SOFTWARE FOR THE DERIVATION OF SCALED SURFACE REFLECTANCES FROM AVIRIS DATA

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1. INTRODUCTION

An operational software program is now available for deriving "scaled surface reflectances" from spectral data collected by the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) (Vane, 1987). The program simulates both the atmospheric scattering and absorption effects. Brief descriptions of the algorithm, inputs, outputs, the limitations of the software, and procedures for obtaining the software are given.

2. FUNCTIONAL OVERVIEW

The program derives scaled surface reflectances using an approximate atmospheric radiative transfer model. Horizontal surfaces having Lambertian reflectances are assumed. The scaled surface reflectances can be converted to the real surface reflectances if the slopes and aspects of the surfaces are known. For simplicity, the scaled surface reflectances are referred to as "surface reflectances" in this document.

The atmospheric scattering effects are modeled using the Simulation of the Satellite Signal in the Solar Spectrum (5S) code (Tanre et al. 1986). The transmittances of seven gases are calculated based on an assumed atmospheric model, the solar and observational geometries, and using the Malkmus (1967) narrow band spectral model. Water vapor values are derived from AVIRIS data in the 0.94 μm and 1.14 μm regions using a 3-channel ratioing technique and a look-up table procedure. The derived water vapor values are used in the process of removing atmospheric gaseous absorption effects from AVIRIS data. Fig. 1a shows an AVIRIS spectrum over a vegetated area. Fig. 1b shows the corresponding derived surface reflectance spectrum.

3. INPUT DATA

The program requires an input file containing information on the AVIRIS scene including geometric parameters, spectral parameters, atmospheric parameters, and input/output parameters. Table 1 shows a sample input file. The input values are based on information provided with the AVIRIS data and knowledge of the aerosol condition when the data were collected. The program can be executed without the need of any field measurements as inputs. However, a measurement of the aerosol optical depth when the AVIRIS data were collected will improve the accuracy of the derived surface reflectances. The input data are described further below:

1. Geometric Parameters
   - Date and Time: the date and time in GMT that the AVIRIS data was measured.
   - Latitude and Longitude: the latitude and longitude of the center position of the AVIRIS scene.

2. Spectral Parameters
   - Wavelength File: the name of the AVIRIS wavelength file.

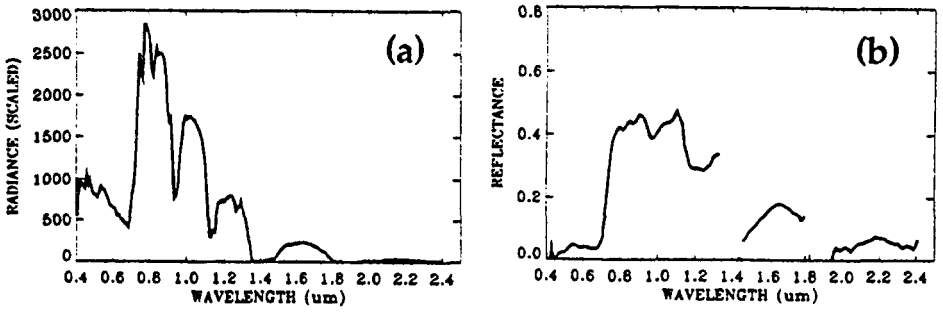

Figure 1. (a): An AVIRIS spectrum over a vegetated area, and (b) the corresponding derived surface reflectance spectrum.

Table 1. An example input file.

Input	Comment
07 23 1990 20 58 32	date and time
37 30 08	latitude
N	hemisphere of the earth (N or S)
117 13 17	longitude
W	hemisphere of the earth (E or W)
/tmp/aviris.wav	wavelength file
10.	spectral resolution of AVIRIS data
1	channel ratio parameters (if "0", defaults used)
0.8630 1.0550 3 3 0.9398 7	
1.0550 1.2470 3 3 1.1414 7	
2	atmospheric model number
1 1 1 1 1 1 1	gas selectors
0.34	total column ozone amount (atm-cm)
1 100	aerosol model and visibility
1.5	average elevation of the surface scene
/tmp/aviris.cub	input AVIRIS data
0	input AVIRIS dimensions
/tmp/aviris_atm.cub	output image file
10.	output data resolution
/tmp/aviris.vap	output water vapor file
/tmp/aviris.lib	output spectral library file

- Spectral Resolution: the AVIRIS spectral resolution in nanometers.
- Channel Ratio Parameters: the center positions and widths of window channels and absorption channels for the 0.94-μm and the 1.14-μm water vapor bands.

3. Atmospheric Parameters
   - Atmospheric Model: a model atmosphere close to the measurement condition.
   - Gas Selectors: indicators for determining which of the seven gases that have absorption features in the 0.4-2.5 μm will be included in atmospheric gaseous transmission calculations. The seven gases are water vapor, carbon dioxide, ozone, nitrous oxide, carbon monoxide, methane, and oxygen.
   - Total Ozone: the vertical column amount of ozone (in units of atm-cm) that is contained in the atmosphere (typically 0.34 atm-cm).
   - Aerosol Model and Visibility or Optical Depth at 0.55 μm: a model of the aerosol conditions and the visibility or the optical depth at 0.55 μm when the AVIRIS measurements were made.

- Average Elevation: the average elevation (in units of km) of the scene.

4. Input/Output Parameters
   - Input AVIRIS Image: the path and file name of the input AVIRIS data.
   - Input AVIRIS Image Dimensions: the dimensions of the input AVIRIS image including the header size in bytes, the number samples, the number of lines, the number of channels, and the storage order.
   - Output Image File: the path and file name of the output surface reflectance data.
   - Output Spectral Resolution: the desired resolution of the output spectra in nanometers. If the output spectral resolution is coarser than the input spectral resolution, then the output spectra will be smoothed using a gaussian function.
   - Output Water Vapor File: the path and file name of output water vapor image file.
   - Output Spectral Library File: the path and file name of output spectral library file.

4. OUTPUT DATA

1. Surface Reflectance Image
   a surface reflectance image that has the same size as the input AVIRIS image.
2. Water Vapor Image
   a single spatial image containing the column water vapor amount at each pixel.
3. Transmittance Lookup Table
   a file containing atmospheric transmittance spectra and band ratios for each of the 60 column water vapor values.

5. LIMITATIONS

The elevations within an image are not allowed to vary. As a result, the program is mostly applicable to images with surface elevation variations less than about 1 km. The atmospheric adjacency effect and the topographic adjacency effect are not modeled. When using our program for surface reflectance retrievals, the band positions between observed and calculated spectra must be matched to 0.5 nm or better.

6. SOFTWARE AVAILABILITY

The source code and user documentation is provided free of charge or royalties. However, CSES retains the title and copyright to the software and documentation. Recipients of this software are required to execute a memorandum of understanding (MOU) provided by CSES that specifies in detail all of the associated conditions. Send requests for an MOU to:

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7. ACKNOWLEDGEMENTS

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8. REFERENCES

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