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David Sims
Institute for the Study of Earth, Oceans, and Space

Media Relations

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DURHAM, N.H. – Scientists Jingfeng Xiao and Scott Ollinger of the University of New Hampshire's Institute for the Study of Earth, Oceans, and Space (EOS) have received funding from the National Science Foundation (NSF) under the first round of competitively awarded grants for the agency's new Macrosystems Biology program. The grant will fund research to help quantify continental-scale carbon fluxes or so-called carbon "sources" and "sinks" in the long-term effort to craft more accurate climate change forecasts and facilitate climate policymaking.

The UNH research is based on a unique modeling method pioneered by Xiao, and will make use of very large sets of ecological data only recently available from study sites across North America.

Says Xiao, the project's principal investigator and a research assistant professor in the EOS Complex Systems Research Center (CSRC), "We will produce new-generation flux maps for North America to quantify ecosystem carbon fluxes. We hope to better understand the magnitude, distribution, and interannual variability of the carbon sink by using new data sets and new modeling techniques."

NSF's large-scale biology program, a first for the agency, is designed to spur research on ecosystem processes and their complex interactions with climate, land use, and invasive species at regional to continental scales. If the continental-scale carbon budget can be "closed," scientists will be in a better position to make climate forecasts, particularly with respect to year-to-year variability in the carbon budget caused by large-scale disturbances like droughts or forest fires.

The $517,000 award from NSF will fund the three-year project. Xiao's successful proposal results in part from pioneering work he has conducted over the last four years. Specifically, he has developed and refined a modeling method whereby data gathered at individual ecological "flux tower" research sites across North America can be "upscaled" or extrapolated to provide a statistically accurate picture of carbon fluxes across the entire continent and encompassing different ecosystem and climate types.

"This approach is very different from traditional ecosystem models, which are built upon a lot of complex, underlying ecosystem processes," Xiao explains. "Our method is a data-driven approach, meaning it is an empirical, statistical model using vast amounts of data being gathered year-round on an hourly basis by the network of flux towers. This approach can lead to model parameters that are more representative of the full spectrum of vegetation and climate conditions, and to more robust estimates of ecosystem carbon fluxes over broad regions."

The network of more than 100 towers dotted around the North American continent measures the covariance (how much two variables change together) of vertical wind velocity and fluctuating carbon dioxide (CO_2) concentration around the tower's one-square-kilometer footprint. From this data, the exchange of CO_2 between the ecosystem and atmosphere can be accurately calculated. Xiao's modeling method essentially allows the numbers from the individual tower sites to be crunched together into the bigger picture.

The data-driven methodology pioneered by Xiao, and now being funded by NSF, was novel enough that it took several years to convince the ecosystem modeling community at large that the technique could accurately be applied continent-wide and eventually, Xiao anticipates, globally as well. Xiao and Ollinger also propose to examine the impacts of disturbances on carbon cycling and to quantify the uncertainty of carbon fluxes using a forest ecosystem model developed at UNH and the relatively new technique of model-data fusion or data assimilation.

The creation of NSF's Macrosystems Biology program follows the agency's ambitious National Ecological Observatory Network (NEON), which is in the process of being put together and when completed in 2016 will provide the first continental network of data-gathering stations. The 62 NEON sites will make some 270 crucial measurements in their respective ecological systems. Scientists from CSRC have been involved in the creation of NEON from its very beginnings.

Notes Xiao, "NEON will collect lots of valuable data at the continental scale. And it's essential to develop the solid methodology to make use of these data sets to address continental-scale science questions. Our methodology should be able to help in this effort."

The University of New Hampshire, founded in 1866, is a world-class public research university with the feel of a New England liberal arts college. A land, sea, and space-grant university, UNH is the state's flagship public institution, enrolling 12,200 undergraduate and 2,300 graduate students.

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Media Contact: David Sims | 603-862-5369 | Institute for the Study of Earth, Oceans, and Space

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