Planetary Protection Compliance Of NASA Missions Past, Present and Future

Dr. J. Nick Benardini

NASA Planetary Protection Officer

NASA Office of Safety and Mission Assurance

Coauthors: Elaine Seasly (NASA), Andy Spry (SETI) and Amy Baker (SETI)

Presentation to the 44th COSPAR Scientific Assembly

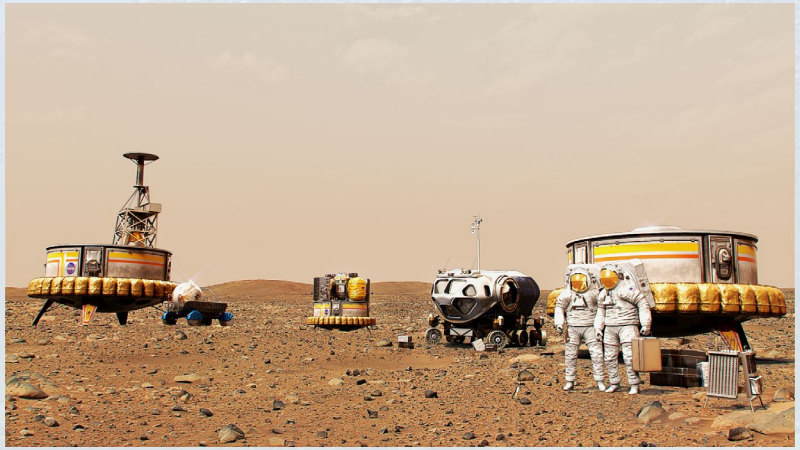
July 22, 2022

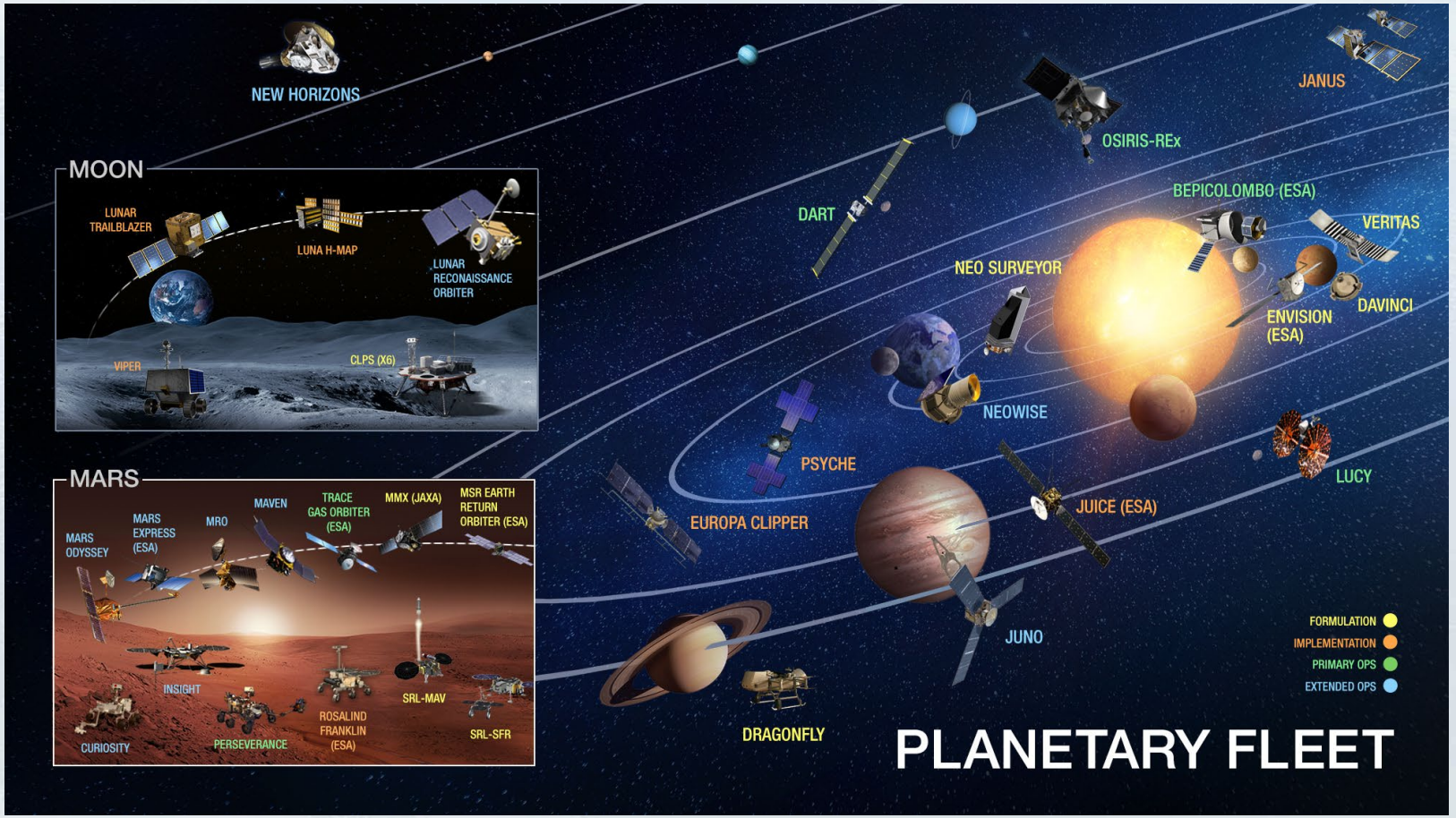
Overview

- Past: Planetary protection disposition report for NASA missions that ended in the period since the 2020 (Sydney – Virtual) COSPAR Scientific Assembly on February 1, 2021.
- Present: Report on planetary protection for ongoing NASA missions
- Future: Description of NASA missions in development/study phase and current planetary protection approaches
- Case study: Mariner 9 Missions Orbit Stability, 50-year inadvertent contamination expired November 17, 2021
- Perspective on planetary protection for US non-NASA Missions

Coordination of Planetary Protection Across Missions

- Robotic
- Crewed
- Commercial





Relevant NASA Mission PP Updates at COSPAR

- Europa Clipper Planetary Protection Status, R. Hendrickson, July 22, 10:15-10:30, PPP2, Room MAICC-UL-3
- Planetary Protection Considerations for Dragonfly at Titan, R. Lorenz, July 22, 10:30-10:45, PPP2, Room MAICC-UL-3
- Ensuring Containment: System-Level Backward Planetary Protection Requirements for Mars Sample Return, B. Clement, July 22, 10:45-11:00, PPP2 Room MAICC-UL-3.
- Sample Retrieval Lander Forward Planetary Protection Status, F. Chen, July 22, 11:30-11:45, PPP2 Room MAICC-UL-3.
- The planetary protection strategy of the Earth Return Orbiter–Capture, Containment & Return System in the context of the Mars Sample Return campaign, G. Cataldo, July 22, 11:45-12:00, PPP2, Room MAICC-UL-3.

NASA Missions Ended in the Period 2021-2022

- None.

New missions are coming online at a faster rate than missions are retiring creating a need for additional resources to help coordinate PP for all NASA missions.

Planetary Protection for Ongoing NASA Missions

- **Solar / Lagrange Point Missions**
  - Solar Cruiser – Cat I
  - SunRISE – Cat I
