



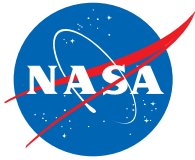
Behavioral Health & Performance Lab Research Update

December 2022

Suzanne Bell, Ph.D.

NASA Johnson Space Center, Houston, TX, USA

suzanne.t.bell@nasa.gov



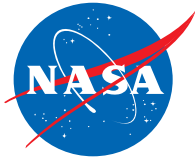
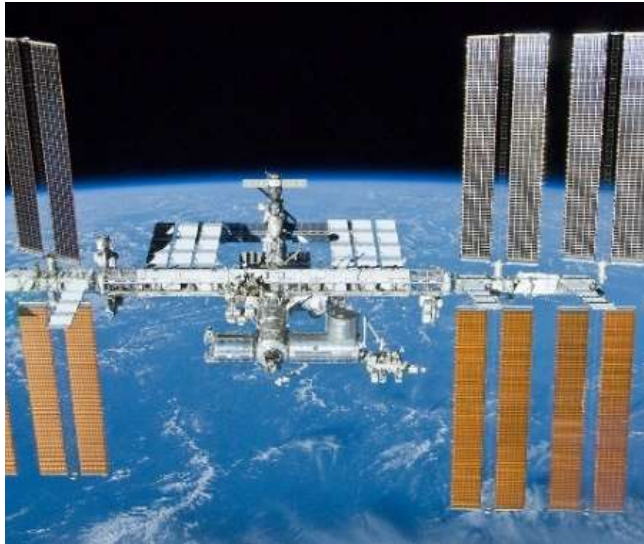
Behavioral Health & Performance Lab

- Lab Lead
 - Suzanne Bell, Ph.D.
- Ph.D. Scientists
 - Steven Anderson, Ph.D. (Health Psychology)
 - Sheena Dev, Ph.D. (Clinical Neuropsychology)
 - Lauren Landon, Ph.D. (IO Psychology)
 - *Alexa Doerr, Ph.D. (IO Psychology)*
- Research Coordinators
 - Alaa Khader, M.S.
 - Jennifer Miller, M.S.
 - Bruce Keller, M.S.
 - Princess Dickson, M.S.
 - *Sydney Begerowski, M.S.*
 - *Julia Schorn, M.S.*
 - *Cara Spencer, B.S.*
- HHPC Contract Management
 - Steve VaderArk, M.S.
- Lab Project Manager
 - Diana Arias, M.S.



Risk Characterization and Reduction Research

- **Behavioral Medicine:** Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders
- **Team:** Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team
- **Sleep, Human Systems Integration Architecture (HSIA)**



Research in Space and Space Analog Environments

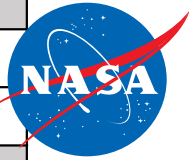
Human Factors Behavioral Performance Exploration Measures (HFBP-EM) Harmonization Project

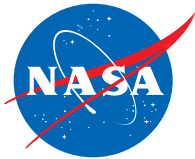
Blue = Subset of measures
administered on the ISS



Expedition 65 Flight Engineer Megan McArthur completes
ROBoT aboard the ISS.

HFBP-EM	Physiology/Biomarkers
	Sleep
	Heart Rate
	Individual Behavioral Health
	Personality Assessment
	Social Desirability
	Depression
	Mood and Affect
	Neurobehavioral Function
	Objective Performance
	Cognition
	ROBoT
	Team & Social Dynamics
	Team Performance: MCC Ratings
	Team Performance: Crew Ratings
	Team Cohesion
	Team Processes
	Psychological Safety
	Conflict, Social Support
	Group Living



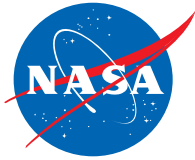


Cognitive Performance

- Cognition battery
- 10 subtests, 15 alternate versions
- Collected pre-, post-, and in-mission
- In-mission data collection frequency varies by research setting
 - Ex.: Every 2 days in shorter missions (e.g., 45 days), 1x/week in longer missions (e.g., 120 days), and 2-3 times in mission on the ISS
- Primary metrics include a speed and accuracy score for each subtests

