SE-590 Lab-Measured Reflectances (OTTER)

Summary:

Laboratory hemispherical reflectance spectra measurements taken to eliminate the effects of atmosphere, understory, exposed soils, mixed species and canopy architecture.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

SE-590 Lab-Measured 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:

Laboratory hemispherical data throughout 440-900 nm range have been taken to help understand remotely sensed data.

Summary of Parameters:

Two parameters were investigated: Emitted radiation and reflected radiation.

Discussion:

Laboratory hemispherical reflectance spectra throughout the 440 to 900 nm range have been taken as an aid to understanding remotely sensed spectral data collected at approximately the same time. Of particular interest is examination of the spectra for the influence of absorption by biochemical constituents in the vegetation, particularly nitrogen, lignin, chlorophyll, starch and cellulose. Also of interest is examination of more gross spectral properties such as the near-IR/red ratio. Obtaining spectra of vegetation samples in the laboratory reduces or eliminates the confounding effects of atmosphere, understory, exposed soils, mixed species, and canopy architecture which are present in aircraft data. Further, acquisition of spectra within an integrating sphere further reduces confounding effects such as stray light, and biomass and geometry differences which are encountered in a bi-directional configuration. Laboratory data may identify spectral regions upon which to concentrate analysis of aircraft data, or may provide a check against aircraft data which has been processed for removal of confounding effects. Thus, the shape of these spectra is of primary interest, as opposed to the magnitude of the absolute reflectance values. It is also anticipated that these data may be input as optical parameters to a radiative transfer model.

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 Landscape Reflectances SE-590 Low Altitude Reflectances Timber Measurements

2. Investigator(s):

Investigator(s) Name and Title:

Name: Lee F. Johnson, Research Scientist

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Title of Investigation:

Laboratory Hemispherical 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

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3. Theory of Measurements:

Information not available.

4. Equipment:

Sensor/Instrument Description:

Two instruments were used in the laboratory measurements: A Spectron SE590 spectroradiometer (Spectron Engineering, Inc., 1990), equipped with a CE390 vis/IR camera (aka: Ames #2), owned by the Ecosystem Science and Technology Branch at NASA/Ames. The integrating sphere used was a LI-COR Model 1800-12, also owned by the Ecosystem Science and Technology Branch at NASA/Ames.

Collection Environment:

Laboratory

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:

Hemispherical Reflectance.

Principles of Operation:

Dispersive grating spectroradiometer with an Integrating Sphere.

Sensor/Instrument Measurement Geometry:

The sample port of the sphere was located at 180 degrees with respect to the illumination source. The camera observed the interior wall of the sphere at 90 degrees. (fully described in LI-COR, 1984).

Manufacturer of Sensor/Instrument:

Manufacturer of SE-590: Spectron Engineering, Inc. 255 Yuma Ct. Denver CO 80223 1-(303)-733-1060 Manufacturer of LI-COR: LI-COR 4421 Superior Street PO Box 4425 Lincoln, NE 68504 1-(402)-467-3576

Calibration:

Specifications:

A spectral calibration was performed on this instrument in June 1990 (Dungan, 1991) using a helium neon laser, with light output at 632.8 nm. The published channel/wavelength mapping for the SE-590 head was established as correct. Radiometric calibration has not been performed on this instrument (other than to establish linearity of response), so radiance measurements are not possible. Rather, measurements are reported in terms of reflectance by comparison to a pressed barium sulfate reference.

Tolerance:

Information not available.

Frequency of Calibration:

Information not available.

Other Calibration Information:

The ratio of reference scans to vegetation scans was 1:1.

5. Data Acquisition Methods:

The Spectron 590 visible/near-IR camera was interfaced with the LI-COR integrating sphere, with the resulting geometry described above. Reference scans were taken by illuminating a pressed barium sulfate reference, background scans were taken by illuminating the flat black surface of the sample port, and vegetation scans were taken by placing the vegetation on the sample port. In all cases the camera observed the painted barium sulfate covering the interior

surface of the sphere. Within a period of approximately one hour, the following measurements were taken: 3 reference scans, 3 scans of the same control sample, 3 more reference scans, 3 scans of the same fertilized sample, and finally 3 background scans.

