Orthorectifying DigitalGlobe Imagery in ERDAS Imagine using the Rational Polynomial Coefficient (RPC) model

The Rational Polynomial Coefficient

DigitalGlobe's QuickBird, WorldView-1 and WorldView-2 satellite images are built up of groups of scan lines acquired as the satellites moves forward in its orbit. As a result, different parts of the same image are acquired from different sensor positions. In order to rigorously describe the transformation from image coordinates to Earth surface coordinates, a mathematical sensor model that incorporates all of the physical elements of the imaging system can be exceedingly long and complex. **Rational Polynomial Coefficients (RPCs)** are simpler empirical mathematical models relating image space (line and column position) to latitude, longitude, and surface elevation. The name Rational Polynomial derives from the fact that the model is expressed as the ratio of two cubic polynomial expressions. Actually, a single image involves two such rational polynomials, one for computing line position and one for the column position. The coefficients of these two rational polynomials are computed by DigitalGlobe from the satellite's orbital position and orientation and the rigorous physical sensor model. Using the georeferenced satellite image, its rational polynomial coefficients, and a DEM to supply the elevation values, ERDAS IMAGINE can compute the proper geographic position for each image cell, producing an **Orthorectified** image. Orthorectification is the process of removing distortion in the image based on the factors previously mentioned.

It's important to note that using the RPC's is just one way to transform from image coordinates to Earth surface coordinates. This process can also be done using the Rigorous Sensor Model; although not all 3rd party remote sensing software packages have access to DigitalGlobe's Rigorous Sensor Model for its satellites.

In this workflow you are going to orthorectify a WorldView-2 image by using an RPC model. Both QuickBird and WorldView-1 Level 1B and Ortho Ready 2A products contain an RPC file; therefore this same process can be accomplished using these sensors as well. This file should be located in the same directory as the image(s) you intend to use in orthorectification.

Note: Prior to Calibrating with Sensor Model and Terrain check the folder where your imagery resides. If there are multiple images in the folder you can reassemble the image tiles into one image for processing (see fig. 1 as an example). To do so please reference the ***WorldView2 Basics and ERDAS IMAGINE*** *located in http://www.digitalglobe.com/partners under Software Partners in the ERDAS/Intergraph tab. In that document there is a section titled "Import DigitalGlobe tile data (.TIL) with ERDAS IMAGINE."*

