Changes in the hydrological cycle in the Caspian Sea basin in recent decades

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This paper is related to the analysis of changes in the hydrological cycle in the Caspian Sea basin and their connection to the key modes of climate variability based on observational data over the past decades. The Caspian Sea is the largest lake in the world, and one of the largest regional climatic variations over the last century is associated with the large Caspian Sea level (CSL) anomalies and regional variations in the hydrological cycle (Arpe et al., 2000). The analysis used monthly-mean values for the Caspian Sea level (CSL) (http://esimo.ru/dataview/viewresource?resourceId=RU_RIHMI-WDC_663&armId=casp), as well as monthly-mean values for the rivers runoff by the data available at the State Hydrological Institute (http://www.hydrology.ru/). Also, the monthly-mean values of the indices characterizing the North Atlantic Oscillation (NAO) and El Niño/Southern Oscillation (Nino3, Nino3.4, Nino4, SOI) were used (https://psl.noaa.gov/gcos_wgsp/Timeseries/).

Figure 1 shows the interannual variations in the CSL for the period 1900–2020 compared with moving 30-year changes in the winter NAO index.

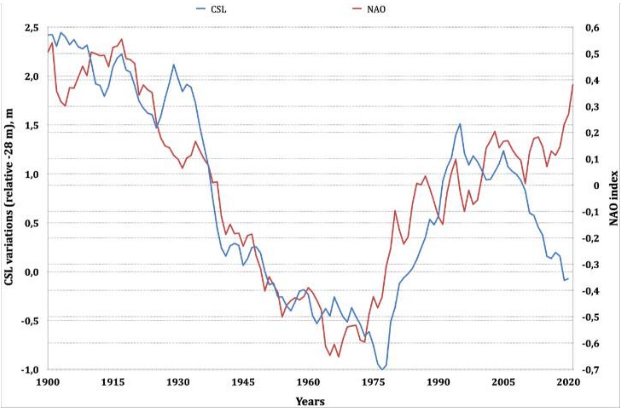

Figure 1. Interannual CSL variations (blue curve) for the period 1900-2020. Moving 30-year changes in the winter NAO index are also noted (red curve).

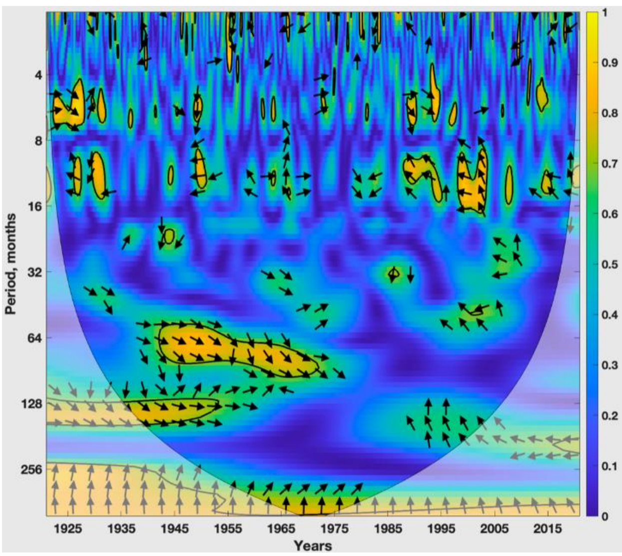

Figure 2. Local coherence of CSL anomalies (at Krasnovodsk station) with the NAO index by monthly-mean data for the period 1921–2020. Regions of significant coherence (at the level of 95%) are highlighted; the arrows show the phase shift (arrow to the right denotes in-phase, to the left, antiphase); regions of boundary effects are also indicated.

Figure 2 with the results of a cross wavelet analysis of GSL variations (at Krasnovodsk station) and NAO index by monthly-mean data for the period 1921-2020 shows significant local coherence for long-term variations.

For the last decades, a significant coherence of CSL with El Niño phenomena has been also noted for long-term variations with periods of about three decades or more. This coherence is more significant with El Niño events, with the strongest surface temperature anomalies at equatorial latitudes in the central Pacific Ocean. Also, a significant coherence for interdecadal and intradecadal variations was noted.

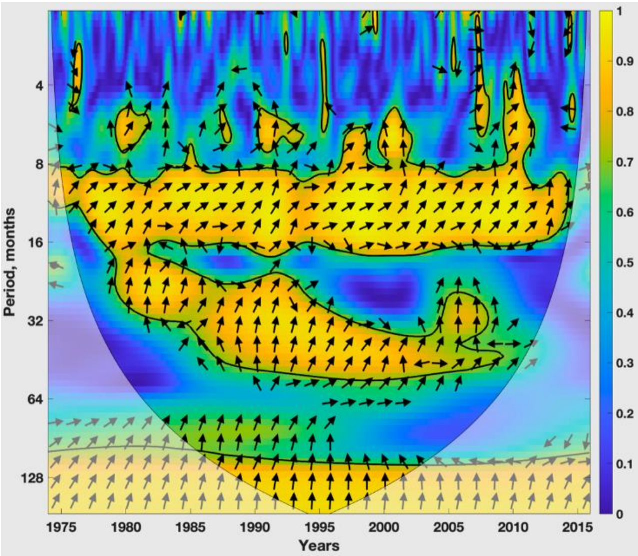

Figure 3. Local coherence of the CSL and Volga River runoff by monthly-mean data for the period 1974–2015.

According to the results of cross-wavelet analysis in Fig. 3, the local coherence of the CSL and the Volga River runoff by monthly-mean data is significantly manifested in the annual cycle. Also, their coherence for interannual and interdecadal variations was noted. Local coherence of the CSL and the Ural River runoff for the period 1938-2016 (not shown) manifests itself significantly in the annual cycle and is much weaker for interannual and interdecadal variations. The runoff of the Volga and Ural rivers shows statistically significant coherence in the annual cycle but has no significant coherence of interannual and interdecadal variations over the past decades.

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References

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