Towards a Scientific Perspective for International Human-Robotic Space Exploration

IAC Jerusalem, 12 October 2015

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About ISECG

◆ ISECG is a non-political agency coordination forum of 14 space agencies
  • Website: www.globalspaceexploration.org

◆ Work collectively in a non-binding, consensus-driven manner towards advancing the Global Exploration Strategy
  • Provide a forum for discussion of interests, objectives and plans
  • Provide a forum for development of conceptual products
  • Enable the multilateral or bilateral partnerships necessary to accomplish complex exploration missions
  • Promote interest and engagement in space exploration among citizens and society

◆ ISECG operating principles
  • Open and inclusive
  • Flexible and evolutionary
  • Effective
  • Mutual interest
About the Global Exploration Roadmap

- The GER is a human space exploration roadmap, recognizing the criticality of increasing synergies with robotic missions while demonstrating the unique and important role humans play in realizing societal benefits.

- The non-binding document reflects a framework for agency exploration discussions on:
  - Common goals and objectives
  - Long-range mission scenarios and architectures
  - Opportunities for near-term coordination and cooperation on preparatory activities

- Since release of updated GER in August 2013, participating agencies have continued discussions and joint work in several areas which are of mutual interest:
  - Increase understanding of design reference missions for early mission themes

- Highlighting opportunities for the science community with a dedicated Science White Paper and within the GER itself is a priority.
GER Mission Themes

ISEC Mission Scenario

Low-Earth Orbit
- International Space Station
- Commercial or Government-Owned Platforms

Beyond Low-Earth Orbit
- Deep Space Missions
- New Horizons
- Space Science Missions

Exploration
- Human Exploration
- Robotics
- Cargo Missions

Mission Activities
- Characterize the composition of the asteroid
- Identify any resources and assess their potential for extraction
- Apply human evaluation capabilities to objects sampled for return to Earth laboratories
- Demonstrate sample collection, caching, storage, and crew transfer for future missions

Contributions to Mars Mission Readiness
- Demonstrations of the following core capabilities:
  - Entry, Descent, and Landing
  - Space, Launch System, and Operations
  - 30-50MW Solar Electric Propulsion

Exploration of a Near Earth Asteroid
- Visions for future surface operations
- Including landing operations
- Leading with human capabilities

Extended Duration Crew Missions
- Visits to an evolvable Deep Space Habitat in the lunar vicinity

Contributions to Mars Mission Readiness
- Demonstrate deep space exploration
- Mission planning and execution
- Human exploration readiness
- Autonomous crew operation capability
- Demonstrate operations with reduced support
- Increase experience with complex deep space surface operations
- Advance core technologies and mission planning strategies for long duration missions
- Demonstrate interactive human and robotic operations in a Mars-like environment
- Gain experience with solar electric propulsion used as a crew propulsion system

Humans to the Lunar Surface
- Using evolvable Deep Space Habitat as staging post

Mission Activities
- Test advanced surface power technologies
- Address high priority abilities of the science community which benefit from human surface presence
- Characterize human health and performance in a partial gravity environment
- Demonstrate long distance mobility concepts
- Explore concepts for human robotic partnerships in planetary surface exploration
- Utilize proven landing technologies demonstrated on robotic missions
- Explore landing sites of interest for extended durations

Contributions to Mars Mission Readiness
- Demonstrate staging operations with an Earth return vehicle
- Demonstrate extended crew mobility and habitation systems
- Demonstrate advanced power systems
- Characterize human health and performance in a partial gravity environment
- Demonstrate operational concepts and enhanced crew autonomy for surface exploration

10/08/2015
ISECG agencies acknowledge science communities as major stakeholders and scientific knowledge gain as important benefit of exploration activities.

- Scientists in general support GER and want to engage in the discussion.

