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Rock Surface Temperatures in the High Altitude Region of the Nepal Himalaya

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Abstract: Long-term measurements of rock surface temperatures were conducted at three sites in the Langtang Valley, Nepal Himalaya. Glacier Camp (5110 m) and Kyangchen site (4110 m) provided data for a south-facing slope, while Gangja La site (5090 m) provided data for a north-facing slope. Frequent freeze-thaw cycles were observed at the Glacier Camp during all periods except for summer, at the Gangja La site during both spring and autumn, and at the Kyangchen site during winter.

要旨：ネパール・ヒマラヤの中央部に位置するランタン谷の3地点において，2年間にわたる岩盤表面温度の測定を行なった。グレーシャー・キャンプ観測点（標高5110 m）とキャンチェン観測点（4110 m）は谷の南向き斜面を，ガンジャ・ラ観測点（5090 m）は北向き斜面を代表する観測点である。観測の結果，これらの3地点では，岩石の凍結破砕作用に影響する，岩盤表面温度が0 ℃をはさんで上下する凍結融解サイクルが頻繁に起こっていることが確認された。その発生する季節は，グレーシャー・キャンプでは夏を除くすべての期間，ガンジャ・ラ観測点では春と秋，キャンチェン観測点では冬であることが判明した。

Key words: Rock surface temperature, Freeze-thaw cycle, Frost shattering, Periglacial, Himalaya.

キーワード：岩盤表面温度，凍結融解サイクル，凍結破砕作用，周氷河，ヒマラヤ.

I. Introduction

Rock surface temperature is determined by the heat balance at an interface between rock and

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air. Fluctuation of rock surface temperature has been considered to be an important factor in the breakdown of rock in a physical environment. The freeze-thaw cycle of the rock surface temperature is principally responsible for inducing the rock breakdown due to the freezing and thawing of water between the joints of the rock. This has been measured in many parts of the world such as in Norway (Battle and Lewis, 1951 ; Hall, 1980), Canadian Rockies (Gardner, 1969, 1992), Colorado Front Range (Fahey, 1973 ; Thorn, 1979), the Alps (Coutard and Francou, 1989 ; King, 1990), Peruvian Andes (Francou, 1988), Antarctica (Matsuoka *et al.*, 1990)and Japanese mountains (Fukuda, 1974 ; Ono and Watanabe, 1986 ; Matsuoka, 1990).

In the Himalaya, measurements of rock surface temperatures have been very limited both in terms of time and space. After the work of Hewitt (1968) in Karakorum, Dronia (1978), Whalley *et al.* (1984) and Francou (1989) measured the rock surface temperatures for short periods at high altitudes in the Himalaya. Recently, Shiraiwa (1992) discussed a relationship between the rock breakdown and the freeze-thaw cycles of rock surface temperatures in the Langtang Valley, Nepal Himalaya, on the basis of two-years continuous monitoring of both rock surface temperatures and rock breakdown.

This report shows all the data of the rock surface temperatures obtained in the Langtang Valley, which are the results of the first long-term monitoring of rock surface temperatures in the high regions of the Himalaya. The report also includes additional data which were obtained after the publishing of Shiraiwa (1992).

II. Method of observation

The measurement of rock surface temperatures was conducted in the Langtang Valley, located approximately 60km north of Kathmandu (Figure 1). The measurements were conducted at three different sites : Glacier Camp (5110m ; Photo 1), Gangja La site (5090m ; Photo 2), and Kyangchen site (4110m ; Photo 3). The Glacier Camp represents a specific altitude on a south-facing slope, while the Gangja La site covers a north-facing slope. The Kyangchen site provides measurements of rock surface temperatures at a lower altitude on a south-facing slope of the valley.

Rock surface temperatures were observed on outcropping rock cliffs at each site. The aspects of the cliffs at each site are shown in Table 1. Thermistors were installed in drilled pits of 1.5 cm depth below the rock surface, and the pits were fixed with silicone rubber mixed with granules (Photo 4). The data were recorded hourly in automatic data loggers (KADEC-U of KONA System Co.).

Observations were carried out continuously from June 1988 to May 1990 at the Glacier Camp,

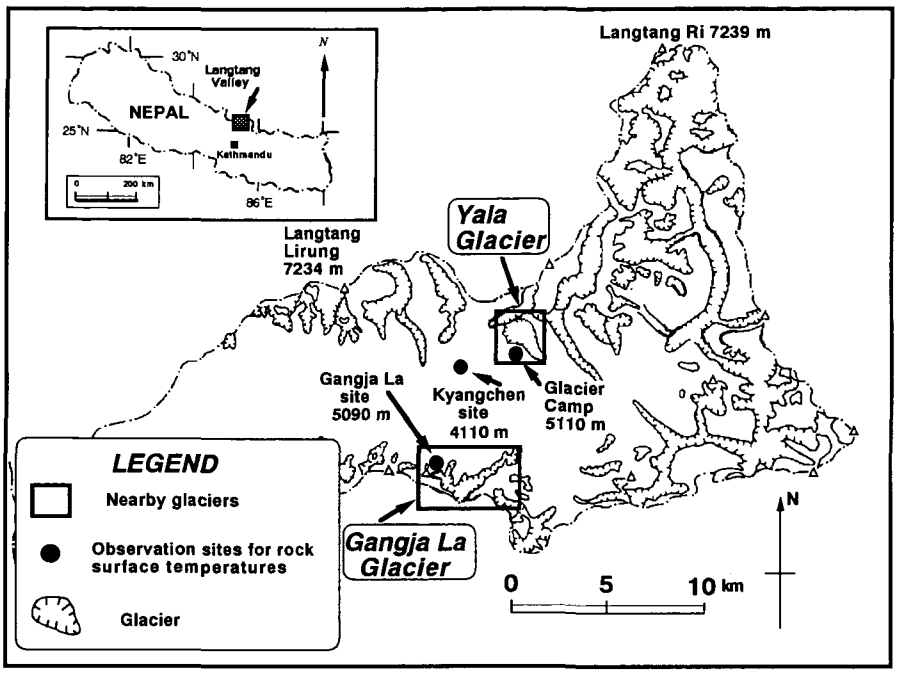

Figure 1 Location map of the Langtang Valley and the measurement sites of the rock surface temperatures.

Table 1 The aspects of the rock cliffs where the thermistors were installed.

	Glacier Camp (5110 m)	Gangja La site (5090 m)	Kyangchen (4110 m)
Aspect of rock surface	S25°W,17°S (May 1, 1988-May 23,1989)	N25°W,60°W (June 1,1989-May 31,1990)	S6°W,90°S (June 5,1990-April 29,1991)
	S28°W,90°S (May 24,1989-May 31,1990)	N,90°N (June 6,1990-May 20,1991)	

from June 1989 to May 1991 at the Gangja La site, and from June 1990 to April 1991 at the Kyangchen site. However, owing to an instrumental problem, the thermistor sensors were re-installed at different exposures both at the Glacier Camp (May 24, 1989) and Gangja La site (June 6, 1990) (Table 1).

III. Results

The time sequences of daily maximum, minimum and mean rock surface temperatures are shown in Figures 2−A to C (Glacier Camp), 3−A to C (Gangja La site) and 4−A and B (Kyangchen). The data are tabulated in Table 2 (Nos. 1 to 17).

At the Glacier Camp, daily freeze-thaw cycles occur in almost all periods except for the

summer monsoon season (June to September) (Figures 2 −A to C). It is worth noting that daily maximum temperatures attain the highest values not during the summer but in spring and autumn. Daily maximum temperatures rise considerably even during the winter season, probably due to intensive incoming short wave radiation.

On the contrary, daily freeze-thaw cycles occur only during autumn (October and November) and spring (March to May) at the Gangja La site (Figures 3−A to C). This is because the lower solar elevation during the winter season is less effective for heating the north-facing slope, and therefore, the rock surface temperature is constrained below freezing point.

The Kyangchen site has freeze-thaw cycles only during winter (December to March), reflecting the warmer conditions at a lower altitude (4110 m) (Figures 4−A and B).

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Photo 1 The Glacier Camp and the Yala Glacier behind. The star denotes the site where the rock surface temperatures were measured.

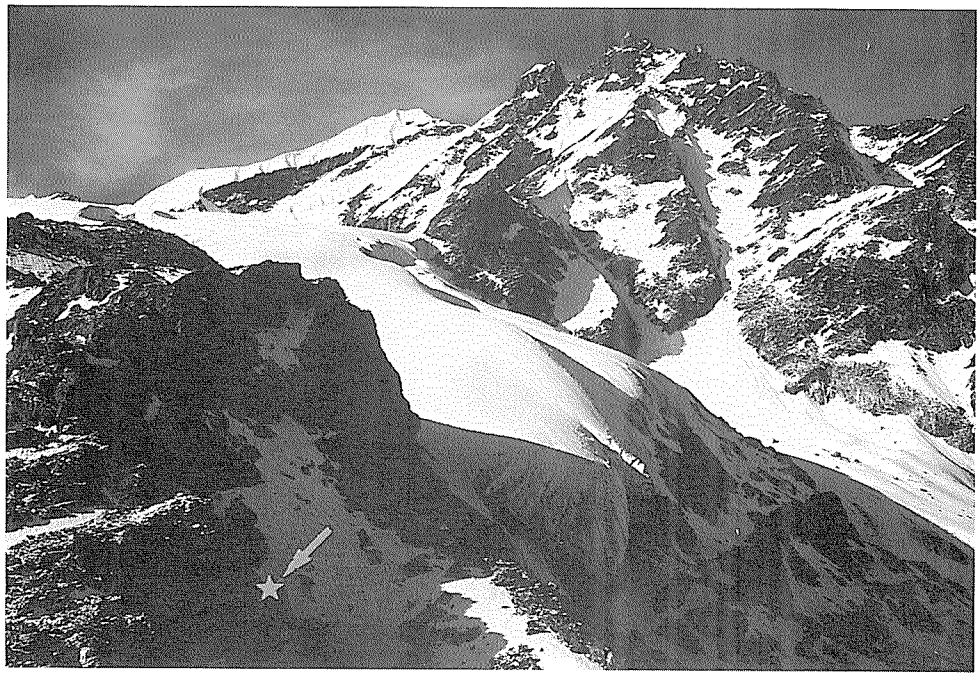


Photo 2 The Gangja La site and the Gangja La Glacier behind. The star denotes the site where the rock surface temperatures were measured.

Photo 3 The Kyangchen site and the Lirung Glacier on the left side. The star denotes the site where the rock surface temperatures were measured.

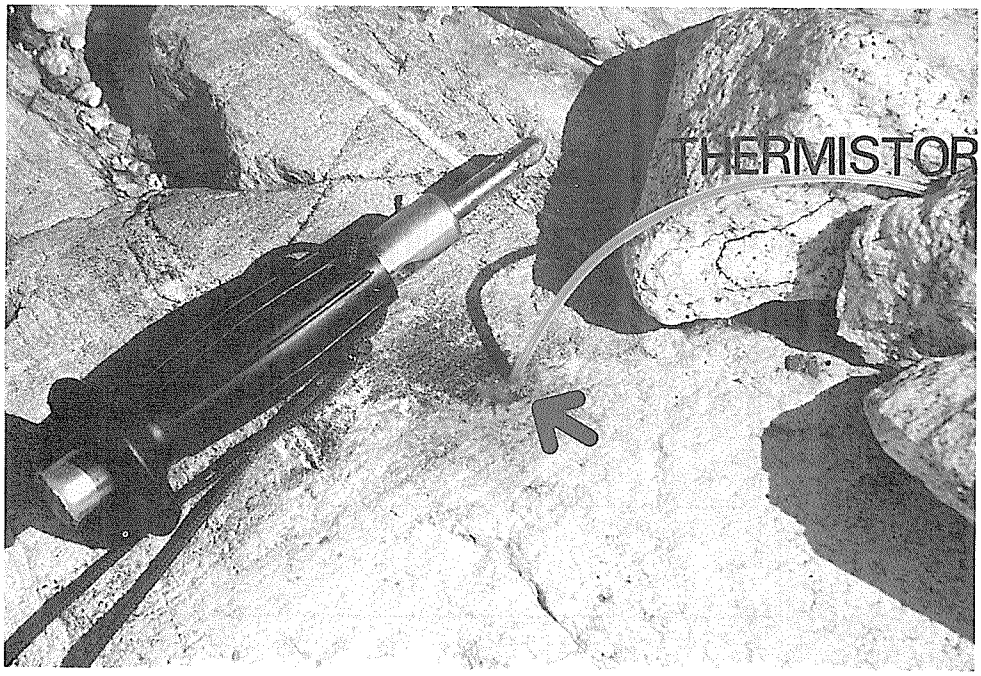


Photo 4 The thermistor sensor indicated by an arrow was fixed at a depth of 1.5cm below the rock surface.

