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THE NIGHT AIRGLOW $O_2(^1\Sigma)$ ATMOSPHERIC BAND AT 8645A^o AND THE ROTATIONAL TEMPERATURE OBSERVED AT 23^{o}S

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14. Abstract/Notes

Ground based measurements of the $O_2(^1\Sigma)(0,1)$ Atmospheric band at 8645A^o and the rotational temperature, together with OI5577A^o, NaD and OH(9,4) band emissions have been carried out at Cachoeira Paulista (22.7^{o}S, 45.0^{o}W), Brazil. Multichannel tilting filter type photometers have been used. The O_2 band intensities occasionally vary from 200 Rayleighs to 1000 Rayleighs during a night. Covariations with OI5577A^o emissions were observed. The rotational temperature determined from the P branch of the $O_2(^1\Sigma)$ vary between 180^{o}K and 230^{o}K. The amplitude of the nocturnal temperature variations is frequently larger than that derived from the OH emission, and the phase of the variation normally leads that of the OH. It was observed on some nights that the temperature variations of both the emissions were out of phase, suggesting a vertical phase propagation of the atmospheric wavelike perturbations.

15. Remarks

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THE NIGHT AIRGLOW $O_2(^1\Sigma)$ ATMOSPHERIC BAND AT 8645Å AND THE ROTATIONAL TEMPERATURE OBSERVED AT 23°S

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Abstract

Ground based measurements of the $O_2(^1\Sigma)(0,1)$ Atmospheric band at 8645Å and the rotational temperature, together with OI5577Å, NaD and OH(9,4) band emissions have been carried out at Cachoeira Paulista (22.7°S, 45.0°W), Brazil. Multichannel tilting filter type photometers have been used. The O_2 band intensities occasionally vary from 200 Rayleighs to 1000 Rayleighs during a night. Covariations with OI5577Å emissions were observed. The rotational temperature determined from the P branch of the $O_2(^1\Sigma)$ vary between 180°K and 230°K. The amplitude of the nocturnal temperature variation is frequently larger than that derived from the OH emission, and the phase of the variation normally leads that of the OH. It was observed on some nights that the temperature variations of both the emissions were out of phase, suggesting a vertical phase propagation of the atmospheric wavelike perturbations.

Introduction

The night airglow $O_2(^1\Sigma_g^+, v=0 - {}^3\Sigma_g^-, v=1)$ Atmospheric band emission at 8645Å, hereafter O_2A, and the rotational temperature, $T(O_2)$, have been observed by several workers since Meinel (1950) observed this emission using a spectrograph and obtained the rotational temperature. The mean band intensity and rotational temperature observed by Berg and Shefov (1962) are 500 Rayleighs and 190 ±20°K, respectively. The nocturnal intensity variations were studied by Misawa and Takeuchi (1977, 1982) using a tilting filter type photometer. Noxon (1978), using a fast scanning grating spectrophotometer, observed the rotational temperatures of the O_2A and OH(6,2) emissions and studied the nocturnal temperature variations. He found that $T(O_2)$ is normally higher than the temperature of OH(6,2), the amplitude of variation is larger and the variation frequently leads that of OH(6,2).

In this paper, we present O_2A band intensity and the rotational temperature measurements obtained using a multichannel tilting filter type photometer from a low-latitude station in the southern hemisphere. The OH(9,4) band and the rotational temperature, T(OH), were also measured simultaneously to study correlation. In Table 1, the photometer characteristics are presented. The calculated O_2A band spectrum is shown in Figure 1 for rotational temperatures of 180°K and 230°K. The P branch was used to determine the band intensity and the rotational temperature. Two samples of the observed spectra are shown in Figure 2, together with the OH(9,4) spectrum. The first peak in the OH(9,4) spectrum is due to the F-region OI7774Å emission.

Observations and results

The observations of the O_2A and OH(9,4) band emissions have been carried out at Cachoeira Paulista (22.7°S, 45.0°W). The OI5577Å emission intensities (E-region component) used in the present analysis were obtained by another multichannel photometer operating at the same location. In the present study, only the data obtained between the period March to August 1983, a total of 27 nights, were used. Salient features observed are summarized below:

1) The observed mean O_2A band intensity is about 450 Rayleights, in agreement with Berg and Shefov (1962).

