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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Experimental studies on particle emissions from cruising ship, their characteristic properties, transformation and atmospheric lifetime in the marine boundary layer" *by* A. Petzold et al.

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On behalf of all co-authors I thank the reviewer for the critical and detailed review of our manuscript. The reviewer raised a set of specific questions which are discussed in the following:

(1) Does the average ratio attributed to Eyring et al. (2007) take into account the types of ship engines which produce the emissions in this study?

The fleet-average specific fuel oil consumption of 0.212 kg/kWh was derived from a set of 50 sample engines of different types (Eyring et al. 2005). This set included engines of the investigated type but also two-stroke marine diesel engines (Köhler 2002, 2003). The reference given in the manuscript (Eyring et al., 2007) has to be replaced by the correct reference Eyring et al. (2005), which however is already contained in the reference list.

(2) P 15113 L 1 and L 6: The range for Aitken and accumulation mode (ACC) particles is given as 0.05 micro m to 1-2 micron m. However, in L 6 the Aitken mode particles have a lower bound less than 0.05 and the ACC have an upper bound greater than 2. How did the range given in L1 increase? Are we talking about the same data in each paragraph?

The first sentence in L1 refers to the size range of optically active particles which ranges from 50 nm to 1 - 2 micro m. The size ranges for the different aerosol modes given in the second paragraph of page 15113 are related to the detection ranges of the applied instruments:

- The Condensation Particle Counter measuring all particles larger than 14 nm covers the full Aitken mode.

- The Passive Cavity Aerosol Spectrometer Probe measuring from 100 nm to 3 micro m in diameter covers the entire accumulation mode.

- The Forward Scattering Spectrometer Probe FSSP 300 measuring from 300 nm to 30 micro m covers the larger particles of the accumulation mode and the coarse mode.

Details of this separation of size ranges according to the applied instrumentation are given in Petzold et al. (2007). This reference will be included during manuscript revision.

(3) P 15114 Eqn 2: Is the derivative taken of concentration cpl or of delta(cpl), the difference between concentration and the background value?

The derivative is taken of the plume concentration cpl, as is stated in the original paper on the Gaussian plume model (von Glasow et al., 2003). It will be updated during

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manuscript revision.

(4) P 15116 L 15-18: For a load of 110% the distribution no longer appears bimodal, but you state that this for load conditions $>$ 75% the structure is bimodal. P 15116 L 15-18: Loads of 100% and 85% appear to have identical distributions for Dp$<$0.1. Can you explain this? It looks interesting.

For an engine load of 110% the size distribution is still bi-modal although the gap between the nucleation mode particles composed of sulphuric acid - water droplets and the combustion mode particles has almost vanished. We explain the observation by an increasing production of sulphuric acid with increasing engine load or combustion temperature, respectively. This increased availability of sulphuric acid leads to an increase in particle production and in turn to an increase in particle size of the nucleation mode particles caused by particle coagulation and gas phase deposition on already existing nucleation mode particles. The almost similar size distributions for engine loads of 85% and 100% are indeed surprising. The only explanation is that the combustion conditions do not vary significantly between 85% and 100% so that the production of sulphuric acid is almost the same for both engine load conditions.

(5) P15120 L 26-27: Why is it that plumes last longer when the analysis depends on lower time and space resolution ECMWF wind data? Is it due to the assumptions in the Gaussian plume model? (Note that the regression line given for plume age t_ECMWF is as a plus or minus. I think that just the plus sign is needed because you state that the ages for ECMWF-derived plumes are larger than for the t_measured.)

The time difference between emission and plume detection which is taken as the plume age, depends crucially on the horizontal wind speed which is the driving force of the transport from the exhaust duct to the point of measurement. The shift to larger plume ages when using ECMWF data is mainly caused by the lower horizontal wind speeds. Another source of this effect might be that because of the lower resolution of the ECMWF data, we could not find close matches between the point of emission and

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the point of plume measurement on one hand and wind field mesh points on the other hand for all plume encounters. Hence, interpolation of data was required for several measurement points. The Gaussian model was driven with the independently determined plume age data, so that it could not influence these input data.

(6) All Technical Corrections will be considered in the manuscript revision process.

References

Eyring, V., H. W. Köhler, J. van Aardenne, and A. Lauer: Emissions from international shipping: 1. The last 50 years, J. Geophys. Res., 110, D17305, doi:10.1029/2004JD005619, 2005.

Köhler, H. W.: Worldwide NOx emissions from merchant shipping, paper presented at 24th Annual Marine Propulsion Conference, 10 - 11 April, Copenhagen, Denmark, 2002.

Köhler, H. W.: NOx emissions from oceangoing ships: Calculation and evaluation, paper presented at Spring Technical Conference, Internal Combust. Engine Div., Am. Soc. of Automotive Eng., Salzburg, Austria, 11 - 14 May, 2003.

Petzold, A., B. Weinzierl, H. Huntrieser, A. Stohl, E. Real, J. Cozic, M. Fiebig, J. Hendricks, A. Lauer, K. Law, A. Minikin, A. Roiger, H. Schlager, and E. Weingartner: Perturbation of European Free Troposphere Aerosol by North American Forest Fire Plumes during the ICARTT-ITOP Experiment in Summer 2004, Atmos. Chem. Phys., 7, 5105 - 5127, 2007.

von Glasow, R., Lawrence, M. G., Sander, R., and Crutzen, P. J.: Modelling the chemical effects of ship exhaust in the cloud-free marine boundary layer, Atmos. Chem. Phys., 3, 233 - 250, 2003.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 15105, 2007.