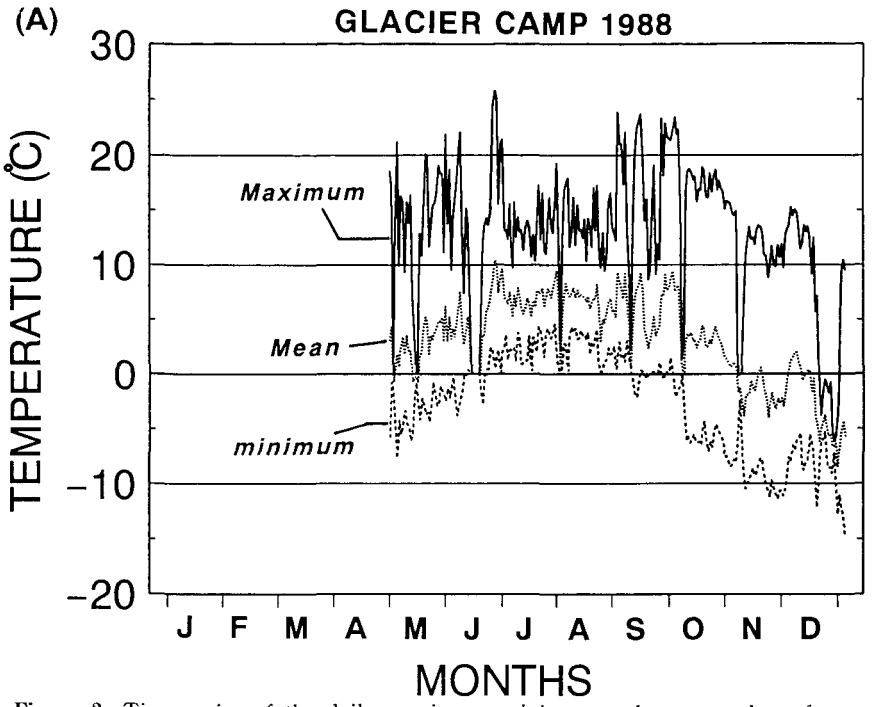
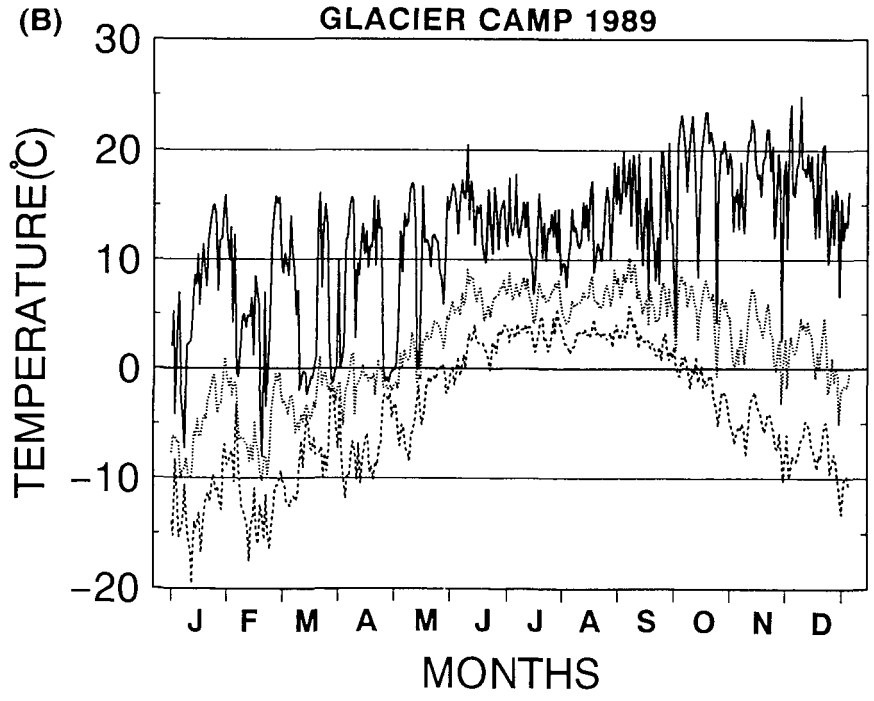


Figure 2 Time series of the daily maximum, minimum and mean rock surface temperatures at the Glacier Camp. (A)1988, (B)1989, (C)1990.



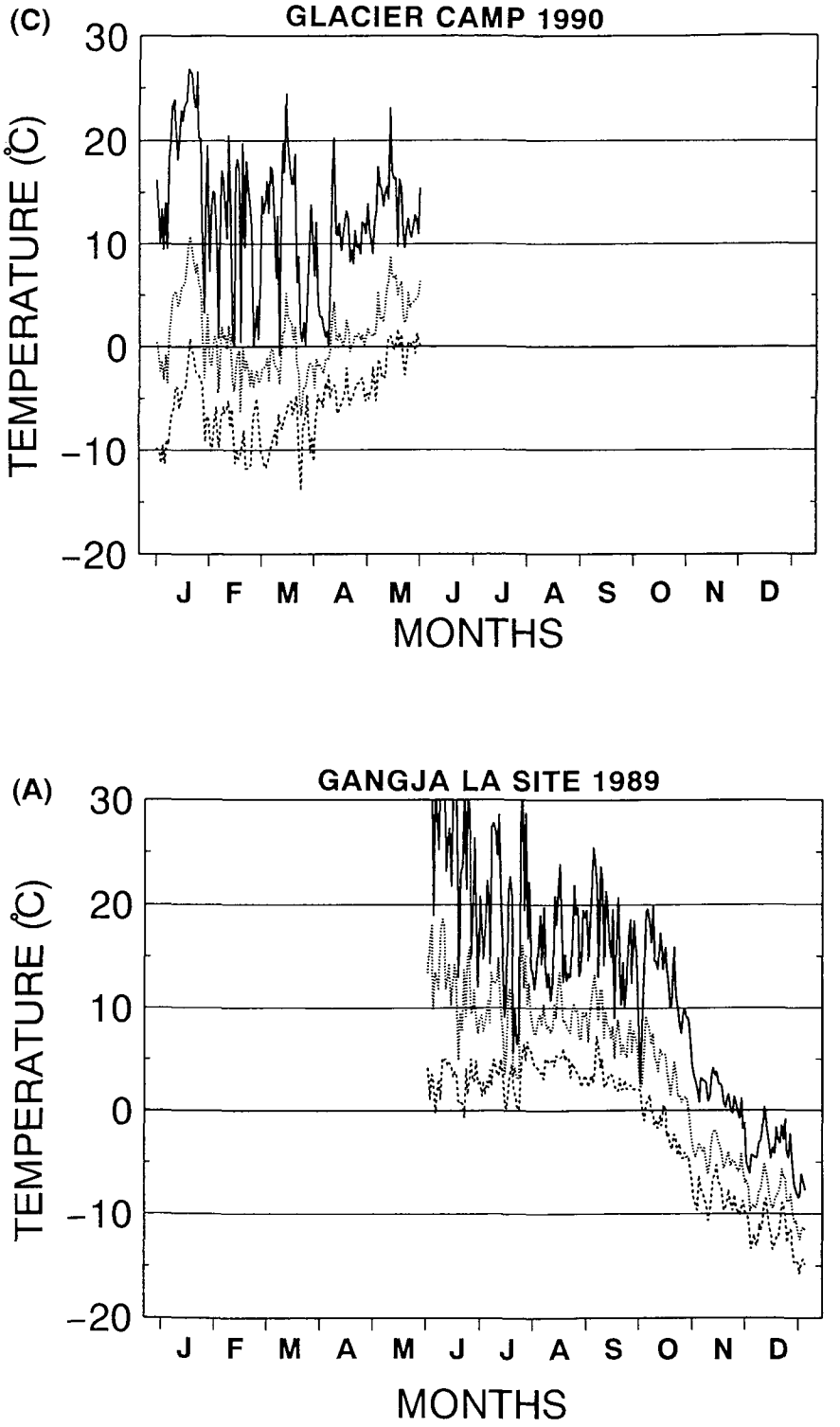
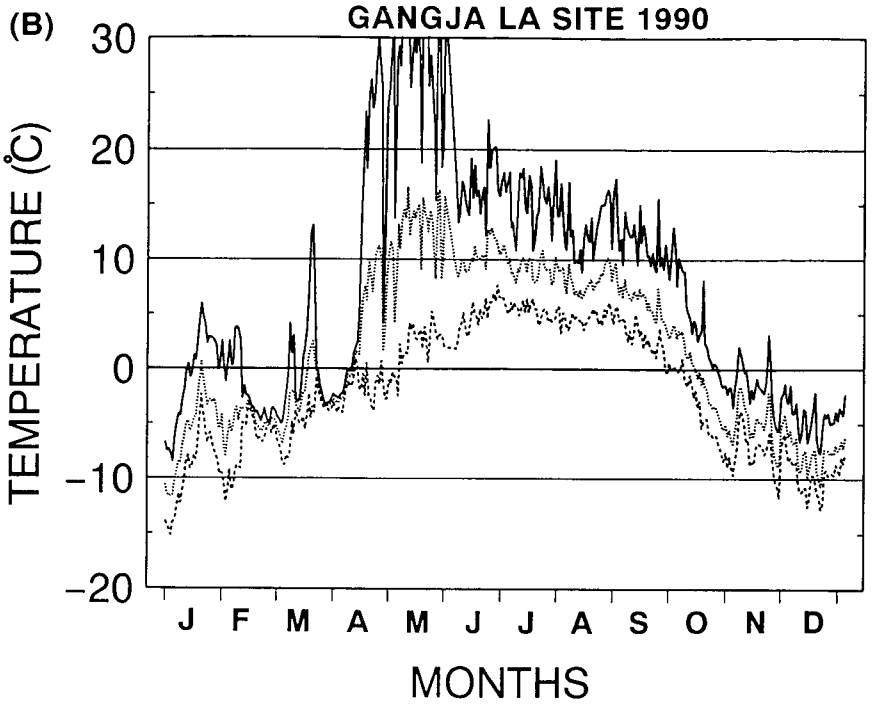
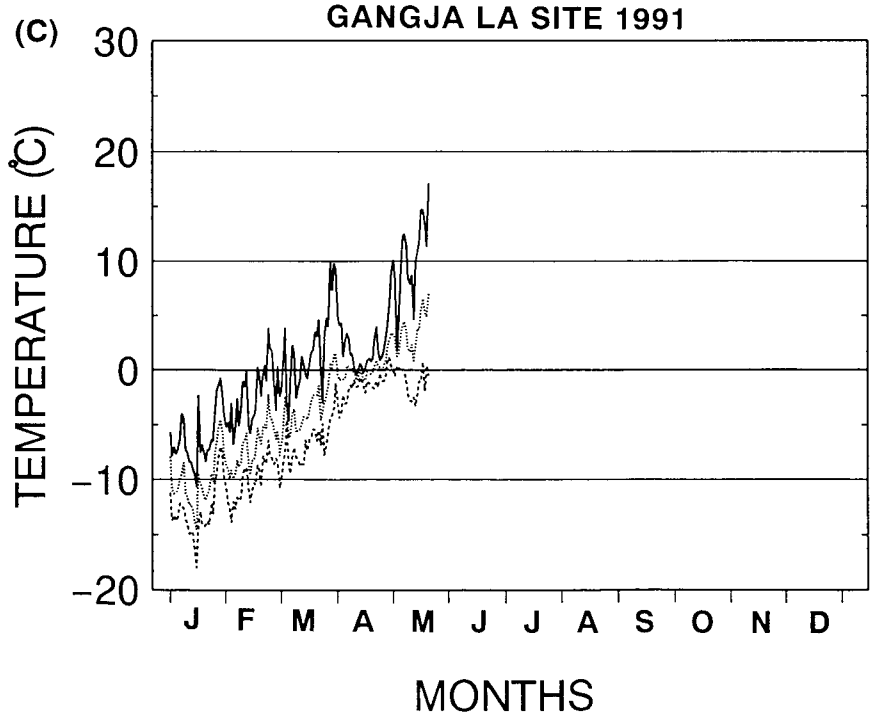


Figure 3 Time series of the daily maximum, minimum and mean rock surface temperatures at the Gangja La site. (A)1989, (B)1990, (C)1991.


