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WATER CIRCULATION IN NOT GLACIATED PART OF THE NORTH-WESTERN SÖRKAPPLAND (SPITSBERGEN)

INTRODUCTION

Characteristic of water circulation in not glaciated part of Sörkappland was prepared out in summer seasons 1983 and 1984 and also on the basis of researches carried out close to Hornsund by members of winter teams in station of Polish Academy of Sciences in Isbjörnhamn and members of summer polar expeditions. In many cases results obtained at meteorological station of PAS were used too especially those concerning spring, autumn and winter seasons. Own researches carried out in Palffyodden region contained meteorological and hydrological observations and hydrographic mapping.

During the expedition in 1983 there were 2 meteorological stations:

— „Palffyodden", located about 300 m south-east of Palffyoden cap on flat marine terrace of 10 m a. s. l. height;

— „Lisbetdalen", located in the Lisbetdalen valley at the foot of Savitsjtoppen, about 3 km from the fiord bank, on eastfacing slope, about 100 m a. s. l.

There was only 1 meteorological station „Palffyodden" but it was moved about 250 m to the north.

Hydrological observations were based on measurements of water levels and temperature of waters of chosen rivers and lakes and decline of snow patches thickness situated near the „Palffyodden" station. Besides at the beginning and at the end of summer 1984 flows of majority of rivers flowing accross the searched area were measured too. Location of the stations ~~and range of hydrometeorological observation~~ is presented on Fig. 1.

Precipitation, flow and evaporation are differentiated during a year and they are closely dependent on climatic conditions, so the course of water circulation is presented in particular seasons accordingly to S. B a r a n o w s k i (1968):

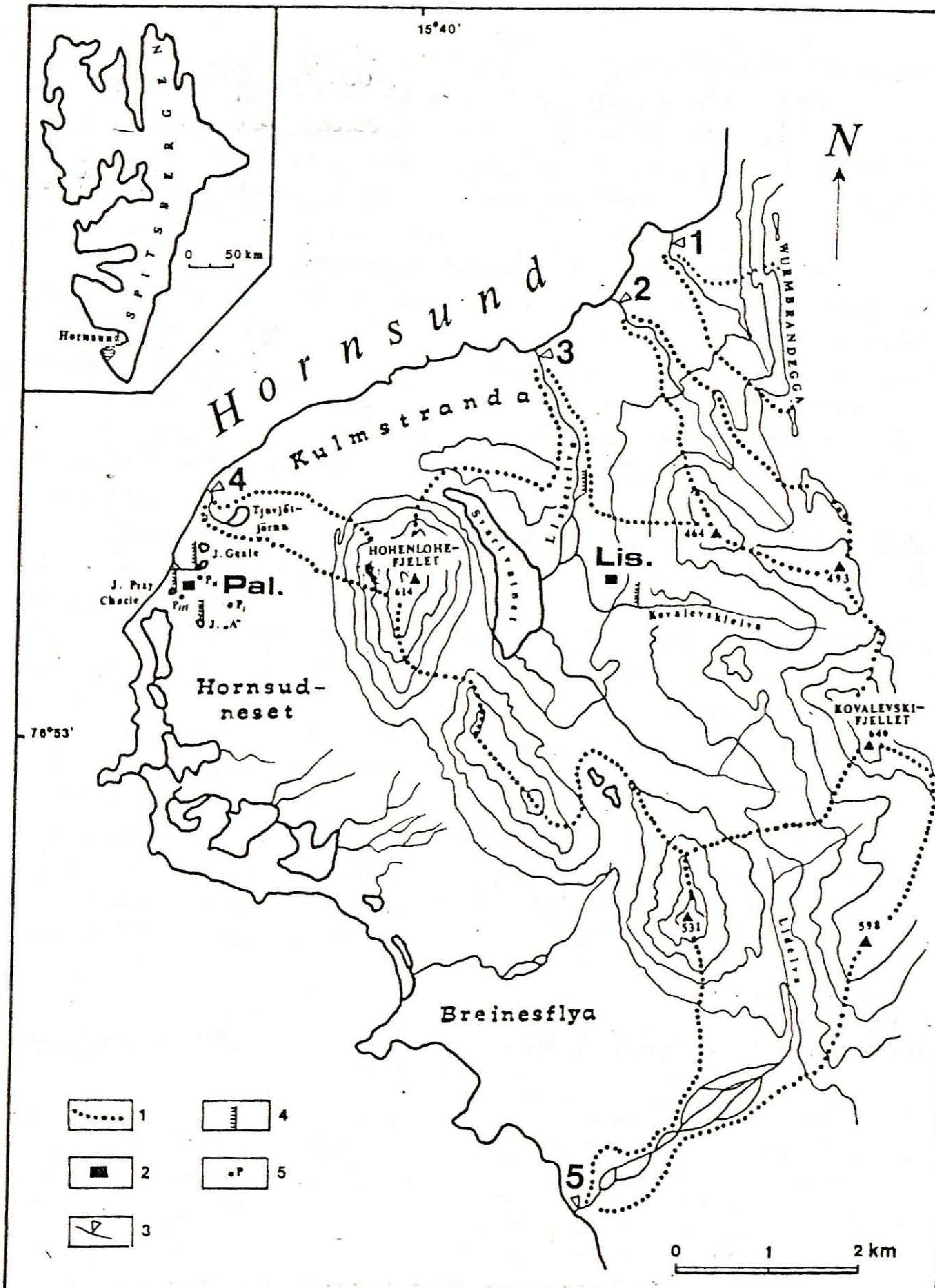

Fig. 1. Location of research area and location of hydrological and meteorological measurements stands

1 — boundary of the catchment area, 2 — meteorological stand (Pal. — Palffyodden, Lis, — Lisbetdalen), 3 — discharge measurement stands, 4 — water-gauge, 5 — snow patches with ablation measurements

— spring ($-2.5°C < T_i < 2.5°C$)
— summer ($T_i \geqslant 2.5°C$)
— autumn ($-2.5°C < T_i < 2.5°C$)
— winter ($T_i \leqslant -2.5°C$)
T_i — mean daily air temperature.

Spring in Hornsund begins on May 23 and lasts meanly 35 days till June 26. Summer is nearly twice as long and lasts till 67 days. It ends on Sep. 1 and then autumn lasts about 44 days on average. Duration of autumn is differentiated and it lasts from 18 to 70 days. Winter is the longest season which lasts from Oct. 15 till May 23, 220 days (Rodzik, Stepko, in print).

