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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Identifying the sources driving observed $PM_{2.5}$ variability over Halifax, Nova Scotia, during BORTAS-B" *by* M. D. Gibson et al.

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Anonymous Referee #2

General comments.

This paper reports the results of a PMF-based source attribution for a set of PM2.5 daily compositional data collected in Halifax, Nova Scotia for the period 11 July – 26 August 2011, coincident with the BORTAS-B ïňĄeld campaign. The suite of particle composition data is comprehensive, including major ions, major and trace metals, BC, and OM as determined by an accelerator mass spectrometer. By examination of the

statistical loadings of individual components in the factors output by the PMF the authors have identiïňĄed, and quantiïňĄed average mass and % contributions for, the following 6 sources - long-range transport pollution, long-range transport marine mixture, vehicles, fugitive dust, ship emissions and reïňĄnery - with the ïňĄrst two sources comprising three-quarters of the PM2.5 mass on average. Given this latter statistic, the source attribution has perhaps not been particularly discriminatory, but as the authors note the PM2.5 total concentrations during their ïňĄeld measurements were particularly low with little in the way of 'episodes' of varying origin to analyse. The authors indicate that it was hoped their measurements might have contributed insight into biomass burning events in the region – the focus of the main BORTAS-B campaign – but given the authors here were not measuring speciïňĄc OC markers this was perhaps always optimistic. Nevertheless, together with the wind direction and air-mass back-trajectory data, the authors have undertaken a considered, quantitative and appropriate source apportionment analysis, which demonstrates the utility of such techniques for PM2.5 source apportionment. The paper is generally well written, and data and results neatly presented, and is suitable for consideration by Atmospheric Chemistry and Physics.

Technical/scientiïňĄc comments.

P4494, l8: insert comma after Edinburgh.

Authors Response Firstly, thank you for taking the time to review the paper and for your very useful and insightful comments that we feel has greatly improved the paper.

Authors Response Comma inserted

P4495 & 4497: In at least a couple of places, the element phosphorus is listed as a metal which it is not.

Authors Response Metals has been changed to elements to now be inclusive of P.

P4495, l18 and many other instances in the paper: On many occasions, the chemical symbols for sulphate, nitrate, ammonium and chloride are presented without their anion

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or cation charges. The charges need to be included. When measured by IC, it is the ions that are measured. (If the halogens are measured by another technique then the neutral chemical symbol can be used.)

Authors Response The correct charge has been given for any ions. Note, the only ions we used were NO3-, SO42- and NH4+.

P4496,l8: Is the sentence beginning “The Partisol stopped sampling if. . .” required? It is not if this QC procedure was never actually activated.

Authors Response I have removed this sentence as it is redundant as you correctly point out! I’ve added. . ..” A flow rate of $\pm$ 5% for the Partisol was deemed acceptable.

P4496, l13: Correct the grammar to “manufacturer’s”

Authors Response Change made

P4497,l3: Rephrase start of sentence to “Due to low PM2.5 mass, the following 14 e lements were not detected in . . .”

Authors Response Change made

P4497, l13 & l 18: There are two citations to a “Gibson et al. (2013)” reference which is not presented in the reference list.

Authors Response Ref added

P4498, l2: What is meant by the precision of 1-min averages? How is the stated precision value of 18% derived?

Authors Response The following change has been made to the manuscript with new text detailing how the 18% for the black carbon measurement was arrived at. The precision of the AE42 aethalometer was determined by side-by-side comparisons with a second AE42 instrument. The relative bias for the two monitors was determined by comparing the mean values over 5759 minutes of collocated readings. All readings of

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one monitor were multiplied by this factor to bring the means into agreement. The Precision was then determined by calculating the absolute value of the difference between the monitors (after adjustment for the bias) divided by the sum of the readings for each minute as follows: abs[(A-B)/(A+B)] (where A is the reading of the first monitor, B is the reading of the second monitor adjusted by the bias). The median value for the 1-minute readings was 0.18. (IQR 0.07-0.40). A precision and bias for 24-hr was not possible as there were only three data points. The 1-minute data points were averaged to match the 24-hour PM2.5 filter samples.

P4498, l3: Is it better to say the 1-min data were averaged rather than integrated to match the 24 h samples?

Authors Response Change made as shown above

P4499, l2: As above, use the phrasing averaged rather than integrated?

Authors Response Change made

P4499, l6: Delete the sentence beginning “The daily wind vectors. . ..” This sentence does not need to be in the methods section.

Authors Response Change made

P4499, l22: At ïňĄrst reading the statement that (5 min) wind speed was 8.0 m/s on 7 days is not consistent with the summary data presented in Table 1 which indicates that the maximum wind speed during the campaign was 5.4 m/s. I think the data in Table 1 summarise the range of daily averages in the meteorological variables, i.e. 5.4 m/s is the highest daily average wind speed. Therefore, (1) start the sentence on p4499 with “Maximum 5-min average wind speed was signiïňĄcant. . ..”, and (2) modify the caption of Table 1 to read: “Descriptive statistics for the daily averages of the meteorological variables. . .”

Authors Response Changes made

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P4499, l28: Phrase as either “This data was accessed. . .” or “These data were accessed. . .” Authors Response Change made

P4500, l4: There is a sudden introduction of ïňĄrst person “we”. Decide whether a passive or ïňĄrst-person approach is being used and review the whole text for consistency.

