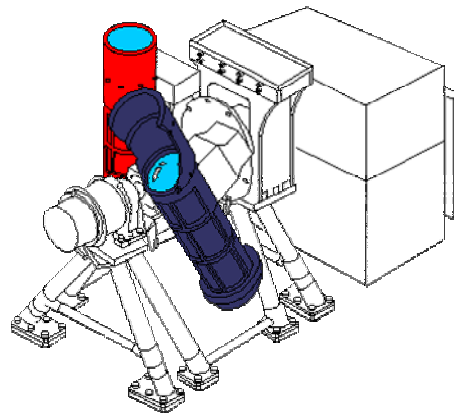


## TUTORIAL

The ASTER (Advanced Space-borne Thermal Emission and Reflection Radiometer) sensor is part of the Earth Observation Satellite<sup>1</sup> and is unique in that it offers nearly simultaneous capture of stereo images, minimizing temporal changes and sensor modeling errors.

The VNIR portion of the ASTER sensor includes two independent telescopes, a Nadir looking one and a backward looking one to help minimize image distortion during data capture. This simultaneous data capture provides true stereo coverage from which a digital elevation model (DEM) can be automatically extracted from using PCI OrthoEngine.



The VNIR sensor includes two independent telescopic assemblies, a Nadir looking one shown above in blue and a backward looking one shown in red, this simultaneous data capture provides true stereo coverage ([http://asterweb.jpl.nasa.gov/content/01\\_mission/03\\_instrument/02\\_VNIR/vnir-c.gif](http://asterweb.jpl.nasa.gov/content/01_mission/03_instrument/02_VNIR/vnir-c.gif)).

Both Aster Level 1A and Level 1B data are supported for DEM extraction by OrthoEngine. Each type does have its own set of benefits and draw backs that you need to consider. Level 1B data is created by applying the radiometric and geometric coefficients to the Level 1A data.

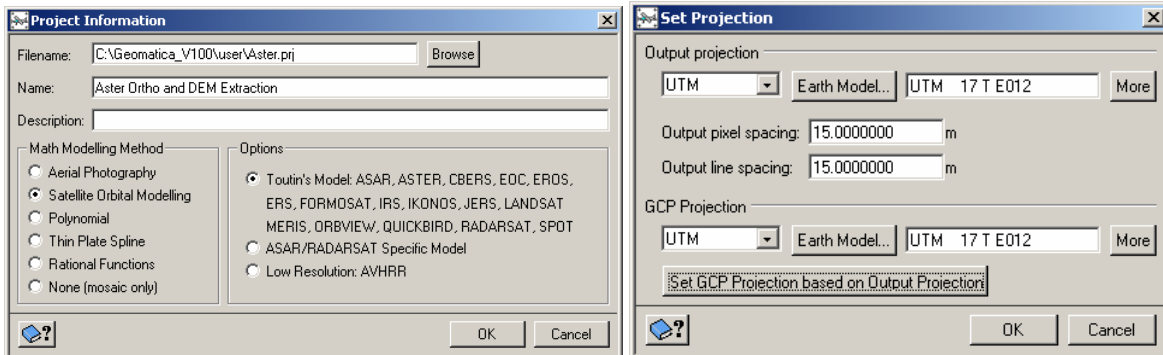
Level 1A also enables you to use the stitching function to stitch continuous scenes from the same path. This can reduce the number of GCPs and tie points required and reduces the seam you may get mosaicking DEMs from the same path. Level 1B data has been rotated so the stitching routine cannot be used with level 1B imagery.

The following is tutorial demonstrates how to use Geomatica OrthoEngine to extract a DEM surface from ASTER level 1B data.

<sup>1</sup> <http://asterweb.jpl.nasa.gov/> for more information on ASTER and the EOS satellite

## Step1 (Create a new Project)

- Create a new project with a Satellite Orbital Math Model using Toutin's Model option to calculate the exterior orientation.

