COASTAL DYNAMICS DURING THE EROSION OF THE ICE COMPLEX AND TABER PERMAFROST DEPOSITS: A MODEL BASED ON THE FRAGMENTARY STATIONARY MATRIXES OF THE TRANSIENT PROBABILITIES

V. Ostroumov

Institute of Physicochemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino, Moscow region, 142290, Russia, Mail to: vostr@issp.psn.ru

The Markovian is one of the interesting properties of the time series of the retreat rate of the coast line (RRCL) in the Arctic. The Markov chain based stochastical model can be used to simulate the dynamics of the shore line of the Arctic seas during thermal abrasion.

F. Are (1991) analyzed data on the RRCL monitored over a long term period. No considerable changes of the RRCL were found. It was shown that the averaged RRCL is practically constant within lithologically homogeneous sites during long term periods. This point is a base for using the Markov chain based stochastic model with a stationary matrix of transition probability to simulate the time series of the RRCL for homogeneous segments of the shore.

Within the ACD program coastal retreat rates are constantly monitored at the key site Malyi Chukochii Cape, East Siberian Sea. Currently, the coastal section consisting of ice rich permafrost deposit of Yedoma type (ice complex) is undergoing erosion. The observed retreat rate of the coastline was 14 m from 1984 to 1988, 11 m from 1988 to 1990, 3m from 1990 to 1991, 15m from 1991 to 1994, and 22 m from 1994 to 1999 (monitoring is carried out by S. Gubin, D. Fyedorov-Davydov, V. Sorokovikov, and V. Ostroumov). The average RRCL for the 15 years time series is 4.3 m/year.

The continuous year-by-year initial time series of the RRCL was calculated using the Markov chain based model with a stationary matrix of transient probabilities. Such model was used to calculate the simulated time series. In the case of homogeneous permafrost sediments along the profile, the modeling consists of the following steps: testing the initial time series for Marcovian; discretization of the initial time series; calculation of the transient probabilities;

Figure 1. Initial (a) and simulated (b) time series of RRCL for a homogeneous site with Yedoma type ice complex deposits.

calculation of the transient probability matrix in cumulated form; calculation of the simulated Markov chain; calculation of the continuous RRCL time series.
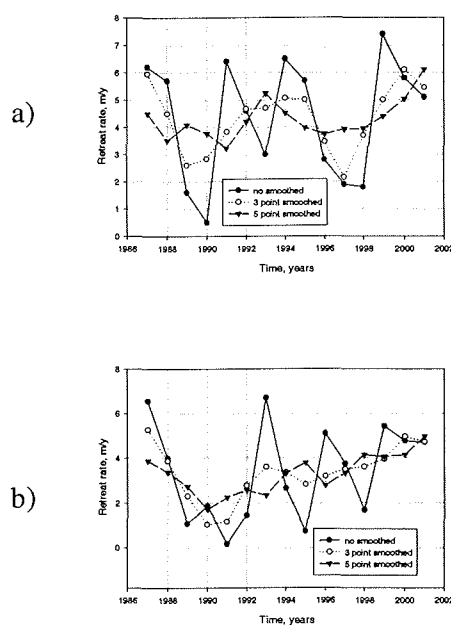
The simulated data can be compared with the initial time series (Fig. 1). The comparison shows that the simulated time series reflects the shape of the dynamic curves for the initial data set.

Along the mentioned profile, the following sequence can be observed: currently (1999) eroded suite of Yedoma deposit, 96 m width; taber deposit of ancient alas, 403 m width; another Yedoma type ice complex, 225 m width; once again taber deposits. Under the current average RRCL of 4.3 m/y, the 96 m suite of the currently eroding ice complex will be completely destroyed within 22 years. Then, the RRCL will decrease to 1.8 m/y. To describe such changes of the average RRCL at the lithological boundaries, a model with fragmentary stationary matrixes of transient probabilities is recommended. The algorithm for such a model has an additional step for changes of the stationary matrixes at the time of changes of the average RRCL.
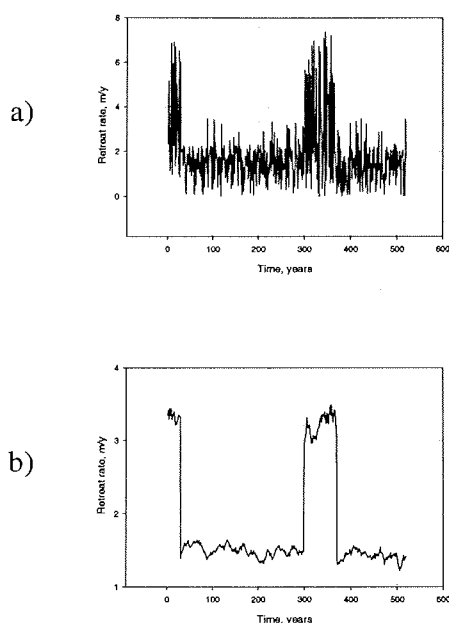
a)

b)

Figure 2. Time series of the RRCL simulated using the fragmentary stationary matrix of transient probabilities (a - not smoothed, b - 41-point smoothed data).

Fig.2 shows the results of simulations using the model based upon the fragmentary stationary matrix of transient probabilities. The contrast changes of the magnitude of the RRCL coincide with the geological boundaries (not smoothed curve, Fig. 2b). Some contrast change of the average RRCL is present in the smoothed curve as well.

The testing of the model and the obtained results confirms that the Markov chain based model can be a helpful instrument for simulations of the RRCL time series. Statistical models can be used in a complex with the deterministic empirical and analytical ones for simulations of the dynamics of Arctic coasts.

References

Are, F.E. 1998. The thermoabrasion of Laptev Sea shores and its input into sediment budget of the sea (in Russian). - *Earth Cryosphere* 1(II): 55-61.