POLISH POLAR RESEARCH	12	2	223—228	1991

Mirosław MIĘTUS

Institute of Meteorology
and Water Management
Marine Branch
Waszyngtona 42
81-342 Gdynia, POLAND

Snow depth at the Hornsund Station, Spitsbergen in 1978—1986

ABSTRACT: Mean annual variation of snow depth at the Hornsund Station has been determined. The snow cover usually appears in late September and remains till the beginning of July the next year. The snow depth keeps growing till the first half of March and from then on, until the third dekad of May it does not change. Towards the end of May fast decrease of snow cover occurs mainly due to subsidence by intensive insolation. If compared to the Arctic Basin the snow cover appears in Hornsund three dekads later and disappears about two dekads sooner.

Key words: Arctic, Spitsbergen, snow depth.

Data and method

The Polish polar station in Hornsund, southwestern Spitsbergen, is located at the entrance to the fiord, on its northern coast. Measurements of snow depth and evaluation of snow density and water equivalent are carried out at the Hornsund Station according to the standard SYNOP observations. Severe climatic and local conditions result in frequent demages of snow-gauges, so that the water equivalent of snow and its density have not been determined systematically. Available are the complete results of these parameters from the expeditions 1979/81 and 1982/83, the incomplete ones from 1978/79, 1979/80, 1983/84 and 1985/86. Depth of snow was however measured regularly each winter. All measurements ware taken close to the station area, where no snow-drifts formed.

The paper present the average annual variation of snow depth one the basis of pentad values and lists factors that affect snow cumulation and decay.

Results and discussion

Snow depth was differentiated in particular seasons. The greatest snow depth was measured in winter 1979/80 (maximum pentad mean of 54 cm at the end of April), in winter 1982/83 (maximum pentad mean equal to 55 cm at the end of April) and in winter 1984/85 (maximum pentad mean exceeding 67 cm at the end of May). Poor snow cover occured in winter 1981/82 when the maximum pentad mean reached scarcely 24 cm and was noted in the second half of May. The permanent snow cover appeared in different time in particularly years. The earliest permanent snow cover appeared in 1978, starting from the fourth pentad of September. The beginning of September is commonly associated with snowfall. It is equite a minute one but a thin layer of snow remains on the ground for several days to decay however later. The earliest snowfall which formed a continuous snow cover though only of two days duration, was observed in autumn 1982, on August 31, when the snow depth was equal to 3 cm. In 1984 the snow cover persisted till the first dekad of July, but generally, in numerous hollows and on northern slopes of hills snow can be observed even afterwards (Pereyma 1981). Relief and lack of scrubs result in formation of snow drifts on leeward sides of low hills, and that makes quite deep snow patches persist in such places all the year round (Czeppe 1966, Baranowski 1968). Observations from the years 1978—86 indicate that a continuous but thin layer of snow appears at the beginning of the second pentad (Table 1) of September and by the end of October it is about 3 cm thick. Snow depth increases systematically by 1—15 cm per pentad approximately till mid February. More intensive increase of snow depth can be observed since the half of February (Table 1, Fig. 1).

Table 1

Depth of snow (in cm) in Hornsund, 1978—1986. Mean pentad values (overlapping means)

Month	Pentad					
	1	2	3	4	5	6
August	—	—	—	—	—	—
September	—	0.0	0.0	0.3	0.5	0.6
October	0.6	0.8	1.6	2.6	2.9	3.2
November	3.7	4.8	5.9	6.5	7.0	8.0
December	9.1	10.2	10.3	10.9	11.6	12.1
January	12.8	13.8	15.3	16.0	17.2	18.1
February	18.1	18.8	21.0	25.5	29.3	30.5
March	30.6	30.0	31.5	33.8	37.8	38.1
April	40.2	38.9	39.9	40.3	41.6	40.8
May	40.4	40.0	39.4	39.9	38.6	36.2
June	34.1	24.7	19.0	13.0	7.6	3.1
July	0.9	0.0	—	—	—	—

