
Glacier Snowline Survey 2005

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Executive Summary

Glaciers of New Zealand provide indisputable, enhanced responses to the changing climate, which are recorded by annual aerial surveys. These surveys measure the altitudes of end-of-summer-glacier snowlines of 50 selected index glaciers, which are used as a surrogate for annual glacier mass-balance. The survey has been made in most years since 1977, but rarely do conditions permit all of the index glaciers to be surveyed each year. The surveys are carried out by hand-held oblique photography taken from a light aircraft, where the position of the glacier snowline is recorded from a similar viewpoint each year.

The glaciers have shown a cyclic trend of positive mass-balances for most of the 29-year monitoring period, with periods of positive balances at near 11 year intervals. Nearly all of the index glacier snowline elevations measured in the 2005-monitoring program indicate positive mass balances, ie below average equilibrium line altitudes (ELAs).

The low ELAs across the Southern Alps were a result of more frequent depressions to the east of the South Island resulting in stronger westerly and cold south westerly circulation than usual, especially from August to December. During this 5-month period more depressions ('lows') to the south east of the Chatham Islands produced frequent episodes of strong cold south westerly winds. For this period, although precipitation was close to normal, temperatures were 0.6°C below average, producing more snow precipitation, and delaying the melting of the seasonal snowpack.

1. Introduction

The results presented in this report continue an annual glacier/climate photographic monitoring programme begun in 1977, of the position (altitude) of the end-of-summer snowline on 50 selected index glaciers, arranged in transects across the Southern Alps, (see Figure 1).

Between 1977 and 1985, a New Zealand glacier inventory was undertaken from Mount Ruapehu in the North Island at 39° 15' S to southern Fiordland at 45° 57' S. A total of 3144 glaciers were identified for the inventory. In the South Island, average peak summits range from 1850 m in Fiordland to 3000 m in the central Southern Alps and descend to 2000 m in the north-central Southern Alps. To the north east, the Kaikoura ranges reach to over 2700 m, where active rock glaciers have developed under the dry climate. Three North Island volcanic cones reach close to the permanent snowline, but only Mount Ruapehu, with a summit at 2752 m, supports glaciers. Because of the distances involved, these glaciers are not included in the annual surveys.

New Zealand has a humid maritime climate, with the Southern Alps lying across the path of the prevailing westerly winds. Mean annual precipitation rises rapidly from 3000 mm along the narrow western coastal plains to a maximum of 15,000 mm or more in the western part of the Alps close to the Main Divide. From this maximum, precipitation diminishes exponentially to about 1000mm in the eastern ranges. This creates steep eastward precipitation gradients and the mean altitudes of the glaciers closely follow these gradients (Chinn and Whitehouse, 1980).

1.1 Glaciers and climate change

Glacier fluctuations are amongst the clearest signals of climate change, because glaciers are highly sensitive indicators of the earth surface energy balance. Glaciers give distinct signals of past climate change from decades to millennia. Atmospheric changes are signalled by direct, immediate changes in annual mass balance, which are filtered, smoothed and enhanced before they become apparent at the glacier front. Glacier snowline altitudes give a direct value for annual glacier health and balance, whereas the climate signal indicated by glacier frontal positions is severely modified by glacier response times and dynamics.

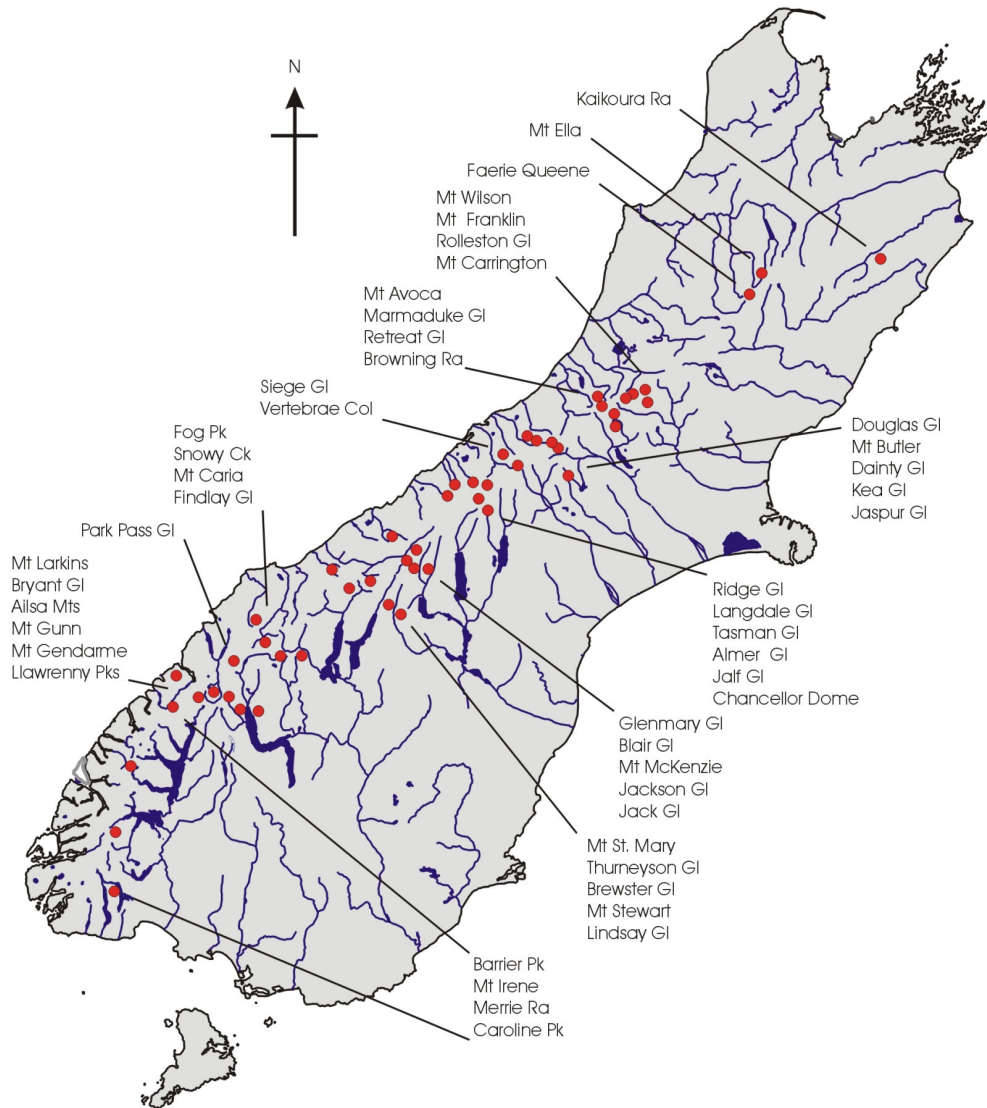


Figure 1 Location of the 50 index glaciers

1.2 The Equilibrium Line Altitude (ELA)

The winter snowpack normally covers the entire glacier in a wedge shape, with the greatest snow depths near the highest altitudes, tapering to zero at the lower

edge. This lower margin, or transient snowline, of the snowpack retreats up-glacier as summer melt progresses, until it reaches a maximum altitude for the year at the end of summer (March - April). Located somewhere near the middle of the glacier, the end-of-summer snowline indicates an equilibrium line where snowfall exactly equals snow loss over the past glacial year (Figure 2). This line, normally visible as the contrast between the discoloured concentration of dust on firn and the clean snow of the previous winter, is the glacier snowline for that year. It is the altitude of this glacier snowline, defined as the Equilibrium Line Altitude (ELA) by Meier and Post, (1962), that is measured each year by the current snowline survey. The higher the altitude of the ELA, the less the amount of snow remaining after summer melt to nourish the glacier, indicating a negative mass balance. Conversely, a low annual ELA indicates a large amount of residual snow remaining at the end of summer and a positive mass balance. It follows that there is a unique position for the ELA across the glacier where the volume of snow accumulated over the past year exactly balances the total volume of snow and ice lost during the year. If the ELA were to lie at (or maintain an average of) this altitude for many years, then there would be no change to the mass or size of the glacier. This unique position of the snowline that indicates that the glacier is in equilibrium with the climate, is defined as the steady-state Equilibrium Line Altitude (ELAo). A snowline of this altitude will indicate zero change to the balance of the glacier. To avoid confusion between the annual and the long-term ELAs, some authors have also referred to the altitude of the annual glacier snowline as the end-of-summer snowline or EOSS.

A shift in climate will change the glacier mass balance and shift the altitude of the annual ELA. Thus the annual snowline position with respect to the long-term average or steady-state ELAo is used as a surrogate for annual balance changes at each glacier (Chinn, 2005; Chinn, 1995). It is the departure of the glacier snowline from the steady-state ELAo, ie. $ELAo - ELA$, that is reported here. These ELA departure values provide a measure of mass balance changes.

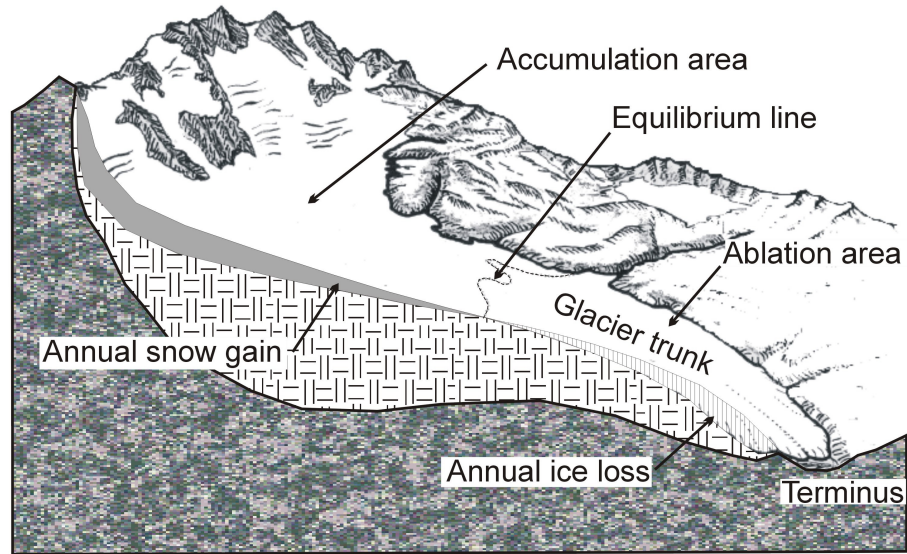


Figure 2 Basic parameters of a glacier.

Glacier studies worldwide have demonstrated that the accumulation area is about twice that of the ablation area so that the ELAo lies at an altitude where the ratio of the accumulation area (AAR) to the total glacier area has an average value close to 0.66. For this programme, initially the steady-state ELAo was crudely estimated using AAR values of 0.66 for each glacier, and as more data was obtained, these approximate values have been progressively adjusted for most index glaciers.

2. Field methods

Collection of field data involves flying over the glaciers in a light aircraft to take oblique photographs of the position of the end-of-summer glacier snowlines. The snowlines visible on the photographs are sketched on to a map of each glacier and the resulting accumulation or ablation areas are mapped and measured by digitiser. The 'snowline altitude' is then accurately read from the glacier area-altitude curve.

2.1 The survey flights

On the flights, the "navigator" seated beside the pilot, holds a folder of photographs of each glacier. These photographs are used to closely duplicate the position from where previous photographs were taken. Photographs are taken by small and medium format SLR cameras, and since the 2001 flight, also in digital format. These surveys also provide the opportunity to record data on selected glacier termini, geomorphic features and events in addition to the index glaciers. The flights are generally flown between 9,000 ft (2,700 m) and 10,000 ft. (3,000 m). The higher the altitude the more easily the glacier snowlines can be defined and mapped, but civil aviation regulations do not permit normal flights to remain above 10,000 ft for prolonged periods.

Significant melt continues throughout February and March, but by April there is a high probability that the first winter snowfall will have occurred. Experience has shown that although successful surveys have been made in April, there is about a 1 in 4 probability of snow before this time. Every year the challenge of the survey is to measure the highest altitude reached by the rise of the glacier snowline as ablation losses proceed, before the first "winter" snowfall. A light fall of fresh snow will conceal the position of the snowline as effectively as a coat of paint. The problem has been standardised by setting the earliest date for the flight at March 1.

'Suitable' weather to fly the entire Southern Alps demands particularly settled conditions. A successful survey cannot be guaranteed as there is also a 1 in 10 probability that there will be no suitable flying weather in the month of March before a fresh snowfall occurs.

2.2 March 2005 flight details

T. Chinn and A. Willsman (NIWA, Dunedin) with Miles Wislang made the flights in a Cessna 206 chartered from Wanaka Flightseeing at Wanaka airfield and piloted by A. Woods, a veteran of many of these survey flights. A high-wing aircraft with a relatively high cruising speed is preferred.

Inclement weather during the first week of March delayed the flight and delivered a skiff of new snow on the 8th. More stormy weather followed culminating in a significant fall of new snow on the 10th. Normally this would be a serious obstacle to recording snowline elevations, as even the smallest snowfall can cover the snowline position as effectively as a coat of paint. However, the strongly positive balance this year meant that the snowline lay below the glacier termini on the smaller glaciers and after a little melt, it is feasible to interpolate the snowline positions using the “snow-patch size” method. The survey flight was delayed a few days to allow for the bulk of this new snow to melt off. To forestall any further snowfalls, the first flight was made on 14 March. It turned out that there were in fact no further snowfalls and the flight could have been made any time up to near the end of April. The rise of the snowline over this period was unknown but small. To see whether there was significant melt during this interval, Fog Peak was photographed from Wanaka on April 16. A further indication of the ablation since the flight is available from Endre Germundssen who visited a couple of the index glaciers during April in the course of his research.

On Monday 14 March, four days after the snowfall, the first flight was made from Wanaka up the West Coast to Greymouth to refuel before successfully completing the northern section. After an overnight stay at Hokitika, the eastern Alps were covered, together with a detailed photographic coverage of a large iceberg calving event at the Tasman Glacier Lake which had occurred on Friday 11th. The Fiordland glaciers were covered on the Tuesday afternoon with no cloud problems excepting for Caroline Peak. This was only the 5th time that the entire set of index glaciers were recorded.

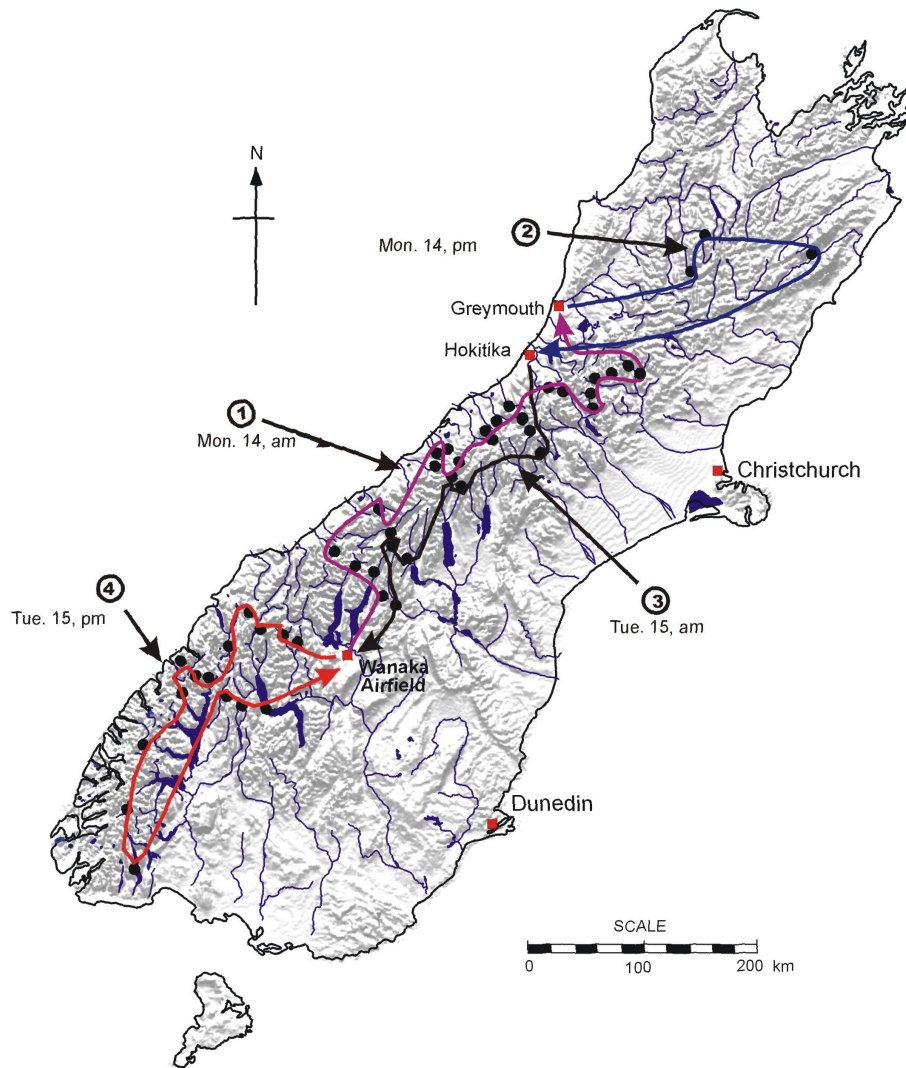


Figure 3 Flight paths for the three flights of the 2005 glacier surveys

3. Derivation of the glacier snowline

Data in this report is presented as “departures from the ELAo” which represents “departure of the climate of the year from the mean climate for glacier equilibrium”. Thus an accurate estimate of the position of the ELAo is an important part of the programme. Associated glacier parameters used are accumulation area (A_c of Fig 2) and ablation area (A_b of Fig 2); total glacier area A , or $A_b + A_c$; and accumulation area ratio (AAR) the ratio of the accumulation area to the entire area of the glacier, $A_c/(A_c + A_b)$.

At the commencement of this project, the value of the ELA was gained by plotting the observed snowline directly on to a topographic map:-

Map + snowline $\longrightarrow$ ELA

On the average glacier the long term EOSS (ELAo) divides the accumulation and ablation areas by a rough ratio of 2:1 (AAR value of 0.6). This position was estimated on small glaciers, and derived from the area-altitude curve on the larger glaciers. As the number of years of data increased, many of the ELAo values were subjectively adjusted:-

Est. AAR @ 0.6 $\longrightarrow$ ELAo, + adjustment $\longrightarrow$ refined ELAo.

Leading to small annual changes to:-

ELA – ELAo $\longrightarrow$ Departure value

The use of a GIS mapping system with digitised areas has added significantly to the accuracy of the data by supplying measured glacier and accumulation or ablation areas:-

Digitised (A_c or A_b) + Area Curve $\longrightarrow$ accurate ELA

Digitised A_c + Glacier Area $\longrightarrow$ accurate AAR

In addition, with the increased number of annual photographs it is frequently more accurate and faster to directly interpolate ELA values between those of previous years (described below), and more than half of the ELA values have been derived by this method:-

Interpolation $\longrightarrow$ direct ELA.

Where ELA – ELAo $\longrightarrow$ Departure

and ELA + Area Curve → AAR

The most significant problems in processing the results are recognising the position of the true end-of-summer snowline, especially when;

- There has been a recent summer snowfall, which effectively “paints out” the snowline.
- The snowline has been only partially recorded due to cloud cover, backlighting or other reasons.
- The current snowline is obscure or ambiguous due to limited discolouration of snowpacks of previous years.

Glacier snowline elevations are normally obtained from detailed mass balance studies where the snowline is mapped as the zero isohyet on the annual mass balance map. In this study the snowlines are derived from oblique aerial photographs by one of “three” methods, depending on the snow cover conditions at the end of summer. The procedures are given in Chinn, (1995) and in Chinn and Salinger (1999).

Firstly by digitising either the accumulation or ablation area to provide a definitive ELA; secondly by interpolating between photographs of past years where a number of snowlines are close in altitude; and thirdly by comparing the sizes of adjacent snowpatches when fresh snow or cloud obscures the snowline of the index glacier.

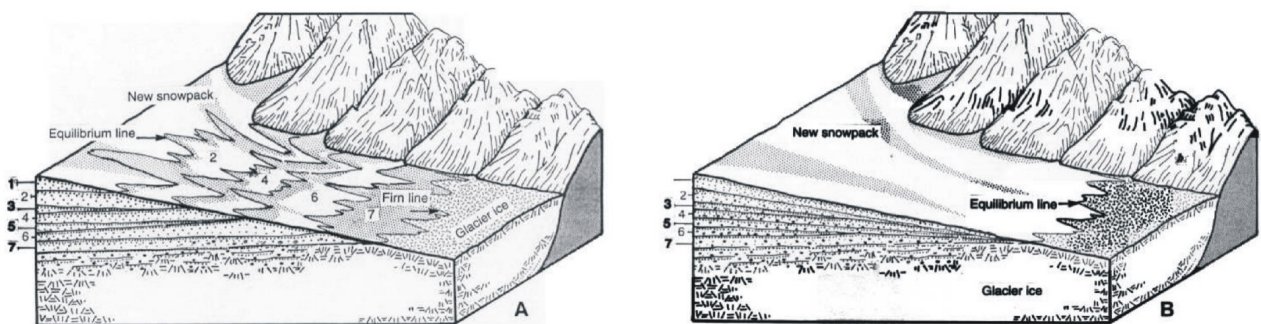


Figure 4 Schematic diagrams of stratigraphy at the glacier equilibrium line. (A) for a year of negative balance (high ELA) and (B) for a year of positive balance (low ELA). Numbers indicate age in years of past firn layers.

3.1 ELAs derived by digitising

This method gives the definitive ELA values upon which the interpolation and snowpatch methods rely. Here the end-of-summer snowline positions are carefully sketched from the oblique photographs, on to detailed base maps of each glacier. The resulting mapped accumulation or ablation zones are digitised using a GIS programme to accurately measure the areas. From the total ablation area for each glacier, the snowline elevation is then read off an area-altitude curve constructed for each glacier. (If the accumulation area was measured, the ablation area is found by total glacier area minus accumulation area). This method provides a single figure for the glacier ELA for the year regardless of the shape of the measured area as it eliminates subjective estimation of the altitude of the snowline. The difference between this altitude and that of the long-term ELA_0 , indicates the annual mass balance of the glacier. Positive values or high snowline elevation signifies less snow and therefore a negative balance.

3.2 ELAs derived by interpolation

With the many photos now available, for many glaciers it may be more accurate and quicker to obtain the ELA value by interpolation. For each glacier photos for all years are arranged in increasing area of snow cover (descending order of ELAs). The current years photograph is then carefully compared and inserted into its appropriate place in the sequence. It has been found that very small differences in snow cover can easily be recognised and that two photos separated by many years can have identical snow coverage. The ELA value is interpolated from the ELA values of the adjacent years. Depending on the similarity of the ELAs, this method frequently places the value of the ELA within a few metres.

3.3 ELAs derived by snow-patch size when the snowline is obscure

Where the true end-of-summer snowlines are obscured by fresh snow, cloud or other reasons, the hidden snowline may be interpolated from the degree of snow cover surrounding the glacier, ie. the size of the intermittent snow patches. Fresh snow on rock has quite a different appearance from fresh snow on existing snow, and it is commonly possible to "see" the snow-patch outline beneath a light cover of new snow. As in the previous method, photographs of the glacier for all years are arranged in order of increasing snow cover on the glacier, which is also the sequence of the size of the snow-patches surrounding the glacier. The photograph from the latest survey is

then slotted into its appropriate place in the snow-patch sequence. The ELA values are interpolated from those of adjacent glaciers as described above. This subjective assessment has proved to be surprisingly consistent (see Chinn et al, 2002). The fresh cover of new snow on the first flight of the 2003 survey made it necessary to use this method on the majority of the glaciers.

3.4 Accuracy of values associated with ELA measurements

Accuracy of the data is dependent on the accuracy of the digitised Ac and/or Ab areas, glacier area and its area curve. Normally all of these values are measured with a high degree of accuracy provided the glacier maintains a constant size. However many of the smaller glacier have undergone large variations of size when both the area and associated area-altitude should be re-measured each year of change. Associated with small glaciers and area changes, are the problems of when the snowline (ELA) rises above the glacier or falls below the glacier terminus. When the ELA falls below the glacier, the ELA can be estimated, but the AAR becomes >1 which has statistical problems. When the ELA rises above the glacier, it is not possible to extrapolate its value and the AAR becomes negative.

3.5 Derivation of the Long-term or Steady-state ELA_0 value

Glacier studies worldwide have demonstrated that the ELA_0 lies at an altitude which divides the accumulation area from the ablation area in a ratio of near 2:1. (Maisch, 1992). This accumulation area ratio (AAR) of accumulation area to the total glacier area has an average value close to 0.6 (Paterson, 1994). On this study, values for the long-term ELA_0 were initially derived by applying an AAR value of 0.6 (Gross, et al. 1976) to the area-altitude curve for each glacier. The ELA_0 is read off the glacier area curves at 0.4 of the area up from the glacier terminus.

Initially the ELA_0 values were approximate estimates only, as measured AARs on glaciers in equilibrium vary from 0.5 to 0.75, depending on glacier topography and other factors. But now the ample data available provides a method of deriving an accurate value for the ELA_0 for each glacier from linear regression plots of the departures of each glacier against the mean for the entire Southern Alps. The method assumes that the ELA_0 indicates the snowline position for a zero mass balance, and that ELA changes each year on an individual glacier are linearly proportional to the average change over the entire alps.

The regression plots for each of the index glaciers are given in Appendix 2, where the annual departures for each glacier are regressed against the annual mean for the Alps without the glacier in question. The correlation and representivity indicated by these regressions is discussed below. At the zero intercept, which indicates a zero average mass balance for the Alps, the mass balance of the individual glacier should also be zero. The adjustment of the ELAo from its estimated value to a precise value indicated by the dataset, the glacier ELAo is adjusted by the constant of the regression equation. The data given here were adjusted in this manner for the 2004 report .

The slope of the regression line indicates the character of the response of the glacier to the climate. The average climate response is given by the mean for the alps, so that any deviation from a 45 slope is an indicator of the individual characteristics of the glacier. Since each years climate is similar over the Alps, the regression slope changes must represent a topographic signal in the ELA values. Similarly, the range of the highest and lowest ELA values is also influenced by the glacier topography. The significance of these properties has yet to be analysed.

4. The 2005 snowline results

4.1 Photographic coverage of the index glaciers

This year the flight was made during a brief low-humidity anticyclone, so that there was little trouble with cloud over the glaciers, excepting for some cloud on Ella and a small patch of cumulus on Caroline Peak which partially obscured the downward view of this glacier.

In addition to the usual 35mm and 120 sized film photographs, high resolution digital images were also taken. Each glacier was imaged at both “sunlight” and “cloudy” exposures to see which gives the best resolution of the snowline.

All of the glaciers had low snowlines, so that no firn was present but varying amounts of February snow remained on most glaciers, and this covered the true snowlines of the larger glaciers. In all cases the snowlines were derived by amount of snow cover present or ‘snow-patch size’ interpolation from the series of past photographs for each glacier.

4.2 Snowline elevation departures

Monitoring results for the 50 index glaciers for the 2004 - 2005 glacial year ending in March 2005, together with the means for all measured years from 1977 to 2005 are shown in Figure 3 and Figure 4 respectively. The snowline departure results for this year averaged 113m below the long-term mean ELAo position, indicating a continuation of the positive mass balance trend which appeared to have ceased in 1998.

Annual data for all measured glacier ELA departures from the long-term ELAo from 1977 to 2005 are given in the matrix of Appendix I. A full data record for each individual index glacier are given in Appendix II. Missing values are years of no data for the particular glacier.

Appendix 1 and the plot of Figure 6 show that the pattern of low and high snowlines tends to follow a cyclic pattern with three groups of low snowlines or positive balances occurring at near 11 year intervals, a period similar to sunspot cycles.

Appendix 2 gives a data table, map and histograms of all measured snowline fluctuation histories as metres of departure from the steady-state ELA_0 for each index glacier. On the annual departure plots, missing values are years of no survey, and arrows indicate measured zero values. The data table provides essential glacier data, snowline data statistics and a table of all measurements and immediate derived values. Photographs of each glacier are available in the 1999 Report, (Chinn and Salinger, 1999).

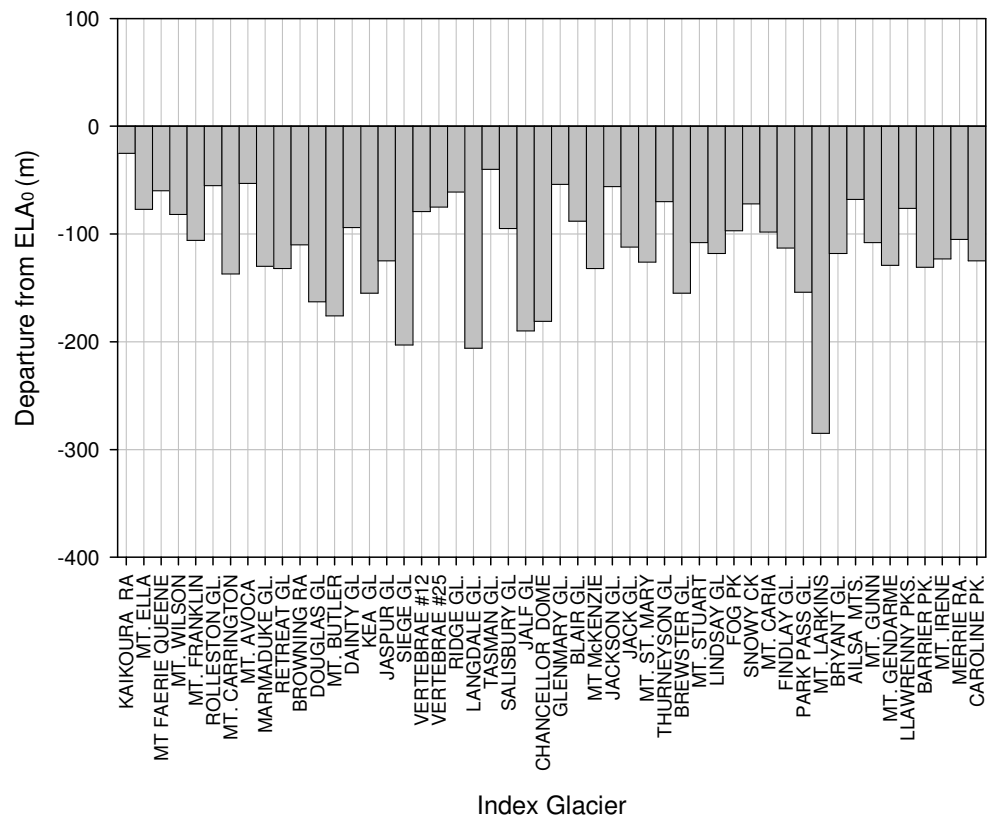


Figure 5 Histogram plot giving the 2005 snowline departures for each index glacier from the long-term ELA_0 .

Mean Annual Departures

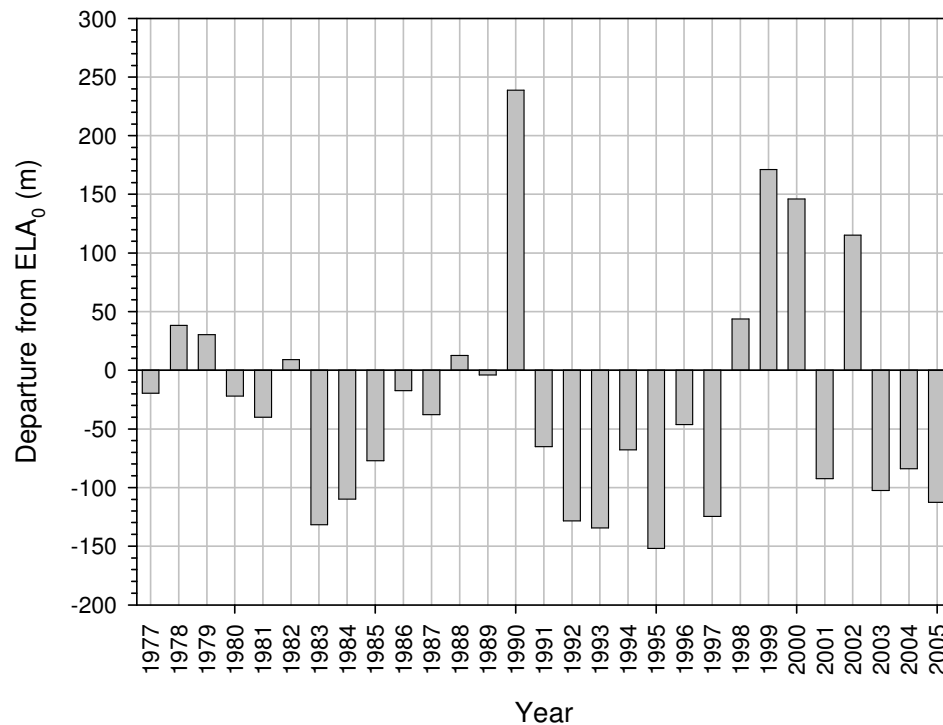


Figure 6 Mean annual departures from the ELA₀ for all measured glaciers for the entire period of these surveys.

4.3 Glacier representivity

The “representivity” of each glacier as an indicator of the overall annual climate of the Southern Alps is indicated by how well the annual values for an individual glacier correlates with the mean value of the 50 index glaciers over the Alps. Correlation coefficients of individual snowline departures for each glacier correlated against the mean of all remaining values for each year are given in Table 1. The correlation plots for each glacier are given in the Appendices. The correlations give a surprising result where representivity appears to be independent of size, gradient or topography. The high correlations indicate that the ELA surface of individual glaciers have a strong relationship with the “mean ELA” of the whole alpine range. This follows the finding of Clare et al (2004) where it was demonstrated that the entire Southern Alps behaves

as a single climatic unit. However the consistently low correlation of the Kaikoura Range glacier suggests that the behaviour of this range is that of a separate climate zone, while it is assumed that accumulation on the low correlation Langdale glacier is dominated by wind redistribution.

Table 1 Correlation coefficients of individual snowline departures for each glacier correlated against the mean of all remaining values for the period 1977 - 2005.

Barrier Pk.	0.94
Caroline Pk.	0.94
Llawrenny Pks.	0.93
Findlay Gl.	0.92
Jalf Gl	0.92
Vertebrae 25	0.91
Siege Gl	0.90
Jackson Gl.	0.90
Mt. Larkins	0.90
Mt. Irene	0.88
Mt. Ella	0.87
Thurneyson Gl	0.87
Mt. Stuart	0.87
Brewster Gl.	0.87
Chancellor Dome	0.87
Mt. St. Mary	0.86
Mt. Franklin	0.86
Marmaduke Gl.	0.86
Mt. Gendarme	0.86
Jaspur Gl	0.86
Mt. Butler	0.86
Bryant Gl.	0.85
Kea Gl	0.85
Browning Ra	0.85
Mt. Carrington	0.85
Salisbury Gl	0.85
Lindsay Gl	0.85
Mt McKenzie	0.85
Ailsa Mts.	0.84
Merrie Ra.	0.83
Dainty Gl	0.82
Tasman Gl.	0.82
Mt. Gunn	0.82
Park Pass Gl.	0.82
Douglas Gl	0.81
Jack Gl.	0.81
Fog Pk	0.81
Vertebrae 12	0.80
Rolleston Gl.	0.79
Mt. Caria	0.77
Mt. Wilson	0.77
Mt. Avoca	0.76
Mt Faerie Queene	0.74
Blair Gl.	0.73
Retreat Gl	0.70
Ridge Gl.	0.70
Glenmary Gl.	0.70
Snowy Ck	0.62
Langdale Gl.	0.60
Kaikoura Ra	0.52

5. Discussion

5.1 The 2004 - 2005 glacial climate

For the 2004 - 2005 glacial year period, New Zealand temperatures were 0.3°C below the 1971-2000 normals. During the March – July period more frequent cooler westerlies prevailed (Figure 7a), with temperatures 0.4°C below average. Seas

around New Zealand trended from slight above average temperatures in late autumn to average, then below average by November. Sea surface temperatures were 1°C below average in December, but by February 2005 had risen to above average.

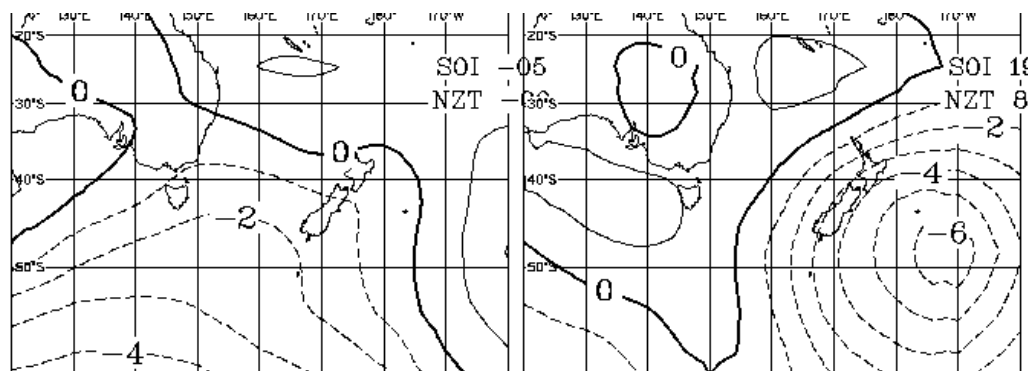


Figure 7. Mean sea level pressure anomalies (a) January – July 2004 and (b) August – December 2004.

The period August – December 2004 very strong and stormy south westerlies prevailed as a result of more frequent depressions east of New Zealand and in the Chatham Island’s area (Figure 7b). As a result temperatures were 0.6°C below average during this period. Temperatures in December were 2°C below the seasonal mean. This resulted in thick snowpack persisting through the spring into early summer.

5.2 Ice gain and loss

Glaciers accumulate the effects of net annual balance changes over years to decades. The effects of climate variations are delayed and distorted before being delivered to the terminus after individual glacier response times have elapsed. To assess the mass changes in response to climate fluctuations a cumulative plot of the “mass balance indices” (MBI) is presented in Figure 9. The MBI represents the steady state (ELA₀) minus the current season ELA. Snowline departure changes with negative ELA (ie lower snowline) result in positive MBI. Figure 9 shows clearly the general mass gain and mass loss to the glaciers. The reliability of use of the ELA as an indicator of mass balance change has been investigated by Chinn et al (2005), where the r values between the ELA and measured mass balance had an average value of 0.9 with a standard deviation of 0.07. Figure 9 also shows good agreement with the generalised climates given in Table 2.

Cumulative Mass Balance Index

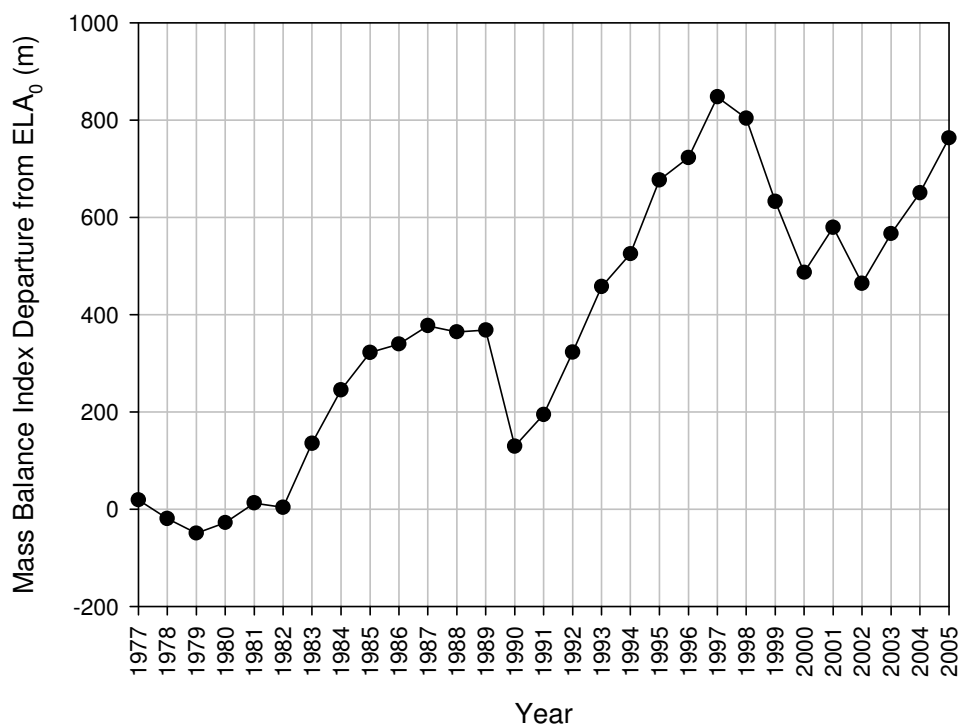


Figure 8 Cumulative Mass Balance Index for all 50 Index Glaciers

Table 2 Generalised climate for 2004 - 2005 year and previous 7 years in Southern Alps and inferred glacier snow input.

Glacier Year	Generalised Climate	Inferred glacier snow input
1997/1998	Higher frequency of anticyclones and westerly winds over the south, southerlies further north. Temperatures 0.2 C below normal, but a very warm summer.	Average
1998/1999	Stronger westerly and northwesterly winds over New Zealand, temperatures 0.8°C above average, with above normal precipitation on the West Coast.	Less
1999/2000	Very anticyclonic, with weaker westerlies than normal. Temperatures 0.7 C above normal, and rainfall slightly below normal.	Less
2000/2001	More northwesterlies over the South Island, temperatures 0.2 C above normal. Rainfall close to average.	Average-High
2001/2002	Higher than normal pressures and more easterlies over the South Island, temperatures 0.3°C above normal, well below average rainfall.	Less
2002/2003	Persistent westerlies and southwesterlies over New Zealand. Cooler spring, rainfall slightly above average in the west and south.	Average-High
2003/2004	More cyclonic westerlies and south westerlies over the South Island from September.	Higher
2004/2005	Cool westerlies during autumn and early winter (temperatures 0.4°C below normal), then strong cold cyclonic southwesterlies through to December (temperatures 0.6°C below normal), precipitation overall close to average	High

6. Acknowledgment

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7 References

- Chinn, T. J. H. 1995. Glacier fluctuations in the Southern Alps of New Zealand determined from snowline elevations. *Arctic and Alpine Research* 27(2): 187—197.
- Chinn, T. J. H. and Salinger, M. J. 1999. New Zealand Glacier Snowline Survey 1999. NIWA Technical Report 68. 119p. National Institute of Water and Atmosphere, Wellington.
- Chinn, T. J. H., Heydenrych, C. and Salinger, M. J. 2002. New Zealand Glacier Snowline Survey 2002. NIWA Client Report AKL2003- 023, 20p. National Institute of Water and Atmosphere, Auckland.
- Chinn, T.J.H.& Whitehouse, I.E. 1980: Glacier snow line variations in the Southern Alps, New Zealand. *In* World Glacier Inventory, pp. 219—228. *International Association of Hydrological Sciences Publication No. 126*.
- Chinn, T.J.H, Heydenrych C. and Salinger M.J 2005. Use of the ELA as a practical method of monitoring glacier response to climate in the New Zealand's Southern Alps. *International Jr. Glaciology*.
- Clare G.R., Fitzharris B.B., Chinn, T.J.H, and Salinger M.J 2002. Interannual variations in end-of-summer-snowlines of the Southern Alps of New Zealand, and relationships with Southern Hemisphere atmospheric circulation and sea surface temperature patterns. *International Journal. of Climatology* 22, pp 107-120.
- IAHS(ICSU)/UNEP/UNESCO, 1998. Fluctuations of glaciers 1990-1995 (W. Haeberli, S. Suter and R. Frauenfelder (eds.)). Paris, UNESCO.
- Gross, G., H. Kerscher and G. Patzelt. 1976. Methodische Untersuchungen über die Schneegrenze in alpinen Gletschergebieten. *Zeitschrift für Gletscherkunde und Glazialgeologie*. 12, 223-251.
- Maisch, M. 1992: Die Gletscher Graubuündens. Geographisches Institut der Universität Zürich.
- Meier, M. F. & Post, A. S. 1962: Recent variations in mass net budgets of glaciers in western North America. *In* Proceedings of Obergurgl Symposium, pp. 63—77. *International Association of Hydrological Sciences Publication 58*.

Paterson, W. S. B. 1994. The Physics of Glaciers. Third edition, Oxford, Pergamon Press. 480 p.

Glossary

<u>Ablation</u>	All processes by which snow and ice are lost from a glacier
<u>Accumulation</u>	All processes by which snow and ice are added to a glacier.
<u>Accumulation Area Ratio (AAR)</u>	The ratio of the accumulation area above the equilibrium line, to the entire area of the glacier.
<u>Departure of the ELA</u>	The elevation difference between the long-term ELA_0 and the annual snowline altitude. Positive departures mean a higher snowline and therefore a negative mass balance.
<u>ELA</u>	The mean altitude of the snowline or equilibrium line across a glacier at the end of summer.
<u>ELA_0</u>	The long-term or steady-state altitude of the ELA which will maintain the glacier in equilibrium with the climate.
<u>Mass balance index</u>	The negative of the ELA departure value. This gives values for annual changes with the same sign as the mass balance changes.
<u>Shaded cells</u>	Areas which have been measured by digitising.
<u>Snowline elevation</u>	The snowline elevation is synonymous with ELA when measured at the end of summer. All other snowline elevations apply to a transient seasonal snowline..
<u>Total Area</u>	The entire area of the glacier. This may change from year to year, especially on the smaller glaciers.

Appendix 1. Index Glacier ELA's (1977 – 2005)

Shaded columns indicate years of positive mass balance

GLACIER	GL.IN. No	ELAo	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
KAIKOURA RA	621/001	2490						5		-30		
MT. ELLA	932B/012	2142						12				
MT FAERIE QUEENE	646/006	2030						-45				
MT. WILSON	None	1820	-37	-11			15		-115	-141	-63	41
MT. FRANKLIN	911A/002	1814		-12	122	-54	-74		-148			-18
ROLLESTON GL.	911A/004	1763	-13	5	-13	1	-3	10	-123	-10	-18	13
MT. CARRINGTON	646C/027	1715		-45		-22	-87	25	-150	-115		-10
MT. AVOCA	685F/004	1965		-55				-15		-95	-55	-5
MARMADUKE GL.	664C/012	1830	-43	-35	78	2	-28	30	-136	-122	-50	9
RETREAT GL	906A/004	1742		-4		38	-50	14	-252		-4	20
BROWNING RA	906A/001	1598		7		10	-34	7	-113		-2	17
DOUGLAS GL	685B/001	2040		91		-163		-18	-214	-240	-223	-128
MT. BUTLER	685C/060	1840	-55	112	55	-34	-40	28	-200	-65	-70	10
DAINTY GL	897/019	1954	-32	57		-7	-77	93	-99		-81	-73
KEA GL	897/007	1820		65		44	-85	134	-230		-120	-82
JASPUR GL	897/003	1725		43		63		-15	-155		-105	-42
SIEGE GL	893A/006	1736	-64	-24		-76	-70	-46	-268		-94	35
VERTEBRAE #12	893A/012	1864		-13		33	-60	-33	-73		-67	-53
VERTEBRAE #25	893A/025	1840		30		25	-39	-8	-62		-50	-27
RIDGE GL.	711L/024	2226		79			2	10	-15	-141	-32	-9
LANGDALE GL.	711I/035	2186	12	65			79	52	-1	-236	-96	-41
TASMAN GL.	711I/012	1790	-10	80	-90	20	30	-30	-90	-95	-90	-70
SALISBURY GL	888B/003	1810	17	17		32	-58	17	-92	-51	-76	-1
JALF GL	886/002	1790	-15	-10		-32	-65	5	-230	-78	-146	-20
CHANCELLOR DOME	882A/007	1756	96	95		77	-93	92	-211		-147	-78
GLENMARY GL.	711F/006	2164		74		-91	-34	17	-29	-144	-56	
BLAIR GL.	711D/038	1938		74		-75	-13	-51	-126	-80	-85	
MT McKENZIE	711D/021	1904		46		6	-16	-2	-184	-62	-124	13
JACKSON GL.	868B/094	2070		28		-20		8	-38	-80	-56	
JACK GL.	875/015	1907		31		23	-22	44	-157	-79	-32	
MT. ST. MARY	711B/039	1926								-171		-91
THURNEYSON GL	711B/012	1970	-40			-44	-27		-105	-88	-65	-32
BREWSTER GL.	868C/020	1935		25		-89	-80	36	-141	-135	-139	-93
MT. STUART	752I/104	1673	-86	57		-23	-67	3	-135		-53	-13
LINDSAY GL	867/002	1730		8		-78	-49	51	-170		-64	38
FOG PK	752E/051	1987				-71		35		-96		-57
SNOWY CK	752C/103	2092		64		-68	66	-54	-59	-68	-72	-56
MT. CARIA	863B/001	1472		-30			-59	-48	-100		-49	53
FINDLAY GL.	859/009	1693					-89	42	-111		-64	32
PARK PASS GL.	752B/048	1824		79		-16	-46	34	-62		-122	39
MT. LARKINS	752E/002	1945								-265		-53
BRYANT GL.	752B/025	1783	-43	101			-20	-3	-163	-163	-173	-13
AILSA MTS.	752B/013	1648		-5					-88	-53	-53	1
MT. GUNN	851B/057	1593	22	45		-64	-62	17	-115		-53	
MT. GENDARME	797G/033	1616					-46	-43	-136		-94	59
LLAWRENNY PKs.	846/035	1476		4			-68	-4	-132		-36	
BARRIER PK.	797I/004	1596		116		-51	-73	-31	-218		-72	
MT. IRENE	797D/001	1563		137					-156		-37	
MERRIE RA.	797B/010	1515		140								
CAROLINE PK.	803/001	1380										
NUMBER		50	15	40	5	32	36	41	41	27	40	38
MEAN		1834	-19	38	30	-22	-40	9	-132	-110	-77	-17
STD. DEV.		214.48	44.03	50.69	83.13	52.94	40.85	40.57	63.87	63.25	45.29	46.12
No. below ELA (+ve balance)			9	6	1	19	29	17	40	25	32	19
% with +ve M.B.			60	15	20	59	81	41	98	93	80	50

GLACIER	GL.IN. No	ELAo	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
KAIKOURA RA	621/001	2490		-5	50				-57	-30	-60	
MT. ELLA	932B/012	2142			28				-87	-72	-142	-15
MT FAERIE QUEENE	646/006	2030		5	5				-62	-57	-65	-57
MT. WILSON	None	1820	-89	68	93				-167	-102	-154	
MT. FRANKLIN	911A/002	1814	-41	35	52				-164	-109	-156	-82
ROLLESTON GL.	911A/004	1763	15	-1	7				-143	-53	-143	-44
MT. CARRINGTON	646C/027	1715	45	55	5				-170	-128	-158	-125
MT. AVOCA	685F/004	1965		10	6				-115	-25	-45	12
MARMADUKE GL.	664C/012	1830	-5	65	-13	168			-175	-75	-155	-82
RETREAT GL	906A/004	1742			36				-73	-120	-277	16
BROWNING RA	906A/001	1598			-25				-116	-71	-118	-11
DOUGLAS GL	685B/001	2040		91	172			-197	-260	-154	-231	-150
MT. BUTLER	685C/060	1840	-9	42	-34			-95	-136	-28	-190	-60
DAINTY GL	897/019	1954	-84	-12	-32			-103	-176	-73	-111	-12
KEA GL	897/007	1820	-83	-58	-36				-230	-92	-250	80
JASPUR GL	897/003	1725		-42	-29				-150	-120	-145	-90
SIEGE GL	893A/006	1736		-70	-64			-323	-386	-116	-396	-72
VERTEBRAE #12	893A/012	1864		-13	-51			-96	-86	-68	-86	-68
VERTEBRAE #25	893A/025	1840		3	-20			-94	-84	-54	-84	-54
RIDGE GL.	711L/024	2226		59	51				-126	-56	-94	-88
LANGDALE GL.	711I/035	2186	-69	39	69			-216	-231	83	-226	51
TASMAN GL.	711I/012	1790	-50	30	-50	310	-65	-150	-100	-20	-115	-75
SALISBURY GL	888B/003	1810	-35	-81	-66			-129	-100	-38	-165	-58
JALF GL	886/002	1790	-51	-32	-31			-210	-220	-38	-240	-8
CHANCELLOR DOME	882A/007	1756	-28	52	-78				-206	-147	-211	-36
GLENMARY GL.	711F/006	2164		16	16			-24	-57	-43	-45	-36
BLAIR GL.	711D/038	1938	-68	57	-62				15	-73	-85	2
MT McKENZIE	711D/021	1904	-14		8				-122	8	-99	6
JACKSON GL.	868B/094	2070	-9		10				-78	-25	-52	2
JACK GL.	875/015	1907	-2	-32	-9			-90	-142	-27	-152	51
MT. ST. MARY	711B/039	1926		-19	46			-76	-141	-76	-156	-71
THURNEYSON GL	711B/012	1970	-52	-20	0			-40	-60	-66	-102	-32
BREWSTER GL.	868C/020	1935	-107		-17			-84	-185	-145	-158	27
MT. STUART	752I/104	1673	5		-10				-138	-33	-158	39
LINDSAY GL	867/002	1730	-115	42	34				-175	-120	-180	45
FOG PK	752E/051	1987	-85	35	45				-93	-87	-99	-93
SNOWY CK	752C/103	2092	-67	-55	11				-34	-58	-62	-35
MT. CARIA	863B/001	1472	-50	28	-43				-97	-72	-106	-82
FINDLAY GL.	859/009	1693	-71	-8	-51				-118	-59	-132	-61
PARK PASS GL.	752B/048	1824	19		-30					-41	-214	-64
MT. LARKINS	752E/002	1945		135	91				-275	-95	-315	-163
BRYANT GL.	752B/025	1783	-20		-30				-27	-55	-153	-103
AILSA MTS.	752B/013	1648	-23		-36				-84	-52	-93	-64
MT. GUNN	851B/057	1593	-38		-59				-108	-64	-122	-86
MT. GENDARME	797G/033	1616	34		-36				-114	-64	-198	-100
LLAWRENNY PKS.	846/035	1476	-22		-47				-116	-68	-176	-15
BARRIER PK.	797I/004	1596	-41		-71				-168	-118	-236	-126
MT. IRENE	797D/001	1563	-37		-26				-156	-51	-163	-65
MERRIE RA.	797B/010	1515			30				-135	-95	-165	-90
CAROLINE PK.	803/001	1380							-160	-47	-150	-78
NUMBER		50	33	33	49	2	1	15	49	50	50	48
MEAN		1834	-38	13	-4	239	-65	-128	-134	-68	-152	-46
STD. DEV.		214.48	39	48	50	100		79	70	42	71	54
No. below ELA (+ve balance)			22	15	19	0	1	14	46	44	48	34
% with +ve M.B.			67	45	39	0	100	93	94	88	96	71

