Responses to Anonymous Referee #2

This paper uses WRF-Chem model to explore the impact of biomass burning (BB) on atmospheric circulation and precipitation during the peak biomass burning season (March) in the Indochina Peninsula (ICP). Authors utilize observations to show that March BB aerosols can reduce precipitation over the ICP in March but increase precipitation from April 1-20, indicating the long-lasting effects of March BB aerosols on precipitation, but with opposite effects in the two months. However, it is hard to determine the causality between BB aerosols over the ICP and atmospheric circulation (and precipitation), just from observations. Therefore, two groups of WRF-Chem experiments: with control (CTRL) and sensitivity (BBER) model scenarios, were performed to discern the mechanisms responsible for these feedbacks of BB aerosols on precipitation. To discern the feedback effects.

The paper is very well-written with brevity and high-quality visualization of all results. The manuscript should be published once the following comments are addressed:

Responses: We greatly appreciate these comments and suggestions. The manuscript has been improved by considering these comments and suggestions. Our detail responses are given point by point below in blue. The revised text is highlighted in red.

Specific comments:

1) Section 4.1: Evaluation of model results

For comparison of CTRL AOD and Precipitation with MODIS and TRMM observations respectively, if possible, please provide some domain-wide statistical difference metrics (such as mean bias, mean error, RMSE, correlation, etc.). This will be helpful to quantify the predictive capability of the default model for the ICP region in this study period.

Responses: As suggested by the reviewer, we have evaluated statistics metrics (mean observation, mean simulation, mean bias, relative mean bias, RMSE, and pattern correlation) for AOD, precipitation and 850-hPa wind. We present them in Table S1 below (also in the supplementary):

Table S1. Evaluation Statistics for AOD, precipitation and 850-hPa wind.

Variable	Mean Obs.	Mean Sim.	Mean Bias	Relative Mean Bias (%)	RMSE	Pattern Correlation
AOD	0.44	0.33	-0.11	-25.63	0.23	0.71
Precipitation (mm day^{-1})	2.22	3.52	1.29	58.25	2.67	0.71
850-hPa zonal wind (m s^{-1})	-0.17	-0.55	-0.38	230.5	1.8	0.94
850-hPa meridional wind (m s^{-1})	0.44	0.30	0.14	-30.85	1.53	0.67

To present the model evaluation more quantitatively, we revised the sentence on Page 11 Line 236 as follows: "*The WRF-Chem ensemble-mean rainfall based on six CTRL members (Fig. 4b) shows a spatial pattern consistent with that in the TRMM and the pattern correlation is up to 0.71, although the model overestimates the convection in the northern tropical Indian Ocean, orographic precipitation in the northwestern ICP region, and rainfall south of Japan*".

We have also added this sentence on Page 11 Line 238 in our revised manuscript: "*It was reported that regional climate models, including the WRF, tend to overestimate precipitation due to deficiencies within the convective cloud and microphysical schemes (Caldwell et al., 2009; Argüeso et al., 2012)*".

The sentence on Page 12 Line 243 has been revised as follows: "*In general, the model can reasonably capture these observed circulation features with the pattern correlation of 0.94 and 0.67 for 850-hPa zonal and meridional wind components, respectively*".

The sentence on Page 12 Line 250 has been modified as follows: "*The spatial pattern of modeled AOD is consistent with MODIS satellite retrieval, with the pattern correlation of 0.71.*"

The following sentence has been added on Page 12 Line 252: "*The model simulation underestimates the AOD by 25.63% for the whole domain.*"

We have revised the last paragraph of this section on Page 13 Line 259 as follows:

"*Generally, the model reproduces well the spatial distributions of rainfall, circulation and aerosols. Specific evaluation statistics are summarized in Table S1. Given this, the ensemble-mean differences between CTRL and BBER (i.e. CTRL minus BBER) are used to examine the effects of BB aerosols and associated physical mechanisms.*"

2) Besides, discerning the direct and indirect effects via sensitivity experiments with and without direct or indirect effects, doing an HYPLIT trajectory analysis to look at BB emissions trajectories in the modeling domain for the March-April period, if possible is encouraged. Trajectories of air mass relative to the black box that outlines the main Indochina Peninsula (ICP; 93º–110ºE, 10º–24ºN), may aid the authors' current inferences more in explaining the opposite impacts in March vs April.

Responses: We have performed the HYPLIT model 96h (4 days) air mass trajectories forward run using the 1-degree GDAS meteorological data at four high BB emission sites (95.75ºE, 18.75ºN; 102ºE, 18.25ºN; 106.5ºE, 15ºN; 105.5ºE, 12.5ºN) representing northwestern Indochina Peninsula, northern Indochina Peninsula, mid-eastern Indochina Peninsula and southern Indochina Peninsula, respectively. The multiple iterations of the trajectory were calculated from March 1st to April 20th 2010 at every six hours. The cluster mean trajectories of air mass and their frequency analysis are showed in supplementary (Fig. S1). It is worth noting that we also only did the trajectory analysis for March, since the results were quite similar to those for March 1st–April 20th.

