Planetary Protection: recent advances for a sustainable space exploration

A. Coustenis, N. Hedman, P. Doran, and

- *The COSPAR Panel on Planetary Protection*

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

- 04 May 2022

Planetary protection and the global governance of outer space activities (key examples)

- 1967 Outer Space Treaty (OST) Articles VI and IX

- 2017 report of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) noted the long-standing role of COSPAR in maintaining the Planetary Protection Policy as a reference standard for spacefaring nations and in guiding compliance with Article IX of the Outer Space Treaty (A/72/20, para. 332)

- 2019 COPUOS Guidelines for the Long-term Sustainability of Outer Space Activities (Guideline D.1 Promote and support research into and the development of ways to support sustainable exploration and use of outer space):

"States and international intergovernmental organizations should consider appropriate safety measures to protect the earth and the space environment from harmful contamination, taking advantage of existing measures, practices and guidelines that may apply to those activities, and develop new measures as appropriate"

The Outer Space Treaty Article IX – and its complexities

- Principle of cooperation and mutual assistance
- Due regard to the corresponding interests of all other States Parties to the Treaty
- States 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
- If a State Part to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the Moon or other celestial bodies, would cause potentially harmful interference with activities of other States Parties…it shall undertake international consultations before proceeding…

COSPAR contributions to COPUOS (key examples)

1963-1964 COSPAR reporting under COPUOS/STSC item on potentially harmful effects of space experiments – 1963 COPUOS report (A/5549) and 1964COPUOS report (A/5785) with inclusion of COSPAR Executive Council resolution (20 May 1964) and appendices

- COSPAR Consultative Group on Potentially Harmful Effects of Space Experiments:

a) Pollution of the upper atmosphere

b) Orbiting dipoles

c) Contamination of the moon and planets

- Panel on Standards for Space Probe Sterilization

1984 and 1988 reports by COSPAR on environmental effects of space activities (A/AC.105/344 and A/AC.105/420)

1980-1991 comprehensive COSPAR reports on progress of space research (starting with A/105/298)

More recent time: COSPAR contributions to items on space weather, NEO, space debris, long-term sustainability of outer space activities

COSPAR Panel on Planetary Protection Members

Chair Athena **Coustenis** (planetology)

Vice-Chairs: Niklas **Hedman** (space law and policy) &
Peter **Doran** (LA State Univ., Hydrogeology, Extreme Environment)

12 members appointed by space agencies

Canada/CSA	**John Moores** (Engineering & planetary Sciences)	**France**	**Olivier Grasset** (geodynamics, planetology)
Germany/DLR	**Petra Rettberg** (microbiology, astrobiology)	**USA**	**Alex Hayes** (planetology)
China/CNSA	**Jing Peng** (engineering)	**Russia**	**Vyacheslav K. Ilyin** (microbiology, medicine)
ESA	**Silvio Sinibaldi** (Astrobiology)	**Spain**	**Olga Prieto-Ballesteros** (geology, astrobiology)
France/CNES	**Christian Mustin** (astrobiology)	**France**	**François Raulin** (chemistry, planetology)
India/ISRO	**Praveen Kumar K** (engineering science)	**Japan**	**Yohey Suzuki** (microbiology)
Italy/ASI	**Eleonora Ammannito** (planetologist)	**Canada**	**Lyle Whyte** (Cold regions microbiology)
Japan/JAXA-ISAS	**Masaki Fujimoto** (space plasma physics)	**China**	**Kanyan Xu** (microbiology, biochemistry)
Russia/Roscosmos	**Natalia Khamidullina** (Radiation conditions)	**Russia**	**Maxim Zaitsev** (astrochem, organic chemistry)
UAE	**Omar Al Shehhi** (engineering)	**NASEM ex officio**	**Colleen Hartman** SB, ASEB & BPA Director
UK/UKSA	**Karen Olsson-Francis** (astrob., microbiology)	**COSPAR CIR Ex-officio**	**Michael Gold**
USA/NASA	**Frank Groen** (Bayesian data analysis, engineering)	**UNOOSA Ex-officio**	**Michael Newman**

9 experts + 3 ex-officio

COSPAR planetary protection Panel & Policy

A special case among the Commissions and Panels in the COSPAR structure is the Panel of Planetary Protection (PPP) which serves an important function for space agencies pursuing the exploration of the planets. The primary objective of the COSPAR PPP is to develop, maintain, and promote the COSPAR policy and associated requirements for the reference of spacefaring nations and to guide compliance with the Outer Space Treaty ratified today by 112 nations, to protect against the harmful effects of forward and backward contamination, 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.

- *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. The Panel has several meetings and invites all stakeholders including the private sector.*

- *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; this is reserved to the engineering judgment of the organization responsible for the planetary mission, subject to certification of compliance with the COSPAR planetary protection requirements by the national or international authority responsible for compliance with the UN Outer Space Treaty.*

Operations of the COSPAR Panel on Planetary Protection

The Panel provides, through workshops and meetings also at COSPAR Assemblies, an international forum for the exchange of information on the best practices for adhering to the COSPAR planetary protection requirements. Through COSPAR the Panel informs the international community, including holding an active dialogue also with the private sector.

Since its restructuring in **mid-2018**, the Panel has had an average of **2-3 full meetings** per year and a large number of telecons between PPP Leads and parts of the Panel members, as well as among COSPAR Leads.
Several subcommittees work on different specific topics.

