The University of Arizona and Biosphere 2: Partnering for the Advancement of Science

Biosphere 2
Property History

- 1800s
  Samaniego's CDO Ranch
- 1920s
  Dr. Lackner's homestead
- 1950s
  Countess of Suffolk's Casa del Oro
- 1960s
  Motorola Conference Center
- 1970s
  UA Conference Center
- 1984
  Space Biosphere Ventures
- **1986**
  Biosphere 2 construction begins
- **1991-94**
  Human missions 1 and 2
- 1994
  Decisions Investment takeover of Biosphere 2 project
- **1996**
  Columbia University management of Biosphere 2
- 2004
  Columbia University departure, strategic realignment
- 2005
  Property taken to market
- **2007**
  New owner: CDO Ranching, development partners

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Biosphere 2 History—Missions

Sept. 1991 (2 years)
4 men, 4 women

B2 Earthscience
Preliminary Site-Use Plan

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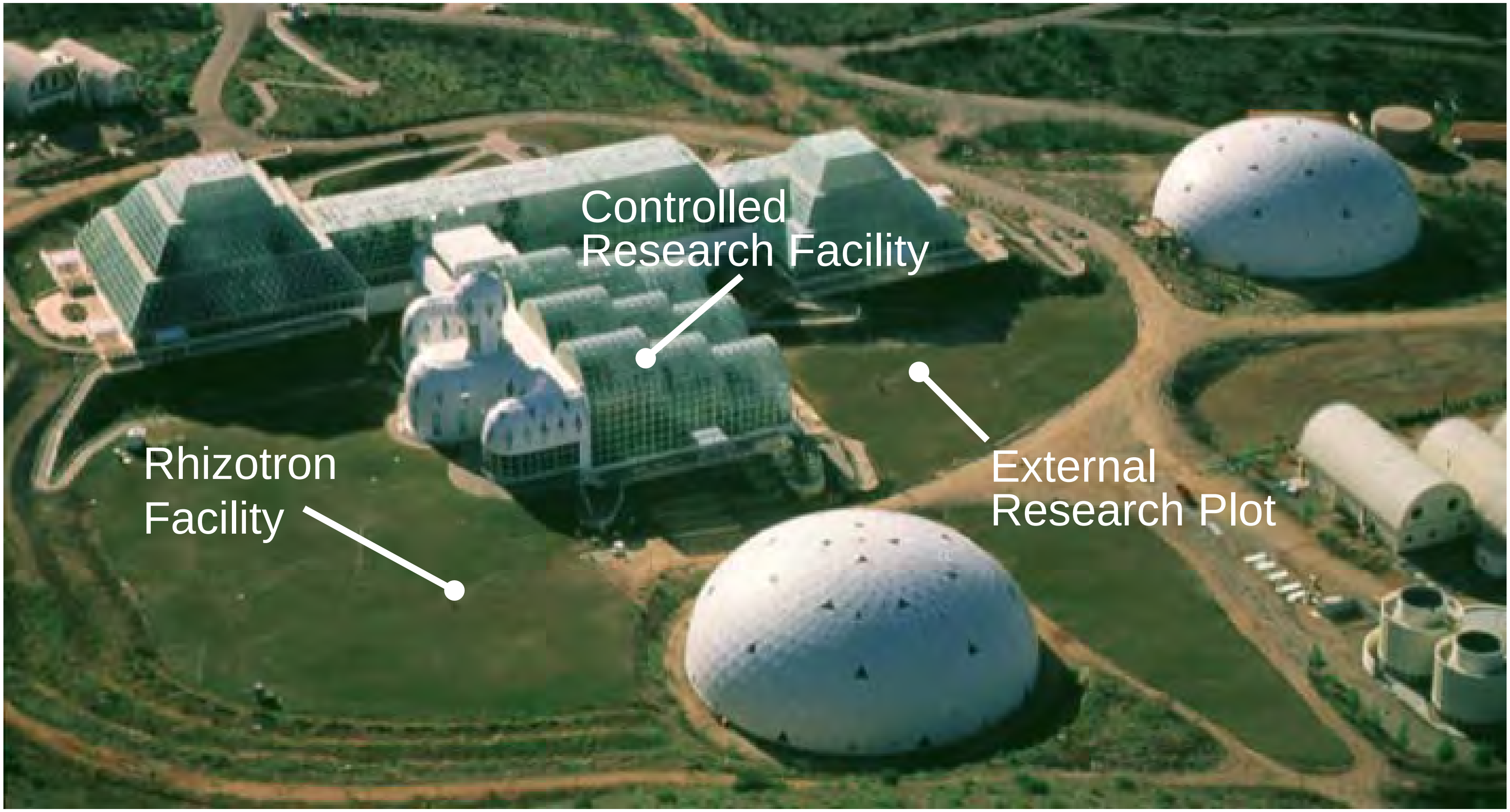

Biosphere 2
General Information

- **Biosphere 2 facility is 3.14 acres**
  - 91' high at its highest point
  - 6,500 windows and 7,200,000 cubic ft. of sealed glass
  - Sealed from the earth below by a 500-ton welded stainless steel liner
- **40-acre total campus area**
  - 300,000 square ft. of administrative offices, classrooms,
    labs, conference center, residential housing
- **2,300,000 visitors 1991-2007**
- **325,000 K-12 student visitors 1991-2007**

