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Introduction: The Planetary Data System (PDS) Geosciences Nodes has developed two web based services for searching and downloading planetary geoscience data. The Orbital Data Explorer (ODE) (http://ode.rsl.wustl.edu) provides access to orbital data from Mars, the Moon, Mercury, and Venus. The Analyst's Notebook (AN) (http://an.rsl.wustl.edu) provides access to landed data sets. There are separate ANs for the active missions Mars Science Laboratory (MSL) and the Mars Exploration Rovers (MER) and for the past missions Phoenix Lander, LCROSS, and the Apollo surface missions. For both services the archives can be searched and data products can be downloaded individually through the web-interface or placed in a cart for later bulk download with FTP. Both services also provide access to documentation included in the archives.

Orbital Data Explorer (ODE): The ODE delivers the ability to search, display, and download PDS data from many orbital planetary missions to the terrestrial planets [1]. For a few data sets derived from instruments that collect point data along an orbit track, ODE provides a granular-level search. This tool allows a user to specify a set of search parameters whereby ODE will search each of the data products to extract the individual records that match the search criteria. The extracted data records are placed into custom data products that the user can download. Currently, ODE supports granular-level searches for the 595 million point MOLA PEDR (Precision Experiment Data Record) data set from MGS and the 6.5 billion point LOLA RDR (Reduced Data Record) and 213 billion point Diviner RDR data sets from LRO. ODE also provides a REST (Representational State Transfer) interface (http://oderest.rsl.wustl.edu) for external users that want to access the ODE metadata and data products without using the ODE web interface. The REST interface allows external users to develop domain-specific tools and interfaces to the data products and metadata within ODE.

Data searching and retrieval. ODEs allow users to search for science data products via form-based or map-based interfaces. Users can make a form-based query by setting parameters of mission, instrument, product type, coverage, location, time, observation angles, and product ID with the form-based Data Product Search interface. Users can also make queries on the Map Search interface with the Select Products By Area tool or by setting parameters in the Map Display Controls panel. 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.

Data representation. Details of search results are shown in a table with a set of functions to select more product information such as browse, metadata, PDS label, or map context. The browse version of image-oriented products provides an overview of the product to help users make downloading decisions. In addition, users may view the products with the footprints or bounding boxes plotted on a base map.

Map display. The ODE web map includes both footprint coverage and base map layers. The footprint coverage maps display the location of data products. Each map layer includes all of the product footprints per instrument product type. Each footprint shows an individual product's surface area coverage. The base map layers provide context background. The footprint maps are overlaid on a number of base maps. The transparency of each map layer can be adjusted in order to provide for combined presentation of layers. Some footprint maps, such as CRISM TRDR, DIVINER and LROC are slow to display due to the large number of product footprints rendered on the map layer. These layers are highlighted with an icon indicating their expected performance.

The ODE web map interface was built based on the ESRI® ArcGIS Server and ArcGIS JavaScript API. Basic functions include map display, pan, zoom in/out, and navigation.

Data Download. Multiple options are provided for acquiring data products from ODE. Users can select and order data products using a web-based "shopping cart" approach, or directly download individual files through the ODE interface.

Footprint coverage maps in KMZ and shapefile format. As mentioned, footprint coverage maps allow users to see what portion of a planetary surface is covered by the footprints of all products of a given product type of a given mission and instrument. ODEs generate product-type coverage KMZ files and shapefiles for further access of the product coverage data with Google Earth/Mars/Moon or other GIS tools. The coverage files include basic product information and links to product details in ODE to assist the user in acquiring product files through this method.

Coordinated observations. A coordinated observation is a planned observation involving multiple in-

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

REST interface. ODE also provides a simple web-based REST interface to allow other groups to develop specialized or domain-specific interfaces to search for PDS products, obtain metadata about those products, and download the products through the URLs stored in ODE's metadata database. Additionally, the ODE REST V2.0 Beta interface also supports MOLA PEDR, LOLA RDR, DIVINER RDR, and Mercury MESSENGER MLA RDR granular-level queries. The query results are the same as the current ODE web-based granular query.

The Analyst's Notebook (AN): The AN service integrates data archives with observation planning and targeting information and documentation to allow the user to place individual data observations in the context of other observations and the reasons for acquiring the data, effectively playing back the mission [2].

Content: The ANs for the Mars missions contain the peer-reviewed, released archives for all science instruments. These notebooks are updated with each PDS data release. The data are supported by documentation that describe the data format and calibration. Other documents are included that provide insight into why particular observations were made along with overall mission strategy and science objectives.

Observation planning and targeting information is extracted from Mars mission science plans and presented in both timeline and list form. Effort has been made to link source commands with resulting data products, albeit with limits due to the absence of round trip data tracking.

Navigation: Data can be found using an interface with a searchable and sortable high-level summary of each sol (Mars day) activities. The primary method for accessing mission data and information is through the Sol Summary interface that links data, documentation, and image mosaics for individual sols or a small group of sols. A map interface provides a view of rover traverses on a base map that can be zoomed and scrolled through. The user can select any rover position in order to be linked to the data for that location.

Data holdings may be searched by time (sol, spacecraft clock time, and UTC date), location (rover-specific site and position), instrument, command sequence, product type, image eye and filter, and product ID. Sol documents may be searched by type, time, and filename. In addition, free text searches are supported. Results are displayed based on user settings, and searches can be bookmarked for later recall.

Context Mosaics: The PDS data archive for MSL includes mosaics generated by the science team from Navcam data. However, sometimes sequences of single frame images are acquired for the purpose of creating a mosaic without a formal data product being archived. For these cases, we have created mosaics from the single frame images to provide context, and have included them in the MSL AN.

Context mosaics, which are not calibrated science products, are created from Navcam, Mastcam and MAHLI images using Microsoft Image Composite Editor (ICE) software in either perspective or simple horizontal cylindrical projection. Navcam context mosaics are created by stitching radiometrically calibrated images and then applying a linear 2% stretch. Mastcam and MAHLI context mosaics use DRCL (radiometrically calibrated and linearized) products as sources. Projection information for the context mosaics is available in the EXIF (Exchangeable Image File Format) data that are part of the embedded JPG file header with each mosaic.

Tool Updates: Both the ODE and AN services are updated for active missions as new data are released by missions to the PDS, typically once every three months for a given mission. Additional data sets are added to ODE based on science community input. In the future, the Geosciences Node plans to create and maintain additional ANs for the InSight and Mars 2020 missions once they begin operations.

Future Development: An updated Map Search interface is currently under development for ODE with the goals of improving performance, usability, and the process of individual product display and download. Work continues to incorporate additional features in the AN, especially in the areas of related observations and visualization, as well as data transformation.

Feedback: A number of ODE and AN functions are based on previous user suggestions, and feedback continues to be sought. (User feedback should be submitted to geosci@wunder.wustl.edu or by using the online form.)

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References: [1] Bennett, K. et al. (2008), LPS XXXIX, Abstract #1379. [2] Stein, T.C. et al. (2010), LPS XLI, Abstract #1414.