USING CONTINUOUS WAVELET TRANSFORM TO ANALYSE SYNOPTIC-SCALE PROCESSES

V. Khokhlov[1], N. Yermolenko[1]
[1]*Odessa State Environmental University, Odessa, Ukraine*

Key words Weather systems, Continuous wavelet transform, North Atlantic Oscillation, Droughts.

Wavelets are fundamental building block functions, analogous to the trigonometric sine and cosine functions. Wavelet transform expands time series into time-frequency space and can therefore find localized intermittent periodicities. The continuous wavelet transform is commonly used to extract details from time series, and the cross-wavelet transform (XWT) of two time series allows revealing their common features in time-frequency space. Here, we used the wavelet analysis (i) to determine a possible linkage between the North Atlantic Oscillation (NAO) and processes over Ukraine at synoptic time scale, and (ii) to examine an impact of the NAO on drought's conditions in Ukraine. The first task seems to be tempted as the NAO-induced changes of hydrometeorological parameters and weather phenomena in Ukraine appear to be not very considerable as its territory is remote relative to the centres of action related to the NAO. The second task is interesting owing to the impact of climate change on characteristics of droughts.

One can be noted that the synoptic conditions in North Atlantic can be connected with changes of weather patterns over Ukraine. However it must be taken into account the fact that this connection occurred only during a few days or 2–3 weeks within cold season [1]. The change of synoptic situation is the process with low noise-to-signal ratio. That the wavelet analysis may reveal some significant variability, the synoptic processes must be active as, for example, the blocking or the evolution of intensive cyclone. Then the changes of these processes would stand out against a background of common synoptic conditions.

Then we used the multiscalar drought index – standardized precipitation evapotranspiration index, SPEI12 – to investigate spatiotemporal droughts variability caused by the climate change. The cross-wavelet transform was applied to reveal a connection between the droughts in Ukraine and teleconnection patterns in the North Atlantics. The analysis showed that the North Atlantic Oscillation (NAO) has a maximal effect on the droughts in Ukraine. The anti-phase relation is registered for the joint fluctuations with the periods 2-3 years and is most prominent in the Southern Ukraine (Fig. 1). On the contrary, the NAO has a small impact on the Northern Ukraine. This fact can be explained by the orientation of main storm tracks for positive and negative phases of the NAO.

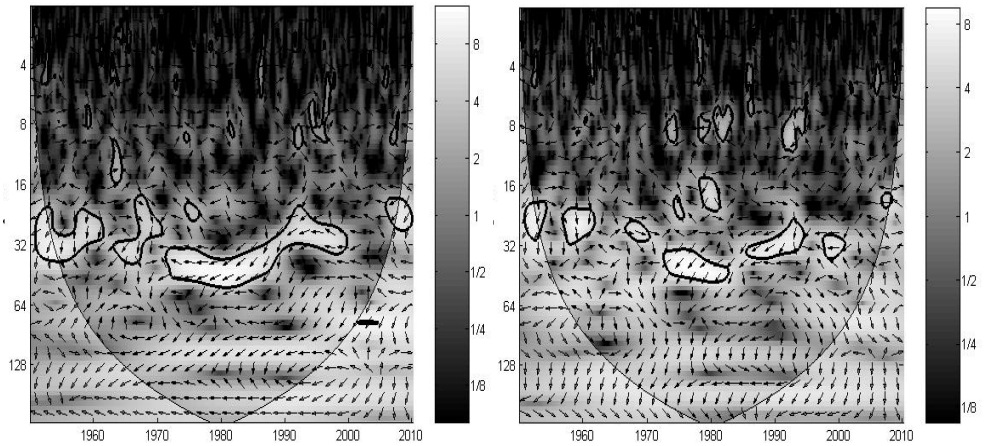

Figure 1. Cross-wavelet transform of NAO indices and SPEI12 for southern (left panel) and northern part of Ukraine; *x*-axis – years, *y*-axis – period (months).

Our results showed that wavelet transform is the best method to detect possible peculiarities from various non-stationary hydrometeorological time series.

References

[1] V. Khokhlov and A. Romanova, *Joint principal component – wavelet analysis of atmospheric teleconnection: the North Atlantic Oscillation case*, Stoch. Environ. Res. Risk Assess., **28**, 369-381 (2014).