Preliminary report on the project

„**The solar and geomagnetic activity and their influences on the terrestrial environment. Case study – climate**"

Program TE, Contract 21/5.10.2011

Stage III, Ist semester 2013

During the first semester of 2013 the research has been conducted to solve some of the tasks, as follows:

1. Trends and periodicities in surface air temperature and precipitation data

The characterization of variability in natural patterns like those of surface air temperature records can be effectively approached, by applying multi-scale analysis methods capable of determining pattern persistence, without suffering from biases produced by trends.

Temporal changes in patterns of daily surface air temperature records from meteorological stations in Canada and Europe were analysed based on two different nonlinear statistical methods, namely detrended fluctuation analysis (DFA) and Haar wavelet analysis. Detrended fluctuation analysis was used with polynomial degrees 1 to 5, and the resulting Hurst exponent H together with the 95% confidence interval was represented for successive segments of the time series. The results showed that H can significantly change over time. The application of Haar wavelets analysis lead to qualitatively similar results; however, their uncertainty intervals are typically lower than in case of DFA.

Also, a new approach for detection and characterization of pattern change, considering time series as a representation of successive states of the studied system, has been introduced. Given a certain time series, every passage of the system from one (multi-resolution) state to another is recorded, and transition frequencies are established. A matrix based on all transitions among accessible states is created. The resulting transition matrix is represented graphically and characterized numerically. A "distinct transitions index" (di) and a "transition symmetry index" (si) are calculated for each matrix. The distinct transitions index is given by the ratio between the number of distinct transitions and the total number of transitions recorded in the matrix. The symmetry index is calculated as the normalized sum of the absolute values of differences between symmetric elements in the matrix. The calculated indices reflect thus system variability from different points of view.

On the other hand, system fluctuations are also characterized with the help of Haar wavelet analysis of the actual time series. Applying this method on temperature records from Canadian meteorological stations showed that the method can capture aspects of pattern change that are otherwise difficult to identify.

The inter-decadal trends of precipitation in the Danube Basin and of Danube discharge were obtained by using standard spectral analysis techniques, the multiple-taper method (MTM). In Fig. 1 is presented an example of applying MTM approach on precipitation data from Sibiu meteorological station (left) and Danube discharge data (right), showing variations of short period (2-7 years), decadal variations with a period of ~11 years and variations with longer periods, 22 and/or 30 years and even longer.

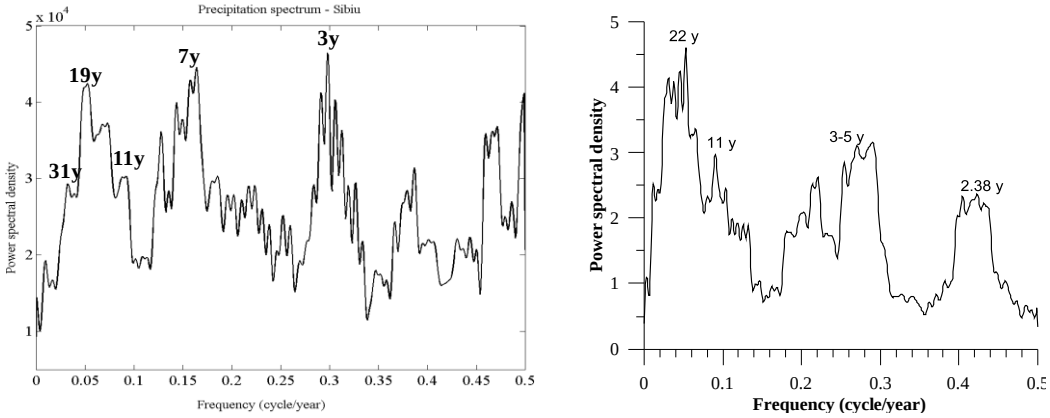

Fig. 1 MTM power spectrum in case of precipitation (left) and Danube discharge (right)

2. Correlation analysis: solar/geomagnetic – climate parameters

The possible changes in temperature and precipitation regime are expected to lead to changes in the water regime of rivers. The evolution of precipitation in the Upper and Middle Danube Basin, for the 20th century, in connection to variations in the Lower Danube discharge, to variations in the North Atlantic Oscillation (NAO), one of the important modes of large-scale climate variability in the Northern Hemisphere, and to solar variability, was investigated. The average precipitation from meteorological stations from Upper and Middle Danube basin was compared to the Danube discharge at Orsova (Fig. 2) and it can be seen a good correlation between these 2 parameters, with correlation coefficient of about 0.6 (95% significance level).

