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LAWS OF DISTRIBUTION OF THE SNOW COVER ON THE GREATER CAUCASUS (SOVIET UNION)

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and A.V. Yashina

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16. Abstract

The study of the laws of the distribution of the snow cover on the mountains of the greater Caucasus is discussed. It is shown that an extremely unequal distribution of the snow cover is caused by the complex orography of this territory, the diversity of climatic conditions and by the difference in altitude. Regions of constant, variable and unstable snow cover are distinguished because of the clearly marked division into altitude layers, each of which is characterized by climatic differences in the nature of the snow accumulation.

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LAWS OF DISTRIBUTION OF THE SNOW COVER ON THE GREATER CAUCASUS (SOVIET UNION)

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The study of the laws of the distribution of the snow cover /7 on the mountains of the greater Caucasus is of definite interest. The complex orography of this territory, the diversity of climatic conditions and the great difference in altitudes above sea level cause an extremely unequal distribution of the snow cover, while as a result of the diversity of its inherent physical and geographical conditions considerable structural differences are created. Meanwhile on the territory of the greater Caucasus because of the clearly marked division into altitude layers regions of constant, variable and unstable snow cover are clearly distinguished (Rikhter, 1948), each of which is characterized by climatic differences in the nature of snow accumulation.

Regions of Constant Snow Cover

The limit of the region of permasnow corresponds to the lower limit of this region.

The snow limit according to the determination of P. V. Kovalave (1955) has now risen as compared with 1916 by 50 to 60 m. In the western portion of the greater Caucasus it now occurs at the altitude of 2800 to 3400 m and gradually increasing towards the east, reaches in the Central Caucasus an altitude of 3500 to 4000 meters. Starting from the altitude of 3500 to 4000 m above sea level, great areas are occupied by thick glaciers, which form a large center of contemporary glaciation of the Caucasus.

The snow distribution in mountanous countries depends to a great extent on the orographic conditions and the direction of the wind. The factor of the wind redistribution of snow is particularly important factor. In connection with the fact that the upper belts of the mountain of the greater Caucasus are

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in the region of a certain circulation of the atmosphere, here the western tranverse prevails. On the leeward slopes large masses of snow accumulate, whereas the ridges and windward slopes remain without snow for a large portion of the winter. Snowfalls are possible all year round. The snow layer is characterized by low density and fine-grained structure. From November to April the average density of snow cover is less than 0.23g/cm^3, while in the areas sheltered from the wind as a rule it does not exceed 0.10 to 0.15 g/cm^3; the minimum value of the density was observed in February. Starting from the end of April, the density of the snow cover increases as a result of melting under the effect of solar radiation and in August it reaches at the lower limit of the zone 0.35 to 0.40 g/cm^3, and at the upper limits it is less than 0.30 g/cm^3. /8

In summer the which has condensed into firn does not melt at all. Gradually slipping under the effect of its own gravity and the pressure of freshly falling masses, and also under the effect of solar radiation, the snow increases in density, is converted into firn and then into ice. From September because of the new snowfalls the average density of the entire thickness of the snow cover decreases. Studied seasonal changes of density, related with the metamorphosis snow thickness under the aspect of solar radiation and meteorological factors, refer only to the snow falling during one year. The density of the snow cover of the previous years, partly converted into firn and ice, does not undergo great changes.

The temperature conditions of the region is peculiar. The summer temperature maximum is low, as a result the average annual amplitude decrease sharply, reaching values of average annual amplitude of the Black Sea coast. Thus for example, at the altitude of 4150 m on the slopes of the El'brus the average annual amplitude of temperatures (17.6°) is equal to the amplitude, fixed at the meteorological stations of Gagr (17.5°) and Gudaut (17.6°). The temperature fluctuations in the snow cover are small.

Region of Variable Snow Cover

This region covers the territories where the stable snow cover occurs for several months; no winters without snow occur in it. The position of the lower limit of the region varies within wide ranges. In conditions of the Western Caucasus it occurs at the altitude of between 500 m (valley of the river Byipi) to 1,000 to 1,200 m (valley of the river Inguri), and in the Central Caucasus between 1,000 m (valley of the Rioni river) to 1,500 to 2,000 m (valley of the river Rargdi).

The thickness of the snow cover in this region and its structural characteristics may be judged according to the data of the snow measuring photographs taken in the Abkhaz Spanetikya, in the valley of the river Bakafan, and in the region of the Military--Georgian road and referring to the normal distribution of precipitations. To explain the characteristics of the distribution of the snow cover on the slopes of different exposure and at a different altitude above sea level, snow measuring photographs as a rule were related to the transversal and longitudinal profiles of the mountain valleys. At altitudes of between 2,000 and 3,000 meters more details of the observations were carried out.

