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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A comparison of four receptor models used to quantify the boreal wildfire smoke contribution to surface $PM_{2.5}$ in Halifax, Nova Scotia during the BORTAS-B experiment" *by* M. D. Gibson et al.

M. D. Gibson et al.

mark.gibson@dal.ca

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Firstly, thank you for taking the time to conduct the review and for providing excellent advice and comments to improve the manuscript.

RC: Abstract: It would be beneficial to include a brief quantitative summary of key metrics of model performance to illustrate why one model is preferred over the others etc.

AR: I have inserted a sentence in the abstract on P24045, l11 between ' . . . receptor model.' . . . and 'The results indicate. . ..' To read as follows. 'The performance of the four receptor models was assessed on their ability to predict the observed PM2.5 with an R2 close to 1.0, an intercept close to zero, a low bias and low RSME.

If this puts the abstract over the word limit this same sentence appears again in the materials and methods (see below).

RC: Methods: It would be useful to highlight which combinations of the metrics of model performance are regarded as being indicative of suitability for the application.

AR: I have inserted a sentence in the methods section, P24053, l116, new paragraph. 'The performance of the four receptor models was assessed on their ability to predict the observed PM2.5 with an R2 close to 1.0, an intercept close to zero, a low bias and low RSME. In addition, suitability was also based upon the models ability to closely predict the observed PM2.5 during low, median and elevated concentrations.'

RC: Results & Discussion: It would be more succinct and would aid comparison between models to combine Tables 4-6.

AR: Thank you for the suggestion. However, because the models identify and quantify different numbers of sources, types of sources and with different chemical species found in some of the predicted sources, there is no utility in combining the four tables. An explanation of this is given on P24055, l 11. 'The reason for the different number of sources identified by each model is due to the different inherent methodology by which each model generates the source identification.'

RC: The data in Table 7 could be incorporated within Figs 1-4.

AR: Indeed, reviewer 1 also wished for Table 7 to be removed and the information it contained incorporated into Figs 1-4. This has been done.

RC: It would be more succinct and would aid comparison between models to combine Figs 1-4 in a composite figure with 4 plots. It would also be beneficial to keep the axis

ACPD
14, C9600–C9613, 2014

scale ranges the same in each plot to aid comparison.

AR: I have changed the y-axis scales to match and created a panel of the four scatter plots, Now entitled 'Fig 1. Comparison of the four receptor model predicted PM2.5 versus the observed PM2.5 a) Absolute Principal Component Scores (APCS) vs. observed PM2.5 b) Pragmatic Mass Closure (PMC) vs. observed PM2.5 c) Chemical Mass Balance (CMB) vs. observed PM2.5 and d) Positive Matrix Factorization (PMF) vs. observed PM2.5

RC: It would be more succinct and would aid comparison between models to combine Figs 5-8 in a composite figure with 4 plots. It would also be beneficial to keep the axis scale ranges the same in each plot to aid comparison.

AR: Note there is a new Fig 2. PMF chemical species source factor profiles. I have combined the Figs 5-8 into one panel, now Fig 3. Comparison of the four receptor model source apportionment timeseries a) Time series of the relevant source contributions to PM2.5 estimated by Absolute Principal Component Scores (APCS) b) Time series of the relevant source contributions to PM2.5 estimated by Pragmatic Mass Closure (PMC) receptor model time series c) Time series of the relevant source contributions to PM2.5 estimated by Chemical Mass balance (CMB) and d) Time series of the relevant source contributions to PM2.5 estimated by Positive Matrix Factorization (PMF).

RC: There is limited interpretation of the data in Figs 5-8; hence it would appear to be of benefit to include further discussion of these figures. The existing discussion of Ni and V concentrations is unclear.

AR: The interpretation of the trends in the sources (with the exception of woodsmoke) in Figs 3 (a-d) are provided in the previous paper (Gibson et al., 2013 ACP). This is stated on P24055, l6. Therefore there is no need to re-iterate here.

