GEOGRAPHIC IMAGER®

for Adobe® Photoshop®

Avenza® SYSTEMS INC.

User Guide

Avenza Geographic Imager User Guide

Geographic Imager® for Adobe® Photoshop® User Guide for Windows® and Macintosh®.

We would like to thank Blue Marble Geographics for contributing technical documentation which has been used in the appendices of this manual. Please see the Acknowledgements (page B/1) for contact information.

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Welcome

Welcome to Geographic Imager, the newest addition to the Avenza suite of mapping plug-ins for the desktop graphics environment.

Combined with Adobe Photoshop, Geographic Imager revolutionizes the way spatial imagery is created, edited and maintained by allowing spatial image files to be created, edited and managed in the familiar and widely-used Adobe Photoshop environment. Geographic Imager allows the most common spatial imaging tasks to be performed where they should be done, in a powerful raster editing environment, and adds the dozens of powerful Adobe Photoshop tools and operations to those that one can perform on such imagery.

Geographic Imager is comprised of a series of geospatial tools for Adobe Photoshop that will continually improve on each previous version by adding additional file support, tools and improvements to existing tools. Geographic Imager is also the perfect companion suite for MAPublisher and Adobe Illustrator users.

This manual assumes that the user is familiar with Adobe Photoshop and has at least a basic understanding of geographic information systems (GIS) terminology and concepts. Please refer to your Adobe Photoshop user guide for more information on using Adobe Photoshop. A glossary of GIS terms is included at the back of this manual for your reference.

By following this manual you will learn how to work with spatial imagery using the Geographic Imager functions in Adobe Photoshop. This manual covers the concepts necessary to open, edit, transform, mosaic, tile and GeoCrop geographic images. A variety of sample imagery has been provided on your Geographic Imager CD or with your Geographic Imager download for use with this guide and the tutorials (*see Tutorial Guide*). However we do encourage you to experiment with your own data to gain additional experience with Geographic Imager's tools and functions.

Together Geographic Imager and Adobe Photoshop will give you a totally integrated spatial image software system with graphics tools and geographic functions present in the same work environment.

So join first class mapping organizations from around the world and experience modern day imaging by reading this user guide, going through the tutorials and experimenting with Geographic Imager.

Contents

What Is Geographic Imager?

Geographic Imager is a powerful suite of tools and functions for Adobe Photoshop that enables spatial imagery to be opened, edited, transformed and saved while retaining all the spatial properties of the image. While most spatial imagery is of a format that Adobe Photoshop can natively open and edit, without the presence of Geographic Imager all geospatial properties of such images will be lost upon re-saving or exporting the image.

In addition to ensuring a safe and trouble-free editing environment for your geospatial photographs and scans, Geographic Imager offers specialized tools for performing certain spatial operations on the image beyond the standard image editing functions native to Adobe Photoshop.

The following is a brief outline of the functions and tools included in this version of Geographic Imager.

GeoTransform Technology
Avenza has partnered with Blue Marble Geographics **(www.bluemarblegeo.com)** to introduce Blue Marble's core GeoTransform technology into Adobe Photoshop via Geographic Imager. GeoTransform, which forms the basis for Blue Marble's Geographic Transformer product, embeds sophisticated image reprojection engine into Geographic Imager and is the underlying technology behind Blue Marble's popular Geographic Transformer stand-alone imaging product. GeoTransform creates an image map from a source image, georeferencing information, and destination image parameters, and allows for the performance of various spatial transformations on geographic imagery.

Georeferencing in Adobe Photoshop
Geographic Imager adds a world coordinate grid to the page and pixel grid systems native to Adobe Photoshop. It allows for the creation and maintenance of this image-to-world relationship throughout Adobe Photoshop operations so that once the image is re-saved or exported the correct georeferencing is preserved. Specifically, Geographic Imager provides smart support for most image level operations, such as crop and resize, and tracks the changes to the image geometry, updating the reference information accordingly. Most of Adobe Photoshop functions are supported. *See page 9 for the list of exceptions.*

Opening/Saving Spatial Imagery
Upon the opening of a geographic image, Geographic Imager automatically recognizes GeoTIFFs and also attempts to locate other matching reference files for the image, and populates the Geographic Imager information panel accordingly. When saving a geographic image using the native Adobe Photoshop *File > Save* or *File > Save As* commands, Geographic Imager automatically creates a corresponding reference file or the GeoTIFF header information. All Adobe Photoshop image export formats are supported by Geographic Imager including the native Adobe Photoshop .psd format and the Adobe Acrobat .pdf format. All formats other than GeoTIFF will be referenced using an external reference file such as a world file.

Transforming
Geographic Imager includes extensive support for thousands of geodetic and projected coordinate systems that allow spatial imagery to be projected and transformed in Adobe Photoshop. Support for customized projections as well as the ability to save custom definitions for later use is also included.

Mosaicking
Geographic Imager allows Adobe Photoshop to automatically combine multiple geographic images to create image mosaics while retaining the georeferencing properties in the new larger image. Create a seamless resultant image from individual image files provided that certain conditions are met.

Georeferencing with GCPs
Geographic Imager allows the referencing of non referenced images using known ground control points and the transformation of such images to fit the GCP's with minimal errors. Multiple referencing types are supported including affine and polynomial. Ground control point data can also be saved as a reference file for later use.

Tiling
Geographic Imager allows Adobe Photoshop to automatically divide spatial imagery into multiple smaller spatial images while retaining the georeferencing properties in each smaller image. Multiple options are available for determining how the tiled images will be created.

GeoCrop
Geographic Imager offers the ability to crop georeferenced images according to spatial coordinates. Options to crop the image by the pixel value, geodetic coordinate, and projected coordinate are available when using the GeoCrop tool.

Automate Tools
Geographic Imager offers the ability automate repetitive tasks using actions and scripts. Geographic Imager will specify a reference file or coordinate system and perform a transformation allowing options to specify a destination coordinate system, pixel size and resampling method using actions and scripts.

Floating Licensing
Geographic Imager offers a floating license option which enables licenses to be shared across a network by multiple users. In such a scenario the Geographic Imager client software can be installed on an unlimited number of computers while concurrent use is limited by the number of floating licenses purchased. This tri-platform solution offers support for Windows, Mac and Linux servers alike and includes the ability to check-out a license for remote use on a laptop computer as well as Internet-enable access for remote users. Floating licenses are a wonderful cost-effective way of sharing software amongst multiple users in a network environment.

Security
Geographic Imager incorporates a licensing system that is designed to deter unauthorized copying and installation of the software. Activation protects the intellectual property and innovation at the heart of the software industry and in particular that of Geographic Imager. Avenza is committed to eliminating unauthorized use of its software and is doing so in a manner designed to have a minimal effect on licensed users. Activation maintains customer privacy and does not change the terms of the existing Product License Agreement. Please refer to page 14 for more information on licensing procedures in Geographic Imager.

Getting Started

Before using Geographic Imager please read this section thoroughly to ensure that you have a suitable hardware environment, become familiar with the installation procedure, and adequately prepare your system and workspace to work with spatial imagery within Adobe Photoshop and Geographic Imager.

In particular, please pay careful attention to the section entitled *Compatibility with Adobe Photoshop*.

Topics covered in this section:
System Requirements
Installation Instructions
Activation and Licensing
The Geographic Imager Tools
Compatibility with Adobe Photoshop
Compatibility with MAPublisher and Other Applications
Colour Modes

System Requirements

Before installing Geographic Imager, please ensure that you have sufficient system resources, as outlined below:

Windows

- Adobe Photoshop* CS3 or CS4
- Intel Pentium 4 processor or later, or equivalent (Dual core or equivalent recommended)
- Windows XP or Vista
- 1 GB of RAM (4 GB recommended)
- 300 MB of available hard-disk space
- CD-ROM drive

Mac OS

- Adobe Photoshop* CS3 or CS4
- PowerPC G5 or above (Intel recommended)
- Mac OS X 10.4.x or higher
- 1 GB of RAM (4 GB recommended)
- 300 MB of available hard-disk space
- CD-ROM drive

* Not all foreign language versions of Adobe Photoshop may be supported. Please contact support@avenza.com for more information.

Installation Instructions

Windows

1. Make sure that a compatible version of Adobe Photoshop is installed on your computer. If Adobe Photoshop is running, exit the program.
2. Ensure that you have administrative privileges for the installation process. If you are unsure whether you have the proper privileges, please consult with your IT department.

   CD version: Insert the Geographic Imager CD into your CD-ROM drive. If Autorun is disabled on your system, navigate to the *Geographic Imager for Windows* directory on the CD, and double-click **setup.exe**.

   Electronic version: Double-click *GI21win.zip* and extract the contents. When you have unzipped the files proceed to the *Geographic Imager* directory and double-click **setup.exe**.

3. Proceed through the installation screens as instructed. Note that you will have options to install documentation and tutorial data. If you choose to install these components these files can be subsequently be found in the *\Program Files\Avenza\Geographic Imager* directory. Additionally you may access the documentation from the Windows Start menu (*All Programs > Avenza > Geographic Imager* folder).
4. Launch Adobe Photoshop. *Please proceed to the section on Registration and Licensing on the following page.*

Mac OS

1. Make sure that you have a compatible version of Adobe Photoshop installed on your computer. If Adobe Photoshop is running, exit the program.
2. Ensure that you have administrative privileges for the installation process. If you are unsure whether you have the proper privileges, please consult with your IT department.

   CD version: Insert the Geographic Imager CD into your CD-ROM drive. Navigate to the *Geographic Imager for Mac* directory on the CD, and double-click **Geographic Imager Installer 2.1.pkg**.

   Electronic version: Mount the *GI21mac.dmg* file if this operation has not been completed automatically. Then proceed to the *Geographic Imager 2.1* mounted disk image and double-click **Geographic Imager Installer 2.1.pkg**.

3. Proceed through the installation screens as instructed. Note that documentation and tutorial data may also be installed at your option. After installation, these files can be found in the */Applications/Avenza/Geographic Imager* directory.
4. Launch Adobe Photoshop. *Please proceed to the section on Registration and Licensing on the following page.*

Activation and Licensing

Both single-user fixed licenses and floating licenses of Geographic Imager are available.

Fixed licenses are licensed per single computer and require activation in order to run. Once activated, they are node-locked or fixed to that particular computer based on a unique machine identification (ID) number. **As such, before completing the activation process be certain that the computer you have installed and are activating on is the one upon which you intend to use Geographic Imager**. Geographic Imager has a built-in Activation Wizard to guide you through the process.

Floating licenses are designed to allow an organization to install Geographic Imager on an unlimited number of computers on a network such that the number of concurrent users is limited to the number of floating licenses purchased. If you purchased such a license system, you will also receive separate instructions on how to install the license server component on your network and how to work with the *Checkout License* function.

The instructions below detail how to activate a single-user copy of Geographic Imager. Note that Geographic Imager will fail to function until activated either as an evaluation or fully licensed installation.

> **IMPORTANT:** Laptop users with a docking station must activate Geographic Imager in the *undocked* state. All users with wireless and fixed NIC's should disable the wireless NIC temporarily before activating Geographic Imager and then activate using a *wired* internet connection.

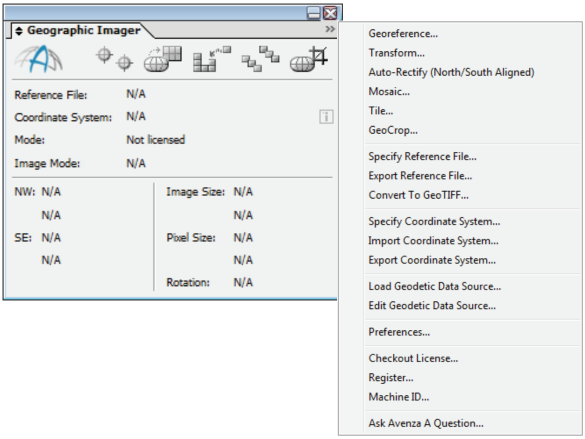
ACTIVATING A PURCHASED COPY OF GEOGRAPHIC IMAGER

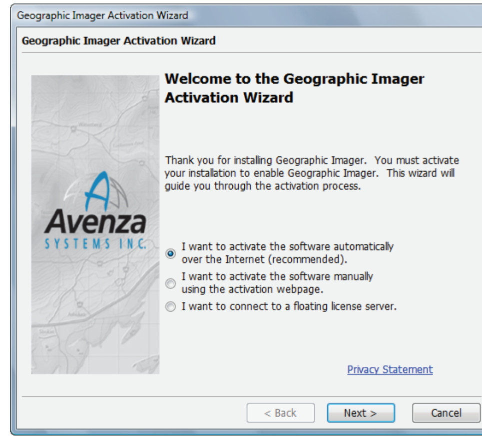
1. To activate Geographic Imager you must supply Avenza Systems with the serial number that was provided to you by when you purchased the product. The following guidelines can also be used to re-activate if you have inadvertently deleted your license file from your hard drive or have had to perform a re-install.
2. After installation of Geographic Imager, launch Adobe Photoshop. The Activation Wizard will appear automatically.

   If you wish to continue to use Photoshop without Geographic Imager you can cancel this wizard and activate Geographic Imager later by selecting Register from the Options menu in the Geographic Imager panel.

   If you have an Internet connection, select the *I want to activate the software over the internet* option and click the *Next* button. At the second screen, select the option *I have already purchased Geographic Imager and want to activate it now* and proceed through the wizard as instructed to complete the activation.

   If you cannot access the Geographic Imager licensing server over the Internet, select the *I want to activate the software manually using the activation webpage* option and click the *Next* button. Then either click the link to **www.avenza.com/register** and follow the steps that fit your situation or call the number provided. In any situation, you will need to supply the Machine ID you see on the Finish screen and your serial number. Avenza Systems will send you an email with a zipped license file attachment containing your Geographic Imager license file. Unzip this attachment and save the enclosed *.lic* file to the appropriate folder in your operating system *(See page 5)*.





ACTIVATING AN EVALUATION VERSION OF GEOGRAPHIC IMAGER

1. After installation of Geographic Imager, launch Adobe Photoshop. The *Activation Wizard* will appear automatically.

   If you wish to delay the start of your 14 day evaluation period, you can cancel this wizard. When you are ready to activate the Geographic Imager demo select Register from the Geographic Imager panel options menu.

   If you have an Internet connection,select the *I want to activate the software over the internet' Internet connection* option and click the *Next* button. At the second screen, select the *I want to activate a 14 day evaluation version* and proceed through the wizard as instructed to complete the activation.

   If you cannot access the Geographic Imager licensing server over the Internet,select the *I want to activate the software manually using the activation webpage* option and click the *Next* button. Then either click the link to **www.avenza.com/register** and follow the steps that fit your situation or call the number provided. In any situation, you will need to supply the Machine ID you see on the Finish screen and your serial number. Avenza Systems will send an email with a zipped license file attachment containing your Geographic Imager license file. Unzip this attachment and save the enclosed *.lic* file to the appropriate folder for your operating system *(see below).*

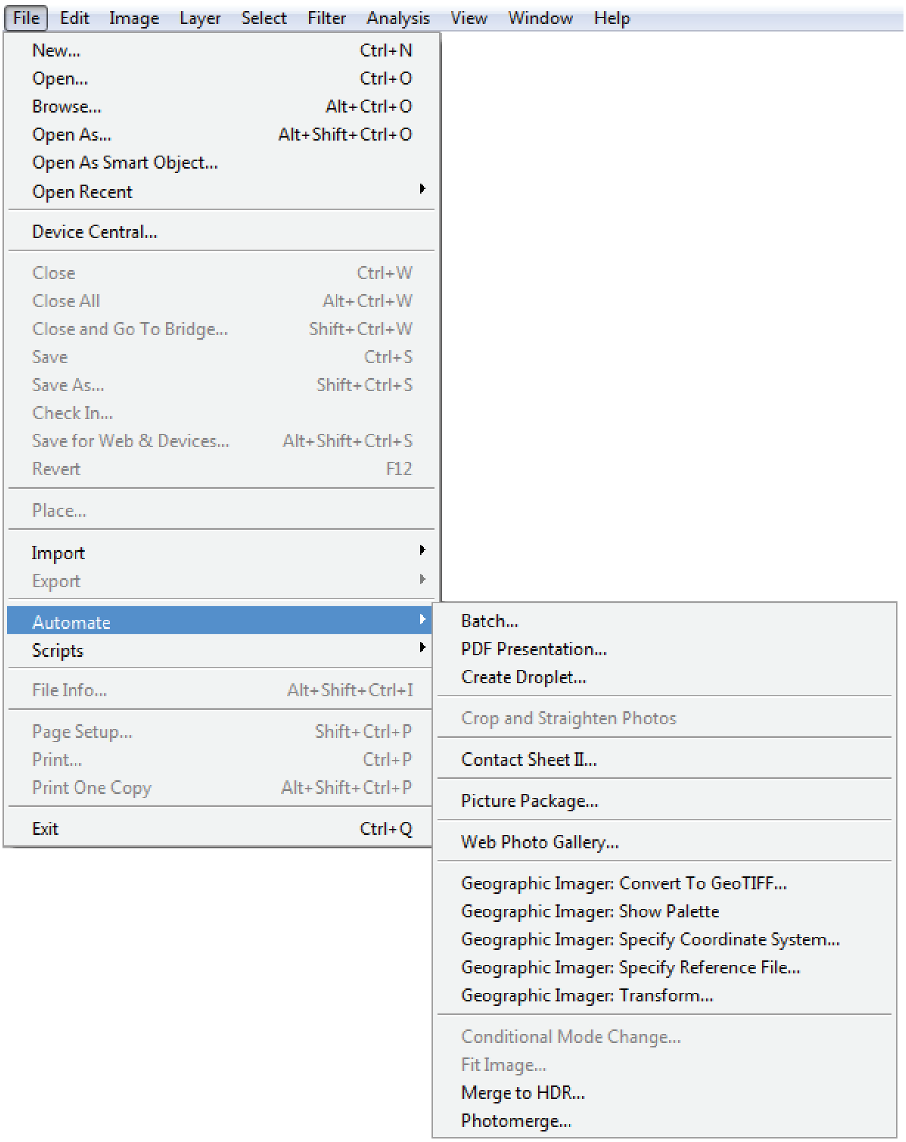
2. When you are ready to purchase the software you can re-open the *Activation Wizard* by selecting **Register** from the Geographic Imager panel options menu.

   Note: The Geographic Imager license file must be located as follows:
   (English version only. May be different in other languages)

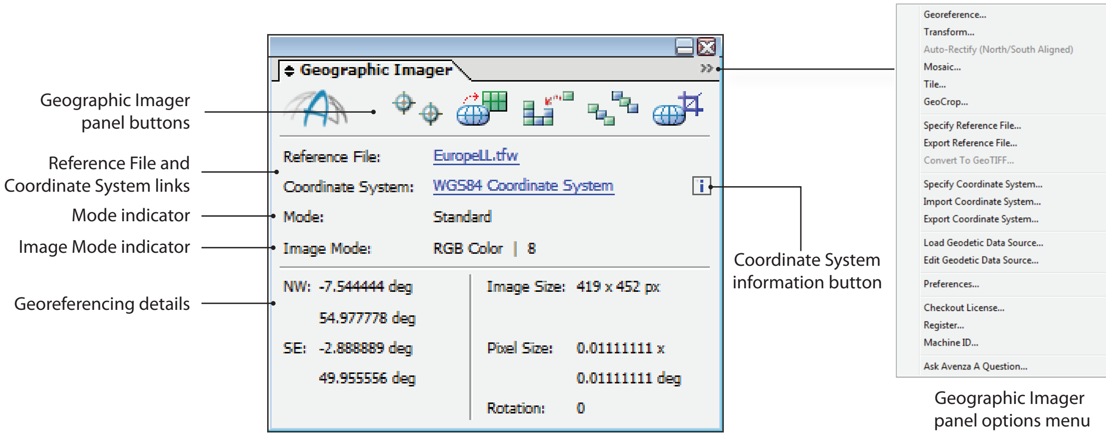
   Windows XP: C:\Documents and Settings\All Users\Application Data\Avenza\Geographic Imager
   Windows Vista: C:\Program Data\Avenza\Geographic Imager
   Mac OS X: /Applications/Avenza/Geographic Imager/Geographic Imager Plug-In

Geographic Imager Tools

In most cases the Geographic Imager panel, which provides access to all the Geographic Imager functions, will open automatically when Photoshop is opened. In the event that the panel does not open or if the panel was closed, reopen it by choosing *File > Automate > Geographic Imager: Show Panel.*



GEOGRAPHIC IMAGER PANEL



GEOGRAPHIC IMAGER BUTTONS

Georeference: Add ground control points and georeference image files.

Mosaic: Assemble multiple images into one file.

Tile: Split images into multiple smaller ones.

Transform: Reproject an image into a different coordinate system, change pixel size and modify pixel dimensions.

GeoCrop: Crop images based on location by specifying coordinates of the output image.

Coordinate System Information: Shows the coordinate system information for the current image.

Double-click the Geographic Imager tab (above the Avenza logo) to change the size of the panel.

REFERENCE FILE / COORDINATE SYSTEM LINKS

These links display the location of the geographic reference file of the image and the current coordinate system of the image as defined in the Geographic Imager coordinate system database.

Reference file

A geographic reference file contains data that relates the image in pixels to the earth in real world coordinates. Along with other parameters, this file contains either the mathematical transformation information or an explicit list of reference points.

Coordinate system

Indicates the current coordinate system of the image.

MODE INDICATORS

The mode indicator displays information about the image referencing mode. Two modes of referencing are supported:

Standard Mode
Standard or Normal transformation mode, maintains an affine referencing only. No ground control points are maintained.
GCP (Ground Control Point) Mode
GCP mode, uses points to reference an image so a pixel will correspond to a geographic coordinate. The list of these points will be maintained across Photoshop operations.

Image Mode
Displays information about the current image colour mode and bit depth (in bits per channel).

GEOREFERENCING DETAILS

These are the geographic reference data values as per the reference file or GeoTIFF header:

- **NW** The location of the northwest (top left) corner of the image in world units.
- **SE** The location of the southeast (lower right) corner of the image in world units.
- **Image size** The image size in pixels.
- **Pixel size** The relative size of each pixel in world units.
- **Rotation** The angle of rotation of the image from north being straight up (a negative value indicates a clockwise rotation and a positive value indicates a counterclockwise rotation).

GEOGRAPHIC IMAGER PANEL OPTIONS MENU

Georeference
Add ground control points and georeference image files. Opens the Georeference dialog box. *See Chapter 8.*

Transform
Reproject an image into a different coordinate system, change pixel size and modify pixel dimensions. Opens the Transform dialog box. *See Chapter 4.*

Auto-Rectify (North/South Aligned)
Images not aligned to true north contain a rotation value that is displayed in the georeferencing details section of the Geographic Imager panel. Use Auto-Rectify (North/South Aligned) to remove the rotation from the image and align the image to true north. Images must contain referencing information before this feature is enabled.

Mosaic
Assemble multiple images into one file. Opens the Mosaic dialog box. *See Chapter 5.*

Tile
Split images into multiple smaller ones. Opens the Tile dialog box . *See Chapter 6.*
GeoCrop
Crop images based on location by specifying coordinates of the output image. Opens the GeoCrop dialog box . *See Chapter 7.*

Specify Reference File
Specify a reference file for the image. Opens the Specify Reference File dialog box. *See Chapter 3.*

Export Reference File
Export a defined coordinate system of a georeferenced image to a reference file. Opens the Export dialog box. *See Chapter 9.*

Convert to GeoTIFF
Convert any image file into a GeoTIFF. Opens the Convert to GeoTIFF dialog box. *See Chapter 9.*

Specify Coordinate System
Specify a coordinate system for an image. Opens the Specify Coordinate System dialog box. *See Chapter 3.*

Import Coordinate System
Imports an already defined coordinate system stored in an external file. Opens the Import Coordinate system dialog box. *See Chapter 3.*

Export Coordinate System
Exports a defined coordinate system to a WKT Definition File. *See Chapter 9.*

Load Geodetic Data Source / Edit Geodetic Data Source
See Chapter 4.

Preferences
Opens the Geographic Imager Preferences dialog box. *See Chapter 11.*

Checkout License
Check out a Geographic Imager user license for a session or duration of time. *See Activation and Licensing.*

Register
Opens the Geographic Imager Activation Wizard. *See Activation and Licensing.*

Machine ID
Displays the current machine identification number.

Ask Avenza a Question
Opens the Avenza Forums home page in an Internet browser

Compatibility with Adobe Photoshop

This version of Geographic Imager is compatible with Adobe Photoshop versions CS3 and CS4. If you are running multiple versions of Adobe Photoshop on your system please ensure that you have installed Geographic Imager to the Photoshop CS3 and/or CS4 plug-ins folder(s). Please note that Geographic Imager is not compatible with the 64-bit version of Adobe Photoshop CS4.

Primarily the operations of concern are the ones that affect the image size, pixel size and orientation of the image. Most of the Photoshop functions that are involved in these operations, such as Crop, are supported. Pixel-level operations, including the majority of plug-ins (e.g. cut and paste), are transparent to Geographic Imager are assumed not to modify georeferencing. These operations are treated as simple image modifications.

Every attempt has been made to ensure compatibility with Adobe Photoshop. Avenza, as third-party developers, regrets that due to various limitations within the Adobe Photoshop development environment, there are a lack of notification and other parameters that are able to be received from many native Photoshop operations. There are also a limited number of procedures within Adobe Photoshop that, when invoked, may adversely affect the georeferencing of a spatial image. A notification or warning message will be displayed whenever any operation is performed which may cause data loss, render georeferencing invalid, closes a document without saving or in any other way may silently affect the georeferencing of the image document.

UNSUPPORTED FUNCTIONS AND OPERATIONS

The following native Adobe Photoshop functions and operations are not supported by Geographic Imager and may damage the georeferencing of your image document if performed:

File > Save for Web and Devices
Save for Web and Devices will create a new file without georeferencing.

Image > Trim *(Partially supported)*
Trim is now partially supported. It works in modes when pixels are trimmed only in one horizontal and/or one vertical direction (e.g. top and left is acceptable, but top and bottom is not).

Image > Reveal All
Reveal is not supported and will result in lost georeferencing.

Channels Panel > Split Channels and Merge Channels
Channels may be split or merged however the new document will not be georeferenced.

Crop Tool *(Limitation)*
Cropping using perspective or with a set width, height or resolution is not supported and will result in damaged georeferencing. Perspective should be unchecked when cropping, click the Clear button to remove set parameters.

AUTOMATE TOOLS: SCRIPTING AND ACTIONS

File > Automate > Batch *(limitation)*
When the Destination is Folder the new image will not be georeferenced.

File > Automate > Droplet
Droplets are not fully supported. Results will vary on different platforms and operating systems therefore it is not fully supported.

File > Scripts > Image Processor
The new file created will not contain georeferencing.

File > Scripts > Script Event Manager
Performing actions or scripts that change the document's geometry using the Script Event Manager are not supported and will not update georeferencing. This is not the case when action is run using the *Actions* panel.

Action Panel > Insert Menu Item
Insert Menu Item from the Actions panel will create incorrect results with some menu items.

Note: The ScriptListener plug-in is not recommended for use of Geographic Imager functions. Please refer to *ScriptExamples.jsx* to create scripts using Geographic Imager supported functions.

Note: When using any automate tools Adobe Photoshop must already be open to ensure correct functionality. In some cases the script will trigger events before Adobe Photoshop has been initialized and the event will not be registered by Geographic Imager. This could result in georeference not being updated.

OTHER SPECIAL NOTES

The following are some additional compatibility and procedural notes that you must be aware of in order to properly and effectively use Geographic Imager.

Transforming Coordinate Systems

- The Transform function creates a transparent background behind the projected image. It is not necessary to flatten the image before mosaicking into another image or further transformations.
- The central latitude parameter is only valid for a geodetic destination coordinate system. This value will always be displayed in degrees.
- Transformations always results in a north-up affinely referenced image.
- Transformations will convert georeferenced image files from GCP mode to Standard mode.
- Multiple transformations will introduce a loss of precision due to the resampling needed when transforming images. Therefore it is recommend to transform images only once to the final source coordinate system. To avoid this problem keep a copy of the original image if it will be needed in another coordinate system.

Georeferencing

- Geographic Imager continuously maintains the proper georeferencing information for all georeferenced image files throughout the duration of the Photoshop session, as well as during a Save procedure. Documents may become implicitly georeferenced upon the file open process if Geographic Imager can locate proper georeferencing information. Once established, the document cannot be "ungeoreferenced" unless an unsupported operation is performed.
- New documents created within Adobe Photoshop are never georeferenced. However, in cases where a new document has been created a reference file for the newly created document may be specified or created using Geographic Imager.
- Coordinate system information can not always be stored in the reference file. World files only contain image reference data and will never maintain the coordinate system. GeoTIFF files store coordinate system information however some projections are not supported. Therefore the coordinate system will not be saved. MapInfo TAB files also contain the same limitation. If the projection is not supported the coordinate system will be saved as the WGS 84 Coordinate System. ER Mapper ERS files must contain an ER Mapper identifier within the coordinate system definition to save the coordinate system with the file. Please refer to Chapter 2 Georeference Formats for more information.
- Compatibility issues may occur when saving coordinate system information in a format different than that of the source.
- Some Adobe Photoshop operations performed in GCP mode may result in a loss of precision or a complete loss of georeferencing. Resize canvas, Crop (non-angular), Flip and Trim are supported. Basically, all operations that do not result in non-integer values for pixel coordinates.
- The Blue Marble Reference Settings File (.rsf) and MapInfo Table file formats (.tab) save the complete reference point list information such that it can be loaded again in the future. ESRI world files simply contain a computed relationship between the source image coordinates and the reference coordinates and not the complete reference point information. As such, reference points cannot be reloaded from an ESRI World file. When an ESRI world file is loaded into the reference point list the 4 corners of the source image are recalculated using the world file parameters, and displayed as reference points. It is recommended that you also save a MapInfo TAB file when in GCP mode so that the raw reference point information can be recalled at a later date.

