Response to Reviewer Comments on "Ozone and carbon monoxide over India during the summer monsoon: regional emissions and transport" by N. Ojha et al.

Anonymous Referee #1

Comment: Authors have made a sincere effort to improve the manuscript and possible suggestions have been adopted. They have compared model simulations with other observations. Manuscript has been improved. But WRF-CHEM model has its limitations. Cumulus parameterization and PBL Schemes have limitations in reproducing the monsoon convection. I think authors should clearly mention this in the conclusions. Asian summer monsoon is a large scale phenomenon. In order to understand convective transport, it is essential that WRF-CHEM model should be able to simulate lower level convergence and upper level divergence. I suggest authors to add a figure showing OLR and 850 hPa winds during monsoon season. Compare this with AGCM results and then clearly state limitations of WRF-Chem in simulating monsoon convection. A figure depicting vertical distribution of cloud droplet number concentration and ice crystal number concentration, averaged over south peninsula (10-20N), will be helpful in depicting model's ability/inability in reproducing convective transport from boundary layer to upper troposphere. Readers should be aware limitations as well.

Response: We thank the reviewer for careful evaluation, insightful comments and suggestions, which helped us in improving the manuscript. The need of evaluating the uncertainties associated with parametrization of processes (convection, PBL) is now mentioned in the conclusions of the revised manuscript (Page: 23, Lines:27-29; Page: 24, Lines:1-2). Following the reviewer's suggestion, a figure showing OLR and 850 hPa winds has been added in the Supplement (Figure 1). WRF-Chem captured the typical wind patterns and low OLR over India during monsoon, which is now and references for more details are provided in the revised manuscript (Page:12, Lines: 2-15).

Here our main focus is to evaluate a regional model (WRF-Chem) and the effects of regional emissions and transport on O_3 and CO. Comparison with the global model providing the boundary conditions is also done (Supplementary material- Figure 5). Conducting and analysing simulations from other GCMs is beyond the scope of this paper. A separate paper could deal with model inter-comparison as the issues raised are clearly important.

We show replication of typical monsoonal wind pattern and convective transport from boundary layer to the upper troposphere and westward export (Figure 9 shows higher CO concentrations in the upper troposphere when emissions at the surface are increased). However, in lack of relevant measurements, it is not possible at this stage to further evaluate the model's ability in simulating cloud droplet / ice crystal number concentrations. Water vapor profiles were measured and the model showed very good agreement (Figure 4).

As suggested by the reviewer, information on limitations and evaluation of WRF simulated meteorology, dynamics and evaluations of WRF convection schemes for Indian summer monsoon are now provided in the revised manuscript (Page 12, Lines: 6-15).