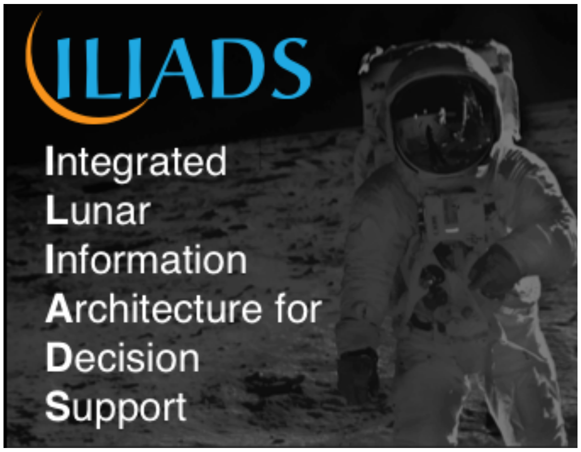

Integrated Lunar Information Architecture for Decision Support (ILIADS) User Guide

Version 1.0: Public Users

January, 2011

Goddard Space Flight Center
Greenbelt, Maryland

Preface

Overview

This document provides detailed instructions for using the features of the Integrated Lunar Information Architecture for Decision Support (ILIADS) System. ILIADS is an extensible, model-based Geospatial Information System (GIS) that provides users with a robust yet simple-to-use software application with which to readily locate, retrieve, quantitatively analyze and display a wide variety of mapped lunar data sets that are stored in widely distributed lunar archives. Invoking the ILIADS software application provides users (e.g., lunar mission planners, scientists, and engineers) with the ability to access and perform "What-if?" analyses of historical lunar data sets (e.g., Clementine, Lunar Prospector, digitized Apollo imagery) and recently collected mapped lunar mission data products (e.g., Kaguya, Lunar Reconnaissance Orbiter) available from the USGS and other lunar data repositories.

Applicability

This document applies to release 1.0 of the ILIADS.

For more information:

Requests for copies of this document, along with questions or proposed changes, should be addressed to:

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NASA/GSFC Code 587

Update History

Version	Date	Description	Affected Pages
1.0	01/24/2011	Initial Draft	All
1.0	4/11/2011	Updated the User's Guide relevant to Public Users	All

Table of Contents

1 Introduction

1.1 Introducing ILIADS

Why Was ILIADS Developed?

Prior to ILIADS's development, NASA did not have an integrated tool suite that made important lunar geographic and environmental data easily and readily available to mission planners. With ILIADS, however, the information and analytical tools are combined in one intuitive application that runs on major computer operating systems.

ILIADS Benefits

There are significant benefits to using the ILIADS GIS:

- Mission planners can easily apply scientific data gathered from remote- sensing satellites and other sources to select potential landing and habitat sites.
- Mission engineers can synthesize and overlay multiple mapped data products and modeled data to conduct "what-if" scenarios to optimize system and element design.
- Mission operators can quickly and intuitively assess the lunar environment to help them plan and make decisions.
- Users can easily collaborate by developing and sharing "plug-and- play" extensions (tools, models, and datasets).

ILIADS Features

ILIADS provides a number of features that make it efficient and flexible:

◆ **ILIADS XGIS (eXploration Geographical Information System)** provides lunar data visualization and analytical tools and models needed to analyze data. Example visualizations include three- dimensional lunar crater scenes, topographic contour maps, surface distance and elevation measurements, and in-situ resource and hazard thematic maps.

◆ **ILIADS is Open Source,** thus users may download and install the application on their desktop computers without paying a license fee.

◆ **ILIADS Adheres to Open Geospatial Consortium (OGC) Standards:** allowing access to a variety of lunar data repositories and algorithms

1.2 What do I need to Use ILIADS?

ILIADS is a rich client software application that is downloaded to and installed on the user's platform. The application executes on the user's computer, and thus performance is dependent on the computer's CPU speed, available internal memory and disk space, graphics hardware, and the network connection speed. Sections 1.2.1 and 1.2.2 list recommended system configurations for the Windows and Mac platforms.

Sun Microsystem's Java Standard Edition (SE) 6 is the only software required to run the ILIADS application and is available for download from Sun's website java.sun.com.

Note: Java SE 6 comes standard with Snow Leopard (Mac OS X 10.6.x).

An internet connection is required to access all of the lunar data products. The available data products include:

- Lunar Mapping and Modeling Project (LMMP) mapped lunar data products
- LMMP data catalogs and other LMMP-unique information (e.g., metadata, product legends, etc.)
- Other lunar data repositories (e.g., United States Geological Survey (USGS) Planetary Interactive GIS on the Web Analyzable Database (PIGWAD))

1.2.1 Windows Specifics

To use ILIADS on a Windows PC, the following lists the **recommended minimum** system configuration:

- Operating System: Windows XP, Windows Vista
- CPU: Pentium 4, 2GHz
- System Memory: 2GB
- Hard Disk: 2GB free space
- Network Speed: broadband
- Graphics Card: 3D-capable with 256MB VRAM

1.2.2 Mac Specifics

To use ILIADS on a Mac, you must have **at least** the following:

- Operating System: Mac OS X 10.5.2 or later
- CPU: Intel Core 2 Duo, 2GHz
- System Memory (RAM): 2GB
- Hard Disk: 2GB free space
- Network Speed: broadband

- Graphics Card: 3D-capable with 256MB of VRAM

1.2.3 A Note About Intel Graphics Processors

Some Intel graphics processors do not work properly with ILIADS. This is due to Intel not providing a complete implementation of OpenGL 2.0 for these chipsets. Currently, the only remedy is to visit the manufacturer's website and try to obtain the latest drivers for the graphics chipset.

1.3 How Do I Obtain and Install ILIADS?

Once Java SE 6 is installed on the user's machine, open a browser and go to the following website:

http://www.lmmp.nasa.gov
The LMMP Portal Window displays as show in Figure 1.

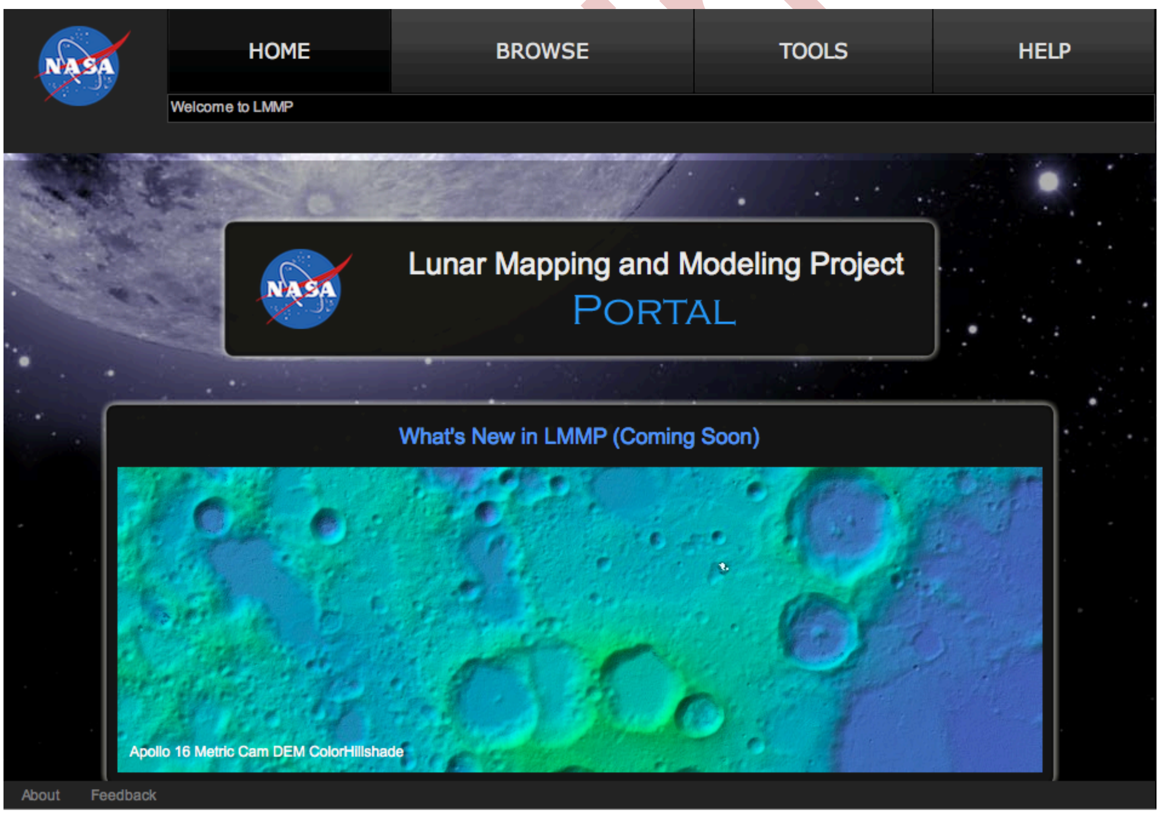

Figure 1.1: LMMP Portal Window

A “Welcome to LMMP” message appears in the menu bar (under the “Home” menu item) of the **LMMP Portal Window as** shown in Figure 1.3.

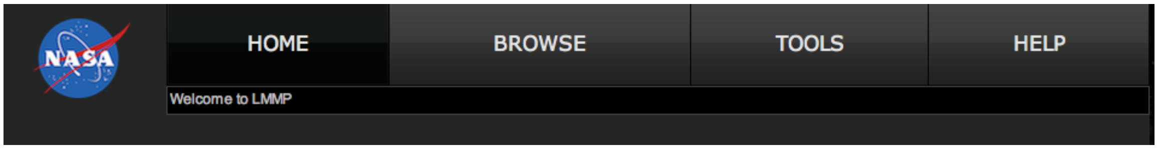

Figure 1.3: Portal Login Window Menu Bar

Select the **Tools** button. The **LMMP Available Applications** window displays as shown in Figure 1.4. Select either the ILIADS Win button or the ILIADS Mac button to download the appropriate installation file for your platform.

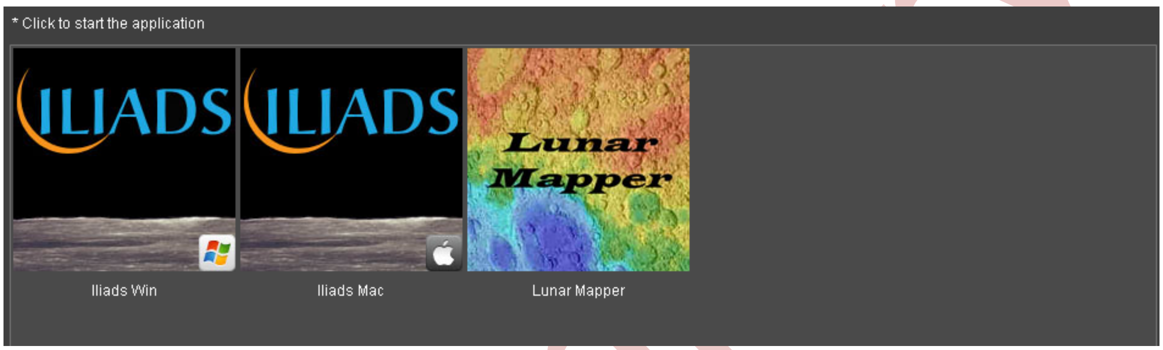

Figure 1.4: LMMP Available Applications Window

After unzipping and running the installer, the application is placed in the following locations based on the user platform:

Platform	Location
Windows	*C:\\Documents and Settings\<user directory>\Application Data\.iliads*\dev
Mac	User’s home directory

Table 1: ILIADS Installation Directory

The ILIADS Start up window displays as shown in Figure 1.5, and the installation progress bar at the bottom of the window updates as the installation proceeds.

What does this manual cover?

This manual describes all of the functions available to ILIADS users.

Organization of this Manual

This manual is organized as follows:

- Section 1 provides an overview of the ILIADS system and of this User's Guide.
- Section 2 explains ILIADS terminology and provides a tour of the ILIADS User Interface with several usage examples.
- Section 3 provides an introduction to Geospatial Information Systems.
- Section 4 describes the most commonly used ILIADS windows.
- Section 5 describes ILIADS menus.
- Section 6 describes several methods for navigating an ILIADS scene.
- Section 7 describes ILIADS data layers and overlays.
- Section 8 describes how to create and save views.
- Section 9 describes the ILIADS data analysis functions.
- Section 10 describes the ILIADS Image Processing Library.
- Section 11 describes the math functions available in ILIADS.
- Section 12 provides descriptions for some special features in ILIADS.
- Appendix A lists the acronyms used in this document.

Document Conventions

This document uses the following terms and notational conventions:

Note:	Indicates a note, providing information that may be helpful to the user.
bold serif type	Indicates menu items, buttons or check boxes that perform some action when selected with the mouse. Can also indicate window and field titles.
Items in CAPS	Indicates a specific key on the keyboard, (e.g., TAB or ENTER)
Items in brackets <>	Describes a value supplied by the user or the database. An example is <requirement ID>, where the user of the system supplies an actual value.
Keystrokes	When menu selections also may be accomplished with a combination of keystrokes, the keystrokes (i.e., accelerator functions) are listed parenthetically with the menu option (e.g., Select All (Ctrl + A)).

Italics	Indicates a data set name or directory name.

2 ILIADS User Interface Basics

2.1 ILIADS Terminology

This section describes some common terms used throughout this document to describe the main ILIADS user interface components.

2.1.1 Window

ILIADS user interface windows are physical workspaces on the user's display where lunar imagery and related lunar data product information is rendered. There are a number of windows that comprise the ILIADS user interface. Section 4 describes the different types of ILIADS windows and the functions used to control window placement.

2.1.2 Data Source

A data source is either a lunar data product supplier or the location of a lunar data product data repository. Table 2.1 lists several ILIADS Data Sources. Access to additional data sources may be added in the future. Section 3 provides more information about the types and formats of data sources available to ILIADS.

LMMP Portal	NASA's LMMP's conduit to lunar data, products, and tools
LMMP OnMoon Server	Web Mapping Service for lunar data
GSFC's Lunar Data Server	
USGS PIGWAD Data Server	U.S Geological Survey's Planetary GIS Web server
PDS Geosciences Node ODE Server	NASA's Planetary Data System, containing archives of data products from NASA's planetary missions.

Table 2.1: ILIADS Data Sources

2.1.3 Project

An ILIADS project is a collection of one or more scenes (see section 2.1.4) that can be saved in the form of a project file. Projects are the highest level of information organization within ILIADS. Thus, a user needs to first create a project, and then can add scenes, data layers, and views displaying lunar data products from different locations and angles. Figure 2.2 provides an example of an ILIADS project file structure.

ILIADS uses can share their project files with other ILIADS users. Section 4.2 provides detailed information about the ILIADS **Project Window** and how users create new projects.

2.1.4 Scene

An ILIADS scene is a collection of data layers and views. Thus, a scene can consist of one or more **image layers**, **elevation layers, feature layers**, and/or **function layers**, and one or more views of the layers. Scenes are visually rendered in an ILIADS **Scene Window**. Users may display multiple scene windows simultaneously to facilitate comparisons. Section 4.3 provides detailed information about the **Scene Window.**

2.1.5 Data Layer

An ILIADS data layer is a visual rendering of either information (e.g. a lunar data product) or the results of a computation (e.g., surface roughness). Table 2.2 lists the different ILIADS layer types.

Image Layer	Tiled lunar images from various NASA satellites (Clementine, LO III, LO IV, etc.)
Shape Layer	Points, lines, polygons, circles, etc. that the user "places" on an ILIADS scene
Feature Layer	Textual labels for lunar landmarks
Function Layer	Results of an analysis (e.g., slope magnitude) or image processing function (e.g., negative)
Elevation Layer	Depicts the lunar topography

Table 2.2: ILIADS Data Layers

Data layers within an ILIADS **scene** can be "stacked" one on top of the other. Users can view more than one layer at a time by adjusting the layer's **opacity**. Section 7 provides detailed information about ILIADS data layers.

2.1.6 View

A view is a saved perspective of an ILIADS scene. Another way to state this is to draw an analogy to a camera. Thus, if the user were looking through a virtual camera to view the moon's surface, then the image contained in an ILIADS scene window is what the user "sees" with the "camera lens". The parameters that define a view are summarized in Table 2.3. Users also have the ability to synchronize a viewpoint over multiple scenes. For example, a user may have three separate scene windows open on the desktop, each containing a data layer from a different lunar data product. The user has the ability to simultaneously view each of these scenes from the same viewpoint, allowing the user to make quick, visual comparisons. Section 8 provides detailed information about ILIADS views.

Position	The latitude and longitude of the "focus point" on the moon's surface directly below the virtual camera.
Heading	The direction (azimuth) of the virtual camera. The default =0 (true north.)
Range	The distance from the virtual camera to the focus point.
Tilt	Rotation, in degrees, of the camera around the *X* axis. A value of 0 indicates that the view is aimed straight down toward the moon (the most common case). A value for 90 for <tilt> indicates that the view is aimed toward the horizon. Values greater than 90 indicate that the view is pointed up into the sky. Values for <tilt> are clamped at +180 degrees.
Description	A user-supplied text string to describe the view.

Table 2.3: ILIADS Viewpoint Parameters

2.1.7 Plug-In

Future releases of ILIADS will allow users to "plug-in" additional algorithms to enhance its image processing and analysis capabilities. ILIADS comes equipped with 19 plug-ins. This list of plug-ins is available by selecting the **Plugins** option of the **Tools** menu, and selecting the **Installed** tab.

2.1.8 Favorites

Users can create shortcuts to ILIADS projects, making it easy for users to switch between projects. Section 4.7 provides more information on the ILIADS **Favorites Window** and how to make a shortcut to an ILIADS project file.

2.2 Creating a New Project

First time ILIADS users begin by creating a new ILIADS project. Follow these steps to create a new ILIADS project file:

1. Select **New Project** from the **File** menu. The **New Project** window opens as shown in Figure 2.1. Users have the option of starting with a "Sample ILIADS Project" that contains pre-defined scenes, or may create a "Standard

ILIADS Project.” The content of the ILIADS sample project is shown in Figure 2.2. By selecting the **Standard** option, users may either create a **Simple Moon Project** that contains one scene entitled “Moon Scene” or an **Empty ILIADS project** . Note that the “Moon Scene” does not contain any data layers or pre-defined views.

2. After selecting the type of new project (sample, simple moon, or empty) the **New Project: Name and Location** window opens as shown in Figure 2.3. Supply a name for the project file in the **Project Name** field and the project file’s location in the **Project Location** field. The default location for ILIADS project files is as follows:

Windows:	Documents and Settings\,<user folder>\My Documents\NetBeansProjects
Mac:	User’s home directory: /Users/<user name>

Click **Browse** to supply a different location in the **Project Location** field.

Click **Finish** to save the new project file.

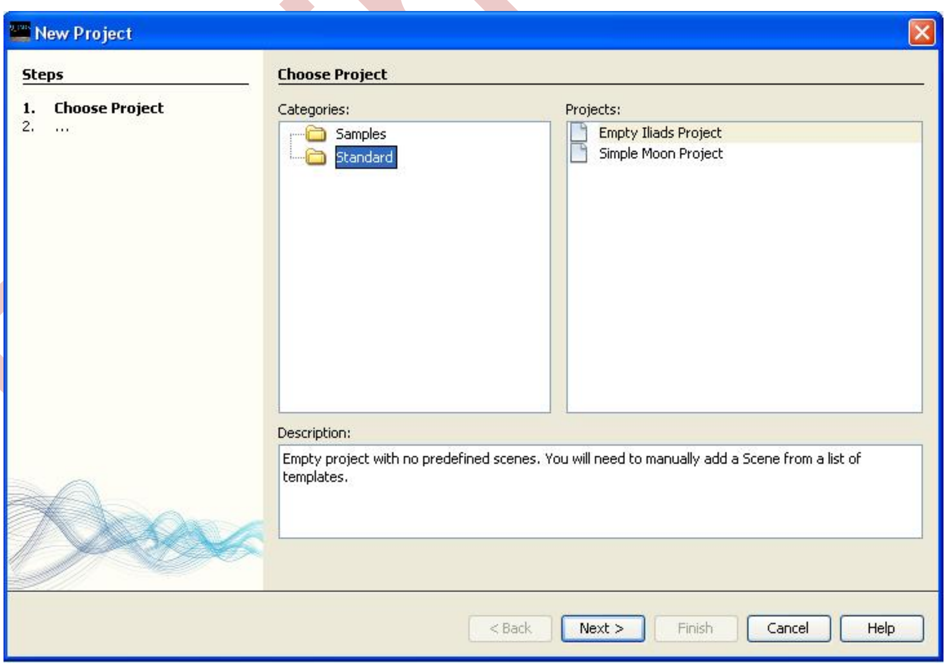

Figure 2.1: ILIADS New Project Window

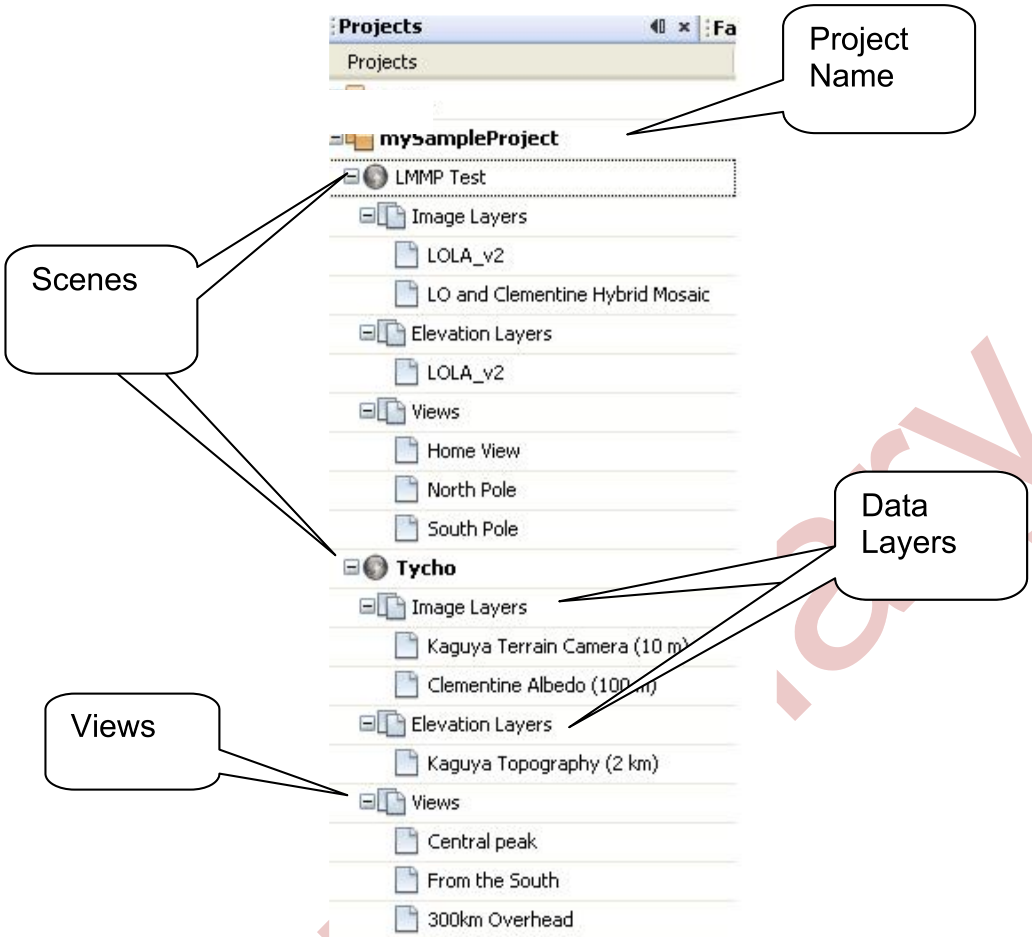

Figure 2.2: ILIADS Sample Project Structure

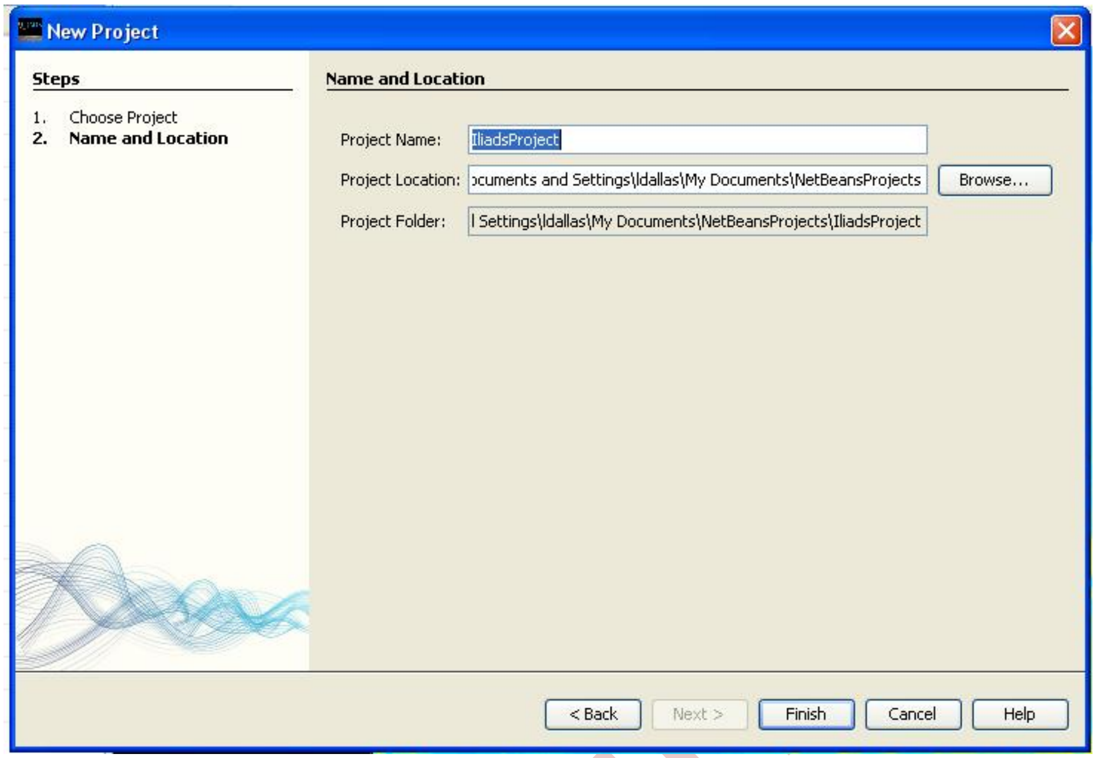

Figure 2.3: Enter New Project Name and Location

2.3 Creating a New Scene

Once the user has created a project, the user can add scenes to the project and begin viewing lunar data products. Follow these steps to create a new scene:

1. Select the project name to contain the new scene in the **Projects** window and select **New Scene** from the **File** menu. The **New Scene** window opens as shown in Figure 2.4. (Alternatively, right-click on the project name and select **New** from the pop-up menu.)
2. The user then selects from one of two templates:

LMMP Moon Template	Automatically loads the LO and Clementine Hybrid Mosaic image layer
Moon Template	Nothing loaded initially

   Click **Next.**
3. Supply a name for the new scene in the **Scene Name** field as show in Figure 2.5. Click **Finish** and the scene is listed in the **Projects** window under the selected project.

