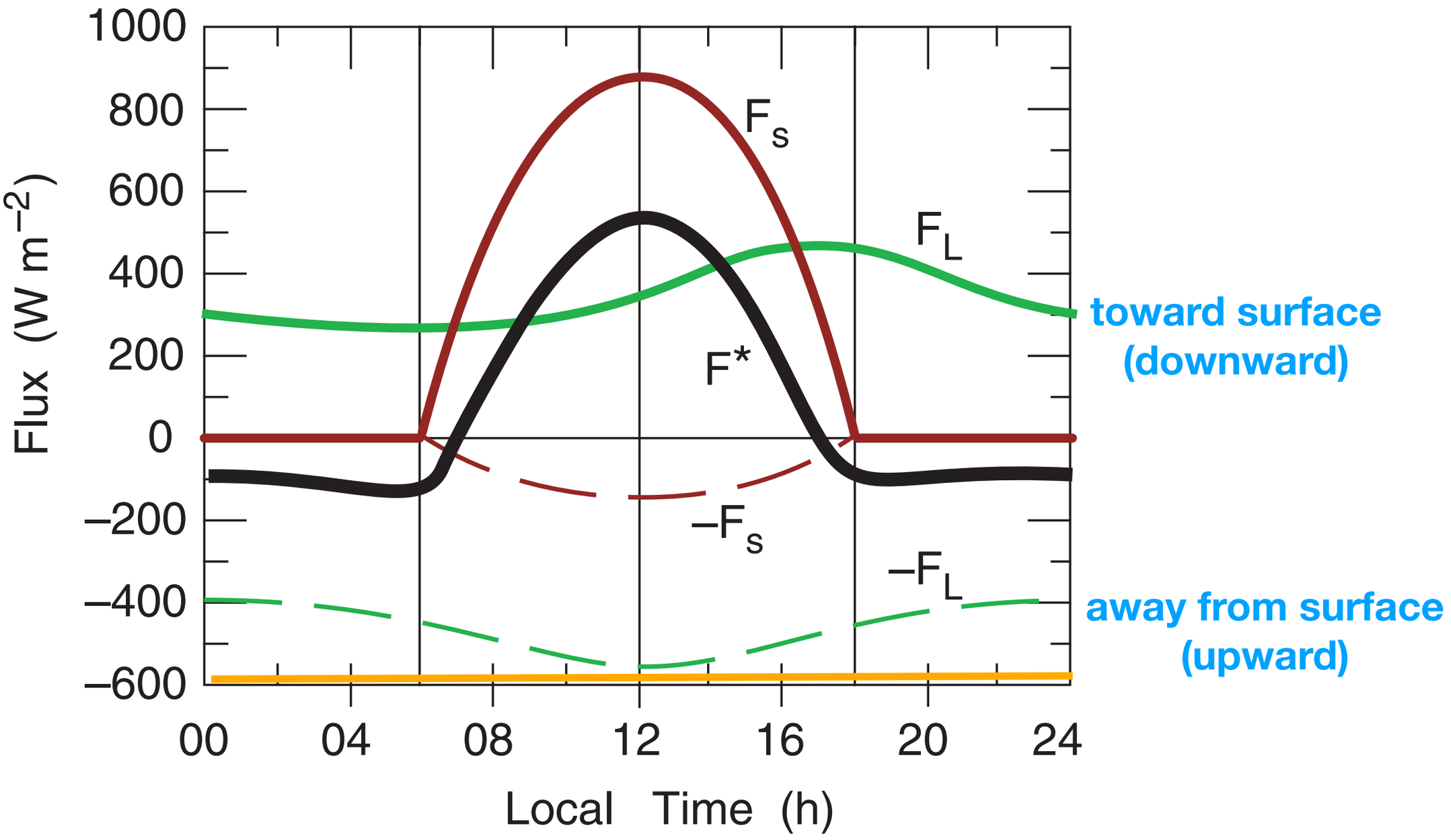
Surface Energy Balance

Radiative fluxes at the surface under clear skies



How does the *upward SW and LW fluxes* change during the day?

Upward SW flux

The upward shortwave flux depends on the downward solar radiation $F_{s\downarrow}$ and on surface albedo α_s:

$$F_{s\uparrow} = (1 - \alpha_s) F_{s\downarrow}.$$

How does the *upward SW flux* change during the day?

