

Challenges of Life Support/Medical Support for Human Missions (8)
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MARS EXPLORATION ANALOGS FOR HUMAN PERFORMANCE: LINKING GROUND ANALOGS,
ISS, AND ARTEMIS

Abstract

Human spaceflight is entering a new phase where simultaneous operations of multiple platforms can simulate different aspects of Mars missions. Each step in human exploration serves as a simulation opportunity for subsequent missions, but each simulation approach has opportunities and limitations of fidelity.

Earth-based analogs have been used to model isolation, confinement and remote conditions of exploration mission scenarios because they offer habitable volumes and levels of control that are not available in current space missions. Unique facilities such as Human Exploration Research Analog (HERA) in the US and Russian NEK (Nazemnyy eksperimental'nyy kompleks or "Ground-Based Experimental Complex") facility in Russia are central to these efforts but are limited by the fidelity of simulated operations.

The International Space Station (ISS) serves as a key place for doing research on the effects of microgravity on human physiology and developing mitigations and countermeasures to those effects to enable future exploration. NASA and ISS international partners are working to add higher fidelity Mars mission elements to ISS missions, including more long-duration missions of up to 12 months, simulations of medical contingencies and other operations that will need to be more autonomous during Mars missions, and understanding crew operational capabilities after a long microgravity transit.

Artemis missions will allow lunar surface operations as an analog for Mars surface operations, with partial gravity and deep space radiation, but with crewmembers that are probably more capable than their counterparts would be after a long transit to Mars. Getting unobtrusive data from early Artemis missions, and knowledge gained from operational experience as Artemis operations develop can improve engineering design, medical requirements and countermeasures, and ultimately ensure mission success on Mars.

Strategic approaches that treat all human spaceflight missions in Low Earth Orbit (LEO) and the lunar vicinity as analogs for future Mars missions can allow human research to be conducted that is more robust to the limitations of any one analog. . Using comparable measures of crew health and performance across ground, ISS and Artemis missions will increase the value of all the missions as exploration analogs. This paper will review the current status of rapidly evolving plans for exploration simulation across human spaceflight platforms, the strategic scientific needs, and operational opportunities that are emerging.