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The Measurement of Ozone in the Atmosphere Over Maitri in Antarctica by Laser Heterodyne Spectrometer

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Abstract

The measurements of ultra high resolution absorption line spectra of ozone at V3 band near 9.5 (μm has been obtained by laser heterodyne spectrometer using carbon di-oxide laser as a local oscillator in Maitri (70° 46' S, 11 ° 45' E) Antarctica. The observations were made from 15 Jan. to 20 Feb. 95 on clear available sunny days. The vertical concentration profile of ozone has been retrieved through inversion of the measured absorption line profile. In the present communication results obtained are discussed.

1. Introduction

In the recent years the global ozone depletion and ozone hole phenomenon over Antarctica has intensified ozone research around the world. Ozone, a minor constituents of the atmosphere is important because it protects life on the earth from harmful part of solar ultra-violet radiation and also significant for controlling stratospheric temperature. Total ozone in the atmosphere has been measured globally with the help of Dobson- spectrometers by monitoring the absorption of solar ultra-violet radiation at selected wavelengths in 280-340 nm wavelength range. Ozone measurements has also been carried out by ozone-sonds placed on rockets andballoons. On global basis ozone has been monitored by satellite using total ozone mapping spectrometers (TOMS) also.

In the infrared region of the spectrum where the fundamental vibrational-rotational absorptions bands of most of the atmospheric molecules are located and a study of window region (8-14 μm) with high resolution instruments give a quantitative information and their concentrations at various altitudes. The laser heterodyne spectrometer due to its high spectral resolution can resolve the individual spectral lines formed in the upper stratosphere thus has unique ability to accurately measure the altitude profile of the constituents from remote location. Unlike the Dobson measurements(the infrared heterodyne spectrometer is unaffected by tropospheric aerosols. The interference due to overlapping absorptions lines are minimized as a result of its high resolution.

The posibility of remote measurement of atmospheric ozone by laser heterodyne technique was first suggested by Menzies (1). Frerking and Muehlner (2) studied the solar absorption spectra of atmospheric ozone with a tunable diode laser heterodyne spectrometer. Abbas *et al.*(3) obtained a vertical profile of atmospheric ozone with a CO_2 laser heterodyne spectrometer. The atmospheric N_2O spectrum near 1180 cm^{-1} was observed by Glenar *et al.* (4) using tunable diode laser. Jain and Arya (5,6) obtained vertical profile of O_3, H_2O and NO_2 using a CO_2 laser heterodyne system.

In view of the above the laser heterodyne spectrometer was setup at Maitri, Antarctica during 14th Antarctic expedition to monitor ozone. The absorption line spectra of ozone with high resolution were taken during clear available sunny days from 15 Jan. to 20 Feb.1995.

2. Experimental Technique

The laser heterodyne is a passive technique in which CO_2 laser line P(24) in the region 1043.163 cm^{-1} were tunned near the absorption line of ozone in V3 band. The solar radiation is sent in the fixed direction in the laboratory by Polar Heliostat stationed outside the Laser Heterodyne hut at Maitri, Antarctica. The incoming solar radiation is chopped and filter out. The CO_2 laser line and solar radiation are combined via zinc-selenide beamsplitter and co-aligned with the help of a He-Ne laser. The two radiations are focussed by lens on the liquid nitrogen cooled high speed Mercury Cadmium Telluride Photovoltaic Detector of band width (1000MHz), which acts as a mixer as well as a narrow band filter. The detected signal is difference frequency (IF). The IF signal thus obtained is amplified in a wide band RF amplifier (5 - 1200 MHz) and passed through various RF filter channels at line center and the wing of the line to resolve the line completely. The signal at various channels is synchronously detected. The block diagram of the system is shown in Fig. 1. The system's details are given elsewhere (5).

