ASTER-MODIS Fire Exercise

The purpose of this exercise is to explore the use of ASTER and MODIS data to characterize active burn areas and to assess pre- and post-fire landscape conditions at local to regional scales.

ASTER Data

ASTER data that were acquired on October 1, 2000 and October 26, 2003 for southern California are made available for this exercise. Several large wildfires (Padua, Grand Prix, Olds) were burning on October 26, 2003. The following ASTER products are available for this exercise:

Registered radiances at the sensor (AST_L1B)
Brightness temperature at the sensor (AST_04)
Surface Emissivity (AST_05)
Surface Reflectance (AST_07)
Surface kinetic temperature (AST_08)
Surface Radiance (AST_09)

For each of the dates, the ASTER data are in UTM projection (Zone 11 North), referenced to the WGS84 datum, rotated to north-up, and the SWIR and TIR bands have been resampled (cubic convolution) to 15 meters to match with the VNIR bands.

MODIS Data

Terra MODIS data that were acquired on October 1, 2000 and October 26, 2003 for southern California are also made available for this exercise:

Daily Surface Reflectance L2G 500m (MOD09GHK)
Daily Land Surface Temperature/Emissivity 5-Min L2 Swath 1km (MOD11_L2)
Daily Thermal Anomalies/Fire 5-Min L2 Swath 1km (MOD14)
Vegetation Indices 16-day L3 250m (MOD13Q1)
(coverage are periods Sept 30 – Oct 15, 2000 and Oct 16 – Nov 1, 2003)

The MOD09GHK and MOD13Q1 data have been transformed from Sinusoidal to UTM (Zone 11 North) projection and resampled to 480m and 240m pixels, respectively, using nearest neighbor resampling. This was performed using the MODIS Reprojection Tool (MRT). The MOD11_L2 and MOD14 products were transformed from 5-minute swath formats to gridded datasets in UTM (Zone 11 North) projection comprised of 960m pixels using nearest neighbor resampling. This was performed using the MRTSwath software. Projection parameters: central lat= 34 N, central lon= 117 W, Zone= 11 north, Datum=WGS84, resampling method=NN, pixel sizes=960m, 480m, 240m

NOTE: More detailed product information can be found on the LP DAAC web page, and an accompanying Excel spreadsheet contains a summary of file-specific information.

Tips for Image Display

ASTER VNIR data are typically displayed as false-color infrared composites, where bands 3N=Red, 2=Green, 1=Blue.

MODIS reflective bands can be displayed as natural color composities, where bands 1=Red, 4=Green, and 3=Blue or as false-color infrared composites (bands 2, 1 3 as Red, Green, and Blue).

Exercise Scenarios

In this exercise you are asked to analyze the ASTER and MODIS datasets according to three scenarios that will enable you to explore the multi-sensor, multi-temporal, and multi-scale characteristics of the data. These three scenarios are broadly defined and are accompanied by sample processing and analysis procedures. You may follow these scenarios or you may formulate different questions to address and develop your own approach to extracting and analyzing information from the data. Keep in mind that you will be expected to present a brief (10 minute) summary of your objectives and results on the last day of the workshop.

This exercise was designed using the ENVI software, although the same scenarios may be implemented using ERDAS Imagine if the file formats and data types are supported.

Scenario #1 – Prepare a statistical summary of geophysical parameters measured by ASTER and MODIS for active fire areas as compared to their pre-fire state and condition. What geophysical parameters are directly comparable, and what factors contribute to uncertainties in the comparisons?

HINT: You can define a region of interest (ROI) with which to extract data values from images that are geographically referenced and of the same pixel dimensions. The ROI can be defined interactively as a graphics overlay or by thresholding values from a particular band.

A. Define ROI Interactively

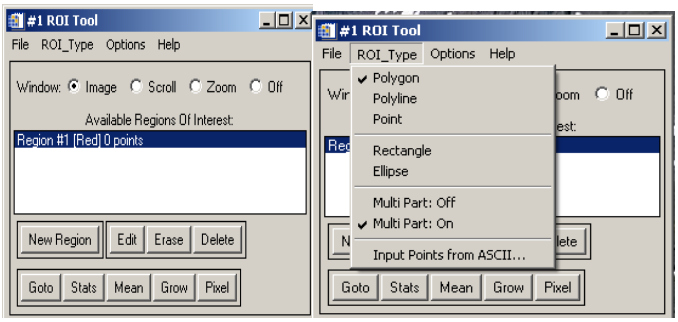
Open the VNIR (rotated) and SWIR (resized and rotated) AST_09 products for October 26, 2003. From the Main ENVI window:

