ER Mapper 6.2

Airphoto Mosaic Tutorial

12 July 2000

ER Mapper

Helping people manage the earth

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About this manual

This manual is intended to get you started with using ER Mapper to create mosaics of digital aerial photographs. It provides simple step-by-step procedures that give you hands-on practice using advanced features of the software.

This manual is not intended to cover all ER Mapper functionality, and does not cover concepts of digital photogrammetry such as DEM generation. Please refer to the *ER Mapper Tutorial* and *User Guide* manuals for more detailed information as needed. (These are also accessible directly from the on-line help system.)

Chapter contents

The chapters in this manual give you extensive hands-on experience using the ER Mapper software through a series of specially designed lessons. Most lessons have two basic sections:

- an overview of key concepts
- a series of step-by-step hands-on exercises

It is recommended that you start at the beginning and proceed through the chapters in order because the later chapters build on concepts learned in earlier ones.

The emphasis of this manual is on learning and using the ER Mapper software, not on teaching image processing, airphoto interpretation, and other concepts.

Setting up practice datasets

The exercises in this manual assume that ER Mapper 6 is installed and licensed, and that the example airphoto datasets have been installed in the 'examples\functions_and_features\airphoto_tutorial' directory.

Typographical conventions

The following typographical conventions are used throughout this document:

- ER Mapper menus, button names and dialog box names are printed in boldface Helvetica type, for example:

    "Select **Print** from the **File** menu to open the **Print** dialog box."

- Where you are asked to click the mouse on an icon button in the user interface, both the button and its formal name are indicated in the text. For example:

    "Click on the **Edit Transform limits** ⟋Ⅺ button."

- Text to be typed in a dialog box text field is shown in boldface Courier typeface, for example:

    "Type **RGB_airphoto_mosaic** in the text field."

1

Airphoto mosaics and ER Mapper

This chapter provides an overview of airphoto concepts and steps used for creating mosaics of digital airphotos. It also describes the basics of image processing and use of the ER Mapper software in assembling airphoto mosaics.

Overview of airphotos and applications

Aerial photographs are taken from an aircraft to capture a series of images using a large roll of special photographic film. The film is then processed and cut into negatives. The most common size for negatives is 9" x 9" (23cm x 23cm). The final scale of the aerial photograph depends on the height of the aircraft when the photo was taken. Aerial photographs are taken with an overlap between each one, to ensure that a final mosaic can be assembled.

Airphotos are now being used extensively as basemaps for updating vector data that is stored and manipulated in GIS and DMS systems. Often it is necessary to create a mosaic of several airphotos to cover the desired area. Common uses and mapping applications for airphotos include:

• land use/land cover mapping

• urban and regional planning

• environmental assessment

- civil engineering

- geologic and soil mapping

- agricultural and forestry applications

- water resource and wetland applications

Types of airphotos

There are generally four types of airphotos in common use, and these are created by using specific types of film in the camera:

- **Panchromatic**–often called black and white, is sensitive to the same range of light wavelengths as perceived by the human eye (the "visible" wavelengths blue, green and red spanning 0.4 to 0.7 micrometers). Panchromatic photos are most commonly used for planimetric and/or topographic mapping. Digitized black and white photos have a single band (layer of information), so they are usually displayed in greyscale on a computer.

- **Natural color**–often called true color, is also sensitive to the same wavelengths of light as perceived by the human eye. Digitized natural color photos have three separate bands, one each for the blue (0.4-0.5 micrometers), green (0.5-0.6) and red (0.6-0.7) wavelengths of light. They are usually displayed using the RGB color system on a computer to recreate the same colors as on the photo print. Natural photos are commonly used for creating photo maps, or for mapping applications that require discrimination of the color of features.

- **Infrared**–often shortened to "IR," is sensitive to a range of wavelengths that includes the red, green and near infrared portions of the spectrum. The near infrared wavelengths (0.7-1.0) cannot be perceived by the human eye, so they provide information that beyond the human perception system. Like panchromatic, digitized IR images have a single band and are usually displayed in greyscale.

- **Color infrared**–often called false color or shortened to "CIR," was developed during World War II to aid camouflage detection. Digitized CIR images have three separate bands, one each for the green (0.5-0.6), red (0.6-0.7) and near infrared (0.7-1.0) wavelengths of light. Like natural color, they are usually displayed using the RGB color system to recreate the same colors as on the photo print. Vegetation usually appears red on these images, thus the term false color. CIR photos are commonly used for agricultural, forestry and wetland studies because the IR band provides valuable information on vegetation health, species and biomass.

Digitizing (scanning) of airphotos

In order for an aerial photograph to be processed in a computer, the photo must first be scanned or digitized to create a digital image file. The photo print or transparency is run through a scanner to convert visible images to digital files. Many airphoto acquisition firms supply their photo data already converted to digital image format, but you may also want or need to scan the photos yourself.

Note: Aerial photographs normally have fiduial marks around the edges. The positions of these marks are crucial for orthorectification. It is, therefore, essential that the scanner that use is alrge enough to include the fiducial marks in the scanned image.

Two factors affect the resolution, or size of features that can be detected, in the digital image of the aerial photograph. These factors are:

- The scale at which the aerial photograph was flown. This is based on aircraft altitude above ground and focal length of the camera during photo acquisition.

- The Dots Per Inch (DPI) used to scan the aerial photo. This determines the size on the ground, in meters or feet, of one pixel on the digital aerial photograph, and approximately corresponds to the size of the smallest feature that can be detected.

Use the following table to decide what scale aerial photography to use and what DPI resolution to use when scanning the photos. A pixel size of 1 meter is adequate for many applications.

Photo scale:	10000	24000	40000	Scanned image file sizes:		
Km. across:	2.3	5.5	9.1			
	Pixel size in meters			# of pixels	color	B & W
150 dpi scan	1.7	4.1	6.8	1350	5 Mb	2 Mb
300 dpi scan	0.8	2.0	3.4	2700	21 Mb	7 Mb
600 dpi scan	0.4	1.0	1.7	5400	83 Mb	28 Mb
1200 dpi scan	0.2	0.5	0.8	10800	334 Mb	111 Mb
2400 dpi scan	0.1	0.3	0.4	21600	1335 Mb	445 Mb

Ask your aerial photograph supplier if they can provide you the aerial photographs pre-scanned, on a CD-ROM, in a format supported by ER Mapper. This will save you having to scan the photos yourself.

Image formats supported by ER Mapper include:

• ER Mapper Algorithm (.alg)

• ER Mapper Raster Dataset (ers)

• ER Mapper Compressed Image (.ecw)

• Windows Bitmap (.bmp)

• ESRI BIL and GeoSPOT (.hdr)

• GeoTIFF/TIFF (.tif)

• 1 bit tiled tiff

• 1bit strip tiff (compressed and uncompressed)

• 1bit scanline tiff (compressed and uncompressed)

• 8 bit greyscale tiled tiff

• 8 bit RGB contiguous tiled tiff

• 8 bit RGB separate tiled tiff

• JPEG (.jpg)

• USGS DOQQ (Grayscale)

• RESTEC/NASDA CEOS (.dat)

Digital Orthophoto Quadrangles

Airphoto images can be supplied as Digital Orthophoto Quarter Quadrangles, known as DOQQs.

A digital orthophoto is a digital image of an aerial photograph in which displacements caused by the camera and the terrain have already been removed. Therefore it combines the image characteristics of a photograph with the geometric qualities of a map. A DOQ image typically covers one-quarter of a 1:24,000 scale USGS topographic map plus a little overlap. The resolution of the image is quite high at one square meter per pixel. As a result of this fine cell size, these images consume large quantities of disk space. A DOQQ is a subset of a DOQ, in that it refers to a Digital Orthophoto Quarter Quad. There are four DOQQs in a DOQ.

You can open DOQQ images directly in ER Mapper, and then use ER Mapper wizards to mosaic and balance them.

Creating airphoto mosaics

An *airphoto mosaic* is an assemblage of two or more overlapping photographs that form a composite view of the area covered by the individual photos. Typically the aircraft flies back and forth across an area acquiring a set of photos that overlap, then the photos are scanned, rectified and assembled into a mosaic.

Aircraft flight while taking aerial photographs

Photo #1

Photo #2

Photo #6

Photo #5

Photo #4

The basic steps involved in creating a mosaic of airphotos are shown below. These steps are covered in detail in the exercises in this workbook.

Digitize airphotos	Scan (digitize) airphoto hardcopy prints or transparencies to create digital image files, or acquire digital format photos saved in image formats such as TIFF.
Read/Import digital airphotos	Read digital airphoto image files stored on tape, CD-ROM, etc. into ER Mapper. If necessary, convert to ER Mapper image format (using ER Mapper import utilities)
Initial image display & evaluation	View image data on to evaluate quality or area coverage, or display statistical information such as histograms or cell values.
Image rectification	Geometrically correct (rectify or geocode) images to correspond to geodetic coordinate systems and map projections such as UTM, State Plane, etc.
Create mosaic of images	Assemble rectified, enhanced images into a mosaic.
Balance mosaic of images	Balance contrast across the mosaic, and minimize visible seam lines between adjacent images.
Data saving and/or compression	Save the processed mosaic in a format suitable for use in GIS and DMS applications, or for serving from an Image Web Server.
Annotation & map composition	Setup map size/scale, and annotate mosaic of images with text, lines, shaded polygons, legends, scale bars, coordinate grids and other map objects.

Data load/import

The first step in creating an airphoto mosaic is loading or importing the data you want to use into ER Mapper. Typically the data might be stored on magnetic tape, CD-ROM, or be available for download from an Image Web Server over a network.

When you import a raster image file (using ER Mapper's import utility programs), ER Mapper converts the data and creates two files:

• a binary data file containing the image data, in band interleaved by line (BIL) format

• a corresponding ASCII header file with an ".ers" file extension

You can open image files in many different formats in ER Mapper without having to import them as ER Mapper raster datasets. Some of these formats contain embedded georeferencing information, which ER Mapper uses to mosaic the images. These formats include ECW V2 compressed, GeoTIFF and USGS DOQQ. Some TIFF images have an accompanying 'World' file, TIFW, that contains the georeferencing information. ER Mapper creates a separate .ers header file for these to accommodate statistical information used for balancing.

Image display

After loading or importing the image data, the next step is usually to display the image to evaluate the data quality, geographic area of coverage, and coverage of overlapping areas with other images used in a mosaic. If the data is of poor quality, you might decide to digitize the photos again. If it has significant cloud cover or haze over your area of interest, you might try to obtain better data.

There are two primary ways airphotos are viewed:

• black and white, or greyscale displays (used to view black and white airphotos or a single band of a color airphoto)

• red-green-blue (RGB) color composite displays (used to view all three bands of a color or color IR airphoto to reproduce the look of the original print)

The way in which you choose to display your raster data is called the "Color Mode" in ER Mapper. You can also view data in traditional two-dimensional planimetric views, or 3-D perspective views if you have an elevation dataset such as a DTM.

In addition to displaying the data, you may want to view statistical information about it. Statistics are often good indicators of image quality. You may want to calculate statistics for the image, such as the mean value in each band, and view them in a tabular format. Or you may want to view statistical information in a graphical format using tools like histograms, scattergrams, and traverse profiles.

Image geocoding

Raster image data is often supplied in a "raw" state and contains geometric errors. Whenever accurate area, direction, and distance measurements are required, raw image data must usually be processed to remove geometric errors and/or rectify the image to a real world coordinate system.

- *Registration* is the process of geometrically aligning two or more images to allow them to be superimposed or overlaid.

- *Rectification* is the process of geometrically correcting raster images so they correspond to real world map projections and coordinate systems (such as Latitude/ Longitude or Eastings/Northings).

- *Orthorectification* is a more accurate form of rectification mainly used on airphotos. It takes into account properties of the camera used to take the images, fiducial marks on the image and terrain details.

If your application requires that your images be registered to one another or rectified to a map projection, you can use ER Mapper's Geocoding Wizard to do this.

Note: DOQQ images have already been orthorectified, so you do not need to use ER Mapper to do it again.

Note: The Geocoding Wizard only supports the ER Mapper Raster Dataset format. Images in any other format that require geocoding will have to be saved as ER Mapper Raster Datasets first. This includes ECW compressed images.

Creating image mosaics

A *mosaic* is an assemblage of two or more overlapping images used to create a continuous representation of the area covered by the images. ER Mapper automates the building of image mosaics because co-registered images referenced in the same processing algorithm are automatically displayed in their correct geographic positions relative to each other.

This means that you are not required to write all images to one large file on disk in order to process and enhance them. This capability is especially important when working with large image files such as scanned airphotos, because final mosaics can consume gigabytes of disk space if they would have to be saved in a single file.

The ER Mapper **Image Display and Mosaic Wizard** automatically mosaics images in a specified directory path.

Image enhancement and correction

Image enhancement refers to any one of many types of image processing operations used to digitally process image data to aid visual interpretation, extract quantitative information, or correct color/brightness distortions. Image enhancement is what many people commonly think of as "image processing."

In ER Mapper, image enhancement operations are greatly simplified by the "algorithms" processing concept. Nearly all types of image enhancement operations can be applied and displayed in real time to provide truly interactive control without writing temporary files to disk.

Typical image enhancement operations include:

- *Contrast enhancements*–Improve image presentation by maximizing the contrast between light and dark portions (or high and low data values) in an image. Or, highlight a specific data range or spatial area in an image.

- *Color balancing*–Use the ER Mapper **Color Balancing Wizard** to balance mosaiced images to produce a seamless single image.

Data saving and compression

Once you have completed processing your data, ER Mapper lets you save your image in a format suitable for serving, for use or further processing.

- ECW Compression enables you to save your imagery in compressed format for use in other applications or serving from an Image Web Server.

- Data export is used to export all or part of a processed airphoto mosaic for use in other software products, such as a backdrop for a GIS or DMS (desktop mapping system) product. Or, you may want export vector annotation or vectorized thematic data to a GIS product.

- Free plug-ins enable you to open ER Mapper images, including ECW compressed images, from within many GIS products.

- Hardcopy printing is often the final goal of processing and annotating images, and ER Mapper provides hardcopy support and output to standard graphics file formats. ER Mapper also includes a built-in PostScript-compatible rendering engine, so you get PostScript-quality output (such as beautiful, smooth text) on any supported device, whether the device supports PostScript or not.

You can also easily print at exact sizes and map scales, and automatically print large images in strips for assembling a mosaic of prints. Supported hardcopy devices include inkjet printers, laser printers, dye sublimation printers, electrostatic plotters, and film recorders. Graphics file formats include PostScript, TIFF, Targa, CGM, and CMYK and RGB color separations.
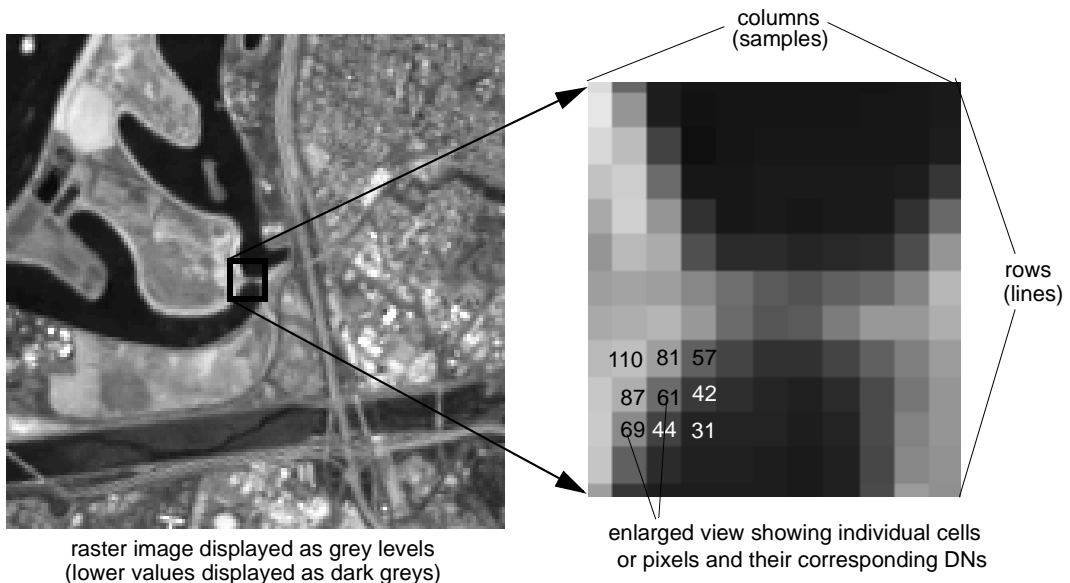
Map composition

ER Mapper's Map Composition tools let you create top quality image maps by adding coordinate grids, map collars, scale bars, legends, north arrows, and many other map objects and standard cartographic symbols. You can layout and compose maps comprised of multiple processed images, and size and scale map output as desired. All map objects are defined as full color PostScript, and you can easily add custom map objects such as company logos or special north arrows.

Image processing concepts

The term *digital image processing* refers to the use of a computer to manipulate image data stored in a digital format. The goal of image processing for earth science applications is to enhance geographic data to make it more meaningful to the user, extract quantitative information, and solve problems.

A digital image is stored as a two-dimensional array (or grid) of small areas called *pixels* (picture elements), and each pixel corresponds spatially to an area on the earth's surface. This array or grid structure is also called a *raster*, so image data is often referred to as *raster data*. The raster data is arranged in horizontal rows called *lines*, and vertical columns called *samples*. Each pixel in the image raster is represented by a *digital number* (or DN).

raster image displayed as grey levels
(lower values displayed as dark greys)

columns
(samples)

rows
(lines)

110 81 57
87 61 42
69 44 31

enlarged view showing individual cells
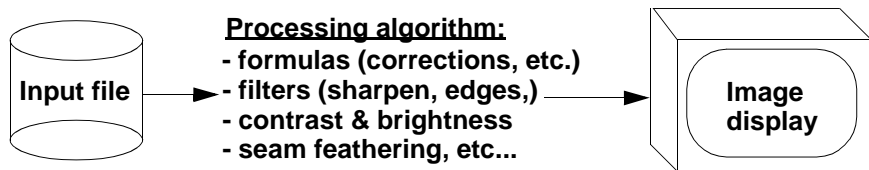or pixels and their corresponding DNs

For digitized airphotos, the DNs represent the intensity of reflected light in the visible, infrared, or other wavelengths of the electro-magnetic spectrum. By applying mathematical transformations to the digital numbers, ER Mapper can enhance image data to highlight and extract very subtle information that would be impossible using traditional manual interpretation techniques.

Black and white airphotos capture reflectance of ground features in a single range of wavelengths, for example visible red/green or infrared (IR). Color airphotos have three *bands* (or layers) of data covering the same geographic area, each capturing reflectance of a different wavelength of light. A natural color airphoto, for example, has three bands of data that record reflectance from the earth's surface in the red, green and blue wavelengths of light respectively.

ER Mapper image processing

ER Mapper lets you combine many processing operations into a single step, and render the results directly to your screen display in near real-time. (In most cases, no processed copies of your original data are written to disk unless you request to do so.) The set of processing steps you apply to your data is called an "algorithm" in ER Mapper.

Input file → **Processing algorithm:**
- formulas (corrections, etc.)
- filters (sharpen, edges,)
- contrast & brightness
- seam feathering, etc... → **Image display**

With ER Mapper, you need to save only a *description of the processing steps* you wish to apply to the data (the algorithm), *not* separate processed copies of the original raster data file. By storing the processing steps separately from the actual data, image processing becomes faster, easier to learn, and more interactive.

In ER Mapper, algorithms can be used for simple viewing of data such as greyscale or RGB band combinations. Algorithms are also used for complex processing and modelling operations involving many images, transformations of the data, and overlays of vector data–in both 2-D planimetric and 3-D perspective views.

The algorithms design also allows ER Mapper to easily handle very large airphoto images (and mosaics of images) much more efficiently than traditional systems. Reducing the need to write processed copies of the data to disk is a very important consideration.

2

Opening and viewing an image

This chapter shows you how to open a digitized airphoto in TIFF format, and how to display it as a color image and enhance the contrast. You learn about the interface ER Mapper provides for creating and editing data view algorithms (the **Algorithm** dialog).

About the algorithms concept

The goal of all image processing is to enhance your data to make it more meaningful and help you extract the type of information that interests you. To make this procedure faster and easier, Earth Resource Mapping developed a new image processing technique called "algorithm data views." Understanding how to use algorithms is the key to understanding how to use ER Mapper effectively.

What is an algorithm data view?

An algorithm is a list of processing steps or instructions ER Mapper uses to transform raw datasets on disk into a final, enhanced image on your screen display. In this sense, algorithms let you define a "view" into your data that you can save, reload, and modify at any time.

You use ER Mapper's graphical user interface to define your list of processing steps, and you can save the steps in an algorithm file on disk. An algorithm file can store any of the following information about your processing:

- Names of image dataset(s) to be processed and displayed
- Subsets of the dataset(s) to be processed (zoomed areas)
- Bands (layers of data) in the dataset(s) to be processed
- Color mapping and contrast enhancements (Transforms)
- Filtering to be applied to the data (Filters)
- Equations and combinations of bands or datasets used to create the image (Formulae)
- Color mode used to display the data (Pseudocolor, Red Green Blue, or Hue Saturation Intensity)
- Any vector datasets, thematic color, or map composition layers to be displayed over the raster image data
- Definition of a page size and margins (used for positioning the image on a page for creating maps and printing)
- Viewpoint and other parameters when viewing the image in 3D perspective

By being able to apply a set of processing steps as a single entity, the complexity often associated with image processing is greatly simplified. In addition, you gain tremendous savings in disk space, since you do not need to store intermediate processed copies of your original data on disk.
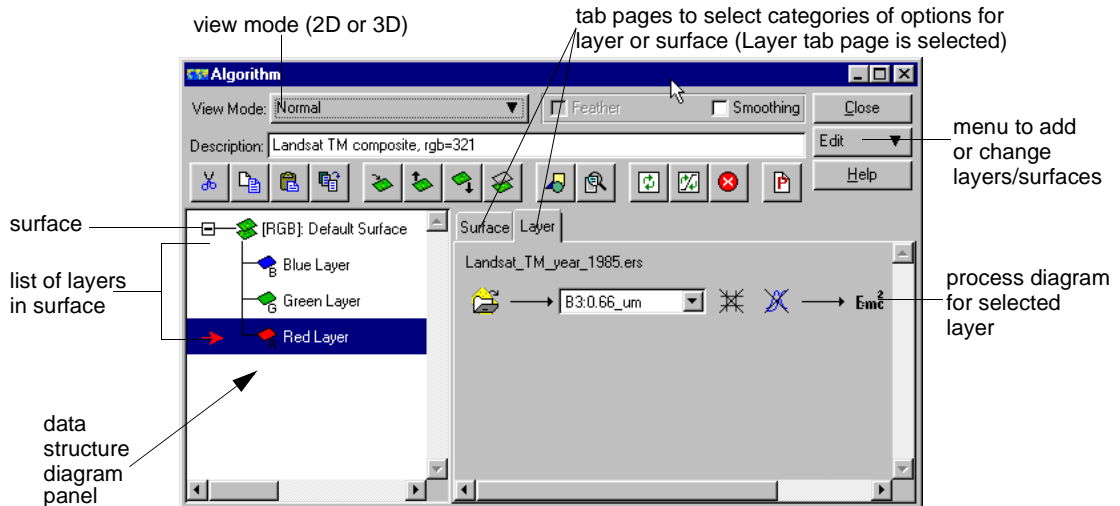
Building Algorithms in ER Mapper

There are three primary ways to build a processing algorithm in ER Mapper:

- Open an image dataset directly (**Open**) and have ER Mapper automatically display the image using a simple default algorithm
- Use the **Algorithm** dialog options to build an algorithm by adding the desired types of layers, loading datasets, and specify processing steps for each layer.
- Use image wizards to have ER Mapper automatically create any of several types of specialized algorithms for you. In this case, ER Mapper adds the appropriate layers to the **Algorithm** dialog, prompts you to load a dataset, and possibly other options as well.

The Algorithm dialog

The **Algorithm** dialog is a special dialog box that serves as your "command center" for creating and editing algorithms in ER Mapper. To open the **Algorithm** dialog, you can select **Algorithm...** from the **View** menu or click the **Edit Algorithm** 🐸 toolbar button. The key components of the **Algorithm** dialog are labelled below and described in the table that follows.

view mode (2D or 3D)

tab pages to select categories of options for layer or surface (Layer tab page is selected)

surface

list of layers in surface

menu to add or change layers/surfaces

process diagram for selected layer

data structure diagram panel

|	
Data structure diagram	Shows a list of surfaces and layers contained in the current algorithm using a hierarchy or "tree" structure. Select (click on) a surface or layer change its options using the Tab pages.
Surface	A group of raster and/or vector data layers that combine to create a view or image. A single algorithm can have multiple surfaces that become independent entities when viewed in 3D mode.
Layers	Components of a surface that contain data used to construct an image. Different layer types can contain raster or vector data, and processing for each layer is controlled independently from the others.
View Mode	Sets the manner in which data is displayed as two dimensions (2D) normal or page layout, or three dimensions (3D).

Tab pages   Display categories of options for controlling the image display and processing techniques, such as Layer for options for the current layer, or Surface for options that apply to an entire surface.

Process diagram   Used to control the processing operations applied to image(s) in the currently selected layer (displayed when Layer tab is selected).

The Process Diagram

When the Layer tab is selected, the horizontal row of buttons on the right-lower panel of the **Algorithm** dialog are called the *process diagram*. They are used to define your image enhancement and processing operations for the currently selected data layer. Each button in the diagram controls a specific image processing function.

As the arrows indicate, the processing stream flows from left to right. Typically, you may specify a dataset to be used, the bands within the dataset to be processed, then apply processing using formulae, filters, transforms or other options to create your desired image. ER Mapper compiles all the processing steps you specified and renders the resulting image to the screen display. The name and function of the main processing diagram buttons are as follows.

Button	Function
Load Dataset	Use to load an image dataset from disk, or edit or view information or comments about an image.
Band Selection `B1:0.850_um`	Use to select one or more bands in the dataset for use in generating an image (a drop-down list).
Formula Emc^2	Use to enter, load, or save a formula to perform image algebra and other arithmetic operations.
Filter	Use to add or delete one or more spatial filters. (There are both pre- and post-formula Filter buttons.)
Transform	Use to adjust image contrast and brightness. (There are both pre- and post-formula Transform buttons.)
Sun Angle	Use to specify sun angle illumination of the image to create shaded relief effects.

Note: A cross or "X" through the button indicates that the function is not active in the current data layer. In addition, there are other buttons for some layer types that you will learn about later in this manual.

Hands-on exercises

These exercises show you how to open a digitized airphoto in ER Mapper, display, enhance the image, and then save and reload a simple image processing algorithm.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Load and display an image dataset
- Use transforms to adjust the image contrast
- Add text labels and comments to an algorithm
- Save the processing algorithm to disk
- Reload and view the saved algorithm

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Displaying an airphoto image

Objectives

Learn to open an image window and the **Algorithm** dialog, load an image, and display the image in color.

Note: The sample airphoto tutorial datasets must be installed on your computer before you can complete this exercise.

About loading data

You can open any of the following image data formats directly into ER Mapper without having to import them as ER Mapper Raster Datasets:

- ER Mapper Algorithm (.alg)

- ER Mapper Raster Dataset (ers)
- ER Mapper Compressed Image (.ecw)
- Vector Map (.erv)
- Windows Bitmap (.bmp)
- ESRI BIL and GeoSPOT (.hdr)
- GeoTIFF/TIFF (.tif)
- JPEG (.jpg)
- USGS DOQQ (Grayscale)
- RESTEC/NASDA CEOS (.dat)

In this example you will open an image in TIFF format.

Open an image window and the Algorithm dialog

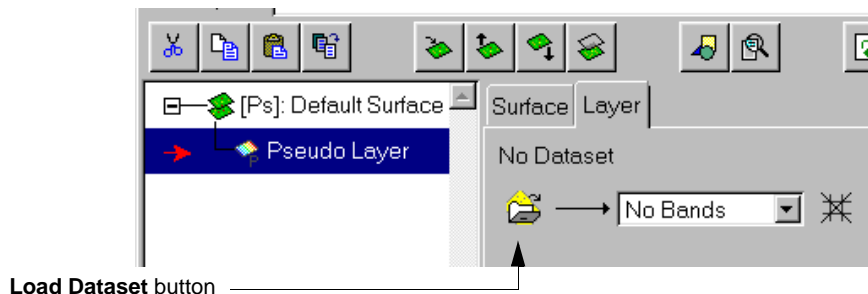1   From the **View** menu, select **Algorithm...**.

