

National Aeronautics and  
Space Administration



Mary W. Jackson Headquarters  
Washington, DC 20546-0001  
Science Mission Directorate / Planetary Science Division

April 25, 2022  
*Update: May 26, 2022*

Reply to Attn of: Science Mission Directorate/PSD

### **NASA Response to the 2022 Planetary Mission Senior Review**

NASA's Planetary Science Division is currently operating more than a dozen spacecraft across the solar system. Upon completion of their Prime Mission (PM), each of these missions may undergo a Senior Review every three years to assess whether operations should continue during an Extended Mission (EM). These extended missions leverage NASA's large investment in order to perform continued science operations at a cost far lower than developing a new mission. In some cases, EMs allow missions to visit new targets with entirely new science goals, while in other cases, the extensions allow missions to continue to acquire valuable long-duration datasets while supporting NASA's programmatic goals.

#### 2022 Senior Review

In the summer of 2021, NASA initiated a review of eight flight projects which were nearing the end of their current missions. These missions were Mars Odyssey, MAVEN, MRO, MSL, InSight, LRO, New Horizons, and OSIRIS-REx. Each team was invited to submit a proposal for an extended mission. The proposals were submitted in January 2022 and were reviewed by independent panels of experts from academia, NASA, and industry. The panels reported to two Review Chairs, who oversaw the process and provided summary findings to NASA.

Seven of the eight missions were asked to submit three-year extensions for operations through the end of FY25. The OSIRIS-REx mission was asked to submit a proposal for an encounter with the asteroid 99942 Apophis in 2029. This extended OSIRIS mission would begin in FY23 shortly before the delivery of the Sample Return Capsule to Earth and would close out in FY31.

At the time of proposal submission, all the missions except for InSight were healthy enough to conduct their proposed EM. InSight's future operations were threatened by decreasing solar flux due to dust buildup on its solar panels, and its EM proposal described a scenario of continued operations which the team acknowledged might not be possible unless the panels were cleaned by a statistically unlikely dust-clearing event.

After evaluation of its proposal, the Mars Odyssey team determined that Odyssey's available propellant was lower than previously thought, and this may affect Odyssey's EM.

### Overview of Review Results

The review panel found that all eight missions have produced high-quality science for NASA during their current mission phase. This science ranged from ground-breaking new discoveries, to refinement of previous results. All the missions proposed high-value science for their extensions. The review panel also found significant programmatic benefit to NASA from several of the missions, including their use as data relays for Mars surface landers and rovers, and support of other NASA missions such as CLPS and Artemis. Several of the missions also have broad science benefits to other divisions within NASA's Science Mission Directorate (SMD). The review panel's Final Report and other material related to the review is posted at <https://science.nasa.gov/solar-system/documents/senior-review>.

All eight missions will be extended, as their health allows. InSight and Odyssey have health risks associated with declining power and propellant respectively, and these two teams will work with NASA to plan appropriately.

The extended missions for MAVEN and OSIRIS-APEX will both be led by new Principal Investigators (PIs). I would like to thank the two original PIs – Dr. Bruce Jakosky on MAVEN and Dr. Dante Lauretta on OSIRIS – for entrusting these missions with the next generation. The EMs provide an excellent opportunity to provide experience and training for new leaders.

### Individual Mission Results

**OSIRIS-APEX (Principal Investigator: Dr. Daniella DellaGiustina, University of Arizona).** The Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) mission visited asteroid 101955 Bennu and the samples it acquired are on the way back to Earth. The extended mission will redirect the spacecraft to encounter Apophis, an asteroid of diameter 350 meters that will pass within roughly 30,000 km of Earth in 2029. The renamed OSIRIS-APEX (APophis EXplorer) mission will enter orbit around Apophis soon after its Earth flyby in 2029, providing an unprecedented close-up look at an S-type rubble pile asteroid. It plans to study changes in the asteroid caused by its close flyby of Earth and use its gas thrusters to attempt to dislodge and study material on and beneath Apophis' surface. Investigations would explore its regolith properties, rotational changes due to tidal forces, and topography. The investigation is not without substantial technical risk, and the team must undertake significant engineering work to ensure that the spacecraft survives the thermal environment at its 0.5 AU perihelion. If the risk is mitigated, the 'new mission' of OSIRIS-APEX would leverage NASA's investment in the existing New Frontiers-class spacecraft and its experienced team. The Apophis flyby will be watched closely from Earth in 2029, and OSIRIS-APEX will have a front-row seat to this extraordinary encounter.

