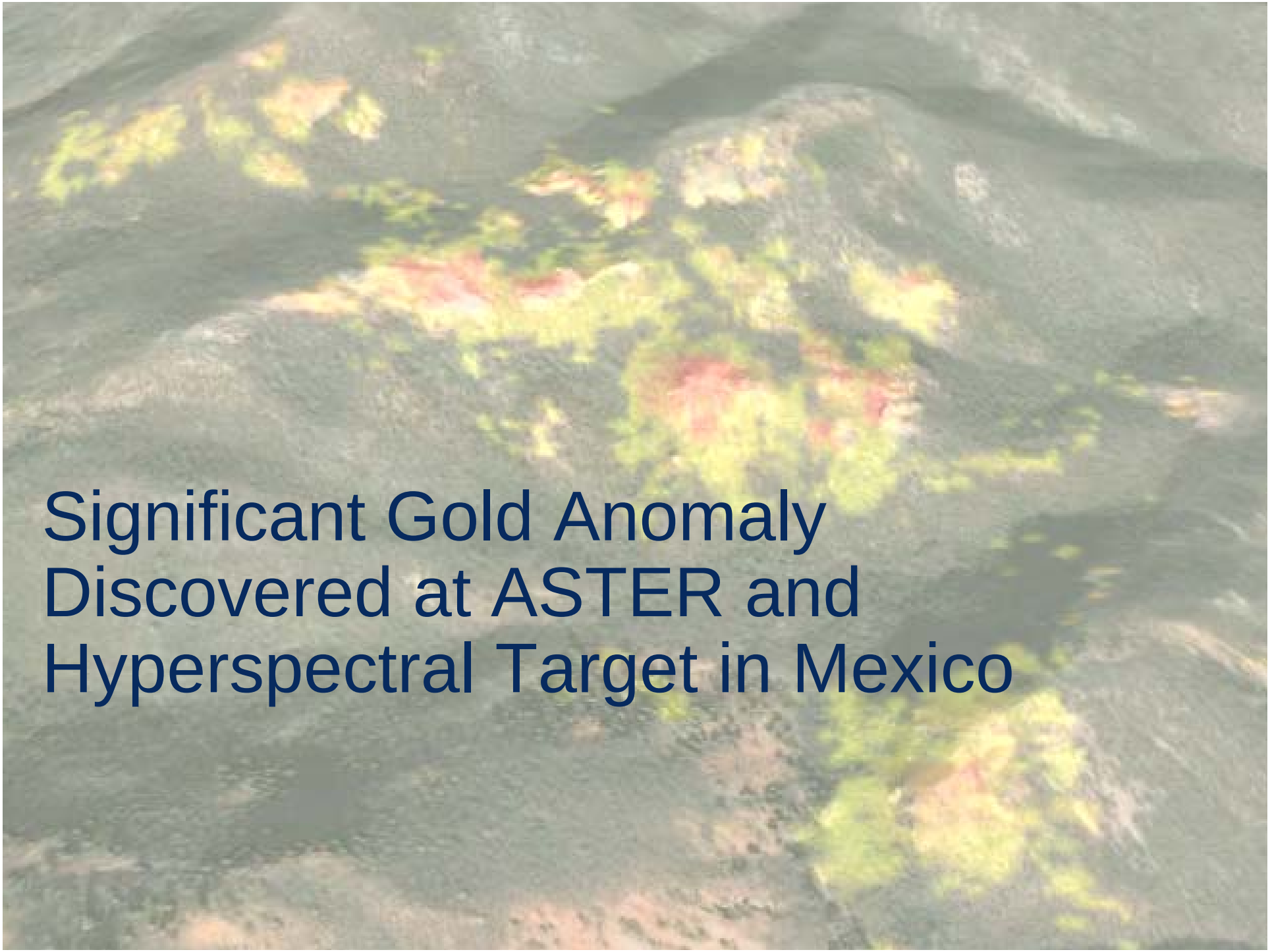
Spectral and Spatial Processing of ASTER and WorldView-2 data

Joe Zamudio, Ph.D.
ITT Visual Information Solutions
jzamudio@ittvis.com

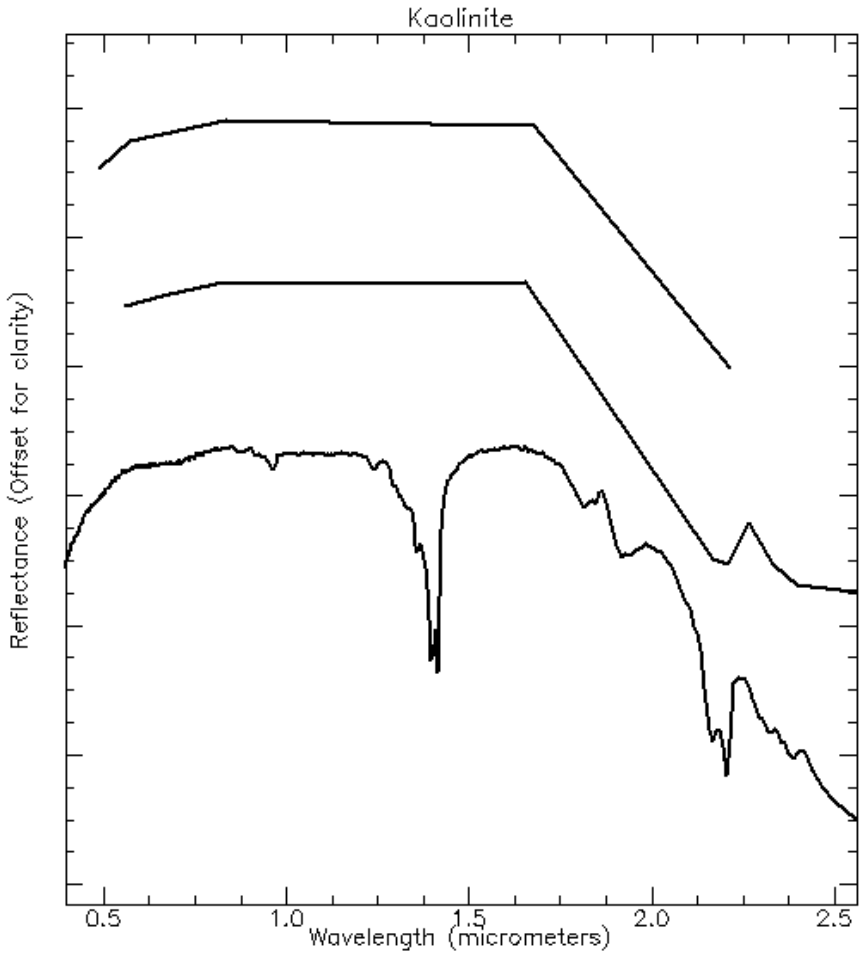
The information contained in this document pertains to software products and services that are subject to the controls of the Export Administration Regulations (EAR). The recipient is responsible for ensuring compliance to all applicable U.S. Export Control laws and regulations.

Engineered for life



Significant Gold Anomaly Discovered at ASTER and Hyperspectral Target in Mexico

Kaolinite at Varying Spectral Resolutions



More channels =
more information

6 Bands TM

9 Bands ASTER

420 bands Lab Spectrum

Preprocessing ASTER Data in ENVI

- ENVI System Preferences -> Misc. -> Auto-Correct ASTER/MODIS = Yes
  - File-> Open External File-> EOS -> ASTER -> HDF files
  - Calibration info automatically applied
- Perform Layer Stacking to get all bands in one file (omit Band 3B)
- Convert to reflectance
  - If using FLAASH convert to BIL and use floating point data with scale factor of 10. Don't do visibility retrieval.
- Mask out clouds, etc.
- Pixels with low reflectance are affected by "crosstalk". Abnormally high band 5 and 9 values due to "crosstalk" produce suspect band 6 and 8 absorption features
  - Masked out using band 4 reflectance value
- AST_07 reflectance data band 5 reflectance values are typically 5 to 12 percent lower than reflectance data measured in the field.
  - Other data sources used to correct band 5 anomaly – for example, Hyperion satellite data
- Accurate calibration of ASTER data is critical because ASTER ratio values for each logical operator were determined from library and image spectra that have been calibrated using field reflectance

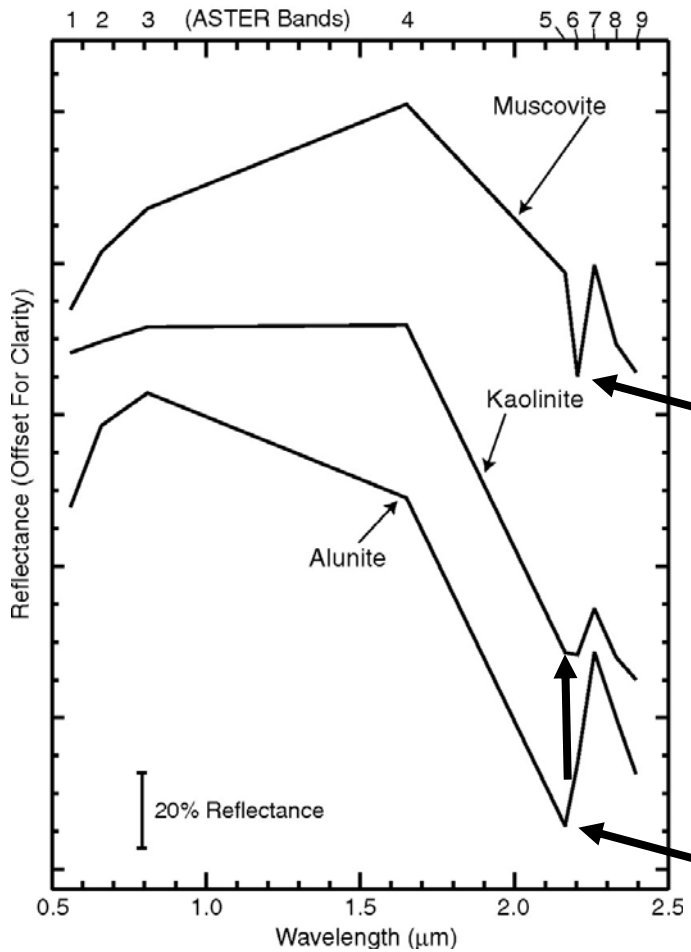
ENVI Band Math Expressions

- References
  - Lithologic mapping in the Mountain Pass, California area using Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data - **John C. Mars and Lawrence C. Rowan**, 2003, Remote Sensing of Environment, v. 84, no. 3, p. 350-366.
  - Regional mapping of phyllic- and argillic-altered rocks in the Zagros magmatic arc, Iran, using Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data and logical operator algorithms - **John C. Mars and Lawrence C. Rowan**; 2006, Geosphere, v. 2, no. 3, p. 161-186.
  - Mapping phyllic- and argillic-altered rocks in southeastern Afghanistan using Advanced Spaceborne Thermal Emission and Reflection Radiometer (**ASTER**) data - **John C. Mars and Lawrence C. Rowan**; 2007, USGS Open file report 2007-1006, USGS Afghanistan Project Product No. 110