A new empty image window opens in the upper-left corner of the screen, and the **Algorithm** dialog opens.

Note that the **Algorithm** dialog shows a default surface with one Pseudocolor layer in the left-hand panel (labelled "Pseudo Layer"), and a process diagram for that layer in the right-hand panel. The words "No Dataset" above the process diagram indicate that no dataset is currently loaded into the layer.

Note: If you open the **Algorithm** dialog when no image windows are currently open (as in this case), ER Mapper opens an empty image window for you automatically. This shortcut saves you the step of opening a window.

Load the airphoto dataset into the Pseudo Layer

1   In the **Algorithm** dialog, click the **Load Dataset** 📂 button..
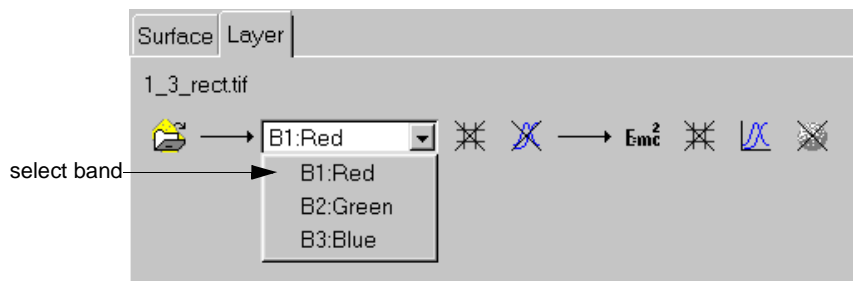

Load Dataset button

The **Raster Dataset** file chooser dialog box appears.

2   From the **Directories** menu (on the **Input File** dialog), select the path ending with **\examples**.

3   Double-click on the directory named 'functions_and_features' and then 'airphoto_tutorial' to open it.

4   Double-click on the image file named '1_3_rect.tif' to load it.

ER Mapper will display only the red band of the color airphoto in a pseudocolor layer.

5   View the red, green and blue bands individually by selecting them from the band drop-down list.

Load the airphoto dataset into the Algorithm

Generally it is more useful to display the Red, Green and Blue bands of color airphotos together, and not singly.

1   Close the image window, but leave the **Algorithm** dialog open.

The layer list and process diagram in the Algorithm dialog will now be blank.

2   On the ER Mapper **Standard** toolbar, click the **Open** 🖆 button.

The **Open** file chooser dialog box appears.

3   From the **Directories** menu (on the **Input** dialog), select the path ending with **\examples**.

4 Double-click on the directory named 'functions_and_features' and then 'airphoto_tutorial' to open it.

5 Double-click on the image file named '1_3_rect.tif' to load it.

ER Mapper will now load the Red, Green and Blue bands of the airphoto into Red, Green and Blue layers, and display the image in color.

If you open an image by clicking on the **Open** 📂 or selecting **Open...** from the **File** menu, ER Mapper will automatically display the image according to the number of bands in the image. In this instance, the image has three bands, so ER Mapper displays the image as RGB.

Note: It is often preferable to use the **Image Display and Mosaic Wizard** 🔧 to open and display an image because it gives you more control over how the image is displayed. This is described later in Chapter 6, "Assembling image mosaics".
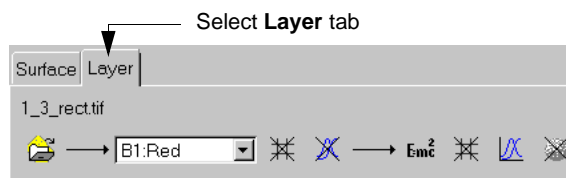

2: Selecting layers and adjusting contrast

Objectives   Learn to view different bands in the dataset and use the **Transform** dialog options to adjust the image contrast. Also learn about image histograms.

Select the Layer tab in the Algorithm dialog

1 In the **Algorithm** dialog, select the **Layer** tab.

Select **Layer** tab
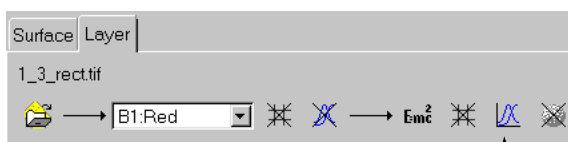
The contents of the right side of the Algorithm dialog change to show the process diagram option buttons.

2 If needed, drag one side of the **Algorithm** dialog to widen it until you can see all the option buttons above.

> **Tip:** When you resize or reposition a dialog box, ER Mapper automatically remembers this the next time you open it. This lets you setup your work environment as you like.
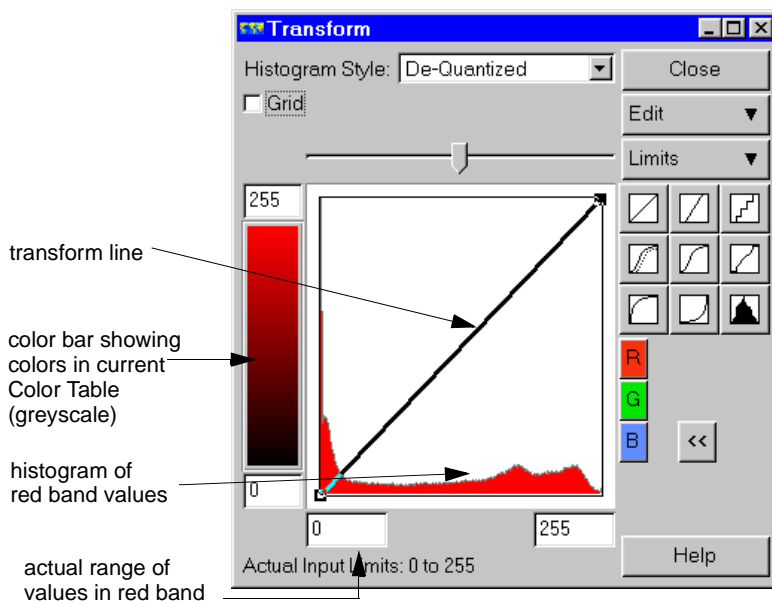
Display the histogram for the Red layer

1 In the **Algorithm** dialog, click on the right-hand **Edit Transform Limits** button (blue) in the Red layer process diagram.

Edit Transform Limits button

The **Transform** dialog box opens showing a histogram of the data values in the current layer (Red in this case), and options for modifying the image contrast.
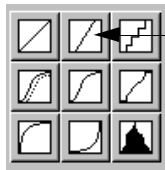

A *histogram* is a graphical display of the relative frequency distribution of values in an image. Peaks in the histogram show where there are many pixels with similar data values, and sometimes indicate identifiable features in an image.

The **transform line** maps the image data values on the X-axis to the output display values on the Y-axis. A linear transform line, as shown above, creates the same input and output histograms. A non-linear transform line causes the output histogram to be different to the input histogram.

The "Actual Input Limits" field shows the actual range of values in the current band of the dataset. In this case, the red band values fill the possible dynamic range of zero to 255.

Apply a 99% clip transform to the data

1 On the **Transform** dialog, click the **Create autoclip transform** ▨ button.

Create autoclip transform button

ER Mapper automatically sets the transform line into a position that clips off one percent of the data values (0.5% from the low end and 0.5% from the high end). This is called "autoclipping" since ER Mapper analyzes the histogram for the selected layer (and automatically positions the transform line for you. Autoclipping is the most commonly used contrast enhancement technique for image datasets.

Note: Autoclipping is not always desirable for airphotos (as opposed to satellite images) because airphotos often contain data in the areas that are clipped. This particular image is a good example of where there is a significant amount of data in the lower values.

Tip: You can set the percentage used for the autoclip function by double-clicking on the ▨ button. Values between 90 and 99.5 are usually used. Lower values create stronger contrast, but also saturate more of the brightest and darkest features. The default is 99 percent.

Apply a Histogram equalize transform to the data

1 On the **Transform** dialog, click the **Histogram equalize** [icon] button.

Histogram equalize button

Tip: Pass the mouse over the button to see the button name (tooltip).

ER Mapper creates a complex piecewise linear transform line and updates the image. Notice that in this case the overall contrast is maximized, but detail may be obscured (saturated) in the brightest and darkest features.
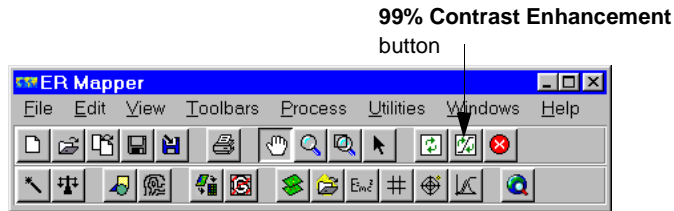
Histogram equalization (also called uniform distribution stretching) automatically adjusts the transform line for the selected layer so that image values are assigned to display levels based on their frequency of occurrence. More display values are assigned to the most frequently occurring portion of the histogram, so the greatest contrast enhancement occurs in the data range with the most values (peaks in the histogram). Histogram equalization tries to create and approximately equal number of each color in the image, and usually creates an image with very strong contrast. In some cases, it can also saturate areas which can obscure detail.

Note: The transforms must be set for each layer individually. Use the **Transform** dialog **R**, **G** and **B** buttons to select the required layer.

Use 99% Contrast Enhancement button

Now you will learn to use a faster, easier way to adjust the image contrast.

1 On the main ER Mapper menu, click the **99% Contrast Enhancement** button.

99% Contrast Enhancement
button

ER Mapper runs the algorithm again to display the airphoto, and automatically adjusts the contrast for all the layers for you. This button performs the following sequence or actions for you automatically:

Process->Limits to Actual->Process->99% autoclip->Process

Note: Again, the 99% Contrast Enhancement is not always desirable for airphotos because it could remove important data from the image. It is included in this tutorial for descriptive purposes only.

Tip: The **Refresh** , **99% Contrast Enhancement** and **STOP** buttons are located on both the main menu and the **Algorithm** dialog. The **STOP** button ceases all processing so you don't have to wait for the processing to finish if you make a mistake.

3: Labelling and saving the algorithm

Objectives Learn to specify description labels, titles, and comments for an algorithm, and save the algorithm processing steps to a file so you can view it later.

In order to save your image and view it later, you need to save the processing steps you defined previously as an algorithm file on disk. Note that you are not creating a new image file, you are only saving a text description of the steps required to enhance your original airphoto image.

Enter a description for the entire algorithm

1   In the **Algorithm** dialog, select the text in the **Description** text field (it currently reads 'No Description').

(To select the text, either drag through it, or triple-click to select the entire line.)

2   Type the following text, then press Enter or Return on your keyboard:

> **`airphoto in RGB`**

This text now becomes a brief description for the entire algorithm.

Save the processing steps to an algorithm file on disk

1   From the **File** menu (on the main menu), select **Save As...**.

The **Save As...** file chooser dialog opens.

2   In the **Files of Type:** field, select 'ER Mapper Algorithm (.alg)

3   From the **Directories** menu, select the path ending with the text **\examples**. (The portion of the path name preceding it is specific to your site.)

4   Double-click on the directory named 'Miscellaneous' and then 'Tutorial' to open it.

5   In the **Save As:** text field, click to place the cursor, then type the following name for the algorithm file:

> **`Airphoto_RGB`**

6   Click the **Apply** button to save the algorithm and leave the dialog open.

Your algorithm is now saved to an algorithm file on disk.

Add comments to the algorithm

1   On the **Save As...** dialog, click the **Comments...** button.

A dialog box appears titled with the algorithm path and file name, and a text area to type comments about your algorithm. The cursor is already active.

2   In the comments dialog, type the following information to describe your algorithm:

```
This algorithm displays the red, green and blue bands of an
airphoto as a greyscale algorithm. A 99% autoclip transform is used
to increase image contrast.
```

3   Click **OK** on the comments dialog to save your comments.

4   Click **OK** on the **Save As...** dialog close it.

4: Reloading and viewing the algorithm

Objectives Learn to reload and display the algorithm you just created.

Open a second image window

1 On the Standard toolbar (on the main menu), click the **New Image Window** button.

    ER Mapper opens a new image window (this is a shortcut for selecting **New** from the **File** menu). Drag the new window to the lower left part of the screen (so you can see all or most of the other image window).

Open the RGB algorithm you created earlier

1 On the main menu, click on the **Open** button.

    The **Open** file chooser dialog appears. (This is a shortcut for selecting **Open...** from the **File** menu.)

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 From the **Files of Type:** list, select 'ER Mapper Algorithm (.alg)'.

4 Double-click on the 'Miscellaneous\Tutorial' directory to open it.

    Your 'Airphoto_RGB' algorithm name should appear in the list.

5 Click once on your algorithm name to highlight it (do not double-click).

6 Click the **Apply** button to load and process the algorithm without closing the **Open** dialog box.

    ER Mapper runs the algorithm and displays the enhanced airphoto dataset in the image window. It looks identical to the other image since they both use the same algorithm and dataset.

View the algorithm comments

1 On the **Open** dialog, click the **Comments...** button.

    The dialog box opens showing the comments you entered for your algorithm. These comments can be very helpful to others who use or display your algorithm, and they are a good way to document the procedures you used to create it.

2 Click **Cancel** on the comments dialog box to close it.

Close both image windows and the Algorithm dialog

1 Close both image windows:

2 On the **Algorithm** dialog, click the **Close** button.

Only the ER Mapper main menu is now open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

• Load and display an image dataset as an RGB image

• Use transforms to adjust the image contrast

• Add text labels and comments to an algorithm

• Save the processing algorithm to disk

• Reload and view the saved algorithm

3

Using GeoTIFF/ TFW images

This chapter explains how you can open and use GeoTIFF images and TIFF images with TFW files in ER Mapper

Georeferencing information

You can mosaic images only if they contain georeferencing information; i.e. that which defines where the image is geographically located. The ER Mapper Raster Dataset format has a header file (.ers), separate from the data file which contains the necessary georeferencing information. The ECW compressed format has the georeferencing information embedded in the data file. GeoTIFF and DOQQ are examples of external formats that also have embedded georeferencing information. Other formats can have associated 'World' or 'Header (.hdr)' files, similar to .ers header files, that contain the georeferencing information.

ER Mapper can create .ers header files to hold georeferencing and statistical information for image files in all supported formats. ER Mapper uses the information in a .ers header file in preference to that embedded in the image data file or contained in an associated 'World' file.

About GeoTIFF/TFW

There are two ways of including georeferencing information with raster images in the TIFF format (Tagged Image File Format) The first way is to use an accompanying text file, called a 'World' File. The second way is to incorporate the information directly into specially identified tags in the TIFF file. In this case, the TIFF file is known as a GeoTiff.

GeoTIFF

GeoTIFF is an industry-wide standard which has been developed by several organizations in the GIS community for specifying cartographic information in TIFF tags. Geographic information is embedded in the TIFF data file in the form of descriptive tags.

TFW

The TFW file is a text file which contains georeferencing information for an associated raw TIFF file. Known as a World file, it contains the following information:

- x resolution
- amount of translation
- amount of rotation
- negative of the y resolution
- x ground coordinate of pixel 1,1 (upper left)
- y ground coordinate of pixel 1,1 (upper left)

World files are not restricted to TIFF images, and are generally named the same as the associated image file with a "W" appended. For example, if the image file is named 'image1.TIF', the corresponding world file is named 'image1.TFW'.

GeoTIFF/TFW and foot-based projections

GeoTIFF

GeoTIFF images do not have a standard unit (i.e feet or meters) for the cell sizes. Generally the units are the same as those for the projection (i.e. cell size is specified in feet for foot-based projections, and meters for meter based projections). ER Mapper always interprets the cell size to be in meters, even for foot-based projections. This could cause problems when you open a GeoTIFF image (e.g. created with MapInfo® or ArcView GIS™) with a foot-based projection in ER Mapper for processing, and then save it for use in the original or another

application. ER Mapper solves this potential problem by calculating the correct cell sizes in meters when opening a GeoTIFF image with a foot-based projection. It then converts the cell sizes back to feet if you save the image in GeoTIFF or ECW compressed format.

TFW

World files have the additional problem of not having datum or projection information. Not knowing the projection, ER Mapper is not able to determine whether to convert the cell sizes to meters, as it can with GeoTIFF images.

For this reason, ER Mapper 6.1 introduced the **Change Projection/Datum/Cell Size** wizard which enables you to edit the .ers ER Mapper header file associated with the image. It creates a new .ers header file if one does not already exist. ER Mapper will then use this information in the .ers header file instead of that in the TFW World file.

With this wizard you can specify the following information:

- datum and projection.
- accept the existing cell size or you can enter a new cell size.
- recalculate the cell sizes to be the correct value in meters.

Caution: Be careful that you enter the correct information. The wizard only edits the header file, but does not reproject the image.

Hands-on exercises

These exercises give you practice using ER Mapper's Change Projection/Datum/ Cell Size Wizard to edit TFW file information

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Open a TIFF image in ER Mapper
- Use the Change Projection/Datum/Cell Size Wizard to edit the header information
- Save the TIFF file in GeoTIFF format.

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.
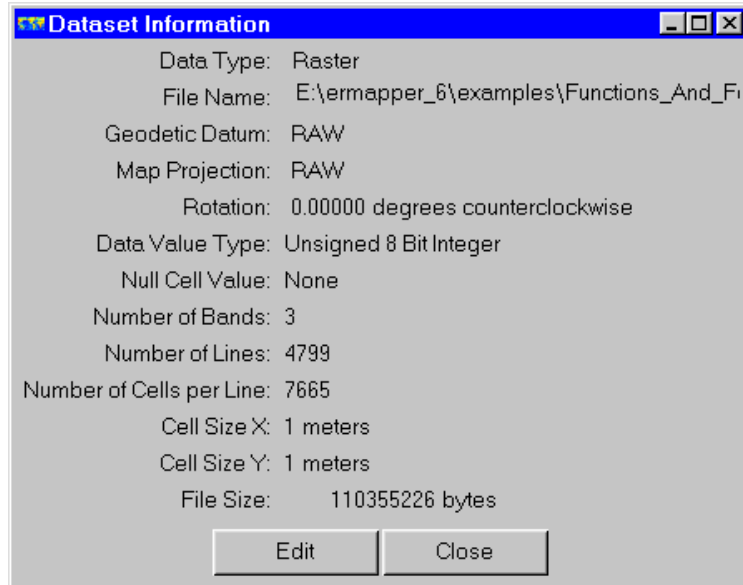
1: Edit the TIFF image header

Objectives   Learn how to use ER Mapper's Change Datum/Projection/Cell Size Wizard to create a .ers header file for a TIFF image.

Examine the current header information

1   Using **Windows Explorer** (or similar) temporarily rename the '1_3_rect.tfw' file in the '\examples\Functions_And_Features' directory.

    This is the 'World' file associated with the '1_3_rect.tif' image file. Renaming it effectively disassociates it from the image file.

2   On the ER Mapper **Common Functions** toolbar, click on the **Load Dataset** button.

3   On the Raster Dataset dialog, select 'GeoTIFF/TIFF(.tif)' in the **Files of Type** field.

4   From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

5   Double_click on the 'Functions_and_Features' directory to open it.

6   Double_click on the 'airphoto_tutorial' directory.

7   Click on the image dataset '1_3_rect.tif' to select it. Do not load it.
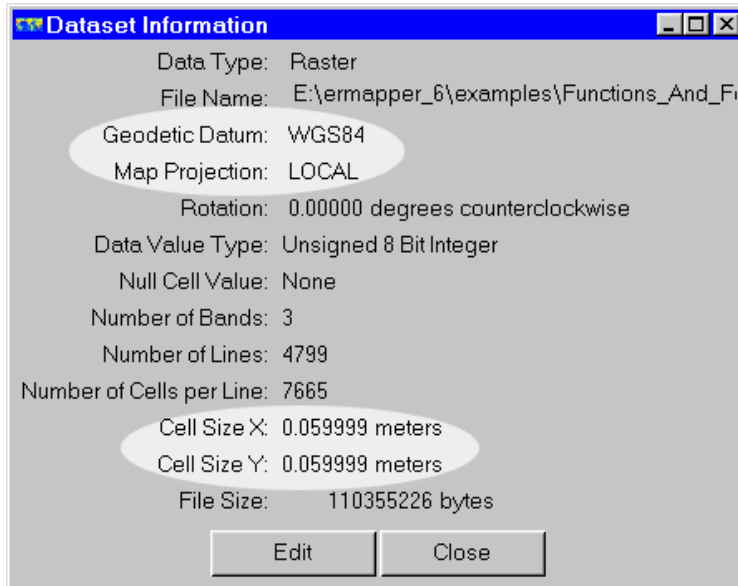
    Leave the **Raster Dataset** dialog box open.

8   Click on the **Info** button to display the **Dataset Information** dialog box.

Notice that the Geodetic Datum and Map Projection fields are both 'RAW'. This indicates that the image does not have any georeferencing information.

9   Click on the **Dataset Information** dialog **Close** button.

10 Using **Windows Explorer** (or similar), restore the '1_3_rect.tfw' file to its correct name. This will re-associate it with the '1_3_rect.tif' image file.

11 Click on the Raster Dataset dialog **Info...** button once again open the **Dataset Information** dialog box.

The image now has Datum, Projection and Cell Size information, which ER Mapper extracts from the TFW file.

The TFW file contains the following information

• The X and Y cell size dimensions

• The real world coordinates of the image reference point, which is located in the middle of the top left cell.

Note: TFW files do not contain Datum and Projection information, so ER Mapper defaults to displaying them as 'WGS84' and 'LOCAL'. Also the cell sizes could be in feet whereas ER Mapper always assumes them to be in meters.
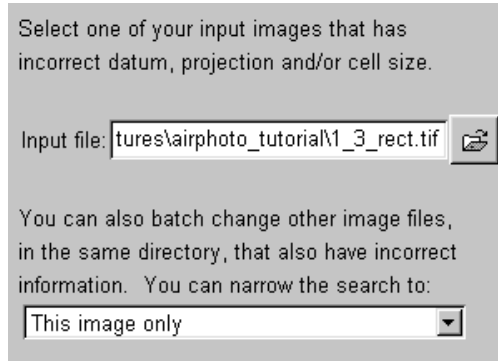
12 Click on the **Dataset Information** dialog **Close** button.

13 Click on the **Raster Dataset** dialog **Cancel** button to close the dialog.

Open the Change Datum/Projection/Cell size wizard

1 From the **Toolbars** menu, select the **Batch Processing** toolbar.

2 Click on the ⚜ button to open the **Change Datum/Projection/Cell Size** wizard.

The first page of the wizard explains the purpose and usage of the wizard. You can obtain more information by clicking on the **Additional help** button.

3   Click on the wizard **Next>** button.

4   Click on the file chooser button 🖼 on the **Input file** field.

5   On the **Select File** dialog, select 'GeoTIFF/TIFF(.tif)' in the **Files of Type** field.

6   From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

7   Double-click on the 'Functions_and_Features' directory to open it.

8   Double-click on the 'airphoto_tutorial' directory.

9   Double-click on the image dataset '1_3_rect.tif' to select it.

10 Select 'This image only' for the search criteria.

You can do batch conversions on a number of image files in the same directory by selecting the appropriate search criteria. This would be particularly useful if you intend mosaicing a large number of images, and need to edit their georeferencing information first.

11 Click on the wizard **Next>** button.

The next wizard page contains the existing image information contained in the TFW World file associated with the image. The wizard does not change the TFW file in any way, but rather creates a .ers header file with the new information.

Note: ER Mapper will ignore the World (TFW) file if a .ers header file already exists.

12 Enter the changes to be included in the .ers header file.

Input image information:
Files selected   : 1
Current datum   : WGS84
Current projection: LOCAL
Current cell size : (units are METERS)
0.059999 x 0.059999

Select changes to make:

Datum: NAD83

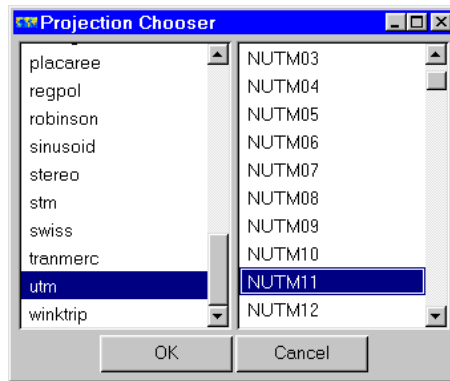Projection: NUTM11

Cell Size: Do not change

13 Click on the chooser 🖼 button on the **Datum** field.

14 In the **Datum Chooser** dialog box, double click on the 'NAD83' entry to select it.

Datum Chooser

Datum:	Description:
NAD27MTR	Spheroid: CLA66MTR, tie point: MEADE'S RANCH
NAD83	Spheroid: GRS80, tie point: GEOCENTRE
NAHRWAN	Spheroid: CLA80MOD, tie point: not specified

15 Click on the chooser 🖼 button on the **Projection** field.

16 In the **Projection Chooser** dialog box, select the 'utm' projection type from the left-hand list, and then double click on the 'NUTM11' projection in the right-hand list to select it.

17 Select 'Do not change' in the **Cell Size** field.

The sizes are already in meters, so there is no need to convert them. If we were using a foot-based projection, the sizes would most likely have been in feet, and would thus have had to be converted to meters.

Note: ER Mapper always interprets the units to be meters. If you select the **Convert to meters** option, the wizard will divide the displayed value by 3.048 so that it is correct in meters. The **Convert to feet** option reverses the calculation.

18 Click on the **Next>** button, and then click **Next>** again on the **Confirm changes** page.

The wizard will create a .ers header file for the TIFF image and edit it to include the datum, projection, cell size and cell size unit values you entered.

19 Click **Close** on the status dialog, and **Finish** on wizard page.

When you open the image in ER Mapper, ER Mapper will ignore the TFW World file in favor of the .ers header file. You can now use ER Mapper to process the image, and then save it in any of the supported formats including GeoTIFF or ECW compressed.

Note: ER Mapper does not change the TFW World file. It creates a new .ers header file for use within ER Mapper, and then uses the information in the .ers header if the image is saved with georeferencing information.
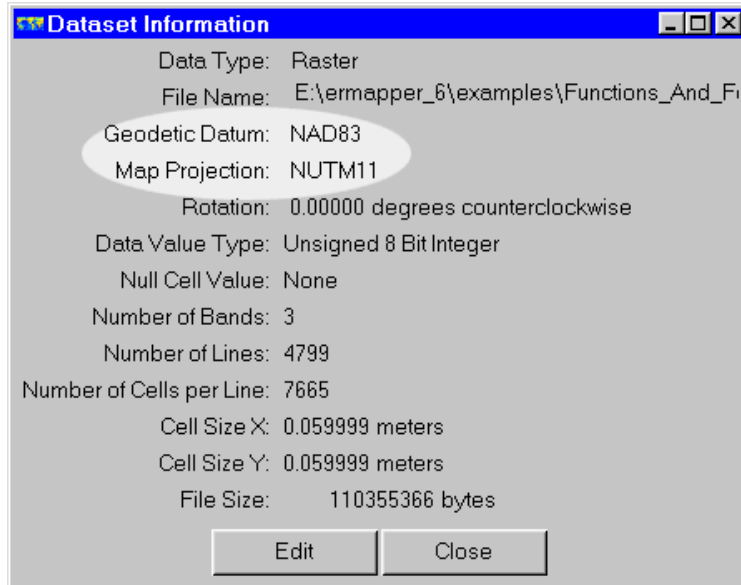
Open the TIFF image

We will now open the TIFF image in ER Mapper.

1 Click on the **Open** button on the **Standard** toolbar.

2 On the **Open** dialog, select 'GeoTIFF/TIFF(.tif)' in the **Files of Type** field.

3 From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

4 Double-click on the 'Functions_and_Features' directory to open it.

5 Double-click on the 'airphoto_tutorial' directory.

6 Double-click on the image dataset '1_3_rect.tif' to load it into an algorithm.

ER Mapper will display the image .

View the TIFF image georeferencing information

1 On the ER Mapper **Common Functions** toolbar, click on the **Load Dataset** button.

2 On the Raster Dataset dialog, select 'GeoTIFF/TIFF(.tif)' in the **Files of Type** field.

3 From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

4 Double_click on the 'Functions_and_Features' directory to open it.

5 Double_click on the 'airphoto_tutorial' directory.

6 Click on the image dataset '1_3_rect.tif' to select it. Do not load it.

7   Click on the **Info** button to display the **Dataset Information** dialog box.

Notice that the Geodetic Datum and Map Projection fields are what you entered with the Change Datum/Projection/Cell size Wizard. ER Mapper extracts this information from the .ers header file.
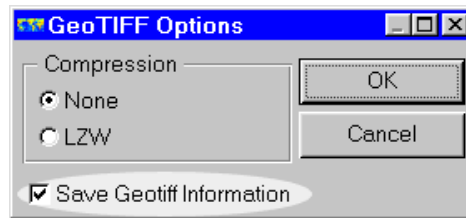
8   Click on the **Dataset Information** dialog **Close** button and the **Raster Dataset** dialog **Cancel** button.
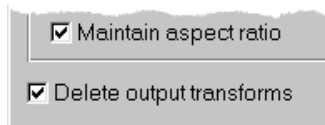
Save the TIFF image as GeoTIFF

You will now save the TIFF image in GeoTIFF format. ER Mapper will extract the georeferencing information from the .ers header file and embed it in the GeoTiff image data file.

