Atmos. Meas. Tech. Discuss., 6, C2075–C2081, 2013
www.atmos-meas-tech-discuss.net/6/C2075/2013/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Assessment of Odin-OSIRIS ozone measurements from 2001 to the present using MLS, GOMOS, and ozone sondes" *by* C. Adams et al.

C. Adams et al.

cristen.adams@usask.ca

Received and published: 16 August 2013

Thank you for your comments, which have helped to improve our manuscript. Below we address the recommended changes point-by-point.

SPECIFIC COMMENTS

The authors need to specify the reasons for using MLS v2.2 rather than v3.3?

We will add the following to Sect. 2.2 of the text:

"For MLS, the v3.3 ozone dataset with higher vertical resolution is also available. How-

ever, for the present study, the v2.2 data has sufficient vertical resolution and does not have oscillations at lower latitudes, as does v 3.3 ."

Page 3827 last paragraph: can you further explain how do you calculate the correlation coefficients for all altitudes?

We will add the following to the text:

"For each altitude level, the R correlation coefficient between all available coincident measurements at the given altitude was calculated. Correlation was calculated between individual measurements (not, e.g., daily zonal means). "

Page 3828, line 26, 'Correlation between OSIRIS and GOMOS is slightly weaker, due in part to the smaller variability in the ozone profiles for the OSIRIS and GOMOS coincidences' I don't agree with this statement, a weaker correlation coefficient indicate a weaker agreement regardless of the variability.

We will delete "due in part to the smaller variability in the ozone profiles for the OSIRIS and GOMOS coincidences"

Page 3829, line 24, 'No other bias at altitudes above 24.5 km is consistently larger than 5 % in all validation data sets.' This not exactly accurate, as both MLS and GOMOS comparison show bias of >5% in southern hemisphere at high latitudes in the southern hemisphere. Please revise this statement.

We will remove this statement.

Page 3830, first line: "Large positive percent differences are observed below 20 km at southern hemisphere high latitudes for comparisons with MLS, and are associated with large standard deviations. These values do not improve when only southern hemisphere summer months are considered, suggesting that this is not due to polar stratospheric clouds" Actually, below 20 km, the negative bias of >5% stand out and is more significant than the positive bias. Can you comment further on this bias? Does it persist when you restrict the compassion to summer months?

This was a typo. We have changed this to “larger positive and negative percent differences”

Page 3830, line 15: “For tropospheric air, 2–5 km beneath the tropopause, strong correlation R > 0.9 is observed between OSIRIS and ozone sondes, suggesting that OSIRIS is capturing tropospheric variations, despite mean percent differences of up to 15 %.” I’m not sure I understand why there is a strong R below the tropopause, when the standard deviation is very large at this region. You might need to present the comparison in different way (maybe a plot of the time series) to illustrate that “OSIRIS is capturing tropospheric variations”

This is a good point. We will investigate this when we revise the paper and may change figure selection.

Page 3831, Section 5.2.1: I find some discrepancies between the text and fig 5. At temperature <16 C, the MLS comparison show very small negative or zero bias, not bias up to 6%, thus make it inconsistent with SAGE II comparison, which show negative bias of 5-12 %. The second paragraph and fig 6 also add to the confusion. If you are investigating altitude pointing errors, then showing the comparison at 32.5 km is not proving anything. I suggest plotting the mean ozone profile for OSIRIS, MLS, and GOMOS for T<16 C, and then look for any obvious altitude mismatch. Line 12, “This supports the explanation that a low bias in ozone measurements is caused by altitude pointing errors and/or lower spectral resolution under low optics temperature” Can you explain why lower temperature would cause a lower spectral resolution? Why you think that pointing errors and wavelength error have the same effect on the ozone retrieval? Please revise the text for the whole section.

We will rework this section with the following. We will rework the text to ensure that it is clear that only the qualitative pattern of decreasing OSIRIS values relative to the validation dataset is consistent for all validation datasets.

We will remove the figures at 32.5 km. We have further-investigated this since the sub-

mission of this paper. We will add profiles of mean relative differences for comparisons with MLS in narrow latitude bands, which do suggest that the optics temperature is caused by a pointing error.

We will also expand upon the discussion of pointing errors and spectral resolution. To summarize, suppose OSIRIS measures an amount of ozone at a given registered altitude, but is actually pointing higher in the atmosphere due to a pointing error. This would lead to a low bias in the ozone profile in the middle and upper stratosphere (because the ozone number density decreases with altitudes). Reduced spectral resolution and wavelength shifts occur when optics temperatures are low because the instrument was focused at a higher temperature. During these periods, ozone retrievals are biased low at UV wavelengths because the ozone cross-section is not correctly smoothed for the spectral resolution. UV wavelengths are used for retrievals in the middle and upper stratosphere, so this would also lead to a low bias in ozone in the upper and middle stratosphere. It is currently thought that both pointing and spectral errors contribute to the low bias in OSIRIS ozone for low optics temperatures.

