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Characteristics of heat and cold waves in Ukraine and North-Western part of Russia and its long-term variability

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Extreme events have a strong impact on economic and ecological systems, causing dramatic effects on agriculture, health and other socio-economic activities. Predicting these impacts is of great importance, and that is why climate studies over the last decades have focused on weather and climate change extremes both in the future and in the past. Heat and cold waves are weather extremes which are forced by synoptic-scale processes and can be amplified by positive regional feedbacks (e.g., soil-atmosphere feedback for heat waves). At the same time, tendencies in the heat/cold wave frequency and auxiliary characteristics are the result of the global processes in the climate system. The goal of the present study is to investigate long-term variability of characteristics of heat/cold waves on the territory of Ukraine and North-Western part of Russia using the routine meteorological observations for the period of 1936-2012. Method of extraction of heat and cold waves is crucial issue, which is addressed in this study. In order to reach the goal the following tasks have been solved:
1. Development of the new objective method to extract heat/cold wave events and to describe its main characteristics such as initial period of the wave formation, intensity and duration. The method is based on the recently developed concept of modulated annual cycle (MAC) and application of adaptive and temporally local time series analysis approach, i.e. empirical mode decomposition (EMD).
2. Analysis of statistical distributions of each type of the extracted characteristics and their joint probabilities with special treatment of extremes.
3. Analysis of its relationship to large-scale atmospheric circulation regimes using simulated annealing clustering of NCEP-NCAR reanalysis patterns of 500 hPa geopotential height. The analysis was accomplished for the period of 1948-2012.
4. Analysis of intrinsic modes of long-term variability of heat/cold wave events frequency, its seasonal-averaged and extreme characteristics by using the empirical mode decomposition (EMD). Interannual to interdecadal modes of variability have been detected encompassing the main time scales of global climate variability in the Northern Hemisphere.