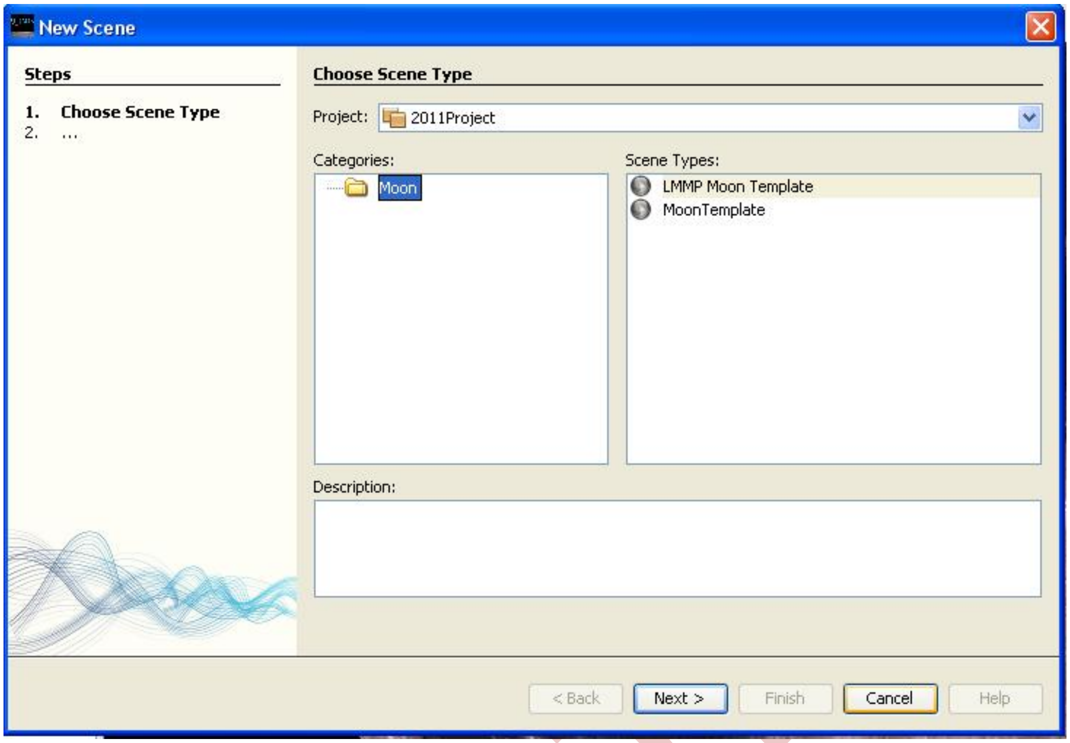

Figure 2.4: New Scene Window

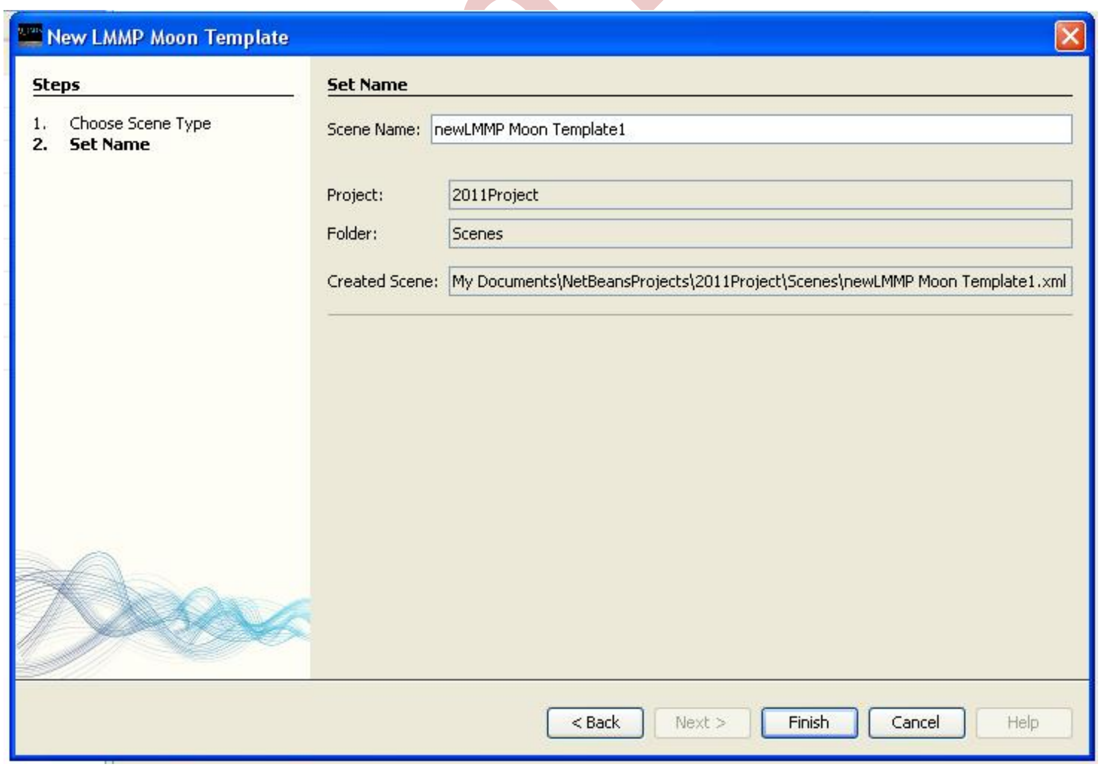

Figure 2.5: Enter Scene Name

2.4 ILIADS Application Window

After creating the new project and new scene, the ILIADS main window appears as in Figure 2.6. Figure 2.6 also labels the ILIADS user interface main components. Table 2.4 describes the callouts shown in Figure 2.6 and lists what document sections further describe these main ILIADS user interface components.

The remaining sections provide three examples of how ILIADS may be used to view lunar data products and are meant to serve as a general introduction to system's functions and capabilities.

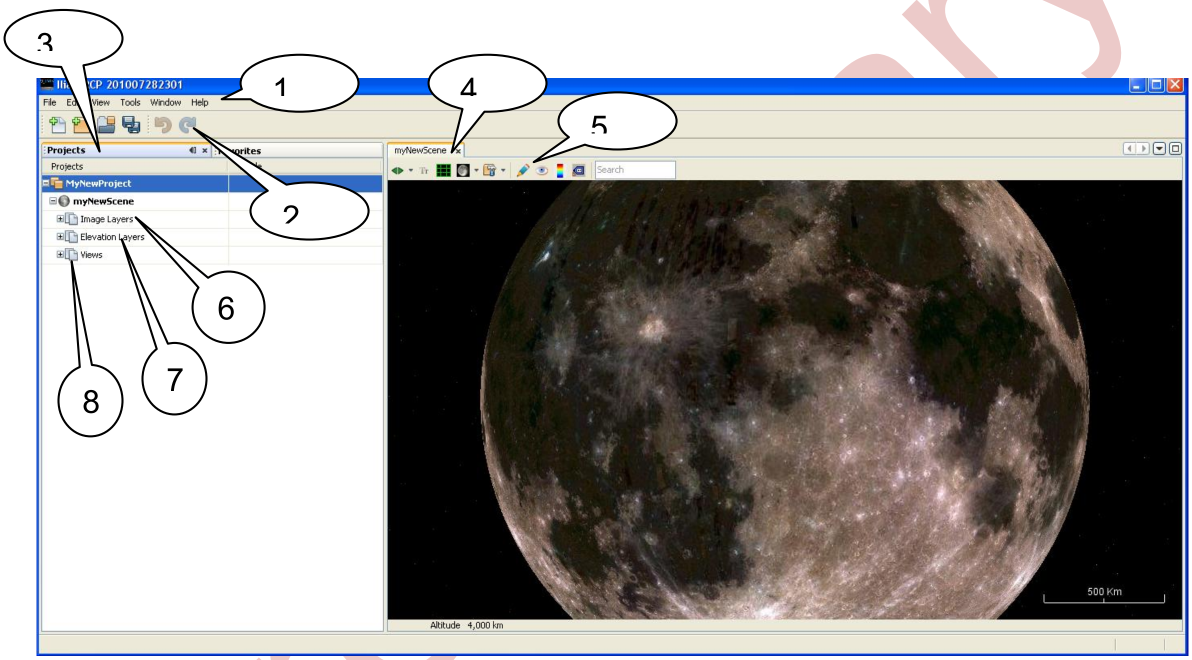

Figure 2.6: ILIADS Main Application Window

Label	Interface Item	Additional Information
1	Main Menus	Section 5
2	Menu Toolbar	Section 5
3	Projects Window	Section 4
4	Scene Window	Section 4
5	Visualization Toolbar	Section 4
6	Image Layers	Section 7
7	Elevation Layers	Section 7
8	Views	Section 8

Table 2.4: Main User Interface Components

2.5 Example 1: View Lunar Relief Map

Follow these steps to view the topography of the moon from a distance, and then zoom up to the Aitken Basin, the moon's largest crater.

1. If you have not done so already, create a new ILIADS project as described in Section 2.2.
2. Create a new scene for this project as described in Section 2.3 and call the scene "myNewScene".
3. Display the lunar landmark labels by clicking the **Show Labels** toolbar button. .

4. Right-click on the **Image Layers** item under "myNewScene" in the **Project Window** and select **Tiled Image Layer**. Select the *ILIADS WMS: Clementine* from the **Sources** list, and select the *Clementine Shaded Relief* data set from the **Layers** list. Click **Next.** Click **Finish** in the **Select Attributes** window. The **Scene Window** updates with the selected data set as shown in Figure 2.7.

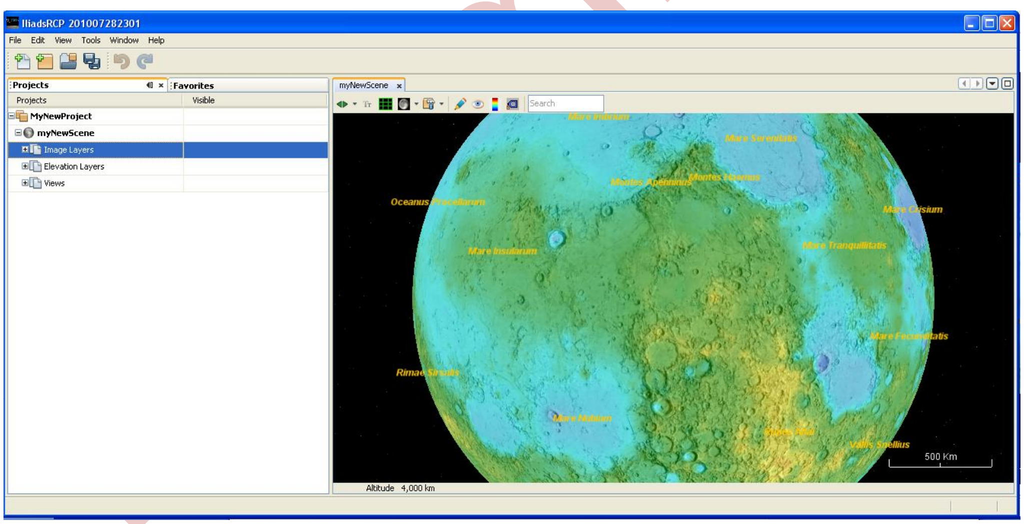

Figure 2.7: Clementine Shaded Relief Map

5. Enter *Aitken* in the **Landmark Search Box** on the **Visualization Toolbar** and hit return. The **Scene Window** updates with the selected data set as shown in Figure 2.8.

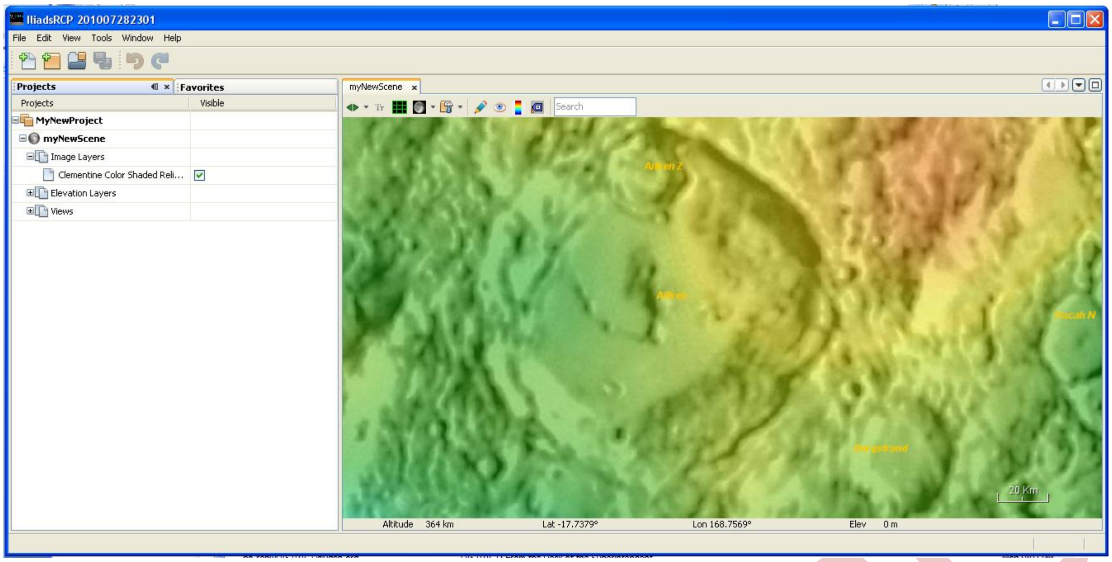

Figure 2.8: Aitken Crater Close-Up

2.6 Example 2: View Geological Composition

Follow these steps to add another data layer to the scene created in section 2.4 that displays the geological composition of the moon. Since text labels were added to the scene as described in Example 1, they remain visible after the geology data layer is added.

1. Select the **Views** button  from the **Visualization Toolbar** and select **Home** to return to the default moon view.

2. Right-click on the **Image Layers** item under the “myNewScene” and select **Tiled Image Layer**. Select *ILIADS WMS: Geology* from the **Sources** list, and select the *Geology Near Side* data set from the **Layers** list. Click **Next.** Click **Finish** in the **Select Attributes** window (in this example we will not alter any of the attributes). The **Scene Window** updates with the selected data set as shown in Figure 2.9.

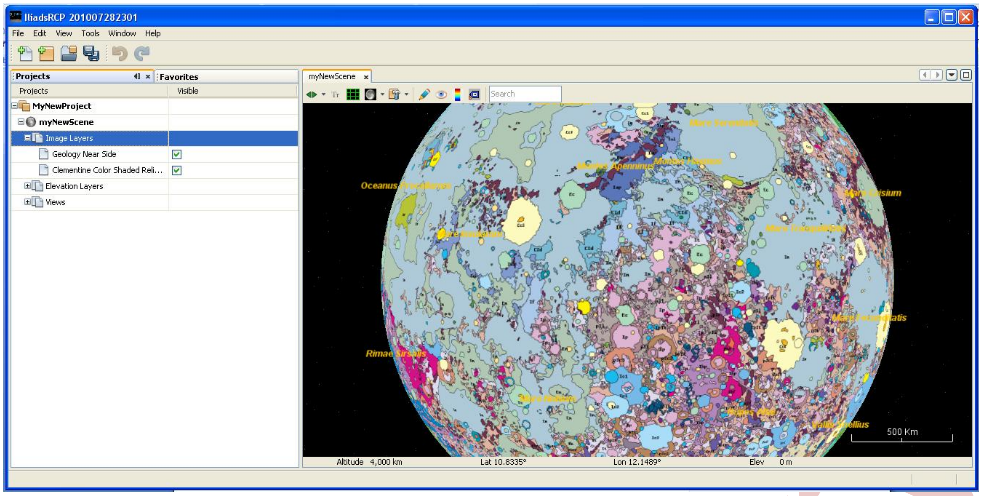

Figure 2.9: Geology Near Side

2.7 Example 3: Calculate Slopes

Follow these steps to calculate and visually display the slopes for a selected area of the moon's topography. This display will be added to the scene created in Example 1.

1. Add another **image layer** to the scene by right-clicking on "myNewScene", selecting **Tiled Image Layer**, selecting *IliadsWmsKaguya* from the **Sources** list, and selecting *Kaguya Terrain Camera* from the **Layers** list. Enter *Tycho* in the **Landmark Search Box** in the **Scene Window Toolbar.** Figure 2.10 shows the **Scene window** containing the *Kaguya Terrain Camera* data set after zooming in on the Tycho crater.

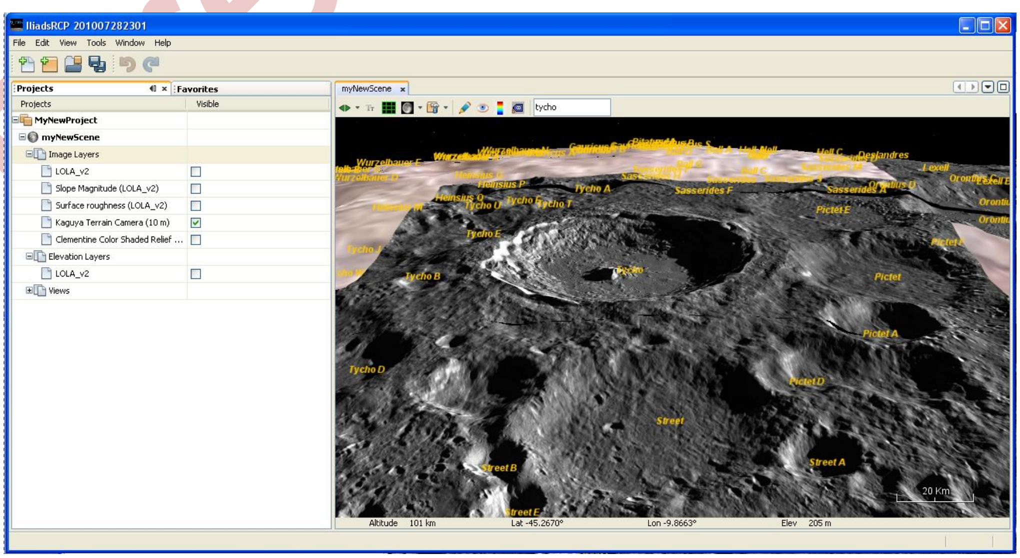

Figure 2.10: Tycho crater

2. Right-click on “myNewScene,” select **New**, and select **Function Layer**. Select *XIS Analysis* from **Sources** list and select the *Slope Magnitude* option from the **Layers** list.   Select **Next**.

3. You now need to specify the dataset to be used as input to the calculation. Select *LMMPWcsTopography* from the **Sources** list, and select *LOLA_V2* from the “Layers” list. Click **Finish** in the next window.

   Note: A topography data set must be used as input to any XIS Analysis Function.

4. Select the **Color Legend** button in the **Scene Window Toolbar.** The scene window appears as in Figure 2.11. Note that the color legend appears in the lower left corner of the **Scene Window.**

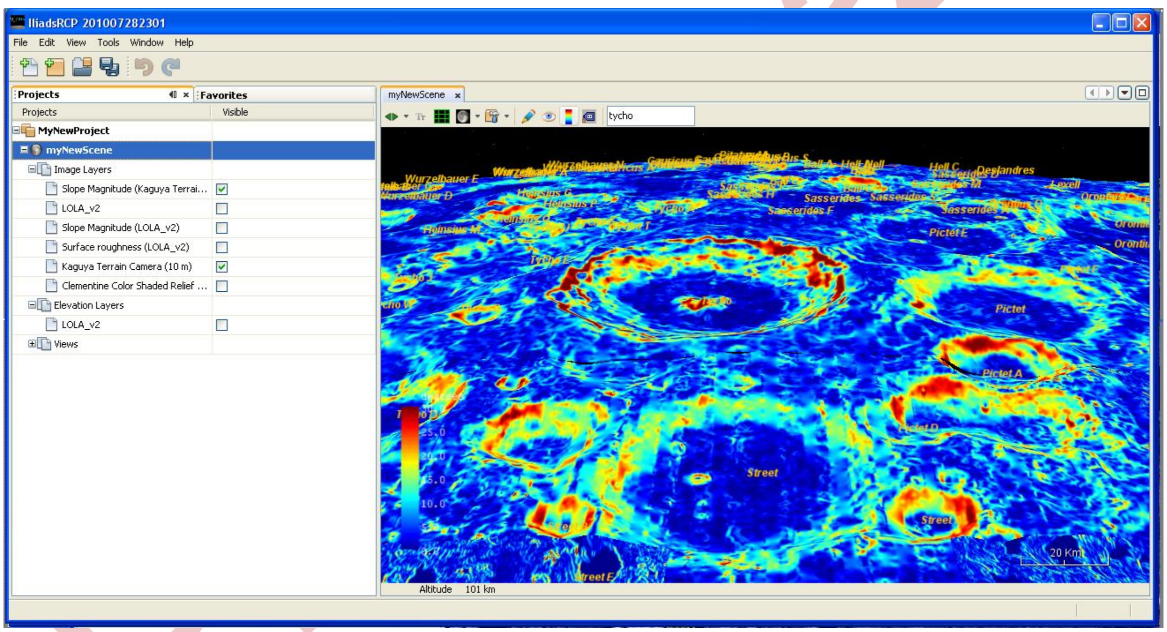

Figure 2.11: Slope Calculation around Tycho Crater

3 GIS Data Types

3.1 Overview

ILIADS provides access to a variety of mapped lunar data sets that have been derived from remotely sensed data collected by several missions, including LRO, Kaguya, Clementine, Lunar Orbiter, and Apollo. These datasets contain information about the lunar terrain and environment and are stored in a variety of formats that determine how they are accessed and displayed by ILIADS. This section describes the different formats of ILIADS data and how this data is served to users over the network.

3.2 GIS Data Types

Geographic Information Systems (GIS) primarily deal with data of three different types as described below:

3.2.1 Image Data

Image data ranges from satellite images, to aerial photographs, to scanned paper maps (maps that have been converted from printed to digital format).

3.2.2 Raster Data

Raster data includes non-visual coverage data, similar to images except that the pixel values contain physical data instead of color values. These can include topographic information, chemical composition data, and other raw sensor values.

3.2.3 Feature Data

Feature data contains the location and shape of geographic features and objects. They use three basic shapes to present real-world features: points, lines, and polygons that represent areas. Examples include geological regions (polygons), navigation paths (lines), and location names (points).

3.3 GIS Data Models

GISs such as ILIADS use models to represent data. The two most commonly used data models within ILIADS are raster and vector.

3.3.1 Raster Model

The raster data model stores geographic information in a grid of rows and columns like those in a spreadsheet. The raster data model is comprised of same-size cells that are identified by their location (i.e., row, column position) within the grid. Each cell may be assigned a numerical value representing a small section of the lunar surface. Thus, imagine laying this grid over the lunar surface and recording for each cell in the grid what exists at that location. If we used a raster model to represent the albedos values at different points on the lunar surface, the cell in row 4, column 8 might contain a value of *high* while the cell in row 5, column 10 might have the value of *medium* (both values represented by numerical codes). Resolution in remotely sensed images is typically expressed in meters, which indicates the size of the ground area covered by each cell.

Raster models work well for representing continuous data that can be measured at every point, like elevation or rock type. They are not as effective at representing point or linear features such as crevices or streams.

3.3.2 Vector Model

A vector model uses points, lines, and polygons to more accurately represent features. Point features are represented as an ordered pair while lines are represented as a series of points, and polygons are represented by the lines that form the boundary. Attributes, like the albedos value in the previous example, are associated with each feature rather than with a grid cell.

The vector data model is best suited to data that can be accurately represented with points, lines, and polygons, such as lunar craters and seas. Vector models also rescale to different sizes more elegantly than rasters.

3.4 GIS Web Services

Web Services are programs that run on a web server and send their results back to a calling program elsewhere on the Internet. ILIADS uses GIS Web Services to create a platform independent distribution channel for lunar GIS data. ILIADS accesses data from different data sources and with different formats and combines them in a single display, without it being apparent that data has come from different sources or locations. The Open Geospatial Consortium (OGC) is the organization that defines, provides, and maintains these web services. Further information about the OGC is available at www.opengeospatial.org.

The following sections describe the three different types of GIS web services. Figure 3.1 provides a graphical summary.

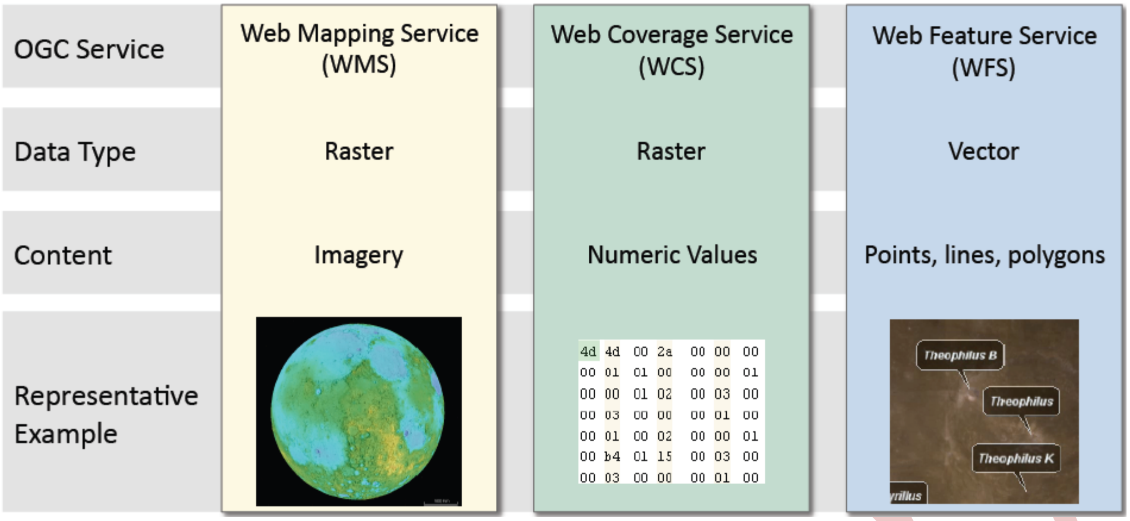

Figure 3.1: *GIS Web Services*

3.4.1 Web Map Service

Web Map Services return visible data images, or maps, of geospatial data and detailed information on specific features shown on the map. A “map” in this context is not the data itself, but is rather a visual representation of geospatial data. A WMS can combine a number of images and other data served by other OGC services to create a single map. This feature is commonly used by "thin" clients such as web browsers, for which the ability to combine and display some GIS data is not within their feature set.

3.4.2 Web Coverage Service

Web Coverage Services differ from Web Map Services in that they return rasters with actual physical values, rather than visible data images. Data returned from a WCS can be interpreted, extrapolated, modeled and analyzed by a client application (e.g., ILIADS) before they are rendered for display. The process of rendering assigns a unique color value to each real-world data value, creating a mapped product that permits the user to visualize the data.

3.4.3 Web Feature Service

A Web Feature Service allows a client application to perform data manipulation operations on a set of geographic features. Data manipulation operations include the ability to:

1. Get or Query features based on spatial and non-spatial constraints.
2. Create a new feature
3. Delete a feature

4. Update a feature

Features, as noted above, consist of points and polygon data, and are returned by the WFS in the Geographic Markup Language (GML). These can be interpreted by the client application (e.g., ILIADS) and drawn to create a mapped product the user can view.

3.5 ILIADS Data Storage

ILIADS provides access to a number of Web Coverage Services, Web Map Services, and Web Feature Services.

To improve performance, ILIADS stores a copy of the data set on the user's computer/workstation after the data set is initially accessed. These data sets are stored in the *cache* subdirectory of the ILIADS application folder. The subdirectory structure in the *cache* mirrors the structure of the datasets listed in the **Data Sources** tab of the ILIADS application. The following sections provide further information on the cache for each supported platform.

3.5.1 Windows Cache Location

The ILIADS cache is stored in this directory:

C:\\Documents and Settings\<user directory>\.iliads\cache\datalibrary

Each downloaded dataset is stored in a separate folder. The items contained in the folder are essentially the display "tiles" that comprise the data set along with the metadata describing the tile. Each tile is approximately 1 MB.

3.5.2 Mac Cache Location

The Mac cache is stored in this directory:

<user home>/.iliads/cache

3.5.3 Clearing the ILIADS Cache

End users do not need to directly access any items in the ILIADS cache. However, there may be instances where the user wants to clear the cache. This may be accomplished by manually deleting one or more folders within the cache or by executing the **Clear Cache** option within ILIADS as instructed below:

Click the **Tools** menu and select the **Clear Cache** option as shown in Figure 3.2. **Note:** This operation may take several minutes to complete.

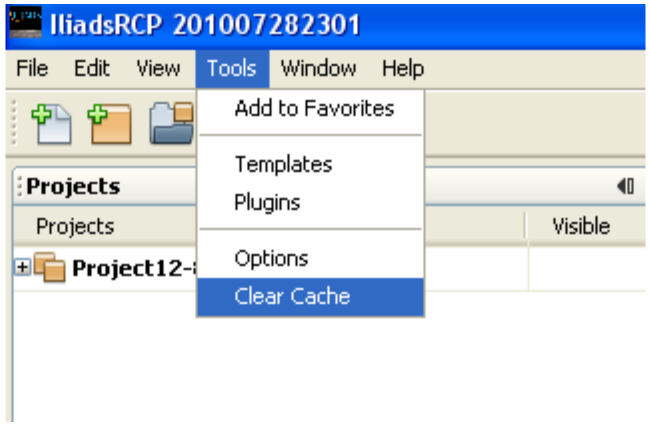

Figure 3.2: ILIADS Clear Cache Option

3.5.4 Changing the Cache Location

Most users will want to use the default location for the cache, but there may be instances when a group of users will want to establish a shared location for a cache. In this case, the user will need to change the default location. Follow these steps to change the location of the cache:

1. Select the **Options** choice from the **Tools** menu. The **Options** Window opens as shown in Figure 3.3.
2. Supply the new location for the cache directly in the **Directory** field, or click the **Browse** button to navigate to the location to contain the Cache.
3. Click **OK** to save the new location.

