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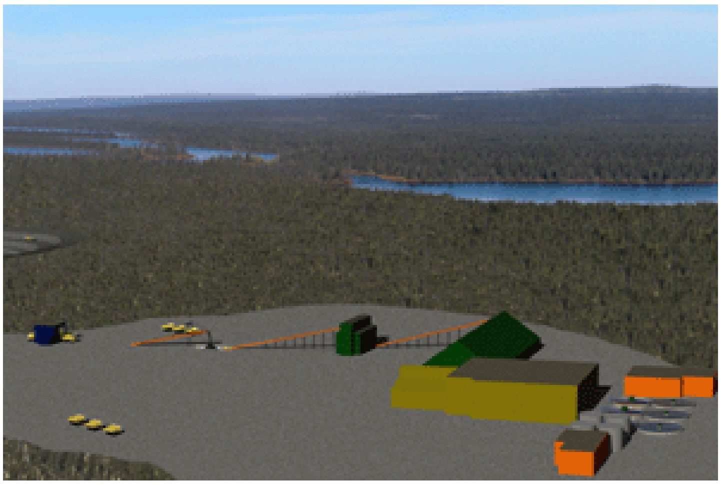

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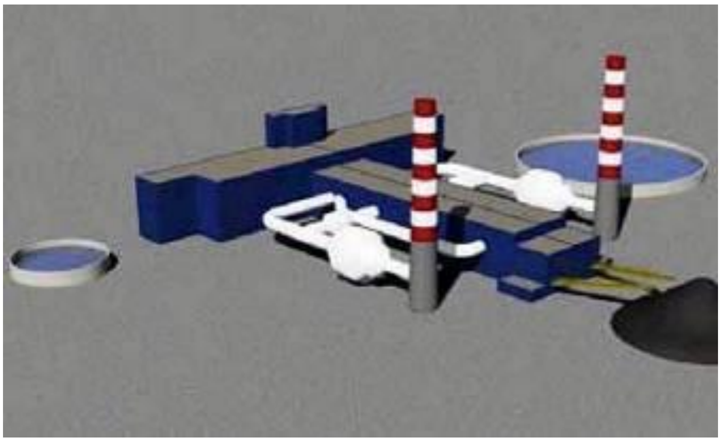
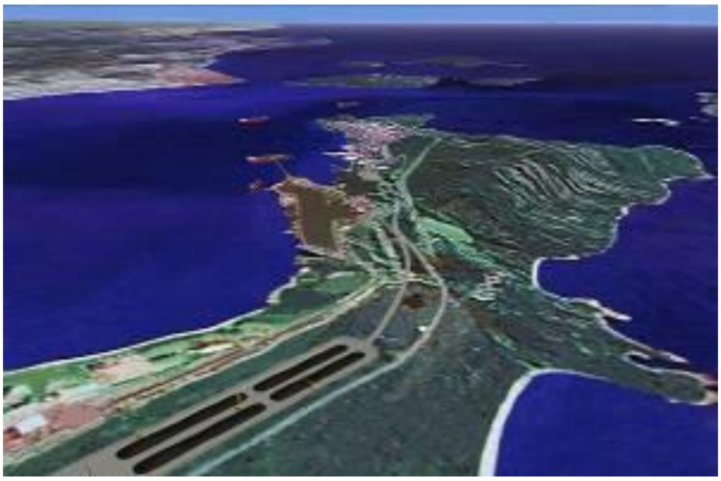


The Elross Lake Automatic Weather Station

BY: Wayne Pollard



2005

The Elross Lake Automatic Weather Station

Introduction

This report summarizes 11 months of data (September 2003 to August 2004) from an automatic meteorological station installed in the Elross Lake area as part of an environmental analysis for mineral exploration activities. This report includes technical data about the sensors installed and details about the location and setting of the meteorological station.

