NEW PLATFORMS FOR WEB-BASED LUNAR AND PLANETARY MAPPING AND GIS. M. D. Hancher[1], R. A. Beyer[2], M. J. Broxton[3], K. Kasraie[4], and M. F. Smith[5], [1]NASA Ames Research Center (M/S 269-3, Moffett Field, CA, 94035, Matthew.D.Hancher@nasa.gov), [2]SETI Institute, [3]Carnegie Mellon University, [4]Research Institute for Advanced Computer Science, [5]Carnegie Mellon University.

Introduction: Web-based mapping technologies such as Google Maps and Google Earth have revolutionized the ways in which Earth scientists visualize, access, and communicate geospatial information. Numerous websites attempt to provide similar services for the lunar and planetary science community, but until now none has offered the degree of flexibility and power that is available for the Earth. Following our successful joint development with Google, Inc., of the new Google Moon [1,2], we have developed and are releasing a number of extensions to the Google Maps API (*Application Programming Interface*) and other tools to bridge that gap.

Background: Existing lunar and planetary mapping websites, such as the USGS Map-a-Planet and PIGWAD services and the ASU Apollo Image Archive, are each based on a purpose-built web mapping infrastructure. Since each tools is developed independently, this involves a significant duplication of effort which represents a distraction from the core purpose of developing new data visualization, analysis, and outreach capabilities. By contrast, the Earth mapping and GIS (*geospatial information systems*) communities have developed a very large number of web-based mapping services all of which take advantage of a relatively small number of common underlying architectures. These architectures, such as the Google Maps API, OpenLayers, and Google Earth, allow Earth scientists to focus on new data and capabilities rather than on reinventing the wheel.

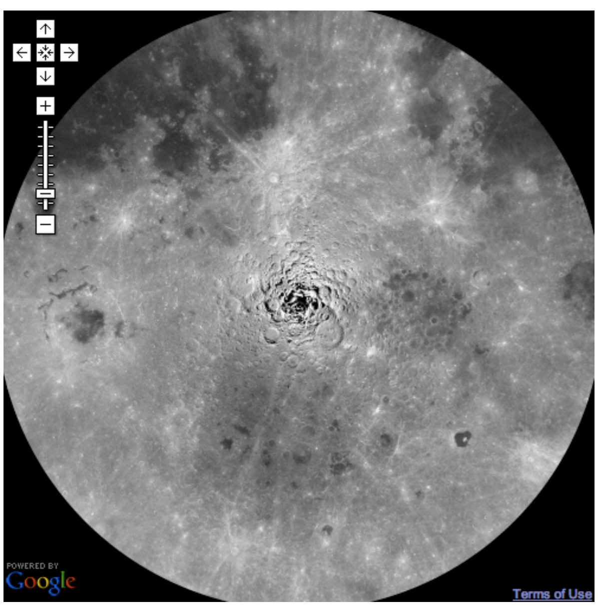

Figure 1. A south polar stereographic base map of the moon, displayed via the Google Maps API.

Lunar and Planetary Mapping Platforms: We have developed a number of extensions to these Web mapping tools to bring this same capability to the lunar and planetary science community. There are three key components to this work: reprocessing of the base map imagery; development of API extensions to provide access to that imagery and other GIS features from within users' websites; and development of KML (*Keyhole Markup Language*) content to provide access to that imagery and supporting data from within 3D geobrowsers such as Google Earth.

The planetary bodies for which we are currently or will soon be providing base map data are the Moon, Mercury, Venus, Mars, Jupiter, Callisto, Europa, Ganymede, and Io. The quality and completeness of the data sets varies from body to body based on the availability of source data. This spans the range from e.g. Mars, where excellent global base maps and many high-resolution insets are available, to Mercury, where the best available base map is an airbrush map that covers only half the planet. A “map” of a gas giant such as Jupiter is of course only of educational interest and not generally as useful as a base map for scientific applications. We hope to expand this list of base maps as additional data becomes available and we are able to process it.

In order to operate efficiently, all web-based mapping and GIS tools rely on map data that has been processed into tiled subsets at multiple resolutions, making it easy for the display software to request only the data that is needed for display at any given time. Because this underlying architecture is common to all tools, it is relatively straightforward to provide map data to a variety of platforms at once.