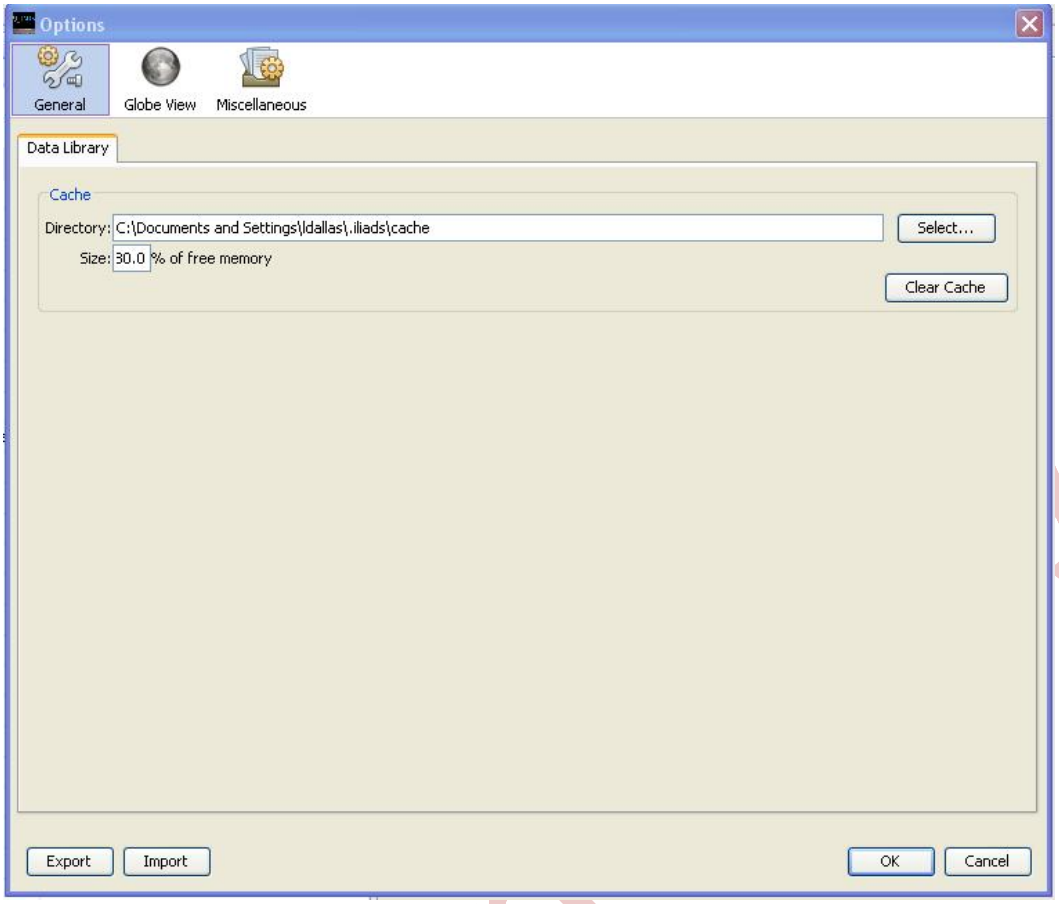

Figure 3.3: Options Window

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4 ILIADS Windows

4.1 Overview

The ILIADS user interface contains several windows that display lunar data, or provide users with the means to select lunar data sets and create ILIADS projects, scenes, and views. The windowing in ILIADS is very flexible, allowing users to arrange and resize windows according to their viewing preferences. Users can also “undock” windows, giving them the appearance of “floating” above the ILIADS application.

Table 4.1 lists buttons and controls that are common to all ILIADS windows.

	Minimizes an ILIADS window and places the window title on either the right or left side bar (see Figure 4.1)
	Closes an ILIADS window
	Opens the “Change Visible Columns” dialog.
	“Pin” window – this opens a window that has been minimized (e.g., the Data Sources Window in Figure 4.1) and anchors it to the top of the ILIADS application window. To pin a window, select the window title from the sidebar, click the **pin button** and the window opens and is placed next to the **Projects** window.
	Maximizes an ILIADS window so that it takes up the entire ILIADS desktop.
	Scrolls window to the left
	Scrolls window to the right

Table 4.1: ILIADS Window Buttons

Section 4.1 describes how ILIADS windows can be moved, arranged, and resized. The remaining sections describe each of the ILIADS windows in more detail.

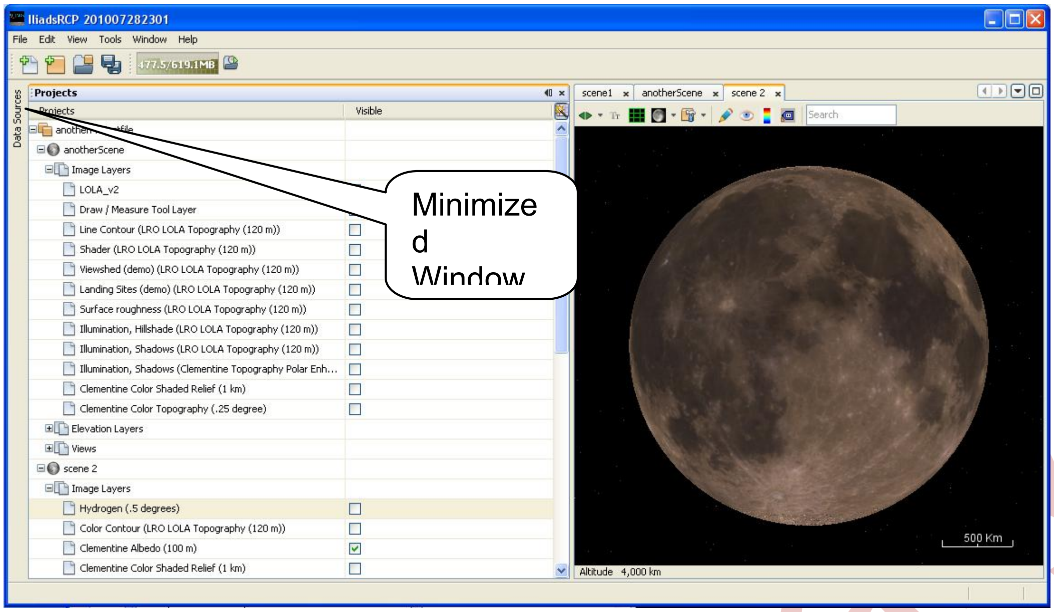


Figure 4.1: Minimized Data Sources Window

4.1.1 Moving ILIADS Windows

Users can reposition the ILIADS windows in whatever configuration they prefer. The default configuration is shown in Figure 4.2, where the **Projects** window appears to the left of the **Scene** window. To move an ILIADS window, click on the window title and drag to the desired position.

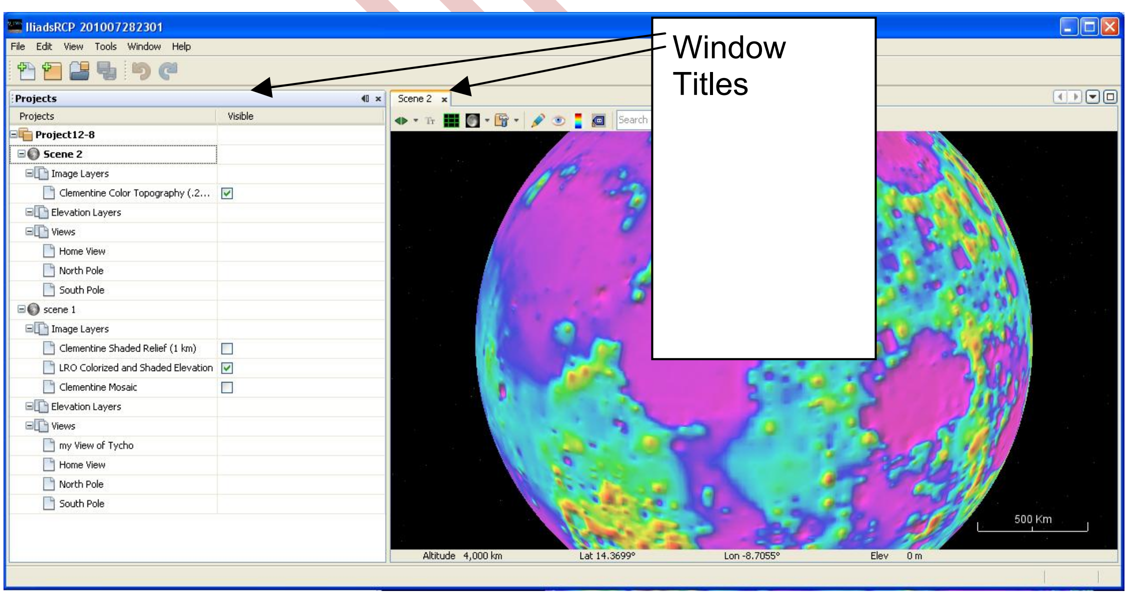


Figure 4.2: ILIADS Default Window Configuration

4.1.2 Resetting the Windows

To return to the default window configuration, select the **Reset Windows** option in the **Windows** menu.

4.1.3 Undocking a Window

An undocked window has the appearance of “floating” above the other windows in the ILIADS application. By undocking a window, users can move the window over the entire surface of the computer desktop. Users may want to do this to facilitate a side-by-side comparison of two scenes. To undock a window, select the window and then select the **Undock Window** option of the **Windows** menu.

4.1.4 Docking a Window

To dock a floating window back to its original position, select the undocked window and select **Dock Window** from the **Windows** menu.

4.2 Project Window

The Project window lists all the projects that are currently open. Figure 4.3 contains an example of this window. There are two columns in this window: **Projects** and **Visible**. The **Projects** column lists the Project folders that are currently open; double-clicking on a Project folder expands the folder to display the Project hierarchy, including Scenes and the **Image Layers**, **Elevation Layers,** and **Views** within each scene. Right-clicking on the Projects column heading brings up the **Visible Columns** dialog box and allows the user to choose whether or not the visible columns are displayed.

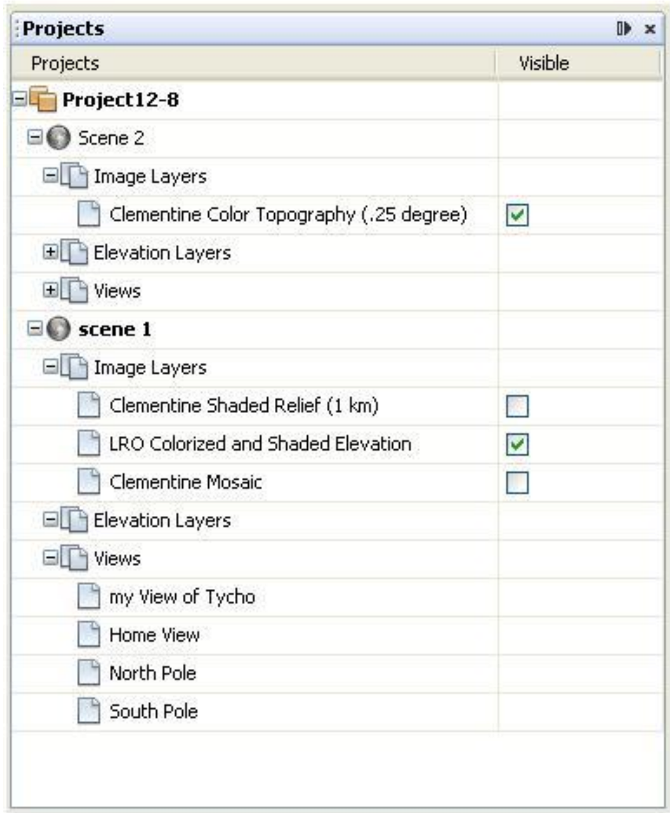


Figure 4.3: ILIADS Project Window

4.3 Scene Window

The Scene window contains the visual results of an ILIADS data request or data analysis. The scene window contains a toolbar as pictured in Figure 4.4. The functions provided by these buttons are described in Table 4.2.

Figure 4.4: Visualization Toolbar

	**Synch Views Button:** Synchronizes all of the open and enabled views so that the virtual camera is looking at the same spot in all views. Reference Section 8 for more details.
	**Text Label Button:** Toggles the display of the text label layer. Clicking this button adds a standard set of text labels to the lunar display that designate various lunar landmarks. Figure 2.7 shows an example of a scene where text labels are toggled to "on".
	**Grid Layer Button:** Toggles the grid layer. Clicking this

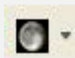
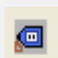
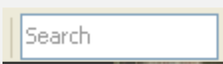
	button adds gridlines to the lunar display as shown in Figure 4.6.
	**Views Button:** Allows the user to apply a saved view to the lunar display. Reference sections 6.3 for details about standard ILIADS views. Reference section 8 for details about user-created views.
	**Toolbox Button**: Provides access to the scale bar (see section 7.7), terrain profile tool (see section 7.7), slide show tool (see section 12), and the capture screenshot tool (see section 12)..
	**Draw/Measure Tool Button:** Activates the **Draw/Measure Tool**. Reference Section 7.6 for details.
	**Navigation Button:** Toggles the globe positioning controls. Reference Section 6.5 for details.
	**Legend Button:** Toggles the display for the colorized data legend. Reference **Section** 7.7.5 for details.
	**Metadata button:** Opens the Metadata window (see section 4.6)
	**Landmark Search Box**. Reference Section 6.4 for details.

Table 4.2: Visualization Toolbar Buttons

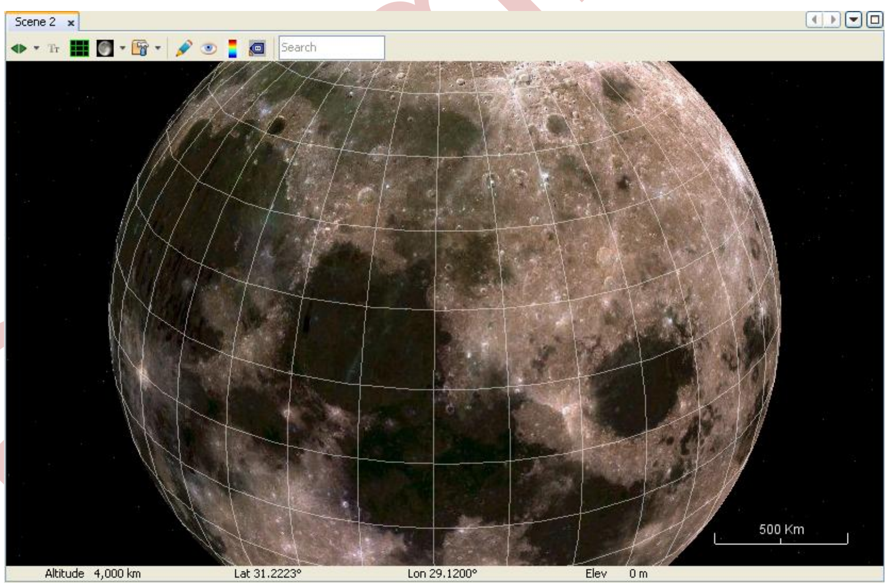


Figure 4.6: Lunar Display with Gridlines Activated

4.4 Data Sources Window

The **Data Sources** window lists all of the available ILIADS data products. These products are grouped into categories which can be expanded to display all of the data products within the category. Figure 4.7 shows the *LMMPWMSOnMoon* category expanded to display all the available WMS data products available. The window also contains columns that display the data product's ID and type (image, raster, or feature set). The display of these two columns can be toggled on and off by right-clicking on one of the **Data Sources** window column heading to bring up the dialog window in Figure 4.8. Select the columns to be displayed by clicking in the check box.

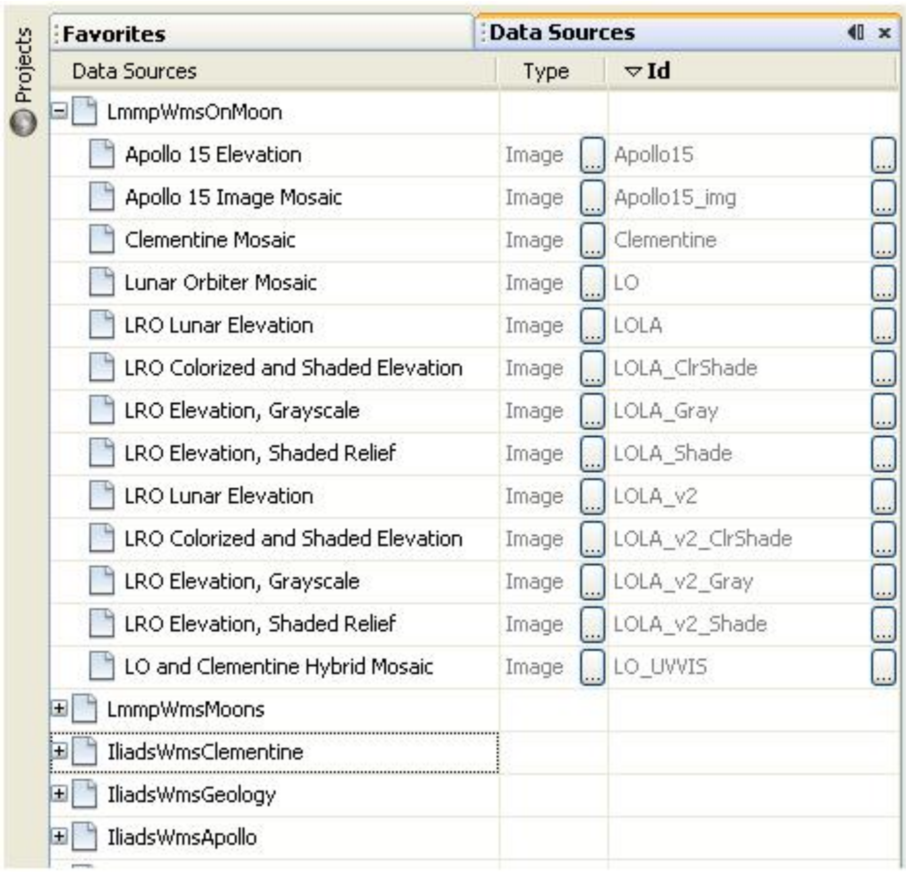


Figure 4.7: Data Sources Window

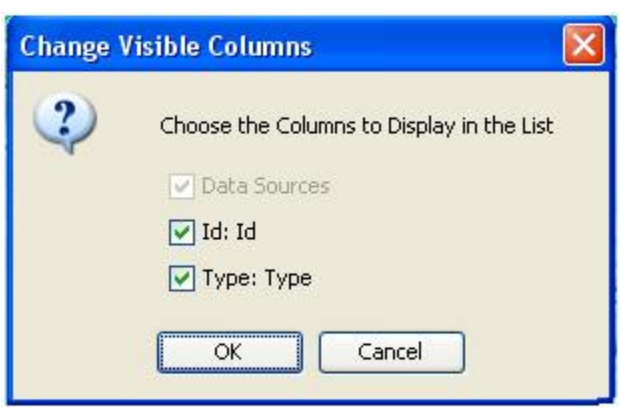


Figure 4.8: Change Data Sources Visible Columns

4.5 Properties Window

The properties window displays a list of attributes pertaining to a selected data product or view. Figure 4.9 shows two examples of the Properties window: the properties for the *LRO Lunar Elevation Data Product* are on the left, and the properties for the ILIADS "Home View" are on the right. The **Properties Window** dynamically updates with the attributes of whatever item is selected in the **Projects Window.** Clicking the button to the right of an attribute in any of the properties windows brings up a dialog box where you can edit the value of the attribute. Section X provides additional information about editing data set properties, Section Y provides additional information about editing view properties.

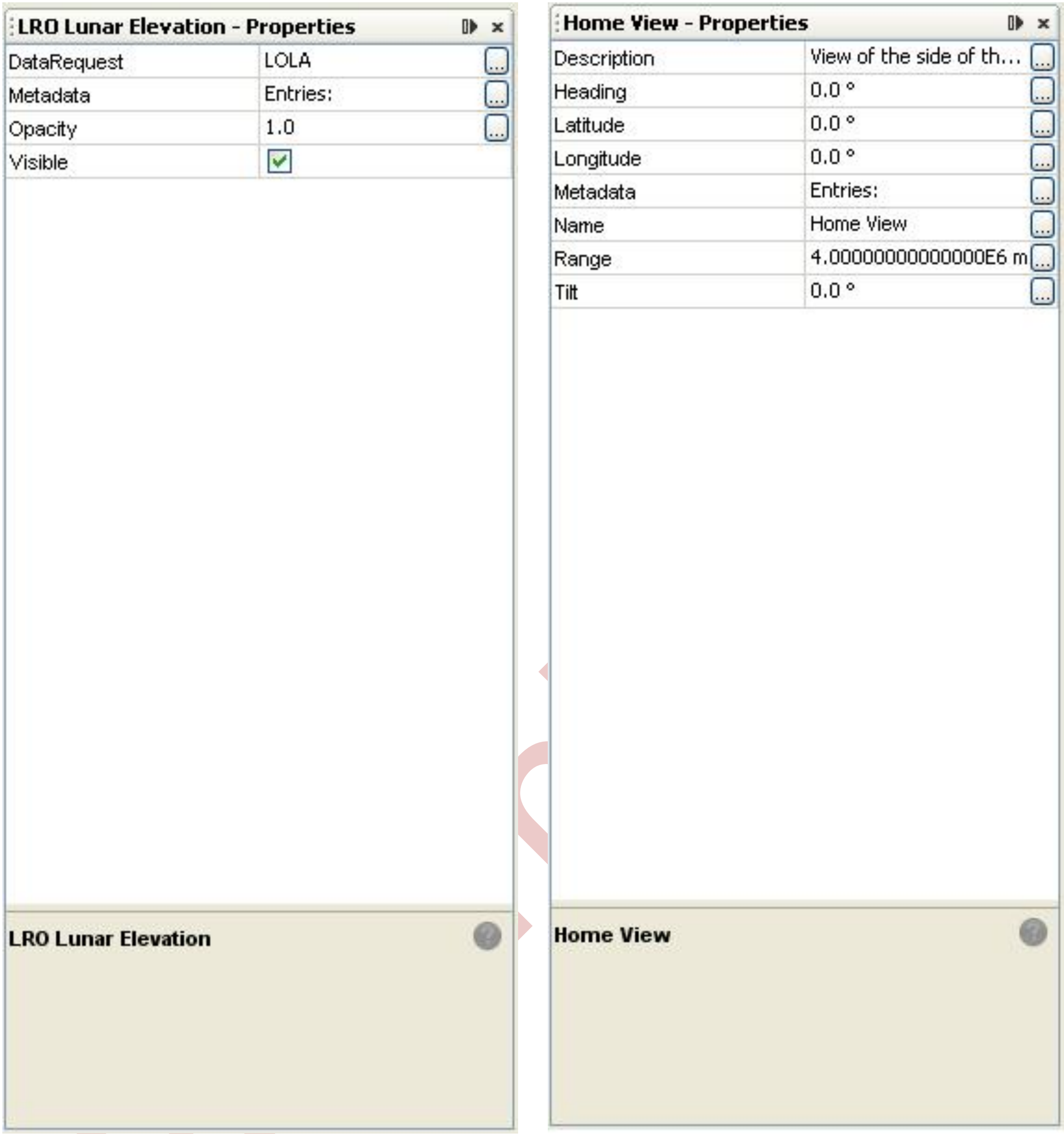


Figure 4.9: Properties Window Examples

4.6 Favorites Window

The **Favorites Window** provides quick access to other ILIADS projects or scenes that the user frequently accesses.

4.6.1 Add a new Favorite

1. Select the name of a project or scene in the **Project Window.**
2. Select the **Add to Favorites** option from the **Tools** menu. The selected item is added to the **Favorites Window.**

4.6.2 Remove a Favorite

1. Right-click on the name of a project or scene in the **Favorites Window.**
2. Select the **Remove From Favorites** option from the pop-up menu. The selected item is removed from the **Favorites Window.**

5 ILIADS Menus

5.1 Introduction

The ILIADS application has six menus, along with a **Menu Toolbar** that provides quick access to commonly used functions. Section 5.1 describes the **menu toolbar,** while the remaining sections describe each of the ILIADS menus.

The menu toolbar is located at the top of the ILIADS Application window. The default configuration for the toolbar is shown in Figure 5.1. Table 5.1 lists the functions activated by each of the buttons.

Figure 5.1: ILIADS Menu Toolbar Default Configuration

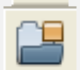
	Creates a new scene in the selected project
	Creates a new project folder
	Opens a project folder
	Saves all updates to all scenes made during this session
	Undo the last operation
	Redo the last operation

Table 5.1: ILIADS Menu Bar Button Functions

The menu toolbar can be expanded to include more buttons by setting toolbar options available via the **View** menu, **Toolbars** option. Table 5.2 describes the additional buttons and lists which **Toolbar** option places the button on the **Menu Toolbar.**

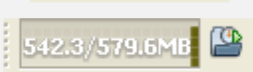
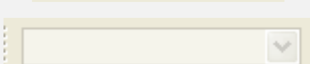
	Cut, Copy, and Paste buttons. Select the **Clipboard** option.
	These buttons are activated by the **Memory** option and are should not be needed by ILIADS uses.
	Activated by the **Build** option – not needed by ILIADS users.

Table 5.2: Optional Menu Bar Buttons

Note: The **Small Toolbar Icons** reduces the size of the **Menu Bar** buttons.

The **Reset Toolbars** option returns the **Menu Bar** to the default configuration.

5.2 File Menu

Table 5.3 describes each of the options in the file menu.

New Project… (Ctrl+Shift+N)	Opens the **New Project** window. See Figure 2.1 and Section 2.2 for details
New Scene…(Ctrl+N)	Opens the **New Scene** window. See Figure 2.4 and Section 2.3 for details.
Open Project…(Ctrl+Shift+O)	Displays the **Open Project** window as shown in Figure 5.3 and provides users with the means of selecting a project file. The **Open Project** window defaults to the **NetBeansProjects** folder in the user's home directory, but the user can navigate to any folder containing an ILIADS project file. Click the **Open Project** button to open the selected project file.
Open Recent Project	Displays a pick list containing the N most recently created ILIADS project files that are not already open in the current application (see Figure 5.4). Left-click on the project name to open the project file.
Close Project	Closes the project file currently selected.
Project Properties	This option is not available.
Export Project…	Displays the **Export Project** window as shown in Figure 5.5 and allows the user to navigate to a location where a copy of the currently selected project file can be saved. The project file may be saved in either the lmmp or iliads.jar file format by selecting either option from the **Files of type** pulldown list.
Import Project…	Opens the **Import Project Window** and lets the user navigate to a specified location
Save	Saves all changes made since the last **save** to the SELECTED scene only.
Save As…	Not enabled for this release
Save All	Saves all changes made since the last **save** to ALL scenes.

Page Setup…	Opens the **Page Setup** function of your workstation.
Print…	Prints a copy of the scene window that is currently selected
Exit	Opens the **Save Window** as shown in Figure 5.6. Any projects that were updated during this ILIADS session will appear in the list. The user may **Save All** changes made during a session by checking the **Save All** button, or may save changes to individual projects by selecting the individual project name and clicking **Save.** **Discard All** will return the projects to their state at the last save operation.

