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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Chemical characterization of fine particulate matter emitted by peat fires in Central Kalimantan, Indonesia, during the 2015 El Niño" *by* Thilina Jayarathne et al.

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Referee #1 General Comments: Jayarathne et al. characterized in-situ particulate matter emitted from 18 peatland fire plumes in Indonesia. The authors have performed thorough and careful analysis of their samples, including an impressive suite of organic and inorganic chemical analyses. They determined that PM emissions from peat fires are overwhelmingly composed of organic carbon that is largely hydrophobic and with a lower OM:OC than observed in other biomass burning experiments. The paper is well written and will be of interest to the scientific community. I recommend publication

following the minor corrections and clarifications noted below.

Response to Referee #1 General Comments: We thank the reviewer for their assessment of the manuscript and their suggestions to improve it. We have incorporated their suggestions into the revised manuscript and detail the changes in response to their specific comments below.

Referee #1 Specific Comment 1: Page 3, line 2: "Thus, a mobile lab. . ." The end of this paragraph feels out of place and would fit better merged with the last paragraph of the Introduction.

Response to Referee #1 Specific Comment 1: As suggested by the reviewer, we have moved the text previously located at the end of the first paragraph of the introduction to the beginning of the last paragraph of the introduction.

Referee #1 Specific Comment 2: Page 4, line 3: Missing space in "spreadslowly".

Response to Referee #1 Specific Comment 2: We thank the reviewer for pointing this out and have corrected this as suggested.

Referee #1 Specific Comment 3: Page 4, line 8: 'which' should be 'with'.

Response to Referee #1 Specific Comment 3: We agree with the reviewer and have revised the text as suggested.

Referee #1 Specific Comment 4: Page 7, line 11: "The samples were collected directly from visible plumes in smoldering peat." Approximately how far from the smoldering peat were the samples collected? This is relevant later in the text when comparing measured EFs to laboratory studies of peat fires (e.g., pg 15, line 7).

Response to Referee #1 Specific Comment 4: We agree that this information is important to include and have changed the text at the beginning of section 2.2 on Sample Collection to now read: "The sampling inlet was mounted on a ∼2.5 m pole to allow sampling of smoke from a safe distance. The inlet was positioned approximately 2-3 m

downwind of the smoldering peat at a point where the plume of smoke had cooled to near-ambient temperature."

Referee #1 Specific Comment 5: Page 8, line 4: "the plume of smoke cooled to near-ambient temperature, to allow for gas-particle partitioning to equilibrate prior to sample collection." Gas-particle partitioning will continue to change at ambient temperature due to plume dilution. Please rephrase the sentence.

Response to Referee #1 Specific Comment 5: We agree with the reviewer and have removed the phrase implying complete equilibration as shown just above. The aerosol evolution over its complete lifetime is beyond the scope of this paper.

Referee #1 Specific Comment 6: Pg 14, lines 8-10: "The percent difference across duplicate samples was 57%, 37%, and 8% for plumes E, F, and W, respectively, indicating temporal variability in emissions from a single plume as the peat fire progresses." Please add further details regarding the timing of the duplicate samples. "Duplicate" implies parallel sampling, whereas the quoted discussion suggests sequential sampling.

Response to Referee #1 Specific Comment 6: We agree with the reviewer that the collected samples are not duplicates and indeed were collected in sequence. We have made several improvements to clarify this:

In section 2.1 we now state: "Two PM samples were collected from plumes E, F and W, bringing the total number of PM samples to 21. Because of the variability in PM emissions within a single plume, both values were used in calculating study-averages.

In section 2.2 we now state: "PM samples were collected over a period of 9-30 minutes each, at PM2.5 concentrations that averaged 15 mg m-3 and ranging from 1-40 mg m-3. The duration of filter sample collection and PM2.5 concentrations sampled are summarized in Table S1 for each plume. For plumes with two samples collected, the time over which samples were collected were comparable and the sampled PM2.5

concentrations were within a factor of three."

