

Reproject and Rectify Images

The Automatic Resampling process in TNTmips (Image / Resample and Reproject / Automatic) is used to change the geometry of a raster object or objects using stored georeference information. Use this process to:

- reproject an image with control point georeference so that its cell grid aligns with its coordinate reference system
- reproject an image to align to a different coordinate reference system
- rectify internal distortions due to the imaging system (lens effects and tilt distortion due to off-nadir imaging)
- orthorectify images using a rational polynomial model to remove distortions due to varying terrain elevations

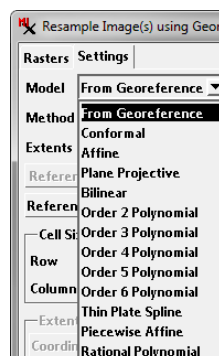
You can reproject or rectify one or more images using the same process settings. Several options are provided for controlling the extents, cell size, and orientation of the result, including using a reference raster to control any or all of these characteristics. Automatic Resampling uses the MicroImages Image Processing Pipeline architecture for fast and efficient processing.

If you wish to simply change the cell size (spatial resolution) of an image without otherwise changing its geometry, use the Zoom/Orient controls in the Raster Extract process (Image / Extract).

Select Input Rasters

Use the Select Raster(s) pushbutton on the Rasters tabbed panel to choose raster objects in one or more Project Files for processing. The selected objects are shown in the list below the pushbutton. All input rasters in the same Project File that have matching dimensions and georeference are shown as one entry in the list and are processed as bands of a single image. Any rasters in the same file that have different dimensions (such as a higher-resolution panchromatic image band) are assigned to a different list entry and processed separately.

Left-click on any list entry to highlight it. The text panel below the input list shows the raster dimensions and georeference information for the highlighted image (or for the top entry if none has been selected).



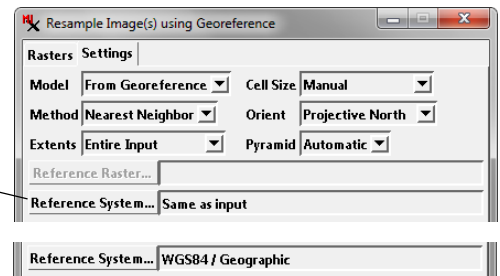
Use the Model menu to choose a coordinate transformation model.

Reprojecting Images

The Automatic Resampling process uses georeference information to control the geometry of the output raster object. By default the output raster cell grid is aligned to the axes of the coordinate reference system (CRS) defined in the raster's georeference information. This default state is shown by the "Same as input" setting in the Reference System field on the Settings tabbed panel. This is the appropriate setting if you are reprojecting an image with control point georeference to align its cell grid to its CRS.

You can reproject an image to a different coordinate reference system by pressing the Reference System pushbutton and choosing the desired CRS components using the standard Coordinate Reference System window.

Press the Reference System button to choose a different coordinate reference system to which to reproject the image.



Other major options for image resampling are controlled by the menus at the top of the Settings tabbed panel: Model, Method, Extents, Cell Size, Orient, and Pyramid. Other controls on the panel may be active or inactive depending on the options you choose from these menus.

Rectifying Images

Image rectification involves changes in the internal geometry of the image. The Model menu on the Settings tabbed panel allows you to choose a coordinate transformation mode for the resampling operation. These models are types of mathematical coordinate transformations between object coordinates (cell row and column position) and map coordinates. Models of varying mathematical complexity are provided to account for different types of spatial distortion that may be present in the image. Some models compute a single transformation in which the map coordinates of control points may be adjusted to varying degrees to achieve the best overall fit. Others, such as piecewise affine and thin plate spline, maintain the assigned map coordinates for all control points but reposition image cells in the patches between the control points.

Transformation models are also used in the Georeference process to compute control point residuals and evaluate the fit of control points. The transformation model that you last used in the Georeference process is saved with the image's georeference information. This saved model is used in the Automatic Resampling process when you use the From Georeference option (the default) from the Model Menu. You should use this option for most images, especially if you have manually georeferenced the image and chosen a suitable transformation model in that step.

