

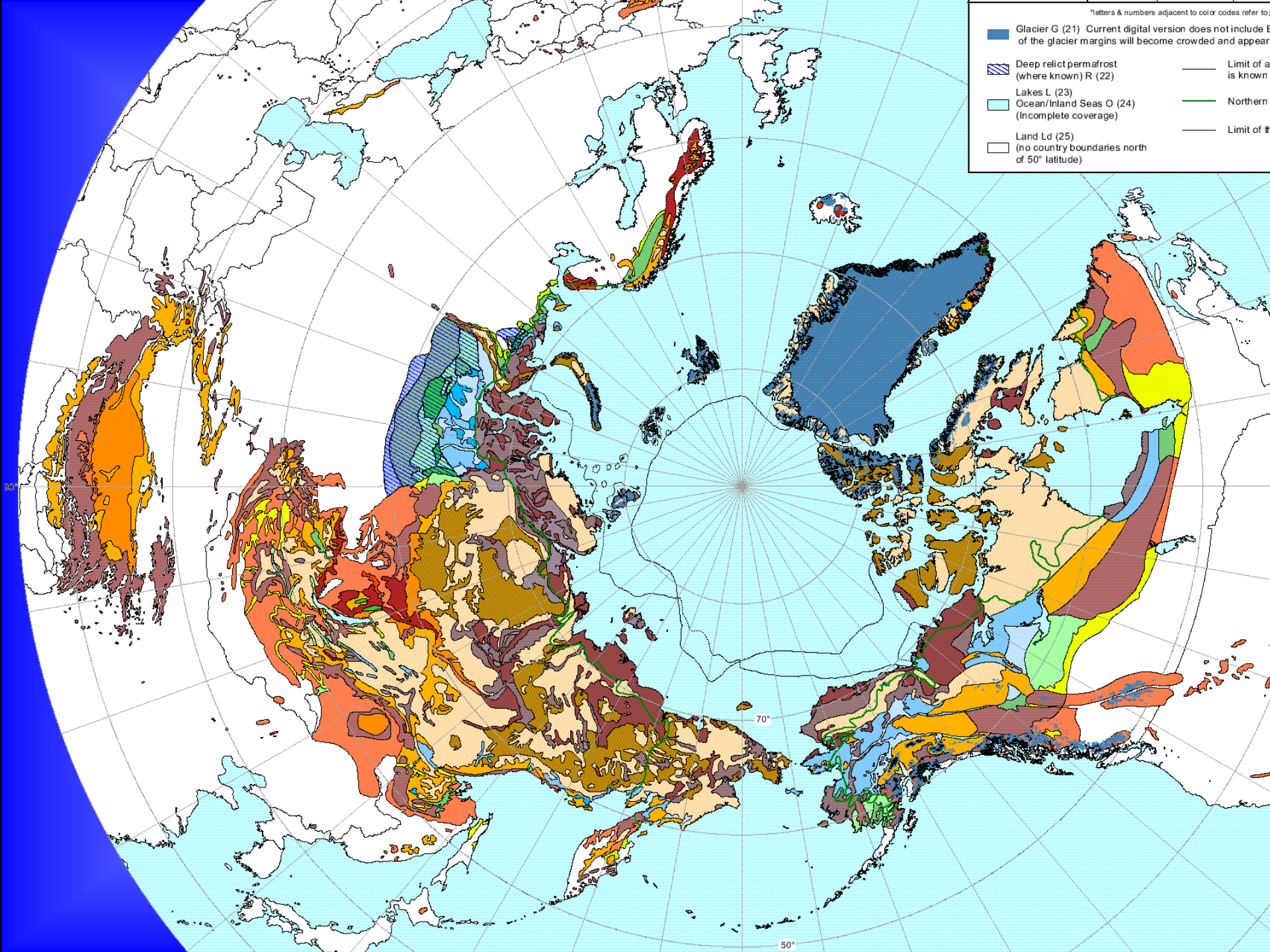


Avalanches and deformation of aggrading permafrost

An aerial photograph of a mountainous landscape. In the foreground, a large, dark, textured area of debris, likely an avalanche runout, covers a significant portion of the slope. The debris field is composed of various sized rocks and sediments. In the background, several sharp, rocky mountain peaks rise against a clear blue sky. The overall scene suggests a high-altitude, mountainous environment where permafrost and avalanches are significant geological features.

Avalanches and deformation of aggrading permafrost

- 1: Aggrading versus degrading permafrost
- 2: Aggrading permafrost; importance of avalanches
- 3: Deformation of aggrading permafrost
- 4: Rock glaciers; types and terminology
- 5: Rock glaciers; geomorphic significance

