LATEST UPDATES TO THE PDS GEOSCIENCES NODE'S ORBITAL DATA EXPLORER. June Wang[1], Daniel M. Scholes[1], Feng Zhou[1], Paul K. Byrne[1], and Edward A. Guinness[1], [1]McDonnell Center for the Space Sciences, Department of Earth and Planetary Sciences, Washington University in Saint Louis, 1 Brookings Drive, Campus Box 1169, St. Louis, Missouri, 63130, jwang39@wustl.edu.

Introduction: The Orbital Data Explorer (ODE), accessible at https://ode.rsl.wustl.edu, is a web-based search tool developed and maintained by NASA's Planetary Data System (PDS) Geosciences Node (https://pds-geosciences.wustl.edu). ODE supports the search, display, and download of PDS archives containing orbital data products from missions to Mars, Mercury, the Moon, and Venus [1].

Key features of ODE include form- and map-based search capabilities across multiple missions and instruments [1], visualization of product metadata and browse products, and a cart system with a high-speed download option via Aspera Connect [2]. New faceted search functionality was added to ODE in summer 2023. ODE also supports specialized granular query tools for subsetting science data at user-specified spatial regions [3]. The Granular Data System (GDS) is responsible for data-point queries related to Mars Global Surveyor (MGS) MOLA (Mars Orbiter Laser Altimeter) PEDR (Precision Experiment Data Record), Lunar Reconnaissance Orbiter (LRO) LOLA (Lunar Orbiter Laser Altimeter) RDR (Reduced Data Record) and DIVINER RDR, and MESSENGER's MLA (Mercury Laser Altimeter) RDR observations.

ODE extends its functionality through a Representational State Transfer (REST) interface at https://oderest.rsl.wustl.edu [4]. This interface allows external users, scripts, and applications to access ODE's cataloged metadata and data products without using the ODE web interfaces. Mars ODE provides a specialized tool for locating coordinated observations from Mars Reconnaissance Orbiter (MRO) instruments, including measurements coordinated with the NASA Phoenix landed mission [1]. Additionally, ODE generates KMZ files (Keyhole Markup Language, KML) and shapefiles for each product type with spatial reference information, enhancing compatibility with GIS tools and offering users with versatile options for data exploration.

ODE updates:

Data Inventory Updates. ODE provides access to an extensive catalog of 43.1 million products sourced from the PDS, ESA's Planetary Science Archive (PSA), and JAXA data repositories, amounting to 2.23 petabytes of data. The catalog includes data from 16 planetary missions and over 70 instruments. ODE is continuously updated with the latest data releases from active missions, including NASA's LRO, MRO, and Mars Odyssey, together with ESA's Mars Express (MEX) and ExoMars Trace Gas Orbiter (TGO).

Both the PDS nodes and mission instrument teams are working to convert archived and active mission data to the PDS4 standard. ODE is continually updated as converted data sets become available. New PDS4 archives and derived data from individual data providers are added to ODE upon their release. Table 1 shows an overview of the PDS version of cataloged data current available in ODE.

Missions	PDS Version
MRO	PDS3 (SHARAD clutter simulations bundle and derived CRISM ATO bundle in PDS4)
MEX	PDS3 (optimized MARSIS radargram data in PDS4)
Odyssey	PDS3 (improved derived Neutron data in PDS4)
ExoMars TGO	PDS4
MGS	PDS3
Viking Orbiter	PDS3
LRO	PDS4 (LAMP and MINI-RF data in PDS3)
ISRO's Chandrayaan-1	PDS4 (Moon Mineralogy Mapper data in PDS3)
GRAIL	PDS3 (derived LGRS data in PDS4)
SELENE	PDS3
Clementine	PDS3 (LIDAR, RSS, and LWIR data in PDS4)
Lunar Prospector	PDS3 (GRS, RSS, and NS data in PDS4)
Lunar Orbiter	PDS3
Magellan	PDS3 (part of the derived RDRS and RSS data in PDS4)
MESSENGER	PDS4 (MASCS data in PDS3)
Venus Express	PDS3

