

Digital Terrain Model Extraction using WorldView-2 Stereo and ERDAS LPS Automated Terrain Extraction

Introduction: The Digital Elevation Model

A digital elevation model (DEM) is a 3-D representation of the terrain's surface, created from elevation data. There are two types of digital elevation models, digital terrain model (DTM) and digital surface model (DSM). DTMs represent the bare ground surface excluding any man-made features while DSMs represent the earth's surface including all objects on it. Raster DEM data files contain elevation values of the terrain over a specified area at a fixed grid interval or post spacing. The intervals between each of the grid points are referenced to a geographical coordinate system. This is usually either latitude-longitude or UTM (Universal Transverse Mercator) coordinate systems. The closer together the grid points are located, the more detailed the terrain information.

DEMs are an integral part of any Geospatial Analysis. They are required both for the description of the three dimensional surface and to orthorectify imagery used in mapping applications or for modeling purposes. There is a variety of DEM source data available, the suitability of which depends on the project specifications. DEMs can be produced by automatic DEM extraction from stereoscopic satellite images collected by DigitalGlobe's WorldView-1 and WorldView-2 satellites.

DigitalGlobe offers two types of stereo products; Basic Stereo products delivered as full scenes that are uncorrected and Ortho-Ready Stereo Products that are area-based and geo-referenced to a map projection and constant base elevation. The stereo imagery is collected in-track, e.g. on the same satellite pass and supplied with a full set of metadata. These products are ideal for DEM generation, 3D visualization and feature extraction applications.

The following tutorial will walk you through loading a DigitalGlobe WorldView-2 Ortho-Ready (OR2A) Stereo pair using the RPC model in ERDAS LPS, creating a block file and extracting a DEM from the stereo pair.

Creating an LPS Block File

1. To get started, open an instance of LPS from your Program files or from your start menu.

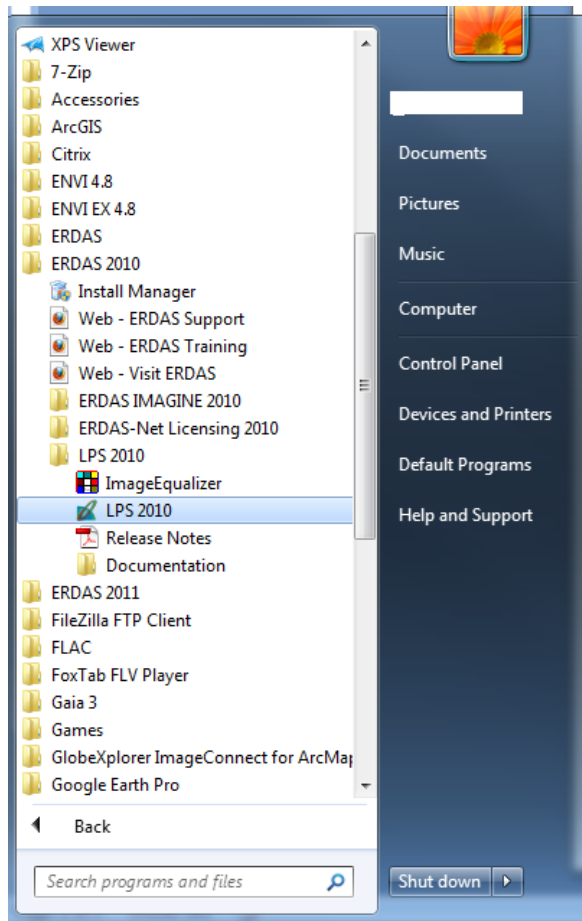


Fig.1. Start LPS from Start Menu in Windows 7

The LPS Project Manager window will open.

