



Analogs: Gateway to Spaceflight Research

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Spaceflight Research in Analogs

- **Analog missions prepare us for near-future exploration to the moon and Mars**
- **Not all experiments can be done in space – there is not enough time, money, equipment, and crew time**
- **Measures, countermeasures, procedures, and equipment can be tested in analogs to address issues prior to flying them in space**
- **Ground-based analog studies are completed more quickly and less expensively**
- **Analogs provide conditions similar to some (but not all) conditions encountered in spaceflight**
- **Analogs provide a more “controlled” environment, often more repeatable scenarios, and higher “n” than available in space**



Human Exploration Research Analog (HERA)

NASA/Johnson Space Center

Isolation and Confinement



Research Capabilities:

- Behavioral Health
- Group Dynamics
- Human Factors and Interactions with the closed environment
- Medical capabilities testing for hardware testing and medical scenarios
- Delayed communications for autonomy research
- Physiological research

HERA provides:

- Mission Control support
- Mission scenarios
- Medical and psychological support
- Flight simulated mission schedules
- Daily exercise
- Habitat maintenance
- No human contact with external personnel



Human Exploration Research Analog (HERA) Isolation and Confinement



HERA HISTORY

- **2014: Began operations with 7 days missions**
- **2015: Extended missions to 14 days**
- **2016: Initiated 30 days missions**
- **2017-19: Introduced reduced habitable volume and began 45 day missions**
- **2020: Continue 45 day missions with varying autonomy**



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Cologne, Germany



Bedrest and Physiological Deconditioning

Long-term medical habitat focusing on addressing risks to astronaut health, including vision impairment, behavioral health, bone loss, cardiovascular alterations and immunological function during missions beyond lower Earth orbit.

- **Operated by DLR's Institute for Aerospace Medicine in Cologne, Germany.**
- **Capabilities include head down bed rest of various durations, increased CO₂ atmosphere, short-arm centrifuge, on-site MRI, lab and testing support.**
- **Suitable for studies concerning physiological deconditioning, musculoskeletal, cardiovascular deconditioning and psychological effects of long-term reduced gravity environment.**





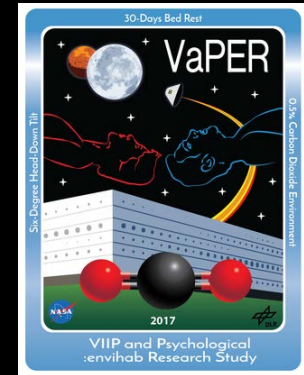
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Bed Rest Studies: VaPER and AGBRESA

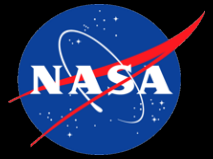
- **VaPER study conducted in Nov. 2017**
 - 30 days 6° head-down tilt bed rest
 - Room atmosphere set to 0.5% carbon dioxide
- **Objective: Study the effects of pressure and increased CO₂ on the eyes and optic nerve.**

- **AGBRESA study completed December 2019**
 - 60 day 6° head-down tilt bed rest
 - Group 1: Supine centrifugation for 30 min/d, continuous
 - Group 2: Supine centrifugation for 6 bouts of 5 min/d
 - Group 3: No centrifugation (control group)
- **Objective: Determine the effects and effectiveness of short-duration continuous and intermittent centrifugation as a countermeasure for microgravity effects.**





IBMP Ground-Based Experimental Complex (NEK) Moscow, Russia



Isolation and Confinement

- High degree of isolation, confinement & control
- Audio and Video surveillance system
- Infrastructure to support HRP-IT system
- Private medical and audio, video capability
- Crew exercise devices
- Controlled lighting system
- Daily health checks
- Training in medical aid skills, emergency responses and escape
- Controlled-access HRP office space
- Educational and outreach activities