GLACIER	GL.IN. No	ELAo	1997	1998	1999	2000	2001	2002	2003	2004	2005
KAIKOURA RA	621/001	2490		30	15	10	-15	25			-25
MT. ELLA	932B/012	2142		17	108	60	-22	46	-64		-77
MT FAERIE QUEENE	646/006	2030		-50	145	160	-55	55	-54		-60
MT. WILSON	None	1820	-149	41	113	108	13	93	-121	-92	-82
MT. FRANKLIN	911A/002	1814		122	164	136	-104	121	-70		-106
ROLLESTON GL.	911A/004	1763	-123	49	87	97	-42	89	-94	-1	-55
MT. CARRINGTON	646C/027	1715	-137	-39	190	237	-135	210	-84	-120	-137
MT. AVOCA	685F/004	1965	-75	70	115	65	-52	88	-52	-20	-53
MARMADUKE GL.	664C/012	1830	-129	143	164	153	-57	140	-117	-27	-130
RETREAT GL	906A/004	1742	-97	47	146	133	-60	93	-78	18	-132
BROWNING RA	906A/001	1598	-108	30			-30	62	-77	-28	-110
DOUGLAS GL	685B/001	2040	-223	220	240	250	-40	245	-134	-35	-163
MT. BUTLER	685C/060	1840	-176	68	98	148	-95	90	-147	-80	-176
DAINTY GL	897/019	1954	-92	98	176	74	-58	126	-67	-44	-94
KEA GL	897/007	1820	-152	78	200	190	-150	195	-159	-90	-155
JASPUR GL	897/003	1725	-100	43			-95	195	-74	-95	-125
SIEGE GL	893A/006	1736	-203	214	414	279	-126	239	-160	-116	-203
VERTEBRAE #12	893A/012	1864	-78	-29	226	129	-70	136	-55	-68	-79
VERTEBRAE #25	893A/025	1840	-71	-5	125	70	-33	80	-51	-45	-75
RIDGE GL.	711L/024	2226	-136	9	89	79	-116	74	-63	2	-61
LANGDALE GL.	711I/035	2186	-226	142	114	89	-211	104	-211	18	-206
TASMAN GL.	711I/012	1790	-102	63	186	110	-80	105	-80	-40	-40
SALISBURY GL	888B/003	1810	-84	42	220	172	-95	50	-95	-78	-95
JALF GL	886/002	1790	-191	-3	260	265	-85		-190	-170	-190
CHANCELLOR DOME	882A/007	1756	-176	92	194	189	-186	159	-186	-151	-181
GLENMARY GL.	711F/006	2164	-112	36	108	84	-46	46	-49	-39	-54
BLAIR GL.	711D/038	1938		34	152	147	-96	67	-93	-88	-88
MT McKENZIE	711D/021	1904	-189	31	174	148	-99	56	-134	-122	-132
JACKSON GL.	868B/094	2070	-54	12	95	63	-54	33	-55	-54	-56
JACK GL.	875/015	1907	-102	33	101	85	-109	78	-147		-112
MT. ST. MARY	711B/039	1926	-84	-37	199	204	-146	189	-131	-71	-126
THURNEYSON GL	711B/012	1970	-70	-5	142	162	-92	135	-97	-35	-70
BREWSTER GL.	868C/020	1935	-156	47	345	220	-165	115	-141	-155	-155
MT. STUART	752I/104	1673	-106	-17	132	177	-83	142	-103	-108	-108
LINDSAY GL	867/002	1730	-85	70	145	140	-90	142	-123	-122	-118
FOG PK	752E/051	1987	-97	111	135	121	-92	125	-25	-95	-97
SNOWY CK	752C/103	2092	-72	66	148	54	-88	28	-51	-58	-72
MT. CARIA	863B/001	1472	-77	-55	178	188	-52	153	-50	-92	-98
FINDLAY GL.	859/009	1693	-113	26	197	140	-79	109	-81	-115	-113
PARK PASS GL.	752B/048	1824	-134	48	138	119	-154	99	-163	-159	-154
MT. LARKINS	752E/002	1945	-312	261	270	255	-280	245	-205	-255	-285
BRYANT GL.	752B/025	1783	-113	-5	227	182	-118	87	-117	-108	-118
AILSA MTS.	752B/013	1648	-55	-27	182	137	-55	37	-65	-58	-68
MT. GUNN	851B/057	1593	-73	-34	209	217	-78	42	-68	-108	-108
MT. GENDARME	797G/033	1616	-126	32	188	159	-131	34	-96	-133	-129
LLAWRENNY PKS.	846/035	1476	-155	2	194	181	-71	137	-100	-96	-76
BARRIER PK.	797I/004	1596	-132	86	304	207	-108	194	-148	-131	-131
MT. IRENE	797D/001	1563	-103	49	102	122	-125	165	-109	-93	-123
MERRIE RA.	797B/010	1515	-130	-70	173		-103	175	-100	-110	-105
CAROLINE PK.	803/001	1380	-130	2	182		-105	195	-89	-110	-125
NUMBER		50	45	50	48	46	50	49	49	45	50
MEAN		1834	-125	44	171	146	-92	115	-103	-84	-113
STD. DEV.		214.48	51.67	68.58	70.02	61.94	51.63	60.75	44.90	53.62	48.94
No. below ELA (+ve balance)			44	11	0	0	46	0	47	42	50
% with +ve M.B.			98	22	0	0	94	0	96	93	100

Appendix 2. Index Glacier details

Rock Glacier

GLACIER DATA		
AREA	45.42	ha
Debris area	41.66	ha
Max Elev	2640	m
Min Elev	2200	m
Mean Elev	2420	m
Length	1.4	km
Elev Range	440	m
Gradient	0.31	

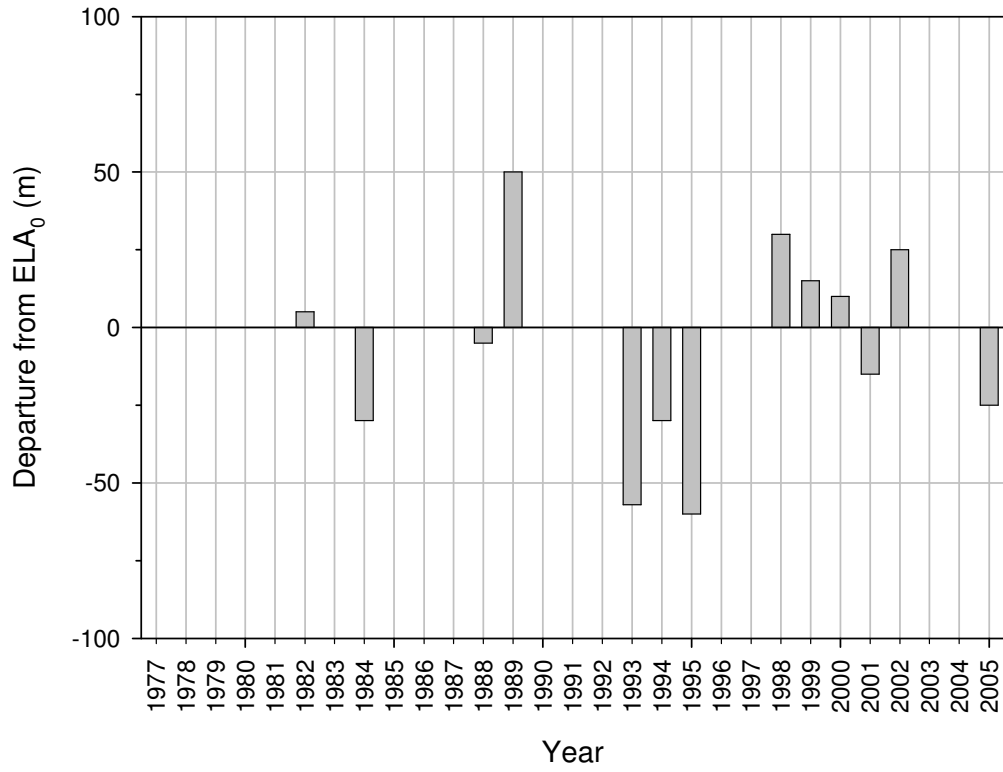
SNOWLINE DATA		
Aspect	S	
ELAo	2490	m
Max SL	2540	m, 1989
Min SL	2430	m, 1995
Mean SL	2485	m
SL Range	110	m
No. surveys	13	

MEASUREMENTS

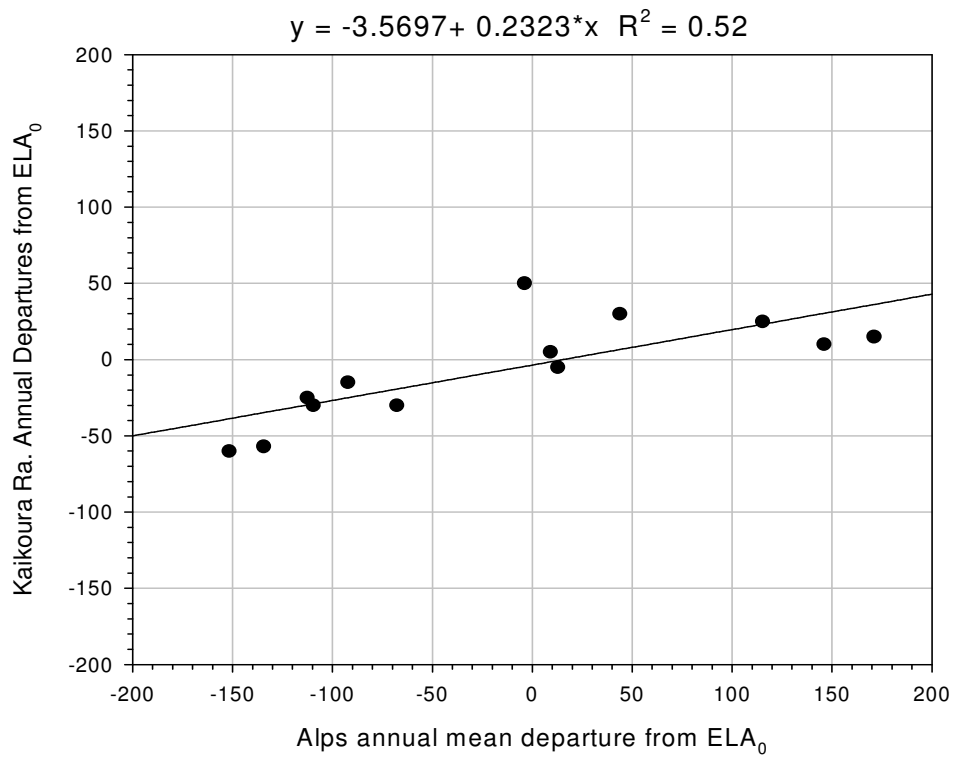
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	DEBRIS	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	2490	0	3.88	41.66	45.54	0.09	0
1977							
1978							
1979							
1980							
1981							
1982	2495	5	3.90	41.64	45.54	0.09	-5
1983							
1984	2460	-30	6.74	38.80	45.54	0.15	30
1985							
1986							
1987							
1988	2485	-5	5.14	40.40	45.54	0.11	5
1989	2540	50	0.90	44.64	45.54	0.02	-50
1990							
1991							
1992							
1993	2433	-57	12.84	32.70	45.54	0.28	57
1994	2460	-30	6.74	38.80	45.54	0.15	30
1995	2430	-60	13.29	32.25	45.54	0.29	60
1996					no visit		
1997					cloud		
1998	2520	30	2.29	43.25	45.54	0.05	-30
1999	2505	15	2.74	42.80	45.54	0.06	-15
2000	2500	10	3.44	42.10	45.54	0.08	-10
2001	2475	-15	6.52	38.90	45.42	0.14	15
2002	2515	25	2.32	43.10	45.42	0.05	-25
2003					No visit	cloud	
2004					No visit	cloud	
2005	2465	-25	6.74	38.80	45.54	0.15	25
MEAN	2485	-5.17	5.57	39.95		0.12	5.17

Kaikoura Ra.



Kaikoura Range



Glacierette

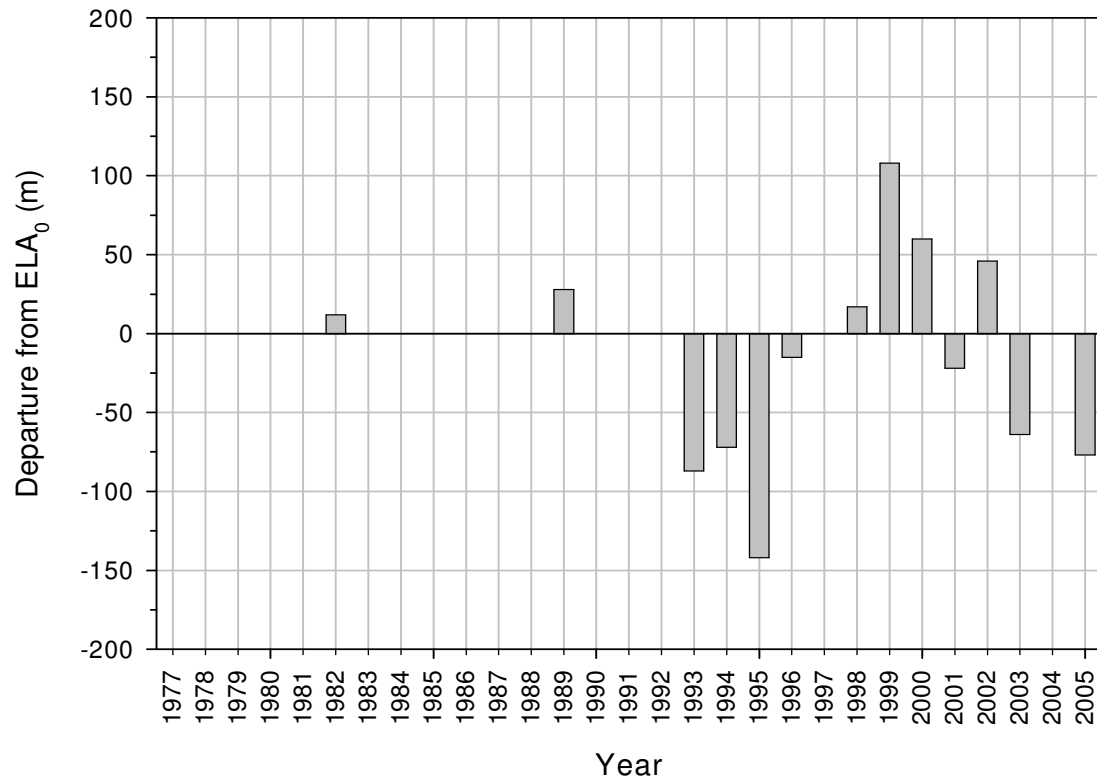
GLACIER DATA		
Aspect	E	
AREA	5.32	ha
Max Elev	2250	m
Min Elev	2080	m
Mean Elev	2165	m
Length	0.34	km
Elev Range	170	m
Gradient	0.5	

SNOWLINE DATA		
ELAo	2142	m
Max SL	2250	m, 2000
Min SL	2000	m, 1995
Mean SL	2126	m
SL Range	250	m
No. surveys	13	

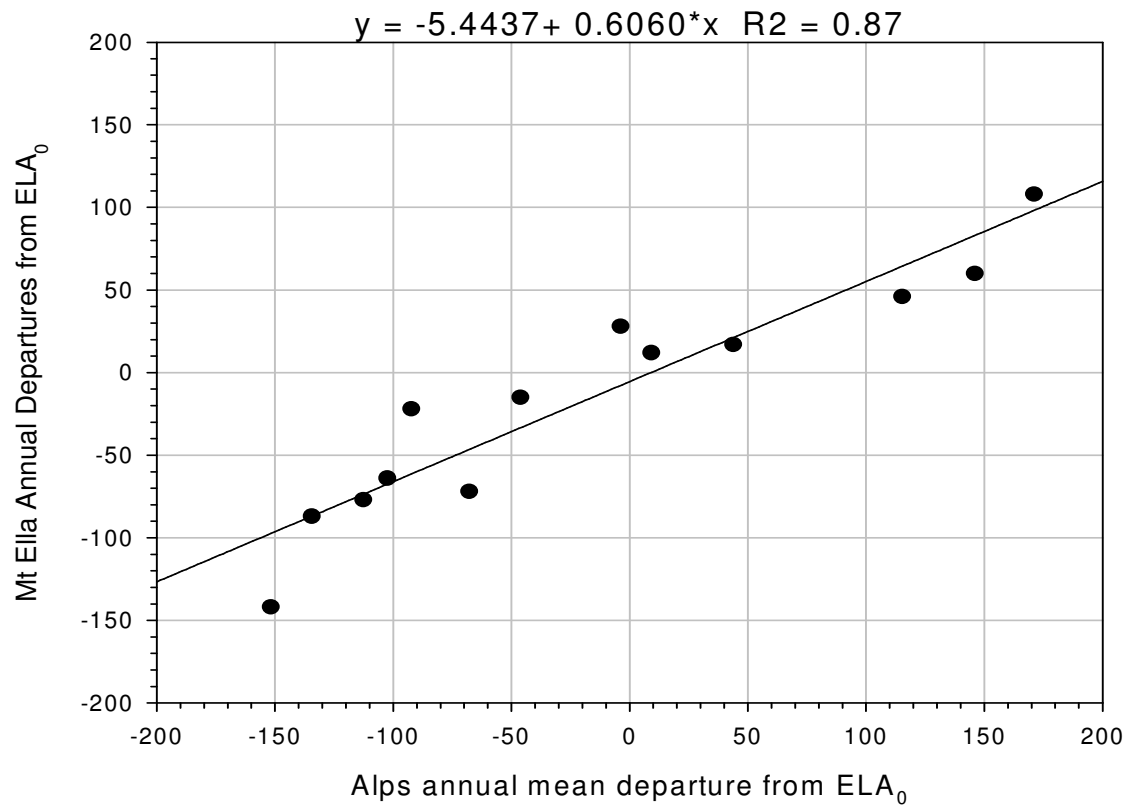
MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	2142	0	3.19	1.45	5.32	0.60	0
1977							
1978							
1979							
1980							
1981							
1982	2154	12	5.32	0.00	5.32	1.00	-12
1983							
1984							
1985							
1986							
1987							
1988							
1989	2170	28	2.17	3.15	5.32	0.41	-28
1990							
1991							
1992							
1993	2055	-87	5.91	0.00	5.91	1.11	87
1994	2070	-72	5.74	0.00	5.74	1.08	72
1995	2000	-142	15.10	0.00	15.10	2.84	142
1996	2127	-15	4.42	0.90	5.32	0.83	15
1997					In cloud		
1998	2159	17	2.92	2.40	5.32	0.55	-17
1999	2250	108	0	5.17	5.17	0.00	-108
2000	2202	60	0.1	2.46	2.56	0.04	-60
2001	2120	-22	4.57	0.75	5.32	0.86	22
2002	2188	46	0.33	1.61	1.94	0.17	-46
2003	2078	-64	5.32	0.00	5.32	1.00	64
2004					No visit	cloud	
2005	2065	-77	5.80	0.00	5.80	1.09	77
MEAN	2126	-16	4.44	1.26		0.84	16

Mt Ella



Mt Ella correlation



Glacierette

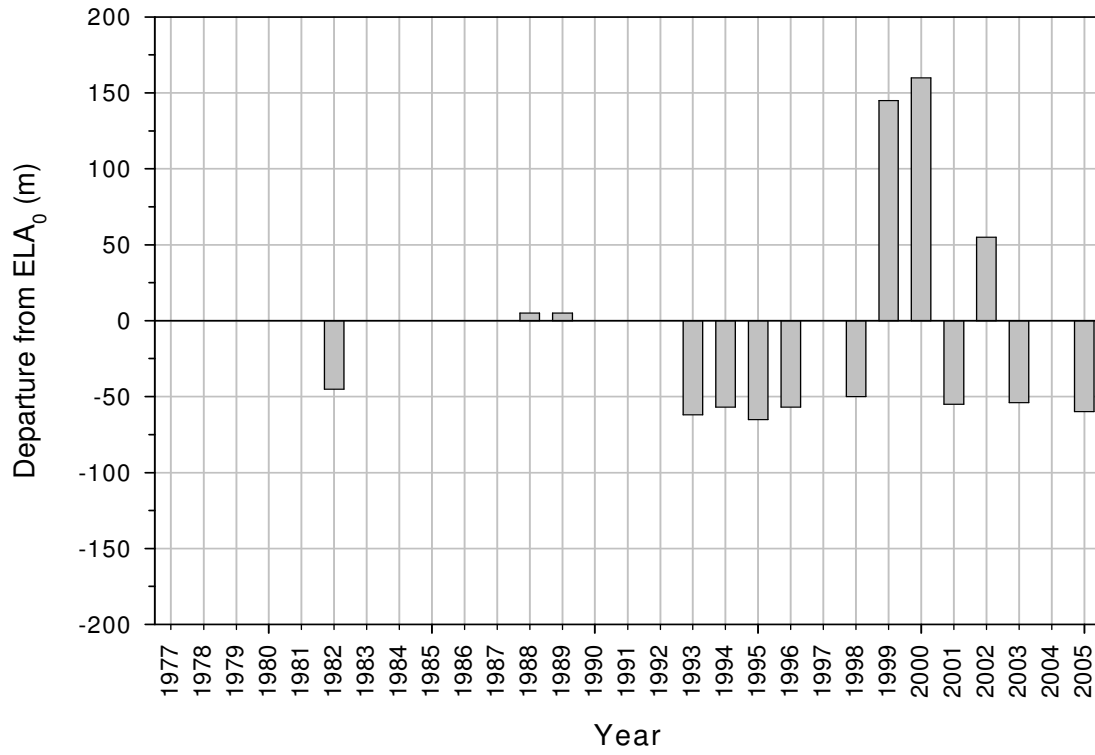
GLACIER DATA		
Aspect	SE	
AREA	5.74	ha
Max Elev	2200	m
Min Elev	1940	m
Mean Elev	2070	m
Length	0.36	km
Elev Range	260	m
Gradient	0.72	

SNOWLINE DATA		
ELAo	2030	m
Max SL	2145	m, 2000
Min SL	1920	m, 1995
Mean SL	1979	m
SL Range	225	m
No. Surveys	14	

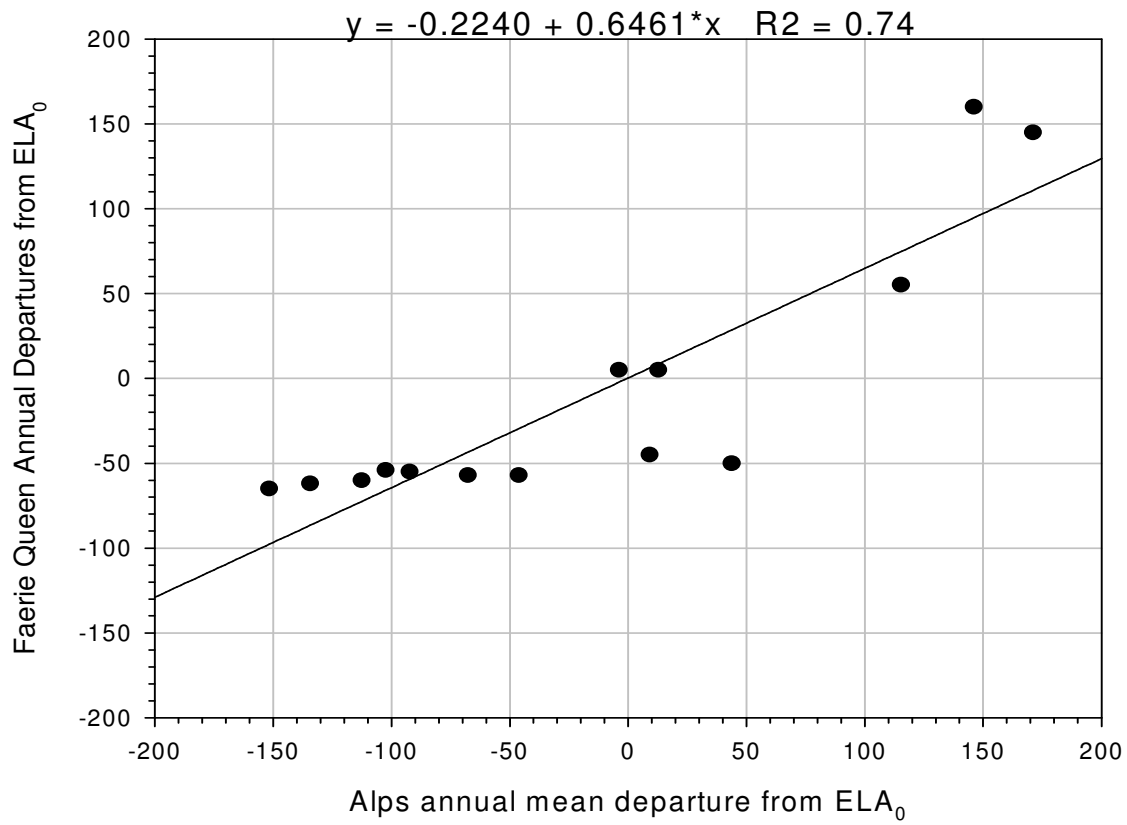
MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELA	2030	45	3.44	2.30	5.74	0.60	0
1977							
1978							
1979							
1980							
1981							
1982	1940	-45	5.74	0.00	5.74	1.00	45
1983							
1984							
1985							
1986							
1987							
1988	1990	5	4.55	1.19	5.74	0.79	-5
1989	1990	5	4.55	1.19	5.74	0.79	-5
1990							
1991							
1992							
1993	1923	-62	6.09	0.00	6.09	1.00	62
1994	1928	-57	5.99	0.00	5.99	1.00	57
1995	1920	-65	8.04	0.00	8.04	1.00	65
1996	1928	-57	5.99	0.00	5.99	1.00	57
1997							
1998	1935	-50	5.84	0.00	5.84	1.00	50
1999	2130	145	0.00	5.74	5.74	0.00	-145
2000	2145	160	0.00	5.74	5.74	0.00	-160
2001	1930	-55	4.57	0.00	4.57	1.00	55
2002	2040	55	3.09	2.65	5.74	0.54	-55
2003	1931	-54	4.57	0.00	4.57	1.00	54
2004					no visit	cloud	
2005	1925	-60	6.09	0.00	6.09	1.00	60
MEAN	1979	-6	4.54	1.27		0.78	6

Faerie Queene



Faerie Queen Correlation



Not numbered

Mt WILSON

NZMS 260 sheet K33

Snow patch

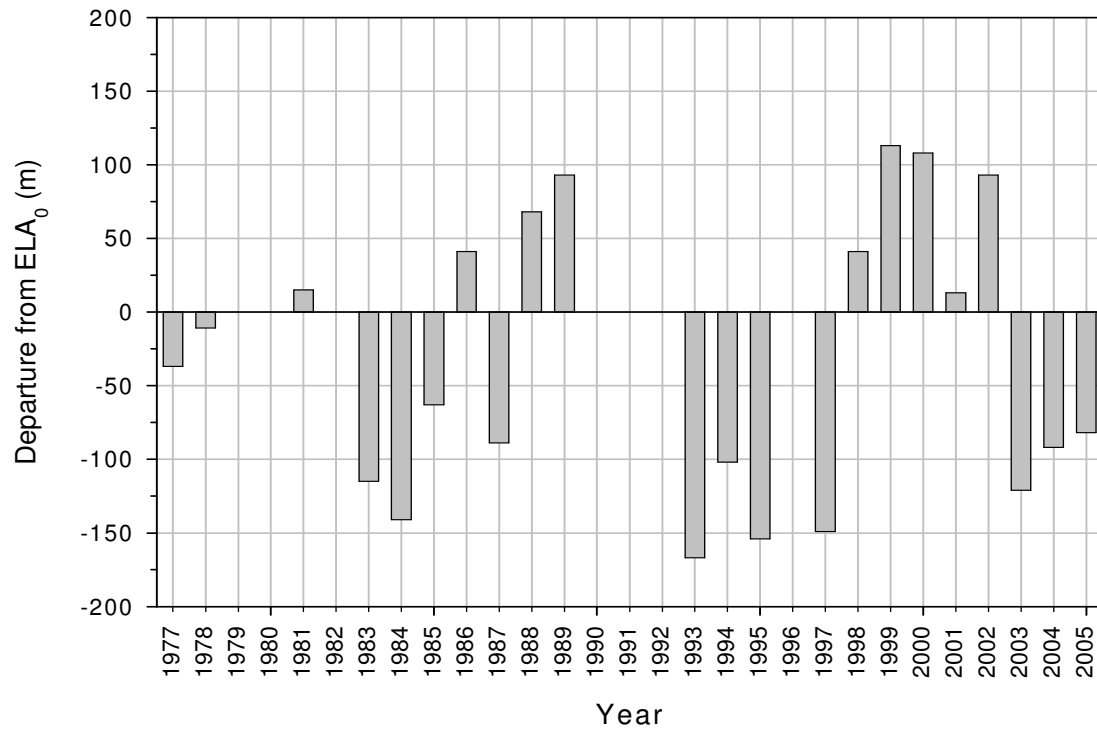
GLACIER DATA		
Aspect	S	
AREA	17.58 to 0.68	ha
Max Elev	2030	m
Min Elev	1740	m
Mean Elev	1885	m
Length	N/A	
Elev Range	290	m
Gradient		

SNOWLINE DATA		
ELAo	1912	@ 7.03 ha
Max SL	2025	m, 1999
Min SL	1745	m, 1993
Mean SL	1878	m
SL Range	280	m
No. Surveys	22	

MEASUREMENTS Digitised values shaded

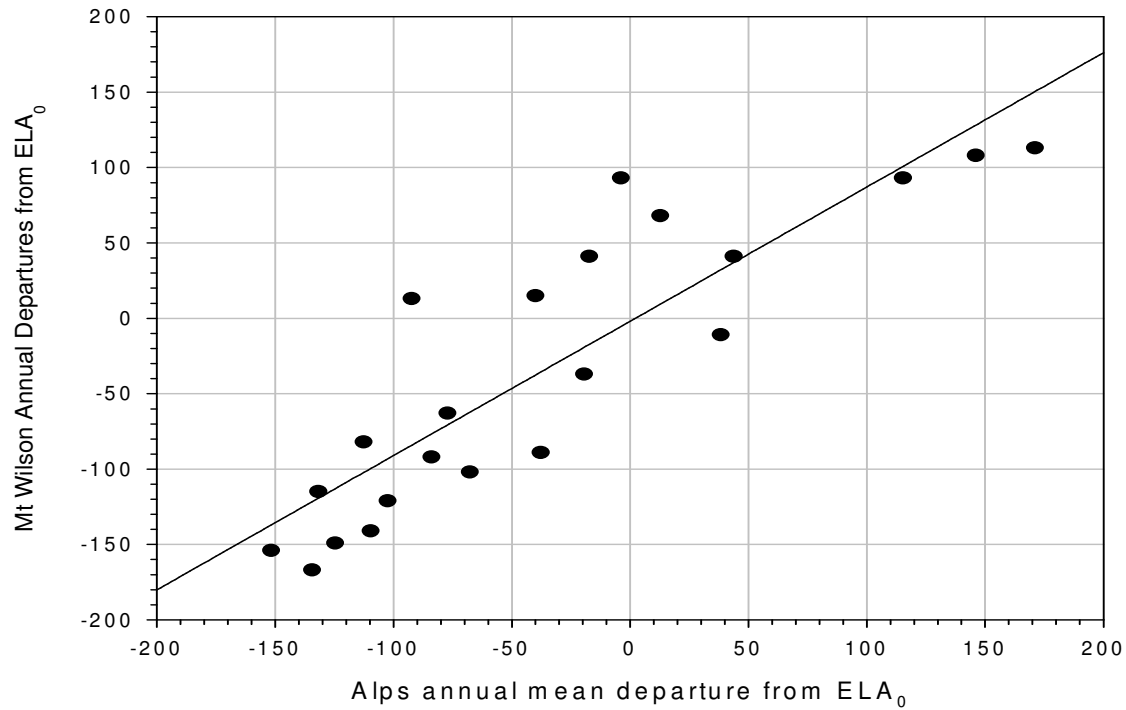
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	N/A	ha	(AAR)	INDEX
ELA	1912		10.55	N/A	7.03	N/A	
1977	1875	-37	6.28		6.28		37
1978	1901	-11	4.68		4.68		11
1979							
1980							
1981	1927	15	3.28		3.28		-15
1982							
1983	1797	-115	4.88		4.88		115
1984	1771	-141	14.78		14.78		141
1985	1849	-63	8.38		8.38		63
1986	1953	41	2.28		2.28		-41
1987	1823	-89	10.48		10.48		89
1988	1980	68	1.48		1.48		-68
1989	2005	93	0.70		0.70		-93
1990							
1991							
1992							
1993	1745	-167	17.13		17.13		167
1994	1810	-102	11.38		11.38		102
1995	1758	-154	15.98		15.98		154
1996							
1997	1763	-149	15.48		15.48		149
1998	1953	41	2.28		2.28		-41
1999	2025	113	0.13		0.13		-113
2000	2020	108	0.68		0.68		-108
2001	1925	13	3.56		3.56		-13
2002	2005	93	0.63		0.63		-93
2003	1791	-121	4.40		4.40		121
2004	1820	-92	10.55		10.55		92
2005	1830	-82	10.48		10.48		82
Mean	1878	-34	6.64		6.64		34

Mt Wilson



Mt Wilson correlation

$$y = -1.9648 + 0.8906 \cdot x \quad R^2 = 0.77$$



Cirque

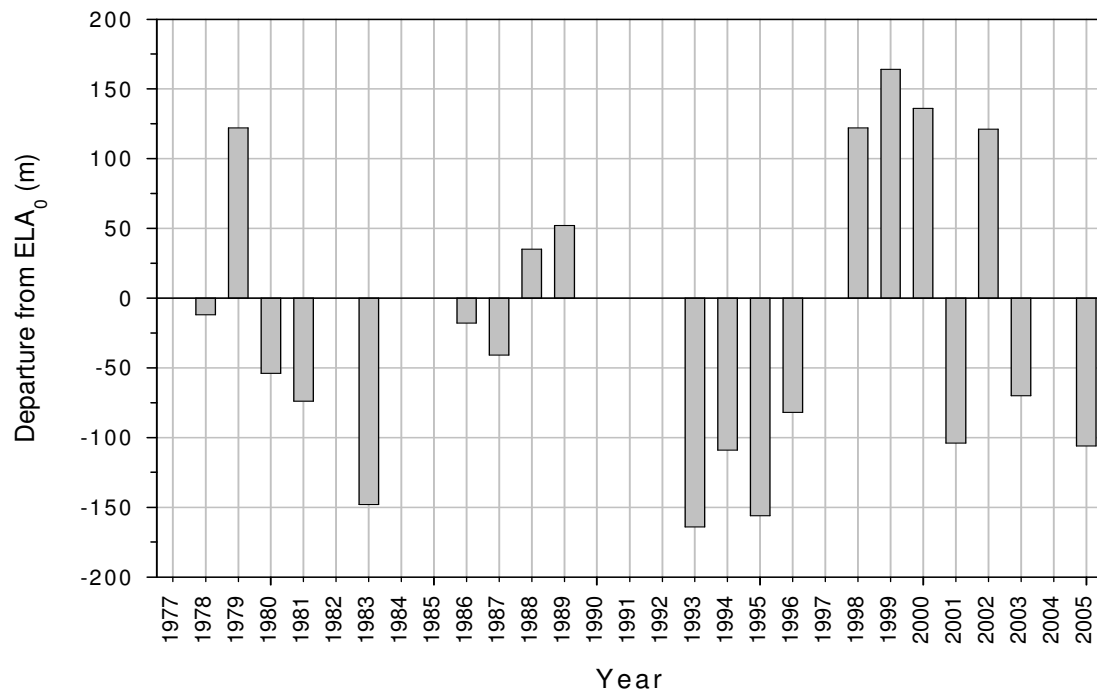
GLACIER DATA		
Aspect	E	
AREA	8.85	ha
Max Elev	2010	m
Min Elev	1680	m
Mean Elev	1845	m
Length	0.5	km
Elev Range	330	m
Gradient	0.66	

SNOWLINE DATA		
ELAo	1814	m
Max SL	1978	m, 1999
Min SL	1650	m, 1993
Mean SL	1795	m
SL Range	328	m
No. Surveys	20	

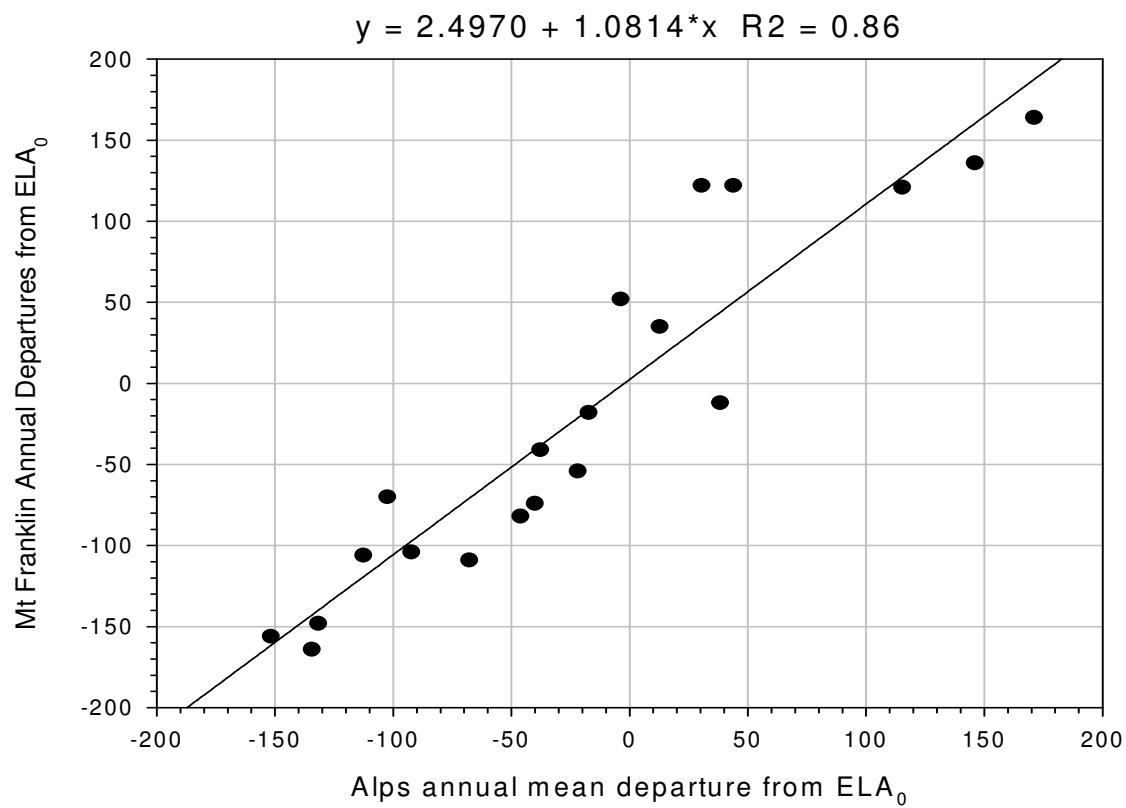
MEASUREMENTS

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1814	0	7.45	1.40	8.85	0.84	0
1977							
1978	1802	-12	7.74	1.11	8.85	0.87	12
1979	1936	122	0.84	8.01	8.85	0.09	-122
1980	1760	-54	8.40	0.45	8.85	0.95	54
1981	1740	-74	8.60	0.25	8.85	0.97	74
1982							
1983	1666	-148	?	0.00			148
1984							
1985							
1986	1796	-18	8.00	0.85	8.85	0.90	18
1987	1773	-41	8.30	0.55	8.85	0.94	41
1988	1849	35	5.30	3.55	8.85	0.60	-35
1989	1866	52	4.62	4.23	8.85	0.52	-52
1990							
1991							
1992							
1993	1650	-164	13.04	0.00	13.04	1.47	164
1994	1705	-109	8.80	0.05	8.85	0.99	109
1995	1658	-156	12.00	0.00	12.00	1.38	156
1996	1732	-82	8.65	0.20	8.85	0.96	82
1997					cloud		
1998	1936	122	0.84	8.01	8.85	0.09	-122
1999	1978	164	0.26	8.59	8.85	0.03	-164
2000	1950	136	0.57	8.28	8.85	0.06	-136
2001	1710	-104	8.85	0.00	8.85	1.00	104
2002	1935	121	0.87	7.98	8.85	0.10	-121
2003	1744	-70	8.60	0.25	8.85	0.97	70
2004					cloud		
2005	1708	-106	8.85	0.00	8.85	1.00	106
Mean	1795	-15	6.48	2.62		0.72	15

Mt Franklin



Mt Franklin correlation



Cirque glacier

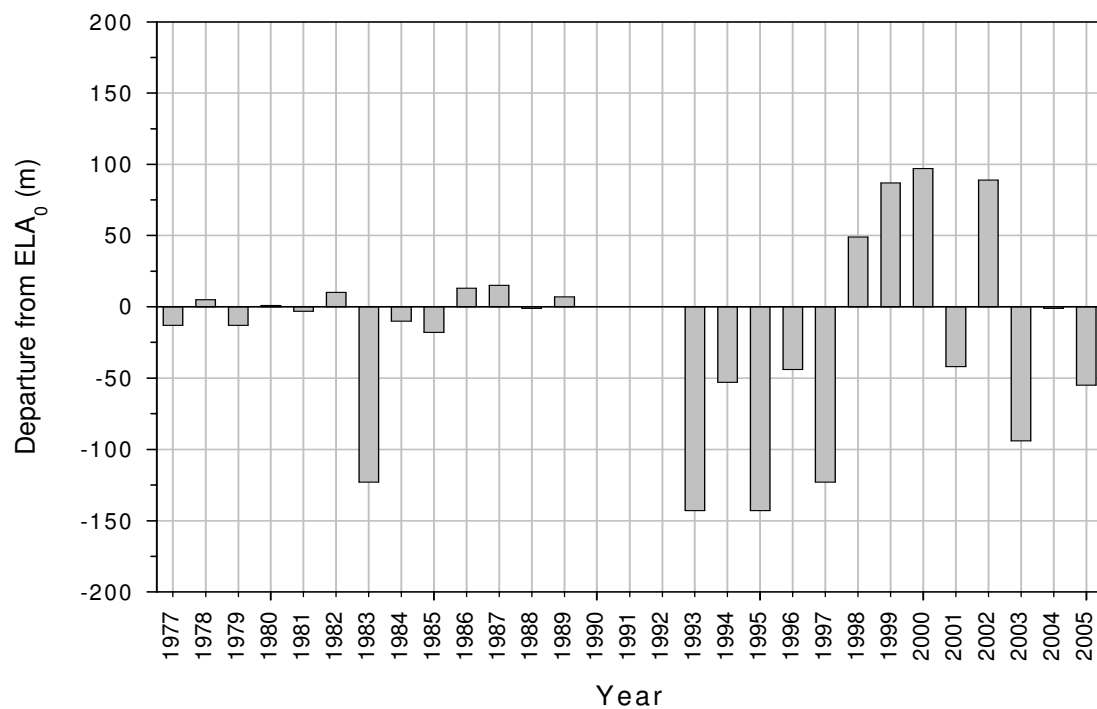
GLACIER DATA		
Aspect	SE	
AREA	19.07	ha
Max Elev	1900	m
Min Elev	1690	m
Mean Elev	1795	m
Length	0.36	km
Elev Range	210	m
Gradient	0.58	

SNOWLINE DATA		
ELAo	1763	m
Max SL	1860	m, 1993, 95
Min SL	1620	m, 2000
Mean SL	1744	m
SL Range	240	m
No. Surveys	26	

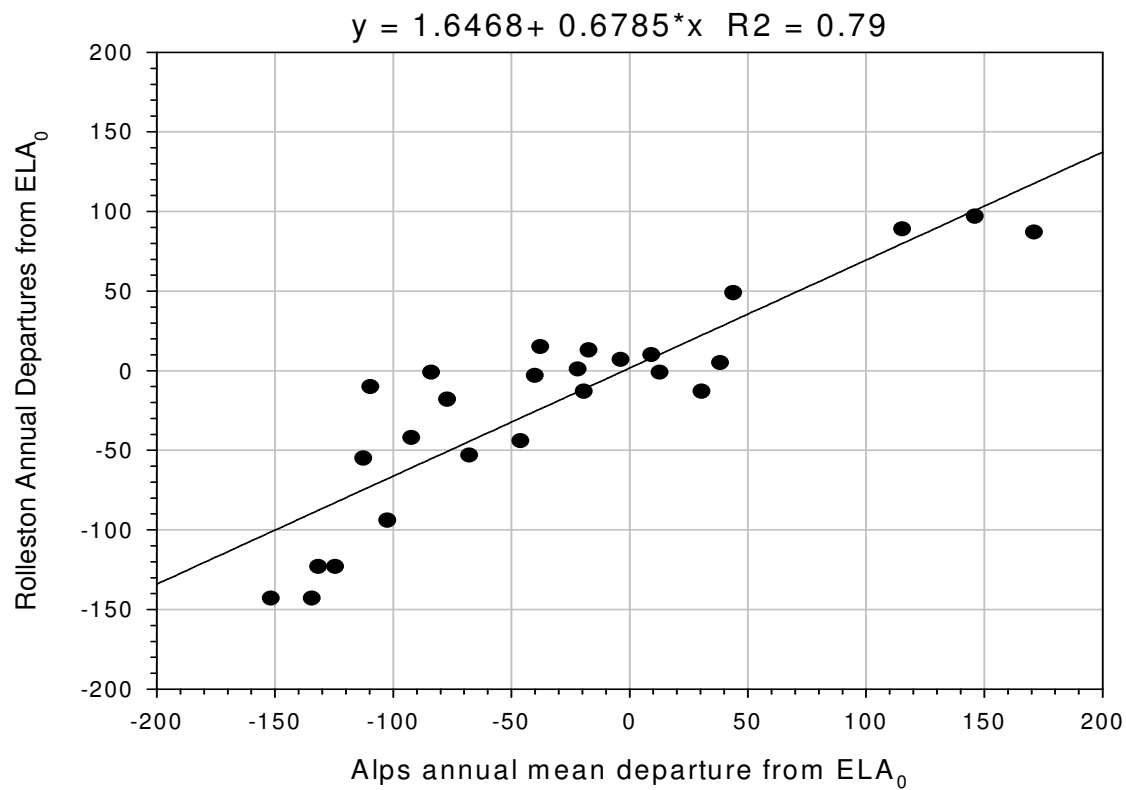
MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
1955	1800	29					
1960	1800	29					-29
ELAo	1763	0	12.07	7.00	19.07	0.63	0
1977	1750	-13	13.67	5.40	19.07	0.72	13
1978	1768	5	11.45	7.62	19.07	0.60	-5
1979	1750	-13	13.67	5.40	19.07		13
1980	1764	1	12.07	7.00	19.07	0.63	-1
1981	1760	-3	12.47	6.60	19.07	0.65	3
1982	1773	10	10.57	8.50	19.07	0.55	-10
1983	1640	-123	?	0.00			123
1984	1753	-10	13.32	5.75	19.07	0.70	10
1985	1745	-18	14.17	4.90	19.07	0.74	18
1986	1776	13	10.47	8.60	19.07	0.55	-13
1987	1778	15	10.47	8.60	19.07	0.55	-15
1988	1762	-1	12.17	6.90	19.07	0.64	1
1989	1770	7	19.07	8.00	27.07	1.00	-7
1990							
1991							
1992							
1993	1620	-143	25.34	0.00	25.34	1.33	143
1994	1710	-53	17.39	1.68	19.07	0.91	53
1995	1620	-143	25.34	0.00	25.34	1.33	143
1996	1719	-44	16.77	2.30	19.07	0.88	44
1997	1640	-123	23.27	0.00	23.27	1.22	123
1998	1812	49	4.78	14.29	19.07	0.25	-49
1999	1850	87	0.79	18.28	19.07	0.04	-87
2000	1860	97	0.6	18.47	19.07	0.03	-97
2001	1721	-42	16.56	2.51	19.07	0.87	42
2002	1852	89	0.71	18.36	19.07	0.04	-89
2003	1669	-94	19.07	0.00	19.07	1.00	94
2004	1762	-1	12.47	6.60	19.07	0.65	1
2005	1708	-55	17.4	1.67	19.07	0.91	55
MEAN	1744	-19	13.23	6.44		0.70	19

Rolleston Gl.



