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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Detection of tar brown carbon with the single particle soot photometer (SP2)" *by* Joel C. Corbin and Martin Gysel-Beer

Anonymous Referee #2

Received and published: 27 August 2019

Summary:

The authors present evidence that a material they identify as tar brown carbon (tar BrC) has a unique signal in the SP2 (evaporation but little/no incandescence) based on observations of emissions from ship engines. They use the time dependent scattering channels and broad-band incandescent channel in the SP2 to provide a method to identify these tar BrC particles. These observations provide additional evidence of further utility of the SP2 in identifying other aerosol types than rBC, and provides a new on-line measurement technique for a specific class of brown carbon that absorbs at the wavelength of the SP2 laser. The analysis approach for identifying the tar BrC is clearly described, and the authors also thoroughly investigate an alternative explanation for the tar BrC associated with low incandescence (if it might instead be thickly coated

rBC). The writing is very clear and the manuscript is logically written. This paper will be a valuable addition to the literature once a few minor points have been addressed.

General Comments: I would like to see more description of the data sets and observations used in the study; although this paper referenced Corbin et al. 2019 (where these measurements were described in more detail), it would make this work more useful as a stand-alone paper to have some additional details of the observations given here. These details would also help the reader better understand how these specific observations of aerosols from ship engine emissions might relate to other aerosol sources, such as biomass burning. Additionally, the authors have pointed out that the in-SP2 annealing that has been observed in Sedlacek et al. 2018 but not in Moteki and Kondo 2008 may be due to differences in experimental procedures; thus, a greater description of the SP2-specific calibrations in this work would be warranted.

I share some of the concerns of Referee #1, that specifically referring to these aerosols detected by the SP2 as "tar BrC" may be mis-leading, given the significant literature surrounding tar balls, and the fact that the aerosols in this current study are identified solely based on their observed signals in the SP2. However, as the authors have taken the time to clarify this in Section 2, I do not have major concerns about this terminology.

Specific Comments: p.7 Section 3.2. Please clarify whether the SP2 operating conditions were the same during observations of both the pure-BC case and the tar-rich case, as this would impact the interpretation of the experiments.

p.8 line 250-252. Clarify if 160 nm is an upper or lower limit.

Figure 4. I found the label "joint-probability histogram" for the color bar confusing. Is this the relative/normalized number density of particles observed in each bin? Please clarify what you mean here.

p. 12 line 371. Is this number fraction of evaporating tar particles fairly consistent over the observed optical size range for the tar-rich fire? What was the optical size

distribution of evaporating tar particles observable by the SP2? Figure 4 suggests that these particles were in general larger than rBC; is this only true for the tar BrC associated with incandescence?

p. 13 line 402-403. This percentage could depend on the SP2 laser power and may not be illustrative of all operational conditions. Can you also provide a percentage for the portion of non-incandescing particles observed by the SP2 that were identified as tar BrC?

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