Reflectance Reference Targets (OTTER)

Summary:

Spectral reflectance measurements of flat field targets as reference points representative of psuedo-invariant targets as measured by the Spectron SE590 spectrophotometer.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

Reflectance Reference Targets (OTTER)

Data Set Introduction:

The Oregon Transect Ecosystem Research (OTTER) Project was a cooperative effort between NASA and several universities to discern the ecology of western coniferous forests using remote sensing technology supported by ground observations. OTTER is an interdisciplinary project that tested a model which estimated the major fluxes of carbon, nitrogen, and water through a temperate coniferous forest ecosystem.

Six Oregon sites across an elevational and climatic gradient were intensively studied. The transect began at the Pacific coast at the site called Cascade Head, passed through the outskirts of Corvallis, through a dense Douglas fir forest at Scio, through a mountain hemlock/subalpine fir community at Santiam Pass, through a Ponderosa pine community near Metolius, and ended at a site east of Sisters called Juniper. In all, the transect stretched some 300 kilometers west to east.

Goals of the project were to simulate and predict ecosystem processes such as photosynthesis, transpiration, above-ground production, nitrogen transformation, respiration, decomposition, and hydrologic processes; combine field, lab, and remote sensing techniques to estimate key vegetation and environmental parameters; construct a "geo-referenced" database for extrapolation and testing of principles, techniques, and prediction; and verify the predictions through direct measurements of process rates or controls on processes.

Objective/Purpose:

OTTER was designed to study the ability of remote sensing to detect biophysical characteristics of plant canopies. The data sets correlating to this document contain data that has been remotely sensed by a spectroradiometer for the six different sites.

Summary of Parameters:

Two parameters were investigated: Emitted radiation and reflected radiation.

Discussion:

One method of correcting remote sensing imagery is to use prominent man-made or natural features that have a relatively flat, seasonally invariant spectral reflectance (Hall et al. 1991, Miller et al. 1990, Schott et. al. 1988). These targets, which have a size on the order of many imagery pixels have been called flat fields, pseudo-invarient features (pif) or radiometric control sets. The purpose of the field reflectance measurement campaign was to measure the reflectance of as many of these targets as possible. If these targets can be selected from the airborne imagery using an image processing system, a simple calibration constant can be calculated. This constant will convert sensor digital number to percent reflectance. The calibration constant is good only for the image it was calculated for, but the pif target can be used to calibrate other images. This method corrects for atmospheric and sensor calibration effects and has proved useful in other research projects. The field targets were chosen with the airborne sensor in mind. Gravel and asphalt roads, gravel pits and parking lots were measured where available at each site. The intention of the experiment was to provide a spectral reflectance measurement representative of the pseudo-invariant targets.

Related DataSets:

Canopy Chemistry Forest-BGC Model Leaf Area Index Data Leaf Reflectances: LICOR Leaf Reflectances: Perkin-Elmer Meteorology Optical Thickness Data: Aircraft Optical Thickness Data: Ground SE-590 Field-Measured Reflectances SE-590 Lab-Measured Reflectances SE-590 Landscape Reflectances SE-590 Low Altitude Reflectances Timber Measurements

2. Investigator(s):

Investigator(s) Name and Title:

Name: Dr. J. R. Miller, Co-director Earth Observations Laboratory Institute for Space and Terrestrial Science

Addresses: Ontario Canada

Telephone Numbers: 1-(416)-665-2032

Electronic Mail Address: fs303003@sol.yorku.ca

Title of Investigation:

OTTER Spectron Spectral Reflectance Measurements

Contact (for Data Production Information):

Name: ORNL DAAC User Services Office

Address: Oak Ridge National Laboratory U.S.A.

Telephone Number: 1-(865)-241-3952

Electronic Mail Address: ornldaac@ornl.gov

3. Theory of Measurements:

Information not available.

4. Equipment:

Sensor/Instrument Description:

Spectroradiometer: In order to collect reflectance measurements of "flat fields" or pseudo-invarent targets, a "Spectron Engineering SE590" was used. This is a portable Spectroradiometer weighing about 1 kg, with interchangeable detector heads. Three measurement heads, with the following spectral ranges: 350-1100 nm, 400-800 nm and a shortwave infrared (SWIR) head 1100-2500 nm, were used during the May 1991 OTTER field campaign. Measurements were made with two heads to provide a spectral signature covering the visible, near-infrared and shortwave infrared.

Collection Environment:

Low altitude atmosphere.

Source/Platform:

Field investigation Ultralight airplane

Source/Platform Mission Objectives:

To collect information in the field by remotely sensing data with a spectroradiometer in an Ultralight, an extremely small, lightweight airplane flown at low altitudes.

Key Variables:

Not applicable.

Principles of Operation:

The detector head uses a diffraction grating to disperse the incoming light onto a linear photodiode array. The signal is conducted to the controller electronics via a cable. The microprocessor based controller processes the signal from the detector head. Integration times are from 1/60 of a second (sec) to 1 sec. The integration time can be automatically selected by the instrument or manually chosen by input from a key pad. The SWIR head always collects data with a 1 sec integration time.

