Research Note

Glacier mass balance investigations in the balance year 1986–87

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Storbreen in southern Norway has been measured continuously since 1949. The mean specific net balance is −0.29 m in water equivalents. In 1987, however, the net balance was 0.32 m, which is the highest surplus in twenty years. The results of the whole period are given in Table 1.

In Svalbard the summer of 1987 was unusually cold, which resulted in the first year with positive net balance on Brøggerbreen and Lovénbreen since the measurements started in 1968. The net balance was 0.22 m and 0.24 m, respectively, while the average is −0.43 m and −0.34 m.

Measurements at Kongsvegen in the inner part of Kongsfjorden started in 1987. The work was concentrated along the central flow line. The result was a positive net balance of 0.50 m.

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Glaciers in Norway

Storbreen

Storbreen is situated in Jotunheimen in southern Norway. Mass balance measurements started in 1949. The specific winter accumulation during 1986–87 was 1.55 m in water equivalents, or 155 g/cm^2. That is 114% of the mean for the period 1949–1987. The summer was cool and the melting was only 1.23 m, 75% of the mean value. The heavy snowfall and the low melting resulted in the greatest surplus during the last twenty years. The net balance was 0.32 m while the mean value is −0.29 m, which gives a cumulative net balance $\Sigma b_n = -10.72$ m. The variation of the mass balance in relation to the altitude is given in Fig. 1. The results of the measurements from 1949–1987 are given in Table 1 and Fig. 2.

Glaciers in Svalbard

Mass balance measurements in Svalbard are now carried out on three glaciers in the Kongsfjord area in the north-western part of Spitsbergen. Brøggerbreen and Lovénbreen close to Ny-Ålesund have been measured since 1967, while investigations on Kongsvegen started in 1987. Brøggerbreen and Lovénbreen are small, isolated cirque glaciers about 6 km^2 in area and their aspect is to the north. The front of these glaciers does not reach the sea. Kongsvegen is situated in

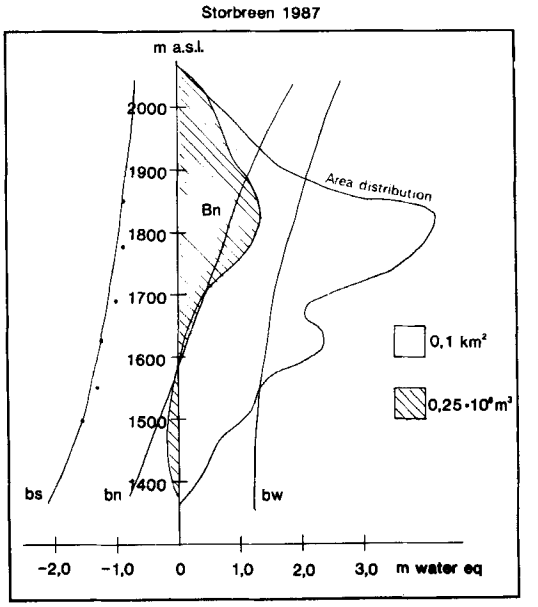

Fig. 1. Mass balance variation related to altitude at Storbreen in 1986/87.

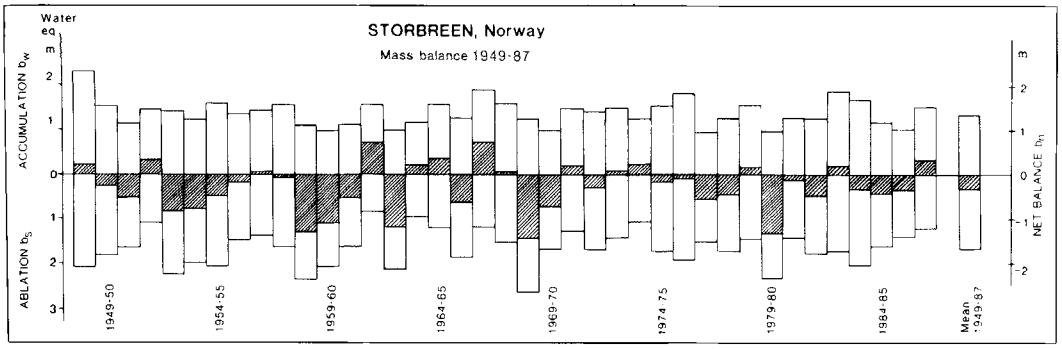

Fig. 2. Mass balance results on Storbreen in the period 1949–87.

