ASTER Preprocessing Toolkit (APTK) Installation and User Guide
Version 1.1.1

Devin A. White, PhD
devin.white@gmail.com

Installation

For use in ENVI Classic, place the APTK folder in your save_add directory. The next time Classic is started, you should see a button for APTK in the File->Open External File->EOS menu. For use in ENVI 5.0 or later, place the APTK folder in your extensions directory. The next time ENVI is started, you should see a button for APTK in your Extensions menu. APTK is not guaranteed to work with versions of ENVI older than 5.0.

Usage

APTK is designed to mitigate multiple issues with how ASTER data are stored, processed, and used by geospatial software packages. The output from an APTK processing run is a new set of one or more ENVI-formatted files, which is consistent with other third party EOS plugins for ENVI (MCTK, EPOC, VCTK, and Hyperion Tools).

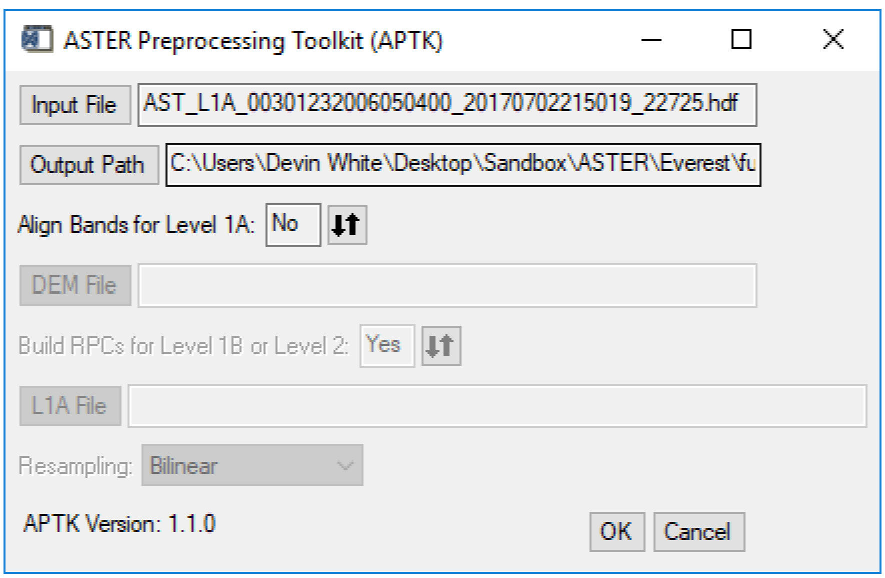

Figure 1. The APTK graphical user interface.

Supported Products

APTK supports all standard ASTER Level 1A, Level 1B, and Level 2 products. For consistency with respect to input file naming conventions and metadata, and to ensure sensor data quality and integrity, it is recommended that products are obtained directly through the NASA EarthData portal: https://earthdata.nasa.gov/. The list of currently supported products is as follows:

Product	Description
AST_L1A	ASTER L1A Reconstructed Unprocessed Instrument Data
AST_L1B	ASTER L1B Registered Radiance at the Sensor
AST_05	ASTER L2 Surface Emissivity
AST_07	ASTER L2 Surface Reflectance VNIR and SWIR
AST_07XT	ASTER L2 Surface Reflectance VNIR and Crosstalk-Corrected SWIR
AST_08	ASTER L2 Surface Temperature
AST_09	ASTER L2 Surface Radiance VNIR and SWIR
AST_09XT	ASTER L2 Surface Radiance VNIR and Crosstalk-Corrected SWIR
AST_09T	ASTER L2 Surface Radiance TIR

Level 1A Processing

For Level 1A, calibration coefficients are applied to individual bands within a swath (VNIR Nadir, VNIR Backward, SWIR, and TIR), the results are combined into a single cube, and that cube is written out to an ENVI file. That file contains correct band names, wavelengths, and a Rational Polynomial Coefficient (RPC) sensor model to enable orthorectification and, for Band 3N/3B, stereo DEM extraction. For a full Level 1A dataset, you should end up with four files, all of which are automatically loaded into ENVI.