WATER CIRCULATION IN PARTICULAR SEASONS

WATER CIRCULATION IN WINTER

During winter (Oct. 15—May 23) the only active phase of water circulation is snowfall giving snow cover which in the others seasons is the basic source of circulating waters. Winter precipitation make nearly 50% of annual precipitation, above 200 mm. There may be distinguished 3 periods during this longest season (Rodzik, Stepko, in print):

a) the first, containing some first weeks, during which fresh snowfall does not melt, air humidity and cloudiness are not high, there are very frosty days ($T_{max} \leqslant -5°C$), daily amplitudes of temperature reach 5—6°, ground is frozen;

b) the second, lasting 4—5 months, begins at the end of November or in December with sudden coolness, frequent are very frosty days ($T_{max} \leqslant -15°C$) and long lasting strong winds (even to 40 m/sec. during gusts), in the middle of winter period southern air exchange increases what leads to temperature rise to several degrees and sometimes causes rainfall;

c) the third, containing some last weeks, there may occur rainfall what create lakes, polar day begins, there appear daily temperature rhythm, there are many fine days, snow cover is not moved by wind.

From the hydrological point of view winter significance for water circulation is snow gathering and ground congelation.

Growing snow cover in Hornsund begins in October and ends in April when snow cover is the thickest reaching 50 cm or even more (Rodzik, in print). Distribution of snow cover is differentiated. Snow does not cover very steep slopes, tops of rocks and convex parts of slopes. Good conditions for snow accumulation are on gentle slopes and in depressions. This differentiated snow cover distribution is caused also by winds and blizzards. During winter the ground is frozen.

WATER CIRCULATION IN SPRING

Spring is the season (May 23—June 26) when temperature of air is about 0°C. Air masses do not bring heavy precipitation, cloudiness and humidity gets higher, mean daily amplitudes of air increases what is caused by polar day. Spring is the season of the most frequent calms. Such conditions are grood for snow cover ablation which is very intensive at the end of spring (Pereyma 1981).

At the beginning of spring warming up of air is impedimented by using great amount of warmth for snow meiting. There are also some days with winter temperatures (Rodzik, Stepko, in print). There is also recrystallization of snow cover and it changes into firn or big, loose crystals what lessens the thickness. A part of snow undergoes sublimation as the snow cover lowers and only small amount of waters flow away. Some waters sink into the snow cover and into the ground if it is not frozen. If ablational water finds under snow cover unpermeable ground it makes an ice cover (basal ice layer) what makes the period of ablation longer (Woo, Heron, Marsh 1981). Basal ice layer can be also created under influence of rainfall infiltration into snow cover under condition that temperature of air at the ground is below 0°C. When infiltrating water meets debris in which pores are not filled with ice it saturates it or flows down. From that subsurface flow there may be sometimes created rapid inter--cover streams, which meeting bends or unpermeable layers appear on the surface (Czeppe 1966).

As a result of slow, insolative ablation during the first period of spring, areas of rocks and fragments of tundra south-facing and protected against wind become uncovered (Rodzik, in print). At the same time ablation on slopes takes place but its speed is less than on plains. Ground thaw is local and it is at first stage (Tab. 1).

Table 1

Snow cover ablation in Hornsund in 1983 on the basis of chosen meteorological elements (by Rodzik, in print)

Period of time	Air temperature °C	Precipitation mm daily	Ablation cm daily			
			coastal plain	S slopes 200 m.a.s.l.	S slopes 200—400 m.a.s.l.	top zone 400 m.a.s.l.
12—18 V	−4.8	0.0	0.1	0.4	0.1	0.1
19—26 V	−1.6	0.0	0.4	0.8	0.5	0.1
27—31 V	−0.1	0.7	1.2	1.8	0.8	0.0
1—9 VI	−2.2	0.2	0.2	0.6	0.3	0.2
10—19 VI	1.3	3.9	2.4	2.0	0.9	0.6
20—29	2.5	0.8	3.4	4.5	4.0	3.9

The second part of spring is characterized by temperatures above 0°C and higher precipitation. Daily amplitudes of temperatures reach even several degrees, winds are not so strong. In such conditions ablation of snow cover is maximal (Tab. 1). In hydrologic literature concerning Canadian Arctic this period is called „break up". Ice and snow thaw and short but intensive period of thawing waters abundance begins.

Intensity of snow cover ablation is greater than ground thawing so ablative waters flow on the surface or make their route inside snow making supranival and subnival beds. Ground thawing contain larger areas free of snow cover. Evaporation reaches 1 mm, daily (Baranowski 1968).

Differentiated exposure causes unequal course of ablation. At the end of spring plain areas and adjoining slopes is partially covered with snow patches. They are situated mainly in these places where the thickness of snow cover was the greatest in winter. In mountainous parts, above 200 m. a. s. l. snow cover of wide, isolated patches dominates (Rodzik, in print).

WATER CIRCULATION IN SUMMER

The direction of air masses circulation is the mostly differentiated in summer. During north and east circulation summer is dry, western and southern circulation brings mist and heavy rainfall. Eastern circulation causes very strong winds of föhn character (Kalicki 1985) in Hornsund.

In summer hydrological processes are not so changeable as in spring. Besides ablative waters from snow patches there are also waters from ground thawing. It can be easily observed at the beginning of summer when tundra is wet, saturated.

Precipitation

Precipitation of summer 1983 and 1984 were similar (Tab. 2). In 1983 the sum of precipitation was 39.5 mm, in 1984 — 40.1 mm but disposition was different. In 1983 the highest precipitation took place in the first half of July, in 1984 — at the end of July and in August.

Precipitation in the mountains are higher than at the seaside. The difference in July was 7.7 mm, in August 10.0 mm. Lower precipitation at the sea-side could be caused by its location — in rain shadow of Hohenlohefjellet (614 m. a. s. l.) massif.

Summer precipitation are of extensive character lasting from two to some days. The amount of precipitation is great after föhns and southern winds. Horizontal precipitation is frequent which appears when humidity of air is close to 100%. Such character of precipitation and attendant

Table 2

Amounts of some of meteorological elements in „Palffyodden" and „Lisbetdalen" in 1983 and 1984

Meteorological element	Lisbetdalen 1983		Palffyodden 1983		Palffyodden 1984	
	12—31 VII	1—21 VIII	12—31 VII	1—21 VIII	1—31 VII	1—21 VIII
mean daily temperature of the air (°C)	4.6	3.3	4.7	3.9	4.2	5.5
mean relative humidity of the air (%)	83	87	87[b]	93	88	92
sum of precipitation at the height of 1 m (mm)	10.1	26.7	2.4	16.7	19.2	20.9
sum of precipitation at the height of ground (mm)	—	—	—	—	25.2	47.8
evaporation (mm)	9.5[a]	13.2	7.3[c]	16.2	—	—
speed of wind (m/s)	2.0	3.9	—	3.1	3.8	5.1

a and c — sum of evaporation from 28 VI—31 VII, b — measurements were begun 14 VII; pause (—) designate lack of measurements

winds causes that measurements of rainfall with pluviometer on the height of 1 m do not show their real amount. Measurements with den pluviometr showed higher amount of precipitation falling on the ground (Tab. 2). In June 1984 the difference was 4.2 m, in July 6 mm in September 25.1 m — more than 100%. Similar differences in measurements of amount of precipitation were found near the Werenskiolda glacier (Liebersbach 1982). The greatest differences in precipitation measurements were obtained between the pluviometer with Grunov net and without it. Precipitation measured with the pluviometer with the net was 3 times higher that while measurements without it.

