

Glacier mass balance investigations in the balance years 1984–85 and 1985–86

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As in previous years Norsk Polarinstittutt has carried out mass balance investigations on Storbreen and Hardangerjøkulen in mainland Norway and on Brøggerbreen and Lovénbreen in Svalbard. More than 20 years of measurements show that the glaciers both in mainland Norway and in Svalbard are retreating.

Both in 1985 and in 1986 the glaciers in Norway had a negative net balance. At Storbreen the mean annual net balance value 1949–86 is -0.30 m in water equivalents, while on Hardangerjøkulen the mean value 1963–86 is -0.02 m.

The two glaciers measured in Svalbard also had negative net balance in 1985 and in 1986. Both measured glaciers have had negative balance nearly all years since the measurements started in 1966. The mean value is close to -40 g/cm² or -0.4 m on both.

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Glaciers in Norway

Storbreen

Storbreen is situated in Jotunheimen in southern Norway. Mass balance measurements started in 1949. In 1985 the winter accumulation was measured in the beginning of May. The result was 120 g/cm², which is 85% of the mean value since 1949. The ablation gave a summer balance of 160 g/cm² which was close to the mean. The net balance result was -40 g/cm² or -0.4 m water equivalents.

In 1986 the winter accumulation measured in the beginning of June was only 105 g/cm², or 1.05 m in water eq., which is one of the lowest values that has ever been measured on this glacier, and it was only 77% of the mean value since 1949. The summer ablation was 137 g/cm² or 1.37 m. The result was a negative net balance of -32 g/cm² or -0.32 m, while the mean has been -30 g/cm². The net balance result from 1986 is shown in Fig. 1. The equilibrium line was then 1770 m a.s.l.

The cumulative net balance for the whole period 1949–1986 is then -1104 g/cm² or -11.04 m of water layer over the whole glacier. The area of the glacier is 5.3 km² so the total volume of ice shrinkage is 65×10^6 m³. That

means that the ice surface on average has lowered 12.3 m over the whole glacier and given an extra quantity of 1.5×10^6 m³ water to the river from the glacier every year.

A new glacier map in the scale 1:10,000 has been constructed from air photos taken in 1985. The former map was constructed in the same scale on the basis of photos from 1968. The volume change during these 17 years could then be calculated. The mean annual shrinkage of the glacier surface was 0.31 m, which is very close to the measured net balance value.

Hardangerjøkulen

Hardangerjøkulen is situated south and west of Storbreen. Both the winter and the summer balance on Hardangerjøkulen usually have the higher values. Mass balance has been measured every year since 1963.

In 1985 the winter balance was 140 g/cm² or 1.40 m water eq., which is 74% of the mean winter accumulation of 1.90 m. The summer balance was calculated to 190 g/cm², which is very close to the mean ablation. The result was a net balance of -50 g/cm² or -0.50 m water eq.

The winter accumulation in 1986 was less than normal too, 1.54 m, which is 80% of the mean

Storbreen 1985

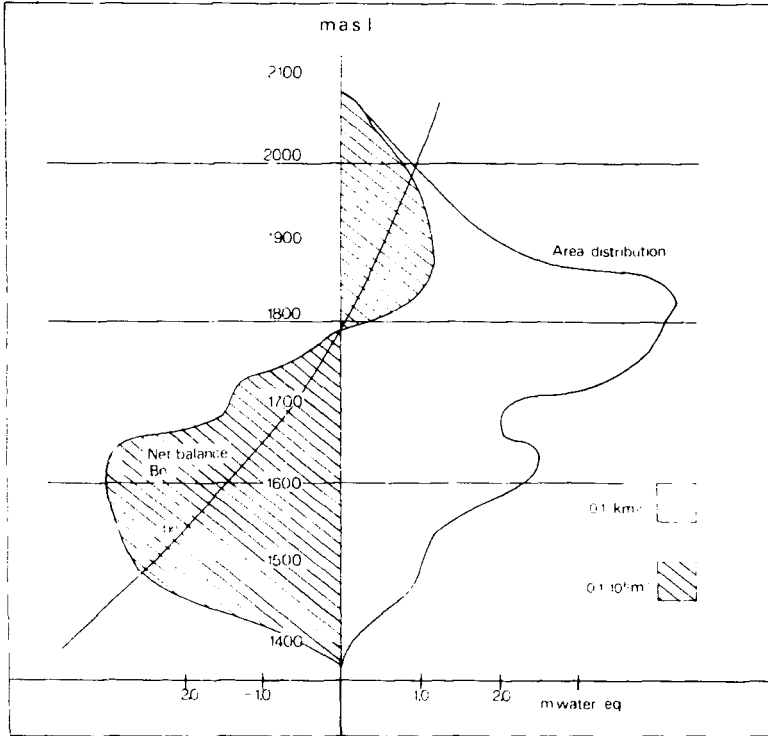


Fig. 1. Net mass balance at Storbreen 1985/86 in relation to height above sea level.