The distribution of the thickness of the snow cover fluctuates within wide limits as a function of the absolute altitude of the place, the exposure of the slope and the nature of the flora. The factor of wind transfer is very important just as in the region of constant snow cover. Here the plant cover and wind transfer cause great diversity in the distribution of the snow, within the limits of one altitude belt, and the exposure of the slope of the Main Caucasian ridge and the altitude above sea level have left their imprint on the general laws of snow built-up, characteristic of the entire territory of the greater Caucasus.

In the opinion of V. Ya. Sharovaya (1958) the exposure of slopes of the Vodorazdel'niy ridge plays a particularly important role. In connection with the activation in winter of the southwest and western air flows, the precipitations fall more often on the windward southern and western slopes. Thus the southern slopes of the Vodorazdel'niy ridge, the western and southwestern slopes of the Bokoviy ridge, turn towards the direction of the main air flows, intercept in winter a great portion of the precipitation, and the northern slopes fall in the region of the decreased amounts of precipitation. On the northern slope we also observe a low recurrence of precipitation as compared with the southern slopes. This interception occurs in the region where both ridges are adjacent to each other.

The difference between the northern and southern slopes /9 of the same altitude above sea level reaches 60 to 70 cm in the region of the Krestoviy Pass and somewhat to the west in the region of the Priel'brus, it increases to 1 m. In the western region of the greater Caucasus the precipitations in winter are more frequent and abundant as compared with other seasons of the year. The maximum number of days of precipitation in winter is observed here on the southern slope (Achishkho Mountain, at the altitude of 1885 m above sea level, 95 days, on the El'brus Mountains at an altitude of 4250 above sea level, 92 days). With the shift to the east the amount of winter precipitations and the recurrence of their fall decreases, which is explained by the characteristics of the cyclonic processes and to a certain extent by the phenic phenomena (for example in the Bylin region east of the El'brus).

The stable snow cover is never established immediately. The free winter period is in places fairly long, but its duration decreases with the altitude. At an altitude of 2,100 - 2,200 m in the valley of the Baksan River, the first snowfalls may be observed in October, but the snow falling during that month melts quickly, and the constant snow cover is established as a rule from the middle to the end of November (according to many years of data of the Terskol Observatory). Thus the prewinter period covers here 1.5 to 2 months.

The periods of formation of stable snow cover on the northern and southern slopes of the main Caucasian ridge differed somewhat. For the northern slope (layout of the Military-Georgian road) a more extensive prewinter period and higher temperatures of the air during the period of the first snow fall are characteristic. In the first winter months the height of the snow cover does not exceed here 5 to 10 cm. A further increase of its thickness is noted only from the end of December to the beginning of January. On the southern slope with stable snow cover, 30 to 50 cm thick, is established already in the middle of November, in December its height reaches 60 to 70 cm.

A stable snow cover is formed on the territory of the greater Caucasus for positive average monthly temperatures[1]: in the Western Caucasus for an average monthly temperature of nearly 5° and an average monthly minimum of 0° in the region of the Central Caucasus at 1.82° and 0° respectively, and on the slopes of the Eastern portion of the greater Caucasus, for positive average monthly temperature 0.8 to 0.3°. In certain regions (for example in the region of the Military-Georgian Road) in individual winters it was possible to establish a snow cover for positive average daily air temperatures.

As a result of the effect of the wind, solar radiation and snow avalaches, a redistribution of the snow takes place between the slopes of different exposure and between the sections of different altitudes above sea level. The wind factor has a particularly active effect in the longitudinal valleys and ravines, with west-east orientation, where the effect of mountain-valley winds is amplified by the effect of the winds on the side of the

[1] An exception was the late winter of 1957-1958.

Black Sea (western and southwestern direction).

In the transversal valley the primary importance must be attributed to mountain-valley wind, because of which a snow exchange is implemented from the leaward to the windward sections of the slopes. The wind induced snow transfer in the same ravine is so great in some places that the difference in the thickness of the snow between the western and eastern slopes reaches in the middle of winter (February-March) 1 m or more. On the eastern slopes of the ridges thick snow ledges and drifts appear, /10
characterized by great density of the snow (Table 1).

Table 1 Height of the Snow Cover (in cm) in Eastern and Western Sections of the Slopes of River Valleys

Region and Time of Observation	Altitude Above Sea Level	Eastern Slope	Western Slope
Valley of the Avadkhari River (basin of the Bvipi river) March	2000	480	360
River of the Inguri River (upstream) February	2200	180	120
Valley of the Pskhenis-Tskali River (upstream) February	2200	160	110
Valley of the Gudamkari River (basin of the Rargvi River) February	2000	120	60
Valley of the Baksan River (upstream) March	2500	210	100

The most active processes of redistribution of the snow occur in the first two or three days after the snow falls. With the increase of the absolute level the factor of the wind induced redistribution of the snow increases. For example in the Priel'brus'e for example, already at an altitude of 3,000 m the snow cover shows an alternation of large snow drifts, of height 4 m or more and sections completely bear of snow.

