Geodetic Activities During the 1999 Juneau Icefield Research Program Field Season

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Summary 5

1. Introduction 5

2. Survey projects 5
2.1. Movement vector determination 9
2.1.1. Lemon Creek Glacier and Ptarmigan Glacier 9
2.1.2. Demorest Glacier 9
2.1.3. Main Taku Glacier and Taku SW-Branch 11
2.1.4. Lower Matthes Glacier and Taku NW-Branch 12
2.2. Longitudinal Profiles 13
2.2.1. Demorest Glacier 13
2.2.2. Matthes Glacier 14
2.2.3. Taku Glacier 16
2.2.4. Taku Glacier SW-Branch 17
2.3. Height and volume changes 18
2.3.1. Short term height and volume changes 19
2.3.2. Long term height and volume changes (1998 to 1999) 19
2.4. Strain 22

3. Proposals 25

4. Acknowledgment 26

5. References 26

Appendices

Appendix A Coordinates of JIRP Benchmarks (ITRF93) 29

Appendix B1 Coordinates of movement profile flags 33
Appendix B2 Coordinates of locations related to various projects 53

Appendix C1 Plots of movement vectors 61
Appendix C2 Plots of short term height changes 77
Appendix C3 Movement vectors and short term height changes (tables) 91

Appendix D Long term height changes (tables) 103

Appendix E Volume changes 111

Appendix F Strain rates 115

Summary

GPS real-time surveys were conducted at seven established sites on the Juneau Icefield, Alaska to determine movement vectors and long term surface elevation changes. Local mass balance, strain rate and short term height change data were also collected. A new movement profile on the Demorest Glacier was established. Longitudinal centerline movement profiles covering some 50 km of the main glaciers within the Taku/Matthes/-Llewellyn Glacier system were surveyed for the first time.

Results of the movement surveys indicate that the flow regime of the Taku Glacier system has been stable for the past 7 years. The analysis of the longitudinal profiles revealed the flow mechanism between the existing movement profiles. For the first time since 1994 a gain in elevation took place at all profiles.

1. Introduction

The surveying program of the Summer Institute of the Juneau Icefield Research Program (JIRP) initially focused on determining glacier surface velocities. With continuous improvement of the surveying instruments, the scope of investigations expanded. The maintenance and enlargement of geodetic networks as reference frames for the investigations of other geosciences, the derivation of glacial strain rates, the monitoring of short and long term height changes and numerous special investigations (accurate determination of the terminus of the Taku Glacier etc.) are now routine tasks. All efforts are aimed at a better understanding of the glacier system and its complex interaction with long and short term variations of the climate. Besides these scientific tasks, JIRP is a rigid training course in field work for all students of geosciences. Participating in various surveying projects, the students are taught the set-up and logistical aspects of surveying tasks, different surveying techniques, evaluation procedures and the critical interpretation of the results obtained.

2. Survey projects

Using Real-Time-GPS (RT-GPS) exclusively in 1999, the main new objective of the survey campaign was to gather movement data, gradients and height changes along the centerlines of the main glaciers of the Icefield. About 60% of the Matthes/Taku Glacier, 25% of the Demorest Glacier and 50% of the SW Branch were covered this season.

As in 1998, an essential topic of the 1999 survey program was the re-establishment of the exact profile locations of former years to gather reliable data for the variation of surface velocities and long-term height changes. Seven profiles on the Demorest, Taku and Matthes Glacier were observed at the 1998 positions, covering elevations from 1000 m to 1500 m. A new profile (Profile 3b) was set up on the Demorest Glacier to close the gap between the existing profiles on this glacier.

The investigation of the volume change of the Lemon Creek Glacier (LANG, 1997a; WELSCH et al., 1998) continued in order to create a time series which may allow, combined with additional data, a prediction of the volume changes in the near future.

All measurements were carried out using the new LEICA 530 RT-GPS system. Theory, principles and evaluation of GPS observations are not described in this report; they are well known and can be reviewed in many publications (e.g . WELLS et al., 1986; SEEBER, 1993).

Profile Project	Location	Survey Dates	Purpose	Type of measure-ment	No. of pts.
Lemon Profile	Lemon Creek Glacier (Camp 17 - Martin Peak)	July 18, 1999 July 30, 1999	AB, MV	RT-GPS RT-GPS	8 8
Ptarmigan Profile	Ptarmigan Glacier (Vesper Peak - Peak 3562)	July 18, 1999 July 30, 1999	AB, MV	RT-GPS RT-GPS	6 6
Demorest Logitudinal	Demorest Glacier (Centerline)	July 28 + August 1, 1999 August 5/9, 1999	AB, GR, MV	RT-GPS RT-GPS	24 24
Taku Longitudinal	Matthes/Taku Glacier (Centerline)	July 27-29 + August 1-3, 1999 August 4-10, 1999	AB, GR, MV	RT-GPS RT-GPS	62 62
SW-Branch Longitudinal	Taku Glacier SW Branch (Centerline)	July 26, 1999 August 6, 1999	AB, GR, MV	RT-GPS RT-GPS	14 14
Profile 3	Demorest Glacier (Taku A - Hodgkins Peak)	July 26, 1999 August 5, 1999	AB, HC, MV	RT-GPS RT-GPS	12 12
Profile3a	Upper Demorest Glacier (Spider Mt.- Peak 5370)	August 1, 1999 August 9, 1999	AB, HC MV	RT-GPS RT-GPS	15 15
Profile 3b	Middle Demorest Glacier (Floprock Pk. - Scattered Pks.)	August 7, 1999 August 9, 1999	AB, MV	RT-GPS RT-GPS	8 8
Profile 4	Taku Glacier (C-10 - Shoehorn Peak)	July 24, 1999 July 31, 1999	AB, HC, MV, MB, SR	RT-GPS RT-GPS	31 31
Profile 5	Taku Glacier SW Branch (SW Taku Pt. - Juncture Peak)	July 25, 1999 August 1, 1999	AB, HC, MV	RT-GPS RT-GPS	12 12
Profile 6	Taku Glacier NW Branch (NW Taku Pt. - Echo Mt.)	July 29, 1999 August 6, 1999	AB, HC, MV	RT-GPS RT-GPS	16 16
Profile 7	Matthes Glacier (Camp 9 - Centurian Peak)	July 31, 1999 August 9, 1999	AB, HC, MV	RT-GPS RT-GPS	16 16
Profile 7a	Matthes Glacier (Taku C - Taku D)	July 29, 1999 August 6, 1999	AB, HC, MV	RT-GPS RT-GPS	14 14
Cathedral	Camp 18 Reference	August 3-6, 1999	POS	STATIC	1
Height change	Lemon Creek Glacier	July 18, 1999	HC	RT-GPS	95
Lemon Lakes	Lemon Creek Glacier	July 18/30, 1999	SUR	RT-GPS	56

Explanation:

Purpose of survey:
AB = Ablation
GR = Gradients
HC = Height comparison
MB = Mass balance
MV = Movement
POS = Position
SR = Strain rates
SUR = Surface

Type of measurement:
STATIC = Static GPS survey
RT-GPS = Real-Time GPS survey

Table 1: Timetable of the survey work carried out during the 1999 JIRP campaign

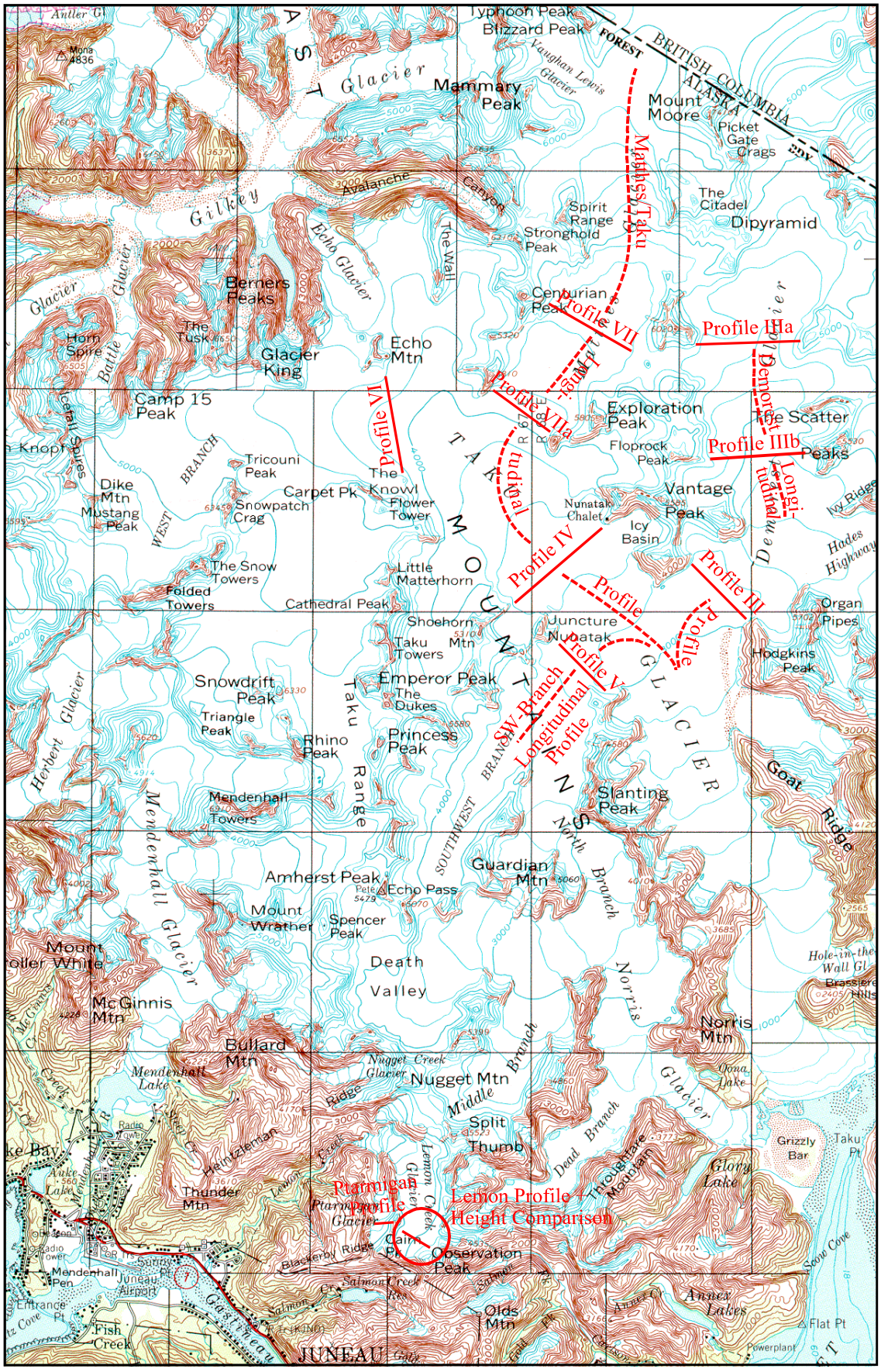


Fig. 1: Location of the 1999 survey projects on the Juneau Icefield

The re-mapping project of the Cathedral Massif Glacier by the Institue of Geography of the Salzburg University (Dr. Slupetzky and his team) was supported by three students and by observing a reference point (FFGR 24) near Camp 18.

Seven lectures were given on GPS, coordinate systems, and the evaluation of movement and strain rate measurements. This year, for the first time, all results including velocity, height change, volume change, strain rates and surface gradients were calculated in the field.

In Fig. 1 the locations of all survey projects on the Juneau Icefield in 1999 are shown, and a related timetable is given in Table 1. Coordinates of all points measured this summer can be found in Appendix B1 (Movement Profiles, pp. 35-51) and B2 (Miscellaneous Projects, pp. 55-59).

2.1. Movement vector determination

Differential GPS observations provide a high relative accuracy. Using short baselines (< 5 km), standard deviations of 1 cm in position and 3 cm in height can be achieved with Rapid Static or RT-GPS measurement techniques. Taking into account that usually a 1" x 2" flagpole is used as a point marker on the sun-cup covered glacier surface, an accuracy of 5 cm in both position and height can be assumed. In Appendices C1 (pp. 63-75) and C2 (pp. 79-89) all movement vectors and height changes are shown. Numerical values for all profiles are given in Appendix C3 (pp. 93-101).

Fourth-order polynomials were used in the derivation of mean velocities for each profile.

2.1.1. Lemon Creek Glacier and Ptarmigan Glacier

For the first time GPS based observations were used to determine the glacier velocities in the Camp 17 area. Despite the 14 days between both survey epochs the results show only minor movements.

The movements of the Ptarmigan Glacier are not significant (App. C3, p. 93) and the orientations of the movement vectors are inhomogeneous and somewhat strange.

The movements of the Lemon Creek Glacier Profile are significant. Except for pt. 1, the movement pattern is conclusive (Fig. 24). The mean velocity is 1 cm/day and the maximum is 2 cm/day.

2.1.2. Demorest Glacier

The Demorest Glacier is the most eastern and one of the three main feeders of the Taku Glacier. With an area of some 175 km^2 it represents about 20% of the total area of the Taku Glacier system.

Profile 3 (App. C1, p. 71) is located between the southwestern end of Washington Basin and the western end of the basin below Hodgkins Peak and the Organ Pipes, where all masses of the eastern feeders of the Taku Glacier have to pass through. The influence of the Taku Glacier on the flow at this profile can be neglected (see chapter 2.2.1), since the

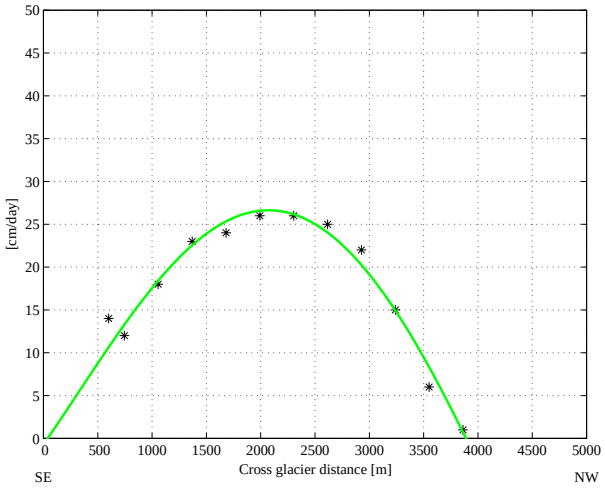


Fig. 2: Profile3

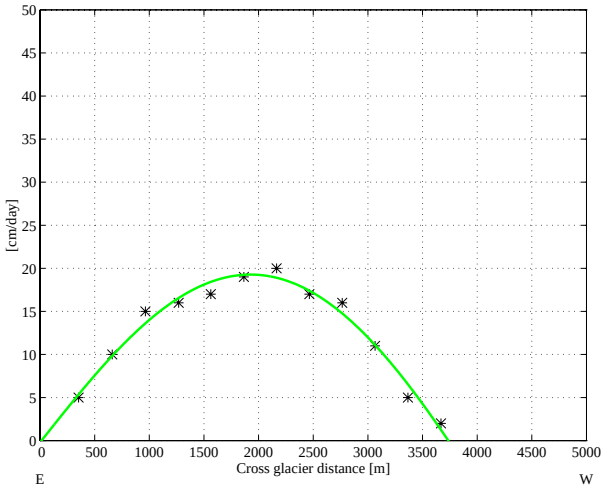


Fig. 3: Profile 3a

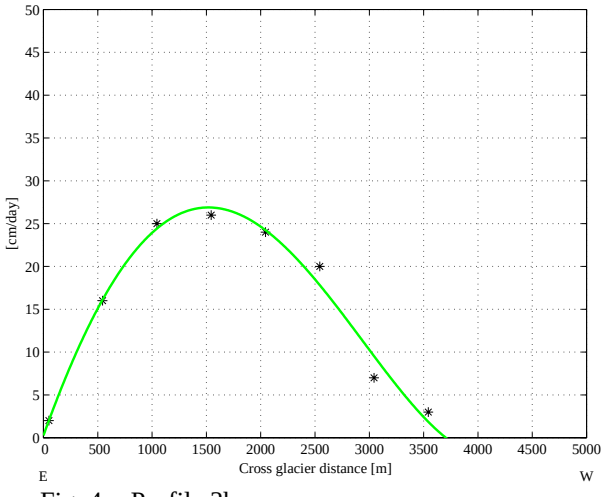


Fig. 4: Profile 3b

profile is situated 1 km above the confluence zone of the Demorest and the Taku Glacier. The movement vectors of the individual points are in good accordance with 1998, when this profile was set up for the first time. The flow is parabolic (Fig. 2). A mean velocity of 17 cm/day and a maximum velocity of 26 cm/day were calculated. Despite the slightly different location of the profile in 1998 and 1999, all values are in good accordance with the mean values of the last decade (LANG and WELSCH, 1997).

Profile 3a (App. C1, p. 71) is located about 9 km below the divide of the Demorest and Tulsequah Glaciers and some 13 km up-glacier from Profile 3. The profile traverses the glacier from the southeast corner of “Spider Mt.” to the unnamed Peak in the southwestern vicinity of Peak 5370. Some points (pts. 7-9 and 12-15) were at a slighly different location this summer. The flow pattern is parabolic (Fig. 3) showing a mean velocity of 12 cm/day and a maximum velocity of 20 cm/day. The insignificant movement vectors at the eastern and western ends were disregarded in the calculation of the mean movement. All movement vectors have a southwestern orientation indicating that the ridge descending from Peak 5370 continues well below the profile. These results agree very well with last year’s results (WELSCH et al., 1998).

Profile 3b (App. C1, p. 71) traverses the Demorest Glacier between Floprock Peak and the southern end of the semicircle formed by The Scatter Peaks. This location is some 8 km upglacier from Profile 3 and some 5 km downglacier from Profile 3a. The flow pattern can be described as asymmetrical channel flow (Fig. 4). The mean velocity (17 cm/day) and the maximum velocity (26 cm/day) are some 30% greater than on Profile 3a. The width of the glacier on both profiles is similar and cannot be causative for the acceleration. The low velocities on the

western end of the profile suggest a small coverage of ice in that area. This and the additonal masses from the region northeast of The Scatter Peaks may cause the substantially higher velocities of Profile 3b.

2.1.3. Main Taku Glacier and Taku SW-Branch

Profile 4, consisting of two parallel lines some 300 m apart, traverses the Main Taku Glacier between Camp 10 and the northeast ridge of Shoehorn Mountain (App. C1, p. 73). The movement patterns of both lines are nearly identical: parabolic increase and decrease of the velocities on the banks in the northeast and southwest and rectilinear flow in the center extending some 2 km with a uniform velocity of about 60 cm/day. The outflow from the basin east of Shoehorn Mountain causes the change of the orientations of the movement vectors of both lines. A mean velocity of 37 cm/day for Profile 4 was calculated. Fig. 5 depicts the measured and adjusted velocities of Profile IV in 1999. These results support the parabolic flow type with a broadened central zone as reported by LANG and WELSCH (1997). Since 1993 identical positions have been used for the movement vector determination at Profile 4. The magnitude and orientation of the individual movement vectors show a high degree of accordance from 1993 to the present. In general, the differences in velocities and orientations do not exceed 2 cm/day and 2 gon resp., showing significantly that there is no change of the glacial behavior in this area.

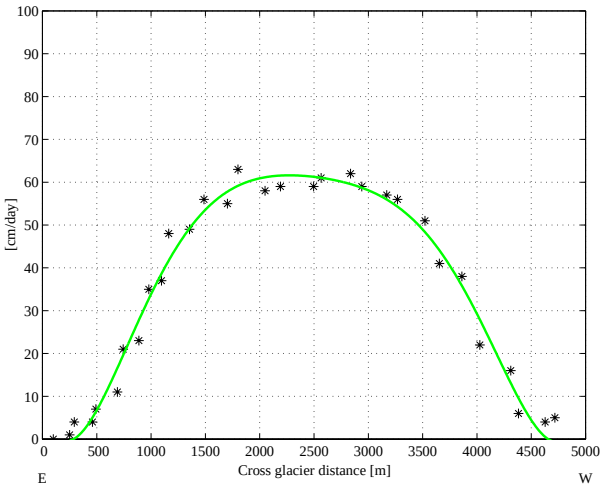


Fig. 5: Profile 4

The Southwest Branch, covering some 40 km^2, forms the smallest tributary within the Taku Glacier system. Profile 5 is located between SW Taku Point and Juncture Peak (App. C1, p. 73) and about 500 m above the confluence with the Main Taku Glacier. The location of Profile 5 permits monitoring the flow of all the ice masses feeding the Taku Glacier system at the lowest elevation. The velocities for Profile 5 are shown in Fig. 6 Unlike previous years when a perfect parabolic flow pattern was dominant, an asymmetrical channel flow with a sharp increase in velocity at the southeastern end of the profile is found. However, the maximum velocity of 10 cm/day and a mean of 6 cm/day correspond very well with the values shown by LANG and WELSCH (1997). The variations of the movement vectors derived over the years at the same positions are in general negligible. It is recommended to monitor this profile carefully in the future in order to clarify whether a change of the flow pattern takes place.

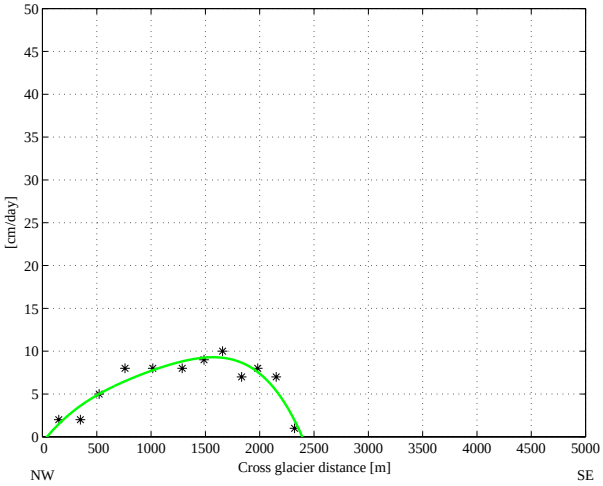


Fig. 6: Profile 5

2.1.4. Lower Matthes Glacier and Taku NW-Branch

Profile 6 (App. C1, p. 75) stretches from NW Taku Point to Echo Mountain. The flow is parabolic with a sharper increase in velocity at the northern end (Fig. 7). The adjusted velocities suggest that only the northernmost point of the profile, although being more than 1 km away from the glacier's bank at Echo Mountain, marks the area where the movement becomes substantial. Compared to 1998, the movement vectors do not differ more than 1 cm/day in velocity and 5 gon in orientation in general. The maximum (29 cm/day) and mean velocities (20 cm/day) are in agreement with the values found over the last decade (LANG and WELSCH, 1997) in this area.

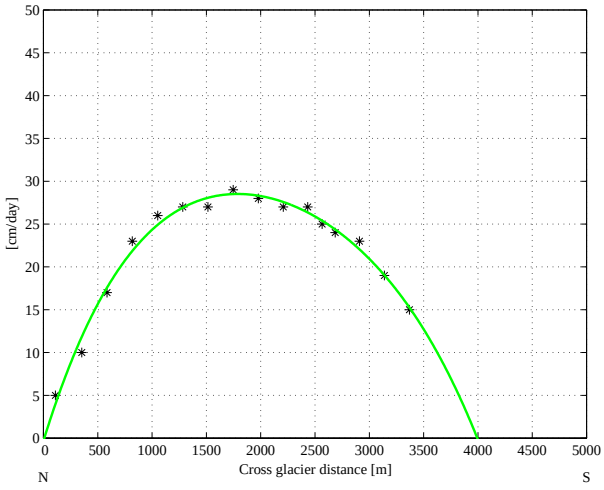


Fig. 7: Profile 6

Profile 7 (App. C1, p. 75) traverses the Matthes Glacier between Camp 9 and Centurian Peak. It is located 5 km above the confluence with the Taku Glacier. An often repeated suggestion (LANG, 1997; WELSCH et al., 1998) was realized this summer: two more flags were added at the western end and the two easternmost flags were abandoned. The mode of flow is parabolic with a broadened central zone of uniform velocity (Fig. 8). The movements at the eastern end of the profile reflect - although insignificant - the outflow of the small basin below Camp 9 towards the Matthes Glacier. The mean velocity is 22 cm/day and the maximum velocity 34 cm/day. Compared to previous years the deviations in velocity and orientation of the movement vectors are negligible.

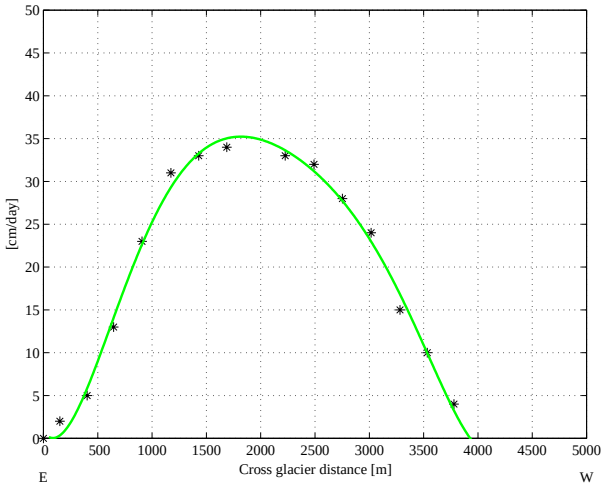


Fig. 8: Profile 7

Towards the confluence of Taku Glacier, the Matthes Glacier valley narrows substantially. Over a distance of only 5 km the glacier's width diminishes from 4 km at Profile 7 to some 3 km at Profile 7a (App. C1, p. 75). Between Profiles 7 and 7a no masses are added to the Matthes Glacier; therefore, the gain in velocity is caused by the changing topography. The increase at Profile 7a of the maximum

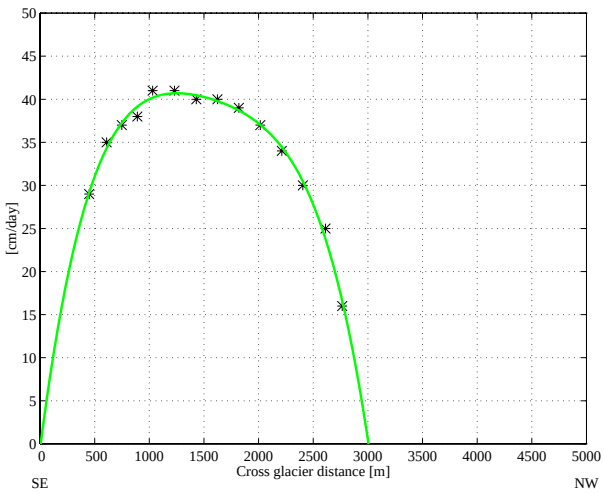


Fig. 9: Profile 7a

and mean velocities to 42 cm/day and 31 cm/day resp. is proportional to the decrease in width. The flow pattern is parabolic (Fig. 9) and the differences to the movement vectors compared to previous years are negligible (1 cm/day in velocity and 3 gon in orientation are the maximum values). This supports the conflusion that there is no significant change of the flow of the Lower Matthes Glacier.

An earlier suggestion is repeated: at the ends of the existing profile substantial movement rates (18 cm/day and 31 cm/day at the western and eastern end resp.) occur. Two points at both ends of the profile should be added to verify the sharp drop in velocity which can be seen with the adjusted velocities in Fig. 9.

2.2. Longitudinal Profiles

Transverse profiles are common means of describing the flow of glaciers at distinct places. Longitudinal profiles along the centerline of a glacier provide useful additional useful information: the gradient of the glacier and the velocities between transverse movement profile. Particular in the confluence areas of glaciers, longitudinal profiles provide a simple method to quantify the flow patterns of the merging glaciers.

This summer longitudinal profiles were established for the first time on the Icefield as a large scale project. The flags had a spacing of 500 m, which proved to be a good compromise between effort and results. About 60% of the Matthes/Taku Glacier, 25% of the Demorest Glacier, and 50% of the SW-Branch were covered, including the convergence area of the three glaciers.

2.2.1. Demorest Glacier

The longitudinal profile on the Demorest Glacier consists of two separate sections (App. C1, p. 63). The upper part (pts. 34-20) starts at Profile 3a and continues 2 km beyond Profile 3b, whereas the lower part (pts. 9-1) covers the last 4.5 km of the Demorest Glacier.

