The COSPAR Panel on Planetary Protection

Athena Coustenis (Paris Observatory, CNRS), Chair
Gerhard Kminek (ESA), Vice-Chair
Niklas Hedman (UNOOSA), Vice-Chair

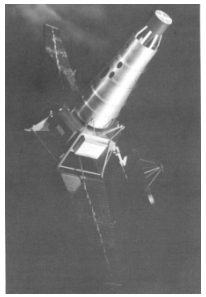
History of planetary protection

"…we are in the awkward situation of being able to spoil certain possibilities for scientific investigations for a considerable interval before we can constructively realize them…we urgently need to give some thought to the conservative measures needed to protect future scientific objectives on the moon and the planets…" J. Lederberg and D. B. Cowie, *Science*, 1958

→ Reflects the concern raised by the International Astronautical Federation (IAF), UN-COPUOS and US National Academy of Science (NAS) in this time period that lead to the Committee on Contamination by Extraterrestrial Exploration (CETEX), established by the International Council of Scientific Unions (ICSU)

→ ICSU adopts the CETEX Code-of-Conduct and established the Committee on Space Research (COSPAR)

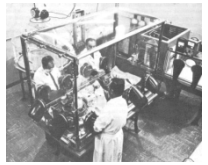
→ COSPAR established the Consultative Group on Potentially Harmful Effects of Space Experiments



→ The first spaceflight missions to use this Code-of-Conduct were the Ranger missions in 1961

→ Since then, all planetary missions had to implement planetary protection measures at different degrees – ranging from simple documentation to terminal sterilization of entire flight systems

→ More detailed quantitative regulations, in particular for Mars, were adopted by COSPAR in 1964 (e.g., C. Sagan and S. Coleman, *Astronautics & Aeronautics*, 1965; C. Sagan, E. C. Levinthal, J. Lederberg, *Science*, 1968)

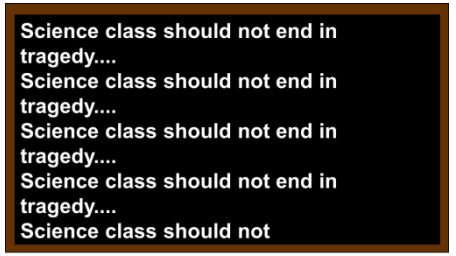


Credit: NASA SP 4210

Rationale for planetary protection

Ensure that scientific investigations related to the origin and distribution of life are not compromised

→ *Protect our investment in space science & exploration*
→ *Unique opportunity to learn more about the origin of life in a way that is no longer possible on Earth*



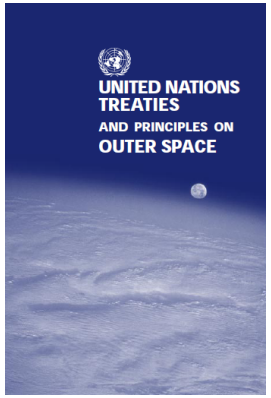
Bart Simpson, Dec. 17, 2000, "Skinner's Sense of Snow"

Protect the Earth from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission

→*Simple prudence - protect the Earth!*
→*In line with the precautionary principle of environmental protection*

Framework for planetary protection

The legal basis and the goal for planetary protection was established in Article IX of the United Nations Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (Outer Space Treaty)



Article IX "...parties to the Treaty shall pursue studies of outer space including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose..."

States are responsible for their national space activities, whether governmental or non-governmental, in accordance with Article VI of the Outer Space Treaty

Article VI: "States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty."

