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Solar x-ray control of the ionospheric absorption measured by the sweep frequency method*

G P GUPTA
Applied Physics Section, Institute of Technology, Banaras Hindu University, Varanasi 221 005

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Abstract. The ionospheric absorption data measured by the sweep frequency method have been compared with the solar x-ray data in the band of 1-8 Å during quiet- and disturbed-sun conditions. The degree of solar x-ray control of the ionospheric absorption and the corresponding limit of solar x-ray flux have been discussed.

Keywords. Control; absorption; sweep frequency method.

1. Introduction

The day-time formation of lower ionosphere (*D*-region) is the result of various ionisation sources such as; solar x-rays of wavelength less than 10 Å, solar Lyman α-radiation and 1108 Å radiation. The contribution from different ionisation sources has been a debatable problem over the last many years and is left uncertain todate. Various workers (Triska and Lastovicka 1970; Ganguly 1972; Deshpande *et al* 1972, Lastovicka 1973; Kotadia *et al* 1976; Rao and Ramana 1977) have studied the influence of solar x-ray on the ionospheric absorption by comparing the well-known A1, A2 and A3 absorption data with the solar x-ray data. Many of them have discussed about the threshold value of solar x-ray flux for controlling the ionospheric absorption. During the quiet-sun conditions when the absorption is not controlled by the solar x-ray, the control of the absorption is generally attributed to solar Lyman α-radiation. In the present paper, the solar x-ray control of the ionospheric absorption measured by the sweep frequency method has been investigated during the quiet- and disturbed-sun conditions. The sweep frequency method is now having obvious advantages over the well-known A1, A2 and A3 methods. The sweep frequency method measures the intensity variation of various radio signals transmitted in certain frequency band and reflected from the ionospheric layers. The details of sweep frequency method and its working have been described elsewhere (Ilias and Gupta 1978).

Since 1968, the ionospheric absorption in the frequency band of 6·3–10·8 MHz has been measured by the sweep frequency method at the Democritus Nuclear Station, Athens (38° N, 23° 49′ E). Data are published since 1969 in the GSR bulletin Athens and since 1973 in the monthly bulletin at the Atmospheric Physics Laboratory,

*Work carried out at the Atmospheric Physics Laboratory, University of Patras, Greece

University of Patras, Greece. With a view to study the solar x-ray control of the ionospheric absorption, the sweep frequency absorption data during the period June-July 1969 of maximum solar activity have been compared with the x-ray data from the Solard 9 satellite in the band of 1–8 Å. The degree of solar x-ray control of the ionospheric absorption and the corresponding limit of solar x-ray flux have been discussed. It is found that the ionospheric absorption is controlled by solar x-ray only during disturbed conditions with the flux greater than 10×10^{-3} erg cm^{-2} sec^{-1} in the band of 1–8 Å.

2. Comparison and results

Although the reflection height of radio signals in the sweep frequency band of 6·3–10·8 MHz is above 250 km, the largest contribution to the ionospheric absorption of radio signals comes from the height range of 60-90 km. Since the solar x-rays are effective below 90 km in the band of 1-8 Å only, we have compared the sweep frequency noon absorption L with the solar x-ray flux F_x in the band of 1-8 Å for June 1969 (figure 1) and July 1969 (figure 2). The noon absorption has been obtained as the average of the absorptions measured at 1100, 1200 and 1300 UT. The correlation coefficient using linear regression analysis is obtained to be 0·77 for figure 1 and 0·25 for figure 2. Thus the solar x-ray control is better in June than in July as reported and probably explained by Triska and Lastovicka (1970). It is seen from figures 1 and 2 that during quiet-sun conditions ($F_x<1\times10^{-3}$ erg cm^{-2} sec^{-1}) the absorption is also large which is explained by some other controlling factors than the solar x-ray.

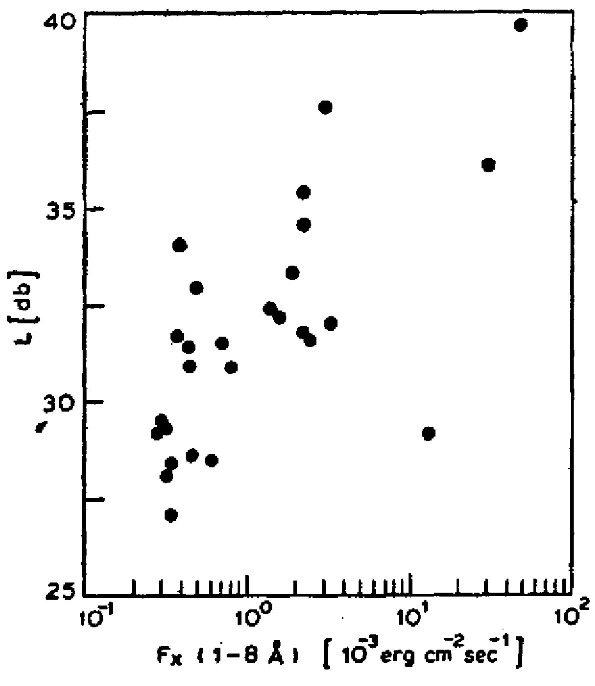

Figure 1. Correlation of sweep frequency noon absorption with solar x-ray flux for June 1969.