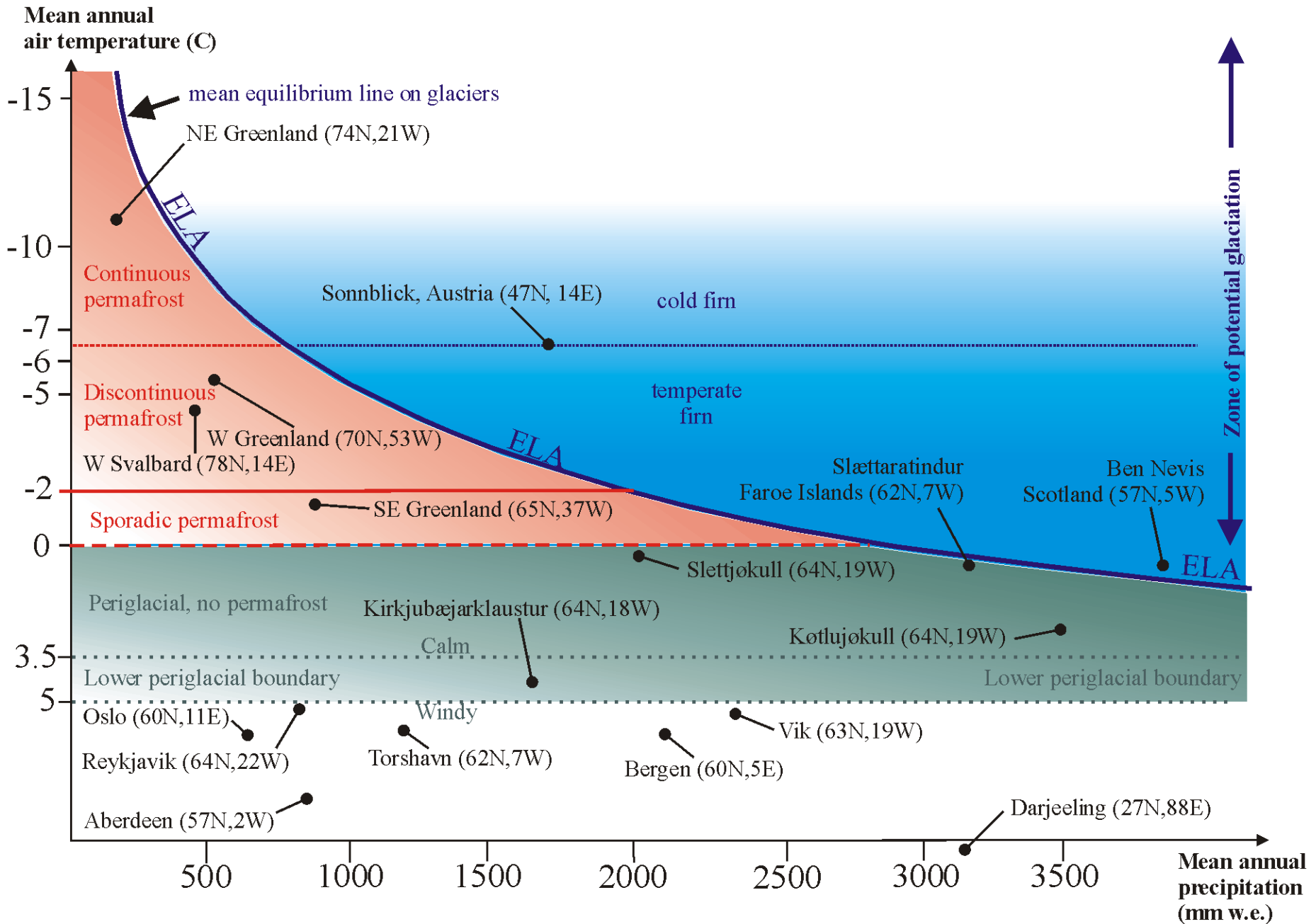


*letters & numbers adjacent to color codes refer to

 Glacier G (21) Current digital version does not include E of the glacier margins will become crowded and appear	 Limit of a is known
 Deep relict permafrost (where known) R (22)	 Northern
 Lakes L (23) (Incomplete coverage)	 Limit of th
 Ocean/Inland Seas O (24) (Incomplete coverage)	
 Land Ld (25) (no country boundaries north of 50° latitude)	

70°

50°



Permafrost and climate change

- Models assume a stable terrain surface
- Importance of geomorphological processes such as erosion and deposition is usually ignored

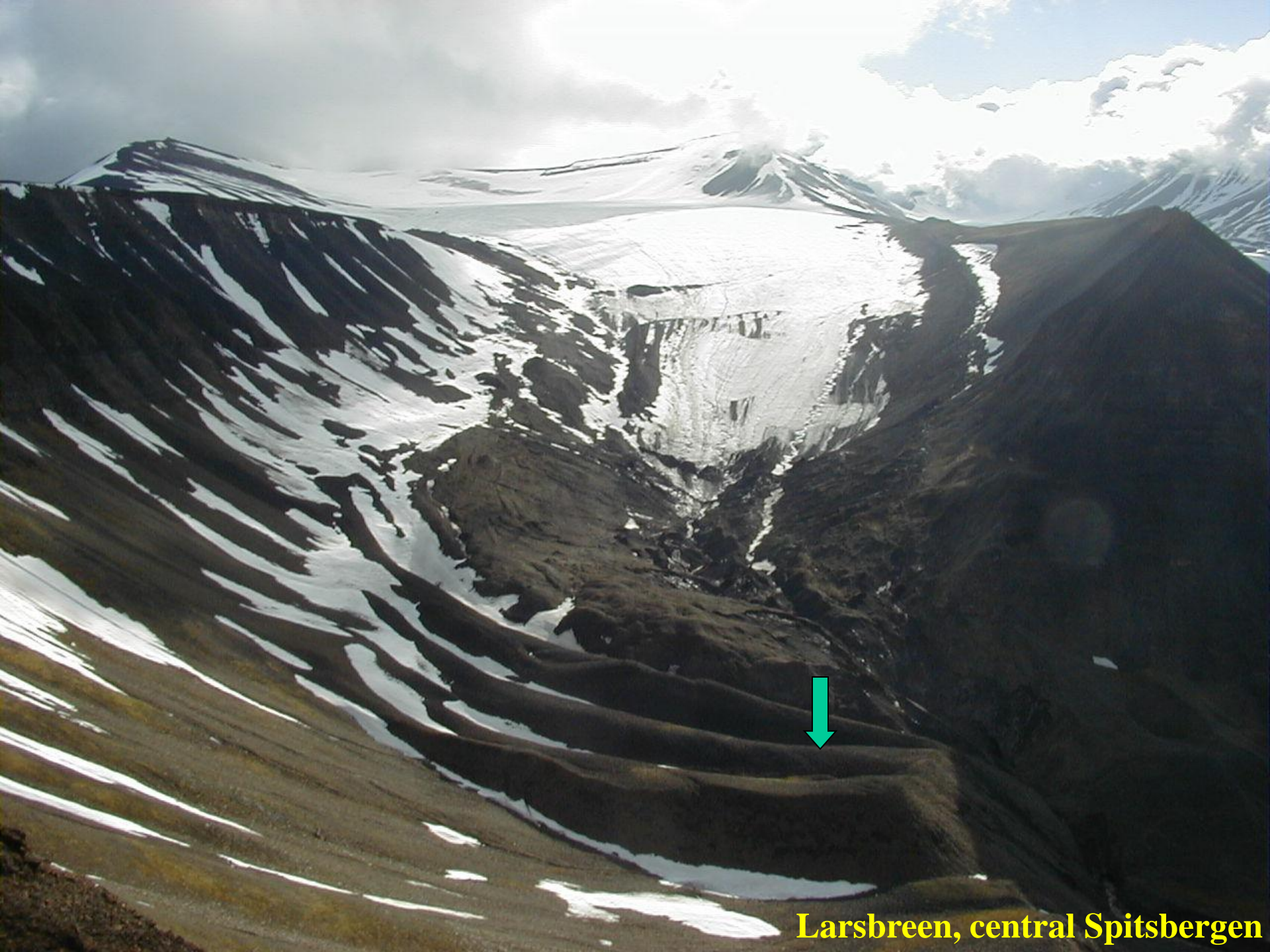
Coarse debris; the Balch ventilation effect:



