SITE AVIRIS IMAGES, 1992 (ACCP)
Get Data

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Summary:

Ten scenes of imaging spectrometer data from the Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) were acquired in 1992 over various Accelerated Canopy Chemistry Program (ACCP) selected sites. These data were processed using the ATmosphere REMoval Program (ATREM) to provide atmospheric corrections and yield apparent surface reflectance. Additional corrections to selected scenes were provided using ground-measured spectra from the Wisconsin site and a multivariate noise reduction algorithm. Selected pixels that coincided with ACCP field study plots within a site were extracted from each of the scenes.

Citation:

Cite this data set as follows (citation revised on September 30, 2002):

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Table of Contents:

1. Data Set Overview:

Data Set Identification:

SITE AVIRIS IMAGES, 1992 (ACCP)

Data Set Introduction:

Ten scenes of imaging spectrometer data from the Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) were acquired in 1992 over various Accelerated Canopy Chemistry Program (ACCP) selected sites. These data were processed using the ATmosphere REMoval Program (ATREM) to provide atmospheric corrections and yield apparent surface reflectance. Additional corrections to selected scenes were provided using ground-measured spectra from the Wisconsin site, and a multivariate noise reduction algorithm. Selected pixels that coincided with ACCP field sites were extracted from each of the scenes.

Objective/Purpose:

The purpose of this data set was to measure spectra of naturally occurring canopies where the chemical constituents were measured.

Summary of Parameters:

The AVIRIS measured reflected radiance of 20 x 20 meter pixels in 224 narrow spectral bands. The resulting image "cube" consisted of 614 samples by 512 lines by 224 spectral bands.

Discussion:

Related Data Sets:

- Leaf Chemistry, 1992-1993 (ACCP)
- Seedling Canopy Chemistry, 1992-1993 (ACCP)
- Calculated Leaf Carbon and Nitrogen (ACCP)
- Visible and Near-Infrared Leaf Reflectance Spectra, 1992-1993 (ACCP)
- Seedling Canopy Reflectance Spectra, 1992-1993 (ACCP)

2. Investigator(s):

Investigator(s) Name and Title:

Kathy Heidebrecht, Imaging Specialist

Title of Investigation:

ACCP Site and Study Plot AVIRIS Data

Contact Information:

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3. Theory of Measurements:

Measuring spectra of 20 x 20 square meter canopies provides measurements of the combination of the leaf spectral signature plus the effects of the surrounding canopy architecture.

4. Equipment:

Sensor/Instrument Description:

Airborne Visible and Infrared Imaging Spectrometer

Collection Environment:

Instrument mounted in NASA's ER-2 aircraft flying at 20 km above sea level.

Source/Platform:

NASA's ER-2.

Source/Platform Mission Objectives:

To collect imaging spectrometer data for a surface area of approximately 12 km x 5 km.

Key Variables:

The fractional amount of reflected incident solar irradiance.

Principles of Operation:

AVIRIS measures data at 10 nm intervals between .4 microns and 2.5 microns resulting in 224 spectral bands. The spectral resolution varies between 10 nanometers in the .4 - 1.8 micron region to approximately 15 nanometers in the 1.9-2.5 micron region.

Sensor/Instrument Measurement Geometry:

Nadir looking.

Manufacturer of Sensor/Instrument:

Not available.

Calibration:

Specifications:

Not available.

Tolerance:

Not available.

Frequency of Calibration:

Not available.

Other Calibration Information:

Not available.

5. Data Acquisition Methods:

The AVIRIS instrument is flown at 20 kilometers in an ER-2 aircraft. As the plane flies over the study area, the AVIRIS instrument is turned on. It takes approximately two minutes to measure a 12 x 10 kilometer area (614 samples x 512 lines x 224 bands).
As the AVIRIS instrument flies, it acquires data in what is called a "run". In this run, there are always 614 samples (cross-track), 224 bands, and any number of lines. At the AVIRIS data processing facility, the runs are chopped up into 512 line data cubes or "scenes". So, for one run, you may have multiple 512-line scenes, and possibly the last scene has less than 512 lines.

6. Observations:

Data Notes:

Not applicable.

Field Notes:

Not applicable.

7. Data Description:

Spatial Characteristics:

Spatial Coverage:

- Harvard Forest, MA, latitude 42.4950, longitude -71.7981
- Blackhawk Island, WI, latitude 43.6333, longitude -89.7583
- Howland, ME, latitude 45.2222, longitude -68.7356
- Gainesville, FL, latitude 29.7000, longitude -82.1667
- Jasper Ridge, CA, latitude 37.4111, longitude -121.7631
- Dunnigan, CA, latitude 38.9167, longitude -120.1122
- Pleasant Grove, CA, latitude 38.7292, longitude -120.4581

Spatial Coverage Map:

Not applicable.

Spatial Resolution:

Pixels are 20 x 20 meters. The total coverage was 614 samples yielding a swath width of approximately 12 kilometers. The flightline length varied on a per site basis.

