

### A Note on the Role of Sky Radiance in Infrared Thermometry<sup>1</sup>

SHERWOOD B. IDSO AND RAY D. JACKSON

*U. S. Water Conservation Laboratory, Phoenix, Ariz.*

1 January 1968

In a recent study of evaporation from a wet soil surface utilizing radiometrically determined surface temperatures, Conaway and van Bavel (1967a) raise the question of whether accounting for sky radiance

justifies the additional effort required. They demonstrate that neglecting the sky radiance altogether does indeed result in a significant error in surface temperature. In contrast to Fuchs and Tanner (1966), however, they furthermore imply that sky radiance is quite variable and that it should be monitored frequently whenever temperature measurements are made by

<sup>1</sup> Contribution from the Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture.

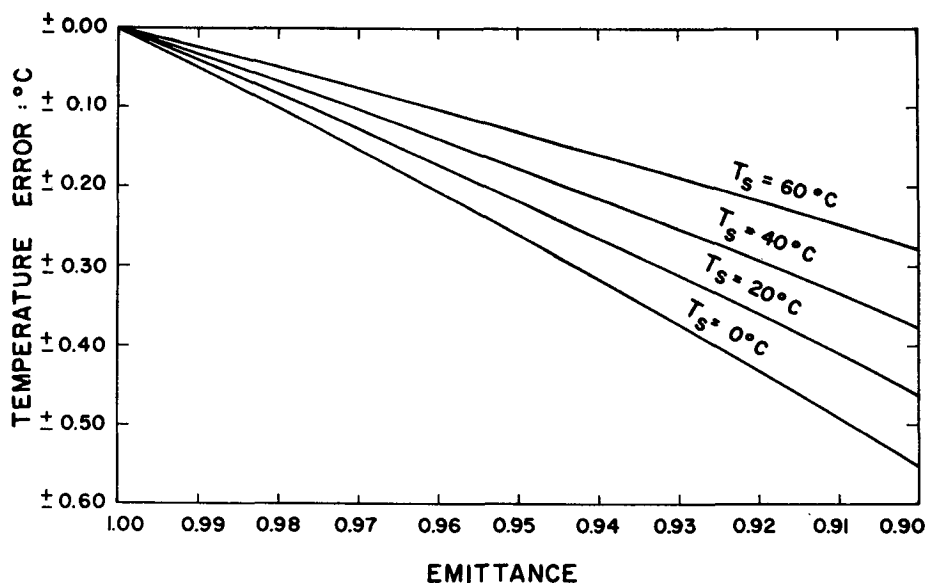


FIG. 1. The error in radiometrically determined surface temperatures as a function of surface emittance for surface temperatures of 0, 20, 40 and 60C, caused by assuming clear sky radiance constant at 1.00 mW cm<sup>-2</sup>, when it actually varies by ±15%.

infrared thermometry (Conaway and van Bavel, 1967b). In that report they present experimental evidence for diurnal fluctuations in clear sky radiance which vary from less than 1.0 to over 4.1 mW cm<sup>-2</sup> in the 600–1300 cm<sup>-1</sup> waveband. Theoretical calculations show these large variations in the energy transmitted by the infrared thermometer's filtering system to be physically impossible, however, and experiments have revealed that they were due to instrument malfunction (Idso and Jackson, 1968).

In a continuous 6-day experiment where clear sky radiance was determined every 10 min, and where the calibration of the infrared thermometer (Barnes Engineering Company<sup>2</sup> Model IT-3) was also checked every 10 min, we found the radiance of the clear sky to vary by no more than  $\pm 15\%$ . A second 6-day experiment about a month later (mid-November) gave similar results. Assuming these maximum variations of  $\pm 15\%$  to be typical, we have constructed a nomogram (Fig. 1) from which the temperature error caused by ignoring these variations can be estimated for a surface of known emittance between the temperatures 0 and 60 C. The nomogram is based upon the equations of Conaway and van Bavel (1967a), assuming the clear sky radiance sensed by an IT-2 or IT-3 infrared thermometer to be  $1.00 \pm 0.15$  mW cm<sup>-2</sup>.

<sup>2</sup> Trade names and company names are for the convenience of the reader and do not imply preferential endorsement of a particular product or company over others by the U. S. Department of Agriculture.

For the Adelanto clay loam soil investigated by Conaway and van Bavel (1967a), the surface emittance was 0.980 and the surface temperature varied between 10 and 30C. Thus, for their situation, the error induced by assuming the sky radiance constant should have been no greater than about  $\pm 0.08$ C. Since the radiometric technique of temperature measurement is stated by them and also Fuchs and Tanner to be accurate to only 0.2C, their question concerning frequent monitoring of sky radiance would thus seem to warrant a negative reply. Under cloudy conditions or for surfaces of lower emittance, however, their affirmative answer may be well taken, depending also upon the purpose for which surface temperature is required. Fig. 1 should be helpful in evaluating these cases and may save much time and effort involved in making nonessential sky radiance measurements.

#### REFERENCES

- Conaway, J., and C. H. M. van Bavel, 1967a: Evaporation from a wet soil surface calculated from radiometrically determined surface temperatures. *J. Appl. Meteor.*, **6**, 650–655.
- , and —, 1967b: Radiometric surface temperature measurements and fluctuations in sky radiant emittance in the 600 to 1300 cm<sup>-1</sup> waveband. *Agron. J.*, **59**, 389–390.
- Fuchs, M., and C. B. Tanner, 1966: Infrared thermometry of vegetation. *Agron. J.*, **58**, 597–601.
- Idso, S. B., and R. D. Jackson, 1968: The significance of fluctuations in sky radiant emittance for infrared thermometry. *Agron. J.*, **60** (in press).