Background

Schefferville lies in a part of the Canadian Shield known as the Labrador Trough. The physiography is dominated by a northwest-southeast trending ridge and valley topography created by 2 large synclines; one with its long axis lying along the Howell's River Valley and the other along Lake Petitskipau. The climate of central Ungava has been classified as humid microthermal under the Koppen-Gieger system (Petersen 1969) but is more widely described as a continental subarctic boreal forest climate. Long-term records indicate a mean annual air temperature of -4.9°C (for the town site at 520 m asl) but tundra ridge areas have been documented to have mean annual air temperatures as low as - 7°C. The seasonal pattern in air temperature is typically continental and is characterized by dramatic extremes with extreme minimums as low as -50°C and extreme maximums above 30°C. The annual precipitation is roughly 732 mm and is roughly skewed with a peak in late summer. Despite the low annual air temperatures permafrost in central Ungava is discontinuous and in the Schefferville area is restricted to upland tundra areas and some lowland organic soils where patched of permafrost form palsas. The discontinuous nature of the permafrost is largely due to the relatively deep snow cover that insulates the ground from the cold winter air temperatures.

Schefferville lies in the transition zone from lichen woodlands of southern Ungava and the true tundra of northern Ungava. The significant relief of the Schefferville area (200-300m) has produces a wide range of vegetation communities. Open lichen spruce woodland and Spruce feather moss communities dominate the forested lowlands while poorly drained areas are typically covered by wetlands. Upland surfaces typically display alpine tundra and alpine heath communities.

Meteorological Station

A standard Campbell Scientific automatic meteorological station was installed adjacent to Elross Lake to provide background environmental data in support of resource exploration activities in the area. The Campbell system installed is designed for use in harsh arctic environments (tested to -55°C) and includes an anchored tripod base equipped with: (1) a Kipp & Zonen SP Lite Pyranometer to measure incoming solar radiation, (2) a HMP45CF T&RH sensor with a radiation shield to measure air temperature and relative humidity, (3) a RM Young wind monitor to measure wind speed and direction, (4) two 107B soil thermistors installed at depths of 5 and 30 cm to measure the ground temperature regime, and (5) a CS105 atmospheric pressure sensor to monitor barometric pressure. A 12-volt gel cell recharged by a 5-watt solar panel powers the system. The heart of the system is a Campbell CR10X data logger which monitors sensor outputs every 60 seconds and records data as hourly averages (base value of the station is ~ $15,000). Air temperatures are collected at a height of 2.0 m above the ground surface and wind and radiation data are collected 3.0 m above the ground.

The station was set up and started by Dale Andersen (Ph.D. student with W. Pollard) on September 21, 2003 and the first download was on August 26, 2004 by Pollard. The McGill Subarctic Research Station (MSARS) maintains a network of 4 other stations in the Schefferville region as part of a CFI funded climate change project called ECONET designed to determine regional variations in microclimate (comparisons between forest, burn, tundra and community locations), to assess the representativeness of airport data and to provide detailed baseline data from which future climate changes can be analyzed.

Setting

The Elross Lake automatic meteorological station is located at 54º 56.1086'N; 67º06.4847'W (UTM 6-21-210E, 60-89-212N zone 19U) roughly 3 km east of Irony Mountain at an elevation of approximately 619 m asl. The met station is situated on the west side of Elross Lake on a small peninsula (Figures 1 & 2) in an area of open spruce woodland (Figure 3). The forest canopy is predominantly White and Black spruce (*Picea glauca and P. mariana*) with scattered Larch (*Larix laricina*), the largest trees are 20-30m high but are ~ 30 m from the station. Smaller spruce (1-2 m high) and shrub vegetation (<1m) surround station. The shrub under story is mainly Labrador Tea (*Ledum sp*), Birch (*Betula glandulosa*) and Willow (*Salix sp*). The ground cover consists of small shrubs (several species of *Vaccinium*) various lichens and mosses (*Cladian stellaris, Cladina rangifera, Hylocomnium splendens, Ptilium sp, Pleurozium sp*).

Elross Lake is one of a string of lakes linked by the Howell's River. These lakes are typically long, narrow, relatively shallow and rimmed with shaley gravel and bouldery beach materials of glacial-fluvial origin. However, much of backshore area on the west side of the lake consists of wetlands and flooded boulder surfaces. The Howell's River Valley occupies a large syncline that formed in the Churchill Province of the Canadian Shield where it meets the Superior Province. The ridge and valley topography of the Labrador Trough reflects Archean tectonic activity and exerts a strong control on drainage patterns in this part of the Churchill Province. The Superior Province lies only 5-6 km west of the Howell's River and is characterised by more typical shield topography. The landscape around Schefferville displays widespread evidence of erosion by glacial meltwater, there are numerous subglacial metlwater channels perched and nested high on the upland surfaces (e.g. Houston Mountain) and there are vast areas of boulder filled channels that are more characteristic of proglacial meltwater. The Howell's River Valley is much wider than the modern river system with a wide flood plain and several terraces indicative of much higher water levels. Boulder streams and surfaces are common in these areas and occur along the west side of Elross Lake.