The data of the snow measuring photographs showed that the greatest height of the snow cover is reached in the Western Caucasus, where its thickness fluctuates as a function of the altitude above sea level within the limits of 2-8 m. In the region of the Abkjz Spanetiya according to the profile plotted from the Bvipi River to the Avadkhari Pass and from the Kodori River to the Klukhori Pass, in April at an altitude of 2800 m the thickness of the snow cover reached 790 cm. At the altitude of 2000 m above sea level, the maximum height of the snow cover (410 cm) was observed in March according to the data of many years. With the decrease of the absolute levels the maximum of the snow cover shifts to February and its thickness also decreases accordingly. At the altitude of 1500 to 1000 m the February maximum of the snow cover is 195 to 135 cm (Table 2)

Table 2 Average Monthly Height of the Snow Cover (in cm) as a Function of the Altitude above Sea Level in the Region of Abkhaz Spanetiya

Altitude Above Sea Level m	Month										
	IX	X	XI	XII	I	II	III	IV	V	VI	VII
1000	-	●	●	25	90	135	125	65	No Data	-	-
1500	●*	●	5	55	130	195	190	125	25	-	-
2000	●	●	40	110	170	210	410	360	110	●	-
2800	●	20	200	310	410	600	760	790	310	120	-

* ● indicate that in the given months the snow cover was unstable.

In the basin of the Inguri River the snow cover is somewhat less thick. Thus at the altitude of 2,000 m above sea level its maximum height occurs in March and does not exceed 130 cm. The decrease of the thickness of the snow cover according to profile is observed over the territory and in other altitude belts. For example at the level of 1,000 m the February maximum of the snow cover does not exceed 45 cm according to the data of many years, and at the altitude of 1,500 m, 75 cm (Table 3). /11

Table 3 Average Monthly Height of the Snow Cover (in cm) as a Function of the Altitude above Sea Level in the Basin of of the Ingrui River

Altitude Above Sea Level, m	IX	X	XI	XII	I	II	III	IV	V	VI	VI
1000	-	-	●	10	30	45	15	●	-	-	-
1500	-	●	●	25	55	75	50	12	119	-	-
2000	-	●	7	29	65	115	130	65	5	●	-
2200	●	●	8	35	80	150	190	90	10	●	-

A certain decrease in the thickness of the snow cover in the valley of the Inguri River as compared with the other regions of the Western Caucasus have been explained by the extension with regard to the latitude of the valley in its upstream and higher ridges (Melgrel'skiy and Svanetskiy 3,000 to 4,000 m), located on the path of the winter southwest flow of air.

In connection with the fact that the fall of precipitations in winter at altitudes exceeding 1,500 to 2,000 m is connected with the winds of the south-west and west directions, carrying moisture from the Black Sea, the thickness of the snow cover, the duration of its stay and the number of days with snow fall are determined to a great extent by the distance from it. With the increasing distance from the Black Sea the period of occurrence of the stable snow cover becomes shorter and its altitude decreases.

The greatest duration of the occurrence of stable snow cover is observed also in the Western Caucasus. Within the limits of the Abkhaz Svanetiya, the snow cover remains longest at the altitude of 2800 m (from October to June). In the valley of the Inguri River the maximum period of stay of the stable snow cover at the altitude 2,200 m is decreased to 7 months (November to May) and at the altitude of 1,000 m to 4 months (December to March). The average number of days with stable snow cover is approximately 175 in the Westersn Caucasus, 150 in the Central Caucasus and 130 in the Eastern Caucasus.

The characteristics of the air circulation and cyclonal processes in the winter season may explain also the unequal degree of stablity of the snow cover in different altitude belts of the Western and Eastern Caucasus. In the Western Caucasus the wind from the western direction is capable of forming the stable snow cover at high altitudes. On the Eastern Caucasus at the same altitudes the snow cover is less stable. Meanwhile in the lower belts of the mountains, where in the cold season of the year winds of eastern direction occur predominantly, in the western Caucasus the snow cover (up to the altitude 1,000 to 1,500 m) is less stable than in the Eastern Caucasus.

Certain differences are also observed in the dimensions of the snow flakes. It was observed that on the Black Sea Coast, and in the south-west slopes of the main Caucasus ridge the size of the falling snowflakes are often larger than 5 cm and on the rest of the territory of the Greater Caucasus are larger than 5 cm and on the rest of the territory of the Great Caucasus it fluctuates between 1 and 5 mm (Sharova, 1958).

