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Ground-Level Humidity, Pressure and Temperature Measurements during the the October 24, 1995 Total Solar Eclipse

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Abstract

Measurements of the relative humidity, air pressure, and air temperature were obtained at Nim Ka Thana, India on October 24, 1995 during the total eclipse of the Sun. Data were also obtained 24 hours previous to the eclipse. The relative humidity increased to 76% near mid-eclipse, which is 32% higher than the previous morning. Near mid-eclipse the temperature fell by 21.5° F relative to 24 hours previous. The atmospheric pressure peaked at + 555 μ relative to the pre-eclipse mean very near mid-eclipse.

Key Words : Air temperature and pressure, Total solar eclipse.

Introduction

The passage of the Moon's shadow through the Earth's atmosphere during a total eclipse of the Sun produces effects near ground level noticeable even to casual observers. Extensive quantitative meteorological measurements were obtained during a total solar eclipse for the first time near the turn of the century (e.g. Bigelow 1924). The perturbation of the atmosphere during a solar eclipse is a useful test of atmospheric models. The perturbation is well-understood; it can be calculated accurately from the well-known geometries of the Earth-Moon-Sun system and the limb-darkening on the Sun.

Observations of the relative humidity, air pressure, and air temperature obtained during the October 24, 1995 total eclipse of the Sun will be reported below. The details of the instrument, data gathering methods, and calibrations will be discussed in the observations section. The results will be discussed and compared to previous measurements in the discussion section.

Observations

The author joined the eclipse expedition from the Indian Institute of Astrophysics at Nim Ka Thana, Rajasthan. The instruments were set up within the roped off area, which had been prepared for the observers. The relative humidity, air pressure, and air temperature were monitored with solid state electronic sensors connected to a laptop computer via an analog-to-digital, A/D, converter board (manufactured by Fascinating Electronics of Reaverton, Oregon, USA). The relative humidity sensors is a capacitive type; the temperature sensor is built around an LM334Z current source device; the pressure sensor is based on the SCC15A, which uses a resistive bridge. The humidity and temperature sensors (part of the same unit) were placed underneath an open black umbrella about 5 feet above the ground. The pressure sensor was located inside the metal enclosure containing the A/D converter board; it was covered with a dark cloth in order to keep light from entering, since the pressure sensor is slightly sensitive to light. The data were collected at the rate of about 2.2 samples per second (a sample consists of readings proportional to relative humidity, air pressure, and air temperature).

