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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Field measurements of trace gases and aerosols emitted by peat fires in Central Kalimantan, Indonesia during the 2015 El Niño" *by* Chelsea E. Stockwell et al.

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Response to Referee #1

We thank the Referee for their encouraging assessment and constructive suggestions, which will improve the paper. The Referee comments are reproduced below followed by our detailed response.

Anonymous Referee #1

The manuscript "Field measurements of trace gases and aerosols emitted by peat fires in Central Kalimantan, Indonesia during the 2015 El Niño" presents the first field emission measurements of comprehensive atmospheric compositions from peat fires

burning in Southeast Asia. This kind of field measurements is extremely rare and thus very valuable to the scientific community of Atmospheric Chemistry and Physics. The measurement methods used in the study are well established and the field experiment design is reasonable and justified. I expected this manuscript would only reported emissions from a rarely studied environment (which itself would add values to literature), but the discussion on the representativeness of the field measurements, comparison to previously available emission factors for the same type of emissions is very useful too. The authors also compare the field measured emission factors to those obtained from lab experiments, and discuss the value and importance of lab data. Peat fire burning in Southeast Asia is such an interesting and important topic from atmospheric chemistry and climate perspectives but many questions still remain as first order research problems due to the limited field data. I believe the manuscript could be much improved in terms of how to scale the field data to a large spatial area in this region, but I understand that the study is also limited by prior data and resource that could be deployed. The manuscript is well written in general, while the readability could be improved by properly introducing acronyms. In summary, I think this manuscript could be published and I list a few minor suggestions as below:

R1.1: The manuscript points the importance and uniqueness of 2015 El Niño event. The authors need to comment on how this field measurements during a El Niño event apply to other 'normal' years, or do the authors suggest that these field measured emission factors can only apply to El Niño events? Can the difference between lab and field comparison be partly explained by the special El Niño event?

Authors: This is an excellent question. The emissions are "possibly" of greatest interest during El Niño years when the "acute" impacts are greatest. For now we can only assume that the emission factors for burning peat (g/kg peat burned) are probably similar in all years, but the total emissions (Tg/yr) are smaller in non-El Niño years when the fire season is not as severe and the amount of peat burned is reduced. However, the summed emissions from several non-El Niño years will surely rival the

emissions from an El Niño year. We don't know enough about what drives the variability in peat-fire emission factors at this point to speculate whether El Niño will drive interannual variability in peat-fire emission factors or lab/field differences, but we do plan future measurements designed in part to probe geographic and inter-annual differences. We're not sure if we should address these questions in this paper, but we now clarify that despite the recent increase in non-El-Niño year emissions, the El Niño year emissions are still anomalously large at P3, L19:

Old text: "With accelerated deforestation and building of drainage canals (e.g. 4000 km of canals as part of the Ex Mega Rice Project (EMRP) started in 1996 (Putra et al., 2008; Hamada et al., 2013)), peat fires and their impacts are now extensive on an annual basis (van der Werf et al., 2010; Wiedinmyer et al., 2011; Gaveau et al., 2014)."

New text: "With accelerated deforestation and building of drainage canals (e.g. 4000 km of canals as part of the Ex Mega Rice Project (EMRP) started in 1996 (Putra et al., 2008; Hamada et al., 2013)), peat fires and their impacts are now extensive on an annual basis (van der Werf et al., 2010; Wiedinmyer et al., 2011; Gaveau et al., 2014) and even more pronounced in El Niño years (Huijnen et al., 2016)."

Regarding the difference between lab and field results, while the 2015 El Niño explains larger overall emissions, the lab/field comparison is based on emission factors (g/kg) relative to units of peat burned, and as a result we believe the comparison should be useful.

R1.2: Related to point 1: This manuscript finds that many significant revisions of emission factors compared previously widely used EFs, mostly reductions (CO2, CH4, NH3). But as the authors point in the introduction, previous studies suggest "in Southeast Asia, in the 1980s-1990s, peatland fires were a major source of carbon to the atmosphere mainly during El Niño induced droughts : : :. " How can the authors reconcile this? The manuscript uses "the 2015 El Niño" in the title, and the authors would be expected to comment more on this event. However, such comments are very rare

in this version of the manuscript.

Authors: We think the Referee is wondering if we mentioned El Niño in the title because we think El-Niño changes the chemical nature of emissions. Our inclusion of El Nino in the title was just to point out the data was collected in a year responsible for a large fraction of the total emissions from the region on a multi-year time-scale. I.e. we went in a year when the conditions were associated with more emissions than most other years. This doesn't prove the data is more relevant, but it is a good choice in case the peat-fire emission factors do change inter-annually. Hopefully this is clear now that we clarify (as described above) that the largest "acute" impacts occur in El Niño years.

R1.3: P5 L14: the definition of fuel moisture is not clear. What is 'wet', what is 'dry'? Here and many places in the manuscript, the authors assume all readers know most of acronyms related to fire studies. Properly introducing them could help the manuscript reach a broad audience of atmospheric scientists.

Authors: Thank you for this comment. We have changed text to read: "Peat deposits can burn at $>$ 100% fuel moisture (defined as 100 $\times$ (wet?dry)/dry)), where "wet" refers to the weight of a fresh fuel sample and "dry" refers to the fuel weight after oven drying until mass loss ceases. This is because the glowing front pre-dries the fuel as it advances."

R1.4: P7 L29: 'cyclones' should be 'cyclone samplers'? The authors need to avoid using 'field language' as much as possible and try to use its formal name.

Authors: Changed (P7, L31 in the revised text).

R1.5: P8 L15: poorly written.

Authors: We made this more definitive by changing to: "Styrene is known to decay in canisters and the styrene data should be taken as lower limits."

R1.6: P8 L21-22: here and other places, the instrument modes and manufactures should be listed as full names with company names and locations.

Authors: We added this information here and in many other places. In just a few cases we skipped to avoid overly long sentences since the supplied info is enough to locate further info on the web.

R1.7: P 9, session 2.2.5: it is unclear if any control (or blank) samples were deployed for these offline measurements? For example, pre-cleaned filters shipped with other filters but without any sampling.

Authors: We did collect field blanks, but since we elected to subtract background filters from source sample filters the field blank correction cancels mathematically. I.e. S-B = (S-c) - (B-c) = S-c-B+c. At P10, L10 we added: "While field blanks were collected, subtracting the background from smoke samples made the field blank correction unnecessary."

R1.8: P13 L13-15: it would be very valuable if those peat characteristics were mapped and it could help to scale these point measurements to large areas and perhaps devise a parameterization to study other peat fire emission. It is very unfortunate that this study did not attempt such an analysis. What would be the authors' recommendations to future field studies? It would be useful for other researchers who are interested in this area.

Authors: We agree this is a logical, important thing to wonder about and that is why we mentioned it. However, we are not sure if there are peat characteristics that correlate with emission differences. We also don't know how well characteristics such as peat type, moisture, etc could be mapped in 3-D along with burn depth. If these connections exist and could be mapped/scaled it would require a substantial additional study. Another Referee questioned the relevance of this inconclusive text so we ultimately deleted it.

R1.9: P15 L 36: what is 'rapid green-up'. Again, the manuscript could be improved and reach a broader audience if these words were properly defined.

Authors: "Green-up" is a forestry term to describe the emergence of fresh new vegetative growth, which is "green" rather than the "black" as might be expected for a burn scar, or "brown" due to a drought, etc. We changed "rapid green-up," to "rapid growth of new vegetation,"