Dr. DellaGiustina will lead the OSIRIS-APEX mission to Apophis, while Dr. Dante Lauretta will continue to lead the OSIRIS-REx mission through the return and analysis of its samples from Bennu.

**New Horizons (Principal Investigator: Dr. Alan Stern, SwRI).** New Horizons flew past Pluto in 2015 and the Kuiper belt object (KBO) Arrokoth in 2019. In its EM2, New Horizons will continue to explore the distant solar system out to 63 Astronomical Units (AU) from Earth. New Horizons' unique location in the solar system makes it capable of addressing broad science goals, and New Horizons' observations of the solar system may be complemented by a suite of observations of relevance to NASA's Heliophysics and Astrophysics divisions. NASA is considering a plan in which science objectives and funding for New Horizons' EM2 may be shared by NASA's Planetary Science, Astrophysics, and Heliophysics divisions, and we will provide additional details on this soon.

***UPDATE:** On May 26, 2022 NASA's New Horizons mission's second extended mission proposal was approved for implementation. In the two-year extended mission, New Horizons will conduct multi-disciplinary observations contributing to important science for NASA's Planetary Science, Heliophysics and Astrophysics Divisions. New Horizons will make distant observations of Uranus and Neptune, observing them from unique geometries not possible from Earth, enabling astronomers to compare them with distant exoplanets. NH's cameras can also be used to map the very faint 'cosmic background' in visible and ultraviolet (UV) light, making important observations of the local interstellar medium that are not possible from Earth. Additionally, NH will explore the heliosphere outward of 54 Astronomical Units (AU), using its instruments to understand the motions of charged particles as they interact with the solar wind, and to understand our heliosphere's large-scale structure.*

*New Horizons will be given the opportunity to submit a plan to become a part of NASA's Heliophysics System Observatory (HSO) at the conclusion of its two-year extended mission. If this plan is accepted, New Horizons would become part of the infrastructure for Heliophysics' fleet of spaceflight missions. In this new role, it would continue making regular measurements of the distant heliosphere using a subset of its instruments.*

**MAVEN (Principal Investigator: Dr. Shannon Curry, University of California, Berkeley).** MAVEN (Mars Atmosphere and Volatile Evolution Mission) in its proposed EM5 plans to study the interaction between Mars' atmosphere and magnetic field during the upcoming solar maximum in Solar Cycle 25. The expected upcoming peak in solar activity is expected to deepen our understanding of how Mars' upper atmosphere and magnetosphere respond to the change in solar conditions. It will also help us explore the response of Mars' climate to seasonal and solar EUV drivers, and its dust cycle. MAVEN will continue as important and growing role in the Mars Relay Network.

**InSight (Principal Investigator: Dr. Bruce Banerdt, JPL).** The Interior Exploration using Seismic Investigations, Geodesy and Heat Transport mission (InSight) has operated the only active seismic station beyond Earth since its landing on Mars in 2018. Its seismic monitoring of marsquakes has provided breakthrough results on Mars' internal structure. InSight's science depends on long-term monitoring to record rare seismic events. The proposed EM2 would continue InSight's seismic and weather monitoring providing input to constrain the structure of the core-mantle boundary by observing through two additional atmospheric 'quiet seasons' on Mars, which allow for the most sensitive observations.

