

Interactive comment on “The ground-based MW radiometer OZORAM on Spitsbergen – description and validation of stratospheric and mesospheric O₃-measurements” by M. Palm et al.

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General comment:

We do not understand why the description of the profile retrieval and the error analysis contradicts the intention on the paper.

We do not conclude that the deviation is caused by spectroscopic error, we present some evidence that this might be the case. Citation from the manuscript page 1952 line 16:

"...the deviation between the satellite instruments and OZORAM may be caused

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caused by spectroscopic error."

Specific comments:

— Section 2 The OZORAM instrument —

The system noise temperature has been changed because the instrument has been cryogenically cooled after 2004. It had been designed to be cooled, but after the first mixers were destroyed during the cooling it had not been attempted again. Because this might have been caused due to some material failure at temperatures lower than 70K, the mixer is now cooled only to 70 K. This explains why other groups get better results using cryogenically cooled instruments at this frequency. Nothing else has been changed apart from the backend spectrometers which has been described in the manuscript.

The instrument is a SSB receiver as has been described at page 1936 line 19. The other modification are described on page 1938. The error numbers are naturally given for the receiver in the configuration used.

— The sideband rejection —

The sideband rejection is 17 dB minimum. The measuring of the sideband performance is difficult at this frequency. Up to the (rather high) uncertainties, the measurement fits the theoretically calculated transmission and rejection of a Martin Puplett interferometer.

— The measured spectrum —

140 K are not that uncommon above Ny Alesund in winter. It is located at sea level. It is, however, the upper limit of tropospheric background we use for the analysis.

— What is meant by on-disk —

The data which are on disk. The data are recorded in 10 min intervals.

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— Line 14: What is the actual integration time, i.e. looking in the direction of the atmosphere and not to a calibration load? —

The time of measuring the atmosphere is slightly less than half of the measuring time. This has been optimized using the Eq. (1). The SNR does not only depend on the measuring time of the atmosphere but also on the measuring times of the calibration loads and the ratio of those times.

— The section about absorption needs rewording... —

We consider Janssen (1993) a good textbook on microwave radiometry inclusive radiative transfer.

— Nowhere in the paper the authors give any details about how they correct tropospheric effects —

On page 1942 line 12 is stated the continuum model MPM93 is fitted simultaneously with the ozone emission. The use of this model corrects for the tropospheric effect by calculation of the tropospheric absorption.

— It is not clear what exactly is meant in... —

O3 is optically thin. "Under the line means" the area of the ozone emission when the tropospheric absorption and emission has been removed.

— Explain how the noise (system temperature) is linked with the covariance. —

Via the radiometric formula (Eq.2) and the total power formula (1). It is a simple error propagation calculation.

— The apriori profile is a mean value. Give details, annual mean or what? —

The profile has been taken from fascod (subarctic, winter) and smoothed in order to match the altitude resolution of the OZORAM.

— What is done with spectral artifacts, give more details about offsets due to non-

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linearities. Where are they generated, how are they taken into consideration? —

Spectral artifacts are retrieved as long as they are sinusoidal. If the instrument would be non-linear it would produce a offset or some functional dependency of the baseline on the frequency in the calibrated spectrum. This can be fitted as a polynomial in the spectrum, but is actually not necessary. This statement will be removed.

— How wrong is wrong, what is right? Please specify. How accurate is the brightness temperature of the cold load known (not the physical temperature)? —

The brightness temperature of the hot and cold load (absorption coefficient more than 99 %) can be calculated from the physical temperature. In the microwave regime they are almost equivalent by definition.

— Probably the polar angle should be the elevation angle I guess. —

Yes.

— Page 1946 section 3.2 results This section is very short —

This section is only included to show the sensibility of the obtained data. In order to be comparable the ECMWF data would have to be smoothed. The data shown in the ECMWF plot seem indeed far too high.

We checked to program to generate the ECMWF plot again and found no error. We do not yet know what the problem is, but will investigate this for the revised version.

— Figure 7 bottom: It seems as if the O3 distribution has a double peak most —

Which peaks are meant? The peak in the mesosphere is due to the high night time values of ozone. The lower most peak is real in the data and can also be observed in the provided MLS data in March 2009.