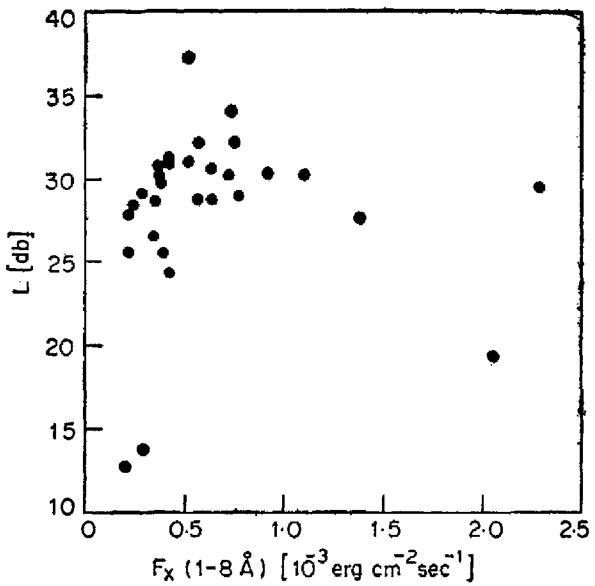

Figure 2. Correlation of sweep frequency noon absorption with solar x-ray flux for July 1969.

The threshold value of F_x (1–8 Å) is found to be 1×10^{-3} erg cm^{-2} sec^{-1} for a certain solar x-ray influence of the ionospheric absorption. However, the ionospheric absorption is not controlled by solar x-ray in the flux range of $1–10\times10^{-3}$ erg cm^{-2} sec^{-1}.

To estimate the value of F_x where the solar x-ray starts controlling mainly the ionospheric absorption, the sweep frequency absorption during a solar x-ray flare (disturbed-sun conditions) of 6 June 1969 in the period of 0950–1030 UT has been correlated with the solar x-ray flux (1–8 Å) in figure 3. The x-ray flux greater than 10×10^{-3} erg cm^{-2} sec^{-1} in the 1–8 Å band are identified as the solar x-ray flare data. The correlation coefficient is found to be 0·75 for figure 3. Thus, during disturbed-sun conditions the ionospheric absorption is mainly controlled by the solar x-ray in the 1–8 Å band with flux greater than 10×10^{-3} erg cm^{-2} sec^{-1}, although the influence of solar x-ray on the absorption is considerable in the flux range of $1–10\times10^{-3}$ erg cm^{-2} sec^{-1}.

3. Conclusions

The ionospheric absorption data in the frequency band of 6·3–10·8 MHz measured by the sweep frequency method have been compared with the solar x-ray data in the band of 1–8 Å during quiet and disturbed-sun conditions of maximum solar activity. As the radio signals are significantly absorbed when penetrating the D-region on the way to the reflecting levels at heights above 250 km and back, the solar x-ray flux F_x in the band of 1–8 Å, effective below 90 km, has been considered. It is found that the solar x-ray control of the ionospheric absorption is mainly for disturbed-sun conditions

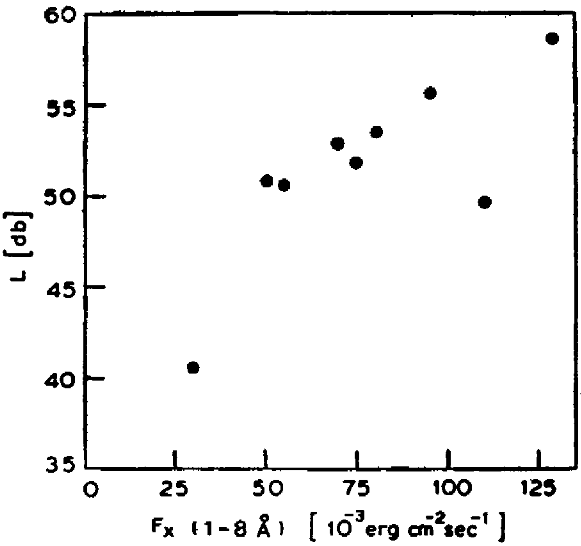

Figure 3. Correlation of sweep frequency absorption with solar x-ray flux during a solar x-ray flare of 6 June 1969 in the period of 0950-1030 UT.

with $F_x > 10 \times 10^{-3}$ erg cm^{-2} sec^{-1}. During quiet-sun conditions with $F_x < 1 \times 10^{-3}$ erg cm^{-2} sec^{-1}, the solar x-ray control of the ionospheric absorption is negligible even at maximum solar activity.

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