The SE590 uses a 12 bit A/D converter and stores data in 16 bit words. The vis-nir heads record data in 256 channels and the SWIR head 66 channels. Scans can be internally averaged. Data is output to a laptop computer or to a builtin tape recorder. Data processing by the laptop computer results in an output file normalized to counts/sec.

Sensor/Instrument Measurement Geometry:

Not applicable

Manufacturer of Sensor/Instrument:

Spectron Engineering, Inc. 255 Yuma Court Denver, Colorado 80223 1-(303)-733-1060

Calibration:

Specifications:

Spectron reflectance calibration has been confirmed in-house against "Labsphere" standard reflectance disks.

Tolerance:

Information not available.

Frequency of Calibration:

Information not available.

Other Calibration Information:

Information not available.

5. Data Acquisition Methods:

In the field, natural solar illumination was used to illuminate the target and a reference halon (Labsphere) panel (99%). Care was taken to ensure that the time between samples of the panel and the target were minimal and that the sky conditions were the same. The automatic selection of integration time mode was employed resulting in different integration times for the panel and the target. The panel was generally much brighter than the target. The resulting ratio gives the target reflectance.

In order to facilitate consistent measurements in the field a measurement stand was constructed which held the Spectron measurement heads a fixed distance (1.0 m) from the target and allowed movement of the heads (+/- 45 degrees) to obtain measurements at different look angles. This may be important for relating the ground based spectral signature measurements with airborne measurements taken at oblique angles. (This off-nadir data set has not been processed at this time.)

Generally two measurements were made of each target in the nadir direction and then other measurements were made at off nadir angles as time permitted. Since only two measurements were taken, a standard deviation is not possible.

6. Observations:

Data Notes:

Data from 800 nm to 1100 nm is not considered valid (See errors section).

Field Notes:

Information not available.

7. Data Description:

Spatial Characteristics:

Site 1: Cascade Head Latitude 44 03' N, Longitude 123 57' 30" W Site 1A: Cascade Head Alder Stand Latitude 44 03' N, Longitude 123 57' 30" W Site 2: Warings Woods Latitude 44 36' N, Longitude 123 16' W Site 3: Scio Control Latitude 44 40' 30" N, Longitude 123 36' 40" W Site 3F: Scio Fertilized Latitude 44 40' 30" N, Longitude 123 36' 40" W Site 4: Santiam Pass Latitude 44 025' 20" N, Longitude 121 50' 20" W Site 5: Metolius Control Latitude 44 25' N, Longitude 121 40' W Site 5: Metolius Fertilized Latitude 44 25' N, Longitude 123 40' W Site 6: Juniper Latitude 44 17' 30" N, Longitude 121 20' W

Spatial Coverage:

Information not available.

Spatial Coverage Map:

Information not available.

Spatial Resolution:

Information not available.

Projection:

Information not available.

Grid Description:

Information not available.

Temporal Characteristics:

Temporal Coverage:

15 May 1991 20 May 1991 21 May 1991 22 May 1991 24 August 1991

Temporal Coverage Map:

Information not available.

Temporal Resolution:

Information not available.

Data Characteristics:

Parameter/Variable:

Emitted radiation Reflected radiation

Variable Description/Definition:

- Emitted radiation: Energy (propogated in the form of elctromagnetic waves) that is released into the atmosphere from the surface of the earth and other substances on the earth's surface.
- Reflected radiation: A measure of the amount of radiation that is turned back from the surface upon which it strikes.

Unit of Measurement:

nm: Nanometers

Data Source:

Field investigation and an ultralight airplane.

Data Range:

Reflected radiation: 7.500 <--> 11.000

Sample Data Record:

Reflected radiation: 9.500 9.548 9.539 9.566 9.603 9.668 9.729 9.794 9.851 9.888 9.934 9.973 10.007 10.046 10.080

8. Data Organization:

Data Granularity:

The data are organized into two fields of information within each file in the data set. The first field is the wavelength (nm) region in which the data have been measured. The second field is a measure of the reflected radiation.

Data Format:

There are 49 ASCII data sets, each accompanied by an XY plot. In addition, there are two data set companion files included with the complete data set: miller.doc and se590.doc.

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

Information not available.

Data Processing Sequence:

Processing Steps:

A number of samples were returned to the laboratory at York University for measurement. These samples where measured in the following manner: The Spectron heads where placed 20 cm from the target at an angle of 26 degrees. The lamp source was at 0 degrees. Dark current measurements were recorded for each integration time used in the series of experiments. An integration time was manually chosen and 8 scans were internally averaged. A gray reflectance reference disk was used (Labsphere, reflectance 50%).

Soil samples described as "dried" were dried with a heat lamp for 1.5 hours and then left to dry without a heat lamp overnight. The soil was measured by the Spectron and then flattened and re-measured.

