



ENVI Processing of AVIRIS Hyperspectral
Data for Mineralogical Classification of
El Pico de Orizaba Volcano, Mexico.

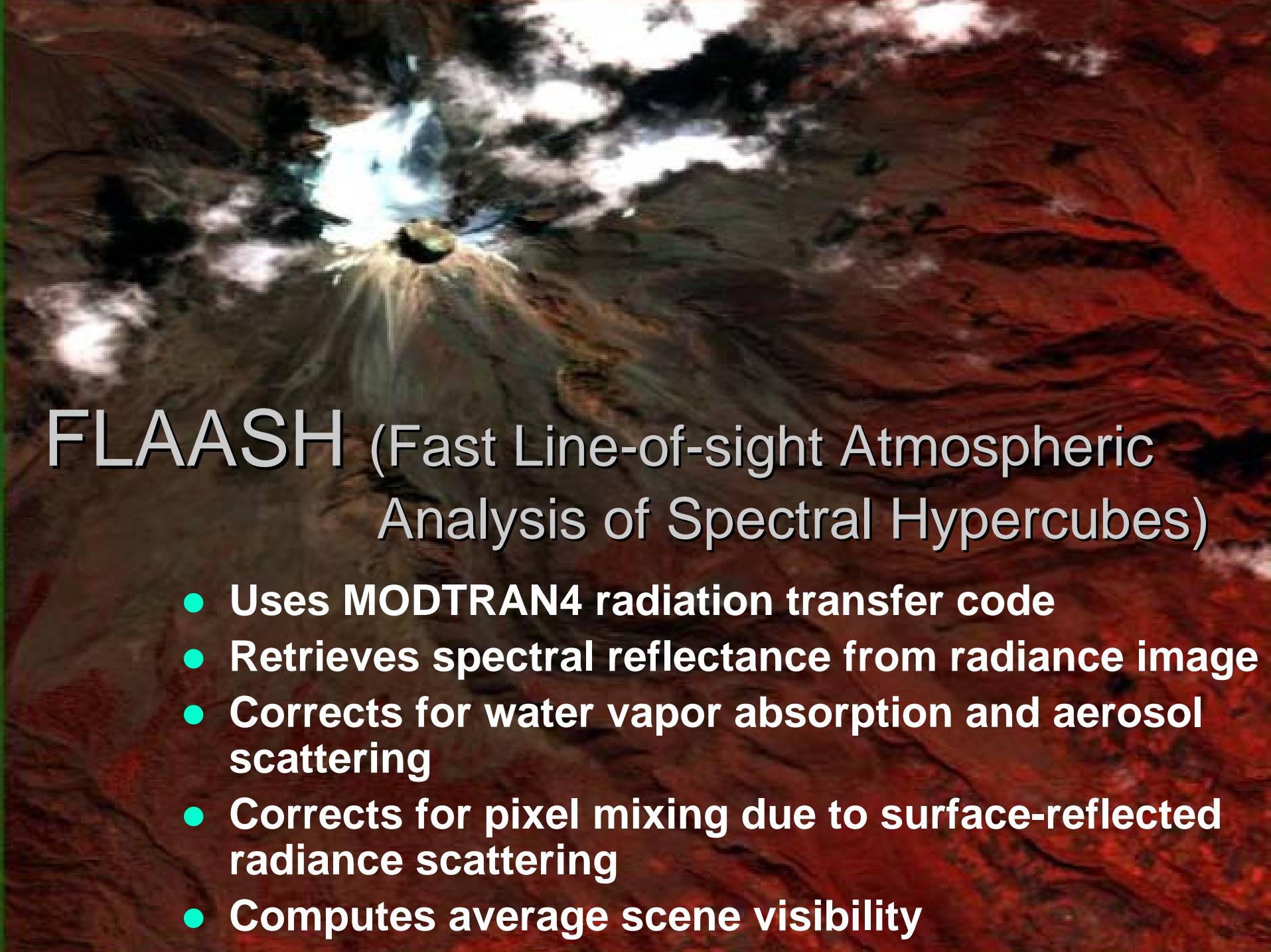


El Pico de Orizaba (Citlaltepetl)