ASTER Mapping Using ENVI's Band Math

- Create logical expressions using Band Math - after Mars and Rowan
- Focus on a series of SWIR ratios that "map" out spectral features
- Specify ratio ranges that suggest argillic and phyllic alteration – mineral groups
  - Advanced Argillic alteration - alunite +/- pyrophyllite
  - Intermediate Argillic alteration - kaolinite group (this work)
  - Phyllic alteration - Al-OH bearing minerals (smectite clays, muscovite, illite)

Laboratory Spectra Resampled to ASTER Bandpasses



- The expression that maps phyllic-altered rocks using band ratios 4/6, 5/6, and 7/6, which define the 2.20 μm absorption feature.
- The expression that maps argillic-altered rocks using band ratios 4/5, 5/6, and 7/6, which define the 2.17 μm absorption feature.

Mars J C , Rowan L C Geosphere 2006;2:161-186

ENVI Band Math Expressions – Mars and Rowan

Map Phyllic Alteration – muscovite, illite, smectite

Mask vegetation

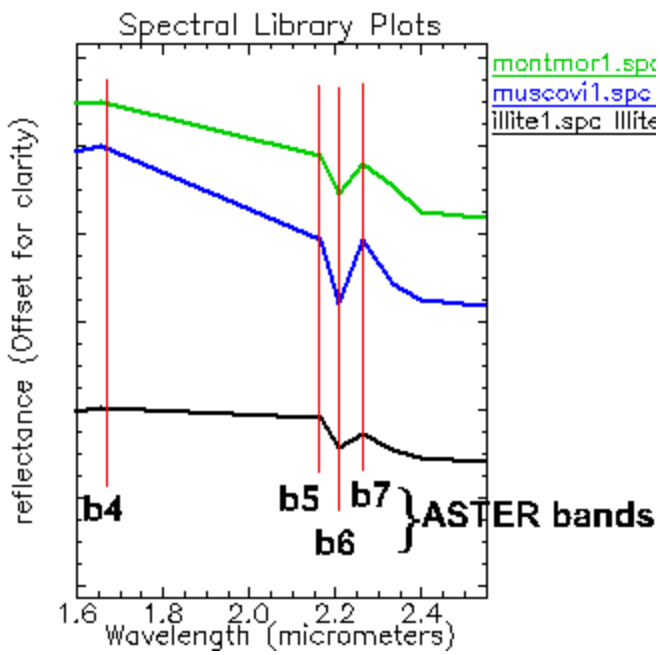
Mask dark pixels

Ratio to map 2.200 µm feature associated with phyllic alteration

((float(b3)/b2) le 1.3)and(b4 gt 2600)and((float(b4)/b6) gt 1.25)
and ((float(b5)/b6) gt 1.05) and ((float(b7)/b6) ge 1.05)

Ratio to delineate argillic from phyllic alteration

Ratio to map the 2.200 µm feature associated with phyllic alteration



Explanation

float – convert to floating point
le – less than or equal to
gt – greater than
ge – greater than or equal to

ENVI Band Math Expressions – Mars and Rowan

Map Argillic Alteration – kaolinite, alunite

Mask vegetation

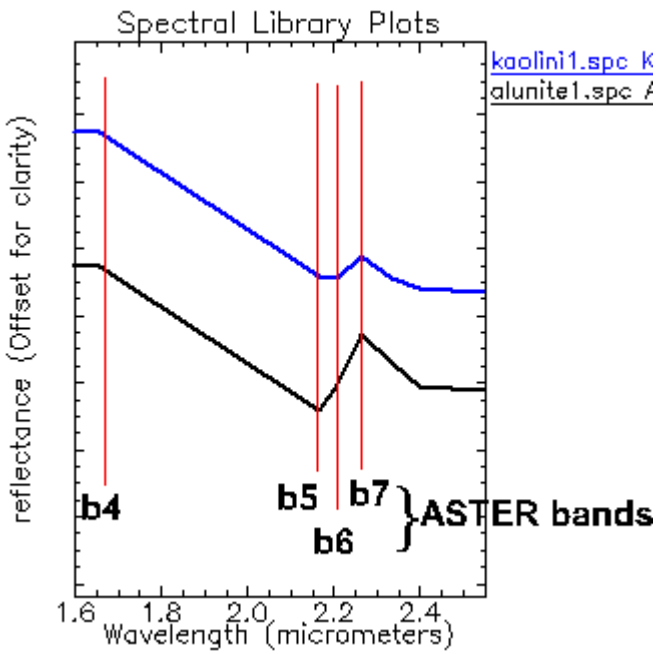
Mask dark pixels

Ratio to map 2.165 µm feature associated with argillic alteration

((float(b3)/b2) le 1.3)and(b4 gt 2600)and((float(b4)/b5) gt 1.25)
and((float(b5)/b6) le 1.05)and((float(b7)/b6) ge 1.03)

Ratio to delineate argillic from phyllic alteration

Ratio to map the 2.200 µm feature associated with argillic alteration



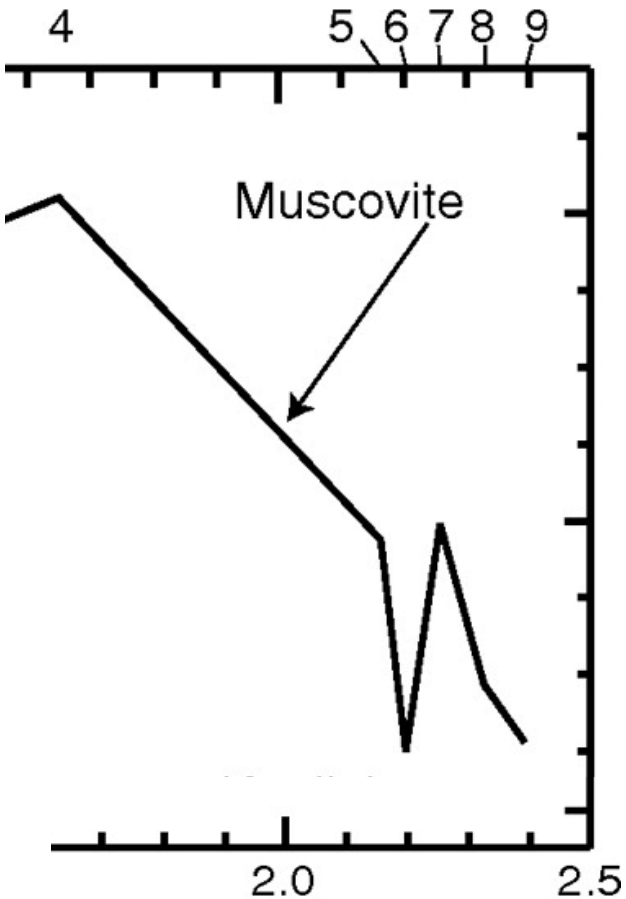
Explanation

float – convert to floating point
le – less than or equal to
gt – greater than
ge – greater than or equal to

ENVI Band Math – Mexico - Phyllic Alteration

((float(b4)/b6) gt 1.38) and ((float(b5)/b6) gt 1.05) and ((float(b7)/b6) ge 1.03)

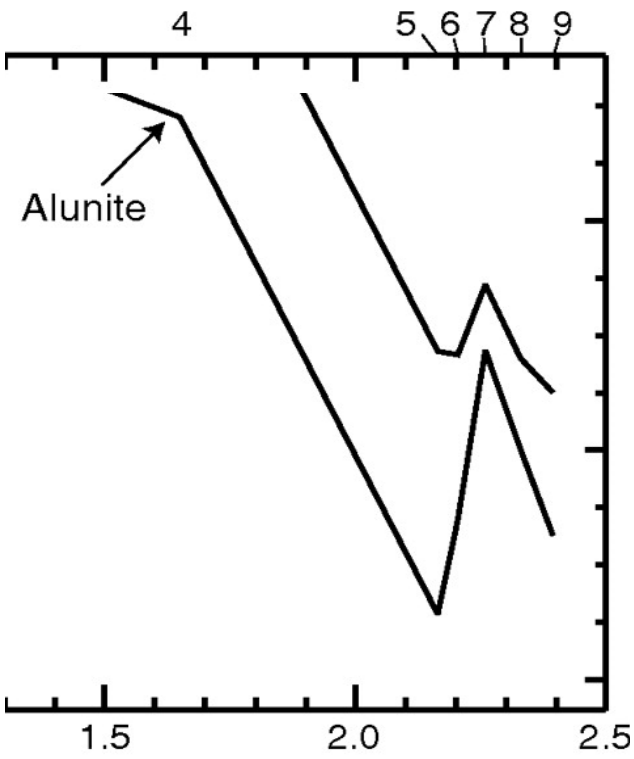
ASTER channel



ENVI Band Math – Mexico - Alunite Alteration

((float(b4)/b5) gt 1.38) and ((float(b5)/b6) lt 0.99) and ((float(b7)/b6) ge 1.03)

