4.3: Computer Model for Changing Fluxes Handout

Model 1 shows something important about carbon pools that is ALWAYS true: the size of a carbon pool changes or stays the same according to the **balance of fluxes** into and out of the pool. If the fluxes into and out of a pool are *exactly the same,* then the pool stays the same size. But if the fluxes into and out of a pool are even a little bit different, then the pool gets larger or smaller.

This means that Model 1 is usually *unstable.* Whenever the fluxes are different, all the carbon eventually moves to one pool or the other. This makes Model 1 different from the Meadow Simulation that you studied in Lesson 2. In the Meadow Simulation the organic carbon pools *stabilize* over time into the pattern of the organic matter pyramid.

Natural ecosystems such as forests, deserts, and prairies are usually more like the Meadow Simulation: Their organic carbon pools stabilize over time. But this leads to an important question: *How do they do that? How do they get their carbon fluxes balanced so that the carbon pools stay about the same size?*

Model 1 isn't a good model of a real ecosystem because only the pools change. Once the fluxes are set, they stay the same for the whole run. In real ecosystems, both pools and fluxes can change over time. In particular, *fluxes depend on the size of the pools*.

Model 2 has fluxes that change in a more realistic way:

- The cellular respiration flux depends on *the size of the organic carbon pool* in a simple way: more organic carbon means more cellular respiration. More organic matter means more living organisms and those organisms have to keep doing cellular respiration in order to stay alive.
- The photosynthesis flux depends on the *size of the organic matter pool* AND the *photosynthesis limit*—the upper limit of how much photosynthesis an ecosystem can support before plants run out of an essential resource (such as water, nutrients, warmth, or sunlight):
    - When the organic matter pool (mostly plants) is small, photosynthesis goes up with the amount of organic carbon (because there are more plants doing photosynthesis).
    - As the size of the number of plants increases, photosynthesis levels out—it increases more and more slowly, even if there is a lot of organic matter (because something that the plants need is in short supply).

In this activity you will investigate patterns in a computer model of an ecosystem, with 1000 kg of carbon (though this model is still different from real ecosystems in some important ways. **Model 2** is at:

https://carbontime.bscs.org/sites/default/files/simulations/pool-flux-simulation-updated/index.html

This model has the same pools and fluxes as Model 1, BUT there is an important difference.

- Since the fluxes depend on the size of the pools, you can set pool sizes but not flux sizes at the beginning of a run.
- You can use the slider to set the upper limit on the photosynthesis flux from 0 to 100 kg/year.

When you run the simulation, you can see both graphs and tables showing how the pools and fluxes change over time. (The graph shows only the Organic Carbon Pool, since the Atmosphere CO_2 Pool is always just the difference between the organic matter pool and 1000 kg.) Notice that you can slide the line on the graph to any time, and the table will show the pools and fluxes at that time.