THE INFLUENCE OF ATMOSPHERIC CIRCULATION ONTO THE FLUCTUATIONS OF THE BALANCE OF MASS OF THE TUYUKSU GLACIER (ILE ALATAU MOUNTAINS)

N.K. Kononova [1], N.V. Pimankina[1], L.A. Yeriskovskaya [1]

[1] Institute of Geography RAS, Moscow, Russia;

[2] Institute of Geography MES, Almaty, Kazakhstan

E-mail: pimankina@mail.ru

INTRODUCTION

The climate of the region is formed by: 1. Abvances of southern cyclons from Iran and Afghanistan, movement of warm tropical masses. 2. Cold invasions from north and north-west, precipitation. 3.Influence of south-western and south-eastern periphery of antycyclon, steady clear weather. 4. Invasion from the west cold and moisture-saturated air masses. The dynamic scheme of synoptic processes is shown in Fig. 1.

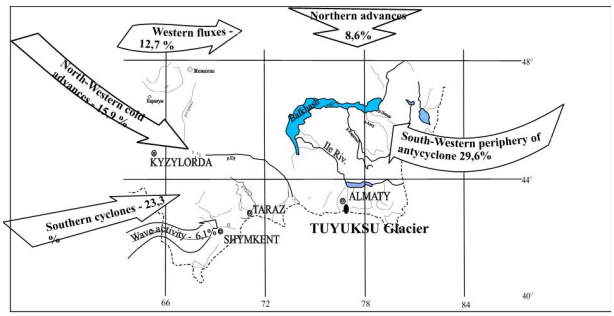


Fig 1. **Scheme of the main synoptic processes contributing into the formation of climate of the region in a cold half-year**

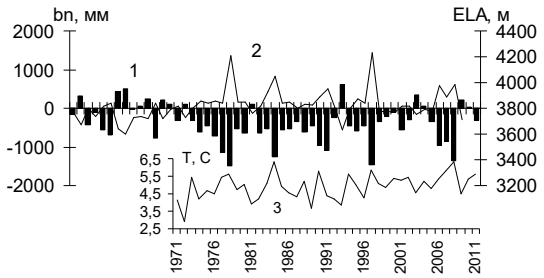


Fig. 2. **Course of the glaciological parameters of the Tuyuksu Glacier and mean summer air temperature (1971-2011). 1 – annual mass-balance of the glacier (bn, mm), 2- equilibrium line altitude (ELA, m), 3 - mean summer air temperature (June-August).**

At present the glaciers of the Ile Alatau Range are at a stage of retreat. The area of an open part of glaciers of the Little Almatinka River decreased from 9,1 sq.km to 5,67 sq.km in 2008. From 1956 to 2012 the Tuyuksu Glacier retreated by 750 m, and the average yearly retreat is 13,6 m. Meteorological observations at the "Tuyuksu-1" glaciological station (H=3450 m a.s.l.), show, that the tendencies in the changes of the air temperature , precipitation, depth of snow cover, are weakly expressed [Data…, 1972-2012, in review]. Fig. 2 presents multiyear course of some characteristics

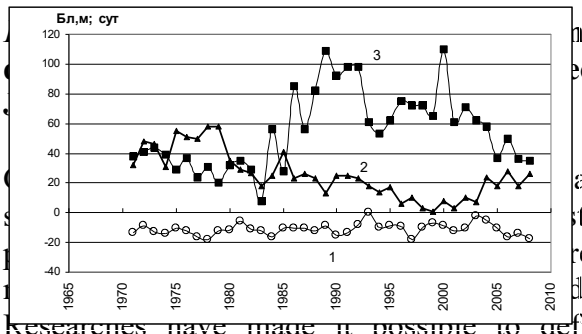
of the glacier. The coefficient of correlation between yearly balance of mass and average summer temperature is –0,56.

METHOD

To assess relations between fluctuations of atmospheric circulation and formation of accumulation and ablation of the Tuyuksu Glacier the Dzerdzeevskii's typification of the Elementary Circulation Mechanisms (ECM, 13 types) of the Northern Hemisphere was used [Dzerdzeevskii, 1962 in review]. Multiyear series of the duration of each ECM (in days), obtained from the Calendar of the ECM [Kononova, 2010, in review] allow to correlated them with the meteorological characteristics. The influence of atmospheric circulation upon the formation of mass-balance is in the fact that the weather type at the particular ECM has specific regime of temperature and humidity.