To better explain the cause of AOD anomaly pattern in Figure 5a, we have added the following text on Page 13 Line 265: "*The aerosol loading anomaly gradually decreased from northern ICP through the northern SCS up to the Northwest Pacific and the anomaly also declined westward from the ICP to the central Bay of Bengal (Fig. 5a). These are the results of BB aerosol dispersion downstream along with the subtropical westerlies and tropical easterlies. Lagrangian dispersion modelling for air mass shows that aerosols over the northern ICP can be transported to the northern SCS and southern China, while the aerosols over the southern ICP have westward trajectories of 11%–31% and partially reach the central Bay of Bengal (Fig. S1)*"

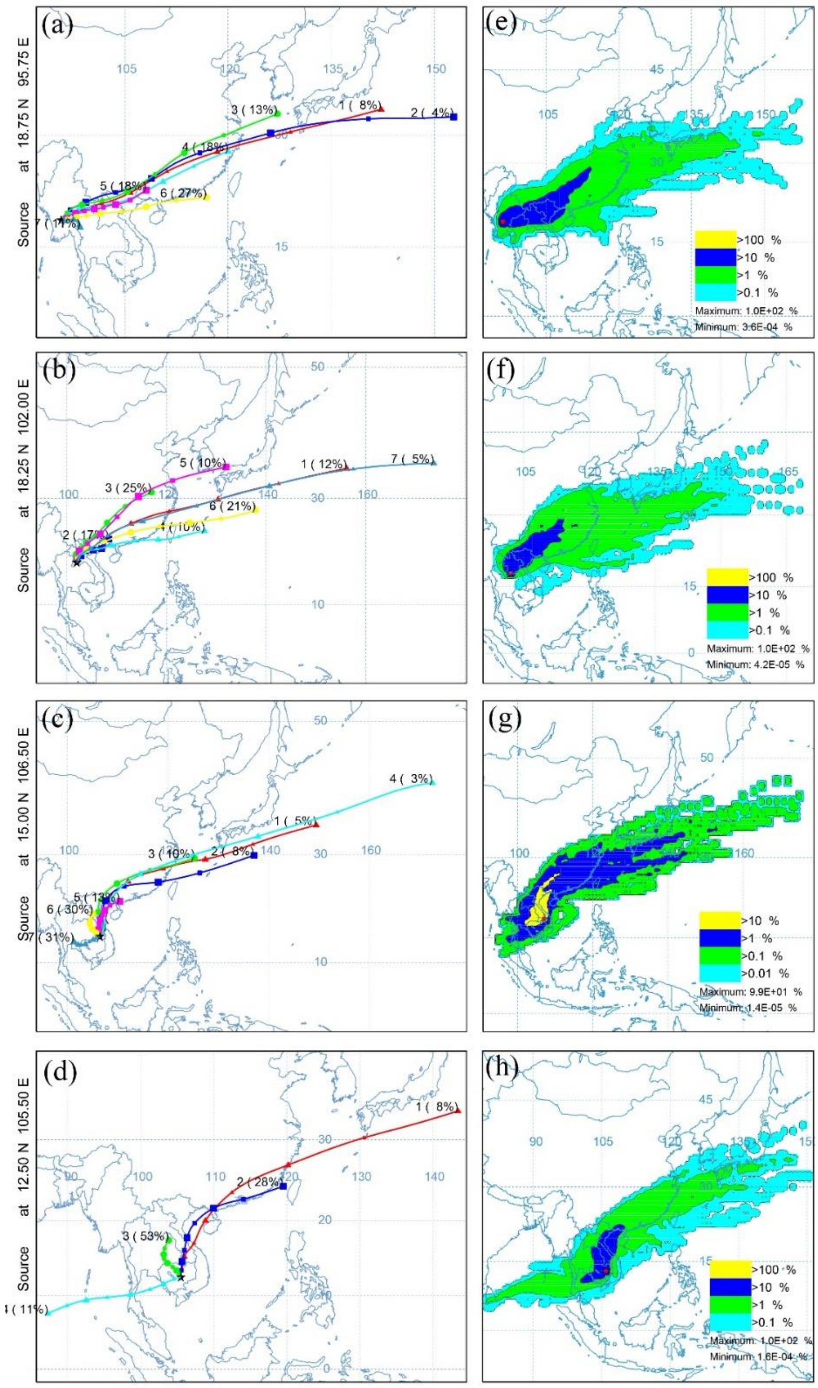

Figure S1: Distribution of cluster mean 96h (4 days) forward trajectories (a–d, left column) of air mass and their frequenies (e–h, right column) based on the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model for north-western Indochina Peninsula (a, e; 95.75 °E, 18.75 °N), northern Indochina Peninsula (b, f; 102 °E, 18.25 °N), mid-eastern Indochina Peninsula (c, g; 106.5 °E, 15 °N), and southern Indochina Peninsula (d, h; 105.5 °E, 12.5 °N) from March 1st to April 20th, 2010. The 1-degree meteorological data from the Global Data Assimilation System (GDAS1) was used to run the model. Note that we did the trajectory analysis only for March, since the results were quite similar to those for March 1st–April 20th.

