European Geosciences Union General Assembly 2018

Spectral coherence between precipitation in the Danube basin and indices of the teleconnections patterns by means of wavelet transform

Romanian Academy
"Sabba S.Ştefănescu" Institute of Geodynamics

Ileana Mareș, C. Mareș, Venera Dobrică, C. Demetrescu
Institute of Geodynamics, Romanian Academy, Bucharest, Romania

The aim of this paper is the analysis of the link between the precipitation in the Danube Basin and climate indices, in the time-frequency domain, through wavelet transform coherence.

The climate indices that characterize the following teleconnections patterns were considered: Arctic Oscillation (AO), Atlantic Multidecadal Oscillation (AMO), East Atlantic (EA), East Atlantic/Western Russia (EAWRUS), Greenland-Balkan Oscillation (GBO), North Atlantic Oscillation (NAO), Scandinavian (SCAND) and Southern Oscillation (SO).

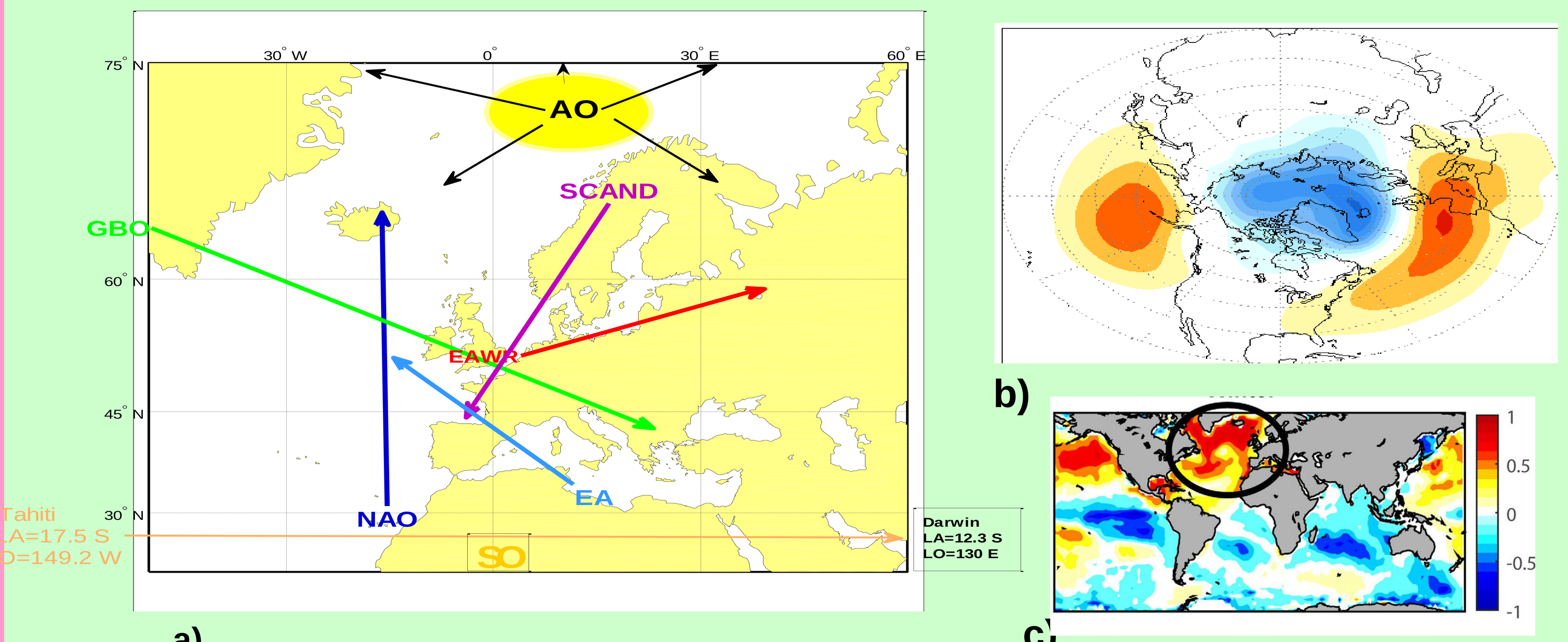

Fig.1.
a) Schematic position of Climate Indices (CIs). The arrows show the definition of CIs, that is, the difference between the locations of the origin and end of the arrow;
b) Wintertime Arctic Oscillation (AO): Positive Phase. Red (blue) – positive (negative) SLP anomalies.
c) AMO winter: positive phase vs. SST

