Atmos. Chem. Phys. Discuss., 14, C11559–C11562, 2015
www.atmos-chem-phys-discuss.net/14/C11559/2015/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impacts of 20th century aerosol emissions on the South Asian monsoon in the CMIP5 models" *by* L. Guo et al.

Anonymous Referee #1

Received and published: 26 January 2015

General comments:

Guo et al., 2014 discuss the anthropogenic aerosol emission impacts on South Asian monsoon rainfall using climate modelling. The manuscript addresses a region of clear low bias in simulating rainfall in the models and try to address the rainfall trends in terms of aerosol effects. The focus is on the difference in rainfall response between models parametrizing direct aerosol effects and those also including indirect effects. Even though the role of aerosols on Asian summer monsoon rainfall trends are previously reported in the literature (e.g. Bollasina et al., 2011; Salzmann et al., 2014), the analysis of difference between direct vs. indirect aerosol effects could be very useful for the scientific community.

The paper is generally well written and the findings are quite interesting. Recent studies showed that only few models are parameterized both albedo vs. life time aerosol indirect effects in the CMIP5 simulations. Recent studies also pointed out that convective rainfall play a dominant role in the simulated total precipitation in most of the CMIP5 models. These points need to be addressed in the manuscript. The findings from the current study are not well described in the context of several other CMIP5 studies. The following comments should be addressed before the manuscript would be satisfactory for publication in ACP.

Specific comments:

1) Authors suggested that "aerosol forcing has been playing a dominant role on drying rainfall trend over South Asia". Salzmann et al., 2014 showed that the drying rainfall trend in Northern India in part be explained by internal variability. It could be useful if authors can provide some quantification aerosol forcing vs. natural/ internal variability (instead of "dominant role").

2) Aerosol-cloud interaction processes are parameterized differently in all the indirect effects included CMIP5 models. How the inter-model differences in aerosol indirect effect parametrization (albedo vs. lifetime) will affect the rainfall trend response over South Asia? It could be useful if authors can provide some insight into this issue over South Asia. It is not clear from the Table 1 that the whether aerosol albedo and the lifetime effects are parameterized in the indirect effect included CMIP5 models. Table 1 from Salzmann et al., 2014 shows that only few models are parametrized/included both albedo and lifetime effects in the simulation. This will be useful for interpreting the findings. Also note that GISS-E2-R model included the albedo effects.

3) Recent study showed that the CMIP5 models fail to simulate the post-1950 decreasing trend of monsoon rainfall (Saha et al., 2014). The failure of representing large-scale changes caused this issue in most of the CMIP5 models. Only 8 out off 48 CMIP5 models used is able to capture the monsoon rainfall features (Saha et al.,

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2014). This indicates that skill of simulating Asian summer monsoon is very poor in most of the CMIP5 models. Authors need to comment if models are poor in simulating essential features, how much reliable the model-simulated impacts of 20th century aerosol emissions on rainfall trends.

4) Stevens et al., 2013 mentioned that "In implementing the new-aerosol climatology to the MPI-ESM-P model, a data-formatting error led to a somewhat weaker anthropogenic aerosol forcing than was foreseen in the original data set, with the effect most pronounced over the heavily populated regions of the northern hemispheric continents." See section 3.5 in Stevens et al., 2013. It is better to avoid this model from the analysis or mention in the paper.

5) In the Conclusion section, authors discussed about the increases in monsoon rainfall in future CMIP5 projections. Sabeer Ali et al., 2013 found that found that most models produce too much (little) convective (stratiform) precipitation compared to observations. Is too strong aerosol effects causing this issue? Better to add remarks on this issue in current context of the work. Whether aerosol indirect effects are enhancing the convective rainfall in the model?

6) Whether aerosol effects have any role in the reported stronger precipitable water-precipitation relationship in most CMIP5 models (Sabeer Ali et al., 2013) ?

Technical comments:

Page 30641, Lines 4-7: Whether the simulated aerosol distributions (aerosol optical depth, column burden) are too high over China? All the CMIP5 models are very poor in the simulating the aerosol-distributions over South Asia, especially Indian region. If the emissions are large enough, then aerosol distribution or deposition should be wrong. Rewrite the sentence.

Page 30642, Lines 18-19: "Maximum concentrations are found pushed up against the foothills of the Himalayas" Whether this is true in monsoon season? Page 30645, Lines

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15-24: The MME-mean will miss out the individual ensemble run features. The ensemble members simulate rainfall trends very differently (positive vs negative) over South Asia (Salzmann et al., 2014). How well these issues are addressed in the reported mean trends?

Page 30656, Lines 25-27: This is a broader view. Better to discuss this issue in the context of the reported dominance of convective rainfall in future CMIP5 projections (Sabeer Ali et al., 2013).

Page 30656, Lines 3-5: How well the clouds are simulated over China vs. South Asia?

The following references are not cited in the manuscript.

Saha, A., S. Ghosh, A. S. Sahana, and E. P. Rao (2014), Failure of CMIP5 climate models in simulating post-1950 decreasing trend of Indian monsoon, Geophys. Res. Lett., 41, 7323–7330, doi:10.1002/2014GL061573.

Sabeerali C.T., et al (2014), Why ensemble mean projection of south Asian monsoon rainfall by CMIP5 models is not reliable?, Clim. Dyn., August 2014, DOI 10.1007/s00382-014-2269-3.

Salzmann, M., H. Weser, and R. Cherian (2014), Robust response of Asian summer monsoon to anthropogenic aerosols in CMIP5 models, J. Geophys. Res. Atmos., 119, 11,321–11,337, doi:10.1002/2014JD021783.

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Stevens et al., (2013), Atmospheric component of the MPI-M Earth System Model: ECHAM6, J. Adv. Model. Earth Syst., 5, 146–172, doi:10.1002/jame.20015.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 30639, 2014.