

***Interactive comment on* “Development of a climate record of tropospheric and stratospheric ozone from satellite remote sensing: evidence of an early recovery of global stratospheric ozone” by J. R. Ziemke and S. Chandra**

Anonymous Referee #1

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Comments to “Development of a climate record of tropospheric and stratospheric ozone from satellite remote sensing: evidence of an early recovery of global stratospheric ozone” by Ziemke et al.

This study carefully uses six years of higher-fidelity OMI/MLS residuals to evaluate the 32-year long record CCD results of stratospheric and tropospheric column ozone (1979–2010). The evaluation shows that CCD results in the Pacific and the zonal means from the tropics to high latitudes are consistent with OMI/MLS results and thus can be used to study the inter-annual variability and long-term trends of ozone. Then it mainly

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analyzes the QBO signals and ozone trends from the long-term data record. It shows that QBO is the main source of inter-annual variability of stratospheric ozone especially in the Southern Hemisphere and also shows QBO signal of 2-7 DU in the troposphere. The trend analysis interestingly shows steady stratospheric ozone recovery at middle latitudes since the middle 1990's and current level is comparable to 1980s. It is generally well organized and written and is suitable for publication on ACP. However, some sections (e.g., the section that discuss cloud ozone) could be improved. I recommend this paper to be published after addressing the following minor specific comments:

1. Title, I suggest adding “column” before ozone from satellite” since the dataset does not include vertical profile, but stratospheric and tropospheric column ozone.
2. P3176 line 21, since these studies are limited to the tropical Pacific, it is better to be more specific: “tropical Pacific” instead of “tropical latitudes”.
3. P3177 line 11, again to be more specific: add “tropical” before “Pacific”
4. Section 3.2.1, CCD results are compared with OMI/MLS residual results only in the tropics (Figures 2 and 3). According to section 3.2 and the results presented later, the CCD method is extended to daily retrievals over the globe, although the original CCD method only derives monthly mean tropospheric ozone column in the tropics using deep convective clouds in the Pacific. Therefore, I suggest that the authors compare both retrievals between 60S-60N.
5. P3178 line 21, the differences also include retrieval errors associated with clouds, which sometimes can be significant. For example, high ozone inside the clouds can cause significant positive errors in the retrieved ozone above clouds due to multiple scattering [Liu et al., 2004].
6. P3178 line 25, it should be noted that the CCD method is a statistical method (subtracting 2-sigma from the mean value): the negative differences could be partly caused by subtracting too much ozone. This should be mentioned here.

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7. P3179, I suggest changing “is correctly deriving” in present continuous tense to “correctly derives”
8. P3179-3180, since the derivation of “cloud ozone” does not involve OCCP, I suggest also plotting the difference between average OCCP (with reflectivity larger than 0.8) and tropopause (even though the average OCCP is probably larger than the tropopause) in another figure, which helps determine whether positive biases are mainly caused by low clouds or not and thus helps identify other sources of “cloud ozone”. I noticed that there are two paragraphs of discussion about the difference between climatologies of OCCP and THIR in p3179 lines 5-24. I think that it is much better to show the difference between average OCCP with reflectivity greater than 0.8 and tropopause since it is consistent with the CCD method. Adding a figure makes it easier to understand and follow the discussion.
9. P3179 line 19, it is not clear about the meaning of “low-to-high ozone concentrations”, please clarify it.
10. P3179 line 23, I suggest also adding “positive retrieval errors associated with clouds”, i.e., “lightning, biomass burning, and positive retrieval errors associated with clouds”
11. P3181 line 24, I suggest removing the words in parenthesis as it is not clear whether these ozone are inside/above deep convective clouds/high reflectivity low clouds.
12. P3183 line 14, this sentence does not read well, add a “there are ” before “clean signals”?
13. P3183 line 24, change “yr” to “years”
14. P3185 line 12, it is not clear about what “Pacific mean CCD measurements” means here: CCD results only in the Pacific (but then Figure 14 shows Atlantic means) or CCD results derived from high reflectivity clouds in the Pacific. Please clarify this.

15. P3188, it may be worthwhile to add another panel in Figure 15 to also show the relative trends in percent since we normally think ozone depletion is much severer in the southern hemisphere (at least relatively). This will help readers better understand the ozone depletion/recovery in both hemispheres.

References

Liu, X., M. J. Newchurch, R. Loughman, and P. K. Bhartia (2004), Errors resulting from assuming opaque Lambertian clouds in TOMS ozone retrieval, *J. Quant. Spectrosc. Radiat. Transfer*, 85, 337-365.

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