3. Results and Discussion

The pressure broadened absorption line width varies with altitude which in turn used to get high profile of ozone. The absorption at the line centre is strongly influenced by the upper altitude molecules while absorption at the wing of the line will be influenced by the lower altitude molecules. The measurement of the total absorption at several frequencies spread over 30-1000 MHz were

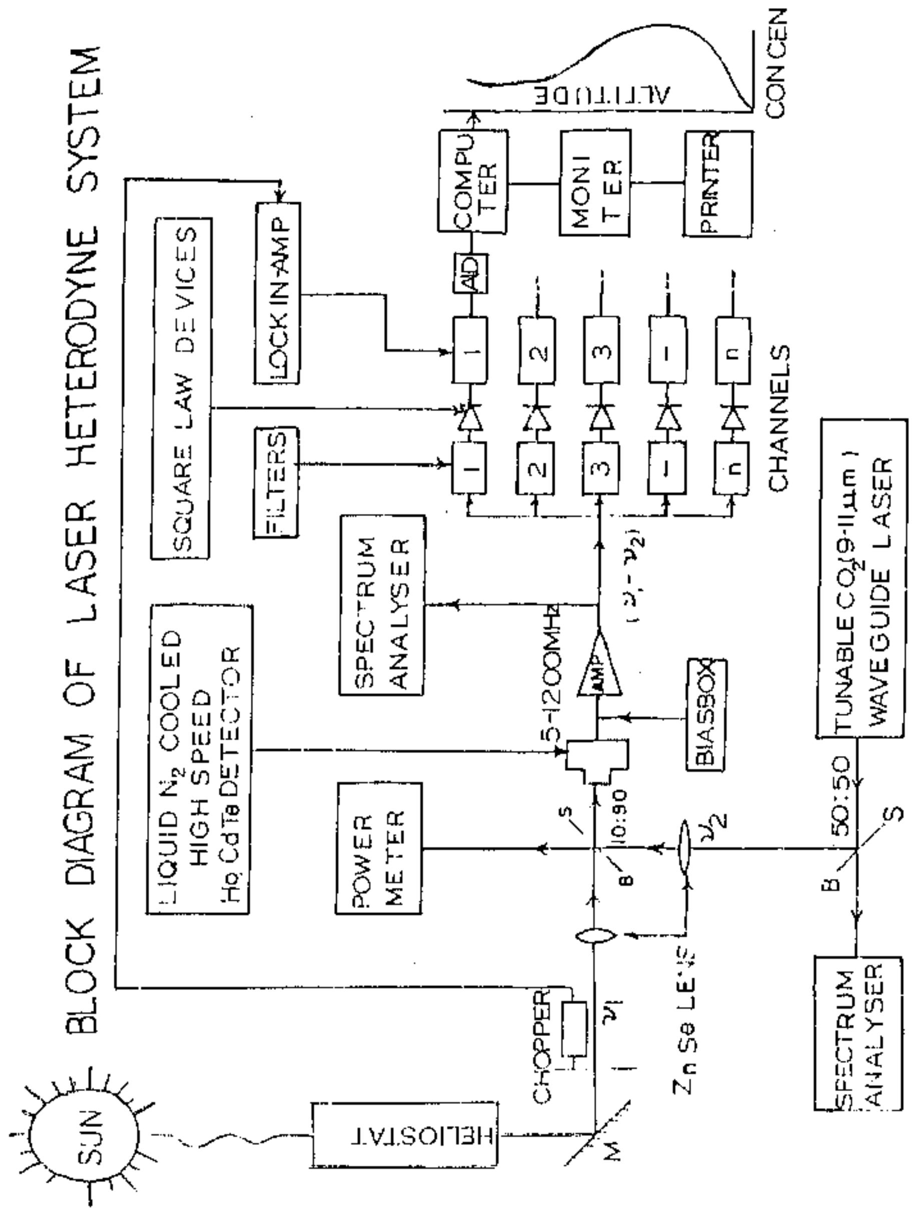

Fig.1: Block diagram of the experiment

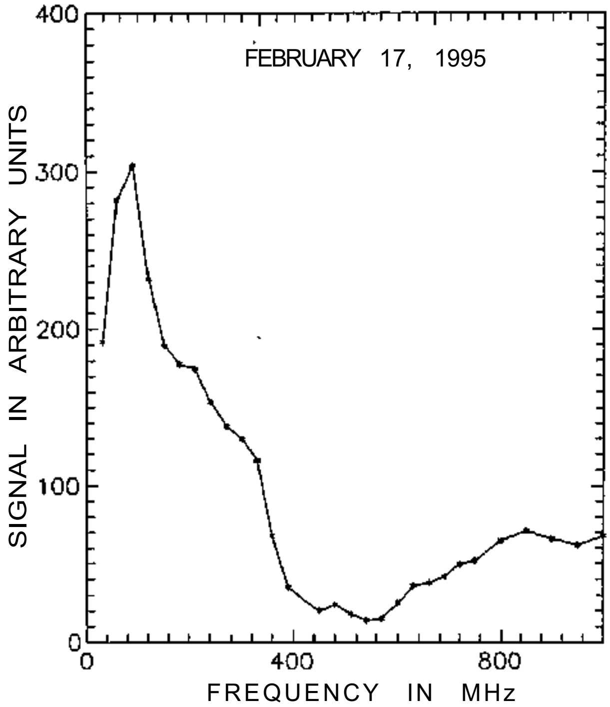

Fig.2: Observed ozone absorption spectra near P(24) CO_2 laser line

