SEARCHABLE OBSERVATION DATA IN PDS'S ORBITAL DATA EXPLORER. J. Wang, K. J. Bennett, D. M. Scholes, 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, slavney, guinness, arvidson}@wunder.wustl.edu.

Introduction: The Orbital Data Explorer (ODE [1, 2, 3], http://ode.rsl.wustl.edu/) was developed at NASA's Planetary Data System's (PDS) Geosciences Node for online data search, exploration, and downloading. ODE consists of a back end processor, databases, and a front-end web site. The database is the heart of ODE. Multiple databases and web sites were designed in ODE for different terrestrial planets. Mars, Mercury, and Moon ODEs were developed for searching and retrieval of the PDS data products through a relational metadata database. An extension of ODE Mars is under development to support the MSL (Mars Science Laboratory) landing site selection process. Additionally, ODE supports several "observation databases" together with the specialized query tools for subsetting science data at particular regions. An ODE observation database is a database that stores individual data records from the PDS data products in a searchable database. With the observation databases and specialized query tools, users can generate dynamic derived files efficiently.

Why Observation Databases?: The primary purpose of ODE is to allow users to search and find single or multiple PDS data products. However, in many cases, users only want the science data for particular regions, which might be a subset of multiple products. This is particularly true for spatial data stored along orbit tracks in time-sequence chunks, such as the LRO (Lunar Reconnaissance Orbiter) LOLA (Lunar Orbiter Laser Altimeter) RDR (Reduced Data Record) and MGS (Mars Global Surveyor) MOLA (Mars Orbiter Laser Altimeter) PEDR (Precision Experiment Data Records) data sets. When a user makes a query, with the current PDS volume and data product structure, the standard ODE query tool would return far more data than actually needed. For example, when searching the lunar laser altimeter data between 0 to 5 degrees latitude and 180 to 190 degrees east longitude, a LOLA RDR query of the observation data base returned 2,606,841 LOLA RDR measurements that matched the selected criteria. In contrast, a standard Lunar ODE query returned 59 individual data products, each with about 200,500 measurements, including some additional points outside of the search range. Each file was approximately 50MB. The results from the standard query found around 4.5 times more data than was actually needed.

ODE now includes a concept of "Observation Databases" together with specialized query tools for searching PDS science data. These tools help science users to find science data for a particular area of the surface or to search parameters that are not easily handled with the data product structure, which save people time searching through the huge database and the effort of developing their own customized extraction tools.

Overview of Observation Databases: An ODE observation database holds the science data extracted from a set of PDS data products in a searchable database. ODE currently supports 3 separate observation databases (Fig. 1). The first example is the MGS MOLA PEDR database that supports the MOLA PEDR query tool. The other two are for the LRO LOLA RDR and LRO Diviner Lunar Radiometer Experiment RDR data sets. All three data sets are time-ordered observations. MOLA PEDRs are binary tables generated from the raw altimetry profile data with precision orbit corrections applied. The LOLA RDRs are calibrated altimeter measurements geolocated and aggregated by orbit. LRO Diviner RDRs include radiance and brightness temperature data for global mapping of the lunar surface temperature.

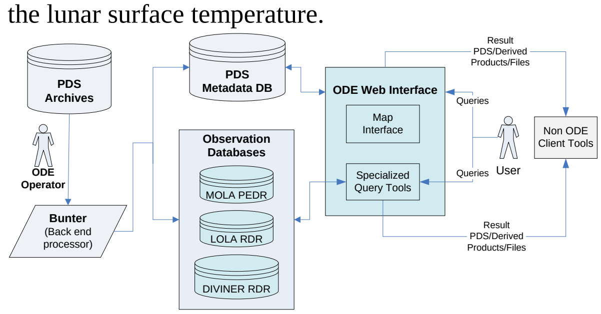


Fig. 1. Architecture of Orbital Data Explorer

Although the three datasets are somewhat different, their observation databases have several common elements. As shown in Fig. 1, each observation database stores the data records from the science data products saved in PDS archives, along with the metadata information from the PDS labels, and organizes them into a searchable database. Then an independent web-based "Query Tool" exists for each of the observation databases. The query tools allow users to query the observation database with special filters and produce one or more derived products.