Budget

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7 M Operating Budget

2.5 M Gifts

2 M Visitors

2.5 Research

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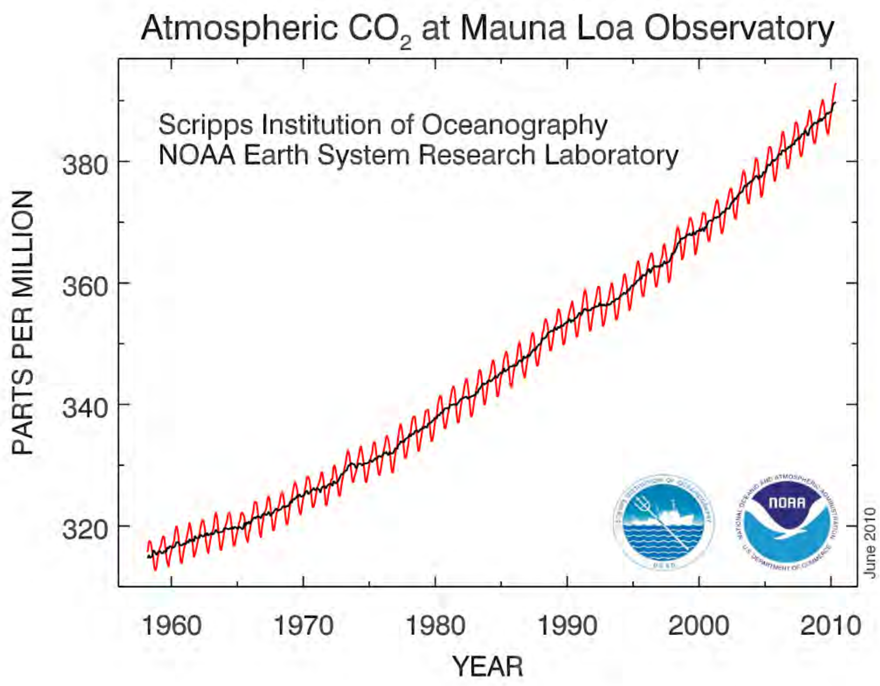
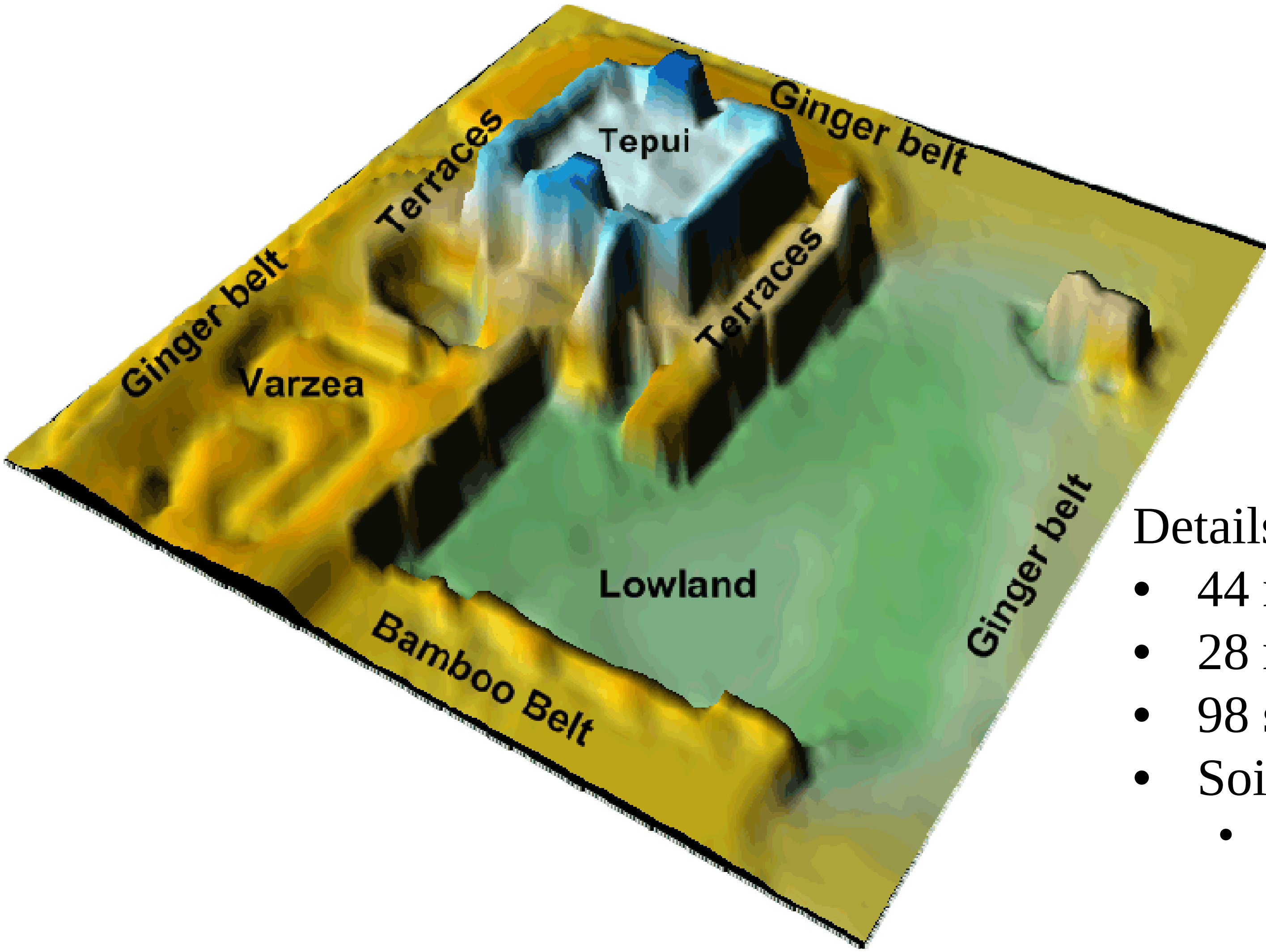
Biosphere 2—Columbia University