Beginning at Profile 3a (pt. 34), the Demorest Glacier steepens between pt. 34 and pt. 29 (2.5 km) gradually from 1° to about 2.5° (Fig.10 and Tab. 2). The effect on the velocity seems to be moderate: an increase of some 20% (18 cm/day to 22 cm/day). The nearly horizontal part between pts. 29 and 28 represents a local anomaly which does not have any influence on the glacier's movement. Beyond pt. 28 the gradient shows only little variation down to pt. 20. The increase of the glacier's width may be causative for the constant velocity between pts. 25 and 23 (Fig. 10) . Between pts. 20 and 9 no data are available, the mean gradient of 1.6° between both points is similar to the values in higher elevations. Despite substantial ice masses added from the Hades Highway, the velocity at pt. 9 is less than at pt. 20 (24 cm/day and 30 cm/day resp.), although the width

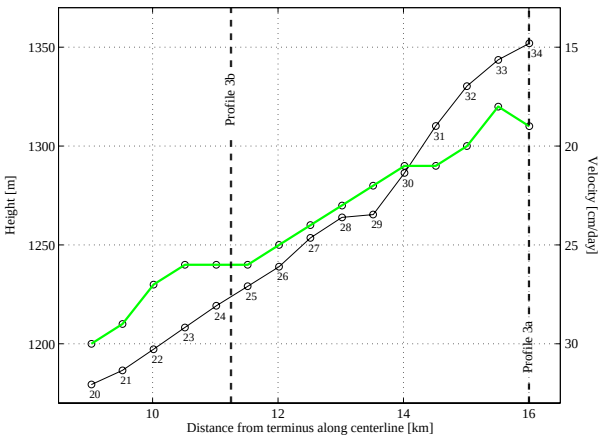


Fig. 10: Longitudinal Profile Demorest Glacier, northern part. Measured velocities (grey) and heights (black).

of the glacier is comparable. This implies that the depth of the ice, and the cross-sectional area of the glacier, must be greater at pt. 9 than at pt. 20.

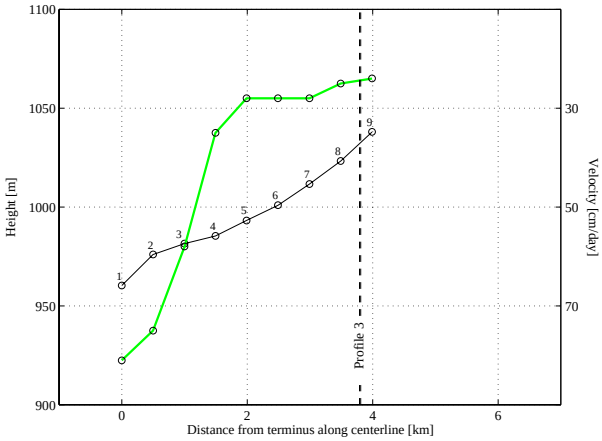


Fig. 11: Longitudinal Profile Demorest Glacier, southern part. Measured velocities (grey) and heights (black).

The area where the influence of the Taku Glacier starts cannot be marked with certainty, the indications are somehow contradictionary. Between pts. 9 and 3 the Demorest Glacier flattens continously (Fig. 11), the gradient drops from 1.7° to 0.5° (Tab. 2). This can be seen as a tailback effect caused by the mightier Taku Glacier damming up the Demorest Glacier. Between pts. 9 and 5 the velocity is quite stable (~ 28 cm/day), whereas a dramatic increase occurs between pts. 5 (28 cm/day) and 2 (75 cm/day). The directions of the movement vectors change constantly from pt. 9 to 1, the biggest alterations are found between pts. 6 and 3. Combining all facts, it can be concluded that the movements of pts. 1-3 are controlled by the Taku Glacier only. The transition zone of the movement regimes is located between pts. 3 and 6, which also corresponds to an extensive crevasse zone at the junction of the Demorest and Taku Glaciers. Upglacier from pt. 6 the influence of the Taku Glacier on the mode of flow of the Demorest Glacier is negligible.

Points from to	Gradient [°]	Velocity (mean) [m/day]
1 2	1.80	0.78
2 3	0.63	0.66
3 4	0.45	0.46
4 5	0.91	0.32
5 6	0.87	0.28
6 7	1.23	0.28
7 8	1.34	0.27
8 9	1.68	0.25

Points from to	Gradient [°]	Velocity (mean) [m/day]
9 20	1.61	0.27
20 21	0.83	0.29
21 22	1.23	0.28
22 23	1.27	0.27
23 24	1.25	0.26
24 25	1.13	0.26
25 26	1.13	0.25
26 27	1.67	0.24

Points from to	Gradient [°]	Velocity (mean) [m/day]
27 28	1.18	0.26
28 29	0.16	0.25
29 30	2.42	0.22
30 31	2.73	0.21
31 32	2.32	0.20
32 33	1.53	0.19
33 34	0.96	0.18

Table 2: Surface gradients and velocities of the Demorest Glacier Longitudinal Profile

2.2.2. Matthes Glacier

The Matthes Glacier longitudinal profile begins in the area of Profile 8 some 5 km south of the divide between the Matthes and Llwellyn Glaciers (LANG, 1997). It continues some 16 km down glacier to its confluence with the Taku Glacier (App. C1, p. 67 and 69).

A section of small acceleration between pts. 85 and 81 (Fig. 12) is followed by a higher

acceleration (pts. 81-75) with a velocity increase from 15 cm/day at pt. 85 to 49 cm/day at pt. 75. Within the next 6 km the Matthes Glacier experiences an exponential drop in velocity approaching the local minimum of 31 cm/day asymptotically. Within the remaining 6 km to the confluence area with the Taku Glacier, a general increase in velocity to 41 cm/day occurs, interspersed with small irregularities.

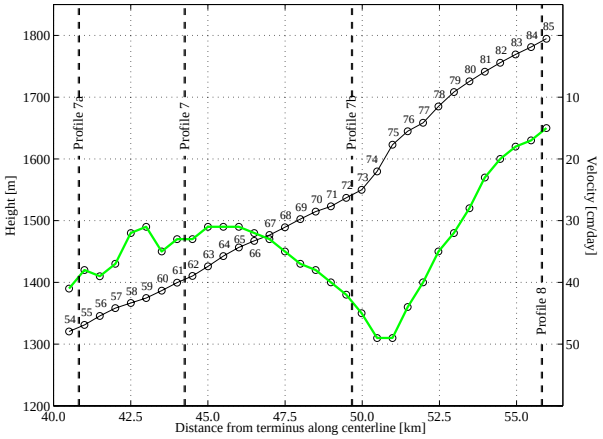


Fig. 12: Longitudinal Profile Matthes Glacier. Measured velocities (grey) and heights (black).

The surface gradient alone cannot cause the varying movement pattern (Tab. 3 and Fig. 12). As no substantial masses are added between Profile VIII and the convergence with the Taku Glacier, one has to agree with PATTERSON (1981) that variations of the slope over short distances do not effect the flow of a glacier. The term "short" refers to a distance less than several times the ice thickness. Taking the average of the known ice thicknesses at Profile VII, VIIa and VIII as representative for the Matthes Glacier (SPRENKE et al., 1997), a distance of less than 2 km has to be considered "short".

It is quite obvious that the width of the glacier rather than its slope effects the velocity. As can be seen in Fig. 13, the glacier's width and the velocity show a surprisingly high degree of negative correlation. The glacier's width is as derived somewhat uncertain for several reasons: the applied graphical method, the maps used are 30 years old and not updated, the contour interval (100 feet) is rather great, and the banks of the glacier are only poorly determinable.

Points from to	Gradient [°]	Velocity (mean) [m/day]
54 55	1.21	0.40
55 56	1.69	0.38
56 57	1.44	0.38
57 58	0.96	0.34
58 59	0.92	0.32
59 60	1.36	0.34
60 61	1.49	0.34
61 62	1.23	0.33
62 63	1.78	0.32
63 64	1.93	0.31
64 65	1.65	0.31

Points from to	Gradient [°]	Velocity (mean) [m/day]
65 66	1.27	0.32
66 67	1.08	0.33
67 68	1.45	0.34
68 69	1.52	0.36
70 71	0.98	0.39
71 72	1.60	0.41
72 73	1.48	0.44
73 74	3.43	0.47
74 75	4.95	0.49
75 76	2.55	0.47
69 70	1.40	0.37

Points from to	Gradient [°]	Velocity (mean) [m/day]
76 77	1.54	0.42
77 78	3.07	0.38
78 79	2.65	0.34
79 80	1.97	0.30
80 81	1.81	0.26
81 82	1.67	0.22
82 83	1.54	0.19
83 84	1.37	0.18
84 85	1.56	0.16

Table 3: Surface gradients and velocities of the Matthes Glacier Longitudinal Profile

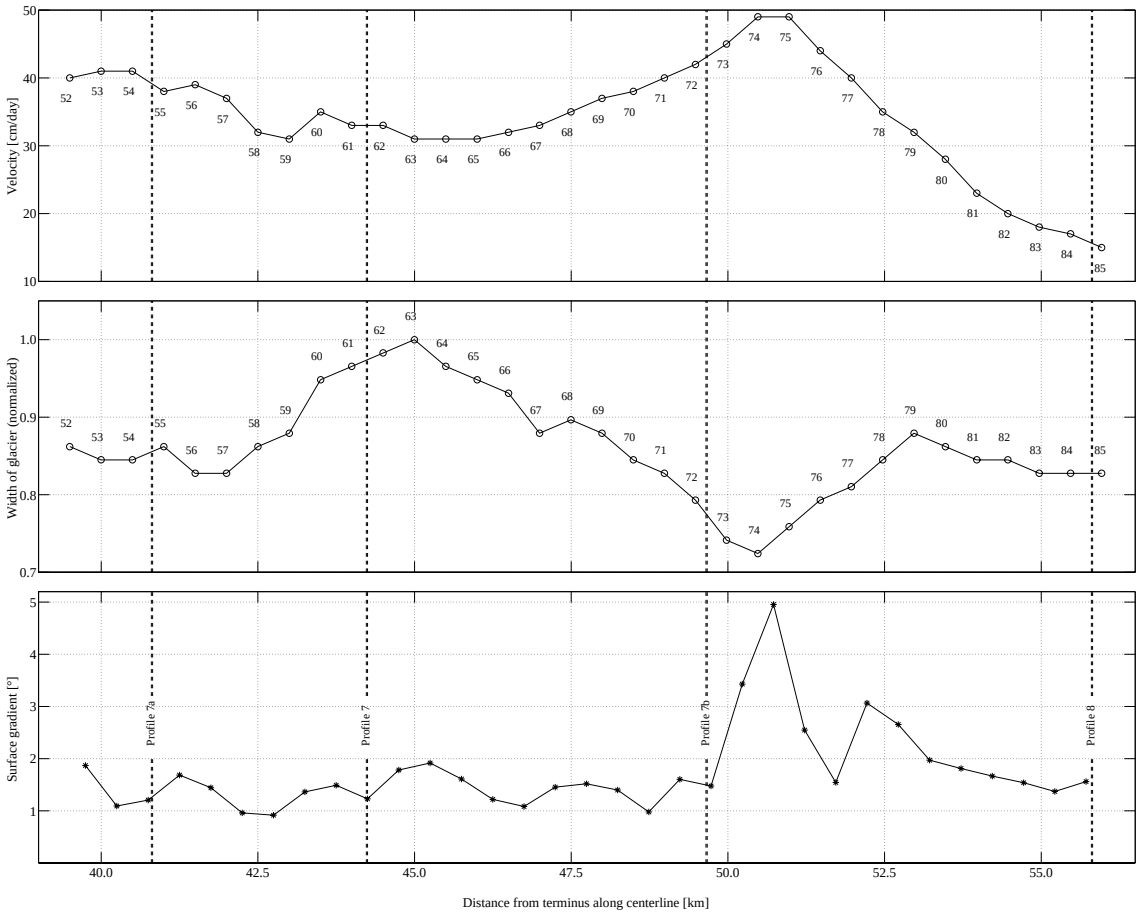


Fig. 13: Longitudinal Profile Matthes Glacier. Measured velocities, glacier width and surface gradients

2.2.3. Taku Glacier

Beginning at pt. 52, the last point where doubtlessly no influence of the Taku Glacier on the flow of the Matthes Glacier exists, the Longitudinal Profile stretches some 15 km down the Taku Glacier (App. C1, p. 69). Two factors are responsible for the acceleration from 41 cm/day to more than 80 cm/day (Fig. 14): First the huge ice masses, which are added: the NW-Branch contributes approximately the same mass than the Matthes Glacier, and the Demorest Glacier some 60% (FRIEDMANN, 1997). Second, the Taku valley narrows substantially towards the last point (pt. 24) of the existing profile. The gradient undulates within the first 8 km (pts. 54-49 “steep”, pts. 49-45 “flat”, pts. 45-41 “steep” and pts. 41-38 “flat”) and stays quite stable (~ 1.5°) in the last section (Tab. 4). An influence of the changing gradient on the velocity again cannot be seen.

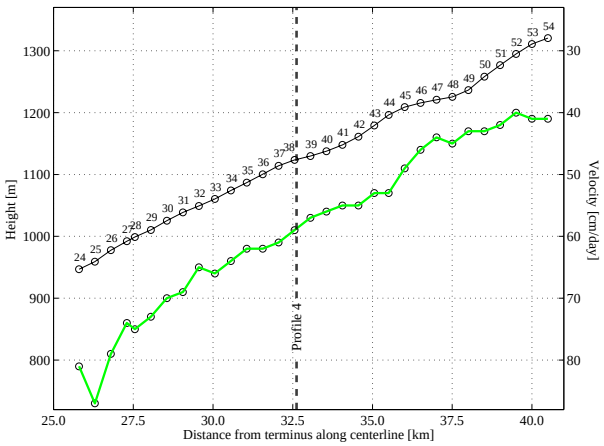


Fig. 14: Longitudinal Profile Taku Glacier. Measured velocities (grey) and heights (black)

The demarcation of the influence of the Matthes Glacier on the flow of the Taku Glacier cannot be clearly identified. The minimum velocity is at pt. 50

(43 cm/day), followed by a section of slow increase up to pt. 46. A sudden acceleration up to 53 cm/day occurs within the next kilometer. The orientations of the movement vectors (App. C3, p. 95) support the assumption that both glaciers are finally united in this area. From pt. 41 downwards the glaciers act as a unit.

Points from to	Gradient [°]	Velocity (mean) [m/day]
24 25	1.43	0.84
25 26	2.11	0.83
26 27	1.67	0.77
27 28	1.54	0.75
28 29	1.32	0.74
29 30	1.70	0.76
30 31	1.53	0.73
31 32	1.19	0.67
32 33	1.28	0.65
33 34	1.56	0.65

Points from to	Gradient [°]	Velocity (mean) [m/day]
34 35	1.47	0.63
35 36	1.55	0.62
36 37	1.58	0.61
37 38	1.07	0.60
38 39	0.73	0.58
39 40	0.89	0.57
40 41	1.16	0.56
41 42	1.53	0.55
42 43	2.07	0.54
43 44	2.18	0.53

Points from to	Gradient [°]	Velocity (mean) [m/day]
44 45	1.43	0.51
45 46	0.79	0.48
46 47	0.57	0.45
47 48	0.54	0.44
48 49	1.26	0.44
49 50	2.48	0.43
50 51	2.15	0.42
51 52	2.07	0.41
52 53	1.87	0.41
53 54	1.09	0.41

Table 4: Surface gradients and velocities of the Taku Glacier Longitudinal Profile

2.2.4. Taku Glacier SW-Branch

The Southwest Branch longitudinal profile begins roughly 3 km upglacier from Profile 5 and continues downglacier to the ”terminus“ of the SW-Branch (App. C1, p. 67). The movements of pts. 14-6 are uniform, (~ 10 cm/day) with only small variations (Tab. 5). The orientations of the movement vectors show an eastern orientation for the first 2 km (pts. 14-11) changing towards northeast (pts.10-7). The influence of the Taku Glacier can be excactly determined. The orientation of the movement vectors begins to reflect the influence of the Taku Glacier at pt. 6, with a much stronger redirection and velocity increase of the flow by the Taku Glacier at pt. 5. App. C1, p. 67 clearly delineates the junction of the SW Branch and the Taku Glacier between pts. 5 and 6. The movement increases from 10 cm/day to 44 cm/day and finally to more than 70 cm/day (Fig. 15) showing impressively that the SW Branch is literally swept away by the mightier Taku Glacier. This is dramatically evidenced by

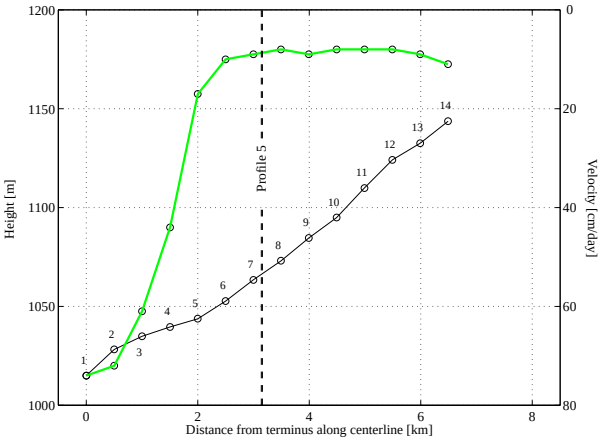


Fig. 15: Longitudinal Profile Taku Glacier SW-Branch.
Measured velocities (grey) and heights (black)

an extensive shear zone which extends across the full width of the SW Branch between longitudinal points 3 to 6.

The gradients between pts. 14 and 6 are similar to those of the other profiles.

Points from to	Gradient [°]	Velocity (mean) [m/day]
1 2	1.51	0.73
2 3	0.77	0.66
3 4	0.54	0.53
4 5	0.47	0.31
5 6	1.04	0.13

Points from to	Gradient [°]	Velocity (mean) [m/day]
6 7	1.24	0.09
7 8	1.10	0.09
8 9	1.33	0.09
9 10	1.19	0.09
10 11	1.72	0.08

Points from to	Gradient [°]	Velocity (mean) [m/day]
11 12	1.62	0.08
12 13	0.97	0.09
13 14	1.27	0.10

Table 5: Surface gradients and velocities of the Taku Glacier SW-Branch Longitudinal Profile

2.3. Height and volume changes

The change of the height of a particular point moving with the glacier's flow is mainly a result of two processes: the ablation and the downhill movement of the point. Since the effects of the two processes are generally not separated, the phrase "short term height change" is used in the following discussion (App. C3, pp. 93-101). It should not be confused with the pure ablation.

As stated before, the accuracy of a GPS determined height is about 5 cm. Therefore, the standard deviation of a height difference is some 7 cm. The timespan between two surveys is some 8 days on average; the standard deviations of the daily height changes are therefore in the range of 1 cm/day.

In order to determine the height changes from one year to the next, the heights of the glacier's surface at a specific point position can be compared, assuming the same position of the point is used year after year and if its height is determined on the same day of the year. In practice, however, a survey can hardly be performed exactly on the same date. Therefore, the height values to be compared have to be interpolated taking the rates of the short term height changes into consideration. The year to year height changes are referred to as "long term height changes" (App. D, pp. 105-109).

MCGEE (1997) discussed the use of GPS for the determination of local surface mass balance. All mass balance data are given in the unit "water equivalent" to compensate for different firn and ice densities. Traditionally, mass balance data are sampled by digging snow pits. This method allows for the determination of reliable density data, and to find the surface of the previous year's firn layer. In contrast, GPS observations can give only height changes of distinct points. To distinguish the traditional mass balance results from GPS derived ones, the latter are called "volume change".

2.3.1. Short term height and volume changes

Plots of all short term height changes are shown in Appendix C2 (pp. 79-89), the corresponding numbers are given in App. C3 (pp. 93-101). In general, the short term height changes show great variations without any regional pattern and are not related to the profile's elevation. The maximum mean height change (-8.6 cm/day) is found at Profile 7a (elevation 1276 m), whereas the minimum (-4.4 cm/day) is at Profile 4 (elevation 1127 m).

In principle, it is possible to use the data of the short term height changes of the double lines of Profile 4 to calculate the volume change in this area. The results may be misleading: the downhill movement of the points pretend a bigger change in height, whereas the deformation of the point grid results in a different area. This can falsify the result in either way. Whereas the area change is well below 0,1%, the error due to the downhill movement can be estimated to be within 2-5%. As no local gradients are available to compensate the heights for, the numbers of the volume change during the summer period of 1999 are given in App. E (p. 117) without discussion.

2.3.2. Long term height and volume changes (1998 to 1999)

The numbers of the long term height changes can be found in App. D (pp. 105-109). It is clearly visible that all profiles experienced an increase in height during the last year. In contrast to the findings of 1998 (WELSCH et al., 1998), a weak trend showing a larger increase in surface elevation at higher elevation profiles can be seen for the 1998-1999 period (Tab. 6). Unfortunately, neither profiles in the ablation area of the Taku Glacier nor profiles on the High Plateau were observed this summer. Profiles in these areas, particularly Profiles 2 and 8, should be resurveyed during the next field season.

Profile	Mean elevation [m]	Mean height change 1998-1999 [m]
III	1034	+0.21
V	1070	+0.40
IV low	1125	+0.63
IV up	1127	+0.57

Profile	Mean elevation [m]	Mean height change 1999-1999 [m]
VIIa	1276	+0.71
VI	1329	+0.71
IIIa	1354	+0.37
VII	1426	+0.86

Table 6: Mean height changes versus elevation

The heights of all points of Profile 3 increased by 0.2 m on an average (Fig. 16). Some points on Profile IIIa were re-positioned this summer. Therefore only 8 out of 15 points are available for a comparison. A quite uniform gain of 0.4 m across the profile is found (Fig. 17).

The heights of all points of Profile 4 increased by 0.6 m on average from 1998 to 1999 (Fig. 18). A very similar pattern of height changes can be seen for the upper and lower line. At the eastern end close to Camp 10 both lines show a decreasing gain in height with the

lowest values at pt. 5 and 8 resp. Further to the west, the height gain first increases and stays stable for about 2.5 km. On the western end the increase drops back to the eastern low values but then reaches peak values again.

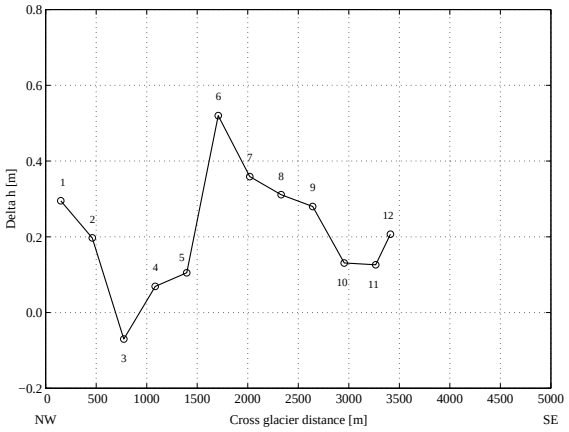


Fig. 16: Height change at Profile 3

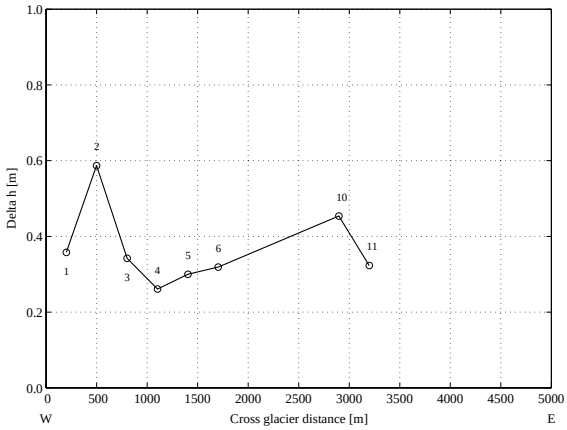


Fig. 17: Height change at Profile 3a

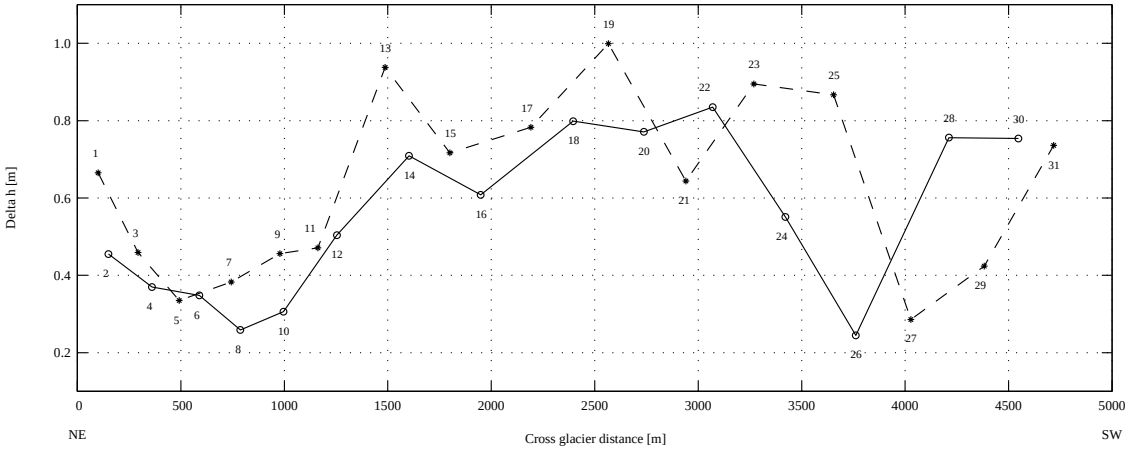


Fig. 18: Height change at Profile 4. Upglacier transect: solid line; downglacier transect: dashed line

The heights of the points of Profile 5 are on average 0.4 m higher in 1999 as compared to 1998 (Fig. 19). An average gain on the northwestern end (pt. 1) is followed by a stretch of minimal elevation gain (pts. 2-5). Further to the southeast a section with an average increase (pts. 6-9) is followed by the maximum height gains of some 0.7 m (pts. 10-11). As in previous years pt. 12 shows a totally different behaviour as its neighboring points. Its position near the top of a small icefall at the base of Taku SW Point may contribute to this anomaly.

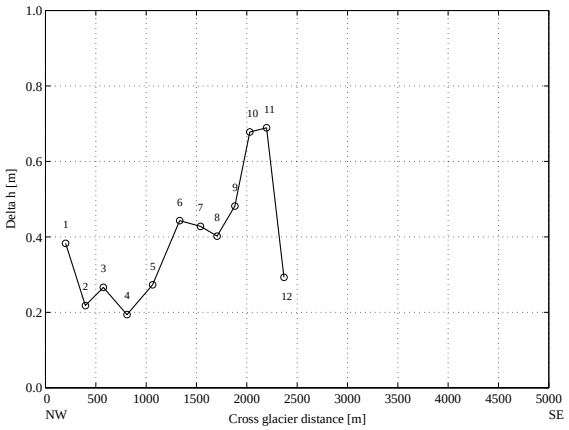


Fig. 19: Height change at Profile 5

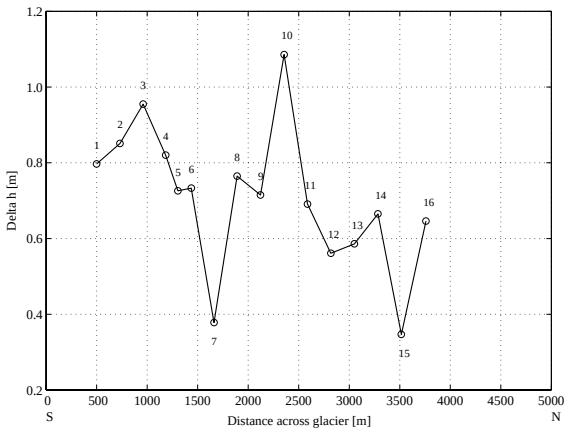


Fig. 20: Height change at Profile 6

Profile 6 experienced a mean increase in elevation of some 0.7 m. In general there is a trend of a smaller increase towards the northern end of the profile (Fig. 20).

The same average increase in height as on Profile 6 can be seen on Profile 7a, which is situated some 50 m lower. Here the elevation gain increases continuously from the northwestern end towards the southeastern end (Fig. 21).

Profile 7, the highest profile of this summer's campaign, experienced the greatest elevation gain. The height increase on both margins are similar, whereas maximum values are found at the central part of the profile (Fig. 22).