Rolleston correlation



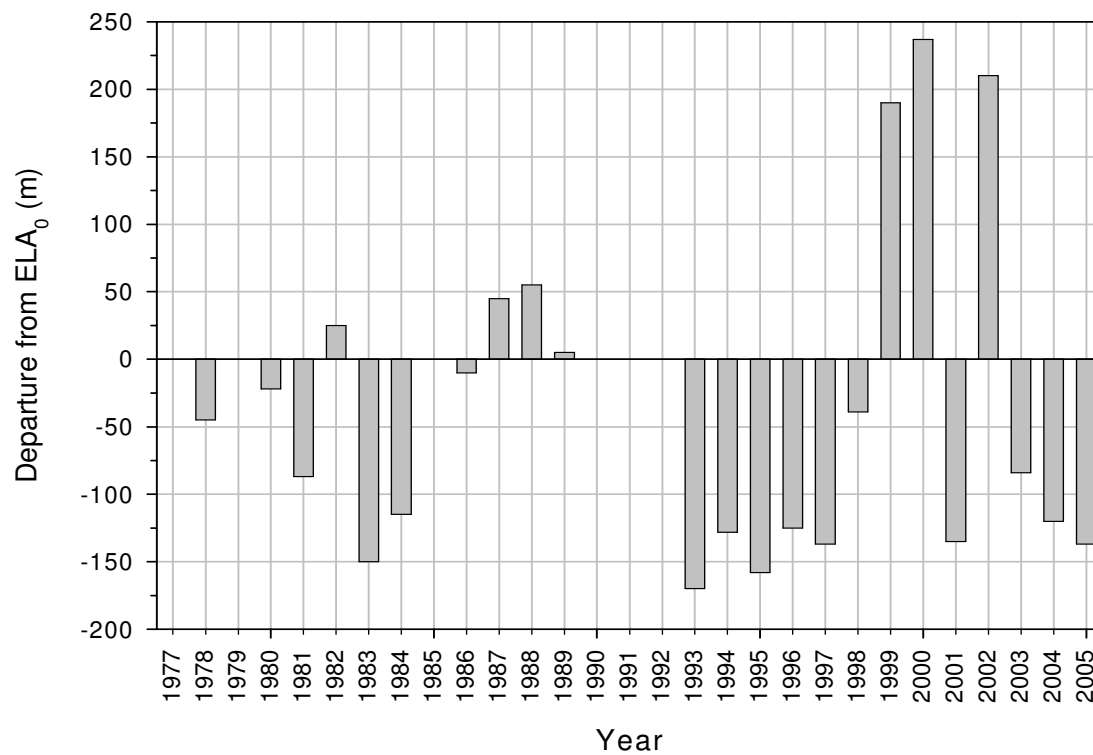
GLACIER DATA		
Aspect	S	
AREA	15.5	ha
Max Elev	1960	m
Min Elev	1595	m
Mean Elev	1778	m
Length	0.71	km
Elev Range	365	m
Gradient	0.51	

SL DATA		
ELAo	1715	m
Max SL	1952	m, 2000
Min SL	1545	m, 1993
Mean SL	1676	m
SL Range	407	m
No. Surveys	23	

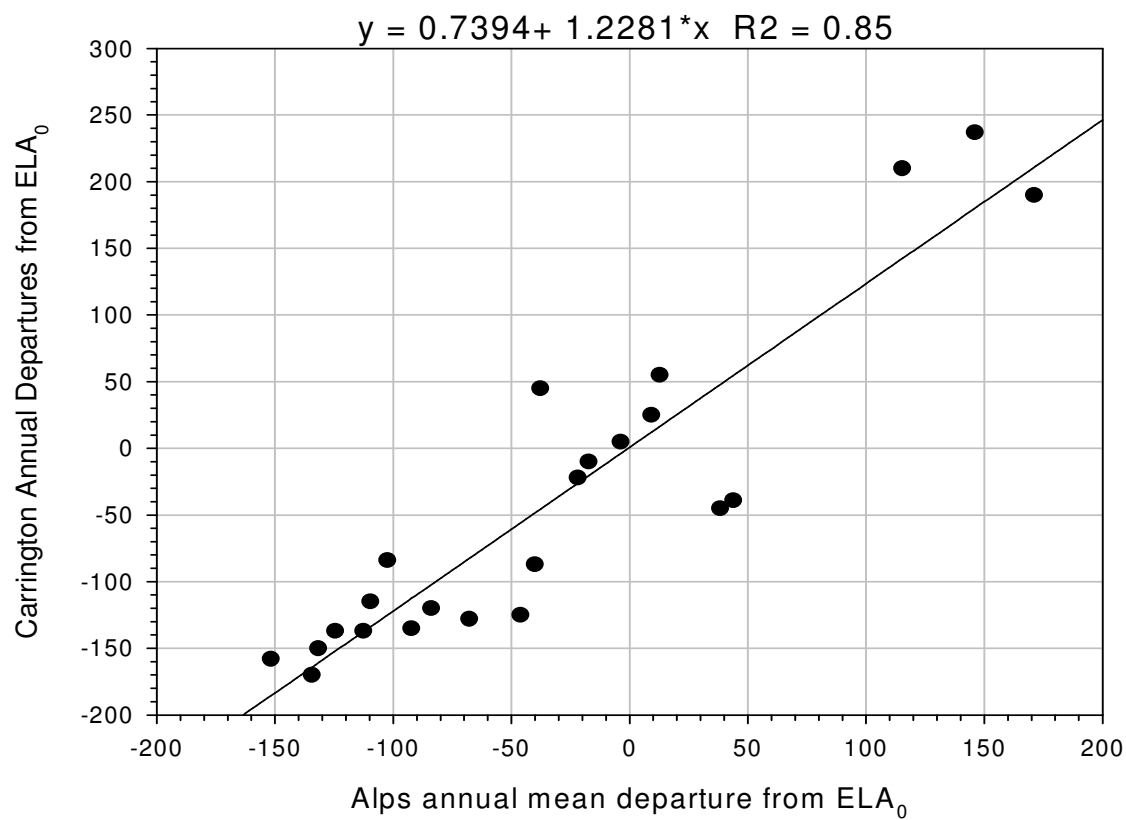
MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1715	0	7.00	8.5	15.5	0.45	0
1977							
1978	1670	-45	8.86	6.64	15.50	0.57	45
1979							
1980	1693	-22	7.70	7.80	15.50	0.50	22
1981	1628	-87	11.60	3.90	15.50	0.75	87
1982	1740	25	6.50	9.00	15.50	0.42	-25
1983	1565	-150	18.50	0.00	15.50	1.19	150
1984	1600	-115	14.50	1.00	15.50	0.94	115
1985							
1986	1705	-10	7.20	8.30	15.50	0.46	10
1987	1760	45	6.00	9.50	15.50	0.39	-45
1988	1770	55	5.80	9.70	15.50	0.37	-55
1989	1720	5	6.90	8.60	15.50	0.45	-5
1990							
1991							
1992							
1993	1545	-170	20.55	0.00	15.50	1.33	170
1994	1587	-128	15.70	0.00	15.50	1.01	128
1995	1557	-158	16.60	0.00	15.50	1.07	158
1996	1590	-125	14.90	0.60	15.50	0.96	125
1997	1578	-137	17.43	0.00	15.50	1.12	137
1998	1676	-39	8.69	6.81	15.50	0.56	39
1999	1905	190	2.94	12.56	15.50	0.19	-190
2000	1952	237	0.48	15.02	15.50	0.03	-237
2001	1580	-135	17.30	0.00	15.50	1.12	135
2002	1925	210	1.30	6.70	8.00	0.16	-210
2003	1631	-84	6.60	1.40	8.00	0.83	84
2004	1595	-120	8.00	0.00	8.00	1.00	120
2005	1578	-137	17.43	0.00	15.50	1.12	137
MEAN	1676	-39	10.50	4.68		0.72	39

Mt Carrington



Carrington correlation



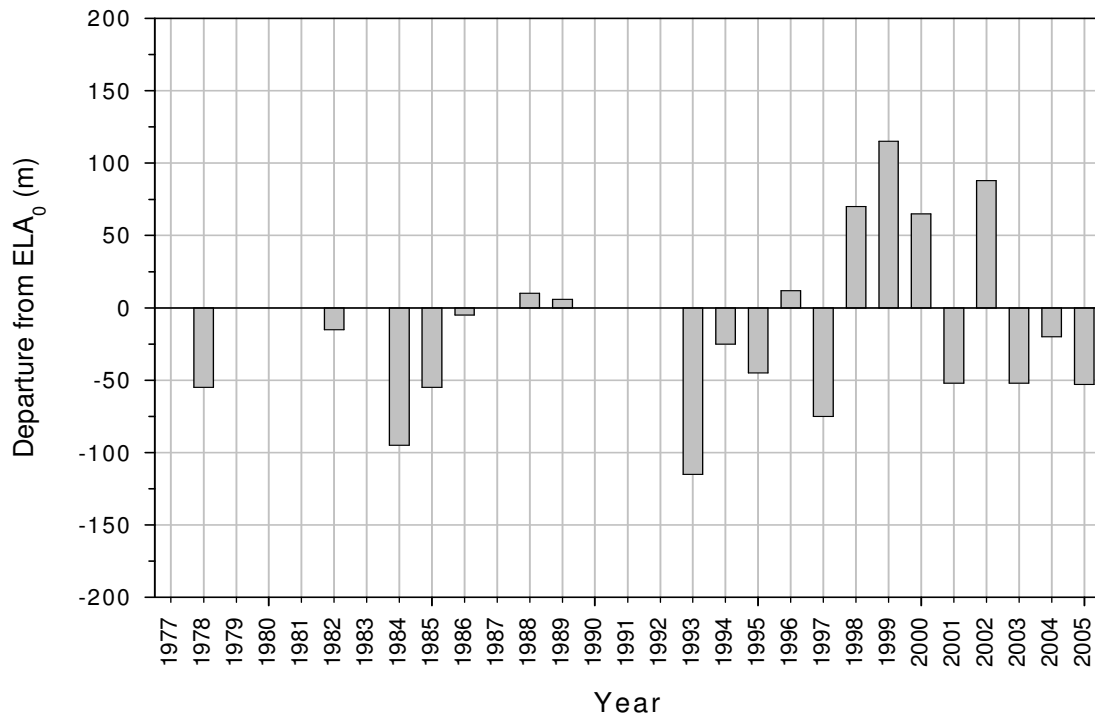
GLACIER DATA		
Aspect	E	
AREA	9.803	m
Max Elev	2080	m
Min Elev	1890	m
Mean Elev	1985	m
Length	0.36	km
Elev Range	190	m
Gradient	0.53	

SNOWLINE DATA		
ELAo	1965	m
Max SL	2080	m, 1999
Min SL	1850	m, 1993
Mean SL	1950	m
SL Range	230	m
No. Surveys	20	

MEASUREMENTS Digitised values shaded

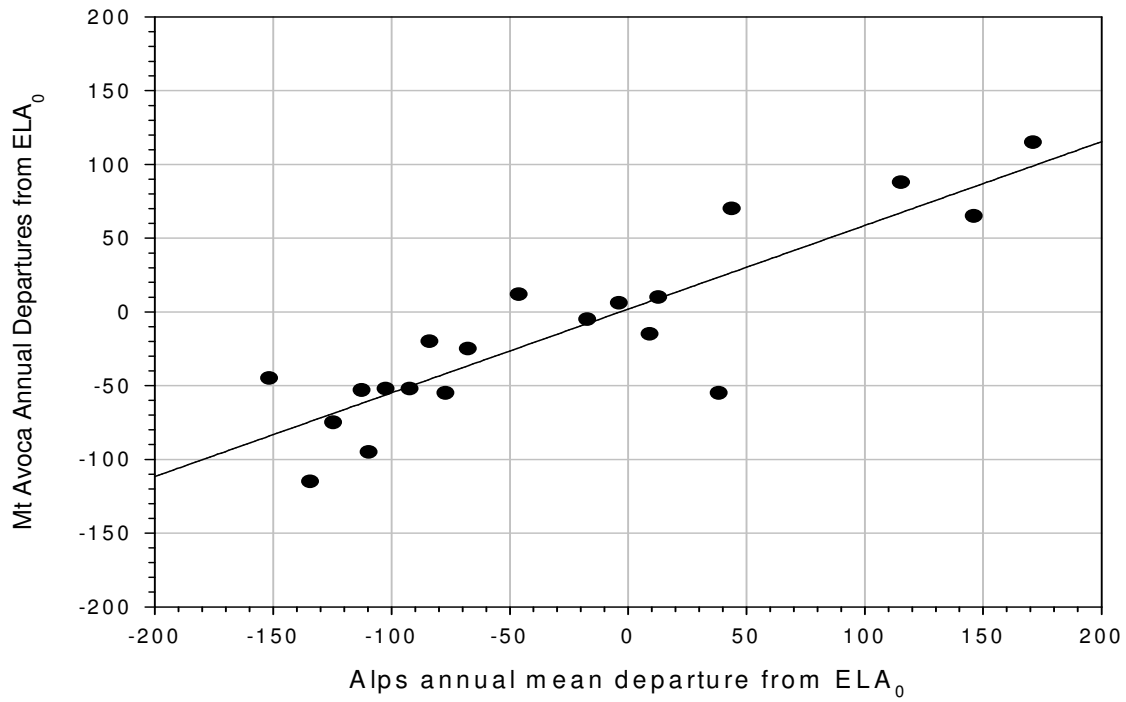
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELA	1965	0	4.40	5.40	9.80	0.45	0
1977							
1978	1910	-55	9.20	0.60	9.80	0.94	55
1979							
1980							
1981							
1982	1950	-15	5.88	3.92	9.80	0.60	15
1983							
1984	1870	-95	10.50	0.00	9.80	1.00	95
1985	1910	-55	9.20	0.60	9.80	0.94	55
1986	1960	-5	4.85	4.95	9.80	0.49	5
1987							
1988	1975	10					-10
1989	1971	6	3.97	5.83	9.80	0.40	-6
1990							
1991							
1992							
1993	1850	-115	11.38	0.00	11.38	1.16	115
1994	1940	-25	7.20	2.60	9.80	0.73	25
1995	1920	-45	8.80	1.00	9.80	0.90	45
1996	1977	12	3.57	6.23	9.80	0.36	-12
1997	1890	-75	9.80	0.00	9.80	1.00	75
1998	2035	70	0.98	5.33	6.31	0.16	-70
1999	2080	115	0.00	3.22	3.22	0.00	-115
2000	2030	65	1.11	2.47	3.58	0.31	-65
2001	1913	-52	0.00	7.13	7.13	0.00	52
2002	2053	88	0.44	3.14	3.58	0.12	-88
2003	1913	-52	0.00	7.13	7.13	0.00	52
2004	1945	-20	6.50	3.30	9.80	0.66	20
2005	1912	-53	0.00	7.13	7.13	0.00	53
MEAN	1950	-15	4.91	3.40		0.54	15

Mt Avoca



Mt Avoca correlation

$$y = 1.8938 + 5676 \cdot x \quad R^2 = 0.76$$



Mountain glacier

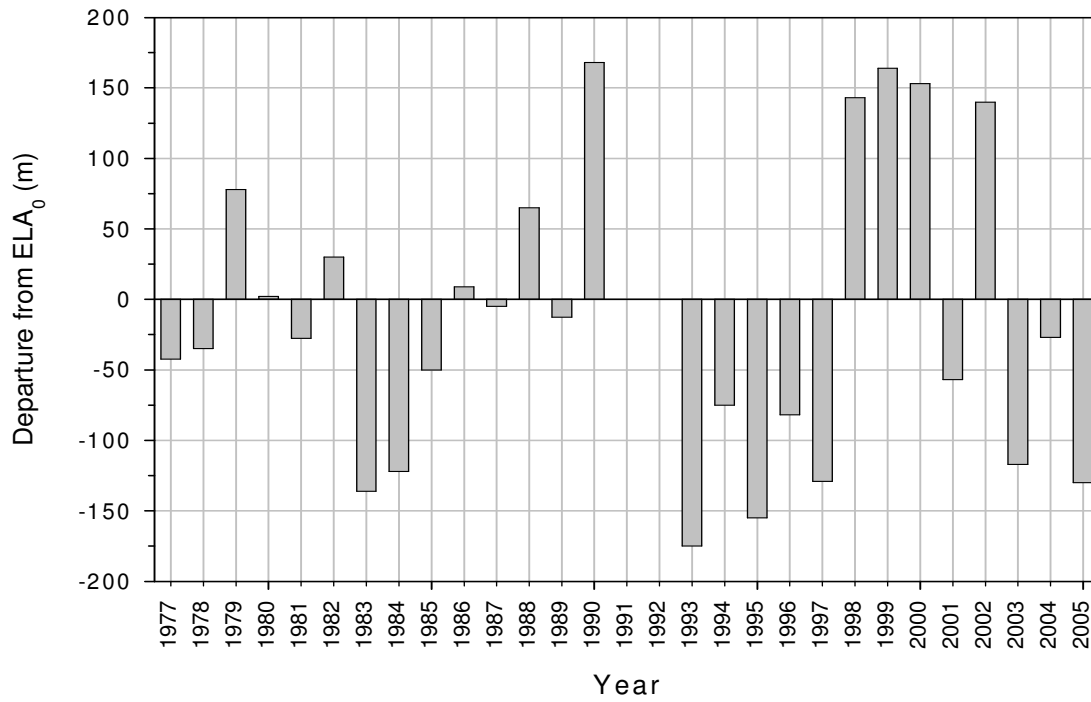
GLACIER DATA		
Aspect	E	
AREA	92.52	m
Max Elev	2100	m
Min Elev	1615	m
Mean Elev	1858	m
Length	1.7	km
Elev Range	485	m
Gradient	0.285	

SNOWLINE DATA		
ELAo	1830	m
Max SL	1998	m, 1990
Min SL	1655	m, 1993
Mean SL	1814	m
SL Range	343	m
No. Surveys	27	

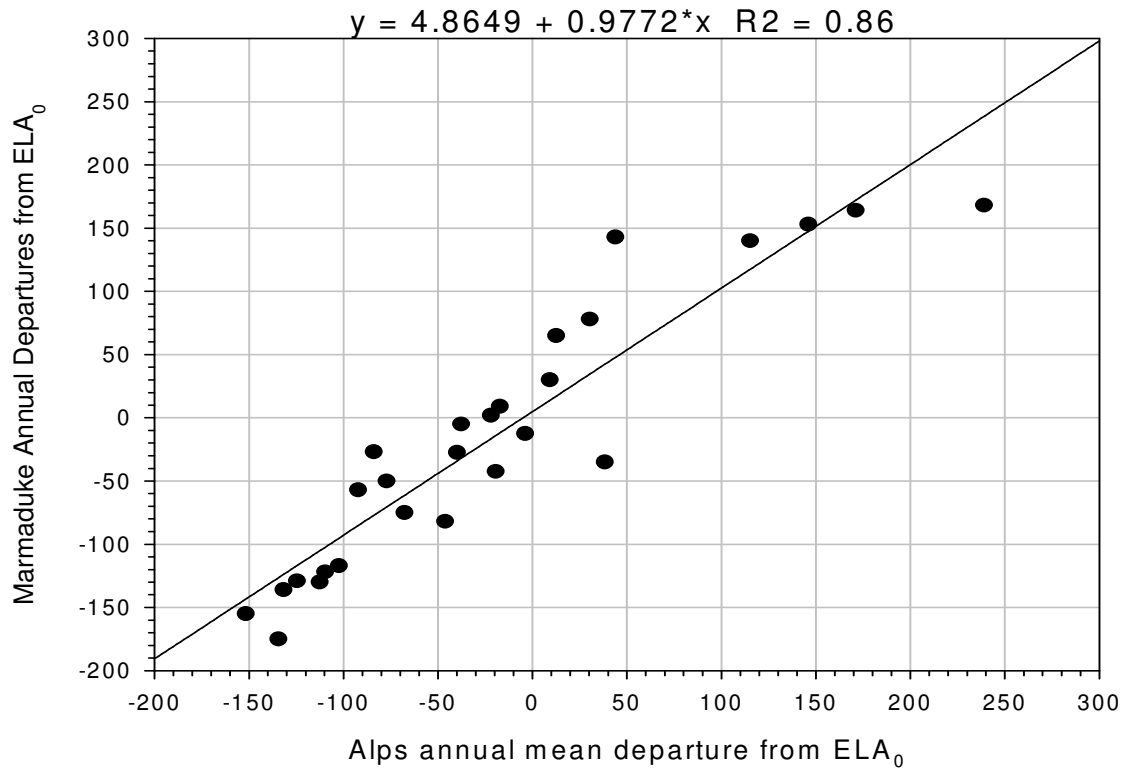
MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE	AREAS			ACCUM.	MASS
	ELEVATION	FROM ELA _o	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELA _o	1830	0	63.72	28.8	92.52	0.69	0
1977	1788	-43	73.02	19.50	92.52	0.79	43
1978	1795	-35	71.52	21.00	92.52	0.77	35
1979	1908	78	44.50	48.02	92.52	0.48	-78
1980	1832	2	63.52	29.00	92.52	0.69	-2
1981	1803	-28	69.72	22.80	92.52	0.75	28
1982	1860	30	49.65	42.87	92.52	0.54	-30
1983	1694	-136	86.72	5.80	92.52	0.94	136
1984	1708	-122	85.52	7.00	92.52	0.92	122
1985	1780	-50	73.97	18.55	92.52	0.80	50
1986	1839	9	61.72	30.80	92.52	0.67	-9
1987	1825	-5	64.77	27.75	92.52	0.70	5
1988	1895	65	48.02	44.50	92.52	0.52	-65
1989	1818	-13	67.02	25.50	92.52	0.72	13
1990	1998	168	22.52	70.00	92.52	0.24	-168
1991							
1992							
1993	1655	-175	90.34	2.18	92.52	0.98	175
1994	1755	-75	78.48	14.04	92.52	0.85	75
1995	1675	-155	92.14	0.38	92.52	1.00	155
1996	1748	-82	82.22	10.30	92.52	0.89	82
1997	1701	-129	91.87	0.65	92.52	0.99	129
1998	1973	143	26.81	65.71	92.52	0.29	-143
1999	1994	164	21.50	71.02	92.52	0.23	-164
2000	1983	153	23.75	68.77	92.52	0.26	-153
2001	1773	-57	75.32	17.20	92.52	0.81	57
2002	1970	140	28.38	53.42	81.80	0.35	-140
2003	1713	-117	74.50	7.30	81.80	0.91	117
2004	1803	-27	66.48	19.37	85.85	0.77	27
2005	1700	-130	91.87	0.65	92.52	0.99	130
MEAN	1814	-16	62.70	28.59		0.68	16

Marmaduke Dixon Gl.



Marmaduke correlation



Mountain glacier

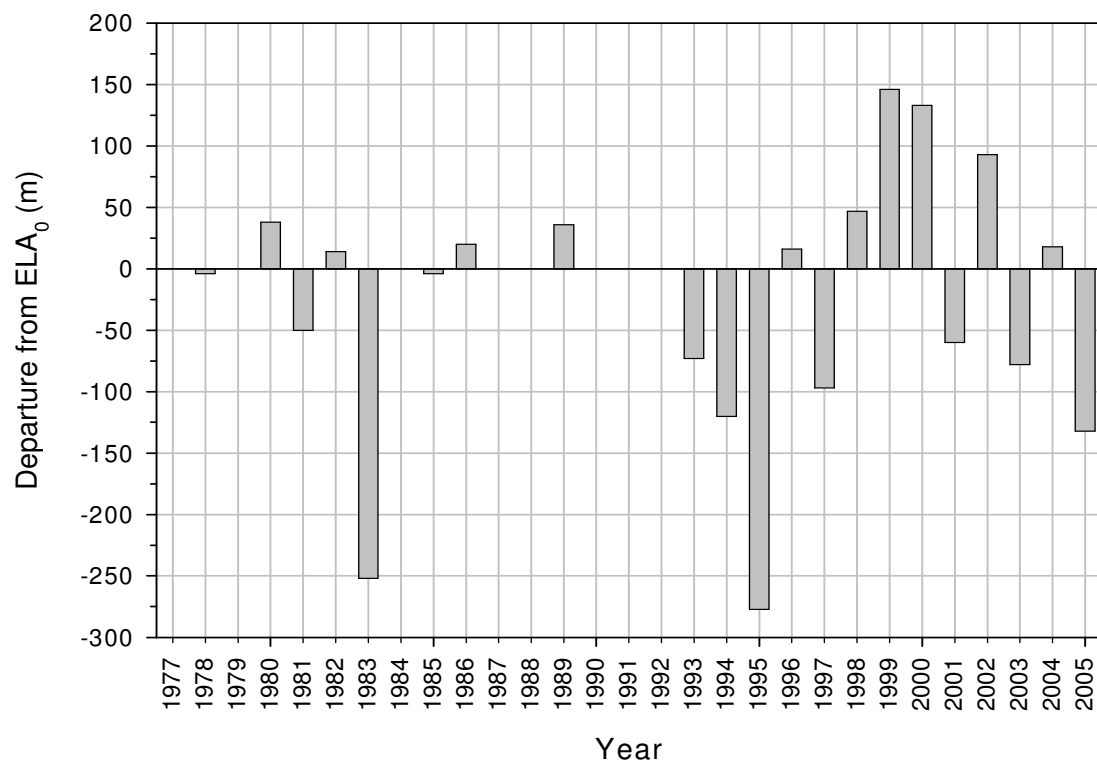
GLACIER DATA		
Aspect	SW	
AREA	28.7	ha
Max Elev	1930	m
Min Elev	1570	m
Mean Elev	1750	m
Length	1.05	km
Elev Range	360	m
Gradient	0.343	

SNOWLINE DATA		
ELAo	1742	m
Max SL	1888	m, 1999
Min SL	1465	m, 1995
Mean SL	1714	m
SL Range	423	m
No. Surveys	21	

MEASUREMENTS Digitised values shaded

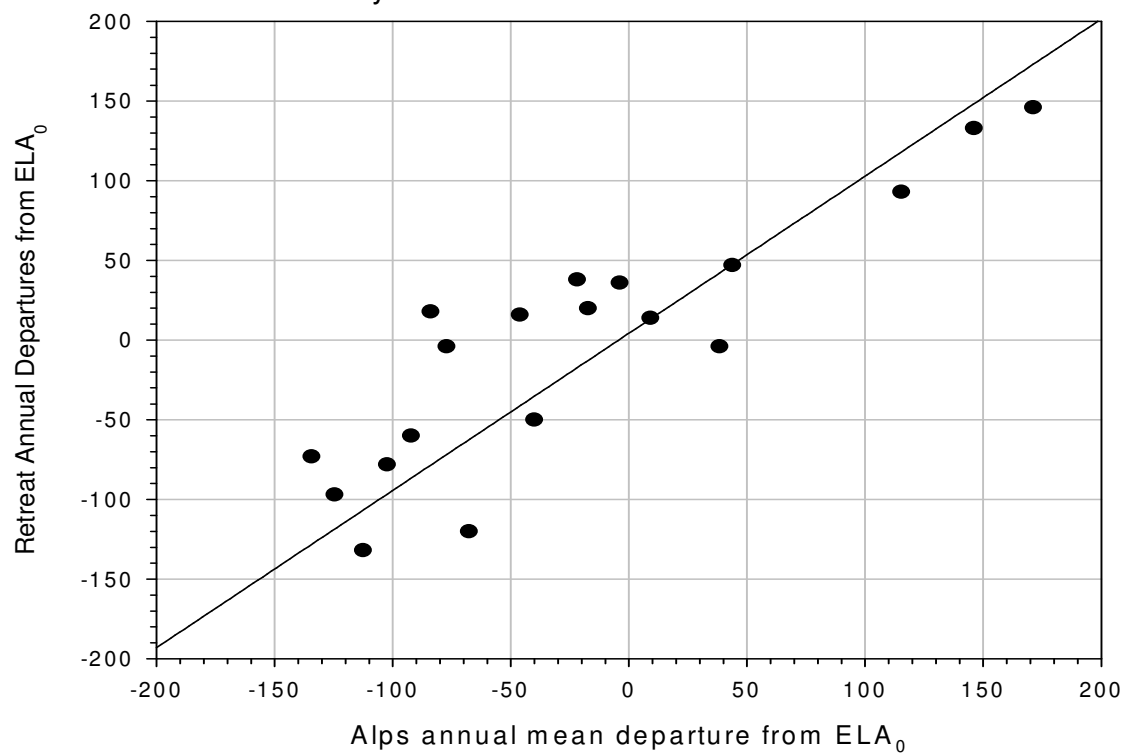
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1742	0	13.90	14.80	28.70	0.48	0
1977							
1978	1738	-4	14.70	14.00	28.70	0.51	4
1979							
1980	1780	38	8.29	20.41	28.70	0.29	-38
1981	1692	-50	20.30	8.40	28.70	0.71	50
1982	1756	14	13.30	15.40	28.70	0.46	-14
1983	1490	-252	31.59	-2.89	28.70	1.10	252
1984							
1985	1738	-4	14.83	13.87	28.70	0.52	4
1986	1762	20	10.78	17.92	28.70	0.38	-20
1987							
1988							
1989	1778	36	8.87	19.83	28.70	0.31	-36
1990							
1991							
1992							
1993	1669	-73	22.82	5.88	28.70	0.80	73
1994	1622	-120	27.20	1.50	28.70	0.95	120
1995	1465	-277	32.41	-3.71	28.70	1.13	277
1996	1758	16	11.65	17.05	28.70	0.41	-16
1997	1645	-97	25.20	3.50	28.70	0.88	97
1998	1789	47	7.28	21.42	28.70	0.25	-47
1999	1888	146	1.91	26.79	28.70	0.07	-146
2000	1875	133	2.39	11.40	13.79	0.17	-133
2001	1682	-60	21.43	7.27	28.70	0.75	60
2002	1835	93	2.88	9.43	12.31	0.23	-93
2003	1664	-78	11.51	0.80	12.31	0.94	78
2004	1760	18	6.51	5.80	12.31	0.53	-18
2005	1610	-132	10.81	1.50	12.31	0.88	132
MEAN	1714	-28	14.79	10.96		0.57	28

Retreat Gl.



Retreat correlation

$$y = 4.266 + 0.9862 \cdot x \quad R^2 = 0.70$$



Small cirque

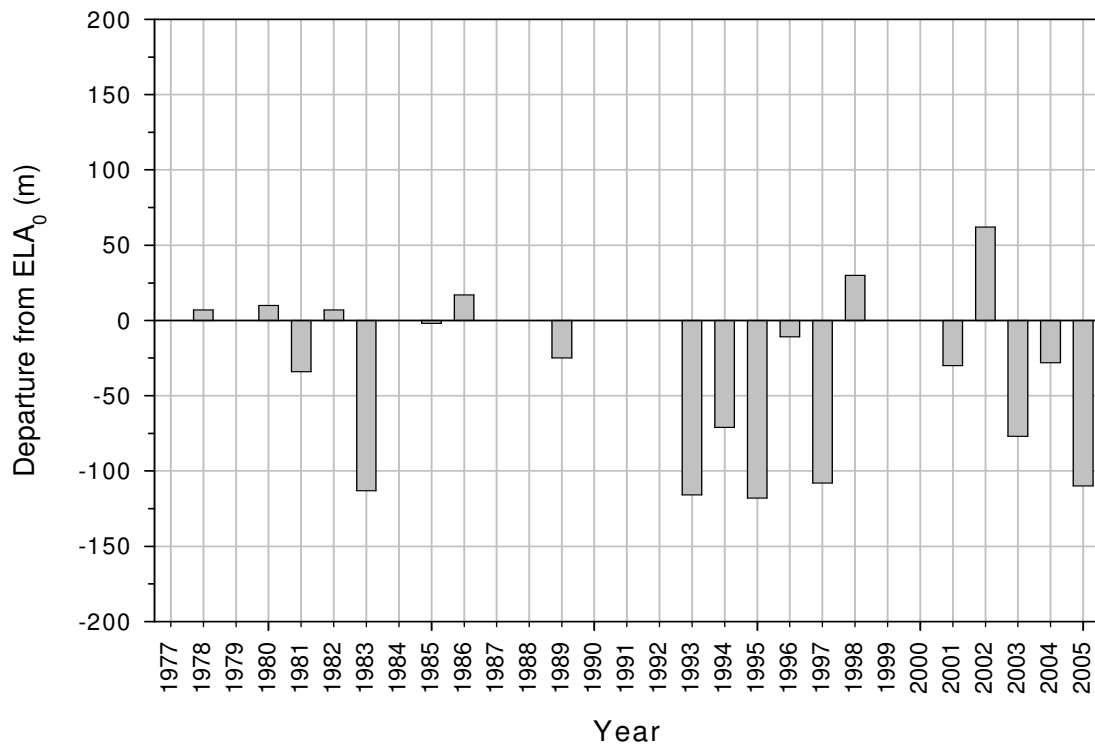
GLACIER DATA		
Aspect	S	
AREA	4.08	ha
Max Elev	1700	m
Min Elev	1530	m
Mean Elev	1615	m
Length		km
Elev Range	170	m
Gradient		

SNOWLINE DATA		
ELAo	1598	m
Max SL	1660	m, 2000
Min SL	1480	m, 1995
Mean SL	1561	m
SL Range	180	m
No. Surveys	21	

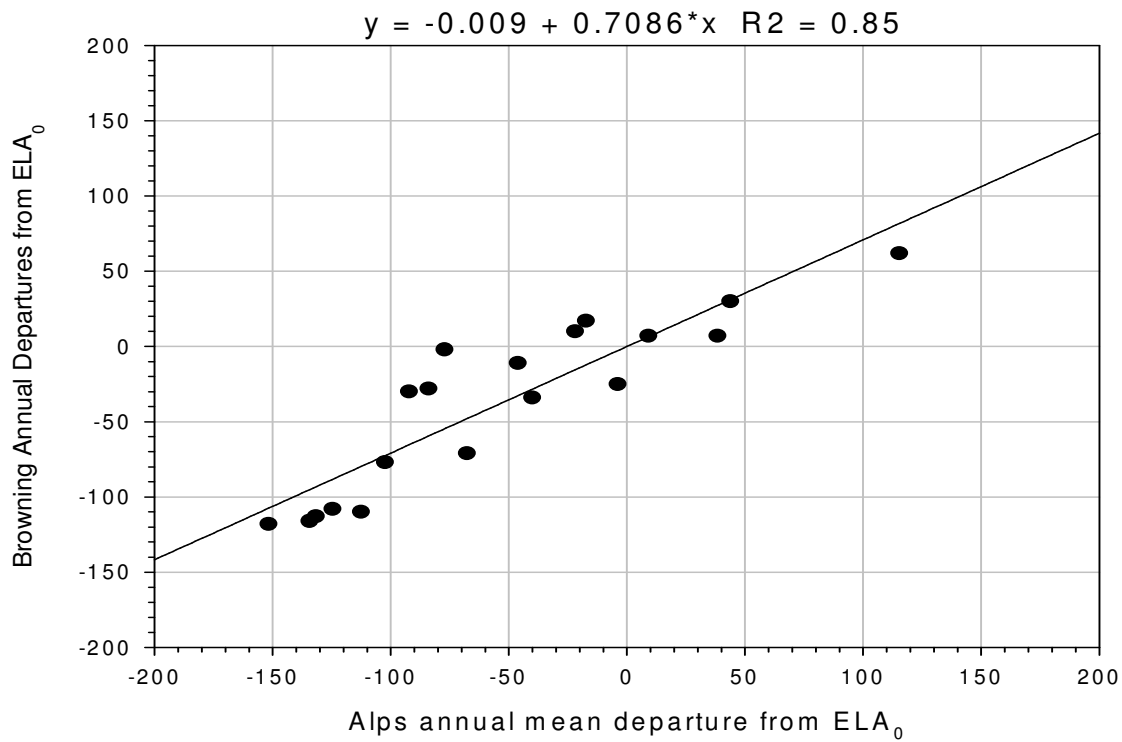
MEASUREMENTS Digitised values in bold type

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1598	0	1.01	3.07	4.08	0.25	0
1977							
1978	1605	7	0.78	3.3	4.08	0.19	-7
1979							
1980	1608	10	0.74	3.34	4.08	0.18	-10
1981	1564	-34	2.45	1.63	4.08	0.60	34
1982	1605	7	0.78	3.3	4.08	0.19	-7
1983	1485	-113	7.48	0	7.48	1.00	113
1984							
1985	1596	-2	1.01	3.07	4.08	0.25	2
1986	1615	17	0.68	3.4	4.08	0.17	-17
1987							
1988							
1989	1573	-25	2.01	2.07	4.08	0.49	25
1990							
1991							
1992							
1993	1482	-116	2.03	2.05	4.08	0.50	116
1994	1527	-71	4.33	0	4.33	1.06	71
1995	1480	-118	20.38	0	20.38	5.00	118
1996	1587	-11	1.38	2.7	4.08	0.34	11
1997	1490	-108	12.81	0	12.81	3.14	108
1998	1628	30	0.55	3.53	4.08	0.13	-30
1999	>>1790		0	above gl	2.27	0.00	
2000	>>1790		0	above gl	1.38	0.00	
2001	1568	-30	2.18	1.9	3.58	0.61	30
2002	1660	62	0	1.14	1.14	0.00	-62
2003	1521	-77	4.08	0	4.08	1.00	77
2004	1570	-28	3.58	0	3.58	1.00	28
2005	1488	-110	12.81	0	12.81	1.00	110
MEAN	1561	-34	3.81	1.65		0.78	34

Browning Ra.



Browning correlation



DOUGLAS GL

Small mountain glacier

GLACIER DATA		
Aspect	SE	
AREA	33.93	ha
Max Elev	2440	m
Min Elev	1820	m
Mean Elev	2130	m
Length	1.18	km
Elev Range	620	m
Gradient	0.508	

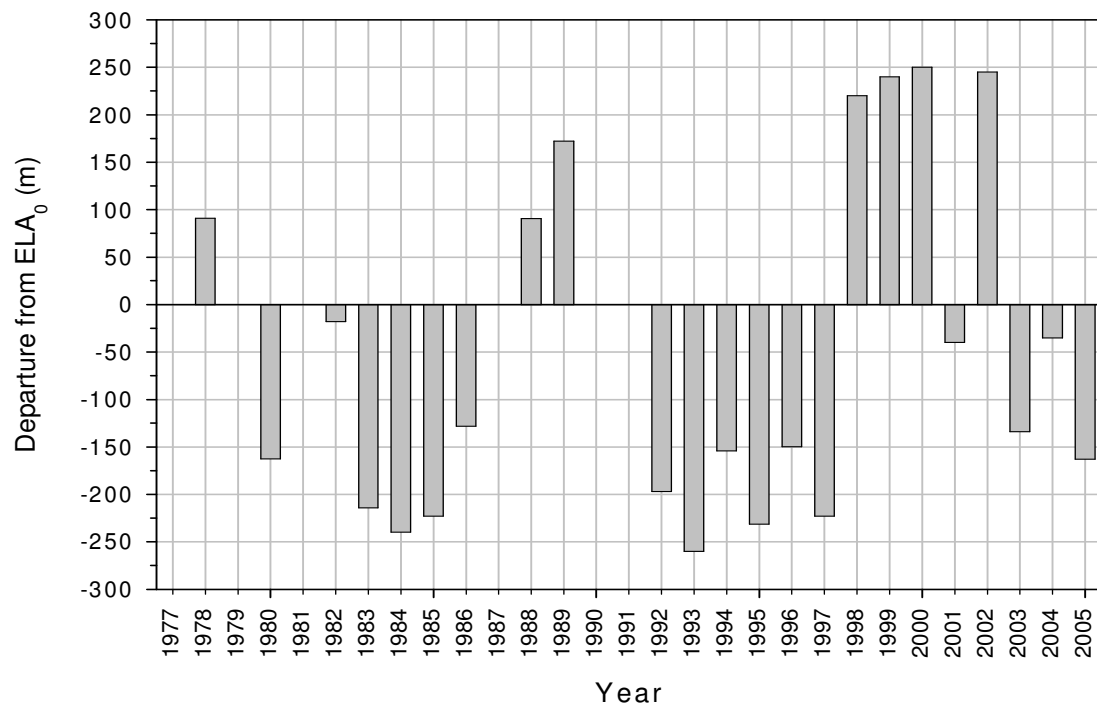
SNOWLINE DATA		
ELAo	2040	m
Max SL	2290	m, 2000
Min SL	1780	m, 1993
Mean SL	1985	m
SL Range	510	m
No. Surveys	23	

MEASUREMENTS

Digitised values shaded

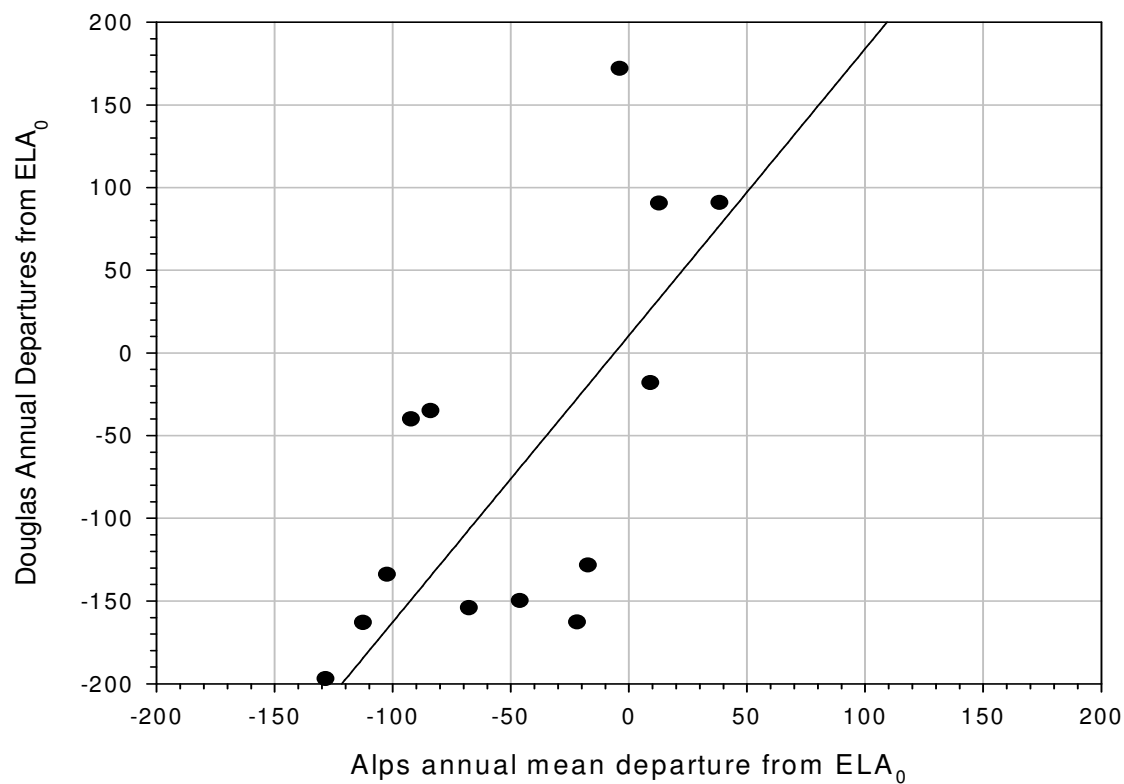
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
1974	2450				14.04		
ELAo	2040	0	24.73	9.20	33.93	0.73	0
1977							
1978	2131	91	19.93	14.00	33.93	0.59	-91
1979							
1980	1877	-163	32.03	1.90	33.93	0.94	163
1981							
1982	2022	-18	25.80	8.13	33.93	0.76	18
1983	1826	-214	33.73	0.20	33.93	0.99	214
1984	1800	-240	35.73	-1.80	33.93	1.05	240
1985	1817	-223	34.23	-0.30	33.93	1.01	223
1986	1912	-128	30.13	3.80	33.93	0.89	128
1987							
1988	2131	91	19.93	14.00	33.93	0.59	-91
1989	2212	172	15.74	18.19	33.93	0.46	-172
1990							
1991							
1992	1843	-197	33.13	0.80	33.93	0.98	197
1993	1780	-260	42.42	-8.49	33.93	1.25	260
1994	1886	-154	31.23	2.70	33.93	0.92	154
1995	1809	-231	35.43	-1.50	33.93	1.04	231
1996	1890	-150	31.43	2.50	33.93	0.93	150
1997	1817	-223	34.23	-0.30	33.93	1.01	223
1998	2260	220	10.71	23.22	33.93	0.32	-220
1999	2280	240	8.91	25.02	33.93	0.26	-240
2000	2290	250	7.96	25.97	33.93	0.23	-250
2001	2000	-40	22.21	6.60	28.81	0.77	40
2002	2285	245	3.31	25.50	28.81	0.11	-245
2003	1906	-134	25.61	3.20	28.81	0.89	134
2004	2005	-35	22.20	7.20	28.81	0.77	35
2005	1877	-163	33.93	0.00	33.93	1.00	163
Mean	1985	-55	25.65	7.78		0.76	55

Douglas Gl.



Douglas correlation

$$y = 10.6231 + 1.7333 \cdot x \quad R^2 = 0.81$$



Shelf glacier

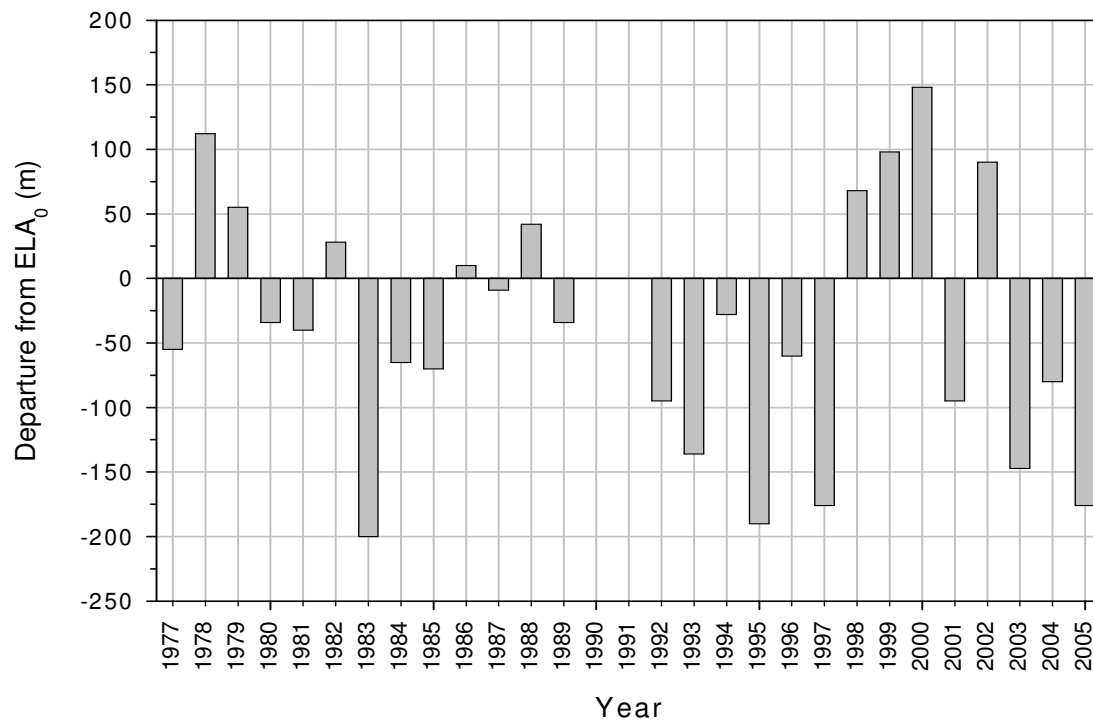
GLACIER DATA		
Aspect	E	
AREA	74.56	ha
Max Elev	2040	m
Min Elev	1680	m
Mean Elev	1860	m
Length	0.66	km
Elev Range	360	m
Gradient	0.455	

SL DATA		
ELAo	1840	m
Max SL	1988	
Min SL	1640	m, 1995
Mean SL	1803	m
SL Range	348	m
No. surveys	27	

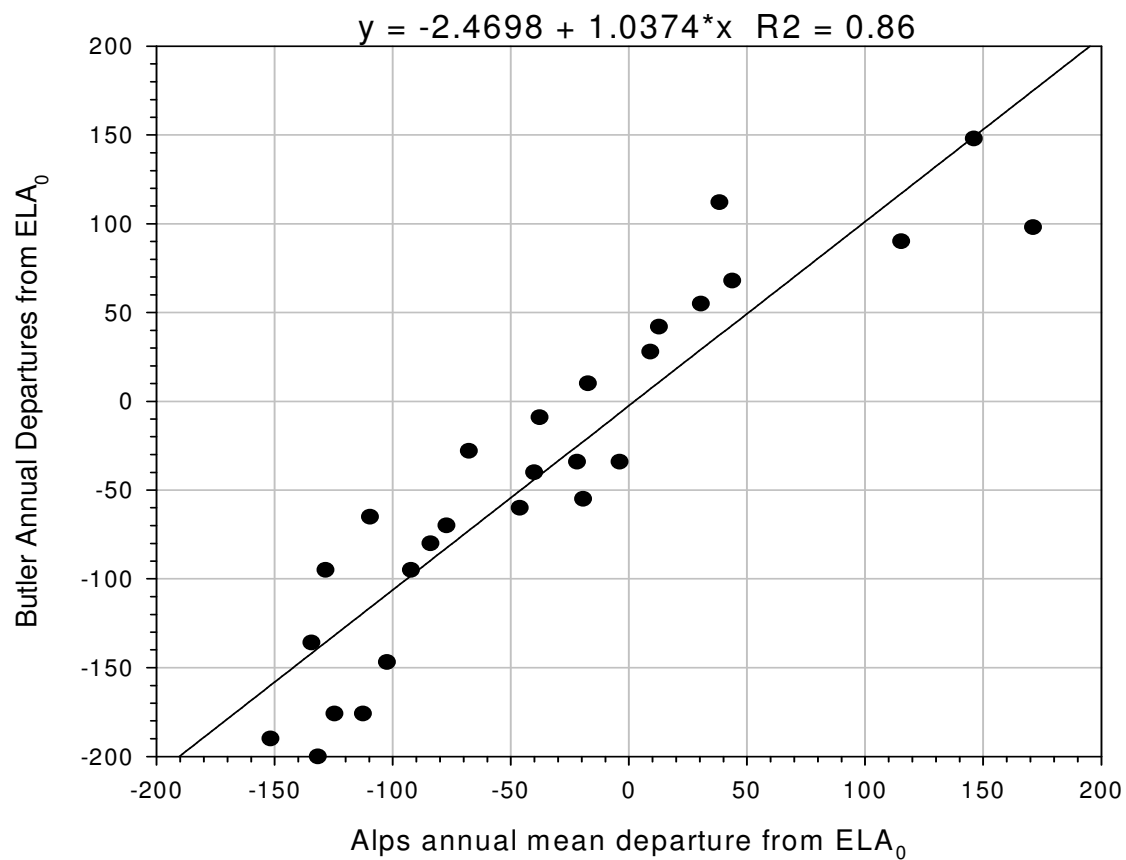
MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1840	0	42.76	31.8	74.56	0.57	0
1977	1785	-55	60.69	13.87	74.56	0.81	55
1978	1952	112	6.39	68.17	74.56	0.09	-112
1979	1895	55	21.46	53.1	74.56	0.29	-55
1980	1806	-34	55.76	18.8	74.56	0.75	34
1981	1800	-40	57.44	17.12	74.56	0.77	40
1982	1868	28	32.1	42.46	74.56	0.43	-28
1983	1640	-200	89.56	0	89.56	1.00	200
1984	1775	-65	62.66	11.9	74.56	0.84	65
1985	1770	-70	63.61	10.95	74.56	0.85	70
1986	1850	10	39.36	35.2	74.56	0.53	-10
1987	1831	-9	46.76	27.8	74.56	0.63	9
1988	1882	42	26.56	48	74.56	0.36	-42
1989	1806	-34	55.76	18.8	74.56	0.75	34
1990							
1991							
1992	1745	-95	67.36	7.2	74.56	0.90	95
1993	1704	-136	72.06	2.5	74.56	0.97	136
1994	1812	-28	53.56	21	74.56	0.72	28
1995	1650	-190	94.1	0	74.56	1.26	190
1996	1780	-60	62.06	12.5	74.56	0.83	60
1997	1664	-176	76.56	0	76.56	1.00	176
1998	1908	68	16.05	58.51	74.56	0.22	-68
1999	1938	98	8.04	66.52	74.56	0.11	-98
2000	1988	148	3.58	70.98	74.56	0.05	-148
2001	1745	-95	67.3	7.26	74.56	0.90	95
2002	1930	90	8.72	65.84	74.56	0.12	-90
2003	1693	-147	73.36	1.2	74.56	0.98	147
2004	1760	-80	66.43	8.13	74.56	0.89	80
2005	1700	-140	72	2.56	74.56	0.97	80
Mean	1803	-37	50.34	25.57	75.19	0.66	31

Mt Butler



Butler correlation



DAINTY GL.
Mountain gl, reliability A

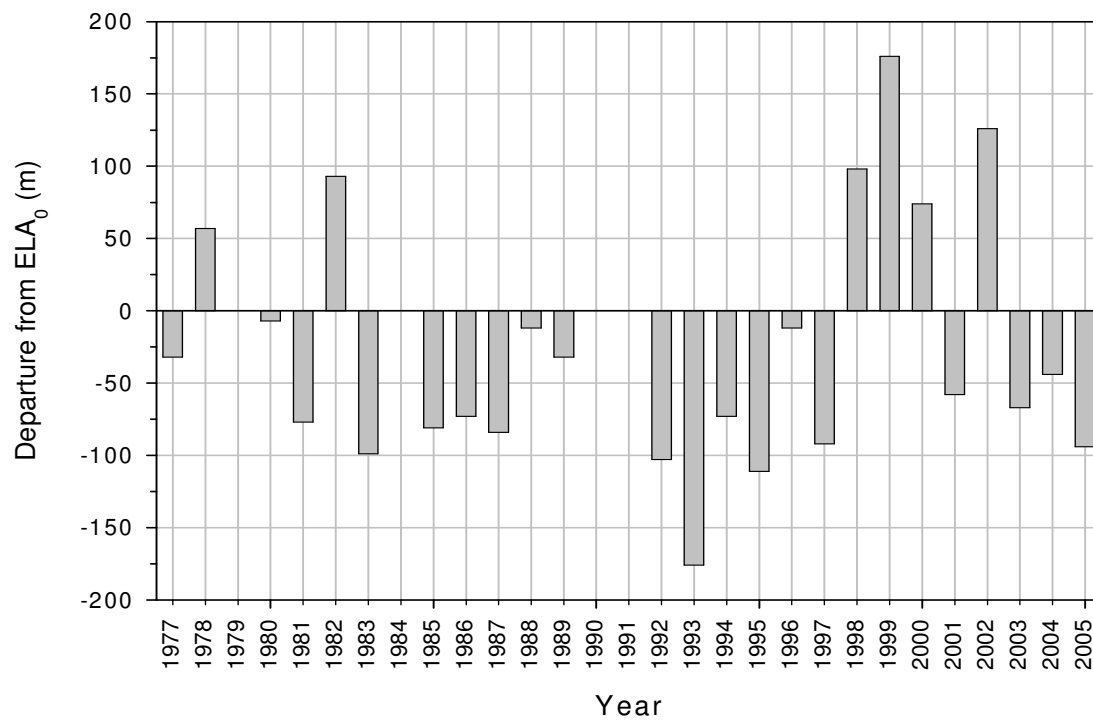
GL DATA		
Aspect	W	
AREA	45.29	ha
Max Elev	2330	m
Min Elev	1750	m
Mean Elev	2040	m
Length	1.45	km
Elev Range	580	m
Gradient	0.4	

SL DATA		
ELA	1954	m
Max SL	2130	m, 1999
Min SL	1778	m, 1993
Mean SL	1926	m
SL Range	352	m
No. Surveys	25	

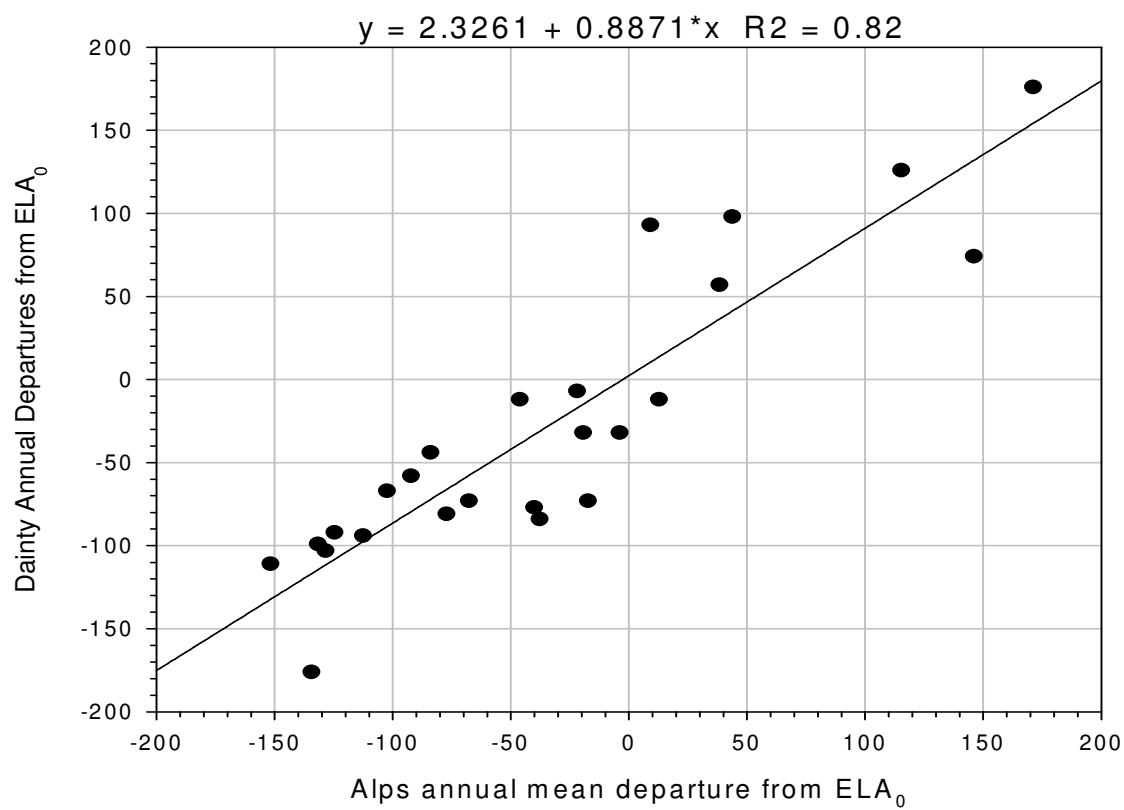
MEASUREMENTS Digitised values in bold type

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELA	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
1955	2100						
ELAo	1954	0	18.29	27	45.29	0.40	0
1977	1922	-32	25.81	19.48	45.29	0.57	32
1978	2011	57	13.09	32.2	45.29	0.29	-57
1979							
1980	1947	-7	20.19	25.1	45.29	0.45	7
1981	1877	-77	37.59	7.7	45.29	0.83	77
1982	2047	93	10.49	34.8	45.29	0.23	-93
1983	1855	-99	40.89	4.4	45.29	0.90	99
1984							
1985	1873	-81	38.29	7	45.29	0.85	81
1986	1881	-73	36.92	8.37	45.29	0.82	73
1987	1870	-84	39.09	6.2	45.29	0.86	84
1988	1942	-12	20.96	24.33	45.29	0.46	12
1989	1922	-32	25.81	19.48	45.29	0.57	32
1990							
1991							
1992	1851	-103	41.39	3.9	45.29	0.91	103
1993	1778	-176	43.71	1.58	45.29	0.97	176
1994	1881	-73	36.92	8.37	45.29	0.82	73
1995	1843	-111	41.94	3.35	45.29	0.93	111
1996	1942	-12	20.96	24.33	45.29	0.46	12
1997	1862	-92	40.29	5	45.29	0.89	92
1998	2052	98	10.23	35.06	45.29	0.23	-98
1999	2130	176	4.15	41.14	45.29	0.09	-176
2000	2028	74	11.79	33.5	45.29	0.26	-74
2001	1896	-58	32.95	12.34	45.29	0.73	58
2002	2080	126	8.25	37.04	45.29	0.18	-126
2003	1887	-67	36.09	9.2	45.29	0.80	67
2004	1910	-44	29.05	16.24	45.29	0.64	44
2005	1860	-94	40.89	4.4	45.29	0.90	94
MEANS	1926	-28	27.79	17.50	45.29	0.61	28

Dainty Gl.