Biosphere 2—Ocean

- Effect of elevated atmospheric CO_2
  - high CO2 in atmosphere reduces pH in seawater
  - lower seawater pH reduces the rate of calcification and growth of corals and coral reefs



Rainforest



Details:
- 44 m x 4 m
- 28 m high
- 98 species
- Soil Depth range
  - 0.25 m to 4.5 m

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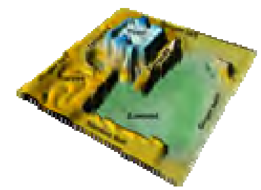
Rainforest

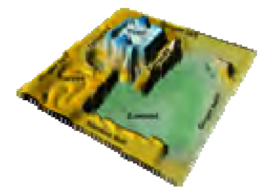


- <u>Experiment</u>: increase CO_2 concentrations from 380 to 820 ppmv in rainforest

- <u>Results</u>: carbon uptake increases linearly to 600 ppmv then stabilize

- <u>Implications</u>: Rainforest ability to store atmospheric carbon may diminish as atmospheric CO_2 concentrations exceed 600 ppmv

Rainforest



- <u>Experiment</u>: increase canopy temperature from less than 35 ^{0}C to greater than 42 ^{0}C

- <u>Results</u>: only some species can adjust their critical temperature; the variance may reflect physiognomy and physiology differences

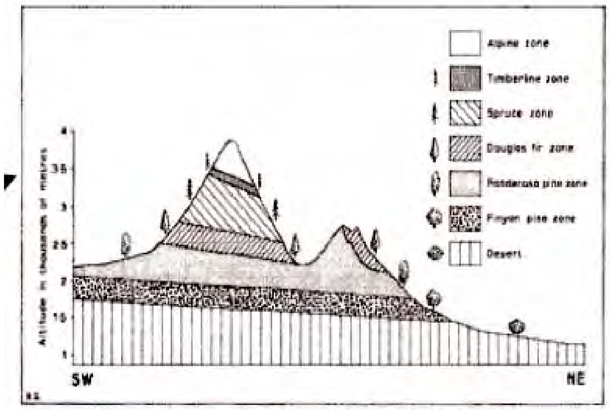
- <u>Implications</u>: results help predict species response to future warming

Biosphere 2—University of Arizona

The University of Arizona
Biosphere Research
Complex Major Experiment

A 3-tiered integrated matrix for addressing the fundamental research question:

"How do we scale change, from organisms to ecosystems?"



