L_{IN}

Incoming longwave radiation is calculated from,

$$L_{IN} = \varepsilon\, \sigma T_a^4,$$

where ε is the emissivity, σ is the Stefan-Boltzmann constant (5.670373×10^{-8} W m^{-2} K^{-4}.) and T_a is the air temperature (in Kelvin) at 2 meters. The parameterisation of incoming longwave radiation is based on the independent variables of air temperature, vapour pressure and cloud cover. The equations are developed by Konzelmann et al. (1994), and has two components, longwave radiation in based on clear sky emissivity (ε_{CS}), and a component based on the emissivity of clouds (ε_{CL}). Clear sky emissivity is a function of the greenhouse gas concentration, the water vapour pressure and the air temperature,

$$\varepsilon_{CS} = 0.23 + b\left(\frac{e_a}{T_a}\right)^{\frac{1}{8}}$$

where e_a is the vapour pressure at 2 meters, and b is 0.433 (Klok and Oerlemans, 2002). The water vapour pressure e_a is calculated either from the relative humidity, as provided from met station data. The conversion from RH(as a fraction) to water vapour pressure (e) is calculated by the equations below:

e = RH*es(T), where es(T) is the saturated vapour pressure at the Temp (T) and is calculated from below.

$es(T) = es(T_0)\exp\{A(T_a-T_0)/(T-T_1)\}$

where A = 17.27

$T_0 = 273.15$ K

$T_1 = 36$ K

$es(T_0) = 0.611$ kPa

The total emissivity is given by,

$$\varepsilon = \varepsilon_{CS}\,(1 - n^2) + \varepsilon_{CL}\, n^2,$$

where n is the fractional cloud cover (between 0 – 1) and ε_{CL} is 0.976, which is provided from the work of Gruell and others 1997. To calculate the fractional cloud cover fraction from the data you are provided with use the number of sunlight minutes in an hour to give you a percentage of cloud cover. So if there is 30 mins sunlight in an hour, there must be 50 % cloud cover and therefore n = 0.5.

The expanded equation for longwave radiation received at the surface is therefore given by,

$$L_{IN} = [\varepsilon_{CS} (1 - n^2) + \varepsilon_{CL}\, n^2]\, \sigma T_a^4$$

L_{OUT}

If it is assumed that the snow/ ice surface of the glacier acts as a black body then the longwave radiation emitted is given by,

$$L_{OUT} = \sigma T_{surf}^4$$

where T_{surf} is the surface temperature and σ is the Stefan-Boltzmann constant. In the ablation season when there is surface melt the surface temperature is assumed to be 0 °C (so 273 K).