

DATA FROM THE LUNAR RECONNAISSANCE ORBITER (LRO): DATA PRODUCTS, TOOLS, AND COMMUNITY USE. N. E. Petro, J. W. Keller, and A. P. Morusiewicz, NASA Goddard Space Flight Center, Greenbelt, MD, 20771 (Noah.E.Petro@nasa.gov).

Introduction: LRO, with a compliment of seven instruments, was launched to the Moon on June 19, 2009. Since entering orbit, over 600 Tb of data has been deposited into NASA's PDS by the instrument teams. With a cadence of deliveries occurring every three months, the LRO holdings have evolved relatively rapidly with new data products and tools being generated with nearly each delivery. This data volume contains a range of products, including higher-level maps, mosaics, and derived products.

The PDS has made available the Lunar Orbital Data Explorer [1], a map-based tool to search for finding and downloading PDS science data of LRO as well as other recent lunar missions. In addition to the PDS holdings, several of the LRO instrument teams have additional products and tools available on their websites (Table 1).

Higher Level Data Products: Several global map products have recently been added to the PDS, here we highlight recent products. The Mini-RF team has assembled a global mosaic of their monostatic measurements [2]. For the first time we have global radar data for the Moon, data that clearly shows variations in rock abundance and surface texture over the entire lunar surface (Figure 1).

The LROC team regularly adds new products to the PDS via the team webpage (Table 1), including shape files, global mosaics, NAC-derived DEM's, and NAC mosaics of selected targets. Recently the LROC team has made available a number of anaglyphs (Figure 2) showcasing the ability of the LRO spacecraft and the LROC team to precisely target the NACs and the excellent registration of the camera system.

The LAMP team has a number of polar products available, including FUV ratio maps of both poles (Figure 3). These following maps are available at a resolution of 240 meters per pixel; Lyman- α (119.57–125.57 nm), Long (130–190 nm), On-band (130–155 nm), Off-band (155–190 nm), H₂O Absorption Feature Depth Maps made by a Ratio map of on/off band.

The LOLA team has prepared a number of map products and special polar products available from their PDS node (Table 1). These include DEM's at range of resolutions from 4 to 1024 pixels per degree and global LOLA-derived roughness (Figure 4) and slope maps at 16 pixels per degree. Special products, polar illumination, sky view, and solar visibility maps are available at 240 meters per pixel.

The Diviner team has multiple global derived products, including polar maximum and minimum temperatures, and from 60° North to 60° South at 32 and 128 pixels per degree, rock abundance, band center of the Christiansen Feature, and surface temperature.

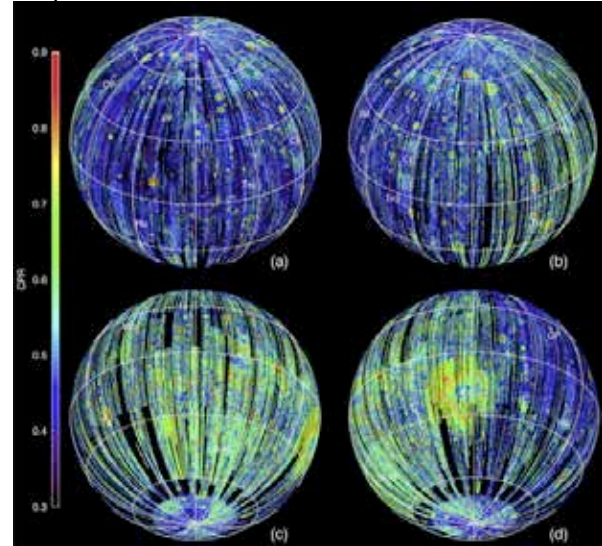


Figure 1. Mini-RF global mosaic of the Circular Polarization Ratio (CPR), one of the number of Mini-RF mosaic products now available online [1-3].

