



February 23, 2023

SMD/Earth Science Division

Dr. Colleen Hartman
Director, Space and Aeronautics
National Academies of Sciences, Engineering, and Medicine
500 5th Street NW
Washington, DC 20001

Dear Dr. Hartman,

I would like to express my sincere appreciation for the Committee's report, *Lessons Learned in the Implementation of NASA's Earth Venture Class*. NASA appreciates the Committee's comprehensive review which will ultimately help inform NASA science in the implementation of the Earth Venture program. I would also like to express our gratitude and congratulations to Drs. Chris Kummerow and Mahta Moghaddam, the Committee's co-chairs; the volunteer members; and the National Academies staff for their diligent support of this effort.

I have reviewed the findings and recommendations of the report, and I am pleased to convey NASA's responses to them. In general, our existing planning appears, by and large, well-aligned with the report's recommendations. Please do not hesitate to contact Dr. Michael New with any questions about NASA's response. He can be reached at (202) 358-1766 or michael.h.new@nasa.gov.

Sincerely,

A handwritten signature in black ink that reads "Sandra E. Connelly". The signature is fluid and cursive, with a large loop at the end of the last name.

Sandra E. Connelly
Acting Associate Administrator
Science Mission Directorate

CC:

Space Studies Board/M. Kivelson

- A. Charo
- G. Holbert

Science Mission Directorate/M. New

- K. St. Germain
- J. Robinson
- M. Kaszyca

NASA Response to Lessons Learned in the Implementation of NASA's Earth Venture Class

Recommendation 3.1: To encourage consideration of a wider set of ideas benefitting Earth system science, NASA's Earth Science Division should, in future Earth Venture solicitations, emphasize that science priorities of potential interest encompass the full range of science priorities in the 2017 National Academies of Sciences, Engineering, and Medicine decadal survey *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space*.

Response 3.1: NASA concurs with this recommendation and has already implemented this approach on the two Earth Venture (EV) solicitations released since publication of the 2017 Decadal Survey. As noted in your report, the Earth Venture Mission 3 (EVM-3) Announcement of Opportunity (AO) included such emphasis; further, the recent Earth Venture Instrument 6 (EVI-6) AO also emphasized the full range of science priorities for consideration. Relevant language can be found in Section 1.3 of the EVI-6 AO:

This PEA calls for investigations addressing any of the science goals in NASA's Earth Science program (see Section 2.1 for further information on these science goals). Investigations may target research in any of the Earth science areas mentioned in the most recent SMD Science Strategy, Science 2020-2024 A Vision for Science Excellence and/or address any of the 35 science questions outlined in the 2017 Decadal Survey. Applications research is also encouraged as described in the NASA SMD ESD Directive on Project Applications Program (2016).

This emphasis was also highlighted during the EVI-6 Pre-Proposal Conference, held May 6, 2022 (reference slide 5 of the presentation: https://essp.larc.nasa.gov/EVI-6/pdf_files/1_Margolis%20-%20EVI-6%20PPC%20Talk.pdf).

NASA plans to continue to emphasize in future AOs that science priorities of potential interest will encompass the full range of science priorities from the 2017 Decadal Survey. **NOTE:** The Earth Venture Continuity (EVC) solicitations are excluded from this approach as the EVC strand specifically seeks proposals to lower the cost for long-term acquisition of key "continuity" observations, per the recommendations of the 2017 Decadal Survey.

Recommendation 3.2: NASA's Earth Science Division (ESD) should not deviate from the foundational principles of the Earth Venture (EV) program. In particular, the ESD should establish and implement an effective process to strictly enforcing the cost caps established for EV missions.

Response 3.2: NASA remains committed to implementing the EV program within its foundational principles of strict cost and schedule constraints for the PI Managed Mission Cost (PIMMC) portion of the investigation, and to be good stewards of the funding entrusted to us. NASA utilizes the processes and requirements contained in NASA Procedural Requirements (NPRs) to enforce these EV foundational principles, such as through regular lifecycle reviews and Key Decisions Points (KDPs) per NPR 7120.5, NASA Space Flight Program and Project Management Requirements, and through the processes outlined in the Earth System Science Pathfinder Program Office (ESSPPO) Program Plan, such as the management of PI-recommended descopes to the project-level science requirements (from baseline to threshold) as a means for mitigating cost and schedule risks.