2. From here you want to select **File > New**. You will be prompted to create a new LPS block file.
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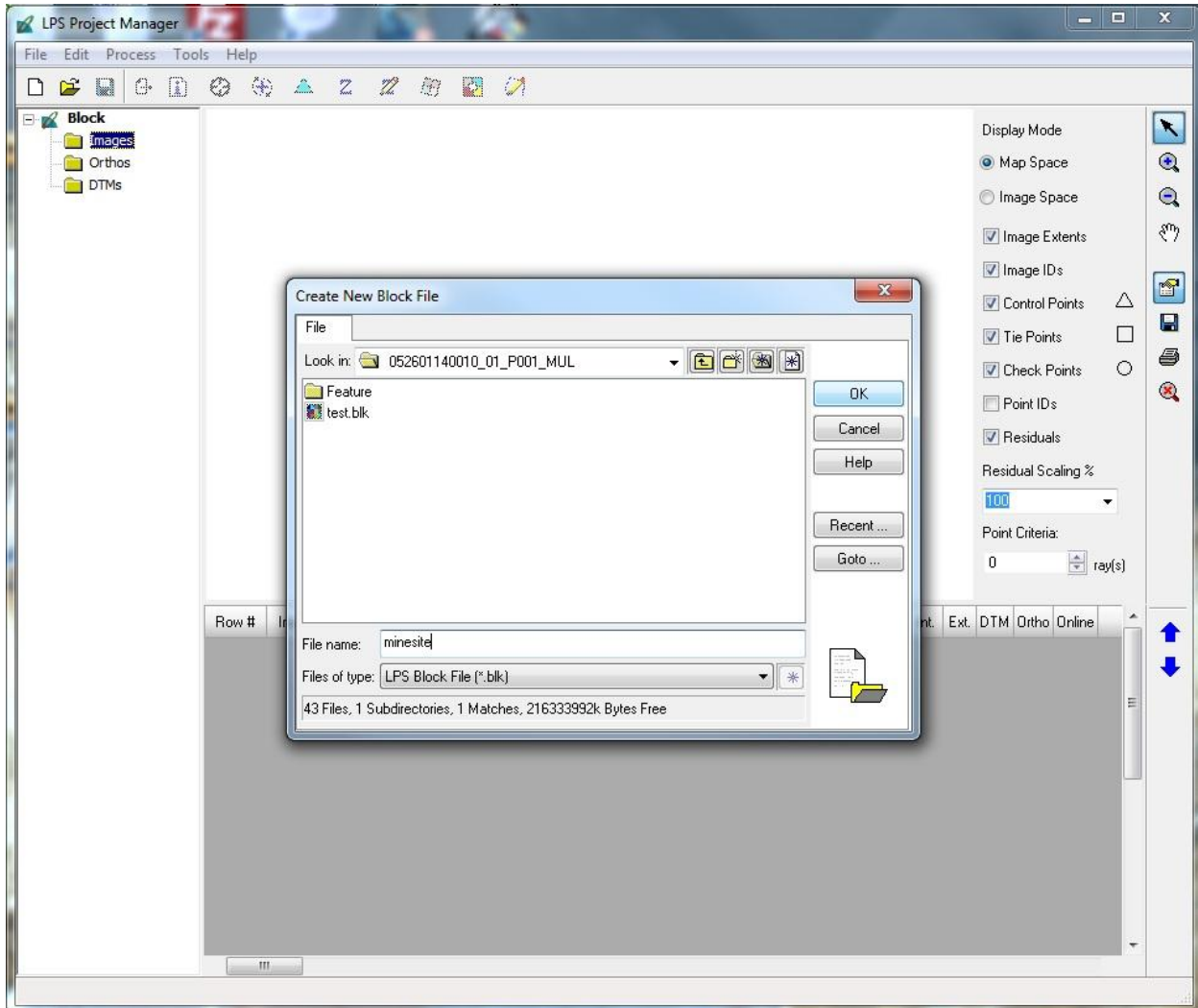


Fig.2. Create New Block File

3. Navigate to a drive where there is sufficient room (storage size) and in the File name window type the name of the block file. In this example we type the name *mine site*. Click **OK** when done.

You will now be prompted to set up the Model. A **Model Setup** window will appear. Because we are using WorldView-2 stereo we have the option to use RPCs provided with the imagery. In this example we will use the supplied RPCs delivered with an OR2A Stereo product.

- From the first dropdown select **Rational Function**. From the second dropdown select **WorldView RPC**. Click **OK**.

