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Atmospheric Measurement Techniques Discussions

Interactive comment on "Ground-based millimeter-wave observation of stratospheric ClO over Atacama, Chile in the midlatitude Southern Hemisphere" *by* T. Kuwahara et al.

Anonymous Referee #1

Received and published: 24 April 2012

In the manuscript "Ground-based millimeter-wave observation of stratospheric ClO over Atacama, Chile in the mid-latitude Southern Hemisphere" a newly developed millimeter-wave radiometer to measure thermal emission of ClO at 204 GHz is described. An initial comparison to independent datasets obtained from satellite instruments has been performed and data obtained from the measurments have briefly been analyzed.

General:

The authors attempt a difficult measurement which aimes at one of the key species of the chemistry of ozone depletion by chlorine species, ClO. Although measurements of

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this species have been obtained before, as mentioned by the authors, the data base is still sparse. The site of Atacama desert is well suited for this measurement, because the water vapor content of the atmosphere is a major problem for the measurement of a weak emission like the one measured here.

The measurements are important and data obtained over the mid-latitudes in the southern hemisphere are a valuable contribution to the monitoring of the chlorine induced ozone depletion.

As I am not native English myself, I am not suited for correction of the language, but I would suggest the manuscript should be copy edited.

The publication suites the scope of the journal "Atmospheric measurement techniques" and is important. However, the publication shows major flaws. Therefor the issues raised below should carefully be considered before the manuscript can be published.

Specific:

page 1909 line 25

Why is it important to take into account the diurnal behavior of ClO. Either cite a publication stating this or elaborate on this statement. Are there any model studies elaborating the importance of the diurnal behavior of ClO?

page 1911 line 4-6

Please cite a publication of a description of the path length modulator, i.e. the oldest one I found is by Gustincic (1977).

page 1911 line 11-12

Please give the frequency of the LO. Also specify how the contribution from the mirror side band is dealt with.

page 1911 line 17

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Please give more information on the type of the FFT spectrometer. Is there an apodization function applied? How is the apodization dealt with?

page 1911 line 19

Why is beefing up the cooling system relevant for this publication? I see the importance for the operation of the instrument, but this is a technical detail which I do not consider interesting.

page 1911 line 21

Please give a citation for the Allan variance time and its usage for millimterwave radiometry or describe more in detail e.g. Schieder, R. Kramer, C. (2001).

What is meant by spectrometer, the whole instrument of just the FFT? For the measurement the Allan variance time of the FFT is not relevant, relevant is the Allan variance time of the whole instrument, which may also be limited by 1/f noise. Please give some more details.

page 1912 line 23

What temperature is meant here? Physical temperature, Brightness temperature, Raleigh-Jeans-Temperature?

page 1912 line 25 ff

Please be more exact here. Give the definition of the Brightness temperature you use. I recommend Janssen (1993) for the differences and finer issues of the definitions of Brigthness temperatures.

page 1915 line 22

What is mean by "a little bad"? In the figure 2 I cannot see much of a difference to the time between 5th and 17th of December.

page 1916 line 5 to 25 page 1917 line 1 to 3

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The averaging kernels depend on the signal-to-noise ratio and this certainly changes if the noise on the spectrum is constant (as it can be made by changing the integration time) as the signal itself changes. I am not convinced that a trick like this can be used to overcome the problem of the changing information content of the spectrum.

I would therefore suggest to prove this by calculating the averaging kernels for the minimum and maximum values of ClO and show both averaging kernels.

page 1916 line 16

The authors claim, that there is no significant channel-to-channel correlation. On page 1917 line 5 they explain, that the spectrum is smoothed by a moving average. As I understand this method, it is introducing a channel to channel correlation. Please explain and/or prove that this is not relevant.

page 1918 line 5

I guess the authors mean the standard deviation of the residuum. The absolute values of the residuum in figure 3 seem larger than 1.8 mK.

page 1918 line 13

Why was the baseline ripple not removed, e.g. by retrieving a set of sinusoidal functions? What happens if the range is chosen wider than 150 MHz?

page 1920 section 4.2.3.

