
THE UNIVERSITY OF ARIZONA
Biosphere 2

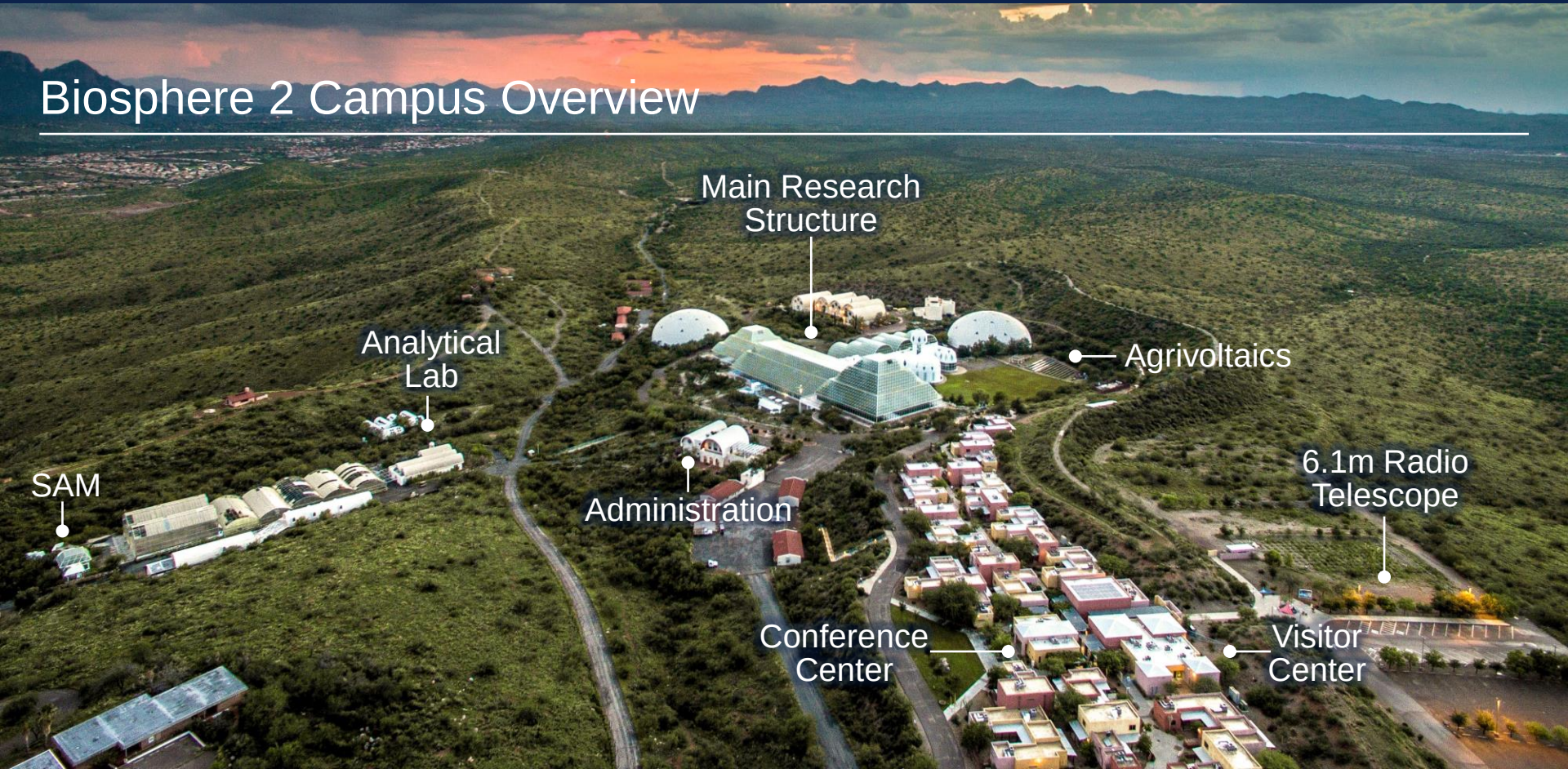

THE UNIVERSITY OF ARIZONA
Biosphere 2

Image Credit: NASA

Facility assets

- – 7,200,000 cubic ft. of sealed glass
- – 40-acre total campus area
- – 300,000 square ft. of administrative offices, classrooms, labs, conference
- – center, housing
- – 2,800,000 visitors 1991-2015

Biosphere 2 Campus Overview

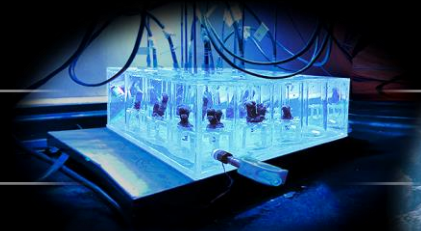


System Complexity vs. Ability to Control Environmental Factors

Degree of Control or Manipulation

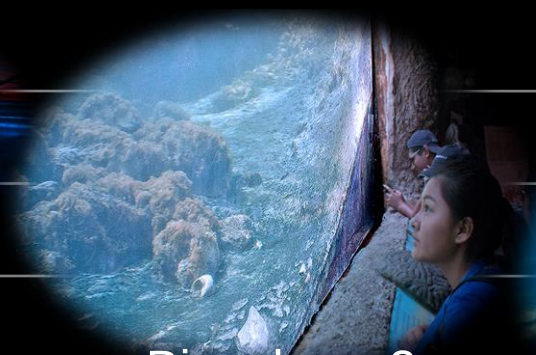
High Control

Low Control



Mesocosms

Highly controlled biological and physical science spaces



Biosphere 2

B2 ecosystems and Landscape Evolution Observatory

Observatory Programs

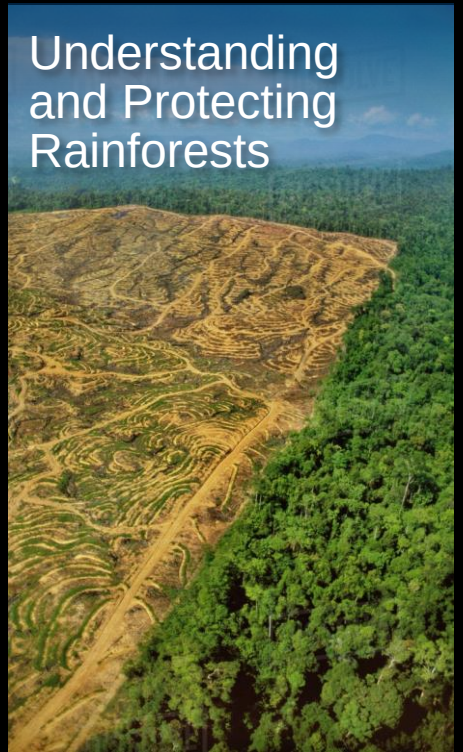
Measurement networks in the natural environment