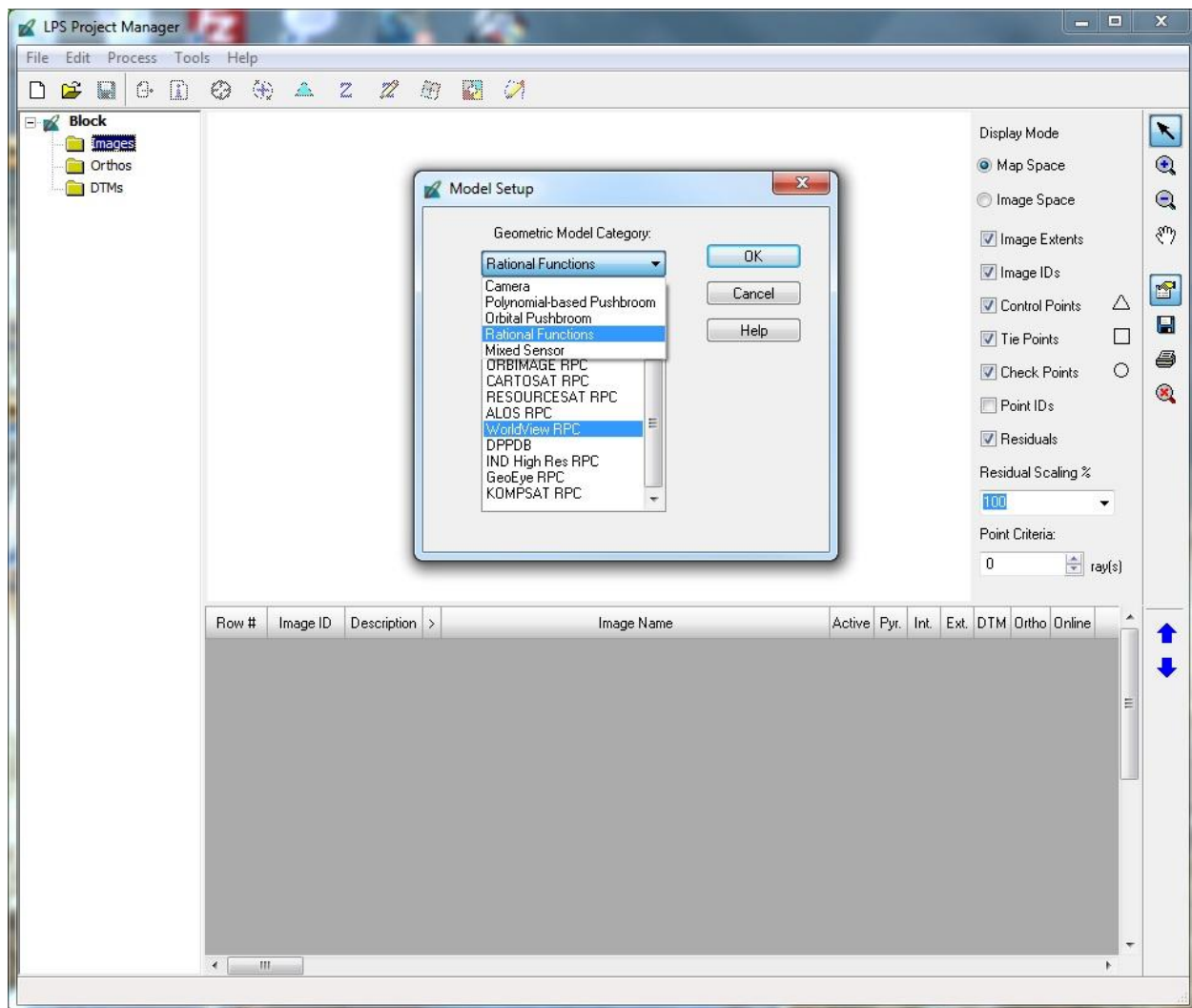


Fig.3. Model Setup

- Next, the Block Property Setup menu will open. Here you can select a coordinate system for the block file. To do so select the **Set...** button and choose from a list of supplied coordinate system for both the horizontal and vertical. For this example we'll use the default Projection: Geographic with the Datum of WGS84 and we'll use the Vertical Spheroid and Datum default of WGS84. Once you have selected the coordinate System click the **OK** button.

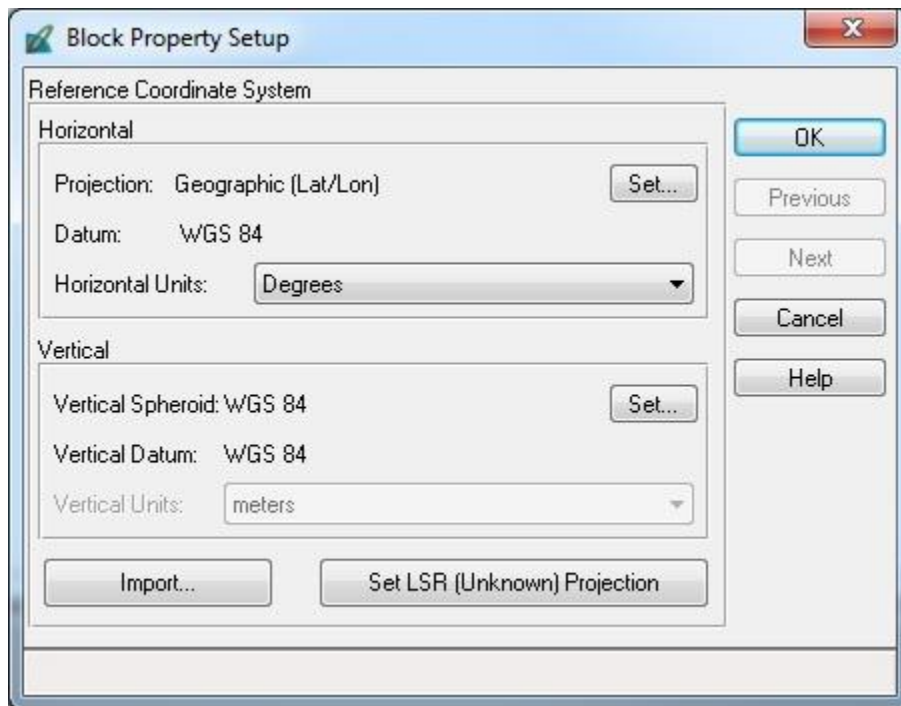


Fig.4. Block Property Setup: Reference Coordinate System

Load Stereo Pair

- Now you will load your stereo image pair. To do so, click on the Add Frame to the list



button in the LPS Project Manager menu. Navigate to the folder that contains your stereo imagery. Select the left image first. In this case we are using WorldView-2 Multispectral pairs. The left image will be the first image in the list. Select this image and click **OK** (see Fig.5.)