2) The observed minimum and maximum intensities are around 200R and 1000R, respectively.
3) The O_2A emission nocturnal variations correlate with the OI5577 emission, and occasional phase shift variations with respect to OI5577 and OH(9,4) are observed.
4) The observed mean rotational temperature of the O_2A emission is 208 ±8°K, which is about 15°K higher than the mean rotational temperature of the OH(9,4) emission.
5) $T(O_2)$, on some nights,co-varies with T(OH), but in some cases varies out of phase.
6) The variations of $T(O_2)$ are normally larger than those of T(OH).

In Figures 3, 4 and 5, nocturnal variations of the O_2A, OH(9,4) and OI5577 emission intensities and the rotational temperatures $T(O_2)$ and T(OH) are presented. Figure 3, May 4-5, 1983, shows a large temperature variation, $\Delta T(O_2) \sim 70°K$, but T(OH) shows a variation only of about 20°K. Figure 4, May 15-16, 1983, shows a good correlation between intensities of the O_2A and OI5577 emissions. Also the rotational temperatures, $T(O_2)$ and T(OH), are correlated. Phase lagged intensity variations between the OI5577, O_2A and OH(9,4) emissions are shown in Figure 5, June 13-14, 1983. The rotational temperatures $T(O_2)$ and T(OH) show some wavelike variation in the opposite phase. These short period (~4 hours) temperature variations are possibly due to some atmospheric disturbance in the emission layers.

Conclusion

The O_2(0,1) Atmospheric band intensities observed at 23°S occasionally vary from 200 Rayleighs to 1000 Rayleighs. The mean band intensity is about 450 Rayleighs. Covariations with the OI5577Å emissions were observed. The rotational temperatures determined from the P branch vary between 180°K and 230°K.

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TABLE 1

The Airglow Photometer Characteristics	
Aperture	5cm diameter
Field of view	2° full angle
Wavelength scanning	tilting filter technique
Photomultiplier	GaAs photocathode
<O_2A band>	
Interference filter bandwidth	$\Delta\lambda$ = 11.9Å at 8680Å
Sensitivity	11.8 pulses/Rayleigh
<OH(9,4) band and OI7774>	
Interference filter bandwidth	$\Delta\lambda$ = 11.1Å at 7750Å
Sensitivity	16.5 pulses/Rayleigh

