Data Set Guide for Mars

This document outlines the data sets available within the OpenSpace astrovisualization software (version 0.15.1). These data sets were compiled from the results of MESSENGER mission. They provide insight into the topographical features, evolution, and physical processes on the surface of Mercury.

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Missions

The data that comprises the global maps available through OpenSpace were gathered by multiple missions to Mars. Many of the datasets contain information that was determined by the Mars Reconnaissance Orbiter (MRO). This mission was launched in 2005 and is currently still operating. The goal of the MRO mission was to search for evidence of water through the study of the Martian surface, atmosphere, and underground. Both the THEMIS IR Day and Night global maps were formed using data from the Mars Odyssey Orbiter. This mission was launched by NASA in 2001 with the goals of determining the composition of the surface of Mars, along with its structure. This mission is ongoing and its instruments remain in operation. The Viking mission also provided data that is used in the creation of the global maps. This mission included the launch of two spacecrafts (Viking 1 and 2) in 1975. Both spacecrafts contained an orbiter, which was equipped with a lander. This mission was the first American mission to land safely on Mars and analyze its surface.

More information about each of the missions described above can be found at the following links:

MRO: NASA Mars Reconnaissance Orbiter Mission Overview site:
https://mars.nasa.gov/mro/mission/overview/

Odyssey: NASA Mars Odyssey Orbiter Mission Overview site:
https://mars.nasa.gov/odyssey/mission/overview/

Viking: NASA Facts Sheet Viking Mission to Mars:
https://mars.nasa.gov/internal_resources/828/

OpenSpace

To access the Mars data on OpenSpace, first the focus must be on the planet. When opening the software, the default scene will be on Earth. Using the *Focus* section of the Menu, it is possible to change the focus to Mars. If it is still not close enough to see its surface, hold the right mouse button and drag away from yourself to zoom in.

Once Mars is in focus, there are different viewing options under *Scene* on the menu. First, it may be necessary to uncheck the *Perform shading* box to allow for easier viewing of the desired datasets. The images created from the Mars missions can be selected from the list available under the dropdown menu *Layers* under *Renderable.* The *Renderable* menu is available for Mars in the *Scene* menu. For Mars, there are options available under both *ColorLayers* and *HeightLayers.* These global maps are discussed in detail below. It may be necessary to have multiple datasets selected at once in order to gain a better visualization of the specific aspect of the Martian surface you wish to see. Many of the datasets will have [Utah] or [Sweden] following the acronym. Select the one closest to your current location for better image quality and viewing. The global maps that are in color will be discussed and each color region will be designated below. All of the images included below were obtained using OpenSpace.

Mars ColorLayers

MOC WA Color

Overview: The MOC WA Color dataset is formed from the data collected by the Mars Orbiter Camera (MOC), an instrument aboard the Mars Global Surveyor (MGS) spacecraft. This camera produces daily wide-angle (WA) images that are similar to weather photographs of Earth. This dataset is a visual representation of the continuous record of the weather on Mars. Seasonal processes are also monitored by the MOC, and these processes are visible over time in OpenSpace. It is interesting to note that the MOC instrument also provides support for the landing site selection process for lander and rover missions in the future.

OpenSpace: The MOC WA Color is the default ColorLayer when viewing Mars on OpenSpace. The global map visible in OpenSpace is the representation of the weather patterns on Mars, as described above.

More information: See the Mars Global Surveyor mission site, specifically the pages on the Spacecraft and its Science Instruments. This site can be found at the following link:
https://mars.nasa.gov/mgs/mission/sc_instruments.html

Viking MDIM

Overview: Data from the Viking missions makes up the information that comprises this dataset. The Viking mission includes the voyages of both Viking 1 and Viking 2 spacecrafts. These crafts were equipped with both orbiter and lander functions. The goals of these missions were to produce high-resolution images of the Martian surface, characterize the structure and composition of the atmosphere and the surface, and to search for evidence of life on Mars.

The Mars Digital Image Model (MDIM) is a monochrome topographic map of the surface of Mars. The color mosaic created from the Viking data is blended with the MDIM data to create the Viking MDIM global map visible in OpenSpace. This dataset has a resolution of 256 pixels per degree and uses the most recent coordinate system definitions.

