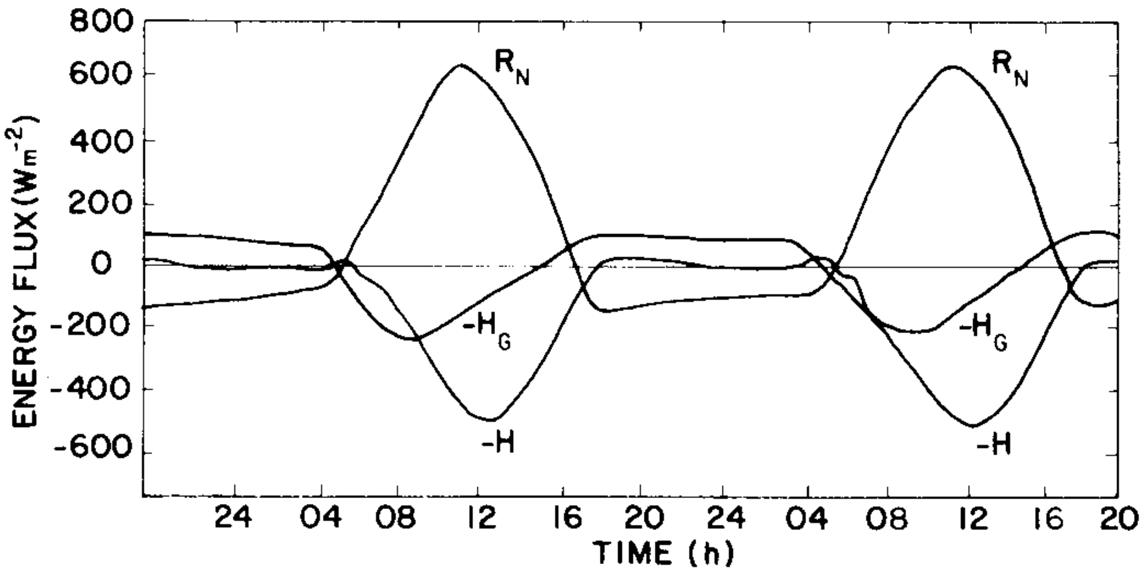


**Fig. 2.3** Observed diurnal energy balance over a dry lake bed at El Mirage, California, on June 10 and 11, 1950. [After Vehrencamp (1953).]

From "Micrometeorology" by Arya

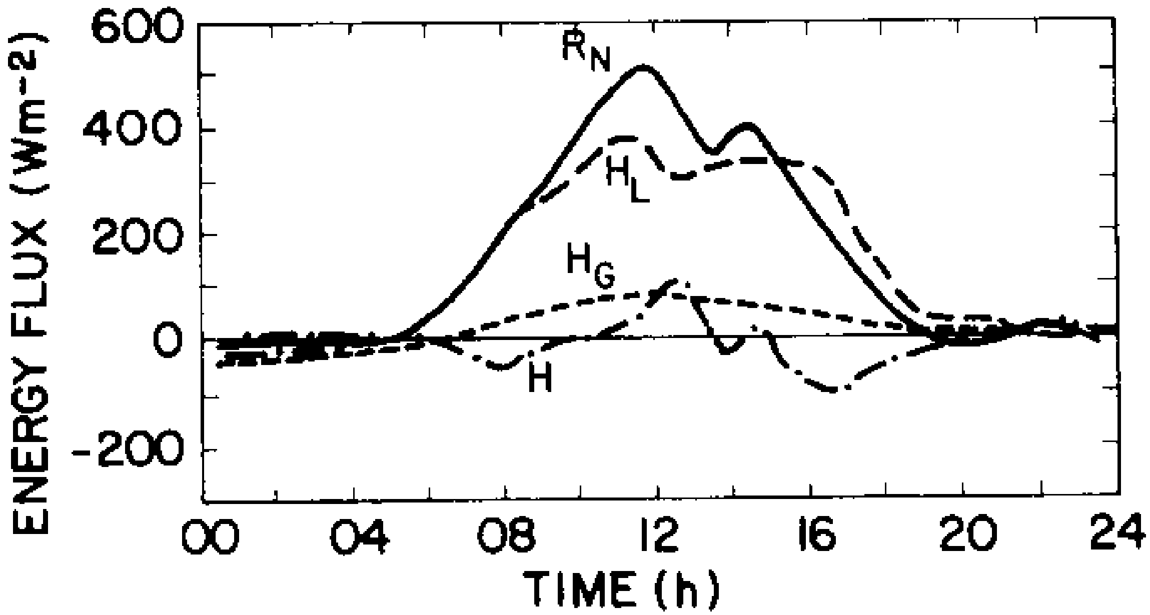


**Fig. 2.4** Observed diurnal energy budget of a barley field at Rothamsted, England, on July 23, 1963. [From Oke (1987); after Long *et al.* (1964).]

