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NET RADIATION AT FORET MONTMORENCY, QUEBEC

by

J.H. McCaughey*

Introduction

The net radiation (Q^*) is the only source of energy available to a surface in the absence of sensible heat advection. It consists of global solar ($K\downarrow$) and reflected solar ($K\uparrow$) radiant energy with a wavelength distribution from 0.3 to 3.0 μm, and of incoming ($L\downarrow$) and outgoing ($L\uparrow$) longwave radiant energy with a wavelength distribution from 3 to 50 μm. These components are related by the radiation balance equation:

$$Q^* = K\downarrow - K\uparrow + L\downarrow - L\uparrow. \tag{1}$$

The underlying surface has a direct control on the net radiation through its reflection coefficient ($K\uparrow/K\downarrow$) and temperature. The latter largely determines the magnitude of the outgoing longwave radiation. The reflection coefficient varies widely for natural surfaces (Sellers 1965). Also, surface temperature can show large differences between surfaces depending upon their vegetative cover, thermal admittance and soil moisture content. Given that the net radiation is measured over short, green grass at a meteorological station, if the surrounding surfaces are different then a question arises as to how accurately this value represents their net radiation.

There is a fundamental problem of transferring the meteorological station net radiation data to surrounding surfaces. The problem can be

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illustrated by considering a meteorological station in an area of coniferous forest. The reflection coefficient for short green grass is 0.26 (Monteith 1959), and an average value for coniferous forest is 0.10 (Oke 1978). This difference in reflection coefficient will produce a significant discrepancy between the meteorological station value of net radiation and that for the forest. Furthermore, the magnitude and temporal behaviour of the surface temperature of the grass and forested surfaces could be significantly different, and thus introduce a further complication into any transfer of meteorological station values to the coniferous forest.

The purpose of this paper is to examine the problem of transferring network net radiation values to a coniferous forest at Montmorency, Quebec. The work was done in the vicinity of the Forêt Montmorency meteorological station which is located in the boreal forest zone, 90 km north of Quebec City. The forest in this area is composed of balsam fir (*Abies balsamea* L. Mill) with minor amounts of black spruce (*Picea mariana* Mill) and white spruce (*Picea glauca* Moench). In the summer of 1976 a study of the radiation balance of forested and logged surfaces was carried out in the area (McCaughey 1978). At this time, net radiation was being measured at the Forêt Montmorency station. Thus a unique opportunity existed to examine how closely the meteorological station values compared to those for the nearby forest and logged surfaces. Subsequently the measurement of net radiation at this meteorological station has been discontinued.

Experimental Sites and Measurements

The Forêt Montmorency meteorological station is located just outside the boundary of the Montmorency Research Forest (6882 ha), an International Hydrological Decade research basin. This basin is topographically diverse with a maximum relative relief of 220 m, and slope inclinations up to 45°. There are two principal surface types in the basin: coniferous forest and clear areas which have been logged. The latter are concentrated on level or moderately inclined slopes (<20°).

Within the research basin two principal measurement sites were used in 1976. One, designated as the forest site, was established in a stand of mature, 50 to 60 year old forest. The other, designated as the cleared site, was established on a level, clear-cut area 400 m from the forest site. The forest had been logged off the cleared site in the fall of 1975. Both sites were 5 km from the meteorological station. At the forest site the mean tree height was 15 m, and the mean spacing between the trees on the forest floor was 3 m (sample of 30 trees). A detailed description of the vegetation on the forest and cleared sites has been reported (McCaughey 1978).

Net radiation values at the forest and cleared sites were measured with Swissteco net pyrradiometers (type S-1), which were purged continuously with nitrogen. Global solar radiation was measured with an Eppley, black and white pyranometer, at a point equidistant between the forest and cleared sites. For convenience these data are referred to as forest site values in the discussion below. McCaughey (1978) has fully described the details of the instrumentation at each site. At the meteorological station net radiation was measured over short, green grass with a Middleton net pyrradiometer which was purged continuously with nitrogen. At a distance of 200 m from the meteorological station global solar radiation was measured with a Kipp and Zonen pyranometer. It was positioned on the flat roof of a research trailer which was located in a large open compound. The horizon of the pyranometer was uninterrupted. This location was designated as the trailer site.

During the experimental period, July 1 to August 31, 1976, uninterrupted hourly integrated values of net radiation were collected at the meteorological station, and the figures from the forest and cleared sites were 51 and 49 days respectively. Only 28 full days of concurrent, hourly integrated global solar radiation data were available from the trailer and forest sites. This much smaller sample was caused by recording difficulties at the forest site. Figure 1 shows the air temperature and rainfall records from the meteorological station during the experimental period. Rain was recorded on 32 of the 62 days. The measured radiation data were not unduly biased towards wet or dry days because, for each flux, close to 50% of the sample days were dry.

RESULTS AND DISCUSSION

Spatial Variation of Global Solar Radiation and Net Radiation

The Montmorency Research Forest is at an average altitude of 750 m above sea level, and in the summer months there is a high frequency of cyclonic storms. Furthermore, because of the complex interaction of these cyclonic disturbances with the diverse topography, precipitation and cloud patterns can change rapidly on a short-term (hourly) basis and over short distances in this area. This causes high frequency spatial variability in the solar energy input. Such behaviour is typical of mountainous regions as has been shown by Hay and Suckling (1979) for British Columbia, and it results