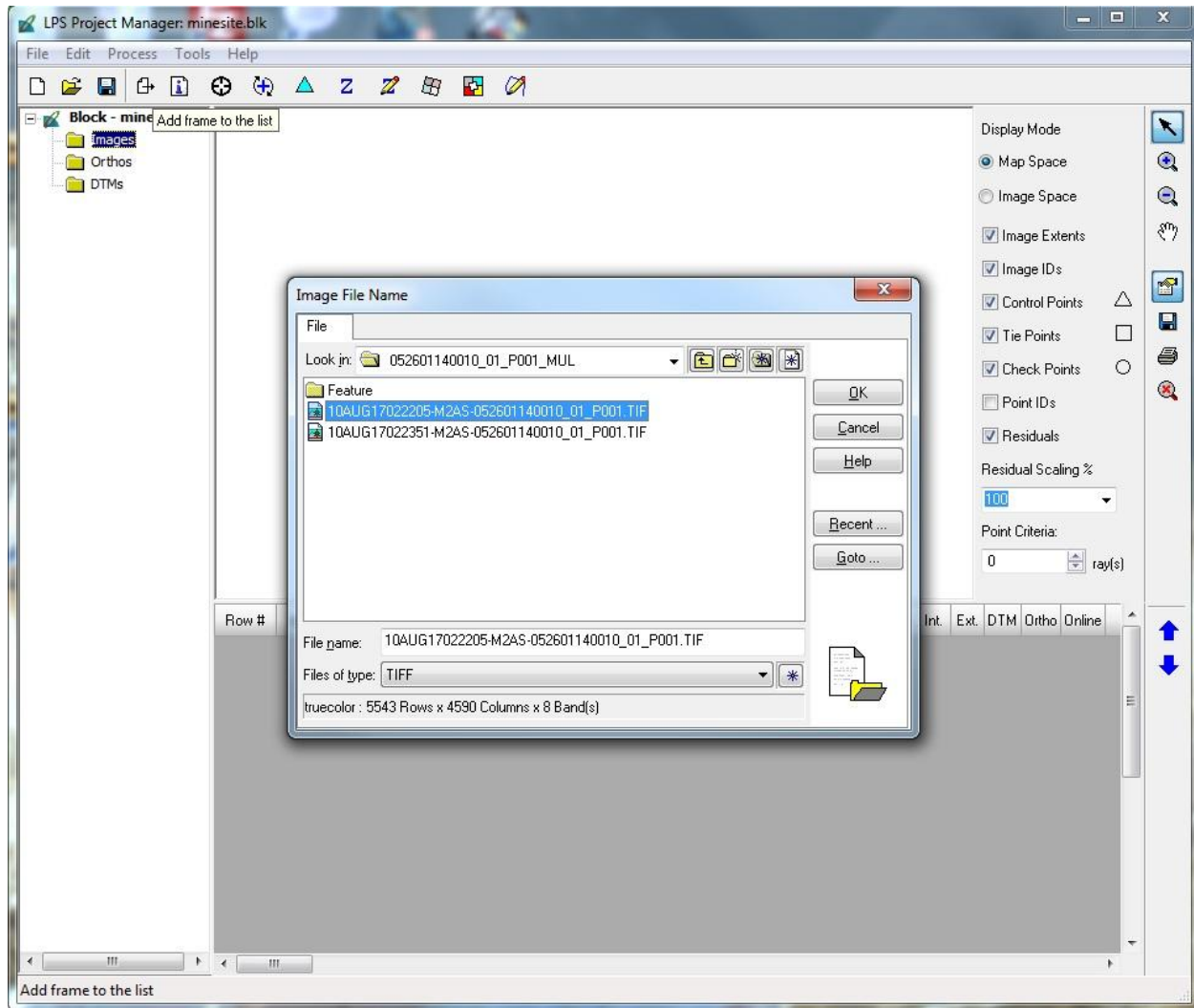


Fig.5. Select first Image of Stereo Pair

Once selected you will see the image loaded into the section below the view that has Row#, ImageID, Description, Image Name, Active, Pyramid, Int, etc....

7. Repeat the steps of Adding frames to the list but this time select the Right image of the pair. This will load the right image. Click **OK** when done.

Assign Rational Polynomial Coefficient

Now that the imagery is loaded you will see in the section that states **Image Name** that the active layers have Pyramids (green boxes) and is Online (green Boxes) but does not have the Interior and Exterior Orientations yet (in Red). Nor does it have DTM or Ortho. For this tutorial we will assign the Interior and Exterior Orientations using the RPC file provided with the OR2A Stereo pair. We will also extract the DTM (later in the tutorial). But first we will assign the RPC orientation to the model.