The random noise generated by random noise on the spectrum can directly be calculated (refer to Rodgers, 2000, page 46, the retrieval error.)

page 1922 section 4.2.6.

Apart from the uncertainties mentioned, the uncertainties caused by spectroscopic data (pressure broadening, line intensity etc.) may cause large systematic errors. Why have they not been dealt with?

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page 1922 lines 23ff

Why does the spectral signal come from only one side band? Acc. to figure 1 there is no side-band filter. Hence, what one sees is a mixture of the spectral signal from both side-bands, the signal band and the mirror band. This may lead to artifacts which resemble baseline features or even contain signatures of trace gases which emit in the mirror band.

page 1923 line 15 to 20

Nedoluha et.al. (2011) and Ricaud et.al. (1997) also used ground based data and have also a rather coarse resolution. They would probably not see a peak at 50 km altitude. The argument that MLS is unrealistically large at 50 km because it is not seen in other ground-based MW measurements is therefore not convincing.

Because of the strong dependency of ClO on the solar zenith angle it would seem natural to ensure that the MLS data are taken at the same SZA as the NATAOS data and not the same local time of the NATAOS position. The 60 degree longitudinal coincidence criterion cover a range of 8 hours solar time. Please correct or be more precise.

The precision of the MLS data is also influenced by the convolution with the NATAOS averaging kernels. Has this been taken into accout? If not, please refer to Rodgers and Connor (2003) on how to compare data sets with different altitude resolution and how to calculate the error on the comparison.

page 1923 line 25

I cannot see why the measurements at a completely different latitude by Nedoluha et.al. (2011) and/or time by Ricaud et.al. (1997) can serve as an argument, that NATAOS measurements are more correct than the MLS measurements.

Section 4.3

The comparison to MLS leaves the impression, that the comparison is restricted to the

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region where it fits alright. Please consider this and correct or explain more conclusive.

I would also suggest to show a time series of the MLS and NATAOS measurements.

Given the deficiencies in the comparison the impression that NATAOS is measuring correct cannot be regarded conclusive and convincing.

page 1924 section 4.4.

I would recommend to remove this section. This is not part of the description of the measurement but an application and is not in the scope of AMT.

The data compared are more than 10 years apart and are made in different parts of the world. The authors should explain the aim of the comparison and what one would expect given the fact, that the Montreal protocol led to a significant decrease of anthropogenic chlorine emissions.

The results are only descriptive and the authors themselves point out some major problems encountered by the measurements (resolution, averaging kernels). They also suggest a solution (comparison with model runs) and refer to a later publication.

Figure 6 to 10

I would suggest to combine figure 6 to 10 into one figure. I would be much easier to actually compare the contributions of the different noise sources.

Figure 12

Why is there only one measurement from NATAOS. I understood measurements have been taken from 5th to 17th of December 2009. Is this a mean of all profiles? Please explain.

Figure 13

What denote the error bars? The standard deviation of all measurements during this time?

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Technical issues:

page 1911 line 2:

add an 'A' at the start of the sentence before Path Length Modulator (PLM)

page 1911 line 3: ".. between the parabolic mirror." There seems a part of the sentence missing.

page 1912 line 20

Either "a translucent medium" or "translucent media"

Figure 12

I cannot find left-light arrows.

Figure 13

Please mention in the caption that this is a mean of all measurements between 5th and 16th of December.

Figure 14 caption

please replace "out" by "our"

in the reference section

what are the numbers behind the reference entries?

References

Gustincic (1977), J. A quasi-optical receiver design Proc. IEEE. Conf., 1977

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

Rodgers, C.D. (2000) Inverse methods for Atmospheric Sounding, Theory and Practice. World Scientific

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

Schieder, R. Kramer, C. (2001) Optimization of heterodyne observations using Allan variance measurements Astronomy Astrophysics, 2001, 373, 746-756

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 1907, 2012.