

1 General comments

This is an interesting dataset and a data analysis that I feel falls well within the scope of ACP. The work illuminates the processes governing the aerosol distribution over the southern ocean as well as the impact of land masses on the aerosol size distribution, complementing and extending observations made elsewhere. I found the paper itself somewhat confusing, and suggest some re-focussing or rewording would help to get the conclusions more clearly understood. These changes are listed below.

In the introduction (L70) New Zealand is claimed to be an optimal place for studying marine air, and yet the dataset clearly shows this is not true for Baring Head. I suspect that there are other places within New Zealand that are much better places for studying the southern marine atmosphere although they may not be practical logistically. (The logistical component should not be down-played - these are not trivial measurements!) There are also a number of other sites in the southern ocean that could be less influenced by land, including Macquarie Island. As noted in line 328 only 7% of the measurements made were classified as clean marine, and in line 109 it is noted that for CO₂ less than 10% of the time is classified as “baseline” (which is also nominally clean marine), noting that this estimate is based on a much longer time series of measurements. This “optimal” claim therefore colours the study of the general aerosol observations, which are overwhelmingly land influenced. This is unfortunate as that analysis is worthwhile.

I note that the same section (L 69) states that New Zealand is far from major pollution sources (meaning those external to New Zealand, although this is not explicit). In the context of aerosol lifetimes (say 1 day or less??) this is generally true although there has been significant aerosol deposits detected in New Zealand from dust and bushfire events in Australia. The statement assumes that there are no significant aerosol sources within New Zealand, which is not true in general and the impact on a measurement set is going to depend critically on site. Given that Baring head is less than 10 km from Wellington it is not really remote.

The second area where I struggled with this paper is in the size definitions used. The terms coarse mode,, climate relevant sizes, nucleation mode, Aitken mode, accumulation mode, N1-10, N10-100 (and N10) and N100 are all used and not well related. This is problematic as there is not a single definition for some of these terms, most critically for Aitken mode (10 - 25 nm lower limit, 80 - 100 nm upper limit) but also for nucleation mode (where in general the upper limit of 10 nm is agreed but the lower limit is often defined by instrumental limitations). A paragraph which defines the limits you are going to use for your work (and relate that to the measurements you report would significantly improve the clarity. I note that this problem is not unique to this work!

Definition of NPF events should be discussed more generally - given that you are then going to say means that it doesn't cut it for this dataset. Also discuss the implications of the definition of a NPF event - what is required of the meteorology for the definition to make sense. (In my opinion this is often left

unstated and it is important to realise the meteorological changes - in essence a change in the source function - can readily be interpreted as particle growth. Also need a shout out about noisy data.

2 Specific Comments

Aerosol measurements and inlet losses: it is difficult to assess as a reader how large the likely losses would be in the inlets for the various instruments. It would be beneficial if some estimate could be given for the losses for the various instruments, or at least an estimate of the difference in losses for the instruments, at different aerosol sizes.

2.1 Significant figures

Given the size of the dataset and the difficulty of clearly distinguishing the various processes that drive aerosol size distributions, the number of significant figures used seems misleading. This is doubly true as the total number of measurements relevant to these estimates is unclear. It is notable that the number of significant figures used in the abstract is less than that used in the general text, suggesting that the authors are somewhat aware of this. I suggest that, for example, L261 “10.9% of the days” is replaced with x out of y days (11%). Alternatively, if this becomes cumbersome there could be a table of the number of measurements that fall in each category. Further, at the same location in the text, the days included Class 1 events - the day itself was not a Class 1 event. This confuses the story as well. So on L261 it is clear that 10.9% is days/days, but the next sentence says “12.1% of the data” which is presumably days/ days, not measurements/measurements as the text would imply. I note that the information provided in Figure 1 is insufficient for the reader to assess the number of measurements or days used in the analyses.

2.2 Section 3.1.2 - Factors favouring npf event occurrence

This section left me uncertain, as there are likely to be a range of correlated variables that would confound an assignment of causation. If land masses are the primary source of npf events, you could expect a correlation of npf events with warmer conditions, clearer skies, etc. Indeed, if you look at Figure 4 it would seem that a label of “Land” for the Event category and “Ocean” for the Non-event category would make great sense of the observations, including the observed ozone concentrations (air impacted by NO_x will have lower ozone concentrations). I suggest making this point clearer. It may be necessary to restrict this comparison to those days with significant land contact to make any firm conclusions.

2.3 Land influence

Figure 7 and the associated commentary. The text suggests that there is a clear relationship between time over land and particle concentration. Given the plots and the correlation coefficients quoted (significant??) this seems unconvincing. I think that this partially because of the way the data are presented. I suggest binning the data (by hour ranges) and showing the median (and I suggest the uncertainty of the medians) and the 75/95% points for the bins. These may more clearly show what you are trying to infer.

