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Marek ANGIEL

Institute of Geography
Jagiellonian University
Research Station at Łazy n/Bochnia,
32-765 Rzezawa, POLAND

Heat flux in selected polar soils in spring and summer (Hornsund, Spitsbergen)

ABSTRACT: Research in Hornsund (SW Spitsbergen) aimed to determine time distribution of heat flux in various soils of Arctic periglacial zone in spring and summer. Typical soils were analysed: tundra gleyey cryogenic soil (*Pergelic Cryaquent*), tundra peaty soil (*Pergelic Histosol*) and arctic desert soil (*Pergelic Cryorthent*). Research sites were located in low plains not covered with ice, near a sea, at 7—13 m a.s.l. Heat flux in soils was measured and recorded automatically every 60 s throughout a whole observation period and concurrently at three sites. In spring and summer intensive heat accumulation was observed in all examined soils. Independently on the weather, a cryogenic gleyey soil received greatest heat throughout a day. Environmental conditions have distinct influence on heat resources in soils.

Key words: Arctic, Spitsbergen, heat flux in soil, periglacial soils.

Introduction

Energy exchange between atmosphere and soils is studied in many branches of physical geography. Although this exchange belongs to the most important processes of physical geography, it is known in details as the major climate-forming process. Significance of energy exchange in broader aspect was noted among others by Chorley and Kennedy (1971), Budyko (1974), Armand (1980) and others. In this paper, the energy exchange between atmosphere and soils is treated as a most important process, which creates a structure of environment in time and space, and influences its functionality. The latter is a development process of the geosystem and determines its dynamics.

Heat exchange between atmosphere and soils may be presented as a thermal balance of an active surface:

$$Q = H + LE + S$$

where: Q — net radiation flux, H — turbulent sensible heat flux, LE — turbulent latent heat flux, S — heat flux in soil.

Net heat flux (radiation balance) in converted to thermal energy in an active layer. This energy is used for vaporisation, heating a soil and lower air layer according to the above-mentioned equation. As results from the balance equation, there is varying relationship between its parts, influenced by differentiation of surface features and various meteorological conditions.

The paper presents results of research on heat flux in soils (S), which is an element of thermal balance of the active surface. It focuses on:

1) time distribution of heat flux in various polar soils in spring and summer;
2) influence of environmental conditions (*i.e.* properties of active surface and meteorological conditions) upon a diurnal course of heat flux in polar soils.

Sites

Research works were carried out in Spitsbergen (Hornsund) in the Fuglebekken drainage basin (77°00'N and 15°33'E) during the expedition of the Department of Ecological Bioenergetics, Institute of Ecology of the Polish Academy of Sciences, in 1989; they focused partly on intensity of metabolic processes in soils.

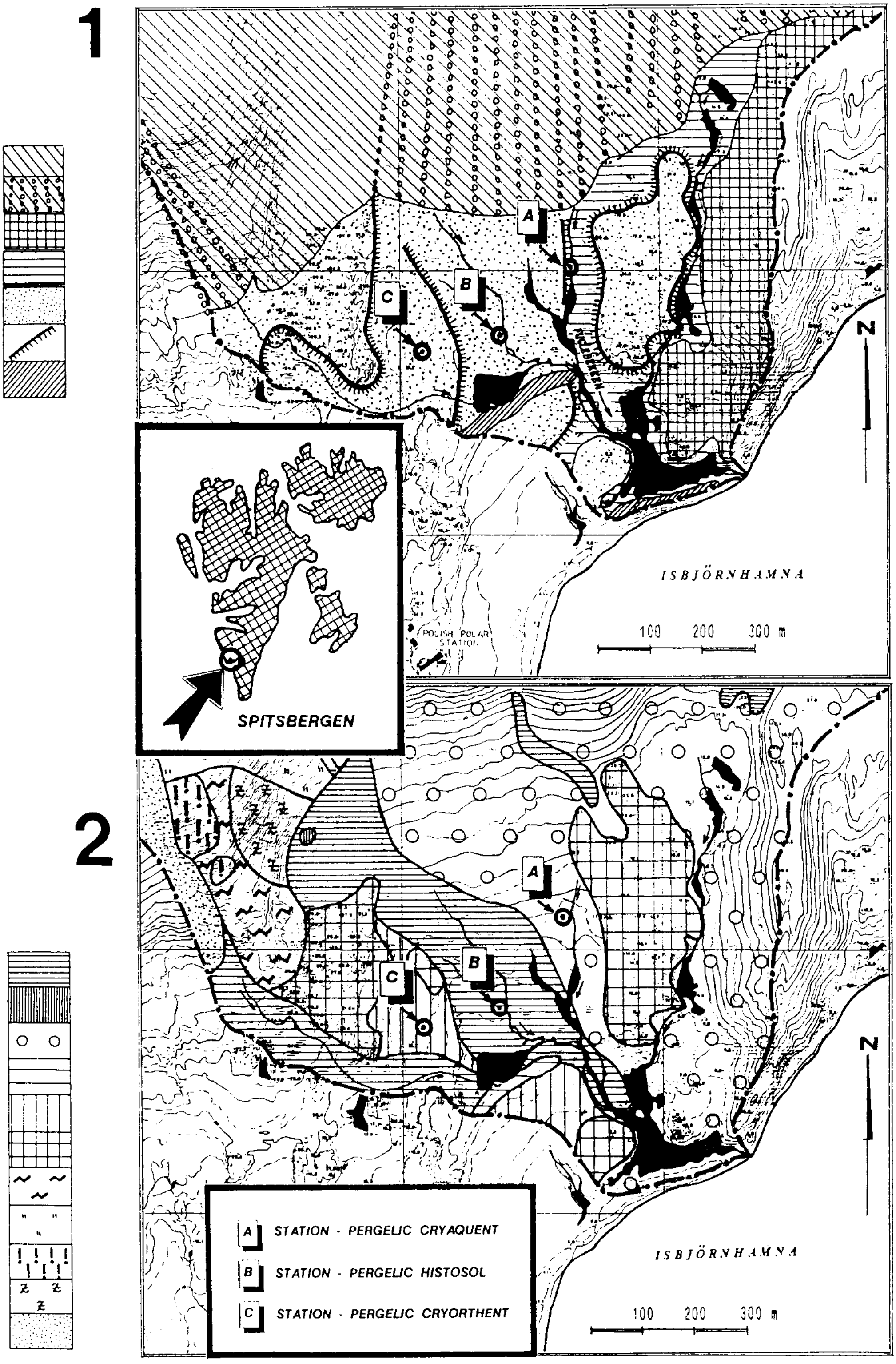
The analysis included serial measurements (selected elements of thermal balance of active surface) carried out from May 14 to August 15, 1989 (94 days) *i.e.* during a polar day. At latitude of Hornsund, the sun does not set between April 24 and August 18. From May 19 to August 1 it does not occur below 5 degrees above a horizon. Research of heat flux in soils was initiated when a snow cover disappeared. Observations started at different time at each research site: at the site A on May 14, at the site B on June 24 and at the site C on June 3. It was due to ablation of a snow cover in the river basin.

Location of research sites against geomorphological conditions of the downstream Fuglebekken and plant associations is presented (Fig. 1). Sites were selected on two low raised marine terraces (with edges at about 5 and 10

Fig. 1. Location of research sites in the downstream Fuglebekken basin (Hornsund, Spitsbergen) against of geomorphological conditions (Jania *et al.*, 1984) and vegetation associations (Godzik 1987).

Geomorphology: 1 — mountain slopes, 2 — talus and proluvial cones, 3 — lateral ice-cored moraine ridges, 4 — outwash plains and fans on bedrock, 5 — plains of raised marine terraces, 6 — edges of raised marine terraces, 7 — storm ridges.

Vegetation associations: a — *Calliergon stramineum* — *Sanonia uncinata*, b — *Tetraplodon mnioides* — *Aplodon wormskjoeldii*, c — stony tundra, d — *Cladonia mitis* — *Cetraria nivalis* — *Rhacomitrium lanuginosum*, e — *Sphaerophorus globosus*, f — *Cladonia mitis* — *Cetraria nivalis* — *Rhacomitrium lanuginosum* — *Sphaerophorus globosus*, g — *Chrysosplenium tetrandrum* — *Cochlearia officinalis* — *Cerestrium alphinum*, h — *Sanonia uncinata* — *Aulaconium turgidum* — *Saxifraga oppositifolia*, i — *Candelariella arctica*, j — *Sanonia uncinata* + *Candelariella arctica* + *Xantoria elegans*, k — rocky lichens.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m a.s.l. respectively) with small inclination (1—4°). Studied surface fragments received the same amounts of thermal energy from total solar radiation due to equal distance of measurement sites from the mountains and small distance between measurement points (up to 250 m). Research sites were different as far as lithology and vegetation were concerned. Water circulation was also different at each site. The sites were situated in different soils: tundra gley cryogenic soil (*Pergelic Cryaguent*), tundra peat soil (*Pergelic Histosol*) and arctic desert soil (*Pergelic Cryorthent*) (Szerszeń 1965, Plichta 1977, Klimowicz and Uziak 1988, Skiba 1991, Fischer and Skiba *in press*).