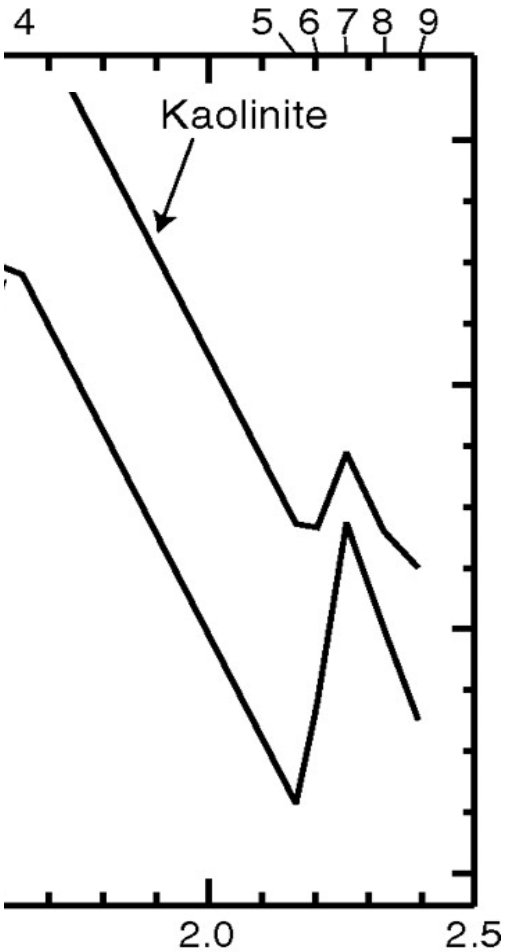
ASTER channel



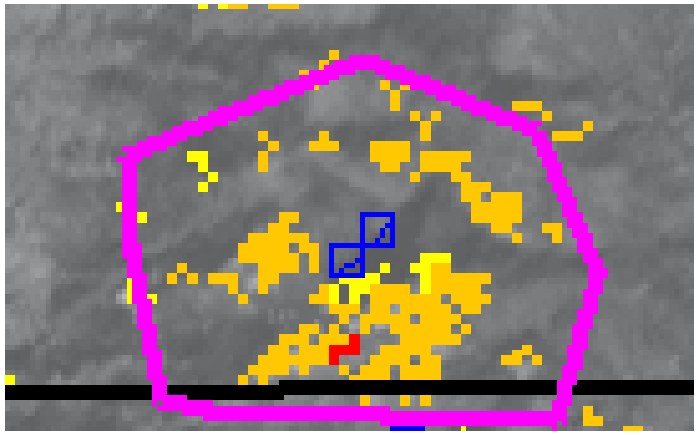
ENVI Band Math – Mexico - Kaolinite Alteration

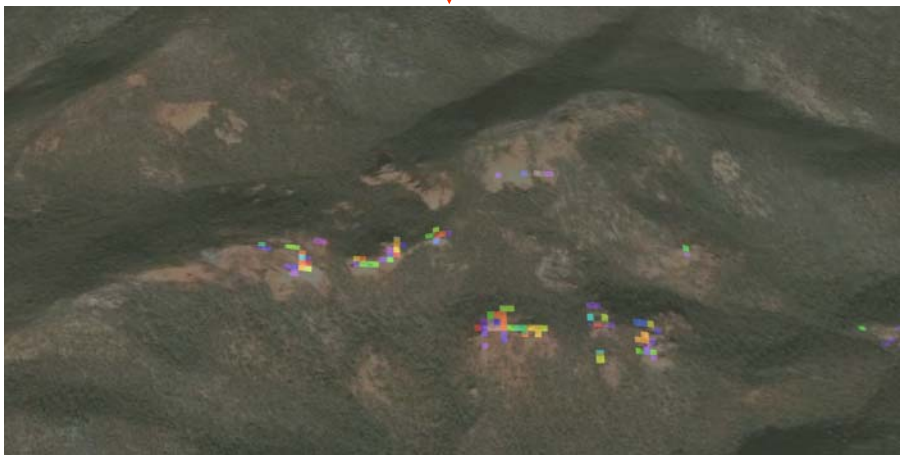
((float(b4)/b5) gt 1.38) and ((float(b5)/b6) le 1.05) and ((float(b5)/b6) ge 0.99) and ((float(b7)/b6) ge 1.03)