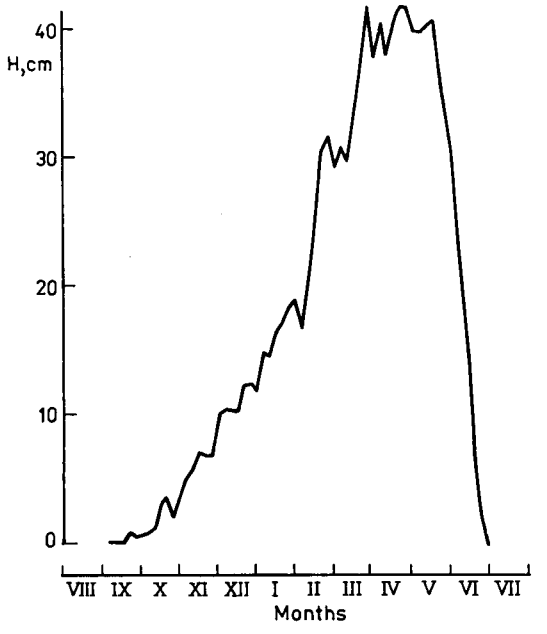

Fig. 1. Variation of snow depth (in cm) at the Hornsund Station, 1978—1986. Mean pentad values

During a single winter, regression in snow cumulation is observed for several times. Such phenomena may result from the fact that there occur often sudden warmings from January to March due to advection of warm air, frequently connected with heavy rainfall, what causes fast degradation of snow cover (Miętus 1988). These sudden weather changes are connected with warm air invading Western Arctic when cyclonal activity replaces the predominating winter high pressure systems. Zonal circulation that brings warm and moist air from south-westerly directions, occurs as frequently as 36% and persists sometimes even for 4—5 days (low pressure types SE_C, S_C and SW_C according to Niedźwiedź and Ustrnul, unpubl.). Moreover, snow cover at Hornsund is modified by strong wind blowing mainly from easterly directions with speeds frequently exceeding 20 ms^{-1} in gusts (Skrzypczak and Wielbińska 1988).

Growth rate of snow cover diminishes in the end of February, and since the end of March till mid-May, a wide plateau appears in the diagram to snow depth variation (Fig. 1), before the decay begins. Average maximum snow depth, about 42 cm, occurs late in April, but absolute maximum, 68 cm, was measured on May 21—23, 1985. Averagely, however, snow cover begins decaying in mid-May to disappear totally at the beginning of July. Beside of intensifying insolation in these months, frequent occurence of pressure systems, which prevent advection of cold arctic air increases the rate of snow cover decay.

In comparision to the whole Arctic Basin (Fig. 2A, Vowinckel and Orvig 1975) snow cover in Hornsund is found to appear about three dekads later and

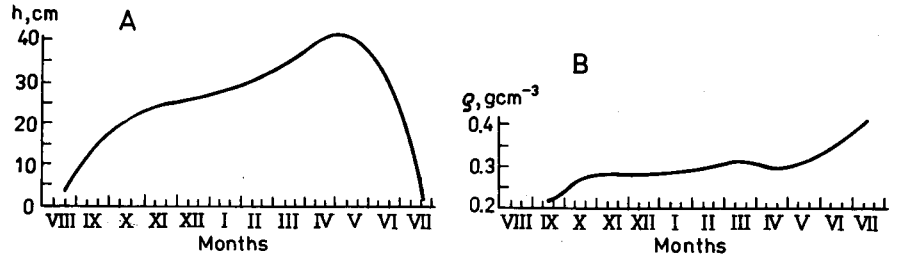

Fig. 2. Variation of A — mean depth of snow, and B — density of snow in the Arctic Basin; after Vowinckel and Orving (1973)

to decay about 1.5 dekads sooner. Moreover, the snow depth diagram for the Arctic Basin shows a wide plateau between November and January, and the maximum snow depth, observed in the first dekad of May, amounts to 40 cm. During the first eight months since the apperance of permanent snow cover in the Arctic Basin, density of snow increases only insignificantly: the snow gets denser only in the period of decay (Fig. 2B). In 1980/81 and 1982/83 the snow in Hornsund was denser i.e. contained more liquid water (Fig. 3) than in average in other parts of the Arctic Basin.

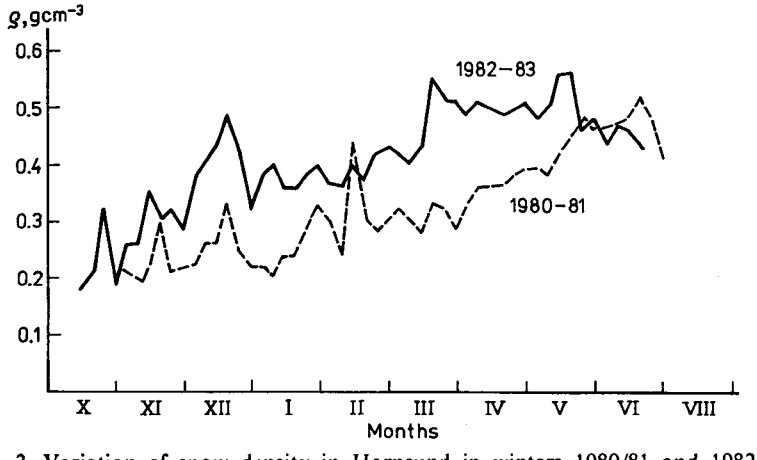

Fig. 3. Variation of snow density in Hornsund in winters 1980/81 and 1982/83

Conclusions

Varying of snow cover at the Hornsund station in 1978—1986 indicates that:

— generally snow cover appears in the second half of September and is present till the beginnig of July;

— snow depth increases systematically due to frequent snowfall till the end of March;

— since mid-winter the rate of snow cumulation decreases due to recurring warmer periods;

— snow depth remains steady from the third dekad of March till third dekad of May;

—snow cover decay starts in the third dekad of May and lasts for about 6 weeks. This process is intensified by insolation, small cloud amount and frequent anticyclonal patterns which prevent advection of cold air;

— comparison of the mean annual snow depth variation in the Arctic Basin and in Hornsund indicates that the snow cover mainstains for a shorter period in the latter area (appears later and decays sooner);

— snow density in 1980/81 and 1982/83 in Hornsund was greater than mean multiannual density for other parts of the Arctic Basin, it also performed significant variation.

References

Baranowski S. 1968. Thermics of the periglacial tundra of SW Spitsbergen. — Acta Univ. Wratislav., 68: 74 pp.

Czeppe Z. 1966. Przebieg głównych procesów morfogenetycznych w południowo-zachodnim Spitsbergenie. — Zesz. Nauk. UJ, Prac. Geogr. 13: 1—129.

Głowicki B. 1985. Radiotion conditions in the Hornsund area. — Pol. Polar Res., 6: 301—318.

Miętus M. 1988. Short period changes of soil temperature against a background of advective changes of air temperature in Hornsund in the light of chosen examples. — Pol. Polar Res., 9: 95—103.

Pereyma J. 1981. Pokrywa śnieżna w rejonie Fiordu Hornsund na Spitsbergenie. — In: 8 Sympozjum Polarne, Sosnowiec: 7—20.

Skrzypczak E. and Wielbińska D. 1988. Mean air temperature at the define wind directions in Hornsund. — Pol. Polar Res., 9: 133—145.

Steffensen E.L. 1982. The Climate at Norwegian Arctic Station. — Klima 5: 44 pp.

Vovinckel E. and Orvig S. 1973. Klimat Arkticheskogo baseyna. — In: Klimat polarnykh reyonov. Gidrometeoizdat, Leningrad: 170—317.

Received October 20, 1987
Revised and accepted February 5, 1990

Streszczenie

Bazując na wynikach pomiarów grubości pokrywy śnieżnej na stacji PAN w Hornsundzie wyznaczono średnie pentadowe wartości grubości pokrywy śnieżnej w okresie 1978—1986. Wartości pentadowe poddano filtracji przez uśrednianie konsekutywne (tab. 1), które pozwoliło wyeliminować ostre piki występujące w przebiegu zmienności pokrywy śnieżnej (fig. 1).

Wskazano na istotny wpływ wiatru na kształtowanie pokrywy śnieżnej. Podkreślono wpływ parodniowych ociepleń połączonych częstokroć z opadem deszczu na załamanie się tempa narastania pokrywy śnieżnej. Uznano, że występująca od połowy lutego insolacja jest przyczyną występowania rozległego plateau na wykresie grubości pokrywy śnieżnej w okresie marzec—maj.

Intensywna insolacja w kwietniu, maju i czerwcu, zmniejszone zachmurzenie oraz często występujące w tym okresie sytuacje antycyklonalne bez wyraźnej adwekcji sprzyjają zanikowi pokrywy śnieżnej w zasadzie do drugiej połowy czerwca, choć średnio rzecz biorąc śnieg zanika w Hornsundzie dopiero na początku lipca (tab. 1). Wyniki zostały porównane z analogicznymi danymi wieloletnimi dla Basenu Arktycznego wewnątrz którego leży również Svalbard (fig. 2A), gdzie śnieg zalega dłużej o około 4—5 dekady i jego gęstość (fig. 2B) jest bardziej ustabilizowana niż w Hornsundzie (fig. 3).

Praca wykonana w ramach CPBP 03.03. B13.