(B)
GANGJA LA SITE 1990
TEMPERATURE (℃)
30
20
10
0
-10
-20
J F M A M J J A S O N D
MONTHS


(C)
GANGJA LA SITE 1991
TEMPERATURE (℃)
30
20
10
0
-10
-20
J F M A M J J A S O N D
MONTHS

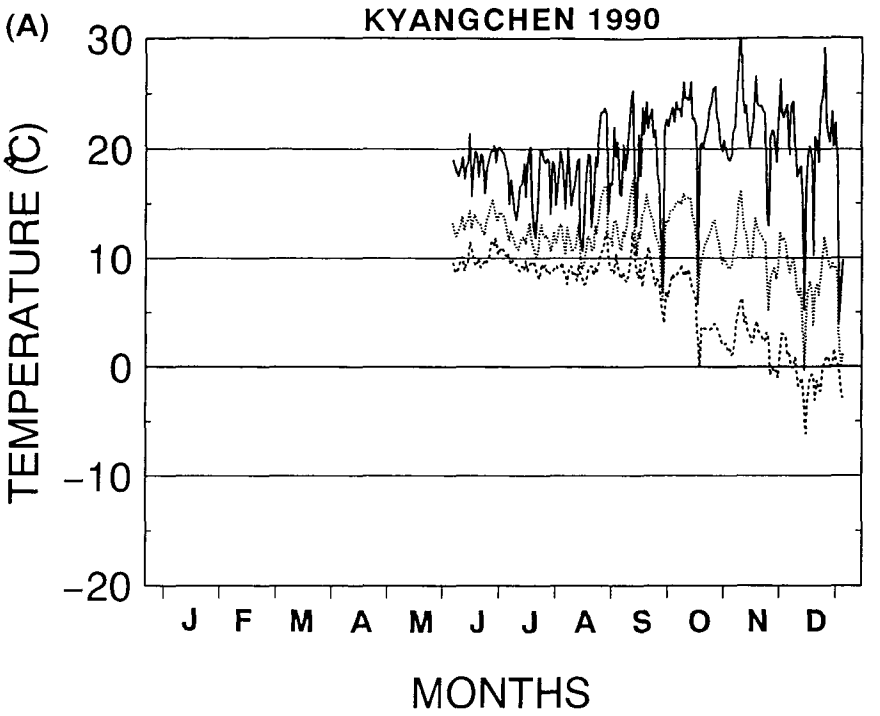


Figure 4 Time series of the daily maximum, minimum and mean rock surface temperatures at the Kyangchen site. (A)1990, (B)1991.

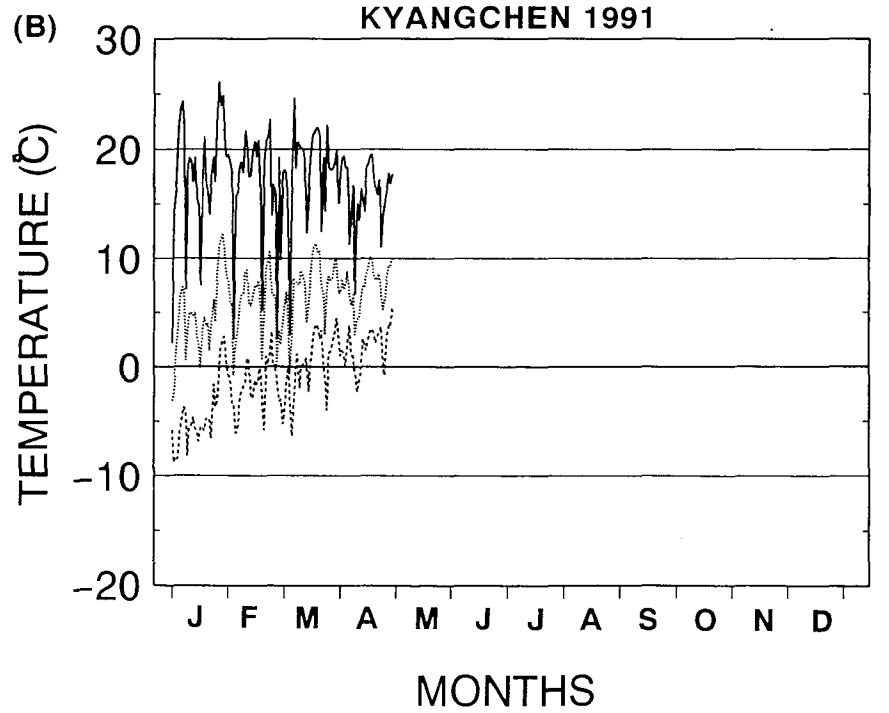


Table 2. Rock surface temperatures at each site (Nos. 1 −17)

Glacier Camp 1988 No. 1

	MAY			JUNE			JULY			AUGUST		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	18.6	−5.8	3.1	13.7	−1.3	3.0	13.1	2.5	7.0	2.1	0.2	0.7
2	17.2	−0.7	4.3	18.7	−2.2	5.3	13.2	3.6	6.8	12.3	0.8	5.5
3	−0.1	−1.8	−0.7	9.5	−1.0	3.2	12.3	1.3	6.4	16.7	2.8	7.2
4	13.5	−5.0	0.3	14.2	−0.3	4.2	15.6	2.2	7.6	17.5	2.7	8.3
5	21.2	−7.7	1.8	16.1	−2.2	3.4	11.1	2.2	6.2	17.9	0.3	7.4
6	9.9	−4.2	0.7	18.1	−3.8	4.9	9.7	2.4	5.2	11.6	3.6	7.1
7	16.3	−5.5	2.4	20.6	−3.0	6.2	15.8	2.4	7.3	13.0	4.3	7.4
8	15.7	−4.4	3.4	22.1	−2.3	7.6	12.5	1.2	6.1	16.2	3.8	7.9
9	9.3	−3.3	1.8	11.6	−1.4	4.4	14.4	3.8	7.9	11.8	4.2	7.0
10	15.8	−4.6	3.6	7.4	0.1	2.7	13.0	3.5	7.4	15.5	3.2	7.7
11	13.8	−4.8	2.0	15.2	−0.1	3.9	13.2	0.9	6.1	13.1	3.3	7.1
12	16.4	−6.1	2.1	13.7	0.4	5.2	11.3	1.0	5.5	13.3	4.0	7.3
13	7.2	−5.4	−0.7	7.9	0.1	3.1	13.5	1.3	6.0	12.4	3.6	7.1
14	3.5	−1.9	−0.3	0.2	0.0	0.1	14.1	1.2	6.9	14.2	3.7	7.0
15	0.0	−0.8	−0.2	0.0	0.0	0.0	13.5	3.5	6.5	10.3	3.2	6.6
16	0.2	−2.6	−0.8	0.0	0.0	0.0	10.7	0.3	5.2	14.3	3.8	7.1
17	12.9	−4.2	1.5	0.0	0.0	0.0	12.8	3.4	6.7	13.5	1.8	6.0
18	10.8	−2.2	2.0	0.1	0.0	0.0	10.3	2.7	6.1	11.6	2.9	6.5
19	15.0	−2.7	4.1	4.0	−1.7	0.5	14.2	2.0	7.5	17.1	2.6	7.0
20	20.1	−3.7	5.2	11.9	−2.8	3.6	17.3	4.3	7.4	13.1	3.5	6.9
21	19.8	−3.5	4.7	13.6	0.1	3.6	12.3	4.0	7.5	17.3	4.1	8.3
22	11.6	−4.4	1.7	14.3	0.4	5.9	16.6	2.8	7.9	10.9	0.3	5.8
23	13.7	−2.7	3.6	13.6	0.5	6.0	11.3	1.5	6.1	9.7	0.2	2.9
24	15.4	−0.7	3.2	15.0	2.3	7.1	11.0	3.8	7.0	13.0	0.7	5.1
25	15.7	−1.7	3.9	24.3	2.4	8.3	14.0	4.2	7.8	9.4	1.2	4.7
26	16.6	−2.9	4.2	25.8	0.5	10.4	16.2	3.8	7.6	11.0	1.3	5.7
27	19.1	−2.7	4.8	25.2	1.6	10.3	13.5	3.3	7.0	15.8	2.4	6.5
28	18.3	−1.1	4.8	15.5	2.2	7.4	12.9	3.8	7.8	16.6	1.8	6.9
29	18.3	−1.6	5.2	21.0	0.1	9.1	15.9	4.6	8.7	13.5	1.9	5.7
30	11.1	−1.9	3.0	21.4	1.9	9.6	19.3	2.0	9.5	12.8	2.6	5.8
31	21.9	−2.5	6.2				11.0	0.3	6.4	12.2	0.5	5.2
Mean	13.5	−3.3	2.6	13.2	−0.3	4.6	13.4	2.6	6.9	13.2	2.4	6.4

