

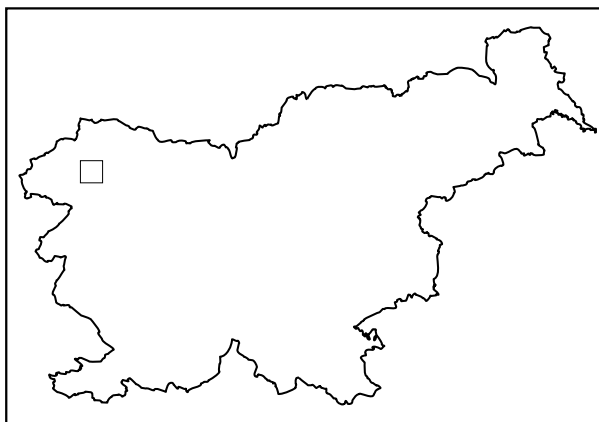
# **THE TRIGLAV GLACIER BETWEEN 1986 AND 1998**

## **TRIGLAVSKI LEDENIK MED LETOMA 1986 IN 1998**

Matej Gabrovec



The Triglav glacier, 1975 (photography Milan Orožen Adamič).  
Triglavski ledenik, 1975 (fotografija Milan Orožen Adamič).



Abstract

UDC: 551.32(234.323.6)

## **The Triglav Glacier between 1986 and 1998**

**KEY WORDS:** glacier, measurements of glacier, glaciology, climate oscillations, Julian Alps

Results are presented of thirteen-year observations of the Triglav glacier. Snow conditions in the annual accumulation period and the published results of annual measurements at the end of the melting period are described. Due to the continual thinning of the ice in the last decade, we no longer speak only of shrinking but of the disintegration of the glacier. Its surface area, which was fifteen hectares in 1946, had shrunk to less than three hectares by 1998.

Izvleček

UDK: 551.32(234.323.6)

## **Triglavski ledenik med letoma 1986 in 1998**

**KLJUČNE BESEDE:** ledenik, merjenje ledenika, glaciologija, klimatska nihanja, Julijske Alpe

Prikazani so rezultati trinajstletnih opazovanj Triglavskega ledenika. Opisane so snežne razmere v vsakoletni redilni dobi ter objavljeni rezultati vsakoletnih meritev ob koncu talilne dobe. V zadnjem razdobju je zaradi stalnega tanjšanja ledu ne govorimo več le o krčenju, ampak o razpadu ledenika. Njegova površina, ki je bila leta 1946 še 15 ha, se je do leta 1998 skrčila na slabe tri hektarje.

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# 1. Introduction

Members of the Anton Melik Geographical Institute have been regularly observing the Triglav glacier and measuring the changes to its size since 1946 (Meze, 1955; Šifrer, Košir, 1976). This article presents the results of regular observations of the glacier from 1986 to 1998. The glacier has shrunk in the fifty-year period, but the speed of its retreat has varied greatly in individual years. In the second half of the 1970's, the retreat almost stopped, but after 1983, the retreat of the glacier accelerated greatly. Since then, the retreat has been so rapid that we can speak of the disintegration of the glacier. Rocky humps began to appear in the middle of the glacier and over the years have joined to completely separate individual parts of the glacier from its central section. Measurement points fixed around the glacier in 1946 thus became completely useless for further measurements. Around them remained only fossil ice, and they are several dozen meters away from the actual glacier. In some cases, there was no ice at all in the direction of the measurement points. The observers therefore first measured the distance to the fossil ice, which melted completely in a few years. This article presents in the table the distance from the glacier to the old measurement points only until 1992. In 1995, four new measurement points were set that with further shrinking of the glacier will soon meet the same fate as their predecessors. To illustrate the annual melting of the glacier, we also present here data on the annual thinning for the entire period treated. Because the glacier does not thin evenly over its entire surface area, the presented values are only of informative character and represent the estimated mean value. The presented data on the thickness of the snow blanket were measured at the snow stakes below the glacier. On Mount Kredarica, the snow conditions are substantially different, and the data from the meteorological station there is—because of its ridge position—of no use for our purposes.



Figure 1: Location of Triglav glacier.  
Slika 1: Lega Triglavskega ledenika.

## 2. Annual reports

### 2.1. 1985–1986 Glacier Year

In the accumulation period, the glacier had the largest amount of snow at the end of April when the snow blanket at the snow stakes below the glacier reached an average of 490 cm. At the end of May, there was only 305 cm of snow left, and at the end of June, 260 cm. The ice was uncovered on July 28<sup>th</sup> on the lower part of the glacier. The ice became rapidly uncovered toward its upper edge. In the previous winter, the snowfalls had been quite evenly distributed, there were therefore no major avalanches, and the quantity of snow at the lower edge of the glacier was substantially smaller (Gartner, 1986–1998). The regular annual observations of the glacier were made by Milan Šifrer and Dušan Košir between September 17<sup>th</sup> and 19<sup>th</sup>. Considerable thinning of the glacier was characteristic. On the western side, the glacier thinned by 1.5 m to 2 m and at the eastern and lower end by about 4 m. A consequence of this thinning was the appearance of a roughly ten meter wide ridge of bare rock that protruded from the ice at the lower end of the glacier between points 16 and 14A. Thus, for the first time in the entire observation period, the connection between the glacier and the glacier tongue on its eastern side was broken. There was only fossil ice left at measurement points 16, 15, and 14C, making further measurements no longer reasonable. A similar situation occurred at points 13 and 12A, where a tongue split from the glacier below Mount Glava. Due to the great melting of snow and ice, the glacier—mainly on the eastern side—was thickly covered with gravel and crisscrossed by deeply cut channels through which water rushed to disappear at the end of the glacier into the karst underground (Šifrer, 1986). Thus, the surface area of the glacier shrank even further compared to 1983 when it was estimated to be the lowest in the past 380 years. In the two preceding years (1984 and 1985), the lower part of the glacier was thickly covered with snow even at the end of the melting period and the glacier therefore did not shrink during these two years (Šifrer, 1987). Fair and sunny weather and the melting of the glacier continued into mid October. The melting period ended on October 24<sup>th</sup> after about half a meter of snow had fallen.

### 2.2. 1986–1987 Glacier Year

Until the beginning of February, there was very little snow, so the snow blanket on the glacier was only half as thick as the previous year. Then, in the middle of February, the snow blanket increased by 180 cm. During the night of April 5<sup>th</sup>, a major storm dropped a layer of snow mixed with desert sand. In the spring and summer, the higher dirt content contributed considerably to the more rapid melting of snow. More snow fell in the first half of May, and that the average height of snow at the snow stakes was 455 cm on May 15<sup>th</sup>. However, there was only 365 cm of snow left on June 6<sup>th</sup>, and the ice reappeared on August 12. A long period of fair weather then followed that melted almost all the snow on the glacier (Gartner, 1986–1998). The regular annual observations for this year were made by Matej Gabrovec, Dušan Košir, Maja Plemelj and Milan Šifrer on September 15<sup>th</sup>. At the time of the measurements, some snow survived only on the northwestern part of the glacier below Mount Glava. On this part of the glacier, the extent therefore did not change compared to the previous year, and due to the wider surface area of the snow, the measurements at point 11 showed an even larger extent. However, the rocky humps south of point 11 or from the mentioned area of snow increased considerably, and the part of the glacier at point 10 was separated. Major changes occurred on the central eastern part of the glacier where a 1–1.5 m thick layer of ice melted. New rocky humps therefore appeared from under the ice, and the old ones protruded even more markedly above the ice. In this way, an unbroken line of rocks appeared running from below Mount Glava toward the southeast. Warm weather without major snowfalls held until the second half of October when 35 cm of snow fell. According to the measurements, even more ice melted.