The first site (A) was located on a raised marine terrace at foot of Fugleberget at 10 m a.s.l. The terrace occupied an extensive area with inclination from 1 to 3°, covered by eluvium with polygon network — sludge craters and debris rings. According to Jahn's classification (1970), it belonged to gravitation modelled soils. Tundra gleyey cryogenic soil (*Pergelic Cryaquent*) developed on them. Measuring instruments were installed in a sludge crater completely devoid of vegetation (association of stony tundra in initial state). Mechanical composition of crater material at 0 to 20 cm depth is presented (Fig. 2A), being a skeletal-gravelly formation; the soil was a clayey silt.

The second site (B) was located on the same marine terrace at 7 m a.s.l. Polygon network was mantled with 5 cm of peat, which comprised living moss *Calliergon stramineum* (0—1 cm), atrophied non-decomposed moss (1—4 cm) and slightly decomposed moss (4—5 cm). The peat covered a gleyey soil, an upper layer (6—8 cm below the surface) of which composed of skeletal stony-gravelly-clayey formation. Deeper parts of the gleyey soil should be classified as light clays. Grain size soil material at the site B is presented (Fig. 2B). The moss and the underlying gleyey soil form a tundra peaty soil (*Pergelic Histosol*).

The third site (C) occurred at 13 m a.s.l. on a higher, raised marine terrace with inclination of 4°. The terrace was composed mainly of marine pebbles and gravel, without eluvium from mountains slopes. The arctic desert soil (*Pergelic Cryorthent*) was formed there. Lichen association *Sphaerophorus globosus* was noted at this site, composed mainly of bushy lichens of the genus *Sphaerophorus* and vascular plants (mostly *Salix polaris*). Vegetation formed a layer up to 4 cm high. Soil material at depth from 5 to 10 cm was of skeletal stony formation (59% of stones and 31% of gravels). Lower parts were occupied by skeletal stony-gravelly-sandy formations; underlying soil layers at depth below 10 cm belonged to compact clayey sands. Grain size of the soil material from this site is presented (Fig. 2C).

Heat flux in soils and wind velocities were measured and recorded automatically every 60 s concurrently at three sites throughout the whole investigation period. Identical sets of measuring equipment were used at each research point. Sensors of heat flux intensity MGS-3A with modified HFM-1A1 gauges were used for measuring heat flux in soil. Sensors were fixed at 1 cm below the soil surface. Wind-gauges W-841 at height of 2 m were used to measuring of wind velocity.

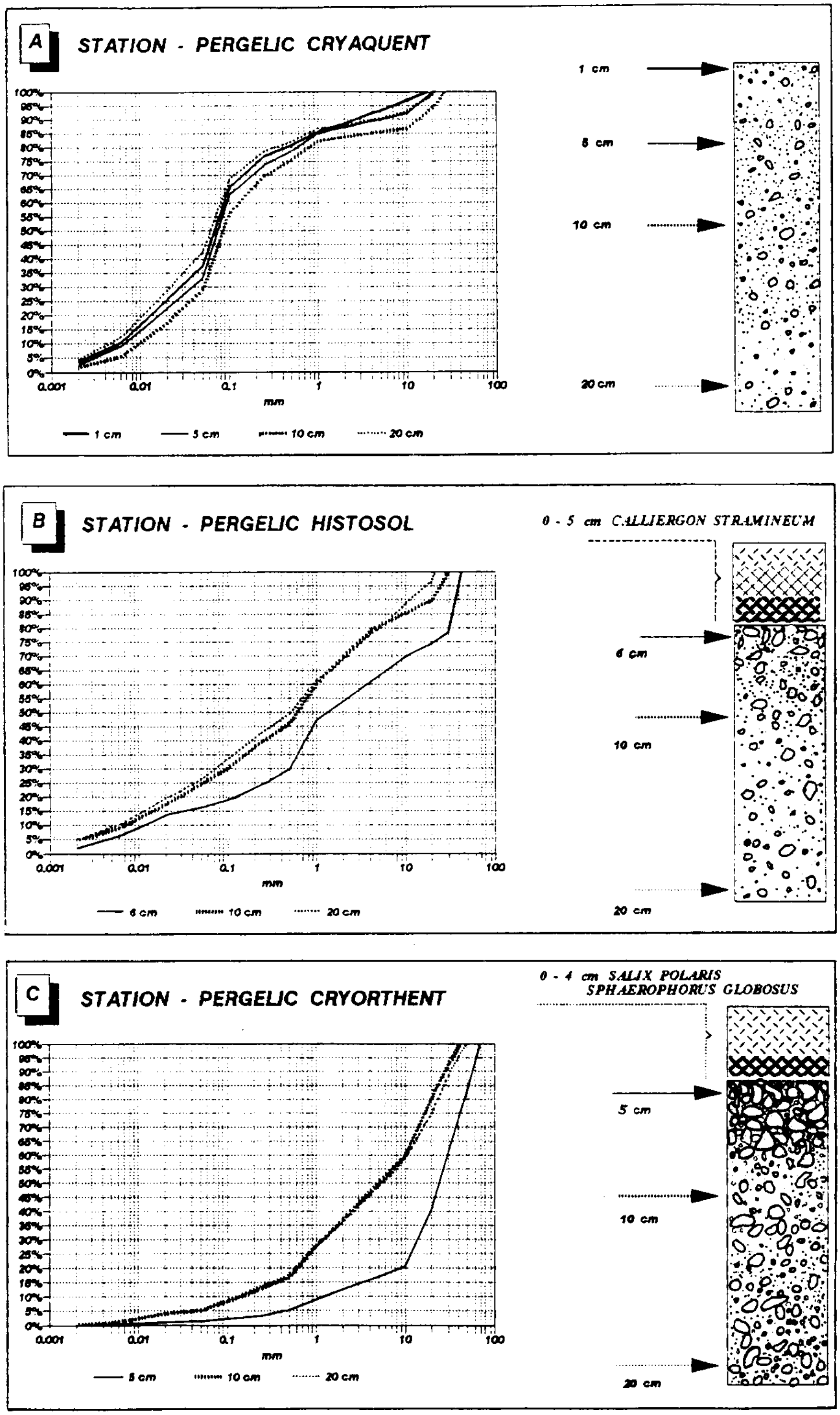

Fig. 2. Grain size of soils against their sections at examined sites in the Fuglebekken basin (Hornsund, Spitsbergen).

Measured values of heat flux and wind velocity were recorded by analog registration sets "LOGGER". The value of each sample was converted to digital form and recorded on compact cassettes. Cooperation of the "LOGGER" with a personal computer enabled computer storage. Preliminary calculations were made with computer programs (developed by Tomasz Jarząbek); results were corrected by taking physical characteristics of measuring instruments into account and 10 minute and 1 h means were calculated.

Information about sunshine, cloudiness and intensity of other phenomena were received from a meteorological station of the Polish Polar Station in Hornsund. The research sites were no more than 900 m away from the station.

Time distribution of heat flux in examined soils

Heat exchange between the active surface and the ground depends mainly on thermal-humidity properties of the latter and on height and density of vegetation. Spatial changes of ground temperature (vertical gradient $\Delta T/\Delta z$) and time ($\mathit{\Delta} T/\mathit{\Delta} t$) as well as thermal conduction and thermal capacity of a ground are the major factors that influence heat flux in soil. Ground humidity exerts greatest influence on changeability of these elements and depends itself on precipitation. The rainfall also decreases a soil temperature whereas evaporating water causes additional energy loss at an active surface. Presence of vegetation influences also a heat flux in soils: the higher and denser the vegetation, the lower the income of solar radiation to the ground and heating of the latter (Budyko 1956, Skoczek 1970, Grzybowski and Itier 1984, Grzybowski 1986).

These general rules of influence of various factors upon heat flux in soils were the key to choose surfaces with different soils and vegetation. Acquired results enabled to estimate influence of precipitation as well as height and density of vegetation upon heat flux in soils.