- Tertiary-aged stratovolcano (elevation: 5605m/18389ft)
- Located at eastern edge of Trans-Mexican Volcano Belt
- Intermediate composition—alternating lava flows of andesite and dacite with periodic pyroclastic events
- Historical eruptions in 1537, 1542, 1566, and 1613
- Capped by the receding Jamapa glacier

AVIRIS (Airborne Visible/Infrared Imaging Spectrometer)

- Whiskbroom-scanned linear array
- Collects data in 224 spectral channels (10nm each) from 400 to 2500 nm
- Flown aboard NASA/ARC ERS-2 at an altitude of 20km; image area is 11x9km
- 20m spatial resolution, 12-bit data collection processed to 16-bit expanded



FLAASH (Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes)

- Uses MODTRAN4 radiation transfer code
- Retrieves spectral reflectance from radiance image
- Corrects for water vapor absorption and aerosol scattering
- Corrects for pixel mixing due to surface-reflected radiance scattering
- Computes average scene visibility

(RGB:50,20,10)

FLAASH Input Parameters

- Scene Center Location (Lat/Long)
- Sensor Type, Sensor Altitude (km)
- Ground Elevation (km), Pixel Size (m)
- Flight Date, Flight Time GMT



FLAASH Input Parameters

- Atmospheric Model (based on surface air temp)
- Water Retrieval (Y/N)—Absorption Feature (1135nm)
- Aerosol Model (standard MODTRAN aerosol types)
- Aerosol Retrieval (Y/N)—Initial Visibility (km)
- Spectral Polishing (Y/N)—Width (# of Bands)
- Wavelength Recalibration (Y/N)



Spectral Hourglass Wizard

- **Semi-automated image processing and classification**
 - **Minimum Noise Fraction (MNF) transformation separates data from noise, reduces dimensionality**
 - **Pixel Purity Index (PPI) to determine spectrally pure pixels for endmember selection**
 - **n-Dimensional Visualizer to manipulate data and collect endmembers**
 - **Classification methods include: Spectral Angle Mapper (SAM) and Mixture-Tuned Matched Filtering (MTMF)**

(SAM.ROI)

Classification Results

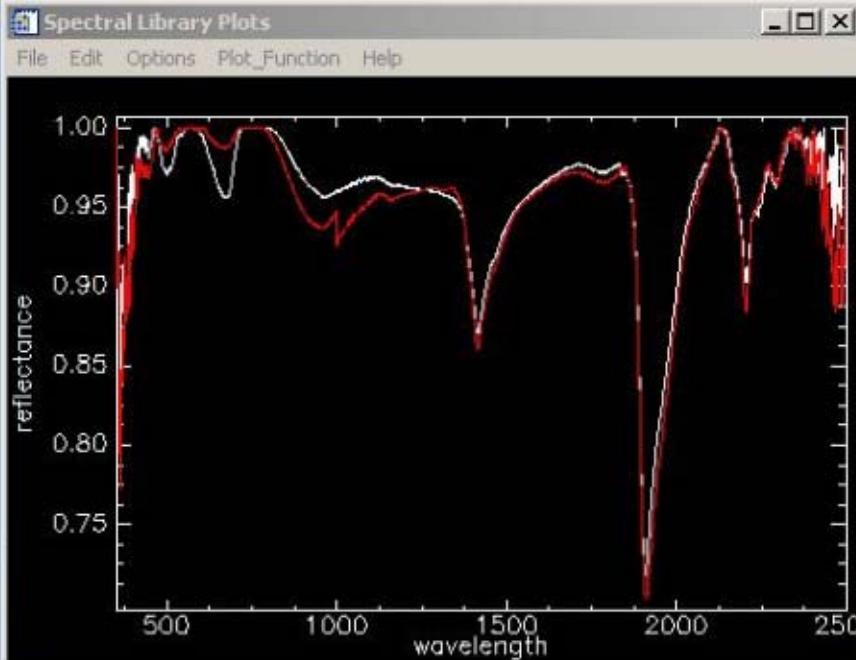
- **SHW and Spectral Angle Mapper (SAM) classification yielded 36 discrete classes**

