NCERA-101 Station Report
Sierra Space/ORBITEC, Madison WI

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1. Impact Nugget.

Sierra Space continues to develop environmental control technologies for space based biological and physical-chemical life support systems, technologies that may have applications for terrestrial environmental control systems.

2. New Facilities and Equipment.

N/A

3. Unique Plant Responses.

Bare root plant grown in our XROOTS aeroponics/hydroponics payload on ISS (Figure 1). Species grown so far; radish, mizuna, lettuce, dwarf wheat, dwarf tomato.

Figure 1. Radish grown in XROOTS payload (6/24/22)

4. Accomplishment Summaries.

Microgravity Plant Growth

The Veggie units fabricated by Sierra Space were delivered to the ISS in 2014 and 2017 and continue to be actively used to support plant research and crop production tests. Sierra Space also continues to support the Advanced Plant Habitat Unit on ISS. The APH was delivered to orbit in 2017 and is also being regularly used to support plant research. Our XROOTS Aeroponics/Hydroponics Technology Demonstration is currently operating on the ISS. It is using one of our Veggie plant growth systems to provide lighting.

Aerospace Environmental Control & Life Support Systems

Sierra Space is collaborating with Blue Origin to develop a commercial space station called Orbital Reef (Figure 2). Part of the station core will be comprised of Sierra Space's Large Inflatable Fabric Environment (LIFE) habitat modules. The LIFE habitat will incorporate 2-3 Astro Garden modules (Figure 3. The Orbital Reef will be serviced in part by Sierra Space Dream Chaser vehicles.

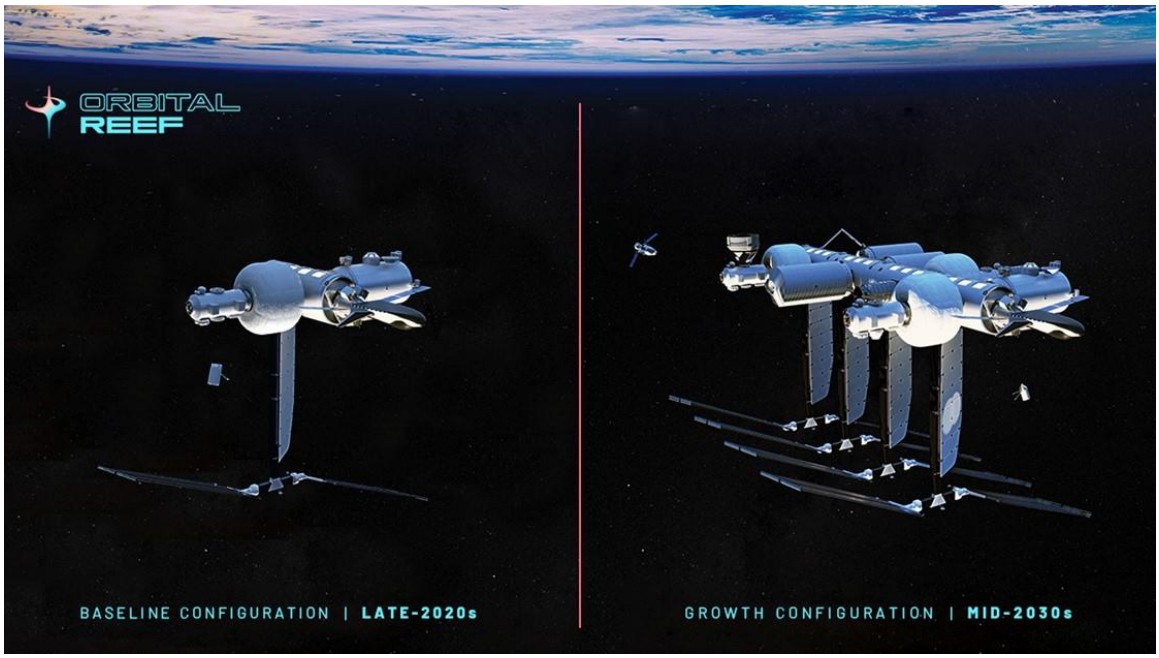

Figure 2. Orbital Reef Concept

Figure 3. Sierra Space Large Inflatable Fabric Environment (LIFE) mockup. Interior view of habitat showing Astro Garden salad crop production system

5. Impact Statements

- Sierra Space is working toward development of hybrid life support systems for space applications, integrating biological and physical/chemical technologies.
- Sierra Space is advancing the technology of controlled environment systems to meet the performance and quality needs of long duration space applications. Some of this technology may be transferable and scalable to terrestrial protected agriculture systems.
- Sierra Space continues to develop LED lighting configurations and control strategies for plant and human lighting applications to provide increased lighting system utility for aerospace and gravitational biology applications.
- Sierra Space continues to use its space biology controlled environment and human life support work in our outreach efforts to spark interest in high school and college students toward STEM fields.

6. Published Written Works.

Morrow, R., J. Wetzel, and S. Moffatt. 2022. In situ Manufacturing derived from Bioregenerative Life Support Systems. ICES-2-22-435.

Moffatt, S., R. Morrow, J. Wetzel, and J. Klopotic. 2022. Astro Garden® “Salad Diet" Scale Ground Prototype Assembly and Plant Growth Testing. ICES-2022-17.

Klopotic, J.M. and J.P. Wetzel. 2022. Trash compaction and processing system development and testing. ICES-2022-104.

Marandola, E. and W. O’Hara. 2022. Assessing dust migration through pressurized habitable volumes. ICES-2022-328.

Burgner, S.E., K. Nermali, G.D. Massa, R.M. Wheeler, R.C. Morrow, and C. Mitchell. 2020. Growth and Photosynthetic Responses of Chinese Cabbage to continuously elevated carbon dioxide in a simulated Space Station "Veggie” crop-production environment. Life Sciences in Space Research, 77:83-88.

Abney, M., R. Gatens, K. Lange, B. Brown, J. Wetzel, R. Morrow, W. Schneider, C. Stanley. 2020. Comparison of Exploration Oxygen Recovery Technology Options Using ESM and LSMAC. ICES-2020-07-31.

7. Scientific and Outreach Oral Presentations.

Morrow, R.C. 2022. Orbital Reef and Commercial Space. Wisconsin Space Grant Consortium Regional Meeting. Invited Speaker.

Morrow, R.C. 2021. Light for life: Innovative Approach for Future Food Production in Space. ISHS Light 2021, Invited speaker.

Morrow, R.C., J.P. Wetzel, and S. Moffatt. 2021. Astro Garden Salad Crop Production System Demonstration Testing. ASGSR Annual Conference (Abstract).

8. Other relevant accomplishments, news and activities.

The Space Systems Group of Sierra Nevada Corporation (which includes what used to be ORBITEC), is now an independent company called Sierra Space. Our applications group is still focused on Propulsion and Environmental Systems (including plant payloads), and continues to operate in our facilities in Madison, Middleton, and Baraboo Wisconsin.

9. Websites:

Sierra Space http://www.sierraspace.com/