1   From the **File** menu, select **Save As...**.

2   On the **Save As...** dialog box, in the **Files of Type:** field, select 'GeoTIFF/TIFF'.

3   From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

4   Double-click on the 'Functions_and_Features' directory to open it.

5   Double-click on the 'airphoto_tutorial' directory.

6   In the **Save as:** field, enter "1_3_rect_geo,tif". (The '.tif' extension will be added automatically if you omit it.)

7   Click **OK** to close the **Save As...** and open the **Save As GeoTIFF/TIFF** dialog box.

8   On the **Save As GeoTIFF/TIFF** dialog box, click on the **Defaults** button.

This ensures that the settings are the same as those of original TIFF image.

9   Click on the **Options...** button to open the **GeoTIFF Options** dialog box.

10 Select the **Save Geotiff Information** option and click on the **OK** button.

This specifies that the georeferencing information in the .ers header file is to be included in the image data file. If you do not select this option, the image will be saved as a normal TIFF file. Any georeferencing information would then have to be included in a separate TFW World file.

11 Make sure that the **Maintain aspect ratio** and **Delete output transforms** options are both selected in the **Save As GeoTIFF/TIFF** dialog box.

12 Click on the **OK** button.

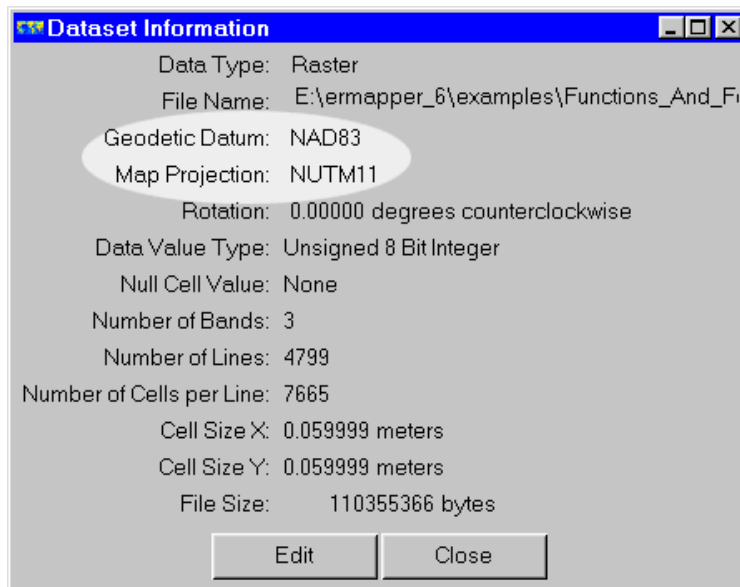ER Mapper indicates the progress of the save via a status dialog box.

Display the GeoTIFF image

1   On the **Standard** toolbar, click the **Open** 📂 button.

2   On the **Open** dialog box, in the **Files of Type:** field, select 'GeoTIFF/TIFF'.

3   From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

4   Double-click on the 'Functions_and_Features' directory to open it.

5   Double-click on the 'airphoto_tutorial' directory.

6   Double-click on the image file '1_3_rect_geo.tif' to load it.

ER Mapper will display the same image as before.

View the GeoTIFF georeferencing information

1 On the ER Mapper **Common Functions** toolbar, click on the **Load Dataset**
   📁 button.

2 On the Raster Dataset dialog, select 'GeoTIFF/TIFF(.tif)' in the **Files of Type** field.

3 From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

4 Double_click on the 'Functions_and_Features' directory to open it.

5 Double_click on the 'airphoto_tutorial' directory.

6 Click on the image dataset '1_3_rect_geo.tif' to select it. Do not load it.

7 Click on the **Info** button to display the **Dataset Information** dialog box.

Notice that the Geodetic Datum and Map Projection fields are the same as those of
the original TIFF image. There is also no '1_3_rect_geo.ers' header file, so
ER Mapper extracts this information from the GeoTIFF file.

8 Click on the **Dataset Information** dialog **Close** button and the **Raster Dataset** dialog **Cancel** button.

Close all windows

1 Close all image windows using the window system controls:

- For Windows, select **Close** from the window control-menu.

2 Click **Close** on the **Algorithm** window to close it.

   Only the ER Mapper main menu should be open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Use the Change Datum/Projection/Cell size Wizard to create and edit a .ers file
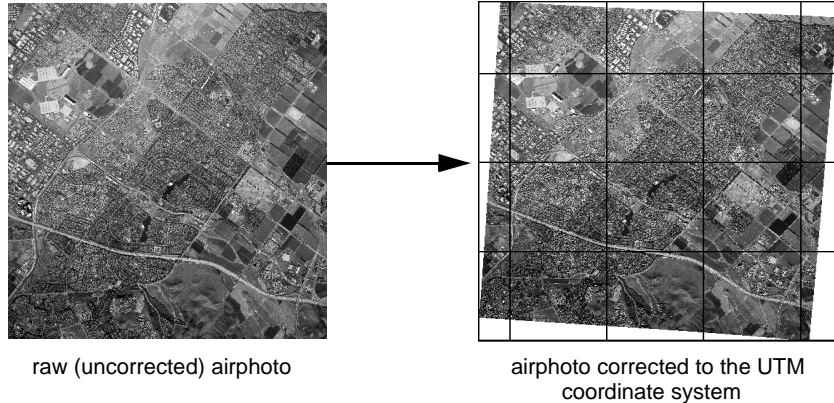- Save the TIFF image with georeferencing information in GeoTIFF format.

4

Image orthorectification

This chapter explains how to use the ER Mapper Geocoding Wizard to geometrically correct raw image data and orthorectify it to real world coordinate systems and map projections.

About image rectification

In order to create a mosaic of two or more airphotos, you must geometrically correct the raw airphoto dataset to a known map coordinate system.

raw (uncorrected) airphoto

airphoto corrected to the UTM coordinate system

This geometric correction process is known as rectification.

The ER Mapper Ortho and Geocoding Wizard can perform four different types of rectification.

- Triangulation
- Polynomial
- Orthorectification using Ground Control Points (GCPs)
- Advanced Orthorectification using exterior orientation

The method you use, with its corresponding degree of accuracy, depends on the amount of information you have about the sensor equipment, the platform it is mounted on and the terrain being scanned or photographed.

For airphotos it is preferable to use Orthorectification rather than Triangulation and Polynomial. For this reason, this chapter concentrates on Orthorectification.

Note: Some airphoto datasets have already been rectified before being opened in ER Mapper. These include orthorectified datasets such as the USGS Digital Ortho Quad (DOQ) series, GeoTIFF images and others. In this case, you do not need to rectify the dataset in ER Mapper, you only need to make sure the proper datum, projection, and other parameters are specified (usually using the dataset header editor).

Ground Control Points

A common way rectify an image is by selecting ground control points (GCPs) between the raw airphoto and a reference image or map, and then creating a new output image that is rectified (or geocoded) to the real world coordinate system.

A *ground control point* (GCP) is a point on the earth's surface where both *image coordinates* (measured in rows and columns) and *map coordinates* (measured in degrees of latitude and longitude, meters, or feet) can be identified. *Rectification* is the process of using GCPs to transform the geometry of an image so that each pixel corresponds to a position in a real world coordinate system (such a UTM or State Plane map projection). This process is sometimes called "geocoding" or "rubbersheeting" because the image data are stretched or compressed as needed to align with a real world map grid or coordinate system.
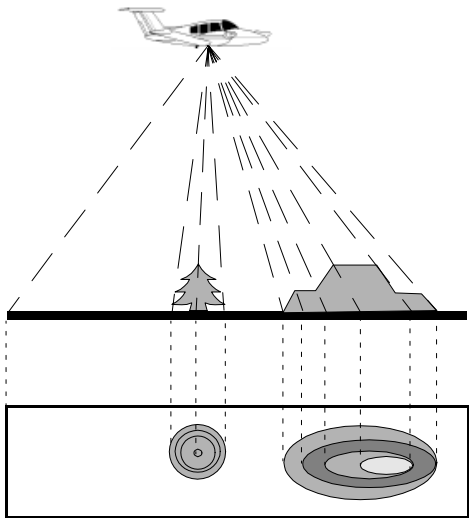
To perform a control point rectification, you need a raw and reference image

- The *raw image* is simply a digitized airphoto that has been imported into ER Mapper

- The *reference image* is any other dataset, hardcopy map, or set of known coordinate points that can be used to correct the raw image. You can use another airphoto or image that has already been rectified, a geocoded vector dataset, a hardcopy map mounted on a digitizing table, or GPS survey points of known features in your image (such as buildings or road intersections).
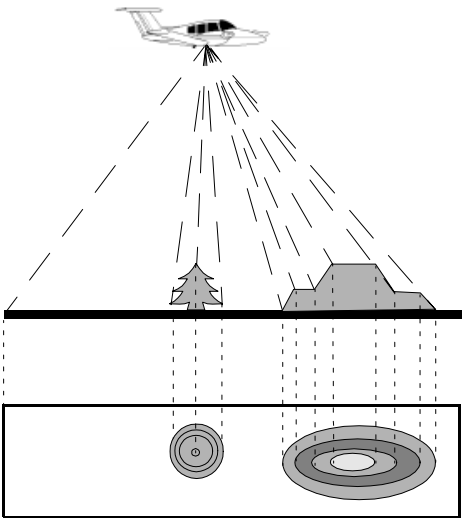
About orthorectification

Orthorectification is more accurate than Linear or Polynomial rectification because it corrects local and global distortions in the image by adjusting for camera characteristics, platform positions and terrain details. This is particularly important

for airphotos because they are generally of a higher resolution than satellite images. The following pictures demonstrate how airphoto images can be distorted by variations in terrain, and the effects of height correction in orthorectification.

Non-orthorectified image

Orthorectified image

It is possible to use Polynomial and Triangulation rectification to correct for terrain variations, provided you choose enough GCPs. The following table shows the numbers of GCPs you would require for Polynomial rectification.

Polynomial order	GCP Requirements		Terrain type
	Minimum	Recommended	
Linear	3	6	
Quadratic	6	12	
Cubic	10	20	
nth	Not possible	Not possible	

From the table you can see that, if the terrain is generally flat, you can use Linear order Polynomial rectification with 6 GCPs. For satellite images covering larger areas, where you need to correct for the earth's curvature, you will need Quadratic order Polynomia1 rectification with 12 GCPs. For gently undulating terrain you should use cubic order polynomial rectification with a recommended 20 GCPs.

Selecting this number of GCPs per image is time-consuming process that still does not rectify images with real-world type terrain. Triangulation rectification does allow you to rectify images with more rugged terrains, but can require hundreds of manually selected GCPs per image.

Orthorectification, on the other hand, requires you to enter only 4 to 6 GCPs, and to identify the positions of fiducial points on the edges of the image. You have to supply the terrain details to the ER Mapper Geocoding Wizard in the form of a DEM (Digital Elevation Model). If the terrain is relatively flat, you can use an average height value.

Note: The ER Mapper orthorectification does not correct images for the curvature of the earth. This is only significant for individual images of areas that are longer than 20 KMs, which precludes most airphotos.

DEM file

A DEM is an image that comprises regularly gridded Z (height) data. If the height information is only available as contours, breaklines or XYZ ascii files, you can use the ER Mapper Gridding Wizard to create a DEM. Refer to the ER Mapper User Guide for information on the Gridding Wizard. The accuracy of the orthorectification depends on the resolution of the DEM. The following table gives a rough guide to the DEM resolutions required:

Airphoto scale	Required accuracy	Height data
1:10,000 - 1:15,000	1 - 2 meters	1 - 2 meter contours
1:20,000 - 1:30,000	2 - 5 meters	5 meter contours
1:40,000+	5+ meters	10 meter contours

Camera file

ER Mapper stores camera characteristics in a camera file for use by the Geocoding Wizard. The camera file information is derived from a camera calibration report.

Advanced orthorectification

In the case of Advanced Orthorectification, the image data supplier provides exterior orientation values that describe the exact position of the aircraft at the time the image was taken, and how this relates to the image. This does away with the necessity to plot Ground Control Points. The following exterior orientation parameters are specified:

Attitude omega   The tilt angle (roll) of the aircraft; i.e. the rotation about the X axis (direction of travel).

Attitude phi   The swing angle (pitch) of the aircraft; i.e the rotation about the Y axis.

Attitude kappa   The azimuth angle (yaw)of the aircraft; i.e the rotation about the Z axis.

Exposure center XYZ   The co-ordinates of the exposure center of the image.

If you do not have the exterior orientation parameters, then you have to specify about 4 to 6 GCPs for the Geocoding Wizard to compute them.

Caution: The format of exterior orientation parameters generated by different photogrammetry devices can vary considerably from device to device, and you might need to modify them to be compatible with ER Mapper.

Input data requirements

You must have the following information available to able to use the Geocoding Wizard to orthorectify an image:

- Camera file containing camera calibration information

- DEM file (You can enter an average height if the terrain is relatively flat)

- Exterior orientation (Only for Advanced Orthorectification. Otherwise you must select GCPs)

- GCPs referenced by their XYZ coordinates.(Not required if you have the exterior orientation parameters.

The diagram below illustrates the required inputs for orthorectification.

Note: The Geocoding Wizard only supports images in ER Mapper Raster Dataset format. If the image is in another format, then you should either save it in ER Mapper Raster Dataset format or use the import utilities to import it as an ER Mapper Raster Dataset.

Hands-on exercises

These exercises give you practice using ER Mapper's Geocoding Wizard to orthorectify an airphoto image.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

• Use the Geocoding Wizard to orthorectify an airphoto

• Use the Camera Wizard to create a Camera File from a calibration report

• Locate fiducial marks on an airphoto

• Pick suitable Ground Control Points (GCPs)

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

In these exercises you will use the Geocoding Wizard to orthorectify the airphoto image of San Diego taken in 1997. The example images are used with permission from Aerial Fotobank.

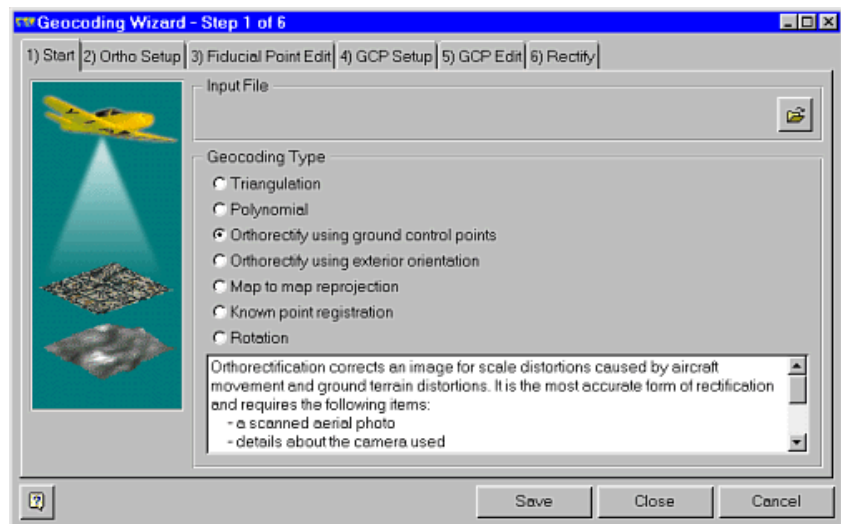# 1: Orthorectify an airphoto using GCPs

Objectives

Learn how to use ER Mapper's Geocoding Wizard to orthorectify an airphoto. Use the Camera Wizard to create a Camera File with given calibration parameters.
Select Ground Control Points

Open the Geocoding Wizard

1 Click on the **Ortho and Geocoding Wizard** 🔳 button in the **Common Functions** toolbar.

The Geocoding Wizard will open with the **1) Start** tab selected.

2 Click the **Load Algorithm or Dataset** 📂 button in the **Input file:** field to open the file chooser.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Select the directory 'Applications\,Airphoto\1_Geocoding' and then double-click on 'San_Diego_Airphoto_34_not_rectified.ers' to select it.

5 Select the Geocoding Wizard **Orthorectify using ground control points** option.

In this example, you do not have exterior orientation parameters which provide information on the position of the platform or aircraft. Instead, you will pick GCPs so that the wizard can compute the exterior orientation parameters. If these parameters were available, you could have chosen the **Orthorectify using exterior orientation** option.

6 Select the **2) Ortho Setup** tab.

Enter terrain and camera details

This tab allows you to enter the terrain details in the form of a DEM or as an average height value. Obviously, using a DEM would produce a more accurate result. However, if the terrain is relatively flat, you can enter an average value. In this example you will enter the name of a DEM file.
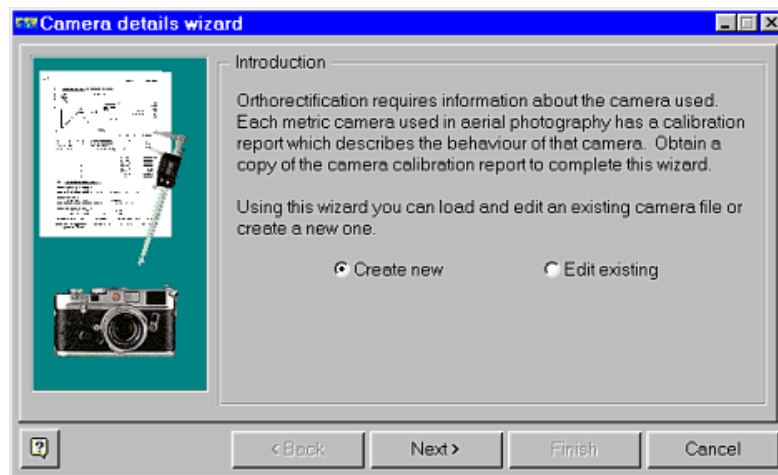
You supply the camera details to the Geocoding Wizard in the form of a camera file. If the applicable camera file does not exist, you can use the Camera Wizard to create one.

1 Select the **Use a DEM file as height** option in the **DEM Setup** box.

Notice that the DEM Setup box changes according to the option that you choose. Because you selected the **Use a DEM file as height** option, the DEM Setup box displays a file and a band chooser for you to select the DEM file and the required data band.

2   Click on the **Load input DEM File** 📂 button to open the file chooser.

3   Select the file 'San_Diego_DEM.ers' from the 'examples\Applications\,Airphoto\1_Geocoding' directory and click on the OK button to return to the Geocoding Wizard.

4   Click on the **Camera Wizard** 📷 button to open the Camera Wizard dialog.
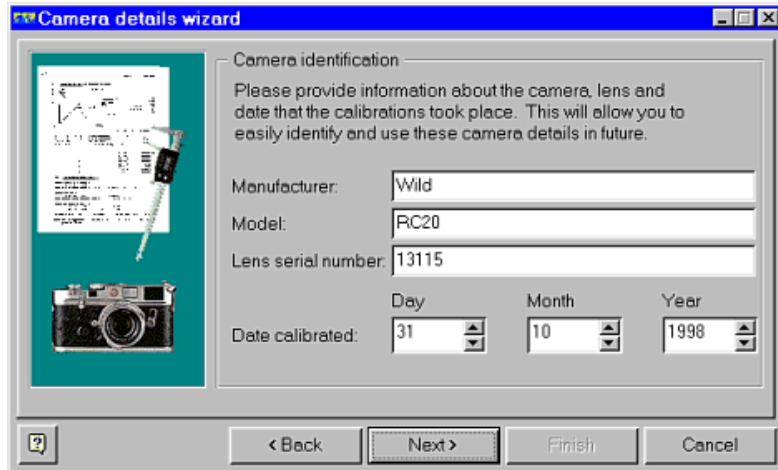
Create a Camera file

The Camera Wizard creates a Camera file for the Geocoding Wizard to use. It does this by providing a number of dialog boxes for you to enter camera calibration information. You normally get this information from a camera calibration report. If you do not have a valid calibration report for the camera that was used to take the image, you can use a generic report for that camera model. This could result in a some inaccuracies.

1   Click on the **Create new** option to create a new Camera File.

You could edit an existing Camera File, in which case the wizard provides you with the **Camera file:** field and chooser to enter the name of the existing file.

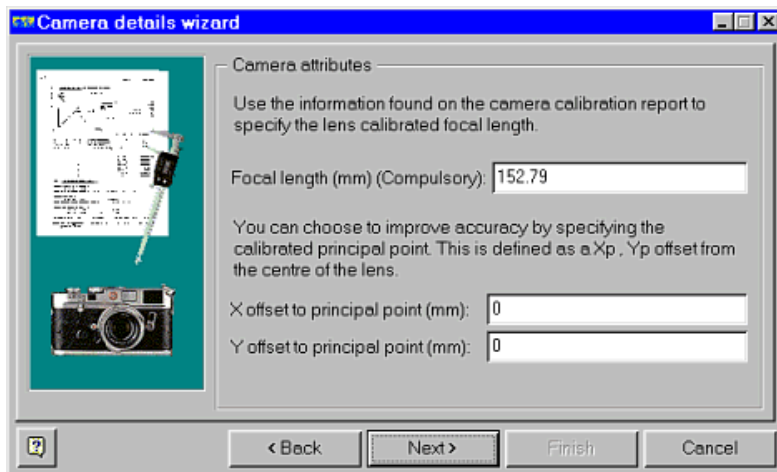2 Click on the **Next>** button to go to the Camera identification page.

The information you enter here is not used by the Geocoding Wizard. Therefore it can be omitted. It is, however, a good idea to include it because it is a means of identifying the camera and the calibration report in the future.

3 Enter the following information in the applicable fields:

Manufacturer:	Wild
Model:	RC20
Lens serial number:	13115
Date calibrated:	Day: 31 Month:10 Year: 1998

4   Click on the **Next>** button to go to the 'Camera attributes page'.

Use this page to enter information on the focal length of the camera lens. The
Camera Wizard uses this information, so it must be entered. In addition, you can
enter information on the position of the Principal Point relative to the lens center as
a measure of lens distortion. Any distortion in the lens would cause the principal
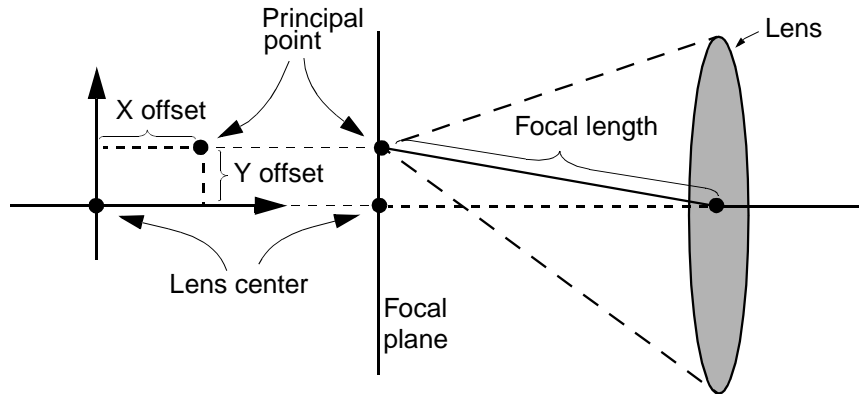point to be offset from the lens center.

5   Enter the following information in the applicable fields:

Focal length: 152.793

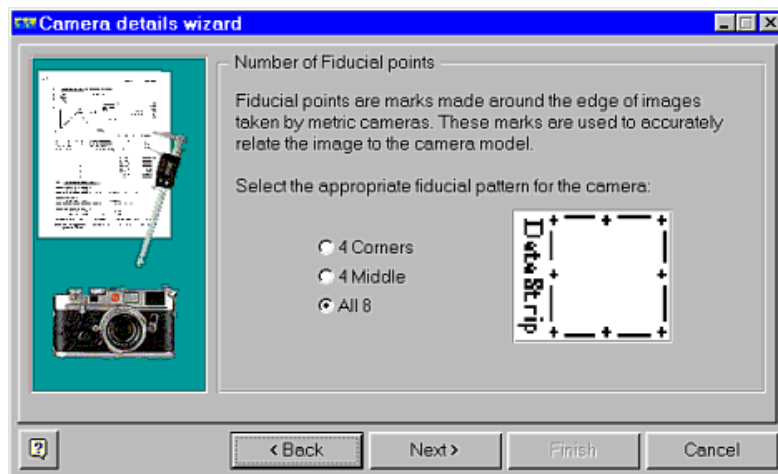**X offset to principal point:** 0

Y offset to principal point: 0

This is the ideal case where the principal point is at the lens center on the focal plane. Lens distortion could cause it to be slightly off-center, and this is represented by the X and Y offsets to the principal point. The diagram below illustrates this by exaggerating the lens distortion.

Note: While the focal length information is critical, you can generally set the principal point offsets to 0 because lens distortion will be negligible compared to that introduced by the scanner.

6   Click on the **Next>** button to go to the 'Number of Fiducial points' page

Aerial photography cameras insert Fiducial marks around the edges of the airphoto images. Different cameras insert these marks in different places on the image. The Geocoding Wizard uses the positions of these marks to relate the image to the camera model. Use this page to specify where the camera has placed the Fiducial marks. If you specify four Fiducial marks where the camera has, in fact, inserted eight, the Geocoding Wizard will only take into consideration the four you specified.

7   Select the **All 8** option; indicating that the Fiducial points are on the four corners and the middle of edges of the image.

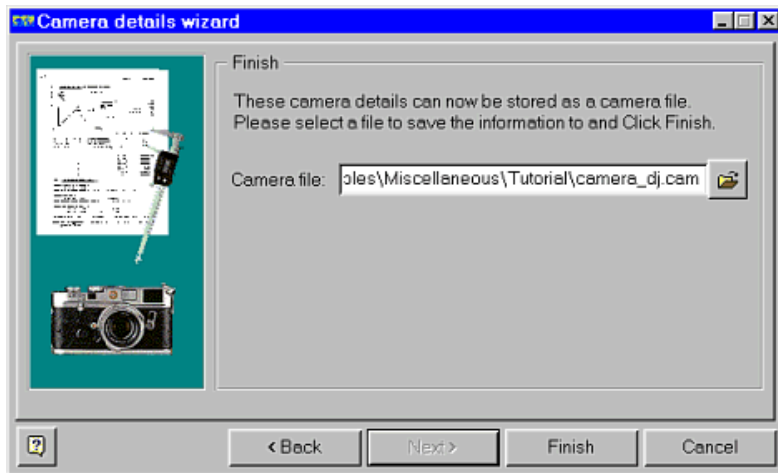8   Click on the **Next>** button to got to the 'Fiducial point offsets' page.

This page enables you to specify the positions of the fiducial points relative to the principal point.

9   Enter the following values in the applicable fields:

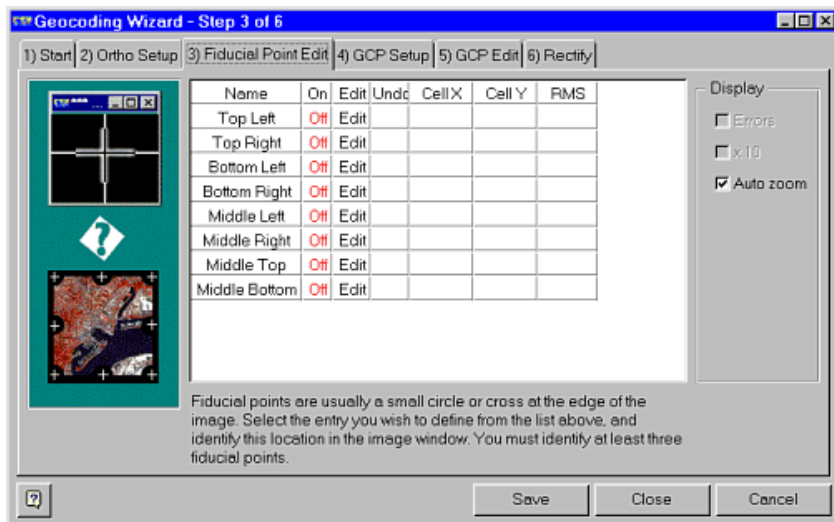|	
Top left	X:-105.99 Y:106.01
Middle top	X: 0.011 Y: 110.01
Top right	X:106.01 Y:106.02
Middle left	X:-109.99 Y: 0.012
Middle right	X:110.01 Y: 0.013
Bottom left	X:-105.99 Y:-105.99
Middle bottom	X:-0.005 Y: -109.99
Bottom right	X:106.0l Y:-105.99

Note: The data strip is not always on the left side of the image. Ensure that your scanned image has the data strip on the same side as what is specified in the Camera File. If not, you will have to either change the Camera file or rotate the scanned image.

