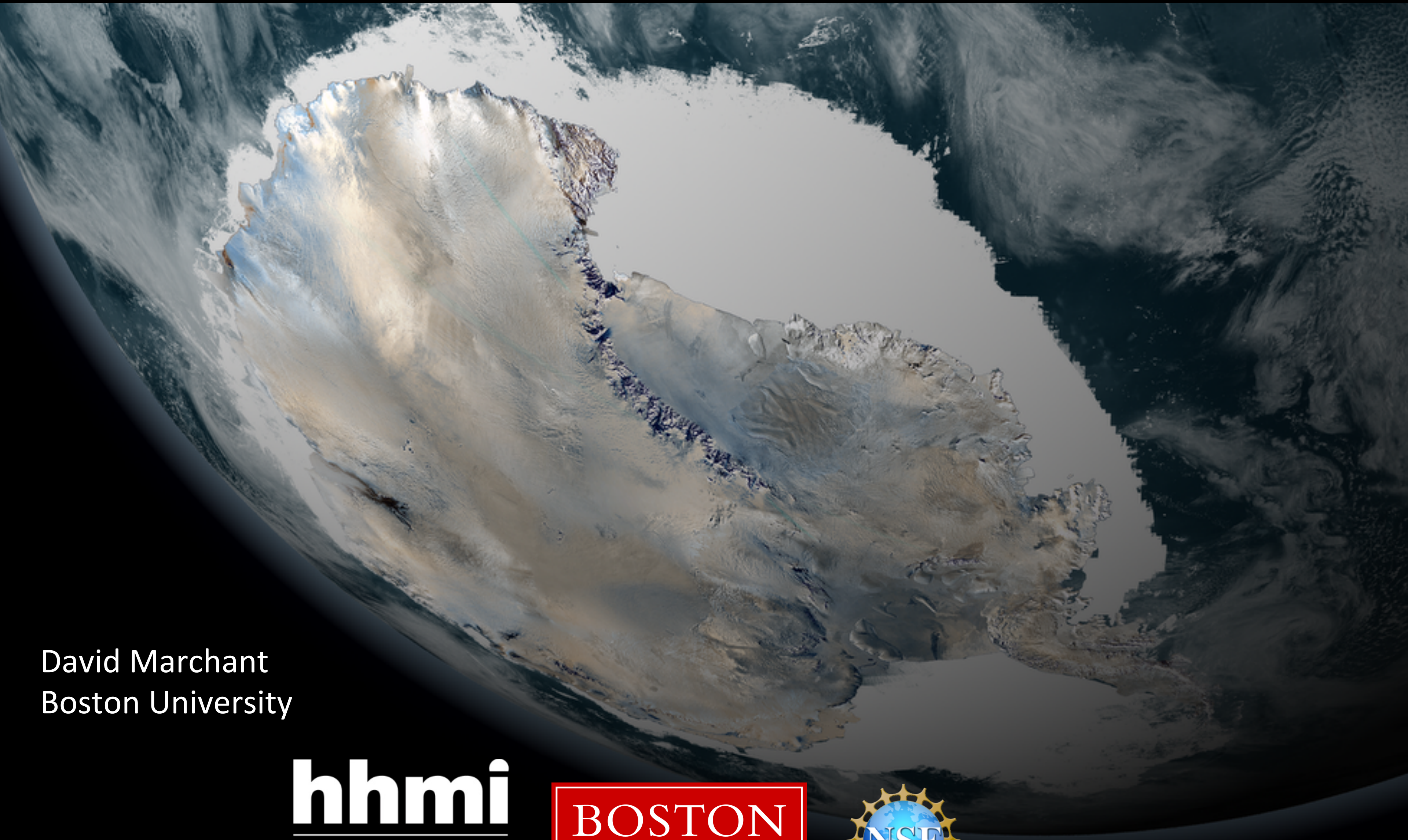
Integration of Science:
Research, Education, & Outreach in Climate Change