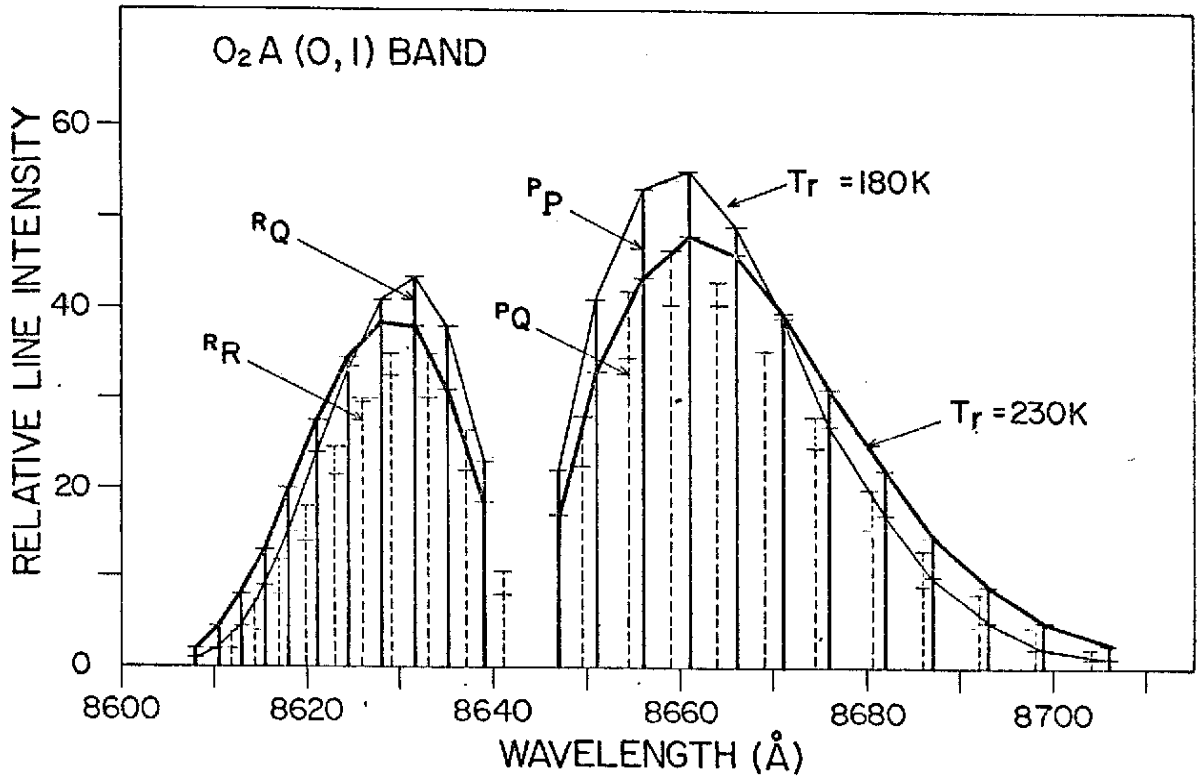

Fig. 1. Calculated O_2 (0,1) Atmospheric band spectrum at 8645Å with the rotational temperatures of 180°K and 230°K. The envelope curves are only for ^{P}P and ^{R}Q branches.

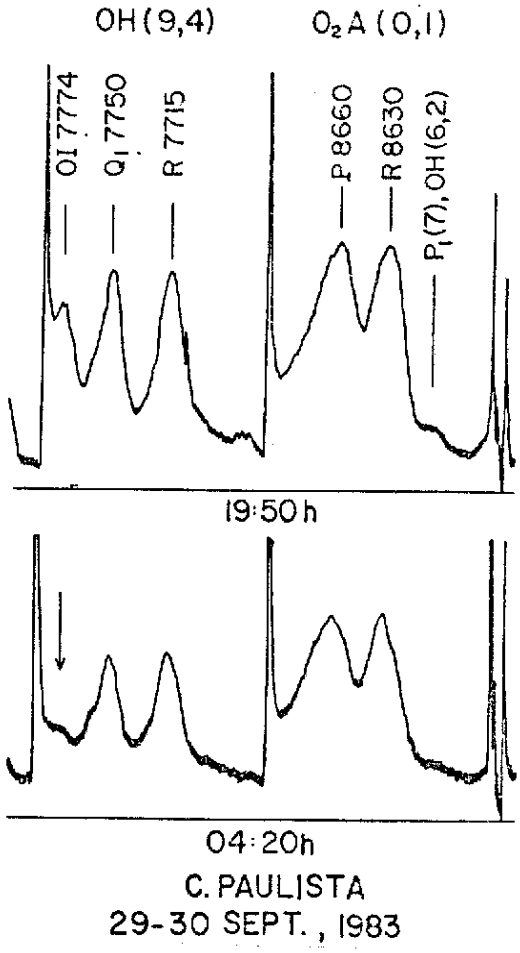

Fig. 2. Observed spectra of the O_2A and OH(9,4) bands. The peak of OI7774Å in the OH(9,4) spectrum can been seen in the top of the figure (19:50 LT), and it disappeared in the early morning (bottom)