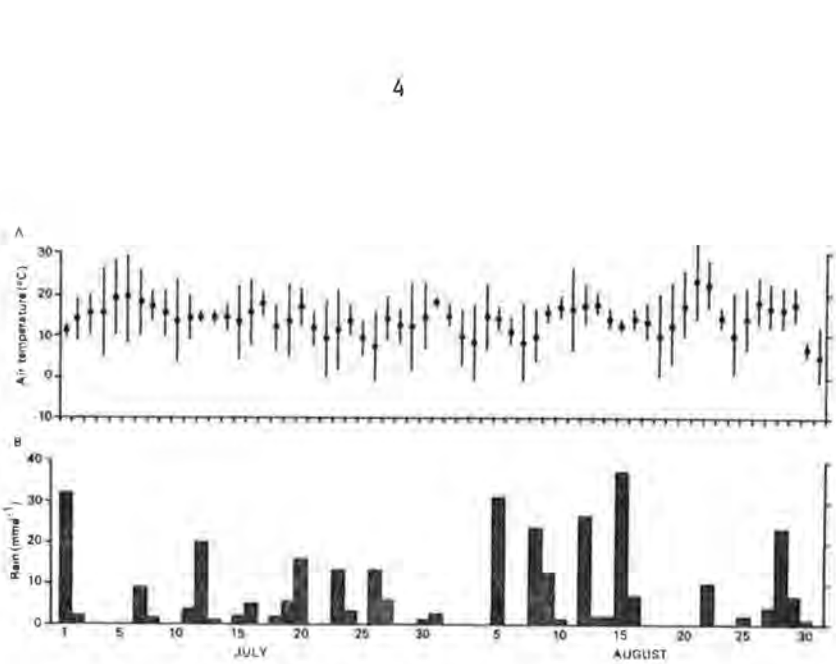

Fig. 1. Surface meteorological conditions at Forêt Montmorency meteorological station during the experimental period in 1976. A. Daily mean screen air temperature and temperature range. B. Daily rainfall.

in low areal representativeness for solar and net radiation at a measurement site. Under fair-weather, with cloudless skies typical of anticyclonic conditions, the areal representativeness will increase. This is illustrated for the Forêt Montmorency meteorological station by considering two contrasting days: July 28 and August 21. The former was characterised by highly variable cloud conditions at both the meteorological station and forest site, and the latter was cloudless during the whole of the daylight period.

Under variable cloud conditions there is a poor relationship between the hourly integrated global solar radiation at the two sites (Fig. 2). This is particularly evident between 0700 and 1600, with the largest differences at 0730 and 1130. Since global solar radiation is the largest component of net radiation during daylight hours then hourly net radiation values are likewise poorly correlated under these conditions. It is clear that the hourly net radiation values at each site are covariant with the local global solar radiation; however, there are significant differences in hourly net radiation between sites, e.g., at 1130 a difference of 300 Wm^{-2} exists. Practically all of this difference is due to the difference in the global solar radiation in response to the different cloud amounts at the

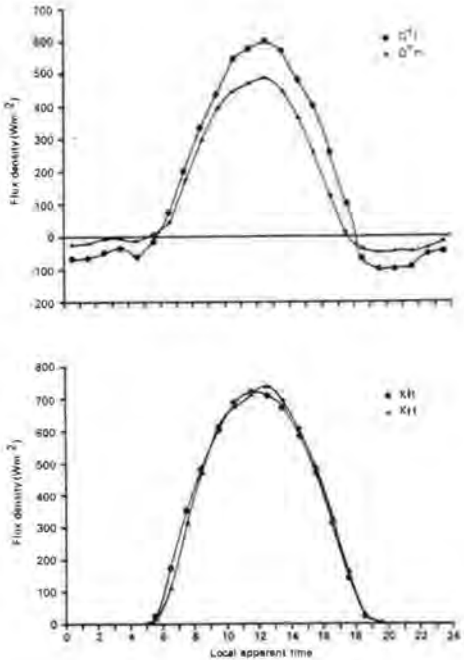

Fig. 3. Radiation data for August 21, 1976. Notation is the same as Fig. 2. During the daylight period the sky was cloudless.

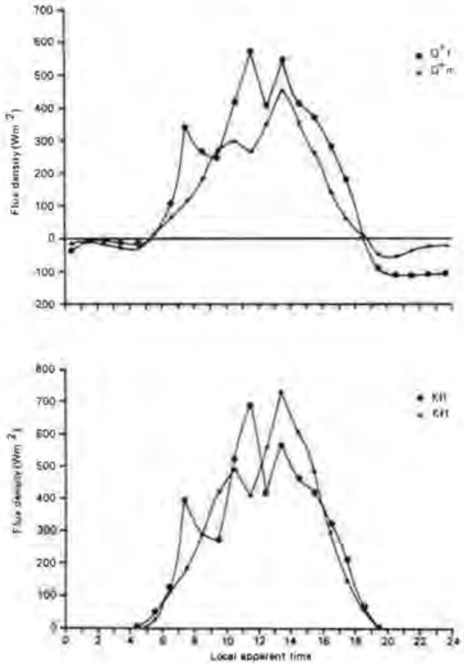

Fig. 2. Hourly net radiation (Q*) and global solar radiation (K↓), July 28, 1976. Subscripts f, m, and t signify forest, meteorological station and trailer sites respectively. Cloud cover was variable all day.

two sites. In contrast, the data for August 21 show that the solar radiation input into both sites is virtually the same, with only minor differences occurring on an hourly basis (Fig. 3). In fact, with the exception of 0630, all differences are within the accepted error of measurement of ± 5%. The net radiation for the forest and meteorological station sites are covariant with the hourly values for the meteorological station being significantly lower during the day and higher (less negative) at night. This pattern reflects systematic differences in the surface controls on net radiation at the two sites. During daylight hours under clear-sky conditions, the global solar radiation at both sites is the same, and since the sky temperature is unlikely to be different, the incoming longwave radiation will be the same at both sites. Therefore the difference between Q^*f and Q^*m results from the difference in the reflection coefficients and possible differences in surface temperature between the sites. The reflection coefficient for the meteorological station is larger than that for the forest which leads to a lower value of net radiation at the meteorological station. Although the surface temperatures of the sites were not measured, it is unlikely that they were large enough to cause major differences in outgoing longwave radiation (see next section). At night the emitted longwave radiation is the only factor which has to be considered in comparing the two sites and, since the meteorological station will cool more than the forest site, its net radiation will be larger (less negative) than that at the forest site.

