Note

Meteorological observations 1998 at the arctic station, Qeqertarsuaq (69°15'N), Central West Greenland

Ole Humlum, Birger Ulf Hansen & Niels Nielsen

Abstract

An automatic meteorological station has been operating at the Arctic Station (69°15'N, 53°31'W) in West Greenland since 1990. This paper summarises meteorological parameters during 1998, including snow cover, ground temperatures and active layer development, and presents comments on the local permafrost thickness.

Keywords

Climate, arctic, permafrost, active layer, snow cover, Greenland, Disko Island.

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Outline of the meteorological year 1998

The mean annual air temperature (MAAT) at the Arctic Station 1997 was -2.5°C (Table 1), which is somewhat higher than the average since the station was established in late 1990 (Nielsen et al., 1995). The MAAT at the station is -4.9°C for the preceding period 1991-1997. According to official meteorological data 1961-1990 the MAAT at Qeqertarsuaq is -3.9°C. The higher MAAT for 1998 is primarily the result of higher winter temperatures, while summer temperatures were close to normal. The lowest 1998 air temperature (-29.1°C) occurred on 25. February, while the highest air temperature (15.6°C) was registered on 30. July. The warmest periods, in general, was in late June and late July, while the remaining part of the summer was somewhat cooler (Fig.1). A maximum solar radiation of 897 W/m^2 was registered on 17. May, shortly after noon.

The mean annual wind speed was 4.0 m/s, with a maximum of 25.4 m/s, which occurred in mid November in connection with a foehn situation with easterly winds. In general, however, the wind speed was comparatively low during the winter and somewhat higher during the summer and autumn (Fig.1). Easterly winds due to air masses flowing off the Greenland Ice Sheet to the east prevailed especially October and November, while winds between south and west were more frequent during the remaining part of the winter than usual. The summer was dominated by southerly and southwesterly winds, which is usual.

The annual total liquid precipitation was 161 mm, which is close to normal. The highest precipitation rate registered was about 4 mm per hour. The amount of solid precipitation during the winter is not measured. The winter 1997-98 snow cover had a typical thickness of about 20 cm and lasted until mid May. The subsequent winter 1998-99 snow cover was established in early October, and had a typical thickness of 15-20 cm throughout November and December. The mean annual surface albedo was about 0.39 at the measurement site.

The mean annual ground temperature at 5 cm depth was -0.6°C, which is 1.9°C higher than the MAAT. At 60 cm and 175 cm depth, the mean annual ground temperature was -0.5°C and -0.6°C, respectively, almost as in 1997. The maximum temperature registered at 175 cm depth was, however, somewhat higher than in 1997, about 0.9°C. The active layer thickness 1998 presumably was about 195 cm, which is somewhat higher than normal for the previous period 1991-97 (170-185 cm). At 300 cm depth in bedrock nearby, the mean annual bedrock temperature was -1.7 °C.

The date for initiation of thawing of the active layer, defined as the time in spring when the near-surface ground temperature (5 cm depth) became stable above 0°C, was 29. May, about 10 days later than in 1997. The date where the maximum thawing depth was reached was 10. September, as inferred from the temperature at 175 cm depth. Also this date was somewhat later than in 1997, about 13 days. Initiation of autumn freezing, defined as the time from where the near-surface temperature (5 cm depth) was consistently below 0°C was on 11. October, compared to 29. September the year before. Finally, the time for complete freezing of the active layer, defined as the time from which ground temperatures at all levels in the active layer again were below -1°C, was not reached before the end of 1998. All levels in the active layer demonstrate a zero curtain effect during autumn freeze-back, especially at 60 cm and 175 cm depth (Fig.1).

At Godhavn, the complete 1991-98 data series indicate

that the initiation of the spring ground thaw usually is in early June, although in some years it may occur in May or even as early as in late April. In this respect 1998 represents a normal initiation of ground thaw. The maximum thaw depth occurs more constantly in mid- or late-September, so again 1998 represents a normal year. Autumn freezing typically begins in late September or early October, which also was the case in 1998. The complete freezing of the active layer occurs, more variably, from late December to late January, and in this respect 1998 was quite normal.

