



Enabling Human Exploration Through International Cooperation

Jancy C. McPhee, Ph.D.
Associate Chief Scientist
NASA Human Research Program





NASA Attendees

David Bauman, Director, Human Research Program

Jancy McPhee, Associate Chief Scientist, Human Research Program

Sharmi Watkins, Artemis Chief Medical Officer

Makaela Mendrala, International Program Specialist

NASA's Human Health & Performance Mission Statement

Leading the global spaceflight
community in protecting
astronaut health and
enabling human
mission performance.



Space Medicine Operations

Maintain astronaut health

- Primary care
- Mission medical support
 - Preflight training
 - Inflight medical support
 - Postflight reconditioning
- Behavioral health support
- **Radiation monitoring**
 - Environment forecasting
 - Radiation exposure assessments
- **Clinic Operations**
 - JSC Occupational Health Clinic
 - Flight Medicine Clinic





Human Systems Engineering & Development

- Design, integration and technology development of systems to enable humans to live and work in space
- Human Factors
- Habitability systems
- Human System Integration
- Spacecraft Design
- Space Architecture
- Space Food Systems
- Advanced Food System Research
- Acoustics and Noise Control
- Lighting
- Program Integration

Biomedical Research & Environmental Sciences

- Assesses physiological and behavioral adaptation to spaceflight and planetary environments.
- Provides countermeasures that optimize astronaut health and performance before, during, and after space exploration.
- Assures safe vehicles and habitats for all phases of human space exploration through environmental monitoring
- Assures safe space suits that enables optimized human performance for space exploration

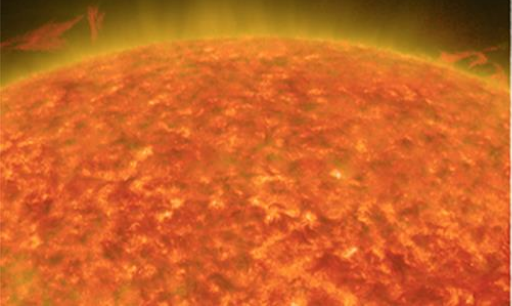


NASA's Human Research Program Mission Statement

To enable space
exploration beyond low
Earth orbit by reducing
the risks to human health
& performance

