DEMs and Orthoimages from ASTER Data

The ASTER sensor is an instrument on board of Terra (EO-1) launched in 1999. Aster has 14 spectral channels that cover the spectrum from visible to thermal infrared (technically ASTER consists of 3 subsystems: VNIR, SWIR and TIR). The VNIR subsystem is a push broom scanner that captures data in the green, red and near infrared range with a spatial resolution of 15 meters in nadir direction. In addition to the nadir-looking optics there is a second one, which points backwards and records in infrared only. This constellation allows to generate digital elevation models (DEM) from the VNIR band 3nadir and VNIR band 3backwards. Based on the DEM an orthoimage can be generated for the VNIR Bands. Most remarkable is that ASTER data are available at no cost via the INTERNET.

Data processing:
The following procedure assumes that you already have some practical experience with **ERDAS IMAGINE Advantage** and **IMAGINE OrthoBASE Pro**. Experience with **Stereo Analyst** and **IMAGINE VirtualGIS** is necessary only if you want to make use of their functionality.

The following text explains how the data need to be processed and will help you to create your own data products from ASTER data successfully.

1. Prerequisites:

1.1. Level 1A ASTER Data

You can download the data via the INTERNET for free in HDF-EOS format.
Info on ASTER: http://asterweb.jpl.nasa.gov
Download via: http://eosdatainfo.gsfc.nasa.gov/eosdata/terra/aster/data_access.html
ASTER Level 1A is the raw data product necessary for this procedure. Level 1B data are already geometrically corrected and thus cannot be used within IMAGINE OrthoBASE Pro.

1.2. 3D-Control Points (reference object points with known coordinates in X, Y and Z)

Theoretically a minimum of 3 points is sufficient. However, you should always use about 10-30 control points per scene. This helps you to increase the positional accuracy, to detect gross errors and finally to enhance the statistical meaning of the resulting accuracy values after triangulation.
A 50k scale map that contains height information meets the requirements of measuring control points with sufficient accuracy in most cases.

1.3. HDF Importer

An ASTER HDF-EOS importer will soon be released by ERDAS. For users with Software Subscription Service (SSS) it will available via the ERDAS secure SSS website www.erdas.com/sss.
Other HDF-EOS resources can be found at: http://hdf.ncsa.uiuc.edu/tools.html.

2. Preprocessing of the data:

2.1. Import the data (convert from HDF to IMG format).

You need the following channels (for a pure DEM only Bands 3n and 3b are required):

- Band 1 (to create a colour-image + orthoimage generation)
- Band 2 (to create a colour-image + orthoimage generation)
- Band 3n (to create a colour-image + DEM and orthoimage generation)
- Band 3b (backward view, DEM generation)

2.2. Determine the correct value for the sensor's side incidence (this value is needed later on for setting up the ASTER sensor model in IMAGINE OrthoBASE Pro). You will find it in the ASTER Metadata. The value is specified with the keyword ‚POINTINGANGLE1' in the category ‚HDF Global Attributes'. It is important to note that you have to change the sign before you can use the value in IMAGINE OrthoBASE.

2.3. Check the image data for bad lines (lines that contain no image information). ERDAS IMAGINE provides a tool to correct such lines with the Image Interpreter (Utilities …|Replace Bad Lines …).

2.4. Rotate each channel 90° counter clockwise. The rotation is needed to display the stereo model properly with Stereo Analyst.
In case Stereo Analyst will not be used the 90° rotation is not necessary. The following procedure though assumes a rotation. It is important that the image dimensions don't change during the rotation (rows and columns are exchanged only).

When all images have been rotated open each one in the Image Info (ERDAS IMAGINE: Tools|Image Information) and delete the Map Model (Edit|Delete Map Model) for each image. At this point the images are still raw images, which are not yet georeferenced. Hence a related Map Model could cause unwanted side effects. That's why it should be deleted.

3. Perform a triangulation, generate a Digital Elevation Model (DEM) and make your own Orthoimage:

3.1. Set up a new block with IMAGINE OrthoBASE Pro 8.5.1: Choose the sensor model ‚Generic Pushbroom'. Load Band 3n (nadir) first and then Band 3b (backwards).