Mosaicking

- Adobe Photoshop allows for duplicate layer names. Therefore, if an image is mosaicked multiple times new layer groups will be generated with the same name within Adobe Photoshop.

Colour Modes

- Support for the various image colour modes available within Adobe Photoshop is identical across the various functions and operations available in Geographic Imager except as indicated below.
- Only RGB, CMYK, Grayscale and Lab Colour modes are supported by all Geographic Imager operations including georeferencing, saving and exporting, transforming, mosaicking, tiling and GCP transformation.

- Support for transforming 32-bit per channel images is currently limited while work continues to expand 32-bit per channel support within Geographic Imager. User experiences may vary depending upon image sources and workflows. Contact Avenza for more details.
- With colour modes that are not supported by all of Geographic Imager operations, the bit per channel will not be displayed (e.g. Bitmap, Duotone, Indexed colour and multichannel).

Adobe Photoshop start-up

- It is recommended that users do not use the Alt+Tab command to switch between programs on Windows machines. During Photoshop start-up, Geographic Imager runs a series of scripts that can be interrupted by the Photoshop debugging tool if this command is used.

COMPATIBILITY WITH MAPUBLISHER AND OTHER APPLICATIONS

MAPublisher

While every effort has been made to ensure that images exported from Adobe Photoshop/Geographic Imager are fully compatible with Adobe Illustrator/MAPublisher, a number of functions within Photoshop such as rotations and channels are not supported and should thus be avoided.

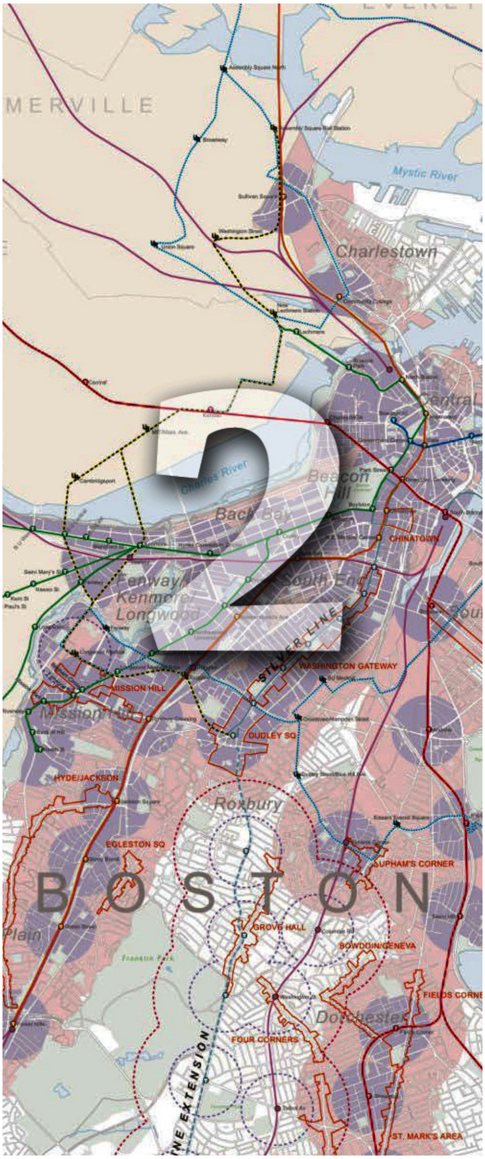
This is due to the fact that the two environments employ slightly different methods for handling, encoding, and reading GeoTIFF headers and world files and as such in some rare instances the georeferencing data created by Geographic Imager may be incorrectly interpreted by MAPublisher. In severe cases, the image may not be properly registered within Adobe Illustrator even after being recognized as a GeoTIFF. It is recommended that a world file be generated from Geographic Imager and used, instead of the GeoTIFF format, for image registration within MAPublisher if GeoTIFFs prove difficult or unsuccessful.

Other Adobe Plug-ins

All efforts have been made to develop and engineer Geographic Imager in accordance with the Adobe Photoshop SDK and third-party development schema. However, Avenza cannot verify and validate compliance and compatibility with other third-party plug-in products that may be installed on any particular system and cannot guarantee that the use of Geographic Imager will perform as expected in such environments and will not clash with other plug-ins. Furthermore, Avenza can neither confirm nor guarantee that the use of any particular third-party plug-in, action or script will not damage the georeference data of any spatial image in use with Geographic Imager.

The use of any other third-party plug-in that in any way alters the geometry of a georeferenced image will damage the georeferencing of the image due to the fact that Geographic Imager has no way of knowing a) that the other plug-in exists; b) that it has been invoked; and c) what it has actually done to the image.

In most instances third-party plug-ins that do not alter the geometry of the image will not have an adverse effect on image georeference data.



Georeference Formats

The key to Geographic Imager is its ability to recognize and maintain the geographic understructure of a spatial image through the opening, editing and saving process.

Spatial images or georeferenced files are normal raster images that carry with them a set of geographic information that indicates the exact location of the image in the real world along with the scale of the image relative to the earth. This "reference data" can exist as a separate external reference file or as header information built into a TIFF image, which constitutes a GeoTIFF.

Image Formats

Adobe Photoshop handles the opening of all images. Supported images used in Geographic Imager are the same as that of Adobe Photoshop and thus includes most common and widely used raster formats.

Reference Formats

Geographic Imager includes support for the following reference file formats:

World Files (*.tfw, *.tifw, *.wld, *.jgw, *.pgw, *.sdw, *.eww, *.blw, *.dmw)
Blue Marble Reference Files (*.rsf)
MapInfo Table Files (*.tab)
GeoTIFF (*.tif, *.tiff)
ER Mapper (*.ers)

This section provides an overview of the formats listed above, as well as additional data considerations when using spatial images.

Georeference Formats

Any image format that can be opened and displayed by Adobe Photoshop can form the basis for a spatial image. This includes, but is not limited to, the following common formats: *.tif, *.jpg, *.bmp, *.psd, *.gif, *.png. Please refer to your Adobe Photoshop user guide for a complete list of the file formats supported by Adobe Photoshop.

In order to be a spatial or geographically referenced image (rather than just a plain photograph or scan) there must be an associated reference file or reference header (in the case of a GeoTIFF) that details the position and scale of the image relative to the real world. *Refer to Default Reference Formats in Chapter 11 of this user guide.*

Please note that although any image, in any colour mode, can be georeferenced and recognized by Geographic Imager, the performance of some Geographic Imager functions are restricted to certain colour modes/bit depths.

SUPPORTED GEOREFERENCED IMAGE REFERENCE FORMATS

World File (*.tfw, *.tifw, *.wld, *.jgw, *.pgw, *.sdw, *.eww, *.blw, *.dmw, *.ers)
Read and Write

World files contain the affine relationship between source image coordinates (pixel locations) and real-world reference coordinates (lat/long or other real-world coordinate units). World files simply contain a computed relationship between source image coordinates and reference coordinates. Reference points cannot be loaded from a world file because they do not exist in the file. When in GCP mode, it is recommended that a reference file in any GCP points supporting format also be exported so that any raw reference point information can be recalled at a later date. World files do not support storing coordinate system information.

Blue Marble Reference File (*.rsf)
Read and Write

The Blue Marble Reference Settings File saves the complete reference point list information such that it can be loaded again in the future. Within a Blue Marble Reference File, the first line contains the version of the file format (not to be confused with the version of the software) and the total number of points in the file. The remaining lines contain, in each line, the point ID, the x (row) pixel, the y (column) pixel, the z (elevation) value which is usually 0.00, followed by the ground coordinates expressed as Latitude or Northing (Y), Longitude or Easting (X) and Elevation (Z). The last value indicates whether the point described on that line is included in the solution, 0 = not included and 1 = included. Blue Marble Reference files support storing coordinate system information.

MapInfo TAB File (*.tab)

Read and Write

MapInfo Table file formats save the complete reference point list information such that it can be loaded again in the future. MapInfo TAB files support storing coordinate system information.

Supported projections when saving the coordinate system are listed below:

Albers Equal-Area	Hotine Oblique Mercator	Hotine Oblique Mercator 1pt
Azimuthal Equidistant	Lambert Azimuthal Equal Area*	Polyconic
Cylindrical Equal Area*	Lambert Conic Conformal	Robinson*
Eckert IV*	Mercator*	Sinusoidal*
Eckert VI*	Miller Cylindrical*	Swiss Oblique Mercator
Equidistant Conic*	Mollweide*	Stereographic Transverse Mercator
Gall Stereographic*	New Zealand Map Grid	

* Coordinate Systems using this projection will not be stored when saving the reference file.

ER Mapper File (*.ers)

Read and Write

The ER Mapper header file is an ASCII file describing the raster data in the data file. The entire header file holds information about the data source and is contained in the *DatasetHeader* block. There are two compulsory sub-blocks, the *CoordinateSpace* block (to define the coordinate space and location) and the *RasterInfo* block (to define the characteristics of the data in the accompanying data file). The *RasterInfo* block my contain a number of optional sub-blocks. To completely define coordinate information in an ERMapper header file you need to include the following data: datum, projection, coordinate type, units, X and Y dimensions for cell size, registration cell X and Y values, registration cell coordinates, and possibly null cell value. Coordinate information is frequently, but not always, given for the upper left corner of an image. This would be registration cell X and Y values of 0.0 and 0.0. For most projections registration coordinates are entered as eastings and northings, the coordinate type will be "EN", and units will be meters (or occasionally feet). If you are using latitude and longitude the projection is Geodetic, coordinate type will be "LL", and the X and Y dimensions for the cell size will be in decimal degrees.

ER Mapper files support storing a limited number of pre-defined coordinate systems. Check the coordinate system details to ensure the ER Mapper identifier exists as the issuer for the coordinate system to be saved. The file will still be exported however the coordinate system will not be saved with the reference file.

ER Mapper reference files do not support rotated images.

GeoTIFF File (*.tif, *.tiff)
Read and Write

Tagged Image File Format (TIFF or TIF) is a common raster graphic file format and one of the most common geospatial image formats you are likely to come across. Many raster geographic images from GIS systems are stored in this format, which can be used in Photoshop as a geographically referenced file. A GeoTIFF is a TIFF file with embedded geographic information such as position and scale in world coordinates, affine transformation or an explicit list of GCP points. This information is automatically detected when the source raster image is opened into Geographic Imager.

Unlike the other geographically referenced image formats discussed in this section, GeoTIFFs do not require a separate reference file. Upon opening a GeoTIFF Geographic Imager will immediate recognize that the image is georeferenced and populate the Reference File link with the location of the GeoTIFF itself. Upon saving a georeferenced image to the *.tif or *.tiff formats, Geographic Imager will write the appropriate georeference header information into the saved file provided the image is referenced as a GeoTIFF. Coordinate system information may be stored in a GeoTIFF file. GeoTIFF files support storing coordinate system information.

Supported projections when saving the coordinate system are listed below:

Albers Equal-Area
Cassini-Soldner - Cassini
Cylindrical Equal Area
Equidistant Conic
Equidistant Cylindrical
Equirectangular
Gnomonic
Hotine Oblique Mercator
Laborde Oblique Mercator
Lambert Azimuthal Equal Area
Lambert Conic Conformal (1SP)
Lambert Conic Conformal (2SP)
Lambert Cylindrical Equal Area
Mercator
Miller Cylindrical
New Zealand Map Grid
Oblique Mercator
Oblique Stereographic
Orthographic
Polar Stereographic
Polyconic
Robinson
Sinusoidal
Stereographic
Transverse Mercator
Transverse Mercator (South Oriented)
VanDerGrinten

DATA CONSIDERATIONS

When obtaining spatial imagery for use with Geographic Imager, whether from an online source, commercial vendor, government office or a source within your organization, there are a number of important considerations to keep in mind. You should always try to obtain data in one of the formats supported by the Adobe Photoshop *File > Open* command and the list of reference files supported by Geographic Imager. In cases where the file format native to a particular mapping application is not supported by Geographic Imager or Adobe Photoshop, you can often request the data provider to export a file in one of the supported formats.

When obtaining data you should acquire as much metadata about the file(s) as possible. If an image is received in any format other than GeoTIFF you should obtain a reference file in one of the formats supported by Geographic Imager. In all cases you should obtain the coordinate system or projection as many reference files do not contain projection information. The important things to find out are the name of the projection, the datum and the units. If you do not have the correct information and you wish to subsequently reproject your data, you will be required to specify the coordinate system.

Opening Geographic Imagery

The ability to automatically recognize georeferenced images is at the foundation of Geographic Imager.

Opening a spatial image is the main starting point for most users wanting to work with Geographic Imager in Adobe Photoshop.

Geographic Imager supports all the image formats supported by Adobe Photoshop as discussed in Chapter 2.

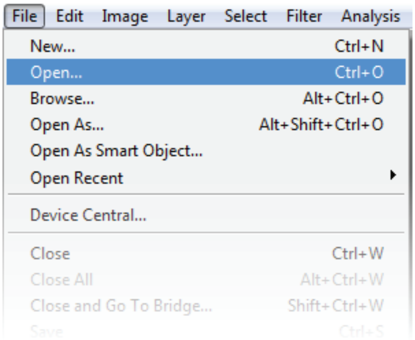
This chapter provides information on how to open a spatial image, select and apply a reference file and select and apply a coordinate system.

Topics covered in this section:

Opening Geographic Imagery

OPENING AN IMAGE

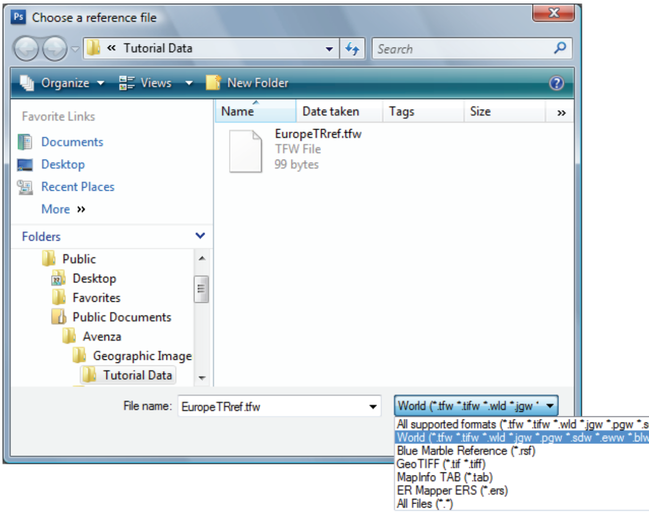
The first step in working with spatial imagery is to open an image file, just the same way a regular image would be opened in Photoshop. For instance, images may be opened using the native Adobe Photoshop *File > Open* menu command, by double-clicking on an image in your operating system file browser or by drag-and-drop. Many Adobe Photoshop supported file formats can form the basis for a spatial image.

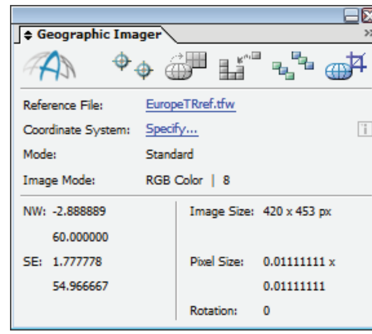


REFERENCING AN IMAGE

In most cases there is need to specify a reference file as Geographic Imager can automatically recognize a file as being georeferenced. In order to automatically read the reference file, it must be in the same folder as the image and have the same file name followed by one of the reference format extensions(e.g. .tfw). When a file is recognized as a geographic image, the Geographic Imager panel will display the link along with the contents of the reference file: the northwest (top left) corner and southeast (bottom right) corner coordinates, image size, pixel size and rotation angle. If a coordinate system is detected, a link to a Geographic Imager Coordinate System database file will also be displayed in the panel.

If the image is not recognized as a GeoTIFF, Geographic Imager will search the folder containing the image for an external reference file with the same name of the format specified in the preferences. *See Chapter 9 for more information on preferences.*





If a reference file is not located and read by Geographic Imager automatically upon opening an image, one can be manually specified. This may be necessary if the reference file and image file are not in the same folder or do not have the same name. In order to specify a reference file, click the **Reference File Specify** link in the Geographic Imager panel or go to the panel options menu and select **Specify Reference File**.

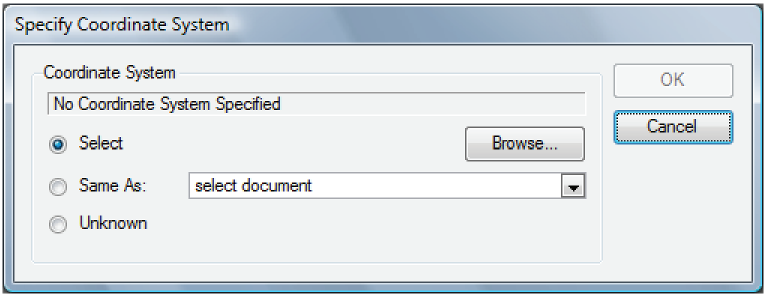
In the Choose a reference file dialog box, browse and select a reference file of one of the supported formats listed in the file type drop-down list. If you do not have a reference file but have access to a set of known point coordinate locations (such as the northwest (top left) corner and southeast (bottom right) corner coordinates) you can create your own reference file using Geographic Imager. *The process of referencing an image and creating a reference file is discussed in Chapter 8.*

Once a reference file has been specified, all changes to an image's referencing, which occurs as a result of image manipulation operations in Photoshop, will be reflected in this reference file. Changes to this file will be automatically saved whenever the image itself is saved.

SPECIFYING A COORDINATE SYSTEM

In order to be able to transform an image, Geographic Imager needs to know the current coordinate system of the image. As many image reference files do not specify coordinate system details, it is often necessary to manually specify the coordinate system by either selecting it from one of the Geographic Imager database files or by importing a separate coordinate system data file such as an ESRI projection (.prj) file.

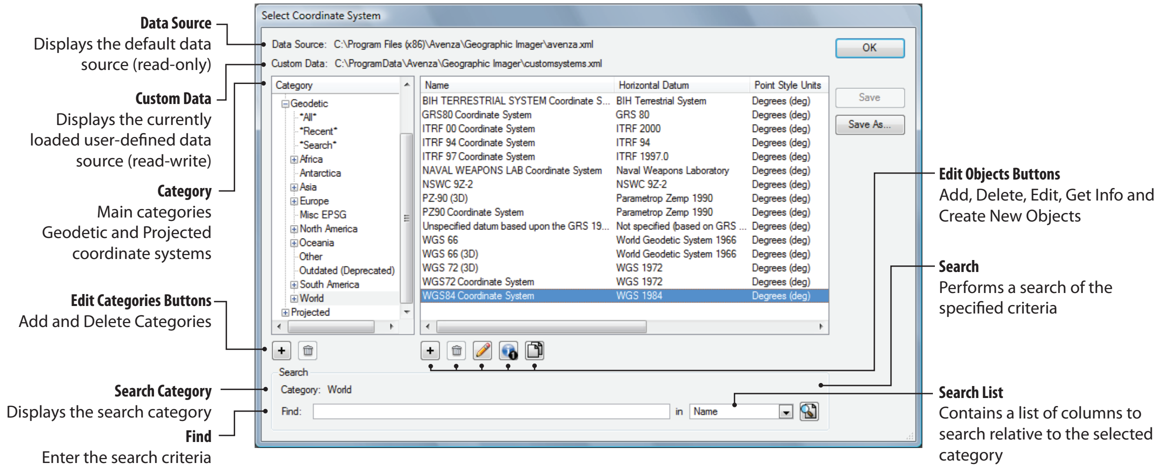
In order to specify a coordinate system, click the Coordinate System Specify link in the Geographic Imager panel, or go to the panel options menu and select **Specify Coordinate System**.



The *Specify Coordinate System* dialog box appears with several options to set the coordinate system. To set the coordinate system to be the same as that of another currently open image with a coordinate system select the **Same As** option and then the desired image to match from the drop-down list. If there are no other referenced images open this option will be greyed out.

To set the coordinate system as unknown, select the **Unknown** option and click OK. An image can not be transformed when the coordinate system is unknown. If the image previously had a coordinate system, in will effectively strip the coordinate system information from the image.

To select a coordinate system from the currently loaded Geographic Imager database, click Browse. The *Select Destination Coordinate System* dialog box appears displaying the contents of the currently loaded coordinate system database. The contents of the dialog box are organized into two categories: Geodetic (unprojected and in latitude and longitude) and Projected. Subcategories for both recently used coordinate systems and recently performed searches are listed at the top. After selecting the desired coordinate system, click OK to apply the selection and close the dialog box. The selected coordinate system is displayed as a link in the Geographic Imager panel.



The *Select Destination Coordinate System* dialog box displays the name, horizontal datum, point style units, EPSG code and envelope of each coordinate system within the selected category. Columns are resizeable and sort information alphabetically or numerically. The coordinate systems are organized into either Geodetic or Projected categories. Each is further subcategorized geographically and regionally.

All categories and subcategories can be searched by the name, horizontal datum, point style units, envelope and EPSG code. The search results are displayed under Geodetic or Projected depending on what category was searched. When searching the name of a coordinate system the results will also display category names that match the search. Note that the search is always relative to the currently selected category on the right panel.

Three special categories store specific information:

All: Displays all of the coordinate systems within that category.
Recent: Displays all of the recently used coordinate systems within that category.
Search: Displays all of the search results for that category.

Note: The main *Coordinate Systems* category contains *All*, *Recent* and *Search* coordinate systems for all geodetic and projected coordinate systems.

Note: The special categories *All*, *Recent* and *Search* cannot be searched.

Note: *Recent* and *Search* categories can be cleared by right clicking the category.

For a more in-depth discussion on projections and coordinate systems, as well as details on editing and adding to the coordinate system database and loading and importing a coordinate system file or database, see *Chapter 4 Transformations and Coordinate Systems*.

Transformations and Coordinate Systems

Geographic Imager adds a new dimension to Adobe Photoshop by having the ability to transform georeferenced images into a common coordinate system. It also allows you to specify a custom coordinate system for transformation. Transforming spatial images into another coordinate system is an integral part of Geographic Imager.

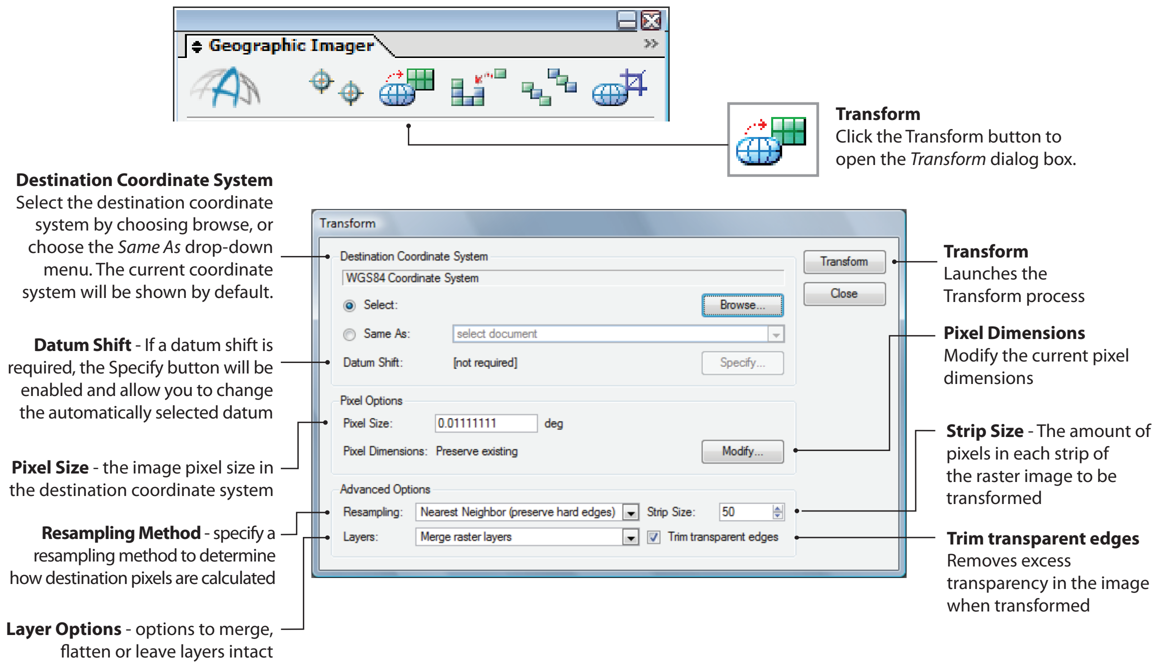
Geographic Imager supports many coordinate systems from around the world.

This chapter provides information on how to transform a spatial image, select and apply a coordinate system, and load, edit and import a geodetic data source.

Topics covered in this section:
Applying a Transformation
Loading the Geodetic Data Source
Editing the Geodetic Data Source
The Coordinate System Editor
The Ellipsoid Editor
The Datum Shift Editor
The Angular Unit
The Linear Unit Editor
Importing Coordinate Systems

Transformations

The Transform process creates a destination georeferenced image in a different coordinate system from a geographically referenced source image. The transformed image and associated reference file can be used for direct import into many GIS, CAD and desktop mapping systems including Adobe Illustrator and MAPublisher.



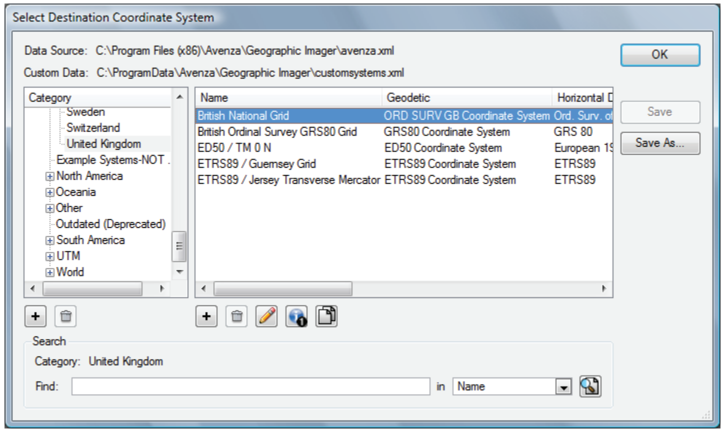
APPLYING A TRANSFORMATION

Once the image has the coordinate system specified *(see page 24)* the Transform button in the Geographic Imager panel will be enabled. Click the **Transform** button to open the Transform dialog box. When opened, the dialog box displays the current geographic parameters of the image.

To set the coordinate system to be the same as that of another currently open and referenced image select *Same As* and then the desired image to match to from the drop-down list. If there are no other referenced images open this option will be greyed out. Changes to pixel size, resampling method, and strip size are available as options in the transformation process.

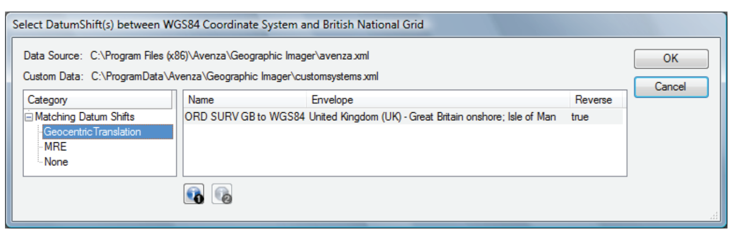
To select a destination coordinate system from the currently loaded Geographic Imager data source (which includes all the coordinate systems and projections available for use within Geographic Imager for transformation purposes) choose the *Select* option and then click the *Browse* button.

The contents of the Select Destination Coordinate System dialog box displays similar tree format to that of an operating system file manager. Scroll through the various categories to find and select the desired destination coordinate system. The current coordinate system will be either geodetic or projected.



Note: Coordinate systems are now tested upon selection/transformation to verify their suitability for the image's geographical area. The user is warned if the coordinate system appears to be partially or fully incompatible with the area.

If a datum shift is required, Geographic Imager will select an appropriate shift for the transformation. If the automatically selected datum shift is not the desired shift, click the *Specify* button to open the *Select Datum Shift* dialog box where the correct datum shift can be chosen. Datum shift types are displayed in the left category column titled Matching Datum Shifts.



Each category will contain the associated datum shift(s) for that reference network. To view the information associated with the datum shift(s) click the View Datum Shift button. If a second datum shift is necessary, reference networks will be listed in a subcategory Using... as Intermediate Shift. The View Second Datum Shift button will become available to view the secondary datum shift information.

Note: Due to the complex nature of performing such transformations, this process may require extended processing time, depending on the original image size, destination pixel size, strip size, resampling method and other parameters. For multiple time-consuming transformations, consider running scripts or actions to automate tasks.

Caution: Upon saving an image after a transformation has been performed, Geographic Imager will update the reference file automatically and the original reference file will be overwritten. In order to keep your original image and reference files, you may choose to use Save As with a new file name and/or file location rather than using the basic Save command.