Glacier Camp 1988 No. 2

	SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	23.9	1.2	9.3	23.4	−2.1	7.6	14.7	−8.3	0.9	13.6	−7.6	0.5
2	21.0	3.0	8.5	21.8	−1.8	7.9	14.5	−7.8	1.1	15.3	−8.0	1.2
3	21.0	1.6	7.9	22.3	−1.4	8.1	14.9	−8.1	0.5	14.4	−6.5	1.4
4	17.3	1.8	6.9	15.6	−1.0	4.7	−0.1	−4.8	−1.7	15.0	−6.9	1.8
5	22.1	1.1	9.2	1.4	0.1	0.4	0.0	−2.4	−1.2	14.8	−5.9	2.0
6	12.9	3.1	6.3	2.8	−3.4	0.0	0.1	−6.4	−2.4	13.4	−5.8	1.3
7	10.0	1.7	4.9	16.7	−6.0	2.7	5.9	−8.9	−3.9	11.4	−5.4	0.6
8	2.2	0.1	0.7	18.6	−5.7	3.7	10.6	−10.5	−2.0	11.9	−8.3	−0.6
9	13.1	−0.6	3.8	18.7	−6.3	3.5	12.1	−10.1	−1.9	13.6	−8.8	−0.2
10	19.5	−1.9	6.6	18.3	−6.0	3.8	13.5	−9.7	−1.8	13.0	−8.0	−0.1
11	22.4	−2.1	7.8	17.7	−5.5	3.1	12.3	−9.2	−0.6	13.5	−7.9	0.4
12	23.1	−0.5	8.1	18.1	−6.0	3.2	12.5	−8.6	−1.3	12.4	−5.5	0.2
13	23.7	0.4	9.3	15.7	−6.3	2.4	11.8	−9.3	−1.5	9.1	−6.3	−1.6
14	19.6	0.2	7.9	16.9	−6.2	3.0	13.1	−9.1	−0.6	12.5	−7.5	−0.4
15	14.0	−0.1	4.1	16.8	−6.5	3.2	13.6	−8.2	0.2	5.7	−9.7	−4.0
16	16.0	−0.4	3.4	18.9	−4.9	4.4	13.4	−7.7	0.6	7.2	−12.2	−4.6
17	8.6	0.1	2.3	18.6	−4.3	4.4	12.9	−7.9	−0.2	−1.2	−9.5	−6.2
18	9.5	0.1	3.0	16.2	−6.2	2.6	10.9	−9.0	−1.4	−3.8	−6.0	−5.0
19	15.7	0.2	4.0	16.1	−7.1	2.5	10.8	−10.2	−2.1	−1.6	−6.0	−4.4
20	19.1	0.2	5.3	18.4	−6.2	3.2	8.8	−10.7	−4.0	−0.5	−5.3	−3.7
21	9.1	0.2	3.5	16.6	−6.7	2.8	9.9	−11.2	−2.6	−0.9	−7.2	−4.7
22	11.9	0.1	4.0	18.0	−5.2	3.8	11.7	−9.7	−1.7	−1.8	−8.6	−5.7
23	10.4	1.1	4.4	18.7	−4.6	4.3	10.1	−10.4	−2.8	−0.7	−8.5	−5.5
24	23.3	−0.3	7.2	16.8	−5.1	3.7	9.8	−10.9	−3.2	−5.2	−9.1	−6.6
25	18.1	−0.2	7.2	17.7	−5.4	3.3	11.8	−11.4	−2.3	−6.2	−7.2	−6.6
26	22.9	−0.3	9.1	16.9	−5.8	2.9	10.6	−10.7	−2.7	−5.6	−9.5	−6.4
27	21.7	0.4	7.7	16.7	−6.2	2.4	11.9	−10.6	−2.2	−3.5	−12.8	−8.5
28	21.4	0.4	7.9	15.0	−7.6	1.6	9.7	−11.1	−3.0	1.2	−11.0	−6.5
29	21.3	1.5	8.8	15.8	−7.5	1.4	12.8	−10.5	−1.6	9.3	−12.2	−5.1
30	22.3	0	9.4	15.7	−8.0	1.1	13.2	−9.3	−0.3	10.5	−12.9	−4.3
31				15.5	−8.5	0.7				9.5	−14.6	−5.7
Mean	17.2	0.4	6.3	16.7	−5.3	3.3	10.6	−9.1	−1.5	6.3	−8.4	−2.8

Glacier Camp 1989 No. 3

	JANUARY			FEBRUARY			MARCH			APRIL		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	2.0	−14.0	−7.7	9.9	−8.5	−1.7	9.4	−9.3	−2.1	10.0	−7.3	−1.4
2	5.3	−15.3	−6.2	13.0	−7.8	−0.8	8.7	−10.3	−3.2	0.0	−2.6	−1.3
3	−4.2	−8.3	−6.2	4.2	−7.5	−2.5	10.6	−10.5	−2.9	0.8	−8.2	−3.5
4	4.3	−11.1	−6.7	12.3	−10.4	−1.3	9.4	−12.2	−3.6	2.2	−9.9	−5.3
5	7.0	−15.4	−6.7	−0.4	−3.2	−1.6	8.5	−12.2	−4.2	11.7	−11.9	−2.2
6	−2.2	−14.7	−10.1	−0.8	−7.3	−4.2	14.0	−12.6	−2.6	12.1	−9.8	−1.4
7	−4.1	−14.2	−9.4	1.5	−10.6	−6.5	10.7	−11.8	−2.5	14.9	−9.9	−0.3
8	−7.3	−10.6	−9.1	4.7	−12.6	−6.3	8.9	−11.7	−3.6	15.7	−7.8	1.2
9	2.1	−13.7	−8.2	5.0	−12.9	−6.3	4.9	−12.1	−5.9	15.3	−6.6	1.4
10	2.3	−15.5	−9.6	3.7	−13.7	−6.8	7.2	−11.6	−5.0	2.8	−7.6	−4.2
11	2.5	−16.6	−10.0	4.9	−14.2	−7.0	−2.0	−8.9	−5.6	9.7	−10.2	−1.4
12	4.8	−19.6	−9.5	4.7	−17.5	−8.5	−0.8	−6.6	−4.2	8.5	−6.8	−1.2
13	8.6	−13.9	−5.7	6.5	−14.3	−7.0	−0.2	−9.1	−4.9	11.8	−10.5	−0.7
14	7.7	−14.6	−6.1	1.2	−13.6	−8.4	−0.4	−6.2	−3.7	13.3	−8.5	0.4
15	10.5	−13.9	−4.6	8.5	−10.9	−4.8	−2.4	−4.2	−3.4	10.4	−7.5	−0.8
16	5.8	−13.1	−6.1	7.3	−15.5	−6.7	−1.9	−5.2	−3.8	12.6	−6.1	−0.5
17	8.9	−16.8	−6.2	5.8	−16.0	−7.7	−0.7	−7.3	−4.6	9.2	−6.0	−1.2
18	11.4	−14.6	−4.7	−3.3	−12.4	−9.5	−0.9	−7.5	−4.3	11.3	−9.6	−0.8
19	8.9	−12.7	−4.3	−8.1	−13.6	−10.3	0.3	−6.2	−3.0	11.1	−8.9	−1.0
20	7.5	−11.8	−4.7	7.0	−15.6	−8.0	1.1	−7.9	−3.7	15.8	−10.2	−0.5
21	11.7	−11.3	−2.9	−3.5	−11.5	−8.2	14.2	−7.7	−0.6	9.4	−8.5	−2.5
22	13.3	−12.1	−2.3	−0.1	−15.0	−9.7	16.1	−7.7	1.1	15.4	−8.9	0.8
23	14.8	−10.4	−0.8	5.0	−16.5	−7.9	7.4	−7.2	−1.6	12.8	−7.2	−0.2
24	15.0	−9.7	−0.6	12.1	−14.5	−3.9	13.1	−9.9	−0.7	12.9	−7.1	0.1
25	14.1	−11.1	−1.5	14.4	−12.9	−2.3	15.1	−7.8	−0.3	0.2	−3.3	−1.7
26	7.1	−10.8	−4.1	15.8	−10.8	−0.5	13.1	−9.4	−1.5	−1.2	−2.4	−1.8
27	11.7	−12.1	−3.2	15.1	−10.7	−1.2	2.6	−7.4	−2.0	−0.8	−2.4	−1.6
28	11.9	−12.9	−3.1	15.7	−10.4	−0.4	−1.0	−1.7	−1.3	−1.3	−3.0	−2.0
29	14.7	−7.8	0.1				−1.3	−2.1	−1.7	−0.4	−2.3	−1.5
30	15.9	−6.9	1.0				−0.2	−3.3	−1.8	−0.2	−4.5	−2.1
31	11.9	−8.8	−1.1				0.1	−5.4	−3.0			
Mean	7.2	−12.7	−5.2	5.8	−12.2	−5.4	5.3	−8.2	−2.9	8.2	−7.2	−1.2

Glacier Camp 1989 No. 4

	MAY			JUNE			JULY			AUGUST		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	−0.1	−3.4	−1.4	16.9	0.2	6.2	17.5	2.4	8.8	7.5	2.2	4.2
2	0.5	−3.2	−1.3	16.4	−1.5	5.1	12.9	3.6	7.4	10.3	1.8	4.4
3	4.5	−5.6	−1.9	14.8	−0.5	5.5	12.2	3.6	6.3	11.4	1.4	5.1
4	12.6	−7.1	1.4	12.3	1.1	5.6	13.4	2.9	6.7	14.7	2.0	6.3
5	8.8	−5.1	0.1	15.6	−0.7	4.9	17.8	2.9	7.9	12.6	2.0	5.7
6	14.2	−5.5	1.7	17.3	0.3	7.0	12.5	4.1	7.2	13.0	2.8	6.0
7	13.0	−7.3	1.0	15.7	1.3	5.8	12.0	3.2	6.6	11.4	3.5	6.0
8	13.4	−7.6	0.8	15.5	0.1	6.2	13.4	3.6	7.5	11.1	3.3	6.0
9	16.3	−8.4	1.1	20.5	2.1	9.2	15.3	3.7	8.4	11.8	3.5	6.3
10	17.0	−6.0	3.3	13.6	3.2	7.8	12.9	4.0	7.2	15.3	3.3	7.1
11	16.8	−5.7	2.7	17.2	2.6	8.4	15.3	3.3	8.3	12.9	3.7	6.7
12	12.7	−4.8	0.6	15.5	3.0	8.4	10.7	3.9	6.5	15.1	3.1	6.6
13	−0.1	−3.3	−1.4	11.3	4.0	7.0	10.2	3.6	6.0	11.8	3.2	6.5
14	0.0	−1.5	−0.6	14.9	2.5	6.1	6.8	2.3	4.2	16.3	2.9	7.9
15	5.7	−3.9	−1.0	14.2	2.3	7.2	8.1	1.5	4.3	17.2	3.8	8.5
16	16.7	−5.2	2.4	15.0	2.3	7.5	12.4	2.5	6.3	8.8	4.6	6.4
17	11.5	−4.0	2.5	11.5	2.4	6.2	16.1	3.5	7.9	10.1	3.2	6.1
18	11.8	−1.8	3.4	10.2	1.9	4.4	13.7	4.9	7.3	11.5	3.3	6.2
19	11.3	−0.9	2.7	9.7	1.6	4.8	10.2	4.6	6.5	10.9	3.4	5.6
20	9.3	−1.2	2.7	16.4	0.8	5.8	13.4	2.5	6.8	9.9	2.9	5.7
21	12.1	−0.8	3.5	13.5	−0.2	4.7	9.9	2.8	6.2	11.6	3.2	5.9
22	12.3	−0.7	4.3	10.5	2.4	6.0	12.9	1.6	6.2	15.2	3.2	7.4
23	11.8	−1.0	4.3	16.6	2.2	6.6	12.4	1.9	6.5	16.7	2.7	7.7
24	11.6	0.1	4.0	14.3	1.4	6.6	14.2	3.2	7.1	15.3	3.0	6.9
25	8.8	−0.1	3.8	10.9	3.5	6.8	12.1	4.7	7.1	10.0	3.4	5.8
26	8.3	0.4	3.0	14.4	3.3	7.5	14.6	3.2	7.9	13.9	2.0	6.6
27	5.9	0.3	1.8	15.0	3.1	7.5	10.7	5.6	7.4	18.9	3.3	9.1
28	9.1	−0.6	2.8	15.4	4.0	8.1	14.7	4.5	8.1	15.1	4.1	7.8
29	15.8	−2.3	4.8	11.8	3.9	6.9	8.6	3.8	6.1	18.6	3.2	8.4
30	14.5	2.1	4.4	11.2	3.8	6.8	9.6	3.2	5.1	14.2	2.7	6.6
31	15.4	−0.5	5.4				9.7	2.3	4.6	15.5	3.6	6.9
Mean	10.4	−3.2	2.0	14.3	1.9	6.6	12.5	3.3	6.8	13.2	3.0	6.5

