

Causal Analysis of Solar Indicators

L. Liszka
Swedish Institute of Space Physics
Umeå, Sweden

When studying physical phenomena, in order to understand them, it is essential to know what is the cause and what is the effect, i. e. to establish the causal relation between the phenomena.

When we try to explain the phenomena we must state why they happen. This is equivalent to recognizing a causal relation between occurring events. As the causal relation; between physical events in complex systems may be very difficult to establish, the explanation is usually limited to theoretical or statistical model, which are compared with the observed data. Very seldom a full statistical proof for the proposed explanation is given, although a variety of method, for model testing may be found in the literature. During recent years; the Tetrad method, a technique for investigating causal relations in measured data has been developed.

A variety of physical and technical processes may be described by some kind of spectral data (e.g. frequency or energy spectra). In a frequency spectrum, a certain quantity (for example the oscillation amplitude) is displayed as a function of frequency. When studying a process it may be of interest to know whether:

- there are causal relations between spectral components
- all observed spectral components are generated by the same source.

When studying time series it is useful to investigate how the frequency spectrum of a particular time series varies in time and if there are any similarities with time variations of frequency spectra of other related time series.

As an illustration of the possible method of analysis two pairs of time series will be used:

1. Rg and C14 production rate. Time series consist of 400 years of data (yearly averages)
2. MPSI and NAO. This pair of time series consists of 30 years of daily averages, converted into monthly averages.

The most important result of analysis of the pair 1 is that it is mainly the first harmonics of the solar cycle that controls the solar activity component of the C14 production rate. In other words a solar cycle with a sharper onset (larger first harmonics) will have a greater influence on the C14 production rate. Also the second pair of solar indicators shows similar properties.