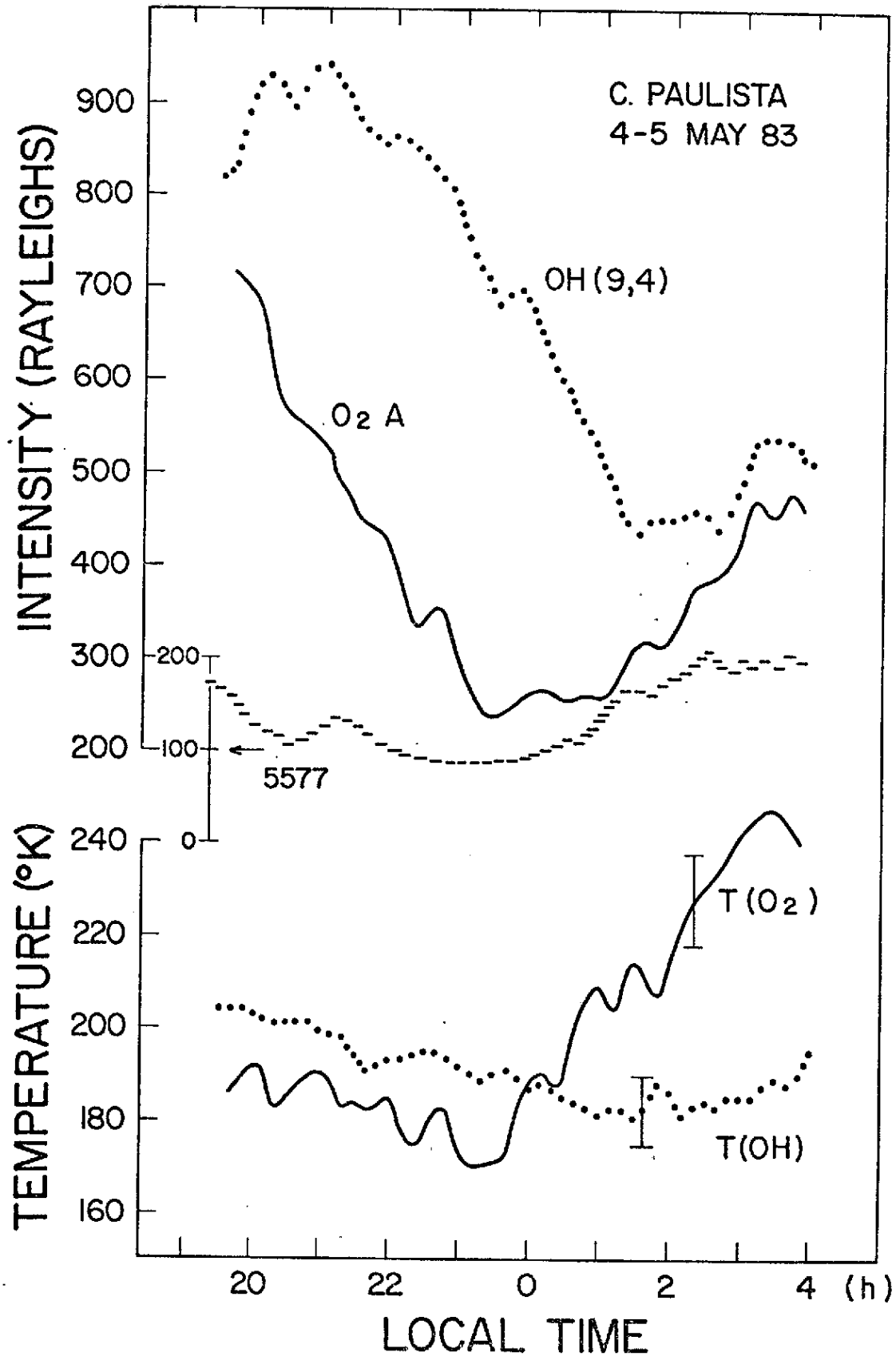

Fig. 3. Nocturnal variations of the O_2A, OI5577 and OH(9,4) intensities and the rotational temperatures, $T(O_2)$ and T(OH), observed at Cachoeira Paulista (22.7°S, 45.0°W) on May 4-5, 1983.

