

Due at end of Finals Week

1. Use the Earth[carbon] model on the class website to explore the impact of different assumptions about the carbon cycle on 21st Century climate. For all cases described below, use emissions scenario RCP 8.5 (Business as Usual) for consistency with the CMIP5 models.

- a. Use the “Past” tab (first one on the left) to *calibrate* the model for the period 1850-2010 by adjusting Land Sinks, Ocean properties, and climate sensitivity to try to match the observed timeseries of *both* CO₂ and temperature.

Notice that there are several different ways to match the observations. For example, you can choose weaker climate sensitivity to CO₂ if you choose shorter climate timescale.

Let this be your “**CONTROL**” scenario. Once you’ve calibrated the model to match CO₂ and temperature over the past 150 years, use the “Future” tab to see projections of CO₂ and temperature in the 21st Century.

Write down your choices of parameters, and the temperature and CO₂ in 2100.

- b. Adjust the sliders on the left-hand-side of the model to create an alternative scenario with the strongest future sinks you can get away with yet still acceptably match the past history of CO₂ and temperature. Let this be your “**BEST CASE**” scenario. Write down your choices of parameters, and the temperature and CO₂ in 2100.
 - c. Adjust the sliders again to create a “**WORST CASE**” scenario with saturating sinks that still acceptably matches the past history of CO₂ and temperature, and write down your choices of parameters, and the temperature and CO₂ in 2100.
 - d. Briefly describe your results for 21st Century climate, comparing the three scenarios. What assumptions were different for the BEST CASE and WORST CASE scenarios? Using what we’ve learned this semester, can you justify or refute any of these assumptions? Do you think any of the three scenarios you chose is more or less realistic? Why or why not?
2. Read the following paper from the ATS 760 web site:
Archer, D., and V. Brovkin (2008), The millennial atmospheric lifetime of anthropogenic CO₂, *Climatic Change*, **90**(3), 283–297, doi:10.1007/s10584-008-9413-1.

Using the slider marked “Simulation Period” at the top of the left-hand panel

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of the Earth[carbon] model, extend your Future results out to the year 3000.

- a. What is the CO₂ and temperature at the end of this simulation for each of your scenarios defined in question 1?
- b. Compare the results of your simulations to those summarized by Archer and Brovkin (2008). What is the total fossil emission (integrated over all of history) in your model compared to their experiments? How do your simulated CO₂ concentrations 1000 years from now compare to theirs? What important processes does your model lack compared to theirs?
- c. Use the temperature in the year 3000 in your model and compare to Figure 3 in Archer and Brovkin (2008) to estimate a change in equilibrium sea level if elevated temperatures persist long enough for ice sheets to reach a new equilibrium. Do this separately for your "BEST CASE" and "WORST CASE" scenarios.