

**PDS GEOSCIENCES NODE'S ORBITAL DATA EXPLORER AND THE LATEST UPDATE FOR PDS4.** J.

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**Introduction:** The Orbital Data Explorer (ODE, <https://ode.rsl.wustl.edu>) is a web-based search tool developed and maintained at NASA's Planetary Data System (PDS) Geosciences Node (<https://pds-geosciences.wustl.edu>). ODE provides search, display, and download functionality for PDS archives of orbital data products from planetary missions to Mars, the Earth's Moon, Mercury, and Venus [1,2,3,4].

Recently ended planetary missions and legacy data in PDS have been directed to transition to the new XML-based PDS4 standard to ensure the long-term value of the archives [5]. ODE has been adapted to access both the PDS3 and PDS4 archives at the PDS Geosciences Node and other nodes. Currently, 1.5 petabytes of PDS data are accessible through ODE. While PDS3 is still the most prevalent format of data available through ODE, the recent MESSENGER (Mercury Surface, Space Environment, Geochemistry and Ranging) PDS4 data migration has been the catalyst for several updates to the ODE website.

**ODE Primary Features:** ODE offers form- and map-based searches of cataloged planetary data across multiple missions and instruments [6]. Searches can be filtered by mission, instrument, processing level, observation type, location, time, observation angle, and PDS product identifier.

ODE provides a detailed view of PDS metadata. Associated data files, metadata labels, format files, and documentation are accessible from the detail pages. Files can be downloaded directly or through the website's cart functionality.

ODE supports a specialized granular query tool for subsetting science data at specified regions [7]. This tool supports queries of orbital laser altimetry and thermal emission spectrometer instruments including: MGS (Mars Global Surveyor) MOLA (Mars Orbital Laser Altimeter) and LRO (Lunar Reconnaissance Orbiter) LOLA (Lunar Orbiter Laser Altimeter) and Diviner, as well as MESSENGER MLA (Mercury Laser Altimeter).

ODE provides an MRO (Mars Reconnaissance Orbiter) coordinated observation search tool. A coordinated observation is a planned observation involving multiple instruments at a given location and time. ODE tracks the coordinated observations from HiRISE (High-Resolution Imaging Science Experiment), CRISM (Compact Reconnaissance Imaging Spec-

trometer for Mars), MCS (Mars Climate Sounder), and CTX (Context Camera).

ODE generates product type coverage KMZ (zipped file of Keyhole Markup Language, KML) files and shapefiles for use with GIS tools. Additionally, a Representational State Transfer (REST) interface (<https://oderest.rsl.wustl.edu/>, [8]) allows external users, scripts, and applications to access the ODE metadata and data products without using ODE web interfaces.

ODE provides a cart system for downloading many files at once. The cart ordering system retrieves data from host PDS nodes and data nodes, adds related files, and provides download information to the user. The ODE cart request download page provides a convenient and fast option with a single click link for users to download the entire user cart request using the Aspera Connect web browser plug-in, which employs the FASP (Fast Adaptive Secure Protocol) data transfer technology to better utilize the user's available bandwidth [9]. HTTP and FTP links are provided on the page for users who prefer to download the files through a client application, a different web browser plug-in, a local script, or directly through the web browser.

**ODE Data Inventory:** ODE provides access to data from more than 13 planetary missions and over 50 individual instruments. Those missions include the ongoing MRO, Odyssey, ESA's (European Space Agency) MEX (Mars Express), and LRO missions, as well as a number of completed missions such as MGS, Viking Orbiter, Clementine, Lunar Prospector, Lunar Orbiter, Indian Space Research Organization's Chandrayaan-1, Magellan, GRAIL (Gravity Recovery and Interior Laboratory), and MESSENGER missions. ODE is updated for active missions as new and accumulating datasets are released by PDS. A total of 23.7 millions PDS products are currently cataloged in ODE. A detailed list of the current ODE holdings can be found at <https://wufs.wustl.edu/ode/odeholdings>.

Most of the PDS4 data available in ODE are the Geosciences Node's MESSENGER holdings. The MESSENGER archives have been migrated to the PDS4 standard - in particular, the GRS (Gamma-Ray Spectrometer), NS (Neutron Spectrometer), MLA, XRS (X-Ray Spectrometer), and derived Radio Science archives. The original PDS3 data products, labels, and documentation remain available and unchanged in their original archive volumes. PDS4 labels and docu-

mentation have been added to the archive volumes. ODE Mercury has been updated to load the MESSENGER PDS4 migrated data. ODE will also add data from future PDS4 archives when available.