Individual bands within a Level 1A swath are not aligned with one another, but are geopositionally correct. The impact of this misalignment is most noticeable in the SWIR swath, where the interband offsets can exceed six pixels. ENVI's solution to this issue is to allow you to orthorectify each band individually and then stack them together (done automatically), but this (1) forces you to orthorectify your data and (2) makes you dependent on ENVI's internal orthorectification module, which is not very robust compared to others like C-3PO. APTK includes a band alignment option, but it does require you to supply a DEM. The first band within a swath is used as the baseline and all others are transferred into its coordinate space using the DEM and their individual sensor models. This does require some interpolation, so you have the option of which method to use. The end result is a single cube with well-aligned bands, in the original viewing geometry, suitable for analysis and visualization. The alignment procedure is computationally expensive, so you will likely have to wait a few minutes for the process to complete. NOTE: It is not recommended to use a DEM with finer spatial resolution than 15m—you won't gain anything since that is the high end of ASTER's spatial resolution. The ASTER 30m global DEM (GDEM) works well.

Without band alignment, the RPC model generated by APTK is only accurate for the first band in a swath. For VNIR Nadir, VNIR Backward, and TIR, the offsets are small enough that you might be willing to ignore them, but it makes a big difference for SWIR. Band alignment should always be performed, but the choice is yours.

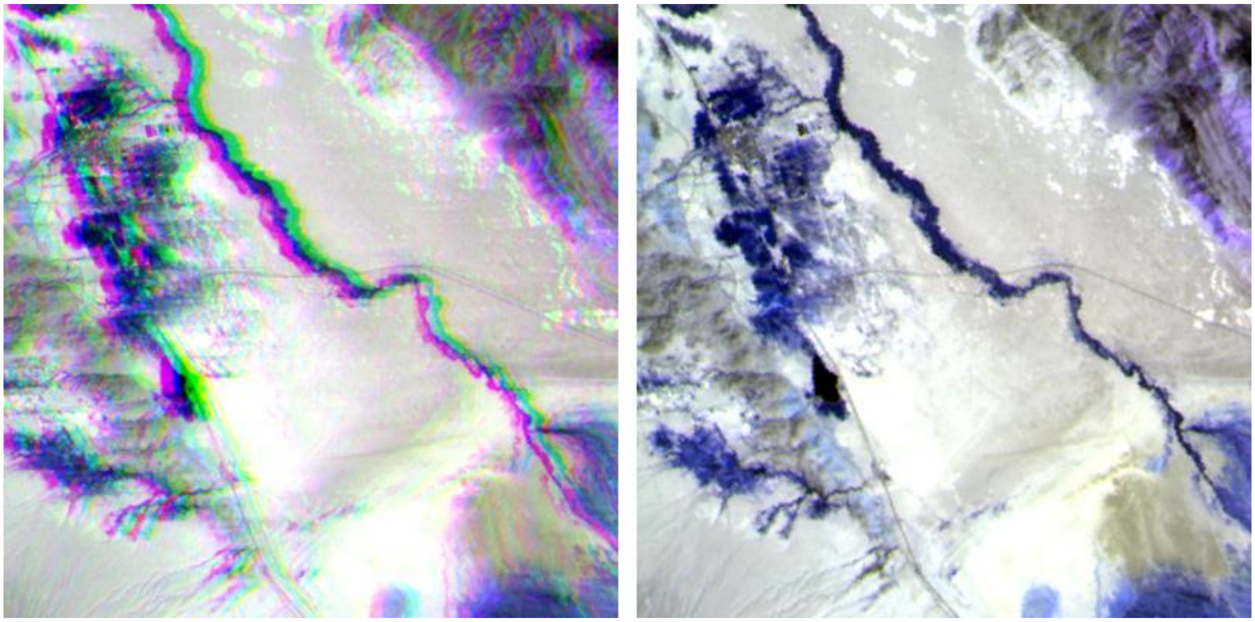

Figure 2. An example of APTK's Level 1A SWIR band alignment capability. Raw bands are displayed on the left in a false color composite, aligned bands are displayed on the right.

