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Height-gradient of electron-loss in the F-region

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Abstract—A theoretical expression is derived for the exponential height-gradient of the coefficient of electron-loss in the F-region, on the assumption that this gradient completely accounts for the initial process of bifurcation. Five models are proposed: parabolic, linear, second-power, cosine and quasi-parabolic.

INTRODUCTION

WITH the rapid accumulation of data on the upper atmosphere now being obtained by many independent methods, especially by means of rockets and satellites, there arises a corresponding need to establish the mathematical relations between all these data, with the ultimate view of constructing a comprehensive theory of the upper atmosphere. The purpose of this present study is to see whether the shape of the F-trace as obtained by ionospheric soundings can be made to yield additional information on loss processes in that region. The actual values of the loss coefficient at various heights can best be obtained by rocket exploration. But as pointed out by BATES (1954), independent confirmation is needed, on account of certain difficulties raised by the rocket model of the atmosphere. One such difficulty may well be the extrapolations often resorted to as regards the ionospheric F-region.

As a first approximation, an exponential decrease of the loss coefficient with height is assumed, e.g. by MARTYN (1955) thus:

$$\alpha = \alpha_0 e^{-bz} \tag{1}$$

where b is found to be unity or more, by analysing observed lunar variations.

A second approximation is obtained from NICOLET (1954) by showing that b in (1) is related to a varying scale-height thus:

$$b = \eta\left(\frac{dH}{dz} + 1\right) \tag{2}$$

where H is the scale-height, assumed to vary linearly within each layer, and η is a constant dependent on the type of electron loss.

A further modification has been suggested by RATCLIFFE *et al.* (1956) who divide the F-region into three levels, of which only the intermediate level is assigned an exponential decrease of the loss-coefficient, the other two levels having a constant loss-coefficient, on the basis of empirical findings.

In this present study, attention is limited to $a(= 1/b)$, to see if its value may be calculated from the shape of the F-trace. With this value, it is hoped that a simple expression for the height-gradient of loss-coefficient in the F-region may be deduced.