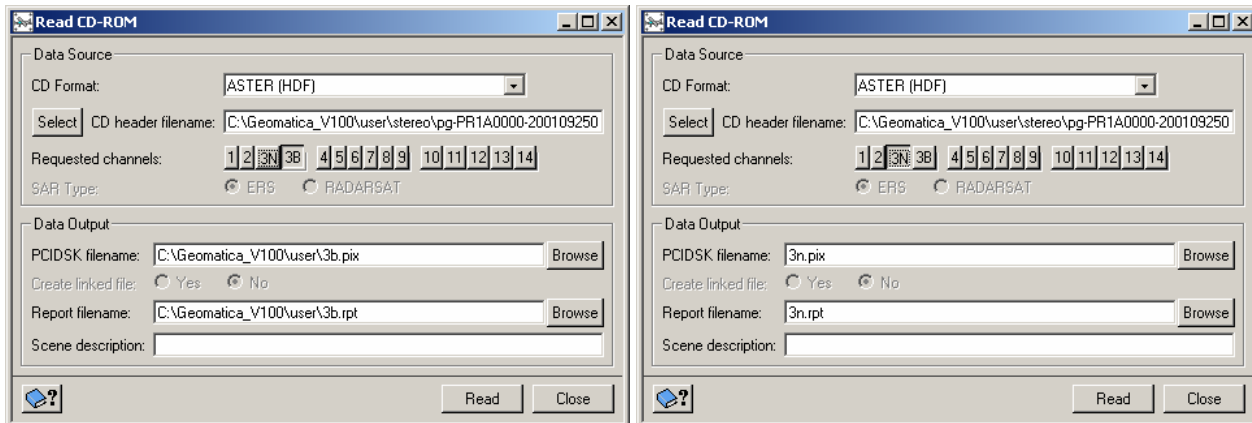


- In the Set Projection window select the output projection, enter the pixel size and the GCP projection and click the OK button.

## Step2 (Data Input)

- Ensure that all associated files are located within the same directory and then select the Read from CD-ROM button from the Data Input processing step.
- Select ASTER(HDF) for the CD Format, the buttons of the Requested Channels should change to reflect ASTER band data
- Select the \*.HDF file as CD Header Filename, and click the 3N button
- Enter an output filename and (optional) a scene description.
- Click the Read button to import the data into a \*.PIX file.

[Repeat step 2 for the 3B channel as well.]



**NOTE:** If you are working with Level 1A imagery and have scenes from the same path you can use Utilities>Stitch Image Tiles to stitch up to five scenes to make one seamless image to work with. Remember to stitch the 3n images and the 3b images separately. The stitch process will rebuild the orbital segment for the strip after stitching is complete

### Step3 (Collect GCPs and TPs)

- Select the “GCP/TP Collection” processing step. (Note: that if you are creating a DEM without GCPs you do not need to actually load the GCPs supplied with the Aster scene. The software will use these behind the scene to perform the adjustment)
- Collect GCPs as you would for any other project, using manual entry, from geocoded images, vectors, chip databases, or a text file.
- Collect tie points as you would for any other project to connect the “3N” and “3B” channels to each other.

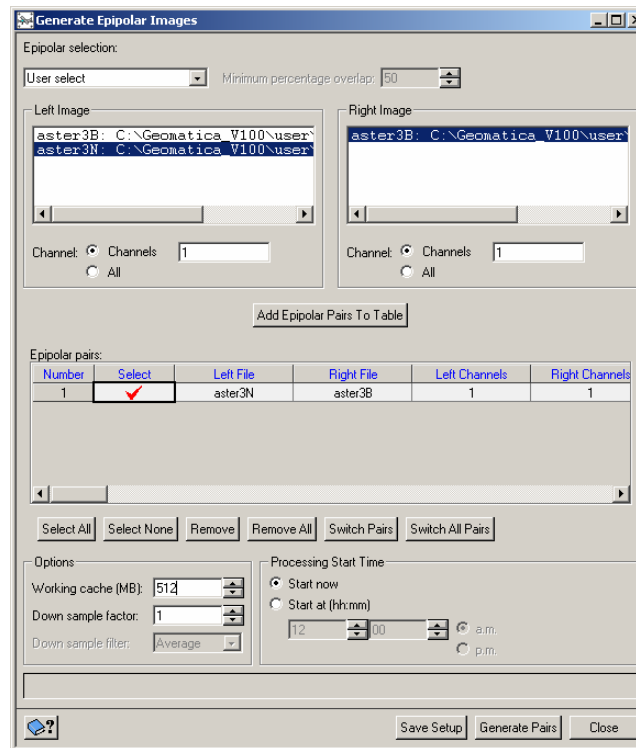
**NOTE:** If you are not collecting GCPs, using ones supplied with the scenes you want to pay particular attention to your tie point collection. You want to try for at least twenty tie points making sure you cover the edges well and ensure a good distribution through the middle.