Projection:

Not applicable.

Grid Description:

Not applicable.

Temporal Characteristics:

Temporal Coverage:

Dates of AVIRIS overflights

- Harvard Forest, MA 6/15/92, 18:00:38 GMT
- Blackhawk Island, WI 6/21/92, 17:58:00 GMT
- Howland, ME 7/5/93, 17:02:10 GMT
- Gainesville, FL 7/8/92, 14:26:00 GMT, 14:42:00 GMT, 14:59:17 GMT, 15:15:17 GMT
- Jasper Ridge, CA 6/2/92, 20:04:33 GMT
- Dunnigan, CA 8/20/92, 20:20:30 GMT
- Pleasant Grove, CA 8/20/92, 20:10:26 GMT

Temporal Coverage Map:

Not applicable.

Temporal Resolution:

Not applicable.

Data Characteristics:

Parameter/Variable:

Scaled Reflectance.

Variable Description/Definition:

The fractional amount of reflected incident solar irradiance.

Unit of Measurement:

Watts/meter^2/micrometer/steradian scaled by 1000.

Data Source:

AVIRIS

Data Range:

0 - 1000.

Sample Data Record:

Not applicable.

8. Data Organization:

Data Granularity:

The scaled reflectance data are presented in two different formats. One is a binary image "cube" which has a complete reflectance spectrum for each pixel in a 614 sample x 512 line area. Associated with the image cube is an ASCII header file with a full description of the images dimensions and units. The second format is a column ASCII file which contains the spectra extracted from the image cube that fall within the study plots. Associated with both files is an ASCII file containing the wavelength centers and resolutions for each of the spectral bands.

- image cube - the scaled reflectance values are stored in Sun-compatible binary format, band interleaved by line (BIL), no header information, 614 samples, 512 lines, 224 bands. There is one image cube per AVIRIS overflight.
- study plot data - the scaled reflectance values are stored in white space separated columns. The first column is band number, the second column is wavelength, and the remaining columns contain the spectra extracted from the image cube that fall within the study plots.
- Ten AVIRIS data collections runs resulted in 13 image cubes.
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Image Files for each Site	Companion Files
bhi92_ref_mnf_sub_bil.cub.gz	bhi92.inf
bhi92_ref_sub_bil.cub	bhi92.wav

gain2_92_ref_bil.cub.gz	gain2.inf
gain3_92_ref_bil.cub.gz	gain3.inf
gain4_92_ref_bil.cub.gz	gain4.inf
gain5_92_ref_bil.cub.gz	gain5.inf
	gain92.wav
hf92_ref_bil.cub.gz	hf92.inf
hf92_ref_mnf_bil.cub.gz	hf92.wav
how93_ref_bil.cub.gz	how93.inf
how93_ref_mnf_bil.cub.gz	how93.wav
jasper92_ref_bil.cub.gz	jasper92.inf
	jasper92.wav
dunnigan92_ref.cub.gz	dunnigan.inf
pleasantgrove92_ref_sub.cub.gz	pleasant.inf
	rice92.wav

Data Format:

- image cube - Sun compatible binary integer data
- study plot data - ASCII columns

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

The formula used is quite complex. Refer to Section 14.

Data Processing Sequence:

Processing Steps:

To each radiance image:

1. apply radiometric correction from AVIRIS's on-board-calibrator
2. run the ATmosphere REMoval Program (ATREM) to retrieve surface reflectance
3. normalize using a gain factors derived from a surface reflectance measurement in the Blackhawk Island, WI scene
4. registered image to map coordinates
5. extracted spectra from pixels that coincide with the study sites

Processing Changes:

None.

Calculations:

Special Corrections/Adjustments:

1. Some of the images had an additional wavelength calibration correction. Harvard Forest, Blackhawk Island, and Howland were spectrally calibrated using a oxygen fitting algorithm that used the sharp oxygen band around 763 nm. The Gainesville, Dunnigan, and Pleasant grove images were corrected by simply shifting the wavelengths in bands 33-96 by 2.5 nm.
2. In the Gainesville image, bands 76-80 (around 1.14 microns) had an erroneous spike, which was smoothed.
3. The Jasper Ridge image was normalized using gain factors derived from surface reflectance measurements made at Cuprite, NV.
4. The Gainesville image was not registered to map coordinates. Instead, one spectrum per study site was extracted from each of the four overflights, then these four spectra were averaged.

Calculated Variables:

surface reflectance

Graphs and Plots:

Not applicable.

10. Errors:

Sources of Error:

- Surface reflectance measurements derived using ATREM have errors up to 10%.
- Spectral calibrations using the oxygen fitting technique have errors of 1 nm.
- The extracted spectra that coincide with the field study sites may not overly the study site by a maximum of 1/2 a pixel.
- In the Gainesville images, the spectra extracted may not lay over each other perfectly with maximum errors of 1/2 pixel.