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10 Click on the **Next>** button to go to the 'Finish' page.

11 Click the **Save** 📁 button in the **Camera file:** field to open the file chooser to select a directory and file name to which to save the new camera file.

12 From the **Directories** menu, select the path ending with the text **\examples**.

13 Select the directory 'functions_and_features\airphoto_tutorial', and then enter '`camera_<your initials>`' in the **Save as:** field.

14 Click on the **OK** button to return to the Camera Wizard.

The file name and directory you entered should now be displayed in the **Camera file:** field.

15 Click on the **Finish** button to return to the Geocoding Wizard.

16 Click the **Load Camera File** 📁 button in the Geocoding Wizard **Camera file:** field to open the file chooser.

17 From the **Directories** menu, select the path ending with the text **\examples**.

18 Select the directory 'functions_and_features\airphoto_tutorial', and then double-click on the 'camera_*<your initials>*' file you saved.

19 Click on the **3) Fiducial Point Edit** tab.
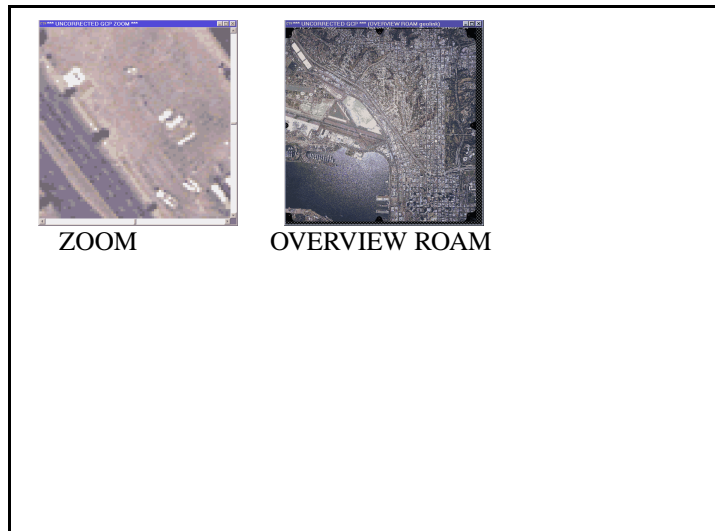
Edit the fiducial points

This wizard page enables you to enter the locations of the fiducial points on the image into ER Mapper.
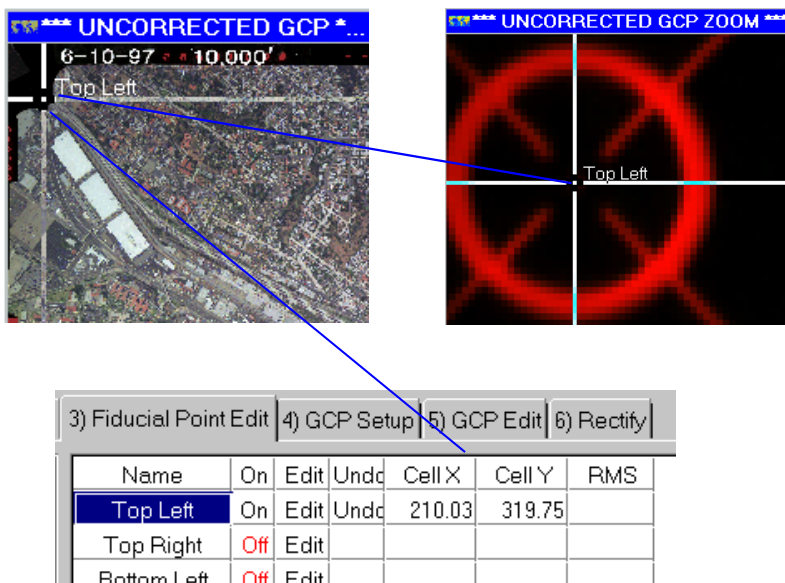

Tip: Images scanned by lower quality scanners often have fiducial points that are difficult to see. It often helps to increase the image contrast before orthorectifying them.

ER mapper opens two image windows one in OVERVIEW ROAM mode, and the other in ZOOM mode.

ZOOM   OVERVIEW ROAM

1   Select the **Auto zoom** option. This causes the ZOOM window to automatically zoom to the selected fiducial mark.

2   Select the **Pointer Tool** on the **Standard** toolbar.

3   On the table, select 'Top Left' in the 'Name' column.

4   In the OVERVIEW ROAM window, click on the Fiducial mark on the top left corner of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

5   On the table, select 'Top Right' in the 'Name' column.

6   In the OVERVIEW ROAM window, click on the Fiducial mark on the top right corner of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

7   On the table, select 'Bottom Left' in the 'Name' column.

8   In the OVERVIEW ROAM window, click on the Fiducial mark on the bottom left corner of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

9   On the table, select 'Bottom Right' in the 'Name' column.

10 In the OVERVIEW ROAM window, click on the Fiducial mark on the bottom right corner of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

11 On the table, select 'Middle Left' in the 'Name' column.

12 In the OVERVIEW ROAM window, click on the Fiducial mark on the middle of the left side of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

13 On the table, select 'Middle Right' in the 'Name' column.

14 In the OVERVIEW ROAM window, click on the Fiducial mark on the middle of the right side of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

15 On the table, select 'Middle Top' in the 'Name' column.

16 In the OVERVIEW ROAM window, click on the Fiducial mark on the middle of the top the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

17 On the table, select 'Middle Bottom' in the 'Name' column.

18 In the OVERVIEW ROAM window, click on the Fiducial mark on the middle of the bottom of the image.

The image in the ZOOM window will automatically zoom to the selected fiducial mark. Use this to adjust the position of the cursor to the center of the red circle.

After selecting the fiducial markers, the table on the **Fiducial Point Edit** tab should be similar to what is shown below.

Name	On	Edit	Undo	Cell X	Cell Y	RMS
Top Left	On	Edit	Undo	211.13	322.41	0.23
Top Right	On	Edit	Undo	5221.11	322.26	0.13
Bottom Left	On	Edit	Undo	202.80	5333.18	0.31
Bottom Right	On	Edit	Undo	5213.25	5333.81	0.26
Middle Left	On	Edit	Undo	112.59	2827.72	0.15
Middle Right	On	Edit	Undo	5311.96	2827.56	0.34
Middle Top	On	Edit	Undo	2716.12	227.64	0.20
Middle Bottom	On	Edit	Undo	2707.95	5428.11	0.13

The RMS column should show values of less than 1.00.

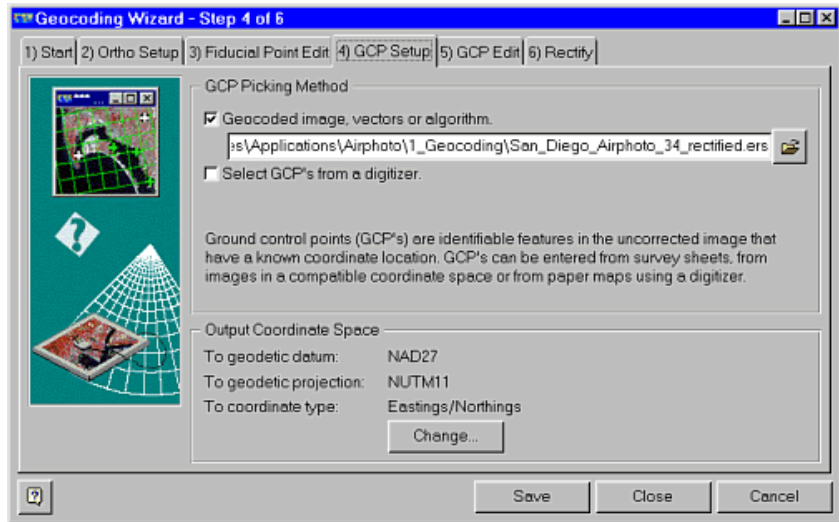The image window should now have all the fiducial points labelled.

19 If necessary, select the **Errors** option, and adjust the position of the selections in the direction of the indicated errors.

The x10 option enlarges the error markers for a more accurate indication.

20 Click on the **4) GCP Setup** tab.

Setup Ground Control Points

The **GCP Setup** tab lets you specify the way that you want to choose control points. Control points may be entered manually, chosen from a reference image, chosen from a digitizing tablet, or chosen using a combination of these three methods.

In this exercise, you will use a previously orthorectified reference image to locate GCPs.

1 In the **GCP Picking Method** box, select **Geocoded image, vectors or algorithm** option.

This tells ER Mapper you plan to pick corresponding points between two images on the screen.

2 Click the **Load Corrected Algorithm or Dataset** 📂 file chooser button.

3 Choose 'ER Mapper Raster Dataset (.ers)' in the **Files of Type:** field.

4 From the **Directories** menu on the file chooser dialog, select the path ending with the text **\examples**.

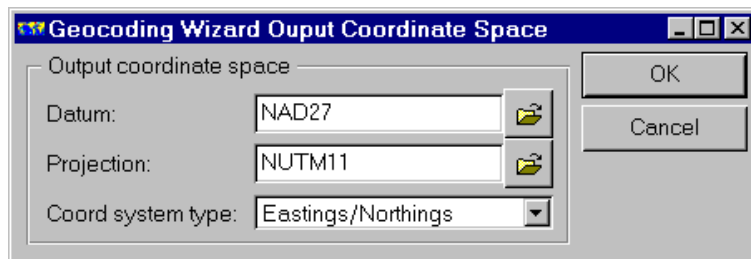5 Double_click on the 'Applications' directory to open it.

6   Double-click on the 'Airphoto\1_Geocoding' directory to open it, then double-click on 'San_Diego_Airphoto_34_rectified.ers' to load it.

This is the already rectified image containing coordinate information.

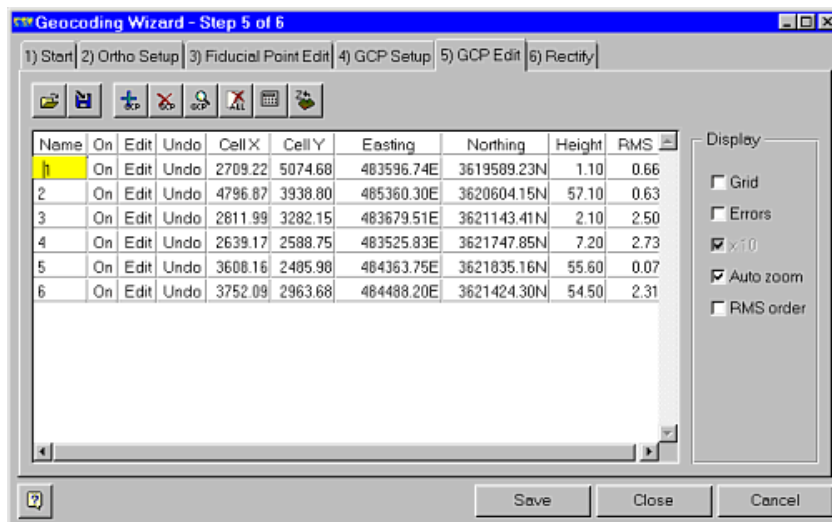### Setup parameters for the image rectification

The **To geodetic datum**, **To geodetic projection** and **To Coordinates**, fields in the Output Coordinate Space box show the datum, projection and coordinate type for the output rectified file you will create. These parameters are included automatically from the 'CORRECTED' (rectified) airphoto image.

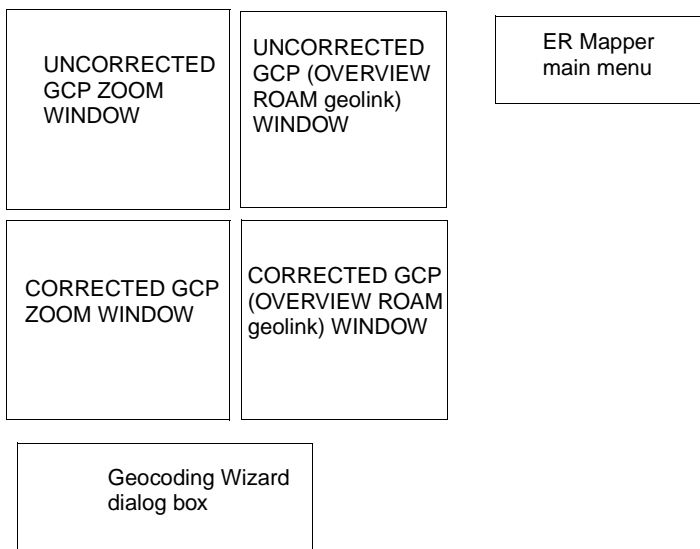7   Click on the **Change...** button to open the **Geocoding Wizard Output Coordinate Space** dialog.

8   If necessary, change the settings to what is displayed above.

9   Click **OK** on the **Geocoding Wizard Output Coordinate Space** dialog to close it.

10 Select the Geocoding Wizard **5) GCP Edit** tab.

Edit Ground Control Points

ER Mapper opens several image windows and dialog boxes. You should see a screen setup similar to this one:

Note: If your system does not position the windows automatically, rearrange them as shown above before proceeding.

Pick a GCP in the upper-left part of the reference image

Note: Make sure the main ER Mapper menu is not hidden by the image windows – move it slightly if needed so you can easily access the toolbars.

1 On the Geocoding Wizard **GCP Edit** tab, select **Auto zoom**.

The ZOOM windows will now automatically zoom into the point selected in the corresponding OVERVIEW ROAM windows.

Note: In this example, the reference image extents are, unfortunately, much smaller than those of the raw image. This means the you will have to confine the GCPs to fall within the reference image extents. You should try to select them over as wide an area as possible, so the first four should be in the four corners of the reference image.

2 Click on a well defined feature in the 'UNCORRECTED GCP (OVERVIEW ROAM geolink)' window to select it.

The 'UNCORRECTED GCP ZOOM' window will zoom ito the selected point

3 Click once in the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window to activate it, then click on the same feature to select it as a GCP.

The 'CORRECTED GCP ZOOM' window will zoom ito the selected point

4 Use the two ZOOM windows to adjust the positions of the GCP.

5 Click on the **Set Z height from DEM** button to fill in the 'Height' field for that GCP.

The wizard will compute the height at that position from the 'San_Diego_DEM.ers' DEM file that you specified earlier. The accuracy of this value depends on the DEM resolution. If you have a definite height value for that GCP, you can also click on the 'Height' field and enter it manually.

You have now picked a GCP in the image.

Pick a second GCP in the lower-left of the reference image

6 On the Geocoding Wizard **Edit GCP** dialog, click the **Add new GCP** button.

7 Click on a well defined feature in the 'UNCORRECTED GCP (OVERVIEW ROAM geolink)' window to select it.

The 'UNCORRECTED GCP ZOOM' window will zoom into the selected point

8   Click once in the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window to activate it, then click on the same feature to select it as a GCP.

The 'CORRECTED GCP ZOOM' window will zoom ito the selected point

9   Use the two ZOOM windows to adjust the positions of the GCP.

10 Click on the **Set Z height from DEM** ![icon] button to fill in the 'Height' field for that GCP.

The wizard will compute the height at that position from the 'San_Diego_DEM.ers' DEM file that you specified earlier. The accuracy of this value depends on the DEM resolution. If you have a definite height value for that GCP, you can also click on the 'Height' field and insert it manually.

You have now picked a second GCP in the image.

11 Following the above steps, pick another four GCPs near the upper-right, lower-right and middle of the reference image.

The more GCPs you pick, the lower the possibility of errors. For orthorectification you need at least four, with six being the recommended number.

Try some other features on the Geocoding Wizard GCP Edit dialog

1   In the Geocoding Wizard **GCP Edit** dialog, click on any GCP number under the 'Name' column.

ER Mapper moves the crosshairs to highlight that point in all the 'OVERVIEW ROAM' and 'ZOOM' windows.

2   Turn off the **Auto Zoom** option at the bottom.

3   Click on any GCP number under the 'Name' column.

ER Mapper moves the crosshairs to highlight that point in the 'OVERVIEW ROAM' windows, but not the 'ZOOM' windows.

4   Click on the **Zoom to current GCP** ![icon] button.

ER Mapper zooms into the selected GCP in the "ZOOM' windows.

5   Select the number text for a GCP under the 'Name' column, and type a short name.

You can give GCPs text labels as well as numbers to help identify them.

6   Click on the text 'On' in the second column for any GCP.

The text changes to 'Off' and all the RMS errors are recomputed without including that GCP. (This is an easy way to see how the positional error of any GCP influences the RMS of the others. For example, turning off a GCP with a large RMS often reduces the RMS of the others.) This can be important when choosing which GCPs will be used for the final image rectification.

7 Turn off other GCPs to see the effect, but turn all on again when finished.

8 Click on the text 'Edit' in the third column for any GCP.

The text changes to 'No' and the "X" and number marking it in the image turns green. This effectively "locks" a GCP so it cannot be edited (that is, clicking in the image windows do not redefine it's position). This is useful when you have several very good GCPs and you to lock them to avoid accidentally changing them.

9 Turn on the **Errors** option.

The magnitude and direction of the calculated positional error are shown graphically by a line for each GCP on the image. (If you have very small RMS errors you may not see the error line, even if you increase the line length by a factor of 10 using the **x10** option.)

10 Turn on the **Grid** option.

A polynomial grid displays over all three image windows. This grid is a simple "preview" of the way in which the FROM (raw) image pixels will be reprojected onto the new coordinate grid of the TO image. (This grid is only an approximation, in reality the lines would be curved.)

11 Click the **Add new GCP** button and select a point on the CORRECTED image.

12 Click on the **Calculate uncorrected point** button. The wizard will automatically position the corresponding GCP on the UNCORRECTED image. Use the ZOOM windows to adjust the GCP position.
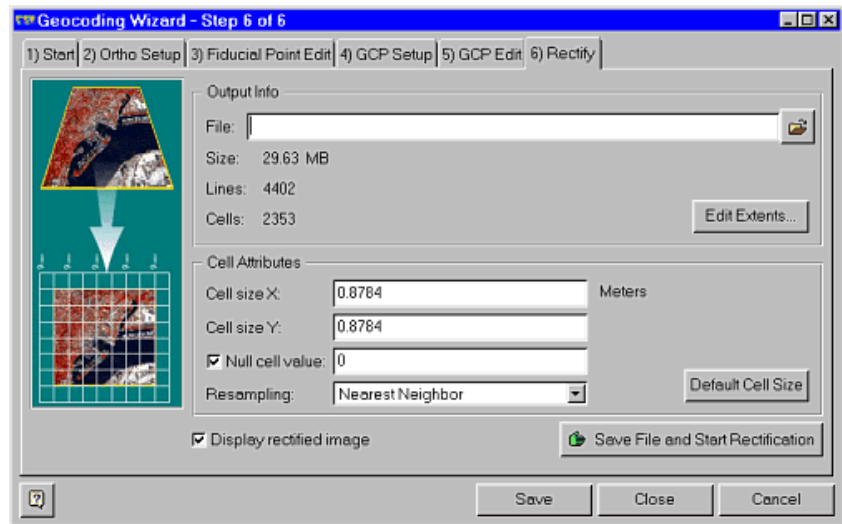
This time saving facility is available once you have positioned four points.

13 Click **Save** on the **Geocoding Wizard** dialog. When asked confirm saving the GCPs to disk, click **Yes**.

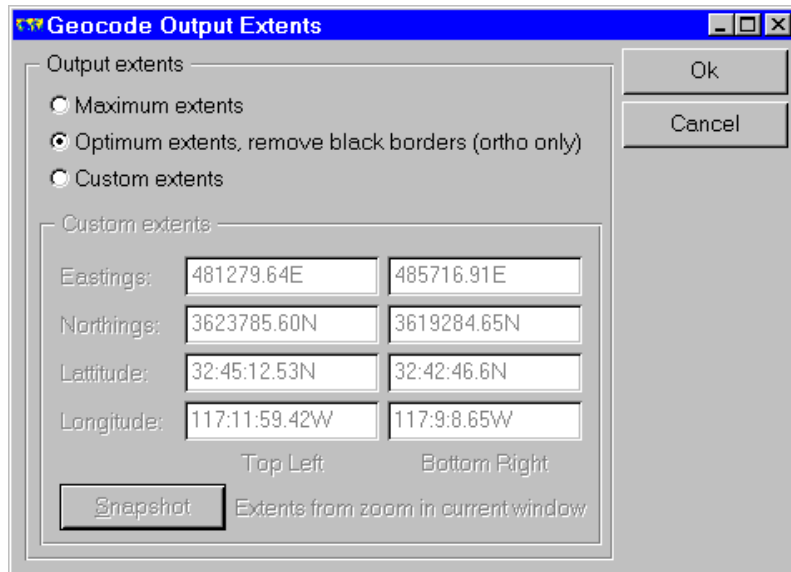This will save the geocoding information into the header file of the UNCORRECTED image.

14 Select the Geocoding Wizard **6) Rectify** tab.

Rectify the image

1 Click the file chooser **[icon]** button in the **Output Info** box.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Double-click on the 'functions_and_features\airphoto_tutorial' directory to open it.

4 Enter the filename '**San_Diego_orthorectified**' (start with your initials), then click **OK**.

5   Click on the **Edit Extents...** button to open the **Geocode Output Extents** dialog box.

This dialog allows you to specify how much of the orthorectified image you want to save. You have three main options:

Maximum extents: Saves the whole image including any portion not visible in the currently active image window.

Optimum extents: Automatically calculates the extents of airphotos to exclude the black edges around them.

Custom extents: Allows you to specify the top left and bottom right coordinates of the area to be included. If you click on the **Snapshot** button ER Mapper will automatically select the extents of the visible part of the image in the currently active image window.

6   Select the Custom extents option and enter the Easting/Northing values shown below.

These values are the extents coordinates for the reference image. Note that the Latitude and Longitude values change automatically as you change the Eastings and Northings values.

7   Click on the **OK** button to exit the **Geocode Output Extents** dialog box. and return to the Geocoding Wizard

8   In the **Resampling:** in the Cell Attributes box select 'Nearest Neighbour'.

The Cell Attributes box also lets you resample the output image to a different cell size (Output Cell width and height), and specify a null cell value. If you do not enter a null cell value, it will default to that in the reference image.

Note: Cells having the null cell value will be treated by ER Mapper as being transparent. This can be very useful if you want to remove black or white edges around individual images to be mosaiced. All you have to do is set the null cell value to 0 for black, or 255 for white. You must, however, use this with care because it can have the undesirable effect of rendering wanted black or white areas in the image transparent as well.

---

9   Click on the **Save** button to save the orthorectification parameters in the 'San_Diego_Airphoto_34 _not_rectified.ers' header file.

You will use this in the next exercise.

10 Select **Display rectified image** to display the image after it is rectified.

11 Click on the **Save file and start rectification** button.

ER Mapper opens a status dialog to indicate the progress of the rectification. This should take approximately 10 minutes.

12 When the operation finishes, click **OK** of the successful completion dialog.

13 Click on the **Close** button to exit the Geocoding Wizard.

You have now rectified the uncorrected airphoto image to correspond to the 1927 North American Datum (NAD27) and UTM zone 11 (NUTM11) map projection.

14 Do not close the image window with the orthorectified image

Evaluate the image orthorectification

1 On the main menu, click the **Edit Algorithm** button to open the **Algorithm** window.

2 The Algorithm window shows the Red, Green and Blue layers of the orthorectified image.

3 In the **Algorithm** window, click on the Blue layer to select it.

4 Click the **Load Dataset** button in the algorithm process diagram.

5 From the **Directories** menu, select the path ending with **\examples**.

6 Double-click on the 'Applications' directory to open it.

7 Double-click on the 'Airphoto' and then on '1_Geocoding' directory to open it.

8 Click once on the image 'San_Diego_Airphoto_34 _rectified.ers' to select it, then click **OK this layer only** button to load it into the Blue layer. (The Red and Green layers should still have the '*<your Initials>*_Airphoto_orthorectified' image.)

9 Select **B3:Blue** from the Blue layer's **Band Selection** drop-down list.

Display the two images to evaluate registration

1 Click the **99% Contrast Enhancement** toolbar button.

This image combines two different images–one in the Red and Green layers and one in the Blue layer. If your images are well aligned the image appears normal. If you see areas that are dominantly yellow or blue, this indicates poor registration.

2 On the **Algorithm** window, turn off the **Smoothing** option.

3 On the main menu, click the **ZoomBox tool** toolbar button.

4 Drag a zoom box over a very small area of the image that contains land and water.

Errors in registration appear as either blue or yellow pixels because this is where the two images do not align perfectly. This is a very simple way to evaluate the registration of two images. If the RMS errors of your GCPs were generally less than one, you should not see more that one pixel offsets or registration errors.

Close all windows

1   Close all image windows using the window system controls:

2   Click **Close** on the **Algorithm** window to close it.

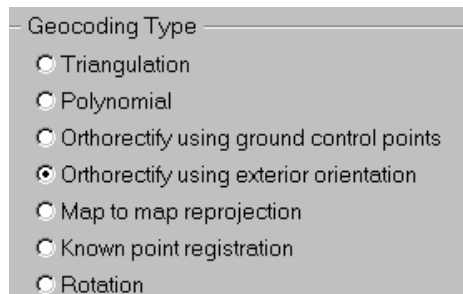# 2: Orthorectify an airphoto using Exterior Orientation

Objectives   Learn how to use ER Mapper's Geocoding Wizard to orthorectify an airphoto using Exterior Orientation parameters

In this exercise you will orthorectify the same image as in the previous exercise. This time, instead of using Ground Control Points, you will enter Exterior Orientation parameters which have been obtained from a photogrammetry, aerial triangulation or geoposition system external to ER Mapper. In the previous exercise you saved orthorectification parameters in the 'San_Diego_Airphoto_34_not_rectified.ers' file. This means that you will not have to re-enter them in this exercise.

Open the Geocoding Wizard

1   Click on the **Ortho and Geocoding Wizard** 🔳 button in the **Common Functions** toolbar.

The Geocoding Wizard will open with the **1) Start** tab selected.

Geocoding Type
- ○ Triangulation
- ○ Polynomial
- ○ Orthorectify using ground control points
- ● Orthorectify using exterior orientation
- ○ Map to map reprojection
- ○ Known point registration
- ○ Rotation

2 Click the **Load Algorithm or Dataset** 📂 button in the **Input file:** field to open the file chooser.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Select the directory 'Applications\,Airphoto\1_Geocoding' and then double-click on 'San_Diego_Airphoto_34_not_rectified.ers' to select it.

   This is the same file as that you used in the previous exercise.

5 Select the Geocoding Wizard **Orthorectify using exterior orientation** option.

   In this example, you enter exterior orientation parameters which provide information on the position of the platform or aircraft.
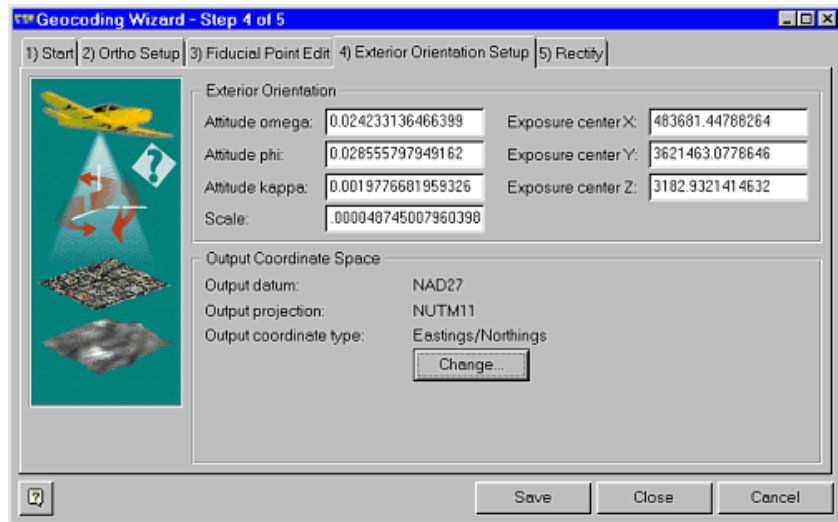
6 Select the **2) Ortho Setup** tab.

   The fields in the Ortho Setup page should contain the information that you entered in the previous exercise because it was saved to the header file of the image being orthorectified.

7 Click on the **3) Fiducial Point Edit** tab.

   The fields in the Fiducial Point Edit page should also contain the information you entered in the previous exercise.

