Anonymous Referee #3

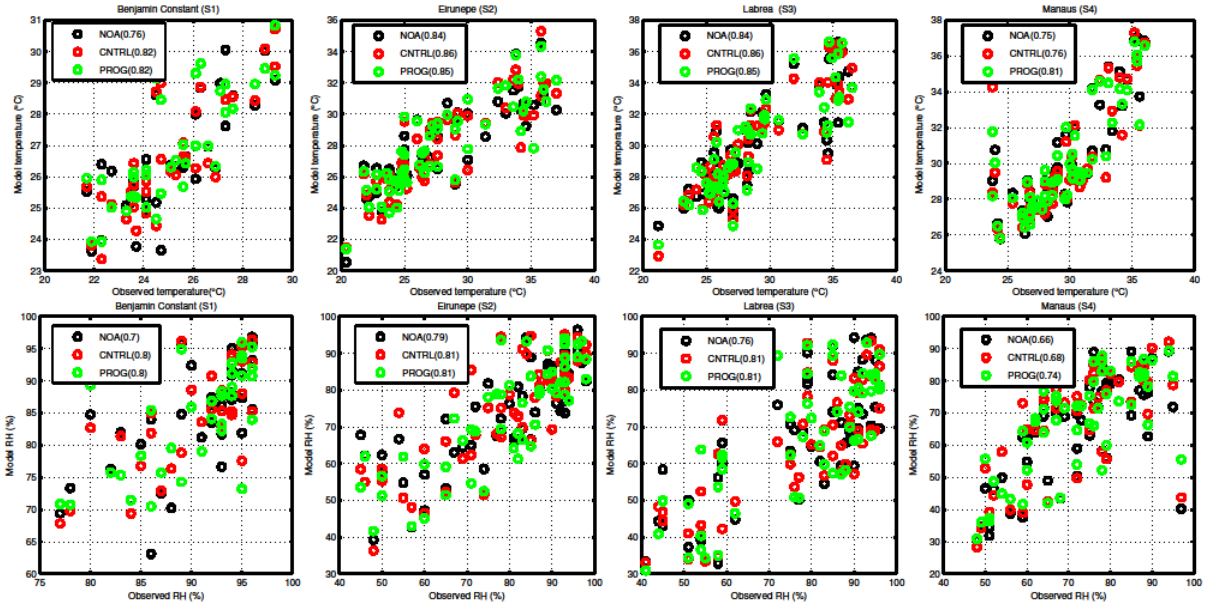
We would like to thank the reviewer for taking time to review this manuscript thoroughly and for their comprehensive comments received. We have addressed all comments in turn below:

Specific comments:

Page 18884, Lines 23-24: It is stated that inclusion of biomass burning aerosols in the MetUM model significantly improves the forecast of temperature and relative humidity. However, we don't see any substantial reduction in mean bias and RMSE (Figs. 9 and 10) due to inclusion of biomass burning aerosols in the model. The bias in relative humidity even increases above 700 hPa when the model is used with a prognostic aerosol scheme. In view of this, I suggest removing this line from the abstract. Could you also please examine the statistical significance of aerosol induced changes in the meteorological parameters reported in this paper?

