Planetary Data Access through the Orbital Data Explorer from the PDS Geosciences Node. J. Wang, K. J. Bennett, D. Scholes, R. Arvidson, J. G. Ward, S. Slavney, E. A. Guinness, T. C. Stein, and V. Heil-Chapdelaine, McDonnell Center for the Space Sciences, Washington University, 1 Brookings Drive, Campus Box 1169, St. Louis, Missouri, 63130, wang@wunder.wustl.edu; bennett@wustl.edu

Introduction: Orbital Data Explorer (ODE [1]) is a web-based tool developed at NASA's Planetary Data System's (PDS) Geosciences Node (http://pds-geosciences.wustl.edu/). It helps users to search and retrieve data from multiple missions and instruments in the rapidly expanding planetary data archives. The current version of ODE is V2.5, which includes Mars and Mercury orbital data products in the database. Special services such as a tool for locating Mars Reconnaissance Orbiter (MRO) and Phoenix coordinated observations and basic Mars Global Surveyor (MGS)'s MOLA (Mars Orbiter Laser Altimeter) data search tools are included in ODE for easy data search and retrieval. New map services and a lunar version of ODE will be included in the coming V3.0 version.

The ODE team is currently working closely with the CRISM (Compact Reconnaissance Imaging Spectrometers for Mars) team at the Applied Physics Laboratory of Johns Hopkins University. This cooperation aims to bring the search and retrieval features from the CRISM website into the ODE system by the end of the MRO mission. In addition, the ODE team is working with the U.S. Geological Survey (USGS) to integrate their Unified Planetary Coordinates (UPC) system into the ODE database.

Overview: ODE provides map and forms-based search, retrieval, and download functions for PDS-compliant archive data for Mars, Mercury, and the Earth's Moon. The basic structure of ODE is shown in Figure 1. It consists of a background processor, a metadata database, and a web site. Planetary data from multiple missions and instruments are processed by a background processor and then organized into a searchable database. Typical ODE data products could be an image, a spectrum, and a time series table of measurements from different instruments and missions. A website is created for data searching, exploration and downloading. The primary audience of the website is the science community, but it is open to the public.

ODE for Mars [1] was developed to aid in the use of data from MRO [2], Mars Express [3], and MGS [4] missions. ODE for Mercury is newly developed for the MESSENGER (Mercury Surface, Space Environment, Geochemistry and Ranging [5]) mission, which was launched in August 2004 on a long journey to Mercury. The prototype version of ODE for the Moon holds data from the Clementine [6] and Lunar Prospector [7] missions. Lunar ODE will provide data search capability and mapping functions to support the upcoming Lunar Reconnaissance Orbiter (LRO) mission and future lunar exploration.

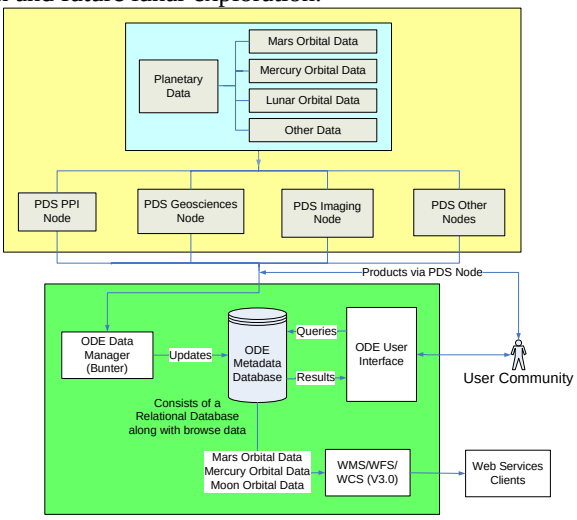

Figure 1. ODE Structure

Other institutions and research centers also develop tools and web systems for planetary data exploration. The Planetary Image Atlas at PDS Imaging Node is a useful web tool to search, display, and download images and other ancillary data for many planetary missions. Other Interactive GIS systems and Web Map Services (WMS) used for planetary data exploration and downloading include USGS PIGWAD (Planetary Interactive GIS on-the-Web Analyzable Database), Map-a-Planet, and UPC Pilot (Planetary Imaging Location Tool, in development), as well as JMARS (Java Mission-planning and Analysis for Remote Sensing) developed at Arizona State University.

ODE complements these websites and tools. ODE has broader imaging and non-imaging cross-mission data holdings for Mars, Mercury, and Moon. Users can search across multiple missions and instruments simultaneously.

Data: ODE currently supports multiple mission data products for Mars and Mercury, with lunar datasets coming soon. The various datasets imported from different instruments and missions are listed in Table 1. The datasets shown in italics are currently in testing and review. They will be added to ODE in the near future. The ODE database holds a total of 2,715,071 and 44,132 products for Mars and Mercury respectively. ODE is integrating USGS's UPC system [8] in order to put the various planetary data in unified, consis-

tent coordinate systems for easy and accurate searching. For example, MGS's Mars Orbiter Camera (MOC) data is being imported in ODE with the UPC system, which is consistent with the coordinate systems of the MRO mission data and MOLA data.