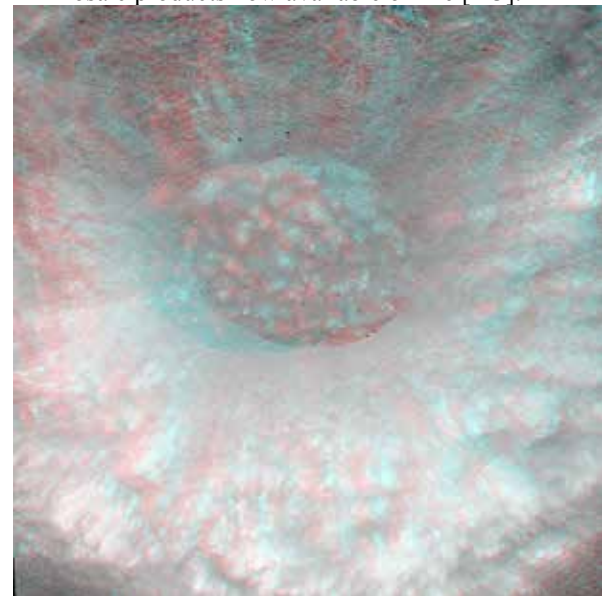


Figure 2. Red-Blue anaglyph of an 8 km diameter crater near Jenner crater. The LROC team has made a number of anaglyphs available on their website (Table 1).

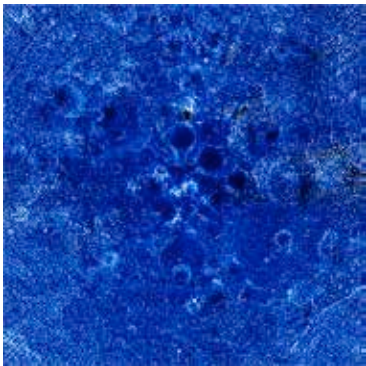


Figure 3. LAMP generated Lyman- α map of the lunar South Pole [3]. LRO has focused on volatiles at the South Pole since arriving at the Moon 5+ years ago.

Table 1. LRO team websites

LRO Project	lunar.gsfc.nasa.gov
Outreach	lunar.gsfc.nasa.gov/education.html
CRaTER	crater.sr.unh.edu
Diviner	diviner.ucla.edu
LAMP	boulder.swri.edu/lamp/
LEND	1503.iki.rssi.ru/LEND-en.html
LOLA	lunar.gsfc.nasa.gov/lola/ imbrium.mit.edu
LROC	lroc.sese.asu.edu
Mini-RF	nasa.gov/mission_pages/Mini-RF/main/index.html

Table 2. Web-based tools for working with LRO data.

Name	URL	Description
PDS Orbital Data Explorer	ode.rsl.wustl.edu/moon	PDS generated tool for downloading data from LRO and other lunar missions/instruments.
Quickmap	target.lroc.asu.edu/q3/	LROC created tool for displaying LROC images and products, and overlaying data from other instruments
Lunaserv	webmap.lroc.asu.edu/lunaserv.html	LROC created tool for projecting lunar data and accurate projection of global data.
LRO Data Users Workshop Archive	lunar.gsfc.nasa.gov/datausersworkshop.html	Presentations from the LRO teams on their datasets.

LRO Data Tools: A number of web-based tools are available that enable viewing, accessing, and interacting with LRO data (Table 2). These tools allow for users to find data over areas of interest, view higher-level map projected data products, and make cursory measurements (e.g., distance, elevation, spectral measurements). While these online tools do

not replace other data analysis or image projecting software (i.e., ISIS, ENVI, MATLAB) they do facilitate finding the appropriate files.



Figure 4. LOLA generated roughness map [4] at 16 pixels per degree centered over the Western Limb (-90° Longitude) over an LRO WAC base image.

Use of LRO Data: The regular updating of LRO data guarantees a nearly constant supply of new data for the community to use. Announcements of new LRO Data are made via the Lunar-L listserve and the PDS website [3].

The LRO Project has begun holding a series of data users workshops with the goal of helping the community work with the large volume of LRO data. Prior to the 2015 LPSC each instrument team presented on the availability of data products as well as available tools for use by the community. Presentations given at the workshops are archived at the LRO website [5].

During the most recent LRO Senior Review the large number of scientific publications by the community that were published outside of the LRO instrument teams was deemed to be of high merit, and illustrated the usefulness and usability of LRO data. We encourage use of LRO data by the community, questions regarding the access and use of LRO data can be directed to the authors of this abstract.

References: [1] Lunar Orbital Data Explorer, (<http://ode.rsl.wustl.edu/moon/>). [2] Cahill, J. T. S., et al., (2014) *Icarus*, 243, 173-190. [3] LRO PDS Archive, (<http://pds-geosciences.wustl.edu/missions/lro/>). [4] Rosenburg, M. A., et al., (2011) *Journal of Geophysical Research (Planets)*, 116, E02001. [5] LRO Data Resources, (<http://lunar.gsfc.nasa.gov/resources.html>).