The problem of heat flux in polar soils has been rarely discussed by Polish scientists. Only Głowicki (1985) and a mixed Polish—Czech team (Brazdil *et al.* 1989) carried such research in Spitsbergen. Głowicki analysed annual heat flux at the research site in Hornsund. He discovered large changeability of daily flux S throughout a whole year and intensive heat accumulation in a ground in July only. Members of the Polish-Czech expedition carried out research of thermal balance of an active surface at a moraine rampart and a polygonal formation at food of the Werenskiold Glacier. They described distribution and size of heat flux in these grounds, they determined that daily totals of the flux S were positive in both types of ground and that daily totals of flux S in polygonal formation exeeded totals in moraines during most of the investigation period (July 28 — September 10, 1985).

Before a spring ablation, a snow cover on a soil surface forms a good insulation layer. A soil does not get and does not lose any heat at that time. Daily heat flux curve is close to a straight line and oscillates near the value of 0.0 Wm^{-2}. In the area around Hornsund, ablation of snow on low raised marine terraces not covered with ice, exists from middle May to the third decade of June. The moment of snow cower vanishing is different for various fragments of a river basin.

Vehement income of heat (from solar radiation) to soil and rapid heating of soil begins with disappearance of a snow cover. This process is independent whether snow cover disappears in May or in June. Heat flux in soil is positive throughout the whole day in this period. The highest mean daily heat flux in soil is also recorded during that time. This phenomenon lasts from 3 to 5 days and is observed in all kinds of soils, independently if they are covered by vegetation or not. Daily rhythm of heat flux becomes fixed when mean daily temperature of soil at depth of 5 cm reaches the value of mean daily air temperature. Daily course and amplitude of heat flux are different for various soils. The period when heat flux in soils is created mainly by net radiation flux begins at this time.

Heat flux in various vegetation and soil environments is to be compared with one another as the upper 5 cm thick layer of soil achieves thermal equilibrium with the air above.

The highest daily mean heat exchange with a soil was recorded in a sludge crater completely devoid of vegetation (*Pergelic Cryaquent*) in May and in a tundra peaty soil (*Pergelic Histosol*) in June (two days after disappearance of a snow cover). Maximum mean daily heat flux reached 51.3 Wm^2 (*Pergelic Cryaquent*) and 54.4 Wm^{-2} (*Pergelic Histosol*) at that time. The lowest mean daily heat flux was recorded in an arctic desert soil (—11.2 Wm^{-2}) and in a tundra gleyey cryogenic soil (—8.1 Wm^{-2}) in June (Fig. 3). From June 24 to August 15 (*i.e.* when heat flux in various soils may be compared with one another), mean monthly values of heat exchange with soils were equal to:

[Wm^{-2}]	June 24—30	July 1—31	August 1—15
A. *Pergelic Cryaquent*	18.4	12.8	16.6
B. *Pergelic Histosol*	15.2	8.7	8.9
C. *Pergelic Cryorthent*	16.1	8.5	7.7

In spring and summer intensive heat accumulation occurred in the all examined soils. It lasted throughout the whole observation period (Fig. 3). Giving up a heat to the atmosphere from cryogenic gleyey soils and mellow initial soils throughout most of a day (daily mean of $S < 0$ Wm^{-2}) was caused by unusually unfavourable meteorological conditions. Very strong wind (>10 ms^{-2}) blew during this period and the sky was covered completely with low clouds throughout the whole day. Only three days with negative mean daily value of heat flux in both these soils were recorded.

Daily heat flux in the examined soils was analysed for days with various weather types. The latter were classified according to these meteorological elements, which most of all influence a heat flux. The following elements were taken into account:

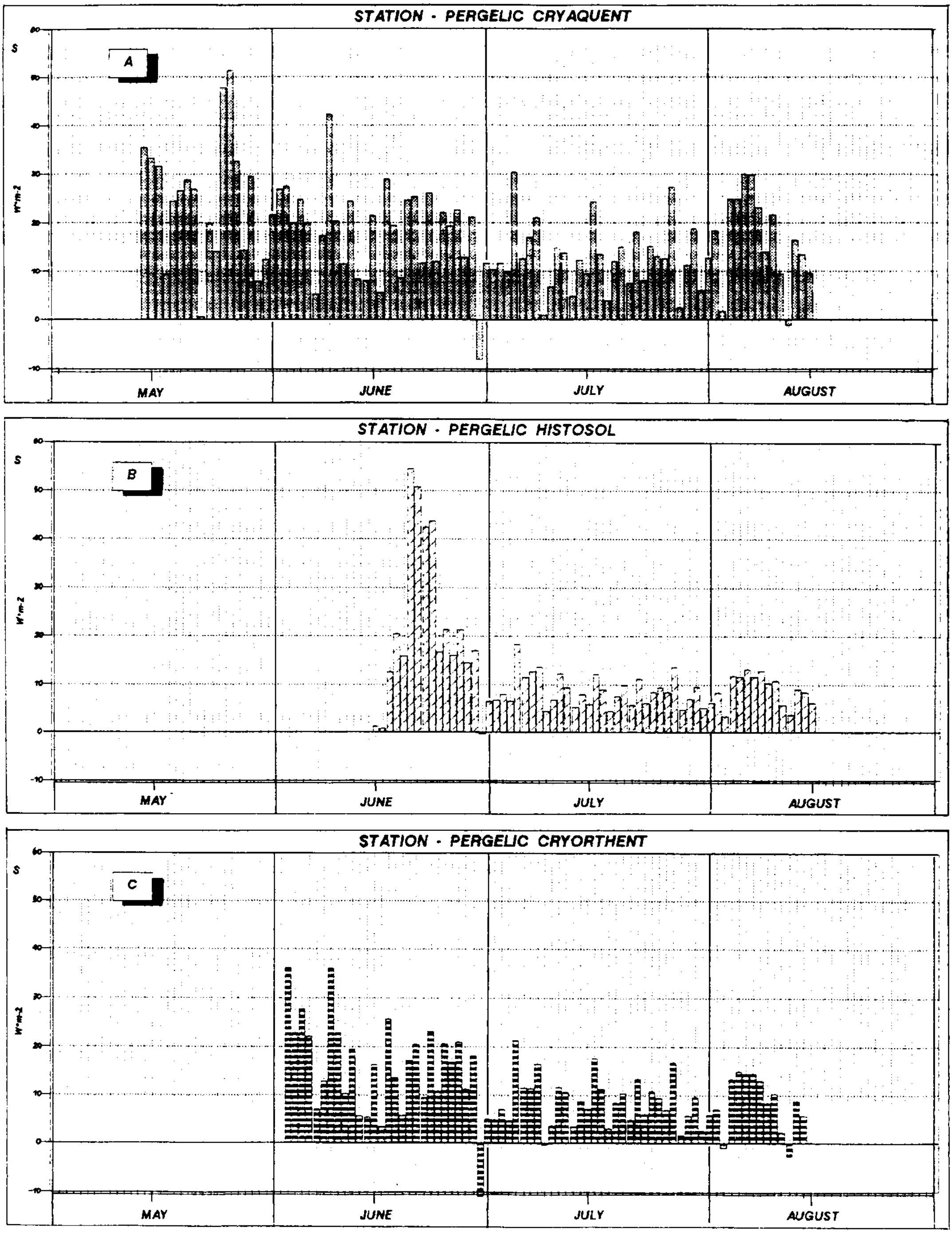

Fig. 3. Mean daily heat flux in selected polar soils in spring and summer 1989 in the Fuglebekken basin (Hornsund, Spitsbergen); daily means of measurements at every 60 s.

Table 1

Maximum, minimum and daily means of heat flux [Wm^{-2}] in selected polar soils of southwestern Spitsbergen on days with various weather types in spring and summer.

