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SOLAR ACTIVITY INFLUENCE TO PRECIPITATIONS, VIII

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Abstract. As in previous papers, by the same author, the Spectral decomposition theorem has been applied to find the eventual influences of the solar activity, known as the Total sunspot area, to the precipitations, on a spot in Serbia. By means of the cross periodograms, cospectral density, quadrature density, cross amplitude, the correlation has been studied. The cross correlation function proved that there may be a time lag of three years, for maximal precipitations, and a nine year lag for minimal precipitations, following the Solar activity.

1. ORIGINS

It is well known that the water is a sine qua non condition of living. So, one of the primary occupations of the spatial probes is the search after this matter, at the earlier times wrongly considered as an element. The main concern of scientists and specialists, on Earth, is the knowledge of the quantities and spots where it may be found, neverthless of that, will this be a still or a flowing one. The same problem is connected to precipitations which should fill the "reservoirs" on the surface.

Therefore it would be of a special benefit if we could be able to predict the maximal or the minimal rainfall, snowfall, etc. To our great sorrow we are, at the times, unable to forecast all conditions which are regulating these phenomena.

Some observed data are of a PERIODICAL nature, if they repeat themselves after the same time, and have the same intensity. But, other seem periodic, having neither the same time interval nor the same intensity. These are known as QUASIPERIODICAL PHENOMENA. To the latter ones we may list the activity of our sun, as well as the precipitations on our planet.

As told, we can not know all the sources of these changes. So, we are forced to use some mathematical methods, such as statistical or probabilistic ones, and look for the best fitting to our observations.

As in previous papers (Jovanović, 2001a-c; 2002ab; 2003; 2004) the spectral decomposition theorem has been applied to find the eventual influences of the solar activity, known as the Total sunspot area, to the precipations, on a spot in Serbia.

2. DATA AND DATA PROCESSING

Our attention has been narrowed to the single one spot, a station, in Serbia. Just from the beginning of these kinds of research, I thought, and J.-C. Pecker confirmed my opinion, in Pecker (1987), that the simultaneous use of data, observed at numerous stations on the Earth's surface, in the case of the solar-terrestrial influence study, may lead to distortions instead of correlation improvement.

Following data notations have been used:

Time series for SOLAR ACTIVITY (yearly means)::

X, Var 9 - TOTAL SUNSPOT AREAS, expressed in millionth parts of the visible solar hemisphere, corrected for sphericity, published by the Data center in Boulder, Colorado, USA.

Time series for PRECIPITATIONS (yearly means)::

Y, VAR 10 - PADAVINE, in mm/m^2, measured on a spot in Serbia, published by the Republic Hydrometeorological Institute in Beograd.

Both series are beginning by the year 1947 and are ending by the year 1996.

For obtaining the corresponding periodograms, of both seriers, we used the SPECTRAL DECOMPOSITION THEOREM which states that: the energy, or variance, of any time series, can be broken down into the contribution of statistical independent oscillations of different periods (frequencies). The peaks, in the spectral periodicity function graph (periodogram), stand for so-called independent harmonics. The most outstanding one is the MAJOR PERIOD (FREQUENCY), and the next ones mark the HIGHER HARMONICS or OVERTONES. My task was to pick up the pairs of vibrations with the same period (frequency) in both periodograms.

Following, we supposed that we have to do with two stationary time series, X, and Y, and that we wish to asses the extent to which we can use the past of X to predict Y. As a criterion of evaluation we used the CROSS CORRELATIONS. They gave the time lag of Y following the X.

More proves gave us the: CROSS PERIODOGRAM, COSPECTRAL DENSITY, QUADRATURE DENSITY and the CROSS AMPLITUDE.

3. RESULTS

The PERIODOGRAM for TOTAL SUNSPOT AREAS has eight peaks (Fig. 1). In other words, this series is a superposition of eight independent vibrations. The *major period* is of 12.5 years (87.86% of the whole). The first overtone is of 5.55 years (4.01%), the second is of 3.85 years (1.56%), the third is of 2.27 years (1.50%), the fourth is of 2.o8 years (1.44%), the fifth is of 2.50 years (1.27%), the sixth is of 3.13 years (1.22%), and the seventh overtone is of 2.77 years (1.04% of the whole variance of the Total sunspot areas).