Table 1. ODE Data Holdings

Planet	Mission	Instrument
Mars	MRO	Shallow Radar (SHARAD), CRISM, High Resolution Imaging Science Experiment (HiRISE), Context Imager (CTX), Mars Color Imager (MARCI), Mars Climate Sounder (MCS), and Radio Science Subsystem (RSS).
	Mars Express	High Resolution Stereo Camera (HRSC), Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS), OMEGA (Observatoire Mineralogie, Eau, Glaces, Activite) Visible and Infrared Mineralogical Mapping Spectrometer, and Planetary Fourier Spectrometer (PFS).
	MGS	Mars Orbiter Laser Altimeter (MOLA), and *MOC Narrow Angle (NA) and Wide Angle (WA) cameras*.
	Odyssey	*Gamma Ray Spectrometer (GRS).*
Mercury	MESSENGER	GRS, RSS, Neutron Spectrometer (NS), X-Ray Spectrometer (XRS), MERCURY Atmospheric and Surface Composition Spectrometer (MASCS), Mercury Laser Altimeter (MLA), and Mercury Dual Imaging System (MDIS) Narrow Angle Camera (NAC) and Wide Angle Camera (WAC).
Moon (prototype)	Clementine	*Ultraviolet-Visual (UV-VIS) Camera, Long-wave Infrared (LWIR) Camera, High-resolution (HiRes) Camera, Near-Infrared (NIR) Camera, two Star Tracker Cameras, and Laser Image Detection and Ranging (LIDAR) system.*
	LP	*GRS, NS, Alpha Particle Spectrometer (APS), Magnetometer (MAG), and Electron Reflectometer (ER).*

Functions: ODE web provides a tool for searching and exploring the rapidly expanding orbital data sets as well as accessing and downloading the PDS archives themselves. The major functions are listed as follows.

Data searching and retrieval. ODE allows users to search for science data products via mission, instrument, product type, location, time, and product ID. ODE supports queries on both single and multiple missions, or searches among single and multiple instruments. Search results are shown in a table or on a map. Special tools are developed for MRO and Phoenix coordinated observations and basic MOLA data searching.

A coordinated observation is a planned observation involving multiple instruments at a given location and time. This tool was developed specially for the MRO mission. It allows users to find and view related products from MRO HiRISE, CRISM, CTX, MCS, and MARCI, as well as the Phoenix Lander data.

Basic tools are also provided to query MOLA Precision Experiment Data Record (PEDR) data by a given search area. Users can set additional filtering parameters, such as a product ID, a partial product ID, and altitude information for the search. Results can be outputted in ASCII, shapefile, or CSV format, or saved in binned images. These new MOLA data services will give users an easy way to find MOLA data of interest and output them in a ready-to-use format.

Data presentation. Details of search results are shown in a table. A product's PDS label may be viewed. A browse version of image-oriented products also provides an overview of the product before users make downloading decisions. In addition, users may view the products with their center points, footprints, and bounding boxes plotted on a map.

Data Download. Download capabilities are enhanced in ODE V2.5. Several options are provided for acquiring data products from ODE. Users can select and order data products using a web-based one-stop "shopping cart" approach, or directly download individual files from the web.

In addition, the ODE team is working closely with the CRISM team to add their functionality, including importing the CRISM TRDR browse images and their mapping functions, into ODE. This cooperation will improve the data search and retrieval capability in ODE.

Future Development: Additional Mars and lunar orbital data (e.g., Mars Odyssey GRS, Chandrayaan Mineralogy Mapper (M3), Miniature Synthetic Aperture Radar (Mini-SAR), and the upcoming LRO mission data) will be imported into the ODE database. Improved mapping functions and map services will be implemented in the coming ODE V3.0 version. A more interactive and friendly user interface will be designed in the future for easy access.

Contact Information: The Geosciences Node welcomes questions and comments from the user community. Please send email to geosci@wunder.wustl.edu. Comments on ODE and suggestions for enhancements can be sent to bennett@wustl.edu.

References: [1] Bennett, K., et al. (2008), *LPS XXXIX*, Abstract #1379. [2] Zurek, R.W., and Smrekar, S.E. (2007), *JGR, 112,* doi:10.1029/2006JE002701. [3] Chicarro, A.F., et al. (2004), *ESA Special Publication, SP-1240*, 3-13. [4] Albee, A., et al. (2001), *JGR, 106,* doi:10.1029/2000JE001306. [5] Solomon, S.C., et al. (2007), *Space Science Reviews, 131,* 3-39. [6] Nozette, et al. (1994), *Science, 266,* 1835-1839. [7] Binder, Alan B. (1998), *Science, 281,* 1475-1476. [8] Becker, K.J. et al. (2007), *LPS XXXVIII*, Abstract #2022.