Classification Results

- Several classes merged together on glacier and in clouds
- Selected Legend
 - Main Cone
 - Glacier
 - Clouds
 - Agriculture
 - Trees (mango?)
 - Unclassified <off>

Spectral Analyst

- **USGS Mineralogical Spectral Library Matching**
 - 3 methods: Spectral Angle Mapper, Spectral Feature Fitting, and Binary Encoding
- **Field Sample Spectroradiometer Measurements**
 - Applied Spectral Devices Field-Spec Pro



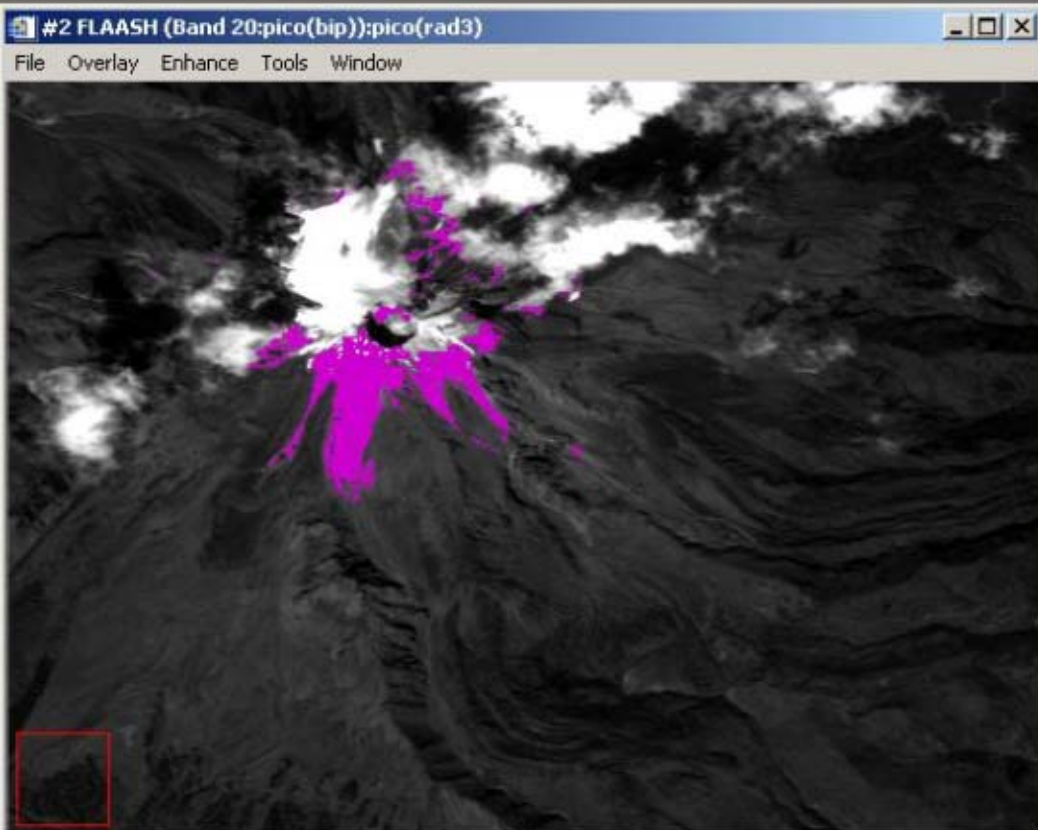
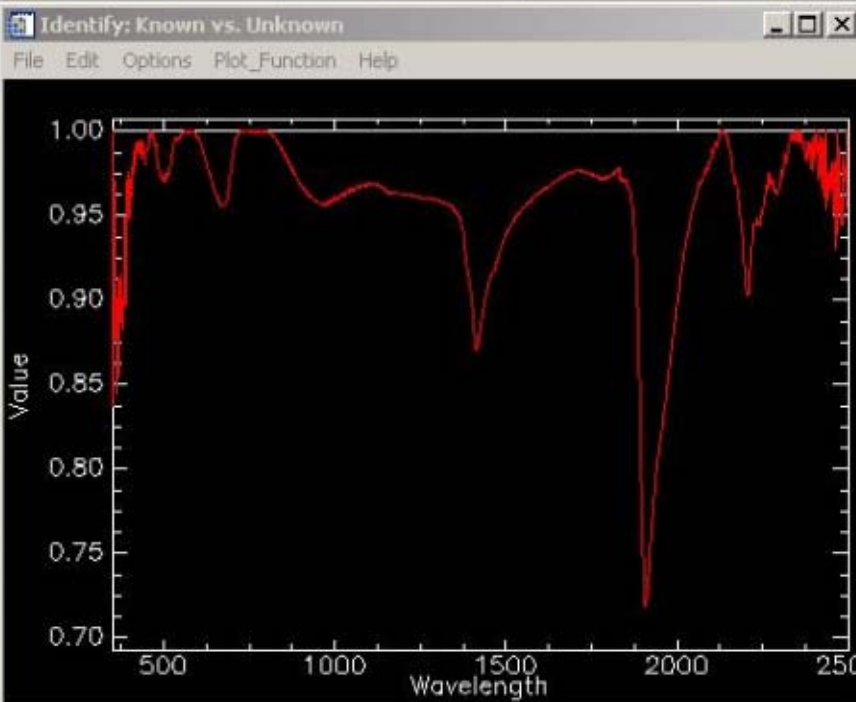
Spectral Analyst