Table. 1. PDS version of cataloged data in ODE

Recent additions to the ODE catalog include PDS4-migrated Clementine data sets that feature raw LIDAR data, gravity and topography data, and LWIR brightness temperature data. Additionally, PDS4-migrated LRO LROC, LEND, LOLA, and DIVINER data, along with twelve bundles of migrated PDS4 MESSENGER MDIS data, have been added to ODE. Notably, the new Version 4 of MEX HRSC map-projected RDR data (REFDR4, PDS3) and ESA's Venus Express MAG (Magnetometer) and VIRTIS (Visible and Infrared

Thermal Imaging Spectrometer) data in PDS3 format were added to the ODE catalog in 2023.

Faceted Search. After an extensive publicly accessible beta test, the enhanced faceted product search functionality in ODE was officially launched on the primary site in summer 2023. This feature is designed to enhance user search efficiency by promptly providing feedback on the results of their filtered selections.

The data product search page now displays the count of cataloged products that match the selected search filters. Furthermore, the product search form's date and angle filters show product counts along with minimum and maximum values, providing users with insights based on the filters they select.

The updated faceted product search page incorporates a results summary box for an enhanced user experience. This box provides a real-time total product count, either with or without applied filters. Applied filters are presented in a list format, akin to e-commerce websites, and can be easily removed by clicking on the respective filter text. Additionally, selected data sets are seamlessly integrated into the filters list, accompanied by their corresponding product count for quick reference.

The results summary box stays on the right side of the screen during vertical scrolling. Once users are satisfied with the previewed results, they can view the product search results either in a table or on the map. Furthermore, upon returning to the search page, ODE automatically populates the filters from the user's last query, streamlining the adjustment of previous search criteria.

ODE REST Updates. The ODE REST interface serves as a tool for software developers and researchers to programmatically access the metadata of the ODE catalog. Queries can be executed through scripts, custom software, or web browsers. Search results are delivered in XML- or JSON-formatted text, and certain queries yield thumbnails or browse images.

Recent enhancements to the ODE REST interface now include support for PDS4 query parameters. Earlier updates incorporated the output of PDS4-specific fields including Bundle Logical Identifier (LID), Collection LID, and Product LID. The latest improvements enable the submission of queries that can selectively narrow down product search results based on PDS4 Product LID, Bundle LID, and Collection LID. These filter parameters facilitate both exact matches and wildcard filtering.

System Upgrades. Upgrades have been implemented for both hardware and software systems supporting ODE, with further updates planned in the latter part of 2024. The underlying systems of ODE GDS have undergone substantial improvements. Previously relying on an aging high-performance computing (HPC) cluster, this system has been replaced by a new job-queuing system that distributes ODE GDS queries across newer and more efficient virtual machines (VMs). This upgrade has enhanced the performance of processing user query requests and improved system reliability, with the flexibility for expansion as user request needs grow.

Additionally, upgrades have been applied to the database system used by the ODE websites. The database host VM, operating system version, and database version have been updated, providing increased performance, security, and stability.

Future Work: The ODE map search interface, related services, and map-processing pipeline are scheduled for an upgrade to the latest version of the ArcGIS map server. ODE will continue to be updated with active mission data releases and migrated data from PDS3 to PDS4. Anticipated PDS4 additions to the ODE in 2024 include future releases of PDS4 MRO HiRISE data and PDS4-migrated Magellan, Clementine, Odyssey GRS, MGS MOLA, and TES data.

Contact Information: The PDS Geosciences Node welcomes questions and comments from the user community regarding additional ODE functions. This feedback is invaluable in identifying opportunities for future improvements and feature additions to the website. If you have any questions or comments, please email us at ode@wunder.wustl.edu or post on the Geosciences Node forum at https://geoweb.rsl.wustl.edu/community.

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References: [1] Wang, J. et al. (2015), 46th LPS, Abstract #1560. [2] Scholes D. et al. (2018), 49th LPS, Abstract #1235. [3] Wang, J. et al. (2011), 42nd LPS, Abstract #1896. [4] Bennett, K. et al. (2014), 45th LPS, Abstract #1026.