Journal of Physical Chemistry and Functional Materials

Home Page of Journal: https://dergipark.org.tr/jphcfum

Correlation Analysis Between Schumann Resonance Frequencies and Dst, Kp

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ABSTRACT

In this study, the relationship between Schumann resonance frequencies (SRF) and the Geomagnetic indices (Dst, kp) was statically inquired. The relationship between the data of Schuman resonance frequencies for the first five months of 2016 and the values of hourly average of Dst and three-hour average of Kp was determined by applying the correlation analysis separately. The highest correlation coefficients are found -12.4% for SRF-Dst at 35 Hz, -11.6% for SRF-Kp*10 at 7 Hz.

ARTICLE INFO

Keywords:

Schumann Resonance Frequencies
Dst
Kp
Normality Analysis
Correlation Analysis

Received: 13-11-2021
Accepted: 21-11-2021
ISSN: 2651-3080
DOI: 10.54565/jphcfum.1022844

1. Introduction

Schumann resonances (SR) are the universal electromagnetic frequencies that occur in the Earth – Ionosphere waveguide, and were expressed by Winfried Otto Schumann for the first time in 1952. Schumann Resonances are the sequences of the different peak values in the Extremely Low Frequency (ELF) band of the electromagnetic spectrum detected in the earth atmosphere near the ground [1,2]. It occurs at the frequency values of 7,8, 14, 20, 26, 33, 39 and 45 Hz (+/- 0.5), especiallywhen there are severe lightning activities [3-5].

Geomagnetic indices are important references for atmospheric studies. It has been observed that many factors, such as flux emitted by the Sun and the effects of X-Ray and UV rays in the ionosphere and the magnetosphere, cause temporary geomagnetic alterations with the solar observation techniques developed in the last century. Geomagnetic indices have been studied and listed by many researchers [6-9].In this study, the relationship between the Schumann resonance data belonging to different days of the first 5 months of 2016, and Dst (the Disturbance Strom Time) and also Kp indices for denoted days was investigated with correlation analysis. The aim of this work is to understand the relationship between SRF and geomagnetic indices, and the effects of the variation of SRF values on the ionospheric conditions changing according to geomagnetic indices.

2. Material and Method

Schumann Resonance data were taken from the website of the Electronics- Telecommunications and Application Laboratory of the Ioannina University Physics Department [10]. The measurements include 24-hour spectrograms, 10-minute resonance frequency changes, and the power variation of the calculated Schumann resonance frequencies (SRF). The main measurements were obtained from the Kalpaki and Neochori stations [11, 12]. The Dst and Kp data were taken from the Omni website, a service of NASA [13]. Because of the fact that the data of SRFwas only available for the dates between January and May of 2016, the inquiry was conducted only for this time interval. The variations of the SRF with Dst and Kp*10 values are given in the Fig.1. and Fig.2 respectively. The unmeasured dates were extracted from the graphs.