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Existing Research Programs

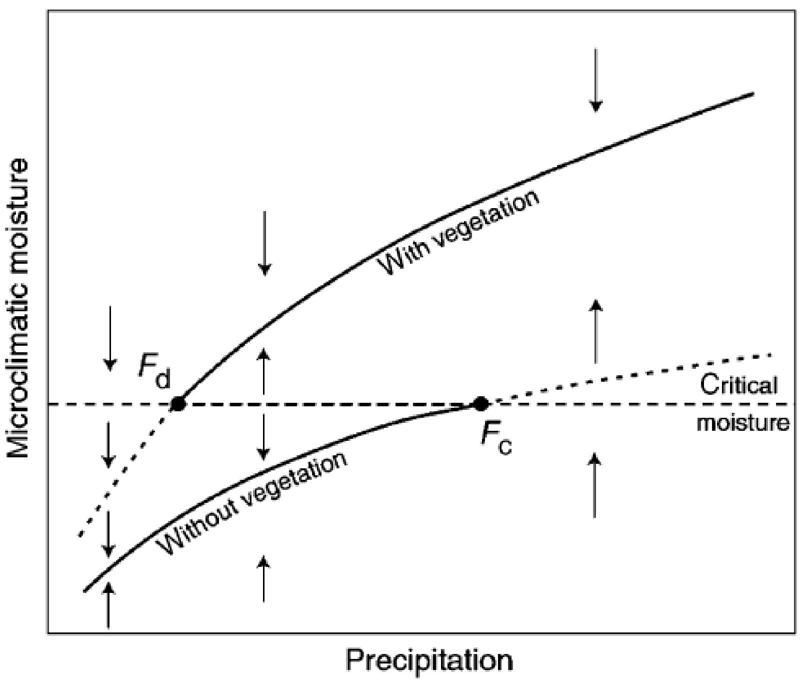
B2 Facility

B2 Mesocosm

<u>Degree of Control</u>

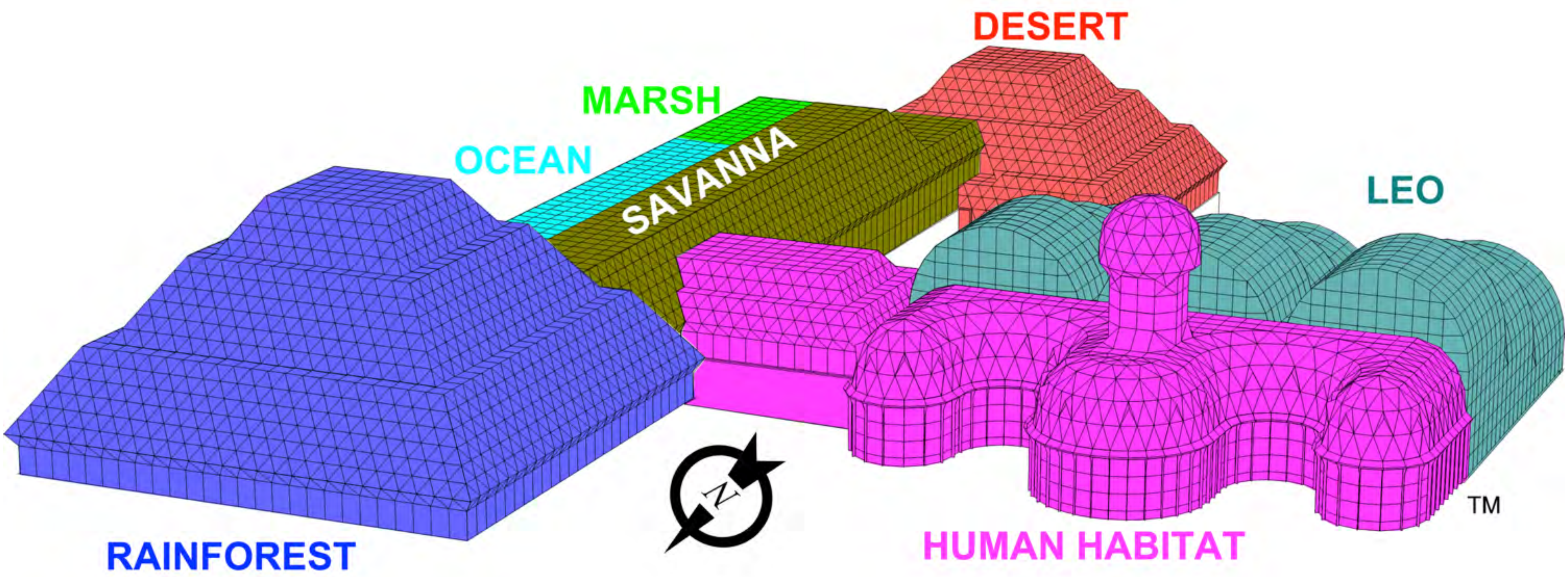
How does biology influence the way that landscapes work?

How does biology affect the way that climate affects patterns of water movement?



Biosphere 2 no longer sealed

- Decoupled into three regions
- Wilderness (Rainforest, ocean, savanna, desert)
- Habitat (Offices, laboratories, public outreach
- LEO (former agricultural area)



Rainforest—What is the future of Amazon forests under climate change?