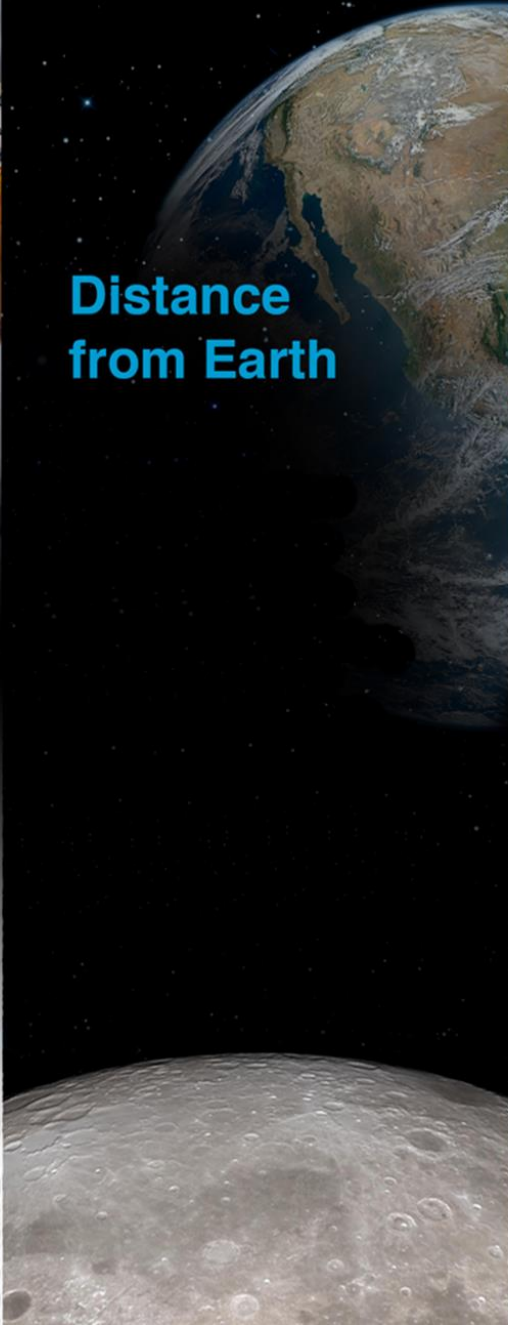


**Space
Radiation**



**Isolation and
Confinement**

**Distance
from Earth**

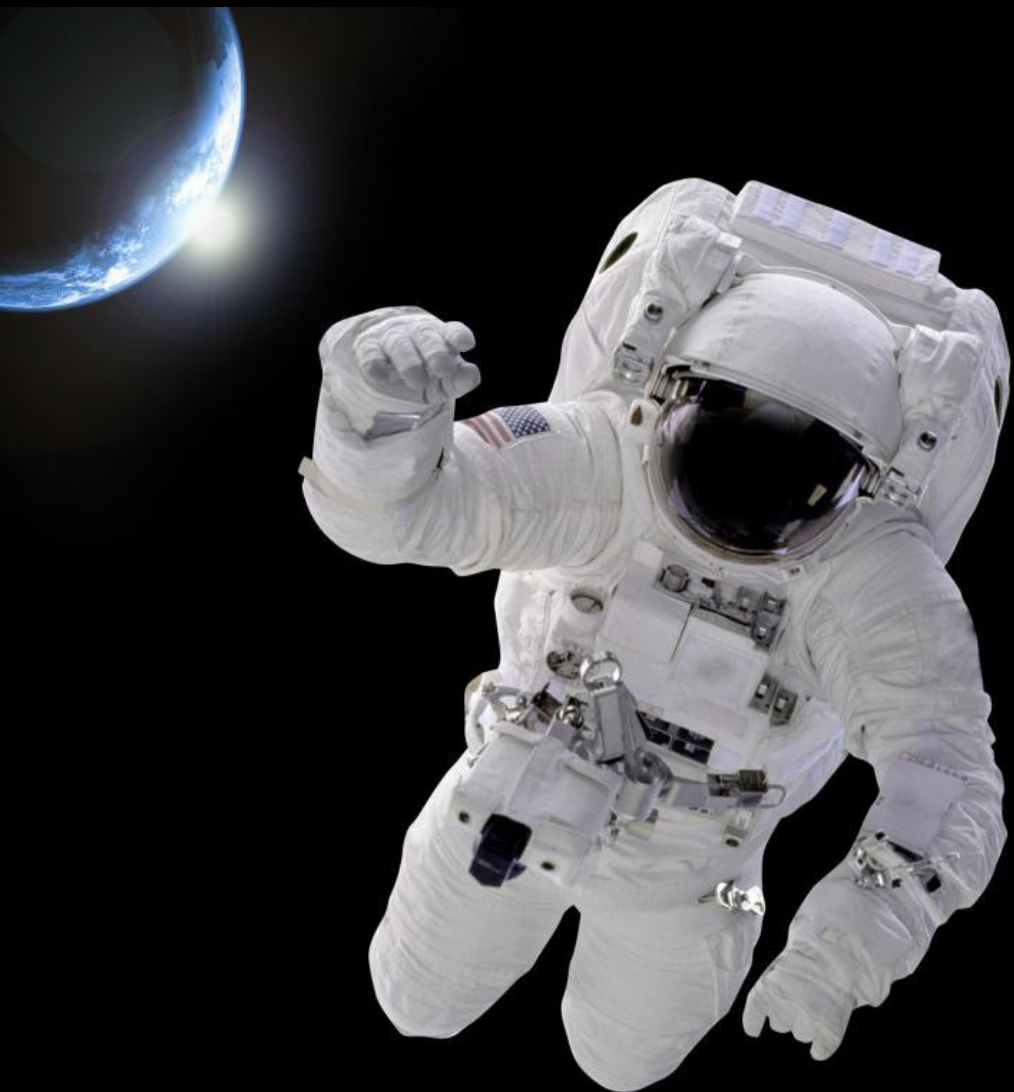


**Gravity
(or lack thereof)**

**Hostile/Closed
Environments**



Effects of Spaceflight on Human Physiology



Brain and vision
changes

Fluid shifts &
congestion
puffiness

Higher radiation
dose may increase
cancer and acute
syndromes

Blood plasma loss
and temporary
anemia upon return

Deterioration of
weight-bearing
bones and muscles

inner ear changes
and eye dominate
motion sensing

Altered sensory and
disorientation

Immune
dysregulation

Altered kidney
filtration and
possible kidney
stones via bone loss

Leg volume
decreases

Touch and pressure
sensors unloaded





Human Research Program

STEPS TO MARS



EARTH:

Ground Analogs of Spaceflight

LOW EARTH ORBIT:

International Space Station
Commercial Spaceflight Vehicles
Commercial Space Stations

LUNAR MISSIONS:

Orion
Gateway
Human Landing Systems
Lunar Outposts and Rovers



GROUND ANALOGS OF SPACEFLIGHT



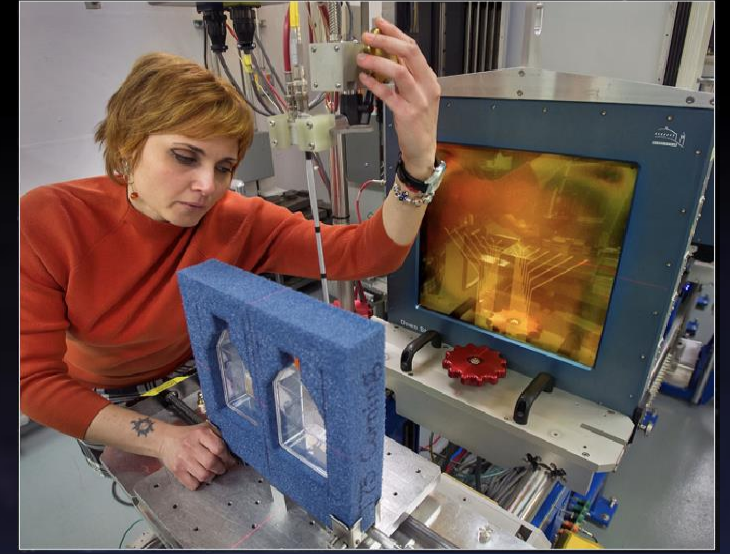
HERA



:envihab



NSRL



Antarctica



Kraken

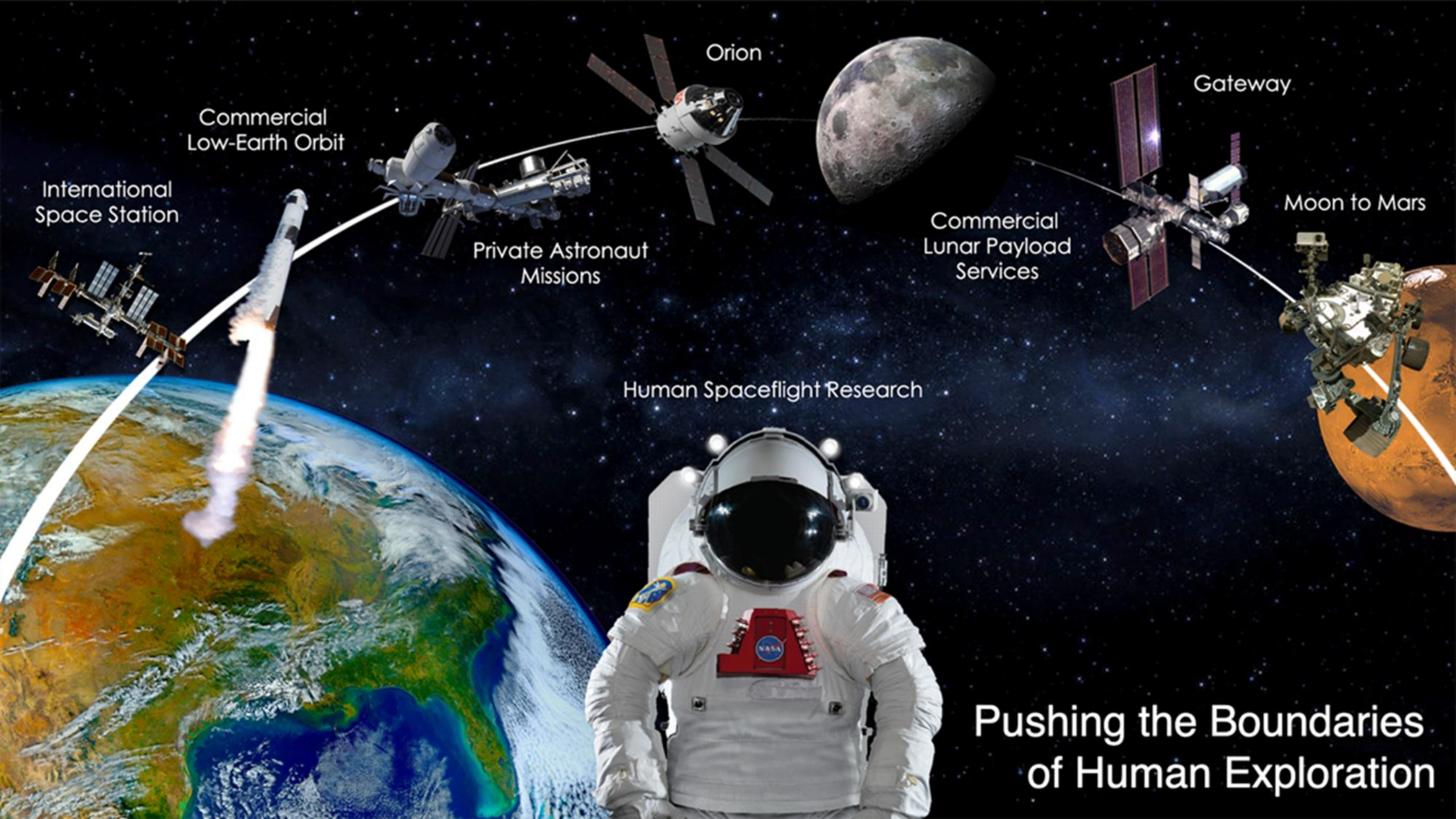


CHAPEA



Low Earth Orbit (LEO) Development





Commercial
Low-Earth Orbit

International
Space Station

Private Astronaut
Missions

Orion

Commercial
Lunar Payload
Services

Gateway

Moon to Mars

Human Spaceflight Research

Pushing the Boundaries
of Human Exploration



Lunar Missions Prepare Us for Mars

IN ORBIT



DEEP SPACE AGGREGATION

Assembling a complex ship in deep space



MARS TRANSIT HABITAT

Round the clock, years-long operations of a Mars-class habitat and life support system



ORBIT TO SURFACE OPERATIONS

Operating an orbiting outpost that deploys a lander and its crew to a planetary surface



COMMERCIAL RESUPPLY AND REFUELING

Leveraging the space logistics supply chain for industry provided cargo deliveries



CREW HEALTH & PERFORMANCE

Studying how the human body and mind adapt to deep space hazards

A roundtrip mission to Mars will take about two years—and once the ship's course is set, there's no turning back.

As much as is possible, lunar systems will be designed for dual Moon-Mars operations.

Integrated missions in the lunar vicinity prepare us for successful Mars missions

ON THE SURFACE



SPACESUIT ADVANCEMENTS

Improving spacesuit design across Artemis missions with astronaut input and private sector innovation



MOBILE OPERATIONS

Living and working 'on the go' inside a mobile habitat for weeks at a time



PLANETARY PROTECTION

Mitigating dust transfer and establishing pristine sample curation protocols



HUMAN ROBOTIC EXPLORATION

Robots pre-positioning surface assets and conducting reconnaissance for astronauts



HUMAN RESILIENCE

Learning how humans can survive and thrive in a partial gravity environment



Biggest Human Risks on Moon Missions

Medical Conditions

Dynamic Loads

Sensorimotor/Manual Control

EVA (Spacewalks)