No systematic mapping of permafrost or permafrost related terrain features have been carried out in this part of West Greenland. Weidick (1968) and Brown et al. (1997), however, both places Disko Island within the zone of continuous permafrost. Adopting a standard continental geothermal gradient of about 0.033°Cm^{-1} (Kappelmeyer and Haenel, 1974), and knowing that the mean ground temperature typically are a few degrees above the average air temperature as demonstrated above, the Qeqertarsuaq MAAT of -3.9°C (1961-1990) indicates a typical permafrost thickness of 40-80 m in southern Disko Island, for altitudes close to sea level. These estimates are presumably somewhat conservative, as the Little Ice Age MAAT most likely was at least 2°C below modern values (Humlum, 1996), which would provide conditions for a somewhat thicker permafrost layer than is suggested by modern meteorological values.

Table 1: see opposite page

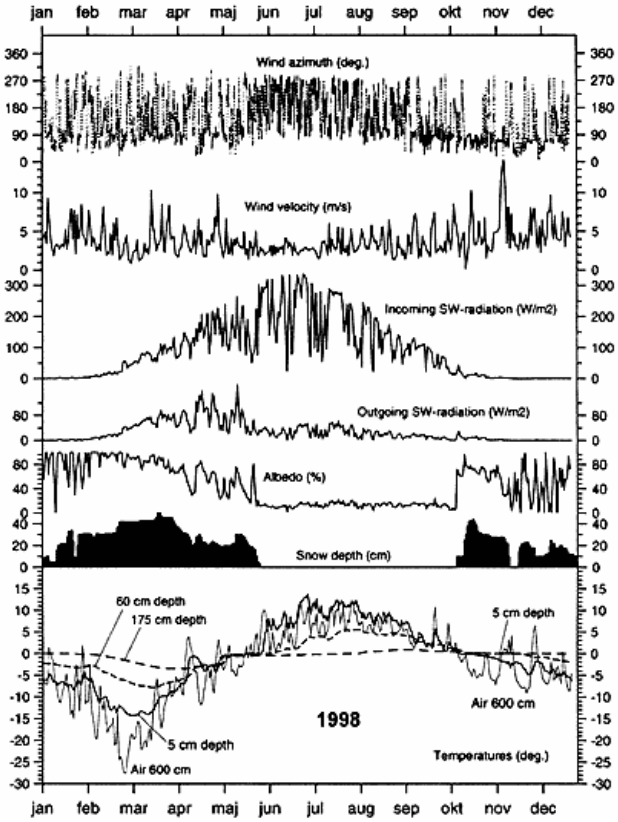

Figure 1: Diagrams showing various mean daily meteorological parameters and ground temperatures at the Arctic Station 1998. The snow cover thickness was measured daily.

References

Brown, J., Ferrians, O.J. (Jr.), Heginbottom, J.A. & Melnikov, E.S., (Editors) (1997): Cirkum-Arctic Map of Permafrost and Ground Ice Conditions (scale 1:10000000). International Permafrost Association. United States Geological Survey (production).

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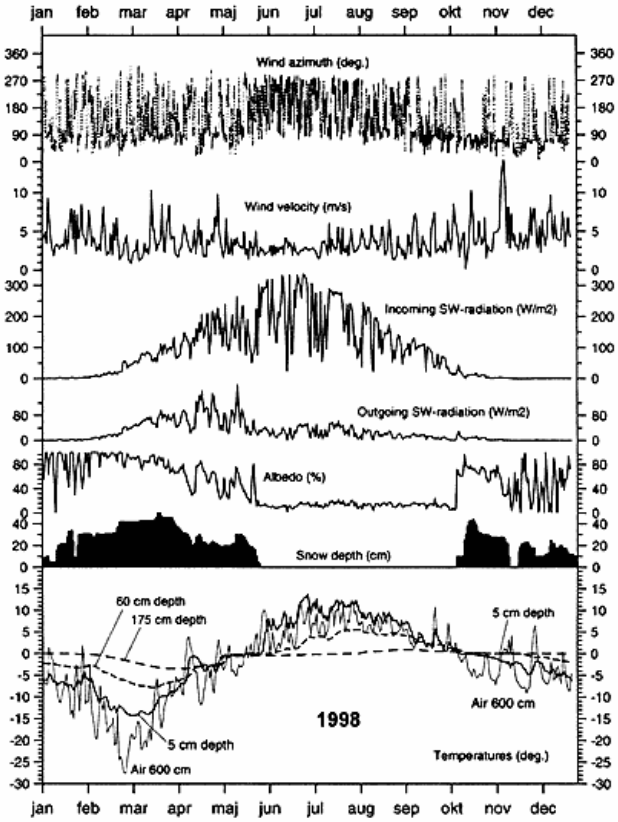

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