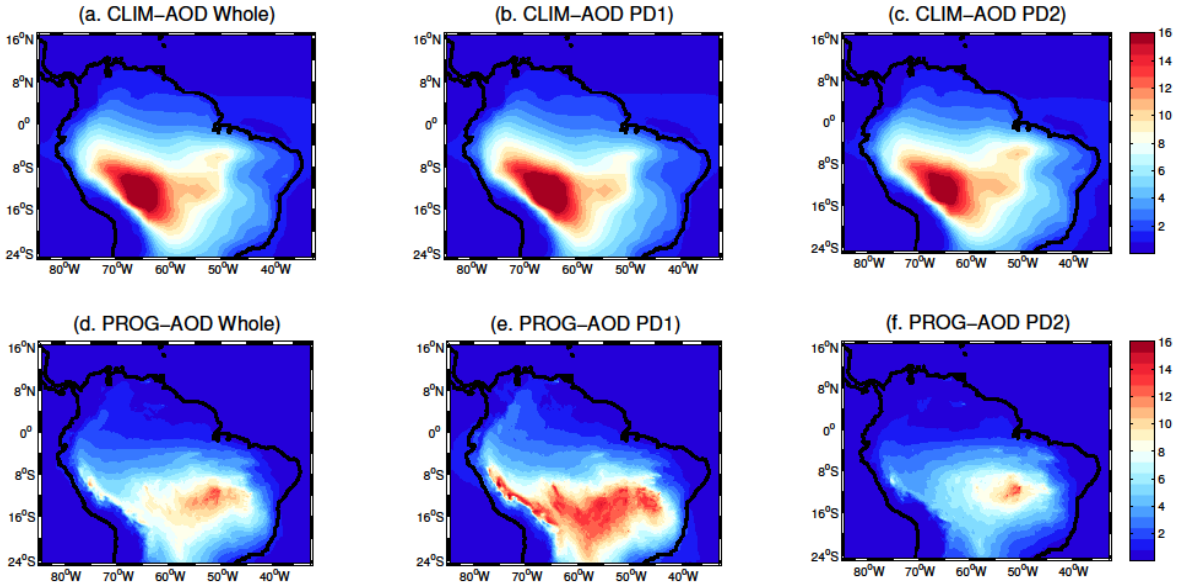
We have clarified this statement by stating,

"*Inclusion of climatological or prognostic BBA in the MetUM makes a small but significant improvement in forecasts of temperature and relative humidity*". **To support this statement, Figure 9 shows how CLIM or PROG tends to reduce bias and RMSE, now clarified in the text as,** *"The inclusion of aerosols tends to improve the surface temperatures biases in forecasts"***. In addition we have tested the significance of the difference between mean correlations between models and observations at S1-4 (shown below, with correlation values shown). PROG and CLIM are significantly better correlated with the observations than NOA at the 99% level as stated in the paper at line 18, page 18899. Furthermore we have now added contours to Figs 4, 5 and 6b, to show where differences due to aerosols are statistically significant, using a method Bence, (1995) that accounts for auto-correlation**.



Page 18889, Line 15: Did you check how the distribution of aerosol other than BBA observed during SAMBBA compared with the climatology used in the MetUM model? If the observed distribution is significantly different from the climatology then it may affect the calculation of aerosol optical properties and your conclusions about aerosol-meteorology interaction.

Non-BBA aerosols make such a small contribution to the AODs over the SAMBBA region (6 to 16%) that any deviations of those species from their climatologies will have had a negligible impact on our results.



Modelled ratio of BBA AOD to AOD from other species(sulphate+mineral dust+sea salt+soot+fossil fuel). PD1 is period 1, PD2 is period 2, Whole is for whole period. Top row shows CLIM and lower row PROG.

Page 18891, Line 9-13: Can you give a reference for this statement?

This statement is drawn from the Figure 2. We have individually analysed the other species such as sea salt, mineral dust and fossil fuels: these species contribution is very small when compared to large BBA contribution over the Amazonia region. Figure 2 now includes contours of BBA AOD, which show how BBA completely dominates the AODs.

Page 18892, Line 18892: Both MODIS and PROG AOD show large reduction in AOD from

PD1 to PD2 (Fig. 2). Given this, how did you find that effects of BBA were similar during both the periods of SAMBBA?

We mean to say that the effects of BBA qualitatively are similar but quantitatively vary. Our study found that, an increase in impact with increase in aerosols. For clarity, we have changed "During both periods of SAMBBA (PD1 and PD2) *pattern of* **impacts of BBA were found to be similar".**

Page 18892, Lines 18-19: Why are the radiative effects larger on day 2?

This is the case for CLIM and PROG so it cannot simply be from the change in AOD from day 1 to day 2. This is also the case for clear-sky as well as whole-sky, so is not simply due to the different changes in the cloud field between runs. The clear-sky radiative budget is a function of both surface temperature and the temperature and moisture profile of the column, we know these evolve in response to changes in the BBA (Figure 5 and the water vapour budget analysis, which reveals that overall impacts the atmosphere are drying in this study). These must combine to give larger radiative effects on day 2. However, we need to investigate these effects on medium, seasonal and climate scale. We will be investigating these impacts in the future SAMBBA studies.

Page 18892, Line 28: Why do you differ from Ten Hoeve et al.?