There have been 12 EV efforts selected since June 2012, including the most recent EVM-3 selection of Investigation of Convective Updrafts (INCUS) in November 2021. As recognized in your report, and with the exception of the now-canceled Geostationary Carbon Cycle Observatory (GeoCarb) mission, the selected EV efforts that have been underway for more than five years have performed consistently within the established cost caps and schedule constraints. Exceptions that have resulted in deviations from the cost caps and schedule constraints are generally the result of impacts that

cannot realistically be accounted for in advance by the project and/or NASA or impacts driven by activities outside of the PIMMC (e.g., significant disruptions like Government shutdowns and the COVID-19 pandemic; market-driven impacts that delay and increase the costs for the acquisition of access to space, primarily for efforts going to geostationary orbit).

As detailed in the NASA response to Recommendations 4.3 and 4.4, there has been an increased focus on EV implementation and management and continued alignment to the EV foundational principles. The outcomes of the noted activities are expected to increase the likelihood of EV mission success within the established cost caps and schedule constraints. Further, to help address the EVI schedule delay concerns noted in your report (as driven by unforeseen challenges with planned access to space opportunities), we plan to utilize NASA's newly established Venture-Class Acquisition of Dedicated and Rideshare (VADR) Launch Services contract for Class D efforts. The VADR multiple-award task order contract was awarded in January 2022 to provide Federal Aviation Administration (FAA)-licensed commercial launch services for NASA and NASA-sponsored payloads to a variety of orbits and is expected to provide reliable and cost-effective commercial access to space for Class D efforts within the EV program. We are already leveraging VADR for the EVI-3 (Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats - TROPICS), EVI-4 (Polar Radiant Energy in the Far Infrared Experiment - PREFIRE), EVM-3 (INCUS), and EVI-6 (AO solicitation phase) efforts.

Recommendation 3.3: In future Earth Venture (EV) announcements of opportunity (AOs), NASA should consider discontinuing the distinction between EV Mission (EV-M) and EV Instrument proposals. NASA would then solicit proposals that provide the full mission architecture as is currently done with EV-M. The AO should list any specific hosting or launch opportunity that NASA offers to provide. EV teams would have the option to incorporate these opportunities in their proposals, accounting for their cost to ensure a level competition against proposals that do not take advantage of such NASA-provided accommodation(s).

Response 3.3: One of the principal differences between the EVI and EVM efforts deals with the management of access to space (i.e., spacecraft, integration, launch, on-orbit operations support). For EVI efforts, NASA is responsible for providing the spacecraft and the launch vehicle and for the costs associated with the integration of the instrument to the NASA-selected platform (i.e., these "accommodations" costs are outside of the PI-managed cost cap); whereas the EVM efforts are considered "complete missions" where the PI is *generally** responsible for the entire scope of work, including the spacecraft, launch, and associated integration requirements, the costs of which are within the PI-managed cost cap (*EVM AOs do allow for proposers to choose between NASA-provided launch services, with an associated reduction to the PI-managed cost cap, or to choose a non-NASA launch service through a PI-arranged and managed approach.).

This differentiation was originally envisioned to give PI's the opportunity to develop an instrument to obtain the desired science without directly managing the complexities of an entire mission (i.e., an EVI) or to manage the entire mission (i.e., an EVM). This approach could also be utilized to help develop the depth and breadth of the PI community by allowing PIs with greater project management experience to take on the more complex management aspects of EVM efforts if so desired. As NASA already offers PIs the option for NASA to provide launch services under EVM efforts, it is conceivable to extend that concept to the spacecraft and associated integration effort. To ensure the impacts to both NASA and the broader science community are fully understood, NASA will assess and study this recommendation in anticipation of the next EVI or EVM AO release.

Recommendation 4.1: NASA should maintain a cadence of approximately one Earth Venture solicitation every 18 months to allow institutions to maintain proposal teams and ensure broad community engagement.