The COSPAR Panel on Planetary Protection:
https://cosparhq.cnes.fr/scientific-structure/ppp

Agenda

COSPAR PPP Executive Meeting, Vienna, 25-26 April 2023

COSPAR Panel on Planetary Protection Executive Meeting

25-26 April 2023

(In Vienna UN Campus and remotely)

AGENDA ***(all times in CET and indicative)***

Day 1: 25 April 2023

9:30-10:00 Welcome and coffee

1) **10:00-10:15 Welcome introduction and purpose of the meeting** *(A. Coustenis, N. Hedman)*
2) **10:15-10:45 Briefing from COSPAR Executive Director** *(J-C. Worms)*
3) **10:45-11:15 Information points/activity report since the last meeting** *(PPP Leads)*
4) **11:15-13:00 Briefings from TBA agency representatives & NASEM**

13:00-14:00 LUNCH BREAK

5) **14:00-14:45 Icy Moons Policy** *(P. Doran, A. Hayes, O. Grasset, O. Prieto Ballesteros)*
6) **14:45-15:45 Discussion on PP Policy : language and structure improvements** *(All)*

15:45-16:00 COFFEE BREAK

7) **16:00-16:45 Discussion on PP Policy: possible considerations for content** *(All)*
8) **16:45-17:30 Follow-on workshop/symposium based on the COSPAR Crewed Missions to Mars Workshop manuscript** *(N. Benardini)*

17:30 END OF DAY 1

Day 2: 26 April 2023

9) **10:00-10:45 Sample Return considerations** *(All, introduction by NASA, ESA, CNES)*
10) **10:45-11:30 Items continued from previous day**
11) **11:30-12:00 Way forward**
12) **12:00-12:30 AOB**

- PPP Membership *(P. Doran)*
- PPP repository
- Next meeting
- other?

12:30 END OF MEETING

COSPAR PPP reported activities 2019-2023

a) ***JAXA's Martian Moon Explorer (MMX)*****:** assigned planetary protection category : outbound Cat III and inbound Cat V: unrestricted Earth return. Full studies in *Life Sci. Space Res. 23 (2019)*

b) ***Updated Planetary Protection for the Moon*** **:***Space Res. Today Aug. 2021, 211, 14-20*

Orbiter and fly-by missions to the Moon*: Category II*. There is no need to provide an organic inventory
Lander missions to the Moon :

- *Category IIa*. All missions to the surface of the Moon whose nominal mission profile does not access areas defined in Category IIb shall provide the planetary protection documentation and an organic inventory limited to organic products that may be released into the lunar environment by the propulsion system
- *Category IIb*. All missions to the surface of the Moon whose nominal profile accesses PSRs and the lunar poles, in particular latitudes south of 79°S and north of 86°N shall provide the planetary protection documentation and full organic inventory

c) ***No change in Planetary Protection category for Venus*** **:** the environmental conditions within the Venusian clouds are orders of magnitude drier and more acidic than the tolerated survival limits of any known terrestrial extremophile organism. Because of this, future orbital, landed or entry probe missions to Venus do not require extra planetary protection measures.: *Zorzano Meier et al., 2023. LSSR 37, 18-24*

d) ***Mars Robotic missions*** **:** Although the science underpinning the Policy is advancing, as highlighted in recent reports (e.g. NASEM 2021, Spry et al. 2021) and in the Panel's work, there are still several knowledge gaps that need to be addressed before they can be directly applied to accommodate the interest of the user. They fall within three main themes, all of which will benefit from more measurements by space missions and ground-based observations: Biocidal effects, contamination transport model and Mars environmental conditions *Olsson-Francis et al., 2023. LSSR 36, 27-35*

e) ***Review of recent findings by the Panel and Policy history :*** *Coustenis et al., 2023. Front. Astron. Space Sci. 10:1172546* and *Coustenis & al., 2023, Acta Astron., 210, 446-452*

Missions to small bodies

The current COSPAR Policy for small bodies states that “imposing forward contamination controls on these missions is not warranted except on a case-by-case basis, so most such missions should reflect Categories I or II”.

A NASEM/SSB CoPP report titled “Planetary Protection Considerations for Missions to Small Bodies in the Solar System” was released in 2022 and a summary presented to the COSPAR Panel soon thereafter: *3rd CoPP report on Planetary Protection for missions to small bodies* (https://nap.nationalacademies.org/download/26714).


frontiers | Frontiers in Astronomy and Space Sciences

TYPE Review
PUBLISHED 30 May 2023
DOI 10.3389/fspas.2023.1172546

Check for updates

OPEN ACCESS

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RECEIVED 23 February 2023
ACCEPTED 15 May 2023
PUBLISHED 30 May 2023

Planetary protection: an international concern and responsibility

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The CoPP report found that it is highly unlikely that small Solar System bodies harbor extinct or extant life or that terrestrial life could proliferate there. The Committee concluded that given the importance of some relatively primitive, volatile-rich, and organic-bearing small bodies to studies of prebiotic chemistry and the sparsity of current knowledge about them, there is no reason at this time to reduce the current categorizations (from Category II to Category I) for missions to small bodies. They did point out that larger objects like Ceres may be an exception. Knowledge about these larger objects is scant, and they should be assessed further before being visited, but for now, Category II is acceptable until further assessment.

PPP took the CoPP report into account at a meeting in 2022 and noted that the findings were compatible with the current policy. After thorough considerations and discussion by the Panel experts, it was decided that there was no need currently to change anything in the Policy as concerns small bodies.