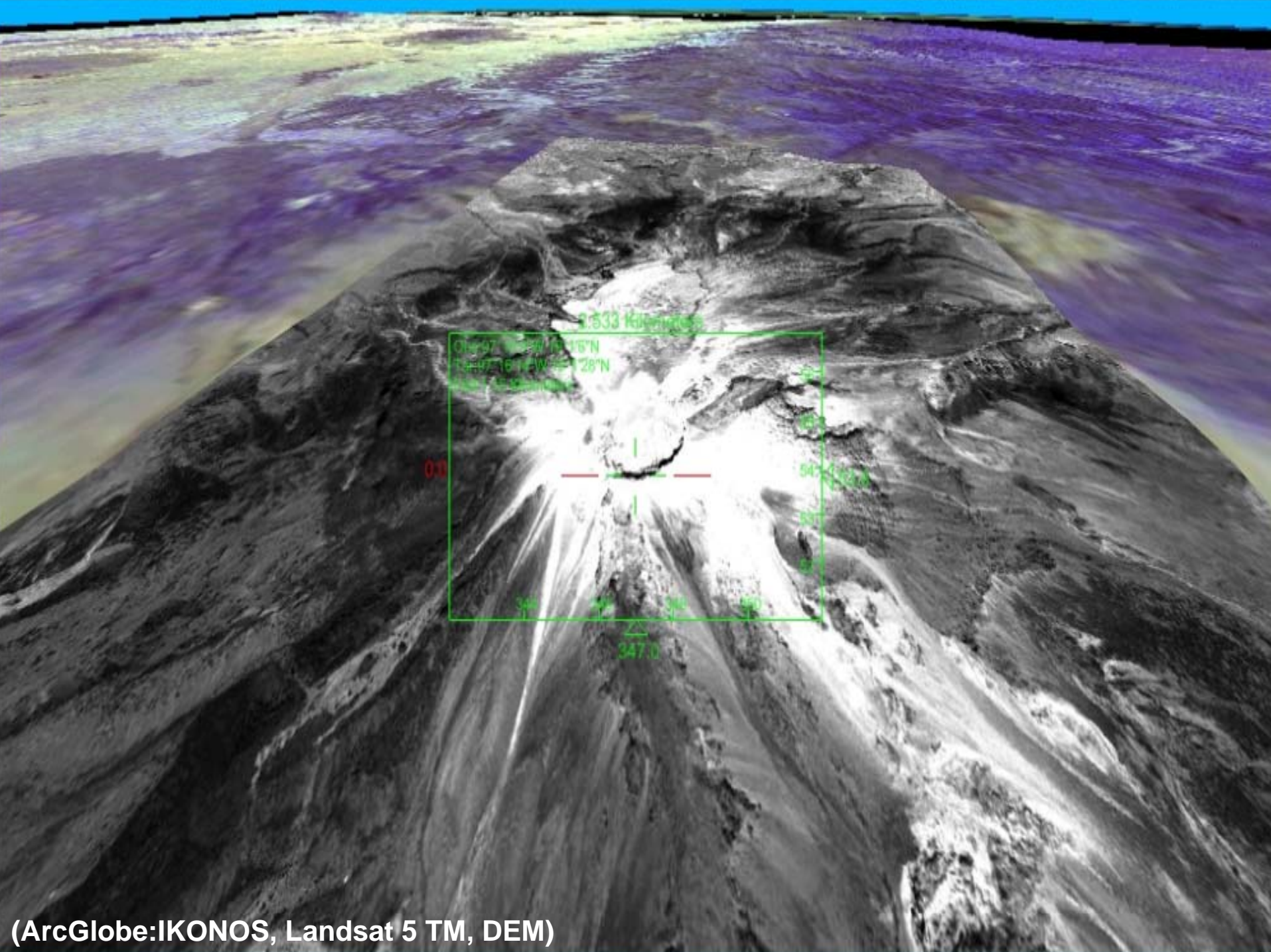
File Options

Unknown: wt.001

Library Spectrum	Score	SAM	SFF
olivineg.spc Olivine	[1.159]	{0.649}	{0.510}
andrad11.spc Andradi	[1.050]	{0.567}	{0.483}
monazite.spc Monazit	[0.976]	{0.464}	{0.512}
rutile2.spc Rutile H	[0.975]	{0.466}	{0.509}
neodymiu.spc Neodymi	[0.975]	{0.461}	{0.514}
hapatite.spc Hydroxy	[0.974]	{0.462}	{0.512}
augite3.spc Augite W	[0.974]	{0.461}	{0.513}
siderite.spc Siderit	[0.974]	{0.461}	{0.513}
actinol1.spc Actinol	[0.974]	{0.464}	{0.509}
alunite4.spc Alunite	[0.973]	{0.461}	{0.512}
hedenbel.spc Hedenbe	[0.973]	{0.463}	{0.511}
topazc.spc Topaz Lit	[0.973]	{0.462}	{0.511}