Page 3831, Section 5.2.2: comments on fig 7: I don’t see the author’s point about the bias at 22.5-24.5 km northern and southern hemispheres. The larger positive bias in the northern hemisphere descending node is prescient for most altitudes for MLS, not only 22-24 km. Similarly, the positive bias in the southern hemisphere is evident for all altitudes above 20 km for GOMOS and sonde comparison, and at 14-25 km for MLS comparison.

We will revise this text accordingly.

Page 3832, line 11: “Therefore the observed latitudinal structure in comparisons between ascending and descending nodes and the validation data sets is not caused by the different seasonal coverage of the ascending and descending nodes.” I don’t think the authors have clearly shown this to be true. Fig 1b show a clear differences in the seasonal and geographical ascending/descending coverage, where most of the high *latitude measurements between 60-90 for both N and S, are from ascending node. Surly this will create some biases when you compare ascending and descending measurements.*

There are differences in the sampling of the ascending and descending node measurements. However, strong latitudinal structure in the biases is observed even when OSIRIS ascending node measurements are compared directly to coincident OSIRIS descending node measurements, thus effectively removing the sampling biases. In order to clarify this in the text, we will revise it as follows.

"Latitudinal structure was observed in the differences between ascending and descending node measurements even for these coincident OSIRIS versus OSIRIS measurements. Therefore, the observed latitudinal structure in comparisons between ascending and descending nodes and the validation data sets is not caused solely by the different seasonal coverage of the ascending and descending nodes."

Line 20 and fig 9: I don't know how much can be concluded by looking at 22.5 km. This might be the peak of the aerosol layer between 30 N and 30 S, but this is not the case for northern and southern hemispheres, where the peak is closer to 15 km. In Fig 9 a and b, it's unclear why the ozone difference increase at higher latitudes, when the magnitude of the aerosol decrease? The authors need to revise this section and clarify their conclusions.

It is extremely difficult to isolate the relationship between OSIRIS aerosol and ozone, as they depend on strongly on altitude and viewing geometry (which varies systematically with latitude and season). This type of figure was the only way that the authors found that they could show this relationship. In order to clarify this in the text and address the questions above, we will revise this paragraph as follows:

"OSIRIS aerosol and ozone retrievals depend on the viewing geometry of the measurement, which varies systematically with latitude and season. Therefore, it is very difficult to isolate relationships between OSIRIS ozone and aerosol retrievals. However, when

mean percent differences in ascending minus descending node ozone were binned by latitude and the difference in retrieved aerosol extinction at 22.5 km, as shown in Fig. 9, the relationship between ozone and aerosol was observed. While 22.5 km is not the peak of the aerosol layer at all latitudes, it an altitude at which the OSIRIS is sensitive to aerosol. For latitudes north of 30°N, and south of 30°S, the measurement node with the larger aerosol extinction observes more ozone. The magnitude of this bias increases toward higher latitudes. Mean percent differences for OSIRIS minus MLS at 22.5 km, binned by latitude and the OSIRIS aerosol extinction are also shown. At high latitudes, OSIRIS measures more ozone than MLS when OSIRIS aerosol extinctions are large. While this aerosol-dependent bias is the clearest at 22.5 km, near the peak sensitivity of limb-scattered measurements to aerosol, some systematic dependence on aerosol extinction was observed for 12.5-27.5 km (not shown). This may explain the high bias in OSIRIS measurements at 22.5 km."

Page 3833, section 5.2.3: The analysis in this section are incomplete and don't add to the paper. I suggest either redo the analysis or delete this section. In general, albedo errors contribute to 1.5%, and are almost negligible above 35 km, where the UV wavelength are used. As the authors noticed, the bias seen at 42km can't be explained by the albedo error.

We have elected to keep this section. As you suggest, the reason for the relationship between albedo and OSIRIS biases is unknown and may not be related directly to albedo errors (e.g., could be related to some unknown quantity). However, this section does point toward a systematic pattern in the OSIRIS data that should be checked when retrievals are improved and in future validation and may be better understood in future studies.

Section 5.3: the authors calculate the drift against MLS, GOMOS, and ozonesonde measurements. Can you comment on the stability of these measurements ?

We will add the following:

“MLS ozone profiles were previously found to be stable relative to lidar to within ±5% per decade for 20-40 km at most lidar stations considered (Nair et al., AMT, 2013). GOMOS data are expected to be stable because the stellar occultation technique is self-calibrating. Ozonesondes are considered a stable dataset and are useful for the assessment of long-term satellite stability (e.g., SPARC/IOC/GAW, 1998).”

TECHNICAL COMMENTS:

We will change the following, as recommended

I fined it a little confusing the use of “high” or “low bias”, I suggest using “negative” or “positive bias” instead.

P3828, line 11-12: replace “are within 5% of zero at all altitudes’ to ’are within 5% at all altitudes’

Fig 2 a,b and c: title should be OSIRIS – MLS, OSIRIS – GOMOS and so. Also, the x-axis title should be moved from the y-axis side.

Fig 5: replace “Variation in percent differences” with “ Relative mean difference”

Fig 6: replace “OSIRIS minus MLS” with “OSIRIS - MLS”

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 3819, 2013.