Phosphorus Cycle Readme

I generally start the weekly modeling projects with this exercise. It is based on a modeling exercise from Chameides, W.L., and Perdue, E.M., 1997, Biogeochemical Cycles: A Computer-Interactive Study of Earth System Science and Global Change, New York: Oxford University Press (Chp. 5, The Global Phosphorous Cycle). The authors have provided a very nice diagram of the global phosphorus cycle on pg. 103 of their book (see below) that can be used directly in STELLA®, and in their first exercise my students are sufficiently challenged with learning how to use the STELLA® software that they don't need the additional challenge of coming up with their own models. In addition, in chapter 4 of their book, Chameides and Perdue go through the mathematics required to derive an analytical solution for the behavior of a simple, 2-reservoir, closed system model that includes flows in both directions between reservoirs. The mathematics require understanding of linear algebra and differential equations at a level that most of my students have not yet achieved and may never encounter. The 6-reservoir solution is even more challenging. I generally go through the math for the 2-box model on the chalkboard (see the Lecture Notes in the Course Documents area of the website), leaving most of the students bewildered and perhaps panicked, wondering what they've gotten themselves into in this course! I then go on to show them how easy it is to model this system in STELLA®, and how one can use the computer to determine the behavior of the system over time via STELLA's finite difference approach to differential equation solving. The students are predictably relieved when they see that they can allow the computer to do the heavy lifting, but, by the end of the course, they also are inspired to enhance their quantitative skills by enrolling in more math courses (see student responses to the course in the Course Documents area of the website).

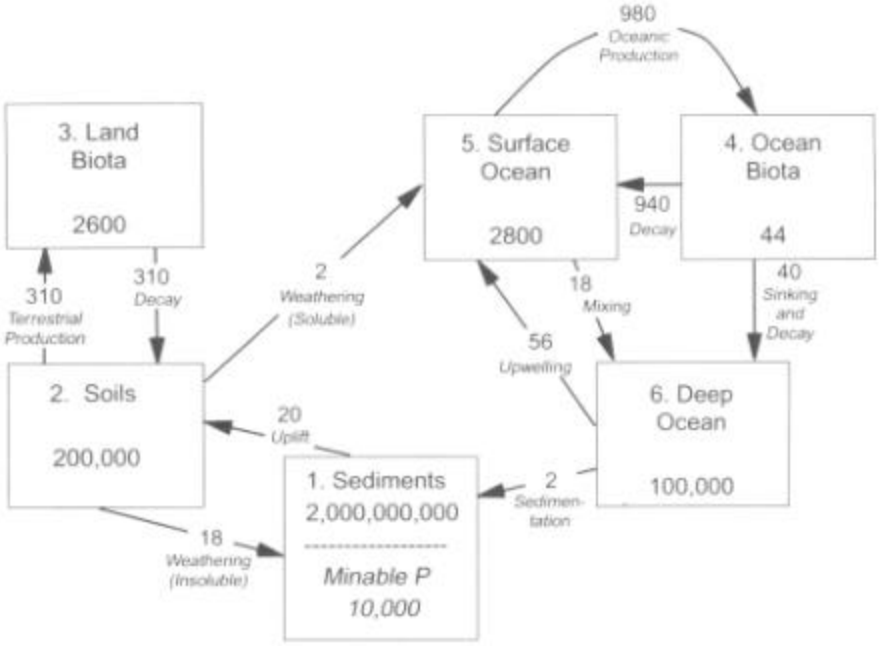

Figure 5.5. The six-reservoir model for the global biogeochemical cycle of P. Reservoirs are given in units of Tg and fluxes are given in units of Tg year^{-1}. (Recall that 1 Tg = 1×10^{12} g.)

The P cycle exercise has several purposes:
1) To get the students comfortable with using STELLA®
2) To demonstrate the behavior of a closed system with multidirectional flows
3) To convey the important concept of steady state behavior
4) To convey the importance of the 1/2 DT rule, which says that the time step (DT) should be halved until there is no longer a change in results from model run to model run.
5) To get the students comfortable with adjusting the model to run different experiments and with interpreting the results of those experiments.

Under Teaching Materials you will find the following:
1) Copies of the exercise for students in Adobe Acrobat (.pdf) format.
2) Copies of the exercise for the instructor in Adobe Acrobat format. These have all of the answers pasted in, including graphs.
3) STELLA® model of the global phosphorus cycle
4) A Fortran 90 version of the model
5) An assessment form that can be given to students to determine whether they understood the concepts the exercises are trying to convey