

Interactive comment on “Modelling the Impacts of Iodine Chemistry on the Northern Indian Ocean Marine Boundary Layer” by Anoop S. Mahajan et al.

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Mahajan et al. present a very interesting modeling study about iodine chemistry in the mbl above the Indian Ocean. Although the manuscript contains several important results, I see two major problems: First, it is very long and tedious to read because of redundant information and commonplaces. Second, some important items should be explained in more detail or analyzed further. I recommend publication after major revisions. My suggestions are explained in more detail below:

1) SUGGESTIONS FOR REMOVING REDUNDANT AND LESS IMPORTANT PARTS OF THE MANUSCRIPT

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- Tables 2 and 3 show differences, percentage differences, absolute differences, and absolute percentage differences between HAL and BASE. I don't think it is necessary to present 4 different ways to compare the scenarios. It is difficult for the reader to understand these quantities as the difference between "absolute changes" and "mean changes" is not defined.

- Don't repeat the numbers from the tables in the text. In most cases, it would be sufficient to refer to the tables.

- For a lot of the numbers, especially when comparing HAL to BASE, the standard deviation is larger than the value (e.g., l. 341: "a small increase of 0.01 ± 0.31 ppbv"). I suspect that such numbers are undistinguishable from zero. This makes it even less important to discuss their values in the text. In many cases, it may be sufficient to state that the value is not affected by iodine chemistry.

- There are many statements in the text describing quite obvious facts which are not even related to iodine chemistry. I suggest to remove them. A few examples are:

— I.306-307: "much higher concentrations of O₃ are observed over the Indian subcontinent as compared to in the surrounding ocean MBL"

— I.392-393: "much higher concentrations of NO₂ are observed over the Indian subcontinent as compared to the surrounding ocean MBL"

— I.396-398: "A sharp decrease is observed from the coast to the open ocean environment, which is expected considering that the primary sources of NO₂ are on the subcontinent."

— I.407-408: "This shows that the MBL is much cleaner than the air above the Indian subcontinent."

— I.409-410: "NO also shows higher concentrations over the Indian subcontinent as compared to the surrounding ocean MBL"

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— I.424-425: "the MBL is much cleaner than the air above the Indian subcontinent"

— I.501-504: "There is a correlation between the hotspots for NO_x, and low concentrations of HO₂ over the Indian subcontinent. This is due to the titration of HO₂ by NO, which forms NO₂ and leads to an increase in O₃ formation."

2) IMPORTANT RESULTS THAT SHOULD BE EXPLAINED BETTER OR ANALYZED FURTHER

- The HAL scenario seems to contain the halogens I, Br, and Cl. However, it is not clear to me if the BASE scenario contains Cl and Br chemistry or if it is without halogens. This should be mentioned in the text.

- I think the most important result of this study is that the current parameterization for the inorganic iodine flux needs to be reduced. It is also mentioned (l. 248) that "models tend to underestimate the sources of nitrogen in the open ocean resulting in lower levels of NO_x in the MBL". I suggest to make another model run with the full inorganic iodine flux and higher NO_x to check if this can also produce realistic results for IO.

- I.387: "the resultant increase or decrease in nitrogen oxides depends on the concentrations of iodine compounds"

I don't understand how iodine compounds can increase nitrogen oxides. Please provide a chemical reaction to explain this. Decomposition of INO₃ is not a real source, it only regenerates NO₂ which was previously consumed in the formation of INO₃.

- I.436-437: "In most of the shipping lanes, where high NO is observed, the inclusion of iodine chemistry leads to an increase in the NO_x concentrations"

This is a very interesting result which should be investigated further! Which reactions in the model cause this effect? Or is this an effect of transport?

- I.482-483: "Hydrogen oxides are impacted by iodine chemistry through the catalytic

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reaction involving IO changing HO₂ into OH."

Is this really the main effect? Please compare this to the indirect effect when IO reduces O₃, which in turn reduces the OH production from O₃.

- I.594-595: "there are pockets of an increase in NO₃ observed over the subcontinent."

This is another very interesting result! Why does iodine increase NO₃ at some locations, and decrease NO₃ at others? Is this just numerical noise, or is there an explanation for this?

3) MINOR COMMENTS

- I.44: "The known effects include [...] oxidation of mercury (Wang et al., 2014)"

I don't think that oxidation of mercury via iodine chemistry is established. Wang et al. investigated it based on theoretical calculations by Goodsite, and they came to the conclusion that NO₂ and HO₂ are more important for RGM generation.

- I.60: "concentrations reaching as high as ~3 parts per trillion by volume (pptv)"

This is a mixing ratio, not a concentration.

Also, note that according to the IUPAC Recommendations (page 1387 of Schwartz & Warneck "Units for use in atmospheric chemistry", Pure & Appl. Chem., 67(8/9), 1377-1406, 1995, <https://www.iupac.org/publications/pac/pdf/1995/pdf/6708x1377.pdf>) the usage of "ppb" and "ppt" is discouraged for several reasons. Instead, "nmol/mol" and "pmol/mol" should be used for gas-phase mixing ratios. I suggest to replace these obsolete units.

- I.101: Change "Li et al. (Li et al., 2019)" to "Li et al. (2019)"

- I.173: Change "The levels observed and simulated IO" to "The levels OF observed and simulated IO"

- I.214-215: "...even when the uncertainty in the observations is considered (Figure 2)"

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I cannot see the uncertainties in Figure 2.

- I.228: "The second reason for overestimating..."

It has already been shown that the first reason (seawater iodide concentrations) cannot explain the overestimation. Thus, it may be better to say "the second POTENTIAL reason for overestimating..."

- I.805: Add volume and page numbers to the reference Mahajan (2019b).

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