Ten Hoever et al. (2012) found BB decreased the net top of the atmosphere solar+IR irradiance modestly, but with large diurnal variation. Their study has both direct, semi direct and indirect aerosols impacts. Ten Hoeve et al. (2012) compared satellite-derived with modeled curves of aerosol optical depth (AOD) versus cloud optical depth (COD) and found that while biomass burning aerosol particles increase CODs with increasing AOD below ~0.2 due to stronger indirect effects than the cloud absorption effects (CAEs) plus semidirect effects (SDEs), BB aerosol particles decrease CODs at higher AODs due to stronger combined CAEs and SDEs than indirect effects. These results suggest that in regions of high BB emissions, BB particles should reduce COD, increasing solar transmission to the surface, warming the surface in a positive feedback. In our study, we have only direct radiative effects and BB aerosol reflect more shortwave radiation back to space. This would imply a cooling of the earth-atmosphere system in our study.

We have added

"**does not agree with results from Ten Hoeve et al. (2012) which showed a positive**

change for higher AODs *and included direct, semi direct and indirect aerosols impacts*

(i.e. Earth–atmosphere warming), *"*

to the paper text.

Page 18894, Lines 16-17: I don't see any red colors above PBL in Fig. 6a. I assume you want to say that green colors in Fig. 6a above PBL represent positive values but it is hard to understand from the color-bar whether these green colors correspond to positive or negative values. I suggest using blue colors for negative values and red colors for positive values. Could you also explain the large cooling seen at 300-400 hPa?

Page 18894, Lines 26-28: Why do you see a warming at 15 km?

We thank reviewer suggestion for changing the color bar. We have changed the color bar in the revised MS. The cooling between 300-400hPa and warming between 200-100hPa effects are addressed in the MS pages 18895-18896 Lines 23-3 and our results supports with others findings.

Page 18894, Lines 20-21: As previously mentioned, please check the statistical significance of these results.

"Differences in BL height in Figure 6b are not statistically significant but physically consistent with flux changes" , **and this is now stated in the text. However, we know that the decreased surface sensible heat flux in the runs with aerosol will lead to reduced entrainment and a shallower BL in the model, and the modelled change in BL height is consistent with this.**

Page 18911, Figure 3: I would suggest using different y-axis scales for different panels. For instance, it is hard to see variations for La Paz. Medellin does not add any value to the model evaluation and thus can be removed.

We thank the reviewer for suggesting the different y-axis scales for different panels. We have adjusted the figure in the revised MS. The variability of AODs at La Paz and Medellin can now be seen more clearly. We still include the Medellin station, as we think it is important to use all available AERONET data and including this plot does not take any additional space in the paper.

Page 18915, Figure 7: Can you use a different color scale to show some variability in ice and liquid cloud water differences? Right now, it looks like that only three values are possible.

As suggested by reviewer, we have used different colour-scale for the figure7. Please see the revised MS.

Page 18916, Figure 8: It is not clear whether white contour represent positive or negative values?

We have re-plotted this figure with negative contour values in dashed lines and positive contours in solid lines. Please find the revised MS.

Minor comments:

Page 18887, Line 4: Change "The weakened in the Hadley circulation causing" to "weakening of the Hadley circulation caused".

We thank reviewer for the suggestion. We have changed this sentence in the revised MS as follows below.

"*This resulted in a weakening of the Hadley circulation, causing small reductions in global precipitation but with larger reductions near the equator***."**

Page 18887, Line 9: Change Paolo to Paulo.

We thank reviewer for typo. We have included this in the revised MS.

Page 18887, Line 14: Add "direct" before "impact of".

We have not included "direct" here because, the SAMBBA projects aims to assess the direct as well as indirect impacts of Amazonian biomass burning aerosols on the regional and global radiation budget. Although this study presents direct impacts but we will be presenting indirect impacts as well in future.

Page 18889, Line 2: Can you please mention the source of chemical initial and boundary conditions?

This is now added to the paper text, *"Meteorological boundary conditions for all runs (3 hourly) are provided by the global operational NWP model (global GA3.1 configuration of the UK at N512 (25 km); Walters et al., 2011). In the PROG, the BBA is free-running for two days, with spin-up of BBA from the beginning of August."*

Page 18894, Line 5: Remove one "surface".
We have removed as suggested.