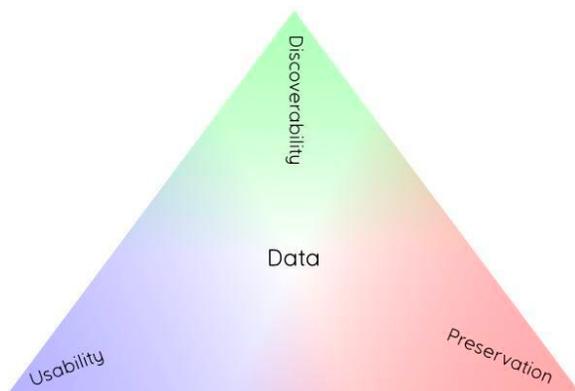


Report of the Planetary Data Ecosystem Independent Review Board. S. Besse¹, C. Coward², E. Lakdawalla³, M. Milazzo⁴, B. Wilson⁵, M. McGrath⁶ and the PDE-IRB team.

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Introduction: The Planetary Data Ecosystem (PDE) Independent Review Board (IRB) was chartered by NASA in the fall of 2020 to conduct a wholistic review of the Ecosystem with the goals of “defining the full environment, identifying missing or overly redundant elements, and providing findings and prioritized recommendations.” Five months of gathering and thoroughly discussing input has culminated in the 67 Findings and 65 Recommendations presented below.

Review process: The scope of the Planetary Data Ecosystem is broad. It encompasses not only the full landscape of science data gathered by researchers using land- and space- based instruments, telescopes, lab and in-situ experiments, observation missions, etc., but also the full range of tools used for search and discovery, data analyses, data reduction pipelines, modeling and simulation tools, and other software or firmware tools used by researchers to locate, calibrate, manipulate, and analyze these data. The IRB repeatedly returned to the inextricably interconnected concepts of data preservation, data discoverability and data usability. Without preservation, data are irrevocably lost, however, and *equally critical*, data gathered and preserved without regard to future discoverability and usability in mind renders the data unavailable for use.



Findings and Recommendations: Findings and Recommendations fall into three broad categories: the continued strategic development of the overall Ecosystem; barriers to data preservation; and barriers to access, usability and development.

- Foster the strategic development of the Planetary Data Ecosystem** to build upon NASA’s investment in the Planetary Data System (PDS) and address the presently unmet usability and data archival needs of the planetary science community. This development includes ensuring that a standing assessment or analysis group exists for the Ecosystem. The group will help ensure that the concept of the Ecosystem is well communicated to the community, and that the needs of the community are clearly communicated to NASA. It is imperative that this group be broadly representative of all aspects of the user and developer community. This group is essential to help NASA continue to refine the full scope of the Ecosystem, to take the recommendations of this IRB and develop a long-term strategy, and to provide guidance as circumstances and knowledge evolve.
- Address barriers to data preservation**, including two time-critical needs, planetary radar data and returned sample data. Although the overall intent of this group of Recommendations is to prioritize development of a community strategy, these two data preservation needs are considered more critical and should take precedence over the many additional preservation needs expressed by the community.
- Address barriers to the use of planetary data and future development around these data.** Multiple structural and technical factors limit the degree to which planetary data is Findable, Accessible, Interoperable, and Reusable (FAIR). Many of these findings echo those from previous assessment reports and most affect the broad range of Ecosystem data users. These barriers have a particularly strong effect limiting the usability of planetary data for some of the most data-intensive efforts, including those working in machine learning, artificial intelligence, and other advanced analytics methods. These barriers significantly limit the scientific return on investment for the resources spent on acquiring planetary data.

Prioritization: Our Recommendations have been prioritized; all three groups of recommendations are of equally high priority. Priority order need not be the same as implementation order. All the recommendations are considered high-priority, and some (the “low-hanging fruit”) will be easier and faster to achieve than others. Therefore, the IRB envisions that a reasonable path forward might involve addressing high-priority and lower-priority recommendations from each group simultaneously. Among the highest ranked recommendations are:

- NASA should ensure that a sustained, community-led coordinating organization for the PDE exists that mirrors the other Planetary Assessment or Analysis Groups (AGs), reports to the Planetary Science Advisory Committee, and meets regularly.
- NASA should proceed with developing the concept of the Planetary Data Ecosystem so that the usability and archival needs of the entire planetary sciences community—all people, professional or amateur, who produce, provide, and/or use data—are better met.
- NASA should establish an archive for planetary radar data either within the PDS Small Bodies Node or separately. This archive should facilitate preservation and usability of data at all processing levels by preservation of data processing procedures (or software). Because of the unique situation of Arecibo Observatory, time is of the essence to preserve the data and prevent irretrievable loss.
- NASA should establish a requirement for the preservation of mission-supported laboratory analyses of returned sample material that makes the information accessible to the planetary science community. Time is of the essence to establish these requirements, as NASA will receive the largest sample return since Apollo in approximately two years.
- NASA should treat mission data archival as a system engineering concern by including early funding for mission data acquisition, processing, and archiving of data and foundational data products (including cartographic products, data acquisition contextual information, coordinate system standards, etc.) so that they are planned well in advance of data acquisition.
- NASA should develop outreach to user communities within the Planetary Data Ecosystem, assess user needs, and develop focused educational and documentation materials that meet highest-priority needs.

- PSA Users Group: A group of scientific experts advising the PSA on strategic development;
- Direct interactions: Scientists from the PSA are available and eager to receive your comments and suggestions;
- ESA missions: If you are part of a mission archiving its data at the PSA, tell us how your data should best be searched and used.

Conclusion: The data gathered by the planetary sciences community is humanity’s treasure. Along with NASA, and all elements of the Planetary Data Ecosystem, it is our responsibility to preserve and ensure its present and future usability.

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