However, with reference to your comment regarding Ni and V. I have re-worded the

ACPD
14, C9600–C9613, 2014

sentences starting on P24055, l27 to read 'With reference to Fig. 3, the trace metal oxide values are worthy of note. This is because, within the PMC model, Ni and V are included in the calculation of the apportioned trace metal oxides. Where as, in the PMF and APCS models, Ni and V are used as unique chemical tracer elements of ship emissions. Because of the inclusion of Ni and V in the trace metal oxide apportioned source, it is not possible for the PMC model to apportion ship emissions.

RC: I'm not convinced by the authors' suggestion that models with intercepts in mod-obs plots are 'not able' to predict below the intercept value. The prediction can presumably be made from the regression line in the mod-obs plots with a quantifiable metric of uncertainty (which could be given and which is different from being 'not able'). Similarly it would be more appropriate to refer to the 'lowest' rather than the 'best' intercept.

AR: Indeed, a very good point! I have provided the metric of uncertainty for each intercept and changed best to lowest in the sentence below. P24054, l21. I have changed the sentence to read . . . 'From Fig. 1 a) and Fig. 1 b) it can be seen the intercepts associated with both the APCS and PMC receptor models mean that they have difficulty predicting PM2.5 less than 2.0 $\pm$1.2 μg m$-$3 and 2.0$\pm$0.2 μg m$-$3 respectively.

P24054, l26. I have changed the sentence to read . . . 'From Fig. 1 d) it can be seen that the PMF model has the lowest intercept ($-$0.07 $\pm$1.57 μg m$-$3). . ..'

P24054, l26. I have changed the sentence to read . . . 'From Fig. 1 c) it can be seen that the CMB intercept was located at $-$0.53 $\pm$0.21 μg m$-$3, a slope of 1.0, ...

RC: Conclusions: The implications of the findings for wider research could be outlined in a clearer and more direct manner.

AR: As per an earlier suggestion, on P24059, l20 I have changed the sentence to read. . .. 'It was found that APCS and PMC receptor models mean that they have difficulty predicting PM2.5 less than 2.0 $\pm$1.2 μg m$-$3 and 2.0$\pm$0.2 μg m$-$3 respectively.

I have also looked at the conclusions in more detail. We have already made changes

ACPD
14, C9600–C9613, 2014

as per reviewer 1's recommendations. Without more direction from your good self we fail to see where we can make the conclusions any clearer or direct. Therefore, apart from the changes above, the conclusion remains the same.

Note to Editor and Print Office Here is the full reference for Wheeler et al. (2014) that is now in print.

Wheeler, A. J., Gibson, M. D., Macneill, M., Ward, T. J., Wallace, L. A., Kuchta, J., Seaboyer, M., and Dabek-zlotorzynska, E.: Impacts of air cleaners on indoor air quality in residences impacted by wood smoke, Environ. Sci. Technol., 48, 12157-12163, 2014.

I have also created a new figure that we feel is a valuable addition to the paper as shown below.

This new figure would be Figure 2. Therefore Figure 5-8, 9, 10, 11 and 12 would become Figures 3, 4, 5, 6 and 7 respectively.

P24052, l12. The sentence 'The PMF factor profile used to identify woodsmoke contained 99% of the levoglucosan mass.' Would be removed.

P24055, l5, new sentences added 'Figure 2 provides the PMF model output associated with the chemical species and their factor source profiles contributions. It can be seen in Fig 2. that the PMF factor profile used to identify woodsmoke contained 90% of the total levoglucosan mass.

Therefore, the following minor changes would need to be made to the manuscript incorporate the new figure.

P24055, l5, 'Figures 5–8 provide . . .' would be changed to 'Figures 3 a-d) provide . . .'

P24055, l7, '. . . with Figs. 5–8 are . . .' changed to '. . .with Figs. 3 a-d) are . . .'

