The hills are alive: Earth surface dynamics and atmospheric interactions in the Biosphere 2 Landscape Evolution Observatory

DeLong, Stephen B.* - Biosphere 2, University of Arizona
Troch, Peter - Biosphere 2, University of Arizona
Huxman, Travis - Biosphere 2, University of Arizona
Pelletier, Jon - Biosphere 2, University of Arizona
Chorover, Jon - Biosphere 2, University of Arizona
Barron-Gafford, Greg - Biosphere 2, University of Arizona
Dontsova, Katerina - Biosphere 2, University of Arizona
Ferre, Ty - Biosphere 2, University of Arizona
Niu, Guo-Yue - Biosphere 2, University of Arizona
Zeng, Xubin - Biosphere 2, University of Arizona

To meet the challenge of predicting landscape-scale changes in Earth system behavior, the University of Arizona has designed and constructed a new large-scale and community-oriented scientific facility – the Biosphere 2 Landscape Evolution Observatory (LEO). The primary scientific objectives are to quantify interactions among hydrologic partitioning, geochemical weathering, ecology, microbiology, atmospheric processes, and geomorphic change associated with incipient hillslope development. The facility is run in a manner in which the atmospheric fluxes are free to enter and leave the facility, but in the future it may be restored to a sealed environment. We are interested in engaging with the atmospheric science community to study experimental land-atmosphere interactions.

LEO consists of three identical, sloping, 333 m^2 convergent landscapes inside a 5,000 m^2 environmentally controlled facility. These engineered landscapes contain 1 meter depth of basaltic tephra ground to homogenous loamy sand and contains a spatially dense sensor and sampler network capable of resolving meter-scale lateral heterogeneity and sub-meter scale vertical heterogeneity in moisture, energy and carbon states and fluxes. Each ~1000 metric ton landscape has load cells embedded into the structure to measure changes in total system mass with 0.05% full-scale repeatability (equivalent to less than 1 cm of precipitation), to facilitate better quantification of evapotranspiration. Each landscape has an engineered rain system that allows application of precipitation at rates between3 and 45 mm/hr.

These landscapes are being studied in replicate as "bare soil" for an initial period of several years. After this initial phase, heat- and drought-tolerant vascular plant communities will be introduced. Introduction of vascular plants is expected to change how water, carbon, and energy cycle through the landscapes, with potentially dramatic effects on co-evolution of the physical and biological systems.

LEO also provides a physical comparison to computer models that are designed to predict interactions among hydrological, geochemical, atmospheric, ecological and geomorphic processes in changing climates. These computer models will be improved by comparing their predictions to physical measurements made in LEO. The main focus of our iterative modeling and measurement discovery cycle is to use rapid data assimilation to facilitate validation of newly coupled open-source Earth systems models.

LEO will be a community resource for Earth system science research, education, and outreach. The LEO project operational philosophy includes 1) open and real-time availability of sensor network data, 2) a framework for community collaboration and facility access that includes integration of new or comparative measurement capabilities into existing facility cyberinfrastructure, 3) community-guided science planning and 4) development of novel education and outreach programs.