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Atmospheric Measurement Techniques Discussions

Interactive comment on "Emission-factor uncertainties in maritime transport in the Strait of Gibraltar, Spain" *by* J. Moreno-Gutiérrez et al.

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Anonymous Referee #3

We would like to thank you for your valuable comments that will contribute to improve the paper's structure before sending it to AMT. It is possible that the title of the paper may bring into focus a deeper analysis of uncertainties than the methodology applied in the emissions' inventories. It might also seem possible that the main aim of the study is the comparison between the two methods used in the Strait of Gibraltar. The fact is that most part of the research addresses the analysis of uncertainties in the emission factors which is precisely the innovative contribution made by the authors as to the influence that the functional condition of the engines exert upon the emission factors.

This is the real objective of the paper that we may have not rightly expressed as it can be inferred from the reviewer's comments. It is our intention to clarify it by providing answers to all the issues concerned and by adding them in the text before sending it to AMT.

1. Does the paper address relevant scientific questions within the scope of AMT? AMT:

'Development, intercomparison and validation of measurement instruments and techniques of data processing and information retrieval for gases, aerosols, and clouds' Also aim of the special issue 'Measurements of ship emissions' is focused on measurement techniques applied in ship emission measurements. This paper addresses calculation of emission inventories using different kinds of emission factors and is not addressing questions that are in scope of AMT or the AMT special issue.

Certainly, no innovative measurement technique is used as both methods are well known. However, the following text appears from page 5945, line 25 up to page 5955, line 5 in the Abstract:

The actual uncontrolled deviations appear in the changes in emission factors that occur for a given engine with age. These deviations are often difficult to quantify and depend on individual shipboard service and maintenance routines. Emission factors for CO and NOx are not constant and depend on engine condition. For example, tests conducted by the authors of this paper demonstrate that when an engine operates under normal in-service conditions, the emissions are within limits. However, with a small fault in injection timing, the NOx emission exceeds the limits (30% higher value in some cases).A fault in the maintenance of the injection nozzles increases the CO emission (15% higher value in some cases).

"This is the real aim of the present study" and it comes up again in lines 19, 20 and 21 of page 5972 where it is stated:

Finally, the largest uncertainty for this inventory type is in the lack of correction factors for engine-maintenance conditions. Maladjustment or a faulty operating system can produce a high uncontrolled emissions percentage for NOx and CO.

and, finally, within the conclusions section, lines 5 to 12 of page 5973, it is clearly stated:

After analysis, the results for both methods may be considered acceptable but the actual uncontrolled deviations appear in the changes in emission factors that occur for a given engine because the emission factors for CO and NOx depend on engine condition. The results of this study and the possible emission reductions that could be obtained if engines were correctly adjusted indicate that emissions monitoring should be continuous and comprehensive for each vessel and the monitoring results should be recorded and analyzed at random by the competent maritime authorities.

However, as it is properly mentioned by the reviewer, these appraisals could have been lightly expressed in the text whose aim seems to be more intimately related to the emissions' inventories rather than to the analysis of uncertainties in the NOx and CO emission factors. No measurement system is explicitly indicated by the authors. This is due to the fact that the results presented by the authors stem from their own testing (page 5972, lines 27 to 30; and page 5973, lines 1 to 3) and have already been published and referred. However, the following text could be inserted in line 3, page 5973:

Emission measurements were carried out both onboard and in test bench according to the Technical Code. The NOx emission measurements on the test bench were carried out with a chemiluminescence (CLD) detector (Emerson NGA2000) but due to limited space, a portable exhaust gas analyzer (TESTO 350 XL MARITIME) was used for onboard measurements. The humidity and temperature probe of the TESTO 350 XL MARITIME was used to measure the ambient conditions. The carbon balance method was used for the calculation of the exhaust emissions. Additional running parameters of the engines were measured on the test bench using a combustion analyzer (DEWE-

SOFT DEWE 2600) and data acquisition equipment (Agilent 34970A data logger). The combustion pressure was measured through indicator valves, using KISTLER 6613C piezoelectric sensors and injection pressure directly in the fuel injection high pressure pipe, using Piezotronics PCB108A2 piezoelectric sensors. The temperatures was measured using Type K thermocouples and the cylinder charge air pressure, Danfoss MBS5150 pressure transducers. Power output was measured using the hydraulic brake on the test bench and a Binsfeld strain gauge torque meter, in the case of E3 test cycle onboard. For the D2 auxiliary engines power output measurement, engine control room watt meters were used. To measure the consumption of marine diesel oil, KRAL OME 20 volumetric flow meters with density correction and the weighting method were used in test bench and onboard, a FLUXUS F601 non-intrusive ultrasonic flow meter was used. The marine diesel oil measurement onboard was compared and checked with both the fuel oil rack reading and the test bench parameters from the engine manufacturer. Load and emission bench tests were undertaken with two models of medium speed propulsion engines. The load tests were carried out with a Junkers BN12 hydraulic load cell. Every running condition was repeated at least three times on different days to obtain a significant sample. The engines tested were propulsion engines, but after slight modifications could run as auxiliary engines; the engines tested onboard had the same combustion chamber and injection system allowing results from the test bench to be extended to both main and auxiliary engines.

2. Does the paper present novel concepts, ideas, tools, or data? The activity data calculated for the strait of Gibraltar are new, the methodology is not. Consideration of cruise emissions only when majority of emissions is from ferries crossing the Gibraltar raises the question how significant is contribution from maneuvering. Certainly, the manoeuvring condition of the ships have not been taken into account because the ships navigating in the Strait sea area analysed navigate under 80% of the load in the main engines according to the information provided by AIS, cross-referred with LLOYD'S REGISTER FAIRPLAY's. Cruise speed, instead of manoeuvring speed, is normally assigned under these loads condition

3. Are substantial conclusions reached? Not really

After the paper's corrections, the real paper's objective of introducing a new uncertainty factor –the upkeeping condition of the engines- for this inventory methodology, shall be more clearly seen. On the other hand, we may say that, on introducing the data of the testings carried out by the authors, that highlight that the real emission factors of NOx can reach values over 30% of the theoretical emission factors, conclusions are firmly grounded and demonstrated -we refer to the paragraph included in lines 9 to 12, page 5973.

10.Is the overall presentation well structured and clear? No

We will provide a new re-structure of the paper before sending it to AMT 11. Is the language fluent and precise? No We will send the paper to a native English language reviewer once it has been re-estructured.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 5953, 2012.