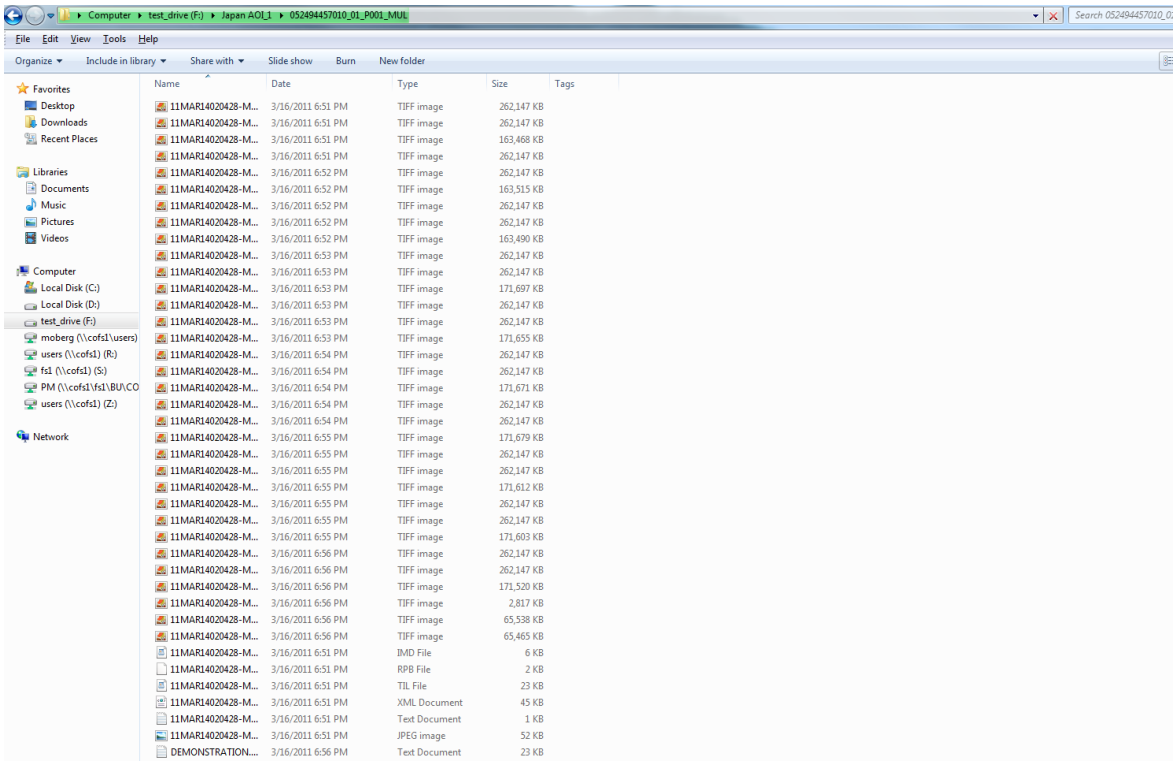

Fig.1. Multiple Image Tiles example

Calibrate WorldView Image with RPCs

1. Open ERDAS IMAGINE and select the **Raster Tab**. Click the **Geometric Calibration** pull down and select **Orthorectify without GCP**