Glacier Camp 1989 No. 5

	SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	20.0	3.2	8.8	22.3	−0.7	8.1	16.5	−5.8	1.9	16.1	−8.0	1.8
2	15.8	2.9	7.9	23.2	1.1	8.6	12.8	−5.4	0.5	15.8	−8.4	1.3
3	17.0	3.4	8.6	21.9	0.5	7.8	18.9	−5.6	3.7	18.3	−8.5	1.9
4	19.2	5.8	10.2	19.8	1.2	8.0	14.3	−5.0	2.0	19.0	−7.9	3.0
5	13.1	5.1	7.9	16.2	0.3	5.7	12.4	−5.6	0.4	24.9	−6.7	4.7
6	19.6	3.9	9.2	20.0	−0.7	6.4	18.3	−8.0	2.4	18.3	−6.3	3.6
7	18.0	4.2	9.7	21.9	−1.8	7.7	20.8	−6.0	4.6	18.3	−6.2	4.1
8	11.0	3.0	6.5	23.1	0.1	7.7	20.9	−3.8	6.1	17.6	−4.8	3.3
9	19.7	1.9	7.3	19.7	−0.6	6.1	22.8	−2.9	7.3	19.7	−5.1	4.4
10	13.9	3.2	6.3	14.7	1.2	5.6	22.0	−2.4	7.1	17.2	−5.5	3.2
11	9.5	2.6	5.1	8.4	−1.2	2.7	18.8	−2.1	6.2	19.5	−7.0	3.1
12	14.7	2.5	5.9	14.9	−0.8	5.0	17.4	−3.4	4.6	16.1	−7.3	1.4
13	15.7	2.8	6.4	20.1	0.3	6.3	17.8	−3.8	4.5	12.0	−8.4	−0.9
14	6.4	2.6	4.1	21.8	−1.7	7.4	15.8	−4.1	3.7	19.8	−9.2	1.6
15	19.4	1.9	7.2	23.4	−1.1	8.1	19.0	−5.2	2.9	12.1	−7.9	−0.1
16	13.0	2.4	6.0	23.4	−1.5	7.7	19.5	−5.8	4.0	17.6	−8.3	1.4
17	11.3	2.1	5.7	20.6	−0.8	6.6	21.9	−5.0	5.5	20.3	−6.7	3.4
18	8.1	1.3	4.3	21.7	−0.6	6.3	21.9	−4.1	6.0	20.5	−5.2	4.7
19	12.1	1.3	4.6	20.4	−1.4	6.9	18.1	−4.2	3.2	14.5	−4.9	1.6
20	7.8	2.1	4.5	19.3	−2.8	3.5	20.4	−5.1	3.0	9.6	−6.3	−2.2
21	20.0	0.8	7.3	4.2	−3.5	−0.7	12.0	−5.8	0.0	11.6	−9.6	−1.9
22	19.5	2.7	8.0	17.0	−5.3	2.9	14.3	−7.2	−0.2	16.0	−8.8	1.0
23	16.3	3.3	7.0	19.9	−3.7	5.9	19.7	−7.4	2.2	11.4	−7.8	−1.3
24	11.9	1.9	4.9	19.7	−2.3	6.5	18.1	−5.9	2.7	16.4	−8.2	0.0
25	20.7	0.8	7.4	20.9	−2.1	5.5	2.5	−7.9	−3.2	15.7	−10.2	−0.7
26	13.6	1.7	5.9	19.5	−2.4	6.1	17.7	−10.3	0.8	6.6	−11.5	−5.1
27	13.3	1.0	5.8	17.8	−3.1	4.8	19.1	−8.0	2.8	15.6	−13.3	−2.0
28	7.4	2.1	3.8	19.8	−4.5	4.7	11.0	−6.0	−1.8	11.8	−11.0	−1.8
29	3.0	0.4	1.7	19.1	−5.1	2.8	22.4	−10.0	1.7	13.5	−9.8	−1.5
30	20.1	−0.5	6.1	12.6	−5.8	0.3	24.1	−9.3	3.0	13.0	−9.9	−1.7
31				15.7	−6.9	0.3				16.2	−11.0	−0.5
Mean	14.4	2.4	6.5	18.8	−1.8	5.5	17.7	−5.7	2.9	16.0	−8.1	1.0

Glacier Camp 1990 No. 6

	JANUARY			FEBRUARY			MARCH			APRIL		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	16.2	−9.8	0.4	13.4	−10.1	−1.9	6.4	−8.5	−3.3	6.8	−11.1	−4.0
2	13.8	−9.9	−0.4	15.1	−9.7	0.0	14.7	−10.4	−2.2	12.1	−7.7	−1.2
3	10.1	−10.2	−2.4	14.9	−8.0	1.0	12.9	−10.7	−2.1	4.1	−4.6	−1.8
4	13.4	−11.3	−1.4	10.9	−5.8	0.6	13.9	−11.7	−1.9	2.9	−5.3	−1.7
5	9.4	−9.4	−3.2	0.8	−8.9	−4.5	16.1	−11.7	−1.0	2.9	−5.2	−2.2
6	14.0	−11.3	−0.8	10.8	−9.8	−1.0	12.9	−11.1	−3.3	1.9	−5.9	−2.6
7	9.5	−9.0	−3.5	17.1	−7.1	1.9	17.5	10.2	−0.3	0.9	−3.5	−1.3
8	18.3	−9.5	1.5	16.1	−5.8	0.8	17.1	−9.5	−0.2	1.5	−4.1	−1.1
9	19.8	−7.8	2.8	13.1	−6.4	1.1	13.3	−8.9	−1.5	0.0	−2.7	−1.3
10	23.4	−6.6	4.7	10.5	−6.0	−0.3	6.6	−8.0	−2.0	6.6	−5.0	−0.2
11	23.9	−5.6	5.3	20.5	−5.2	2.1	12.7	−9.6	−2.2	16.9	−4.1	3.1
12	21.4	−3.8	5.4	13.2	−7.8	0.1	−0.9	−6.5	−3.6	20.3	−3.7	4.4
13	18.1	−4.1	4.0	0.7	−6.0	−3.3	12.3	−7.6	−0.9	11.0	−4.1	0.8
14	19.8	−6.0	4.1	−0.1	−8.7	−4.3	19.8	−8.0	1.5	10.8	−6.5	0.6
15	22.9	−5.0	5.7	17.3	−11.3	−2.0	16.9	−7.2	1.5	12.0	−6.2	1.3
16	21.8	−4.1	5.8	18.2	−9.9	−0.6	24.5	−6.8	5.2	9.3	−5.6	0.6
17	23.4	−4.0	6.3	17.1	−10.9	−0.5	19.8	−5.9	2.9	10.7	−5.2	0.0
18	23.7	−2.7	7.7	0.4	−10.7	−6.4	17.8	−5.4	2.6	12.2	−4.6	0.8
19	26.8	−0.7	10.1	19.7	−9.5	−0.1	15.8	−5.3	2.2	13.2	−2.0	2.6
20	26.6	0.8	10.7	9.6	−8.1	−2.3	15.8	−6.6	0.7	12.4	−4.4	1.7
21	26.3	−0.2	9.7	18.0	−11.8	−1.4	18.7	−5.7	1.9	8.2	−5.7	−0.5
22	23.7	−1.1	8.2	15.8	−11.8	−2.1	6.2	−4.7	−1.8	9.4	−5.1	0.1
23	23.1	2.5	7.1	13.8	−11.5	−3.8	8.8	−7.4	−2.6	8.0	−5.0	0.4
24	26.6	−2.6	8.1	11.6	−11.5	−2.3	1.4	−11.7	−5.4	11.3	−4.1	1.1
25	20.2	−2.8	6.2	−0.1	−7.7	−4.0	0.5	−13.9	−6.7	9.6	−3.6	1.0
26	20.2	−3.3	5.5	1.6	−6.0	−2.8	2.4	−7.5	−4.0	9.9	−3.6	1.4
27	9.8	−3.8	1.1	4.0	−5.0	−2.3	0.1	−7.6	−3.9	9.0	−3.2	0.7
28	3.3	−6.4	−3.0	0.7	−6.4	−3.5	4.5	−4.7	−2.6	12.1	−3.0	1.2
29	15.2	−9.2	0.4				9.7	−7.5	−1.5	11.9	−4.3	0.2
30	19.5	−6.7	3.3				13.8	−10.3	−1.7	10.9	−5.3	0.8
31	7.3	−7.0	−1.5				11.2	−8.7	−1.9			
Mean	18.4	−5.7	3.5	10.9	−8.5	−1.5	11.7	−8.4	−1.2	9.0	−4.8	0.2

Glacier Camp	1990		No. 7
	MAY		
	MAX	MIN	MEAN
1	13.9	−4.5	1.8
2	11.4	−5.1	1.3
3	10.0	−4.1	1.1
4	9.0	−1.9	1.2
5	12.2	−3.8	1.1
6	13.1	−5.3	2.1
7	17.5	−1.2	5.4
8	15.6	−1.8	2.8
9	15.3	−2.9	2.9
10	13.6	−2.8	2.4
11	14.9	−3.0	3.9
12	15.6	−0.2	5.7
13	14.3	0.9	6.3
14	23.1	1.0	8.8
15	17.0	0.5	6.9
16	16.3	−0.3	6.6
17	16.4	0.3	6.9
18	9.7	1.7	4.9
19	16.3	−0.1	5.8
20	15.5	1.2	6.3
21	11.1	−1.5	3.2
22	9.6	−2.8	2.3
23	11.6	−1.1	2.8
24	12.5	0.4	5.3
25	10.9	0.5	3.8
26	10.6	0.1	4.2
27	11.7	0.5	4.3
28	12.8	−0.7	4.5
29	12.2	1.3	4.7
30	10.9	0.7	5.1
31	15.4	0.1	6.3
Mean	13.5	−1.1	4.2

Gangja La 1989 No. 8

	MAY			JUNE			JULY			AUGUST		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1				32.1	4.2	13.4	17.2	1.4	9.3	13.3	4.3	7.6
2				36.5	1.1	17.0	14.7	2.9	7.7	16.1	4.0	9.1
3				36.0	3.6	18.0	17.9	1.6	8.3	19.0	3.7	9.3
4				18.9	3.1	9.8	22.3	2.9	9.7	14.2	3.7	8.3
5				32.4	−0.2	13.5	20.6	2.2	10.8	19.8	3.1	10.4
6				27.4	2.1	12.6	14.2	4.0	8.5	14.2	5.1	8.8
7				25.2	3.1	11.7	27.4	2.4	13.4	12.0	5.0	8.0
8				36.0	1.1	17.6	27.8	5.0	12.4	13.4	4.6	8.2
9				34.4	5.1	18.6	26.9	4.4	12.4	10.7	4.8	7.6
10				34.4	4.9	17.9	24.7	3.6	12.6	12.4	4.9	8.0
11				23.1	5.1	11.8	28.6	3.4	14.9	20.8	4.3	10.4
12				25.9	4.4	12.8	19.8	5.0	10.0	18.0	5.4	9.0
13				27.3	4.7	14.3	14.1	3.1	7.5	21.5	5.1	12.1
14				21.7	4.4	10.2	9.1	0.5	3.6	23.9	5.1	13.5
15				30.9	3.3	12.7	11.2	0.2	5.2	17.0	5.3	11.0
16				31.8	3.8	14.2	21.4	2.2	10.8	12.5	6.1	8.6
17				31.0	3.7	12.7	22.7	3.6	11.9	15.2	4.9	8.8
18				12.9	0.8	4.9	20.7	4.5	9.4	12.6	5.3	8.2
19				22.9	0.9	9.5	5.7	2.2	3.4	13.4	5.2	7.9
20				23.8	0.7	7.8	9.9	1.6	4.2	13.0	3.2	7.6
21				33.8	−0.7	13.7	6.4	0.3	3.1	16.1	4.7	9.5
22				21.4	4.1	9.0	7.6	0.1	3.3	21.9	4.3	10.5
23				30.6	1.6	15.1	27.6	3.4	14.3	19.0	4.0	9.6
24				29.0	3.0	15.9	30.6	5.7	16.1	19.8	3.6	9.9
25				14.7	5.1	9.4	19.4	6.5	11.9	13.1	3.4	7.1
26				20.4	2.9	9.6	28.8	4.9	15.2	13.8	2.3	6.9
27				26.4	2.9	11.7	16.7	6.8	10.3	19.5	2.7	9.7
28				17.7	4.9	9.1	22.2	5.8	12.5	18.7	3.5	9.1
29				12.0	2.6	7.5	13.9	5.8	9.2	19.5	3.1	9.6
30				20.8	3.0	8.9	13.5	4.9	8.3	14.6	2.3	6.7
31							11.8	4.3	7.4	18.1	2.9	9.3
Mean				26.4	3.0	12.4	18.8	3.4	9.7	16.3	4.2	9.0