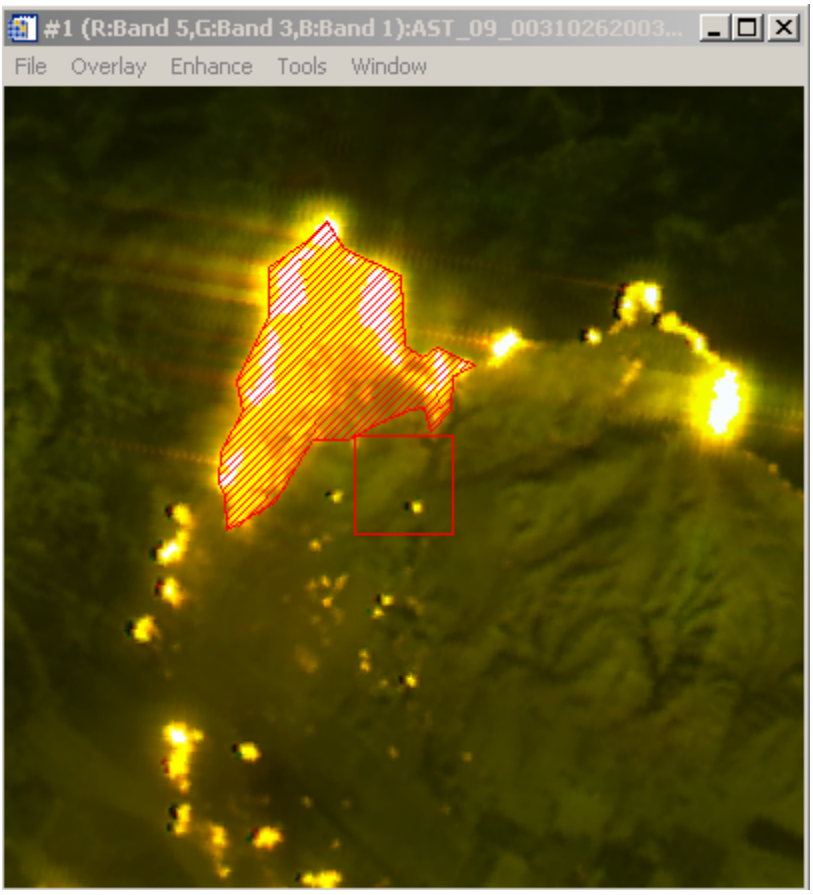
File → Open Image File → (Multiple files can be selected by holding down the CTRL key and clicking with the left mouse button)
Basic Tools → Region of Interest → ROI Tool
Specify display window in which to draw
ROI Type (polygon)

Use the left mouse button to define polygon vertices, then use the right button to close the polygon.

Edit the ROI name, line type, and color as needed.

Right click again on the diamond icon in the polygon to finish.



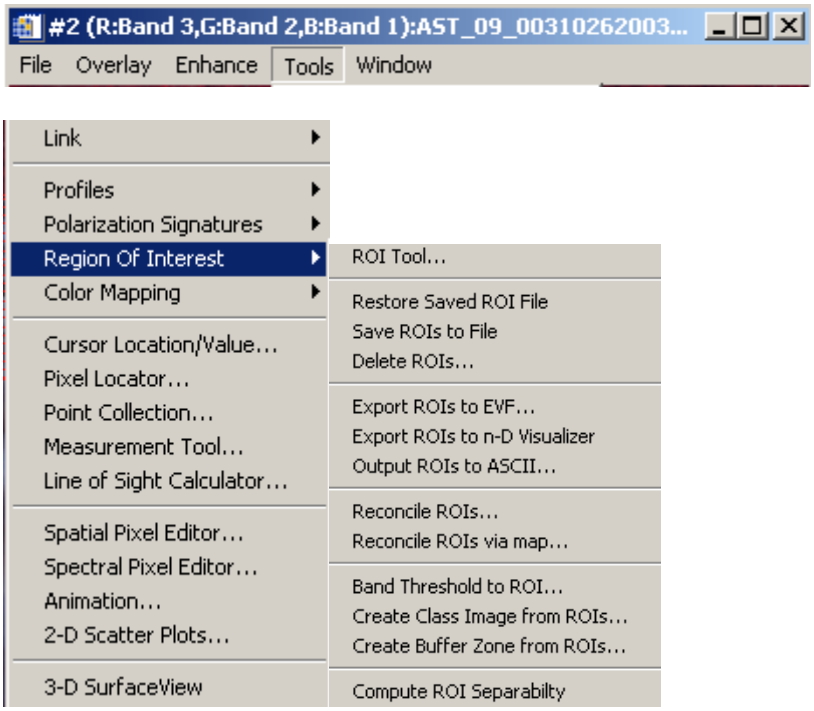


From the ROI Tool window you have options to compute statistics (Stats button), further edit the ROI, or perform other operations.