### 2.3. 1987–1988 Glacier Year

In the accumulation period, the snow reached its greatest thickness on April 8<sup>th</sup> with 510 cm of snow at the snow stakes. At the end of June, the snow stakes indicated three meters of snow still remaining. The

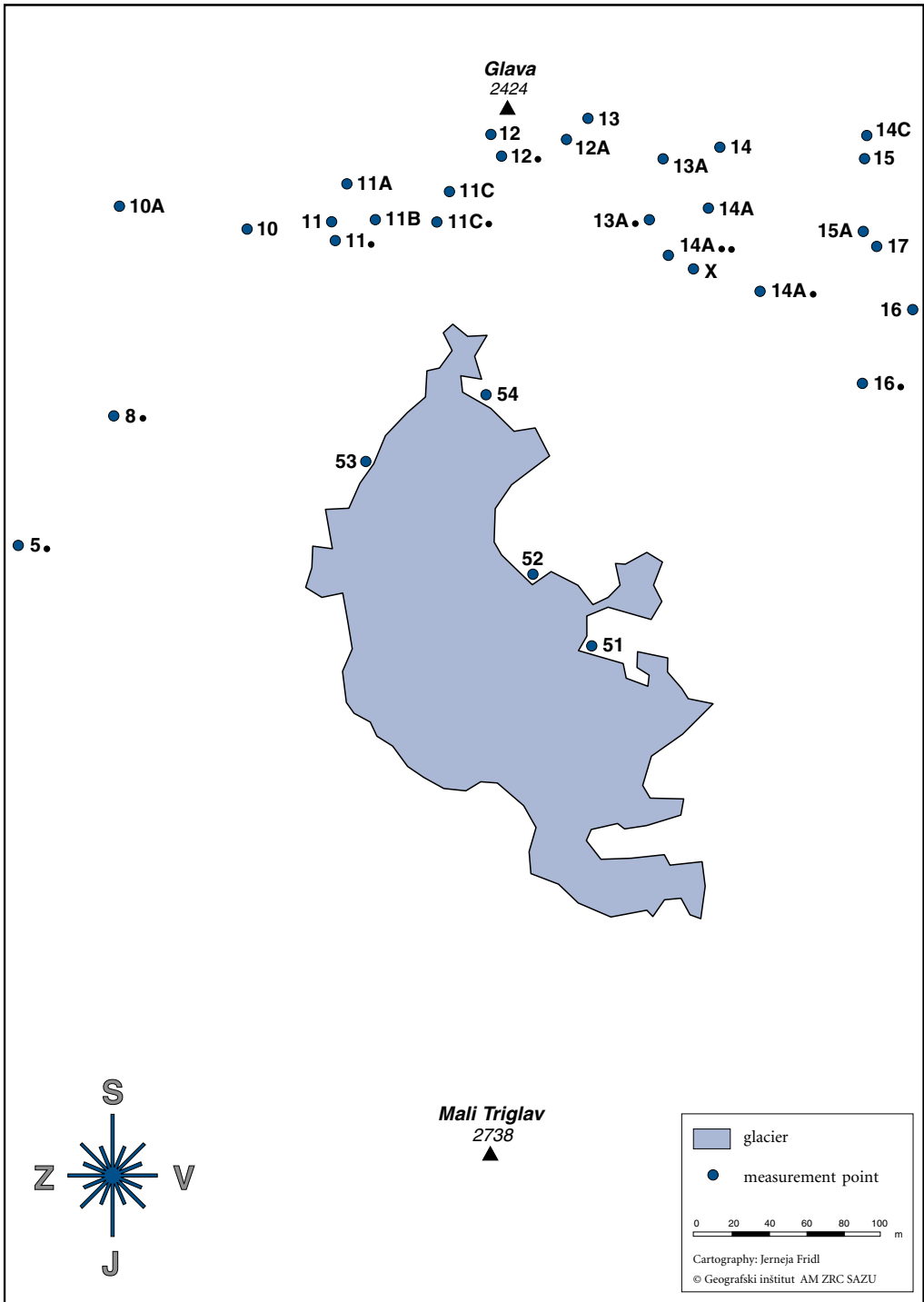


Figure 2: Location of measurement points along glacier.  
Slika 2: Položaj merilnih točk ob ledeniku.

ice appeared through the snow on July 30<sup>th</sup>. The snow remained until the first half of September only in some spots on the edge of the glacier. Compared to the previous year, the extent of the glacier did not decrease significantly. On September 13<sup>th</sup>, a six-day period of bad weather began that ended the melting period and during which 95 cm of snow fell (Gartner, 1986–1998). After this bad weather, a two-month period of fair weather started and the snow melted leaving only 10 cm to 20 cm of snow on the glacier. Matej and Peter Gabrovec were therefore able to take measurements on November 12<sup>th</sup>. They established a similar extent as the previous year, but the fossil glacier tongues on the lower edge of the glacier retreated significantly. The glacier thinned again by approximately one meter.

#### 2.4. 1988–1989 Glacier Year

In the spring, there was only half of the usual amount of snow, 275 cm of snow on May 10<sup>th</sup> and 220 cm on June 6<sup>th</sup>. In spite of the small quantity of snow in the accumulation period, ice protruded from the snow only on August 3<sup>rd</sup> due to largely unstable and cold weather in May, June, and July. After this date, the ice melted very rapidly over the entire surface of the glacier (Gartner, 1986–1998). The regular measurements taken by Dušan Košir, Filip Štucin, and Marko Žerovnik on September 16<sup>th</sup> confirmed the further shrinking of the glacier. It had thinned by about one and a half meters. The result of this was the renewed enlargement of the humps running eastward from Mount Glava, so that they almost cut off the lower, northeastern part of the glacier. In this lower section, the glacier had retreated by about five meters. The melting period concluded at the end of September when 80 cm of snow fell.

#### 2.5. 1989–1990 Glacier Year

The largest amount of snow at the snow stakes occurred at the end of April (330 cm), and by the end of May the snow blanket had lowered by a good meter. Ice protruded from the snow on July 24<sup>th</sup>. At the end of August, snow only remained in individual hollows at the edge of the glacier. In September, the weather was changeable, and the rainfall ended each time with a few centimeters snow that melted at the next thaw (Gartner, 1986–1998). Measurements were taken by Matej Gabrovec, Mauro Hrvatin, and Karel Natek on September 19<sup>th</sup>. This year again represented a major milestone in the disintegration of the glacier. Because the entire surface of the glacier thinned by about two meters, the humps in the middle enlarged greatly and finally separated the lower, northeastern part of the glacier. At points 14A•, 14A••, X and 13A•, we could only measure the distance to the fossil ice. This data is no longer of any importance and is therefore not published here. In addition, the joined humps running from Mount Glava upwards toward the saddle between Mount Mali Triglav and Mount Triglav practically separated the western part of the glacier (it was only connected to the central part of the glacier by a 30-cm wide strip of ice). In many places, the glacier was covered with gravel, especially its eastern part. An approximately two-meter retreat was also recorded at the upper edge of the glacier. The melting period only ended during the last ten days of October, when 60 cm of snow fell.

