

The authors calculate four sets of global biomass burning (BB) emission estimates with bottom-up approach, through combining two different aboveground biomass (AGB) with two different land cover classification (LCC) datasets. Modeled atmospheric CO concentrations from four simulations that use these four sets of BB emission estimates are then compared with observations. This study is a useful reference for the large uncertainties introduced to BB emission estimates (and hence model simulations) from AGB and LCC. The following comments need to be addressed.

1. I found the abstract a little hard to understand without reading through the main text. Please consider revising it.

- For example, “We estimated four types of global BB emissions” is misleading and I suggest change it to “We developed four sets of global biomass burning emission estimates”.
- “We found a substantial spatial difference in CO emissions for both the AGB and LCC data ...” This sentence can be changed to “We found a substantial spatial difference in CO emissions result from the use of the AGB and/or LCC data”.
- “At ground-based observation sites during fire seasons, statistical comparisons indicated that the impact of differences in the BB emissions estimates on atmospheric CO variability was poorly defined in our simulations.” This sentence is very hard to understand without reading through the main text.
- Consider adding some numbers in the abstract. For example “The mean annual BB emissions with their standard deviation are 526 ± 53 , 219 ± 35 , 624 ± 57 , and 293 ± 44 Tg CO yr⁻¹, for GlcGlob, GlcGeoc, McdGlob, and McdGeoc, respectively.”

2. In the introduction, please acknowledge previous studies that attempted to address or quantify the uncertainties in BB emission estimates caused by land surface information (including but not limited to AGB, LCC, burned area etc) if there's any.

3. Line 81: “If a 1-km resolution grid point showed a fire flag on a particular day, then the 4 surrounding sub-grids with a 500 m resolution, located within the original MOD14A1 grid, were assumed to have burned; that is, $BA_{i,k} = 250,000 \text{ m}^2$.” I'm a little confused here. Shouldn't it be $BA_{i,k} = (500+500) \times (500+500) \text{ m}^2 = 1 \text{e}6 \text{ m}^2$?

4. Section 2.3: I'm wondering why the authors only pick three sites. And what are the reason(s) for choosing these three specific sites?

5. Line 125: Need more information on the description of MOPITT. For example, which MOPITT version are you using. And “mean XCO distribution products (L3V95.6.3; Deeter et al., 2014) retrieved from both thermal infrared and near infrared observations”, do you mean you used both TIR and NIR products separately, or used the joint product (JIR)? The model results need to be smoothed with MOPITT averaging kernel and prior profile before comparing to MOPITT, if you have done so please state it here for clarification.

6. Results: Please consider separate the results section to two sub-sections "comparisons of emission estimates" and "comparisons of model results".

7. Line 145: Figure 1 is for the year of 2009. While this info is included in the figure caption, it needs to be also included here in the main text.

8. Adding figures of global maps for the four datasets you use would be more intuitive for readers (2 LCC and 2 AGB).

9. Figure 2: This figure provides mean and standard deviation of the four BB emissions estimates. While this is useful, please also provide maps for the 4 estimates so that it's more intuitive and straightforward.

10. The authors compared their global total CO emission estimates with that from Andreae (2019), which is very useful. It would be nice if the authors can also provide comparisons of regional total CO emission estimates to other emission inventories. The main goal of this paper is to demonstrate the large differences in the emission estimates caused by AGB and LCC. For this purpose, Figures 2 & 3 are not enough. It would be helpful to show more detailed comparisons of the four estimates. For example, results for more regions such as those in which the three ground sites locate, or the six regions highlighted in Figure 6, or the 14 GFED regions.

11. Line 190: Change “we compared each BB estimate in the atmospheric CO field” to “we compared modeled CO fields using each BB emission estimate.”

12. Section 3: If I understand correctly, the four emission estimates are monthly. Comparing model results driven by monthly fire emissions to daily observations is not informative as fire events are episodic. Model will not capture fire-induced daily variability from observational data. As shown in Figure 5, the model-observation agreement is poor. The author also noted this issue in the Discussion section. I suggest either (1) downscale the emission estimates to daily resolution with active fire detection satellite products and re-run the model, or (2) average the daily observations to monthly before doing the comparisons.

13. Line 221: Please change “Monthly mean XCO variations and the root mean square error (RMSE, ppb)” to “Monthly mean XCO and the root mean square error (RMSE, ppb)”. It was confusing.

14. Line 222: I'm wondering if there is a specific reason for choosing southeast North America instead of Pacific Northwest?