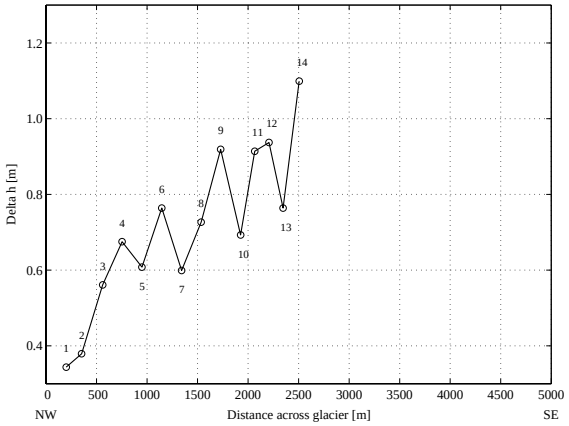


Fig. 21: Height change at Profile 7a

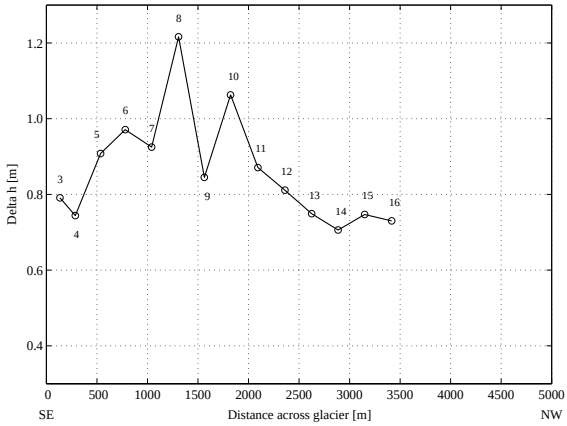
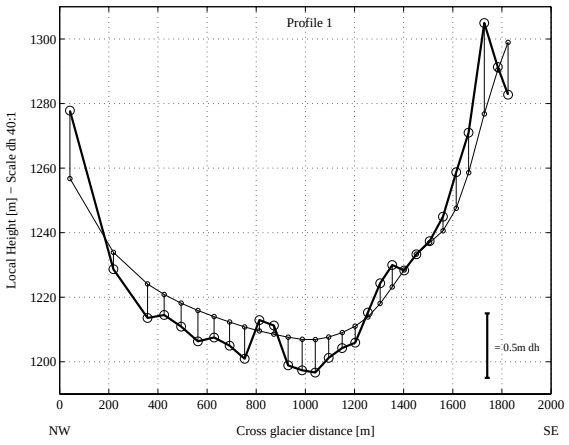


Fig. 22: Height change at Profile 7

A mean loss in height of at least 10.5 m for the uppermost 20% of the Lemon Creek Glacier (Fig. 24) was revealed by LANG (1997a) for the period 1989-1997. A resurvey conducted in 1998 showed that the strong negative trend continued, and a mean loss in height of 2.2 m between 1997 and 1998 was observed (WELSCH et al., 1998). The observations on the "Lemon Height Comparison Profiles" were taken on July 18 this summer. That is 16 days prior to the reference day of August 3. In order to correct the measured heights for the ablation which has taken place during this period, the mean daily height change of the Lemon Creek Glacier movement profile was used.

As a result a mean elevation gain of about 0.1m is found (Fig. 23). The gain in height is much less than on the profiles of the Taku Glacier system at similar elevations. But compared to former years, the devastating downwaste of the Lemon Creek Glacier has slowed condsiderably, at least for the 1998 to1999 time period.



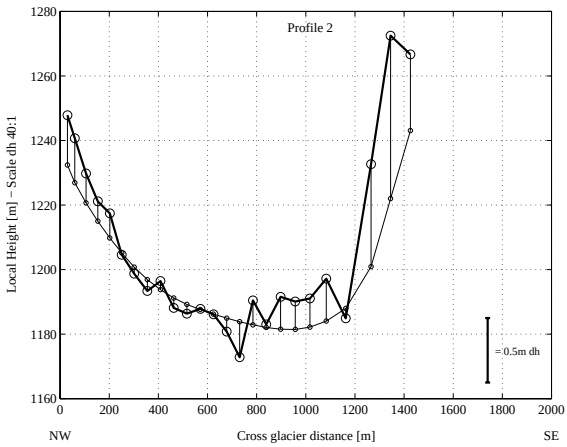


Fig. 23, part I: Lemon Creek Glacier height change 1998-1999: Profiles 1, 2. Thin line: glacier surface 1998, bold line: glacier surface 1999.

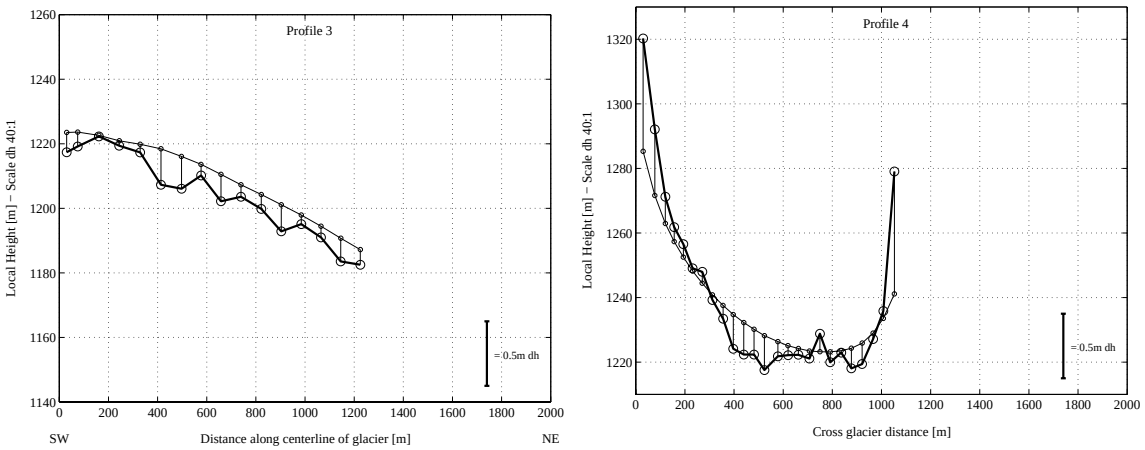


Fig. 23, part II: Lemon Creek Glacier height change 1998-1999: Profiles 3, 4. Thin line: glacier surface 1998, bold line: glacier surface 1999.

The gain of volume at Profile 4 from 1998 to 1999 amounts to $0.6 \cdot 10^6$ m^3. It is the first year since 1994 to register an increase in volume (Tab. 7). The absolute values in Tab. 7 show that this year's gain still leaves the surface well below what it was in 1993, and that several more positive years are needed to restore the glacier to its 1993 elevation.

Timespan (reference day: July, 25)	Volume change (dV) [$m^3 \cdot 10^6$]	Sum dV [$m^3 \cdot 10^6$]
1993 - 1994	+0.187	+0.187
1994 - 1995	-1.514	-1.327
1995 - 1996	-0.552	-1.879
1996 - 1997	-0.555	-2.434
1997 - 1998	-1.043	-3.477
1998 - 1999	+0.575	-2.902

Table 7: Volume change at Profile 4 since 1993

2.4. Strain

According to WELSCH (1997) strain rates can be derived from repeated observations of geometric figures such as triangles. Strain rate measurements, in conjunction with the methods of continuum mechanics, form the basis for further studies of glaciodynamics.

The distribution of the strain rates across the main Taku Glacier on Profile 4 has been consistent over the years. As an example the maximum principle strain rate e1 is shown in Fig. 25.

On the eastern end very small strain rates are dominant, indicating only little stress within the first 500 m of the profile. This is in accordance with the small increase of velocity in this area. Within the next 1 km the maximum principle strain rates are magnified by a factor of 10, which is caused by the rapid increase of the glacier's flow rate. As a consequence numerous shear crevasses are found in this area. In the central section of Profile 4

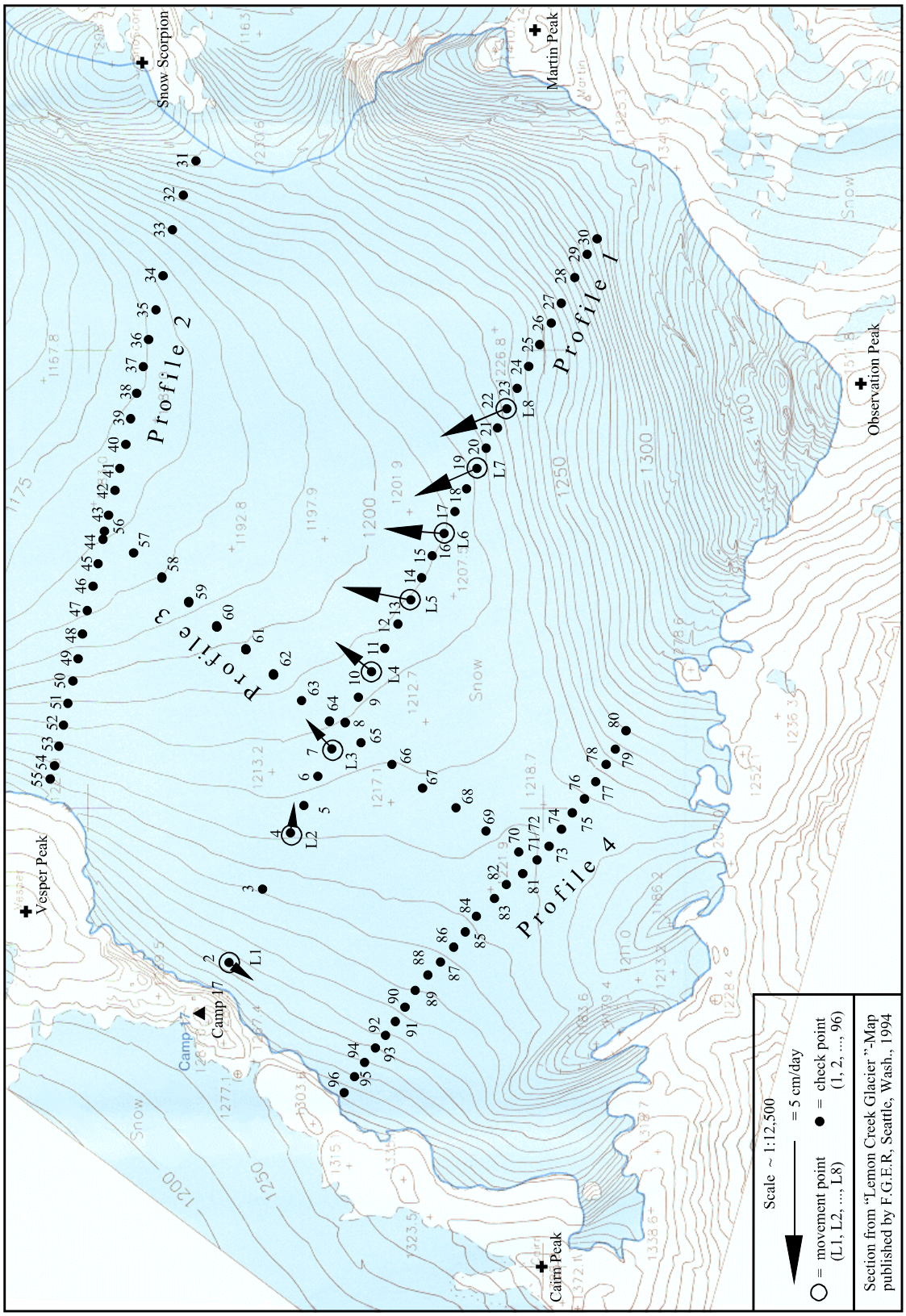


Fig. 24: Movement vectors and locations of height comparison profiles on the Lemon Creek Glacier

a more or less homogeneous movement leads to strain rates which are as low as those found at the eastern end. Here only a few crevasses can be seen on the glacier's surface. Toward the western end the velocity slows down, again resulting in a peak of maximum principle strain. As with the eastern end, numerous shear crevasses are present in this section of the glacier. The velocity and the strain rates at the western end of the profile, being 2-4 times larger than those on the eastern end, show the disturbing influence of the ice flow from the basin between Shoehorn Mountain and Juncture Peak. The calculated strain values arer presented in Appendix F (p. 117).

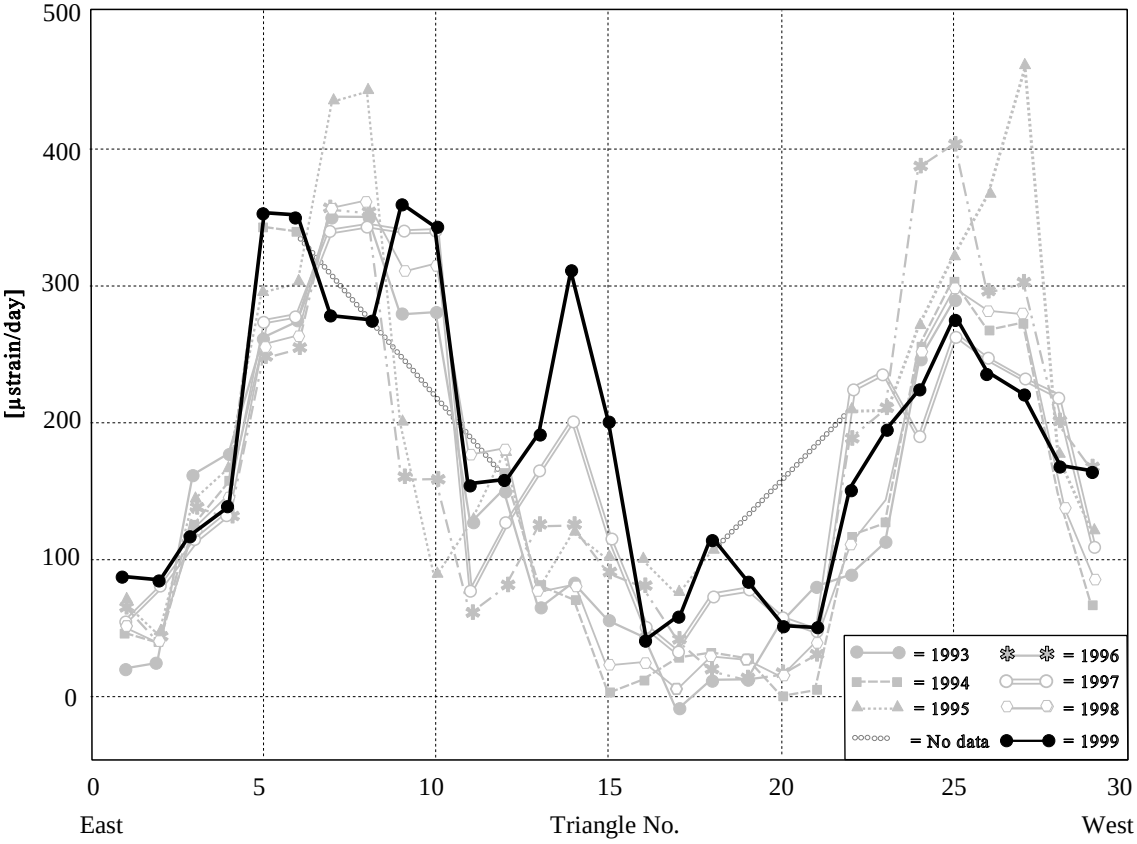


Fig. 25: Maximum principle strain rate (e1) at Profile IV, 1993-1999. Data for 1999 are in black

3. Proposals

The surveying program as practiced this summer proved to be a good compromise between keeping up the records of the traditional movement profiles, investigating new areas and special topics, and last but not least giving lectures to the students. It is suggested to keep up a similar schedule in the future which allows for the measurement of 5-7 old profiles each season, but yet leaves enough time to establish 2-4 new profiles to fill the gaps between existing profiles (e. g. on the Demorest Glacier) or to investigate glaciers which have not been explored. Special investigations (e. g. Lemon Creek Glacier height comparison) will still fit in.

Some of the existing profiles should be re-arranged (see chapter 2.1.3.), and for reliable short term height changes a greater timespan between both surveys is advised. The determination of local glacier gradients will permit the calculation of pure ablation from GPS observations only. The resurvey of profiles in lower (e.g. Profile II) and in the highest elevations (e.g. Profile VIII) is necessary to gather more data for long term height changes.

The completion of the longitudinal profiles of the entire Taku-Matthes-Llewellyn-Glacier system remains a top priority for upcoming seasons.

A possible focus for the survey work in the near future is the Llewellyn Glacier. Profiles on the Llewellyn Glacier at elevations similar to those on the Taku Glacier will provide important data pertaining to the different flow regimes of glaciers on the maritime and the continental side of the Icefield. Continued collection of long term height change data will lead to a better understanding of the entire Icefield and the complex processes controlling the fluctuations of the glaciers.

The small-scale flow pattern of the Taku Glacier (as an example) should be investigated (LANG, 1997b) with the aid of a permanently monitoring GPS-receiver array.

4. Acknowledgment

The professional support and the excellent logistics provided by Prof. Dr. M. M. Miller made the completion of this summer's survey program possible. All this could not have been performed without the excellent off-ice logistics handled perfectly by Kathleen B. Schoen and the all the participants of the 1999 summer Institute who always helped out when necessary.

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Appendix A

Coordinates of JIRP benchmarks (ITRF93)

Date of last revision:
October 1, 1999

Camp 10 area						
Point name	Point number	GPS	Year	Easting [m]	Northing [m]	Height [m]
FFGR 19	1	*	1995	488001.819	6503290.614	1180.835
FFGR 19B	1.1	-	1985	488383.812	6503660.530	1241.866
FFGR 19D	1.2	-	1985	488260.073	6503696.172	1254.266
FFGR 19C	1.3	*	1995	487983.650	6503410.034	1197.999
Taku B Lower	1.4	-	1983	488291.605	6503745.868	-
Camp 10 North	1.5	-	1987	487953.316	6503398.642	-
SW-Taku	2	-	1987	487333.574	6495903.938	-
SW-Taku East	2.1	-	1987	487312.700	6495908.412	-
SW Taku Lower	2.2	*	1992	487320.590	6495968.918	1133.487
Taku A	3	-	1982	490529.133	6501653.627	1512.038
Taku B	4	-	1981	488584.437	6504541.022	1590.036
Taku B Cairn	4.1	-	1983	488583.775	6504540.870	-
Taku C	5	-	1982	485696.044	6506827.041	1545.431
Taku C Lower	5.1	-	1987	485645.149	6506713.779	1528.351
Sunday Point	6	-	1987	490254.409	6500611.311	-
Sunday Point Cairn	6.1	-	1987	490235.701	6500682.263	-
Taku D	7	-	1983	482941.369	6509777.053	-
Taku D Cairn (FFGR65)	7.1	*	1995	482942.071	6509779.957	1774.108
Taku D Lower	8	*	1995	482601.539	6509092.743	1399.212
Camp 9	9	*	1996	489442.404	6510665.079	1556.223
Camp 9 Cairn	9.1	-	1983	489443.183	6510663.361	-
NW Taku	10	*	1995	479186.763	6505147.717	1402.060
NW Taku Cairn	10.1	*	1997	479188.345	6505144.663	1402.149
Shoehorn Peak	11	-	1981	482657.922	6500295.567	1326.342
Juncture Peak	12	-	1983	485056.994	6498619.047	1339.311
Juncture Peak Lower	12.1	-	1983	485424.713	6498221.909	-
Bavaria Point	13	-	1987	489420.666	6501375.002	-
Glacier King	14	-	1982	474734.289	6509446.896	1481.238
Glacier King Cairn	14.1	-	1982	474736.005	6509445.705	-
Camp 10 A	15	*	1992	489181.351	6501882.011	1105.757
Vantage Peak	16	-	1982	490390.615	6504291.679	1709.737
Twin Peak Geodetic	17	-	1981	500177.078	6499821.685	-
Scott	19.1	*	1995	487963.303	6503372.111	1189.739
Exploration Peak	-	-	1984	487450.796	6507809.503	-

Camp 10 area - continued						
Point name	Point number	GPS	Year	Easting [m]	Northing [m]	Height [m]
Lupine	-	*	1998	490263.717	6500621.560	1080.574
Vista (Camp 9)	-	*	1998	489873.478	6510298.945	1564.057

Camp 18 area						
Point name	Point number	GPS	Year	Easting [m]	Northing [m]	Height [m]
FFGR 45 (Camp 18 Hill)	1	*	1997	484309.150	6524412.394	1746.191
Camp 8	2	-	1987	492140.788	6521149.048	-
FFGR 31 (Camp 8)	2.1	*	1993	492136.624	6521147.773	2051.576
FFGR 39 (Blizzard Pt.)	4	*	1993	487443.145	6524360.975	1984.385
FFGR 68 (Camp 18 Hill)	5	*	1997	484425.554	6524412.335	1751.611
FFGR 24 (Camp 18 Hill)	6	*	1995	484189.635	6524371.872	1733.416
FFGR 43 (Camp 18)	7	*	1995	483990.101	6524352.738	1703.762
FFGR 44 (Cleaver)	8	*	1997	483834.598	6524280.382	1669.572
FFGR 31 (Cleaver)	9	*	1997	483705.534	6524279.606	1623.548
FFGR 49 (Cleaver)	11	-	1982	483244.123	6524040.612	-
FFGR 48 (Cleaver)	12	-	1982	483375.593	6524007.974	-
Camp 19	14	-	1981	482226.811	6522614.250	-
FFGR 18 (Camp 19)	15	-	1982	482294.684	6522477.554	-
FFGR 12 (Camp 19)	16	*	1995	482221.820	6522621.728	1292.865
Mammary Peak Pt.	17	*	1997	484896.620	6522670.609	1928.018
Mt. Moore	18	-	1983	492458.688	6521225.686	2176.952
Mt. Moore Cairn	18.1	-	1983	492460.494	6521228.959	-
FFGR 63 (Camp 18 Hill)	22	*	1997	484315.335	6524309.996	1723.699
FFGR 64 (Camp 18 Hill)	23	*	1997	484219.214	6524334.390	1727.783
Camp 19TL	25	-	1981	482224.893	6522611.681	-
FFGR 04 (Cleaver)	26	*	1995	483309.746	6524118.094	1388.753
FFGR 53 (Camp 19)	27	*	1995	482195.157	6522670.922	1277.773
FFGR 42	28	-	1982	483435.183	6524134.408	1426.096
N1 (Camp 18)	29	*	1995	484073.444	6524262.764	1698.457
N2 (Camp 18)	30	*	1997	483956.314	6524239.526	1682.217
FFGR 34 (Camp 18 Hill)	31	*	1997	484554.464	6524402.905	1734.890
FFGR 62 (F10 Pt.)	32	*	1997	492497.562	6535469.195	1860.563

* = Coordinates derived using GPS measurements Year = year of (last) observation

Appendix B1

Coordinate Listing of Movement Profile Flags

Lemon Creek Glacier (Camp 17 – Martin Peak Saddle) (1)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LEM 01	478658.271	6472199.604	1257.925	18.07.99	18:07
LEM 02	478955.316	6472091.105	1225.044	18.07.99	18:12
LEM 03	479146.553	6472015.917	1216.859	18.07.99	18:19
LEM 04	479322.219	6471944.401	1211.728	18.07.99	18:25
LEM 05	479485.615	6471876.157	1208.534	18.07.99	18:30
LEM 06	479638.536	6471814.316	1208.585	18.07.99	18:37
LEM 07	479786.888	6471755.514	1214.844	18.07.99	18:43
LEM 08	479924.317	6471702.207	1229.381	18.07.99	18:51
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LEM 01	478658.252	6472199.574	1257.223	30.07.99	11:41
LEM 02	478955.375	6472091.103	1224.365	30.07.99	11:51
LEM 03	479146.629	6472016.001	1216.132	30.07.99	11:56
LEM 04	479322.314	6471944.516	1211.030	30.07.99	12:02
LEM 05	479485.642	6471876.370	1207.843	30.07.99	12:06
LEM 06	479638.531	6471814.512	1207.937	30.07.99	12:10
LEM 07	479786.776	6471755.722	1214.066	30.07.99	12:16
LEM 08	479924.197	6471702.423	1228.656	30.07.99	12:20

Ptarmigan Glacier (Vesper Peak – Peak 3652) (1)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
PTARMIGAN 01	478281.189	6472611.053	1157.852	18.07.99	19:35
PTARMIGAN 02	478134.939	6472604.899	1130.118	18.07.99	19:40
PTARMIGAN 03	478026.147	6472602.251	1124.299	18.07.99	19:44
PTARMIGAN 04	477951.938	6472600.607	1124.585	18.07.99	19:49
PTARMIGAN 05	477896.290	6472599.553	1125.128	18.07.99	19:53
PTARMIGAN 06	477797.124	6472597.845	1130.134	18.07.99	19:57
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
PTARMIGAN 01	478281.093	6472611.142	1157.101	30.07.99	13:55
PTARMIGAN 02	478134.857	6472605.061	1129.437	30.07.99	13:59
PTARMIGAN 03	478026.110	6472602.327	1123.609	30.07.99	14:01
PTARMIGAN 04	477951.892	6472600.663	1123.918	30.07.99	14:04
PTARMIGAN 05	477896.236	6472599.550	1124.489	30.07.99	14:06
PTARMIGAN 06	477797.113	6472597.793	1129.502	30.07.99	14:08

(1) = Coordinates do not belong to the JIRP coordinate system due to reference to a single point solution.