Smaller Scale

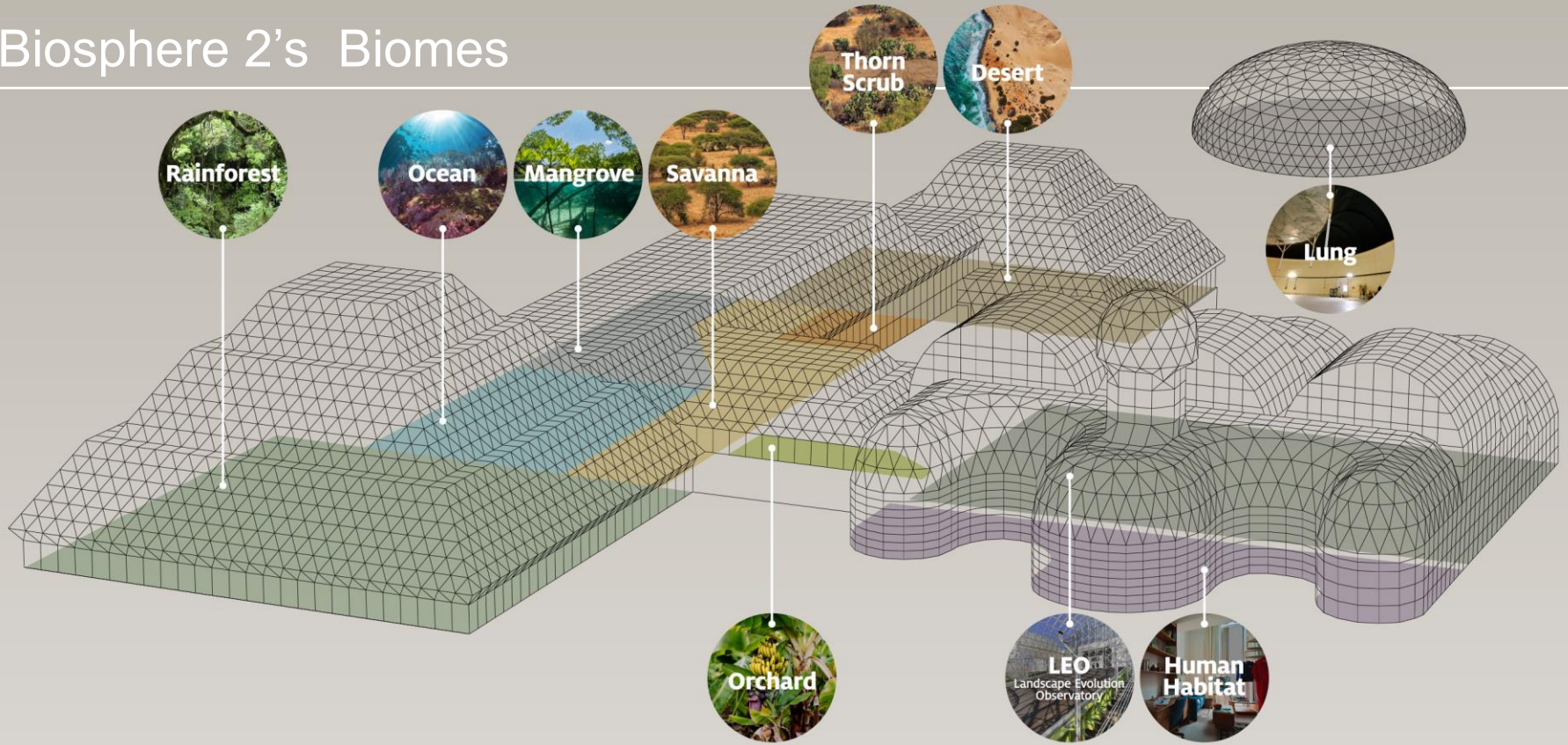
Larger Scale

Spatial, Temporal and Climatic Scale in Natural Ecosystems

Biosphere 2: Addressing Multiple Grand Challenges



Biosphere 2's Biomes



Biosphere 2: Addressing Multiple Grand Challenges

Ocean

What are the impacts of global climate change on our oceans and our planet?

Rainforest

What is the future for rainforests under climate change?

Food and Energy

How can we better assure global food and energy security?

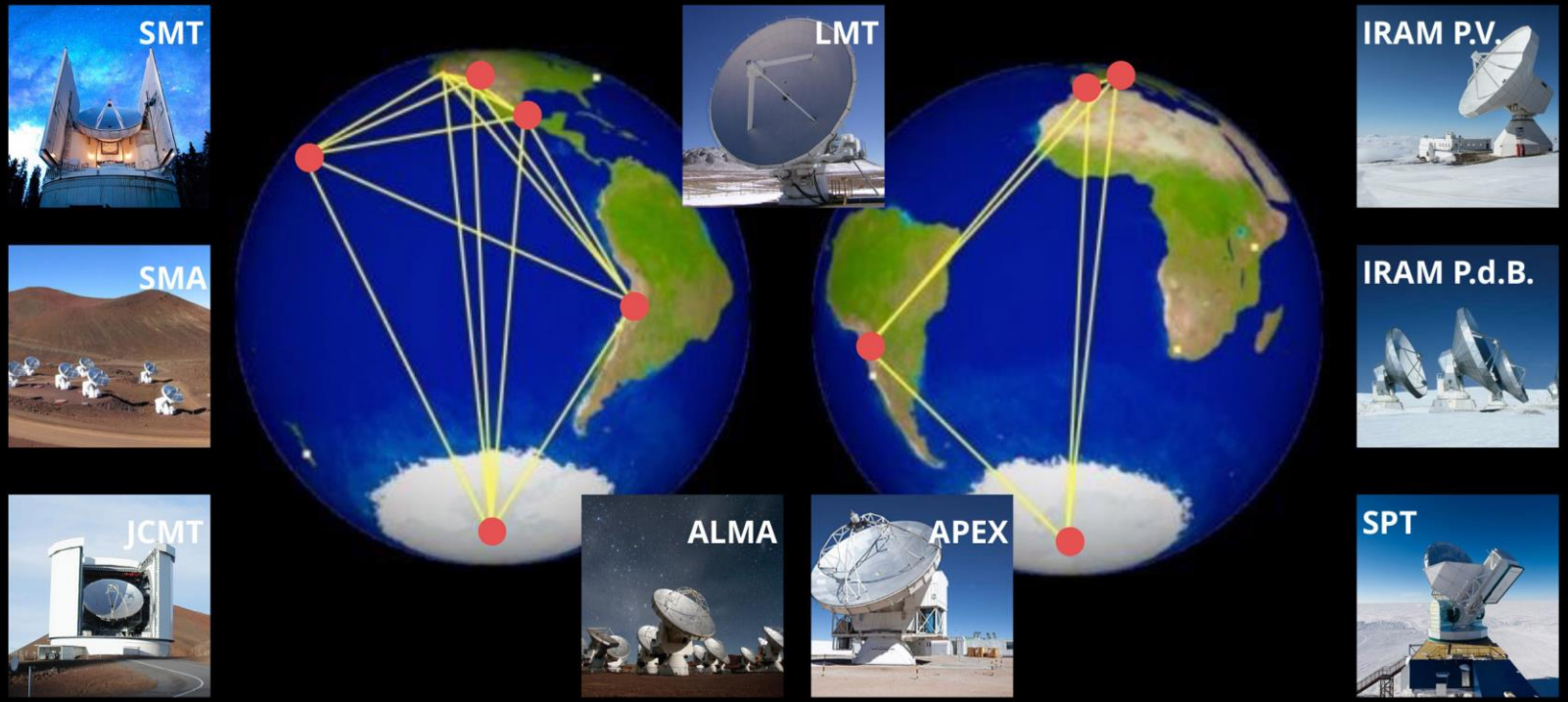
Co-locating vegetation + renewable energy = food, energy, and water benefits


THE UNIVERSITY OF ARIZONA
Biosphere 2
POWERED BY

THE UNIVERSITY OF ARIZONA
Biosphere 2

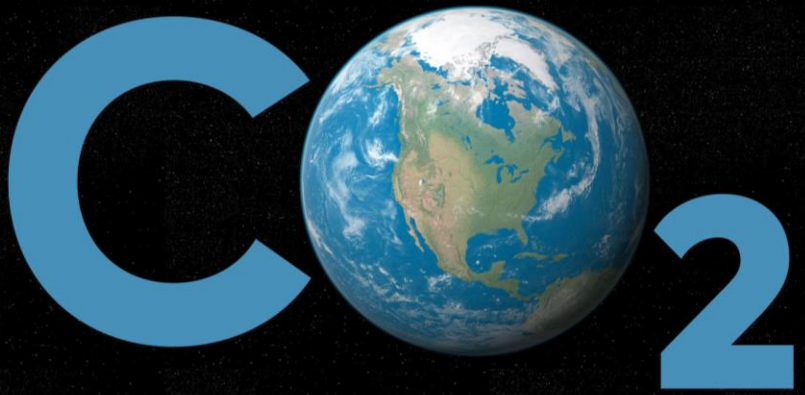
Biosphere 2
Resiliency Observatories Consortium

