Atmos. Chem. Phys. Discuss., 9, C8387–C8392, 2009
www.atmos-chem-phys-discuss.net/9/C8387/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Background ozone over Canada and the United States" *by* E. Chan and R. J. Vet

E. Chan and R. J. Vet

elton.chan@ec.gc.ca

Received and published: 14 December 2009

Authors' responses to reviewer #2 are as follows:

Specific comments: The definition of "Background" has been revised and this should clarify many issues raised by the reviewer and reconcile any contradictory statements.

The definition has been re-defined as "The term background ozone is qualitatively defined as ozone mixing ratios measured at a given site in the absence of strong regional and local influences."

P21115 L7-9 has been re-worded as: Thus, if the (continental and/or regional) background is indeed rising, the achievability to meet air quality standard by one local jurisdiction may become increasingly difficult in the future.

Added: “Background is not directly observable. All of these studies reported on measured O3 and inferred what was happening to background.”

Pg xxx18, line 8: 925hPa. What about mtn sites? We only used backward trajectories arrived at 925hPa including the mtn sites. It was found to be satisfactory as shown in Fig. 7a and 7b. The CMC trajectory model has clearly taken the topography into consideration.

“I am confused how you connect the 4 trajectories per day on GMT time, with the one 6hr average O3 on LT.” We used one 6hr averaged value for one trajectory. Except for the decadal trend analysis in which 4 trajectories were associated with one value. In North America, one “GMT day” covers two “local time days”. This is depicted in attached Fig. 1.

Line 22: The cleanest clusters are assumed to represent “background” air, according to our revised definition of the background. “The cleanest cluster does not give the background distribution and it doesn’t matter whether you use the 50th, 90th or 95th percentile.” The cleanest cluster extracted by 95th percentile does give the air flow that has the least regional/local effects. Other lower percentile statistics would not guarantee that. Please also refer to our response to reviewer #1.

Pg 21119, line 10-15: “I don’t understand. Are you doing the PCA analysis for each season separately?” Yes, line 10-15 has been revised to give clarity. “Does this mean the geographical groupings change by season?” Yes, the geographical groupings change by season and this is shown in original Fig 1.

“Again, don’t understand how you link the 4 GMT traj per day with the one 6-hour ozone value.” No, we did not link 4 GMT to one 6-hour ozone value. We linked a GMT traj with a 6-hour averaged value centered at the corresponding GMT. Please refer to our illustration shown in attached Fig. 1. If one thinks of the trajectory and ozone data matching process in terms of moving averages may help. In this context, what we did was time moving matching.

ACPD

9, C8387–C8392, 2009

Pg xxx21: "The organization is very confusing. You must start with the results of the PCA analysis as this is key for the rest of the analysis. If reader doesn't understand the PCA, they will not understand rest of paper. This organization is partly why it took me so long to get thru your paper."

Based on this comment, the authors have re-ordered the sections 3 and 4, the Statistical method section and Results and discussion section. We have presented the PCA results first.

"What are all the numbers here? What does it mean where you state "the mixing ratios ranged from 31 to 38 in spring. The mixing ratios of what? Very confusing." Added: the mixing ratios of background ozone ranged. . .

Pg 21122 L6-7: "What regions are PC1, PC5, etc?" Added the region names. Note that PC1 (southern Quebec/northeastern US), PC5 (northern Atlantic Canada), PC6 (southern Ontario), PC8 (Prairie Provinces), PC10 (northern Pacific) and PC11 (western Ontario).

"Table 1b is impossible to figure out. This is all very poorly presented." With two illustration figures suggested by reviewer #1, Table 1 should be much easier to follow. Please see attached figures (Fig. 2 and Fig. 3) in our response to reviewer #1. The ranges (min and max) were simply calculated from the fitted red curves for a given region.