In order to minimize the spatial variations in global solar radiation input into the meteorological station and forest sites the period of integration can be increased. The longer the period of integration then the greater is the likelihood that short term (hourly) variability will average out. The period of integration chosen in this experiment was 24 hours. Whenever daily totals are considered there is no significant difference between the sites (Fig. 4). The line of best fit to the distribution is $K{\downarrow}t = 0.012 + 0.99\ K{\downarrow}f$, with a correlation coefficient (r) of 0.99. This correlation is significant at the 0.01 level of significance.

Net Radiation Variation

McCaughey (1978) has shown that, for this sample period, the daily totals of net radiation for the cleared site were systematically lower than those for the forest. The average reduction was 10%, and the principal reason for the reduction was that there had been a significant

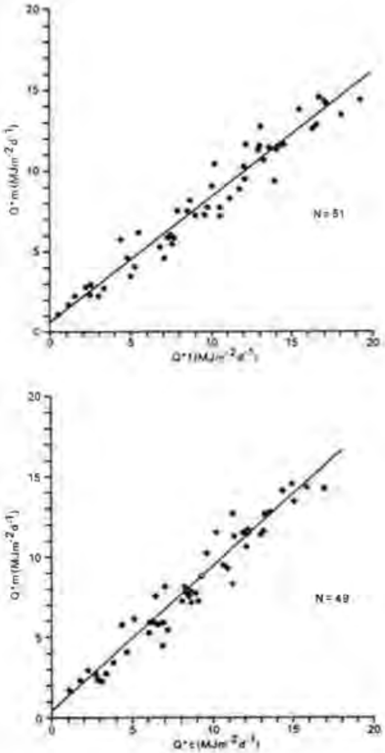

Fig. 5. Relationship between net radiation at the meteorological station (Q*m) and that at the forest (Q*f) and cleared (Q*c) sites, July and August, 1976.

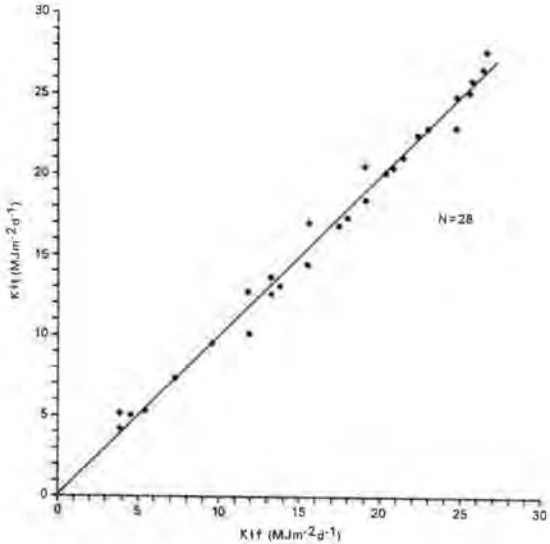

Fig. 4. Relationship between global solar radiation at the trailer and forest sites, July and August 1976.

increase in the reflection coefficient after the forest was logged. The daily mean reflection coefficient for the forest was 0.07 compared to 0.18 for the logged site. There was no evidence to suggest that there were significant differences in the outgoing longwave radiation between the sites in terms of daily totals. This implied that, because of the regular rainfall during this period, the soil moisture content of both surfaces remained high and, therefore, since evaporation would remain high the surface temperature difference between the sites was suppressed. Whenever the daily net radiation regime for the meteorological station is considered in this context the principal conclusion is that it is more closely related to that for the cleared site than to that for the forest. This is because its reflection coefficient of 0.26 (Monteith 1959) is closer to that for the cleared site. The relationships between the daily totals of net radiation for the meteorological station and that for the forest and cleared sites are $Q^*m = 0.694 + 0.764\ Q^*f$, $r = 0.97$, and $Q^*m = 0.366 + 0.895\ Q^*c$, $r = 0.97$ (Fig. 5). Both correlations are significant at the 0.01 level of significance. The average difference of 10% between Q^*m and Q^*c compares to a difference of 24% between Q^*m and Q^*f.

These data illustrate very clearly that the meteorological station values of net radiation cannot be assumed to represent those for the surrounding region. On an hourly basis there can be very large differences as a result of spatial variation of solar radiation across the basin. The spatial variation of solar radiation disappears whenever daily totals are considered, but there still remains systematic differences in net radiation because of different reflection coefficients of short grass, coniferous forest and logged areas.

Further analysis of the components of the radiation balance of the forest and cleared sites, using data from 1978 and 1979 (McCaughey 1980), has shown that, when these surfaces dry, the difference between their daily net radiation become more pronounced. This is caused by the increased loss of longwave radiation from the cleared surface caused by the greater surface heating during the daylight period because less energy is being consumed by evaporation. Under these conditions the meteorological station value of net radiation will diverge further from those of the surrounding surfaces. Thus, the use of uncorrected meteorological station values of net radiation cannot be used to characterise the surrounding basin at Forêt Montmorency in either wet or dry summer conditions. It should be acknowledged that in winter, when the area is snow-covered, the meteorological station value of net radiation will be a better representation of the surrounding area because of the similarity in the reflection coefficient and surface temperature of all of the surfaces.