From the ROI Tool window, save the ROI(s) you have defined:
File → Save ROIs

The ROI can be used as a mask to extract and export pixel values to an ASCII text file.

From the image Display window:
Tools → Region of Interest → Output ROIs to ASCII
Select Input files for ROI data
Select Output ROI
Enter Output Filename



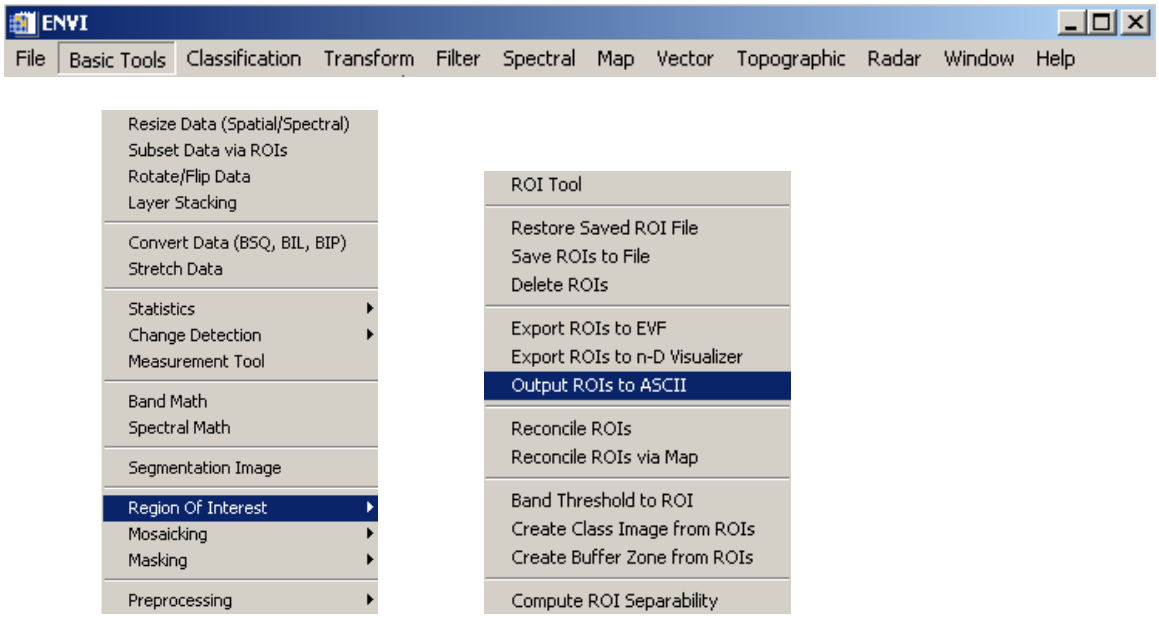
OR From the main ENVI menu

Basic Tools → Region of Interest → Output ROIs to ASCII

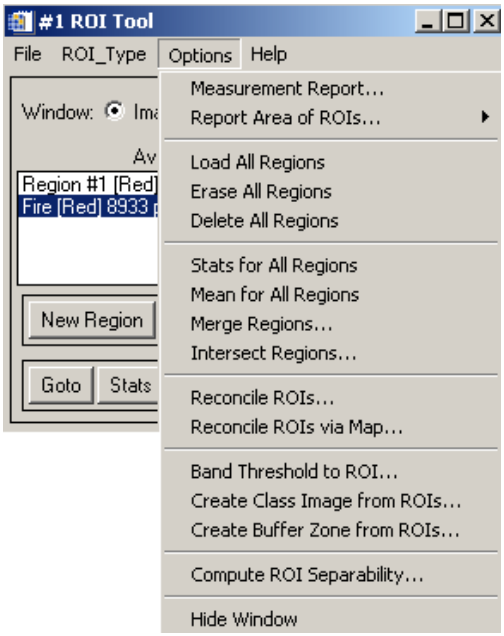
Select Input files for ROI data

Select Output ROI

Enter Output Filename



OR From the ROI Tool menu



The ASCII file that is created can be accessed by other ENVI functions, or the file may be edited and imported in Excel.