3.2. Define the Sensor Parameters for the VNIR sensor of the ASTER satellite. You can do this using the OrthoBASE Frame Editor (Frame Editor|Sensor):

GENERAL		
Sensor Name	ASTER VNIR nadir	ASTER VNIR backward
Focal Length (mm)	329.0	329.0
Principal Point x0 (mm)	0.0	0.0
Principal Point y0 (mm)	0.0	0.0
Pixel Size (mm)	0.007	0.007
Sensor Columns	4100	5000

MODEL PARAMETERS		
Polynomial Orders of Sensor Model		
X	2	2
Y	2	2
Z	2	2
Omega	1	1
Phi	1	1
Kappa	2	2

3.3. Define the Parameters for your ASTER stereo pair. Please use the Frame Editor in IMAGINE OrthoBASE again (Frame Editor|Frame Attributes):

	ASTER VNIR nadir	**ASTER VNIR backward**
Side Incidence (degrees)	Take the value that you determined in section 2.2	Take the value that you determined in section 2.2
Track Incidence (degrees)	0.0	-30.96
Ground Resolution (meters)	15.0	15.0
Sensor Line Along Axis	y	y

3.4. Compute Image Pyramid Layers (Edit|Compute Pyramid Layers).

3.5. Calculate Tie Points using the Point Measurement Tool. Measure two tie points manually in each of the overlapping images. They serve as initial points for the automatic tie point measurement. You can start the procedure using the following settings (Edit|Auto. Tie Point Generation Properties):

Images Used	All Available
Initial Type	Tie Points
Image Layer Used for Computation	1
Intended Number of Points per Image	200
Keep All Points	- disabled -

3.6. Measure ground control points (GCPs) using the Point Measurement Tool (Edit|Point Measurement). You should measure at least 4 GCPs in the corners of the overlapping area (stereo model). However additional 10 to 30 GCPs that are evenly distributed over the stereo model are much better because they enable quality control and make it easier to detect blunders. Each point must be measured in both images. Good GCP locations are crossroads, estuaries and lakesides. Crossroads are good because identification is easy and often height values are provided on crossroads in maps.

3.7. Start the triangulation. To get good results you must ensure that your point measurements contain no blunders. OrthoBASE offers two features for blunder detection (Edit|Triangulation Properties|Advanced Options: Simple Gross Error Check and Process| Graphic Status). You have two options for doing the adjustment: weighted and free-weighted iterative adjustment (Edit|Triangulation Properties|General: Iterations With Relaxation, 0 = weighted adjustment, 3 = weighted adjustment for the first three iterations and free-weighted adjustment for the following, 5 = free-weighted adjustment for all iterations).

3.8. Generate a Digital Elevation Model (DEM) with IMAGINE OrthoBASE Pro. Please ensure that the triangulation was done successfully. This is important for the subsequent processing. Repeating the triangulation might delete all earlier defined settings for DEM extraction (e.g. definition of exclude areas). Therefore it is highly recommended to save user defined areas for strategy parameters and exclude areas to AOI files. Height values for exclude areas should be saved to a text file.

3.9. Calculate Orthoimages using the DEM that you calculated in paragraph 3.8. You should use the nadir band as the image source.

3.10. Create a Natural Colours Orthoimage based on the three nadir bands (see 2.1). First you must merge the three bands, that are stored in individual files, and save them into one three band image file. You can use the ERDAS IMAGINE function ‚Interpreter|Utilities|Layer Stack' for this (using the ASTER HDF-EOS Importer this step will not be necessary). As a result it is possible to display the new file as a colored image with the ERDAS IMAGINE Viewer. You will recognize that the image is colour infrared.

With ERDAS IMAGINE you can now transform the colour infrared image into a natural colour image using the function ‚Interpreter|Spectral Enhancement|Natural Colour'.

Then you must attach the coloured image instead of the previous b/w nadir band in IMAGINE OrthoBASE Pro. You can use the attach function of IMAGINE OrthoBASE Pro's Frame Editor (Edit|Frame Editor|Sensor). You must make sure that the Attach button becomes active. Before starting OrthoBASE Pro you should rename the folder that contains the images or you must move the images to another folder using the Microsoft Explorer. As a result IMAGINE OrthoBASE Pro cannot find the original images and you can attach the colour nadir image manually.

After having attached the colour image with the block file you can proceed with the orthoimage generation in the same way as you did before. Again you can use the DEM that you calculated in paragraph 3.8.

4. Further capabilities offer stereo restitution with Stereo Analyst and 3D-animation with IMAGINE VirtualGIS

4.1. For stereo restitution with Stereo Analyst just load the blockfile that you generated with IMAGINE OrthoBASE Pro. As a prerequisite triangulation must have been done successfully. You should use the ASTER b/w-channels ‚band 3n' and ‚band 3b'. It is not possible to use colour images for stereo restitution because there is one channel for the backward view only. Hence the processing of a colour image for the backward view is impossible.

4.2. Make your own 3D-Animation with IMAGINE VirtualGIS (VGIS). Load the DEM in the VGIS-Viewer. Then load the orthoimage. You can now make use of all features offered by VGIS.

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