SE-590 Landscape Reflectances (OTTER)

Summary:

Bidirectional spectral reflectance factors of landscape elements (litter, scrubs and grasses, leaves) measured by the Spectron SE590 spectroradiometer.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

SE-590 Landscape Reflectances (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 that 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:

The objective of this study is to characterize the sources of spectral diversity in the OTTER sites, for evaluation of biophysical phenomena which may be inferred from remotely sensed observations. The integration tool is a "turbid media" radiative transfer model (SAIL) which requires knowledge of element spectral properties in a scene.

Summary of Parameters:

The diversity of landscape components within an Otter site was defined in situ, by visual inspection. In general, these include litter, soil, bark, scrubs and grasses, leaves of tree species. In all cases the bidirectional spectral reflectance factor of these materials, in the 400 to 950 nanometer range was parameter sought.

Discussion:

The spectral reflectance factor of landscape elements should be relatively insensitive to variations in irradiance. Variations in observed remotely sensed observations should originate from interactions between these reflectance sources, incident irradiance and the 3-D geometry of the landscape elements. If variable, the spectral diversity in the landscape elements will be of primary importance in understanding remotely sensed measurements. In 1990 two measurement campaigns were undertaken by the LGRSS/UMCP staff; once in June and a second time in October. The enclosed data come from the October campaign, carried out between 10/6/90 and 10/11/90. The team, consisting of Dr. Goward and Ms. Jingli Yang and accompanied by Dr. Waring, traveled to Sisters, Oregon for measurements at Santiam, Metolius and the Juniper Site for the first 2.5 days. The remainder of the time was spent in Corvallis, conducting day trips to Cascade Head, Scio and Warings Wood. Most of the measurements were collected in situ. However, this was of only limited success in Cascade Head and of no success in Scio. In the latter case, samples were collected and brought back to Corvallis for measurement in the parking lot of the Forest Science Building, OSU.

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 Reflectance Reference Targets SE-590 Field-Measured Reflectances SE-590 Lab-Measured Reflectances SE-590 Low Altitude Reflectances Timber Measurements

2. Investigator(s):

Investigator(s) Name and Title:

Name: Samuel N. Goward, Associate Professor

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Title of Investigation:

Samuel Goward's SE590 Investigation.

Contact (for Data Production Information):

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3. Theory of Measurements:

Numerous approaches to collecting field spectra have been attempted in the past, including quite elaborate boom mounts on trucks. Such complex approaches are both costly and difficult to use on field settings. Use of tripods or hand-held instruments have alternate problems such as small surface IFOV and the "sneaker factor" - looking at your own shoes when the instrument is at arms length. Indeed the reflectance of the tripod and light colored clothing can be a problem. To overcome these various problems we have defined field procedures which balance between the desire for near-nadir measurements, large IFOV and the sneaker factor.

The underlying assumption in this measurement campaign is that there are selected sources of spectral reflectance in landscapes which combine to produce observed remotely sensed observations. This spectral reflectance factor should be relatively invariant, at least over short periods of times. The spectrometer used in this study was designed to measure spectral reflectance. Because any radiometer measures only reflected radiance it is necessary to independently measure irradiance. A panel of painted barium sulfate was used as the transfer standard. The source of illumination is unobscured solar radiation.

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:

Ground

Source/Platform:

Field Investigation Ultralight

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:

Surface Radiation

Principles of Operation:

Grating spectrometer

Sensor/Instrument Measurement Geometry:

For all measurements (with the exception of selected bark and water tower readings,) the instrument head was aligned at 90 degrees from the principle plane of the sun and at 45 degree from vertical. From a 1.2 meter high tripod, this placed the IFOV 1.2 meters away from the operator and the equipment. The portion of the bidirectional field observed by the instrument approximated the nadir view by observing at right angles to the strong bidirectional patterns that occur in the principle plane of the sun.

For cases in which it was not possible to measure at right angles, such as the water tower sides and the tree bark of mature species, the measurements were collected with the sun slightly to one side but behind the operator. Each measurement was paired with a panel reading, held in the same position as the object being measured.

Manufacturer of Sensor/Instrument:

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

Calibration:

Specifications:

The barium Sulfate panel was covered when not in use. The panel was a bit worn but still intact. No characterization of specific reflectance properties, either spectral or bidirectional had been carried out on this panel. The reflectance spectra presented here assumed that the Barium Sulfate

panel was a perfectly diffuse 100% reflector. Generally the reading nearest the time of the measurement was used for calibration. Only a single scan of the panel was used in October. This error was recognized during the winter and later studies will used an 8-scan average of the panel measurement for calibration in the future.

Tolerance:

Information not available.

Frequency of Calibration:

During the field measurements, calibration readings were taken every 15 - 20 minutes during measurements.

Other Calibration Information:

Unfortunately the LGRSS/UMCP spectrometer was not available in June 1990 when the NASA Ames staff conducted the cross-calibration study. This instrument had been periodically evaluated at the calibration facilities at NASA Goddard Space Flight Center. A quick cross-calibration with the OSU instrument suggests that the instrument is within three channels of the OSU spectral calibration.

