Net longwave radiation

Net long wave radiation can be estimated using the Brunt equation:

$$Q_{lw} = \sigma * \left [{T_s}^4-(c+d*\sqrt[2]{e_2})*{T_2}^4 \right]*(1-a*C)$$

where σ is the Boltzmann constant that equals $1.17 * 10^{-7} cal/cm^2/K^4/day$, T_s is the temperature of the surface in Kelvin, T_2 is the temperature at the 2 m level, e_2 is the vapor pressure of the air at the 2 m level (mb), c,d are empirical coefficients, C is the cloudiness (decimal fraction of the sky covered) and a is a constant depending upon cloud type, 0.25, 0.6 and 0.9 for high, medium and low clouds, respectively.

The constants c and d have been compiled:

Location	**c**	**d**
Sweden	0.43	0.082
Washington	0.44	0.061
Austria	0.47	0.063
Algeria	0.48	0.058
California	0.50	0.032
England	0.53	0.065
France	0.60	0.042
India	0.62	0.029
Oklahoma	0.68	0.036

If data on cloud type are not available, the last term of the equation $(1-aC)$ can be replaced by $(0.10+0.9*C)$ or by $\left (0.10+0.9*\frac{n}{N} \right)$, where the ratio n/N corresponds to the ratio of actual to potential sunshine hours per day.

There is an alternative equation that does not require surface temperature:

$$Q_{lw} = \sigma*{T_2}^4* \left (0.56-0.08*\sqrt[2]{e_2} \right) * \left (1-a*C \right) $$

where T_2 is in Kelvin and e_2 is in mb.