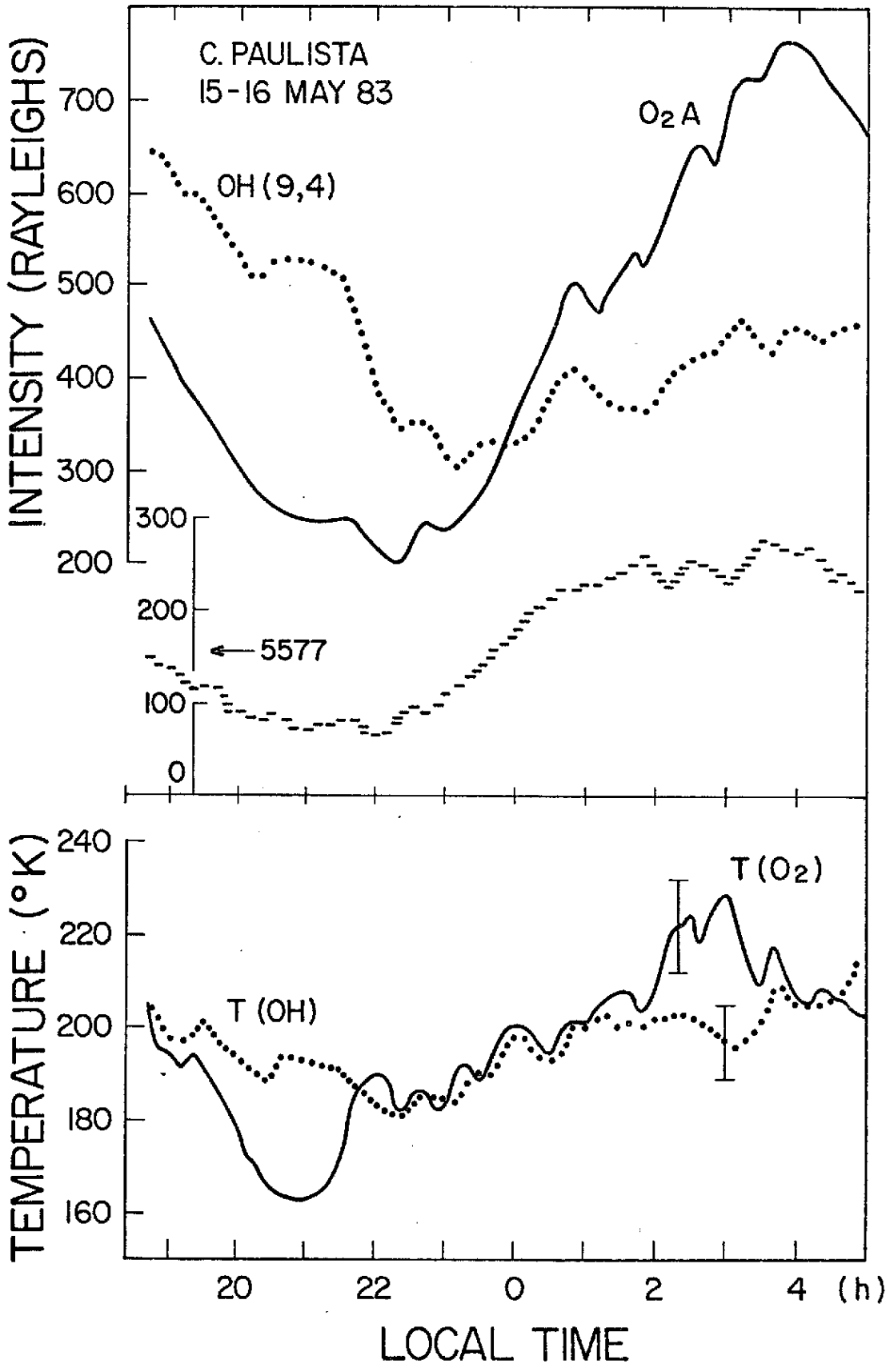

Fig. 4. Nocturnal variations of the O_2A, OI5577 and OH(9,4) intensities and the rotational temperatures $T(O_2)$ and T(OH) observed at Cachoeira Paulista (22.7°S, 45.0°W) on May 15-16, 1983.