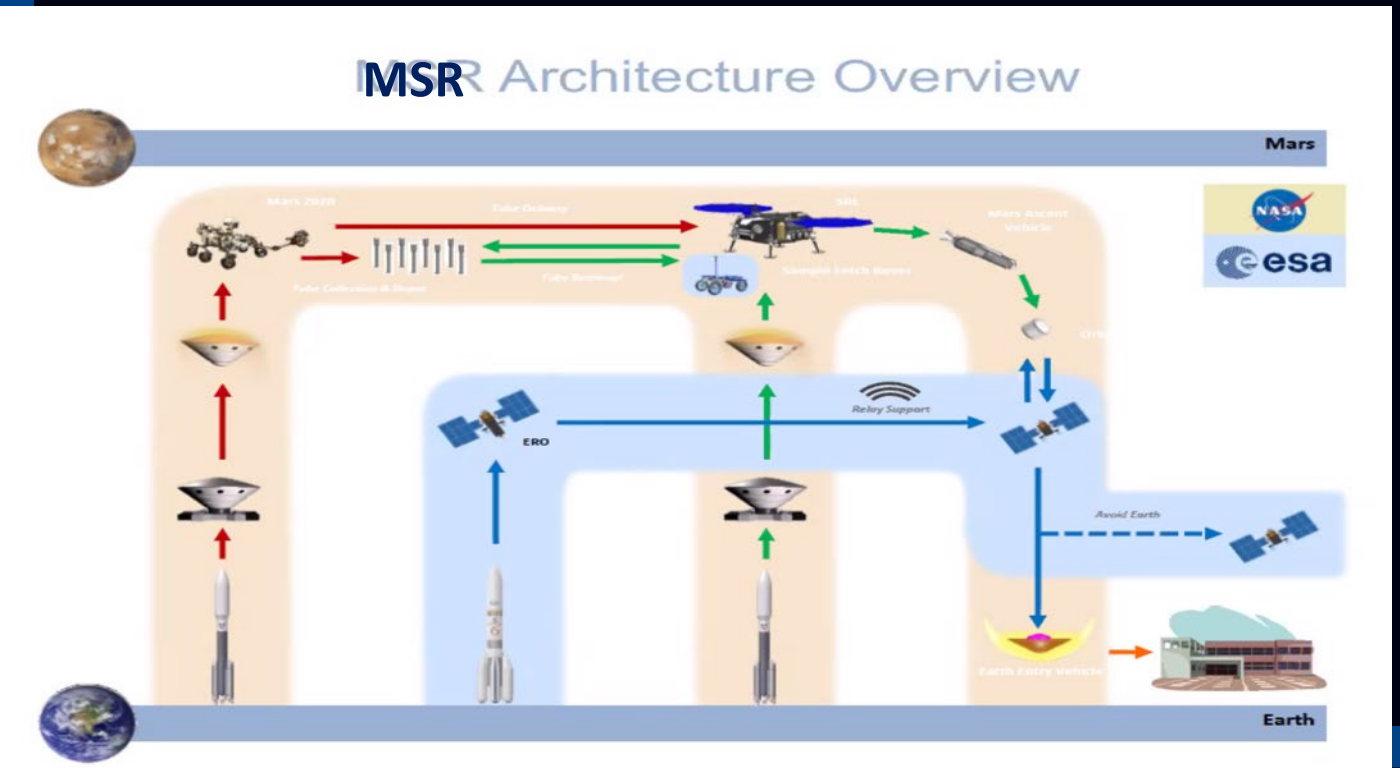
Coustenis et al., 2023. Front. Astron. Space Sci. 10:1172546.

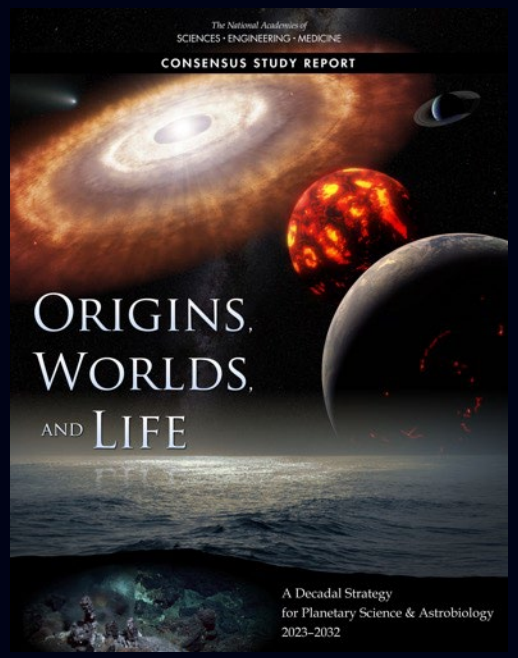
Future items for consideration

After the updated Policy published in Aug. 2021, the Panel is considering new needs for guidance in space exploration. **PP policy editorial review and restructuring**

Martian Robotic and human Exploration *(Olsson-Francis et al., 2023; Spry et al., submitted)*

MSR : PPP gets regular reports and will be a major item in future meetings.





Some themes have been showcased in the OWL and Voyage 2050.

COSPAR PP Policy editorial review and restructuring process

Objective is to enhance the understanding and clarity of the Policy and associated guidelines for consistency and transparency by:

- Clarifying the status of the Policy as a non-legally binding international standard;
- Quoting both OST Article VI and IX;
- Adding a chapter clarifying the role and function of COSPAR PPP;
- Restructuring the Policy and associated guidelines with explanatory text, including graphics/tables on:
  a) Planetary protection process overview (categorization and corresponding guidelines);
  b) Planetary protection categories in relation to target bodies;
  c) Guideline specification;
  d) Appendix with terms and definition;
  e) Appendix with reporting process.

Review undertaken by small group: PPP Leadership with NASA, ESA and some scientists members. To be presented to full PPP 1st quarter 2024.