- To do so click on under the **Int.** in the **red box** next to the first image in the pair. See Fig.6

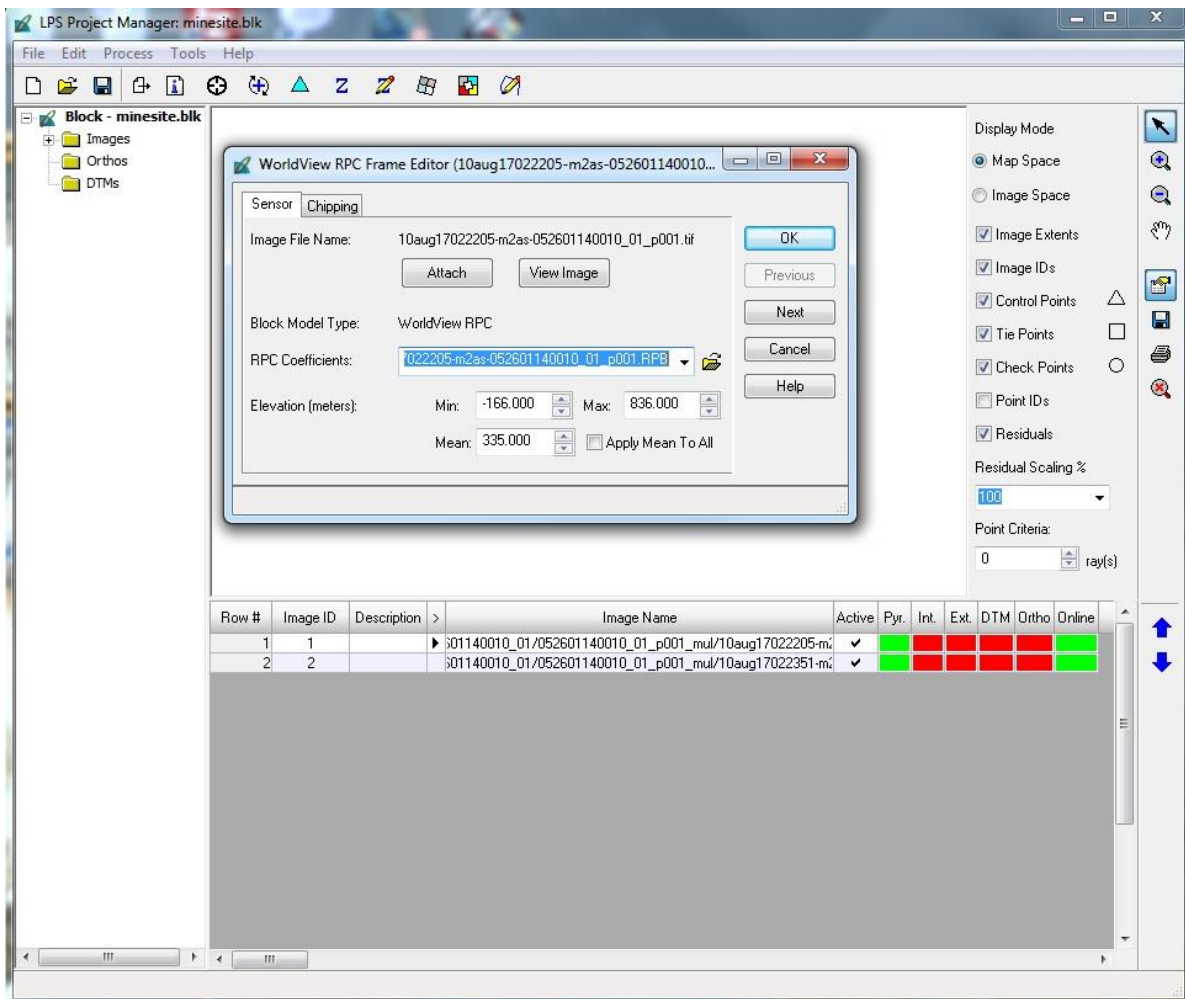



Fig.6. WorldView RPC Frame Editor Window

The WorldView RPC Frame Editor Window will appear. The image will automatically populate in the **Image File Name** (See Fig.6). The **RPC Coefficients** file will also automatically populate if the RPB file (File containing RPC information) is in the same folder as the imagery. (Fig.6). **Elevation** (meters) information is pulled from the RPB file and populated here. In this example we'll select the defaults. And Click **OK**. Repeat the process (page 6 and 7) for assigning the RPC model to the second image (right image in pair) in the list by clicking on the red box next to the second image in the *Int* column.

Now that the RPC model has been applied we can now add relative tie points to our model.

TIE POINT PROCESS

- The process that we'll use is the Automatic Tie Point . Click on this button to begin Auto Tie Point.