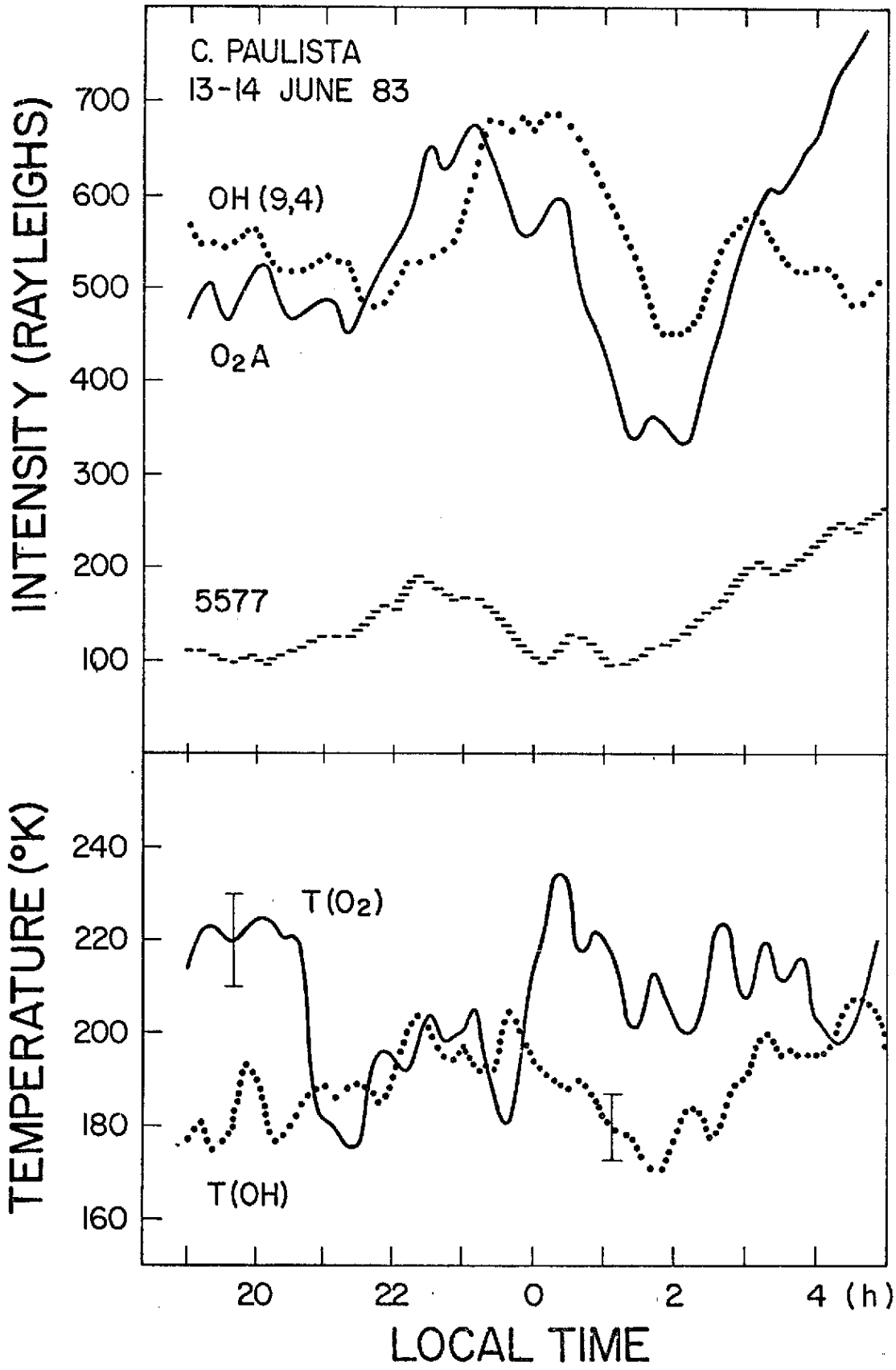

Fig. 5. Nocturnal variations of the O_2A, OI5577 and OH(9,4) intensities and the rotational temperatures $T(O_2)$ and T(OH) observed at Cachoeira Paulista (22.7°S, 45.0°W) on June 13-14, 1983.