Dainty correlation



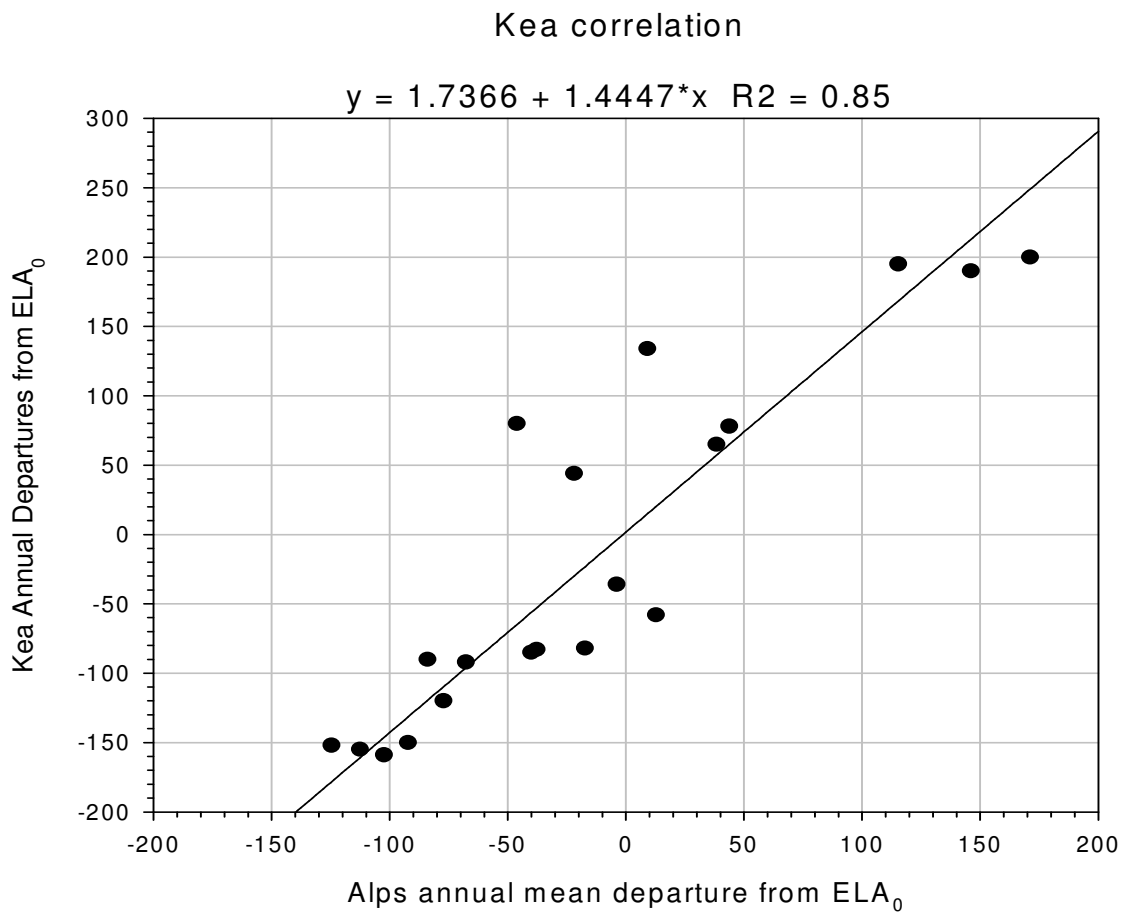
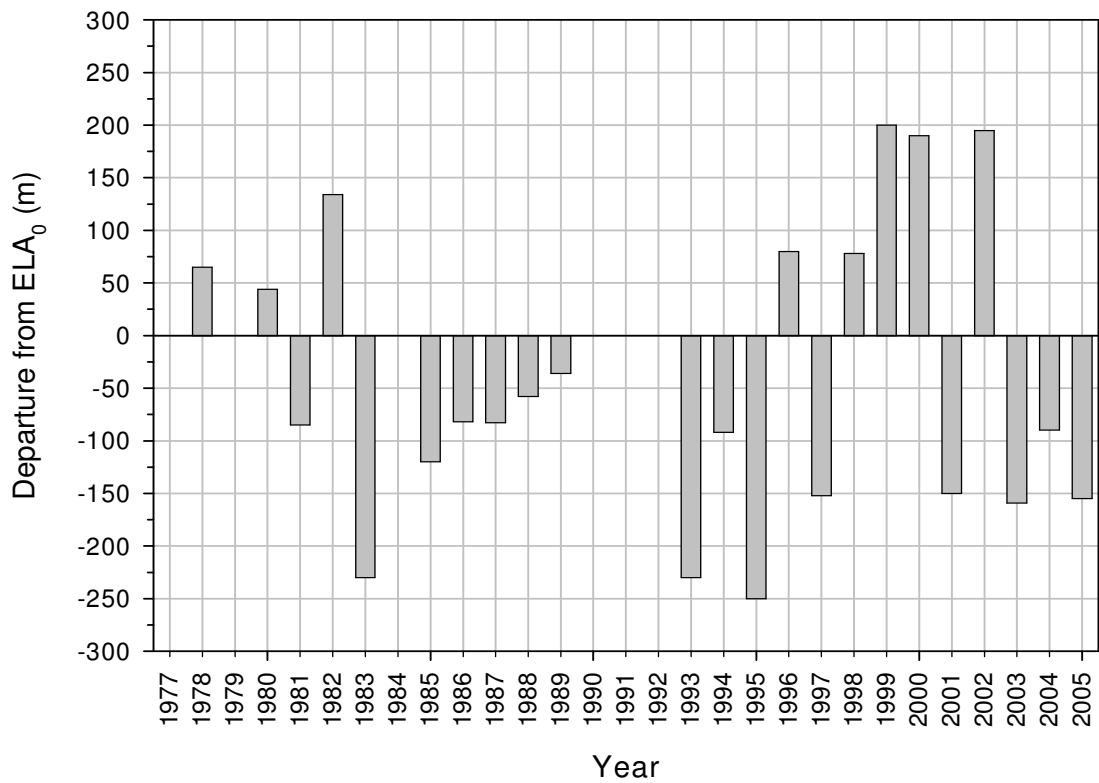
GL DATA		
Aspect	S	
AREA	76.94	ha
Max Elev	2030	m
Min Elev	1650	m
Mean Elev	1840	m
Length	0.95	km
Elev Range	380	m
Gradient	0.453	

SL DATA		
ELAo	1820	m
Max SL	2020	m, 1999
Min SL	1570	m, 1995
Mean SL	1777	m
SL RANGE	450	m
No. Surveys	23	

MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1820	0	43.62	23.5	67.12	0.65	0
1977							
1978	1885	65	34.25	42.69	76.94	0.45	-65
1979					no flight		
1980	1864	44	39.34	37.6	76.94	0.51	-44
1981	1735	-85	66.64	10.3	76.94	0.87	85
1982	1954	134	16.53	60.41	76.94	0.21	-134
1983	1590	-230	96.44	19.5	115.94	0.83	230
1984							
1985	1700	-120	73.1	3.84	76.94	0.95	120
1986	1738	-82	66.54	10.4	76.94	0.86	82
1987	1737	-83	66.59	10.35	76.94	0.87	83
1988	1762	-58	60.94	16	76.94	0.79	58
1989	1784	-36	56.43	20.51	76.94	0.73	36
1990							
1991							
1992							
1993	1590	-230	94.83	17.89	112.72	0.84	230
1994	1728	-92	68.13	8.81	76.94	0.89	92
1995	1570	-250	100.75	23.81	124.56	0.81	250
1996	1900	80	31.26	45.68	76.94	0.41	-80
1997	1668	-152	80.79	3.85	84.63	0.95	152
1998	1898	78	31.74	45.2	76.94	0.41	-78
1999	2020	200	1.47	75.47	76.94	0.02	-200
2000	2010	190	2.3	74.64	76.94	0.03	-190
2001	1670	-150	76.94	0	76.94	1.00	150
2002	2015	195	0.92	66.2	67.12	0.01	-195
2003	1661	-159	67.12	0	67.12	1.00	159
2004	1730	-90	58.32	8.8	67.12	0.87	90
2005	1665	-155	67.12	0	67.12	1.00	155
MEAN	1777	-43	54.15	26.17		0.65	43

Kea Gl.



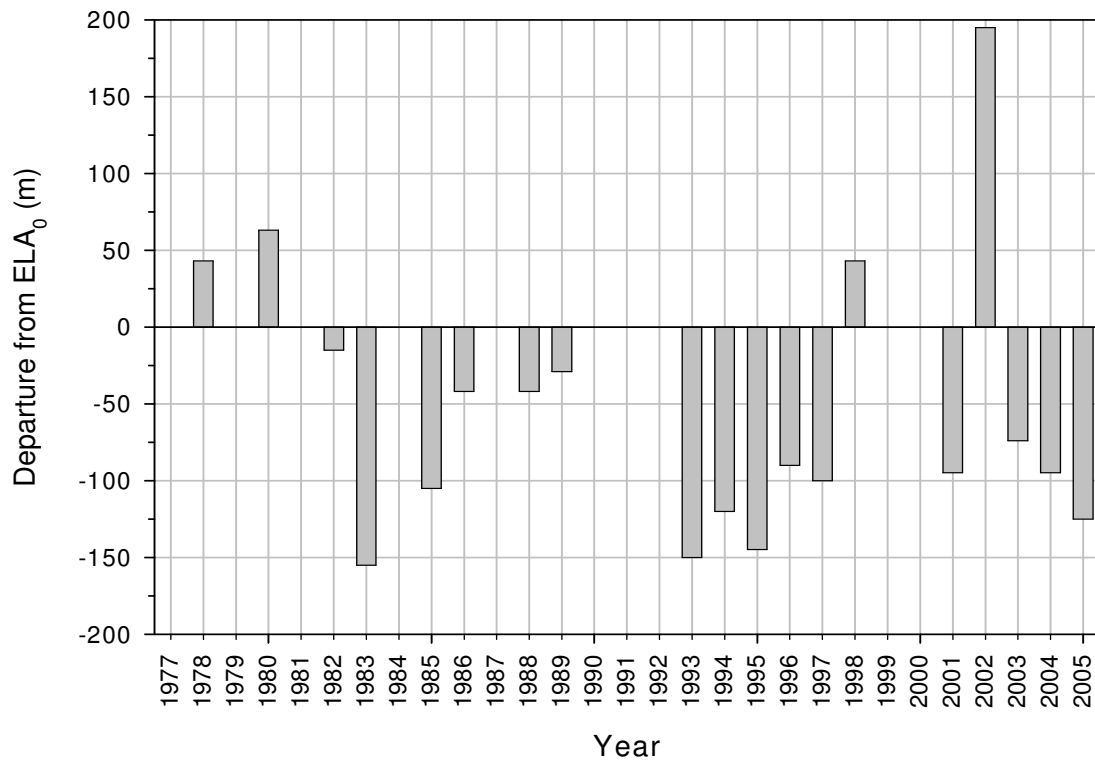
GLACIER DATA		
Aspect	SW	
AREA	14.09	ha
Max Elev	1920	m
Min Elev	1600	m
Mean Elev	1760	m
Length		km
Elev Range	320	m
Gradient		

SNOWLINE DATA		
ELAo	1725	m
Max SL	1920	m, 2000
Min SL	1570	m, 1983
Mean SL	1674	m
SL Range	350	m
No. Surveys	21	

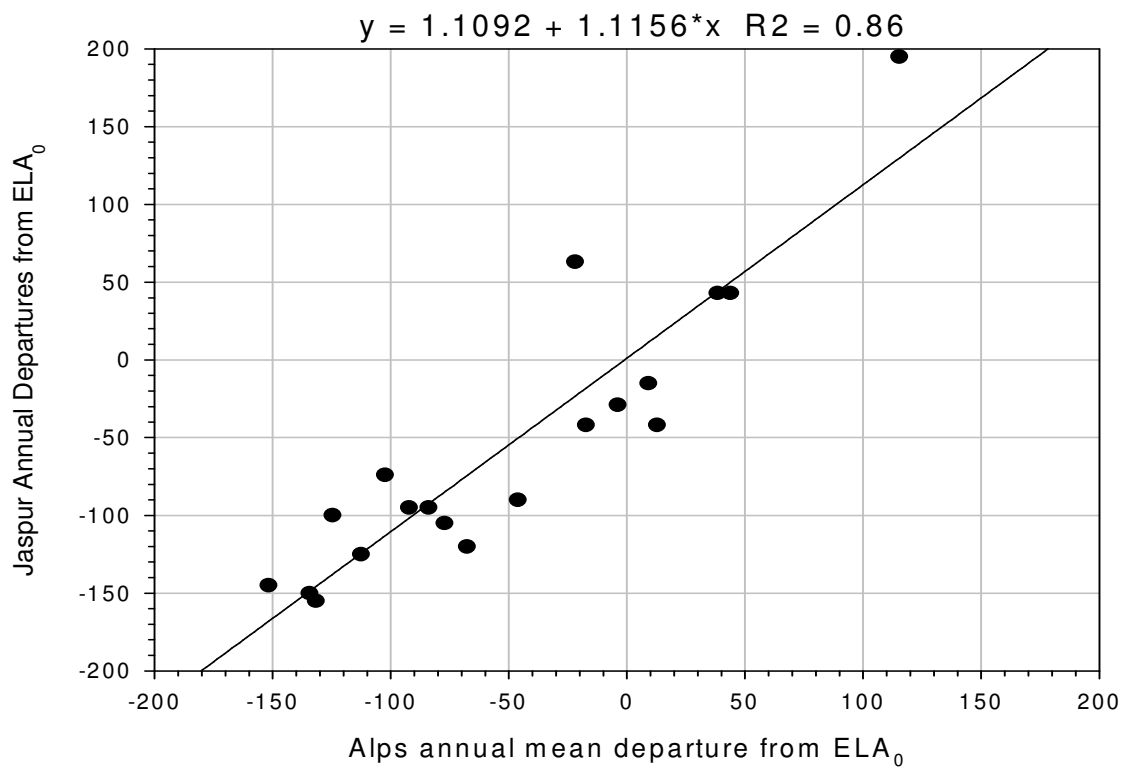
MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1725	0	9.39	4.7	14.09	0.67	0
1977							
1978	1768	43	6.49	7.6	14.09	0.46	-43
1979					no flight		0
1980	1788	63	4.29	9.8	14.09	0.30	-63
1981							0
1982	1710	-15	10.34	3.75	14.09	0.73	15
1983	1570	-155	14.09	0	14.09	1.00	155
1984							0
1985	1620	-105	14.09	0	14.09	1.00	105
1986	1683	-42	11.84	2.25	14.09	0.84	42
1987							0
1988	1683	-42	11.84	2.25	14.09	0.84	42
1989	1696	-29	11.23	2.86	14.09	0.80	29
1990					no flight		0
1991					no flight		0
1992							0
1993	1575	-150	25.59	0	25.59	1.00	150
1994	1605	-120	17.39	0	17.39	1.00	120
1995	1580	-145	19.24	0	19.24	1.00	145
1996	1635	-90	13.59	0	13.59	1.00	90
1997	1625	-100	16.55	0	16.55	1.00	100
1998	1768	43	5.77	8.32	14.09	0.41	-43
1999	>1950			14.09	14.09	0.00	0
2000	>1950			7.84	7.84	0.00	0
2001	1630	-95	13.89	0.2	14.09	0.99	95
2002	1920	195	0	7.84	7.84	0.00	-195
2003	1651	-74	13.59	0	13.59	1.00	74
2004	1630	-95	13.39	0.2	13.59	0.99	95
2005	1600	-125	17.39	0	17.39	1.00	125
MEANS	1670	-55	12.40	3.35	14.51	0.72	37

Jaspur Gl.



Jaspur correlation



GLACIER DATA		
Aspect	SE	
AREA	151.9	ha
Max Elev	2130	m
Min Elev	1370	m
Mean Elev	1750	m
Length	3.186	km
Elev Range	760	m
Gradient	0.239	

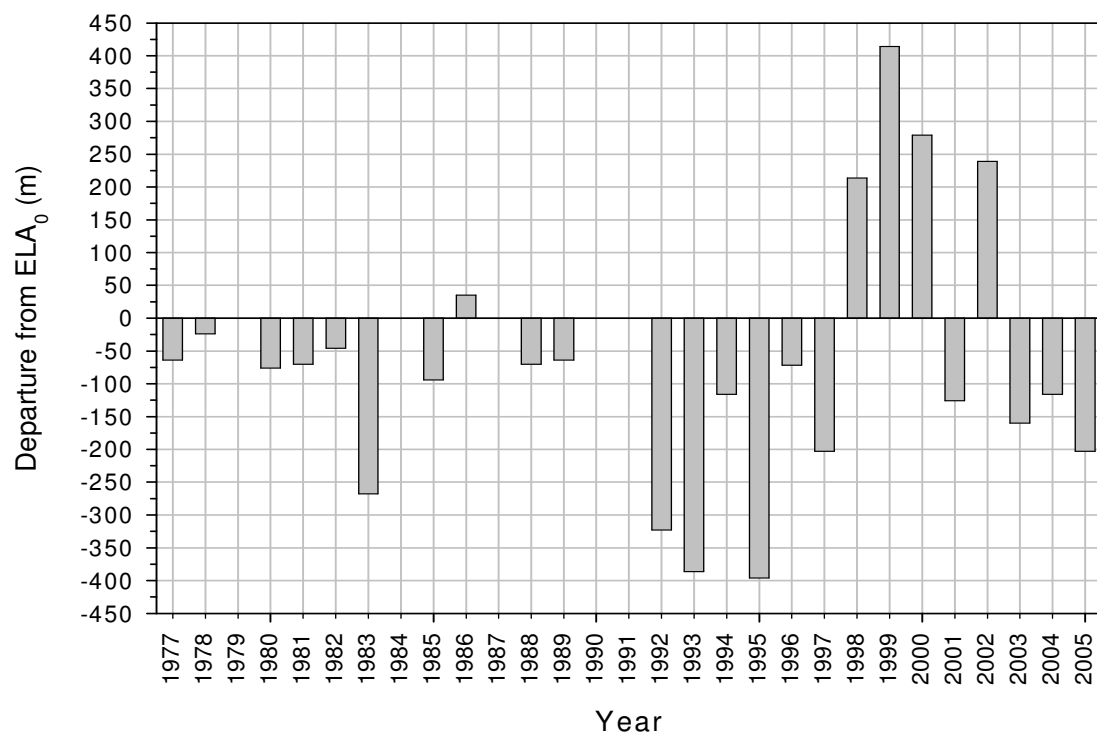
SNOW LINE DATA		
ELAo	1736	m
Max SL	2150	m, 1999
Min SL	1340	m, 1995
Mean SL	1675	m
SL Range	810	m
No. Surveys	24	

MEASUREMENTS

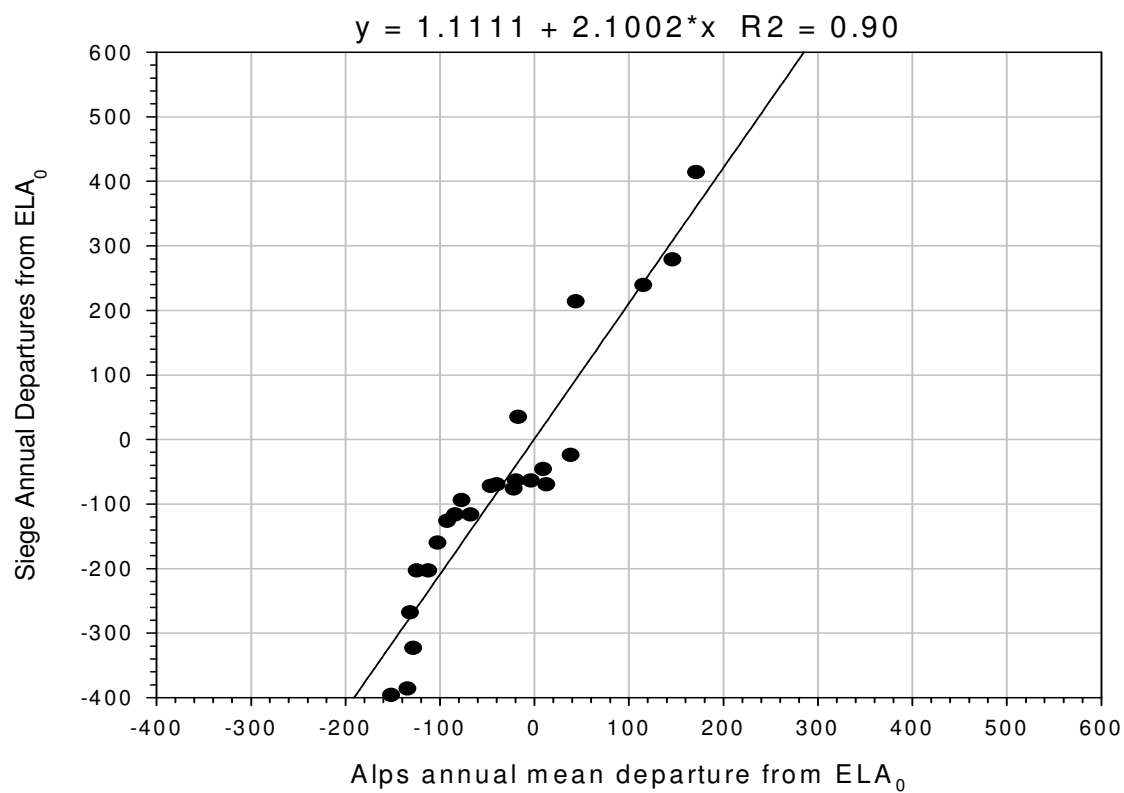
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1736	0	61.4	90.5	151.9	0.40	0
1977	1672	-64	78.9	73	151.9	0.52	64
1978	1712	-24	67.66	84.24	151.9	0.45	24
1979					no flight		
1980	1660	-76	82.19	69.71	151.9	0.54	76
1981	1666	-70	80.4	71.5	151.9	0.53	70
1982	1690	-46	80.4	71.5	151.9	0.53	46
1983	1468	-268	130.57	21.33	151.9	0.86	268
1984							
1985	1642	-94	87.96	63.94	151.9	0.58	94
1986	1771	35	48.32	103.58	151.9	0.32	-35
1987							
1988	1666	-70	80.4	71.5	151.9	0.53	70
1989	1672	-64	78.81	73.09	151.9	0.52	64
1990					no flight		
1991					no flight		
1992	1413	-323	141.9	10	151.9	0.93	323
1993	1350	-386	153.9	0	153.9	1.00	386
1994	1620	-116	78.4	73.5	151.9	0.52	116
1995	1340	-396	155.4	0	155.4	1.00	396
1996	1664	-72	80.47	71.43	151.9	0.53	72
1997	1533	-203	116.4	35.5	151.9	0.77	203
1998	1950	214	30.83	121.07	151.9	0.20	-214
1999	2150	414	4.36	147.54	151.9	0.03	-414
2000	2015	279	24.27	127.63	151.9	0.16	-279
2001	1610	-126	97.61	54.29	151.9	0.64	126
2002	1975	239	28.9	123	151.9	0.19	-239
2003	1576	-160	107.4	44.5	151.9	0.71	160
2004	1620	-116	94.9	57	151.9	0.62	116
2005	1533	-203	116.4	35.5	151.9	0.77	203
MEANS	1665	-71	83.93	68.21		0.55	71

Siege Gl.



Siege correlation



Cirque glacier

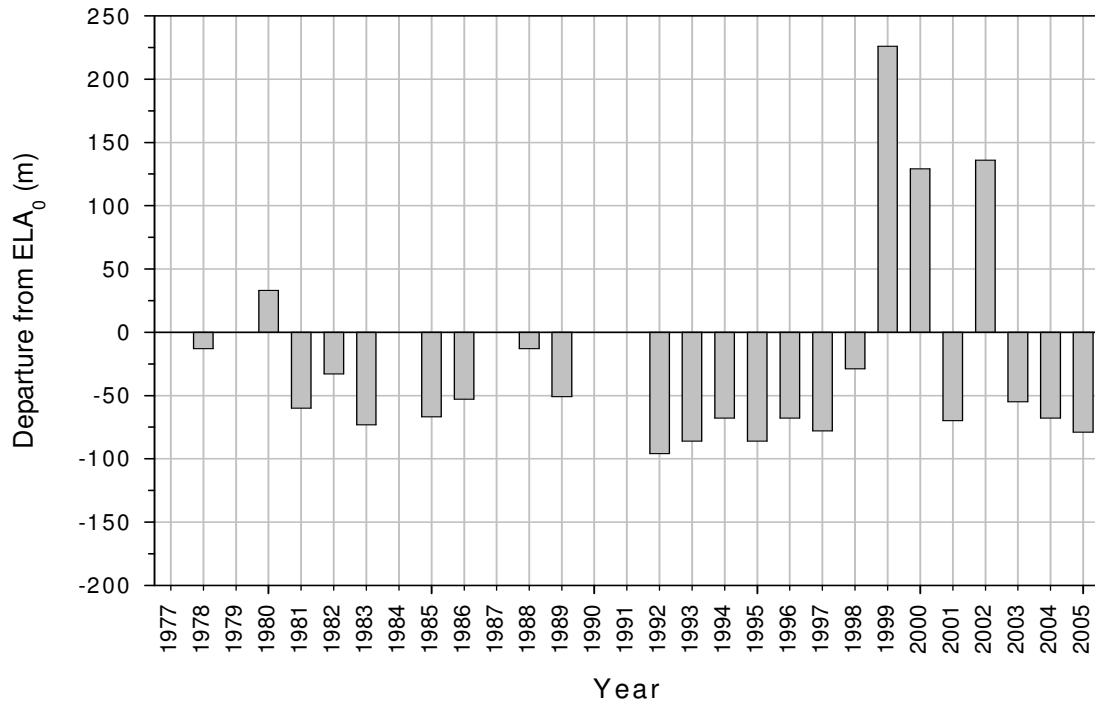
GLACIER DATA		
Aspect	SW	
AREA	30.45	ha
Max Elev	2100	m
Min Elev	1730	m
Mean Elev	1915	m
Length	0.63	km
Elev Range	370	m
Gradient	0.592	

SNOWLINE DATA		
ELAo	1864	m
Max SL	2090	m, 1999
Min SL	1768	m, 1992
Mean SL	1837	m
SL Range	322	m
No. surveys	23	

MEASUREMENTS Digitised values shaded

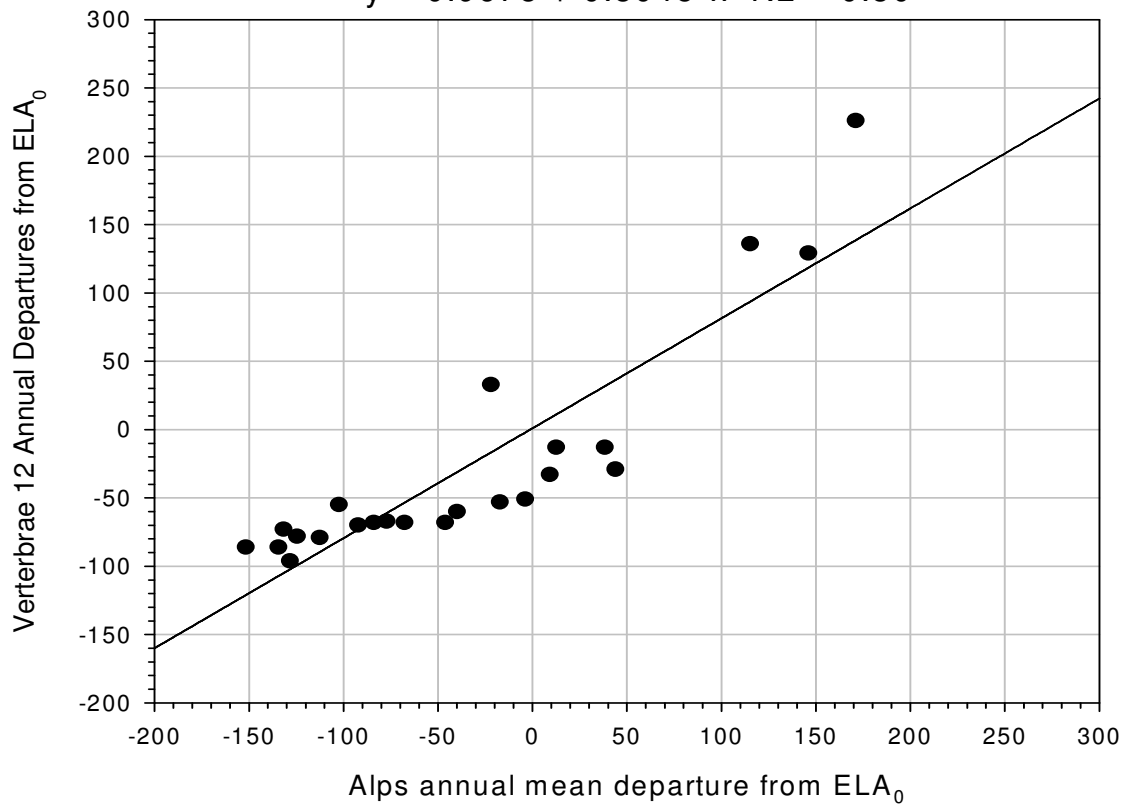
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1864	0	22.95	7.50	30.45	0.75	0
1977							
1978	1851	-13	24.15	6.30	30.45	0.79	13
1979					no flight		
1980	1897	33	19.58	10.87	30.45	0.64	-33
1981	1804	-60	27.45	3.00	30.45	0.90	60
1982	1831	-33	25.65	4.80	30.45	0.84	33
1983	1791	-73	28.35	2.10	30.45	0.93	73
1984							
1985	1797	-67	27.95	2.50	30.45	0.92	67
1986	1811	-53	27.05	3.40	30.45	0.89	53
1987					no visit		
1988	1851	-13	24.15	6.30	30.45	0.79	13
1989	1813	-51	26.96	3.49	30.45	0.89	51
1990					no flight		
1991					no flight		
1992	1768	-96	29.35	1.10	30.45	0.96	96
1993	1778	-86	28.95	1.50	30.45	0.95	86
1994	1796	-68	28.05	2.40	30.45	0.92	68
1995	1778	-86	28.94	1.51	30.45	0.95	86
1996	1796	-68	28.05	2.40	30.45	0.92	68
1997	1786	-78	28.55	1.90	30.45	0.94	78
1998	1835	-29	25.5	4.95	30.45	0.84	29
1999	2090	226	0.73	29.72	30.45	0.02	-226
2000	1993	129	5.53	24.92	30.45	0.18	-129
2001	1794	-70	27.87	2.58	30.45	0.92	70
2002	2000	136	4.45	26.00	30.45	0.15	-136
2003	1809	-55	27.35	3.10	30.45	0.90	55
2004	1796	-68	27.95	2.50	30.45	0.92	68
2005	1785	-79	28.55	1.90	30.45	0.94	79
MEAN	1837	-27	23.75	6.70	30.45	0.78	27

Vertebrae #12 GI.



Vertebrae 12 correlation

$$y = 0.9678 + 0.8045 \cdot x \quad R^2 = 0.80$$



Mountain glacier

GLACIER DATA		
Aspect	SW	
Area	75.55	ha
Max Elev	2040	m
Min Elev	1700	m
Mean Elev	1850	m
Length	1.15 Km	km
Elev Range	360 m	m
Gradient	0.313	

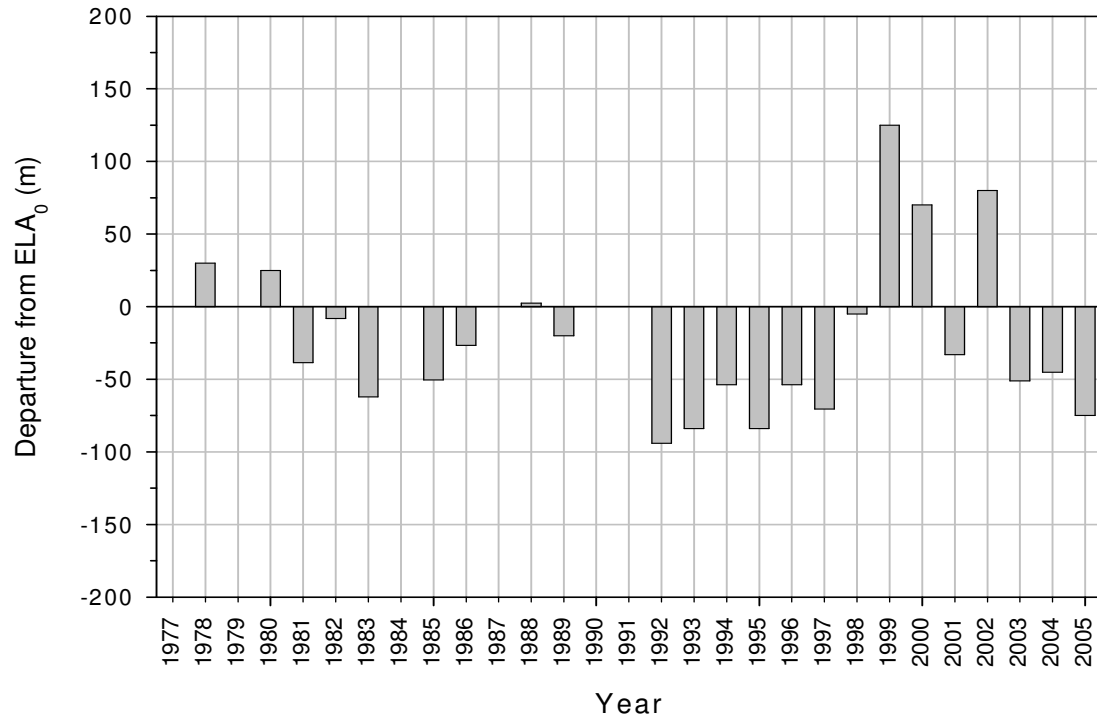
SNOWLINE DATA		
ELAo	1840	m
Max SL	1965	m, 1999
Min SL	1746	m, 1992
Mean SL	1817	m
SL Range	219	m
No. surveys	23	

No 25

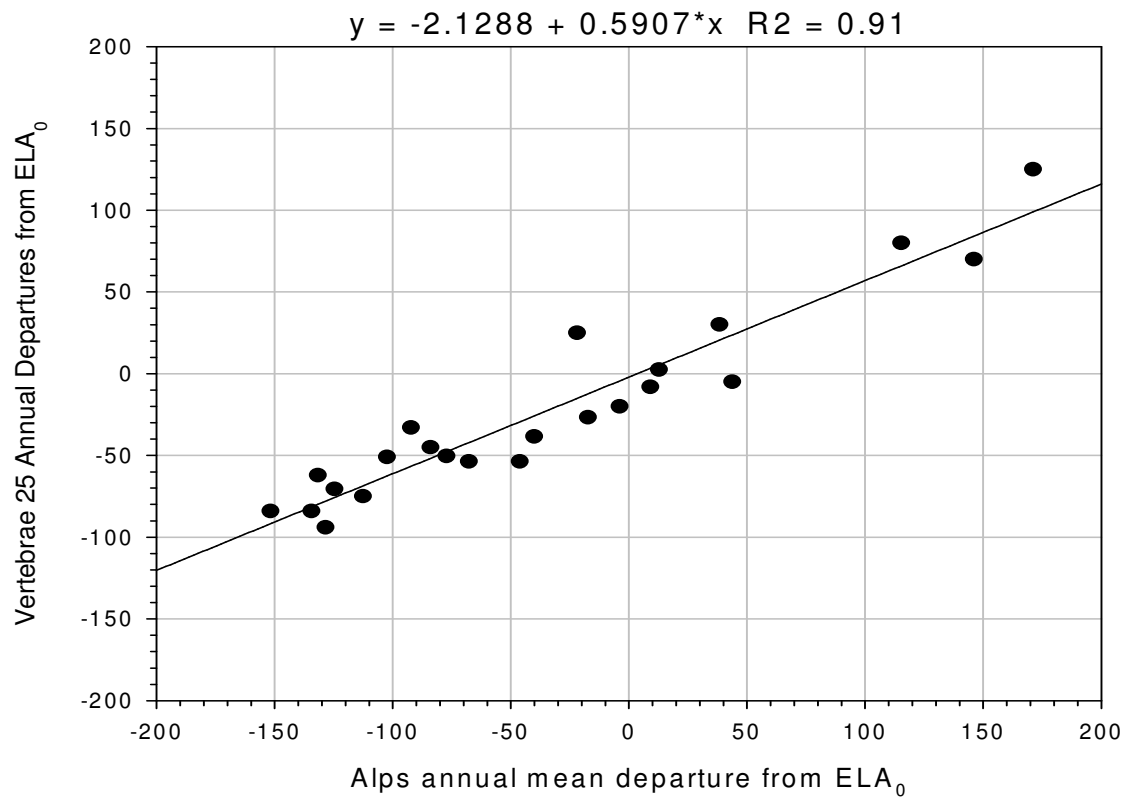
MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELA _o	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELA _o	1840	0	45.33	30.22	75.55	0.60	0
1977							
1978	1870	30	49.49	26.06	75.55	0.66	-30
1979							
1980	1865	25	52.12	23.43	75.55	0.69	-25
1981	1802	-39	70.44	5.11	75.55	0.93	39
1982	1832	-8	65.53	10.02	75.55	0.87	8
1983	1778	-62	71.55	4.00	75.55	0.95	62
1984							
1985	1790	-50	70.55	5.00	75.55	0.93	50
1986	1813	-27	67.05	8.50	75.55	0.89	27
1987							
1988	1843	3	60.35	15.20	75.55	0.80	-3
1989	1820	-20	65.56	9.99	75.55	0.87	20
1990							
1991							
1992	1746	-94	73.65	1.90	75.55	0.97	94
1993	1756	-84	73.08	2.47	75.55	0.97	84
1994	1786	-54	71.05	4.50	75.55	0.94	54
1995	1756	-84	73.08	2.47	75.55	0.97	84
1996	1786	-54	71.05	4.50	75.55	0.94	54
1997	1770	-71	72.25	3.30	75.55	0.96	71
1998	1835	-5	61.98	13.57	75.55	0.82	5
1999	1965	125	2.64	72.91	75.55	0.03	-125
2000	1910	70	18.08	57.47	75.55	0.24	-70
2001	1807	-33	68.03	7.52	75.55	0.90	33
2002	1920	80	12.55	63.00	75.55	0.17	-80
2003	1789	-51	70.75	4.80	75.55	0.94	51
2004	1795	-45	70.55	5.00	75.55	0.93	45
2005	1765	-75	72.25	3.30	75.55	0.96	75
MEAN	1817	-23	59.09	16.46		0.78	23

Vertebrae #25 GI.



Vertebrae 25 correlation



Mountain glacier

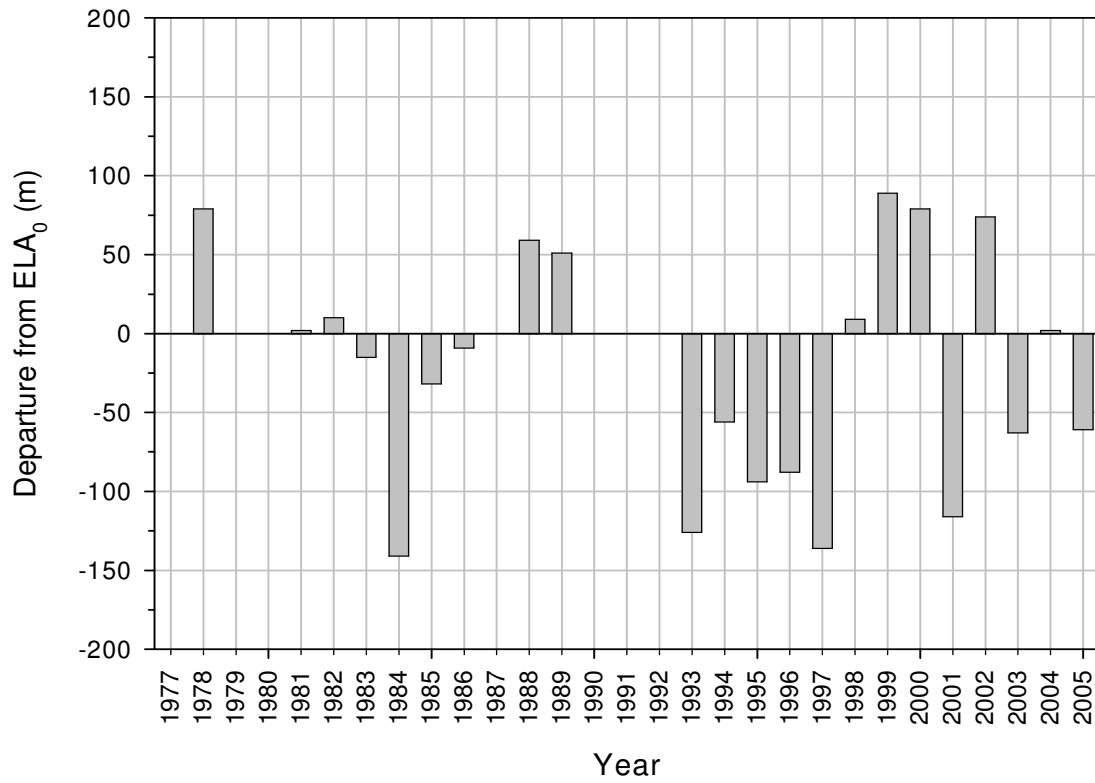
GLACIER DATA		
Aspect	SE	
AREA	73.52	ha
Max Elev	2490	m
Min Elev	2110	m
Mean Elev	2300	m
Length	1.04	km
Elev Range	380	m
Gradient	0.365	

SNOWLINE DATA		
ELAo	2226	m
Max SL	2315	m,1999
Min SL	2085	m,1984
Mean SL	2204	m
SL Range	230	m
No. surveys	22	

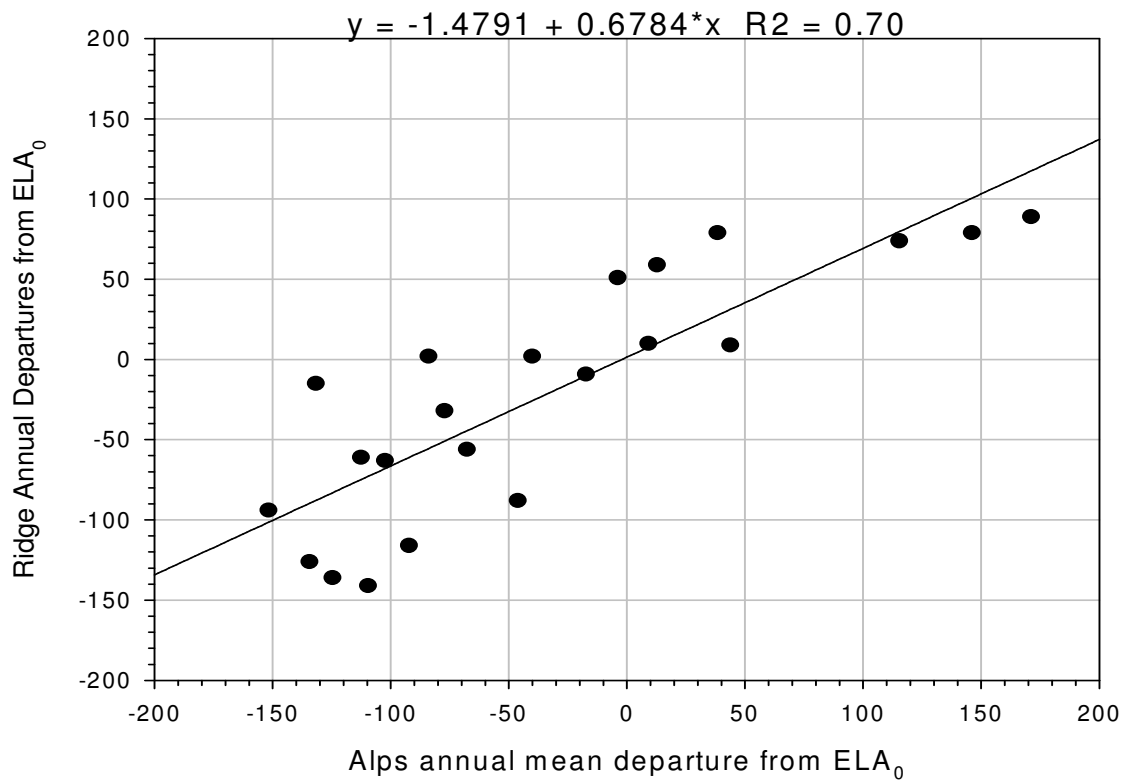
MEASUREMENTS Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	2226	0	51.72	21.80	73.52	0.70	0
1977							
1978	2305	79	22.22	51.30	73.52	0.30	-79
1979					no flight		
1980							
1981	2228	2	49.41	24.11	73.52	0.67	-2
1982	2236	10	47.98	25.54	73.52	0.65	-10
1983	2211	-15	56.32	17.20	73.52	0.77	15
1984	2085	-141	76.52	0.00	76.52	1.00	141
1985	2194	-32	60.40	13.12	73.52	0.82	32
1986	2217	-9	55.02	18.50	73.52	0.75	9.1
1987							
1988	2285	59	27.82	45.70	73.52	0.38	-59
1989	2277	51	30.01	43.51	73.52	0.41	-51
1990					no flight		
1991					no flight		
1992							
1993	2100	-126	75.02	0.00	75.02	1.00	126
1994	2170	-56	66.32	7.20	73.52	0.90	56
1995	2132	-94	70.83	2.69	73.52	0.96	94
1996	2138	-88	70.01	3.51	73.52	0.95	88
1997	2090	-136	76.32	0.00	76.32	1.00	136
1998	2235	9	47.02	25.50	72.52	0.65	-9
1999	2315	89	53.30	20.22	73.52	0.72	-89
2000	2305	79	44.87	28.65	73.52	0.61	-79
2001	2110	-116	73.52	0.00	73.52	1.00	116
2002	2300	74	23.12	50.40	73.52	0.31	-74
2003	2163	-63	66.22	7.30	73.52	0.90	63
2004	2228	2	50.04	23.48	73.52	0.68	-2
2005	2165	-61	66.32	7.20	73.52	0.90	61
MEAN	2204	-22	54.39	19.22		0.74	22

Ridge Gl.



Ridge correlation



Cirque glacier

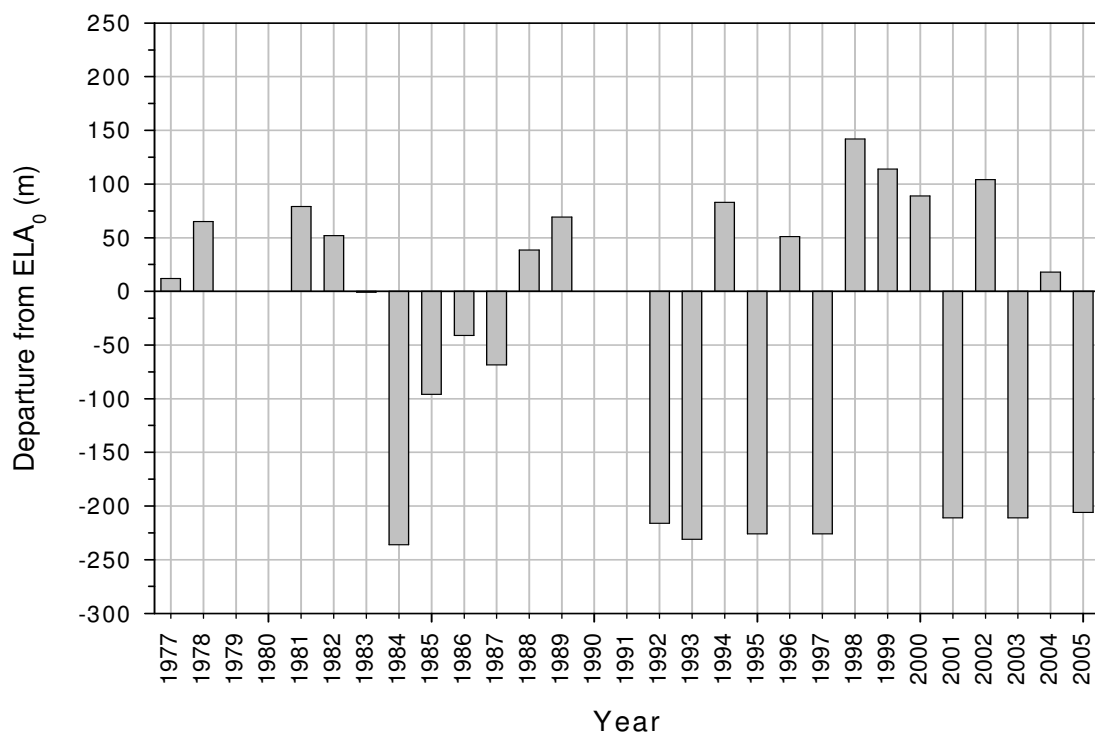
GLACIER DATA		
Aspect	NW	
AREA	40.42	ha
Max Elev	2580	m
Min Elev	2090	m
Mean Elev	2335	m
Length	1.03	km
Elev Range	490	m
Gradient	0.478	

SNOWLINE DATA		
ELA	2186	m
Max SL	2328	m,1998
Min SL	1950	m,1984
Mean SL	2144	m
SL Range	378	m
No. surveys	25	

MEASUREMENTS Digitised values shaded

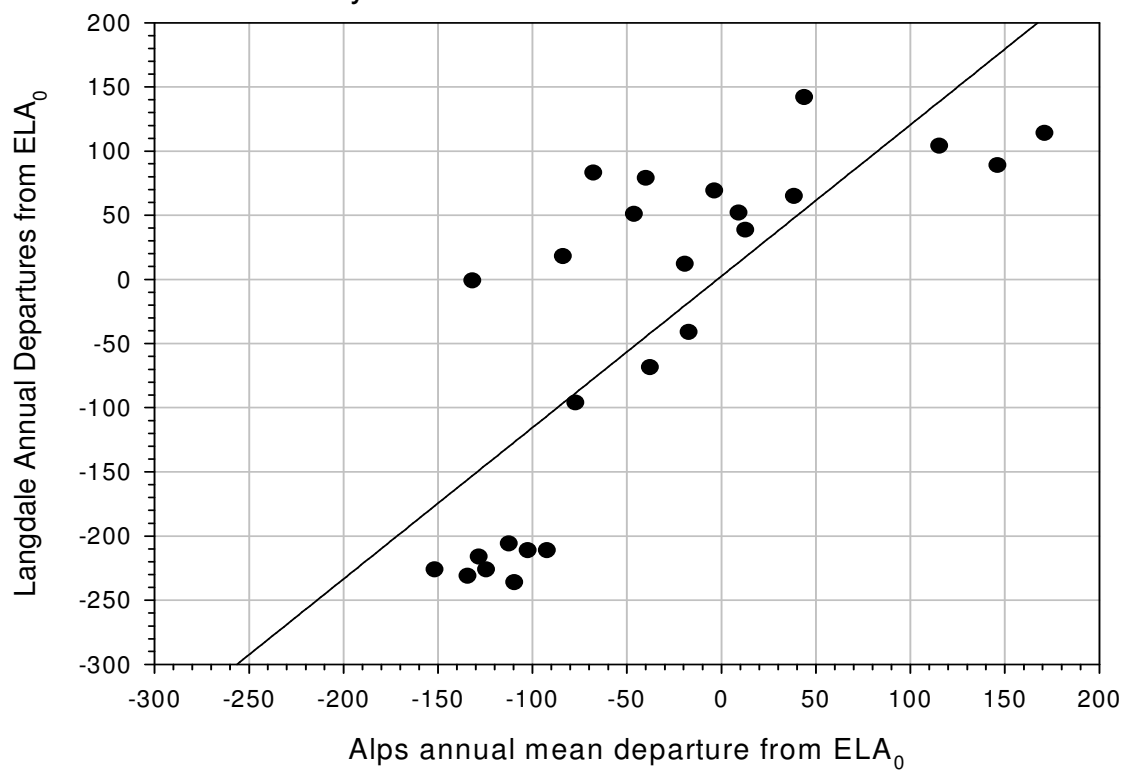
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELA	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	2186	0	29.42	11.00	40.42	0.73	0
1977	2198	12	32.62	7.80	40.42	0.81	-12
1978	2251	65	19.42	21.00	40.42	0.48	-65
1979					no flight		
1980							
1981	2265	79	15.12	25.30	40.42	0.37	-79
1982	2238	52	24.25	16.17	40.42	0.60	-51.9
1983	2185	-1	33.72	6.70	40.42	0.83	1
1984	1950	-236	47.33	0.00	47.33	1.17	236
1985	2090	-96	38.73	1.69	40.42	0.96	96
1986	2145	-41	36.22	4.20	40.42	0.90	41
1987	2118	-69	37.52	2.90	40.42	0.93	68.5
1988	2225	39	27.92	12.50	40.42	0.69	-38.6
1989	2255	69	18.37	22.05	40.42	0.45	-69
1990					no flight		
1991					no flight		
1992	1970	-216	45.42	0.00	45.42	1.12	216
1993	1955	-231	47.33	0.00	47.33	1.17	231
1994	2269	83	13.85	26.57	40.42	0.34	-83
1995	1960	-226	47.33	0.00	47.33	1.17	226
1996	2237	51	24.58	15.84	40.42	0.61	-51
1997	1960	-226	47.33	0.00	47.33	1.17	226
1998	2328	142	5.40	35.02	40.42	0.13	-142
1999	2300	114	7.62	32.80	40.42	0.19	-114
2000	2275	89	12.42	28.00	40.42	0.31	-89
2001	1975	-211	45.42	0.00	45.42	1.12	211
2002	2290	104	9.42	31.00	40.42	0.23	-104
2003	1975	-211	45.42	0.00	45.42	1.12	211
2004	2204	18	36.64	8.78	45.42	0.91	-18
2005	1980	-206	45.42	0.00	45.42	1.12	206
MEAN	2144	-42	29.69	12.43		0.73	42

Langdale GI.