#### 2.6. 1990–1991 Glacier Year

This winter there was again more precipitation, and at the end of December there was an average 285 cm of snow at the snow stakes. By the middle of February, the snow blanket had thickened by a further 130 cm. This amount remained until the middle of April when there was about four meters of snow. Unstable weather with snow continued throughout the following month, and numerous avalanches were triggered on the glacier in this period. The snow blanket was thickest on May 11<sup>th</sup>, when average depth of the snow at the snow stakes was 580 cm. Due to low temperatures in May and snowfalls in June, there was still 570 cm of snow in the middle of the month. In the second half of June and in July, fair and warm weather prevailed, the snow melted quickly, and the ice first protruded on August 4<sup>th</sup> (Gartner, 1986–1998). The regular annual measurements were made by Matej Gabrovec and Mauro

Hrvatín. In 1991, we did not record a strong retreat of the glacier as was the case in the previous few years. Due to the abundance of snow in late spring and the numerous avalanches, a great deal of snow piled up in the lower part. Below Mount Glava, the snowfield stretched all the way to point 12A where it filled the space of the former glacier tongue, and snow also filled the area of the northeastern glacier tongue separated by humps. However, the warm summer uncovered the entire upper part of the glacier. In this part, thinning of the glacier occurred again this year. At its upper edge, the glacier retreated by approximately one meter and thinned by about half a meter around the central humps. The melting period ended on October 13<sup>th</sup> when 35 cm of snow fell on this and the following days.

## 2.7. 1991–1992 Glacier Year

The first longer period of snow began around November 12<sup>th</sup>. After a two-week snow, there were already two meters of snow at the snow stakes on November 26<sup>th</sup>, a considerable amount for this period. A period of predominantly fair weather then followed until the end of January, and the snow on the glacier stayed at the November level. The first heavier precipitation period only began in the second half of March when two and a half meters of snow fell in seventeen days. At the beginning of April, there was 465 cm of snow, the highest snow level of the season. The melting period began in June when changeable weather with above-freezing temperatures and rain prevailed. At the end of the month, there was only 135 cm of snow left. The ice protruded from the snow on July 19<sup>th</sup> (Gartner, 1986–1998). The spring of 1992 was warmer compared with 1991, but mainly there was no more snowfall in that period. The snow therefore melted a month earlier, and the ice protruded ten days earlier. Because of the late spring weather described and extremely high August temperatures, the glacier experience a strong retreat in 1992 after a one-year hiatus. The lower, northeastern part of the glacier that had separated from the central part in 1990 was separated at that time from the central part by only a three-meter strip of rock. In 1992, the rocky barrier between the two parts of the glacier was several dozen meters wide. The lower edge of the glacier, which had been covered by snow in 1991, was again the same as in 1990. Again, the glacier thinned strongly in its upper part (by an average of approximately two meters), and the ice retreated considerably at its westernmost edge. The regular annual measurements were taken on September 17<sup>th</sup> by Matej Gabrovec, Mauro Hrvatín, and Dušan Košir. The melting period ended on the last day of September.

TABLE 1: ANNUAL CHANGES OF THE DISTANCE OF THE MEASUREMENT POINTS FROM THE GLACIER FROM 1986 TO 1992.

PREGLEDNICA 1: LETNE SPREMENBE RAZDALJE MERILNIH TOČEK OD LEDENIKA OD LETA 1986 DO LETA 1992.

	16●	14A●	14A●●	11C	11	10
1986	+2,9	+6,5	+48,2	+30,8	+6,3	+2,2
1987	+5,0	+0,6	+1,8	+1,6	-5,6*	-0,4*
1988	+1,2	+2,0	-0,3*	+0,0	+2,4	-6,3
1989	0,0	+8,7	+5,1	...	+4,7	+6,2
1990	!	!	!	!	+1,0	+0,7
1991	!	!	!	!	-8,0*	-1,9*
1992	!	!	!	!	+8,3	!

... no data

! no glacier remained in the vicinity of the measurement point

\* distance measured to the snow

... ni podatka

! v okolici merilne točke ni več ledenika

\* oddaljenost izmerjena do snega

## 2.8. 1992–1993 Glacier Year

There was above-average snowfall in November and December, and there was 280 cm of snow at the snow stakes in the middle of December. Subsequently, there was very little precipitation until the end of March.





Figure 3: Triglav glacier 18. 9. 1986 (photography Dušan Košir).  
Slika 3: Triglavski ledenik 18. 9. 1986 (fotografija Dušan Košir).



Figure 4: Triglav glacier 19. 9. 1990 (photography Matej Gabrovec).  
Slika 4: Triglavski ledenik 19. 9. 1990 (fotografija Matej Gabrovec).



Figure 5: Trglav glacier 26. 9. 1995 (photography Matej Gabrovec).  
Slika 5: Triglavski ledenik 26. 9. 1995 (fotografija Matej Gabrovec).



Figure 6: Trglav glacier 23. 9. 1997 (photography Matej Gabrovec).  
Slika 6: Triglavski ledenik 23. 10. 1997 (fotografija Matej Gabrovec).

The highest snow level on the glacier was three and a half meters, recorded on April 18<sup>th</sup> after a three-day snowfall. In May, the snow melted considerably due to the quite fair and warm weather, and there was only 190 cm of snow left at the beginning of June. This year, the ice protruded on July 9<sup>th</sup>. The melting period ended on October 21st when more than one meter of fresh snow fell (Gartner, 1986–1998). Measurements were taken just before the deterioration of the weather on the last day of the melting period (October 20<sup>th</sup>) by Matej Gabrovec and Miha Pavšek. At the time, there was about 15 cm of new snow on the glacier; however, this did not impede the observations because there was no snow on the rocky surroundings of the glacier. Regrettably, all the measurement points on the lower edge finally became totally useless due to the continuing retreat of the glacier. In their vicinity, the glacier tongue was already completely separated and almost completely covered with gravel. At its new lower edge, the glacier had retreated a further six to seven meters, and on the upper edge by two to three meters.