ASTER channel



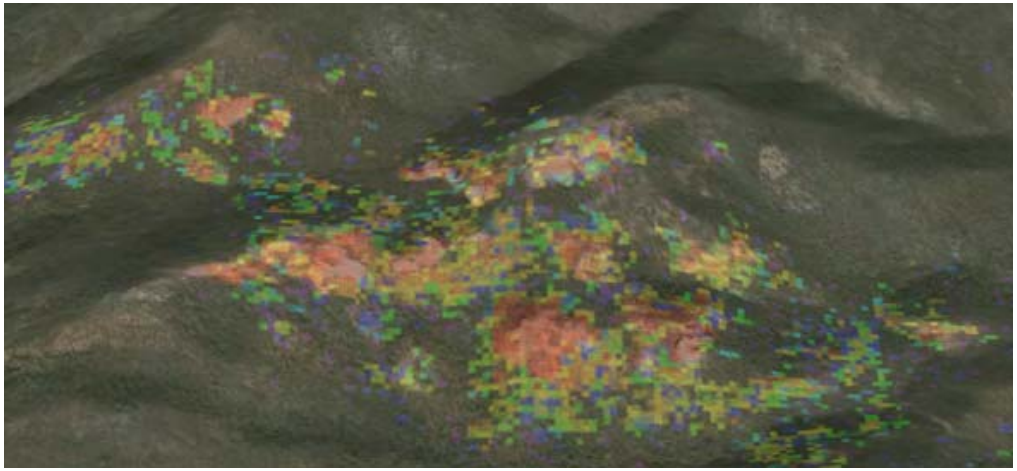
Comparison of ASTER and HyMap Results





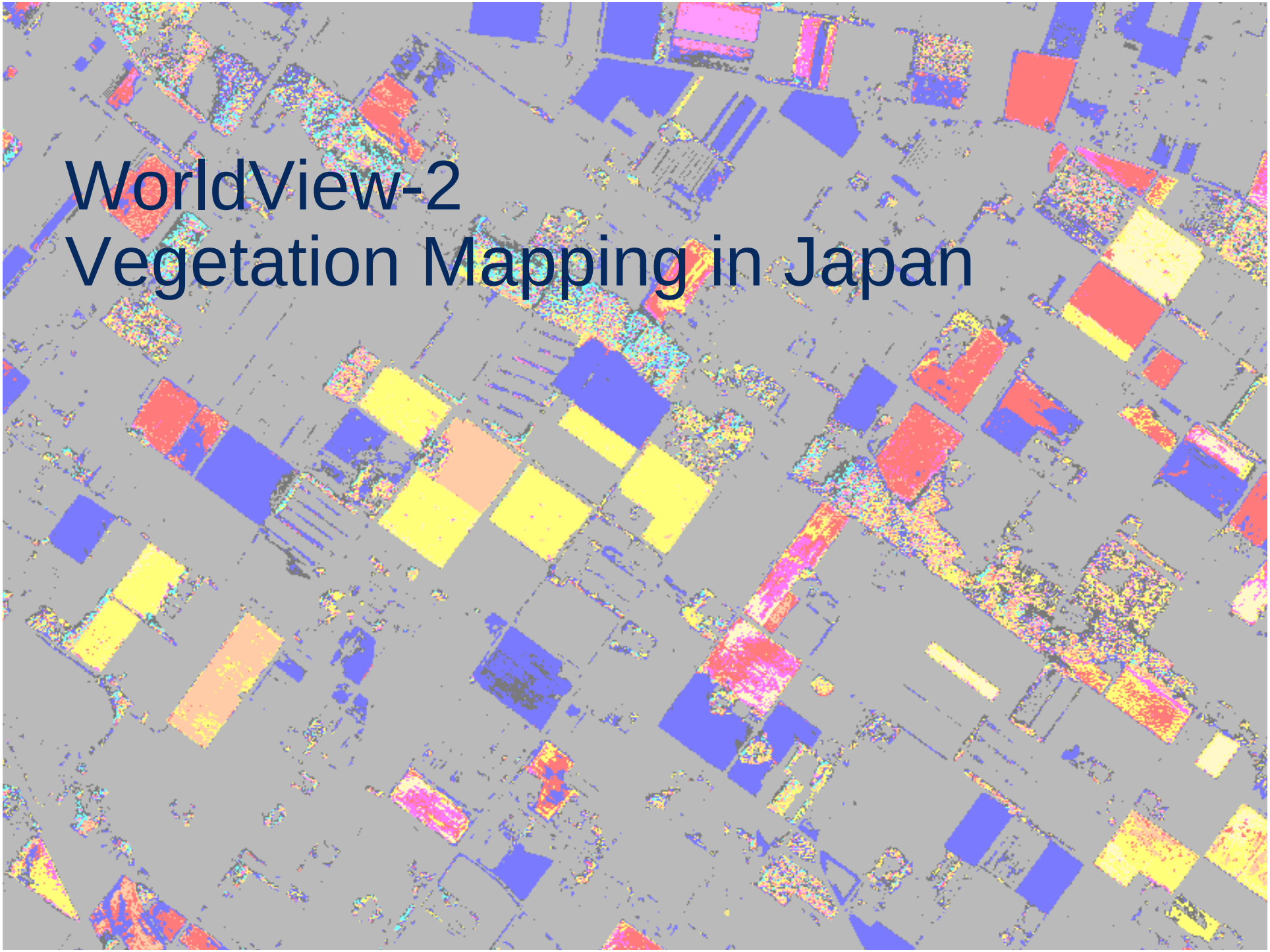
alunite

advanced argillic (alunite)
argillic (kaolinite)
phyllic

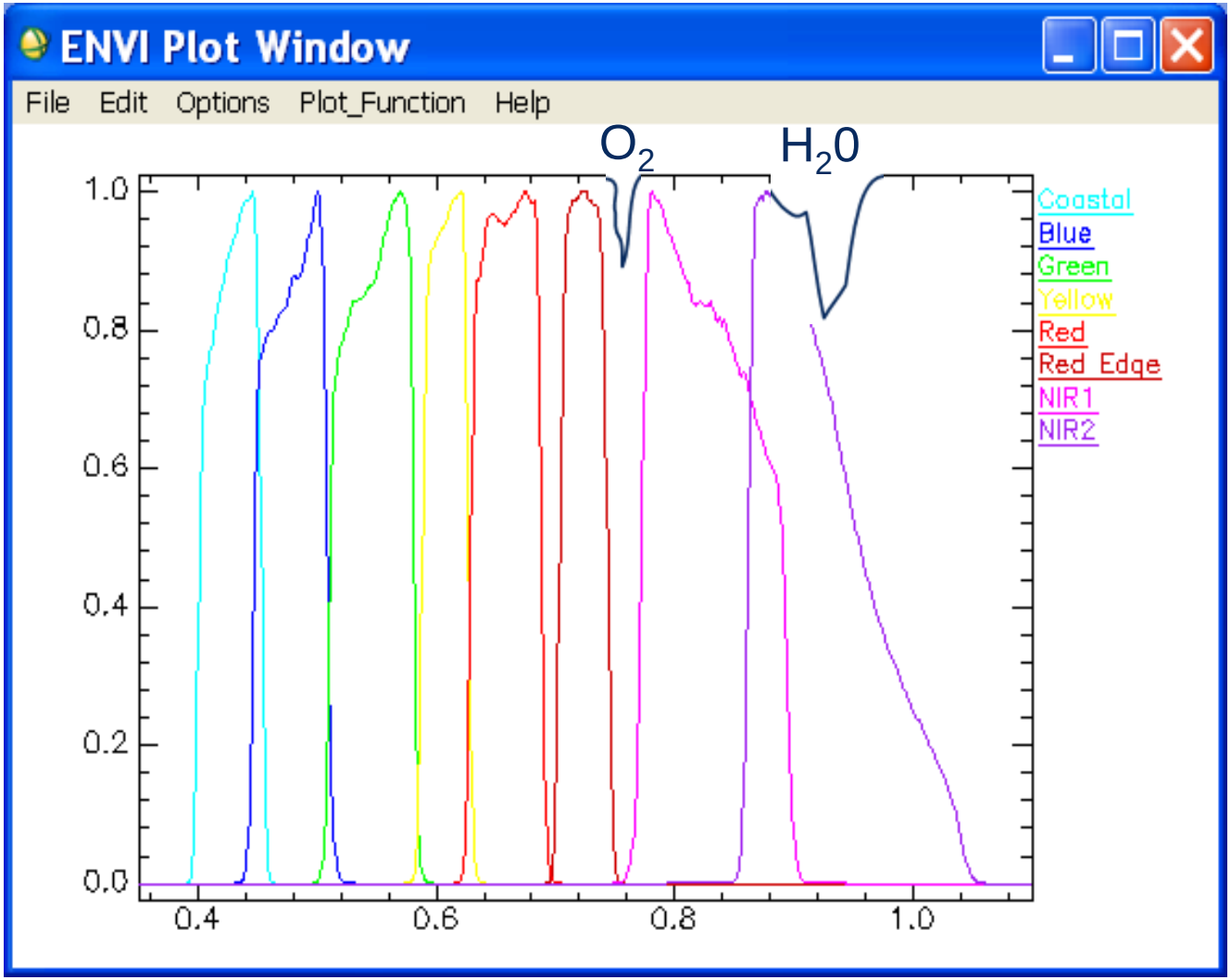


kaolinite-dickite

WorldView-2
Vegetation Mapping in Japan

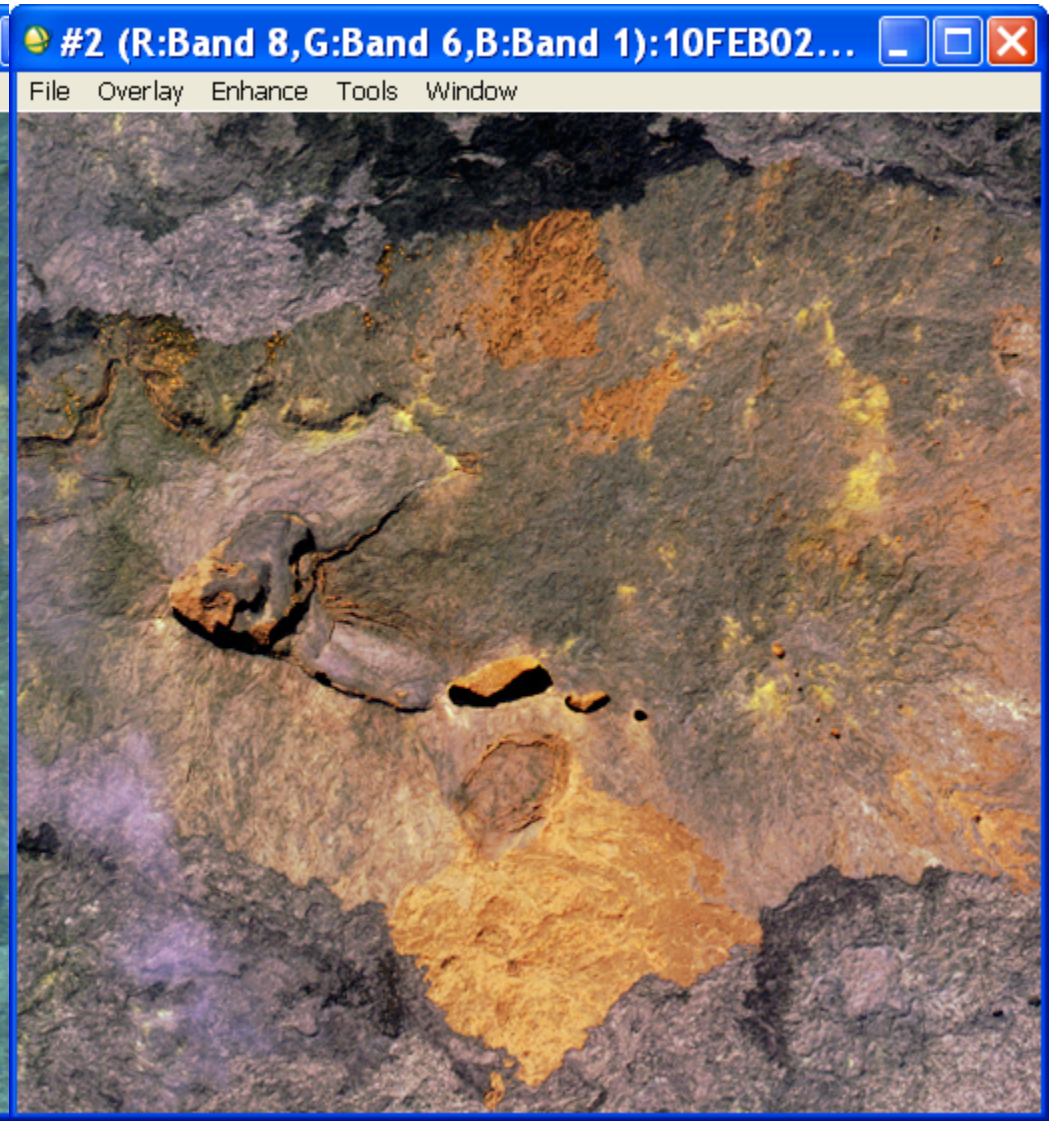


WorldView-2 Bandpasses and Atmospheric Gas Absorptions



WV-2 True Color NIR2,Red Edge,Coastal Blue

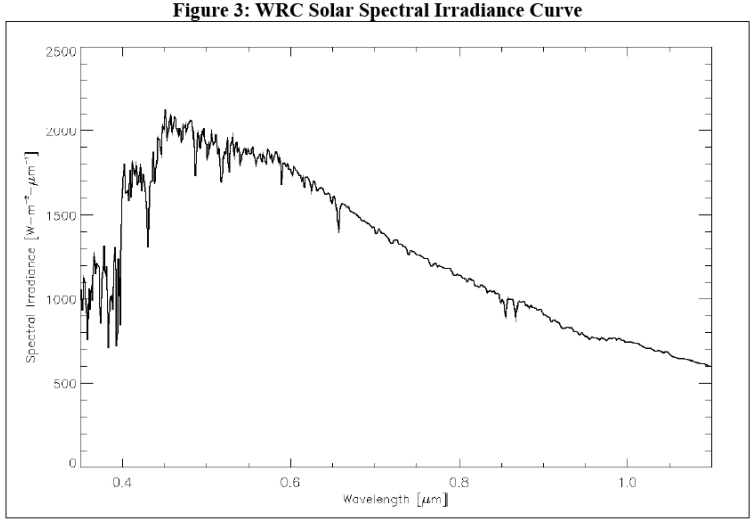
WV-2 CIR NIR2,Red Edge,Coastal Blue

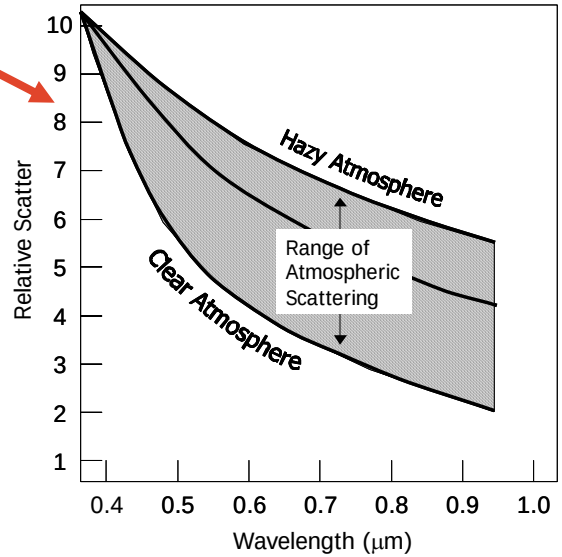


WorldView-2 Conversion to Reflectance

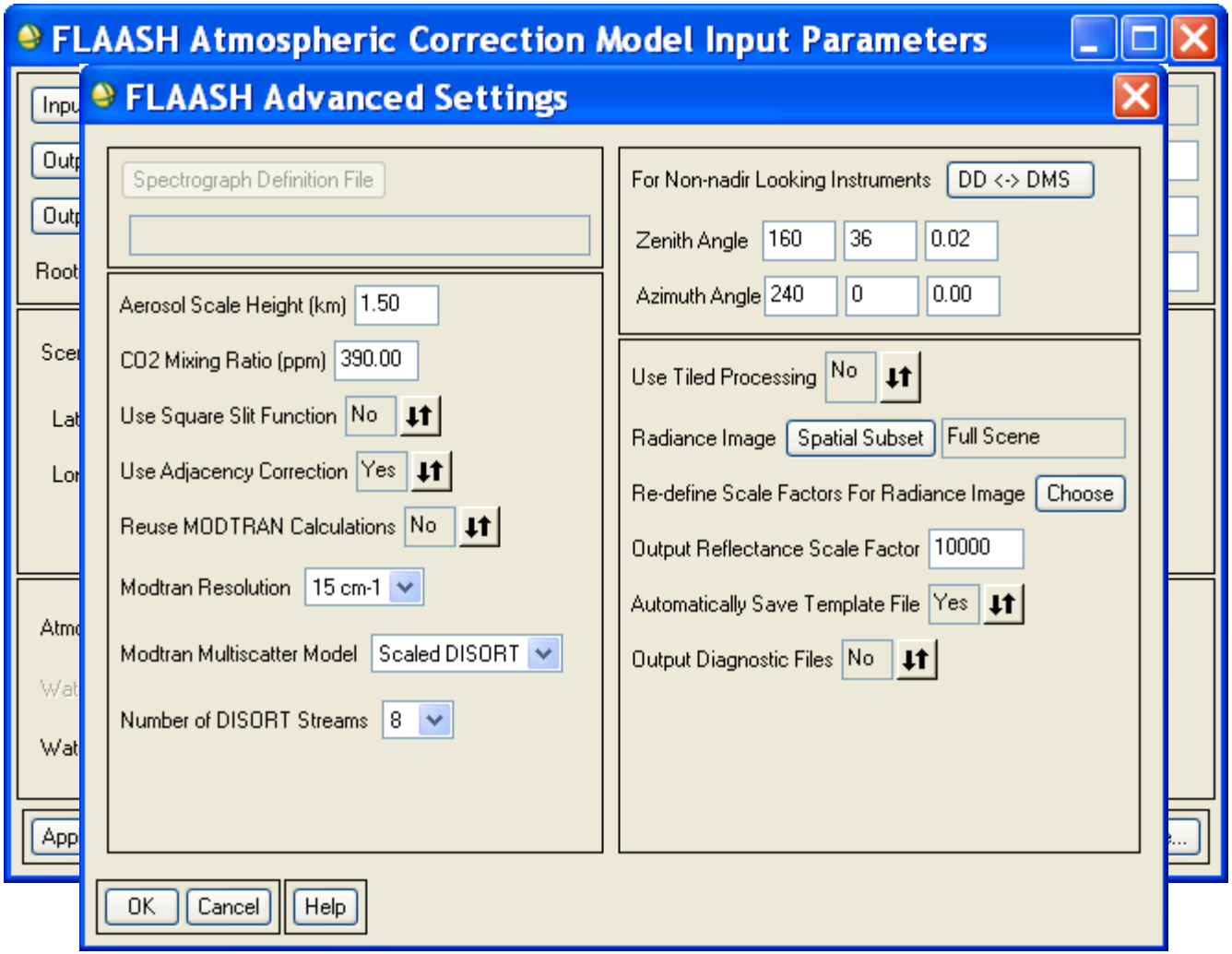
- ENVI - WorldView-2 Radiance tool
  - Factors from .IMD file
- Radiance data includes
  - solar irradiance curve
  - atmospheric gas absorptions
  - atmospheric scattering (path radiance)
