Primary aerosols from ship diesel engine exhaust within the framework of HICE measurement campaign

L. Mueller[1,2,3], G. Jakobi[1,3], M. Elsasser[1,2,3], B. Stengel[3,4], R. Rabe[3,4], O. Sippula[3,5], E. Karg[1,3], M. Sklorz[2,3], T. Streibel[2,3], J. G. Slowik[6], A.S.H Prevot[6], J. Schnelle-Kreis[1,3] and R. Zimmermann[1,2,3]

[1]Joint Mass Spectrometry Centre, Cooperation Group Comprehensive Molecular Analytics, Helmholtz Zentrum München, Ingolstädter Landstr. 1, 85764 Neuherberg, Germany
[2]Joint Mass Spectrometry Centre / Chair of Analytical Chemistry, University of Rostock, 18051 Rostock, Germany
[3]HICE –Helmholtz Virtual Institute of Complex Molecular Systems in Environmental Health – Aerosols and Health, www.hice-vi.eu
[4]Fakultät für Maschinenbau und Schiffstechnik Lehrstuhl für Kolbenmaschinen und Verbrennungsmotoren, Albert-Einstein-Str. 2, Universität Rostock, 18059 Rostock, Germany
[5]Department of Environmental Science, University of Eastern Finland, Kuopio, Finland
[6]Laboratory of Atmospheric Chemistry, Paul Scherrer Institute, 5232 Villigen, Switzerland
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Presenting author email: laarnie.mueller@helmholtz-muenchen.de

Particulate matter attributed to ship emissions has been correlated to adverse health effects worldwide (Corbett, 2007). Due to the complexity and limited knowledge on the composition of the emitted aerosols from ship emissions, it has been difficult to correlate their chemical components to toxic effects in humans. Thus, there is a need for a high-time resolution and high throughput of chemical information on the emissions from ships in order to identify the processes related to ship operation on the evolution of chemicals that may affect biological systems. In this study, the time-resolved chemical characteristics of primary emitted aerosols from a ship diesel engine were investigated using the High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-TOF-AMS, Aerodyne Research Inc., DeCarlo *et al*., 2006).

A set of state-of-the art online instrumentation measuring gases, size distribution and chemical composition were used in conjunction with the cell exposure system (Air-Liquid-Interface) during the Helmholtz Virtual Institute of Complex Molecular Systems in Environmental Health (HICE) measurement campaign that took place in Rostock on November 19-30, 2012 to investigate the characteristics of the emitted primary aerosols and their effects on lung epithelial cells. In particular, the HR-TOF-AMS has been used to investigate the non-refractory components of the ship engine exhaust particles. Heavy Fuel Oil (HFO 180) and Destillate fuel (EN 590) were used as fuels in a one-cylinder ship diesel engine operated at different loads according to ISO 8187-4 E2 for emission testing.

Corresponding weighting factors were used to define the duration of each operation point resulting in a test cycle that is representative to sea operation. Higher loads (>50% of nominal output) represent a normal operation for ships sailing across the sea. Lower loads used in this study are typical for operation close to the coast or within harbours. This allows the investigation of the effects of engine loads at constant speed and fuel types to the emitted non-refractory aerosols. Fig. 1 shows the response of the AMS to the two types of fuels and engine loads. The 75% load represents “sailing” condition whereas the 25% denotes the “idling” operation. Organics and sulphate compounds were detected by the AMS in the HFO experiment whereas only organic compounds were detectable in the DF experiment. The evolution of non-refractory compounds differs between the HFO and DF with the engine operation. Elevated concentrations of organics were observed at 25% load in the HFO whereas the highest concentration was observed at 75% for DF.

High resolution data analysis and comparison with other online techniques will be shown in details.

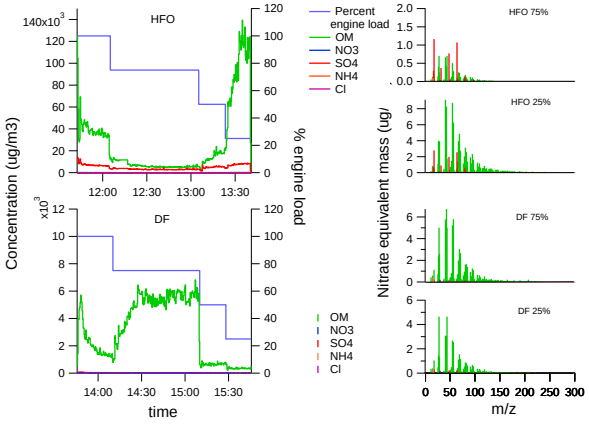

Fig.1. Progression of the measured non-refractory components with the ISO load operation in HFO (*top left)* and DF (*bottom left)*. The average mass spectra for load 75% and 25% for HFO *(top right)* and DF *(bottom right,)* respectively.

This work is part of the Helmholtz Virtual Institute of Complex Molecular Systems in Environmental Health, HICE. Health effects of organic compounds in aerosols are currently being investigated in the framework of HICE.

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