Table 1. Specific mass balance in water equivalents (m) for Austre Brøggerbreen and Midtre Lovénbreen 1967–1986.

Year	Austre Brøggerbreen			Midtre Lovénbreen		
	b_w	b_s	b_n	b_w	b_s	b_n
1966–67	0.77	1.42	-0.65			
1967–68	0.57	0.67	-0.10	0.48	0.51	-0.03
1968–69	0.40	1.33	-0.93	0.41	1.25	-0.84
1969–70	0.37	0.91	-0.54	0.36	0.89	-0.53
1970–71	0.65	1.23	-0.58	0.70	1.16	-0.46
1971–72	0.95	1.26	-0.31	0.98	1.20	-0.22
1972–73	0.74	0.82	-0.08	0.82	0.84	-0.02
1973–74	0.75	1.67	-0.92	0.70	1.59	-0.89
1974–75	0.78	1.09	-0.31	0.83	1.04	-0.21
1975–76	0.72	1.17	-0.45	0.75	1.10	-0.35
1976–77	0.76	0.87	-0.11	0.80	0.84	-0.04
1977–78	0.75	1.31	-0.56	0.81	1.29	-0.48
1978–79	0.77	1.48	-0.71	0.80	1.46	-0.66
1979–80	0.75	1.27	-0.52	0.83	1.26	-0.43
1980–81	0.46	1.01	-0.55	0.51	0.97	-0.46
1981–82	0.64	0.68	-0.04	0.66	0.64	0.02
1982–83	0.70	0.97	-0.27	0.75	0.92	-0.17
1983–84	0.69	1.42	-0.73	0.74	1.42	-0.68
1984–85	0.93	1.48	-0.55	0.98	1.46	-0.48
1985–86	0.98	1.30	-0.32	1.06	1.27	-0.21
1967–86	0.71	1.17	-0.46	0.74	1.11	-0.37

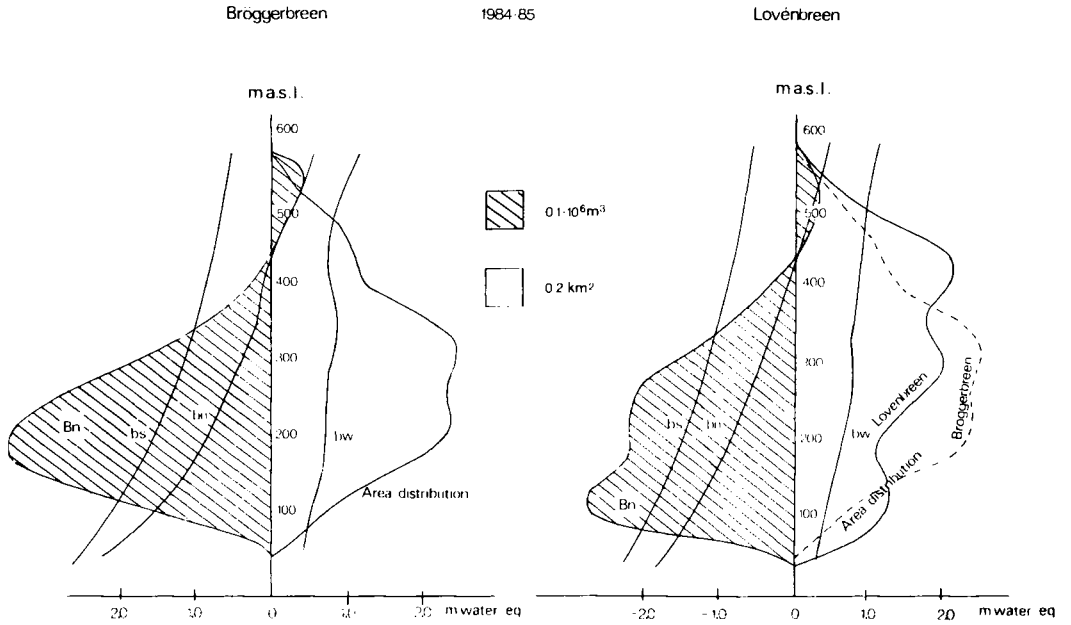


Fig. 2. Mass balance variations in relation to height in 1984/85 on Austre Brøggerbreen and Midtre Lovénbreen.

