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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Influence of enhanced Asian NO_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_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_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_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_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_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_x transport. In Figure 3 one finds ozone production everywhere below 300 hPa. In the area of transport, however, it seems that O_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 Section4? 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_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_x, HNO_3 and O_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.

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