

They've Got the Whole World in Their Hands

By David Sims (*Originally published in the Winter 2006 edition of EOS Spheres, the quarterly newsletter of the Institute for the Study of Earth, Oceans, and Space, Univ. of New Hampshire*)

Students of Earth System Science (EOS 867) get a rigorous, big-picture view of life on Earth



When graduate student Quinn Thomas was flying back from last December's annual meeting of the American Geophysical Union in San Francisco, he peered down at snow-laden Earth and pondered what fraction of sunlight was being reflected back into the atmosphere by the cold, white surface—the planet's "albedo." He thought about the theory of "snowball Earth," which proposes that some 600 million years ago our planet hurtled through space like a cosmic snowball frozen from pole to pole. He saw Earth below and, in his head, pictured the equation-filled boxes, arrows and connecting lines that comprise a mathematical model representing the complex system of feedbacks that make the world go 'round—a picture that had been hammered home in the Earth system science class he would finish upon return to UNH.

Graduate students Liz Burakowski and Quinn Thomas

The former Dartmouth College undergraduate, who had presented his senior, honors thesis work on tropical tree mortality at AGU, says that while he has always thought of things scientific in such a "systems" way, it wasn't until he took the Earth system science course taught last semester by Cameron Wake and George Hurtt that he saw the forest for the trees. And the clarity of this newfound vision was provided most powerfully by the rigorous exercise of building a mathematical model from scratch with some of his classmates.

Says Thomas, a 2005-'07 Research & Discover fellow in the masters program, "One of the reasons I came here to UNH and to EOS is that modeling intimidated me as an undergraduate and I wanted to overcome that. If I'm going to be limited by anything I want it to be my own ability to think, not an inability to use tools." Mission accomplished.

Ask any of the 14 graduate and undergraduate students what the most challenging, intellectually stimulating, and exasperating aspect of the class was and you'll get one answer—the modeling.

“It was *very* challenging, and you never know if you’re right,” says Elizabeth Burakowski, a Wellesley College graduate and masters candidate. She adds, “The quote at the top of every single one of our lab handouts was, ‘All models are wrong. Some are useful.’ To know that your model is wrong is very frustrating.” The oft-cited quote from statistician George Box encapsulates the inherent ambiguity of mathematical models. And for students accustomed to having their knowledge evaluated as “right or wrong,” to spend an extraordinary amount of time and effort building a model only to come up short was a new educational experience indeed. However, Burakowski notes, “This was a lesson Cameron and George were looking to teach us.”

That is, these students, in modeling very real, very complex Earth system issues such as “The Effects of an Urban Environment on Cloud Formation and Temperature” or “Permafrost and Carbon: Source or Sink,” were challenged to come up with real-world data to obtain original, meaningful results.

The EOS 867 course, designed by Wake and Hurtt, was awarded NASA grant funding through the Universities Space Research Association (USRA) ESSE 21 program. The New Hampshire Space Grant Consortium and EOS also contributed funds for the class, which has been offered twice now, doubled in size from its initial offering and, for this last go-round, included students from each of EOS’s four centers and a variety of departments—from physics to economics.

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Cameron Wake, Professor

ESSE 21 is a collaborative undergraduate-graduate education program that offers small grants to colleges and universities to engage a diverse interdisciplinary community of faculty and scientists in the development of courses, curricula and degree programs. In addition to a rigorous, ongoing assessment process that Hurtt and Wake built into the course itself, USRA has its own assessment process, which is carried out by program evaluator David Reider. In mid-November, Reider sat in on Lecture #17.

“To me, George and Cameron are doing precisely what I believe the grant should fund. They’re collaborating, co-teaching, so they’re bringing in specific expertise at the instructor level from very specialized domains, they’re creating a joint curriculum, and certainly the students benefit from that,” Reider says.

Reider notes that such an approach also provides professional benefit to the instructors themselves, particularly when this “systems” course is taught in a systems way. Given a collaboration between two professors with distinctly different research interests, and a research institute (EOS) working within the academic structure, Reider asserts, “You have all this cross fertilization going on that seems to be working. To me, there’s nothing

better in higher education than for that to happen.”

Currently, Hurtt and Wake are extending the reach of Earth system science. “The lessons learned in developing and teaching the class are being disseminated to the broader community in a variety of ways,” Wake says. This includes a paper describing the class and the student evaluation process published in the *Journal of Geoscience Education*, and the eventual dissemination of all class materials via NASA’s education web site. Wake and Hurtt are also part of a team, which includes UNH’s Leitzel Center and faculty from Elizabeth City State University in North Carolina, that has been funded by NASA to train faculty at Historically Black Colleges and Universities on how to develop and teach Earth system science.

Says Wake, “The educational experience of many science students is one of increasing specialization through their university education. A course like Earth System Science, while it builds on students’ disciplinary strengths, encourages them to broaden their horizons and examine how their specific discipline fits into the larger system.”

From his perspective, Quinn Thomas believes that, in addition to the rigors of building a mathematical model to investigate the dynamics of snowball Earth, the reams of papers from professional journals used as required reading put him in good stead for his future scientific endeavors.

“We read scholarly papers that disagreed with each other, and I even heard some of these authors speak at AGU. One of the things you need as a climate change scientist, or someone working to bring it to the forefront of public attention, is an understanding of the limitations of the known science, because if you don’t, you can’t effectively educate the public.”

ESS at the University of New Hampshire

http://esse21.usra.edu/ESSE21/esse21_newhampshire.html

Hurtt, George *et al*, 2006 “Broadening Student Horizons: The Development, Delivery and Assessment of a New Course in Earth System Science” *Journal of Geoscience Education*, May, 2006, v.54 n.3, pp 329-338

<http://www.nagt.org/nagt/jge/abstracts/index.html>

Earth System Science EOS 895 Syllabus

http://esse21.usra.edu/syllabi/UNHsyllabus795_f05.pdf