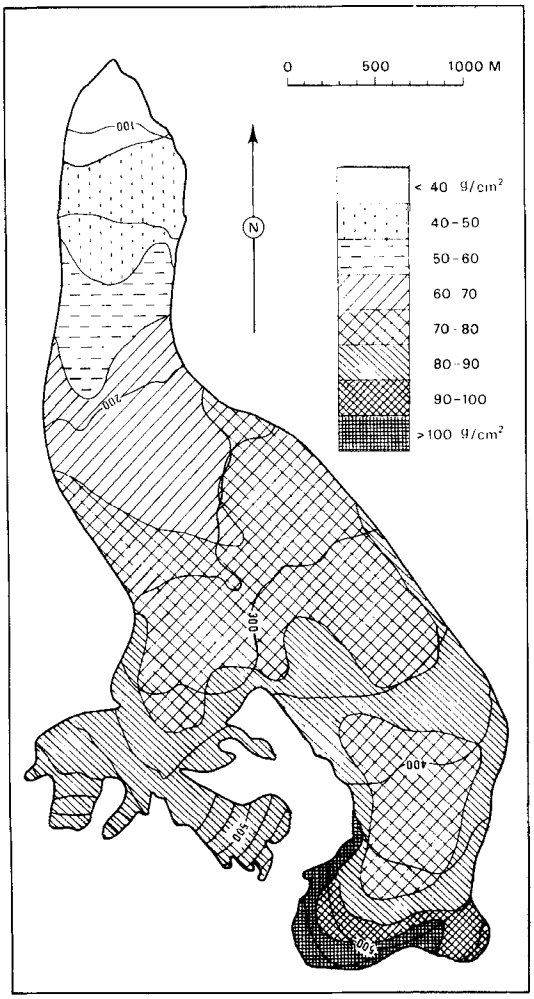

Fig. 3. Distribution of snow accumulation on Brøggerbreen 1986/87.

the inner part of Kongsfjorden. The glacier is 26 km long and the area is 105 km^2. The front is calving in the fjord and the top level reaches a little above 800 m a.s.l. Kongsvegen belongs to the so-called Spitsbergen type of glaciers that consists of large continuous ice masses divided into individual ice streams by mountain ridges and nunataks. In the upper saddle area at 750 m a.s.l. Kongsvegen is connected to Sveabreen which drains to the south-east, while Kongsvegen drains to the north-west.

Both accumulation and ablation values on the glaciers in Svalbard are less than in mainland Norway. In this north-western part maximum snow depths during the winter are usually about one meter close to sea level, increasing up to three meters in the higher areas of the glaciers.

Brøggerbreen

The winter accumulation was measured in the middle of May. The specific winter balance was $b_w = 0.82$ m in water equivalents, which is slightly more than the average for the last twenty years. The snow distribution has been almost the same from one year to the next (Fig. 3). The amount is about doubled from the lowermost to the highest areas. The summer of 1987 was cool and the summer melting was the lowest that has ever been measured since the recordings started in 1967. The specific value was 0.60 m and resulted in a positive net balance $b_n = 0.22$ m. This is the first year of surplus on this glacier in the observation period (Fig. 4). The variation of the mass balance related to altitude is shown in Fig. 5.

