# ▶ Radiometer for Atmospheric Measurements (RAM) Instrument and Retrieval


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## ▶ General

The Radiometer for Atmospheric Measurements (RAM) was designed and built at the Institute of Environmental Physics, University of Bremen. It offers long-term stability suitable for the monitoring purposes within the Network for the Detection of Stratospheric Change (NDSC). Since November 1994 it is operated continuously, providing information on ***stratospheric chlorine monoxide (ClO)*** and ***profiles of stratospheric ozone*** from emisson lines at 204.35 GHz and 142.175 GHz, respectively.

Information on ClO is obtained under favorable weather conditions in the winter / spring period, while one to five ozone profiles are retrieved per hour nearly independent of weather conditions all year round.

Ozone profiles are retrieved for the altitude range from 12 km to 55 km with a vertical resolution of about 10 km.

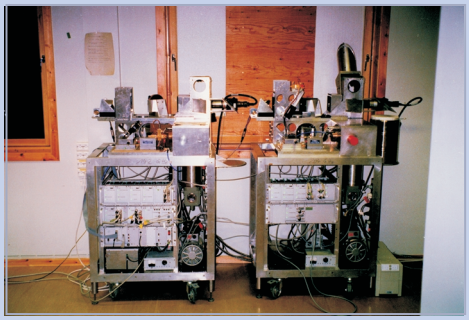


Figure 1. Photo of the RAM. In the left rack the ozone section is installed, the right rack contains the ClO-section. The atmospheric radiation is received through Styrofoam windows visible behind the instrument. On the top part of the racks the quasi-optics, the mixer and the calibration facilities are mounted. The lower parts hold the amplifier chain, the spectrometer and control electronics.

## ▶ Spectra

### ▸ ClO

We detect the set of weak ClO-lines around 204.35 GHz using the beam switch technique to reduce non-linear effects in the amplifier chain. The subtraction of a daytime and a nighttime spectrum eliminates instrumental effects. This procedure is feasible, because ClO in the layer of main interest around 20 km is only present in sunlit regions.

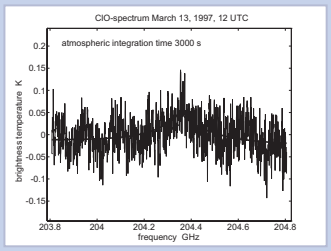



Figure 3. Calibrated day-minus-nighttime ClO-spectrum of March 13, 1997. A fitted spectrum is underlayed (thick line).

### ▸ ozone

The strong ozone line at 142.175 GHz is detected with a bandwidth of 1.65 GHz. The spectrum is composed of two spectra in slightly overlapping frequency ranges.

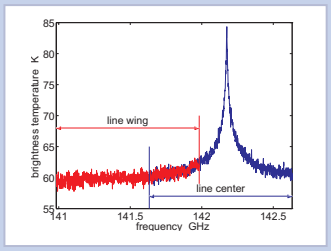



Figure 4. Calibrated ozone spectrum of March 20, 1997 at 17h (UTC). The two spectra are indicated by different colours.

## ▶ Instrument

The instrument consists of two front-ends sharing one back-end. The basic design of the two front-ends is similar. The beam guiding to the mixer is done with a system of mirrors and wire grids. The RAM is operated in the single-sideband mode. Coolable whisker contacted Schottky diodes are used for the two mixers. The back-end contains the amplifier chain and an acousto optical spectrometer (AOS). The whole system is computer controlled.

### ▸ instrument performance

| | 204 GHz | 142 GHz |
|---|---|---|
| sideband suppression | > 15 dB | > 15 dB |
| single sideband system noise | 1150 K (cooled) | 2610 K (uncooled) |
| IF-frequency range | 7.5 - 8.5 GHz | 6.85 - 8.5 GHz |
| spectrum bandwidth | 0.96 GHz | 1.65 GHz |
| AOS bandwidth | 955 MHz | |
| effective resolution | 1.3 MHz | |

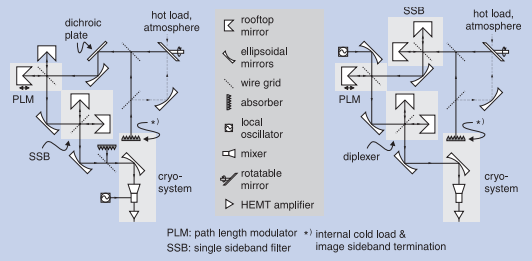


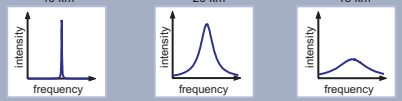

Figure 2. The quasi-optics of the two front-ends. On the left is the ozone front-end, on the right is the ClO front-end.

## ▶ Retrieval

From the shape of the detected pressure broaded emission line information on the vertical distribution of the trace gas is obtained. For the RAM profile retrieval the ***optimal estimation method*** is used.

### ▸ radiative transfer

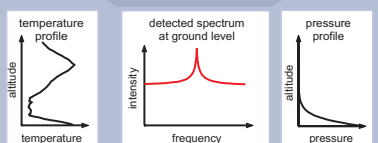
- pressure broaded emission line from every altitude
- other trace gases and tropospheric attenuation (water vapor)




theoretical lines from different altitude levels

### ▸ inversion (optimal estimation)

- measured spectrum
- temperature and pressure profile




### ▸ retrieved profile

- ozone profile

altitude range
12 km - 55 km

vertical resolution
10 km