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FIRST MEASUREMENTS OF THE NEW ClO-mm-WAVE SOUNDER AT THE JUNGFRAUJOCH ALPINE STATION

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ABSTRACT

In the last years many progresses have been made in the field of the detection of stratospheric trace constituents. However, only few techniques are suitable to detect ClO, one of the key constituents in ozone depletion chemistry. One of these techniques is mm-wave radiometry. This work presents the first measurements performed by a new 204GHz radiometer at the Jungfraujoch Alpine Station.

1 INTRODUCTION

Ground-based millimeter wave radiometry has already been used for the detection of several minor constituents in the stratosphere. The domination of pressure broadening over doppler broadening in the spectral line shape gives the possibility to retrieve profiles at altitudes of 15-70 km even from ground-based sites.
Encouraged by the success of other institutes [Parrish et al. 1988] [de Zafra et al. 1989] and the results of the ozone sounders at our institute, the IAP decided to develop a ClO-radiometer.

2 INSTRUMENTATION

The Institute of Applied Physics (IAP) has a long experience in the field of millimeter wave radiometry. The difference between the earlier instruments and the ClO-radiometer is in the calibration procedure, which is used to eliminate baseline problems and nonlinearity effects both, in the spectrometers and in the frontend electronics and optics. In this work the frequency switch calibration technique [Gerber and Kämpfer 1991] was used and has shown to be suitable for the detection of ClO. This technique is well established in the field of radio astronomy and seems to be an alternative approach to the beam switch calibration technique [Parrish et al. 1988].
Fig 1. shows a block diagram of the electronics used in the radiometer. The spectrometer consists of a broadband 10x40MHz filterbank. Near the line center a 21x2MHz spectrometer is used to get better information about this spectral region. During winter 91/92 also a chirp transform spectrometer of 160MHz overall bandwidth [Osterschek IGARRS 1991] has been used go get better information about the far wings of the ClO line.

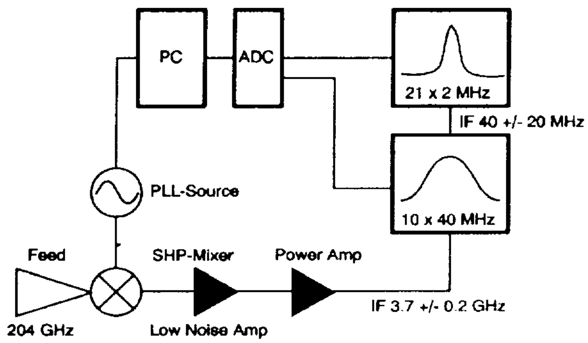

Fig.1: Block diagram of the ClO-radiometer receiver electronics.

3 JUNGFRAUJOCH STATION

Due to strong absorption by water vapour, only dry high altitude sites at suitable for ClO measurements. The Jungfraujoch Alpine Station in the Swiss Alps (3570m) gives the possibility to perform mm-wave measurements even at frequencies between 200 and 300GHz. During winter 90/91 a water vapour radiometer of our institute has shown that zenith absorption at 204GHz is better than 2dB on most of the winter days and better than 0.5dB on several days [Peter and Kämpfer 1992]. Therefore the usable elevation angle is very flat which enhances the spectral line strength by a factor of 2 to 4.

4 FIRST RESULTS

During the EASOE 91/92 campaign two periods of measurements have been performed. One from January 23 to 29, 1992. The second from March 24 to April 15, 1992. The dashed line in Fig.2 shows a typical daytime spectrum which has been measured by end of January, when the lower stratosphere was in a chemically disturbed state. Large contributions in the far wings of the spectral line indicate that an anomalous high ClO concentration in the lower stratosphere was present these days.

