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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Estimates of biomass burning emissions in tropical Asia based on satellite-derived data" *by* D. Chang and Y. Song

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Dear Referee,

We have manuscript entitled "Estimates of biomass burning emissions in tropical Asia based on satellite-derived data" (MS No.: acp-2009-431), and attach our responses to the comments in detail as another sheet in this cover letter.

We have recalculated the burned areas and fire emissions using March as the starting month for a fire year, and the results do not change greatly.

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We would like to appreciate you very much for your kindly help.

Sincerely yours

Song Yu

Responses to Anonymous Referee #2

"Estimates of biomass burning emissions in tropical Asia based on satellite-derived data" (acp-2009-431) by D. Chang and Y. Song

This paper describes the estimates of emissions from fires in southeastern Asia. The methods combine various datasets, including satellite burn area products to determine the emissions. The information provided in the paper is valuable, since the emissions from fires, particularly in this region of the world, is of great importance because they can impact air quality and climate. The authors compare the results when two different burned area products are used to estimate the emissions, highlighting the uncertainty in using such products for However, there are some changes and details that need to be included in the paper to make it eligible for publication. Most importantly are more specific descriptions about the uncertainties in the estimation process. I might suggest a new section in the manuscript which highlights the various uncertainties in the processes and datasets applied.

Response: Accepted. We evaluate the emission uncertainties using Monte Carlo simulation in our revised manuscript and add the discussion of uncertainties in Section 3.4.

Some more specific comments are here: Exactly what were the spatial and temporal resolutions of the emission estimates? For what purpose can they be used? (e.g., modeling?)

Response: Accepted. We added more comments about this emission estimation in the revised manuscript. The specific content is as follows:

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Both L3JRC- and MCD45A1-based emission inventories have a high temporal resolution (daily) and medium spatial resolution of 1 km (L3JRC) or 500 m (MCD45A1) and can be used in the simulation of global and regional atmospheric chemistry.

Page 19605, line 8: what is the GlobCarbon product? Is there a reference for this?

Response: GlobCarbon product refers to the GLOBCARBON Burnt Area Estimate (BAE) product. We also added a reference for this product in our revised manuscript (European Space Agency: GLOBCARBON, Demonstration Products and Qualification Report, version 3.1, 161 pp., 2006).

Section 2.2.3: much of the data used to determine fuel loading is older (the references are from the early-mid 1990's. How might this impact the results? How much has land cover changed in that region of the world since then? Also, what is the biomass expansion factor (Page 19607, line 1)?

Response: When determining the fuel load, we attempted to use the up-to-date biomass density data, e.g., Chhabra and Dadhwal (2004) for India, Shrestha and Singh (2008) for Nepal. But for most countries, the updated information was limited. As the biomass density for vegetation would not change significantly over two decades, we assumed the biomass density data for 1990s (Brown et al., 1993; Brown 1997) were applicable. Chhabra and Dadhwal (2004) calculated the aboveground biomass density for forest in India using biomass expansion factor (BEF), which is defined as the ratio of aboveground biomass density of all living trees of diameter breast height (DBH) that is equal or greater than 2.54 cm to growing stock volume density (GSVD) for all trees of DBH that is equal or greater than 12.7 cm. We are sorry our previous statement was not clear and we have revised this sentence.

Section 3.1: Why weren't years after 2006 analyzed?

Response: As L3JRC product only covers the period of April 2000-March 2007, and we focused on comparing the discrepancies between L3JRC and MCD45A1 burned

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area products, the burning occurrences after the fire year 2006 were not analyzed in this paper.

Page 19610, line 15: What is meant by “Indonesia processes about 80.4% of the total peatland..” ?

Response: We are sorry we made a spelling error and we revised the word “processes ” to “possess”.

Page 19610, line 29: reword to “. . . when India experiences high summer temperatures and dry weather conditions. . .”

Response: Accepted.