- FLAASH - convert to reflectance

Figure 3: WRC Solar Spectral Irradiance Curve

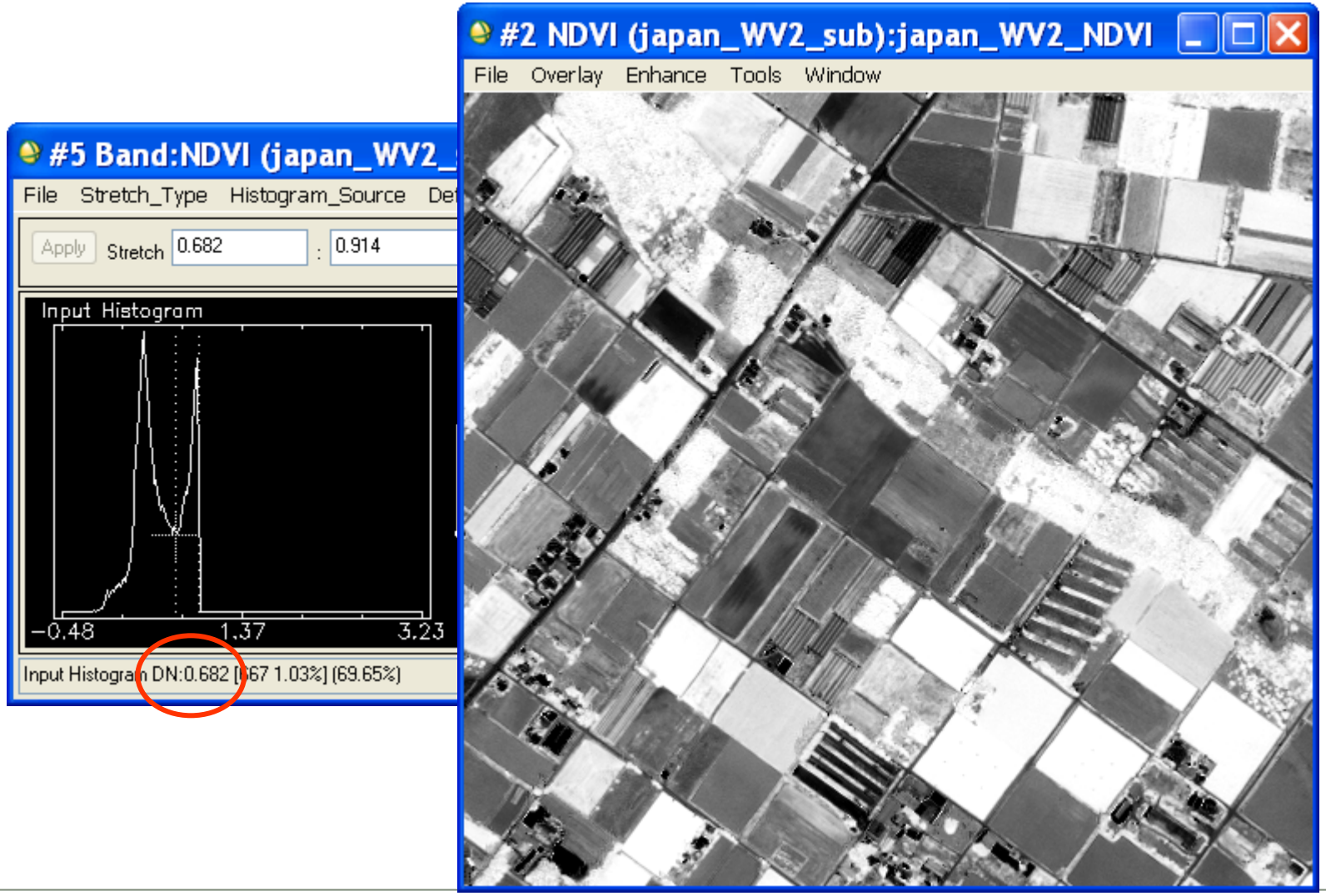




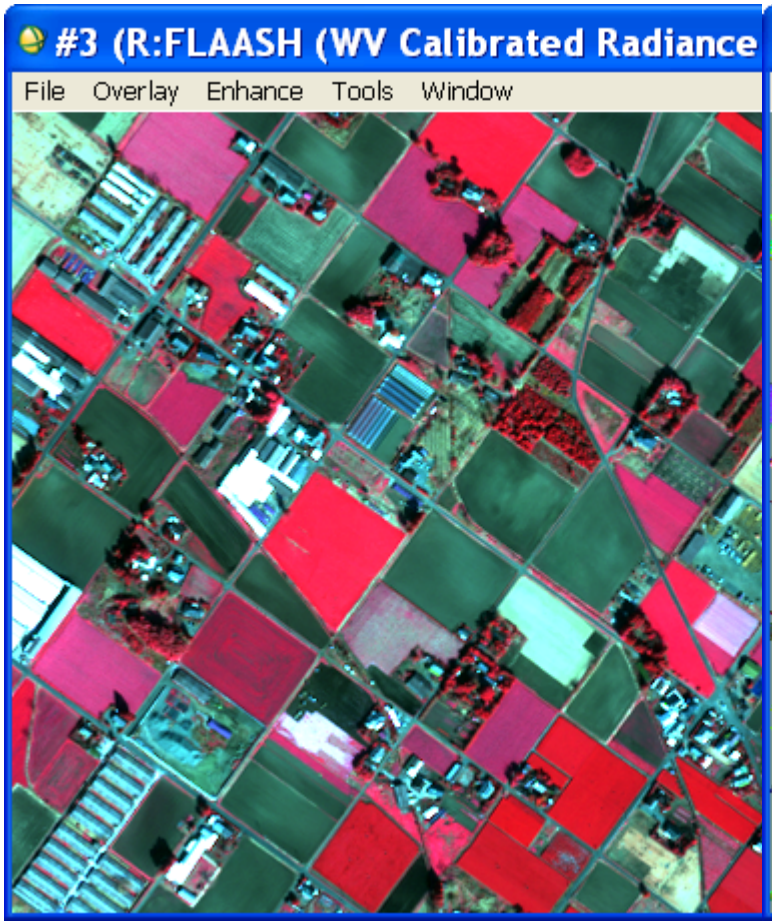
FLAASH


FLAASH Atmospheric Correction Model Input Parameters
FLAASH Advanced Settings
Spectrograph Definition File
Aerosol Scale Height (km) 1.50
CO2 Mixing Ratio (ppm) 390.00
Use Square Slit Function No
Use Adjacency Correction Yes
Reuse MODTRAN Calculations No
Modtran Resolution 15 cm-1
Modtran Multiscatter Model Scaled DISORT
Number of DISORT Streams 8
For Non-nadir Looking Instruments DD <-> DMS
Zenith Angle 160 36 0.02
Azimuth Angle 240 0 0.00
Use Tiled Processing No
Radiance Image Spatial Subset Full Scene
Re-define Scale Factors For Radiance Image Choose
Output Reflectance Scale Factor 10000
Automatically Save Template File Yes
Output Diagnostic Files No
OK
Cancel
Help