## 2.9. 1993–1994 Glacier Year

At the end of December, there was 235 cm of snow and over the next two months, its thickness did not change substantially. There were abundant snowfalls in April, and at the end of the month, there was 485 cm of snow at the snow stakes, the highest level of the season. At the end of May, there were still four meters of snow. The snow melted quickly in June and July, but the ice protruded only on July 24<sup>th</sup>, two weeks later than the previous year, because of the thicker spring snow blanket. Predominantly warm sunny weather followed with only shorter periods of poor weather. In the middle of September, seventeen centimeters of snow fell, but it melted over the next few days. The melting period ended at the beginning of October when bad weather with a rapid drop in temperature began and 15 to 20 cm of new snow fell (Gartner, 1986–1998). The regular annual observations were made by Ivan Gams and Miha Pavšek on September 25<sup>th</sup>. The extent of the glacier was practically the same as the previous year. On the basis of the forty years of observations made between 1955 and 1994, Ivan Gams also analyzed changes on the glacier in the light of climatic indicators and published his findings in an extensive dissertation (Gams, 1994).



Figure 7: Lower part of glacier covered with gravel, 27. 9. 1995 (photography Jerneja Fridl).  
Slika 7: Z gruščem prekrti spodnji del ledenika 27. 9. 1995 (fotografija Jerneja Fridl).



Figure 8: Mark on the rock of the glacier edge 4. 9. 1997. Since then till 24. 10, when this picture was made, a half meter of ice was melted (photography Matej Gabrovec).

Slika 8: Oznaka na skali kaže rob ledenika 4. 9. 1997. Od takrat do 24. 10., ko je bila posneta ta slika, se je stopilo še pol metra ledu (fotografija Matej Gabrovec).

## 2.10. 1994–1995 Glacier Year

Until March, very rapid changes were characteristic of the weather, and there were consequently a large number of days with strong winds on Mount Kredarica. Along with frequent falls of fine snow, the winds had the greatest influence on the snow blanket on the glacier. In the middle of March, there was an average of two and a half meters of snow at the snow stakes. The largest amount of snow recorded was in April, 310 cm, and in the middle of June, 230 cm still remained. The ice protruded the same day as the previous year, July 24<sup>th</sup>. From the middle of August until the end of September, the weather was quite unstable with periodic snowfalls during which up to 10 cm of snow fell. There were several centimeters of snow on the glacier when the measurements were taken on September 27<sup>th</sup>. All the snow melted in October during extremely fair weather, and the melting period only ended in the first days of November (Gartner, 1986–1998). This year, Franjo Drole, Jerneja Fridl, Matej Gabrovec, and Miha Pavšek measured the glacier using a Nikon DTM-A10LG electronic digital theodolite instead of the usual measuring tape. We established coordinates for 104 points along the circumference of the glacier and calculated the surface area, which was then 3.03 hectares. We also measured the coordinates of all the measurement points according to which the glacier had been measured since 1946. Along the current lower edge of the glacier, we also established four new measurement points, numbered 51 to 54. Compared to the previous year, the glacier had thinned a little, but its surface area had not changed significantly.

## 2.11. 1995–1996 Glacier Year

After changeable weather in December, there was an average of 140 cm of snow at the snow stakes at the end of 1995. In the spring, the amount of snow was well below the average, only 220 cm in the middle of April. This level remained until the end of May. The weather in the first half of June was unusually warm and sunny with a maximum temperature of 14.3°C. The snow melted quickly, and there was less than



Figure 9: Triglav glacier 8. 12. 1997 (photography Jernej Gartner).  
Slika 9: Triglavski ledenik 8. 12. 1997 (fotografija Jernej Gartner).

half a meter of snow left by the middle of June. With such a thin snow blanket remaining in June, the glacier should have retreated greatly this year in average summer weather. However, cold weather with frequent snowfalls in the second half of June completely stopped the melting of the snow, and the ice only protruded on July 20<sup>th</sup>. The August weather was changeable with showers and storms, and the snow along the edge of the ice did not melt away at all. September was unusually cold with frequent snowfalls; the minimum temperature was above the freezing point only two days, and the maximum temperature was only 2.4°C. The newly fallen snow from the first half of the month therefore did not melt at all. At the end of the melting period on September 10<sup>th</sup>, snow remained on the eastern lower part of the glacier while the western and central part of the glacier was uncovered. Considering the growth of the rocky humps,



Figure 10: Triglav glacier 8. 5. 1998 (photography Jernej Gartner).  
Slika 10: Triglavski ledenik 8. 5. 1998 (fotografija Jernej Gartner).



Figure 11: Triglav glacier 9. 6. 1998 (photography Jernej Gartner).  
Slika 11: Triglavski ledenik 9. 6. 1998 (fotografija Jernej Gartner).

we estimate that the glacier thinned here by about half a meter, but we were unable to make detailed measurements due to the early snow. During the visit by Matej Gabrovec and Mauro Hrvatin on October 27<sup>th</sup>, the glacier and its surroundings were completely covered by a half-meter snow blanket.

## 2.12. 1996–1997 Glacier Year

In November, 180 cm of snow fell on a base of 20 to 50 cm. In the lower layers, this snow was mixed with Sahara sand due to a deep Mediterranean depression. For the rest of the winter, there was rel-



Figure 12: Triglav glacier 16. 8. 1998 (photography Jernej Gartner).  
Slika 12: Triglavski ledenik 16. 8. 1998 (fotografija Jernej Gartner).

atively little precipitation, and the thickness of the snow blanket remained approximately the same until the end of April when it increased to 335 cm after half a meter of snow fell. At the end of June, there was an average of 130 cm of snow left at the snow stakes. Due to cold weather in July, the ice only protruded on August 8<sup>th</sup> (Gartner, 1986–1998). The measurements were taken the first time this year on September 4<sup>th</sup> by Matej Gabrovec, Mimi Urbanc, and Peter Frantar. Due to the cold weather in August, the glacier was almost about the same as it was in 1995. Throughout September, the weather was sunny and warm with maximum temperatures reaching 13 °C, and the snow melted most in September this year. Matej Gabrovec and Mimi Urbanc therefore repeated the measurements on October 24<sup>th</sup>. There were several centimeters of new snow on the glacier on this date, but this did not impede the observations. In September alone, the glacier retreated by about two meters everywhere along its lower edge. At point 52, where there had still been some snow at the beginning of September, a ten-meter wide belt of rocky ground was newly uncovered. At its lower edge (point 54), the glacier had thinned by a good half meter in the same period. In the center of the glacier, near the humps east of point 53, the glacier had thinned by one meter over the summer. Humps also completely separated a smaller glacier tongue east of point 52 this year. At its upper margin, the glacier retreated by about half a meter on the eastern side and by two meters on the western side compared to 1995.

### 2.13. 1997–1998 Glacier Year

There was considerable snow in November and December, and there were about two meters of snow at the end of 1997. After that, there were no major snowfalls until the end of March. More snow fell in April, and at the end of the month there was 380 cm of snow at the snow stakes. Sand from the Sahara fell with the last April snow. In this month, a major avalanche that carried a meter of snow away with it was triggered in the central part of the glacier. By the middle of June, there was something less than two meters of snow left, and the ice protruded between July 15<sup>th</sup> and 20<sup>th</sup>. The melting period ended on August 28<sup>th</sup> when ten centimeters of snow fell, and another 35 cm of snow fell on September 12<sup>th</sup> when the weather worsened again, (Gartner, 1986–1998). The regular annual observations were made on October 17<sup>th</sup> by Matej Gabrovec, Franci Petek, and Mimi Urbanc. At that time, Mount Kredarica was bare, although there was about half a meter of snow on the glacier and the surroundings of the glacier were also covered to a considerable extent. Unfortunately, we were only able to locate measurement point 53, where the glacier had retreated by three meters. We estimated that the glacier also thinned by about one meter at this point. The humps east of this point had risen even further and the north-western part of the glacier was only connected with the central part by a two-meter wide belt. At the upper edge, the glacier had retreated by two meters in the eastern part and by four meters in the western part.

