

## ASTER Images

### Background

The ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) sensor is an imaging instrument flown on the Terra satellite which was launched in December 1999. ASTER is a cooperative effort between NASA and Japan's Ministry of Economy and has been designed to acquire land surface temperature, emissivity, reflectance, and elevation data.

An ASTER scene covers an area of approximately 60 km by 60 km and data is acquired simultaneously at three resolutions. The images are georeferenced to the WGS-84 datum and Universal Transverse Mercator projection. The scenes are normally delivered in the along-track orientation to produce a smaller dataset. You may want to rotate the image so north is up, as described later in this document.

The primary full ASTER dataset is the **ASTER L1B Registered Radiance at the Sensor** product. This complete ASTER scene consists of 15 bands of data; including one band which points backwards to create parallax. Also note that at-sensor radiance values have been scaled to integer digital numbers (DNs) since these values can be stored and transmitted more compactly.

The three basic bands in the visible and near infrared (VNIR) part of the spectrum have a 15m resolution and an 8-bit unsigned integer data type. This data set also features a near infrared backward-scanning band labeled Band 3B. This is used to create a stereo view of the earth to develop elevation information and should not be used for analysis or classifications.

The six bands in the short wave (SWIR) have a 30m resolution and also have an 8-bit unsigned integer data type. **As of April 2008 the ASTER SWIR detectors no longer function.**

Finally there are five thermal bands (TIR) with a 90m resolution and have a 16-bit unsigned integer data type. See the appendix for specific wavelength information. You can learn more about the ASTER program at: <http://asterweb.jpl.nasa.gov/>

There are many **ASTER products** derived from individual scenes. You can view the list of products, as well as individual documentations sheets at: [https://lpdaac.usgs.gov/lpdaac/products/aster\\_products\\_table](https://lpdaac.usgs.gov/lpdaac/products/aster_products_table).

### Request for free international ASTER Data

Students working at the Yale Center for Earth Observation (YCEO) on course projects can obtain a few scenes for free. Please contact a member of the YCEO staff to learn more. Other students who wish to use ASTER data for educational purposes, and faculty wishing to use ASTER data to support a NASA or other government grant, can apply for free data through the USGS. You will need to register and include your contract/grant information as part of the application process. You can find an Application for Approved Access to ASTER from the Land Processes DAAC at: <https://igskmncnwb001.cr.usgs.gov/aster/afd/index.php>

Users can also request specific ASTER image acquisitions but you need to submit a proposal first. If this is accepted, you can then log in to a site to set up tasking parameters. More information on this can be found at the [JPL ASTER](#) site.

## Obtaining ASTER Data

There are three sources of ASTER data as of April 2012; The DataPool, GloVis, and Reverb|Echo. These are described below. There is a large but limited collection of free ASTER images of the United States and U.S. Territories at the LP DAAC DataPool site. This will soon be expanded to include data from March 2000. Accessing this site is described in the next section.

U.S. and international ASTER scenes can be obtained from the USGS [GloVis](#) site or the USGS [Reverb | ECHO](#) site. You must register at each site to order data. U.S. scenes are free, and international scenes are available to approved users at a cost of \$80 each. If you are not an approved user, and wish to obtain international ASTER images, you will be re-directed to the Japanese [ERSDAC](#) site.

### LP DAAC DataPool - Free Individual Scenes of the U.S.

The Land Processes Distributed Active Archive Center (LP DAAC) provides the most recent two years of ASTER Level-1B products for the U.S. and territories for free. The LP DAAC Data Pool site lets you search, select, and immediately download these scenes. You can reach the Data Pool at: [https://lpdaac.usgs.gov/lpdaac/get\\_data/data\\_pool](https://lpdaac.usgs.gov/lpdaac/get_data/data_pool)

At the DataPool site click on the Direct Search – *ASTER MODIS* button and then select the ASTT data group and then the “*AST L1B 3*” data set where you will have over 30,000 images to choose from. You begin the search process by selecting the spatial extent of the search. On this page you can either draw a box on a map or input bounding coordinates and add the selection to your search criteria. Next you need to define a date (or range of dates) of interest. You can further limit your search results using the Day/Night flag.