5. Data Acquisition Methods:

Multiple samples (10 in this case) are collected of each material. The mean of the measurements is taken to represent the material. The variance of the measurement is a quality check. If the variance was large, the mean was rejected as a representative measurement and another measurement campaign was planned to redo the measurements.

All measurements were taken in the field under solar illumination. The instrument was aimed at a 45 degree elevation angle and perpendicular to the solar plane in order to get the most uniform solar illumination and to avoid getting the tripod or investigator's feet in the field of view. For each landscape component, a measurement of the calibration panel was taken first, and then several measurements were taken of the landscape component to measure the variability of the measurements. At the end, another measurement of the calibration panel was taken to monitor the variability of the solar illumination condition.

6. Observations:

Data Notes:

Most materials are not perfect diffuse or "lambertian" reflectors. It is therefore quite possible to derive quite different spectral reflectance factors in solar irradiance and sensor sun relations are not controlled.

Field Notes:

Observations were only collected when the sun was greater than 30 degrees above the horizon.

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:

6 October 1990 7 October 1990 8 October 1990 10 October 1990 11 October 1990

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 electromagnetic 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:

Emitted radiation: Approximately 0.000 <--> 10.000 Reflected radiation: Approximately 0.000 <--> 75.000

Sample Data Record:

- Emitted radiation: 0.68 0.79 0.92 0.93 0.84 0.86 0.73 0.72 0.61 0.53 0.54 0.57 0.57 0.59 0.53 0.52 0.50 0.53 0.47 0.49 0.49
- Reflected radiation: 3.55 3.44 3.45 3.32 3.18 3.08 2.87 2.74 2.53 2.43 2.36 2.28 2.17 2.13 2.02 1.94 1.93 1.89 1.86 1.84 1.85

8. Data Organization:

Data Granularity:

The data are organized into three 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, while the third field is a measure of the emitted radiation.

Data Format:

There are 47 ASCII data sets, each accompanied by an XY plot. In addition, there are two data set companion files included with the complete data set: goward.doc and se590.doc.

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

Information not available.

Data Processing Sequence:

Data processing information is not available.

Calculations:

Special Corrections/Adjustments:

Averages and standard deviations of the landscape measurements for each wavelength were determined. Reflectances were then calculated by ratioing the average of the landscape measurements for each wavelength and the average of calibration panel observations bracketing the data. Both the averages and the standard deviations of the landscape reflectance for each wavelength are reported.

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:

The lack of a calibration standard for the barium sulfate panel is a problem. Errors of as much as 10-15% relative are expected from this. Failure to scan average on the calibration readings increased noise in the measurements, which is estimated to be 1-5% relative. Sample selection is not always successful in isolating material reflectance properties. High variance measurements

should be rejected. Spectral measurements below 400 nanometers and above 900 nanometers should not be used.

Quality Assessment:

Data Validation by Source:

The measurements of bark, litter and other "background materials was successful. The branch needle and scrub measurements are representative of in situ conditions but are not density controlled relative to other spectral sources and therefore must be considered unique to the observation conditions. The understory measurements, particularly at Warings Wood, display wide variance and unrealistic numbers. They should be considered suspect. In general, as the variance of the measurements increases, their reliability decreases.

Confidence Level/Accuracy Judgment:

Information not available.

Measurement Error for Parameters:

Information not available.

Additional Quality Assessments:

Information not available.

Data Verification by Data Center:

To be determined.

11. Notes:

Limitations of the Data:

As data variance increases, the reliability of the dat decreases. In addition, Warings Wood understory measurements should be considered suspect.

Known Problems with the Data:

Some problems have already been discovered such as mislabeling (e.g., bitter root should be bitter brush,) and it was found that the water tower and bark samples were processed incorrectly.

Usage Guidance:

Information not available.

Any Other Relevant Information about the Study:

Measurements were collected in June 1990 and June 1991 which attempted to replicate observations in October 1990.

12. Application of the Data Set:

The landscape 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 these 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.

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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:

Petzold, D. E. and Goward, S. N. (1988), Reflectance spectra of Subarctic lichens, Remote Sens. Environ. 24 : 481-492.

Goward, S. N. and Huemmrich, K. F. (1991), Vegetation canopy PAR absorptance and the normalized difference vegetation index: An assessment using the SAIL model, Remote Sensing of Environment (submitted, June 1991)

Spectron Engineering Inc., SE590 Field-Potable Data-Logging Spectroradiometer Operating Manual

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 IFOV Instantaneous Field Of Vision LGRSS Laboratory for Global Remote Sensing Studies NASA National Aeronautics and Space Administration nm Nanometer ORNL Oak Ridge National Laboratories Oak Ridge, Tennessee, U.S.A. OSU Oregon State University OTTER Oregon Transect Ecosystem Research SWIR ShortWave Infrared UMCP University of Maryland at College Park

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