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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of topography on black carbon transport to the southern Tibetan Plateau during pre-monsoon season and its climatic implication" *by* Meixin Zhang et al.

Anonymous Referee #2

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This study uses WRF-Chem at two horizontal resolutions to investigate the impacts of topography on the transport and distribution of BC over the TP during the pre-monsoon season. A sensitivity test that the inner domain at 4 km resolution applies the 20 km-resolution topography is also conducted to confirm the importance of topography complexity. It is found that the prevailing up-flow across the Himalayas driven by the large-scale circulation is the dominant transport mechanism of South Asian BC into the TP in the simulations at both resolutions, and the simulation at the finer resolution (4 km) resolves more valleys and thus transport BC more efficiently. This is an interesting and important work in understanding BC contamination over the TP and its radiative impact. However, a number of caveats leave the conclusions unconvincing.

The smooth 4 km sensitivity test has different results from the 20 km simulation, indicating the effects of other factors. It is necessary to discuss or quantify: 1) how wind field changes under different resolutions and whether/how much it is related to the representation of topography, 2) the impact of resolution on PBL and vertical mixing, 3) the influences of resolution on emissions, and 4) other possible parameters that could lead to the differences in BC transport over the TP. This paper still requires additional work.

Major issues:

1. This study only emphasizes the importance of topography, but according to the comparisons of the 20 km simulation and the smooth 4 km simulation in Figure 13, 15, 16, 17, and Figure S5, there could be other factors contributing to the differences in the transport of BC over the TP in the simulations at the two resolutions. The manuscript attempts to provide some interpretations, but many of them do not seem appropriate (e.g., L445-448). In particular, under the two resolutions, wind vectors show different patterns. A detailed examination on the interactions of modeling resolution, wind speed, and topography is required.

2. The study uses the MYNN planetary boundary layer scheme. This local PBL scheme may not be able to account for deeper vertical mixing. The study does not comment on the impact of cloud convection in vertical mixing, which could also contribute to the differences in BC transport flux. Does the simulation period include cloudy days? Does the study account for cloud layers, which normally serves as an extension of PBL?

3. For emission, there are two main concerns: 1) The study uses a combined emission from two emission inventories for different years. Since emissions change dramatically in recent years, using different emissions over distinct regions could cause bias and also lead to inconsistency near the boundaries. 2) Are emissions conservative in the inner domain across different resolutions? This is crucial to understand the differences in BC transport at the two resolutions.

4. Figure 7: Although the magnitudes are similar, R values of the comparisons are actually quite low and there is no obvious improvement when using 4 km resolution. This indicates large uncertainties which could be due to model setup, such as emission and/or PBL scheme selection.

5. L480-483: The distribution of resolution-induced differences in BC forcing in snow do not follow that for snow water equivalent. More information about SNICAR and how it represents snow processes are needed. The influences of fresh snow cover, BC caused snow melt runoff should all be investigated to understand BC forcing in snow.

Specific comments:

L187-188: Please complete the sentence.

Figure 4: Why are averaged fire emissions calculated over the region between 26-29 N instead the whole inner domain?

Additionally, the manuscript includes a lot of duplicate information, which need to be removed to make the writing more concise.

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