Table 5.3: File Menu Options

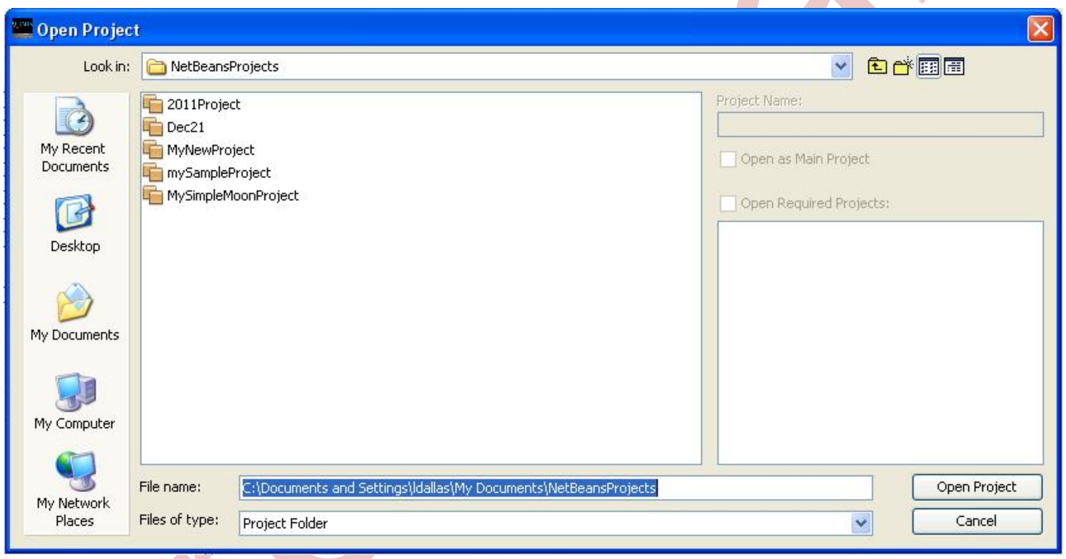
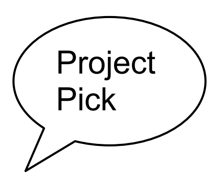


Figure 5.3: Open Project Window



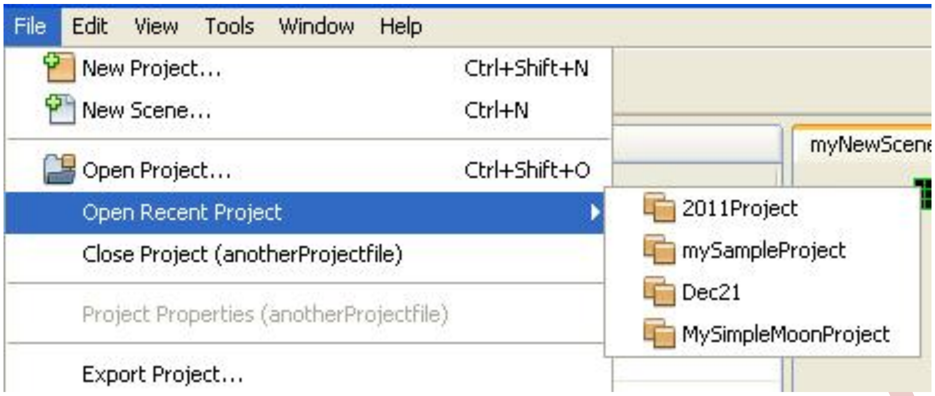


Figure 5.4: Open Recent Project Pick-List

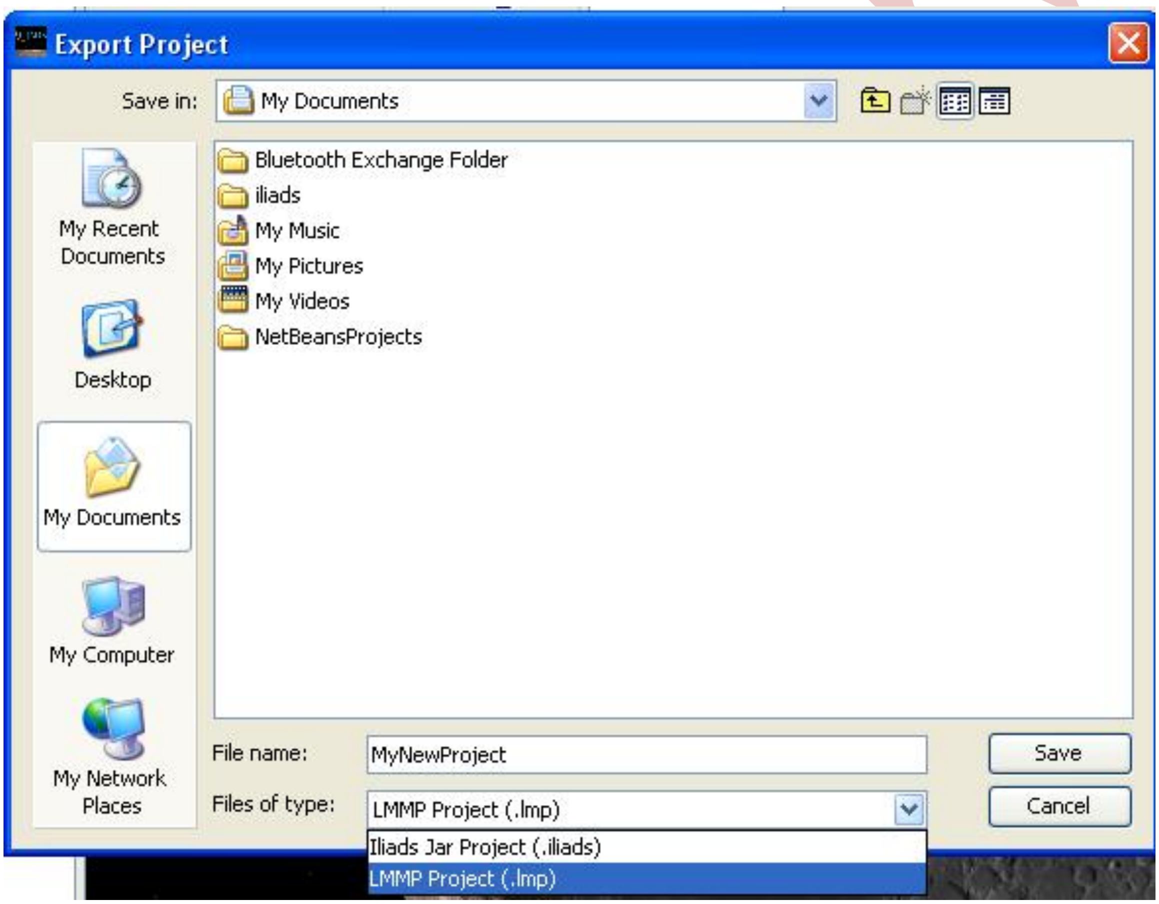


Figure 5.5: Export Project Window

Figure 5.6: Save Window

5.3 Edit Menu

Table 5.4 describes each of the options in the **Edit** menu.

Undo	N/A
Redo	N/A
Cut	Removes the selected item and places it on the clipboard
Copy	Copies a selected item (project file, scene, layer, or view.)
Paste	Pastes a copied or cut item into the selected item (e.g., a scene into a project, a layer into a scene.)
Paste Formatted	Not enabled in this release
Delete	Deletes selected item (project file, scene, data layer, etc.). Users are asked to confirm or cancel before the delete operation is executed.
Select All	Not enabled in this release

Table 5.4: Edit Menu Options

5.4 View Menu

Table 5.5 describes each of the options in the **View** menu.

3D View	Opens a scene that is currently closed. Select a **Scene** from the **Projects Window,** select the **3D View** option, and a new scene window is added displaying the current state of the scene (active layers and views are loaded.)
IDE Log	Opens the **Output-IDE log** window for the

	NetBeans Integrated Development Environment. Users should not need to view this log file.
Toolbars	Adds or removes icons from the **Menu Toolbar** as described in section 5.1.
Show Editor Toolbar	?
Full Screen	Toggles the ILIADS application window into full screen mode.

Table 5.5: View Menu Options

5.5 Tools Menu

Table 5.6 describes each of the options in the **Tools** menu.

Add to Favorites	Adds the selected Project or Scene to the **Favorites** window (See Section 4.7)
Templates	Opens the **Template Manager** window. See section 12 for details.
Plugins	Opens the **Plugins** window. See section 12 for details.
Options	**Options** provides access to several miscellaneous functions as follows: • **General** – Opens the **Options** window (see Section 3.5.4) • **Globe View** – Allows the user to control which data overlays display automatically when a new scene is created. See section 7.7 for details. • **Miscelaneous** – These settings should not be altered.
Clear Cache	Selecting **Clear Cache** clears the *cache* subdirectory of the ILIADS application folder. See section 3.5.3 for details.

Table 5.6: Tools Menu Options

5.6 Window Menu

Table 5.7 describes each of the options in the **Window** menu.

ColorMap Builder	
Data Sources	Opens the **Data Sources** window. Reference section 4.4 for details.
WebDAVexport	
Files	Opens the **Files** window. Reference section 4.8

	for details.
Projects	Opens the **Projects** window. Reference section 4.2 for details.
Favorites	Opens the **Favorites** window. Reference section 4.7 for details.
Properties	Opens the **Properties** window. Reference section 4.5 for details.
Processes	Not enabled in this release
Close Window	Closes the window currently selected.
Maximize Window	Maximizes the window currently selected.
Undock Window	Undocks the window currently selected. Reference section 4.1.3 for details.
Clone Document	Not enabled in this release
Close All Documents	Closes all open **Scene** windows.
Close Other Documents	Closes all **Scene** windows except the active scene.
Documents…	Opens the **Documents** window, which lists all scenes currently open in ILIADS.
Reset Windows	Returns all windows to the default configuration (see Section 4.1)

Table 5.7: Window Menu Options

5.7 Help Menu

Table 5.8 describes each of the options in the file menu.

Help Contents	Opens the **Help** window, which will eventually contain the contents of the ILIADS User Manual. The contents will be accessible by indexed topics or by search text string.
Check for Updates	Verifies that the user is running the most up to date version of ILIADS, and installs any recent updates if the application is out of date.
About	Displays the **About** window as shown in Figure 5.7. This window lists the ILIADS and Java product versions currently running on the user's machine, as well as the user directory where the ILIADS application is stored.

Table 5.8: Help Menu Options

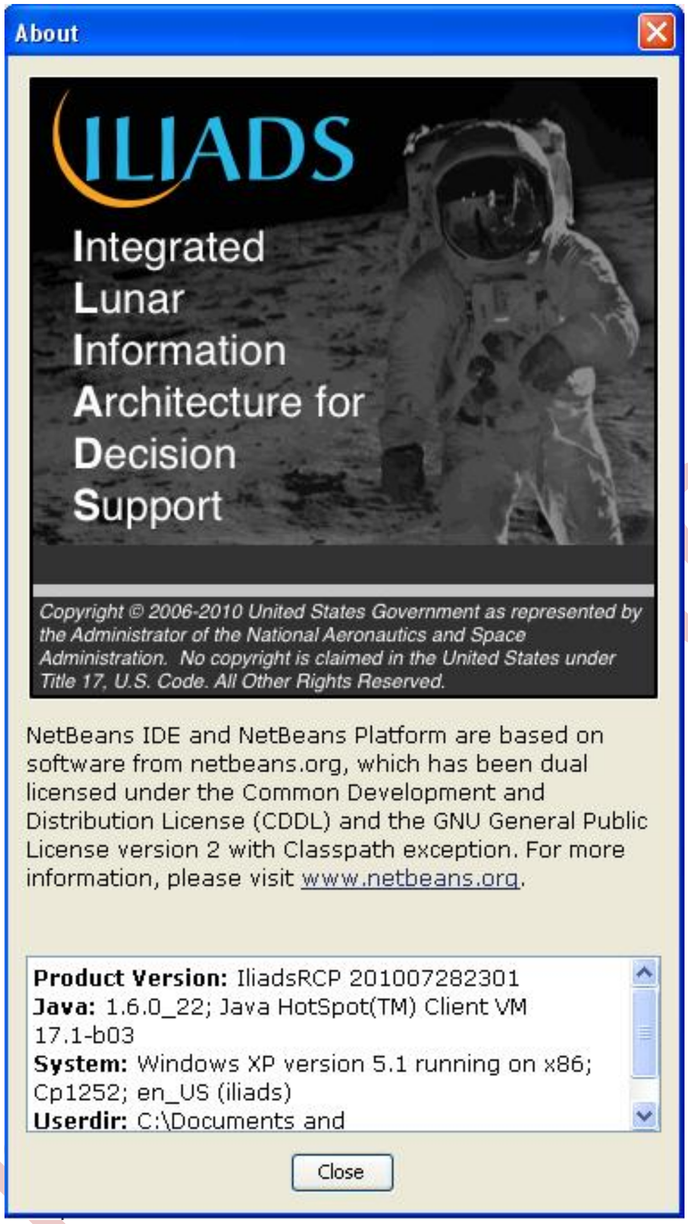


Figure 5.7: About ILIADS Window

6. Navigation

6.1 Introduction

Within ILIADS, the moon and its terrain are displayed in the **Scene Window.** ILIADS provides a number of ways for the user to navigate the 3D view of the moon by using the computer mouse, trackpad, or the ILAIDS navigation control buttons. Users can rotate the lunar globe in any direction, zoom in or out, and can tilt the globe to change the viewing angle of the terrain..

6.2 Navigating with the Mouse or Trackpad

Using the mouse, users can navigate by rotating the moon from a fixed position in the **Scene Window** to different locations and can zoom in or out. The **location bar** located at the bottom of the **Scene Window** dynamically updates the altitude, latitude, longitude, and elevation as the mouse changes position on the lunar surface. Figure 6.1 shows a close up view of the **location bar.**

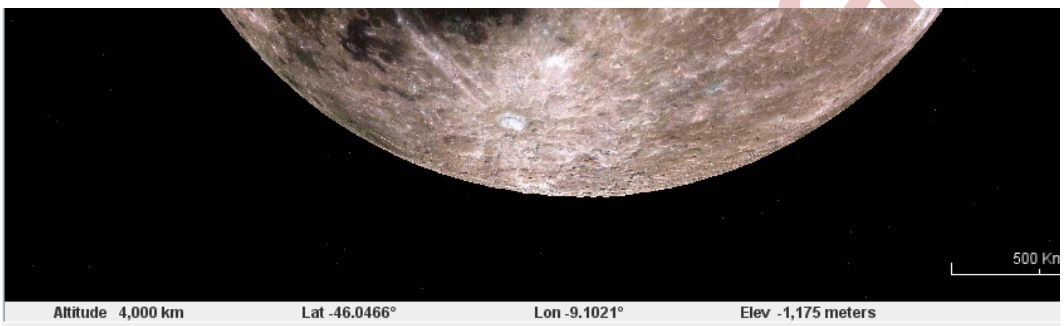


Figure 6.1: ILIADS Location Bar

The following table describes how to navigate with the computer mouse or trackpad.

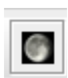
Change the view in any direction (north, south, east, or west)	To change the view, position the cursor anywhere on the **Scene** press the LEFT mouse button. Drag the mouse in any direction to rotate the view to the desired location. If using a trackpad, click the left button and move your finger in the desired direction. **Note**: ILIADS only loads data that is visible to the user. When rotating, there may be a delay in displaying the data as ILIADS fetches the data from the server or performs an analysis on a function layer.
To zoom in/out	Use the scroll wheel on the mouse to zoom in or out on the **Lunar Display Panel.** Scrolling forward zooms in; scrolling backwards zooms out. If using a trackpad, click

	the left button and push upward on the right edge to zoom in; push downward on the right edge to zoom out. **Note**: ILIADS dynamically loads data at the current zoom level. When zooming, there may be a delay in displaying the data as ILIADS fetches data from the server or performs an analysis.

6.3 Standard Views

ILIADS offers a set of three pre-defined lunar locations: the near side, the north pole, and the south pole. This section describes how to navigate to each of these locations. Section 7 describes how to create and save custom views.

6.3.1 Home View

Click the **Views**  **button** in the **Visualization Toolbar** and select **Home** to return to the default view as shown below. The ILIADS lunar default view is the near side, with the lunar mare Sinus Medii positioned in the center of the lunar globe display. Any data set(s) or layers that are currently active will remain active after returning to the default view.

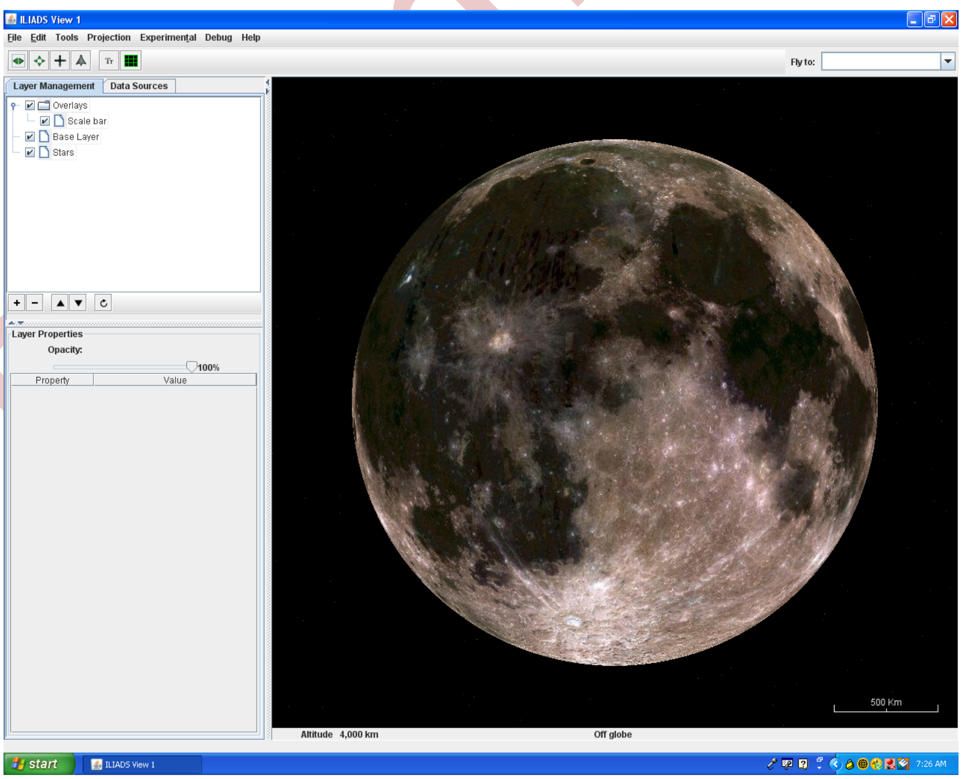
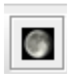


Figure 6.2: ILIADS Home View

6.3.2 North Pole

Click the **Views**  button in the **Visualization Toolbar** and select **North** to display the moon's north pole.

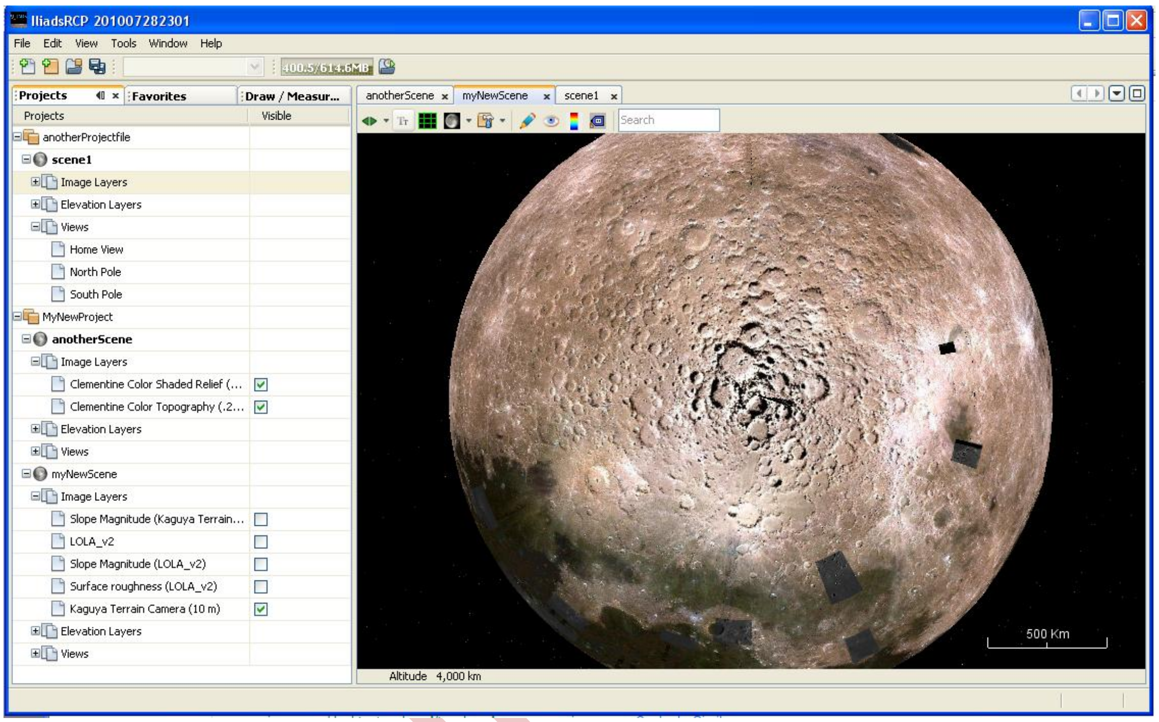
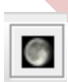


Figure 6.3: ILIADS North Pole View

6.3.3 South Pole

Click the **Views**  button in the **Visualization Toolbar** and select **South** to display the moon's south pole.

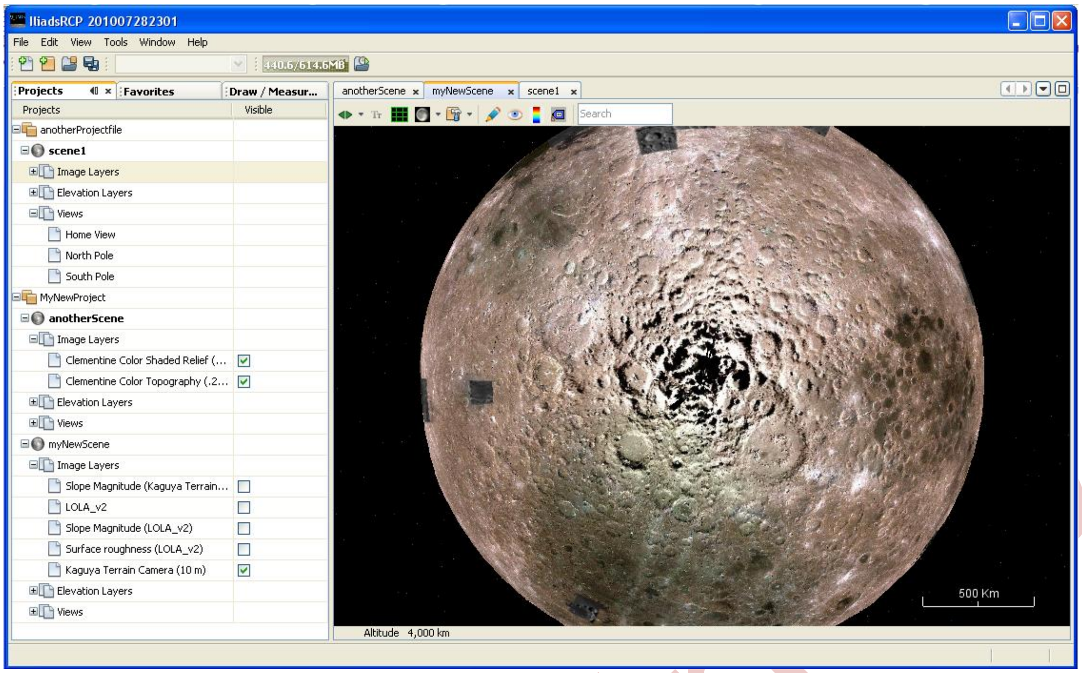


Figure 6.4: ILIADS South Pole View

6.4 Landmark Search

The **Landmark Search Box** in the **Visualization Toolbar** allows the user to navigate to a specific landmark on the moon. Type the location in the box. ILIADS auto-completes the text string based on the characters supplied by the user.

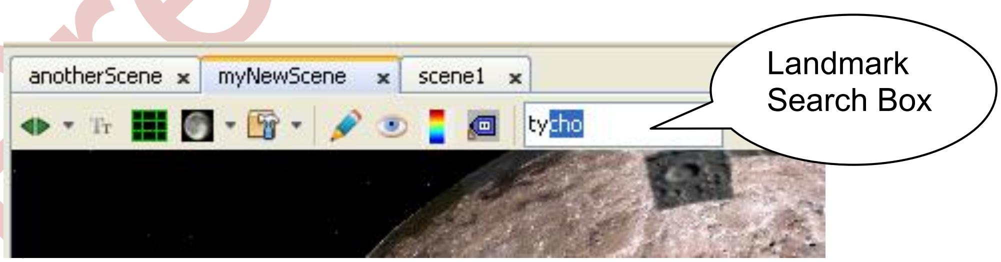


Figure 6.5: Landmark Search

The moon zooms in until the specified location is centered in the **Scene Window**.

6.5 Navigation Tool

ILIADS also provides a **Navigation Tool** that is accessible from the **Visualization Toolbar**. This tool is activated by clicking on the "eye" icon on the toolbar. Once activated, a series of buttons are placed in the lower left corner of the Scene Window as shown in Figure 6.6. These buttons perform the functions described in Table 6.1.

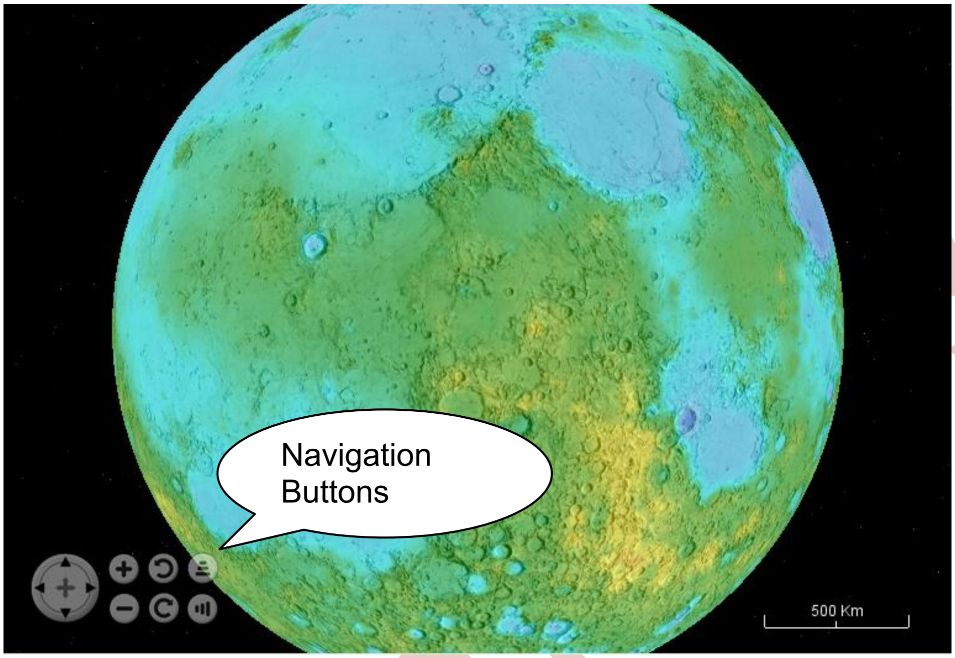


Figure 6.6: Navigation Buttons

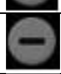
	Rotates the globe in a north, south, east, or west direction by clicking the left mouse button on the corresponding arrow on the button. The globe continues to rotate in the selected direction as you hold down the mouse.
	Zooms in
	Zooms out
	Rotates the globe clockwise, maintaining the current view
	Rotates the globe counter-clockwise, maintaining the current view
	Tilts the globe upward. (The range of the tilt operation is 180°)
	Tilts the globe downward. (The range of the tilt operation is 180°)

Table 6.1: Navigation Button Functions

7 Data Layers

7.1 Introduction

An ILIADS data layer is a form of information or the result of a computational process that ILIADS can render and display in the **Scene Window**. Users may add multiple layers in one or more Scene Windows, and can adjust the opacity of a layer so that more than one layer is visible simultaneously. Users may also rearrange the "stacking" order of layers, and may adjust the viewing perspective on these layers.

Layers are categorized in the **Project Window** as either **Image Layers** or **Elevation Layers** as shown in Figure 7.1 below.

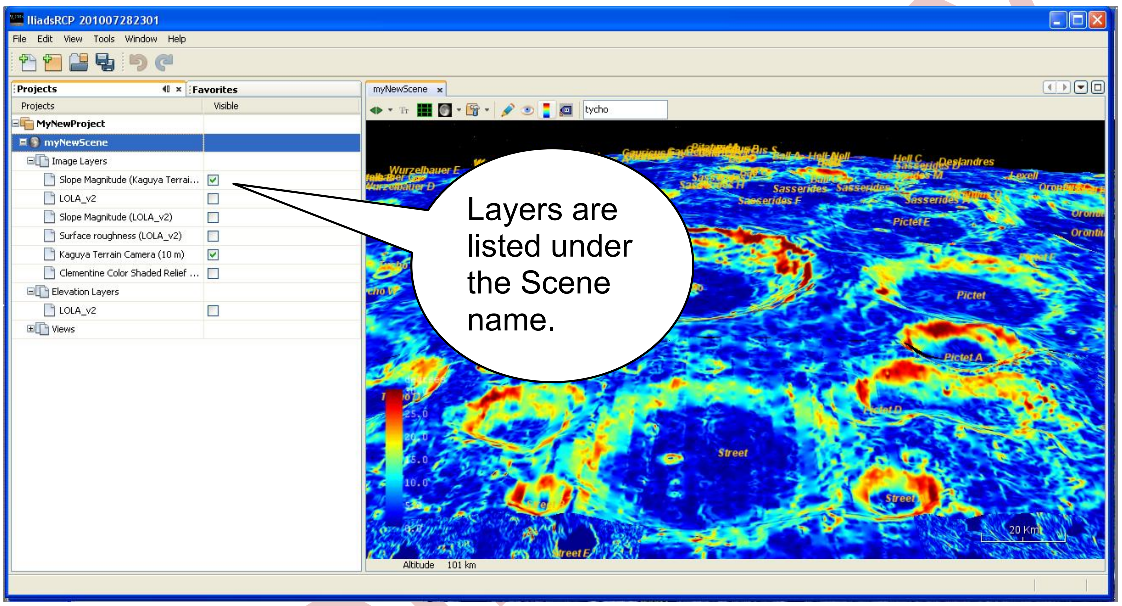


Figure 7.1: ILIADS Data Layers

Section 7 describes each of the different ILIADS data layer types, and how users can rearrange and control the ways layers are displayed.