Level 1B Processing

Level 1B datasets are notoriously difficult to work with. First and foremost, the scene is projected onto the WGS-84 ellipsoid, which means that the projection was done under the assumption that the Earth is perfectly flat with a height of 0m above the ellipsoid. In mountainous areas, you can see positional errors on the order of 500m when compared to orthorectified Landsat data or Google Earth. Second, the projected scene is rotated such that it mimics the sensor's orbital scan path, which most geospatial software packages do not like. Third, ENVI is the only software package that offers the option to build RPCs to enable orthorectification and stereo DEM extraction for Level 1B, but their approach is incomplete and as such requires the user to supply ground control points to bring the data closer to where it is supposed to be on the ground. It in essence reproduces the ellipsoid projection effect unless you force it to consider a different solution via ground control, which puts a significant burden on the user. APTK mitigates all of these issues.

At a minimum, APTK processes each Level 1B swath in a similar fashion to Level 1A, producing a calibrated cube with correct band names and wavelengths. Band realignment is not required. Unless you elect to build RPCs, each cube is automatically "unrotated" in its native UTM projection so that North is up, which is what most geospatial software packages prefer. This does require some interpolation, so you have the option of which method to use. If you do elect to build RPCs, swaths are left in their rotated state, but you can then perform orthorectification or, for Band 3N/3B, stereo DEM extraction.

The Level 1B RPCs built by APTK are far more accurate than those built natively by ENVI, which uses a reverse-engineering approach that involves piecing together required sensor model information scattered across the supplied file and available technical documentation, filling in the remaining gaps with reasonable photogrammetric tradecraft. However, to do this ENVI has to assume that the sensor is looking straight down, which is generally not the case. That can lead to significant positioning errors unless you supply ground control points. APTK's method can correctly position a Level 1B swath after orthorectification, including Band 3B (see below), to within documented platform positional uncertainty (50m), which means that ground control is not required unless highly precise coordinates are needed for a specific application. It achieves this result by pulling key metadata about sensor position and orientation from the Level 1A file used to create the Level 1B file. By incorporating this information, an accurate sensor model can be built, from which accurate RPCs can be generated.