Lovénbreen

Lovénbreen is situated close to Brøggerbreen and

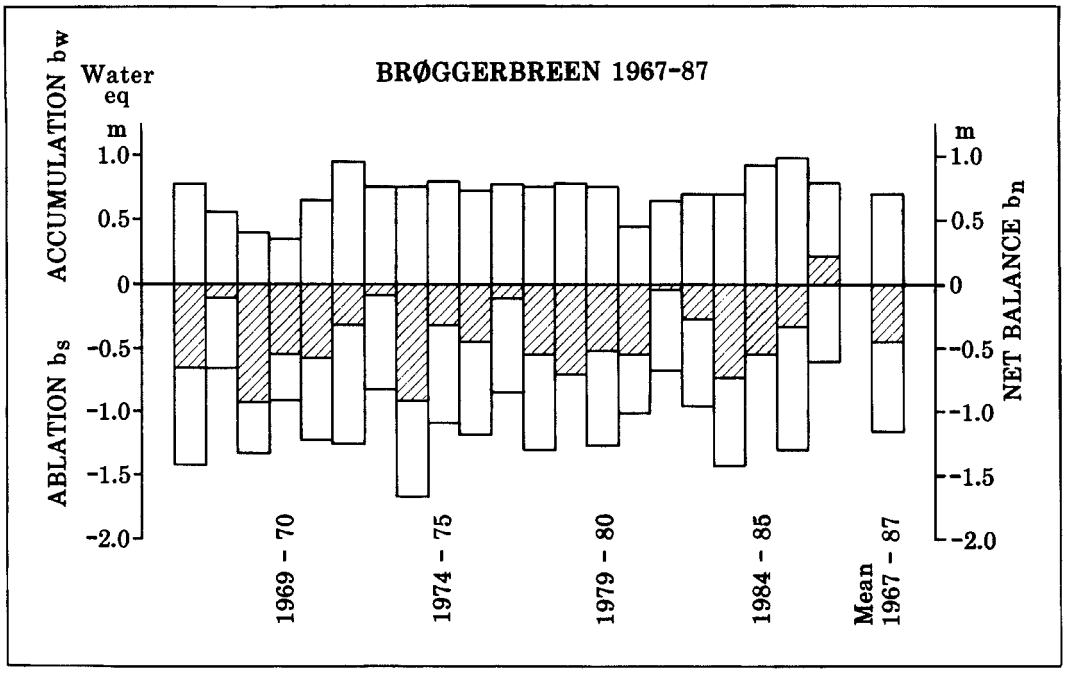

Fig. 4. Mass balance results on Brøggerbreen in the period 1967–87.

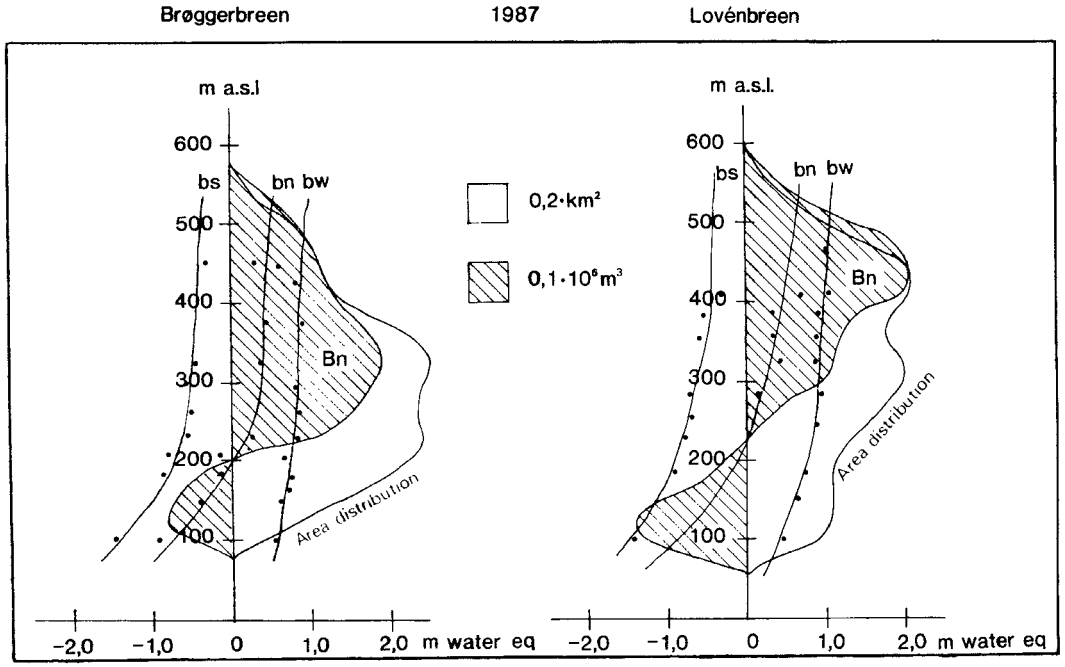

Fig. 5. Mass balance variations related to altitude in 1986/87 on Brøggerbreen and Lovénbreen.