Quality Assessment:

Data Validation by Source:

Not applicable.

Confidence Level/Accuracy Judgement:

Not applicable.

Measurement Error for Parameters:

Not applicable.

Additional Quality Assessments:

Not applicable.

Data Verification by Data Center:

Not applicable.

11. Notes:

Limitations of the Data:

The signal to noise ratio is less than 1000:1.

Known Problems with the Data:

Not applicable.

Usage Guidance:

20 x 20 m pixels, 224 bands, 614 samples/columns, and 512 lines/rows or 224 x 614 x 512 = 70,418,432 bytes
Each pixel is encoded in 12 bits, which requires a 2-bytes integer for storage. So, multiply the above by 2.

Many of the cubes are full size (614 x 512 x 224). Here are the reasons for the ones that are not full size:
BHI: We only worked with a subset (100 samples x 100 lines) of the full image since Blackhawk Island was completely contained within it. The rest of the image was surrounding city and was not relevant.
bhi92_ref_sub_bil.cub - this is a derived product from the original radiance data. The USGS did the processing on it. Part of their processing was to remove what is called "bad bands" which are bands that have no useful information in them. So, 27 bands are deleted from this file making 197 bands. The exact deleted bands are noted in the bhi92.info file.
bhi92_ref_mnf_sub_bil.cub - this is derived from bhi92_ref_sub_bil.cub. The "bad bands" were reinserted as bands with all 0's.
HF:
hf92_ref_mnf_bil.cub - this is a derived product from the reflectance cube hf92_ref_bil.cub. The "bad bands" are removed from it and are noted in the hf92.info file.
HOW:
how93_ref_mnf_bil.cub - this is a derived product from the reflectance cube how93_ref_bil.cub. The "bad bands" are removed from it and are noted in the how93.info file.
RICE:
pleasantgrove92_ref_sub.cub - this image only has 472 lines. That is all that AVIRIS acquired.

Any Other Relevant Information about the Study:

Not applicable

12. Application of the Data Set:

Reflectance image data can be used with any hyperspectral image processing technique. These data in conjunction with the study site chemistry can be used in the analysis of canopy chemistry constituents of closed canopy spectra.

13. Future Modifications and Plans:

No further work on this data is planned.

14. Software:

Software Description:

ATREM (ATmosphere REMoval Program) - This program is designed for retrieving scaled surface reflectance from spectral imaging data collected by AVIRIS. The Malkmus narrow band model and a pressure scaling approximation are used in calculating atmospheric transmittances of all gases. The atmospheric scattering is modeled using the 5S code. Standard atmospheric models are used in determining all gas concentrations except water vapor. Water vapor is derived on a pixel by pixel basis using the 0.94 and the 1.14 micrometer water vapor bands.

Spectral Calibration Software - this software computes the spectral offset of wavelengths in AVIRIS bands 33-96 (the "B" spectrometer). It uses the shape of the narrow 762 nanometer oxygen band to determine the proper wavelength calibration.

Software Access:

ATREM - the ATREM software and documentation can be retrieved via anonymous ftp to "cses.colorado.edu", in the directory "pub/atrem", files "README" and "atrem_atrem2_0_1.tar.Z".

Spectral Calibration Software - this software can be obtained by contacting Kathy Heidebrecht at kathy@cses.colorado.edu, 303-492-1866.

Suggested software for reading Hyperspectral data are:

ENVI Research Systems Inc, www.rsinc.com/envi/index.cfm
PCI, www.pcigeomatics.com/
MicoImages TNT MIPS, www.microimages.com/
GenIsis, home.jps.net/bgr/genesis.htm

15. Data Access:

Contact Information:

ORNL DAAC User Services
Oak Ridge National Laboratory
Telephone: (865) 241-3952
FAX: (865) 574-4665

Email: ornldaac@ornl.gov

Data Center Identification:

ORNL Distributed Active Archive Center
Oak Ridge National Laboratory
Telephone: (865) 241-3952
FAX: (865) 574-4665
Email: ornldaac@ornl.gov

Procedures for Obtaining Data:

Users may place requests by telephone, electronic mail, or FAXr. Data is also available via the World Wide Web at /">http://

Data Center Status/Plans:

These data are available from the ORNL DAAC. Please contact the ORNL DAAC User Services Office for the most current information about these data.

16. Output Products and Availability:

Available via FTP or on CD-ROM. A complete listing of all data sets can be found on the World Wide Web at /">http://

17. References:

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18. Glossary of Terms:

A glossary is available at http://cdiac.esd.ornl.gov/cdiac/glossary.html. For additional terms, see the EOSDIS glossary at http://www-v0ims.gsfc.nasa.gov/v0ims/glossary.of.terms.html.

19. List of Acronyms:

URL

Uniform Resource Locator

ACCP

Accelerated Canopy Chemistry Program

GMT

Greenwich Mean Time

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