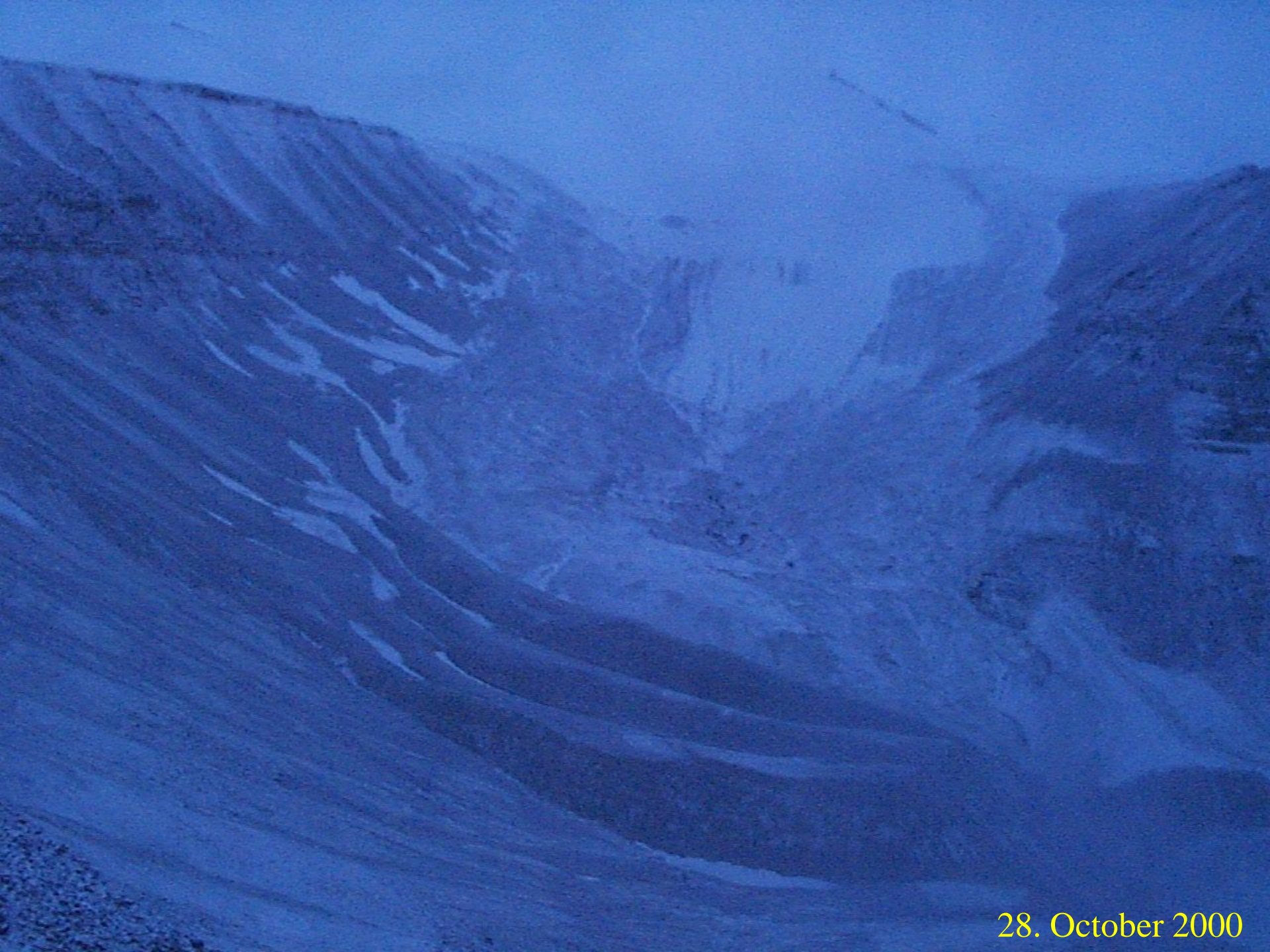


**Cold air accumulation
= Balch ventilation**

Examples of temperature variations in coarse debris:



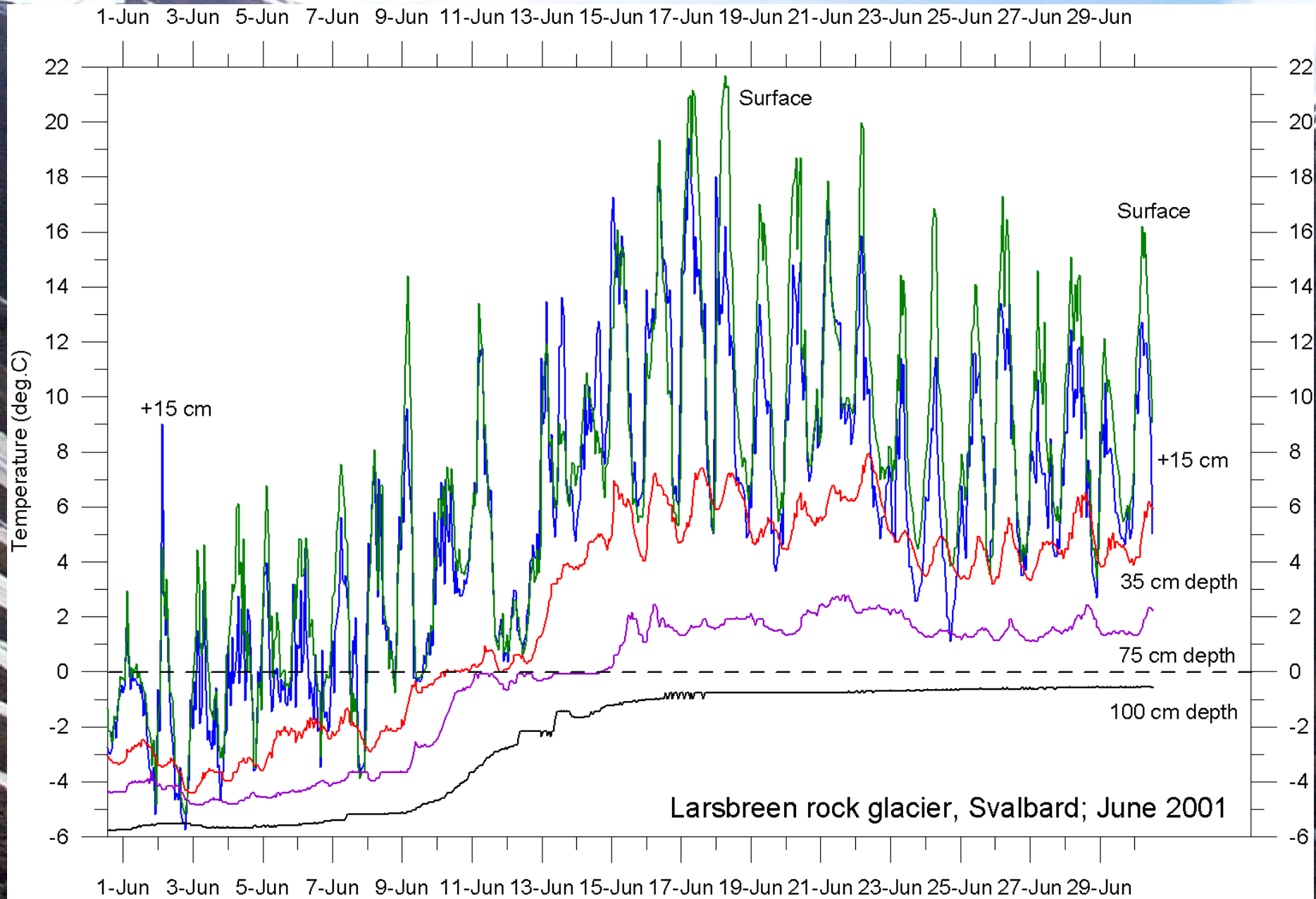
Larsbreen, central Spitsbergen



28. October 2000



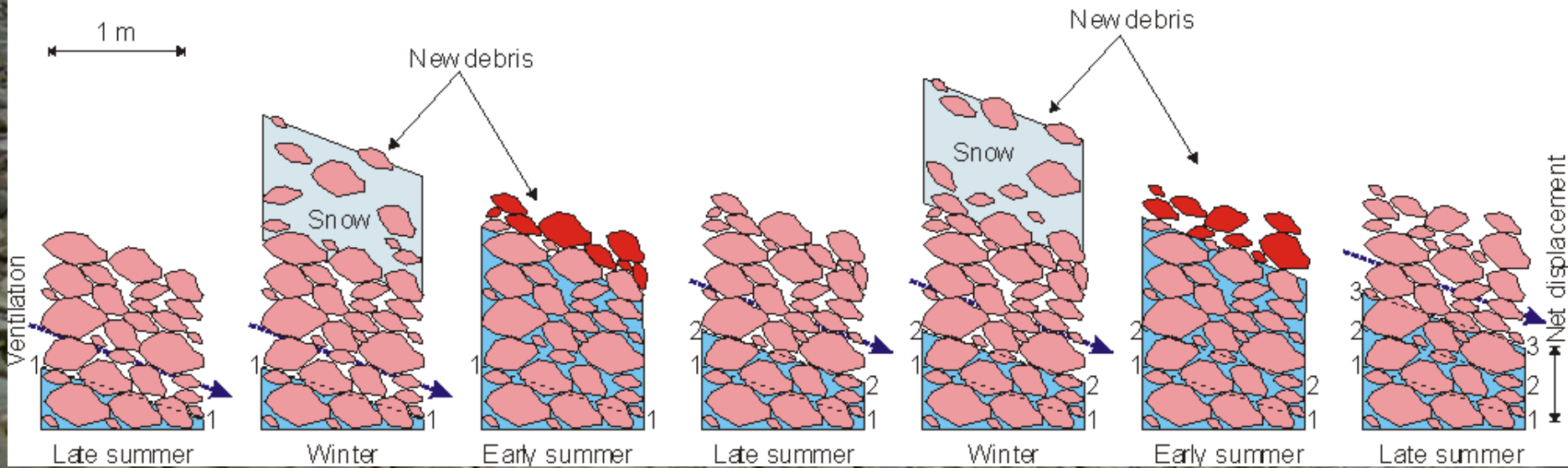
20. February 2001



27.June 2001

Aggrading permafrost; geomorphic processes:

Displacement of active layer and permafrost caused by debris accumulation

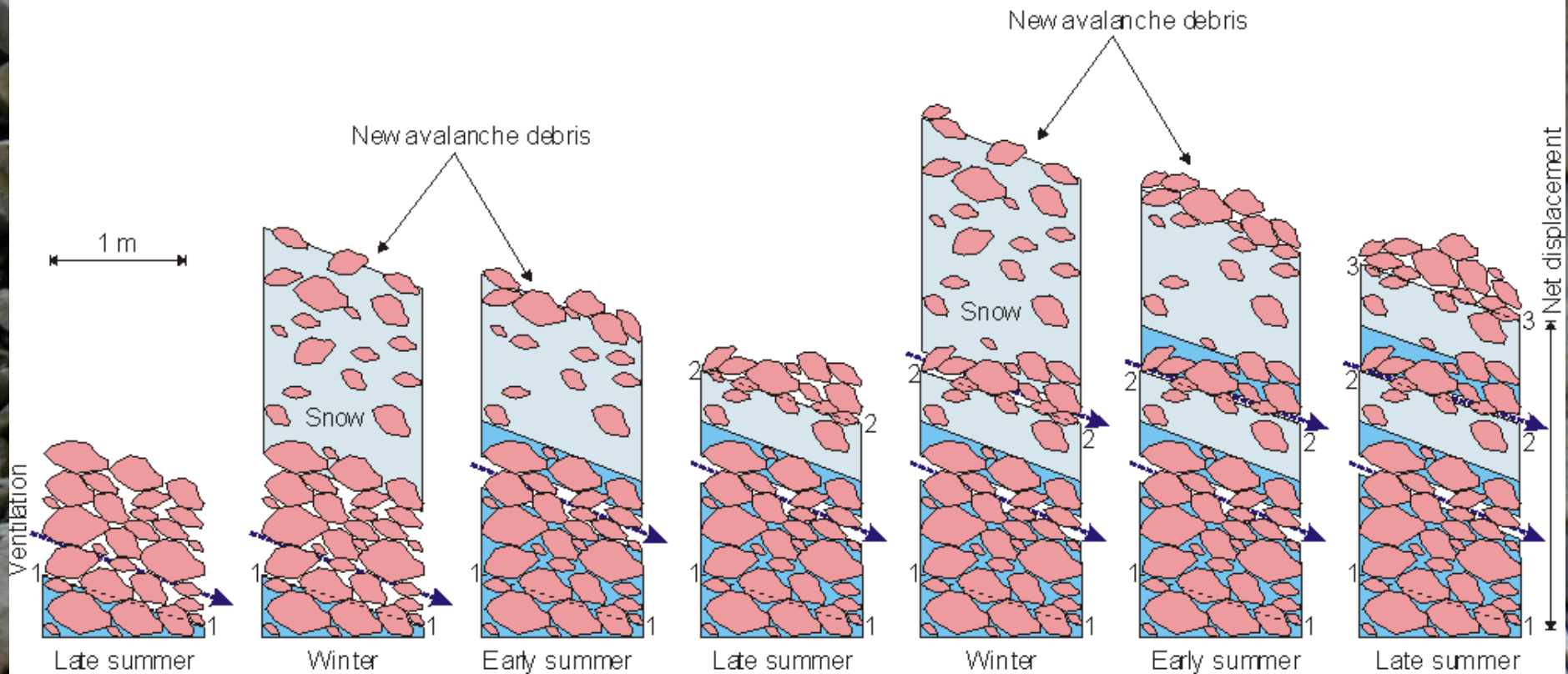


Annual permafrost net growth rate: 0-5 cm

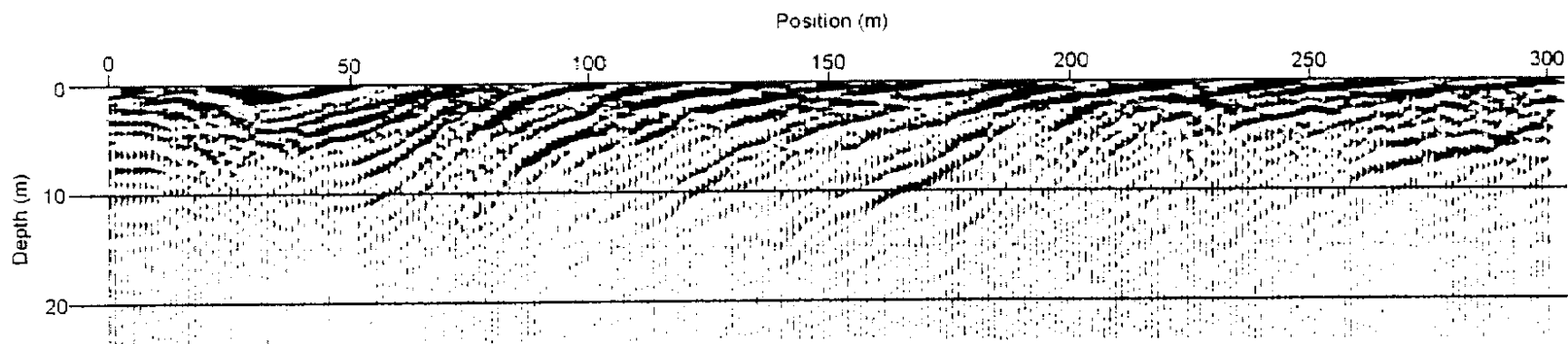




Displacement of active layer and permafrost caused by avalanche-debris accumulation