Table 3.1

Radiative Properties of Natural Surfaces[a]

Surface type	Other specifications	Albedo (a)	Emissivity (ε)
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) 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).

Upward LW flux

The upward longwave flux depends on the downward longwave flux $F_{L\downarrow}$, the surface emmisivity ϵ_s, and the radiating temperature, T_s:

$$F_{L\uparrow} = (1 - \epsilon_s)F_{L\downarrow} + \epsilon_s \sigma T_s^4,$$

where $\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4} is the Stefan-Boltzmann constant.

Text

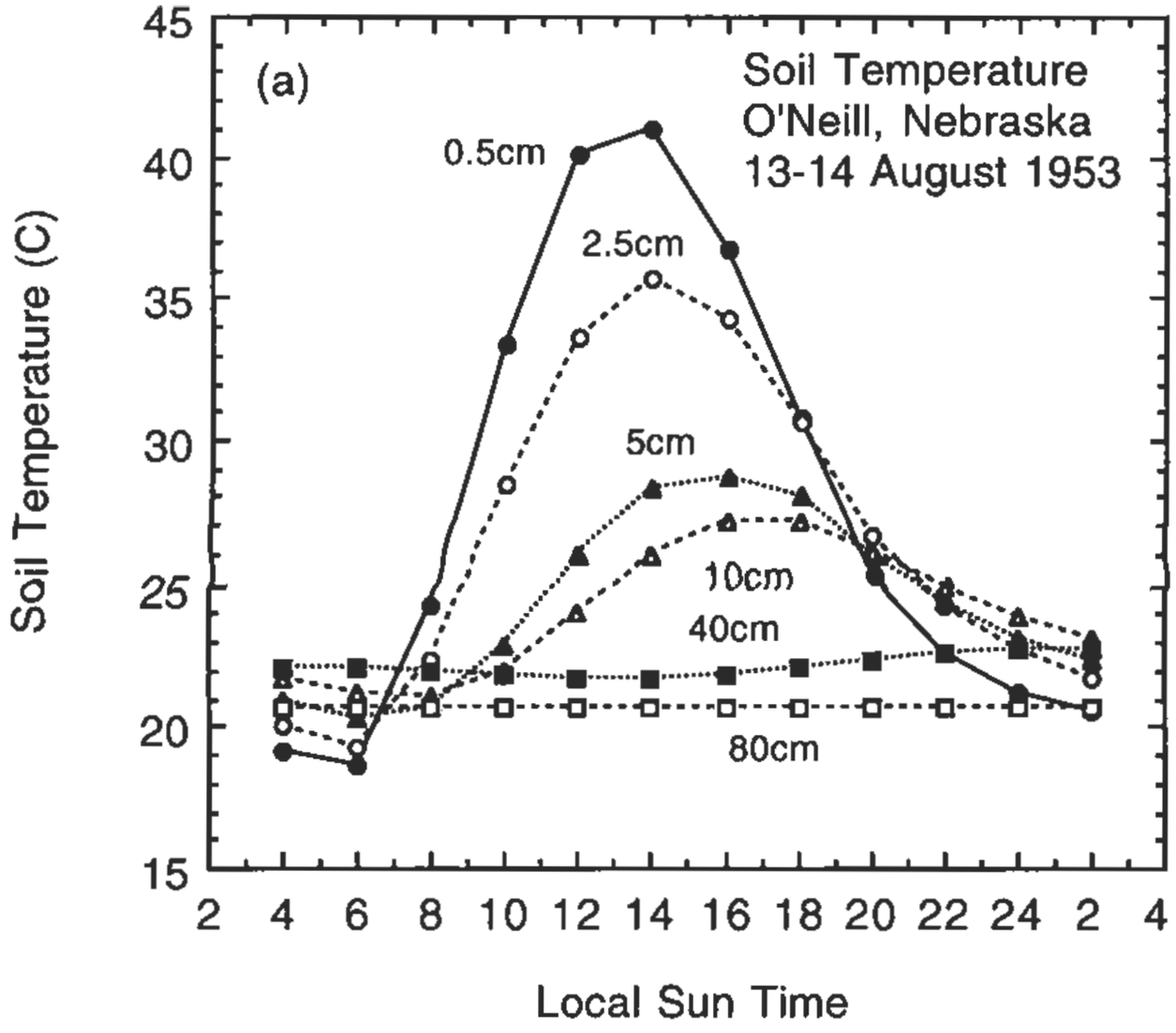
How does the *upward LW flux* change during the day?