Gangja La 1989 No. 9

	SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	21.1	3.5	10.7	13.7	−1.0	5.7	0.8	−6.3	−3.2	−4.3	−13.4	−9.3
2	25.5	2.8	12.3	19.3	0.6	9.2	3.2	−7.7	−3.6	−4.4	−12.0	−9.1
3	24.4	3.9	13.2	19.6	0.9	8.5	3.0	−7.9	−4.1	−4.6	−12.8	−9.5
4	21.8	7.3	11.2	18.3	1.5	8.0	2.9	−8.6	−3.5	−4.6	−13.1	−9.0
5	13.0	6.3	8.8	16.3	0.0	6.5	2.7	−9.0	−4.8	−3.1	−11.0	−7.8
6	23.7	4.2	11.8	19.9	−0.4	7.5	0.9	−10.7	−6.2	−3.0	−11.6	−7.6
7	22.3	5.1	11.8	14.6	−1.4	5.3	1.4	−9.6	−5.0	−2.0	−10.7	−6.7
8	14.1	2.4	7.1	14.5	−1.0	4.8	3.4	−8.3	−3.2	0.4	−8.8	−5.1
9	21.3	2.3	9.7	13.7	−1.8	3.8	4.2	−6.6	−2.2	−0.9	−8.5	−5.7
10	19.9	2.9	8.5	17.3	−0.5	6.0	3.4	−6.2	−1.9	−2.2	−10.2	−6.9
11	16.2	3.6	8.2	15.9	−1.5	5.5	3.8	−5.3	−2.2	−3.3	−11.4	−8.2
12	14.9	3.5	7.0	13.7	0.6	5.5	2.6	−7.0	−3.0	−4.7	−11.9	−9.2
13	19.6	3.4	8.3	15.9	0.2	5.5	2.6	−7.2	−3.5	−3.6	−13.5	−9.5
14	9.0	2.4	5.1	13.7	−2.6	3.7	2.4	−7.7	−4.0	−4.2	−12.9	−8.7
15	16.0	2.1	7.5	12.3	−2.1	2.7	0.7	−9.7	−5.6	−1.6	−12.1	−8.2
16	20.7	1.9	8.9	10.0	−3.4	1.4	0.3	−9.4	−5.2	−2.8	−12.2	−8.1
17	14.5	3.2	7.3	10.4	−3.8	2.6	1.3	−8.8	−4.6	−3.2	−10.7	−7.2
18	10.3	2.1	5.5	15.9	−2.3	4.8	1.6	−7.7	−4.0	−1.4	−8.9	−5.7
19	14.5	2.1	6.4	11.3	−2.8	3.6	0.0	−9.0	−5.4	−2.9	−9.3	−6.5
20	10.1	3.0	5.7	10.1	−4.4	1.4	−0.3	−9.7	−4.9	−0.8	−10.2	−6.4
21	12.4	2.1	5.2	8.3	−3.2	1.5	1.4	−8.2	−4.9	−4.0	−12.8	−8.7
22	16.8	2.2	7.7	7.5	−4.6	0.8	0.8	−9.4	−5.3	−4.6	−11.7	−8.8
23	18.6	2.5	8.8	9.5	−4.7	1.1	−0.2	−9.8	−5.9	−2.2	−11.5	−8.1
24	12.4	2.1	5.7	10.0	−4.1	1.3	−0.8	−10.1	−5.9	−5.0	−12.9	−9.6
25	18.5	2.1	7.8	9.1	−4.6	1.3	1.2	−9.4	−4.2	−7.3	−14.7	−10.9
26	16.1	2.1	7.2	9.0	−4.4	0.0	−1.8	−8.7	−5.7	−7.8	−14.5	−10.7
27	14.7	2.0	6.5	7.3	−5.6	−1.2	−1.2	−9.9	−7.0	−8.4	−14.7	−12.0
28	7.7	2.1	3.9	4.3	−7.0	−3.0	−5.0	−10.0	−6.8	−8.3	−15.8	−12.5
29	2.7	1.9	2.2	3.5	−8.8	−3.9	−5.7	−10.6	−7.3	−6.1	−14.8	−11.5
30	8.4	0.0	2.7	2.8	−9.1	−4.6	−6.1	−12.4	−9.8	−7.0	−14.4	−11.3
31				2,1	−9.7	−4.0				−7.7	−14.9	−11.7
Mean	16.0	2.9	7.8	11.9	−2.9	2.9	0.8	−8.7	−4.8	−4.1	−12.2	−8.7

Gangja La 1990 No.10

	JANUARY			FEBRUARY			MARCH			APRIL		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	−6.7	−13.9	−10.6	0.1	−10.5	−7.3	−3.9	−5.6	−4.8	−2.3	−3.1	−2.8
2	−7.5	−14.3	−11.4	−1.2	−12.2	−8.1	−4.4	−6.5	−5.5	−2.5	−3.4	−2.9
3	−7.4	−14.7	−11.7	0.2	−11.6	−6.4	−4.5	−6.8	−5.7	−2.6	−4.0	−3.1
4	−7.8	−15.2	−11.6	2.6	−9.2	−4.7	−5.0	−7.5	−6.4	−2.7	−3.6	−3.1
5	−8.5	−14.0	−11.6	0.3	−11.1	−5.8	−4.9	−8.6	−6.9	−2.3	−3.6	−2.8
6	−6.1	−13.8	−10.1	0.5	−10.8	−5.3	−3.4	−8.8	−5.7	−2.2	−4.0	−2.8
7	−5.1	−12.6	−9.4	3.7	−9.7	−3.8	−2.1	−7.9	−5.3	−1.4	−2.6	−1.9
8	−4.1	−11.4	−8.5	3.8	−8.8	−3.5	−0.3	−8.2	−4.5	−0.4	−1.7	−1.0
9	−4.3	−12.3	−8.6	3.6	−8.9	−4.8	4.2	−7.6	−2.2	−0.1	−1.2	−0.5
10	−2.9	−11.3	−7.1	2.5	−9.1	−3.6	1.4	−4.8	−2.1	−0.2	−1.5	−0.7
11	−1.9	−9.9	−6.2	−2.7	−4.9	−3.6	3.1	−6.0	−2.0	0.3	−1.5	−0.5
12	−0.2	−8.5	−5.0	−1.5	−5.1	−3.7	−2.7	−3.8	−3.2	1.5	−0.8	0.7
13	0.5	−7.9	−4.8	−2.4	−5.2	−3.6	−3.0	−4.4	−3.6	2.0	0.9	1.5
14	−0.8	−9.1	−5.7	−2.5	−3.2	−2.9	−2.8	−5.0	−4.0	2.5	0.2	1.5
15	−0.3	−8.9	−5.2	−2.9	−3.5	−3.2	−1.4	−4.9	−3.1	5.2	−1.8	1.3
16	1.3	−7.9	−4.5	−3.4	−4.2	−3.7	0.9	−4.4	−2.2	13.7	−1.9	4.3
17	0.8	−8.3	−4.4	−3.5	−4.5	−4.1	2.1	−5.5	−2.0	18.2	−0.4	6.6
18	2.5	−6.9	−2.6	−4.0	−5.4	−4.8	3.6	−4.4	0.4	23.4	−2.5	7.6
19	4.6	−4.4	−0.8	−3.9	−6.5	−5.3	7.4	−2.3	1.3	18.2	0.6	6.1
20	6.0	−2.3	0.7	−4.4	−6.3	−5.4	12.4	−4.5	1.9	25.1	−2.4	10.0
21	4.9	−3.9	−0.7	−4.8	−6.3	−5.7	13.1	−3.4	2.5	26.3	−2.6	8.9
22	4.1	−5.1	−1.9	−4.3	−6.7	−5.6	8.5	−4.0	1.1	23.7	−3.7	7.0
23	2.3	−6.8	−3.3	−3.6	−6.4	−5.0	−0.1	−0.7	−0.4	24.6	−3.8	8.8
24	2.9	−6.1	−2.9	−4.3	−5.5	−4.9	−0.3	−1.8	−0.8	27.7	−1.3	10.4
25	2.9	−5.8	−2.8	−4.9	−5.5	−5.2	−1.5	−2.6	−2.2	29.9	−0.6	11.2
26	2.8	−6.9	−3.1	−5.0	−5.5	−5.3	−2.2	−3.2	−2.7	27.8	−1.4	11.2
27	2.6	−7.5	−2.8	−3.6	−5.9	−4.6	−2.9	−3.5	−3.2	25.6	0.8	9.1
28	2.1	−8.1	−3.7	−3.6	−5.1	−4.5	−3.3	−3.6	−3.5	4.3	−1.4	1.6
29	−0.1	−8.6	−5.3				−3.1	−3.7	−3.4	12.7	−2.8	3.8
30	0.4	−9.7	−5.5				−3.1	−3.9	−3.4	23.8	−2.7	8.4
31	2.6	−9.5	−4.2				−2.7	−3.7	−3.1			
Mean	−0.7	−9.2	−5.7	−1.8	−7.1	−4.8	0.0	−4.9	−2.8	10.7	−1.9	3.3