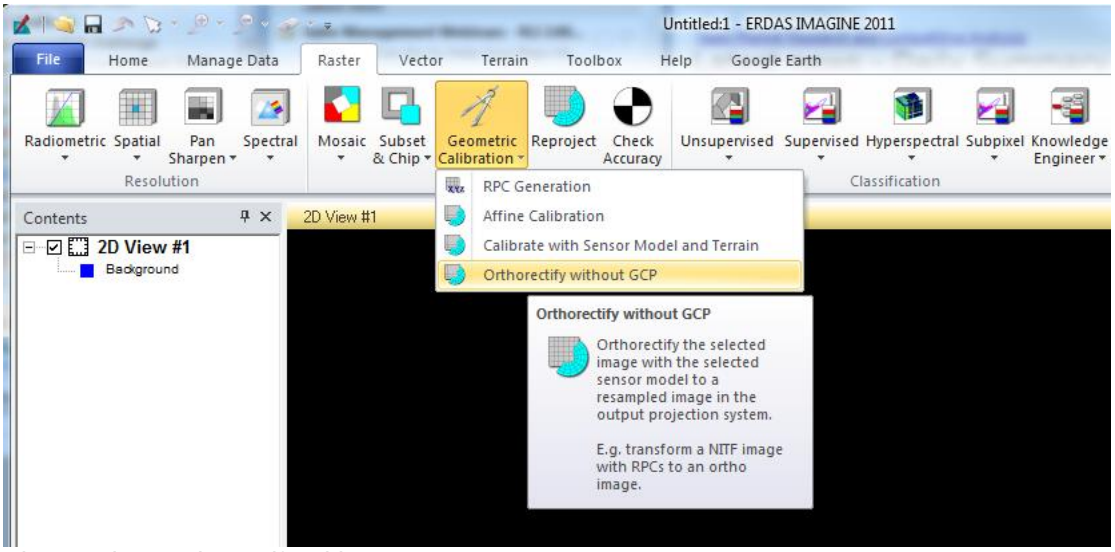

Fig.2. Select Orthorectify without GCP

2. Select the image file to be Orthorectified in the file chooser

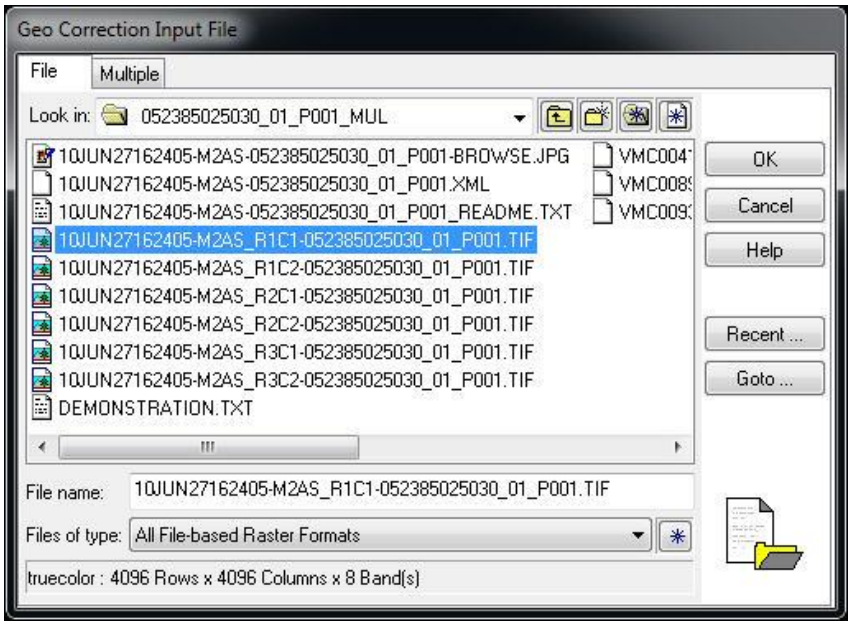

Fig.3. Geo Correction Input File

3. Select the **WorldView RPC** model in the **Set Geometric Model** dialog
   Note: WorldView RPC will serve both WorldView-1 and WorldView-2 sensors. You'll also notice QuickBird RPC is also available.