The COSPAR planetary protection Policy for robotic missions to Mars

- In 2021, the Panel evaluated recent scientific data and literature regarding the planetary protection requirements for Mars and the implications of this on the guidelines. The group focused on three key areas:

1) Biocidal effects of the martian environment, 2) water stability, and 3) transport of spacecraft bioburden.

- These areas were discussed in the context of survival of dormant cells (where cells are either dormant or in a state of maintenance) vs proliferation (cells are actively defining) (National Academies of Sciences, Engineering, and Medicine. 2015; Rummel et al., 2014).

Life Sciences in Space Research 36 (2023) 27–35

Contents lists available at ScienceDirect

Life Sciences in Space Research

journal homepage: www.elsevier.com/locate/lssr

The COSPAR Planetary Protection Policy for robotic missions to Mars: A review of current scientific knowledge and future perspectives

Karen Olsson-Francis [a,*], Peter T. Doran [b], Vyacheslav Ilyin [c], Francois Raulin [d], Petra Rettberg [e], Gerhard Kminek [f], María-Paz Zorzano Mier [g], Athena Coustenis [h], Niklas Hedman [i], Omar Al Shehhi [j], Eleonora Ammannito [k], James Bernardini [l], Masaki Fujimoto [m], Olivier Grasset [n], Frank Groen [l], Alex Hayes [o], Sarah Gallagher [p], Praveen Kumar K [q], Christian Mustin [r], Akiko Nakamura [s], Elaine Seasly [l], Yohey Suzuki [s], Jing Peng [t], Olga Prieto-Ballesteros [g], Silvio Sinibaldi [f], Kanyan Xu [u], Maxim Zaitsev [v]

The COSPAR Panel on Planetary Protection will continue to work with the different national and international space agencies, the scientific community, and other stakeholders (e.g., the private sector and industry) to develop a roadmap for coordinating research activities addressing the identified knowledge gaps. This will include further characterisation of the biocidal effects at the surface of Mars, which needs to be addressed before *in-situ* reduction can be considered as an approach for bioburden control for robotic missions. Although the science underpinning the Policy is advancing, as highlighted in more recent reports (e.g. National Academies of Sciences, Engineering, and Medicine 2021, Spry et al. 2021) and in this paper, there are still several knowledge gaps that need to be addressed before they can be directly applied to accommodate the interest of the user. In brief, these knowledge gaps fall within three main themes, all of which will benefit from more measurements by space missions and ground-based observations: *Biocidal effects, contamination transport model and Mars environmental conditions*

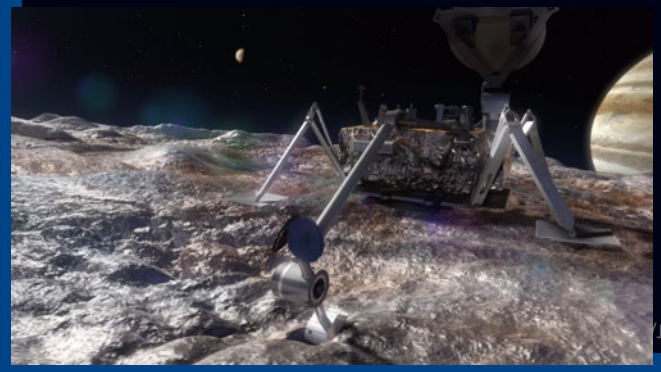
Olsson-Francis et al., 2023. LSSR 36, 27-35

Mars Human exploration

- Human exploration of Mars will require additional planetary protection considerations to those for robotic missions. COSPAR has co-sponsored with NASA a series of workshops on Planetary Protection for Human Missions to Mars to address knowledge gaps for planetary protection in the context of future human missions to Mars. These interdisciplinary meetings considered the next steps in addressing knowledge gaps for planetary protection in the context of future human missions to Mars. Reports from these workshops are posted under Conference Documents at https://sma.nasa.gov/sma-disciplines/planetary-protection/.
- A report was issued after the June 2022 COSPAR Meeting on "Planetary Protection Knowledge Gaps for Crewed Mars Missions" (*Spry et al., 2022*) and represented the completion of the COSPAR series. This report aims to identify, refine, and prioritize the knowledge gaps that are needed to be addressed for planetary protection for crewed missions to Mars, and describes where and how needed data can be obtained.
- The knowledge gaps addressed in this meeting series fall into three major themes: "*1. Microbial and human health monitoring; 2. Technology and operations for biological contamination control, and; 3. Natural transport of biological contamination on Mars." (Kminek et al., 2017)*
- This approach was consistent with current scientific understanding and COSPAR policy, that the presence of a biological hazard in Martian material cannot be ruled out, and appropriate mitigations need to be in place. The findings will be published in *Spry et al. (2023, submitted to Astrobiology)* with COSPAR support. This paper will highlight the scientific measurements and data needed for knowledge gap closure, updating and completing in more detail the material previously presented in the *Spry et al. (2021)* Planetary Science Decadal Survey white paper **(https://doi.org/10.3847/25c2cfeb.4a582a02).**

Planetary Protection of the Outer Solar System (PPOSS)

- Project led by the European Science Foundation, funded by the EC with DLR/Germany, INAF/Italy, Eurospace, Space Technology/Ireland, Imperial College London (UK), China Academy of Space Technology and NAS-SSB
- Recommended a revision of the planetary protection requirements for missions to Europa and Enceladus, based based partly on the NAS-SSB 2012 Icy Bodies Report and on an ESA PPWG recommendation
- COSPAR was involved throughout the multi-year-long process and at the end updated the requirements for missions to Europa and Enceladus