Our Proposal: A Global Network of Biosphere 2s

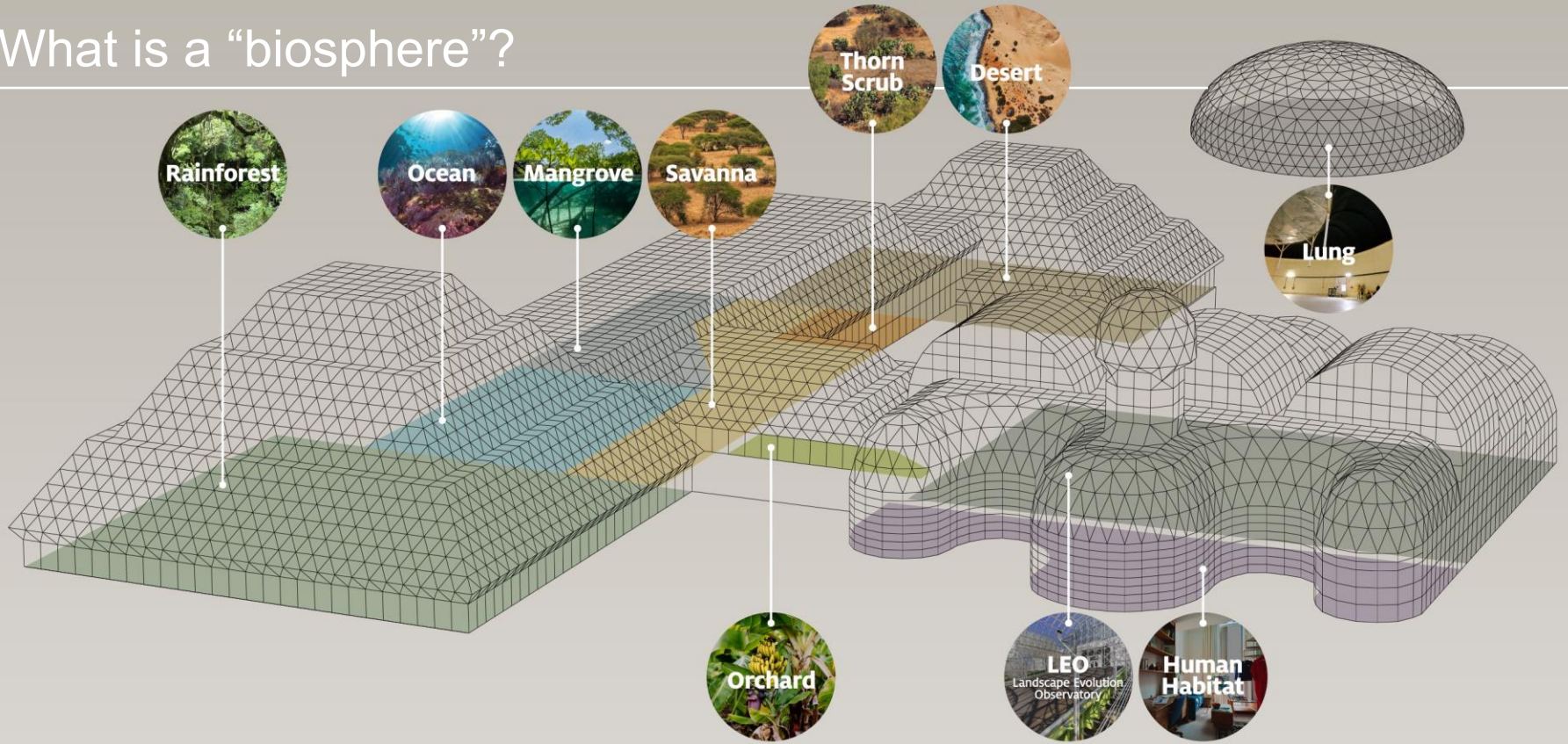


A Sustainable Framework That Can Make a Difference

This Observatory Consortium could make the needed measurements to establish a more equitable system of carbon credit valuation.



What is a “biosphere”?



A Biosphere 2 in Sweden

Implementation: An Inclusive Global Network


EXPLORE
MOON to MARS

THE UNIVERSITY OF ARIZONA
Biosphere 2

Space Analog for the Moon and Mars (SAM)

Biosphere2.org

THE UNIVERSITY OF ARIZONA
Biosphere 2

Space Analog for the Moon and Mars (SAM)

Biosphere2.org

Biosphere 2 Campus Scale

System Complexity vs. Ability to Control Environmental Factors

Degree of Control or Manipulation

High Control

Low Control

Mesocosms

Highly controlled biological and physical science spaces

Biosphere 2

B2 ecosystems and Landscape Evolution Observatory

Observatory Programs

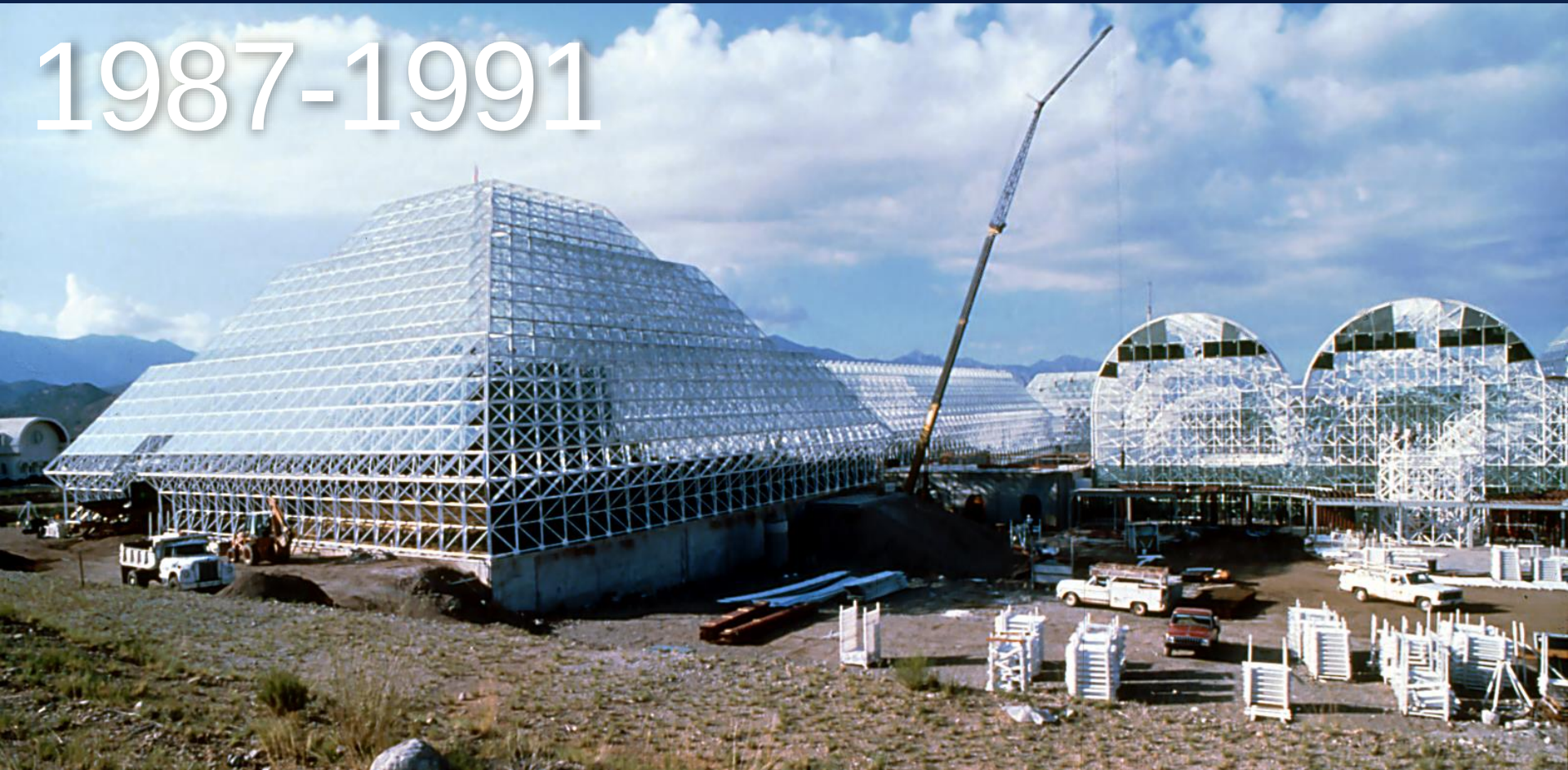
Measurement networks in the natural environment

