

Review of “A comprehensive biomass burning emission inventory with high spatial and temporal resolution in China”

This study addresses what the authors believe are key weaknesses of current biomass burning emission inventory for China: 1. Missing sources (in particular firewood), 2. Incomplete or source specific EF, 3. Estimates of crop straw utilization and its variability across regions/provinces, 4. Province level resolution of available inventories is not appropriate for modeling / evaluation emission impacts of atmospheric chemistry, climate or health.

#### SPECIFIC COMMENTS:

P1, Ln 25-26 “Corn, rice and wheat represent the major crop straws, with their total emission contribution exceeding 80% for each pollutant.”

Please clarify for which pollutants (“each pollutant”) crop straw combustion accounts for 80% of total emissions. Do they refer to SO<sub>2</sub>, CO, CH<sub>4</sub>, and Hg? Or all pollutants listed in lines 20-21? Do the authors mean that the combined emissions of corn, rice, and wheat account for 80% of the inventory total emissions of specific pollutants?

Statements regarding emissions of EC and NH<sub>3</sub> are contradictory, please clarify / correct:

P1, Ln 24-25 “...firewood contributes most to EC and NH<sub>3</sub> emission.”

P1, Ln 26-27: “Corn straw burning has the greatest contribution to EC, NO<sub>x</sub> and SO<sub>2</sub> emissions; rice straw burning is dominant contributor to CO<sub>2</sub>, VOC, CH<sub>4</sub> and NH<sub>3</sub> emissions”

P1, Ln 31: “The temporal distribution shows that higher emissions occurred in April, September, and October during the whole year.”

This statement is unclear. Do the authors mean that the combined emissions from April, September, and October exceeded emissions for the remainder of the year? Please clarify.

P2, Ln3: “haolocarbon” important to secondary chemistry?

P2, Ln17 change “critical” to “significant”

P2, L2: “The amount of straw outdoor burning in China in 2009 is 0.215 billion tons (MA,2011).”

This should statement should be qualified e.g. change: “is” to “was estimated as”.

Also, please provide a couple lines describing the data and the source of data, since the citation is not readily accessible.

P4 L3: Please provide a citation for the “energy statistical yearbook” and provide a brief (1 sentence) description of the yearbook.

P4, L7 “statistical yearbook” is this the “energy statistical yearbook”? Please clarify.

P4, L11 “yearbook” is this the “energy statistical yearbook”? Please clarify.

P5, L1 delete “including” before “domestic combustion”

The authors use the term “field burning” to refer to burning of crop residue in the field, and grassland and forest fires. The widely used terminology in biomass burning research refers to in-field crop residue burning, grassland, and forest fires as “open burning”. The author should use this terminology not “field burning” when referring to the combined crop residue, grassland, and forest burning. The use of “field burning” by the authors is inconsistent with accepted terminology and is confusing, a forest is not a “field”.

P5, L11 What is the unit “a” in Mg/a?

P5, L23: Please clarify the source of data in Figure S1 (statistical yearbook?) and note that it is prefecture level.

Table 3. Are the superscripts denoting reference for Nk also the references for Dk and CEk? Please clarify.

Section 2.2.2 Firewood.

Please clarify exactly which regression equation(s) were used to predict firewood consumption.

P6, L26 What is the unit “a” in ton/a? Is a = “annum”? If so I recommend using year (“yr”) instead. Also, is this metric ton?

P6, L26: “damaged area” = “burned area”? I assume by “damage area” the authors mean burned area. I recommend the authors use “burned area” instead of “damaged area” for consistency with biomass burning literature and accepted terminology. From an ecological standpoint a burned forest or grassland is not generally “damaged” since fire is a natural part of many if not most ecosystems.

P6, L29: More details are needed on the data used and the method used to determine the spatial and temporal distribution of burned area.

1. Describe the “damaged area” data from NBSC (2013c) and NBSC (2013d).
  - a. Is the data county level, prefecture level, province level?
  - b. What is the time resolution of the data (annual, monthly, daily)?
  - c. How was the data collected, e.g. is it based on administrative reports from local land management agencies?
  - d. Does the dataset include both wildfires and fires used for ecosystem management, e.g. clearing logging debris or rangeland burning for grazing?
2. Provide a web link to where the references NBSC (2013c) and NBSC (2013d) can be accessed.