Type of weather	Soil	Site	Daily mean	Mean daily max	Mean daily min	Daily amplitude
1. Sunny days, without precipitation, with long sunshine						
1A. Cloudless or sunny day, without precipitation or fog, with very weak wind and with sunshine over 12h	*Pergelic Cryaquent*	A	24.4	117.9	—74.3	192.2
	Pergelic Histosol	B	12.1	45.9	—14.1	60.0
	Pergelic Cryorthent	C	13.5	66.9	—32.4	99.3
1B. Cloudless or sunny days, without precipitation or fog, with weak wind and with sunshine over 12h	*Pergelic Cryaquent*	A	29.6	109.6	—52.3	161.9
	Pergelic Histosol	B	11.6	44.0	— 9.0	53.0
	Pergelic Cryorthent	C	18.8	71.3	—28.1	99.4
2. Days with moderate cloud cover, without precipitation, with long sunshine						
2A. Days with moderate cloud cover, without precipitation or fog, with very weak wind and with sunshine from 6 to 12h	*Pergelic Cryaquent*	A	24.7	89.4	—36.4	125.8
	Pergelic Histosol	B	14.0	39.6	— 7.5	47.1
	Pergelic Cryorthent	C	17.7	63.4	—19.1	82.5
2B. Days with moderate cloud cover, without precipitation or fog, with weak or moderate wind, with sunshine from 6 to 12h	*Pergelic Cryaquent*	A	22.1	104.9	—31.5	136.4
	Pergelic Histosol	B	12.9	36.1	— 6.9	43.0
	Pergelic Cryorthent	C	16.2	57.8	—19.7	77.5
3. Days with moderate cloud cover or cloudy days, without precipitation, with short sunshine						
3A. Days with moderate cloud cover or cloudy days, without precipitation, with very weak wind and with sunshine from 0 to 6h	*Pergelic Cryaquent*	A	16.2	63.2	—23,0	86.2
	Pergelic Histosol	B	10.2	28.5	— 3.3	31.8
	Pergelic Cryorthent	C	13.0	37.1	—11.8	48.9
3B. Days with moderate cloud cover or cloudy days, without precipitation, with weak or moderate wind and with sunshine from 0 to 6h	*Pergelic Cryaquent*	A	16.0	61.7	—16.7	78.4
	Pergelic Histosol	B	9.3	26.7	— 3.0	29.7
	Pergelic Cryorthent	C	10.7	41.1	—11.5	52.6
4. Days with precipitation, without fog, cloudy, with very short sunshine						
4A. Days with precipitation, without fog, cloudy or with moderate cloud cover, with very weak wind, with sunshine from 0 to 3h	*Pergelic Cryaquent*	A	11.1	44.5	— 8.1	52.6
	Pergelic Histosol	B	7.0	15.3	1.2	16.5
	Pergelic Cryorthent	C	5.8	17.6	— 3.8	21.4
4B. Days with precipitation, without fog, cloudy or with moderate cloud cover, with weak or moderate wind, with sunshine from 0 to 3h	*Pergelic Cryaquent*	A	12.0	30.2	— 8.3	38.5
	Pergelic Histosol	B	7.5	13.2	1.7	14.9
	Pergelic Cryorthent	C	7.7	19.4	— 5.2	24.6
4C. Days with precipitation, without fog, cloudy or with moderate cloud cover, with strong wind, with sunshine from 0 to 3h	*Pergelic Cryaquent*	A	— 8.1	17.3	—31.7	49.0
	Pergelic Histosol	B	—0.3	12.8	— 5.3	18.1
	Pergelic Cryorthent	C	—11.1	6.4	—26.1	32.5
5. Days with precipitation and fog, with complete cloud cover, without sunshine						
5A. Days with precipitation and fog, cloudy or with complete cloud cover, with very weak wind and with sunshine from 0 to 1h	*Pergelic Cryaquent*	A	18.0	68.2	—16.8	85.0
	Pergelic Histosol	B	9.3	23.9	— 3.5	27.4
	Pergelic Cryorthent	C	11.7	40.7	— 8.1	48.8
5B. Days with precipitation and fog, cloudy or with complete cloud cover, with weak or moderate wind and with sunshine from 0 to 1h	*Pergelic Cryaquent*	A	7.3	30.4	— 6.7	37.1
	Pergelic Histosol	B	6.0	13.4	0.0	13.4
	Pergelic Cryorthent	C	4.6	17.4	— 3.9	21.1

1. cloud cover (only low clouds),
2. sunshine duration,
3. occurrence and duration of precipitation and fog,
4. wind velocity.

Five weather types were distinguished; mean wind velocity throught a day enabled subdivision into two or three subtypes (Table 1). Mean daily heat flux in examined soils during days with different weather types is presented (Figs 4—8). In spring and summer 1989 particular weather types lasted:

1. sunny days without precipitation and with large sunshine duration — 6.5% of days,
2. days with medium cloud cover without precipitation and with long sunshine — 31.2% of days,
3. days with moderate cloud cover or cloudy days without precipitation and with short sunshine — 25.8% of days,
4. days with precipitation, without fog, cloudy days with very small sunshine duration — 19.3% of days,
5. days with precipitation and fog, with complete cloud cover, without sunshine — 17.2% of days.

Maximum, minimum and daily means of heat flux in studied soils have been arranged for various weather types (Table 1). The largest heat (average throughout a day) was received by a tundra gleyey cryogenic soil (*Pergelic Cryaquent*) independently of the weather. A heat flux in a tundra peaty soil (*Pergelic Histosol*) was higher than in a tundra gleyey cryogenic soil (*Pergelic Cryaquent*) only on days with precipitation and very strong wind (subtype 4C). In these days a 5-cm moss layer in a tundra peat soil protected a ground surface from vehemently giving up the heat to the atmosphere. The lowest mean daily heat flux was observed in a tundra peaty soil on sunny days with precipitation and fog. The largest maximum daily heat flux was recorded in a tundra gleyey cryogenic soil at all types of weather, and the lowest ones were recorded in a tundra peaty soil. The lowest minimum daily heat flux was recorded in a tundra gleyey cryogenic soil in all spring and summer days. The highest minimum daily values were recorded in a tundra peaty soil.

The highest daily amplitudes of the flux *S* were recorded in a sludge crater of a tundra gleyey cryogenic soils at all types of weather. On sunny days without precipitation (type 1), mean daily amplitude of heat flux in this soil was equal to 170 Wm^{-2} (in comparison to 57 Wm^{-2} in a tundra peaty soil). On days with precipitation and fog (type 5), mean daily amplitude of heat flux was equal to 58 Wm^{-2} in a tundra gleyey cryogenic soil and to 20 Wm^{-2} in a tundra peaty soil.

All examined soils received largest amount of heat (by conduction) on cloudless or sunny days without precipitation or fog, with slight winds and sunshine lasting over 12 hours (Fig. 4). The smallest amount of heat reached all kinds of soils on days with precipitation and fog, complete cloud cover and

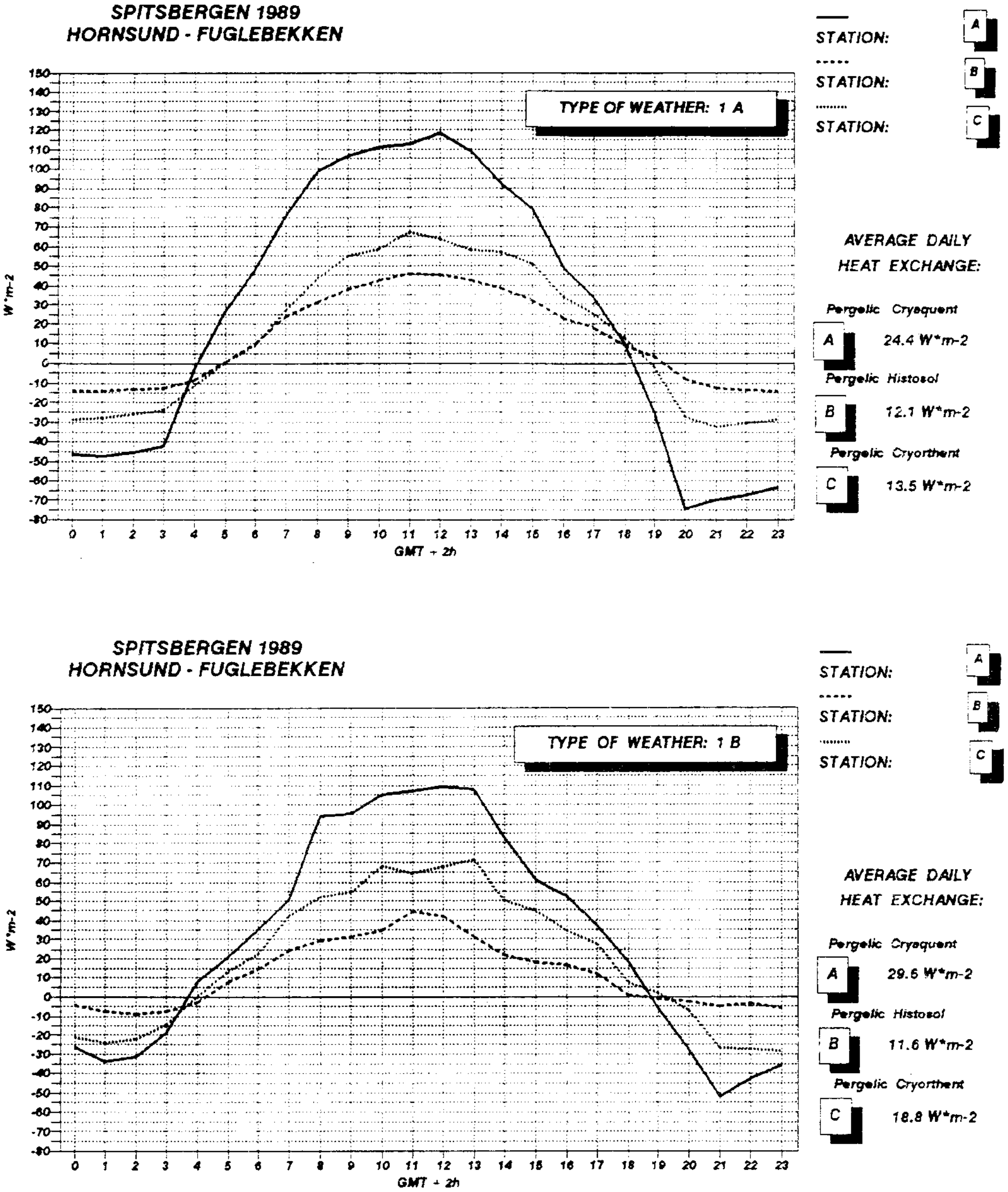

Fig. 4. Daily course of heat flux in selected polar soils on sunny days without precipitation and with very long sunshine in spring and summer; results from measurements at every 60 s.