OpenSpace: The Viking MDIM dataset provides a representation of topographical features on the Martian surface as determined by the Viking mission's orbiters and landers. The monochrome map has a high resolution that allows for the viewing of details on the surface when zoomed in.

More Information: See the Mars Viking Colorized Global Mosaic 232m v2 page at the following link:
https://astrogeology.usgs.gov/search/map/Mars/Viking/MDIM21/Mars_Viking_MDIM21_ClrMosaic_global_232m

MOLA Pseudo Color

Overview: The Mars Orbiter Laser Altimeter (MOLA) is an instrument aboard NASA's MGS Spacecraft. Between 1998 and 1999, the altimeter took 27 million elevation measurements. These were then compiled into a global elevation map. On the global grid, the general accuracy of the points is 42 feet. The elevation map is represented on OpenSpace by the Pseudo Color dataset, which, as the name suggests, is falsely colored so that differences in elevation are more easily detected.

OpenSpace: The MOLA Psuedo Color global map provides a visualization of the elevation differences on the surface of Mars. Using the colors seen in the image, the relative elevation of Mars can easily be determined. The cooler colors (purple and blue) correspond to areas of low elevation. The yellow areas in the image correspond to areas that are close to the average elevation level of Mars.

More Information: See the Mars - MOLA False Color Topography Mapping page on the 3D Warehouse site at the following link:

https://3dwarehouse.sketchup.com/model/6cf1b6474cfb63ff6a12484fa9d9be10/Mars-MOLA-False_Color-Topography_Mapping?hl=en
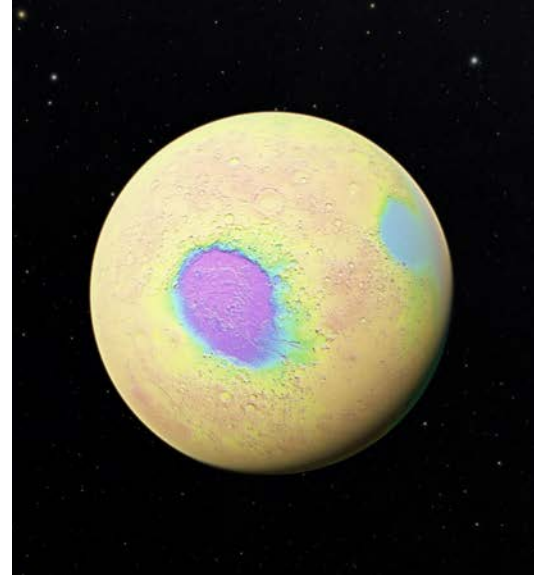
MOLA HRSC

Overview: There is a specific dataset that uses data from MOLA in conjunction with that of HRSC. The HRSC is the High-Resolution Stereo Camera that is on the European Space Agency's Mars Express (MEX) spacecraft. The HRSC is the only dedicated stereo camera orbiting Mars. To gather data, the MOLA fires infrared laser pulses to the surface and measured the time it took for the reflected pulses to return from the surface of Mars. More than 600 million measurements were taken by the two instruments from 1998 to 2001. These measurements comprise the data used to create the global map. The combination of the two instruments results in the global map that portrays topographical features as well as seasonal changes in the elevation of the Martian surface.