The two map projections most commonly used by Web mapping software are simple cylindrical (a.k.a. Plate Carree) and equatorial Mercator. These projections are both suitable in equatorial regions but unsuitable for use near the poles. Since the polar regions are often of great significance in lunar and planetary science, this is a critical shortcoming. To address this problem, we provide our datasets not only in the two equatorial projections but also in north and south polar stereographic projections.

To make it as easy as possible to use these maps to build Web mapping services, we have developed extensions to two different JavaScript Web mapping APIs: Google Maps [3] and OpenLayers [4]. These extensions make it as easy to build lunar and planetary map websites as it is for the Earth. For Google Maps, these extensions build on the existing API support for building maps using Google Moon and Google Mars data. They also include the definition of polar stereographic projections, making it straightforward to build polar Web maps using the polar stereographic map tiles. We also provide a few core features, such as latitude and longitude read-out capability, that are of fundamental interest in scientific applications.

Finally, we have also developed a set of KML files that provide access to these same base maps in KML-compatible 3D geobrowsers such as Google Earth. Scientists can immediately visualize their own KML data on top of these base maps, without having to write any additional code at all. We also provide KML descriptions of associated data such as place names and geographic feature types. Unfortunately, since KML currently only supports simple cylindrical coordinates the polar stereographic maps are not available in this format.

Example Applications: We have developed a number of example applications that demonstrate the use of these platforms to visualize and communicate lunar and planetary map data. For outreach and education purposes, we demonstrate how to present new imagery from a lunar orbiter in its geospatial context by overlaying it on Google Moon. We also demonstrate how to provide a map-based interface to other databases of information such as Wikipedia articles about places on the Moon.

For scientists, we have developed several examples of how these platforms can be used to quickly build rich browse and index tools for planetary imagery. By providing coverage information for multiple instruments, the ability to directly browse imagery in its geospatial context, and offering quick links to the raw and processed source data, these examples show how web map interfaces can dramatically simply much of the menial work involved in selecting and obtaining data for scientific analysis.

Image Processing: The datasets that we provide were gathered from a number of sources and processed into their final forms using the NASA Vision Workbench [3], an open-source image processing toolkit developed at NASA Ames. It was used to assemble each dataset from source tiles or coverages, reproject the composited datasets into each of the four output projections, and tile and subsample the resulting datasets to produce image pyramids that can be efficiently loaded by a Web GIS tool as the user navigates the map. Reference software demonstrating how to perform all these steps will be publicly released in a forthcoming release of the Vision Workbench, so that scientists can easily process their own base maps and image overlays rather than relying exclusively on those that we provide.

Limitations and Future Work: Because the APIs we have developed are extensions to, rather than replacements for, the existing Google Maps and OpenLayers APIs, they are subject to the bugs and limitations of those underlying frameworks. Neither is perfect. These extensions exercise little-used core API features, such as support for custom map projections, and so they risk encountering new bugs. Further, bugs that have limited impact on the Earth, such as those impacting geographical features that span the antimeridian, can be more significant on other planetary bodies. Fortunately, both Google Maps and OpenLayers are being actively developed, and both have highly active user support forums. Understanding the existing bugs illuminates what is possible today versus what is likely to be possible in a few months time, as the underlying issues are slowly addressed.

We are currently developing a number of additional capabilities that we hope to also release to the planetary science community. Work to provide access to these datasets from within the NASA World Wind Java client is underway. Many capabilities that are standard in commercial GIS software packages are not yet supported directly by existing Web GIS APIs. We have already addressed a couple of the most glaring holes in our API extensions, such as the ability to conveniently measure the latitude and longitude of points on the map, but this is trivial compared to what is possible. For example, the ability to easily overlay latitude and longitude grid lines over the base maps in all supported projections is critical but not yet supported by many Web mapping tools. We are very interested to receive feedback from the Lunar and planetary science communities regarding what other API extensions they would find most valuable.

References: [1] R. A. Beyer et al. (2007) "Google Moon, Google Mars, and Beyond." Poster at AGU 2007. [2] M. D. Hancher et al. (2007) "NASA Data in Google Moon." http://ti.arc.nasa.gov/moon (Jan 2008). [3] Google, Inc. "Google Maps API." http://code.google.com/apis/maps/ (Jan 2008). [4] "OpenLayers." http://www.openlayers.org/ (Jan 2008). [5] M. J. Broxton et al. "NASA Vision Workbench." http://ti.arc.nasa.gov/visionworkbench (Jan 2008).