Human Systems Integration



Biggest Human Risks on Mars Missions

Pharmaceuticals

Food & Nutrition

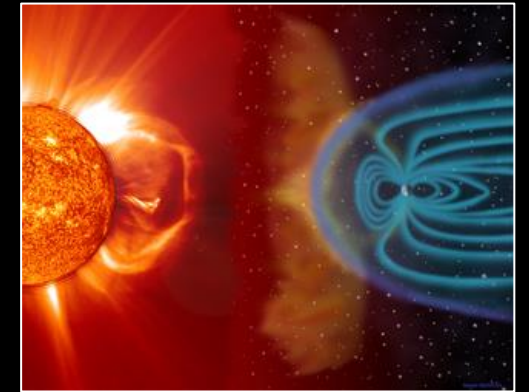
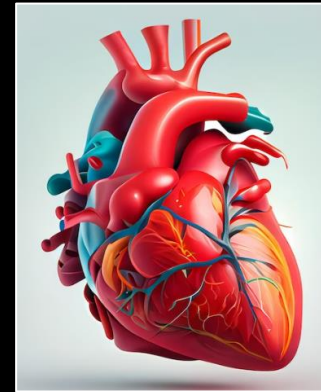
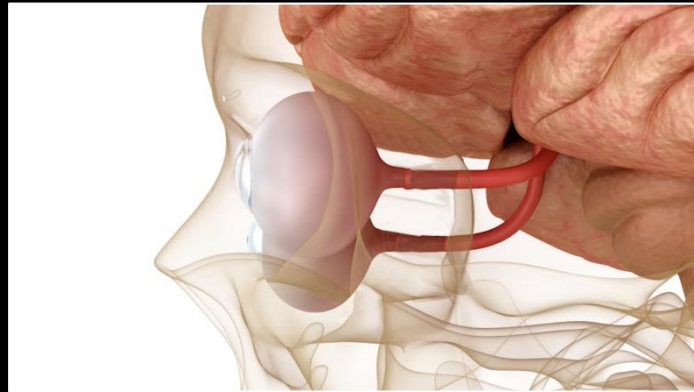
Team Dynamics

Behavioral Health)

Cardiovascular (Long term health)

Spaceflight Associated Neuro-ocular Syndrome

Cancer (Long term health)





Top Crew Health and Performance Challenges for Mars



Earth-Independent Human Operations



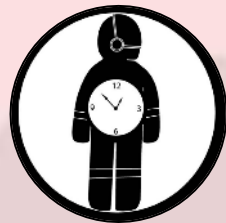
Computational Injury & Anthropometric Models



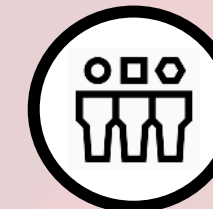
Mars Duration Food System



Exploration Exercise Countermeasures



Mars Duration Effects on Human Physiology



Understanding Individual Variability in Spaceflight



Risk Mitigations for Vehicle Atmospheres



Sensorimotor Countermeasures



Moon2Mars: HRP Partnerships



U.S. Gov. Education & Research Grants

- Outreach
- Working Groups



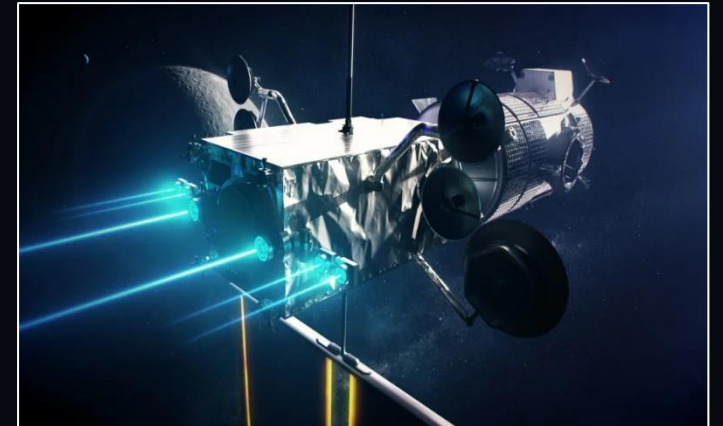
International

- Space Agencies
- Government Agreements



Commercial

- Commercial Crew Program
- Commercial Free-Flyers
- LEO Destinations



National Aeronautics and Space Administration

A decorative graphic on the left side of the slide. It features three overlapping circular segments: the top one is orange and textured like Mars, the middle one is grey and cratered like the Moon, and the bottom one shows a portion of Earth with blue oceans and green land. A thick, grey, curved arrow originates from the bottom left and points towards the right, passing behind the title text.