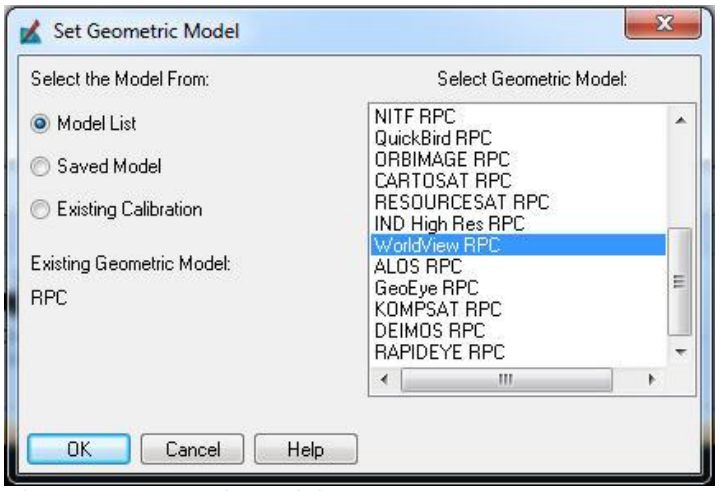

Fig.4.Set Geometric Model

4. In the **WorldView RPC Model Properties**, select the corresponding RPB file and specify the elevation source.

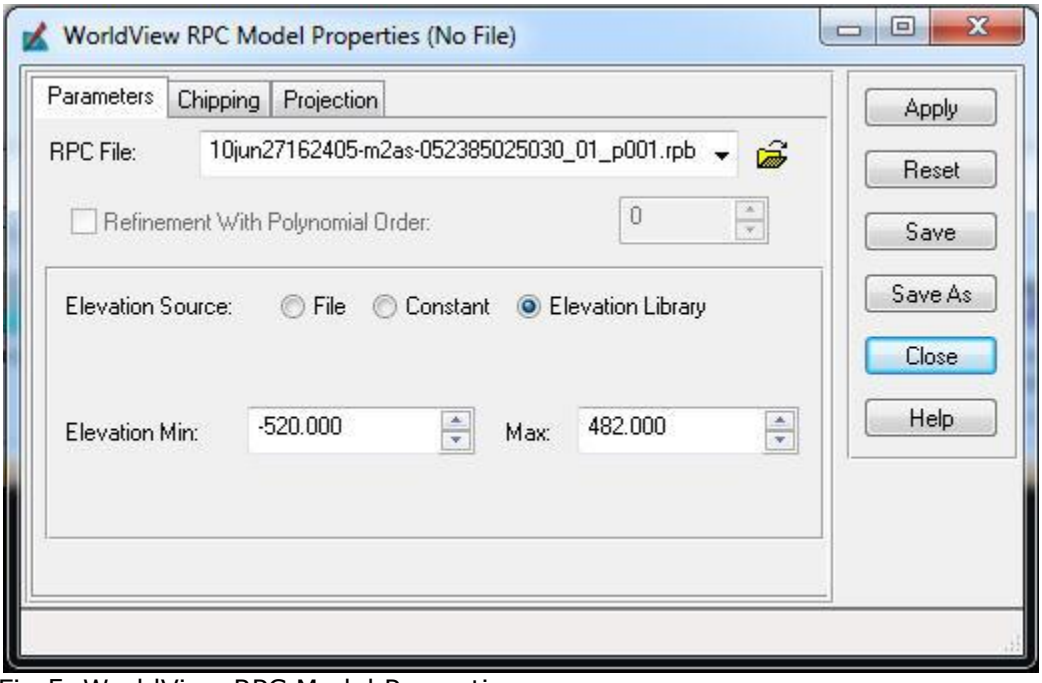

Fig.5. WorldView RPC Model Properties

5. **Elevation Source:** Specify an elevation source to be used in the geocorrection. An elevation source can improve your results. *Note: Elevation will be a separate file that is not supplied by DigitalGlobe with the Basic (1B) and OrthoReady (2A) products.*

- **File** Click this radio button if elevation information is coming from a separate file, such as a DEM. You select the file in the **Elevation File** field, below.
- **Constant** Click this radio button to input an average elevation value for the scene. You enter that value in the **Elevation Value** field, below.
- **Elevation Library** Click this radio button to use the data in the **Elevation Library** as the source. See additional info below on using the Elevation Library

(Note: you need to change Files of type to RPC in the Files of type dropdown menu)

