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Impact of atmospheric circulation regimes on air temperature and precipitation patterns in Northern Eurasia.

O. Anisimov, S. Reneva, O. Zakharova, and E. Zhiltcova
Hydrological Institute, St. Petersburg, Russian Federation (oleg@oa7661.spb.edu)

Many recent studies employ the numeric indices to characterize the continuum of atmospheric circulation regimes. Example is given by the North Atlantic Oscillation (NAO) index, defined as the difference of normalized mean sea-level pressure anomalies between Lisbon, Portugal and Stykkisholmur, Iceland. Variations of this index have been shown to be coherent with the observed changes in the precipitation and temperature regimes over large territories in Europe and Asia, ultimately leading to the conclusion that it may be used to characterizes and predict regional climate variations. More accurate and detailed results may be obtained through analysis of the full-scale atmospheric circulation regimes characterized by finite number of modes. In this study we present such results for Northern Eurasia and analyze the effect of the atmospheric circulation on air temperature and precipitation patterns.

In conventional Russian climatology the atmospheric circulation regimes are characterized by three major circulation forms, W, E, and C. These forms are defined on the basis of the 3-dimensional analysis of the sea-level pressure field and generally correspond to dominating westerlies over European part of the continent and most of Siberia (form W), and presence and location of the atmospheric blockings (forms E and C). Daily circulation data for the period 1890-2007 have been used to calculate the monthly and seasonal frequencies of the three circulation forms (W, E, and C) defined as the ratio of the cumulative number of days with the given form of circulation to the duration of the period. We analyzed the century-scale variations in the frequency of each of the circulation forms and compared them with the changes in the temperature and precipitation patterns. We selected the years when the frequency of any given circulation form was above 60% in winter, in summer and in each of the months and for each season/month constructed 4 “discrete” time series of air temperature and precipitation at 455 Russian weather stations corresponding to the years dominated by either W, E, or C circulation forms, or none of the above. We constructed the maps of temperature and precipitation departures averaged over the “discrete” time intervals, analyzed the characteristic features of the spatial patterns and their resilience in time and over space. One of the findings was the discernible difference between the characteristic spatial patterns of the winter temperature and summer precipitation under the three atmospheric circulation forms. Summer temperature patterns are not so distinct and spatial features are not constant in time presumably because of the short discrete time series for each of the circulation forms. This is also a case with the winter precipitation, largely because the precipitation departures in winter are relatively small compared to the summer.

The overall conclusion of this study is that there is a strong correspondence between the frequency of the W, E, and C forms of atmospheric circulation and spatial features of the air temperature and precipitation fields in Northern Eurasia. Analysis of the iconic patterns of the climatic variables corresponding to the periods dominated by specific circulation forms may serve as a useful tool for mid-range (decadal-scale) prediction of regional climate variations and evaluation of the GCMs.

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