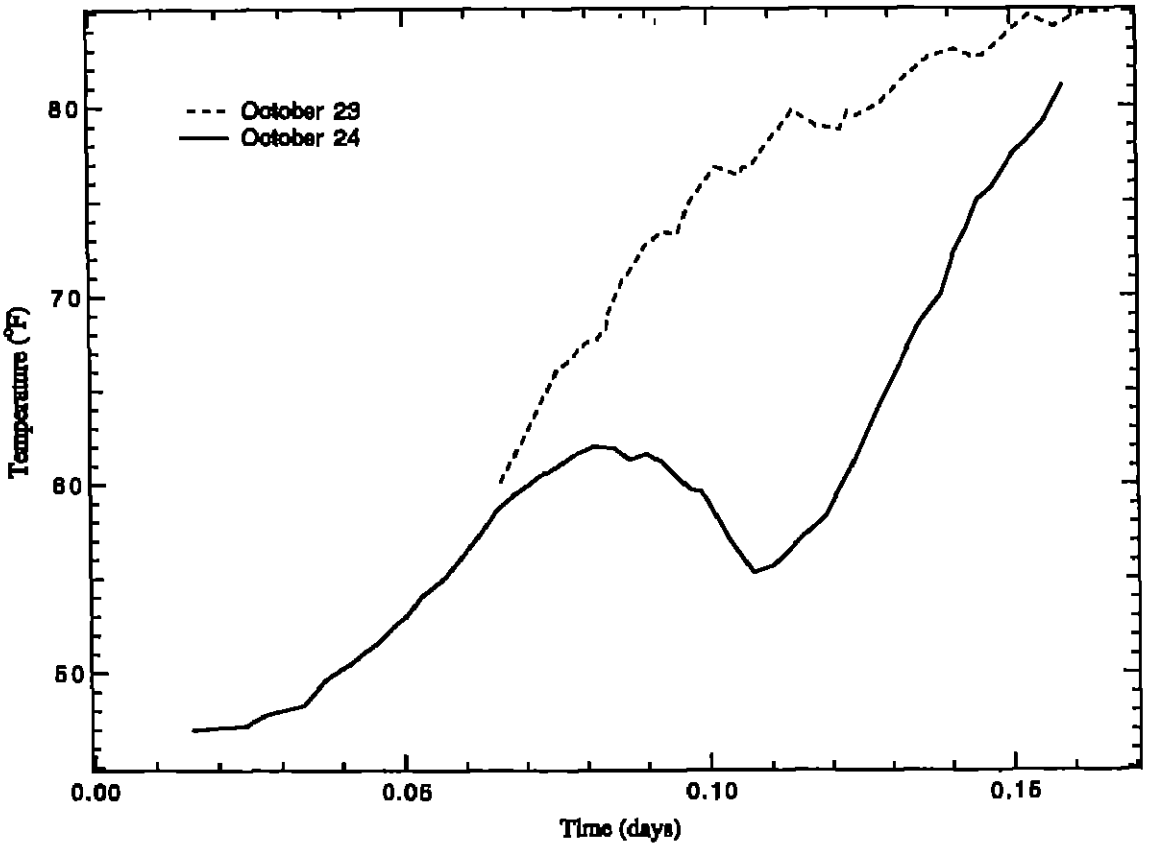

Figure 1 : Air temperature during the eclipse of October 24, 1995 and 24 hours previous. Time 0.00 corresponds to 00h30m UT. This plot is a smoothed representation of the complete dataset.

Data were obtained on October 23, 1995 starting at 02h05m UT and again on October 24, 1995 starting at 00h53m UT. First contact occurred at about 01h56m on October 24, 1995. The weather conditions on both mornings were nearly perfect, and more importantly, nearly identical. Clouds were absent and winds were not detectable at least until about 03h00m UT; beyond this time there was a slight breeze.

The data were calibrated in Austin, Texas, USA using the hourly broadcast local humidity, pressure, and temperature. The temperature sensor calibration was supplemented with measurements of ice water. A temperature term was also included in the calibration equation for the pressure, since the pressure sensor is also slightly temperature sensitive. The precision of each humidity, pressure, and temperature measurement is about ± 0.2% ± 0.0001 in-Hg, and ± 0.03° F, respectively; the corresponding accuracies are ± 3%, ± 0.1 in Hg, and ± 2° F.

Discussion

We present the meteorological data in Figures 1-3. Comparison of the data obtained on October 23 and 24 near 02h00m UT (just after first contact) shows that the pressure and temperature were nearly identical on each morning, but the relative humidity was slightly lower on the morning of the eclipse. The general trends of the humidity and temperature readings during the eclipse are as expected and are consistent with previous reports.

