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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Wintertime radiative effects of black carbon (BC) over Indo-Gangetic Plain as modelled with new BC emission inventoriesin CHIMERE" *by* Sanhita Ghosh et al.

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Reply to query, point 4 by Referee 2:

Dear Referee: Thank you for your comments. We are incorporating your suggestions in the next version of the manuscript. Here we discuss your query, point 4. Please let us know if any further suggestions are there.

4. Line 315-319; what is cause for the lower values of BC at high altitude. Is there no impact of transport of air masses?

Response: Thank you for an interesting question. In our analyses presented for various stations, Nainital is a high altitude station and is classified as a low-polluted station. As seen from Figure 1, the BC emission strength at Nainital is relatively lower than the IGP. Hence, as expected and consistent with observational studies, the simulated atmospheric BC concentration is found to be the lowest at Nainital among stations under investigation. The spatial pattern (refer to Figures 3f-g) of BC surface concentration while exhibiting the lowest value at high altitude and low-polluted location (e.g., Nainital), and the moderately high values at semi-urban stations (e.g., Kharagpur and Ranchi) is seen to reach the maximum at megacities (Kolkata and Delhi). The simulated spatial pattern is consistent with observation.

Yes, Nainital is influenced by transport of BC pollution from the IGP. We request you to kindly watch the animation showing a representation of transport of BC concentration over the IGP as a supplement (please see BC-animation-1 in supplementary material). This animation shows the hourly monthly mean of surface BC concentration to highlight the diurnal cycle and its visualisation shows the diurnal evolution of the BC plume over the IGP. The BC surface plume is observed to be shrinking during daytime hours (1000 LT–1600 LT) and swelling-up during late evening till morning hours (1800 LT–0600 LT) when it is visualised spreading towards the south (central India) and north (Himalayan side) and also from the upper/northern IGP towards the lower/eastern IGP. The diurnal feature of surface BC plume distribution thereby appears exhibiting the pollution breathing pattern by the IGP region.

As visualised from the animation and our analysis presented in the manuscript (lines 362-368), it is seen that there is transport of BC pollution from the IGP towards Nainital, though, atmospheric dispersion is inhibited by the Himalayan mountains. As discussed in Section 3.1, there is a confinement of pollution near the surface within the shallow boundary layer height in winter due to low vertical mixing and weak dispersion of atmospheric pollutants, thereby, stagnant weather under the prevailing meteorological conditions, viz. low temperature and weak wind speed, the downdraft of the air mass, and a narrow PBLH (refer to Section 3.1). Besides, the Himalayan mountains northward, further, inhibits the dispersion of aerosol pollutants and favours their confinement over the IGP.

The diurnal variability in BC surface concentration presented in Figure 4 further confirms the influence of transport of BC pollution at Nainital. It is worth noting that the specific feature observed in the temporal trend of BC concentration (refer to Section 3.2, Lines 340-345), comprising of peaked BC concentration during late afternoon hours (1500–1800 LT) at high altitude location, Nainital, unlike the temporal trend observed at plain locations (e.g., Kolkata, Kharagpur), conforms with measurements. This specific feature, as inferred from available studies is attributed to the deepening of atmospheric mixing depth during the late afternoon hours which flushes out pollutants, including BC to the high altitude locations from the valley.

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