Longitudinal Profile Demorest Glacier

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LON DEM 01	490757.060	6497410.805	960.315	28.07.99	17:10
LON DEM 02	490726.365	6497907.699	975.972	28.07.99	16:59
LON DEM 03	490830.577	6498400.633	981.523	28.07.99	16:42
LON DEM 04	491050.040	6498839.717	985.377	28.07.99	16:24
LON DEM 05	491377.856	6499212.162	993.237	28.07.99	16:09
LON DEM 06	491791.226	6499497.722	1000.910	28.07.99	15:54
LON DEM 07	492235.338	6499729.974	1011.666	28.07.99	15:48
LON DEM 08	492684.833	6499945.309	1023.304	28.07.99	15:42
LON DEM 09	493117.983	6500195.032	1037.997	28.07.99	15:18
LON DEM 20	495941.051	6504359.726	1179.373	01.08.99	16:40
LON DEM 21	495864.649	6504850.024	1186.556	01.08.99	16:35
LON DEM 22	495719.417	6505325.879	1197.256	01.08.99	16:30
LON DEM 23	495497.285	6505774.325	1208.315	01.08.99	16:25
LON DEM 24	495249.123	6506208.799	1219.233	01.08.99	16:19
LON DEM 25	495037.577	6506662.252	1229.103	01.08.99	16:07
LON DEM 26	494854.766	6507127.234	1238.978	01.08.99	16:02
LON DEM 27	494690.040	6507599.935	1253.568	01.08.99	15:57
LON DEM 28	494530.462	6508074.829	1263.921	01.08.99	15:49
LON DEM 29	494390.582	6508553.612	1265.337	01.08.99	15:43
LON DEM 30	494281.943	6509041.109	1286.445	01.08.99	15:37
LON DEM 31	494193.390	6509530.082	1310.170	01.08.99	15:30
LON DEM 32	494177.432	6510029.054	1330.370	01.08.99	15:25
LON DEM 33	494192.374	6510525.762	1343.637	01.08.99	15:19
LON DEM 34	494282.718	6511013.718	1351.956	01.08.99	15:00

Longitudinal Profile Demorest Glacier - continued

Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LON DEM 01	490760.072	6497405.107	959.439	05.08.99	16:40
LON DEM 02	490729.664	6497902.700	975.168	05.08.99	16:32
LON DEM 03	490833.025	6498396.728	980.979	05.08.99	16:20
LON DEM 04	491050.789	6498837.011	984.919	05.08.99	16:06
LON DEM 05	491377.335	6499209.971	992.790	05.08.99	15:53
LON DEM 06	491790.051	6499495.836	1000.459	05.08.99	15:29
LON DEM 07	492233.821	6499728.361	1011.158	05.08.99	15:26
LON DEM 08	492683.205	6499944.096	1022.775	05.08.99	15:11
LON DEM 09	493116.289	6500194.102	1037.363	05.08.99	15:07
LON DEM 20	495941.468	6504357.394	1178.922	09.08.99	15:42
LON DEM 21	495865.351	6504847.843	1186.135	09.08.99	15:40
LON DEM 22	495720.125	6505323.867	1196.847	09.08.99	15:37
LON DEM 23	495498.165	6505772.425	1207.810	09.08.99	15:28
LON DEM 24	495249.932	6506206.924	1218.738	09.08.99	15:26
LON DEM 25	495038.359	6506660.357	1228.653	09.08.99	15:23
LON DEM 26	494855.450	6507125.394	1238.433	09.08.99	15:20
LON DEM 27	494690.802	6507598.147	1253.061	09.08.99	15:18
LON DEM 28	494530.956	6508072.711	1263.322	09.08.99	15:13
LON DEM 29	494391.218	6508551.943	1264.855	09.08.99	15:11
LON DEM 30	494282.380	6509039.456	1285.815	09.08.99	15:08
LON DEM 31	494193.398	6509528.411	1309.493	09.08.99	15:03
LON DEM 32	494177.143	6510027.486	1329.807	09.08.99	14:59
LON DEM 33	494191.919	6510524.402	1343.144	09.08.99	14:55
LON DEM 34	494282.196	6511012.314	1351.456	09.08.99	14:45

Longitudinal Profile Matthes/Taku Glacier

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LON TAKU 24	490889.627	6496929.679	946.782	28.07.99	17:30
LON TAKU 25	490565.931	6497307.464	959.160	28.07.99	17:44
LON TAKU 26	490194.839	6497645.241	977.639	28.07.99	17:51
LON TAKU 27	489812.825	6497965.365	992.135	28.07.99	18:00
LON TAKU 28	489618.959	6498128.367	998.944	28.07.99	18:07
LON TAKU 29	489235.668	6498449.710	1010.427	28.07.99	18:13
LON TAKU 30	488848.864	6498768.799	1025.340	28.07.99	18:26
LON TAKU 31	488471.617	6499101.062	1038.748	28.07.99	18:33
LON TAKU 32	488098.835	6499436.344	1049.158	27.07.99	12:44
LON TAKU 33	487723.615	6499767.389	1060.361	27.07.99	12:38
LON TAKU 34	487348.925	6500101.067	1074.068	27.07.99	12:32
LON TAKU 35	486995.023	6500454.788	1086.930	27.07.99	12:19
LON TAKU 36	486652.259	6500816.186	1100.390	27.07.99	12:12
LON TAKU 37	486312.306	6501181.040	1114.116	27.07.99	12:04
LON TAKU 38	485985.242	6501559.564	1123.495	27.07.99	11:53
LON TAKU 39	485675.799	6501949.426	1129.825	27.07.99	14:27
LON TAKU 40	485364.475	6502341.713	1137.566	27.07.99	14:35
LON TAKU 41	485064.935	6502746.042	1147.794	27.07.99	14:41
LON TAKU 42	484784.073	6503160.682	1161.172	27.07.99	14:48
LON TAKU 43	484537.282	6503595.770	1179.260	27.07.99	14:53
LON TAKU 44	484289.725	6503967.502	1196.298	29.07.99	16:28
LON TAKU 45	484084.822	6504427.005	1208.815	29.07.99	16:49
LON TAKU 46	483954.448	6504907.917	1215.718	29.07.99	16:59
LON TAKU 47	483909.399	6505405.714	1220.695	29.07.99	17:28
LON TAKU 48	483900.558	6505903.479	1225.350	29.07.99	17:45
LON TAKU 49	483952.366	6506401.708	1236.388	29.07.99	17:59
LON TAKU 50	484058.063	6506888.973	1257.986	29.07.99	18:14
LON TAKU 51	484277.311	6507336.563	1276.663	29.07.99	18:52
LON TAKU 52	484569.112	6507741.390	1294.706	29.07.99	18:50
LON TAKU 53	484851.901	6508149.687	1310.907	29.07.99	18:44
LON TAKU 54	485109.198	6508581.787	1320.494	01.08.99	19:25
LON TAKU 55	485355.608	6509017.515	1331.035	01.08.99	19:18
LON TAKU 56	485598.555	6509453.735	1345.728	01.08.99	19:11
LON TAKU 57	485844.072	6509890.252	1358.342	01.08.99	19:05
LON TAKU 58	486093.540	6510323.253	1366.715	01.08.99	10:16
LON TAKU 59	486352.825	6510750.468	1374.704	01.08.99	10:08
LON TAKU 60	486622.333	6511171.870	1386.601	01.08.99	10:01
LON TAKU 61	486907.888	6511581.621	1399.589	01.08.99	09:32
LON TAKU 62	487210.364	6511979.364	1410.317	01.08.99	09:26

Longitudinal Profile Matthes/Taku Glacier – continued

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LON TAKU 63	487520.307	6512370.237	1425.845	03.08.99	17:47
LON TAKU 64	487829.067	6512765.252	1442.621	03.08.99	17:37
LON TAKU 65	488126.819	6513166.677	1456.664	03.08.99	17:30
LON TAKU 66	488414.298	6513574.419	1467.288	03.08.99	17:23
LON TAKU 67	488676.828	6513996.955	1476.690	03.08.99	17:16
LON TAKU 68	488896.124	6514444.604	1489.341	03.08.99	17:09
LON TAKU 69	489045.080	6514919.194	1502.346	03.08.99	17:03
LON TAKU 70	489154.859	6515405.826	1514.703	03.08.99	16:48
LON TAKU 71	489161.589	6515901.024	1523.163	03.08.99	16:42
LON TAKU 72	489071.889	6516388.642	1537.043	03.08.99	16:35
LON TAKU 73	488909.595	6516860.471	1549.892	03.08.99	16:27
LON TAKU 74	488844.748	6517355.696	1579.820	03.08.99	16:20
LON TAKU 75	488837.972	6517852.713	1622.907	03.08.99	16:15
LON TAKU 76	488853.440	6518347.933	1644.950	03.08.99	16:08
LON TAKU 77	488887.196	6518845.206	1658.380	03.08.99	16:04
LON TAKU 78	488939.386	6519340.657	1685.057	03.08.99	15:57
LON TAKU 79	488996.272	6519837.418	1708.240	03.08.99	15:51
LON TAKU 80	489057.106	6520334.600	1725.475	03.08.99	15:47
LON TAKU 81	489152.162	6520825.208	1741.273	03.08.99	15:33
LON TAKU 82	489247.239	6521315.807	1755.810	03.08.99	15:25
LON TAKU 83	489358.628	6521802.186	1769.210	03.08.99	15:17
LON TAKU 84	489506.482	6522278.125	1781.140	03.08.99	15:05
LON TAKU 85	489654.276	6522754.063	1794.716	03.08.99	14:56
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LON TAKU 24	490891.710	6496923.537	945.898	05.08.99	16:52
LON TAKU 25	490568.959	6497301.228	958.305	05.08.99	16:59
LON TAKU 26	490199.382	6497640.134	976.647	06.08.99	10:20
LON TAKU 27	489817.522	6497961.748	991.418	05.08.99	17:11
LON TAKU 28	489623.889	6498125.000	998.052	05.08.99	17:13
LON TAKU 29	489240.583	6498446.561	1009.616	05.08.99	17:22
LON TAKU 30	488853.526	6498764.728	1024.940	05.08.99	17:28
LON TAKU 31	488475.432	6499097.162	1037.960	05.08.99	17:35
LON TAKU 32	488102.605	6499431.643	1048.162	05.08.99	17:45
LON TAKU 33	487727.319	6499762.620	1059.050	05.08.99	17:50
LON TAKU 34	487352.892	6500096.730	1073.121	05.08.99	17:54
LON TAKU 35	486999.065	6500450.749	1085.992	05.08.99	17:58
LON TAKU 36	486656.537	6500812.397	1099.590	05.08.99	18:01
LON TAKU 37	486316.634	6501177.457	1113.287	05.08.99	18:04
LON TAKU 38	485989.120	6501556.724	1122.834	04.08.99	16:13

Longitudinal Profile Matthes/Taku Glacier – continued

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LON TAKU 39	485679.439	6501946.573	1129.142	04.08.99	16:18
LON TAKU 40	485367.917	6502338.742	1136.858	04.08.99	16:23
LON TAKU 41	485068.080	6502742.939	1147.066	04.08.99	16:28
LON TAKU 42	484786.978	6503157.350	1160.393	04.08.99	16:32
LON TAKU 43	484539.595	6503592.125	1178.488	04.08.99	16:36
LON TAKU 44	484291.114	6503964.658	1195.802	04.08.99	16:40
LON TAKU 45	484085.935	6504424.263	1208.291	04.08.99	16:44
LON TAKU 46	483955.352	6504905.286	1215.317	04.08.99	16:48
LON TAKU 47	483910.238	6505403.194	1220.259	04.08.99	16:56
LON TAKU 48	483901.119	6505900.879	1224.893	04.08.99	17:01
LON TAKU 49	483952.503	6506399.122	1235.815	04.08.99	17:05
LON TAKU 50	484057.512	6506886.497	1257.474	04.08.99	17:10
LON TAKU 51	484275.975	6507334.478	1276.091	04.08.99	17:14
LON TAKU 52	484567.384	6507739.766	1294.170	04.08.99	17:18
LON TAKU 53	484850.035	6508148.098	1310.405	04.08.99	17:21
LON TAKU 54	485108.375	6508580.913	1320.203	04.08.99	17:28
LON TAKU 55	485354.471	6509016.022	1330.655	06.08.99	16:44
LON TAKU 56	485597.563	6509452.091	1345.411	06.08.99	16:49
LON TAKU 57	485843.189	6509888.686	1357.914	06.08.99	16:58
LON TAKU 58	486092.004	6510321.067	1366.278	09.08.99	18:18
LON TAKU 59	486351.154	6510748.495	1374.032	09.08.99	18:16
LON TAKU 60	486620.608	6511169.467	1386.056	09.08.99	18:14
LON TAKU 61	486906.305	6511579.356	1398.995	09.08.99	18:12
LON TAKU 62	487208.738	6511977.149	1409.754	09.08.99	18:09
LON TAKU 63	487519.242	6512368.667	1425.415	09.08.99	18:26
LON TAKU 64	487828.057	6512763.690	1442.126	09.08.99	18:28
LON TAKU 65	488125.860	6513165.041	1456.195	09.08.99	18:30
LON TAKU 66	488413.418	6513572.695	1466.803	09.08.99	18:32
LON TAKU 67	488676.088	6513995.097	1476.157	09.08.99	18:34
LON TAKU 68	488895.533	6514442.543	1488.813	09.08.99	18:37
LON TAKU 69	489044.725	6514916.958	1501.867	09.08.99	18:39
LON TAKU 70	489154.799	6515403.501	1514.308	09.08.99	18:41
LON TAKU 71	489161.842	6515898.606	1522.780	09.08.99	18:44
LON TAKU 72	489072.232	6516386.085	1536.593	09.08.99	18:46
LON TAKU 73	488909.992	6516857.736	1549.342	09.08.99	18:51
LON TAKU 74	488844.914	6517352.731	1579.146	09.08.99	18:56
LON TAKU 75	488838.154	6517849.738	1622.340	09.08.99	18:59
LON TAKU 76	488853.742	6518344.913	1644.478	10.08.99	15:15
LON TAKU 77	488887.220	6518842.435	1657.847	10.08.99	15:48
LON TAKU 78	488938.846	6519338.242	1684.535	10.08.99	15:44
LON TAKU 79	488995.496	6519835.323	1707.734	10.08.99	15:38

Longitudinal Profile Matthes/Taku Glacier – continued

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LON TAKU 80	489056.401	6520332.775	1725.028	10.08.99	15:34
LON TAKU 81	489151.724	6520823.625	1740.819	10.08.99	15:30
LON TAKU 82	489246.934	6521314.456	1755.448	10.08.99	15:27
LON TAKU 83	489358.246	6521800.972	1768.790	10.08.99	15:23
LON TAKU 84	489506.076	6522277.023	1780.731	10.08.99	15:20
LON TAKU 85	489653.893	6522753.061	1793.808	10.08.99	15:15

Longitudinal Profile Taku Glacier SW Branch

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LON SW 01	489153.978	6498308.010	1015.035	26.07.99	18:12
LON SW 02	488654.555	6498350.878	1028.207	26.07.99	18:01
LON SW 03	488156.475	6498317.778	1034.913	26.07.99	17:48
LON SW 04	487671.255	6498185.930	1039.625	26.07.99	17:34
LON SW 05	487235.576	6497941.765	1043.735	26.07.99	17:17
LON SW 06	486870.171	6497605.623	1052.719	26.07.99	17:00
LON SW 07	486548.927	6497226.206	1063.459	26.07.99	13:25
LON SW 08	486232.682	6496840.868	1073.048	26.07.99	13:38
LON SW 09	485914.690	6496458.237	1084.596	26.07.99	13:49
LON SW 10	485611.143	6496062.971	1094.926	26.07.99	14:04
LON SW 11	485307.361	6495666.293	1109.960	26.07.99	14:36
LON SW 12	485006.445	6495263.837	1124.132	26.07.99	14:57
LON SW 13	484717.770	6494857.400	1132.579	26.07.99	15:38
LON SW 14	484440.731	6494442.844	1143.632	26.07.99	15:52
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LON SW 01	489160.697	6498303.743	1014.219	06.08.99	10:44
LON SW 02	488660.749	6498346.263	1027.326	06.08.99	10:49
LON SW 03	488161.584	6498313.748	1034.042	06.08.99	10:53
LON SW 04	487675.095	6498183.097	1038.832	06.08.99	10:58
LON SW 05	487237.259	6497941.197	1043.038	06.08.99	11:07
LON SW 06	486871.100	6497606.085	1052.101	06.08.99	11:10
LON SW 07	486549.545	6497226.978	1062.754	06.08.99	11:25
LON SW 08	486233.139	6496841.674	1072.394	06.08.99	11:40
LON SW 09	485915.102	6496459.166	1083.845	06.08.99	11:55
LON SW 10	485611.705	6496063.677	1094.373	06.08.99	11:59
LON SW 11	485308.020	6495666.797	1109.384	06.08.99	12:02
LON SW 12	485007.270	6495264.254	1123.545	06.08.99	12:10
LON SW 13	484718.662	6494857.801	1131.899	06.08.99	12:15
LON SW 14	484441.703	6494443.527	1142.922	06.08.99	12:22

Profile 3 (Demorest Glacier, Taku A – Hodgkins Peak)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
DEM 01	491627.079	6501358.355	1015.797	26.07.99	15:03
DEM 02	491863.047	6501154.488	1021.630	26.07.99	15:17
DEM 03	492098.676	6500950.720	1024.457	26.07.99	15:28
DEM 04	492334.554	6500746.677	1028.961	26.07.99	15:35
DEM 05	492570.296	6500542.958	1027.574	26.07.99	15:42
DEM 06	492806.262	6500339.040	1026.843	26.07.99	15:50
DEM 07	493041.928	6500135.075	1035.592	26.07.99	15:59
DEM 08	493277.740	6499931.534	1045.504	26.07.99	16:05
DEM 09	493513.532	6499727.559	1048.442	26.07.99	16:11
DEM 10	493749.423	6499523.802	1047.074	26.07.99	16:36
DEM 11	493984.359	6499320.678	1044.989	26.07.99	16:58
DEM 12	494103.024	6499234.982	1042.329	26.07.99	17:05
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
DEM 01	491627.067	6501358.269	1015.366	05.08.99	13:42
DEM 02	491862.529	6501154.158	1021.204	05.08.99	14:44
DEM 03	492097.471	6500949.906	1023.957	05.08.99	14:57
DEM 04	492332.709	6500745.477	1028.506	05.08.99	15:03
DEM 05	492568.185	6500541.566	1027.060	05.08.99	15:08
DEM 06	492804.051	6500337.721	1026.132	05.08.99	15:13
DEM 07	493039.604	6500133.928	1034.932	05.08.99	15:18
DEM 08	493275.619	6499930.488	1044.767	05.08.99	15:25
DEM 09	493511.491	6499726.591	1047.704	05.08.99	15:29
DEM 10	493747.872	6499522.825	1046.431	05.08.99	16:09
DEM 11	493983.473	6499319.926	1044.359	05.08.99	16:24
DEM 12	494101.775	6499234.439	1041.624	05.08.99	16:32

Profile 3a (Upper Demorest Glacier, Spider Mt. – Peak 5370)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
DEM UP 01	492009.683	6510931.602	1354.577	01.08.99	13:11
DEM UP 02	492309.351	6510940.424	1343.005	01.08.99	13:17
DEM UP 03	492611.755	6510949.336	1336.706	01.08.99	13:23
DEM UP 04	492911.923	6510958.447	1335.583	01.08.99	13:27
DEM UP 05	493213.042	6510967.166	1334.979	01.08.99	13:32
DEM UP 06	493513.414	6510976.364	1337.872	01.08.99	13:39
DEM UP 07	493807.409	6510984.579	1342.556	01.08.99	13:47
DEM UP 08	494109.448	6510992.832	1348.352	01.08.99	13:52
DEM UP 09	494407.213	6511001.091	1354.213	01.08.99	13:57
DEM UP 10	494706.581	6511009.717	1359.308	01.08.99	14:04
DEM UP 11	495006.768	6511018.261	1364.672	01.08.99	14:10
DEM UP 12	495309.020	6511026.776	1369.551	01.08.99	14:13
DEM UP 13	495607.578	6511035.213	1375.463	01.08.99	14:20
DEM UP 14	495908.106	6511043.518	1382.261	01.08.99	14:26
DEM UP 15	496208.896	6511052.760	1396.352	01.08.99	14:32
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
DEM UP 01	492009.714	6510931.626	1354.055	09.08.99	13:11
DEM UP 02	492309.330	6510940.292	1342.641	09.08.99	13:15
DEM UP 03	492611.799	6510949.028	1336.349	09.08.99	13:18
DEM UP 04	492911.783	6510957.641	1335.142	09.08.99	13:21
DEM UP 05	493212.622	6510965.973	1334.395	09.08.99	13:25
DEM UP 06	493512.936	6510975.021	1337.399	09.08.99	13:30
DEM UP 07	493806.858	6510983.145	1342.032	09.08.99	13:32
DEM UP 08	494108.846	6510991.351	1347.848	09.08.99	14:04
DEM UP 09	494406.563	6510999.768	1353.732	09.08.99	14:12
DEM UP 10	494705.954	6511008.505	1358.843	09.08.99	14:15
DEM UP 11	495006.179	6511017.287	1364.224	09.08.99	14:17
DEM UP 12	495308.586	6511026.154	1369.084	09.08.99	14:20
DEM UP 13	495607.362	6511034.925	1375.020	09.08.99	14:24
DEM UP 14	495908.031	6511043.377	1381.843	09.08.99	14:27
DEM UP 15	496208.888	6511052.740	1395.745	09.08.99	14:30

Profile 3b (Demorest Glacier, Floprock Peak – The Scatter Peaks)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
DEM MID 01	496374.305	6506824.861	1235.485	07.08.99	11:51
DEM MID 02	495883.988	6506762.848	1229.325	07.08.99	12:08
DEM MID 03	495387.511	6506702.636	1231.291	07.08.99	12:13
DEM MID 04	494891.494	6506640.948	1227.371	07.08.99	12:18
DEM MID 05	494394.597	6506582.871	1232.674	07.08.99	12:27
DEM MID 06	493898.548	6506522.531	1239.514	07.08.99	12:33
DEM MID 07	493402.704	6506463.361	1240.836	07.08.99	12:39
DEM MID 08	492907.070	6506404.580	1287.987	07.08.99	12:51
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
DEM MID 01	496374.299	6506824.825	1235.362	09.08.99	15:57
DEM MID 02	495884.069	6506762.517	1229.245	09.08.99	16:04
DEM MID 03	495387.695	6506702.138	1231.133	09.08.99	16:08
DEM MID 04	494891.706	6506640.436	1227.346	09.08.99	16:14
DEM MID 05	494394.802	6506582.405	1232.543	09.08.99	16:13
DEM MID 06	493898.728	6506522.135	1239.440	09.08.99	16:18
DEM MID 07	493402.780	6506463.219	1240.699	09.08.99	16:22
DEM MID 08	492907.139	6506404.577	1287.822	09.08.99	16:25

Profile 4 (Taku Glacier, Camp 10 – Shoehorn Mt.) - Lower Line

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
TAKU IV 01	487744.644	6503055.208	1117.399	24.07.99	12:38
TAKU IV 03	487601.389	6502925.647	1120.282	24.07.99	12:47
TAKU IV 05	487454.612	6502792.537	1119.897	24.07.99	12:50
TAKU IV 07	487267.485	6502622.747	1117.473	24.07.99	13:06
TAKU IV 09	487090.401	6502461.191	1117.964	24.07.99	13:08
TAKU IV 11	486957.088	6502340.020	1118.744	24.07.99	13:14
TAKU IV 13	486718.705	6502123.142	1118.520	24.07.99	13:19
TAKU IV 15	486486.953	6501913.654	1115.176	24.07.99	13:28
TAKU IV 17	486195.768	6501649.707	1119.408	24.07.99	13:38
TAKU IV 19	485918.457	6501397.895	1125.890	24.07.99	13:43
TAKU IV 21	485638.982	6501144.203	1132.252	24.07.99	13:53
TAKU IV 23	485399.923	6500927.533	1134.212	24.07.99	14:04
TAKU IV 25	485112.130	6500666.726	1136.108	24.07.99	14:14
TAKU IV 27	484830.906	6500413.141	1136.912	24.07.99	14:23
TAKU IV 29	484572.818	6500179.077	1140.386	24.07.99	14:31
TAKU IV 31	484323.802	6499953.145	1145.000	24.07.99	14:40
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
TAKU IV 01	487744.663	6503055.200	1117.329	31.07.99	13:55
TAKU IV 03	487601.622	6502925.454	1119.821	01.08.99	11:37
TAKU IV 05	487454.950	6502792.189	1119.614	31.07.99	14:12
TAKU IV 07	487268.433	6502621.637	1117.189	31.07.99	14:20
TAKU IV 09	487092.454	6502459.359	1117.621	01.08.99	11:52
TAKU IV 11	486959.854	6502337.373	1118.406	01.08.99	11:56
TAKU IV 13	486721.642	6502120.512	1118.207	31.07.99	14:56
TAKU IV 15	486490.315	6501910.707	1114.856	31.07.99	15:03
TAKU IV 17	486199.012	6501647.076	1118.972	31.07.99	15:20
TAKU IV 19	485921.933	6501395.360	1125.367	31.07.99	15:26
TAKU IV 21	485642.297	6501141.687	1131.869	31.07.99	15:35
TAKU IV 23	485403.105	6500925.212	1133.828	31.07.99	15:41
TAKU IV 25	485114.504	6500665.010	1135.940	31.07.99	15:49
TAKU IV 27	484832.165	6500412.258	1136.591	31.07.99	15:58
TAKU IV 29	484573.208	6500178.936	1140.186	31.07.99	16:07
TAKU IV 31	484323.866	6499952.783	1144.738	31.07.99	16:13

Profile 4 (Taku Glacier, Camp 10 – Shoehorn Mt.) – Upper Line

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
TAKU IV 02	487527.437	6503206.789	1124.103	24.07.99	17:25
TAKU IV 04	487380.275	6503056.824	1123.004	24.07.99	17:31
TAKU IV 06	487219.615	6502892.603	1120.241	24.07.99	17:10
TAKU IV 08	487080.336	6502749.339	1119.304	24.07.99	17:19
TAKU IV 10	486937.634	6502603.197	1119.062	24.07.99	16:58
TAKU IV 12	486756.810	6502417.299	1118.869	24.07.99	16:52
TAKU IV 14	486485.895	6502197.210	1120.530	24.07.99	16:33
TAKU IV 16	486225.044	6501969.973	1119.665	24.07.99	16:33
TAKU IV 18	485894.273	6501668.930	1125.726	24.07.99	16:18
TAKU IV 20	485642.318	6501441.064	1131.753	24.07.99	16:16
TAKU IV 22	485393.716	6501219.102	1136.110	24.07.99	15:54
TAKU IV 24	485124.702	6500991.207	1136.599	24.07.99	15:58
TAKU IV 26	484870.501	6500782.294	1138.126	24.07.99	15:39
TAKU IV 28	484512.046	6500493.905	1138.614	24.07.99	15:27
TAKU IV 30	484251.450	6500282.048	1140.176	24.07.99	15:20
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
TAKU IV 02	487527.460	6503206.748	1123.841	31.07.99	18:44
TAKU IV 04	487380.479	6503056.647	1122.737	31.07.99	18:38
TAKU IV 06	487220.243	6502892.024	1119.965	01.08.99	11:21
TAKU IV 08	487081.516	6502748.249	1119.041	31.07.99	18:00
TAKU IV 10	486939.574	6502601.439	1118.824	31.07.99	17:55
TAKU IV 12	486759.413	6502414.989	1118.541	31.07.99	17:49
TAKU IV 14	486488.749	6502194.572	1120.009	31.07.99	17:41
TAKU IV 16	486228.142	6501967.347	1119.218	31.07.99	17:35
TAKU IV 18	485897.672	6501666.483	1125.184	31.07.99	17:24
TAKU IV 20	485645.653	6501438.292	1131.224	31.07.99	17:17
TAKU IV 22	485396.965	6501216.724	1135.668	31.07.99	17:11
TAKU IV 24	485127.612	6500989.100	1136.264	31.07.99	17:02
TAKU IV 26	484872.678	6500780.725	1137.748	31.07.99	16:43
TAKU IV 28	484512.985	6500493.278	1138.213	31.07.99	16:31
TAKU IV 30	484251.694	6500281.967	1139.957	31.07.99	16:23

Profile 5 (Taku Glacier SW Branch, Juncture Peak – SW Taku Pt.)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
SW TAKU 01	485737.866	6498029.845	1058.188	25.07.99	15:00
SW TAKU 02	485856.668	6497873.887	1060.683	25.07.99	15:11
SW TAKU 03	485965.479	6497730.950	1063.942	25.07.99	15:21
SW TAKU 04	486107.250	6497545.036	1066.249	25.07.99	15:30
SW TAKU 05	486272.269	6497352.201	1066.140	25.07.99	15:37
SW TAKU 06	486448.909	6497147.732	1065.773	25.07.99	15:46
SW TAKU 07	486583.271	6496990.895	1068.939	25.07.99	15:58
SW TAKU 08	486691.216	6496865.687	1073.331	25.07.99	16:09
SW TAKU 09	486806.267	6496732.064	1077.107	25.07.99	16:16
SW TAKU 10	486901.919	6496619.505	1078.584	25.07.99	16:23
SW TAKU 11	487008.394	6496490.990	1079.966	25.07.99	16:28
SW TAKU 12	487117.354	6496357.613	1081.783	25.07.99	16:32
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
SW TAKU 01	485737.917	6498029.966	1057.795	01.08.99	17:00
SW TAKU 02	485856.777	6497873.988	1060.362	01.08.99	16:55
SW TAKU 03	485965.768	6497731.146	1063.659	01.08.99	16:50
SW TAKU 04	486107.655	6497545.466	1065.708	01.08.99	16:45
SW TAKU 05	486272.590	6497352.702	1065.894	01.08.99	16:38
SW TAKU 06	486449.231	6497148.234	1065.504	01.08.99	17:35
SW TAKU 07	486583.660	6496991.415	1068.663	01.08.99	16:19
SW TAKU 08	486691.658	6496866.275	1073.009	01.08.99	16:14
SW TAKU 09	486806.530	6496732.465	1076.824	01.08.99	16:07
SW TAKU 10	486902.195	6496619.962	1078.293	01.08.99	15:53
SW TAKU 11	487008.641	6496491.377	1079.501	01.08.99	15:46
SW TAKU 12	487117.382	6496357.706	1081.469	01.08.99	15:36

Profile 6 (Taku Glacier NW Branch, Taku NW Pt. – Echo Mt.)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
NW TAKU 01	478980.603	6505811.804	1324.859	29.07.99	14:36
NW TAKU 02	478921.449	6506034.719	1326.514	29.07.99	14:47
NW TAKU 03	478861.379	6506256.854	1326.084	29.07.99	14:53
NW TAKU 04	478798.180	6506470.411	1325.797	29.07.99	15:02
NW TAKU 05	478770.775	6506587.995	1325.375	29.07.99	15:08
NW TAKU 06	478742.834	6506717.515	1323.902	29.07.99	15:12
NW TAKU 07	478690.444	6506936.280	1321.843	29.07.99	15:16
NW TAKU 08	478636.357	6507159.049	1322.622	29.07.99	15:20
NW TAKU 09	478581.718	6507384.097	1326.143	29.07.99	15:25
NW TAKU 10	478526.067	6507610.155	1329.876	29.07.99	15:31
NW TAKU 11	478471.834	6507835.208	1333.020	29.07.99	15:36
NW TAKU 12	478415.946	6508059.095	1335.017	29.07.99	15:45
NW TAKU 13	478358.085	6508285.787	1336.061	29.07.99	15:50
NW TAKU 14	478307.002	6508512.277	1336.548	29.07.99	15:56
NW TAKU 15	478255.153	6508738.797	1336.244	29.07.99	16:00
NW TAKU 16	478204.678	6508976.292	1335.115	29.07.99	16:06
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
NW TAKU 01	478981.777	6505811.747	1324.229	06.08.99	15:09
NW TAKU 02	478922.996	6506034.583	1325.994	06.08.99	15:11
NW TAKU 03	478863.225	6506256.928	1325.600	06.08.99	15:14
NW TAKU 04	478800.118	6506470.234	1325.280	06.08.99	15:20
NW TAKU 05	478772.763	6506587.753	1324.862	06.08.99	15:22
NW TAKU 06	478744.971	6506717.407	1323.434	06.08.99	15:24
NW TAKU 07	478692.571	6506936.160	1321.297	06.08.99	15:26
NW TAKU 08	478638.558	6507158.849	1322.052	06.08.99	15:28
NW TAKU 09	478584.003	6507383.941	1325.496	06.08.99	15:32
NW TAKU 10	478528.225	6507609.869	1329.359	06.08.99	15:34
NW TAKU 11	478473.986	6507834.921	1332.485	06.08.99	15:36
NW TAKU 12	478417.985	6508058.796	1334.455	06.08.99	15:39
NW TAKU 13	478359.874	6508285.585	1335.450	06.08.99	15:41
NW TAKU 14	478308.356	6508512.061	1336.020	06.08.99	15:43
NW TAKU 15	478255.922	6508738.662	1335.767	06.08.99	15:47
NW TAKU 16	478205.074	6508976.195	1334.626	06.08.99	15:49