Several agencies agreed in winter 2014/15 to facilitate interaction

- ASI, CNES, CNSA, CSA, DLR, ESA, JAXA, NASA, SSAU, UKSA (+ESF, SSERVI)

Objectives

- Coordinate interaction with the science communities on exploration planning and activities as required for the generation of ISECG products
- Advance the development of a Science White Paper for the articulation of science opportunities in the GER in conjunction with the science communities
Interaction with science communities present at major conferences / scientific events


Cross-Exchange between scientific groups and ISECG agencies

- COSPAR Panel for Exploration:
  - Joint workshop in February 2016 for review/input to Science White Paper
  - Joint session planned at the COSPAR Scientific Assembly in August 2016 to highlight SWP findings
- International Space Life Sciences Working Group (ISLSWG) inputs already reflected in GER2
Science White Paper – Concept & Scope

◆ Describe an international view of the science that could be enabled by human missions in the GER
  • Engage the scientific communities in identifying these opportunities
  • Target the same stakeholder community as the GER
  • Focus on human missions and human/robotic concepts
  • Incorporate activities that have feed-forward benefits to Mars exploration

◆ Incorporate interdisciplinary scientific topics that
  • Encompass all relevant science communities and disciplines: planetary science, space science, life sciences, astrobiology, astronomy, physical sciences, etc.
  • Span all destinations (LEO, cis-lunar space, Moon, asteroids, Mars)
  • Incorporate input from the international science communities
Apply a transparent, interactive process that stimulates discussion on science opportunities in preparation of GER3
Table of Contents (as of 10/2015) – total ~20 pages

◆ Scope & Purpose
  • Broad interaction between science communities and ISECG agencies

◆ Exec. Summary (2)
  • To be written

◆ 1. Linkage to GER (2)
  • GER approach
    - Connect to Goals & Objectives
    - Long-term horizon goal (Mars)
    - Near-term destination focus
  • Human-robotic partnership / Value of human presence

◆ 2. Science Topics (2)
  • Introduce topics
  • Spans all destinations
  • Incl. many scientific disciplines

◆ 3. Cislunar Deep Space Habitat (4)
◆ 4. NEA in Cislunar Space (4)
◆ 5. Lunar Surface (4)
  • Each chapter 3-5 to highlight
    - Short summary of the mission theme including DRMs
    - Scientific opportunities structured by science topics
    - Science findings

◆ Conclusion (1)
◆ References (1)
  • E.g. GER2, COSPAR PEX, Decadal Surveys, MEPAG report, ILEWG, others, …
SWP Science Topics

◆ Living and working in space
  • Overarching questions:
    - How do we become a spacefaring species?
    - How do we sustain life outside Earth?
  • Disciplines involved, e.g.
    - Human physiology, life sciences and life support
    - Prospecting and utilising local resources

◆ Our place in the universe
  • Overarching question:
    - How do terrestrial planets form and evolve?
    - How does life evolve in the planetary environment?
  • Disciplines involved, e.g.
    - Astronomy
    - Planetary geology
    - Solar physics, space physics
    - Astrobiology (understanding the building blocks of life)
Science Enabled by Humans to a Cislunar Habitat

- Human-assisted lunar sample return
  - Increased return through more and improved selection of lunar samples
- Construct and/or service large space telescopes
- Understand combined effects of radiation/reduced-gravity/isolation on humans
- Monitor Earth’s climate to help design exoplanet observing instrument
- Facilitate access to challenging regions by low-latency telerobotics (e.g. permanently shadowed crater floors)
  - Telerobotics experience useful for Mars exploration
Science Enabled by Humans to a NEA

◆ Sample return provides key science
  • Humans permit careful selection of samples for high sample quality
  • Larger sample return mass compared to robotic missions
  • Increase the value of the current meteorite collections
  • Provide an archive of samples for analyses that must be done on Earth

◆ Increased surface access
  • Multiple drilling sites
  • Exposure ages at different depths

◆ Instrument deployment
  • Placing instruments on the surface enabled by humans
  • Long-term instrument deployment
Science Enabled by Humans to the Lunar Surface

◆ Sample return provides key science
  • Humans best at identifying scientifically important samples
  • Improve our understanding of impact cratering
  • Provide insight into the evolution of the terrestrial planets
  • Study the history of the Sun

◆ Understand lunar volatiles
  • Record of the flux and composition of volatiles
  • Help answer astrobiological questions
  • Install and maintain resource utilization equipment (i.e. generate water)

◆ Emplacement of delicate or large astronomical instruments

◆ Understand the physiological effects of the lunar environment on human health, contributing to medical benefits on Earth

◆ Understand how plants and other non-human forms of life adapt to, or can be protected from, the conditions on hostile planetary surfaces

◆ Feed-forward activities (using the Moon as a gateway to the Solar System)