COSPAR at a glance

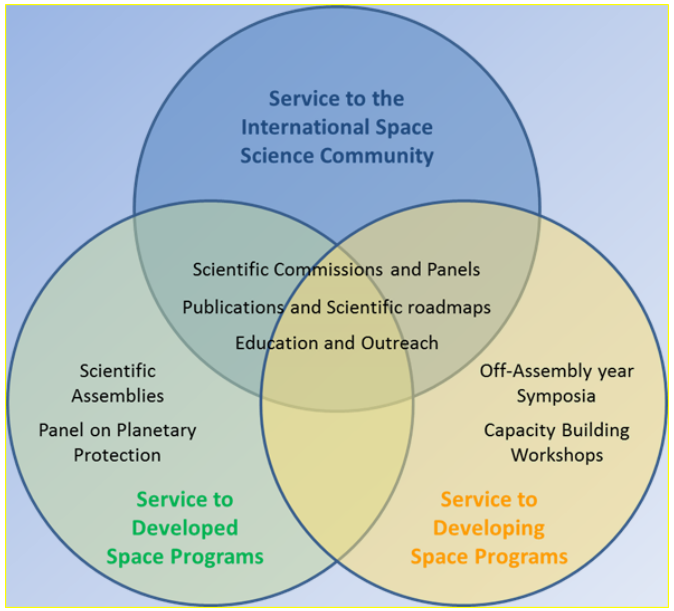
The **Purpose** of COSPAR, by its Charter from the International Council for Science (ICSU), is to promote at an international level scientific research in space, with emphasis on the exchange of results, information and opinions, and to provide a forum, open to all scientists, for the discussion of problems that may affect scientific space research

The **Objectives** of COSPAR are achieved mainly through the organization of scientific assemblies and publications

The **Organizational Structure** of COSPAR consists of:

- Scientific Commissions - representing each and every scientific discipline involved in space research

- Panels - designed to deal with crosscutting issues that can affect particular segments of the international space research community, and often for which there is an urgent need for input



COSPAR planetary protection policy

A special case among the Commissions and Panels in the COSPAR structure is the Panel of Planetary Protection which serves an important function for space agencies pursuing the exploration of the planets. COSPAR PPP maintains and promulgates a planetary protection policy for the reference of spacefaring nations to guide compliance with the Outer Space Treaty ratified today by 110 nations, i.e.

The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized.

In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission.

COSPAR Panel on Planetary Protection

- The primary objective of the Panel within COSPAR is to develop, maintain, and promote the COSPAR policy and associated requirements that must be achieved to protect against the harmful effects of forward and backward contamination.
- This policy must be based upon the most current, peer-reviewed scientific knowledge, and should enable the exploration of the solar system, not prohibit it.

Scope and Objectives of the Panel on Planetary Protection

- It is not the purpose of the Panel to specify the means by which adherence to the COSPAR planetary protection policy and associated guidelines is achieved; the best and most cost effective means to adhere to the COSPAR planetary protection requirements is reserved to the engineering judgment of the organization responsible for the planetary mission, subject to certification of compliance within the COSPAR planetary protection requirements by the national or international authority responsible for compliance with the UN Outer Space Treaty.
- However, the Panel should make every effort, through symposia, workshops, and topical meetings at COSPAR Assemblies, to provide an international forum for the exchange of information on the best practices for adhering to the COSPAR planetary protection requirements.
- Through COSPAR the Panel will inform the international community, e.g., the Committee on the Peaceful Uses of Outer Space (COPUOS) of the United Nations, as well as various other bilateral and multilateral organizations, of policy consensus on planetary protection.

COSPAR Panel on Planetary Protection ToRs

- The Terms of Reference ensure a good balance between representatives appointed by space agencies and scientists
- The Panel, led by a Chair with the support of two Vice Chairs, consists of appointed members who represent national or international space agencies and representatives of COSPAR Scientific Commissions B – *Space Studies of the Earth-Moon System, Planets and Small Bodies of the Solar Systems*, and F-*Life Sciences as Related to Space*.
- The COSPAR Bureau formally appoints the Panel leadership and members.