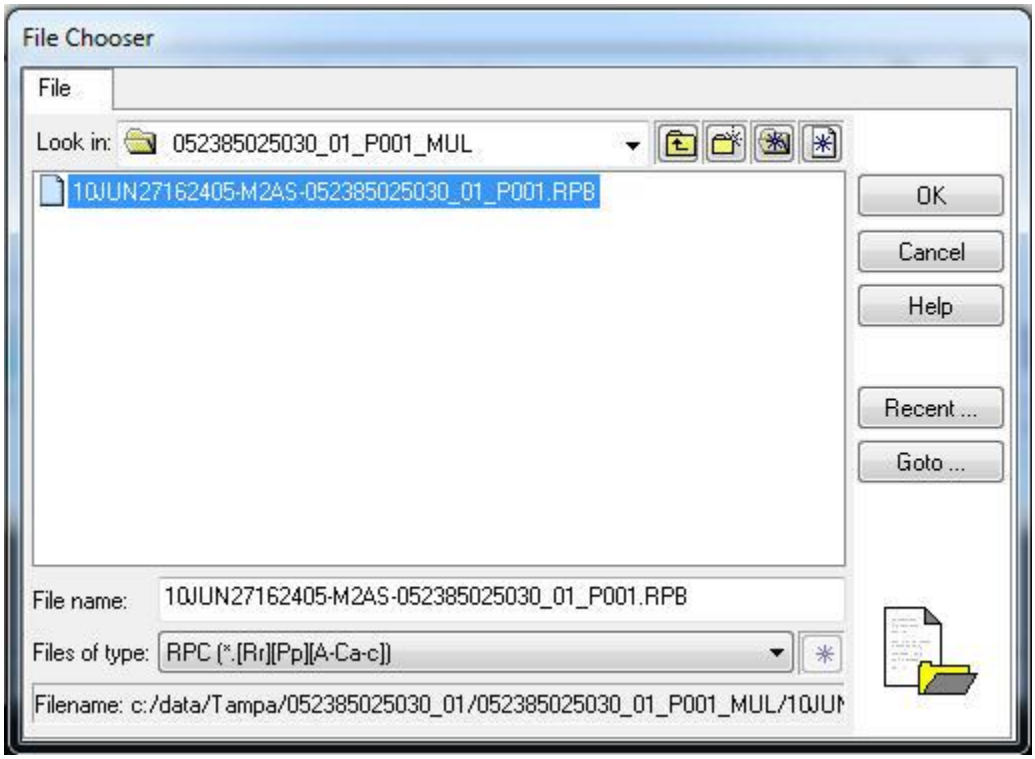

Fig.6. Select RPC (.RPB) file

6. Click **Apply. Done**

Add elevation source to the Elevation Library Manager

The Elevation Library Manager provides a method to collect and manage your elevation source files, including Digital Elevation Model data (DEM), as well as Digital Terrain Elevation Data (DTED) used by the U.S. National Geospatial-Intelligence Agency.

Concept: Many companies and agencies maintain data holdings of elevation data used for ortho-rectifying data and other terrain-related purposes. The elevation data is generally of multiple resolutions covering different spatial locations - perhaps a global elevation dataset which covers everywhere the company might be interested in at a lower resolution and then a patchwork of higher resolution data sets and tiles covering locations which have been studied in more depth.

How do you select (or even find) the best elevations source data for the locations you are interested in and how do you patch together potentially multiple tiles (at potentially multiple resolutions)?

ERDAS IMAGINE 2010 provides a potential solution to this issue - the Elevation Library Manager. The Elevation Library Manager provides a method to collect and manage your elevation source files, including Digital Elevation Model data (DEM), as well as Digital Terrain Elevation Data (DTED) used by the U.S. National Geospatial-Intelligence Agency.

The Elevation Library Manager simplifies elevation source file organization by storing the locations and relevant files of elevation data in a prioritized list. You can store multiple directories containing multiple elevation source files in the list, and store individual elevation source files.