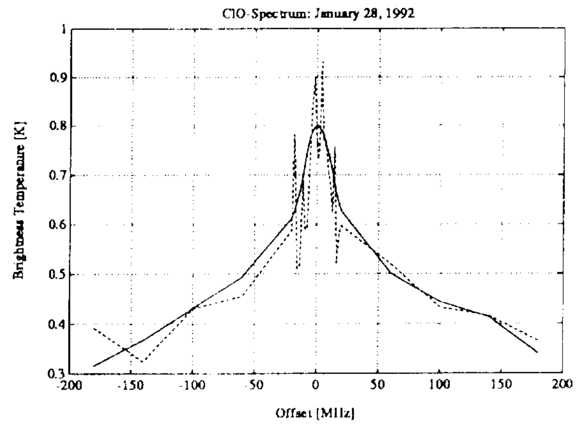

Fig.2: Comparison between a measured ClO spectrum by end of January (dashed) and a model calculation using the best estimation profile for this time (solid).

The VMR profile in Fig.3 was obtained by variation of a model profile at 30-45km and a boxcar function at lower heights. As ground-based millimeter wave radiometers do not have a high altitude resolution, the assumption of an 'unphysical' boxcar function is valid for this purpose.

By end of March the far wing contributions were no longer present in the measured daytime spectrum (Fig.4). Therefore the profile in Fig.3 without the boxcar function is a good estimation for the ClO amount in the upper stratosphere.

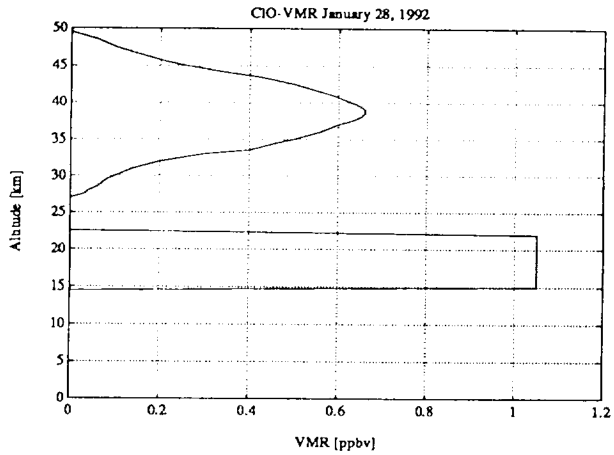

Fig.3: ClO VMR profile for the end of January. The error bars are about 30% in the upper and 50% in the lower bulk.

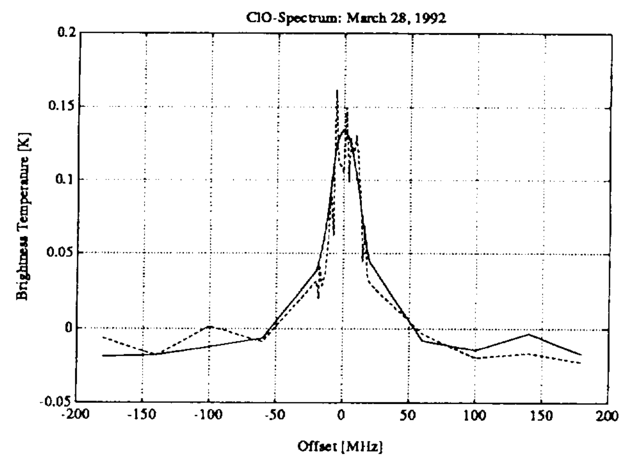

Fig.4: Comparison between a measured ClO spectrum by end of March (dashed) and a model calculation using the best estimation profile (solid).

Some remarks about the error of the obtained profile should be made: Two different layers of ClO could be detected in January 1992 (one in March/April). The two layers can be retrieved independently. Therefore the overall error of the two bulks of the profile are not significantly correlated. The estimated error is about 30 percent for the upper stratosphere ClO amount and 50 percent for the enhanced layer around 18km. Due to the limited bandwidth of our spectrometer the location of the lower ClO layer may be slightly lower than expected.

5 CONCLUSIONS

The IAP ClO-radiometer has successfully finished its first period of field measurements. It has proved to be able to detect anomalous high ClO amounts in the lower stratosphere. The Jungfraujoch Station is suited as a place for long term measurements of stratospheric trace constituents due to its low humidity.

6 ACKNOWLEDGMENTS

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