Responses to Reviewer 2's Comments

We appreciate Reviewer 2's positive evaluation of our manuscript and constructive comments. Please see our responses in blue font below.

General Comments

1. *Line 74: "However, particle emissions are not often measured in these studies." What studies do the authors refer to here? Yokelson et al. and Jayarathne et al. both use filter- based particle sampling and Stockwell et al. 2016 makes BC measurements of garbage burning. More context is needed here.*
   Response: The reviewer is correct that Yokelson et al. (2013), Jayarathne et al. (2018), and Stockwell et al. (2016) measured particle emissions. The sentence "However, particle emissions are not often measured in these studies" is deleted.

2. *Figure 1: Is there a reason for the order of the categories in the bar graph? Just a suggestion for readability, and not a requirement, but it may help if the categories were sorted by mass %.*
   Response: There is not a specific reason for the order of the categories in Fig. 1. It happens to be the order of the mass fraction data we received from our South Africa collaborators. We organized the results in the material category order of Fig. 1. While it will improve readability of Fig. 1 to sort categories by mass%, it would require reorganization of the order of all results. Therefore, we prefer to leave the category order in Fig. 1 as is.

3. *Line 85: Can the authors elaborate on if the floor mat is composed of petroleum-based materials (i.e. synthetic) or natural (i.e. cowhide and natural rubber) since these are likely to have different emission factors. The floor mat appears to be synthetic but it should be specified.*
   Response: The floor mat appears to be synthetic rubber. This is confirmed by the strong preference of even carbon n-alkanes with the carbon preference index (CPI; the ratio of the sums of odd to even carbon numbers) of particles emitted from the floor mat burning, an indication of petroleum products (Rogge et al., 1993). The floor mat CPI is 0.49, close to that of plastic bottles (0.58) and plastic bags (0.53). On other hand, the CPI from dry vegetation burning emission was 6.01. This data will be published in a future publication. The synthetic specification is added to the floor mat description:

   > "The single synthetic leather/rubber piece (a car floor mat) measured in this study may not be representative of all such materials available elsewhere."

4. *Line 172 Carbon is misspelled 'caron'*
   Response: Thanks for catching this. It is corrected.

5. *Line 189 "...likely formed from re-condensation of evaporated plastic molecules". Could the authors elaborate on this suggestion on why the aerosol emissions were highest from plastic bottle burning? Wouldn't condensation of vaporized plastic be true for the plastic bags and synthetic rubber as well? I assume this conclusion comes from the extent of smoldering phase compared to flaming phase?*
   Response: Upon heating, plastic materials go through softening, melting, decomposition, and burning stages, depending on the temperature. Bond breakages will likely occur when

plastics are heated to 450 °C, generating smaller molecules. Thermal decomposition of polyethylene and polypropylene (widely used for plastic bags) generates a large amount of volatile and flammable alkanes and alkenes (Bockhorn et al., 1999). These thermal decomposition products are efficiently oxidized to CO_2 and CO in the hot flame environment, generating less particle emissions. On the other hand, thermal decomposition of polyethylene terephthalate (PET; widely used for plastic bottles) forms semivolatile carboxylic acid and hydroxyl esters including phthalates as well as non-volatile compounds with interconnected aromatic rings (Holland and Hay, 2002; Sovová et al., 2008). These semivolatile decomposition products quickly cool after leaving the heating zone and recondense into particles. The description of plastic bottle particle emission is revised as below:

> "However, PM emissions were the highest among all the waste materials. The strong plastic odor and light-yellow colored sticky particles were likely formed from condensation of semi-volatile thermal decomposition products, such as carboxylic acids and hydroxyl esters including phthalates (Holland and Hay, 2002; Sovová et al., 2008)."

6. *Figure 4: Can the authors explain why nitrogen oxide emissions are observed from plastic bag combustion and not from plastic bottle burning?*
   Response: NO_x can be formed from two main mechanisms in the combustion process relevant to this paper: 1) oxidation of fuel-bound nitrogen (N); and 2) oxidation of combustion air nitrogen (N_2) in the high temperature flame (Hill and Douglas Smoot, 2000). It is postulated that the fuel nitrogen is first released mainly as tar molecules and light gases (e.g., hydrogen cyanide [HCN] and ammonia [NH_3]) when volatilized upon heating. These molecules then react with oxygen (O_2) under high temperatures to form NO_x. Because plastic bottles only smolder, the volatized molecules quickly cool after leaving the heating zone and have little chance to react with O_2 to form NO_x. On the other hand, in the flaming combustion of plastic bags, the combustion temperature is much higher. The volatilized molecules have more time to react with oxygen in the flame to form NO_x; some NO_x can also form from the oxidation of air N_2 in the high temperature flame. The relative NO_x contributions from these two mechanisms are unknown. The following sentence is added to the text:

   > "Due to the higher combustion temperatures, NO_x concentrations during plastic bag burning were also higher than those in plastic bottles burning."

7. *Figure 6: I find it interesting that the OC and EC PM2.5 mass fractions are similar for the plastic bags and combined burning. Does this suggest that when plastic bags are contained in garbage the plastic burning dominates the total emissions? Or does it suggest that when plastic bags are contained in the garbage it increases the higher efficiency flaming emissions of the combined refuse?*
   Response: We think plastic bag increased the combustion efficiency of the combined materials. As shown in Table S5 and discussed in Section 3.5, burning behaviors differ between separated and combined waste materials, causing emissions to change. We think the similar high combustion efficiency of plastic bags and combined materials is the main cause for the similar OC and EC abundances in $PM_{2.5}$.

References:

Bockhorn, H., Hornung, A., Hornung, U., Schawaller, D. (1999). "Kinetic study on the thermal degradation of polypropylene and polyethylene." *Journal of Analytical and Applied Pyrolysis* 48 (2):93-109. https://doi.org/10.1016/S0165-2370(98)00131-4

Hill, S.C., Douglas Smoot, L. (2000). "Modeling of nitrogen oxides formation and destruction in combustion systems." *Progress in Energy and Combustion Science* 26 (4):417-458. https://doi.org/10.1016/S0360-1285(00)00011-3

Holland, B.J., Hay, J.N. (2002). "The thermal degradation of PET and analogous polyesters measured by thermal analysis–Fourier transform infrared spectroscopy." *Polymer* 43 (6):1835-1847. https://doi.org/10.1016/S0032-3861(01)00775-3

Rogge, W.F., Hildemann, L.M., Mazurek, M.A., Cass, G.R., Simoneit, B.R.T. (1993). "Sources of fine organic aerosol. 2. Noncatalyst and catalyst-equipped automobiles and heavy-duty diesel trucks." *Environmental Science & Technology* 27 (4):636-651.

Sovová, K., Ferus, M., Matulková, I., Španěl, P., Dryahina, K., Dvořák, O., Civiš, S. (2008). "A study of thermal decomposition and combustion products of disposable polyethylene terephthalate (PET) plastic using high resolution fourier transform infrared spectroscopy, selected ion flow tube mass spectrometry and gas chromatography mass spectrometry." *Molecular Physics* 106 (9-10):1205-1214. 10.1080/00268970802077876