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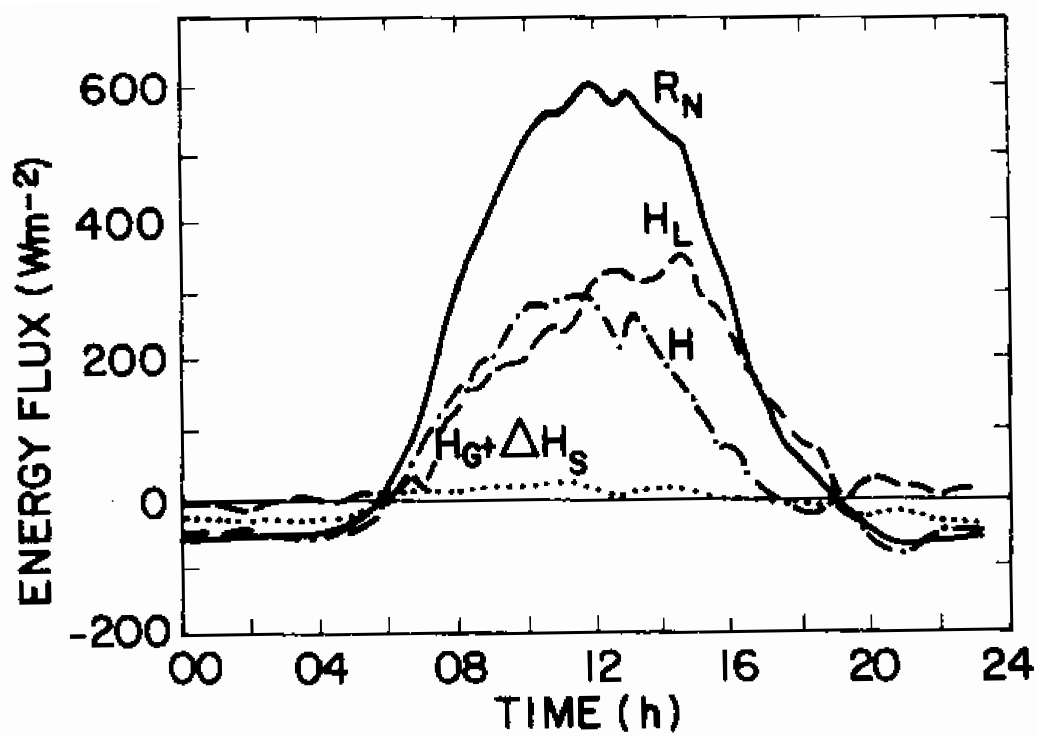


**Fig. 2.5** Observed energy budget of a Douglas fir canopy at Haney, British Columbia, on July 23, 1970. [From Oke (1987); after McNaughton and Black (1973).]

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**Table 3.1**

Radiative Properties of Natural Surfaces[a]

| Surface type | Other specifications | Albedo ($a$) | Emissivity ($\varepsilon$) |
|---|---|---|---|
| Water | Small zenith angle | 0.03–0.10 | 0.92–0.97 |
| | Large zenith angle | 0.10–0.50 | 0.92–0.97 |
| Snow | Old | 0.40–0.70 | 0.82–0.89 |
| | Fresh | 0.45–0.95 | 0.90–0.99 |
| Ice | Sea | 0.30–0.40 | 0.92–0.97 |
| | Glacier | 0.20–0.40 | |
| Bare sand | Dry | 0.35–0.45 | 0.84–0.90 |
| | Wet | 0.20–0.30 | 0.91–0.95 |
| Bare soil | Dry clay | 0.20–0.35 | 0.95 |
| | Moist clay | 0.10–0.20 | 0.97 |
| | Wet fallow field | 0.05–0.07 | |
| Paved | Concrete | 0.17–0.27 | 0.71–0.88 |
| | Black gravel road | 0.05–0.10 | 0.88–0.95 |
| Grass | Long (1 m)<br>Short (0.02 m) | 0.16–0.26 | 0.90–0.95 |
| Agricultural | Wheat, rice, etc. | 0.10–0.25 | 0.90–0.99 |
| | Orchards | 0.15–0.20 | 0.90–0.95 |
| Forests | Deciduous | 0.10–0.20 | 0.97–0.98 |
| | Coniferous | 0.05–0.15 | 0.97–0.99 |

[a] Compiled from Sellers (1965), Kondratyev (1969), and Oke (1978).