Soils at the site are poorly developed consisting of an organic layer 5-10 cm thick overlying weakly eluviated reddish silty-sand. The soil is well drained and despite the widespread occurrence of wetlands there is no evidence of gleying. The peninsula upon which the station is located appears to be a small delta deposited by one of the several streams that drains the extensive wet lands west of Elross lake.

Meteorological data

Table 1 and Figures 4, 5 and 6 present the temperature and wind data for the 11 month period from Sept 21, 2003 -August 26, 2004 for the Elross Lake met. station. Over this period the mean air temperature was – 5.4°C, the mean annual temperature is probably only slightly warmer (~ -5.1°C). Over the same period the mean temperature for the town of Schefferville was –3.5°C and –4.8°C for the tundra site on Ferriman Ridge, so clearly the Elross Lake area is considerably cooler than the town site. A minimum of –47.45°C was recorded at the Elross site in mid January while the town and Ferriman Ridge recorded minimums of -39.9°C and –43.1°C, respectively. The difference probably reflects cold air drainage from the surrounding upland surfaces. The maximum temperature of 27.07°C is warmer than the town site and Ferriman ridge which saw a maximum temperatures of 25.7°C and 23.4°C, respectively. The plot of temperature data (Figure 4) displays considerable variability with several warm periods during the winter and even positive temperatures in mid March. A comparison between the temperature and humidity data suggests that the warm periods during the winter correspond to snowfall events. Despite the apparently high maximum, the summer temperatures were consistently cool hovered around 10°C and with several frost events in June and July. Table 1 presents a statistical summary of the air temperature data.

Table 1: Temperature Data for Elross Lake	
Minimum	-47.450001
Maximum	+27.07
Sum	-43684.05
Mean	-5.3864427
Median	-3.5555
RMS	15.342373
Std Deviation	14.366631
Variance	206.40009
Std Error	0.15953079
Skewness	-0.41803562
Kurtosis	-0.4429504

At first glance the soil temperatures appear problematic in that they remain relatively warm during the coldest winter months when they reached only –2.1°C. Shallow frost occurs from mid December until early June (Figure 5); the flat nature of the soil temperatures indicates a thick continuous snow cover. In a previous study Nicholson (1978) found that 80-cm of snow was sufficient to inhibit deep frost penetration. Summer temperatures are very warm reaching 15°C and consistently around 10°C, even at depths of 30 cm. These warm temperatures reflect direct heating by solar radiation and relatively dry soil with little evaporation. These soils are much warmer than the tundra soils of Ferriman Ridge where temperatures rarely rise above 5°C, and permafrost is reached at depths of 120-130 cm. The steep rise in soil temperature around June 7 probably corresponds with the completion of snowmelt. Even though the mean annual air temperature is cold enough to generate permafrost the warm nature of the soil temperature suggests that permafrost is probably not present at this site. However deeper temperature sensors would be needed to confirm this hypothesis. Permafrost up to 100 m deep has been recorded at various mine sites during the main period of ore extraction. Permafrost overlain by an active layer 2.4 m thick was documented near the Timmins Mine site (south east of Elross Lake) by Wright (1981) and palsas (permafrost cored peat mounds) were documented at Goodream Lake 3-4 kilometres east of Elross Lake (Cummings and Pollard 1988).

The site is not very windy despite its close proximity to Elross Lake; normally a large open area (long fetch) like Elross Lake is much windier than woodland locations. There is a fairly constant wind of 3-5 kph. Roughly 5-6 major wind events were recorded with sustained velocities >25 kph. A sustained maximum wind velocity of 36 kph was experienced, in mid January. By comparison the met station on Ferriman ridge recorded an average wind velocity of 23 kph for the same period (this includes periods when the wind sensor was immobilized by rime ice). The maximum sustained wind velocity recorded on Ferriman Ridge was 65 kph (same January storm), but the most notable pattern was the sustained nature of the winds (these ridges would be good locations for wind farms. The strongest winds were from the north and north north-east at Elross Lake. Ferriman winds also had high winds from the north and north-northeast but also displayed significant wind events coming from the south and east. Winds patterns in the Schefferville region reflect the funnelling effect of the ridge and valley topography, the high winds on the ridge reflect compressive airflow. At Elross Lake the fall and winter are the windiest periods while the late winter, spring and summer were fairly calm, by comparison, Ferriman Ridge displayed high winds year round.

