NASAfacts

Variable Gravity Plant Biology Spaceflight Research

Studying plant growth and development responses aboard the International Space Station at multiple gravity levels

NASA and the European Space Agency (ESA) are collaborating to perform plant biology research aboard the International Space Station using the European Modular Cultivation System (EMCS) facility. Working with multiple US and international investigators, NASA Ames Research Center is conducting variable gravity plant experiments in space; these include TROPI-1 (2006), TROPI-2 (2010), Plant Signaling (2011), and Seedling Growth (2013–2015).

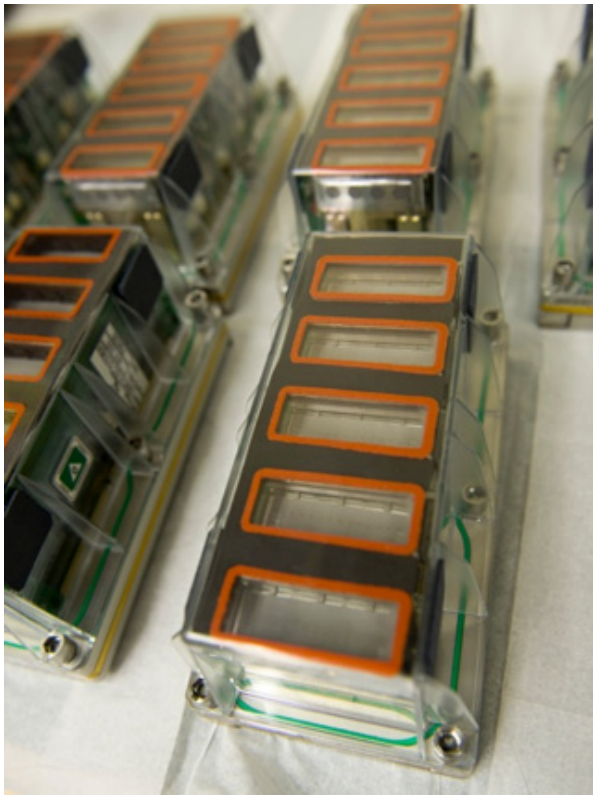
The EMCS facility

The ESA-developed EMCS is a unique incubator system that provides dedicated, controllable life support for biological experiments in a multi-gravity environment. Two independent centrifuge rotors inside the EMCS create gravitational forces ranging from 0 *g* (static rotor) to 2 *g*. This range includes the fractional *g*-forces found on the moon and Mars.

The basic modular component of the EMCS is an experiment container with an internal volume of 6 x 6 x 16 cm that mounts onto the centrifuge rotors. These experiment containers hold experiment-specific hardware and provide gas, water, electrical and data connections to their contents from the EMCS.

The EMCS provides lighting and control of temperature, humidity and gaseous atmosphere composition, including ethylene scrubbing. Rotor-mounted camera systems capture images for near real-time downlink to the ground.

Although research conducted in the EMCS has historically focused on plant biology, the system can accommodate experiments involving various organisms such as cell and tissue cultures, small invertebrates or aquatic specimens. Payload and experiment developers must design, test, and integrate new "experiment unique equipment" to fit within the EMCS experiment containers.

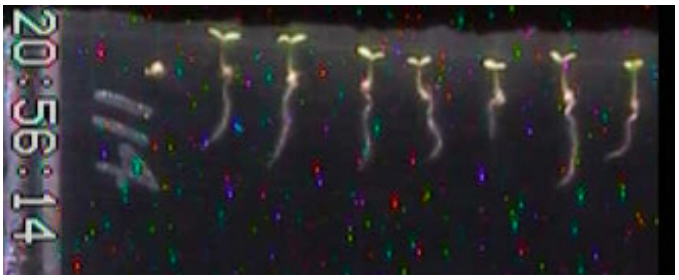


Assemblies of ESA experiment containers loaded with equipment for Seedling Growth-1.

Variable Gravity Plant Biology Spaceflight Research

Ames Research Center Plant Biology
To support spaceflight studies of the germination and early growth of the plant *Arabidopsis thaliana,* experiment unique equipment was designed and developed by the Space Biosciences Division at NASA Ames Research Center. First used for the TROPI-1 mission in 2006, this equipment includes seed cassettes, lighting, hydration and air circulation systems. Also, a heating system eliminates condensation on the surface of the seed cassettes, ensuring that clear views of the seedlings are available for real-time imaging by the EMCS rotor mounted camera.

The seed cassettes are large enough to support *A. thaliana* growth for up to eight days. White, blue and red LEDs supply light for plant growth and photo-stimuli according to experimental protocols.



Images of four day old *Aradopsis thaliana* plants growing in a seed cassette were downlinked to Earth in near real time during the Seedling Growth-1 experiment.

The Seedling Growth experiments
The Seedling Growth program involves three spaceflight studies of *A. thaliana* and is jointly supported by NASA and ESA. The principal investigators are Dr. John Z. Kiss, University of Mississippi (NASA) and Dr. F. Javier Medina, Centro de Investigaciones Biologicas at Universidad Complutense de Madrid (ESA).

National Aeronautics and Space Administration

Ames Research Center
Moffett Field, CA 94035

www.nasa.gov

FS-2013-08-07-ARC

Major goals of the Seedling Growth experiments are to determine how gravity and light responses in plants interact, and to better understand the cellular signaling mechanisms involved. This research will help us understand light and gravity sensing systems that are conserved throughout the plant kingdom. Scientific results of this project are broadly relevant; both for improving crops on Earth and also for employing plants in bio-regenerative life support systems aboard spacecraft during long duration space missions.

For each Seedling Growth flight, 16 experiment containers are prepared on Earth and transported to the station aboard a SpaceX Dragon capsule.

To start an experimental run, an astronaut mounts the loaded experiment containers onto one or both EMCS rotors. From this point on, an entire 6-day long experiment runs without further crew intervention. The EMCS is controlled by a combination of ground commanding and automation software. When each run is completed an astronaut removes the experiment containers from the EMCS. At this time the biospecimens may be frozen or chemically preserved.

Video and still image data are downlinked during the experiments. Frozen or preserved samples are returned to Earth aboard a SpaceX Dragon capsule for biochemical and genomic analysis.

Support for this project is provided by the Space Biology Project, managed by the Space Life and Physical Sciences Research and Applications Division within the Human Exploration and Operations Mission Directorate at NASA Headquarters.

For more information, contact:
Marianne Steele, Ph.D.
Project Manager
Lockheed Martin
Space Biosciences Division
NASA Ames Research Center
marianne.k.steele@nasa.gov
spacebiosciences.arc.nasa.gov