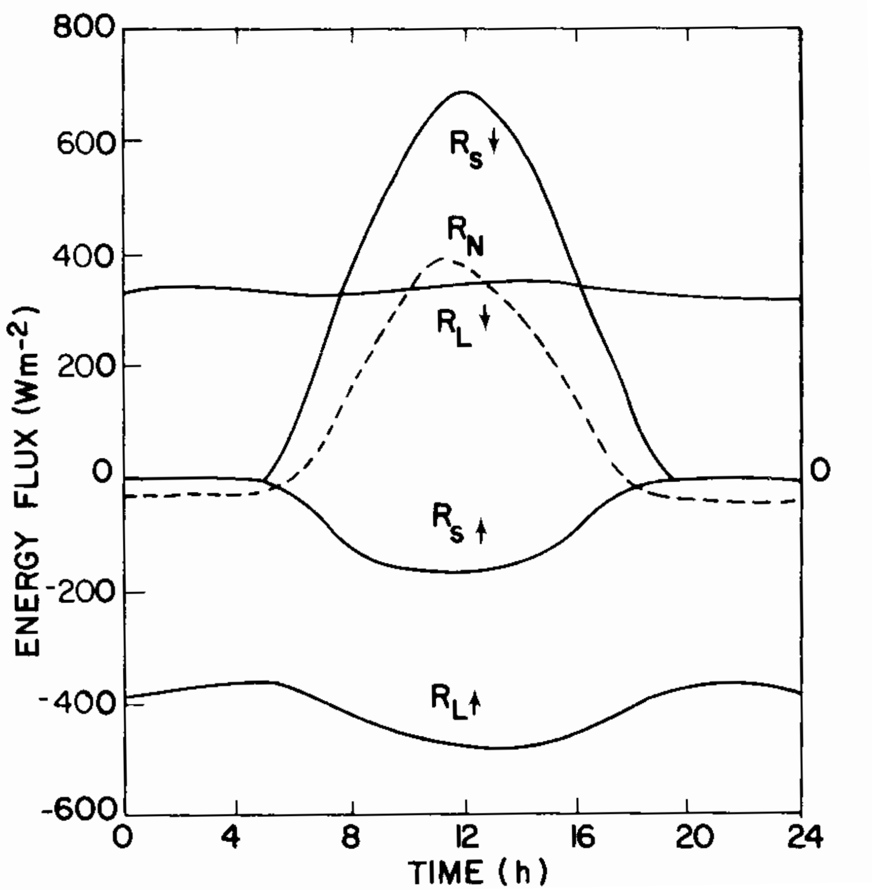


**Fig. 3.4** Observed radiation budget over a 0.2-m-tall stand of native grass at Matador Saskatchewan, on July 30, 1971. [From Oke (1987); after Ripley and Redmann (1976).]