## 3. Conclusion

The thirteen-year period studied is marked by the steady retreat of the glacier. The thinning of the central part is especially characteristic. The result is that its profile is increasingly concave. In the past, the central part was convex, but it has become concave the last few years. For this reason, snow from the upper part can slide downwards more rapidly. During the period studied, the central part was always uncovered in summer, and in years with a thicker snow blanket, the snow only survived until the end of the melting period at the lower edge of the glacier. Due to the thinning of the ice, more and more rocky humps protruded in the middle of the glacier; and when they joined, they separated individual parts of the glacier from the central part. The glacier therefore not only kept retreating, but literally disintegrated. In 1995, its surface area was 3.03 hectares, and it became even smaller in the following three years. In the table below, the main data on the glacier is presented for the period studied.

TABLE 2: THICKNESS OF THE SNOW BLANKET AND OBSERVATIONS OF THE GLACIER FROM 1986 TO 1998. PREGLEDNICA 2: DEBELINA SNEGA IN OPAZOVANJA LEDENIKA OD LETA 1986 DO LETA 1998.

year	maximum thickness of snow	thickness of snow in June (date of measurement)	Appearance of the ice	Date of measurement	End of melting period	Annual thinning of glacier
1986	490	250 (20. 6.)	28. 7.	17. 9.	24. 10.	4
1987	455	365 (12. 6.)	12. 8.	15. 9.	pr. 20. 10.	1.5
1988	510	305 (20. 6.)	30. 7.	12. 11.	13. 9.	1
1989	275	220 (11. 6.)	3. 8.	16. 9.	pr. 30. 9.	1.5
1990	330	220 (21. 5.)	24. 7.	19. 9.	pr. 20. 10.	2
1991	580	570 (12. 6.)	4. 8.	24. 9.	13. 10.	0.5
1992	465	135 (28. 6.)	19. 7.	17. 9.	30. 9.	2
1993	345	190 (6. 6.)	9. 7.	20. 10.	21. 10.	2
1994	485	410 (23. 5.)	24. 7.	25. 9.	pr. 5. 10.	0.1
1995	310	230 (17. 6.)	24. 7.	27. 9.	pr. 1. 11.	0.5
1996	220	45 (19. 6.)	20. 7.	27. 10.	pr. 10. 9.	0.5
1997	335	130 (29. 6.)	4. 8.	4. 9.; 24. 10.	14. 10.	1
1998	380	195 (9. 6.)	15.–20. 7.	17. 10.	28. 8.	1

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## 5. Summary in Slovene – Povzetek

### Triglavski ledenik med letoma 1986 in 1998

*Matej Gabrovec*

#### 1. Uvod

Sodelavci Geografskega inštituta Antona Melika redno opazujejo Triglavski ledenik in merijo spremembe njegovega obsega vse od leta 1946 (Meze, 1955, Šifrer, 1963, 1987, Šifrer, Košir, 1976). V tem članku so prikazani rezultati rednih opazovanj ledenika od leta 1986 do 1998. Ledenik se je v petdesetletnem razdobju krčil, vendar pa je bila hitrost umikanja med posameznimi leti precej različna. V drugi polovici sedemdesetih let se je umikanje ledenika skoraj povsem ustavilo. Od leta 1983 pa se je krčenje ledenika močno pospešilo. Odtlej je umikanje tako hitro, da lahko govorimo že o razpadanju ledenika. Sredi ledenika so se namreč začele pojavljati skalne grbine, ki so se z leti povezovale in tako posamezne dele ledenika povsem ločile od osrednjega dela. Merilne točke, ki so bile okoli ledenika določene leta 1946, so tako za na-



daljnje merjenje postale povsem neuporabne. Ob njih je namreč ostal le fosilni led, do pravega ledenika pa so bile oddaljene več deset metrov. V nekaterih primerih pa v smeri merjenja sploh ni bilo več ledu. Opazovalci ledenika so (smo) zato sprva merili razdaljo do tega fosilnega ledu, ki pa se je v nekaj letih tudi povsem stopil. V tem članku zato v preglednici objavljamo oddaljenost ledenika od starih merilnih točk le do leta 1992. Zato smo leta 1995 določili štiri nove merilne točke, ki pa jih bo ob nadaljnjem krčenju ledenika kmalu doletela ista usoda kot njihove predhodnice. Za ponazoritev letnega taljenja ledenika objavljamo za celotno tu obravnavano razdobje tudi podatke o letnem tanjšanju. Ker se ledenik ne tanjša na celotni površini enakomerno, so objavljene vrednosti le informativnega značaja in predstavljajo ocenjeno srednjo vrednost. Objavljeni podatki o debelini snežne odeje so zmerjeni na snegomerih pod ledenikom. Na Kredarici so zaradi slemenske lege snežne razmere bistveno drugačne, zato podatki tamkajšnje meteorološki postaje za naš namen niso uporabni.

## 2. Letna poročila

### 2.1. Ledeniško leto 1985–1986

V redilni dobi je bilo največ snega na ledeniku ob koncu aprila, ko je snežna odeja na snegomerih pod ledenikom dosegla v povprečju 490 cm. Ob koncu maja je bila snega še 305 cm, ob koncu junija pa 260 cm. Led je bil razkrit 28. 7., in sicer na spodnjem delu ledenika. Led se je hitro odkrival proti zgornjemu robu. V preteklo zimi so bile snežne padavine dokaj enakomerno razporejene, zato ni bilo večjih plazov in količina snega na spodnjem robu ledenika je bila bistveno manjša (Gartner, 1986–1998). Redna letna opazovanja ledenika sta opravila med 17. in 19. septembrom Milan Šifrer in Dušan Košir. Značilno je bilo močno stanjšanje ledenika. Na zahodni strani se je ledenik stanjšal za 1,5 do 2 m, na vzhodnem in spodnjem koncu za okoli 4 m. Posledica tega je bil nastanek okoli 10 m širokega živoskalnega hrbta, ki je izpod ledu pogledal na spodnjem koncu ledenika med točkama 16. in 14A. Tako je bila prvič v vsem opazovalnem razdobju prekinjena zveza med ledenikom in ledeniškim jezikom na njegovi vzhodni strani. Ob merilnih točkah 16, 15 in 14C je bil tako le fosilni led in nadaljnje merjenje ob teh točkah ni več smiselno. Podobno se je zgodilo pri točkah 13 in 12A, kjer se je od ledenika odcepil jezik pod Glavo. Zaradi tolikšnega taljenja snega in ledu je bil ledenik predvsem na vzhodni strani na debelo prekrit z drobirjem, prepresali pa so ga tudi globoko zajedeni žlebovi, po katerih je drla voda in ob koncu ledenika ponikala v kraško notranjost (Šifrer, 1986). Tako se je površina ledenika še skrčila glede na leto 1983, ko je bila ocenjena na najnižjo v zadnjih 380 letih. V obeh predhodnih letih (1984 in 1985) je bil spodnji del ledenika še ob koncu talilne dobe na debelo prekrit s snegom, zato se v teh dveh letih ledenik ni skrčil. (Šifrer, 1987). Lepo in sončno vreme in taljenja ledenika se je nadaljevalo še do sredine oktobra, talilna doba se je končala 24. 10., potem ko je zapadlo okoli pol metra snega.