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Other model options are provided for cases in which the resampling operation is intended to rectify spatial distortions in the image that are not adequately accounted for by the saved georeference transformation model. The minimum number of non-colinear georeference control points required to compute a particular transformation model increases with the mathematical complexity of the model. The available models are briefly described below with the minimum number of control points shown in parentheses after the model name. For a more detailed description see the Technical Guide entitled *Georeference: Choosing a Model*.

Conformal (2): supports uniform rescaling and rotation only; does not change the internal image geometry.

Affine (3): supports separate linear scaling factors in the X and Y directions, as well as rotation and axis shear.

Plane Projective (4): models tilt distortion in oblique (off-nadir) images.

Bilinear (4): models lens distortion where not enough control points can be located for higher-order polynomial models.

Order 2 Polynomial (6) through Order 6 Polynomial (28): polynomial models with orders 2 through 6 can be selected to model various types of non-uniform distortion. To ensure mathematical stability it is recommended that the image have at least twice the minimum required number of control points.

Piecewise Affine (3): assumes control points are correctly located in both image and map coordinates. A mesh connecting the closest control points divides the image into triangular areas, each of which is resampled using its own affine model derived from its vertices. Incorrect control points only affect the immediately surrounding triangles.

Thin Plate Spline (3): assumes control points are correctly located in both image and map coordinates but applies smoothly varying transformations to the areas between the control points. These transformations are modeled mathematically as the deformation of a thin elastic plate. See the TechGuide entitled *Reproject Using Thin Plate Spline Model* for more information.

Rational Polynomial: allows you to orthorectify an image that has rational polynomial coefficients (RPC) defining an empirical orthorectification model. An RPC model relates row and column positions in the unrectified image to latitude and longitude using terrain elevation values. Use this option for ortho-ready satellite images with georeference and RPC model coefficients provided by the vendor. You are prompted to choose the auxiliary text file containing the RPC coefficients and to choose an elevation raster covering the image area.

You can re-georeference an ortho-ready image with accurate control points to adjust the RPC model and produce a more accurate rectification result (see the TechGuide entitled *Georeferencing Ortho-Ready Images for Rational Polynomial Orthorectification*). You can also use the Georeference process to compute an RPC model for any image using a DEM and accurate 3D control points (see the TechGuide entitled *Compute Rational Polynomial Model for Orthorectification*). In either of these cases, the RPC coefficients are stored with the image georeference and loaded automatically when you select the image in the Automatic Resampling process. You can use the default From Georeference

model option for images that already have the RPC model saved with the georeference information.

When using the Rational Polynomial model manually or embedded in the image georeference, a *geoid height* correction value appropriate for the image area should be entered in the Geoid Height field to correct DEM elevation values (referenced to the geoid) to WGS84 ellipsoid values used in the RPC model. See the TechGuide entitled *Rational Polynomial Orthorectification* and the tutorial *Orthorectification Using Rational Polynomials* for more information.

Resampling Method

Transforming an image to a new coordinate reference system or image geometry involves creating a new raster cell grid on a different alignment than the original raster. A value for each cell in the new raster must be computed by sampling or interpolating over some neighborhood of cells in the corresponding position in the original raster. Use the Method menu to choose the resampling method. Resampling may introduce visual artifacts in the resampled image, such as aliasing (jagged edges) blurring, and edge halos. The various resampling methods provided are designed to mitigate one or more of these artifacts. For more detail and illustrated examples see the TechGuide entitled *Resampling Methods*.

Nearest Neighbor: each cell value in the resampled raster is set by copying the value from the single closest input cell. This method is most suitable in cases where the image must be reprojected but preserving the original cell values for later quantitative analysis is important.

Bilinear: the output cell value is the linear distance-weighted average of the values of the four closest input cells. This method minimizes aliasing but introduces significant blurring. It is most suitable when resampling to a smaller output cell size.

