanding is that AERONET has a very strict cloud screening requirement. I did not see details on how AERONET data are compared with models. Was it assumed that AERONET is representative of all conditions, regardless of cloud cover? This could lead to substantial biases if there is some correlation between meteorology and aerosol. Or was there a cloud-screening criterion applied to the model output as well? If so, how does one reconcile the model scale with the AERONET scale?

I don't know much about satellite remotely-sensed aerosol products, but I suspect there are a number of potential biases. One obvious one would be the late-morning/early afternoon timing of the overpasses not accurately reflecting a daily average in aerosol. Also, my understanding is that some (if not all) of the passive sensors used (MISR, MODIS, SeaWIFS) require a surface albedo in order to make certain retrievals. If so, what albedo product was used? Is there, say, an annual cycle in albedo (perhaps due to vegetation or agricultural cycles) that is not properly represented in this region that causes an observational bias? Is there an issue with retreivals of external aerosol mixtures (e.g. mixed absorbing and scattering aerosol)? As I said, this is not my area but I believe this should be explored much more carefully.

(c) Uncertainty/variability

Most of the figures showing observations lack any indication of uncertainties or variability (whichever is larger). This should be included to aid in comparing observations with models.

2. Quantifying causes of model biases

(a) While the manuscript lists all the potential sources of biases in models, it would be a lot more satisfying if you could actually quantify these bias sources in some way. I understand that it's not easy to do with high precision for a variety of reasons (e.g. model dependence), but even a ranking or sorting the bias sources into tiers (e.g. Tier 1: dominant bias source; Tier 2: major bias source; Tier 3: minor bias source) seems

ACPD
14, C9850–C9854, 2014

Interactive Comment

like it would be very useful. Such quantification (or semi-quantification) would be a much more satisfying product of this research than the mostly qualitative statements that are currently provided. In some cases, it seems like it wouldn't take much work to actually provide quantitative estimates, but maybe for others it will require some new analyses.

(a) A related issue is that the manuscript addresses the bias sources somewhat superficially. You broadly describe what the problem is, but don't really do a good job of analyzing more carefully what the specific issue is. Here are some examples:

* The low bias in relative humidity is described, and there is speculation that the cause is a high bias in temperature. Well, why isn't this checked? It would be quite easy to take the model output, apply a more appropriate T, and see if the humidity bias disappears. Or if it corrects a small fraction of the bias, then one would conclude that it's actually an absolute humidity bias.

* Boundary layer depth is mentioned as a source of bias in comparing surface observations. There must be some measure of boundary layer thickness in this region, either in situ or remotely-sensed, that can be used to evaluate this idea quantitatively.

* A low-bias in sulfate aerosol is found. Wouldn't it be interesting to try to isolate this problem? Determine whether it is, say, a result of gas-to-particle conversion that is too slow or in the sulfur emission inventory. The former could be diagnosed if *total* sulfur was accurately represented in the model, but the ratio of gas phase to particle phase sulfur was too high. Similarly for organics and nitrate, at least for those models that actually have nitrate.

These are just a few examples. I suggest you look at every source of bias that you believe to be significant and identify more precisely the reason for the bias.

Other comments:

Figures: many of the figures are far too small. I had to increase their size to twice

ACPD

14, C9850–C9854, 2014

normal size at which point they were just big enough to read. Please make them legible at normal size.

I've provided a number of other comments in an attached PDF file. Some may overlap with the above and can be ignored. Most identify areas where the wording is awkward, ambiguous or otherwise requiring editing.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/14/C9850/2014/acpd-14-C9850-2014-supplement.pdf

---

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 19095, 2014.

ACPD

14, C9850–C9854, 2014

Interactive Comment