



2022 MELISSA CONFERENCE
8-9-10 NOVEMBER 2022

CREATING
A CIRCULAR
FUTURE

Autonomous complex biospheres in space : moral grounds, historical perspectives and a way forward

Louise Fleischer

The Spring Institute for Forests on the Moon



Forests on the Moon

~~Autonomous complex biospheres in space~~: moral grounds, historical perspectives and a way forwards


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A lush tropical forest scene with sunlight filtering through the canopy. The foreground features a large tree trunk covered in moss and ferns. The background is filled with dense green foliage and tall trees.

Life is good

A black and white photograph showing a boot print in the dark, granular soil of the moon. The boot print is clearly visible, showing the tread pattern of the sole. The surrounding surface is covered in small rocks and dust. The lighting creates a strong shadow to the right of the boot print.

Humans are
space travelers

THE SPRING INSTITUTE

FOR FORESTS ON THE MOON



Artworks by Azuma Makoto.

Photographs: Shinoki Shunsuke

Spread life into space that
can thrive in a closed-
matter, open-energy
ecosystem for millenniums

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PLANET EARTH

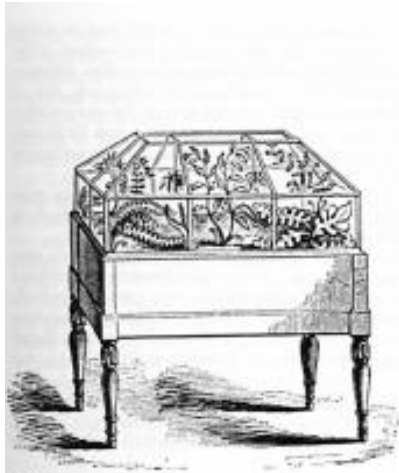


Abb. 8



Abb. 9

Wardian cases

Ward, Nathaniel Bagshaw. *On the growth of plants in closely glazed cases*. J. Van Voorst, 1852.



and foliage, but also about their roots. Why do farmers hoe their turnips? why do gardeners labour to "stir the earth" between growing crops? why does every thing pine and perish that is left to starve in a soil which hoe or fork never disturb? Whatever the form of a Wardian case may be, the idea that it might be hermetically sealed must be abandoned, and we must go back to nature, who sends many a fresh breeze to stir and agitate her verdant darlings.

Hibberd, Shirley. "HOW TO CONSTRUCT A WARDIAN CASE." *National magazine* 1, no. 4 (1857): 238-239.



The Bottle

“In 1960 David Latimer got curious and decided to plant a glass bottle with seed. He would have never guessed it would turn into a beautiful case study of a self-sustaining sealed ecosystem that has been called “the world’s oldest terrarium.”

In fact, after all these years, David’s sealed bottle garden is still thriving and robust. With thriving plant life, despite not watering it since **1972.**”

- Biologic performance

The Shrimp



Developed in the 80s as a NASA spin-off, the Ecosphere is a closed aquatic ecosystem a delicate balance of Hawaiian shrimps, algae and microorganisms. According to [testimonies from original customers](#), some ecospheres have shrimps still living after 20 years.



A photograph of a dense, lush tropical jungle interior. The scene is filled with various types of green plants, including large-leafed species and numerous hanging vines. In the background, a complex structure of glass and metal is visible, suggesting an indoor conservatory or greenhouse environment. The lighting is bright, filtering through the foliage. The text "BIOSPHERE 2" is overlaid in white on the right side of the image.

BIOSPHERE 2

Biosphere 2 by the Numbers

- 3.14 acre research facility belonging to the University of Arizona
- 7,200,000 cubic feet under sealed glass; 6,500 windows
- sealed from the earth below by a 500-ton welded stainless steel liner
- 2 crewed missions, 2-year long in 1991 and 6 months long in 1994



Biomes under Glass

- Ocean
- Mangrove wetlands
- Tropical rainforest
- Savanna grassland
- Fog desert



Spread life into space that
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*What is the right balance of species
for long term ecosystem survival?*

Spread life into space that
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credit NASA