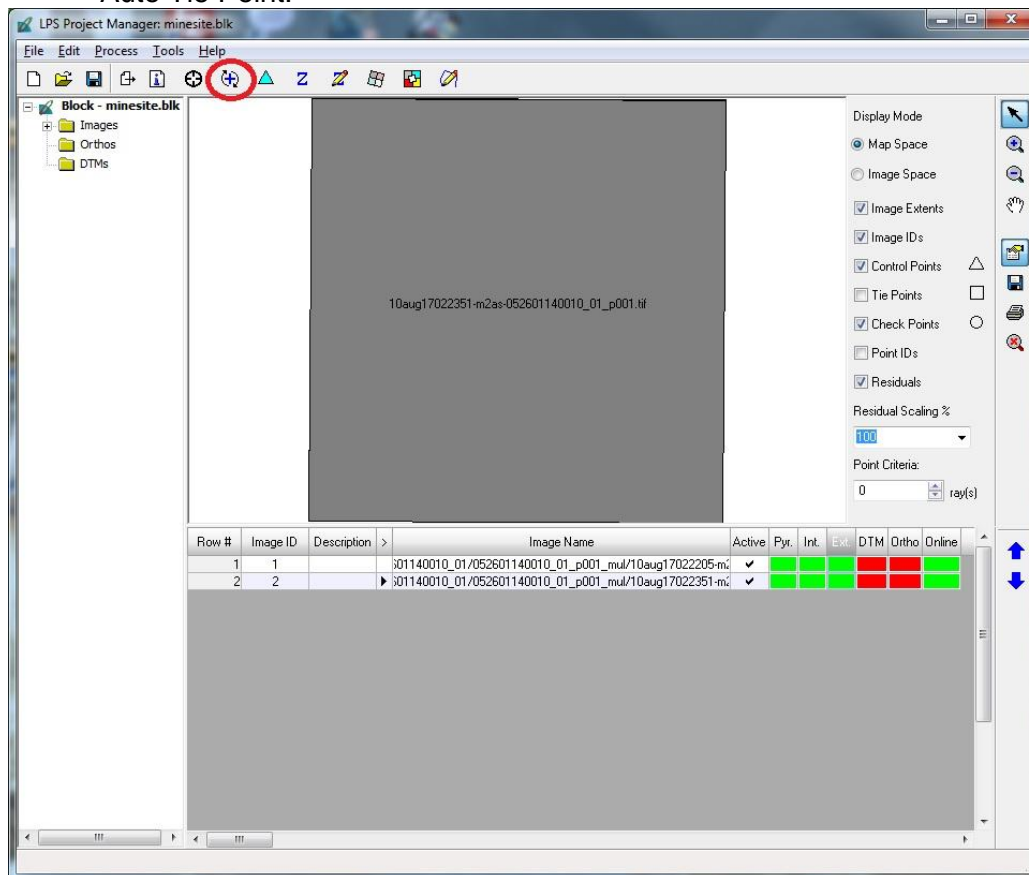
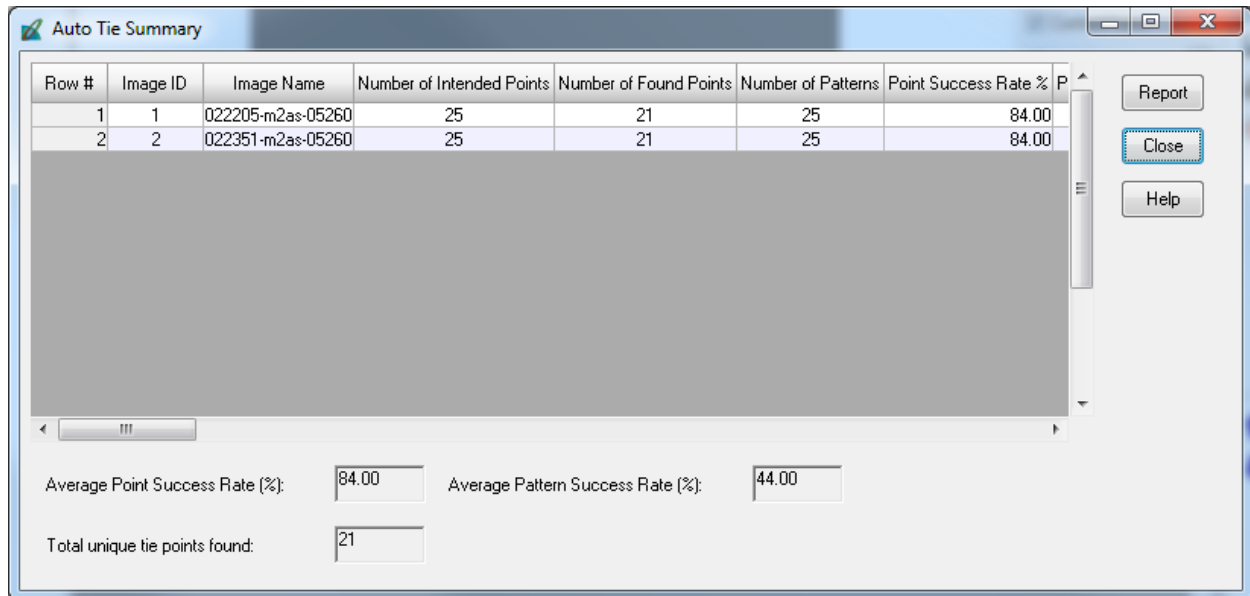


Fig.7. Auto Tie Point

Once Auto Tie Point is complete an Auto Tie Summary will appear.