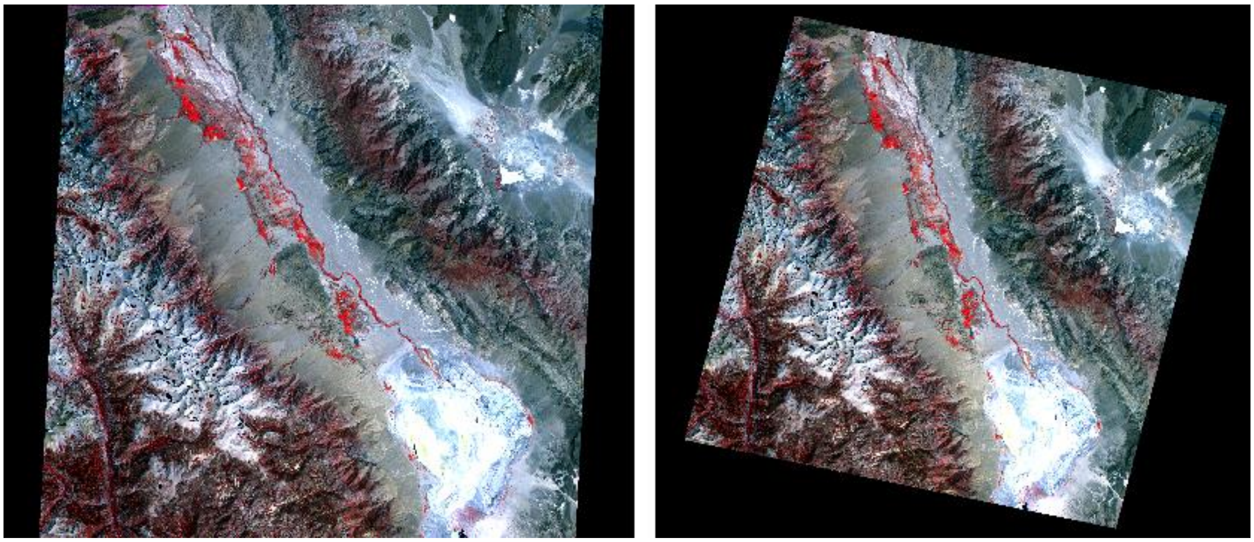

Figure 3. The original scan-path-aligned Level 1B swath and APTK's unrotated, north-is-up output for the same swath. The scale for each image is different.

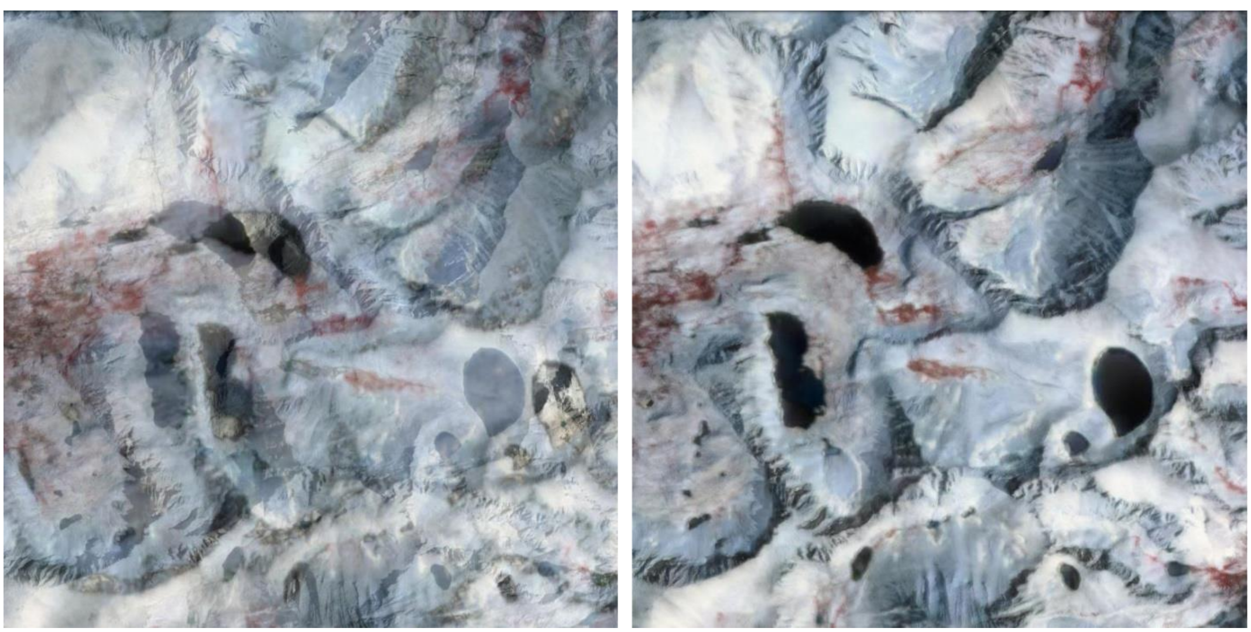

Figure 4. Comparison of no-ground-control orthorectification output for ENVI vs. APTK in a mountainous region. ENVI output is on the left, APTK output is on the right. Both outputs are overlaid, with transparency, on commercial high resolution satellite imagery as presented in Google Earth. Residual displacement for APTK is well within documented platform positional uncertainty (50m).

