ACTIVITIES FOR MBL MEL Project DEB-0108960

Research activities
The aim of this research was to extend our analysis using the MEL model along three lines: **(1)** examine multiple sources of the same element resource to plants (e.g., NH_4, NO_3, N-fixation, & dissolved organic N [DON]), **(2)** generalize from two to three or more element resources, and **(3)** generalize to non-elemental resources (e.g., light and water). Development of this new model is now complete. The approach is general enough that the model can now be extended to any number of element and non-element resources and to any number of sources for any single resource. The form of the model that we have implemented has eight resources or sources of resources: CO_2, NH_4, NO_3, DON, N_2-fixation, PO_4, H_2O, and light. In addition, the model has been formulated to run on a daily time step, which allows a more accurate assessment of the soil water balance and of the losses of soil-water solutes. We have calibrated it to data from Hubbard Brook and are preparing a manuscript describing the approach, the model, and its application (Rastetter et al. in prep). Because this manuscript is still in preparation, details of this work are specified in below under findings.

Education activities
One of the major successes of the current project has been the use of the MEL model in the modeling course of our Semester in Environmental Sciences program, an intensive, semester-long program for undergraduate students from a consortium of small colleges. Six to ten students per year build their own models using a Microsoft Windows interface and model development tool developed in part with support from this project. The source code and executable model are available to anyone on our web site at http://ecosystems.mbl.edu/ Research/Models/mel/welcome.html. We also have found the MEL model to be a particularly effective tool for teaching about coupled biogeochemical cycles.

Contributions:
Our perspective on ecosystem regulation has been focused by an emerging paradigm in ecology based on resource optimization, which serves as the basis for the MEL model. We anticipate that this paradigm will develop into a broadly synthetic theory of ecosystem regulation that will unify concepts from biogeochemistry, eco-physiology, and community and population biology. The foundation of the Resource Optimization Paradigm is that organisms have a limited set of internal assets (biomass, proteins, carbohydrate...) that they can allocate toward acquiring resources from the environment (carbon, nitrogen, water, light...). The optimum allocation of these assets is one where all resources in the environment equally limit production; otherwise the organisms would be expending too many assets toward the acquisition of a resource that was not limiting and could therefore increase production by reallocating those assets toward a limiting resource. Changes in resource availability and plant requirements through time complicate this picture, but the overall concept still applies. Selective pressure should strongly favor organisms that approach an optimum-allocation pattern. As a result, resources are taken up in proportion to the metabolic requirement of the organisms, which links element cycles to one another and synchronizes their rates of cycling though ecosystems. This concept of optimization and the resulting linkage among element cycles serves as the theoretical foundation that is formalized in the MEL model.