Height of Maximum Emission of 6300 Å Night Airglow & Electron Content in the F-Region at Low Latitudes

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From the electron density profiles of Ahmedabad, and the airglow observations made at Mt. Abu, India, a determination of height of maximum intensity is made for the 6300 Å night airglow emission. It is concluded that the maximum intensity of emission (i) is in the height region 300-400 km, and (ii) is not critically dependent on the height of the maximum electron density.

1. Introduction

It is known that the dissociative recombination of O₂⁺ (and also probably NO⁺) with the electron is the main source for 6300 Å night airglow emission in the low latitudes. Experimental determination of the height of the emission layer was done by Van Rhijn method in the earlier years¹⁻⁴, while its direct determination was done by rocket experiments⁵⁻¹⁸.

Problems in height determination by Van Rhijn method are well known¹⁵,¹⁴ and hence the wide discrepancies from 100 to 700 km for 6300 Å emission could be understood. Theoretically, it has been concluded¹⁴,¹⁸ that the bulk of the emission should originate in the 300 km height region which agrees with the rocket observations. In a theoretical study Lagos et al.¹⁷ have suggested that the 6300 Å emission maximum is slightly below the ionisation maximum. Peterson¹₈ has pointed out that the height of maximum emission of 6300 Å lies about one scale height below the height of maximum electron density of the night-time F-region. From the ground based ionospheric and night airglow observations taken at Ahmedabad (23°N, 72.6°E geogr.) and Mt. Abu (24.6°N, 72.7°E geogr.), India, during 1967-69, it will be shown in the present paper that the total electron content between 300 and 400 km is mainly responsible for the observed 6300 Å emission and also that the height of maximum 6300 Å emission lies between 300 and 400 km.

2. Results

The correlation coefficients of the total electron content between 200 km and hmF₉ (height of F₉ peak) and I₆₃₀₀, intensity of 6300 Å emission, were found on many nights considering the half-hourly observations. The correlation is good only on a few occasions, and only fair in the case of the rest. The nocturnal variation of I₆₃₀₀ and the electron content up to hmF₉ on some nights when the correlations were good are shown in Fig. 1. Electron density profiles for four of these nights during pre-midnight hours (where more structure is seen) are given in Fig. 2. Electron density profiles up to hmF₉ are calculated from ionosonde data and are extrapolated above by assuming Chapman layer).

Also we calculated the half-hourly total electron content (Nₑ) in the horizontal slabs defined by hₙ-hₙ₊₁ where h₁ = 200 km and hₙ = 300 km for the first slab. For the successive slabs hₙ increased by 20 km. The calculations were done up to hₙ = 400 km.

Fig. 1—Nocturnal variation of 6300 Å intensity and electron content (Nₑ) up to hₑFₑ in the ionosphere on some nights.
Correlation coefficients \( r \) between \( N_e \) \((h_e=200)\), the electron content between \( h_a=200 \), and \( I_{6300} \) were found using half-hourly observations. A plot of these correlation coefficients \( r \) against \( h_a \) is presented in Fig. 3. The last point in the graph is for \( h_{mF_0} \) when \( r \) decreases. It can be concluded that on each of these nights the correlation coefficient showed a maximum positive value between 300 and 400 km. It is also noted that for \( h_a > 400 \) km, the value of \( r \) decreased. It shows that the electron content above 400 km does not substantially contribute to the total 6300Å emission as observed from the ground. This is in agreement with the theoretical prediction of Lagos et al.\(^{17}\) and Peterson\(^{18}\). Values of maximum correlation coeffi-
scientists for heights in the range 300-400 km from Fig. 3 also suggest that the height at which maximum 6300 Å emission is observed lies in the range 300-400 km.

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References