International Cooperation at NASA

International Cooperation is NASA's Heritage

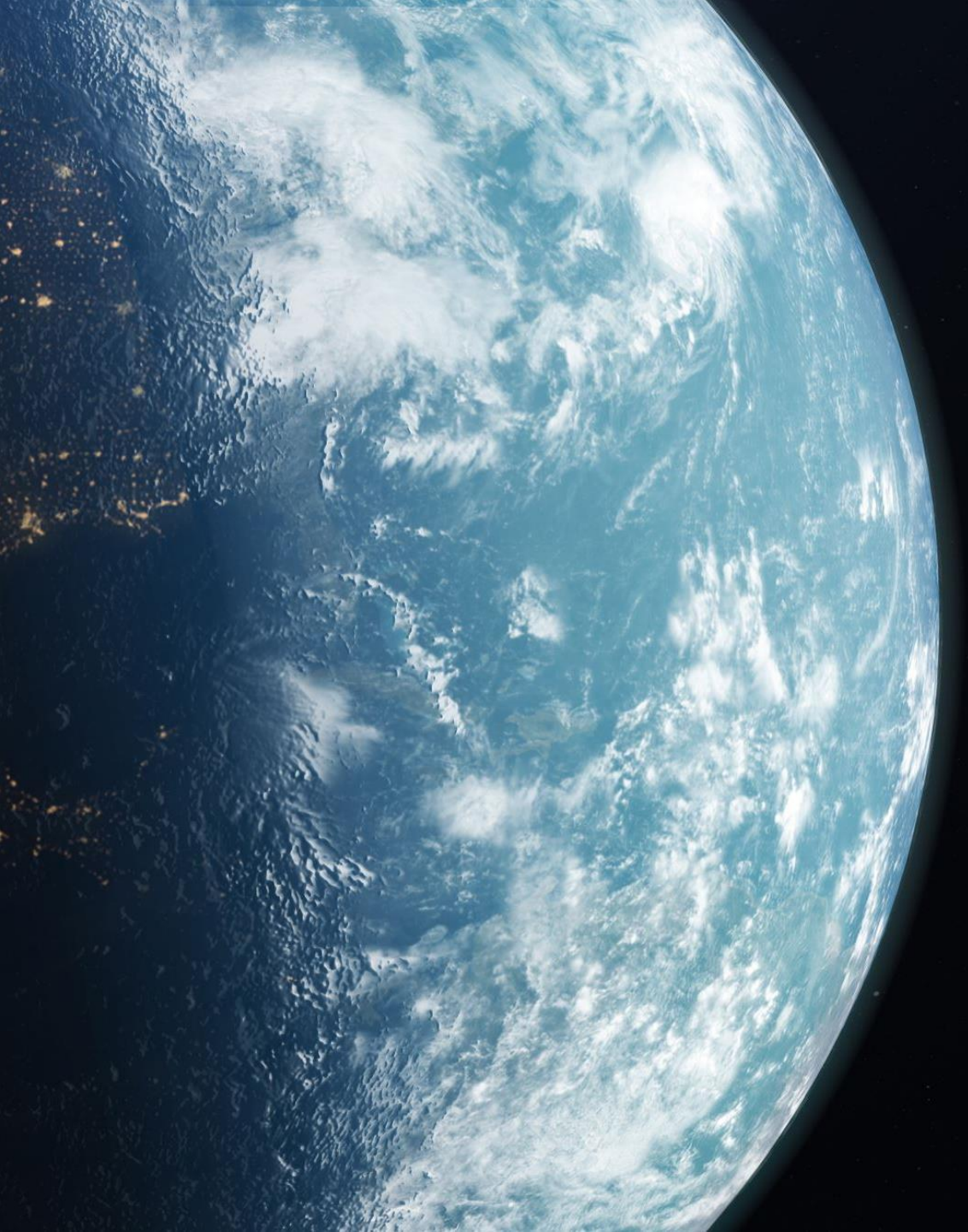
- Has been a cornerstone of NASA's activities throughout its history
- Directed by National Aeronautics and Space Act that created NASA in 1958
- Is strongly endorsed by the 2020 National Space Policy
- Includes over 6,700 total agreements with over 135 nations
- Brings multiple benefits to NASA and its partners
- Is pursued for a variety of reasons, through a combination of choice and necessity