8 Click on the **4) Exterior Orientation Setup** tab.

Enter Exterior Orientation parameters

Exterior Orientation parameters contain information on the position of the platform or aircraft at the time the image was taken. You would have to obtain this data from a system external to ER Mapper.
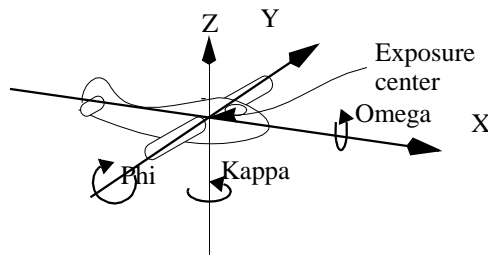
If these parameters are not available then you would use Ground Control Points as in the previous exercise.

1 Enter the information in the relevant fields as shown in the table below:

Field name	Description	Enter value
Attitude omega	The tilt angle (roll) of the aircraft; i.e. the rotation about the X axis (direction of travel).	0.024233136466399
Attitude phi	The swing angle (pitch) of the aircraft; i.e the rotation about the Y axis.	0.028555797949162
Attitude kappa	The azimuth angle (yaw)of the aircraft; i.e the rotation about the Z axis.	0.0019776681959326
Exposure center X	The X co-ordinate of the exposure center of the image.	483681.44788264

Field name	Description	Enter value
Exposure center Y	The Y co-ordinate of the exposure center of the image.	3621463.0778646
Exposure center Z	The Z co-ordinate of the exposure center of the image.	3182.9321414632
Scale	The scale of the image expressed as a decimal value.	0.000048745007960398

The following diagram illustrates the relationship between the parameters.

Note: The Phi, Kappa and Omega values can be negative or positive, depending on the direction of rotation.

Caution: The format of the exterior orientation values is not consistent for the different devices that can be used to generate them. Before using them on a set of airphotos, it is advisable to orthorectify one image using GCPs and then compare the results.

2 Click on the **Change..**. button to open the **Geocoding Wizard Output Coordinate Space** dialog.

3 Enter the **Datum**, **Projection** and **Coord system type** as shown below

---

Tip: NUTM11 is a utm projection type.

---

4 Click on the **5) Rectify** tab.

Rectify the image

1 Click the file chooser ⏏ button in the **Output Info** box.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Double-click on the 'functions_and_features\airphoto_tutorial' directory to open it.

4 Enter the filename '`San_Diego_orthorectified_advanced`' (start with your initials), then click **OK**.

5 Click on the OK button to return to the Geocoding Wizard.

6 In the **Resampling:** in the Cell Attributes box select 'Nearest Neighbour'.

The Cell Attributes box also lets you resample the output image to a different cell size (Output Cell width and height), and specify a null cell value.

7 Click on the **Save** button to save the orthorectification parameters in the 'San_Diego_Airphoto_34 _not_rectified.ers' header file.

8 Select **Display rectified image** to display the image after it is rectified.

9 Click on the **Save file and start rectification** button.

ER Mapper opens a status dialog to indicate the progress of the rectification.

10 When the operation finishes, click **OK** on the successful completion dialog.

11 Click on the **Close** button to exit the Geocoding Wizard.

You have now rectified the uncorrected airphoto image to correspond to the 1927 North American Datum (NAD27) and UTM zone 11 (NUTM11) map projection.

12 Do not close the image window with the orthorectified image

Evaluate the image orthorectification

1 On the main menu, click the **Edit Algorithm** ⬙ button to open the **Algorithm** window.

2 The Algorithm window shows the Red, Green and Blue layers of the orthorectified image.

3 In the **Algorithm** window, click on the Blue layer to select it.

4 Click the **Load Dataset** 📥 button in the algorithm process diagram.

5 From the **Directories** menu, select the path ending with **\examples**.

6 Double-click on the 'Applications' directory to open it.

7 Double-click on the 'Airphoto' and then on '1_Geocoding' directory to open it.

8 Click once on the image 'San_Diego_Airphoto_34 _rectified.ers' to select it, then click **OK this layer only** button to load it into the Blue layer. (The Red and Green layers should still have the '*<your Initials>*_Airphoto_orthorectified_advanced' image.)

9 Select **B3:Blue** from the Blue layer's **Band Selection** drop-down list.

Display the two images to evaluate registration

1 Click the **99% Contrast Enhancement** 🖼 toolbar button.

This image combines two different images–one in the Red and Green layers and one in the Blue layer. If your images are well aligned the image appears normal. If you see areas that are dominantly yellow or blue, this indicates poor registration.

2 On the **Algorithm** window, turn off the **Smoothing** option.

3 On the main menu, click the **ZoomBox tool** toolbar button.

4 Drag a zoom box over a very small area of the image that contains land and water.

Errors in registration appear as either blue or yellow pixels because this is where the two images do not align perfectly. This is a very simple way to evaluate the registration of two images. If the RMS errors of your GCPs were generally less than one, you should not see more that one pixel offsets or registration errors.

Close all windows

1 Close all image windows using the window system controls:

2 Click **Close** on the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

• Use the Camera Wizard to create a Camera File

• Select fiducial markers on an airphoto image

- Use options to modify the GCP display and edit GCPs

- Enter Exterior Orientation parameters for advanced orthorectification.

- Use the Geocoding Wizard to orthorectify a "raw" airphoto image to the chosen datum and map projection.

5

Reprojecting images

This chapter describes how you would use the ER Mapper Geocoding Wizard to change an image projection or datum.

UTM and State Plane projections

An example of where you are likely to want to change the image projection or datum is in the United States of America where your airphoto image could have a Universal Transverse Mercator projection, and you need to mosaic it with images that have a State Plane projection. You can use the ER Mapper Geocoding Wizard to change from a UTM to the required State Plane projection.

UTM projections

UTM, Universal Transverse Mercator, is a system of world coordinates like latitude and longitude, from 80 degrees south latitude to 84 degrees north latitude, except the measurements are in meters and UTM lines are orthogonal (are always at right-angles to each other).

UTM Northing is the distance north from the equator in meters and Easting is the distance east from central meridians of (60) 6-degree-wide zones starting at longitude 180 degrees. Northing is also divided into 8-degree zones from south to north using the letters C to X with the equator at M/N, (A,B and Y,Z being reserved for the UPS coordinate system at the poles).

All measurements are POSITIVE by incorporating a system of "false" easting and northing by adding an arbitrary number to the central meridians (500,000m) and 10,000,000m to the distance south of the equator in the southern hemisphere.

State plane projections

The United States of America use a system of map projections for various regions. This system is known as the "State Plane Coordinate System (SPCS)". The Lambert Conformal Conic projection is the most widely used, with Transverse Mercator projections being used for States with predominantly north to south extents. The panhandle of Alaska is mapped using the Oblique Mercator projection. The Lambert Conformal Conic is a conic projection usually based on two standard parallels. It can represent the pole as a single point. This projection is good for mapping a region, continent and at medium or large scale.

Older maps are projected onto the Clarke 1866 spheroid with tie point at Meade's Ranch in Kansas (datum NAD27). More recent maps are projected onto the 1983 datum (datum NAD83).

Constraints

The Geocoding wizard only supports images in the ER Mapper Raster Dataset format. Images in other formats, including ECW compressed, have to be originally imported or saved as ER Mapper Raster datasets before you can reproject them. Because of the size of some images, you may have to reproject individual images before mosaicing them rather than reprojecting the whole mosaiced image.

Hands-on exercises

These exercises give you practice using ER Mapper's Geocoding Wizard to change an image projection from a UTM to a State Plane.i

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

• Use the ER Mapper Import utilities to import a TIFF image into ER Mapper Raster Dataset format.

• Use the Geocoding Wizard to change an image projection.

Before you begin...   Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

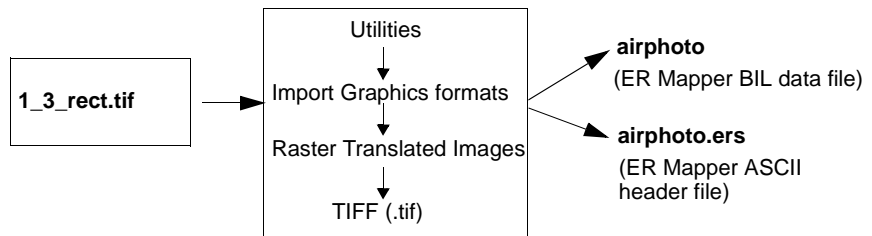# 1: Import an image into ER Mapper

Objectives   Learn how to import a GeoTIFF image into ER Mapper.

For this exercise, you will import the TIFF image, '1_3_rect.tiff', that you modified in Chapter 3, "Using GeoTIFF/TFW images". For this reason you must do that exercise before starting this one.

You have to import this image as an ER Mapper Raster Dataset because the Geocoding Wizard supports only ER Mapper Raster Datasets.

Importing a TIFF image

To import a dataset from an external file into ER Mapper, you will use the import programs listed under the **Utilities** menu in ER Mapper. In this case, you will import an airphoto that is in TIFF format. When you import a dataset into ER Mapper, it creates two files: and binary data file (in Band Interleaved by Line or "BIL" format), and an ASCII header file with a ".ers" file extension:
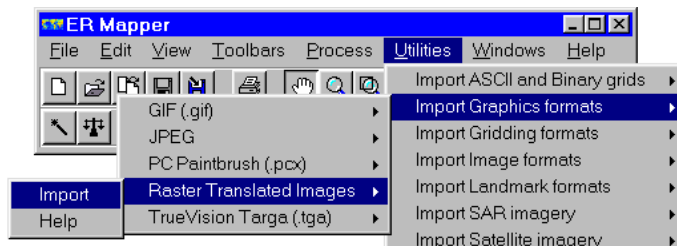
You should have the following three files in your 'examples\Functions_And_Features\Airphoto_Tutorial' directory:

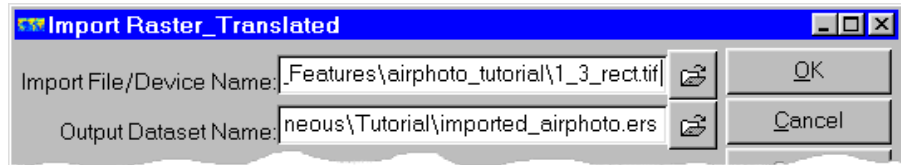|	
1_3_rect.tif	The image data file.
1_3_rect.tfw	The "world" TFW header file originally supplied with the TIFF image file. This is a text file that contains georeferencing information, but does not include the datum or projection of the image.
1_3_rect.ers	An ER Mapper header file created by the **Change Projection/Datum/Cell Size Wizard** in the exercise in Chapter 3, "Using GeoTIFF/TFW images". This header file does include the image datum and projection, and will be used by ER Mapper rather than the TFW file.

Note: When you import the TIFF image, ER Mapper will extract the georeferencing information from the associated TFW file if a .ers header file does not exist. You would then have to use the ER Mapper **Change Projection/Datum/Cell Size Wizard** to add the datum and projection information, as explained in Chapter 3, "Using GeoTIFF/TFW images".

Open the TIFF import dialog

1 From the **Utilities** menu, select **Import Graphics formats**, then select **Raster Translated Images**, then **Import**.

The **Import Raster_Translated** dialog box opens. This dialog lets you specify the name of the input file to be imported, and the name of the ER Mapper dataset to be created. All image formats that can be opened directly in ER Mapper are imported via this dialog box.

2   Click the file chooser 🗁 button on the right side of the **Import File/Device Name** field.

The **Input File Selection** dialog box opens.

3   In the **Files of Type:** field, select 'GeoTIFF/TIFF(.tif)'.

4   From the **Directories** menu (on the **Input File** dialog), select the path ending with **\examples**.

5   Double-click on the directory named 'functions_and_features' and then 'airphoto_tutorial' to open it.

6   Double-click on the image file named '1_3_rect.tif' to load it.

7   Click the file chooser 🗁 button next to the **Output Dataset Name** field.

The **Output Dataset Selection** dialog box opens.

8   From the **Directories** menu (on the **Output Dataset** dialog), select the path ending with **\examples**.

9   Double-click on the directory named 'Miscellaneous' followed by 'Tutorial'

10 In the **Save As:** field, enter the text **imported_airphoto** then click **OK**.

11 Click **OK** on the **Import TIFF** dialog.

ER Mapper reads the TIFF file and begins creating a dataset in ER Mapper format.

12 When the import finishes, click **OK** on the confirmation dialog, then click **Cancel** on the **Import Raster_Translated** dialog.

In this case, ER Mapper translated the TIFF image data and created two files:

•   'imported_airphoto' (the binary data file)

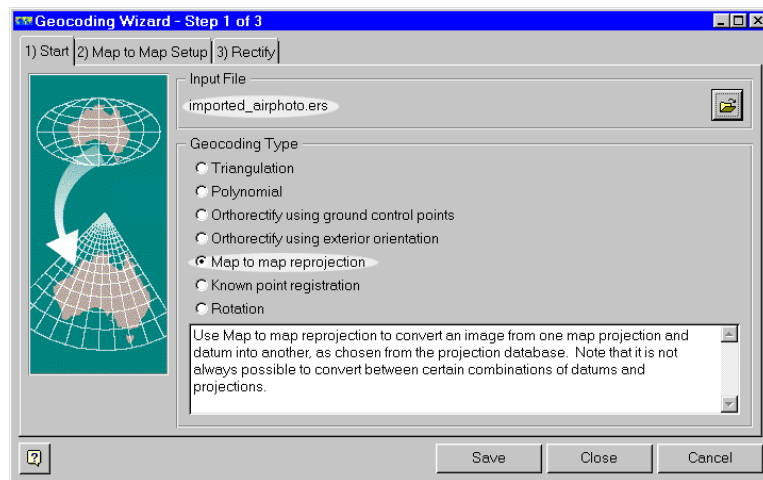•   'imported_airphoto.ers' (the ASCII header file)

2: Reproject the image

Objectives   Learn how to change the image datum and projection.

Open the Geocoding WIzard

1   Click on the **Ortho and Geocoding Wizard** 🔳 button in the **Common Functions** toolbar.

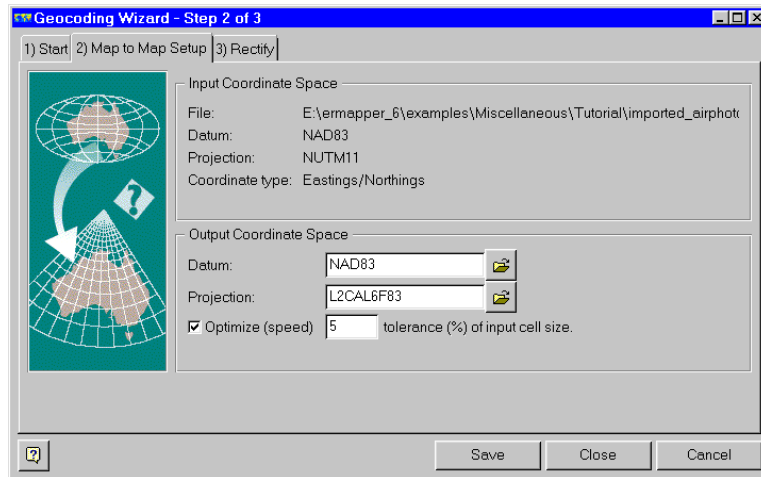The Geocoding Wizard will open with the **1) Start** tab selected.

2   Click the **Load Algorithm or Dataset** 📂 button in the **Input file:** field to open the file chooser.

3   From the **Directories** menu, select the path ending with the text **\examples**.

4   Select the directory 'Miscellaneous\Tutorial' and then double-click on 'imported_airphoto.ers' to select it.

This is the image that you imported earlier.

5   Select the Geocoding Wizard **Map to map reprojection** option.

6   Select the **2)Map to Map Setup** tab.
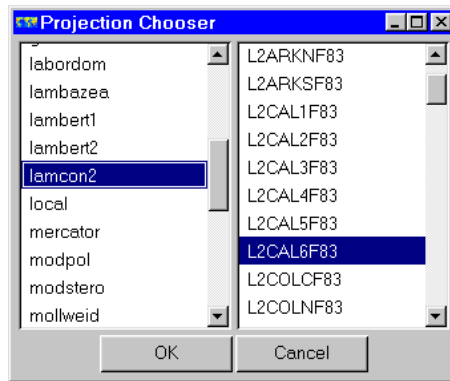
Map to Map setup

The Geocoding Wizard Map to Map Setup page displays the datum and projection of the input image, and allows you to enter new settings to which the image can be reprojected.

In this example you are going to change the UTM type projection, 'NUTM11' to a State Plane Lambert Conformal Conic (lamcon2) type projection, 'L2CAL6F83'. This is 'NAD83' datum zone 6 in feet. State Plane projection projections are bounded by county borders, so the choice of projection depends on the county covered by the image.

The State Plane System was developed in the 1930s and was originally based on the North American Datum 1927 (NAD27). While the NAD27 State Plane System has been superseded by the NAD83 System, maps in NAD27 coordinates are still in use.
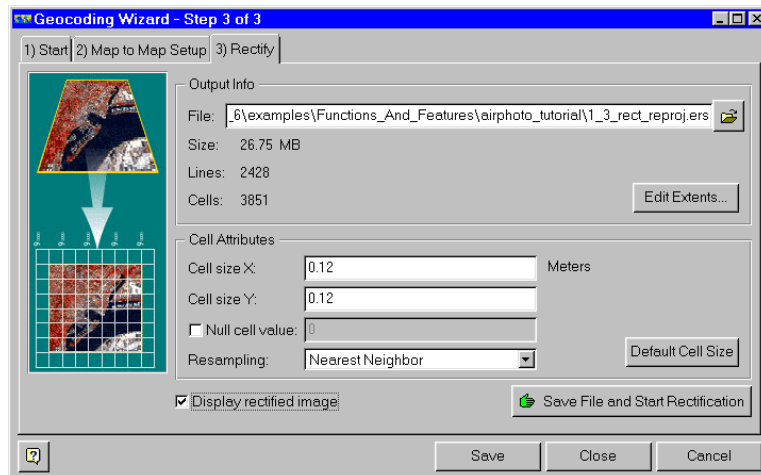
1 Click on the Projection field chooser 🗁 button to open the **Projection Chooser dialog box**.

2 From the left-hand projection type list, select 'lamcon2'.

3 From the right-hand projection list, double click on 'L2CAL6F83' to select it and close the **Projection Chooser** dialog box.

4 Click on the **3) Rectify** tab to go to the final wizard page.

Rectify the image

The Geocoding Wizard Rectify page allows you to enter the file name for the reprojected image. It also displays information about the image and enables you to change the extents and cell size.

1 Click the file chooser ![file chooser icon] button in the **Output Info** box.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Double-click on the 'Miscellaneous/Tutorial' directory to open it.

4 Enter the filename '`imported_airphoto_reproj`', then click **OK**.

You should notice that the reprojected file size is 107.75 MB, which is approximately the same size as the original image. This is usually a good indicator that the new projection is compatible with the original.

To speed up this exercise, you will reduce the output file size by resampling the image to have larger cell sizes; i.e. lower resolution. This will result in a degraded image, which would not be suitable for all applications.

5 In the **Cell Attributes** box, edit the **Cell size X** and **Cell Size Y** values to both be 0.12 meters. Press the **Enter** button to confirm the changes.

The output file size should now be 26.75 MB, which is approximately 25% of the original size.
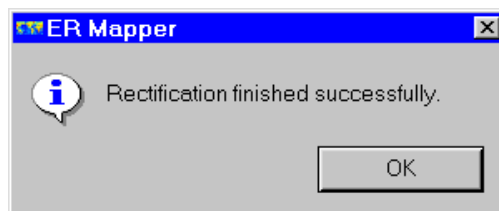
6 Leave the **Null cell value** box unchecked, so that the reprojected image has the same null value as the original image.

The null cell value is the value that the cell must have for ER Mapper to interpret it as a null cell (i.e. transparent). This is normally 0. The Geocoding Wizard gives you the option of leaving the null cell value to be that of original image (if one exists), or entering a new value.

7 Select the **Display rectified image** option, and click on the **Save File and Start Rectification** button.

This will save the reprojection information in the .ers header file of the original image, and start the wizard creating the new reprojected image.

ER Mapper displays a status box that indicates the progress of the reprojection, and indicates successful completion.

8 Click **OK** to close the completion dialog box.

ER Mapper will display the reprojected image, 'imported_airphoto_reproj', in an image window.

9 Click on the Geocoding Wizard dialog **Close** button to exit the wizard.

Close all windows

1   Close all image windows using the window system controls:

2   Click **Close** on the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned...   After completing these exercises, you know how to perform the following tasks in ER Mapper:

•   Import a Tiff image in ER Mapper

•   Change the image project from a UTM to a State plane projection.

•   Resample the reprojected image to have larger cell sizes.

6

Assembling image mosaics

This chapter explains how to create algorithms to display and process two or more separate airphoto images as a mosaic. You will learn how ER Mapper approaches the concept of creating mosaics and how to build an image mosaic algorithm.

About assembling mosaics

The term "mosaic" refers to assembling two or more overlapping images to create a continuous representation of the area covered by the images (a mosaic). In this example, you will create a mosaic of several overlapping aerial photos to cover a larger geographic area. The process of creating image mosaics is very simple in ER Mapper once the images are rectified to the same datum and map projection. Any number of co-registered images used in the same processing algorithm are automatically displayed in their correct geographic positions relative to each other.

Requirements for mosaics

In order for ER Mapper to create a mosaic, each of the images must have the following in common:

- they must be registered to the same geographic datum
- they must be registered to the same map projection

- they must be rotated the same amount from north (if rotation is used).

You will learn how to rectify images to datums and map projections later.

Mosaic capabilities

Other than having a common datum and map projection, you can create mosaics that contain very different types of data. An image mosaic can be built with datasets that have:

- different numbers of bands (i.e., three for a color airphoto versus seven for a Landsat satellite image)
- different data formats (i.e., byte format versus floating point format)
- different resolutions or cell sizes (i.e., 1-meter versus 3-meter).

Image display priority

By changing the order of the algorithm layers containing the separate images, you can control image display priority (that is, which images appear on top of others in the event of overlap). Images loaded into the uppermost layer of any type always appear on top of any other images in layers below where overlap occurs between them.

Images loaded into the lowest layer of any type always have the lowest display priority and will only be visible in areas where there is no overlap from datasets in layers above them. For example, if you are creating a mosaic with a high resolution dataset and a lower resolution image, you can display the entire extents of the high resolution image by putting its layer(s) on top in the algorithm layer list.

Note: Layer priority only applies to raster layers; vector layers always appear on top of raster layers regardless of their position in the algorithm layer list.

Hands-on exercises

These exercises show you how to create greyscale and RGB image mosaic algorithms.

The ER Mapper **Image Display and Mosaic Wizard** provides the easiest and most efficient way of mosaicing images, and should be used where possible.

What you will learn...
After completing these exercises, you will know how to perform the following tasks in ER Mapper:

• Use the Image Display and Mosaic Wizard to speed creation of greyscale and RGB mosaics

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

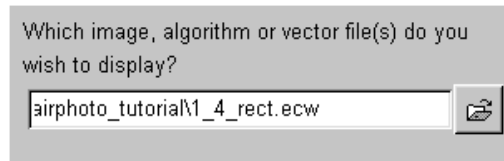# 1: Creating mosaics automatically

Objectives

Learn how to speed the creation of greyscale and RGB mosaic algorithms using the Image Display and Mosaic Wizard.

Start the Image Display and Mosaic wizard

1 On the **Common Functions** toolbar, click the **Image Display and Mosaic Wizard** ![button] button.

The **Select files to display and mosaic** page of the Image Display and Mosaicing Wizard opens

2 Click the **Load Image** ![button] button.

> Which image, algorithm or vector file(s) do you wish to display?
>
> airphoto_tutorial\1_4_rect.ecw ![button]
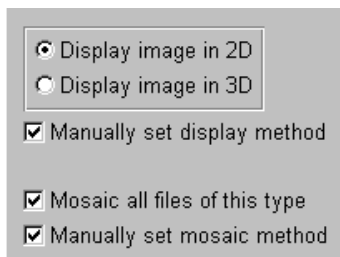
The **Select File** dialog opens.

3 From the **Directories** menu (on the **Select File** dialog), select the **\examples** path.

4 Double_click on the 'Functions_and_Features' directory to open it.

5 Double_click on the 'airphoto_tutorial' directory.

6 Double-click on the image dataset '1_4_rect.ecw' to select it.

This is a 1GB high resolution airphoto of San Diego that has been orthorectified and compressed with ER Mapper ECW compression.

Tip: You can save disk space by compressing the individual images before mosaicing them.

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7   Select the following options on the wizard page:

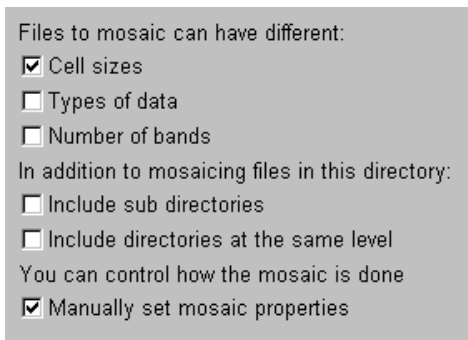|	
Display image in 2D	Image will be displayed in a 2D mode.
Manually set display method	Enables you to set how the image is to be displayed. If you do not select this option, the wizard will set the display method.
Mosaic all files of this type	The wizard will search for files of the same type and automatically mosaic them.
Manually set mosaic method	Enables you to set how the images are to be mosaiced. If you do not select this option, the wizard will set the mosaicing

8   Click on the **Next>** button to go to the next wizard page.

Select file types to mosaic

This page allows you to specify the characteristics and location of image files that the wizard must search for to mosaic with the image already selected.

1   Select the **Cell sizes** and **Manually set mosaic properties** options. Do not select the other options on the page.
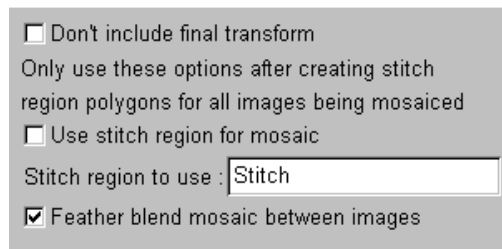
This tells the wizard that the images to be mosaiced must all have the same data types and number of bands, but can have different cell sizes. They are also in the same directory.

2   Click on the **Next>** button to go to the next wizard page.

Select mosaic properties

This page allows you to specify properties of the mosaiced image.

1   Select the **Feather blend mosaic between images** options. Do not select the other two options.

```
☐ Don't include final transform
Only use these options after creating stitch
region polygons for all images being mosaiced
☐ Use stitch region for mosaic
Stitch region to use : Stitch
☑ Feather blend mosaic between images
```
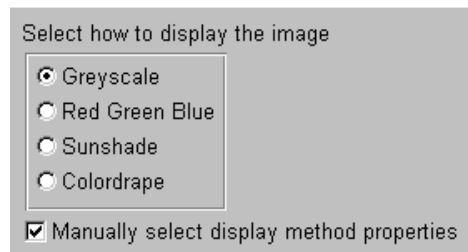
It is not necessary to define and use stitch regions here. You will see later that the Image Balancing Wizard does this automatically.

2   Click on the **Next>** button to go to the next wizard page.

Select display method

This page allows you to specify how you want the mosaiced image to be displayed.

1   Select the **Greyscale** display option and **Manually select display method** properties.
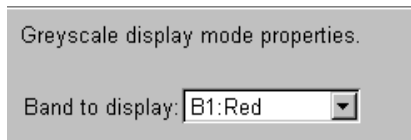
```
Select how to display the image
◉ Greyscale
○ Red Green Blue
○ Sunshade
○ Colordrape
☑ Manually select display method properties
```

2   Click on the **Next>** button to go to the next wizard page.

Select display band

This page allows you to select the image band to display as a greyscale.

1   Select band 'B1:Red' from the drop-down menu.

Greyscale display mode properties.

Band to display: B1:Red ▼

This specifies that the Red band of the image is to be displayed as Greyscale.