7.2 Image Layer

An ILIADS Image Layer contains either a series of tiled images or lunar data represented as images. Image layers are added to a scene as follows:

1.	Left-click on the name of the scene in the **Project Window** that will contain the new image layer.
2.	Right-click and select **New** from the pop-up menu.
3.	Select **Tiled Image Layer** from the next cascading menu. (You can also skip step 2 and right-click on the **Image Layers** expandable

	item in the scene hierarchy, and click the pop-up menu item **Tiled Image Layers.**)
4.	The **New Tiled Image Layer Window** opens as shown in Figure 7.2.
5.	Select a data source from the **Sources** scrolling list on the left.
6.	Select a data set from the **Layers** scrolling list on the right.
7.	Click **Next.** The **New Tiled Image Layer (set attributes)** window opens as shown in Figure 7.3.
8.	As there are no **Data Request Parameters** to configure for this data set, click **Finish.** The data set will load in the scene window and will now be listed in the **Image Layers** folder in the **Project Window** for the selected scene as the top-most layer in the scene since it was most recently added.

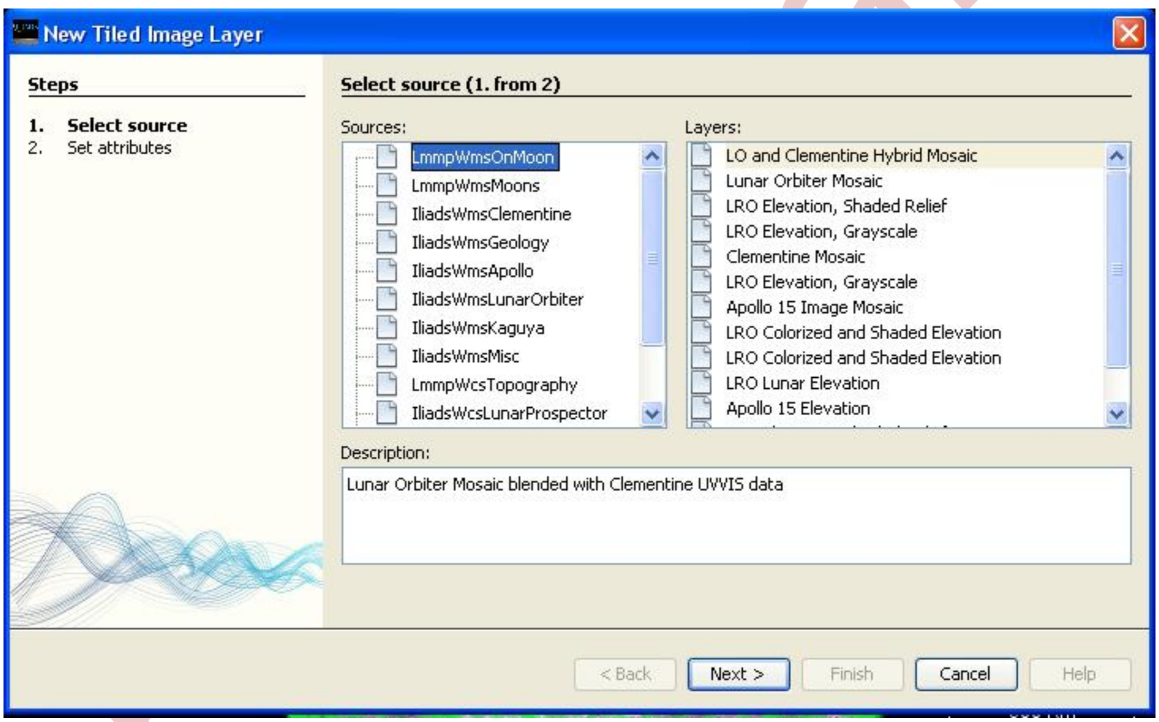


Figure 7.2: New Tiled Image Layer Window

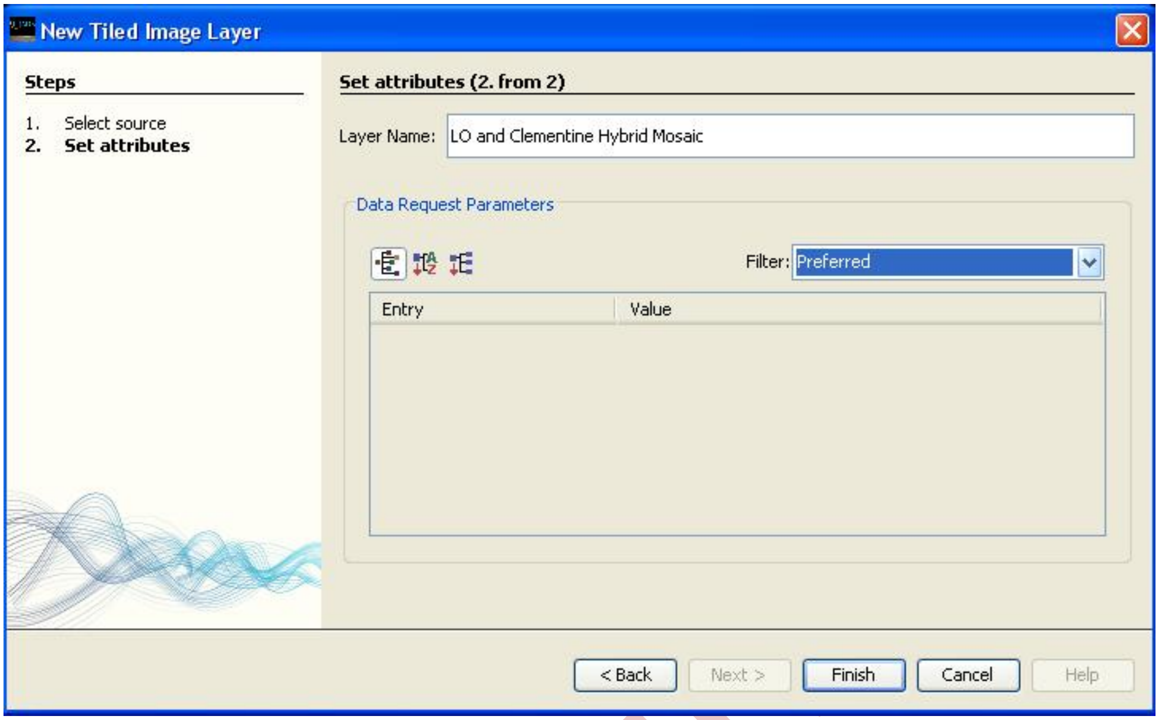


Figure 7.3: New Tiled Image Layer Attributes Window

7.3 Elevation Layer

An ILIADS elevation layer contains lunar topography data that is interpreted as elevation data. Elevation layers are most commonly used as input to ILIADS analyses and functions, as explained in Sections 9 and 10. While ILIADS **Image layers** are images (or data represented as an image), **elevation layers** are elevation (topography) data that give the view it's 3D appearance.

If the user selects a topography layer as a source when adding an image layer (see section 7.2) the raw topography data is converted to an image using a colormap and added to the **Image layers** folder. If the user selects a topography layer as a source when adding an elevation it is NOT converted to an image; rather, the raw data is interpreted as elevation data and added to the **Elevation** folder of the selected scene. This elevation data may only be visible when you are zoomed into a crater or hill and looking at it from an angle.

Elevation layers are added to a scene as follows:

1.	Left-click on the name of the scene in the **Project Window** that will contain the new elevation layer.
2.	Right-click and select **New** from the pop-up menu.

3.	Select **Elevation Model** from the next cascading menu. (You can also skip step 2 and right-click on the **Elevation Layers** expandable item in the scene hierarchy, and click the pop-up item **Elevation Model.**)
4.	The **New Elevation Model Window** opens as shown in Figure 7.4.
5.	Select a data source from the **Sources** scrolling list on the left.
6.	Select a data set from the **Layers** scrolling list on the right.
7.	Click **Next.** The **New Elevation Model (set attributes)** window opens as shown in Figure 7.5.
8.	Most elevation layers allow you to select a color map for the display of the data. The color mapping highlights contours and differing elevations in the topography. ILIADS offers a variety of color maps common to GIS applications. Select a color map by clicking on the desired option from the **Color Map** pull-down list and click **Finish.** The data set will load in the **Scene** window and the layer name will be added to the **Elevation Layers** item in the scene hierarchy.

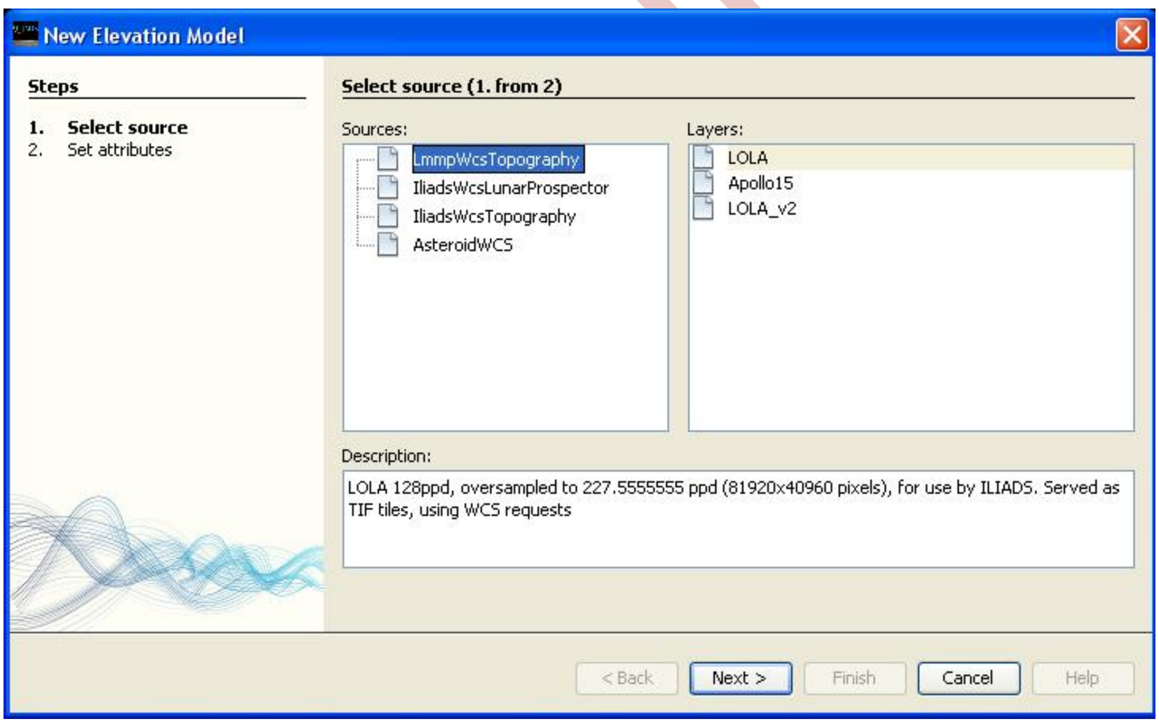


Figure 7.4: New Elevation Model Window

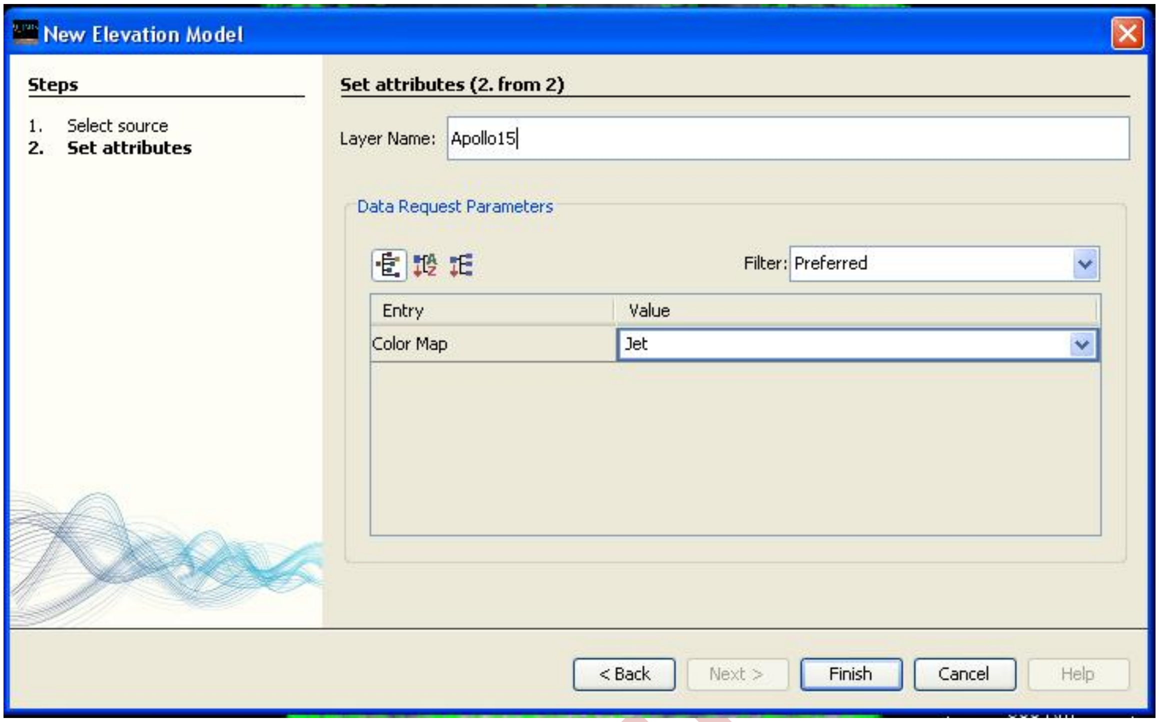


Figure 7.5: New Elevation Model Attributes Window

7.4 Feature Layer

This version of ILIADS contains only one type of feature layer: lunar nomenclature. While the **Text Label Layer** is available from the **Visualization Toolbar** (see section 4.3), the nomenclature feature layer contains lunar landmarks labeled at a much higher resolution. The user may select nomenclature data in either LMMP or ILIADS format. To add this **Feature Layer:**

1	Left-click on the name of the scene to contain the new feature layer.
2	Right-click and select **New** from the pop-up menu.
3	Select **Feature Layer** from the next cascading menu. (You can also skip step 2 and right-click on the **Image Layers** expandable item in the scene hierarchy, and click the pop-up menu item **Feature Layer.**)
4	The **New Feature Layer Window** opens.
5	Select a data source from the **Sources** scrolling list on the left. In this case, select either the *LMMPBetaNomenclatureWfs* source or the *IliadsLunarWfs* source.
6	Select a data set from the **Layers** scrolling list on the right.

7.	Click **Next.** The **New Feature Layer (set attributes)** window opens as shown in Figure 7.3. As there are no **Data Request Parameters** to configure for this data set, click **Finish.** The data set will load in the scene window and will now be listed as the top-most layer in the scene hierarchy under the **Image Layer** folder since it was most recently added.

Note: The nomenclature feature layer always remains visible, even if several other layers (image, function, elevation, etc.) have since been added.

7.5 Function Layer

A function layer is the result of an analysis or mathematical computation represented visually in the **Scene Window. Function Layers** require topographical data sets as input in order to achieve meaningful results. ILIADS offers three types of **Function Layers** as described in Table 7.1. Function layers are added to a scene as follows:

1. Left-click on the name of the scene to contain the new elevation layer.
2. Right-click and select **New** from the pop-up menu.
3. Select **Function Layer** from the next cascading menu. (You can also skip step 2 and right-click on the **Image Layers** expandable item in the scene hierarchy, and click the pop-up item **Function Layer.**)
4. The **New Function Layer Window** opens as shown in Figure 7.6.
5. Select the type of function from the **Sources** scrolling list on the left. ILIADS offers a variety of analyses and calculations grouped as follows:

Function Type	**Description**	**Where to look for detailed information**
XIS Analysis	eXtraplanetary Information Systems analyses commonly found in geographic information systems.	Section 9
ImageProcessing	set of standard algorithms and graphical tools for image processing and analysis.	Section 10
Math	standard set of mathematical calculations. Reference Section 11 for details	Section 11

Table 7.1: Function Layer Types

6. Select a specific function from the **Layers** scrolling list on the right.
7. Click **Next.** The **New Function Layer (input)** window opens as shown in Figure 7.7.
8. Select the source of the data set to be used as input from the **Sources** scrolling list on the left, then select the specific data set from the **Layers** scrolling list on the right. Click the **Next** button.

   Note: the data set selected does not have to be the source of an elevation layer in the current scene.

9. The **New Function Layer (set Attributes) Window** opens and allows you to configure the input parameters for the selected function. The parameters listed vary with the function selected. Detailed information about each function, including a list of input parameters, is available for each function as listed in Table 7.1 above.
10. After supplying the input parameters, click **Finish.** The results of the computation are shown in the **Scene** window, and the new layer is listed in the **Image Layer** folder of the selected scene hierarchy.

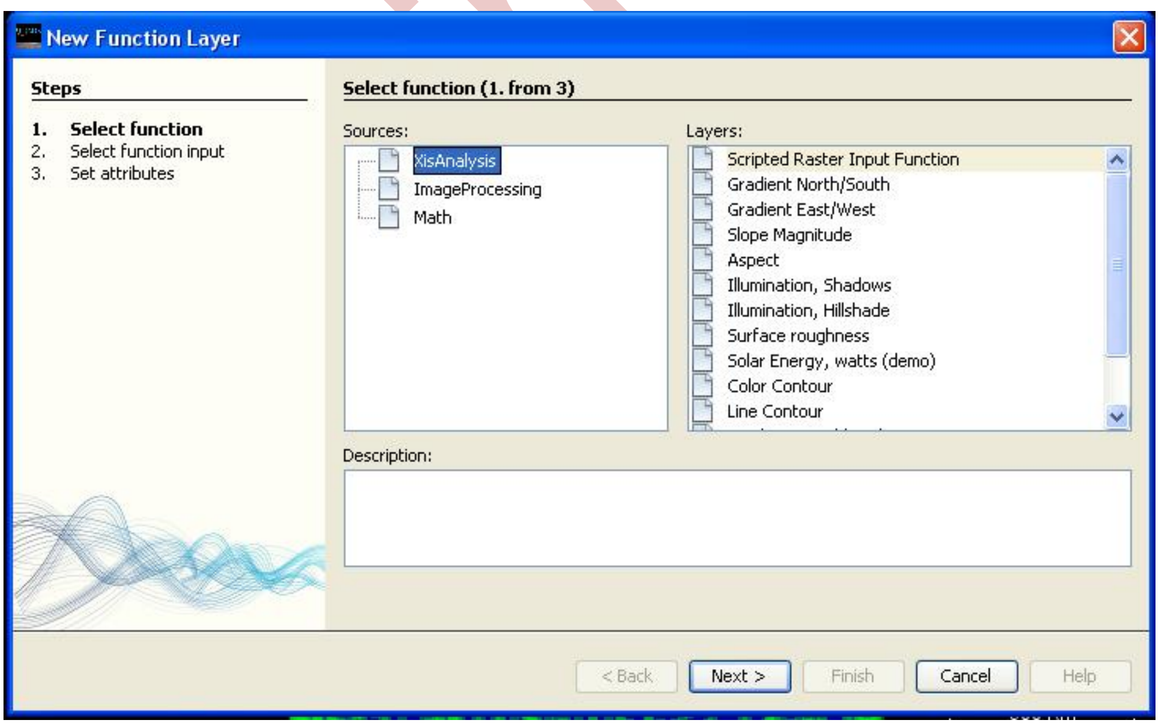


Figure 7.6: New Function Layer Window

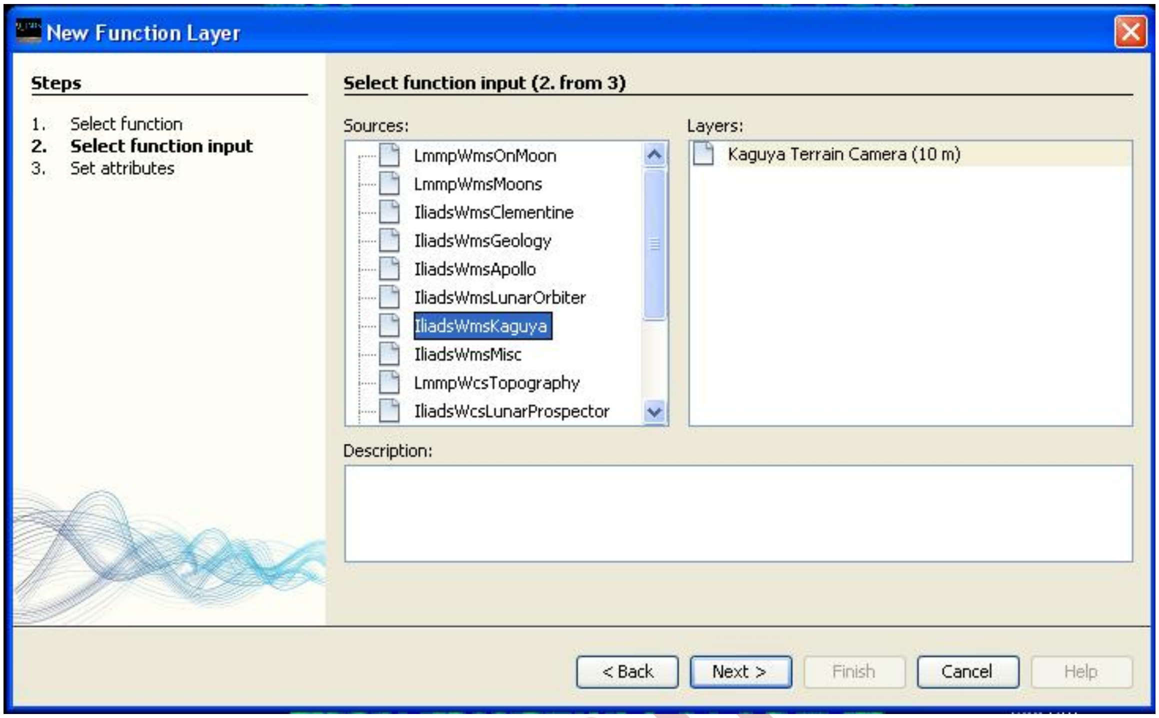


Figure 7.7: Function Layer Input Window

7.6 Shape Layer

The ILIADS **Draw/Measure Tool** provides users with a means of highlighting one or more regions within a scene window or measuring the distances and area between points on the lunar surface. Users can "draw" objects such as lines, points, paths, circles and squares to denote areas of interest. Users can set various display options for a drawing layer, such as displaying "tooltip" latitude and longitude values when the user mouses over marked points on the drawing. This section describes how to add a **Shape Layer** by using the **Draw/Measure Tool** and how to set the attributes of the layer.

1.	Left-click on the name of the scene to contain the new **Shape** layer.
2.	Right-click and select **New** from the pop-up menu.
3.	Select **Shape Layer** from the next cascading menu. (You can also skip step 2 and right-click on the **Image Layers** expandable item in the scene hierarchy, and click the pop-up menu item **Shape Layer.**)
4.	A new **Shape Layer** is added to the **Image Layer Folder** for the selected scene. This layer is called **Draw/Measure Tool Layer <n>** as shown in Figure 7.8.

5.	Select the **Draw/Measure Tool Button** from the **Visualization Toolbar** . The **Draw/Measure Tool Window** opens as shown in Figure 7.9
6.	Select the colors for the shape **Lines**, **Points,** and **Tooltip** text by clicking each of the corresponding buttons. The **Choose a Color** window opens for each button – click on the desired color and click **OK** to set the color. The default colors are as follows: **Line –** yellow; **Point –** blue; **Tooltip -** white
7.	Select the type of shape you want to add from the **Shape** pulldown list. The available choices are ***point, line, path, polygon, circle, ellipse, square***, and ***rectangle.***
8.	Indicate the **Path Type** by selecting the desired option from the pulldown list. The available choices are: • ***Linear –*** • ***Rhumb –*** • ***Great Circle -***
9.	Select the options you want to apply to this shape by clicking the corresponding check box: • **Follow Terrain –** • **Rubber Band –** • **Tooltip –** if checked, point coordinates, line distances, perimeter, shape area, and/or radius are each displayed when object points are moused over in the **Scene** window. The information displayed is dependent upon the shape created. • **Control Points –** • **Free Hand -**
10.	Click the **New** button. Position the mouse on the **Scene** window where you want to create the shape and click and drag to add points, stretch circle/square/etc. For *paths,* click **End** when you are finished defining the shape; otherwise, the shape is defined after you release the mouse button. Clicking **New** erases the shape and allows you to start over. **Note:** Clicking and dragging on any of the defined points on a shape allows you to adjust/resize the shape.
11.	Additional Shapes may be added to the same layer by clicking the **+** sign in the upper left corner of the **Dr.aw/Measure Tool Window.** A new "tab" is added to

	the window that contains the number of the shape being defined. Repeat steps 6-10 above to create a new shape.
12.	Click the **Projects** window tab to return to the **Projects window,** or close the **Draw/Measure Tool Window** when you are finished

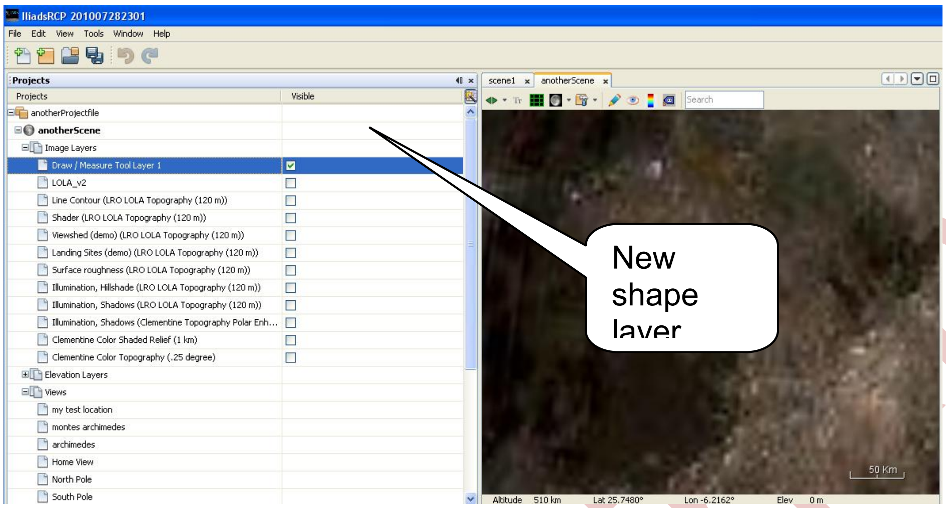


Figure 7.8: New Draw/Measure Tool Layer

Note: The control points defining a shape are always visible – even if additional data layers are added to a scene after a shape layer was defined, the control points of the shape(s) remain visible (provided the “Control Points” check box was selected).

