

The authors thank the editor for their comments and have provided additional clarification and discussion on La Niña and model comparisons below. All page and line numbers referenced in this response correspond to the tracked changes version of the manuscript.

Dear Ryan J. Pound

Thank you for the revised submission and carefully handling the referee's comments. A referee insisted on clarifying the impact of the simulations covering a LaNiña period, pointing out that sea surface temperatures might differ from those of other years. While it is obvious and clearly stated throughout the manuscript that the GEOS-Chem classic model results cover the 2 years 2020/21, could you clarify the impact of this choice of years for me in one last iteration? I decided not to send the manuscript to the referee but to handle this last step as editor to speed up the process.

It is difficult for me to judge how exactly LaNiña years differ from other years. The discussion around Figures 12 and 13 showed "higher emissions at higher latitudes and a decrease in emissions from warmer, tropical waters." The manuscript identifies temperature as a key parameter determining iodine emissions (Sections, 3,4,7); am I correct? Which temperatures did the model derive for the high and low latitudes and how much do they differ from "normal" years. Could you comment on whether you'd expect similar large changes in other years, or in other words, are the findings particularly enhanced due to anomaly temperatures in these years?

You are correct. Temperature is a key parameter in determining the inorganic iodine emissions and a key development in this work compared to Carpenter et.al 2013. This comparison shows the temperatures from the MERRA2 meteorology used to drive the GEOS-Chem model and the difference between the 2020+2021 average to the previous decade (at the 4°x5° resolution used for the global modelling results presented in this work).

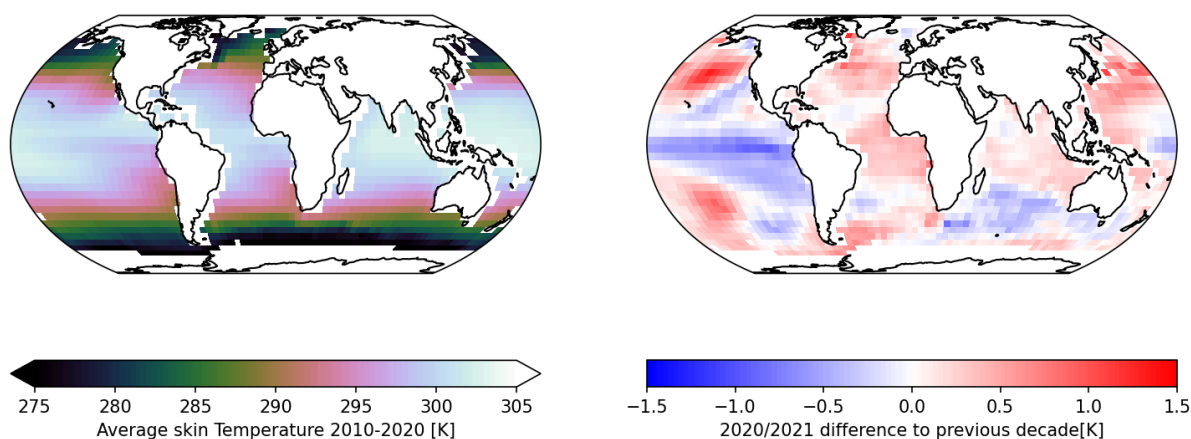


Figure 10(d) in the manuscript shows the temperature dependence of the inorganic iodine emissions. Comparing the temperature anomaly for the 2020/2021 period to this figure, the difference in sea surface temperatures in these La Niña years does not have a significant impact on our conclusions and we would expect to see similar results to those presented in this manuscript in other years.

The authors have included additional discussion of this in the manuscript on lines 359-362:

“Although the 2020-2021 period is within a La Niña event, a change in temperature of 1K changes total inorganic iodine emissions by ~ 3 % (figure 10). As such temperature variations due to ENSO are likely to result in changes in the inorganic iodine concentrations of less than 10% locally, and likely less globally. ”

Why were modeling results compared with observations at different times? I assume it is impossible to run the model over longer times for time reasons. My concern is that temperatures (and other parameters) might differ between the years, so one would not necessarily expect a good agreement. In this respect, please explain the “equivalent model” in line 396 in more detail – I first misunderstood this as temperature and other parameters (wind speed) being identical, similar to the comparison with the lab experiments. A short sentence would help a lot, thank you. Could you also comment, if not done above, how much the modeled meteorology is affected by the strong La Nina and whether this can have impact on the simulated iodine emissions.

As discussed above, even the relatively large SST change in the 2020+2021 La Nina period, compared with the previous decade, results in only a small difference in the model predictions for inorganic iodine emissions. As such we do not expect differing years to be a large source of uncertainty in these model-observation comparisons.

The text on lines 382-383 has been updated to read

“...compares published observations of average daytime surface IO mixing ratios to the model predictions from the corresponding day of the year during the simulated period.”

I also understood that both model results are based on identical temperature and wind speed, that is, meteorology – the difference of interest here is the chemistry. More for curiosity, can we learn more from Figure 16? There appear to be time periods with better and worse agreement in each location.

You are correct, the meteorology is identical in the “old” and “new” model results, along with all emissions (excluding inorganic oceanic iodine emissions) and the atmospheric chemistry scheme. These two scenarios show the sensitivity of modelled surface O₃ to the change in oceanic iodine emissions. While there are times of better or worse agreement between the model and the measurements, it is unlikely that model failure is determined solely by the iodine emissions. Overall, uncertainties in the chemistry, transport and deposition, together with errors and uncertainties in the emission of other species (NO_x, VOCs, halogens, particulate) will combine to provide the overall error profile. This additional discussion has been included on lines 430-433

“While there are times of better or worse agreement between the model and observations at all locations presented in figure 16, model failure is likely not strongly influenced by year-to-year variability in the iodine emissions. Overall, uncertainties in the chemistry, transport and deposition of iodine species, together with errors and

uncertainties in the emission of other species (NO_x, VOC's, halogens, particulate) will combine to provide the overall error profile."

In summary, could you elaborate on the possible impact of LaNina on the results and, more generally, on the use of different years for the model observation comparison? Or, make the statement clearer that the results do not reflect possible impacts of LaNina.

Thank you very much, I hope the comments are clear, kind regards, Thorsten
Bartels-Rausch