In the Central Caucasus in the region of the Eastern Priel'brus (valley of the Baksan River) the snow cover reaches its maximum thickness (250 cm) at the altitude of 3,000 m. The maximum of duration of the occurrence of the snow cover is also observed at this altitude. The stable snow cover remains here for 7 months (November to May). Below 3,000 m the duration of the stable snow cover and its thickness flucturates within wide limits as a function of the relief, the flora and the exposure of the slopes. The greatest masses of snow are accumulated in depressions in plain areas sheltered from the wind, whereas the ridges and folds of the slope remain without snow almost the entire winter.

As a rule in this region the maximum height of the snow cover is observed in summer masses and on the northern slope. For example in the valley of the Baksan River at the altitude of 2,000 to 2,500 m in the middle of winter (February to March), the height of the snow cover at the bottom of the valley is 80 cm (in individual years 100 to 130 cm) and on the northern slope at the level of 2,500 m, 130 to 160 cm. On the slopes of the southern exposure, the height of the snow cover is low, 30 to 40 cm, and the lower sections of the slopes, as a result of the radiation-induced thaws, are periodically free from snow.

In the eastern portion of the Central Caucasus (region of the Krestoviy Pass) the thickness of the snow cover (averaged over many years) at the altitude of 2,380 m does not exceed 250 cm. With the decrease of latitude its thickness increases. This law is manifested particularly clearly on the northern slope (Table 4).

Table 4 Average Monthly Height of the Snow Cover (in cm) as a Function of the Altitude Above Sea Level in the Region of the Krestoviy Pass

Altitude Above Sea Level	Months X	XI	XII	I	II	III	IV	V
2000	No Data	12	45	90	120	137	105	10
1500	"	No Data	17	65	90	97	30	-
1000	"	"	10	45	52	45	5	-

The establishment of the snow cover for positive monthly temperatures, and also the great thickness of the snow layer protect the soil from deep freezing. Thus for example at the altitude of 3,000 m at the depth of 30 cm the temperature of the snow cover does not go below -10, -15°, and at the altitude of 2,000 m, less than -7, -10° (Figure 1).

The analysis of variation of the temperature minima according to the profile of the fresh layer makes it possible to draw the conclusion that in the studied regions on conditions that there is uniform distribution of the snow cover the soil is protected from deep freezing during the whole year. A certain freezing of the soil is possible only in the falls months, when the average temperature of the air drops below 0^{o}, and the snow cover has not yet been established. This is most probable for the Central Region of the Caucasus.

In connection with the great fluctuations of altitude and physical and geographical differences within the limits of the Greater Caucasus, the density of the snow cover varies greatly. We should mention first of all the regular decrease of the density of the snow cover with the increase of the altitude above sea level observed over the entire territory. Thus from 0.40 g/cm^3 at the altitude of 1,000 m, it drops to 0.15 to 0.20 g/cm^3 at the altitude of 3,000 m (February-March). For Western Caucasus in February and March it is characteristic to find a high density of the snow cover, 0.30 to 0.40 g/cm^3. But it is not constant and varies within wide limits as a function of the meteorological conditions and the exposure of the slope. On the northern slopes the snow density as a rule is lower by 0.05 to 0.15 g/cm^3 than on the southern slopes for the entire winter. At the beginning of the thaw and in fair weather the difference in density of snow cover on these slopes may reach 0.20 g/cm^3. The considerable increase of density occurs uniformly over all slopes during the wet snowfall and in advective thawing processes. /14

According to the data of the snow measuring photographs in the basins of the rivers Bvipi, Korodi, Inguiri and Rioni, a very clear law was revealed for the variation of the density in time and according to the altitude. The density of the snow cover decreased from 0.30 g/cm^3 at the altitude of 1,000 m to 0.18 g/cm^3 at the altitude of 2,800 m and from 0.33 g/cm^3 in December - January to 0.40 g/cm^3 in February-March. A

Figure I Variation of the Temperture Within the Thickness of the Snow Cover in the Priel'brus Region at the Altitude of 2,250 m on January 5 and 6, 1957,