Apply Cancel Help

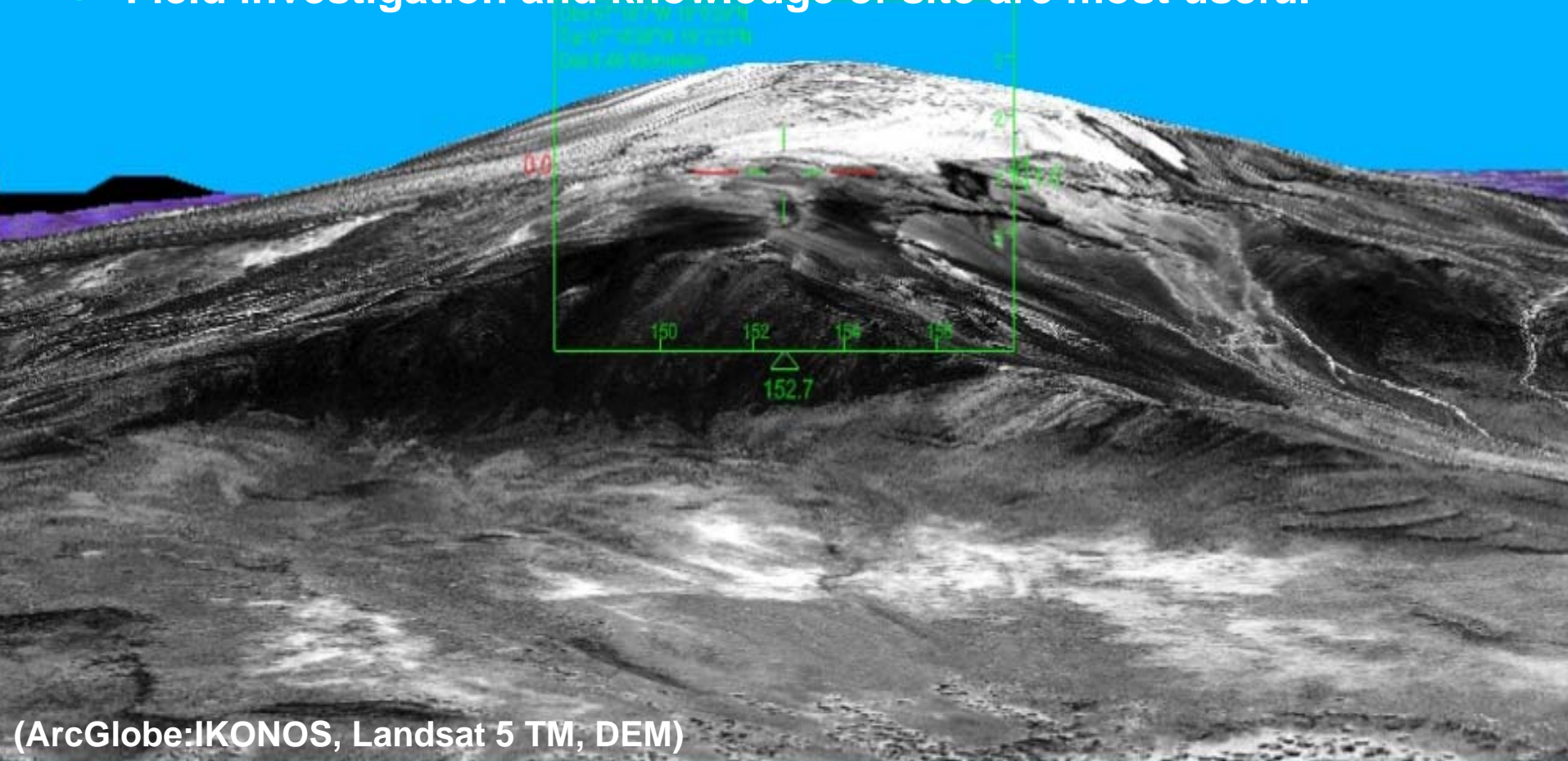




(ArcGlobe:IKONOS, Landsat 5 TM, DEM)

