Simulation of Soil and Vegetation Dynamics with Coupled Models

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Simulation modeling is a powerful method for predicting and understanding the dynamics of ecosystems. Yet, individual ecosystem models tend to be have most detail within their specific scientific field, and only generalizations about other connected parts of the ecosystem. A model of soil physics (FroST: Frozen Soil Temperatures) was linked with a model of vegetation dynamics (Hybrid) in order to predict ecosytstem properties within forests in Canada. FroST contains details describing moisture and temperature flux, but only simple equations for vegetation dynamics. Hybrid details biogeochemistry and forest succession, with little emphasis on soil properties. The linkage between these models was performed using a modeling framework which allowed querying of information from one model to another at each time step and with common data format. FroST provided information for Hybrid about soil temperature, and the amount of water available for roots. Hybrid provided information to FroST about latent heat and transpiration. Results of linked models showed results that were significantly different than results for simulations using the models in "stand-alone" mode. By linking these models, the complexity for individual systems is captured, and simulations appear to provide more realistic results. This method also can be used to evaluate how much detail is necessary about other parts of the ecosystem within any given model, and can provide a means for obtaining "scaled" values for "other discipline" parameters that would be an improvement over "best guesses" currently used.

Root mean square error (rms) and regression coefficients (r^2) were derived for each network and showed similar predicting ability for each data set. The network trained from the combined data set used taxonomic data and a few quantitative parameters. Networks trained from the soil order data required more quantitative data, and these differed between orders. These trained networks can be used to make predictions of water holding capacity when the required parameter data is available. In addition, the parameters used by the networks can give insight into complex relationships embedded in data at varying scales that might not be otherwise observed.