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## ***Interactive comment on “A case study into the measurement of ship emissions from plume intercepts of the NOAA Ship *Miller Freeman*” by C. D. Cappa et al.***

**Anonymous Referee #2**

Received and published: 9 December 2013

The manuscript present results from a plume intercept study from a ship cruising on low sulphur fuels. The emission factors of different chemical species in both the gaseous and particulate phases are reported as a function of ship speed. Furthermore, the EF of black carbon as measured by different techniques is compared. Throughout the manuscript, the authors compare and contrast the results to other studies and discuss the potential impacts of sampling in plume compared with direct stack emissions or test rigs. The work is of high scientific relevance, and aspects of the study are the first of its kind.

As a general comment, I suggest the authors include reference to the MARPOL

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convention. The fuel sulphur content, as determined by the authors, is  $\sim 0.1\%$  m/m, which will be the requirement for all vessels within the ECA zones as of 2015 (<http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-%28SOx%29-%E2%80%93-Regulation-14.aspx>). This makes the work extremely relevant. I suggest having 'MARPOL' or 'MARPOL compliant fuel' (or similar) in the title or abstract to increase the interest in the paper.

The paper is suitable for publication after the few minor corrections and queries listed below have been addressed.

#### Minor Corrections/Queries

The authors need to check the document for consistency in terminology. BC needs to be rBC or eBC where appropriate, SO<sub>2</sub>- or SO<sub>4</sub> and kg-fuel-1 or kg-1 fuel (a few examples are given below)

Page 24641, line 27 onwards. There is a lot of information in the description of the instruments. The authors might consider tabulating it for clarity and consistency i.e. sometimes the manufacture of the instrument is given, sometimes not. Same with model numbers.

Page 24642 Line 2 I think this is the first use of OM, please expand.

Line 6 (CN<sub>>3nm</sub>) I believe is the first use of CN, please expand. I would also suggest the instrument is described as an Ultrafine Condensation Particle Counter (UCPC), TSI model 3025a or similar. Not all readers will be aerosol scientists. Same for 3010. 3010 also has a D<sub>50</sub> of 10nm, unless it has been modified (Needs updating elsewhere e.g. figure 1; page 24649)

Line 15. I suggest a slight modification to this sentence. 'Corrections to the HR-AMS due to an instrumental collection efficiency (mostly caused by bounce from the internal heated surface, Huffman; Matthew; Middlebrook), need to be applied.' Or similar. Not all readers will know of the AMS CE issue.

Line 22, measured not measused

Page 24643, line 3 I think should be (SP-AMS, rBC)

Table 1, replace BC with rBC and eBC where appropriate. Typo in Extinction EF units.

Page 24646 - line 18. Section 3.1.4 should be 3.1.3

Page 24647 Line 3. I am probably missing something here, but if you have 53% POM and 47% BC, then POM/BC is 1.13 isn't it?

Line 18, first use of POC, please expand

Figure 3. There are 4 speeds, 5 intercepts and yet 6 solid-line traces. Can the authors clarify what is being shown?

Section 3.1.3/Fig 1. The authors state that the EFCN is not a function of the ship speed, but that the ratio of the 2 EFCN's could be a function of plume age. I suggest removing the ratio of EFCN from fig 1 as it is potentially mis-leading. It would be good to see what they mean by 'some correspondence' for the effect of plume age and coagulation. What I can't quite reconcile is whether the EFCN as a function of speed shows no trend because it is masked by the plume age. For example, if one could fit or assume a coagulation rate to the data and the EFCN were normalised to the same plume age, would a dependence on speed be observed? Is figure 1 d appropriate if it is affected by another process?

Fig 5/6, why does the speed ratio go above 1?

I think it would be very useful to include the EF CO<sub>2</sub>, especially as a lot of the modelling work surrounding the implementation of the new MARPOL limits has focused on the potential CO<sub>2</sub> effects.

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 24635, 2013.

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