

Statistical Analyses of Elementary Circulation Mechanisms According to Dzerdzeevskii as Opportunity for Further Insight in Climate Time Series

Mihael Brenčič^{1,2}

¹Department of Geology, Faculty of Natural Sciences and Engineering, University of Ljubljana, Aškerčeva cesta 12, SI-1000 Ljubljana, Slovenia.

²Geological Survey of Slovenia, Dimičeva ulica 14, SI-1000 Ljubljana, Slovenia

Abstract

Classification of northern circulation patterns defined by Dzerdeevskii with 41 elementary circulation mechanisms (ECM) represents important source for investigations of various climate characteristics and its time depended variability. The data set which is on the daily basis available from 1899 onward can be understood as set of categorical data consecutively followed on the equal time interval; such series of data can be defined as time series. Concept of time series offers various opportunities for probabilistic and statistical modelling. As it is the case with rational time series data (e.g. air temperature, pressure data, etc.) their structure can be investigated with several techniques. The analysis can start with exploratory data analyses and then followed with frequency determination. Important part of each time series analysis is determination of trends. They are of different sorts; usually they are indicating if analysed sample reflects stationarity and ergodicity. Important part of trend analysis is also periodicity detection.

Categorical data as it is ECM data set have meaning but not value; therefore among arithmetical operation ECM categories can only be counted, ranking is not possible as well as not any other arithmetical operation. Categories must be transferred into another “measure” which allows further modelling; such measures are understood as dispersion measures; they are represented as Gini index, entropy, Chebycheff dispersion, Song measure and Renyi measure. Based on these measures, similarly as in rational time series data analysis, moving filters can be applied.

Statistically speaking ECM categories are representing also an alphabet consisting of 41 letters; as in quantitative linguistic analyses different combinations and relations between letters can be observed. Such observation can be understood also as pattern analysis. Promising data analysis tool for ECM time series is also Markov chain approach.

We are presenting consistent analysis of ECM data set as a categorical time series analysis. It is illustrated that time series is strongly non-stationary with time dependent trends where also probability density of time series is time dependant. Non-stationary behaviour is also reflected in non persistent periodicity which shows time dependent changes in parent stochastic process. Frequencies of patterns in ECM data sets for different lengths are also represented. As a conclusion possible interpretations of the statistical results are represented.

Literature:

Brenčič, M., 2016: Statistical analysis of categorical time series of atmospheric elementary circulation mechanisms - Dzerdzeevski classification for the Northern hemisphere. Plos One doi: 10.1371/journal.pone.0154368