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Solar cycle variation and its impact on critical frequency of F layer

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The ionosphere exhibits the variability over different time scales. In the present paper we present the long term solar activity variations of mid latitude ionosphere. To accomplish this study we have considered a famous Australian station namely Hobart (42.88°S , 147.32°E), which falls in the mid latitudinal region. The variability has been examined over the previous three solar cycles i.e, 21, 22 and 23 solar cycles. To characterize the long term variability of the solar activity we have used four indices namely sunspot number (Rz), solar radio flux (F 10.7cm), Mg II core to wing ratio and solar flare index. Similarly, for ionospheric variability we have the critical frequency of F2 layer (foF2). From our study, we found that the long term changes in the solar activity indices which are closely and synchronously reflected in the ionospheric foF2. To quantify the magnitude of association between the long term solar activity variations and the ionsopehric variations we have performed the single regression analysis and computed the correlation coefficients between the two types of indicies, and found that there exists an extremely strong correlation between the two types of indices for all the three solar cycles. Hence, it has been concluded that the ionospheric foF2 is strongly influenced by solar activity with an 11-year variability.

Keywords: Solar cycle, foF2, Geomagnetic indices, Correlation coefficient

1 Introduction

Ionospheric variability changes from hour to hour, day to day, month to month, year to year as well as from one cycle (11 years) to other[1-3]. Each type of the ionospheric variability has its own sources and own characteristic features. Although, short time variations are caused by the transient changes like solar flares and coronal mass ejections the long term variation are thought to be caused by the long term cyclic variability of the solar activity. The short term variations are sudden and intense and last only for shorter period of time while the long term variations are smooth and follow a particular trend. The solar cycle variations of the ionosphere have been studied since past, which are thought to be caused by the cycle variation of solar irradiance - a primary source of ionization in the ionosphere[4-6]. The studies devoted to study the long term or solar activity variations of the ionosphere have been realized by using various ionospheric parameters like critical frequency and peak electron density of F2 layer, Total Electron Content (TEC) etc[6-14] and various indices like smoothed sunspot number (Rz), solar radio flux (F10.7cm), solar EUV and UV flux etc for representing the solar activity. Moreover, different studies have used the values of ionospheric parameters; while some have used daily median values[15], some have noon time values[16,17] while some others have used monthly median values[11,18] to investigate how the ionospheric variability changes with long term variations in the solar activity.

It has been found association that of long term variability of ionosphere with solar activity is very complex. In some earlier studies, before the EUV observations were made available, people used sunspot number and solar radio flux as solar indices to investigate the long term behavior of ionosphere using foF2 or NmF2[4,8,19]. However, it was found that monthly values of foF2 or TEC exhibits a linear relationship with sunspot number particularly for lower values of sunspot number, but saturates for higher values of sunspot number. This feature was known as saturation effect. Several explanations were proposed for the cause of the saturation effect[8,20] which was resolved by agreeing that neither sunspot number nor radio flux are appropriate proxies for investigating the solar activity variations of ionospheric foF2 or NmF2 and it was suggested that solar extreme ultraviolet (EUV) flux can serve as an apt and good proxy for studies concerning long term solar activity variations of ionosphere since these

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