CONCLUSIONS

In the sample period considered the net radiation at Forêt Montmorency is more representative of the nearby logged site than the forest site. The principal parameter causing differences in net radiation between the sites is the reflection coefficient. Surface temperature differences between the sites are not significant because of the high soil moisture contents at this time. However, whenever the surfaces dry out there are likely to be significant differences in surface temperature between them, and, therefore, the coefficients of the regression equations which are presented will change. It is acknowledged that these equations are not general transfer functions for the Forêt Montmorency station but, rather, they are illustrative.

A general solution to the problem of transferring net radiation data from a meteorological station to a nearby surface, with different reflective and thermal characteristics, could be based on regression equations developed from a data base which was large enough to encompass the complete range of differences in the surface characteristics. Another approach which could be attempted is to simply rely upon measured global solar radiation at a meteorological station and in conjunction with measured reflection coefficients the absorbed solar radiation at nearby sites could be calculated. Then the longwave terms of the radiation balance could be calculated from established models. Arnfield (1979) has shown that the models of Swinbank (1963) and Idso and Jackson (1969) give very satisfactory estimated of $L\downarrow$ on a daily basis. The transformation of these models to give net longwave radiation necessitates a knowledge of the air temperature regime at the various sites near to the meteorological station in question.

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MEDICAL BIOMETEOROLOGY:

YESTERDAY, TODAY AND TOMORROW*

by

Simon Kevan**

What exactly does the familiar expression "feeling under the weather" mean? Certainly, its usage in the vernacular suggests an extremely clear relationship between weather conditions and a sense of well-being. Unfortunately, scientific clarification of this saying has proved to be rather elusive. The existence of such a paradox however, cannot be blamed on academic disinterest or lack or research efforts. Serious concern about the relation between weather and health has been well documented since the times of the ancient Greeks. In fact, medical biometeorology, must be ranked as one of the oldest of all sciences. A strong foundation for its study was laid during the fourth century B.C. by the generally acclaimed father of medicine, Hippocrates of Cos. He believed so strongly in the importance of the weather-health relationship that he devoted a major portion of one of his most famous discourses "Airs, Waters and Places" to its discussion. There is insufficient time to dwell on the historical development of his ideas through later Greek, Roman and Renaissance times; it should, however, be pointed out that his impact was sufficiently great to ensure that up until the mid-1800's a consideration of the weather/health relationship was thought to be integral to a physician's knowledge (Miller, 1962).

Significant to the development of medical biometeorology in

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* This paper was presented at the AGU-CMOS Meeting held in Toronto, 22-27 May, 1980.

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North America were the writings and practices of Thomas Sydenham and John Arbuthnot. Both of these eminent physicians influenced many of America's earliest medical practitioners with their endorsement of weather and health studies. As a result, many of America's earliest meteorological records, many of them kept by doctors, were not the result of mere idle curiosity on behalf of the pioneering medical community. Nor is it co-incidental that the United States Weather Bureau was in fact established by the United States Army Medical Department. As Hume (1940) points out "It all began with records kept for nigh a century exclusively by medical officers of the Army, and finally the Weather Bureau itself was established by an Army Medical Officer". Even James Pollard Espy, one of America's most brilliant pioneers of meteorology was associated with the Medical Department of the United States Army.

The Canadian tradition of medical biometeorology is not quite so rich, but nonetheless, a few points are worth noting. For instance, the first regular observations taken in Canada were made during the 1740's and 1750's by Dr. J.F. Gauthier of Montreal. The McGill University Observatory was established by Dr. Charles Smallwood; who, it should be added, was Canada's first professor of Meteorology. Nor should the efforts of Sir William Hingston M.D. (1884) go unrecognized.

Aside from the importance which early medical doctors played in the accumulation of meteorological data, their attitudes and convictions concerning weather and health were to have equally far reaching ramification in terms of tourism and resort development. As Robinson (1976) points out, it was the medical profession which was largely responsible for the growth of tourism, first with their recommendations concerning the medicinal properties and healing qualities of mineral waters, then with their belief concerning the therapeautic merits of bathing in the sea and finally with the curative powers of residing in the purer air conditions of numerous country resorts. By late 1800 climatotherapy had become sufficiently popular and lucrative as to develop many of the major resort towns of Europe and North America.

By World War I the attitude of the medical community towards medical biometeorology had changed drastically. Interest waned in North America almost to the point of placing the subject into a state of total disrepute. Valiant attempts were made during the 1930's and 1940's by such scholars as William F. Petersen (1934/5, 1947), Clarence A. Mills (1939), and Ellsworth Huntingdon (1924, 1938, 1945) to revitalize interest; however, though their theories and findings gained popular acclaim, the medical community tended to ignore much of their work.

World War II brought about a flurry of interest in specific matters such as heat, cold and altitude adaptation, and considerable progress was made in these areas of physiological biometeorology. Consequently, interest in those and similar specialized aspects of medical biometeorology remains active in North America. Unfortunately, concern with the more general aspects of weather and health remains relatively low in academic spheres. This is not to say that no interest has been shown by North American research workers; rather, the interest has tended to be concentrated among independent enthusiasts who have not been fortunate to have the benefits of coordinated and concentrated research facilities which have allowed so many other disciplines to make so much progress in more recent years.

In Europe, especially Central Europe, the attitude is quite different. There, the academic community actively supports research concerning the more general aspects of weather and health. This interest has led to significant advances in both the theoretical and practical aspects of climatotherapy and general medical biometeorology.

