



## **An exercise to teach quantitative analysis and modeling using Excel-based analysis of the carbon cycle in the anthropocene**

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A computer modeling exercise was created to allow students to investigate the consequences of fossil fuel burning and land use change on the amount of carbon dioxide in the atmosphere. Students work with a simple numerical model of the carbon cycle which is rendered in Excel, and conduct a set of different sensitivity tests with different amounts and rate of C additions, and then graph and discuss their results. In the recommended approach, the model is provided to students without the biosphere and in class the formulas to integrate this module are typed into Excel simultaneously by instructor and students, helping students understand how the larger model is set up. In terms of content, students learn to recognize the redistribution of fossil fuel carbon between the ocean and atmosphere, and distinguish the consequences of rapid vs slow rates of addition of fossil fuel CO<sub>2</sub> and the reasons for this difference. Students become familiar with the use of formulas in Excel and working with a large (300 rows, 20 columns) worksheet and gain competence in graphical representation of multiple scenarios. Students learn to appreciate the power and limitations of numerical models of complex cycles, the concept of inverse and forward models, and sensitivity tests. Finally, students learn that a reasonable hypothesis, may be “reasonable” but still not quantitatively sufficient – in this case, that the “Industrial Revolution” was not the source of increasing atmospheric CO<sub>2</sub> from 1750-1900. The described activity is available to educators on the Teach the Earth portal of the Science Education Research Center (SERC) <http://serc.carleton.edu/quantskills/activities/68751.html>.