The samples were prepared as follows. One set each of about 10 needles was selected from the control and fertilized foliage. The needles were aligned vertically, and joined at the bottom by a piece of cellophane tape. The needle-bunch was then inserted into the sample port such that the tape itself was not present within the port.

The camera field-of-view was 6-degrees, approximately circular, as defined by the entrance slit of the camera.

To improve the signal/noise, the data-logger was set to a scan-average of 8 (ie: each spectrum was an average of 8 individual spectra). The scan-averaged spectra were themselves combined and averaged to formulate the means and standard deviations reported to PLDS.

The illuminator was equipped with a heat shield to eliminate radiation at wavelengths greater than 1100 nm.

All measurements were taken in the Spectral Measurements Lab of the NASA/Ames/Ecosystem Science and Technology Branch.

6. Observations:

Observation information is 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:

17 August 1990 18 August 1990 04 December 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 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:

Emitted radiation: Approximately 0.00 <--> 1.000 Reflected radiation: Approximately 0.000 <--> 50.000

Sample Data Record:

- Emitted radiation: 0.064 0.078 0.044 0.047 0.039 0.094 0.038 0.099 0.020 0.058 0.004 0.037 0.014 0.043 0.019 0.045 0.021 0.034 0.020 0.024
- Reflected radiation: 0.165 0.505 0.661 0.883 1.154 1.452 1.576 1.612 1.821 1.926 2.025 2.001 2.182 2.335 2.398 2.466 2.552 2.700 2.795 2.873

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 7 ASCII data sets, each accompanied by an XY plot. In addition, there are three data set companion files included with the complete data set: aug90.doc, dec90.doc and se590.doc.

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

The target reflectance is calculated as follows (LI-COR, 1984):

reflectance (scan) = [response(scan) - average background response]/[average reference response - average background response]

The means and standard deviations represented herein for each site were subsequently formed from these reflectances. The pressed barium sulfate was assumed to be an ideal reflector.

Data Processing Sequence:

Processing Steps:

Target reflectance was calculated from each vegetation response spectrum (it should be recalled that each of these three spectra is in turn an average of eight spectra, due to the instrument scan-average operation.)

Processing Changes:

Information not available.

Calculations:

Special Corrections/Adjustments:

Wavelengths 440 nm and 900 nm were deleted due to noise considerations.

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:

Due to the lengthy period of time between collection and measurement, it is likely that some denaturation of chlorophyll, protein, starch and sugars occurred, possibly to a greater extent in the control than in the fertilized samples. In fact, the foliage was visibly desiccated at the time of measurement, the control samples more so than the fertilized samples. To compensate, efforts were made to select needles with as fresh an appearance as possible.

Quality Assessment:

Data Validation by Source:

The measurements themselves are rather stable, as evidenced by the low standard deviation.

Confidence Level/Accuracy Judgment:

Information not available.

Measurement Error for Parameters:

Reflectance of the pressed barium sulfate was assumed to be 100 percent. The actual values range from 0.999 percent at 400 nm to 0.992 percent at 1100 nm. This deviation is considered within the noise level of the data.

Additional Quality Assessments:

Wavelengths 440 nm and 900 nm presented some problems to noise considerations and consequently were deleted.

Data Verification by Data Center:

To be determined.

11. Notes:

Notes about the data are not available.

12. Application of the Data Set:

The laboratory 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 laboratory work with field study and remote sensing techniques 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:

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

Dungan, J., Field Spectroradiometer Calibration Progress Report, Interoffice Memorandum, NASA/Ames Research Center, 5 January 1991.

LI-COR, Model 1800-12 Integrating Sphere Instruction Manual, Publication No. 8305-0034, revised August 1984.

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 PLDS Pilot Land Data System

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