Fruit flies, 1947



Albert II, 1949



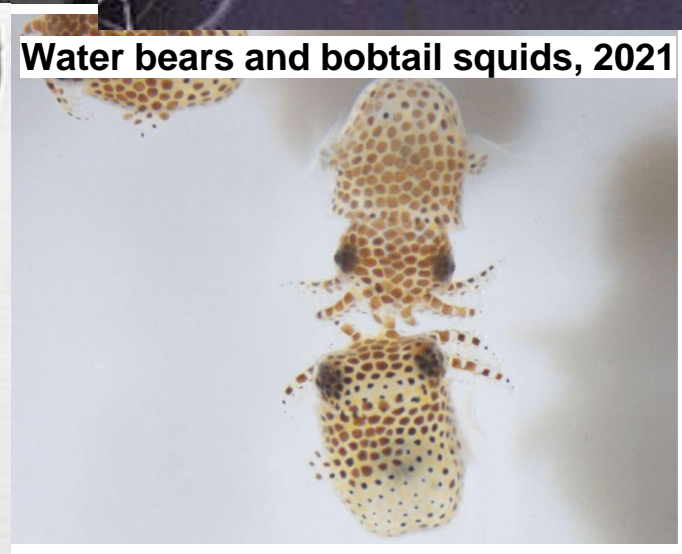
Spiders, 1973



Laika, 1957



Felicette, 1963

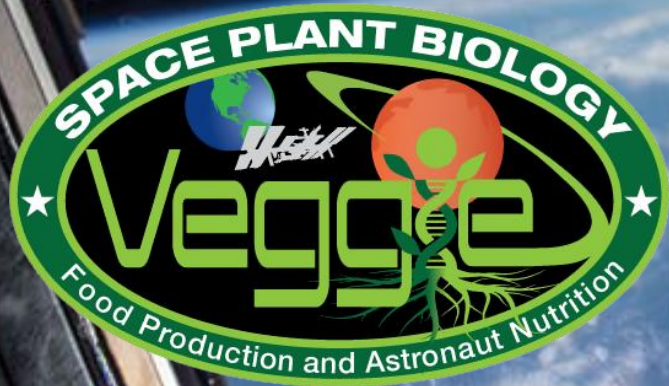


Water bears and bobtail squids, 2021

MELISSA



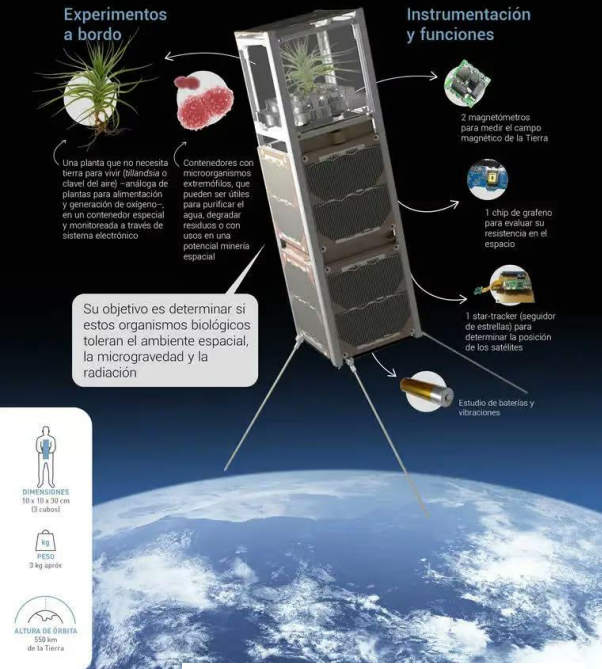
MICRO-ECOLOGICAL
LIFE SUPPORT SYSTEM
ALTERNATIVE



credit NASA

PLANTSAT

MISIÓN: CARGA DE EXPERIMENTOS BIOLÓGICOS EN EL ESPACIO



Experimentos a bordo

- Una planta que no necesita tierra para vivir (ballamosa o claveles del aire) –análogo de plantas para alimentación y generación de oxígeno–, en un contenedor especial y monitoreada a través de sistema electrónico
- Contenedores con microorganismos extremófilos, que pueden ser útiles para purificar el agua, degradar residuos o con usos en una potencial minería espacial

Instrumentación y funciones

- 2 magnetómetros para medir el campo magnético de la Tierra
- 1 chip de grafeno para evaluar su resistencia en el espacio
- 1 star-tracker (seguidor de estrellas) para determinar la posición de los satélites
- Estudio de baterías y vibraciones

Su objetivo es determinar si estos organismos biológicos toleran el ambiente espacial, la microgravedad y la radiación