**ODE PDS4 Updates:** In addition to database and backend coding changes, a number of updates have been made to the ODE interface to support the inclusion of PDS4 data archives in the ODE website.

The PDS3 standard utilized observation product type abbreviations, such as EDR (Experiment Data Record) and RDR (Reduced Data Record), but the abbreviations were not limited to a set list. PDS4 standard processing levels include Raw, Calibrated, and Derived (<https://pds.nasa.gov/datastandards/documents/policy/PolicyOnProcessingLevels03112013.pdf>), which are now used in the ODE product search to group products. As shown in Figure 1, product search is grouped by missions, instruments, and PDS4 standard processing levels.

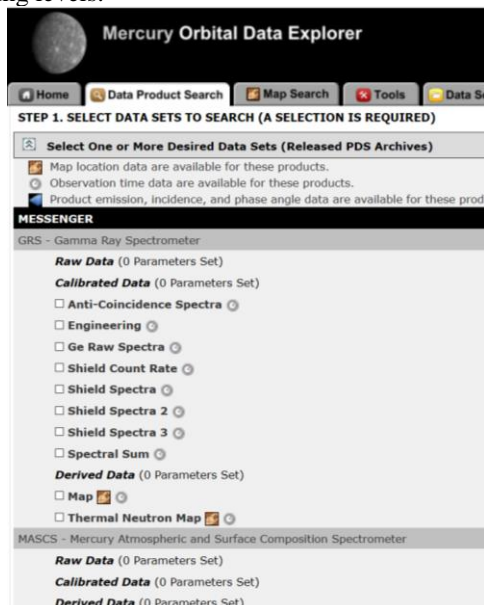


Figure 1. Products Form-based Search Grouped by Missions, Instruments, and PDS4 Standard Processing Levels in ODE Mercury Web Interface.

Additionally, with the transition from PDS3, more user friendly product type names are displayed in the data product search page, the search results list, and other product lists of ODE, rather than product type abbreviations.

The ODE product detail page has been updated to support PDS4 products. Most product metadata is presented the same for both PDS3 and PDS4 data products, but PDS4-specific information is displayed when available. PDS4 product logical identifiers (LIDs), bundle and collection identifiers, links to the associated PDS4 bundles, and links to more about PDS4, such as documentation and tutorials, are provided in the prod-

uct detail page. In addition to access to the new PDS4 XML labels, links to previous PDS3 labels are still provided for those who have software that uses them or users who want to reference the older labels. A new label display with improved highlighting has been implemented for both PDS4 XML and PDS3 labels, as shown in Figure 2.

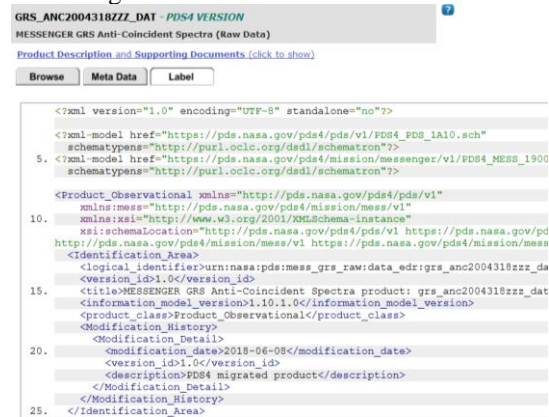


Figure 2. Updates to the PDS4 XML Label Display.

**Future Work:** Newly released data from the ongoing MRO, MEX, LRO, and Odyssey missions will continue to be added to ODE. As data archives are migrated to the PDS4 standard, ODE will be updated to reflect the archive changes. Additional updates to support PDS4 products through the ODE website will be made, as they are identified. We will continue to provide support for ODE website users and ODE REST API users. We plan to make updates to further simplify ODE's PDS data product search to assist non-expert users. We will provide additional information for interacting with data products through online tutorials.

**Contact Information:** The PDS Geosciences Node welcomes questions and comments for additional ODE functions from the user community. Please send email to [ode@wunder.wustl.edu](mailto:ode@wunder.wustl.edu) or post on the Geosciences Node forum <https://geoweb.rsl.wustl.edu/community/>.

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