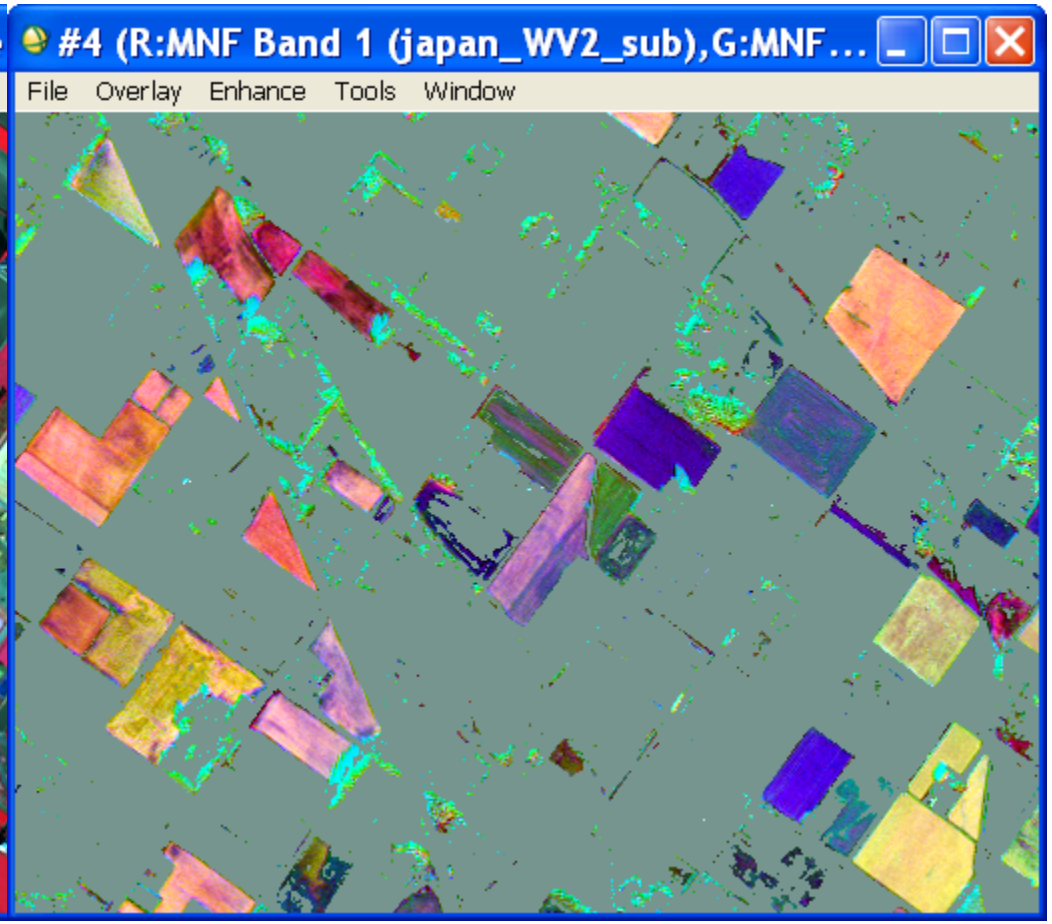
ENVI Processing - NDVI



ENVI Processing – MNF Transform (non-veg masked out)



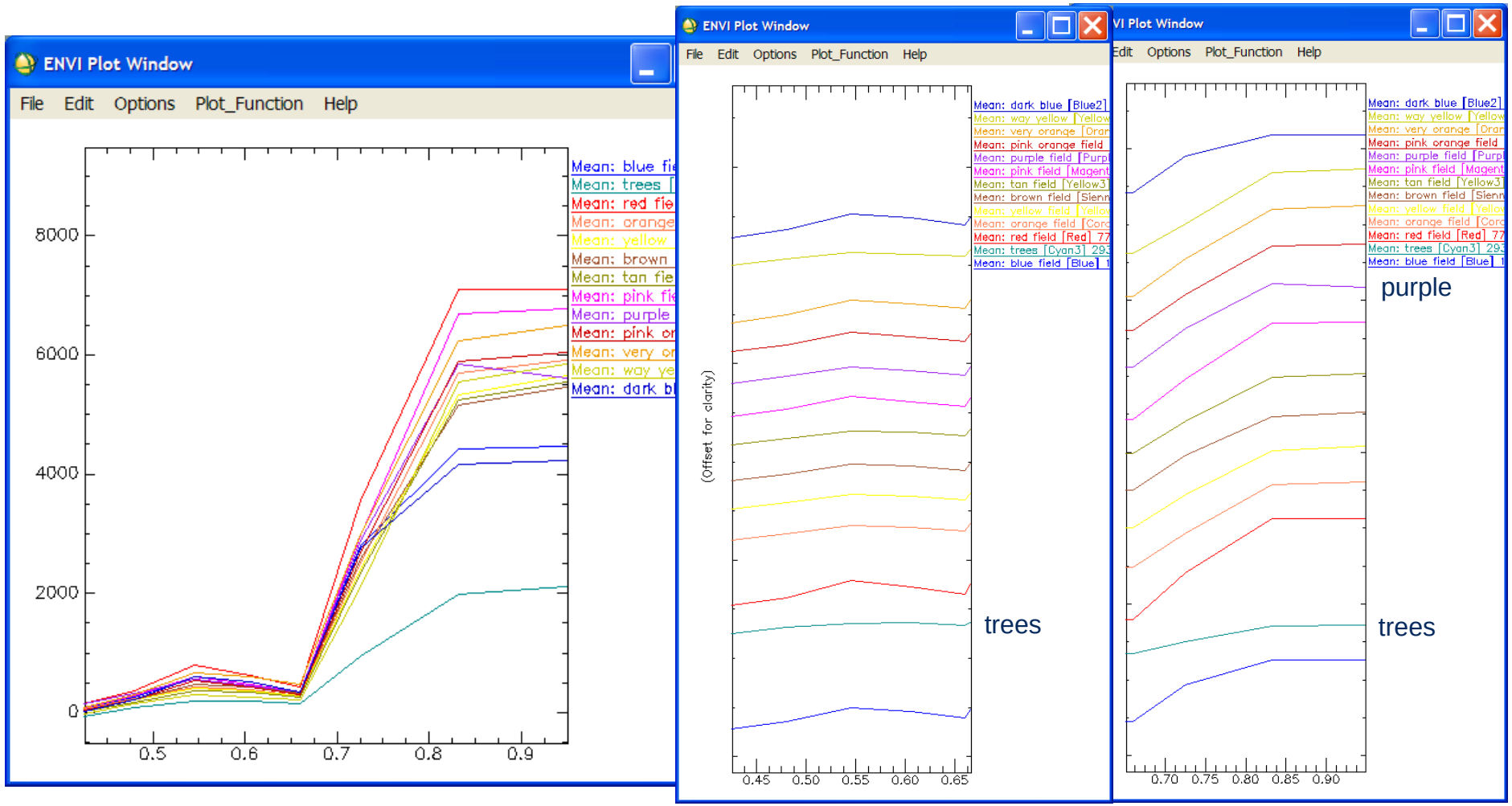
CIR



MNF bands 1,2,3 as RGB

WorldView-2 – Vegetation Reflectance Spectra

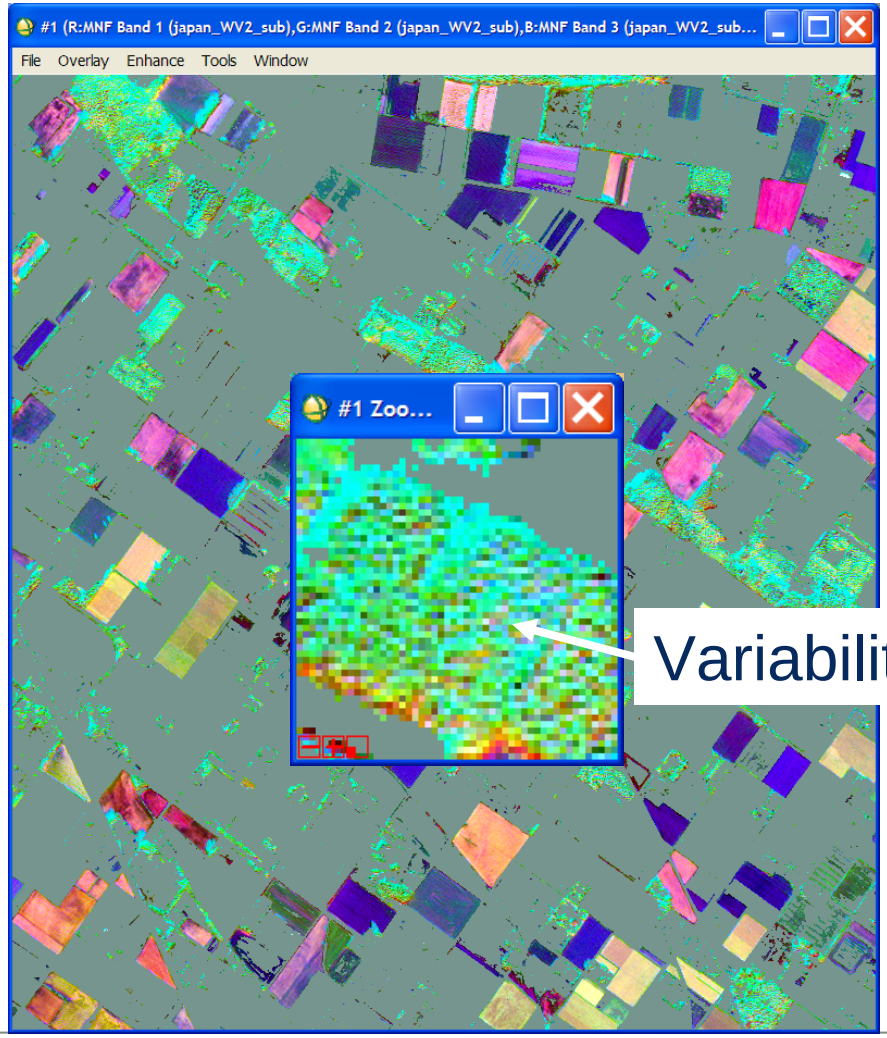
Mean spectra from training sites based on MNF data