David Marchant
Boston University

hhmi Howard Hughes Medical Institute

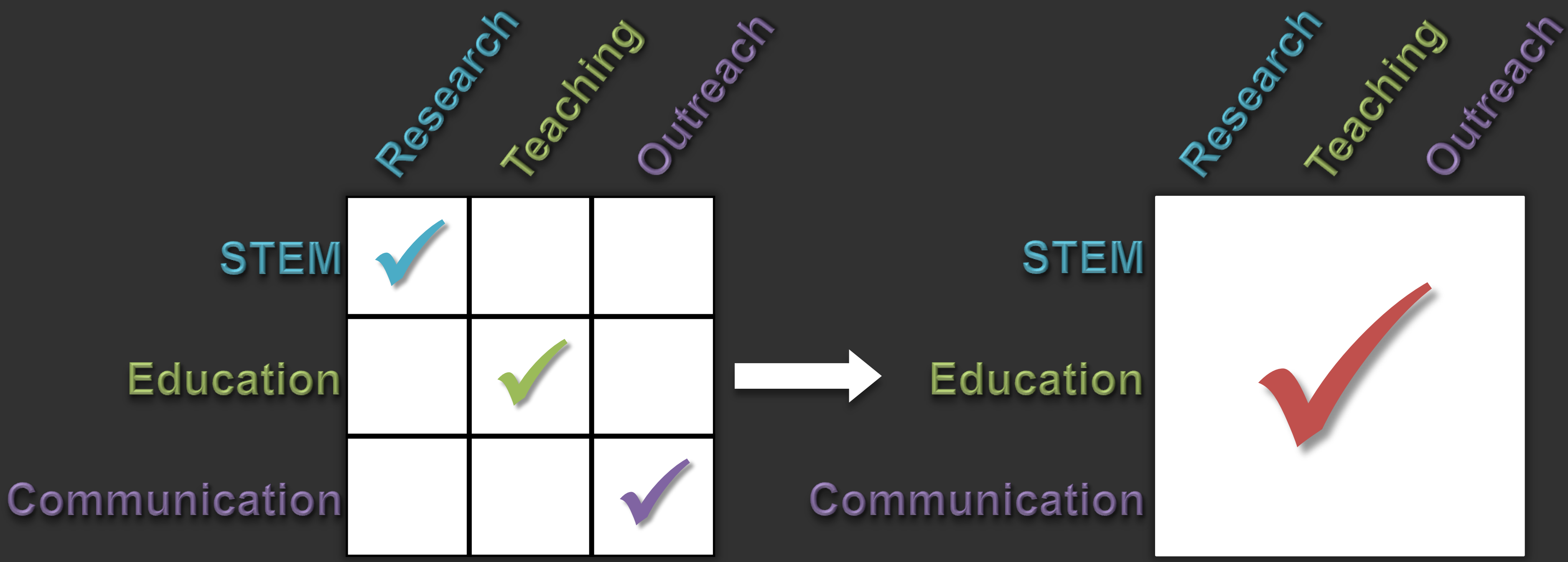
BOSTON UNIVERSITY

NSF

Our Golden Opportunity: Climate change as a lure for STEM education

- **Asking scientific questions**
- **Communicating results to the general public**
- **Educating the next generation of students to do the same**

Seeding a Cultural Change in Undergraduate STEM Education: Climate Science as a tool to integrate research, science education, and outreach



Current Paradigm

Our Plan

Program Elements

Engage a cohort of 20 first-year students interested in climate science across three schools and colleges at BU:

The College or Arts & Sciences, The College of Communication, and the School of Education

1.5 year long program:

1. University-wide seminar series on climate change

2. Hypothesis-driven, problem-based laboratory course

3. Summer internship program

4. Fieldwork in Antarctica

Fall 1	Spring 1	Summer 1	Fall 2

Seminar Course: All Aspects of Climate Change

Climate Science

Wallace Broecker
- National Academy of Sciences
- Columbia University

George Denton
- National Academy of Sciences
- University of Maine

Wally Fulweiler
- Sloan Fellow, Earth & Environment and Biology, Boston University

Seminar 2014

Science Education

Scott Solberg
- Associate Dean of Research in SED, Boston University

Graham Chedd
- Producer, NOVA TV, Boston, MA

Jennifer Berglund
- Prehensile Productions

Science Communication

Tony Janetos
- Director, Pardee Center for the Study of the Longer-Range Future
- Boston University

Mathew Nisbet
- Professor of Public Policy, Communication, and Urban Affairs, Northeastern Univ.

Ellen Shell
- Co-Director, Center for Science & Medical Journalism
- Boston University

Fall 1	Spring 1	Summer 1	Fall 2


What happened to all the carbon that was once in the atmosphere?
Theory:
Carbon removed from the atmosphere through weathering and now lies in the ocean sediment
If correct, the early atmosphere is in Earth's rocks

Laboratory Course: Three modules

- Develop GK-12 lesson plans
- Work with local teachers
- Visit classrooms

BOSTON Public Schools
Focus on Children

Public Schools of Brookline

READING PUBLIC SCHOOLS
Reading, MA

Science Research Module

Methods:
- Scanning Electron Microscopy
- X-Ray diffraction studies
- Environmental chamber
- Permafrost degradation
- Sublimation of buried ice

STEM Skills:
- Mathematical literacy
- Analytical proficiency
- Computer literacy

Science-Education

Science-Communication

Science -- Communication -- Education --

Antarctic Research: Science, Education & Outreach

Science Education Module

Education-Communication

Science Communication Module

Outreach:
- Develop Strategies
- Translate Findings
- Blogging
- Web design
- Film
- Print media

Seed a cultural change that places early, consistent , and simultaneous emphasis on science, science education, and science communication.

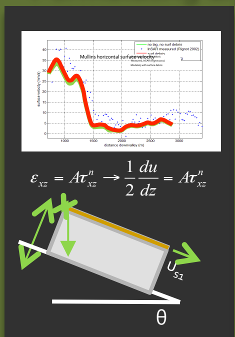
Fall 1	Spring 1	Summer 1	Fall 2

Summer internships: 10-12 weeks

Intern with any of the speakers in the Fall Seminar Series, or any other researcher studying an aspect of climate change at BU or at nearby schools.

Fall-Winter Antarctic Expedition

- Integration of technology
- Spatial reasoning and problem solving
- Application of geological concepts
- Quantitative analysis
- Formulating and testing hypotheses



Research Themes

- Atmospheric evolution
- Antarctic Ice Sheet stability
- Vegetation history of Antarctica
- Antarctic geomorphology applied to ice ages on Mars

STEM Skills

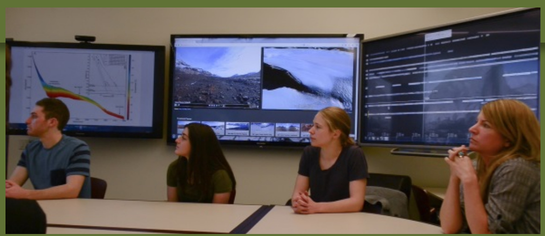
Field Instruments & Techniques

- Ground Penetrating Radar
- LiDAR terrain characterization
- Longitudinal strain analysis
- Time-lapse imaging
- Meteorological data collection
- Stratigraphic analysis
- Geological mapping

Fall 1	Spring 1	Summer 1	Fall 2

Virtual Antarctic Exploration

- Digital Image Analysis Laboratory
- Web-based virtual fieldwork
- GIS analysis
- Computational modeling, DEM's
- Ultra-high resolution imagery