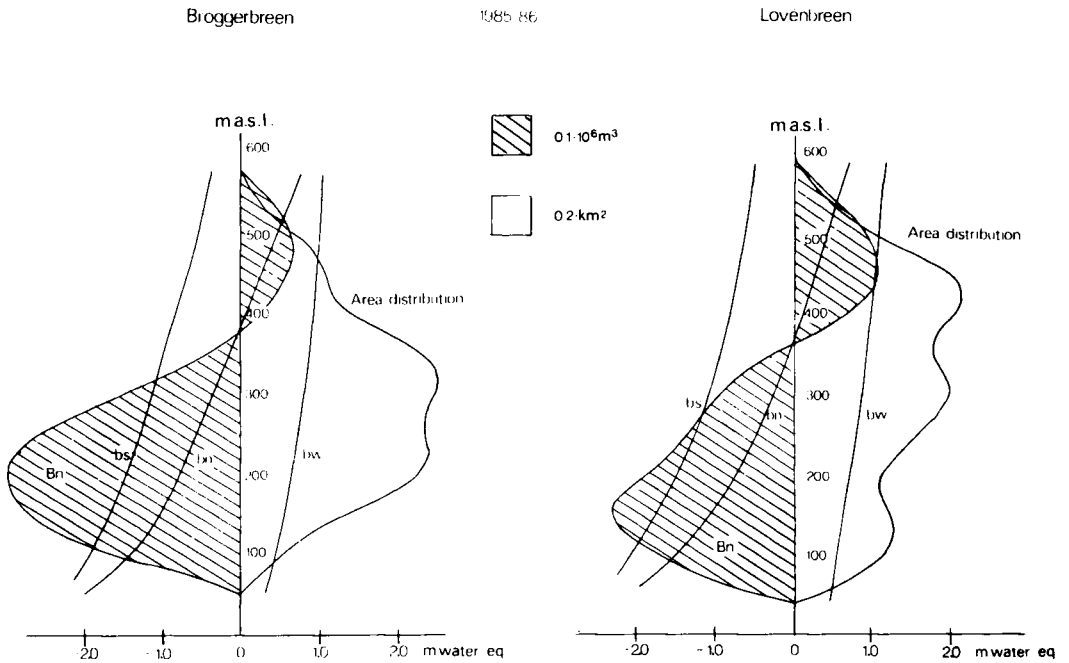


Fig. 3. Mass balance variations in relation to height in 1985/86 on Austre Brøggerbreen and Midtre Lovénbreen.

value. The summer melting was also less than normal, and total ablation was 1.60 m. The result was a net balance close to zero, -0.06 m.

The cumulative net balance of the observation period 1963–86 is -0.50 m. Hardangerjøkulen is thus nearly in climatic equilibrium.

Glaciers in Svalbard

Brøggerbreen

During the winter 1984/85 the snow accumulation was about 130% of the mean value of the obser-

a slightly higher deficit than the average for the previous 18 years.

The following winter 1985/86 also had heavy snowfall. The winter balance was 0.98 m, which is the highest winter precipitation since the registrations started in 1967, 140% of the mean. But the summer of 1986 was warm, the ablation was 1.30 m, and thus there was one more year of negative net balance, -0.32 m. The cumulative net balance since 1967 then becomes -9.23 m (see Table 1). The distribution of snow accumulation in 1985–86 is shown in Fig. 5, and the mass balance variations related to height can be seen in Fig. 3.

