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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluating local anthropogenic impact on remote Arctic monitoring stations: a case study at Summit, Greenland" *by* G. S. W. Hagler et al.

G. S. W. Hagler et al.

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We would like to thank the two anonymous reviewers for their helpful comments on this manuscript. Below are the authors' responses (preceded by R) to the reviewers' comments (preceded by C).

Response to anonymous reviewer #1:

C: My first concern is the title. The paper only deals with contamination at Summit. Reference to remote Arctic monitoring stations other than Summit should be removed from the title.

R: While the results do suggest that other Arctic field sites powered by local generators

may face similar measurement challenges, the authors agree that the focus of this paper is on Summit, Greenland. We have altered the title to reflect this. The title is now: "Local anthropogenic impact on particulate elemental carbon concentrations at Summit, Greenland"

C: While it is clear that concern over contamination of both air and snow samples near the camp is warranted, it is unfortunate that this effect was not evaluated earlier. Both of the previous studies conducted by Hagler et al. (2007 a, b) reported carbon concentrations from snow collected near the camp (1 km south in the clean sector). The authors should discuss the potential impact of their current findings, i.e., factor-of-two contamination of EC in snow, on their previous results and conclusions.

R: We regret that we did not spend more time discussing this issue in the original draft and we added in substantial further text discussing the connection between these results and our prior published findings. We also sought to lessen the paper's length by cutting the introductory first paragraph in section 3.2:

Added text: "Given the difference in camp vs. distant (10 or 20 km) snow pits, one conclusion is that our past reported carbonaceous snow concentrations (Hagler et al., 2007a,b) may have contamination issues. While no absolute guarantee can be placed on the trace level measurements reported, both the bap data presented here and the nature of the reported snow concentrations give some support that our prior research findings remain unchanged. First, it should be noted that all snow concentrations previously reported (Hagler et al., 2007a,b) were at a satellite location twice the distance (1 km from Summit Camp) as the 1-meter snow pits discussed here. This alone reduces the likelihood of significant camp impact. Next, as shown in Fig. 1, concentrated local plumes tend to be uncommon, short-lived, and higher than background concentrations by orders of magnitude. In the rare event that precipitation coincides with a concentrated plume, one would expect surface snow concentrations to similarly increase by orders of magnitude. In our surface snow samples collected in 2006 (Hagler et al., 2007b), very thin surface layers were collected and no orders-of-magnitude concen-

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tration spikes were observed. Thus, it is not expected that the summer 2006 surface snow samples suffered any substantial camp impact. This is an important point, as a major conclusion was based upon assessing buried summer layers in a 3-meter snow pit relative to the surface snow (Hagler et al., 2007a).

Determining potential contamination of layers in the 3-meter snow pit data (Hagler et al., 2007b) is more challenging, as a rare thin layer of contaminated snow would likely be diluted by non-contaminated snow in a relatively thick sample layer (10-20 cm). One simple comparison is to compare the top 1-meter average of our 3-meter pit (0.35 μg kg-1) at the satellite site to the 1-meter pits closer to camp (0.53 μg kg-1), finding concentrations 34% lower and much closer to the range of the distant snow pits (0.23-0.30 μg kg-1). This is only a rough comparison, as the 3-meter and 1-meter snow pits were sampled nearly 2 months apart. Another strategy is to assess layer-by-layer patterns in the 3-meter pit; it appears that nearly every layer with an EC increase (decrease) in concentration has a corresponding increase (decrease) in the potassium ion (K+) within an error margin of one layer (Hagler et al., 2007b). As K+ is a known tracer for biomass burning, these results suggest that a long-distance source was controlling the EC levels in the snow pit. One wintertime snow pit layer stands out as an exception (120-130 cm), in which EC increases and K+ remains low, which may suggest a contamination concerns. As the 2006 snow pit analysis mainly focused on summertime snow layers (Hagler et al., 2007a), the findings are expected to be trustworthy."