Authors Response Changes made

P4500, l7: It is stated here that back-trajectories were calculated twice per 24 h period at 07:00 UTC and 19:00 UTC, but the caption on Figure 2 states that trajectory initialisation was at 08:00 UTC, and makes no mention of a second back trajectory per 24 h period. Please correct text and/or Figure 2 caption as required.

Authors Response New text added as below Figure 2. Map of ensemble HYSPLIT 2-day air mass back trajectories between 11 July 2011 and 25 August 2011. Trajectories were initialized twice per day at 08:00 UTC and 20:00 UTC with an arrival height of 500 m. Colours denote upwind source region (cyan = Marine, red = SW, green = WNW and blue = N)

P4500, l24: Insert “The” before “PMF method”

Authors Response The now inserted

P4500, l27: It is sufiňĄcient to list only a sub-set of all these references as examples of previous PMF application.

Authors Response Pruned the number of refs by half.

P4501, l23: Insert “is the” before “residual matrix” Authors Response I’ve cut back on that section so the correction is no longer needed

P4501, l23: The “i” and “j” should be subscripts to “S” not superscripts.

Authors Response I’ve cut back on that section so this correction is no longer needed

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P4502, l1 and l2: In two places insert “number of” before “degrees”

Authors Response I’ve cut back on that section so the correction is no longer needed

P4502, l4: Single word for “dataset”

Authors Response I’ve cut back on that section so the correction is no longer needed

P4502, l12: Plural “components”

Authors Response I’ve cut back on that section so the correction is no longer needed

P4503, l6: Lower case for “levoglucosan”

Authors Response Correction made

P4505, l18: Lower case for “sea salt” when referring to sea salt generally (could use upper case if referring speciïňĄcally to a source identiïňĄed from the PMF that is given the label Sea Salt).

Authors Response Correction made

New figure (Figure 8 Source profiles for the seven PMF factors) was added to help articulate the PMF factors profiles and the subsequent sources identified

P4506,l27: Delete the comma after “Figure 7”

Authors Response Correction made

P4509, l23: Start new sentence at “Both are. . .”

Authors Response Correction made

Reference list: The doi address is given for a subset of the references but not others.

Delete the doi for all those references (most, perhaps all, of them) that are uniquely cited by volume and page numbers.

Authors Response All DOI’s deleted. Other corrections also made in references.

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Table 1: Why does this table summarise 42 days of meteorological data, yet there were 45 days of PM2.5 sample collection?

Authors Response It should have been 45. Correction made

Table 2: In the footnote, is the text “Data Meteorological Data Summary” erroneously present?

Authors Response I’ve removed “Data” to read “Meteorological Data Summary”

Table 3: Group the data for the ions determined by IC separately from the data for the C831 elements determined by ICP (i.e. do not intersperse the lines of data) and add the correct anion and cation charges to all those species quantiïňĄed by IC.

Authors Response We’ve added the charge to the three ions in the table. We feel there is no additional value in breaking out the ions in this table.

Authors Response Below are the new Figure Captions:- Figure 1. Location of the DGS used during BORTAS-B (source of maps: free within ArcGIS v10)

Figure 2. Map of ensemble HYSPLIT 2-day air mass back trajectories between 11 July 2011 and 25 August 2011. Trajectories were initialized twice per day at 08:00 UTC and 20:00 UTC with an arrival height of 500 m. Colours denote upwind source region (cyan = Marine, red = SW, green = WNW and blue = N)

Figure 3. HYSPLIT 2-day air mass back trajectory vertical profiles initialized twice per day at 08:00 UTC and 20:00 UTC

Figure 4. Time series of total PM2.5 mass and major species concentration

Figure 5. Time series of total PM2.5 mass and macro species concentration

Figure 6. Time series of total PM2.5 mass and micro species concentration

Figure 7. Time series of total PM2.5 mass and trace species concentration

Figure 8. Source profiles for the seven PMF factors

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Figure 9. Time series of PM2.5 source apportionment based upon PMF output

Figure 10. Source Contribution Rose

Figure 11. Back trajectories associated with the highest values of each PMF cluster.

Figure 12. Average mass concentration (μg/m3) of attributed sources and percentage source contributions over the 45 days of sampling

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/13/C2645/2013/acpd-13-C2645-2013-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 4491, 2013.

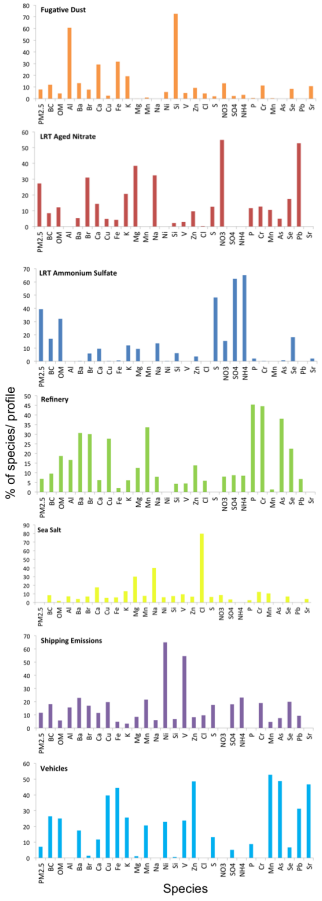

Fig. 1. Figure 8 Source profiles for the seven PMF factors

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