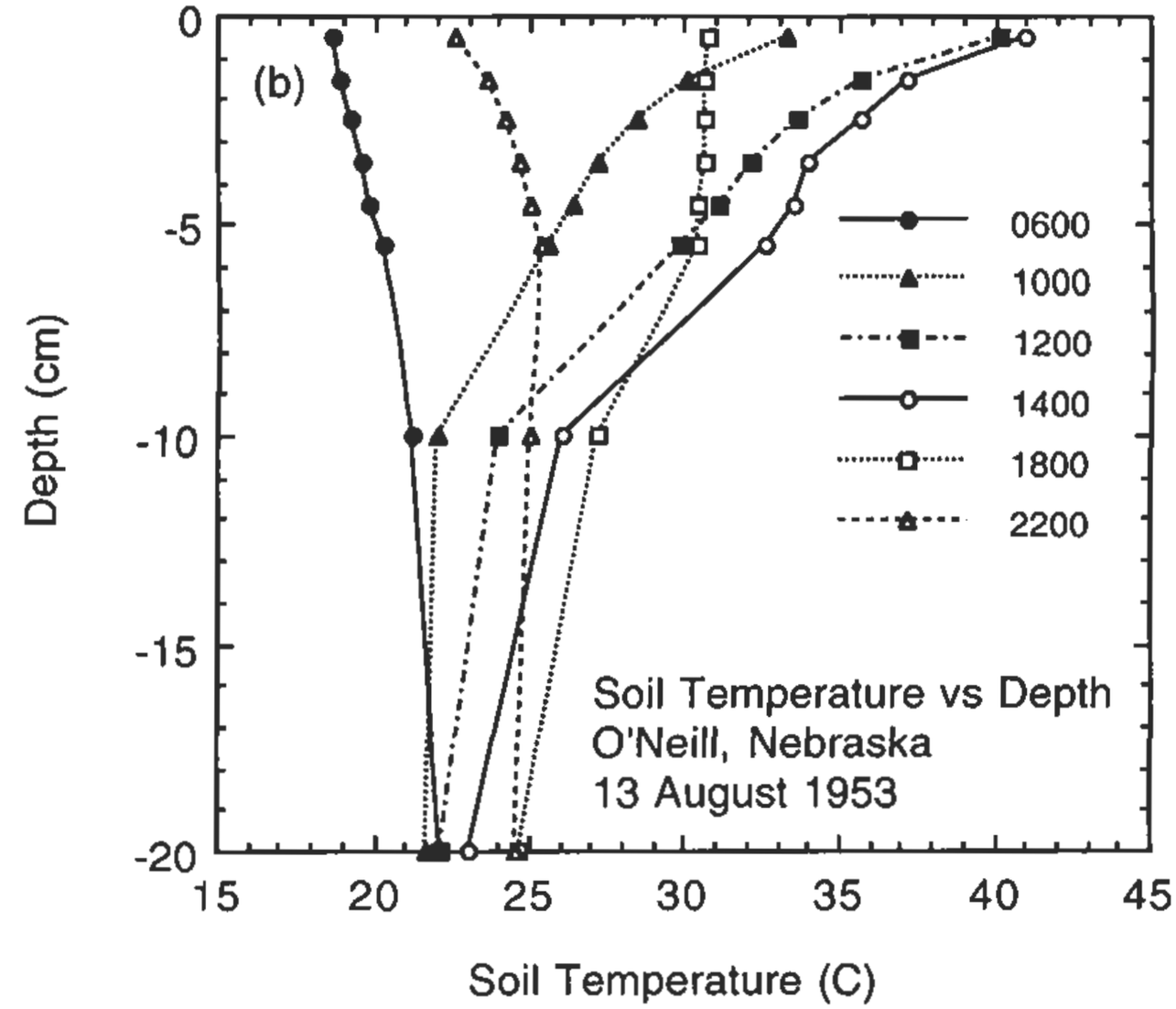
5.67e-8 * (19+273)^4
= 412

5.67e-8 * (41+273)^4
= 552

change is 140 W/m^w

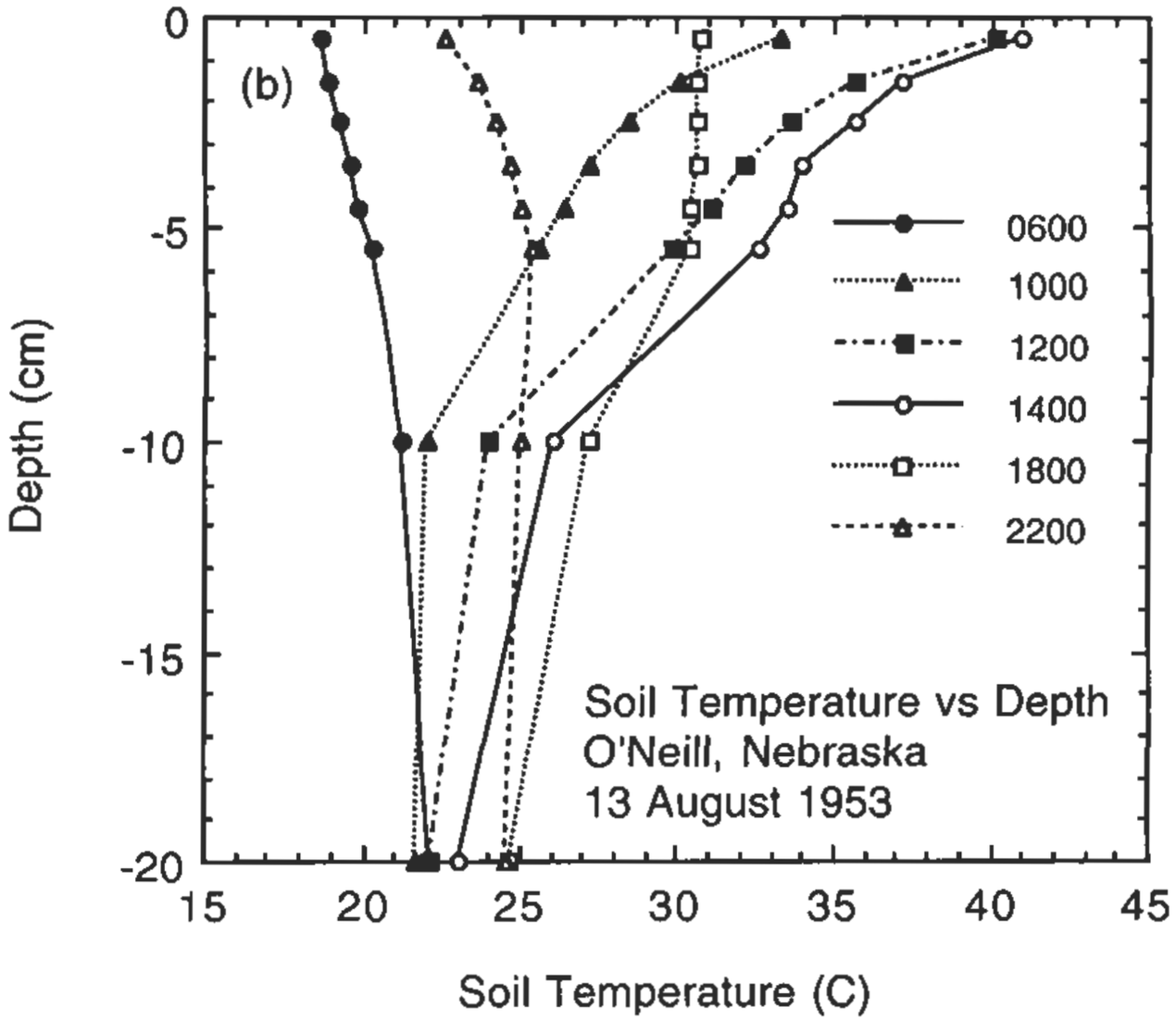
Soil tempeature at various depths under a grass field





How does the surface temperature change during the day?

Calculate upward LW for the minimum and maximum surface temperatures



Soil Heat Flux

The upward ground heat flux depends on the temperature gradient:

$$F_G = -k\frac{dT}{dz},$$

where k is the thermal conductivity.