Key: 1) Height of the Snow Cover, cm; 2) Time of day

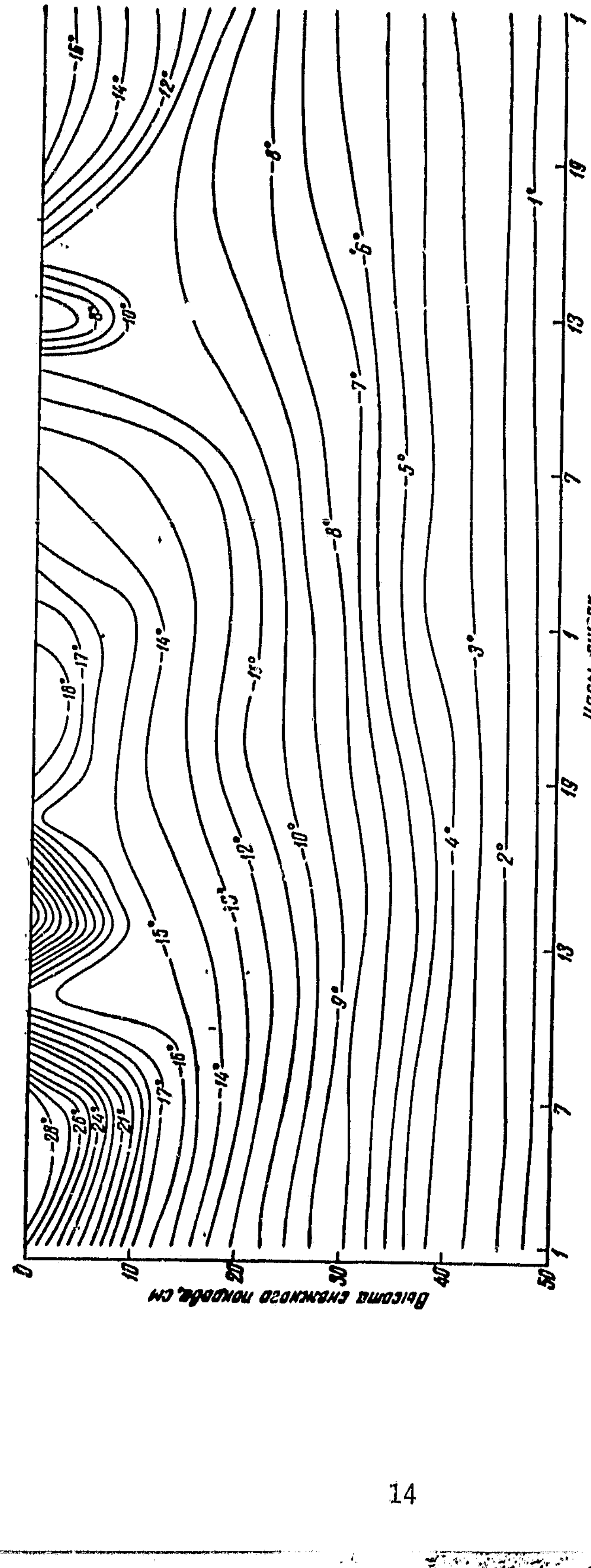

Рис. 1. Изменение температуры в толще снежного покрова в Приэльбрусье на высоте 2250 м 5 и 6 января 1957 г.

particularly clear increase in the snow density takes place in spring months. In March the density of the snow at the upper level of this zone is on the average higher by 0.10-0.12 g/cm^3 than in December. In the lower belt of these mountains this difference decreases to 0.05 to 0.10 g/cm^3 (Table 5).

Table 5 Density Distribution (in g/cm^3) of the Snow Cover in the Western Caucasus

Altitude Above Sea Level, m	Months XII - I	I - III
2800	0,18-0.20	0,28-0,30
2300	0.21	0,33
2000	0.22	0,35
1700	0,23	0,34
1500	0,25-0.28	0.35-0.37
1000	0,30	0,40
500	0.35	0,40

Table 6 Density Distribution (in g/cm^3) of the Snow, in the Central Caucasus

Altitude Above Sea Level, m	Months XII-I	II-II
3000	0.18	0.21
2500	0.20	0.21-0.28
2200	0,26	0.26-0.30
2000	0.24-0.26	0.31

On the territory of the Central Caucasus the density is relatively low and reaches high values only during the period of thawing or in the lower portion of the region (Table 6).

In the region of East Priel'brus, at the bottom of the valley of the Baksan river, the density of 0.25 g/cm^3 is most characteristic for winter, decreasing greatly during the time of snowfalls because of the freshly falling snow. At the end of March-beginning of April, when the snow begins to melt, the density of the snow cover rises to 0.35 g/cm^3. The difference in the density of the snow cover on the northern and southern slopes is clearly manifested. In January the snow density is greater by 0.07 g/cm^3 because of the greater insulation on the southern slope than on the northern one, and in March it is greater by 0.09 g/cm^3. The density of the snow at the bottom of the valley has a middle value as compared with this density on the northern and southern slopes.

The values of density of the snow cover indicated are average data for these regions. The detailed snow measuring photograph reveals considerable differences in its density in connection with the nature of the plant cover and the microclimatic conditions. In the forest the snow density is usually less than in open sections. A certain increase of the density of the snow cover is observed on the windward slope because of its consolidation by the wind and snow brought by blizzards. /15

Snow avalanches, characteristic for the entire territory of the Great Caucasus have a considerable effect on the nature of the occurrence of a snow cover. Dry snow avalanches (in the middle of winter) and wet ones (in spring) clear systematically the upper sections of the mountain slopes and cause its accumulation a the foot of the slopes and at the bottom of the deep ravines and valleys. The snow avalanches occur particularly often starting from an altitude of 1,400 m, which is explained by the great thickness of the snow cover and the process of metamorphosis of the snow layer. On mountain ravine and valleys in the Georgian republic in winter avalanches carry more than 0.5 million m^3 of snow (in each ravine or valley).