Table 1. Specific mass balance in water equivalents (m) for Storbreen 1949–1987.

Storbreen (5.30 km² in 1986) No. of years	Year	b_w	b_s	b_n	Σb_n	E.l.a.
		(m water equivalents)				
1	1949	2.28	2.08	0.20	0.20	1650
2	1950	1.52	1.81	−0.29	−0.09	1750
3	51	1.13	1.67	−0.54	−0.63	1770
4	52	1.44	1.13	0.31	−0.32	1630
5	53	1.40	2.25	−0.85	−1.17	1850
6	54	1.21	1.98	−0.77	−1.94	1830
7	55	1.57	2.06	−0.49	−2.43	1800
8	56	1.31	1.48	−0.17	−2.60	1705
9	57	1.42	1.37	0.05	−2.55	1680
10	58	1.54	1.62	−0.08	−2.63	1700
11	59	1.07	2.35	−1.28	−3.91	1930
12	1960	0.98	2.07	−1.09	−5.00	1910
13	61	1.10	1.62	−0.52	−5.52	1820
14	62	1.54	0.82	0.72	−4.80	1510
15	63	0.96	2.14	−1.18	−5.98	1900
16	64	1.16	0.95	0.21	−5.77	1655
17	65	1.54	1.20	0.34	−5.43	1650
18	66	1.25	1.86	−0.61	−6.04	1815
19	67	1.89	1.17	0.72	−5.32	1570
20	68	1.64	1.59	0.05	−5.27	1700
21	69	1.22	2.64	−1.42	−6.69	2020
22	1970	0.97	1.69	−0.72	−7.41	1840
23	71	1.46	1.28	0.18	−7.23	1690
24	72	1.39	1.70	−0.31	−7.54	1770
25	73	1.48	1.40	0.08	−7.46	1705
26	74	1.26	1.02	0.24	−7.22	1630
27	75	1.55	1.70	−0.15	−7.37	1760
28	76	1.81	1.90	−0.09	−7.46	1740
29	77	0.94	1.48	−0.54	−8.00	1840
30	78	1.26	1.70	−0.44	−8.44	1815
31	79	1.55	1.45	0.10	−8.34	1700
32	1980	0.99	2.30	−1.31	−9.65	1975
33	81	1.30	1.40	−0.10	−9.75	1730
34	82	1.28	1.75	−0.47	−10.22	1780
35	83	1.90	1.70	0.20	−10.02	1640
36	84	1.70	2.00	−0.30	−10.32	1770
37	85	1.20	1.60	−0.40	−10.72	1790
38	86	1.05	1.37	−0.32	−11.04	1770
39	87	1.55	1.23	0.32	−10.72	1590
Mean	1949–87	1.36	1.65	−0.29		1760

the mass balance values are usually very closely connected. In 1986/87 the winter accumulation (Fig. 6) was the same as on Brøggerbreen (0.82 m), while the summer ablation was a little less, $b_s = 0.58$ m. This is due to the fact that a greater part of Lovénbreen lies at a higher elevation than Brøggerbreen. The net balance was $b_n = 0.24$ m. The variations in the balance curves related to altitude can be seen in Fig. 5.

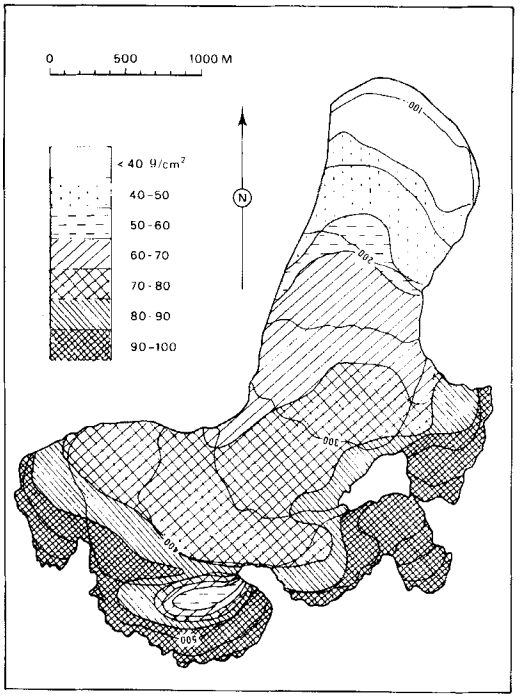

Fig. 6. Distribution of snow accumulation on Lovénbreen in 1986/87.