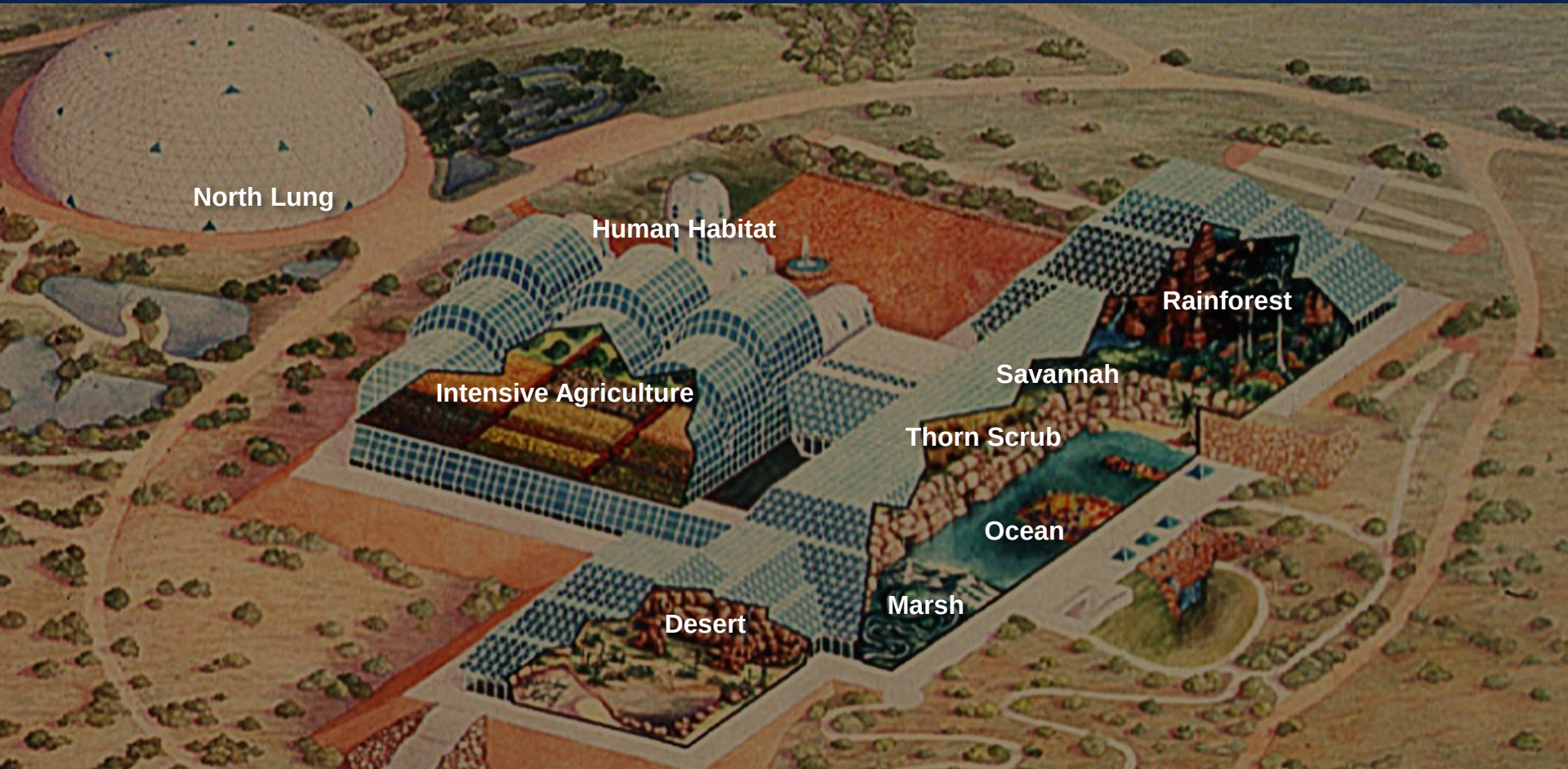
Smaller Scale

Larger Scale

Spatial, Temporal and Climatic Scale in Natural Ecosystems

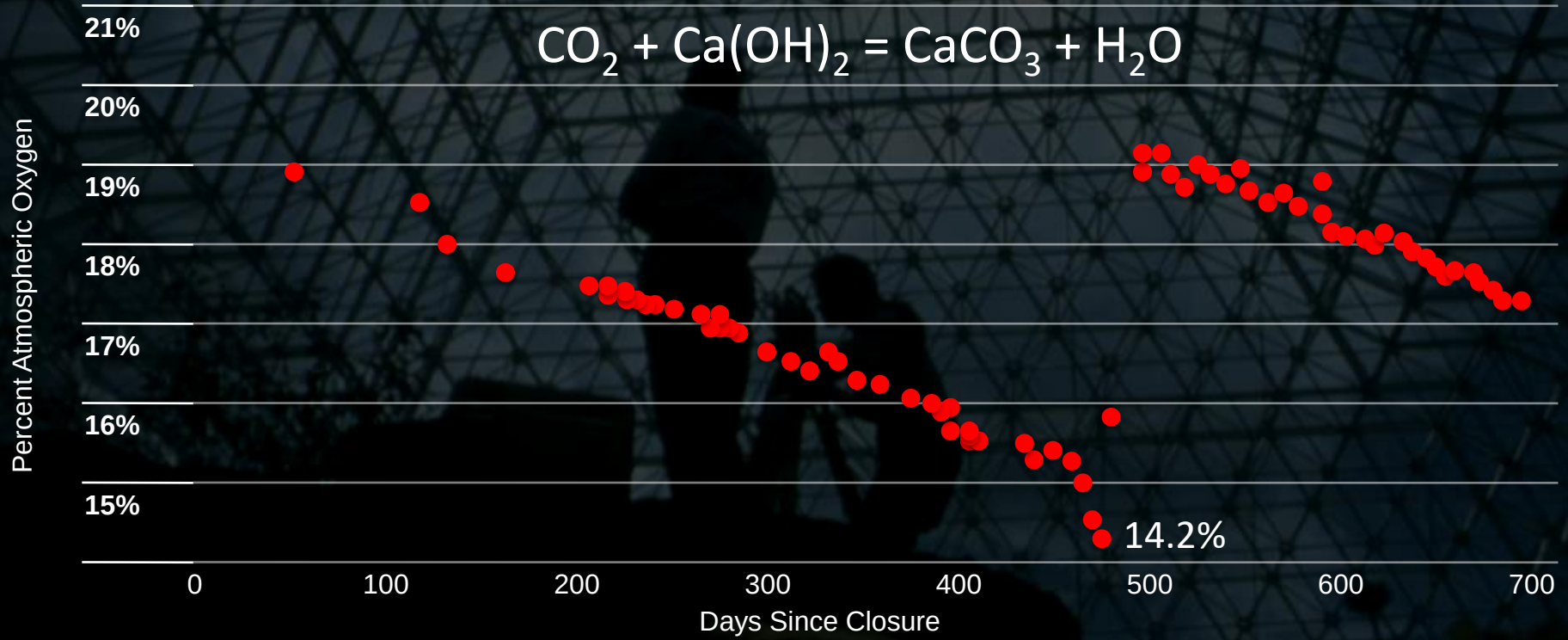
1987-1991




North Lung
Human Habitat
Rainforest
Savannah
Intensive Agriculture
Thorn Scrub
Ocean
Marsh
Desert

