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Climatic resources of the Aktru mountainous-glacial representative basin (Altai)

I.M. Sevastyanova, V.V. Sevastyanov

National Exploratory Tomsk State University (Tomsk, Russia)

In this article the meteorological and aerological observations in the Aktru mountainous-glacial basin in Altai are summarized. The peculiarities of cloudiness alteration, air temperatures, relative air humidity, steam tension, and local winds are examined. They are studied according to supervisions at the Aktru and Uchitel stations, on glaciers and on slopes. Numerous characteristics are received for mountainous-valley, glacial winds and foehns. Interaction of local winds with the characteristics of temperature and air humidity has been studied in the Aktru basin. The air temperature lapse rates in the atmosphere over the Aktru valley according to the results of stationary radiosondes are analysed. The comparative observations revealed the peculiarities of microclimates formation at various hours of a day, for separate synoptic periods and for different types of local air circulation in the atmosphere.

Keywords: glaciology; mountainous-glacial basin; meteorological observations; aerological observations; climate.

Introduction

Nowadays much attention is given to the study of the mountainous areas due to the process of mountainous terrain development. Biodiversity preservation in the mountainous areas of Altai and Sayan has aroused the researchers' interest in connection with contemporary climate changes. Altai-Sayan eco-region is regarded as rather valuable in this respect. The Altai and Sayan mountains are included in the list of 200 ecological regions of the world established by the World Wide Fund for Nature (WWF). "Golden Mountains of Altai" and "Ubsunurskaya Kotlovina" located in this area are designated by UNESCO as World Heritage Sites. Altai-Sayan eco-region occupies an area of over one million square kilometers in the territories of Russia, Mongolia, China and Kazakhstan.

The monitoring of the Aktru mountainous-glacial basin has resulted in a large number of articles, scientific reports and proceedings of scientific conferences where various questions on glaciology, hydrology, climatology, paleogeography, geobotany, geoecology in the mountainous areas are considered.

The work in the Aktru basin was started up by the staff of Glaciology and Climatology laboratories of Tomsk State University under direction of the head of the laboratory professor M.V. Tronov, doctor of science, the State Prize Laureate.

In 2011 the Aktru meteorological station was given the status of observer in "INTERACT Project" launched by the European Union.

Taking into account the growing interest of researchers in mountainous areas, it is important to consider the previous studies of climatic conditions in the Aktru basin.

Materials of investigation

The research basis is the data of the meteorological, aerological, aktinometric and heat balance observations in the Aktru mountainous-glacial representative basin in Altai.

Full-scale glaciological, hydrological and meteorological observations in the Aktru basin were initiated as part of "The International Geophysical Year" program (1956–1957). Further observations were made under the guidance of professor M.V. Tronov.

The water balance observations in various mountainous-glacial basins of Russia were made within the framework of "The International Hydrological Decade" program during 1965–1976. The program was focused on monitoring the ice balance, heat and water. Further research was carried out within the framework of "The International Hydrological Program", "The International Program of Fluctuation of Glaciers" and some other programs in the subsequent period.

The Aktru basin is located in the southeasten part of Altai Republic on the northern slope of the North-Chuiski Range. The area of Aktru mountainous-glacial basin up to the closing hydrological section line is 42.9 square kilometers. Modern glaciation covers the top parts of mountain ridges. The glaciers snouts in their low position are hydrological active. In the basin the significant difference in heights – from 4045 m (Aktru-Bash main peak) to 2150 m (height of the closing section line) can be seen. The network of meteorological stations (15) was established in order to characterize the meteorological regime in different sites of the area, in various relief forms, at various heights, on glaciers and peaks. The observations in the Aktru basin were made up at the altitude up to 3050 m above sea level.

The basic meteorological station is the Aktru station. Before 1971 the meteorological and heat balance observations had been made basically in the summer period (May–September). During 1971–1993 the Aktru station was included in the network of hydrometeorological stations, the observations being made all the year round. The Aktru station was engaged in long-term observations. It enabled the researchers to transform short rows of observations to long ones at the different meteorological stations of the basin under study.