Row #	Image ID	Image Name	Number of Intended Points	Number of Found Points	Number of Patterns	Point Success Rate %
1	1	022205-m2as-05260	25	21	25	84.00
2	2	022351-m2as-05260	25	21	25	84.00

Average Point Success Rate (%): 84.00 Average Pattern Success Rate (%): 44.00

Total unique tie points found: 21

Fig.8. Auto Tie Summary

10. This window will provide a glimpse of how many tie points were collected and the success of the operation. Click **Close** when complete.

DEM Extraction

11. Next, we'll extract our DEM. In the LPS Project Manager toolbar select the  DTM Extraction button. This will open the **Start DTM Extraction** window

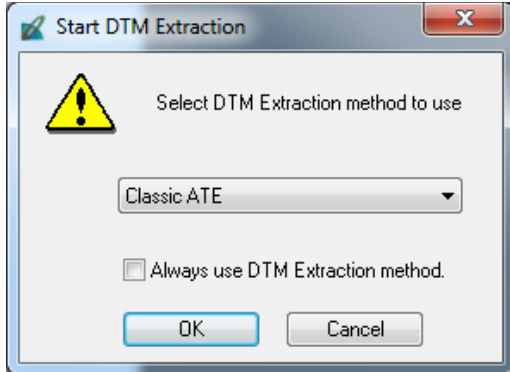


Fig.9. Start DTM Extraction

12. From the dropdown window in Fig.9.you have the option to select Classic ATE. This is the process we'll use for this example. Leave the "Always use DTM Extraction method." Check box empty and click **OK**.

A DTM Extraction window will appear

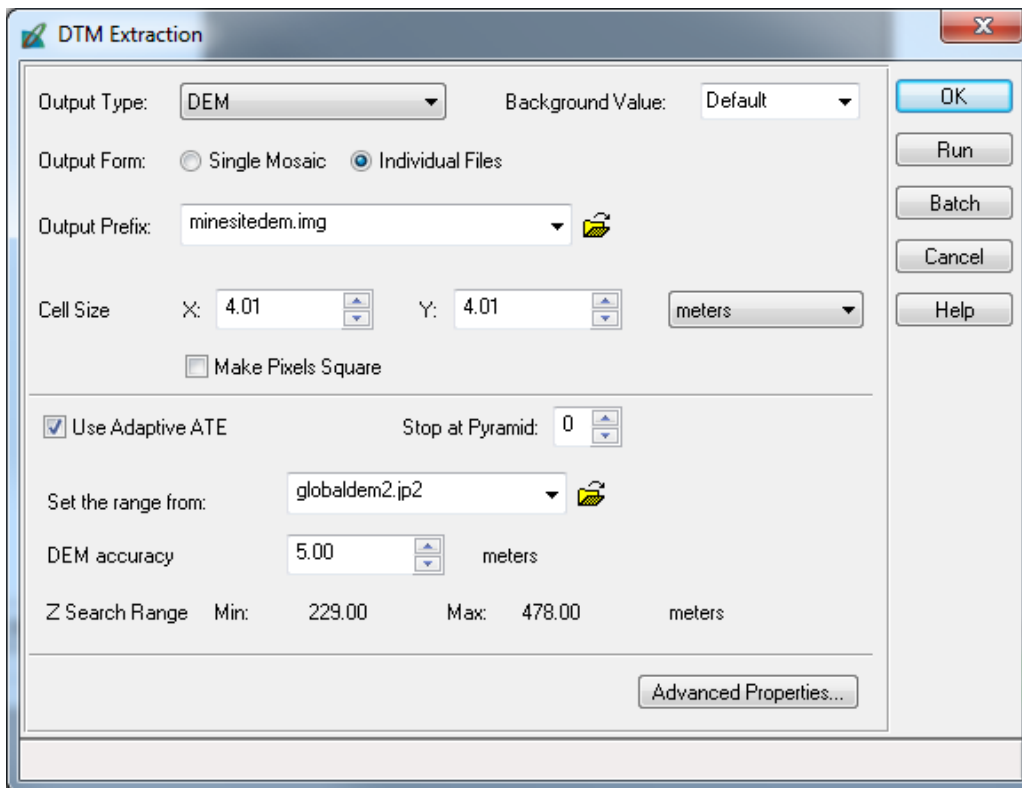


Fig.10. DTM Extraction Window

13. In the output type there are a few choices you can select from including: 3D shape, ASCII, DEM, Socet Set TIN, LTF, and Terramodel TIN. For this example we'll use **DEM**.
14. Leave Background Value as Default. For **Output Form**: select **Individual Files**. If you choose the **Individual DTM Files** option, the DTMs extracted from each image pair have a separate output file. Give the DTM an output Name in the **Output Prefix** window. Navigate to a directory where you want this file to reside. It will have an *.img* prefix.
15. For **Cell Size** You may specify a grid distance in the X and Y direction which is used to extract a DTM posting. In this example we'll select double the GSD of WorldView-2 MS of 4.00 meters. This defaults to 4.01 meters. **Meters** will be the units used.
16. Use the **Adaptive ATE**. This is an advanced algorithm that extracts the elevation information from an image. The Adaptive ATE process asks you for specific information about the images so that the Adaptive ATE algorithm can take that information and fine tune the extraction process. The Adaptive ATE process takes longer to complete than the traditional ATE.
17. Use the *default* for **Stop at Pyramid** and the *default* for **Set the range from**. The Set the Range From setting defaults to the global DEM file. If the block file does not have a Cartesian coordinate system and you want to use a different DEM for the minimum and maximum Z values, then use the standard file selector to select a different DEM. If the block file has a Cartesian coordinate system, this field is not active; enter the elevation values in the **Z Search Range** fields.
18. Finally we'll give it a DEM accuracy of 5.00 meters, which is the vertical accuracy of WorldView-2.
19. Once ready and all your parameters are set click **Run**

