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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Influence of vessel characteristics and atmospheric processes on the gas and particle phase of ship emission plumes: In-situ measurements in the Mediterranean Sea and around the Arabian Peninsula" *by* Siddika Celik et al.

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This paper presents an analysis of a large dataset of ship plumes measured from a research vessel in the Mediterranean.Âă It's a very impressive data set with many gas and particle phase instruments.Âă The authors used AIS ship positioning to attribute measured ship plumes to individual ships, a non-trivial exercise.Âă The various emission factors were computed (accounting for plume dilution) and then related to

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ship/engine characteristics, operational conditions, atmospheric conditions, etc. ÂăThe paper is generally well written and the data will be very useful for better understanding of ship emissions.

Because a large number of ships were measured, and because it's not possible to follow individual ship plumes in a Lagrangian fashion from a research vessel, the analysis is generally done on all the detected plumes as a whole, with a lot of bin-averaging involved.Âă This unfortunately buries many details and real sources of variability.Âă I would like to see the authors trying to tease out some of those complexities (see detailed comments below).Âă I think the authors should make it clear at the beginning that their measurements are not Lagrangian (i.e. following the same ship plume over time).Âă Thus their observations of the effect of plume aging represent the variability of an ensemble of initially different plumes at various stages of aging.Âă The observations don't uniquely capture the plume aging effect and this should be acknowledged.Âă

The different emission factors as a function of plume age/photochemical processing is very interesting.Âă Can author say something about the max distance (or time) down wind of source for which the various EF estimates still represent stack emissions?

I wonder whether it'd be useful to have two different terminologies: 1) emission factors for very close to the emitting ship, representing what's coming out of the stack (=emission inventories for modelling); 2) x ratios (or named something else) that represents 'emission factors' further downwind.Âă This would make it clearer that the 'emission factors' observed from a ship far away do not always represent what's initially coming out of the stack.

Some specific comments:

plume age 20 min. transported over 4 km. implies very low winds in general low winds (poor dispersion) contributes to CO2 being detectable for so long? p. 9.Âă evidence of enhanced OH concentrations within the plumes? Fig.3aÂă given the small range in ambient O2 concentration (at most a few %), I'm surprised that the BC EF changes so

much.Âă does humidity affect the BC EF?Fig.3bÂă the NO:NO2 ratio depends on the reactions with O3 and so plume age.Âă it's also probably affected by photochemistry. those complexities are not teased out in this figure.Âă perhaps limit the analysis only to a certain plume age?

Fig3. Does organic EF vary with combustion efficiency or ship velocity? Fig.5 as eluded to in section 3.2 the importance of coagulation on aerosol number emission also depend on the plume age to some extent. that complexity is again not teased out here Fig.6 besides coagulation and condensation, could wind speed or sea state alter the performances of the ships engines, and hence the aerosol emission factors?

P 13 line 16. 1/3 of initial ratio? Initially it's almost all NO

SO2/sO4 ratio decreases with humidity. Could this be partly due to cloud processing (if cloudy)?

Fig9 changes in aerosol composition with aging. Would be interesting to see this separated to daytime and nighttime

Relationship between O/C ratio and organic EF. Unclear whether 'increase in mass through Oxidation' occurs in atmosphere or in stack

P 18 line 19. Higher NO:NO2?

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