Basner et al., 2015

Test	Cognitive Domains Assessed
Motor Praxis	Sensorimotor speed
Visual Object Learning	Spatial learning and working memory
Fractal 2-Back (N-back)	Working memory
Abstract Matching	Abstraction, concept formation
Line Orientation	Spatial orientation
Emotion Recognition	Emotion identification
Matrix Reasoning	Abstract reasoning
Digit Symbol Substitution	Complex scanning and visual tracking
Balloon Analog Risk	Risk decision making
Psychomotor Vigilance	Vigilant attention



Performance: Robotics On-Board Trainer (ROBoT-r)

- Research adaptation of an astronaut training simulation of Candarm2 docking procedures on the ISS
- Collected pre-, post-, and in-mission
- In-mission data collection frequency varies by mission length:
 - Ex.: every two days in shorter missions (e.g., 45 days) and 1x/week in longer missions (e.g., 120 days)
- Primary outcome metrics include speed, approach accuracy, and overall score

Ivkovik et al., 2019





HFBP-EM Research Settings

	Campaign Manipulation	Crew	Mission Scenarios	Days in mission	Habitat Size	Off-nominal events
HERA C4	Sleep restriction	5, 4-person crews; American	Travel to asteroid; Emergency Event	45	148.6m ³	Hurricane Harvey: Mission 2 early egress
HERA C5	Reduced privacy and habitable volume	4, 4-person crews; American	Travel to Phobos; Emergency Event	45	<148.6m ³	Covid19: Mission 5 post-mission early termination
NEK-SIRIUS19	Single 24-hr sleep restriction	1, 6-person crew; multinational	Lunar Landing	120	550 m ³	NA
NEK-SIRIUS17	NEK pilot/feasibility	1, 6-person crew; multinational	NA	17	550 m ³	NA
ISS	N/A	8, 3-11 person crews; multinational	EVA	150-350	388 m ³	NA

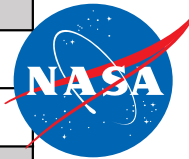
HFBP-EM Harmonization Project Aims

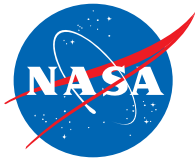
Data harmonization required to compare HFBP-EM measures across different research settings:

1. Build a Harmonized database of individual and team HFBP-EM data from spaceflight analogs and spaceflight settings
2. Summarize the trajectory of individual and team outcomes within and between mission settings

Blue = Subset of measures administered on the ISS

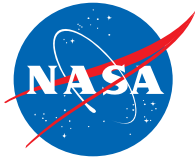
HFBP-EM	Physiology/Biomarkers
	Sleep
	Heart Rate
	Individual Behavioral Health
	Personality Assessment
	Social Desirability
	Depression
	Mood and Affect
	Neurobehavioral Function
	Objective Performance
	Cognition
	ROBoT
	Team & Social Dynamics
	Team Performance: MCC Ratings
	Team Performance: Crew Ratings
	Team Cohesion
	Team Processes
	Psychological Safety
	Conflict, Social Support
	Group Living