From “Micrometeorology” by Arya

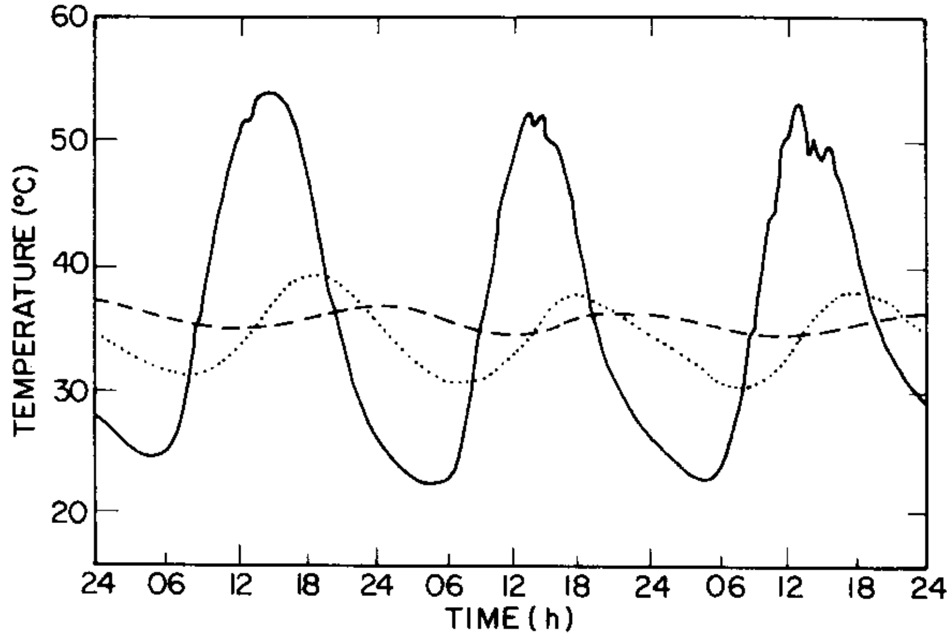


**Fig. 4.1** Observed diurnal course of subsurface soil temperatures at various depths in a sandy loam with bare surface. ——, 2.5 cm; ·····, 15 cm; ---, 30 cm. [From Deacon (1969); after West (1952).]

From "Micrometeorology" by Arya

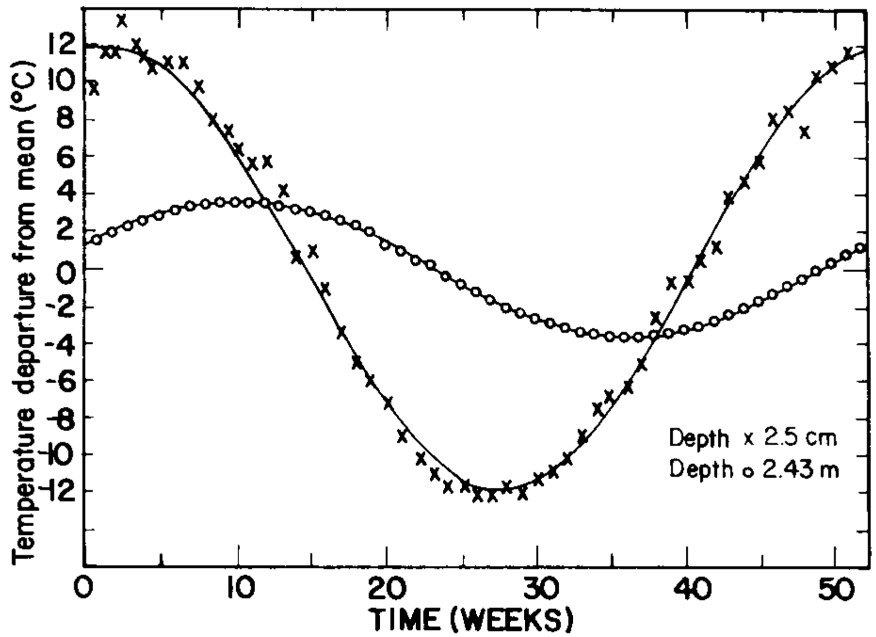


**Fig. 4.2** Annual temperature waves in the weekly averaged subsurface soil temperatures at two depths in a sandy loam soil. ×, 2.5 cm; ○, 2.43 m. Fitted solid curves are sine waves. [From Deacon (1969); after West (1952).]

From "Micrometeorology" by Arya

Table A7. *Representative values of the thermal conductivity $k_s$, specific heat $c_s$, density $\rho_s$ and thermal diffusivity $\kappa_s$ for various types of surface based mainly on*

Data for clay and sand are approximately consistent with Eq. A24, in which $C_{si}$ is equal to $2.7 \times 10^6$ and $2.2 \times 10^6$ J m$^{-3}$ K$^{-1}$ for clay and sand respectively; $C_w$ is equal to $\rho_w c_l$, with $\rho_w = 1000$ kg m$^{-3}$ and $c_l = 4186$ J kg$^{-1}$ K$^{-1}$; and $\eta_s$ is taken from Table A9. The reader should also consult e.g. Geiger (1965, Table 10), Hillel (1982, Table 9.3) and Oke (1987, Table 2.1).