Summary

In general the Elross Lake site is slightly cooler than the town of Schefferville, however it appears to have its own microclimate that is characterized by very cold winter temperatures. Summer temperatures are comparable to Scheffervilles but the sheltered nature of the study site results in slightly warmer maximum temperatures. The local microclimate might be controlled by topographic inversions in temperature. Normally windy regions like Schefferville experience considerable mixing and temperature inversions are scarce, but the calm nature of the Elross Lake site and the high local relief would be conducive to local cold air drainage. This might explain why the extreme minimum (-47.5°C) is so much colder than for Schefferville (-39.9°C). Extreme minimum temperatures for other ECONET sites include -41°C for both the woodland site (east of Irony Mountain) and a burns site (south of the Howell’s River bridge just off the Mennihek Road), and -43.1°C for Ferriman Ridge. Cold air drainage might also explain the several summer frost events.

Ground freezing and permafrost in the Schefferville region are strongly influenced by snow distribution. At Elross Lake snow insulates the ground against the extreme cold winter air temperatures. Widespread wetlands also inhibit ground freezing. It is therefore unlikely that permafrost is present in this part of the Howell's River Valley, highland areas to the east probably have patchy permafrost particularly Irony Mountain. The topography rises toward the west where areas of open vegetation and well drained surfaces could be subject to permafrost. If permafrost is a potential issue it would be useful to install a series of deeper (20+ m) ground temperature cables.

Figure 1: Oblique air photos showing the location of the automatic weather station location on the west side Elross Lake at 54º 56.1086N; 67º06.4847W.

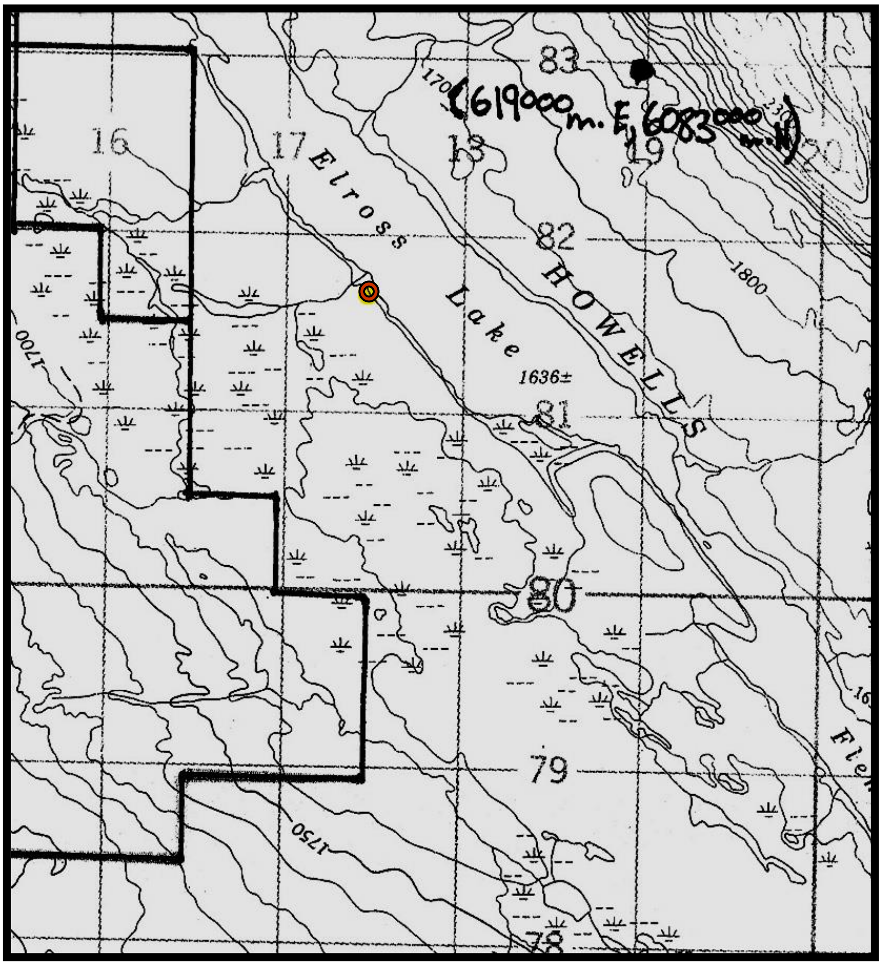


Figure 2. Location of the automatic weather station on the west side of Elross Lake (from 1:50,000 NTS topographic map).