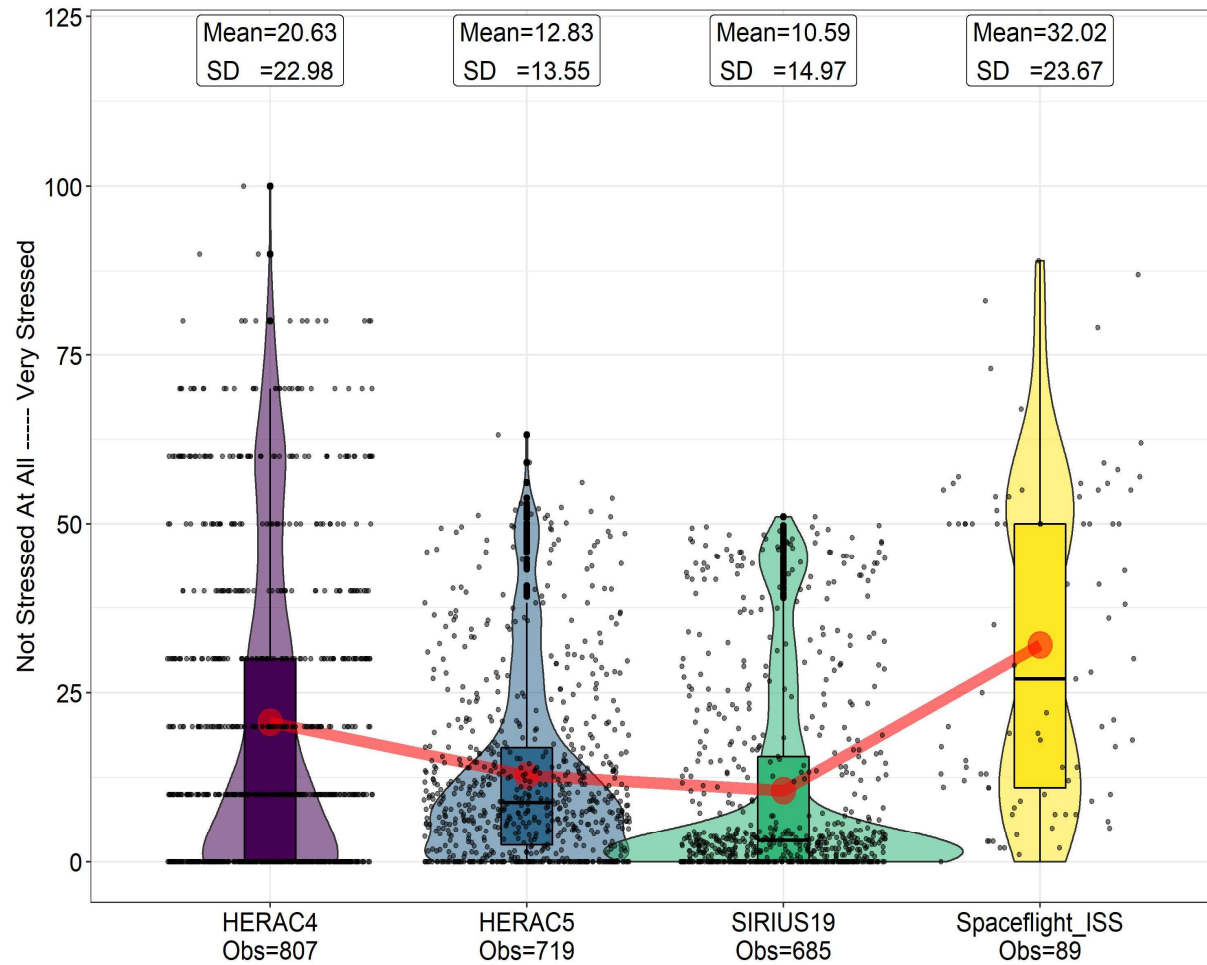


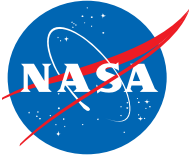
HFBP-EM Harmonized Database

	n	Age Mean (SD)	Sex	Education (% advanced degrees)	Military experience n (mean years, SD)	ICE experience n (mean months, SD)
HERA C4	20	39.26 (8.4)	7F 13M	75%	5 (20.6, 13.12)	0 (0, 0)
HERA C5	16	36.96 (5.52)	4F 12M	100%	6 (14.16, 8.08)	2 (12.1, 16.79)
SIRIUS19	6	34.34 (5.13)	3F 3M	100%	2 (15. 7.07)	4 (4.6, 2.98)
ISS	15	45.75 (8.85)	3F 10M	100%	NA	NA
Total	57	39.47 (7.63)	17F 38M	91%	NA	NA