DIMENSIONES
10 x 10 x 30 cm
El cubo

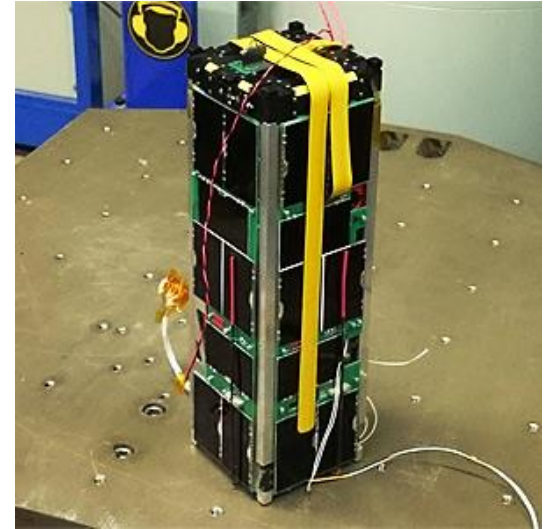
PESO
3 kg aporé

ALTURA DE ÓRBITA
500 km
de la Tierra

Launched April 1st, 2022

“Started in 1999, the CubeSat Project began as a collaborative effort to reduce cost and development time, increase accessibility to space, and sustain frequent launches.”

- CalPoly Cubesat Design Specification

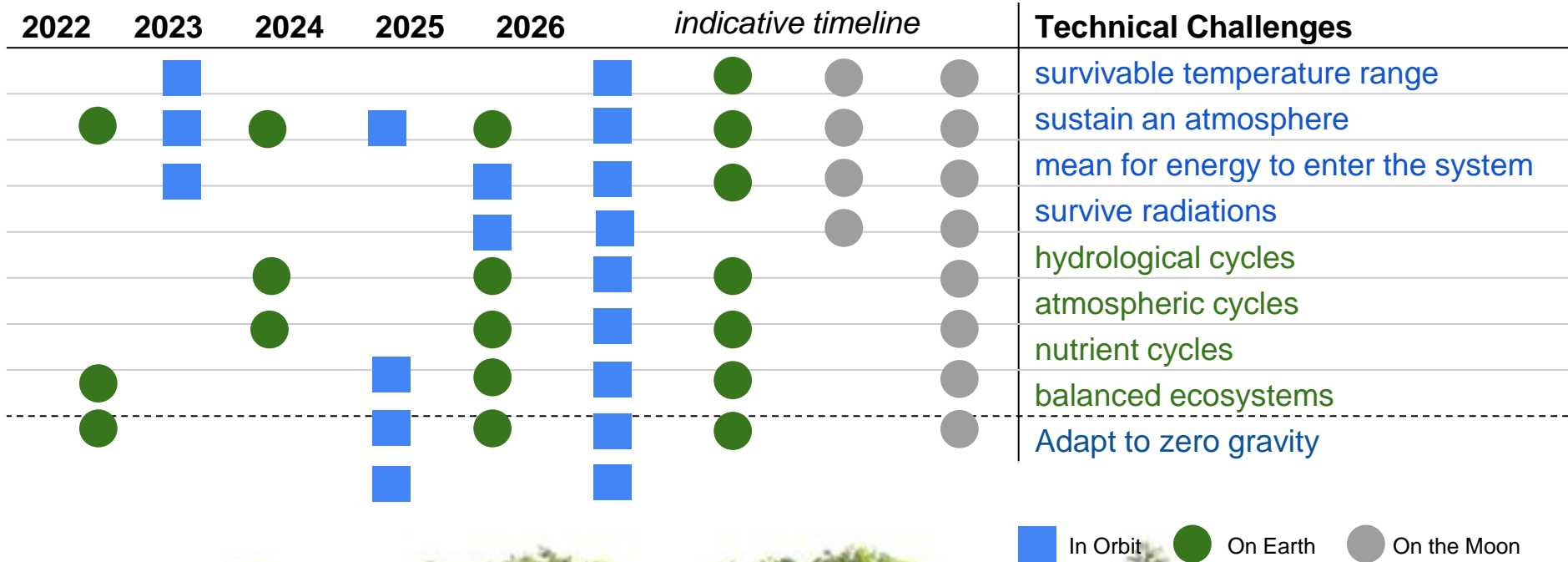


GreenCube (ENEA)
Launched in July, 2022

*What is the minimal protection from space needed to
maintain a high-plant ecosystem alive?*

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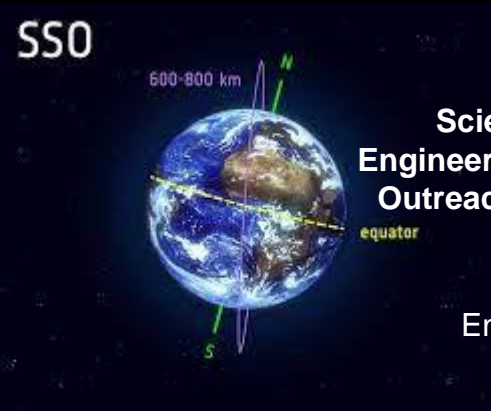
Forests on the Moon



First Steps in Orbit

Cubes at terrarium

Station aquarium



Science: passive thermal control
Engineering: space grade capabilities
Outreach: online community building
and artistic coverage

End of 2023/ beginning of 2024
Duration of 1 - 5 years

Why

When

Is it possible to maintain life-compatible temperatures in a partially transparent container in orbit?