Due to dust accumulation on its solar panels, InSight's electrical power production is low, and the mission may not remain operable for the duration of its current EM, unless its solar panels are cleared by a passing 'dust devil' in Mars' atmosphere. Such clearing events have been experienced by other Mars landers, but not InSight. It is most likely that InSight will not be able to operate during its EM2, but the mission's proposal was reviewed to assess the potential science case should the spacecraft power status improve. NASA plans to fund InSight in FY23, pending regular assessment. If the spacecraft power situation improves and the spacecraft remains healthy, InSight could conduct its proposed EM2.

**LRO (Project Scientist: Dr. Noah Petro, GSFC).** During EM5, the Lunar Reconnaissance Orbiter (LRO) plans to continue its comprehensive global studies of the moon, which have contributed to a true revolution in our understanding of the Moon. The evolution of LRO's orbit away from the poles will allow it to explore the Permanently Shadowed Regions (PSRs) in detail, with an emphasis on understanding volatile sequestration and the difference between the northern and southern PSRs. Additional studies will explore lunar volcanism, impact craters, tectonics, and more. LRO remains healthy and able to conduct multi-wavelength and multi-instrument investigations. Furthermore, LRO's high programmatic importance to NASA is growing rapidly, providing extremely valuable support for Artemis planning and the Commercial Lunar Payload Services (CLPS) program, through targeted high-resolution studies.

**MSL (Project Scientist: Dr. Ashwin Vasavada, JPL).** The Mars Science Laboratory (MSL) and its Curiosity rover have driven more than 27 km on the surface of Mars, exploring the history of habitability in Gale crater. In EM4, MSL will traverse to higher elevations, finally reaching the sulfate-bearing layers in Gale Crater which were a strong motivation for MSL's landing site selection. MSL will also travel to one of the 'boxwork' structures in Gale crater to explore their role in past groundwater flow. The MSL team will work with NASA to identify efforts that could address the mismatch in methane results between those detected in situ by MSL, and those measured in-orbit by ESA's ExoMars Trace Gas Orbiter (TGO).

Based on the panel's feedback, I have directed the mission to prioritize reaching the clay-sulfate boundary during EM4. Due to the rover's aging wheels and mechanical systems, the rover may not reach this important destination if it is not prioritized.

**MRO (Project Scientist: Dr. Rich Zurek, JPL).** The Mars Reconnaissance Orbiter (MRO) has provided a wealth of data regarding the processes on Mars' surface and has revolutionized our understanding of Mars' history and present state. In its 6th EM, MRO's studies will continue to contribute to our understanding of the evolution of Mars' surface, its ices, its active geology, and its atmosphere and climate. In addition, MRO will continue to provide important relay service to other Mars missions. MRO's CRISM instrument will be shut down entirely, after the loss of its cryocooler in 2017 ended the use of one of its two spectrometers.

**Mars Odyssey (Project Scientist: Dr. Jeffrey Plaut, JPL).** In EM9, Mars Odyssey plans to perform new thermal studies of rocks and ice below Mars' surface, monitor its radiation environment, and continue its long-running climate monitoring campaign. These observations will leverage the record 20 years of Mars science observations made by Odyssey. Odyssey

continues to provide unique support for real-time data relay from other Mars spacecraft, and its radiation monitoring contributes substantially to the Mars Space Weather Network and the Inter-Planetary Network, especially as the Sun moves toward solar maximum. The team will continue to investigate Odyssey's propellant status and NASA will plan accordingly.

Making NASA's data usable by the broad community is important. MRO and MSL proposed additional tasks to convert their older mission data into the PDS4 standard, while OSIRIS proposed to port the OSIRIS-REx image and cartographic tools into the standard ISIS package. We will be supporting these overguide requests.

I am excited about the future science that these missions will be able to conduct, paving new paths while building upon the work they have done in the past. I commend the teams for their successful operations during the previous mission phases, and I thank the more than 50 members of the community on the review panels that helped to evaluate these missions.

---

Dr. Lori S. Glaze  
Director, Planetary Science  
NASA Headquarters