Gangja La 1990 No.11

	MAY			JUNE			JULY			AUGUST		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	25.5	−1.0	10.8				17.9	6.4	11.3	17.0	3.3	9.1
2	28.7	−1.4	11.6				16.1	5.9	10.8	13.5	5.2	9.3
3	30.8	−0.3	10.8				17.0	5.2	9.5	11.3	4.9	7.6
4	13.7	−0.7	4.2				18.0	5.1	10.2	10.9	4.0	6.9
5	28.1	−0.8	8.3				12.9	6.1	8.8	17.1	3.6	9.7
6	29.3	−2.5	13.2	16.8	1.8	8.9	13.4	5.4	8.9	12.1	4.3	8.4
7	27.4	2.3	10.9	13.3	2.5	8.5	12.0	6.1	8.4	12.7	5.2	7.8
8	33.3	0.5	13.6	14.1	3.8	8.8	10.8	5.6	7.8	9.7	4.5	6.8
9	32.4	1.3	14.6	17.1	4.2	10.1	15.1	5.6	9.2	10.0	4.8	7.2
10	30.9	1.5	13.7	16.7	5.2	9.9	17.9	4.9	8.8	9.7	4.6	6.7
11	33.6	1.4	16.6	15.2	3.8	8.8	17.5	5.4	9.8	11.1	4.4	7.3
12	25.5	4.2	12.1	14.4	3.0	9.1	18.3	6.3	10.2	8.8	4.5	6.4
13	27.9	3.6	13.6	14.0	3.1	9.0	14.7	5.2	9.6	12.1	3.6	6.9
14	30.2	4.1	14.4	19.2	4.7	10.1	14.2	6.4	8.8	13.3	4.1	7.3
15	28.6	2.9	13.7	15.5	6.1	9.8	17.7	5.2	10.1	12.0	4.4	7.6
16	30.8	2.7	14.6	18.6	5.2	11.3	16.8	6.0	10.2	11.6	4.8	7.9
17	28.6	3.3	15.0	15.7	4.9	10.4	10.8	6.4	8.1	13.9	5.0	8.2
18	18.7	3.6	9.0	16.3	4.0	10.1	12.0	5.5	7.9	9.9	5.6	7.2
19	34.5	1.8	15.6	14.1	5.5	10.1	14.0	5.5	8.1	11.6	5.1	7.6
20	33.9	3.9	14.3	16.0	4.6	10.4	14.4	4.0	8.7	12.9	5.3	8.1
21	36.3	2.9	13.8	16.6	4.8	10.4	18.5	4.3	10.4	13.6	4.1	7.9
22	25.6	0.6	12.5	12.1	6.5	9.1	17.1	5.3	10.8	14.9	4.6	8.8
23	28.4	2.7	14.4	22.7	4.6	12.7	15.6	5.5	9.4	15.0	4.0	8.5
24	25.6	5.3	13.8	18.3	6.1	12.4	15.1	5.5	9.1	15.0	5.5	9.5
25	22.1	4.5	10.5	20.0	6.1	12.9	16.7	4.5	9.2	15.9	4.8	9.9
26	15.3	3.5	8.2	20.2	6.9	12.0	15.2	4.7	9.1	16.4	5.8	10.3
27	36.1	2.7	15.9	20.1	6.2	11.8	11.7	4.4	7.7	15.8	6.1	9.8
28	33.9	3.1	16.3	16.3	7.7	11.2	15.4	4.4	8.1	11.0	5.0	8.0
29	18.3	3.2	8.2	15.7	6.5	10.4	19.1	4.7	10.4	16.3	4.1	9.1
30	20.0	2.8	9.6	17.1	6.7	10.7	14.0	5.7	9.5	17.4	5.6	9.8
31	33.0	2.0	15.7				14.0	5.7	8.9	13.4	5.8	8.0
Mean	28.0	2.1	12.6	16.6	5.0	10.4	15.3	5.4	9.3	13.1	4.7	8.2

Gangja La 1990 No.12

	SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	10.8	4.4	6.9	11.0	0.2	3.8	−3.5	−9.7	−7.0	−3.1	−8.4	−6.1
2	11.9	4.7	7.6	7.6	0.1	2.8	−1.7	−8.5	−5.7	−1.4	−8.1	−5.6
3	9.5	4.6	6.5	10.2	−0.2	3.5	−0.2	−7.3	−4.3	−4.0	−8.5	−6.7
4	14.4	4.4	8.3	9.5	0.1	3.3	2.1	−4.9	−1.8	−4.0	−8.8	−6.8
5	13.2	3.3	7.2	9.0	1.0	3.5	1.6	−3.8	−1.6	−3.0	−8.5	−6.3
6	12.5	2.6	6.9	8.9	−0.7	2.5	0.8	−4.1	−2.1	−5.2	−10.4	−8.5
7	12.1	3.6	6.4	5.8	−1.3	1.2	−0.3	−5.4	−3.4	−6.6	−11.2	−9.4
8	12.1	2.3	6.4	5.2	−1.5	1.0	−0.2	−6.5	−3.8	−5.9	−11.2	−9.1
9	13.3	3.1	7.2	4.7	−0.5	1.7	−1.2	−6.4	−4.1	−3.6	−10.8	−7.6
10	11.7	5.1	7.0	3.3	−1.5	0.5	−3.1	−8.8	−6.3	−3.8	−10.8	−7.4
11	9.5	4.3	6.4	4.5	−2.6	0.4	−1.8	−8.5	−5.6	−6.7	−12.6	−10.1
12	15.0	3.1	7.4	4.2	−1.9	0.0	−2.7	−8.7	−6.2	−6.1	−12.0	−9.2
13	11.5	3.6	6.7	2.6	−3.4	−0.8	−1.7	−7.6	−5.2	−5.0	−9.7	−8.1
14	13.2	1.9	6.9	3.2	−2.9	−0.2	−0.8	−6.8	−4.4	−3.5	−9.7	−7.5
15	12.2	3.3	6.8	3.5	−5.4	−1.3	−1.6	−6.8	−4.8	−2.1	−10.3	−7.3
16	10.3	2.2	5.5	8.2	−4.9	−0.6	−1.8	−7.0	−4.8	−6.4	−11.2	−9.3
17	10.4	2.7	6.1	2.4	−4.6	−1.5	−2.0	−7.1	−5.1	−7.5	−11.7	−10.1
18	9.4	2.0	5.4	2.1	−4.5	−1.8	−2.2	−7.8	−5.5	−7.7	−12.8	−10.7
19	10.7	1.6	5.3	1.1	−5.9	−3.1	−1.0	−7.5	−4.5	−5.3	−12.3	−8.9
20	9.3	1.8	4.6	0.8	−5.8	−3.2	3.2	−6.4	−2.1	−4.0	−9.5	−7.4
21	8.9	1.1	4.2	0.2	−6.2	−3.6	1.3	−5.6	−2.6	−4.4	−9.2	−7.3
22	15.6	2.4	7.4	0.6	−6.0	−3.4	−2.3	−8.0	−5.8	−4.0	−9.7	−7.4
23	9.4	3.8	5.9	0.4	−6.1	−3.6	−4.3	−9.6	−7.6	−5.0	−9.7	−7.8
24	10.3	2.4	4.7	−0.3	−6.8	−4.2	−5.1	−10.3	−8.2	−4.9	−9.5	−7.7
25	9.1	2.0	4.4	−0.7	−7.2	−4.6	−5.6	−10.8	−8.9	−4.9	−9.7	−7.7
26	11.4	0.3	4.1	−1.6	−7.9	−5.3	−5.6	−11.8	−8.8	−3.8	−8.7	−6.9
27	10.1	−0.5	3.5	−1.5	−8.4	−5.5	−2.5	−7.3	−5.3	−4.7	−9.2	−7.4
28	8.2	0.7	2.9	−1.4	−7.6	−5.0	−2.3	−6.4	−4.9	−3.5	−9.7	−7.2
29	10.0	0.0	3.2	−2.3	−9.0	−6.1	−1.3	−5.9	−4.1	−3.8	−8.1	−6.6
30	13.0	0.1	4.1	−1.6	−8.0	−5.5	−2.8	−7.3	−5.3	−4.2	−8.6	−7.2
31				−1.7	−9.0	−6.5				−2.3	−7.7	−6.3
Mean	11.3	2.6	5.9	3.2	−4.1	−1.3	−1.6	−7.4	−5.0	−4.5	−9.9	−7.8

Gangja La 1991 No.13

	JANUARY			FEBRUARY			MARCH			APRIL		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	−5.7	−11.2	−8.0	−4.8	−12.1	−9.0	−2.4	−10.8	−7.8	4.9	−2.9	−0.4
2	−7.9	−13.7	−11.0	−5.7	−12.5	−9.9	−1.9	−10.1	−6.8	4.1	−4.4	−0.9
3	−7.1	−13.3	−11.3	−3.0	−13.9	−9.2	0.6	−8.6	−5.5	4.3	−3.9	−0.8
4	−7.7	−13.8	−11.2	−6.8	−12.0	−9.9	3.9	−7.5	−2.4	1.2	−2.3	−0.8
5	−7.3	−13.5	−11.0	−5.1	−12.7	−9.5	−2.8	−4.6	−3.4	2.7	−3.1	−0.8
6	−6.3	−12.2	−10.1	−2.6	−11.6	−8.2	−4.7	−8.7	−6.2	3.4	−3.0	0.4
7	−4.0	−12.4	−9.4	−5.1	−11.9	−8.8	−0.8	−9.5	−5.9	2.9	−1.8	0.3
8	−4.5	−12.7	−8.5	−3.6	−11.7	−8.4	2.3	−7.9	−3.9	1.4	−1.4	0.0
9	−7.3	−13.6	−11.2	−1.0	−9.7	−6.6	1.5	−7.1	−3.6	1.5	−1.7	0.1
10	−7.6	−14.1	−11.6	−1.5	−8.9	−6.4	−2.6	−8.0	−5.7	0.2	−0.9	−0.3
11	−8.4	−15.0	−12.3	−0.1	−9.0	−5.7	−1.7	−8.2	−5.4	−0.5	−1.5	−0.9
12	−8.4	−14.7	−12.3	−5.1	−10.7	−8.4	−0.9	−8.8	−5.4	−0.1	−1.5	−0.8
13	−9.1	−14.9	−12.9	−5.8	−12.1	−9.6	1.3	−8.6	−4.9	0.6	−0.7	−0.2
14	−9.6	−16.3	−13.9	−4.4	−11.0	−8.3	0.5	−8.6	−4.3	0.4	−0.8	−0.3
15	−10.7	−18.0	−14.5	−4.2	−10.3	−8.3	−0.4	−6.4	−4.3	−0.3	−1.4	−0.9
16	−2.3	−14.2	−9.4	−3.6	−10.5	−7.6	−0.8	−7.4	−4.5	0.2	−2.1	−0.9
17	−7.6	−12.9	−10.4	0.3	−8.7	−5.3	0.6	−6.4	−3.6	0.9	−1.0	−0.2
18	−6.8	14.0	−10.7	−0.3	−9.1	−6.0	1.6	−6.2	−3.0	1.1	−1.2	0.0
19	−7.6	−14.3	−11.6	−2.4	−10.7	−6.9	1.9	−5.4	−2.3	0.8	−1.3	−0.4
20	−8.4	−14.1	−11.9	−0.3	−7.8	−5.2	3.5	−5.5	−2.3	1.0	−1.6	−0.2
21	−7.3	−13.8	−11.3	0.5	−8.5	−5.0	3.1	−6.5	−2.3	2.9	−1.7	0.3
22	−7.3	−14.1	−11.0	−1.0	−8.5	−5.3	4.6	−5.5	−1.4	4.0	−1.0	0.9
23	−6.4	−12.1	−9.5	3.9	−6.4	−2.2	−0.2	−6.9	−4.5	1.8	−1.6	0.3
24	−6.5	−13.2	−10.2	2.1	−7.8	−4.3	−3.0	−4.9	−3.9	0.9	−0.3	0.2
25	−4.0	−10.3	−7.9	1.7	−8.1	−4.6	3.1	−7.8	−3.1	1.2	−1.0	0.0
26	−1.8	−9.4	−6.4	−1.2	−8.6	−5.3	4.8	−6.9	−2.3	1.7	−1.0	0.3
27	−1.4	−8.0	−5.4	−3.7	−8.1	−6.3	4.0	−5.7	−1.5	3.0	−0.8	0.9
28	−0.7	−7.0	−4.6	0.4	−8.5	−5.5	9.9	−4.5	0.7	4.2	1.1	2.1
29	−2.2	−7.7	−5.5				7.3	−4.1	0.2	6.3	1.1	2.9
30	−4.0	−9.8	−7.5				9.8	−3.8	1.4	9.1	0.3	3.4
31	−5.2	−10.6	−8.6				9.2	−1.2	1.6			
Mean	−6.2	−12.7	−10.0	−2.2	−10.1	−7.0	1.7	−6.8	−3.4	2.2	−1.4	0.1