When a Level 1B file is supplied to APTK and RPC building is enabled, you will be prompted to supply the Level 1A file that served as the source for the Level 1B file:

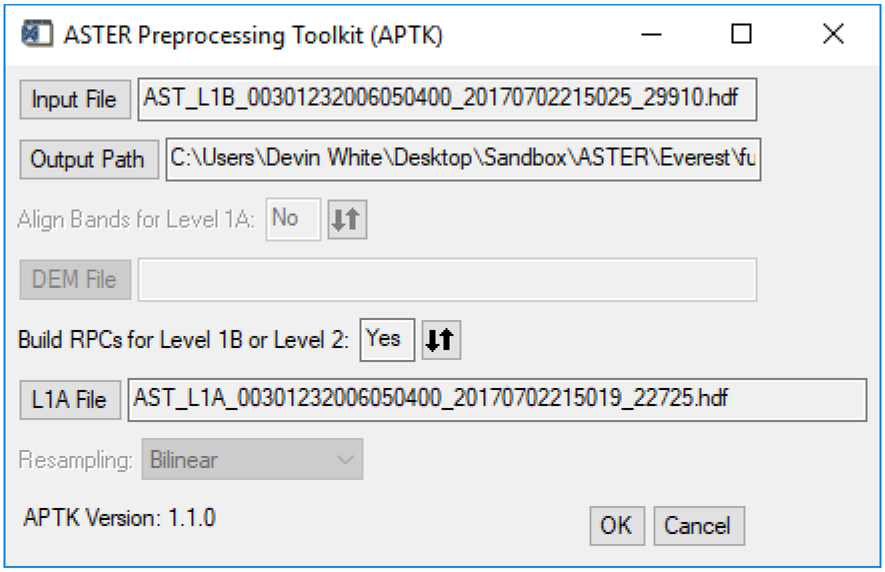

Figure 5. The APTK graphical user interface with RPC building enabled for a Level 1B file.

APTK will check to ensure that the granule ID (numeric sequence after the product ID in each filename) matches for both files before RPCs are built. NOTE: When downloading data from NASA's EarthData portal, it is very easy to include corresponding Level 1A products when ordering Level 1B or Level 2 products.

Level 2 Processing

Level 2 datasets are processed in a nearly identical fashion to Level 1B since all Level 2 products are derived from Level 1B products. Scale factors are automatically applied to produce scientifically meaningful values, wavelengths are included, and band names reflect both Level 2 product type and source data type (VNIR, SWIR, or TIR). Outputted files have names that also reflect Level 2 product type in order to differentiate between the VNIR and SWIR variants of AST_07XT and the surface radiance and sky irradiance datasets stored in AST_09T, for example. RPC building is available for Level 2 as well and the requirements are the same as for Level 1B: You must provide the Level 1A file that was the source of the Level 2 file you are processing.

Application Programming Interface

The following pages contain documentation for IDL routines that enable you to process Level 1A, Level 1B, and Level 2 datasets programmatically. The available options exactly mirror those present in the GUI.

Acknowledgements

I would like to thank the NASA/USGS Land Processes Distributed Active Archive Center (LP DAAC) for providing technical assistance and challenging sample data during the initial development of APTK.

CONVERT_ASTER_L1A, FILE, OUT_DIR [,R_FNAMES=R_FNAMES] [,R_FIDS=R_FIDS] [,MSG=MSG] [,/PROGRESS] [,/ALIGN] [,DEM_FID=DEM_FID] [,DEM_POS=DEM_POS] [,INTERP={0|1|2}]

FILE

Set this parameter to the fully qualified path on your system for the Level 1A dataset that you want to process.

OUT_DIR

Set this parameter to the fully qualified path on your system for a directory where you want to place output files.

R_FNAMES (optional)

The routine will populate a user-supplied variable with an array of fully qualified paths for outputted files.

R_FIDS (optional)

The routine will populate a user-supplied variable with an array of ENVI File IDs (FIDs) for the outputted files, which are opened in ENVI automatically.