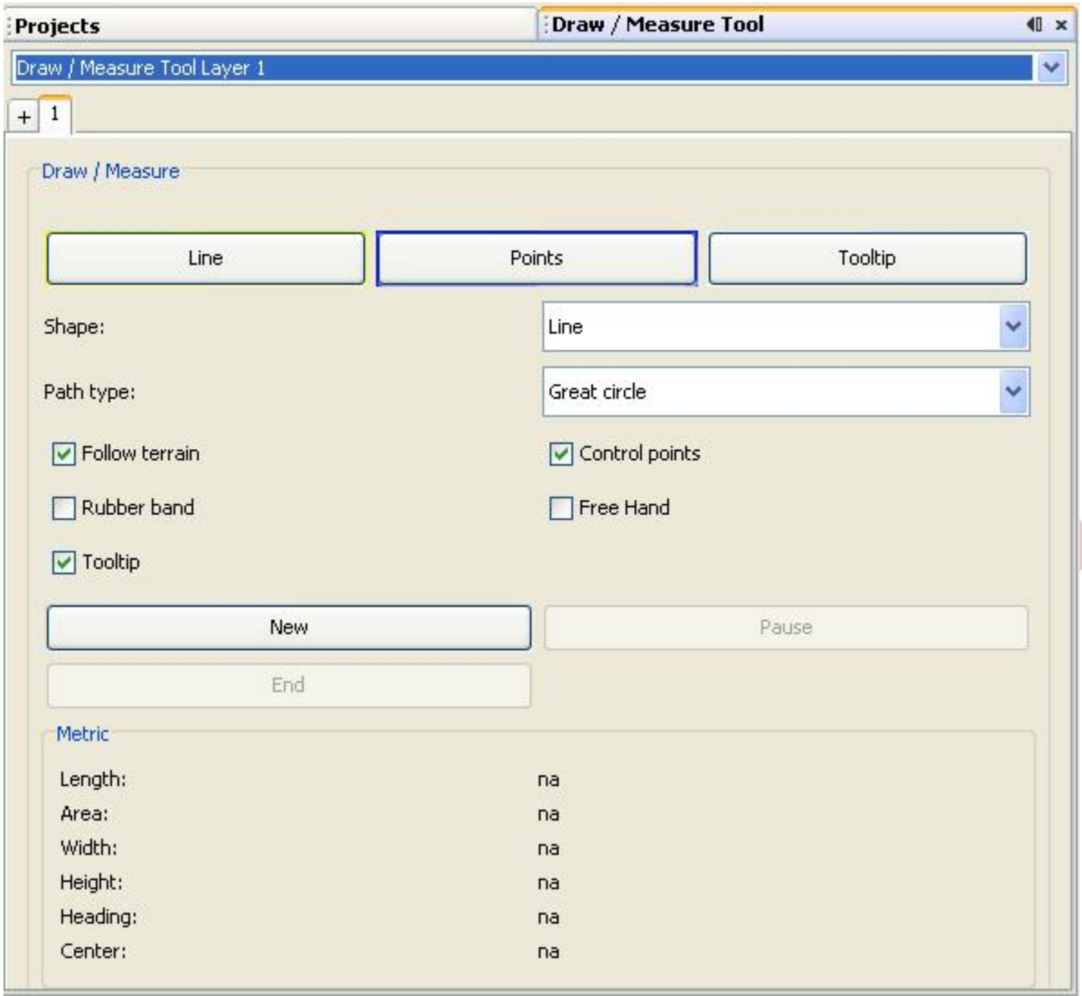


Figure 7.9: Draw/Measure Tool Window

7.7 Image Overlays

ILIADS provides several image overlays that provide supplementary information when viewing lunar data products.

7.7.1 Stars Overlay

Currently, the **Stars** overlay is not based on actual stellar maps. Future releases of ILIADS will provide an accurate star map that will change with time. The **Stars** overlay is "active" by default and may be removed by selecting the **Options** choice in the **Tools Menu,** selecting the **Globe View** button, and unchecking the **Stars** check box.

7.7.2 Place Name Overlay

The **Place Name** overlay provides text labels on several lunar landmarks. It is first activated by clicking the **Text Label** button on the **Visualization Tool Bar.**

7.7.3 Scale Bar Overlay

The **Scale Bar** indicates the map scale in kilometers and adjusts dynamically as the user zooms in and out of the display. The **scale bar** overlay is displayed by default. Users can remove the **scale bar** by selecting the **Options** choice in the **Tools Menu,** selecting the **Globe View** button, and unchecking the **Scale Bar** check box.

7.7.4 Terrain Profile Graph

The **Terrain Profile** overlay is activated by first clicking the **Toolbox Button** in the **Visualization Toolbar** (see Table 4.2) and then selecting the **Terrain Profile** option. This overlay is positioned in the lower left corner of the **Scene Window.** When the user positions the mouse anywhere on the globe, the terrain profile overlay draws a line of latitude that intersects the cursor. The terrain profile graph dynamically updates as the cursor is moved to illustrate the elevation of the terrain along the latitude segment displayed. The minimum and maximum elevations along the latitude line segment are listed in the terrain profile overlay.

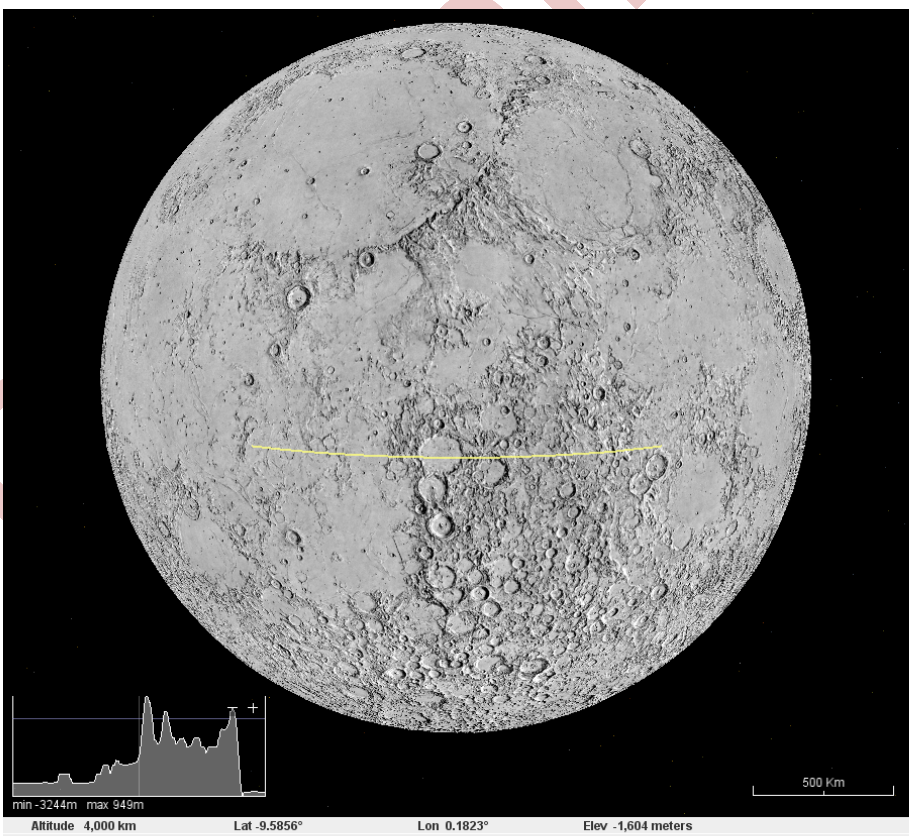


Figure 7.10: ILIADS Terrain Profile Overlay

7.7.5 Color Legend

The **Color Legend** overlay is activated by selecting the **Color Legend Button** in the **Visualization Toolbar** (see Figure 4.2). This overlay is positioned in the lower left corner of the **Scene Window.** The **color legend** helps users interpret data that are rendered in the scene window with a color map. Reference Section 2.7 for an example of how the **color legend** is used.

7.8 Layer Management

This section describes how users can rearrange layers, delete a layer, and adjust several of the most commonly used layer properties.

7.8.1 Stacking

As users add **image** or **function layers** to a **Scene,** the new layer is effectively "stacked" on top of the previously activated data layer. That is, data layers are listed in the **Projects window** within a scene hierarchy in the order that they have been "stacked", where the most recently added data layer appears at the top of the list. Figure 7.11 illustrates this concept.

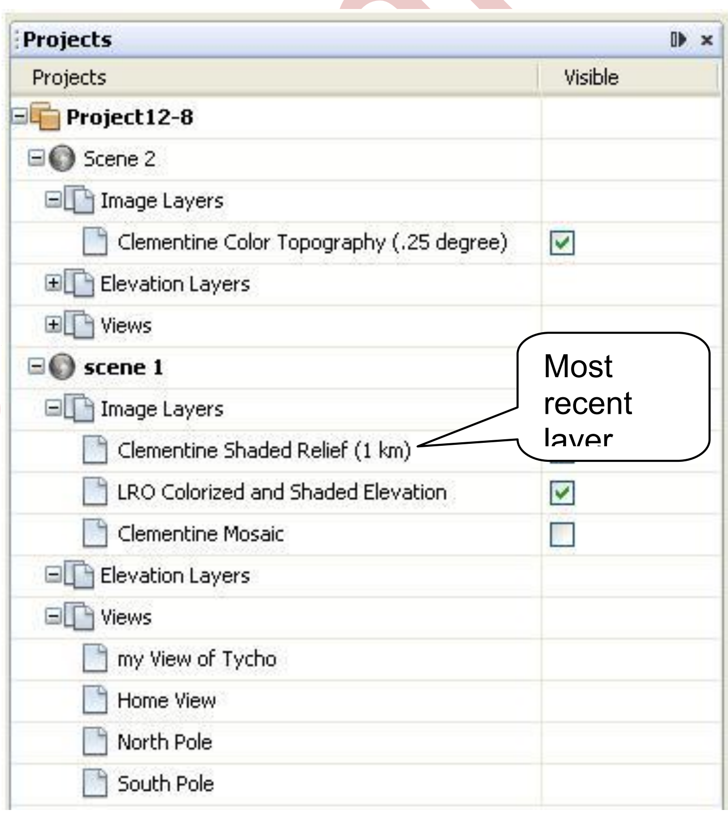


Figure 7.11: ILIADS Layer Management

Users can change the order of the layers by clicking and dragging to another location within the list. For example, referencing Figure 7.11, the user could click on the *Clementine Mosaic* layer and drag it above the *Clementine Shaded Relief* layer. The **Scene Window** would then display the *Clementine Mosaic* layer, provided the layer is checked as **Visible** (see section 7.8.3).

Note: Users can essentially view more than one layer at a time by adjusting a layer's **opacity.** Section 7.8.4 provides further information about adjusting a layer's opacity.

7.8.2 Delete a Layer

To delete any layer, select the layer name in the **Project Window** and right-click. Select the **Delete** option from the pop-up menu and click **OK** in the confirmation window.

7.8.3 Set Visibility

Users can prevent a data layer from loading and displaying by deselecting the corresponding checkbox in the **Project Window** (see section 4.2)**.** In fact, if a scene has many data layers and the user is only interested in one or two, it is advisable to de-select the remaining layers to increase ILIADS' performance.

7.8.4 Opacity

User's can adjust a layer's opacity so that data from more than one data set may be viewed at a time. For example, by setting the top layer's opacity to about 50%, users can essentially "see through" the top data layer to see data from the preceding layer. This feature is best used when 2 or 3 data sets are "active."

To adjust a layer's opacity, follow these steps:

1.	Open the **Properties Window** if it's not already displayed**.**
2.	Click the layer name in the **Project Window**. The properties for the selected layer are listed in the **Properties Window.**
3.	Enter a new value in the field next to **Opacity** and hit **return.** The value entered should be between 0.0 and 1.0.

Figure 7.12 provides an example of how the opacity feature might be used. In this example, the *Geology:All* dataset was first loaded in to the **Scene Window**. Next, the user selected the *ILIADSWcsLunar Prospector:Calcium* data set. By default, all datasets have an opacity value of 100%, thus obscuring any previously loaded data sets. By setting the opacity to around 50%, users can still

get an idea of both the calcium and geology values for different points on the lunar surface.

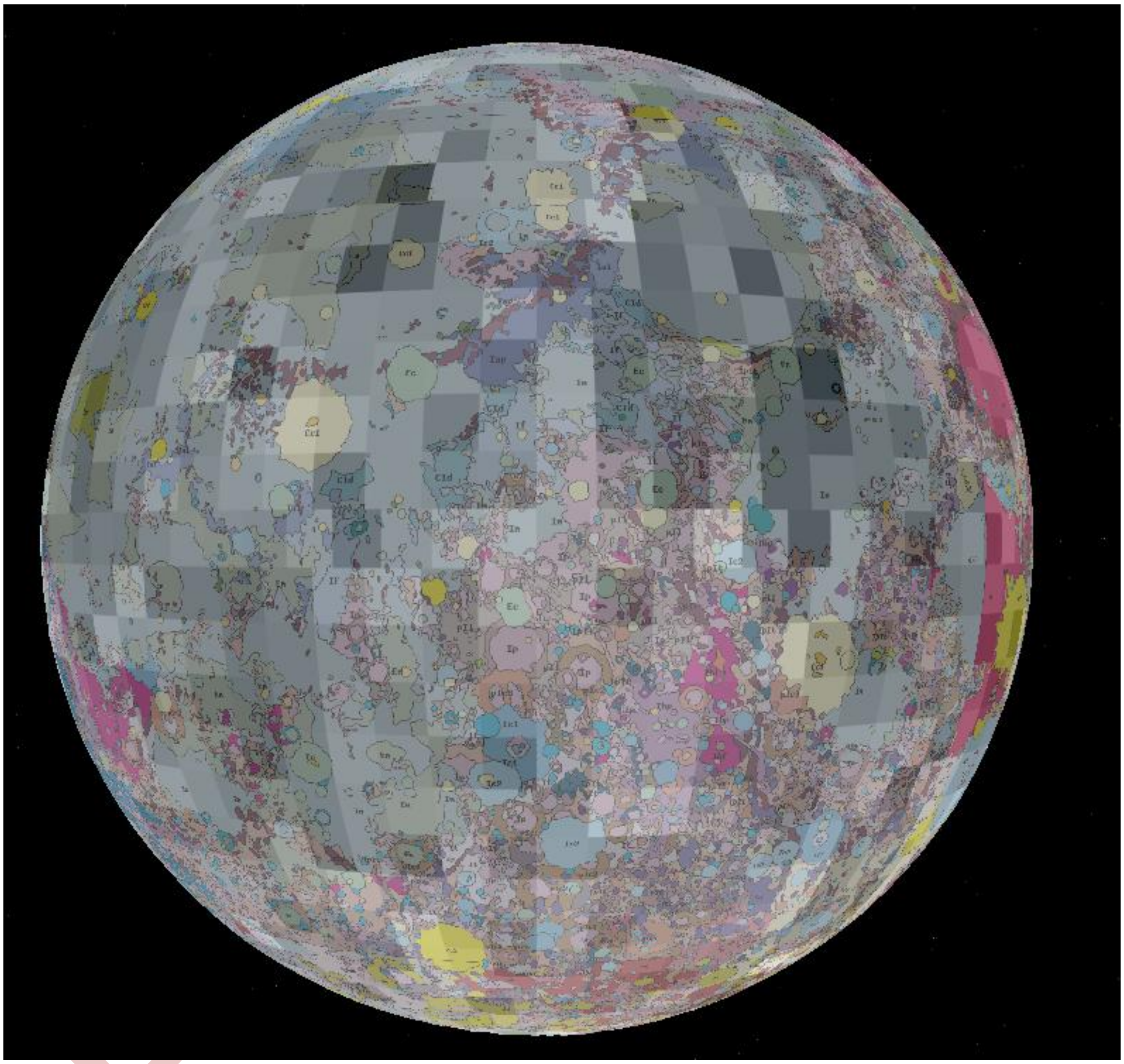


Figure 7.12: ILIADS Data Opacity Example

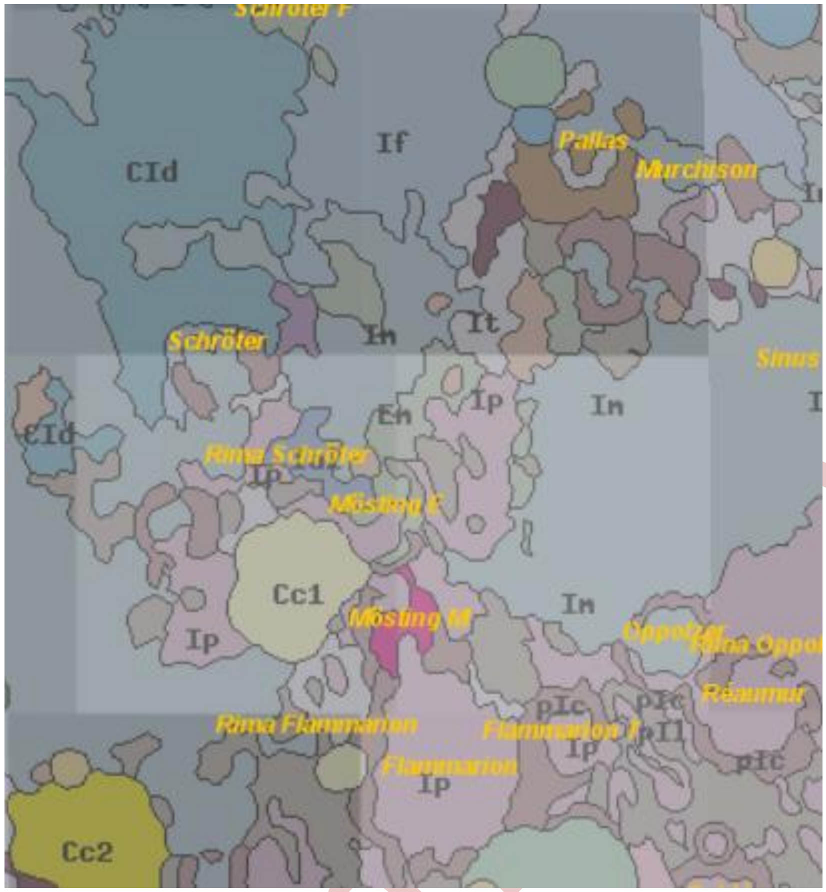


Figure 7.13: ILIADS Layer Opacity Close-Up View
(Geology All data set underneath Calcium data set)

7.8.5 Color Map

For those data sets that make use of a color map, the user may want to change the default settings. Follow these steps to change the color map for a loaded data set:

1.	Open the **Properties Window** if it's not already displayed**.**
2.	Click the layer name in the **Project Window**. The properties for the selected layer are listed in the **Properties Window.**
3.	Click the button on the far right next to the **Data Request** heading. The **Data Request** window opens listing the attributes for this data layer. These will vary based on the data set selected.
4.	Select the desired color map from the **Color Map** pulldown list.
5.	Supply values for **Color Map Min** and **Color Map Max.** The range should suit the data set being displayed. Click **OK** to save the new settings. The data layer will reload with the new settings.

7.9 A Note About Performance

ILIADS dynamically loads layers and performs calculations on the fly. It will do this on all layers that are available and enabled. If there are many layers loaded, this can make ILIADS sluggish when traversing the moon, as ILIADS needs to request new sections of data from the server and perform the calculations for any function layer.

To increase the speed of ILIADS, set the layer's corresponding "enabled" checkbox to "off". This will suppress data fetching and calculating until the layer is switched back to "on."

8 Views

8.1 Introduction
8.2 Create a View
8.3 Copy a View
8.4 Delete a View
8.5 Synchronize Views

8.1 Introduction

The ILIADS **View function** allows users to save a particular viewing perspective of the lunar surface. Section 2.1.6 describes how ILIADS' use of the term **view** is analogous to that of a camera view. Thus, users can save a given "camera" angle and zoom on the moon's surface as shown in the active **Scene window**, and can apply the view to one or more **scene** windows and/or data layers when desired.

This section describes how to create, copy, and delete views. It also explains how to apply a view to more than one **scene** window, facilitating comparisons of different analyses or data sets while looking at the same position.

8.2 Create a View

As an example, consider the **scene window** depicted in Figure 8.1:

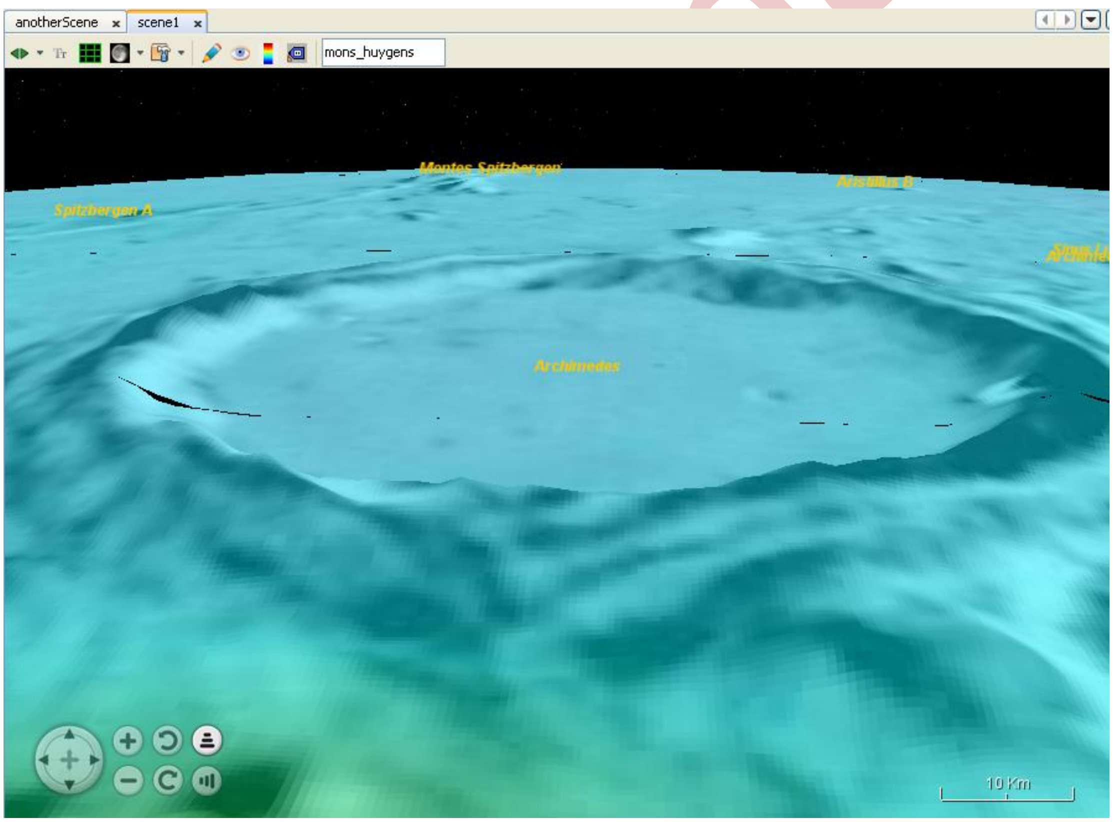


Figure 8.1: Zoom of Crater Archimedes

This scene contains a close up of the lunar crater Archimedes as depicted with the *Clementine Color Relief* data set. To save the current viewpoint in in this

scene window so that it may be quickly recalled at a later time, perform the following steps:

1. Make sure that the **scene window** containing the desired view is the active ILIADS scene window.
2. Select the down arrow on the **Views Button** in the **Visualization Toolbar** (see section 4.3) and select **Save View.**

   Note: Be sure to click the down error on this button. If you click the globe, the scene will navigate to the **Home** position.
3. The **New Location** window opens as shown in Figure 8.2. The window contains the **Latitude, Longitude, Range, Heading,** and **Tilt** that define the viewpoint in the active **Scene Window.**
4. Supply a name for this view in the **Name** field and click **Finish**. This name will subsequently be listed under the **Views** heading for the active scene in the **Project Window** and in the view pick-lists for the **Views Button** in the **Visualization Toolbar.**

   The user may also enter any additional descriptive information in the **Description** field. This information is optional.

   Note: At this point, this newly defined view is only available to the currently active scene. If you switch to another scene, this view will not be available.

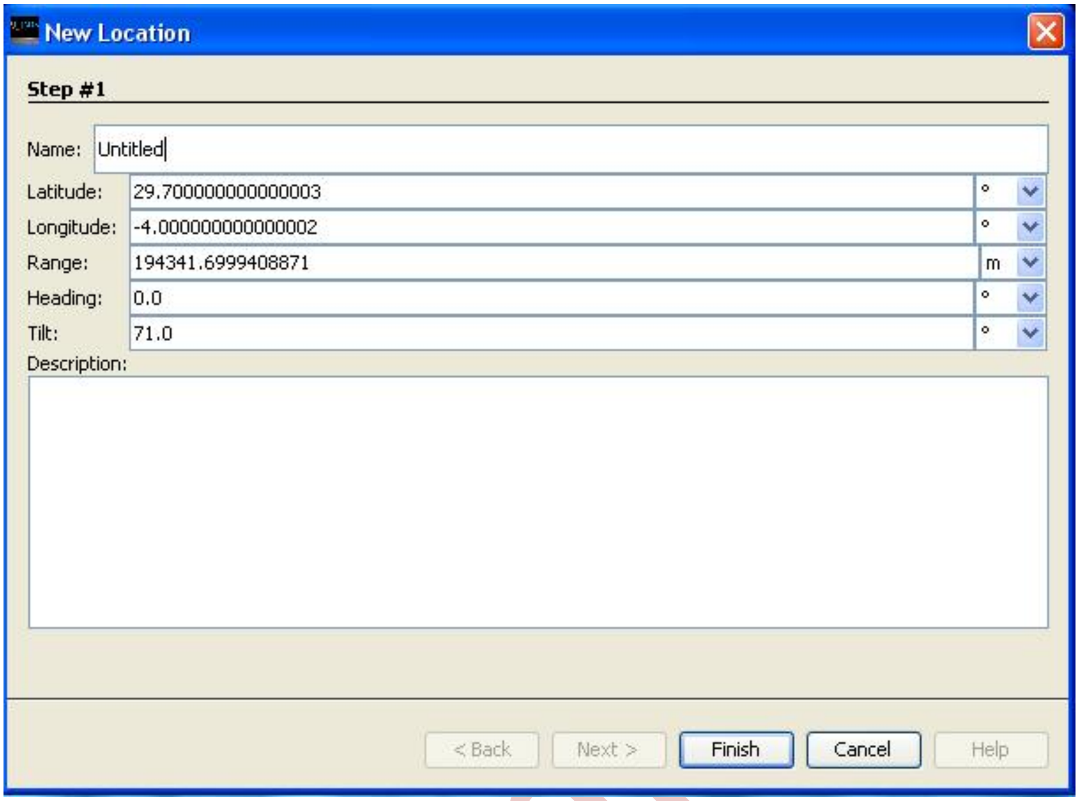


Figure 8.2: New Location Window

8.3 Copy a View

To copy a view to another scene hierarchy:

1. Select the name of the view in the **Project Window.** Right click on the scene name and select **Copy** from the pop-up menu.
2. Select the **Views folder** of **the** scene to contain the copied view. Right click and select **paste.** The **Views folder** now contains the copied view.

8.4 Delete a View

To delete a view, select the name in the **Project Window**, right click, and select the **delete** option.

8.5 Synchronize Views

ILIADS provides users with the ability to synchronize the view in all open scene windows. With the click of a button, the user can navigate to the same location in all open scene windows. This is very useful for making comparisons across different image or function layers at the same lunar location.

By default, the synchronize function sends all scene windows to the same latitude and longitude. The user also has the option of synchronizing across the following view parameters:

Heading	The direction (azimuth) of the virtual camera. The default =0 (true north.)
Range	The distance from the virtual camera to the focus point.
Tilt	Rotation, in degrees, of the camera around the *X* axis. A value of 0 indicates that the view is aimed straight down toward the moon (the most common case). A value for 90 for <tilt> indicates that the view is aimed toward the horizon. Values greater than 90 indicate that the view is pointed up into the sky. Values for <tilt> are clamped at +180 degrees.

To synchronize open views:

1. Enable synchronization on those open scene windows that you want to synchronize. Do this by clicking the **synch views button** on the **visualization toolbar.** The button background goes from grey to white when activated as shown in Figure 8.3
2. Indicate how the views should be synchronized. By default, they will all synch across latitude and longitude. To also synch the **Heading, Range,** and/or **Tilt,** perform this action *for each open scene window where synchronization has been activated:*

   Click the down arrow on the **synch views button** of the **visualization toolbar**. Select **Heading** and/or **Range** and/or **Tilt** to synch on these view parameters. A check mark is placed next to each attribute selection.
3. Click on the scene window that contains the **View** that you want to navigate to. Navigate to the desired location by selecting a **View** or by navigating in the scene window using other navigation methods. All open scene windows will travel to the same location.

   Note: The “active” scene window drives the location of all open scene windows.

 Synchronization ON	 Synchronization OFF

Figure 8.3: Synchronization Button

9 Data Analysis

9.1 Introduction

ILIADS offers a variety of extraplanetary information systems analyses or "XisAnalysis" that are commonly found in geographic information systems. These functions may be applied to any ILIADS *topography* data set. The following sections describe the functions available in ILIADS and provide instructions for applying these functions to an ILIADS topography data set.

9.2 Scripted Raster Input Function

This function will be fully implemented in a future ILIADS release.

9.3 Gradient North/South

Applying the **Gradient North/South** function allows the user to view the amount of change in elevation in a north/south direction.

