A-1.2 A Study of Ozone in the Upper-Stratosphere with a Millimeterwave Telescope

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Abstract The Department of Physics and Astrophysics, Nagoya University, has developed a microwave ozone sensor operated at 110 GHz employing an SIS mixer receiver. The receiver noise is 34 K (SSB). The image sideband is suppressed by > 10 dB with two backshorts. The acousto-optical spectrometer covers 60 MHz with 2048 CCD channels.

Key Words Millimeterwave Ozone Sensor, Stratospheric Minor Components, SIS receiver, Acousto-Optical Spectrometer

The antenna in our instrument consists of an offset paraboloidal reflector coupling to the waveguide input of the heterodyne mixer via a conical horn. The reflector has an aperture of 10 cm. By rotation of the reflector, we can point the beam on an arbitrary elevation angle, the dummy load at ambient temperature and a cold load. The input to our receiver from the cold load is automatically adjusted to the sky temperature at the beginning of each integration in load switching mode.

The front end of the instrument is a Nb SIS mixer receiver developed at the Department of Physics and Astrophysics, Nagoya University, and Fujitsu Laboratories Ltd., Fujitsu Ltd.(Ogawa *et al.* 1990, Ogawa 1991). The receiver noise is 34 K (SSB). The response in the image sideband is suppressed below the one in the signal band more than 10 dB with two backshorts. The mixer block is kept at a temperature of 4 K by a closed cycle refrigerator. The 1st local power is supplied by a phase-locked Gunn oscillator at 55 GHz through a frequency doubler. The center frequencies of the 1st, 2nd, and 3rd IF are 1550, 375, and 65 MHz, respectively.

The acousto-optical spectrometer covers 60 MHz bandwidth with 2048 pixels of CCD. The frequency resolution of the spectrometer is 35 kHz.

Observations can be carried out both in frequency and load switching modes. In the frequency switching observations, the frequency is switched by 18 – 30 MHz in every 2 seconds. In the load switching observations, the beam is switched from the sky to the cold load or backwards in every 15 seconds.

The telescope was pointed towards the north at an elevation angle of 45° until February 1993, and 25° after March 1993 in order to get the best S/N ratio. The output of the spectrometer is converted to the brightness temperature at the top of the troposphere by correcting for tropospheric absorption by a chopper wheel method described in Kawabata *et al.* (1992). The integration time was 2.5 – 10 minutes.

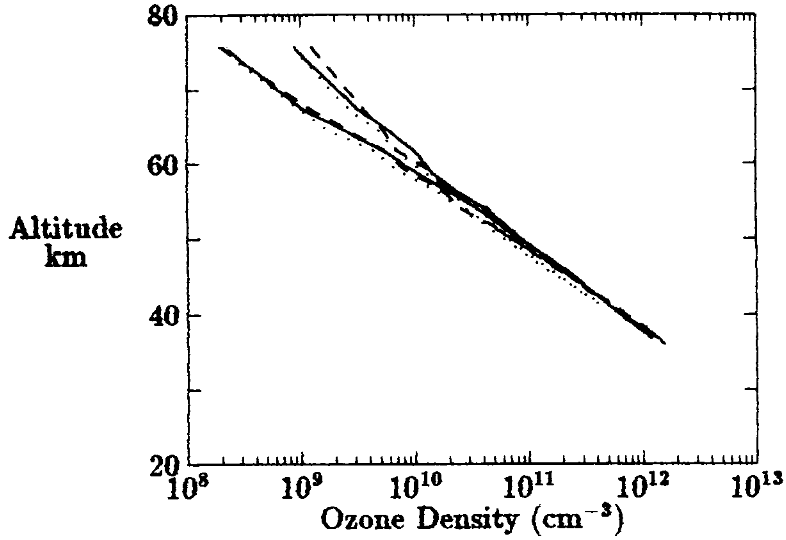

Figure 1: Ozone number density retrieved from millimeterwave spectrum. Solid lines: 9 December, dashed lines: 26 March, dotted line: 11 March.

In order to get the mixing ratio, we are adopting the differential brightness method, basically the same as the one described in Kawabata *et al.* (1992). In calculations of weighting functions in the differential brightness method, we have assumed the pressure and temperature obtained by the Lagrangian interpolation of NASA88 model for the latitude of the observing site.

Examples of retrieved altitude profile of O_3 number densities at noon and midnight are illustrated in Figure 1. The year of the all of these observations is 1993. Observations on 9 December and 11 March are carried out by the frequency switching mode with frequency shift of 30 and 18 MHz, respectively. Observations on 26 March are carried out by the load switching mode. Figure 2 illustrates recorded spectrum superimposed on the spectrum calculated from the retrieved profile and residuals.

Figure 3 illustrates diurnal variations of mixing ratio by our instruments. Vertical dotted lines represent the sunrise and the sunset at the sea level.

Summarizing observations obtained by our instrument, we may conclude as follows (Ogawa *et al.* 1994).

1. Diurnal variations of the mixing ratio at various altitudes from 36 through 75 km appear in agreement with theoretical calculations and observations by many authors except night-time variations near the top of the mesosphere.

2. The ozone mixing ratio above 70 km shows night-time variation variable from day to day with an amplitude of about 20 % of the midnight value.

3. Time variations of the mixing ratio just before the sunrise and after the sunset are obtained from observations with an integration time of 3 minutes.