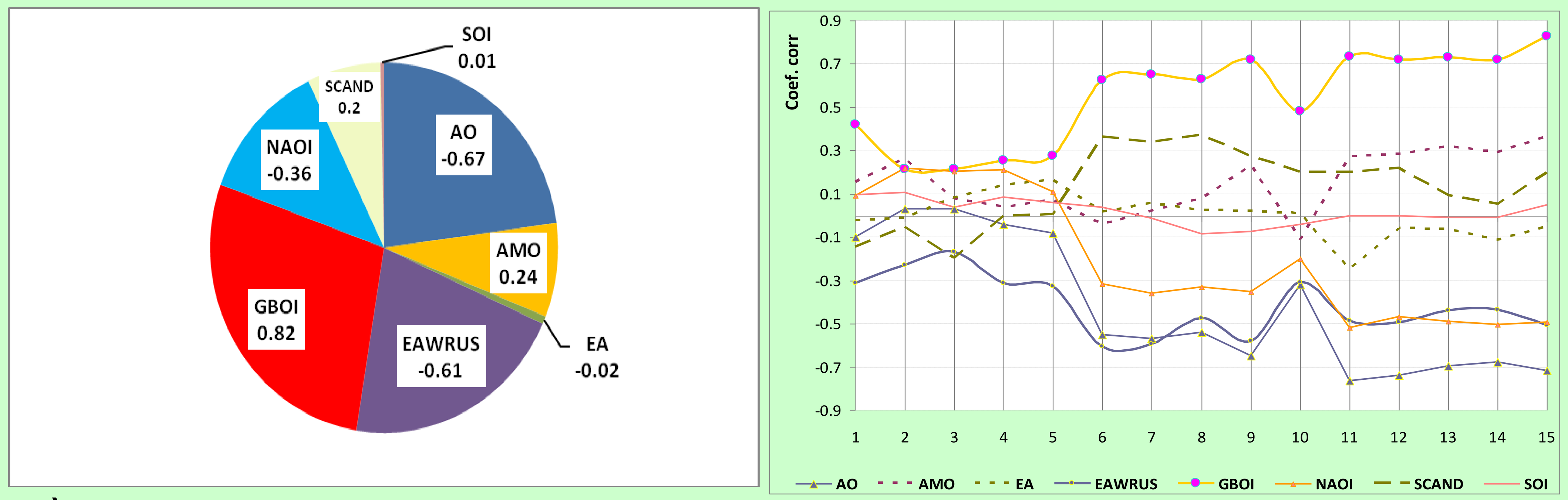

Fig. 2. Correlation coefficients (R) between precipitation field in the Danube basin and the 8 climate indices for winter season. (For 95%CL=> R=0.27).
a) Precipitation is quantified by first component (PC1_PP) of the EOFs decomposition
b) Spatial details on the stations, for the correlations between CIs and the precipitation field in winter