Line 24, "What is the significance of this statement "The PCA regions were ordered by the percentage of the total variance. . ." Did you use this ordering?" It is the authors' experience from the readers that asked in the past whether the PCA-derived regions were ordered according to the percentage of variance explained. Yes, we use the percentage of the total variance for the ordering and we use this ordering throughout and shown in all PCA figures.

"This is a very interesting analysis and could be the subject of one paper on its own.

ACPD

9, C8387–C8392, 2009

In fact I would recommend this as there is too much in this paper and it is not well explained. That there are daily variations between sites that are well correlated on a regional basis is very interesting. That said, I am very surprised that there was not a single outlier. That is the PCAs didn't put a single site into a wrong category. Seems quite remarkable."

As long as the sample size is large enough (in this study 10 years by season) and the pollutants are close to normally distributed such as ozone, the groupings in theory will be very stable. No outlier in any of the regions is remarkable indeed, but not totally surprising. This also indicates the fact that the selection of the 97 "non-urban" sites is quite successful. Note that the authors attempted to apply the same PCA approach on aerosols, but did find many outliers. This could be attributed to the shorter atmospheric life time and stronger local effects in aerosols and the differences in the nature of the sampling sites. The length of the paper is an issue. However, if one tries to analyze and integrate information in both space and time, the length is quite inevitable. The authors will keep the PCA analysis in this paper as the results were tightly linked with the groupings that were used to do the regional trend analysis. This decision is to consolidate the comments from reviewer #1 and reviewer #2.

Pg 21123: Figure 2 is all trajectories or just the "background" cluster? Yes, all trajectories were used. Figure 2 shows, for each season, the 10-year-average backward trajectory (three days) at each site. All trajectories were used to calculate the average air flow trajectories at each site. It can be seen that the average air flow trajectories for all sites in a given region have similar average flow directions.

Table 1: I cannot figure out what is being presented. As mentioned above, this should be clear now with two illustrative figures.

What are the two numbers in each column? They are the ranges (min/max) of the annual fitted curve for a given season.

Are all sites in each grouping averaged into one value or do the numbers in the table

ACPD

9, C8387–C8392, 2009

somehow give information on variations between sites. All background data from all the sites in each grouping were used to fit the annual curve (1a), and the diurnal curve (1b).

Why are there multiple PCs for the same region? Don't the PC regions change for each season? To quantify background ozone, the PCA-derived regions were grouped together in seven geographical regions. The groupings of sites were used based on the PCA/JJA months as provided in the caption: "The groupings of sites are based on the principal component analysis for the JJA months."

For the diurnal values are these the min/max O3 mixing ratios or the amount of daily variation (max minus min)? Min/max of the fitted diurnal curve during a given season in a given region.

I assume the diurnal variations are based on hourly data, but everything else uses 6 hour averages? Yes, except the regional decadal trend analysis.

Table 2: This table needs to give information on the regions. The authors do not find including the geographical labels are really beneficial. The labels could only be a very rough spatial correspondence to the actual PCA groupings. For example, two PCA groupings have sites from the same state or province. However, we would include caption such as "See Figure 1 for the spatial locations of the PCA-derived regions".

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 21111, 2009.

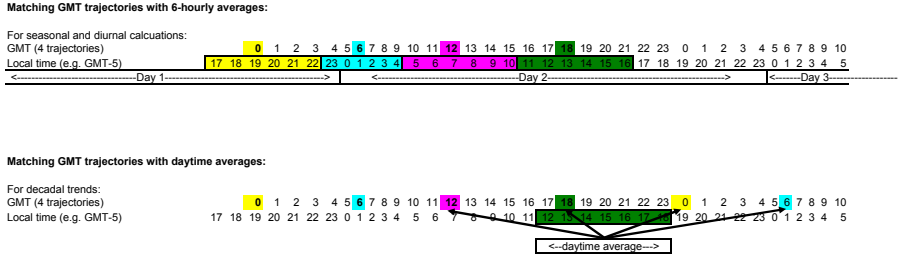

Fig. 1.

ACPD

9, C8387–C8392, 2009