Rainfall predominates in summer. In the third decade of September snow mixed with rain begins to fall. Snow accumulation begins first in top parts of mountains situated up-land (Kovalevskifjellet).

Condensation waters

Condensation waters irrespectively of precipitation supply underground waters. It may be stated on the basis of air humidity which is great in summer reaching sometimes even 100% (Fig. 2). Surfaces of rocks and debris are wet and slippery. Changes of air temperature during a day and cloudiness cools the ground which in contact with warmer air cools it below dew-point.

It is hard to estimate the amount of condensation waters. It must be realized that it is an important source of intercover water alimentation

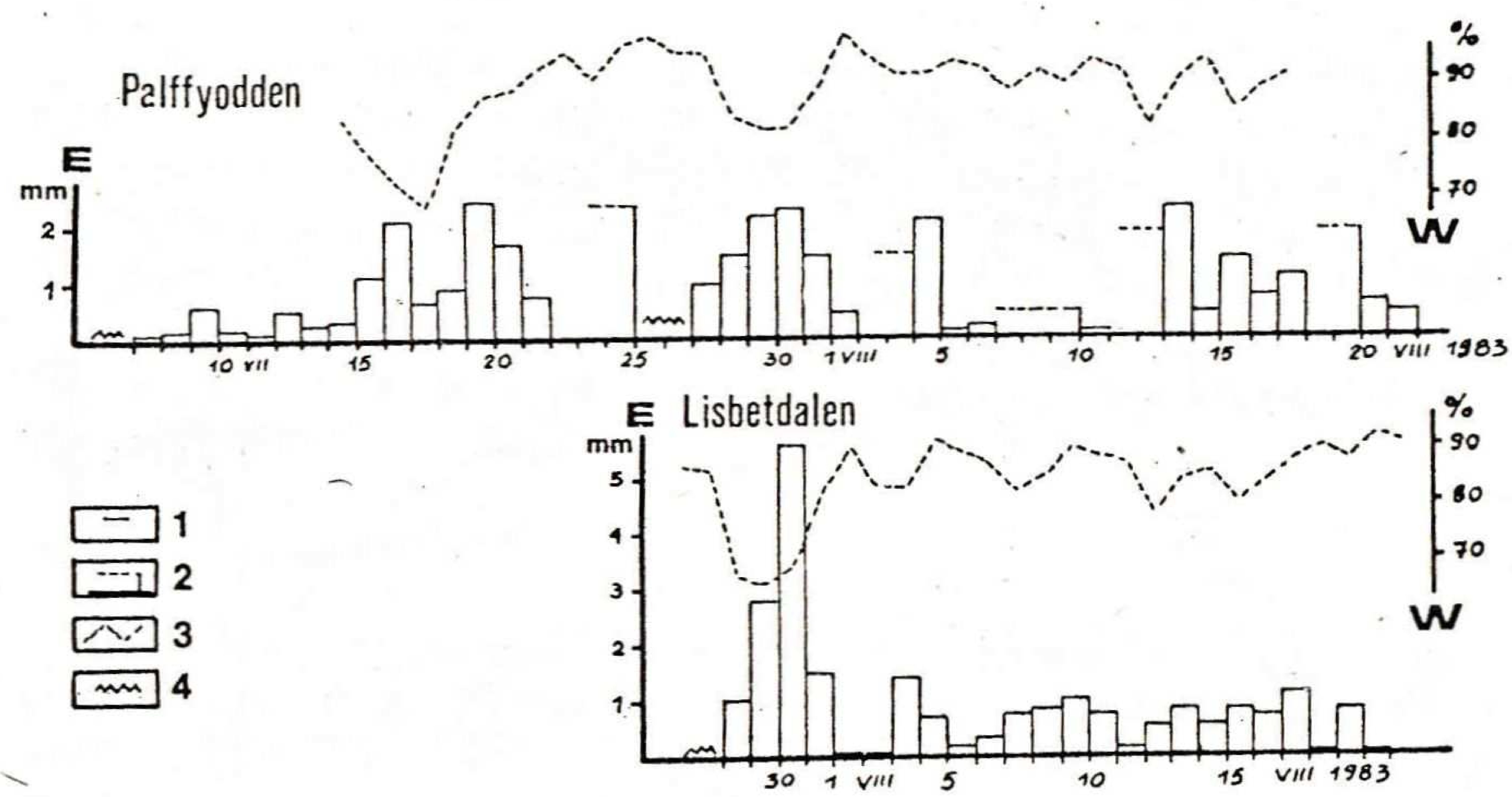

Fig. 2. Daily evaporation (*E*) on the background of mean daily relative humidity of air (*W*) at „Palffyodden" and „Lisbetdalen"

1 — daily evaporation, 2 — 2—3 days evaporation, 3 — mean daily humidity of air, 4 — no measurements of evaporation

(Fig. 2). Share of water vapour in supplying the first underground water horizon in steppe zone by W. W. Klimoczkin (1959), A. A. Makkawcew (1936) is estimated for 20—50% of total precipitation.

Outflow

In summer both surface and underground outflow takes place above low boundary of active layer of permafrost. Ground thawing which begins in spring and lasts till the end of summer makes conditions which make possible under surface water circulation. Waters circulating in covers and rock cracks get on the surface as springs, swamps or leakings supplying rivers, lakes or marshes with water. As, because of frozen, impermeable basement, surface outflow dominates in spring, in summer outflow takes place under surface of the ground.

In summer water level gradually decreeses in both rivers disturbed sometimes by short lasting freshets (Fig. 3). They were caused by rainfall (21—26 VII, 9 VIII 1983 — the Kovalevskielva) or by higher temperature of air (30 VII 1983 — the Kovalevskielva) or by both these factors at the same time (21 VIII 1983 — the Kovalevskielva) — Fig. 3.

