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Atmospheric Measurement Techniques Discussions

Interactive comment on "Validation of OSIRIS mesospheric temperatures using satellite and ground-based measurements" *by* P. E. Sheese et al.

Anonymous Referee #1

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This manuscript presents global temperatures derived from Rayleigh scattering measurements in the mesosphere (50-85km) made by OSIRIS during more than 10 years and assesses their quality by means of comparison with SABER, ACE-FTS, SOFIE and PCL measurements. The comparisons show a good agreement with differences within 4-5K between 55 and 80km. Above 80km, OSIRIS shows a 5-15K cold bias. At 50km, OSIRIS temperatures are up to 10K colder (generally at high southern latitudes).

From my point of view, this work presents a dataset which is new and evaluates its quality properly. The paper is well organized and easy to follow. Therefore, I think

it deserves publication. However, I think the manuscript can be improved if the authors expand their explanations on the possible sources of temperature differences they found, particularly because, in some cases, they are not within their estimated errors. Indeed, temperature differences could be discussed in terms of combined systematic errors from the two instruments involved in the comparisons. Additionally, I also think that they have not considered all possible sources of systematic errors, neither have they commented them thoroughly in terms of previously reported errors or biases of the other instruments. I think these issues can be easily addressed before this work is published in AMT. The specific changes and corrections I suggest are:

Abstract: Include as well differences found in the edges of the measurements (50 and 85km) and a sentence summarizing the main errors in OS temperatures.

P9495 L6-8: some references to results from OSIRIS could illustrate this sentence

P9495: include a reference to a more detailed description of OSIRIS (maybe Murtagh et al. (2002), that you already have in your reference section but is not used in the text)

P5495 L9: 'vertical spacing' instead of 'vertical resolution'

P5495 L24: ' from around 20km' instead of 'from the surface'

P5495 L25: 'field of view' instead of 'resolution'

P5495 L28: delete 'daytime' (temperatures from SABER are derived from the 15um emission also at nighttime)

P5496 L5-6: whether 'a minimum' instead of 'an approximately' or 'sampling' instead of 'resolution'

P5496 L16: SOFIE temperature retrievals extend up to 102 km (Stevens et al., 2012)

P5496 L16: 'field of view' instead of 'resolution'

P5496 L17: Perhaps more precise to write '66 and 83deg' (Stevens et al., 2002 or

Marshall et al., 2011). In fact, you write '66deg' in section 3.3.

P5496 L18: include the version number (v1.2) of SOFIE temperatures you compare with

P5496 L23: What is PCL vertical resolution and sampling?

P5497 L8: 'lower by 2-3K' (see Remsberg et al., 2008)

P5497 L14: Include reference to radiance at 278nm in Fig.1a.

P5498 L28ff: Fig1b suggests that temperatures from 318.5nm match the MSIS profile around 65km, better than those from 347.5nm (although I understand that in the retrieval at 347nm you use T_o and n_o taken at 72km and not at 85km as in the plot). Could you justify the choice of the initial altitude of the 347nm retrievals at 72km instead of, let's say, 60-65km?

P5498 L3ff: On the one hand and according to Table 1, the systematic error due to T_o decreases one half in 5km and the noise error at 84km is smaller than 2K. On the other hand, the Tk error from the O2 A-band measurements is significantly smaller at 90km than at your z_o=85km (P5498 L2). I would not be surprised to see smaller errors in the 80-85km altitude range if the initital altitude of the retrieval were 90km. Have you done any test in that sense? Would that reduce the differences (in particular, with PCL) in the upper mesosphere?

P5499 L8: Specify what 'corresponding MSIS [M] profile' is

P5500 L20: Given that the mesospheric temperature presents typical scenarios (polar summer and winter, mid-latitudes, etc...), comment on any significant latitudinal or seasonal dependence of the estimated errors (I think you suggest there is some when attributing differences to larger errors in the southern high latitudes P5506 L15).

P5501 L5ff: You do not mention temperature errors due to uncertainties in other important parameters, as n_o (which I guess comes from MSIS), n(z) (which,should have

errors coming from, e.g., cross section uncertainties), not accurate inclusion of multiple scattering (you mentioned that has a large impact in the comparisons later on, e.g., with SOFIE), OSIRIS pointing; O3 and NO2 absorption. Include estimations of systematic errors due to these sources in your error budget or, at least, comment on them explicitely in the text

P5501 L15: Indicate the criterium used for PMC detection and mention if there could be Tk errors coming from failed detections

P5501 L25: Indicate the percentage of profiles that were filtered out. Is there any 'preferred' altitude of the outliers where the temperature more often departs from 3.5xMAD?

P5502 L8: Delete 'is'

P5503 L4: You could comment on the differences in temperature amplitudes (>10K) and their causes (different vertical resolutions, larger SABER non-LTE errors in inversion layers, co-location mismatch)

P5503 L15: The differences should be compared with the SABER and OSIRIS combined systematic errors. I think they will lie within that combined error and, therefore, can be expected and explained

P5503 L15: There is no discussion in terms of known biases from SABER. For example, the 2K high bias in the mid-mesosphere found here agrees with a reported SABER 2K low bias (Remsberg et al., 2008)

P5503 L20: You are suggesting here that a higher surface albedo could account for up to 4K error in the stratopause. That implies that you must include that source of error in your budget (Table 1), even if you have to specify that it takes place only at high latitudes

P5503: Even if the number of co-located pairs is not large, please, give some information about the behaviour of the SABER and OSIRIS differences for PM temperatures

P5504 L2: ...but I can only read in Sheese et al. (2011) that 'An investigation into the source of these biases is needed', refering to the OSIRIS cold bias wrt SABER in the mesopause. Could you add a short line in the text outlining possible reasons for SABER and OSIRIS disagreement at 85km?

