

SPECTRAL MEASUREMENTS OF SOLAR RADIATION IN SNOW

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ABSTRACT

Snow cover spectral attenuation characteristics were observed using a Li-1800 portable spectroradiometer at Schefferville, Quebec. A specially designed fiber optic probe was used for measurements in the snow cover. A Radio Shack TRS-80 model 100 portable computer was used to transfer data from the spectroradiometer to 3.5 inch microdisks in the field. This greatly increased the throughput of the field instrumentation and made it possible to collect data at high spectral resolution in the wavelengths between 400 and 1100 nm. Spectral attenuation of solar radiation was measured by multi-level observations of solar radiation intensity in the snow cover. The lowest attenuation was observed around 580 nm and the maximum from 990 to 1100 nm.

INTRODUCTION

In order to interpret satellite images and understand the spectral reflectance characteristics of snow, it is important to know more about the mechanisms involved in the attenuation of solar radiation by the snow cover. If a significant amount of solar radiation can penetrate through the snow pack, then the characteristics of the substrate can affect the reflectance of the snow surface and influence the runoff processes at the snow-soil interface. Even though a significant amount of modeling work has been done on the penetration of solar radiation through snow (Giddings and LaChapelle, 1961; Barkstrom and Querfeld, 1975; Wiscombe and Warren, 1981), not many field investigations have been conducted to verify these models. This paper describes some preliminary results from a field measurement programme currently undertaken at Schefferville, Quebec.

METHODOLOGY

A new fiber optics probe has been designed to measure the attenuation of solar radiation at different depths in a snowpack (Granberg, in prep.). The first 70 cm of a 1.2 m fiber optics cable is enclosed in a hard plastic tube, forming a rigid probe. The other end is connected to the fiber optics light conductor supplied by the manufacturer of the LI-1800 radiometer. The optically polished, flat end of the fiber optics cable (4 mm in diameter) was used directly as light collector. The probe was attached to a specially designed tripod, enabling the probe to be inserted into the snow to precisely determined depths (Figure 1).

A LI-1800 spectroradiometer was used for all field measurements. Data were transferred from the radiometer to a TRS-80 model 100 portable computer, from which the data were transferred to cassette tapes. During spring 1986, this method was further improved. After acquiring a portable 3.5 inch disk drive, data could be stored on microdisks rather than cassette tapes. This greatly increased the throughput of the field data

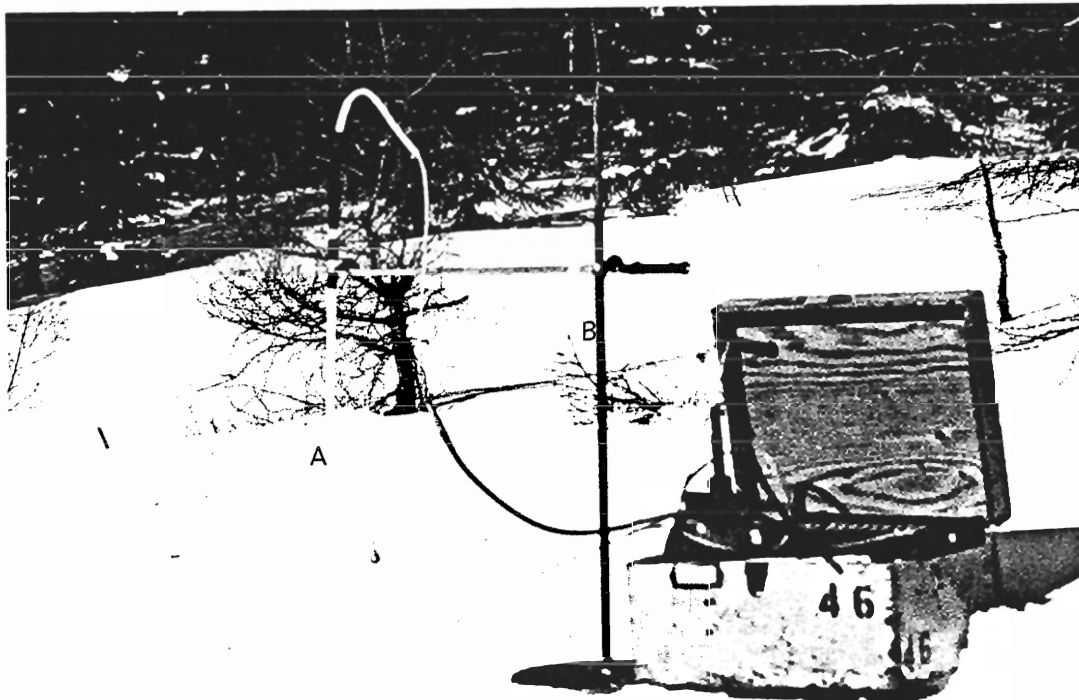


Fig. 1 : Set up showing spectral attenuation data collection,
(A) fiber optics probe, (B) tripod, (C) Li-1800
spectroradiometer.

acquisition system. In the laboratory the data were transferred from the TRS-80 model 100 computer to a Hewlett Packard computer system.

The spectral distribution of solar radiation was measured at 2 or 10 cm depth intervals by lowering the probe along with the extension arm of the tripod. The data was collected at a spectral resolution of 2 nm and at 10 cm depth intervals, during the winter of 1986. Improvements in the field data acquisition system permitted data to be collected at a spectral resolution of 1 or 2 nm and at 2 cm depth intervals during the spring of 1986.