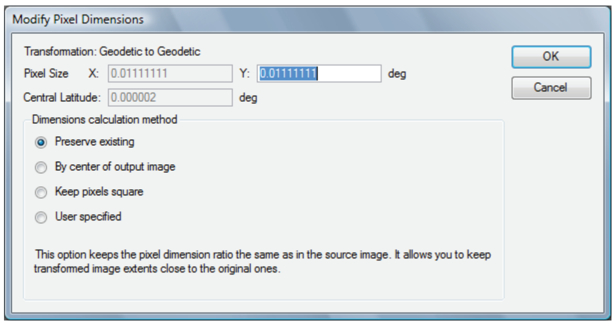
PIXEL DIMENSIONS

Pixel Size

Displays the current image's pixel dimension of the selected destination coordinate system's units.

Modify pixels dimensions

By clicking on the *Modify* button in the *Transformation* dialog, the option of specifying the method of calculating pixels dimensions is available. The following are the available methods to calculate pixel dimensions:



Note: *Preserve existing* and *By Center of Output Image* methods are not available for all transformations. To use the *Preserve existing* method, the transformation needs to be either *Geodetic to Geodetic* or *Projected to Projected*. To use *By Center of Output Image* the transformation outcome needs to be *Geodetic*.

- **Preserve existing** - This option keeps the pixel dimension ratio the same as in the source image. It allows you to keep transformed image extents close to the original.
- **By center of output image** - This option calculates the pixel ratio based on the central latitude of the outgoing image which will be the latitude of the true scale. Choosing this option minimizes the distance of distortion of the image.
- **Keep pixels square** - This option makes sure the pixels of the transformed image are square.
- **User specified** - This option allows you to specify a custom x-to-y ratio.

Note: Multi-layer transformations can be transformed without flattening the image, maintaining the original layers. Existing transparency is now properly maintained during transformation. To guarantee a seamless destination image (i.e. with no gaps between the adjacent layers),make sure there is a sufficient pixel overlap between the layers, for instance, when tiling the original image. Using Nearest-Neighbor method or a smaller strip size may also solve the problem.

Note: Multi-spectral images are supported and maintained for transformations, including support for infrared (RGBI), alpha and spot channels.

Note: Geographic Imager now provides full support for transformation of rotated images.

ADVANCED OPTIONS

Transform Resampling Methods

The user also has the option to change the resampling method of the transformation. The following methods are available when transforming an image:

- **Nearest Neighbor** - Takes the value of the pixel that is closest to the transformed location in the source image. This is the fastest method in terms of processing time, and is the method to use for transforming imagery containing a colour panel that is to be preserved. It also is the best method to preserve original colours during a transformation of image in some non-RGB colour modes, such as CMYK, by avoiding the internal conversion to/from RGB in the process.
- **Bilinear Interpolation** - Takes a weighted average value of the four pixels closest to the transformed location in the source image. This method results in a smoother image than the nearest neighbor method but at the expense of requiring more processing time.
- **Bicubic Interpolation** - Takes a weighted average value of the sixteen pixels closest to the transformed location in the source image.

Strip Size

When an image is transformed Geographic Imager transforms one horizontal strip of the image at a time. The user has the option to change the size of each strip being transformed. The default strip size is 50 pixels and will work for the majority of raster imagery; however some images may be optimized by editing the strip size. Choosing smaller strip size will result in a higher-precision transformation, but the transformation process may be slower.

For example, if an image being transformed displays a spherical curve, a smaller strip size may be necessary to maintain a smooth image edge. If a larger strip size is used there may a be a stepped edge to the image.

Layer Options

- **Leave intact** - Maintains the original layer structure.
- **Merge raster layers** - Combines only raster layers while maintaining vector layers, for example text and transparency.
- **Flatten image** - Combines all layers into one layer, not maintaining transparency.

Trim transparent edges

Choose this option to trim any excess transparency while maintaining the extents of the image.

The Geodetic Data Source

You can extend Geographic Imager to support an unlimited number of custom linear and angular units, ellipsoids, datums, datum shifts and coordinate systems. The parameters for each definition are stored within an XML database file (avenza.xml) referred to as the Geodetic Data Source. Geographic Imager ships with a base data source file that is read only. It is stored in the following location:

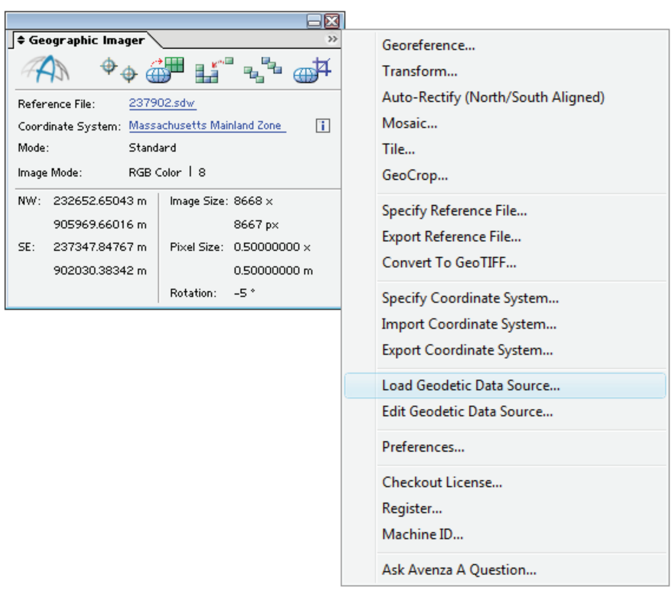
Windows XP: C:\Program Files\Avenza\Geographic Imager\avenza.xml
Windows Vista: C:\Program Files\Avenza\Geographic Imager\avenza.xml
Mac OS X: /Applications/Avenza/Geographic Imager/Geographic Imager Plug-in/Data Source Files/avenza.xml

Geographic Imager allows you to create a custom definition where parameters are stored within an XML database file. It is recommended that these custom XML files are saved in the same location as geocalc.xsd, which is needed to load the file. The location of geocalc.xsd is in the following location:

Windows XP: C:\Documents and Settings\All Users\Application Data\Avenza\Geographic Imager
Windows Vista: C:\ProgramData\Avenza\Geographic Imager
Mac OS X: /Applications/Avenza/Geographic Imager /Geographic Imager Plug-in/Data Source Files

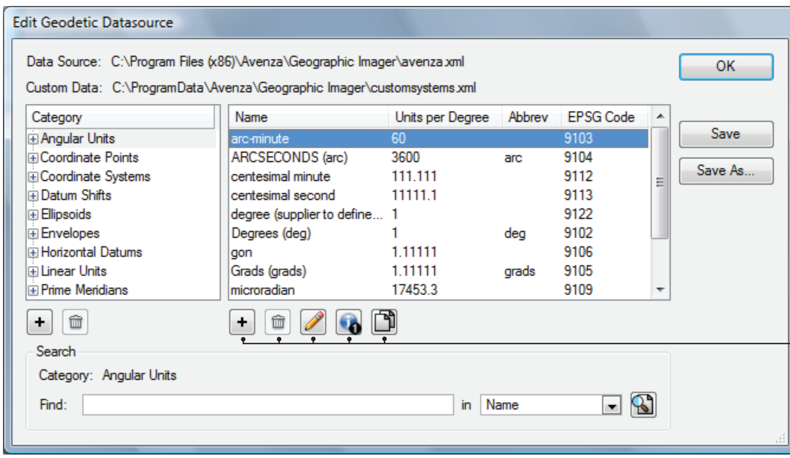
LOADING A GEODETIC DATA SOURCE

A geodetic data source or coordinate system database can be loaded into Geographic Imager, thus greatly extending the coordinate systems available for use. Open the Geographic Imager panel options menu to load a geodetic data source.



EDITING A GEODETIC DATA SOURCE

Geographic Imager allows you to view, search and define coordinate system definitions. In this way Geographic Imager can be extended to support your own custom coordinate systems. By editing the geodetic data source, it is possible to transform coordinates to and from a coordinate system that is based on a standard map projection but is not predefined within Geographic Imager. The geodetic data source can be edited by choosing **Edit Geodetic Data Source** from the Geographic Imager panel options menu.



Edit Objects Buttons
New Object, Delete Object, Edit Object, Get Info and Copy Object buttons

Note: Opening any object from the main Geodetic Data Source file that is protected will warn you that the entry is protected and will not allow you to edit the parameters, but will allow you to make an editable copy of it, or to simply view its parameters.

At the top of the Edit Geodetic Data Source dialog box, two directory paths are listed: the main Geodetic Data Source file which is protected from user modification, and the Custom parameter file, where all user-defined definitions are stored.

On the left-hand side of the dialog box, the categories are listed in a Category list. Each coordinate system object contains subcategories which contain recently more geodetic data objects, recent definitions, search results or all the definitions within that category. To expand a category to see its subcategories, click the plus sign (Windows) or arrow (Mac) to the left of the category name. To see the entries at any particular level of category, click the category itself. When an object, category or subcategory is selected, the list box to the right displays the information stored within each one. User defined coordinate system objects can be organized using drag-and-drop within the dialog box. Columns can be resized and sorted alphabetically/numerically. Entries loaded from the main Geodetic Data Source will be shown in black text, while entries from the Custom Data file will be shown in blue.

New categories can be created by clicking the New Category button. A new category will be titled "New Category" by default and can be renamed by single-clicking on it. Subcategories can also be created using the same method. Only user-defined categories can be deleted using the Delete Category button.

WORKING WITH DATA SOURCE OBJECTS

Individual entries in the Geodetic Data Source are known as **Objects**. There are different types of objects for different types of definition. Objects contained in the Geodetic Data Source are:

- **Angular Units** – type of units for measuring rotation.
- **Coordinate Points** – used to define the orientation of axes used and the type of units used in the system.
- **Coordinate Systems (Coordinate Reference Systems)** – a complete definition needed to express the context of a set of map data.
- **Datum Shifts (Datum Transformations)** – parameters to transform coordinates from one datum to another.
- **Ellipsoids** – an ellipsoid gives a horizontal datum its size and shape. An ellipsoid does not have an origin and cannot be used as a base model for coordinates on its own.
- **Envelopes** – defines a geographic area of use for a particular object.
- **Horizontal Datums** – more commonly referred to as just "datum" is the base model maps are built on. All coordinate systems must have a datum associated with them to be related to any other map. Without a known datum, coordinates are meaningless.
- **Linear Units** – units for measuring straight line, Cartesian distances.
- **Prime Meridians** – defines longitude values of meridians.

Geographic Imager can support an unlimited number of custom objects. The parameters for each custom definition are stored within an XML database file referred to as the Geodetic Data Source (avenza.xml). All user-defined parameters will be stored in a separate XML database. The master data set provided can be updated and maintained by Avenza Systems, without the need to redefine or re-import custom definitions.

CREATING NEW OBJECTS

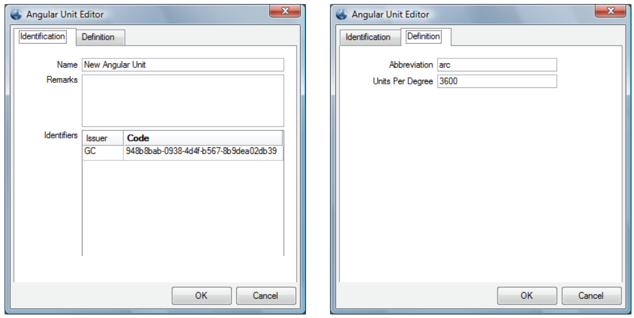
To create new objects, an object's definition needs to be completed. Creating a new object will prompt the object's editor dialog box, there are two tabs in each editor: Identification and Definition.

The **Identification** tab is used to name the object and associate identifying codes with it (if applicable). It is important to enter an appropriate name for the object. The Remarks field can be used to add notes on a definition and is optional. The Identifiers list may be used to add identifying codes for an object that may come from other databases. The GC code is a unique identifier assigned by Geographic Imager. Do not alter this code. To enter additional codes use the space below.

The **Definition** tab is used to define each object's parameters. Refer to the list below when creating new objects. Each object will have a definition unique to that object.

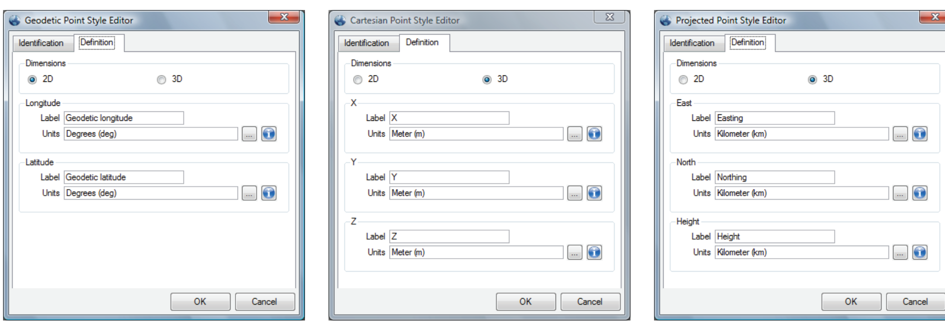
Angular Units

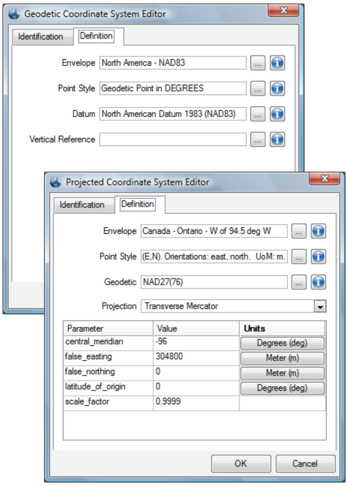
For angular units, enter a conversion for the new unit in terms of the scientific standard Degrees. The *Abbreviation* is used to identify the unit within the application interface (Example: The abbreviation for degrees is "deg").



Coordinate Points

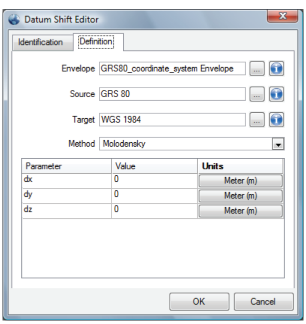
For coordinate points, specify the coordinate point dimensions in either 2D or 3D. For Geodetic and Projected Coordinate Points, the Longitude and Latitude style of units must be entered for all 2D Dimensional Points. The Longitude, Latitude and Ellipsoid Height style of units must be entered for 3D Dimensional Points.





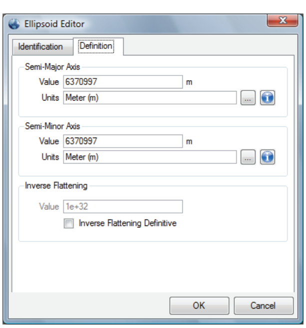
Coordinate Systems

For Coordinate Systems, you must select an Envelope defining the appropriate area of use. If you are unsure of the appropriate envelope, you can leave it set to the default World envelope. The Point Style is how you will select the style of linear units for your system. For Most systems, you will want to select "Projected point in ___ (appropriate units)". Then select the Geodetic model that using the appropriate datum for your system. When you select the appropriate projection for your system, the parameters needed to define the system will appear in the table below. Enter the needed parameters and define the units each parameter is specified in.



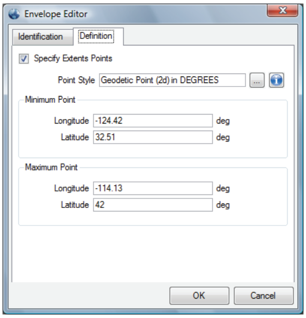
Datum Shifts

For Datum Shifts, select an Envelope (appropriate geographic area of use), Source, Target and Method. If you are unsure of a more specific envelope, leave it se to the default "World" Envelope. The Source and Target fields are used to specify the two geodetic models the Transformation is valid for. The Method specifies the necessary parameters to define a particular datum transformation. With the proper method selected, enter the appropriate parameters for your datum transformation. Be sure to define the appropriate units for each parameter by clicking the Units button.



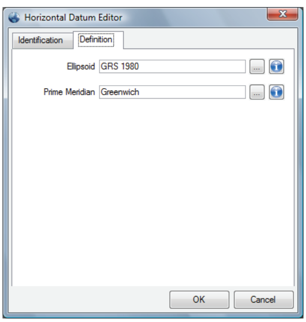
Ellipsoids

For Ellipsoids you must enter the parameters for the Semi-Major Axis and Semi-Minor Axis (often noted as "a" and "b" respectively) define the linear units the axes are specified in by selecting a predefined unit in the appropriate fields. The Inverse Flattening (often noted as "1/f") will automatically calculate in the field below. Alternately, you can make the Inverse Flattening definitive by enabling the check box at the bottom. You can then manually enter the Inverse Flattening rather than the Semi-Minor Axis parameter.



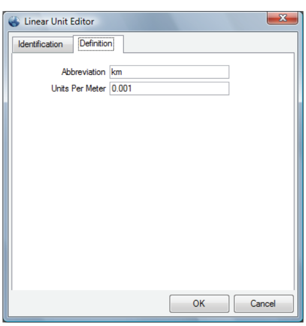
Envelopes

For Envelopes, specify the extents of the envelope (it is not required but very much recommended). Checking Specify Extents Points will be required to enter the minimum and maximum points of the envelope and the point style the value represent.



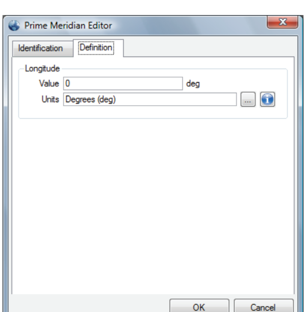
Horizontal Datums

For Horizontal datums you must select the Ellipsoid the datum is based on, as well as the prime meridian used.



Linear Units

For Linear units, enter a conversion for the new unit in terms of the scientific standard Meters. The Abbreviation is used to identify the unit within the application interface (Example: The Abbreviation for Meters is "m")



Prime Meridians

For Prime Meridians you must enter the longitude value of the Prime Meridian and the angular unit that value is in.

EDITING OBJECTS

When a stock object that ships with Geographic Imager is selected and the *Edit Object* button is clicked, a warning will appear indicating that the object must be copied before it can be edited. With user-defined objects or copies of existing objects the object editor dialog box will immediately open and the user will be able to make edits to the object. This may also be accessed by double-clicking the object.

DELETING OBJECTS

When a stock object that ships with Geographic Imager is selected and the Delete Object button is disabled. Only user-defined objects will the Delete Object button be enabled.

COPYING OBJECTS

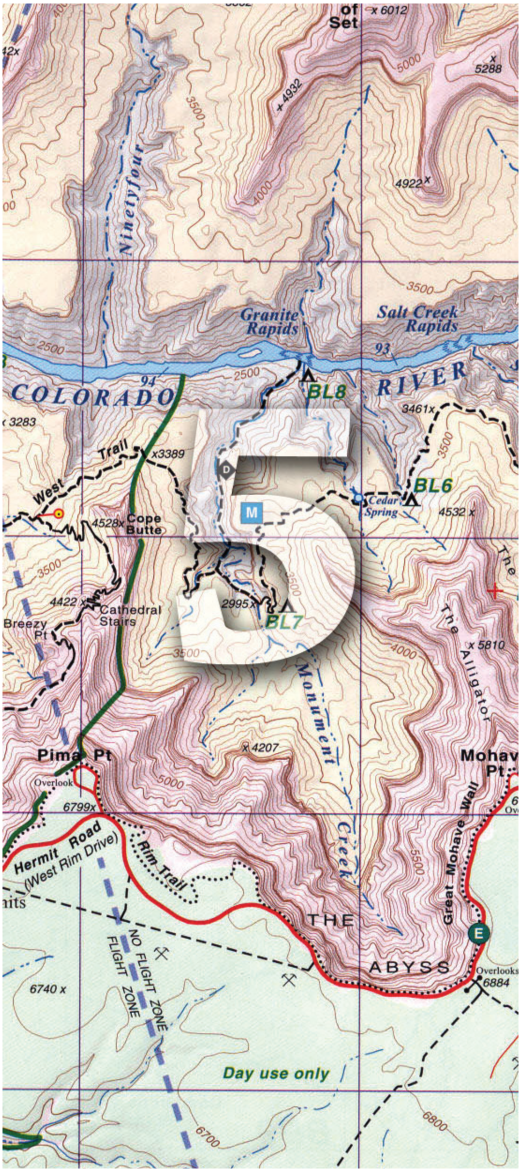
Any object can be copied. Select an object and click the Copy Object button and a new object will be created with "Copy of:" automatically appended to the Name field.

IMPORTING ADDITIONAL COORDINATE SYSTEM DEFINITIONS

In some cases the coordinate system of an image is not listed in the Geodetic Data Source or the reference file format does not support the coordinate system. In such cases, it may be useful to import additional coordinate system definitions. By using the Import Coordinate System menu item in the Geographic Imager panel Options menu, additional coordinate system definitions can be imported and merged with the existing data source information. Geographic Imager imports the following coordinate system file formats: WKT definitions (.wkt), MAP files (.map), ESRI projection files (.prj), and MapInfo TAB files (.tab).

Note: When a new coordinate system is imported, it will automatically replace the source coordinate system of the currently selected image. If you wish to transform the image to the imported coordinate system, open another referenced file and then import the coordinate system to that file. When the transform image option is selected the Same as option can be used to select the destination to be the same as the image with the imported coordinate system.

Note: When the definition is imported, it is added to the Geodetic Data Source. If the imported file matches an existing definition, the stock definition will be used and the definition will not be added. All new imported coordinate systems are located at the top level of the appropriate category in the Coordinate Systems tree view (in either Geodetic or Projected). You can always drag-and-drop user-defined definitions to an appropriate category or subcategory. Before exiting Adobe Photoshop, be sure to save your Geodetic Data Source if you wish to use the Coordinate System definition again.



Mosaicking

Geographic Imager recognizes the ubiquitous need of cartographers to mosaic adjoining images to create a composite geographic image.

The ability to automatically join images and maintain georeferencing throughout the process underlies Geographic Imager's true power.

In this chapter you will learn how to mosaic spatial images.

Topic covered in this section:
Mosaicking an Image

Mosaicking

The Mosaic function creates a composite georeferenced image from multiple input georeferenced images sharing a common coordinate system and pixel resolution. The process creates a single composite image from multiple individual georeferenced images. The file size of each individual image should be taken into consideration when mosaicking large images. In this case, it is recommended to limit the amount of images being mosaicked.

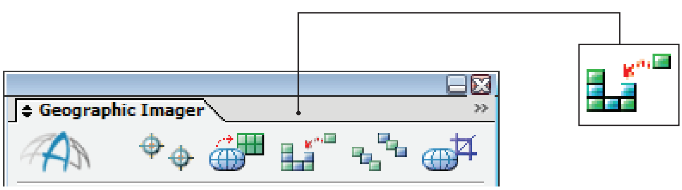
A reference file must exist for each input georeferenced image to be mosaicked. The reference file is used to determine input georeferenced image extents and the resultant composite georeferenced image extents.

In order to be mosaicked, images must satisfy certain conditions. The input georeferenced images must share a common coordinate system and pixel size/dimension (the actual area covered by 1 pixel in geographic units) in order to be mosaicked. The mosaicking results will not be possible if any of these variables are not the same amongst all images being mosaicked. In addition, mosaicking of images with different pixel registration, while technically possible, may result in loss of precision.

MOSAICKING AN IMAGE

The first step to mosaicking multiple spatial images is to open all the georeferenced image files to be mosaicked. Ensure that all files have the same coordinate system, pixel size/dimension. It may be necessary to assign a coordinate system, and/or perform a coordinate system transformation prior to mosaicking. Using the Same As option and selecting the destination image will resolve this problem.

When all images are ready, select the destination mosaic image (where the mosaic will occur) and click the **Mosaic** button in the Geographic Imager panel.

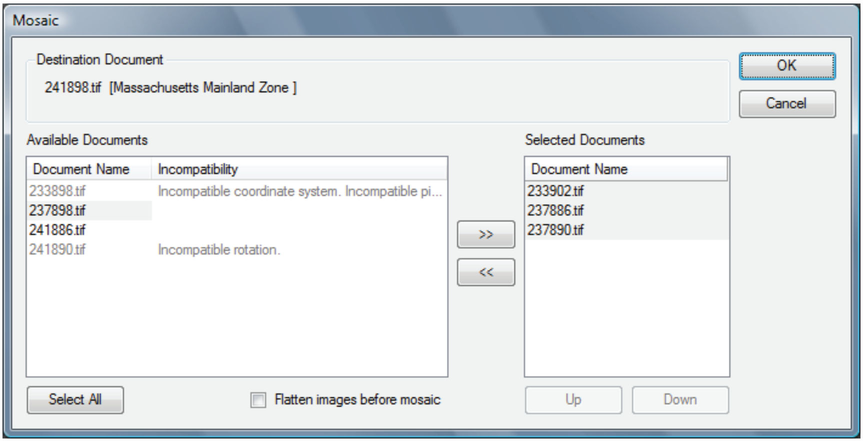


Mosaic
Used to assemble multiple images into one image.

The Mosaic dialog box displays the destination document, available documents to mosaic and the selected documents that will be mosaicked. The destination document will be displayed along with the coordinate system. A list of all open documents will be displayed in the Available Documents column. Images that do not satisfy the mosaic conditions of the destination document are displayed in grey, suffixed with the reason why they do not meet the mosaic conditions and will not be selectable. Images that meet the mosaic conditions of the destination document can be selected individually or by using the Select All button.

With all the documents selected in the Available Documents column to be mosaicked press the ">>" button to transfer the documents to the Selected Documents column. Adversely a document can be removed from the Selected Documents column by pressing the "<<" button to move it back to the Available Documents column. All documents in the Selected Documents column will be used in the mosaic. Documents can be reordered by using the Up and Down buttons or by removing and adding documents back to the selected documents column. The last document in the Selected Documents column list will be the first layer at the top of Adobe Photoshop Layers panel.

The *Flatten images before mosaic* check box can be used when a selected document contains multiple layers. If the layers in the Selected Document column list do not need to be maintained in the mosaic, flatten the image before the mosaic is performed.



Note: For a speedier and easier method of preparing images to be mosaicked, transform one image then transform the other images use the option Same As in the Transform dialog box. This will guarantee compatibility for the purpose of mosaicking when transforming the other images. The same coordinate system and the same pixel dimensions should be applied when using this option.

Note: It is recommended that no more than 50 images be mosaicked at a time. A large number of images will use a significant amount of memory and may affect Adobe Photoshop and Geographic Imager performance.

Note: Only georeferenced documents in a supported colour mode will be displayed in the list of available documents. Supported colour modes are CMYK, RGB, Grayscale, Lab and Duotone.

Note: When mosaicking georeferenced documents in different colour modes, the colour mode of the destination document will be the colour mode of the resulting mosaic.

Note: Images with multiple channels will maintain its channels.

Note: Resultant images mosaicked or combined using the Adobe Photoshop Photomerge operation will not contain georeferencing information.

Note: It is recommended that prior to mosaicking rotated images the user first flatten each image, duplicate the image layer and delete the background image layer. This will ensure that the resultant mosaic will display properly without whitespace.

Tiling

Geographic Imager allows for large images to be tiled or divided using different parameters in order to create a series of smaller georeferenced images.

This allows for smaller file sizes and images covering specific data extents.

Topic covered in this section:
Tiling an Image

Tiling

The Tiling function creates multiple georeferenced images covering smaller portions of a single larger georeferenced image. The process uses user defined parameters to split a larger image into separate tiles and writes the proper reference files for each tile or adds the reference information to the specified reference file format. These images are automatically saved to a specified destination.

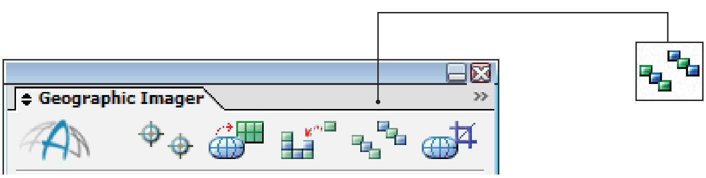
TILING AN IMAGE

The first step in tiling an image is to ensure that the georeferenced image you wish to tile is open and that it has an associated reference file (if you wish to maintain georeferencing).

Note: Any non-georeferenced images can be tiled; however, the output TIFF files will contain no georeferencing.

Note: Tiles cannot be created when the image is in GCP mode.

After opening the image click the Tile button to open the Tile dialog box.



Tiling
Used to split an image into multiple smaller images

The Tile dialog box displays two options for creating tiled images. The options for creating tiled images are *By Number of Tiles* or *By Size of Tiles*.

