Atmos. Chem. Phys. Discuss., 10, C1052–C1057, 2010
www.atmos-chem-phys-discuss.net/10/C1052/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "A trajectory analysis of atmospheric transport of black carbon aerosols to Canadian High Arctic in winter and spring (1990–2005)" *by* L. Huang et al.

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Received and published: 29 March 2010

Reply to Referee #2

The authors wish to thank this referee for the insightful comments, questions, and suggestions, which have helped to improve this manuscript.

Referee comments and questions are labeled with numbers, and author comments and answers to the questions follow.

1) Why only investigate January and April and present them as representatives for entire seasons? Why not investigate the whole seasons of interest?

The focus of the current study is to investigate the inter-annual variations of BC observed at Alert. The use of January and April data instead of DJF (for winter) and MAM (for spring) was to eliminate the transformation of atmospheric transport patterns in the whole seasons of interest and to emphasize the inter-annual variations within each dataset.

Although no trajectory analyses have been done for the whole seasons, January and April trajectories are considered representative to winter and spring, respectively. This is because that long-range atmospheric transport to Alert investigated in this study is largely controlled by the near-surface circulation in the northern high latitudes. The seasonal characteristics of near-surface circulation have been revealed, for instance, by analyzing mean sea level pressure for the four mid-season months (i.e. January, April, July, and October) over the period 1970-1999 (Serreze and Barry, 2005).

2) Why only investigate winter and spring and not the whole year? This should make the paper much more solid.

There are two major reasons that restrict our current study to winter and early spring. First of all, the emission inventory used in the currently study involves the anthropogenic BC emissions from fossil fuel combustion, which dominates the Arctic BC abundance only in the cold seasons. For warmer months between May and September, BC emitted by boreal and temperate wildfires at northern latitudes contributes significantly to the Arctic free troposphere (Lavoue et al., 2000;Warneke et al., 2010), which may affect the observed BC concentrations at Alert. Without considering BC emitted from open biomass burning, the current study is applicable to the cold months of January and April.

Besides, long-range atmospheric transport events to Alert are only frequent in the cold seasons. Based also on calculation of 10-day back trajectories, Sharma et al. (2006) showed that over 50% of the atmospheric transport was attributed to the Arctic sector between May and September. Thus, most of the trajectories are not long enough to

ACPD
10, C1052–C1057, 2010

identify possible source regions affecting Alert in the warm seasons. Considering both reasons, only the cold seasons (i.e. winter and early spring) were investigated in this study.

3) Why was the specific time period chosen? Why wasn't more recent measurement data used?

The period of interest was chosen depends on the BC measurement data, as well as the BC emission inventory data. Although more recent measurement data at Alert are available, BC emissions from the potential source regions were compiled for 1990-2005 (Sharma et al., 2009), which determined the specific time period chosen in the current study.

4) Page 2 Line 18-24:"The anthropogenic emissions..." Consider reformulation.

This statement has been changed to the following three sentences. The anthropogenic emissions from Europe and former USSR were recently identified to be the major sources of the observed Arctic haze (Quinn et al., 2007;Shindell et al., 2008;Stohl, 2006). However, locations within the Arctic might be impacted differently by source regions. Sharma et al. (2006), for example, showed that Alert (82.5°N, 62.5°W), Nunavut was about two times more frequently affected by the atmospheric transport of air mass from North America than Point Barrow (71°N, 156.6°W), Alaska from 1989 to 2003."

5) P2L29-P3L1:"The impact of emissions..." Consider reformulation.

Corrections have been made to this sentence. "The impact of emission variation on the observed BC concentrations was highlighted in their study. For instance, the decreasing trend in BC concentrations at Alert was attributed to the reduction of BC emissions, particularly from the former USSR."

6) P3L4: emphsizing -> emphasizing

This correction has been made.

ACPD

10, C1052–C1057, 2010

7) P3L4: varing -> varying

It has been corrected .

8) P4L30-32: Why is it favourable that the emissions in Russia have increased?

Our calculations show that BC annual emissions in the former USSR have been slightly increased since 2000. The increase was estimated according to the statistics on fuel consumptions by the United Nations (2007). This is probably due to the recovery from the economic slowdown since 1991.

9) P5L10-11:“A pronounced decreasing...” How does this connect to the statement on P5L30-32?

The decreasing trend mentioned in the previous manuscript was observed based on the emission data of the former USSR for the 1990s. Since 2000, the annual BC emissions from the former USSR have shown signs of increase. For the purpose of clarity, the statement has been changed to "BC surface flux in the former USSR decreased by more than 50% of its 1990 level during the first half of the 1990s, and since then has remained fairly stable with signs of a progressive increase."

10) P6L10-12:”The number would be...” Consider reformulation.

This line is removed in the revised manuscript, and so this correction is not applicable.

11) P9L2-5:”Inter-annual variations...” Consider reformulation.

This line is modified to the following two sentences. "Thus, about 80% of the inter-annual variation of BC concentrations observed at Alert between 1990 and 2005 is reconstructed by considering the year-to-year changes in transport frequency and surface emission flux. The ability of our model to reconstruct BC inter-annual variability implies that atmospheric transport plays an important role in connecting source emissions and the surface BC observed at the Canadian high Arctic site during the haze season."

ACPD

10, C1052–C1057, 2010

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ACPD

10, C1052–C1057, 2010

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 2221, 2010.

ACPD

10, C1052–C1057, 2010

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