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Measurements of Water Vapour over Delhi during the Solar Eclipse - 1995

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Abstract

Ground-based IR spectroradiometer has been used for the measurements of water vapour over Delhi (28.7N, 77.2E, 220MSL) during October 24, 1995 solar eclipse. Water vapour variation has been measured during solar eclipse and its value found to be less during the maximum phase. This variation of water vapour has been compared with the baseline values observed over Delhi, where maximum obscuration of the sun was about 95.7 percent.

Key Words : Solar eclipse, Watervapour

Introduction

Atmospheric disturbances during solar eclipses are well known. The possibility of changes in stratospheric and mesospheric ozone during solar eclipse have been studied by several workers (Burnett and Burnett, 1985; Chimonas, 1973; Wuebbles *et al.*, 1979). In addition to ozone observations, measurements of other minor constituents could provide a better understanding for the eclipse effects. Consequently, experiments for upcoming solar eclipses, when properly supported by theoretical analysis, could contribute significantly to present understanding of atmospheric chemical and physical phenomena. In fact proper data on trace species concentration during an eclipse could provide a direct demonstration of the coupling between various chemical cycles. Water vapour absorbs and emits the infrared radiation and makes a substantial contribution to the energy budget as well as in the chemistry of the atmosphere. In view of this, we have proposed to study the changes in the chemical and physical properties of water vapour during solar eclipse. While detailed measurements of diurnal variations could provide similar knowledge, the difference in time scale between the diurnal cycle and a solar eclipse event suggests that the latter event may provide a clearer picture. Thus observations were carried out to measure atmospheric water vapour.

Experimental setup

The infrared spectroradiometer is basically a double monochromator. A heliostat has been used for tracking the sun. The solar radiation is focused on the entrance slit by a Newtonian telescope. The in-built chopper with frequency 163.4 Hz at the entrance slit converts continuous light signal to square wave. The incident radiation is dispersed by the gratings blazed at 1600 nm and passed through the filter to detector fixed at the exit slit. The electrical signal generated by the detector is amplified by the auto ranging lock-in-amplifier. It has preset preamplifier and phase angle settings for four different detectors with sensitivity 10^{-14} amperes for photovoltaic and 10^{-7} volts for photoconductive detectors. The output of the lock-in amplifier is fed to the computer for data processing and analysis. A block diagram of the systems is shown in Fig. 1. A wide range thermal detector with a KRS 5 window and sensitive in the spectral range 700 nm to 20000 nm has been used for the present study.

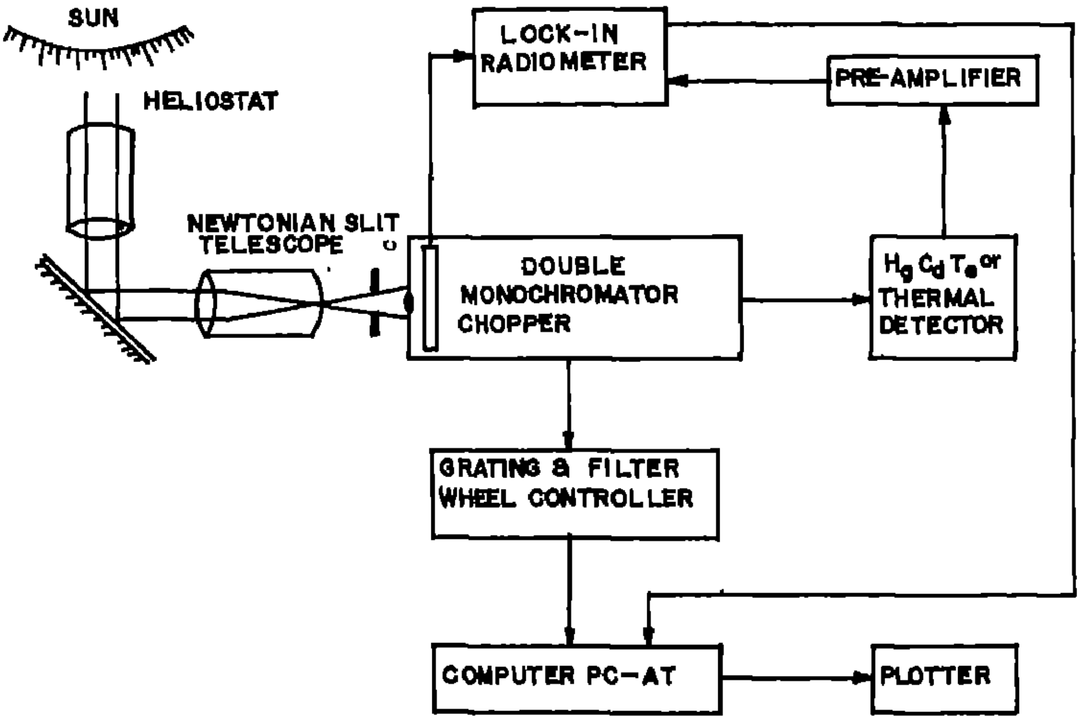

Figure 1 : Block diagram of the infrared spectro-radiometer.

