Indian Journal of Radio & Space Physics
Vol. 4, March 1975, pp. 44-45

Influence of Magnetic Declination on the Noon Bite-out Phenomenon of the Equatorial F2 Region

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Received 7 June 1974

The effect of magnetic declination on the noon bite-out phenomenon is investigated. The occurrence of critical sunspot number for east declination stations during the sunspot minimum period and for west declination stations during sunspot maximum period is explained on the basis of the theoretical model of R. A. Goldberg. [*Ann. Géophys.*, **22** (1966), 588].

1. Introduction

STUDIES on the F2 region by Appleton[1], Bailey[2], and Rastogi[3], have shown that the magnetic field of the earth has a control over the characteristics of this region. Extensive work has been done on the symmetric behaviour of *f*oF2 about the dip equator, and magnetic dip emerged as a useful parameter in explaining the behaviour of the F2 region. However, the effect of longitude on the F2 region established by Maeda[4] Rao[5], Lyon and Thomas[6], Rastogi and Sanatani[7], and Rao and Malhotra[8] indicated that the dip parameter alone cannot fully account for the magnetic control.

Eyfrig[9] has suggested that the influence of magnetic declination upon the diurnal variation of *f*oF2 is so strong that any theory that leaves out magnetic declination as a parameter of control will fail to describe the features of the F2 layer. He also suggested that there is a certain, but complicated influence of declination on the equatorial F2 region. Goldberg[10] developed a theoretical model based on the skewness between the magnetic control and geographically oriented solar control to interpret F2 declination effects. Comparing the predictions of Goldberg's theoretical model concerning topside vertical and latitudinal density slope behaviour with their experimental results of Aloutte topside sounder satellite, Fitzenreiter *et al.*[11] suggested that the declination effect is a factor which must be considered as an important perturbation.

It is well known that the diurnal variation of *f*oF2 often exhibits a minimum around noon with peaks in the forenoon and afternoon hours. This phenomenon is usually referred to as noon 'bite-out' and is mostly confined to the equatorial latitudes[12]. It may be noted that the explanations of Mitra[13] and Martyn[14] also account for the noon bite-out phenomenon of the equational F2 Region. In this paper the effect of magnetic declination on the noon bite-out phenomenon is investigated.

2. Results

Olatunji[15] reported that out of the two peaks in the diurnal variation of *f*oF2 for equatorial stations, the afternoon peak was higher during the sunspot minimum period, and with increasing sunspot number the forenoon peak became prominent. The sunspot region in which the magnitudes of the forenoon and afternoon peaks becomes equal is referred to as the 'critical sunspot number'. Sarma and Mitra[16] showed that this critical sunspot number increased with increases in magnetic dip. But Raju and Rao[17] have shown after a more detailed analysis that the critical sunspot number is dependent both on geographic latitude and magnetic dip.

In Fig. 1 the variation of the parameter 'G', pertaining to the diurnal asymmetry of *f*oF2, with the sunspot number for Huancayo and Kodaikanal are presented. 'G' is defined as $G = |f1-f3|/(t3-t1)$, where $f1$ and $f3$ refer to the forenoon and afternoon peaks of *f*oF2 respectively and $t1$ and $t3$ are the corresponding times. The minimum value of G is indicative of the sunspot number region wherein the magnitudes of the fore noon ($f1$) and afternoon ($f3$) peaks are equal. Though Kodaikanal is situated in the northern hemisphere and Huancayo in the southern hemisphere, the magnitude of the magnetic dip at both the stations is approximately the same. The critical sunspot number for Huancayo, whose magnetic declination is 5°E, has a value 30-40 while