7. Click on the **Terrain Tab** and select **Elevation Library**

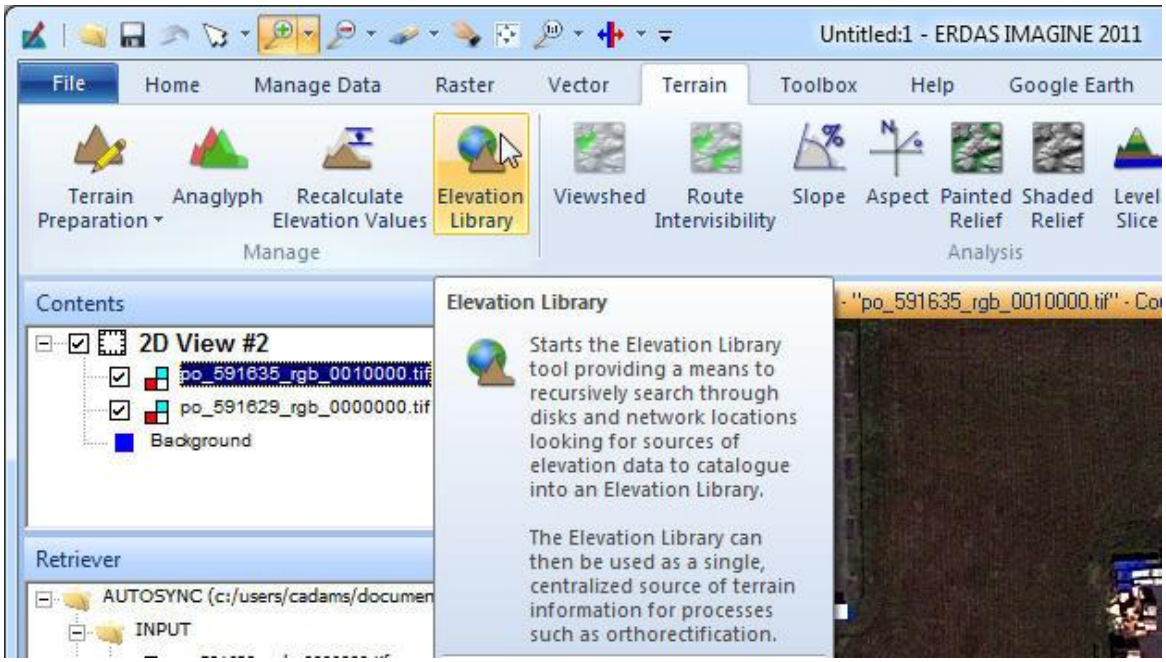

Fig.7. Elevation Library Tab

8. In the **Elevation Library Manager**, click the **Add Elevation** Source icon 

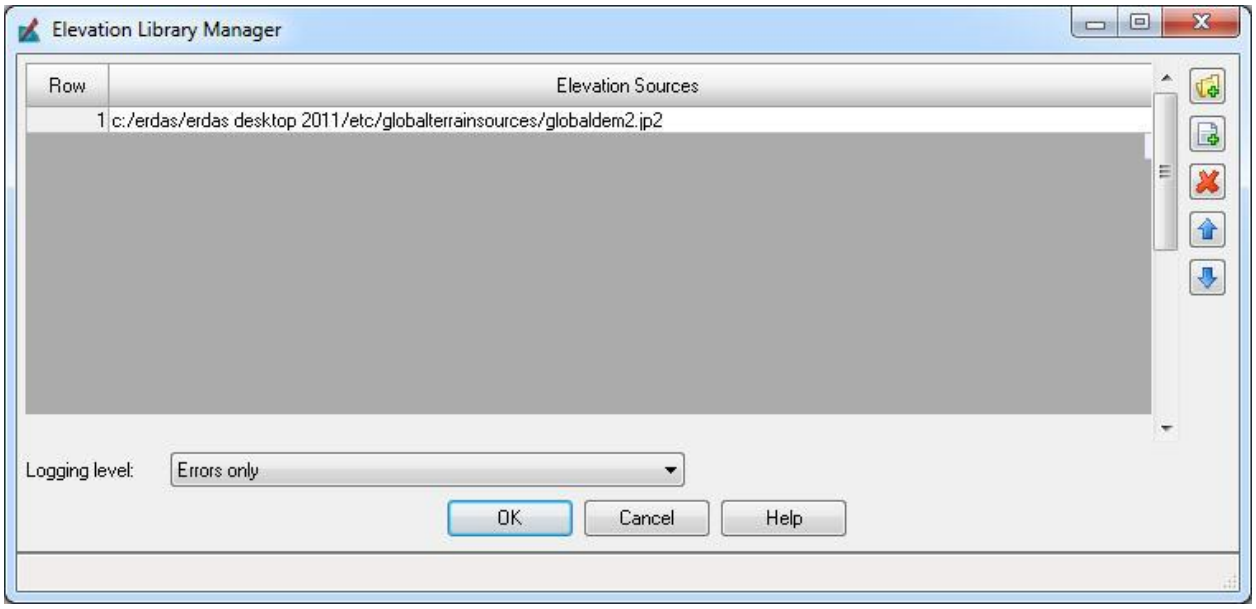

Fig.8. Elevation Library Manager

9. Navigate to the directory with you DEM file, select Elevation file you wish to use and click **OK**