Oxygen Concentration in Biosphere 2

9/26/1991 through 8/26/1993



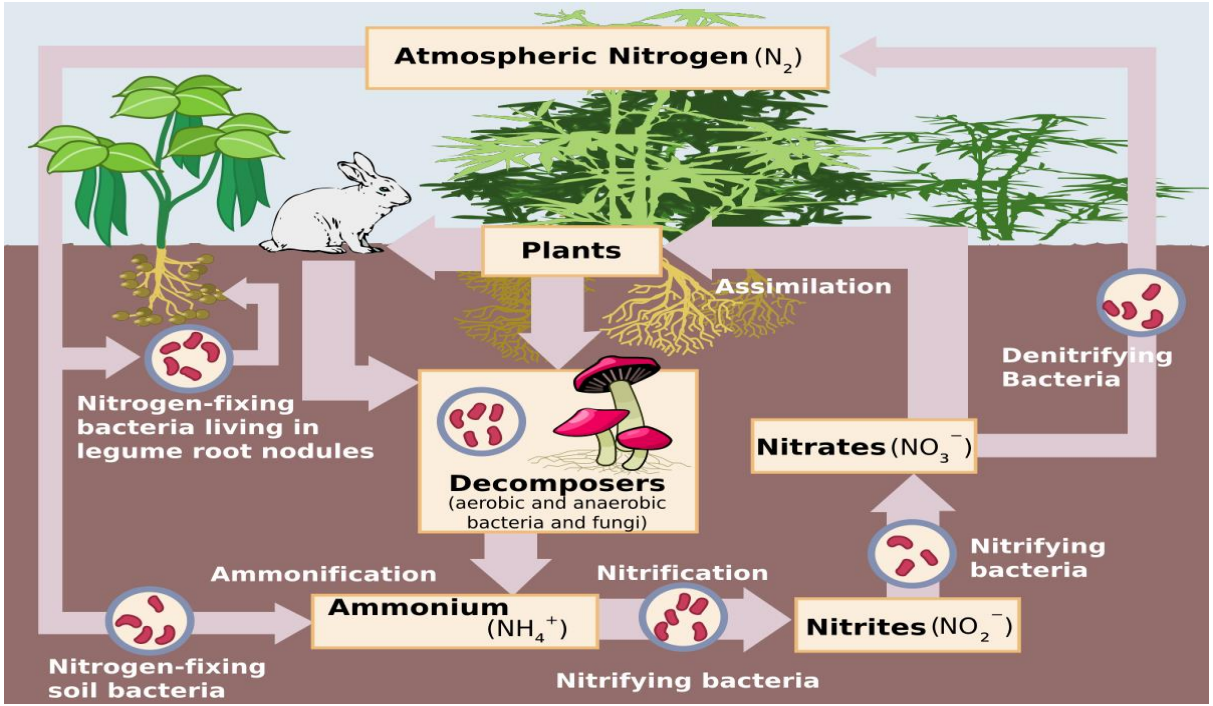
THE UNIVERSITY OF ARIZONA
Biosphere 2

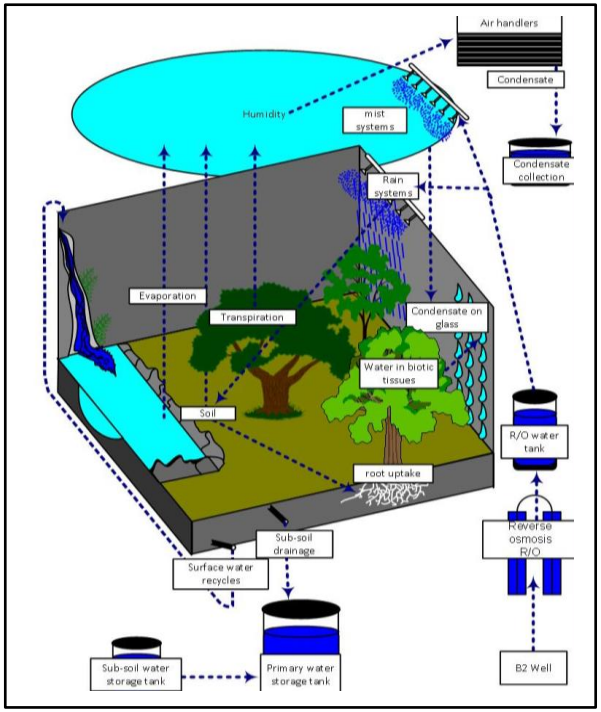
Space Analog for the Moon and Mars (SAM)

Biosphere2.org

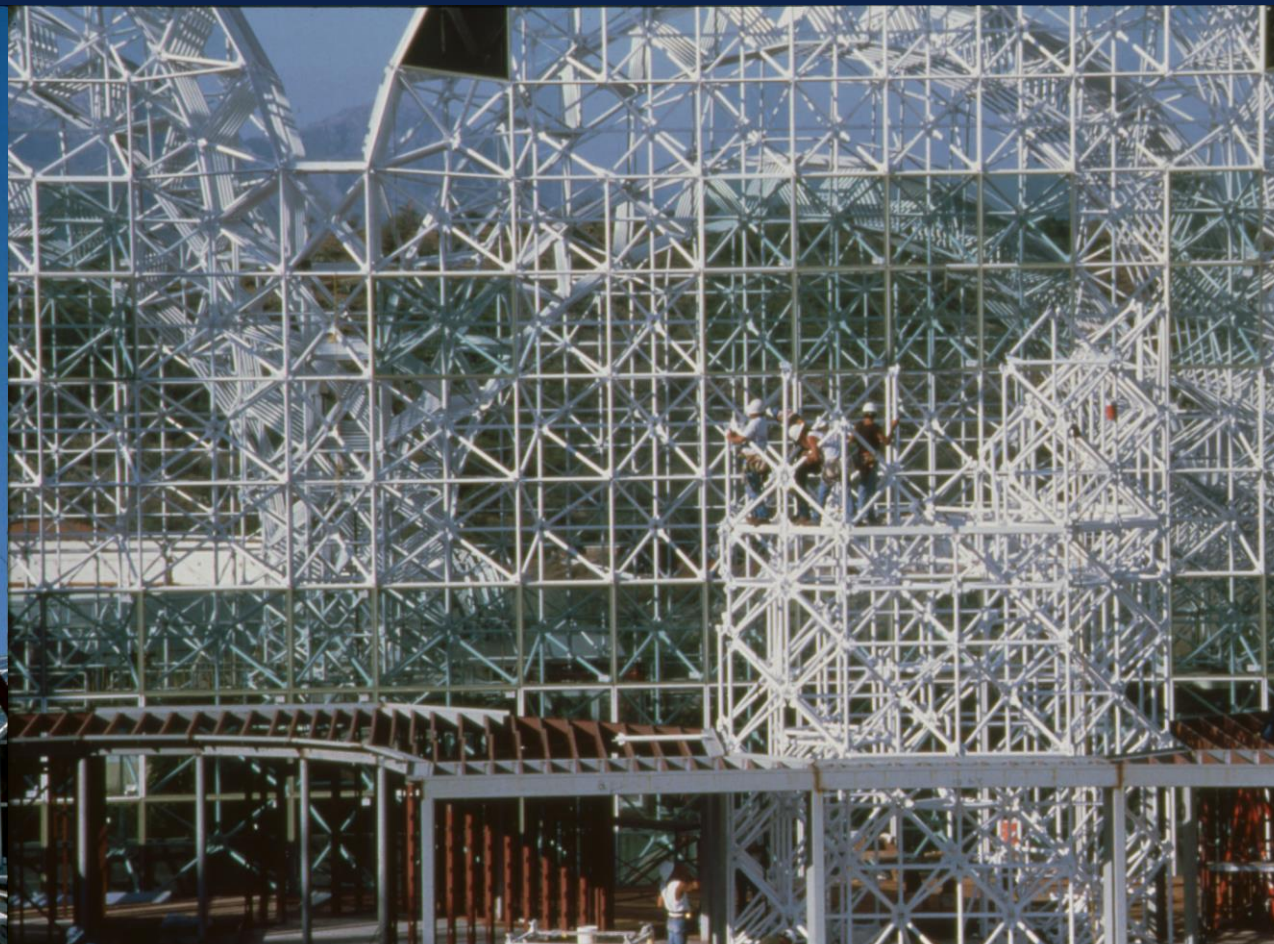
Earth Systems Science

$$6CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$$





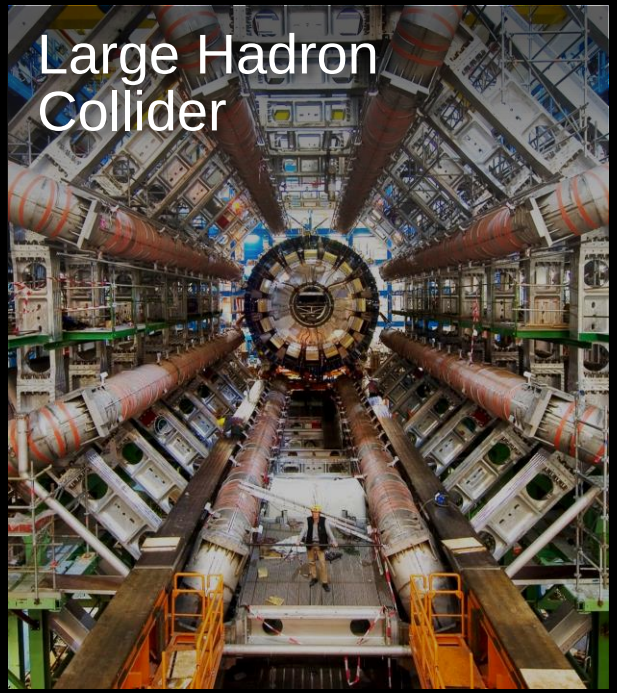
Construction

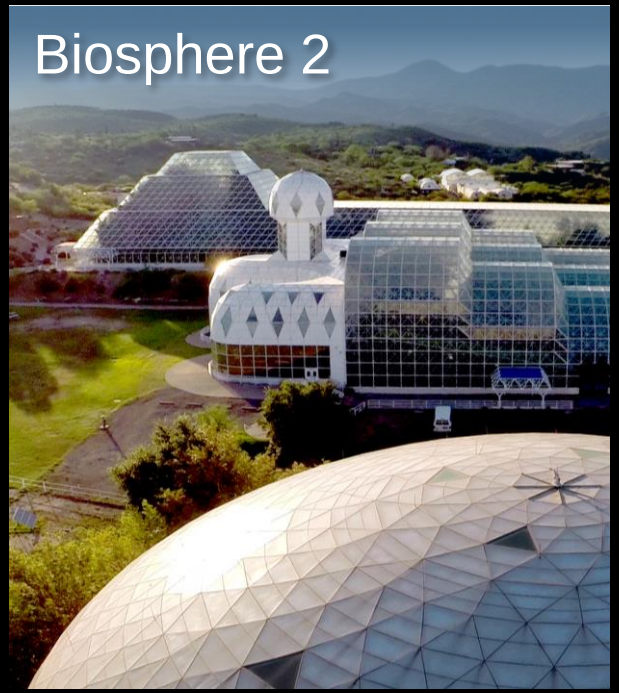


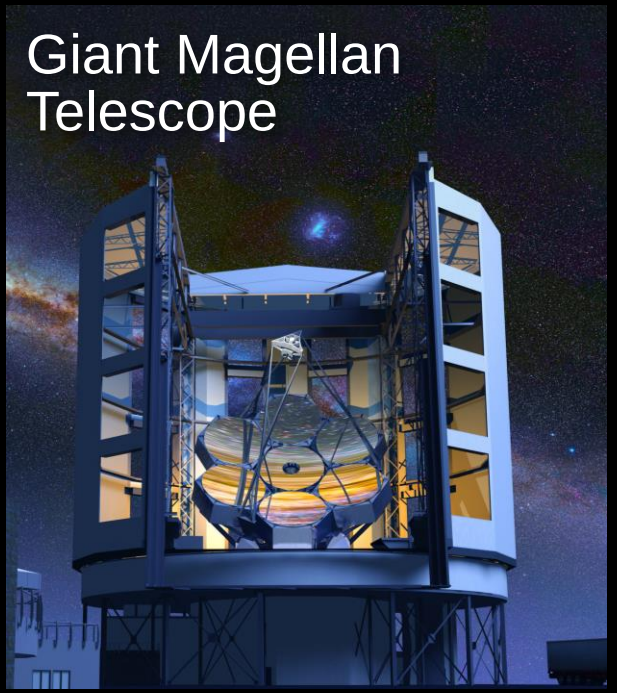
The First Human Mission

Four men and four women were sealed inside Biosphere 2 in September 1991. During the two-year mission, O_2 levels dropped by more than 25%.