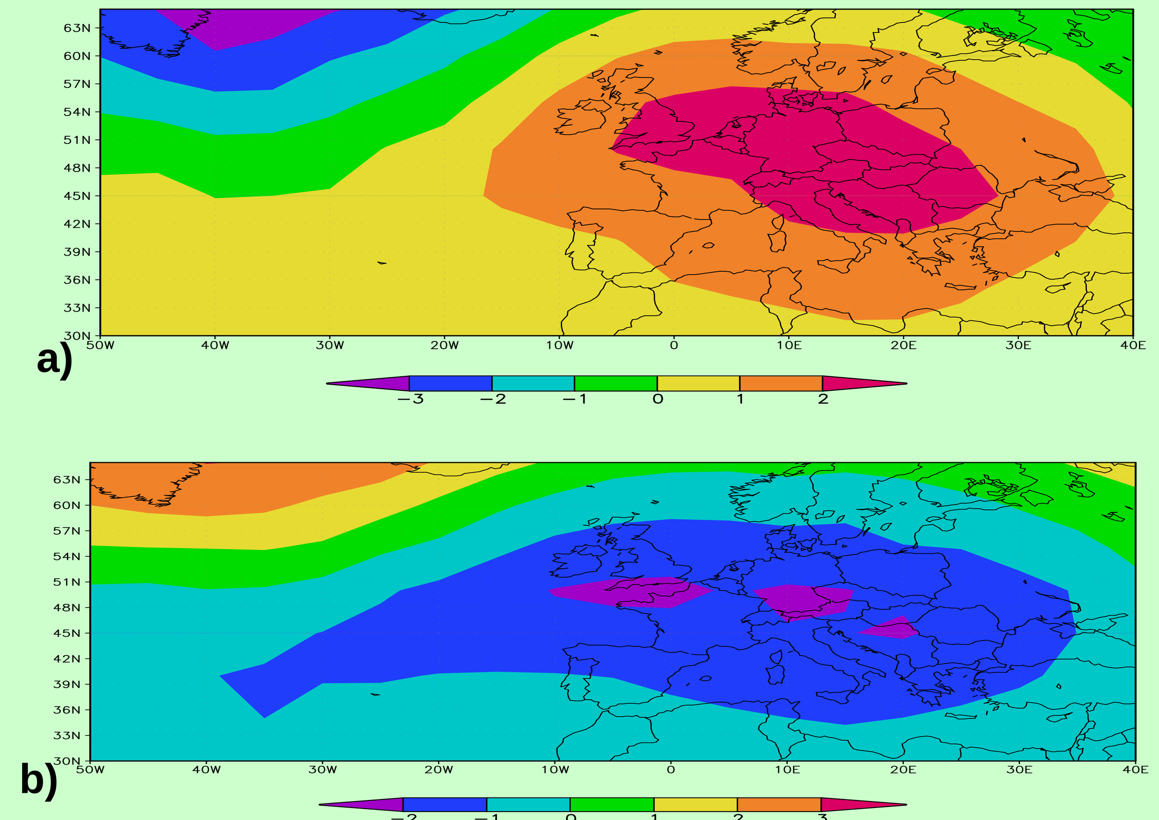

Fig.3. Composite maps of sea level pressure (SLP) associated with extreme precipitation during winter
a) precipitation below normal (GBOI⁻);
b) precipitation above normal (GBOI⁺)

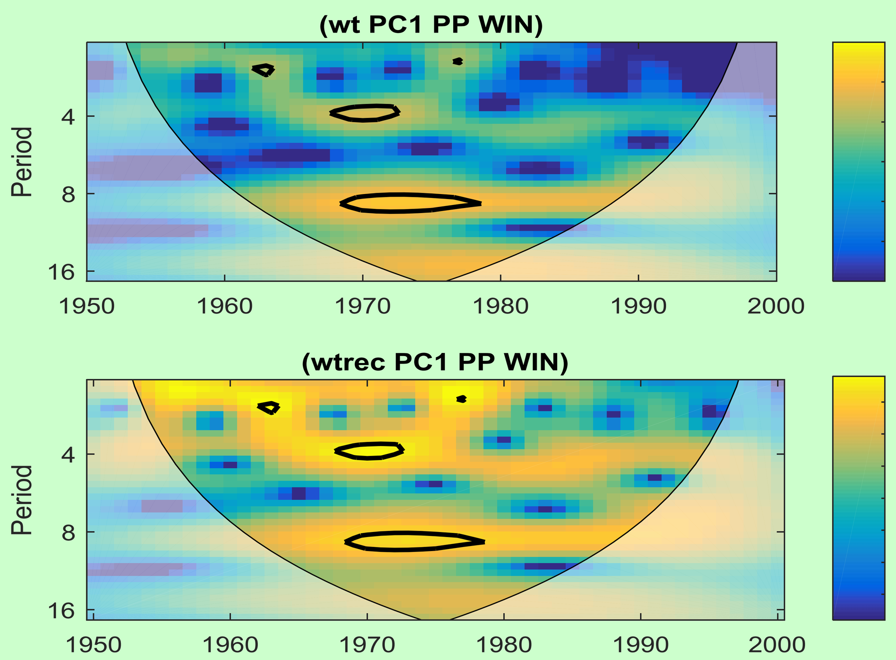

Fig. 4. Wavelet power spectrum for winter PC1_PP in Danube basin, estimated by two Matlab software packages; according to *Grinsted et al.* (2004) (wt-top figure) and a rectified method by *Ng and Chan* (2012) (wtrec-bottom figure)