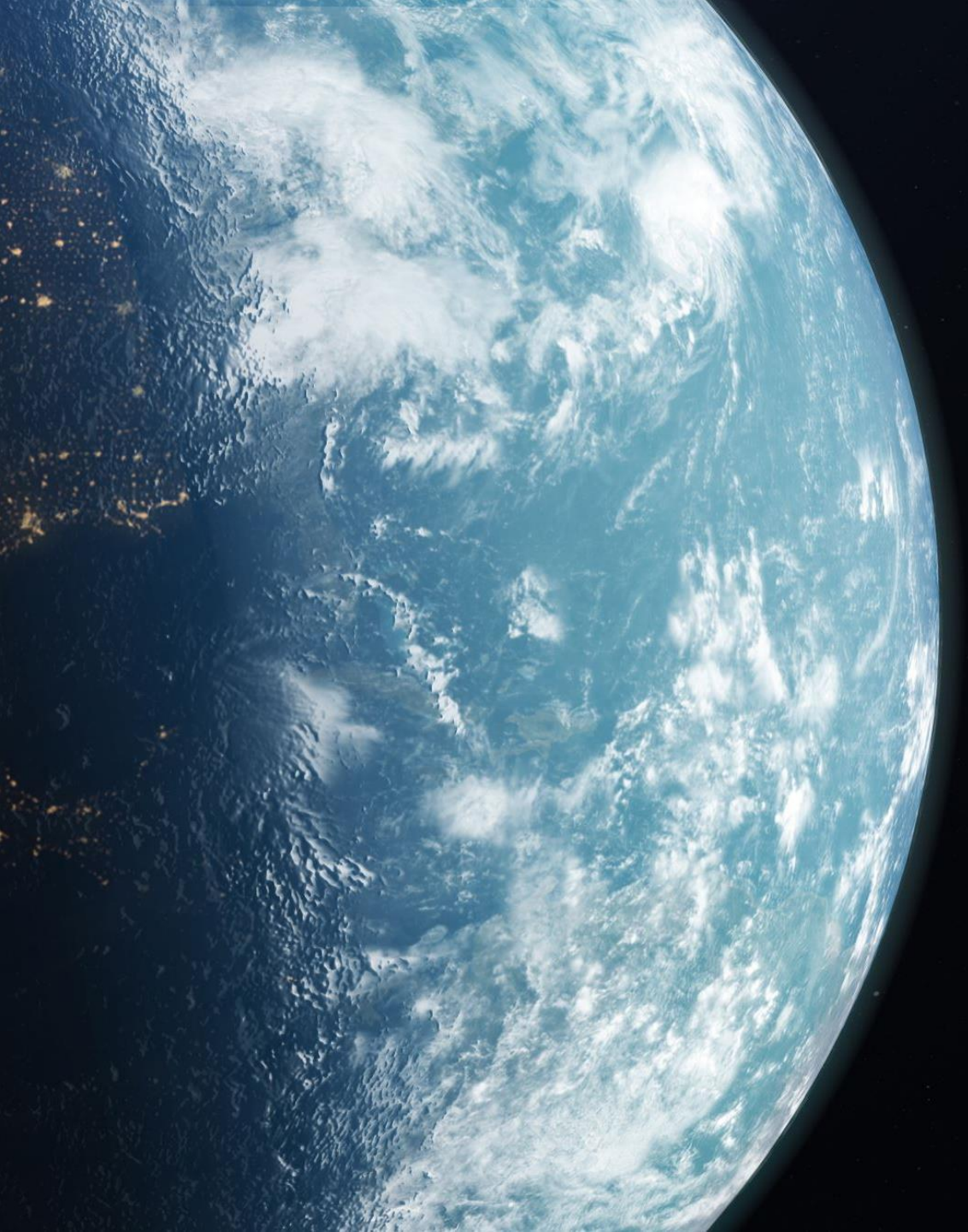
International Cooperation is NASA's Heritage