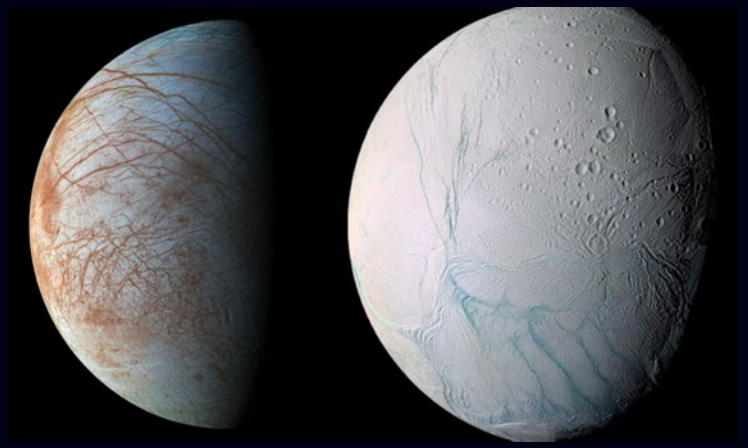
/JPL/Cassini

Published in

Space Res. Today (2020) 208

"Planetary protection: New aspects of policy and requirements", 2019.

Life Sci. Space Res. *23 & The Internl PP Handbook: Dec. 2018*



Europa *Enceladus*

- *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.*

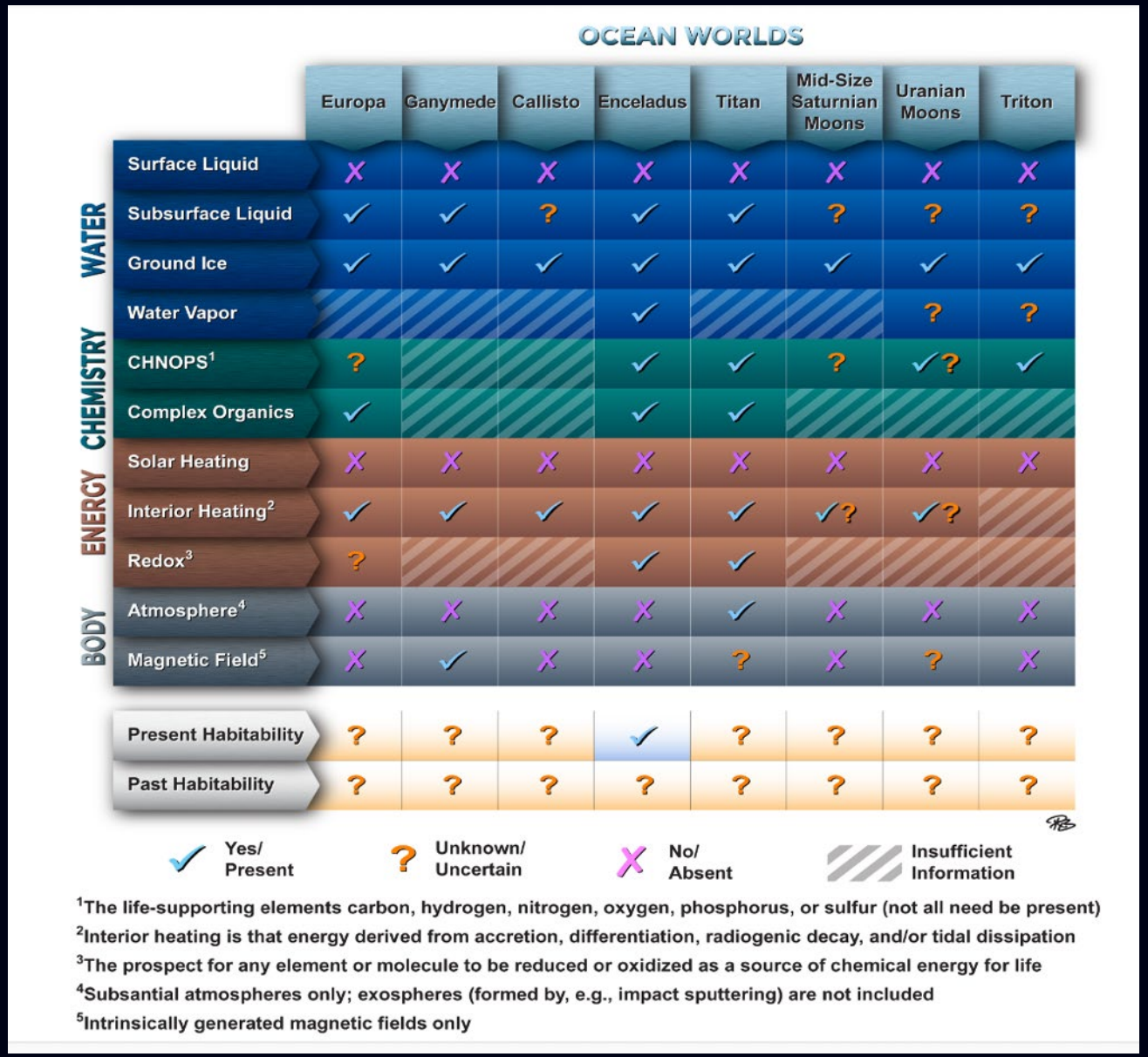
Future items for consideration

After the PPOSS study, the Panel is also looking at the

Future exploration of Icy Worlds

The Panel has been working on a thorough review of the current knowledge for Icy Moons+Ocean Worlds (Icy Worlds: *outer solar system moons and dwarf planets like Pluto, but not more primitive bodies*:) and is making proposals for better coverage in the Policy

(Doran et al., in preparation)



Modified from NASEM Decadal. OWL, Courtesy of P. Byrne

COSPAR POLICY ON PLANETARY PROTECTION

Prepared by the COSPAR Panel on Planetary Protection and approved by the COSPAR Bureau on 3 June 2021.

