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A causal link between the North Atlantic, the North Pacific surface water temperature nonlinear trends, the Eastern Arctic ice extent drift and change in atmospheric circulation regimes over Northern Eurasia

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Atlantic Multidecadal Oscillation (AMO) and Pacific Decadal Oscillation (PDO) monthly time series (Ernfield, et al, 2001) were investigated for last 150 years by implementation of a comprehensive smoothing technique controlled by cross-validation procedure, which provided more statistically significant trend evaluation than moving average or linear trend techniques. It was found that there is a winter sea surface temperature (SST) oscillation of around the 64-69 year scale behind a known SST fluctuation of decadal scale for winter months. The AMO trend demonstrates waters warming in the first part of twentieth century, cooling period in 50-th and 60-th, and warming in 80-th – 90-th years. The PDO nonlinear trend has similar periodicity, but it is shifted in 34 year by phase. This result confirms the global ocean conveyer theory of Broker. Weak AMO and PDO linear trends respond to the greenhouse warming effect related to carbon dioxide concentration increasing. It demonstrates a slow warming behind a more strong (in amplitude) oscillation responded to still not well understood world ocean properties. This result was confirmed by independent research based on wavelet analysis of the same time series. Decadal and multidecadal scales were detected at wavelet power spectrum as a statistically significant with account to 95% probability level. Similar study was carried out for paleoclimate proxy data related to the AMO and PDO for last six centuries. Nonlinear trends and wavelet spectrum confirm above conclusions on existence of the SST natural oscillations in the Atlantic and Pacific Oceans with a periodicity of about 60 years. Hurrell's data on monthly the North Atlantic Oscillation (NAO) index with account for SST since 1856 were also used and provided very close conclusions with respect to decadal and multidecadal oscillations and its phases. Similar study was carried out for the 20-th century ice extent (IE) time series obtained in Arctic and Antarctic Research Institute (St. Petersburg) for Russian margin seas: Kara, Laptev and East-Siberian during late summer and early autumn (Polyakov, et al, 2002). The IE smoothed curve in Barents and Kara Seas shows a coherent behavior: two minimums (in 20-th –30-th and in 80-th – 90-th) and one maximum in the middle of 20-th century. Wavelet analysis provided similar anomalies in power spectrum. It turned out that the atmospheric sea level pressure (SLP) climate series for Northern Siberia demonstrated fluctuations of decadal and multidecadal scales. The surface atmosphere temperature (SAT) series for North Asia sites displayed analogical time and spectral structures. Coherency of the AMO/PDO/NAO/IE trends, on one hand, and SLP/SAT trends, on other hand, proved a close relationship existed in various modules of the climate system (atmosphere-ocean-glacial cover) in the Northern Hemisphere. Another issue of this study was an investigation of the phase delay detected under analysis of the smoothed curve signatures responded to above climate parameters. Considered phase delays in decadal and multidecadal oscillations were also explored by means of a cross wavelet analysis tool. To quantitative evaluate a linkage between above parameters we carried out a cross wavelet analysis (Grinsted, et al, 2004) and revealed some ranges in power spectrum, which are statistically significant with account for 95% probability level.