UPDATES TO THE ORBITAL DATA EXPLORER FROM THE PDS GEOSCIENCES NODE. J. Wang, K. J. Bennett, D. M. Scholes, J. G. Ward, S. Slavney, E. A. Guinness, and R. E. Arvidson, Washington University in St. Louis, 1 Brookings Drive, CB 1169, St. Louis, Missouri, 63130, {wang, bennett, scholes, ward, slavney, guinness, arvidson}@wunder.wustl.edu

Introduction: The Orbital Data Explorer (ODE [1, 2], http://ode.rsl.wustl.edu/), developed at NASA's Planetary Data System's (PDS) Geosciences Node (http://pds-geosciences.wustl.edu/), is a web-based tool to help users to find and download data from the rapidly expanding planetary data archives. The current version of ODE, V2.5 [2], includes Mars ODE for data sets from the Mars Reconnaissance Orbiter (MRO), Mars Express, and Mars Global Surveyor (MGS) missions; Mercury ODE for MESSENGER (Mercury Surface, Space Environment, Geochemistry and Ranging) data; and Lunar ODE for Clementine and Lunar Prospector data. Key features of V2.5 include location-, time-, and product ID- based search, product browse, and shopping-cart-style download. Additional tools locate MRO and Phoenix coordinated observations, and search the MGS's MOLA (Mars Orbiter Laser Altimeter) altimetry data.

Three major releases are in the works: V2.6, V3.0, and V4.0. V2.6's new capabilities are mainly focused on supporting data from the Lunar Reconnaissance Orbiter (LRO) mission. All LRO data sets are incorporated as they are released, and a LOLA (Lunar Orbiter Laser Altimeter) query tool is provided similar to the MOLA query tool.

V3.0 will be focused on product coverage map services. This includes a major overhaul of the Web map display and query function, as well as Open Geospatial Consortium (OGC) WMS (Web Mapping Services) and WFS (Web Feature Services) services. The web services for PDS product coverage (footprint) information can be accessed through free and commercial GIS software packages. V4.0 will expand on this WebGIS initiative by providing selected PDS data through these services. This abstract will focus on V3.0.

System Overview: V3.0 will provide product footprint map and coverage-based information for searching, displaying, and downloading PDS-compliant archive data for Mars, Mercury, and the Earth's Moon. "Footprints" show the surface coverage of data products as shown in the example in figure 1. ODE currently supports about 2 million individual product footprints.

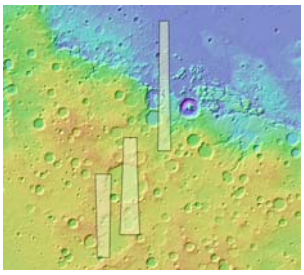

Figure 1. Footprints Overlain on a MOLA Basemap

The basic structure of ODE is shown in figure 2. It consists of a background processor, a metadata database, a ESRI® Geodatabase, and a website with Web services provided. Planetary data from multiple missions and instruments are processed by the background processor to "normalize" the product data, which are then organized into both a searchable database and a Geodatabase. "Normalization" ensures that all footprint data use the same unified coordinate system, such as the IAU2000 planetocentric system. Product footprints can then be used to build maps and to publish Web services using ESRI® ArcGIS Server 9.3.1. Users can query footprints and ultimately product data through the website interface or the published Web services.

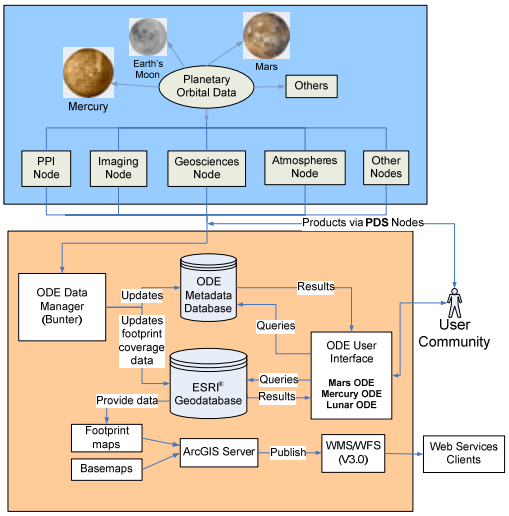

Figure 2. ODE Structure

Data Processing & Database: ODE holds various orbital data sets from multiple missions, instruments, and planets. Data sets may have disparate providers, data formats, coordinate systems (particularly older data sets), and projections, which makes it difficult to search, display, and correlate data from various in-