### 2.2. Ledeniško leto 1986–1987

Do začetka februarja je bilo zelo malo snežnih padavin, tako da je bila na ledeniku takrat snežna odeja pol tanjša kot prejšnje leto. Nato pa se je v drugi tretjini februarja snežna odeja odebelila za 180 cm. V noči na 5. april je v neurju zapadla plast snega, ki je bila zelo pomešana s puščavskim peskom. Ta pomladi in poleti zaradi večje umazanosti snega precej prispeva k hitrejšemu topljenju snega. Več sneženja je bilo spet v prvi polovici maja, tako da je bila povprečna višina snega na snegomerih 15. 5. 455 cm, 12. 6. pa ga je bilo še 365 cm. Led se je tega leta pojavil 12. avgusta. Sledilo je dolgo obdobje lepega vremena, zato je skopnel skoraj ves sneg na ledeniku (Gartner, 1986–1998). Redna letna opazovanja so tega leta opravili Matej Gabrovec, Dušan Košir, Maja Plemelj in Milan Šifrer 15. septembra. V času merjenja se je nekaj snega ohranilo le na severozahodnem koncu ledenika pod Glavo. Na tem delu ledenika se zato obseg glede na prejšnje leto ni spremenil, zaradi obširnejše površine snega so meritve na točki 11 pokazale celo večji obseg. Močno pa so se povečale grbine južno od točke 11 oziroma od omenjenega snežišča. Tako se je prekinila zveza med ledom ob točki 10 z ledenikom. Do večjih sprememb je prišlo na vzhodnem in osrednjem delu ledenika, tu se je stalila 1 do 1,5 m debela plast ledu. Zato so se tu izpod ledu pokazale nove grbine, stare pa so se še markantneje dvignile iznad ledu. Tako je nastal cel prag, ki izpod Glave poteka proti jugovzhodu. Toplo vreme brez večjih snežnih padavin se je obdržalo do druge polovice oktobra, ko je zapadlo 35 cm snega. Tako se je po meritvah stopilo še nekaj ledu.

### 2.3. Ledeniško leto 1987–1988

V redilni dobi je sneg dosegel največjo debelino 8. aprila, ko je bilo na snegomerih 510 cm snega. Ob koncu junija je bilo na snegomerih še tri metra snega. Led se je pokazal izpod snega 30. julija. Do prve polovice septembra je sneg obdržal le ponekod na obrobju ledenika. Glede na prejšnje leto se obseg ledenika ni bistveno zmanjšal. 13. septembra se je začelo šestdnevno obdobje slabega vremena, v katerem je zapadlo 95 cm snega in s tem se je zaključila talilna doba (Gartner, 1986–1998). Po tem poslabšanju pa je nastopilo dvomesečno obdobje lepega vremena, tako da se je sneg stopil in ga je na ledeniku ostalo le 10 do 20 cm. Tako sta lahko 12. novembra Matej in Peter Gabrovec izvedla meritve. Ugotovila sva podoben obseg kot prejšnje leto, močno pa so se skrčili fosilni ledeniški jeziki na spodnjem robu ledenika. Spet pa se je ledenik stanjšal, in sicer v povprečju za en meter.

### 2.4. Ledeniško leto 1988–1989

Pomladi je bilo pol manj snega kot običajno, 10. 5. ga je bilo 275 cm, 11. 6. pa 220 cm. Kljub majhni količini snega v redilni dobi pa se je zaradi pretežni nestalnega in hladnega vremena v maju, juniju in juliju led pokazal šele 3. avgusta. Po tem datumu pa je led zelo hitro skopnel po celotni površini ledenika (Gartner, 1986–1998). Redne meritve so 16. septembra opravili Dušan Košir, Filip Štucin in Marko Žerovnik. Ugotovili so nadaljnje krčenje ledenika. Stanjšal se je za približno poldrugi meter. Posledica tega je bilo ponovno večanje grbin, ki se od Glave vlečejo proti vzhodu, tako da so že skoraj odrezale spodnji, severovzhodni del ledenika. Na tem spodnjem delu se je ledenik umaknil za okoli pet metrov. Talilna doba se je zaključila konec septembra, ko je zapadlo 80 cm snega.

### 2.5. Ledeniško leto 1989–1990

Največ snega je bilo na snegomerih v tem letu ob koncu aprila (330 cm), do konca maja snežna odeja upadla za dober meter. Led se je pokazal izpod snega že 24. 7. Do konca avgusta se je sneg obdržal le v posameznih kotanjah na robu ledenika. Septembra je bilo spremenljivo vreme, padavine so se končevale s sneženjem, vsakokrat je zapadlo po nekaj centimetrov snega, ki pa se je ob naslednji odjugi stopil (Gartner, 1986–1998). Meritve so 19. septembra opravili Matej Gabrovec, Mauro Hrvat in Karel Natek. To leto pomeni spet večjo prelomnico v razpadanju ledenika. Ker se je ledenik po celotni površini stanjšal za okoli 2 m, so se močno povečale grbine sredi njega in dokončno ločile spodnji, severovzhodni del ledenika. Pri točkah 14A $\bullet$ , 14A $\bullet\bullet$ , X in 13A $\bullet$  smo tako lahko zmerili le razdalje do fosilnega ledu. Ti podatki pa nimajo več pravega pomena in jih zato tu ne objavljamo. Poleg tega so se med seboj povezale grbine, ki potekajo od Glave navzgor v smeri proti sedlu med Malim Triglavom in Triglavom, tako se je od ledenika praktično ločil tudi njegov zahodni del (z osrednjim delom ledenika ga je povezoval le 30 cm širok pas ledu). Ledenik je bil na več mestih prekrit z gruščem, to še posebej velja za njegov vzhodni del. Približno dvometrski umik smo zabeležili tudi na zgornjem robu ledenika. Talilna doba se je zaključila šele v zadnji dekadi oktobra, ko je zapadlo 60 cm snega.

