Author Response to Reviewer #1

Please note that we have provided a document containing revised figures and tables, both for the main article and for the supplemental material. In our responses to the reviewers, we will refer to these revised figures and tables, rather than the original.

The authors used aerosol observation from AERONET and EP-TOMS to adjust simulated aerosol, and this adjusted aerosol was used as input for a GCM. This is superior to some of the previous studies where aerosol parameters were crudely specified. However, this study does not give any significant finding or new insight. The conclusions were already known or expected. Thus, I ask the editor to reject this paper for publication in ACP.

In this extremely short critique, it is difficult to sort out the message intended by Reviewer #1. It is first stated that the method applied in this work is *"superior to some of the pervious studies."* And yet, the Reviewer states that the results are neither significant nor provide "*new insight*." We could argue that it is indeed not expected that a "*superior*" implementation of aerosol optical properties would reproduce no large change in model response compared to experiments in which aerosol parameters were more "*crudely specified*." This in and of itself is an interesting result, is it not?

We would further put forth that the direct and semi-direct impacts of absorbing aerosols on the hydrologic cycle remain unresolved and not "*already known or expected*" as the Reviewer suggests. In a current review paper in ACPD *Koch and del Genio* [ACPD, 10, 7323-7346, 2010, www.atmos-chem-phys-discuss.net/10/7323/1020/] outline in detail the disparate results obtained from studies which have examined the semi-direct effect of absorbing aerosols. Different studies, both observationally-based and model-based, have shown that the semi-direct aerosol effect can have a positive (decreased clouds) or negative (increased clouds) effect on the surface energy balance depending on multiple factors such as aerosol optical properties, vertical distribution of aerosols (particularly with regards to their vertical distribution relative to cloud), the underlying stability of the atmosphere in the region (e.g. convergent or divergent region) [*Koch and del Genio,* 2010], and large-scale cloud distributions themselves (e.g., *Randles and Ramaswamy*, 2008, in the Asian context). In this study, we add to the knowledge of climate response to direct and semi-direct aerosol effects as we probe into the problem by isolating aerosol effects one-by-one (e.g. first we increase AOD, then we change SSA in two different ways). This step-wise approach is a time-tested way to unravel the complex physics of the real world. In doing so, we believe that we have demonstrated that absorbing aerosols are an important contributor to the climate and hydroclimate in southern Africa, and that their impact is dependent on their total absorption (aerosol absorption optical depth) and how clouds change in response to aerosol-induced heating of the atmosphere.

We would also like to point out that it has just very recently come to our attention that there is a paper in press in the *Journal of Geophysical Research* (*JGR*) that also examines the effects of biomass burning aerosols on the climate of southern Africa during the austral winter (*JJAS* in their paper) [*Tummon et al., Simulation of the direct* *and semi-direct effects on the southern African region during the biomass burning season, in press, JGR*]. The *JGR* paper uses a regional model (RegCM) with prescribed SSTs and on-line (interactive) aerosols and no aerosol indirect effect. They only consider the forcing of aerosols simulated by their model and a case similar to MOZEX in which biomass burning emissions are from GFEDv2 [*van der Werf et al.,* 2006]. In both of their cases, their simulated aerosol optical depth peaks one to two months early and dies off one month too early compared to both satellite and AERONET measurements, and spatially the peak in their AOD is roughly 5 degrees too far to the south. In contrast, we consider multiple aerosol scenarios with differing prescriptions of aerosol optical depth and aerosol absorption optical depth to yield an even wider perspective into the model response to direct and semi-direct effects of biomass burning aerosols. Even so, the *JGR* paper reports extremely similar findings to ours (i.e. surface air temperature decrease, increased precipitation, increased vertical velocity, and increased clouds with inclusion of aerosol forcing relative to a case without aerosol radiative interactions). In fact, their temperature decrease is practically the same as our experiments MOZEX and HIGHEX (they obtain -0.21°C for their AERO experiment while HIGHEX has a decrease of -0.27°C; for their GFED experiment they obtain -0.07°C while we obtain -0.12°C for MOZEX). In both papers, the aerosols act to reduce the positive bias in surface temperature compared to observations (see supplemental Figure S.3). They generally get stronger increases in precipitation, but their precipitation increases are, like ours, confined to the tropical belt where atmospheric conditions are favorable to instability. The fact that such a paper is currently in press, given it's similarities to our present study, strongly supports our position that our study is both very timely and worthy of publication in ACP.

Aside from these comments, it is difficult to address or rebut more substantively the Reviewer's opinion of this paper because no details are given to justify his/her opinion. In our view, the Reviewer's comments between sentences 2 and 3, 4 are coming close to being contradictory. We feel that the Reviewer has misunderstood our paper and its significance in the context of the unresolved science contained in the problem at hand.

1. The authors frequently use a term "column integrated AOD". AOD is by definition a column-integrated quantity. AOD is obtained by integrating aerosol extinction coefficient in the vertical. Please simply say AOD.

This is easily revised in the revised manuscript.