At this point, it is pertinent to focus attention on some of the improvements in methodological techniques which have been developed by West German research workers. Rather than trying to correlate the incidence of specific health conditions with specific meteorological factors, e.g., the incidence of heart attacks vs daily mean temperatures, barometric pressure and the like, which is a technique which has tended to produce rather disappointing results - but which is the technique still widely used by American researchers - the German biometeorologists have examined the relations between health matters and general weather conditions. Their findings have been much more encouraging, and definite statistically significant relationships have been proven to exist.

The best known of these German schemes is the Bad Tolzer Weather Phase Model which was developed by Drs. Hans Ungeheuer and Helmuth Brezowsky. As details concerning their methodology and findings are relatively easy to come by (see Brezowsky, 1964; Landsberg, 1969; Kugler, 1972; Kevan, 1980), there is little need to discuss their work in detail. Their scheme like Becker's "Konigsteiner" and Daubert's "Tubinger", requires for its basis the analysis of weather conditions in terms of the Bjerknes cyclone model. Figure 1 shows the type of relationships which have generally been found to exist under different prevailing weather conditions. Obviously, this diagram shows idealized conditions and relationships. In actuality the effect of weather on health and welfare depends upon a myriad of factors such as the intensity and origin of cyclonic, anticyclonic and frontal conditions. Dr. Wolfgang Kuhnke's Decimal Classification system shows just how complex the study can get. Not only does his system taken into account cyclogenetic factors but it also considers global atmospheric flow patterns, upper and lower air mass conditions as well as equivalent temperatures. The permutations and combinations of weather conditions which exist using such a complex system are staggering.

One thing that should be pointed out however is that the various schemes have been developed in order to explain weather and health relationships which exist in different regions of Germany. The reason for developing modified versions for various regions is that both general and local weather conditions vary with geographical location. These differences have been found to exert important moderating influences on biometeorological relationships. Austrian research workers have found the differences to be significant. They have found that the weather phase type systems do not work well. It seems that the Alps exert too much of an influence. On the other hand Kuhnke's decimal system has met with some success; however, the Austrian researchers believe that they must develop their own working model if their medical biometeorological efforts are to prove worthwhile.

Clearly, the West Germans take the study of medical biometeorology seriously. The Deutscher Wetterdienst has a well established medical meteorological division. This division even goes so far as to produce daily medical meteorological forecasts. (Table One). These forecasts provide comments concerning the general weather conditions, the degree of biotropy (weather influence) and the types of medical conditions which are affected by the weather. It would be wrong however to give the impression that the German medical community has accepted this service with open arms. It seems that there are still many German physicians who view this service with scepticism; nonetheless, it is gaining recognition. Perhaps the main reason for this reservation lies in the fact that even now there is really very little physiological or pathological justification for the findings which appear to exist.

This lack of scientific justification has undoubtedly contributed to North America's lack of concern in the general aspects of medical biometeorology. Any future research worker is bound to meet considerable resistance from the medical community. That, in itself, is bound to make research difficult; but equally as trying will be the formulation of working

