Climate Modelling in-class worksheet 4 (week 5)

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The focus of this week's assignment is to calculate forcing and feedback using a 1-dimensional radiative equilibrium model. The scientific community has failed to converge on a standard notation for any of this, so this worksheet compares the differences and similarities between Hartmann Chapter 10, the Gerard Roe feedback article presented by Luke, and the course notebooks.

1) Define the symbol ΔR used in Rose notebook *14-climate sensitivity and feedback,* including units

radiative forcing (Wm^{-2}): the rate at which energy begins to accumulate in the climate system

2) What symbol does Hartmann Chapter 10 use for this same concept?

dQ (disagrees with Rose and Roe)

3) How about Roe?

ΔR_f

4) In Section 14.2.3, Rose calculates the *stratospheric adjusted radiative forcing* and gets a value of 4.3 Wm^{-2} for doubled CO2. How does this compare with Hartmann's value in Section 10.3.1?

Hartmann gets 4 Wm^{-2} which is slightly smaller

5) Hartmann in section 10.3.1 discusses the *Planck feedback*. Is this the same as Rose's *Equilibrium climate sensitivity without feedback*? Explain how they are similar or different? What are the units and values for each?

Yes, it is essentially the same thing. Rose says that it is the most basic climate process and is present in every model, so they do not define it as a feedback. The main difference is that they are inverses of each other so they have different units (Rose uses $Wm^{-2}K^{-1}$ and Hartmann uses K / (Wm^{-2}). Rose gets 3.3 $Wm^{-2}K^{-1}$ and Hartmann gets 0.26 K / (Wm^{-2}). We can see that 1/3.3 = 0.3, which is similar to Hartmann's value.

6) Can you find the same Planck feedback concept in Roe? Is Roe's approach more similar to Hartmann or Rose?

Roe's explanation of this concept is closer to Hartmann's because it also talks about the blackbody radiation of the planet. However, Roe does get a value closer to Rose's when they talk about the reference climate sensitivity parameter, determined after removing all dynamic feedbacks and using a finite absorptivity of the atmosphere in longwave bands (not perfect blackbody).

7) Hartmann shows OLR as a function of surface temperature, and surface temperature as a function of CO2, in figures 10.2 and 10.3. How do his values of OLR and surface temperature compare with values you get for OLR in Lab 14 section 5?

In the lab, we get OLR = 255 Wm^{-2} and Ts = 291 K

In Hartmann, surface temperature of 291 K corresponds to OLR of 270 Wm^{-2}, which is a much higher OLR.

In the lab, doubling the CO2 leads to a change in surface temperature of 3K, which is more similar to the Hartmann value from fig 10.2.

8) Hartmann writes the climate sensitivity parameter with Planck and H2O feedbacks as $(\lambda_R)_{FRH}$. How would Rose represent this using the notation of lab 14? How about Roe?

Rose would write this as $\lambda_0 - \lambda_{h2o}$

Roe writes everything in terms of λ_0, so this would be $\lambda_0(1+c_1)$ if water vapour is the 1st feedback.