P6, L31: A more detailed description of the forest and grassland biomass and combustion efficiency data is needed:

1. Provide a web link to where the references Tian et al. (2003), Lu et al. (2011), and EPD (2013) can be accessed. If they are not accessible, the work is not reproducible.

2. What forest components does the biomass number listed in Table 4 include? Organic soil/duff, litter, down dead wood, understory herbs and shrubs?
3. Is the forest biomass derived from forest inventory data?
4. The combustion efficiency of forests is 0.1 – 0.2. Is this because much of the forest biomass numbers include boles and branches of live trees which do not burn?
5. Does grassland category include shrub lands?
6. Please comment on how the biomass loadings and consumption estimates used in this study compare with those used in previous global emission inventories (e.g. GFED, van der Werf et al., 2010; FINN, Wiedinmyer et al., 2011) and surveys of fuel consumption (e.g. van Leeuwen et al., 2014) and studies of grassland biomass in China (e.g. Ni, 2004; Ma et al. 2016; . Zhao et al., 2014)
7. The value of 1800 kg/ha (180 g/m<sup>2</sup>) used in this study compares reasonably well with Ni (2004) study of northern China Northern (325.5 g/m<sup>2</sup>).

P7, L1 Units for grassland biomass are kg/ha while other quantities are listed as kg/hm<sup>2</sup>. While these units are equivalent, please be consistent by using either ha or hm<sup>2</sup> throughout the manuscript.

Table 4. Note the units for forest biomass.

P7, L10: Provide a web link to where the references EOCAIY (2013) and NBSC (2013b) can be accessed

### Section 2.3 EFs

The VOC emissions factors for forest, grasslands, open residue burning, and feces burning seem quite low compared to those reported in extensive reviews such as Akagi et al. (2011). I imagine the difference is that the VOC category in Table 5 & 6 include only a subset of VOC present in biomass smoke and measured in other studies. Please comment in the differences.

### Section 2.4 Spatial Distribution

Is the land use data of Ran et al. (2010) publicly available? If so, please provide a web link where it may be accessed.

Figure 2 is not very useful. It should be replaced with or augmented with table that provides the total emissions and percent of each species by source.

### Results and discussion

Please include a table providing total annual fuel consumption and emissions for the 12 species in Table 7 by source. This will be needed to compare current paper to previous studies that may have focused on only a subset of sources.

P9 L15-16 Please note the total annual burned area of forest and grasslands.

Figures 4 & 5 are difficult to read and the data would be better presented as tables, perhaps in the supplement.

P13, L13-14: Are specific crops typically burned harvest season, sowing season, or both? Or does it vary by region and practice?

### Section 3.6

Please describe how parameters were estimated for the PDFs used in the Monte Carlo simulation.

Figure S4. Please note the data sources used to derive the non-carbon PM components.

### **TECHINCAL**

The manuscript contains many minor grammatical errors, here are a few:

P13, Ln3-4: Change "This is because the main contribution of these species emission sources is from straw outdoor burning" to "This is because straw outdoor burning is the main source for these species"

P13, Ln 4: change "The outdoor burning straw mainly occurs in..." to "The outdoor burning of straw occurs mainly in..."

P13, L19 insert "a" between "have" and "relatively" and change "peak" to "peaks"

P13, L20: change "discrepancies" to "differences"

P13, L28: change "while" to "where"

P14, L7: change 'peak" to "peaks"

P14, L14: Change "Besides" to "Additionally"

P16, L23-25 Sentence beginning "More localized EF of..." is jumbled and must be rewritten

### **REFERENCES**

Akagi et al. (2011) Atmos. Chem. Phys. 11, 4039-4072.

Ma, A. et al. Carbon storage in Chinese grassland ecosystems: Influence of different integrative methods. Sci. Rep. 6, 21378; doi: 10.1038/srep21378 (2016).

Ni (2004) Plant Ecology, 174, 217-234.

van der Werf et al. (2010) Atmos. Chem. Phys., 10, 11707-11735

van Leeuwen et al. (2014) Biogeosciences, 11, 7305-7329.

Wiedinmyer et al. (2011) Geosci. Model Dev., 4, 625-641

Zhao et al. (2014) Remote Sens. 6, 5368-5386.