YUSO 2017 Remote Sensing Energy Balance Answers

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1

$E_{in} = \pi R^2 \sigma_0$
$F_{SB}(T) = \sigma T^4 \Rightarrow E_{out} = 4\pi R^2 \sigma T^4$
$E_{in} = E_{out} \Rightarrow \pi R^2 \sigma_0 = 4\pi R^2 \sigma T^4 \Rightarrow \frac{1}{4}\sigma_0 = \sigma T^4 \Rightarrow T = (\frac{\sigma_0}{4\sigma})^{1/4}$
$T = (\frac{1376.6}{4(5.67*10^{-8})})^{1/4} = 278.5812.... \approx 278.6$ K
Accept answers within ± 0.1 K.

2

Adding albedo to the model gives the equation $\frac{1}{4}\sigma_0(1-\alpha) = \sigma T^4$
$T = (\frac{\sigma_0(1-\alpha)}{4\sigma})^{1/4} = (\frac{1376.6(1-0.3)}{4(5.67*10^{-8})})^{1/4} = 254.8158... \approx 254.8$ K
Accept answers within ± 0.1 K.
The first model deviated from the approximate average global temperature by $288 - 278.6 = 9.4$ K. This model deviates by $288 - 254.8 = 33.2$ K. Thus, though it is a better model in the sense that it includes more accurate physics, its prediction of the average temperature at equilibrium is worse than that given by the simpler model.

3

Adding the greenhouse factor to the model gives the equation $\frac{1}{4}\sigma_0(1-\alpha) = \epsilon\sigma T^4$
Solving for ϵ, we have $\epsilon = \frac{\sigma_0(1-\alpha)}{4\sigma T^4} = \frac{1376.6(1-0.3)}{4(5.67*10^{-8})(288^4)} = 0.6128 \approx 0.61$
Accept answers within ± 0.02.
Increasing ϵ decreases the predicted equilibrium temperature, decreasing ϵ increases the predicted equilibrium temperature.