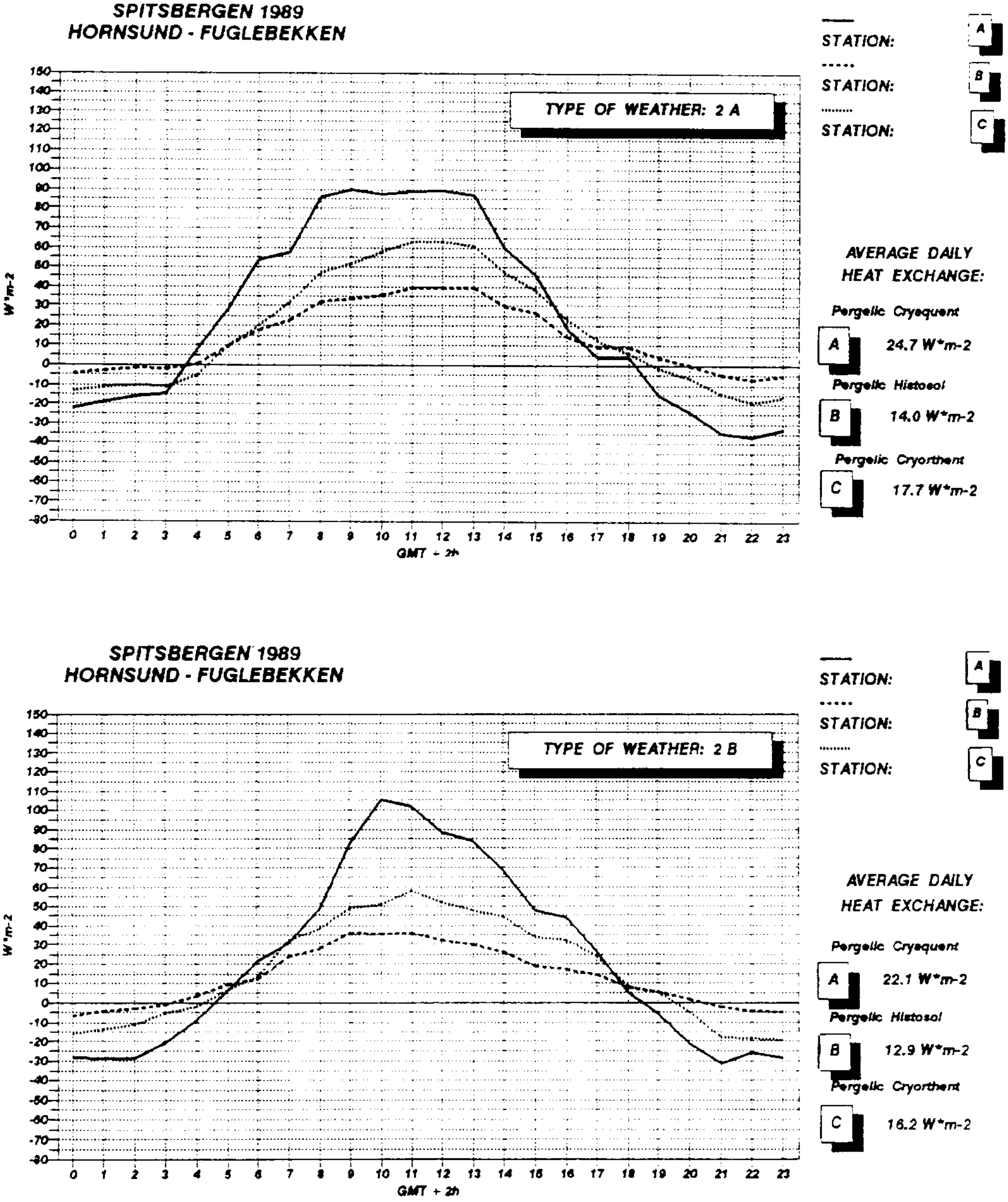

Fig. 5. Daily course of heat flux in selected polar soils on days with moderate cloud cover, without precipitation and with long sunshine, in spring and summer; results from measurements at every 60 s.

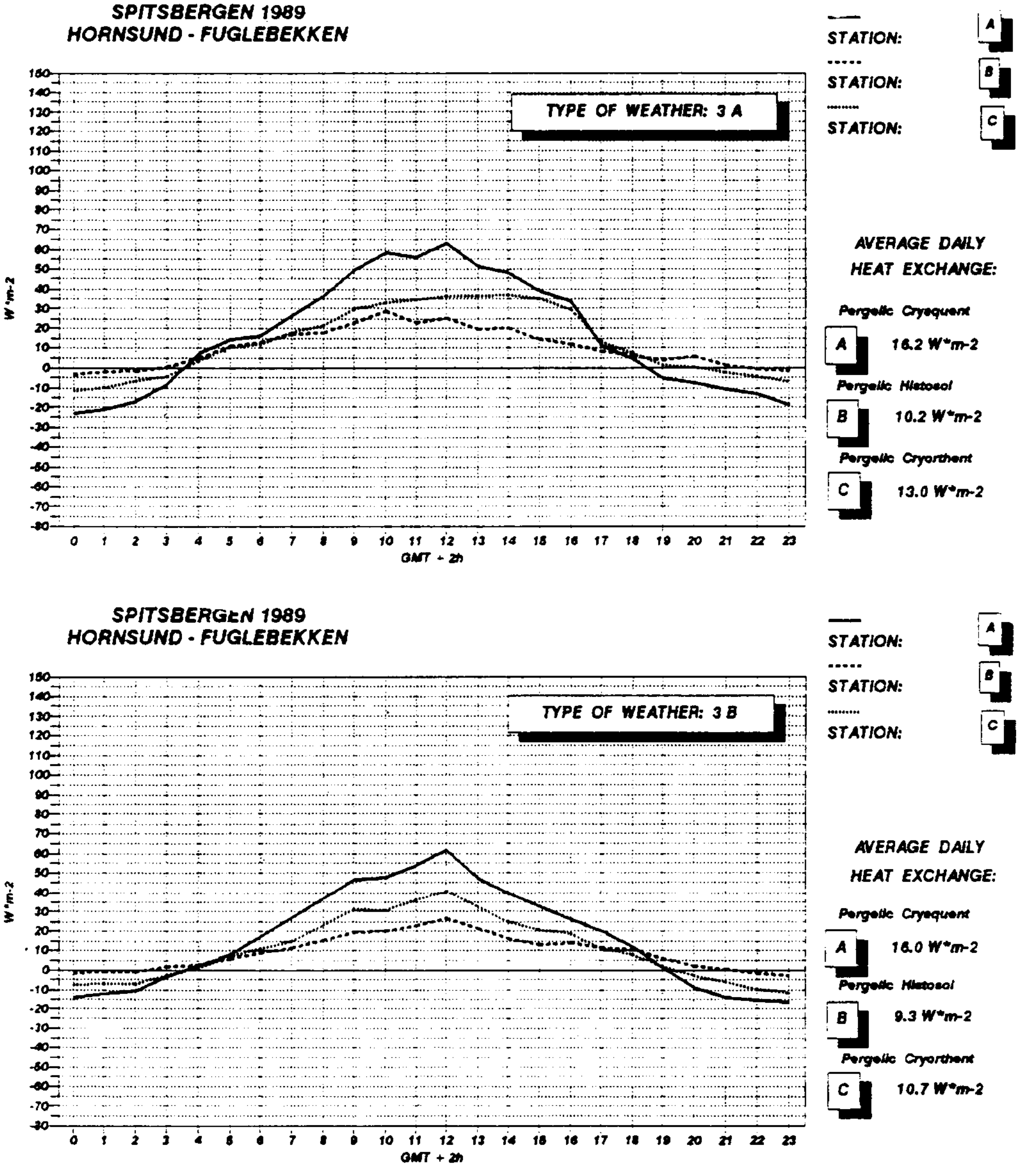

Fig. 6. Daily course of heat flux in selected polar soils on days with moderate cloud cover or on cloudy days, without precipitation and with long sunshine in spring and summer; results from measurements at every 60 s.

