Publ. Astron. Obs. Belgrade No. 67 (2000), 85 - 88

2800 MHz SOLAR FLUX AND SAVA RIVER FLUX

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Abstract. The investigation by applying the spectal decomposition theorem to the solar activity impact on the Sava river flux at one station, followed by crosscorelations, indicated that there is an eight year lag between the solar radiation at 2800 MHz maximum and the maximum of the Sava river on the one hand, and, on the other, an eleven year lag between the solar radiation minimum and the minimum minimorum of the river flux. Chi-square test and the Kolmogorov-Smirnov test have been applied for evaluationg the sesults obtained.

1. INTRODUCTION

Looking for better correlation, I started with the total sunspot areas, total areas of sunspot umbrae, total areas of sunspot penumbrae, total areas of faculae, ending with 2800 MHz solar radiation. Then I used series for different rivers' levels, ending with river flux/flow, as a better parameter for water abundance or lack on it[1] to [20].

Experience has shown that all above listed values have an oscillatory character.The water has a basic importance in everyday's life, agriculture, industry, economic planing etc. An exact prediction of its quantity could be of an enormous benefit in general. But, today, the science does not exactly know the mechanism of the hydrologic cycle.One may only suppose what are the causes of many phenomena occurance. Therefore a statistical or a probability analysis may be of some help. So, I will use the solar radiation of 2800 MHz as a promoter of Sava river flux.

2. ATA CHOICE, DATA AND DATA PROCESSING

J.-C.Pecker (1987) confirmed my opinion that the simultaneous usage of data, observed at several stations along a river, in the case of solar – terrestrial influence study, can lead to distortion instead of correlation improvement. Therefore, I took only data recorded at one station on the bank of river the Sava.

Following data notations have been used:

Time series for SOLAR ACTIVITY (yearly means)::

OTTA – SOLAR RADIO FLUX AT 2800 MHz (10.7 cm) from the entire solar disc, corrected to within a few percents for factors such as: antenna gain, atmospheric absorption, bursts in progress, and background sky temperature, in units 10^{-22} Joules/second/square meter/Hertz. Each number has been mutliplied by 10 to suppress the decimal point; published by the National Geophysical Data Center, Boulder, Colorado, USA.

Time series for SAVA RIVER FLUX (yearly means)::

SMQV – MAXIMAL SAVA RIVER FLUX, expressed in m^3/s,

SMQN – MINIMAL SAVA RIVER FLUX, expressed in m^3/s.

At my disposal, I had OTTA series since the year 1947 to 1997 (daily observations), and Sava river flux series starting by the year 1931 until 1996 (monthly means).

The computer processing programme, for technical reasons, limited my investigation to the section between 1947 and 1996.

I applied, for periodogram construction, the so-called SPECTRAL DECOMPOSITION THEOREM, which states that the energy, or variance, of any time series can be broken down into contributions of statistically independent oscillations of different frequencies (periods). Each peak in the periodogram stands for a harmonic. The most outstanding one is called the MAJOR FREQUENCY (PERIOD), and the following ones are HIGHER HARMONICS, or OVERTONES.

Looking for paired up independent oscillations, with the same periods (frequencies), has been performed.

The next assumption was that we have to do with two stationary time series. X_t, and Y_t, and that we wish to asses the extent to which we can use the past of X_t, to predict Y_t; cross-correlation values, between solar radiation and the respective maximal, minimal river flux have been calculated.

Fourier series residuals have been calculated for significance level evaluation. Next, a comparision of such frequency histogram with normal distribution function has been constructed. Chi-square test has been carried out, and, in conclusion the Kolmogorov-Smirnov test has been used as one more significance evaluation.

3. RESULTS

The periodogram for the OTTA 4786 series shows five peaks – five independent oscillations. The major period has 10 years (91.64%), the first overtone has 5 years (3.49%), the second overtone has 3.08 years (1.86%), the third 2.11 years (1.55%), and the fourth 2.5 years (1.45%).