Before measurements, the system was calibrated using halogen-tungsten lamp upto 2.5 micron and black body source above 2.5 micron. A typical system response curve with thermal detector obtained from 1000 to 14000 nm is shown in Fig. 2. The output of the system has been recorded in Watt cm^{-2} nm^{-1}. amp^{-1}.

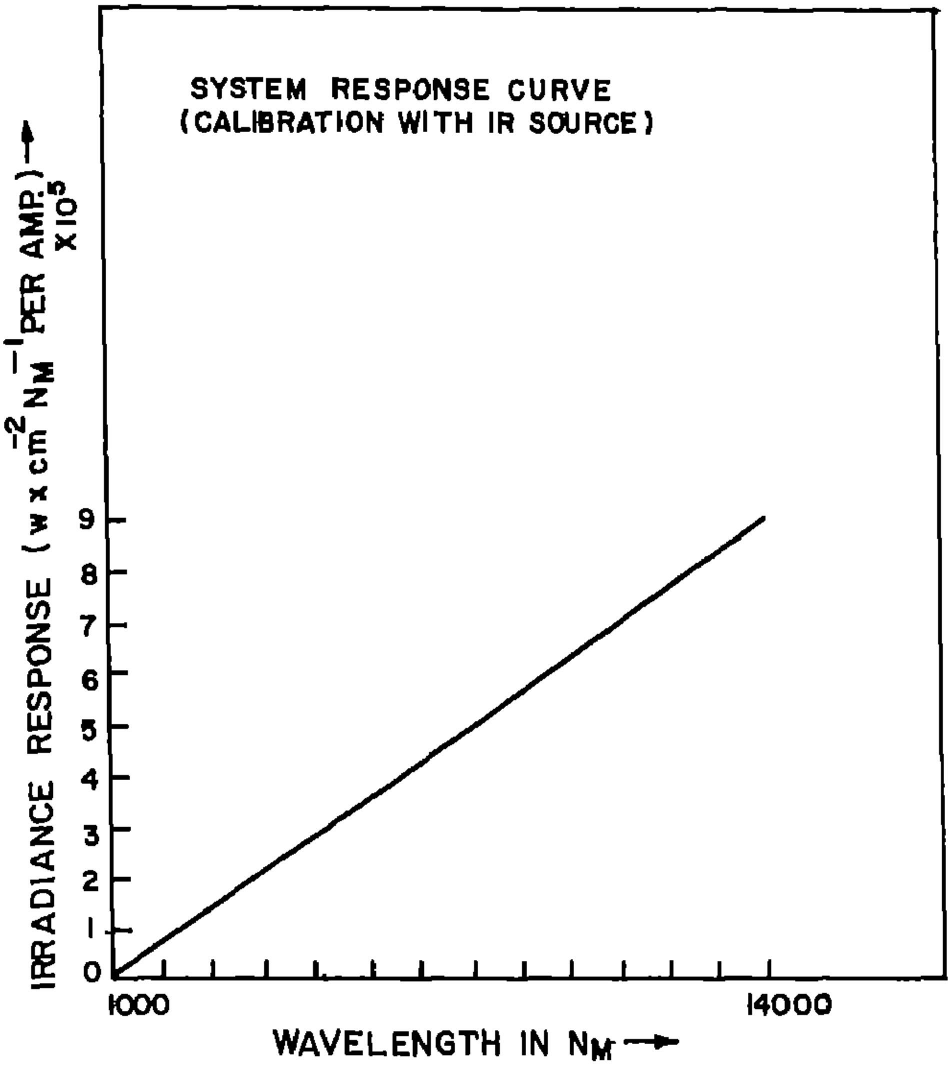

Figure 2 : System response curve between 1000 and 14000 nm.

Results and Discussions

Water vapour column abundances are measured by high resolution spectroscopic absorption of sunlight in the 1155 to 1165 nm wavelength region (Ghosh *et al.*, 1993). The measurements during the partial solar eclipse at Delhi on 24 October 1995 were made under good atmospheric conditions. The maximum obscuration of the Sun on solar eclipse day was 95.7%. The baseline comparison data for October 22, 25 and 26 were also carried under good atmospheric conditions.

