

Interactive comment on “Analysis of SAGE II ozone of the middle and upper stratosphere for its response to a decadal-scale forcing” by E. Remsberg and G. Lingenfelser

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General remarks: It is disappointing to us that you did not recognize the clear motivation for our study. The paragraph beginning on page 17310, line 17, points out the disagreements among the solar cycle responses from observed data sets (SBUV, SAGE II, and HALOE) and those of models that currently represent the standard for the previous ozone assessment (see Figure 3.19 of WMO (2007)). In our minds their apparent disagreements were casting doubt on the ability of satellite remote sensors to record either the natural or the anthropogenically-forced, long-term changes in stratospheric ozone. To the contrary, our analyses of the HALOE and the SAGE II ozone from

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1991 to 2005 are showing signatures of the 11-yr response profile that are very similar to each other and are in-phase with that of the solar flux proxies. At the very least, we believe that we are showing that the findings from the SAGE II and HALOE ozone time series depend on the assumptions and terms for their analyses and perhaps on how well anomalous forcings were accounted for in the particular span of each dataset. Models of the effects of a direct, solar uv-forcing are also in reasonable agreement with the results of our analyses. We shall revise the manuscript to make our motivation and findings more explicit, particularly for the abstract.

Major points: Bring out the new findings and new understanding: See our response above to your general remarks. We also refer you to the reply that we posted earlier to the comments of Referee 1.

Address error bars in much more depth and consider the full SAGE II time frame: In our response to Referee 1 we noted that we accounted for the effects of serial correlation at lag-1 in our analyses and that we shall include a Table of the confidence intervals for the 11-yr and linear trend terms in our revised manuscript. All the terms of our present regression model are periodic, except for the trend term, and are therefore orthogonal and separable. If we were to consider a further analysis of the SAGE II data from 1984 onward, we would need to add a term to account for the effects of the changing chlorine, at least, and most likely add terms to account for the more episodic, volcanic and ENSO events of the early 1990s. Those terms are not periodic, and their uncertainties are not separable. This circumstance means that we would need to conduct sensitivity studies of the impact of those non-periodic forcings, which is beyond the intent of our present analysis and manuscript.

Altitude versus pressure coordinates problem: As Rosenfield et al. (2005) pointed out, trend analyses in altitude versus pressure coordinates would be helpful in sorting out the effects of the changing greenhouse gases on the temperature trends in the stratosphere and hence the ozone trends, too. We commented about this issue in the paragraph beginning on page 17311, line 11, and decided not to conduct separate

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analyses of the HALOE ozone mixing ratio versus altitude data for comparison with the SAGE II number density versus altitude data. Note that the fundamental quantity from the HALOE dataset is ozone mixing ratio rather than number density, requiring information about temperature to convert them to the same quantity. However, the NOAA satellite T(p) or T(z) trends have already been shown by Shine et al. (2008) to have a systematic error. What is really needed is for the HALOE ozone to be re-retrieved using corrected T(z) or T(p) analyses, although that is clearly not anticipated. Even so, for the time period of 1991-2005 the 11-yr terms from both our SAGE II and HALOE results were shown to be in-phase throughout nearly all the latitude/altitude domain. This outcome indicates that the issue of analyzing data time series in altitude versus pressure coordinates is really secondary to our goal of finding an 11-yr ozone response analogous to that due to the solar uv-forcing in the middle and upper stratosphere.

Minor points: Page 17311, lines 8 to 10: The effect of an EESC term was described for the HALOE ozone by Remsberg (2008), although it was not explicitly included as a term in his regression model. We pointed the reader to his paper regarding that qualitative effect. By considering a range for an EESC predictor we would merely be bracketing its effect on the ozone and its associated trend and 11-yr terms. Based on the reasonable, in-phase relationship that we have already obtained for the 11-yr term from the SAGE II time series, it is judged that the primary impact of including an explicit EESC proxy would be just a slight change to the derived amplitude of the 11-yr response but not to the overall shape of that profile.

Page 17311, lines 25 and 26: See above response to the analogous Major Point.

Page 17313, line 15: The average spacing for the time series points is 20 to 25 days, as stated at line 21. Generally, the profiles that were averaged for each point were obtained within just a few days.

Page 17316, lines 25 to 29: We shall add that information. Soukharev and Hood used SAGE II data from 1984 through 2003, Lee and Smith analyzed SAGE II data from

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1984 to 2000, and Randel and Wu used SAGE plus SAGE II data from 1979 to 2005.

Page 17318, lines 15 to 17: A comment shall be added. Differences in the trends that we obtained for HALOE versus SAGE II ozone are of the same order as those inferred by Rosenfield et al., at least above the peak of the ozone layer.

Pages 17321-22: The secondary peak above the stratopause in our analyzed, 11-yr response profile is more pronounced in SAGE II than in HALOE ozone. Its exact cause is unclear to us but may be due to slight biases in the retrieved SAGE II ozone of the lower mesosphere. However, we have concluded qualitatively that only a small part of it can be the result of changes in H₂O. We agree that a similar, small trend in reactive chlorine would have a small effect on the amplitude of the ozone response of the upper stratosphere.

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