

General comments:

This manuscript presented an extensive experimental data set for both fresh and aged PM_{2.5} source profiles of smoldering-dominated combustions of peat collected from six geographically different areas, representing four main climate regions. The reported results could provide a good reference for the emission factors especially of organic and elemental carbon species before and after atmospheric aging processes, facilitating better constrained modelling studies based on receptor-oriented source apportionment analysis. However, the reasons for the similarities and differences in the corresponding source profiles of the six types of peat seem to be not well explained; and discrepancies between 2-day and 7-day aging which relate to the influence of photochemical aging on the evolution of chemical characteristics of biomass burning particles are lack of further interpretation. Details about the oxidation experiments using the PAM-OFR are insufficiently provided, although which might have been described elsewhere. The OH exposure or the photochemical age is definitely important, while other parameters such as the initial concentration of gaseous precursors, humidity, and seed particles are also key to the heterogeneous oxidation processes. Differences in the final products and their yields are therefore dependent on the abovementioned influence factors and some wall-loss effects during different chamber experiments. In this sense, how can the authors conclude that the volatilization of SVOCs during longer aging processes would serve as the main cause for the reduction of OM abundance in PM_{2.5}? More convincing explanation and corresponding evidence/data are necessary.

In general, this work contains a large number of chemical data characterizing the emission factors of laboratory-generated peat smoke particles, which could be useful for air quality modeling and further application in biomass-burning-aerosol-related research fields; yet some details and further interpretations need to be clarified and improved accordingly. I would suggest a major revision on the current version before consideration for the final publication in AMT. In addition to the above concerns, some specific comments are detailed as below.

Major comments:

1. As stated in the general comments, one of the major concerns is the determinant reason behind the reduction of OM abundance in PM_{2.5} after an even longer photochemical aging. Further discussion would be required for the identification of the crucial influence from volatilization of SVOCs.
2. Table 1 summarizes the average PM_{2.5} source profiles for both fresh and aged peat samples of six different origins. The detailed chemical information could be quite useful. While my major concern is that why the mass fraction of WSOC in PM_{2.5} decreased after experiencing 2-day or 7-day aging for most of the peat samples? Besides, the WSOC fraction of Aged 7 was almost lower than that of Aged 2; what is the reason? This seems to be opposite to the general results concluded in previous studies which suggest that the oxygenated organic fraction tends to increase with atmospheric aging processes, contributing to a higher water-soluble organic fraction as the oxygenated organics are normally more polar/water-soluble than fresh biomass burning organic compounds. More in-depth discussion is necessary.
3. Page 9, Line 213-214: The analysis for PM_{2.5} Florida peat source profiles suggested that the two subtropical profiles should not be combined with other biomes. In this sense, how should the readers understand the equivalence measures for combined 'Subtropical + Temperate', or rather 'Florida + Alaska' in Table 2, where a high P-value was also reported? Consequently, how about the related experimental data for these two types of peat source profiles? Related clarification is needed.

Specific comments:

1. **Abstract:** The expression of '5 orders of magnitude' sounds confusing. Is it supposed to be the discrepancy between reactive/ionic species and the carbon

content, within ~3 orders of magnitude? Following this, the authors mentioned about ‘the two distinguishable clusters’ in Sect. 3.3 of Line 244, Page 10. I would agree that species abundance in PM_{2.5} mass percent > 1% or 10% are distinct. However, it’s not clear to me why the results around 0.1% were regarded as one distinguishable cluster, as quite few data were actually covered within this range as displayed in Figure 2. Please clarify this point accordingly.

2. **Abstract:** It’s a bit strange to say ‘low temperature OC’; are you trying to mean ‘highly volatile OC’?
3. What is the relationship between ‘Elemental Carbon (EC)’ and ‘EC1, EC2, EC3’ in this study? I assumed the EC here was the sum of EC1+2+3, similar to that of OC; however, the mass fraction of EC is much lower than that of EC1 or EC2, as summarized in Table 1. Please provide the corresponding discussion.
4. **Figure 3:** Why does the ratio of EC of Borneo, Malaysia increase for the A2/F2 but decrease for the A7/F7 scenario, which is different from all the other types of peat? Additionally, do you have any idea on the increase of EC ratio for the A7/F7 case of Pskov, Siberia?
5. In Sect. 3.4.2, the authors used the IMPROVE soil formula by Malm et al. (1994) to calculate the mass of mineral components. How did you think of the uncertainty in such an estimation, considering that large variabilities in the corresponding mineral species even exist for the six different types of peat? Further, is it appropriate to apply an empirical equation for the US country into the conditions for different origins representing various climate regions (i.e., boreal, temperate, subtropical, and tropical)? Corresponding details are preferred.

Technical corrections:

1. **Abstract**, line 37: “...*the reduction of OM abundances in PM_{2.5} by 3–18 % after 7*

days *aging*". A similar issue exist in some other sentences (e.g., Lines 238, 279, 287, 478, 502, etc.), since the 7-day here is just an equivalent duration for laboratory oxidation but not a real time period. Please check through the manuscript.

2. Page 5, line 95: "...and elsewhere ~~where~~ it is transported over long distances".
3. Page 7, line 161: "...A portion (0.5 cm²) of the other *half* quartz-fiber filter ~~half~~..."
4. Page 17, line 477: "... the majority of the TC is ~~in~~ OC..."