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Atmospheric
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Discussions

Interactive comment on “Solar response in tropical stratospheric ozone: a 3-D chemical transport model study using ERA reanalyses” *by* S. Dhomse et al.

M. Weber (Referee)

weber@uni-bremen.de

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1 Summary

This paper reports on the solar cycle response on stratospheric ozone using the 3D Chemical Transport Model (CTM) SLIMCAT. Three different model runs, two using winds and temperatures from different met analyses, ERA-40/ECMWF operational and ERA-Interim, and the third a perpetual repeating 2004 meteorology (no temperature trend). The model results are compared with observations from SAGE, SBUV, and HALOE using different analysis techniques (composite difference, lag correlation, and trend regression model).

Best agreement between model and observations are achieved in the middle stratosphere. Larger differences between model and observations are found in the upper stratosphere where SAGE and SBUV show larger solar cycle variations (4comparable to the model results. The model run with meteorology without temperature trends is in better agreement with SAGE and SBUV. The authors make the argument that a positive upper temperature trend as evident in the met analysis reduces the solar ozone response due to the ozone-temperaure anti-correlation in the upper stratosphere. This leaves still the question opens why HALOE and SAGE/SBUV do not agree. Apart from retrieval issues, one should be aware that temperature profiles are also needed in the ozone retrieval. SBUV uses a temperature climatology, HALOE uses retrieved temperatures at least for part of the altitude range complemented by temperatures from met analysis data. This could also have an impact on the results.

In the lower stratosphere (<30km) the model runs also show larger solar cycle changes than observations. The author explain this by downward transport of ozone-rich air but why is this not confirmed by observations (transport too strong in model). The lower stratosphere is more affected by aerosols in particular in connection with the major volcaniv eruptions from El Chichon and, in particular, from Pinatubo both occurring close to solor maxima. Fig. 1 seems to indicate that the major eruptions lead to overestimated aerosol related loss in the modelled LS ozone and may have lead to the stronger solar response compared to observations. Again the model run with fixed meteorology shows a smaller solar response in absence of major volcanic eruptions. This could be more clearly worked out in this paper. It is surprising that the solar cycle response in the composite analysis that does not distinguish between aerosol and solar related changes (Fig. 5) leads to similar results than the regression analyis (Fig. 6) where the influence of aerosols and the solar cycle are separated. Is there an explanation for it?

2 Other major issues

SBUV and SAGE data sets. The authors do not use the original SBUV data but the SAGE-corrected SBUV profiles from McLinden et al. (2009). Similarly a modified SAGE dataset from Randel and Wu (2007) is used as well here. This brings up the question if this modified SBUV dataset is then really independent of SAGE. Apparently the results for the corrected SBUV data set look very similar to SAGE. The authors should provide a clear motivation why they did not use the original SBUV merged nor SAGE data sets.

Figure 5. Runs A and B in Figure 5 look different in Panel a than in Panels b and c. No explanation is given.

Role of aerosols. On p. 13986, l. 9, the authors state: *... the larger solar response in runs A E40 and B EI 10 is most probably due to combinations of more ozone loss (due to aerosols) during solar minimum months and stronger downward mixing of ozone-rich air below 30 km, where the ozone photochemical lifetime increases rapidly from a few months to a few years.* This may be true for the Pinatubo (solar cycle 22) and El Chichon eruptions (solar cycle 21), but is certainly not the case for solar cycle 23. As pointed out earlier, the regression model should have separated aerosol from solar effects. Please explain.

Satellite retrieval errors. The authors state (p. 13989, l. 1): *However, we also note that different satellite instruments use different measurement techniques, have retrieval errors and have algorithm limitations (e.g., see Wang et al., 1996; Barthia et al., 2004).* This discussion remains somewhat vague here. In general there is quite good agremeent between the various satellite data sets (see WMO report). There may be an issue with data sampling. The occultation data sets have a fairly low sampling, but Tarao et al. (2007) showed that the sampling of HALOE and SAGE II is sufficient for calculating zonal mean data.