5. Environmental conditions for replication

Given current understanding, the physical environmental parameters in terms of water activity and temperature thresholds that must be satisfied at the same time to allow the replication of terrestrial microorganisms are:

- Lower limit for water activity: 0.5 (record was 0.62, now 0.585)
- Lower limit for temperature: -28°C (10 degree buffer)

These numbers based on exhaustive literature review made by MEPAG SR-SAG2 (Rummel et al. 2014), with follow-on reviews by a COSPAR Colloquium (Hipken and Kminek 2015) and U.S. National Academies/European Science Foundation joint panel (Rettberg et al. 2016)

LLAw = 0.5

LLT = -28ºC

It's all about temperature and connectivity

- Europa (Jupiter) clear evidence of connection on some timescale to fluids beneath
  T_{surf}=-143°C (midday at equator, colder toward poles / other times)

- Enceladus (Saturn) plumes indicating connection
  T_{surf}=-193°C (midday at equator, colder toward poles / other times)

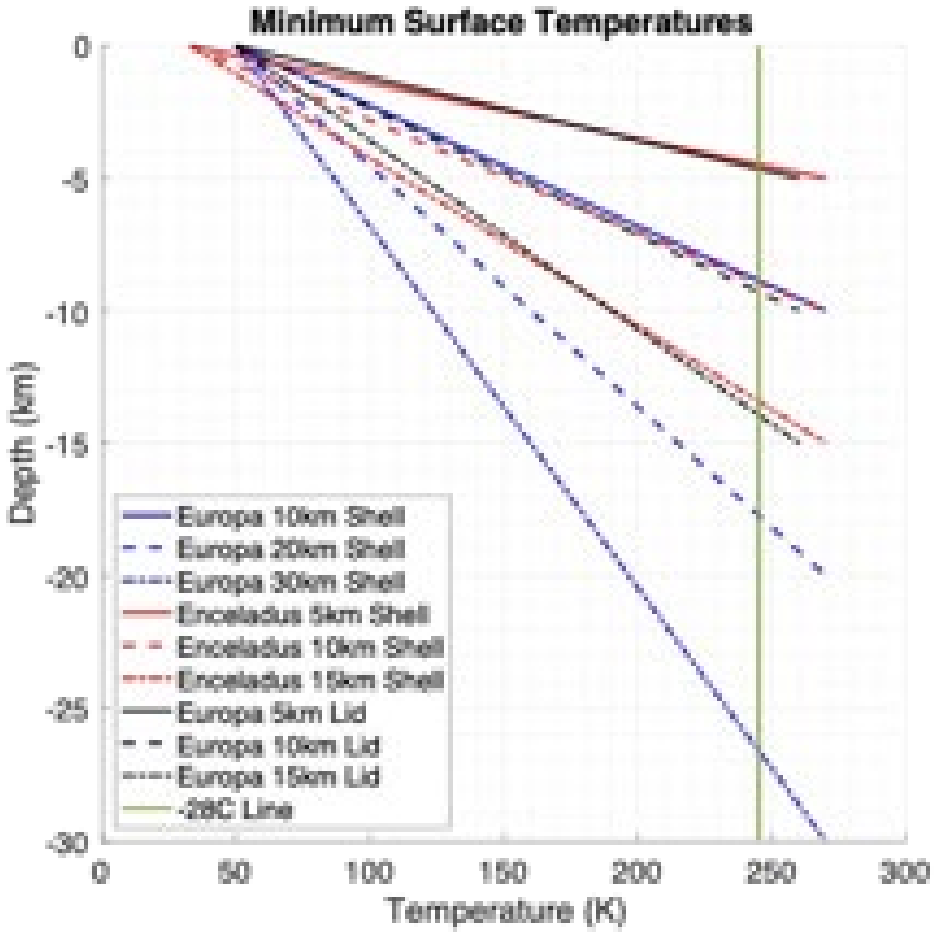
- Ganymede (Jupiter) internal ocean ~3 X larger than Europa, but lacks clear evidence of a connection
  T_{surf}=-113°C (midday at equator, colder toward poles / other times)