Gangja La 1991 No.14

	MAY		
	MAX	MIN	MEAN
1	10.1	−0.1	3.2
2	8.3	−0.6	2.9
3	1.7	0.4	1.2
4	4.7	0.1	1.5
5	9.3	0.3	3.1
6	12.2	0.0	4.1
7	12.5	0.0	4.4
8	11.4	−1.1	3.6
9	8.4	−2.2	1.9
10	7.9	−2.8	1.7
11	8.7	−2.9	2.4
12	4.6	−2.5	0.7
13	9.8	−3.3	2.1
14	10.9	−2.2	3.8
15	11.7	−1.0	3.7
16	14.7	−1.1	5.6
17	14.7	0.8	6.5
18	13.3	−1.9	5.2
19	11.3	0.4	4.8
20	17.1	−0.5	7.0
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
Mean	10.2	−1.0	3.5

Kyangchen 1990 No.15

	MAY			JUNE			JULY			AUGUST		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1							19.7	11.0	14.1	19.8	9.1	13.1
2							19.6	10.7	13.9	18.8	9.6	13.1
3							18.5	10.2	13.4	16.9	8.7	11.1
4							17.8	10.5	12.4	14.5	8.6	10.3
5				19.0	9.6	13.2	14.9	9.8	11.6	20.1	7.6	12.8
6				18.3	8.8	12.4	17.2	9.4	12.5	18.1	9.1	12.2
7				17.8	8.6	12.0	16.0	9.8	12.3	14.8	9.3	10.6
8				17.5	9.0	12.3	14.2	9.5	11.3	15.8	8.4	10.7
9				18.3	9.8	12.9	13.5	9.4	10.9	16.9	8.6	10.8
10				19.3	10.1	13.8	14.7	9.0	10.8	18.8	7.9	12.0
11				17.2	8.8	12.5	16.6	8.8	11.4	19.1	9.4	13.1
12				18.4	9.6	13.2	16.8	9.3	11.8	11.7	8.6	10.1
13				18.7	9.6	13.4	18.7	8.9	11.9	10.6	8.1	9.0
14				21.4	11.4	14.4	15.6	9.8	11.3	12.4	7.6	9.4
15				15.6	10.8	12.7	19.2	8.8	12.2	17.6	7.7	10.9
16				18.1	10.0	13.4	20.2	9.4	13.3	19.5	8.7	12.0
17				19.8	9.4	14.0	15.2	9.7	11.4	19.3	9.2	11.9
18				19.4	9.3	13.4	12.6	9.6	10.7	12.8	9.3	10.6
19				17.4	10.0	13.2	11.8	8.9	10.0	15.4	8.4	10.9
20				19.5	9.1	13.1	14.5	8.4	10.5	19.3	9.1	13.0
21				19.1	9.3	12.5	19.9	8.1	12.3	18.3	8.6	12.2
22				15.9	9.9	12.1	19.8	9.5	13.1	21.6	9.7	13.8
23				18.2	9.6	13.4	19.0	9.0	12.1	23.3	10.4	15.5
24				19.1	10.0	14.0	18.7	9.4	11.9	23.3	10.8	16.1
25				19.8	11.4	14.8	19.1	8.6	12.1	23.7	11.5	16.6
26				19.8	11.6	15.3	18.8	8.7	11.6	23.1	12.5	16.5
27				20.3	11.1	14.7	14.0	8.6	10.6	14.0	10.1	11.9
28				18.7	11.9	13.9	18.8	8.6	11.3	16.9	8.9	11.9
29				20.1	10.3	13.3	18.3	9.1	12.4	16.7	8.9	11.0
30				20.1	10.7	14.2	14.8	9.3	11.4	22.0	8.6	13.4
31							17.1	9.0	11.9	19.2	10.4	13.5
Mean				18.7	10.0	13.4	17.0	9.3	11.9	17.9	9.1	12.3

Kyangchen 1990 No.16

	SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	20.6	9.4	12.9	22.4	8.2	14.5	19.4	1.1	9.2	24.0	1.1	9.9
2	15.9	8.5	11.0	24.3	8.4	15.1	21.5	1.3	10.6	19.4	1.2	8.5
3	15.7	8.1	10.7	23.5	8.6	15.1	22.0	2.8	11.3	23.9	0.0	9.2
4	20.4	8.7	12.5	23.7	8.7	15.2	25.7	4.2	12.8	24.3	−0.1	10.0
5	18.0	8.0	11.9	22.9	9.4	14.9	28.9	5.0	15.3	20.2	0.9	8.8
6	19.7	7.8	13.1	26.1	8.5	15.9	30.6	6.1	16.2	17.4	−0.7	7.0
7	21.6	8.6	14.5	24.6	8.8	15.4	24.8	6.3	13.9	17.9	−1.8	6.6
8	24.8	10.5	16.3	24.6	8.4	15.4	23.2	4.1	12.6	18.4	−1.3	7.2
9	25.3	12.4	17.2	24.4	9.0	15.5	24.0	4.6	12.4	15.5	−1.0	4.8
10	16.9	10.4	13.3	26.1	8.0	15.4	21.5	3.4	10.5	5.2	−3.5	−0.4
11	12.9	8.8	10.2	22.7	7.2	13.9	20.1	2.9	10.0	16.4	−6.2	3.7
12	21.3	8.2	12.4	22.8	6.9	13.5	21.3	2.2	10.2	19.5	−3.1	6.7
13	17.5	9.5	11.8	22.1	6.1	11.9	22.8	2.5	11.7	20.3	−1.0	7.9
14	23.8	7.4	14.0	8.3	2.4	5.7	26.6	3.6	13.6	19.1	−0.7	7.0
15	21.3	8.7	14.3	20.1	0.0	8.7	24.0	4.2	12.7	10.2	−0.8	3.7
16	24.3	9.9	15.8	20.5	3.6	9.9	23.8	3.2	12.3	21.1	−3.1	7.1
17	21.8	11.0	14.9	20.1	3.4	10.7	23.9	3.0	12.1	20.7	−1.2	7.7
18	22.9	10.4	14.4	21.2	3.6	11.4	23.5	2.4	11.7	18.7	−1.9	6.5
19	23.6	9.2	13.7	21.9	3.4	11.6	23.2	2.4	11.4	24.0	−2.3	8.5
20	21.0	8.7	13.4	23.6	3.4	12.0	13.9	3.2	8.2	24.7	−0.2	10.5
21	21.7	7.3	12.2	24.2	3.5	12.6	12.9	2.3	5.2	29.1	0.5	11.9
22	17.7	8.1	11.7	25.5	3.6	13.3	21.0	−0.8	8.1	22.6	0.9	10.4
23	16.6	7.8	10.8	25.7	4.0	13.4	21.7	−0.1	8.7	21.2	0.9	9.5
24	12.0	6.2	8.2	22.9	3.9	12.4	21.5	−0.5	9.2	20.6	0.1	9.0
25	6.8	4.9	6.0	22.5	3.4	11.6	18.7	−0.3	8.0	23.4	0.2	9.6
26	21.9	4.0	11.4	20.4	2.6	10.4	21.2	−1.0	8.9	20.2	1.6	9.0
27	22.7	6.9	13.4	19.7	2.2	9.5	26.3	1.5	12.4	22.4	0.6	9.2
28	22.0	6.4	13.2	20.8	2.0	10.0	23.3	3.1	11.7	19.0	0.3	7.5
29	23.0	7.5	14.3	19.9	2.2	9.7	22.8	3.0	11.8	4.0	−0.2	1.9
30	23.8	8.5	14.3	19.0	1.6	9.1	23.6	2.8	11.2	7.4	−2.2	0.0
31				18.9	1.8	9.1				9.8	−2.9	1.2
Mean	19.9	8.4	12.8	22.1	5.1	12.3	22.6	2.6	11.1	18.7	−0.8	7.1

Kyangchen 1991 No.17

	JANUARY			FEBRUARY			MARCH			APRIL		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
1	2.2	−5.8	−3.1	18.7	−1.5	5.8	17.9	−5.3	4.0	17.4	1.0	6.9
2	14.5	−8.8	−2.4	17.9	−3.3	5.8	18.1	−4.1	5.8	19.2	1.5	8.1
3	16.3	−8.3	1.3	2.6	−3.3	−0.8	17.7	−1.2	7.0	19.4	1.2	7.1
4	21.8	−8.5	3.8	15.7	−6.1	2.1	11.3	−0.1	3.2	18.3	0.1	7.7
5	23.7	−6.0	6.5	16.1	−5.8	3.6	2.9	−3.7	−0.7	18.3	2.1	8.8
6	24.3	−4.6	7.3	18.3	−3.1	5.8	18.2	−6.4	3.0	11.3	3.8	6.6
7	21.9	−3.7	7.0	18.8	−2.3	6.6	24.6	−3.5	8.2	14.7	1.4	5.7
8	7.1	−4.2	0.6	17.8	−1.8	6.8	18.2	−0.2	7.9	16.7	1.0	6.8
9	18.1	−8.2	3.3	21.7	−1.4	8.7	20.6	1.2	7.6	6.7	−0.3	3.0
10	19.2	−5.6	5.0	20.3	0.8	8.9	20.3	−2.0	7.6	15.1	−2.3	4.4
11	19.0	−5.4	4.9	17.5	0.7	5.7	20.0	0.0	8.8	13.5	−1.2	4.5
12	17.0	−4.6	4.7	17.6	−2.8	5.6	20.0	0.2	8.5	16.4	−0.7	6.4
13	19.3	−5.6	5.0	19.7	−2.9	6.5	19.0	0.3	7.7	15.2	2.6	7.5
14	15.4	−5.9	3.0	20.7	−1.2	7.5	12.3	0.8	4.0	14.3	2.1	7.4
15	14.7	−6.9	1.8	19.3	−1.6	7.5	15.5	−2.3	5.5	18.3	1.5	8.5
16	7.5	−5.6	−0.1	20.8	−1.1	8.0	19.1	−0.5	7.9	18.7	2.6	9.1
17	16.8	−5.5	3.6	16.3	−0.1	5.4	21.2	1.7	10.3	19.4	3.3	10.1
18	21.1	−5.9	4.6	5.2	−3.3	0.6	21.5	3.4	11.2	19.5	3.5	10.1
19	17.2	−4.8	3.8	18.9	−5.8	5.3	21.9	3.9	11.4	17.6	3.1	8.6
20	15.6	−4.8	4.0	20.8	1.0	9.2	21.9	3.8	10.5	16.3	2.2	8.0
21	14.0	−4.7	1.5	21.2	0.2	9.6	21.1	2.6	10.6	15.8	2.8	8.1
22	17.7	−6.6	4.1	22.7	1.1	10.7	12.4	3.4	7.4	17.2	3.3	8.5
23	19.3	−1.6	6.3	13.9	3.3	6.8	19.3	0.7	6.7	11.0	3.7	6.5
24	17.0	−3.7	4.1	16.8	0.0	6.6	14.3	−1.3	2.9	13.9	0.9	5.3
25	23.5	−3.2	8.0	15.9	0.2	6.1	22.2	−4.0	7.6	15.4	−0.8	6.4
26	26.1	−0.4	10.9	2.5	−1.6	0.2	18.3	1.3	8.3	16.4	2.7	8.2
27	23.9	1.7	11.7	19.3	−3.2	3.4	18.1	1.4	8.0	17.8	3.8	9.3
28	24.9	2.6	12.3	9.8	−3.0	2.1	18.2	2.4	8.1	16.8	3.7	9.3
29	21.0	2.8	10.9				18.8	3.2	9.8	17.7	5.6	10.0
30	19.3	0.8	9.0				20.0	4.5	10.1			
31	19.5	−0.7	7.8				15.0	3.1	6.9			
Mean	18.0	−4.2	4.9	16.7	−1.7	5.7	18.1	0.1	7.3	16.1	1.9	7.5