

Interactive comment on “The natural oscillations in stratospheric ozone observed by the GROMOS microwave radiometer at the NDACC station Bern” by L. Moreira et al.

Anonymous Referee #2

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The paper of Moreira et al. investigates natural oscillations in stratospheric ozone observed by the GROMOS microwave radiometer at the NDACC station Bern (January 1997 to January 2015). The variability of these data is fitted using a regression analysis covering the annual oscillation, the semi-annual oscillation as well as QBO, ENSO, and solar cycle. The paper presents some new results, particularly with respect to ENSO and solar cycle effects. It should therefore be interesting for the ACP readership. However, before publication some important revisions should be implemented as detailed below. In particular, it would be useful to include a few direct comparisons of observations with analyses results (in addition to Figure 5). My main concerns are related to the robustness of the results, particularly of the results obtained for the solar cycle.

C1

Major 1: The authors should provide more information on the robustness of their results. In this context, they should show a few comparisons between the time series of the original data and the regression results (sum and individual components), for example, at the altitudes of maximum AO and SAO amplitudes and at altitudes of relatively large solar and ENSO signals. This would give an impression, how well the observed variability is fitted and what is left as residuals.

Major 2: The authors state that the surprisingly large amplitudes of the solar cycle signal cannot be solely explained by solar cycle effects alone but may be increased by a self excited oscillation. This is a rather speculative argument. In addition, it is not clear why the effect of such a self excited oscillation can be fitted with a same time series of normalized solar radio flux at 10.7 cm (shifted by 1 year). This procedure also inherently assumes that the effect of the self excited oscillation would have the same time behavior (phase shift) as the other solar effects. Is this really plausible? Again, it would be good to analyze the robustness of the results obtained from scaling one particular proxy curve. What is the impact of data anomalies? What is the impact of vertical resolution?

Minor: What is the altitude grid used in the fitting procedure?

Page2, line5, Please add a reference after “. . . eddy mixing processes”.

Page2, line13: typo? Please replace “roll” by “role”.

Page3, line14 (and in the following), “measurement contribution” is more common than “measurement response” in this context.

Page3, line13: I would not state that the ground station data have been validated by satellite observations. Usually, the opposite is the case. Maybe “. . . are in good agreement” with satellite observations.

Page3, line23: Maybe specify “. . . to analyses the temperature . . . for natural variability are from the European Centre for Medium-Range Weather Forecast /ECMWF).”

C2

Page3, line39: "molecular oxygen"?

Page4, line4: The choice of the indices for the last term is somewhat confusing. It is not immediately obvious that AO and SAO are represented.

Page4, line8: The expression "1-year" for a 1-year time shift and "1-season" for a shift by 1 season is not immediately obvious.

Page5, line16: Please reformulate first sentence.

Page 5, line19: "Local time" is more common than "time of day".

Page6, line2: Could you please explain, why this is a "consequence"?

Page 6, line11: What do you mean? The 11-year oscillation is the result of several processes.

Page 6, line 15: Why "Otherwise"?

Page 6, line22-23: For the same latitude?

Figure 4 and discussion in text.: The y-axis of Figure 4 does show the amplitude but the cycle. In addition, the x-axis should have a length corresponding to 12 months instead of 11 months.

Page 7: line30: The ozone SAO and the temperature SAO seem to be 1.5 months out of phase (and not 1). This becomes more apparent, when not looking only at the under-sampled maxima.

Page 8, line1: Maybe replace "equinox season" by "around equinox".

Page 8, line6-7: Is this only an effect of chemistry? Transport should also play a role (considering the vertical ozone gradient).

Page 9, line11: Maybe replace "relatively in agreement" by "in relatively good agreement".

C3

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C4