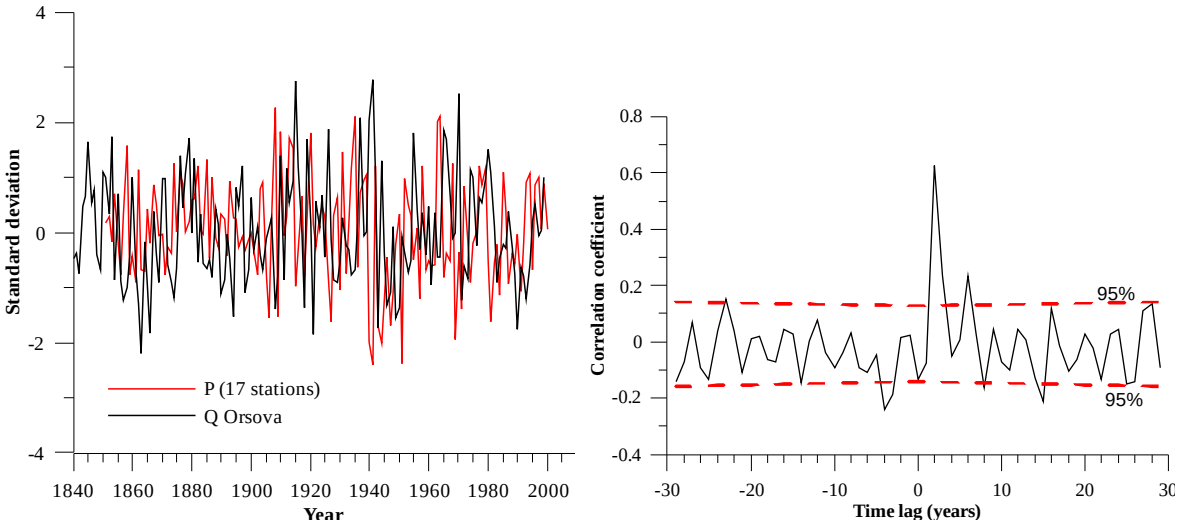

Fig. 2 The evolution of precipitation in the Upper and Middle Danube Basin and Danube discharge at Orsova (left), the correlation coefficient between them (right)

To discuss inter-annual to inter-decadal variability, the time series have been filtered by means of 11-, and 22-years running averages and the corresponding variations were compared. It reveals significant variations at the decadal and inter-decadal timescales (Fig. 3).

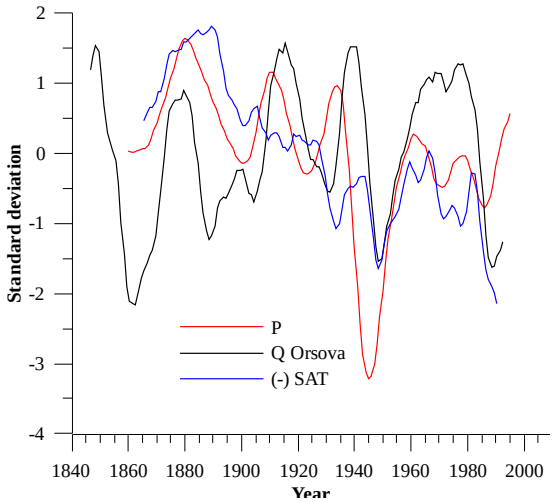

Fig. 3 The interdecadal trend of precipitation in the Upper and Middle Danube Basin and Danube discharge at Orsova

The discharge data and precipitation show similar variability at decadal and interdecadal timescales.

3. Dissemination of results

Presentations at international conferences:

C. Suteanu, V. Dobrica, C. Demetrescu, A comparative approach to surface air temperature patterns and pattern change, European Geosciences Union (EGU) General Assembly, Vienna, Austria, 7-13 April 2013.

C. Suteanu, A variable resolution transitions perspective on time series: applications regarding pattern change in surface air temperature records, European Geosciences Union (EGU) General Assembly, Vienna, Austria, 7-13 April 2013.

V. Dobrica, C. Demetrescu, Signature of Hale and Geissberg cycles in geomagnetic activity and in climate parameters, COST Action ES1005, WG2 workshop on the influence of interplanetary perturbations on the Earth's atmosphere and climate, Sunny Beach, Bulgaria, 13-16 May 2013.