Langdale correlation

$$y = 2.5096 + 1.1798 \cdot x \quad R^2 = 0.60$$



Valley glacier

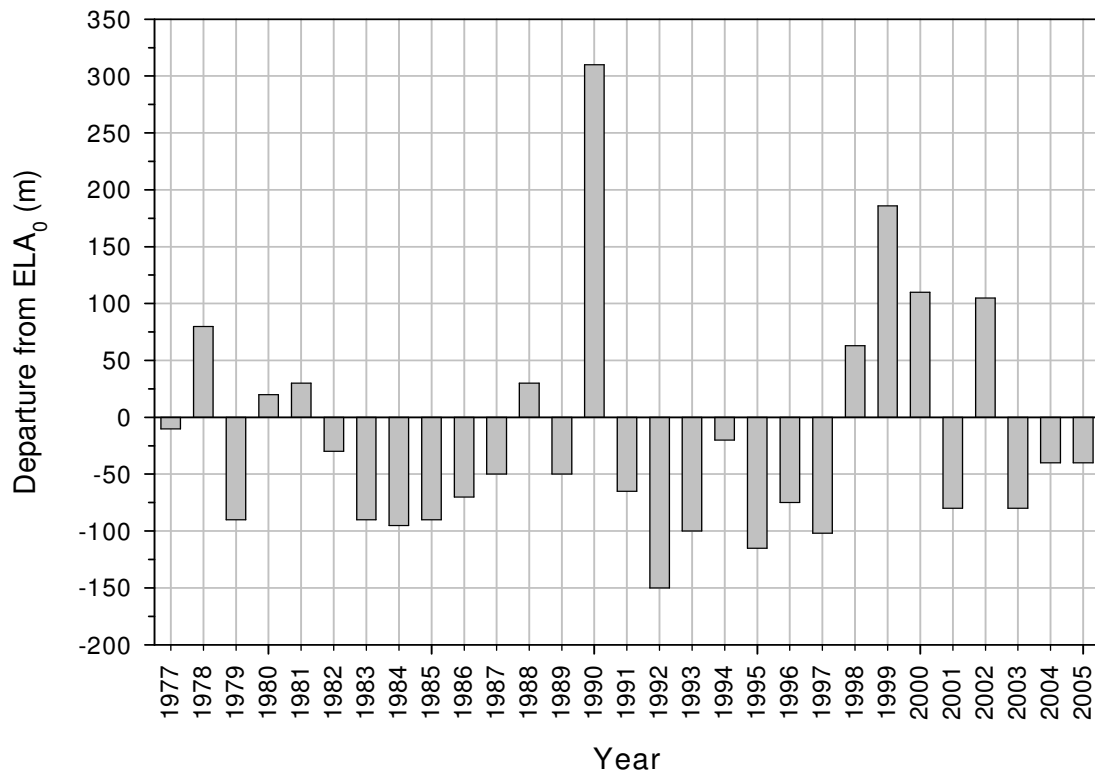
GLACIER DATA		
Aspect	SW	
Max Elev		
Min Elev		
Mean Elev		
Elev Range		
Length		
Gradient		
Gradient @	0.096	

SNOWLINE DATA		
ELAo	1790	1955 to '01
ELA	1778	1977 to '01
Max SL	2100	m, 1990
Min SL	1666	m, 1995
Mean SL	1778	m
SL Range	434	m
No. surveys	29	

MEASUREMENTS Values from contour counts shaded

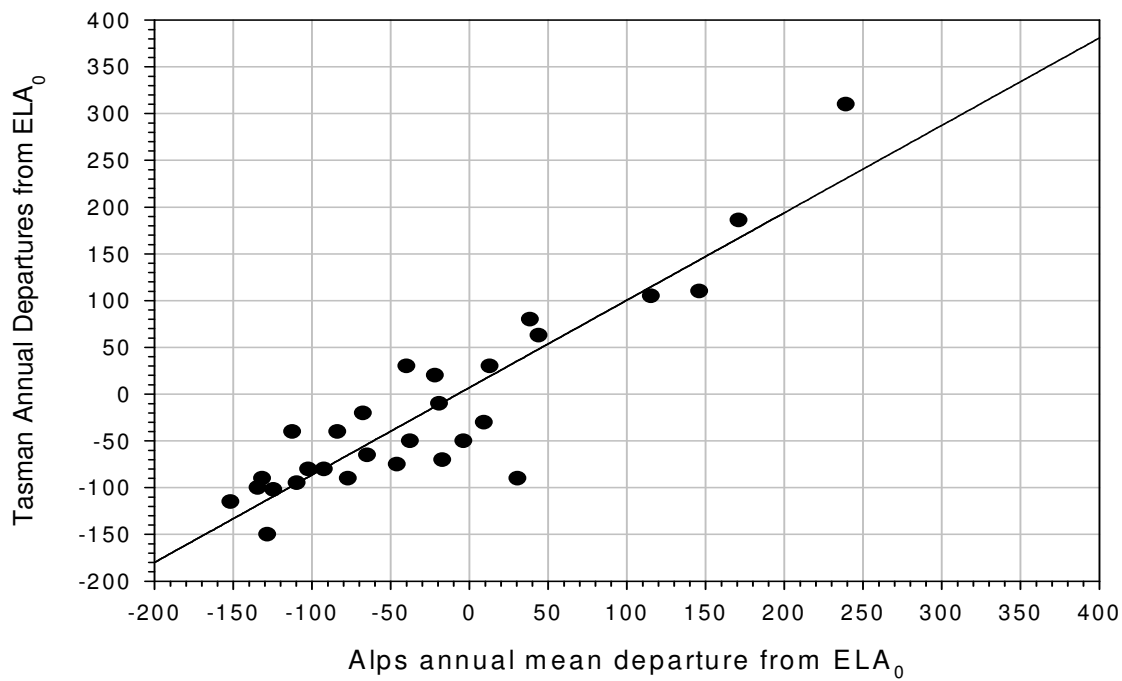
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELA	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1790	Too large to measure					
1977	1780	-10					10
1978	1875	85					-85
1979	1700	-90					90
1980	1810	20					-20
1981	1755	-35					35
1982	1760	-30					30
1983	1710	-80					80
1984	1695	-95					95
1985	1700	-90					90
1986	1780	-10					10
1987	1761	-29					29
1988	1840	50					-50
1989	1760	-30					30
1990	2100	310					-310
1991	1755	-35					35
1992	1690	-100					100
1993	1682	-108					108
1994	1770	-20					20
1995	1666	-124					124
1996	1755	-35					35
1997	1688	-102					102
1998	1853	63					-63
1999	1976	186					-186
2000	1900	110					-110
2001	1710	-80					80
2002	1895	105					-105
2003	1710	-80					80
2004	1750	-40					40
2005	1750	-40					40
MEAN	1778	-12					12

Tasman Gl.



Tasman correlation

$$y = 7.0823 + 0.9346 \cdot x \quad R^2 = 0.82$$



Mountain glacier

GLACIER DATA		
Aspect	SW	
AREA	311.90	ha
Max Elev	2390	m
Min Elev	1340	m
Mean Elev	1865	m
Length	2.98	km
Elev Range	1050	m
Gradient	0.352	

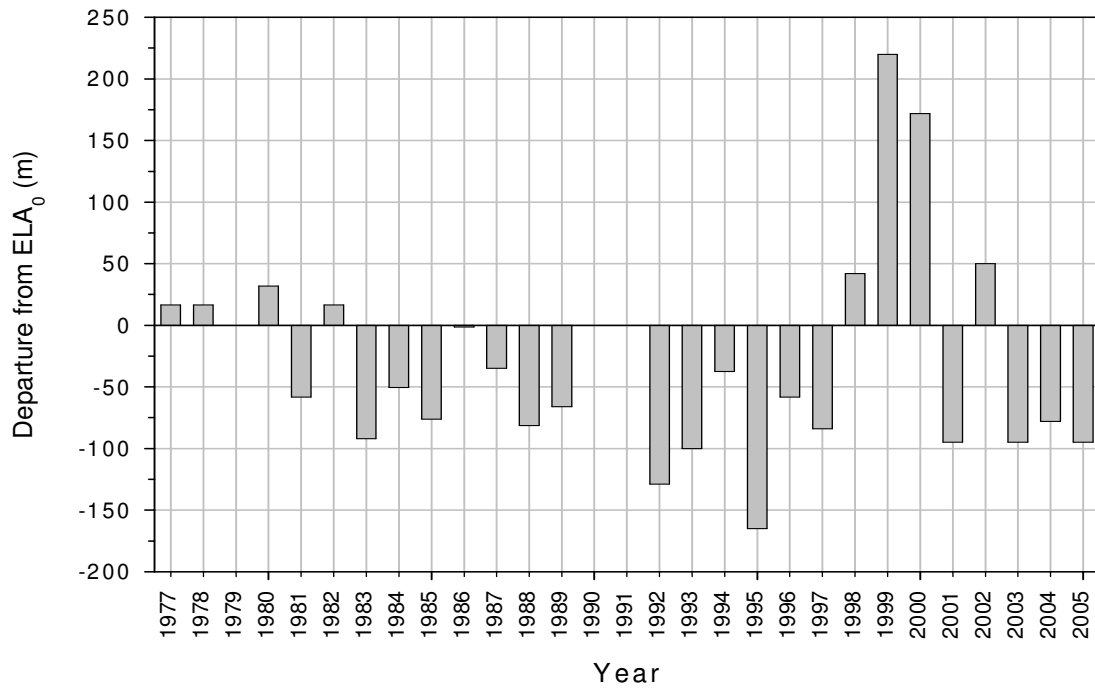
SNOWLINE DATA		
ELAo	1810	m
Max SL	2030	m, 1999
Min SL	1645	m, 1995
Mean SL	1778	m
SL Range	385	m
No. surveys	26	

MEASUREMENTS

Digitised values shaded

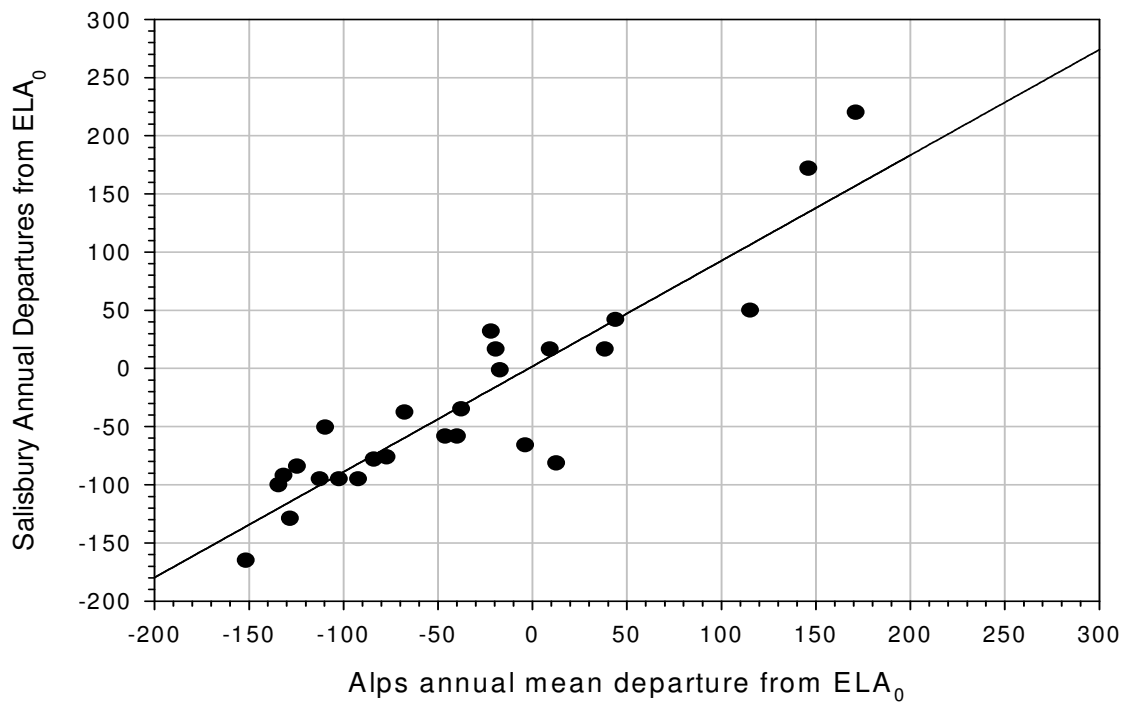
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1810	0	246.90	65.00	311.90	0.79	0
1977	1827	17	239.90	72.00	311.90	0.77	-17
1978	1827	17	239.90	72.00	311.90	0.77	-17
1979					No flight		
1980	1842	32	228.51	83.39	311.90	0.73	-32
1981	1752	-58	268.90	43.00	311.90	0.86	58
1982	1827	17	239.90	72.00	311.90	0.77	-17
1983	1718	-92	279.56	32.34	311.90	0.90	92
1984	1760	-51	266.90	45.00	311.90	0.86	51
1985	1734	-76	275.90	36.00	311.90	0.88	76
1986	1809	-1	250.90	61.00	311.90	0.80	1
1987	1775	-35	261.90	50.00	311.90	0.84	35
1988	1729	-81	268.90	43.00	311.90	0.86	81
1989	1744	-66	271.90	40.00	311.90	0.87	66
1990					No flight		
1991					No flight		
1992	1681	-129	289.90	22.00	311.90	0.93	129
1993	1710	-100	279.90	32.00	311.90	0.90	100
1994	1772	-38	228.96	82.94	311.90	0.73	38
1995	1645	-165	296.67	15.23	311.90	0.95	165
1996	1752	-58	267.90	44.00	311.90	0.86	58
1997	1726	-84	276.90	35.00	311.90	0.89	84
1998	1852	42	223.24	88.66	311.90	0.72	-42
1999	2030	220	116.70	195.20	311.90	0.37	-220
2000	1982	172	132.50	179.40	311.90	0.42	-172
2001	1715	-95	281.66	30.24	311.90	0.90	95
2002	1860	50	219.00	92.00	311.00	0.70	-50
2003	1715	-95	279.90	32.00	311.90	0.90	95
2004	1732	-78	275.90	36.00	311.90	0.88	78
2005	1715	-95	281.66	30.24	311.90	0.90	95
Mean	1778	-32	249	61		1	32

Salisbury Gl.



Salisbury correlation

$$y = 1.7939 + 0.9076 \cdot x \quad R^2 = 0.85$$



Small saddle glacier

GLACIER DATA		
Aspects	N & S, E & W	
AREA	102.10	ha
Max Elev	1985	m
Min Elev	1580	m
Mean Elev	1783	m
Length	na	
Elev Range	405	m
Gradient	na	

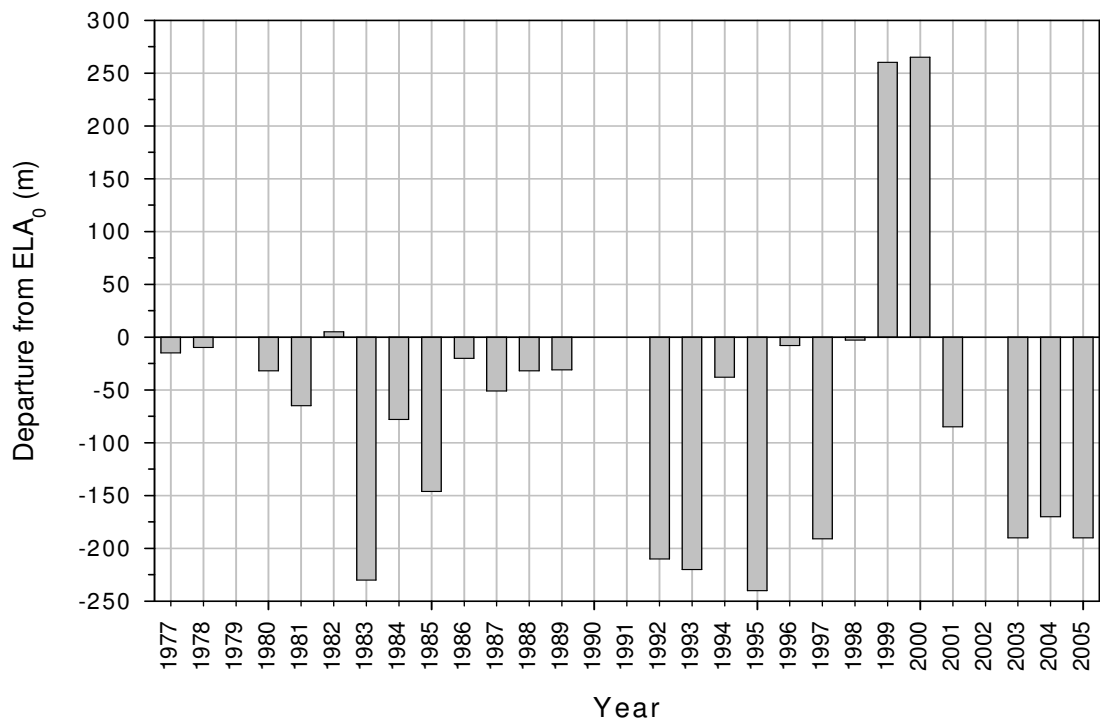
SNOWLINE DATA		
ELAo	1790	m
Max SL	2055	m, 2000
Min SL	1550	m, 1995
Mean SL	1721	m
SL Range	505	m
No. surveys	25	

MEASUREMENTS

Digitised values shaded

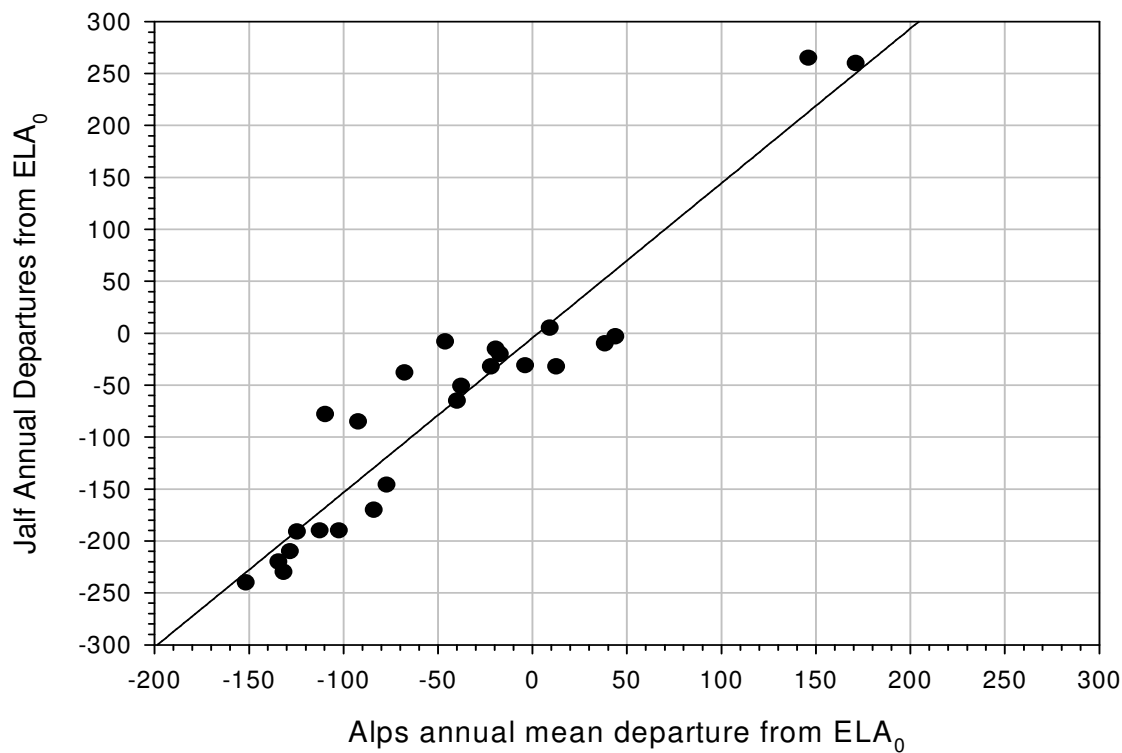
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1790	0	14.10	88.00	102.10	0.14	0
1977	1775	-15	21.30	80.80	102.10	0.21	15
1978	1780	-10	19.10	83.00	102.10	0.19	10
1979					no visit		
1980	1758	-32	36.41	65.69	102.10	0.36	32
1981	1725	-65	66.10	36.00	102.10	0.65	65
1982	1795	5	13.10	89.00	102.10	0.13	-5
1983	1560	-230	104.60	0.00	104.60	1.02	230
1984	1712	-78	72.96	29.14	102.10	0.71	78
1985	1644	-146	92.18	9.92	102.10	0.90	146
1986	1770	-20	24.40	77.70	102.10	0.24	20
1987	1739	-51	56.10	46.00	102.10	0.55	51
1988	1758	-32	36.10	66.00	102.10	0.35	32
1989	1759	-31	35.62	66.48	102.10	0.35	31
1990					no visit		
1991					no visit		
1992	1580	-210	102.10	0.00	102.10	1.00	210
1993	1570	-220	103.60	0.00	103.60	1.01	220
1994	1752	-38	41.47	60.63	102.10	0.41	38
1995	1550	-240	106.10	0.00	106.10	1.04	240
1996	1782	-8	17.25	84.85	102.10	0.17	8
1997	1599	-191	99.54	2.56	102.10	0.97	191
1998	1787	-3	15.82	86.28	102.10	0.15	3
1999	2050	260	0.00	102.10	102.10	0.00	-260
2000	2055	265	0.00	102.10	102.10	0.00	-265
2001	1705	-85	76.06	26.04	102.10	0.74	85
2002					In cloud		
2003	1600	-190	99.10	3.00	102.10	0.97	190
2004	1620	-170	96.60	5.50	102.10	0.95	170
2005	1600	-190	99.10	3.00	102.10	0.97	190
MEAN	1721	-69	53.87	46.78		0.53	69

Jalf Gl.



Jalf correlation

$$y = -4.4938 + 1.4891 \cdot x \quad R^2 = 0.92$$



Cirque glacier

GLACIER DATA		
Aspect	SW	
AREA	24.08	ha
Max Elev	1960	m
Min Elev	1580	m
Mean Elev	1770	m
Length	0.55	km
Elev Range	380	m
Gradient	0.436	

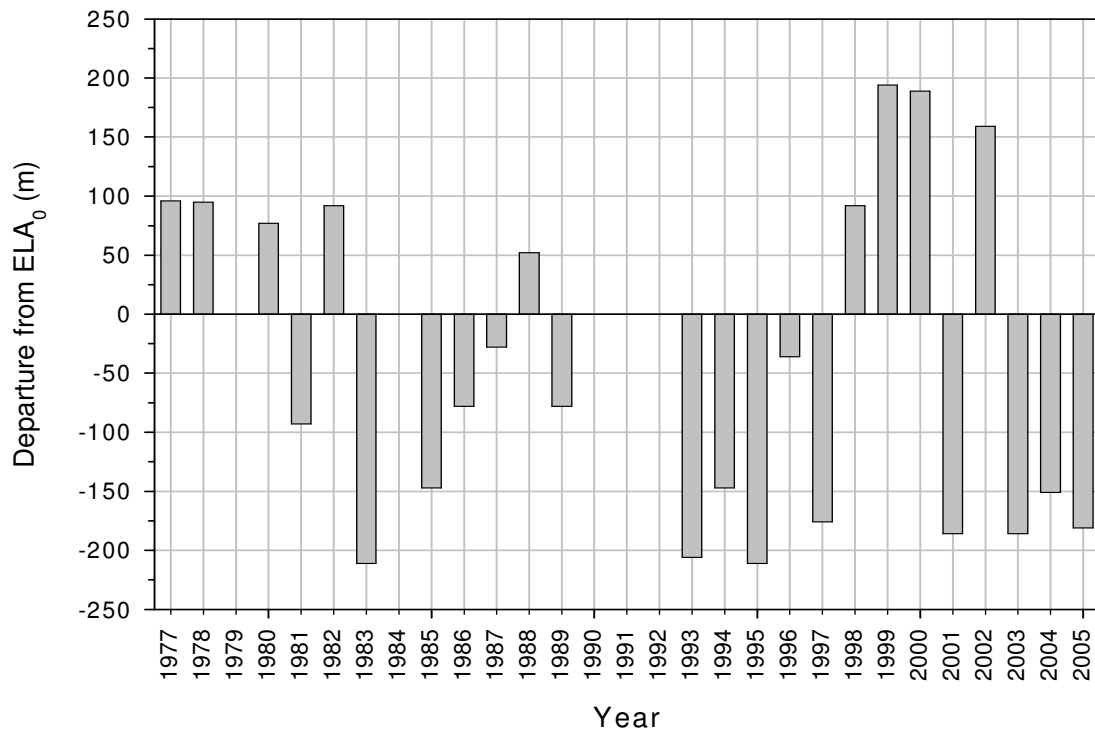
SNOWLINE DATA		
ELAo	1756	m
Max SL	1950	m, 1999
Min SL	1545	m, 1995
Mean SL	1711	m
SL Range	405	m
No. surveys	24	

MEASUREMENTS

Digitised values shaded

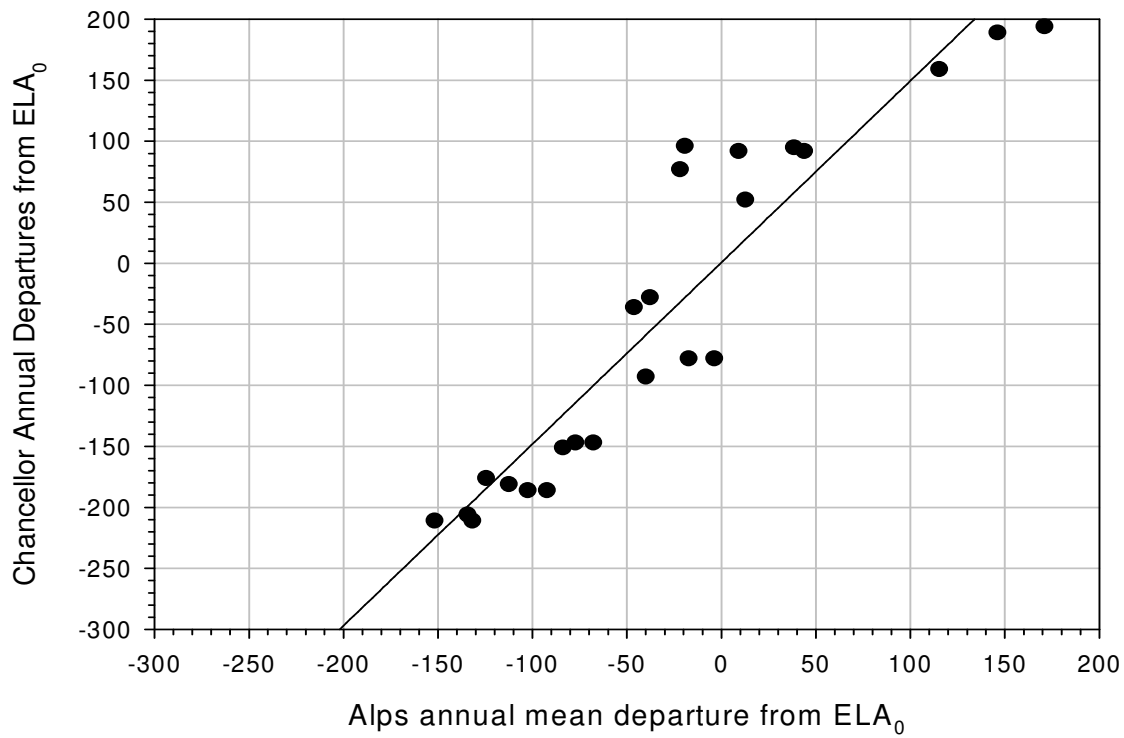
YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1756	0	18.83	5.25	24.08	0.78	0
1977	1852	96	9.45	14.63	24.08	0.39	-96
1978	1851	95	9.63	14.45	24.08	0.40	-95
1979							
1980	1833	77	13.85	10.23	24.08	0.58	-77
1981	1663	-93	21.05	3.03	24.08	0.87	93
1982	1848	92	10.67	13.41	24.08	0.44	-92
1983	1545	-211	28.90	0.00	28.90	1.20	211
1984							
1985	1609	-147	22.95	1.13	24.08	0.95	147
1986	1678	-78	20.65	3.43	24.08	0.86	78
1987	1728	-28	19.33	4.75	24.08	0.80	28
1988	1808	52	17.33	6.75	24.08	0.72	-52
1989	1678	-78	20.59	3.49	24.08	0.86	78
1990							
1991							
1992							
1993	1550	-206	27.99	0.00	27.99	1.16	206
1994	1609	-147	22.95	1.13	24.08	0.95	147
1995	1545	-211	28.90	0.00	28.90	1.20	211
1996	1720	-36	7.42	16.66	24.08	0.31	36
1997	1580	-176	24.08	0.00	24.08	1.00	176
1998	1848	92	10.67	13.41	24.08	0.44	-92
1999	1950	194	0.00	24.08	24.08	0.00	-194
2000	1945	189	0.00	15.46	15.46	0.00	-189
2001	1570	-186	0.00	24.08	24.08	0.00	186
2002	1915	159	1.38	22.70	24.08	0.06	-159
2003	1570	-186	0.00	24.08	24.08	0.00	186
2004	1605	-151	22.95	1.13	24.08	0.95	151
2005	1575	-181	0.00	24.08	24.08	0.00	181
MEAN	1711	-45	14.45	9.48		0.60	45

Chancellor Dome



Chancellor correlation

$$y = 0.6972 + 1.4882 \cdot x \quad R^2 = 0.87$$



Cirque glacier

GLACIER DATA		
Aspect	S	
AREA	58.51	ha
Max Elev	2350	m
Min Elev	2010	m
Mean Elev	2180	m
Length	1.19	km
Elev Range	340	m
Gradient	0.277	

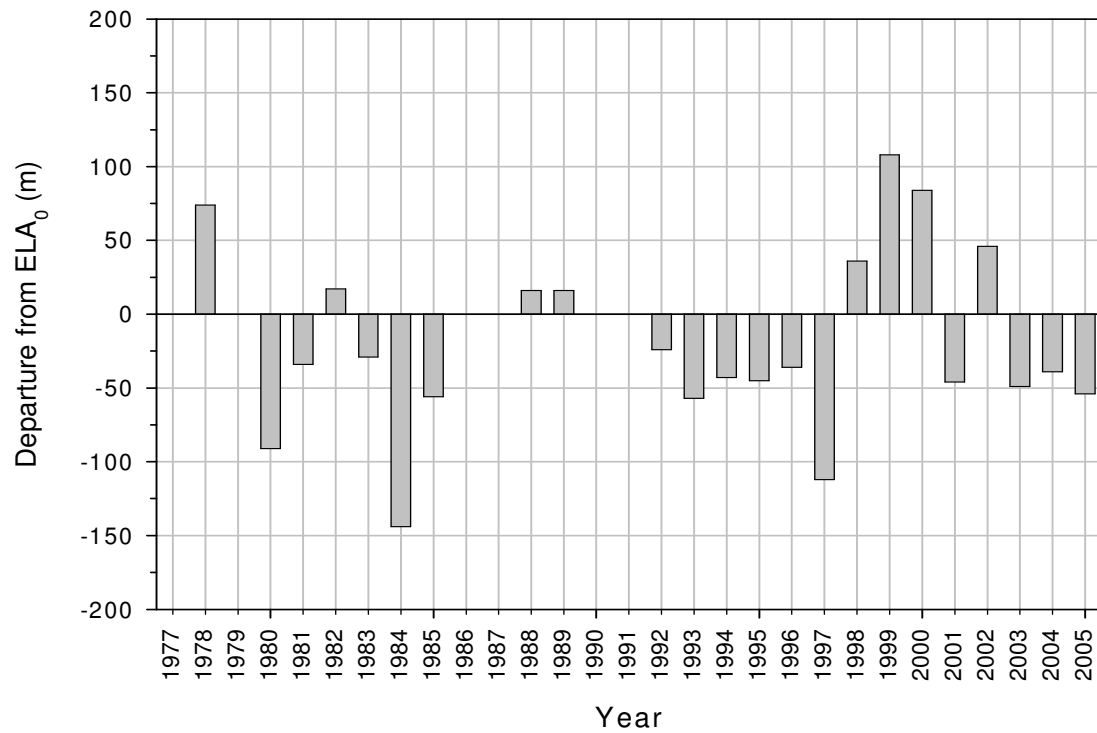
SNOWLINE DATA		
ELAo	2164	m
Max SL	2272	m, 1999
Min SL	2020	m, 1984
Mean SL	2125	m
SL Range	252	m
No. Surveys	23	

MEASUREMENTS

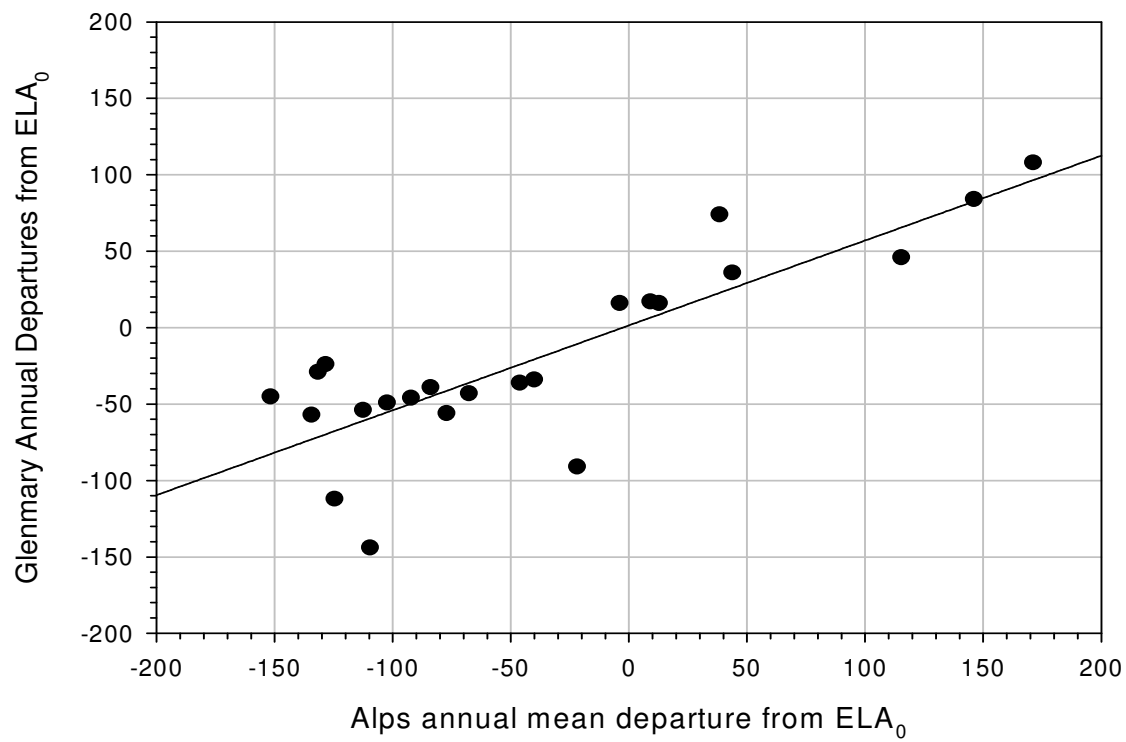
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	2164	0	39.51	19.00	58.51	0.68	0
1977							
1978	2238	74	22.93	35.58	58.51	0.39	-74
1979							
1980	2073	-91	53.45	5.06	58.51	0.91	91
1981	2130	-34	46.11	12.40	58.51	0.79	34
1982	2181	17	36.00	22.51	58.51	0.62	-17
1983	2135	-29	44.85	13.66	58.51	0.77	29
1984	2020	-144	57.31	1.20	58.51	0.98	144
1985	2108	-56	49.42	9.09	58.51	0.84	56
1986							
1987							
1988	2180	16	36.51	22.00	58.51	0.62	-16
1989	2180	16	36.02	22.49	58.51	0.62	-16
1990							
1991							
1992	2140	-24	44.31	14.20	58.51	0.76	24
1993	2107	-57	49.51	9.00	58.51	0.85	57
1994	2121	-43	47.41	11.10	58.51	0.81	43
1995	2119	-45	47.64	10.87	58.51	0.81	45
1996	2128	-36	46.26	12.25	58.51	0.79	36
1997	2052	-112	55.52	2.99	58.51	0.95	112
1998	2200	36	32.34	26.17	58.51	0.55	-36
1999	2272	108	13.37	45.14	58.51	0.23	-108
2000	2248	84	20.19	38.32	58.51	0.35	-84
2001	2118	-46	47.78	10.73	58.51	0.82	46
2002	2210	46	30.01	28.50	58.51	0.51	-46
2003	2115	-49	48.31	10.20	58.51	0.83	49
2004	2125	-39	46.26	12.25	58.51	0.79	39
2005	2110	-54	48.31	10.20	58.51	0.83	54
Mean	2125	-39	46.26	12.25		0.79	39

Glenmary Gl.



Glenmary correlation
 $y = 1.4695 + 0.5551 \cdot x$ $R^2 = 0.70$



GLACIER DATA		
Aspect	SE	
AREA	24.62	ha
Max Elev	2240	m
Min Elev	1790	m
Mean Elev	2015	m
Length	0.63	km
Elev Range	450	m
Gradient	0.71	

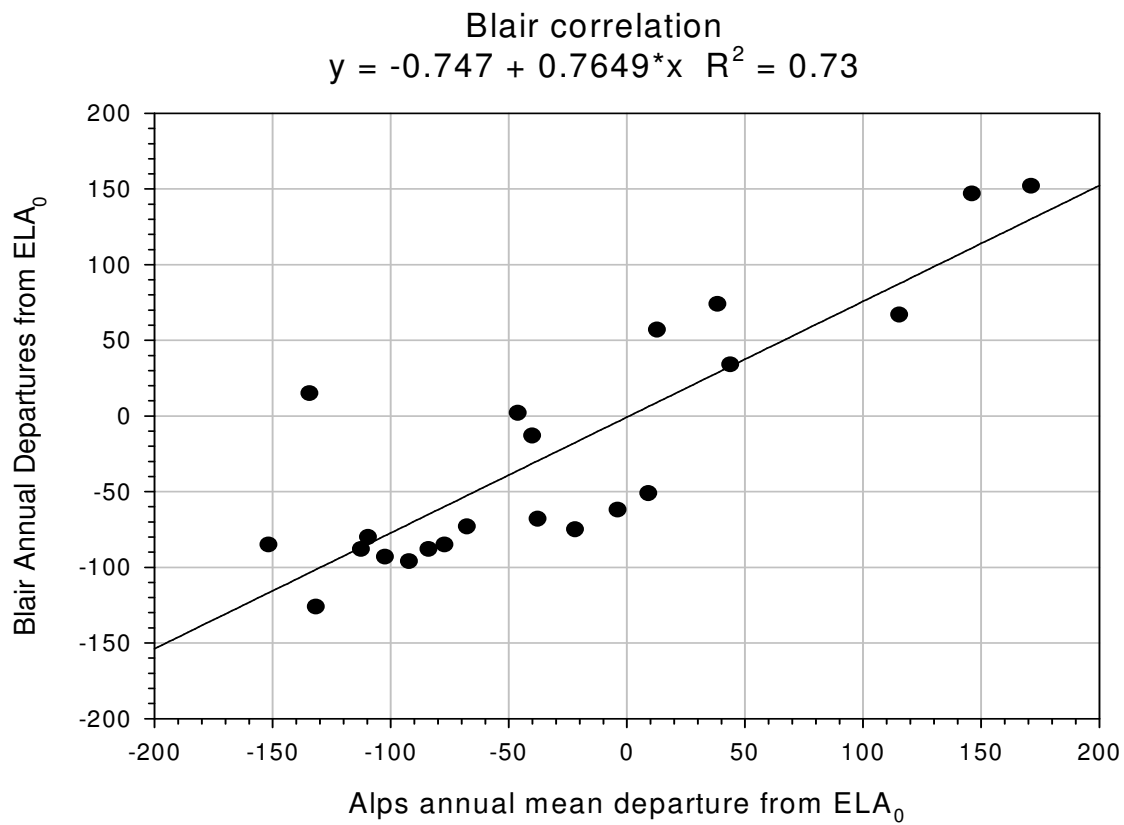
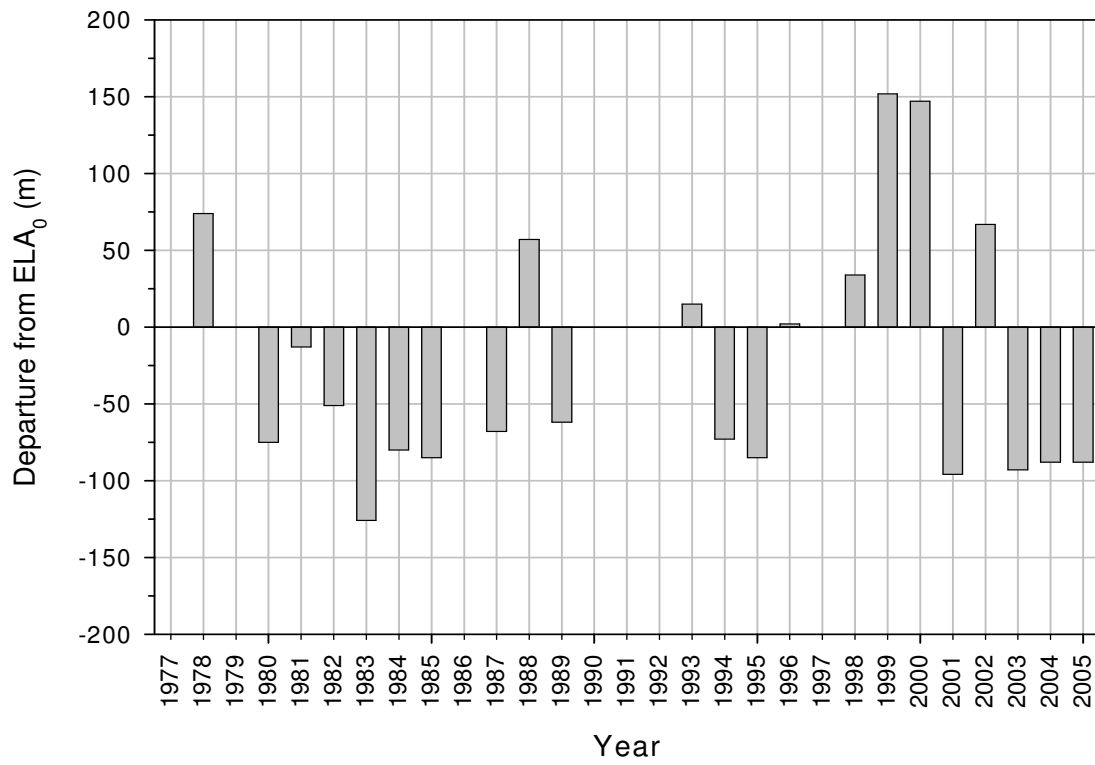
SNOWLINE DATA		
ELAo	1938	m
Max SL	2090	m, 1999
Min SL	1812	m, 1983
Mean SL	1914	m
SL Range	278	m
No. Surveys	22	

MEASUREMENTS

Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1938	0	18.52	7.90	26.42	0.70	0
1977							
1978	2012	74	13.42	13.00	26.42	0.51	-74
1979							
1980	1863	-75	22.82	3.60	26.42	0.86	75
1981	1925	-13	19.23	7.19	26.42	0.73	13
1982	1887	-51	21.52	4.90	26.42	0.81	51
1983	1812	-126	25.28	1.14	26.42	0.96	126
1984	1858	-80	23.12	3.30	26.42	0.88	80
1985	1853	-85	23.28	3.14	26.42	0.88	85
1986							
1987	1870	-68	22.43	3.99	26.42	0.85	68
1988	1995	57	14.82	11.60	26.42	0.56	-57
1989	1876	-62	22.10	4.32	26.42	0.84	62
1990							
1991							
1992							
1993	1953	15	17.69	8.73	26.42	0.67	-15
1994	1865	-73	22.72	3.70	26.42	0.86	73
1995	1853	-85	23.28	3.14	26.42	0.88	85
1996	1940	2	18.44	7.98	26.42	0.70	-2
1997							
1998	1972	34	16.36	10.06	26.42	0.62	-34
1999	2090	152	6.04	20.38	26.42	0.23	-152
2000	2085	147	6.17	20.25	26.42	0.23	-147
2001	1842	-96	23.75	2.67	26.42	0.90	96
2002	2005	67	14.02	12.40	26.42	0.53	-67
2003	1845	-93	23.62	2.80	26.42	0.89	93
2004	1850	-88	23.28	3.14	26.42	0.88	88
2005	1850	-88	23.28	3.14	26.42	0.88	88
MEAN	1914	-24	19.01	7.21		0.72	24

Blair Gl.



Mountain glacier

GLACIER DATA		
Aspect	S	
AREA	48.67	ha
Max Elev	2100	m
Min Elev	1760	m
Mean Elev	1930	m
Length	0.69	km
Elev Range	340	m
Gradient	0.49	

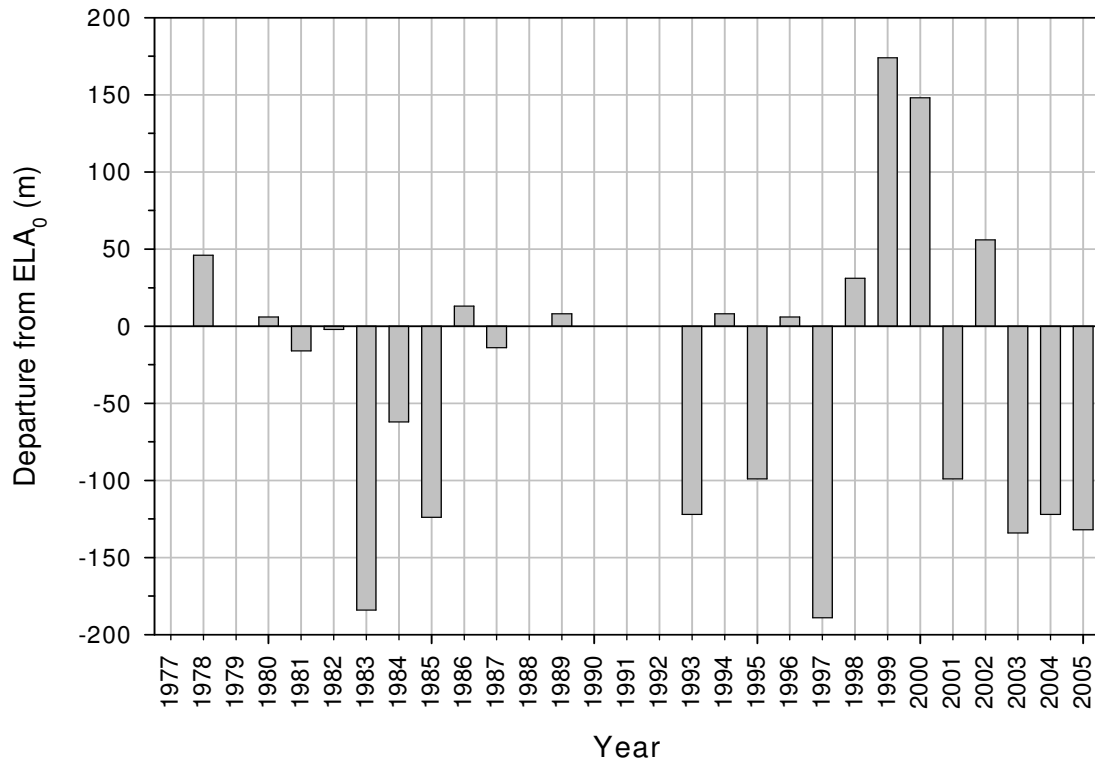
SNOWLINE DATA		
ELAo	1904	m
Max SL	2078	m, 1999
Min SL	1715	m, 1983
Mean SL	1869	m
SL Range	363	m
No. Surveys	23	

MEASUREMENTS

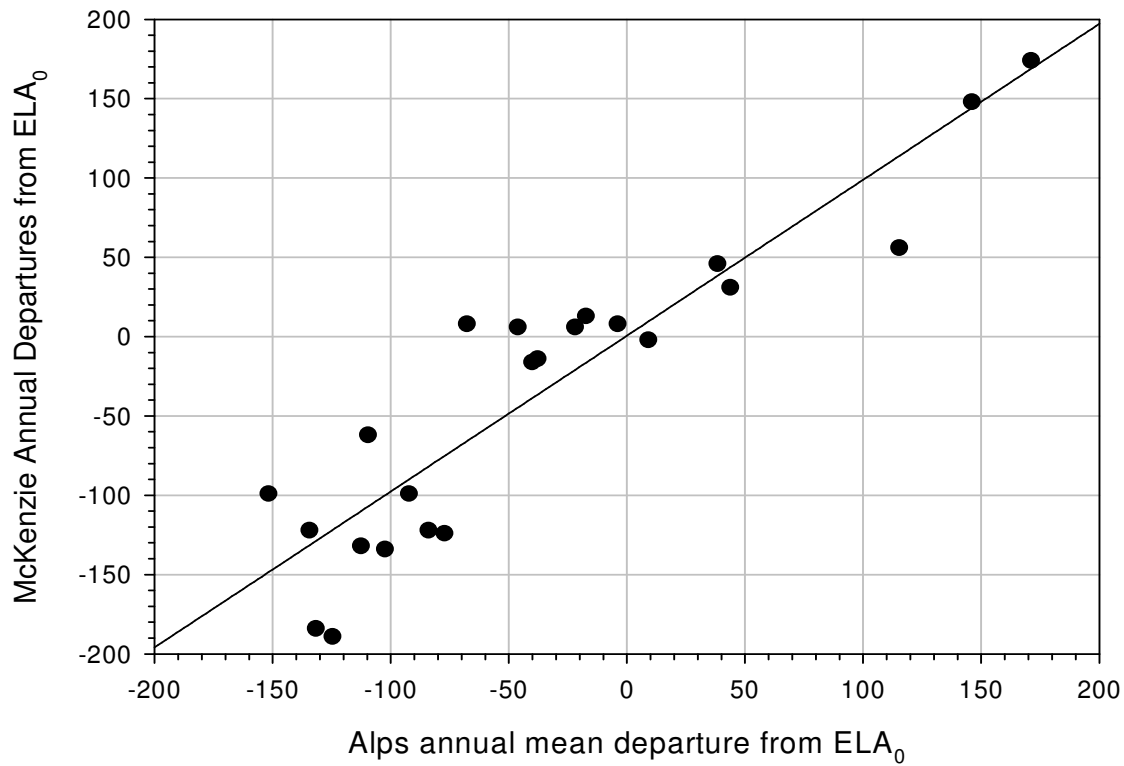
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1904	0	30.87	17.80	48.67	0.63	0
1977							
1978	1950	46	22.78	25.89	48.67	0.47	-46
1979							
1980	1910	6	29.86	18.81	48.67	0.61	-6
1981	1888	-16	33.48	15.19	48.67	0.69	16
1982	1902	-2	31.35	17.32	48.67	0.64	2
1983	1720	-184	60.63	-11.96	48.67	1.25	184
1984	1842	-62	39.64	9.03	48.67	0.81	62
1985	1780	-124	48.67	0.00	48.67	1.00	124
1986	1917	13	28.87	19.80	48.67	0.59	-13
1987	1890	-14	33.23	15.44	48.67	0.68	14
1988							
1989	1912	8	29.70	18.97	48.67	0.61	-8
1990							
1991							
1992							
1993	1782	-122	46.35	2.32	48.67	0.95	122
1994	1912	8	29.70	18.97	48.67	0.61	-8
1995	1805	-99	43.86	4.81	48.67	0.90	99
1996	1910	6	29.86	18.81	48.67	0.61	-6
1997	1715	-189	60.63	-11.96	48.67	1.25	189
1998	1935	31	25.53	23.14	48.67	0.52	-31
1999	2078	174	2.81	45.86	48.67	0.06	-174
2000	2052	148	5.83	42.84	48.67	0.12	-148
2001	1805	-99	43.87	4.80	48.67	0.90	99
2002	1960	56	20.67	28.00	48.67	0.42	-56
2003	1770	-134	47.72	0.95	48.67	0.98	134
2004	1782	-122	46.35	2.32	48.67	0.95	122
2005	1772	-132	47.72	0.95	48.67	0.98	132
MEAN	1869	-35	34.05	14.06		0.70	35

Mt McKenzie



McKenzie correlation
 $y = 0.6540 + 0.9827 \cdot x$ $R^2 = 0.85$



JACKSON GL

Mountain glacier

GLACIER DATA		
Aspect	NW	
AREA	52.15	ha
Max Elev	2300	m
Min Elev	1920	m
Mean Elev	2110	m
Length	0.5	km
Elev Range	380	m
Gradient	0.76	

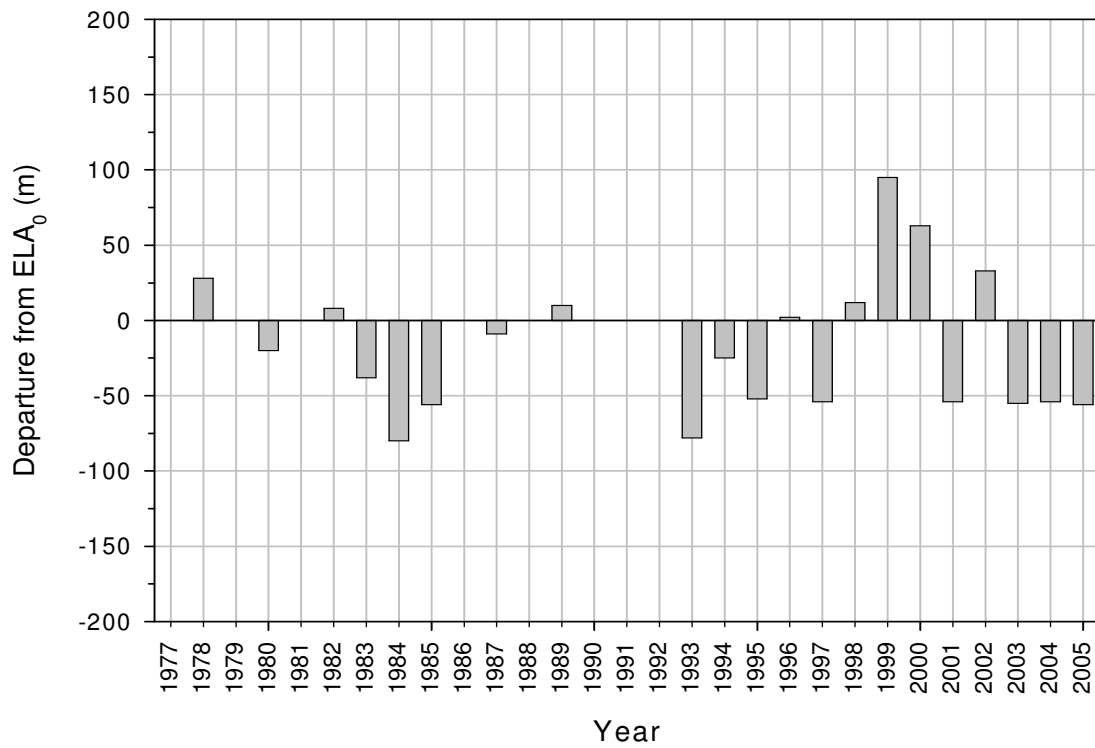
SNOWLINE DATA		
ELAo	2070	m
Max SL	2165	m, 1999
Min SL	1990	m, 1984
Mean SL	2052	m
SL Range	175	m
No. Surveys	21	

MEASUREMENTS

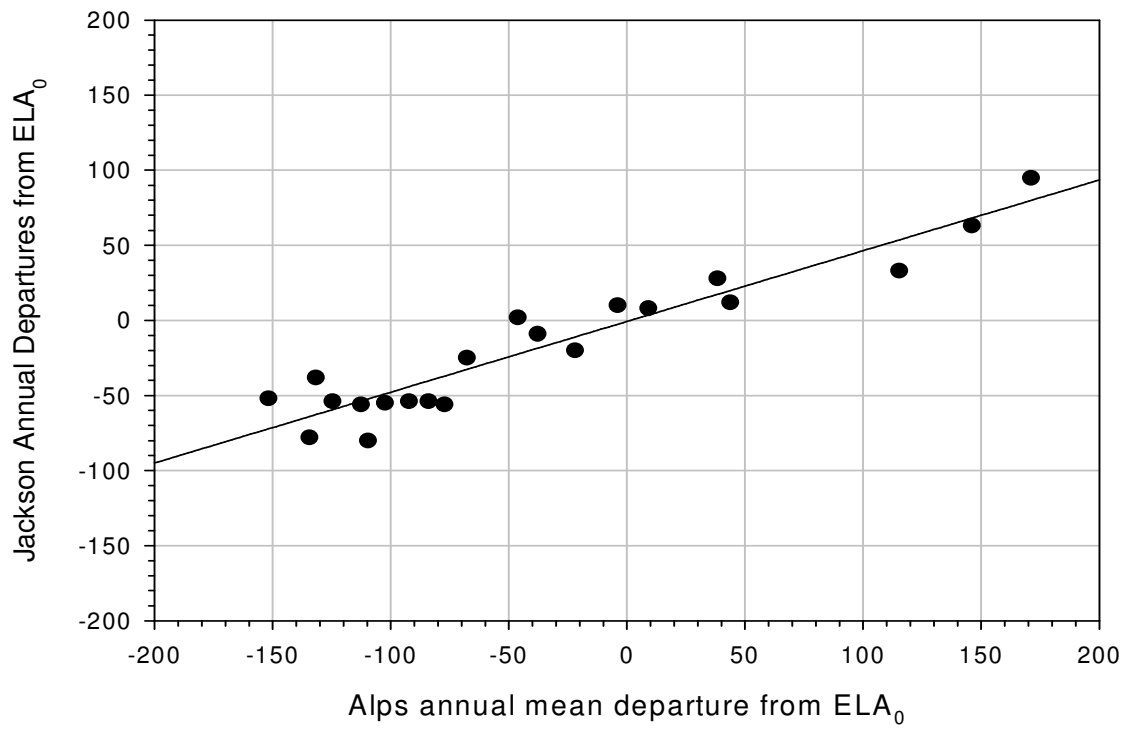
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE	AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	BALANCE
	m	m	ha	ha	ha	INDEX
55	2100					
ELAo	2070	0	30.15	22.00	52.15	0
1977						
1978	2098	28	23.37	28.78	52.15	-28
1979						
1980	2050	-20	35.65	16.50	52.15	20
1981						
1982	2078	8	28.15	24.00	52.15	-8
1983	2032	-38	41.85	10.30	52.15	38
1984	1990	-80	49.05	3.10	52.15	80
1985	2014	-56	45.32	6.83	52.15	56
1986						
1987	2061	-9	32.71	19.44	52.15	9
1988						
1989	2080	10	27.75	24.40	52.15	-10
1990						
1991						
1992						
1993	1992	-78	48.97	3.18	52.15	78
1994	2045	-25	37.12	15.03	52.15	25
1995	2018	-52	44.31	7.84	52.15	52
1996	2072	2	29.97	22.18	52.15	-2
1997	2016	-54	44.85	7.30	52.15	54
1998	2082	12	27.05	25.10	52.15	-12
1999	2165	95	8.64	43.51	52.15	-95
2000	2133	63	15.49	36.66	52.15	-63
2001	2016	-54	45.00	7.15	52.15	54
2002	2103	33	22.77	29.38	52.15	-33
2003	2015	-55	50.65	1.50	52.15	55
2004	2016	-54	45.00	7.15	52.15	54
2005	2014	-56	45.32	6.83	52.15	56
MEAN	2052	-18	34.67	16.97		18

Jackson Gl.