The University of Arizona

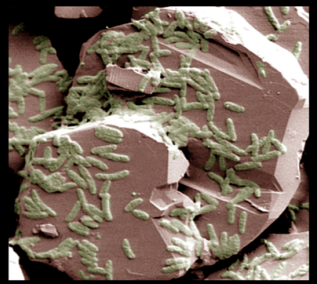




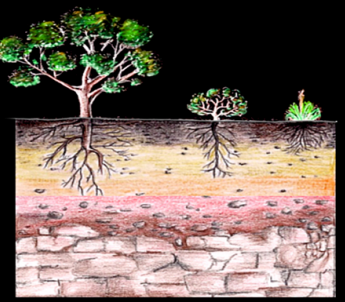


Biosphere 2: Addressing Multiple Grand Challenges

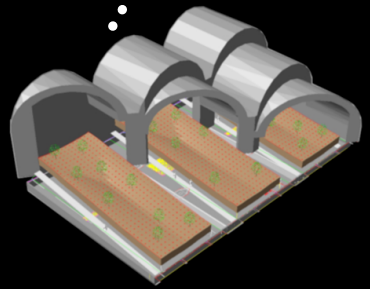
Hillslope hydrology



Microbial and plant colonization



Biogeo-weathering and ecosystem dynamics

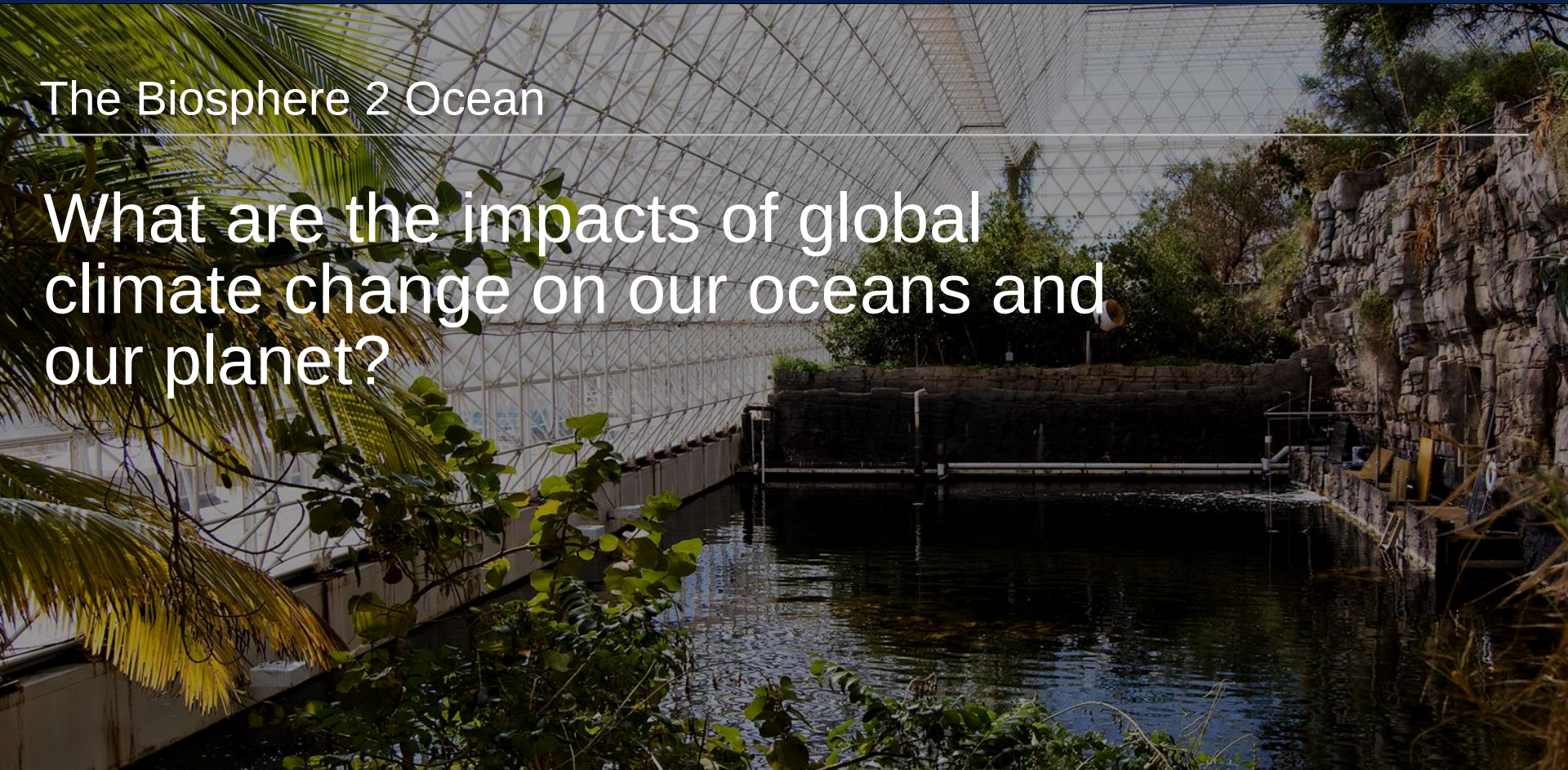


Surface/subsurface water flow paths and connectivity

Biosphere 2

Landscape Evolution Laboratory — LEO

How does water flow through the landscape?



The Biosphere 2 Ocean

What are the impacts of global climate change on our oceans and our planet?

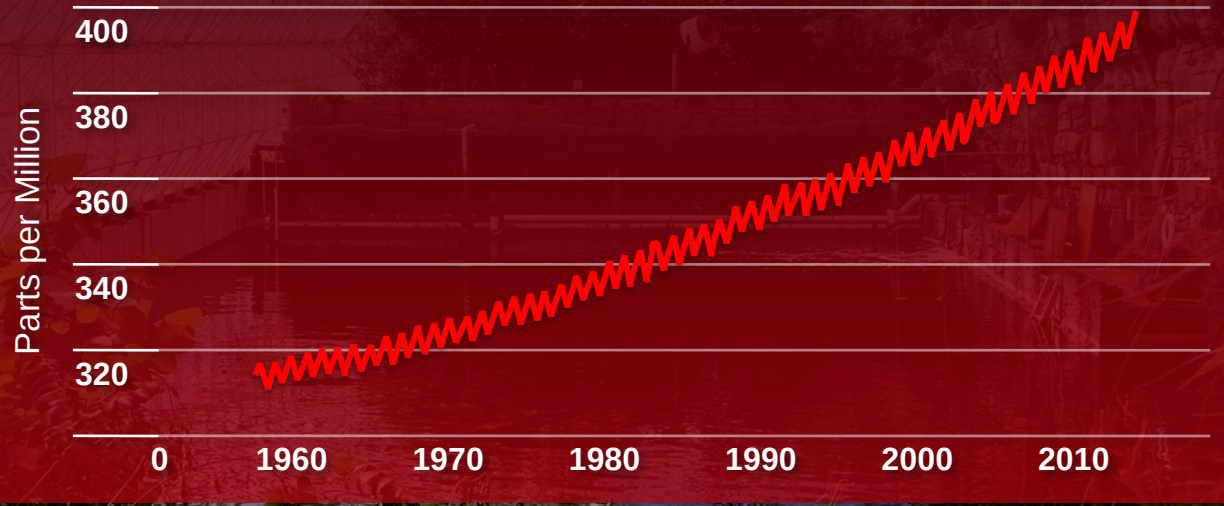
Effects of Elevated Atmospheric CO_2 in the Biosphere 2 Ocean

Reduced pH in seawater which reduces the rate of calcification and growth of corals and coral reefs.

