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Response of Electron Density in the Ionosphere over Nsukka Zone to Solar Flare Effect

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Research Article

Abstract: It is known that the sun's activities affect the earth's atmosphere. In this work, the effect of solar flare on electron density in the ionosphere within Nsukka geographical zone was investigated. The electron density data on flare days and non-flare days were compared and it was observed that electron density is higher on flare days than on non flare days. It was also observed that there is a difference of one hour between the times of the peaks of the electron density in the ionosphere on flare days and non-flare days. The findings have obvious implications for the aviation and communication industries as well as military establishments.

Keywords: atmosphere, electron density, ionosphere, solar flare.

1. Introduction

The ionosphere is the upper region of the atmosphere at which exists mainly ionized particles in such quantities that affect radio propagation. The ionization is mainly due to the sun's activities such as solar wind, prominences, coronal mass ejections and solar flares. The effect of these activities could be very harmful but the earth's magnetic field gives the earth a protection from some of the released charged particles. It is a known fact that the solar activities affect the electron density in the ionosphere. Solar flares which is the source of highly energetic particles with energy that extends into the Gev ranges produces copious amounts of electromagnetic radiations in all the wavelengths and also violent magnetohydrodynamic phenomena such as shocks and fast mass ejections J.H. Dillinger (1937) in Onwuneme [5] recognized that fadeouts in high frequency radio propagation were the result of abnormally strong absorption in the ionosphere occurring at the same time as solar flare. The simultaneity between the fade out and the visible flare shows that the cause is electromagnetic, and the occurrence of radio absorption indicates that the electron density in the D region has been enhanced [5] which is caused by hard x-rays released during the flare. In Nsukka, (6.50^{o}N and 7.00^{o}E), the hourly electron density variations showed a general trend. They are characterized by a large maxima appearing around noon and minima around midnight. When flare occurs, the electron density is higher [4]. Kolawole and Ishwood (1980) observed a diurnal variation in the peak of electron density in the F2 layer of the ionosphere and reported that there is a clear tendency for the afternoon maximum to occur later as the solar activity decreases (Onwuneme 2005). All these point to the fact that the solar activities enhance events in the ionosphere irrespective of the particular layers thus we have a solar controlled ionosphere. Even with this effect it must be known that the scientists are yet to come to a conclusion on the explanation of the phenomenon of solar flares. So many models have been proposed and countered; example of such models are emerging flux model, magnetohydrodynamic model, open field model, electric discharge theory and also the flare as a relaxation phenomenon.

2. Materials and Method

The electron density data was collected from the Centre for Basic Space Science (CBSS), University of Nigeria, Nsukka (UNN) using GPS receiver on the flare days and non-flare days (2/10/2010 and 22/10/2010). The solar flare occurrence data were gotten from www.swpc.noaa.gov, courtesy of Space Weather Prediction Center, National Oceanic and Atmospheric Administration, Boulder, USA. Solar flare datasets were collected on 17/10/2010 and 26/10/2010. The electron density was plotted against time for the flare days and non-flare days.

3. Results and Discussion

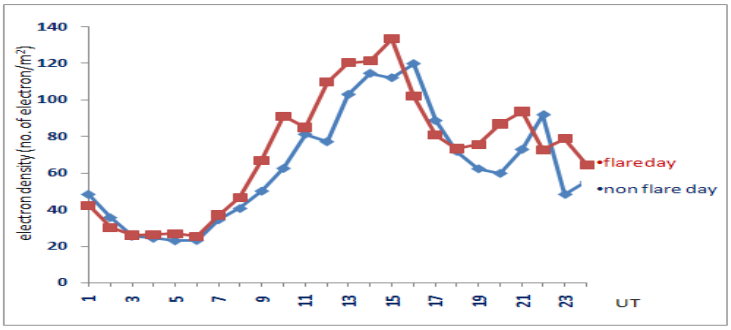

Figure 3.1: Hourly electron density versus time for 2/10/2010 (non-flare day) and 17/10/2010 (flare day)

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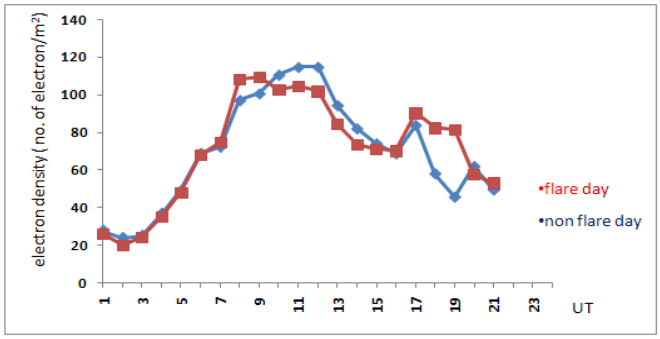

Figure 3.2: Hourly electron density versus time for 22/10/2010 (non-flare day) and 26/10/2010 (flare day)

In fig. 3.1, the non flare day of 2nd October was compared with flare day of 17th October, it is seen that on the 17th at early hours of the day that the electron density is low and then reaches a peak at 14:00 hours (2pm), then starts to decrease. At around the 18:00 hours (6pm), it rises and reaches a lower peak (a significant inflection) at the 20:00 hours (8pm) and later falls. However, for a non-flare day, the same sequence is followed, but it reaches a peak at the 15:00 hours (3pm) then decreases, at around 19:00 hours, it rises again reaching a lower peak at the 21:00 hours then falls. In fig. 3.2, the flare day of October 26th was compared with non-flare day of October 22nd 2010. The peak of flare day occurred at around 13:00UT and then decreases. It rises at 20:00 UT reaching a peak at around 21:00 UT and then decreases again. However, for the non-flare day, the 22nd October, 2010, the peak occurred at the 14:00UT then decreases and rises at the 19:00 UT and at 20:00 UT; it reaches a lower peak (an inflection) and finally decreases. This showed that the electron density on the flare day appears to be lower than that on the non-flare day. However, the lower peak on the flare day is higher than that on the non-flare day. Similarly, like the comparison of the 17th and 2nd of October, the peaking of the electron density on the flare day occurs an hour earlier. Thus the difference of 1 hour in the peaks appears to be a general trend.

4. Conclusion

.In this work we observed two different peaks - a high one around after midday and a low peak (an inflection) around 20:00UT. The electron density on 22 October 2010 (non-flare day) seems higher than that of the flare day of 26th October 2010 and gives a concern as to what could be the cause. It could be that other solar activities like solar storm took place but was not observed. However, all these mean that solar flare effect on electron density in the ionosphere should be looked into further. This work is very important and has obvious implications and applications in the aviation and communication industries and other radio wave stations. The peak of the flare day an hour earlier than the non flare day is certainly worth looking into.

Acknowledgements

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