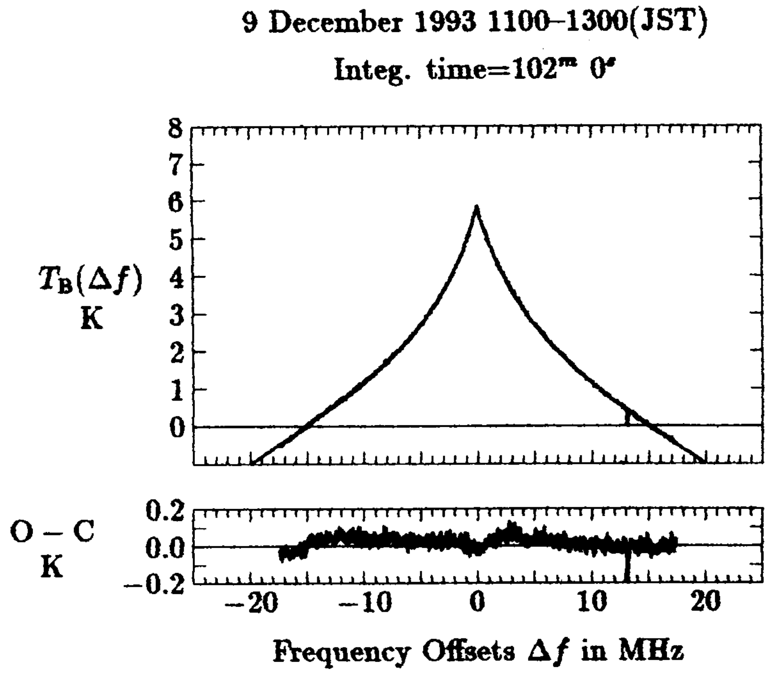

Figure 2: O_3 spectrum recorded superimposed with calculated from the retrieved profile(upper) and residuals(lower).

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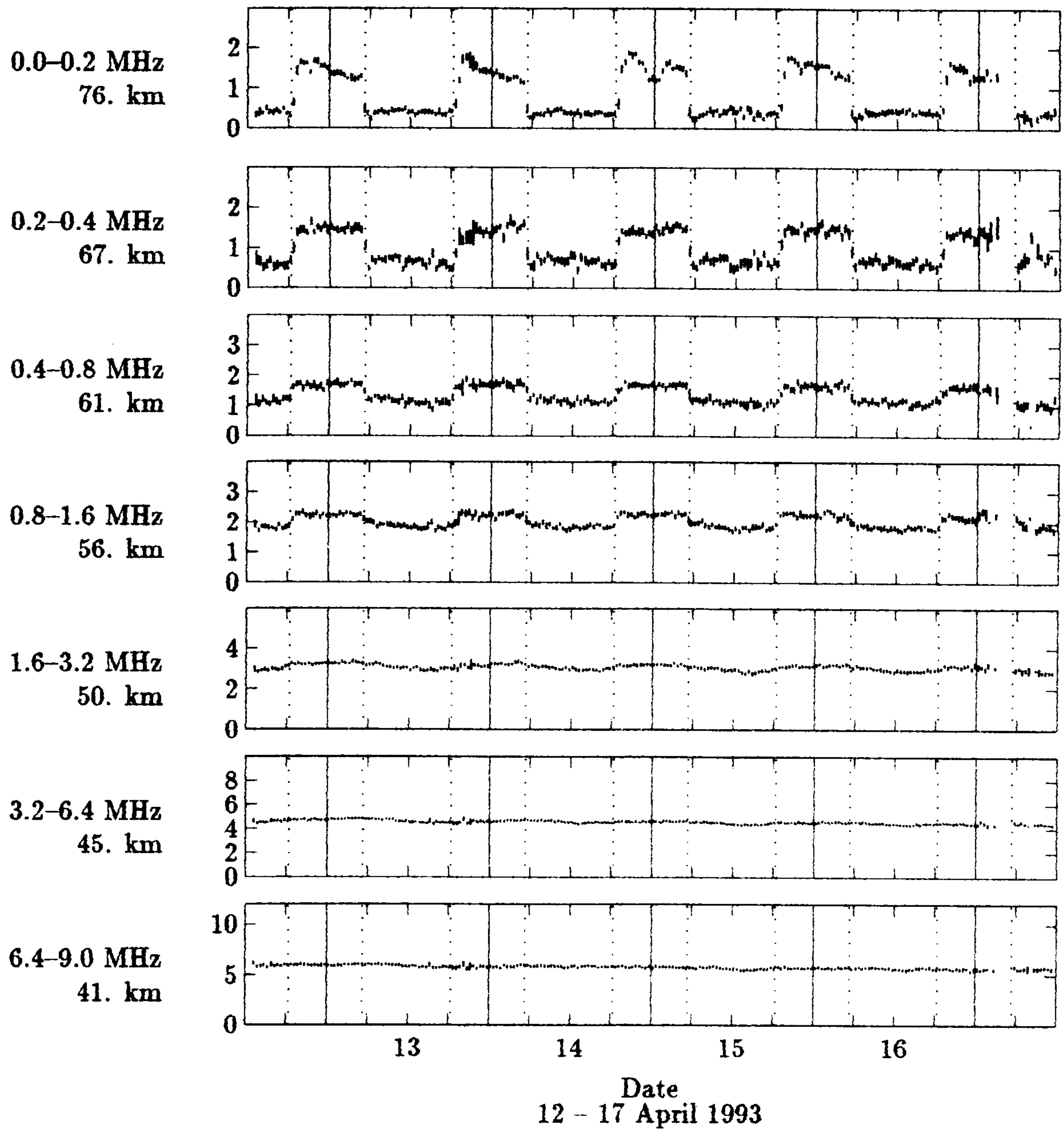

Figure 3: Diurnal variations of O_3 mixing ratio (ppm)