Users may search the data by location and other parameters, such as a product ID (or partial ID), orbit number, UTC time, channels, and altitude (LOLA or MOLA) information. The Diviner RDR search tool contains additional filters for detectors, local time of day, emission angles, solar incidence angles, solar azimuth angles, and quality flags. Query results are exported as several types of ready-to-use derived products, including ASCII or CSV tables, shapefiles, and binned images.

Observation Databases maintenance: Each observation database has global coverage of the data products. The MOLA searchable database includes approximately 595 million individual PEDR measurements. In the case of LOLA and Diviner, there are 751 million and 48.5 billion records respectively, and these two databases continue to grow with each release of new LRO data. In order to speed up the query operation in the observation database, the global data products are grouped into small tiles by geographic location. There are 288 tiles with coverage of 15*15 degrees each for LOLA or Diviner RDRs. MOLA data has 32 tiles with a tile size of 45*45 degrees. The tile structure is saved in its own indexed SQL database table. In this table, each record defines the coverage extent of one tile and indicates the name of its corresponding indexed SQL database data table that stores the real data. Those data tables include information such as product id, the location of a point, elevation, planet radius, orbit number, channel, and UTC time. The ODE observation databases reflect the contents of PDS archives and datasets. The observation databases are usually updated every one to three months whenever the archives are updated.

Applications: Specialized query tools are web-based tools. They are accessible from the ODE tools page (Fig. 1). Once a user sends a query request through the query tool, the tool links to the observation database and finds tiles covering the data of interest. Then, instead of searching through the whole database, it only looks into the indexed SQL data table related to the tiles found in the first step. The data of interest is exported as derived products in the form of ASCII or CSV tables, shapefiles, and binned images.

Although map-projected gridded data are pre-generated and available at various resolutions in the PDS archives, a user may want to use the science data to make a custom map of a specific region. The user makes a specific query and loads the derived products into various end user client tools for further analysis. The following example is a query on the LOLA RDR data at Abbe Crater. There were 404,989 laser altimeter points returned from the search, and the results were saved in a 3D shapefile. The derived 3D shapefile was loaded into ESRI® ArcGIS software for 3D display (Fig. 2) and further processed to generate a 3D surface (Fig. 3).

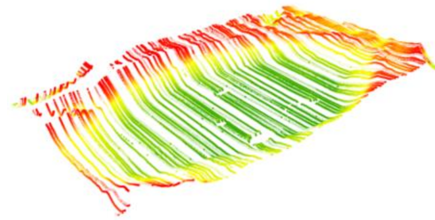


Fig. 2 Visualization of 3D Shapefile in ESRI® ArcGIS

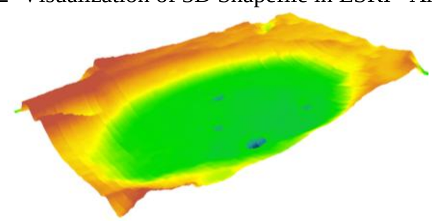
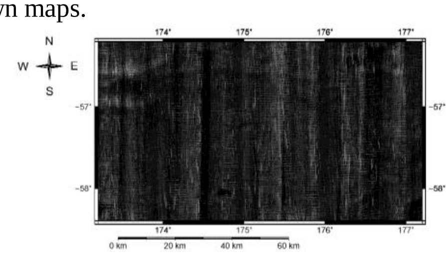
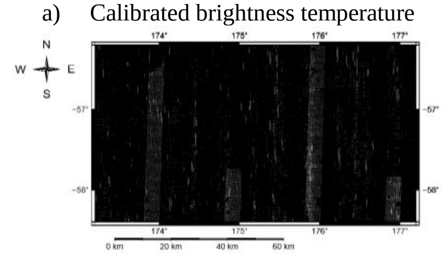


Fig. 3. Generation of 3D Surface in ESRI® ArcGIS

Fig. 4 is another example of a user application with the Diviner RDR query results. The query was carried at Abbe Crater and generated derived map-projected JPEG2000 binned images. A user can load these images in GMT (Generic Mapping Tools [4]) and create their own maps.



a) Calibrated brightness temperature



b) Radiance

Fig. 4. Map-projected Binned Image of Diviner RDR Query Results Plotted in GMT

As shown in these examples, with the observation database and specialized query tools, users can make customized queries and create their own products on-the-fly.

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 may 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. [3] Wang, J. et al. (2010), *LPS XLI*, Abstract #2251. [4] Wessel, P. and Smith, W. H. F. (1998), *EOS Trans. AGU*, 79(47), 579.