Panel on Planetary Protection Membership

- Chair: Athena Coustenis
- Vice-Chairs: Niklas Hedman (UNOOSA) and Gerhard Kminek (ESA)

- Nine members appointed by space agencies:

France/CNES	Michel Viso
Germany/DLR	Petra Rettberg
India/ISRO	Praveen Kumar K
Italy/ASI	Eleonora Ammannito
Japan/JAXA-ISAS	Masaki Fujimoto
Russia	Vyacheslav K. Ilyin
USA/NASA	James Green
UKSA	Karen Olson-Francis
China/CNSA	TBA

- Nine scientists representing members of SC B and SC F

Olivier Grasset (France, SC B)	Alex Hayes (USA, SC B)
Maria-Paz Zorzano (Sweden/Spain, SC B)	Maxim Zaitsev (Russia, SC B)
Olga Prieto-Ballesteros (Spain, SC B)	Akihiko Nakamura (Japan, SC B&F)
François Raulin (France, SC F)	Peter Doran (USA, SC B)
Kanyan Xu (CAST)	

- Ex-officio member: Colleen Hartman, NASEM SSB & ASEB Board Director

Panel on Planetary Protection Membership

- New structure : Open Session with presentation and discussion open to interested parties (including private sector: i.e. Space X and Blue Origin)
  and Closed Session for further deliberations and decisions
  - *2-3 meetings per year and several teleconferences*

New COSPAR Policy updated official document published in the August 2020 Space Research Today issue

https://cosparhq.cnes.fr/scientific-structure/ppp

Planetary Protection of the Outer Solar System (PPOSS)

→ European Commission funded a project led by the European Science Foundation with DLR/Germany, INAF/Italy, Eurospace, Space Technology/Ireland, Imperial College London (UK), China Academy of Space Technology (partner), and NAS-SSB (observer)

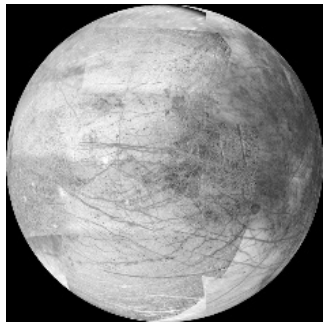
→ Recommended a revision of the planetary protection requirements for missions to Europa and Enceladus, based partly on the NAS-SSB 2012 Icy Bodies Report

→ The PPOSS recommendations were presented to the ESA PPWG and to COSPAR

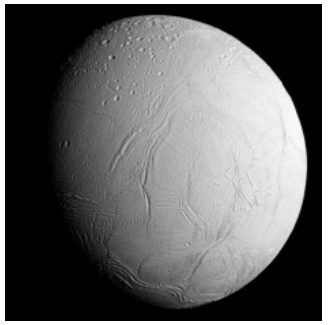
→ The ESA PPWG submitted a written assessment of the PPOSS recommendation to COSPAR

→ COSPAR was involved throughout the multi-year-long process and at the end updated the requirements for missions to Europa and Enceladus

New COSPAR Policy updated official document published in the August 2020 SRT issue



Credit: NASA/JPL/Galileo



Credit: NASA/JPL/Cassini

- *Policy should include a generic definition of the environmental conditions potentially allowing Earth organisms to replicate*
- *implementation guidelines should be more specific on relevant organisms*
- *implementation guidelines should be updated to reflect the period of biological exploration of Europa and Enceladus*
- *implementation guidelines should acknowledge the potential existence of Enhanced Downward Transport Zones at the surface of Europa and Enceladus.*

Martian Moons eXploration (MMX- JAXA)

→ ESA and JAXA studied sample return missions from Phobos and Deimos

→ To support a categorization, ESA initiated an activity with a science consortium to evaluate the level of assurance that no unsterilized martian material naturally transferred to Phobos (or Deimos) is accessible to a Phobos (or Deimos) sample return mission

→ NASA supported the activity from the very beginning providing test materials and expert advice

→ At a later stage, JAXA started their own experimental and modelling work supporting the overall assessment

→ The ESA-JAXA-NASA coordinated activities completed with an independent review by the NAS and the European Science Foundation

→ The result of the ESA-JAXA-NASA coordinated activities and the result of the NAS-ESF review were presented to the ESA Planetary Working Group (PPWG) and to COSPAR