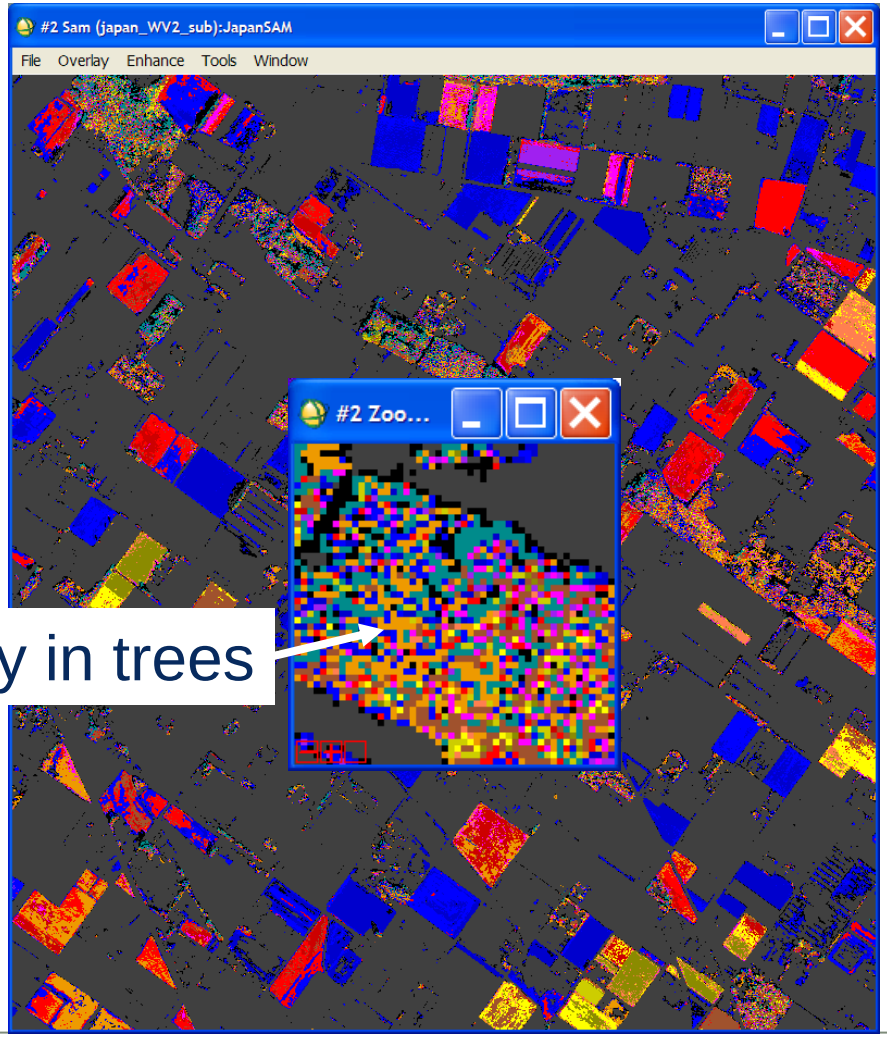


Visible **VNIR**

Matching Spectra using Spectral Angle Mapper

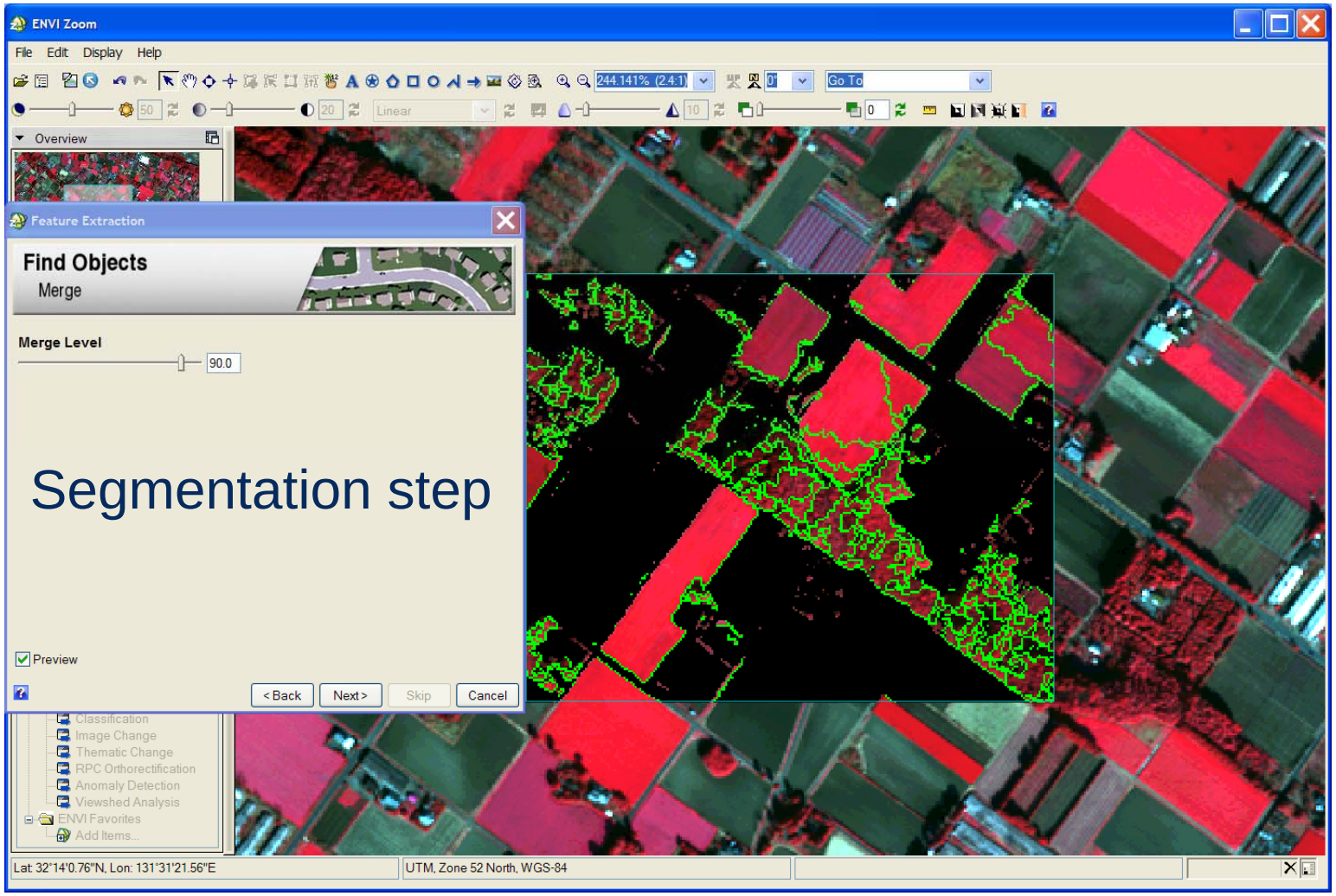
MNF SAM Classification





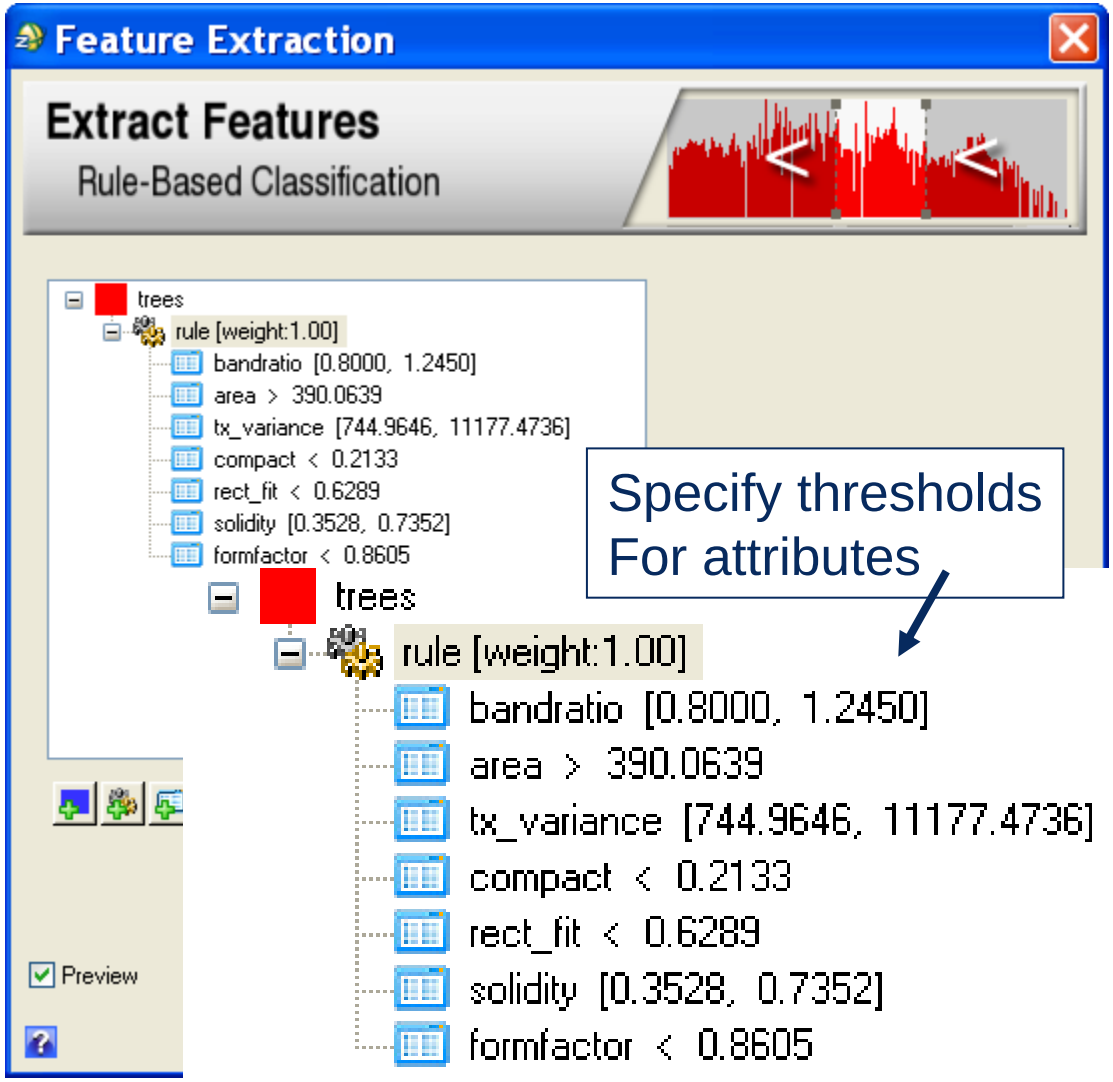
Variability in trees

ENVI Processing – Feature Extraction for Spatial and Spectral Mapping of Trees



Feature Extraction – Rule-based Classification

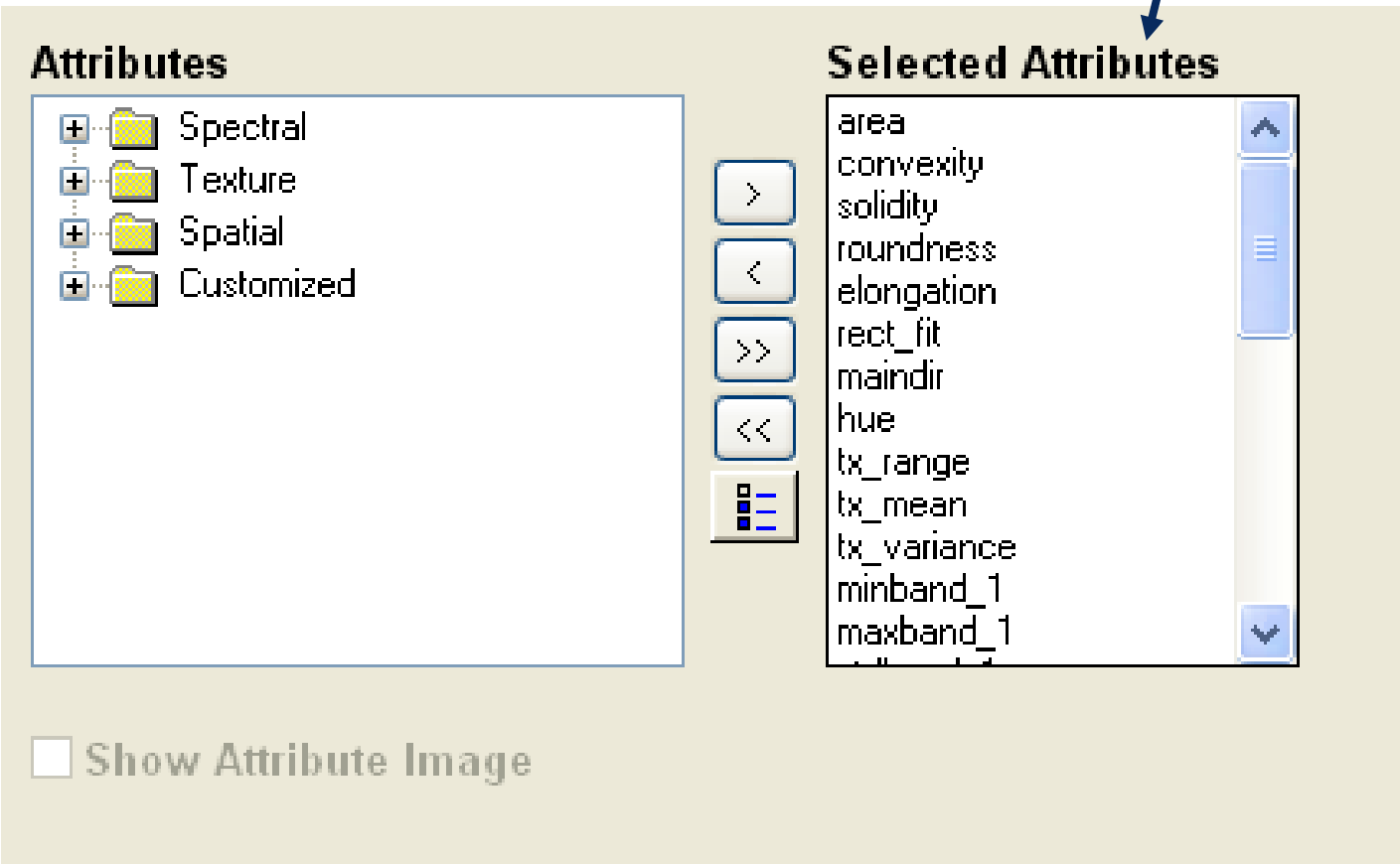
- **Spatial attributes**
  - Segment area, length, compactness, convexity, solidity, form factor, rectangular fit, roundness, elongation, main axis direction, axes length, number of holes, hole solid ratio.