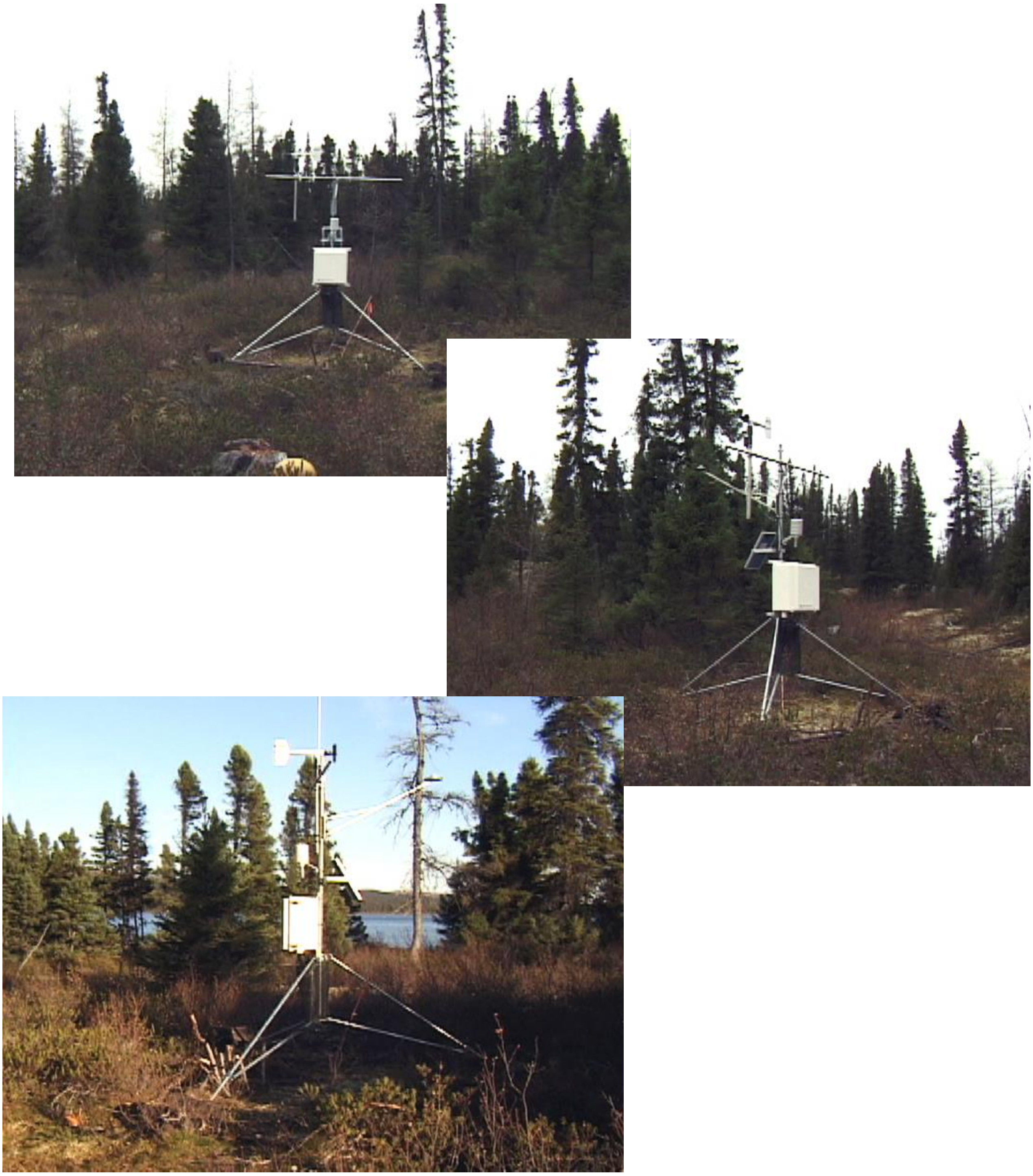


Figure 3: Campbell automatic meteorological station installed in September 2003. Sensors include air temperature, soil temperatures at 5 and 25 cm, wind velocity and direction, relative humidity, solar radiation and barometric pressure. The station is situated in a clearing adjacent to a collapsed cabin approximately 30m from Elross lake. The local vegetation is open spruce forest (*Picea mariana* and *Picea glauca* with lichen C*ladina rangifera* and *Cladina stellaris* ground cover.