### 2.6. Ledeniško leto 1990–1991

V tokratni zimi je bilo spet več padavin, tako je bilo ob koncu leta na snegomerih v povprečju 285 cm snega. Do srede februarja se je snežna odeja odebelila še za 130 cm. Do srede aprila se je debelina snega obdržala na tej ravni, bilo je torej okoli štiri metre snega. Nestalno vreme s sneženjem se je nadaljevalo še ves naslednji mesec, v tem času so se na ledeniku tudi prožili številni plazovi. Najvišja snežna odeja je bila 11. 5., ko je bila povprečna debelina snega na snegomerih 580 cm. Zaradi nizkih temperatur v maju in snežnih padavin v juniju je bilo sredi tega meseca še vedno 570 cm snega. V drugi polovici junija in juliju pa je prevladovalo lepo in toplo vreme, tako da je sneg hitro kopnel in 4. avgusta se je prvič pokazal led (Gartner, 1986–1998). Redna letna merjenja sva 24. 9. opravila Matej Gabrovec in Mauro Hrvat. V letu 91 ne beležimo več močnega krčenja ledenika kot v zadnjih nekaj letih. Zaradi obilice snega v pozni pomladi in številnih plazov se je v spodnjem delu nakopičilo ogromno snega. Tako je pod Glavo snežišče segalo vse do točke 12A, kjer je zapolnilo prostor nekdanjega ledeniškega jezika, s snegom pa je bilo zapolnjeno tudi območje severovzhodnega, z grbinami odrezanega ledeniškega jezika. Vendarle pa

je bil zaradi toplega poletja razkrit ves zgornji del ledenika. Na tem delu pa je tudi tega leta prišlo do tanjšanja ledenika. Na zgornjem robu se je ledenik umaknil za približno 1 m, pri srednjih grbinah pa se je stanjšal za okoli pol metra. Talilna doba se je zaključila 13. oktobra, v tem in v naslednjih dneh je zapadlo 35 cm snega.

## 2.7. Ledeniško leto 1991–1992

Prvo daljše obdobje sneženja je nastopilo po 12. novembru. Po 14-dnevnem sneženju je bilo 26. 11. na snegomerih na ledeniku 2 metra snega, kar je precej za ta čas. Sledilo je obdobje pretežno lepega vremena vse do konca januarja, zato se je na ledeniku obdržala novembrska debelina snega. Prvo močnejše padavinsko razdobje je nastopilo šele v drugi polovici marca, ko je v 17 dneh zapadlo dva in pol metra snega. V začetku aprila je bilo snega 465 cm, to pa je tudi največja snežna debelina v tej sezoni. Obdobje taljenja se je začelo v juniju, ko je prevladovalo spremenljivo vreme s pozitivnimi temperaturami in dežjem. Ob koncu meseca je bilo le še 135 cm snega. Led se je pojavil izpod snega 19. 7. (Gartner, 1986–1998). V primerjavi z letom 91 je bila v letu 92 pozna pomlad toplejša, predvsem pa v tem času ni bilo več snežnih padavin. Zato je sneg skopnel mesec dni prej, led pa se je pokazal 10 dni prej. Zaradi omenjenega vremena v pozni pomladi in izredno visokih avgustovskih temperatur je bilo za leto 1992 po enoletnem presledku spet značilno močno skrčenje ledenika. Spodnji, severovzhodni del ledenika, ki se je od osrednjega dela odcepil leta 1990, je takrat ločil od glavnega dela le 3-metrski skalni skok. Leta 1992 je bila skalna pregrada med obema deloma ledenika široka že nekaj deset metrov. Spodnji rob ledenika, ki je bil leta 91 prekrit s snegom, je bil tega leta približno enak stanju iz leta 1990. Ponovno se je ledenik močno stanjšal v zgornjem delu (v povprečju za okoli dva metra), led pa se je močno skrčil tudi v skrajnem zahodnem delu. Redna letna merjenja so 17. 9. opravili Matej Gabrovec, Mauro Hrvat in Dušan Košir. Talilna doba se je zaključila zadnji dan septembra.

## 2.8. Ledeniško leto 1992–1993

V novembru in decembru so bile nadpovprečne snežne padavine, tako da je bilo sredi decembra na snegomerih 280 cm snega. Odtlej je bilo do konca marca zelo malo padavin. Največ snega na ledeniku, tri in pol metre, je bilo 18. aprila po tridnevem sneženju. V maju je v dokaj lepem in toplem vremenu sneg precej skopnel, tako da ga je bilo v začetku junija le še 190 cm. Led se je tega leta pokazal že 9. julija. Talilna doba se je končala 21. oktobra, ko je zapadlo čez meter novega snega (Gartner, 1986–1998). Meritve sva opravila tik pred poslabšanjem vremena zadnji dan talilne dobe (20. 10.) Matej Gabrovec in Miha Pavšek. Na ledeniku je v tem času sicer bilo okoli 15 cm novega snega, ki pa zaradi kopne okolice ni oviral opazovanj. Zaradi nadaljnjega krčenja ledenika so žal vse merilne točke na spodnjem robu postale dokončno povsem neuporabne. V njihovi okolici je bil namreč že povsem ločen ledeniški jezik, ki je bil praktično povsem prekrit z gruščem. Na novem spodnjem robu se je ledenik umaknil za šest do sedem metrov, na zgornjem robu pa za dva do tri metre.

## 2.9. Ledeniško leto 1993–1994

Ob koncu decembra je bilo snega 235 cm, njegova debelina se v naslednjih dveh mesecih ni bistveno spremenila. Obilne snežne padavine so bile v aprilu, ob koncu meseca je bilo tako v tej sezoni na snegomerih največ snega, to je 485 cm. Ob koncu maja je bilo še štiri metra snega, v juniju in juliju je sneg hitro kopnel, led pa se je zaradi debelejšje pomladne snežne odeje vendarle pokazal dva tedna kasneje kot prejšnje leto, to je 24. 7. Po tem je bilo pretežno toplo sončno vreme z le krajšimi poslabšanji. Sredi septembra je zapadlo 17 cm snega, vendar je ta sneg v naslednjih dneh skopnel. Talilna doba pa se je zaključila na začetku oktobra, ko je nastopilo slabo vreme z močno ohladitvijo in je zapadlo 15 do 20 cm snega (Gartner, 1986–1998). Redna letna opazovanja sta opravila 25. septembra Ivan Gams in Miha Pavšek. Obseg ledenika je bil praktično enak kot leto prej. Gams je na podlagi štiridesetletnih opazovanj analiziral spremembe na ledeniku v luči klimatskih pokazateljev in rezultate objavil v obširnejši razpravi (Gams, 1994).

## 2.10. Ledeniško leto 1994–1995

Do meseca marca je bilo značilno zelo hitro spreminjanje vremena, zato je bilo na Kredarici veliko število dni z močnimi vetrovi. Ti so imeli ob pogostih padavinah rahlega snega največji vpliv na snežno odejo na ledeniku. Sredi marca je bilo na snegomerih v povprečju dva in pol metra snega. Največ snega je bilo aprila, ko ga je bilo 310 cm; sredi junija pa ga je bilo še vedno 230 cm. Led se je pojavil istega dne kot prejšnje leto, to je 24. 7. Od srede avgusta do konca septembra je bilo precej nestalno vreme z občasnim sneženjem, ko je zapadlo do 10 cm snega. Nekaj centimetrov novega snega je bilo na ledeniku tudi ob meritvah, ki smo jih tega leta opravili 27. septembra. Ves sneg pa je oktobra ob izredno lepem vremenu skopnel, tako da se je talilna doba končala šele v prvih dneh novembra (Gartner, 1986–1998). Tega leta smo Franjo Drole, Jerneja Fridl, Matej Gabrovec in Miha Pavšek ledenik izmerili s teodolitom z elektrooptičnim razdaljemerom. Določili smo koordinate 104 točk na obodu ledenika in izračunali površino, ki je takrat bila 3,03 ha. Zmerili smo tudi koordinate vseh merilnih točk, od katerih se je meril ledenik od leta 1946 naprej. Ob sedanjem spodnjem robu ledenika pa smo določili tudi štiri nove merilne točke, ki smo jih oštevilčili od 51 do 54. Glede na prejšnje leto se je ledenik nekoliko stanjšal, njegova površina pa se ni bistveno spremenila.