By Size of Tiles - Splits image by specified number of pixels or ground units of current coordinate system

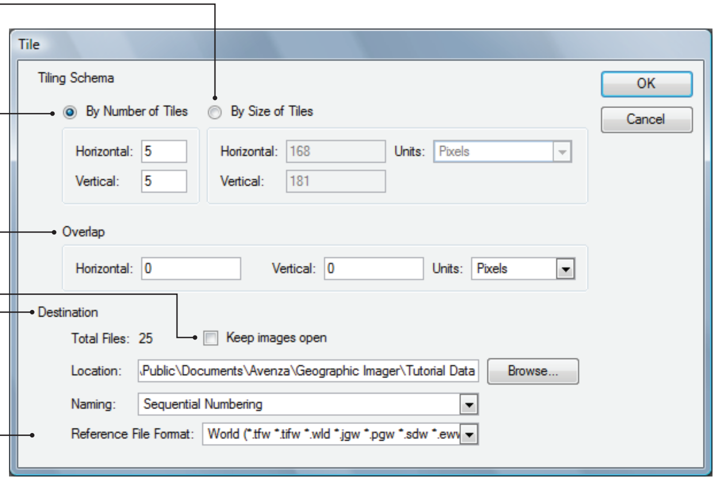
By Number of Tiles - Splits image into equal-sized tiles based on numbers specified in horizontal and vertical fields

Overlap - Defines the amount of overlap each image contains from its adjoining images along the edges

Keep Images Open - When checked, it keeps the tile document windows open after they are created

Destination - Indicates the total number of files to be created, location of where new images will be saved to and the naming schema to be used for each new image

Reference File Format - The current reference file used will be selected. The output reference file can be changed by selecting the desired format.



Note: It is recommended that all images be flattened using the Adobe Photoshop Flatten function before proceeding with a tiling operation. If a multi-layered image is tiled without flattening first, it will result in each tile containing all of the layers from the original image. In some cases this may result in blank layers in one or more of the resultant tiles if all layers do not contain image content that covers all image pixels.

By Number of Tiles
This option creates a series of equally-sized georeferenced image tiles from the original image based upon user entered parameters. The user has the ability to specify the number of horizontal and vertical tiles.

By Size of Tiles
There are two options for creating tiles by a specific size. These options are by number of pixels and by ground units of the coordinate system of the base image. For instance, if an image is in a coordinate system using meters, then the ground units option would be meters. The user has the ability to specify the same size for both horizontal and vertical tiles or different sizes for both the horizontal and vertical tiles. Tiles will be created to the specifications outlined (the edge tiles may be smaller).

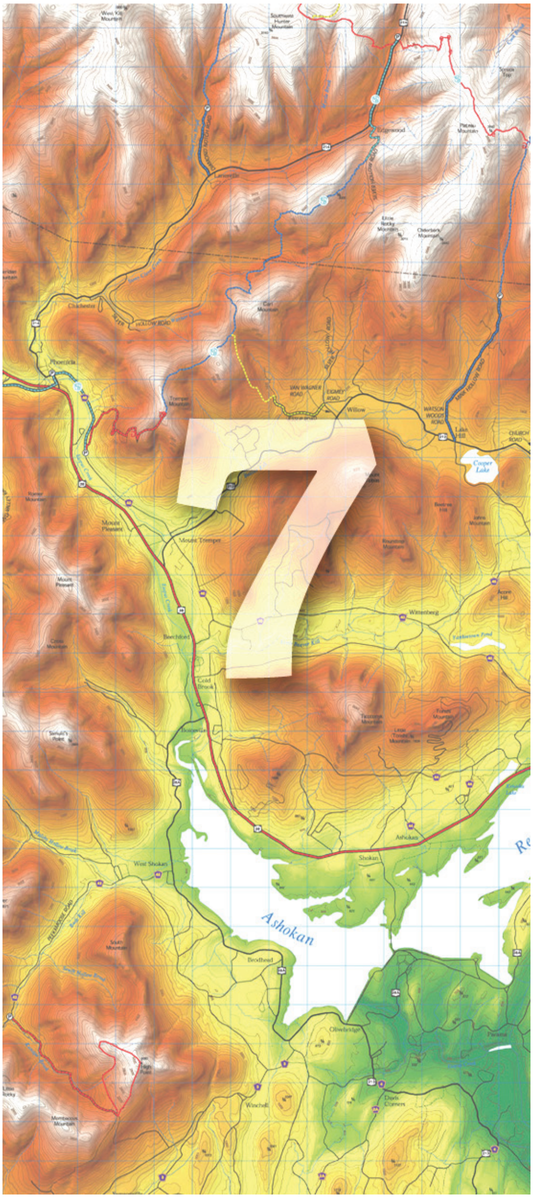
Overlap
The Overlap section specifies the amount of overlap that each tile has with its abutting tiles. The amount of overlap for each tile can be set to either the number of pixels or by a percentage. The amount of overlap may be the same for both horizontal and vertical directions or different in each direction. This option may be especially useful to guarantee eventual gaps-free mosaicing of individually transformed tiles.

Destination
Total Files displays the total number of tiled image files that will be created for the current tiling operation. This value is updated as the number or size of each tile changes.

The Location text box displays the destination folder to which the tiled image files will be saved.

The Naming drop-down list contains two naming conventions for the tiled image files: Sequential Numbering and Separate Row/Column Numbers. In both options, each tile will retain the name of the source image and add its associated numbering convention. The Sequential Numbering option will begin at the first tile in the top-left corner and continue left to right numbering each tiled image beginning with the number 1 (e.g. ImageName1.tif, ImageName2.tif). The second option, Separate Row/Column Numbers will append the row number and the column number for the position of each tile, beginning with 1,1 at the top-left. For example, a two row and three column image will have tiled images named ImageName_1_1.tif, ImageName_1_2.tif, and ImageName_1_3.tif for the first row, and ImageName_2_1.tif, ImageName_2_2.tif, and ImageName_2_3.tif for the second row.

Reference File Format
The reference file format drop-down list contains options for reference file formats that will be created with the image tiles. The reference file format displayed by default is the reference file format of the active image selected to tile. All output images will be TIFF file format along with the reference file format selected from the drop-down list. When selecting the GeoTIFF reference file format, no reference file will be created because the TIFF stores this information within itself.



GeoCrop

The GeoCrop tool in Geographic Imager allows the user to crop georeferenced images according to known geographic coordinates.

In this chapter you will learn how to use GeoCrop and understand its functions.

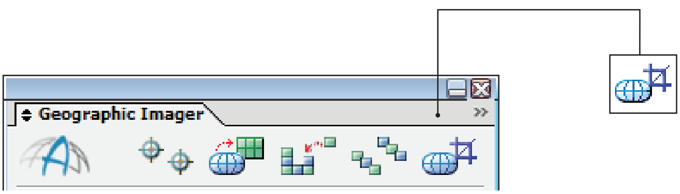
The topic covered in this section:
Using GeoCrop

GeoCrop

The GeoCrop function crops georeferenced images according to known geographic coordinates. The user input needed to perform a GeoCrop will be two sets of coordinates. The ability to crop using three different coordinate types is available. They include pixel, geodetic and projected coordinates. The first set will be for the Top-Left corner and the second set for the Bottom-Right corner of the image. The produced image will have coordinates that are accurate to the size of one pixel. GeoCrop will be available to the user once a reference file has been specified to the current image, until then it will be grayed out.

USING GEOCROP

To start, ensure that an image is open and the reference file has been specified. Click the **GeoCrop** button to open the GeoCrop dialog box.



GeoCrop
Crop by specifying the top-left and bottom-right location of the output image in either pixel, geodetic or projected values.

Coordinate Type Selection
Specify the type of coordinate for both the top-left and bottom-right corners

Coordinate Entry Boxes
Enter the top-left and bottom-right coordinates of the area to crop to

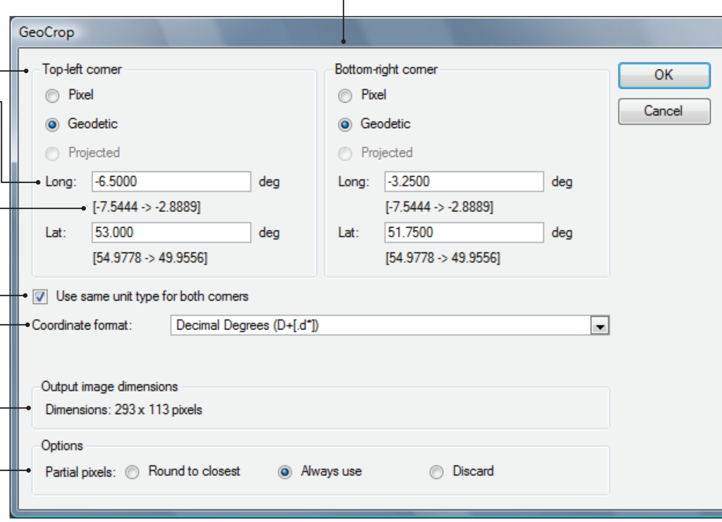
Crop Range - The values in brackets underneath represent the Crop Range coordinate extents of the image

Use same unit type for both corners check box constrains both corners to use the same type of coordinate units

Coordinate Format
Geodetic values can be entered in Decimal Degree or Delimited Degree Minutes Seconds.

Output Image Dimensions
Displays the final image size based on the specified coordinates

Partial Pixel Options
These options allow you to change the way that partial pixels are handled when the image is cropped



COORDINATE TYPE SELECTION

Pixel
If there is no set coordinate system for the current image the only coordinate type available will be pixel. When the pixel option is chosen, the unit is measured using actual pixel values from the image.

Geodetic
Geodetic will be available when the georeferenced image is specified to a geodetic coordinate system. The units for geodetic coordinates will always be degrees, allowing you to display latitude/londitude values.

Projected
When the image has a projected coordinate system, then all three coordinate options will be available to specify crop values. When specifying a projected coordinate value, the units will be the same as the current coordinate system of the selected image.

Note: When specifying coordinates, the same coordinate type or a combination of different coordinates can be used (e.g. specify a pixel value of 0, 0 and a projected value of 342702.509, 578870.120). The Use same unit type for both corners check box constrains both corners to use the same coordinate type.

Crop Range
Displays the minimum and maximum values in the X and Y dimension that the image can be cropped to. Crop range values change depending on the coordinate type chosen.

Coordinate Format
The coordinate format options will be enabled when the geodetic coordinate type is selected. Choose either Decimal Degrees or Delimited Degree Minutes Seconds to enter values in that format. Changing the format will convert Decimal Degrees to Degrees Minutes Seconds and vice versa.

OUTPUT IMAGE DIMENSIONS

The output image dimensions will change based on the crop coordinate values entered by the user.

Options
When cropping an image the handling of partial pixels is decided by the user. The options are Round to closest, Always Use, and Discard.

- **Round to closest**: When this option is selected the partial pixel involved in the crop function will round its value to the closest pixel.
- **Always use**: This option will maintain the pixel and value and use it in the output image
- **Discard**: The discard option will drop partial pixels from the final output image.

Georeferencing

Geographic Imager allows for the addition of ground control points (GCP) and georeferencing of image files using affine or polynomial methods.

The flexibility of the Georeference tool empowers Geographic Imager to provide an intuitive method for selecting reference points within a source image along with providing support for multi-layered images.

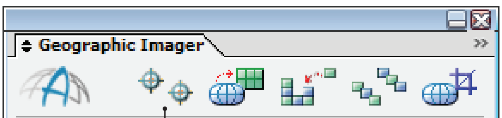
This section provides an overview of how to establish ground control points and to georeference spatial images that do not have a reference file.

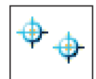
Topics covered in this section:

Opening a Source Image
Adding a Reference Point
Quick Georeference
Deleting a Reference Point
Importing Previously Defined Reference Points
Exporting Points
Assessing Residual Errors
Standard Deviation

Using Georeference

The Georeference function provides tools to georeference an unreferenced image by establishing ground control points (GCPs). A referencing solution is calculated when GCPs are added, modified, or deleted, provided there are a sufficient number of included points for the solution model being used. Associated errors (the difference between computed values and the values you provided) are displayed for each point in the reference point list. The Georeference function also allows for the analysis of an image's control points. Select or modify points in order to minimize the referencing error and to prepare the image for subsequent transformation.





Georeference
Allows for the addition of ground control points and georeferencing of image files and location of individual pixel coordinates.

Select Points
Draw a rectangular marquee within the main view panel to select available ground control points

Hand Tool
Pan to an area of interest within the main view panel

Zoom In
Centres the display and zooms in one level to the area of interest. Draw marquee to zoom in to a specific area.

Zoom Out
Centres the display and zooms out one level from the click location

Add Points
Click on a specific location within the display panel, and a new point record is added to the Reference Point List

Cursor Location
Geodetic Coordinates
Projected Coordinates
(if coordinate system is projected)

Pixel Values

Delete Points
Delete selected points from the reference list

Add Points
Add points to the reference list

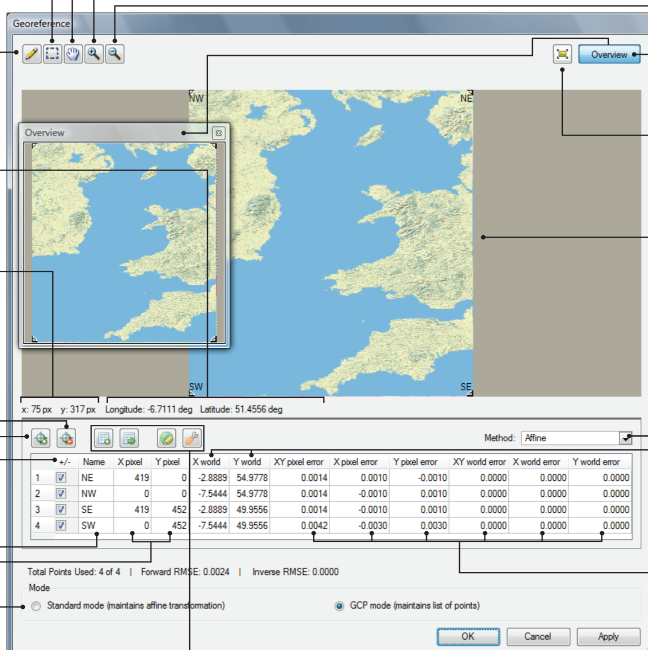
+/-
Point selection for use

Name
Name for each point

X pixel
Image (pixel) coordinate for X value

Y pixel
Image (pixel) coordinate for Y value

Standard or GCP Mode
converts between GCP mode and Standard mode



Overview Panel
Toggles the display of the Overview window

Zoom To Extents
Zooms out and fits the entire image's extents within the display panel

Main View Panel
Displays the source image and reference points

Method
Type of calculations used to compute the referencing

X World
Real world coordinate value for X (East/West)
Y World
Real world coordinate value for Y (North/South)

XY pixel error, X pixel error, Y pixel error, XY world error, X world error, Y world error - Calculated error values between page (pixel) coordinates and real world coordinates

Import Points
Import a set of previously defined reference points

Export Points
Export the reference list to a .log or .csv file

Quick Georeference
Quickly georeference an image using one tie-point, two tie-points or by an existing document

Georeference Preferences
Set table precision, error detection tolerance, and coordinate format

OPENING A SOURCE IMAGE

To begin georeferencing, select the source image to be georeferenced. Once the image has been opened, click the **Georeference** button in the Geographic Imager panel. The entire image will be displayed in the main view panel.

Main View Panel

The main view panel is where a user selects the locations of reference points within the source image to be georeferenced. The main view panel is used for precise selection of source image coordinates for reference points to be defined. The portion of the image displayed by this panel, and the actions which can be performed within it are controlled by using the set of tool buttons above the main view panel. These tool buttons include: Add Points, Select Points, Hand Tool, Zoom In, Zoom Out and Zoom to Extents.

Overview Panel

The overview panel contains a view of the entire source image to be georeferenced. As the portion of the image displayed in the main view panel changes (e.g. by zooming into an area of interest), a highlighted rectangle area representing the main view area will be drawn in the overview panel. The overview panel can be easily toggled on and off using the Overview button.

ADDING A REFERENCE POINT

The **Add Points** button at the top of the Georeference dialog box turns the arrow cursor into a pencil cursor. Click the image in the main view panel to add a point using the pencil cursor. Points are added to the reference point list below. Alternatively, click the Add Points button above the reference point list to add a new reference point to the list. This method locates the new point in the northwest corner (0,0) of the image by default. Once a point has been added, the values of a point can be modified. Also, a name can be specified for each reference point by manually typing it into the point Name input box. Right-click a row in the reference point list to center, zoom or delete a GCP.

Note: It is recommended that users do not edit GCP points in Standard mode. If GCP points need to be edited the mode should be switched to GCP mode. This will ensure that the image is not distorted or rotated unexpectedly.

Determine the Pixel Coordinates

Assign an image or pixel coordinate (X/Y pixel) to the GCP point in the respective image by clicking the image at the desired position or entering the pixel location in the table. Coordinates can be viewed using the cursor location status along the bottom of the image.

Determine the Reference East and Reference North Coordinates

Assign a reference coordinate (map coordinate) to the reference point by entering the value in the respective Reference East (X world) and Reference North (Y world) text boxes. In the Georeference Preferences dialog box, select a coordinate format from the drop-down list.

- When an unreferenced image is opened, three formats are available (Projected, Decimal Degree, DMS)
- When a geodetic image is opened, two formats are available (Decimal Degree, DMS)
- When a projected image is opened, only one format is available (Projected)
- Cannot convert to or from projected units.

When this drop-down list is changed the existing GCP points will be reloaded and converted into the selected format.

Decimal Degrees (D+[.d*]) allows for points to be formatted using the following specifications:

Decimal (Decimal Degrees)
44.7059, -79.4118
W 121.818793, N 54.314983

Delimited Degrees Minutes Seconds (D+dMM'SS[.s*]") allows for points to be formatted using the following specifications:

N 44d42'21", W 79d24'42"
-24 44 56.3994, 138 19 06.96
121d40'51"W, 54d15'23"N

Projected Units allows for points to be formatted using the following specifications:

Grid (UTM, State Plane, etc.)
52793.07, 24589454
652901.85, 4872196.36

Note: Within Geographic Imager, Reference East coordinates are positive to the east (and increase to the east) and represent either longitude or grid easting values. Reference North coordinates are positive north (and increase to the north) and represent either latitude or grid northing values. All formats allow for signed (-) or hemispherical (N, S, W, E) classification.

Note: In the Western Hemisphere you must indicate the sign for geodetic longitude values or apply a "W" direction indicator, for example "-69 30 15.0 or 69 30 15.0 W". In the Southern Hemisphere you must indicate the sign for geodetic latitude values or apply an "S" direction indicator, for example "-45 30 15.0 or 45 30 15.0 S". Otherwise, the geodetic values will be assumed to be in the eastern or northern hemispheres, respectively.

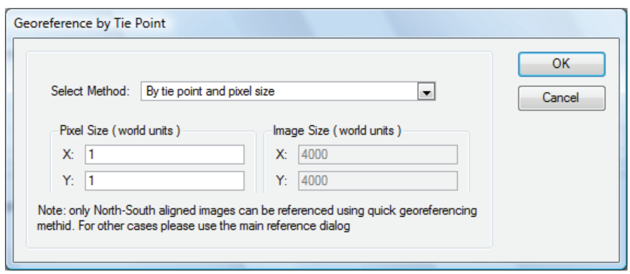
QUICK GEOREFERENCE

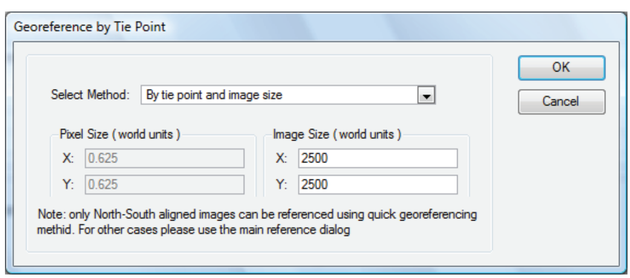
An image can be georeferenced using only one GCP, two GCPs or an existing document. Certain conditions and information are needed using this approach. The following methods and condition are explained below:

By one tie-point (North/South aligned) and pixel size or image size

1. One GCP coordinate is known (pixel and world location).
2. The image is not rotated (image North/South aligned).
3. The pixel size or image size in world units is known.

Pixel size or image size must be in world units (geodetic or projected). Change the method to enter either pixel size or image size.

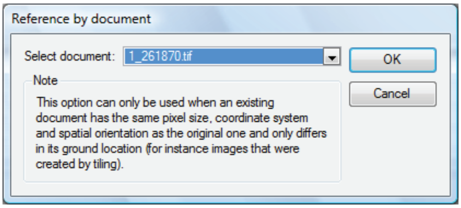




By one tie-point and existing document

1. One GCP coordinate is known (pixel and world location).
2. The image is not rotated (image North/South aligned).
3. An existing document is open having the same coordinate system and pixel size.

The open georeferenced document does not have to contain the geographic extents of the image being georeferenced. Quick georeference by one tie-point and existing document will use a georeferenced image as the source to georeference an unreferenced image (as long as the second condition above is met). Select *By tie point and existing document* from the drop-down list to use this method.



By two points (North/South aligned)

1. Two GCP coordinates are known however these points must not contain the same coordinates in either the pixel or world values (X/Y pixel and X/Y world).
2. The image is not rotated (image North/South aligned).

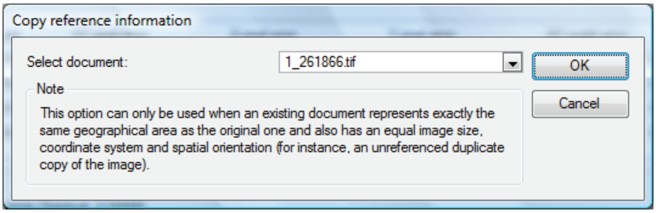
This method helps reduces the amount of time spent georeferencing images.

Copy from another document (same size/reference)

An open georeferenced document containing the same geographic details:

- Geographic extents (NW and SE coordinates)
- Image size
- Pixel size
- Rotation

This method copies all the geographic details from a georeferenced image into an unreferenced image.



Note: When Quick Georeference is used, the precision needs to be set to the longest pixel value. If the precision is less than the pixel value, the pixel value may be modified. If it is modified, the image will not be able to be mosaicked with other images of the same pixel value.

DELETING A REFERENCE POINT

Use this Delete Points button to delete a selected a point in the reference point list.

IMPORTING PREVIOUSLY DEFINED REFERENCE POINTS

To import a set of previously defined reference points, click the **Import Points** button in the Georeference dialog box Reference point file formats include Blue Marble Reference files (.rsf), MapInfo Tab files (.tab), Comma Delimited files (.csv), and Text files (.txt, .log) and GeoTIFF files (.tif, .tiff). If the table already includes some points, imported points will be added to the existing list.

Provided that the required values are present, a .csv or .txt reference file can be created by adhering to the following syntax or by exporting from a spreadsheet program such as Microsoft Excel:

- **.csv format**: pixel X value, pixel Y value, ground X value, ground Y value
- **.txt format**: pixel X value [TAB] pixel Y value [TAB] ground X value [TAB] ground Y value

EXPORTING POINTS

When in GCP mode, the current GCP points can be exported to an external file for future use. Click the **Export Points** button and save the points using the available export reference formats: Log files (.log) and Text files (comma separated values) (.csv).

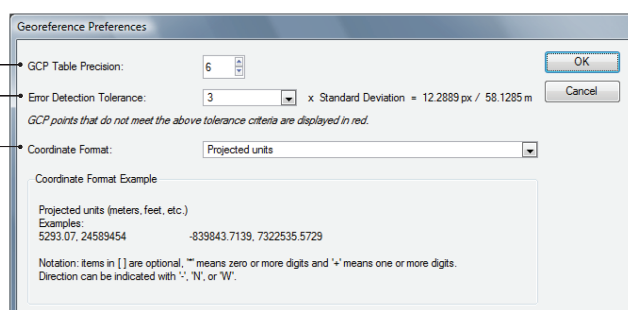
The exported log file will contain all of the GCP pixel and world coordinates (including used and unused points), referencing method, residual error values, and points used. The exported text file will include all GCP points (including used and unused points).

GEOREFERENCE PREFERENCES

GCP Table Precision
Controls the number of decimal places for GCP values

Error Detection Tolerance
Sets the range of error tolerance. A higher value means more tolerance, a lower value means less tolerance.

Coordinate Format
Set the coordinate format in Decimal Degrees, Delimited Degrees Minutes Seconds, or Projected Units



ASSESSING RESIDUAL ERRORS

Once you have added enough points to compute a georeferencing solution, residual errors for each reference point are calculated. A residual error is the computed difference between an observed source coordinate and a calculated source coordinate as the result of the transformation. A large residual error indicates possible error in either the observed source coordinates or the reference coordinates of the reference point in question. As a general rule you should apply several different transformation methods, select/deselect questionable points and select the method and reference points that yield the minimum residual error, assuming that you have defined the reference points correctly.

Residual values are calculated via the associated error values between computed values and entered values through either the affine or various polynomial methods.

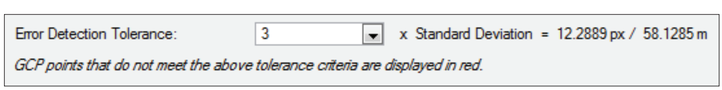
See Appendix A for more information regarding the affine and polynomial solution models.

STANDARD DEVIATION

The standard deviation is calculated from the residual errors of the GCP points. It is a statistic that calculates how much the entered control points match with the computed values (depending on the chosen calculation method). In the Georeference Preferences dialog box, the *Error Detection Tolerance* is the product of the multiplier coefficient and the standard deviation.

Depending on the accuracy of the GCP points, the multiplier coefficient and the calculation method used, points that fall outside of the standard deviation range are considered as error. To set the threshold to tolerate more error, change the multiplier coefficient to a larger value. To set a threshold that will tolerate less error, change the multiplier coefficient to a smaller value. Points that do not comply with the tolerance range (standard deviation multiplied by coefficient) will be shown in red.

This method of error detection can be turned off by selecting *None* in the multiplier drop down list. This will ensure all the reference points are listed in black.



Note: The values displayed in the Error Detection Tolerance correspond to the XY pixel error and the XY world error respectively. As the tolerance level is changed these values will update indicating the maximum tolerance value allowed. Values that exceed the maximum tolerance will be displayed in red in the list of GCP points.

TABLE PRECISION

When the coordinate format or GCP table precision is modified, there will be an option to "Reload" or "Recalculate" the GCP points. Both options will provide an acceptable product, however the user must evaluate their specific needs.

Reload: This will revert any changes made in the Georeference dialog and reload the points form the original data. The highest level of accuracy will be maintained using the reload method because the new table precision will be based on the original precision. Any points that have been added during this GCP session will be lost.

Recalculate: This will apply any changes made in the Georeference Preferences dialog and apply them to the current data in the GCP table. This method will maintain all new changes, including added points, in the Georeference dialog. The table precision will only be as accurate as the existing data.

Save and Export

Geographic Imager saves georeferenced images with full georeferencing properties thus offering limitless possibilities for continuously modifying files without the worry of losing the georeferencing.

This chapter will provide information on how to save georeferenced images in a proper image format, as well as exporting defined coordinate systems.

Topics covered in this section:

Save and Export

Geographic Imager supports all Adobe Photoshop image file formats. When saving any georeferenced image Geographic Imager creates a reference file. It is important to ensure that files are saved properly.

SAVING IMAGE FILES WITH GEOREFERENCING

Using the Adobe Photoshop Save function will save the image and update the reference file. When using the Save As function, Geographic Imager will create a new reference file with the same name of the image and the reference file format saved will be the same reference format of the active georeferenced image. Geographic Imager will create a reference for any image file Adobe Photoshop can save.

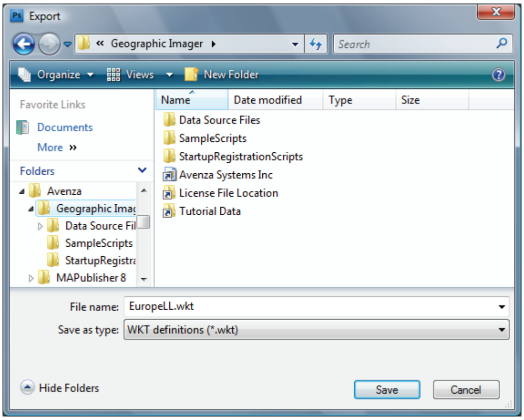
It should be noted that some image formats, such as GeoTIFF, contain georeferencing information within the image file itself and no external reference file is needed. When saving a GeoTIFF to another image format using the Save As function, Geographic Imager will prompt a notice that an external reference file must be saved. All supported reference file types will be listed and one must be selected to save the image with georeferencing.

Geographic Imager will automatically update associated reference files based on the latest transformation settings when saved. Users must be careful as the original reference file may be overwritten in the process.

Caution: Upon saving an image after a Geographic Imager function has been performed, Geographic Imager will update the reference file automatically and the original reference file will be overwritten. In order to avoid damaging your original image file and reference file, take care to Save As with a new file name and/or file location rather than using the basic Save command.

EXPORTING COORDINATE SYSTEM DATA

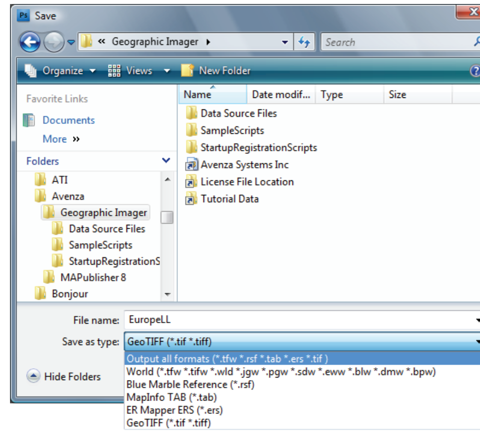
The defined coordinate system can be exported as a WKT Definition File (.wkt) via the Geographic Imager panel options menu. Select Export Coordinate System from the panel options menu to access the Export dialog box.