Response 4.1: NASA concurs with this recommendation and remains committed to maintaining a regular cadence of EV solicitations, subject to available budgets. NASA's current plan, as communicated in public forums, such as the ESD Community Forums, maintains an alternating cadence of 3 years for EVI's and EVC's (i.e., an EVI or EVC AO issued every 18 months) and every 4 years for EVMs.

Recommendation 4.2: NASA should keep the Earth Venture selection process as a one-step process.

Response 4.2: NASA concurs with this recommendation and will consider the insights provided by the committee in any future deliberations on the Earth Venture selection process.

Recommendation 4.3: NASA project management should implement risk-based safety and mission assurance principles and procedures by using NASA procedural document (NPR) *NASA Space Flight Program and Project Management Requirements* (NPR 7120.5F), Section 3.5 (Principles Related to Tailoring Requirements) to tailor management and review requirements to the particulars of their Earth Venture project and thereby reduce cost and management burden.

Recommendation 4.4: NASA should conduct an in-house analysis of the project management and review practices used in Earth Venture missions with the aim of streamlining processes and reducing budgetary and schedule pressures on these small, budget-constrained projects.

Responses 4.3 and 4.4: *NOTE: Due to parallels with recommendations 4.3 and 4.4, NASA is providing a consolidated response.* NASA concurs with recommendations 4.3 and 4.4. While NASA recognizes the need to further improve in these areas, we want to summarize two notable activities that are already ongoing to address these concerns and recommendations:

1. **SMD Class D Mission Implementation Plan:** The NASA SMD formally established an SMD Class D Tailoring/Streamlining approach through a December 2017 Decision Memorandum. This approach applies to all Class D missions under \$150M, excluding launch costs (including EVI-6, 8 of the 13 EV efforts to date are Class D; all but one of these Class D efforts, GeoCarb, fit within this dollar threshold). This SMD Class D approach has been included in applicable AOs since its inception and is currently undergoing a formal update and refresh to take advantage of outcomes from the below noted Commercial Engagement activity, to make updates to account for the revision to NPR 7120.5F, and to provide general updates to ensure the plan aligns with current best practices.

The stated goal of this Class D approach is to reduce management overhead costs, encourage innovation, and allow for the appropriate risk relaxation of the formal NASA program management, engineering, and mission assurance requirements for this classification of missions within NASA's framework of standard processes and best practices. As such, the SMD Class D guidelines seek to reduce the total overall documentation requirements, including the number of separate document submittals, contract deliverables, the number of reviewers and approvers, and the configuration management burden; SMD aims to have documentation approved at the lowest level possible for decision authority. To support achievement of this goal, SMD has:

- Waived the Earned Value Management burden through a formal procurement deviation approved by the NASA Assistant Administrator for Procurement.
- Developed a formal "SMD Standard Mission Assurance Requirements for Payload Classification D" as SMD Policy Document SPD-39. Key themes within this document include (1) an emphasis on implementing developer practices that have been proven successful, (2) using teamwork between NASA and the developer to assure mission success, and (3) driving efforts based on characterization and management of risk rather than enforcement of broad but prescriptive requirements. Additionally, emphasis is on insight (NASA knowledge of development activities and team participation) as opposed to oversight (NASA approval and extensive process control of development activities).

