Homework Set 2

Due October 5, 2023

For these exercises, consider Budyko's equation

$$R\frac{\partial T}{\partial t} = Qs(y)(1-\alpha(y,\eta)) - (A+BT) + C(\overline{T}-T)$$

with standard parameters $Q = 342$, $A = 202$, $B = 1.9$, and $C = 3.04$. Also, take

$$\alpha(y,\eta) = \begin{cases} \alpha_1 = 0.32 & y < \eta \\ \alpha_2 = 0.62 & y > \eta \end{cases} \quad \text{and} \quad s(y) = 1 - 0.241\left(3y^2 - 1\right).$$

1. Remove the heat transport in the model by replacing the parameter C with zero. Find the equilibrium solution for each value of η, and discuss its stability.

2. Graph each of the equilibrium temperature distributions found in Exercise 1 for ice lines at these latitudes: 23.5º, 45º, and 66.5º. Compare the graphs to those of the equilibrium solutions for Budyko's equation with the standard parameters. Discuss the differences.

3. Reconsider the situation in Exercise 1 (where $C = 0$). Is there a value of η where the ice line condition is met? (The ice line condition is that the average temperature across the discontinuity at the ice line is -10°C.)