Follow these steps to apply the **Gradient North/South** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Gradient North/South Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **XIS Analysis** from the **Sources** list and select **Gradient North/South** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the Select **Function (input) Window** and select the topography data set from the **Layers** list. Click **Next**.
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is Jet
    - **Color Map Min** – Default is 0
    - **Color Map Max** – Default is 30

    Click **Finish.** The function layer will load in the **Scene Window.**

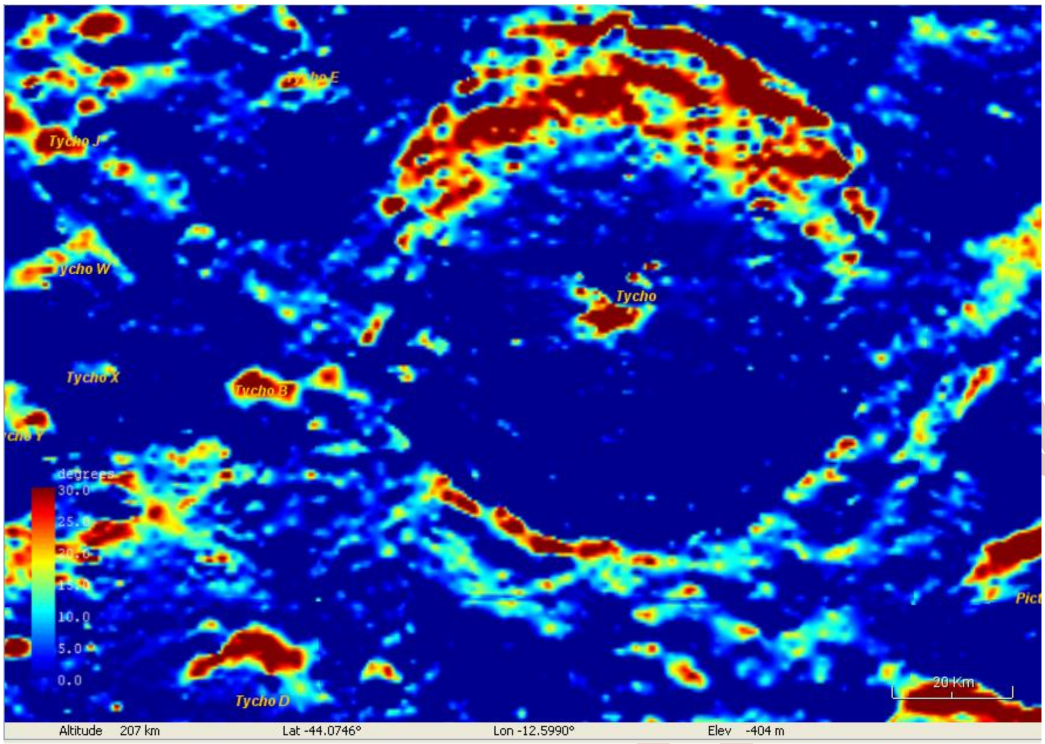


Figure 9.1: Gradient North/South Example

9.4 Gradient East/West

Applying the **Gradient East/West** functions allows the user to view the amount of change in elevation in a north/south direction.

Follow these steps to apply the **Gradient East/West** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Gradient East/West Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Gradient East/West** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –**
    - **Color Map Min**

- **Color Map Max**

Click **Finish.** The function layer will load in the **Scene Window.**

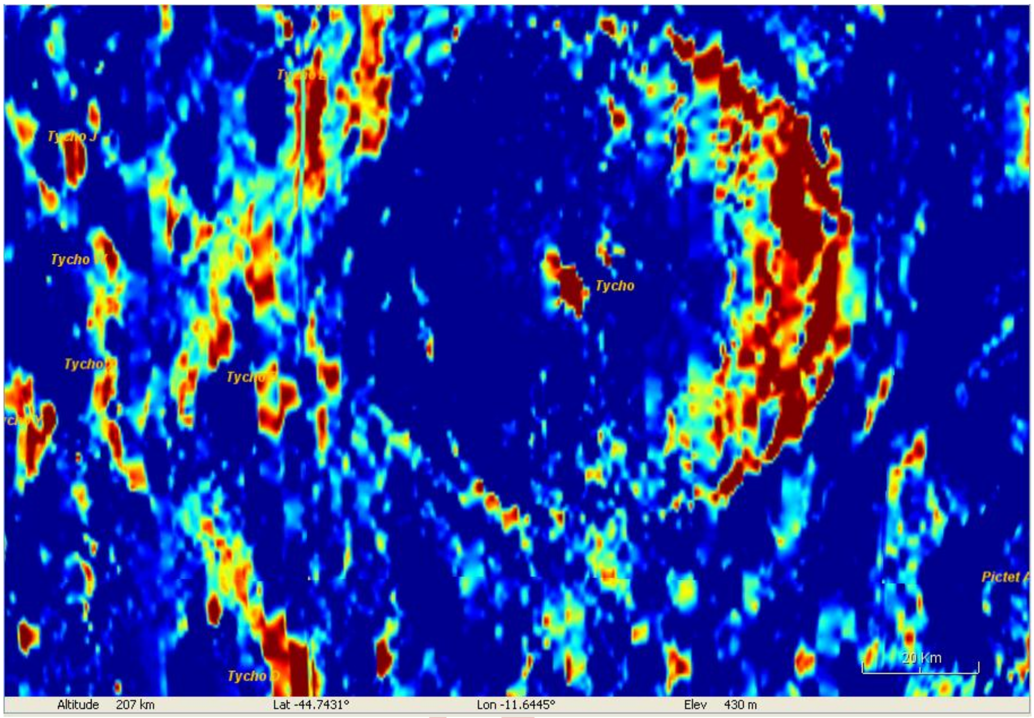


Figure 9.2: Gradient East/West Example

9.5 Slope Magnitude

Applying the **slope** function allows users to view the magnitude of the gradiency at different points along the moon's topography. Figure 9.5 provides an example of the resulting display after applying the **slope** function. The *Clementine Topography Polar Enhanced* data set was used as input. The view is zoomed in on the *Rozhdestvenskiy* crater of the moon's north pole. The function is displayed using the **Jet** colormap with **Color Map Min** and **Color Map Max** set to 0 and 30, respectively.

Follow these steps to apply the **Slope** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Slope Magnitude Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Slope**

Magnitude from the **Layers** list. Click the **Next** button.

3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window,** specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is 0
   - **Color Map Max** – Default is 30

   Click **Finish.** The function layer will load in the **Scene Window.**

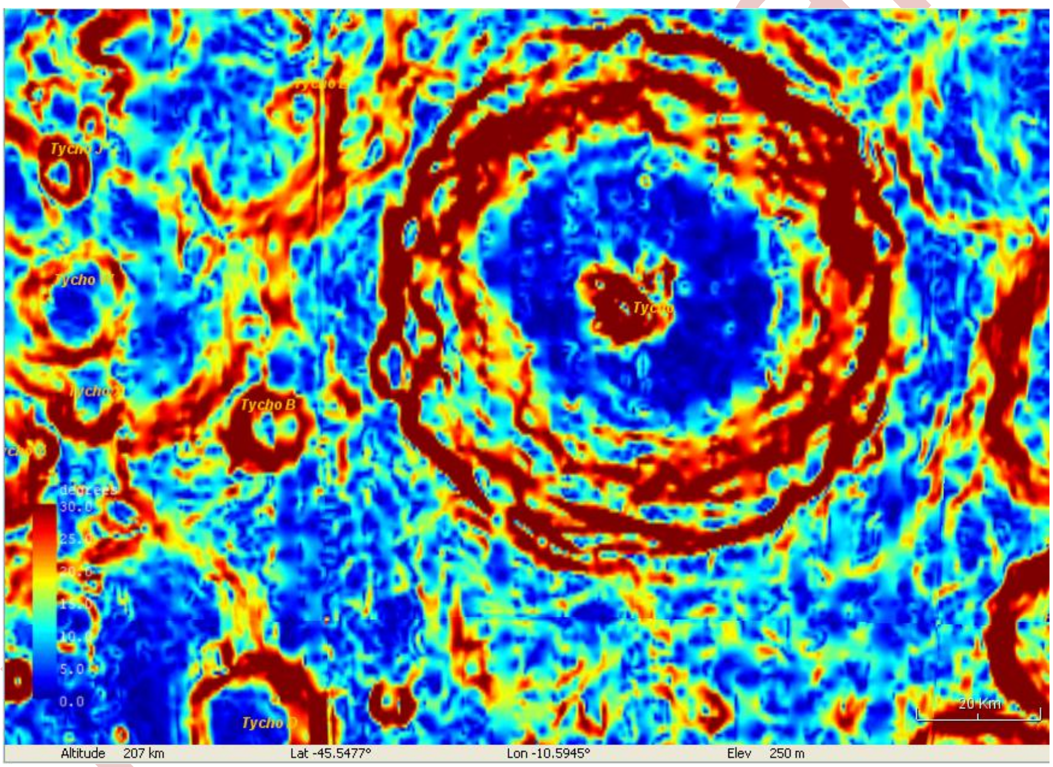


Figure 9.3: Slope Function Example

9.6 Aspect

Applying the **Aspect** function provides information about the direction of the topographical slopes on the moon. ILIADS uses the **Gradient North/South** and

Gradient East/West functions to calculate the aspect. The aspect is determined by taking the *atan2(gradN, gradE)* of each element of their results.

Figure 9.6 shows an example of the **Aspect** function applied after loading the *Clementine Topography Polar Enhanced* data set. The function is displayed using the **Jet** colormap.

Follow these steps to apply the **Aspect** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Aspect Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Aspect** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window,** specify values for the following parameters:

    - **Color Map –** Default is JET
    - **Color Map Min** - Default is 0
    - **Color Map Max** – Default is 360

Click **Finish.** The function layer will load in the **Scene Window.**

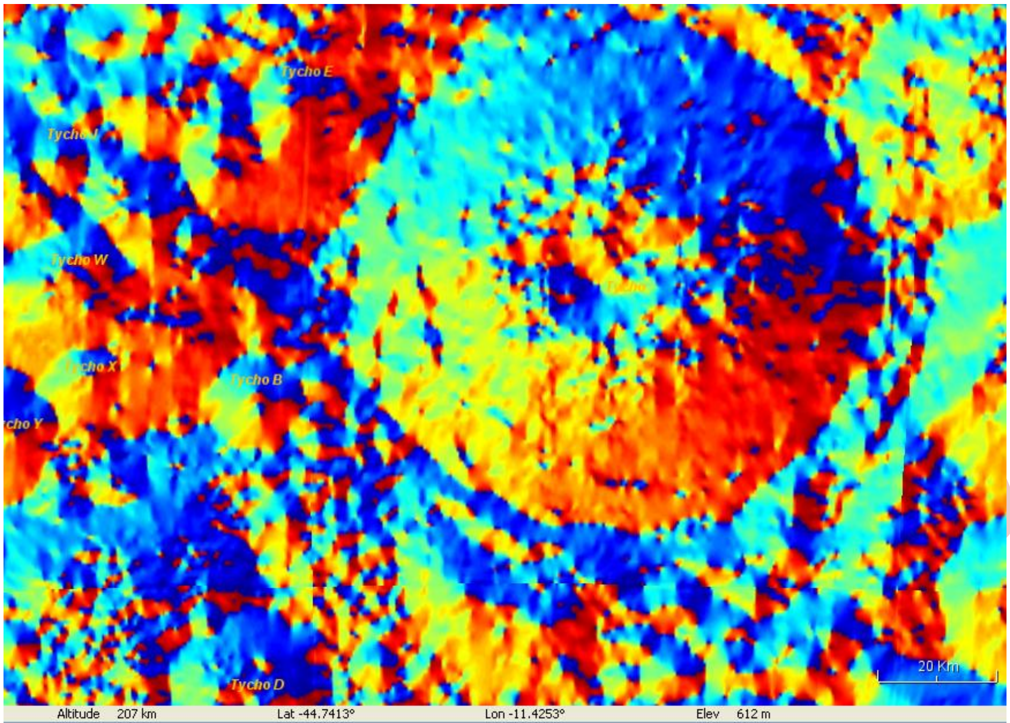


Figure 9.4: Aspect Function with Jet Color Map

9.7 Illumination, Shadows

Applying the **Illumination, Shadows** function calculates, for each point, the azimuth (i.e., the angle of cardinal direction of the sun) and the elevation (the angle of height) of the sun for a specified time. This information is used to determine if there is any surface on the lunar topography that is obscured from the sun. If the point is obscured, the value is set to zero. If the sun is visible from the point, the value is set to 1.

Follow these steps to apply the **Illumination, Shadows** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Illumination,Shadows Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Illumination, Shadows** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window,** specify values for the

following parameters:

- **Color Map –** Default is JET
- **Data Time Year** – Default is 2011
- **Data Time Month** – Default is 1
- **Data Time Day** – Default is 1
- **Data Time Hour** – Default is 0
- **Data Time Minute** – Default is 0
- **Data Time Second** – Default is 0.0
- **Color Map Min** – Default is 0.0
- **Color Map Max** – Default is 1.0

Click **Finish.** The function layer will load in the **Scene Window.**

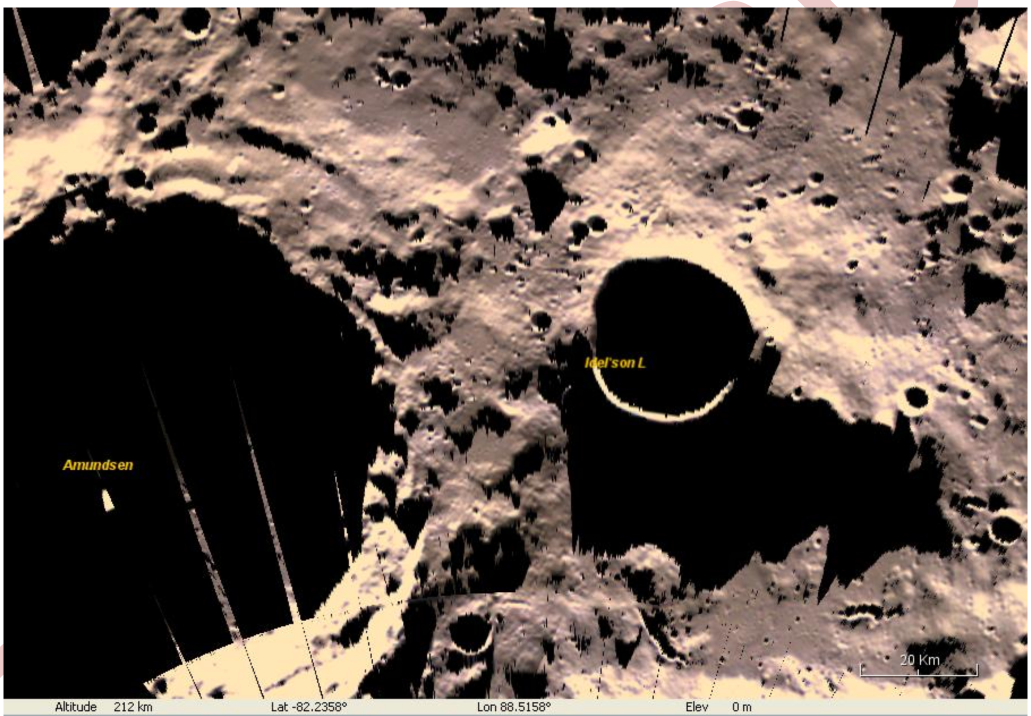


Figure 9.5: Illumination, Shadows Applied to the LRO LOLA Topography Data Set

9.8 Illumination Hillshade

Applying the **Illumination Hillshade** function obtains the hypothetical illumination of a surface by determining illumination values for each cell in a raster. It does this by setting a position for a hypothetical light source and calculating the illumination values of each cell in relation to neighboring cells. It can greatly enhance the visualization of a surface for analysis or graphical display, especially when using transparency.

The **Illumination Hillshade** calculation differs from the **Illumination Shadows** calculation (see section 6.6) in that it does not cast shadows.

Follow these steps to apply the **Illumination Hillshade** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Illumination Hillshade Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Illumination, Hillshade** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET
    - **Data Time Year** – Default is 2011
    - **Data Time Month** – Default is 1
    - **Data Time Day** – Default is 1
    - **Data Time Hour** – Default is 0
    - **Data Time Minute** – Default is 0
    - **Data Time Second** – Default is 0.0
    - **Color Map Min** – Default is 0.0
    - **Color Map Max** – Default is 1.0

    Click **Finish.** The function layer will load in the **Scene Window.**

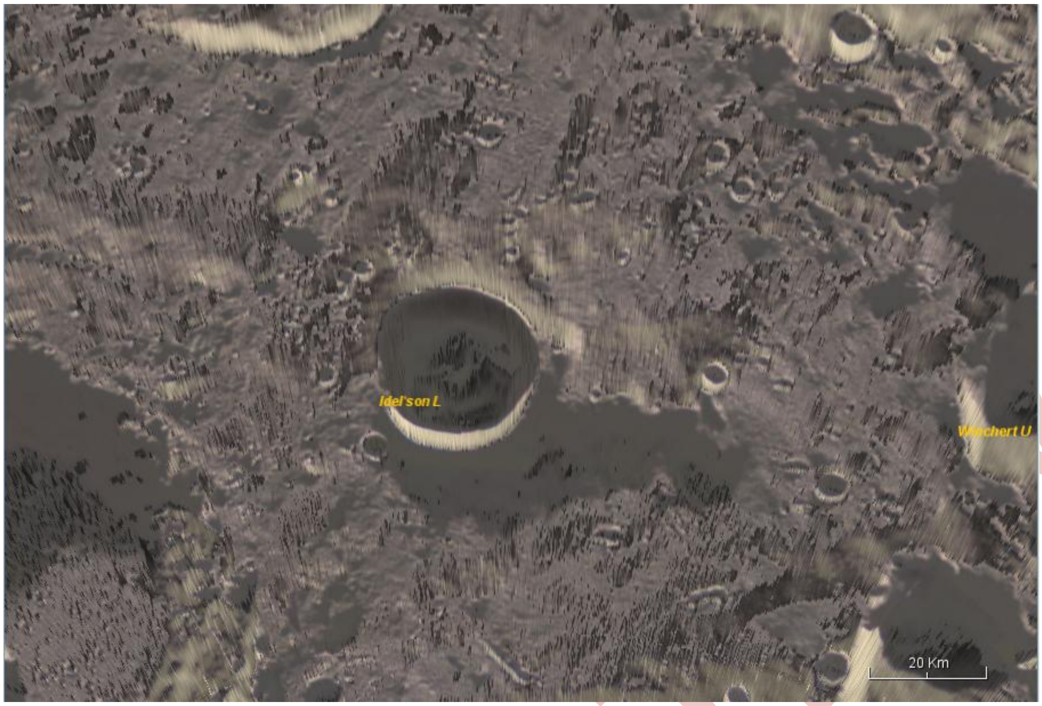


Figure 9.6: Illumination Hillshade Function Using the LRO LOLA Topography Data Set

9.9 Surface Roughness

The **Surface Roughness** function within the **XIS Analysis Library** calculates the surface roughness of the topography using an unsharp mask. The topography is smoothed using a weighted mean and the rough locations are then found by subtracting the smoothed surface from the original data. The weighted mean uses the great circle distance to ensure an even and accurate calculation across the projection.

Follow these steps to apply the **Surface Roughness** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Surface Roughness Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Surface Roughness** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the

following parameters:

- **Color Map –** Default is JET
- **Function Parameter A** - roughness parameter (in meters); Default is 5000
- **Color Map Min** – Default is 0
- **Color Map Max** – Default is 5000

Click **Finish.** The function layer will load in the **Scene Window.**

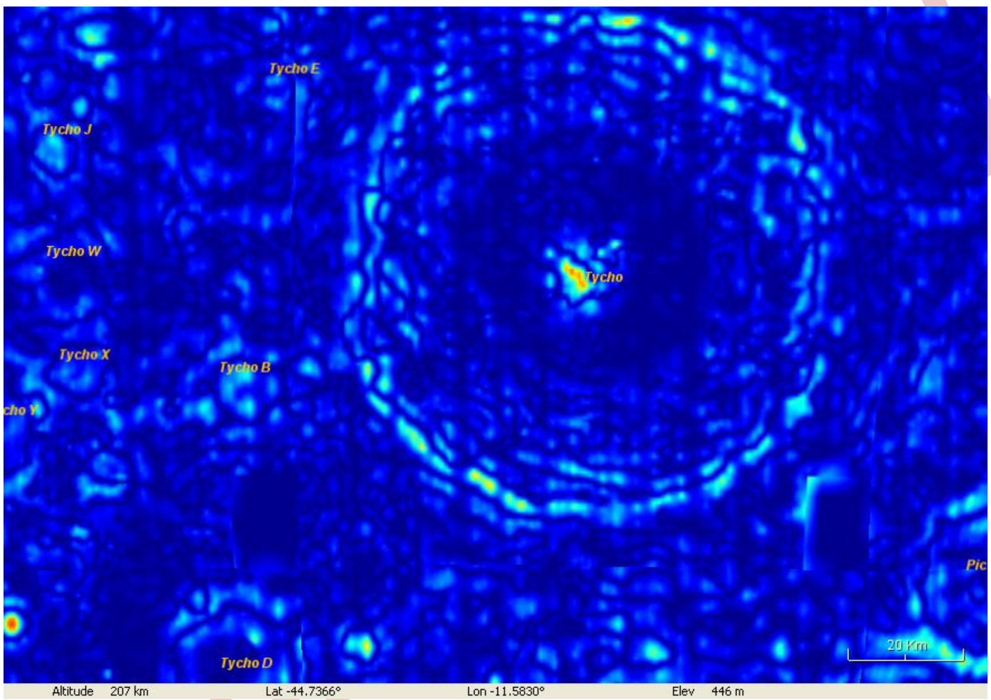


Figure 9.7: Surface Roughness Example

9.10 Solar Energy

Applying the **Solar Energy** function to an ILIADS topography data set calculates the number of watts a particular location gets in energy at a specified time. The value is largely dependent on the angle of the sun and how perpendicular the surface is to the sun. The algorithm is based upon the surface temperatures at the nearside of the Moon as a record of the radiation budget of the Earth's climate system.

Follow these steps to apply the **Solar Energy** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Solar Energy,** click **New** in the pop-up

menu, and select the **Function Layer** option from the pop-up menu.

2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Solar Energy** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –**
   - **Data Time Year**
   - **Data Time Month**
   - **Data Time Day**
   - **Data Time Hour**
   - **Data Time Minute**
   - **Data Time Second**
   - **Color Map Min**
   - **Color Map Max**

   Click **Finish.** The function layer will load in the **Scene Window.**

Figure 9.8: Solar Energy of Synthesized Topography (Jet Color Map)

9.11 Color Contour

The **Color Contour** function creates a color contour map of the lunar surface with a user-specified number of contours.

Follow these steps to apply the **Color Contour** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Color Contour Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Color Contour** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –**
    - **Function Parameter A –** number of contours
    - **Color Map Min**
    - **Color Map Max**

    Click **Finish.** The function layer will load in the **Scene Window.**

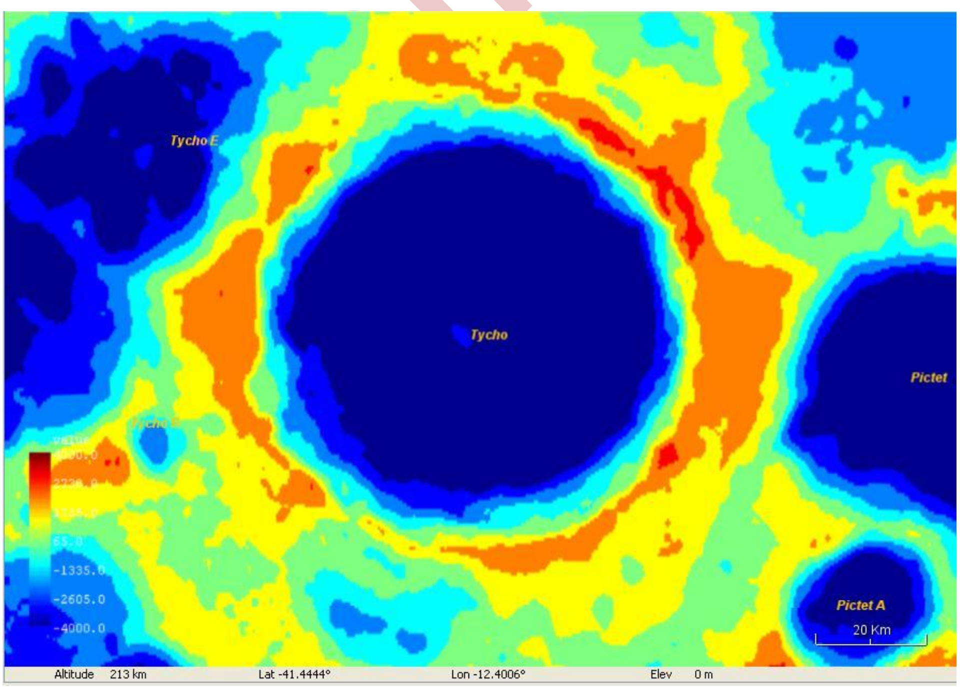


Figure 9.9: Color Contour Around Tycho

9.12 Line Contour

The **Line Contour** function creates a line contour map of the lunar surface.

Follow these steps to apply the **Line Contour** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Line Contour Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Line Contour** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –**
    - **Function Parameter A –** contour distance in meters
    - **Color Map Min**
    - **Color Map Max**

    Click **Finish.** The function layer will load in the **Scene Window.**

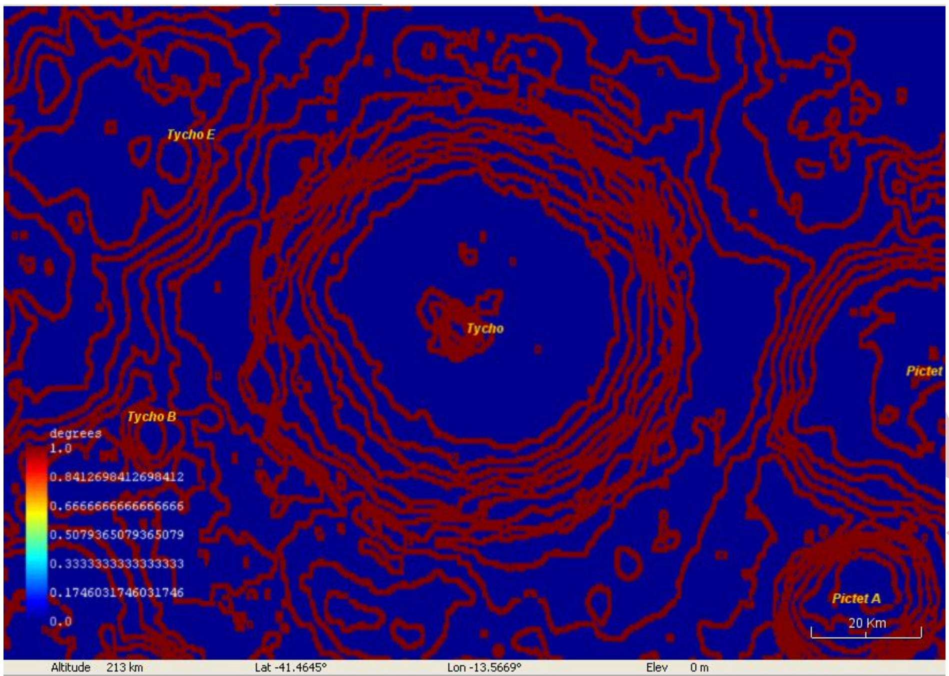


Figure 9.10: Line Contour around Tycho

9.13 Landing Sites

The **Landing Site** analysis uses the surface roughness calculation in combination with a “roughness cutoff” to create a binary image of areas that are considered too rough for landing versus those that are acceptable. The user specifies the size of the smooth area needed for landing (in meters), a corresponding “roughness cutoff” value, and a maximum slope.

Follow these steps to apply the **Landing Site** analysis function:

1. Right click on the scene name in the **Project window** in which to add the **Landing Site Function,** click **New** in the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **Landing Site** from the **Sources** list and select **Line Contour** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –**

- **Color Map Min**
- **Color Map Max**
- **Function Parameter A –** contour distance in meters
- **Function Parameter B –** roughness cutoff
- **Function Parameter C –** maximum slope

Click **Finish.** The function layer will load in the **Scene Window.**

Note: Currently, this analysis function is used primarily for demonstration.