In the footnote to Table S1, we added a reference to Stockwell et al. (2016, Table S1), which provides additional details including sampling location, peat type, burning inclusions, burn depth, surface fuels, temperature, relative humidity, wind, and other sampling notes.

And finally, section 3.1 now reads: "The percent difference across samples collected sequentially from the same plume was 57%, 37%, and 8% for plumes E, F, and W, respectively, indicating temporal variability in emissions within the fire as it progresses."

Referee #1 Specific Comment 7: Pg. 20, line 17: Missing space "emissionsfrom"

Response to Referee #1 Specific Comment 7: We thank the reviewer for pointing out this typo and have revised the text as suggested.

Referee #1 Specific Comment 8: Pg 21, lines 13-17: Has the VA:SA ratio been measured in smoke from other fuel types? Is a ratio of _1.9 specific to peat smoke or biomass burning smoke in general?

Response to Referee #1 Specific Comment 8: We agree with the reviewer that it is necessary to further elaborate upon this point. We have revised text in section 3.5.3 to read:

"3.5.3 Lignin decomposition compounds Syringaldehyde (S), vanillin (V), syringic acid (SA) and vanillic acid (VA) derived from lignin pyrolysis were quantified, with a combined EF ranging 15-154 mg kg-1 and averaging 80$\pm$50 mg kg-1 (Table S1). Correlations among aldehydes (V and S) were not significant, possibly due to V partitioning to the gas phase, as indicated by its detection on backup filters, whereas other species (S, VA, and SA) were detected only on front filters indicative of particle phase species. We examined the potential of the VA:SA ratios to be useful in distinguishing this source from other types of biomass burning, since VA:SA depends on the lignin composition of the biomass (Simoneit et al., 1999). A significant moderate correlation was observed

between EFVA and EFSA (R2=0.65; p=0.004). Based on linear regression analysis, VA:SA was found to be 1.9±0.2 for freshly emitted peat smoke in this study (Figure 7). This value agrees well with observations of VA:SA in PM2.5 in Malaysia affected by Sumatran peat fires, which had a VA:SA ratio of 1.7±0.4 (Fujii et al., 2015b) and the ratio of vanillyl phenols to syringyl phenols ratio of 2.0 reported for Kalimantan peat (Orem et al., 1996). Meanwhile, other studies indicate lower VA:SA ratios for near-source emissions of Sumatran peat burning (1.1±0.4) (Fujii et al., 2015a) and laboratory burning of South Sumatran peat (0.11) (Iinuma et al., 2007). Because other biomasses in South Asia have VA:SA that fall in this range, such as bamboo (1.17) and sugar cane (1.78) (Simoneit et al., 1999), this ratio is unlikely to be useful in distinguishing peat burning from other types of biomass burning in the absence of other distinguishing chemical or physical properties. Further, syringyl compounds degrade more quickly in peat compared to vanillyl compounds (Orem et al., 1996) and post-emission SA degrades more quickly than VA by photolysis in the atmosphere, such that VA:SA is likely to increase with smoke transport (Fujii et al., 2015b). Consequently, this ratio has limited utility in source identification and apportionment."

Referee #1 Specific Comment 9: Pg. 27, line 12: typo "peatl"

Response to Referee #1 Specific Comment 9: We thank the reviewer for pointing out this typo and have revised the text as suggested.

Works Cited

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Iinuma, Y., Bruggemann, E., Gnauk, T., Muller, K., Andreae, M. O., Helas, G., Parmar, R., and Herrmann, H.: Source characterization of biomass burning particles: The combustion of selected European conifers, African hardwood, savanna grass, and German and Indonesian peat, Journal of Geophysical Research-Atmospheres, 112, 26, D08209, 10.1029/2006jd007120, 2007.

Orem, W. H., Neuzil, S. G., Lerch, H. E., and Cecil, C. B.: Experimental early-stage coalification of a peat sample and a peatified wood sample from Indonesia, Organic Geochemistry, 24, 111-125, https://doi.org/10.1016/0146-6380(96)00012-5, 1996.

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Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2017-608/acp-2017-608-AC1-supplement.pdf

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