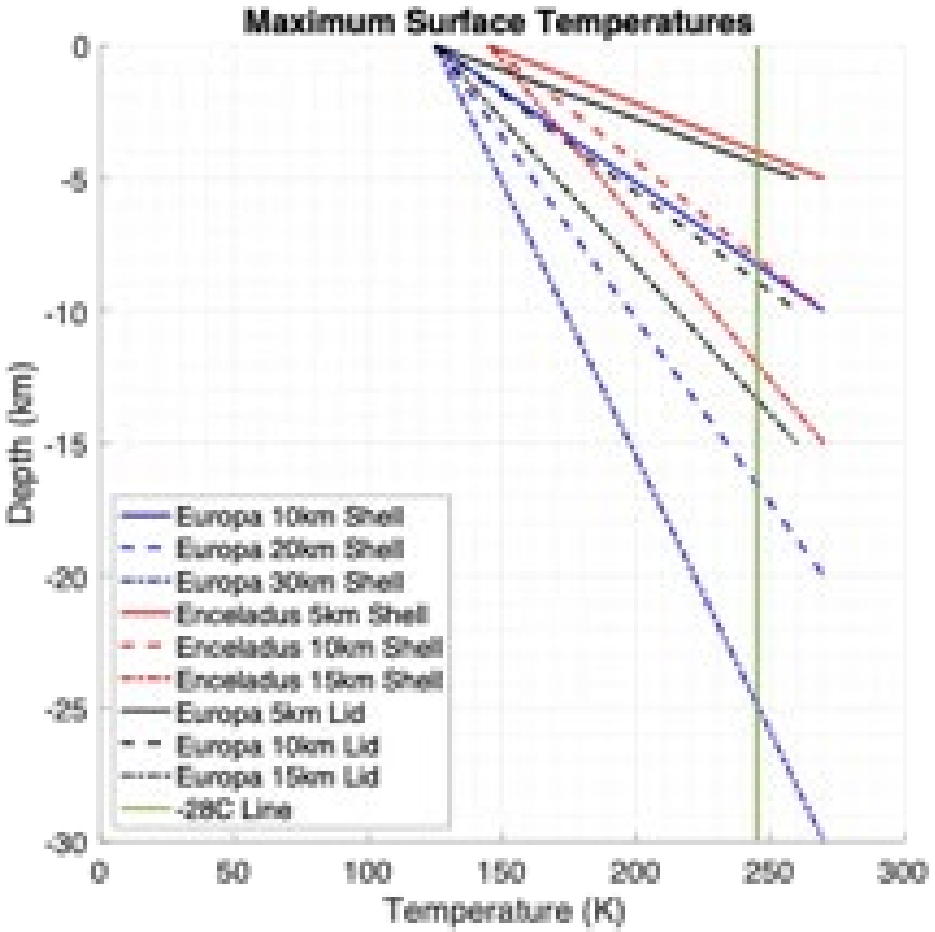
- Titan (Saturn) internal ammonia-rich water but at ~-100C. Possible connection, but perhaps only one-way
  T_{surf}=-179°C

- Callisto (Jupiter), possible deep (100 km) subsurface ocean.
  T_{surf}=-110°C (midday at equator, colder toward poles / other times)

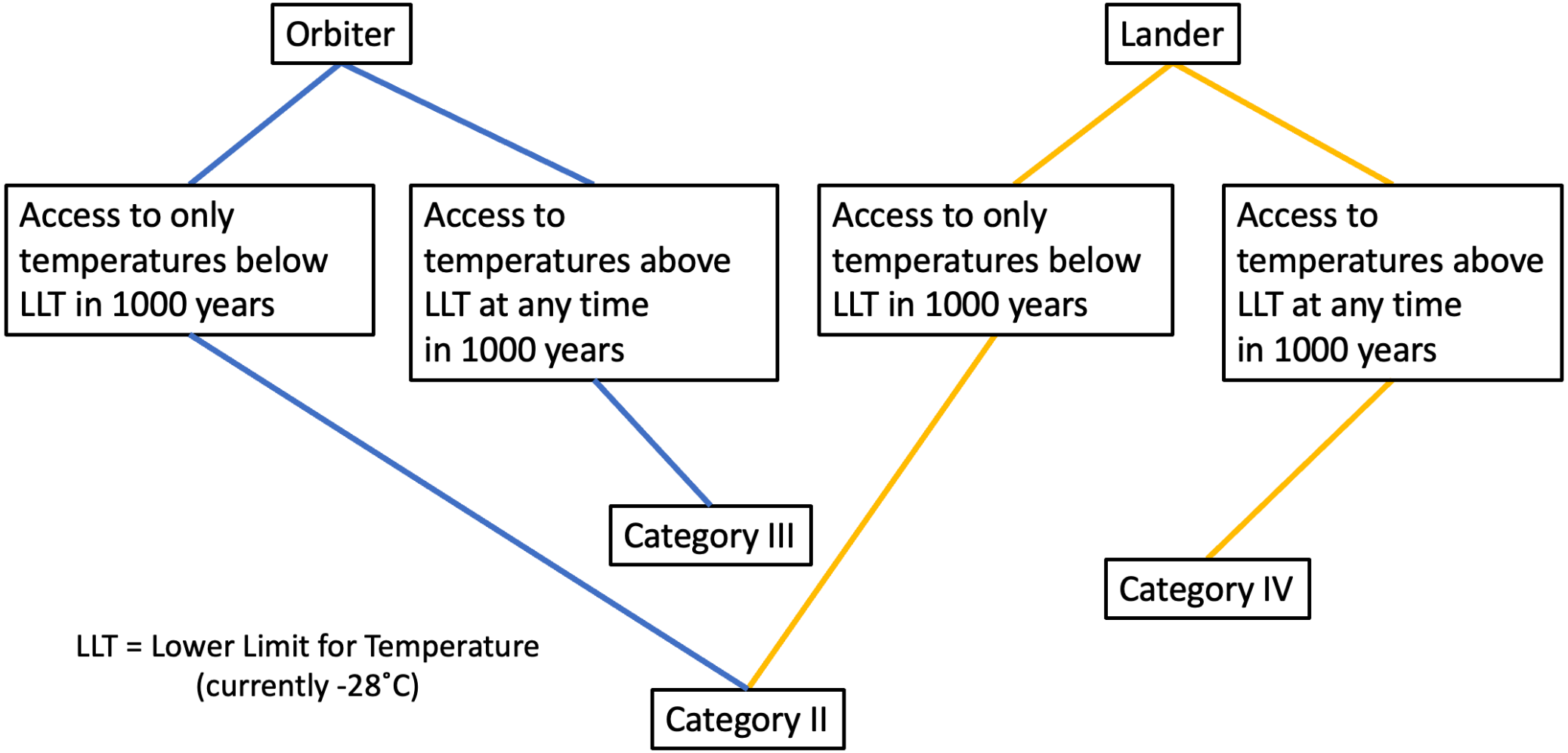
- Triton (Neptune), may (?) have an internal ocean about 100-150 km ice shell
  T_{surf}=-235°C

How deep is LLT?





