We appreciate the careful consideration of our manuscript by this reviewer. We have considered the points raised and revised our manuscript accordingly. Our detailed responses and all changes that have been made are presented below.

General comments

In this study the authors present results from aircraft measurement on BC in the Canada oil sand region. The BC size distribution was investigated by calculating particle size from the measured mass concentration and density using SP2 instrument. The BC concentration and size distribution in and out-of-plume in the OC region and downwind area were studied and compared. The number and mass size distribution did not show significant temporal differences. Some interesting and valuable information was obtained from this BC study on the OS region. The manuscript is well-organized and clearly presented. I'd like to suggest the acceptance of this manuscript after a minor revision.

Specific comments

(1) Line 169. Is the width of "0.7" that geometric standard deviation, or coefficient of variation?

Our response: The fitting parameters "mass distribution width" and "number distribution width" are defined by Equations (1) and (2), respectively. Briefly, the measured masses of the individual rBC cores were first grouped into different size bins and then fitted by a lognormal curve:

$$\frac{\mathrm{d}m}{\mathrm{d}\log D_{\mathrm{MEV}}} = A_{\mathrm{mass}} \times \exp\left\{0 - \left[\frac{\ln\left(D_{\mathrm{MEV}}/X_{1,\,\mathrm{mass}}\right)}{X_{2,\,\mathrm{mass}}}\right]^2\right\} \quad (1)$$

where the fitting parameter $X_{1,\,\mathrm{mass}}$ is termed the mass median diameter (MMD), and the fitting parameter $X_{2,\,\mathrm{mass}}$ is referred to as the mass distribution width ($\mathrm{Width_{mass}}$). Similarly, rBC number-size distribution was expressed as:

$$\frac{\mathrm{d}N}{\mathrm{d}\log D_{\mathrm{MEV}}} = A_{\mathrm{number}} \times \exp\left\{0 - \left[\frac{\ln\left(D_{\mathrm{MEV}}/X_{1,\,\mathrm{number}}\right)}{X_{2,\,\mathrm{number}}}\right]^2\right\} \quad (2)$$

where the fitting parameter $X_{1,\,\mathrm{number}}$ is termed the number median diameter (NMD), and the fitting parameter $X_{2,\,\mathrm{number}}$ is referred to as the number distribution width ($\mathrm{Width_{number}}$).

In addition, for a lognormal rBC mass-size distribution, the mass distribution width ($\mathrm{Width_{mass}}$) determined by Equation (1) can be converted to the standard deviation of the

distribution (σ_{mass}) by $\sigma_{mass} = \exp\left(\text{Width}_{mass}/\sqrt{2}\right)$. Similarly, Width_{number} can be converted to the standard deviation of a lognormal rBC number size distribution (σ_{number}) by $\sigma_{number} = \exp\left(\text{Width}_{number}/\sqrt{2}\right)$. For a lognormal distribution, therefore, a distribution width of ~ 0.7 corresponds to a standard deviation of ~ 1.6. The "Width_{mass} vs. σ_{mass}" and "Width_{number} vs. σ_{number}" relationships were added to the manuscript.

(2) Lines 174-184. It would be better for readability and easy in a comparison if this information can be present in a table or well-designed figure.

Our response: A table was added as suggested. In addition to the results from fresh urban emissions discussed in this paragraph, rBC size distributions observed for biomass burning plumes and in remote areas were also involved in this table.

(3) Lines 190-191. BC mass, or number concentration distribution?

Our response: The statement that "rBC cores emitted from fossil fuel combustion were smaller in size compared to those from biomass burning" is valid for both rBC mass and number size distributions. Detailed MMD and NMD were presented in Table 1 and discussed in the sentence following this statement.

(4) Line 203. Suggest to rephrase as "including results from the present study".

Our response: The change was made as suggested.

(5) Line 203. Any suggestion on the variation of this 60 nm proposed?

Our response: We noticed that three values (i.e., 30, 40 and 60 nm) are being used in aerosol-climate models as the NMD of black carbon emitted by fossil fuel combustion. But we were unable to estimate the uncertainties of these NMD settings, including that we proposed (i.e., 60 nm) based on the SP2 measurement results on rBC.

(6) Line 222-223. Suggest to revise as "mean negligible difference in the size distribution between the in- and out-of-plume over the OS region".

Our response: The change was made as suggested.

(7) Line 230-232. The information on other measurements during the flight may be necessary to be mentioned in the Method section.

Our response: A new section entitled "Additional dataset used" was added to the Method section, in which the measurements of NO_x, NO_y and organic aerosol (OA) were introduced briefly. Accordingly, descriptions of NO_x and NO_y measurements were removed from this

paragraph.

(8) Lines 300-305. Source types, species present in the ambient air, and the degree of aging are all factors can significantly affect the change of BC size distribution.

Our response: We agree with the reviewer that in addition to the factor we mentioned, there could be other factors that can change rBC size distribution during aging. The sentence was revised to "……influences of aging on rBC size distribution may partially depend on the presence of atmospheric processes that can lead to increased rBC core mass and size in a single particle (e.g., rBC coagulation and evaporation of cloud droplets containing multiple rBC particles).".

(9) Line 338. Figure S2 or Table S2?

Our response: It should be Figure S2. This point was clarified in the revised manuscript.

(10) Figure 1. Is it possible to place a real map in this figure?

Our response: Google Earth images showing flight tracks were provided as suggested. Caption of Figure 1 was updated accordingly.