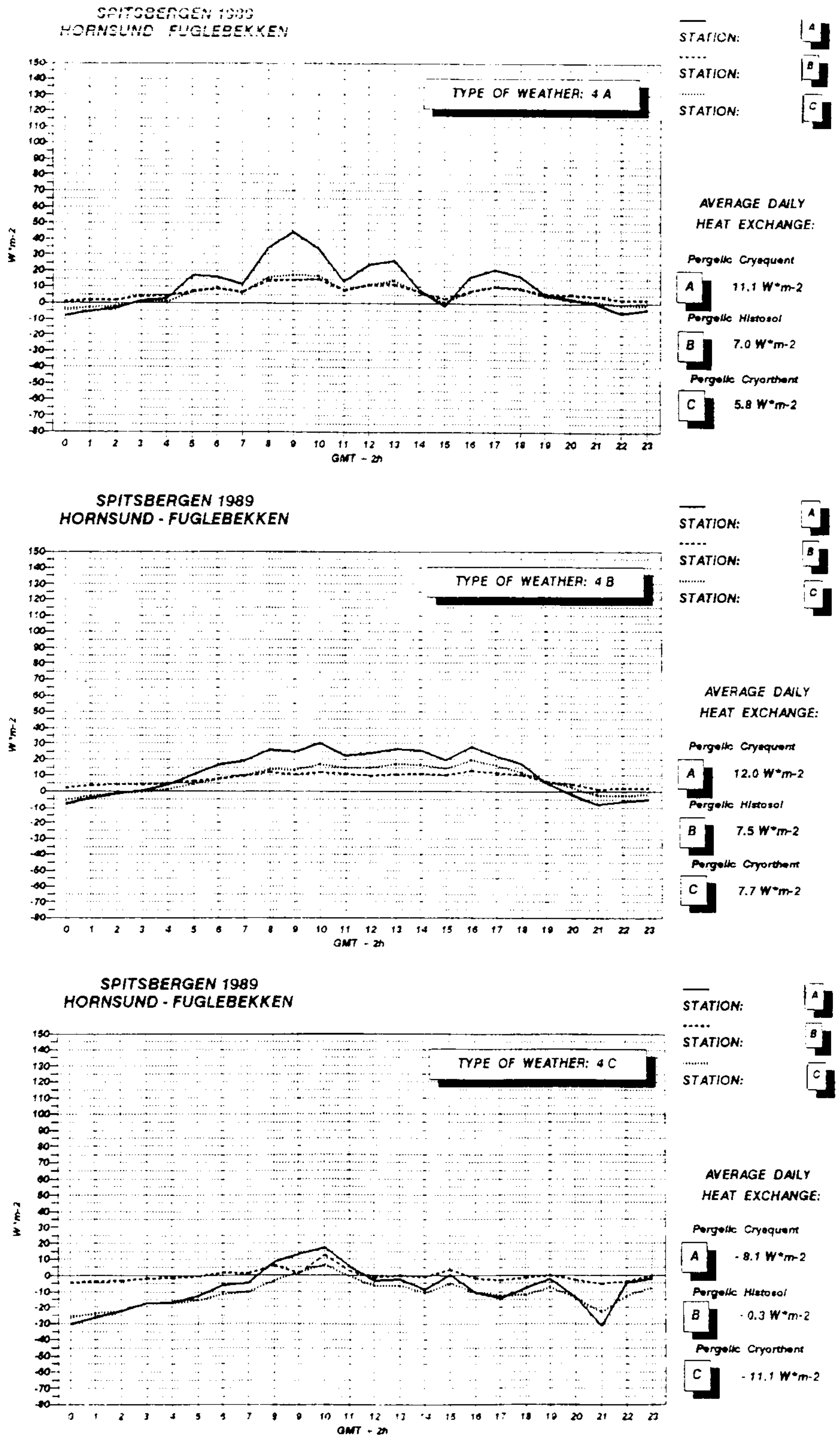

Fig. 7. Daily course of heat flux in selected polar soils on cloudy days with precipitation, without fog and with very low sunshine in spring and summer; results from measurements at every 60 s.

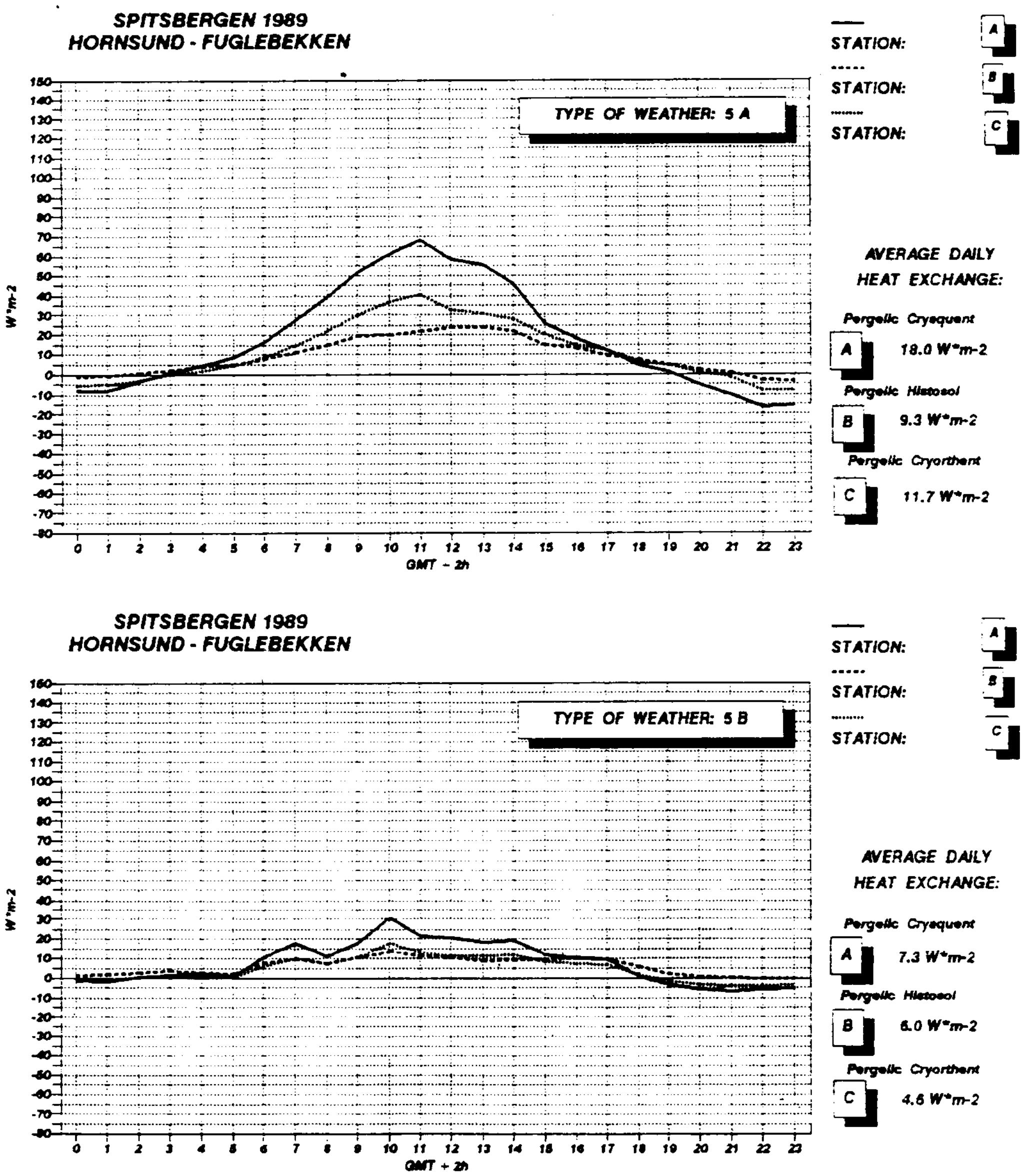

Fig. 8. Daily course of heat flux in selected polar soils on days with precipitation and fog, with complete cloud cover and without sunshine in spring and summer; results from measurements at every 60 s.

moderate winds (Fig. 8). Negative daily balance of heat flux was recorded in all soils on rainy days with moderate cloud cover and very strong winds (Fig. 7).