- Reduced the review burden by requiring only two Headquarters-level lifecycle reviews during the project development lifecycle: KDP-C and KDP-D or -E.
 - Developed an SMD Class D Tailoring Matrix for NPR 7120.5F that includes a pre-populated compliance matrix for Class D projects, which may be further tailored by the Project and the Program Office.
2. Commercial Engagement Activity: In January 2022, NASA's ESD initiated an internally-led study to assess, through internal/external benchmarking and engagement with industry, academia, and other Government Agencies, the current state of engagement within the EV program to identify common issues/trends, and to develop an engagement approach that aligns with the goals and recommendations described in the Earth Science Decadal Survey and the SMD 2020-2024 Science Plan. Notable activities include:
- Conducted internal SMD/ESD/ESSPPO culture survey with ~30 individuals (Leadership; Program Executives; Program Scientists; Mission Managers; Subject Matter Experts).
 - Collaboration/benchmarking of several NASA programs/projects (e.g., Commercial Lunar Payload Services [CLPS]; Space Technology Mission Directorate [STMD]; Launch Services Program [LSP]; Rapid Spacecraft Development Office [RSDO]; Commercial LEO Destinations) and with other Government agencies such as National Oceanic and Atmospheric Administration (NOAA) and the Space Development Agency (SDA).
 - Leveraged numerous existing reports and studies, including this National Academies EV Lessons Learned report.
 - Engaged with ~70 industry representatives from 30 companies (1-on-1; at conferences).

The recommendations from this activity, which were finalized during the 4th quarter of FY22 and are currently in various stages of implementation, focus on ensuring alignment with the EV foundational principles and higher EV risk management philosophy, and ensure NASA takes advantage of commercial technology advances. Relevant to your Recommendations 4.3 and 4.4, this activity is implementing strategies to:

- Continue streamlining processes (including the AO process), reviews, and reporting (especially contractual deliverables) by focusing on outcomes instead of process, which ensures better alignment with commercial industry expectations, practices, and schedules.
- Allow for greater use of contractual insight versus oversight, with a heavier reliance on established and proven commercial processes and procedures.
- Provide top-down advocacy to help overcome cultural challenges associated with implementing higher risk tolerance missions.

Further, and relevant to your related Finding 4.1 (classifying all EV missions as Class D), this engagement study assessed and recommended that all EV efforts should be Class D to better align with the foundational EV principles to facilitate demonstration of innovative ideas and higher-risk technologies; the more complex, Class C efforts are better aligned with the new Earth System Explorers program.

NASA recognizes that continued improvement per Recommendations 4.3 and 4.4 is necessary to achieve the goals of the EV program. In addition to the above noted items, NASA is committed to performing additional analysis, as necessary, of the project management and review practices used in the EV missions to further streamline processes and increase the probability of mission success within established cost caps and scheduled constraints.

Recommendation 4.5: NASA should ensure that Earth Venture announcements of opportunity include examples of contract deliverables with descriptions for various classes of instruments deployed in flight projects to provide the proposal teams with a better idea of reporting requirements that will facilitate budgeting and better inform contract negotiations.

Response 4.5: NASA concurs with this recommendation and has already implemented this approach as a common practice. Both the EVM-3 and EVI-6 AO's (released in November 2020 and April 2022, respectively) included existing, applicable contracts in the document libraries. Further, the text of each AO specifically noted these contracts as being representative of the type of contract likely to be awarded to the selected investigation, including contract clauses, requirements, and deliverables, and encouraged proposers to consider the reference contract during proposal development to be prepared for likely contractual requirements in the case of selection.

Recommendation 4.6: To support diversification among potential principal investigators that may not have strong existing ties to NASA's Earth Science Division or to NASA's Centers, NASA's Science Mission Directorate should call for "mission concept planning proposals" in its annual solicitations for Research Opportunities in Space and Earth Sciences.

Response 4.6: NASA recognizes the importance of diverse mission teams and the benefit of community participation in strategic missions. As is evident throughout NASA's *Science 2020-2024: A Vision for Scientific Excellence*, NASA SMD believes strongly in the importance of diverse and inclusive teams to tackle strategic problems and maximize scientific return. Inclusion is one of our core values and SMD is committed to fostering an inclusive environment of belonging where diversity of thought, backgrounds, and perspectives are welcomed and celebrated.

NASA is cautious, however, that issuance of the recommended ROSES call may actually perpetuate the identified concerns by providing further development funding for PIs that already have the existing resources to submit such a proposal, thereby exacerbating the divide between those PIs that don't have such resources. Therefore, NASA is pursuing alternative ways of increasing the diversity of PIs as noted below.

