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## ***Interactive comment on “A climatology of the diurnal variations of stratospheric and mesospheric ozone over Bern, Switzerland” by S. Studer et al.***

### **Anonymous Referee #2**

Received and published: 22 October 2013

**Overview:** This manuscript presents a study of the diurnal cycle in ozone in the stratosphere and lower mesosphere based on 17 years of high time resolution GROMOS measurements taken at Bern, Switzerland. Because of the long time series, the authors are able to not only derive climatological diurnal variations but are also able to estimate seasonal and inter-annual variations in the ozone diurnal cycle. Large discrepancies remain between model and measurements on the character of the diurnal cycle, and this data set is very important to the ongoing effort to understand this variability. I believe the manuscript is generally well-written, and recommend it for publication after some revision, as described below.

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Major Comments 1. I appreciate the reason for not applying the GROMOS averaging kernels to the AURA MLS and the model output in order to preserve the information from the higher resolution output/measurements. However, in several places it is speculated that differences in the derived diurnal cycle with GROMOS might be due to the varying resolutions. Even if it is not a major component of the paper, the authors should be able to repeat at least portions of the analysis using the convolved model output or AURA MLS data and answer the question as to whether and to what degree the vertical resolution is influencing the differences.

2. I am somewhat new to this research topic, so I appreciated the thorough list of past studies. However, it would be very helpful to the reader to summarize some of these results overall. As a community addressing the diurnal cycle in ozone, how much agreement or disagreement exists on the size of the variations/mechanisms in the mesosphere, and then in the stratosphere. I was a bit confused because the authors state for example that photochemical box models can reproduce the afternoon maximum in the middle stratosphere but the next paragraph says there is no clear picture to explain diurnal variations in the middle stratosphere. Such a summary picture would also help relate the current results to past studies.

3. The authors seem to be grasping at straws in the discussion of the inter-annual variability in the last section. The authors speculate as to several causes to explain the largest variations, but these ideas should be explored further with more in depth discussion, or possibly removed altogether or put forth as part of a continuing effort. The authors could instead go into details about how their results either support or conflict with our current understanding of diurnal oscillations in the context of previous studies. Although the model results cannot be used to study the inter-annual variability, could the GROMOS data be added to Figure 8 to compare inter-annual variability with AURA/MLS?

Minor Comments: L97-98 not sure what you mean here. In accordance with their used photochemical models? The correct grammar would be 'in accordance with the

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respective photochemical models used' but I'm still not sure I follow what the authors are saying.

L139-140: Suggest the authors also add the chemical mechanism for the stratospheric afternoon ozone maximum.

L145: This paragraph is confusing. The authors have just summarized several results relating to the middle stratosphere, including the SMILES analysis that includes dynamical variability. This paragraph could be removed, and the relevant issues about the diurnal cycle in the mesosphere vs. stratosphere introduced earlier. Also, throughout this discussion care should be taken to identify the altitude ranges covered by the various studies. It would help the reader to discuss the results in the mesosphere/upper stratosphere separately from the middle stratosphere/middle atmosphere (I assume these refer to the same region) according to the dominate chemical/dynamical mechanisms.

L210 AURA MLS should be added to the data sources

L270 I don't understand the two sentences "The stub land model part satisfies the coupler needs. Atmosphere and Land models are simulated actively within this configuration" Can the authors explain this with less colloquial language for those not familiar with WACCM. Models are simulated... do you mean the atmospheric and land conditions are simulated by the model?

L354 what is the source of the climatology? Satellite or ground-based data or a combination?

L486 In this paragraph, either refer to the altitude or pressure rather than switching between the two. Also, the Parrish paper should be introduced earlier, in the introduction. A new manuscript by Parrish et al. has recently been submitted to ACPD. It should soon be citable (in place of the Quadrennial reference). Are there other results that can be compared here?

Technical Comments: L44 Studying diurnal variations (remove 'the') or studying the

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diurnal variation in ozone

L55 their lifetime, the result being...

L152 replace 'a lot of ' with 'many'

L184 has continuously retrieved ozone profiles

L214 has operated

L216 in the north-east direction

L229 GROMOS was upgraded

L311 ...closest grid point to Bern (45N and 7.5 E) has been used for the comparison...

L427 Remove ')'

L431 replace "equal" with "equivalent"

L433-438: These two sentences can be combined. '...since the stratosphere is less disturbed and exhibits less year-to-year variability in summer compared to winter, when planetary wave activity is high.'

L450 noted by Scheiben et al. (2013),

L512 While the January model output are mostly within the GROMOS ...

L528 for all months.

L564 Figure 9

L687 missing page numbers

Figure 2: The difference between red and magenta is hard to discern in this figure. What about another color for the a priori? Also a priori instead of apriori in caption.

Figure 3a Both absolute and relative mean differences are with respect (don't need commas here).

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Figure 5a: error bars (two words).

Figure 5a: Additionally, the relative mean differences are shown by the two green diamonds.

Figure 8: a 3-month moving average is applied (red). It would also be interesting to add the GROMOS time series to this plot.

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 22445, 2013.

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