PHYS2205 Physics for Future Leaders
Lecture Climate Systems Science
Assignment Questions

Overview

You are going to use a simple climate model to evaluate explore the effect of different forcings on the climate system. Your task is to describe what it changes, where and by how much.

Tools

Thankfully some of the hard work has been done and someone has already developed the climate model for you! Go to www.carbonator.org. On the home page you will find different scenarios. There is a 'tutorial' tab that explains the basics on how to vary the forcings within a given scenario, which you will need to do. It is possible to download the input and output data for creating figures with your preferred software of choice. Effective use of figures will be an advantage when comparing scenarios and preparing your answers to the questions.

Marking Rubric

Marks for each question will be split according to:
- Depth and clarity describing model results (25%)
- Appropriate use of figures (25%)
- Correct Answer: (50%)

Bonus mark for anyone who can create a scenario in advanced mode that 'breaks' the model!

Part 1: Understanding the impact of emissions scenarios on climate projections (40 marks)

1. Select the scenarios "Rapid Emissions Reductions (RCP3)" and in a separate tab "Business as usual (RCP8.5)"
2. Take note of the differences in the input forcing (hint: download the input forcing data and plot them on the same graph)
3. Make sure the 'Internal Variability' mode is not enabled
4. Run both scenarios and save the output

Questions:

1. What are the key differences in the input forcings and what may that represent in terms of mitigation and adaption effort? (10 marks)
2. What are the key differences in the model output after you run both scenarios in terms of temperature, sea level and greenhouse gas (GHG) concentrations at years 2000, 2050 and 2100 of the simulation? (20 marks)
3. Comment on the main cause for the differences between the scenarios at the end of 2100? (10 marks)

Part 2: Understanding the impact of human activity on the climate system (30 marks)

1. Select the "Moderate Emissions Reduction (RCP4.5)" scenario and save the input data
2. Make sure the 'Internal Variability' option is not enabled

3. Run the scenario with all forcings enabled and save the output; we'll refer to this as the "Anthropogenic Forcings Experiment"
4. Re-edit the scenario to switch off all GHG forcings (CO_2, CH_4 and SO_2) so that only the volcanic and insolation forcings are enabled. We'll refer to this as the "Natural Forcings Experiment"
5. Re-run this scenario and save the output

Questions:

1. Over the period 1850 to 2000 what are the differences in the model output (i.e. temperature, sea level, ocean acidity) between the Anthropogenic and Natural forcing experiments? (10 marks)
2. How and why does each of the climate forcings affect temperature? (Hint: you can run the scenario with only 1 forcing enabled at a time) (20 marks)

Part 3: Geoengineering the climate system (30 marks)

1. Select the "Geoengineering" scenario, saving the input forcings and run the scenario. Save the output.
2. Repeat the above but with the "Geoengineering Failure" scenario.

Questions:

1. Compare the output from the "Geoengineering" scenario to the "Business as usual (RCP8.5)" scenario you ran in Part 1. What is the main impact on global mean temperature of applying a geoengineering strategy relative to the business as usual case? (15 marks)
2. Compare the "Geoengineering" and "Geoengineering Failure" scenarios. What is the impact of sudden cessation of geoengineering? Do you think geoengineering is a good solution to climate change? Why / why not? (Hint: what happens to the other climate variables other than temperature) (15 marks)