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Comment on trends and ozonesonde data

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Community comment on "Multidecadal increases in global tropospheric ozone derived from ozonesonde and surface site observations: can models reproduce ozone trends?" by Amy Christiansen et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-330-CC1, 2022

Comment on "Multidecadal increases in global tropospheric ozone derived from ozonesonde and surface site observations: Can models reproduce ozone trends?" by A. Christiansen, et al.

First, we would like to express that this paper was well-motivated and written, has important concluding messages, and was a pleasure to read. This comment will cover two topics/points of concern:

- Suggested additional references and discussion
- Choice of data archives, station selection, and data version caveats

Topic 1: References and Discussion

- Tropical free-tropospheric (FT; above 5 km) and lower stratospheric ozonesonde trends from 1998-2019 were recently published in Thompson et al. (2021; https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2021JD034691). These represent a definitive reference for the model comparisons here because they are based on reprocessed SHADOZ data. A good place to reference is near lines 69-81. On an annually-averaged basis, the FT ozone trends from SHADOZ are fairly weak at 5 zonally distributed tropical sites +(1-4)%/decade, but the seasonal variability in the ozone trends was significant at all sites, with trends up to +(10-15%)/decade in some months. Although only one station, Nairobi (also see second Topic), in your study overlaps with ours, we note that quantifying the seasonal variability of trends magnitude is important for diagnosing the trends and potential dynamic factors. At Nairobi, for example, FT ozone increases 5-10%/decade in February-April, but decreases in the mid-FT August-September (Fig 6 in Thompson et al.). We also observed that the FT ozone increase is strongest during the seasonal minimum (e.g., analogous to your 5^{th} percentile positive ozone trends). Trends output from the Thompson et al., (2021) paper is located here so you can make direct comparisons: https://tropo.gsfc.nasa.gov/shadoz/SHADOZ_PubsList.html.

- The MERRA-2 GMI simulation used in this study was extensively evaluated against ozonesonde data in Stauffer et al., (2019; https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019JD030257) from 1980-2016. In short, M2 GMI overestimates FT ozone in mid- and high-latitudes, underestimates FT ozone in subtropical and tropical latitudes, and has a notable step change in ozone after ~1998 associated with an observing system upgrade incorporated into MERRA-2. This step change in M2 GMI ozone may mostly lie above the altitudes that you examine and is perhaps not a concern (see Figure 2a in that paper). A high bias in M2 GMI surface ozone occurs across all latitudes compared to the ozonesonde measurements. These are important simulation characteristics to be aware of when discussing trends comparisons with real data, and this information would complement your Figure S4, for example.

Topic 2: Ozonesonde Data Sources and Versioning

- We were surprised to see a lack of tropical ozonesonde data included in this study, and wondered whether it was because only data from WOUDC and NOAA GML archives were sought. Especially for tropical ozonesonde data, WOUDC is not kept as up to date as SHADOZ (https://tropo.gsfc.nasa.gov/shadoz/Archive.html) and NDACC (https://www-air.larc.nasa.gov/missions/ndacc/data.html). Stations such as La Reunion, Pago Pago American Samoa, Paramaribo, etc. would probably qualify for inclusion based on your criteria if data were retrieved from SHADOZ instead of WOUDC.

- The global ozonesonde community is involved in an ongoing data reprocessing and homogenization effort (e.g., Tarasick et al., 2016; Van Malderen et al., 2016; Witte et al., 2017; Sterling et al., 2018; Witte et al., 2019; Ancellet et al., 2022). Homogenization accounts for changes in ozonesonde preparation and station procedures and reduces measurement biases associated with them. See, for example, our Wallops Island (NASA site back to the 1960s; Witte et al., 2019; https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018JD030098) station where "before" and "after" reprocessing comparisons are provided. The homogenized data versions are more accurate than non-homogenized data. See the preprint of Stauffer et al., (2022) at https://www.essoar.org/doi/abs/10.1002/essoar.10511590.1 for a summary of global ozonesonde network data quality, data sources, homogenized data availability, and links to the references above. The data at WOUDC for most stations are likely not homogenized. We know they are not for nearly all SHADOZ stations, for example. Caution must be exercised when calculating trends from non-homogenized data, and the time series should be evaluated for step-changes if non-homogenized data are used.

- A note regarding the Stauffer et al., (2020) study referenced in your paper: The ozonesonde "dropoff" was found not to be a concern below about the 50 hPa level at affected stations, so the inclusion of all tropospheric data at "affected" stations should not harm your results, with the possible exception of Hilo, and, if added, Costa Rica. The Stauffer et al., (2022) study updates the status of this low bias problem, which still appears to be confined to stratospheric ozonesonde data at select stations.

Thank you for your consideration, and please feel free to contact us with questions,

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