Freshets of the Lisbetelva were also caused by rainfall and warming up. They are about 2—3 days transfered accordingly to freshets of Kovalevskielva. Culmination of freshets accordingly to precipitation in the Kovalevskielva takes place some hours, in the Lisbetelva after 2—3 days. The reason of slower reaction of the Lisbetelva on rainfall and warming

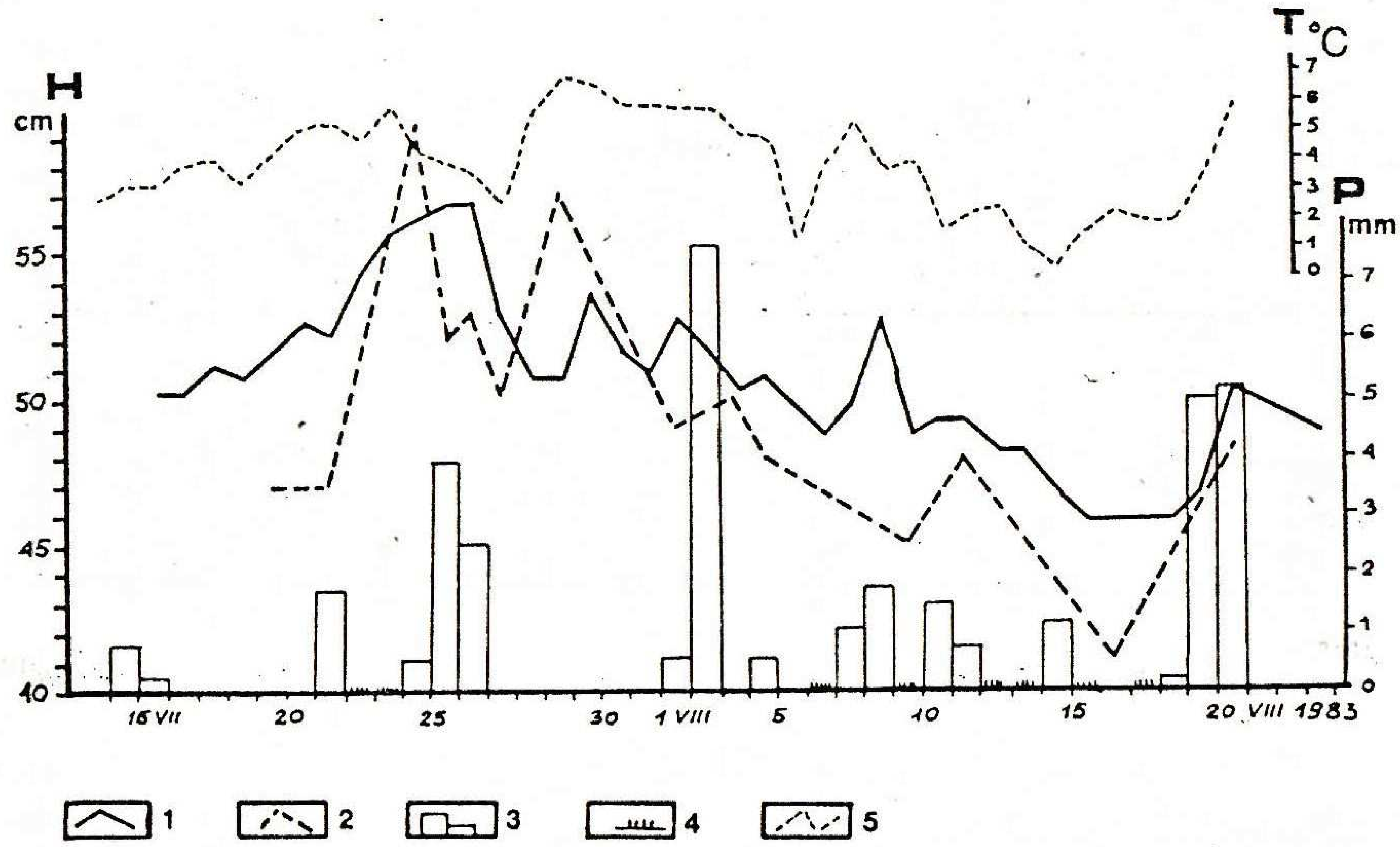

Fig. 3. Water levels (*H*) in the Kovalevskielva and the Lisbetelva on the background of mean daily temperature of air (*T*) and daily sums of precipitation (*P*)

1 — water levels in the Kovalevskielva, 2 — water levels in the Lisbetelva, 3 — daily sums of precipitation, 4 — trace of precipitation, 5 — mean daily temperature of air

Table 3

Outflow from periglacial catchment basins at the beginning and the end of summer 1984

No of profile	Name of catchment basin	Area of catchment basin sq km	Beginning of summer			End of summer		
			date of measurements	discharge cub. m/sec	modilus of discharge l/sec/sq/ /km²	date of measurements	discharge cub. m/sec	modilus of discharge l/sec/sq/ /km²
1	pod Wurmbrandeggą	1.7	29 VI	0.23	135.3	27 VIII	0.02	11.8
2	Savitsjelva	3.7	,,	0.79	213.5	,,	0.05	13.5
3	Lisbetelva	17.1	,,	4.99	291.8	,,	0.12	7.1
4	Tjuvjojötjörna	2.0	,,	0.15	75.0	,,	0.02	10.0
5	Lidelva	5.5	10 VII	0.78	141.3	18 VIII	0.41	74.5

up is the bigger area of its catchment area and the presence of the svartvatnet which equalizes water level of the Lisbetelva.

In summer outflow in catchment basins of periglacial rivers gets smaller. In the Lisbetelva it decreased more than 40 times. At the end of summer there were no snow patches which could supply the river with water in that basin. In the Lidelva basin outflow was smaller twice only as till the end of summer ablation of many years lasting snow area situated in the upper part of the valley took place (Fig. 1, Tab. 3).

Evaporation

Evaporation at the coast and inside the mountains is nearly the same (Tab. 2). Mean daily evaporation at the coast and inside the mountains was nearly 1 mm. It is close to mean value of evaporation measured with the Wild evaporimeter for surrounding of the Polish Academy of Sciences base in spring; it was 1 mm daily (Baranowski 1968). The highest evaporation took place during dry days with low relative humidity of the air (Fig. 2). It reached even 5, 6 mm daily.

Evaporation from the ground is particularly high during sunny days. There can be observed white, misty precipitation above swampy depressions (e. g. 29, 30 VI 1984 — Hornsundneset). Strong catabatic winds causing drying up the ground cause greater evaporation.

Transpiration does not play an important role in the ground moisture because of poor plant cover. It may be greater locally on areas covered with moss (part of the southern part of Harnsundneset, bottom of Lisbetdalen).