| Surface | $k_s$ (W m$^{-1}$ K$^{-1}$) | $c_s$ (J kg$^{-1}$ K$^{-1}$) | $\rho_s$ (kg m$^{-3}$) | $\kappa_s$ ($10^{-6}$ m$^2$ s$^{-1}$) |
|---|---|---|---|---|
| *Sand soil* | | | | |
| dry | 0.3 | 800 | 1600 | 0.23 |
| $\eta = 0.2$ | 1.9 | 1260 | 1800 | 0.84 |
| $\eta = 0.4$ | 2.2 | 1480 | 2000 | 0.74 |
| *Clay soil* | | | | |
| dry | 0.25 | 890 | 1600 | 0.18 |
| $\eta = 0.2$ | 1.1 | 1170 | 1800 | 0.52 |
| $\eta = 0.4$ | 1.6 | 1550 | 2000 | 0.52 |
| *rock* | 2.9 | 750 | 2700 | 1.4 |
| *ice* | 2.5 | 2100 | 910 | 1.3 |
| *snow* | | | | |
| old | 1.0 | 2090 | 640 | 0.7 |
| new | 0.1 | 2090 | 150 | 0.3 |
| *water* | 0.6 | 4186 | 1000 | 0.14 |

From Garratt

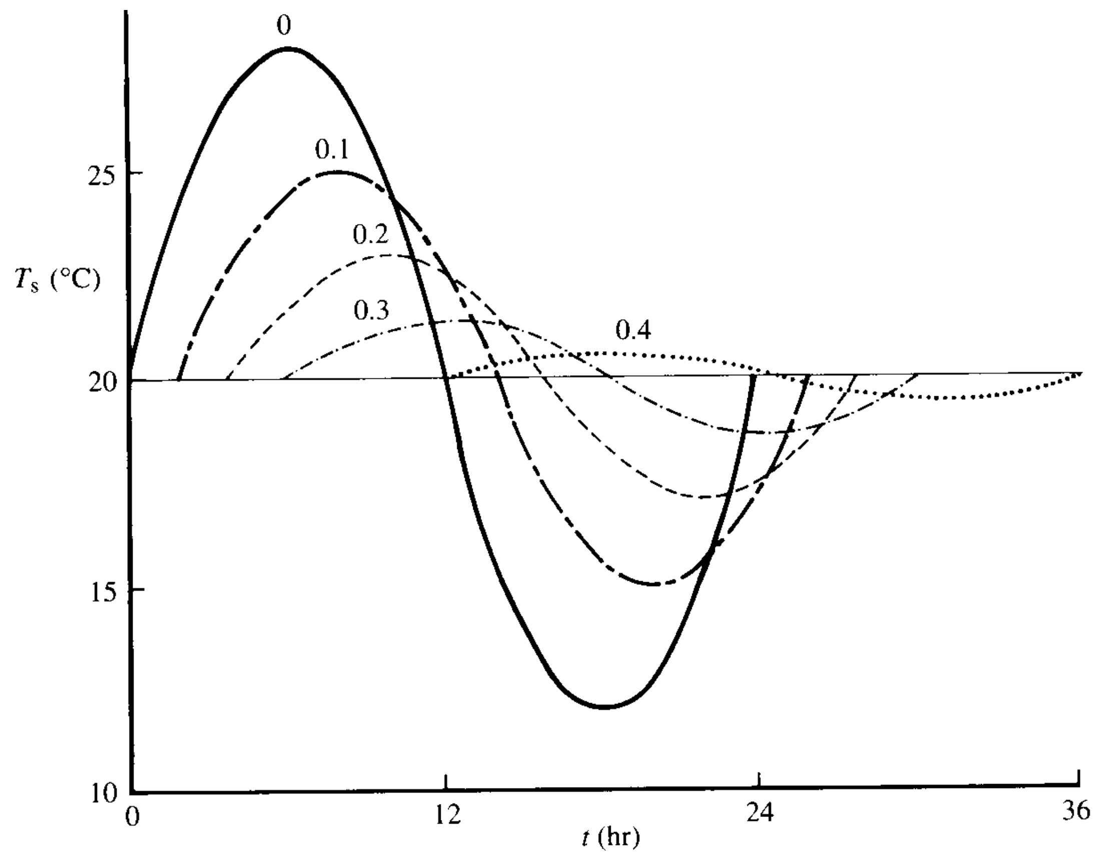


Fig. 5.1 Idealized variation of soil temperature through a diurnal cycle for several depths in the soil (indicated in metres). The curves represent the solutions to Eq. 5.7 for sinusoidal forcing; these are given by Eq. 5.8. A uniform soil is assumed with $\kappa_s = 0.8 \times 10^{-6}\ \mathrm{m^2\,s^{-1}}$ and $k_s = 1.68\ \mathrm{W\,m^{-1}\,K^{-1}}$.