Kongsvegen

1987 was the first year of mass balance investigations at Kongsvegen. A stake net was established in May 1987 when the snow accumulation was sounded. The stake net was limited to nine stakes, 2.5 km apart, along the central flow line. The accumulation measurements this first year were concentrated along the central area too. The snow depth was about 1 m (0.35 m water eq.) up to 350 m a.s.l. 10 km from the front. Then the depth increased rapidly to twice this value at 450 m a.s.l., 3 km higher up, followed by a regular increase to about 3 m (1.10 m water eq.) in the top areas. The mean specific snow accumulation was 0.86 m. In addition, there is some superimposed ice forming at the snow/ice interface during the ablation season. Measurements over several years at Brøggerbreen and Lovénbreen show that the amount of superimposed ice was at least 0.10 m per year, and this value was used when the accumulation at Kongsvegen in 1987 was estimated. The total accumulation was then $b_w = 0.96$ m.

Because of the cool summer the melting was

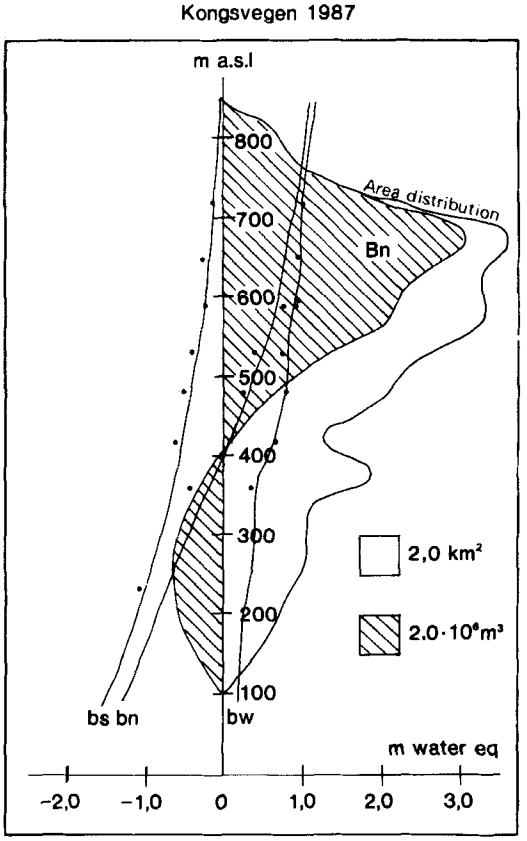

Fig. 7. Mass balance related to altitude on Kongsvegen in 1986/87. Note the different scale of area and total net balance compared to Fig. 5.

low, and the total summer ablation calculated from the stake measurements was $39.5 \cdot 10^6$ m^3 of water. In addition to the melting, ice mass is lost by calving. The ice flux in a cross profile in the lower part of the glacier could be estimated. Radio-echo soundings gave a mean depth of 250 m (Dowdeswell et. al. 1984) and velocity measurements in 1964 (Voigt 1965) gave a mean velocity of only 0.04 m/d, or about 15 m/y. The width of the investigated ice stream is 2 km, and thus the ice flux was about $8 \cdot 10^6$ m^3 of ice per year, which is used as an estimate of the calving rate. Added to the melting this gave a total ablation of $46.5 \cdot 10^6$ m^3 water, or a specific value $b_s = 0.46$ m in water equivalents.

The net balance was then $b_n = 0.50$ m. The mass balance variation related to altitude is shown in Fig. 7. This year gave a rather high positive net balance, but the summer of 1987 was extremely cold so it does not give any indication of the average situation on this glacier.

The equilibrium line altitude on Brøggerbreen and Lovénbreen was at, or just above, 200 m a.s.l., while the altitude at Kongsvegen was close to 400 m a.s.l. This means that the equilibrium line in general is at a higher elevation in the eastern part of the Kongsfjord area, in agreement with the analysis of the variations of the equilibrium line in Svalbard made by Liestøl (in press).

References

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