Interactive comment on “Influence of enhanced Asian NO\textsubscript{x} emissions on ozone in the Upper Troposphere and Lower Stratosphere (UTLS) in chemistry climate model simulations” by Chaitri Roy et al.

Anonymous Referee #2

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The study by Roy et al. investigates how the increasing Asian NO\textsubscript{x} emissions and associated ozone production affect the ozone radiative forcing and monsoon circulation. Roy et al. employ the ECHAM5-HAMMOZ model and from the model simulations they find that a doubling of NO\textsubscript{x} emissions produces high ozone in the lower troposphere, a reverse monsoon Hadley circulation and negative precipitation anomalies over India.

The paper is quite well written and interesting results are derived. However, I have some concerns (1) the low vertical resolution applied in the model simulations and (2) the fact that NO\textsubscript{x} production by lightning is not considered in the model simulations. Before publication the following points of criticism and suggestions for improvements should be considered:

Specific comments:

p2, l40: What is meant with NO\textsubscript{x} limited regions?

p5, l118: A horizontal resolution of T42 and a vertical resolution of 31 levels is a quite low resolution. In the horizontal it probably may not be a big deal for the results of this study, but I am a bit worried about the vertical resolution. For the monsoon circulation vertical transport is quite important and I could imagine that you would derive different (probably more accurate) results when performing simulations with a higher vertical resolution. The impact of the low model resolution on the results of this study should be discussed in the paper.

p6, l122: Do I understand it correctly that for each following year the emissions of the year 2000 are used? I would suggest to rewrite the sentence to make this more clear.

p6, l123: I guess for varying the SST and sea ice for each year a data base is used which provide these values. Which database was used? Which database has been used for the emissions?

p6, l123: Why has the time period 2000-2010 been chosen? Why is the simulation not continued until a more recent year as e. g. 2015 or why is the simulation only covering a 10 year period and not a longer period of e. g. 30 years?

p6, l127: The four experiments should be summarized in a table giving the values used for initialisation as well as the resulting values (e.g. as the estimated heating rates).
p6, l127ff: How were the assumed numbers of increase motivated? How large is the observed trend?

p7, l155: I don’t really agree with what you state concerning Figures 1(c) to (e). Using the present x- and y-scale and showing the figures in the present (small!) size makes the differences seem to be low. However, if one would change the x- and y-scale (zooming in) one would see the differences much better. To have a more objective view on the quality of the model simulations the differences between measurements and model simulation should be quantified, thus a quantitative estimate should be given.

p8, l181: Lightning is important for the amount of NO\textsubscript{x} in the UTLS especially during the monsoon season. Why is then lightning not considered in the model simulation? How reliable are your results if lightning is not considered? This is really a drawback of this study and the consequences of not considering lightning for the results of this study need to be discussed in more detail.

p9, l212: I have difficulties to see the connection that ozone production is found where there is NO\textsubscript{x} transport. In Figure 3 one finds ozone production everywhere below 300 hPa. In the area of transport, however, it seems that O\textsubscript{3} production is enhanced. So, I would suggest some rewording of the sentence to be more precise.

p10, l227: I would say that the transport across the tropopause is only visible in Figure 4f.

p10, l228: It would be helpful for the reader if the areas of the Tibetan Plateau, Bay of Bengal and South China Sea would be marked in the figures.

p10, l235: Why does one get this behaviour in the subsidence? Is that really discussed in Section 4? What exactly is discussed in Section 4? This paragraph should be rewritten.

P12, l266: The regions discussed should be marked in the Figures.

P14, l314: The fact that model simulations were performed with a low vertical resolution of 31 levels and without considering NO\textsubscript{x} production from lightning should be part of the discussion section. What are the consequences of these simplifications for your results.

Figure 1: How would the differences look like if the x-axis and y-axis would be changed to focus on the UTLS region. In example if one would plot the profiles only up to 50 hPa and up to 1000 ppb. I assume the differences would become more pronounced. As stated before some quantitative estimates on the differences should be added.

Technical corrections:

p2, l36: skip “the” before India.

P4, l79: I think it should rather read “increasing” than “rising”.

P4, 85-87: I would suggest to rewrite the sentence as follows: “The paper is organized as follows: In Section 2 the data and model set up are described. The results are summarized in Section 3 and discussed in Section 4 followed by conclusions given in Section 5.”

p5, l102: Is 8.3 x 3 really correct or is there a typing error?

p7, 157-159: I would suggest to combine the last two sentences so that it reads: “Fadnavis et al. (2015) compared the model simulation with aircraft observations over the various regions all over the globe during the monsoon season and found a reasonable agreement for PAN, NO\textsubscript{x}, HNO\textsubscript{3} and O\textsubscript{3} mixing ratios.”
p6, l127: I would rather call it “simulations” than “experiments”.
p7, l167: skip “etc” or move it forward so that it reads “.........aerosols etc........
p8, l182: Change sentence so that it reads: “In Figure 2 longitude-pressure........”
p11, l249: delete “the” before central India.
p14, l324: Change wording of the sentence to: “These simulations show that an increase........” or to “These simulations show that increases in . . . .”.
p14, l32: add “the” so that it reads “across the tropopause”.
p22, l683: “Show the same but.......” Change wording of the sentence.