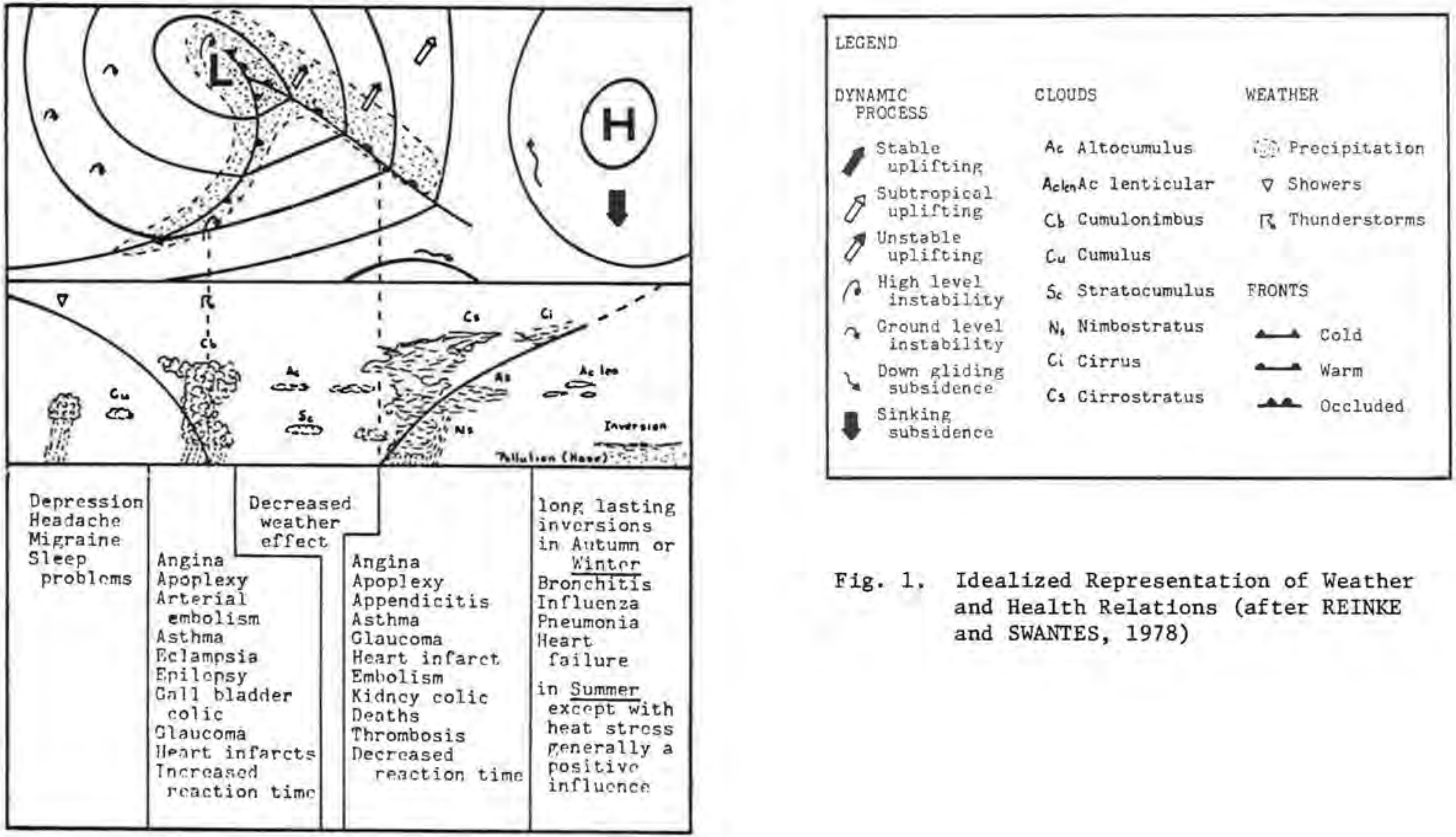

Fig. 1. Idealized Representation of Weather and Health Relations (after REINKE and SWANTES, 1978)

TABLE ONE

Sample of a Medical Meteorological Forecast

Weather report for physicians of Scleswig-Holstein, Bremen, Hamburg, Wiedersachen, Nordrhein-Westfalen and Berlin, valid from 29.12.77 to the evening of 30.12.77

1) Weather conditions and weather forecast:

   A border disturbance of the strengthening North Sea low is developing over the southeast of the British Isles. Behind it renewed maritime polar air moves towards north and west Germany.

2) Intensity of weather effect:

   Thursday, moderate but increasing; Friday, weak to moderate.

3) Hints for physicians:

   a) Subjective complaints
      Thursday, general symptoms going away then worsening. Pain sensitivity and sleep disturbances increasing. Friday, motor muscle restlessness increasing further.

   b) Thursday night, especially in the northwest and west, heart and circulation problems increase as does the likelihood for thrombosis. Friday, the weather effect disappearing; then renewed proneness to all effects, spasms, apoplexy, angina, colics and arthritis.

4) Postscript

   This forecast will be in effect until 31.12.1977.

meteorological criteria. The German experience has indicated the significance of upper atmospheric data in determining weather-health relationships. Unfortunately, North America's network radiosonde stations in North America is quite limited so that many of the necessary details will be lacking. Furthermore, more complete weather data concerning air mass conditions and movements, global circulation patterns, and the like will have to become more readily available. In addition to this an attempt will have to be made to analyze the seasonal meteorological constraints of the region in question; since the significance of the weather conditions of one season are not necessarily the same as those of another. These should not be considered as insurmountable obstacles. Nevertheless, however, their existence should make it obvious that a workable scheme will take a great deal of time and patience to develop.

In closing I would like to say that the meteorological community of Canada has proved to be extremely receptive to the idea of studying aspects of general medical biometeorology. The encouragement which has been offered to me has been particularly noteworthy; and the attitude that the meteorological limitations to such research should not be considered as obstacles, but rather that they should be looked at as challenges has been particularly inspiring. Let us hope that the interest and pursuit of research in this field will before long become much more widespread that it is today.

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CALIBRATION OF MULTI-SPECTRAL SCANNER DATA FOR URBAN ALBEDO MEASUREMENTS USING TARGET REFLECTANCE PANELS: SOME USER EXPERIENCES*

by

R.D. Brown and J.E. Lewis**

Surface albedo investigations were conducted for the Montreal urban area, during which Canadian Centre for Remote Sensing (CCRS) target calibration panels were employed to establish relationships between scanner recorded energy and surface integrated reflectance or albedo. It was originally believed the panels (7.62 m by 7.62 m of known 4, 8, 16, 32 and 64% reflectance) offered a more reliable means for calibrating airborne data than surface measurements, which have instrumentation and sampling problems. Data were collected at solar noon from an altitude of 1432 m above sea level in bands 4, 9 and 10 of the CCRS Daedalus 1260 multi-spectral scanner for three dates (March 16, 1978; April 18, 1979; June 26, 1979). The aim was to study the effects of contrasting surface cover, produced by seasonal change, on the magnitude and spatial distribution of albedo values and to provide data to test an urban canyon albedo model (Arnfield, 1976).

Conversion of the multiband data to single integrated albedo values was accomplished following a method employed by Thomson and Dillman (1973). Pixel counts in each band were first converted to energy values,

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* This paper was presented at the Sixth Canadian Remote Sensing Symposium held at Halifax in May, 1980.

** R.D. Brown is a recent graduate in climatology from McGill University who is now working as a consultant in Newfoundland. J.E. Lewis is Associate Professor of Climatology in the Department of Geography at McGill University.