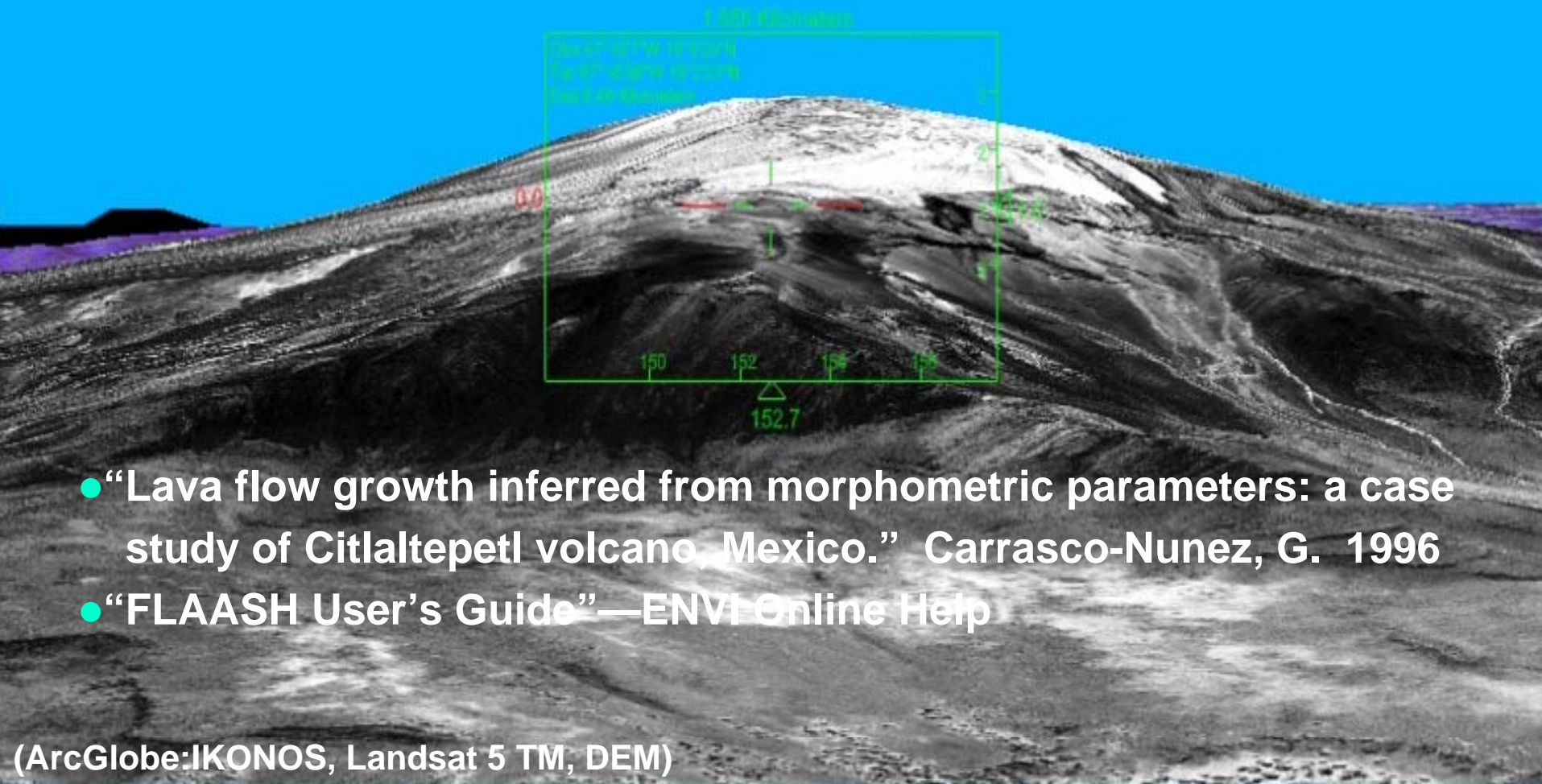
Conclusions

- Hyperspectral data is toilsome to manipulate correctly
- FLAASH is extremely powerful for atmospheric correction
- SHW and SAM classification need supervision and revision
- Spectral Analyst and library matching are indispensable
- Field investigation and knowledge of site are most useful



References

- “Imaging Spectroscopy and the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS).” Green, et al. 1998
- “Stratovolcano stability assessment methods and results from Citlaltepctl, Mexico.” Zimbelman, et al. 2003



- “Lava flow growth inferred from morphometric parameters: a case study of Citlaltepctl volcano, Mexico.” Carrasco-Nunez, G. 1996
- “FLAASH User’s Guide”—ENVI Online Help