Our commitment to and focus on diversity and inclusion is demonstrated within the recently released EVI-6 AO. The EVI-6 AO requires the development and submission of a "Diversity and Inclusion Plan" that describes how the proposer will create and maintain a diverse and inclusive team, including how the proposer will broaden participation with unrepresented or under-represented groups. The AO expands evaluation factor B-5, Probability of Investigation Team Success, to include an evaluation of this Plan, whereby the science panel (augmented, as necessary, with reviewers with expertise in diversity and inclusion initiatives) will evaluate the Plan focusing on how executable and effective the Plan is expected to be. Directly relevant to your recommendation, the evaluation will focus on "the *scientific* expertise of the PI...but not their *experience* with NASA missions." (*Emphasis provided in AO*)

In addition, NASA SMD maintains a "New Principal Investigator (PI) Resources" webpage (<https://science.nasa.gov/researchers/new-pi-resources>) that provides prospective PIs with guidance and resources to support PIs as they develop mission concepts and proposals. This webpage also provides a link to the NASA-supported "PI Launchpad Workshop", which was developed to help broaden the pool of potential PIs by finding the best science ideas and promoting them, and by creating a science community that values diversity and empowerment. This workshop was previously held in November 2019 and June 2021, with the next session planned for 2023, and includes discussions on forging scientific, technical, and management partnerships to support development of an EV proposal.

NASA recognizes the need to continue its efforts on increasing PI mentoring and shadowing opportunities and to better engage unrepresented or under-represented groups. NASA plans to further

develop these efforts in conjunction with the recommendations of the May 2022 NASAM report on *Advancing Diversity, Equity, Inclusion, and Accessibility in the Leadership of Competed Space Missions* (<http://nap.nationalacademies.org/26385>). Of specific relevance is Recommendation 2 from that report: “NASA should work to make the pre-proposal ‘competition before the competition’ process transparent and accessible. Additionally, NASA should use its own resources to expand support of pre-proposal and proposal efforts of diverse, external principal investigators through its field centers and encourage other institutions in the business of supporting and investing in Science Mission Directorate proposals and missions to do the same.”

Recommendation 4.7: To facilitate selection of Earth Venture (EV) missions that are considered high risk but also have the potential to deliver an additional important science and/or a high-value applications product, NASA should request that EV teams include in their submission a supplemental document that highlights what a mission might accomplish beyond the stated baseline objectives. Given the difficulties in rating applications that have not been demonstrated, or the enhanced science that may be enabled by new types of observations, the Earth Science Division should evaluate the supplemental information and provide its assessment to the associate administrator of the Science Mission Directorate at the time of mission selection. The associate administrator would have the option of working with the appropriate program to fund the enhanced science or applications.

Response 4.7: NASA believes this recommendation is analogous to the existing Science Enhancement Option (SEO) concept as described in Section 5.2.5 of the SALMON 3 AO and Section 4.3.1 of the current EVI-6 AO, and even the NOAA Operational Enhancement Opportunity concept per Section 4.3.2 of the current EVI-6 AO and Section 5.1.6 of the recent EVM-3 AO.

A PI may propose an SEO to broaden the scientific impact of investigations, beyond the baseline investigation and associated cost cap, such as through extended missions, guest investigator programs, general observer programs, participating scientist programs, interdisciplinary scientist programs, or archival data analysis programs. The EVI-6 AO, for example, provides up to \$5.3M in potential additional funding for an SEO that addresses one or more of the following activities: (a) Augmented applications and user group outreach activities; (b) Decreased data latency to enhance science goals and/or the operational or applications goals of other agencies or partners; (c) Enhanced calibration/validation activities; and/or (d) More robust and wide-ranging mission science team support including the introduction of promising early-career co-investigators into the science team. The EVI-5 AO provided up to \$5M for the SEO.

While NASA considers any proposed SEO as optional (and allows for additional proposal pages for PIs to address the SEO), NASA does assess the proposed SEOs in the overall evaluation process (reference Factors A-5 and B-6 in the SALMON 3 AO) and may choose to fund the SEO at any time during the investigation (i.e., at selection or during formulation/implementation). Further, this SEO assessment is provided to the SMD Associate Administrator for considerations as part of the overall evaluation package.