Adding instrumentation

- Above
- Below
- Spatially

Stress the System

- Drought—approximately 70 days
- Hold all other conditions constant

B2 Earthscience
Research Program Organization

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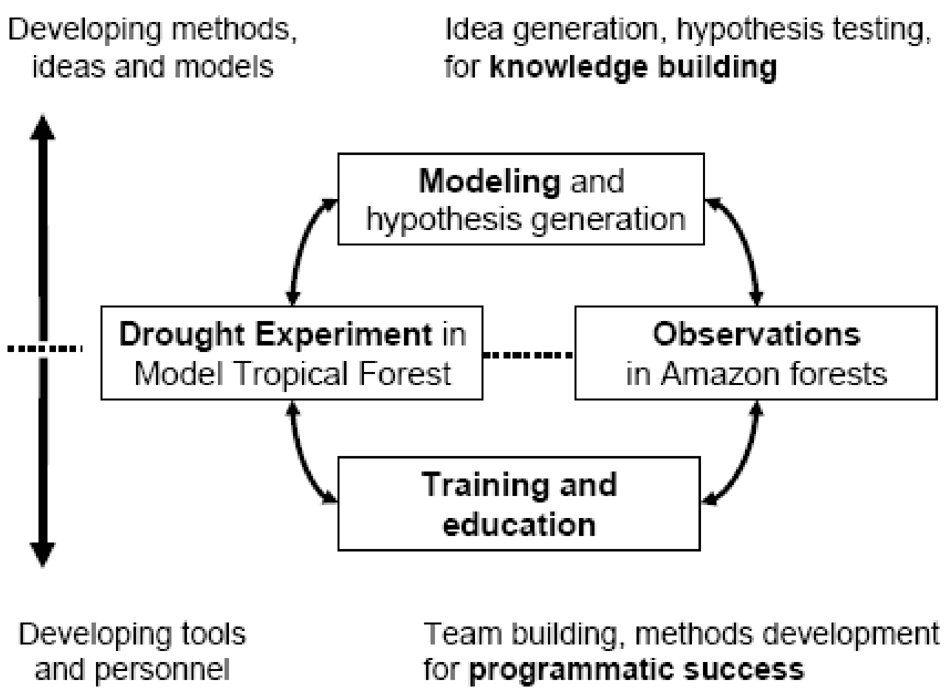
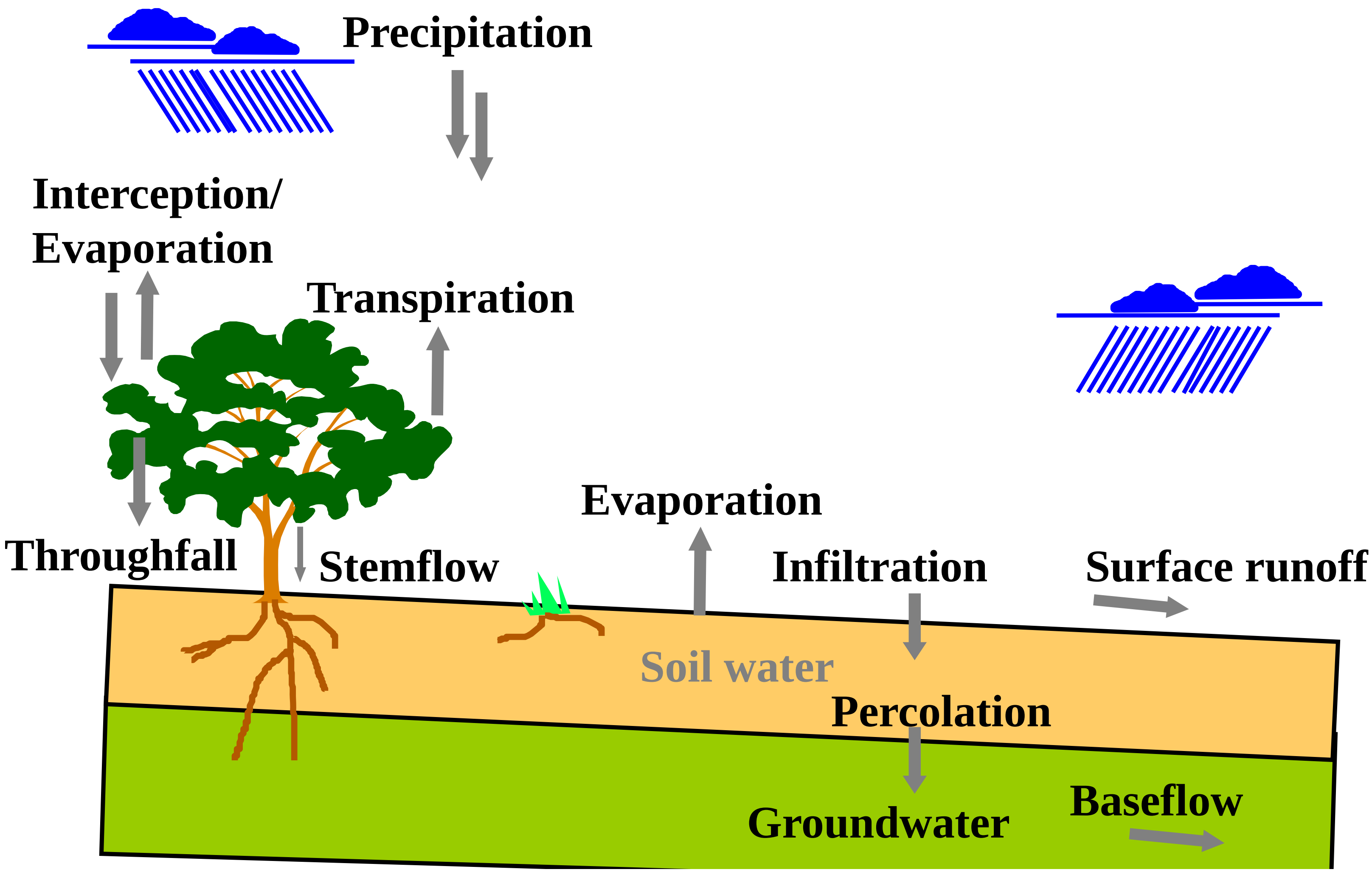
– Integration of modeling and experimentation
– Iteration between natural and experimental settings
– Test-bed for instrument development
– Developing ideas, methods, tools, and personnel to do 'big science'



Where does all the water go?
How does biology muck up the dynamics



Model Landscape – Experimental Hillslope

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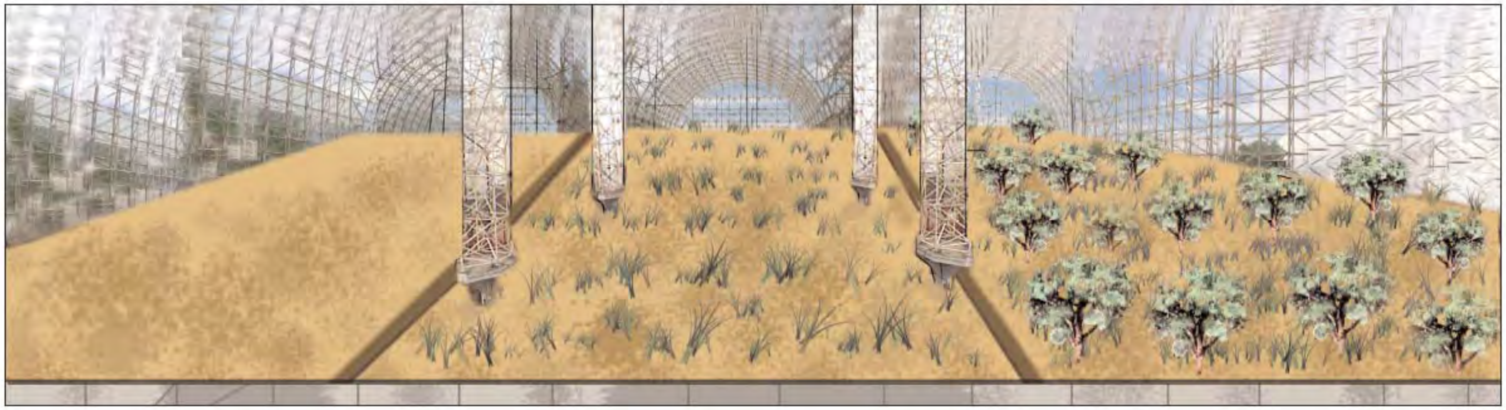