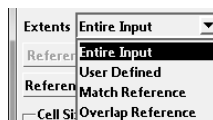
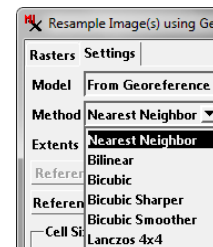
Bicubic (cubic convolution): the closest 4 by 4 block of input cells is used to compute each output cell value. The output value is a distance-weighted average of these input values, with weighting factors set using a cubic (third-order) function of distance. This method reduces both aliasing and blurring in comparison to the nearest neighbor and bilinear methods.

Bicubic Sharper and Bicubic Smoother: these methods are variants of the bicubic interpolator that alter the interpolation coefficients to produce mildly sharper or smoother results (respectively). The differences between the three bicubic methods are subtle and may be difficult to see without direct comparison of test results.

Lanczos 4 x 4: similar to the bicubic method but uses a different mathematical combination of input cell values. It produces results similar to bicubic and bicubic sharper methods and is best suited for resampling to a larger cell size.

Extents Menu

The option selected from the Extents menu sets the extents of the input image that are transferred to the output. The default option is Entire Input. The User Defined option activates the controls



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in the Extents box on the Settings panel. Use the Extents controls to enter minimum and maximum map extents values to define the input image area to process. Press the Coordinate pushbutton to choose the coordinate reference system for the entered coordinates (this choice does not set the coordinate reference system used for the output raster).

Extents			
Coordinates...	WGS84 / Geographic		
Longitude	W 118 28 04.510	to	W 117 30 23.622
Latitude	N 36 50 16.680	to	N 37 31 25.782

Choose the Match Reference option

to match the extents of the output to those of a reference raster or the Overlap Reference option to process only the image portion that overlaps a reference raster. In either case, you are automatically prompted to choose the reference raster (unless you have already selected a reference raster to control cell size and/or orientation).

The Reference Raster pushbutton is also

Extents	Match Reference	Pyramid	Automatic
Reference Raster...	sanbruno.rvc / MAP		

activated so you can choose a different reference raster if necessary; the name of the current reference raster is shown in the text field to the right of the pushbutton.

Cell Size

The Cell Size menu sets the method for determining the cell size of the output raster. The Manual option activates the Cell Size controls on the Settings panel, in which you can enter values for Row and Column size. The By Image Size option activates the Image Size controls, in which you can set the number of Rows and Columns for the output raster; the output cell size is then automatically computed from the input and output image sizes and shown in the Cell Size fields.

Cell Size	Manual
Orient	Manual
Pyramid	By Image Size
	Match Reference
	Match Original

Reference System...	Same as input	
Cell Size (meters)		
Row	28.49	
Column	28.53	
Image Size		
Rows		417
Columns		325

The Match Reference option matches the output cell size to that of a reference raster. You are then automatically prompted to choose

the reference raster (unless you have already selected a reference raster to control extents and/or orientation). The Match Original option sets the output row and column cell sizes to be equal to those of the input raster.

Orient

Options on the Orient menu set the orientation of the output cell grid. The default option Projective North is appropriate for most cases; it orients the output raster so that the north direction of the output coordinate reference system is at the top of the raster. The Geographic options let you set the top of the output as Geographic North, South, East, or West. The Match Reference option matches the cell grid orientation to that of the current reference raster. If you have not already selected a reference raster, you are automatically prompted to choose one.

Orient	Projective North
Pyramid	Projective North
	Geographic North
	Geographic South
ographic	Geographic East
	Geographic West
	Match Reference

Pyramid

The Pyramid menu sets the method for computing cell values in the reduced-resolution image tiers created for each output raster to speed display at different zoom levels. The Average option is appropriate for images and other continuous-value raster objects. The Sample option should be used for categorical rasters, in which the relative raster cell values have no numerical meaning and are merely identifiers of a category. The Automatic option chooses the method automatically based on the properties of the raster object.

Pyramid	Automatic
	Automatic
	Sample
ographic	Average
	None

Compression

Use the options on the standard Compression menu to set the compression type to use for the output raster.

Running the Process

When you have set all of the desired resampling options, press the Run pushbutton at the bottom of the Resample Images window to execute the process immediately. Queue Job and Save Job pushbuttons are also provided to perform the operations using TNTmips Job Processing; see the TechGuide entitled *System: TNTmips Job Processing System* for more information.