Jackson correlation
 $y = -0.7054 + 0.4711 \cdot x \quad R^2 = 0.90$



JACK GL.

Small cirque glacier

GLACIER DATA		
Aspect	W	
AREA	21.48	ha
Max Elev	2280	m
Min Elev	1800	m
Mean Elev	2040	m
Length	0.337	km
Elev Range	480	m
Gradient	1.42	

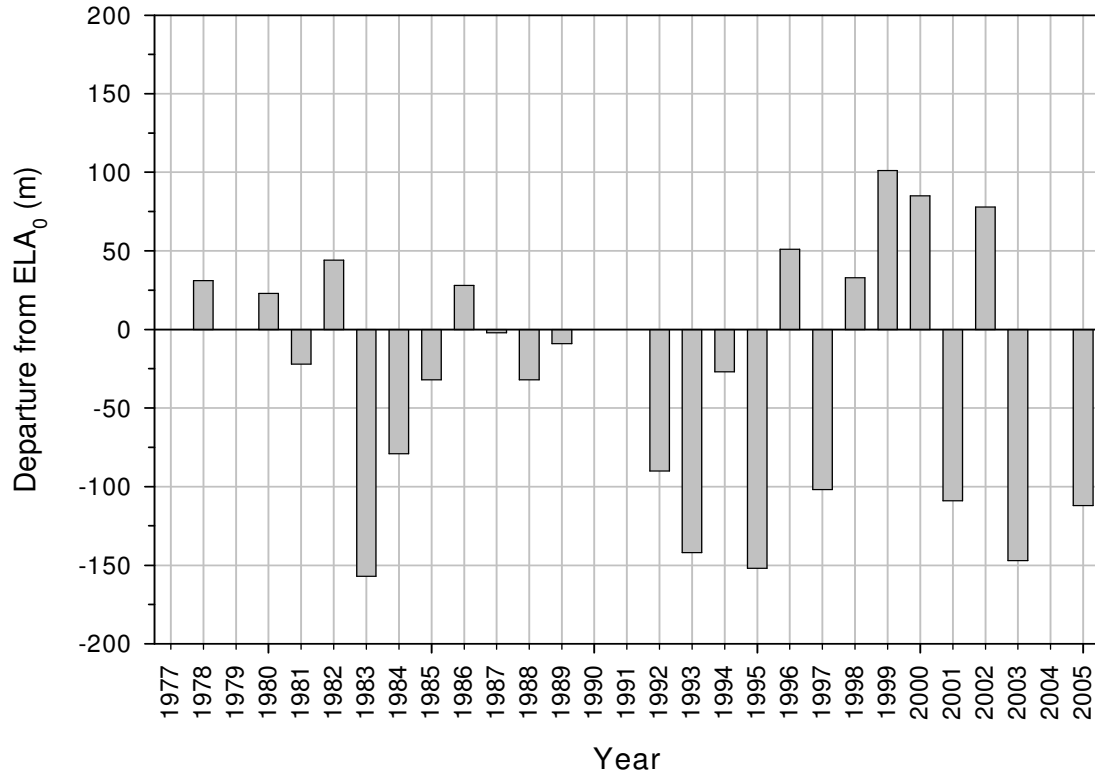
SNOWLINE DATA		
ELAo	1907	m
Max SL	2008	m, 1999
Min SL	1750	m, 1983
Mean SL	1880	m
SL Range	258	m
No. Surveys	24	

MEASUREMENTS

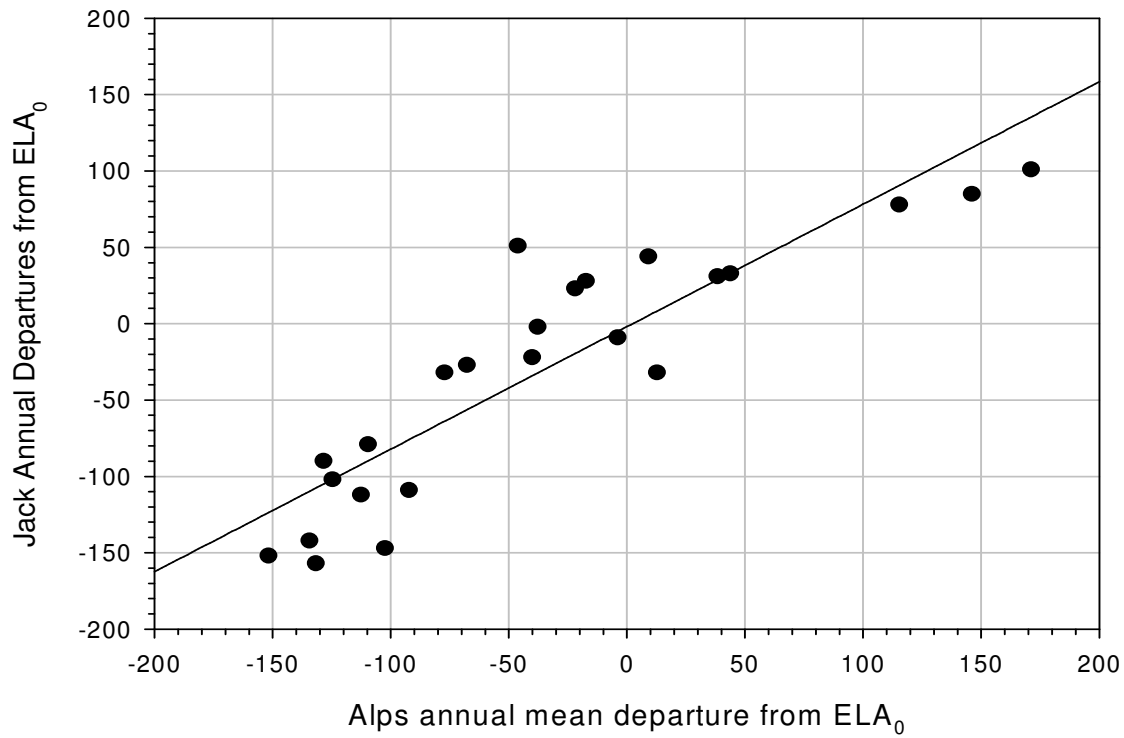
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1907	0	15.68	5.80	21.48	0.73	0
1977							
1978	1938	31	11.48	10.00	21.48	0.53	-31
1979							
1980	1930	23	12.88	8.60	21.48	0.60	-23
1981	1885	-22	17.35	4.13	21.48	0.81	22
1982	1951	44	9.00	12.48	21.48	0.42	-44
1983	1750	-157	29.77	-8.29	21.48	1.39	157
1984	1828	-79	19.68	1.80	21.48	0.92	79
1985	1875	-32	17.88	3.60	21.48	0.83	32
1986	1935	28	11.98	9.50	21.48	0.56	-28
1987	1905	-2	15.88	5.60	21.48	0.74	2
1988	1875	-32	17.88	3.60	21.48	0.83	32
1989	1898	-9	16.55	4.93	21.48	0.77	9
1990					no visit		
1991					no visit		
1992	1817	-90	19.88	1.60	21.48	0.93	90
1993	1765	-142	21.13	0.35	21.48	0.98	142
1994	1880	-27	17.68	3.80	21.48	0.82	27
1995	1755	-152	26.98	0.49	27.47	1.26	152
1996	1958	51	7.63	13.85	21.48	0.36	-51
1997	1805	-102	20.19	1.29	21.48	0.94	102
1998	1940	33	11.15	10.33	21.48	0.52	-33
1999	2008	101	1.96	19.52	21.48	0.09	-101
2000	1992	85	2.86	18.62	21.48	0.13	-85
2001	1798	-109	20.40	1.08	21.48	0.95	109
2002	1985	78	3.68	17.80	21.48	0.17	-78
2003	1760	-147	21.48	0.00	21.48	1.00	147
2004					cloud		
2005	1795	-112	20.40	1.08	21.48	0.95	112
MEAN	1880	-27	15.45	6.29		0.72	27

Jack Gl.



Jack correlation
 $y = -1.9371 + 0.8023 \cdot x \quad R^2 = 0.81$



Rock glacier

GLACIER DATA		
Aspect	SE	
AREA	28.32	ha
Max Elev	2200	m
Min Elev	1760	m
Mean Elev	1980	m
Length	0.7	km
Elev Range	440	m
Gradient	0.629	

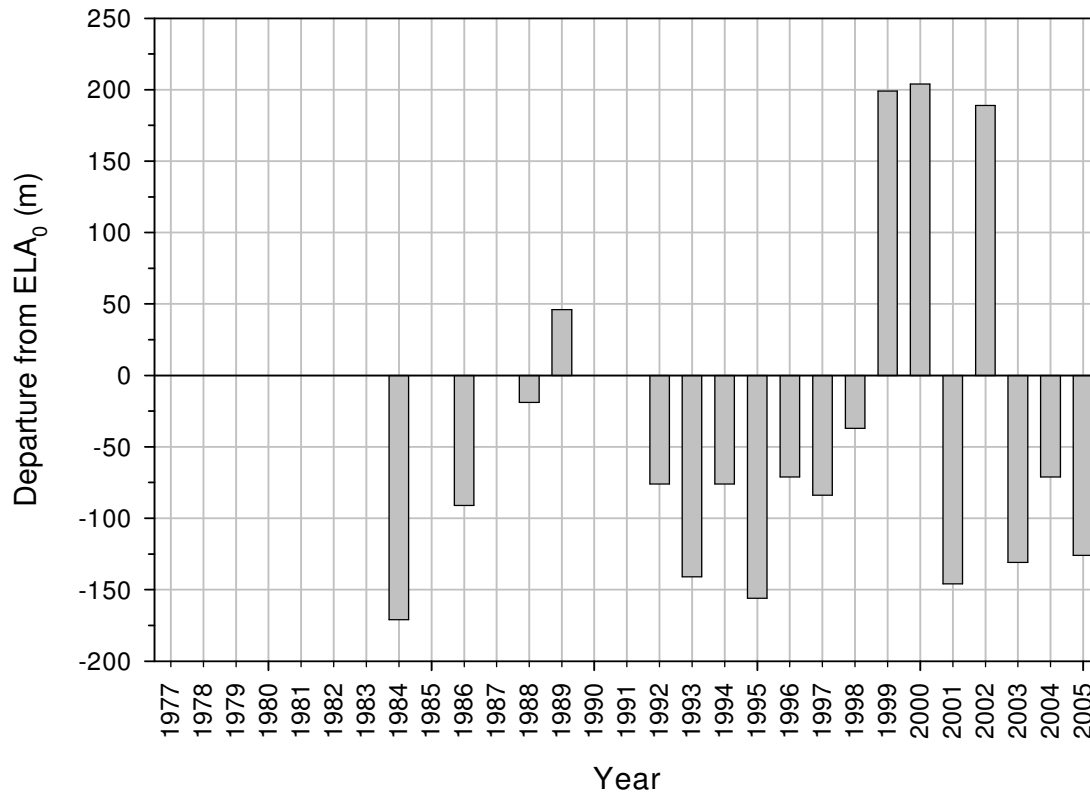
SNOWLINE DATA		
ELAo	1926	m
Max SL	2130	m, 2000
Min SL	1755	m, 1984
Mean SL	1884	m
SL Range	375	m
No. Surveys	18	

MEASUREMENTS

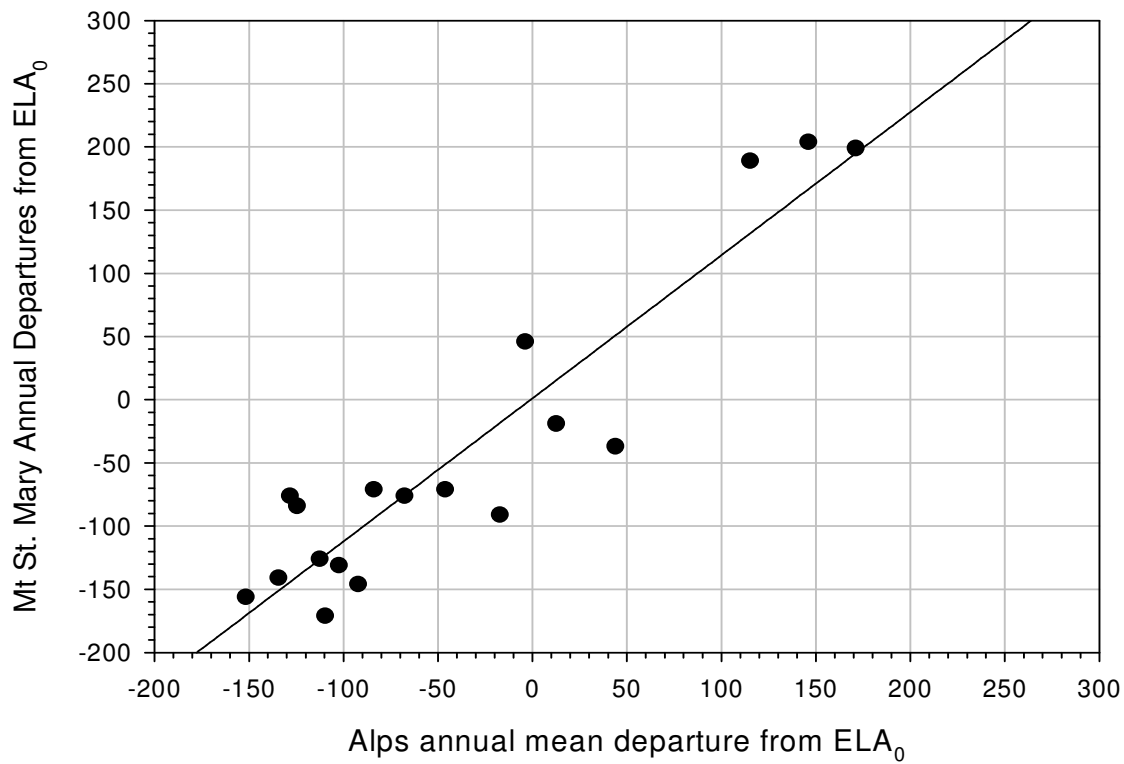
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE	AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO
	m	m	ha	ha	ha	(AAR)
ELAo	1926	0	6.52	21.80	28.32	0.23
1977						
1978						
1979						
1980						
1981						
1982						
1983						
1984	1755	-171	20.32	8.00	28.32	0.72
1985						
1986	1835	-91	12.33	15.99	28.32	0.44
1987						
1988	1907	-19	7.92	20.40	28.32	0.28
1989	1972	46	4.41	23.91	28.32	0.16
1990						
1991						
1992	1850	-76	11.32	17.00	28.32	0.40
1993	1785	-141	16.69	11.63	28.32	0.59
1994	1850	-76	11.32	17.00	28.32	0.40
1995	1770	-156	18.39	9.93	28.32	0.65
1996	1855	-71	11.08	17.24	28.32	0.39
1997	1842	-84	11.75	16.57	28.32	0.41
1998	1889	-37	8.93	19.39	28.32	0.32
1999	2125	199	0.42	27.90	28.32	0.01
2000	2130	204	0.37	27.95	28.32	0.01
2001	1780	-146	17.22	11.10	28.32	0.61
2002	2115	189	0.52	27.80	28.32	0.02
2003	1795	-131	15.72	12.60	28.32	0.56
2004	1855	-71	11.08	17.24	28.32	0.39
2005	1800	-126	15.72	12.60	28.32	0.56
MEAN	1884	-42	10.54	17.74		0.37
						42

Mt St Mary



Mt St. Mary correlation
 $y = 1.1126 + 1.1326 \cdot x \quad R^2 = 0.86$



GLACIER DATA		
Aspect	S	
AREA	117.8	ha
Max Elev	2450	m
Min Elev	1720	m
Mean Elev	2085	m
Length	1.23	km
Elev Range	730	m
Gradient	0.59	

SNOWLINE DATA		
ELA	1970	m
Max SL	2132	m, 2000
Min SL	1865	m, 1983
Mean SL	1941	m
SL Range	267	m
No. Surveys	24	

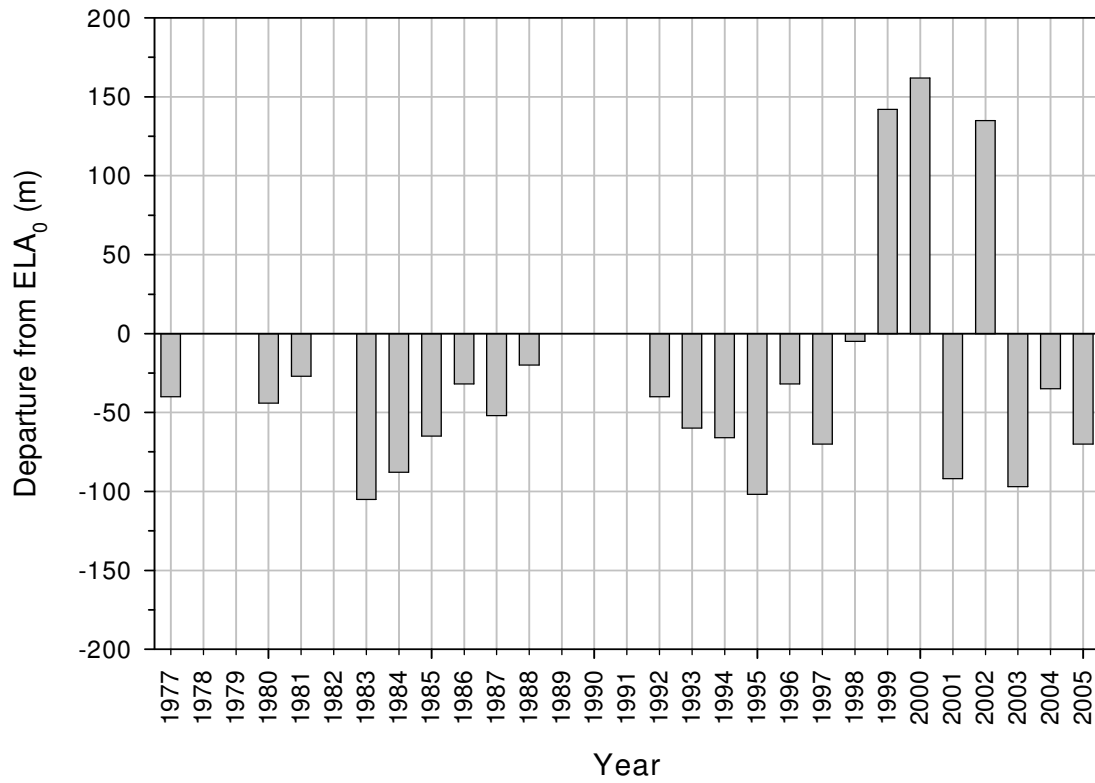
MEASUREMENTS Digitised values shaded

MEASUREMENTS

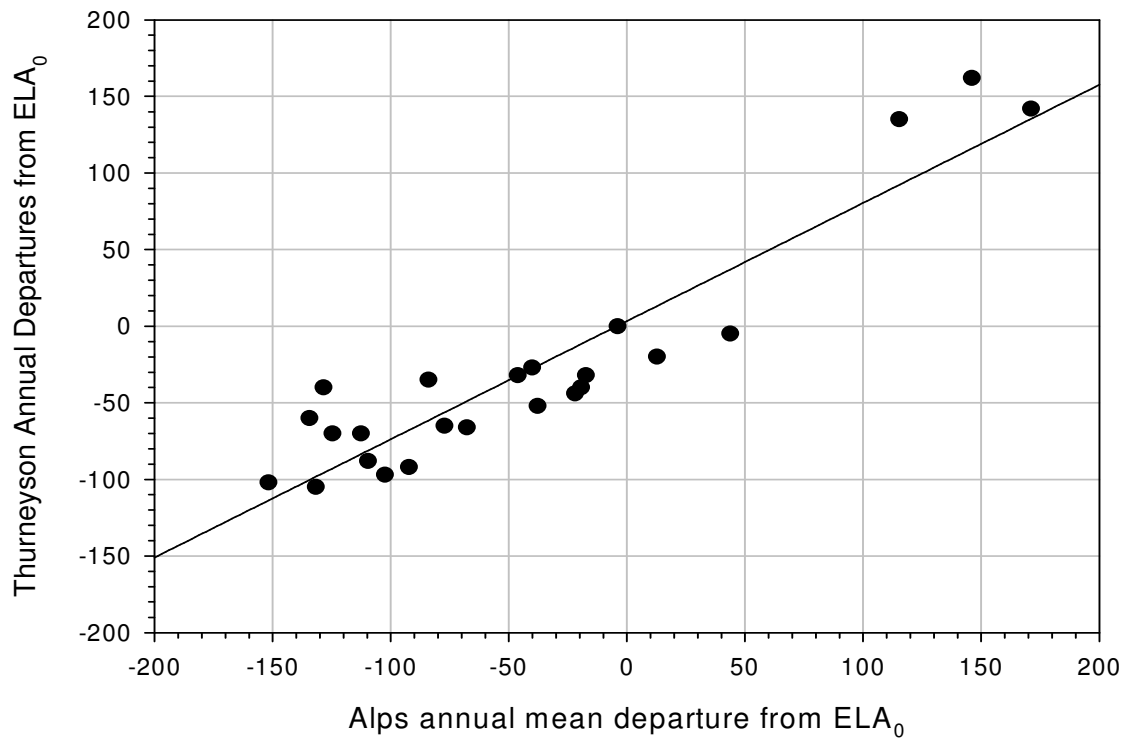
Digitized values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELA	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1970	0	84.60	33.20	117.80	0.72	0
1977	1930	-40	95.30	22.50	117.80	0.81	40
1978							
1979							
1980	1926	-44	98.00	19.80	117.80	0.83	44
1981	1943	-27	92.80	25.00	117.80	0.79	27
1982							
1983	1865	-105	109.80	8.00	117.80	0.93	105
1984	1882	-88	107.00	10.80	117.80	0.91	88
1985	1905	-65	103.40	14.40	117.80	0.88	65
1986	1938	-32	94.08	23.72	117.80	0.80	32
1987	1918	-52	100.30	17.50	117.80	0.85	52
1988	1950	-20	90.80	27.00	117.80	0.77	20
1989	1970	0	84.60	33.20	117.80	0.72	0
1990							
1991							
1992	1930	-40	95.30	22.50	117.80	0.81	40
1993	1910	-60	101.90	15.90	117.80	0.87	60
1994	1904	-66	103.40	14.40	117.80	0.88	66
1995	1868	-102	109.40	8.40	117.80	0.93	102
1996	1938	-32	94.08	23.72	117.80	0.80	32
1997	1900	-70	103.85	13.95	117.80	0.88	70
1998	1965	-5	85.28	32.52	117.80	0.72	5
1999	2112	142	38.69	79.11	117.80	0.33	-142
2000	2132	162	31.67	86.13	117.80	0.27	-162
2001	1878	-92	107.84	9.96	117.80	0.92	92
2002	2105	135	40.80	77.00	117.80	0.35	-135
2003	1873	-97	108.60	9.20	117.80	0.92	97
2004	1935	-35	95.30	22.50	117.80	0.81	35
2005	1900	-70	103.85	13.95	117.80	0.88	70
MEAN	1941	-29	90.77	26.84		0.77	29

Thurneyson Gl.



Thurneyson correlation
 $y = 3.3343 + 0.7714 \cdot x \quad R^2 = 0.87$



Mountain glacier

GLACIER DATA		
Aspect	S	
AREA	249.5	ha
Max Elev	2390	m
Min Elev	1655	m
Mean Elev	2023	m
Length	2.69	km
Elev Range	735	m
Gradient	0.27	

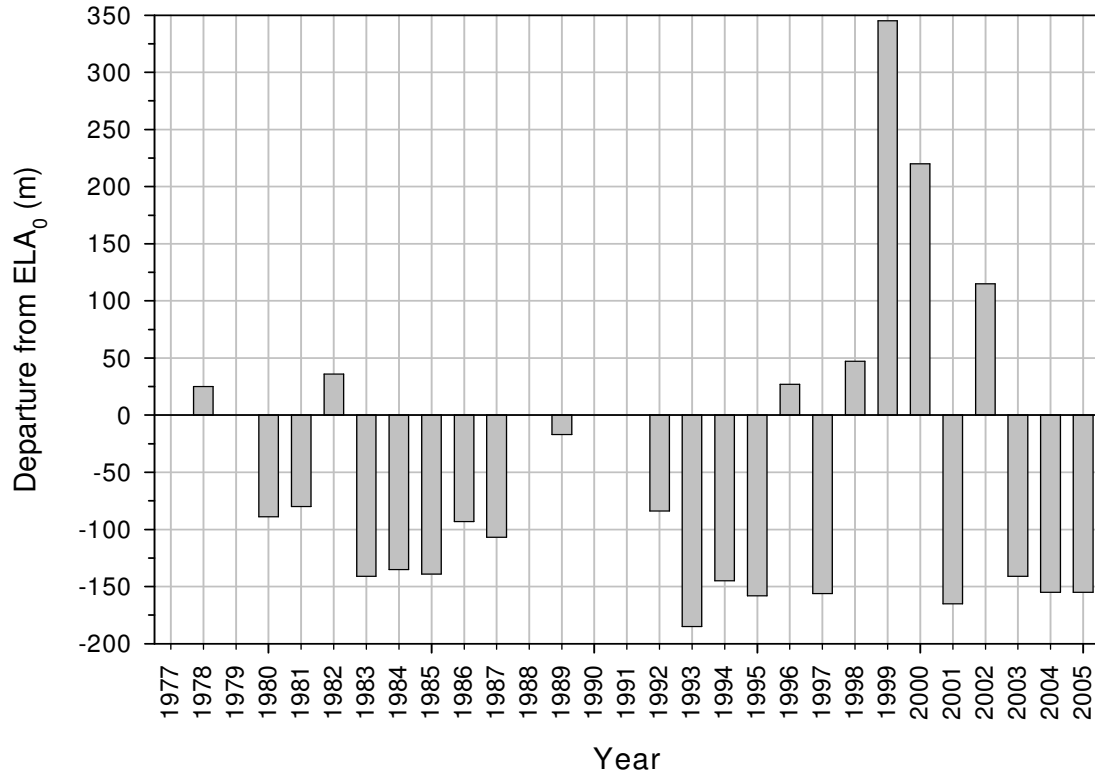
SNOWLINE DATA		
ELAo	1935	m
Max SL	2280	m, 1999
Min SL	1750	m, 1993
Mean SL	1889	m
SL Range	530	m
No. Surveys	24	

MEASUREMENTS

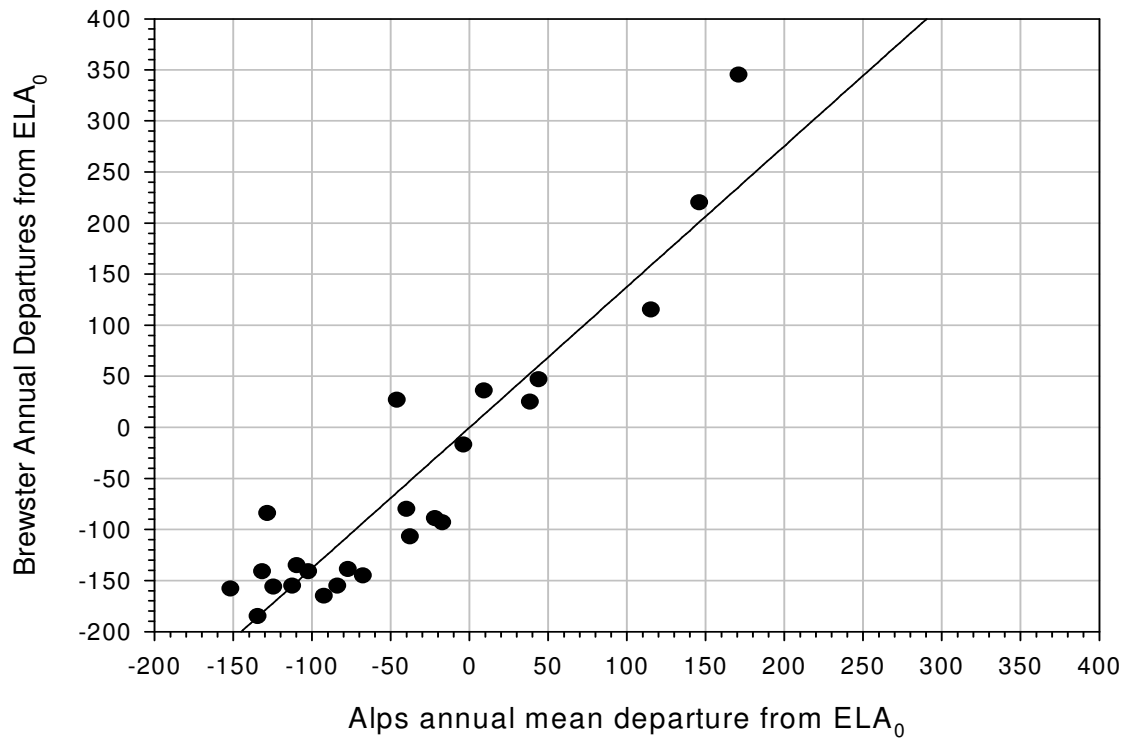
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1935	0	121.50	128.00	249.50	0.49	0
1977							
1978	1960	25	98.72	150.78	249.50	0.40	-25
1979							
1980	1846	-89	193.50	56.00	249.50	0.78	89
1981	1855	-80	188.50	61.00	249.50	0.76	80
1982	1971	36	80.18	169.32	249.50	0.32	-36
1983	1794	-141	221.30	28.20	249.50	0.89	141
1984	1800	-135	218.40	31.10	249.50	0.88	135
1985	1796	-139	220.50	29.00	249.50	0.88	139
1986	1842	-93	195.50	54.00	249.50	0.78	93
1987	1828	-107	205.60	43.90	249.50	0.82	107
1988							
1989	1918	-17	140.40	109.10	249.50	0.56	17
1990							
1991							
1992	1851	-84	190.50	59.00	249.50	0.76	84
1993	1750	-185	234.70	14.80	249.50	0.94	185
1994	1790	-145	222.50	27.00	249.50	0.89	145
1995	1777	-158	227.60	21.90	249.50	0.91	158
1996	1962	27	89.93	159.57	249.50	0.36	-27
1997	1779	-156	226.30	23.20	249.50	0.91	156
1998	1982	47	66.96	182.54	249.50	0.27	-47
1999	2280	345	8.18	241.32	249.50	0.03	-345
2000	2155	220	29.15	220.35	249.50	0.12	-220
2001	1770	-165	228.66	20.84	249.50	0.92	165
2002	2050	115	203.00	46.50	249.50	0.81	-115
2003	1794	-141	221.30	28.20	249.50	0.89	141
2004	1780	-155	226.30	23.20	249.50	0.91	155
2005	1780	-155	226.30	23.20	249.50	0.91	155
MEAN	1889	-46	168.70	80.80		0.68	46

Brewster Gl.



Brewster correlation
 $y = -0.2269 + 1.3784 \cdot x$ $R^2 = 0.87$



Moutain glacier

GLACIER DATA		
Aspect	SE	
AREA	31.55	ha
Max Elev	1860	m
Min Elev	1570	m
Mean Elev	1715	m
Length	0.54	km
Elev Range	290	m
Gradient	0.54	

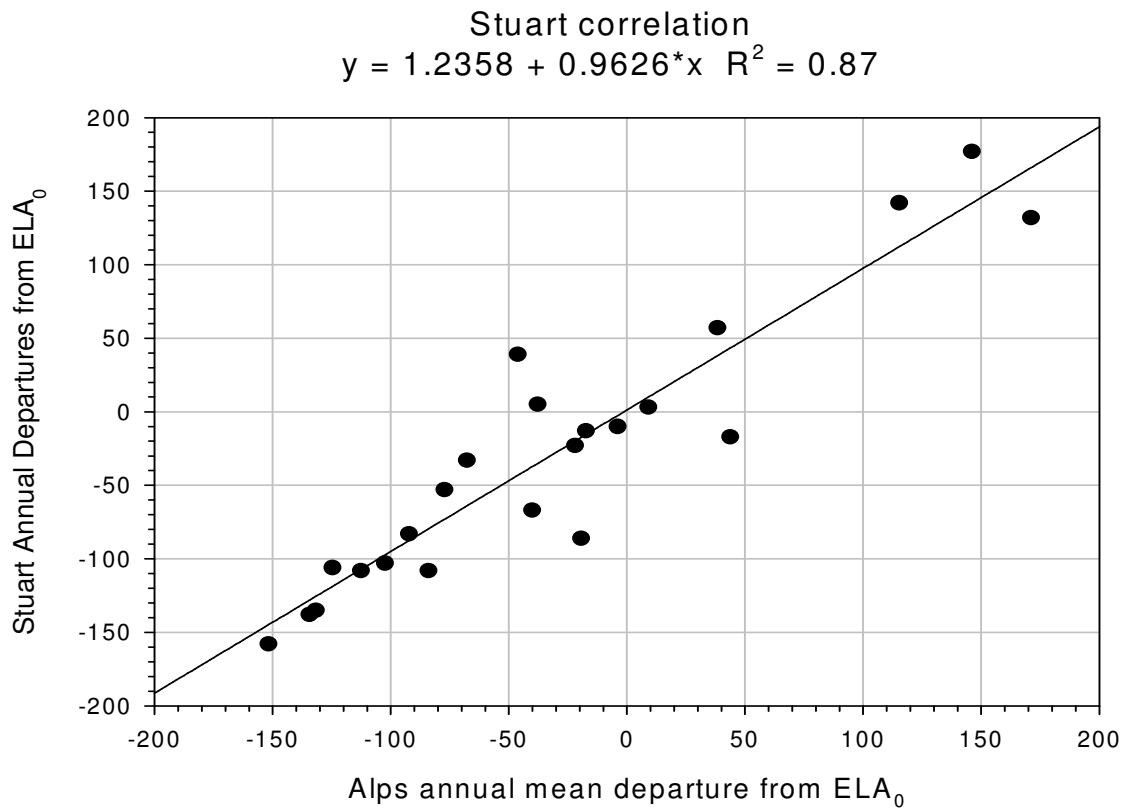
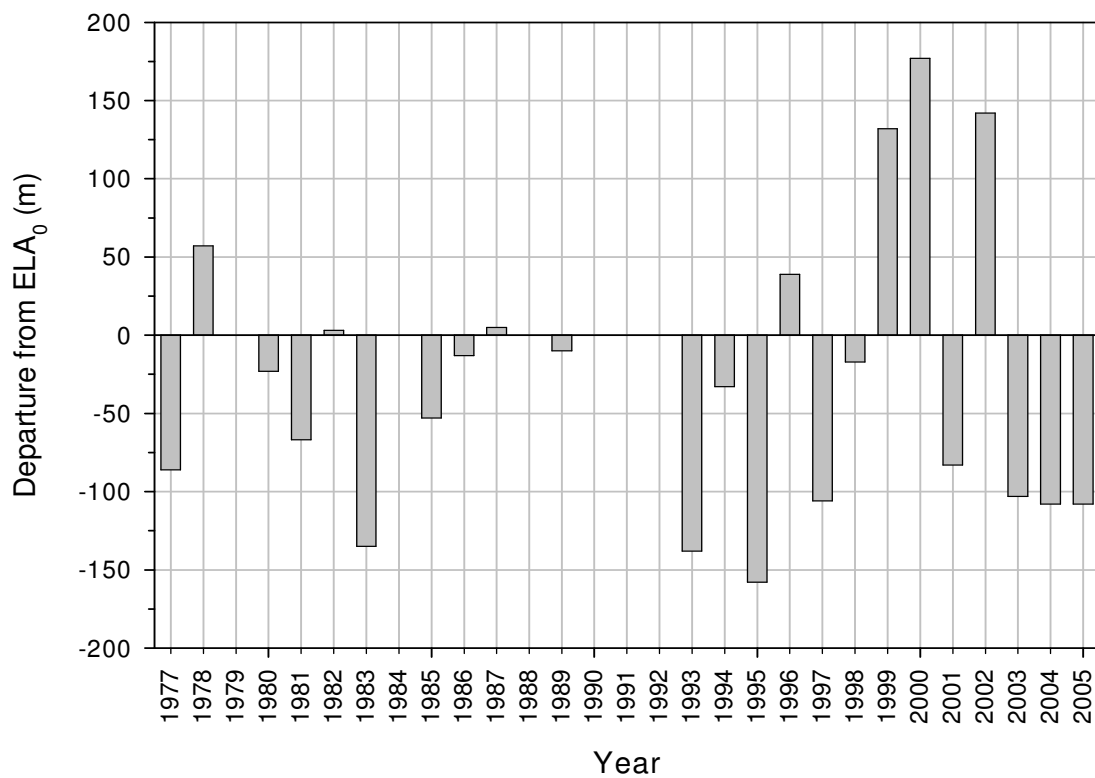
SNOWLINE DATA		
ELAo	1673	m
Max SL	1850	m, 2000
Min SL	1515	m, 1995
Mean SL	1647	m
SL Range	335	m
No. Surveys	23	

MEASUREMENTS

Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1673	0	21.05	5.00	26.05	0.81	0
1977	1587	-86	30.86	0.69	31.55	0.98	86
1978	1730	57	18.53	13.02	31.55	0.59	-57
1979							
1980	1650	-23	27.25	4.30	31.55	0.86	23
1981	1606	-67	29.85	1.70	31.55	0.95	67
1982	1676	3	25.33	6.22	31.55	0.80	-3
1983	1538	-135	63.56	0.00	63.56	2.01	135
1984							
1985	1620	-53	29.10	2.45	31.55	0.92	53
1986	1660	-13	26.55	5.00	31.55	0.84	13
1987	1678	5	25.07	6.48	31.55	0.79	-5
1988							
1989	1663	-10	26.32	5.23	31.55	0.83	10
1990							
1991							
1992							
1993	1535	-138	65.05	0.00	65.05	2.06	138
1994	1640	-33	27.95	3.60	31.55	0.89	33
1995	1515	-158	73.05	0.00	73.05	2.32	158
1996	1712	39	21.20	10.35	31.55	0.67	-39
1997	1567	-106	42.89	0.00	42.89	1.36	106
1998	1656	-17	26.87	4.68	31.55	0.85	17
1999	1805	132	5.46	26.09	31.55	0.17	-132
2000	1850	177	0.00	26.05	26.05	0.00	-177
2001	1590	-83	30.59	0.96	31.55	0.97	83
2002	1815	142	4.37	21.68	26.05	0.17	-142
2003	1570	-103	31.55	0.00	26.05	1.21	103
2004	1565	-108	26.05	0.00	26.05	1.00	108
2005	1565	-108	26.05	0.00	26.05	1.00	108
MEAN	1647	-26	29.88	6.30		0.96	26

Mt Stuart



Mountain shelf glacier

GLACIER DATA		
Aspect	S	
AREA	52.53	ha
Max Elev	1880	m
Min Elev	1610	m
Mean Elev	1745	m
Length	0.57	km
Elev Range	270	m
Gradient	0.47	

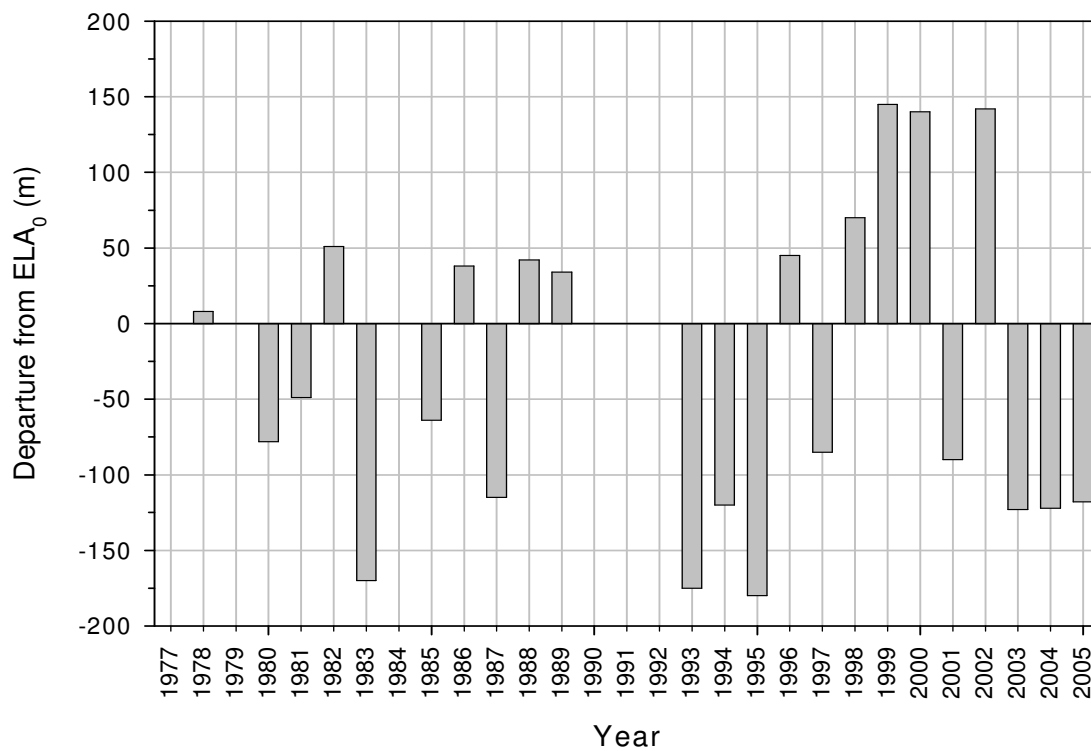
SNOWLINE DATA		
ELAo	1730	m
Max SL	1875	m, 1999
Min SL	1550	m, 1995
Mean SL	1700	m
SL Range	325	m
No. Surveys	23	

MEASUREMENTS

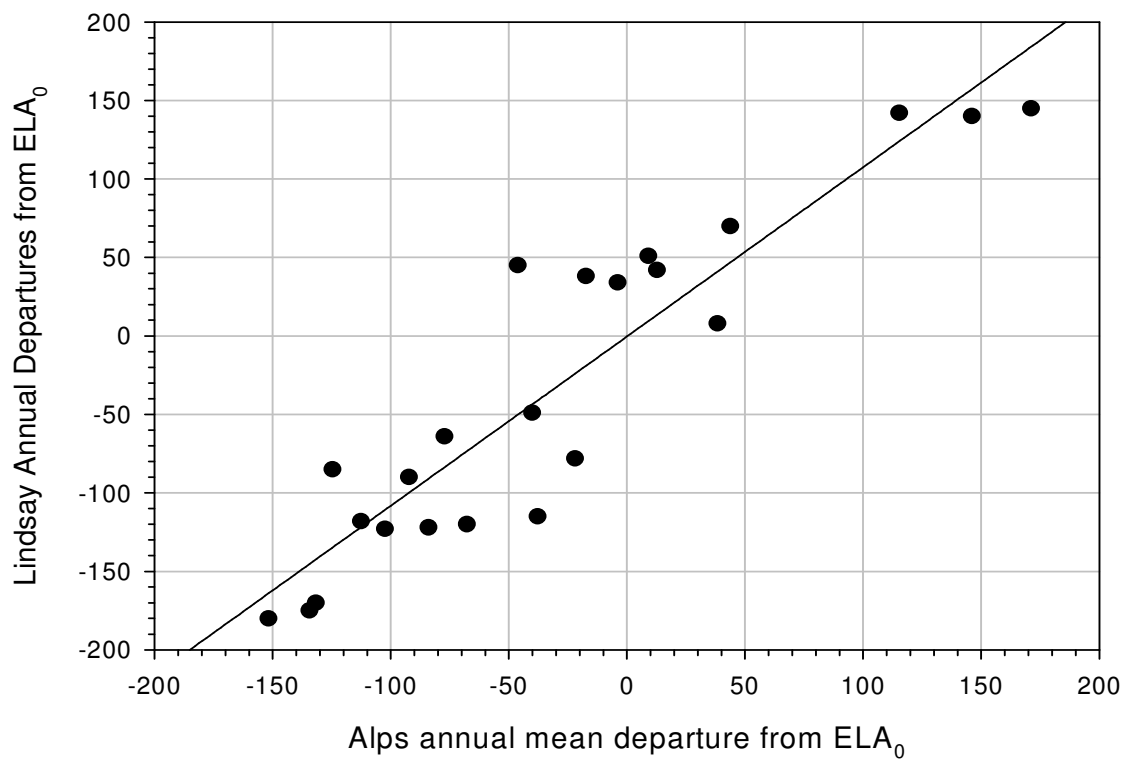
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1730	0	39.23	13.30	52.53	0.75	0
1977							
1978	1738	8	37.09	15.44	52.53	0.71	-8
1979							
1980	1652	-78	50.51	2.02	52.53	0.96	78
1981	1681	-49	48.60	3.93	52.53	0.93	49
1982	1781	51	22.41	30.12	52.53	0.43	-51
1983	1560	-170	65.66	0.00	65.66	1.25	170
1984							
1985	1666	-64	49.63	2.90	52.53	0.94	64
1986	1768	38	27.53	25.00	52.53	0.52	-38
1987	1615	-115	52.33	0.20	52.53	1.00	115
1988	1772	42	24.63	27.90	52.53	0.47	-42
1989	1764	34	28.49	24.04	52.53	0.54	-34
1990							
1991							
1992							
1993	1555	-175	69.94	0.00	69.94	1.33	175
1994	1610	-120	52.53	0.00	52.53	1.00	120
1995	1550	-180	73.50	0.00	73.50	1.40	180
1996	1775	45	24.47	28.06	52.53	0.47	-45
1997	1645	-85	69.00	1.65	70.65	1.31	85
1998	1800	70	14.45	38.08	52.53	0.28	-70
1999	1875	145	0.94	51.59	52.53	0.02	-145
2000	1870	140	1.47	51.06	52.53	0.03	-140
2001	1640	-90	51.09	1.44	52.53	0.97	90
2002	1872	142	1.05	51.48	52.53	0.02	-142
2003	1607	-123	52.53	0.00	52.53	1.00	123
2004	1608	-122	52.53	0.00	52.53	1.00	122
2005	1612	-118	51.53	1.00	52.53	0.98	118
MEAN	1700	-30	38.95	16.90		0.74	30

Lindsay Gl.