OpenSpace: This dataset utilizes two different instruments to create a global map that illustrates the elevation and topography of Mars. The colors used on this global map correspond to relative elevations. Regions that are at low elevations are represented by cool colors, such as the purple and blue visible in the image provided. Warmer colors (reds and oranges) correspond to areas at high elevation. The majority of the surface is very close to the average elevation and is represented by yellows, as seen in the image.
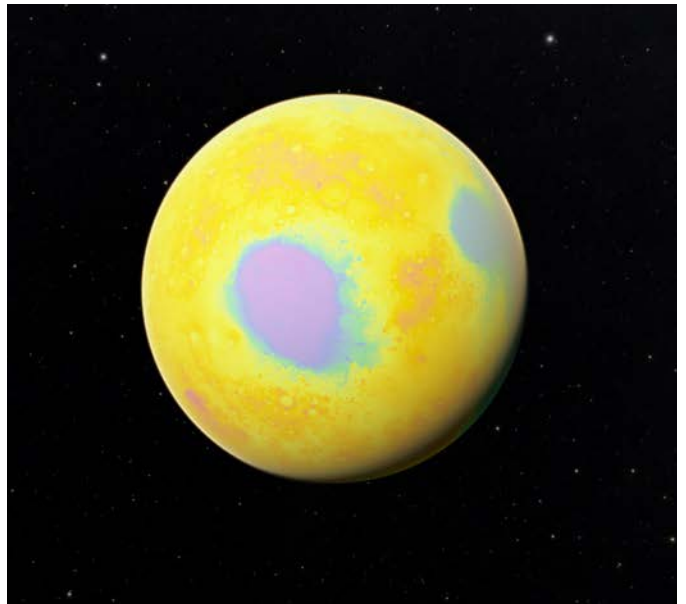
More Information: See the Mars MGS MOLA - MEX HRSC Blended DEM Global 200m v2 information site at the following link:
https://astrogeology.usgs.gov/search/map/Mars/Topography/HRSC_MOLA_Blend/Mars_HRSC_MOLA_BlendDEM_Global_200mp

Themis IR Day

Overview: The THEMIS IR data comes from the THermal EMission Imaging System. Data from the THEMIS imaging system is part of the data collected during the Mars Odyssey mission. This global map represents only the temperatures during the Martian day. Infrared (IR) pulses are sent to the surface of Mars, and the results of these pulses allow for the measurement of temperatures.

OpenSpace: The THEMIS IR Day dataset is a visual representation of the daytime temperatures on the surface of Mars.

More Information: See the Mars Odyssey THEMIS - IR Day Global Mosaic 100m v12 information site at the following link:
https://astrogeology.usgs.gov/search/map/Mars/Odyssey/THEMIS-IR-Mosaic-ASU/Mars-MO_THEMIS-IR-Day_mosaic_global_100m_v12

Themis IR Night

Overview: Like the Themis IR Day data, the IR Night data is part of the data collected from the Mars Odyssey mission. Infrared pulses were used to determine the temperatures on Mars during its night. This dataset is only from 60N to 60S latitude. The global map visual representation has a resolution of 100 meters/pixel.

OpenSpace: The THEMIS IR Night dataset is a visual representation of the nighttime temperatures on the surface of Mars.

More Information: See the Mars Odyssey THEMIS-IR Night 60N60S Mosaic 100m v14 information site at the following link:
https://astrogeology.usgs.gov/search/map/Mars/Odyssey/THEMIS-IR-Mosaic-ASU/Mars-MO_THEMIS-IR-Night_mosaic_60N60S_100m_v14

CTX Mosaic

Overview: This global map is comprised of data that was produced by the context camera (CTX) on the Mars Reconnaissance Orbiter (MRO). This camera is designed so that it provides context images for the data of other MRO instruments, identifies and provides images of features relevant for NASA's Mars Exploration Program, and conducts a scientific investigation of the surface of Mars. The resolution of the global map is 5 m/pixel. Specific regions that were explored were the Human Exploration Zones of Mars. On this map, the edges between these regions will appear hard instead of blended. The hard edges occur as a result of differences in season, time, and calibration of the data.

More Information: See the Context Camera (CTX) Image Mosaics for Mars Human Exploration Zones 5m information site at the following link:
https://astrogeology.usgs.gov/search/map/Mars/MarsReconnaissanceOrbiter/CTX/HumanExplorationZones/CTX_Human_EZ_sites_Oct2015

HiRISE Local Set

Overview: This dataset is the result of a specific image taken by the High Resolution Image Science Experiment (HiRISE) camera on the Mars Reconnaissance Orbiter (MRO). The image is of the landing site of the Pathfinder, which was the ancient flood plain near the Ares and Tiu outflow channels. This specific dataset provided new details of the surface of Mars that other images had not. The image the HiRISE camera took is centered at 19.1ºN latitude, 326.8ºE longitude. It has a range of 284.7 km (176.9 miles) and is scaled at 28.5 cm/pixel.