Some reference files that do not store the coordinate system information will benefit from a WKT Definition File. This file stores all the parameters of the coordinate system that was exported.

Some projections are not supported when saving a reference file and will not store the coordinate system. *Please refer to Chapter 2 Georeference Formats.*

EXPORTING A REFERENCE FILE

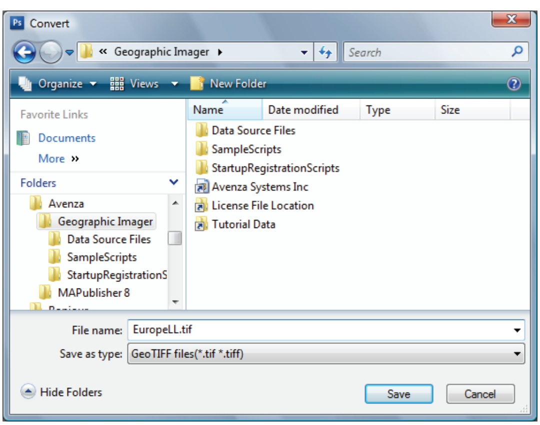


The defined coordinate system for a georeferenced image can be exported as a reference file via the Geographic Imager panel options menu. Select Export Reference File from the options menu to access the export dialog, and choose from the list of available reference file format options: Blue Marble Reference File (.rsf), MapInfo TAB File (.tab), GeoTIFF (.tif)*, World Files (.tfw, .tifw, .wld, .jgw, .pgw, .sdw, .eww, .blw, .dmw) and ER Mapper (.ers).

Export functionality may also be used to change the referencing file format of an image. The georeferencing information should be first exported into the desired reference file format. The new file may then be specified as the reference file for the image by clicking on the Reference File link in the Geographic Imager panel and selecting the new file.

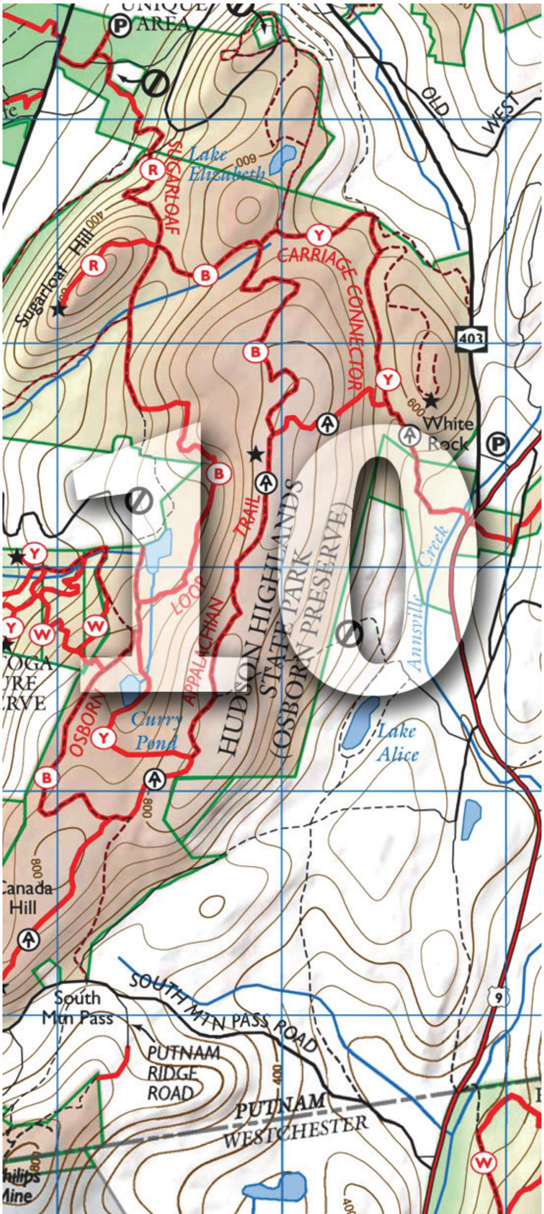
This method will only export GeoTIFF referencing into the current image.

If the original image referencing has changes after the export was performed, only the current referencing file will be updated; previously exported files will not be touched and may thus become unsynchronized with the true image referencing.



CONVERT TO GEOTIFF

The ability to convert a georeferenced file with an external reference to a GeoTIFF is available through the Geographic Imager panel options menu. This function is only available if the image is being referenced by a file other than a GeoTIFF (e.g. a JPEG). There is no external reference file because all of that information is stored in the GeoTIFF. If the file is already a GeoTIFF, the option to Convert to GeoTIFF will be disabled. Just use Save or Save As to save the existing GeoTIFF.



Automating Geographic Imager

Geographic Imager now supports the use of actions and scripts to help automate repetitive tasks.

This chapter provides information on how to use actions and scripts to automate Geographic Imager.

Topics covered in this section:

Unsupported / Supported Functions
Geographic Imager Actions
Geographic Imager and Using Actions
Creating Scripts for Geographic Imager Functions
Script Examples
Batch Processing Script Examples

Automating Geographic Imager

Adobe Photoshop actions and scripts are supported in Geographic Imager and can now be automated using Javascript and actions (but currently not with Visual Basic or Applescript). Actions and scripts are primarily used with Geographic Imager for transformations.

Actions and scripts automate repetitive tasks and will greatly assist in time consuming manual tasks. Scripts have a benefit over actions because conditional logic can be written into them so that it can make decisions based on the current task. Scripts can also involve multiple applications. Another benefit of using scripts is that it can use variable paths while actions only use an absolute path of the file location. Since scripts are written in Javascript, they are cross platform compatible and will work with different computers, whereas actions may not always work with different systems.

Scripts can be viewed and edited in any text editor such as TextEdit and Notepad as long as the extension remains jsx. Ideally scripts should be created and run using Adobe's ExtendScript Toolkit 2 supplied with Adobe Photoshop. This application provides many degugging tools and assistance with creating scripts.

Scripts can be created using Adobe's plug-in ScriptListener that is installed with Photoshop. With this plug-in installed your actions will be recorded into a log. The log is used to create a script. The ScriptListener plug-in is located in ..\Adobe Photoshop CS3\Scripting Guide\Utilities. Please refer to Adobe's Scripting Guide for more information on Scripting ..\Adobe Photoshop CS3\Scripting Guide\Photoshop CS3 Scripting Guide.pdf

UNSUPPORTED / SUPPORTED FUNCTIONS

Photoshop operations used in actions or scripts will now maintain georeferencing information. Please note that there are some functions that are not yet supported.

Unsupported Functions

- Adobe Photoshop closed when using automate tools
- Insert menu item from Action panel
- Script Event Manager
- Droplet
- Image Processor
- Batch process
  - *File > Automate > Batch*, where the *Destination* drop-down list is set as *Folder*. Specifying new folder names and new file names are unsupported.

Supported Functions

- Run script using ExtendScript Toolkit 2
- Run script using *File* > *Scripts* > *Browse*
- Run script by double-clicking script
- Run script by drag-and-drop into Adobe Photoshop
- Run action using Action Panel
- Batch process
    - *File* > *Automate* > *Batch*, where the *Source* drop-down list is set as *Folder* or *Open Files.*
    - *File* > *Automate* > *Batch*, where the *Destination* drop-down list is set as *None* or *Save and Close.*
- Actions that run a script or another action
- Scripts that run another script or action
- Actions that run a script that run another script or action
- Actions that run an action that runs another script or action
- Scripts that run a script that run another script or action
- Scripts that run an action that runs another script or action

GEOGRAPHIC IMAGER ACTIONS

The Geographic Imager panel buttons, links and option menu can not be detected using actions therefore should not be used to record actions. To record actions with Geographic Imager use the following menu items from the *File* > *Automate* menu.

Geographic Imager: Convert To GeoTIFF
Used when recording an action to create a GeoTIFF for all other reference formats.

Geographic Imager: Show Palette
Will show/hide the Geographic Imager panel.

Geographic Imager: Specify Coordinate System
Used when recording an action to specify the coordinate system of an image.

Geographic Imager: Specify Reference File
Used when recording an action to specify the reference file of an image.

Geographic Imager: Transform
Used when recording an action to perform a coordinate system transformation.

Note: *Modify Pixel Dimensions*, *Strip Size* and the *Trim transparent edges* option will not be recorded.

GEOGRAPHIC IMAGER AND USING SCRIPTS

Geographic Imager operations are now supported using JavaScript. Geographic Imager operations that can be preformed using scripts include:

- Specify reference file
- Specify coordinate system
- Transform to another coordinate system - specify pixel size and resampling method
- Transform to another open document's coordinate system

Geographic Imager will install a folder named **SampleScripts**. Three files are installed:

- **ScriptExamples.jsx**, containing example scripts.
- **GeographicImager.jsxinc** provides convenient functions for performing Geographic Imager scripts.
- **ScriptBatchProcessingExample.jsx** containing an example script for batch processing.

Another Geographic Imager will install is a folder named **StartupRegistrationScripts**. This contains six scripts used by Geographic Imager. This folder and contents should not be renamed or deleted. These scripts are used for Geographic Imager to enabled actions and scripts to be used.

Creating Scripts for Geographic Imager Functions

The beginning of each script you create using Geographic Imager functions will require the following code:

```
#target Photoshop
#includepath "/C/Program Files (x86)/Avenza/Geographic Imager/SampleScripts"
#includepath "/C/Program Files/Avenza/Geographic Imager/SampleScripts"
#includepath "/Applications/Avenza/Geographic Imager/Geographic Imager Plug-in/
SampleScripts/"
#include "GeographicImager.jsxinc"
```

This section refers to the platform and location of files needed to run a script using Geographic Imager functions. To use scripts on any platform include all of the `#includepath`. However if the script will be platform specific, only the `#includepath` for the platform intended to run the script is needed.

It is not recommended to create scripts using the ScriptListener plug-in with Geographic Imager functions. Refer to the following section to create a script using Geographic Imager functions.

Script Examples

The following examples are taken from the file **ScriptExamples.jsx**:

▶ `SpecifyReferenceFile("C:/temp/reference.wld", giFormatWorld);`

Specifies a reference file to the current document when not automatically detected. The location and the name of the reference file must be specified. The type of reference file must also be specified, in this case it is a World file.

- For an RSF reference file use `giFormatRSF`
- For a GeoTIFF reference file use `giFormatGeoTiff`
- For a TAB reference file use `giFormatTab`
- For an ERS refer ence file use `giFormatErs`

The above constants can be found in GeographicImager.jsxinc.

▶ `SpecifyCoordinateSystem("", "WGS84_coordinate_system");`

Specifies the coordinate system if the reference file does not contain coordinate system information.

This example uses the WGS84 Coordinate System. This example leaves the issuer empty. If one is not specified, the default issuer is GC. `WGS84_coordinate_system` is the code taken from the issuer GC. This information is obtained from the *Coordinate System Viewer* dialog box (the *Identification* tab in this dialog box has a list called *Identifiers*, which contains the Issuer/Code pairs).

The following example will specify the WGS84 Coordinate System using the issuer EPSG:
`SpecifyCoordinateSystem("EPSG", "4326");`

▶ `Transform("", "WRLD-MOLLEWEIDE");`

Performs a transformation to the Molleweide Coordinate System. This transformation does not change pixel size, strip size, or resampling for a transformation. The pixel size, strip size, resampling method and other options will be used from the last transformation. When an issuer is not specified, GC is used.

▶ `Transform("", "WRLD-SINUSOIDAL", 1228.5, giResamplingCubic);`

Performs a transformation to the Sinusoidal Coordinate System, changes the destination pixel size to 1228.5 ground units (meters, in this case) and uses the resampling method of Bicubic. Again, with an empty string in the first parameter, the GC issuer is used.

- For Nearest Neighbor resampling method use `giResamplingNearestNeighbor`
- For Bilinear use `giResamplingBilinear`

```
▶ var docRef = FindDocumentRefByDocumentTitle("MyOtherOpenDocument.
tiff");TransformAs(docRef);
```

Performs a transformation based on another open image's coordinate system. Running this script will require two images open. This performs the same function as using 'Same As' in the transformation dialog.

The example below will convert the active document to a GeoTIFF with no further settings overwriting the active document. The example will work on both platforms. Convert to GeoTIFF will only work when the reference format is not a GeoTIFF.

```
▶ var folderPath=app.activeDocument.fullName.path;
```

This will get the full path name of the active document in the platform-specifc format (c:/ or /c/...) without the name of the document.

```
var fileName=app.activeDocument.name;
```

This will get the name of the active document

```
folderPath = Folder(folderPath).fsName;
```

Interprets the platform-specific path string into the javascript path format.

```
var myfilename=folderPath +  "/" + fileName;
```

This will append the file name with the directory of the active document.

```
ConvertToGeoTIFF(myfilename);
```

This will overwrite the active document to a GeoTIFF. To create a new document, replace "myfilename" with the path of the directory to create the new file (e.g. ConvertToGeoTIFF(C:/temp/geotiff.tiff);)

Note: The *Identification* tab that contains the Issuer and Code fields in the *Coordinate System Viewer* dialog box can be copied (Ctrl+C). This will help when specifying a coordinate system using scripts since any Issuer/Code combination can be used.

Batch Processing Script Examples

The following examples are taken from the file **ScriptBatchProcessingExample.jsx**:

```
▶ var folderPath;
  if( Folder.fs == "Windows" )
  {
      folderPath = "C:/Program Files/Avenza/Geographic Imager/Tutorial data";
        if( Folder(folderPath).alias ) {
             folderPath = (Folder(folderPath).resolve()).fsName;
```

```
        }
    }
    if( Folder.fs == "Macintosh" )
    {
        folderPath = "/Applications/Avenza/Geographic Imager/Tutorial data";
    }

    open(File(folderPath + "/EuropeLL.tif"));
    open(File(folderPath + "/EuropeLR.tif"));
    open(File(folderPath + "/EuropeTL.tif"));
```

This section of code will correctly identify the platform and opens the tutorial files Avenza includes with Geographic Imager. The name of the file is not case sensitive however the file type extension must be exact. For example, the file name *EuropeLL.tiff* will not work because of the extra f on the tif file extension. Keep in mind this is purely an Adobe Photoshop example so refer to the Adobe Photoshop Scripting Guide for alternate scripts to open files.

```
    open(File(folderPath + "/EuropeTR.tif"));
    SpecifyReferenceFile(folderPath + "/EuropeTRref.tfw", giFormatWorld);
```

The first line will open one of the tutorial files, this is not a GeoTIFF so the second line will specify the associated reference file.

```
    var numberDocuments = GetNumberDocuments();

    var documentID = 0;
```

Calculate the number of open documents. This will be used to run through all open images in the loop.

```
    for ( var i = 1; i <= numberDocuments; i++ )
```

Selects one of the open images making it active to perform an operation. The follow examples are included in a loop and will be performed for each image.

```
    {
      documentID = GetDocumentIDByIndex(i);
      SetDocumentCurrentByID(documentID);
```

Selects the active image.

```
    RemoveCoordinateSystem();
```

Sets the current coordinate system to unknown.

```
    SpecifyCoordinateSystem("", "WGS84_coordinate_system");
```

Specifies the coordinate system to WGS84.

```
Transform("EPSG", "27700");
```

Transforms to the British National Grid Coordinate System.

```
app.activeDocument.rotateCanvas(-45);
```

Rotates the canvas counter clockwise 45 degrees.

```
}
```

Preferences

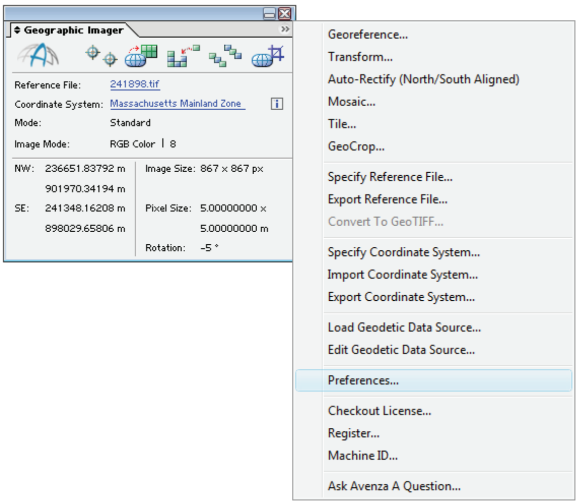
Geographic Imager offers the flexibility of user-defined preferences for a variety of functions to help you save time and customize Geographic Imager to your own personal liking.

In this chapter you will learn how to set the Geographic Imager Preferences and select the appropriate option for your needs.

The topic covered in this section is as follows:
Geographic Imager Preferences

Geographic Imager Preferences

Geographic Imager has preference settings that users may select and edit as desired. The Preferences panel can be accessed from the Geographic Imager panel options menu.



The following options may be adjusted according to individual preferences:

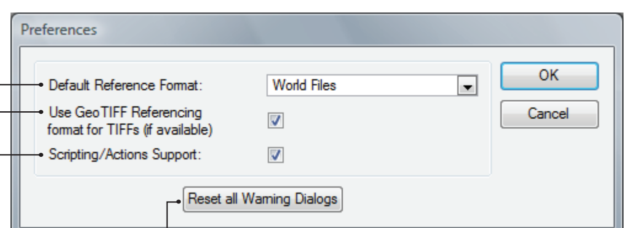
- Default Reference Formats
- Use GeoTIFF Referencing format for TIFFs
- Scripting / Action Support
- Reset all Warning Dialogs

Default Reference Formats - lists all the supported reference file formats (excluding GeoTIFF). When multiple reference files are found in the same directory the Reference File Ambiguity dialog box will be prompted listing the multiple reference files.

Use GeoTIFF Referencing - this option uses GeoTIFF as the referencing default. It overrides the selection from the drop-down list when a GeoTIFF is detected. This box is checked by default.

Scripting/Action Support check this option to disable/enable scripting/action functionality

Reset all Warning Dialogs - All Geographic Imager's warning dialogs that were disabled by checking "Don't show again" will be now enabled and will be shown the next time they are applicable



DEFAULT REFERENCE FORMATS

The options for Default Reference Formats are:

- World files
- MapInfo TAB files
- Blue Marble Reference files
- ER Mapper ERS files

When multiple reference files are found in the same directory the Reference File Ambiguity dialog box will be prompted listing the multiple reference files. The default reference format will be selected in the list, checking the option to always use the default reference format if available will not show the Reference File Ambiguity dialog box again and always use the default reference format.

Note: Only reference files with the same name as the image are listed in the Reference File Ambiguity dialog box. Reference files with a different name than the associated image will have to be specified manually.

When the *Use GeoTIFF Referencing format for TIFFs* check box is checked, it instructs Geographic Imager to use GeoTIFF as the referencing default and overrides the selection from the Default Reference Format drop-down list. This check box is checked by default.

SCRIPTING/ACTION SUPPORT

When the *Scripting/Action Support* check box is checked, automated functions within Geographic Imager will be enabled using scripts and actions.

Appendices

Appendix A - Technical Reference Guide

AFFINE AND POLYNOMIAL SOLUTION MODELS

Referencing method determines the mathematical model that is used to translate a coordinate of a pixel to the point on the plane of projection, or vice versa.

The most commonly user method is an affine referencing. Mathematically, an affine transformation is any transformation that preserves collinearity (i.e., all points lying on a line initially still lie on a line after transformation) and ratios of distances (e.g., the midpoint of a line segment remains the midpoint after transformation). In this sense, the regular maps we are working with are affinely referenced to their respective plane of projection. Any images that are open in the Standard mode, where only the transformation is being maintained, are affinely referenced. The affine method requires a minimum of three reference points defined and included in the reference point list. This transformation type should generally be applied when referencing large scale maps (1:100,000 or less) published in a nearly rectilinear map projection such as the Mercator or Transverse Mercator.

For the purpose of GCP transformations, a bigger number of points are commonly provided, and more precise polynomial approximations should be used, that can more correctly describe the referencing than the basic affine method. The basic rule is the more points are provided, the higher degree polynomial can be used as there is a minimal requirement on the number of points for each method:

- **Linear (first order) Polynomial Transform**: minimum of 3 points
- **Quadratic (second order) Polynomial Transform**: minimum of 6 points
- **Cubic (third order) Polynomial Transform**: minimum of 10 points
- **Quartic (fourth order) Polynomial Transform**: minimum of 15 points
- **Quintic (fifth order) Polynomial Transform**: minimum of 21 points

Please note that GCP transformation of an image with a large set of GCP points should provide the best results, but using an affine or a low-polynomial referencing is unlikely to take advantage of this additional data, and most likely the shape of the resultant image will be quite similar to the original one. This being said, having the sufficient number of points doesn't guarantee that the highest degree polynomial available will result in a plausible solution, so sometimes a trial-and-error approach should be followed.

Memory Considerations

RAM RECOMMENDATIONS

Occasional User
A minimum of 1 GB RAM is required. A graphics or GIS user who uses Geographic Imager with medium sized data sets including some low-resolution or small coverage raster images.

Power User
The recommended memory for a power user is 4 GB RAM or more. A professional cartographer who uses Geographic Imager daily and works with large image files.

RAM USAGE HINTS

Users often ask us why is so much RAM needed to operate Geographic Imager. First of all, Adobe Photoshop requires a significant amount of RAM itself in order to run smoothly. Secondly, imagery data sets are often large which increases the need for RAM even further. Image data sets contain raster data which must be stored in memory. Since we are adding georeferencing properties to Photoshop, this increases the file size, which increases the RAM requirements. Geographic Imager builds a mini-raster GIS application inside Photoshop so that it can georeference data sets and modify them according to various needs.
This also has some overhead.

In addition, Adobe Photoshop loads the entire file into memory rather than just reading it from disk, thus more RAM memory is required.

When you are importing a large number of files into Photoshop using Geographic Imager, you'll notice that the amount of available memory will decrease rapidly and your computer loses speed. This is due to the memory management. Geographic Imager reserves a fairly large amount of memory for each action, which may not properly returned when the procedure is done. The solution is simple: save your file, close it and open it again. It's not even necessary to close Photoshop itself. By closing the file, the reserved memory is properly returned.

RAM SAVING TIPS

Many raster data files are large and when a series of such files is opened, you may find that the program starts to run more slowly. This is because scratch and memory allocations are being used up. The best solution is to periodically save your work, quit out of Adobe Photoshop and then restart. This will free up the available scratch memory.

The minimum number of undos can be reduced (since they *all* reside in memory).

You can set a primary and secondary scratch disk under the Photoshop preferences option in order to draw additional storage from a partitioned or multi-drive environment.

Directory Listing

Adobe Photoshop Plug-Ins Directory (where XXX indicates the version):

Windows XP:
- Dutch: C:\Program Files\Adobe\Adobe Photoshop XXX\Insteekmodules
- English: C:\Program Files\Adobe\Adobe Photoshop XXX\Plug-Ins
- French: C:\Program Files\Adobe\Adobe Photoshop XXX\Modules externes
- German: C:\Programme\Adobe\Adobe Photoshop XXX\Zusatzmodule
- Italian: C:\Programmi\Adobe\Adobe Photoshop XXX\Plug-In

Mac OS X:
- /Applications/Adobe Photoshop XXX/Plug-Ins

Geographic Imager License File Location

The Geographic Imager license file must be located as follows (English version. May be different in other languages):

- **Windows XP**: C:\Documents and Settings\All Users\Application Data\Avenza\Geographic Imager
- **Windows Vista**: C:\Program Data\Avenza\Geographic Imager
- **Macintosh**: /Applications/Avenza/Geographic Imager/Geographic Imager Plug-In

Note: Power PC users using 10.4 will have to enter the IP address and not the server name in the floating license wizard. Some foreign language versions on 10.5 may also need the IP address to be entered instead of the server name.

Technical Support Options

Please consult this user guide as well as the following online options before contacting Avenza technical support as your situation may be easily addressed by one of the answers contained therein.

GEOGRAPHIC IMAGER USER FORUM

The Geographic Imager User Forum is located at *http://www.avenza.com/forum*. Answers to common technical questions may be found in the **Common Support Issues and FAQs** category. All users with a Geographic Imager license (evaluation or permanent) can post and read topics under the **General Questions for Evaluation and Licensed Users** category. Additionally, users with maintenance have access to the **Maintenance Users** category. There, users can find additional information relative to software updates and other important details pertaining to maintenance.

CONTACTING AVENZA TECHNICAL SUPPORT

Avenza offers a number of methods for direct communication with our qualified and experienced technical experts. Please have your Geographic Imager registration details handy to get prompt attention and include it in any email correspondence. Support issues are handled on a first come, first-served basis. Avenza does not guarantee a response within any specified time. For priority support consider joining the Geographic Imager Maintenance Program. Maintenance users can also post questions under the *Maintenance Users* category using the user form and Avenza support staff will post answers.

- Email: support@avenza.com
- Online form: www.avenza.com/support.form.html
- User forum: www.avenza.com/forum
- Phone: +1.416.487.6442 (free for Geographic Imager Maintenance Program subscribers. Others $49 USD per incident)

GEOGRAPHIC IMAGER MAINTENANCE PROGRAM (GIMP)

The Geographic Imager Maintenance Program is a subscription-based service plan that guarantees its members:

- Unlimited priority technical support - guaranteed same business day (9-4 EST) or next business day response
- GIMP only telephone support (+1-416-487-6442)
- Free Geographic Imager updates
- Free Geographic Imager version upgrades
- Additional discounts and offers available to GIMP members only

Your Geographic Imager purchase includes a one-year membership in the Geographic Imager Maintenance Program so you are well on the way to worry-free use of Geographic Imager and will be able to enjoy all the benefits of the GIMP immediately. All Geographic Imager Maintenance Program subscriptions begin on the date of purchase and run for one (1) calendar year.

Your email address has been automatically entered in the *gi-maintenance-l* online email list for GIMP subscribers so that you are assured of receiving all the latest GIMP news and access to all the update and upgrade files. If you purchased your Geographic Imager license from a reseller or are the end user but not the person who purchased the software, please contact us at **sales@avenza.com** to ensure that we receive your email address and add you to the GIMP notification group.

RENEWAL

Approximately 6-8 weeks prior to the expiration of your annual GIMP subscription you will be notified regarding renewal options. You will be contacted a minimum of five times prior to expiration in order to ensure that you have ample opportunity to renew or not at your discretion. You will have the option of renewing your GIMP for an additional year at the then prevailing price or canceling without penalty. Of course, if you cancel or let your GIMP lapse you will no longer be entitled to the benefits of the program as outlined above and will thus have to purchase future upgrades at the upgrade price.

There is a grace period of approximately 30 days from the time of the GIMP expiry during which you may still renew without penalty. All post-expiration renewals will be backdated to the actual expiry date.

LAPSED SUBSCRIPTIONS

Failure to renew your GIMP within 30 days from the expiry date will result in a lapsed GIMP subscription. Lapsed subscriptions may not be renewed and the licensee will be required to purchase support and upgrades accordingly. Please direct all GIMP questions and purchase inquiries to **info@avenza.com.**

WISHLIST

As either a new or experienced Geographic Imager user we value your opinions on how we can improve our product. Please let us know what functions you would like to see incorporated into future upgrades of Geographic Imager.

Post to our user forum with the subject "Feature Request" at **www.avenza.com/forum**

Coordinate Systems

This section will help to familiarize you with the common coordinate systems that are supported in Geographic Imager. You also can define your own additional custom coordinate systems.

GEODETIC

A Geodetic Coordinate System is a three-dimensional coordinate system defined by an ellipsoid, the equatorial plane of the ellipsoidal and a plane defined along the polar axis (a meridional plane).

Coordinates in a Geodetic Coordinate System are given by a geodetic latitude (the angle between the normal to the ellipsoid at a location and the equatorial plane), a geodetic longitude (the angle between the meridional reference plane and a meridional plane containing the normal to the ellipsoid at a location) and a geodetic height (the perpendicular distance of a location from the ellipsoid).

A geodetic datum is the only required defining parameter for a Geodetic Coordinate System in Geographic Imager. A geodetic datum defines constants that relate a Geodetic Coordinate System to the physical earth, the dimensions of the reference ellipsoid, the location of the origin of the system, and the orientation of the system.

A geodetic coordinate is specified in Geographic Imager by latitude, longitude, and ellipsoidal height values. Any angular unit defined within Geographic Imager may be used to specify latitude and longitude coordinates.

The ellipsoidal height of a location is defined as the elevation of the location above the geoid (essentially a modeled surface representing mean sea level) and the separation of the geoid surface from the ellipsoidal surface. Geographic Imager assumes a value of 0.0 if the ellipsoidal height of a location is unknown. Any distance unit defined within Geographic Imager may be used to specify ellipsoidal height values.

The New Zealand Map Grid

The North Island and South Island of New Zealand have been mapped on one projection with one grid known as the New Zealand Map Grid.

The projection adopted was derived from mathematical analysis to give a small range of scale variation over the land area of New Zealand. This has been achieved at the expense of abandoning the orderly arrangement of scale curves. Such a projection has no recognized name. It is simply called the New Zealand Map Grid projection. The projection is conformal but is unlike any other projection used for detailed mapping.

Easting values are always less than 5,000,000 meters and northing values are always greater than 5,000,000 meters.

There are no required parameters for defining a New Zealand Map Grid Coordinate System in Geographic Imager.

US State Plane

There are two State Plane Coordinate Systems defined in the United States, one based on the North American Datum of 1927 and the other based on the North American Datum of 1983.

