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Interactive comment on “Aircraft observations of enhancement and depletion of black carbon mass in the springtime Arctic” by J. R. Spackman et al.

Anonymous Referee #2

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This study reports vertical measurements of black carbon, carbon monoxide, and ozone conducted during 5 flights in April 2008 over the Alaskan Arctic. The BC measurements were conducted with a sophisticated Single-Particle Soot Photometer (SP2) instrument. The authors conduct various analyses on the data to explore and characterize the nature of Arctic BC deposition, for which much research is needed.

Overall, this is a useful contribution to the literature and the manuscript is well-written. The authors go beyond simply reporting the measurements and present informative interpretations of the data. I recommend publication in ACP after these minor issues are addressed:

General comments:

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Please include the duration of the flights and times of day that they took place. Are there any diurnal cycles in Arctic boundary layer processes that could have biased your interpretation of the measurements?

The explanation for why O₃-BC correlation during O₃ depletion events is evidence for BC removal by dry deposition needs more explanation/development. The following sentence is one example (p15178,15): "The general theory is that Br₂ is released into the atmosphere from the brine during sea-ice formation so the correlation between O₃ and BC mass suggests BC particles have been preferentially removed by contact with the snow." This suggests a link between sea-ice formation and BC removal, but what is the physical mechanism? Does increased surface roughness from snow or sea-ice enhance near-surface turbulence, which increases the dry deposition rate? Please elaborate.

Related to this comment, what value do you assume or calculate for the "removal efficiency factor" (p15180,2), and how do you justify it?

Section 4.1 and Figure 6: Correlations are discussed qualitatively. It would be helpful to include statistics of these correlations (e.g., R² values) to make the analysis more rigorous.

p15172,14: Can you provide a brief description of how your measurements compare with those conducted for ARCTAS (Jacob et al, 2010)? I see that this paper is also in ACPD, and would be interesting to know the level of agreement (if described qualitatively) between measurements conducted during the same period with an identical instrument.

Specific comments:

abstract, sentence spanning lines 18-22 is awkward.

p15168,20: Explain why colder temperatures and weaker insolation imply longer residence times for aerosols (specifically BC, for which photochemistry plays less impor-

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tant of a role).

p15169,20: The statement "high-latitudes are isolated from lower latitudes in winter...induces a weak meridional barrier to transport" seems contradictory to me. A "weak" barrier would seem to imply less isolation. Please clarify this description.

p15170,4: "blend" -> perhaps "partitioning" ?

p15171,19: Does the range of particle sizes measured by the SP2 refer to the particles containing BC, or just the BC component?

p15173,2: "This important observation constrains global aerosol models": This statement needs refining. Although very important, these measurements (spanning a limited spatial domain over 5 days) must be augmented with other data to truly constrain "global" aerosol models.

The two paragraphs beginning at p15175,17 lack coherence and context. Please polish them before publication.

p15174,5: "minimum observed altitude" -> "altitude of minimum concentration" (?)

p15174,13-20: This passage is a bit awkward.

p15174,26: "evidence for particle removal in the ultrafine and fine modes"... but no evidence for removal in coarser modes?

p15174,29: "pushing the Arctic air further north": What is the evidence for this? Could the air have been displaced vertically and/or southward instead?

p15176,9-10: 200ppb CO criterion for defining anthropogenic or biomass-burning plumes: This seems somewhat arbitrary, especially in situation where CO and BC become decoupled. Is this threshold used elsewhere? Why exclude BC from the defining criteria of pollution/burning-affected plumes? (It is not even clear to me where this threshold is applied in the study, so perhaps it is not relevant).

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p15176,17: "BC vertical gradient approaching a factor of 5": Define "gradient" and how the factor of 5 applies. Is this the spread between minimum and maximum values?

p15175,21: "support this conclusion": Do the enhanced CO values support the conclusion that the observed gradients `_can_` or `_cannot_` be attributed to depletion?

p15175,15: "estimate BC removal at 15 ng/kg." Over what time, or at what rate, did this removal occur? (i.e., It may be more informative to report the removal with a time dimension).

p15177,1: "Sampling...may play a role": It is not the "sampling" that plays a role.

p15177,12: Is there a connection between the diamond dust and the moisture source from the leads? If so, you may want to clarify this with wording such as "resulting diamond dust".

p15178,25: For a mode of 160nm, would the fraction of BC mass missed by the SP2 be much different from the 10% cited earlier for a mode of 200nm? (presumably it would be less).

p15178,29: "On the other hand, the size distributions support the CO data that indicate similar sources across the boundary layer transition": How, specifically, do the size distributions support inferences made from the CO data?

Figure 5: Using log(height) or pressure as the vertical coordinate could improve clarity of the boundary layer data.

Figure 6: Please include correlation statistics for these data.

Figure 9: Are all k_{BL} values the same in this box model?

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 15167, 2010.

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