The PERIODOGRAM for PRECIPITATIONS has seven independent oscillations – seven peaks (Fig. 2).The *major period* is of 12.5 years (24.50% of the whole). The first overtone has 3.57 years (22.15%), the second is of 4.55 years (19.54%), the third is of 2.94 years (11.40%), the fourth is of 2.38 years (10.29%), the fifth is of 2.17 years (6.66%), and the sixth overtone is of 25.00 years (5.45% of the whole variance of precipitations).

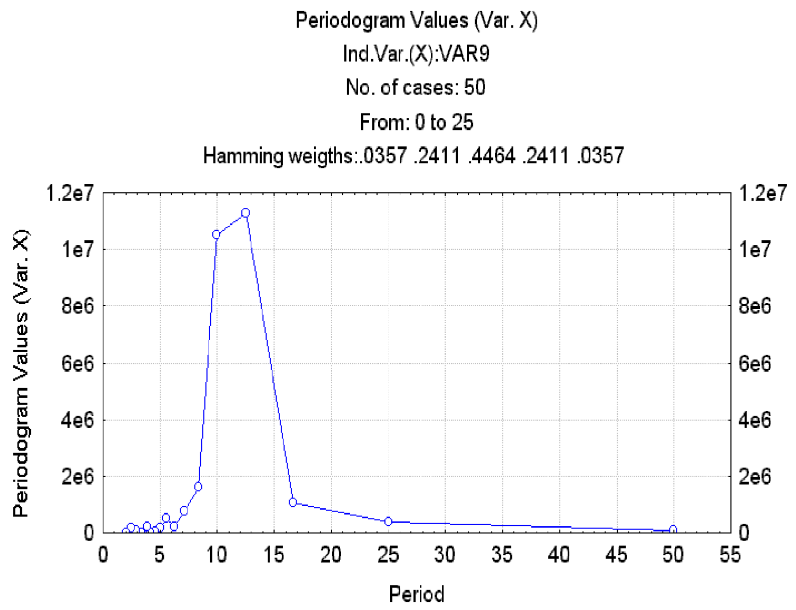


Figure 1:

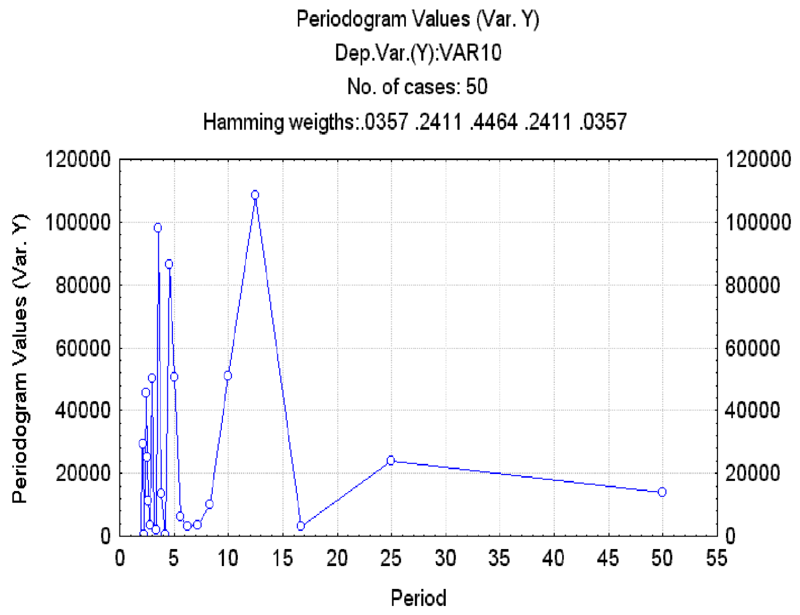


Figure 2:

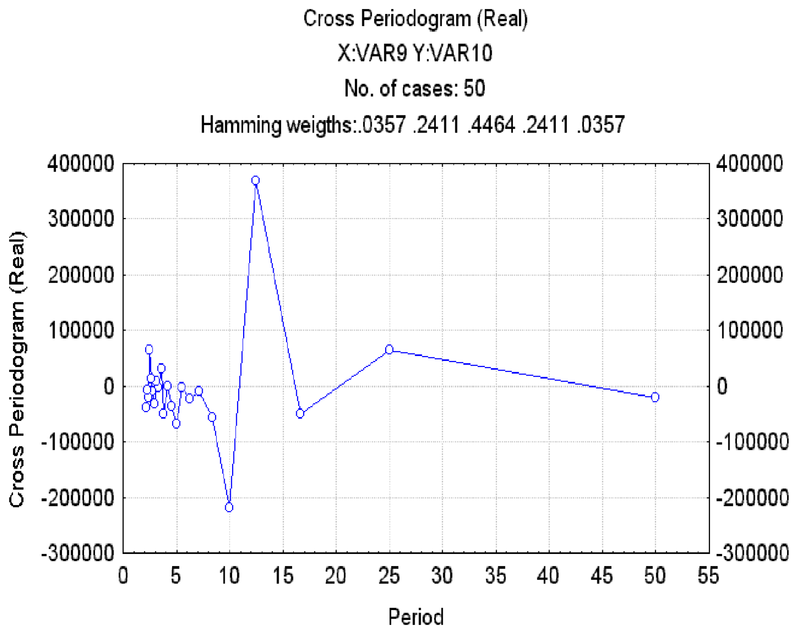
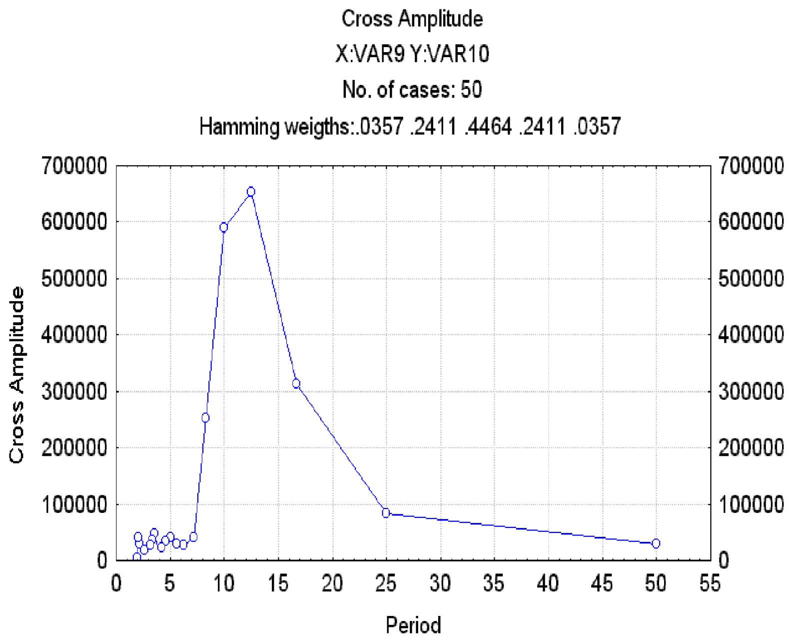


Figure 3:

Figure 4:



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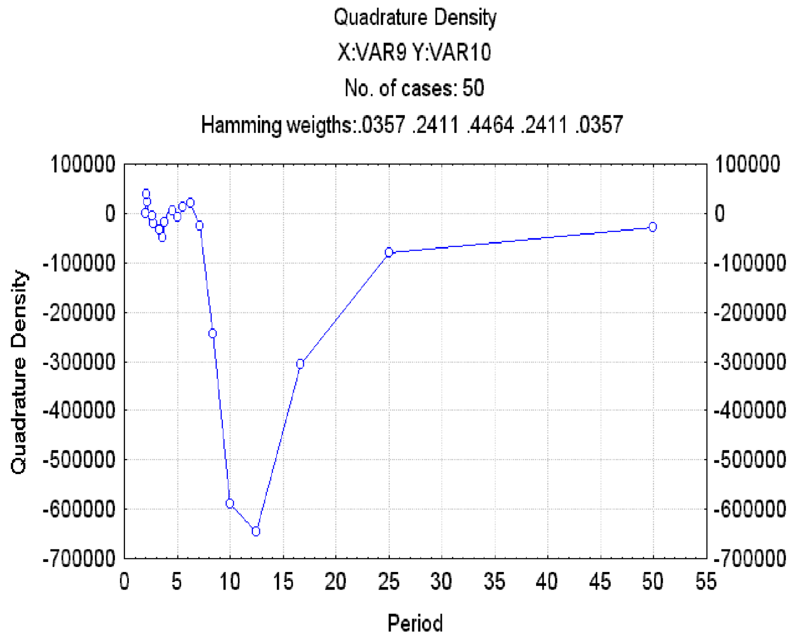

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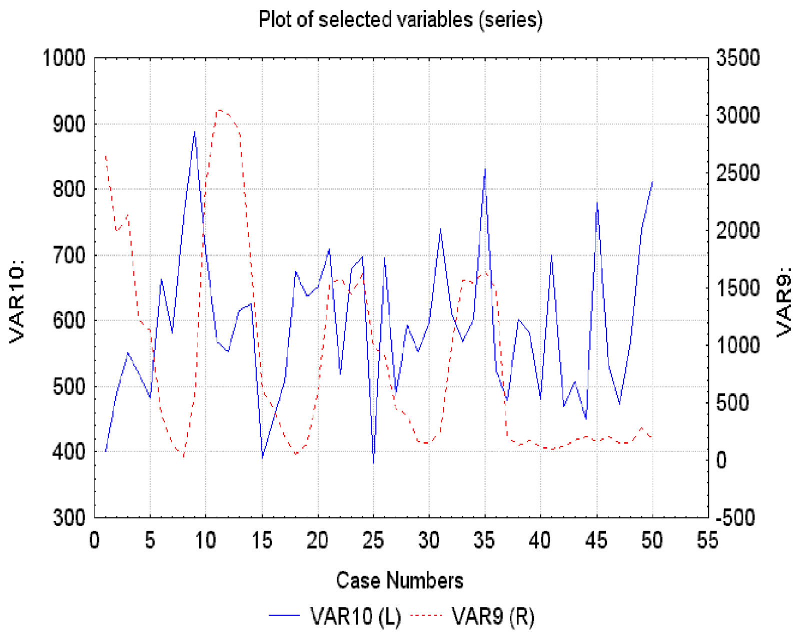

Figure 7:

If we compare, now, these two periodograms and their independent oscillations, we conclude that they have only *one pair of corresponding periods* 12.50 years long. Both of these are major periods.

The same correlation may be proved by means of their CROSS PERIODOGRAMS (Fig. 3 and Fig. 4), CROSS AMPLITUDE (Fig. 5), and QUADRATURE DENSITY (Fig. 6).

Now we turn to CROSS CORRELATIONS. The positive *maximum* of this graph stands for the *time lag of three years*, and the negative *minimum*stands for the *time lag of nine years.*

Let us show both time series in one Fig. 7 to see the obvious time lag.

4. CONCLUSION

According to constructed periodograms, following the Spectral decomposition theorem, and for calculated cross periodograms, cross amplitude and quadrature density, as well as for corresponding cross correlations, for the index of solar activity, known as the TOTAL SUNSPOT AREAS, expressed in millionth parts of the visible solar hemisphere, corrected for sphericity, X, VAR 9 time series, from the one side, and PRECIPITATIONS, expressed in mm/m^2, measured on a station in Serbia, X, VAR 10 time series, from the other side, we are entitled to announce that, in the statistical sense, *the solar activity may influence*, with accuracy given, *maximal precipitations with a lag of three years, and the minimal precipitations with a lag of nine years.*

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