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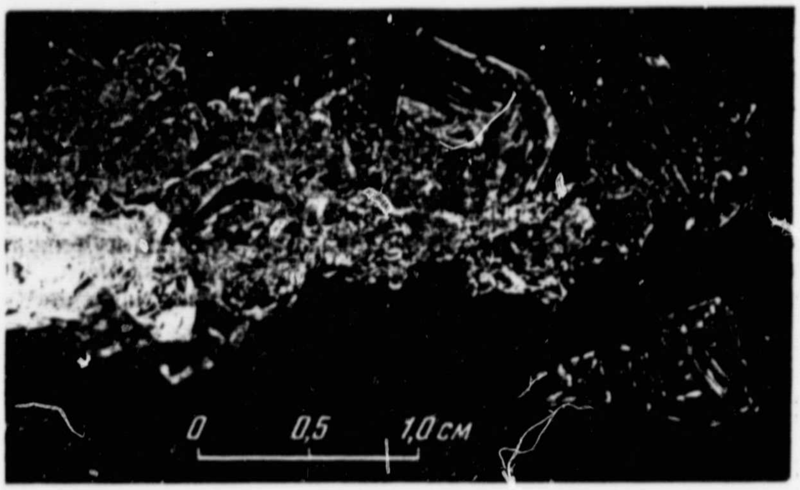
Figure 2 Crystals of Deep-Seated Snow. Photo by A. V, Yashina.



The accumulation of large masses of snow of high density (0.50 to 0.60 g/cm^3) of average thickness in the snow cone up to 10 to 15 m delays the melting of the snow in the spring and regulates the discharge of mountain rivers in summer.

Besides the variation of the thickness and density of the snow layer differences are also observed in its structure. Immediately after the establishment of the stable snow cover under the effect of solar radiation and temperature gradients processes of recrystallization of the snow cover start. At the end of January, it is characteristic for the profile of the snow layer on afforested and open sections of the bottom of valleys and northern slopes to find in the presence of thawed soils, a clearly marked free flowing level of deep-seated frost, up to 45 to 50 cm thick. The crystals of the deep-seated frost have a clearly marked shape of hexadral prisms and caps, hollow inside (Figure 2). The dimensions of other crystals fluctuates within the limits of 2 to 5 mm, and on rare occasions they reach 7 mm. Usually crystals near the soil surface become larger. The transition from the level of the deep-seated frost may be gradual (in the case of great thickness of the snow cover) or abrupt, limited on the top by an ice layer. The vertical orientation of the crystals predominate (the basis of the prisms are at the bottom). The vertical texture with suspended clusters of crystals and large number of gaps between them (the dimensions of the gap reach 0.5 to 1 cm^3) is well marked. The structure of the upper levels is less clearly marked. It is characterized by crystals of dimensions 1-2 mm of nonclearly outlined shape. The levels are usually separated by ice layers, which correspond to periods with thaws between snowfalls. /16

An example of a clearer differentiation of the snow layer on stratigraphic strata may be the description given below of the cross-section of the snow cover in the upper reaches of the Baksan ravine (Central Caucasus) in the middle of February 1957. For an average height of the snow cover of 45 to 50 cm, the upper 0 to 5 cm were represented by freshly fallen fraiable ones, consisting of fragments with snowflakes (density 0.10 to 0.15 g/cm^3); below at a depth of 5 to 25 cm a firm dense wind slab occurs (density 0.38 to 0.40 g/cm^3) of fine-grained snow. The thickness of the wind slab fluctuated between 10 and 25 cm. At the depth of 25 to 50 cm a layer of free-flowing deep-seated frost was observed. The crystals of the deep-seated frost were large (5-7 mm) of prismatic shape, hollow inside and of vertical orientation. They were firmly bound in clusters. The vertical texture with suspended clusters of crystals and large number of gaps between them was particularly clearly marked. Underneath at the limit with the grass cover, the crystals became larger (up to 10 mm), the number and size of the gaps increased. The crystals freezing firmly had their sides touching and gradually acquired a cylindrical shape and a horizontal orientation. The porosity of the lower layer was so great that the freezing cylindrical crystals created the impression of a brittle lattice; the soil was melted.

