FACTORS AFFECTING TEMPORAL VARIATIONS IN THE ALBEDO OF SNOWCOVER

by

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This study considered relationships between snowcover albedo, snow characteristics, air temperature and precipitation at a site in Peterborough, Ontario, Canada (Lat. 44° 25' N, Long. 78° 17' W, Elev. 220 m) for the 1980-81 snow season. The data collected was used to test the effectiveness of the USACE equation for albedo prediction at this site.

Short wave radiation measurements were taken using two Eppley Pyranometers and the snow characteristics, air temperature and precipitation were recorded at an adjacent snow time profile site (within 20 m of the radiation measurement site).

The measured albedo of the snow cover at solar noon ranged from 95% to 55% during the snow season. Figure 1 shows the most dramatic changes in albedo resulted from periodic rainfall and ablation events as well as new snowfall events. The snowmelt event of Jan. 26, 1981 lowered the measured albedo from 84% to 67% within a one day period. The albedo did not increase again until new snowfall occurred.

The USACE predictive equations were found to have an accuracy of only 48% in this study (Figure 2) when an intitial albedo of 85% was used in the equations as suggested by Petzold (1977). The observed mean noontime albedo of snow less than 24 hours old was found to be 81.17% (S.D. ± 5.23) and ranged from 75% to 95%. However, when this empirically derived initial albedo for new snow was used it did not improve the predictive ability of the equations (Strickland, 1981). From Figure 2, it can be seen that the prediction was particularly poor at the beginning of the winter with a persistent underprediction. There could be several reasons for this occurrence. The extremely low temperatures of this period cause the physical characteristics of the surface layer of snow to change very slowly. Also, at this time of the year the sun's noon time zenith angle is at its smallest. This study found that approximately 14% of the variability in albedo during sunny, non-melting conditions could be explained by the zenith of the sun. Although, the scatter in the points is much greater at low zenith angles than at higher zenith angles (see Strickland, 1981, p. 94). In the later part of the winter it can be seen that the predicted variation using the USACE equation is considerably greater than the observed. For instance, in Figure 2 it predicts a 5% greater reduction in albedo during the Jan. 27 to 31 ablation than really occurs.

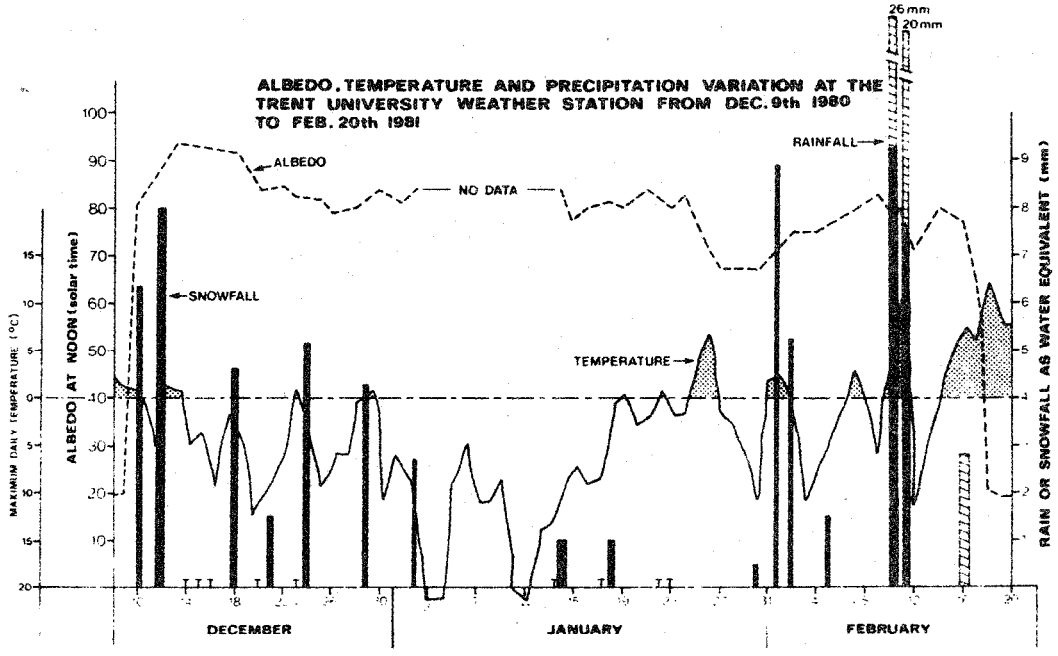

Figure 1.