**Annual permafrost net growth rate: 0-100 cm
...and mass balance is positive...**

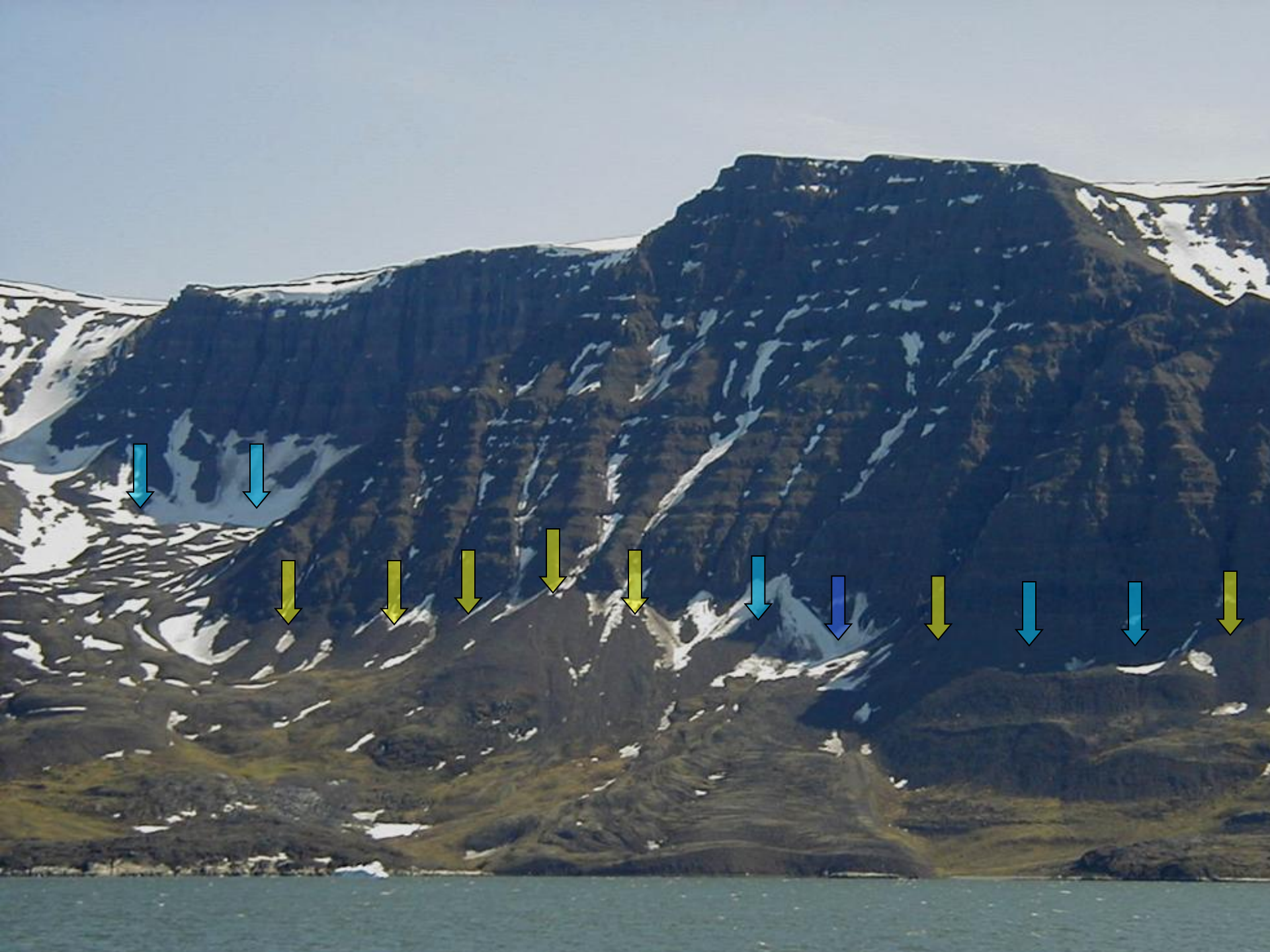


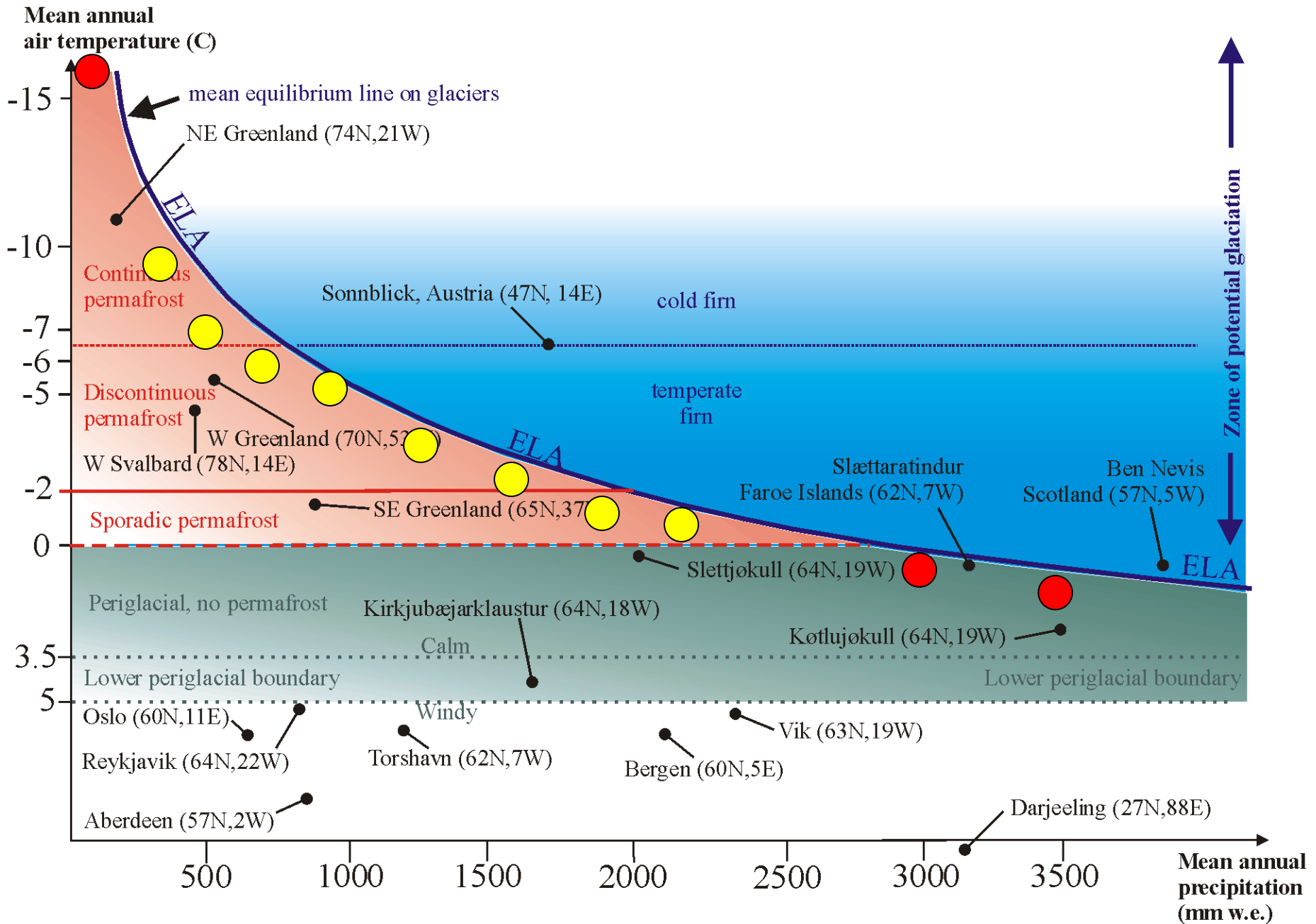
K. Isaksen 2000

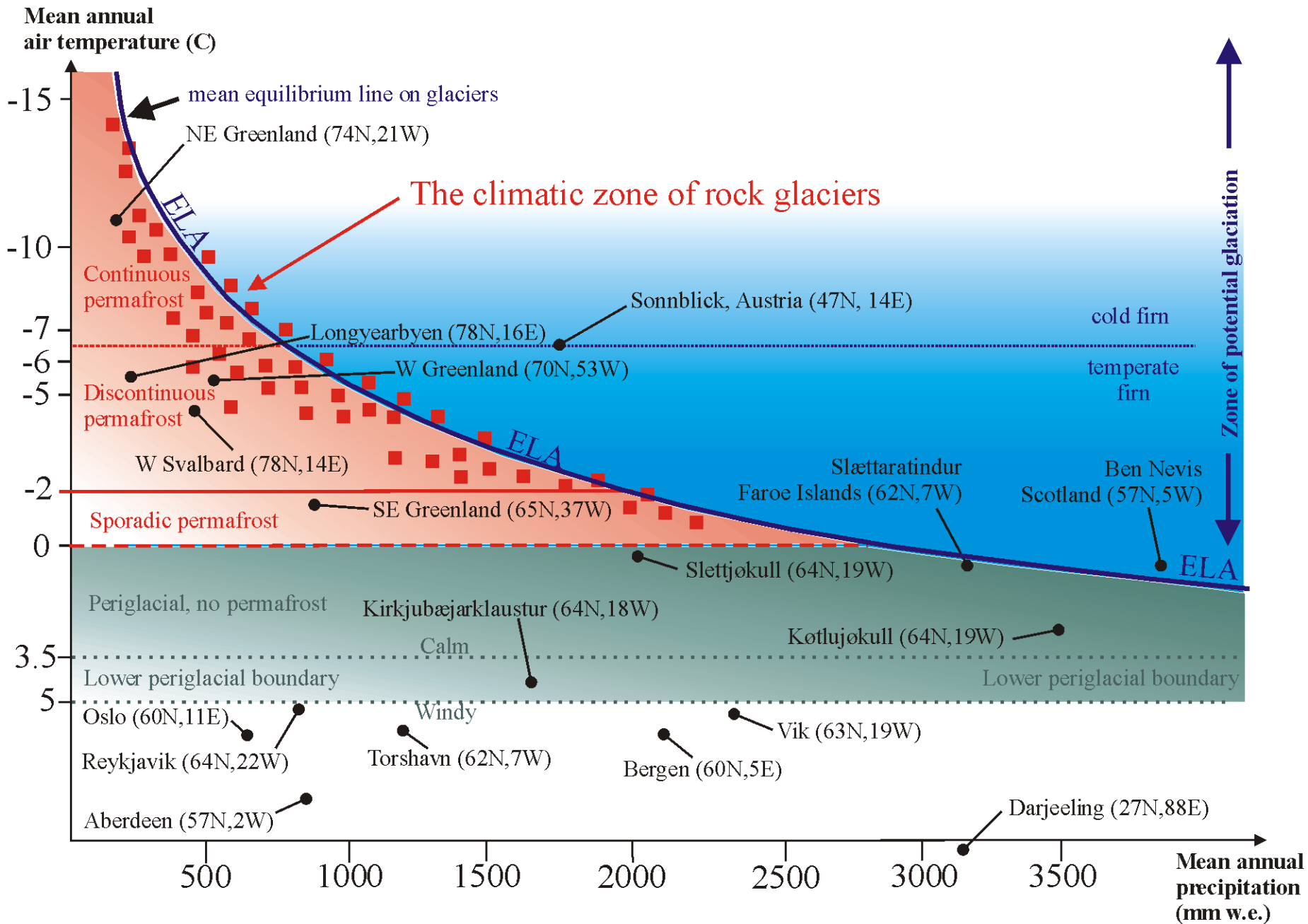


Oxygen delta 18-O values:
-10.97 to -17.47

No fractionation. Precipitation mainly
between -2 and -10 deg.C.











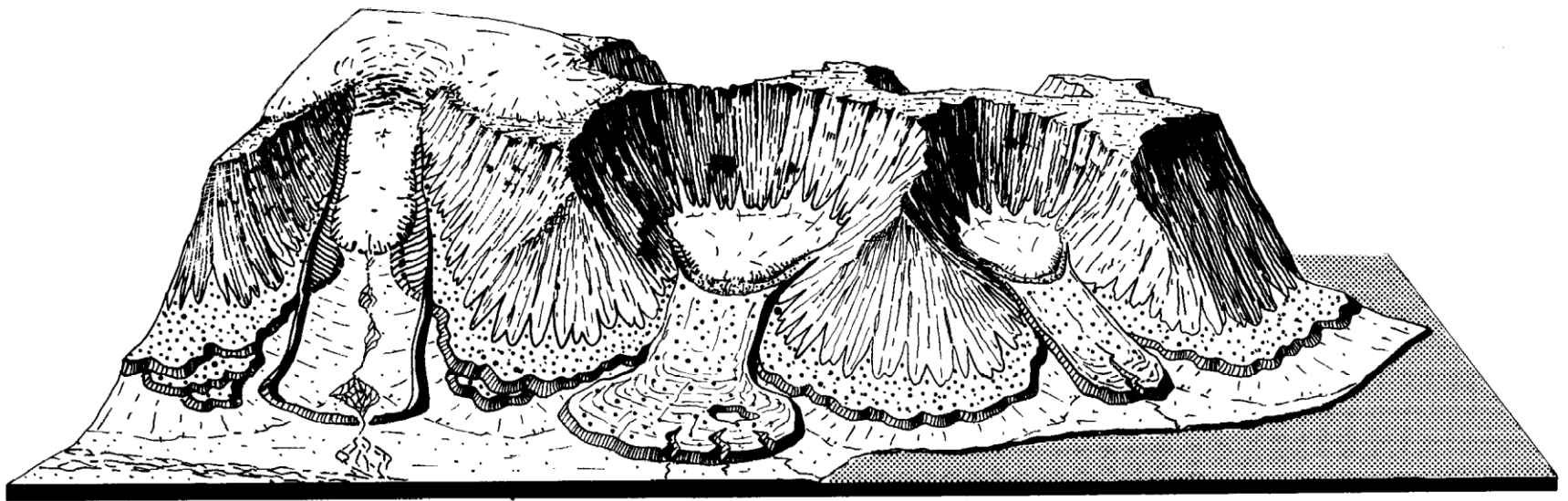






GREENLAND

ROCK GLACIER TYPES, DISKO



OH 82



AUSTRIA



ICELAND



NEW ZEALAND



CHILE



SCOTLAND



ROMANIA



Climatic signals recorded in snow avalanche-dominated colluvium in western Norway: depositional facies successions and pollen records

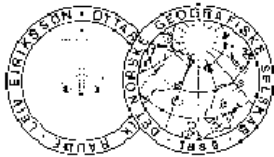
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Glacier characteristics and sediment transfer system of Longyearbreen and Larsbreen, western Spitsbergen