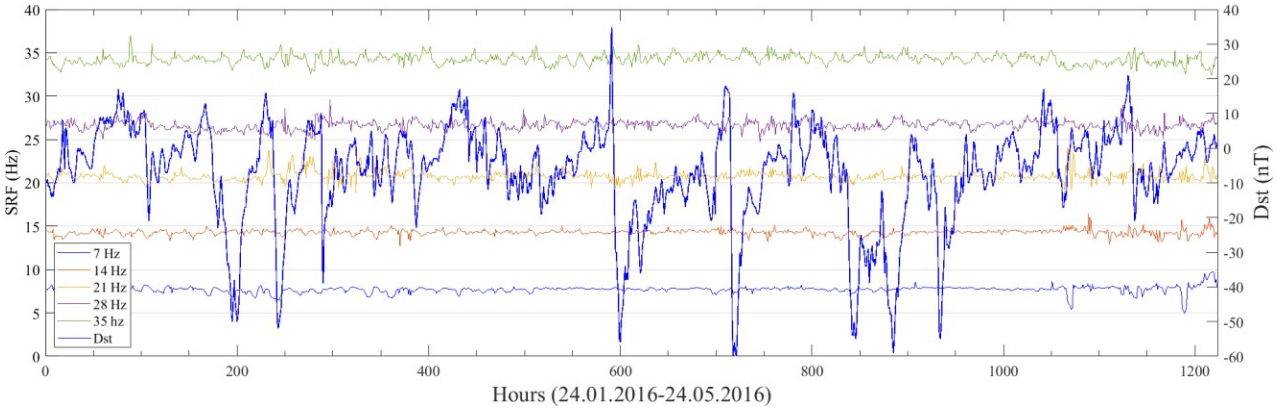

Figure 1. The variation of the SRF with Dst for the chosen dates

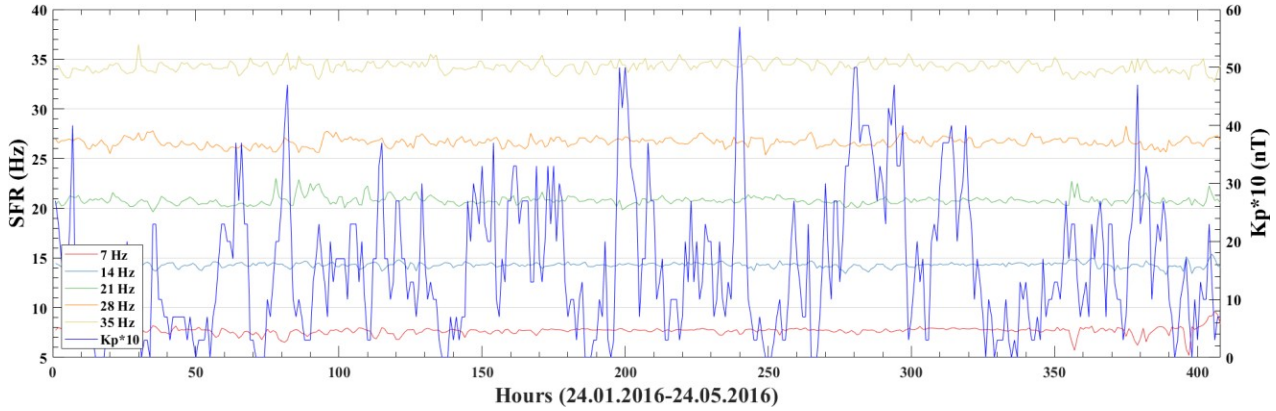

Figure 2. The variation of the SRF with Kp*10 for the chosen dates

The relationship between SRF and Dst, Kp*10 was examined with Bivariate Correlation tests.In order to make the correlation tests, firstly, determined the normality of variables. Each variable was classified according to skewness and kurtosis values according to normality distribution analysis[14].

The relationship between Dst, Kp and SRF was examined with Bivariate Correlation tests. In order to make the correlation tests, firstly, determined the normality of variables.

3. Results

In this study, for certain days of January, February, March, April and May 2016 SR data whichwas taken from the web address of the Field of Electronics-Telecommunications and Application Laboratory in the Department of Physics of Ioannina University (39 ° 40 'N; 20 ° 50' E.) were used.

The dates of the data of SR are January (24-31), February (1-5), March (21-31), April (1-21), May (18-25) in 2016 [15]. The data is collected every 10 minutes. Since data is taken every 10 minutes, the amount of data per day is 144. In total, 52 days of data were used in the study. So the total number of the data studied is 7488. SR were converted into hourly averages in order to be able to compare with the Dst data, and converted into 3-hour averages to be able to analyze with Kp data.The analysis were made with 1224 data of Dst and 408 data of Kp. The normality analysis of SRF, Dst and Kp are given in Table 1 and Table 2, respectively. The * signs mean the correlation is significant at the 0.05 level, and ** means that it is significant at the 0.01 level, which means it has a higher significance degree.

Table 1. Normality analysis results of SRF-Dst

	7 Hz	14 Hz	21 Hz	28 Hz	35 Hz	Dst
Highly Skw.	-1,326		1,402			-1,279
Mod. Skew		0,015		0,250	0.221	
Mesokurtic	12,831	5,197	5,933	1,469	0.747	2,153

Table 2. Normality analysis results of SRF-Kp*10

	7 Hz	14 Hz	21 Hz	28 Hz	35 Hz	Kp*10
Highly Skw.	-1,240		1,661			
Mod. Skew						0,806
Fairly sym.		-0,295		0,073	0,086	
Leptokurtic	11,188	1,874	5,750		0,673	
Mesokurtic				0,298		0,112

The Pearson, Spearman and Kendall Tau-b correlation analysis between SRF and Dst and Kpare given in Table 3 and Table 4, respectively.

Table 3. Spearman and Kendall Tau-b correlation coefficients of SRF-Dst

	Spearman	**Kendall tau_b**
	Dst	**Dst**
7 Hz	,116**	,080**
Sig.	,000	,000
14 Hz	-,050	-,034
Sig.	,083	,080
21 Hz	,088**	,059**
Sig.	,002	,002
28 Hz	-,015	-,011
Sig.	,598	,559
35 Hz	-,124**	-,084**
Sig.	,000	,000

Table 4. Pearson, Spearman and Kendall Tau-b correlation coefficients of SRF-Kp*10

	Pearson	**Spearman-Kendal tau-b**
	Kp*10	**Kp*10**
7 Hz		-,116*
Sig.		,019
14 Hz	-,041	-,008
Sig.	,411	,867
21 Hz		-,108*
Sig.		,029
28 Hz	,021	
Sig.	,667	
35 Hz	-,007	-,032
Sig.	,881	,518

4. Conclusion and Discussion

In this study, the relationship between Schumann resonance frequencies and the geomagnetic indices Dst, Kp was statistically investigated. The effects of Dst, Kp indices on SRF were examinedby correlation analysis.
The significance values are less than 0.01 for 7 Hz, 21Hz, 35 Hz and higher than 0.05 for 14 Hz and 28 Hz at SRF-Dst correlation analysis. According to this correlation analysis, the highest correlation coefficients between SRF and Dst obtained from Spearman analysis and values were found to be -12.4% in the negative direction for 35 Hz, 11.6% in the positive direction for 7 Hz and 8.8% in the positive direction for 21 Hz.
The significance values are less than 0.05 for 7 Hz, 21Hz and higher than 0.05 for 14 Hz, 28 Hz and 35 Hz at SRF-Kp*10 correlation analysis. According to this correlation analysis, the highestcorrelation coefficients between SRF and Kp*10 obtained from Spearman- Kendall Tau-b analysis and values were found to be -11.6% for 7 Hz and -10.8% for 21 Hz in the negative direction.
The results indicate that the interaction between SRF and Dst, Kp*10 might be negligible. Because, although some coefficient values seem relatively high, like 12 %, the wider perspective shows that the significant values are higher or close to the limits. In other words, the relationship is not worth to consider. However, note that the data of SRF was interrupted with huge gaps and the time interval was sparse. Therefore, a bigger data collection might give better and more meaningful results.

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