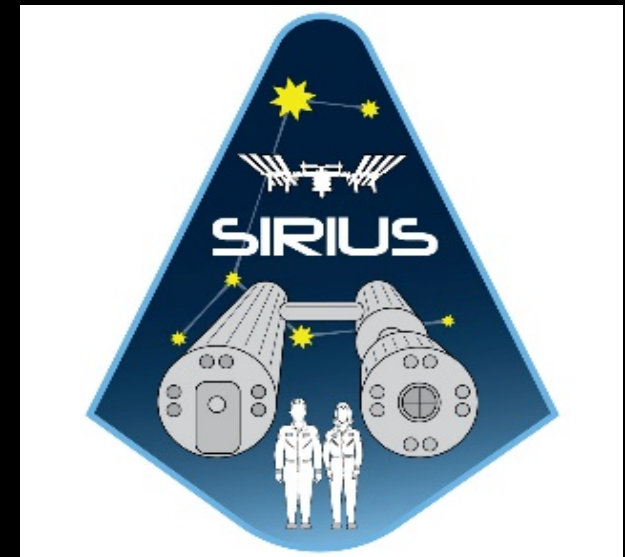


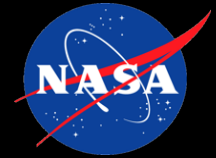


IBMP Ground-Based Experimental Complex (NEK) SIRIUS – Scientific International Research In a Unique terrestrial Station



- **SIRIUS 19 - 4 month isolation mission completed in July, 2019**
 - Multicultural crew of 6: 4 Russian, 2 U.S. crewmembers
 - 3 male:3 female crewmembers
 - Mission language - English and Russian
 - Mission Scenario
 - Lunar mission
 - Landing of 4 crewmembers on-surface operations
 - Communication delay of 5 minutes
 - HRP research focused on individual and team psychology
 - Other research included physiological adaptation, training and performance, telemedicine, microbiology
- **SIRIUS 20/21 - 8 month isolation mission schedule to begin in November, 2020**
 - Mission Scenario
 - Extended lunar orbit
 - Multiple surface EVAs rotating all crew
 - Communication delay
- **Future - 12 month isolation mission following SIRIUS 20/21**



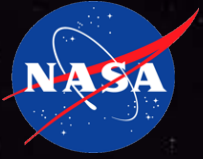


NSF Antarctic Stations

Isolation, Confinement and Extreme Environment

- Environment provides Isolation, Confined and Extreme/hostile conditions – a unique test bed for Lunar or Mars missions
 - Constrains operations and communications
 - Suitable for research in behavioral health, human performance, medical capabilities, nutrition, autonomy, physiological effects
- Availability for HRP research studies is limited, NSF plays role in determining studies allowed
- NSF provides logistics support for research hardware, supplies, etc
- Station access includes McMurdo (large coastal), South Pole (small inland), and Palmer (small coastal)