Haigh et al., 2010 paper. On p. 13989, l. 8: *Recently, a negative solar response in upper stratospheric ozone was noted by Haigh et al. (2010).* This is a very sparse discussion. The results from Haigh et al. should be discussed in more detail here (she is co-author!!). Her results are derived from MLS/AURA and covers a rather short period during the descending phase of solar cycle 23 (starting in 2004). This apparent negative trend is according to her study consistent with the UV irradiance change from SIM observations that are much higher than Lean et al. as used in this model study. There is also a recent study by Merkel et al.(2011) looking at upper atmospheric ozone trends from SABER observations and WACCM model results which extends the study by Haigh et al. (2010). Up to 50 km SABER shows a positive trend, above this altitude a negative daytime trend.

3 Minor issues

p. 13976, l. 5: "for the 1978-2005 period" (add "the").

p. 13976, l. 24: "datasets" (use plural).

p. 13978, l. 5: "they" is doubled.

p. 13978, l. 21: move reference (Brasseur and Solomon) to the end of the sentence. Here one could also refer to Fig. 2 in Dikty et al. (2010). They show the anti-correlation between temperature and ozone in the upper atmosphere, which in this case is dominated by seasonal variations but applies as well as for longer term ozone and temperature changes.

p. 13978, l. 24: change "linked with the dynamical fields" to "linked to changes in atmospheric dynamics".

p. 13978, l. 25: "eruptions" (use plural).

p. 13979, l. 7: better "... for long-term studies (e.g. Feng et al., ...)"

p. 13980, l. 15: "ending in 2005" (add "in").

p. 13980, l. 23: add an url for the merged SBUV data: http://acdb-ext.gsfc.nasa.gov/Dataservices/merged/.

p. 13981, l. 6: "from the 1979-2005 period" (replace "for" by "from the").

p. 13981, l. 11: "more than five profiles available" (add "available").

p. 13983, l. 6: change "also see" to "see also".

p. 13983, l. 14: "from the CPC data" (add "the").

p. 13984, l. 10, 12, p. 13985, l. 4: Brackets should be put only to the year of publication (in latex: citet instead of citep).

p. 13985, l. 9: change "of" to "with".

p. 13987, l. 3: "for the 1979-2005 period" (add "the").

p. 13987, l. 4: remove "also". Upper stratospheric trends have no impact on total ozone, the later is mainly related to LS ozone. You may say that negative trends in both US and LS ozone is apparent in the RW SAGE data relative to SBUV.

p. 13987, l. 23: I do not understand what "similar" here means (to what?). also change "profile ozone" to "ozone profiles".

p. 13989, l. 12: "play a minor role" (add "a").

p. 13989, l. 25: There are several other datasets available: ENVISAT (GOMOS, MIPAS, SCIAMACHY), ODIN (SMR, OSIRIS), and MLS/AURA. All these instruments have a much better sampling than ACE-FTS.

p. 13992. DOI of Randel and Wu is wrong.

4 References

Dikty, S., M. Weber, C. von Savigny, T. Sonkaew, A. Rozanov and J. P. Burrows, Modulations of the 27-day solar cycle signal in stratospheric ozone from SCIAMACHY (2002-2008), J. Geophys. Res., 115, D00I15, doi:10.1029/2009JD012379, 2010

Merkel, A. W., J. W. Harder, D. R. Marsh, A. K. Smith, J. M. Fontenla, and T. Woods, The impact of solar spectral irradiance variability on middle atmospheric ozone, Geophys. Res. Lett., 38, LXXXXX, doi:10.1029/2011GL047561, 2011.

Terao, Y. and Logan, J. A.: Consistency of time series and trends of stratospheric ozone as seen by ozonesonde, SAGE II, HALOE, and SBUV(/2), J. Geophys. Res., 112, D06 310, 778 doi:10.1029/2006JD007667, 2007.

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