Page 19611, line 3: Change to “. . . January through March, which is the local dry season. . .”

Response: Accepted.

Section 3.2.1: Is it that surprising that the MCD45A1 and the GFEDv2.1 products compare well, since they are both based on MODIS observations? And on page 19612, line 11, what is meant by the line “It is noted that we did not include constant in equation”?

Response: (1)MCD45A1 and GFEDv2.1 products are both based on the MODIS sensor. But the algorithms for the two products are quite different. MCD45A1 product is produced from a change detection algorithm based on a bidirectional reflectance distribution function (BRDF) model (Roy et al., 2005), while GFEDv2.1 was produced based on calibrating the MODIS active fire data (Giglio et al., 2006). We also add this note in the revised manuscript. (2)We reworded the word “constant” to “intercept”.

Page 19613, line 12: this sentence is unclear and should be reworded.

Response: Accepted. We revised this sentence to “Ground studies of open fires in India have been limited by political intervention and practical difficulties, so existing statistical data tend to be small in scale.”

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Page 19613, lines 20-end (and again in section 3.2.5): Can the L3JRC see through clouds/smoke? Also, are boreal forests similar to those in India?

Response: (1) The L3JRC product is based on the direct detections by the SPOT VEGETATION sensor. Preprocessing is conducted to remove clouds and shadows, and postprocessing reconfirms the results (Tansey et al., 2008). Thus L3JRC product is defined without an unmapped class. (2)The L3JRC product has been evaluated globally using a large number of Landsat TM and ETM+ image pairs and a number of regional products derived from in situ or remote means (Tansey et al., 2008). Validation result suggested that it performed well in the forested regions. Tansey et al. (2008) indicated that as L3JRC is originally designed to detect fire activities in boreal forest, the good performance in forest was expected. We reworded this part in the revised manuscript.

Page 19614, line 10: Exchange “which” with “that”

Response: Accepted. We reworded this sentence.

Sections 3.2: the authors looked at differences in area burned between the two satellite products. Did they look at the differences in fuel burned from each? This could be valuable.

Response: We appreciate the referee’s suggestion and add more discussion about the differences on the biomass burned calculated from the two products in section 3.1 as follows: The annual amounts of biomass burned in tropical Asia for the seven fire years are summarized for each vegetation type in Table 1. The amount of biomass burned as calculated from L3JRC (74 Tg yr-1) was comparable to that from MCD45A1 (79 Tg yr-1), and they showed similar interannual variation, with a maximum in the fire year 2004 and a minimum in 2000. Of the total biomass burned, 28% of MCD45A1 was attributed to peat burning, whereas 63% of L3JRC was from peat land. This difference was probably caused by large burned peat area by L3JRC and high carbon density of SOC (63.65 kg C m-3).

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Page 19616, lines 15-18: I am surprised that a similar percentage of CO emissions come from peat in Indonesia for each input dataset, even though the MCD45A1 inventory showed much less peat burned than the L3JRC product. Can the authors explain this?

Response: We are sorry the previous description was not clear. The total emissions in Indonesia calculated from L3JRC and MCD45A1 were 8.5 Tg CO yr-1 and 4.1 Tg CO yr-1 respectively. Of the total L3JRC-based emission, 97% (8.2Tg) was contributed by peat burning, while 95% (4.0 Tg) of the total MCD45A1-based emission was from peatland. Although the burned peat area detected by MODIS was relatively small, the peat biomass loading (64 kg C m-3) was greatly larger than the biomass density for forest (about 16 kg C m-3) and for other fuels (e.g., grassland, agriculture). This led to the fact that peat burning made the biggest contribution to the MCD45A1-based emissions. We have revised this part.

Page 19616, line 22: reword sentence.

Response: After reviewing this part, we thought this sentence was not necessary and deleted it.

Page 19616, lines 27-29: There is a very large difference in the fuel loadings used for this study and those from other studies. Why is that?