MSG (optional)

The routine will populate a user-supplied variable with a string error message if processing does not complete successfully. The default return value is a null string ('').

PROGRESS (optional)

Set this keyword to indicate that you want to see a progress bar during processing.

ALIGN (optional)

Set this keyword to force band alignment within each swath. This requires the use of a DEM, whose FID and band position must be supplied via the DEM_FID and DEM_POS keywords. The interpolation method used can also be indicated using the INTERP keyword (default is bilinear).

DEM_FID (optional)

Use this keyword to supply the FID for the DEM you want to use during band alignment. DEM_POS must also be used.

DEM_POS (optional)

Use this keyword to supply the zero-based band number of the elevation data you want to use during alignment. DEM_FID must also be used.

INTERP (optional)

Use this keyword to indicate which interpolation method to use during band alignment. 0 = Nearest Neighbor, 1 = Bilinear, 2 = Cubic Convolution.

CONVERT_ASTER_L1B, FILE, OUT_DIR [,R_FNAMES=R_FNAMES] [,R_FIDS=R_FIDS] [,MSG=MSG] [,/PROGRESS] [,INTERP={0|1|2}] [,/BUILD_RPCS] [,L1A_FILE=L1A_FILE]

FILE

Set this parameter to the fully qualified path on your system for the Level 1B dataset that you want to process.

OUT_DIR

Set this parameter to the fully qualified path on your system for a directory where you want to place output files.

R_FNAMES (optional)

The routine will populate a user-supplied variable with an array of fully qualified paths for outputted files.

R_FIDS (optional)

The routine will populate a user-supplied variable with an array of ENVI File IDs (FIDs) for the outputted files, which are opened in ENVI automatically.

MSG (optional)

The routine will populate a user-supplied variable with a string error message if processing does not complete successfully. The default return value is a null string ('').

PROGRESS (optional)

Set this keyword to indicate that you want to see a progress bar during processing.

INTERP (optional)

Use this keyword to indicate which interpolation method to use during the "unrotation" process. 0 = Nearest Neighbor, 1 = Bilinear, 2 = Cubic Convolution.

BUILD_RPCS (optional)

Set this keyword to indicate that you want to build RPCs instead of unrotating the data.

L1A_FILE (optional)

Use this keyword to provide the fully qualified path on your system for the Level 1A dataset from which the supplied Level 1B dataset was derived. Using this keyword is only required when the /BUILD_RPCS keyword is set.

CONVERT_ASTER_L2, FILE, OUT_DIR [,R_FNAMES=R_FNAMES] [,R_FIDS=R_FIDS] [,MSG=MSG] [,/PROGRESS] [,INTERP={0|1|2}] [,/BUILD_RPCS] [,L1A_FILE=L1A_FILE]

FILE

Set this parameter to the fully qualified path on your system for the Level 2 dataset that you want to process.

OUT_DIR

Set this parameter to the fully qualified path on your system for a directory where you want to place output files.

R_FNAMES (optional)

The routine will populate a user-supplied variable with an array of fully qualified paths for outputted files.

R_FIDS (optional)

The routine will populate a user-supplied variable with an array of ENVI File IDs (FIDs) for the outputted files, which are opened in ENVI automatically.

MSG (optional)

The routine will populate a user-supplied variable with a string error message if processing does not complete successfully. The default return value is a null string ('').

PROGRESS (optional)

Set this keyword to indicate that you want to see a progress bar during processing.

INTERP (optional)

Use this keyword to indicate which interpolation method to use during the "unrotation" process. 0 = Nearest Neighbor, 1 = Bilinear, 2 = Cubic Convolution.

BUILD_RPCS (optional)

Set this keyword to indicate that you want to build RPCs instead of unrotating the data.

L1A_FILE (optional)

Use this keyword to provide the fully qualified path on your system for the Level 1A dataset from which the supplied Level 2 dataset was derived. Using this keyword is only required when the /BUILD_RPCS keyword is set.