Profile 7 (Matthes Glacier, Camp 9 – Centurian Peak)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
CAMP_9 03	488875.589	6511059.324	1438.607	31.07.99	15:17
CAMP_9 04	488742.010	6511131.096	1429.673	31.07.99	15:24
CAMP_9 05	488520.935	6511249.375	1425.537	31.07.99	15:30
CAMP_9 06	488305.823	6511364.022	1425.849	31.07.99	15:34
CAMP_9 07	488075.255	6511486.294	1425.110	31.07.99	15:39
CAMP_9 08	487839.924	6511611.379	1423.486	31.07.99	15:44
CAMP_9 09	487614.210	6511731.606	1422.453	31.07.99	15:48
CAMP_9 10	487386.392	6511854.309	1415.143	31.07.99	15:53
CAMP_9 11	487147.432	6511982.416	1409.240	31.07.99	16:00
CAMP_9 12	486912.542	6512107.944	1413.642	31.07.99	16:14
CAMP_9 13	486677.913	6512231.682	1420.587	31.07.99	16:19
CAMP_9 14	486445.891	6512351.088	1417.167	31.07.99	17:09
CAMP_9 15	486214.436	6512478.135	1416.760	31.07.99	17:22
CAMP_9 16	485980.325	6512605.722	1424.616	31.07.99	17:29
CAMP_9 17	485760.241	6512725.697	1432.355	31.07.99	17:36
CAMP_9 18	485544.077	6512843.783	1440.516	31.07.99	17:42
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
CAMP_9 03	488875.549	6511059.307	1437.849	09.08.99	14:23
CAMP_9 04	488741.827	6511131.082	1429.028	09.08.99	14:28
CAMP_9 05	488520.554	6511249.074	1424.869	09.08.99	14:41
CAMP_9 06	488305.069	6511363.171	1425.189	09.08.99	14:45
CAMP_9 07	488073.997	6511484.685	1424.369	09.08.99	14:49
CAMP_9 08	487838.308	6511609.094	1422.739	09.08.99	14:54
CAMP_9 09	487612.488	6511729.216	1421.649	09.08.99	14:59
CAMP_9 10	487384.616	6511851.877	1414.309	09.08.99	15:04
CAMP_9 11	-	-	-	-	-
CAMP_9 12	486910.907	6512105.519	1412.848	09.08.99	15:19
CAMP_9 13	486676.387	6512229.285	1419.795	09.08.99	15:24
CAMP_9 14	486444.563	6512348.990	1416.484	09.08.99	15:29
CAMP_9 15	486213.520	6512476.206	1416.058	09.08.99	15:38
CAMP_9 16	485980.046	6512604.409	1423.852	09.08.99	15:43
CAMP_9 17	485760.076	6512724.794	1431.698	09.08.99	15:47
CAMP_9 18	485544.058	6512843.439	1439.785	09.08.99	15:52

- = not accessible

Profile 7a (Lower Matthes Glacier, Taku D – Taku C)

Epoch 0					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LOW MAT 01	483727.071	6509199.384	1299.571	29.07.99	16:48
LOW MAT 02	483850.041	6509107.932	1298.897	29.07.99	17:09
LOW MAT 03	484017.000	6508983.948	1299.455	29.07.99	17:16
LOW MAT 04	484171.482	6508870.376	1299.079	29.07.99	17:22
LOW MAT 05	484330.120	6508753.358	1298.850	29.07.99	17:26
LOW MAT 06	484487.875	6508636.971	1298.322	29.07.99	17:31
LOW MAT 07	484646.130	6508520.759	1299.581	29.07.99	17:39
LOW MAT 08	484802.002	6508406.678	1306.978	29.07.99	17:51
LOW MAT 09	484954.918	6508294.632	1315.517	29.07.99	17:56
LOW MAT 10	485116.197	6508176.401	1319.609	29.07.99	18:00
LOW MAT 11	485229.909	6508093.184	1320.502	29.07.99	18:04
LOW MAT 12	485343.496	6508009.786	1322.199	29.07.99	18:08
LOW MAT 13	485455.674	6507927.804	1322.652	29.07.99	18:13
LOW MAT 14	485584.827	6507833.621	1322.320	29.07.99	18:20
Epoch 1					
Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LOW MAT 01	483726.073	6509198.334	1299.057	06.08.99	15:11
LOW MAT 02	483848.689	6509106.396	1298.198	06.08.99	15:16
LOW MAT 03	484015.195	6508982.039	1298.680	06.08.99	15:22
LOW MAT 04	484169.618	6508868.293	1298.378	06.08.99	15:26
LOW MAT 05	484327.930	6508751.246	1298.178	06.08.99	15:31
LOW MAT 06	484485.656	6508634.709	1297.646	06.08.99	15:36
LOW MAT 07	484643.718	6508518.494	1298.951	06.08.99	15:40
LOW MAT 08	484799.645	6508404.301	1306.314	06.08.99	15:45
LOW MAT 09	484952.535	6508292.344	1314.778	06.08.99	15:49
LOW MAT 10	485113.796	6508174.187	1318.887	06.08.99	15:53
LOW MAT 11	485227.516	6508090.962	1319.774	06.08.99	15:57
LOW MAT 12	485341.346	6508007.789	1321.498	06.08.99	16:03
LOW MAT 13	485453.684	6507926.055	1322.015	06.08.99	16:08
LOW MAT 14	485583.143	6507832.067	1321.632	06.08.99	16:13

Appendix B2

Coordinate Listing of Locations related to various projects

Height Comparison Lemon Creek Glacier [(1)]

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LEMON 01	478658.205	6472199.620	1257.968	18.07.99	10:35
LEMON 02	478658.759	6472199.421	1257.765	18.07.99	10:43
LEMON 03	478825.750	6472140.693	1234.862	18.07.99	10:47
LEMON 04	478955.332	6472091.076	1225.052	18.07.99	10:54
LEMON 05	479018.437	6472066.277	1221.821	18.07.99	10:56
LEMON 06	479082.814	6472041.339	1219.126	18.07.99	11:01
LEMON 07	479146.552	6472015.927	1216.848	18.07.99	11:05
LEMON 08	479207.277	6471991.858	1214.929	18.07.99	11:08
LEMON 09	479265.698	6471967.587	1213.253	18.07.99	11:14
LEMON 10	479322.262	6471944.405	1211.749	18.07.99	11:16
LEMON 11	479377.248	6471920.267	1210.523	18.07.99	11:18
LEMON 12	479431.759	6471896.973	1209.499	18.07.99	11:20
LEMON 13	479485.574	6471876.262	1208.574	18.07.99	11:22
LEMON 14	479539.072	6471855.262	1207.908	18.07.99	11:24
LEMON 15	479588.691	6471835.396	1207.853	18.07.99	11:26
LEMON 16	479638.571	6471814.311	1208.615	18.07.99	11:28
LEMON 17	479689.192	6471793.099	1209.992	18.07.99	11:30
LEMON 18	479738.521	6471773.330	1211.997	18.07.99	11:32
LEMON 19	479786.855	6471755.512	1214.815	18.07.99	11:34
LEMON 20	479833.433	6471736.825	1219.008	18.07.99	11:36
LEMON 21	479879.360	6471719.569	1224.138	18.07.99	11:39
LEMON 22	479924.328	6471702.154	1229.393	18.07.99	11:42
LEMON 23	479970.119	6471682.100	1234.298	18.07.99	11:44
LEMON 24	480020.389	6471662.416	1237.880	18.07.99	11:46
LEMON 25	480070.828	6471642.376	1241.545	18.07.99	11:48
LEMON 26	480120.580	6471621.520	1248.492	18.07.99	11:51
LEMON 27	480166.790	6471602.143	1259.556	18.07.99	11:54
LEMON 28	480225.968	6471577.892	1277.768	18.07.99	11:57
LEMON 29	480276.507	6471556.299	1291.402	18.07.99	11:59
LEMON 30	480313.402	6471536.154	1299.920	18.07.99	12:02
LEMON 31	480404.834	6472429.232	1243.990	18.07.99	12:32
LEMON 32	480326.886	6472450.547	1222.947	18.07.99	12:39
LEMON 33	480248.898	6472466.384	1201.864	18.07.99	12:44
LEMON 34	480146.514	6472478.331	1188.957	18.07.99	12:49
LEMON 35	480068.089	6472488.284	1185.005	18.07.99	12:54
LEMON 36	480002.328	6472496.986	1183.162	18.07.99	12:57
LEMON 37	479942.930	6472504.719	1182.400	18.07.99	13:00
LEMON 38	479883.828	6472512.539	1182.493	18.07.99	13:03
LEMON 39	479826.205	6472520.892	1183.031	18.07.99	13:05
LEMON 40	479772.235	6472528.443	1183.867	18.07.99	13:07

Height Comparison Lemon Creek Glacier (1) - continued

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LEMON 41	479718.729	6472535.225	1184.792	18.07.99	13:10
LEMON 42	479666.527	6472542.558	1185.929	18.07.99	13:16
LEMON 43	479613.335	6472550.133	1187.149	18.07.99	13:20
LEMON 44	479559.940	6472556.684	1188.578	18.07.99	13:22
LEMON 45	479506.030	6472563.237	1190.157	18.07.99	13:24
LEMON 46	479453.040	6472568.962	1192.177	18.07.99	13:26
LEMON 47	479399.098	6472576.422	1194.735	18.07.99	13:28
LEMON 48	479346.222	6472582.866	1197.858	18.07.99	13:30
LEMON 49	479292.920	6472589.381	1201.727	18.07.99	13:32
LEMON 50	479242.732	6472595.812	1206.130	18.07.99	13:36
LEMON 51	479194.554	6472602.058	1210.775	18.07.99	13:38
LEMON 52	479146.190	6472608.032	1215.946	18.07.99	13:40
LEMON 53	479098.492	6472613.332	1221.622	18.07.99	13:42
LEMON 54	479053.029	6472618.292	1227.909	18.07.99	13:44
LEMON 55	479024.220	6472626.154	1233.383	18.07.99	13:46
LEMON 56	479573.540	6472554.613	1188.186	18.07.99	14:06
LEMON 57	479532.165	6472486.580	1191.712	18.07.99	14:29
LEMON 58	479485.094	6472421.614	1195.435	18.07.99	14:32
LEMON 59	479437.773	6472356.586	1198.882	18.07.99	14:35
LEMON 60	479391.416	6472289.678	1202.109	18.07.99	14:39
LEMON 61	479344.011	6472223.995	1205.247	18.07.99	14:42
LEMON 62	479295.623	6472156.762	1208.265	18.07.99	14:46
LEMON 63	479246.857	6472091.753	1211.472	18.07.99	14:50
LEMON 64	479201.985	6472024.114	1214.607	18.07.99	14:54
LEMON 65	479167.118	6471952.585	1217.055	18.07.99	14:57
LEMON 66	479123.511	6471881.344	1219.396	18.07.99	15:02
LEMON 67	479078.965	6471809.108	1220.822	18.07.99	15:04
LEMON 68	479041.312	6471732.772	1221.894	18.07.99	15:06
LEMON 69	478996.813	6471662.983	1223.582	18.07.99	15:09
LEMON 70	478958.902	6471585.529	1224.593	18.07.99	15:12
LEMON 71	478942.241	6471543.830	1224.472	18.07.99	15:14
LEMON 72	478942.543	6471543.800	1224.438	18.07.99	15:16
LEMON 73	478978.231	6471520.752	1224.173	18.07.99	15:27
LEMON 74	479013.560	6471497.386	1224.134	18.07.99	15:34
LEMON 75	479052.447	6471476.688	1224.509	18.07.99	15:37
LEMON 76	479087.510	6471454.109	1225.242	18.07.99	15:43
LEMON 77	479125.925	6471432.814	1226.852	18.07.99	15:48
LEMON 78	479165.006	6471412.320	1229.974	18.07.99	15:56
LEMON 79	479203.747	6471395.829	1234.513	18.07.99	16:00
LEMON 80	479244.418	6471376.612	1242.110	18.07.99	16:06

Height Comparison Lemon Creek Glacier (1) – continued

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LEMON 81	478909.517	6471574.568	1225.204	18.07.99	16:20
LEMON 82	478883.182	6471607.094	1226.038	18.07.99	16:25
LEMON 83	478851.526	6471633.723	1227.314	18.07.99	16:26
LEMON 84	478807.893	6471667.212	1229.172	18.07.99	16:31
LEMON 85	478770.977	6471688.122	1231.135	18.07.99	16:36
LEMON 86	478736.470	6471711.089	1233.229	18.07.99	16:39
LEMON 87	478702.194	6471736.297	1235.699	18.07.99	16:42
LEMON 88	478669.717	6471762.463	1238.521	18.07.99	16:44
LEMON 89	478633.783	6471786.405	1241.782	18.07.99	16:46
LEMON 90	478596.689	6471805.382	1245.390	18.07.99	16:47
LEMON 91	478562.428	6471824.073	1249.186	18.07.99	16:49
LEMON 92	478530.009	6471843.748	1253.496	18.07.99	16:51
LEMON 93	478498.532	6471863.500	1258.294	18.07.99	16:53
LEMON 94	478467.245	6471881.458	1263.909	18.07.99	16:55
LEMON 95	478429.546	6471901.950	1272.571	18.07.99	16:57
LEMON 97	478386.704	6471922.694	1286.247	18.07.99	17:00

Height Comparison Lake Linda and Lake Lynn (1)

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
CAVE 01	478705.160	6471222.081	1214.215	18.07.99	17:22
CAVE 02	478708.789	6471219.296	1214.671	18.07.99	17:23
CAVE 03	478705.705	6471219.206	1215.578	18.07.99	17:24
CAVE 04	478704.780	6471224.359	1213.712	18.07.99	17:25
LINDA 01	478654.682	6471248.099	1212.056	18.07.99	17:28
LINDA 02	478662.578	6471254.022	1212.069	18.07.99	17:31
LINDA 03	478672.333	6471257.311	1212.047	18.07.99	17:32
LINDA 04	478678.831	6471269.330	1212.066	18.07.99	17:33
LINDA 05	478680.013	6471282.856	1212.092	18.07.99	17:34
LINDA 06	478676.281	6471329.393	1212.003	18.07.99	17:36
LINDA 07	478671.547	6471343.869	1212.037	18.07.99	17:36
LINDA 08	478667.006	6471352.782	1212.091	18.07.99	17:37
LINDA 09	478662.837	6471360.106	1212.090	18.07.99	17:38
LINDA 10	478564.371	6471473.300	1212.099	18.07.99	17:57
LINDA 11	478539.397	6471485.136	1212.086	18.07.99	17:58
LINDA 12	478519.980	6471489.822	1212.026	18.07.99	17:59
LINDA 13	478507.716	6471489.973	1212.067	18.07.99	17:59
LINDA 14	478495.832	6471486.771	1212.039	18.07.99	18:00
LINDA 15	478490.990	6471484.656	1212.050	18.07.99	18:00

Height Comparison Lake Linda and Lake Lynn [(1)] - continued

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LYNN 01	478740.559	6471380.402	1212.024	18.07.99	14:46
LYNN 02	478767.351	6471382.325	1212.017	18.07.99	14:47
LYNN 03	478793.776	6471379.018	1212.013	18.07.99	14:49
LYNN 04	478817.844	6471373.187	1212.022	18.07.99	14:50
LYNN 05	478837.540	6471365.596	1212.038	18.07.99	14:52
LYNN 06	478856.584	6471355.037	1212.091	18.07.99	14:54
LYNN 07	478890.858	6471324.288	1212.005	18.07.99	14:56
LYNN 08	478921.328	6471291.189	1212.065	18.07.99	14:57
LYNN 09	478945.099	6471269.978	1212.002	18.07.99	14:58
LYNN 10	478960.335	6471247.188	1212.000	18.07.99	15:00
LYNN 11	478968.797	6471227.095	1211.999	18.07.99	15:01
LYNN 12	478971.854	6471201.720	1212.013	18.07.99	15:04
LYNN 13	478974.928	6471181.133	1212.050	18.07.99	15:04
LYNN 14	478977.513	6471166.140	1212.018	18.07.99	15:06
LYNN 15	478976.186	6471164.382	1211.990	18.07.99	15:06
LYNN 16	478973.250	6471164.181	1212.002	18.07.99	15:07
LYNN 17	478969.357	6471166.446	1212.046	18.07.99	15:07
LYNN 18	478959.739	6471169.016	1212.009	18.07.99	15:08
LYNN 19	478950.944	6471168.297	1212.005	18.07.99	15:08
LYNN 20	478942.505	6471164.982	1212.005	18.07.99	15:09
LYNN 21	478934.118	6471161.989	1212.038	18.07.99	15:09
LYNN 22	478910.597	6471170.845	1212.090	18.07.99	15:17
LYNN 23	478870.348	6471195.580	1212.073	18.07.99	15:22
LYNN 24	478867.099	6471204.539	1211.960	18.07.99	15:25
LYNN 25	478859.169	6471221.401	1211.841	18.07.99	15:32
LYNN 26	478852.788	6471219.314	1211.884	18.07.99	15:34
LYNN 27	478847.348	6471210.672	1212.608	18.07.99	15:36
LYNN 28	478791.731	6471211.603	1212.052	18.07.99	16:01
LYNN 29	478776.670	6471220.916	1212.000	18.07.99	16:03
LYNN 30	478731.170	6471283.674	1212.035	18.07.99	16:07
LYNN 31	478712.141	6471310.129	1212.038	18.07.99	16:09
LYNN 32	478700.260	6471334.451	1212.024	18.07.99	16:12
LYNN 33	478700.266	6471351.004	1212.038	18.07.99	16:13
LYNN 34	478706.544	6471363.087	1212.005	18.07.99	16:13
LYNN 35	478711.107	6471369.497	1212.036	18.07.99	16:14
LYNN 36	478721.475	6471374.784	1211.978	18.07.99	16:15
LYNN 37	478727.294	6471377.306	1212.029	18.07.99	16:15
LYNN 38	478733.820	6471379.492	1211.989	18.07.99	16:16
LYNN 39	478740.573	6471380.391	1212.022	18.07.99	16:16

Height Comparison Lake Linda and Lake Lynn (1) - continued

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
LINDA	478494.253	6471479.578	1210.027	30.07.99	13:01
LYNN	478741.910	6471370.603	1210.034	30.07.99	12:43

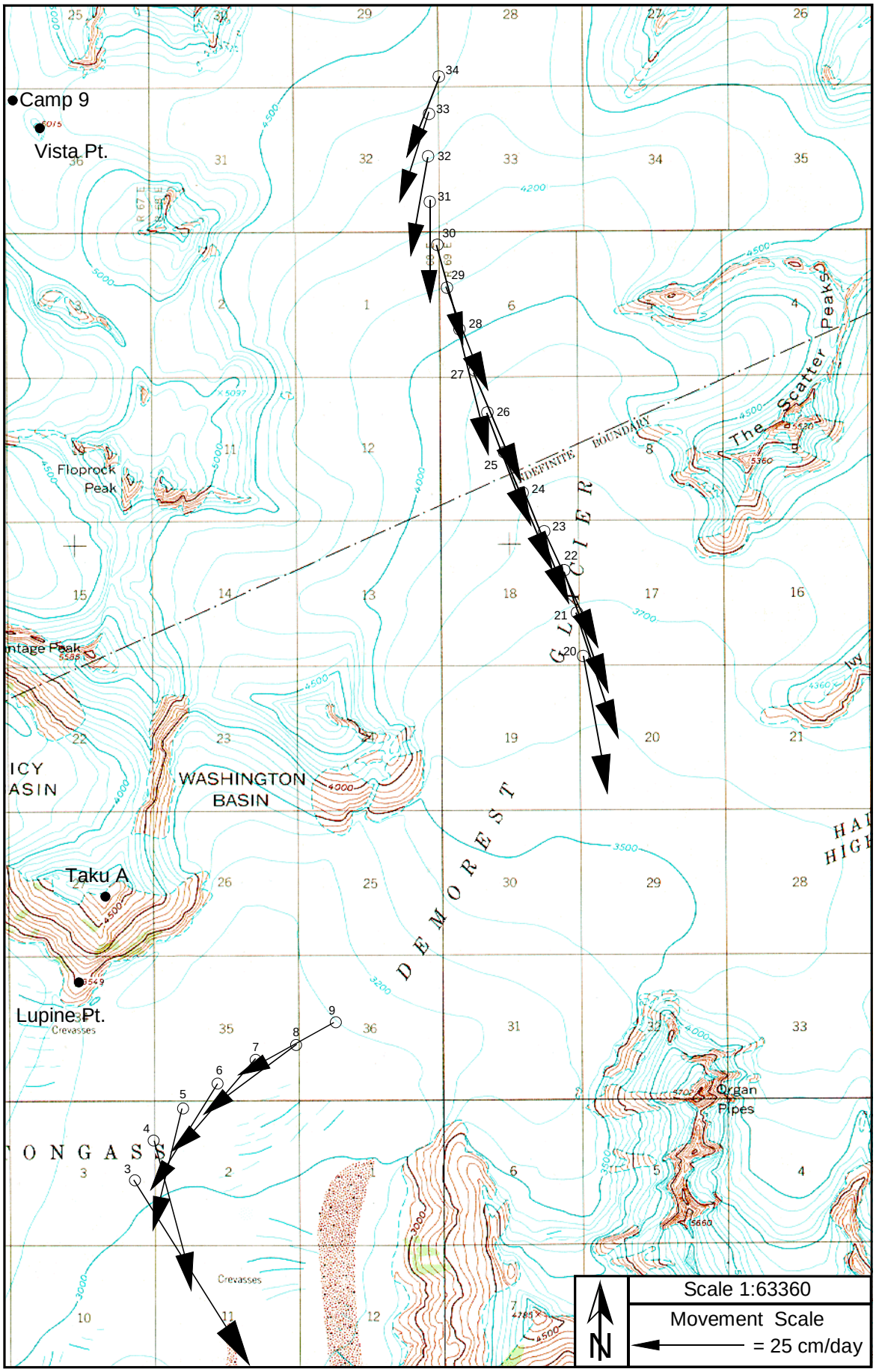
Testpit locations

Point	Easting [m]	Northing [m]	Height [m]	Date	Time
PROFILE 3 Test Pit	492560.117	6500105.535	1021.959	28.07.99	15:31
PROFILE 3A Test Pit	494279.351	6511026.570	1351.639	09.08.99	14:09
PROFILE 5 Test Pit 1	486289.139	6501310.997	1127.003	01.08.99	12:17
PROFILE 5 Test Pit 2	486509.246	6496728.178	1077.130	06.08.99	11:29
PROFILE 6 Test Pit	478631.637	6507139.523	1322.042	06.08.99	15:29
PROFILE 7A Test Pit	484535.143	6508229.631	1293.802	29.07.99	17:46

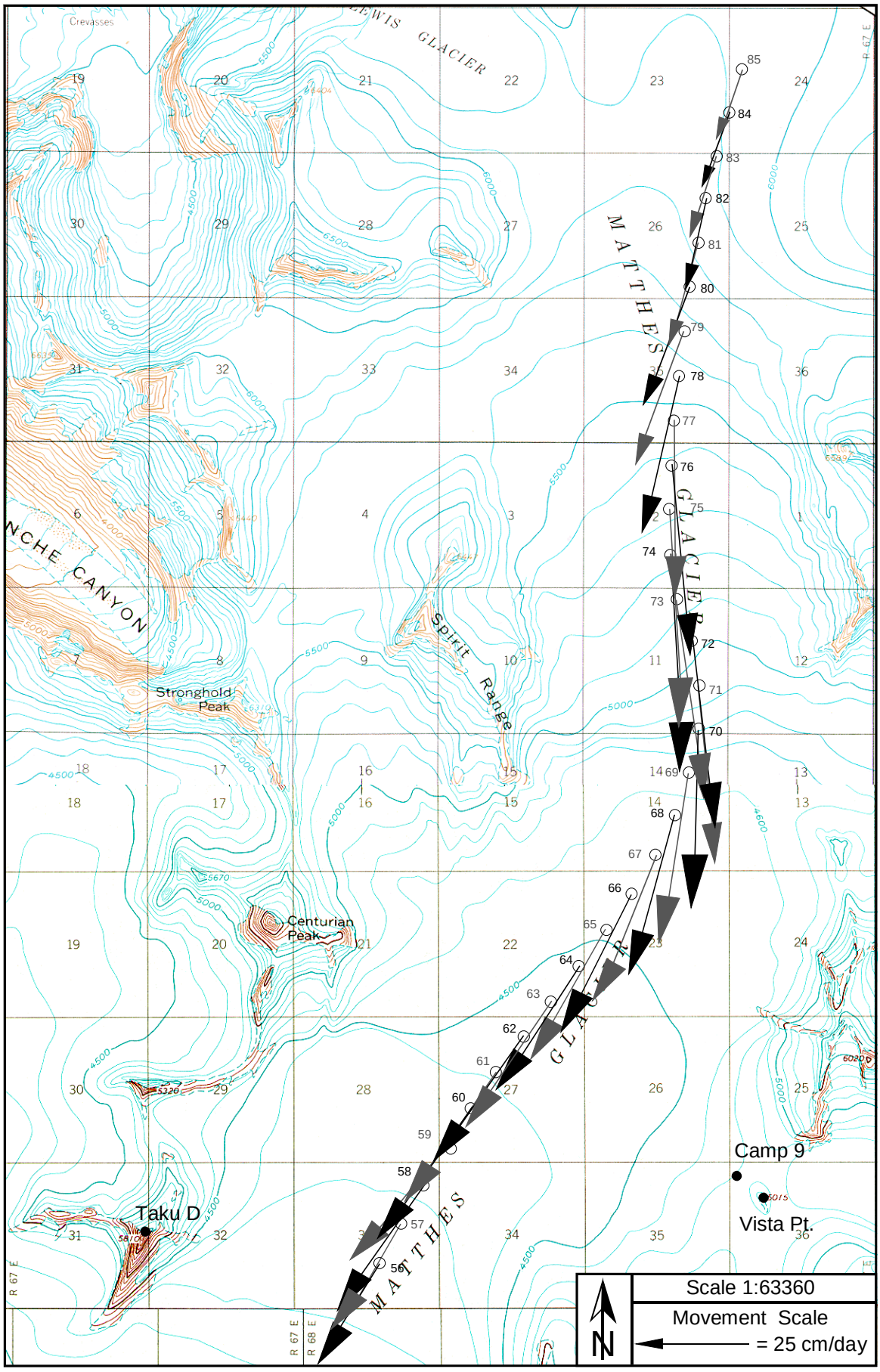
(1) = Coordinates do not belong to the JIRP coordinate system due to reference to a single point solution