taken which will provide information about the concentration at various heights. The absorption line profile has been obtained with ultra high resolution by a laser heterodyne spectrometer at Maitri, Antarctica in the month of 15 Jan. to Feb.95 on clear sunny days. An example of observed ozone absorption line spectra near P (24)CO_2 laser line is shown in Fig.2. Absorption line profiles has been inverted by the inversion programme developed by Jain (7,8) to get vertical profile of ozone. A typical mixing ratio profile of ozone retrieved from the observed spectra is shown in Fig.3.

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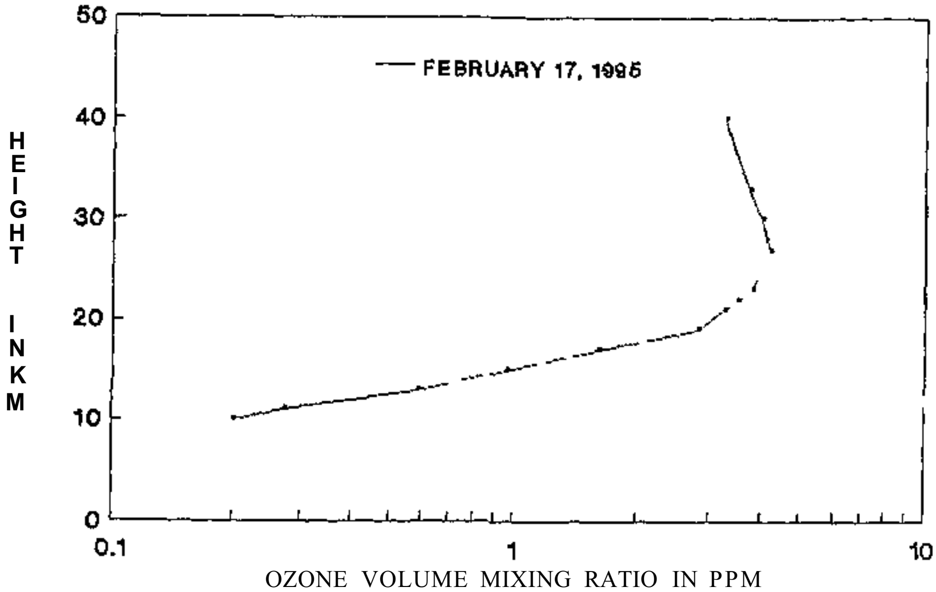

Fig 3 Mixing ratio profile of ozone retrieved from observed spectra

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