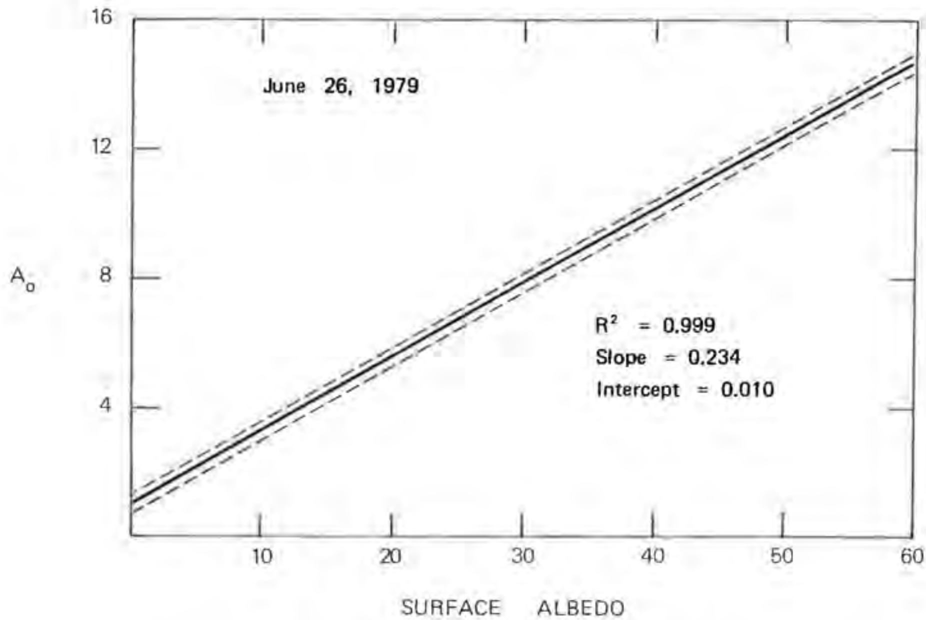

Fig. 1. Panel/scanner relationship for June

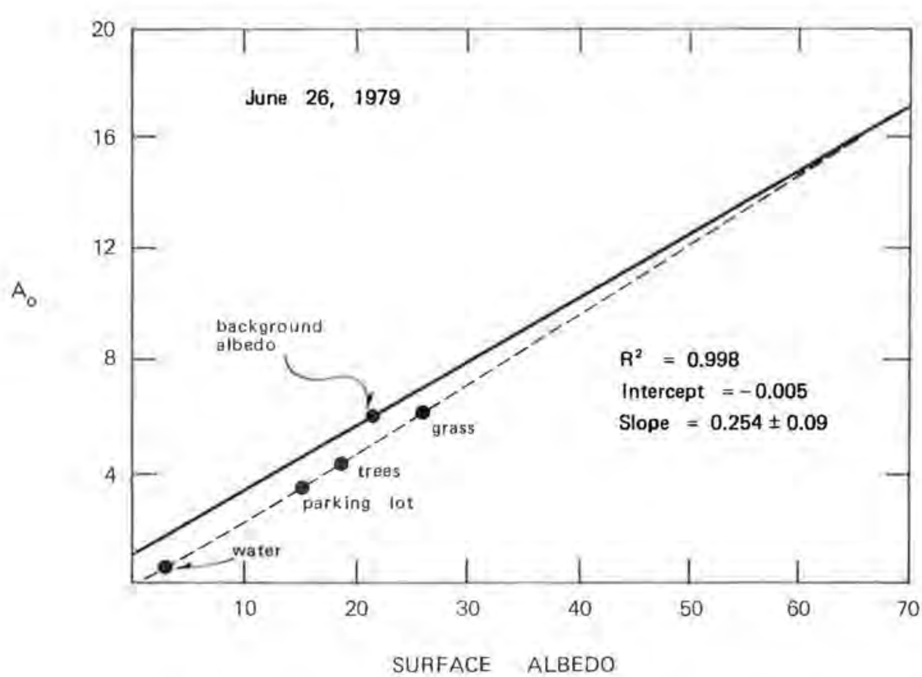

Fig. 2. Comparison of panel albedo and surface albedo

summed, then divided by total incoming solar radiation recorded at the time of each flight pass to produce scanner albedos, A_o. Regression analysis between target panel reflectance and corresponding scanner albedo enabled a linear equation to be derived for predicting surface albedo from the airborne data. Figure 1 shows results for the June flight. R^2 values > 0.99 were also obtained in March and April. A noticeable feature of the three relationships were significant (0.01 level) positive intercepts. Path radiance is one obvious effect that could have produced the observed intercepts. In order to test this hypothesis, an estimate of path radiance was obtained in each band for each flight by observing the darkest object in the flight path. Assuming this point represents zero ground reflectance, the scanner-recorded energy represents path radiance. This is, however, an overestimate since the assumption of zero ground reflectance is not reached in reality. Table One compares these estimates (PR) with the intercepts (I) obtained from linear regression analyses between scanner energy and panel reflectance for each band. In only two out of nine cases could the path radiance estimate alone have explained the observed intercepts, suggesting that other effects were modifying the signals recorded by the scanner when viewing the panels. Two possible effects that could account for this relate to the small size of the target reflectance panels (generally, only 2-4 pixels could be clearly identified as belonging to each of the panels).

Turner et al. (1971) pointed out the problem of background reflectance influencing target radiance under certain hazy atmospheric conditions. Radiance sensed from small ground objects usually includes some reflected radiance from the surrounding environment. While this process may well have been operating in June where haze was present, it does not explain the March and April results which were obtained under clear atmospheric conditions.

CCRS suggested that a Modular Transfer Function (MTF) effect may be associated with the small number of pixel values obtained over each panel. The MTF follows a step function as the scanner moves from one area of reflectance to another. Small areas of high contrast such as the panel configuration would not be large enough to allow the scanner to reach an equilibrium response. This would cause an apparent increase in radiance values recorded at the sensor when background reflectance > target reflectance, or an apparent decrease in recorded radiance when background reflectance < target reflectance. Both of these would alter the slope and consequently the intercept of a panel/scanner relationship.

