occurrence of a storm, given a flare. There are so many small features on the sun any of which may be associated with a storm.

Thus the solar terrestrial picture divides itself into four parts:

1. Forecasting the flares themselves.
2. Given a flare will there be a magnetic storm?
3. The effect of a magnetic storm on the ionosphere.
4. The effect of the ionospheric storm on the radio propagation.

Mr. Cook concluded his talk on this wide subject by showing films of types of solar flares and solar activity.

R.N.K.

22 April 1969

ESTIMATING NET RADIATION INTENSITIES

By E.T. Linacre

Dr. Linacre, Associate Professor of Climatology, Macquarie University, presented an outline of his studies of methods of estimating net radiation from commonly available climatological statistics.

In opening his talk he stressed the importance of a reliable knowledge of net radiation income in relation to the evaporation from crops, irrigation practice and hydrology generally. As satisfactory techniques for measuring net radiation directly have not yet been applied widely, it is necessary to devise simple and reliable methods of estimation capable of wide application.

Starting from the expression for net radiation income, Q_n, in terms of its components and introducing Swinbank's atmospheric longwave radiation formula with an Ångstrom type allowance for cloudiness, Dr. Linacre showed how after some approximation one arrives at

$$Q_n = (1 - \alpha)Q_s - 16 \,.\, 10^{-4} (100 - T)(0.2 + 0.8n/N) \ \mathrm{cal/cm^2\ min}$$

in which Q_s = global shortwave radiation intensity,

α = albedo of surface ($\approx$ 0.25 for most crops),

T = mean daily screen temperature ($^{\circ}$C),

n/N = bright sunshine as fraction of day length.

The assumption made that surface temperature is equal to screen temperature is a good approximation for mean daily values with freely transpiring crops, but is less satisfactory for bare or thinly vegetated surfaces.

Monthly mean values of Q_n (observed over crops) versus Q_n (calculated from formula) showed very satisfactory agreement for such diverse places as Aspendale, Copenhagen and Ibadan. Where measurements of Q_s were lacking, standard methods of estimation could be employed and the resulting Q_n values were still of adequate accuracy.

Dr. Linacre then considered further simplifications of the formulation in the interests of climatological studies and, among other interesting features, he showed how mean annual temperature range in relation to the mean annual range of Q_s constitutes a useful index of continentality with a sounder physical basis than many used in the past.

The Chairman, Dr. A.J. Dyer, launched the ensuing discussion by remarking that he hoped those concerned with problems in which net radiation is a basic consideration would not always be content with estimates, but would support the campaign to have net radiation more widely observed on a regular basis. He agreed, however, that Dr. Linacre's studies are valuable in the existing situation.

Dr. Linacre agreed that more observations of both Q_s and Q_n are desirable but pointed out that developments in new areas required estimations to be made with existing climatological data, often of the simplest kind. It seemed, however, that integrated daily net radiation is not as easily recorded with accuracy as the short-wave income. Furthermore, in some climates, seasonal changes of the surface over which the net radiometer was exposed were often quite marked. Usually, with the lack of adequate information as to the seasonal changes in albedo and of the difference in temperature between surface and air, the observations cannot be used to obtain accurate estimates of the net radiation income of a crop differing markedly from the climatological observing site. Net radiation observations are essential to specific research but difficulties arise in making them routine observations for a climatological network.

The role of the (100 - T) factor in the formula was then discussed. At first sight it seemed that the longwave radiation loss should increase with increasing temperature, and not decrease as indicated by the factor. However, Swinbank's formula for the longwave radiation downwards from the atmosphere effectively takes account of the amount of water vapour above the observation point in terms of temperature - this stems from the fact that there is a strong correlation between them. A high temperature implies a large amount of water vapour in the atmosphere (true of most places with the exception of some deserts) and therefore reduced long wave radiation loss, provided, as assumed in the derivation, the crop on the surface is preventing high daytime surface temperatures from occurring.

Dr. Linacre's work is reported in the following papers:

J. Irrign. & Drainage Divn., Proc. Amer. Soc. Civil Engrs. 93, No. 1R4, Dec. 1967. 61-79.
Agric. Met. 5 (1968): 49-63.
J. Appld. Ecol., April 1969.
Archiv. Met. Geophys. Biokl. B (in press).

E.L.D.