P5504 L11: I think that dividing the comparisons in latitudes but not in seasons might not be advisable because ACE-FTS biases in the upper mesosphere might be dependant on seasons (positive in the polar summer and negative in the polar winters, see Sica et al. 2008). Examine if that also happens in comparisons with OSIRIS.

P5504 L12: You should use ACE-FTS averaging kernels to smooth OSIRIS profiles. If not available, why using a running mean and not a gaussian, which, in principle, should be more representative of ACE-FTS FOV? Does using a gaussian change the comparisons?

P5504 L17: That contradicts your finding of an improvement of 0-2K in comparisons with v3.0 with respect to v2.2. Remove 'little' and write a number.

P5504 L22: Add 'or Fig. 7a between 60 and 70km'

P5505 L9: Delete 'using the stricter coincidence criteria'. Both criteria lead that result.

P5505 L10: ACE-OS using the -4K-line as reference and SABER-OS behave similarly. That reinforces the results of the comparisons with SABER. It also justifies the use of the -4K-line in the plots, which you do not currently mention in your discussion. Include a comment on this.

P5505 L16: Could you include possible reasons for the significantly different behavior in the southern high latitudes above 75km?

P5505 L25: Again, I would avoid grouping polar summer with polar winters, given the large difference in temperatures in these two scenarios. What happens if your sub-plots are done for different seasons instead of hemispheres?

P5506 L8: I miss discussion regarding previously reported biases of the other instruments. Specify the findings of Stevens et al. that you refer to: for example, comparisons with SABER and ACE-FTS point to a SOFIE 2-4K cold bias at 75km in the polar summer; also, Stevens et al. show a SOFIE 2-3K warm bias at 50km, which might partially explain the differences you find here

P5506 L14: Would comparisons of OSIRIS vs SABER for the Antarctic (including all seasons) lead to a similar results, particularly, a 8K colder bias in the stratopause? That should be the case if the bias is due to inaccurate inclusion of multiple scattering. If so, why OS-ACE does not show that larger bias in the 60S-82S box?

P5506 L17: This is another reason to include in Table 1 systematic errors coming from wrong multiple scattering.

P5507 L7: OSIRIS warming around 80km is not as large as that of PCL (difference at the peak is almost 20K and OS barely shows a positive gradient). According to PCL Tk geophysical variance, that should not be due to time mismatch. What is the distance between PCL location and OS measurement? You have not smoothed PCL profiles, which (I guess) have better vertical resolution than that of OS. Could the difference of the inversion layer be partially explained by the different vertical resolutions? Also, comment on the excellent agreement below 70km.

P5507 L11: Why haven't you used OS averaging kernels to smooth PCL profiles to match the vertical resolutions?

P5507 L22ff: The standard deviation gives information not only about the coincidence mismatch but also about the precision

P5508: Include anywhere in the summary that, except for ACE-FTS (which has a 4K bias) and at southern high latitudes, OS measures 2-5K WARMER temperatures from 60 to 80km.

P5508: Also, once the combined systematic errors are considered in the manuscript,

mention wether the differences are within the combined errors or not

FIGURES

Fig1b: What do you mean with 'Normal retrieval' in the legend? 'derived from MSIS' or even 'MSIS Tk'? Please, clarify here or in the text

Fig. 4: You could plot SABER and OSIRIS combined error instead of the standard deviation of the difference. Also, it is interesting that restricting the coincidence criteria, the results remain the same but, since both Fig. 4a and 4b are similar, it is enough with Fig.4a and a comment in the text. Please, remove Fig. 4b.

Fig. 5: What happened to latitudes higher than 72deg? Comparisons with SABER at very high latitudes would be a nice test to see if comparisons with SOFIE make sense.

Fig. 6: What happened to latitudes higher than 60S?

Figs 5 and 6: For consistency, please, use the coincidence criteria used for Fig 4a (1000km;1h) in these plots

Fig. 8: Why do you also show ACE-FTS 4K bias in v3.0 if those temperatures are not yet validated nor such a bias in v3.0 has been reported? Your comparisons show that ACE v3.0 temperatures are 0-2K colder than v2.0, at least below 80km.

Fig. 8: Given the small effect of tightening the coincidence criteria, please, remove right panels and leave the discussion only in the text. I would also merge the plots showing v2.2 and v3.0 together for an easier comparison of these two versions. Additionally, as in the case of SABER comparisons, plot the combined systematic error instead of the standard deviation

Fig. 11: Remove standard deviations and add combined systematic error

Fig. 13: Again, given the similarity of the three plots, I would prefer having only one of them and a short discussion in the text. Also, remove standard deviation and plot combined errors.

REFERENCES

Bucholtz 1995: Referenced in the text but not included in the list

Gattinger et al. 2008: the doi does not correspond to the reference. Maybe 10.1139/p08-015?

Murtagh et al. 2002: this reference is not used in the paper

Stevens et al. 2012: the paper is now published

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