RESULTS

The closest relations were found between the value of winter balance of the glacier and total duration of the winter sub-types of ECM type 12 in January-May. For the period of observations 1991-2008 the coefficient of correlation is 0.63. The closest negative relations were found between the summer balance and total duration of the ECM 2, 4, 7 и 10 (Fig.3). The coefficient of correlation is -0, 55. The increase in the number of days with those types causes the weather without precipitation and higher air temperature.



mer mass balance of the Tuyuksu Glacier, m (1), echanisms ECM 2+4+7+10 (2) and 13л (3), days, for

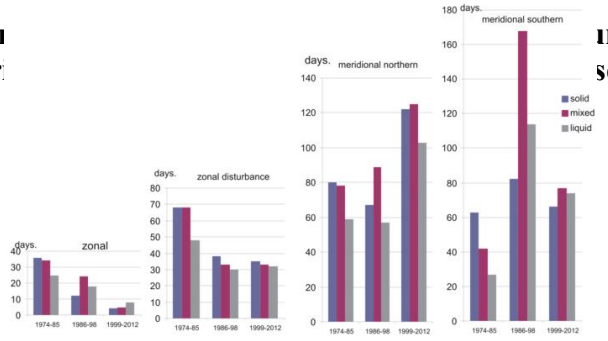
ablation was evaluated through the number of days and st. At the average, in June-August there 52 days with recipitation for 1972-2012 is 420 mm, from which 150 d.

Researches have made it possible to define certain periods of fluctuations of glaciological parameters of different duration according to the macro-circulation processes.

The first period lasted from 1957 to 1973 (Table 1). The boundaries of the period correspond to the period of prevalence of meridional northern and southern processes [Kononova, 2010, in review]. Heightened winter accumulation, reduced negative yearly balance were observed. Snow line altitude was 3750 m a.s.l.

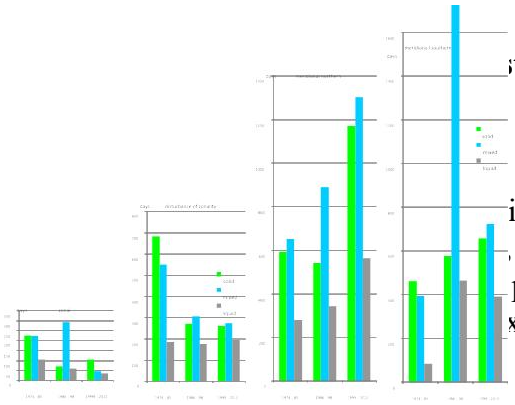
For the period from 1974 to 1998 the greatest values of negative yearly balance and the raise of the snow line to 3870 m a.s.l. (by 120 m higher than in previous period) were typical. The boundaries of the period correspond to the periods with more long action of zonal processes (1974-1985) and after that – rapid increase in the duration of meridional southern processes (1986-1998). The first 10-years is characterized by small value of the days with precipitation and sums of precipitation brought with zonal fluxes in summer (Fig. 4-5). The number of days and sums of precipitation connected with the meridional southern processes (type 13s, southern cyclons), was low. During the next years the number of days with solid precipitation falling on the glacier decreased, but the number of days and sums of mixed and liquid precipitation transported by the southern meridional processes increased sharply (by 4 times!).

Fig. 4. **Su ine-August according to the groups of atmospher servation**



The increase in the sums of liquid precipitation, warming the snow cover on the glacier and stimulating melting of snow accumulated in winter, plays important role in ablation of the glacier.

***Fig. 5.* Sums (...st according to the groups of atmospheric circulation du...**



The next perio... ...ime span is rather favorable for the life of glacier. The ac... ... and meridional northern fluxes increased. Total number (... processes increased by twice in comparison with the previo... ...xed precipitation have increased.

***Table 1.* Glacioclimatic characteristics of the Tuyuksu Glacier**

Characteristics	Period of observations			
	1957-1973 (increase in meridional northern and southern processes)	1974-1998		1999-2012 (prevalence of meridional northern processes)
		1974-1985 (prevalence of zonal processes)	1986-1998 (prevalence of meridional southern processes)	
Average air temperature for IX-Y	(-7,3)	-7,1	-6,8	-6,2
Average air temperature for VI-VIII	(4,1)	4,9	4,8	5,3
Average air temperature in July	(4,6)	5,9	5,7	5,7
Sums of precipitation for IX-Y at "Tuyuksu-1", mm	(563)	549	535	670
Sums of precipitation for YI-YIII, mm	(445)	385	446	422
Average depth of snow cover in April, cm	-	67	84	108
Winter balance, mm	1086	555	500	637
Summer balance, mm	-1186	-1257	-1030	-969
Yearly balance, mm	-80	-702	-532	-355
Equilibrium line altitude, m	3750	3892	3852	3817

Acknowledgement.
This article was performed within RFBR (Russian Foundation for Basic Research), project 11-05-00573.

References

1. Data on the study of the Tuyuksu Glacier, 1971-2010. Archival materials of the Institute of geography.
2. Dzerdzeevskii, B. 1962. Fluctuation of climate and of general circulation of the atmosphere in extra-tropical latitudes of the Northern Hemisphere and some problems

ofdynamic climatology - Tellus, vol. 14, № 3, pp. 328-336.
3. Kononova Nina K. 2010. Long-term fluctuations of Northern Hemisphere atmospheric circulation according to Dzerdzeevskii's classification. - Geography, Environment, Sustainability Journal. Institute of Geography, Russian Academy of Sciences. No 01 [3], c. 25-43.