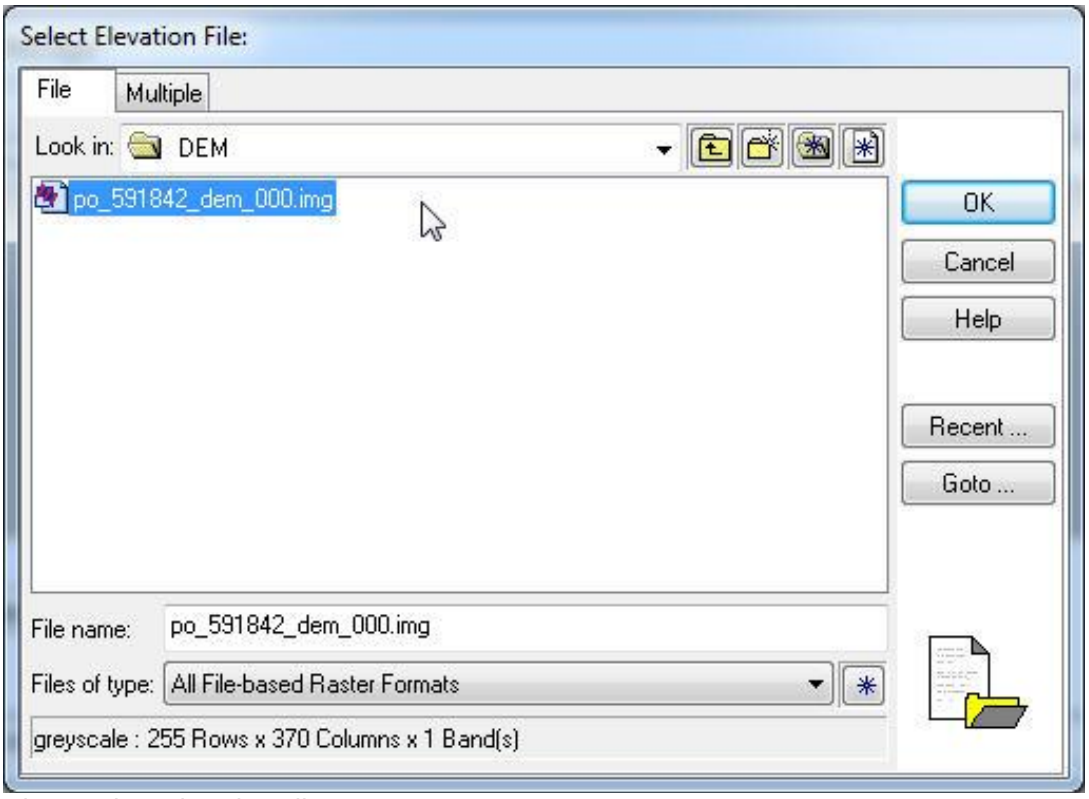

Fig.9. Select Elevation File

10. You should now see the new elevation source in the Elevation Library Manager. Click **OK**

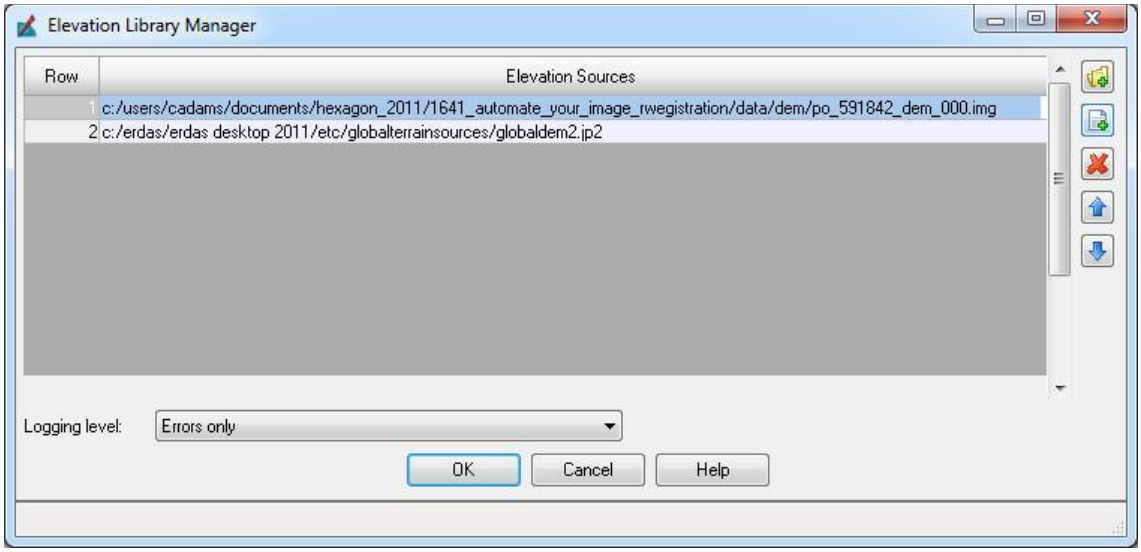

Fig.10. Elevation Library Manager

Note: If you do not have a DEM that you can use you have the option to use the default globaldem2.jp2 that is supplied with the software by ERDAS.