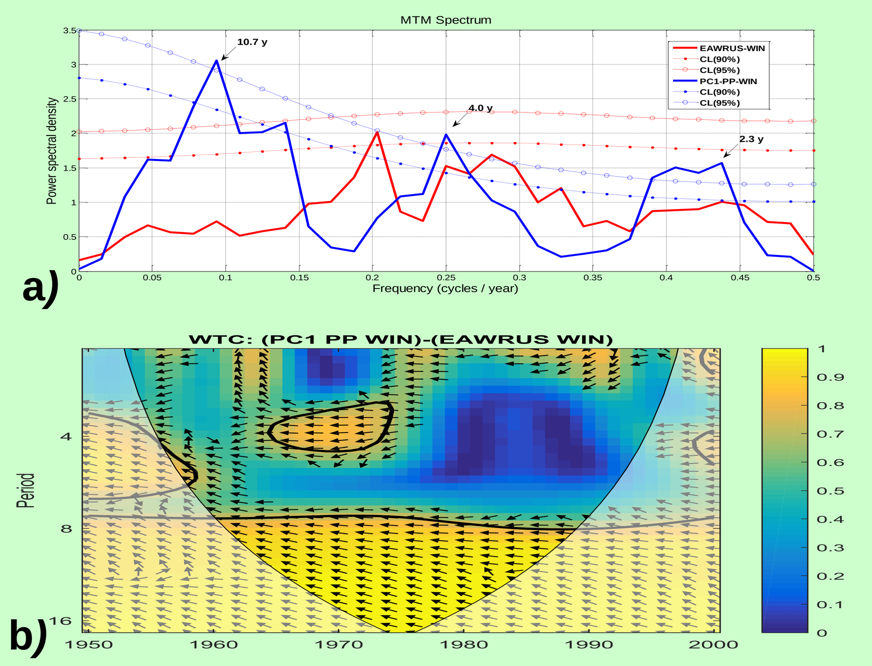

Fig. 5. Spectral analysis (PC1_PP and EAWRUS):
a) MultiTaper method (MTM)
b) Wavelet Transform Coherence (WTC-*Grinsted et al.* (2004))

