Comparison of quantitative drought indices for the South of Siberia

*Anna Aleksandrovna Riazanova[1,2], Nadezda Nikolaevna Voropay[1,3], Igor Georgievich Okladnikov[1,2], Evgeny Petrovich Gordov[1,2]

1. Institute of Monitoring of Climatic and Ecological Systems of the Siberian Branch of the Russian Academy of Sciences, Tomsk, 2. V.E. Zuev Institute of Atmospheric Optics of Siberian Branch of the Russian Academy of Science, Tomsk, 3. V.B. Sochava Institute of Geography of Siberian Branch of the Russian Academy of Science, Irkutsk

Monitoring of climate extremes, including droughts, under on-going climate change is of scientific and practical importance. Drought is a temporary decrease of environment moisture in relation to its average state. Due to the complex character of drought, it is often studied only from one side (either in the atmosphere or in the soil). In order to obtain a quantitative assessment of the droughts, different hydrothermal indices are used. These hydrothermal indices usually are combination of air temperature and precipitation values. In this paper comparison analysis of the most well-known foreign and Russian drought indices is presented. These are Selyaninov hydrothermal coefficient (GTC), Ped drought index (Si), standardized precipitation index (SPI) and standardized precipitation-evapotranspiration index (SPEI). The analysis was carried out using the web-GIS "CLIMATE" [Gordov, 2016]. Statistical package written in R language and allowed to calculate SPI/SPEI indices (https://cran.r-project.org/web/packages/SPEI/index.html; Vicente-Serrano, 2010) were integrated into the web-GIS "CLIMATE". The integration procedure of R statistical package was developed and described earlier in [Ryazanova, 2017]. Then functionality of the “CLIMATE” system was extended by a software module based on the integrated package to calculate the SPI/SPEI indices. Development of software modules of the system “CLIMATE” that allow calculating Selyaninov hydrothermal coefficient and Ped drought index were described earlier [Riazanova, 2016; Ryazanova, 2017]. As input data for this study the ECMWF (European Centre for Medium-Range Weather Forecasts, UK) ERA-Interim reanalysis data [Dee, 2011] on air temperature and the sum of precipitation at the Earth’s surface were used. To improve the quality of the precipitation reanalysis data, we use an approach that was presented in a previous study [Riazanova, 2016]. All hydrothermal indices were calculated for the territory of Southern Siberia (50˚-65˚ N, 60˚-120˚ E) from 1979 to 2017, which allows obtaining spatial assessments of aridity/moisture of the territory in contrast to the existing assessments of other Russian authors. Calculation and analysis were carried out only for month of the growth season (from May to September) for the study area. By the results of the analysis it was obtained that maximum linear correlation coefficient is between SPI and SPEI (0.8-0.9), Si and GTC (0.7-0.9) in the active growth season (JulyAugust). In the mountain area (May, September) GTC was not calculated because average daily temperature was below 10˚C (this is necessary condition for calculating). Consequently, the relation between the GTC and other indices for May and September in the mountains was not defined. In the foothills correlation coefficients is high (about ±1.0), because in these areas there are contrasts of sums of atmospheric precipitation in windward and leeward slopes in comparison with plain. In other cases, relations between the series of drought indices are not statistically significant (±0.2) for the most part of investigated territory. Spatial distribution of extreme and severe droughts for investigated period shows similar results for SPI and SPEI. Frequency of severe drought is maximal in July and August (2-3 droughts) for all territory. But, centers with maximal frequency (up to 5 droughts) were detected in May and August. Analysis of Si shows maximal frequency of severe drought (up to 4 droughts) in July and August in Sayan. Analysis of anomaly of GTC shows uniform spatial distribution (2-3 droughts). As a result, all drought indices demonstrate droughts, but in order to understand which index is more relevant to real situation, a comparison of those with characteristics of vegetation, for example, NDVI required. It is planned for the next step of investigation.

Keywords: drougths, droughts indecies, SPI/SPEI, Southern Siberia, Selyaninov GTC, Ped index