When you select the “*Get the granules*” link you are taken to a series of pages that list all of the images meeting your criteria. You will need to view browse images of each scene to narrow your search. Use one of the icons on the left for Browse or Browse and Meta Data. Once you have selected the data you can download the data from this page.

**A note of caution...** While it is tempting to obtain as much data as possible, you should only download one or two scenes initially. Only after you have had the opportunity to work with these scenes and evaluated their usefulness should you consider obtaining more imagery.

### ASTER Data at GloVis

GloVis is the USGS Global Visualization Viewer site that is now a primary source of international ASTER scenes. While you can obtain data from many sensors here, this document only covers ASTER data. Connect to the site at: <http://glovis.usgs.gov/>. This will use Java to open a data

visualization window (it may be behind your current browser window). You must register at the site to access data on GloVis. Also, you will need prior approval to obtain ASTER data directly.

From the **Collection** menu select the **ASTER → ASTER L 1A VNIR**. At the prompt warning that ASTER downloads are restricted click the *Continue in GLOVIS* button. Navigate to your area of interest by entering latitude and longitude in decimal degrees or clicking on a location in the interactive map. You may need to zoom in to more detail, or pan to your specific location. There are typically many images stacked for each location. You can reduce the list by adjusting the percent of maximum cloud cover.

The upper-most scene in the list will have a yellow box around it. You can right click on this to bring up a menu of options. These include opening a window with a larger browse image or detailed metadata. The *Select Scene* option lists all available data at that location. You can select any one of these to bring it to the top of the stack. Images that you are sure you do not want can be hidden to simplify your selection process. When you decide on a particular image click on the *Add* button, or right click on it and select *Add to Scene List*. When you are done selecting scenes, click on the *Order* button to open the *Shopping Basket* window. **You must be a registered user to place orders within GLOVIS.**

In the Shopping Basket web page you will use the *Select Process* button to select any ASTER product, or if you want the basic ASTER scene select **ASTER Level 1B**. Make sure you have selected the **Level 1B** data; you do **NOT** want the Level 1A data! If you want multiple products for the same scene, you will need to return to the GLOVIS application, reselect the dataset, add it to the shopping cart, and select the processing level. When all data have been selected submit the order for processing. An email will be sent with a link to retrieve the data.

## Importing Data into ENVI

The basic ASTER Level 1B data sets are provided in the hierarchical data format (HDF). ENVI can directly open these data, but there are a few special processing steps you should perform on these files. ASTER **products** are handled a bit differently, as described briefly next.

### ASTER Product Import

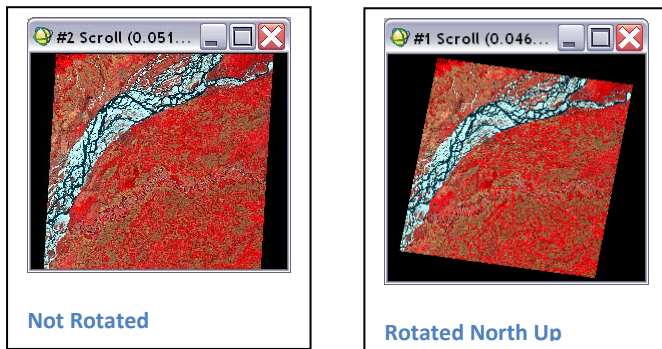
ASTER products such as **AST\_07 Surface Reflectance** or **AST\_08 Surface Kinetic Temperature** need to be opened as external files within ENVI. To do this, from the main menu select **File → Open External File → EOS → ASTER**. This will properly import the data into ENVI. You may need to rotate the dataset as described below.