It may be supposed that ground evaporation gets smaller in summer during decreasing of air temperatures. Evaporation in not glaciated catchment areas of the south-western Spitsbergen is estimated for about 90 mm yearly, what makes the fourth part of annaual sum of precipitation in Hornsund (Leszkiewicz 1985, Rodzik, Stepko, in print).

Retention

Water can be stored on the surface and under it. Surface retention makes water in lakes and snow patches. The amount of it is impossible to be estimated because of the lack of knowledge of lake bathometry and size of snow patches.

For seatching changes of lake retention in summer, measurements of water level of effluent lake (Gęsie lake), periodically drain lake (Przy Chacie lake) and of lake without outlet („A") took place.

Water levels of periodically drain lake decrease in summer. Water levels of effluent lake in 1983 were stable from the end of July, earlier they systematically decreased. In 1984 water level was stable during the whole

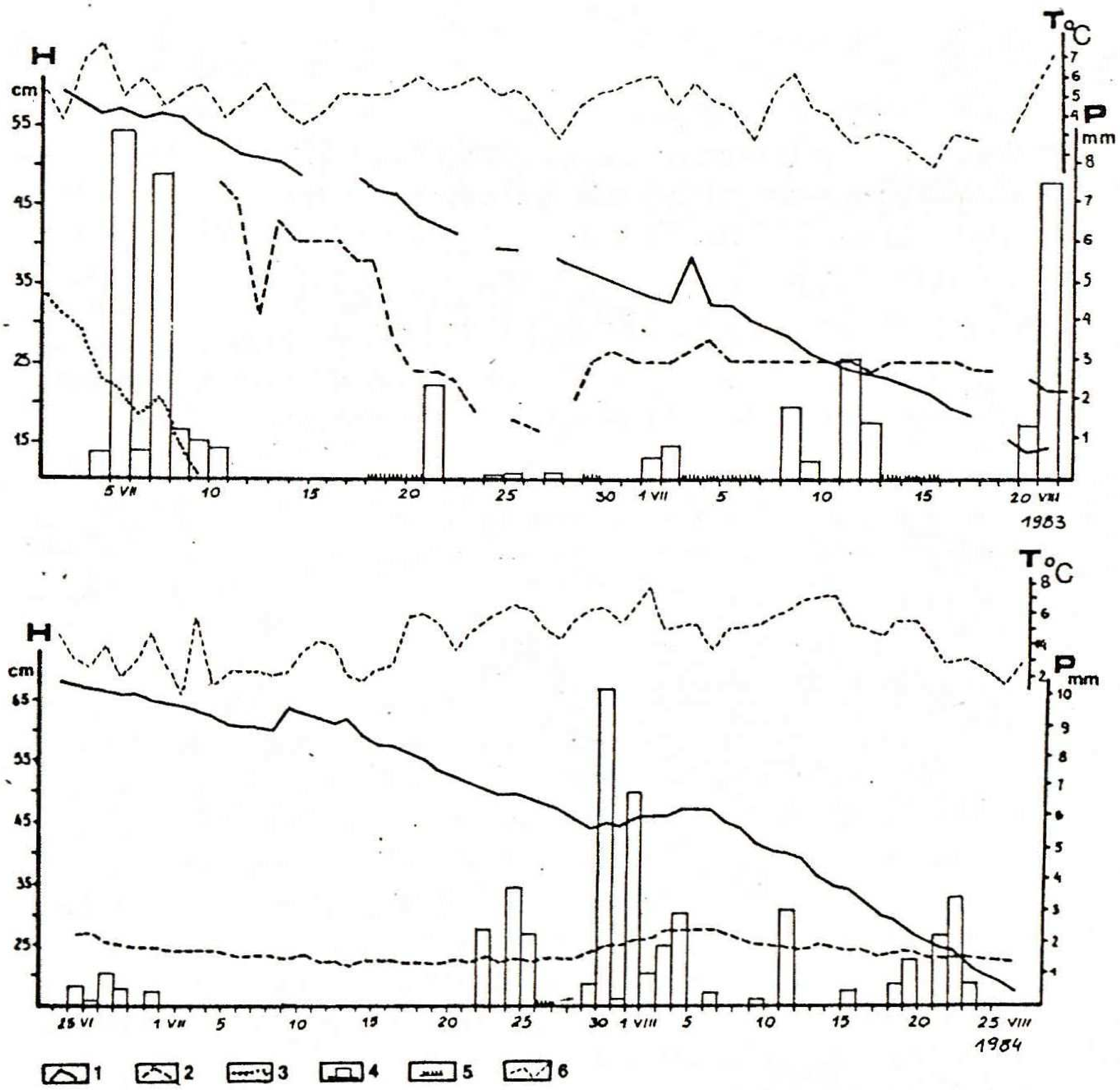

Fig. 4. Water levels (*H*) of Przy Chacie, Gęsia, „A" lakes on the background of mean daily temperature of air (*T*) and mean daily sums of precipitation (*P*)

1 — water levels of Przy Chacie lake, 2 — water levels of Gęsie lake, 3 — water levels of „A" lake, 4 — daily sums of precipitation, 5 — trace of precipitation, 6 — mean daily temperature of air

search season. Water level of periodical lake decreased untill complete disappearance (Fig. 4).

A small increase of water level was noticed in all lakes caused by precipitation and higher air temperatures. Which caused snow patches ablation and thawing of permafrost. There were sudden changes of water level caused by sway of lake surface because of strong winds (Fig. 4).

Lowering of water levels in summer causes changes of coast line and areas of lakes decrease or they even disappear.

Snow retention in summer exists as snow patches. They can be met mainly within mountain valleys. Patches situated on coastal plains melt in the first part of summer.

In 1983 ablation of snow patches was higher than the following year. It was probably caused by higher temperatures of the air at the beginning of summer 1983. Speed of ablation of the snow patch p_{11} in 1983 was 11 cm daily, in 1984 about 7 cm daily. Besides this patch melted in 1984 9 days later than in 1983. It may be stated that ablation in 1984 began a week later than in 1983 as accumulation of snow in winter in both years was similar — in winter 1982/1983 — 218.8 mm, 1983/1984 — 229.1 mm.

The speed of snow patches ablation was the highest when mean daily temperature of air was above 5°C and when rainfall was at that same time. It reached 33 cm daily (Fig. 5).