Virtual Research and Exploration

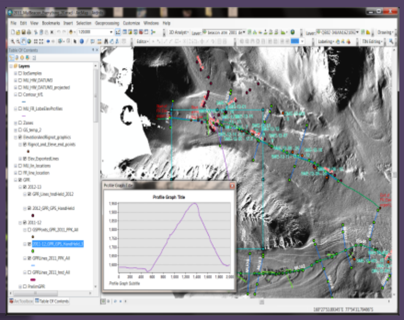
Operational Support

- Access to satellite imagery
- Provide guidance on sample locations
- Plan traverse locations
- Highlight key areas to avoid with seasonal snow cover
- Data transfer and communications support

Digital Image Analysis Laboratory (DIAL)

STEM Data Synthesis & Analysis

- Analyze raw data from field
- Return finished products
  Processing radar data
- LiDAR point cloud synthesis
- Meteorological data analysis
- Geospatial analysis: samples

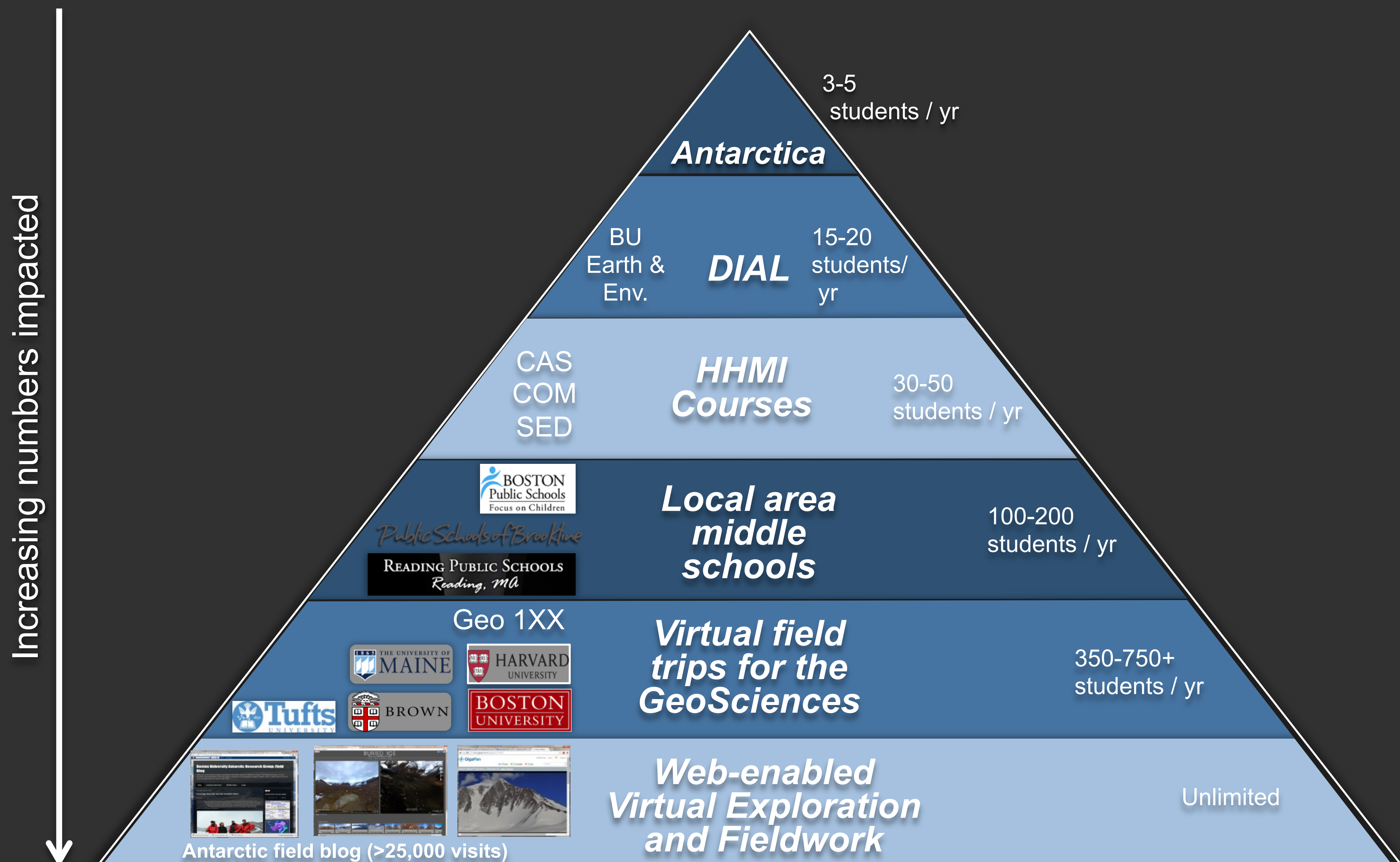


play

Fall 1	Spring 1	Summer 1	Fall 2


HHMI-BURECS 2015
www.burecs.com

Program Reach and Scalability



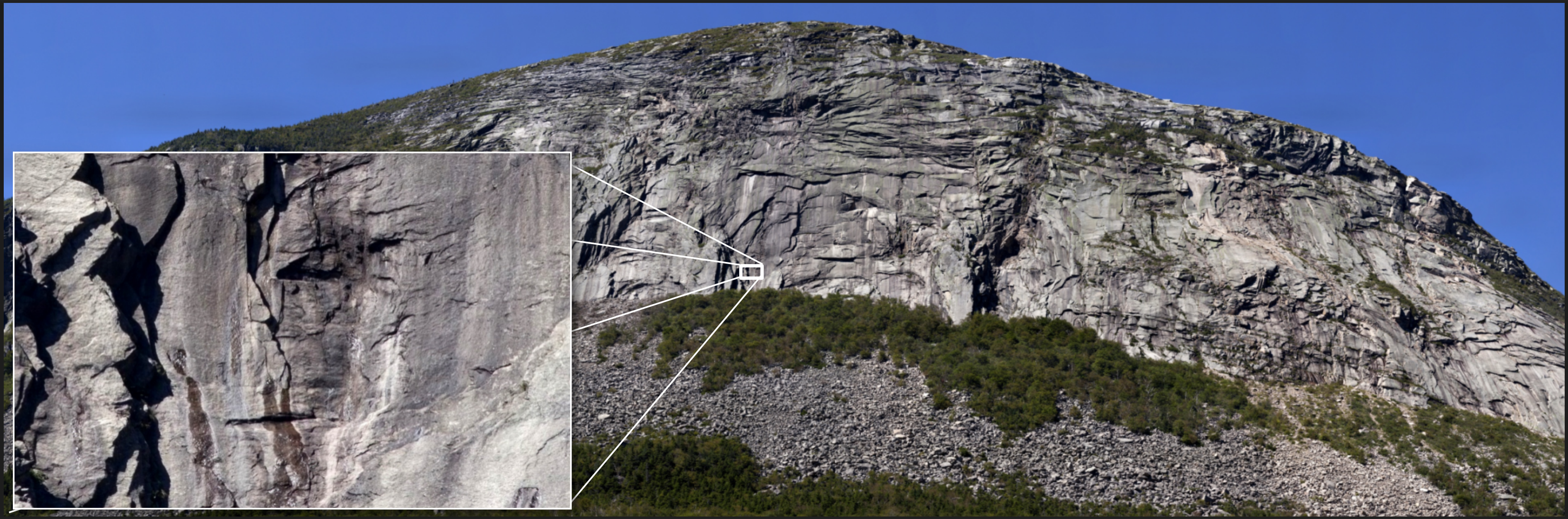
All products archived on a dedicated BU HHMI website: BURECS.com