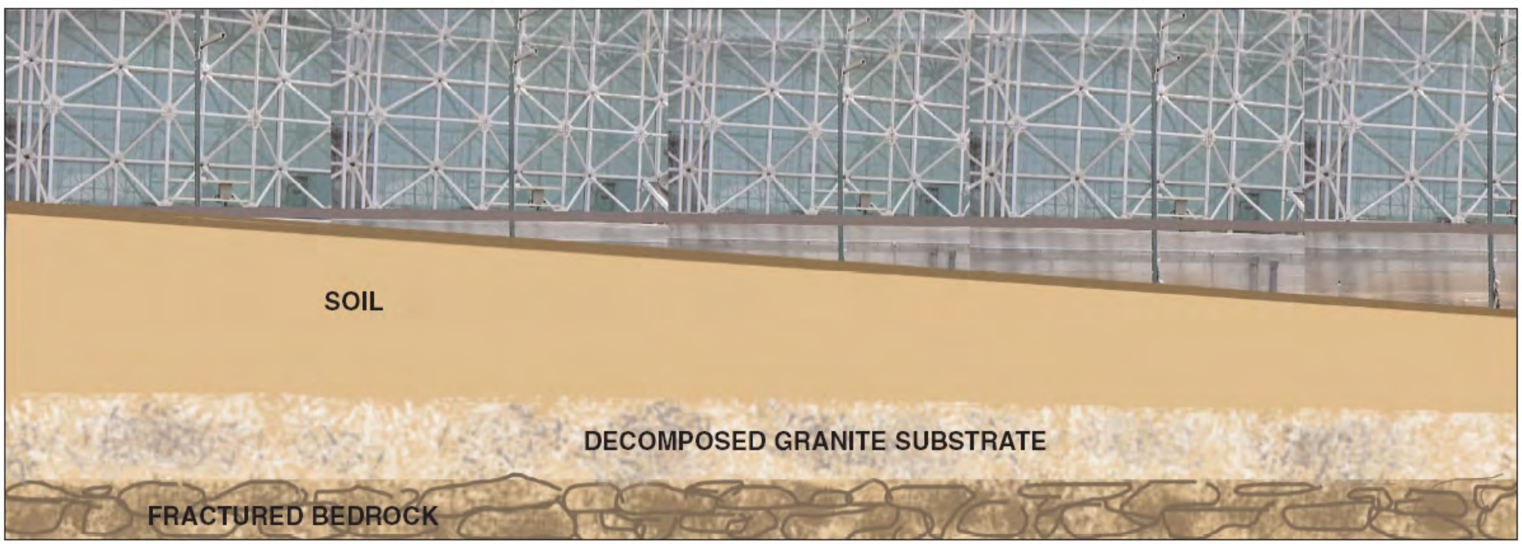

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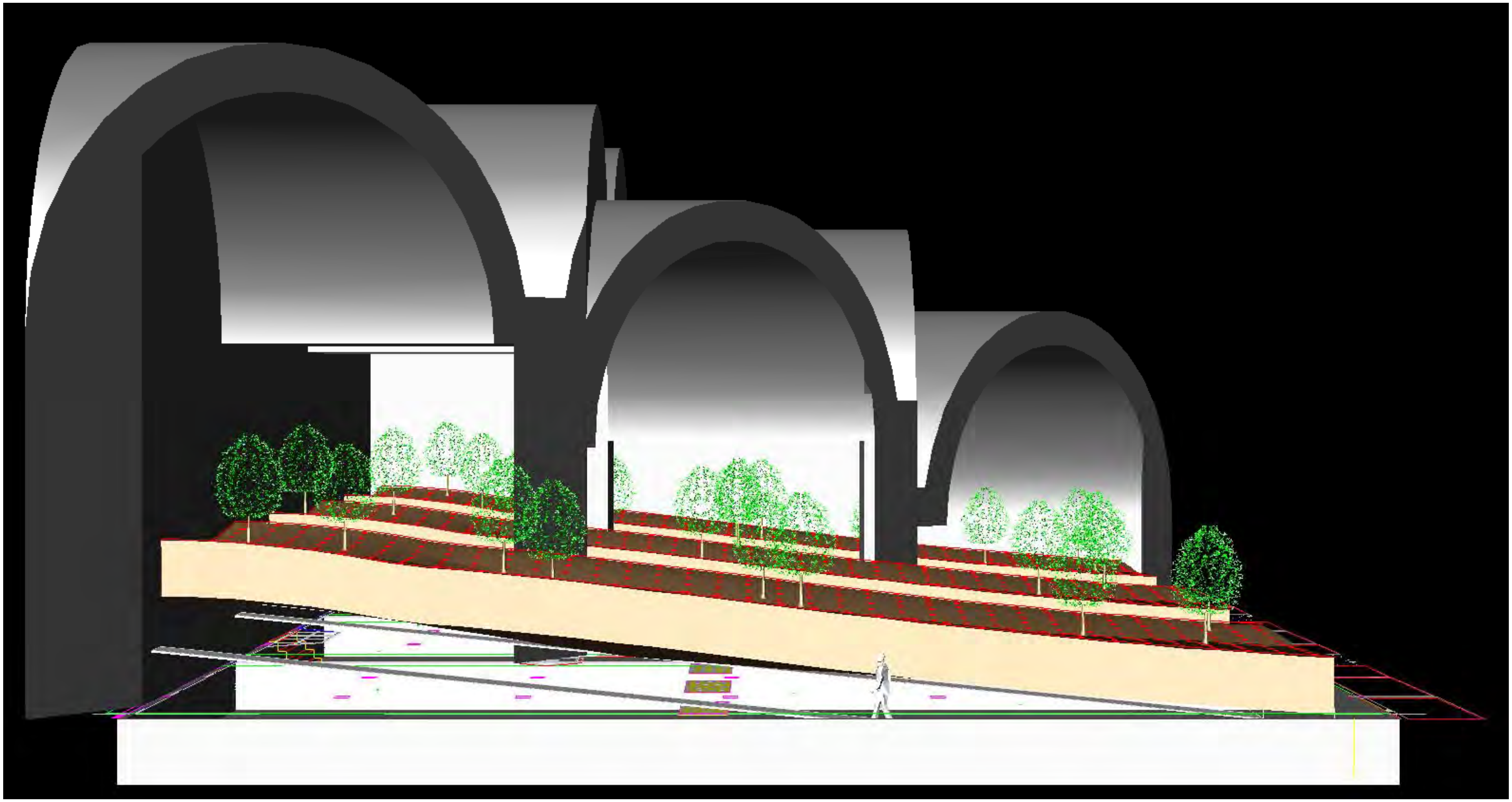
A new scaling tool