Appendix C1

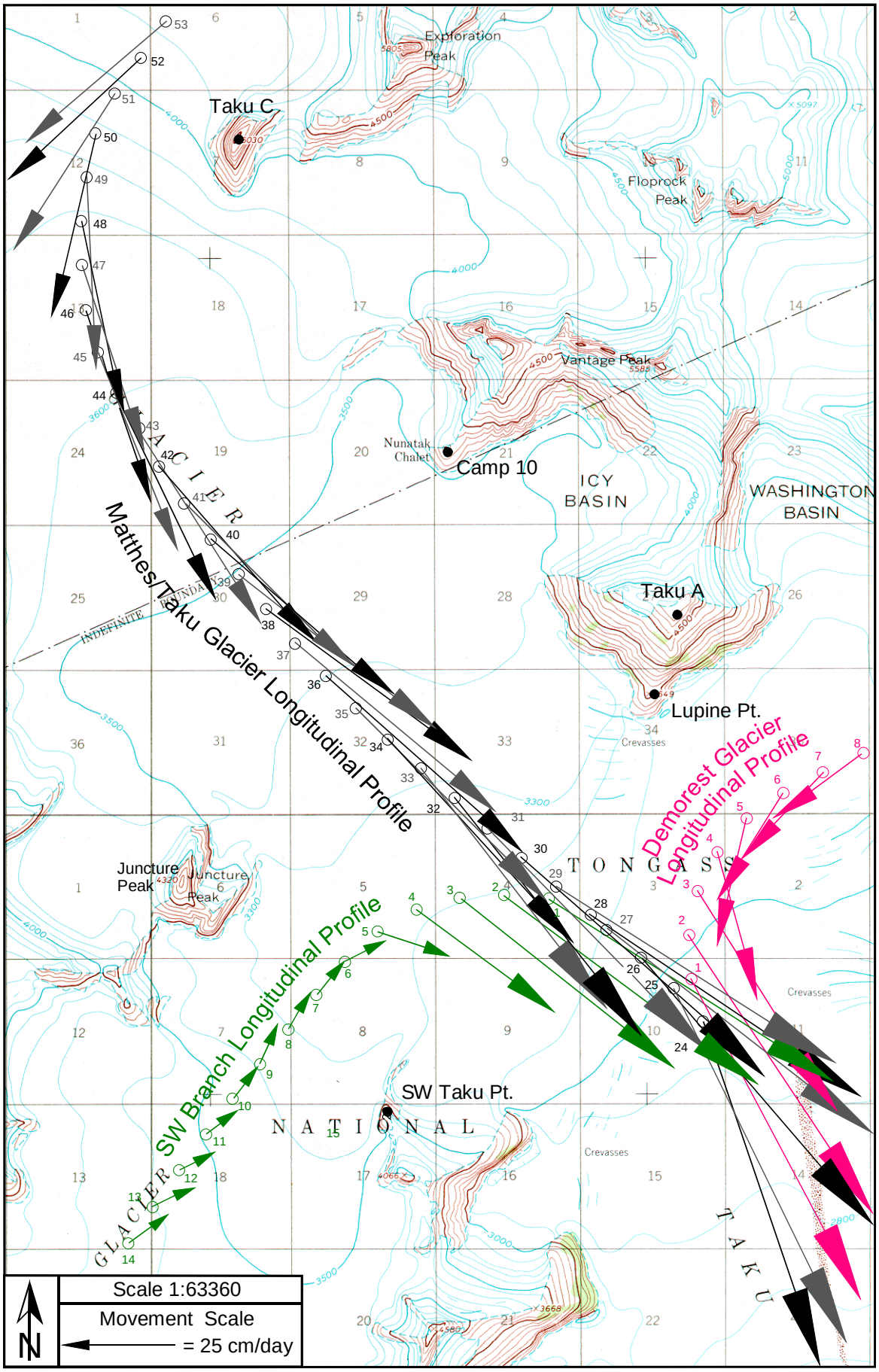
Plots
of Movement Vectors



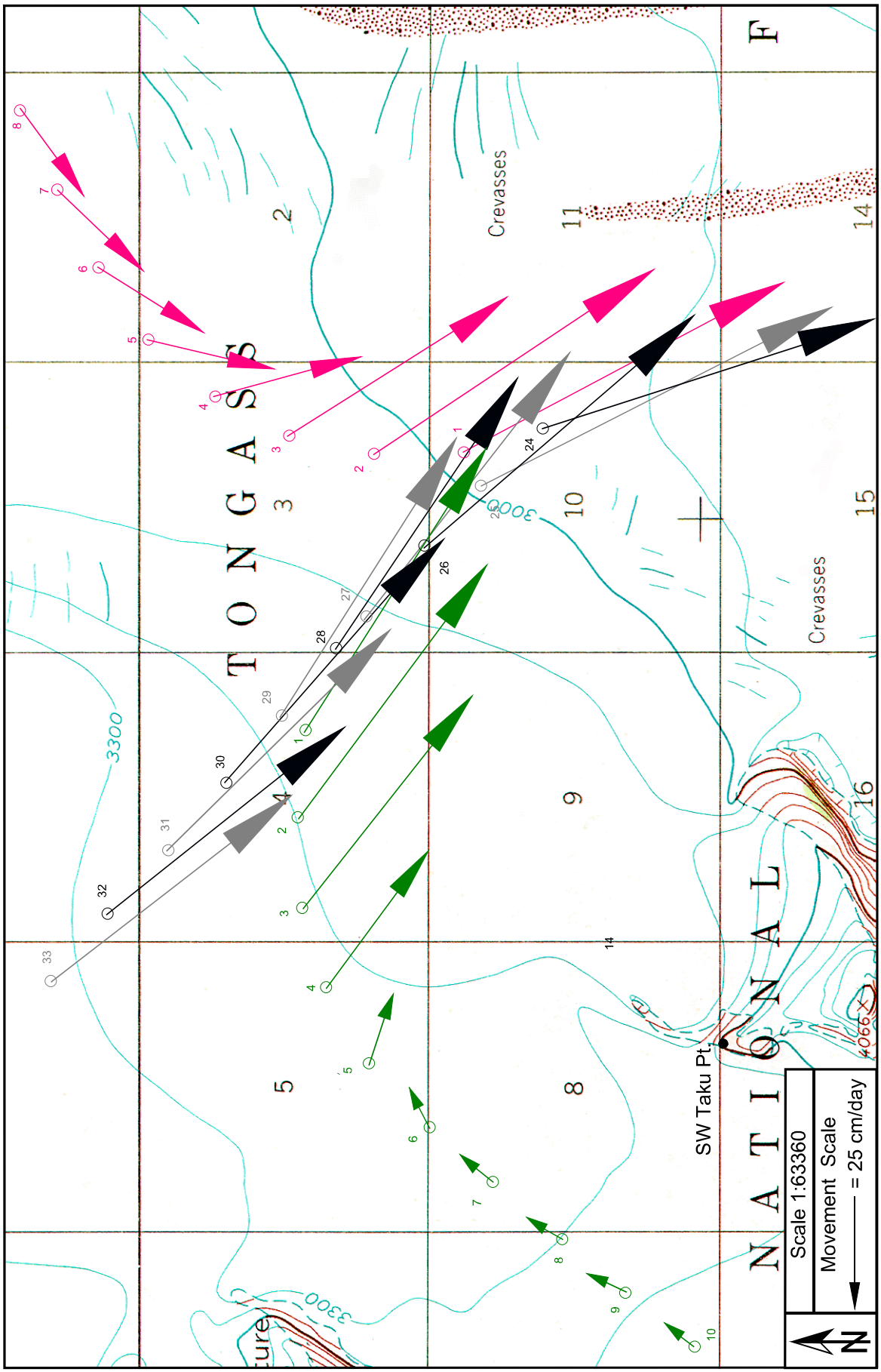
Longitudinal movement profile on the Demorest Glacier



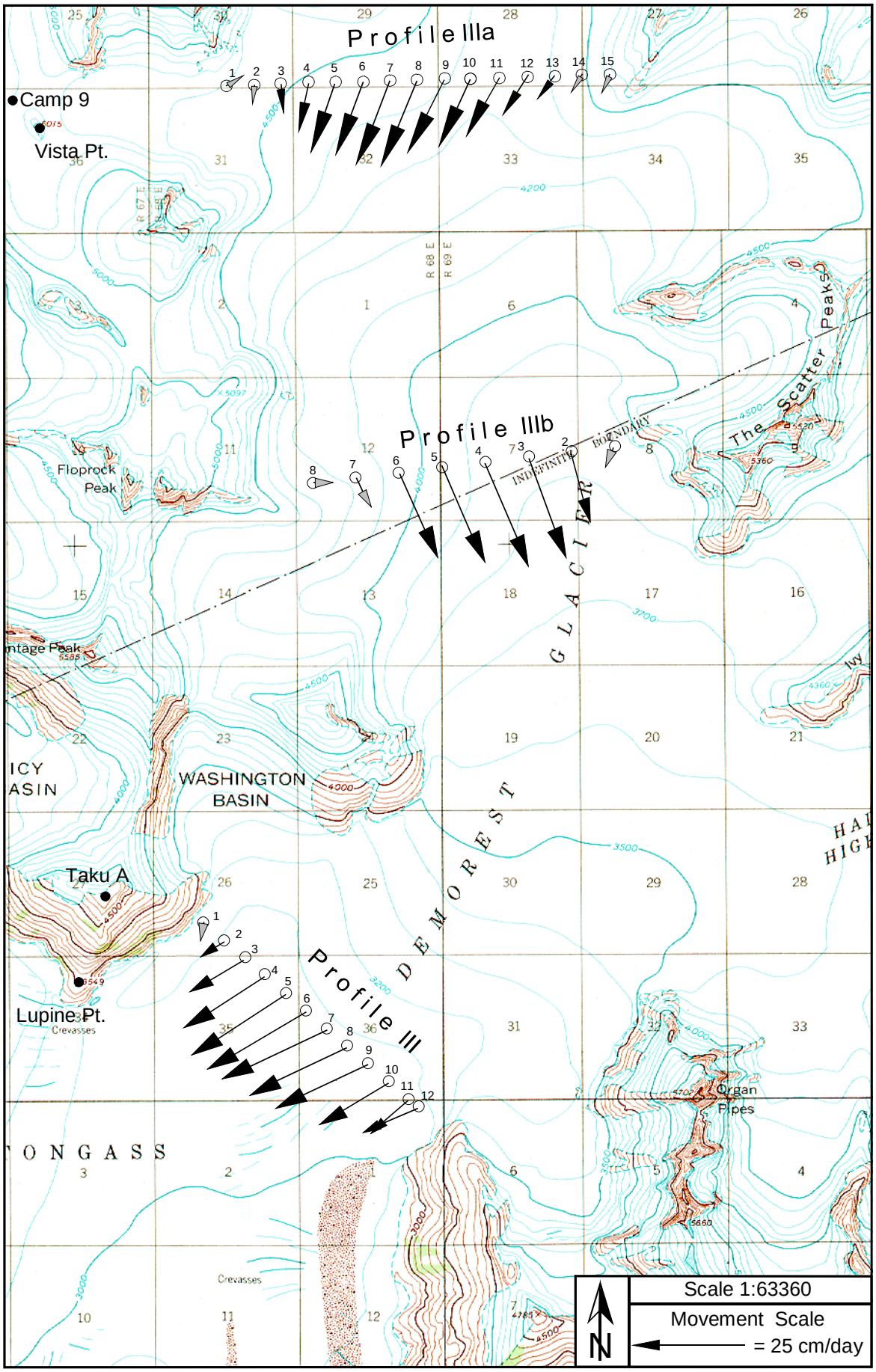
Longitudinal movement profile on the Matthes Glacier



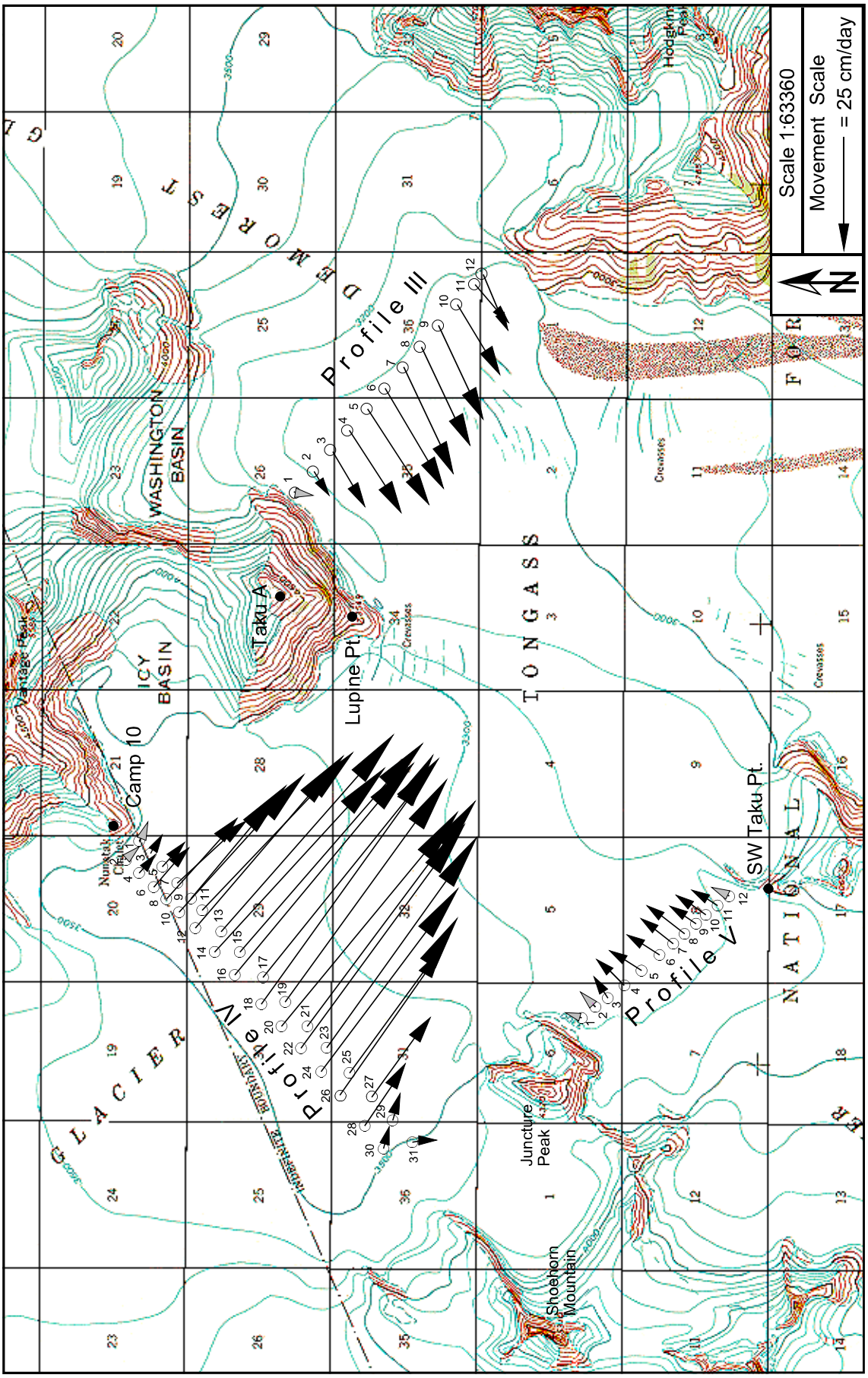
Longitudinal movement profiles on the SW Branch of the Taku Glacier (green), Demorest Glacier (red) and the Taku Glacier (black and grey alternating)



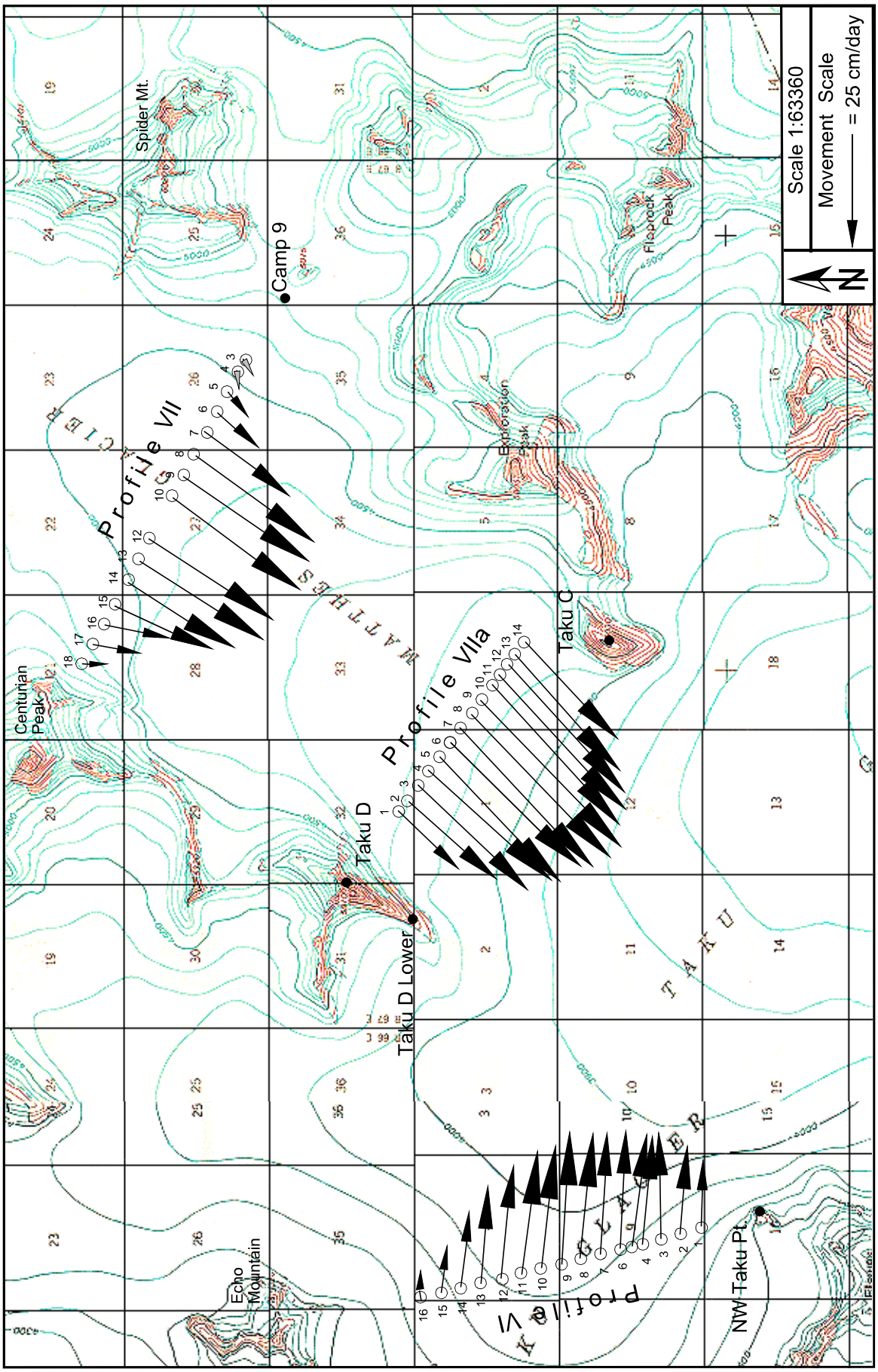
Section of the longitudinal movement profiles in the confluence area of Demorest Glacier, Taku Glacier and SW Branch



Movement profiles on the Demorest Glacier



Movement profiles on the Lower Demorest and Main Taku Glacier

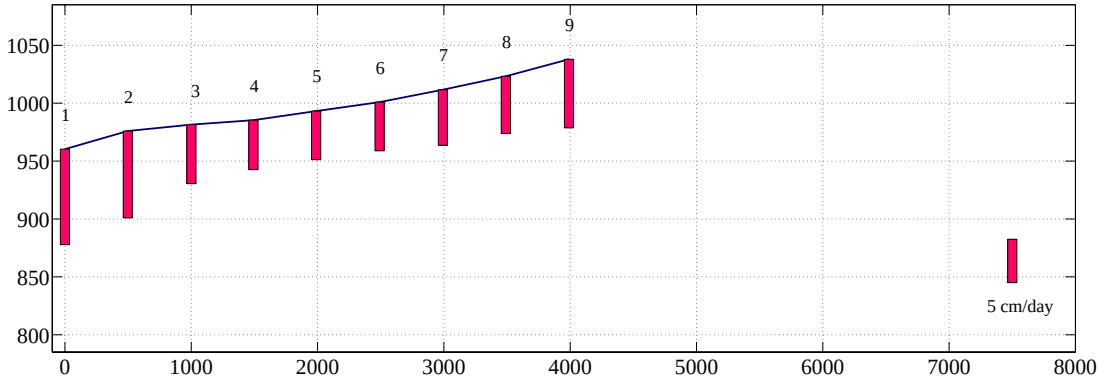


Movement profiles on the Lower Matthes and Taku Glacier

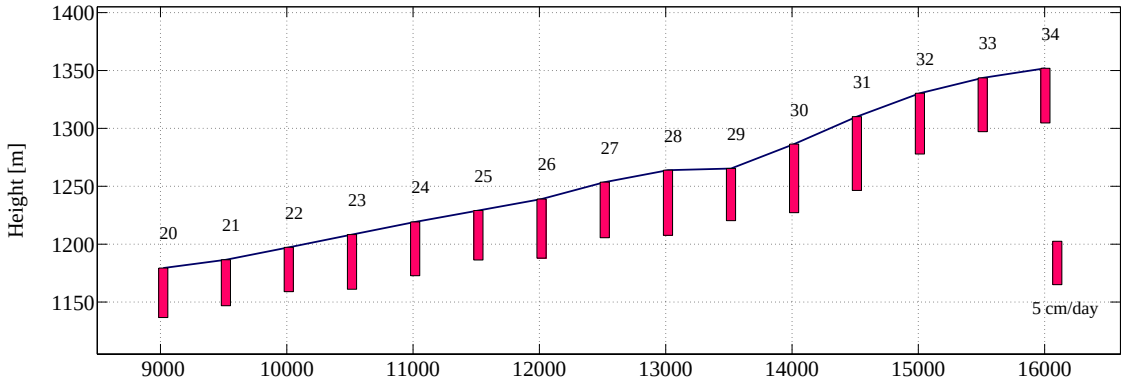
Appendix C2

Plots
of Short Term Height Changes

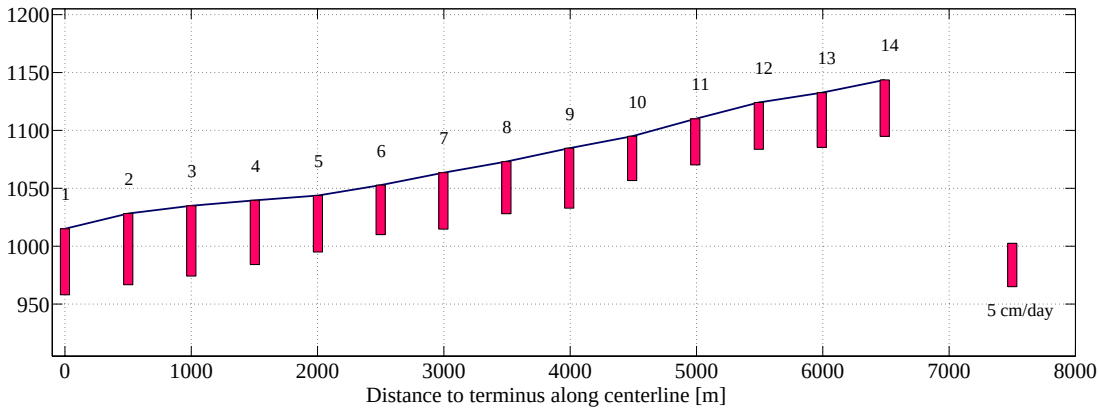
Longitudinal Profile − Demorest Glacier (I) 28.7. − 9.8.99



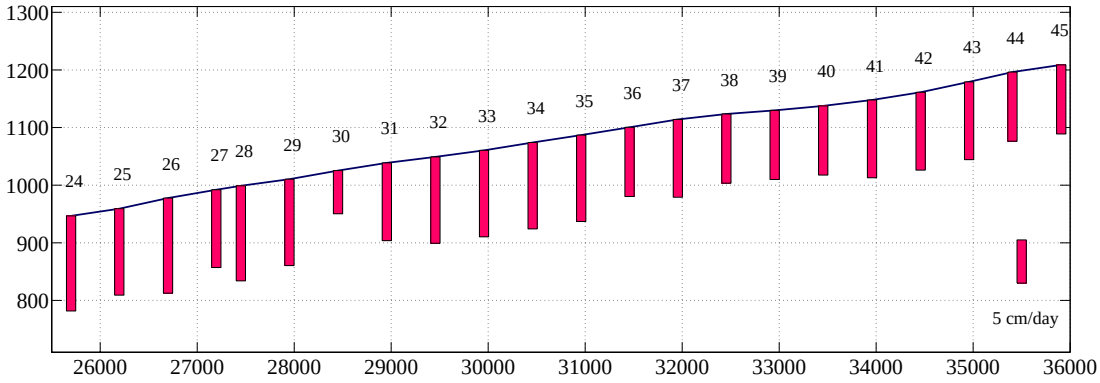
Longitudinal Profile − Demorest Glacier (II) 28.7. − 9.8.99



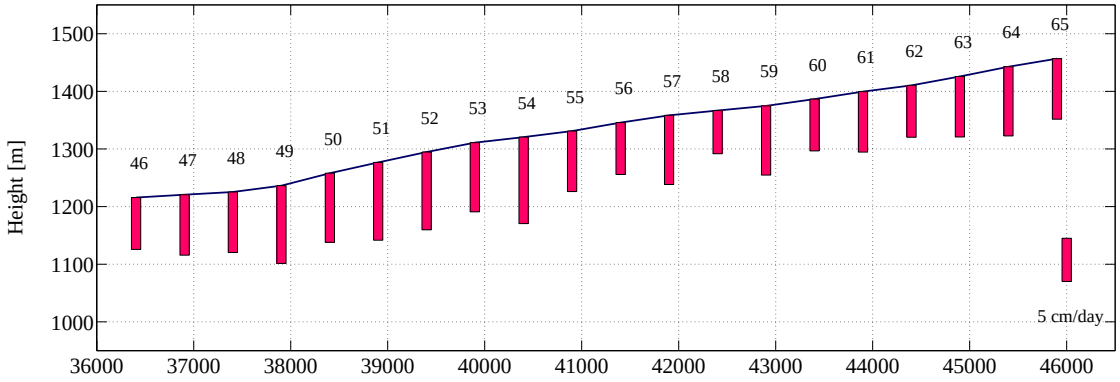
Longitudinal Profile − Taku Glacier SW Branch 26.7. − 6.8.99



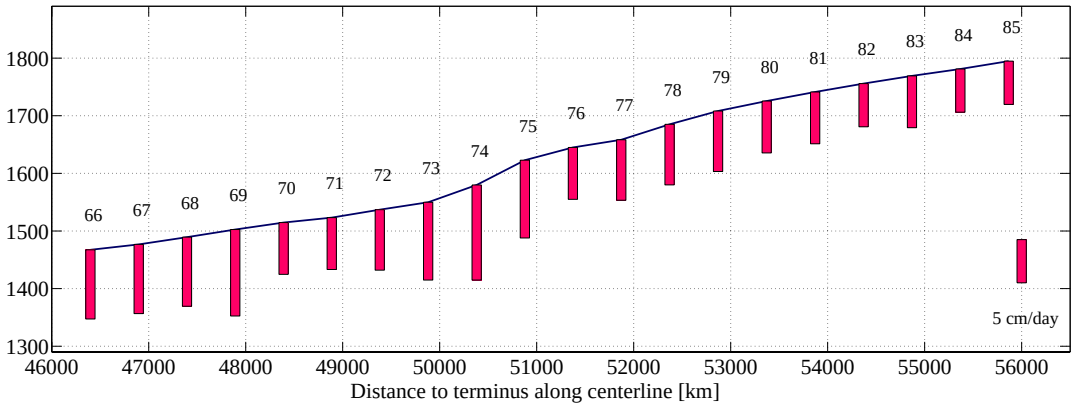
Longitudinal Profile − Taku/Matthes Glacier (I) 27.7. − 10.8.99



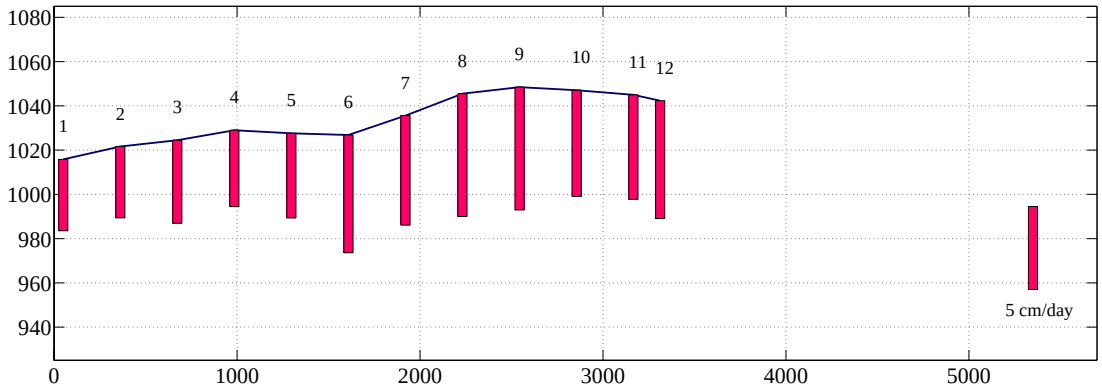
Longitudinal Profile − Taku/Matthes Glacier (II) 27.7. − 10.8.99