2   Click on the **Next>** button to go to the next wizard page.

Mosaic and display the images

The wizard searches the current directory and mosaics and displays the following images:

• 1_4_rect.ecw

• 1_5_rect.ecw

• 2_6_rect.ecw

• 2_7_rect.ecw

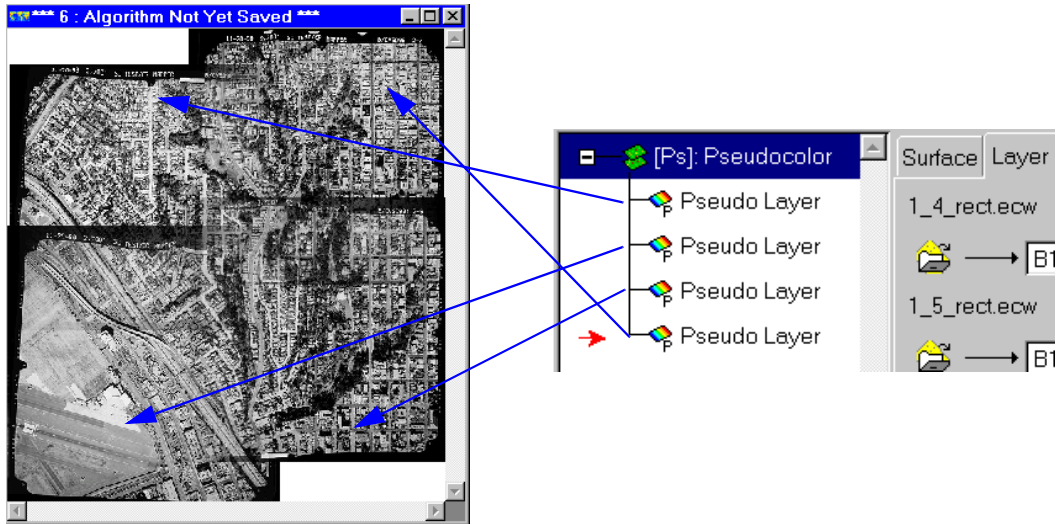1   For the moment, leave the **Image wizard has finished** page open.

2   Drag the lower border of the image window downward about 50%.

3   Right-click in the image window, select **Quick Zoom,** then **Zoom to All Datasets**.

ER Mapper zooms out to show the full extents of all four airphoto images.

4   On the main menu, click the **Edit Algorithm** 🖼 button.

The **Algorithm** dialog box opens.

You now have a algorithm that displays band 1 of each dataset as a greyscale image mosaic.

5   If necessary, use the **Move Up** and **Move Down** buttons to arrange the layers so that they are as shown in the diagram above.

Turn the top image on and off

1   Right-click on the top 'Pseudo Layer' and select **Turn Off**.

Only the top right, bottom left and bottom right images display (since the top left image is turned off).

2   Right-click on the top 'Pseudo Layer' and select **Turn On**.

The top left image redisplays in its appropriate geographic position again. Any images in a mosaic can be displayed or not displayed by turning their layers on or off.

Zoom in to the geographic extents of any image dataset

1   Widen the image window

2   Select the top 'Pseudo Layer' ('1_4_rect.ecw') in the algorithm.

3   Right-click in the image window, select **Quick Zoom,** then **Zoom to Current Dataset**.

ER Mapper zooms in to the full extents of the '1_4_rect.ecw' dataset (but also displays part of the lower dataset that occupies the same extents).

Zoom to Current Dataset lets you instantly zoom in or out to the extents of any raster image dataset(s) in the currently selected layer, so it is very useful for mosaic algorithms.

4   Right-click in the image window again, and select **Zoom to All Datasets** from the **Quick Zoom** menu.

ER Mapper zooms out to display the full extents of the mosaiced image.
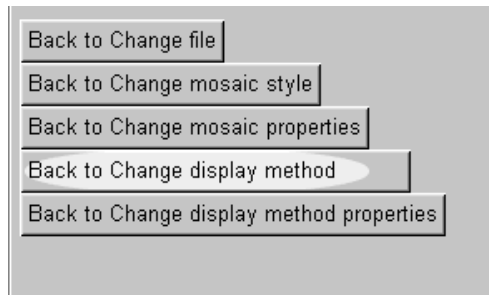
2: Creating an RGB image mosaic

Objectives   Learn how display several overlapping images in different sets of red, green, and blue raster layers to create an RGB image mosaic.

We use the Image Display and Mosaicing wizard to re-display the existing greyscale mosaiced image as an RGB image.

Change the image display method

1   On the **Image wizard has finished** wizard page, which should still be open, click on the **Back to Change display method** button.

This will return you to the **Select display method** wizard page.

2   On the **Select display method** page, select the **Red Green Blue** option.

3   Click on the **Next>** button to go to the next wizard page.

4   Select **RGB 123** as the Red Green Blue display mode type.

This option allocates band 1 to Red. band 2 to Green and Band 3 to Blue.

5   Click on the **Next>** button to mosaic and display the images, and to go to the final wizard page.

    The wizard will now display the mosaiced image in RGB mode.

6   Leave the **Image wizard has finished** wizard page open for the moment.

Tip: In RGB mosaic algorithms, each group of red, green and blue layers act together as a set. Therefore, you normally want to keep them grouped together in the layer list in the **Algorithm** dialog. (To see which dataset is loaded into a particular layer, select the layer–the name is shown above the process diagram.)

3: Adding a GeoTIFF image to the mosaic

Objectives   Learn how to add an additional image to the mosaic.
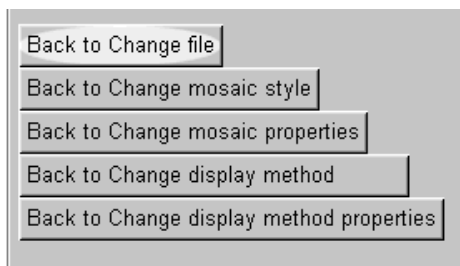
We use the Image Display and Mosaicing wizard to add a GeoTIFF image to the mosaic.

Add an extra image to the mosaic

The 'airphoto_tutorial' directory contains the image file that you saved in GeoTIFF format in a previous exercise. The Display and Mosaic Wizard did not automatically include it in the mosaic because it is in a different format to the other image files. You can, however manually add it to the mosaic.

Tip: This procedure is included to demonstrate that it is possible to mosaic images with different file formats. In this case it would have been better to have compressed the GeoTIFF image with ECW v2 first, and then have let the wizard automatically include it in the mosaic with the other ECW v2 compressed images.

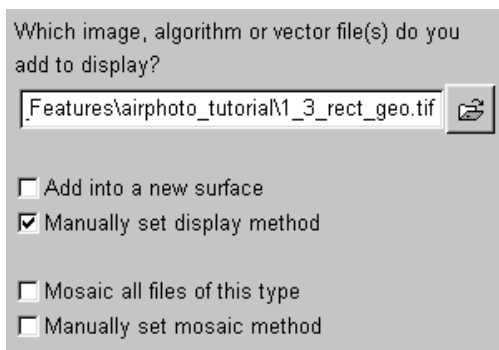1 On the wizard dialog, select the **Back to Change file** button.

Back to Change file
Back to Change mosaic style
Back to Change mosaic properties
Back to Change display method
Back to Change display method properties
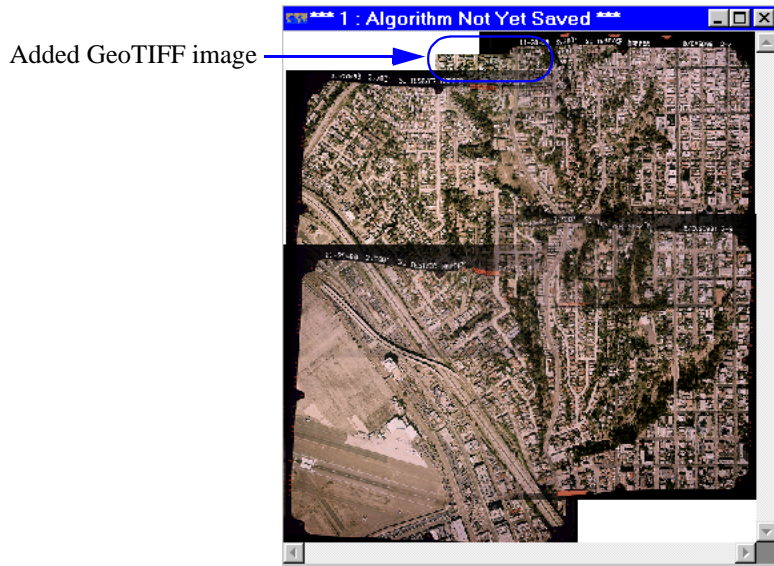
The wizard will go back to the file input page.

2 Click on the **<Back** button to go back one page.

3 Select the **Add more to this window** option, and then click on the **Next>** button.

Use the Image Wizard to quickly display images and vectors.

○ Display in a new window
● Add more to this window
○ Change display in this window

4 On the **Select files to add to display** wizard page, click on the file chooser button.

5 In the 'airphoto_tutorial' directory, double-click on the '1_3_rect_geo.tif' file to select it.

6 Make sure that only the **Manually set display method** option is selected before clicking on the **Next>** button.

Which image, algorithm or vector file(s) do you add to display?

Features\airphoto_tutorial\1_3_rect_geo.tif

☐ Add into a new surface
☑ Manually set display method

☐ Mosaic all files of this type
☐ Manually set mosaic method

The wizard will add the '1_3_rect.tif' image to the mosaic, and automatically set the display mode to **Red Green Blue**.

Added GeoTIFF image

7   Click on wizard **Finish** button to close it.

Save the mosaic algorithm to disk

1   From the **File** menu (on the main menu), select **Save As...**.

The **Save As...** file chooser dialog opens.

2   In the **Files of Type:** field, select 'ER Mapper Algorithm (.alg)'

3   From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

4   Open the 'functions_and_features\airphoto_training' directory.

5   In the **Save As:** text field, type the following filename:

airphoto_mosaic

This name denotes that it is a mosaic of airphotos.

6   Click **OK** to save the algorithm.

Your mosaic algorithm is now saved to an algorithm file on disk.

Close all image windows and dialog boxes

1   Close both image windows by selecting **Close** from the **File** menu.

2   Click **Close** on the **Algorithm** dialog to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned
After completing these exercises, you know how to perform the following tasks in ER Mapper:

• Use the Image Display and Mosaic Wizard to speed creation of greyscale and RGB mosaics

• Turn images on or off in a mosaic

• Add images to mosaics

7

Color balancing image mosaics

This chapter explains how you use the ER Mapper **Image Balancing Wizard for Airphotos** to balance and color match airphoto mosaics.

Hands-on exercises

These exercises show you how to balance and color match mosaic algorithms using the **Image Balancing Wizard for Airphotos**.

For these exercises, we will be using the airphoto mosaic algorithm we created previously using the **Image Display and Mosaic Wizard**.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Use the Image Balancing Wizard to balance and color match an airphoto mosaic.

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Color balancing the mosaic

Objectives   Learn how to use the **Color Balancing Wizard for Airphotos** to color balance mosaiced images so that they interface seamlessly with one another.

Open the airphoto mosaic

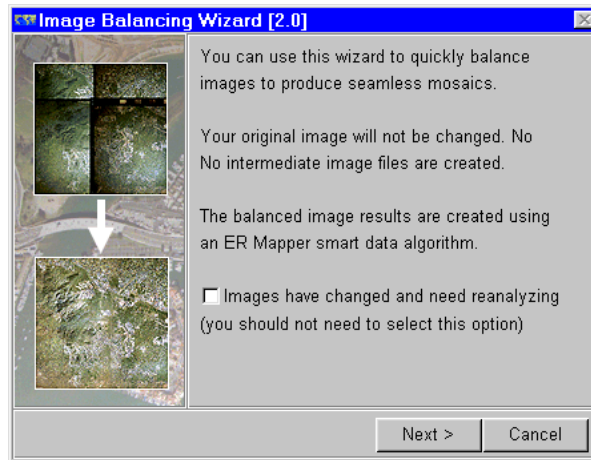1   On the main menu, click the **Open** 🖼 button.

click to open
algorithm

2   From the **Directories** menu, select the **\examples** path.

3   Open the 'functions_and_features\airphoto_tutorial' directory.

4   Double-click on the algorithm 'airphoto_mosaic.alg' to open it.

This is the algorithm that you saved in the previous exercise. It comprises one GeoTIFF and four ECW compressed airphotos of San Diego that were mosaiced using the **Image Display and Mosaic Wizard**.

Open the Image Balancing Wizard for Airphotos

1 Click on the **Image Balancing Wizard for Airphotos** 🏧 button on the
Common Functions toolbar to open the wizard.

The wizard processes the currently active image window

2 Select the **Images have changed and need reanalyzing** option.

The wizard has to analyze the images the first time it is used on them, and skips
over it if the images have been previously analyzed. Selecting this option forces the
wizard to analyze the images regardless of whether this has been done before.

3 Click on the **Next>** button to go to the next wizard page.

Analyze images for balancing

The wizard requires the images to be analyzed before it can do the balancing. The
analysis information is stored in the image dataset header files. If the images have
not yet been analyzed or you selected the reanalyzing option, the wizard will now
do so.

1 Click on the **Next>** button for the wizard to analyze the images.

The wizard will calculate the statistics for the four images and write the
information into their respective header files.

Note: ER Mapper creates header (.ers) files for the images to store the analysis
information if they do not already exist.

2 Click on the **Next>** button to go to the next wizard page.

Select how to balance the images

In addition to color balancing, you also have a number of options for displaying the image. These are described below:

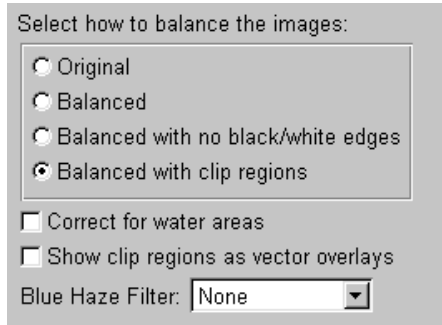|		
Original	Remove any color balancing and display the unbalanced images. The white boxes in the diagram show the extents of the individual images with their black edges removed.	
Balanced	Display the balanced images but do not clip edges.	
Balanced with no black/ white edges	Display the balanced images and remove the black or white edges. It is preferable not to select this option when balancing images that have very dark water, near the edges of the image. The color balancing wizard for airphotos may select too much of the image as dark edges to be removed. **Note:** Some images are supplied with their black edges already removed, in which case it is not necessary to select this option.	
Balanced with clip regions	When mosaicing images, compute clip regions to hide the edges between images. Clip regions are areas of overlap that are trimmed off to create a seamless join. The wizard re-computes the clip regions every time you run it. By default, the wizard turns feathering ON for when balancing with clip regions, and OFF in all other cases.	

Correct for water areas.	If your image has large areas with low contrast, such as water, they could be discolored by the balancing process. Select this option to prevent this happening.

1   Select the **Balanced with clip regions** option.

Select how to balance the images:

- C Original
- C Balanced
- C Balanced with no black/white edges
- ● Balanced with clip regions

□ Correct for water areas
□ Show clip regions as vector overlays
Blue Haze Filter: None ▼

2   Do not select the **Correct for water areas** because the image does not have large areas of water.

3   Select 'None' in the **Blue Haze Filter** field.

The Image Balancing Wizard uses this field for handling effects caused by having a "blue haze" filter on the camera lens at data capture time.

4   Click on the **Next>** button for the wizard to balance the images and go to the Color matching page.

The wizard will create the clip regions and then balance the image. It will then display it in the image display window as the temp-balance algorithm.
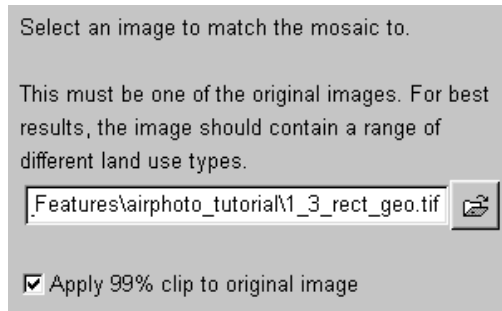
Color matching the image

To create a seamless mosaic, the wizard is able to match the colors of the mosaiced image to the whole mosaiced image or to one of the images that are part of the mosaic. Alternatively you can skip the color matching altogether.

C Match colors to entire mosaic
● Match colors to individual file
C Skip color matching

For this exercise we will match the color to the '1_3_rect_geo.tif' image.

1   Select the **Match colors to individual file** option, and then click on the **Next** button.

Select an image to match the mosaic to.

This must be one of the original images. For best results, the image should contain a range of different land use types.

.Features\airphoto_tutorial\1_3_rect_geo.tif

☑ Apply 99% clip to original image

2   Use the file chooser button to select the image to which the colors are being matched. In this case we will select '1_3_rect_geo.tif'.

3   Select the **Apply 99% clip** option to improve the contrast, and click on the **Next** button.

Caution: Generally you would not select the **Apply 99% clip** option if you are going to compress the image, because you usually want the compressed image to be the same as the original.

The wizard will display the status of the color matching which could take some time to finish. It will then display the final balanced and matched image in temporary algorithm.

4   Click on the **Finish** button to exit the Color Balancing Wizard for Airphotos.

View the algorithm

1   On the main menu, click the **Edit Algorithm** ⬙ button.
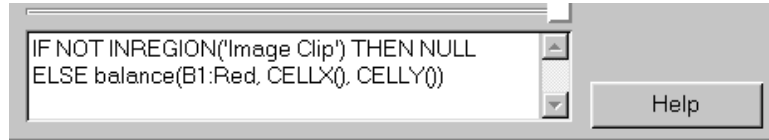
The **Algorithm** dialog box opens.

You now have a algorithm that displays the Red, Green and Blue layers of the four images.

2   Select the top Red layer and click on the **Edit Formula** $E{=}mc^2$ button on the process diagram.
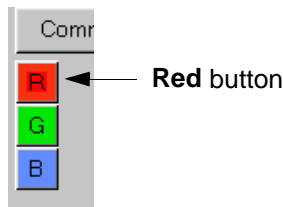
This will open the **Formula Editor**.

You should notice that the wizard has applied a formula to the layer. This is displayed in the text box at the bottom of the **Formula Editor** dialog box.

The formula applies a balancing function, 'balance()', to the areas of the image that fall within the automatically created clip region, 'Image Clip'. Raster cells outside the clip region are converted to nulls.

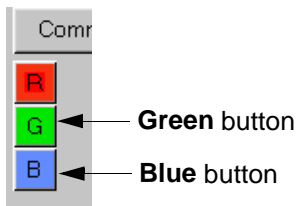3   On the **Formula Editor** dialog , click on the **Red** button to view the formula for the next red layer.

Note that the formula applied is the same as that for the top red layer.

4   Click three times more on the Red button, to move to the three lower red layers.

Not that, in all cases, the formula applied is the same.

5   Repeat the above steps for the Green and Blue layers by clicking on the Green and Blue buttons respectively.

6   Click on the Close button to exit the **Formula Editor**.

7   Once again select the top Red layer, and click on the **Edit Transform Limits** button on the right side of the Process Diagram.
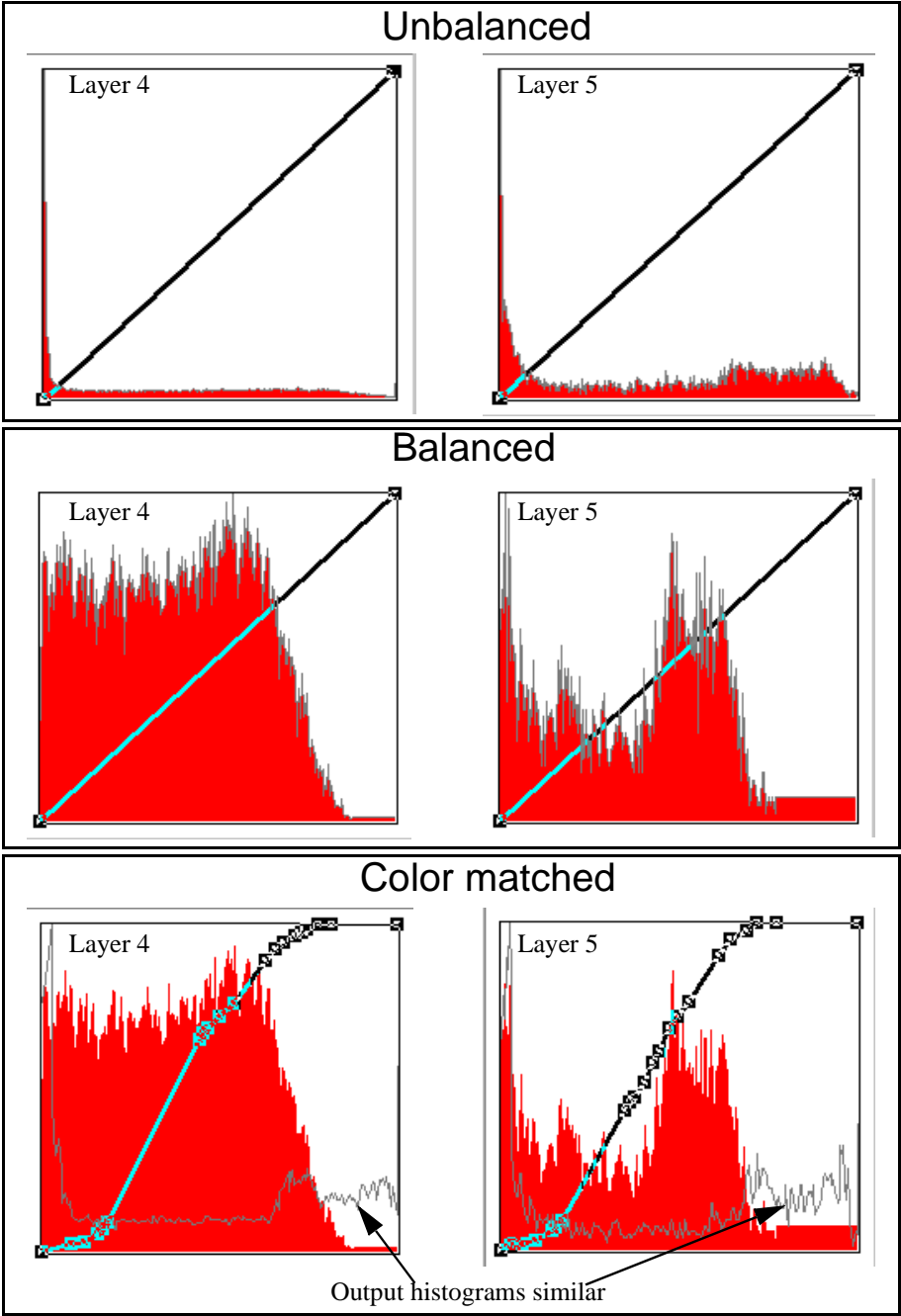
This will open the **Transform** dialog box.

8   View the histograms and transforms of all the Red layers by clicking on the Red button.

A histogram is a plot showing the range of pixel values on the X-axis against their relative frequency on the Y-axis.

The transform line maps the data values on the X-axis to the display brightness on the Y-axis. The Y-axis values will always be 0 to 255, but the X-axis values depend on the image data. The X-axis values in our example image are from 0 to 255. A linear transform line will create an output histogram that is the same as the input. You can alter this line to create different output histogram, which is shown as a separate unfilled graph.

To match the colors, the wizard has changed the transform lines so that the output histograms for each layer are the same.

The following histograms of two of the layers illustrates this.

Output histograms similar

9   Repeat the above for the Green and Blue layers.

In all cases note how the wizard has matched the histograms for the five images that make up the mosaic.

Save the balanced algorithm to disk

1   From the **File** menu (on the main menu), select **Save As....**

The **Save Algorithm** file chooser dialog opens.

2   From the **Directories** menu, select the path ending with the text **\examples**.

3   Open the 'functions_and_features\airphoto_tutorial' directory.

4   In the **Save As:** text field, type the following filename:

`airphoto_mosaic_balanced.alg`

This name denotes that it contains a balanced mosaic of the airphoto images.

5   Click **OK** to save the algorithm.

Your balanced algorithm is now saved to an algorithm file on disk.

Note: At this stage, the only disk space being used is that to store the original one GeoTIFF and four compressed images. It is now possible to save the balanced mosaic in any image format, including ECW compressed.

Close the image window and Algorithm dialog

1   On the main menu, select **Close** from the **File** menu to close the image window.

2   Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen.

What you learned   After completing these exercises, you know how to perform the following tasks in ER Mapper:

•   Use the Color Balancing Wizard for Airphotos to balance and color match the mosaiced images.

•   Open the Formula Editor to view the formula that the wizard applies to the layers.

•   Open the Transform dialog to view the histograms and transforms.

8

Compressing images

This chapter shows you how to save your large mosaic as a compressed image.

About Enhanced Compression Wavelet (ECW) compression

ER Mapper compresses images using wavelet compression technology that offers very high quality results at high compression rates. You can typically compress a color image to less than 2% to 5% of its original size (50:1 to 20:1 compression ratio) and compress a grayscale image to less than 5% to 10% of its original size (20:1 to 10:1 compression ratio).

This means that, at 20:1 compression, 10GB of color imagery will compress down to 500MB, which is small enough to fit on to a single CD-ROM. You may actually achieve higher compression rates where your source image has a structure well suited to compression.

In addition to reducing storage requirements, you can also use the free imagery plug-ins for GIS and office applications to read the compressed imagery in a wide range of software applications such as ArcView®, AutoCAD MAP®, MapInfo®, ER Viewer, Photoshop™, Microsoft Office® and Excel®, and other software applications.

Hands-on exercises

These exercises show you how to save images in ECW compressed format using the **Compression Wizard**.

For these exercises, we will be using the airphoto mosaic algorithm we created and color balanced previously.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

• Use the Compression Wizard to save images in ECW compressed format.

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Saving a compressed image to disk

Objectives

Learn how to save large images in compressed format using the ER Mapper ECW compression.

Tip: The compression process could take a long time because of the large size of the image being compressed. It is suggested that you time this exercise to allow the compression to take place overnight.

1 From the main ER Mapper **File** menu, select **Save as a Compressed Image**.

The **Compression Wizard** will open.

Input image to be compressed

1   Select the **Select input image (or mosaic) to compress** option as the source of the image(s) to be compressed and click on the **Next >** button.

2   In the **Input file:** field, click the **Select File** 📂 button.

3   From the **Directories** menu, select the **\examples** path.

4   Open the 'functions_and_features\airphoto_tutorial' directory, then double-click on the algorithm 'airphoto_mosaic_balanced.alg' to select it.

This is the image mosaic that you created earlier, and you now save it as a compressed image.

In addition to using an algorithm as the source image to be compressed, you could specify any other file format supported by ER Mapper, such as ESRI BIL, TIFF, JPG as the input.

Compressed image file name

5   In the **Output file:** field, click the **Select File** 📂 button.

6   From the **Directories** menu, select the **\examples** path.

7   In the **Select File** dialog, choose ER Mapper compressed images (.ecw) in the **Files of Type** field.

8   Open the 'functions_and_features\airphoto_tutorial' directory.

9   In the **Open:** text field, enter the text `airphoto_mosaic_compressed`
    and separate each word with an underscore (_).

10 Click **OK** on the **Select File** dialog.

    Your file name appears as the **Output File** name with a '.ecw' extension.

    ER Mapper will save the compressed image as a header (.ers) and a compressed
    data (.ecw) file. You can use **File / Open** or one of the wizards to open the header
    (.ers) or data (.ecw) file just like any other image file supported by ER Mapper.

Note: The data (.ecw) file contains embedded georeferencing information, so the header
    (.ers) file can be dispensed with if the compressed image is to be used in
    applications other than ER Mapper.

Compress to Grayscale, RGB or Multi

11 In the **Compress to:** field, select the *Color (RGB)* option

    The compression engine internally converts the RGB color image into YUV color
    space, specifically the one defined as the "JPEG Digital version of YUV". YUV is
    a color space that separates out intensity (Y) from chromatic or color changes (U
    and V). This enables more efficient compression of color imagery, ensuring that
    detail is preserved. The RGB to YUV conversion (and back again for
    decompression) is automatic; the user always sees the file as a RGB file.

    Other compression options available are:

Grayscale	The compression engine constructs and compresses a grayscale view of your input image data using the normal formula for Intensity from Red, Green and Blue.
Multiband	The compression engine compresses all the bands of a multi-band image. Use this option for compressing hyperspectral images.

12 Click on the **Next >** button to continue

Compression ratio

13 Check the **Compress for Internet** usage box.

This option is for compressed images to be served on an ER Mapper Image Web Server. The transfer rate over a network for images compressed with this option is higher, thus allowing faster zooming and roaming. However, the actual compression ratio achieved will be less than that for images compressed without this option. For more information on the Image Web Server, refer to the ER Mapper web site, http://www.earthetc.com.

14 If necessary, change the **Colorscale ratio:** to 50 and click on the **Recompute desired output size** button.

This value is the desired compression ratio that you would like to achieve. For example, you might specify a ratio of 20:1 for an input file of 1,000MB to achieve a desired a 50MB compressed image (so the output image is 5% of the size of the input image).