OpenSpace: When the HiRISE dataset is activated, strips of detailed images will appear dispersed around the globe. In order to see the detail that the HiRISE camera provided, zoom into these strips.

More Information: See the Mars Reconnaissance Orbiter page that includes the Mars Pathfinder Landing Site and Surroundings Press Release. It can be found at the following link:
https://mars.nasa.gov/mro/gallery//press/hirise-pathfinder-landing.html

Mars HeightLayers

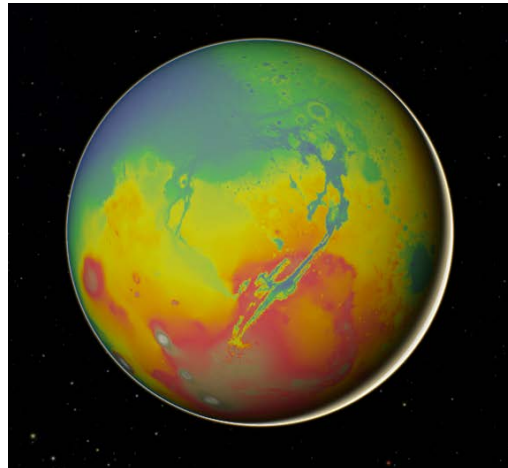## MOLA Elevation

Overview: The Mars Orbiter Laser Altimeter (MOLA) is an instrument on the Mars Global Surveyor (MGS). This instrument was used because it is important to determine the heights of surface features in order to adequately map the surface of Mars. The data gathered by the MOLA was used to put together a global elevation map that shows the relative elevations of the topographical features of the Martian surface.

OpenSpace: The MOLA Elevation dataset is the default dataset when Mars becomes the Focus. This dataset works in conjunction with the selected ColorLayer to provide a more complete image of the elevation and topography of the Martian surface. In the image below, the MOLA Elevation HeightLayer and the MOLA HRSC ColorLayer are selected. This ColorLayer provides the colors seen in the image.

More Information: See NASA's MOLA Homepage that contains information about the Mars Orbiter Laser Altimeter and is available for reference. It can be found at the following link: https://attic.gsfc.nasa.gov/mola/

HiRISE Local Set

Overview: The HiRISE camera on the Mars Reconnaissance Orbiter was used as the data source for both the ColorLayer and HeightLayer of the same name. The HeightLayer dataset is an elevation map that corresponds to the Color Layer of the same name. This map is a color-coded topographic map that is comprised of data from stereo images from the HiRISE imager for the Mars Pathfinder lander. Because the data source is the same as that of the ColorLayer, this map is also centered at 19.1ºN latitude, 326.8ºE longitude, and has the same range of 284.7 km (176.9 miles).

OpenSpace: When the HiRISE dataset is activated, strips of detailed images will appear dispersed around the globe. In order to see the detail that the HiRISE camera provided, zoom into these strips.

More Information: See the NASA's Mars Reconnaissance Orbiter page with the press release for the Mars Pathfinder Landing Site and Surroundings. It can be found at the following link:

https://mars.nasa.gov/mro/gallery/press/hirise-pathfinder-landing.html

Other Useful Materials

Edwards, C. S., Nowicki, K. J., Christensen, P. R., Hill, J., Gorelick, N., and Murray, K. (2011), Mosaicking of global planetary image datasets: 1. Techniques and data processing for Thermal Emission Imaging System (THEMIS) multi-spectral data, *J. Geophys. Res.*, 116, E10008, doi:10.1029/2010JE003755.

  This text provides details on the collection of data that comprises the THEMIS datasets. It also explains how the global maps were created. This work is useful in the process of understanding the creation of global grids from the data gathered from the instruments on Mars missions.

To see examples of data gathered by the instruments on Mars missions, see the Mars Global Data Sets site. The site for each dataset contains individual tiles depicting images taken by the instruments. Specific datasets that are detailed on this site that are also available in OpenSpace include the THEMIS Day and Night IR datasets, as well as the MOLA Elevation dataset. This site can be found at the following link:

http://www.mars.asu.edu/data/