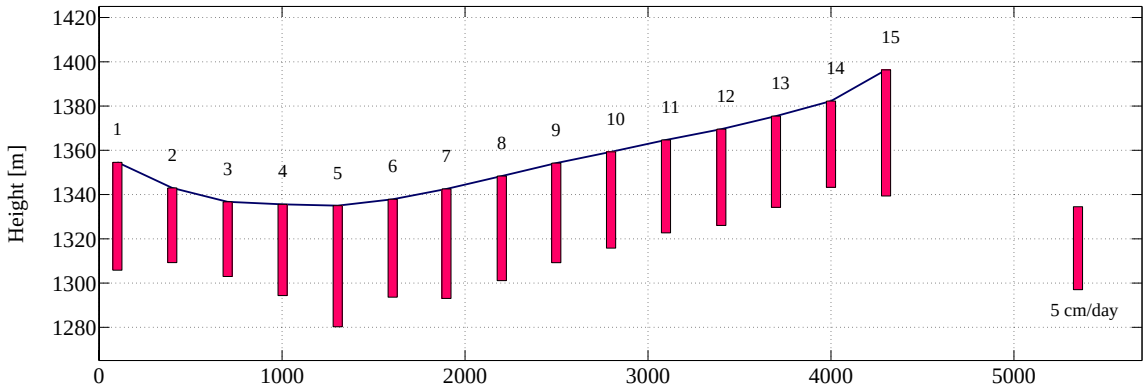
Longitudinal Profile − Taku/Matthes Glacier (III) 27.7. − 10.8.99



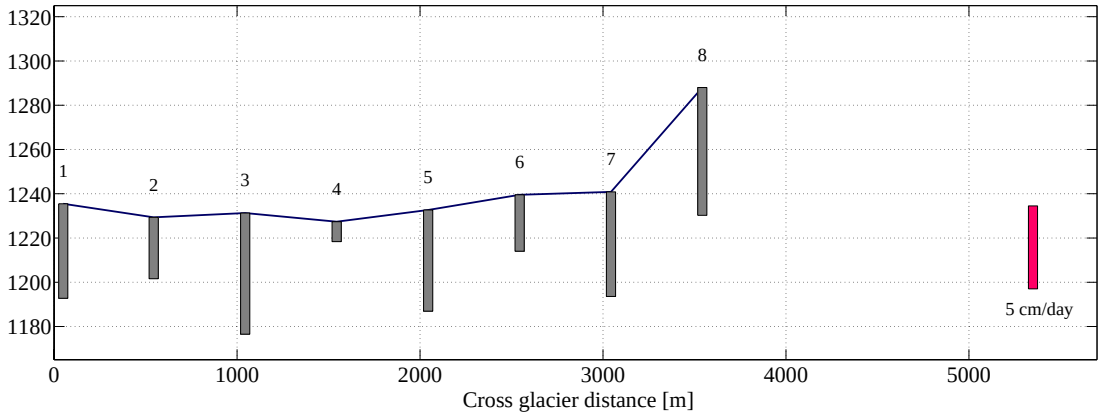
Profile III 26.7. – 5.8.99



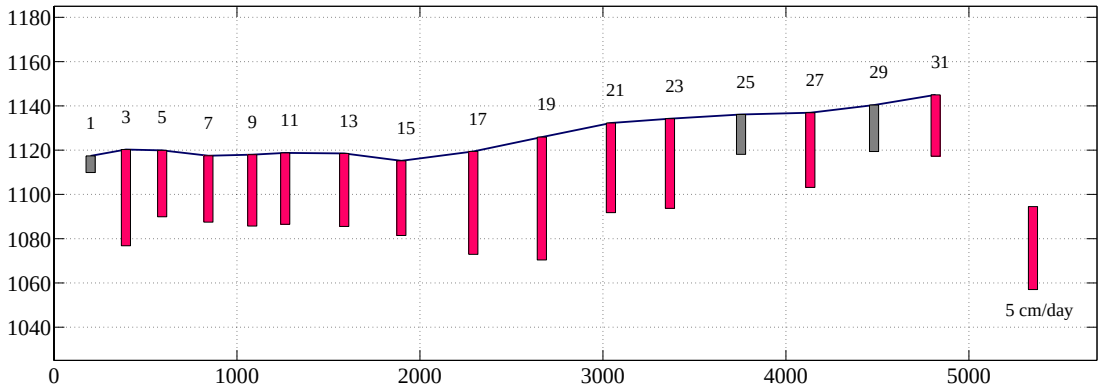
Profile IIIa 1.8. – 9.8.99



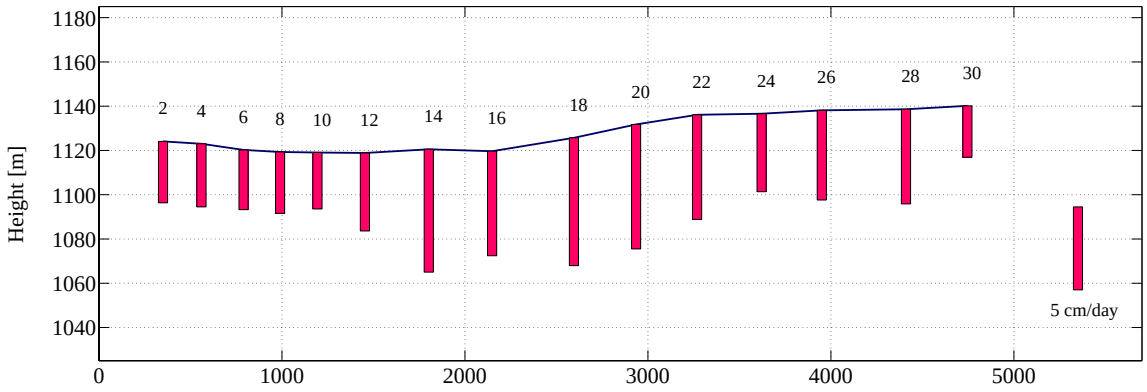
Profile IIIb 7.8. – 9.8.99



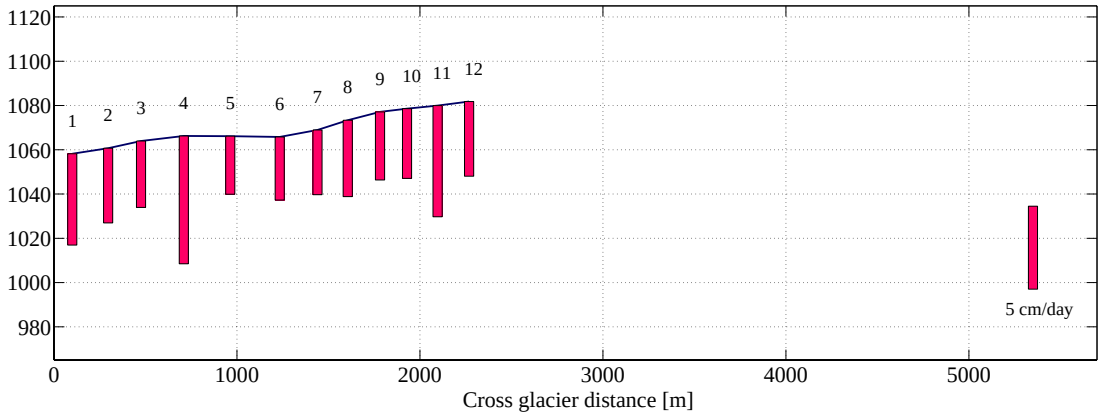
Profile IV (Lower Line) 24.7. − 31.7.99



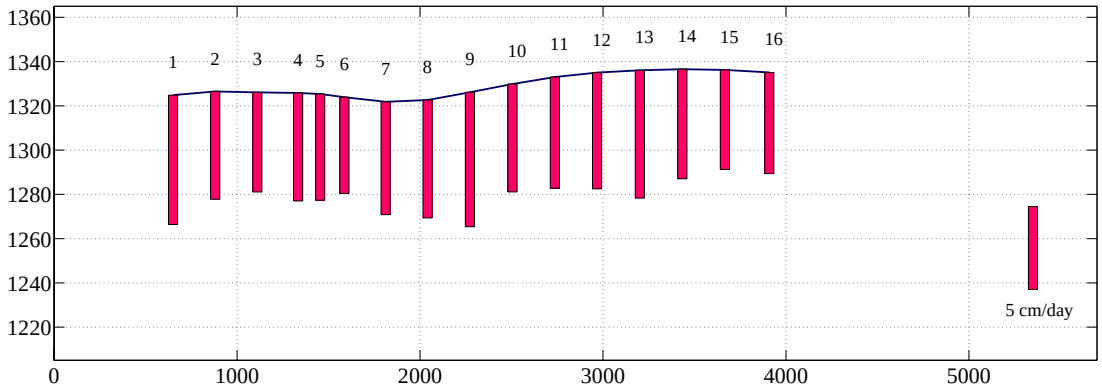
Profile IV (Upper Line) 24.7. − 31.7.99



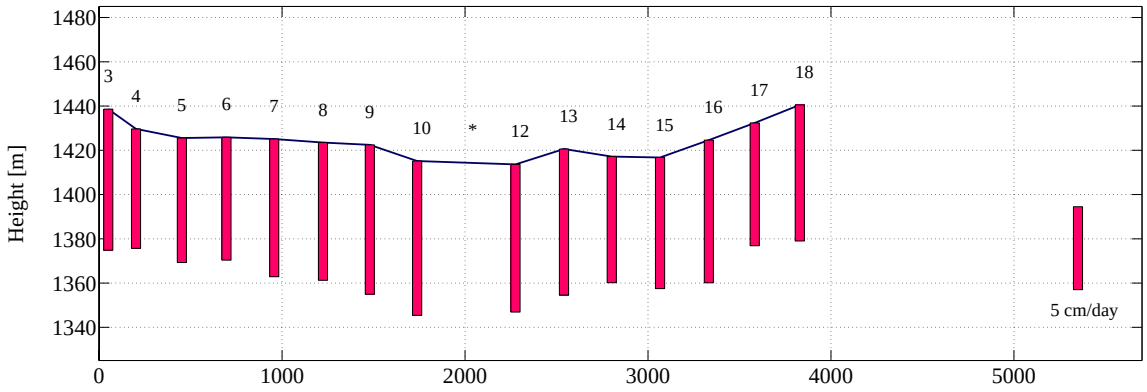
Profile V 25.7. − 1.8.99



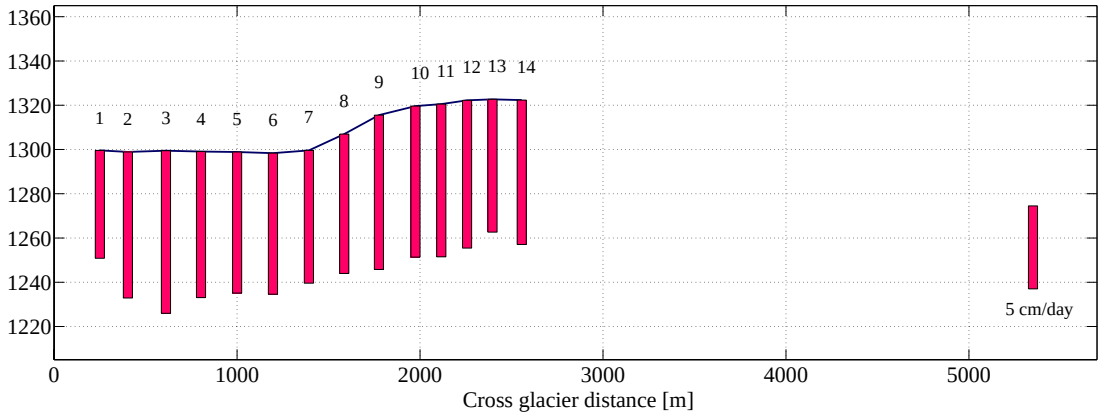
Profile VI 29.7. – 6.8.99



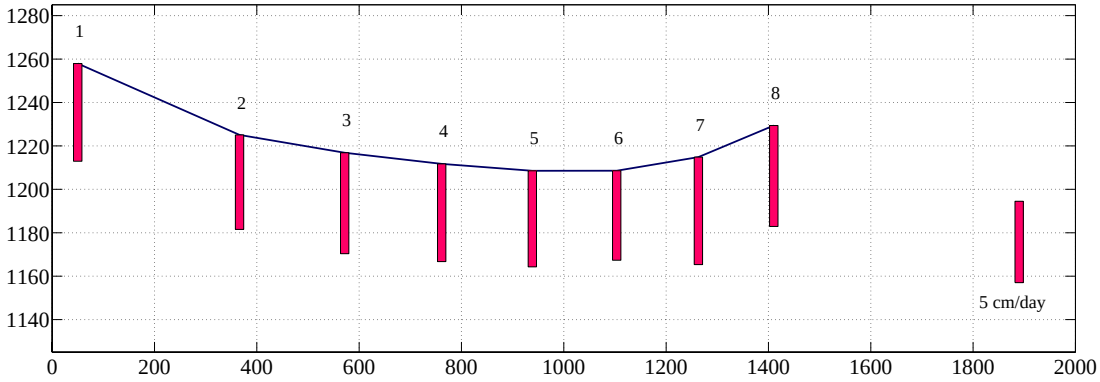
Profile VII 31.7. – 9.8.99



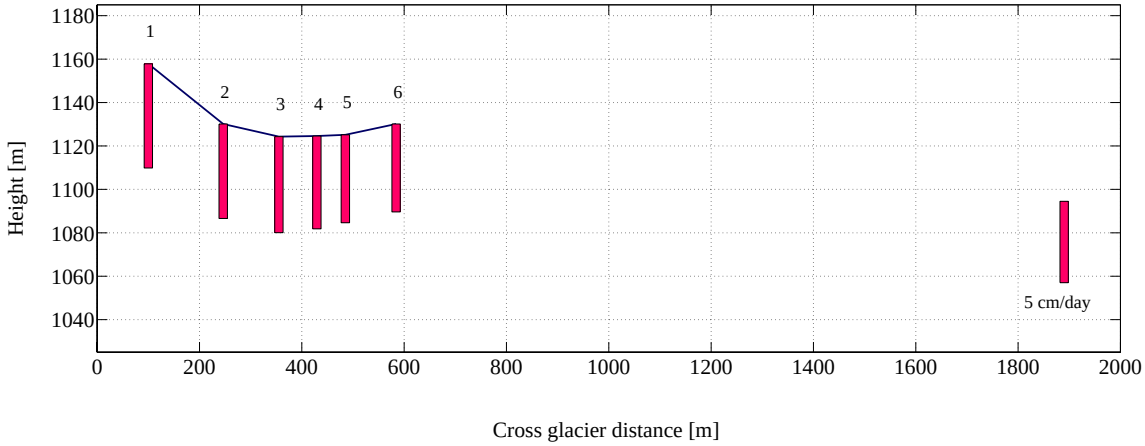
Profile VIIa 29.7. – 6.8.99



Lemon Creek Glacier 18.7. − 30.7.99



Ptarmigan Glacier 18.7. − 30.7.99



: significant height change

: insignificant height change

∗ : outlier

Appendix C3

Movement Vectors
and
Short Term Height Changes
(Tables)

Lemon Creek Glacier (Camp 17 – Martin Peak Saddle)

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
LEM 01	0.00	0.00	0.04	0.00	236.04	-70.2	-6.0
LEM 02	316.24	316.24	0.06	0.00	102.28	-67.9	-5.8
LEM 03	205.49	521.73	0.11	0.01	46.85	-72.7	-6.2
LEM 04	189.67	711.39	0.15	0.01	44.24	-69.8	-6.0
LEM 05	177.08	888.47	0.22	0.02	8.06	-69.1	-5.9
LEM 06	164.95	1053.42	0.20	0.02	398.08	-64.8	-5.5
LEM 07	159.58	1213.00	0.24	0.02	368.65	-77.8	-6.6
LEM 08	147.41	1360.41	0.25	0.02	367.72	-72.4	-6.2

Ptarmigan Glacier (Vesper Peak - Peak 3652)

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
PTAR 01	0.00	0.00	0.13	0.01	347.39	-75.0	-6.4
PTAR 02	146.38	146.38	0.18	0.02	369.98	-68.1	-5.8
PTAR 03	108.82	255.20	0.08	0.01	371.09	-69.0	-5.9
PTAR 04	74.23	329.43	0.07	0.01	355.75	-66.7	-5.7
PTAR 05	55.66	385.09	0.05	0.00	296.45	-63.9	-5.4
PTAR 06	99.18	484.27	0.05	0.00	213.27	-63.2	-5.4

Longitudinal Profile Demorest Glacier

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
LONG DEM 01	0.00	0.00	6.44	0.81	169.04	-87.6	-11.0
LONG DEM 02	497.84	497.84	5.99	0.75	162.87	-80.4	-10.1
LONG DEM 03	503.83	1001.67	4.61	0.58	164.35	-54.5	-6.8
LONG DEM 04	490.88	1492.55	2.81	0.35	182.80	-45.8	-5.7
LONG DEM 05	496.16	1988.71	2.25	0.28	214.88	-44.7	-5.6
LONG DEM 06	502.41	2491.12	2.22	0.28	235.50	-45.0	-5.6
LONG DEM 07	501.18	2992.30	2.21	0.28	248.05	-50.8	-6.4
LONG DEM 08	498.41	3490.71	2.03	0.25	259.25	-52.9	-6.6
LONG DEM 09	499.98	3990.69	1.93	0.24	268.03	-63.3	-7.9
LONG DEM 20	5031.34	9022.03	2.37	0.30	188.72	-45.2	-5.7
LONG DEM 21	496.21	9518.25	2.29	0.29	180.17	-42.1	-5.3
LONG DEM 22	497.52	10015.77	2.13	0.27	178.48	-40.9	-5.1
LONG DEM 23	500.45	10516.22	2.09	0.26	172.38	-50.5	-6.3
LONG DEM 24	500.36	11016.58	2.04	0.26	174.06	-49.5	-6.2
LONG DEM 25	500.37	11516.94	2.05	0.26	175.08	-45.1	-5.7
LONG DEM 26	499.63	12016.57	1.96	0.25	177.35	-54.6	-6.8
LONG DEM 27	500.58	12517.15	1.94	0.24	174.36	-50.6	-6.4
LONG DEM 28	500.99	13018.14	2.17	0.27	185.43	-59.9	-7.5
LONG DEM 29	498.80	13516.94	1.79	0.22	176.83	-48.2	-6.0
LONG DEM 30	499.45	14016.39	1.71	0.21	183.54	-63.0	-7.9
LONG DEM 31	496.93	14513.32	1.67	0.21	199.71	-67.7	-8.5
LONG DEM 32	499.23	15012.55	1.59	0.20	211.59	-56.2	-7.0
LONG DEM 33	496.93	15509.48	1.43	0.18	220.55	-49.3	-6.2
LONG DEM 34	496.25	16005.73	1.50	0.19	222.64	-50.0	-6.3

Longitudinal Profile Taku/Matthes Glacier

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
LON TAKU 24	0.00	0.00	6.49	0.81	179.19	-88.4	-11.1
LON TAKU 25	497.50	497.50	6.93	0.87	171.22	-85.5	-10.7
LON TAKU 26	501.80	999.29	6.84	0.79	153.72	-99.1	-11.4
LON TAKU 27	498.41	1497.71	5.93	0.74	141.78	-71.7	-9.0
LON TAKU 28	253.29	1750.99	5.97	0.75	138.14	-89.3	-11.2
LON TAKU 29	500.17	2251.16	5.84	0.73	136.28	-81.1	-10.2
LON TAKU 30	501.43	2752.60	6.19	0.78	145.70	-40.0	-5.0
LON TAKU 31	502.71	3255.30	5.46	0.69	150.70	-78.8	-9.9
LON TAKU 32	501.38	3756.68	6.03	0.65	156.98	-99.6	-10.8
LON TAKU 33	500.38	4257.06	6.04	0.66	157.96	-94.1	-10.2
LON TAKU 34	501.73	4758.79	5.88	0.64	152.84	-94.7	-10.3
LON TAKU 35	500.37	5259.16	5.71	0.62	149.98	-93.8	-10.2
LON TAKU 36	498.09	5757.25	5.71	0.62	146.15	-80.0	-8.7
LON TAKU 37	498.68	6255.94	5.62	0.61	144.02	-82.9	-9.0
LON TAKU 38	500.25	6756.19	4.81	0.59	140.25	-66.0	-8.1
LON TAKU 39	497.74	7253.93	4.63	0.57	142.32	-68.2	-8.4
LON TAKU 40	500.81	7754.74	4.55	0.56	145.32	-70.7	-8.8
LON TAKU 41	503.20	8257.94	4.42	0.55	149.57	-72.7	-9.0
LON TAKU 42	500.81	8758.75	4.42	0.55	154.35	-77.9	-9.7
LON TAKU 43	500.21	9258.95	4.32	0.53	163.99	-77.2	-9.6
LON TAKU 44	446.62	9705.57	3.17	0.53	171.08	-49.6	-8.3
LON TAKU 45	503.12	10208.69	2.96	0.49	175.45	-52.3	-8.7
LON TAKU 46	498.27	10706.96	2.78	0.46	178.94	-40.1	-6.7
LON TAKU 47	499.83	11206.79	2.66	0.44	179.54	-43.7	-7.3
LON TAKU 48	497.84	11704.64	2.66	0.45	186.47	-45.7	-7.7
LON TAKU 49	500.92	12205.55	2.59	0.43	196.62	-57.3	-9.6
LON TAKU 50	498.60	12704.15	2.54	0.43	213.93	-51.1	-8.6
LON TAKU 51	498.40	13202.55	2.48	0.42	236.28	-57.1	-9.6
LON TAKU 52	499.03	13701.58	2.37	0.40	251.98	-53.6	-9.0
LON TAKU 53	496.67	14198.25	2.45	0.41	255.09	-50.2	-8.4
LON TAKU 54	502.90	14701.15	1.20	0.41	248.11	-29.1	-10.0
LON TAKU 55	500.58	15201.73	1.88	0.38	241.42	-38.1	-7.8
LON TAKU 56	499.31	15701.04	1.92	0.39	234.55	-31.6	-6.5
LON TAKU 57	500.83	16201.87	1.80	0.37	232.66	-42.8	-8.7
LON TAKU 58	499.72	16701.59	2.67	0.32	238.98	-43.6	-5.2
LON TAKU 59	499.74	17201.33	2.59	0.31	244.72	-67.2	-8.1
LON TAKU 60	500.21	17701.55	2.96	0.35	239.63	-54.5	-6.5
LON TAKU 61	499.44	18200.98	2.76	0.33	238.82	-59.4	-7.1

Longitudinal Profile Taku/Matthes Glacier - continued

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
LON TAKU 62	499.69	18700.67	2.75	0.33	240.33	-56.3	-6.7
LON TAKU 63	498.84	19199.52	1.90	0.31	237.94	-43.0	-7.1
LON TAKU 64	501.37	19700.89	1.86	0.31	236.56	-49.5	-8.2
LON TAKU 65	499.80	20200.68	1.90	0.31	233.75	-46.9	-7.8
LON TAKU 66	498.90	20699.58	1.94	0.32	230.05	-48.5	-8.0
LON TAKU 67	497.45	21197.03	2.00	0.33	224.13	-53.3	-8.8
LON TAKU 68	498.48	21695.51	2.14	0.35	217.78	-52.8	-8.7
LON TAKU 69	497.42	22192.93	2.26	0.37	210.04	-65.9	-10.9
LON TAKU 70	498.86	22691.79	2.33	0.38	201.66	-39.5	-6.5
LON TAKU 71	495.24	23187.03	2.43	0.40	193.35	-38.4	-6.3
LON TAKU 72	495.80	23682.83	2.58	0.42	191.50	-45.0	-7.4
LON TAKU 73	498.96	24181.79	2.76	0.45	190.83	-55.1	-9.0
LON TAKU 74	499.45	24681.25	2.97	0.49	196.44	-67.4	-11.0
LON TAKU 75	497.06	25178.31	2.98	0.49	196.12	-56.7	-9.3
LON TAKU 76	495.46	25673.77	3.03	0.44	193.64	-47.1	-6.8
LON TAKU 77	498.42	26172.19	2.77	0.40	199.46	-53.3	-7.6
LON TAKU 78	498.19	26670.38	2.47	0.35	214.01	-52.2	-7.5
LON TAKU 79	500.01	27170.39	2.23	0.32	222.59	-50.6	-7.2
LON TAKU 80	500.89	27671.28	1.96	0.28	223.46	-44.7	-6.4
LON TAKU 81	499.73	28171.01	1.64	0.23	217.20	-45.4	-6.5
LON TAKU 82	499.73	28670.74	1.38	0.20	214.12	-36.2	-5.2
LON TAKU 83	498.97	29169.71	1.27	0.18	219.42	-42.0	-6.0
LON TAKU 84	498.38	29668.08	1.17	0.17	222.47	-40.9	-5.8
LON TAKU 85	498.36	30166.44	1.07	0.15	223.20	-40.8	-5.8

Longitudinal Profile Taku Glacier SW Branch

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
LON SW 01	0.00	0.00	7.96	0.74	136.02	-81.6	-7.6
LON SW 02	501.26	501.26	7.72	0.72	140.77	-88.1	-8.2
LON SW 03	499.18	1000.44	6.51	0.61	142.52	-87.2	-8.1
LON SW 04	502.81	1503.25	4.77	0.44	140.47	-79.3	-7.4
LON SW 05	499.43	2002.68	1.78	0.17	120.73	-69.6	-6.5
LON SW 06	496.50	2499.18	1.04	0.10	70.62	-61.7	-5.7
LON SW 07	497.15	2996.33	0.99	0.09	42.96	-70.5	-6.5
LON SW 08	498.49	3494.83	0.93	0.08	32.80	-65.5	-6.0
LON SW 09	497.52	3992.34	1.02	0.09	26.57	-75.1	-6.9
LON SW 10	498.37	4490.72	0.90	0.08	42.83	-55.3	-5.1
LON SW 11	499.64	4990.36	0.83	0.08	58.44	-57.5	-5.3
LON SW 12	502.51	5492.87	0.92	0.08	70.16	-58.7	-5.4
LON SW 13	498.52	5991.39	0.98	0.09	73.10	-68.0	-6.3
LON SW 14	498.61	6490.00	1.19	0.11	61.06	-70.9	-6.5

Profile 3 (Demorest Glacier, Taku A – Hodgkins Peak)

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
DEM 01	0.00	0.00	0.09	0.01	209.01	-43.1	-4.3
DEM 02	311.84	311.84	0.61	0.06	263.89	-42.6	-4.3
DEM 03	311.52	623.35	1.45	0.15	262.18	-50.0	-5.0
DEM 04	311.88	935.24	2.20	0.22	263.27	-45.5	-4.6
DEM 05	311.57	1246.81	2.53	0.25	262.90	-51.4	-5.1
DEM 06	311.87	1558.68	2.57	0.26	265.77	-71.1	-7.1
DEM 07	311.67	1870.35	2.59	0.26	270.80	-66.0	-6.6
DEM 08	311.51	2181.86	2.36	0.24	270.83	-73.8	-7.4
DEM 09	311.78	2493.63	2.26	0.23	271.81	-73.7	-7.4
DEM 10	311.71	2805.34	1.83	0.18	264.21	-64.4	-6.4
DEM 11	310.57	3115.91	1.16	0.12	255.23	-63.0	-6.3
DEM 12	146.37	3262.28	1.36	0.14	273.92	-70.5	-7.1

Profile 3a (Upper Demorest Glacier, Spider Mt. – Peak 5370)

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
UP DEM 01	0.00	0.00	0.04	0.00	58.71	-52.2	-6.5
UP DEM 02	299.80	299.80	0.13	0.02	209.76	-36.4	-4.5
UP DEM 03	302.54	602.33	0.31	0.04	190.93	-35.8	-4.5
UP DEM 04	300.31	902.64	0.82	0.10	210.96	-44.1	-5.5
UP DEM 05	301.25	1203.88	1.26	0.16	221.55	-58.4	-7.3
UP DEM 06	300.51	1504.40	1.43	0.18	221.78	-47.3	-5.9
UP DEM 07	294.11	1798.51	1.54	0.19	223.35	-52.5	-6.6
UP DEM 08	302.15	2100.66	1.60	0.20	224.55	-50.4	-6.3
UP DEM 09	297.88	2398.54	1.47	0.18	229.07	-48.1	-6.0
UP DEM 10	299.49	2698.03	1.36	0.17	230.40	-46.5	-5.8
UP DEM 11	300.31	2998.34	1.14	0.14	234.66	-44.8	-5.6
UP DEM 12	302.37	3300.71	0.76	0.09	238.75	-46.7	-5.8
UP DEM 13	298.68	3599.39	0.36	0.04	240.91	-44.4	-5.5
UP DEM 14	300.64	3900.03	0.16	0.02	231.05	-41.7	-5.2
UP DEM 15	300.93	4200.96	0.02	0.00	223.90	-60.6	-7.6

Profile 3b (Demorest Glacier, Floprock Peak – The Scatter Peaks)

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
DEM MID 01	0.00	0.00	0.04	0.02	210.82	-12.4	-5.7
DEM MID 02	494.22	494.22	0.34	0.16	184.71	-8.1	-3.7
DEM MID 03	500.11	994.34	0.53	0.25	177.55	-15.8	-7.3
DEM MID 04	499.84	1494.18	0.55	0.26	175.01	-2.5	-1.2
DEM MID 05	500.28	1994.46	0.51	0.24	173.62	-13.1	-6.1
DEM MID 06	499.70	2494.16	0.43	0.20	172.90	-7.4	-3.4
DEM MID 07	499.36	2993.52	0.16	0.07	168.70	-13.7	-6.3
DEM MID 08	499.11	3492.63	0.07	0.03	103.16	-16.5	-7.7

Profile 4 (Taku Glacier, Camp 10 – Shoehorn Mt.) – Lower Line

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
TAKU IV 01	0.00	0.00	0.02	0.00	123.76	-7.0	-1.0
TAKU IV 03	193.15	193.15	0.30	0.04	144.00	-46.1	-5.8
TAKU IV 05	198.15	391.30	0.49	0.07	150.88	-28.3	-4.0
TAKU IV 07	252.68	643.98	1.46	0.21	155.00	-28.4	-4.0
TAKU IV 09	239.71	883.68	2.75	0.35	146.39	-34.2	-4.3
TAKU IV 11	180.15	1063.83	3.83	0.48	148.59	-33.8	-4.3
TAKU IV 13	322.28	1386.11	3.94	0.56	146.51	-31.3	-4.4
TAKU IV 15	312.40	1698.51	4.47	0.63	145.81	-32.1	-4.5
TAKU IV 17	393.01	2091.52	4.18	0.59	143.38	-43.6	-6.2
TAKU IV 19	374.58	2466.10	4.30	0.61	140.12	-52.4	-7.4
TAKU IV 21	377.45	2843.55	4.16	0.59	141.33	-38.3	-5.4
TAKU IV 23	322.64	3166.19	3.94	0.56	140.13	-38.4	-5.4
TAKU IV 25	388.39	3554.57	2.93	0.41	139.84	-16.8	-2.4
TAKU IV 27	378.67	3933.25	1.54	0.22	138.95	-32.1	-4.5
TAKU IV 29	348.42	4281.66	0.41	0.06	122.11	-20.0	-2.8
TAKU IV 31	336.24	4617.90	0.37	0.05	188.74	-26.2	-3.7

Profile 4 (Taku Glacier, Camp 10 – Shoehorn Mt.) – Upper Line

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
TAKU IV 02	0.00	0.00	0.05	0.01	168.31	-26.2	-3.7
TAKU IV 04	210.11	210.11	0.27	0.04	145.50	-26.7	-3.8
TAKU IV 06	229.74	439.85	0.85	0.11	147.42	-27.6	-3.6
TAKU IV 08	199.81	639.66	1.61	0.23	147.47	-26.3	-3.7
TAKU IV 10	204.26	843.92	2.62	0.37	146.88	-23.8	-3.4
TAKU IV 12	259.34	1103.25	3.48	0.49	146.20	-32.8	-4.7
TAKU IV 14	349.05	1452.30	3.89	0.55	147.49	-52.1	-7.4
TAKU IV 16	345.95	1798.25	4.06	0.58	144.76	-44.7	-6.3
TAKU IV 18	447.25	2245.50	4.19	0.59	139.73	-54.2	-7.7
TAKU IV 20	339.71	2585.21	4.34	0.62	144.14	-52.9	-7.5
TAKU IV 22	333.27	2918.49	4.03	0.57	140.22	-44.2	-6.3
TAKU IV 24	352.57	3271.05	3.59	0.51	139.89	-33.5	-4.7
TAKU IV 26	329.03	3600.09	2.68	0.38	139.77	-37.8	-5.4
TAKU IV 28	460.06	4060.15	1.13	0.16	137.44	-40.2	-5.7
TAKU IV 30	335.85	4396.00	0.26	0.04	120.31	-21.9	-3.1

Profile 5 (Taku Glacier SW Branch, Juncture Peak – SW Taku Pt.)