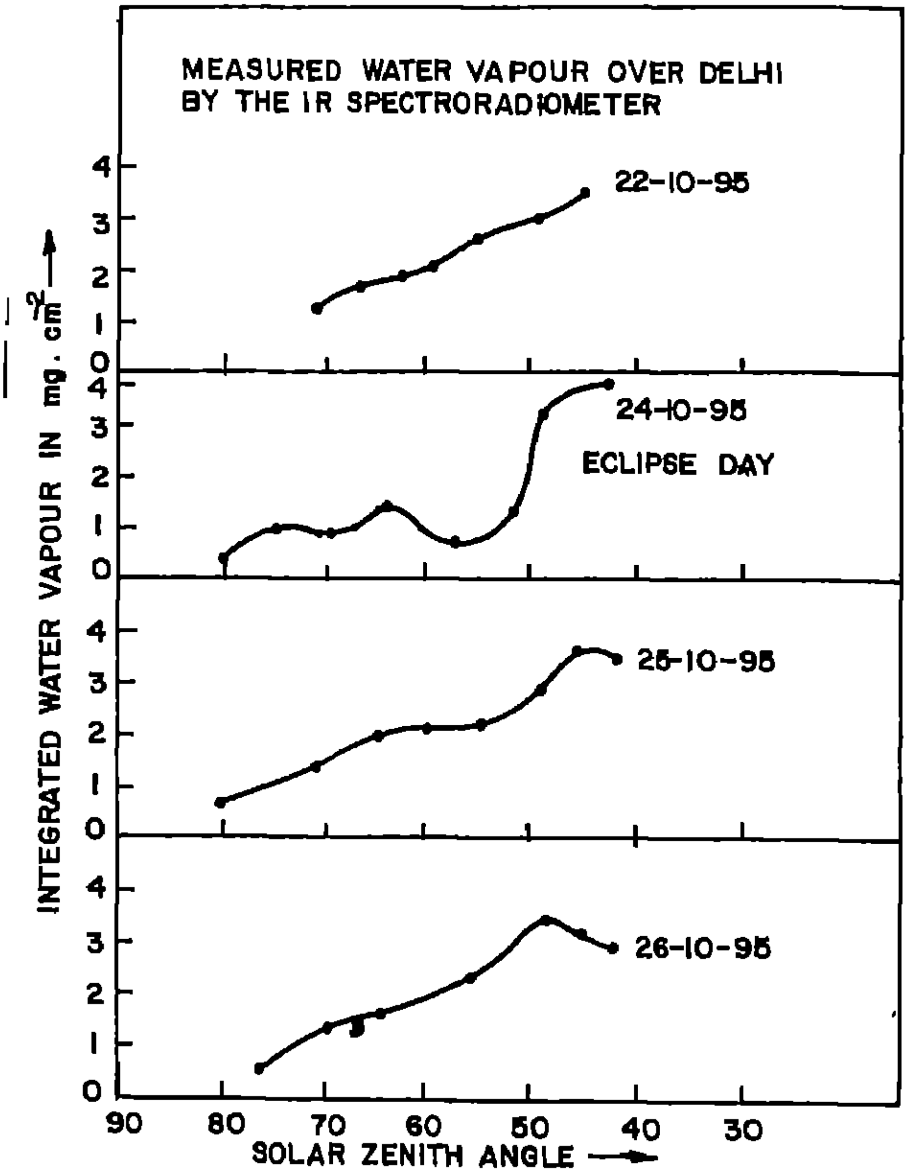

Figure 3 : Variation of integrated water vapour in the morning hours for different solar zenith angles.

The derived water vapour column abundances for the morning hours during October 22-26 with respect to solar zenith angles are shown in Fig. 3. Several observations of 5 minutes each are included in the baseline data, only morning hours data were obtained on each day. The eclipse measurements of October 24, 1995 are also shown along with the baseline values of October 22-26, 1995, data in Fig. 3. No significant instrumental adjustments were made during these observations. It is clear from Fig. 3 that on solar eclipse day the water vapour content decreases as the percentage of solar obscuration increases and vice versa. In other words, on solar eclipse day sunrise time atmospheric conditions extended upto about 50° solar zenith angles. The decrease in water vapour may be due to its conversion into liquid water through condensation. This condensation may be due to significant decrease in air temperature during eclipse (Appu *et al.*, 1996). The baseline observations show that water vapour content increases monotonically with time. The overall error calculated for the derivation of water vapour column density comes out to be about 23% in the present study.

Conclusion

The measured water vapour density variation over Delhi shows that it increases monotonically with decrease in solar zenith angles. On the solar eclipse day especially during the maximum phase water vapour content was found to be significantly decreased.

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