TABLE ONE

Comparison Between I and PR Rounded to Nearest Integer Count

BAND	MARCH		APRIL		JUNE	
	I	PR	I	PR	I	PR
4	26	21	13	8	15	7*
9	11	2*	8	4°	14	4*
10	6	0*	7	2*	13	4*

* significant difference at 0.01 level
* " " at 0.05 level

To obtain an estimate of how large the error is in the regression lines due to "panel effects", the panel relationship in June was compared with a relationship derived from four large target surfaces close to the site where the panels had been displayed. Ground observations of albedo had not been taken over these surfaces during the flights (the panels had been considered sufficient for groundtruthing purposes); therefore, the surfaces were assigned typical values from the literature. Results of the June comparison can be seen in Figure 2. It was originally hypothesised that the new relationship should pass through the point where background reflectance equals panel reflectance (indicated in Fig. 2) since an MTF effect would tend toward zero at this point. However, the point of intersection was considerably higher suggesting that signals recorded over the panels were all increased by some amount, that amount decreasing with increasing panel reflectance. For the June calibration, therefore, this suggests that the MTF effect may be compounded by in-scattering of radiance from around the panels. Calculation of confidence intervals about the slope of the new relationship, however, showed that it was not significantly different from the panel relationship at the 0.05 level.

In the final analysis, the slopes of the panel relationships were retained, and the lines shifted through the origin to allow prediction of surface albedo. This ignores path radiance effects, but the error attributable to this is < 2% based on the path radiance estimates obtained from the darkest pixel method. The question that must be addressed now is whether the panels offer any advantages over groundtruthing obtained from surface observations. In June, this did not seem to be the case. However, in March and April there was a poor range of surface albedos available for calibrating the airborne data and in these instances, the panels offered a more reliable method. Combination of both methods where possible in climatological studies such as surface albedo investigations is recommended considering the "panel errors" found in this work.

Acknowledgements

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NEWS AND COMMENTS

Many readers of the Climatological Bulletin will be saddened by news of the sudden death of Fritz Muller. He died of a heart attack on July 26, 1980, while leading a field trip on the Rhone Glacier.

Fritz Muller was primarily a glaciologist, but his work is well known in the field of climatology due to his interest in radiation balance and the detailed conditions governing the physical processes of ice. He had a long association with McGill University, initially through the Arctic Institute of North America in 1954 and then as a member of the staff of the Geography Department from 1959 until he left in 1972 to become Chairman of the Institute of Geography of the Swiss Federal Institute of Technology in Zurich. Much of his research, both at McGill and after he left, concentrated on the Canadian North particularly in relation to work on Axel Heiberg Island and the North Water Project near Baffin Island and Greenland. During these studies he made many climatological investigations and provided original climatic data in an area with few regular observing stations. He also provided opportunities for research for many students in climatology, especially those working in the field of the radiation and energy balance over ice.

The American Association for the Advancement of Science will be holding its annual meeting in Toronto from 3 to 8 January, 1981. Among the sessions planned is a particularly interesting one for climatologists under the general title of "Climate and Ecology". Within this framework there will be a total of nine topics of which those scheduled for January 6 and 7 appear to be especially interesting to climatologists at the present time. These topics are: (a) Planning for Uncertainty - climatic change and the study of societal impacts, organized by David M. Burns; (b) Climate and Food - studies in vulnerability and response, organized by John G. Corbett; (c) CO_2-induced climatic change and the dynamics of Antarctic ice, organized by David M. Burns and Charles Bentley; and (d) Testing theories of climatic change, organized by Alan D. Healt. Further information on the annual meeting is available in the issue of Science for 12 September 1980 or can be obtained by writing to the AAAS at 1515 Massachusetts Avenue NW, Washington, D.C., 20005.

Several Canadian Climatologists have recently been, or currently are, on sabbatical leave. John Hay (University of British Columbia) recently spent a leave at Boulder, Colorado in association with NCAR and the University. Among his activities he began work on modelling techniques to incorporate the use of satellite data into an understanding of the mesoscale variability of solar radiation. Harry McCaughey (Queens University) spent a sabbatical recently at the University of British Columbia. His work there included a field experiment, in association with Tim Oke, to determine evaporation at a suburban site in Vancouver and a rural site at Vancouver Airport. John Lewis (McGill University) currently has a sabbatical year (Sept. 1980 to Aug. 1981) the first half of which will be spent visiting universities and institutions in Scandinavia, the United Kingdom, and Germany. Later in his sabbatical he will be at Resolute Bay in connection with climatological and remote sensing investigations supported by Petrocan. Ben Garnier (McGill University) is on sabbatical leave until January 1981. He will be in New Zealand from mid-October to the end of December gathering material for a revision of his book The Climate of New Zealand (published 1958) which is now both out of date and out of print.

There is strong emphasis on climatology at provincial government levels in British Columbia these days. Rick Wilson as Director of the Air Studies Branch in the Ministry of Environment heads a team of some 22 persons involved in climatological or climatologically related studies. Much of the work involves climatic impact studies, and the monitoring of climatically related matters such as air pollution, drought, and scientific irrigation. Recent publications resulting from this work include "Climatological Analysis for Settlement Suitability: Victoria's Highlands and Metchosin Areas" by R. Chilton, and "An Analysis of Solar Radiation for British Columbia" by John E. Hay.

Marie Sanderson is this year's President of the Canadian Association of Geographers. She will bring a climatological viewpoint to the position which, it is hoped, will be reflected in more emphasis on climatology in the Associations activities.

Tim Oke (University of British Columbia) and Stan Tuller (University of Victoria) were among Canadian climatologists attending the 24th International Congress of the International Geographical Union, held in Tokyo at the end of August, 1980. It is hoped that a report on climatology at the Congress will be available for the next issue of the Climatological Bulletin (April, 1981)

"Basic research is what I'm doing when I don't know what I am doing".

Wernher von Braun.

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