THE EDITOR
Arctic and Alpine Research

Sir:

The Problem of Inversions in Estimating the Height of Glaciation Limits in Arctic Regions

In a recent article in this journal, Andrews and Miller (1972) used mean July temperatures for various stations on Baffin Island to predict the height of the 0°C isotherm and hence estimate the height of the glaciation limit. The postulated relationship is based on the fact that in the warmest period of the year the mean 0°C isotherm is at its lowest elevation and hence may critically influence the distribution of snow and ice bodies. Differences between the actual glaciation limit height and the predicted height were then examined (Andrews and Miller, 1972, Table 1) and a spatially coherent pattern of positive and negative differences was observed (Andrews and Miller, 1972, Figure 5). This letter reexamines the data and suggests an explanation for the pattern of differences.

In order to obtain data from as wide an area of Baffin Island as possible, Andrews and Miller (1972) examined climatic data recorded at different times over the last 40 to 50 years. Some stations, e.g., Lake Harbour and Pangnirtung, ceased operations in the 1940s, whereas others, e.g., Broughton Island, Cape Hooper, and Dewar Lakes, only became operative in the late 1950s or early 1960s. In view of this problem, the authors allow for climatic variability of ±2°C and interpret the predicted height of the glaciation limit as ±250 m. Although this large range complicates any attempt to explain the pattern of differences between actual and predicted heights, consideration of station elevations suggests a reason. Figure 1 shows a plot of station elevations against the differences between predicted and actual glaciation limits (from Table 1 of Andrews and Miller, 1972). With only two exceptions there is a clear division of stations on the basis of height. The lower stations show positive anomalies whereas higher stations show negative anomalies. This is apparently due to the presence of a regional inversion throughout the area. Temperature data for standard pressure levels at Frobisher Bay and Arctic Bay indicate that in July an inversion generally occupies the lower layers of the atmosphere up to a level somewhere between the 1,000 and 950 mb heights (approximately 65 to 500 m). In addition, Bilello (1966) noted that the mean depth of surface inversions in July at Clyde River (1950 to 1959) was 340 m. In Figure 2 using the same lapse rate as Andrews and

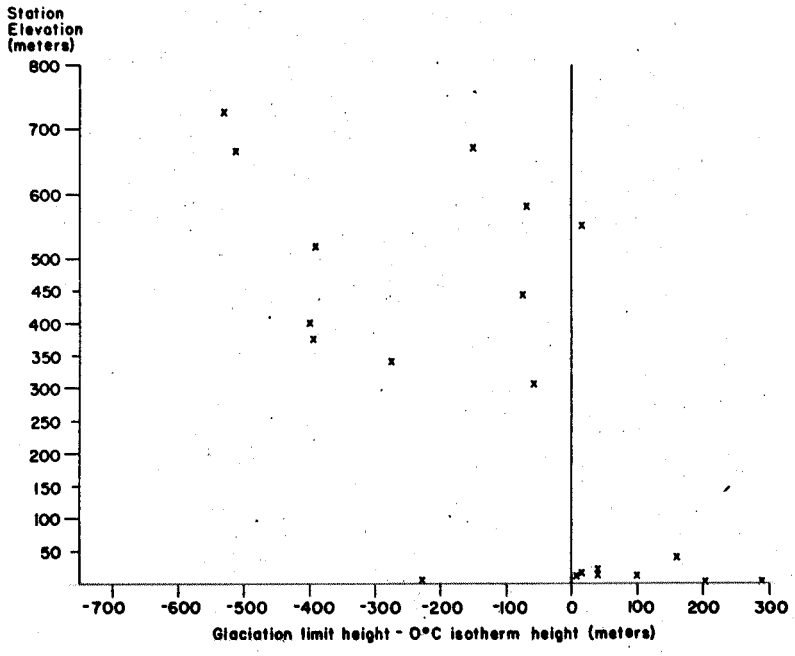

FIGURE 1. Relationship between station elevation and actual glaciation limit height minus freezing level height (data from Andrews and Miller, 1972, Table 1).

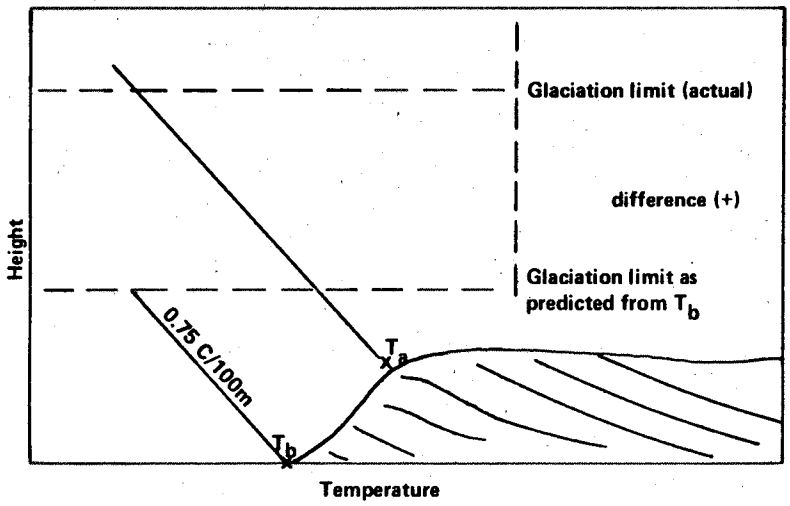

FIGURE 2. Diagram to illustrate the influence of a regional inversion on estimating height of the 0°C isotherm (see text for discussion).

Miller (1972, p. 52) the surface temperature beneath the inversion (T_b) is cooler than the temperature which could be expected if no inversion were present (T_a). If it is assumed that the height of the glaciation limit can be predicted by T_a, then it is clear that the predicted height using stations beneath a regional inversion will always be lower than the "actual" glaciation limit height. Thus if the stations with elevations of less than 65 m are ignored, all of the differences between predicted and actual glaciation limit height in Table 1 of Andrews and Miller are seen to be negative. The only exceptions are Flitaway Lake and Ekalugad Sandur which are short-term expedition stations and can therefore be considered unrepresentative. The observed spatially coherent pattern of differences is now seen to be a reflection of station elevations. All the negative differences are related to the DEW line stations (as noted by Andrews and Miller, 1972) or field stations inland which are situated at elevations greater than 300 m, and hence (presumably) above the regional inversion.

Thus when attempting correlation between glaciation limits in Arctic regions and mean July freezing level heights, care should be taken to use only those climatic stations above the regional surface inversion. A detailed analysis of the variabiliity of surface inversions throughout the Canadian Archipelago is presently underway.

RAYMOND S. BRADLEY
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