The periodogram for SMQV 4887 series has seven independent oscillations. The major period has 3.63 years (21.44%), the first overtone 5 years (15.36%), the second 2.35 years (15.34%), the third 8 years (13.60%), the fourth 2.11 years (13.27%), the fifth 40 years (13.25%), and the sixth 13.3 years (7.73%).

Comparing the listed periodograms for OTTA and SMQV series we see that there are two independent oscillations in the later corresponding to two of the formar. The first overtone of OTTA has it response in the first overtone of the SMQV, and the third overtone of the first series has its response in the fourth overtone of the second series. 5.45% of the radiation influences 28.63% of the Sava river maximal flux.

The cross-correlation analysis shows that there exists a eight years lag between OTTA and SMQV series (STATGRAF programme).

The highest cross-correlation value corresponds, as we mentioned before, to the eight years lag in the case OTTA 4786 versus SMQV 4887. So, 2800 MHz solar flux influences the MAXIMAL SAVA RIVER FLUX/FLOW, meaning that *maximal Sava river flux may follows, with an 8 year lagging between, the maximal 2800 MHz solar flux.*

Chi-square test for two of seven frequencies of SMQV 4887 series gives the value 5.107141 with 1 degree of freedom and a significance level p=0.0238342.

The Kolmogorov-Smirnov test gave a value of d=0.1000000 with no significance.

The periodogram for SMQN series has again seven peaks – seven independent oscillations. The major period has 3.63 years (25.53%), the first overtone 2.35 years (22.29%), the second 5 years (16.56%), the third 8 years (13.54%), the fourth 40 years (12.25%), the fifth 3.08 years (8.96%), and the sixth 13.33 years (0.88%).

We see, comparing the cited periodograms of OTTA and SMQN series, that they have two corresponding oscillations. The first overtone of OTTA has its response in the second of the SMQV series, as well as the second overtone of the first has its response in the fifth overtone of the second series. 5.35% of the solar radiation influence 25.52% of the Sava river minimal flux.

By means of cross-correlations we found that there exists a lag of eleven years between OTTA and SMQN series.

Cross-correlations have their highest value against eleven years lag in the case of OTTA 4988 versus SMQN 4988. So, 2800 MHz solar flux influences the minimal SAVA RIVER FLUX/FLOW, meaning that *minimal Sava river flux may follow, after an 11 year lagging between, the maximal 2800 MHz solar flux.*

Chi-square test, for two of seven independent frequencies, gives the value 0.4247530 with 1 degree of freedom and a signifiance level p = 5145796.

The kolmogorov-Smirnov test shows a value of 0.0250000 with no significance.

4. CONCLUSION

The spectral decomposition theorem, according to constructed periodograms and after corresponding cross-correlations calculation, for the index of solar activity, known as ADJUSTED 2800 MHz SOLAR FLUX, radiating from the whole solar disc, corrected within a few percents, for antenna gain, atmospheric absorption, bursts in progress and background sky temperature, expressed in units of 10^{-22} Joules/second/square meter/Hertz, OTTA series, at one hand, and maximal Sava river flux, SMQV series, expressed in m^3/s, observed on one station, on the other hand, entitles us to announce that, in statistical sense, the solar activity may influence, with the accuracy given, the MAXIMAL (MAXIMUM MAXIMORUM) SAVA RIVER FLUX, with eight year lag, and the MINIMAL (MINIMUM MINIMORUM) SAVA RIVER FLUX, SMQN series, after a lag of eleven years.

We must, at this place, turn our attention to the fact, mentioned in Jovanović, B.D. (1993c), that maximal Sava river flux followed the maximum of Greenwich total sunspot areas by a seven year lag, supported by a better fitting.

EXPLANATION. To avoid eventual misunderstandings we must add that the river flux has several maxima and minima during a year, but, our maximum maximorum is the greatest one that occurs once in several years, as well as minimum minimorum is the smallest minimum which occurs once in a longer period of years.

Acknowledgement

I am deeply indebted to my colleague Dr. Emilija Nikolic-Djoric, who in this case, as well as in previous ones, lent me her unselfish help in statistical evaluation.

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