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Atmospheric Measurement Techniques Discussions

Interactive comment on "The ground-based MW radiometer OZORAM on Spitsbergen – description and validation of stratospheric and mesospheric O_3-measurements" *by* M. Palm et al.

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We would lime to thank the referee for the detailed and constructive review.

General comments

Paragraph 1: This paper contains ...

The publication is an announcement of an instrument and its data set including an error discussion. The features shown in the publication are for demonstration purposes only in order to show the sensibility of the data. The features shown are well known (the diurnal cycle of mesospheric ozone or present in another independent data set). The

authors think that there is much potential in a data set like the one presented and therefore it is worthwhile to publish a description of the data set.

Paragraph 2: Generally speaking ...

We are well aware that the publication describes nothing new in the respect of ground based microwave radiometry and suggesting the contrary is not intended.

The theory has been described cursory (as has been stated in the manuscript) which is necessary for the understanding of the error discussion without studying the cited literature. Where to actually make the cut is rather difficult but the manuscript will be revised in this respect.

Paragraph 3: The microwave ozone-measuring ...

The OZORAM is a NDACC instrument and the tropospheric background has always been fitted along with the stratospheric signal, though the model has changed.

We are thankful for the hint of an investigation of the different calibration schemes. We do however think, that such a thorough study of the different calibration schemes would be far beyond the scope of the intended publication and we also think that more groups operating microwave radiometers should be involved into such a study.

Paragraph 5: The comparison between profiles ...

The HITRAN spectral catalog has been used microwave radiometry before, e.g. (Hocke,2007).

The JPL catalog is not complete with respect to ground based microwave radiometry because the air broadening and its temperature dependency are missing.

For this work, the JPL catalog has been appended with the missing parameters:

gamma = 0.0025 GHz/Pa n_gamma = 0.71

This is done by default in the ARTS forward model.

Specific comments

Paragraph 6: The intercomparison discussion ...

The comparison is limited by the fact, that most of the time the OZORAM has been measuring no other instruments have been operating at this latitude (to our knowledge, except SMR/ODIN). Because there is another year of measurements available, more satellite instruments measuring at daytime will be included in the comparison.

A discussion of the possible errors of the satellite instruments is beyond the competence of the authors. Errors found in the literature have been included in the comparison.

A more thorough review of other results will be included in the revised version.

Paragraph 7: The error discussion gives only the most cursory ...

The OZORAM is different from the instrument investigated in Connor et.al (1995). It uses the total power technique, i.e. every measurement is calibrated using black body targets. The result is a fully calibrated power spectrum including the atmospheric emission. The instrument used by Conner et. al. (2005) uses the beam switching technique. The result is a difference spectrum of spectra measured at two different elevation angles. The tropospheric absorption has to be derived by other means.

The opacity of the atmosphere is retrieved along with the ozone signal using the MPM98 Model of tropospheric absorption. The temperatures are taken from the general setup of the retrieval and the error for a wrong temperature profile is explicitly given in Figure (5), named sigma_T.

Paragraph 8: There's no entry in Table 2 for the noise ...

The measurement noise depends on the noise temperature of the instrument, the integration time and the frequency resolution. The connection between eq 2 and eq 12d is via the radiometric formula and the total power equation. It is a simple error

propagation calculation.

A typical noise value for the measurement in the configuration presented (1h integration time, 60 kHz resolution) is 0.5 K.

The spectrum is largely dominated by random fluctuations and has been corrected for baseline errors already (also, compare answer to referee #3 (AC C 908)). The baseline effects do vary on shorter and longer timescales and are retrieved for each spectrum separately. This has indeed not been explained in the publication but will be included in the revised version.

We decided not to average the spectra more than 1 hour. The intended usage of the data is for short time scale analysis, e.g. diurnal change in the mesosphere or short term features in the stratosphere due to wave activity.

The integration over longer times is a difficult issue. The atmosphere above Spitsbergen is rather unstable, even on short timescales. Example are the change of ozone dependent on the SZA or dynamic variations like the polar vortex. Also the water vapor content can change very quickly (Palm,2010). Some of the baseline artifacts which are not removed by calibration are variable on timescales of hours. Integrating spectra before removing them leads to strange baseline artifacts which are difficult to analyze later on.

To smooth the data to lower spectral resolution does not help solving any problem nor does it clarify possible error sources, but will mask short variations of the baseline. Degradation of the spectrum will remove information and may, if at all, optically enhance the spectrum.

The high resolution of the spectrum is considered a great advantage for the removal of baseline effects, because short variations can clearly be observed and are not smoothed away. The high resolution over the whole bandwith makes it possible to distinguish most wave-like baseline structures from the emission features in the strato-

sphere and mesosphere.

Paragraph 9: The argument in section 5 is not convincing. ...

The main statement of this chapter is supposed to be that the oscillatory pattern is not necessarily due to lack of regularization, as is sometimes stated. We are also not the first group to put forward this idea (e.g. Boyd, 2007).

Not only the line parameters but the line shape itself may be wrong, which has been shown for other rotational lines in the microwave region (Rohart, 2008). In this case the search for a consistent set of parameters using the Voigt line shape model would be futile. But this is a study to be done by a properly equipped and experienced laboratory group.

Compare also the answer to review #4 (AC C911).

Paragraph 10: The oscillatory pattern ...

The authors are well aware that the statement about the oscillatory deviation is rather speculative. This will be clarified in the revised version.

Paragraph 11: It is curious that the oscillations ...

Without a detailed investigation of the calculations done by Connor (1995) we can only speculate about the differences in the error calculation.

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Interactive comment on Atmos. Meas. Tech. Discuss., 3, 1933, 2010.