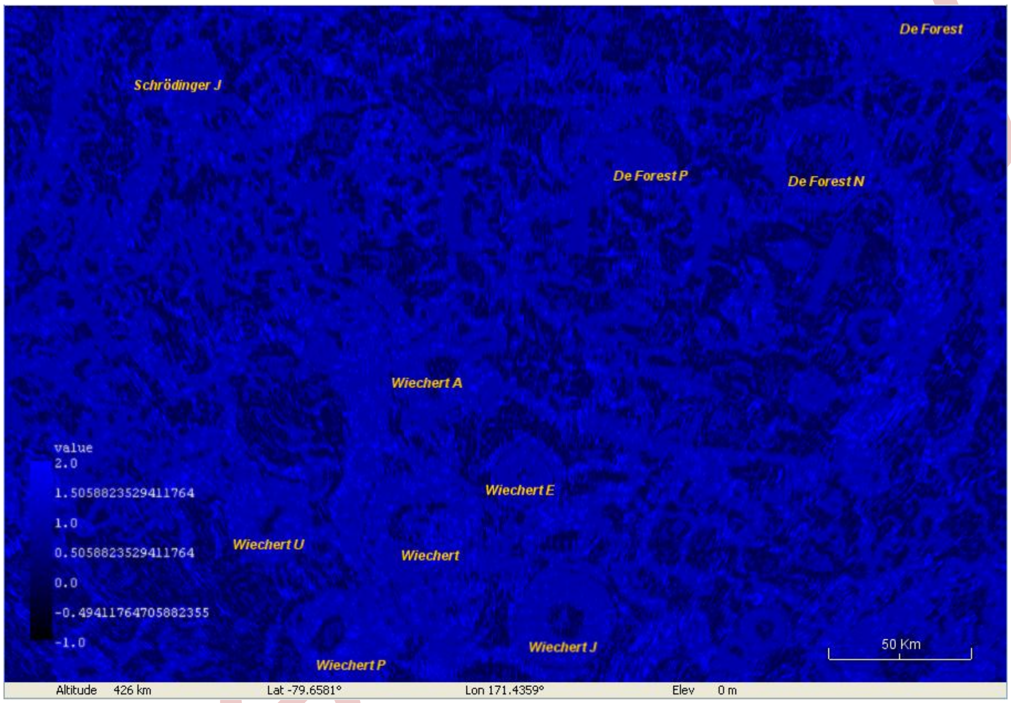


Figure 9.11: Landing Sites Example

9.14 Viewshed

In digital imaging, a viewshed is a binary raster indicating the visibility of a viewpoint for an area of interest. A pixel with a value of unity indicates that the viewpoint is visible from that pixel, while a value of zero indicates that the viewpoint is not visible from the pixel. As an example, this calculation may be used to determine what coverage a radio tower would have from a specified location.

Follow these steps to apply the **Viewshed** analysis function:

1. Right click on the scene in the **Project Window** in which to add the **Viewshed Function,** click New in the pop-up menu, and select the **Function Layer** option from the pop-up

menu.

2. In the **New Function Layer Window**, select **Viewshed** from the **Sources** list and select **Line Contour** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –**
   - **Function Parameter A –** latitude of viewshed point
   - **Function Parameter B –** longitude of viewshed point
   - **Color Map Min**
   - **Color Map Max**

   Click **Finish.** The function layer will load in the **Scene Window.**

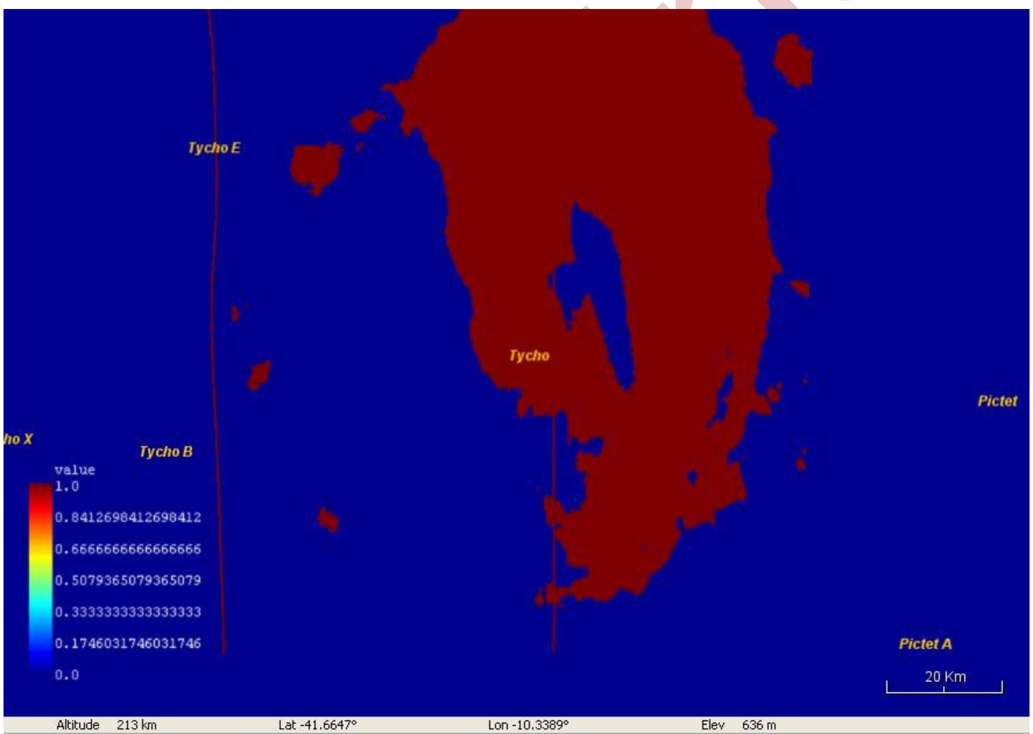


Figure 6.12: Viewshed Example

9.15 Shader

The **Shader** analysis function is based on an algorithm provided by the Applied Physics Laboratory (APL) to perform a lunar lighting analysis.

Follow these steps to apply the **Shader** analysis function:

1. Right click on the scene in which to add the **Shader** in the **Project Window**, click **New** from the pop-up menu ,and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select the **XIS Analysis** from the **Sources** list and select **Shader** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET
    - **Data Time Year** – Default is 2011
    - **Data Time Month** – Default is 1
    - **Data Time Day** – Default is 1
    - **Data Time Hour –** Default is 0
    - **Data Time Minute** – Default is 0
    - **Data Time Second** – Default is 0.0
    - **Color Map Min** – Default is 0.0
    - **Color Map Max** – Default is 1.0
    - **Function Parameter D –** shading type. The valid choices are:
        - **Photometric** – this is the default; calculates brightness of a location based on the angle of incidence from the sun
        - **Shadows** – calculates shadows cast by the sun
        - **Earthshine** – calculates brightness of a location based on the angle of incidence from the Earth
        - **Earthshineshadows** – calculates shadows cast by the Earth

    Click **Finish.** The function layer will load in the **Scene Window.**

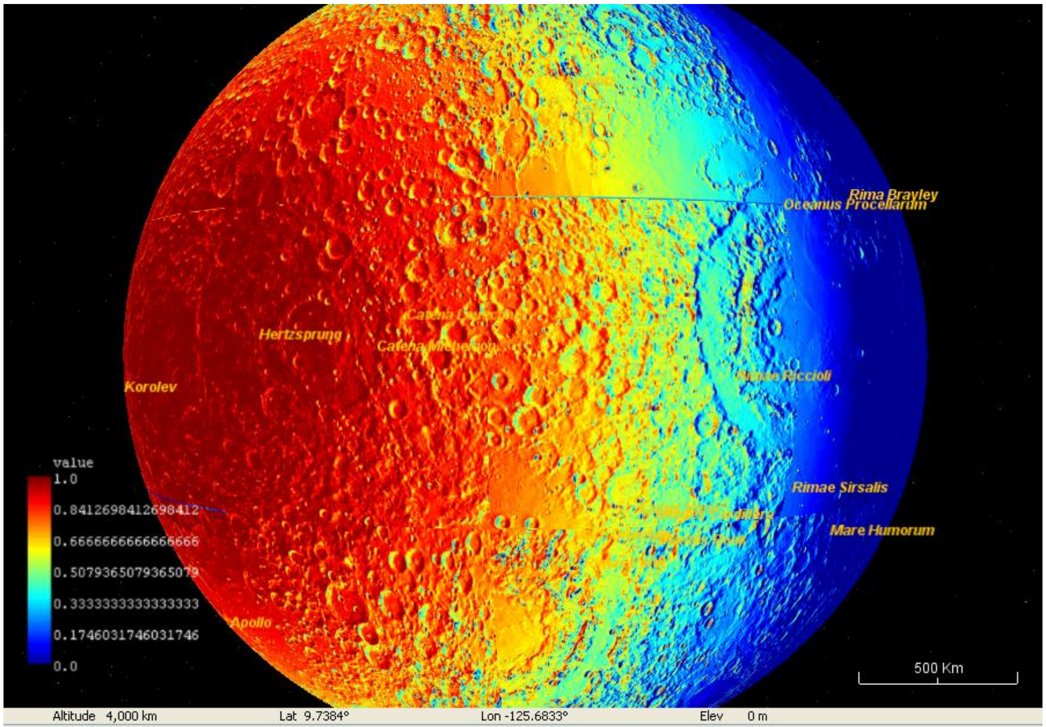


Figure 6.6: Shaded Relief Analysis of Synthesized Topography (Summer Color Map)

10 Image Processing Library

10.1 Introduction

ILIADS offers a variety of image processing algorithms that may be applied to a number of ILIADS data sets. Most of these functions deal with the filtering, morphology, or shape of the features within an image. These functions are applied to remove the imperfections within an image that are commonly introduced during segmentation.

10.2 Scripted Image Input Function

This function will be fully implemented in a future version of ILIADS.

10.3 Negative

Applying the negative function from the **Image Processing Library** calculates the "photographic negative" of the data currently displayed in the **Scene Window.** For example, if the current image is displayed in grayscale, true black becomes true white and vise versa, and any gradients in between are also reversed.

Follow these steps to apply the **Negative** image processing function:

1. Right click on the scene in the **Project Window** in which to apply the **Negative** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Negative** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET
    - **Color Map Min** – Default is -1.0
    - **Color Map Max** – Default is 1.0

    Click **Finish.** The function layer will load in the **Scene Window.**

10.4 Log Transformation

Logarithmic Transformations can be used to brighten the intensities of an image. More often, it is used to increase the detail (or contrast) of lower intensity values. The transformation uses the formula *constant*log(value)*.

Follow these steps to apply the **Log Transformation** image processing function:

1. Right click on the scene in the **Project Window** in which to apply the **Log Transformation** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Log Transformation** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET
    - **Color Map Min** – Default is 0.0
    - **Color Map Max** – Default is 1.0
    - **Function Parameter A** – Value for logarithmic transformation. The default is 0.6

    Click **Finish.** The function layer will load in the **Scene Window.**

10.5 Power Transformation

Selecting the **Power Transformation** option from the ILIADS **Image Processing Functions** applies a power transformation using the formula

*Constant * Value^gamma*

Follow these steps to apply the **Power Transformation** image processing function:

1. Right click on the scene in the **Project Window** in which to apply the **Power Transformation** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Power**

Transformation from the **Layers** list. Click the **Next** button.

3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is -0.0
   - **Color Map Max** – Default is 1.0
   - **Function Parameter A** – multiplication constant. The default is 1.0
   - **Function Parameter B** – Power constant. The default is 2.0

   Click **Finish.** The function layer will load in the **Scene Window.**

10.6 Median Filter

Median filtering is a common image processing function used to reduce random variations in brightness or color, often referred to as image "noise". The noise is removed by calculating the median value of adjacent values.

Follow these steps to apply the **Median Filter** image processing function:

1. Right click on the scene in the **Project Window** in which to apply the **Median Filter** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Median Filter** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is 0.0
   - **Color Map Max** – Default is 1.0
   - **Function Parameter A** – Mask size. The default is 5.0.

   Click **Finish.** The function layer will load in the **Scene**

Window.

10.7 Laplacian Filter

Applying the **Laplacian Filter** ILIADS image processing function detects edges and sharpens the image. The convolution kernel {-1,-1,-1;-1,9,-1;-1,-1,-1} is used to calculate the laplacian image.

Follow these steps to apply the **Laplacian Filter** image processing function:

1. Right click on the scene in the **Project Window** in which to apply the **Laplacian Filter** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Laplacian Filter** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET

    Click **Finish.** The function layer will load in the **Scene Window.**

10.8 Unsharp Mask

The **Unsharp Mask** function applies a Gaussian blur to a copy of the original image and compares this image to the original.

Follow these steps to apply the **Unsharp Mask** image processing function:

1. Right click on the scene in the **Project Window** in which to apply the **Unsharp Mask** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Unsharp Mask** from the **Sources** list and select **Log Transformation** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the

following parameters:

- **Color Map –** Default is JET
- **Color Map Min** – Default is 0.0
- **Color Map Max** – Default is 1.0
- **Function Parameter A** – size of the convolution mask. The default is 3.

Click **Finish.** The function layer will load in the **Scene Window.**

10.9 Dilation

Selecting the **Dilation** option from the ILIADS **Image Processing Library** performs the morphology operator dilation on a binary image. **Dilation** is one of the basic operations in mathematical morphology. The dilation operation is used to enlarge the boundaries of foreground (bright) regions in an image and to shrink background color holes in such regions. The operation uses a structuring element or "kernel" for probing and expanding the shapes contained in the input image.

Follow these steps to apply the **Dilation** image processing function. The default **dilation kernel** is 5, but users can change this in step 4 of the instructions.

1. Right click on the scene in the **Project Window** in which to apply the **Dilation** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Dilation** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is 0.0
   - **Color Map Max** – Default is 1.0
   - **Function Parameter A** – Half the sidelength of the structuring element. The default is 5.0

   Click **Finish.** The function layer will load in the **Scene Window.**

10.10 Erosion

Erosion is one of two fundamental operations (the other being **dilation**) in Morphological image processing. Erosion can be used to eliminate small clumps of undesirable pixels, *e.g.* "salt noise," quite effectively The basic effect of the operation on a binary image is to "erode" away the boundaries of regions of foreground pixels (*i.e.* white pixels, typically). Thus areas of foreground pixels shrink in size, and holes within those areas become larger.

The erosion operator uses a structuring element or "kernel" to calculate the precise effect of the erosion on the input image. Users can adjust the size of the kernel by changing the radius.

Follow these steps to apply the **Erosion** image processing function. The default value of the **erosion kernel's radius** is 5, but users can change this in step 4 of the instructions.

1. Right click on the scene in the **Project Window** in which to apply the **Erosion** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Erosion** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET
    - **Color Map Min** – Default is 0.0
    - **Color Map Max** – Default is 1.0
    - **Function Parameter A** – Half the sidelength of the structuring element. The default is 5.0.

    Click **Finish.** The function layer will load in the **Scene Window.**

10.11 Opening

The **Opening** operation is another technique used to smooth an image's edges. The **Opening** image processing function applies an **erosion** operation followed by a **dilation** operation using the same size structuring element or "kernel" for both operations.

Follow these steps to apply the **Opening** image processing function. The default value of the **opening kernel's radius** is 5, but users can change this by executing step 5 of the instructions.

1. Right click on the scene in the **Project Window** in which to apply the **Opening** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Opening** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET
    - **Color Map Min** – Default is 0.0
    - **Color Map Max** – Default is 1.0
    - **Function Parameter A** – Half the sidelength of the structuring element. The default is 5.0.

    Click **Finish.** The function layer will load in the **Scene Window.**

10.12 Closing

The ILIADS **Closing** operation is similar to the **dilation** operation in that it tends to enlarge the boundaries of foreground (bright) regions in an image and shrink background color holes and concave areas in such regions, but it is less destructive of the original boundary shape. The **closing** image processing function applies a **dilation** operation followed by an **erosion** operation using the same size structuring element or "kernel" for both operations. The effect of the operation is to preserve background regions that have a similar shape to the kernel, or that can completely contain the kernel, while eliminating all other regions of background pixels.

Follow these steps to apply the **Closing** image processing function. The default value of the **closing kernel's radius** is 5, but users can change this by executing step 5 of the instructions.

1. Right click on the scene in the **Project Window** in which to apply the **Closing** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.

2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Closing** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is 0.0
   - **Color Map Max** – Default is 1.0
   - **Function Parameter A** – Half the sidelength of the structuring element. The default is 5.0.

   Click **Finish.** The function layer will load in the **Scene Window.**

10.13 Boundary Extraction

The **Boundary Extraction** image processing function within uses the **erosion** method to locate boundaries or outlines within an image.

Follow these steps to apply the **Boundary Extraction** image processing function.

1. Right click on the scene in the **Project Window** in which to apply the **Boundary Extraction** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Boundary Extraction** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is 0.0
   - **Color Map Max** – Default is 1.0

   Click **Finish.** The function layer will load in the **Scene Window.**

10.14 Region Filling

Region Filling is an image processing function used to effectively fill the "holes" in an image. The user supplies the input point of the region, and the function uses the **negative** method to fill the surrounding region.

Follow these steps to apply the **Region Filling** image processing function.

1. Right click on the scene in the **Project Window** in which to apply the **Region Filling** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Region Filling** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET
    - **Color Map Min** – Default is 0.0
    - **Color Map Max** – Default is 1.0
    - **Function Parameter A** – Row of Input point. The default is 50.
    - **Function Parameter B** – Column of Input point. The default is 50.

    Click **Finish.** The function layer will load in the **Scene Window.**

10.15 Extract Connected Components

Once region boundaries within an image have been detected, it is often useful to extract those regions that are not separated by a boundary. Any set of pixels that is not separated by a boundary is call connected. Each maximal region of connected pixels is called a connected component. Connected components labeling scans an image and groups its pixels into components based on pixel connectivity, *i.e.* all pixels in a connected component share similar pixel intensity values and are in some way connected with each other. Once all groups have been determined, each pixel is labeled with a graylevel or a color (color labeling) according to the component it was assigned to.

The ILIADS **Extract Connected Components** image processing function uses a series of **dilations** to find the connected components. The user specifies a point location, and the pixels surrounding this location are used to determine the connected components. Follow these steps to apply the **Extract Connected Components** image processing function.

1. Right click on the scene in the **Project Window** in which to apply the **Extract Connected Components** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Extract Connected Components** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET
    - **Color Map Min** – Default is 0.0
    - **Color Map Max** – Default is 1.0
    - **Function Parameter A** – Row of Input point. The default is 50.
    - **Function Parameter B** – Column of Input point. The default is 50.

    Click **Finish.** The function layer will load in the **Scene Window.**

10.16 Binary Extract Connected Components

The **Binary Extract Connected Components** function is similar to the **Extract Connected Components** function (see section 7.14) except that it is applied to a binary image.

The ILIADS **Binary Extract Connected Components** image processing function uses a series of **dilations** to find the connected components. The user specifies a point location, and the pixels surrounding this location are used to determine the connected components. Follow these steps to apply the **Binary Extract Connected Components** image processing function.

1. Right click on the scene in the **Project Window** in which to apply the **Binary Extract Connected Components** image processing function, click **New** from the pop-up menu, and

select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Binary Extract Connected Components** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is 0.0
   - **Color Map Max** – Default is 1.0
   - **Function Parameter A** – Row of Input point. The default is 50.
   - **Function Parameter B** – Column of Input point. The default is 50.

   Click **Finish.** The function layer will load in the **Scene Window.**

10.17 Binary Region Filling

The **Binary Region Filling** function is similar to the **Region Filling** function (see section 10.13) except that it is applied to a binary image. The user supplies the input point of the region, and the function uses the **negative** method to fill the surrounding region.

Follow these steps to apply the **Binary Region Filling** image processing function.

1. Right click on the scene in the **Project Window** in which to apply the **Binary Region Filling** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Binary Region Filling** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET

- **Color Map Min** – Default is 0.0
- **Color Map Max** – Default is 1.0
- **Function Parameter A** – Start Row of Input point. The default is 50.
- **Function Parameter B** – Start Column of Input point. The default is 50.

Click **Finish.** The function layer will load in the **Scene Window.**

10.18 Point Detection

Follow these steps to apply the **Point Detection** image processing function.

1. Right click on the scene in the **Project Window** in which to apply the **Point Detection** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Point Detection** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is 0.0
   - **Color Map Max** – Default is 1.0

   Click **Finish.** The function layer will load in the **Scene Window.**

10.19 Colorize

Follow these steps to apply the **Colorize** image processing function. Colorize takes a gray scale image and applies the selected colormap to it.

1. Right click on the scene in the **Project Window** in which to apply the **Colorize** image processing function and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Colorize** from the **Layers** list. Click the **Next** button.

3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is 0.0
   - **Color Map Max** – Default is 1.0

   Click **Finish.** The function layer will load in the **Scene Window.**

10.20 Edge Detection

Images may sometimes contain sharp changes in or discontinuities in brightness which may likely to correspond to discontinuities in depth, surface orientation, changes in material properties and/or variations in scene illumination.

In the ideal case, the result of applying an **Edge Detection** operation to an image may lead to a set of connected curves that indicate the boundaries of objects, the boundaries of surface markings, and curves that correspond to discontinuities in surface orientation. ILIADS supports three methods of edge detection:

1. Sobel – a 3x3 gradient edge detector
2. Prewitt -
3. Roberts – a 2x2 gradient edge detector

Follow these steps to apply the **Edge Detection** image processing function.

1. Right click on the scene in the **Project Window** in which to apply the **Edge Detection** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Edge Detection** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

- **Color Map –** Default is JET
- **Color Map Min** – Default is 0.0
- **Color Map Max** – Default is 1.0

Click **Finish.** The function layer will load in the **Scene Window.**

10.21 Directional Line Detection

Direction Line Detection is similar to edge detection, but instead of finding all sharp lines and edges in an image, it finds only those running in the selected direction. Follow these steps to apply the **Directional Line Detection** image processing function.

1. Right click on the scene in the **Project Window** in which to apply the **Directional Line Detection** image processing function, click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Image Processing** from the **Sources** list and select **Directional Line Detection** from the **Layers** list. Click the **Next** button.
3. Select a topography data source from the **Sources** list in the **Select Function (input) Window** and select the topography data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

   - **Color Map –** Default is JET
   - **Color Map Min** – Default is 0.0
   - **Color Map Max** – Default is 1.0
   - **Function Parameter A** – Direction for Detection:
     - 0 = horizontal
     - 1 = vertical
     - 2 = +45° (this is the default)
     - 3 = - 45°
   - Click **Finish.** The function layer will load in the **Scene Window.**

11 ILIADS Math Tools

11.1 Introduction

For this release of ILIADS, a subset of the math functions may be applied to an ILIADS image layer as indicated in the following subsections. In future releases, these functions will be available for scripting.

To apply any math function, follow these steps:

1. Right click on the scene in the **Project Window** in which to apply an ILIADS Math function , click **New** from the pop-up menu, and select the **Function Layer** option from the pop-up menu.
2. In the **New Function Layer Window**, select **Math** from the **Sources** list and select the desired math function (e.g., **Absolute Value, Arccosine, Arcsine,** etc.) from the **Layers** list. Click the **Next** button.
3. Select a data source from the **Sources** list in the **Select Function (input) Window** and select the data set from the **Layers** list. Click **Next.**
4. In the **Set Attributes Window**, specify values for the following parameters:

    - **Color Map –** Default is JET

    Click **Finish.** The function layer will load in the **Scene Window.**

11.2 Absolute Value

This function calculates the absolute value of each point in the selected data set and plots the result.

11.3 Arccosine

This function calculates the arccosine value of each point in the selected data set and plots the result.

11.4 Arcsine

This function calculates the arcsine value of each point in the selected data set and plots the result.

11.5 Arctangent

This function calculates the arctangent value of each point in the selected data set and plots the result.

11.6 Addition

TBD

11.7 Copy Data

TBD

11.8 Cosine

This function calculates the cosine value of each point in the selected data set and plots the result.

11.9 Division

TBD

11.10 Equals

TBD

11.11 Floor

The floor function maps a real number to the largest previous integer. Thus, *floor(x)* is the largest integer not greater than x. This function calculates the floor value of each point in the selected data set and plots the result.

11.12 GreaterThan

TBD

11.13 LessThanEqual

TBD

11.14 LessThan

TBD

11.15 Multiplication

TBD

11.16 Power

TBD

11.17 Round

TBD

11.18 Sine

This function calculates the sine value of each point in the selected data set and plots the result.

11.19 Subtraction

TBD

11.20 Tangent

This function calculates the tangent value of each point in the selected data set and plots the result.

12 Additional Features

12.1 Introduction

This section describes several additional functions available in the ILIADS system.

12.2 Template Manager

TBD

12.3 Plugins

The ability to create and install new ILIADS plugins will be available in a future release.

12.4 Slideshow Tool

12.5 Capture Screenshot Tool

ILIADS allows the user to capture a screenshot of the active **Scene Window.** The user may save the captured image in one of a number of image file formats, including *bmp, gif, tiff,* and *jpeg*. Follow these steps to capture and store an image of an ILIADS **Scene** Window:

1. The **Scene Window** containing the image of interest should be the active window.
2. Click the **Tools** button in the **Visualization Toolbar** and select the **capture screenshot** menu item
3. The **Save Screenshot As…** window opens as shown in Figure 12.1
4. Navigate to the location where the image file should be stored. Supply a **name** for the file in the **File Name** field. Select the image file format (the default is **tiff.)** Click **Save** to save the file in the specified location.

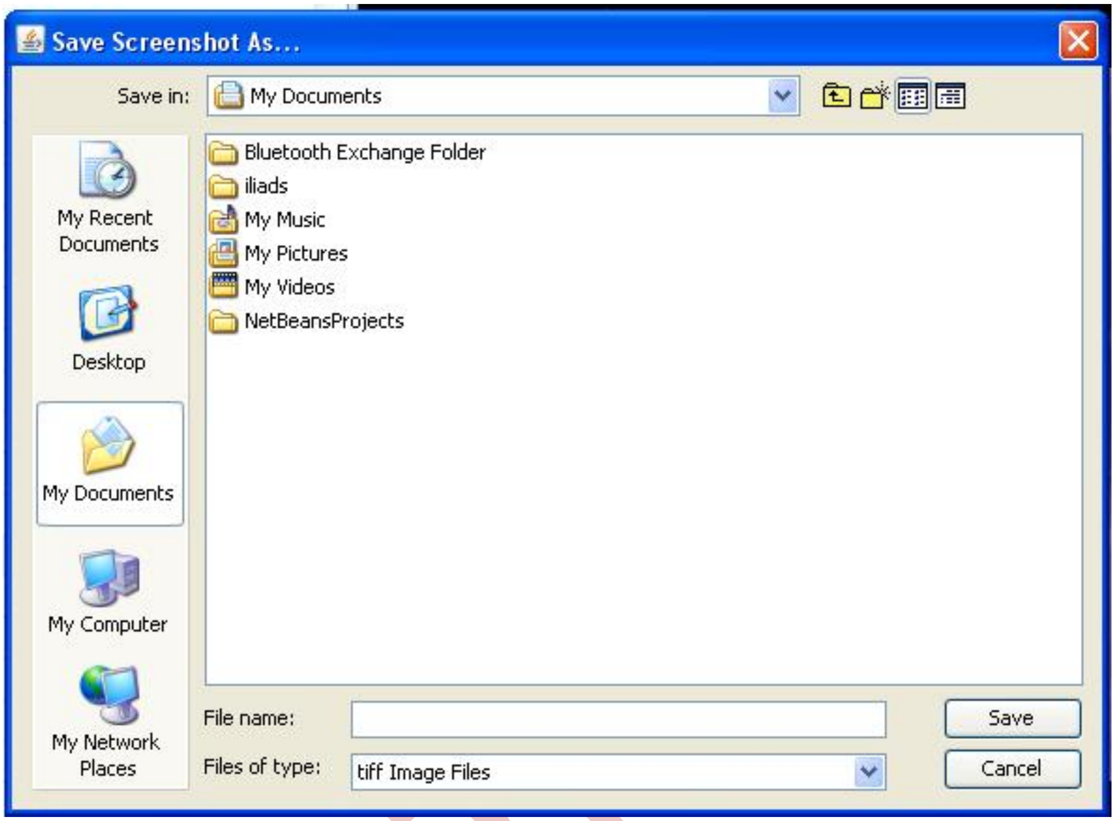


Figure 12.1: Save Screenshot Window

Appendix A: Acronyns

The following table contains the acronyms used throughout this document.

Acronym	Definition
GIS	Geographic Information System
GSFC	Goddard Space Flight Center
ILIADS	Integrated Lunar Information Architecture for Decision Support
JRE	Java Runtime Environment
LEAP	Lunar Exploration Analysis Portal
NASA	National Aeronautics and Space Administration
ODE	Orbital Data Explorer
PDS	Planetary Data System
PIGWAD	Planetary Interactive G.I.S. on-the-Web Analyzable Database
RAM	Random access memory
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
XGIS	EXploration Geographical Information System