There is a pretty strong relationship between mean daily heat flux in a tundra gleyey cryogenic soil and mean daily heat flux in an arctic desert soil, and a worse relationship between heat flux in a tundra gleyey cryogenic soil and in a tundra peaty soil. These relationships were determined for all months during the examination period. They are linear and can be presented with the following equations:

June $Sc = 0.975\ Sa - 1.433 \quad r = 0.88$
$Sb = 0.646\ Sa + 5.806 \quad r = 0.92$
July $Sc = 0.711\ Sa - 0.538 \quad r = 0.91$
$Sb = 0.448\ Sa + 2.937 \quad r = 0.86$
August $Sc = 0.607\ Sa - 2.370 \quad r = 0.93$
$Sb = 0.325\ Sa + 3.473 \quad r = 0.88$

where: Sa — tundra gleyey cryogenic soil (*Pergelic Cryaquent*), Sb — tundra peaty soil (*Pergelic Histosol*), Sc — arctic desert soil (*Pergelic Cryorthent*).

These relationships are presented (Figs 9—11). For the whole examination period they are as follows (Fig. 12):

June 24 — August 15 $Sc = 0.703\ Sa - 1.07 \quad r = 0.81$
$Sb = 0.434\ Sa + 3.474 \quad r = 0.62$

Recapitulation and conclusions

Spatial distribution of heat exchange with a ground depends on kind of soil and water management of a given area. It can be observed particularly on low raised marine terraces of southwestern Spistbergen which are almost flat. Homogeneous areas varying in heat exchange with a ground (instantaneous and hourly, daily, monthly or seasonal means) are to be distinguished. Heat flux exchange with a ground changes direction from positive to negative (and *vice versa*) in each area at different hours throughout a day. The highest positive and negative values of daily heat exchange occur at different hours.

In spring and summer the highest hourly, daily and monthly heat exchange with a ground is recorded in a tundra gleyey cryogenic soil (*Pergelic Cryaquent*) which is devoid of vegetation. During research work in 1989, a tundra peaty soil (*Pergelic Histosol*) received in June 87.1% of heat that reached a tundra gleyey cryogenic soil (*Pergelic Cryaquent*) at the same time, 67.9% in July and 53.5% in August. An arctic desert soil (*Pergelic Cryorthent*) received in June 87.5% of heat that reached a tundra gleyey cryogenic soil (*Pergelic Cryaquent*) through conduction at the same time, 66.9% in July and 46.6% in August.

Influence of environmental conditions on daily heat flux in various soils is strongly indicated. Influence of active surface features and meteorological conditions upon heat resources in a soil can be observed.

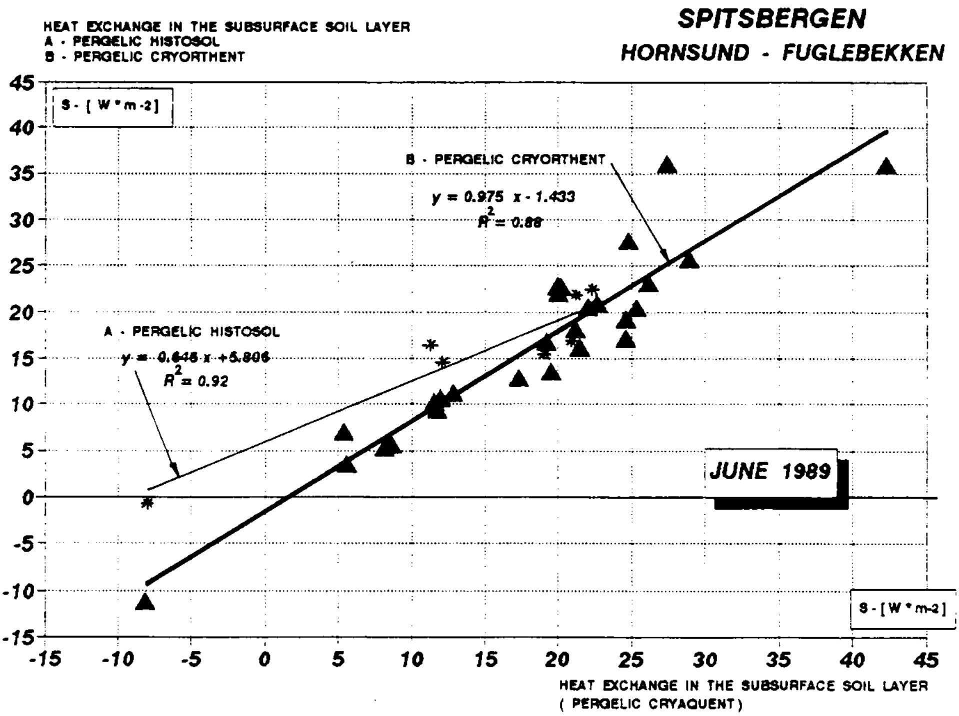

Fig. 9. Relationship between mean daily heat flux in *Pergelic Cryaquent* and mean daily heat flux in *Pergelic Histosol* (A) and *Pergelic Cryorthent* (B) in June 1989; daily mean calculated from measurements at every 60 s.

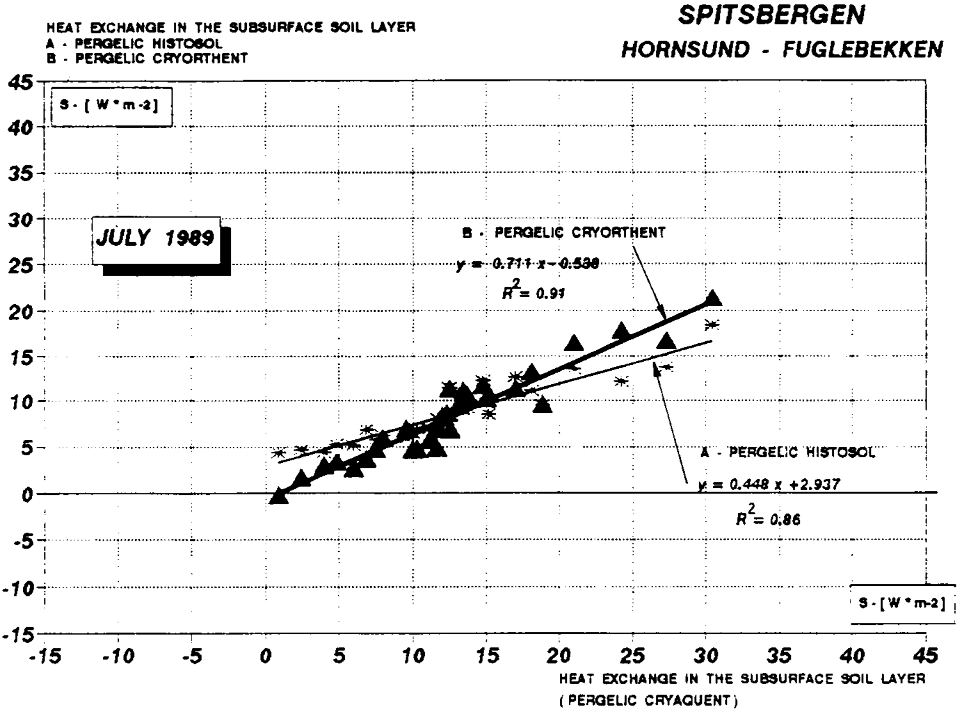

Fig. 10. Relationship between mean daily heat flux in *Pergelic Cryaquent* and mean daily heat flux in *Pergelic Histosol* (A) and *Pergelic Cryorthent* (B) in July 1989; daily mean calculated from measurements at every 60 s.

