Progress Report Project Number: 3211-2065

**Creating new climate drivers and interactions in global climate models**

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## Abstract

This proposal involves the identification of important climate drivers not already present in current climate models. The drivers to be perturbed are 1) carbon cycle feedbacks, 2) hydrological cycle feedbacks and 3) economic feedback responses to climate change. The scientific analysis of the significant feedbacks in the Earth system is the key to reliability and uncertainty estimation of future climate prediction and is critical in making meaningful policy decisions. The programmatic objective is to make ORNL the central DOE institution for computational climate modeling and to leverage the significant present and future ORNL computational resources to obtain future funding in the burgeoning field of numerical climate, carbon and water cycle modeling and economic-climate feedbacks.

## Body of Progress Report

The technical R&D objectives of this LDRD are the evaluation and creation of new climate drivers/feedbacks in the climate modeling system. The installation of state of the art global climate models and an assessment of feedbacks and critical biogeochemical physical parameterizations in the global climate models operating on ORNL computational platforms are central to this LDRD. The deliverables will be several refereed journal articles, meeting presentations and a clear delineation of future (2-5 years) funding opportunities. This LDRD is intended to position ORNL climate science at the forefront of the US climate modeling efforts.

We have a wide range of accomplishments to report at this juncture:

We have ported the US state-of-the-art global Climate Model (CCSM2) to the CCS/CSM high performance computing center. We have evaluated the control run of the CCSM2 (Branstetter and Erickson, 2003) and have performed a variety of sensitivity tests of the CCSM2.

An additional milestone is that we have, with colleagues at LLNL, ported the only fully coupled climate-carbon cycle model in the US to ORNL computers. The effect of acclimation has been coded in to IBIS terrestrial biosphere submodel and an experimental run has been staged. We have 3 additional test runs of the CCSM2 staged to explore new scientific characteristics of the CSM2.

In the area of hydrologic cycle feedbacks, we are developing new modeling procedures to improve how soil moisture dynamics and lateral transport of water is represented in the CCSM2 code. Our initial computational experiments completed this year indicate that the code for soil wetting and drying is not realistic and that there may be errors in the land surface modules of CCSM2. We are now in the process of recoding the important parts of the land surface model, including a new simplified algorithm and supporting global data for estimating TOPMODEL baseflow parameters and soil profile characteristics. This new approach is based on work completed by Pan this year that evaluated a number of different methods for calculating topographic index and flow direction.

We have several refereed publications published, in press and in preparation.

Our program development strategy is initially to build an obvious expertise/group that is active in global climate modeling science. At the national CCSM2 workshop in Breckenridge, CO in June, 2003, ORNL had 14 scientific/computational scientists representing our efforts. We had several lectures, posters and workshop participation on a variety if climate modeling issues.

Extensive team/partnership building with DOE program sponsors, NASA sponsors, sister DOE National laboratories and university colleagues has been a focus of this LDRD. Erickson has initiated and taken responsibility in contacting and visiting scientists at LANL (Jan. 2003), LLNL (Dec. 2002) and DOE Headquarters (1.25 hour presentation to Patrinos, Elwood, Farrell, Amthor (May, 2003)). As the funding increases on the computer hardware side continue, we are positioned to secure funding from DOE HQ as the climate science budget grows in concert with the hardware applications. King is pursuing collaborations with Jon Foley, University of Wisconsin, author of the IBIS terrestrial biosphere model.

We have, at present, 5 proposals submitted to NASA, 6 proposals submitted to DOE HQ and 1 submitted to USAID.