

Optical Thickness Data: Aircraft (OTTER)

Summary:

Airborne sun photometer data collected from 1990 through 1991 used to provide quantitative atmospheric correction to remotely sensed data of forest reflectance and radiance.

Table of Contents:

[1. Data Set Overview](#) [2. Investigator\(s\)](#) [3. Theory of Measurements](#) [4. Equipment](#) [5. Data Acquisition Methods](#) [6. Observations](#) [7. Data Description](#) [8. Data Organization](#) [9. Data Manipulations](#) [10. Errors](#) [11. Notes](#) [12. Application of the Data Set](#) [13. Future Modifications and Plans](#) [14. Software](#) [15. Data Access](#) [16. Output Products and Availability](#) [17. References](#) [18. Glossary of Terms](#) [19. List of Acronyms](#) [20. Document Information](#)

1. Data Set Overview:

Data Set Identification:

Optical Thickness Data: Aircraft (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 provide quantitative atmospheric correction to remotely sensed data of forest reflectance and radiance.

Summary of Parameters:

One parameter was investigated: The total optical thickness.

Discussion:

Information not available.

Related DataSets:

[Canopy Chemistry](#) [Forest-BGC Model](#) [Leaf Area Index Data](#) [Leaf Reflectances: LICOR](#) [Leaf Reflectances: Perkin-Elmer](#) [Meteorology](#) [Optical Thickness Data: Ground](#) [Reflectance Reference Targets](#) [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:

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Title of Investigation:

Airborne Sunphotometer Data

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3. Theory of Measurements:

The two-axis solar-tracking system is designed to 1) be able to acquire the sun starting from a position several degrees away and 2) to track the sun with an accuracy of plus or minus one-tenth of a degree in the presence of aircraft movement. A large field of view (FOV) is required because the initial pointing is manually controlled until solar acquisition occurs. The large FOV simplifies the initial pointing and, in addition, enables the system to reacquire the sun if tracking is lost because of abrupt movements of the aircraft.

4. Equipment:

Sensor/Instrument Description:

Sun Photometer: A ten-channel filter-wheel instrument which is manually operated and used to measure direct, incoming solar radiation with 10 nm filter bandpasses.

The instrument consists of a solar-tracking system, detector module, temperature-control system, nitrogen-purge system, mechanical drive chain, and data-collection system.

Collection Environment:

Upper atmosphere.

Source/Platform:

C-130

Source/Platform Mission Objectives:

A NASA airplane used for remote sensing purposes, the C130 is the primary airborne platform for spectral sensors. Sensing equipment carried by this aircraft include: the NS001 Thematic Mapper Simulator (TMS), the Thermal Infrared Multispectral Scanner (TIMS), Advanced Solid-state Array Sensor (ASAS), the Push Broom Microwave Radiometer (PBMR), and an airborne tracking sun photometer.

Key Variables:

Not applicable.

Principles of Operation:

The sensors used are Claires photoresistors that have been matched to track each other over the operational range of sun intensities. The dome rotation is referred to as azimuth motion. The central section of the dome is free to rotate within the dome, perpendicular to the azimuth, and is referred to as elevation motion.

The detector module is a cylindrical unit that plugs into the main unit through a connector. It contains six separate silicon photodetectors, each with its own optical filter; a sun sensor for sun-tracking purposes; and a temperature sensor and heater to control the temperature inside the module. The filters range for 380 to 1020 nanometers with a nominal bandwidth of 10 nm. The detectors used are silicon Detector Corporation devices that combine a detector and preamplifier inside a TO-5 style can. The FOV of each detector is set by the entrance aperture to two degrees, the inside surfaces of the aperture assembly are anodized a dull black to reduce internal reflections, and a baffle is included to further reduce reflections. The 2-degree FOV allows for plus or minus one degree of tracking error without affecting the solar-radiation signal. The entrance aperture is protected from the airstream with a fused quartz window; no lenses are used in the system.

The six detectors located inside the detector module require absolute temperature control and are temperature controlled to 45 degrees C plus or minus one degree by an analog temperature control system located inside the aircraft. To reduce heat loss the dome shell and the detector module are constructed of fiberglass.

The wavelength bands of the six detectors are centered at 380, 450, 526, 600, 940, and 1020 nm. Their full-width, half-maximum bands are 12.1, 5.5, 12.1, 10.3, 14.4, and 12.1 nm, respectively.

Sensor/Instrument Measurement Geometry:

Not applicable.

Manufacturer of Sensor/Instrument:

Sensors: Claires Photoresistors Detectors: Detector Corporation

Calibration:

No calibration information is available.

5. Data Acquisition Methods:

The sensing technique uses a shadow mask that bisects each detector when the system is in balance. This design allows for very accurate tracking, yet at the same time provides a FOV of plus or minus twenty-five degrees.

6. Observations:

Data Notes:

The six detector signals, detector temperature, altitude, latitude, longitude, tracking error, suntracker azimuth and elevation position, and Greenwich mean and local times are recorded on

floppy disks and (optionally) printed on hardcopy for backup. A microcomputer is used to process the data and to graphically display channel voltages and optical depth plots in real time.

