NAME: Paul J. Hanson
ORGANIZATION: Oak Ridge National Laboratory
PROGRAM AFFILIATION: TES
ABSTRACT TITLE: Long-term Experiments and Observations: Fertile Ground for Model Benchmarking and Improvement In the Context of Environmental Change

ABSTRACT: The DOE Office of Science Biological and Environmental Research (BER) program is a key supporter of fundamental research to understand ecological effect of environmental change. Recent and ongoing research in this area provides an understanding of how climatic and atmospheric changes can modify the form and function of terrestrial ecosystems. A number of BER’s long-term observations and manipulations are being used to evaluate, parameterize and hopefully improve ecosystem models. Key results from several other BER-funded studies are highlighted as potential fodder for future model-experiment-observation interactions.

For example, long-term support of elevated carbon dioxide (CO₂) exposure studies in a range of ecosystems demonstrated enhanced terrestrial carbon uptake into both plant biomass and soil carbon pools. The uptake capacity, has however, been shown to be reduced when nutrient limitations or water stress become key constraints. Long-term and large-scale precipitation manipulations designed to induce severe drought have revealed a tremendous contrast between the resilience of trees in wet eastern ecosystems and their vulnerability in dry western environments. Warming studies, both completed and ongoing, demonstrate a complex mixture of responses, including extended annual growth periods and enhanced nutrient mineralization resulting in increased plant growth. Such arguably beneficial responses are contrasted with warming-induced losses of important greenhouse gases to the atmosphere (CO₂ and methane) and the acceleration of drought conditions. BER has also pioneered studies to apply state-of-the-science technologies, molecular analyses, and genetic methods to the evaluation of ecosystem-scale responses to climatic and atmospheric changes. All of this research produces important lessons-learned that should be reconciled against the predictive capacity of available ecosystem models. Are such lessons being transferred to the model-projection activities?

Models’ predictive capacity stems from the presence of fundamental mechanisms and important structural relationships within prognostic models. The absence of key mechanisms within ecological models undermines their capacity to provide policy-relevant predictions of both climate change impacts and future greenhouse gas trajectories from those ecosystems. Future model-experiment-observation should be fostered to improve a wide range of ecosystem. Through the development of an integrated understanding of multiple, interacting environmental effects (i.e., structured models), the scientific community can generate viable prognostic models to inform policy makers and the public about the capacity of ecosystems to provide goods and services for society under projected rapid rates of climate change.