

Response to Referee #1

I find this a very interesting and valuable statistical study comparing observed northern Atlantic sea surface temperature (SST) changes and model-simulated changes.

I am not a statistics expert and recommend that the statistical methodology should be reviewed by a suitable colleague, but I think I understand the basic approach. A key point of this is that no particular physical mechanism is studied (such as ocean circulation change), but rather simply the statistical relation of SST fields from various model runs (with different forcings) to the observed SST field. In this way we can find how various forcings relate to SST changes (though not by what mechanism) in the models, and whether that resembles what is observed in the northern Atlantic. I think it would be useful to make this a bit more clear right at the outset, because it confused me a bit while reading the introductory part of the paper, until I got to the Methods.

Thank you for these remarks. I have expanded the introduction to state more specifically that I was only interested in the statistical aspects and not the physical mechanisms for attributing the observed changes in SST over the historical period.

Important findings of this study in my view are:

- that aerosol forcing leads to the opposite SST response compared to observed. This should lay to rest the previous discussions of whether the Atlantic warming hole is caused by aerosol forcing.
- that the historical runs of CMIP6 with all forcings do not get the observed warming hole.
- that increasing greenhouse gases are the main reason for the observed warming hole.

If the author agrees with my assessment, I suggest bringing these conclusions out in somewhat clearer language in the paper, including the abstract.

I agree with the referee to put more emphasis on the results related to attribution. The proposed bullets are indeed important, yet, they are only referring to the unconstrained CMIP6 simulations. I have reworded them to emphasize the results from the statistical method, by mentioning that:

- The warming hole has an anthropogenic origin.
- The impact of the aerosols is an increase in SST which is opposed to the effect of GHGs which largely contribute to the cooling of the warming hole over the historical period.
- Large uncertainties remain in the quantification of the impact of each anthropogenic forcing.

I have added these elements in the manuscript, especially in the abstract, and I have developed them in the conclusion.

I recommend using fewer acronyms (like WH for warming hole) because it makes the paper hard to read.

I have reduced the number of acronyms as requested.