2.4 Coastal effects

L491: “coastal sources are likely not important for particle formation at Baring Head”. The text then goes on to say this is really based on Mace Head observations, which is a very different location and may not apply here. It should be noted that there is some evidence of coastal sources of atmospheric iodine and new particle formation events at Cape Grim which also did not correlate with tide.(Grose et al., 2007) The studies of npf near the Great Barrier Reef also showed no real tidal signal but they considered that the source was most likely coastal. (Modini et al., 2009) This section needs a clearer message and conclusion and not rely so heavily on tide data for that conclusion.

2.5 Cloud Processing of aerosol distribution

This topic area which needs more consideration can most readily be seen in figure 11. The bi-modal structure appears to indicate that there is significant cloud processing of the aerosol for the entire period (as noted by the Hoppel minimum comment on L565. How does this change the size distributions as cloud processing varies, especially given the time scale of cloud processing versus the timescale used for considering npf? How can you distinguish the changes caused by cloud processing from gas phase particle growth?

L572 - “One key message from our work is that marine secondary aerosol formation should not be studied with the same criteria as continental new particle formation.” This paper would be much stronger if this point was accompanied by some suggestion of what criteria should be used. Are you suggesting that looking at 2 - 4nm particle concentrations are more appropriate? I sort of think so.

3 Technical Corrections

L76, L109 - correct subscript

L171 - correct superscript.

L182 - 2 - 4 nm diameter.

L205 How many days' of data?

L277 - “Finokalia which has a more similar distance to the equator.” Why is the distance to the equator important?

L297 - “the start height of the free troposphere can be variable” really means the height of the planetary boundary layer is variable.

L318 “saw nighttime increases in sub-3 and sub-10 nm particle concentrations” - occasionally? Often? Some indication of prevalence would be useful.

L320 - “To see more quantitatively” - To assess

L326 - radon concentration below

L327 “recently passed the southern tip of North Island” - given that the measurements are near the southern tip of the North Island it seems almost a give. If radon is your indicator presumably this means recent is in the last day?

L350 - “and we saw earlier” - correct the English

L352 - “With Condensation sink” ? Do you mean “Considering the variation in the calculated condensation sink”?

L352 - “slightly higher” is it significant?

L357 - Sentence starting “Over land” does not make sense.

L371 - reference the section where these limits are defined (2.3.1??)

L375 - “typically cleaner” has a very broad meaning. You mean that such differences are expected given the predominance of intense aerosol sources on land.

L376 - delete previous

L381 - replace numbers with observations (or aerosol concentrations)

L387 - not clear how the frequency of observations could create a trend, unless you are talking about the uncertainty in the medians??

L397 “A similar cycle”

L399 - is there a seasonal cycle in rainfall at this location?

L408 Figure 5 The end of the boxes are hard to detect (black box, black points). Suggest make box hollow or wider so that it is easier to distinguish.

L411 - the cycle depends on both the production and loss terms, and you should mention your assumption on the diurnal cycle of the loss term. Is this the cause of the early evening concentration increase??

L412 “rush hour” - the fact that you do not see a signal relevant to traffic probably should be clearer. Given the close proximity to Wellington it is an open question as to whether the impact of the city can be seen in the record.

L418 “time over land” - this needs definition in terms of the time window considered (in the last 72 hours?) and any vertical-based filter.

L439 - make it clear that the first part of your assessment is for all data.

L478 - “of ours” it was not measurements of you - it is “measurements reported here” or “our measurements at Baring head”

L528 - It appears that figure 10 shows patterns dominated by a small number of high particle concentration events - events that may have nothing to do with the more distant part of the track. Is there enough data here for these patterns to be interpretable? For example, the cluster “near Tasmania”- is it due to emissions from New Zealand rather than Tasmania? It is unclear to me.

L550 - y axis label in Figure 11 is wrong. Marking the start of the days with dates (9th/10th) would make it much easier to follow in the text. Given that Figure 12 supports Figure 11 it would be much better if the plotted area

aligned in the two figures - which is probably best achieved by combining the two plots.

References

- Grose, M. R., Caine, J. M., McMinn, A., Gibson, J. A. E., Grose, M. R., Caine, J. M., ... Gibson, J. A. E. (2007). Coastal marine methyl iodide source and links to new particle formation at Cape Grim during February 2006. *Environmental Chemistry*, 4(3), 172–177. doi:10.1071/EN07008
- Modini, R. L., Ristovski, Z. D., Johnson, G. R., He, C., Surawski, N., Morawska, L., ... Kulmala, M. (2009). New particle formation and growth at a remote, sub-tropical coastal location. *Atmospheric Chemistry and Physics*, 9(19), 7607–7621.