### Step4 (Model Calculation)

- Select the “Model Calculations” processing step and click on the Perform Bundle Adjustment button.

### Step5 (Create Epipolar images)

- Click the Create Epipolar Image button found from the DEM From Stereo processing step to open the Generate Epipolar Images panel.
- Under Left Image section of the window click on your left image, the right image should then appear in the list of available images for the right hand side. Click the right hand image and then click Add Epipolar Pairs To Table button to record the pair into the List of Epipolar Pairs list.
- Click the Generate Pairs button to start the process.



## Step6 (Extract DEM)

Under the DEM From Stereo Processing step list, select the Extract DEM automatically button.

- Click in the Select column under Stereo pairs to select epipolar pairs that you just generated
- In the Minimum elevation and Maximum elevation boxes, type the estimated elevation for the terrain in the stereo pair. (The minimum and maximum elevations are used to estimate the search area for the correlation. This increases the speed of the correlation and reduces errors. If the resulting DEM contains failed values on peaks or valleys, increase the range).
- In the Background value box, type the value used to represent the "No Data" pixels in the DEM (The "No Data" or background identifies the pixels that lie outside the extracted DEM overlap area so they are not mistaken for elevation values).
- In the DEM Detail list, click the level of detail that you want in the extracted DEM (DEM Detail determines how precisely you want to represent the terrain in the DEM. Selecting High, Medium or Low determines at which point in correlation process you want to stop. Low means that the process stops during the coarse correlation phase on aggregated pixels so the level of detail in the DEM will be quite low. High means the process continues until correlation is performed on images at full resolution).
- In the Output DEM channel type list, select 32 bit.
- In the Pixel sampling interval list, click the number of image pixels and lines (sampling frequency) that will be used to extract one DEM pixel (Pixel Sampling controls the size of the pixel in the final DEM relative to the input images. The higher the number you choose, the larger the DEM pixel will be, and the faster the DEM is processed).
- Under Geocoded DEM, select Create Geocoded DEM to geocode and merge the epipolar DEMs together. However, if you want to edit the DEM before it is geocoded do NOT select Create Geocoded DEM, and click the Extract DEM button.
- If you choose to geocode your DEM then in the Output filename box, type the path and an output file name for the geocoded DEM file (.pix) and click the Extract DEM button.

Select	Left Image	Right Image	Epipolar Pair	Epipolar DEM	DEM Report
<input checked="" type="checkbox"/>	aster3N	aster3B	Online	aster3B_dem.pix	aster3B_dem.rpt
<input type="checkbox"/>					
<input type="checkbox"/>					
<input type="checkbox"/>					

Select All | Select None

Epipolar DEM Extraction Options

Minimum elevation: 0  
Maximum elevation: 500  
Failure value: -100  
Background value: -150  
DEM detail: Medium  
Output DEM channel type: 32 bit real  
Pixel sampling interval: 2 Resolution: 30.0

Use clip region  
 Fill holes and filter  
 Create score channel  
 Delete Epipolar Pairs after use

Geocoded DEM

Create Geocoded DEM  
 Delete Epipolar DEMs after use  
Output filename: C:\Geomatica\_v100\user\DEM-from-ASTER.pix  
Upper left: 624015.000000 X 5128230.000000 Y  
Lower right: 639480.000000 X 5056320.000000 Y  
Resolution: 15 X 15 Y  
DEM bounds:  All images  Selected images  
Output option: Use last value