Each of the State Plane Coordinate Systems divides the United States into over 130 sections, each with its own projection surface and grid network. With the exception of very narrow states, such as Delaware, New Jersey, and New Hampshire, most states divide into two to ten zones.

Zones extending primarily in an east-west direction are based on the Lambert Conformal Projection, while zones extending in a north-south direction are based on the Transverse Mercator Projection. Alaska, Florida and New York use both Transverse Mercator and Lambert Conformal for different areas. The Aleutian panhandle of Alaska uses the Oblique Mercator Projection.

Zone boundaries follow state and county lines and, because each zone is small, distortion is less than 1 in 10,000. Each zone has a centrally located origin and a central meridian that passes through the origin. The United States uses a two-zone numbering system: The United States Geological Survey (USGS) Code System and the National Ocean Service (NOS) Code System. However, other code systems do exist. The State Plane zone is the only required defining parameter for any of the State Plane Coordinate Systems supported in Geographic Imager.

We strongly recommend the use the NGS NACOM geodetic datum transformation method when converting state plane coordinates. However, you may use the Moldensky method when converting state plane coordinate system of 1927 coordinates and select one of the defined set of NAD27 datum transformations.

A State Plane coordinate is specified in Geographic Imager by northing and easting values. The U.S. Survey Foot is the standard unit in the State Plane Coordinate System of 1927. The meter is the standard unit in the State Plane Coordinate System of 1983. Any distance unit defined within Geographic Imager may be used to specify State Plane coordinates.

Map Projections

This section helps you become familiar with the map projections that are supported in Geographic Imager.

Aitoff

The Aitoff projection is a modified azimuthal projection that is neither conformal nor equal area. It was developed by David Aitoff (or Altow) in 1889. The central meridian is a straight line half the length of the equator. Other meridians are equally spaced along the equator and concave toward the central meridian. The equator is straight. Other parallels are equally spaced along the central meridian and concave toward the nearest pole. The poles are represented by points. This projections is symmetrical about the equator and the central meridian. Scale is true along the equator and the central meridian. This projection is supported on spheres only.

The Aitoff projection requires the following parameters:

- Longitude of the Center of the Projection
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Alaska State Plane 27

The State Plane Coordinate System (SPCS) is not a projection; rather it is a system for specifying positions of geodetic stations using plane rectangular coordinates. This coordinate system that divides all fifty states of the United States, Puerto Rico and the U.S. Virgin Islands into over 120 numbered sections, referred to as zones. Each zone has an assigned code number that defines the projection parameters for the region.

There are four possible projections for SPCS. The geometric direction of each state determines the projection utilized. For states that are longer in the east-west direction, the Lambert Conformal Conic is used. States which are longer in the north-south direction use the Transverse Mercator Projection. The panhandle of Alaska, which the sole distinction of lying at an angle, garners the use of the Oblique Mercator Projection. While Guam uses a Polyconic projection

The formulae for these calculations are based on Publication 62-4, State Plane Coordinates by Automatic Data Processing, U.S. Department of Commerce 1968. These projections should only be used for data that has been computed using this method. For all other state plane calculations use Exact Methods. The parameters for these coordinate systems are defined in Publication 62-4. For further information, contact the U.S. Department of Commerce.

The Alaska27 Projection is hardcoded and does not require any parameters.

Albers Equal-Area Conic

The Albers Equal-Area Conic projection is a map projection in which the parallels are unequally spaced arcs of concentric circles spaced closer to each other near the north and south edges of the map. The meridians are equally spaced and intersect the parallels at right angles.

The Albers Equal-Area Conic projection is used for equal-area maps of regions with predominant east-west expanse, such as the United States. It is used exclusively by the USGS for sectional maps of all 50 states. When *Albers Equal Area* is selected in the *Edit Geodetic Data Source* dialog box the following parameters will need to be entered:

- False Northing and False Easting
- Latitude of Southern Standard Parallel
- Latitude of Northern Standard Parallel
- Longitude of the Central Meridian
- Latitude of the Origin of the Projection

Azimuthal Equal Area

The Azimuthal Equal Area projection is an equal-area projection with the azimuthal property showing true directions from the center of the projection. Its scale at a given distance from the center varies less from the scale at the center than the scale of any of the other azimuthal projections.

When *Azimuthal Equal Area* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Center of the Projection
- Latitude of the Center of the Projection

Azimuthal Equal Area (Polar Aspect)

The Azimuthal Equal Area (Polar Aspect) projection is an equal-area projection with the azimuthal property showing true directions from the center of the projection. Its scale at a given distance from the center varies less from the scale at the center than the scale of any of the other azimuthal projections. All meridians in the polar aspect are straight lines.

The *PolarAzimuthalEqualArea* projection has the following parameters:

- Longitude of Origin
- Latitude of Origin
- False Northing
- False Easting

Azimuthal Equidistant

The Azimuthal Equidistant projection is neither an equal-area nor a conformal projection. The outer meridian of a hemisphere on the equatorial aspect is a circle. Distances and directions measured from the center are true. We recommend using the Azimuthal Equidistant projection for coordinate systems in which distances are measured from an origin.

The Azimuthal Equidistant projection is used in oblique aspect for atlas maps of continents, and in world maps for aviation.

When *Azimuthal Equidistant* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Central Meridian
- Latitude of Origin of Projection

Azimuthal Equidistant (Polar Aspect)

The Azimuthal Equidistant (Polar Aspect) projection is neither an equal-area nor a conformal projection. The outer meridian of a hemisphere on the equatorial aspect is a circle. Parallels on the polar projection are circles spaced at equidistant intervals. All meridians on the polar aspect are straight lines. Distances and directions measured from the center are true.

The Azimuthal Equidistant (Polar Aspect) projection is used in the polar aspect for world maps and maps of the polar hemispheres.

The *PolarEquidistant* projection has the following parameters:

- Longitude of the Central Meridian
- Latitude of the Origin of the Projection
- False Easting
- False Northing

Behrmann

The Behrmann projection is a variation of the generic Equal Area Cylindrical, in which the latitude of the standard parallel is always 30 degrees. It was originally presented by Walter Behrmann in Berlin in 1910.

The Equal-Area Cylindrical projection represents an orthographic projection of a sphere onto a cylinder. Like other regular cylindrical projections, the graticule of the normal Equal-Area Cylindrical projection consists of straight equally spaced vertical meridians perpendicular to straight unequally spaced horizontal parallels. To achieve equality of area, the parallels are spaced form the equator in proportion to the sine of the latitude. This is the simplest equal-area projection. This projection is supported on spheres only.

The Behrmann projection has the following parameters:

- Longitude of the Central Meridian
- False Easting
- False Northing

Belgium 72

The Belgium 72 projection is a special case of the Lambert Conformal Conic (2-parallel) projection.

The *Belgium72* projection has the following parameters:

- Longitude of the Central Meridian
- Latitude of the Origin of the Projection
- Latitude of Southern Standard Parallel
- Latitude of Northern Standard Parallel
- False Easting
- False Northing

Bipolar Oblique Conic Conformal

This conformal projection was constructed specifically for mapping North and South America. It is composed of two oblique adaptations of the Lambert Conformal Conic projection. The juncture of the two conic projections consists of a great circle arc cutting through Central America from southwest to northeast. There is a slight mathematical discontinuity along this arc, which is resolved by an adjustment that leaves a small intermediate area slightly non-conformal. The earth is treated as a sphere by this projection, due to the relatively small scale of the map.

The *Bipolar Oblique Conformal Conic* projection has no parameters, as the poles and parallels used by the conic projections are set to specific values.

Bonne

The Bonne projection is psuedoconical and equal-area. The central meridian is a straight line. Other meridians are complex curves. Parallels are concentric circular arcs, but the poles are points. Scale is true along the central meridian and along all parallels. There is no distortion along the central meridian and along the standard parallel.

The Bonne projection is used for atlas maps of continents and for topographic mapping of some countries.

When *Bonne* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting

- Longitude of the Central Meridian
- Latitude of Standard Parallel

Cassini

The Cassini projection is a cylindrical projection. It is neither equal-area or conformal. The central meridian, each meridian 90 degrees from the central meridian and the equator are straight lines. Other meridians and parallels are complex curves. Scale is true along the central meridian and along lines perpendicular to the central meridian. Scale is nearly constant but not true along lines parallel to the central meridian.

The Cassini projection has been used for topographic mapping in England and currently in a few other countries.

When *Cassini* is selected in the *Edit Geodetic Data Source* dialog box the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Central Meridian
- Latitude of True Scale

Craster Parabolic

The Craster Parabolic projection is a pseudocylindrical, equal area projection used for thematic world maps in textbooks. It was originally presented by John Evelyn Edmund Craster in 1929. It was further developed by Charles H. Deetz and O.S. Adams in 1934. The central meridian is a straight line half as long as the equator. Other meridians are equally spaced parabolas intersecting at the poles and concave toward the central meridian. The parallels are unequally spaced, farthest apart near the equator. They run perpendicular to the central meridian. This projection is symmetrical about the central meridian or the equator. Scale is true along latitudes 36°46′ N and S, and constant along any given latitude. This projection is supported on spheres only.

This projection is also known as Putniņš P4, which was independently presented in Latvia in 1934.

The *CrasterParabolic* projection has the following parameters:

- Longitude of the Central Meridian
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Danish System 34

(Pre-1999 variation, using order 11 polynomial)

This projection is a variation of the Transverse Mercator projection used in Denmark, and is also referred to as UTS34. The projection consists of a base UTM (zones 32 & 33) calculation, which is then adjusted by an order 11 polynomial.

The polynomials used in the Danish System 34 projection were developed by K. Poder and K. Engsager of Kort & Matrikelstyrelsen. The polynomial coefficients can be obtained by contacting Kort & Matrikelstyrelsen.

Note that this projection was superseded in 1999, by a newer version that uses an order 13 polynomial to further adjust the results achieved using this projection.

The *DanishSystem34* Projection has the following parameters:

- Region

The *Region* parameter is used to indicate which part of Denmark the projection is being applied to. The valid region values are as follows:

Region	Key
Jylland	"j", "J", or "1"
Sjælland	"s", "S", or "2"
Bornholm	"b", "B", or "3"
National	"u", "U", or "4"

Danish System 34 (1999)

(1999 variation, using order 13 polynomial)

This projection is a variation of the Transverse Mercator projection used in Denmark. The projection consists of a base UTM (zones 32 & 33) calculation, which is then adjusted by an order 11 polynomial, and then further adjusted by an order 13 polynomial.

Note that a previous version of this projection was used up until 1999, based solely on the order 11 polynomial. This newer version is a further refinement of those results using the additional order 13 polynomial.

The polynomials used in the Danish System 34 projection were developed by K. Poder and K. Engsager of Kort & Matrikelstyrelsen. The polynomial coefficients can be obtained by contacting Kort & Matrikelstyrelsen.

The *DanishSystem34_99* Projection has the following parameters:

- Region

The *Region* parameter is used to indicate which part of Denmark the projection is being applied to. The valid region values are as follows:

Region	Key
Jylland	"j", "J", or "1"
Sjælland	"s", "S", or "2"
Bornholm	"b", "B", or "3"
National	"u", "U", or "4"

Double Stereographic

The Double Stereographic projection consists of two mappings. First, the ellipsoidal data is mapped to a conformal sphere. Then a second conformal mapping is done of the spherical data to the plane.
This projection is used in New Brunswick, Canada.

When *Double Stereographic* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Scale Reduction Factor at the Center of the Projection
- Longitude of the Center of the Projection
- Latitude of the Center of the Projection

Eckert I

The Eckert I projection is a pseudocylindrical projection that is neither conformal nor equal area. This projection was presented by Max Eckert in 1906, and is generally used for novelty maps of the world showing a straight-line graticule.

Meridians in this projection are represented by equally spaced converging straight lines broken at the equator. The central meridian is half as long as the equator. Parallels are represented by equally spaced straight parallel lines that are perpendicular to the central meridian. Poles are represented by lines half as long as the equator. This projection is symmetrical about the central meridian or the equator. Scale is true along latitudes 47°10′ N and S, and constant along any given latitude or meridian.

The *EckertI* projection has the following parameters:

- Longitude of the Center of the Projection
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system, wherein this projection is incorporated.

Eckert II

The Eckert II projection is a pseudocylindrical projection that is equal area. This projection was presented by Max Eckert in 1906, and is generally used for novelty maps of the world showing a straight-line equal area graticule.

Meridians in this projection are represented by equally spaced converging straight lines broken at the equator. The central meridian is half as long as the equator. Parallels are represented by unequally spaced straight parallel lines that are perpendicular to the central meridian. Poles are represented by lines half as long as the equator. This projection is symmetrical about the central meridian or the equator. Scale is true along latitudes 55°10′ N and S, and constant along any given latitude.

This projection is supported on spheres only.

The *Eckert II* projection has the following parameters:

- Longitude of the Center of the Projection
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Eckert III

The Eckert III projection is a pseudocylindrical projection that is neither conformal nor equal area. This projection was presented by Max Eckert in 1906 and is used primarily for world maps.

Meridians in this projection are equally spaced semi-ellipses, concave toward the central meridian.
The central meridian is a straight line half as long as the equator. Parallels are represented by equally spaced straight parallel lines that are perpendicular to the central meridian. Poles are represented by lines half as long as the equator. This projection is symmetrical about the central meridian or the equator. Scale is true along latitudes 35°58′ N and S, and constant along any given latitude.

The *Eckert III* projection has the following parameters:

- Longitude of the Center of the Projection
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Eckert IV

The Eckert IV and Eckert VI were created by Max Eckert in 1906, and are used for world maps. Both are pseudocylindrical projections whose central meridian is a straight line. 180th meridians of the Eckert IV projection are semicircle, and all other meridians are equally spaced elliptical arcs. The parallels are unequally spaced straight lines parallel to one another, and the poles are straight lines half as long as the equator. Scale is true along latitude 40º30' for the Eckert IV.

The *Eckert IV* projection has the following parameters:

- Longitude of the Central Meridian
- Latitude of Origin
- Radius of the Sphere
- False Northing
- False Easting

Note: If the *spherical_radius* parameter is set to a value greater than zero, then it will be used as the radius of the sphere. If this parameter is set to a value less than or equal to zero, then the semi-major radius of the ellipsoid will be used as the radius of the sphere.

Eckert VI

The Eckert IV and Eckert VI were created by Max Eckert in 1906, and are used for world maps. Both are pseudocylindrical projections whose central meridian is a straight line. Meridians on the Eckert VI projection are equally spaced sinusoidal curves. In both projections, the parallels are unequally spaced straight lines parallel to one another, and the poles are straight lines half as long as the equator. Scale is true along latitude 49º16' for Eckert VI.

The *Eckert VI* projection has the following parameters:

- Longitude of Origin
- Latitude of Origin
- Radius of Sphere
- False Easting
- False Northing

Note: If the *spherical_radius* parameter is set to a value greater than zero, then it will be used as the radius of the sphere. If this parameter is set to a value less than or equal to zero, then the semi-major radius of the ellipsoid will be used as the radius of the sphere.

EOV (Egyseges Orszagos Vetulet)

The Egyseges Orszagos Vetulet (EOV) is a conformal cylindrical projection in transversal position used uniformly for the Hungarian civilian base maps and, in general, for spatial informatics. The current implementation for the *EgysegesOrszagosVetulet* projection does not require any user defined parameters.

Equal-Area Cylindrical

The Equal-Area Cylindrical projection represents an orthographic projection of a sphere onto a cylinder. Like other regular cylindrical projections, the graticule of the normal Equal-Area Cylindrical projection consists of straight equally spaced vertical meridians perpendicular to straight unequally spaced horizontal parallels. To achieve equality of area, the parallels are spaced form the equator in proportion to the sine of the latitude. This is the simplest equal-area projection.

When *Equal-Area Cylindrical* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Central Meridian
- Latitude of the Standard Parallel

Equidistant Conic

The Equidistant Conic is the simplest kind of conic projection. It is the projection most likely to be found in atlases of small countries, with its equally spaced straight meridians and equally spaced circular parallels.

When *Equidistant Conic* is selected in the *Edit Geodetic Data Source* dialog box, enter values for the following parameters:

- False Northing and False Easting
- Longitude of the Central Meridian
- Latitude of the Origin of the Projection
- Latitude of the Southern Standard Parallel
- Latitude of the Northern Standard Parallel

Equidistant Cylindrical

The Equidistant Cylindrical projection is probably the simplest of all map projections to construct and one of the oldest. Meridians and parallels are equidistant straight lines, intersecting at right angles. Poles are shown as lines. This projection is used only in spherical form.
If the equator is made the standard parallel, true to scale and free of distortion, the meridians are spaced at the same distances as the parallels, and the graticule appears square. This form is often called the Plate Carree or the Simple Cylindrical Projection.

When *Equidistant Cylindrical* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- Radius of the Sphere

- False Northing and False Easting
- Longitude of the Central Meridian
- Latitude of True Scale

Note: Only a spherical form of this projection is used. The radius of the sphere is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated. You are required to specify a geodetic datum when you use this projection as part of a coordinate system in order to perform geodetic datum shifts into other coordinate systems.

European Stereographic

The European Stereographic projection is a derivation of the Stereographic projection for use in the Netherlands. When *European Stereographic* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Latitude of the Center of the Projection
- Longitude of the Center of the Projection
- Scale Reduction Factor at the Center of the Projection

Fuller (Dymaxion)

R. Buckminster Fuller's Dymaxion Projection is a method of projecting the spherical earth onto a twenty-sided polyhedron known as an icosahedron. This icosahedron is then unfolded in such a way that the major land masses will appear whole, without the map borders breaking them apart. More information may be found at the Buckminster Fuller Institute (**www.bfi.org**). The *Fuller* projection has no parameters.

Note: The present Fuller projection only works on small scale datasets, that are contained in one of the grid faces of the projection. Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

For more information about the map and the work of Buckminster Fuller, visit the Buckminster Fuller Institute at www.bfi.org.

Gall Stereographic

The Gall Stereographic projection is a cylindrical perspective projection that is neither conformal nor equal area. It is produced geometrically by projecting the Earth perspectively from the point on the equator opposite a specified meridian, onto a secant cylinder cutting the globe at latitudes 45° N and S. It was presented by James Gall in 1855. It is sometimes known simply as the Gall projection, or as Gall's Stereographic projection. This projection is used primarily for world maps in British atlases and some other atlases. It resembles the Mercator, but has less distortion of scale and area near the poles.

The meridians in the Gall Stereographic projection are equally spaced straight parallel lines .77 as long as the equator. Parallels are unequally spaced straight parallel lines perpendicular to meridians. The poles are represented by straight lines equal in length to the equator. The projection is symmetrical about any meridian or the equator. Scale is true along latitudes 45° N and S in all directions, and is constant in any given direction along any other latitude. There is no distortion at latitudes 45° N and S, but shape, area and scale distortion increase moderately away from these latitudes and become severe at the poles.

The *GallStereographic* projection has the following parameters:

- Longitude of Origin
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Gnomic

The Gnomic projection is used for plotting great circle arcs as straight lines on a map. Scale, shape and area are badly distorted along these paths, but the great circle routes are precise in relation to the sphere.

When *Gnomic* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Latitude of the Center of the Projection
- Longitude of the Center of the Projection
- Radius of the Sphere

Goode Homolosine

The Goode Homolosine projection is a pseudocylindrical composite projection that is equal area. It is used primarily for world maps in a number of atlases, including Goode's Atlas (Rand McNally). It was developed by J. Paul Goode in 1923 as a merging of the Mollweide (or Homolographic) and sinusoidal projections, thus giving rise to the name "Homolosine".

Each of the six central meridians is a straight line 0.22 as long as the equator, but not crossing the equator. Other meridians are equally spaced sinusoidal curves between latitudes 40°44' N and S. The poles are represented by points. Scale is true along every latitude between 40°44' N and S and along the central meridian within the same latitude range.

The *GoodeHomolosine* projection has the following parameters:

- Longitude of Origin
- False Northing
- False Easting

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Guam State Plane 27

The State Plane Coordinate System (SPCS) is not a projection; rather it is a system for specifying positions of geodetic stations using plane rectangular coordinates. This coordinate system that divides all fifty states of the United States, Puerto Rico and the U.S. Virgin Islands into over 120 numbered sections, referred to as zones. Each zone has an assigned code number that defines the projection parameters for the region.

There are four possible projections for SPCS. The geometric direction of each state determines the projection utilized. For states that are longer in the east-west direction, the Lambert Conformal Conic is used. States which are longer in the north-south direction use the Transverse Mercator Projection. The panhandle of Alaska, which the sole distinction of lying at an angle, garners the use of the Oblique Mercator Projection. While Guam uses a polyconic projection.

The formulae for these calculations are based on Publication 62-4, *State Plane Coordinates by Automatic Data Processing*, U.S. Department of Commerce 1968. These projections should only be used for data that has been computed using this method. For all other state plane calculations use Exact Methods. The parameters for these coordinate systems are defined in Publication 62-4. For further information contact the U.S. Department of Commerce.

The *Guam27* Projection does not require any parameters.

Hammer Aitoff

The Hammer Aitoff (or simply Hammer) projection is a modified azimuthal projection that is equal area. H.H. Ernst von Hammer developed it in 1892. It is used most often for whole-world maps.

In this projection, the central meridian is depicted as a straight line half the length of the equator. Other meridians are depicted as complex curves, unequally spaced along the equator and concave toward the central meridian. The equator is straight. Other parallels are depicted as complex curves, unequally spaced along the central meridian and concave toward the nearest pole. The poles themselves are represented by points. This projection is symmetrical about the central meridian and the equator. Scale decreases along the central meridian and the equator as you move away from the center.

This projection has moderate distortion, with less shearing action on the outer meridians near the poles than may be found in pseudocylindrical projections.

The *HammerAitoff* projection has the following parameters:

- Longitude of Origin
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Hotine Oblique Mercator (Rectified Skew Orthomorphic)

The Hotine Oblique Mercator (HOM) projection is a cylindrical, conformal map projection. It is similar to the Mercator projection, except that the cylinder is wrapped around the sphere so that it touches the surface along the great circle path chosen for the central line, instead of along the earth's equator.

Scale becomes infinite 90 degrees from the central line and is true along a chosen central line, along two straight lines parallel to the central line, or along a great circle at an oblique angle.

The HOM projection is used for geographic regions that are centered along lines that are neither meridians nor parallels, but that may be taken as great circle routes passing through the region, such as the Alaskan panhandle.

Two cases of the Hotine Oblique Mercator projection are implemented within Geographic Imager, differing only in their defining parameters.

When *Hotine Oblique Mercator (2 Points)* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the First Point
- Latitude of the Origin of the Projection
- Latitude of the Second Point
- Latitude of the First Point
- Longitude of the Second Point

The Rectified Skew Orthomorphic (RSO) projection is used throughout the world, particularly in Malaysia. The RSO projection is equivalent to a HOM projection except that the defining parameters are different. You can specify a HOM projection by specifying a point and the azimuth defining the central line.

This case allows for the entering of parameters for the RSO projection. When *Hotine Oblique Mercator (1 Point & Azimuth)* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Azimuth of the Central Line

- Latitude of the Origin of the Projection
- Longitude at the Center of the Projection
- Scale Factor at the Center of the Projection
- Skew Azimuth

Note: The *Skew Azimuth* parameter is essential for correct rectified to skew coordinate transformation. If you have researched a coordinate system and there is no defined skew angle simply enter the azimuth of the central line as the skew angle. This will provide for an identity rectified to skew transformation.

IMW Polyconic

The IMW Polyconic projection is a modified polyconic projection devised as a basis for the 1:1,000,000 scale International Map of the World (IMW) series. The IMW Polyconic projection differs from the ordinary polyconic in two principle ways: all meridians are straight and two meridians are made true to scale.

When *IMW Polyconic* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Latitude of the Northern Standard Parallel
- Longitude of Central Meridian
- Longitude of the Meridian True to Scale
- Latitude of the Southern Standard Parallel

Krovak

The Krovak Projection was created and used in Czechoslovakia in the early part of the 20th century. It is an oblique version of the Lambert Conformal Conic projections with a pseudo standard parallel that intersects the centerline of the projection at a defined azimuth. The projection accurately preserves scale and area along the pseudo standard parallel. It is primarily used in the Czech Republic.

When *Krovak* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Latitude of True Scale
- Origin Latitude
- Origin Longitude (centerline)
- Azimuth

Laborde

The Laborde Projection is an Oblique Mercator projection that is primarily used in Madagascar. It is a cylindrical, conformal map projection similar to the Mercator system, except the cylinder is wrapped around the sphere so that it touches the surface along the great circle path at a chosen azimuth from the centerline. It was adopted for use in the Madagascar grid system in 1926.

When *Laborde* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Scale Factor
- Origin Latitude
- Origin Longitude (centerline)
- Azimuth

Lambert Conformal Conic (1 parallel)

The Lambert Conformal Conic (1 parallel) projection is a map projection in which the scale is true along a single standard parallels, and the true shape of small areas is preserved. Parallels are unequally spaced arcs of concentric circles spaced closer to each other near the center of the map. The meridians are equally spaced and intersect the parallels at right angles.

Coordinate systems based on this projection are used extensively in France.

When *Lambert Conformal Conic (1 parallel)* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Latitude of the Origin of the Projection
- Longitude of the Center of the Projection
- Scale Factor at the Center of the Projection

Lambert Conformal Conic (2 parallels)

The Lambert Conformal Conic (2 parallel) projection is a map projection in which the scale is true along two standard parallels, and the true shape of small areas is preserved. Parallels are unequally spaced arcs of concentric circles spaced closer to each other near the center of the map. The meridians are equally spaced and intersect the parallels at right angles. The scale is true along two standard parallels.

The Lambert Conformal Conic projection is widely used in atlases, in aeronautical charts, and in plane coordinate systems in surveying. It is also used in the State Plane Coordinate System for states with large east-west extents.

When *Lambert Conformal Conic (2 parallel)* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Latitude of the Southern Standard Parallel
- Latitude of the Northern Standard Parallel
- Longitude of the Central Meridian
- Latitude of the Origin of the Projection

Lambert Conformal Conic Extended

This is a variation of the standard Lambert Conformal Conic projection that is provided for the definition of coordinate systems used in specific counties in the U.S. states of Minnesota and Wisconsin. Within a specific county in one of these states, the ellipsoid must be expanded by an additional amount to account for the average elevation within that county. In the case of a Wisconsin county, the ellipsoid must also be adjusted based on the average geoid height for that county. For Minnesota counties, the average geoid height should be set to zero.

The *LambertConformalConicExtended* projection has the following parameters:

- Longitude of Origin
- False Northing
- Latitude of Origin
- Average Elevation (Minnesota and Wisconsin)
- Scale Factor at projection center
- Average Geoid Height (Wisconsin-only)
- False Easting

Lambert State Plane 27

The State Plane Coordinate System (SPCS) is not a projection; rather it is a system for specifying positions of geodetic stations using plane rectangular coordinates. This coordinate system that divides all fifty states of the United States, Puerto Rico and the U.S. Virgin Islands into over 120 numbered sections, referred to as zones. Each zone has an assigned code number that defines the projection parameters for the region.

There are four possible projections for SPCS. The geometric direction of each state determines the projection utilized. For states that are longer in the east-west direction, the Lambert Conformal Conic is used. States that are longer in the north-south direction use the Transverse Mercator Projection. The panhandle of Alaska, which has the sole distinction of lying at an angle, garners the use of the Oblique Mercator Projection. Conversely Guam uses a Polyconic projection.

The formulae for these calculations are based on Publication 62-4, *State Plane Coordinates by Automatic Data Processing*, U.S. Department of Commerce 1968. These projections should only be used for data that has been computed using this method. For all other state plane calculations use Exact Methods. The parameters for these coordinate systems are defined in Publication 62-4. For further information contact the U.S. Department of Commerce. The *Lambert27* projection does not require any parameters.

Loximuthal

The Loximuthal projection is a pseudocylindrical projection that is neither conformal nor equal area. It was presented by Karl Siemon in 1935, and independently as "Loximuthal" by Waldo R. Tobler. This projection has the special feature that loxodromes (rhumb lines) from the central point (the intersection of the central meridian and central latitude) are shown straight, true to scale, and correct in azimuth from the center. The azimuths with respect to other points along a rhumb line, however, are not shown correctly, due to angular distortion on the map projection.

The central meridian in the Loximuthal projection is a straight line generally over half as long as the equator (depending on the central latitude). Other meridians are depicted as equally spaced complex curves that are concave toward the central meridian and which intersect at the poles. The parallels are equally spaced straight parallel lines running perpendicular to the central meridian. The poles are represented as points. The projection in symmetrical about the central meridian, and around the equator in the case where the central latitude is the equator. Scale is true along the central meridian, and is constant along any given latitude. Distortion varies from moderate to extreme, and is absent only at the intersection of the central latitude and central meridian.

The *Loximuthal* projection has the following parameters:

- Longitude of Origin
- Latitude of Origin
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

McBryde-Thomas Flat-Polar Quartic

The McBryde-Thomas Flat-Polar Quartic Projection is a pseudocylindrical, equal area projection. It was presented by F. Webster McBryde and Paul D. Thomas in 1949. It is primarily used for examples in various geography textbooks, and is sometimes known simply as the Flat-Polar Quartic projection.

