INFLUENCE OF THE EQUATORIAL NORTH ATLANTIC ON THE SEA ICE SHRINKING IN THE ARCTIC

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The sea surface temperature (SST) anomalies in low latitudes affect the climate change because of the large amount of heat accumulated in this part of the World Ocean [Palmer et al., 2007]. In this region, up to the end of summer (September-October) SST reaches the highest values and greatly affects the Arctic climate. Presumably, the mechanism of the influence of the SST anomalies on the Arctic includes the interaction of the atmospheric and oceanic circulation patterns, such as NAO, Hadley and Ferrel cells for the atmosphere, and the ocean Gulf Stream, the North Atlantic and the Norwegian currents. To investigate the relationship between the circulation patterns, the data of monthly SST from HadISST dataset for 1951-2013 (http://www.metoffice.gov.uk/) were used. Also involved were the data on the water temperature at Kola section in the Barents Sea for 1951-2013 (http://www/pinro.ru/n22/labs/labhidro), monthly sea ice extent (SIE) data in the Arctic (http://www.aari.ru/datasets) and NAO index data (http://www.cpc.ncep.noaa.gov/). Multivariate correlation analysis was used to determine the maximum correlation coefficients between the SST anomalies and the climate characteristics and the corresponding delays. The location of the area of SST anomalies in the North Atlantic, which is influenced by the Arctic SIE is found (fig.1 a). This area is the same for SIE in all months, but with different delays for every monthly SIE [Alekseev et al., 2016]. Fig. 1 b presents the time series of October SST anomalies and SIE 38 months later in December. The positive SST anomalies intensify and extend Hadley and Ferrel cells in the atmosphere [Adam et al., 2014; Huang and McElroy, 2014]. As a result, the meridional atmospheric circulation is enhanced. The oceanic heat transport by Gulfstream, North Atlantic/ Western Shpitsbergen and Norwegian currents also increases (fig. 2). The NAO circulation is diminished under positive SST anomalies (fig.3). Under negative NAO phase, zonal winds in the atmosphere over the Atlantic north of 40 ° N are followed by the decreased heat flux from the ocean. Thus, the NAO participates in the transmission of the influence of low-latitude SST anomalies through the impact on the SST north of 40 ° N. Finally, the strengthening of the oceanic heat inflow to the Norwegian and Barents seas and the decrease of winter spread of sea ice cover in the Arctic occurred.

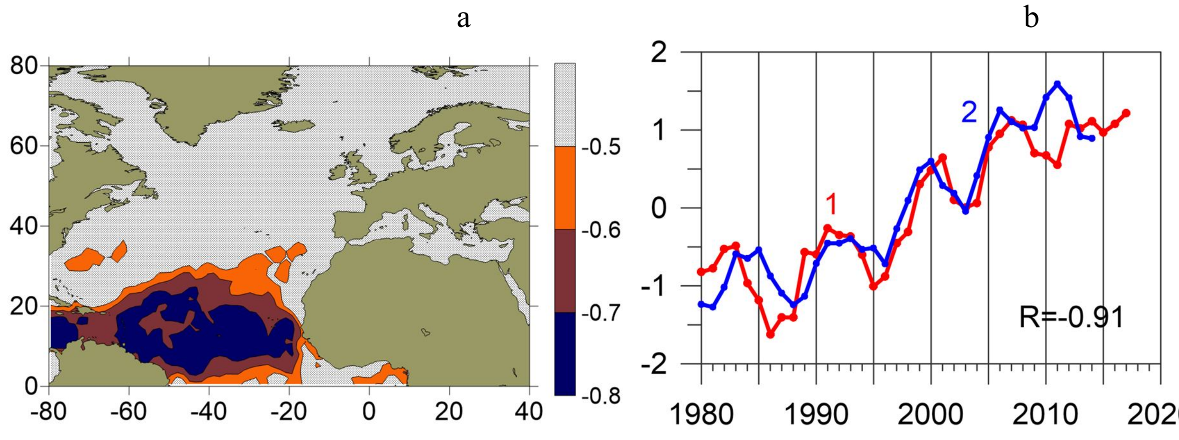

Figure 1. a) pattern of correlation coefficients between SST anomalies in October and December SIE in the Arctic after 38 months, b) standardized anomalies of October SST (1) and December SIE (2) both smoothed by 3-year averaging. R is the correlation coefficient between (1) and (2). The correlation between detrended series is -0.78. Note that the sign for the both series reversed.

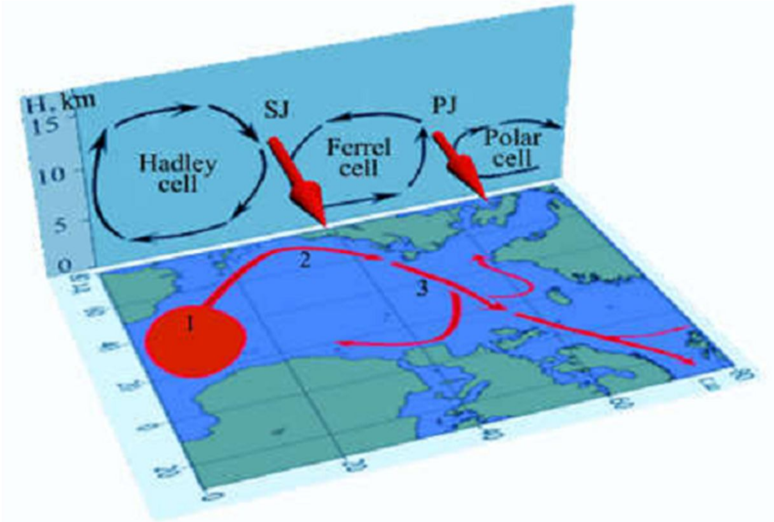

Figure 2. Idealized depiction of the SST anomaly effect on the Arctic. 1 – SST anomaly, 2 – Gulfstream, 3 – North Atlantic, Norwegian and West Spitsbergen currents, SJ – Subtropical jet, PJ – polar jet.

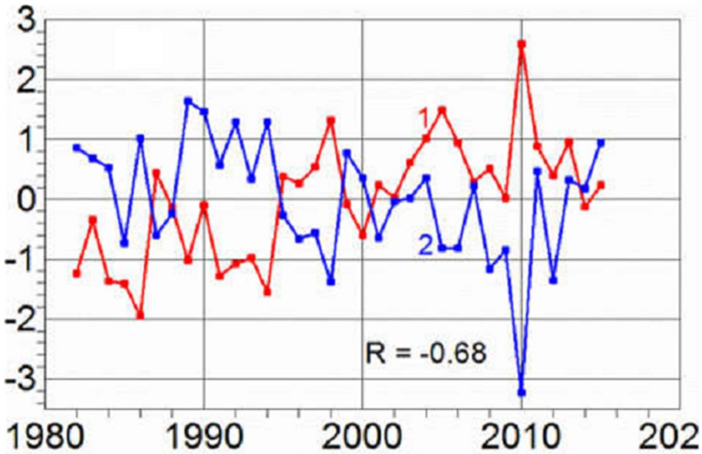

Figure 3. Normalized anomalies of annual SST (1) and annual NAO index (2). R is the correlation coefficient.

Conclusions

The relationship between the SST anomalies in low latitudes of the North Atlantic and the SIE anomalies in the Arctic with a lag of up to 3 years is established. The mechanism of remote influence of SST anomalies to the Arctic includes interaction between atmospheric and oceanic circulation modes that drive the heat transport to high latitudes.

References

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