The Uchitel meteorological station (the name of the pass given by mountaineers) located at 3050 m height was of great value for the climate study in the Aktru basin. It is known to be the average height of the snow line location.

In the Aktru basin the aerological observations on temperature, air humidity, and wind conditions were of utmost importance. The weather balloons and stationary radiosondes were ascended in the valley, on glaciers, and in the Uchitel pass.

The actinometric and heat balance observations were made at the Aktru and Uchitel stations and on glaciers. The actinometric and heat balance observations were of the utmost scientific and practical importance for studying the variability of the components of radiation and thermal balances.

The results of the study

The annual rate of air temperature and temperature lapse rate in the Aktru basin are given in table 1.

The annual rate of air temperature is well-expressed. The mean annual temperature at the Aktru station is –5.2 °C. The minimum values of air temperature are marked in January (–21.6 °C), the maximum ones – in July (9.7 °C).

Table 1. Mean monthly and annual air temperature and air temperature lapse rates γ in the Aktru basin, °C [1]

Station	Month						
	I	II	III	IV	V	VI	VII
Aktru (2150 m)	−21.6	−17.4	−12.7	−6.6	2.9	8.4	9.7
Uchitel (3050 m)	−23.6	−20.5	−14.6	−11.6	−3.8	3.0	4.5
γ	0.28	0.34	0.21	0.56	0.74	0.60	0.58

Station	Month					Mean
	VIII	IX	X	XI	XII	
Aktru (2150 m)	7.9	4.4	−5.5	−13.2	−18.6	−5.2
Uchitel (3050 m)	3.1	−1.6	−10.5	−15.3	−20.5	−9.3
γ	0.53	0.67	0.54	0.26	0.23	0.50

Note. The data obtained at the Uchitel station in winter months are provided by S.V. Kharlamov.

The lapse rates vary within wide ranges (0.21–0.74 °C per 100 m). The greatest values of temperature lapse rate are marked during the mid-seasons of a year. This is caused by snow cover cooling.

The average values of cloud-amount, relative air humidity and vapor pressure are given in table 2. The cloudiness regime in the mountainous-glacial basin is of particular value. Non-uniform distribution of clouds often leads the zones of significant precipitation to form in basins. It is significant for the balance of glaciers mass. The relative air humidity in the Aktru valley remains high throughout the year. The least humidity is recorded in April–May. At high altitudes the relative humidity increases as the temperature falls.

Table 2. Mean meteorological values at the Aktru station [1]

Characteristic	Month						
	I	II	III	IV	V	VI	VII
Total clouds, points	4.9	4.6	5.3	6.7	5.8	6.1	7.3
Relative humidity, %	70	70	64	60	58	64	71
Vapor pressure, hPa	0.8	1.1	1.5	2.2	4.3	7.0	8.5

Characteristics	Month					Mean
	VIII	IX	X	XI	XII	
Total clouds, points	7.5	4.5	5.8	5.7	4.0	5.7
Relative humidity, %	70	67	67	69	74	67
Vapor pressure, hPa	7.4	5.6	2.7	1.5	1.1	3.6

Aerological observations made it possible to estimate the structure of local air flows, the temperature and humidity characteristics. Mountainous-valley air circulation was well expressed in the Aktru basin in the summer period. Its frequency made up 60–70%. The characteristics of wind in the Aktru basin are shown in Table 3. Foehns represent a significant feature of the climate in the Aktru basin (table 4). They cause the snow to

melt fast. In the summer period they exert a profound effect on the regime of glaciers. Numerous characteristics are received for mountainous-valley, glacial winds and foehns. Interaction of local winds with the characteristics of temperature and air humidity has been studied in the Aktru basin.