The DEM.img file will be created in the directory that you provided in the **Output Prefix** window (Fig.10).

Once the DEM has been created you can load the DEM in an IMAGINE viewer to view.

20. Open IMAGINE from your **start menu**.

21. Click on **File > Open > Raster Layer** and Navigate to the directory with you DEM.img file

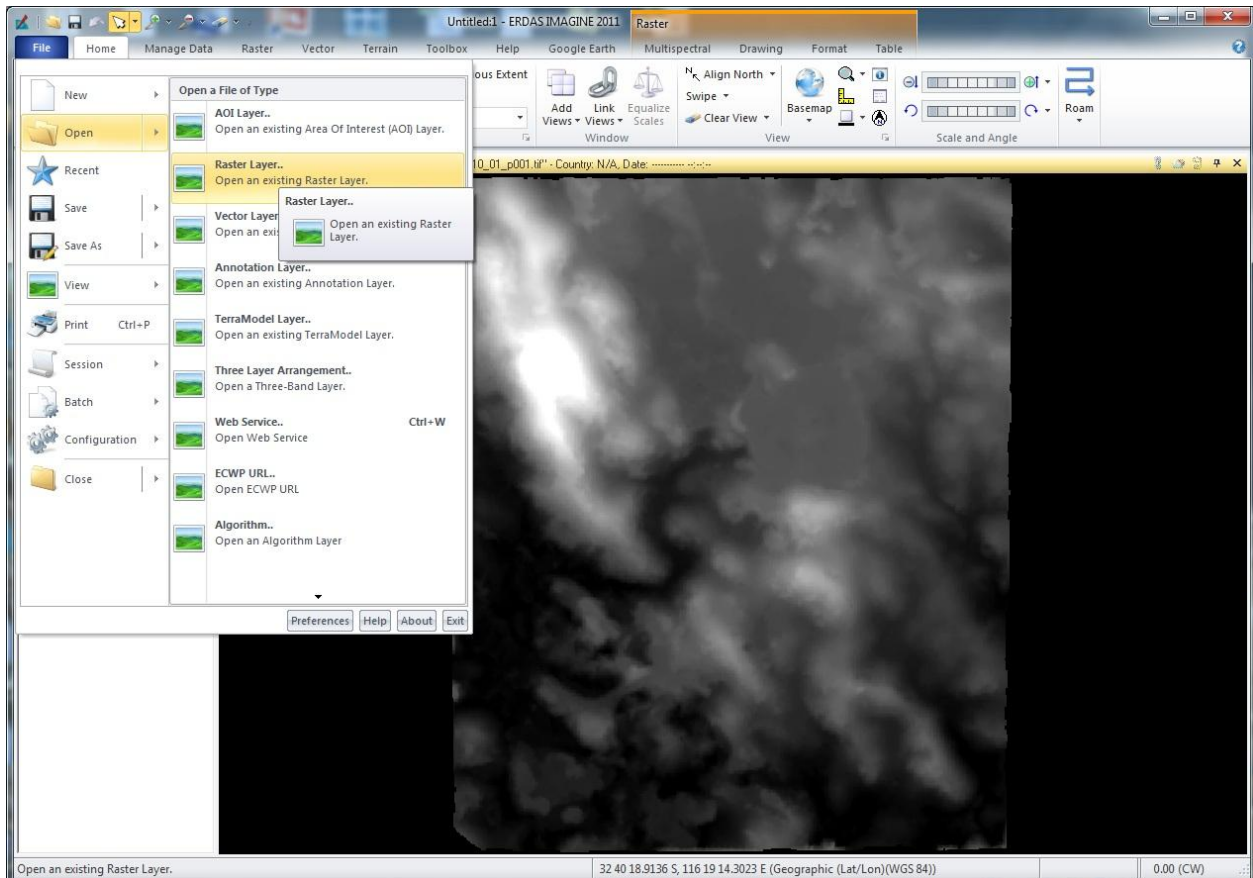


Fig. 11. Load and View DEM in IMAGINE

For more information on DEM extraction techniques in ERDAS LPS go to <http://erdas.com/service/support/ERDASSupport.aspx>

For more technical information on DigitalGlobe Products and Services please visit <http://www.digitalglobe.com/resources>
Additional Documents and Imagery Product Samples may be downloaded from here.