The Compression Wizard uses the Target Compression ratio as a measure of how much information content to preserve in the image; i.e as a quality indicator. If, however, your image has areas that are well suited to compression, a greater rate of compression may be achieved while still achieving the desired information content. The actual compression ratio could also be less than the target if you are compressing small files. The Compression Wizard uses multiple wavelet encoding techniques at the same time, and adapts and chooses the best technique depending on the area currently being compressed.
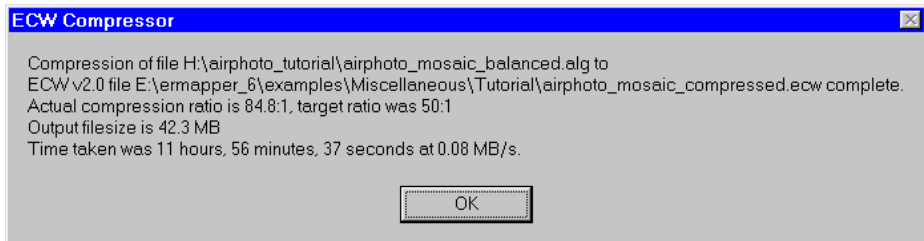
One example of this is an image that has large areas of water or desert. These can often be compressed with greater efficiency. Another example is a compressed image that consists of high resolution airphotos, over lower resolution satellite imagery where there are no airphotos. Because the satellite images are lower spatial resolution, greater compression can be achieved in these areas of the image, while still preserving high quality detail in the airphoto area.

15 Click on the **Finish** button to start the compression process.

Note: The compression of an image this large could take a long time to complete.

Compression process

A status dialog will display the progress of the compression. When the compression is complete, a dialog will display the Target and Actual compression rates.


```
ECW Compressor                                               ×

Compression of file H:\airphoto_tutorial\airphoto_mosaic_balanced.alg to
ECW v2.0 file E:\ermapper_6\examples\Miscellaneous\Tutorial\airphoto_mosaic_compressed.ecw complete.
Actual compression ratio is 84.8:1, target ratio was 50:1
Output filesize is 42.3 MB
Time taken was 11 hours, 56 minutes, 37 seconds at 0.08 MB/s.

                          OK
```

Except when compressing very small files (less than 2MB in size), the Actual compression ratio will generally be greater than the Target compression ratio.

Comparing compressed and original images

1 On the main menu, click the **Open** 📂 button.

An image window and the **Open** dialog box appear.

2 From the **Directories** menu, select the **\examples** path.

3 Open the 'functions_and_features\airphoto_tutorial' directory, then double-click on the algorithm 'airphoto_mosaic_balanced.alg' to open it.

This is the original image map, which comprises four compressed and mosaiced airphotos.

4 Re-size the image window to make it larger.

5 Right-click on the image and, from the **Quick Zoom** menu, select **Zoom to Page Extents**.

The image will enlarge so that the map page fills the image window.

6 On the main menu, click on the **New** ☐ button.

This will open a second image window.

7 On the main menu, click the **Open** 🖼 button.

An image window and the **Open** dialog box appear.

8 In the **Files of Type:** field, select 'ER Mapper compressed images (.ecw)'.

9 From the **Directories** menu, select the **\examples** path.

10 Open the 'functions_and_features\airphoto_tutorial' directory, then double-click on the file 'airphoto_mosaic_compressed.ecw' to open it.

This is the compressed image file that you have just created.

11 Re-size this new image window to make it the same size as the other.

12 Right-click on the image and, from the **Quick Zoom** menu, select **Zoom to All Datasets**.

The image will enlarge to fill the image window.

13 Move the image windows so that they are next to one another.

14 Compare the quality of the two images.

The quality should be virtually identical because the original mosaic was made up of individually compressed images. This is an example of how you could create mosaics with thousands of large images while conserving disk space. The steps to follow are:

1. After geocoding the images, compress them and store them on disk.

2. Use the Image Display and Mosaic Wizard to mosaic the compressed images.

3. Use the Balancing Wizard to balance and color match the mosaiced image.

4. Use the Compression Wizard to compress the final image.

Close both image windows and dialog boxes

1   Close the image window using the window system controls:

2   Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu should be open on the screen

What you learned   After completing these exercises, you know how to perform the following tasks in ER Mapper:

•   Save the image in compressed format using the ECW compressor.

9

Exporting to GIS systems

This chapter shows you how to save all or part of a processed mosaic image for use in a GIS or desktop mapping software product.

About use in GIS systems

Once you have created your mosaic of images in ER Mapper, you may want to save all or part of the mosaic image in a format suitable for use in a GIS or Desktop Mapping System (DMS). The procedure you will use depends upon the raster formats your GIS can accept, and its capabilities for handling large image datasets.

Note: ER Mapper provides free plug-ins to most GIS or Desktop Mapping System applications, which allow you to open ER Mapper images directly in those applications. Formats supported include ER Mapper algorithms, raster datasets, virtual datasets and ECW compressed images. Where possible, you are advised to use these plug-ins which are available for download at **www.ermapper.com**.

Since GIS and desktop mapping systems are usually designed to handle vector (line/polygon) data, they have limited capabilities for handling raster (image) data. For example, ER Mapper has no problem handling a 20,000 by 20,000 pixel image,

but few GIS or DMS applications can do this. When preparing to save an enhanced image from ER Mapper for use in a GIS or DMS, there are three possible solutions to this problem:

• Save the image in ECW compressed format. The high compression rates achieved by using this format make the image files significantly smaller. You can then use the applicable free plug-in to open the compressed image in the GIS application.

• Resample the image to a lower spatial resolution (cell size). This creates much smaller files, but you lose detail in the image. This may be best if you want to make a single image file that covers a large geographic area.

• Subset the airphoto (or mosaic) image into a set of smaller files, each covering a smaller geographic area. This maintains the original detail in the airphotos and creates individual files small enough for your GIS or DMS to handle. (It still requires a large amount of disk space to store all the individual high resolution files.)

Cropping or subsetting images

Often you will want to crop or subset part of the entire mosaic that covers just an area of interest, or subset a large mosaic into smaller pieces. There are two basic steps:

• Zoom into the desired area. You can do this visually by dragging a zoom box with the the mouse, or by entering exact coordinates in the **Algorithm Geoposition Extents** dialog.

• Save the area of interest to an external file. You can save to an ER Mapper UDF (Universal Data Format) dataset (which can be read by many systems), or to a graphics file such as TIFF.

Spatial resolution (cell size)

Digitized aerial photos are often created at very high resolution; for example one meter pixel size or even less. This creates very large image files that can be hundreds of megabytes in size. There are two reasons why you may want to consider reducing the spatial resolution (cell size) of the exported image:

• **GIS/DMS file size limitations**–If you want to use an image covering a large geographic area, you may need to resample the image to a lower spatial resolution (larger cell size), thus creating a smaller file that can be handled by the GIS product.

• **Detail required for the project**–The amount of detail in airphotos is often not needed for a particular application or project. For example, for updating a general land use database, it may not be necessary to use imagery with less than 1-meter resolution. If desired, you can resample the image to the level of detail needed for the project to create files that are only as large as necessary for the application.

Raster formats for GIS and DMS products

The two most common formats accepted by GIS and DMS products are TIFF (Tagged Image File Format) and BIL (band interleaved by line) format.
ER Mapper's native format is binary BIL, so that is the best solution for products that can read BIL format. Use the following guide to determine which format you need to use:

*   **ArcView GIS® OR ARC/INFO®** –Create an ER Mapper UDF (Universal Data Format) dataset (in BIL format), which, in addition to the ".ers" header file, includes a ".hdr" file that allows ArcView GIS® or ARC/INFO® to read the BIL file directly.

*   **Autodesk World™, AutoCAD MAP® or AutoCAD®** –Use ER Mapper to save the image to a TIFF format file.

*   **MapInfo**–Use ER Mapper to save the image to a TIFF format file. Alternatively, ER Mapper also provides a free upgrade to MapInfo users that allows MapInfo to directly read ER Mapper format image files and algorithms. The link automatically passes the map projection information to MapInfo. This allows users to integrate very large mosaics of imagery as backdrops into MapInfo quickly and easily.

*   **Other GIS and DMS products**–Use ER Mapper to save the image to a TIFF or other compatible graphics format file.

Using compressed images in GIS applications

The ECW Compression Wizard, which is included in ER Mapper, enables you to save large images in the ECW compressed format with minimal loss in quality. Compression rates can typically be in the order of 50:1.

The relatively small file sizes of ECW compressed images make them ideal for use in GIS applications. The free plug-ins available for many GIS products allow you to open ECW compressed images directly in those products. You can also open ECW compressed images served over a network (e.g. the Internet) by entering their URLs. You can then roam over and zoom into the image over the network from within the application.

Hands-on exercises

These exercises show you how to crop an area of interest from a mosaic image, save the area as an ER Mapper UDF dataset and a TIFF file.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Define an exact area of interest using geographic coordinates
- Save the image as a new UDF dataset
- Resample the resolution (cell size) of a dataset
- Save an image as a TIFF format graphics file

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Defining an area of interest

Objectives

Learn to define exact areas of interest in an image, and how to subsection an image into smaller files.

Open the final mosaic algorithm

1 On the main menu, select **Open** from the **File** menu.

An image window and the **Open** dialog appear.

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

3 Open the 'functions_and_features\functions_and_features\airphoto_tutorial' directory.

4 Double-click on your 'airphoto_mosaic.balanced.alg' algorithm to open it.

The balanced RGB mosaic image displays. Next you define a small area of interest for your project.

Zoom into the project area

Assume that you have a project to display a particular building near the center of the mosaic image. The project calls for an image showing an exact area defined by Easting and Northings values (meters) in the UTM projection being used.

1 From the **View** menu, select **Geoposition**.

The **Algorithm Geoposition Extents** dialog opens.

2 Click the **Extents** tab to display the current mosaic extents.

3 Enter the following values in the Eastings and Northings Top Left and Bottom Right fields:

> Top Left - Easting: **483881**
>
> Top Left - Northing: **3622145**
>
> Bottom Right - Easting: **483921**
>
> Bottom Right - Northing: **3622105**

4 Click the **Apply** button.

ER Mapper zooms to the exact extents you entered. You have now defined a project area to be exported for analysis in your GIS or DMS system.

Also notice that the area is approximately 1.2 by 1.1 kilometers in size (in the Eastings and Northings Size fields), and that the it displays approximately 1970 by 985 pixels of the mosaic image.

5 Click **Close** on the **Algorithm Geoposition Extents** dialog.

2: Creating a UDF dataset

Objectives   Learn to save the area of interest to a new raster dataset in UDF format, and how to resample the image to a larger cell size (reduce the spatial resolution).

Note: You can also use the following procedure to save your entire mosaic of images to a single, large ER Mapper dataset. This may be desirable if disk space is not an issue because displaying and zooming a processed ER Mapper dataset is much faster than displaying and zooming a mosaic of images that have complex formulas and other options in the algorithm (where the processing must be executed each time you zoom or pan).

Setup the algorithm for dataset output

Saving an image as a dataset is similar to creating an algorithm for the screen display, except that you are sending the resulting processed image to a new dataset on disk, instead to an image window on the screen.

1   On the main menu, select **Algorithm** from the **View** menu.

The **Algorithm** dialog opens. Note that this algorithm has red, green and blue layers to create the RGB color image. You want your output ER Mapper dataset to also have red, green and blue bands.

2   Examine the layer labels.

The layer labels you see determine what the band labels will be in the new output dataset. In this case, your output dataset will have three bands labelled 'Red Layer,' 'Green Layer' and 'Blue Layer.'

layer labels become band labels in output dataset

Note: ER Mapper merges any layers with the same label into a single band in the output dataset. (So if you have two or more sets of red, green and blue layers, they are merged into single red, green and blue bands in the output dataset.) To output layers as individual bands, make sure each layer has a unique label in the algorithm.

Save the project area to a full resolution UDF dataset

In this case, assume you want to maintain the full resolution of the airphoto data when you create the output dataset. This guarantees that all the detail in the airphoto will be carried through to the new dataset.

1   On the main menu, select **Save As...** from the **File** menu.

The **Save As...** dialog opens. This dialog lets you specify the name for the new dataset to be created, and parameters for the dataset such as data type and size/ resolution.

2   In the **Files of Type:** field, select 'UDF (.ers)'.

3   From the **Directories** menu, select the path ending with the text **\examples**.

4   Open the 'functions_and_features\airphoto_tutorial' directory

5   In the **Save As:** field, enter the filename `project_area_full`, then click **OK**.

This will be the filename for the new UDF dataset.

6   On the **Save as UDF** dialog, click the **Defaults** button.

The contents of the four parameters fields on the dialog change to display the settings and values read from the current algorithm. Notice that:

•   The **Output Type** field is set to 'Multilayer' because there are more than three layers in the algorithm. You should change this to 'RGB'.

•   The **Width** and **Height** fields are set to the number of pixels displayed in the area you defined with **Geoposition** . This creates a full resolution dataset.

Note: You should *always* click the **Defaults** button to load the values that pertain to the current algorithm first, *then* you can change them as needed.

---

7   Make sure that the **Maintain aspect ratio** and **Current View** options are selected.

The **Current View** option limits the image size to the extents currently being displayed in the image window.

8   Click **OK**.

ER Mapper creates a new output dataset on disk in the form of three files; the image data file, with a ".bil" extension, and two header files with a ".ers" and ".hdr" extension respectively. This enables them to be opened in ER Mapper and applications like ArcInfo®.

9   Click **OK** on the completion dialog.

Display the new dataset in RGB

1   On the main menu, select **New** from the **File** menu.

A new image window opens.

2   On the main menu, click the **Open** 🗁 button.

The **Select a Dataset** dialog opens.

3   On the **Open** dialog, **Files of Type** field, select either 'ER Mapper Raster Dataset (.ers)' or 'ESRI BIL and GeoSPOT (.hdr)'.

You can do this because saving an image as UDF creates the BIL data file with a .ers and a .hdr header file.

4   From the **Directories** menu (on the **Select File** dialog), select the path ending with the text **\examples**

5   Double-click on the directory named 'functions_and_features\airphoto_tutorial.'

6   Double-click on the dataset 'Project_area_full.ers' or 'Project_area_full.hdr' to load it.

Both selections will open the same image.

7   Click **OK** on the **Open** dialog.

ER Mapper displays the entire subsetted image as an RGB algorithm.

View information about the new dataset

1   On the **Algorithm** dialog, click the **Load Dataset** 🗁 button.

The **Raster Dataset** dialog opens, and your 'Project_area_full' dataset is highlighted (since it is the dataset currently loaded in the layer).

2   On the **Raster Dataset** dialog, click the **Info** button.

The **Dataset Information** dialog opens showing information about the dataset:

It shows the datum and projection, number of rows and columns (image dimensions, pixel (cell) size in meters (approximately 0.06 - meter resolution), and file size (about 1.3 Mb in this case).

3   Click **Close** on the **Dataset Information** dialog.

Save the project area to a half resolution UDF dataset

Let us assume that the full detail in the airphoto is not needed, and you would like to resample the image to approximately 0.12 - meter resolution to create a smaller file for your GIS. One way to do this is to follow the same steps as before, but divide the default image width and height values by two to create a dataset at half the original resolution. (You may also want to do this simply to reduce the file size when covering a large area if your GIS or DMS cannot handle very large images.)

1   Activate the image window containing the original mosaic image (named 'airphoto_mosaic_balanced').

The contents of the **Algorithm** dialog change to show the mosaic algorithm.

2   On the main menu, select **Save As...** from the **File** menu.

The **Save As...** dialog opens. This dialog lets you specify the name for the new dataset to be created, and parameters for the dataset such as data type and size/ resolution.

3   In the **Files of Type:** field, select 'UDF (.ers)'.

4   From the **Directories** menu, select the path ending with the text **\examples**.

5   Double-click on the directory named 'functions_and_features/ airphoto_tutorial.'

6   In the **Save As:** field, enter the filename `project_area_half`, then click **OK**.

This will be the filename for the new UDF dataset.

7   On the **Save as UDF** dialog, click the **Defaults** button.

The contents of the four parameters fields on the dialog change to display the settings and values read from the current algorithm.

8   Open the **Output Type** field, select 'RGB'.

As before, this tells ER Mapper to rescale the real data values into an 8-bit integer (0-255) data range in the output dataset.

9   Change the values in the **Width** and **Height** fields as follows (the original values divided by 2 and rounded up):

Cells Across (width) = **330**

Cells Down (height) = **330**

10 Click **OK**, then click **Yes** when asked to confirm the dataset creation.

ER Mapper creates a new half-resolution output dataset on disk.

11 Click **OK** on the completion dialog.

Note: When creating a new dataset with different cell sizes to the original data, ER Mapper resamples the original data to the new output cell size during the process of creating the new dataset. If the 'Smoothing' button is turned on in your algorithm (as in this case), ER Mapper uses bilinear interpolation to create the new output dataset cell values. If the 'Smoothing' button is turned off, ER Mapper uses nearest neighbor resampling. Bilinear usually creates a nicer looking output image, so it is recommended that you turn on Smoothing in your algorithm before writing the new dataset. (If you are creating the dataset at the original resolution, this does not matter.)

Display the half resolution dataset in RGB

1   On the main menu, select **New** from the **File** menu.

A new image window opens.

2   On the main menu, click the **Open** button.

The **Select a Dataset** dialog opens.

3   On the **Open** dialog, **Files of Type** field, select either 'ER Mapper Raster Dataset (.ers)' or 'ESRI BIL and GeoSPOT (.hdr)'.

You can do this because saving an image as UDF creates the BIL data file with a .ers and a .hdr header file.

4 From the **Directories** menu (on the **Select File** dialog), select the path ending with the text **\examples**

5 Double-click on the directory named 'functions_and_features\airphoto_tutorial.'

6 Double-click on the dataset 'Project_area_half.ers' or 'Project_area_half.hdr' to load it.

Both selections will open the same image.

7 Click **OK** on the **Open.** dialog.

ER Mapper displays the subsetted and resampled image as an RGB algorithm.

View information about the half resolution dataset

1 On the **Algorithm** dialog, click the **Load Dataset** button.

2 On the **Raster Dataset** dialog, click the **Info** button.

It shows the number of rows and columns is half that of the other dataset 'Project_area_full,' the cell size is approximately 0.12 meters, and the file size is about 326.7 KB (25% the size of the full resolution subset image).

Geolink the subset images to see the resolution difference

In order to compare the difference in detail between the full and half resolution subset images, it is helpful to use ER Mapper's geolinking feature to tie the two image windows together. That way, you can zoom to the exact same area in both windows and see how the different cell sizes affect detail in the data.

Make sure the newest image window (containing the 'Project_area_half' dataset) is active (it should be by default).

1 On the **Algorithm** dialog, turn off the 'Smoothing' option.

Turning off smoothing will allow you to see individual pixels when you zoom in on a small area later (smoothing would integrate and smooth out pixels).

2 Right-click in the image window, select **Quick Zoom**, then select **Set Geolink to Window**.

The window title bar shows that the window is set to "WINDOW geolink" mode.

3 Activate the other image window containing the 'Project_area_full' dataset.

4 On the **Algorithm** dialog, turn off the 'Smoothing' option.

5   Right-click in the image window, select **Quick Zoom**, then select **Set Geolink to Window**.

The window title bar shows that the window is also set to "WINDOW geolink" mode.

6   Drag a zoom box in one of the windows to zoom on a very small area.

The two windows zoom to the same area automatically, and you should be able to see individual pixels in the two images. (Zoom in some more if you cannot.)

Notice difference in detail between the two images–this is the effect of resampling to a larger cell size. So, in exchange for creating a much smaller file, you must reduce the level of detail in the image.

Note: Geolinking images is a very useful feature for analyzing different images or the same image in different ways or zoom levels. You can also set these options using the **Geolink** tab on the **Algorithm Geoposition Extents** dialog. See the ER Mapper *Tutorial* manual for examples of the different geolink modes, and the *User Guide* for more information.

7   If desired, pan to other areas in both images by clicking – both images will pan to the same area because they are geolinked in Window mode.

8   Click **Close** on the **Algorithm** dialog (you do not need it anymore).

Resampling to an exact cell size

You can also resample an ER Mapper dataset to any desired cell size. This may be a more intuitive way to resample an image by selecting a cell size rather than using image dimensions as in the previous procedure. However, this technique requires an ER Mapper dataset as input (you cannot use an algorithm as in the previous procedure). To do this:

•   Select **Process/Geocoding Wizard**.

•   On the Geocoding Wizard **Start** page, load the dataset to be resampled (.ers file), and select **Rotation**, then click on the **Rotation Setup** tab.

•   On the **Rotation Setup** page, enter 0 for the **Rotation angle**, then click on the **Rectify** tab.

A rotation angle of 0 ensures that the image is resampled without being rotated.

•   On the **Rectify** page, enter the desired cell size (in meters) in the **Cell size X** and **Cell size Y** fields.

•   In the **File** field, enter the file name of the resampled image.

- If you want to save only a portion of the entire image, first determine the desired upper-left and lower-right coordinates. Then click **Extents** on the **Rectify** page and enter the desired extents on the **Geocode Output Extents** dialog.

- The dimensions and output file size for the resampled dataset at the cell size you entered are displayed in **Output Info** box.

- Select 'Bilinear' for **Resampling**.

- Click on the **Save File and Start Rectification** button to create the new resampled output dataset.

3: Creating a ".hdr" file for ESRI products

Objectives   Learn to create a header (.hdr) file for the full resolution ER Mapper dataset so it can be read directly by ESRI products.

The ESRI products ArcView GIS® and ARC/INFO® can read image files stored in binary BIL format, which is also ER Mapper's internal raster format. If you already have a ER Mapper dataset, you can simply have ER Mapper create a ".hdr" file for the dataset so the same image can be read by directly by ESRI products (without creating a new dataset). If you have saved the image in UDF format, as in the previous exercises, ER Mapper has already created the ".hdr" file so you need not do anything else. You can also use the ER Mapper export facilities to create the ".hdr" file for a ER Mapper Raster Dataset. This exercise demonstrates how you would do this.

Close the half resolution subset image window

1   Close the image window containing the half resolution subset image. (Leave the two other windows open.)

Zoom out on the full resolution subset image

1   If needed, activate the window containing the full resolution subset image.

2   Right-click in the image window, select **Quick Zoom**, then select **Zoom to All Datasets**.

The image zooms out to the full extents of the subsetted project area. (This is not strictly needed, but helps to simply the following concepts.)

Create the ".hdr" file for the ER Mapper dataset

1   From the **Utilities** menu, select **Export Raster**, then **ARC/INFO BIL Image (.hdr)**, then **Export**.

The **ER Mapper raster file to make ARC/INFO compatible** dialog opens.

2   Click the [⊞] button next to the **File** field.

3   From the **Directories** menu (on the **Select File** dialog), select the path ending with the text **\examples**.

4   Double-click on the directory named 'functions_and_features\airphoto_tutorial.'

5   Double-click on the dataset 'Project_area_full.ers' to load it.

6   Turn on the **Verbose Messages** option.

7   Click **OK** to start the export process.

ER Mapper displays messages about the export process, including the datum, projection, cell size and registration coordinate encoded in the ".hdr" file.

The ARC/INFO BIL Image export utility does three things:

• Renames the ER Mapper binary data file to add a ".bil" file extension (so ESRI products recognize it as a BIL format image). In this case, the original 'Project_area_full' dataset is renamed to 'Project_area_full.bil.'

• Creates a corresponding ".hdr" file for the binary data file ('Project_area_full.hdr'). This ASCII header file provides the projection, cell size and parameters needed to register the image when it is loaded into ArcView or ARC/INFO.

• Changes the "source file" reference in the ER Mapper header (.ers) file from 'Project_area_full' (the previous filename) to 'Project_area_full.bil.' This lets you load and use the dataset in ER Mapper just as you did before.

8   Click **Close** on the **Batch Engine Output** dialog to close it.

Close the subset image window

1   Close the subset image window image window containing the full resolution subset image

You now have now transformed an ER Mapper dataset into an ESRI-compatible dataset (without actually creating a new image file, only an ASCII header file.)

Note: The above procedure is useful if you already have an ER Mapper Raster Dataset, and you simply want to create an additional ".hdr" file for it. If you were saving the image from an algorithm, it would be quicker to save it as 'UDF' or 'ESRI BIL and GeoSPOT (.hdr)' type file.

4: Saving a subset image to a TIFF file

Objectives   Learn to save a portion of the airphoto mosaic to a TIFF graphics file. This file format can be read by most GIS and DMS products.

The original 'airphoto_mosaic_balanced' algorithm should be open on the screen. If you closed it, open it again using **File/Open**.

Zoom into the project area

For this example, assume that the project calls for an image showing part of the airport in the lower left corner of the full mosaic image. Again you will define the exact project area using Easting and Northings values in the UTM projection system.

1   From the **View** menu, select **Geoposition**.

The **Algorithm Geoposition Extents** dialog opens.

2   Click the **Extents** tab to display the current mosaic extents.

3   Enter the following values in the Eastings and Northings Top Left and Bottom Right fields:

> Top Left - Easting: **483350**
>
> Top Left - Northing: **3621735**
>
> Bottom Right - Easting: **483534**
>
> Bottom Right - Northing: **3621565**

4   Click the **Apply** button.

ER Mapper zooms to the exact extents you entered, and shows part of the airport area. This is the image you will save to a TIFF file. The area displayed is 184 by 170 meters in size (in the Eastings and Northings Size fields), and 3057 by 2833 pixels of the mosaic image (the Cell X and Cell Y Size fields).

5   Click **Close** on the **Algorithm Geoposition Extents** dialog.

Save the project area to a true color (24-bit) TIFF file

In this case, assume you want to maintain the full resolution of the airphoto data when you create the output dataset. This guarantees that all the detail in the airphoto will be carried through to the new dataset.

1   On the main menu, select **Save As...** from the **File** menu.

The **Save As...** dialog opens. This dialog lets you specify the name for the new dataset to be created, and parameters for the dataset such as data type and size/resolution.

2 In the **Files of Type:** field, select 'GeoTIFF/TIFF (.tif)'.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Double-click on the directory named 'functions_and_features\airphoto_tutorial.'

5 In the **Save As:** field, enter the filename `project_area_full`, then click **OK**.

This will be the filename for the new tif file.

6 On the **Save as GeoTIFF/TIFF** dialog, click the **Defaults** button.

The contents of the four parameters fields on the dialog change to display the settings and values read from the current algorithm. Notice that:

• The **Output Type** field is set to ''RGB', indicating that it will be saved as a true color image.

• The **Width** and **Height** fields are set to the number of pixels displayed in the area you defined with **Geoposition** (3067 by 2833). This creates a full resolution dataset.

Note: You should *always* click the **Defaults** button to load the values that pertain to the current algorithm first, *then* you can change them as needed.

---

7 Make sure that the **Maintain aspect ratio** and **Current View** options are selected.

The **Current View** option limits the image size to the extents currently being displayed in the image window.

8 Click **OK**.

ER Mapper creates a new output dataset on disk.

9 Click **OK** on the completion dialog.

Display the new dataset in RGB

1 On the main menu, select **New** from the **File** menu.

A new image window opens.

2 On the main menu, click the **Open** button.

The **Select a Dataset** dialog opens.

3   On the **Open** dialog, **Files of Type** field, select 'GeoTIFF/TIFF (.tif)'.

4   From the **Directories** menu (on the **Select File** dialog), select the path ending with the text **\examples**

5   Double-click on the directory named 'functions_and_features\airphoto_tutorial.'

6   Double-click on the dataset 'Project_area_full.tif'.

7   Click **OK** on the **Open** dialog.

ER Mapper displays the entire subsetted image as an RGB algorithm.

View information about the new dataset

1   On the **Algorithm** dialog, click the **Load Dataset** 📂 button.

The **Raster Dataset** dialog opens, and your 'Project_area_full' dataset is highlighted (since it is the dataset currently loaded in the layer).

2   On the **Raster Dataset** dialog, click the **Info** button.

The **Dataset Information** dialog opens showing information about the dataset:

It shows the datum and projection, number of rows and columns (image dimensions, pixel (cell) size in meters (approximately 0.06 - meter resolution), and file size (about 25 Mb in this case).

3   Click **Close** on the **Dataset Information** dialog.

Save the project area to a half resolution ER Mapper dataset

Let us assume that the full detail in the airphoto is not needed, and you would like to resample the image to approximately two-meter resolution to create a smaller file for your GIS. One way to do this is to follow the same steps as before, but divide the default image width and height values by two to create a dataset at half the original resolution. (You may also want to do this simply to reduce the file size when covering a large area if your GIS or DMS cannot handle very large images.)

1   Activate the image window containing the original mosaic image (named 'airphoto_mosaic_balanced').

The contents of the **Algorithm** dialog change to show the mosaic algorithm.