Lindsay correlation
 $y = 1.0787 + -0.3464 \cdot x \quad R^2 = 0.85$



GLACIER DATA		
Aspect	SE	
AREA	18.22	ha
Max Elev	2150	m
Min Elev	1840	m
Mean Elev	1995	m
Length	0.4	km
Elev Range	310	m
Gradient	0.775	

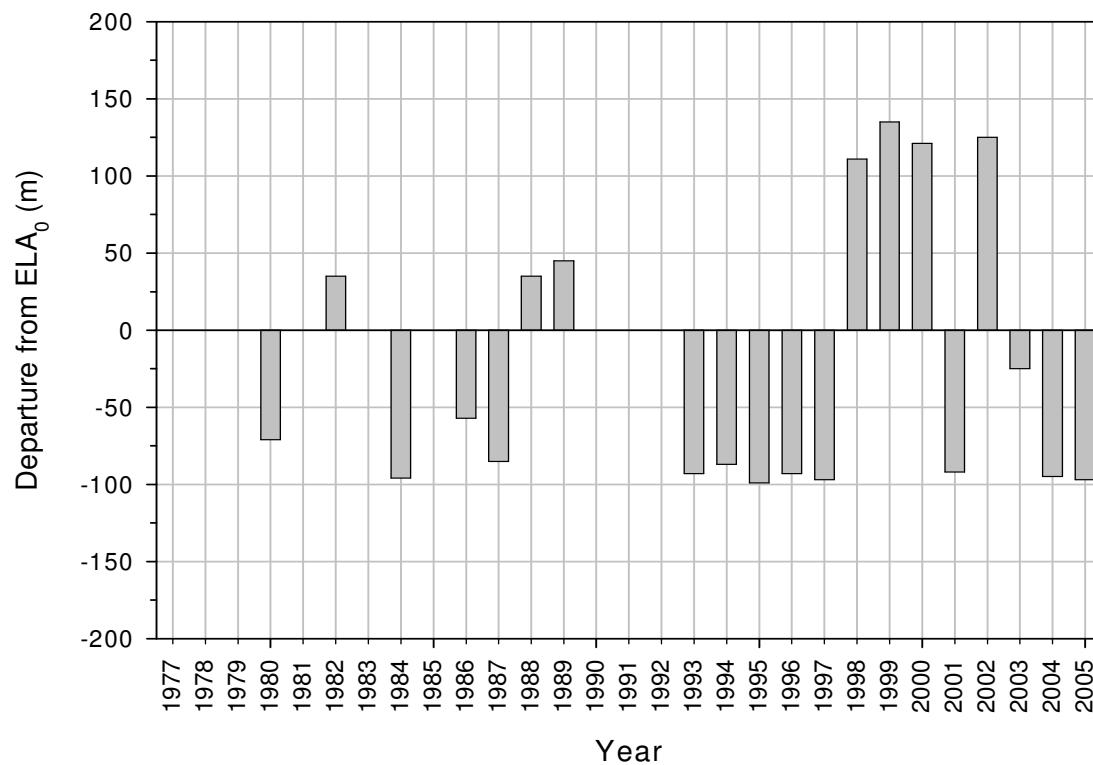
SNOWLINE DATA		
ELAo	1987	m
Max SL	2122	m, 1999
Min SL	1888	m, 1995
Mean SL	1963	m
SL Range	234	m
No. Surveys	20	

MEASUREMENTS

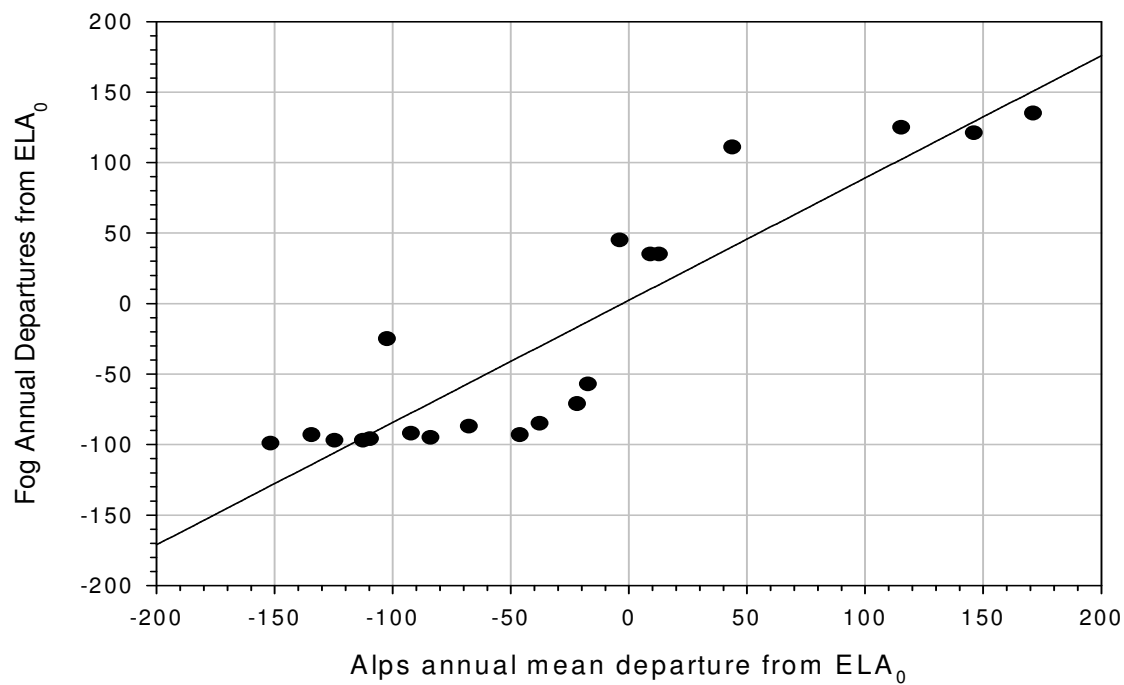
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1987	0	12.02	6.20	18.22	0.66	0
1977							
1978							
1979							
1980	1916	-71	34.40	0.00	34.40	>1	71
1981							
1982	2022	35	14.75	3.47	18.22	0.81	-35
1983							
1984	1891	-96	42.80	0.00	42.80	>1	96
1985							
1986	1930	-57	30.40	0.00	30.40	>1	57
1987	1902	-85	39.00	0.00	39.00	>1	85
1988	2022	35	14.75	3.47	18.22	0.81	-35
1989	2032	45	6.62	11.60	18.22	0.36	-45
1990							
1991							
1992							
1993	1894	-93	37.80	0.00	37.80	>1	93
1994	1900	-87	17.58	0.64	18.22	0.96	87
1995	1888	-99	44.36	0.00	44.36	>1	99
1996	1894	-93	41.70	0.00	41.70	>1	93
1997	1890	-97	43.25	0.00	43.25	>1	97
1998	2098	111	1.77	16.45	18.22	0.10	-111
1999	2122	135	0.74	17.48	18.22	0.04	-135
2000	2108	121	1.28	16.94	18.22	0.07	-121
2001	1895	-92	17.42	0.80	18.22	0.96	92
2002	2112	125	1.13	17.09	18.22	0.06	-125
2003	1962	-25	15.40	2.82	18.22	0.85	25
2004	1892	-95	18.22	0.00	18.22	1.00	95
2005	1890	-97	43.25	0.00	43.25	1.00	97
MEAN	1963	-24	22.28	4.78		0.50	24

Fog Pk.



Fog correlation
 $y = 2.4027 + 0.8670 \cdot x$ $R^2 = 0.81$



SNOWY CK

Small mountain glacier

GLACIER DATA		
Aspect	W	
AREA	53.13	ha
Max Elev	2210	m
Min Elev	2000	m
Mean Elev	2105	m
Length	0.73	km
Elev Range	210	m
Gradient	0.29	

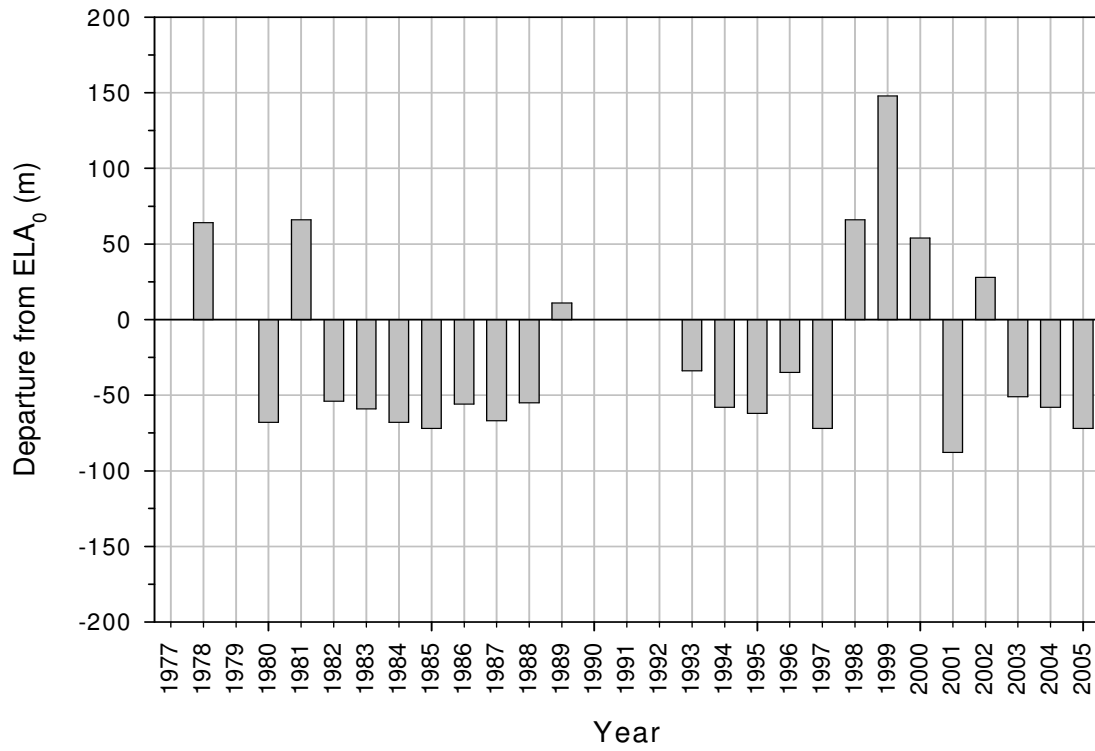
SNOWLINE DATA		
ELAo	2092	m
Max SL	2240	m, 1999
Min SL	2004	m, 1997
Mean SL	2071	m
SL Range	236	m
No. Surveys	24	

MEASUREMENTS

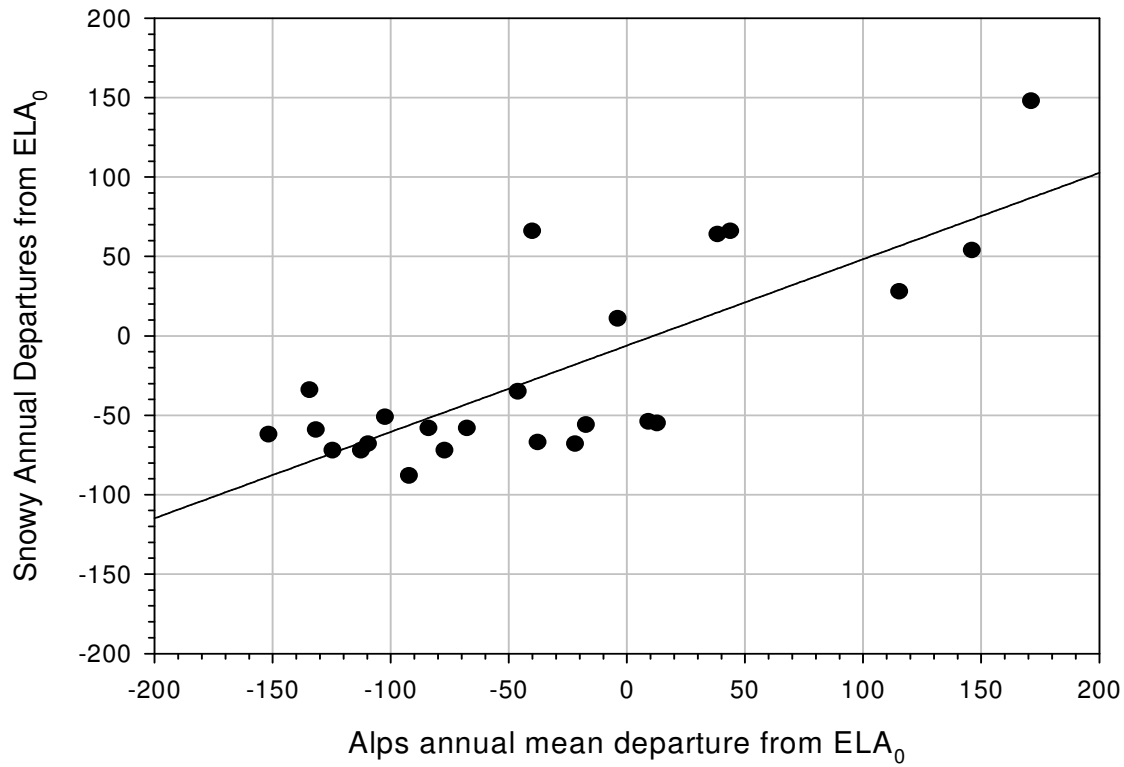
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	2092	0	31.88	21.25	53.13	0.60	0
1977							
1978	2156	64	6.86	46.27	53.13	0.13	-64
1979							
1980	2024	-68	48.36	4.77	53.13	0.91	68
1981	2158	66	6.42	46.71	53.13	0.12	-66
1982	2038	-54	45.43	7.70	53.13	0.86	54
1983	2033	-59	53.13	0.00	53.13	1.00	59
1984	2024	-68	48.33	4.80	53.13	0.91	68
1985	2020	-72	49.13	4.00	53.13	0.92	72
1986	2036	-56	45.93	7.20	53.13	0.86	56
1987	2025	-67	48.19	4.94	53.13	0.91	67
1988	2037	-55	45.93	7.20	53.13	0.86	55
1989	2103	11	28.18	24.95	53.13	0.53	-11
1990							
1991							
1992							
1993	2058	-34	40.69	12.44	53.13	0.77	34
1994	2034	-58	46.13	7.00	53.13	0.87	58
1995	2030	-62	47.13	6.00	53.13	0.89	62
1996	2057	-35	41.04	12.09	53.13	0.77	35
1997	2020	-72	64.34	-11.21	53.13	1.21	72
1998	2158	66	6.42	46.71	53.13	0.12	-66
1999	2240	148	53.13	0.00	53.13	1.00	-148
2000	2146	54	10.50	42.63	53.13	0.20	-54
2001	2004	-88	52.73	0.40	53.13	0.99	88
2002	2120	28	21.83	31.30	53.13	0.41	-28
2003	2041	-51	44.73	8.40	53.13	0.84	51
2004	2034	-58	53.13	0.00	53.13	1.00	58
2005	2020	-72	64.34	-11.21	53.13	1.21	72
MEAN	2071	-21	39.46	13.67		0.73	21

Snowy Pk.



Snowy correlation
 $y = -6.0951 + 0.5437 \cdot x \quad R^2 = 0.62$



Small cirque

GLACIER DATA		
Aspect	SE	
AREA	17.13	ha
Max Elev	1600	m
Min Elev	1400	m
Mean Elev	1500	m
Length	0.3	km
Elev Range	200	m
Gradient	0.67	

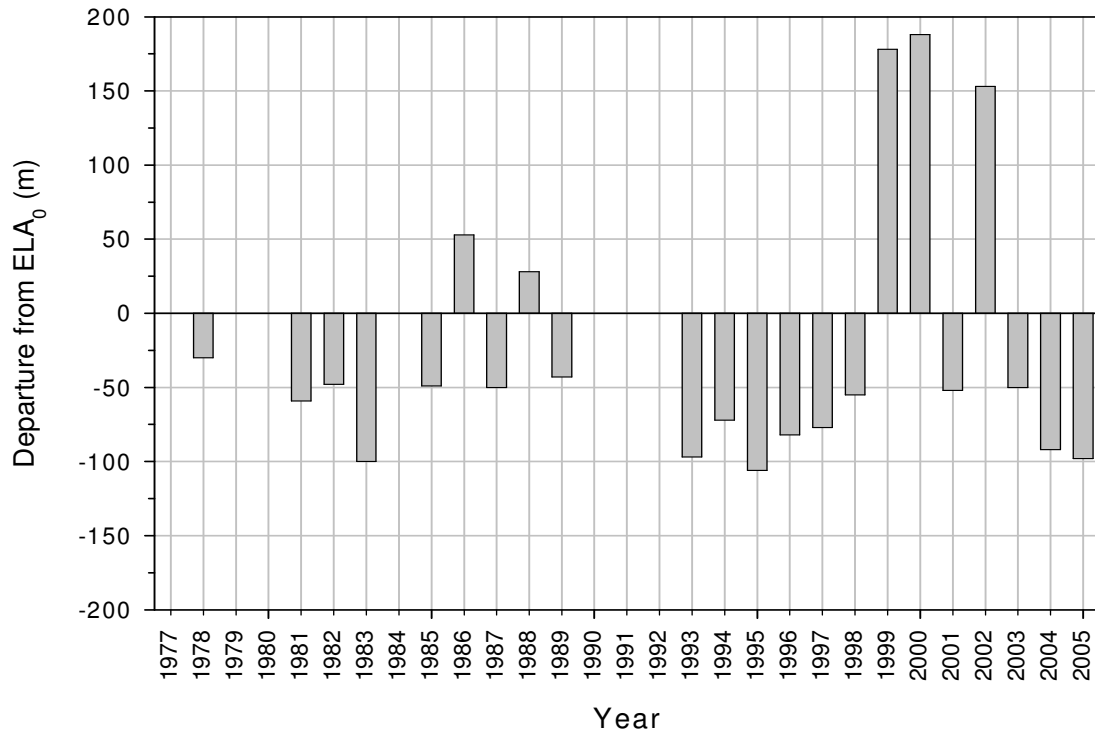
SNOWLINE DATA		
ELAo	1472	m
Max SL	1660	m, 2000
Min SL	1366	m, 1995
Mean SL	1447	m
SL Range	294	m
No. Surveys	22	

MEASUREMENTS

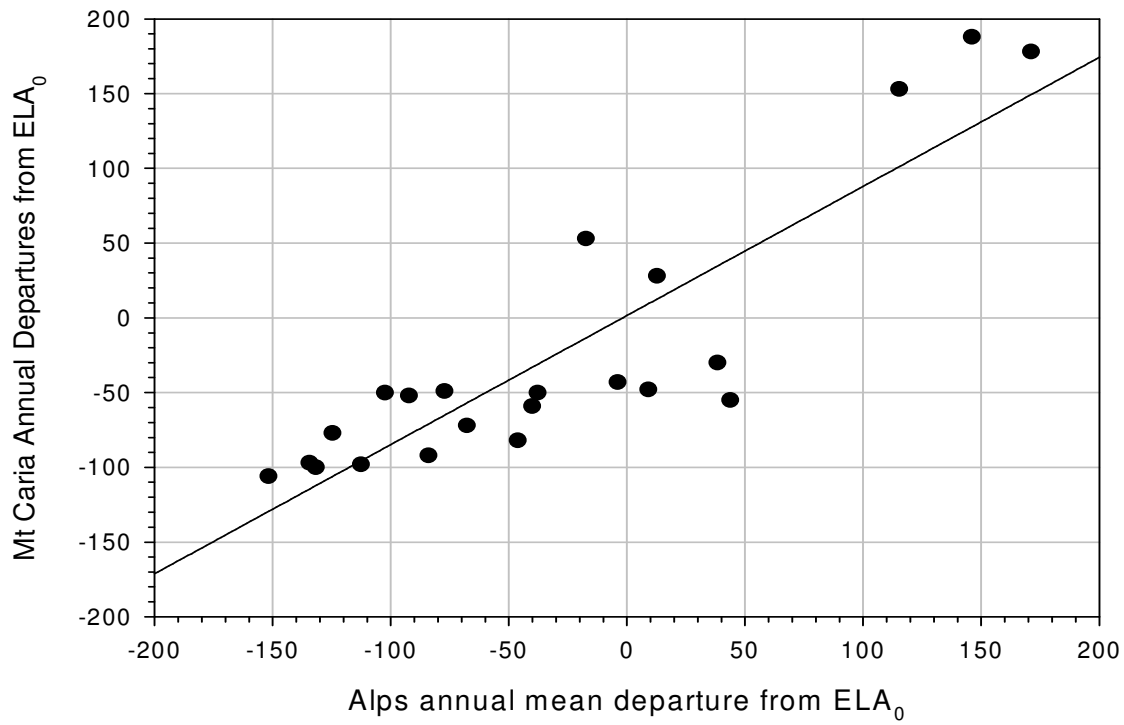
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1472	0	2.83	14.30	17.13	0.17	0
1977							
1978	1442	-30	7.05	10.08	17.13	0.41	30
1979							
1980							
1981	1413	-59	13.66	3.47	17.13	0.80	59
1982	1424	-48	10.74	6.39	17.13	0.63	48
1983	1372	-100	42.80	0.00	42.8	2.50	100
1984							
1985	1423	-49	10.84	6.29	17.13	0.63	49
1986	1525	53	9.80	7.33	17.13	0.57	-53
1987	1422	-50	11.06	6.07	17.13	0.65	50
1988	1500	28	6.43	10.70	17.13	0.38	-28
1989	1429	-43	9.80	7.33	17.13	0.57	43
1990							
1991							
1992							
1993	1375	-97	35.98	0.00	35.98	2.10	97
1994	1400	-72	17.13	0.00	17.13	1.00	72
1995	1366	-106	54.48	0.00	54.48	3.18	106
1996	1390	-82	22.00	0.00	22	1.28	82
1997	1395	-77	19.50	0.00	19.5	1.14	77
1998	1417	-55	12.46	4.67	17.13	0.73	55
1999	1650	178	0.00	17.13	17.13	0.00	-178
2000	1660	188	0.00	8.74	8.74	0.00	-188
2001	1420	-52	9.15	3.50	12.65	0.72	52
2002	1625	153	0.00	8.74	8.74	0.00	-153
2003	1422	-50	8.14	0.60	8.74	0.93	50
2004	1380	-92	8.74	0.00	8.74	1.00	92
2005	1374	-98	35.98	0.00	35.98	2.10	98
MEAN	1447	-25	14.75	4.81		0.91	25

Mt Caria



Mt Caria correlation
 $y = 1.5587 + 0.8636 \cdot x \quad R^2 = 0.77$



Cirque glacier

GLACIER DATA		
Aspect	SW	
AREA	67.15	ha
Max Elev	1900	m
Min Elev	1550	m
Mean Elev	1725	m
Length	0.875	km
Elev Range	350	m
Gradient	0.4	

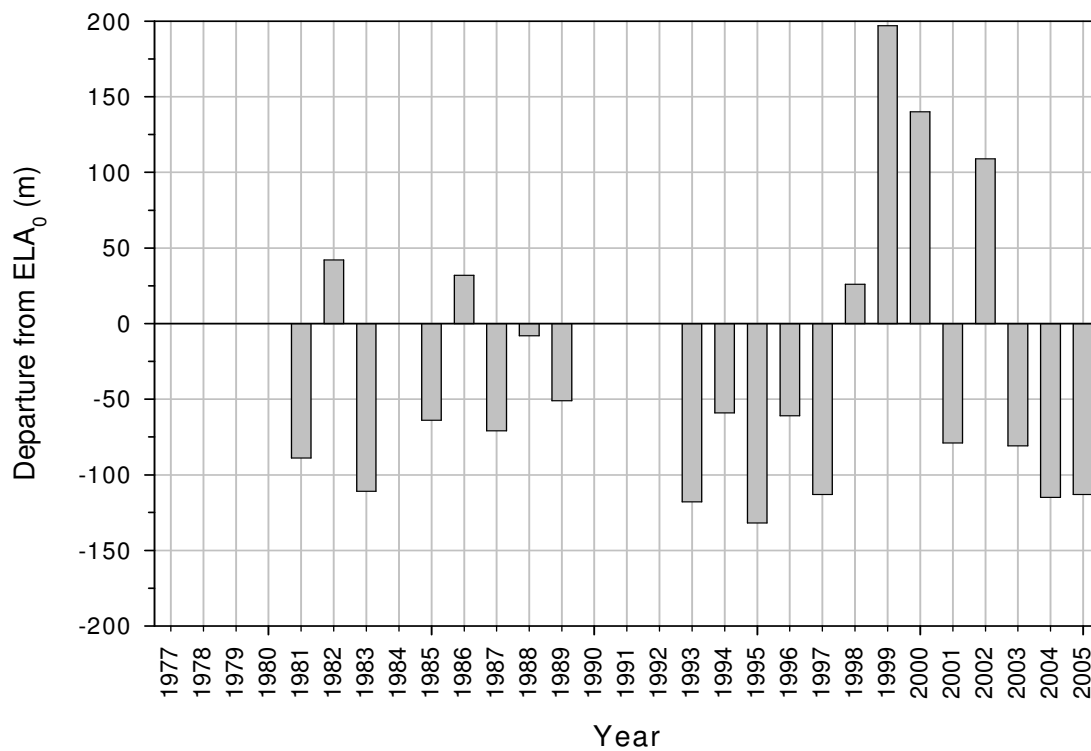
SNOWLINE DATA		
ELA₀	1693	m
Max SL	1890	m, 1999
Min SL	1561	m, 1995
Mean SL	1659	m
SL Range	329	m
No. Surveys	21	

MEASUREMENTS

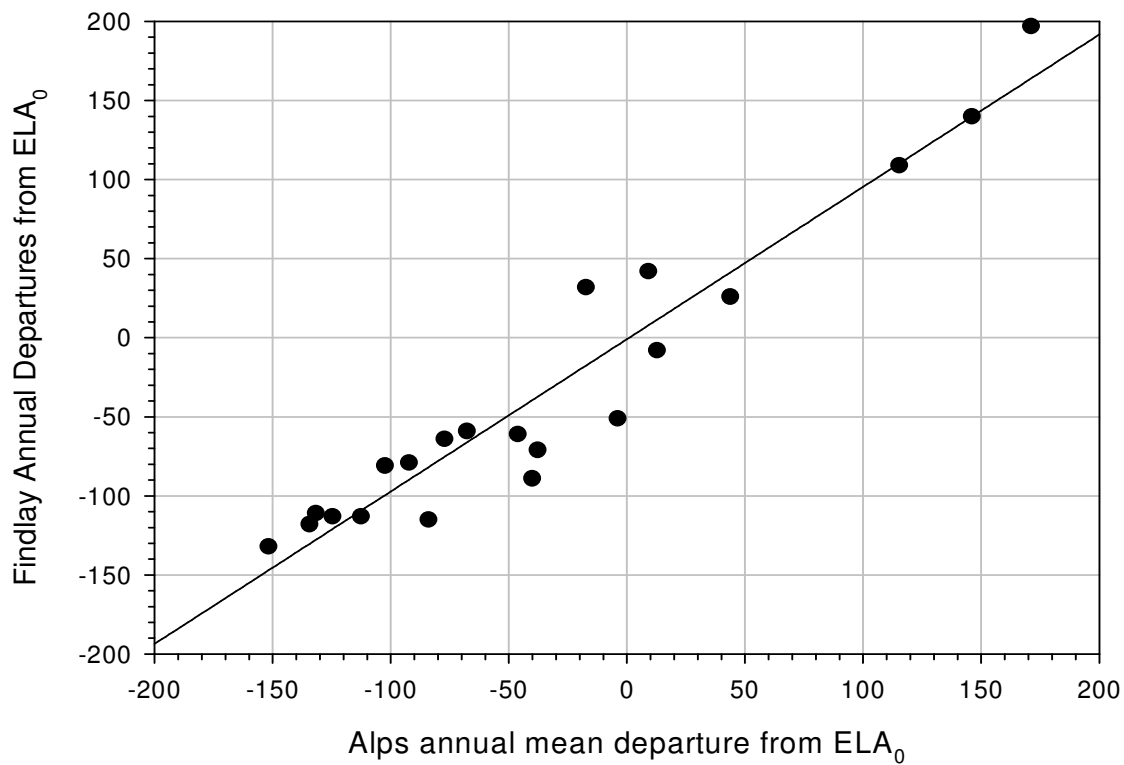
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELA ₀	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELA₀	1693	0	35.95	31.2	67.15	0.54	0
1977							
1978							
1979							
1980							
1981	1604	-89	57.53	9.62	67.15	0.86	89
1982	1735	42	25.85	41.30	67.15	0.38	-42
1983	1582	-111	61.52	5.63	67.15	0.92	111
1984							
1985	1629	-64	48.89	18.26	67.15	0.73	64
1986	1725	32	27.95	39.20	67.15	0.42	-32
1987	1622	-71	51.05	16.10	67.15	0.76	71
1988	1685	-8	35.15	32.00	67.15	0.52	8
1989	1642	-51	44.15	23.00	67.15	0.66	51
1990							
1991							
1992							
1993	1575	-118	62.90	4.25	67.15	0.94	118
1994	1634	-59	46.87	20.28	67.15	0.70	59
1995	1561	-132	65.17	1.98	67.15	0.97	132
1996	1632	-61	47.54	19.61	67.15	0.71	61
1997	1580	-113	62.00	5.15	67.15	0.92	113
1998	1719	26	29.05	38.10	67.15	0.43	-26
1999	1890	197	2.11	65.04	67.15	0.03	-197
2000	1833	140	7.82	59.33	67.15	0.12	-140
2001	1614	-79	54.01	13.14	67.15	0.80	79
2002	1802	109	10.79	46.63	57.42	0.19	-109
2003	1612	-81	45.62	11.80	57.42	0.79	81
2004	1578	-115	53.02	4.40	57.42	0.92	115
2005	1580	-113	53.02	4.40	57.42	0.92	113
Mean	1659	-34	41.37	23.74		0.62	34

Findlay Gl.



Findlay correlation
 $y = -0.9110 + 0.9634 \cdot x \quad R^2 = 0.92$



Valley glacier

GLACIER DATA		
Aspect	S	
AREA	213.6	ha
Max Elev	2200	m
Min Elev	1500	m
Mean Elev	1850	m
Length	2.63	km
Elev Range	700	m
Gradient	0.267	

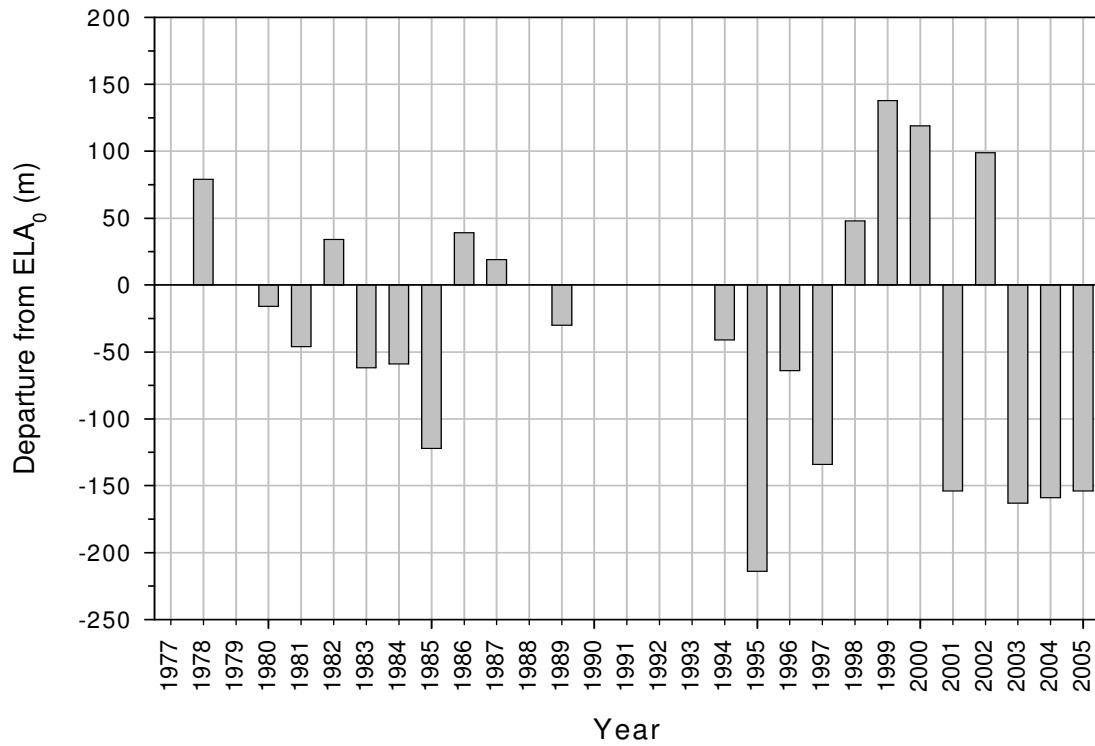
SNOWLINE DATA		
ELAo	1824	m
Max SL	1962	m, 1999
Min SL	1610	m, 1995
Mean SL	1786	m
SL Range	352	m
No. Surveys	22	

MEASUREMENTS

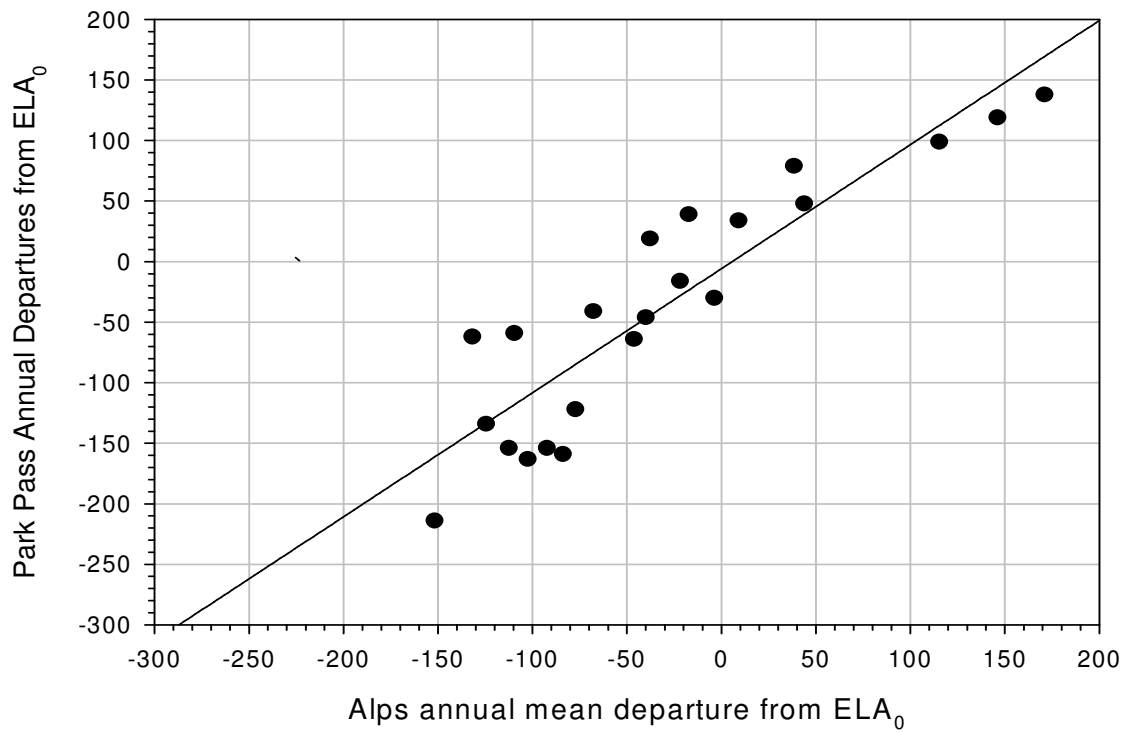
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1824	0	127.90	85.70	213.60	0.60	0
1977							
1978	1903	79	91.29	122.31	213.60	0.43	-79
1979							
1980	1808	-16	131.60	82.00	213.60	0.62	16
1981	1778	-46	139.20	74.40	213.60	0.65	46
1982	1858	34	112.40	101.20	213.60	0.53	-34
1983	1762	-62	142.67	70.93	213.60	0.67	62
1984	1765	-59	141.60	72.00	213.60	0.66	59
1985	1702	-122	156.60	57.00	213.60	0.73	122
1986	1863	39	110.10	103.50	213.60	0.52	-39
1987	1843	19	117.60	96.00	213.60	0.55	-19
1988							
1989	1794	-30	134.60	79.00	213.60	0.63	30
1990							
1991							
1992							
1993							
1994	1783	-41	138.10	75.50	213.60	0.65	41
1995	1610	-214	187.60	26.00	213.60	0.88	214
1996	1760	-64	143.17	70.43	213.60	0.67	64
1997	1690	-134	160.20	53.40	213.60	0.75	134
1998	1872	48	105.80	107.80	213.60	0.50	-48
1999	1962	138	62.07	151.53	213.60	0.29	-138
2000	1943	119	71.34	142.26	213.60	0.33	-119
2001	1670	-154	168.24	45.36	213.60	0.79	154
2002	1923	99	82.82	130.78	213.60	0.39	-99
2003	1661	-163	169.10	44.50	213.60	0.79	163
2004	1665	-159	168.60	45.00	213.60	0.79	159
2005	1670	-154	168.60	45.00	213.60	0.79	154
Mean	1786	-38	128.31	83.38		0.60	38

Park Pass Gl.



Park Pass correlation
 $y = -5.8011 + 1.0249 \cdot x$ $R^2 = 0.82$



Glaciette

GLACIER DATA		
Aspect	SE	
AREA	27.47	ha
Max Elev	2220	m
Min Elev	1680	m
Mean Elev	1950	m
Length	0.5	km
Elev Range	540	m
Gradient	1.08	

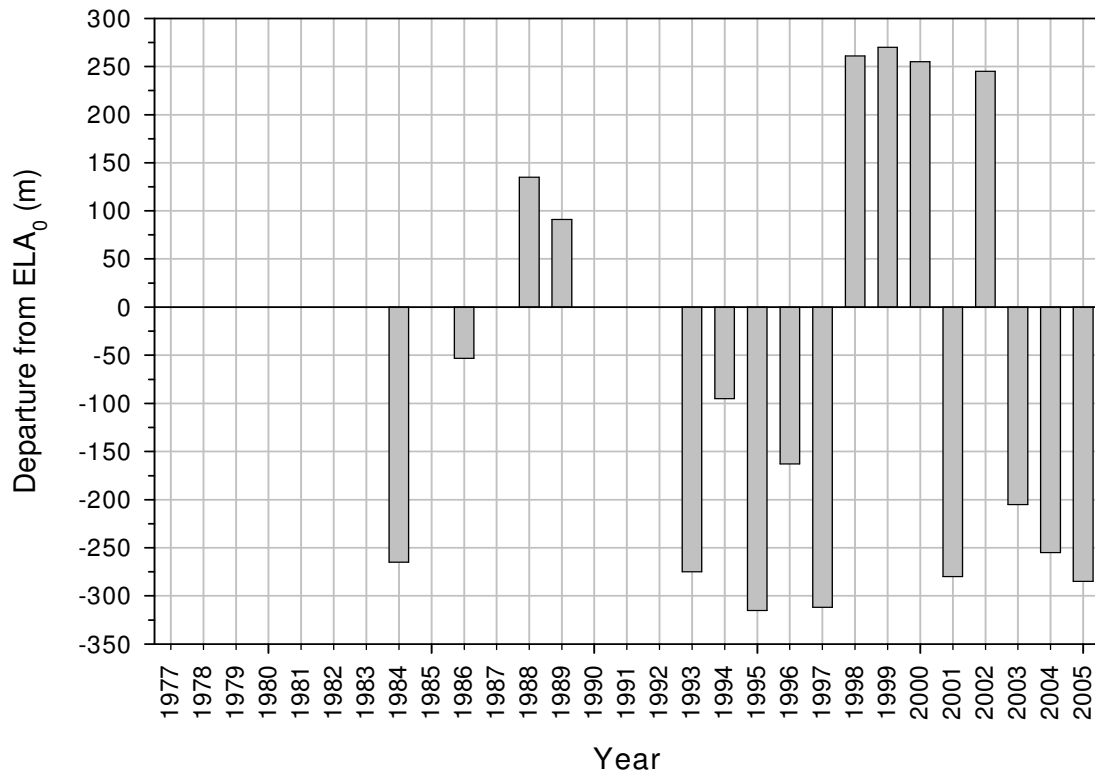
SNOWLINE DATA		
ELAo	1945	m
Max. SL	2215	m, 1998
Min. SL	1630	m, 1995
Mean SL	1872	m
SL Range	585	m
No. surveys	18	

MEASUREMENTS

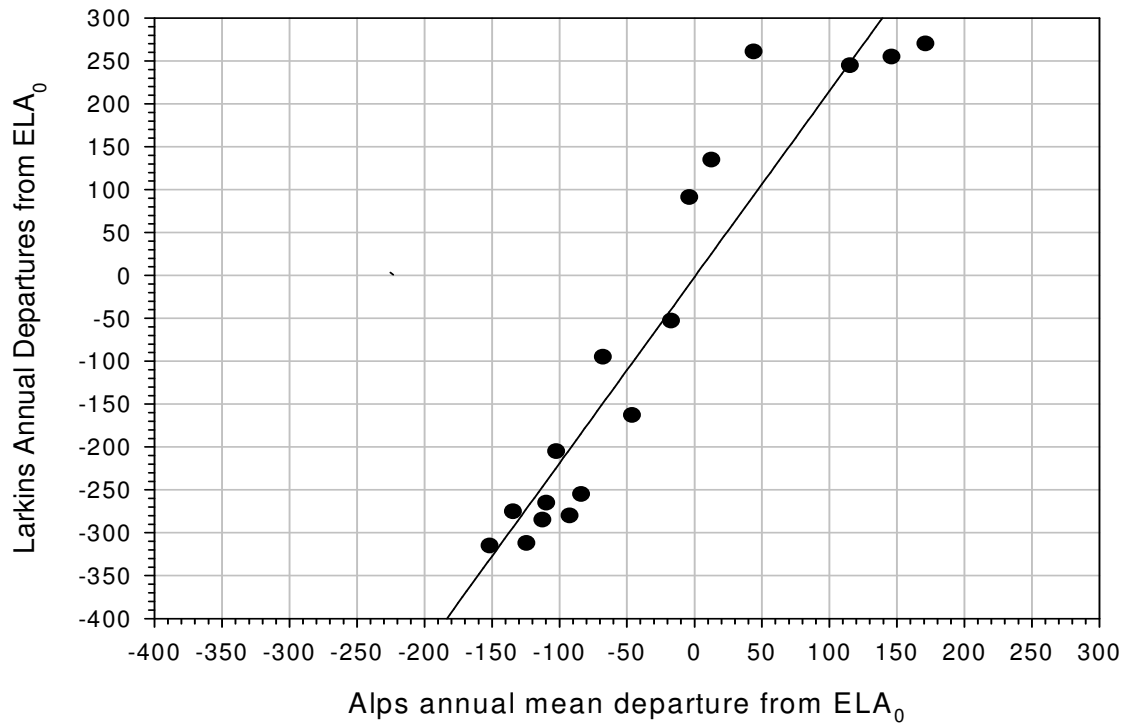
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1945	0	17.67	9.80	27.47	0.64	0
1977							
1978							
1979							
1980							
1981							
1982							
1983							
1984	1680	-265	33.82	0.00	33.82	1.23	265
1985							
1986	1892	-53	33.82	0.00	33.82	1.23	53
1987							
1988	2080	135	9.47	18.00	27.47	0.34	-135
1989	2036	91	10.84	16.63	27.47	0.39	-91
1990							
1991							
1992							
1993	1670	-275	39.50	0.00	39.50	1.44	275
1994	1850	-95	23.40	4.07	27.47	0.85	95
1995	1630	-315	43.61	0.00	43.61	1.59	315
1996	1782	-163	27.47	0.00	27.47	1.00	163
1997	1633	-312	36.80	0.00	36.80	1.34	312
1998	2206	261	0.92	26.55	27.47	0.03	-261
1999	2215	270	0.95	26.52	27.47	0.03	-270
2000	2200	255	1.46	14.75	16.21	0.09	-255
2001	1665	-280	27.47	0.00	27.47	1.00	280
2002	2190	245	2.17	14.04	16.21	0.13	-245
2003	1740	-205	15.51	0.70	16.21	0.96	205
2004	1690	-255	27.47	0.00	27.47	1.00	255
2005	1660	-285	27.47	0.00	27.47	1.00	285
MEAN	1872	-73	20.92	7.58		0.78	73

Mt Larkins



Larkins correlation
 $y = -2.0444 + 2.1689 \cdot x \quad R^2 = 0.90$



Mountain glacier

GLACIER DATA		
Aspect	SE	
AREA	29.7	ha
Max Elev	2180	m
Min Elev	1660	m
Mean Elev	1920	m
Length	0.94	km
Elev Range	520	m
Gradient	0.55	

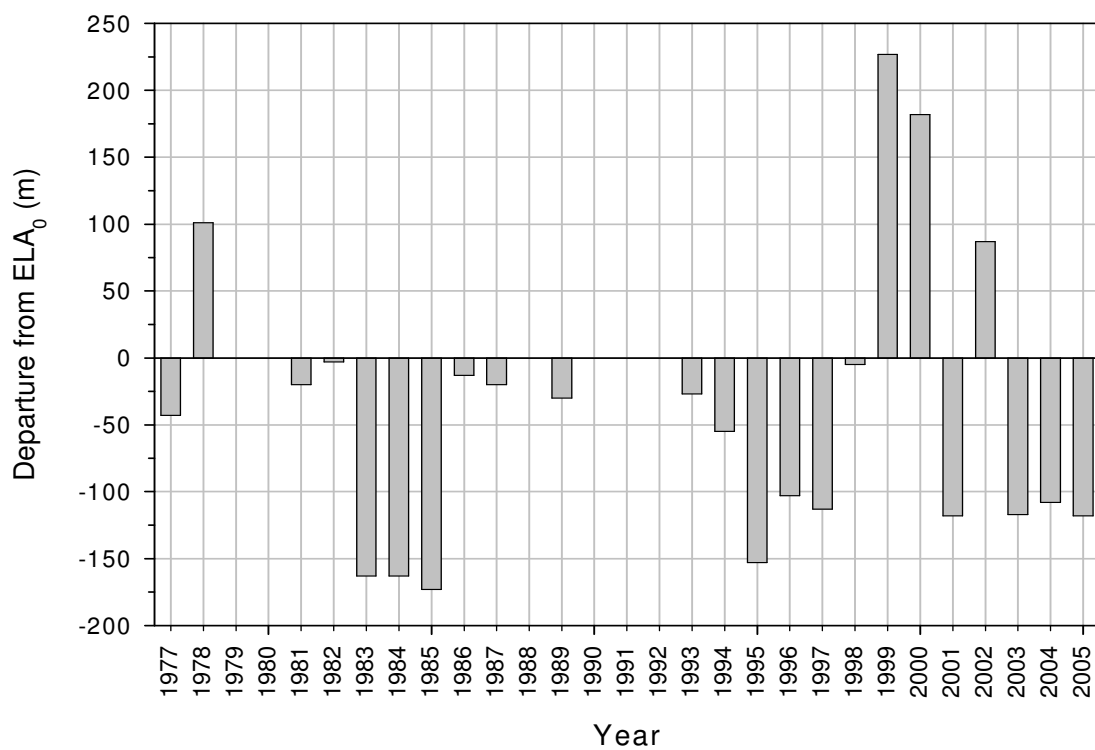
SNOWLINE DATA		
ELAo	1783	m
Max. SL	2010	m, 1999
Min. SL	1610	m, 1995
Mean SL	1742	m
SL Range	400	m
No. surveys	23	

MEASUREMENTS

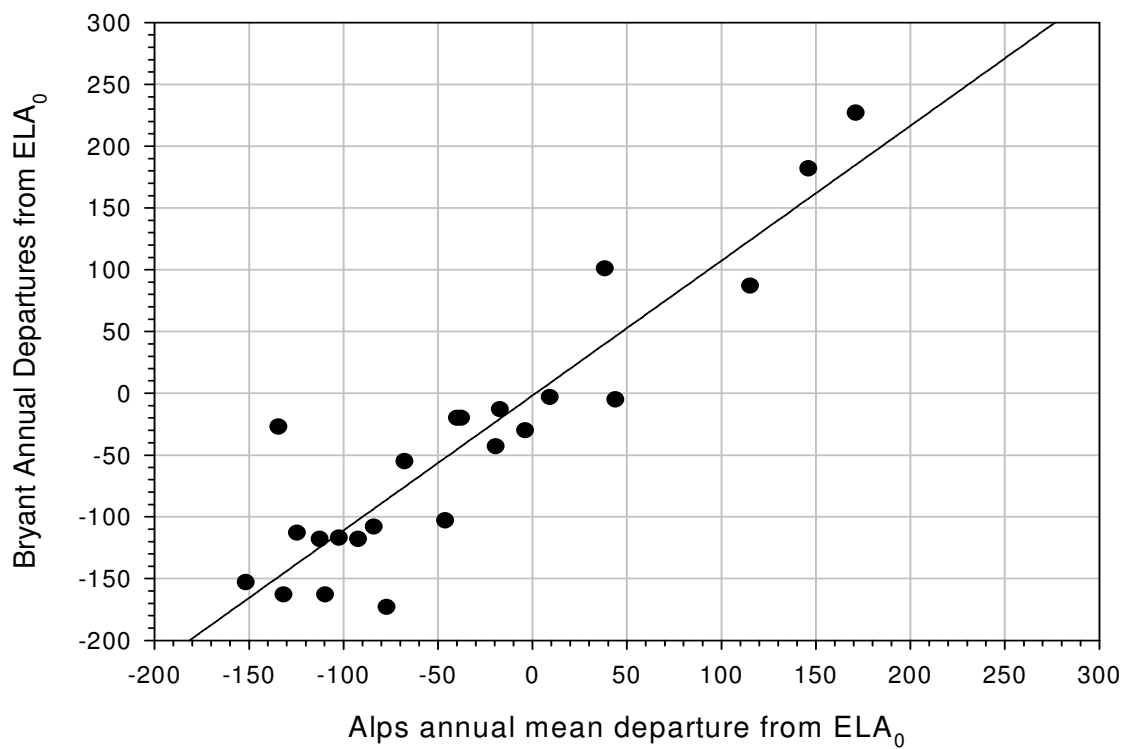
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1783	0	12.20	17.50	29.7	0.41	0
1977	1740	-43	20.90	8.80	29.7	0.70	43
1978	1884	101	4.90	24.80	29.7	0.16	-101
1979							
1980							
1981	1763	-20	15.70	14.00	29.7	0.53	20
1982	1780	-3	12.70	17.00	29.7	0.43	3
1983	1620	-163	34.50	0.00	34.5	1.16	163
1984	1620	-163	31.80	0.00	31.8	1.07	163
1985	1610	-173	37.30	0.00	37.3	1.26	173
1986	1770	-13	14.08	15.62	29.7	0.47	13
1987	1763	-20	15.70	14.00	29.7	0.53	20
1988							
1989	1753	-30	17.40	12.30	29.7	0.59	30
1990							
1991							
1992							
1993	1756	-27	17.20	12.50	29.7	0.58	27
1994	1728	-55	23.40	6.30	29.7	0.79	55
1995	1630	-153	40.17	0.00	40.17	1.35	153
1996	1680	-103	29.10	0.60	29.7	0.98	103
1997	1670	-113	29.01	0.69	29.7	0.98	113
1998	1778	-5	13.16	16.54	29.7	0.44	5
1999	2010	227	0.97	28.73	29.7	0.03	-227
2000	1965	182	1.85	27.85	29.7	0.06	-182
2001	1665	-118	29.20	0.50	29.7	0.98	118
2002	1870	87	5.50	24.20	29.7	0.19	-87
2003	1666	-117	28.80	0.90	29.7	0.97	117
2004	1675	-108	29.06	0.64	29.7	0.98	108
2005	1665	-118	28.80	0.90	29.7	0.97	118
MEAN	1742	-41	20.16	10.27		0.69	41

Bryant Gl.