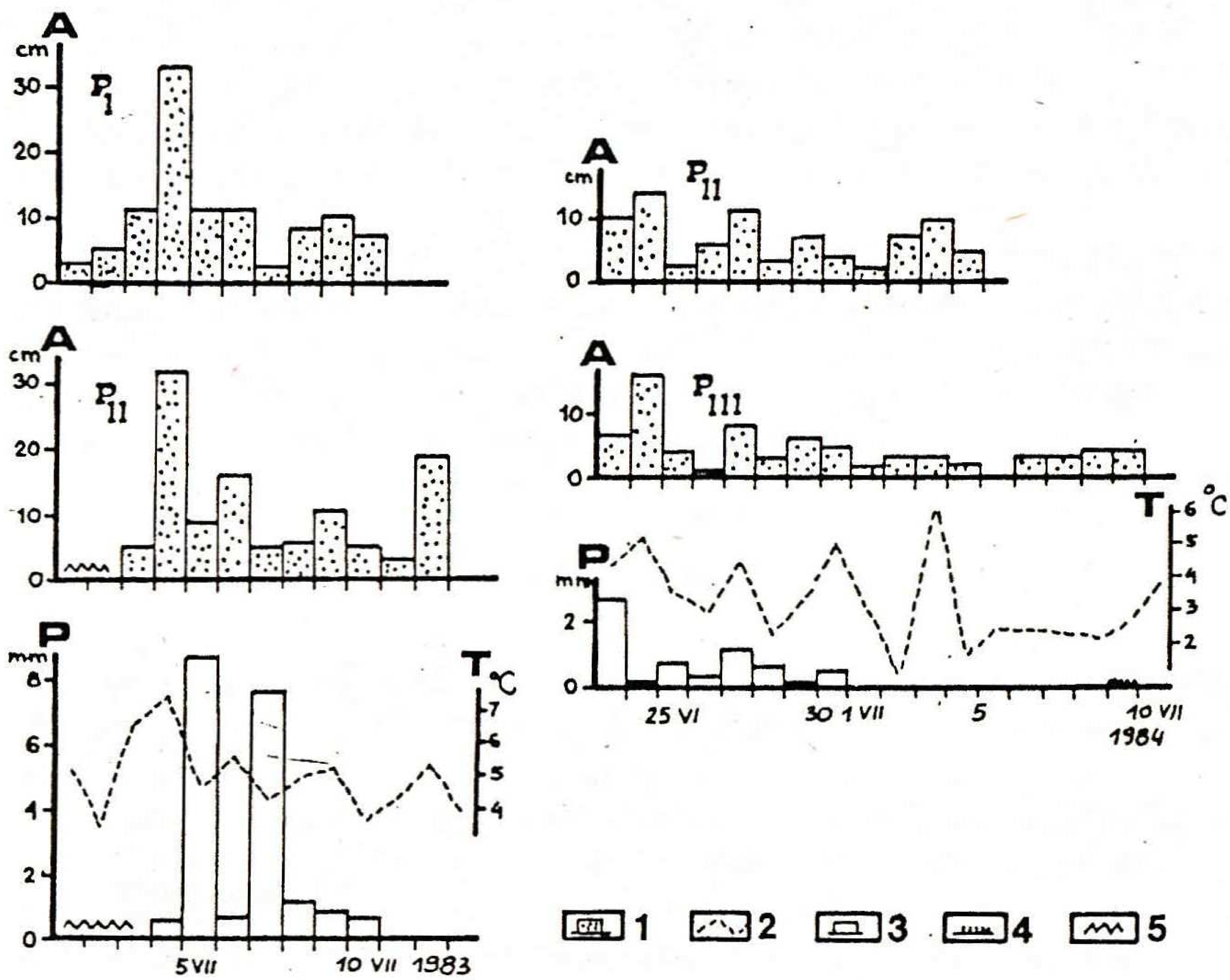

Fig. 5. Speed of snow patches (*A*) melting on the background of mean daily temperature of air (*T*) and daily sums of precipitation (*P*)

1 — speed of snow patches melting, 2 — mean daily temperature of air, 3 — daily sum of precipitation, 4 — trace of precipitation, 5 — lack of observations

Subsurface retention is made by water in cover deposits and by iceing frozen ground.

At the end of summer free water level exists locally only — in depressions and swampy areas. Majority of covers is deprived of flowing waters in summer, as thawing of frozen ground in deeper parts is slow and water from thawing evaporates or supplies lack of ground moisture.

Water in frozen ground appears as ice in solid or loose deposits, temperature of which is below 0°C. Water in frozen ground takes shapes of porous ice, ice edges or ice lentlicles.

Hydrological subperiods during summer

On the basis of differentiated course of meteorological and hydrological elements in summers of 1983 and 1984 there could be distinguished 2 hydrological subperiods in summer:

— earlier — subperiod of intensive ablation of snow patches and intensive melting of frozen ground,

— later — subperiod of snow patches and slow melting of frozen ground.

Subperiod of intensive ablation of snow patches and intensive melting of frozen ground in 1983 lasted till the end of July, in 1984 till the end of the second decade of July. The beginning of this subperiod could not be stated because the expeditions arrived too late, during polar summer. There were many sunny and calm days during this subperiod. Mean daily temperature is often above 4°C. Precipitation, only rainfall is at the beginning of July or at the end of June and at the beginning of July. Relative humidity of air is differentiated but rather below 90%. Evaporation may reach 2 mm daily.

Weather conditions are good for ablation of snow from winter accumulation. At the end of June and at the beginning of July ablation is very intensive. During good conditions (high temperature, föhn wind, rainfall) it may be over 30 cm daily. During this subperiod snow patches on plains melt, in mountainuous valleys snow cover disappear but snow patches remain.

During this period thawing of frozen ground is also intensive. Thickness of active layer of permafrost on plains in sandygravel deposits in first days of July it reaches 1 m.

Fast snow ablation, intensive thawing of permafrost cause larger run--off which at the beginning of this subperiod reaches even more than 290 l/sec/sq km. Water levels in effluent lakes are lowered or they are on the same level, water levels in periodically drain lakes are lowered systematically. Many lakes on plains disappear.

Subperiod of slow ablation of remains of snow patches and slow melting of frozen ground plasted in 1983 from the beginning of August, in 1984 from the third decade of July. The end of this subperiod could not be stated because the expeditions researches were finished. Cloudy days prevail during this subperiod. There are often rainfalls or rainfalls with snow. Relative humidity of air is often higher than 90%. Evaporation is smaller than in the first subperiod.

In mountainuous valleys ablation of remains of snow patches takes place. Thawing of permafrost on plains and on slopes is very slow and at the end of this subperiod permafrost may increase.

Run-off is some times less than in the first subperiod of summer. At the end of August it is about 20 l/sec/sq/km except the Lidelva drainage basin which in its upper part is covered with snow (Tab. 3). Water levels in periodically drain lakes get lower, in effluent lakes they are stable.

