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EOS

MEETINGS

Converting Raw Data Into Ecologically Meaningful Products

Data-Model Assimilation in Ecology: Techniques and Applications; Norman, Oklahoma, 22–24 October 2007

A U.S. National Science Foundation workshop brought together more than 40 researchers from different disciplines to discuss applications of data assimilation techniques in ecology, define major scientific questions to be addressed, and identify future research challenges.

The field of ecology has become a data-rich enterprise, due largely to rapid development of measurement sensors and long-term accumulation of data from research networks. With the implementation of the National Ecological Observatory Network (NEON), a network with different kinds of sensors at many locations over the nation, large volumes of ecological data will be generated every day. There will be an unprecedented demand to convert the massive raw data into ecologically meaningful products using data assimilation techniques.

Data assimilation is a technique that combines observational data into ecological models to improve ecological forecasting. Data assimilation becomes a valuable tool to improve model parameterization, choose between alternative model structures, better design sensor networks and experiments for data collection, and analyze uncertainty of ecological forecasts.

Applications of data assimilation in ecology have been made in recent years. In this workshop, for example, one study evaluated how the distribution and abundance of species were influenced by climate and land use change using a Bayesian hierarchical approach. By integrating observed net ecosystem carbon exchange (NEE) and a measure of surface reflectance into an ecosystem carbon model with a Kalman filter method, it was possible to retrieve complete estimates of carbon stocks and fluxes, with errors, for Arctic tundra. Growth, mortality, and NEE estimations at Harvard Forest (an ecological research site affiliated with Harvard University, Cambridge, Mass.) were improved using an optimized ecosystem demography model.

Also presented at the workshop was a study that used a deconvolution method to partition soil respiration into contributions by plants with different pathways of carbon fixation during photosynthesis (C_3 forb and C_4 grass) and other sources. In addition, a simplified analytical model predicted that reduced maximum evapotranspiration (ET_{max}) results in longer soil moisture memory and an out-of-phase relationship between rainfall and soil moisture variations.

One presentation highlighted how regional streamflow in Australia was simulated using a three-dimensional variational assimilation approach. Several researchers discussed advancements in understanding uncertainty related to measurements and optimization methods on model prediction. Another important application discussed at the workshop involved how to extract information from manipulative experiments in order to advance predictive understanding.

The workshop also highlighted research challenges. One major challenge, for example, is how to get the community ready within 5–10 years for ecological forecasting using NEON data. It is urgent to develop our data assimilation capability so as to advance ecological understandings and generate products that benefit the society. While data assimilation has been an essential tool in weather forecasting, its application to ecology is still in its infancy. It will take major efforts to make this technique ready for ecological forecasting.

The workshop ended with an education session, in which participants discussed how to get students in ecology prepared for data assimilation. Attendees agreed that a variety of programs need to be developed, such as summer schools and short-term workshops. Also, semester-long data assimilation courses need to be offered to graduate and undergraduate students.

More information can be found at http://bomi.ou.edu/luo/NSF_workshop.htm.

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