Data for the August 1990 flights only have been and will be processed. The August data have been processed and offered in two files, one for each day, August 13 and 14. The data were not divided into separate files corresponding to individual flight lines or runs.

Field Notes:

Information not available.

7. Data Description:

Spatial Characteristics:

Spatial Coverage:

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 Map:

Information not available.

Spatial Resolution:

Information not available.

Projection:

Information not available.

Grid Description:

Information not available.

Temporal Characteristics:

Temporal Coverage:

19 June 1990 20 June 1990 21 June 1990 13 August 1990 14 August 1990

Temporal Coverage Map:

Not applicable.

Temporal Resolution:

Not applicable.

Data Characteristics:

Parameter/Variable:

Total optical thickness.

Variable Description/Definition:

Optical thickness or depth related to the distance a frequency will travel within the atmosphere. It includes aerosol, ozone and Rayleigh optical thickness.

Unit of Measurement:

Unitless

Data Source:

C-130

Data Range:

Rayleigh Optical Thickness (at a specific wavelength) 380: Approximately .200 <--> .450 450: Approximately .100 <--> .220 526: Approximately .055 <--> .120 600: Approximately .030 <--> .070 1020: Approximately .004 <--> .010 940: Approximately .005 <--> .012 Net Optical Thickness (at a specific wavelength) 380: Approximately 0.003 <--> 0.022 450: Approximately 0.020 <--> 0.175 526: Approximately 0.018 <--> 0.130 600: Approximately 0.035 <--> 0.150 1020: Approximately -0.003 <--> 0.050 940: Approximately 0.050 <--> 0.080

Sample Data Record:

Rayleigh Optical Thickness 380: .444 .443 .442 .442 .442 .441 .440 .440 .139 .438 450: .220 .220 .219 .219 .219 .219 .218 .218 .218 .217 526: .116 .116 .116 .116 .115 .115 .115 .115 .115 .115 600: .068 .068 .068 .068 .068 .068 .067 .067 .067 .067 .067 1020: .008 .008 .008 .008 .008 .008 .008 .008 .008 .008 940: .011 .011 .011 .011 .011 .011 .011 .011 .011 .011 Net Optical Thickness 380: 0.140 0.141 0.145 0.148 0.140 0.149 0.192 0.153 0.151 0.149 450: 0.119 0.120 0.120 0.122 0.116 0.123 0.158 0.126 0.126 0.124 526: 0.086 0.085 0.087 0.085 0.079 0.085

0.112 0.087 0.087 0.086 600: 0.115 0.117 0.117 0.117 0.115 0.117 0.140 0.120 0.120 0.118
1020: 0.031 0.031 0.031 0.030 0.031 0.031 0.039 0.031 0.032 0.032 940: 0.822 0.825 0.827
0.822 0.820 0.082 0.832 0.820 0.817 0.810

8. Data Organization:

Data Granularity:

Each file in the data set consists of 23 fields of data. The first eight fields consist of such information about the measurement site as the index number of the sample, the PDT time, the solar time, the solar elevation, the air mass, the latitude, the longitude, and the altitude. The next six fields consist of the Rayleigh optical depths for the sample, and the following six fields consist of the net optical depths for the sample. The final three fields also give such information about the measurement site as the atmospheric pressure, the 940 wavelength transmission, and the amount of water vapor in the atmosphere.

Data Format:

There are two ASCII data sets: aug1390.dat and aug1490.dat. In addition, a data set companion file is also available: airsunp.doc and is included in the complete data set.

9. Data Manipulations:

Information concerning data manipulation is not available.

10. Errors:

Sources of Error:

Aside from the Rayleigh scattering, the 380 and 450 nm bands are affected by aerosol extinction and nitrogen dioxide absorption, the 526 and 600 nm bands are affected by aerosols and ozone, the 940 nm band is situated at a water vapor absorption feature but is also affected by aerosols, and only the 1020 nm band is affected by aerosols alone.

Condensation forming on the window was a problem that could have affected the results. To prevent condensation from forming on the window, a dry-nitrogen purge system was included. The nitrogen is on during descent.

Quality Assessment:

Quality assessment information is not available.

11. Notes:

Notes about the data are not available.

12. Application of the Data Set:

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

13. Future Modifications and Plans:

No future plans, 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

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

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 or on CD-ROM.

Also available on-line via the World Wide Web at <http://daac.ornl.gov>.

17. References:

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Spanner, M. A., R. C. Wrigley, R. F. Pueschel, J. M. Livingston, and D. S. Colburn. 1990. Determination of atmospheric optical properties during the First International Satellite Land Surface Climatology Project Field Experiment. J. of Spacecraft and Rockets 27(4): 373-379.

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.

ASAS Advanced Solid-state Array Sensor ESD Environmental Sciences Division (Oak Ridge National Laboratory) FOV Field of View FTP File Transfer Protocol NASA National Aeronautics and Space Administration nm nanometers ORNL Oak Ridge National Laboratories Oak Ridge, Tennessee, U.S.A. OTTER Oregon Transect Ecosystem Research PBM R Push Broom Microwave Radiometer TIMS Thermal Infrared Multispectral Scanner TMS Thematic Mapper Simulator

20. Document Information:

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