The central meridian is a straight line 0.45 as long as the equator. Other meridians are fourth-order (quartic) curves that are equally spaced and concave toward the central meridian. The parallels are unequally spaced straight parallel lines, spaced farthest apart near the equator and running perpendicular to the central meridian. The poles are represented by lines one-third as long as the equator.

Scale is true along latitudes 33°45′ N and S, and is constant along any given latitude. Distortion is severe near the outer meridians at high latitudes. This projection is free of distortion only at the intersection of the central meridian with latitudes 33°45′ N and S.

The *McBrydeThomasFlatPolarQuartic* projection has the following parameters:

- Longitude of Origin
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Mercator

The Mercator projection is a cylindrical, conformal map projection in which meridians and parallels are straight lines that cross at 90-degree angles. Angular relationships are preserved. To preserve conformality, parallels are placed increasingly farther apart with increasing distance from the equator. This results in extreme distortion at high latitudes. Scale is true along the equator or along two parallels equidistant from the equator.

Despite its drawbacks, the Mercator projection is quite useful for navigation because rhumb lines, which show constant direction, are straight. The Mercator projection is also appropriate for conformal maps of equatorial regions.

When *Mercator* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Central Meridian
- Latitude of True Scale

Military Grid Reference System

The Military Grid Reference System projection is an extension of the UTM system (between 80° south and 80° north latitude) which uses a standard-scaled grid square, based on a point of origin on a map projection of the surface of the Earth in an accurate and consistent manner to permit either position referencing or the computation of direction and distance between grid positions. The *MilitaryGridReferenceSystem* projection has no parameters.

Miller Cylindrical

Meridians and parallels are straight lines, intersecting at right angles on the Miller Cylindrical projection. Poles are shown as lines. This projection is used only in spherical form and provides a compromise between Mercator and other cylindrical projections.

When *Miller Cylindrical* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- Radius of the Sphere
- Longitude of the Central Meridian
- False Northing and False Easting

Note: Only a spherical form of this projection is used. The radius of the sphere is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated. You are required to specify a geodetic datum when you use this projection as part of a coordinate system in order to perform geodetic datum shifts into other coordinate systems.

Mollweide

The Mollweide projection is a pseudocylindrical equal-area projection. The central meridian is a straight line, 90th meridians are circular arcs, and all other meridians are equally spaced elliptical arcs. Parallels are unequally spaced straight lines, parallel to each other. Poles are shown as points. This projection is used only in spherical form. When *Mollweide* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- Radius of the Sphere
- Longitude of the Central Meridian
- False Northing and False Easting

Note: Only a spherical form of this projection is used. The radius of the sphere is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated. You are required to specify a geodetic datum when you use this projection as part of a coordinate system in order to perform geodetic datum shifts into other coordinate systems.

New Zealand Map Grid

The New Zealand Map Grid (NZMG) is a projection that is used to convert latitudes and longitudes to easting and northing coordinates used for most mapping of New Zealand. The projection is unique to New Zealand. It was designed by Dr W. I. Reilly (1973) to minimize the scale error over the land area of the country.

The *NewZealandMapGrid* projection has the following parameters:

- Longitude of NZMG Origin
- Latitude of NZMG Origin
- False Easting
- False Northing

Oblique Mercator Azimuth

The Oblique Mercator projection is a cylindrical, conformal map projection. It is similar to the Mercator projection, except that the cylinder is wrapped around the ellipsoid so that it touches the surface along the great circle path chosen for the central line, instead of along the earth's equator. Scale becomes infinite 90 degrees from the central line and is true along a chosen central line, along two straight lines parallel to the central line, or along a great circle at an oblique angle. The Oblique Mercator projection is used for geographic regions that are centered along lines that are neither meridians nor parallels, but that may be taken as great circle routes passing through the region, such as the Alaskan panhandle. In this variation of the Oblique Mercator projection, a point and an azimuth define the central line where the cylinder touches the ellipsoid.

The planar points determined by this projection may be left "unrectified" (often these are referred to as the u, v coordinates in published formula) or they may be "rectified" (often these are referred to as the x, y coordinates in published formula). Rectification consists of rotating the coordinates by a certain angle. This implementation of the Oblique Mercator projection allows for a flag to be set to determine if the points should be rectified, or not. By default, the points will be rectified. If an unrectified version of the projection is desired, the "Unrectified Flag" parameter should be set to 1.5In the case where the points are rectified, the angle of rotation may be one of three values. Most commonly, it may be a user-specified rotation, or a rotation such that the y-axis will be parallel to the meridian through the center of the projection (the angle used in this case is often referred to in published formula as alpha). Less commonly, it may be a rotation such that the y-axis will be parallel to the meridian through the natural origin of the projection (the angle used in this case is often referred to in published formula as gamma).

If the *Rotation Angle* parameter is a non-zero number, it will be used in the rectification. If the *Rotation Angle* is zero, the default behavior will be to rectify so that the y-axis will be parallel to the meridian through the center of the projection. If it is desired that the rectification cause the y-axis to be parallel to the meridian through the natural origin of the projection, the *Use Gamma Flag* parameter should be set to 1.

By default, the planer coordinates will be provided in terms of the natural origin of the projection. Alternately, they may be shifted based on the center of the projection. If it is desired that the coordinates be shifted, the *Center Flag* parameter should be set to 1. Note that this is only an option in the Oblique Mercator Azimuth projection, and is not currently supported in the Two Point case.

By default, the *Azimuth* parameter provided is assumed to be the angle at the center of the projection (alpha). However, there may be times when you want instead to specify the angle at the natural origin of the projection (gamma). Since each angle may be computed based on the other, either one can be specified when define the projection. If the *Azimuth Is Gamma* flag is set, it is assumed that the value passed in via the *Azimuth* parameter is the angle at the natural origin of the projection (gamma). Otherwise, it is assumed that the value passed in via the "Azimuth" parameter is the angle at the center of the projection (alpha).

The *ObliqueMercatorAzimuth* Projection has the following parameters:

- Longitude at the Center of the Projection
- Latitude of the Origin of the Projection
- Azimuth of the Central Line
- Scale Factor at the Center of the Projection
- False Easting
- False Northing
- Rotation Angle (Defaults to 0)
- Unrectified Flag (Defaults to 0)
- Use Gamma Flag (Defaults to 0)
- Center Flag (Defaults to 0)
- Azimuth is Gamma (Defaults to 0)

Oblique Mercator Two Points

The Oblique Mercator projection is a cylindrical, conformal map projection. It is similar to the Mercator projection, except that the cylinder is wrapped around the ellipsoid so that it touches the surface along the great circle path chosen for the central line, instead of along the earth's equator. Scale becomes infinite 90 degrees from the central line and is true along a chosen central line, along two straight lines parallel to the central line, or along a great circle at an oblique angle. The Oblique Mercator projection is used for geographic regions that are centered along lines that are neither meridians nor parallels, but that may be taken as great circle routes passing through the region, such as the Alaskan panhandle. In this variation of the Oblique Mercator projection, two points define the central line where the cylinder touches the ellipsoid.

The planar points determined by this projection may be left "unrectified" (often these are referred to as the u, v coordinates in published formula) or they may be "rectified" (often these are referred to as the x, y coordinates in published formula). Rectification consists of rotating the coordinates by a certain angle. This implementation of the Oblique Mercator projection allows for a flag to be set to determine if the points should be rectified, or not. By default, the points will be rectified. If an unrectified version of the projection is desired, the "Unrectified Flag" parameter should be set to 1.

In the case where the points are rectified, the angle of rotation may be one of three values. Most commonly, it may be a user-specified rotation, or a rotation such that the y-axis will be parallel to the meridian through the center of the projection (the angle used in this case is often referred to in published formula as alpha). Less commonly, it may be a rotation such that the y-axis will be parallel to the meridian through the natural origin of the projection (the angle used in this case is often referred to in published formula as gamma). If the *Rotation Angle* parameter is a non-zero number, it will be used in the rectification. If the *Rotation Angle* is zero, the default behavior will be to rectify so that the y-axis will be parallel to the meridian through the center of the projection. If it is desired that the rectification cause the y-axis to be parallel to the meridian through the natural origin of the projection, the *Use Gamma Flag* parameter should be set to 1.

The *ObliqueMercatorTwoPoint* projection has the following parameters:

- Latitude of the Origin of the Projection
- Latitude of the First Point
- Longitude of the First Point
- Latitude of the Second Point
- Longitude of the Second Point
- False Easting
- False Northing
- Rotation Angle (Defaults to 0)
- Unrectified Flag (Defaults to 0)
- Use Gamma Flag (Defaults to 0)

Orthographic

The Orthographic projection closely resembles a globe in appearance, since it is a perspective projection from infinite distance. Only one hemisphere can be shown at a time. This projection is used chiefly for pictorial views and is used only in spherical form.

When *Orthographic* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters need to be entered:

- Radius of the Sphere

- False Northing and False Easting
- Longitude of the Center of the Projection
- Latitude of the Center of the Projection

Note: Only a spherical form of this projection is used. The radius of the sphere is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated. You are required to specify a geodetic datum when you use this projection as part of a coordinate system in order to perform geodetic datum shifts into other coordinate systems.

Perspective Conic

The Perspective Conic projection is produced by projecting the Earth perspectively from the center (or from some other point) onto a tangent or secant cone, along the standard parallels. The meridians are equally spaced straight lines converging at a common point representing one of the poles. The parallels are represented as unequally spaced concentric circular arcs centered on the pole of convergence of the meridians. The other pole may not be represented on the projection, though in some cases it may appear as a circular arc. Along the standard parallels scale is true and there is no distortion. Other conformal or equal-area conics demonstrate less rapid distortion in a north-south direction, however, and are preferred to the Perspective Conic.

The *PerspectiveConic* Projection has the following parameters:

- Longitude of the Center of the Projection
- Latitude of Southern Standard Parallel
- Latitude of Northern Standard Parallel
- False Easting
- False Northing

Polar Stereographic

The Polar Stereographic projection somewhat resembles other polar azimuthal projections, with straight radiating meridians and concentric circles for meridians. This projection is used for polar mapping within the Universal Polar Stereographic (UPS) coordinate system.

When *Polar Stereographic* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters need to be entered:

- False Northing and False Easting
- Longitude of the Center of the Projection
- Latitude of the Center of the Projection
- Scale Reduction Factor at the Center of the Projection

Polyconic

The Polyconic projection is neither an equal-area nor a conformal projection. Scale is true along each parallel and along the central meridian. Parallels of latitude are arcs of non-concentric circles and the projection is free of distortion only along the central meridian.

The Polyconic projection can be used to represent small areas on any part of the globe, preserving shapes, areas, distances, and azimuths in their true relation to the surface of the earth. Polyconic projections over large areas usually result in serious errors and exaggeration of details.

When *Polyconic* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Center of the Projection
- Latitude of the Center of the Projection

Quartic Authalic

The Quartic Authalic projection is a pseudocylindrical, equal area projection that is used primarily for world maps. It was first presented by Karl Siemon in 1937, and then later presented independently by Oscar Sherman Adams in 1945. This projection serves as a basis for the McBryde-Thomas Flat Polar Quartic projection.

The central meridian is depicted as a straight line 0.45 as long as the equator. Other meridians are equally spaced curves, concave toward the central meridian. The parallels are straight parallel lines perpendicular to the central meridian. These are spaced farthest apart near the equator, but gradually grow closer spaced when moving toward the poles. The poles are represented by points.

Distortion is significant near the outer meridians, at high latitudes, but is less than in the sinusoidal projection. There is no distortion and scale is true along the equator. Scale is constant along any given latitude.
The *QuarticAuthalic* projection has the following parameters:

- Longitude of Origin
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Robinson

The Robinson projection provides a means of showing the entire Earth in an uninterrupted form. The Robinson projection is destined to replace the Van der Grinten projection as the premier projection used by the National Geographic Society.

When *Robinson* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Central Meridian

Sinusoidal

The Sinusoidal projection is pseudocylindrical and equal-area. The central meridian is a straight line. All other meridians are shown as equally spaced sinusoidal curves. Parallels are equally spaced straight lines, parallel to each other. Poles are points. Scale is true along central meridian and all parallels.

The Sinusoidal projection is used for maps of South America and Africa.

When *Sinusoidal* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Central Meridian

Space Oblique Mercator

The Space Oblique Mercator (SOM) projection is a modified cylindrical projection with the map surface defined by a satellite orbit. The SOM is an extremely complicated projection. We urge you to refer to *Map Projections a Working Manual* by Snyder for a detailed explanation.

The SOM projection was designed especially for continuous mapping of satellite imagery. The ellipsoidal form with a non-circular satellite orbit is implemented within Geographic Imager.
When *Space Oblique Mercator* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Central Meridian
- Semi-major Axis of the Satellite Orbit
- Eccentricity of the Satellite Orbit
- Longitude of Perigee relative to the Ascending Node
- Time of Revolution of the Satellite
- Inclination of the Satellite Orbit
- Longitude of the Ascending Node

Stereographic

The Stereographic projection is the only known true perspective projection of any kind that is also conformal. The central meridian and a particular parallel (if shown) are straight lines. All other meridians and parallels are shown as arcs of circles.

When *Stereographic* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Center of the Projection

- Scale Reduction Factor at the Center of the Projection.
- Latitude of the Center of the Projection

Stereographic 70

Stereographic 70 is a derivation of the Stereographic projection for use in Romania.

When *Stereographic 70* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered

- False Northing and False Easting
- Longitude of the Center of the Projection
- Scale Reduction Factor at the Center of the Projection.
- Latitude of the Center of the Projection

Swiss Oblique Mercator

The Swiss Oblique Mercator projection is a particular case of an Oblique Mercator projection, which in turn differs from the Mercator and Transverse Mercator projections in that the central line with true scale is neither the equator (as in the Mercator), nor a meridian (as in the Transverse Mercator), and is chosen to suit the region to be mapped. In the Swiss Oblique Mercator this line has an azimuth of 90 degrees and contains the centre of the projection.

The *SwissObliqueMercator* projection has no parameters.

Tilted Perspective

The Tilted Perspective projection represents a view of the Earth from space in which the view is from anywhere other than a point precisely facing the center of the Earth. This projection is therefore used to generate pictorial views of the Earth resembling those seen from space.

It is a modified azimuthal projection that is neither conformal nor equal area. The central meridian and a particular parallel (if shown) are straight lines. Other meridians and parallels are usually arcs of circles or ellipses, but some may be parabolas or hyperbolas. If the point of perspective is above the sphere, less than one hemisphere may be shown.

The *TiltedPerspective* projection has the following parameters:

- Azimuth
- Tilt
- Longitude of Origin
- Latitude of Origin
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Times

The Times projection is a pseudo-cylindrical projection that is neither equal area nor conformal. It was first presented by John Moir in 1965. It is used to generate the world maps in The Times Atlas of the World, produced by Collins Bartholomew.

The central meridian and equator are depicted as straight lines. All other meridians are equally spaced curves, concave toward the central meridian. The parallels are straight lines perpendicular to the central meridian, increasing in separation away from the equator. Scale is correct along the two parallels at 45° N and S.

The *Times* projection has the following parameters:

- Longitude of Origin
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Transverse Mercator (Gauss-Kruger)

The Transverse Mercator projection is similar to the Mercator Projection, except that the axis of the projection cylinder is rotated 90 degrees from the polar axis. This projection does not have the straight meridians and straight parallels of the Mercator projection, except for the central meridian, the two meridians 90 degrees away, and the equator. Nor does the Transverse Mercator projection have the straight rhumb lines of the Mercator projection; rather, it is a conformal projection. Scale is true along the central meridian or along two straight lines equidistant from and parallel to the central meridian.

The Transverse Mercator projection is the projection used in the State Plane Coordinate System for states with predominant north-south extent. It is also the geometric basis for the UTM Coordinate System.

The term Gauss-Kruger, or simply Gauss, refers to coordinate systems in parts of the world, for example, Germany and South America, based on the Transverse Mercator projection.

When *Transverse Mercator* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Central Meridian
- Latitude of the Origin of the Projection

- Scale Reduction Factor at the Central Meridian
- Transverse Mercator Extended

This is a variation of the standard Transverse Mercator projection that is provided for the definition of coordinate systems used in specific counties in the U.S. states of Minnesota and Wisconsin. Within a specific county in one of these states, the ellipsoid must be expanded by an additional amount to account for the average elevation within that county. In the case of a Wisconsin county, the ellipsoid must also be adjusted based on the average geoid height for that county. For Minnesota counties, the average geoid height should be set to zero.

The *TransverseMercatorExtended* projection has the following parameters:

- Longitude of the Central Meridian
- Latitude of the Origin of the Projection
- Scale Reduction Factor at the Center of the Projection
- False Easting
- False Northing
- Average Elevation (Minnesota and Wisconsin)
- Average Geoid Height (Wisconsin only)

Transverse Mercator Snyder

This projection is based on the description and formulae in John P. Snyder's Map Projections-- A Working Manual (U.S. Geological Survey Professional Paper 1395), pp. 60-64. These formulas have been superseded by more precise versions. There are, however, some instances where users may want to use the older, less precise formulas (for example, if the results will be compared to old data).

The *TransverseMercatorSnyder* projection has the following parameters:

- Longitude of the Central Meridian
- Latitude of the Origin of the Projection
- Scale Reduction Factor at the Center of the Projection
- False Easting
- False Northing

Transverse Mercator South Oriented

This is a projection used in the southern hemisphere. It is identical to the standard Transverse Mercator, except that the false easting and northing are interpreted instead as a false westing and southing.

The *TransverseMercatorSouthOriented* projection has the following parameters:

- Longitude of the Central Meridian

- Latitude of the Origin of the Projection
- Scale Reduction Factor at the Center of the Projection
- False Easting
- False Northing

Transverse Mercator State Plane 27

The State Plane Coordinate System (SPCS) is not a projection; rather it is a system for specifying positions of geodetic stations using plane rectangular coordinates. This coordinate system that divides all fifty states of the United States, Puerto Rico and the U.S. Virgin Islands into over 120 numbered sections, referred to as zones. Each zone has an assigned code number that defines the projection parameters for the region.

There are four possible projections for SPCS. The geometric direction of each state determines the projection utilized. For states that are longer in the east-west direction, the Lambert Conformal Conic is used.

States that are longer in the north-south direction use the Transverse Mercator Projection. The panhandle of Alaska, which has the sole distinction of lying at an angle, garners the use of the Oblique Mercator Projection. Conversely, Guam uses a polyconic projection.

The formulae for these calculations are based on Publication 62-4, *State Plane Coordinates by Automatic Data Processing*, U.S. Department of Commerce 1968. These projections should only be used for data that has been computed using this method. For all other state plane calculations use Exact Methods. The parameters for these coordinate systems are defined in Publication 62-4. For further information contact the U.S. Department of Commerce.

The *Mercator27* projection does not require any parameters.

Two-Point Fit

The Two-Point Fit Projection is used when a local grid needs to be converted to another coordinate system. From two known points (with both easting/northing and lat/long values for each point), the remainder of the grid values can be derived and used for coordinate conversion purposes.

When *Two-Point Fit* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing Northing and False Easting of the first point
- Northing and False Easting of the second point
- Latitude and Longitude of the first point
- Latitude and Longitude of the second point

What happens is that Geographic Imager takes two points (i.e. a line) from one coordinate system (lat/long for example) and *the same* two points from a second coordinate system (e.g. local survey coordinates) and matches them. You must have *two* points that you know what the coordinates are in *both* systems.

For example: A surveyor ties into 2 benchmarks (BM1 = 45N, 84W and BM2 = 45 00 01N, 84W). She starts at BM1 and calls it 10000/10000(Northing/Easting) and traverses to BM2 and gets some N/E value. You now have two points (BM1 & BM2) that have Lat/Long coordinates and Local coordinates. That is, you now have the endpoints and orientation of a common line in two coordinate systems. You need to define a new coordinate system using those two points as the references. Any scaling, rotation, etc. issues are taken care of because you have just linked two points (i.e. defined a line length and orientation in space) that are common to both coordinate systems.

Universal Transverse Mercator

The Universal Transverse Mercator (UTM) projection class is an extension of the Transverse Mercator projection class that allows all UTM zones in a given horizontal datum to be represented by a single GeoCalc object.

The *UniversalTransverseMercator* projection has the following parameters, all of which are optional:

- Current zone number
- Currently in northern hemisphere (is_north)
- Automatically set zone (autoset)

The actual Transverse Mercator parameter values to use when converting between geodetic and projected coordinate are determined from the values of the zone and is_north parameters.

If the autoset parameter is set to 1, then the zone and is_north parameters will be automatically recomputed each time a conversion from geodetic coordinates is performed, based on the input geodetic coordinates. Conversions from projected coordinates always use the UTM projection currently specified by the parameters.

Note: In GeoCalc version 6.3, Military Grid Reference System (MGRS) and U.S. National Grid (USNG) coordinate systems are defined with a UTM projection and a point style with the appropriate string format option.

V and H

V and H Projection for lat and long transform to the V[ertical] and H[orizontal] coordinates used for wired telephone (AT&T). Created by Jay K. Donald of AT&T in 1957 to simplify the calculation of distance between telephone rate centers. The system is based on Donald Elliptic Projection. It is a two-point equidistant projection for the continental United States and Canada. It uses units of the square root of one-tenth of a mile.

The *V and H* projection has no parameters.

Van der Grinten 1

This projection is neither conformal nor equal-area, but shows the globe enclosed in a circle.
This projection is exclusively used for world maps. The central meridian and equator are straight lines, with scale true along the equator only.

When *Van der Grinten* is selected in the *Edit Geodetic Data Source* dialog box, the following parameters will need to be entered:

- False Northing and False Easting
- Longitude of the Center of the Projection
- Radius of the Sphere

Vertical Perspective

The Vertical Perspective projection represents a view of the Earth from space in which the view is from a point precisely facing the center of the Earth. This projection is therefore used to generate pictorial views of the Earth resembling those seen from space. It is an azimuthal projection that is neither conformal nor equal area. The central meridian and a particular parallel (if shown) are straight lines. Other meridians and parallels are usually arcs of circles or ellipses, but some may be parabolas or hyperbolas. If the point of perspective is above the sphere, less than one hemisphere may be shown.

The *VerticalPerspective* projection has the following parameters:

- Longitude of the Center of the Projection
- Latitude of the Center of the Projection
- False Easting
- False Northing
- Height

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Winkel I

The Winkel I projection is a pseudocylindrical projection that is neither conformal nor equal area. Oswald Winkel developed it in 1914 as the average of the Sinusoidal and Equidistant Cylindrical (Equirectangular) projections. It is used primarily for world maps.

The central meridian is a straight line, while other meridians are equally spaced sinusoidal curves concave toward the central meridian. The parallels are equally spaced straight parallel lines perpendicular to the central meridian. The poles are represented by lines. If the latitude of true scale is chosen to be 50°28', the total area scale will be correct, though local area scales will vary.

The *Winkel I* projection has the following parameters:

- Longitude of the Center of the Projection
- Latitude of True Scale

- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Winkel II

The Winkel II projection is a pseudocylindrical projection that is neither conformal nor equal area. Oswald Winkel developed it in 1918 as the average of the Mollweide and Equidistant Cylindrical (Equirectangular) projections. It is used primarily for world maps.

The central meridian is a straight line, while other meridians are equally spaced curves concave toward the central meridian. The parallels are equally spaced straight parallel lines perpendicular to the central meridian. The poles are represented by lines. The length of the poles and of the central meridian will depend on the choice of the latitude of true scale. Scale is true along the north and south latitudes specified by the latitude of true scale, but the projection is generally distorted.
The *Winkel II* projection has the following parameters:

- Longitude of the Center of the Projection
- Latitude of True Scale
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Winkel Tripel

The Winkel Tripel projection is a modified azimuthal projection that is neither conformal nor equal area. Oswald Winkel developed it in 1921 as the average of the Aitoff and Equidistant Cylindrical (Equirectangular) projections. It is used primarily for whole world maps.

In this projection, the central meridian is a straight line. Other meridians are equally spaced along the equator and are concave toward the central meridian. The equator and the poles are straight lines, while all other parallels are curves, equally spaced along the central meridian and concave toward the nearest pole. Scale is true along the central meridian and constant along the equator. Distortion is moderate, except near the outer meridians in the polar regions.

The *Winkel Tripel* projection has the following parameters:

- Longitude of the Center of the Projection

- Standard Parallel
- False Easting
- False Northing

Note: Only a spherical form of this projection is used. The semi-major axis of the ellipsoid (sphere) is used for forward and inverse projection from grid to geodetic coordinates within the system wherein this projection is incorporated.

Datum Transformation Methods

This section describes the datum transformation methods used by Geographic Imager. Geographic Imager includes a number of predefined geodetic datum transformations based on the Molodensky method, the DMA Multiple Regression Equations method, the NGS NADCON method, the NGS HARN method, the Bursa/Wolfe method, and the Canadian National Transformation Version 2.0 method. You can also define your own geodetic datum transformations.

There seem to be many ways to view geodetic datums, what they consist of, and how they are defined. Within Geographic Imager, geodetic datums are viewed in a couple of ways. First of all, reference ellipsoid parameters are used directly to perform grid to geodetic conversions for a particular coordinate system, and to calculate a variety of values (geodetic distance, geodetic azimuths, etc.). Secondly, the transformation parameters and transformation method for a given "geodetic datum" are also used to perform the conversion from one geodetic datum to another.

When you select a geodetic datum name from within the "Datums" list as part of a coordinate definition you are actually specifying two things, the reference ellipsoid and the transformation parameters and method to be used.

Molodensky Transformations

The Molodensky transformation method shifts coordinate values between local and geocentric datums using three linear shift parameters. It provides a general solution with limited accuracy. The Molodensky method provides a transformation that is accurate to within 5-10 meters.

For a detailed discussion of the Molodensky algorithms and parameters for a variety of local geodetic datums, please refer to Defense Mapping Agency Technical Report TR 8350.2, 1991 *Department of Defense World Geodetic System 1984: Its Definition and Relationships with Local Geodetic Systems*. The Molodensky method can be defined for local geodetic datums worldwide.

Geocentric Transformations

A three-parameter translation between two geocentric coordinate systems. This is a non-simplified Molodensky transformation. There are three steps that are performed by this transformation. First the input point is represented as a Cartesian point in three dimensions on the input datum. The coordinates of this point are then translated using the dx, dy, and dz parameters. Finally, the translated point is represented converted to a geodetic point on the output datum.

ED50 to ED87 North Sea

The ED50 to ED87 North Sea Transformation consists of 4th order reversible polynomial that is used to convert coordinates between the ED50 and ED87 datums.

This formula was published in a 1991 note created by the Norwegian Mapping Authority (Statens Kartverk) entitled "Om Transformasjon mellom Geodetiske Datum i Norge".

The *ED50ToED87NorthSea* transformation method is hard-coded and does not require any parameters.

Tokyo to JGD2000

Converts coordinates from the Tokyo datum to the JGD 2000 (Japan Geodetic Datum of 2000) using a grid file defined by GSI (Japanese Geographical Survey Institute).

NTF to RGF93

Converts coordinates from NTF (Nouvelle Triangulation de la France) to RGF93 (Reference Geodesique pour la France) using a grid file defined by IGN (the French National Geographical Institute). The default grid file assumes a Greenwich prime meridian.

Four Parameter Method

Based on the Helmert family of transformations, a four parameter transformation is similar to a seven parameter transformation, except it does not include rotations.

The four parameters needed to define the transformation are:

Parameter	Often Noted as
X Translation	dX
Y Translation	dY
Z Translation	dZ
Scale	k

Polynomial

The Polynomial datum shift methods uses a collection of parameters which define a high order mathematical function for transforming between two horizontal datums. These equations are usually created by local and regional geodetic authorities. They generally provide high accuracy transformations, but are limited to specific areas of use. In many cases the accuracy of these transformations is around one meter.

For a detailed description of generalized polynomial datum transformations, please refer to the OGP guidance notes. These are freely available from **www.epsg.org**

Note: Caution—Polynomial datum shifts are generally computed for specific areas of use. Since the derivations of the formula are based on a limited number of reference points, using the transformation for data outside of the pre-determined envelopes may cause unreliable results.

Six Parameter Method

Based on the Helmert family of transformations, the six parameter transformation is very similar to a seven parameter transformation, except it does not contain a scale parameter.

The six parameters needed to define the transformation are:

Parameter	Often Noted as
X Translation	dX
Y Translation	dY
Z Translation	dZ
Scale	k
X Rotation	rX
Y Rotation	rY
Z Rotation	rZ

Seven Parameter Methods

There are two types of seven parameter transformation available. The difference between the two is the rotation sense (which direction the rotations take place in.) This method is sometimes referred to as the Bursa-Wolfe method. The seven parameter methods incorporate three geocentric translations, three geocentric rotations, and a scale correction factor. To change parameters from one rotation sense to the other, you must simply reverse the sign of the rotation values.

The seven parameters needed to define the transformation are:

Parameter	Often Noted as
X Translation	dX
Y Translation	dY
Z Translation	dZ
Scale	k
X Rotation	rX
Y Rotation	rY
Z Rotation	rZ
Scale	k

Note: To properly define a seven parameter translation, you MUST know which rotation sense is used for your transformation parameters.

The two types of rotation sense for seven parameter transformations are:

Position Vector Rotation: The rotations are defined as positive clockwise, as may be imagined to be seen by an observer at the origin of the coordinate frame, looking in the positive direction of the axis about which the rotation is taking place.

