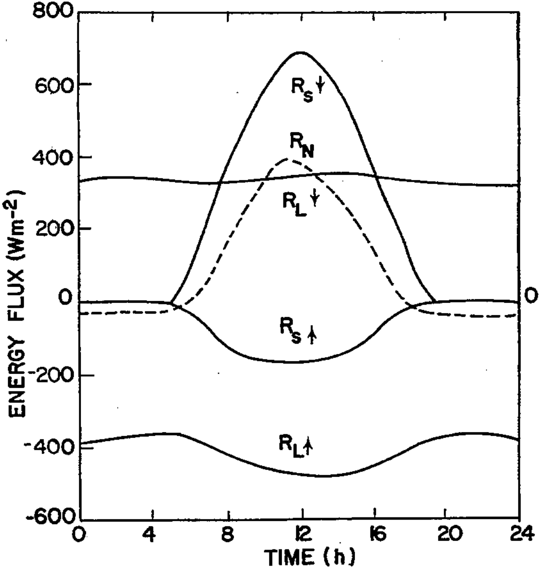

Figure 3.4 Observed radiation budget over a 0.2 m stand of native grass at Matador, Saskatchewan, on 30 July 1971. [From Oke (1987); after Ripley and Redmann (1976).]

Problems and Exercises

1. The following measurements were made over a short grass surface on a winter night when no evaporation or condensation occurred:
Outgoing longwave radiation from the surface = 365 W m^{-2}.
Incoming longwave radiation from the atmosphere = 295 W m^{-2}.
Ground heat flux from the soil = 45 W m^{-2}.
(a) Calculate the apparent (equivalent blackbody) temperature of the surface.
(b) Calculate the actual surface temperature if surface emissivity is 0.92.
(c) Estimate the sensible heat flux to or from air.

2.
(a) Estimate the combined sensible and latent heat fluxes from the surface to the atmosphere, given the following observations:
Incoming shortwave radiation = 800 W m^{-2}.
Heat flux to the submedium = 150 W m^{-2}.
Albedo of the surface = 0.35.
(b) What would be the result if the surface albedo were to drop to 0.07 after irrigation?

3. The following measurements or estimates were made of the radiative fluxes over a short grass surface during a clear sunny day:
Incoming shortwave radiation = 675 W m^{-2}.
Incoming longwave radiation = 390 W m^{-2}.
Ground surface temperature = 35°C.
Albedo of the surface = 0.20.
Emissivity of the surface = 0.92.
(a) From the radiation balance equation, calculate the net radiation at the surface.
(b) What would be the net radiation after the surface is thoroughly watered so that its albedo drops to 0.10 and its effective surface temperature reduces to 25°C?
(c) Qualitatively discuss the effect of watering on other energy fluxes to or from the surface.

4. Show that the variation of about 28% in terrestrial radiation in Figure 3.4 is consistent with the observed range of 10–30°C in surface temperatures.

5. Explain the nature and causes of depletion of the solar radiation in passing through the atmosphere.

6. Discuss the consequences of the absorption of longwave radiation by atmospheric gases and the so-called greenhouse effect.

7. Discuss the merits of the proposition that net radiation R_N can be deduced from measurements of solar radiation $R_{S\downarrow}$ during the daylight hours, using the empirical expression

$$R_N = AR_{S\downarrow} + B$$

where A and B are constants. On what factors are A and B expected to depend?

8.
(a) Discuss the importance and consequences of the radiative flux divergence at night above a grass surface.
(b) If the net longwave radiation fluxes at 1 and 10 m above the surface are -135 and -150 W m^{-2}, respectively, calculate the rate of cooling or warming in °C h^{-1} due to radiation alone.

9. The following measurements were made at night from a meteorological tower:

Net radiation at the 2 m level = -125 W m^{-2}.
Net radiation at the 100 m level = -165 W m^{-2}.
Sensible heat flux at the surface = -75 W m^{-2}.
Planetary boundary layer height = 80 m.

Calculate the average rate of cooling in the PBL due to the following:
(a) the radiative flux divergence;
(b) the sensible heat flux divergence.