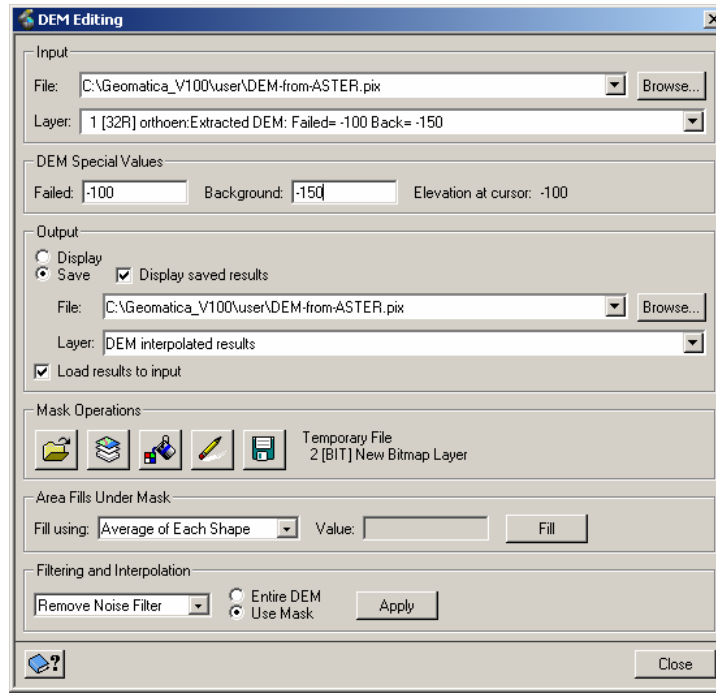
Extraction Start Time

Start now  
 Start at [hh:mm]  
12 : 00  
 a.m.  
 p.m.

Extract DEM | Close

## Step7 (Edit DEM)

Digital elevation models extracted from images often contain pixels (and sometimes large areas) with failed or incorrect values. PCI Geomatica gives you the ability to edit the DEM in order to smooth out these irregularities and create a more pleasing continuous raster surface.



- From the Processing step list, select DEM From Stereo, click the Manually edit generated DEM button (this will open Focus and initiate the DEM editing tools).
- From the DEM Editing dialog box, choose your DEM that you just created by clicking Browse and open the file with the File Selector.
- Choose the layer that contains the DEM from the Layer list box.
- Type the value assigned to pixels that have no elevation values because the image correlation failed in the Failed box and the value assigned to the area that lies outside the DEM in the Background box.
- Enable Save option and choose a file from the File list box. Type a name for the new layer or select an existing layer from the Layer list box.
- Enable the Load results to input check box.
- Under the Mask operations portion of the window, click the New Mask Layer button.
- Click the Mask failed areas button to generate a bitmap mask representing all parts of your DEM that are equal to your failed area.
- If your failed areas are relatively small and spread out across the image then using then interpolating the failed cells based on surrounding ones will often be enough to create an continuous surface. Under the Filtering and Interpolation part of the window select your method of interpolation, select the Use Mask radio button and then click the Apply button.

## Step8 (Examine Results)

- Examine the resultant output in the Focus window and then continue editing if necessary.

Bad results in your surface can often be related to several factors including, the data, the stereo coverage, the accuracy of the model generated from your control etc. If there are larger more complex failed areas in the surface that could not be easily corrected with the editing tools then you may want to return to OrthoEngine and try generating the Epipolar images again or extracting the DEM but using different parameters (such as increasing the down scale factor or using a score channel). For more information see Applying Tool Strategies for Common Situations in Digital Elevation Models in the PCI Geomatica help files.

The failed areas from the DEM extracted in this example were interpolated with no problems and only required one attempt to create a continuous surface. The image below is a screen capture from Focus demonstrating the spatial fit of the interpolated surface with both the orthophotographs created from the original stereo images and the vector control sources that were used to correct the imagery.

