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Atmospheric Measurement Techniques Discussions

Interactive comment on "Ozone profiles above Kiruna from two ground-based radiometers" *by* Niall J. Ryan et al.

Anonymous Referee #2

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General comments

This is an interesting paper on the validation of the two microwave radiometers KIMRA and MIRA 2 based in Kiruna, Sweden. KIMRA and MIRA 2 are compared to each other when at the same location, to ozone profiles measured by radiosonde (RS) launched from Sodankylä, and to simultaneous measurements by MLS.

The effects on the ozone profiles of a unsolved problem of standing wave in the KIMRA measured spectrum are described. This is leading to a low bias of KIMRA towards MIRA 2, RS and MLS around 22 km.

7 and 5 months mean profiles for the 2012-2013 winter are first compared, then a comparison with RS using regression is performed with the distinction between measurement inside and outside the vortex. Finally, a 5 winters climatology of KIMRA is

used to assess the presence of a dip in the arctic winter ozone profile at 35 km. A qualitative explanation for the presence of this dip in the ozone profile is given and the necessity of further investigations is mentioned.

The paper is clear and well written with good quality figures. The scientific contribution is relevant for publication and lies within the scope of AMT. The methods used for the comparisons are valid, and the related work is referenced. The paper will make a good contribution to AMT, provided that the following comments are addressed.

Specific comments

P1, line16: "KIMRA is low-biased with respect to the ozonesonde data due to a general low bias in the KIMRA profiles around 22 km altitude," A low bias due to a general low bias looks redundant. Please, modify in order to make clear that KIMRA is low biased with respect to radiosonde, MIRA 2 and MLS.

P2, line25-26: To what extent is the inversion procedure presented here different from the older one? Were the older KIMRA spectra showing a similar standing wave? Was the older inversion setup able to deal with that? Please, describe shortly the changes with respect to the previous retrieval setup.

P3, line12: The authors mentioned the two FFTS of KIMRA but only the characteristics of the narrowband FFT are mentioned. What are the characteristics of the second FFTS? Please add.

P3, line 13: "Narrowband often centered": please, mention that the FFTS can be moved to another frequency here instead of later in the text at p3, line 29-33.

P5, line 8: Is the uncertainty estimation of 1 ppmv constant for the whole altitude range? The standing wave on the wings of the spectrum should affect only the bottom of the profile? Please, describe the variation of the 1 ppmv uncertainty with altitude.

P5, line12: Oscillations in the baseline are due to reflections along the quasi-optic path. The distance of the reflection to the horn can be deduced from the oscillation

frequency. Were the authors able to determine in which of the components of KIMRA the reflections are set?

P5, line 22 and Figure 2: The measurement contribution (MC) is 140% at 45 km and 120% at 18km. Can such deviations from 100% be explained? Please, explain the high MC values. As the MC is the sum of the surfaces of the AVK, the shape of the envelope of the AVK should correspond to the shape of the MC profile. This is not the case in Figure 2. Please comment.

P6, line15 and Figure 3 Measurement error of KIMRA resp. Mira 2: the whiskers are the 1 standard deviation of the differences. Are the dashed blue lines, the observation errors which are related to the measurement covariance matrix? In that case, the errors should be minimum in the middle part of the profile where the SNR is maximum? What is exactly the dashed blue line? Please modify in order to clarify what the "the sum of the average measurement error" is.

Does considering the standard deviation/sqrt(n) instead of the standard deviation of the n differences change the conclusions of section 4.2? Same comments for Figure 7 and 8 and conclusions of section 5.3. Please comment.

P9, line 22-23 and Figure 5: Is the number of coincidences influencing the regression coefficient? The statement of higher correlation for MIRA 2 and RS is done on 25 coincidences for KIMRA vs RS and 13 coincidences for MIRA 2 vs RS. Please comment.

The reader cannot deduce from the good r coefficient of MIRA 2 vs RS that the bias ($\pm$ the standard deviation) of the differences between RS and radiometers is within the range of the sum of the measurement errors from RS and MIRA 2. The regression plot and factors without an estimation of the errors are not sufficient to establish the good correspondence between MIRA 2 and RS, please add errors bars to figure 5 or show the profile of the difference.

P12, line 20-21 : The authors emphasized that the arctic winter dip in ozone at 35 km

is not a result of the biases in KIMRA ozone profiles, but an issue could be : to what extent the bias in KIMRA ozone profiles, bias related to the presence of the standing wave in the measured spectra, is enhancing the ozone dip at 35 km or the maximum intensity at 27 km?

Do the authors have any suggestions? Is it possible to correlate the intensity of the ozone dip with the opacity of the troposphere or with the intensity of the standing wave? How is the standing wave in winter 2008, when the ozone dip is not as clear?

MLS show the ozone dip in Figure 12. Are the MLS profiles AVK smoothed by KIMRA? What is the influence of the smoothing by KIMRA AVK on the ozone dip intensity measured by MLS? Please describe the eventual effects of AVK smoothing of MLS ozone profiles by KIMRA AVK on the ozone dip measured by MLS.

Technical comments

Figure 4, righthand side: up left panel: in the text p6, line 29: slope=0.81, in the figure: slope=0.9; down left panel: in the text p6, line 32: slope=1.0, in the figure, slope=1.07. Please make it consistent.

P8, line 10: Livesey (2008) is not in the reference list

P10, line9: "...shows better agreement with MLS." Please, mention here a reference to Figure 8.

P10, line 14: it should be Figure 4 instead of Figure 3

P13, line 27: Calisesi (2003) is not cited in the text

P16, line 6: Palm(2010) should go to P17, line 22

P17, line 17: Nash(1996) is not cited in the text

P19, Figure 2 left and middle: please add a vertical dashed line at MC=100%

P20, Figure 3, legend: a priori "used" for the Inversion

P20, Figure 4, p26 Figure 12, p27 Figure 13: why ppv instead of ppmv? Please adapt for similarity with the others figures.

P25, Figure 10, legend: should be “as Figure 9” instead of “as Figure 10”

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