

Review on article:

Measurement of inland ship emissions and their contribution to NO_x and ultrafine particle concentrations at the Rhine

Philipp Eger et al.

The authors present the results of a comprehensive study on the differentiated assessment of inland shipping emissions on the Upper Rhine near Worms in Germany. They use a wide range of measurement techniques to detect gaseous (CO₂, NO_x and O₃) and particulate (PNSD, PNC, PM_x, soot) air pollutants. Two sites have been selected for the measurements, allowing different scenarios to be mapped. One site was located on a bridge in order to record the plumes from passing ships close to the source. The second site was chosen directly on the banks of the Rhine. In this way, it is possible to determine the level of emissions that could affect people living near the Rhine. Particularly noteworthy is the methodology developed to identify individual ship plumes. The algorithm used avoids overlapping plumes, which can be caused by several ships passing at the same time. As a result, only clearly identifiable ship plumes are included in the evaluation. This results in a significantly reduced number of evaluable ship plumes and also reduces the number of individual ships in the composition of the shipping fleet. At the same time, the quality of the subsequent allocation and classification is significantly improved. In particular, the continuous long-term measurements over a period of one year provide a good picture of the emissions of the shipping fleet in this part of the Rhine. In addition, the emission factors can be calculated under real conditions, leading to a better understanding of the impact on inland navigation. This work represents a solid contribution and, in part, a new scientific approach to the measurement and characterisation of emissions from inland navigation under real conditions. The work is recommended for publication by the peer reviewer. The following suggestions may be incorporated into the authors' opinion.

P3 L21:

...high temporal resolution of ~1 s...

Maybe one can mention, that the SMPS has a different and longer temporal resolution for a whole scan of the size range. Additionally, one could also explain the "problem" with scanning devices as a SMPS with a moderate sampling time. The assumption with a scanning device as the SMPS is that the aerosol spectrum does not change much over the time of a scan. However, this can occur with passing ships and short-term increases and thus lead to a distorted PNSD.

P4 L11

...Instrument-specific sampling lines of 4-5 m length...

It seems that the calculated particle loss under 10 percent is relatively low. I would expect a higher particle penetration at this length of the sampling line. Did you use separated sampling lines or did you use one sampling line with a higher volume flow and a manifold leading to the individual measuring devices?

P4, L12

...to enable an undisturbed incoming flow.

Doesn't the bridge itself generate turbulence that can contribute to influencing the wind field at the measurement site? Are downwind eddies possible that carry road traffic emissions down to the measurement site and superimpose the ship plumes as well?

P5 L5

...to avoid strong interferences from road traffic.

You have chosen the locations to also avoid the influence of traffic related air pollutants. I am not familiar with the local conditions, but a look at the Nibelungen Bridge shows that this is a double bridge with two lanes each. What traffic volume can be expected there? Is there rush hour and congestion with traffic jams on the bridge? Especially with winds from northern directions, lee vortices could transport the TRAPs to the sampling point.

P6 Table 1

Here the temporal resolution from the AIS signals is 1 s. To the best of my knowledge, an inland vessel sends a data set only every 10 s, depending on the current movement status.

P12 L20-21

...further results [...] refer to this instrument.

This sentence is somewhat confusing, since in the coming chapters the results on RIV site will also be reported, which, however, were measured with the SMPS.

P12 L26-27

The study by Pohl et al. was performed in Duesseldorf. So please change Upper to the Lower Rhine.

P14 L16

...as well as modern ships with exhaust after treatment...

With regard to the CLINSH project. Weren't up to 40 ships retrofitted with downstream exhaust aftertreatment systems? Are the data or names of the ships available the authors to specifically read them out in their data set in order to be able to better scale up the positive effect of the emission reduction? This would be a good contribution, especially in view of the continuing increase in shipping traffic in the future.

P21 L10

With a BC fraction of 38 % for...

It is (for me) not clear to which correlation the value is. Can you please more specify this. Is it $BC_{880\text{ nm}}$ to total BC?

P21 L14

The proportion coming from biomass burning is mentioned here as about 10 % from biofuel combustion. Could it be a possible reason that the analyzed probe isn't just from ships because you also measure the background were also particles coming from wood fires, cigarette smoke, etc. Maybe there could be a hint, if the amount of bb is higher during the wintertime due to fireplaces?

P21 L25

...(see methods).

Please refer to the chapter.