Response: The difference may be explained by the fact that only the field crop residue was taken into account in our study as most agricultural burning in Asia occurs after the harvest season, when most farmers burn off the crop residue to get rid of it. The agricultural fuel loading in Levine (1999) and Heil (2007) contained many other fuels. For example, the agricultural fuels in Levine (1999) included the fuels in plantation areas (mainly rubber trees and oil palms), and the agricultural fuel loading used in Heil (2007) was an average value for agriculture, grassland, and savannah vegetation types. The biomass density for these fuels is higher than that for crop residue. This led to that their agricultural fuel loading was larger than ours. We added this point in the

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revised manuscript.

Page 19617, line 10: reword. Here is a suggestion: “Inventories of biomass burning emissions for all of Asia, representative of the mid-1990’s, have been . . ..”

Response: Accepted.

Page 19617, line 13: Change “theirs” to “these”. And remove “respectively” on line 14.

Response: Accepted. We reworded this sentence in the revised manuscript.

Page 19617, line 23: Change “undoubted” to “estimated”

Response: Accepted.

Page 19618, lines 1-3: This is mentioned several times in the paper and should be removed.

Response: Accepted. We deleted this sentence.

Page 19618, lines 12-18: More detail is needed here. Can the authors explain why the emissions are lower than other studies. Why were the fuel loadings so much lower? What happens when the fuel loadings from Hoelzemann et al. are applied?

Response: We appreciate the referee’s suggestion and add more discussion to explain why the emissions in our study were lower than previous studies. A comparison of the data used in calculating fire emissions suggested that the available fuel load values in this study, especially for forested regions, were smaller than those used in Hoelzemann et al. (2004) and van derWerf et al. (2006). The biomass density data used in our study were from previous studies, and the data in Hoelzemann et al. (2004) and van der Werf et al. (2006) were estimated from ecological models. The literature data applied in our work only assessed the biomass density for trees above a certain diameter (Brown et al., 1993; Brown, 1997), and consequently excluded most fire susceptible parts of the vegetation (Hoelzemann et al., 2004). The average forest biomass loading for all of Tropical Asia is 14 kg DM m-2 in our study, and the tropical forest fuel load is 29 kg DM

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m-2 in Hoelzemann et al. (2004). If we used the data in Hoelzemann et al. (2004), the estimated emission may be twice the present result in this study.

Page 19619, line 6: Why would the combustion factor increase as burning progresses? How does this impact your results when you are using a burn area?

Response: We are sorry that the previous description was not clear. Ito et al. (2007) studied the open fire emissions in Southern Africa. They calculated the combustion factor using an empirical formula and found it increased from June to September. As the burned area decreased during this period and fuel load and emission factor did not change greatly, the increase of fire emission was attributed to the effect of combustion factor. But in our work, as the burned area and fuel load were the key factors that led to the difference in fire emissions estimated from the two products, we did not consider the variation of combustion factor. We have deleted this sentence in the revised manuscript.

Table 2: Can fuel burned be added to this table?

Response: Accepted. We add the biomass burned in Table 1.

Tables 4-5: How reliable are the datasets to which the satellite estimates are compared (e.g., data from the Forest Fire Control Division)?

Response: The Forest Fire Control Division (FFCD) data were collected from 120 forest fire control stations in Thailand (Prayoonyong, Forest Fire Control Division, personal communication, 2010). This information could be the lower limit of the fire-affected area, as the forest fire control stations do not cover the whole Thailand. We have reworded this part in the revised paper. The information about the validation of the statistical data for Bhutan obtained from International Forest Fire News is limited, thus we are not sure about the reliability of the reference data. Generally, because of the practical difficulties, the survey data tend to be small.

Table 6: there are a lot of significant figures included in this table. Do you think that

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the values estimated should have 4 significant figures? I think two is more appropriate. (Same comment for Tables 7 and 8).

Response: Accepted. We revised Table 6, 7 and 8.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 19599, 2009.

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Interactive Comment