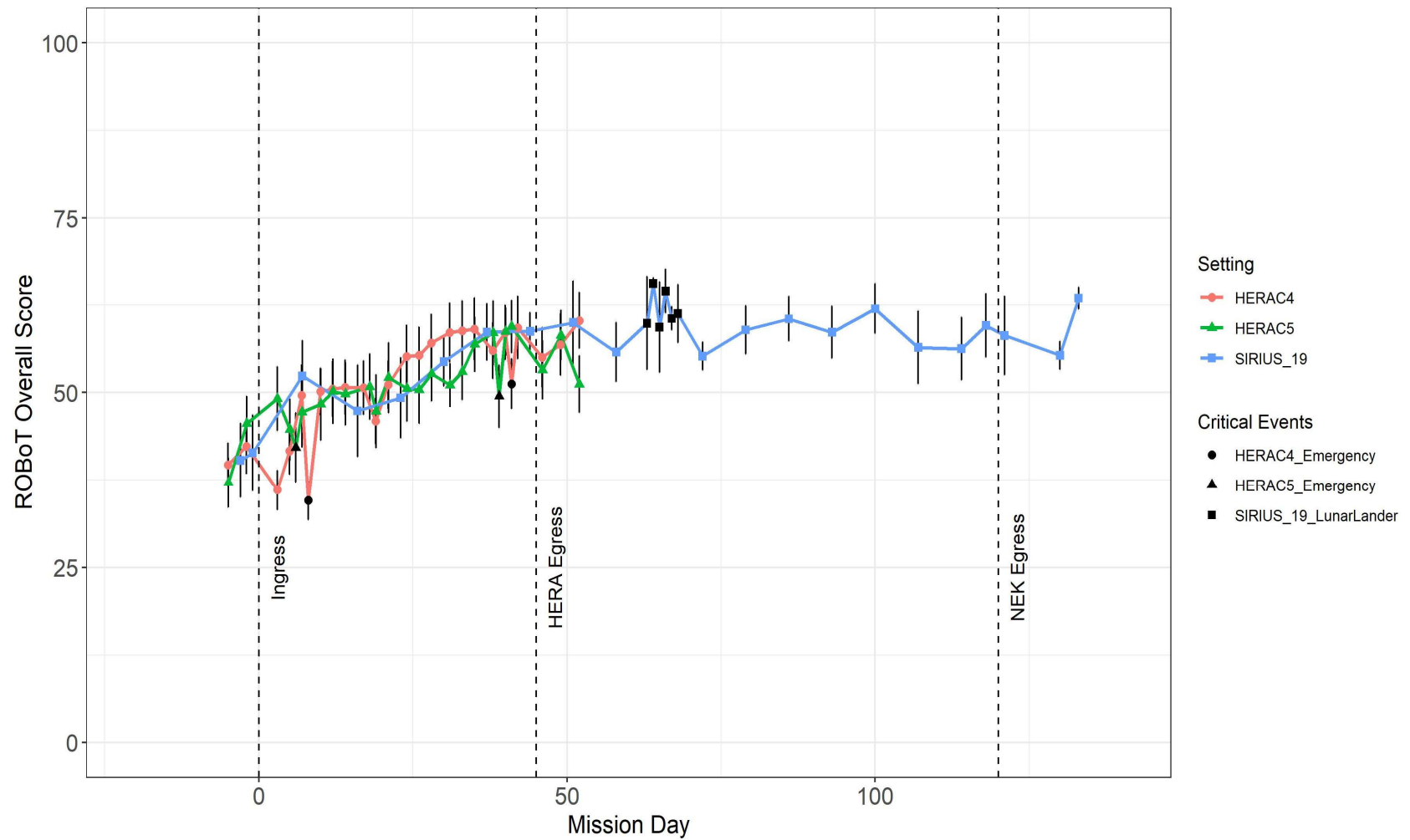


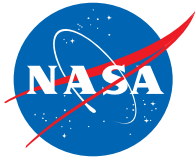
Morning Stress Ratings Across Research Settings





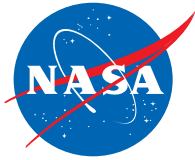
ROBoT-r, Operationally Relevant Performance Across Research Settings Over Time





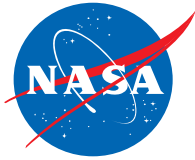
Example HFBP-EM Harmonization Results

- Sleep deprivation condition (HERA C4) associated with:
 - Increased psychological distress, particularly fatigue/inertia and mental fatigue
 - Worse performance over time on tasks of vigilant attention and spatial orientation only
 - No distinct effects on the operationally relevant performance task (ROBoT-r)
- Minimal symptoms of depression reported
- Critical event of a simulated lunar landing (SIRIUS19) was associated with performance changes in ROBoT-r and Cognition, but not with changes in sleep or ratings of mood and affect
- While on average social support was similar across analogs, some teams and individuals reported a substantial decline
- Across all settings and missions, teams rated themselves as high performing
- On average, ratings of stress and workload were higher from those on the ISS than those in analog settings
- On average, ratings of team processes and group living from those on the ISS were lower than those in analog settings
- Declines in psychological safety and team cohesion over time appear to be between-team differences rather than between-campaign differences (e.g., sleep deprivation)

