Ground Based Spaceflight Analogs for Human Research

Ronita L. Cromwell, PhD
Universities Space Research Association
NASA Flight Analogs Project Scientist
Analog Definition

A facility or environment that recreates the effects of spaceflight on the human being.
Overview

• Provide examples of ground-based analogs and discuss the unique characteristics of each
• Discuss the process by which research studies are assigned to analogs
• Discuss international efforts
  – Standardization of Bed Rest
  – International Analog Research Working Group
NEEMO

• NASA Extreme Environment Mission Operations
  – Located 3.5 miles off of Key Largo, FL

• Facility Operations:
  – National Oceanic & Atmospheric Administration (NOAA)
  – National Undersea Research Center at University of North Carolina, Wilmington (NURC)
NEEMO

• Aquarius
  – Underwater habitat - an environment similar to living in space
  – Operating depth 47 feet
  – 11 cubic meters living/lab space, similar to Destiny module of the ISS

• Application
  – Isolation/confinement
  – telemedicine
  – Extravehicular activities
  – Simulations of partial gravity

• For more information
  – http://www.uncw.edu/aquarius
Haughton-Mars Project

• Location
  – Site of the Haughton meteorite impact crater
  – Devon Island in the Canadian high arctic

• Facility Operations
  – Mars Institute
  – SETI Institute (Search for Extraterrestrial Intelligence)
Haughton-Mars Project

- Haughton-Mars Project
  - International, interdisciplinary field research project
  - Rocky, polar desert setting provides insights into the evolution of Mars
  - Terrestrial analog for Mars and lunar studies

- Application
  - Human performance
    - physical
    - behavioral
  - Extravehicular activity systems
  - Human factors

- For more information
  - [http://www.marsonearth.org](http://www.marsonearth.org)
Antarctica

- 64 stations operated by 20 countries
- United States Antarctic Program
  - National Science Foundation, Office of Polar Programs
- 3 year-round research stations
  - Palmer Station
  - Amundsen-Scott South Pole Station
  - McMurdo station
    - Main US station
    - Located on Ross Island
Antarctica

• Antarctic environment
  – Climate, terrain, temperature, isolation and stress parallels that of long-duration space missions

• For more information

• Application
  – Isolation/confinement
  – physiological stress
  – disrupted circadian rhythms
  – telemedicine
Flight Analogs Research Unit (FARU)

- FARU
  - Located at University of Texas Medical Branch in Galveston, TX
  - NASA bed rest facility

- Facility Operations:
  - NASA owned and funded through the NIH to the Institute for Translational Sciences - Clinical Research Center at UTMB
Flight Analogs Research Unit (FARU)

• 6° head-down tilt bed rest
  – model for studying physiological changes that occur during spaceflight under controlled conditions
    • Deconditioning - confinement to bed
    • Bone loss - long duration of inactivity
    • Fluid shifts - 6° head-down tilt

• Applications
  – Studies of physiological mechanisms
  – Platform for testing countermeasures

• For more information
  — http://www.nasa.gov/centers/johnson/slsd/about/divisions/hacd/project/flight-analogs.html
Analog Studies

• Proposals for studies
  – solicited through the NASA Research Announcement (NRA) process
  – directed by Human Research Program (HRP)
  – must fill knowledge gaps and address spaceflight risks as described in the HRP Integrated Research Plan (IRP)
  – include budget planning for study personnel to support research at the analog site
  – Applications must include the appropriate analog worksheet
    » Feasibility
    » Analog assignment
Analog Assignment

- Match study requirements to characteristics of each analog to determine optimal analog(s) for each study.
  - Research and implementation requirements are assessed by the Flight Analogs Project using the FAP Analog Assessment Tool.
  - Tool optimizes requirements against analog characteristics resulting in selection of analog(s) that satisfy study needs.
  - Approach is an effective way for matching research studies to appropriate analogs that is requirement based.
  - Studies with behavioral health emphasis will be subject to the BHP Analog Assessment Tool for further refinement of analog selection.
International Standardization of Bed Rest

• A study group of the International Academy of Astronautics (IAA) was formed in 2009 to standardize the 60-day, 6° head-down tilt bed rest platform
  – establish consistency across bed rest studies world wide
  – allow for increased data sharing and collaboration internationally
  – Standard conditions and standard measures were addressed

• Standard Conditions
  – Subject selection
  – Study integration
  – Clinical support
  – Dietary standards
  – Biological sample handling
  – Study management
  – Data management
International Standardization of Bed Rest

• Standard Measures Purpose
  – Characterize analog platform
  – Monitor physiological systems not targeted by the study (effective for countermeasure assessment)
  – Compare to spaceflight studies to assess analog fidelity
  – Compare across studies within the platform, as well as compare multiple platforms (multi site studies)

• Standard Measures Disciplines
  – Sensorimotor
  – Cardiovascular
  – Exercise/Muscle
  – Bone
  – Nutrition
  – Hematology
  – Immunology
  – Psychology
International Standardization of Bed Rest

• When complete, the final document will be presented to the IAA
• Results will be published as guidelines for conducting bed rest studies
Purpose

- to heighten awareness for the use of analogs as platforms
  - to study human adaptation,
  - to simulate space environments,
  - and for countermeasure development.

Effective use of ground analogs would compensate for limited resources of the ISS and serve as the next level test bed for the study of human adaptation in space and countermeasure development.
International Collaboration on Analog Utilization Workshop

• International Human Life Sciences Spaceflight Analog Research Working Group (IARWG)
  – IARWG should establish a relationship with the Expert Group on Human Biology and Medicine within Scientific Committee on Antarctic Research (SCAR) to open discussions on utilizing Antarctica as an analog for spaceflight.
  – Define problems of interest to all members that would require collaboration in analog environments. Develop a strategy for defining science objectives for IARWG.
  – Determine which analogs provide optimal opportunities for collaborative interests.
  – Define standard measurements that would allow data sharing.
  – Develop plans for data sharing and archiving.
  – Determine the current status of plans to use the various analogs.

• Workshop Proceedings
  – http://www.dsls.usra.edu/meetings/IAA/analog
Points of Contact
- Isabel Marcil – CSA
- Oliver Angerer – ESA
- Yamamoto Masafumi – JAXA
- Vadim Gushin – Russia
- Lauren Leveton - NASA

Begin discussions of isolation and confinement research
- Identify key questions regarding isolation and confinement studies
- Decide on a collaborative study to address objectives common to all agencies
Thank you for your attention.