

# Interactive Planetary Visualization and Analysis with NASA's Solar System Treks Portals

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## Abstract

NASA's Solar System Trek online portals provide web-based suites of interactive visualization and analysis tools enabling mission planners, planetary scientists, students, and the general public to explore planetary surfaces as seen through the eyes of many different instruments aboard a wide range of spacecraft. The portals present a vast collection of mapped data products from past and current missions for a growing number of planetary bodies. As web-based toolsets, the portals do not require users to purchase or install any software beyond current web browsers. The interactive and immersive capabilities of these portals are being used for site selection and analysis by NASA and a number of its international partners, supporting upcoming missions. They are also being used by formal and informal educators, students from elementary through university levels of study, and members of the public who are engaged in the excitement of solar system exploration. This presentation will provide an overview of the Solar System Treks and highlight many of the exciting new additions to the project implemented this past year.

## 1. Introduction

NASA's Solar System Treks program of lunar and planetary mapping and modeling produces a suite of interactive visualization and analysis tools. The program is managed by NASA's Solar System Exploration Research Virtual Institute and developed at NASA's Jet Propulsion Laboratory. These tools enable mission planners, planetary scientists, and engineers to access mapped data products from a wide range of instruments aboard a variety of past and current missions, for a growing number of planetary bodies. While originally initiated for mission planning and science, this technology has demonstrated great benefits for public outreach. As

components of NASA's Science Outreach and Education Infrastructure, they are available as resources for NASA Outreach and Science Education programs, and to the greater outreach and education community. As new missions are being planned to a variety of planetary bodies, these tools are facilitating the public's understanding of the missions and engaging the public in the process of identifying and selecting where these missions will land.

The portals provide easy-to-use tools for browsing, data layering and feature search, including detailed information on the source of each assembled data product. Interactive maps, include the ability to overlay a growing range of data sets including topography, mineralogy, abundance of elements, and geology. They provide analysis tools that facilitate measurement and study of terrain including distance, height, and depth of surface features. They allow users to easily find and access the geospatial products that are available. Users have the ability to drill down to find the PDS data used to produce the geospatial products. Data products can be viewed in 2D and 3D, and can be stacked and blended together rendering optimal visualization that reveals details that no single data set can show. Data sets can be plotted and compared against each other. In addition to keyboard and mouse control, standard gaming and 3D mouse controllers allow users to maneuver first-person visualizations of flying across planetary surfaces. The portals also provide users the ability to specify any area of terrain for generation of STL/OBJ files that can be sent to 3D printers to make 3D models.

The new Virtual Reality Extension is an exciting addition to the Solar System Treks. Users can draw a path across the surface using the browser interface. A QR code is then generated which is read by the user's smart phone. Placing the phone in an inexpensive set of Google Cardboard-compatible goggles, the user then flies along their specified path in virtual reality.

Along with the web portals, the project supports additional clients, web services, and APIs that facilitate dissemination of planetary data to a range of external applications and venues. Through its APIs, the project is serving data to a growing community of digital planetariums.

Six Solar System Trek portals are available to the public, with more portals in development and planning stages.

## 2. Moon Trek

NASA's Moon Trek is the successor to and replacement for NASA's Lunar Mapping and Modeling Portal (LMMP). New tools have been added to facilitate traverse path planning including boulder detection and distribution analysis, and crater detection and distribution analysis. Many new data products have been added. Enhanced high-resolution views were added in direct response to areas of interest identified in the recent Lunar Science for Landed Missions Workshop held at NASA Ames Research Center. Users can interactively fly over spectacular lunar landforms and go roving across regions of special scientific interest.

## 3. Mars Trek

The project's Mars Trek portal has been assigned by NASA's Planetary Science Division to support site selection and analysis for the Mars Human Landing Exploration Zone Sites. This effort is concentrating on enhancing Mars Trek with data products and analysis tools specifically requested by the proposing teams for the various sites. Mars Trek allows users to explore current and past areas of robotic operation on Mars in great detail. Users can also examine the areas that have been identified as top candidates for future robotic and human exploration, gaining a better understanding of what makes these areas so compelling.

## 4. Vesta Trek and Ceres Trek

Vesta Trek was one of the original Trek Portals. Data gathered from multiple instruments aboard NASA's Dawn mission have been compiled into Vesta Trek's user-friendly set of tools, enabling users to study the asteroid's features. As Dawn nears the completion of its mission, the new Ceres Trek portal complements Vesta Trek portal with data returned from Dawn's current exploration of the dwarf planet Ceres.

## 5. Titan Trek and IcyMoons Trek

The Cassini mission conducted multi-instrument investigations of the Saturn system. It brought back a valuable collection of data about those worlds. The Cassini mission commissioned NASA's Solar System Treks Project to implement two new online portals enabling integration, access, and dissemination of data gathered through the mission's investigations of Saturn's moons. Titan Trek highlights Saturn's largest moon, and IcyMoons Trek features a number of Saturn's other moons as studied by the Cassini mission. Data include imagery from the VIMS and ISS cameras, as well as the RADAR synthetic aperture images, topography, derived physical parameters and community-sourced geological and hydrological mapping products.

## 6. Upcoming Portals

A number of new portals are in development. This year, we began work on a visualization and analysis portal for Mars' moon, Phobos. We are coordinating this effort with the International Phobos/Deimos Landing Site Working Group, with landing site selection and analysis for JAXA's MMX mission as a primary driver. Portals for other subject planetary bodies are in the planning stage.

## 7. Summary and Conclusions

NASA's online, web-based Solar System Treks planetary visualization portals provide exciting, interactive, immersive tools that allow scientists, mission planners, students, and the public to see and understand planetary surfaces in ways they never have before. The EPSC community is invited to provide suggestions and requests as the development team continues to expand the capabilities of the portals.

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