ATS 630, Energy Balance Model Homework #1, Due 20 Sep 2023

Write a 3-Level Energy Balance Model (EBM3) according to the equations in the handout "A Three Level Global Mean Energy Balance Model". The equations for the solar (S) absorption and thermal emission (L) are given in the appendix for the three layers (the 3rd layer is actually the surface).

In this initial version of the model, each layer will be balanced for gain and loss of radiation components only, i.e.:

$S_1 = L_1(T_1, T_2, T_3)$
$S_2 = L_2(T_1, T_2, T_3)$
$S_3 = L_3(T_1, T_2, T_3)$

Your answers will first be the temperature for each layer. As you look at these equations, you see three equations and three unknowns (T_1, T_2, T_3), since all for the radiation coefficients (i.e. the solar and infrared absorption, reflection and transmission) will be assigned in this first problem.

Select the radiation coefficients as given in Table 2, 3rd column of SOLAR and INFRARED under the $EBM3_o$ heading. $EBM3_o$ refers to the base model with radiative transfer of energy only (i.e. no fluxes of heat by other means between the layers.)

Note: the values for Temperature that should be returned from your model for this problem should be those in the bottom right-hand corner (w/o HF).

Use double precision for the variables as some of the quantities will be small differences of large numbers.

Write the code to be flexible so that the radiation coefficients can be altered.

Your answers will also include the values listed in the Appendix under Solar Quantities and some of the Infrared Quantities (LH and SH will be calculated in the remaining two assignments), i.e. calculate:

Solar energy absorbed at surface, absorbed in atmosphere, reflected by atmosphere and reflected by surface.

Infrared energy transmitted directly to space, surface emissions not directly transmitted to space, total energy emitted by atmosphere to space.