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## ***Interactive comment on “Carbonaceous aerosols recorded in a Southeastern Tibetan glacier: variations, sources and radiative forcing” by M. Wang et al.***

### **Anonymous Referee #3**

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This paper analyzed the variation of carbonaceous aerosols recorded in the Zuoqiupu glacier located in southeastern Tibet over the period of 1956–2006. The authors further investigated corresponding variation, sources, and radiative forcing over the last 10 years using the global aerosol-climate model CAM5. This is an interesting and valuable study since the change of carbonaceous aerosols in the Zuoqiupu glacier can be traced back to the two world hotspots of carbonaceous aerosols, South Asia and East Asia. The topic of the study is suitable for ACP. I recommend publishing the paper after the authors address the following comments.

General Remarks

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The authors need to go through the paper to clarify the concepts of seasonal variation of BC and OC and the seasonal variation of the ratio of OC/BC. The two seasonal variations should be discussed separately owing to different reasons behind them. For example, the authors listed potential reasons on page 19725 lines 9-14 to explain the seasonal dependence of the relationship between OC and BC shown in Fig.2. However, the explanations help only to explain the seasonal variation of BC and OC, not the ratio of OC/BC.

In addition to the change of emission and atmospheric removal, the change of atmospheric circulation pattern during monsoon and non-monsoon seasons also contributes to the carbonaceous aerosols at studied site. It is good that the authors describe the atmospheric circulation pattern during two seasons on page 19726 lines 12-26. It would be even better if the authors could show the corresponding circulation patterns on a figure, such as Fig 3.

Fig. 5 indicates a rapid increase of the ratio of OC/BC in the Zuoqiupu ice core after 1990. However, this increase is not observed from the regional emissions on the figure compiled by Bond et al., 2007 and Lu et al., 2011. Therefore, the conclusion of “Because of the stronger increasing trend in OC than BC during 1990-2006, the contribution of OC to the total radiative forcing cannot be neglected” (page 19731 lines 17-18) needs to be further checked to its regional representation.

Specific comments Page 19721 lines 5-6: Is this correct for the sentence “During the cold and dry winter monsoon seasons. . .”? The monsoon season should be June-Sept as indicated in the abstract.

Page 19721 line 23-24: The emissions of biofuel consumption and biomass burning are typically categorized separately.

Page 19722 line 11 and 14: It would be better to use “source types” instead of “combustion sources” here.

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Page 19722 line 15: Is it robust to estimate regional RF impact with only Zuoqiupu glacier ice core data?

Page 19723 lines 6-7: Are there any differences between EC and BC in terms of their concentrations? Do the authors need to convert the measured EC to BC concentration in order to compare with model simulation?

Page 19723 line 8-9: Why can the ice-core measurements only account for the water-insoluble part of OC from aerosol emissions?

Page 19723 lines 23-25: Could you elaborate on the approach of “offline mode”? Do you mean the simulation used an approach typically used for chemistry transport model (CTM)? How does this approach provide dynamic feedback between cloud/precipitation and aerosol?

Page 19725 lines 2-3: The numbers in text are opposite of the numbers shown in Fig. 2.

Page 19725 lines 9-11: Other potential reasons, such as the change of transport path and strength, may also have an impact.

Page 19726 lines 6-9: This could be simply because the time span of non-monsoon season (Oct-May) is much longer than that of monsoon season (Jun-Sept).

Page 19727 lines 20-21: Why did BC and OC fluxes drop between mid-1990 to 2002?

Page 19728 lines 14-15: What about after 2003 during which the OC/BC ratio in ice core still increased but the OC/BC emission ratio decreased as shown in Lu et al., 2011?

Page 19729 lines 7-8: Why would including water-soluble OC lead to increased bias?

Page 19729 lines 11-14: Is it possible that there is a positive trend of influence from South Asia?

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Page 19729 line20 (also see Figure 6): According to the authors' explanation in section 3.4 first paragraph, the more coal combustion relative to oil consumption, the higher OC/BC would be. However, Fig. 6 shows that despite the increase of coal combustion being much slower than the increase of oil consumption during 1996-2002, corresponding OC/BC increased dramatically.

Page 19730 lines 1-15: How does this knowledge help to interpret the measured and simulated data?

Page 19730 lines 26-27: Could the authors explain what the MAC scaling factor within spectral broadband is and how to get these factors for BC and OC?

Page 19732 line 6-7: This site is located in complex terrain, affected by both South Asia and East Asia. There may be a need for further investigation of its regional representation in terms of concentration and deposition before using the ice core measured carbonaceous aerosols to infer regional radiative forcing.

Page 19732 lines 14-15: Again, we cannot exclude changes in atmospheric transport path and strength as potential reasons.

Table 1: Adding BC emissions over these regions would help to explain the impact per unit emission in source regions.

Technique corrections: Page 19723 lines 18-19: "wet scavenging" and "removal by precipitation" are redundant. Page 19731 lines 5-6: This repeats page 19730 lines 20-23. Figure 2: Add the time period of the ice core measurements. Figures 3 and 4: Change location of ice core from color pink to black. Figure 6: The dashed lines on subfigures are extended beyond 1979.

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