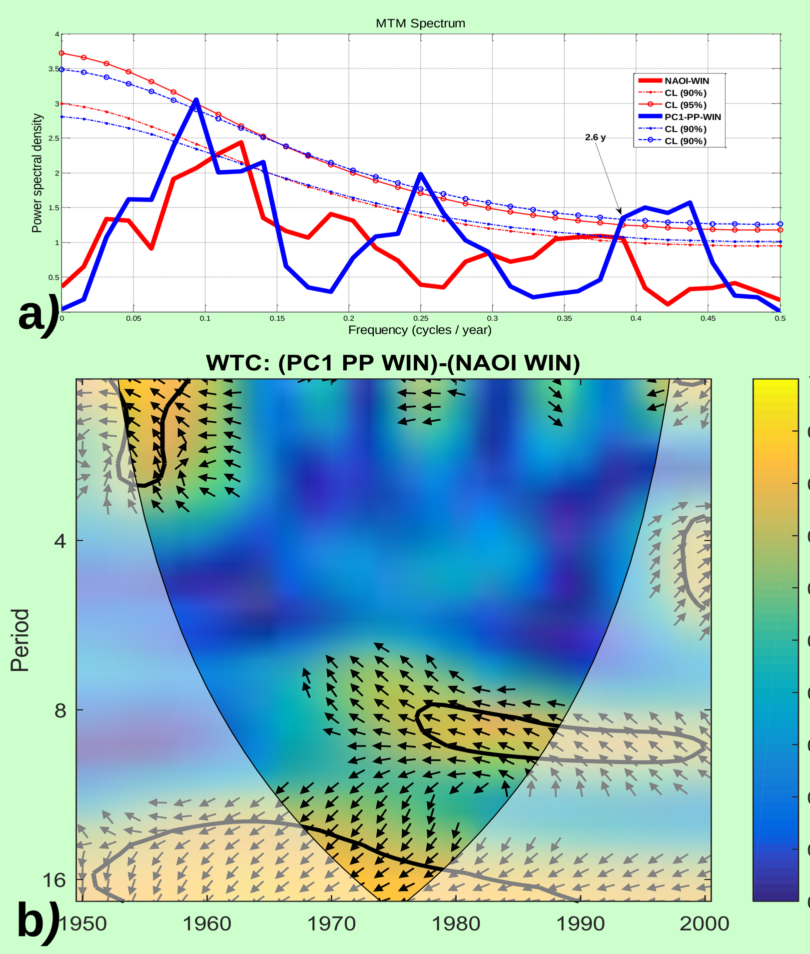

Fig. 6. Spectral analysis (PC1_PP and NAOI):
a) MTM
b) WTC

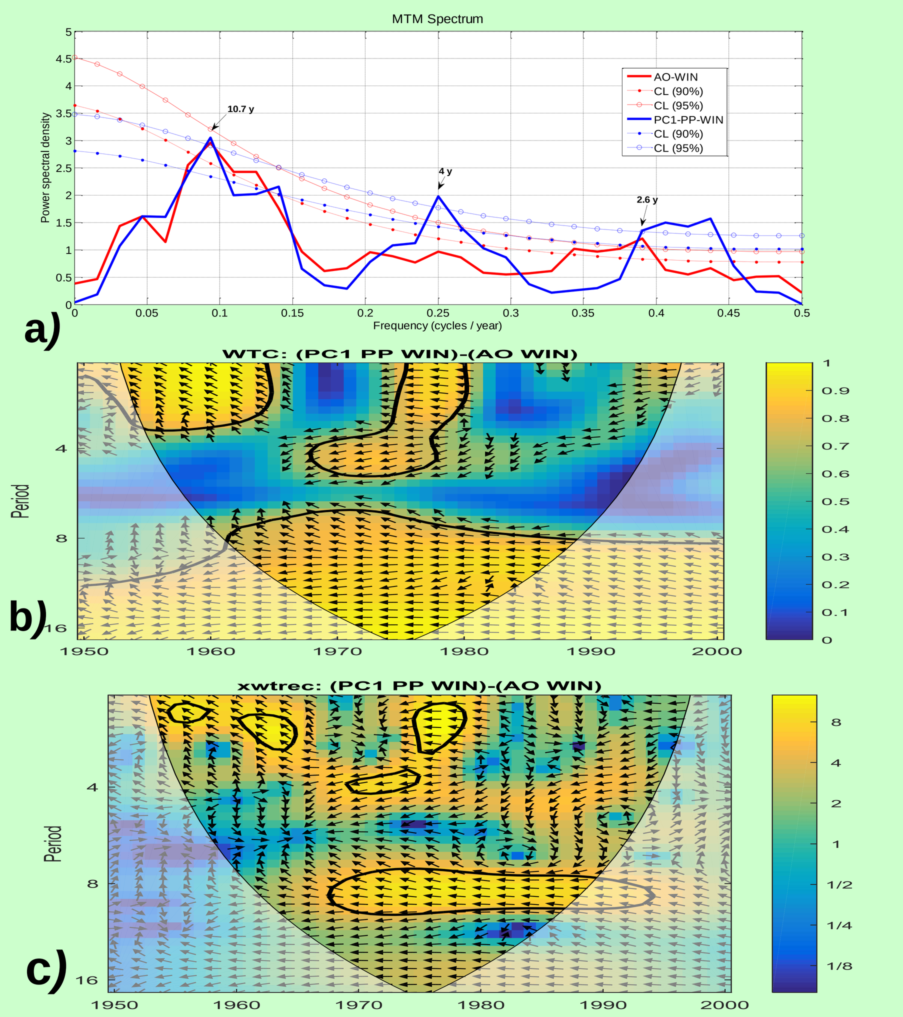

Fig. 7. Spectral analysis (PC1_PP and AOI): a) MTM; b) WTC;
c) Rectified wavelet cross spectrum (xwtrec- *Ng and Chan* (2012))