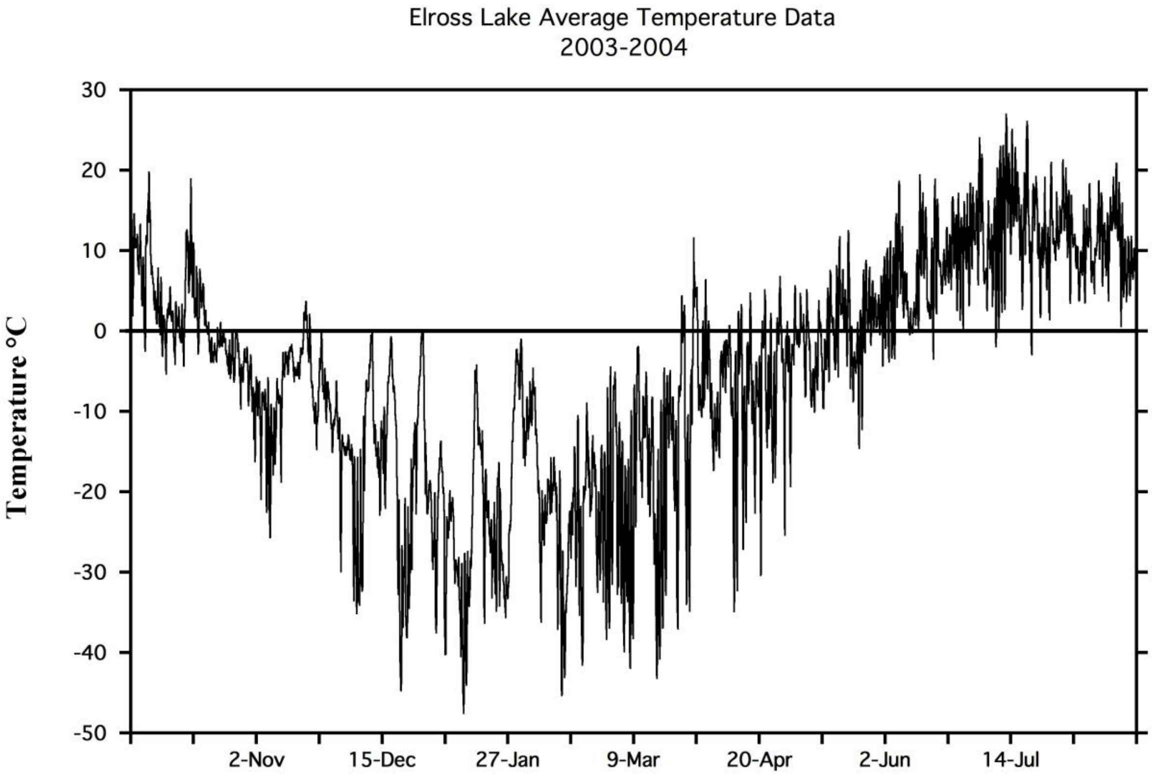


Figure 4. Elross Lake air temperature summary (based on plot of hourly air temperatures)