## 2.11. Ledeniško leto 1995–1996

Po spremenljivem vremenu v decembru je bilo ob koncu leta na snegomerih v povprečju 140 cm snega. V pomladanskem času je bil količina snega precej pod povprečjem, saj ga je bilo sredi aprila le 220 cm. Ta količina se je obdržala do konca maja, v prvi polovici junija pa je bilo neobičajno toplo in sončno vreme z maksimalno temperaturo 14,3 °C, zato je sneg hitro kopnel in ga je do srede junija ostalo le še slabe pol metra. Ob tako nizki junijski snežni odeji bi se ob povprečnem poletnem vremenu ledenik tega leta močno skrčil. Vendar pa se je v drugi polovici junija ob hladnem vremenu z večkratnim sneženjem kopnenje snega povsem ustavilo, led pa se je pojavil šele 20. julija. Avgustovsko vreme je bilo spremenljivo s plohami in nevihtami, sneg na obrobju ledu tako sploh ni skopnel. September je bil nenavadno mrzel z večkratnim sneženjem, le dva dneva je bila minimalna temperatura nad lediščem, maksimalna pa je bila komaj 2,4 °C. Novozapadli sneg v prvi polovici meseca tako ni več skopnel. Sneg se je ob koncu talilne dobe obdržal na vzhodnem in spodnjem delu ledenika, medtem ko je bil odkrit zahodni in osrednji del ledenika. Na tem delu glede na porast grbin ocenjujemo, da se je ledenik stanjšal za okoli pol metra. Zaradi zgodnjega snega podrobnejših meritev nismo uspeli napraviti, ob našem obisku 27. oktobra (Matej Gabrovec in Mauro Hrvatini) je bil tako ledenik kot njegova okolica povsem pokrit s polmetrsko snežno odejo.

## 2.12. Ledeniško leto 1996–1997

Že v novembru mesecu je na 20 do 50 cm podlago zapadlo 180 cm snega. V prvem delu so bile te padavine ob globokem sredozemskem ciklonu pomešane s saharskim peskom. V nadaljevanju zime je bilo razmeroma malo padavin, tako je debelina snežne odeje ostala približno enaka do aprila, ob koncu tega meseca pa je po sneženju, ko je zapadlo pol metra snega, narasla na 335 cm. Ob koncu junija je bilo na snegomerih v povprečju še 130 cm snega. Zaradi hladnega julijskega vremena se je led pokazal šele 4. 8. (Gartner, 1986–1998). Meritve smo tega leta prvič opravili Matej Gabrovec, Mauro Hrvatini, Mimi Urbanc in Peter Frantar 4. septembra. Zaradi hladnega avgustovskega vremena je bil takrat ledenik približno tak kot leta 1995. Cel september je bilo sončno in toplo vreme z maksimalnimi temperaturami do 13 °C, zato se je led tega leta najbolj talil prav v septembru. Zato sva 24. oktobra Matej Gabrovec in Mimi Urbanc ponovila meritve. Na ledeniku je bilo sicer tega dne nekaj cm novega snega, ki pa ni oviral opazovanj. Na spodnjem robu se je ledenik samo v septembru povsod umaknil za okoli dva metra. Pri točki 52, kjer je bilo v začetku septembra še nekaj snega, pa se je na novo odkril deset metrov širok pas skalnega dna. Na spodnjem robu (pri točki 54) se je ledenik v tem času stanjšal za dobre pol metra. Sredi ledenika, pri grbinah vzhodno od točke 53 se je ledenik v tem poletju stanjšal za en meter. Grbine so tega leta tudi povsem odrezale manjši ledeniški jezik vzhodno od točke 52. Na zgornjem robu se je ledenik glede na leto 1995 na vzhodnem delu umaknil za okoli pol metra, na zahodnem delu pa za dva metra.

## 2.13. Ledeniško leto 1997–1998

V novembru in decembru je bilo precej snežnih padavin, tako da je bilo ob koncu leta približno dva metra snega. Potem ni bilo večjih padavin vse do konca marca. Več padavin je bilo v aprilu, ob koncu meseca je bilo tako na snegomerih 380 cm snega. Ob zadnjem aprilskem sneženju je padel tudi saharski pesek. V tem mesecu se je na osrednjem delu ledenika sprožil večji plaz, ki je od tod odnesel meter snega. Sredi junija je bilo še slaba dva metra snega, led pa se je pokazal med 15. in 20. julijem. Talilno obdobje se je končalo že 28. avgusta, ko je zapadlo 10 cm snega, 12. septembra pa je ob ponovnem poslabšanju zapadlo še 35 cm snega (Gartner, 1986–1998). Redna letna opazovanja smo Matej Gabrovec, Franci Petek in Mimi Urbanc opravili 17. oktobra. Takrat je bil na Kredarici kopno, na ledeniku pa je bilo okoli pol metra snega, v precejšnji meri je bila zasnežena tudi okolica ledenika. Od merilnih točk smo žal lahko našli le točko 53, ob kateri se je ledenik umaknil za tri metre. Ocenjujemo, da se je ledenik na tem mestu tudi za približno en meter stanjšal. Zato so se še bolj povečale grbine vzhodno od te točke, tako je severozahodni del ledenika s svojim osrednjim delom povezan le še z dva metra širokim pasom. Na zgornjem robu se je ledenik na vzhodnem delu umaknil za dva metra, na zahodnem delu pa celo za štiri metre.

## 3. Sklep

Za obravnavano trinajstletno razdobje je značilno stalno krčenje ledenika. Posebej značilno je tanjšanje osrednjega dela ledenika. Posledica tega je, da je podolžni profil vse bolj konkaven. V preteklosti je bil osrednji del izbočen, v zadnjih letih pa postaja vse bolj vbokel. Zaradi tega lahko sneg z zgornjega dela hitreje splazi navzdol. V obravnavanem obdobju je bil tako osrednji del ledenika vedno razkrit, v letih z debelejšo snežno odejo se je do konca talilne dobe ohranil sneg le na spodnjem robu ledenika. Zaradi tanjšanja ledu se je sredi ledenika pokazalo vedno več skalnih grbin, ko so se te med sabo združile, so posamezne dele ledenika odrezale oziroma ločile od osrednjega dela. Ledenik se tako ni samo umikal, ampak je dobesedno razpadal. Leta 1995 je bila njegova površina 3,03 ha, v naslednjih treh letih pa se je še nekoliko zmanjšala.