Langdon C, Takahashi T, Marubini F, Atkinson MJ, Sweeney C, Aceves H, Barnet H, Chipman D, Goddard J (2000). Effect of calcium carbonate saturation state on the calcification rate of an experimental coral reef. Global Biogeochemical Cycles 14: 639-654

Langdon, C, Broecker W, Hammond D, Glenn E, Fitzsimmons K, Nelson SG, Peng TH, Hajdas I, Bonani G. 2003. "Effect of elevated CO2 on the community metabolism of and experimental coral reef." Global Biogeochemical Cycles 17(1): 11-1 to 11-14

Global Increase in Atmospheric CO_2



Source: R.F. Keeling, et al. Scripps Institution of Oceanography

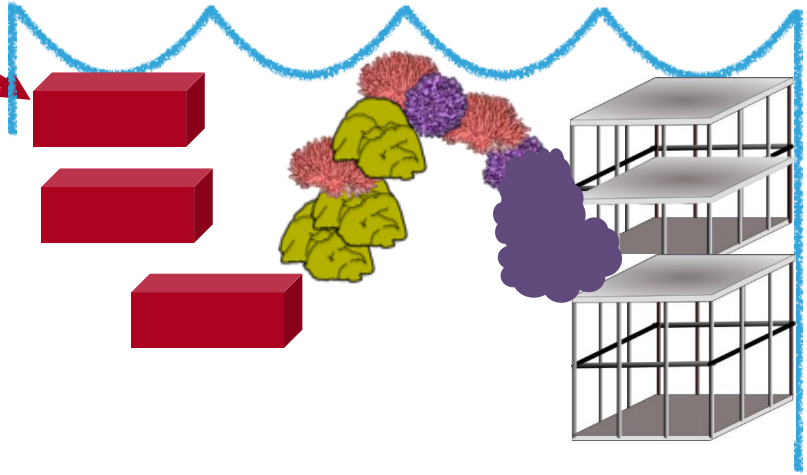
Ocean System—Phase 3 Engineering a Resilient Reef

A "FRANKIN-REEF"

PROBIOTIC & STRESS-HARDENING EXPERIMENTS

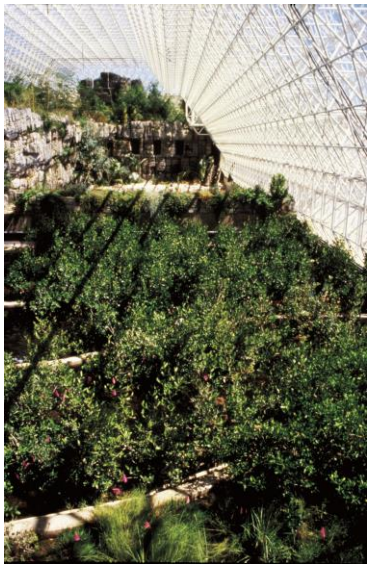
Life History Strategy	Competitive	Weedy	Tolerant
Representative species	*Acropora millepora*	*Pocillopora damicornis*	*Porites lobata*
Projected colony size (cm^2)	1500	1250	2000
Projected growth rate ($cm\ yr^{-1}$)	6.0	2.6	1.6
Spawning mode	broadcast spawner	brooder	broadcast spawner
Spawning frequency	annual	monthly	annual
Fecundity ($eggs\ col^{-1}$)	650,000	3000	1,400,000
Precompetency period*	3-5 days	1 day	3-5 days
Background adult mortality rate	moderate	high	low
Thermal sensitivity**	high	high	low
DHW range for mild bleaching	4-6	4-7	6-10
DHW range for moderate bleaching	6-8	7-10	10-12
DHW range for severe bleaching	8-12	10-13	12-14
DHW range for mortality	>12	>13	>14

* Temperature sensitive
** DHW values are estimated to show relative sensitivities; these values will be more precisely determined as part of the analysis



COMING TO B2O ~2024

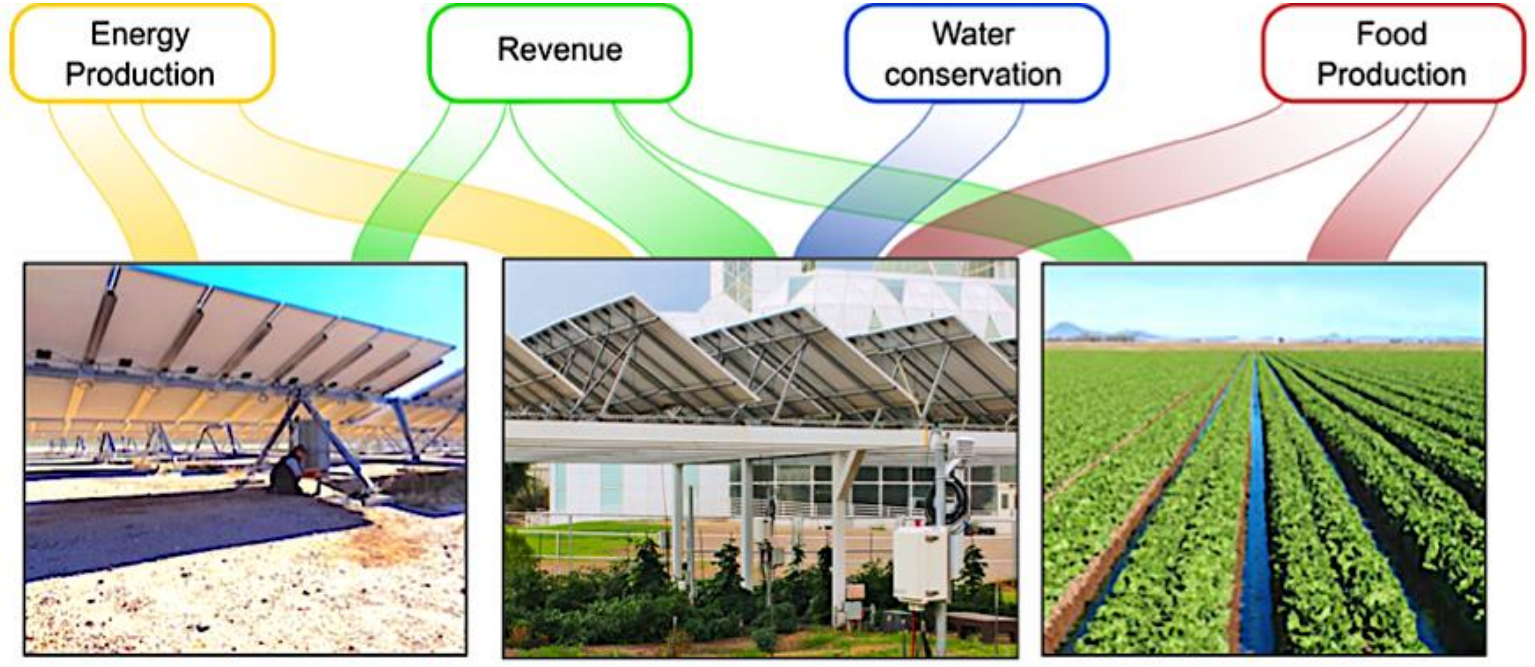
Mangrove System



- Southwestern Florida
- Block transplanted including sediment, plants, Microbes and animals
- Red, Black and White mangroves
- Salinities range 20-32 PPT


BIOSPHERE 2 | WATER ATMOSPHERE AND LIFE DYNAMICS
WALD

Co-locating vegetation + renewable energy = food, energy, and water benefits



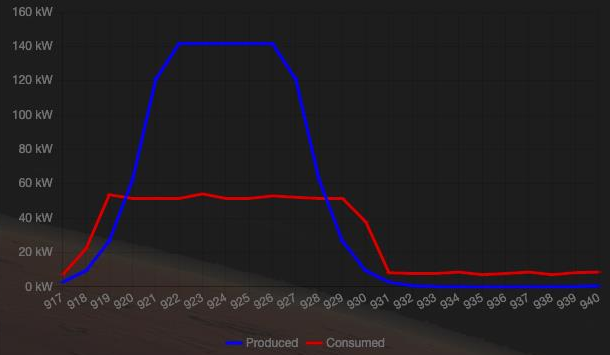
International Collaborations

- ARAVA Valley, southern Israel
- CNRS
- Mexico
- UM6 Morocco
- Sweden

Greenhouse Configuration

Free Space · Wheat · Cabbage · Strawberry · Radish · Red Beet · Onion

Energy Production / Consumption



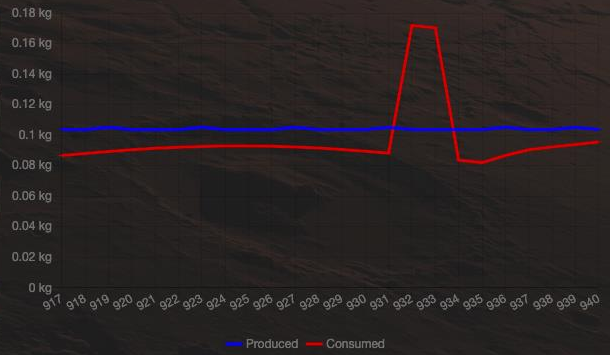
Storage Levels

Air Storage 1	
Oxygen (O_2)	671.268767 kg
Carbon dioxide (CO_2)	3.463951 kg
Nitrogen (N_2)	2684.1375 kg
Methane (CH_4)	0.172428 kg
Free hydrogen (H_2)	0.000261 kg
Water (H_20) vapor	31.396042 kg
Water Storage 1	
Potable	2554.107968 kg
Urine	0.390938 kg
Waste (carries feces)	0.43775 kg
Treated	6.33 kg
Nutrient Storage 1	
Biomass (edible, inedible)	106.20163 kg
Nitrogen	99.757956 kg