P24055, l27, '. . . reference to Fig. 6,' changed to '. . .reference to Fig. 3 b),"

ACPD
14, C9600–C9613, 2014

P24056, l22 '. . .series plot shown in Fig. 9.' Changed to '. . .series plot shown in Fig. 4.'

P24056, l22 '. . .feature of Fig. 9. . .' Changed to '. . .feature of Fig. 4 is . . .'

P24056, l28 '. . .seen from Fig. 9 that . . .' Changed to '. . .seen from Fig. 4 that . . .'

P24057, l9. 'Figure 10 provides . . .' changed to 'Figure 5 provides . . .'.

P24057, l15. 'Figure 10a shows . . .' changed to 'Figure 5a shows . . .'.

P24057, l19. '. . . in Fig. 10a are . . .' changed to '. . .. In Fig. 5a are . . .'.

P24057, l20. 'Fig5' changed to 'Fig 3 a)'.

P24057, l22. '. . .in Fig. 10.' changed to '. . . in Fig 5.'

P24057, l23. '. . .in Fig. 8.' changed to '. . . in Fig 3 d), it can . . .'

P24058, l2. '. . .from Fig. 10b that. . .' changed to '. . . from Fig. 5b that . . .'

P24058, l3. '. . .in Fig. 10 a.' changed to '. . . in Fig. 5a.'

P24058, l6. '. . . timeseries (Fig. 8) was . . .' changed to '. . .timeseries (Fig. 3 d)) was. . .'

P24058, l8. '. . .from Fig. 10c that. . .' changed to '. . .from Fig. 5c that. . .'

P24058, l11. '. . .in Fig. 10d.' changed to '. . .in Fig. 5d.'

P24058, l11. 'Fig. 10d shows . . .' changed to 'Fig. 5d shows . . .'

P24058, l13. '. . . in Fig. 10d points . . .' changed to '. . . in Fig. 5d points . . .'

P24058, l14. 'Figure. 11 provides . . .' changed to 'Figure 6 provides. . .'

P24058, l17. '. . . shown in Fig. 9 and 10.' changed to '. . . shown in Fig. 4 and 5.'

P24058, l18. '. . . shown in Fig. 9 on ...' changed to '. . . shown in Fig. 4 on ...'

P24058, l19. '. . . seen in Fig. 12 where ...' changed to '. . . seen in Fig. 7 where ...'

ACPD
14, C9600–C9613, 2014

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 24043, 2014.

