

COSPAR/ISECG Workshop on the Scientific Perspectives for the Global Exploration Roadmap

*Co-organized by the COSPAR Panel on Exploration (PEX)
and the ISECG Science Working Group (SWG)*

Introduction

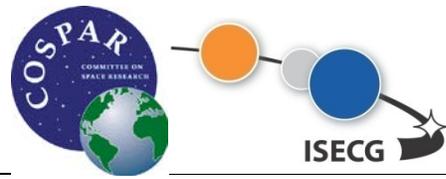
Ambitious plans to build new space infrastructure, transport systems, and space probes require international cooperation to create a sustainable long-term space exploration program. Space agencies are seeking synergies on priorities, objectives, and approaches for future exploration of space. Furthermore, an increasing number of countries and organizations show interest in participating in future space exploration efforts. There are currently many independent groups planning activities related to future space exploration scenarios of the Earth-Moon-Mars space addressing different stakeholders. A prominent coordination forum has recently been the International Space Exploration Coordination Group (ISECG), which published the second iteration of the Global Exploration Roadmap (GER) in 2013.

As a forum of 15 leading space agencies, ISECG is the visible and credible forum for coordinated discussion between the participating agencies. The Global Exploration Roadmap provides insights into agencies' exploration planning while seeking broad stakeholder feedback on the potential future mission themes, infrastructure and preparatory activities. As an element of the continued roadmapping effort, the ISECG agencies are soliciting input from and coordinating discussion with the scientific communities to better articulate and promote the scientific opportunities of the proposed GER mission themes, i.e. the exploration of the lunar surface, extended duration stays in cislunar space and visits to Near-Earth asteroids. An improved understanding of the scientific drivers and the requirements to address priority science questions associated with these exploration destinations (Moon, Near-Earth Asteroids, Mars and its moons) as well as the preparatory activities in cis-lunar space is beneficial to optimize the partnership of robotic assets and human presence beyond low Earth orbit.

For this workshop ISECG participating agencies and COSPAR, as one major representative of the science community, joined forces to discuss the basic framework for strategic scientific perspectives for the Global Exploration Roadmap as well as the contents and way forward for the development of a Science White Paper (SWP) to highlight the opportunities in early exploration missions.

Workshop Overview

The workshop on the scientific contents of (human) exploration missions took place on 10-11 February 2016 at CNES Headquarters in Paris. The workshop was co-organized by the Science Working Group of ISECG and the Panel on Exploration of COSPAR, with significant involvement from the European Science Foundation and NASA's Solar System Exploration Research Virtual Institute. Participation was free of charge and openly communicated to the scientific communities worldwide together with targeted direct invitations to ensure international representation of diverse



scientific disciplines. 43 participants attended the workshop including scientists from different countries and representatives from space agencies (NASA, CSA, ESA, CNES, DLR, ISRO ...). A preliminary draft of the Science White Paper had been distributed to the workshop participants in advance in order to prepare the discussions in the workshop sessions that were structured along the SWP (see Workshop Agenda below). Thus, the participants came well-prepared and engaged thoroughly during both workshop days.

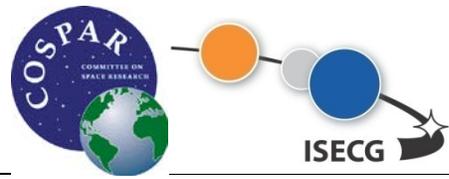
After welcome messages to the participants from the co-organizers, host and supporters of the event, representatives from the ISECG agencies and from its Science Advisory Group introduced the Global Exploration Roadmap as well as the scope and status of the SWP development. This set the scene for consecutive sessions on the SWP draft contents and structure, each co-chaired by science representatives, where many lively discussions were held.

After Session 1 addressed the overarching science topics for exploration, the following Sessions 2-4 on the science opportunities within each ISECG mission theme each focused around the following points:

- Do the SWP chapters miss science elements?
- Is there agreement/disagreement or need for further elaboration for any of the proposed science?
- What needs to be considered when editing the SWP for release?
- What are chapter highlights?
- What are links between scientific activities at different destinations or within different mission themes?