Modeling courtesy of Britney Schmidt and Jacob Buffo


Orbiter
Lander
Access to only temperatures below LLT in 1000 years
Access to temperatures above LLT at any time in 1000 years
Access to only temperatures below LLT in 1000 years
Access to temperatures above LLT at any time in 1000 years
Category III
Category IV
Category II
LLT = Lower Limit for Temperature (currently -28˚C)

Missions to Icy Worlds (preliminary findings)

Recent discoveries related to the habitability and astrobiological relevance of the outer solar system have expanded our understanding of where and how life may have originated. As a result, the Icy Worlds of the outer solar system have become among the highest priority targets for future spacecraft missions dedicated to astrobiology-focused and/or direct life detection objectives. This has led to a renewed interest in planetary protection concerns and policies for exploration of these worlds. After reviewing the current knowledge and the history of planetary protection considerations for Icy Worlds, the Panel subcommittee proposes to discuss at our next meeting (December 2023) the following considerations:

- Establish a definition for Icy Worlds that captures the outer solar system moons and dwarf planets like Pluto, but excludes more primitive bodies: *all bodies with a crustal composition believed to be greater than 50% water ice by volume that have enough mass to assume a nearly round shape;*
- Define Indices for the lower limits of Earth life with regards to water activity (LLAw) and temperature (LLT), and expand them into all areas of planetary protection policy. These values are currently set at 0.5 and -28°C and were originally established for defining Mars Special Regions;
- Establish LLT as a parameter to assign categorization for Icy Worlds missions. The proposed categorization will have a 1000-year period of biological exploration, to be applied to all Icy Worlds

Doran et al., 2023. LSSR, to be submitted.

Planetary protection:
For sustainable space exploration and to safeguard our biosphere

- COSPAR maintains a non-legally binding planetary protection policy and associated requirements to guide compliance with the UN Outer Space Treaty. The COSPAR Policy is the only international framework for planetary protection

- COPUOS in its 2017 report noted the long-standing role of COSPAR in maintaining the Planetary Protection Policy as a reference standard for spacefaring nations and in guiding compliance with the Outer Space Treaty

The Policy will continue to be updated but not in a rushed process. We give thorough consideration to all arguments and scientific inputs and make an informed decision

In the meantime, there is need for community input on science findings and research reserves regarding recent reports:
Studies/Survey/Workshop/Focused conferences?

Reporting to COSPAR

It is recommended that spacefaring entities inform COSPAR when establishing planetary protection requirements for planetary missions, and *also* that they 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:

- *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*
- *The probable composition (identification) of the bioburden for Category IV missions, and for Category V "restricted Earth return" missions*
- *Methods used to control the bioburden, decontaminate and/or sterilize the space flight hardware*
- *The organic inventory of all impacting or landed spacecraft or spacecraft-components, for quantities exceeding 1 kg*
- *Intended minimum distance from the surface of the target body for launched components, for those vehicles not intended to land on the body*
- *Approximate orbital parameters, expected or realized, for any vehicle which is intended to be placed in orbit around a solar system body*
- *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*

Future meetings and activities

Archiving of reports: getting organized in the web site

Future meetings :

- 6-7 December 2023 in Vienna
- Week of 22 April 2024 in London, UK

Workshops, open and closed sessions

Next COSPAR General Assembly : 13-21 July 2024, Busan, South Korea

We are looking very much forward to continue this constructive collaboration with CoPP !

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

Thank you !

PPP Recent publications (extract)

https://cosparhq.cnes.fr/scientific-structure/panels/panel-on-planetary-protection-ppp/

- The COSPAR Panel on Planetary Protection, 2020. « COSPAR Policy on Planetary Protection ». *Space Res. Today* 208, Aug. 2020
- The COSPAR Panel on Planetary Protection, 2020. « Planetary Protection Policy: For sustainable space exploration and to safeguard our biosphere ». *Research Outreach* 118, 126-129.
- Coustenis, A., Hedman, N., Kminek, G., The COSPAR Panel on Planetary Protection, 2021. "To boldly go where no germs will follow: the role of the COSPAR Panel on Planetary Protection". *OpenAccessGovernment,* July 2021
- Fisk, L., Worms, J-C., Coustenis, A., Hedman, N., Kminek, G., the COSPAR PPP, 2021.Updated COSPAR Policy on Planetary Protection. *Space Res. Today* 211, August 2021. doi.org/10.1016/j.srt.2021.07.009
- Coustenis, A., The COSPAR Panel on Planetary Protection, 2021. « Fly me to the moon: Securing potential lunar water sites for research ». *OpenAccessGovernment,* Sept. 2021
- Olsson-Francis, K., Doran, P., et al., 2023. The COSPAR Planetary Protection Policy for missions to Mars: ways forward based on current science and knowledge gaps. *LSSR*, 36, p. 27-35.
- Zorzano M-P., et al., 2023. The COSPAR Planetary Protection Requirements for Space Missions to Venus. *LSSR*, 37, 18–24.
- Coustenis, A., et al., 2023. Planetary protection: Updates and challenges for a sustainable space exploration. *Acta Astron.*, 210, 446-452. https://doi.org/10.1016/j.actaastro.2023.02.035
- Coustenis, A., et al., 2023. Planetary Protection: an international concern and responsibility. Frontiers in Astronomy and Space Sciences, *Front. Astron. Space Sci. 10:1172546.* .