planet_temp is a MATLAB script to solve the one-dimensional heat equation:

$$\rho c_p \frac{\partial T}{\partial t} = \frac{\partial}{\partial z}\left(k \frac{\partial T}{\partial z}\right)$$

where ρ is density [kg/m^3], c_p is specific heat capacity [J/kg·K], T is temperature [K], t is time [s], z is depth [m] (z = 0 at the surface, negative at depth) and k is thermal conductivity [W/m·K].

The default boundary conditions are:

$k \frac{\partial T}{\partial z}\Big|_{z=0} = \varepsilon \sigma {T_{z=0}}^4 - F_s cos\alpha$ at the surface (z = 0)

$k \frac{\partial T}{\partial z}\Big|_{z=d} = Q_T$ at depth (z = d)

where ε is emissivity, σ is the Stefan-Boltzmann constant (σ = 5.67 x 10^{-8} W/m^2·K^4), F_s is the solar flux [W/m^2], α is the solar zenith angle and Q_T is the heat flux [W/m^2] in the positive z-direction at the lower boundary.

User-specified variables:

Note: The user can also change thermophysical properties. Conductivity and heat capacity are stored in arrays k and c, respectively. Density is stored in variable *rho*, emissivity in e and albedo in a.

See script for definitions of the following variables:

TOP/BOTTOM/TWO_LAYER	Set one of these variables to 1 and the others to 0
Fs	Heat flux that illuminates surface ***when it is not in shadow***
w	Set this to 0 if Fs is not a function of time
Fsurr	Heat flux that illuminates surface ***at all times***
Qt	Heat flux at the lower boundary
dz	Spatial resolution [m]
dt	Temporal resolution [s]
nt	Number of time-steps (total simulation time = nt*dt)
nt_out	Time-step interval at which to plot temperature profiles
nz	Number of points along temperature profile (max. depth = nz*dz)
T_init	Initial temperature profile
ntshadow	From this time-step on, the surface is illuminated only by Fsurr

To run the script:

1. Open MATLAB.
2. Make sure planet_temp.m is in the 'Current Folder'.
3. Call "planet_temp".

Output:

Average, maximum, minimum temperature profiles are stored in *T_avg*, *T_max*, *T_min*, respectively. *T_vs_z* is a table with depth in the first column, and temperature profiles (at intervals of *nt_out*) in the successive columns.