- **Spectral attributes**
  - Band minimum, maximum, average and standard deviation
- **Texture attributes**
  - Variance, range, mean, and entropy
- **Color space and band ratio**
  - Hue, saturation, intensity, NDVI, or other ratios



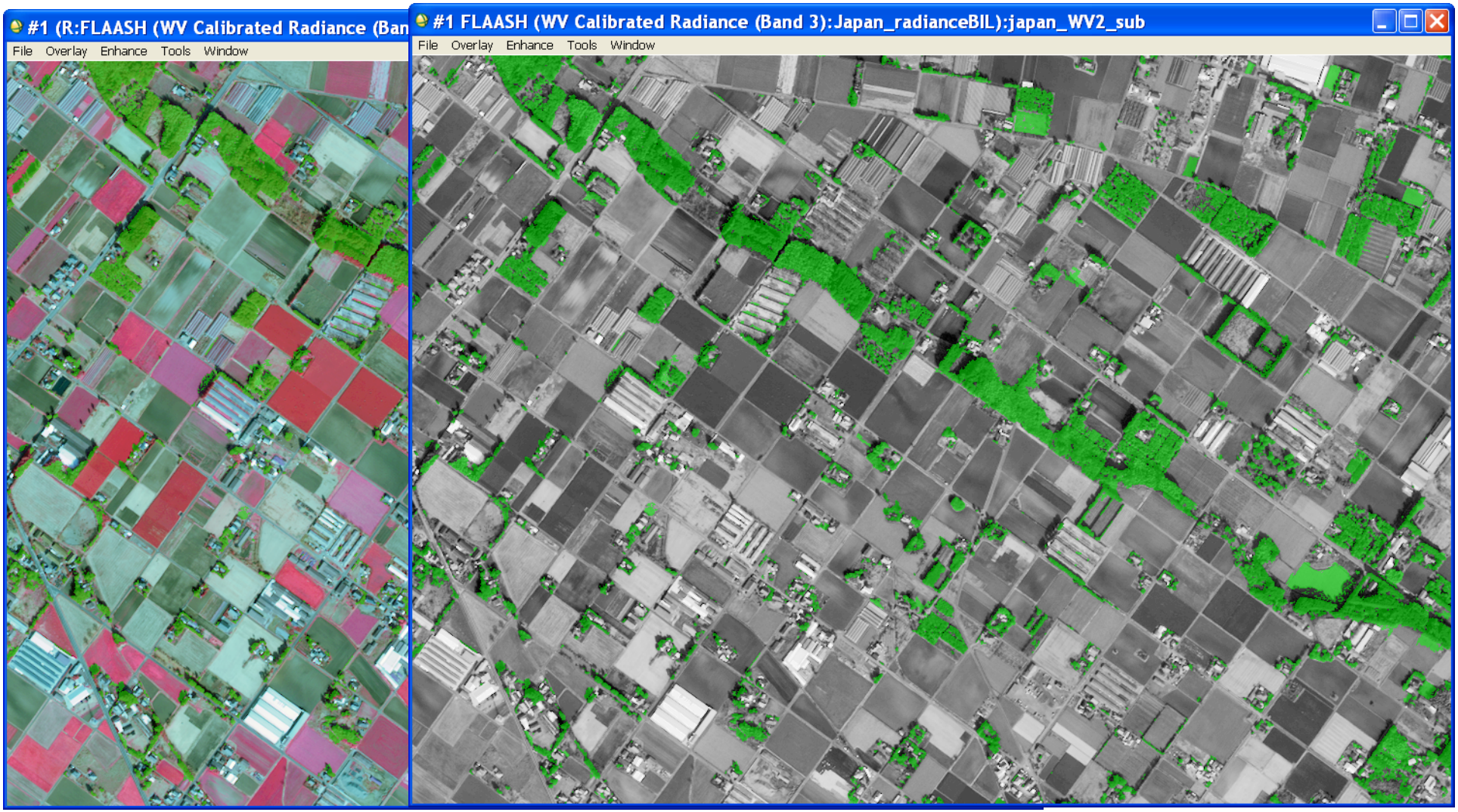
Feature Extraction - Supervised Classification

- Two classes specified
  - Trees
  - Fields

Fx automatically selects Best attributes



Feature Extraction - Supervised Classification - Trees



Questions?