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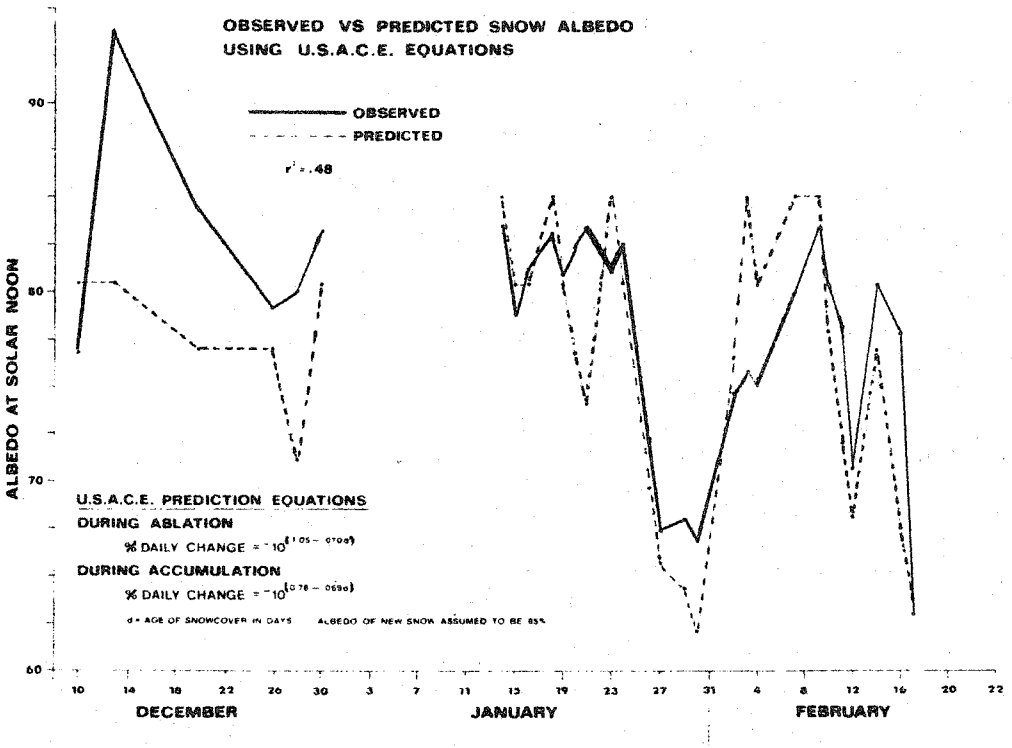

Figure 2

Most of the snow covered area of the northern hemisphere is in the 40° N to 50° N latitude range and is exposed to the same kind of extreme weather variability as Peterborough, Ontario. Albedo prediction in this area is difficult not only because these changes occur so rapidly but also because relationships that hold true at higher latitudes or in the laboratory cannot necessarily be applied. For example, this study (Strickland, 1981) found a slight negative relationship between percentage cloud cover and snow albedo rather than the traditional positive relationship reported in the literature. This may have resulted from the fact that most overcast days had wet snow conditions and these snow conditions may have masked the effect of the cloud cover. However, this is probably a common event in lower latitude snowcover and should be considered when predictions are attempted. More research is needed; for albedo variations of 15% associated with melt periods at these latitudes could have a significant influence on energy budgets at both the local and global scale.

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