Apart from the fact that the MLS data in the plot are not smoothed to the OZORAM altitude resolution and range, the overall structure is not that different. The OZORAM

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starts measuring just after the event and shows high ozone value in the stratosphere at about 30 km. The air seems to start descending again in both datasets and in March the MLS data even develop a double peaked structure.

Please compare the plots appended which show the MLS data (recalculated using the OZORAM instrument function) compared to the OZORAM data at three different altitudes. Apart from the offset, which is caused by the oscillation in the OZORAM profile, the match is as good as it can get.

— It would be interesting to plot potential temperature contours as an overlay to the ozone profiles to highlight downward and upward movement during the stratospheric warming. —

This is not in the scope of the paper.

— I suggest to omit the wording "simulated retrieval" as it is no retrieval —

The term has been coined by Rodgers and Connor (2003) in order to describe the comparison of data with different altitude resolution. It is of course no retrieval which is why it is called simulated. It simulates the effect of the lower altitude resolution instrument, which is the OZORAM, to the atmosphere.

— Please specify the used values —

$\gamma = 0.0025 \text{ GHz/Pa}$

$n_{\gamma} = 0.71$

Those values are filled in into the JPL catalog by the ARTS forward model.

The error on the line intensity is assumed to 1 %. The value in the table is a mistake.

— On the oscillations I am not convinced that the oscillations —

We are well aware that this is speculative and we do say so, see the comment above.

— What kind of hardware changes happened in between? This is not given in section C950

2.2 —

It is described in section 2.2 page 1938 top.

— Figure 5 It does not make sense to plot values higher than say 80km —

This depends. Please refer to answer to review #4. The instrument is sensitive up to 100 km altitude as the AVK's show. Of course there is no profile information in the data anymore, this is why the AVK matrix and the apriori profile is needed to interpret the data.

References

Janssen, M. A. (Ed.) Atmospheric Remote Sensing by Microwave Radiometry, John Wiley & Sons, Inc, 1993

Rodgers, C. D. & Connor, B. J. Intercomparison of remote sounding instruments J. Geophys. Res., 2003, 108, 4116

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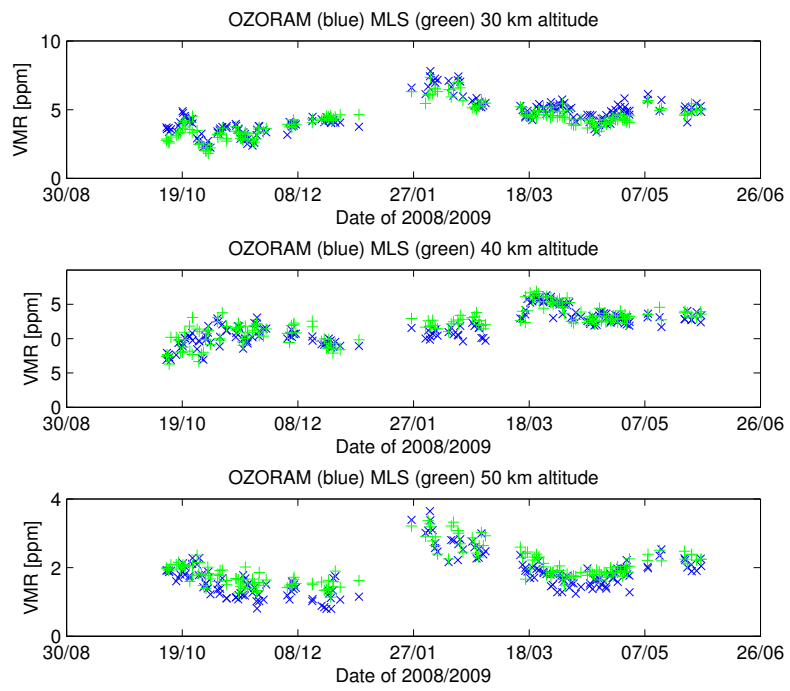


Fig. 1. Time series of MLS and OZORAM 2008/09