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Impact of fluctuation of hydro-physical regime in the North Atlantic on the climate of Eurasia

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In the mid-1970s a heat content in the North Atlantic Ocean has substantially changed. Because of its high energy value the event appears to have a significant impact on the regional environment. To verify this suggestion we analyzed the global ocean-atmosphere data related to the negative (1950-1970) and positive (1980-1999) phases of the North Atlantic Oscillation (NAO). The analysis of these data have shown the existence of a thermal dipole in the North Atlantic upper layer which can be interpreted in a sense as an oceanic counterpart of atmospheric NAO. To identify this North Atlantic Dipole (NAD) its index was considered as the ocean 0-100-m layer temperature difference between regions (20°-40°N; 80°-30°W) and (50°-70°N; 60°-10°W). Then the NAD index was suggested a possible physical mechanism factor of the regional ocean-atmosphere system variability which in turn could produce a draw effect on the recent climate of Eurasia. The study showed that the current phase (2000-2013) of the climate in the North Atlantic region becomes qualitatively similar to the situation, typical for period 1950-1970, when the index of continentality in the Eurasian region was a very high. There is a reason to believe that in the coming decades this index is likely to increase, that would be primarily manifested by relatively cold weather in winters and by hot-dry summer seasons.
To assess the variability of ocean heat content it was used a General Ocean Circulation model developed at the Institute of numerical mathematics, Russian Academy of Sciences. This model belongs to the class of σ-models, and its distinguishing feature is the splitting of the physical processes and spatial coordinates. By using the model there were performed numerical experiments for the evolution of hydrophysical regime of the North Atlantic Ocean at the period of 1958-2006, with a spatial resolution of 0.25°x0.25° for 25 horizons with time window of 1 hour. As initial conditions for the experiment the results of 20 years adapting calculation with Levitus array data for the state on January 1958 were taken. The data of CORE array were also accepted as ocean surface boundary conditions. Calculations of mean temperature were made for the colder (January, February, March) and warmer (July, August, September) seasons within each of the 3 climate scenarios that occurred in the region during periods of 1958-1974, 1975-1999 and 2000-2006. After that there were calculated area-averaged temperature profiles in two 5-degrees squares: Labrador sea (57.5°-62.5°N, 57.5°-52.5°W) and a region of Gulf Stream (42.5°-47.5°N, 40°-30°W). As a result there have been observed quasi-antiphase of 700-m layer heat content variability in these squares. In the Labrador sea during the transition from I to II climate scenario it was followed a heat discharge – ocean lost heat, while the transition from II to III scenario was marked by accumulation of heat. In the area of the Gulf stream the transition from I to II scenario was characterized by heat accumulation by the ocean, whereas a transition from II to III scenario was distinguished by a relatively weak heat loss. In respect to prognostic targets it was supposed that the result could be essential for disclosure of relationships between climatic parameters of the Eurasian continent and the thermodynamic processes in the specific areas of the North Atlantic Ocean.