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Atmospheric Measurement Techniques Discussions

Interactive comment on "Identification of platform exhaust on the RV Investigator" *by* Ruhi S. Humphries et al.

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We would like to thank the referee for their review of the manuscript. In addressing the points, we expect a significant improvement of the manuscript. In responding to the referee's concerns, we will respond to each comment specifically. 0. The referee's general comments were primarily concerned with the applicability of the method beyond its use on the RV Investigator. We note that the method being described has been developed specifically for the RV Investigator platform and its use beyond this platform, while possible, is not within the scope of this manuscript. The manuscript serves primarily as a description of the algorithm utilised on this platform only. 1. The data utilised in the manuscript are from periods in the remote marine boundary layer of the Southern and Pacific Oceans. CCN concentrations in these regions are known

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Discussion paper

to be very low, in the concentration range of tens to a few hundred. Concentrations above this are not observed, and those above 1000 cm-3 are rare even in urban air in the Southern Hemisphere. In addition, when looking at the time-series of CCN, CN, BC, CO, CO2 and relative wind direction, it is clear that these periods are from local ship exhaust rather than any natural phenomenon. We will include a figure in the appendices to this show this clearly in the revised manuscript. In addition, the goal of algorithm is not to reduce the high CCN values, as the referee suggest. The use of CCN was intended purely as an effective and obvious indicator of exhaust due to the relatively low background concentrations and high exhaust concentrations, but without being part of the algorithm itself.

2. We agree that a quantification of the advantage of this method over the traditional methods should be included in the manuscript, and in particular in the abstract. We will do this in the revised manuscript.

3. Figure 1 includes all the data from the full voyage data undertaken. While we haven't included the other parameters mentioned by the referee in the figure, we note that the goal of the algorithm is to work as a near-real-time algorithm where much of that information is unavailable, so inclusion of that information in Figure 1 isn't really applicable. However for the reader to properly understand this dataset, we will include a map of the voyage plotted in Figure 1 as one of the appendix figures. Figure 2 is referred to in multiple locations within the manuscript. In the introduction, it is intended to show the reader what the raw time-series looks like, which is essentially what the algorithm is processing. It shows the distinctly different signals in each of the parameters included in the algorithm, which is important in giving context in the introduction.

4. We agree with this comment and will include a schematic overview of the RV Investigator for the manuscript.

5. Residence times – due to the way the algorithm removes data within a 20 minute window of a positively identified exhaust period, the question of residence time is not

important for the manuscript, and so has not been included. We will clarify this more explicitly in the text. Calibrations – we have described in the manuscript why we use uncalibrated data in the algorithm – this is primarily because we are looking for relative changes in data signals, and calibrations do not effect short-term relative changes. This has already been dealt with in the manuscript.

6. The choice of tracers utilised by the algorithm were based on data availability and its effectiveness in the method. O3 was tested and found not to be effective, presumably because of the timescale of the chemistry involved, or the fact that the ship burns cleanly relative to other ships where O3 is a good tracer. NO2 is not part of the permanent instrument suite aboard the RV Investigator, so is unavailable for use. The use of ratios is not likely to extract any additional information for the purposes of exhaust identification other than what the individual data streams utilise.

7. BC is indeed the common tracer for exhaust. However, because of the noise in the data at the high frequency being utilised (1 Hz), it wasn't as useful as expected. The manufacturer of this instrument recommends averaging 1 Hz data to 20 min time steps in order to get effective signal-to-noise ratios. The chosen value of 0.07 ug/m3 hasn't been described as to why this was chosen, and this will be included in the revised manuscript .

8. The criteria utilised in the algorithm was chosen so as to distinguish between self-ship exhaust, and the background atmosphere, which includes polluted urban environments where the ship might port. If a signal comes from a nearby point source (i.e. a close-passing ship), the algorithm will likely incorrectly identify this as self-ship exhaust. For small-scale events, the sensitivity of the algorithm can be tuned by the user in order to identify, or not, that event, at the cost of falsely identifying non-exhaust data. In any case, the algorithm is not an end-to-end solution, and the data must be examined by human eye before a final dataset is published and applied to other datasets.

9. All the data utilised in this algorithm are 1 Hz data. This has been included explicitly

for some instruments, but not for all, and will therefore be stated more clearly in the revised manuscript . Because all the data input are at the same frequency, the window filter weighting isn't a concern.

10. The referee has a keen eye! We will ensure to double check this in the revised manuscript .

11. The disappearance of peaks between Figure 2 and Figure 3 is likely a result of differences in plotting (i.e. changes in colours and marker sizes). We assure the referee that the underlying data is the same. Nevertheless, we will replot these figures ensuring consistent plotting parameters between the figures . In regards to why an exhaust signature is visible in some parameters but not others, we believe this is a result of the sensitivity and response times of the particular instruments, with CN being the most sensitive to this particular exhaust signal.

12. We will already include a quantification of this method in the manuscript as per the referee's previous comments. We will consider adding the traditional algorithm to Figure 3, or at the very least, will add an additional Figure in the appendices.

13. Our previous amendments to the manuscript from points 2 and 12 above cover most of the concern here. The addition of case studies to illustrate why the new algorithm recovers or removes data compared to the traditional filter will be a useful addition, and will be included in the revised manuscript.

14. The amendments that address points 2, 12 and 13 above will address the reviews concerns in this point.

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