Monitoring snow depth and cover at remote sites

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Background

Snow acts as an efficient insulator of soils, particularly in polar regions where air temperature can fall to below -30 °C (Coulson *et al*., 1995). The depth of the snow layer, the time of year when it first occurs and the time and manner that it melts, can be critical to the over-winter survival of soil organisms. However, such details are often dependent on human observation and are not available from remote, unoccupied sites. Most recording snow sensors (Fig 1 & 2) record the depth of snow at a single spot or over a very small area. The recent availability of high resolution digital cameras and the reduction in cost of solid state memory have enabled the development of systems to photographically record snow depth and cover over a much larger area.

This poster describes a system developed by scientists and engineers at the British Antarctic Survey for deployment at very cold, inaccessible sites which may only be visited once a year.

Recording snow depth

Snow depth is most commonly monitored using ultrasonic ranging sensors (Fig. 1) which measure the distance from the sensor to the target (snow). Other monitors use a “ladder” of sensors which can detect the presence of snow. An example of a ladder type probe which uses temperature sensors mounted 2.5 cm apart on a post is shown in Fig 2.

These types of sensor can only provide data on snow depth at a specific spot rather than over an area. Studies requiring information on the area of snow cover have previously relied on human observation of snow poles. The system described here provides a record in the form of digital photographs which can be analysed using image analysis software.. The camera will provide information on local redistribution of drifting snow, snow depth over any type of terrain/vegetation and percentage ground cover.

Figure 1

SR50 sonic ranging probe

Figure 2

Ladder of temperature sensors to detect snow level

Figure 3

System at Mars Oasis showing wind generator, solar panels and camera housing.

Why monitor snow depth?

Where there is continuous snow cover throughout the winter, many animals, such as spiders and springtails as well as fungi and bacteria, remain active in the subnivean environment.

As snow begins to melt the edge of snow patches provide an ideal moist habitat for the growth of all types of soil organism. This is of particular importance in extreme environments such as at Mars Oasis (Alexander Island, Antarctic Peninsula) where for much of the year water is a limiting factor to growth and survival.

These edge effects can in total provide a substantial area providing a kick-start to the organisms during the spring thaw.

Snow cover also protects organisms against the damaging effects of UV radiation. Recent studies (2) have shown that even thin layers of snow and ice are enough to completely cancel the biological effect of ozone depletion. However, as snow melts, the exposed organisms will experience an increase in UV radiation by approximately an order of magnitude which may cause stress if they do not posses sufficient UV-screening compounds. The snow edge can retreat rapidly (between 5 and 15 cm per day).

How does it work?

Internal environmental control enables the digital camera to operate down to -35°C and to continue operating through a three month period without solar or wind energy (Fig. 3). The power source for the system consists of solar panels, a wind generator and batteries acting as a reservoir. Time stamped colour images of 1600x1280 pixels on a 2.24 megapixel camera are taken and compressed to JPEG images for storage onto a low temperature memory card. Current capacities of available memory cards allow five good resolution images to be taken per day for up to two years. Automatic exposure allows pictures to be taken down to very low light levels. Information telling the camera exactly when to take a photograph is stored on the memory card.

The camera photographs an array of snow stakes marked with reflective tape 2.5cm wide (Fig. 4). Images will be analysed using image analysis software to provide information on snow depth and area cover

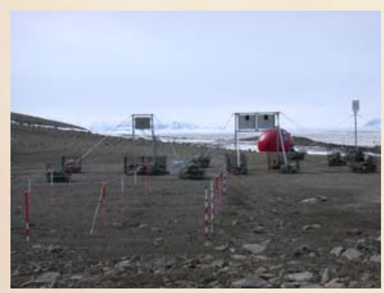

Figure 4
Mars Oasis study site showing snow poles in front of the camera

Other applications

Regular photographs at remote unmanned sites in Antarctica are beneficial to many scientific and operational investigations.

A system has been installed at Signy station (maritime Antarctic) to study sea ice formations and coverage (Fig. 5). This has replaced the previous sea ice camera which required expensive traditional chemical processing of the photographic black and white film. If in the future information from the camera can be sent back to the UK by satellite, it will help plan the timing of the first call by ship each season.

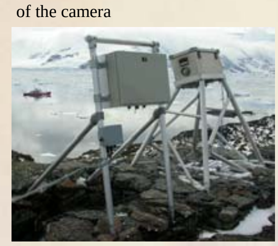

Figure 5.

New digital sea-ice camera (nearest) alongside old at Signy.

References

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