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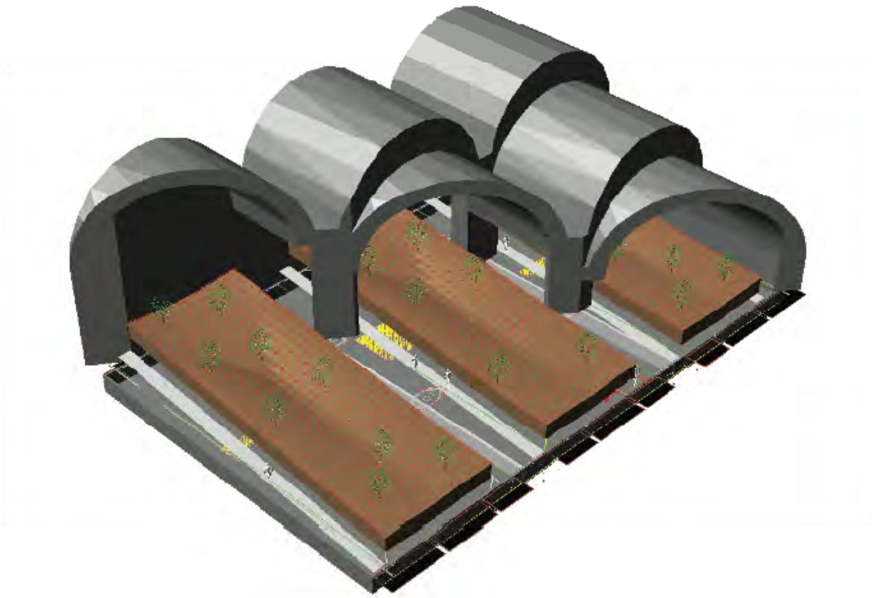