Table 3. Characteristics of valley wind in Aktru in summer season [1]

Characteristics	Hour				
	7	10	13	16	19
Thickness of valley wind layer, m					
average	300	410	480	580	530
maximum	540	880	1020	1140	920
minimum	30	150	80	340	150
Number of cases with valley wind	4	23	25	24	19
Total quantity of observations	17	40	46	32	27
Average wind speed, m/s	1	2	2	3	2

Table 4. Number of days with foehns within a year in the Aktru mountainous-glacial basin [1]

Number of days with foehns	Month						
	I	II	III	IV	V	VI	VII
Minimum	5	5	5	8	10	5	4
Maximum	20	15	14	16	20	12	10
Average	10	9	8	10	15	7	6

Number of days with foehns	Month					Total
	VIII	IX	X	XI	XII	
Minimum	3	6	6	5	0	–
Maximum	10	16	18	16	12	–
Average	5	10	11	11	6	108

The data on temperature lapse rates in the atmosphere over the Aktru valley according to the results of stationary radiosondes showed that the greatest lapse rate was observed in the lower 100-meter layer of atmosphere. It should be noted that it decreased with the altitude (table 5).

Table 5. Lapse rates of air temperature (°C per 100 m) in different weather in the Aktru station (height 2150 m) in the afternoon [1]

Weather	Layer, m						
	2–100	100–200	200–300	300–500	500–700	700–1000	2–1000
Clear	3.10	1.50	0.61	0.70	0.79	0.75	1.00
Cloudy	1.46	1.19	1.20	0.90	0.62	0.93	0.97
Average	2.08	1.20	0.88	0.91	0.72	0.87	1.00

Thermal regime in the atmosphere considerably differs from its regime on the slopes. In summer in the daytime the air temperature on the slopes is warmer than in the atmosphere at the same altitude but at night it is colder. The maximum air temperature difference is observed at 13–14 o'clock and reaches 2 °C (table 6).

Table 6. Mean difference of temperature (ΔT) and relative humidity (ΔU) on the slope and in the atmosphere at the same altitude in the Aktru basin [1]

Station	Mean difference	Hour					
		07	10	13	16	19	22
Slope, 2500 m	ΔT, °C	−0.2	1.6	2.0	1.0	−0.4	−0.6
	ΔU, %	3	9	8	9	10	14
Uchitel, 3050 m	ΔT, °C	−1.5	0.9	1.1	0.5	−1.2	−1.4
	ΔU, %	5	11	7	10	14	19

The annual amount of precipitation at the Aktru station makes up about 520 mm. However this amount is not representative for the whole basin. According to hydrological control, the average amount of precipitation in the Aktru mountainous-glacial basin is estimated about 1000 mm [2]. Almost 75% of all precipitations fall in the warm season of the year.

Conclusion

In doing long-term research we received the significant scientific results in the field of mountain climatology.

The observation results obtained in the Aktru basin made it possible to evaluate the influence of various relief forms and different types of underlying surface on the climate.

The comparative observations revealed the peculiarities of microclimates formation at various hours of a day, for separate synoptic periods and for different types of local air circulation in the atmosphere.

The received conclusions are important for conducting modern climatic research in the mountainous areas.

The research of this kind is necessary for studying nature and biodiversity respond to the climate changes in the Altai and Sayans mountains.

The comparative analysis of glaciological, hydrological, meteorological research in different mountainous-glacial basins shows that the Aktru basin is representative for many other basins located in the similar relief conditions.

In order to investigate both the climate changes and recreational properties in the mountainous areas it is necessary to establish a reasonable network of meteorological stations for making observations at various altitudes, in different forms of the relief and on different underlying surface. At present making such observations proves possible.

It should be noted that mountainous climates of such basins as the Aktru are characterized by a great number of sunny days. It is important to use such basins in recreational industry.

Reference

[1] Sevastyanov V.V. Climate of alpine areas of the Altai and Sayan mountains. Tomsk : Publishing house of Tomsk University, 1998. 201 p.

[2] Tronov M.V., Olejnik I.Ja., Shantykova L.N. Experience of complex research of water balance in mountainous-glacial representative basin (Aktru basin in Altai) // *Glacio-hydro-climatology of highlands.* 1973. № 24. P. 66–73.

Сведения об авторах

Севастьянова Людмила Михайловна – кандидат географических наук, доцент кафедры метеорологии и климатологии Томского государственного университета (г. Томск, Россия). E-mail: lms40849@gmail.com

Севастьянов Владимир Вениаминович – доктор географических наук, профессор кафедры метеорологии и климатологии Томского государственного университета (г. Томск, Россия). E-mail: vvs187@mail.ru