Bryant correlation
 $y = -1.8276 + 1.0917 \cdot x \quad R^2 = 0.85$



Cirque glacier

GL DATA		
Aspect	S	
AREA	22.91	ha
Max Elev	1830	m
Min Elev	1530	m
Mean Elev	1680	m
Length	0.75	km
Elev Range	300	m
Gradient	0.4	

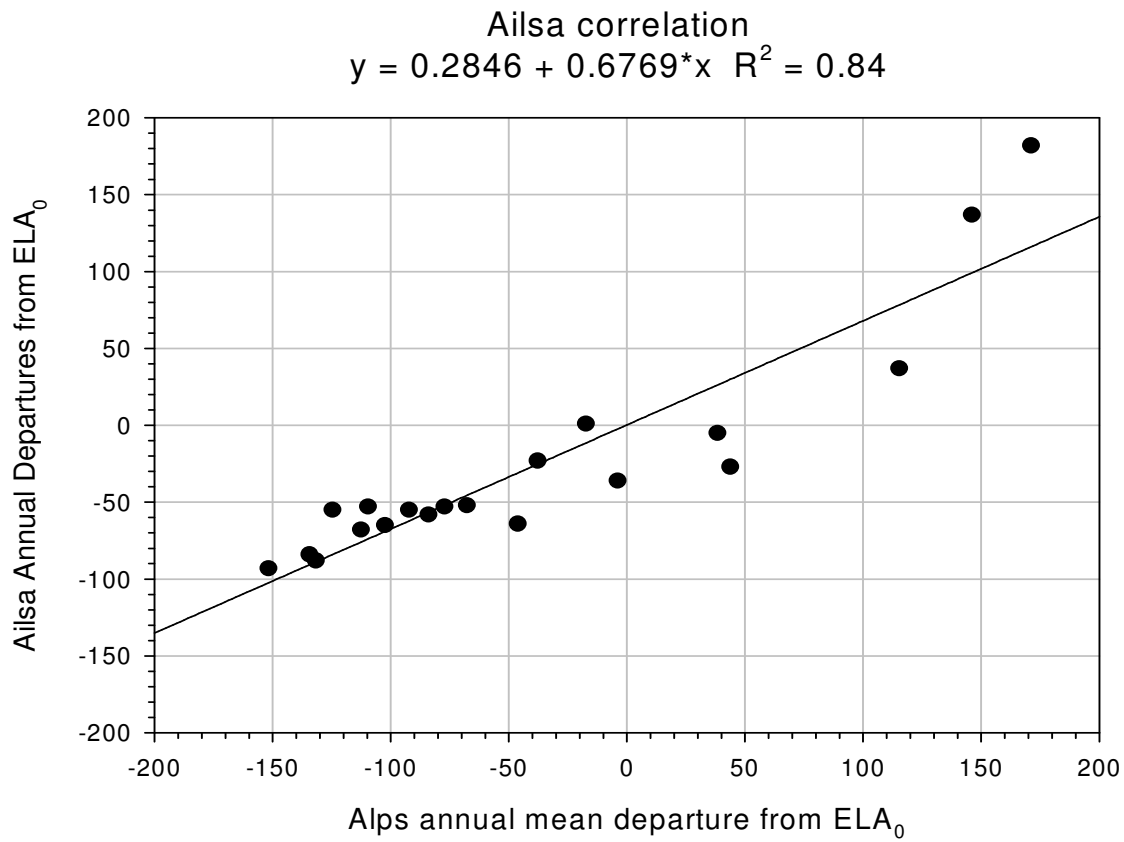
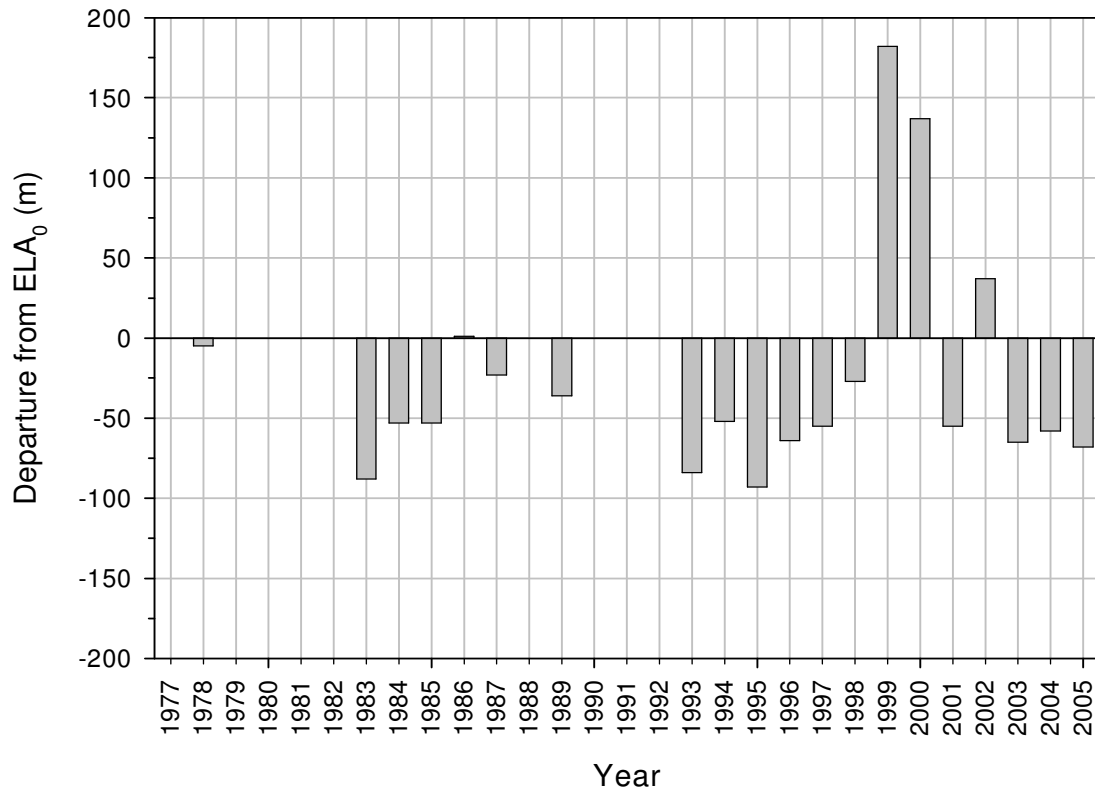
SNOWLINE DATA		
ELAo	1648	m
Max SL	1830	m, 1999
Min SL	1555	m, 1995
Mean SL	1621.9	m
SL Range	275	m
No. surveys	20	

MEASUREMENTS

Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1648	0	7.72	10.50	18.22	0.42	0
1977							
1978	1643	-5	9.32	13.59	22.91	0.41	5
1979							
1980							
1981							
1982							
1983	1560	-88	19.21	3.70	22.91	0.84	88
1984	1595	-53	14.91	8.00	22.91	0.65	53
1985	1595	-53	14.91	8.00	22.91	0.65	53
1986	1649	1	8.57	14.34	22.91	0.37	-1
1987	1625	-23	11.48	11.43	22.91	0.50	23
1988							
1989	1612	-36	12.78	10.13	22.91	0.56	36
1990							
1991							
1992							
1993	1564	-84	18.81	4.10	22.91	0.82	84
1994	1596	-52	14.71	8.20	22.91	0.64	52
1995	1555	-93	19.79	3.12	22.91	0.86	93
1996	1584	-64	16.27	6.64	22.91	0.71	64
1997	1593	-55	15.15	7.76	22.91	0.66	55
1998	1621	-27	11.91	11.00	22.91	0.52	27
1999	1830	182	0.00	22.91	22.91	0.00	-182
2000	1785	137	0.77	22.14	18.91	0.04	-137
2001	1593	-55	10.52	7.70	18.22	0.58	55
2002	1685	37	4.35	13.87	18.22	0.24	-37
2003	1583	-65	13.42	4.80	18.22	0.74	65
2004	1590	-58	10.42	7.80	18.22	0.57	58
2005	1580	-68	13.42	4.80	18.22	0.74	68
MEAN	1622	-26	12.05	9.96		0.54	26

Ailsa Mts



Cirque glacier

GLACIER DATA		
Aspect	SE	
AREA	53.72	ha
Max Elev	1820	m
Min Elev	1470	m
Mean Elev	1645	m
Length	0.75	km
Elev Range	350	m
Gradient	0.47	

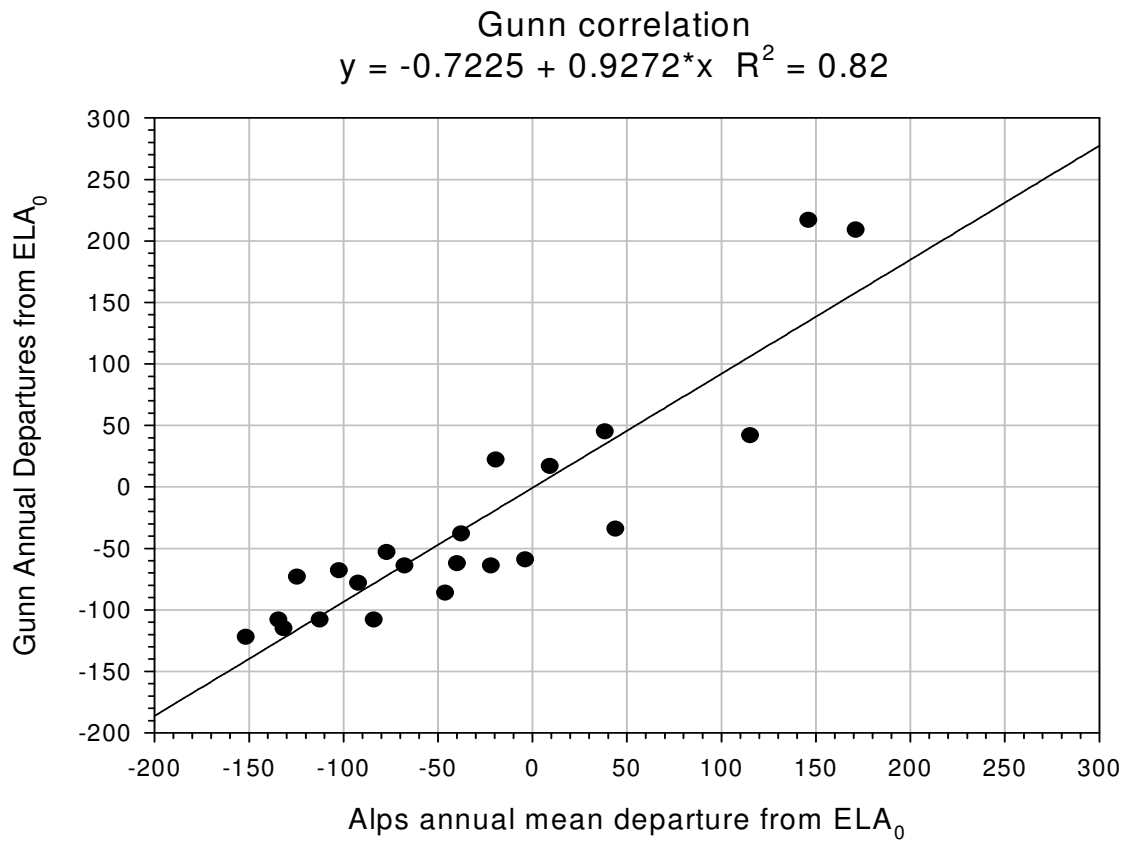
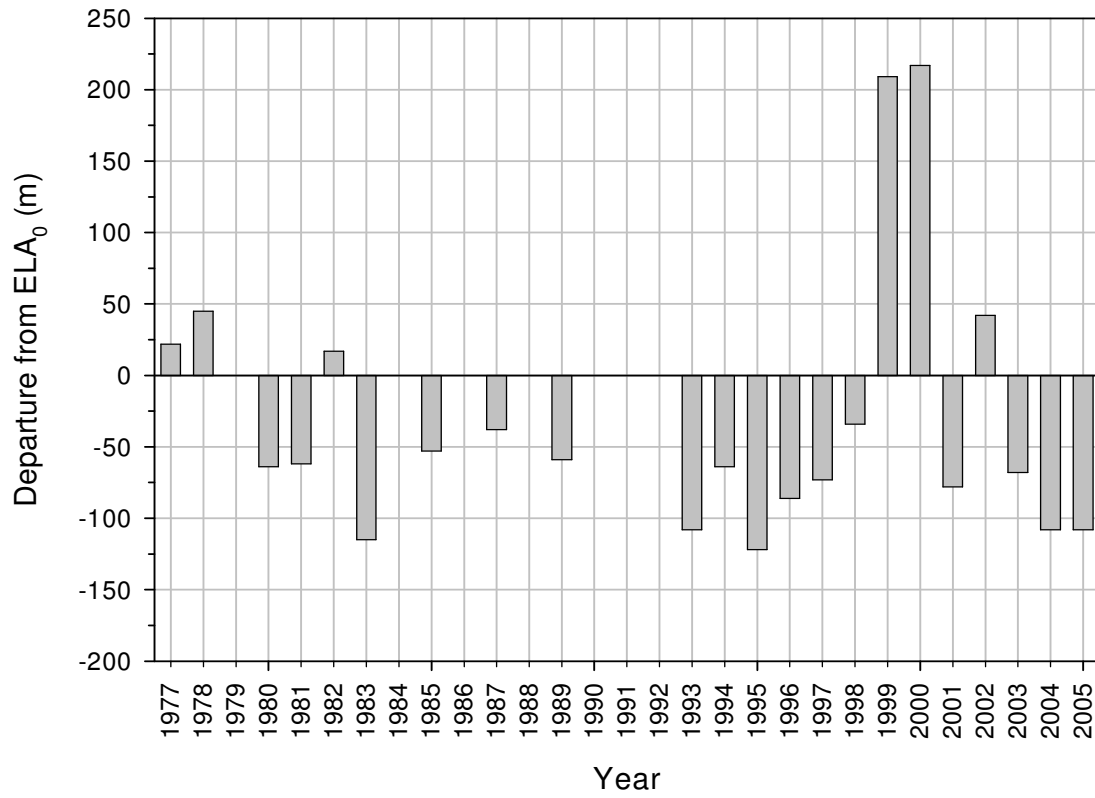
SNOWLINE DATA		
ELAo	1593	m
Max SL	1810	m, 2000
Min SL	1471	m, 1995
Mean SL	1562	m
SL Range	339	m
No. surveys	22	

MEASUREMENTS

Digitised values shaded

YEAR	SNOWLINE	DEPARTURE	AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO
	m	m	ha	ha	ha	(AAR)
ELAo	1593	0	14.67	21.00	35.67	0.41
1977	1615	22	14.72	39.00	53.72	0.27
1978	1638	45	12.11	41.61	53.72	0.23
1979						
1980	1529	-64	33.40	20.32	53.72	0.62
1981	1531	-62	32.44	21.28	53.72	0.60
1982	1610	17	15.50	38.22	53.72	0.29
1983	1478	-115	51.31	2.41	53.72	0.96
1984						
1985	1540	-53	30.24	23.48	53.72	0.56
1986						
1987	1555	-38	26.32	27.40	53.72	0.49
1988						
1989	1534	-59	31.84	21.88	53.72	0.59
1990						
1991						
1992						
1993	1485	-108	48.12	5.60	53.72	0.90
1994	1529	-64	33.40	20.32	53.72	0.62
1995	1471	-122	53.32	0.40	53.72	0.99
1996	1507	-86	40.12	13.60	53.72	0.75
1997	1520	-73	36.19	17.53	53.72	0.67
1998	1559	-34	25.42	28.30	53.72	0.47
1999	1802	209	0.77	52.95	53.72	0.01
2000	1810	217	0.49	53.23	53.67	0.01
2001	1515	-78	28.09	16.38	44.47	0.63
2002	1635	42	8.83	26.84	35.67	0.25
2003	1525	-68	25.97	9.70	35.67	0.73
2004	1485	-108	30.07	5.60	35.67	0.84
2005	1485	-108	30.07	5.60	35.67	0.84
MEAN	1562	-31	27.67	23.15		0.56
						31

Mt Gunn



Mountain gl, reliability B

GLACIER DATA		
Aspect	S	
Area	49.35	ha
Max Elev	1900	m
Min Elev	1440	m
Mean Elev	1670	m
Length	0.525	km
Elev Range	460	m
Gradient	0.88	

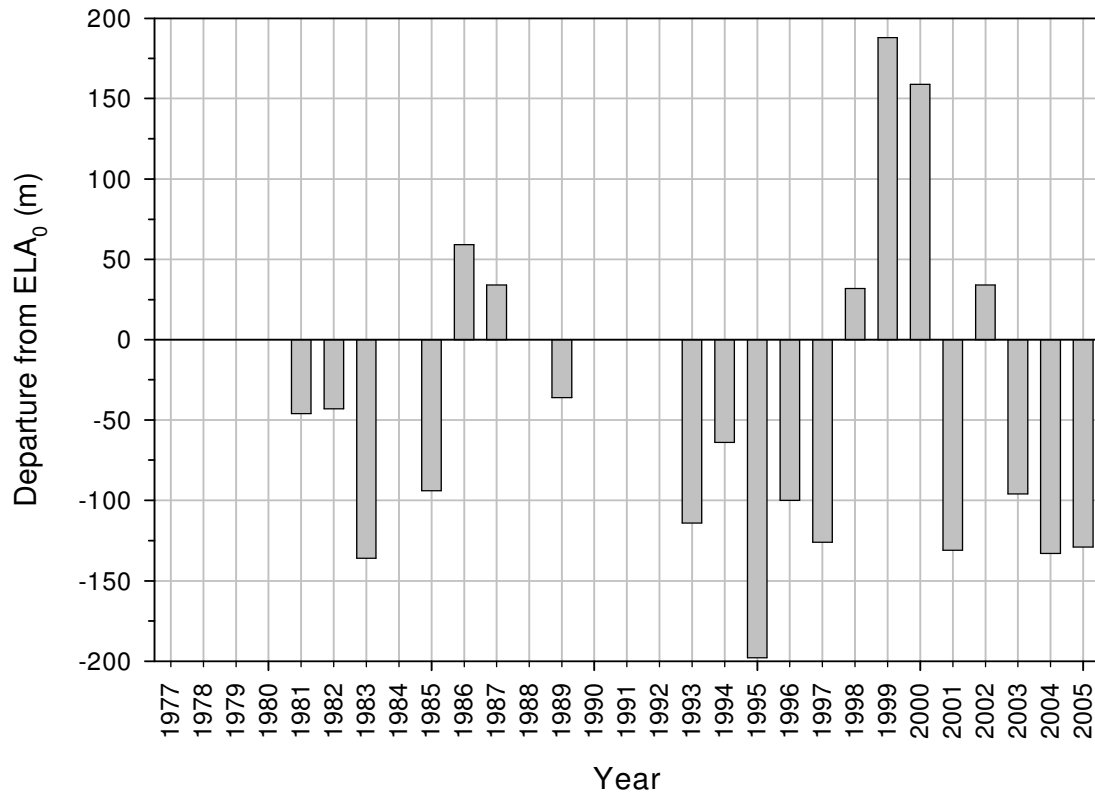
SNOWLINE DATA		
ELA	1616	m
Max SL	1804	m, 1999
Min SL	1418	m, 1995
Mean SL	1578	m
SL range	386	m
No. surveys	20	

MEASUREMENTS

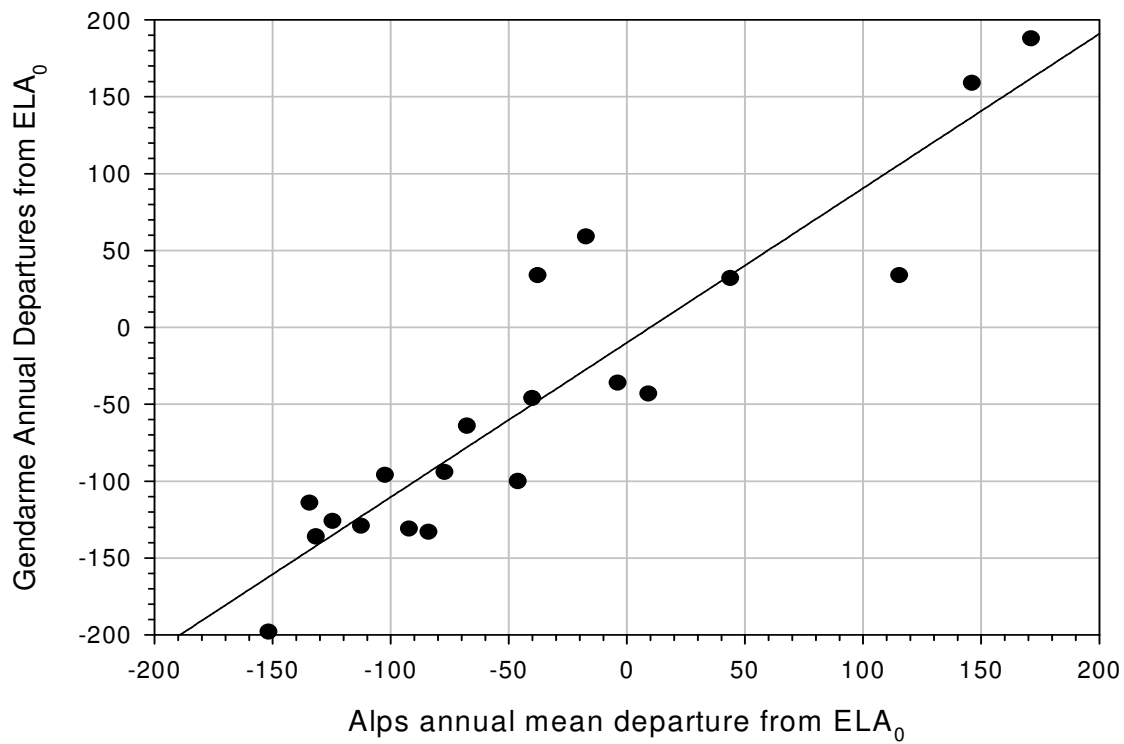
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE	AREAS	ACCUM.	MASS
	ELEVATION	FROM ELA	ABL.	TOTAL	AREA RATIO
	m	m	ha	ha	(AAR)
ELAo	1616	0	31.85	17.50	49.35
1977					
1978					
1979					
1980					
1981	1570	-46	38.36	10.99	49.35
1982	1573	-43	37.85	11.50	49.35
1983	1480	-136	55.97	0.00	55.97
1984					
1985	1522	-94	44.53	4.82	49.35
1986	1675	59	21.95	27.40	49.35
1987	1650	34	25.87	23.48	49.35
1988					
1989	1580	-36	35.50	13.85	49.35
1990					
1991					
1992					
1993	1502	-114	46.42	2.93	49.35
1994	1552	-64	40.55	8.80	49.35
1995	1418	-198	58.67	0.00	58.67
1996	1516	-100	45.20	4.15	49.35
1997	1490	-126	47.25	2.10	49.35
1998	1648	32	26.45	22.90	49.35
1999	1804	188	2.33	47.02	49.35
2000	1775	159	6.08	43.27	49.35
2001	1485	-131	48.45	0.90	49.35
2002	1650	34	25.85	23.50	49.35
2003	1520	-96	47.95	1.40	49.35
2004	1483	-133	49.35	0.00	49.35
2005	1487	-129	49.35	0.00	49.35
MEAN	1578	-39	36.34	14.01	0.74

Gendarme



Gendarme correlation
 $y = -9.8823 + 1.0044 \cdot x \quad R^2 = 0.86$



Cirque glacier

GLACIER DATA		
Aspect	SW	
AREA	18.06	ha
Max Elev	1680	m
Min Elev	1310	m
Mean Elev	1495	m
Length	0.75	km
Elev Range	370	m
Gradient	0.49	

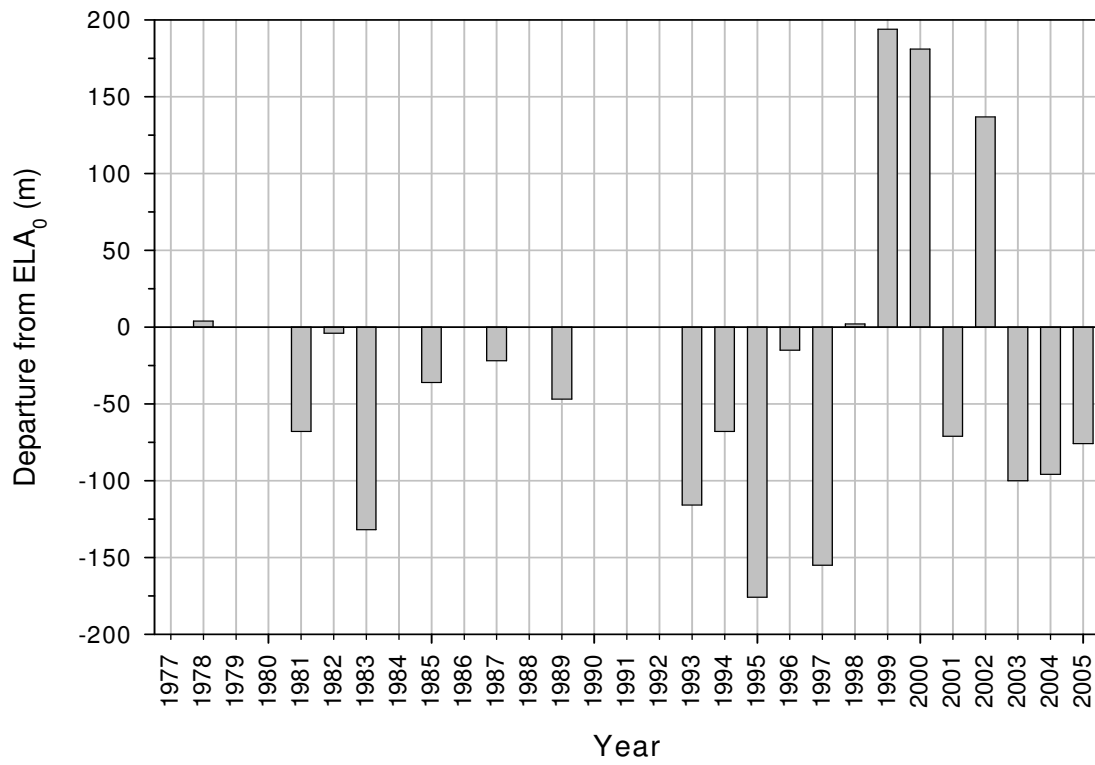
SNOWLINE DATA		
ELAo	1476	m
Max SL	1670	m, 1999
Min SL	1300	m, 1995
Mean SL	1443	m
SL Range	370	m
No. surveys	20	

MEASUREMENTS

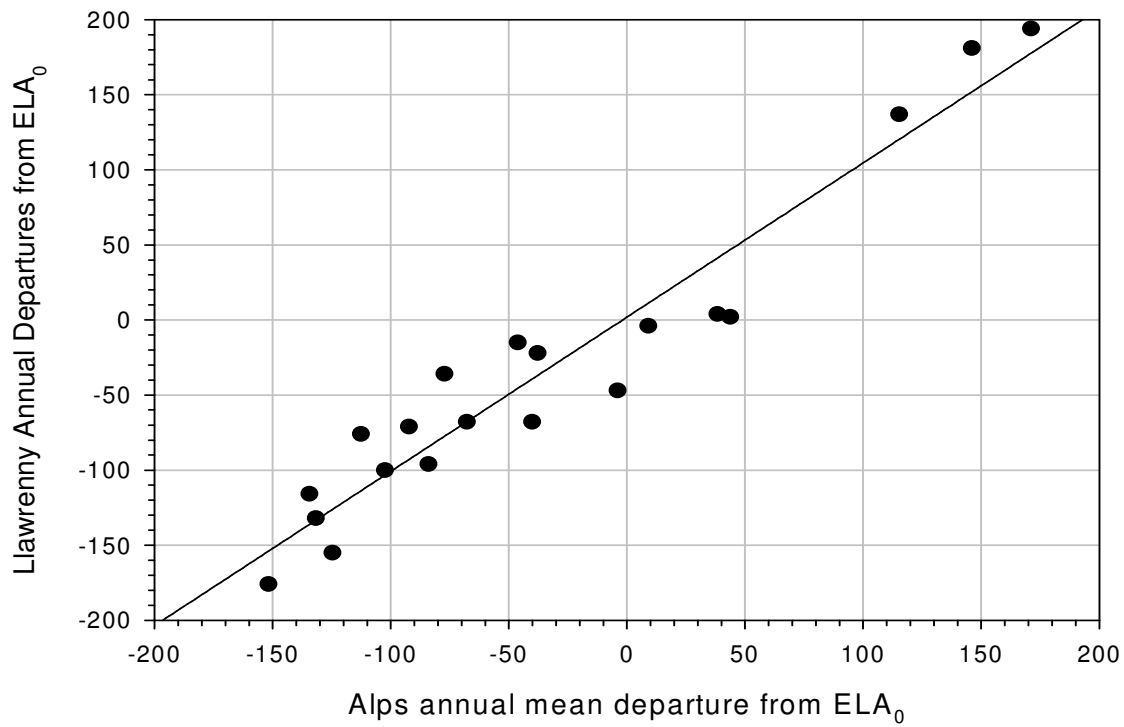
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE	AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO
	m	m	ha	ha	ha	(AAR)
ELAo	1476	0	9.26	8.80	18.06	0.51
1977						
1978	1480	4	8.96	9.10	18.06	0.50
1979						
1980						
1981	1408	-68	15.56	2.50	18.06	0.86
1982	1472	-4	9.35	8.71	18.06	0.52
1983	1344	-132	17.46	0.60	18.06	0.97
1984						
1985	1440	-36	12.77	5.29	18.06	0.71
1986						
1987	1454	-22	11.40	6.66	18.06	0.63
1988						
1989	1429	-47	13.96	4.10	18.06	0.77
1990						
1991						
1992						
1993	1360	-116	17.12	0.94	18.06	0.95
1994	1408	-68	15.60	2.46	18.06	0.86
1995	1300	-176	27.80	0.00	27.8	1.54
1996	1461	-15	10.54	7.52	18.06	0.58
1997	1321	-155	17.70	0.36	18.06	0.98
1998	1478	2	9.17	8.89	18.06	0.51
1999	1670	194	0.28	17.78	18.06	0.02
2000	1657	181	0.63	17.43	15.73	0.03
2001	1405	-71	15.72	2.34	18.06	0.87
2002	1613	137	2.07	12.52	14.59	0.11
2003	1376	-100	16.96	1.10	18.06	0.94
2004	1380	-96	17.06	1.00	18.06	0.94
2005	1400	-76	15.72	2.34	18.06	0.87
MEAN	1443	-33	12.64	6.02		0.69
						33

Llawrenny Peaks



Llawrenny correlation
 $y = 1.9083 + 1.0273 \cdot x$ $R^2 = 0.93$



Mountain glacier

GLACIER DATA		
Aspect	S	
AREA	57.56	ha
Max Elev	1900	m
Min Elev	1420	m
Mean Elev	1660	m
Elev Range	480	m
Length	0.75	km
Gradient	0.64	

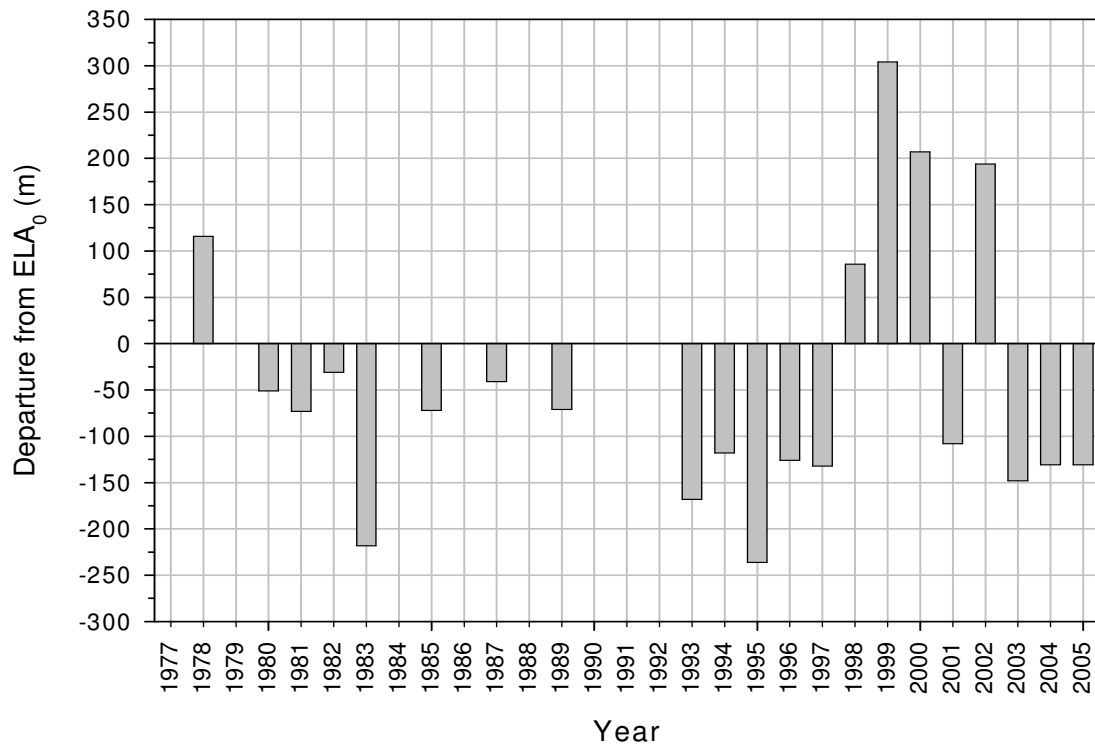
SNOWLINE DATA		
ELAo	1596	m
Max SL	1900	m, 1999
Min SL	1360	m, 1995
Mean SL	1560	m
SL Range	540	m
No. Surveys	21	

MEASUREMENTS

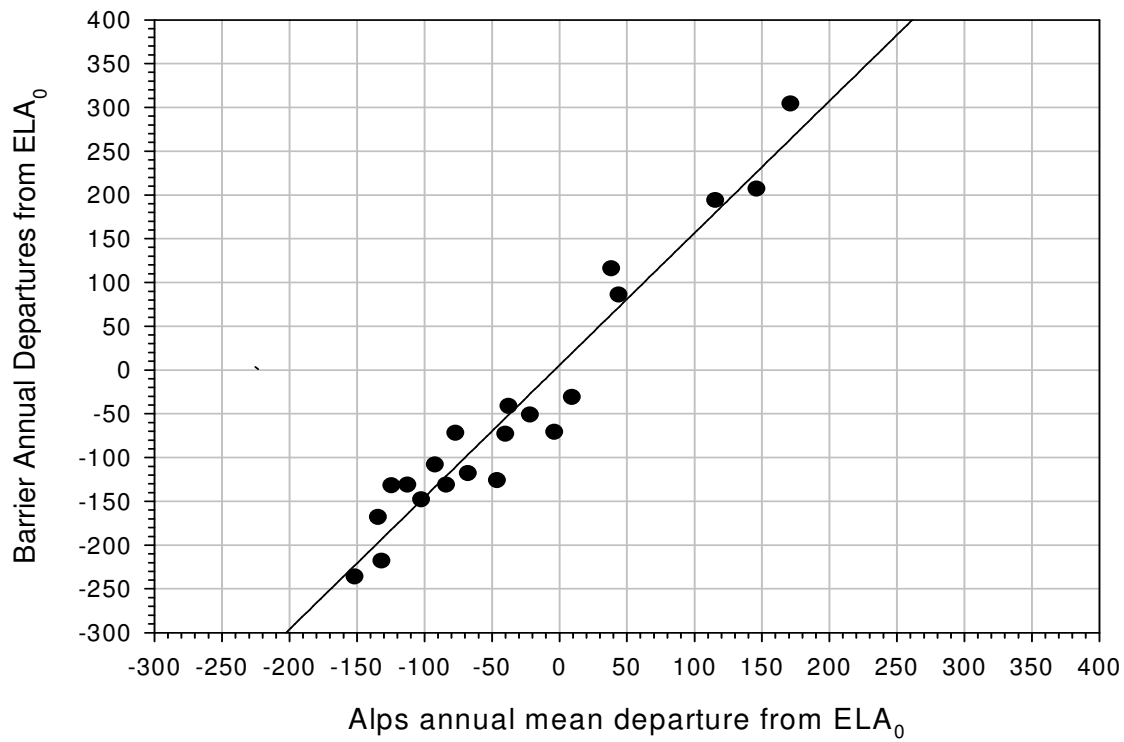
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1596	0	40.36	17.20	57.56	0.70	0
1977							
1978	1712	116	20.06	37.5	57.56	0.35	-116
1979							
1980	1545	-51	48.56	9	57.56	0.84	51
1981	1523	-73	51.23	6.33	57.56	0.89	73
1982	1565	-31	45.36	12.2	57.56	0.79	31
1983	1378	-218	63.9	0	63.9	1.11	218
1984							
1985	1524	-72	51.19	6.37	57.56	0.89	72
1986							
1987	1555	-41	46.86	10.7	57.56	0.81	41
1988							
1989	1525	-71	50.96	6.6	57.56	0.89	71
1990							
1991							
1992							
1993	1428	-168	60.7	0	60.7	1.05	168
1994	1478	-118	55.23	2.33	57.56	0.96	118
1995	1360	-236	65.03	0	65.03	1.13	236
1996	1470	-126	55.51	2.05	57.56	0.96	126
1997	1464	-132	56.75	0.81	57.56	0.99	132
1998	1682	86	25.14	32.42	57.56	0.44	-86
1999	1900	304	0	57.56	57.56	0.00	-304
2000	1803	207	3.28	54.28	57.56	0.06	-207
2001	1488	-108	54.56	3	57.56	0.95	108
2002	1790	194	5.36	32.82	38.18	0.09	-194
2003	1448	-148	56.56	1.00	57.56	0.98	148
2004	1465	-131	56.75	0.81	57.56	0.99	131
2005	1465	-131	56.75	0.81	57.56	0.99	131
MEAN	1560	-41	42.96	14.47		0.75	41

Barrier Peak



Barrier correlation
 $y = 5.5366 + 1.5086 \cdot x \quad R^2 = 0.94$



Glacierette

GLACIER DATA		
Aspect	E	
AREA	12.78	ha
Max Elev	1800	m
Min Elev	1450	m
Mean Elev	1625	m
Elev Range	350	m
Length	0.5	km
Gradient	0.7	

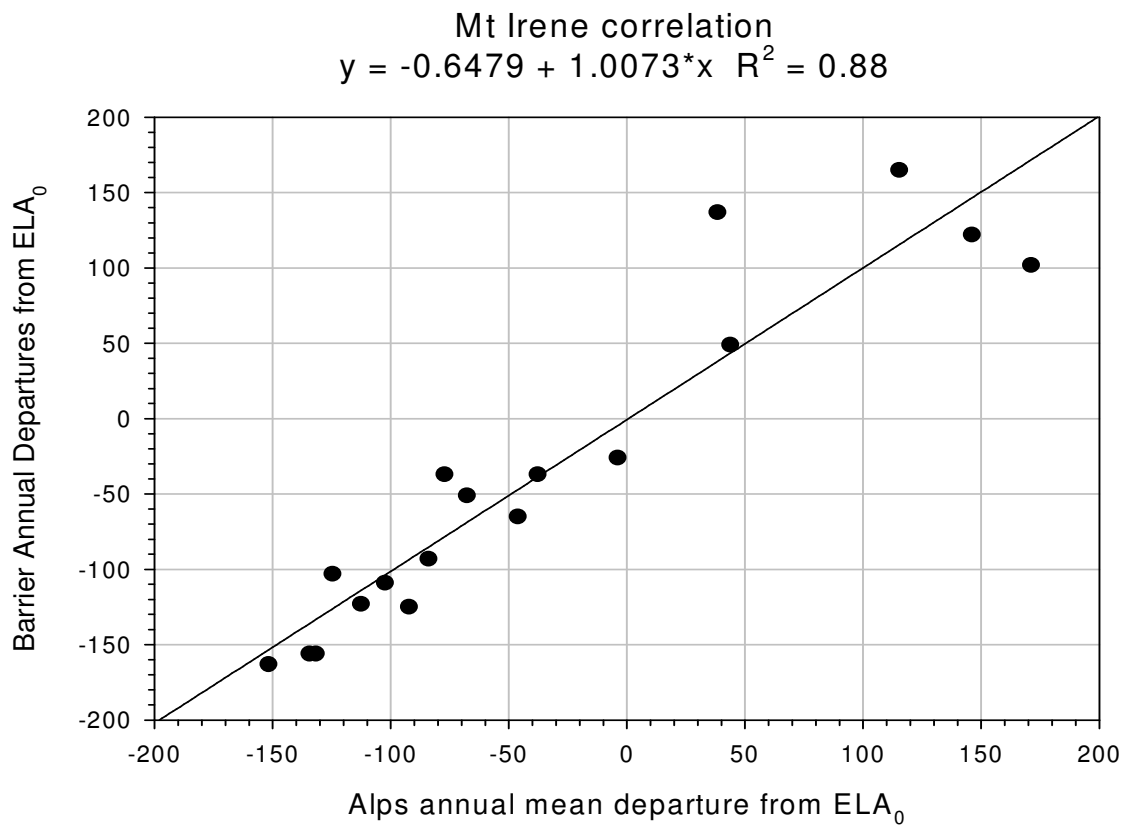
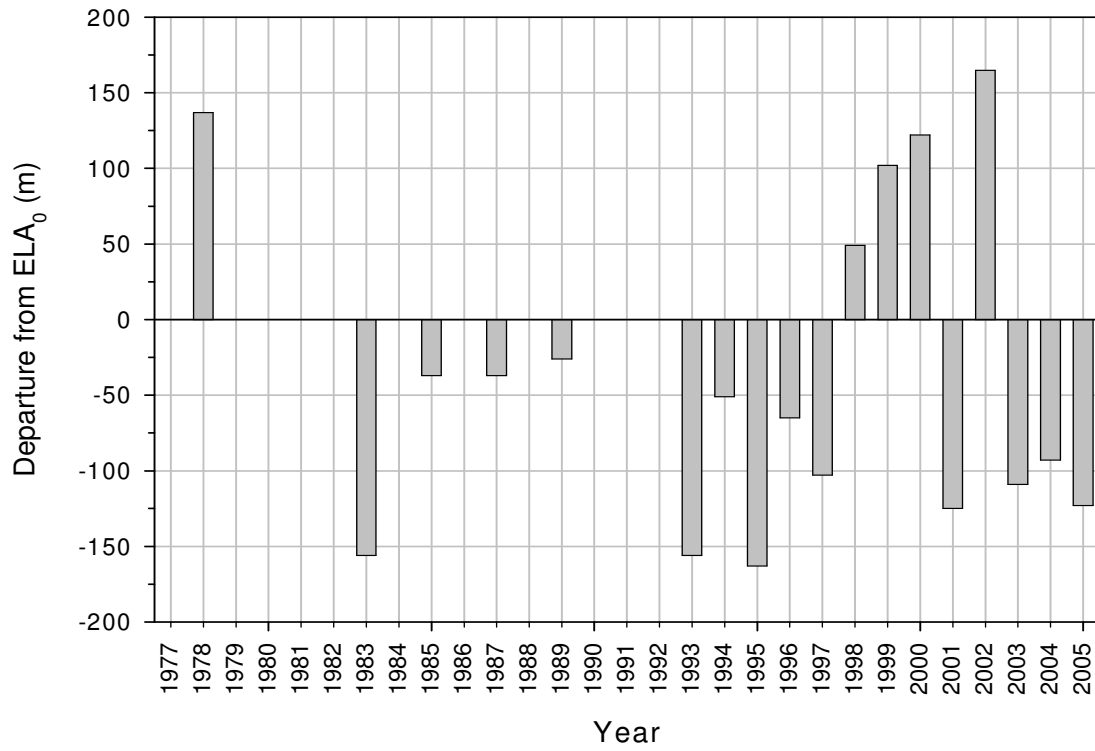
SNOWLINE DATA		
ELA ₀	1563	m
Max SL	1728	m, 1978
Min SL	1400	m, 1995
Mean SL	1526	m
SL Range	328	m
No. Surveys	18	

MEASUREMENTS

Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELA ₀	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELA₀	1563	0	7.55	10.40	17.95	0.42	0
1977							
1978	1700	137	1.00	16.95	17.95	0.06	-137
1979							
1980							
1981							
1982							
1983	1407	-156	31.25	-13.30	17.95	1.74	156
1984							
1985	1526	-37	10.05	7.90	17.95	0.56	37
1986							
1987	1526	-37	10.05	7.90	17.95	0.56	37
1988							
1989	1537	-26	9.25	8.70	17.95	0.52	26
1990							
1991							
1992							
1993	1407	-156	31.25	-13.30	17.95	1.74	156
1994	1512	-51	11.05	6.90	17.95	0.62	51
1995	1400	-163	32.65	-14.70	17.95	1.82	163
1996	1498	-65	12.13	5.82	17.95	0.68	65
1997	1460	-103	20.00	-0.05	19.95	1.11	103
1998	1612	49	4.73	13.22	17.95	0.26	-49
1999	1665	102	2.20	15.75	17.95	0.12	-102
2000	1685	122	1.47	16.48	17.95	0.08	-122
2001	1438	-125	17.59	0.36	17.95	0.98	125
2002	1728	165	0.57	10.33	10.9	0.03	-165
2003	1454	-109	16.05	1.90	17.95	0.89	109
2004	1470	-93	17.95	0.00	17.95	1.00	93
2005	1440	-123	17.59	0.36	17.95	0.98	123
MEAN	1526	-32	13.48	4.17		0.74	32

Mt Irene



Patchy glacierette

GLACIER DATA		
Aspect	E	
AREA	12.78	ha
Max Elev	1700	m
Min Elev	1400	m
Mean Elev	1550	m
Elev Range	300	m
Length	0.5	km
Gradient	0.6	

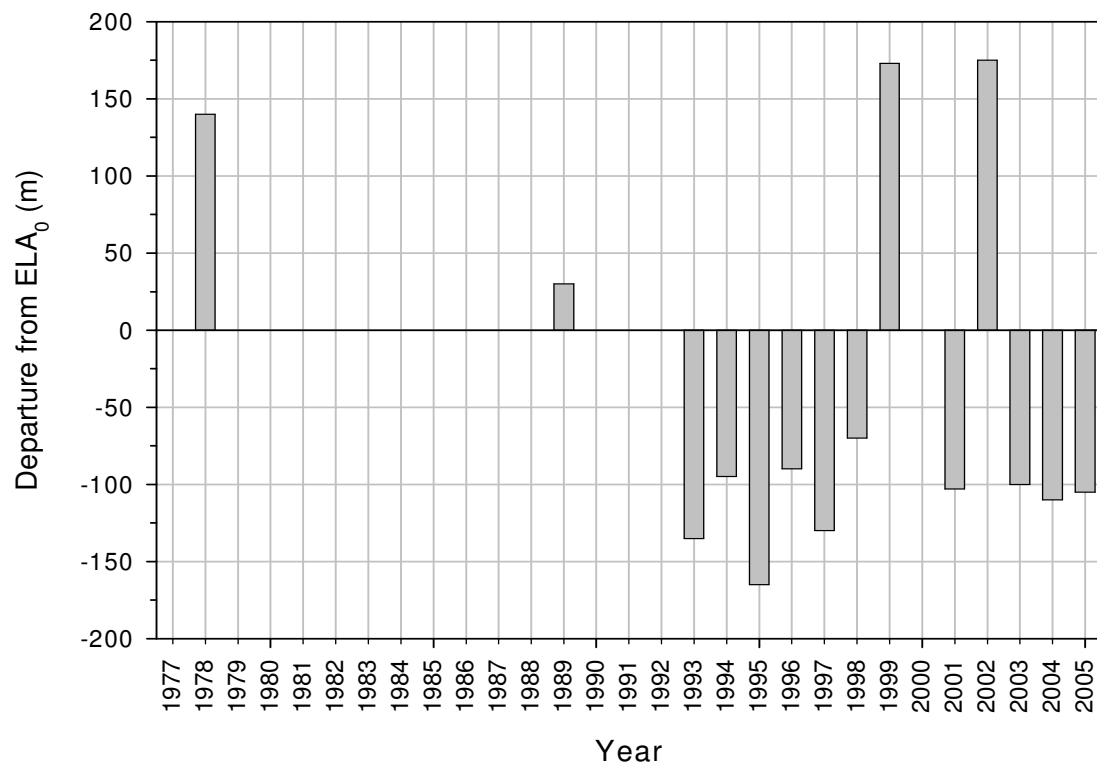
SNOWLINE DATA		
ELAo	1515	m
Max SL	1688	m, 1999
Min SL	1350	m, 1995
Mean SL	1478	m
SL Range	338	m
No. Surveys	16	

MEASUREMENTS

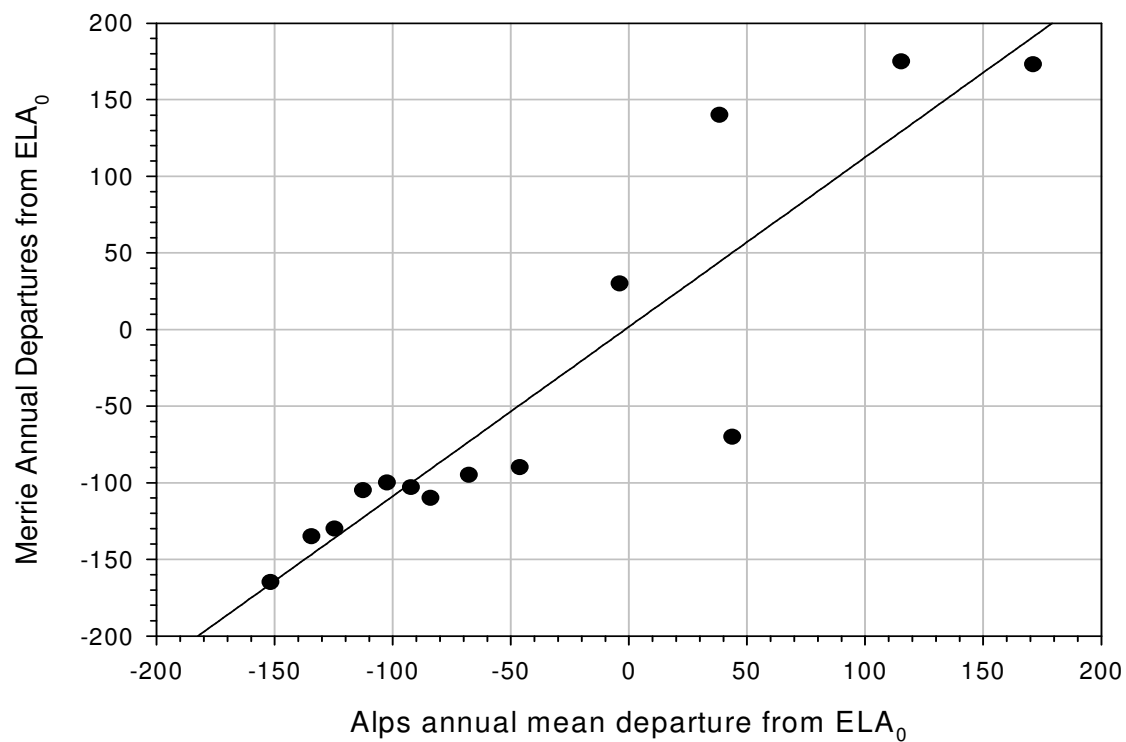
Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1515	0	7.13	5.65	12.78	0.56	0
1977							
1978	1655	140	1.34	11.44	12.78	0.10	-140
1979					No visit		
1980					No visit		
1981					No visit		
1982					No visit		
1983					No visit		
1984					No visit		
1985					No visit		
1986					No visit		
1987					No visit		
1988					No visit		
1989	1545	30	5.83	6.95	12.78	0.46	-30
1990					No visit		
1991					No visit		
1992					No visit		
1993	1380	-135	16.20	0.00	16.2	1.27	135
1994	1420	-95	11.73	1.05	12.78	0.92	95
1995	1350	-165	19.34	0.00	19.34	1.51	165
1996	1425	-90	11.53	1.25	12.78	0.90	90
1997	1385	-130	15.65	0.00	15.65	1.22	130
1998	1445	-70	10.67	2.11	12.78	0.83	70
1999	1688	173	0.47	12.31	12.78	0.04	-173
2000					In cloud		
2001	1412	-103	12.38	0.4	12.78	0.97	103
2002	1690	175	0.42	1.76	2.18	0.03	-175
2003	1415	-100	11.88	0.9	12.78	0.93	100
2004	1405	-110	12.78	0	12.78	1.00	110
2005	1410	-105	12.38	0.4	12.78	0.97	105
MEAN	1478	-37	9.79	2.94		0.77	37

Merrie Range



Merrie correlation
 $y = 1.8057 + 1.1059 \cdot x \quad R^2 = 0.83$



Patchy glacierette

GLACIER DATA		
Aspect	SE	
AREA	9.99	ha
Max Elev	1600	m
Min Elev	1260	m
Mean Elev	1430	m
Elev Range	340	m
Length	0.5	km
Gradient	0.68	

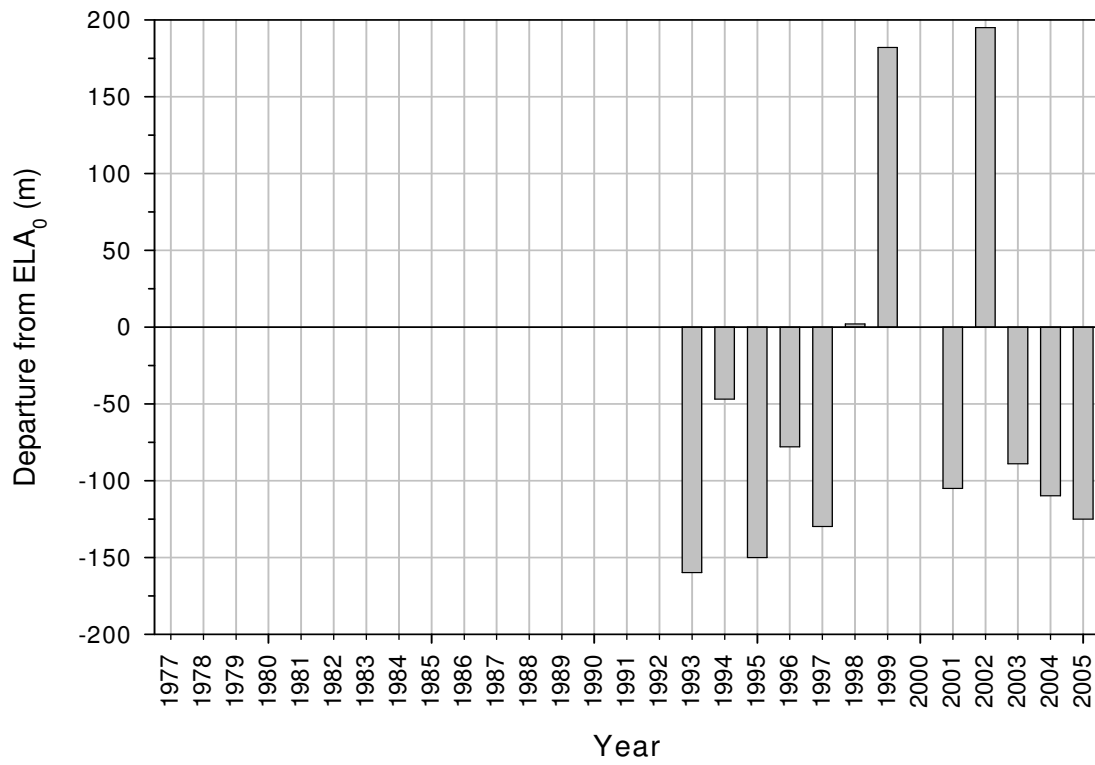
SNOWLINE DATA		
ELAo	1380	m
Max SL	1575	m, 1999
Min SL	1220	m, 1993
Mean SL	1328.75	m
SL Range	355	m
No. Surveys	12	

MEASUREMENTS

Digitised values shaded

YEAR	SNOWLINE	DEPARTURE		AREAS		ACCUM.	MASS
	ELEVATION	FROM ELAo	ACCUM.	ABL.	TOTAL	AREA RATIO	BALANCE
	m	m	ha	ha	ha	(AAR)	INDEX
ELAo	1380	0	7.50	2.50	10	0.75	0
1977					No visit		
1978					No visit		
1979					No visit		
1980					No visit		
1981					No visit		
1982					No visit		
1983					No visit		
1984					No visit		
1985					No visit		
1986					No visit		
1987					No visit		
1988					No visit		
1989					No visit		
1990					No visit		
1991					No visit		
1992					No visit		
1993	1220	-160	15.79	0.00	15.79	1.58	160
1994	1333	-47	8.95	1.04	10	0.90	47
1995	1230	-150	14.90	0.00	14.9	1.49	150
1996	1302	-78	8.92	1.07	10	0.89	78
1997	1250	-130	13.30	0.00	13.3	1.33	130
1998	1382	2	7.43	2.56	9.99	0.74	-2
1999	1562	182	0.69	2.76	3.45	0.07	-182
2000					In cloud		
2001	1275	-105	2.85	0.60	3.45	0.83	105
2002	1575	195	0.46	1.83	2.29	0.13	-195
2003	1291	-89	2.55	0.90	3.45	0.74	89
2004	1270	-110	10.00	0.00	10	1.00	110
2005	1255	-125	13.30	0.00	13.3	1.33	125
MEAN	1329	-51	7.80	0.98		0.88	51

Caroline Pk



Caroline correlation
 $y = 3.8549 + 1.1280 \cdot x \quad R^2 = 0.94$

