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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Lower tropospheric ozone over India and its linkage to the South Asian monsoon" *by* Xiao Lu et al.

Anonymous Referee #2

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The study of Lu et al. analyzes the processes influencing lower tropospheric ozone over the Indian subcontinent with a focus on the influence of the South Asian monsoon but also analyzing interannual variability and trends. It mainly relies on a set of 20-year (1990-2010) long GEOS-CHEM simulations and analyzing the lower tropospheric ozone budget with respect to contributions from photochemistry, transport and deposition. The model-derived results are backed up with lower tropospheric ozone data derived from OMI satellite observations of the years 2006 - 2014 which, overall, show very good agreement with the model in terms of spatial distribution and seasonal behavior.

The publication is very well written (with small grammatical issues that will require some copy-editing), clearly structured, and the analyses are comprehensive and convincing.

In particular, the authors present a thorough analysis of the factors driving ozone variability over India including meteorological variability (seasonal, interannual), variations in anthropogenic and biomass burning emissions, and trends in methane. The paper has a good chance to become an important reference for future studies on the lower tropospheric ozone budget over India.

I support publication of this manuscript and have only a few small comments that may require minor revisions:

- As pointed out by Lelieveld et al. (The Indian Ocean Experiment: Widespread Air Pollution from South and Southeast Asia, Science, 2001), the ratio of emissions of NOx to those of CO and VOCs is much smaller over India than e.g. over Europe or the United States. As a consequence ozone production over India is likely strongly NOx-limited. It would have been nice if the authors had paid somewhat more attention to this aspect, notably in the analysis of the factors driving the long-term increase in ozone.

- Figure 2c shows the seasonal cycle of lower tropospheric ozone together with the different monthly production and loss terms. Why do these terms not sum up to positive values when the total burden of ozone increases? Take e.g. the budget for the month of March: The losses sum up to about -12 Tg, the gains only to about +11 Tg. Despite this negative budget, the ozone concentrations increase. from March to April. Please clarify.

- Page 4, line 86: decreases in ozone associated with the summer monsoon had also been reported based on MOZAIC aircraft observations, e.g. Srivastava et al. (Atmos. Env., 2015) or Bhattacharjee et al. (Meteorol. and Atmos. Phys., 2015).

- It was not always entirely clear, which regions the individual budgets and concentrations were representing, i.e., over which domain the values were averaged. "Lower troposphere over India" is not an exact term. Is this only over land, or over a rectangular domain covering India? I suggest adding such information to the figure captions.

- The same problem holds for some of the stated correlations, e.g. the correlation of r = 0.81-0.97 mentioned on page 10, line 223. What exactly was correlated here?

- Page 15, line 343: The statement "the mean correlation over India is still dominated by the temperature impact on ozone chemical production" is not quite correct. I would argue that high temperatures and high ozone levels are both a result of intense solar radiation, rather than temperature being directly the main driver for high ozone production.

- Page 16, Eq. 1: The grid indices i,j should probably be discarded, since equation 2 suggests that the norm is calculated by integration over a domain rather than a single grid cell. Probably the manuscript would also benefit from a schematic figure of the ozone budget in the pre-monsoon and monsoon seasons, i.e., a box representing the volume of the lower troposphere over India and the individual budget terms shown as arrows (in case of transport and deposition) or just numbers (in case of chemical production and loss within the box).

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