The physical principle of metamorphosis of the snow layer may be explained as follows. Snow as a good insulator, causes a sharp drop in temperature between the surface of the snow cover and the surface of the melted soil, as a result of which a pressure gradient of water vapor is created between the upper and lower levels of the snow layer. In the above described case, as a result of the formation on the surface of the snow cover of a firm wind slab of relatively large thickness the decrease of temperatures between the lower level and the surface of the snow cover became so large that between the upper and lower levels of the snow cover a pressure gradient of water vapor arose. Under the effect of the gradient the migration of water vapors began from the warmer lower levels to the cooler upper levels. The migration of vapor created conditions of incomplete saturation and decreased the relative humidity in the lower layer, as a result of which the evaporation started from the surface of snow grains, the growth of some crystals at the expense of others and the formation of gaps. The vertical orientation of migration of the water vapors is indicated by the vertical orientation of the crystals. The largest crystals of the deep-seated frost were observed in sections with thick layer of last year's turf, which under the effect of the processes of decomposition created an additional thermal effect. The metamorphosis of the snow cover, leading to the formation of a free-flowing level of deep-seated frost, causes the occurrence of avalanches on the steep sections of the slope.

In the spring, when the soil underneath begins to thaw, the process of migration of vapor from the lower levels to the upper ones is intensified and the growth of the crystals of the firn level takes place particularly intensely. At the same time the thickness of the firn layer increases. The levels lying on top become more dense (Figure 3).

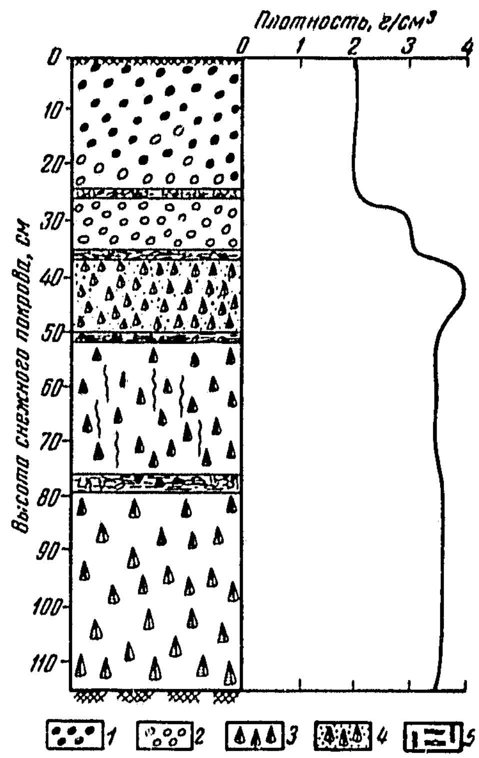
The variation of the density of the density of the snow cover over the structural layers on the afforested and open sections take place unequally. On the bear sections the upper /16 layer of the snow cover have a relatively higher density (0.21

-0,28 g/cm^3) than the lower one (0,15-0,23 g/cm^3) because of consolidation by the wind and radiation thawing processes. In the afforested sections because of the layer being covered by tree trunks there is no increase in the density of the upper layer. Therefore in the shady sections of the wood we observe a staggered nature of the density distribution over the profile of the snow cover and specifically the increase of density from the upper layers to the middle ones and its decrease in the layer of free-flowing deep-seated frost (Figure 4).

Figure 3 Distribution of the Density of the Snow Cover According to the Structural Layers in the Forest in Spring

1) Melting snow, consisting of shapeless lumps of ice; 2) Deposit of dry snow, becoming denser under the effect of the force of gravity; 3) Deep-seated frost (crystals of different dimensions); 4) Fine grained and medium grained snow with inclusion of crystals of deep-seated frost; 5) Ice layers and ice formations

Key: 1) Height of the snow cover cm



Because of the high temperature gradient, the recrystallization of the snow cover takes place more intensely on the southern slope than on the northern one. This process is observed particularly clearly in the establishment of a stable snow cover in clear frosty weather. In this case the entire 30-40 centimeter snow cover has a clearly marked crystalline structure. The crystals of 3-4 mm, free-flowing, are weakly bound to each other. In bright sunny weather the crystals on the surface of the snow cover have a structure of melted grains of frost. On cloudless days the effect of solar radiation is so great that the snow cover acquires from the surface a cellular structure, and on the surface of the soil because of the seepage of the water produced by the thaw an ice crust 1-2 cm thick is formed.

The snow measuring photograph made it possible to determine the reserves of water in the snow cover according to the individual basins of the rivers of the Great Caucasus (Table 7).