→ The ESA PPWG submitted a written assessment of the proposed categorization to COSPAR

→ COSPAR was involved throughout the multi-year-long process and at the end assigned a planetary protection category specifically for the MMX mission (outbound Cat III and inbound Cat V: unrestricted Earth return)

Reporting to COSPAR

It is recommended that COSPAR members inform COSPAR when establishing planetary protection requirements for planetary missions, and

also that COSPAR members provide information to COSPAR within a reasonable time not to exceed six months after launch about the procedures and computations used for planetary protection for each flight and again within one year after the end of a solar-system exploration mission about the areas of the target(s) which may have been subject to contamination.

Reports should include, but not be limited to, the following information:

1. *The estimated bioburden at launch, the methods used to obtain the estimate (e.g., assay techniques applied to spacecraft or a proxy), and the statistical uncertainty in the estimate*
2. *The probable composition (identification) of the bioburden for Category IV missions, and for Category V "restricted Earth return" missions*
3. *Methods used to control the bioburden, decontaminate and/or sterilize the space flight hardware*
4. *The organic inventory of all impacting or landed spacecraft or spacecraft-components, for quantities exceeding 1 kg*
5. *Intended minimum distance from the surface of the target body for launched components, for those vehicles not intended to land on the body*
6. *Approximate orbital parameters, expected or realized, for any vehicle which is intended to be placed in orbit around a solar system body*
7. *For the end-of-mission, the disposition of the spacecraft and all of its major components, either in space or for landed components by position (or estimated position) on a planetary surface*

Planetary protection categories

The different planetary protection categories (I-V) reflect the level of interest and concern that contamination can compromise future investigations or the safety of the Earth; the categories and associated requirements depend on the target body and mission type combinations

Category I: All types of mission to a target body which is not of direct interest for understanding the process of chemical evolution or the origin of life

Category II: All types of missions (gravity assist, orbiter, lander) to a target body where there is significant interest relative to the process of chemical evolution and the origin of life, but where there is only a remote[1] chance that contamination carried by a spacecraft could compromise future investigations

Category III: Flyby (i.e. gravity assist) and orbiter missions to a target body of chemical evolution and/or origin of life interest and for which scientific opinion provides a significant[2] chance of contamination which could compromise future investigations

Category IV: Lander (and potentially orbiter) missions to a target body of chemical evolution and/or origin of life interest and for which scientific opinion provides a significant[2] chance of contamination which could compromise future investigations

Category V: Two subcategories exist - unrestricted Earth return for solar system bodies deemed by scientific opinion to have no indigenous life forms, and restricted Earth return for all others

[1]Implies the absence of environments where terrestrial organisms could survive and replicate, or a very low likelihood of transfer to environments where terrestrial organisms could survive and replicate

[2]Implies the presence of environments where terrestrial organisms could survive and replicate, and some likelihood of transfer to those places by a plausible mechanism

Planetary protection categories

Category I: Flyby, Orbiter, Lander: Undifferentiated, metamorphosed asteroids; others TBD

Category II: Flyby, Orbiter, Lander: Venus; Moon (with organic inventory); Comets; Carbonaceous Chondrite Asteroids; Jupiter; Saturn; Uranus; Neptune; Ganymede†; Titan†; Triton†; Pluto/Charon†; Ceres; Kuiper-Belt Objects > 1/2 the size of Pluto†; Kuiper-Belt Objects < 1/2 the size of Pluto; others TBD

Category III: Flyby, Orbiters: Mars; Europa; Enceladus; others TBD

Category IV: Lander Missions: Mars; Europa; Enceladus; others TBD

Category V: Any Earth-return mission.
"Restricted Earth return": Mars; Europa; Enceladus; others TBD
"Unrestricted Earth return": Venus, Moon; others TBD

†Additional analysis is required.

https://cosparhq.cnes.fr/scientific-structure/ppp

Further reading

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