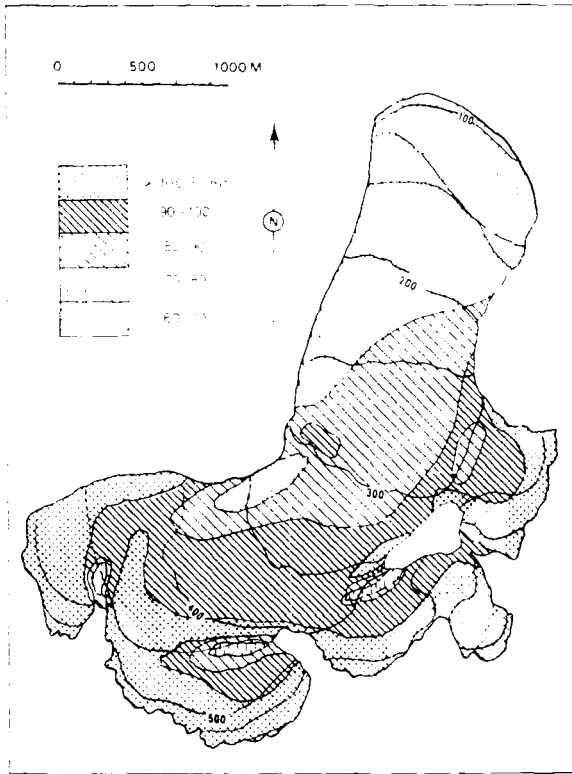


Fig. 4. Distribution of the snow accumulation on Lovénbreen in 1985/86.

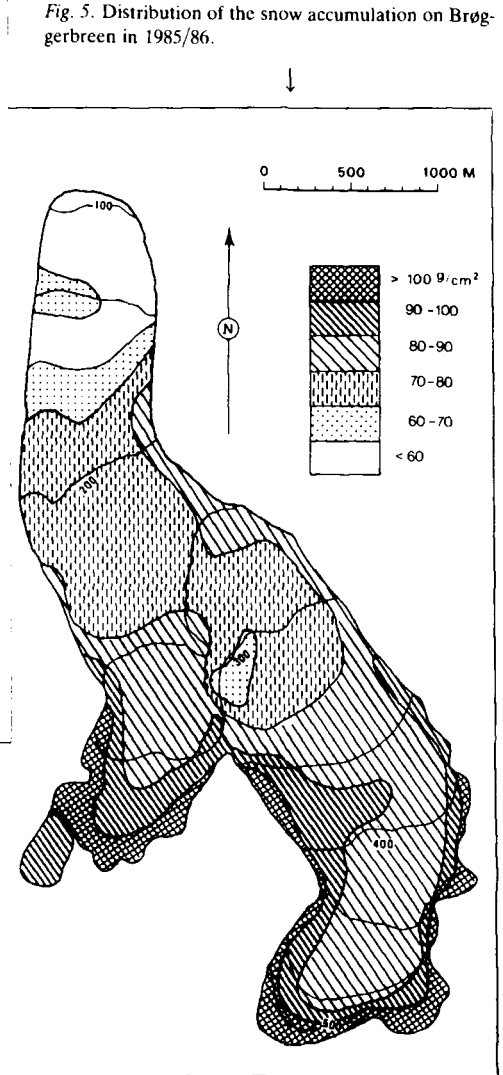


Fig. 5. Distribution of the snow accumulation on Brøggerbreen in 1985/86.

vation period 1967–84, giving a specific winter balance $b_w = 0.93$ m, measured in water equivalents. The following summer was warmer than normal and the specific summer balance was $b_s = 1.48$ m. The result was a net balance $b_n = -0.55$ m, which in spite of the great snowfall was

Based on air photos from 1977 a glacier map was constructed in the scale 1:20,000 with counter interval 10 m. One of the stakes was plotted on the map and surveyed in 1985. The vertical difference of the glacier surface was then 5.20 m. The cumulative net balance during the same period was 4.95 m in water equivalents, which is 5.50 m of ice. The direct measurements on the map thus agreed well with the annual mass balance measurements.

Lovénbreen

Due to a little higher average elevation Lovénbreen usually has slightly higher winter accumulation and a slightly lower ablation in the summer. Thus the net balance usually is a little less negative

than on Brøggerbreen. These two years have been no exception.

In 1985 the winter balance was 0.98 m and the summer balance was 1.46 m, which resulted in a negative net balance of -0.48 m. Both the accumulation and the ablation were about 30% above the mean values.

In the snow-rich winter of 1986 the accumulation was 1.06 m, but in the following warm summer the ablation was 1.27 m. Accordingly the net balance was -0.21 m (Figs. 2, 3 and 4).

The mean net balance on Lovénbreen is then -0.37 m, while it is -0.46 m on Brøggerbreen (Table 1).

The equilibrium line during these 20 years of measurements is then a little above 400 m a.s.l., which is about 100 m above an equilibrium line that would keep the net balance at zero.