RESULTS

The spectral attenuation of solar radiation in the wavelengths from 400 to 1100 nm and the attenuation of solar radiation in percent of incoming solar radiation are shown in Figure 2. The data were collected in April, 1986 (Profile SR), at a spectral interval of 2 nm. In section A of Figure 2, the top graph represents the incoming solar radiation, expressed in mV. It was obtained by measuring the reflected radiation from a barium sulfate plate and then dividing it by the absolute reflectance of barium sulfate (Grum and Luckey, 1968). Each successive graph in section A of Figure 2 represents the spectral variations in solar radiation (I_z) measured at depth intervals of 10 cm.

In section B of Figure 2, the attenuation of solar radiation was plotted at 10, 20 and 30 cm depths. The attenuation was obtained by subtracting the solar radiation measured at individual depths from the incoming radiation at each wavelength. These values were converted into percent of incoming solar radiation. About 60 percent of the incoming solar radiation at 400 nm was attenuated at a depth of 10 cm (section B, Fig. 2). The attenuation decreases up to 580 nm. The lowest attenuation of 38 percent was observed around 580 nm. After 580 nm, the attenuation increases with increasing wavelength. Almost 100 percent attenuation was observed at 990 nm.

To compare these results with results obtained earlier during the winter a similar set of measurements are shown in Figure 3. This data set was collected in February 1986 at intervals of 10 cm. (Profile BC). The graphs show that the results observed in the earlier section were repeated in February, 1986.

CONCLUSIONS

The Li-1800 spectroradiometer and new fiber optics probe performed satisfactorily under extreme temperature conditions at Schefferville. The data transfer from the radiometer to the TRS-80 model 100 computer and thence to disk in the field greatly increased the throughput of the field data acquisition system.

Measurements of the attenuation of solar radiation by the snow pack show that the lowest attenuation occurs near 580 nm and the maximum attenuation between 990 and 1100 nm. In the present study the maximum penetration was observed at 580 nm which is in the green part of the spectrum.

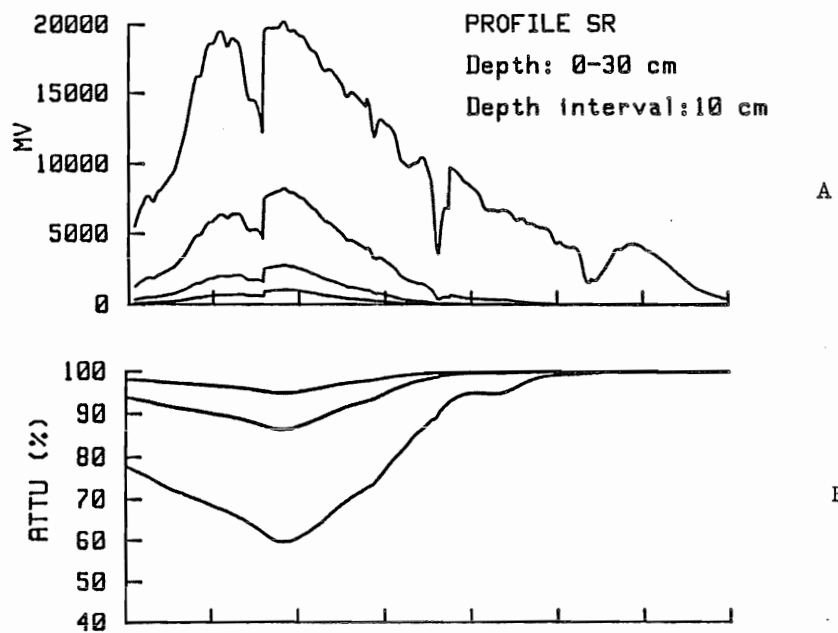


Fig. 2: Attenuation of solar radiation in a snow cover

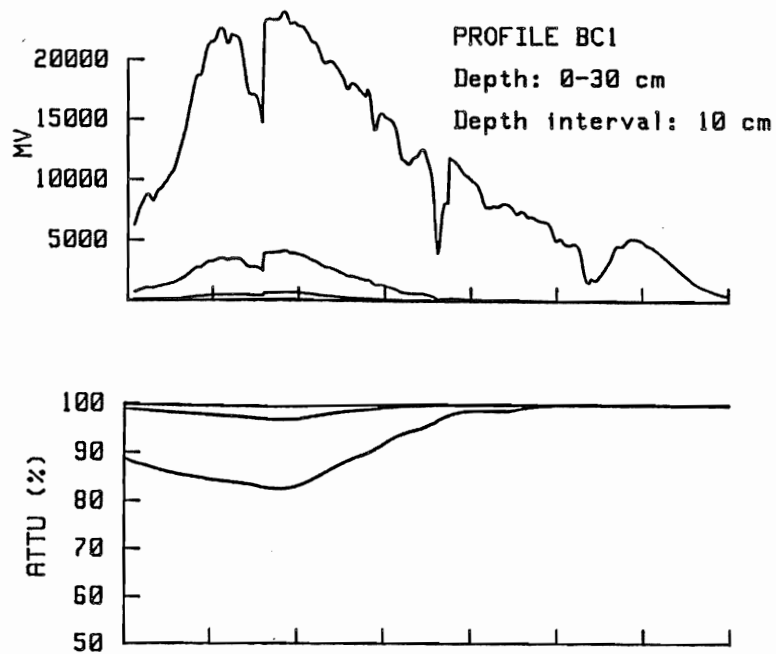


Fig. 3: Attenuation of solar radiation in a snow cover

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