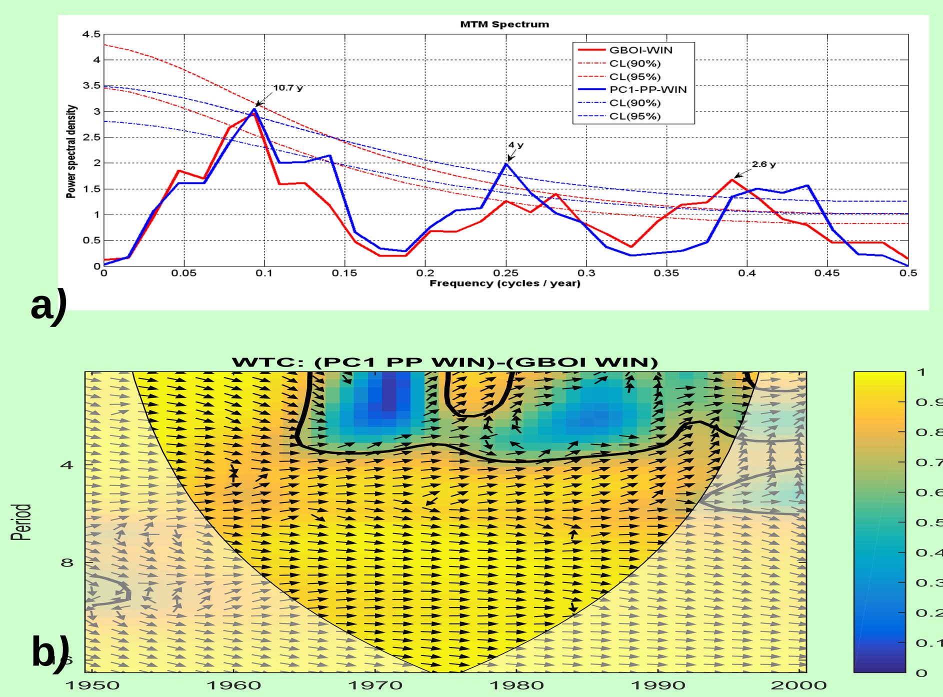

Fig. 8. Power spectra for Greenland-Balkan Oscillation and precipitation in the Danube basin during winter. a) MTM); b) WTC;

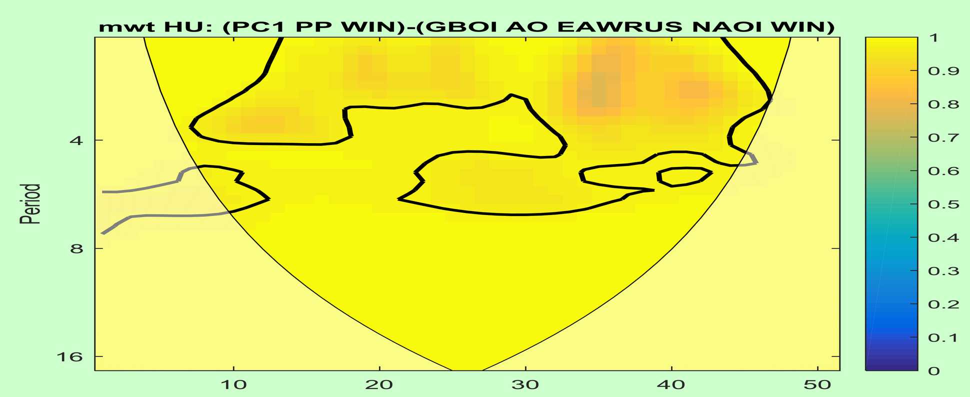

Fig.9. Multiple wavelet coherence (mwt) between the dependent variable (precipitation field) and four significant independent variables (GBOI, AOI, EAWRUS and NAOI) during winter (1950-2000), estimated by the Matlab routines, kindly provided by *Dr. Wei Hu*.

CONCLUSIONS:The most significant values of the wavelet coherence between precipitation and climate indices, taking into account both the time and frequency domains, were observed with indices of the teleconnections patterns: GBO, EAWRUS and AO. For frequency bands corresponding the periods of (4-17yr), these three climate indices showed significant coherence with precipitation in the Danube basin, almost over the entire time domain. The weakest coherence of the precipitation was obtained with EA, SCAND and SO.

MATLAB software packages for wavelet analysis were provided by:

Grinsted, A., J. C. Moore, and S. Jevrejeva (2004). Application of the cross wavelet transform and wavelet coherence to geophysical time series, *Nonlinear Processes Geophys*., 11, 561–566.
Hu, W., and Si, B. C. (2016). Multiple wavelet coherence for untangling scale-specific and localized multivariate relationships in geosciences. *Hydrology and Earth System Sciences*, *20*(8), 3183-3191.
Ng, E. K., and Chan, J. C. (2012). Geophysical applications of partial wavelet coherence and multiple wavelet coherence. *Journal of Atmospheric and Oceanic Technology*, *29*(12), 1845-1853.