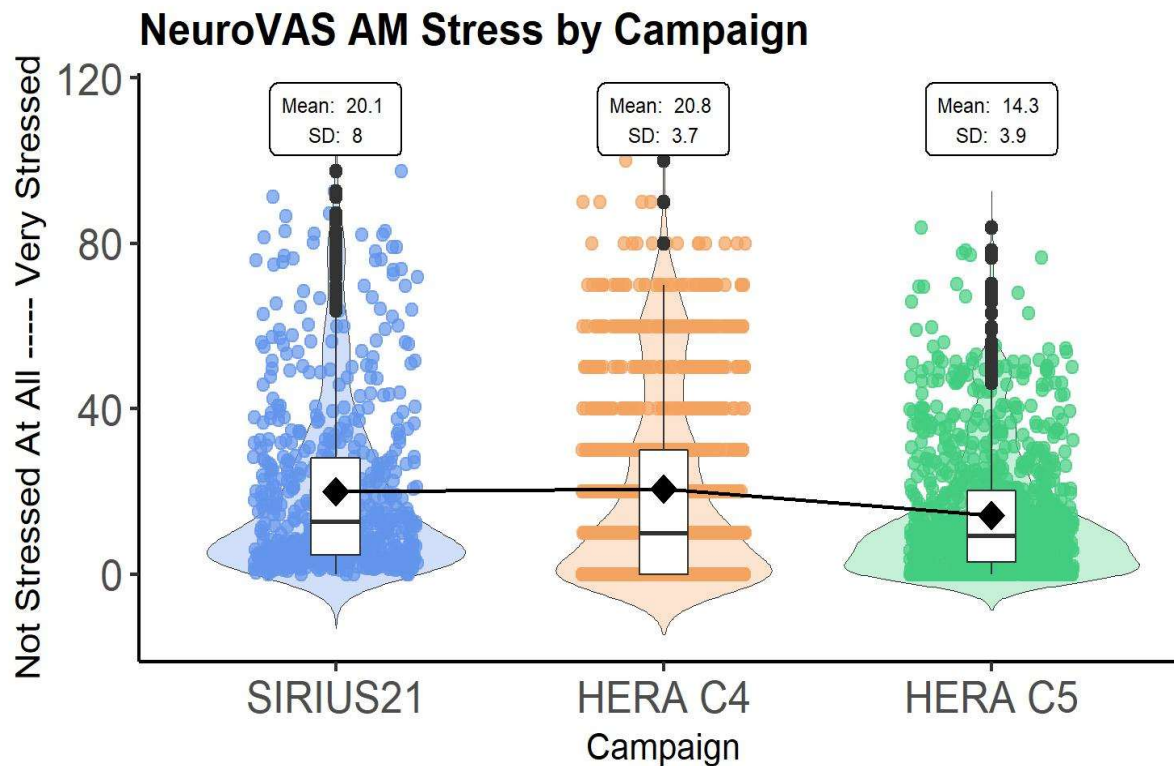


Current and Future Efforts for HFBP-EM

- Continued data collection and data collaboration (SIRIUS 21 *completed*, HERA C6, C7)