WATER CIRCULATION IN AUTUMN

In autumn (1 IX—15 X) temperatures of air are lower reaching winter temperatures. Gradually run-off is stopped, evaporation is lowered and period of snow accumulation begins. In autumn ground freezing begins from the surface down and from permafrost up the ground. In September temperature of ground till the depth of 160 cm is above 0°C but in October is below 0°C (Baranowski 1968).

Snow cover in autumn is not continuous. Snow is accumulated in depressions and covers less than half of the area. At the end of autumn thickness of snow cover reaches twenty odd cm. It happens that at this time a mass of warm air and rainfall appear and it causes that snow cover disappear and the surface of the ground begins to thaw.

CONCLUSIONS

The not glaciated area of the north-western Sörkappland is characterized by 2 periods of water circulation during a year, a passive and active ones (Fig. 6).

Passive period contains winter months and lasts from the middle October till the end of May. Water circulation is stopped because of temperatures below 0°C. There takes place a very important for water circulation process, accumulation of snow cover and ground freezing (Fig. 7*A*).

Active period begins at the end of May and lasts till middle October and it is characterized by water circulation. It contains spring, summer and autumn.

During spring active period temperatures of air above 0°C and long-lasting insolation during the polar day cause ablation of snow cover, ice thawing in lakes and rivers and local ground thawing. It makes that water begins to flow, mainly on the surface (Fig. 7*B*). These processes begin earlier on plains than in the mountains because of higher temperatures of air.

During summer active period processes which began in spring take place (Fig. 7*C*). There can be distinguished 2 subperiods: an earlier one of intensive snow patches ablation and intensive frozen ground thawing

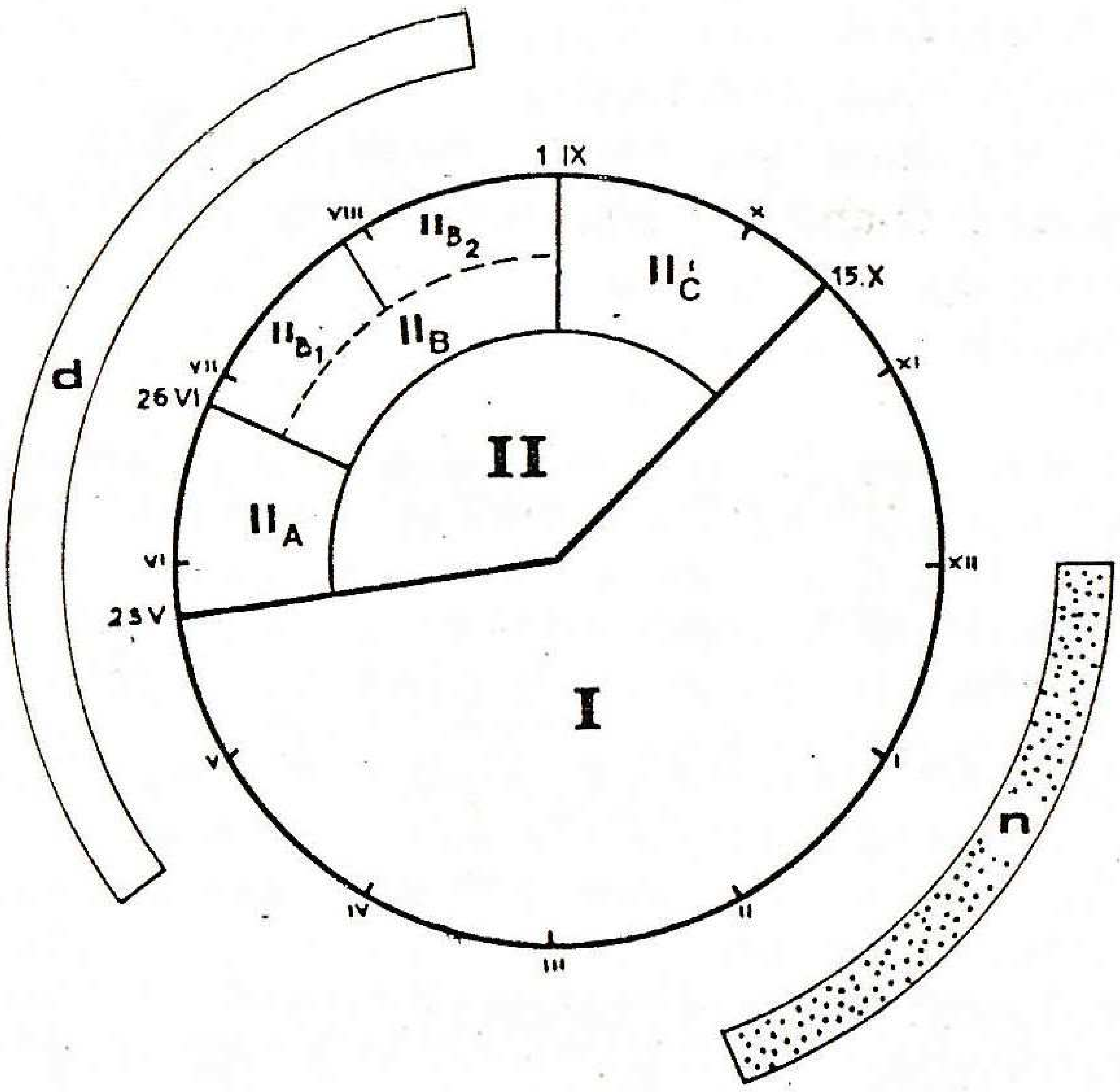

Fig. 6. Periods and subperiods in the north-western Sörkappland

d — polar day, *n* — polar night; I — passive winter period, *A* — spring; II — active period, *B* — summer, *C* — autumn; II_{B_1} — subperiod of intensive snow patches ablation and intensive melting of frozen ground, II_{B_2} — subperiod of slow ablation of remains of snow patches and slow melting of frozen ground

