Geophysical Research Abstracts,
Vol. 11, EGU2009-12178, 2009
EGU General Assembly 2009

The Shale Hills Critical Zone Observatory for Embedded Sensing and Simulation

C Duffy (1), K Davis (2), T Kane (3), and E Boyer (4)

(1) Penn State University, CEE Department, University Park, PA, United States (cxd11@psu.edu), (2) Penn State University, Meteorology Department, University Park, PA, United States (davis@met.psu.edu), (3) Penn State University, Electrical Engineering Department, University Park, PA, United States (tjk7@psu.edu), (4) Penn State University, School of Forest Resources, University Park, PA, United States (ewb100@psu.edu)

The future of environmental observing systems will utilize embedded sensor networks with continuous real-time measurement of hydrologic, atmospheric, biogeochemical, and ecological variables across diverse terrestrial environments. Embedded environmental sensors, benefitting from advances in information sciences, networking technology, materials science, computing capacity, and data synthesis methods, are undergoing revolutionary change. It is now possible to field spatially-distributed, multi-node sensor networks that provide density and spatial coverage previously accessible only via numerical simulation. At the same time, computational tools are advancing rapidly to the point where it is now possible to simulate the physical processes controlling individual parcels of water and solutes through the complete terrestrial water cycle.

Our goal for the Penn State Critical Zone Observatory is to apply environmental sensor arrays, integrated hydrologic models deployed and coordinated at a testbed within the Penn State Experimental Forest. The NSF-funded CZO is designed to observe the detailed space and time complexities of the water and energy cycle for a watershed and ultimately the river basin for all physical states and fluxes (groundwater, soil moisture, temperature, streamflow, latent heat, snowmelt, chemistry, isotopes etc.).

Presently fully-coupled physical models are being developed that link the atmosphere-land-vegetation-subsurface system into a fully-coupled distributed system. During the last 5 years the Penn State Integrated Hydrologic Modeling System has been under development as an open-source community modeling project funded by NSF EAR/GEO and NSF CBET/ENG. PIHM represents a strategy for the formulation and solution of fully-coupled process equations at the watershed and river basin scales, and includes a tightly coupled GIS tool for data handling, domain decomposition, optimal unstructured grid generation, and model parameterization. (PIHM; http://sourceforge.net/projects/pihmmodel/; http://sourceforge.net/projects/pihmgis/)

The CZO sensor and simulation system is being developed to have the following elements: 1) extensive, spatially-distributed smart sensor networks to gather intensive soil, geologic, hydrologic, geochemical and isotopic data; 2) spatially-explicit multiphysics models/solutions of the land-subsurface-vegetation-atmosphere system; and 3) parallel/distributed, adaptive algorithms for rapidly simulating the states of the watershed at high resolution, and 4) signal processing tools for data mining and parameter estimation. The prototype proposed sensor array and simulation system proposed is demonstrated with preliminary results from our first year.