Processing Changes:

Not applicable.

Calculations:

Special Corrections/Adjustments:

The resultant scans of the laboratory analysis were dark current corrected and then put into ratios to produce a reflectance. The above procedure generally reduced or removed the problems experienced in the field (see errors).

Calculated Variables:

Information not available.

Graphs and Plots:

There is an XY plot for each data set to show obvious discrepancies in the spectra.

10. Errors:

Sources of Error:

It was discovered during processing of the data set that the reflectance ratio calculated between 800 and 1100 nm with the broad band head (350-1100 nm) suffered from noise and "sag". It was determined that this is due to very low signal levels (due to low solar energy) in this spectral region and incorrect adjustment for dark current. For that reason data from 800 nm to 1100 nm is not considered valid.

In order to correct this problem a number of samples of rock, gravel and asphalt were returned for measurement in the laboratory. In the lab, a current-controlled lamp with high NIR light output was used as a source. The Spectron was used to measure the reflectance of the samples in the lab.

Quality Assessment:

Data Validation by Source:

All submitted spectra have been plotted for obvious discrepancies.

Confidence Level/Accuracy Judgment:

Subject to problems discussed in ERRORS, the investigator has confidence in the quality of the data set.

Measurement Error for Parameters:

Information not available.

Additional Quality Assessments:

Data taken at Site 3 (Scio) on May 20, 1991 shows poor signal to noise in the SWIR region due to lateness in the day and cloudy conditions.

Data Verification by Data Center:

To be determined.

11. Notes:

Limitations of the Data:

It is subjective as to how representative of the targets the measurements actually are.

Known Problems with the Data:

Data from 800 nm to 1100 nm is not considered valid.

Usage Guidance:

Information not available.

Any Other Relevant Information about the Study:

Information not available.

12. Application of the Data Set:

The flat-field reflectance measurements are a key portion in the OTTER project goals. The give hard, physical data about the sites in the study. The combination of this remote sensing techniques with field study and laboratory work will help to simulate and predict ecosystem processes.

13. Future Modifications and Plans:

None, the OTTER campaign is complete.

14. Software:

Software Description:

The public domain software package, Imdisp, is provided for image display on IBM compatibles. The popular shareware program, Stuffit, is necessary to extract the execution file for the Macintosh image display program, Image4pds.

Software Access:

Software to display most of the OTTER image data (except Aviris and Asas data) on Macintosh and IBM personal computers (and compatibles) is provided on the CD-Rom disc containing the data sets.

15. Data Access:

Contacts for Archive/Data Access Information:

Name: ORNL DAAC User Services Office

Address: ORNL DAAC User Services Office Oak Ridge National Laboratory U.S.A.

Telephone Number: 1-(865)-241-3952

Electronic Mail Address: ornldaac@ornl.gov

Data Center Identification:

ORNL DAAC

Procedures for Obtaining Data:

Contact the ORNL DAAC User Services Office Oak Ridge National Laboratory U.S.A.

Telephone: 1-(865)-241-3952 FAX: 1-(865)-574-4665 Internet: ornldaac@ornl.gov

Data Center Status/Plans:

To be determined.

16. Output Products and Availability:

Available via FTP file or on CD-ROM.

Also available online via the World Wide Web at http://daac.ornl.gov.

17. References:

Hall, F. , D. Strebel, J. Nickeson and S Goetz " Radiometric Rectification: Towards a Common Raiometric Response Among Multidata, Multi sensor images. Remote Sensing of Environment 35:11-27 (1991).

Miller J, C. Elvidge, B. Rock and J. Freemantle "An Airborne Perspective on Vegetation Phenology from the Analysis of AVIRIS Data Sets over the Jasper Ridge Biological Preserve". Proceedings IGARSS'90 Washington, D. C., pp 565-568, May 20-24, 1990.

Reflectance Calibration Standards, Labsphere, Inc. P.O. Box 70, North Sutton, NH, U.S.A. 03260.

Schott, J. , C. Salvaggio and W. Volchok. " Radiometric Scene Normalization Using Pseudoinvariant Features." Remote Sensing of Environment 26:1-16 (1988).

SE590 Field-Portable Data-logging Spectroradiometer Operating Manual, Spectron Engineering, Inc. 225 Yuma Court, Denver CO 80223 U.S.A.

18. Glossary of Terms:

Glossary terms can be found in the Glossary list.

19. List of Acronyms:

Additional acronyms can be found in the Acronyms list. ESD Environmental Sciences Division (Oak Ridge National Laboratory) FTP File Transfer Protocol NASA National Aeronautics and Space Administration nm Nanometer ORNL Oak Ridge National Laboratories Oak Ridge, Tennessee, U.S.A. OTTER Oregon Transect Ecosystem Research pif Pseudo-invarient features SWIR Shortwave Infrared

20. Document Information:

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Curator:

DAAC Staff

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