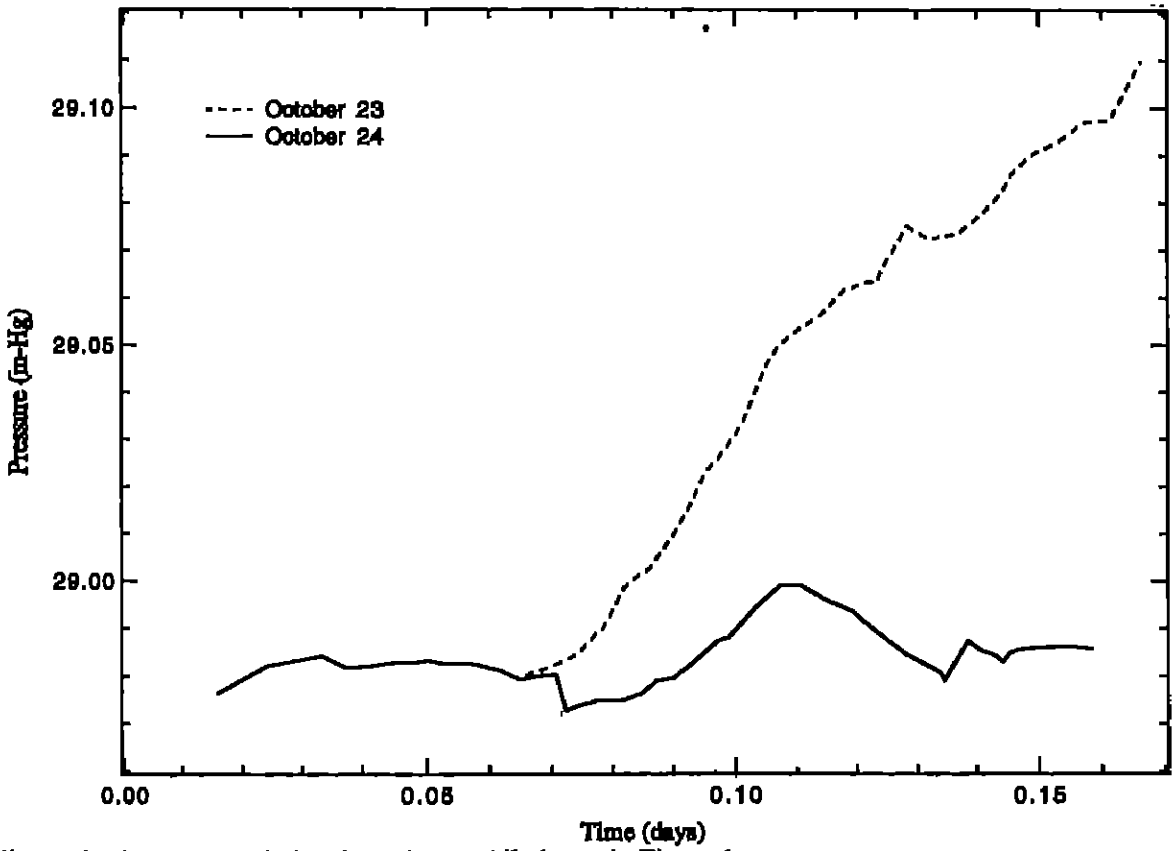

Figure 2 : Air pressure during the eclipse. All else as in Figure 1.

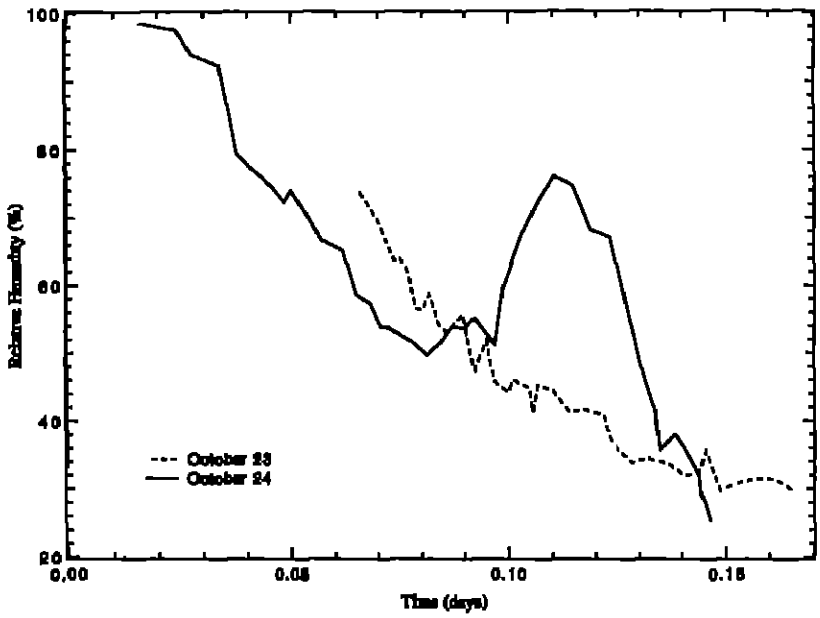

Figure 3 : Relative humidity during the eclipse. All else as in Figure 1.

The air pressure readings are similar to that recorded by Anderson *et al.* (1972) during the March 7, 1970 eclipse. Like their recording, ours shows a central symmetric peak flanked on both sides by depressions in the pressure relative to the pre-eclipse mean. Our measurements indicate that the pressure peaked at +0.0164 in-Hg (+555μ bar) relative to the pre-eclipse mean about 4 minutes after mid-eclipse; Anderson *et al.* (1972) found that the pressure peaked at +450μ bar relative to the pre-eclipse mean also very near mid-eclipse. Chimonas (1973) interpret Anderson et al.'s results as being due to Lamb waves generated by cloud cooling during the eclipse. This explanation seems problematical considering the close similarity between our data and that of Anderson *et al.* and considering the very different large scale tropospheric conditions present during the two eclipses.

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References

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