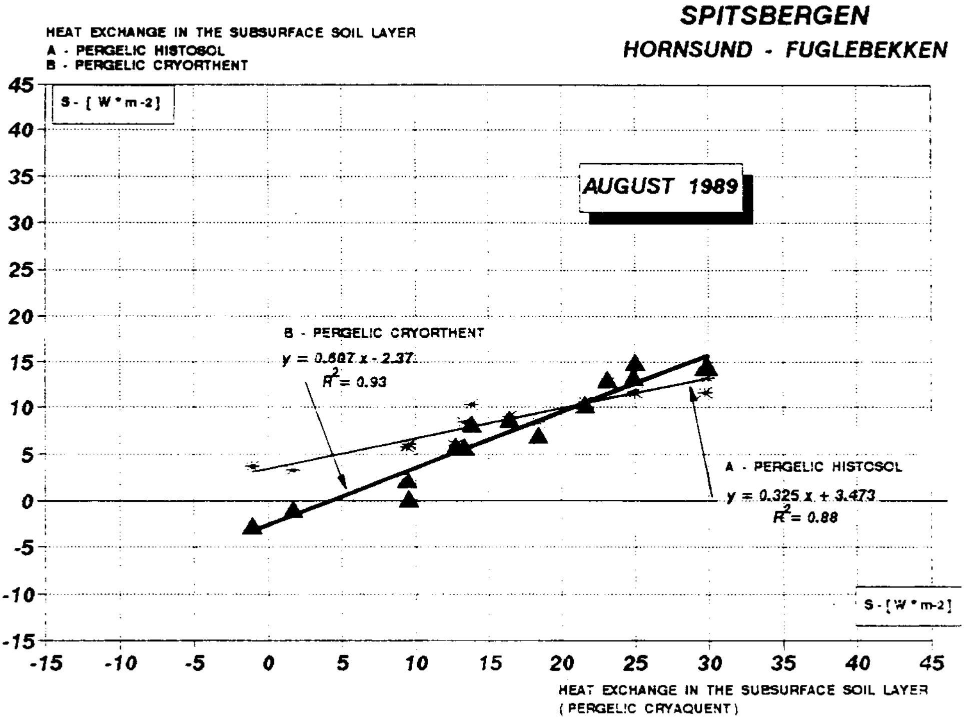

Fig. 11. Relationship between mean daily heat flux in *Pergelic Cryaquent* and mean daily heat flux in *Pergelic Histosol* (A) and *Pergelic Cryorthent* (B) in August 1989; daily mean calculated from measurements at every 60 s.

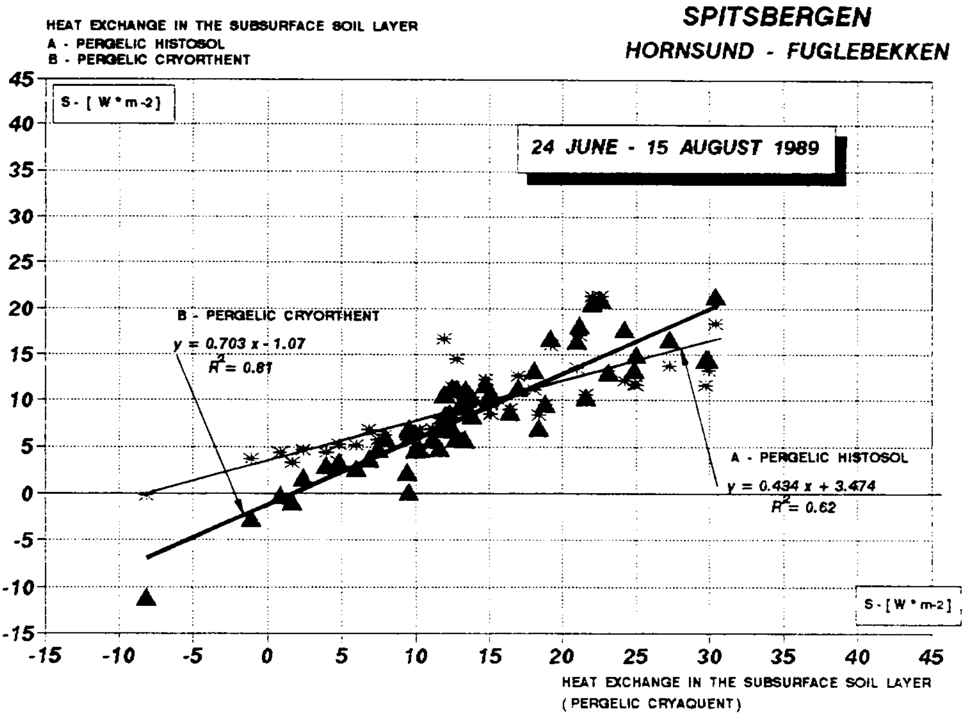

Fig. 12. Relationship between mean daily heat flux in *Pergelic Cryaquent* and mean daily heat flux in *Pergelic Histosol* (A) and *Pergelic Cryorthent* (B) from June 24 to August 15, 1989; daily mean calculated from measurements at every 60 s.

Assuming that heat flux in all discussed soils on sunny or cloudless days is equal to 100%, its value on days with precipitation and fog amounts to 45.3% in a tundra gleyey cryogenic soil (*Pergelic Cryaquent*), 69% in a tundra peaty soil (*Pergelic Histosol*) and 50% in an arctic desert soil (*Pergelic Cryorthent*). A soil devoid of vegetation is apparently subjected to heat loss caused by increased humidity (precipitation). A 5-cm moss layer in a tundra peaty soil (*Pergelic Histosol*) allows to reduce influence of such unfavourable conditions by about 25%.

Amount of heat that reaches a tundra peaty soil (*Pergelic Histosol*) during a sunny or cloudless day amounts to 40.6% of heat to a tundra gleyey cryogenic soil (*Pergelic Cryaquent*) and heat to an arctic desert soil (*Pergelic Cryorthent*) amounts to 58.3% of heat that reaches a cryogenic gleyey soil. On rainy and foggy days these values are higher: 61.9% and 64.3%, respectively. A 5-cm thick layer of dense moss (*Calliergon stramineum*) in a tundra peaty soil (*Pergelic Histosol*) reduces mean daily heat flux by 60% on sunny days and by 40% on rainy days. Less dense vegetation (*Pergelic Cryorthent*) — (*Sphaerophorus globosus, Salix polaris*) of similar thickness in an arctic desert soil reduces mean daily heat flux by 40% on sunny days and by 35% on rainy days.

Tundra gleyey cryogenic soil (*Pergelic Cryaquent*) which is completely devoid of vegetation has the largest potential capabilities of heat accumulation amongst the all investigation soils on low raised marine terraces in southwestern Spitsbergen during spring and summer.

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Streszczenie

Badania zmierzały do określenia czasowego rozkładu wielkości strumienia ciepła w różnych glebach arktycznej strefy peryglacjalnej. Przeprowadzono je w okresie wiosenno-letnim 1989 roku w zlewni rzeki Fuglebekken (Hornsund, Spitsbergen). Stanowiska badawcze położone były w obrębie niskich, nie zlodowaconych nizin nadmorskich na wysokości 7—13 m n.p.m. (fig. 1). Do analizy wybrano gleby typowe dla tego rejonu: kriogeniczną glebę glejową, glebę torfowo-glejową i glebę inicjalną luźną (fig. 2). Strumień ciepła w glebach wytypowanych do badań był mierzony i rejestrowany automatycznie co 60 sekund przez cały okres obserwacji, równocześnie na trzech stanowiskach. Najwyższe średnie dobowe wartości wymiany ciepła z podłożem na każdym ze stanowisk notowano w drugim lub trzecim dniu po zejściu pokrywy śnieżnej. Maksymalne średnie dobowe wartości strumienia ciepła osiągnęły wówczas: 51,3 Wm^{-2} w kriogenicznej glebie glejowej (maj) i 54,4 Wm^{-2} w glebie torfowo-glejowej (czerwiec). Najniższe średnie dobowe wartości strumienia *S* zanotowano w czerwcu (dzień z bardzo silnym wiatrem i z opadem) w glebie inicjalnej luźnej (11,2 Wm^{-2}) i w kriogenicznej glebie glejowej (8,1 Wm^{-2}). W okresie wiosenno-letnim we wszystkich badanych glebach występowała intensywna akumulacja ciepła (fig. 3). Dobowy rozkład wielkości strumienia ciepła w omawianych glebach przeanalizowano oddzielnie dla dni o różnych typach pogody (fig. 4—8). Przedstawiono charakterystykę wydzielonych typów i podtypów pogody oraz zestawiono średnie maksymalne, średnie minimalne i średnie dobowe wartości strumienia ciepła w badanych glebach (tab. 1). Istnieje dość silny związek między średnim dobowym strumieniem ciepła w kriogenicznej glebie glejowej a średnim dobowym strumieniem ciepła w glebie inicjalnej luźnej oraz słaby związek między tą pierwszą glebą a glebą torfowo-glejową. Są to związki liniowe (fig. 9—12). W okresie wiosenno-letnim najwyższe godzinne, dobowe i miesięczne wartości wymiany ciepła z podłożem notowano w pozbawionej roślinności kriogenicznej glebie glejowej, najniższe — w glebie torfowo-glejowej. Stwierdzono wyraźny wpływ warunków środowiska geograficznego na przebieg dzienny strumienia ciepła w różnych glebach. Obserwowano zarówno wpływ właściwości powierzchni czynnej, jak też wpływ warunków meteorologicznych na kształtowanie się zasobów ciepła w glebie.

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