Table 7 Reserves of Water (in mm) in the Snow Cover on the Greater Caucasus

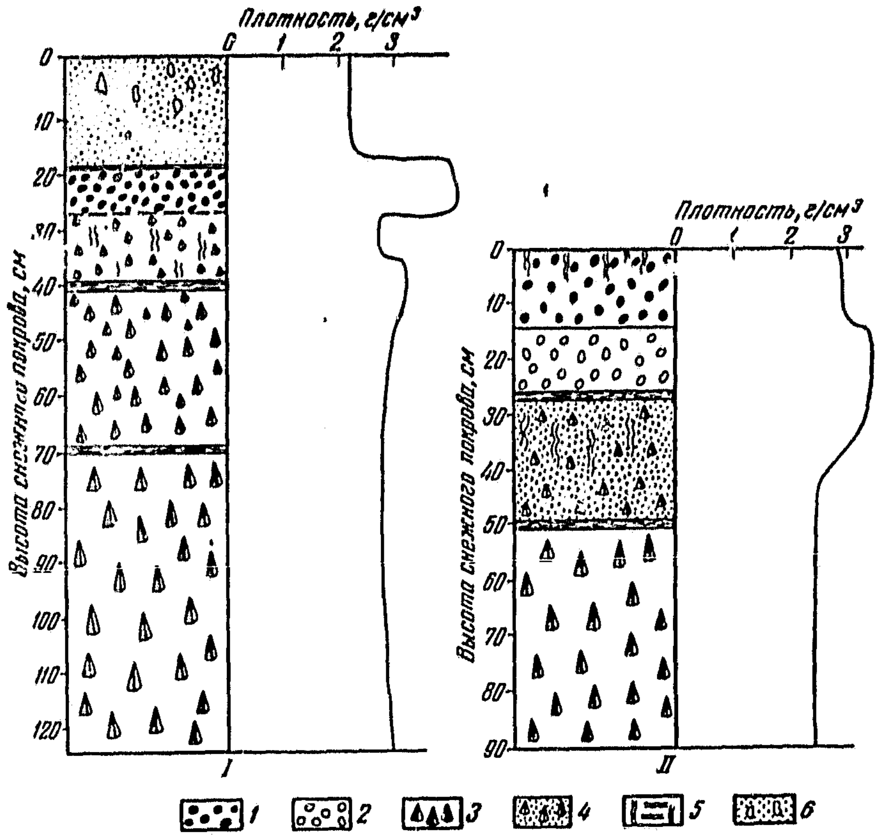
River Basin	Altitude Above Sea Level			
	1000	1500	2000	2800
Bvipi and Kodori	450	670	1100	2400
Inguri	100	250	440	1600
Rioni	150	390	410	1500
Aragvi-Liakhvi	150	390	410	1500

The analysis of the data shows the sharp decrease of the water supply with increase for the distance from the Black Sea and their increase with the increase of the absolute altitude. A certain exception may be observed for the Inguri River basin where in spite of its closeness to the sea, the water reserve in the snow cover on the lower levels are less than in the basin of the Rioni River, which is further away from the Sea. The /18

Figure 4 Distribution of the Density of the Snow Cover According to the Structural Layers in the Forest(I) and in a Bare Section (II)

1-5 See Figure 3; 6- Fine Grained sandy snow with inclusions of ice

Key: 1) Height of the snow cover, cm; 2) Density g/cm^3



difference in the reserves of water in these basins is explained by the different thickness of the snow cover.

In the western Priel'brus region the results of water from the snow cover are low and according to the profile in the valley of the Baksan River at the altitude of 2,200 m they constitute 228 mm, gradually increasing with the increase of the absolute altitude up to 279 mm at the altitude 2,500 m and 450 mm at the altitude of 3,000 m.

2

Region of Unstable Snow Cover

The region of unstable snow cover includes the foothills and the lower sections of the slopes. In the periods between snowfalls, the snocover here usually falls completely, remaining not more than several days, and it may lie for about 2 to 3 months only in individual winters with most snowfall. In connection with the shortness of the stay of the snow cover no interesting laws were observed in the distribution and structure.

More frequent and abundant snowfalls are characteristic /19 for the Western Caucasus in the region of the unstable snowcover than in the Eastern one. Wet snowfalls accompanied by rain are very common. The density of the snow cover as a rule is higher here than the density of snow in the region of the variable snow cover.

General Conclusions

1. The stable snow cover on the territory of the Greater Caucasus is formed for positive average monthly air temperatures.

2. The maximum height and water reserves of the snow cover are observed in the Western Caucasus; with the increase of the distance from the Black Sea, they decrease gradually.

3. The snow cover in the Western Caucasus is less stable up to altitudes of 1,000 to 1,500 m, than in the Eastern Caucasus, and starting from the altitude 1,500 to 2,000 m it is more stable.

4. The density of the snow cover on the territory of the Greater Caucasus decreases with the increase of the altitude above sea level and with the increase of the distance from the Black Sea.

5. In the region of the variable snow cover the height of the snow cover increases with the increases of the altitude above sea level, and the time of occurrence of the maximum thickness shifts from January-February to March-April.

6. The height of the snow cover in the region of the variable snow cover exceeds to a considerable extent the height which can

protect the soil from deep freezing.

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