C: With respect to sector-controlled air sampling, it would be informative for the authors to compare average Bap from PSAP measurements including and excluding sectorscreeneddata. Averaging times should correspond to their previous atmospheric sampling durations, e.g., 4-7 days.

R: For the sake of length (reviewer #2 suggested shortening and we added in substantial further text to discuss linkages to past findings), we have decided to forgo this addition and instead include a summer average estimate in this response. It can be

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roughly estimated that if the [bap] spikes occurred 1.6% of the time (value reported in the text) at roughly 14.5 Mm-1 (value used to calculate the generator emissions rate), this would have increased the resulting summer-average concentration of bap by:14.5*0.016 = 0.23 Mm-1. This would have more than doubled the summer average (sector-controlled average = 0.15 Mm-1).

C: The PSAP is an excellent means of studying the temporal variation of Bap. However, in this paper, the authors attempted to estimate EC emissions from the camp based on PSAP measurements. They converted measured Bap to EC concentration using a factor (mass absorption efficiency) of 24 m2/g determined from PSAP and EC measurements in Hagler et al. (2007b). This could be internally consistent, despite biases in the measurements of Bap with the PSAP and EC with the NIOSH thermal/optical transmittance protocol (Virkkula et al., 2005, AS&T, 39, 68-83; Chow et al., 2001, AS&T, 34, 23-34), if background EC measured in the clean air sector had the same optical properties as EC from the nearby camp generator. This is probably not the case. Liousse and Cachier reported large variations (5-20 m2/g) in the mass absorption efficiency in diverse environments. Some discussion recognizing this potential inconsistency is warranted.

R: It is a good point that we did not thoroughly discuss the degree of uncertainty in our estimation of the generator emissions rate. While it is true that applying a sector-controlled (i.e. background) derived mass absorption efficiency value to the fresh source is questionable, what lends some support is the fact that a very similar value has been derived in an urban setting using identical measurement techniques (18.3 m2 g-1 determined by Carrico et al, 2002). At this point, we do not feel it is necessary to add in a lengthy discussion about the full variety of mass absorption efficiency estimates. Instead, we added in a sentence discussing the several sources of uncertainty affecting the calculated generator emissions rate:

Added text: "It should be noted that the value of Q is a best estimate, relying an assumptions of a representative spike in [bap], that the mass absorption efficiency value

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is accurate, and that the case of ground reflection applies. While there is significant uncertainty in the estimated value of Q, the meteorology data are measured values and strengthen the conclusions about relative contamination risk over various wind angles and distance from camp."

Citation: Carrico, C. M., et al. (2003), Urban aerosol radiative properties: Measurements during the 1999 Atlanta Supersite Experiment, Journal Of Geophysical Research-Atmospheres, 108.

Response to anonymous reviewer #2:

C: I agree with reviewer #1 that the title should only mention Summit.

R: As mentioned above, we have agreed to alter the title to mention only Summit, Greenland.

C: For readers not familiar with the Summit camp, it would be helpful if the paper presents a map of the camp or gives a web address where such a map is available.

R: We appreciate the suggestion and have added in a web address as well as longitude/latitude to the research site in the introduction.

C: Some comments should be made on how are handled the days with flights at camp. Are they excluded from figure 1? Is the wind sector controller taking care of that?

R: It can be noted that Fig. 1 has no PSAP or sector control data eliminated. We already have details on how we handled aircraft activity in the introduction: "However, the camp generators are in continuous use and intermittent (every 2-3 weeks during the spring to summer and every 2-3 months during late-summer to early-spring) supply aircraft arrivals occur regardless of wind direction. As these emitting sources could potentially contaminate our atmospheric sampling for organic and elemental carbon, protective measures were integrated into our atmospheric sampling protocol during the field season (cessation of integrated filter sampling during air traffic and ongoing sector control at all other times)." *note: we have added in "integrated filter" to better

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specify which measurements were manually shut off.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 1239, 2008.

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Interactive Comment