B. Band Threshold to ROI

Another approach would be to use the MODIS Fire/Thermal Anomalies (MOD14) as a mask by which to extract pixel values. Open the MOD14_FireMask and the images from which to extract data values.

File → Open Image File(s)

Apply a color-coding scheme from a previously built look-up table (LUT).
From Display window:
Tools → Color Mapping → Density Slice
Select band
File name (MOD14*.dsr)

Subset the MODIS_FireMask to match the coverage and spatial resolution of an ASTER product:
From the Main ENVI menu:
Basic Tools→ Resize Data
Select input file
Spatial subset
Subset by file
Select output Dimensions by Pixel size (15.0 m)
Nearest Neighbor (NN) resampling
Choose output file

Display the 'resized' MODIS fire mask.

Construct an ROI of active fires defined by the MOD14_FireMask:
From the Display window of the 'resized' MODIS fire mask:

Tools → Region of Interest → Threshold to ROI
Select band
Specify Min, Max,
Specify Output ROI file

You can then use the resultant ROI file to overlay upon, or extract pixel values from, image files that are open using any of the 'Region of Interest → Export to ASCII' options.

Scenario #2 – Map the spatial (geographic) extent of burned areas in the October 26, 2003 ASTER image, and if possible, map the extent of burn scars in the October 2000 and October 2003 ASTER images. Can a relative chronology of the different burn areas/burn scars be established?

HINT: The normalized burn ratio (NBR) computed from Landsat TM & ETM+ data is commonly used as an index of burn severity. This is a normalized ratio of the expression:

(Band 4 – Band 7) / (Band 4 + Band 7)

Band 4 = 780-900 nm
Band 7 = 2090-2350 nm

This can be translated for use with ASTER data using the following substitution of ASTER bands:

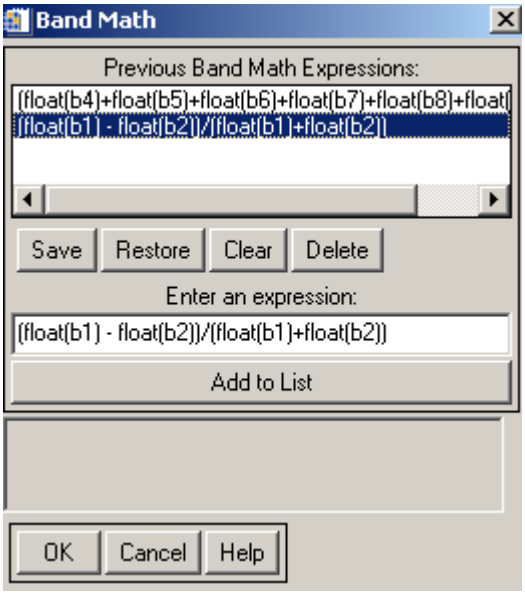
(Band 3N – Band [5:8]) / (Band 3N + Band [5:8])

Band 3N = 760-860 nm
Band 5 = 2145-2185 nm
Band 6 = 2185-2225 nm
Band 7 = 2235-2285 nm
Band 8 = 2295-2365 nm

The ENVI Band Math function can be used to setup numerical expressions in which variables are mapped to Files or Bands.

From the ENVI Main window
Basic Tools → Band Math

The following example was setup to use ASTER bands 3N and one of the SWIR bands to compute NBR. The 'float' specification is important because the ASTER bands are Integer data types, but the output is a ratio that needs to be a floating point datatype. The variable names must begin with 'b' or 'B' followed by up to 5 numerals.



Once valid Band Math expressions are defined and image Files/Bands are associated with the variables, the Band Math results should be written to an output file.

Using the same Band Math constructs, you could also synthesize a broader spectral band for the SWIR data by averaging and weighting specific SWIR bands. Consider how you would perform a sensitivity analysis of which ASTER bands might provide an indicator of burn severity.

Scenario #3 – Assess and quantify differences in the state and condition of natural vegetation between October 2000 and October 2003. Use one of the MODIS vegetation indices as the metric, and explores ways in which to use results from Scenarios 1 or 2 as stratification layers. Confine your analyses to the geographic extent of ASTER coverage.

HINT: You may want to subset and/or resize the MODIS vegetation indices to correspond to the geographic extent of the ASTER coverage.

Summary

Prepare a brief summary (2-3 Powerpoint slides) for use in a 10-minute presentation on the last day of the workshop. The presentation should address:

- Objective(s)
- Methods
- Results
- Discussion