struments. Therefore, product footprints from various data sets may need to be normalized before being imported into the database. For example, data sets with planetographic coordinates stored in PDS are transformed to planetocentric coordinates using a background processor, or directly acquired from the USGS Unified Planetary Coordinates (UPC) database.

After normalization, data are loaded into a SQL database and a Geodatabase for the ODE application. The SQL database currently holds the product metadata, while the Geodatabase only includes product footprints. The Geodatabase was chosen for the improvement of the system performance and better data organization. All of the footprints are available in four projections including simple cylindrical projections centered at 0 longitude and 180 longitude, as well as two stereographic projections at the north pole and south pole. The projection is not carried out on the fly because some GIS tools may have issues in interpreting the footprints that cross meridians and poles.

Footprints are stored as vector data in the Geodatabase, and loaded into ESRI® ArcMap to generate maps. The basemaps are generated using mosaics from different instruments, which are also available in four projections.

Major Updates: V3.0 is mainly focused on the map display, Web services, and its coverage-based search capabilities. The major updates are illustrated as follows.

Map Display. The ESRI® ArcGIS Server was chosen as the platform to build a Web map for ODE. The Web map includes both footprint coverage and basemap layers as shown in figure 3. In this example, the product footprints of the MRO Context Camera (CTX) Reduced Data Record (RDR) data, represented as the green polygons, are overlain on a gray Mars Orbiter Camera image mosaic in a simple cylindrical projection. Basic mapping and GIS functions include map display, pan, zoom in/out, navigation, and identification as illustrated in the toolbar above the map window. The map visually represents independent data sets and product types using various colors and symbology, and displays them in separate layers.

Figure 3. Graphical User Interface at a Client Side

Web services. All the GIS resource data and maps are stored on the ArcGIS server. Web services such as OGC WMS and WFS are then published to provide maps of georeferenced footprint data. Those services make the footprint data easy to share among the clients without buying specialized or expensive GIS software. Users can use the service within a Web browser or custom application. Some free GIS software such as Gaia 3.4.0, NASA WorldWind, and CARIS Easy View, as well as the commercial alternatives like ArcMap and ArcGlobe, can be used at a client side to access the GIS services.

Data searching. In addition to searching for science data products via mission, instrument, product type, location, time, and product ID, ODE allows users to query based on product coverage. Users can select coverage areas of visible product layers through the map interface to find data products with footprints intersecting the selected area, as shown in figure 4. The selected products can be further reviewed, added to the download cart, or exported as a list.

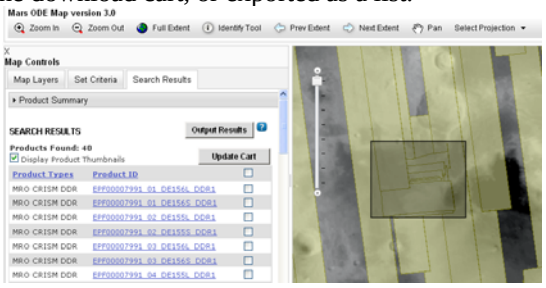

Figure 4. Finding Data Products through Web Interface

Future Development: Additional MESSENGER, MRO, and MEX data releases will be imported into the ODE database. Other PDS data sets and new query tools similar to the MOLA query tool will be included in ODE based on user inputs. Updates to the map, as well as GIS functions and data services, will be implemented in the future for easy data access. For example, an image server may be populated for V4.0 in order to organize the raster data products more efficiently.

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] Wang, J. et al. (2009), *LPS XL*, Abstract #1193.