### Processing Basic Level 1B ASTER Files

For the ASTER L1B data you can simply use the **File → Open** command in ENVI to open the dataset. ENVI will automatically apply the proper calibration coefficients to convert the integer DNs back to floating-point radiance values. As stated earlier, ASTER files contain data with three different spatial resolutions. When you open the HDF file the ENVI software opens four files. The first contains three VNIR bands with 15m resolution. The second is the backward viewing NIR band, also at 15m resolution and is rarely used. The third file contains six SWIR bands at

30m resolution. Finally the fourth file contains the five TIR bands at 90m resolution.

## Image Rotation



The image to the left is georeferenced but is NOT oriented with north at the top of the image. The ASTER HDF dataset is aligned to the angled path of the satellite, which results in a smaller dataset for storage and downloading. You should rotate the image to align it so north is up. From the main ENVI menu select **Basic Tools** → **Rotate / Flip**. Take all defaults because ENVI will extract the correct rotation angle from the header information. If you are working with thermal data, and plan to convert to degrees Kelvin (or Celsius), save the output to Memory rather than an ENVI dataset and proceed to the next section.

## Creating Degrees Kelvin band

ENVI has a two-step process that can perform basic atmospheric correction then convert the emissivity bands to a brightness-temperature map in degrees Kelvin. You will open the original ASTER HDF file, or the rotated file described above, to perform this task.

From the ENVI main menu bar, select **Basic Tools > Preprocessing > Calibration Utilities > Thermal Atmospheric Correction**. In the file selection dialog, choose the ASTER TIR bands. Set the Wavelength Units to micrometers, and leave everything else at default values. Direct the **Output Result to Memory** and click OK.

Again from the ENVI main menu bar, select **Basic Tools > Preprocessing > Calibration Utilities > Calculate Emissivity > Emissivity Normalization**. This tool will calculate emissivity and temperature values from your ASTER TIR radiance data that has been atmospherically corrected in the previous step. In addition to the default 5-band emissivity file, select Yes to produce the optional single temperature layer in degrees Kelvin. You can save this file in ENVI standard format or first convert this to Celsius using band math to subtract 273.15 from the file.

## ASTER DEM creation

The CEO Lab has software that can be used to create 15 m resolution DEM data from the ASTER images. If you know the elevation of several locations within the scene, you can create an *absolute* DEM. If you do not have this information, you can create a DEM with *relative* elevation values. From the ENVI main menu bar, select **Topographic** → **DEM Extraction** → **DEM Extraction Wizard**. See a member of the CEO staff for more information on this topic.

## Appendix A – ASTER Band Details

<b>Band</b>	<b>Label</b>	<b>Wavelength</b>	<b>Resolution</b>	
B1	VNIR_Band1	0.52 - 0.60	15m	} <span style="border: 1px solid black; padding: 2px;">First File</span>
B2	VNIR_Band2	0.63 - 0.69	15m	
B3	VNIR_Band3N	0.76 - 0.86	15m - Nadir view	
B4	VNIR_Band3B	0.76 - 0.86	15m - Backward scan (used to create high resolution DEM)	} <span style="border: 1px solid black; padding: 2px;">Second File</span>
<b>Note: SWIR data invalid as of April 2008</b>				
B5	SWIR_Band4	1.60 - 1.70	30m	} <span style="border: 1px solid black; padding: 2px;">Third File</span>
B6	SWIR_Band5	2.145 - 2.185	30m	
B7	SWIR_Band6	2.185 - 2.225	30m	
B8	SWIR_Band7	2.235 - 2.285	30m	
B9	SWIR_Band8	2.295 - 2.365	30m	
B10	SWIR_Band9	2.36 - 2.43	30m	
B11	TIR_Band10	8.125 - 8.475	90m	} <span style="border: 1px solid black; padding: 2px;">Fourth File</span>
B12	TIR_Band11	8.475 - 8.825	90m	
B13	TIR_Band12	8.925 - 9.275	90m	
B14	TIR_Band13	10.25 - 10.95	90m	
B15	TIR_Band14	10.95 - 11.65	90m	