ACPD
14, C9600–C9613, 2014

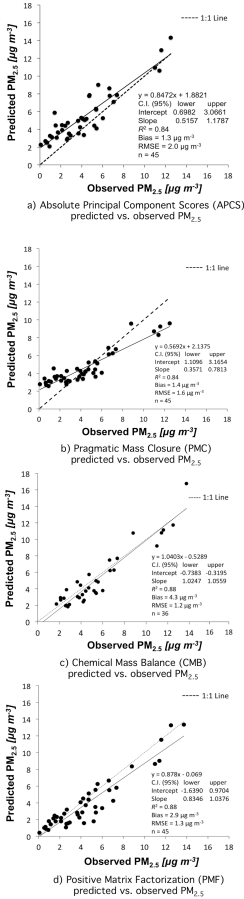

Fig. 1. Four receptor model predicted vs. observed PM2.5

ACPD
14, C9600–C9613, 2014

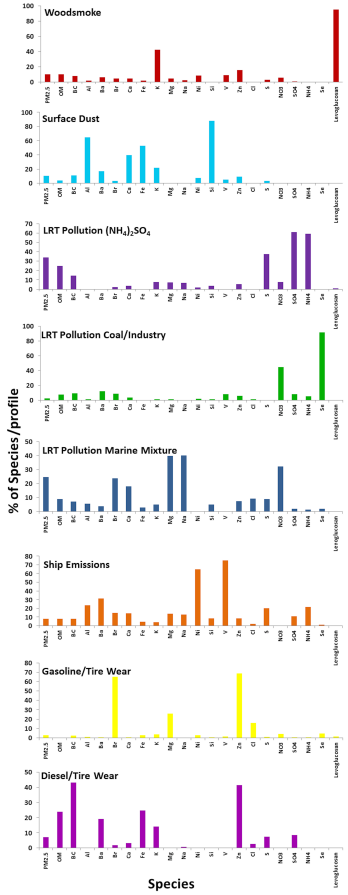

Fig. 2. PMF chemical species source factor profile contributions

ACPD
14, C9600–C9613, 2014

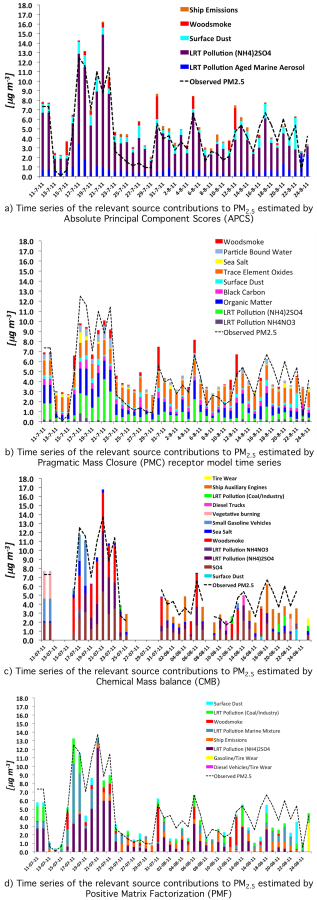

Fig. 3. Four receptor model source apportionment timeseries

ACPD
14, C9600–C9613, 2014

ACPD
14, C9600–C9613, 2014

Interactive Comment

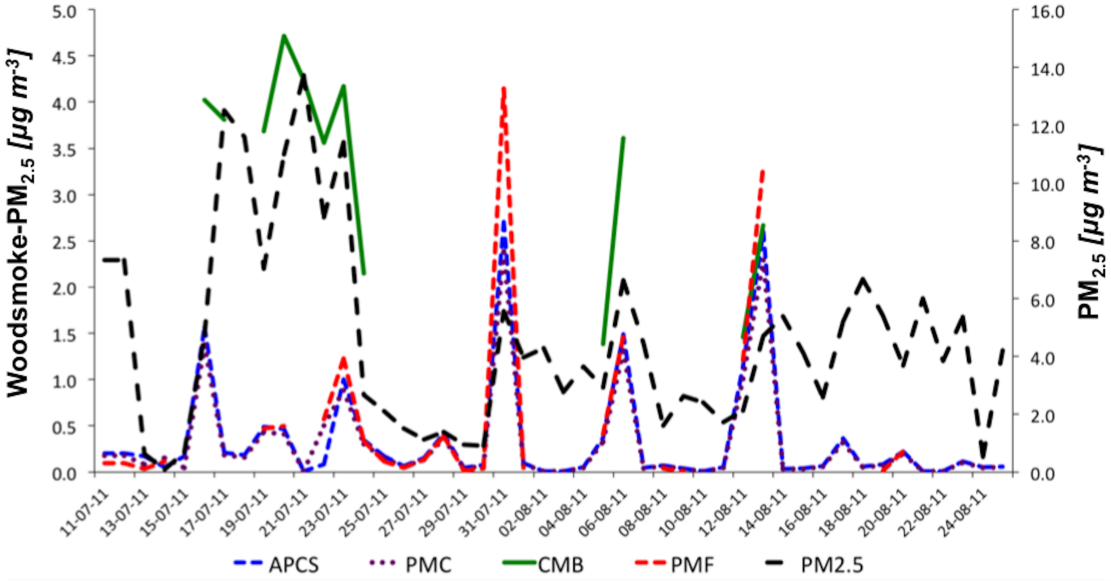

Fig. 4. Time series of the woodsmoke contribution to the total PM2.5 mass estimated from the four receptor models during BORTAS-B.