Virtual Fieldwork: Extension Beyond Antarctica

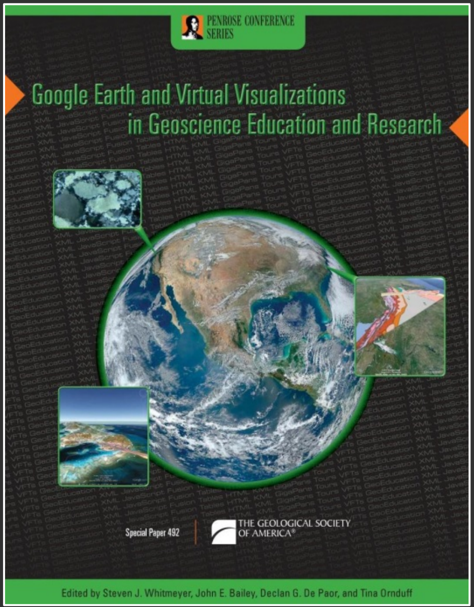
An ever expanding tool for teaching geosciences

It has long been known that the best geoscience education includes a significant fraction of fieldwork, but fieldtrips across the country have been greatly reduced in scope due to financial and logistical concerns. The impact is greatest in introductory courses, where the large numbers of students make it financially untenable to travel… from Penrose Conference on Geoscience Education, 2012

Expansion of digital products to local field sites: University Geo Labs



Basic considerations for virtual lab development



2012, Google Earth and Virtual Visualizations in Geoscience Education and Research: Google Earth and Virtual Visualizations in Geoscience Education and Research, v. 492, p. 1-468.

Context	Class Level Pre-requisite skills Pre-requisite knowledge
Goals	Conceptual goals Critical thinking Technical skill improvement
Assignment	Present a problem Propose hypotheses Collaborative work Produce tangible product
Data	Geologic maps High-resolution imagery Ice core data Meteorological data Excavation data
Assessment	Content comprehension Critical thinking Technical skills Pre- and post-activity surveys Comparison with control groups

Outcomes and Assessments

Outcomes

HHMI Elements	**Observational** Experimental Field-based Virtual fieldwork	**Quantitative** Mathematics Statistics Geophysics Geochemistry	**Graphical** GIS Web design Multimedia	**Conceptual** Integrate observations & theory	**Communicative** Verbal Written Multimedia	**Collaborative** Interdisciplinary teamwork Peer-to-peer teaching	**Ethical** Societal impacts Integrity
Seminar							
Lab Course							
Internship							
Field Research							

Assessments

Capitalize on faculty research in assessment strategies within the School of Education and College of Communication

- Pre- and post-participation surveys
- Evaluation of products by CAS, SED, and COM collaborating faculty
- Focus group interviews
- Content and network analyses of social media
- Graduate research in assessment, media use, and media effects, BU's Emerging Media Studies
- Track and analyze student retention in STEM and science education/communication
- Evaluate efficacy of virtual exploration in 1XX level course at BU and university partners; compare to control groups

Assessment Strategy

Capitalize on faculty research in assessment strategies within the School of Education and College of Communication. In addition utilize assessment strategy for collaborative GK-12 GLACIER grant.

1. Pre- and post-participation surveys for HHMI participants and control groups addressing science literacy, interest in science, expectations of program, and program outcomes.
2. Evaluation of products, reports, and presentations by faculty collaborators in CAS, COM, and SED.
3. Focus group interviews with student workgroups, and other combinations of students.
4. Content and network analysis of student social media use across the period of the program.
5. Proposed MS/PhD thesis work in focused areas of program (assessment, media use, media effects) for BU's graduate program in Emerging Media Studies
6. Analyze student retention in STEM disciplines and science education/communication at BU, and beyond, and compare to control groups; track progress beyond duration of award.
7. Evaluate efficacy of the digital media produced as part of this program (virtual fieldwork and exploration) in 1XX level courses in natural sciences at BU and in partnering schools; compare to control groups.