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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Total ozone trends and variability during 1979–2012 from merged datasets of various satellites" *by* W. Chehade et al.

Anonymous Referee #1

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General comments

The discussion paper presents an updated trend analysis of global total ozone records. It is a thorough and comprehensive piece of work, well suited for publication in ACPD. A few things should be addressed though before publication.

The use English is quite poor and should be improved substantially. Also the introductory part of the paper (pages 30409 to 30420) is very long and should be shortened substantially. Pages 30418 to 30420 are almost all that is needed. These changes would substantially increase readability of the manuscript.

Is my impression correct that using wintertime eddy heat flux (EHF) instead of annual mean eddy heat flux gives better results (at least in the Northern Hemisphere, NH) and

is used throughout most of the paper? E.g. comparing Figs. 3 and 4. If that is the case, there really is no point in using annual mean eddy heat flux in the NH. Remove it, and remove Fig. 3.

Also, wintertime eddy heat flux seems to make the AO (AAO) term almost vanish. This would make sense, because I would expect AO / AAO and EHF to be correlated anyways. I have a feeling that just using wintertime EHF and not using AO / AAO (just briefly mentioning that they exist and what results would be different) in all the regressions would avoid uncertainty due to possibly correlated proxies in the regression, and would make the paper clearer. I suggest that the authors consider that.

A related issue might be the fairly large and unexplained difference between post turnaround PWLT trends and trends from fitted EESC between 10 and 40 N (e.g. Fig. 7). This is also the region, where the AO effect is largest (Fig. 6). This should be discussed. Or is this just a data-set effect that goes away when using SBUV V8.6 - where there is little difference between PWLT and trends from fitted EESC (Fig. 10, 11).

Detailed comments

pg 30408 lines 6 to 8: sentence needs to be fixed, e.g. add "contributing" after factors

pg 30408 line 17 state what fraction of variance is typically explained

pg 30409 line 2 replace "Similar ... are observed" by "Before 1997, both approaches give similar and significant negative trends."

pg 30409 lines 3 to 4 replace "turnaround trends" with "trends after 1997", replace "than indicated by the EESC trends" with "than trends derived by fitting EESC"

pg 30409 line 19 "is governed" → "are governed". Singular / Plural also wrong in next sentence

pg 30413 lines 27 to 29 and next page: Easterly and westerly phase at which level?

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The thermal wind relation relates warm tropics (descent) and cold extra-tropics (ascent) with increasing westerlies with altitude.

pg 30419 Eq. 1: There should be 2 QBO terms in the Equation

pg 30420, lines 7 to 8: Several papers (Randel and Thompson JGR 2011, Sioris et al. ACPD 2013) show/use time lags between ozone and ENSO. How is this handled here? Needs a line or two of explanation.

pg 30420, lines 14 to 16: I find it hard to believe that Eddy heat flux and AO or AAO index are not correlated. Is that really true? I think additional statements are needed here.

pg 30420, lines 17 to 20: Good.

pg 30420 How are these monthly proxies averaged to give annual means?

pg 30420 What about annual means averaging over 1 winter in the Southern hemisphere, but averaging over 2 half winters in the Northern Hemisphere?

pg 30421 lines 19 to 24: This statement is not true!! Any additional proxy that is not linearly dependent (correlated) with the other proxies will pick up some variance and will increase R and R^2. You need F-tests, or adjusted R to check if adding a new proxy makes sense.

pg 30422 lines 18 to 19: 3rd or 4th repetition of this statement. Fix text.

pg 30424 line 24/25: Steinbrecht et al. 2001 should be Steinbrecht et al. 2011 throughout the manuscript.

pg 30425 line 16 to 18: I disagree. Since you are accounting for dynamical / transport changes (by AO /AAO and EHF proxies), differences between the hemispheres must/should have another cause. Could it be mixing out from the (much larger) Antarctic ozone hole?

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pg 30425 Eq. 2: What is δ. Please state. I am guessing you mean $\delta =$ years - 1997.

pg 30426 line 5 to 6: Please give an explanation / interpretation why the AO coeff. would be smaller.

pg 30426 lines 13 to 20: This discussion is not very satisfactory. There is no question when the uncertainty bars overlap. But the significant differences between 15 to 30° N should be discussed. One thing that is probably not picked up by the EESC term, are long-term changes due to (upper) stratospheric cooling and also due to possibly increasing speed of the BDC. The cooling means that a long term ozone increase is overlaying the EESC / ODS related trend. So EESC coefficients tend to come out too small, and after 1997 ozone will increase more than modelled by EESC alone - contrary to your statement in lines 15 to 20, which I cannot follow).

A similar argument would go for increasing BDC and higher latitudes (opposite in the tropics). I am not sure how these would work our at 15 to 30° N. Please add more and more plausible discussion here.

page 30427, lines 12 to 14: typos "MMOD"? "latitiude" "un changed"

Figure 1: check the axis labels. QBO winds are -40 to 40 m/sec not -400 to 400 m/sec. Aerosol index is optical depth (no units), not pptv. Is Eddy heat flux measured in K m/s or in K/m/s?

Figs. 6 to 8, 10: Plot only R^2, do not also plot R. Much clearer, and the two are related anyways.

Fig. 8: I think this Figure is misleading. It suggests that both the pre- and post turn-around trends agree between the three data sets. But pre- and post turnaround EESC trends are not independent, and not two different pieces of information. What agrees between data-sets are the EESC fitting coefficients. I would recommend to drop Fig. 8, and add 2 sub-panels to Fig. 9. One for R^2 and rms, and one that explicitly shows the EESC coefficients (in DU /pptv) for the three data sets.

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Fig. 10 should be omitted. The main information is also given (and in a better way) in Fig. 11.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 30407, 2013.

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