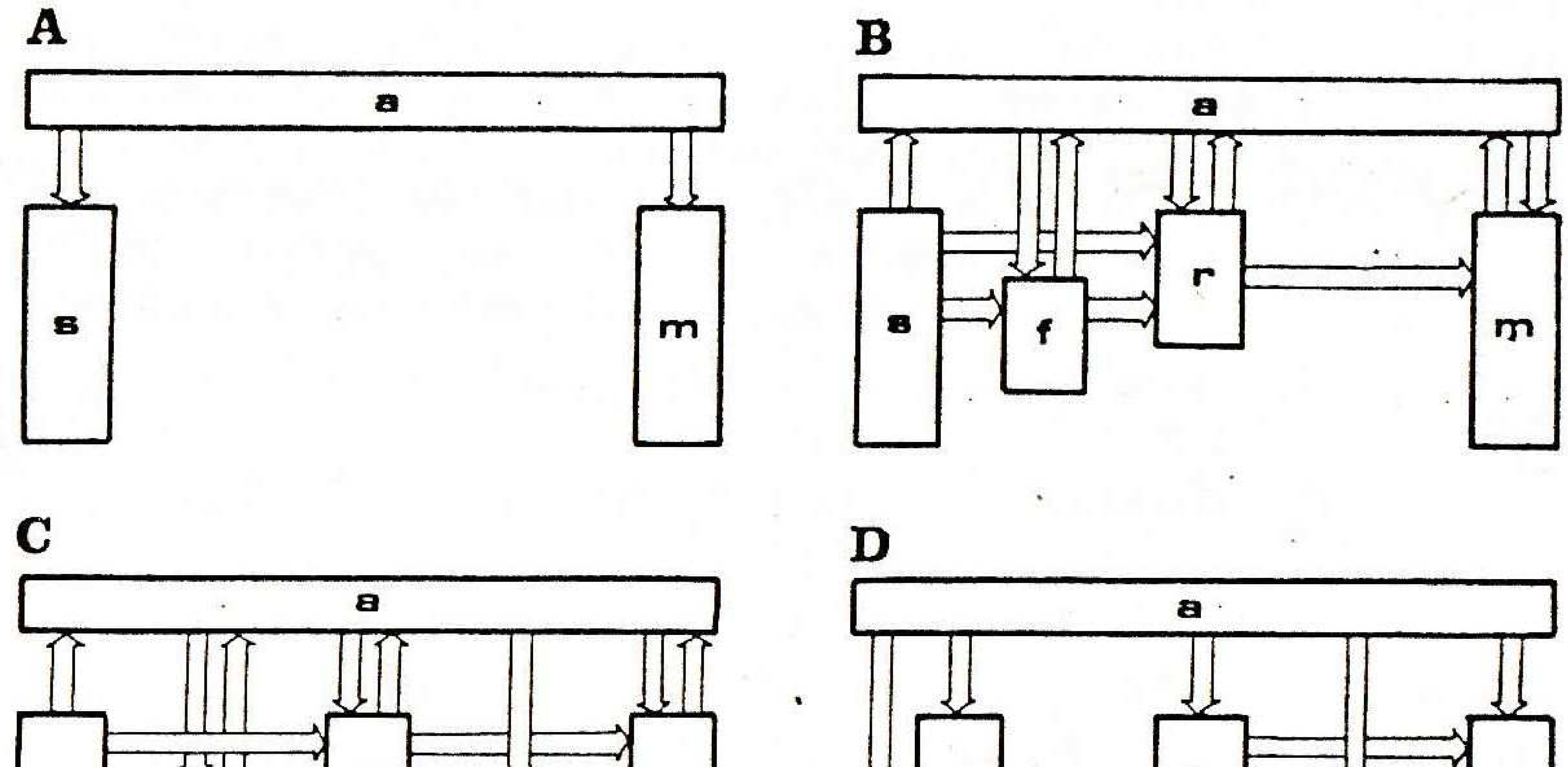

Fig. 7. Scheme of water circulation in the north-western Sörkappland in passive (*A*) period, spring active (*B*), summer active (*C*) and autumn active (*D*)

a — water in atmosphere, *s* — snow cover, *f* — forms of dispersed surface outflow, *r* — rivers and lakes, *g* — underground waters, *m* — fiord and sea, *p* — permafrost and a later one of slow ablation of remains of snow patches and slow thawing.

Amount of outflow in summer active period depends on amount of water which was accumulated in snow cover during passive winter period. Dynamics of out flow depends on weather conditions in summer, mainly on temperature, föhn winds and rainfals.

During autumn active period outflow becomes smaller because of low temperatures and then disappears. The polar night begins. Snowfall with rain or snowfall only appears (Fig. 7*D*). Snow cover begins to appear which may undergo ablation during warming-up. At the end of active period surface and underground waters as well as the ground freeze. The period of snow accumulation begins.

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KRĄŻENIE WODY W NIEZLODOWACONEJ CZĘŚCI PÓŁNOCNO-ZACHODNIEGO SÖRKAPPLANDU (SPITSBERGEN)

Streszczenie

Na niezlodowaconym obszarze północno-zachodniego Sörkapplandu, w rocznym cyklu krążenia wody można wyróżnić dwa okresy: pasywny i aktywny. Okres pasywny obejmuje miesiące zimowe i trwa od połowy października do końca maja. Obieg wody jest zahamowany wskutek ujemnych temperatur powietrza. Podczas tego okresu odbywa się jednakże bardzo ważny proces dla późniejszego krążenia wody, mianowicie akumulacja pokrywy śnieżnej oraz zamarzanie gruntu. Okres aktywny trwa od końca maja do połowy października i charakteryzuje się ożywioną cyrkulacją wody. Obejmuje on porę wiosenną, letnią i jesienną.

W okresie aktywnym wiosennym dodatnie temperatury powietrza oraz długotrwała insolacja w czasie dnia polarnego powodują ablację pokrywy śnieżnej, tajanie lodu w jeziorach i rzekach oraz lokalne odmarzanie gruntu, dzięki czemu woda zaczyna odpływać, głównie powierzchniowo. Procesy te rozpoczynają się wcześniej na równinach nadmorskich niż w górach, z powodu wyższych temperatur powietrza.

W okresie aktywnym letnim nadal trwają procesy zapoczątkowane wiosną. W okresie tym można wyróżnić dwa podokresy: wcześniejszy podokres intensywnej ablacji płatów śnieżnych i intensywnego wytapiania zmarzliny oraz późniejszy podokres powolnej ablacji szczątkowych płatów śnieżnych i powolnego wytapiania zmarzliny.

Wielkość odpływu w okresie aktywnym letnim zależy od ilości wody zakumulowanej w pokrywie śnieżnej w okresie pasywnym zimowym, poprzedzającym sezon letni. Dynamika odpływu zależy od warunków pogodowych w czasie lata, głównie od temperatury powietrza, wiatrów fenowych i opadów deszczu.

W okresie aktywnym jesiennym następuje stopniowe zanikanie odpływu, spowodowane ujemnymi temperaturami powietrza. Rozpoczyna się noc polarna, i zaczyna się tworzyć pokrywa śnieżna. Pod koniec okresu aktywnego zamarzają wody powierzchniowe i podpowierzchniowe oraz grunt.