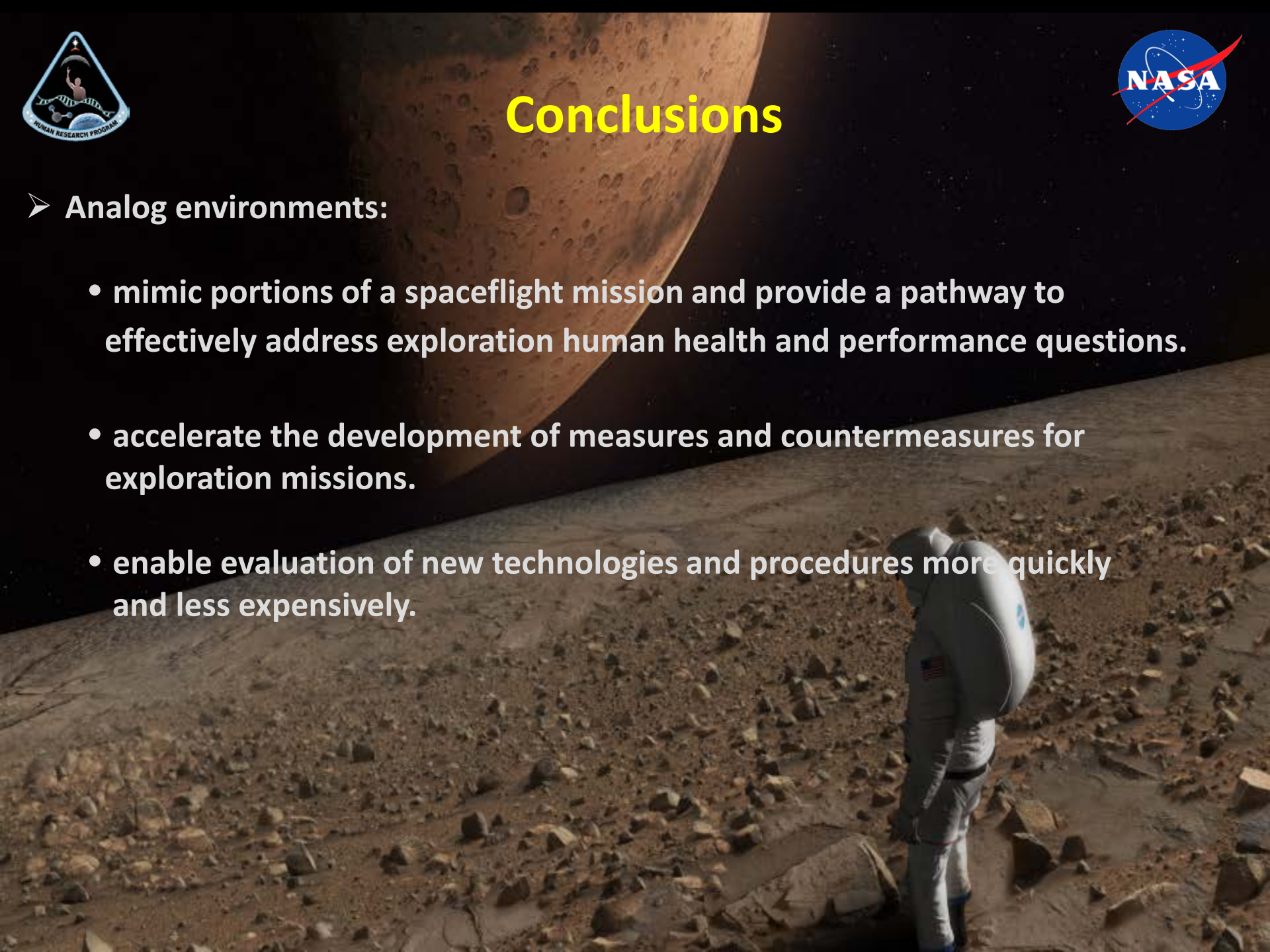




Conclusions

➤ Analog environments:

- **mimic portions of a spaceflight mission and provide a pathway to effectively address exploration human health and performance questions.**
- **accelerate the development of measures and countermeasures for exploration missions.**
- **enable evaluation of new technologies and procedures more quickly and less expensively.**



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Analog Missions

Sub-navigation: Analog Missions | Overview | Images | Videos | Media Resources

Mission Overview

An Analog is a situation on Earth that produces effects on the body similar to those experienced in space, both physical and mental/emotional. These studies help prepare us for long duration missions. NASA is associated with at least 15 analog missions throughout the world.

- Why do we use Analog Missions?
- How Analog Missions promote global collaboration

Types of Analogs

- HERA
- NASA Space Radiation Lab (NSRL)
- HESTIA
- simHab
- Antarctic Stations
- Aquarius/NEEMO
- Parabolic Flight
- NEK
- ACC
- Concordia
- Desert RATS
- Pavilion Lake Research Project (PLRP)
- Houghton Mars Project (HMAP)
- In-Situ Resource Utilization (ISRU)
- HI-SEAS

About Analog Missions



HERA Campaign 3 Ends With Return of Mission XII Crew

AnaBlogs

- Volunteer for a Space Simulation! 22 days ago
- 8 Amazing Places You Can Visit 'Mars' on Earth 22 days ago
- Antarctica Provides ICE to Study Behavior Effects... 22 days ago

ANALOG MISSIONS



MISSION TO MARS 100-200 DAYS

Space

- No gravity
- Astrenauts
- Communication Delay
- Rough Radiation
- Supported by a Mission Control
- In Immediate Emergency Exit
- Space Food
- Confined, Crowded Interior
- Unfamiliar Places

Analog

- Gravity
- Everyday Falls
- Communication Delay
- 'Normal' Radiation
- Supported by a Mission Control
- In Immediate Emergency Exit
- Space Food
- Confined, Crowded Interior
- Unfamiliar Places

For Researchers



NASA ANALOGS IN THE NEWS



Experience an Analog



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