Climate Modelling in-class worksheet 3 (week 4)

Group members:

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The focus of this week's assignment is the two-layer atmospheric model described in Hartmann Chapter 3 Figure 3.10 and Rose lab7 Section 2.

In Hartmann's model both layers are black, i.e. ε=1. In Rose's 2 layer model in lab9 section 2, he uses the ε=0.586 value he found by matching the top of the atmosphere OLR in Lab 7 section 4.

1) If you haven't done so already, do the Lab 7 exercise "solving for ε" and show that ε=0.586 does indeed provide the best match to an OLR of 238.5 Wm^{-2}
2) What happens when you put ε=1 into the LW.absorptivity values for the two layers in Lab9 section 2 cell 10? Can you reproduce the values Hartmann gets in equation 3.53 page 71?
3) Rose replaces the two layer model with a 30 layer model in which each layer has ε=0.053. Show that these two models have close to the same total transmissivity for their atmospheres, given the fact that the total transmissivity is just the product of the individual layer transmissivities.
4) Suppose we had not been able to negotiate a treaty to save the ozone layer, and ozone was reduced by 50% everywhere. How does that affect the temperature profile produce by lab 9 cell 71? Make a version of that plot comparing the reference run with climatological ozone and the 50% reduction case.

Note – Last week Rachel mentioned Suki Manabe's Nobel prize. One of his most famous papers is Manabe and Weatherald 1967 in which they first produced the figures that Hartmann shows in Chapter 3 Figure 3.16 and 3.17, and Rose calculates in Lab 9 cell 71.