

Interactive comment on “Field test of available methods to measure remotely SO₂ and NO_x emissions from ships” by J. M. Balzani Lööv et al.

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We would like to thank both of the reviewers for their useful comments and suggestions. In the following are listed the changes of the paper that were made to meet the reviewers requests. For each point, the final page and line numbers are those of the corrected version while the first page and line numbers are those of the version that the referee refers to.

Referee Andreas Richter:

Concerning the suggestion to add a section about the experimental difficulties: We have added a short section about this to the start of ‘Conclusions’. We have mentioned the problems related to the logistics and the characteristics of the harbour environ-

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ment, not those that are intrinsic to the measurement techniques (like the problem of establishing a baseline in the sniffer measurements). (P. 24, line 14-20).

“The experimental problems encountered during the campaign were mainly due to the logistical difficulties related to measuring simultaneously on the same air volume by the different techniques (sniffer and optical). Further, the fact that most of the measurements took place in a harbour environment caused a relatively high level of ‘noise’ on the measurements due to the many nearby emission sources. It also meant that ships, for what concerns speed and use of auxiliary engines, were often not in the conditions typically found on the open sea. In spite of these difficulties, the results of the campaign allow to draw a series of conclusions:”

Concerning the question about the influence of response time on the measurements: We have added a sentence about this: The response time is not expected to influence the integrated signal but a log response time will smear out the signal and make the determination of the baseline more uncertain. (P. 8, line 24-28). “While the response time is not expected to have an influence of the integrated peak signal caused by the passage of a ship, it is likely to have an influence on the uncertainty of the measurements: A high response time broadens the peak and reduces the height and will thus increase the influence of noise and make the determination of the baseline more uncertain. “

Concerning the comment to Fig 10:

We have cancelled the figure and added some text about the uncertainties on the comparison. (P. 23, line 22-28).

“Direct comparison of Mobile DOAS to direct stack measurements has only been used to a limited extent for measurements of industries; Rivera et al. [2009] did SO₂ measurements on a power plant in Spain for validation purposes and the average determined flux with the DOAS came within 7 % of the values monitored at the plant measurements. Johansson [2014] et al. have compared emission inventories in east Texas to mobile DOAS measurements, with a correspondence within a factor of 2 for large

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scale industrial conglomerates.”

Outliers:

We have added a sentence about the possible sources of outliers. (P. 17, line 25-27).

“Outliers may be caused by interferences from other emission sources than the ship under investigation, or by measurements with high uncertainty due to low signal intensity.”

Technical points:

“g/s” has been changed to “kg/h” and consequently the scale in Figure 6 (which now has become Fig. 5) has been changed.

Figure 3 has been cancelled.

Figure 4 and 5 have been modified as requested.

Page 9748, line 3: Correction has been made. (P. 12, line 14)

Page 9748, line 5: A sentence has been added to explain that the plume is intersected twice because the light reaching the telescope has already passed through the plume before being reflected from the sea surface. (P. 12, line 17-18).

“In this case, since the measurements are made by intersecting the plume perpendicularly with the telescope looking on the side of the air platform, the plume is intersected twice because the light reaching the telescope has already passed through the plume before being reflected from the sea surface.”

page 9748, line 26: “bi-dimensional” is now “2-dimensional”. (P. 13, line 8).

page 9749, line 14: correction has been made. (P. 13, line 22).

page 9749: A reference to Prata (2014) has been inserted here and in section 2.2.3. (P. 13. Line 18 and p. 21 line 1-2).

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page 9751, line 14: correction has been made. (P. 15, line 13).

page 9754, line 25/26: “error” has been changed to “difference”. (P. 18, line 11).

page 9756, line 13: “. . .and the background..” has been cancelled. (P. 19, line 27)

page 9757, line 1 and 2: The missing part of the sentence has been added. (P. 20, line 13).

“The on-board stack measurements within the harbour gave values of FSC (1.2 % (m/m) with a standard deviation of 0.15 % (m/m)) that were not significantly different from those obtained on the open sea, however, the contribution from the two auxiliary engines running on MDO with lower sulphur content was not measured on-board”.

page 9758, line 9: correction has been made. (P. 21, line 16).

page 9762, line 21: correction has been made. (P. 25, line 23).

page 9763, line 2: A comment regarding the health impact of emissions in harbours has been added. (P. 26, line 1-2).

“As a caveat, it should be mentioned that ship emissions in harbours, are likely to be particularly important from a health perspective.”

page 9763, line 6: correction has been made. (P. 26, line 5).

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 9735, 2013.

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