Coordinate Frame Rotation: Rotation is positive counter-clockwise, as may be imagined to be seen by an observer at the origin of the coordinate frame, looking in the positive direction of the axis about which the rotation is taking place.

Ten Parameter Molodensky-Badekas Method

The Molodensky-Badekas 10 parameter transformation method allows for very high accuracy transformation of coordinates between datums over large areas.

For a detailed reference on Molodensky-Badekas coordinate transformations, refer to the EPSG Surveying and Positioning Guidance Note Number 7, part 2: **www.epsg.org/guides/G7-2.html**.

The ten parameters needed to define the transformation are:

Parameter	Often Noted as
X Translation	dX
Y Translation	dY
Z Translation	dZ
Scale	k
X Rotation	rX
Y Rotation	rY
Z Rotation	rZ
Scale	k
X Ordinal	X
Y Ordinal	Y
Z Ordinal	Z

Canadian National Transformation

Geographic Imager supports the definition of a geodetic datum based on the Canadian National Transformation Version 2.0 directly. The Canadian National Transformation originally defined an accurate transformation from NAD27 to NAD83 for Canada, but the method has been adopted by Australia, New Zealand, Spain, and several other locations around the world. The shift values for a geographic area are stored in a single grid file, representing latitude and longitude shifts (named with the extension .gsb).

Geographic Imager uses grid files in a format published and provided by the Canadian Government. While the definition of this method is supported, it does require additional files to implement new datum transformations using this method. Contact information is as follows:

Natural Resources Canada
Geodetic Survey Division
Geomatics Canada
Room 440
615 Booth Street
Ottawa, Ontario
K1A 0E9

Phone: (613) 995-4410
Fax: (613) 995-3215
Email: information@geod.NRCan.gc.ca
Web: www.geod.NRCan.gc.ca

NGS HARN Method

Geographic Imager supports the definition of a geodetic datum based on a NGS High Accuracy Reference Network (HARN).

The National Geodetic Survey is establishing HARNs within the U.S. on a state-by-state basis. You can think of a HARN as a geodetic datum, most easily viewed as an enhanced NAD83 datum. HARNs are also known as NAD83/91 and High Precision Grid Networks (HPGN).

The NGS HARN method is actually very similar to the NGS NADCON method. As with the NADCON method the shift values for a geographic area are stored in a set of grid files, one representing latitude shifts (named with the extension .las) and one representing longitude shifts (named with the extension .los). The major difference is that the HARN data files contain shifts from NAD83 to a HARN instead of NAD27 to NAD83. Geographic Imager uses grid files in a format published and provided by the National Geodetic Survey. Questions about the availability of other HARN grid files (and the HARN systems in general) should be addressed to:

NGS Information Services, NOAA, N/NGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

Phone: (301) 713-3242
Web: www.ngs.noaa.gov

The current HARNs are already pre-defined within Geographic Imager. As new HARNs are completed and made available, they will be added to avenza.xml.

NADCON Method

The NGS NADCON method transforms coordinate values between the North American Datum of 1927 (NAD 27) and the North American Datum of 1983 (NAD 83). The NGS NADCON method provides a transformation that is accurate to within 0.15-0.5 meters. (Please refer to NOAA Technical Memorandum NOS NGS-50 "NADCON - The Application of Minimum Curvature-Derived Surfaces in the Transformation of Positional Data from the North American Datum of 1927 to the North American Datum of 1983.")

The NGS NADCON method applies a simple interpolation algorithm using a gridded set of standard datum shifts as parameters. The shift values for a geographic area are stored in a set of grid files, one representing latitude shifts (named with the extension .las) and one representing longitude shifts (named with the extension .los). Geographic Imager uses grid files in a format published and provided by the National Geodetic Survey. Questions about the availability of other NADCON grid files (and the NGS NADCON method in general) should be addressed to:

National Geodetic Survey
11400 Rockville Pike
Rockville, MD 02852

Phone: (301) 713-3242
Web: www.ngs.noaa.gov

MRE (Multiple Regression Equations) Method

The DMA Multiple Regression Equations transformation method shifts coordinate values between geodetic datums. It can be defined for local geodetic datums worldwide. The DMA Multiple Regression Equations method uses Doppler-derived parameters and provides a general solution with limited accuracy. It provides a transformation that is accurate to within 3-10 meters.

For a detailed discussion of the DMA Multiple Regression Equations algorithms and parameters for a variety of local geodetic datums, please refer to Defense Mapping Agency Technical Report TR 8350.2, 1991 "Department of Defense World Geodetic System 1984: Its Definition and Relationships with Local Geodetic Systems."

The main advantage of the DMA Multiple Regression Equations method lies in the modeling of distortions for datums that cover continental-sized land areas. This achieves a better fit in geodetic applications than the Molodensky method.

Note: Caution—The DMA Multiple Regression Equations method is an application of the theory of least squares. The coefficients for the mathematical regression equations are determined by fitting a polynomial to predicted shifts in a local area. If the DMA Multiple Regression Equations method is applied outside of the local area for which the coefficients of the equations are determined, the results may be unpredictable.

Ordnance Survey Great Britain - OSTN02

To cope with the distortions in the OSGB36 TRF, different transformations are needed in different parts of the country. For this reason, the national standard datum transformation between OSGB36 and ETRS89 is not a simple Helmert datum transformation. Instead, Ordnance Survey has developed a 'rubber-sheet' type transformation which works with a transformation grid expressed in easting and northing coordinates. The grids of northing and easting shifts between ETRS89 and OSGB36 cover Britain at a resolution of one kilometre. From these grids a northing and easting shift for each point to be transformed is obtained by a bi-linear interpolation.

The National Grid Transformation copes not only with the change of datum between the two coordinate systems, but also with the TRF distortions in the OSGB36 triangulation network, which make a simple datum transformation of the Helmert type limited to applications at 5m and larger accuracy levels. This transformation removes the need to estimate local Helmert transformations between ETRS89 and OSGB36 for particular locations.

Because the National Grid Transformation works with easting and northing coordinates, other ETRS89 coordinate types (3-D Cartesian or latitude and longitude) must first be converted to eastings and northings. This is done using the same map projection as is used for the National Grid (see section 7 below), except that the GRS80 ellipsoid rather than the Airy ellipsoid is used. After the transformation, the resulting National Grid eastings and northings can be converted back to latitude and longitude (this time using the Airy ellipsoid) if required.

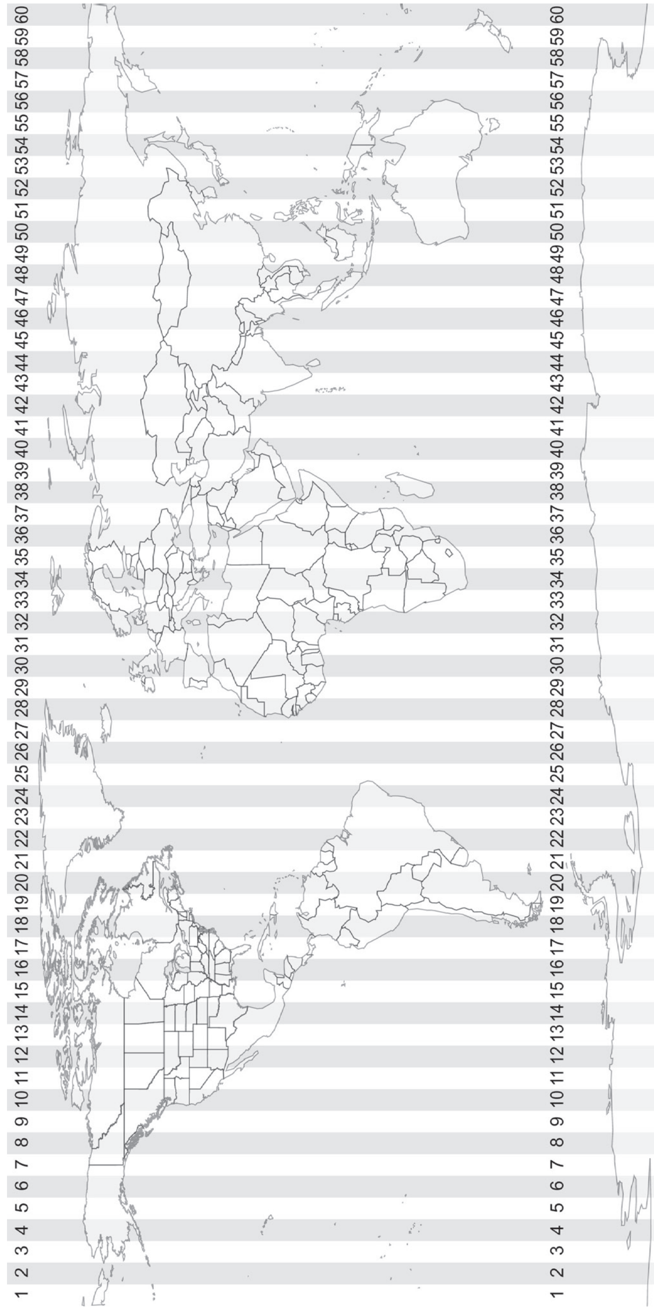
Longitude Rotation

The Longitude Rotation datum shift method is a transformation on a two-dimensional or three-dimensional geographic coordinate system that changes the longitude values by a rotation value and leaves the latitude and elevation values unchanged.

The one parameter to define a longitude rotation is the angle of rotation. You can extend Geographic Imager to support an unlimited number of custom linear and angular units, ellipsoids, datums, datum shifts, and coordinate systems. The parameters for each custom definition are stored within an XML database file referred to as the Geodetic Data Source, a file named avenza.xml. All user-defined parameters will be stored in a separate XML database. This allows you to update the master data set provided and maintained by Avenza Systems, without the need to redefine or import custom definitions again.

UTM Zone Map

UTM Zone	Central Meridian	Longitude Range
1	177W	180W-174W
2	171W	174W-168W
3	165W	168W-162W
4	159W	162W-156W
5	153W	156W-150W
6	147W	150W-144W
7	141W	144W-138W
8	135W	138W-132W
9	129W	132W-126W
10	123W	126W-120W
11	117W	120W-114W
12	111W	114W-108W
13	105W	108W-102W
14	99W	102W-96W
15	93W	96W-90W
16	87W	90W-84W
17	81W	84W-78W
18	75W	78W-72W
19	69W	72W-66W
20	63W	66W-60W
21	57W	60W-54W
22	51W	54W-48W
23	45W	48W-42W
24	39W	42W-36W
25	33W	36W-30W
26	27W	30W-24W
27	21W	24W-18W
28	15W	18W-12W
29	9W	12W-6W
30	3W	6W-0
31	3E	0-6E
32	9E	6E-12E
33	15E	12E-18E
34	21E	18E-24E
35	27E	24E-30E
36	33E	30E-36E
37	39E	36E-42E
38	45E	42E-48E
39	51E	48E-54E
40	57E	54E-60E
41	63E	60E-66E
42	69E	66E-72E
43	75E	72E-78E
44	81E	78E-84E
45	87E	84E-90E
46	93E	90E-96E
47	99E	96E-102E
48	105E	102E-108E
49	111E	108E-114E
50	117E	114E-120E
51	123E	120E-126E
52	129E	126E-132E
53	135E	132E-138E
54	141E	138E-144E
55	147E	144E-150E
56	153E	150E-156E
57	159E	156E-162E
58	165E	162E-168E
59	171E	168E-174E
60	177E	174E-180E



Appendix B - Acknowledgements

Avenza Systems Inc. would like to acknowledge and thank the following companies and individuals for their contributions to Geographic Imager for Adobe Photoshop and for data and other files that may appear on the Geographic Imager for Adobe Photoshop CD. In addition to those mentioned below we wish to thank the many beta-testers who helped us design and test this product. Please note the maps used for the chapter intro pages are credited on the first page of this guide.

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Appendix C - Glossary

If you have difficulty with some of the GIS terminology used, you can also access the following for more information:

www.gisdevelopment.net/glossary/
www.geo.ed.ac.uk/agidict/

A

Accuracy
The closeness of results of observations, computations or estimates to the true values or the values accepted as being true. Accuracy relates to the exactness of the result, and is distinguished from precision, which relates to the exactness of the operation by which the result is obtained.

Affine transformation
A geometric transformation that scales, rotates, skews, or translates images or coordinates between any two Cartesian spaces.

AGI
Association for graphic Information.

Algorithm
A set of rules for solving a problem.

ASCII
American Standard Code for Information Interchange, a widely used industry standard code for exchanging alphanumeric codes in terms of bit-signatures.

ANSI
American National Standards Institute, an association formed by the American Government and industry to produce and disseminate widely used industrial standards.

Application
A set of computer programs designed for a specific task.

Aspect
Individual azimuthal map projections are divided into three aspects: the polar aspect which is tangent at the pole, the equatorial aspect which is tangent at the equator, and the oblique aspect which is tangent anywhere else. (The word *aspect* has replaced the word *case* in modern cartographic literature).

Azimuth
The angle measured in degrees between a base line radiating from a center point and another line radiating from the same point. Normally, the base line points North, and degrees are measured clockwise from the base line.

B

Binary
A number system of base 2. Numbers are represented simply as a series of 0's or 1's in contrast to base 10 number systems that represent numbers using the characters 0-9. For example, the base 10 number 65535 translates to the base 2 number 1111111111111111. Binary numbers are the fundamental basis of computing.

Bitmap
A grid of small squares, cells or pixels stored in memory and used to generate an image.

C

Cartography
The organization and communication of geographically related information in either graphic or digital form. It can include all stages from data acquisition to presentation and use.

Cell
The basic element of spatial information in a raster image.

Colour Ramp
A graduated range of colours between two extreme colour selections.

Conformal
A map projection is conformal when at any point the scale is the same in every direction. Therefore, meridians and parallels intersect at right angles and the shapes of very small areas and angles with very short sides are preserved. The size of most areas, however, is distorted.

Contour
A line connecting points of equal elevation.

Curvature
The amount of curve in line as defined by a series of points.

D

Data model
An abstraction of the real world which incorporates only those properties, being relevant to the application at hand. The data model would normally define specific groups of entities, and their attributes and the relationships between these entities. A data model is independent of a computer system and its associated data structures.

Datum
The reference specifications of a measurement system, usually a system of coordinate positions on a surface (a horizontal datum) or heights above or below a surface (a vertical datum).

Datum Shift
Returns geographic coordinates based on a different datum (and spheroid/ellipsoid) than the one used to obtain the original coordinates.

DEM
Digital Elevation Model. DEM is a raster format used by the USGS to record elevation information. Unlike other raster file formats, DEM cells do not represent colour brightness values but rather the elevation of points on the earth's surface.

Developable surface
A developable surface is a simple geometric form capable of being flattened without stretching. Many map projections can then be grouped by a particular developable surface: cylinder, cone, or plane.

Digital
The ability to represent data in discrete units or digits.

Drag
To hold down the mouse button while you move the mouse cursor on the screen.

Drag-and-drop
The act of dragging a file with the mouse over another executable file to cause some action on the first file.

DTP
Desktop Publishing.

E

Element
A fundamental geographical unit of information, such as a point, line, area, or pixel.

Ellipsoid
The identification given to established representations of the Earths shape. A three-dimensional, closed geometric shape, all planar sections of which are ellipses or circles. An ellipsoid has three independent axes, and is usually specified by the lengths a,b,c of the three semi-axes. If an ellipsoid is made by rotating an ellipse about one of its axes, then two axes of the ellipsoid are the same, and it is called an ellipsoid of revolution, or spheroid. If the lengths of all three of its axes are the same, it is a sphere. When used to represent the earth, an oblate ellipsoid of revolution, made by rotating an ellipse about its minor axis.

EPS
Encapsulated Post Script file format The EPS format is used to transfer PostScript language artwork between applications. Also see PostScript.

Equal areas
A map projection is equal area if every part, as well as the whole, has the same area as the corresponding part on the Earth, at the same reduced scale. No flat map can be both equal area and conformal.

Equidistant
Equidistant maps show true distances only from the center of the projection or along a special set of lines. For example, an Azimuthal Equidistant map centered at Washington shows the correct distance between Washington and any other point on the projection. It shows the correct distance between Washington and San Diego and between Washington and Seattle. But, it does not show the correct distance between San Diego and Seattle. No flat map can be both equidistant and equal area.

F

FAQ
Frequently Asked Question.

Feature
A set of points, lines or polygons in a spatial database that represent a real-world entity. The terms feature and object are often used synonymously.

File
A collection of related information that can be accessed by an assigned name.

Filter
See Plug-in filters.

Folder
A storage area for files within the Macintosh OS, the equivalent of a DOS or UNIX directory.

Format
The way in which data is arranged for storage and for transmission between software and computers.

FTP
File Transfer Protocol.

G

GCP
Ground control point. Any point which is recognizable on both remotely sensed images, maps and aerial photographs and which can be accurately located on each of these. This can then be used as a means of reference between maps or, more commonly, between maps and digital images. Often used in the geometric correction of remotely sensed images and surveying.

GeoCrop
The ability to crop images based on location is a new feature to Geographic Imager. Crop by specifying the top left and bottom right location of the output in either pixel, geodetic or projected values.

Geodetic
Of or relating to the study of the shape and size of the earth: A geodetic coordinate is the specification of a precise location on the surface of the earth.

Geodetic Reference System
The true technical name for a datum. The combination of an ellipsoid, which specifies the size and shape of the earth, and a base point from which the latitude and longitude of all other points are referenced.

Geographic features
Points, lines, and areas that comprise a map.

Geographic Information System (GIS)
Any system designed for the capturing, storing, checking, integrating, analyzing and displaying of spatially referenced data about the earth.

Geographic Transformation
A systematic conversion of the latitude-longitude values for a set of points from one geographic coordinate system to equivalent values in another geographic coordinate system. Depending on the geographic coordinate systems involved, the transformation can be accomplished in various ways. Typically, equations are used to model the position and orientation of the "from" and "to" geographic coordinate systems in three-dimensional coordinate space; the transformation parameters may include translation, rotation, and scaling. Other methods, including one used in transformations between NAD 1927 and NAD 1983, use files in which the differences between the two geographic coordinate systems are given for a set of coordinates; the values of other points are interpolated from these.

Georeference
To establish the relationship between page coordinates on a planar map and known real-world coordinates.

GeoTIFF
An industry-wide standard for specifying information in TIFF tags which was developed by several organizations within the GIS community. GeoTIFF files are raster images that contain georeferencing information as well as image information in a single file.

GIR
Geographic Information Retrieval.

GIS
Geographic Information Systems.

GPS
Global Positioning Systems.

Graticule
The spherical coordinate system based on lines of latitude and longitude.

Great Circle
A circle formed on the surface of a sphere by a plane that passes through the centre of the sphere. The equator, each meridian, and each other full circumference of the Earth forms a great circle. The arc of a great circle shows the shortest distance between points on the surface of the Earth.

Grid
A set of regularly spaced sample points or an exact set of reference lines over the earth's surface.

H

HARN
High Accuracy Reference Network. A resurvey and readjustment of NAD 1983 control points using GPS techniques. The resurvey date is often included as part of the datum name: NAD 1983 (1991) or NAD91.
Header File
A file associated with an image that contains georeferencing information for the image. File extensions may be TFW or JPW (tiff, jpeg World Files), IRP (Image Report Files) or TAB (Table files).

I

Icon
An image representing a software function or tool.

Image
A graphic representation or description of a scene, typically produced by an optical or electronic device. Examples include remotely sensed or satellite data, scanned data, and photographs.

Import sequence
The order of steps required to import data.

Integer
A number without a decimal. Integer values can be less than, equal to, or greater than zero.

J

JPEG, JPG
Joint Photographic Experts Group, is a lossy compression technique for raster file formats.

L

Label
Text used to identify a map feature.

LANDSAT
The generic name for a series of earth resource scanning satellites launched by the United States of America.

Latitude
Angular distance, expressed in degrees and minutes, along a meridian north or south of the equator.

Lat/Long
Latitude/Longitude. Unprojected.

Layer
A designated level in artwork used for storing, organizing and editing graphic or mapping data.

Longitude
The angular distance east or west from a standard meridian to another meridian on the earth's surface; expressed in degrees and minutes.

Line
One of the basic geographical elements, defined by at least two pairs of X,Y coordinates; usually too narrow to be an area. See also arc, path and vector.

Linear scale
The relation between a distance on a map and the corresponding distance on the Earth. Scale varies from place to place on every map. The degree of variation depends on the projection used in making the map.

Lossless/Lossy
Lossless techniques compress image data without removing detail; lossy techniques compress images by removing detail.

M

Mac OS
Apple Macintosh operating system.

Map
A graphic representation of features of the earth's surface or other geographically distributed phenomena.

Map coordinates
The X,Y representations of ellipsoidal earth locations on a mapping plane.

Map extent
The geographic extent of a geographic data set specified by the minimum bounding rectangle.

Map Projection
A map projection is a systematic representation of a round body such as the Earth on a flat (plane) surface. Each map projection has specific properties that make it useful for specific purposes. Also see Projection.

Marquee
A dashed rectangle drawn with a selection tool used to select multiple objects.

Meridian
A line of longitude running vertically from the north pole to the south pole.

Metadata
Data about data typically including information such as currency, accuracy, and extent. Metadata is typically stored in data models or data dictionaries.

Mosaic
Maps of adjacent areas with the same spatial reference and scale whose boundaries have been matched and dissolved. A raster dataset that is composed of two or more merged raster datasets — for example, one image created by merging several individual images or photographs of adjacent areas.

Molodensky Transformation
A transformation method that shifts coordinate values between local and geocentric datums. It uses Doppler-derived parameters and provides a general solution with limited accuracy. The Molodensky method provides a transformation that is accurate to within 5-10 meters.

MrSID
MrSID is a file format developed by LizardTech that reduces the size of large, high-resolution images to a fraction of their original size while maintaining the original image quality and integrity.

N

NAD
North American Datum.

NADCON
North American Datum Conversion Utility. The standard NAD27-NAD83 datum transformation program, created by the United States National Geodetic Survey. Transformation is derived from a minimum curvature surface from the National Geodetic Reference System. Approximate accuracy of 0.15-0.50 meter. NADCON is the fastest, simplest, and most accurate datum transformation for mapping at scales of 1:200 and smaller and is intended for conversion of NAD27 to NAD 83 in the continental United States, Puerto Rico, and the Virgin Islands.

Network
Two or more interconnected computer systems for implementation of specific functions or a set of interconnected graphic lines defining some spatial features.

NSDI
National Spatial Data Infrastructure.

O

OS
Operating System.

Orthophoto
A modified copy of a perspective photograph of the earth's surface with distortions due to tilt and relief removed.

Overlay
A set of graphical data that can be superimposed on another set of graphical data through registration to a common coordinate system. The process of laying one set of digital spatial data over another for analysis purposes.

P

Parameters
Variable options or choices; boundaries of operations or of an object.

Path
A line/vector defined by a series of points (a string of X,Y coordinates).

PDF
Portable Document Format. Developed by Adobe, a PDF is a file type, which can be used to cross Macintosh, Windows, DOS, and UNIX platforms.

Pixel
The smallest unit of information in a grid cell map or raster image.

Pixel depth
The number of data bits each pixel represents. In 8-bit contexts, the pixel depth is 8, and each display pixel can be one of 256 possible colours or shades of gray. With a 24-bit raster (or with three coregistered 8-bit rasters) the pixel depth is 24, and 16,777,216 colours are possible.

Pixel-size / Pixel resolution
The actual amount of geography represented by a single pixel. The size of a pixel in geographic units. The amount of detail found in one pixel of the image. For example an image with one meter resolution means that each pixel in the image represents one square meter on the ground

Plug-in
A module supplied separately from the Adobe Photoshop program, usually for creating special effects in artwork. Geographic Imager is a plug-in module that enables the incorporation of functionality within the Adobe Photoshop environment.

PMS
Pantone™ Matching System.

Polynomial
A mathematical expression involving a sum of powers in one or more variables multiplied by coefficients. A technique used to geographic data to another geographic data set based on some control points.

Positional Accuracy
The degree to which a position is measured or depicted, relative to its correct position as established by either other features or by other accurate processes.

PPC
Power PC (e.g. IBM PowerPC processor for Mac).

Precision
That which relates to the exactness of the operation by which the result is obtained. The exactness with which a value is expressed, whether the value be right or wrong.

Projection
The representation on a plane surface of any part of the surface of the earth. Also see Map Projection.

R

Raster
A method for the storage, processing and display of image data. Each given area is divided into rows and columns, which form a regular grid structure. Each cell must be rectangular in shape, although not necessarily square. Each cell within this matrix contains an attribute value as well as location coordinates. The spatial location of each cell is implicitly contained within the ordering of the matrix, unlike a vector structure which stores topology explicitly. Areas containing the same attribute value are recognized as such, however, raster structures cannot identify the boundaries of such areas as polygons. Also raster structures may lead to increased storage in certain situations, since they store each cell in the matrix regardless of whether it is a feature or simply 'empty' space.

Record
A set of attributes relating to any entity; a set of related, contiguous data.

Redundancy
The duplication of data in a database.

Remote Sensing
The technique of obtaining data about the environment and the surface of the earth from a distance, for example, from aircraft or satellite.

Render
To cause to be or to become, to draw.

Residual Error
The difference between computed and observed values. Adjustments in the georeferencing procedures can be made if it is determined that the residuals are not acceptable. Additional control points can be added, or those selected can be adjusted in order to arrive at an optimal solution.

Resolution
The number of dots per inch displayed on screen or printed to an output device.

Rhumb line
A line on the surface of the Earth cutting all meridians at the same angle. A rhumb line shows true direction. Parallels and meridians, which also maintain constant true directions, may be considered special cases of the rhumb line. A rhumb line is a straight line on a Mercator projection. A straight rhumb line does not show the shortest distance between points unless the points are on the equator or on the same meridian.

Rubbersheeting
A procedure to adjust the coordinates all of the data points in a dataset to allow a more accurate match between known locations and a few data points within the dataset. Rubbersheeting, also known as rubber banding, preserves the interconnectivity or topology, between points and objects through stretching, shrinking or re-orienting their interconnecting lines.

S

SAIF
Spatial Archive and Interchange Format. SAIF is a Canadian Draft National Standard for Geomatics data interchange. It is a specification for data, which includes an object-oriented data model, and a language for describing both spatial and non-spatial data.

Scale
The relation between the size of an object on a map and its size in the real world.

Scanner
A device for converting images from maps or photographs of part of the real world into digital form automatically.

SEA
Self-Extracting Archive, a file compression format for reducing the size of large files for archival or transfers.

Spatial
Of space, a two or three-dimensional position in space.

Spatial Data
Any information about the location and shape of, and relationships among, geographic features. This includes remotely sensed data as well as map data.

Sphere Coordinates
X,Y locations on the ellipsoidal earth, usually expressed in degrees and minutes.

SPOT
An earth resource satellite with high-resolution sensors launched by France in January 1986.

Static Graphic Files
Unchanging and uneditable graphic files.

T

TIF, TIFF
Tagged Image File Format, a common raster graphic file format.

Tile
A discrete part of the earth's surface. By splitting a study area into tiles, considerable savings in access times and improvements in system performance can be achieved.

Topography
The study of the relief of a given area on the Earth's surface, usually on a large scale, including both natural and man-made features.

Topology
The way in which geographic features relate to each other.

Toponym
The place names of a region or map feature.

Transform
The process of changing the scale, projection, or orientation of a mapped image.

TRIM
A GIS data file format from the Terrain Resource Information Management of British Columbia, Canada.

U

UNIX
A general-purpose, multi-user computer operating system.

URL
Universal Resource Locator or Internet address.

USGS
United States Geological Survey.

UTM
Universal Transverse Mercator, a common map projection.

UTM Grid
A grid system based upon the Transverse Mercator projection. The UTM grid extends North-South from 80˚N to 80˚S latitude and, starting at the 180˚ Meridian, is divided eastwards into 60, 6 degree zones with a half degree overlap with zone one beginning at 180 degrees longitude. The UTM grid is used for topographic maps and georeferencing satellite images.

V

Vector Linework / Artwork
One method of data type, used to store spatial data. Vector data is comprised of lines, defined by beginning and end points, which meet at nodes. The locations of these nodes and the topological structure are usually stored explicitly. Features are defined by their boundaries only and curved lines are represented as a series of connecting arcs. Vector storage involves the storage of explicit topology, which raises overheads, however it only stores those points which define a feature and all space outside these features is 'non-existent'.

Vector Data
An abstraction of the real world where positional data is represented in the form of coordinates. In vector data, the basic units of spatial information are points, lines and polygons. Each of these units is composed simply as a series of one or more coordinate points, for example, a line is a collection of related points, and a polygon is a collection of related lines.

Vertex
One of a set of ordered X,Y coordinates that constitute a line. A points representing spatial X,Y coordinates that occur along a line between the nodes and help define the shape of the arc.

VPF
Vector Product Format. A binary format used by the US Defense Mapping Agency. It is well documented and can be used as an internal format and as a transfer format. It carries geographic and attribute information but no display data. VPF files are sometimes referred to as VMAP products. MAPublisher 6 does not support VPF files.

W

World file
A text file containing information about where an image should be displayed in real world coordinates. When an image has a properly configured world file, GIS software can use the information to accurately overlay the image with any other data already in that coordinate system. A file associated with an image that contains georeferencing information for the image.

WWW
World Wide Web.

Z

Zone
Any well-defined region of more or less belt-like form.

Zoom
To magnify or reduce the current view of a document.