



<sup>1</sup>Department of Earth and Atmospheric Sciences, Purdue University, West Lafayette, IN. Email: gjbowen@purdue.edu <sup>2</sup>Department of Geology and Geophysics, University of Utah, Salt Lake City, UT. Email thure.cerling@utah.edu <sup>3</sup>Global Change and Ecosystem Center, University of Utah, Salt Lake City, UT. Email jim.ehleringer@utah.edu

### The challenge

Training the next generation to address macrosystem-scale science requires new approahesch. The instructor-mentoring teams, critical instrumentation, and essential modeling skills key to address continental scale questions often exceed the capacities of individual universities.

### The opportunity

New, collaborative approaches to inter-university training can be developed that leverage the collective human, intellectual, and physical resources of multiinvestigator networks. These approaches should bring together a diverse faculty with wide-ranging and complimentary expertise and junior scientists representing a spectrum of the skills and disciplines key to Macrosystems Biology.

Such an effort must be structured around a coherent scientific theme. Our project centers on stable isotope data, which are of cross-cutting relevance in macrosystems science for their ability to source, trace, integrate, and record processes that are scalable from cellular through ecosystem and onto continental scales.



The initial 32 ITCE faculty come from 25 different universities and federal agencies. Each participate in the lecture and lab courses, web module development iBook, research-in-residence training, and inter-university postdoctoral training.

### A training model with impact



ITCE builds on 17 years of interdisciplinary training through the University of Utah Stable Isotope Ecology short courses. This record demonstrates a capacity to sustain interdisciplinary and inter-university faculty engagement and to change the perspectives and careers of students.

Publications, courses, and other metrics show the expansion of stable isotope themes into graduate-level instruction at universities across the U.S. and an increase in long-term stable isotope data series that provide powerful earth systems information complementary to other measures. All of these efforts contribute to the scientific and human infrastructure needed to support scaling processes from organism to ecosystem to regional and continental scales. This training lays a foundation for the use of anticipated NEON data products.

# ITCE: Inter-university Training in Continental-scale Ecology

Gabriel Bowen<sup>1</sup>, Thure Cerling<sup>2</sup>, and James Ehleringer<sup>3</sup>

# A solution: Inter-university continental-scale training

We are developing a cohort-based graduate student and postdoctoral training program to prepare junior scientists to address ecological, hydrological, and atmospheric challenges at regional-to-continental scales. Graduate students and post-docs from the biological, earth, and physical sciences will use stable isotopes as tracers, integrators, and recorders of processes and patterns over scales from the molecular to that of global significance. These individuals will develop broadly applicable technical skills in the laboratory and in modeling, strong interdisciplinary communication abilities, and a network of professional relationships.

Inter-university training will emphasize five key approaches to build bridges across disciplines and scales:

- 1. Interdisciplinary cohort development and recognition of research approaches that span scales
- 2. Two intensive, 2-week lecture and hands-on laboratory courses offered by teams of 14-16 faculty each
- 3. Post-course research-in-residence opportunities to expand a student's thesis focus at other universities
- 4. Post-course networking and engagement, with annual workshops and sessions at national meetings
- 5. Postdoctoral training emphasizing continental-scale projects with multi-investigator and multi-university teams



### A diversity of scientific approaches and linkages







Synthesis, meta-analysis, and training exercises using multiple data streams from existing and developing large-scale networks

Strong integration with CI resources for data management, access, and use, including student training and development/deployment of new spatial analysis and modeling tools for the macrosystems-isotope research community

- evolving data networks?
- opportunity that is evolving so fast?
- other national networks?

http://wateriso.eas.purdue.edu/itce/index.html, ITCE webpage http://co2.utah.edu, urban CO<sub>2</sub> data http://isomap.org, spatial isotope data sets and products



Cohort-based training with multi-university instructors, instrumentation, mini projects, database and spatial model development, web modules

## Key challenges for ITCE

• How do we sustain cohort development and interactions after training and in the face of an evolving and undefined macrosystems network? What are the most effective methods to engage with emerging and

• What are the most effective means to engage with universities and investigators not yet actively participating?

How do we keep up with an iBook and electronic educational

• What are the best approaches to engage with NEON, CUAHSI, and

How do we most effectively instill essential practices for data curation and maintenance as part of a graduate-training culture?