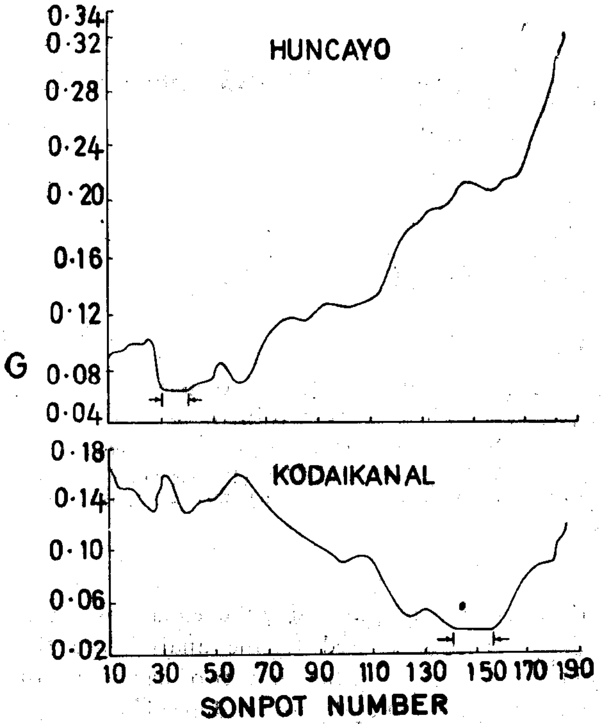

Fig. 1—The variation of G with sunspot number for Huancayo (decl. = 5°E) and Kodaikanal (decl. = 3° W)

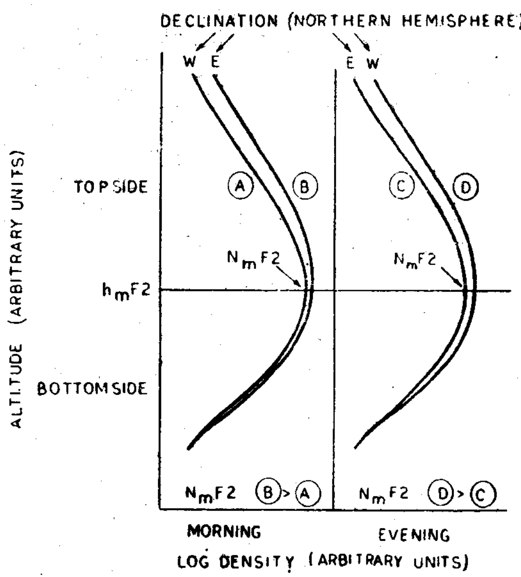

Fig. 2—Theoretically predicted effect of declination on the F 2 region, after Goldberg[10]

Kodaikanal, whose magnetic declination is 3°W, has a value 141-157. From this it is evident that for the east declination station the critical sunspot number falls in the sunspot minimum period whereas for the west declination station it falls during sunspot maximum period. The same analysis is carried out for two Indian stations, Trivandrum (decl. = 3°W) and Tiruchirapally (decl. = 2°W) and for one American station, Talara (decl. = 5°E). The results of this analysis clearly supported the earlier conclusion.

3. Discussion

The above results can be explained on the basis of the theoretical model discussed by Goldberg[10]. This model has been developed based on a F-region current system necessary to create a balance of forces under equilibrium conditions. In Fig. 2 the theoretically predicted effect of declination on the F2 region electron density profile is presented. From Fig. 2 it is clear that for stations having west declination there is a tendency to suppress the morning values of NmF2 ($1{\cdot}24 \times 10^4 \times f$oF2, where foF2 is in MHz) and enhance the evening values. Obviously the morning and afternoon peaks of the noon bite-out phenomenon will be influenced by this effect. On the contrary for stations having east declination the effect is opposite, and it becomes clear why the critical sunspot number is low for Huancayo and Talara and high for Kodaikanal, Trivandrum and Tiruchirapally.

Kohl *et al.*[18] have suggested that different diurnal variations observed at pairs of stations having similar geographic latitudes and magnetic inclinations, but different declinations may be caused by neutral air winds which produce at any station vertical ionospheric drifts having diurnal variation with a phase and amplitude which depend on the local magnetic declination. However, it is known that at equatorial latitudes, to which our analysis is confined, the neutral air winds do not play an essential role[19].

Acknowledgement

The authors are grateful to Prof. B. Ramachandra Rao for encouragement and to Dr B. V. Krishna Murty and Dr H. Kohl for helpful discussions.

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