  - Global Lyman-alpha Imagers of the Dynamic Exosphere (GLIDE) Category I
  - IMAP – Cat I (L1)
  - Solar Parker Solar Probe – Cat II (Venus flyby)
- **Lunar Missions**
  - ARTEMIS (THEMIS follow-on) – Cat II
  - Lunar Reconnaissance Orbiter – Cat II extended mission until 2025
  - CAPSTONE – Cat II (in partnership with NZ)
  - Artemis I – Cat IIa
  - Artemis I Secondary Payloads (ArgoMoon, BioSentinel, CubeSat for Solar Particles (CuSP), EQUULEUS, Lunar IceCube, Lunar Polar Hydrogen Mapper (LunaH-Map), LunIR, Near-Earth Asteroid Scout, OMOTENASHI, and Team MILES) – Cat II
  - Lunar Trailblazer - CatII
  - Gateway – Cat II outbound, Cat I in NRHO operation, unrestricted Earth return
  - HLS – Category IIa or IIb depending on destination, with unrestricted Earth Return
- **Mars Missions**
  - Mars Odyssey - Cat.III orbiter in extended mission until 2025
  - Mars Reconnaissance Orbiter - Cat.III orbiter in extended mission until 2025
  - MAVEN - Cat.III orbiter in extended mission until 2025
  - Mars Science Laboratory/Curiosity Rover - Cat.IVa in extended mission until 2025
  - InSight - Cat.IVa lander, mission just recently extended until at least the end of 2022 (power dependent)
  - Mars 2020/Perseverance - Cat.IVb (subsystem sterilization) mission, w/ restricted Mars sample return
  - MMX – P-Sampler – Cat III, unrestricted Earth return (in partnership with JAXA)
  - The Escape and Plasma Acceleration and Dynamics Explorers (EscaPADE), Category III
  - Mars Sample Return Campaign –
    - Earth Return Orbiter Cat III (in partnership with ESA),
    - Sample Return Lander Cat IVb with restricted Earth Return
- **Asteroid Missions**
  - OSIRIS-Rex – Cat II with unrestricted sample return (2023) in extended mission until 2031 (OSIRIS – APEX [APophis EXplorer])
  - Lucy – Cat II
  - DART – Cat II
  - Psyche – Cat III (Mars flyby)
  - JANUS – Cat II
- **Jovian Missions**
  - JUNO – Cat III (recategorized from Cat II due to Europa, Ganymede, Io flyby)
  - Europa Clipper – Cat III
- **Saturian Missions**
  - Dragonfly –TBC; II* evaluation in process
- **Other**
  - New Horizons – Cat II (Pluto system)