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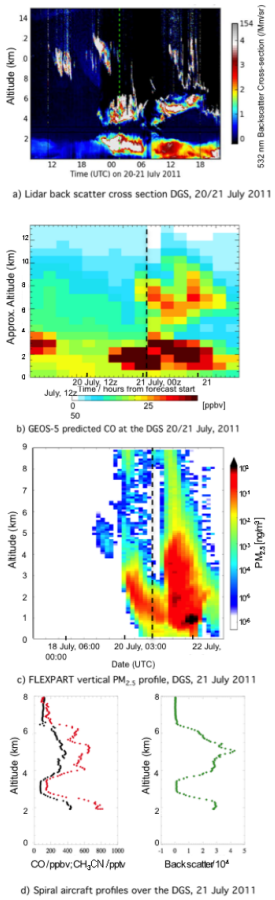

Fig. 5. Comparison of simultaneous observations (a) Lidar backscatter cross section DGS, 20/21 July 2011 (b) GEOS-5 CO forecast at the DGS 20/21 July 2011 (c) FLEXPART vertical PM2.5 profile, DGS, 21 July 201

ACPD
14, C9600–C9613, 2014

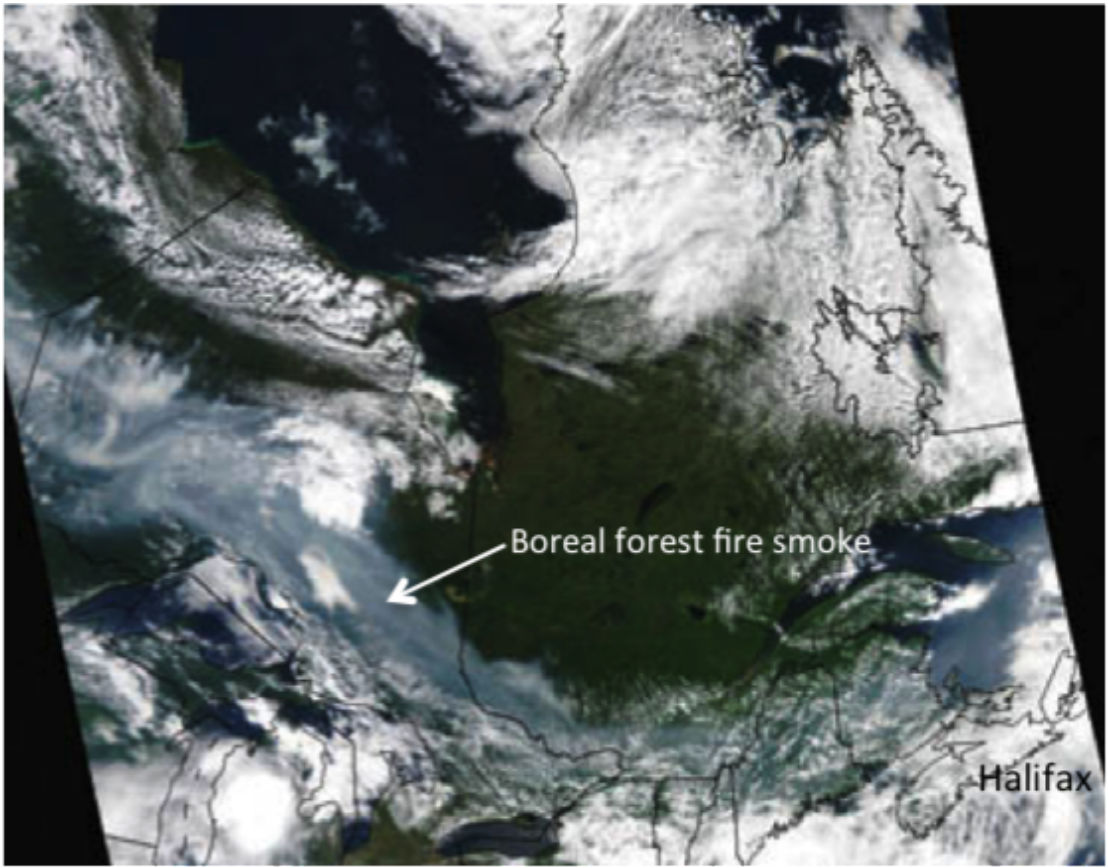

Fig. 6. NASA AQUA MODIS true colour satellite image at 18:00UTC on 18 July 2011 clearly showing boreal forest fire smoke from Northern Ontario advecting over Halifax, Nova Scotia.