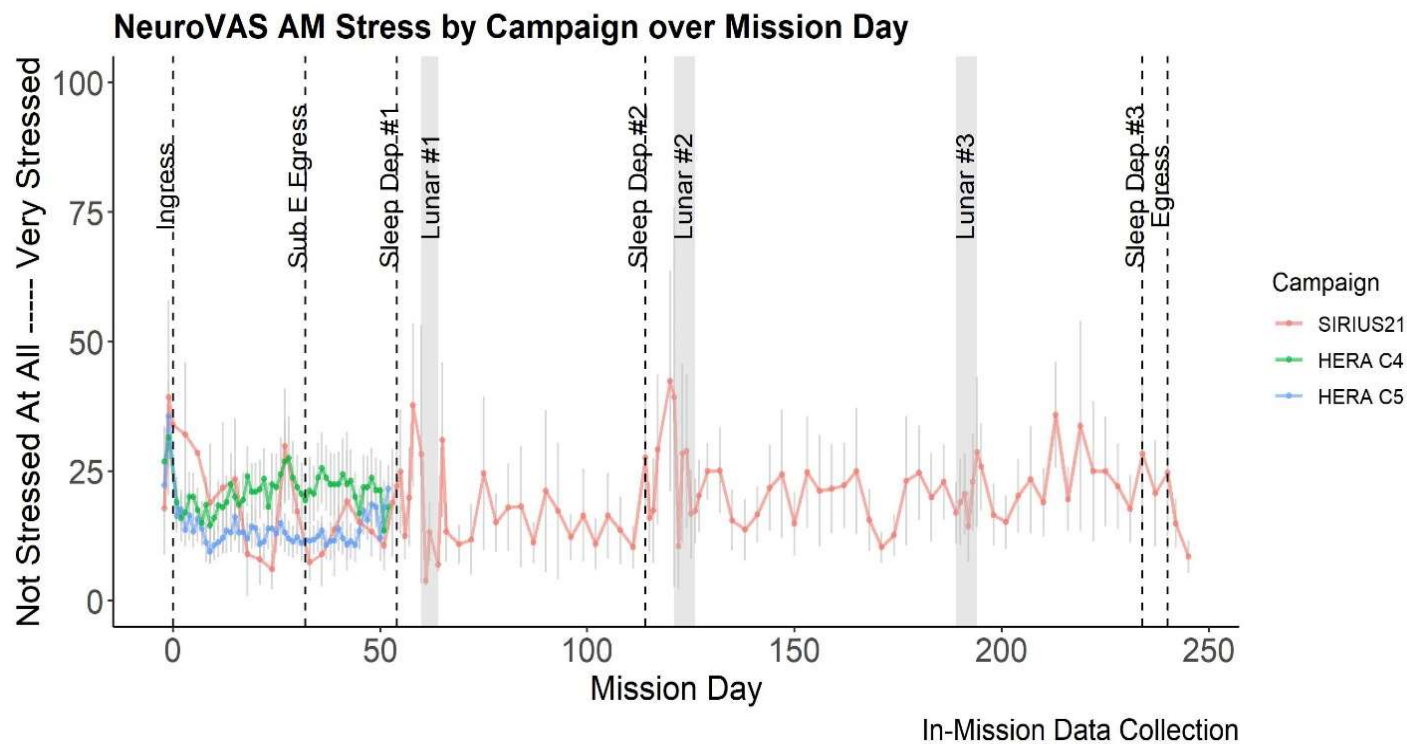
HFBP-EM in SIRIUS21



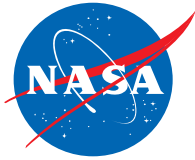
- 6 participants in living and working in NEK, Moscow, Russia for 240 days



HFBP-EM in SIRIUS21



- 6 participants in living and working in NEK, Moscow, Russia for 240 days



Current and Future Efforts for HFBP-EM

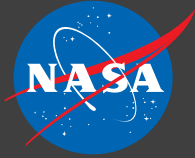
- Continued data collection and data collaboration (SIRIUS 21 *completed*, HERA C6, C7)
- Short form validation and refinement of HFBP-EM suite (HERA C6)
- Normative datasets to identify operationally relevant thresholds (i.e., norms)
- Publishing results from harmonized database
- Advanced statistical modeling



Underway: Human Factors and Behavioral Performance Research for Artemis II

Overarching Research Goal: To utilize Artemis II data to further define the likelihood and consequences of BMed, Team, HSIA, and Sleep Risks beyond LEO and to create a research infrastructure that can be expanded to include future Artemis missions.





Expedition 61 Astronauts

Questions?

Suzanne Bell, Ph.D.
suzanne.t.bell@nasa.gov