Science: ecosystem evolution in 0g
Engineering: space requirements
Outreach: international collaborative student team

End of 2024
Duration of multiple months

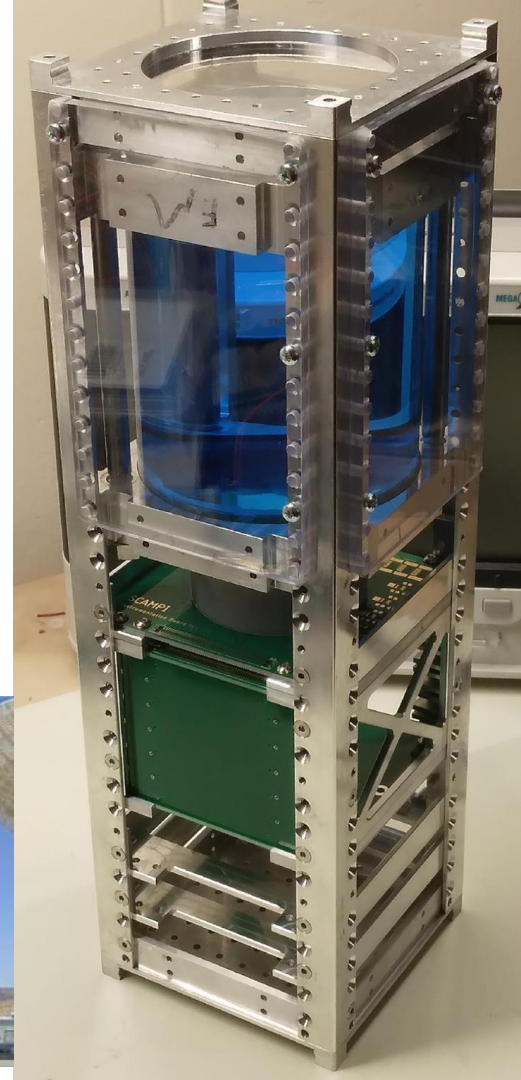
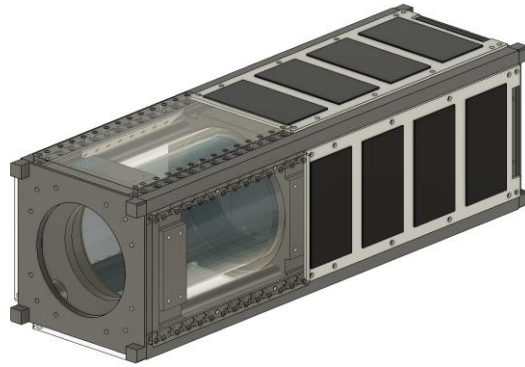
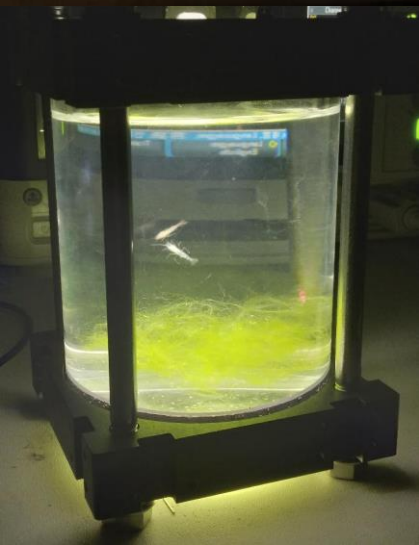
What is the impact of microgravity on a stable marine ecosystem?



Ecosphere in Space

MIT student Christian Haughwout's [phD thesis](#) explored the design of a cubesat carrying an ecosphere: a biosphere made of shrimps, algae and microbacterias.

His thesis covers the mechanical, thermal and instrumental design along with an economic assessment of the project.