- About 730 active international agreements
- 9 partners account for 50% of the agreements (Japan, UK, Germany, France, Canada, Australia, ESA, Italy, and South Korea)
- By mission area: 60% are in science missions
- By region: nearly half with European space organizations
- All Mission Directorates have cooperative international programs



Guidelines for International Cooperation

- NASA international partners are generally government agencies due to significant investment levels and legal requirements.
- Each partner funds its respective contributions (no exchange of funds).
 - Contributions need not be equivalent.
 - NASA does not fund foreign researchers
- Cooperation must be consistent with U.S. foreign policy objectives.



Guidelines for International Cooperation

Projects/Partnerships:

- Must have scientific and technical merit
- Must demonstrate a specific benefit to NASA and support Mission Directorate activities
- Are structured to protect against unwarranted technology transfer
- Are structured to establish clearly defined managerial and technical interfaces to minimize complexity
- Are documented in a written, binding agreement, closely coordinated with the U.S. Department of State and other U.S. government agencies

ARTEMIS ACCORDS



United for Peaceful Exploration of Deep Space

International HRP Partnerships: The Road to Collaboration



- Form **relationships** between agencies or scientists
- Develop top-level **ideas** for mutually-beneficial research
- Identify **agreements** allowing more in-depth conversations
- Develop **detailed** collaboration and study design creation plans
- Identify **agreements** for detailed study plans for implementation, roles and responsibilities, data sharing, intellectual property, publication rights, etc.
- **Implement** study, analyze, and jointly publish and report



A man with a beard and glasses is speaking at a wooden podium. The podium has a sign that reads "CONFERENCE Center" and "THE NASA CASE HISTORY". Behind him is a large screen displaying a stylized illustration of a rocket launching from a space station, with a large red sun in the background and various stars and planets. The audience is visible in the foreground, silhouetted against the stage.

Joint International Opportunities

- Conferences and Meetings
 - Korea-U.S. Space Health Symposium (Sept. 2024)
 - International Astronautical Congress (October 2024)
 - Human Research Program Investigator's Workshop (January 2025)
- Space Platform Partner-Associated Forums
 - ISS-Associated
 - Gateway-Associated
- Targeted Virtual or In-Person Meetings

Existing HRP International Partners



وكالة الإمارات للفضاء
UAE SPACE AGENCY



Korea Disease Control and Prevention Agency
National Institute of Health



Ground-Based International Research Collaborations



CIPHER (Complement of Integrated Protocols for Human Exploration Research)

CIPHER seeks to assess the whole human response to time spent in space.



14 studies that evaluate:

- Bone and joint health
- Brain and behavior
- Cardiovascular system
- Exercise performance
- Sensorimotor systems
- Vision
- Biomarkers

The Goal : Extrapolate station data to predict effects on missions to the Moon, Mars, and beyond!

ISS4Mars Use Cases Recommended for Future Implementation



Earth-Independent Medical Operations



Earth-Independent Integrated Operations



Earth-Independent ECLSS/Food/Autonomy



Post-Landing Assessment



Lower-Body Negative Pressure Countermeasure

Growing a Community of Partners

- Guidance
 - Standardizing data types
 - Proper handling human data
 - IRB, consent
 - Human research complement limits
 - Data protection
- Advisory roles
 - Accelerators
 - Agency Roadmaps
- Emerging Space Agencies
 - Education
 - Ground analogs
 - Space – LEO and Commercial
 - Artemis



Partnering to Overcome the Challenges of Future Space Exploration

