

Atmos. Meas. Tech. Discuss., author comment AC2
<https://doi.org/10.5194/amt-2022-131-AC2>, 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Reply on RC2

Sarah A. Strode et al.

Author comment on "SAGE III/ISS ozone and NO₂ validation using diurnal scaling factors"
by Sarah A. Strode et al., Atmos. Meas. Tech. Discuss.,
<https://doi.org/10.5194/amt-2022-131-AC2>, 2022

Response to Reviewer 2 Comments

This is a very well written paper, and is a good fit for AMT. It demonstrates the utility of global chemistry-climate models to scale measurements of diurnally varying species for comparing or merging data sets. I would recommend the paper for publication after just a few minor details are addressed, as given below.

We thank the referee for the helpful comments and respond to individual points below.

Line 18: What do you mean by "variability in the shape"? I think you can leave out "in the shape"

We removed "shape".

Lines 48-49: Please be more specific about the findings

We elaborated this sentence by adding: "due to changes over time in the relative frequency of sunrise and sunset measurements combined with diurnal variability"

Line 107: please give approximate altitudes

We added: (~18-59 km).

Section 2.1.4: Why is v3.6 of the ACEFTS data being used instead of the more current v4.2? Version 3.6 O₃ exhibits a drift in the upper stratosphere, and there were biases between the two versions (<https://doi.org/10.5194/amt-15-1233-2022>)

When we performed our analysis, Version 3.6 was the recommended version for validation studies [Wang et al., 2020]. In addition, the positive bias for ozone in the middle stratosphere is approximately 3% in version 3.6 but 2-9% in version 4.1 [Sheese et al., 2022, <https://doi.org/10.5194/amt-15-1233-2022>]. We added this explanation to the description of ACE-FTS in section 2.1.3.

Lines 133-135: does this mean that this is like a specified dynamics run?

There are multiple methods for constraining or specifying the dynamics in a global atmospheric chemistry model. The specific method for constraining the meteorological fields in our simulation is described in the Orbe et al [2017] reference.

Line 160: Undoubtedly, it would be important above 50 km as well. Should say something like "within the SAGE observation range it's only important between 40 and 50 km."

We added "within the SAGE III/ISS observation range"

Figure 1: are these at a specific sza or averaged over all szas?

This is the amplitude of the diurnal cycle, calculated as the maximum of the monthly mean diurnal cycle minus the minimum of the monthly mean diurnal cycle at each grid box, and then averaged over longitudes and latitude bands. Multiple SZAs are thus considered since the maximum and minimum occur at different SZAs. We updated the text describing the figure in section 2.2.2 to clarify that we are using the monthly mean diurnal cycle.

Line 197: please be more specific about the findings

We added "and that accounting for diurnal variability along the line of sight can reduce the bias below 30 km by over 10%"

Lines 221-230: please be more quantitative about previous findings

We added additional information to this discussion including percent differences. We now state: "Parrish et al. (2014) found reasonable agreement between the simulated O₃ diurnal cycle at Mauna Loa, Hawaii with microwave ozone profiling radiometer (MWR) observations at most levels, with most of the modelled and measured values agreeing to within 1.5% of the midnight value. However, between 39 and 43 km, the morning versus night differences in the MWR observations are 2-3% higher than in the model." In the discussion of the Frith et al [2020] results, we now state: "They found good overall agreement with the structure of the MLS differences, generally within 2%, while the simulated sunrise/sunset ratio differed from that of SAGE III/ISS above approximately 2 hPa but agreed within approximately a percent below 2 hPa."

Section 3.2 in general: please be more quantitative in your descriptions

In addition to the changes made for the previous comment, we also add additional quantitative information to the description of our model comparison to the SAGE III/ISS observations in this section. We added the following:

"The largest percent difference in this range for the sunrise observations is 13% and occurs at 20 km for the 20°S-20°N band. The largest percent difference in this range for the sunset observations is 12% and occurs at 20.5 km for the 20°S-20°N band."

"The SAGE III/ISS sunrise and sunset averages for this latitude band reaches a peak of 4.5×10^{12} molec cm⁻³ at 26.5 km while the model reaches a peak of 4.3×10^{12} molec cm⁻³ at 26 km."

"For June-Aug., the model agrees with the observations within 30% between 20 and 50 km, with the largest percent difference occurring at 20 km."

Section 4.1.1: Why was 35 km chosen to be shown? Seems like it might be more interesting to see closer to 40-45 km where amplitudes are largest.

We chose 35 km because it is more relevant to the comparison with OSIRIS observations.

Figs 5,6 captions: sza values are missing the degree sign

We added the degree sign.

Line 295: It's a touch confusing. Would recommend something like "variability is largest at 60deg S"

We reworded this sentence to state: "At 60°S, the differences between individual years and climatology reach values above 20% near 10-20 km (Fig. 6d)."

Fig 7: These plots could very easily be made much more intuitive to read. Please color coordinate/use different line styles to group the plots. Like all OSIRIS comparisons could be one color but different line styles for different criteria, and the ACE could be a different color with the same line styles.

We modified the lines in Fig. 7 for SAGE III – OSIRIS so that the "no correction" and "with correction" sunrise comparisons are both red and the "no correction" and "with correction" sunset comparisons are both blue, but we use solid lines for the comparisons with no correction and dashed lines for the comparisons with correction. Consequently, it is now easier to see the effect of the diurnal corrections by comparing solid versus dashed lines of the same color.

Line 361: The sentence "The sign of the difference switches with altitude." should either be elaborated on or deleted.

We reworded this sentence to say: "The sign of the difference switches between positive and negative depending on altitude."

Line 367: $\text{abs}(\text{SZA}) > 90^\circ$ could be $|\text{SZA}| > 90^\circ$

We changed $\text{abs}(\text{SZA})$ to $|\text{SZA}|$