From Space, there are no borders

The Netherlands

MIT, USA

Stanford, USA

Chile

Norway

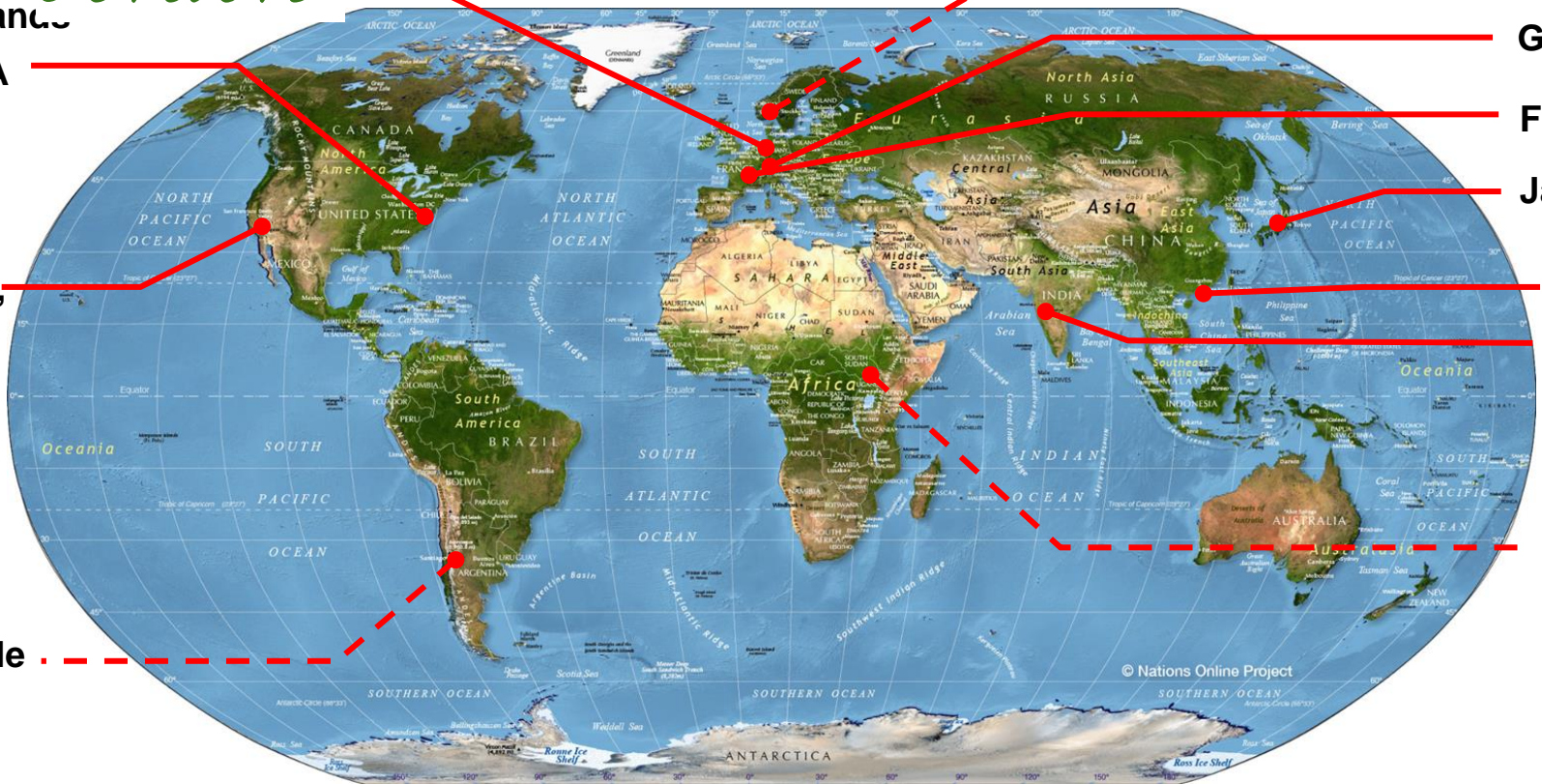
Germany

France

Japan

Hong Kong
India

Rwanda



© Nations Online Project

**Spring
germinated here**

You are here

Paris

Cantal

Toulouse





esa



@explorasciences



ALL HELP IS WELCOME

As a student

- Join the ISS team as a Master or PhD
- Apply for internships

As a scientist

- sign up as mentors
- share your knowledge, papers and expertise
- partner in consortiums
- participate in our science interviews

As an institution

- sponsor outreach efforts
- communicate about your grants and call for projects

And any other step you can take to help us get closer to our goal

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Forests on the Moon

~~Autonomous complex biospheres in space: moral grounds, historical perspectives and a way forwards~~
& Humans making a difference

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