Wednesday, 10 February 2016		
10:00	Welcome	CNES, COSPAR, PEX, ISECG
10:15-10:35	Introduction to GER and Scope of the Science White Paper (SWP) Development	Juergen Hill Francois Spiero
10:35-11:00	Overview and Status of the Science White Paper (SWP)	Ben Bussey Jean-Claude Worms
11:00-12:30	Session 1: Science Topics for Exploration	Ben Bussey Jean-Claude Worms
12:30-14:00	Lunch (Au Chien Qui Fume)	
14:00-15:30	Session 2: Science Opportunities of a Cis-lunar Deep Space Habitat	Ben Bussey James Carpenter
15:30-16:00	Coffee Break	
16:00-17:30	Session 3: Science Opportunities at a Near Earth Asteroid in Cis-lunar Space	Jean-Claude Worms Stephan Ulamec
Thursday, 11 February 2016		
09:00-10:30	Session 4: Science Opportunities on the Lunar Surface	Ian Crawford James Carpenter
10:30-11:00	Coffee Break	
11:00-12:30	Session 5: Mars Perspectives	Nicole Buckley Richard Bonneville
12:30-14:00	Lunch (Buffet)	
14:00-16:00	Session 6: Open discussion & Synthesis	Pascale Ehrenfreund Ben Bussey Jean-Claude Worms

Final agenda of the COSPAR/ISECG Workshop



Workshop Findings and Recommendations

The following paragraphs summarize only some elements of the discussions from the sessions:

- Session 1:
 - The participants strongly recommended to sufficiently address the rationale for scientific exploration early in the SWP document. This element of “Why Explore?” is crucial for decision-makers.
- Session 2:
 - A general concern about using the terminology “cislunar” in a public document for potentially uninformed readers was raised. A better description for the location of these activities should be used.
 - The participants largely agreed that the SWP chapter on cislunar space needs to focus on relevant science in the lunar vicinity and that requires the infrastructure of the deep space habitat, while discussion of ancillary science (e.g. Earth observation) should be limited. Otherwise there is a risk of overselling the mission theme. A “less is more” approach should be regarded.
 - While astronauts are enablers and operators of various activities in the Earth-Moon space, their role as subjects of medical research should not be neglected. Careful wording needs to be chosen.
- Session 3:
 - Scientific objectives vary depending on the type of asteroid. The difference needs to be addressed along with the necessity to study various types of near-Earth asteroids for complementary science.
 - The ISECG mission theme highlighted particularly the asteroid redirect mission concept currently developed in the US. The participating scientists expressed the opinion that full-scale asteroid exploration is required to address the science objectives and that the investigation of a retrieved boulder would not allow for large science return.
- Session 4:
 - The participants agreed that the lunar surface provides a much stronger science case than the other two mission themes.
 - Polar areas on the Moon were highlighted as a promising start point for scientific exploration while recognizing that global access is the long-term goal.
 - Aspects of astrobiology and planetary protection science are not sufficiently addressed in the current SWP draft.
 - The participants agreed that humans provide a clear benefit over robotic explorers when it comes to surface exploration, sampling, sample selection and context analysis. They also stressed that a scientists on the lunar surface would further increase scientific return and that the selection of scientists as astronauts is highly recommended.
- Session 5:
 - Mars forward science has to be defined on the basis of the science done in the previously discussed mission themes. Mars science could provide a frame for the SWP by highlighting it in the introductory chapters as well as in the conclusions.
 - For each mission theme chapter, call-out boxes could be used in the SWP to address Mars forward science.

- Session 6:
 - Regarding the overall structure of the SWP, the participants discussed the relationship of the three mission themes and the role of the ISECG reference missions in enabling the science opportunities. It was proposed to discuss science opportunities with respect to extended duration stays in the lunar vicinity, asteroids and the lunar surface in their respective chapters without using the GER reference missions. Instead, those reference missions should be discussed in a separate chapter as a filter to the opportunities identified before. This approach would increase the robustness of the SWP to programmatic changes and inform GER-3 development.
 - Due to the strong case for lunar surface exploration, it was recommended to re-order the mission theme chapters as 1) Lunar surface, 2) Extended duration mission in lunar vicinity, 3) Near-Earth asteroid.
 - The number of pages available to the mission theme chapters does not need to be distributed evenly, but it could be distributed according to the scientific case and the number of opportunities identified for each.

The workshop findings and recommendations will serve as an input to the finalization of the ISECG Science White Paper, due for publication in the fall of 2016, and to the refinement of the 3rd version of the GER (expected to be released in 2017).

Workshop Image



International participants of the COSPAR/ISECG Workshop in Paris