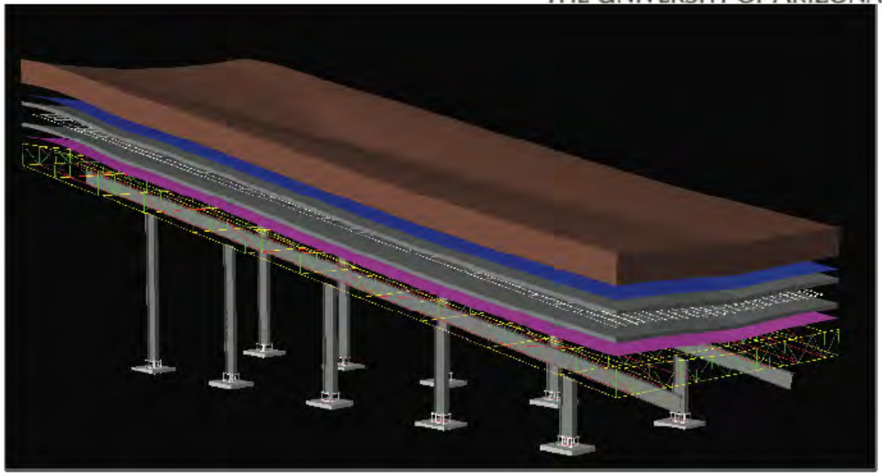

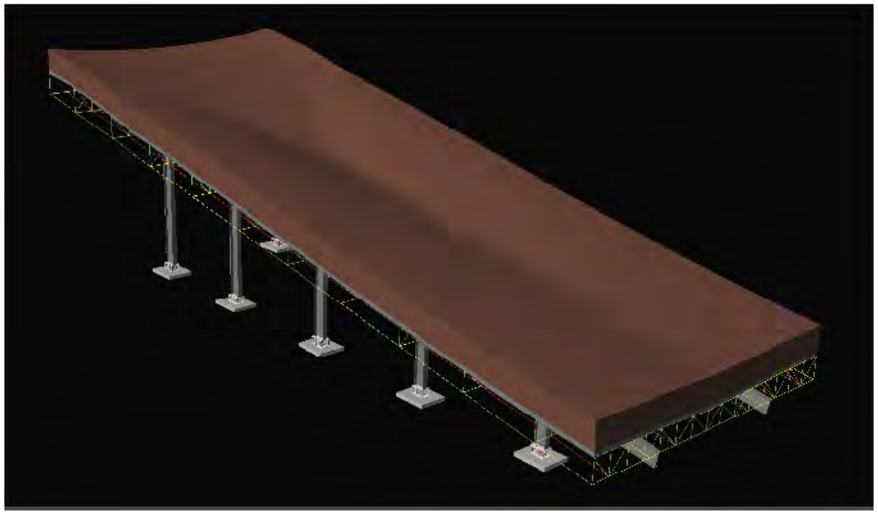

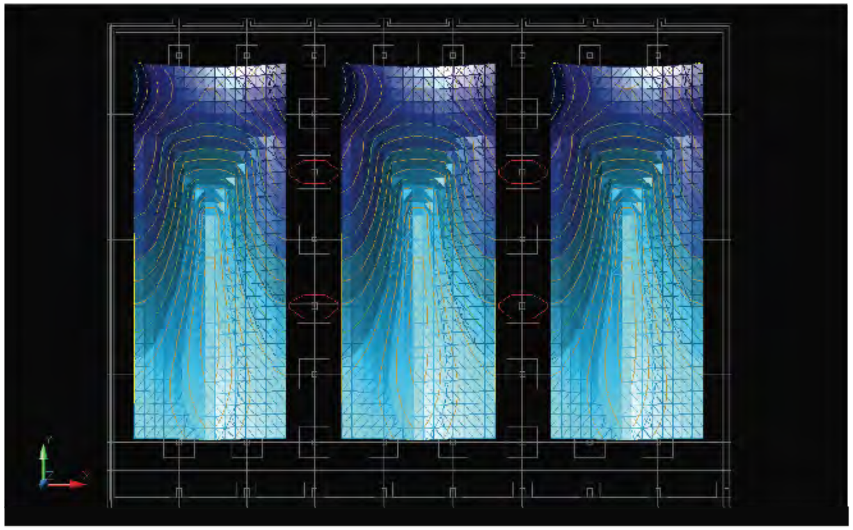

Biosphere 2

With over 100,000 visitors annually, Biosphere 2 continues to be one of Arizona’s top attractions. This 40-acre facility campus just north of Tucson serves as a center for research, outreach, teaching and learning about Earth and its living systems.

B2 Earthscience
Core Mission

B2 Earthscience blends research, education, and outreach to build

Concepts observations and theory

Tools facilities, methods, models, experiments

Teams future scientists and educators

Translational Framework stakeholder relationships and dissemination

to guide society toward sustainability and resilience in the face of global environmental change.

B2 Institute
Grand Challenge

Global Warming

- How much inertia does the climate system hold with respect to past anthropogenic forcings?
- Can biological feedbacks to warming, through conservation efforts, offset some climate warming?
- Are there thresholds of forcings that result in abrupt climate change, and can anthropogenic inputs of greenhouse gases approach those thresholds?
- What is the optimal distribution of adaptation versus mitigation efforts for society in the face of different climate scenarios?
- In the event of run-away warming, can bioengineering save life on the planet?

B2 Institute
Grand Challenge

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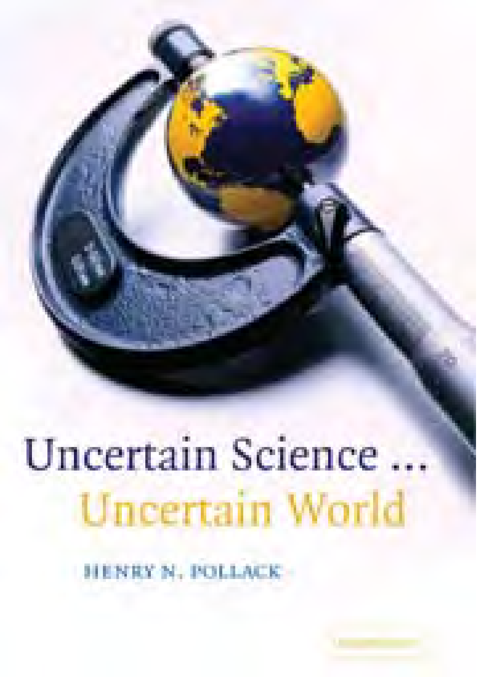
Global Environmental Change

- What are the large-scale human impacts on the global environment?
- Can we identify, estimate, communicate and cope with
  uncertainty in the science of the global environment?
- Which elements of our understanding are most crucial in generating uncertainty (how good does a measurement have to be)?
- How can we evaluate and quantify uncertainties in the Earth System?
- How can we inform scientific and scholarly colleagues of these uncertainties, across disciplines?
- How can we communicate them in a clear, timely and useful way to all levels of decision-makers?



B2 Institute
Tackling The Grand Challenges

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The work needed to address these challenges requires the collaboration of:

- Climatologists, atmospheric chemists, and physicists
- Biologists, chemists, and microbiologists
- Ecologists
- Systematic biologists and epidemiologists
- Medical doctors
- Physical and biological oceanographers
- Glaciologists and hydrologists
- Geologists, geophysicists, and geochemists
- Materials scientists
- Statisticians, economists, and demographers
- As well as scholars of non-linear dynamics, the news media, and government

Biosphere 2
Residential and Visitor Housing

Biosphere 2
Classrooms