ACPD
14, C9600–C9613, 2014

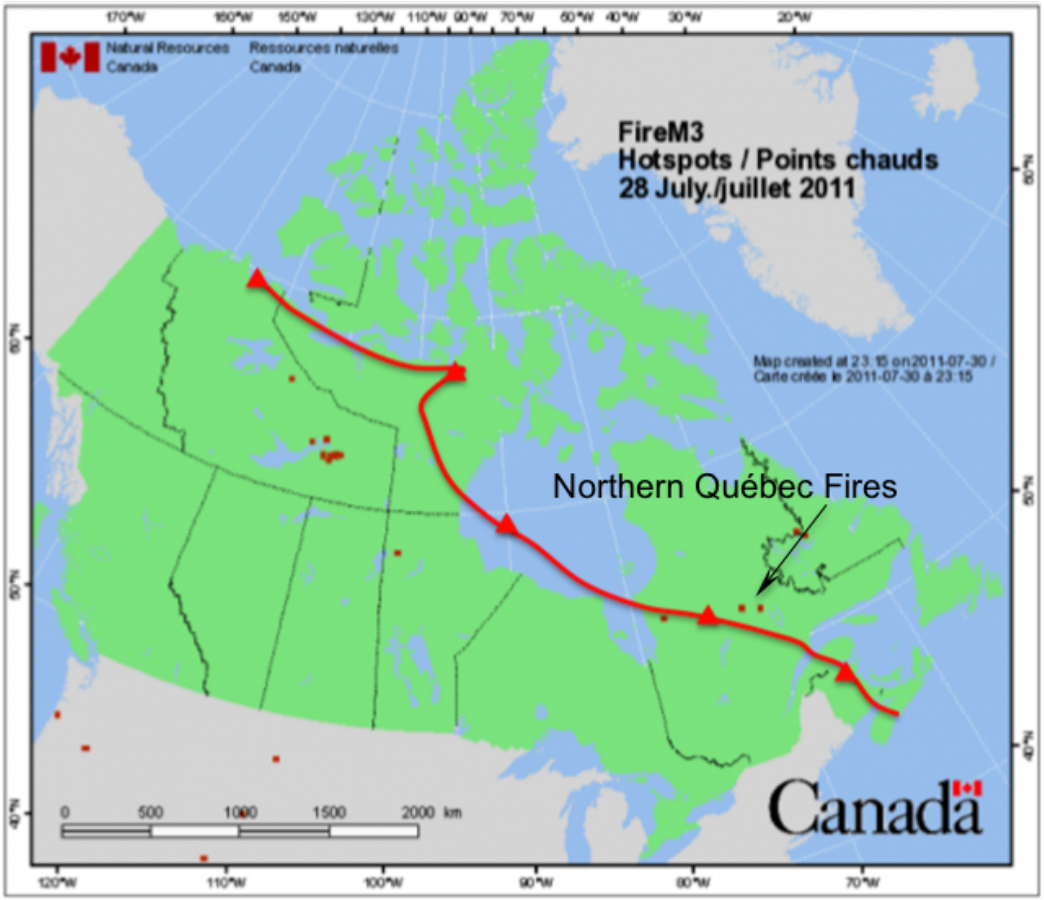

Fig. 7. 5 day HYSPLIT air mass back trajectory arriving at 12:00UTC overlaying the fire hot spot map for 28 July 2011.

ACPD
14, C9600–C9613, 2014