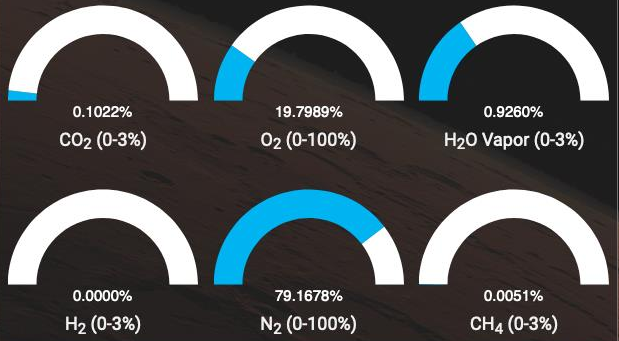
Inhabitants Status

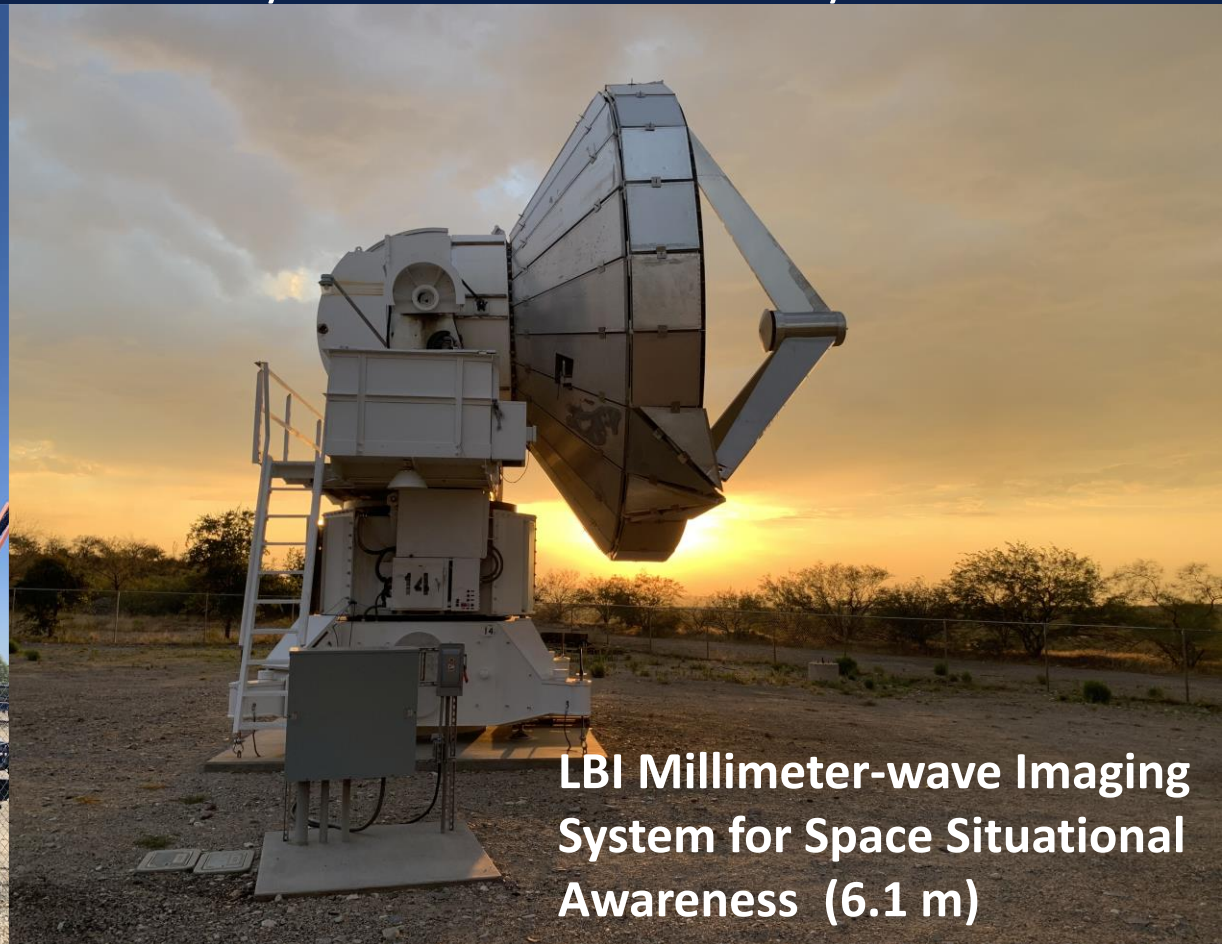
O_2 (min. 8%):	19.799%
CO_2 (max. 1%):	0.102%
Potable Water (sans 3 days):	2554.107968 kg
Food (sans 20 days):	982.65708 kg
Inhabitants:	4/4

CO_2 Production / Consumption



Atmospheric Monitors



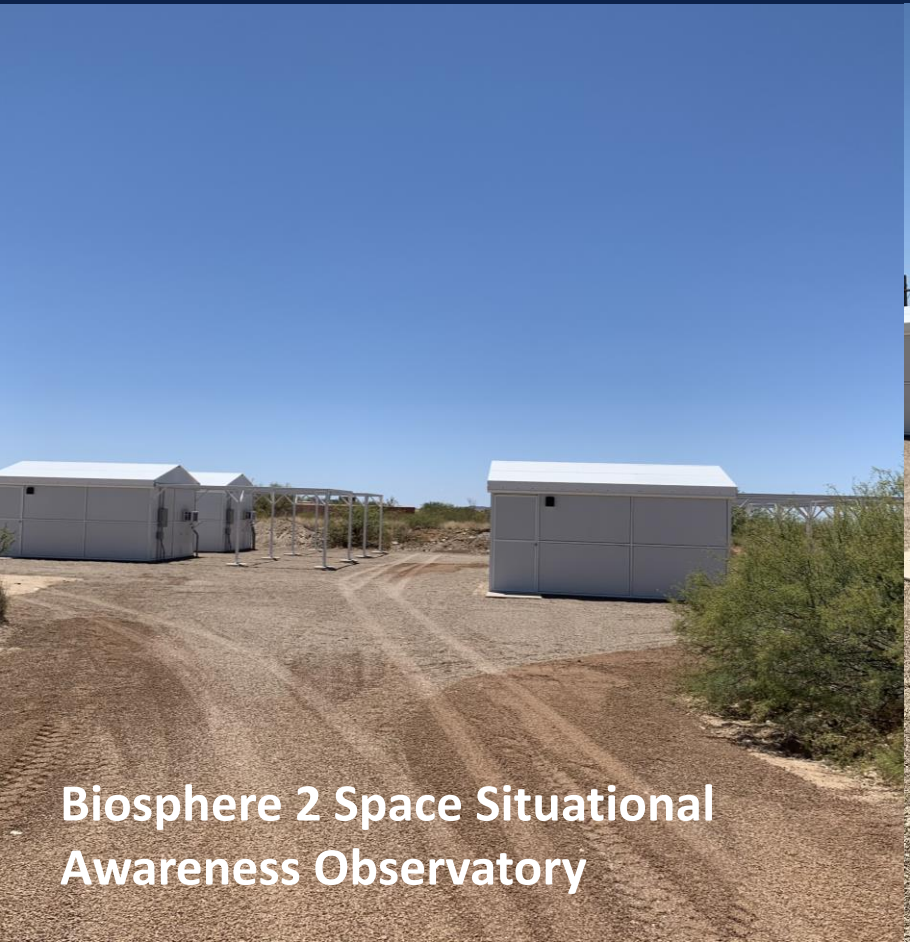


LBI Millimeter-wave Imaging System for Space Situational Awareness (6.1 m)

THE UNIVERSITY OF ARIZONA
Biosphere 2

Lunar and Planetary Laboratory

Biosphere2.org



Biosphere 2 Space Situational Awareness Observatory