2   On the main menu, select **Save As...** from the **File** menu.

The **Save As...** dialog opens. This dialog lets you specify the name for the new dataset to be created, and parameters for the dataset such as data type and size/ resolution.

3   In the **Files of Type:** field, select 'GeoTIFF/TIFF (.tif)'.

4   From the **Directories** menu, select the path ending with the text **\examples**.

5   Double-click on the directory named
    'functions_and_features\airphoto_tutorial.'

6   In the **Save As:** field, enter the filename `project_area_half`, then click
    OK.

    This will be the filename for the new tiff dataset.

7   On the **Save as GeoTIFF/TIFF (.tif)** dialog, click the **Defaults** button.

    The contents of the four parameters fields on the dialog change to display the
    settings and values read from the current algorithm.

8   Open the **Output Type** field, select 'RGB'.

    As before, this tells ER Mapper save the image as a real color tiff file.

9   Change the values in the **Width** and **Height** fields as follows (the original
    values divided by 2 and rounded up):

    Cells Across (width) = `1533`

    Cells Down (height) = `1416`

10 Click **OK**, then click **Yes** when asked to confirm the dataset creation.

    ER Mapper creates a new half-resolution output dataset on disk.

11 Click **OK** on the completion dialog.

Note: When creating a new dataset with different cell sizes to the original data,
ER Mapper resamples the original data to the new output cell size during the
process of creating the new dataset. If the 'Smoothing' button is turned on in your
algorithm (as in this case), ER Mapper uses bilinear interpolation to create the new
output dataset cell values. If the 'Smoothing' button is turned off, ER Mapper uses
nearest neighbor resampling. Bilinear usually creates a nicer looking output image,
so it is recommended that you turn on Smoothing in your algorithm before writing
the new dataset. (If you are creating the dataset at the original resolution, this does
not matter.)

Display the half resolution dataset in RGB

1   On the main menu, select **New** from the **File** menu.

    A new image window opens.

2   On the main menu, click the **Open** button.

    The **Select a Dataset** dialog opens.

3　On the **Open** dialog, **Files of Type** field, select 'GeoTIFF/TIFF (.tif)'.

4　From the **Directories** menu (on the **Select File** dialog), select the path ending with the text **\examples**

5　Double-click on the directory named 'functions_and_features\airphoto_tutorial.'

6　Double-click on the dataset 'Project_area_half.tif' to load it.

Both options will open the same image.

7　Click **OK** on the **Open.** dialog.

ER Mapper displays the subsetted and resampled image as an RGB algorithm.

View information about the half resolution dataset

1　On the **Algorithm** dialog, click the **Load Dataset** button.

2　On the **Raster Dataset** dialog, click the **Info** button.

It shows the number of rows and columns is half that of the other dataset 'Project_area_full,' the cell size is approximately 0.12 meters, and the file size is about 6.5 Mb (25% the size of the full resolution subset image).

Close the image windows and the Algorithm dialog

1　Close the image windows.

2　On the **Algorithm** dialog, click the **Close** button.

Only the ER Mapper main menu is now open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

• Define an exact area of interest using geographic coordinates

• Save the image as a new UDF dataset

• Resample the resolution (cell size) of a dataset

• Save the image as a TIFF format graphics file

10

ArcView® GIS Users

This chapter explains how to use the free ER Mapper Imagery Extension for ESRI's ArcView® GIS software. It also explains how to obtain and install the extension, and the additional imaging capabilities ArcView users can gain by using the extension in conjunction with ER Mapper.

Plugins are available for other applications. This chapter is included as an example of how you can use them.

Note: You must have a licensed copy of ArcView GIS version 3.1 or greater to install and run the ER Mapper Imagery Extension.

As imagery data sources become more important for GIS applications, the need to efficiently process, enhance and display large image files also becomes more important. Earth Resource Mapping (developers of ER Mapper) provides a free extension (or "plug-in") that lets ArcView GIS users directly display ER Mapper imagery and algorithms. With the ER Mapper Imagery Extension, ArcView GIS users are no longer restricted by limited image handling capabilities. In addition, you can experience the full power of ER Mapper algorithms from within ArcView GIS, and give your vector GIS data real world meaning by presenting it over image backdrops.

How to obtain the ER Mapper Imagery Extension

You can obtain the free ER Mapper Imagery Extension from two sources:

*   **The ER Mapper installation CD-ROM**–The extension can be installed as a separate component from the ER Mapper installation CD-ROM. (It is recommended that you also install ER Mapper to gain access to a wide variety of sample data and test drive the software in free evaluation mode to see what it can do for you.)

*   **The ER Mapper web site**–You can download the latest version of the extension from the ER Mapper web site at www.ermapper.com. Navigate to the "free software" area and download the ArcView GIS plug-in.

Hands-on exercises

These exercises show you how to use the ER Mapper Imagery extension for ArcView GIS.

What you will learn...   After completing these exercises, you will know how to perform the following tasks in ArcView GIS using the ER Mapper Imagery Extension:

*   Enable the ER Mapper Imagery Extension after starting ArcView GIS

*   Display an ER Mapper algorithm file (.alg) as an Image Data Source

*   Display and ECW compressed image (.ecw) as an Image Data Source

Before you begin...   Before beginning these exercises, you must have installed ArcView GIS version 3.1 or higher and the ER Mapper extension for ArcView on your system. .

1: Using the ER Mapper extension

Objectives   Learn to enable the ER Mapper extension for ArcView and display ER Mapper imagery (.ers) files and algorithm (.alg) files.

Start ArcView GIS

1   Start the ArcView GIS software on your system.

2   If the **Welcome to ArcView GIS** dialog appears, click **Cancel**.

3   Click the **Maximize** ⬜ button in the upper-right corner of the ArcView GIS application window (if it is not already maximized)

ArcView GIS expands to fill your desktop.

Load the ER Mapper extension

1 From the **File** menu, select **Extensions...**.

2 On the **Extensions** dialog, click on the box next to 'ECW v2.0 and ER Mapper Imagery' (a check mark should appear).

3 Turn on the 'Make Default' option, then click **OK**.

turn on ER Mapper
extension

load extension
on startup

The ER Mapper Imagery Extension for ArcView GIS loads. You can now display ER Mapper algorithm and imagery files. Since you selected 'Make Default,' the extension will load automatically each time you start ArcView GIS.

Open an ER Mapper algorithm (.alg) file

ER Mapper algorithms let you define a "view" into your data that you can save, reload, and modify at any time. By using the ER Mapper Imagery Extension, you can display ER Mapper algorithms just like any other image data source.

1 If the Project window is not open, select **File** -> **New Project**.

2 On the Project window, click **New** to open a View window. (It should be titled 'View1'.)

3 On the **Add Theme** dialog, select 'Image Data Source' from the 'Data Source Types' list. (ER Mapper imagery and algorithms are always image data sources in ArcView GIS.)

4 Double-click on the folder where ER Mapper is installed. Then open the directory named 'functions_and_features\airphoto_tutorial.'

5 Double-click on your 'airphoto_mosaic.alg' algorithm to open it.

6 Click the check box next to the theme to turn it on.

ArcView GIS displays the unbalanced mosaic of five orthorectified color airphotos of the San Diego, California area that you created in a previous exercise.

7　Click the **Zoom In** ⊕ tool, then drag a box over the central part of the mosaic image to zoom into it.

8　Click the **Pan** 🖑 tool, then drag the image to view adjacent areas.

This example shows how you can access the power of ER Mapper algorithms to apply complex image enhancements and display them directly with ArcView GIS.

Add a second view to display the ECW compressed image

1　Click the **Minimize** ▁ button on the 'View1' window to minimize it (or close it if desired).

2　On the Project window, click **New** to open a new View window. (It should be titled 'View2'.)

3　Click the **Add Theme** ➕ button (or select **View > Add Theme**).

The files in the 'functions_and_features\airphoto_tutorial' directory should be displayed.

4　Double-click on the file 'airphoto_mosaic_compressed.ecw.'

5　In the 'View2' window turn on the new theme.

ArcView GIS displays the compressed balanced image mosaic that you created in a previous exercise. If you compare it to the algorithm you loaded earlier, you can see how the balancing has enhanced the image.

An advantage of using an ECW file over an algorithm is that you only require one file. The algorithm requires the algorithm file itself and the data and header files of each individual image in the mosaic.

6　Enlarge the 'View2' window to make the image larger.

7　Zoom in and pan to different parts of the image using the **Zoom In** ⊕ and **Pan** 🖑 tools.

Zoom, pan and measure the image

1　Click the **Zoom In** ⊕ tool, then drag a box over the central part of the SPOT image to zoom into it.

2　Click the **Pan** 🖑 tool, then drag the image to view adjacent areas.

3   Click the **Measure** ⊞ tool, then drag a line to view distances across an area.

The line length appears in the lower-left corner of the ArcView GIS dialog.

4   Move the mouse pointer around inside the image.

Geographic coordinates appear in the upper-right area indicating that the image is georeferenced. (In this case to the UTM projection, so units are meters of Easting and Northings.)

Close ArcView GIS

1   If desired, save your views as an ArcView project using **File > Save Project As....**

2   Close ArcView GIS by clicking the **Close** $\boxed{\times}$ button on the application window or selecting **File -> Exit**.

What you learned...

After completing these exercises, you know how to perform the following tasks in ArcView GIS using the ER Mapper Imagery Extension:

- Enable the ER Mapper Imagery Extension after starting ArcView GIS
- Display an ER Mapper algorithm file (.alg) as an Image Data Source
- Display an ECW compressed image file (.ecw) as an Image Data Source

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Windows® applications (OLE)

This chapter explains how you can use your office software's OLE capabilities to easily display and manipulate large images inside Windows applications (without having to save the image as part of the file).

Note: To use the OLE capabilities described here, make sure you first install ER Viewer, from the ER Mapper installation CD-ROM or download it from the ER Mapper website at www.ermapper.com.

About ER Viewer

ER Viewer is a free, easy to use image viewing application featuring interactive roaming and zooming of very large image files. In this example we use it as an OLE server application to let you view images inside other Windows applications. ER Viewer offers unequalled stability and supports a wide range of image formats, including:

• Universal Data Format (UDF) images

• ER Mapper compressed and uncompressed images

- TIFF and GeoTIFF images
- Windows BMP images
- SPOTView images
- ESRI BIL (ARC/INFO and ArcView) images
- ER Mapper algorithms

What is OLE?

Many Windows applications support OLE–*Object Linking and Embedding*. OLE is a program-integration technology developed by Microsoft that lets you easily share information between programs. This capability allows you to insert an object (such as an image) into any OLE-enabled application. Most office applications running under Microsoft Windows support OLE.

With a *linked object*, information is created in one file (the *source* file) and inserted into another file (the *destination* file) while maintaining a connection or "link" between the two files. When you save the destination file (such as a word processing document), you save only the link to the source file and do not embed the image as part of the document.

For example, several different documents can display the same image, all via links to the single source image file. If the source image file is modified, the linked image objects in the destination files are also automatically updated to reflect any changes.

Sharing image files using OLE

In addition to letting you view images, ER Viewer also acts as an OLE server application to let you view images inside your favorite Windows applications. Using ER Viewer's OLE capabilities provides many advantages for sharing large image files throughout your enterprise, including:

- You can display image files much larger than the application itself is capable of displaying (for example a 500MB airphoto) since ER Viewer performs the processing (not the application where the image is displayed)

- Much faster display of large image files in documents, since ER Viewer performs the processing (not the application where the image is displayed)

- Word processing documents, spreadsheets, presentations, and other applications can all share a single copy of the original imagery files

- Documents can display images in many additional image formats not supported by the destination application, but that are supported by ER Viewer

- Images can be displayed in the application without having to permanently embed and save the image files as part of the document (so the documents remain small in size)

- You can access the power of ER Mapper Algorithms to apply complex processing enhancements that create beautiful images interactively without changing the original image files

Hands-on exercises

These exercises show you how to insert an image into another Windows application as a linked OLE object using ER Viewer as the source application.
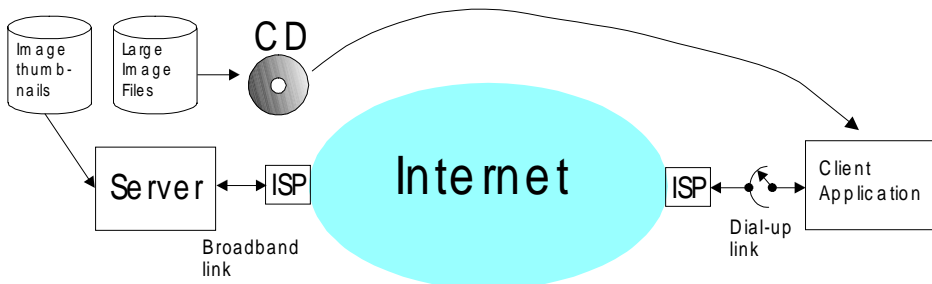
What you will learn...

After completing these exercises, you will know how to perform the following tasks in OLE-enabled Windows applications:

- Insert an image as a linked OLE object into another Windows application
- Edit the image object within the application using the ER Viewer toolbar
- Copy and paste an OLE image form one area to another

Before you begin...

Before beginning these exercises, you must have installed ER Viewer on your system.

1: Using OLE to display images

Objectives   Learn how to use ER Viewer as an OLE server to display and edit large image files within OLE-enabled Windows applications.

With Object Linking and Embedding (OLE), you can use ER Viewer as a powerful image viewing engine to display and edit large image files directly inside your Windows applications. This allows you to display images in many formats that cannot be read by the application itself, and also makes the document files much smaller because only a link to the image file is saved with the document.

The following example uses Microsoft Word as the example OLE-enabled application. You can use any other OLE-enabled word processing application if desired (WordPerfect, Framemaker, and so on).

Start Microsoft Word (or other OLE-enabled word processor)

1   Start up the Word application on your system (or another OLE-enabled word processor).

2   Type the text **San Diego Airphoto Mosaic Unbalanced** as the first line of your document, then press **Enter** to create a new line.

Open the Windows Explorer

1   Open the Windows Explorer application (select **Start > Programs > Windows Explorer**).

2   Open the ER Mapper installation directory. Then open the directory 'examples\functions_and_features\airphoto_tutorial'

3   Move the Word application window and the Explorer window side by side (resize them if needed).

Drag an algorithm image file into the Word document

1   Drag the file 'airphoto_mosaic.alg' from the Explorer window and drop it into the Word document window.

After a short time, the image file displays in your document.

2   In the word processor, click once on the image to select it, then drag the lower-right corner handle to make it much larger.

The image redisplays at the larger size. This is the image mosaic you created in a previous exercise.

Zoom and roam using the ER Viewer toolbar

1 In Word, double-click on the image.

   The word processor's native toolbar changes to display the ER Viewer zoom and roam tools. When you double-click on a linked object, the object's *server application* (ER Viewer) is temporarily enabled inside the *container application* (the word processor) so you can edit the object.

2 Click the **ZoomBox Tool** button, then drag a box to enclose the area of white buildings in the lower central portion of the image.

3 ER Viewer zooms in to display the area you defined with your box.

4 Click the **Hand Tool** button, then drag the image.

5 ER Viewer roams (or pans) to display the adjacent area of the image.

Return to the Word application

1 In the word processing document, click outside the image area.

   The usual word processor toolbar and interface returns, and the image is updated to the new extents you defined.

Insert the ECW compressed image into the document

1 Press Enter twice to create two new lines below the image, then type the text **San Diego Airphoto Mosaic Balanced and Compressed**.

2 In the Explorer window, open the ER Mapper home directory, then open the directory 'examples\functions_and_features\airphoto_tutorial'.

3 Drag the file 'airphoto_mosaic_compressed.ecw' from the Explorer window and drop it into the word processing document window.

   After a short time, the image file displays in your document.

4 Click once on the image to select it, then drag the lower-right corner handle to make it larger.

   This is the compressed image mosaic you created earlier. When compared to the already loaded algorithm, it demonstrates how the balancing has enhanced the image.

Tip: Most OLE-enabled applications also let you insert a linked OLE object into a document using a menu command (as an alternative to the drag and drop method shown in the previous example).

Zoom into and center the compressed image

1   Double-click on the inserted image to display the ER Viewer toolbar.

2   Use the **Zoom Tool** 🔍 to zoom in on the central portion of the image,

then use the **Hand Tool** ✋ to drag the image and center it.

3   When finished, click outside the image to return to the word processing application.

Copy and paste the compressed image

1   Click once on the compressed image to select it.

2   Press Ctrl+C (or select **Edit > Copy**) to copy it.

3   Press Enter twice to create two new paragraphs in your document.

4   Press Ctrl+V (or select **Edit > Paste**) to paste the image into the new location.

It is sometimes useful to copy and paste OLE images from one part of your document to another. For example, you might insert an airphoto covering a large area, then copy and paste it to different parts of the document and zoom in to show different areas of interest.

(Optional) Save your word processing document.

1   Save your document, then close the application.

Note: You can display very large image files inside a document very quickly without having to embed the image files. (That is, images are not saved as part of the document, only the link to them is saved.)

What you learned   After completing these exercises, you know how to perform the following tasks in OLE-enabled Windows applications:

•   Insert an image as a linked OLE object into another Windows application

•   Edit the image object within the application using the ER Viewer toolbar

•   Copy and paste an OLE image from one area to another

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Image Web Servers

Once you have created your airphoto mosaic, you need to consider how you are going to use them, and how to make them available for others to use. The Internet has become a popular way of distributing data. However, the large sizes of airphotos and slow network connections have precluded using the internet to distribute them. Traditionally, vendors have made 'thumbnail" images, generally in JPEG format, available on a Web Site. Users could then order the full images which would be sent to them on a CD or other suitable medium. The diagram below illustrates this:

ER Mapper Image Web Server

The ER Mapper Image Web Server has changed the way images are distributed. You can now make your large airphoto mosaics available for download over the Internet or company intranet. The combination of ECW v2 compression technology and the ECWP data transfer protocol has made this possible.

Server side

The Image Web Server is available as an add-on to the Microsoft IIS (Internet Information Server). For small numbers of clients (less than 10) or evaluation purposes, you could use the Microsoft PWS (Personal Web Server). The following diagram shows the server architecture:

After installing the IIS or PWS, you can then add the Image Web Server. As with any other web server you would have to define a virtual directory for the image storage areas. You would then copy your ECW compressed images into the server directory.

The Image Web Server also downloads controls to the client when requested by that client.

For a client application to access an image stored in the Image Web Server it must specify the URL of the image. The URL must include the ECW protocol (ecwp) and the address of the Image Web Server. A typical URL is as follows:

 ecwp://earth.ermapper.com/images/hugeimage.ecw

This is embedded in the HTML string. The IIS uses this to detect which incoming packets are destined for the Image Web Server, and directs them there.

Client side

The ECW compressed image data is in the form of blocks, which the Image Web Server can send separately as required.

When a client, in the form of an Internet Explorer or Netscape browser, accesses an Image Web Server page it needs to have valid control files installed. These controls enable the client to decompress, read, and display ECW compressed images. The Image Web Server can download these to the client when requested. .

The following diagram illustrates the interactions between the client and the Image Web Server.

When the client application accesses the image via the URL, it sends a request to the Image Web Server for the information contained in the image header.

Using this information, the browser can use mouse and key entries to interactively request the control for a specific view of the image. On receiving this request, the control checks which image blocks are required, and requests the Image Web Server to send those that it has not already cached. It then refreshes the display with the new information. In this way the user can roam over and zoom into the image in real time. Only the portion of the image actually being viewed is decompressed. This minimizes the network bandwidth and memory requirements for the client PC, with significant gains in performance.

The control caches all the blocks that it receives and will not access the server if all the required blocks are already cached. If there is insufficient room to cache new blocks, it will flush the least recently used from the cache.

To access the server from within applications other than the Internet Explorer or Netscape browsers, you would first have to download the applicable free plug-in from the ER Mapper web site. You can then open the image in that application by specifying its URL, just as you would if you were using a browser. In the case of Microsoft Office applications, you must have the free ER Viewer program installed on your PC. You can then use Windows OLE (Object Linking and Embedding) to insert the images into your Office document. As with the browsers, the plug-in enables you to roam and zoom interactively with extremely efficient usage of the client PC's resources.

Hands-on exercises

These exercises show you how to open an image served over the Internet via an Image Web Server. We will access the public www.earthetc.com Image Web Server to get the image.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in OLE-enabled Windows applications:

- Open an image in ER Mapper by specifying its URL
- Open an image in ArcView by specifying its URLI

Before you begin...

Before beginning these exercises, you must have installed ER Viewer and the ArcView plugin on your system. Your PC must also be able to access the Internet.

1: Open an image in ER Mapper

Objectives

Learn how to open an image served from an Image Web Server in ER Mapper.

Load the image into an algorithm

1   Click on the **Standard** toolbar **Open** ⬚ button to display the **Open** dialog.

2   Enter '**`ecwp://www.earthetc.com/images/usa/SanDiego3i.ecw`**' in the **Open** dialog **Open:** field

Open:

ecwp://www.earthetc.com/images/usa/SanDiego3i.ecw

Files of Type:

ER Mapper compressed images(.ecw)

This is the URL for the 'SanDiego3i.ecw' image at the ER Mapper public Image Web Server site. The Enhanced Compression Wavelet Protocol (ecwp) is used to compress, transfer and decompress the image.

3   Click **OK** on the **Open** dialog.

If your PC has access to the Internet, the image window will display the compressed 'spotcalif.ecw' image. You will notice that the imagery that we have used in previous exercises is a subset of this much larger image.

4   Re-size the window as required and use the **ZoomBox** [icon] tool to zoom
    into the same part of the image that we have previously been using.

Zoom into this part
of the image ——————→

Zoom into this part
of the image ——————→

ER Mapper will request the server for the image blocks pertinent to your view and
display the zoomed image. The server only sends the blocks required for the view.

Note: If the image appears blurred, try clicking on the Refresh ⟳ button. With slow network links ER Mapper might display the image before it is fully downloaded.

Clicking the Refresh ⟳ button forces ER Mapper to redisplay the image using all information cached in the PC.

---

5 Click on the **Edit Algorithm** ⛁ button to open the **Algorithm** window.

You should notice that the image has been loaded into Red Green and Blue layers in the algorithm. You can now process the displayed image using the process diagram buttons.

Saving the image as an algorithm

1 From the **File** menu, select **Save**.

The **Save As...** dialog box allows you to save your image view in a number of formats. If you do not want to save the actual image data, you can save the view and any enhancements by saving the algorithm.

2 In the **Save As** dialog select 'ER Mapper Algorithm' from the **Files of type** list.

3 From the **Directories** menu, select the path ending with the text **\examples**. (The portion of the path name preceding it is specific to your site.)

4 Double-click on the directory named 'functions_and_features' and then 'airphoto_tutorial' to open it.

5 In the **Save As:** text field, click to place the cursor, then type the following name for the algorithm file:

    `Airphoto_mosaic_balanced_url`

6 Click the **Apply** button to save the algorithm and leave the dialog open.

The algorithm will be saved to disk.

7 Close the image window.

Reloading the algorithm

1 Click on the **Open** 🗁 button on the **Standard** toolbar to display the **Open** dialog box.

2 Select your saved 'Airphoto_mosaic_balanced_url.alg' algorithm and click **OK**.

ER Mapper will now display the image view from the www.earthEtc.com Image Web Server. If the view is not cached on the PC, it will request it over the Internet.

Once again, you may have to click on the **Refresh** button ⟐ a number of times to get a clear image.

3 Close the image window.

Using the History file

ER Mapper keeps a list of the five most recently accessed URLs. If you want to reload the image you can select it from this list instead have having to type it in the URL again.

1 Click on the **Open** 🖆 button on the **Standard** toolbar to display the **Open** dialog box.

2 On the **Open** dialog box, select the **ECW URL History** menu.

This will display up to 5 most recently accessed URLs.

Volumes	Directories	ECW URL History
	ecwp://www.earthetc.com/images/usa/SanDiego3i.ecw	
oria	ecwp://www.earthetc.com/images/usa/SanDiegoMosaic.ecw	
lg	ecwp://www.earthetc.com/images/usa/spotcalif.ecw	

3 Select the required URL from the list and click **OK**.

ER Mapper will display the selected image.

4 Close the Image and the Algorithm windows.

2: Open an image in ArcView® GIS

Objectives   Learn how to open an image served from an Image Web Server in ArcView® GIS.

Open a URL file

The ER Mapper extension enables you to open an ECW compressed image, served via an ER Mapper Image Web Server, inside arcview by specifying its URL. You can then zoom into and roam over this image in real time. The Image Web Server sends the compressed image blocks as they are requested.

The extension includes the facility to store image URLs in a 'Favorites' list so that they can easily be accessed in later ArcView® sessions. You can also select URLs from a 'History' list that displays the last 20 URLs requested.

1 Open the ArcView application.

2 On the Project window, click **New** to open a new View window. (It should be titled 'View1'.)

3 Click the **Add ECW Image Theme from an Image Web Server URL** [image] button (or select **View > Add URL Theme**).

   This should open the **Image Theme URL** dialog box.

4 Enter the following URL in the **URL:** field.

   ecwp://www.earthetc.com/images/usa/SanDiego3i.ecw

   This URL will access the SanDiego3i.ecw compressed image file at the Earth Resource Mapping www.earthetc.com web site. The protocol used is ECWP (Enhanced Compression Wavelet Protocol).

5 Click on the **OK** button.

   The image will be loaded as theme via the Internet. If you have a slow connection to the Internet this step could take a few minutes. If your PC is not able to access the www.earthetc.com web site, it will display an error message.

6 In the 'View1' window turn on the 'Sandiago3i.url' theme.

ArcView GIS displays the San Diego airphoto mosaic image.

Turn on the theme

7   In the 'View1' window, select the 'Sandiego3i.URL' theme and then select **Edit > Delete Themes** to remove the theme. Answer **Yes** to the **Delete Themes** query.

8   Click the **Add ECW Image Theme** [icon] button (or select **View > Add URL Theme**) to reopen the **Image Theme URL** dialog box.

    The **URL:** field should now be blank.

9   From the **History:** list select the 'ecwp://www/earthetc.com/images/usa/ Sandiago3i.ecw' entry.

    The **History:** list contains the last 20 URLs entered. This saves you from having to type in the full URL to re-open a recently accessed image.

    The **URL:** field should now contain the URL that you selected from the **History:** list. If you were to click on the **OK** button, it would re-load the image as a theme in the 'View1' window.

10 Click on the **Add to Favorites** button to open the **Add to Favorites** dialog box.

This box allows you to select a directory and file name to store URLs that you are likely to access again. The file names all have a .url extension.

You should note that there is already a 'sandiego3i.url' entry in the 'arcview\averm\urls' directory. The ER Mapper extension automatically creates these files in the default directory whenever you access a URL. The **Add to Favorites** facility is really only required if you want to save the URL to another directory and/or under another name.

11 Click on the **OK** button to return to the **Image Theme URL** dialog box.

12 Click on the **Open from Favorites** button.

This opens the **Open From Favorites** dialog box

13 Select the 'arcview\averm\urls' directory if it is not already selected.

14 Select the 'sandiego3i.url' file that was automatically created by the ER Mapper extension.

15 Click on the **OK** button to return to the Image Theme URL dialog.

The URL: field should now contain the full URL .

16 Click on the **OK** button.

The image will be loaded as theme via the Internet. If you have a slow connection to the Internet this step could take a few minutes. If your PC is not able to access the www.earthetc.com web site, it will display an error message.

17 In the 'View1' window turn on the 'Sandiego3i.url' theme.

Zoom, pan and measure the image

1 Click the **Zoom In** 🔍 tool, then drag a box over the central part of the image to zoom into it.

2   Click on the **Refresh View** ⟦↻⟧ button to improve the image resolution.

Tip: If you are connected to the Internet via a slow link, you may have to click on the
Refresh View button a number of times to get the best resolution. This is because
ArcView® may display the image before it is fully downloaded from the server.
The **Refresh View** button reloads the image with all new information that has
been cached on the PC.

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3   Click the **Pan** ⟦✋⟧ tool, then drag the image to view adjacent areas.

4   Click on the **Refresh View** ⟦↻⟧ button to improve the image resolution.

5   Click the **Measure** ⟦📏⟧ tool, then drag a line to view distances across an
area.

The line length appears in the lower-left corner of the ArcView GIS dialog.

Close ArcView GIS

1   If desired, save your views as an ArcView project using **File > Save Project As....**

2   Close ArcView GIS by clicking the **Close** ☒ button on the application window or selecting **File > Exit**.

What you learned...

After completing these exercises, you know how to perform the following tasks:

• Display an ECW compressed image in ER Mapper via its URL

• Display an ER Mapper URL file (.ecw) in ArcView as an Image Data Source.

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