3) Adding maybe a supplemental figure on the BB emissions for the ICP region focusing on the March-April season might be helpful in explaining the instant vs delayed impacts of BB burning aerosols in ICP regions' atmospheric circulation and precipitation patterns.

Responses: We have replaced Figure 2 by the one overlaid with March BC emission from BB and the time series of the BB emissions (BC, OC and SO2) for both CTRL and BBER runs (Page 6 Line 137). The new Figure 2 and its caption are shown below, and the sentence around Line 162, Page 8 has been modified as follows: "*The control experiment (CTRL) has the original BB emissions, while the sensitivity experiment (BBER) has the March BB emissions reduced to 15% (Fig. 2b)*."

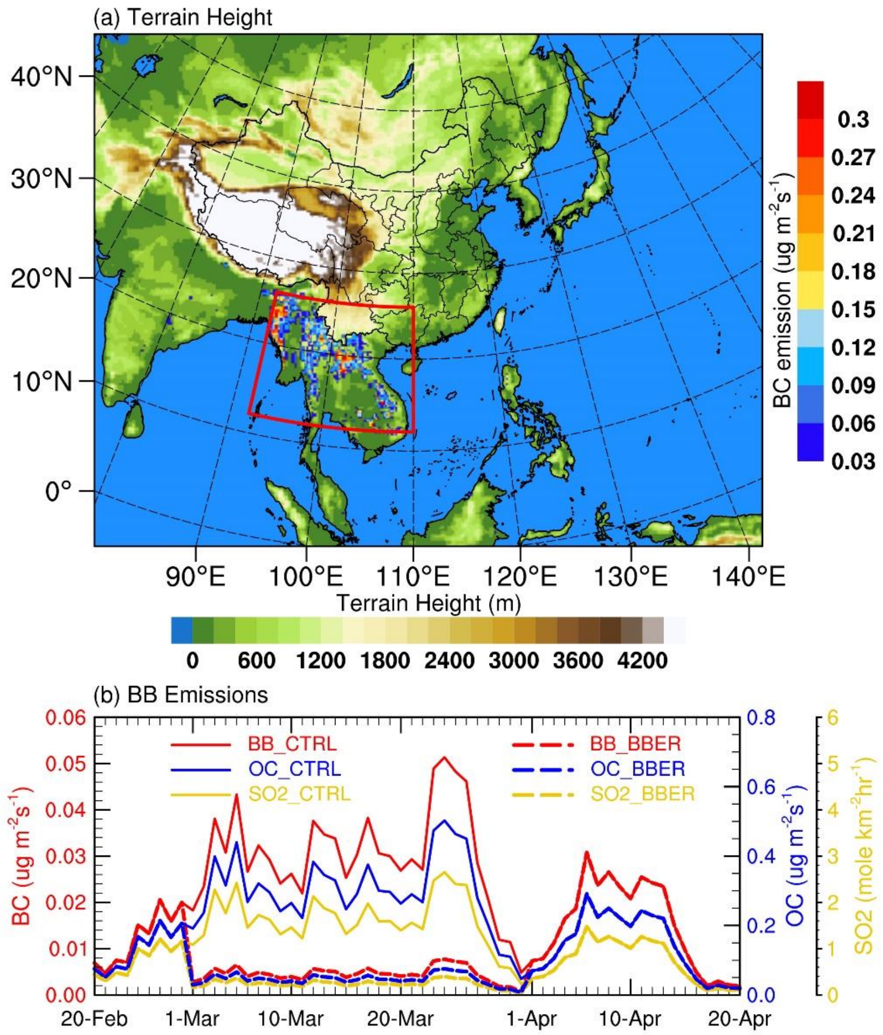

Figure 2: (a) Model domain, orography (shading; m) and March BC emission input in the model from BB based on the Fire INventory from NCAR (FINN) version 1.5. (b) The time series of BB emissions (BC, OC and SO_2) averaged over Indochina [92 °–110 °E, 12 °–26 °N; as outlined by the red box in (a)] from February

20th to April 20th 2010. The solid curves are the emissions for control experiment (CTRL). The dashed curves are the emissions for the sensitivity experiment (BBER), i.e., the March emissions are reduced to 15%.