*Missions not launched

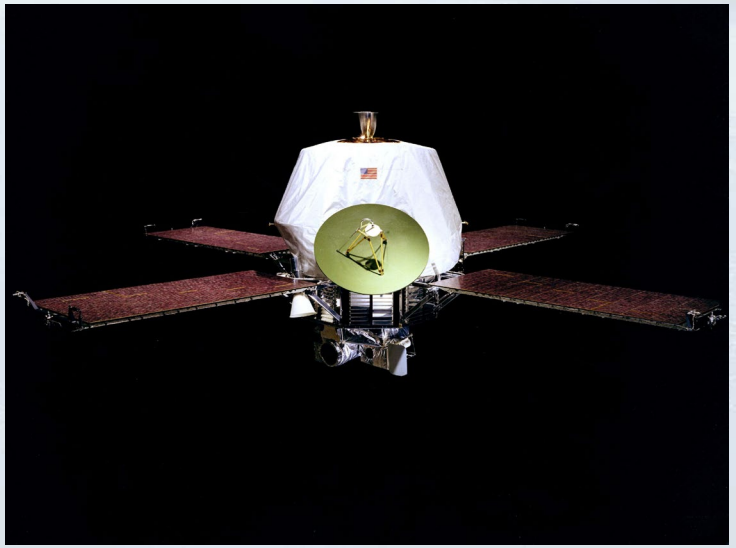
All operating NASA missions continue to be consistent with international planetary protection guidelines and NASA PP Policy.

NASA Missions in Development/Under Study

Solar / Lagrange Point Missions	
• NGR Space Telescope (L2 - CatI)?	• NEO Surveyor (L1 – CatI)
Lunar Missions	
• CLPS (Cat IIa and IIb - TBC)	• Artemis II and III (IIa – TBC)
Mars Missions	
• Crewed Mars Architecture Team	
Asteroid Missions	
• N/A	
Jovian Missions	
• Europa Lander (IV – TBC)	
Saturian Missions	
• N/A	
Other	
• VERITAS (Venus; II – TBC) • DAVINCI (Venus; II – TBC)	• Decadal Study concepts TBD

Mariner 9 – 50-year Mars Inadvertent Impact Requirement Expired on November 21, 2021

- Launched on May 30th, 1971
- Entered Mars orbit on November 13, 1971 on a 90-day mission.
- Formally ended on 27 October 1972 when the supply of spacecraft attitude control gas was depleted, spacecraft attitude could not be maintained, and signal was lost.
- 50-year inadvertent impact PP requirement expired on Nov. 21, 2021.
- Deorbit estimate was recalculated and refined based on updated Mars gravity models of Mars and influences of Phobos and Deimos and a more defined martian atmosphere model.
- Predicted minimum altitude = 1590km and would be 1583km in Oct/Nov 2043
- Updated analysis projects spacecraft to be in orbit for millennia to come!



Mars orbits for Planetary Protection can be highly stable meeting the 50-year requirement but may serve to verify low risk potential Mars parking orbits.

Perspective on Planetary Protection for US Non-NASA Missions

- NASA is not a regulatory agency and has no authority over non-NASA launches from US territory or non-US launches by other US entities.
- NASA supported National Strategy for Planetary Protection to addresses the US obligation to authorize and supervise activities of its individuals and entities in outer space in 2021. Paused and now awaiting Executive authorization to restart interagency working group.
- NASA plans to continue to provide expertise and advice on a consultative basis, through the US government interagency consultation process, principally involving the FAA launch review process.
- Non-US launches on which NASA has provided support in the period 2021-2022 include:
  - *CAPSTONE / Lunar Photon*

Thank You!

NASA Planetary Protection remains committed to enabling and ensuring missions are consistent with international policy as well as leveraging existing mission datasets to evaluate and feed forward into the policy making of tomorrow!

Abstract

NASA monitors its spacecraft from a planetary protection (PP) perspective, to ensure continued compliance with planetary protection requirements. This report to COSPAR on previous, ongoing and future missions will describe the issues and considerations regarding the PP implementation and compliance status of each mission, with changes noted as appropriate from previous reports. Missions not described in other presentations will be covered, including (but not limited to): Mars Odyssey, Mars Reconnaissance Orbiter, Escape and Plasma Acceleration and Dynamics Explorers (EscaPADE), Juno, New Horizons, Parker Solar Probe, Dragonfly, Artemis I and its secondary payloads, and NASA partnered missions.