Once the elevation source has been selected the Resample Window will appear.

Here you will select the output file name. This will be the image that is orthorectified.

11. Navigate to a folder where you want the image to reside and give it a name. It will be given the .img extension.

12. Select the Elevation Library as the Elevation source. This is the file you have identified in the previous section of **Add Elevation Source to Elevation Library.**

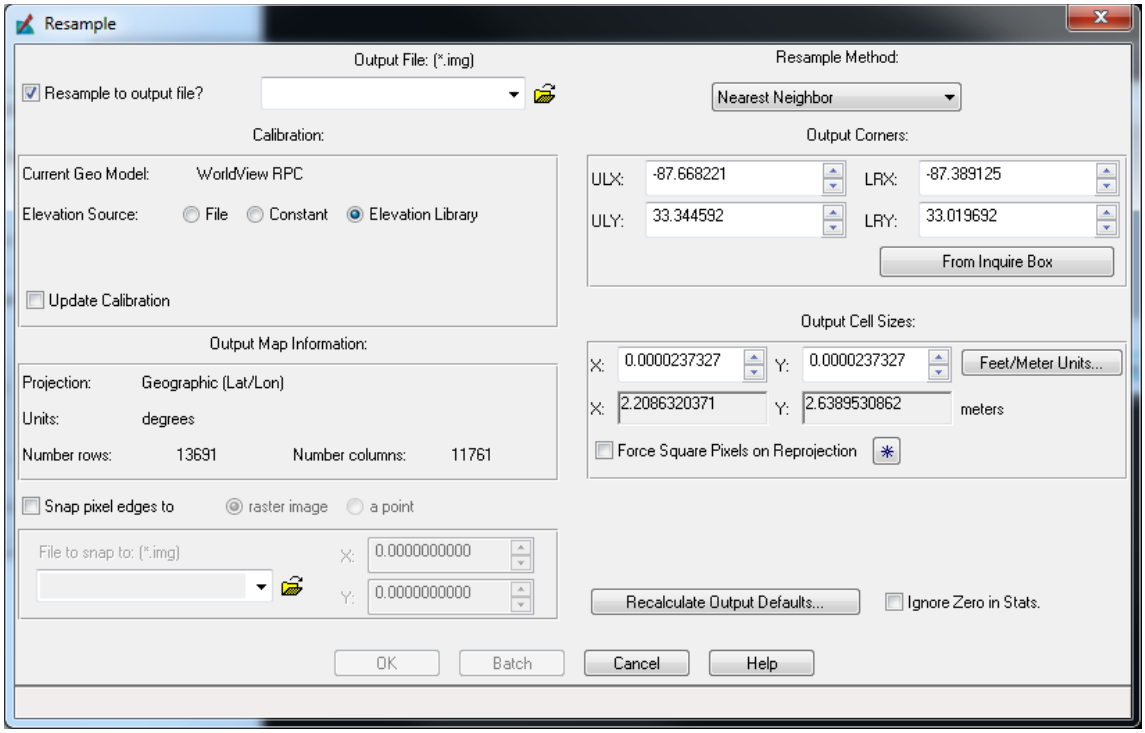

Fig.11. Resample Window (Orthorectification)

Under Resample Method you have a few options, Nearest Neighbor, Bilinear Interpolation and Cubic Convolution. The **Nearest Neighbor** method provides the most spectral fidelity. It is the best option for scientific applications and spectral classification where the user may want the 'most pure' pixel. The **4X4 Cubic Convolution** method provides a good balance between smoothness and sharpness. **Bilinear interpolation** results in an improvement in image quality over nearest-neighbor interpolation, but may still result in less-than-desirable smoothing effects. You may want to play with these methods and see which one produces the most desirable product for your purposes.

13. In this case we'll select Nearest Neighbor as the default.

For the remaining parameters we'll leave the defaults.

14. When you are ready select **OK** and run your orthorectification.

Navigate to your output folder and open your image in the IMAGINE Viewer to view your output Ortho Image.

15. In the file menu select **File > Open> Raster Layer** and navigate to the folder where your Ortho image resides.

For more information on ERDAS IMAGINE 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.