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
SW TAKU 01	0.00	0.00	0.13	0.02	25.24	-39.2	-5.5
SW TAKU 02	196.05	196.05	0.15	0.02	52.37	-32.1	-4.5
SW TAKU 03	179.64	375.69	0.35	0.05	62.14	-28.3	-4.0
SW TAKU 04	233.80	609.49	0.59	0.08	48.10	-54.1	-7.7
SW TAKU 05	253.80	863.30	0.60	0.08	36.19	-24.6	-3.5
SW TAKU 06	270.20	1133.50	0.60	0.08	36.34	-26.9	-3.8
SW TAKU 07	206.52	1340.02	0.65	0.09	40.86	-27.6	-3.9
SW TAKU 08	165.32	1505.34	0.74	0.10	41.01	-32.3	-4.6
SW TAKU 09	176.33	1681.67	0.48	0.07	36.95	-28.4	-4.1
SW TAKU 10	147.71	1829.38	0.53	0.08	34.60	-29.1	-4.2
SW TAKU 11	166.89	1996.27	0.46	0.07	36.17	-46.5	-6.7
SW TAKU 12	172.23	2168.50	0.10	0.01	18.69	-31.4	-4.5

Profile 6 (Taku Glacier NW Branch, Taku NW Pt. – Echo Mt.)

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
NW TAKU 01	0.00	0.00	1.17	0.15	103.10	-63.0	-7.8
NW TAKU 02	230.63	230.63	1.55	0.19	105.58	-52.0	-6.5
NW TAKU 03	230.11	460.74	1.85	0.23	97.43	-48.3	-6.0
NW TAKU 04	222.71	683.46	1.95	0.24	105.80	-51.7	-6.5
NW TAKU 05	120.73	804.19	2.00	0.25	107.70	-51.4	-6.4
NW TAKU 06	132.50	936.69	2.14	0.27	103.23	-46.8	-5.8
NW TAKU 07	224.95	1161.64	2.13	0.27	103.60	-54.6	-6.8
NW TAKU 08	229.24	1390.88	2.21	0.28	105.78	-57.0	-7.1
NW TAKU 09	231.59	1622.47	2.29	0.29	104.35	-64.7	-8.1
NW TAKU 10	232.81	1855.28	2.18	0.27	108.38	-51.7	-6.5
NW TAKU 11	231.50	2086.77	2.17	0.27	108.42	-53.5	-6.7
NW TAKU 12	230.76	2317.53	2.06	0.26	109.27	-56.2	-7.0
NW TAKU 13	233.96	2551.49	1.80	0.23	107.16	-61.1	-7.7
NW TAKU 14	232.18	2783.67	1.37	0.17	110.06	-52.8	-6.6
NW TAKU 15	232.38	3016.05	0.78	0.10	111.11	-47.7	-6.0
NW TAKU 16	242.80	3258.85	0.41	0.05	115.22	-48.9	-6.1

Profile 7 (Matthes Glacier, Camp 9 – Centurian Peak)

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
CAMP_9 03	0.00	0.00	0.04	0.00	274.54	-75.8	-8.5
CAMP_9 04	151.64	151.64	0.18	0.02	294.96	-64.5	-7.2
CAMP_9 05	250.73	402.37	0.48	0.05	257.50	-66.9	-7.5
CAMP_9 06	243.76	646.12	1.14	0.13	246.14	-66.0	-7.4
CAMP_9 07	260.98	907.11	2.04	0.23	242.24	-74.1	-8.3
CAMP_9 08	266.51	1173.61	2.80	0.31	239.19	-74.6	-8.3
CAMP_9 09	255.74	1429.35	2.95	0.33	239.74	-80.4	-9.0
CAMP_9 10	258.76	1688.11	3.01	0.34	240.16	-83.3	-9.3
CAMP_9 12	537.46	2225.57	2.92	0.33	237.77	-79.3	-8.9
CAMP_9 13	265.26	2490.83	2.84	0.32	236.09	-79.2	-8.8
CAMP_9 14	260.94	2751.78	2.48	0.28	235.93	-68.3	-7.6
CAMP_9 15	264.03	3015.81	2.14	0.24	228.22	-70.2	-7.9
CAMP_9 16	266.62	3282.43	1.34	0.15	213.37	-76.5	-8.6
CAMP_9 17	250.66	3533.09	0.92	0.10	211.49	-65.7	-7.4
CAMP_9 18	246.31	3779.40	0.34	0.04	203.55	-73.2	-8.2

Profile 7a (Lower Matthes Glacier, Taku D – Taku C)

Point	Point to point distance [m]	Sum of distances [m]	Total Movement [m]	Daily Movement [m]	Bearing of movement [gon]	Total height change [cm]	Daily height change [cm]
LOW MAT 01	0.00	0.00	1.45	0.18	248.37	-51.4	-6.5
LOW MAT 02	153.25	153.25	2.05	0.26	245.96	-70.0	-8.8
LOW MAT 03	207.96	361.21	2.63	0.33	248.22	-77.5	-9.8
LOW MAT 04	191.74	552.95	2.80	0.35	246.47	-70.0	-8.8
LOW MAT 05	197.13	750.07	3.04	0.38	251.17	-67.2	-8.5
LOW MAT 06	196.04	946.12	3.17	0.40	249.39	-67.5	-8.5
LOW MAT 07	196.34	1142.46	3.31	0.42	252.00	-63.0	-8.0
LOW MAT 08	193.16	1335.62	3.35	0.42	249.73	-66.3	-8.4
LOW MAT 09	189.57	1525.19	3.30	0.42	251.29	-73.8	-9.3
LOW MAT 10	199.97	1725.16	3.27	0.41	252.57	-72.2	-9.1
LOW MAT 11	140.91	1866.07	3.27	0.41	252.35	-72.8	-9.2
LOW MAT 12	140.92	2006.99	2.93	0.37	252.34	-70.1	-8.9
LOW MAT 13	138.94	2145.93	2.65	0.33	254.11	-63.7	-8.0
LOW MAT 14	159.85	2305.78	2.29	0.29	252.54	-68.8	-8.7

Appendix D

Long Term Height Changes (Tables)

Profile 3 (Demorest Glacier) height differences 1998-1999
Reference day : July, 26

Point	Position difference [m]	Delta height [m]
DEM 01	0.0	0.30
DEM 02	0.0	0.20
DEM 03	0.0	-0.07
DEM 04	0.0	0.07
DEM 05	0.0	0.11
DEM 06	0.1	0.52

Point	Position difference [m]	Delta height [m]
DEM 07	0.1	0.36
DEM 08	0.0	0.31
DEM 09	0.1	0.28
DEM 10	0.0	0.13
DEM 11	1.2	0.13
DEM 12	0.0	0.21

Profile 3a (Upper Demorest Glacier) height differences 1998-1999
Reference day: August, 6

Point	Position difference [m]	Delta height [m]
UP DEM 01	0.1	0.36
UP DEM 02	0.1	0.59
UP DEM 03	0.1	0.34
UP DEM 04	0.1	0.26

Point	Position difference [m]	Delta height [m]
UP DEM 05	0.0	0.30
UP DEM 06	0.1	0.32
UP DEM 10	9.6	0.45
UP DEM 11	4.6	0.32

Profile 4 (Taku Glacier) height differences 1998-1999
Reference day : July, 28

Lower Line

Point	Position difference [m]	Delta height [m]
TAKU IV 01	0.1	0.67
TAKU IV 03	0.1	0.46
TAKU IV 05	0.4	0.34
TAKU IV 07	1.0	0.38
TAKU IV 09	1.8	0.46
TAKU IV 11	2.4	0.47
TAKU IV 13	2.8	0.94
TAKU IV 15	2.9	0.72
TAKU IV 17	2.9	0.78
TAKU IV 19	2.9	1.00
TAKU IV 21	2.9	0.64
TAKU IV 23	2.7	0.90
TAKU IV 25	2.2	0.87
TAKU IV 27	1.1	0.29
TAKU IV 29	0.1	0.42
TAKU IV 31	0.6	0.74

Upper Line

Point	Position difference [m]	Delta height [m]
TAKU IV 02	0.4	0.46
TAKU IV 04	0.4	0.37
TAKU IV 06	0.7	0.35
TAKU IV 08	1.4	0.26
TAKU IV 10	1.3	0.31
TAKU IV 12	2.9	0.50
TAKU IV 14	3.1	0.71
TAKU IV 16	3.5	0.61
TAKU IV 18	2.7	0.80
TAKU IV 20	2.9	0.77
TAKU IV 22	3.1	0.84
TAKU IV 24	3.7	0.55
TAKU IV 26	12.2	0.25
TAKU IV 28	0.4	0.76
TAKU IV 30	0.4	0.75

Profile 5 (Taku Glacier SW Branch) height differences 1998-1999
Reference day: July, 27

Point	Position difference [m]	Delta height [m]
SW TAKU 01	3.0	0.38
SW TAKU 02	3.0	0.22
SW TAKU 03	6.2	0.27
SW TAKU 04	2.7	0.19
SW TAKU 05	1.1	0.27
SW TAKU 06	1.4	0.44

Point	Position difference [m]	Delta height [m]
SW TAKU 07	6.0	0.43
SW TAKU 08	2.9	0.40
SW TAKU 09	0.8	0.48
SW TAKU 10	3.4	0.68
SW TAKU 11	4.3	0.69
SW TAKU 12	0.5	0.29

Profile 6 (Taku Glacier NW Branch) height differences 1998-1999
Reference day: August, 8

Point	Position difference [m]	Delta height [m]
NW TAKU 01	0.8	0.80
NW TAKU 02	1.8	0.85
NW TAKU 03	1.9	0.96
NW TAKU 04	1.6	0.82
NW TAKU 05	1.8	0.73
NW TAKU 06	1.8	0.73
NW TAKU 07	1.9	0.38
NW TAKU 08	2.0	0.77

Point	Position difference [m]	Delta height [m]
NW TAKU 09	1.9	0.72
NW TAKU 10	2.0	1.09
NW TAKU 11	1.9	0.69
NW TAKU 12	1.8	0.56
NW TAKU 13	1.4	0.59
NW TAKU 14	1.3	0.67
NW TAKU 15	0.8	0.35
NW TAKU 16	0.3	0.65

Profile 7 (Matthes Glacier near Camp 9) height differences 1998-1999
Reference day : July, 29

Point	Position difference [m]	Delta height [m]
CAMP_9 03	0.1	0.79
CAMP_9 04	0.2	0.74
CAMP_9 05	0.2	0.91
CAMP_9 06	0.5	0.97
CAMP_9 07	0.5	0.93
CAMP_9 08	0.3	1.22
CAMP_9 09	0.3	0.85

Point	Position difference [m]	Delta height [m]
CAMP_9 10	0.1	1.06
CAMP_9 11	0.1	0.87
CAMP_9 12	0.1	0.81
CAMP_9 13	0.1	0.75
CAMP_9 14	0.1	0.71
CAMP_9 15	0.1	0.75
CAMP_9 16	0.5	0.73

Profile 7a (Lower Matthes Glacier) height differences 1998-1999
Reference day: July, 29

Point	Position difference [m]	Delta height [m]
LOW MAT 01	0.1	0.34
LOW MAT 02	0.3	0.38
LOW MAT 03	0.2	0.56
LOW MAT 04	0.1	0.68
LOW MAT 05	0.4	0.61
LOW MAT 06	0.3	0.76
LOW MAT 07	0.3	0.60

Point	Position difference [m]	Delta height [m]
LOW MAT 08	0.3	0.73
LOW MAT 09	0.4	0.92
LOW MAT 10	0.2	0.69
LOW MAT 11	0.6	0.91
LOW MAT 12	0.4	0.94
LOW MAT 13	0.3	0.76
LOW MAT 14	0.3	1.10

Lemon Creek Glacier height differences August 3, 1998- August 3, 1999

Point	Position difference [m]	Delta height [m]
Lemon 01	0.1	0.50
Lemon 02	0.1	0.52
Lemon 03	0.1	-0.13
Lemon 04	0.2	-0.26
Lemon 05	0.1	-0.16
Lemon 06	0.2	-0.18
Lemon 07	0.2	-0.24
Lemon 08	0.3	-0.16
Lemon 09	0.1	-0.18
Lemon 10	0.1	-0.25
Lemon 11	0.5	0.08
Lemon 12	0.1	0.07
Lemon 13	0.0	-0.22
Lemon 14	0.6	-0.24
Lemon 15	0.2	-0.26
Lemon 16	0.3	-0.16
Lemon 17	0.2	-0.12
Lemon 18	0.5	-0.13
Lemon 19	0.2	0.04
Lemon 20	0.3	0.16
Lemon 21	0.2	0.17
Lemon 22	0.2	0.00
Lemon 23	0.0	0.00
Lemon 24	0.1	0.01
Lemon 25	0.1	0.11
Lemon 26	0.1	0.28
Lemon 27	0.0	0.31
Lemon 28	0.1	0.70
Lemon 29	0.1	0.02
Lemon 30	0.1	-0.41
Lemon 31	0.1	0.59
Lemon 32	0.1	1.26
Lemon 33	0.1	0.79
Lemon 34	0.1	-0.08
Lemon 35	0.1	0.33
Lemon 36	0.1	0.22
Lemon 37	0.2	0.22
Lemon 38	0.2	0.25
Lemon 39	0.1	0.02

Point	Position difference [m]	Delta height [m]
Lemon 40	0.2	0.19
Lemon 41	0.3	-0.28
Lemon 42	0.1	-0.11
Lemon 43	0.2	0.00
Lemon 44	0.2	0.01
Lemon 45	0.2	-0.08
Lemon 46	0.3	-0.07
Lemon 47	0.1	0.07
Lemon 48	0.1	-0.09
Lemon 49	0.1	-0.05
Lemon 50	0.1	-0.01
Lemon 51	0.2	0.19
Lemon 52	0.0	0.15
Lemon 53	0.1	0.23
Lemon 54	0.1	0.34
Lemon 55	0.0	0.38
Lemon 56	0.2	-0.12
Lemon 57	0.3	-0.18
Lemon 58	0.1	-0.09
Lemon 59	0.2	-0.07
Lemon 60	0.3	-0.21
Lemon 61	0.3	-0.11
Lemon 62	0.2	-0.09
Lemon 63	0.2	-0.21
Lemon 64	0.2	-0.09
Lemon 65	0.1	-0.25
Lemon 66	0.0	-0.28
Lemon 67	0.1	-0.06
Lemon 68	0.1	-0.04
Lemon 69	0.2	-0.01
Lemon 70	0.2	-0.11
Lemon 71	0.0	-0.15
Lemon 72	0.1	-0.06
Lemon 73	0.1	0.14
Lemon 74	0.3	-0.08
Lemon 75	0.2	-0.01
Lemon 76	0.1	-0.15
Lemon 77	0.1	-0.16
Lemon 78	0.0	-0.05

Lemon Creek Glacier height differences August 2, 1997- August 3, 1998 (cont.)

Point	Position difference [m]	Delta height [m]
Lemon 79	0.0	0.06
Lemon 80	0.2	0.95
Lemon 81	0.1	-0.05
Lemon 82	0.1	-0.07
Lemon 83	0.0	-0.11
Lemon 84	0.1	-0.27
Lemon 85	0.1	-0.19
Lemon 86	0.0	-0.25
Lemon 87	0.1	-0.27

Point	Position difference [m]	Delta height [m]
Lemon 88	0.1	-0.10
Lemon 89	0.1	-0.04
Lemon 90	0.2	0.09
Lemon 91	0.2	0.02
Lemon 92	0.1	0.10
Lemon 93	0.1	0.11
Lemon 94	0.1	0.21
Lemon 95	0.3	0.51
Lemon 96	0.4	0.87

Appendix E

Volume Changes

Profile 4 (Taku Glacier, Camp 10 – Shoehorn Mt.) 1998, July 25 – 1999, July 25

	July 25, 1998			July 25, 1999				
Triangle Points	Area [m²]	Σ(dh/3) [m]	Volume [m³]	Area [m²]	Σ(dh/3) [m]	Volume [m³]	Delta Area [m²]	Delta Volume [m³]
1 2 3	24936.9	20.06	500344.6	24928.4	20.56	512606.4	-8.5	13040.4
2 3 4	26261.9	22.00	577807.5	26232.9	22.42	588272.8	-29.0	10908.4
3 4 5	24298.0	20.62	501131.4	24345.3	21.02	511730.6	47.3	9979.0
4 5 6	27348.3	20.69	565752.9	27334.3	21.02	574440.3	-14.0	9404.4
5 6 7	29283.8	18.84	551853.3	29318.1	19.17	561987.1	34.3	10779.4
6 7 8	22241.1	18.69	415746.7	22225.1	18.97	421703.0	-16.0	7212.2
7 8 9	26340.7	17.88	471066.4	26327.7	18.21	479447.4	-13.0	9449.5
8 9 10	21196.5	18.45	390985.0	21298.3	18.74	399222.6	101.8	8009.2
9 10 11	18682.2	18.18	339725.0	18725.6	18.55	347432.8	43.4	7987.1
10 11 12	25597.0	18.50	473522.3	25614.2	18.86	483004.7	17.2	11131.1
11 12 13	31011.6	18.11	561669.9	30940.4	18.67	577695.4	-71.2	19178.5
12 13 14	35741.3	18.58	664005.0	35669.8	19.26	687000.9	-71.5	25010.7
13 14 15	33020.4	17.25	569748.0	32983.2	18.03	594594.2	-37.2	25808.8
14 15 16	37176.0	17.72	658941.3	37124.1	18.41	683295.4	-51.9	24996.8
15 16 17	42908.9	17.37	745214.7	42784.3	18.03	771509.0	-124.6	29381.1
16 17 18	48635.5	20.83	1013285.4	48572.6	21.54	1046366.4	-62.9	34706.9
17 18 19	40582.1	22.76	923725.1	40635.5	23.61	959467.3	53.4	35601.7
18 19 20	36839.1	26.86	989457.4	36913.9	27.73	1023442.7	74.8	33075.5
19 20 21	41077.0	29.11	1195792.6	41069.1	29.90	1228166.3	-7.9	32836.5
20 21 22	36603.9	32.57	1192030.5	36535.7	33.32	1217257.9	-68.2	25797.1
21 22 23	35581.4	33.37	1187299.8	35531.3	34.14	1213061.2	-50.1	27104.4
22 23 24	40134.1	34.85	1398589.4	39936.5	35.59	1421462.0	-197.6	25720.9
23 24 25	45230.6	34.90	1578457.4	45060.6	35.60	1604277.9	-170.0	30746.7
24 25 26	41421.1	36.41	1508307.6	39934.4	36.91	1473926.0	-1486.7	-16986.1
25 26 27	47461.1	36.60	1737215.1	46892.1	37.01	1735602.7	-569.0	6604.5
26 27 28	59078.4	37.41	2209915.0	60454.2	37.84	2287520.8	1375.8	62966.8
27 28 29	47546.0	38.12	1812469.5	47738.4	38.60	1842654.8	192.4	28296.3
28 29 30	47408.3	39.06	1851819.6	47455.7	39.69	1883599.1	47.4	31975.8
29 30 31	49100.1	41.23	2024581.7	49134.2	41.83	2055067.4	34.1	33416.4
SUM	1042743.4	747.05	28610460.4	1041716.1	763.24	29185815.1	-1027.4	575355.0

Profile 4 (Taku Glacier, Camp 10 – Shoehorn Mt.) 1999, July 24 – July 31

	July 24. 1999			July 31. 1999				
Triangle Points	Area [m²]	Σ(dh/3) [m]	Volume [m³]	Area [m²]	Σ(dh/3) [m]	Volume [m³]	Delta Area [m²]	Delta Volume [m³]
1 2 3	24928.1	10.59	264105.4	24929.0	10.35	260612.8	0.9	-6098.3
2 3 4	26231.8	12.46	326927.1	26234.7	12.15	322286.4	2.9	-8106.2
3 4 5	24343.1	11.06	269259.3	24353.7	10.74	264910.2	10.6	-7611.9
4 5 6	27334.0	11.05	301968.1	27323.3	10.78	297765.5	-10.7	-7360.4
5 6 7	29312.6	9.20	269783.4	29334.9	8.93	265375.3	22.3	-7734.5
6 7 8	22221.7	9.01	200128.3	22220.1	8.74	196764.7	-1.6	-5886.4
7 8 9	26326.2	8.25	217112.4	26301.7	7.97	212752.2	-24.5	-7619.3
8 9 10	21295.1	8.78	186900.1	21273.8	8.51	183544.5	-21.3	-5867.6
9 10 11	18721.1	8.59	160814.1	18715.1	8.31	157802.5	-6.0	-5273.7
10 11 12	25602.6	8.89	227649.7	25621.1	8.60	223551.7	18.5	-7188.0
11 12 13	30928.9	8.71	269422.0	30925.7	8.40	263910.2	-3.2	-9655.5
12 13 14	35652.5	9.31	331794.3	35687.1	8.92	324140.8	34.6	-13394.0
13 14 15	32968.2	8.08	266228.8	32995.1	7.69	259162.7	26.9	-12364.2
14 15 16	37103.1	8.46	313781.3	37163.8	8.03	305025.7	60.7	-15319.3
15 16 17	42764.7	8.08	345666.8	42805.0	7.69	336126.5	40.3	-16696.4
16 17 18	48560.7	11.60	563287.8	48534.7	11.13	550025.0	-26.0	-23176.7
17 18 19	40625.4	13.67	555538.9	40612.1	13.18	543914.2	-13.3	-20326.0
18 19 20	36899.7	17.79	656432.8	36929.2	17.26	645608.7	29.5	-18950.1
19 20 21	41059.5	19.96	819752.0	41041.9	19.49	808428.1	-17.6	-19816.3
20 21 22	36529.9	23.37	853764.3	36507.5	22.92	844117.2	-22.4	-16877.0
21 22 23	35523.5	24.19	859361.6	35526.8	23.79	851297.0	3.3	-14107.1
22 23 24	39925.3	25.64	1023699.1	39956.5	25.26	1015399.3	31.2	-14543.4
23 24 25	45052.2	25.64	1155124.6	45058.7	25.35	1147681.7	6.5	-13037.7
24 25 26	39928.5	26.94	1075846.0	39943.6	26.65	1069422.6	15.1	-11243.5
25 26 27	46887.0	27.05	1268230.6	46894.8	26.76	1260662.2	7.8	-13227.6
26 27 28	60453.0	27.88	1685671.1	60443.9	27.52	1672934.5	-9.1	-22255.5
27 28 29	47738.9	28.64	1367115.7	47725.8	28.33	1358581.3	-13.1	-14917.0
28 29 30	47458.9	29.73	1410733.0	47430.3	29.45	1402891.4	-28.6	-13720.2
29 30 31	49124.4	31.85	1564807.7	49199.8	31.63	1559871.3	75.4	-8678.8
SUM	1041500.7	474.48	18810906.4	1041689.7	464.55	18449839.3	189.0	-361052.6

Appendix E

Volume Changes

Profile 4 (Taku Glacier, Camp 10 – Shoehorn Mt.)

Triangle Points	e1 [µstrain/day]	e2 [µstrain/day]	e3 [µstrain/day]	Θ [gon]
1 2 3	88.84	-83.85	-4.99	105.89
2 3 4	84.79	-69.02	-15.77	112.43
3 4 5	111.56	-49.52	-62.04	103.11
4 5 6	139.65	-195.70	56.05	96.16
5 6 7	352.55	-243.55	-109.00	99.12
6 7 8	346.58	-356.05	9.47	101.79
7 8 9	277.11	-409.96	132.85	107.44
8 9 10	276.20	-419.22	143.02	97.58
9 10 11	357.36	-403.29	45.93	93.84
10 11 12	340.67	-237.12	-103.54	110.76
11 12 13	153.92	-168.72	14.80	110.41
12 13 14	157.90	-19.42	-138.47	119.15
13 14 15	191.89	-74.97	-116.91	125.63
14 15 16	312.56	-78.97	-233.59	144.54
15 16 17	197.44	-62.71	-134.73	163.78
16 17 18	41.45	-117.82	76.37	131.69
17 18 19	60.28	-106.88	46.60	125.84
18 19 20	110.78	3.39	-114.17	47.86
19 20 21	85.03	-146.03	60.99	17.76
20 21 22	52.20	-139.84	87.64	182.70
21 22 23	52.09	-39.06	-13.04	181.74
22 23 24	151.61	-40.06	-111.55	187.15
23 24 25	193.26	-172.71	-20.55	7.47
24 25 26	223.82	-169.78	-54.03	5.36
25 26 27	274.94	-251.02	-23.92	7.70
26 27 28	236.94	-258.46	21.52	10.14
27 28 29	220.75	-260.14	39.39	7.51
28 29 30	171.44	-257.74	86.30	13.34
29 30 31	167.51	51.86	-219.37	57.83