BERND ETZELMÜLLER, RUNE STRAND ØDEGÅRD, GEIR VATNE, RØNNAUG SÆGROV MYSTERUD, TORE TONNING & JOHAN LUDVIG SOLLID



Etzelmüller, B., Ødegård, R. S., Vatne, G., Mysterud, R. S., Tonning, T. & Sollid, J. L. 2000. Glacier characteristics and sediment transfer system of Longyearbreen and Larsbreen, western Spitsbergen. *Norsk Geografisk Tidsskrift–Norwegian Journal of Geography* Vol. 54, 157–168. Oslo. ISSN 0029-1951.

Two small high-Arctic glaciers (Longyearbreen and Larsbreen) on Svalbard (78°N 15°E) were studied with respect to glaciological and hydrological characteristics. Fieldwork during the melting season of 1993 and 1994 was coupled with digital map analysis based on high-resolution digital elevation models (DEM) to reveal the dynamics and temperature regime of small glaciers in a high-Arctic environment, and its relationship to the material transport and sedimentation of these glaciers. The study showed Longyearbreen and Larsbreen to be low activity glaciers, cold-based with temperate patches, and thus having a low potential of basal erosion. The transport of ions and suspended solids in the glacial meltwater implies storage of material in and around the glacier which comes into contact with the meltwater. The study suggests that small Arctic glaciers couple the slope system with the fluvial system and therefore build a highly effective denudation system. Small polythermal glaciers are therefore important in understanding Pleistocene and Holocene landform development in cold regions.

Keywords: *cold glaciers, DEM, GIS, high-Arctic glaciers, map analysis, sediment budget*

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