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## ***Interactive comment on “A global historical ozone data set and signatures of El Niño and the 11-yr solar cycle” by S. Brönnimann et al.***

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### Reply to Reviewer 1

"My main problem with this paper is that I came away without any appreciation for the properties of the data set. The only presentation of the long-term behavior of ozone is Figure 7 that presents an almost unreadable summary of the total ozone behavior versus latitude and time. What is the ENSO structure of the data set? The QBO structure? The solar cycle structure? How does it represent the combination of chlorine dependence and carbon dioxide dependence of ozone?"

The focus of the paper was intentionally technical, and comparably less material was devoted to the structure of the data set. The revised version will move parts of the tech-

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nical material to a supplement, so that analysis of the structure of the data set can be examined in greater detail. Specifically, ENSO and solar cycle structure will be shown in greater detail. Because the data set ends in 1978, there is little value in examining the data for chlorine dependence and because the (small) close-to-linearly increasing chlorine signal is not statistically distinguishable from the close-to-linearly increasing CO<sub>2</sub> signal, it is not possible to use regression based approaches to separate the influence of chlorine and CO<sub>2</sub> on ozone. The solar, ENSO, and QBO structures of the HISTOZ data set are not shown because they are very similar as those for the model alone (shown in Fig. 3), with the slight modifications discussed in Figs. 10 and 11.

"Another issue is the lack of skill found in the ozone profile results. I understand that the authors only assimilated total ozone data, but I wonder what is the meaning of this lack of skill in the profile. My understanding is that profile is the important piece of information for climate model simulations. It is the profile of ozone that determines its radiative properties. Does this mean that the HISTOZ data set is not useful for these climate simulations? Or does it just mean that a much simpler climatology with chlorine dependence would work just as well."

It is true that the vertical structure does not have additional skill at the full resolution of the data set. This means that one might as well use the bias-adjusted SOCOL model output. It should be noted, however, that the skill score is based on variability. "Smoothed" data are likely to yield a better skill, but would be deficient in variability. Note that the product does show skill even in the vertical when compared to the climatology of the bias-adjusted SOCOL model output. So in this sense HISTOZ is better than a climatology. In the revised manuscript we will incorporate a little more information on the skill measures and their interpretation.

"The stated goal of this data set was to include realistic variability, but I am not certain that variability is important to the long-term climate simulations. Is a data set with ENSO variability in ozone going to have any different impact in climate simulations than a data set that contains the same response to chlorine but no representation of

ENSO has significant effects on the stratospheric ozone distribution. The ozone distribution, in turn, may affect stratospheric circulation on interannual time scales. The same might be true for ozone changes due to volcanic and solar influences. For instance, the response of the stratosphere (in an atmospheric circulation model) to a strong ENSO event might be different depending on how ozone is specified. We will provide some more discussion on this point in the revised manuscript. Note again that our data set does not cover the satellite period, but can be merged with existing data (BDBP), so the chlorine response is less of a focus of the paper.

"I appreciate that the unusual ozone variability in the early 1940s is interesting. The authors present some results for this time period in Figure 10 but I did not understand the basis for these results. Are they just taking the ENSO variability from a later time period (post 1979) and applying it to the ENSO index for the 1940s? If so, how do we test the validity of the results? I assume that the test is the few Dobson stations that exist during this time period. Do these stations have a clear enough signal to provide a meaningful test?"

I am not sure whether I understand this comment. We are not using post-1979 ENSO variability and apply it to the 1940s. Rather, the panels on the 1940s (upper row) use only information from the 1940s (historical ozone data, chemistry-climate model simulations). We cannot validate the final product in the historical time period, but we can validate the approach by applying it to scattered ground based total ozone series during the satellite period and comparing the result to zonally averaged satellite data. This is what is done in the paper. All of the available observations from the 1940s were used to construct the data set, not for testing. Here's a clarification what the figure shows: The left panel shows the difference 1940-42 minus neighbouring years, not using any observations ("background"), the middle figure shows the same difference, but using all (sparse) observations. The right panel shows the difference of the differences (i.e., the impact of the observations on the result). In the lower row we

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then compare the ENSO signal prior to 1979 and after 1979. The revised manuscript will add a more detailed interpretation of the results.

"Overall, I think that this paper does not provide a clear enough explanation of the methods to allow the reader understand the data set. It also does not provide a clear picture of the results. I suggest that the explanation of the methods be expanded and placed in supplementary material. The big picture of the methods can be briefly presented in the paper. I also suggest an expanded description of the results of the data set; enough so that the reader can gain some appreciation of the properties of the data set. As the paper stands, I came away with the impression that the authors did a lot of work and have produced a data set that may be useful. However, it is not clear to me how that data set is useful."

We will expand the technological part but move it to supplementary material, which gives more room for analyses.

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