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

Answer to referee 1.

Dear referee, thank you very much for your interest in our work and your valuable comments, most of which we agree with and help us in improving this study.

General comments:

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.

The Introduction part is shortened.

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.

Only Wintertime dynamical proxies are used in this study.

Detailed comments

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

Done.

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

Done.

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

Done.

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"

Done.

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

Done.

pg 30413 lines 27 to 29 and next page: Easterly and westerly phase at which level? The thermal wind relation relates warm tropics (descent) and cold extra-tropics (ascent) with increasing westerlies with altitude.

The introduction part is shortened and the detailed description of QBO is not included.

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

Done.

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.

In this study, annual mean are used in the regression and not monthly means, no need for time lag.

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.

The correlation between monthly average measurements of EHF and AO is very small (0.06) while the correlation between the wintertime EHF and AO/AAO is 0.36

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

The average of twelve months.

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

The dynamical proxies are averaged over the winter seasons in each 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.

F-tests and adjusted R are performed and showed that the regression including EHF and AO/AAO is improved especially north 30°N and in the 40 -60 °S latitude band.

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

Done.

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

Done.

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?

The mixing out of Antarctic ozone hole with the high latitude southern hemisphere ozone certainly decreases the amounts of ozone and eventually the trends decrease, but the values of theses trends are higher than northern counter parts since the northern hemisphere is subject to higher inter-annual variability. Our results also agree well with the studies included.

pg 30425 Eq. 2: What is . Please state. I am guessing you mean = years – 1997.

Done.

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

After checking the numbers, the values of AO coefficient actually decreased by only 10% and not as stated in the study (refer to Figure1 included as supplement).

The aim of the paper is to update the total ozone trends based on satellite data that cover the period 1979-2012, for this reason the latest SBUV/SBUV-2 MOD 8.6 is used as a core dataset in this study and MOD 8.0 and GSG combined with MOD 8.6 are used in the sensitivity study.
The large difference between the trends estimated from EESC and PWLT regressions in the latitude bands 40- 65°S and 10- 40°N for MOD 8.6 and MOD 8.0 respectively, is due to the evolution of the parameterized EESC in which the turnaround of ODS abundances starts in the early nineties and lasts till the late nineties (slow turnaround) peaking at 1997 compared to the sharp inversion of the ODS abundances used in the PWLT regression model. The aerosol signals of El Chichon and Mount Pinatubo are weakened/enhanced and picked up by ODS signal modeled by EESC which also influence the magnitude of the MgII signal. This can be seen (Figures, 2 and 3 included as supplements) in difference between the proxy contributions obtained from both regression model for MOD8.6 60 – 65°S and MOD 8.0 20 – 25°N latitude bands.

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

Done.

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?

Done.
Eddy heat flux measured 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.

Done.

Fig. 8: I think this Figure is misleading. It suggests that both the pre- and post turnaround 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 R2 and rms, and one that explicitly shows the EESC coefficients (in DU /pptv) for the three data sets.

EESC coefficient is added to Fig.9

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

Done.