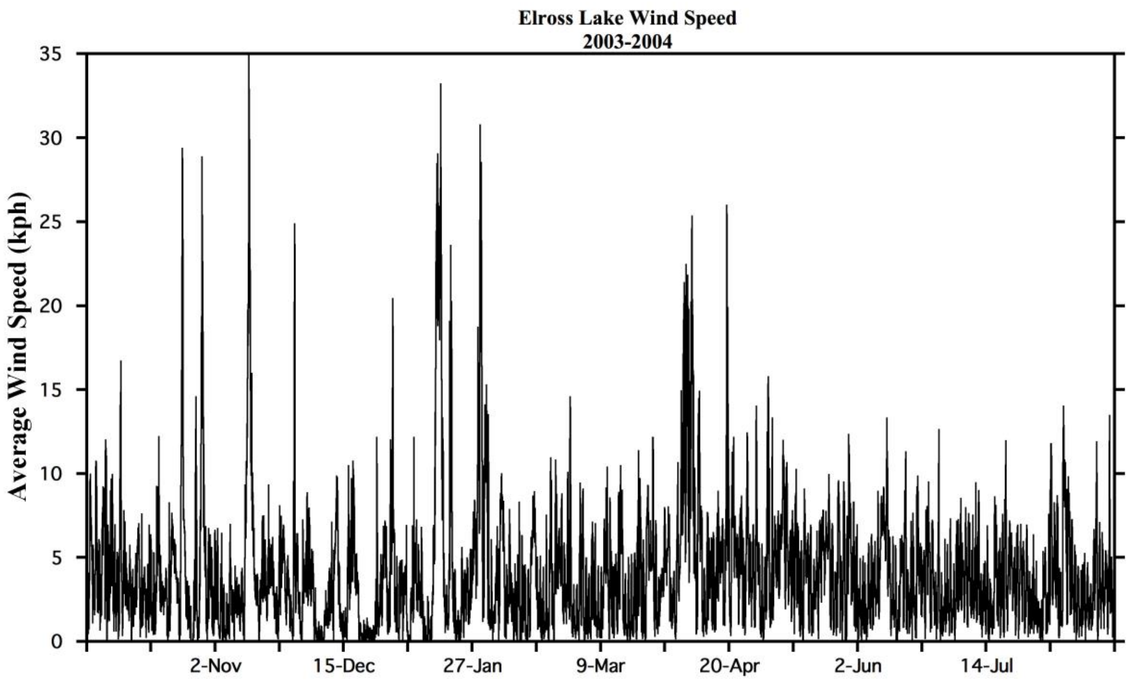


Figure 5: Elross Lake wind velocity summary

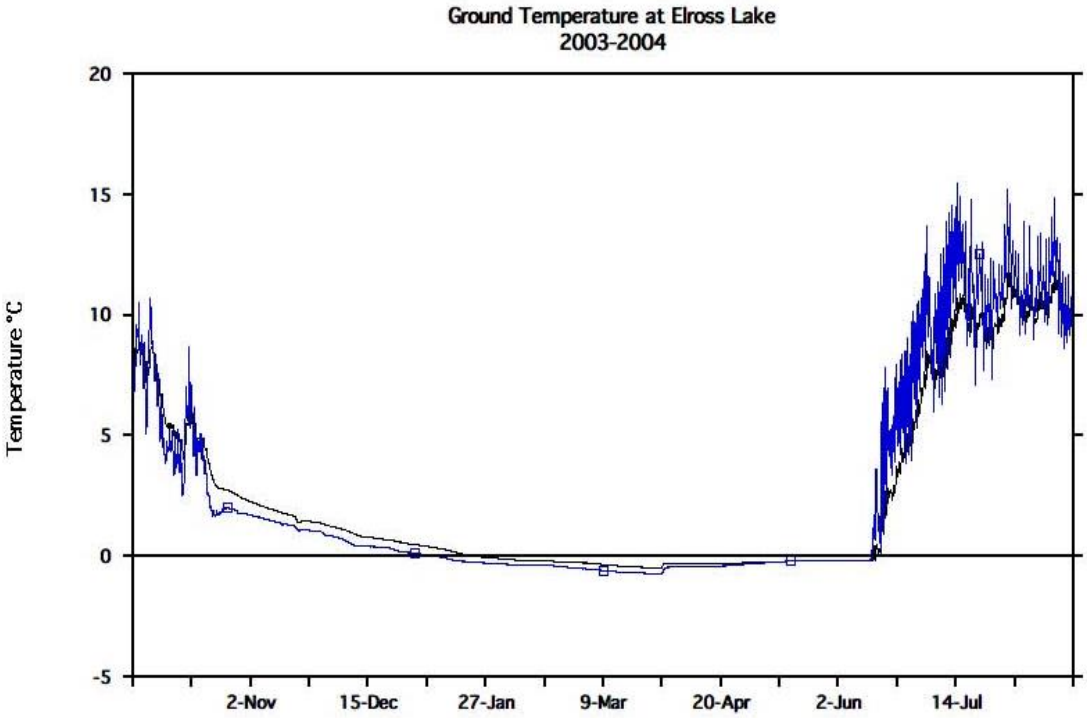


Figure 6: Elross lake soil temperature data at depths of 5 (blue) and 25 (black) cm.